

Model 6517B Electrometer

Reference Manual

6517B-901-01 Rev. E August 2022



6517B-901-01E

Model 6517B
Electrometer
Reference Manual

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Safety precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS, 42.4 V peak, or 60 VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories. Maximum signal levels are defined in the specifications and operating information and shown on the instrument panels, test fixture panels, and switching cards.

When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as protective earth (safety ground) connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to protective earth (safety ground) using the wire recommended in the user documentation.

The  symbol on an instrument means caution, risk of hazard. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The  symbol on an instrument means warning, risk of electric shock. Use standard safety precautions to avoid personal contact with these voltages.

The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains hazards that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

The **CAUTION** heading with the  symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits — including the power transformer, test leads, and input jacks — must be purchased from Keithley. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Safety precaution revision as of June 2018.

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Section 1

Introduction

In this section:

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Welcome

The 6½-digit 6517B Electrometer/High Resistance Meter provide reliable measurements of current levels down to 10 aA (10×10^{-18} A), charge levels down to 1 fC, and the highest resistance measurements available up to 10^{18} Ω. The 6517B can also measure across a large voltage range, up to 200 V, with an input impedance exceeding 200 TΩ.

Extended warranty

Additional years of warranty coverage are available on many products. These valuable contracts protect you from unbudgeted service expenses and provide additional years of protection at a fraction of the price of a repair. Extended warranties are available on new and existing products. Contact your local Keithley Instruments office, sales partner, or distributor for details.

Contact information

If you have any questions after you review the information in this documentation, please contact your local Keithley Instruments office, sales partner, or distributor. You can also call the Tektronix corporate headquarters (toll-free inside the U.S. and Canada only) at 1-800-833-9200. For worldwide contact numbers, visit tek.com/en/contact-tek.

Section 2

Remote operations

In this section:

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Introduction

You can use GPIB (IEEE-488) or RS-232 remote communications with the 6517B.

The GPIB interface conforms to the IEEE-488.2-1987 standard and the SCPI 1996 (Standard Commands for Programmable Instruments) standard. IEEE-488.2 defines a syntax for sending data to and from instruments, how an instrument interprets this data, what registers exist to record the state of the instrument, and a group of common commands. The SCPI standard defines a command language protocol. It goes one step farther than IEEE-488.2 and defines a standard set of commands to control every programmable aspect of an instrument.

The RS-232 serial interface allows you to send program messages to the instrument and receive response messages from the instrument. You can use all commands over this serial port. The RS-232 serial interface is based on the electrical and mechanical characteristics of the RS-232C standard. Typically, the serial port is used with a controller that cannot accommodate an IEEE-488 bus interface, such as a laptop computer.

Select the communications interface

You can set the communications interface to be GPIB or RS-232.

NOTE

Changing the communication interface re-initializes the instrument and restores the power-on defaults.

To select the communications interface:

1. Press the **MENU** key to display the MAIN MENU.
2. Select **COMMUNICATION** and press the **ENTER** key. The COMMUNICATIONS SETUP menu is displayed.
3. Select **GPIB** or **RS-232**. Press the **ENTER** key.

For information on connecting and setting up the GPIB (IEEE-488) communications interface, refer to [GPIB communications interface](#) (on page 2-2). For information on connecting and setting up the RS-232 communications interface, refer to [RS-232 serial interface](#) (on page 2-8).

GPIB communications interface

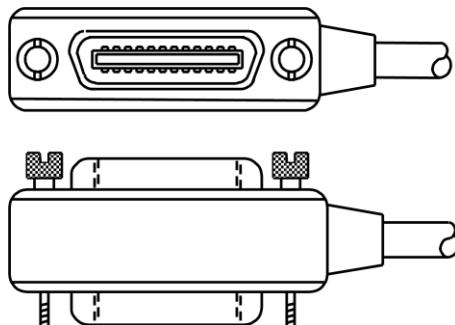
The 6517B has a built-in GPIB (IEEE-488) interface. Over this interface, you can send data to the instrument and receive data from the instrument.

The following information describes how to make the GPIB connections to the instrument and how to set the GPIB address. It also describes how to set the data elements that are included with each reading and how to operate the 6517B from the front panel when GPIB is connected. General bus commands are also described.

IEEE-488 bus connections

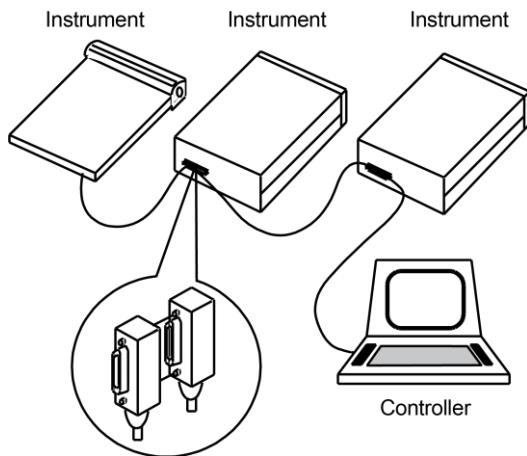
The 6517B can be connected to the IEEE-488 bus through a cable equipped with standard IEEE-488 connectors. An example is shown in the following figure. The connector can be stacked to allow a number of parallel connections to one instrument. There are two screws on each connector to ensure that connections remain secure.

Figure 1: IEEE-488 connector



A typical connection scheme for a multi-instrument test system is shown in the following figure. It is recommended that you stack no more than three connectors on any one instrument to avoid possible mechanical damage.

To minimize interference caused by electromagnetic radiation, use only shielded IEEE-488 cables.

Figure 2: Multi-instrument connections

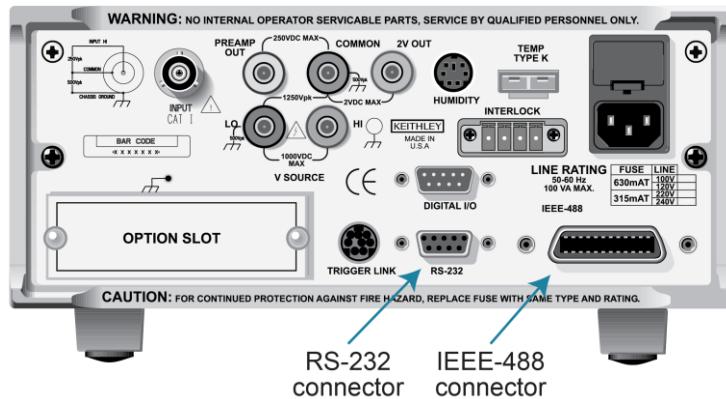
You can have up to 15 devices connected to a GPIB interface, including the controller. The maximum cable length is the lesser of either:

- The number of devices multiplied by 2 m (6.5 ft)
- 20 m (65.6 ft)

You may see erratic bus operation if you ignore these limits.

To connect the 6517B to the IEEE-488 bus:

1. Line up the cable connector with the connector on the rear panel. The connector is designed so that it fits only one way. The following figure shows the location of the IEEE-488 connector.

Figure 3: IEEE-488 and RS-232 connector locations

2. Tighten the screws securely, but do not overtighten them.
3. Add additional connectors from other instruments, as required.
4. Make certain that the other end of the cable is properly connected to the controller. Most controllers are equipped with an IEEE-488 style connector, but a few may require a different type of connecting cable. Consult the instruction manual for your controller for the proper connecting method.

Select the GPIB primary address

The default GPIB address is 27. You can set the address from 1 to 30 if it is unique in the system. This address cannot conflict with an address that is assigned to another instrument or to the GPIB controller.

NOTE

GPIB controllers are usually set to 0 or 21. To be safe, do not configure any instrument to have an address of 21.

The instrument saves the address in nonvolatile memory. It does not change when you send a reset command or when you turn the power off and on again.

To check the present primary address or to change to a new one:

1. Press the **MENU** key to display the MAIN MENU.
2. Select **COMMUNICATION**. Press the **ENTER** key. The COMMUNICATIONS SETUP menu is displayed.
3. Select **GPIB**. Press the **ENTER** key.
4. If you are switching from the RS-232 interface to the GPIB interface, the instrument is reset to the power-on defaults. After the reset, repeat the steps above to display the GPIB menu.
5. Select **ADDRESS**. Press the **ENTER** key. The primary address of the instrument is displayed. For example, if the instrument is set to primary address 27, the following message is displayed:

ADDRESS = 27 (0 to 30)

To change the primary address, use the **◀** and **▶** keys and the **RANGE ▲ ▼** keys to set the new address value. Press the **ENTER** key.

6. Press the **EXIT** key to return to the measurement display.

Select the GPIB data elements

You can select the following data elements to be sent with each reading:

- **RDG:** The numeric value of the reading.
- **RDG#:** The buffer location of the reading. The reading number can be reset to zero from the GENERAL MENU in the TIMESTAMP option.
- **UNIT:** The units of the reading.
- **CH#:** The channel number the reading was made on.
- **HUM:** Relative humidity reading if the Model 6517-RH is used. The humidity sensor is enabled from the A/D CONTROLS option in the GENERAL MENU.

- **ETEMP:** The external temperature reading if the Model 6517-TP is used. The humidity sensor is enabled from the A/D CONTROLS item of the GENERAL MENU.
- **TIME:** The real-time or relative timestamp for each reading. Timestamp type is selected from the TIMESTAMP option in the GENERAL MENU.
- **STATUS:** The reading status information, such as normal reading, measurement overflow or underflow, and relative reading.
- **VSRC:** The actual output level of the voltage source.

NOTE

You can also select the data elements using remote communications using the [:FORMat:ELEMents](#) (on page 11-58) command.

To set up the GPIB elements:

1. Press the **MENU** key.
2. Select **COMMUNICATION**. Press the **ENTER** key.
3. Select **GPIB**. Press the **ENTER** key.
4. Select **ADDRESS**. Press the **ENTER** key.
5. Select **ELEMENTS**. Press the **ENTER** key.
6. Use the **◀** and **▶** keys to move between the elements. Use the RANGE **▲** and **▼** keys to set each option to **y** or **n**.
7. When the elements are set, press the **ENTER** key.

IEEE-488 front-panel operation

The following paragraphs discuss aspects of the front panel that are part of IEEE-488 (GPIB) operation, including messages, status indicators, and the LOCAL key.

IEEE-488 status indicators

The REM (remote), TALK (talk), LSTN (listen), and SRQ (service request) annunciations show the GPIB bus status.

The REM indicator is on when the instrument is in the remote state. The instrument must be addressed to listen with REM true before the REM indicator turns on. When the instrument is in the remote state, all front-panel keys except for the LOCAL key are locked out. When REM is turned off, the instrument is in the local state, and front-panel operation is restored.

The TALK indicator is on when the instrument is in the talker active state. To place the instrument in the talk state, address it to talk with the correct MTA (My Talk Address) command. TALK is off when the instrument is in the talker idle state. To place the instrument in the talker idle state, send an UNT (Untalk) command, address it to listen, or send the IFC (Interface Clear) command.

The LSTN indicator is on when the 6517B is in the listener active state, which is activated by addressing the instrument to listen with the correct [MLA](#) (My Listen Address) command. LSTN is off when the instrument is in the listener idle state. To place the instrument in the listener idle state, send [UNL](#) (Unlisten), address it to talk, or send the [IFC](#) (Interface Clear) command over the bus.

When the SRQ indicator is on, a service request was generated. You can program the instrument to generate a service request (SRQ) when one or more errors or conditions occur. This indicator stays on until the serial poll byte is read or all the conditions that caused the SRQ have ended.

LOCAL key

The LOCAL key cancels the remote state and restores local operation of the instrument.

Pressing LOCAL also turns off the REM indicator and returns the display to normal if a user-defined message was displayed.

The LOCAL key is inoperative if the LLO (Local Lockout) command is in effect.

General bus commands

General commands are commands that have the same general meaning, regardless of the instrument. The following table lists the general bus commands.

Command	Effect on 6517B
DCL	Device clear. Returns the 6517B and all devices on the GPIB to known conditions. See DCL (on page 2-6) for details.
GET	Group execute trigger. Initiates a trigger. See GET (on page 2-7) for details.
GTL	Go to local. Cancel remote; restore 6517B front-panel operation. See GTL (on page 2-7) for details.
IFC	Interface clear. Goes into talker and listener idle states. See IFC (on page 2-7) for details.
LLO	Local lockout. LOCAL key locked out. See LLO (on page 2-7) for details.
REN	Remote enable. Goes into remote operation when next addressed to listen. See REN (on page 2-7) for details.
SDC	Selective device clear. Returns the 6517B to known conditions. See SDC (on page 2-8) for details.
SPE, SPD	Serial polling. Serial polls the 6517B. See SPE, SPD (on page 2-8) for details.

DCL

Use the device clear (DCL) command to clear the GPIB interface and return it to a known state. The DCL command is not an addressed command, so all instruments equipped to implement DCL are returned to a known state simultaneously.

When the 6517B receives a DCL command, it:

- Clears the input buffer, output queue, and command queue
- Cancels deferred commands
- Clears any command that prevents the processing of any other device command

The DCL command does not affect instrument settings and stored data.

GET

GET is a GPIB trigger that is used as an arm, scan, or measure event to control operation. The 6517B reacts to this trigger if it is the programmed control source. GET can also be used as the pretrigger for the reading buffer.

GTL

Use the go to local (GTL) command to put an instrument that is in remote mode instrument into local mode. Leaving the remote state also restores operation of all front-panel controls.

IFC

The controller sends the interface clear (IFC) command to place the 6517B in the talker idle state and the listener idle state. The instrument responds to the IFC command by canceling illumination of the front-panel TALK or LSTN lights if the instrument was previously placed in one of these states.

Transfer of command messages to the instrument and transfer of response messages from the instrument are not interrupted by the IFC command. If transfer of a response message from the instrument was suspended by IFC, transfer of the message resumes when the instrument is addressed to talk. If transfer of a command message to the instrument was suspended by the IFC command, the rest of the message can be sent when the instrument is addressed to listen.

This command does not affect the status of the instrument. Settings, data, and event registers are not changed.

To send the IFC command, the controller needs to set the IFC line true for a minimum of 100 μ s.

LLO

The LLO command prevents local operation of the instrument. After the instrument receives LLO, all its front-panel controls except POWER are inoperative. In this state, pressing LOCAL does not restore control to the front panel. You must use the GTL command to restore control to the front panel.

REN

The remote enable (REN) command is sent to the 6517B by the controller to set up the instrument for remote operation. Generally, place the instrument in the remote mode before you attempt to program it over the bus. Setting REN to true does not place the instrument in the remote state. You must address the instrument to listen after setting REN to true before it goes into remote operation.

SDC

The selective device clear (SDC) command is an addressed command that performs essentially the same function as the device clear (DCL) command. However, because each device must be individually addressed, the SDC command provides a method to clear only selected instruments, instead of clearing all instruments simultaneously with the DCL command.

When the 6517B receives an SDC command, it:

- Clears the input buffer, output queue, and command queue
- Cancels deferred commands
- Clears any command that prevents the processing of any other device command

An SDC call does not affect instrument settings and stored data.

SPE, SPD

Use the serial polling sequence to obtain the 6517B serial poll byte. The serial poll byte contains important information about internal functions (see [Status model](#) (on page 13-1)). Generally, the serial polling sequence is used by the controller to determine which of several instruments has requested service with the SRQ line. The serial polling sequence may be performed at any time to obtain the status byte from the 6517B.

RS-232 serial interface

The 6517B has a built-in RS-232 serial interface. Over this interface, you can send program messages to the instrument and receive response messages from the instrument. You can also place the instrument in the talk-only mode, which allows you to send readings to an external listening device, such as a serial printer.

The serial port of the 6517B can be connected to the serial port of a computer for send/receive operation or to a listener (such as a serial printer) for talk-only operation.

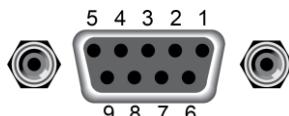
You can use the SCPI programming language over the RS-232 serial interface to communicate with the 6517B.

RS-232 interface connections

You can connect the serial port of the 6517B to the serial port of a computer or listening device (for example, a serial printer) using an RS-232 cable terminated with DB-9 connectors. The serial port uses the transmit (Tx), receive (Rx), and signal ground (Gnd) lines of the RS-232 standard.

If your computer uses a DB-25 connector for the RS-232 interface, you need a cable or adapter with a DB-25 connector on one end and a DB-9 connector on the other, wired straight through. Do not use a null modem cable. The following figure shows the pins and the following tables provide pinout identification for the 9-pin (DB-9) connector.

Figure 4: RS-232 interface connector



Pin number	Designation
2	Transmitted data (Tx)
3	Received data (Rx)
5	Signal ground (Gnd)

RS-232 6517B configuration

The RS-232 Serial Interface is selected and configured from the COMMUNICATION menu of the MAIN MENU.

To configure the RS-232 interface on the 6517B:

1. Press the **MENU** key.
2. Select **COMMUNICATION**. Press the **ENTER** key.
3. Select **RS-232**. Press the **ENTER** key.
4. If you are switching from the GPIB interface to the RS-232 interface, the instrument is reset to the power-on defaults. When reset is complete, repeat the steps above to display the RS-232 SETUP menu.
5. Select **BAUD**. Press the **ENTER** key.
6. Select **115.2K, 57.6K, 38.4K, 19.2K, 9600, 4800, 2400, 1200, 600**, or **300**. Press the **ENTER** key.
7. Select **Terminator**. Press the **ENTER** key.
8. Select **<CR>, <CR+LF>, <LF>**, or **<LF+CR>**. Press the **ENTER** key.
9. Select **FLOW-CTRL**. Press the **ENTER** key.
10. Select **NONE** or **XON-XOFF**. Press the **ENTER** key.
11. Press the **EXIT** key to return to the reading display.

RS-232 computer configuration

From your communications software, configure the RS-232 interface for your computer as follows:

- **RTS-CTS:** OFF
- **XON-XON:** ON
- **Local echo:** ON

Make sure the RS-232 parameters (baud rate, terminator, and flow control) of your computer match the RS-232 parameters of the 6517B.

Select the RS-232 data elements

You can select the following data elements to be sent with each reading:

- **RDG:** The numeric value of the reading.
- **RDG#:** The buffer location of the reading. The reading number can be reset to zero from the GENERAL MENU in the TIMESTAMP option.
- **UNIT:** The units of the reading.
- **CH#:** The channel number the reading was made on.
- **HUM:** Relative humidity reading if the Model 6517-RH is used. The humidity sensor is enabled from the A/D CONTROLS option in the GENERAL MENU.
- **ETEMP:** The external temperature reading if the Model 6517-TP is used. The humidity sensor is enabled from the A/D CONTROLS item of the GENERAL MENU.
- **TIME:** The real-time or relative timestamp for each reading. Timestamp type is selected from the TIMESTAMP option in the GENERAL MENU.
- **STATUS:** The reading status information, such as normal reading, measurement overflow or underflow, and relative reading.
- **VSRC:** The actual output level of the voltage source.

NOTE

You can also select the data elements using remote communications using the [:FORMat:ELEMents](#) (on page 11-58) command.

To set up the data elements:

1. Press the **MENU** key.
2. Select **COMMUNICATION**. Press the **ENTER** key.
3. Select **RS-232**. Press the **ENTER** key.
4. Select **ADDRESS**. Press the **ENTER** key.
5. Select **ELEMENTS**. Press the **ENTER** key.
6. Use the **◀** and **▶** keys to move between the elements. Use the RANGE **▲** and **▼** keys to set each option to **y** or **n**.
7. When the elements are set, press the **ENTER** key.

RS-232 operating considerations

The following topics describe considerations that apply to RS-232 operations.

Response messages (queries)

After a query command is sent and parsed, the response message is immediately sent to the computer. The computer should be ready to receive the response message at that time.

Data format

The RS-232 interface only supports the ASCII data format. If the RS-232 interface is selected, the data format defaults to ASCII and cannot be changed. Attempts to change the data format using the :FORMAT [:DATA] command result in an error message.

Flow control

The 6517B does not support any form of hardware flow control. Software flow control is in the form of **X_ON** (Control+Q) and **X_OFF** (Control+S) characters. If the input queue of the 6517B becomes more than 3/4 full (2048 characters maximum), the instrument issues an **X_OFF** command. The control program should respond to this and stop sending characters until the 6517B issues the **X_ON**, which it does once its input buffer has dropped below half-full. The 6517B also recognizes **X_OFF** and **X_ON** sent from the controller. An **X_OFF** causes the 6517B to stop outputting characters until it sees an **X_ON**. Incoming commands are processed after the <LF> character is received.

Device clear action

A Control C (^C) sent over the interface interrupts the 6517B microprocessor and forces a device-clear action to take place. This clears any pending operation and discards any pending output. You can also use ^X as a device-clear character.

Reception of a break condition also causes a device-clear action and displays the appropriate error message.

The 6517B signifies the completion of the device-clear action by echoing back the DCL followed by the carriage return and line feed characters.

RS-232 SCPI commands

The following SCPI commands are unique to the RS-232 interface and cannot be used over the GPIB interface:

- :SYSTem:LOCal: Take the 6517B out of remote operation.
- :SYSTem:REMote: Put the 6517B in remote operation.
- :SYSTem:LLOCKout: Enable or disable local lockout.

See [SCPI command reference](#) (on page 11-1) for more information on using these commands.

Error messages

The following error messages are associated with RS-232 interface operation. If one of these errors occurs, bit B11 of the Operation Condition Register is set.

Error messages

Error code	Error message	Description
+800	RS-232 framing error detected	Start or stop bit mismatch between computer and 6517B.
+801	RS-232 parity error detected	Parity type mismatch between computer and 6517B.
+802	RS-232 overrun detected	Data received before previous data can be read.
+803	RS-232 break detected	A break occurred (device clear occurred).
+804	RS-232 noise detected	Noisy signal that could corrupt data.
+805	Invalid system communication	RS-232 interface selection lost on power-up; instrument defaults to GPIB.
+806	RS-232 settings lost	RS-232 settings lost on power-up.
+807	RS-232 OFLO; characters lost	A character was received but discarded due to a lack of input buffer space. Each line-feed character (<LF>) closes a buffer and opens another. If too many line feeds are sent in succession, all buffers are filled before they have a chance to be read.
+808	ASCII only with RS-232	A data format other than ASCII was selected.

Program examples

The following examples presume QuickBASIC version 4.5 or later and a Keithley Instruments KPC-488.2 or CEC IEEE-488 interface card with CEC driver version 2.11 or later, with the Model 6517B at address 27 on the IEEE-488 bus.

Changing the function and range

The 6517B has independent controls for each of its measurement functions. This means, for example, that you can enable autorange for the voltage function and disable it for the current function.

The following example program illustrates how to change the function and range. It sets the range for several functions, then makes readings on each of those functions.

The 6517B rounds the range parameter to an integer before choosing the appropriate range. Therefore, sending VOLtage:DC:RANGe 20.45 sets the 6517B to the 20 V range.

```
'Example program that demonstrates changing function and range,
'making readings on various functions.
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card
>Edit the following line to point to the QuickBASIC
'libraries on your computer:
'$INCLUDE: 'c:\qb45\ieeeqb.bi'
'Initialize the interface as address 21.
CALL initialize(21, 0)
'Reset the SENSe1 subsystem settings, along with the trigger
'model. Each READ? will cause one trigger.
CALL SEND(27, "*rst", status%)
'Set range for each function to measure.
CALL SEND(27, "volt:dc:rang 10", status%)
CALL SEND(27, "curr:dc:rang 0.003", status%)
CALL SEND(27, "res:rang 10e6", status%)
'Switch to voltage and make reading.
CALL SEND(27, "func 'volt:dc';:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
'Switch to current and make reading.
CALL SEND(27, "func 'curr:dc';:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
'Switch to 2-wire ohms and make reading.
CALL SEND(27, "func 'res';:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
```

One-shot triggering

When one-shot triggering is configured, each activation of the selected trigger source produces one reading.

Typical trigger sources for non-SCPI instruments are:

- IEEE-488 talk
- IEEE-488 Group Execute Trigger (GET)
- “X” command

Arming the instrument to respond to triggers is implicit in the non-SCPI instruments. Sending a command to a non-SCPI instrument to change any of the trigger controls causes the instrument to arm itself for triggers.

The SCPI trigger model implemented in the 6517B gives you:

- Explicit control over the trigger source (the TRIGger subsystem)
- A two-level control for arming the instrument for triggers
- A way to completely disable triggers

Changing any of the settings in the TRIGger subsystem does not automatically arm the 6517B for triggers.

The following program sets up the 6517B to make one reading each time it receives an external trigger pulse.

After the 6517B receives the INITiate command, it stops in the TRIGger layer of the trigger model, waiting for a pulse on the external trigger jack. Each time a pulse arrives on the external trigger jack, the 6517B makes one reading. Because TRIGger:COUNT is set to INFinity, the trigger model never exits from the TRIGger layer. You can send the ABORT command to put the trigger model in the idle state, which disables triggers until another INITiate command is sent.

```
'Example program that demonstrates one-shot external triggering.  
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card.  
'Edit the following line to point to the QuickBASIC  
'libraries on your computer.  
'$INCLUDE: 'c:\qb45\ieeqb.bi'  
'Initialize the interface as address 21.  
CALL initialize(21, 0)  
'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems  
'and put trigger model in IDLE state.  
CALL SEND(27, "*rst", status%)  
CALL SEND(27, "trig:sour ext;coun inf", status%)  
'Start everything.  
CALL SEND(27, "init", status%)
```

Continuous triggering 1

The following example program sets up the 6517B to make readings as fast as it can when it receives an external trigger. The actual reading rate depends upon other factors, such as A/D integration time and autorange on/off.

After the 6517B receives the `INITiate` command, it stops in ARM:LAYER2 of the trigger model, waiting for a pulse on the external trigger jack. After the external trigger signal occurs, the 6517B moves to the TRIGger layer. Since `TRIGger:SOURce` is set to `IMMEDIATE`, a reading is triggered immediately, with a subsequent reading triggered as soon as the previous one is finished.

```
'Example program to demonstrate continuous triggering.
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card.
>Edit the following line to point to the QuickBASIC
libraries on your computer.
'$INCLUDE: 'c:\qb45\ieeqqb.bi'
'Initialize the interface as address 21.
CALL initialize(21, 0)
'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state.
CALL SEND(27, "*rst", status%)
'*RST sets TRIG:SOUR to IMM
CALL SEND(27, "arm:lay2:sour ext", status%)
CALL SEND(27, "trig:coun inf", status%)
'Start everything.
CALL SEND(27, "init", status%)
```

Continuous triggering 2

The following example program sets up the 6517B to make readings continuously after an external trigger is received. The trigger rate is set to make one reading every 50 ms.

After the 6517B receives the `INITiate` command, it stops in ARM:LAYER2 of the trigger model, waiting for a pulse on the external trigger jack. After the external trigger signal occurs, the 6517B moves to the TRIGger layer. Because `TRIGger:SOURce` is set to `TIMER`, a reading is triggered immediately, with a subsequent reading every 50 ms. Because `TRIGger:COUNT` has been set to infinity, the trigger model never exits from the TRIGger layer.

```
'Example program to demonstrate continuous triggering
'at a specified rate.
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card.
>Edit the following line to point to the QuickBASIC
libraries on your computer
'$INCLUDE: 'c:\qb45\ieeqqb.bi'
'Initialize the interface as address 21.
CALL initialize(21, 0)
'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state.
CALL SEND(27, "*rst", status%)
'*RST sets TRIG:SOUR to IMM.
CALL SEND(27, "arm:lay2:sour ext", status%)
CALL SEND(27, "trig:coun inf;sour tim;tim .05", status%)
'Start everything.
CALL SEND(27, "init", status%)
```

Generating SRQ on buffer full

When your program must wait until the 6517B has completed an operation, it is more efficient to program the 6517B to assert the IEEE-488 SRQ line when it is finished instead of repeatedly sending serial polls to the instrument. An IEEE-488 controller typically addresses, then unaddresses the instrument to talk each time it performs a serial poll. Repeated polling of the 6517B generally reduces its overall reading throughput. To improve throughput, you can use the `srq%()` function call.

The 6517B provides a status bit for nearly every operation it performs. It can be programmed to assert the IEEE-488 SRQ line whenever a status bit becomes true or false. The IEEE-488 controller (your computer) can examine the state of the SRQ line without performing a serial poll, thereby detecting when the 6517B has completed its task without interrupting operations.

The following example program segment sets up the 6517B to assert SRQ when the reading buffer has completely filled, then arms the reading buffer, initiates readings, and waits for the 6517B to indicate that the buffer is full.

NOTE

This is not a complete program. It does not show the commands to configure the trigger model and the reading buffer. For an example that configures the reading buffer, see [Store readings in the buffer](#) (on page 2-17).

This example can be modified for any event in the 6517B status reporting system.

```
'Reset STATUS subsystem (not affected by *RST).
CALL SEND(27, "stat:pres;*cls", status%)
CALL SEND(27, "stat:meas:enab 512", status%)
'Enable BFL.
CALL SEND(27, "*sre 1", status%)'enable MSB
CALL SEND(27, "trac:feed:cont next", status%)
'Start everything.
CALL SEND(27, "init", status%)
WaitSRQ:
IF (NOT(srq%)) THEN GOTO WaitSRQ
CALL SPOLL(27, poll%, status%)
IF (poll% AND 64)=0 THEN GOTO WaitSRQ
```

After the program has detected an asserted SRQ line, it serial polls the 6517B to determine if it is the device requesting service. This is necessary because serial polling the 6517B causes it to stop asserting the SRQ line. In addition, in test systems that have more than one IEEE-488 instrument programmed to assert SRQ, your program must determine which instrument is requesting service.

Once an event register has caused a service request, it cannot cause another service request until you clear it by reading it, such as by using `STATus:MEASurement [:EVENT]?` or by sending the `*CLS` command.

Store readings in the buffer

The reading buffer in the 6517B is flexible. You can control the size of the buffer (in readings) using TRACe:POINTS. You can use TRACe:ELEMents to store extra data stored with each reading, such as the channel number and timestamp. Be aware that storing extra data reduces the maximum size of the buffer.

You can also use TRACe:FEED:CONTrol to choose when and how long to record readings in the buffer.

The following example program sets up the 6517B to make 20 readings and store them as fast as it can into the buffer, then reads the data after the buffer fills. The readings are stored with the timestamp and other information, but the program reads only the reading values and timestamp.

```
'Example program to demonstrate the reading buffer.  
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card.  
'Edit the following line to point to the QuickBASIC  
'libraries on your computer.  
'$INCLUDE: 'c:\qb45\ieeqqb.bi'  
'Initialize the interface as address 21.  
CALL initialize(21, 0)  
'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems  
'and put trigger model in IDLE state.  
CALL SEND(27, "*rst", status%)  
'Reset STATus subsystem (not affected by *RST).  
CALL SEND(27, "stat:pres;*cls", status%)  
CALL SEND(27, "stat:meas:enab 512", status%)  
'Enable BFL.  
CALL SEND(27, "*sre 1", status%)  
'Enable MSB.  
CALL SEND(27, "trig:coun 20", status%)  
'TRACe subsystem is not affected by *RST.  
CALL SEND(27, "trac:poin 20;elem none", status%)  
CALL SEND(27, "trac:feed:cont next", status%)  
'Start everything.  
CALL SEND(27, "init", status%)  
'Initialize reading$ while the 6517B is busy making readings.  
reading$ = SPACE$(4000)  
WaitSRQ:  
IF (NOT(srq%)) THEN GOTO WaitSRQ  
CALL SPOLL(27, poll%, status%)  
IF (poll% AND 64)=0 THEN GOTO WaitSRQ  
  
CALL SEND(27, "trac:data?", status%)  
CALL ENTER(reading$, length%, 27, status%)  
PRINT reading$
```

Making readings with the scanner card

The Model 6521 and Model 6522 are optional 10-channel scanner cards for the 6517B. Only one channel can be closed at a time. If you close a channel while another channel is closed, the first one opens with a break-before-make operation.

You can use the scanner card two ways. One is to issue a command to close a particular channel before sending other commands to make readings. The other way is to program the scan list and let the meter take care of closing a channel before making a reading.

The following example program measures voltage on channel 1, current on channel 2, and resistance on channel 3, using the ROUTe:CLOSE command.

```
'Example program to demonstrate making readings on different
'scanner channels.
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card.
>Edit the following line to point to the QuickBASIC
libraries on your computer.
'$INCLUDE: 'c:\qb45\ieeqb.bi'
'Initialize the interface as address 21.
CALL initialize(21, 0)
'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems
'and put trigger model in IDLE state. Set function to voltage.
CALL SEND(27, "*rst", status%)
'Close channel 1, make a voltage reading.
CALL SEND(27, "rout:clos (@1);:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
'Close channel 2, make a current reading.
CALL SEND(27, "func 'curr:dc'", status%)
CALL SEND(27, "rout:clos (@2);:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
'Close channel 3, make an ohms reading.
CALL SEND(27, "func 'res'", status%)
CALL SEND(27, "rout:clos (@3);:read?", status%)
reading$ = SPACE$(80)
CALL ENTER(reading$, length%, 27, status%)
PRINT reading$
```

The following example program sets up the 6517B using a scan list to measure dc voltage on channels 1, 2, and 3. The meter makes ten sets of readings, with each set spaced 15 seconds apart. Each of the three readings in each group is made as fast as possible. The 6517B stores the readings in the buffer and asserts SRQ when the buffer is full. The program waits for the SRQ, then reads the readings from the buffer.

```
'Example program to demonstrate using the scan list.  
'For QuickBASIC 4.5 and KPC-488.2/CEC interface card.  
'Edit the following line to point to the QuickBASIC  
'libraries on your computer.  
'$INCLUDE: 'c:\qb45\ieeqqb.bi'  
'Initialize the interface as address 21.  
CALL initialize(21, 0)  
'Reset controls in INIT, ARM;LAY1, ARM:LAY2, and TRIG subsystems  
'and put trigger model in IDLE state. Set the function to DCV.  
CALL SEND(27, "*rst", status%)  
'Reset STATus subsystem (not affected by *RST).  
CALL SEND(27, "stat:pres;*cls", status%)  
CALL SEND(27, "stat:meas:enab 512", status%)  
'Enable BFL.  
CALL SEND(27, "*sre 1", status%)  
'Enable MSB.  
'*RST sets TRIG:SOUR to IMM.  
CALL SEND(27, "trig:coun 3", status%)  
CALL SEND(27, "arm:lay2:sour tim;tim 15", status%)  
CALL SEND(27, "arm:lay2:coun 10", status%)  
'TRACe subsystem is not affected by *RST.  
CALL SEND(27, "trac:poin 30;elem none", status%)  
CALL SEND(27, "trac:feed sens1;feed:coun next", status%)  
'The buffer is now armed.  
CALL SEND(27, "rout:scan (@1:3)", status%)  
CALL SEND(27, "rout:lsel init", status%)  
'Start everything.  
CALL SEND(27, "init", status%)  
'Initialize reading$ while the 6517B is busy taking readings.  
reading$ = SPACE$(2500)  
  
WaitSRQ:  
IF (NOT(srq%)) THEN GOTO WaitSRQ  
CALL SPOLL(27, poll%, status%)  
IF (poll% AND 64)=0 THEN GOTO WaitSRQ  
CALL SEND(27, "form:elem read,time,chan", status%)  
CALL SEND(27, "trac:data?", status%)  
CALL ENTER(reading$, length%, 27, status%)  
PRINT reading$
```

Using the staircase sweep test sequence

The following program performs a staircase sweep. Using the source voltage measure current (SVMI) method, this test measures the current through a DUT at eleven voltage steps (0 V through 10 V).

The eleven readings are stored in the buffer and displayed on the computer at the conclusion of the test.

```
'Quick Basic 4.5, KPC-488.2/CEC card.
'
'$INCLUDE: 'ieeqqb.bi'
CALL initialize(21, 0)
CLS
CALL send(27, "*rst", status%)
CALL send(27, "*CLS", status%)
CALL spoll(27, KIspoll%, status%)
'Configure status model to SRQ on Buffer Full.
CALL send(27, "stat:meas:enab 512", status%)
CALL SEND(27, "*sre 1", status%)
'Set current to autorange.
CALL send(27, ":SENS:FUNC 'CURR'", status%)
CALL send(27, ":SENS:CURR:RANG:AUTO ON", status%)
'Configure Staircase Sweep from 0 V to 10 V in 1 V steps.
CALL send(27, ":TSEQ:TYPE STSW", status%)
CALL send(27, ":TSEQ:STSW:STAR 0", status%)
CALL send(27, ":TSEQ:STSW:STOP 10", status%)
CALL send(27, ":TSEQ:STSW:STEP 1", status%)
CALL send(27, ":TSEQ:STSW:STIM 0.3", status%)
CALL send(27, ":TSEQ:TSO imm", status%)
'Wait for commands to complete processing.
DATA1$ = SPACE$(600)
CALL send(27, "*OPC?", status%)
CALL enter(DATA1$, length%, 27, status%)
' Start test sequence.
CALL send(27, ":TSEQ:ARM", status%)

'Wait for SRQ (buffer full).
WaitSRQ
IF (NOT (srq%)) THEN GOTO WaitSRQ
CALL spoll(27, poll%, status%)
If (poll% AND 64) = 0 THEN GOTO WaitSRQ
'Send buffer readings to computer screen:
CALL send(27, ":TRACE:DATA?", status%)
CALL enter(DATA1$, length%, 27, status%)
A = 1
FOR I = 1 TO 11
r$ = MID$(DATA!$, A, 13)
PRINT r$
A = A + 14
NEXT I
END
```

Section 3

Measurement options

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Introduction

This section contains detailed information on measurement options, such as using the voltage source, analog output, measurement range, relative offset, and preamplifier output.

Integration time

You can select the integration time of the analog to digital (A/D) converter. This is the time the input signal is measured and is also known as aperture. The integration time affects the amount of reading noise and the reading rate of the instrument. The integration time is specified in parameters based on the number of power line cycles (PLCs), where 1 PLC for 60 Hz is 16.67 ms (1/60) and 1 PLC for 50 Hz and 400 Hz is 20 ms (1/50).

The shortest amount of time, or lowest NPLC value, results in the fastest reading rate but increases the reading noise and decreases the number of usable digits.

The longest amount of time, or highest NPLC value, provides the lowest reading noise and more usable digits, but has the slowest reading rate.

From the front panel, the integration time is set using the SPEED menu of the configuration menu for each function. You can set different integration times for each function. You can select the following options:

- **FAST:** Sets integration time to 0.01 PLC. Use FAST if speed is of primary importance at the expense of increased reading noise and less usable resolution.
- **MEDIUM:** Sets integration time to 0.1 PLC. Use MEDIUM when a compromise between noise performance and speed is acceptable.
- **NORMAL:** Sets integration time to 1 PLC. A compromise like MEDIUM, but NORMAL provides better noise performance at the expense of speed.
- **HIACCURACY:** Sets integration time to 10 PLC. Use HIACCURACY when high common-mode and normal-mode rejection is required.
- **SET-SPEED-EXACTLY:** Select the PLC (0.01 to 10). Use the cursor keys and the RANGE keys to enter the PLC value. An integer PLC value increases noise rejection. Be sure to press the **ENTER** key after entering the value.
- **SET-BY-RSLN:** This parameter optimizes the integration time for the present resolution setting.

You can also set the speed using the SCPI commands [:SENSe\[1\]:<function>:APERture](#) (on page 11-71) or [\[:SENSe\[1\]\]:<function>:NPLCycles](#) (on page 11-83).

When you use the aperture command to set the integration time, the time is set in seconds per integration. The relationship between NPLC and aperture is expressed as follows:

$$\text{Aperture} = \frac{\text{NPLC}}{f}$$

Where:

- Aperture is the integration rate in seconds per integration.
- NPLC is the number of power line cycles per integration.
- f is the power line frequency.

For 400 Hz line power, use 50 Hz to calculate aperture.

If line synchronization is enabled ([:SYSTem:LSYNc:STATE](#) (on page 11-161)), the integration period does not start until the beginning of the next power line cycle. For example, if a reading is triggered at the positive peak of a power line cycle, the integration period does not start until that power line cycle is completed. The integration period starts when the positive-going sine wave crosses zero volts.

When powering on, the instrument uses the NPLC value to determine the integration period. If the instrument is using a different power line frequency, NPLC remains the same, but the aperture may change.

While the instrument is processing a reading, triggers are ignored.

To set the integration time from the front panel:

1. Press the **CONFIG** key.
2. Press the function key.
3. Select **SPEED**. Press the **ENTER** key.
4. Select the speed. Press the **ENTER** key.
5. Press the **EXIT** key to return to the measurement display.

Display resolution

The 6517B can display readings at 3.5, 4.5, 5.5, or 6.5 digit resolution. The display resolution of a reading depends on the selected resolution setting (fixed or auto). It is also affected by the SET-BY-RSLN setting of the integration time, which optimizes the integration time for the selected resolution. The default display resolution for every function is 5.5 digits. Each function can have a different resolution setting.

The following table summarizes the relationship between the integration time and the selected resolution setting.

Integration times when set by resolution is enabled (all functions)

Resolution	Integration time (NPLCs)	60 Hz aperture (s)	50 Hz or 400 Hz (s)
Auto*	1.00	0.016667	0.02
3.5	0.01	1.6667e-4	0.0002
4.5	0.02	3.3333e-4	0.0004
5.5	0.20	0.0033	0.004
6.5	2.00	0.0333	0.04

*With AUTO resolution selected, display resolution is set to 6.5 digits.

When automatic resolution is selected, the instrument selects the optimum resolution for the present speed (integration period setting), as shown in the following table.

Automatic resolution (all functions)

Resolution*	Integration time
3.5	0.01 to <0.02 PLC
4.5	0.02 to <0.20 PLC
5.5	0.20 to <2.00 PLC
6.5	2.00 to 10.00 PLC

*If SET-BY-RSLN integration is selected, display resolution is 6.5 digits and the integration time 1.0 PLC.

The display resolution for resistance readings may be less than what was selected. For example, assume for a resistance measurement that the measured current is 00.100 pA (20 pA range, 4½ digit resolution). If you discount the leading zeros, the current reading has a usable resolution of 2½ digits (0.100 pA). Since the current measurement only uses 2½ digits, the resolution of the resistance display is also limited to 2½ digits.

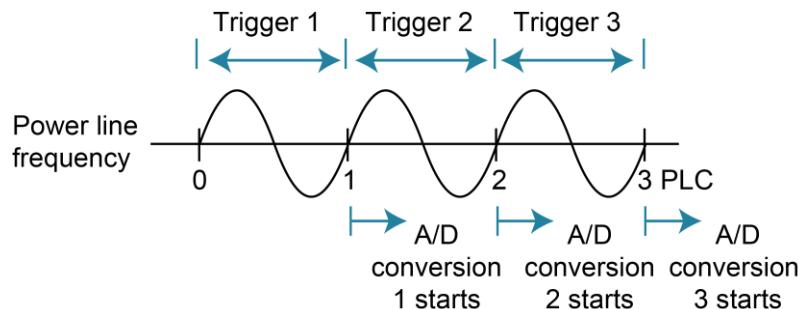
To set the display resolution from the front panel:

1. Press the **CONFIG** key.
2. Press the function key.
3. Select **RESOLUTION**. Press the **ENTER** key.
4. Select the resolution. Press the **ENTER** key.
5. Press the **EXIT** key to return to the measurement display.

Line synchronization

Synchronizing A/D conversions with the power line frequency increases common mode and normal mode rejection. When line synchronization is enabled, measurements are initiated at the first positive-going zero crossing of the power line cycle after the trigger. A/D conversions assume an integration time of ≤ 1 power line cycle (PLC). See the following figure for an example of A/D conversions when line synchronization is enabled.

Figure 5: Line cycle synchronization



Changing the state of line synchronization halts triggers and puts the instrument into idle. Press the **TRIG** key to return to re-arm triggers.

You can set line synchronization through the front-panel menu, as described in the following procedure, or with the remote command [**:SYSTem:LSYNc:STATe**](#) (on page 11-161).

To enable or disable line synchronization:

1. Press the **MENU** key.
2. Select the **GENERAL** menu.
3. Select **A/D-CONTROLS**.
4. Select **LINE-SYNC**. The power line frequency is displayed.
5. Select **ENABLE** or **DISABLE**.
6. Press the **ENTER** key.
7. Press the **EXIT** key as needed to return to the measurement display.

Voltage source

The built-in bipolar 1 W voltage source of the 6517B can source up to ± 1000 V (the voltage source may reach ± 1010 V if it is uncalibrated). The two voltage ranges of the voltage source are summarized in the following table.

Voltage source ranges			
Range	Maximum output		Step size
	Voltage	Current	
100 V	± 100 V	± 10 mA	5 mV
1000 V	± 1000 V	± 1 mA	50 mV

⚠ WARNING

The maximum common-mode voltage for the voltage source is 750 V_{PEAK}, so the voltage between voltage source LO and earth (chassis) ground must never exceed 750 V_{PEAK}. The voltage between voltage source HI and earth (chassis) ground must never exceed 1750 V_{PEAK}. Exceeding these values may create a shock hazard.

Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the 6517B while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the 6517B before handling cables connected to the outputs. Putting the equipment in standby mode does not guarantee that the outputs are not powered if a hardware or software fault occurs.

NOTE

Capacitive inputs increase preamplifier noise, resulting in noise across the voltage source terminals.

Voltage source configuration

Use the CONFIG V-SOURCE menu to configure the voltage source. The menu options are summarized in the following table.

To display the CONFIG V-SOURCE menu, press the **CONFIG** key and then the **OPER** key.

CONFIG V-SOURCE menu

Menu item	Description
RANGE	Select the voltage source range (100 V or 1000 V). Refer to Setting voltage source value (on page 3-9).
V-LIMIT CONTROL LIMIT-VALUE	Voltage limit menu: Enable or disable voltage limit. Set maximum absolute output limit. Refer to Voltage and current limit (on page 3-10).
RESISTIVE-LIMIT	Enable or disable the resistive current limit. Refer to Voltage and current limit (on page 3-10).
METER-CONNECT	Enable or disable the internal voltage source LO to ammeter LO connection. Refer to Ammeter LO to voltage source LO connection (on page 3-8) for detail.

Sourcing options

You can use the voltage source as an independent source or it can be internally connected to the ammeter to source voltage and measure current (SVMI). You can also make or break the internal connection between voltage source LO and ammeter LO.

Independent source

When the 6517B is used as an independent source, voltage is available at the V-SOURCE HI and LO terminals on the rear panel, as shown in the following figure. In this configuration, the voltage source functions as a stand-alone voltage source.

Figure 6: Voltage source (independent configuration)

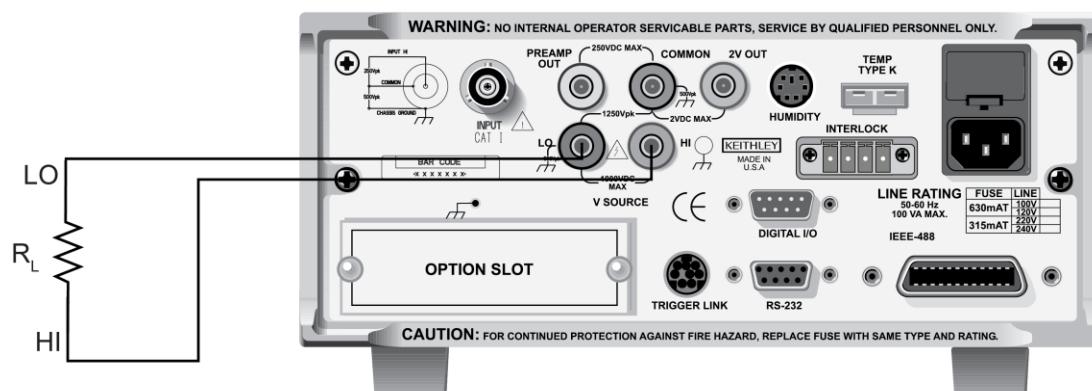
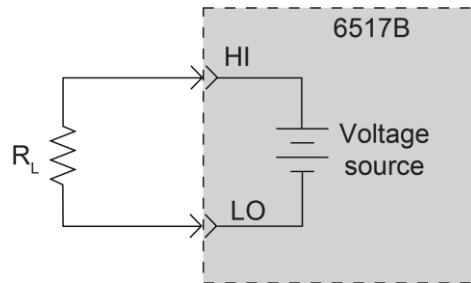


Figure 7: Voltage source (independent configuration) - equivalent circuit

The voltage source is isolated ($>1 \text{ G}\Omega$) from the measurement circuits of the 6517B when voltage source LO is not internally connected to ammeter LO. Refer to [Ammeter LO to voltage source LO connection](#) (on page 3-8) for more information.

Source voltage and measure current

When the 6517B sources voltage and measures current (SVMI), the voltage source LO is connected to ammeter LO, as shown in the following figure. In this configuration, V-SOURCE HI and INPUT HI terminals are used.

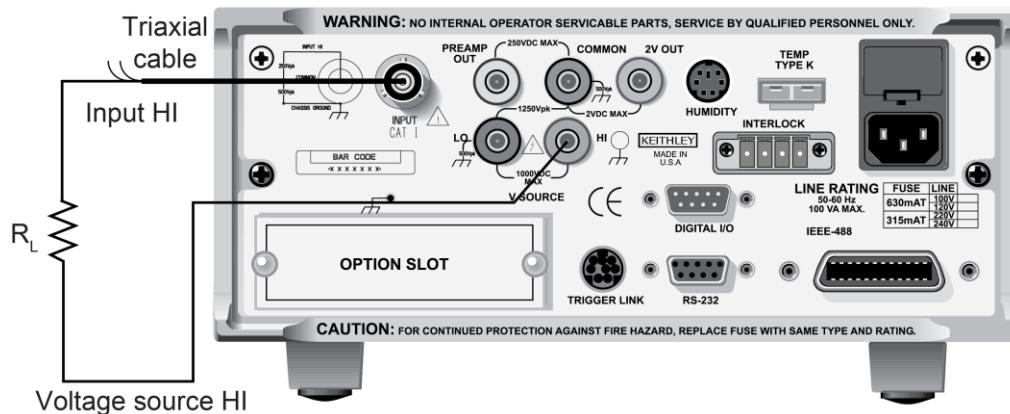
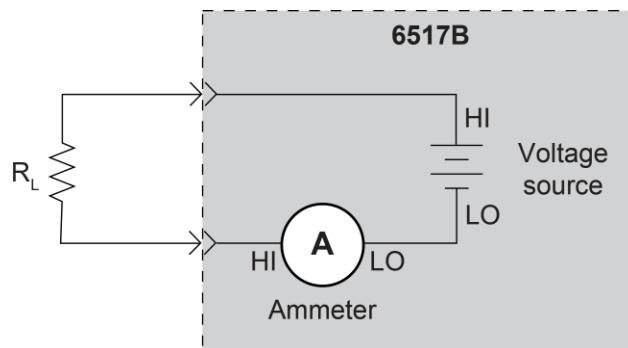
Figure 8: Voltage source (SVMI configuration)

Figure 9: Voltage source (SVMI configuration) - equivalent circuit

NOTE

You can make or break the voltage source LO to ammeter LO connection. Refer to [Ammeter LO to voltage source LO connection](#) (on page 3-8) for more information.

When the voltage source is connected to a capacitor, the inherent noise of the preamplifier is amplified. This is expected performance. Adding a series resistance does not decrease the noise. However, shunting the output of the voltage source (HI to LO) with a 0.1 μ F capacitor reduces this noise.

Ammeter LO to voltage source LO connection

You can use the meter connect option to make or break the internal connection between voltage source LO and ammeter LO.

To make the connection:

1. Press the **CONFIG** key.
2. Press the **OPER** key. The CONFIG V-SOURCE menu is displayed.
3. Select **METER-CONNECT**.
4. Select **ON**.
5. Press the **ENTER** key.
6. Press the **EXIT** key.

To break the connection:

1. Press the **CONFIG** key.
2. Press the **OPER** key. The CONFIG V-SOURCE menu is displayed.
3. Select **METER CONNECT**.
4. Select **OFF**.
5. Press the **ENTER** key.
6. Press the **EXIT** key.

Setting voltage source value

The following information describes the voltage source display, how to select the range, and how to set the voltage value.

Displaying the voltage source value

With the instrument in the normal measurement display state, the programmed voltage source value is displayed on the right side of the secondary display. If the screen is in another display state, you can display the voltage source as follows:

- If a NEXT display is open, press the **NEXT** key or **PREV** key until the voltage source is displayed.
- If you are in a menu, use the **EXIT** key to return to the measurement display.

When a NEXT display is open, you can temporarily display the voltage source value. Press the **VOLTAGE SOURCE** ▲ or ▼ key. The voltage source value appears on the secondary display for a few seconds.

Selecting the voltage source range

The voltage source range is selected in the CONFIG V-SOURCE menu. You can select ±100 V or ±1000 V. The 100 V range provides better resolution. The 100 V range is 5 mV compared to 50 mV for the 1000 V range.

When the voltage source value displayed, the position of the decimal point denotes the presently selected range. For example, a reading of 000.000 V is 0 V on the 100 V range, but a reading of 0000.00 V is 0 V on the 1000 V range.

The voltage source range cannot be changed when Auto V-source Ohms is selected.

To select the voltage source range:

1. Press the **CONFIG** key.
2. Press the **OPER** key.
3. Select **RANGE**.
4. Select the range.
5. Press the **ENTER** key.
6. Use the **EXIT** key to return to the previous screen.

Adjusting the voltage source value

You can adjust the voltage source value. If you change the value while the 6517B is operating, the output voltage is immediately changed to the new value.

NOTE

The voltage source value cannot be changed if Auto V-source Ohms is selected.

To adjust the voltage source value:

1. Press the **VOLTAGE SOURCE ▲ or ▼ key**. The EDIT annunciator turns on and a digit blinks to indicate the cursor position. The voltage source edit mode is canceled if a change is not made within three seconds.
2. Use the **◀ and ▶ keys** to place the cursor on the digit to be changed.
3. Use the **▲ and ▼ keys** to increment or decrement the value.
4. To change the polarity, do one of the following:
 - Increment or decrement the reading past 0 V.
 - Place the cursor on the + or – and press the **▲ or ▼ key**.

Voltage and current limit

There are absolute limits for the voltage and current sources. The voltage source has a 1 mA current limit for the 1000 V range, a 10 mA limit for the 100 V range, and an adjustable voltage limit.

The voltage source can be set to a maximum absolute value of voltage that can be sourced. For example, setting a value of 30 V limits the voltage output from –30 V to +30 V. If autovoltage source ohms is enabled, the voltage limit of the voltage source can only be set to a value that is >400 V.

If the current limit is reached, the **VOLTAGE SOURCE OPERATE** indicator flashes. While in current limit, the programmed voltage value is not sourced. For example, if the voltage source is programmed to source 200 V to a 100 kΩ load, current limit occurs at approximately 100 V ($100 \text{ k}\Omega \times 1 \text{ mA} = 100 \text{ V}$), so the voltage source only outputs 100 V.

A resistive current limit is also available for the voltage source. When selected, a 20 MΩ resistor is placed in series with the voltage source HI lead. This allows current to be limited. For example, with a programmed voltage of 100 V, current is limited to 5 μA ($100 \text{ V} / 20 \text{ M}\Omega = 5 \mu\text{A}$).

The voltage source should be used with a test fixture that incorporates a safety interlock switch, such as the Keithley Instruments Model 8009 Resistivity Test Fixture. When the interlock is properly installed, the 6517B cannot source voltage when the lid of the test fixture is open or ajar. Refer to “Interlock” in the *Model 6517B User’s Manual* for more information.

Setting a voltage limit

To set a voltage limit:

1. Press the **CONFIG** key.
2. Press the **OPER** key.
3. Select **V-LIMIT**. Press the **ENTER** key.
4. Select **CONTROL**. Press the **ENTER** key.
5. To enable the voltage limit, select **ON**. To disable it, select **OFF**.
6. Press the **ENTER** key.
7. Select **LIMIT-VALUE**.
8. Use the **▲**, **▼**, **◀**, and **▶** keys to set the voltage limit.
9. Press the **ENTER** key.
10. Use the **EXIT** key to return to the previous screen.

Selecting resistive current limit

When the resistance current limit is enabled, a 20 MΩ resistor is placed in series with the HI V-SOURCE lead to extend the current limit capabilities of the voltage source. When it is disabled, a normal current limit occurs at 1 mA.

To set a resistive current limit:

1. Press the **CONFIG** key.
2. Press the **OPER** key.
3. Select **RESISTIVE-LIMIT**. Press the **ENTER** key.
4. To enable the resistance current limit, select **ON**. To disable it, select **OFF**.
5. Press the **ENTER** key.
6. Use the **EXIT** key to return to the previous screen.

Operate and standby

⚠ WARNING

Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the 6517B while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the 6517B before handling cables connected to the outputs. Putting the equipment in standby mode does not guarantee that the outputs are not powered if a hardware or software fault occurs.

The **OPER** key toggles the output between operate and standby. In operate (VOLTAGE SOURCE OPERATE indicator on), the voltage source is applied to the output terminals. In standby, the voltage source is removed from the rear-panel output terminals.

If the VOLTAGE SOURCE OPERATE indicator is flashing, the voltage source is in current limit.

CAUTION

A relay switch in series with OUTPUT HI is opened when the voltage source is placed in standby. The transition to an open output creates a potential for noise spikes. The open output allows dielectric absorption to recharge capacitors to unexpected voltage levels.

Analog outputs

The 6517B has two analog outputs on the rear panel. 2V OUT provides a scaled 0 V to 2 V output, with the value of 2 V corresponding to full-range input.

PREAMP OUT is useful in situations that require buffering.

⚠ WARNING

When floating input LO above 30 V_{RMS} from earth ground, hazardous voltage is present at the analog outputs. Hazardous voltage that may present a shock hazard may also be present when the input voltage exceeds 30 V_{RMS} when the voltage function is selected or when input currents exceed 30 pA when the current function is selected.

CAUTION

Connecting PREAMP OUT, COMMON, or 2V OUT to earth while floating the input may damage the instrument.

2 V analog output

The 2V OUT analog output provides a scaled 0 V to 2 V output that is noninverting in the voltage mode.

Typical 2 V analog output values

Range	Applied signal	Nominal 2V analog output value*
20 pA	10.4 pA	-1.04 V
2 µA	1.65 µA	-1.65 V
200 V	35 V	0.35 V
20 nC	19 nC	-1.9 V

*Output values within $\pm 15\%$ of nominal value.

For a full-range input, the output is 2 V.

The 2 V analog output signal is not corrected during calibration. Gain errors of up to 15 percent may appear at this output, depending on function and range selection.

The output impedance is 10 kΩ. To minimize the effects of loading, the input impedance of the device connected to 2V OUT should be as high as possible. For example, with a device with an input impedance of 10 MΩ, the error due to loading is approximately 0.1 percent.

Connections for using the 2 V analog output are shown in the following figure.

Figure 10: Typical 2 V analog output connections

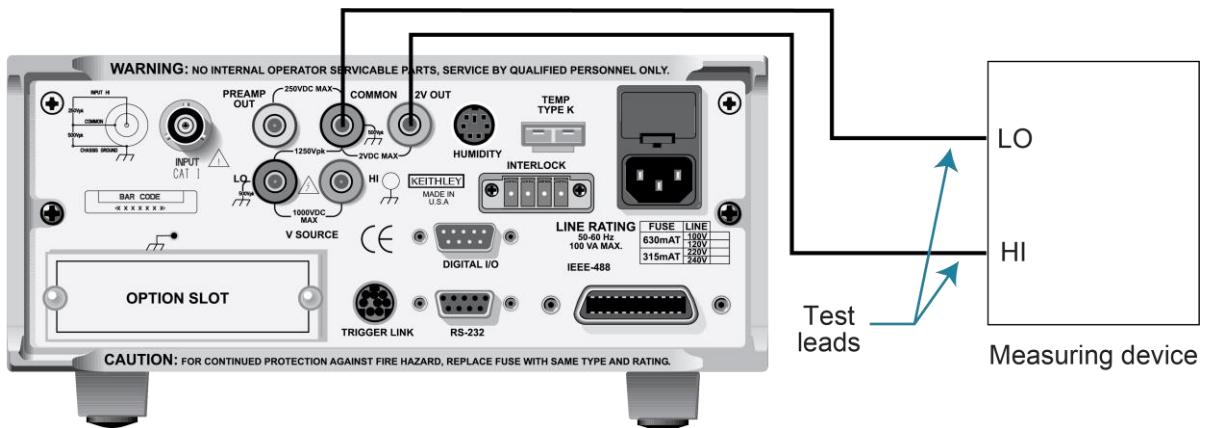
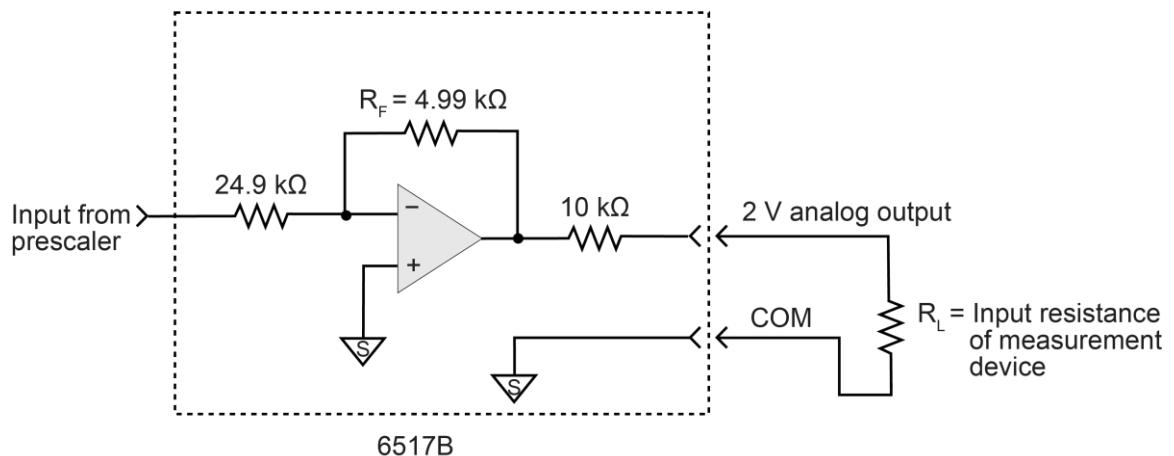


Figure 11: Typical 2 V analog output connections - equivalent circuit



Preamplifier output

The PREAMP OUT terminal of the 6517B follows the signal amplitude applied to the INPUT terminal. Some possible uses for the inverting PREAMP OUT include buffering of the input signal and guarding in the voltage mode.

When guard is enabled, PREAMP OUT is internally connected to the inner shell of the INPUT triaxial connector to configure the input for guarded voltage measurements. It is referenced to COMMON and rated at 200 V dc maximum. Refer to “Shielding and guarding” in the *Model 6517B User’s Manual* for more information on guarding.

WARNING

High voltage may be present between the PREAMP OUT and COMMON terminals. A safety shield must be used whenever hazardous voltages (>30 V_{RMS}, 42 V_{PEAK}) will be present in the test circuit. To prevent electrical shock that could cause injury or death, never use the 6517B in a test circuit that may contain hazardous voltages without a properly installed and configured safety shield.

CAUTION

Connecting PREAMP OUT, COMMON, or 2V OUT to protective earth (safety ground) while floating the input may damage the instrument.

NOTE

The PREAMP OUT accuracy is uncalibrated. Gain error of up to 15 percent may appear at this output, depending on the function and range selection. For all voltage ranges, PREAMP OUTPUT accuracy is typically 10 ppm.

The output resistance of PREAMP OUT is 1 Ω. The output resistance appears between input low and analog output low to keep the resistor out of the loop when using external feedback elements. To keep loading errors under 0.1 percent, the device connected to PREAMP OUT should have a minimum input impedance of 100 kΩ.

CAUTION

To prevent damage to the 6517B, do not connect a device to PREAMP OUT that draws more than $\pm 100 \mu\text{A}$. For example, at 200 V, the impedance connected to PREAMP OUT must be at least $2 \text{ M}\Omega$ ($200 \text{ V} / 100 \mu\text{A} = 2 \text{ M}\Omega$).

Full-range outputs for voltage, current, and charge functions and ranges are listed in the following table.

Full-range PREAMP OUT values

Function*	Range	Full-range value
Voltage	2 V	2 V
	20 V	20 V
	200 V	200 V
Current	2 nA, 2 μA , 2 mA	2 V
	20 pA, 20 nA, 20 μA , 20 mA	20 V
	200 pA, 200 nA, 200 μA	200 V
Charge	2 nC, 20 nC, 200 nC	20 V
	2 μC	200 V

* The PREAMP OUT value for the resistance function corresponds to the value for the current range that is used to make the measurement.

The connections and equivalent circuits for the preamplifier output are shown in the following figures.

Figure 12: Typical PREAMP OUT connections

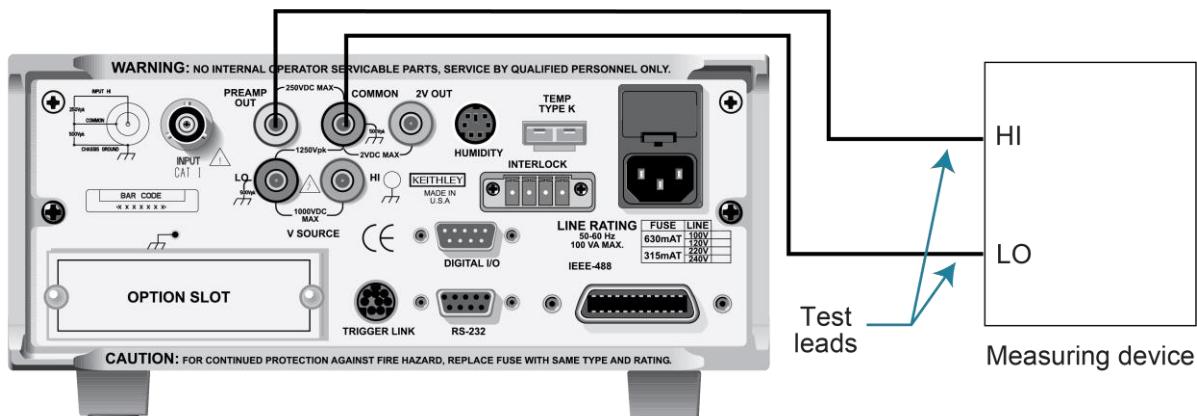
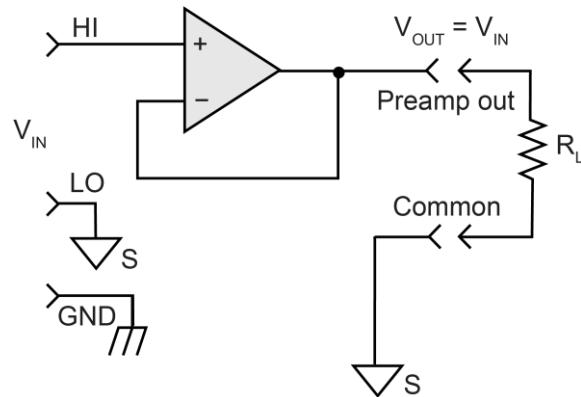
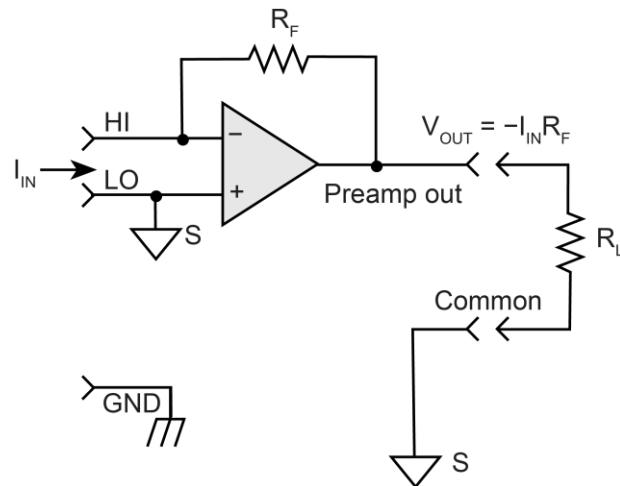
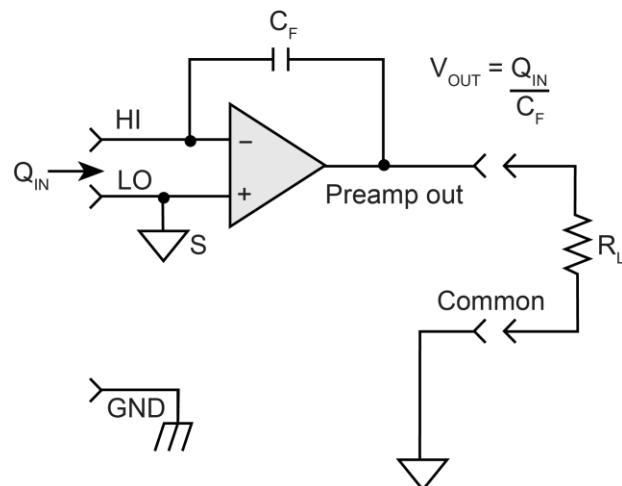


Figure 13: Typical voltage PREAMP OUT connections - equivalent circuit**Figure 14: Typical current and resistance PREAMP OUT connections - equivalent circuit****Figure 15: Typical charge PREAMP OUT connections - equivalent circuit**

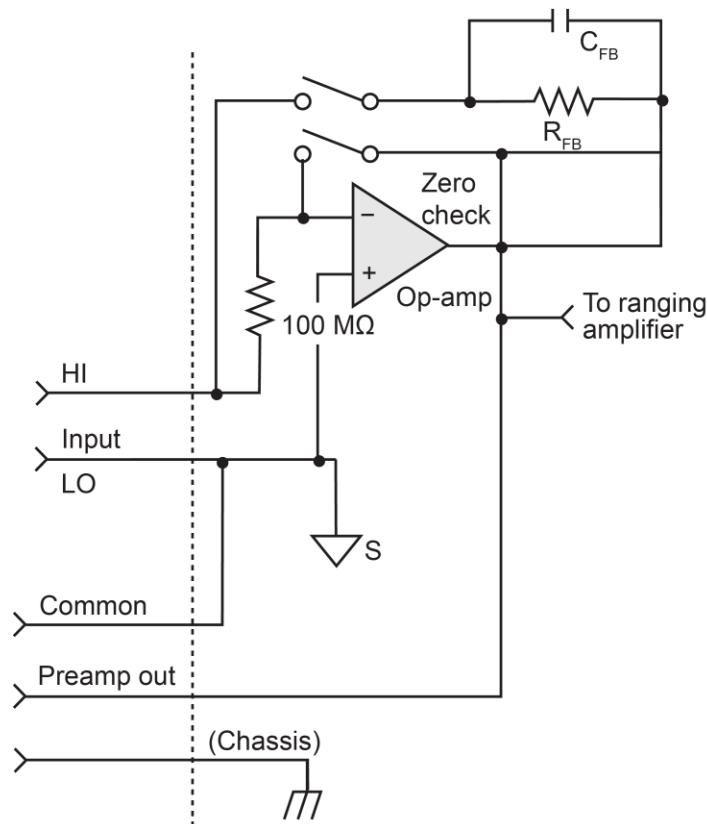
Using external feedback

The external feedback feature provides a means to extend the capabilities of the 6517B. It allows uses such as logarithmic currents, nondecade current ranges, and nonstandard charge ranges. The following topics discuss the basic 6517B input circuitry and methods to implement these capabilities.

6517B input circuitry

A simplified diagram of the 6517B input when the external feedback feature is enabled is shown in the following figure. An input current applied to the inverting (-) input of the operational amplifier (op-amp) is nulled by a current feedback through the internal feedback network made up of R_{FB} and C_{FB} . Because the output of the op-amp appears at the PREAMP OUT connection, this internal network can be replaced by an external network connected between the preamplifier output and input HI connections.

Figure 16: 6517B input circuitry (external feedback mode)



When using external feedback, consider the following factors:

- The maximum current value that can be supplied by the preamplifier output is 20 mA when the current or resistance function is selected. Maximum current is 1 mA for the voltage function. The maximum voltage span in external feedback is ± 20 V.
- The input impedance when external feedback is enabled is given by the relationship:

$$Z_{IN} = Z_{FB} / A_v$$

Where:

- Z_{FB} is the impedance of the external feedback network
- A_v is the open-loop gain of the 6517B (typically greater than 55×10^6).

The input impedance is $Z_{IN} = 10 \text{ M}\Omega | Z_{FB}$ when zero check is enabled.

- The voltage at the PREAMP OUT terminal is given by the formula:

$$V = -IZ_{FB}$$

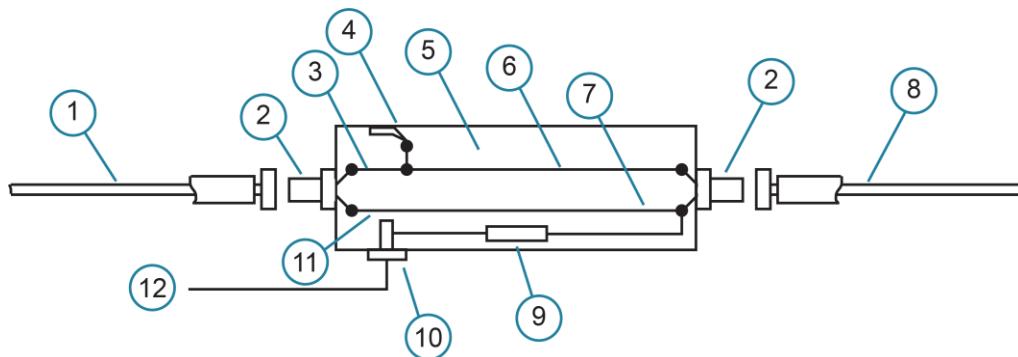
- House any feedback elements in a suitable shielded enclosure (see [Shielded fixture construction](#) (on page 3-18)). Insulators connected to Input HI should be made of Teflon™ or other high-quality insulating material and should be thoroughly cleaned to maintain the high input impedance and low input current of the 6517B. If these insulators become contaminated, they can be cleaned with methanol and then dried with clean pressurized air.

Shielded fixture construction

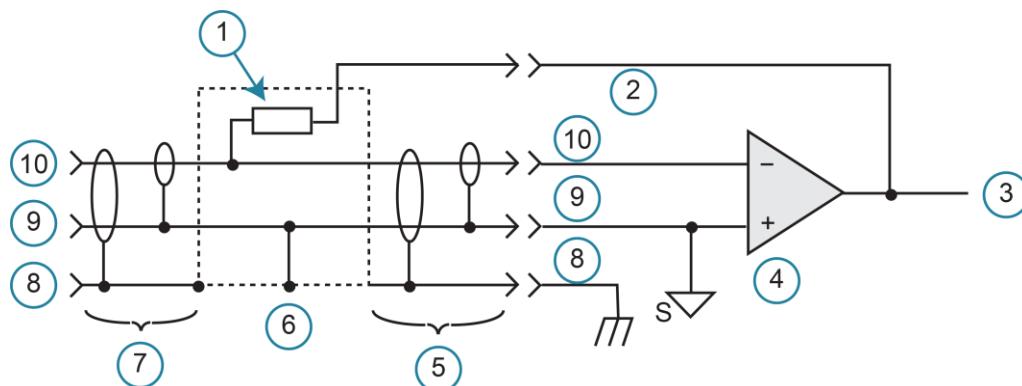
Since shielding is critical for proper operation of external feedback, it is recommended that a shielded fixture similar to the one shown in the following figure be used to house the feedback element. The fixture is constructed of a commercially available shielded fixture, modified to replace the standard BNC connectors with triaxial female connectors.

For convenience, a banana jack can be mounted on the box to make the PREAMP OUT connection. Alternately, a wire can be run through a rubber grommet mounted in a hole in the side of the box.

Input low is connected to chassis ground in the shielded box. This connection can be made by using a small solder lug secured with a screw.

Figure 17: Shielded fixture construction

Item	Description	Manufacturer part number
1	Triaxial cable to 6517B input	Keithley 7078-TRX-3
2	Female triaxial	Keithley 7078-TRX-TBC
3	LO	Not applicable
4	Solder lug	Not applicable
5	Shielded box	Pomona 2390
6	Input LO (inner shield)	Not applicable
7	Input HI (center conductor)	Not applicable
8	Triaxial cable from signal	Keithley 237-ALG-2
9	Feedback element	Not applicable
10	Banana jack	Keithley BI-9-2
11	HI	Not applicable
12	To preamplifier out	Not applicable

Figure 18: Shielded fixture construction - equivalent circuit

Item	Description	Item	Description
1	Feedback element	6	Shielded fixture
2	Preamplifier out	7	237-ALG-2 cable
3	To ranging amplifier and A/D	8	GND
4	6517B input amplifier	9	LO
5	7078-TRX-3 cable	10	HI

External feedback procedure

To operate the 6517B external feedback feature:

1. Connect the feedback element between the PREAMP OUT terminal and the INPUT high terminal.
2. Press the **V** key to select the voltage function.
3. Press the **CONFIG** key.
4. Press the **V** key. The CONFIGURE DCV menu is displayed.
5. Select **EXT-FDBK**.
6. Press the **ENTER** key.
7. Select **ON**.
8. Press the **ENTER** key.
9. Press the **EXIT** key to return to the measurement display. The display shows the voltage measured at the output of the input preamplifier (PREAMP OUT).

Nonstandard coulombs ranges

Normally, the 6517B has four charge ranges, allowing it to measure charge between 10 fC and 2.1 μ C. You can use different charge measurement ranges by placing an external feedback capacitor between the PREAMP OUT and INPUT high and then placing the instrument in the external feedback mode.

Charge is related to capacitance and voltage as follows:

$$Q = CV$$

Where:

- Q is the charge in coulombs
- C is the capacitance in farads
- V is the voltage in volts

The 6517B display reads charge directly in units determined by the value of C. For example, a 10 μ F capacitor shows a reading of 10 μ C/V.

In practice, the feedback capacitor should be greater than 100 pF for feedback stability. To ensure low leakage and low dielectric absorption, it should be of suitable dielectric material (such as polystyrene, polypropylene, or TeflonTM). The capacitor should be mounted in a shielded fixture such as the one shown in [Shielded fixture construction](#) (on page 3-18).

To discharge the external feedback capacitor, enable zero check. The discharge time constant is given by $t = (10 \text{ M}\Omega) (C_{FB})$. Allow five time constants for discharge to within 1 percent of final value.

Logarithmic currents

The use of a diode junction in the external feedback path permits a logarithmic current-to-voltage conversion. The relationship for a junction diode is given by the equation:

$$V = m k T / q \ln(I/I_0) + I_{RB}$$

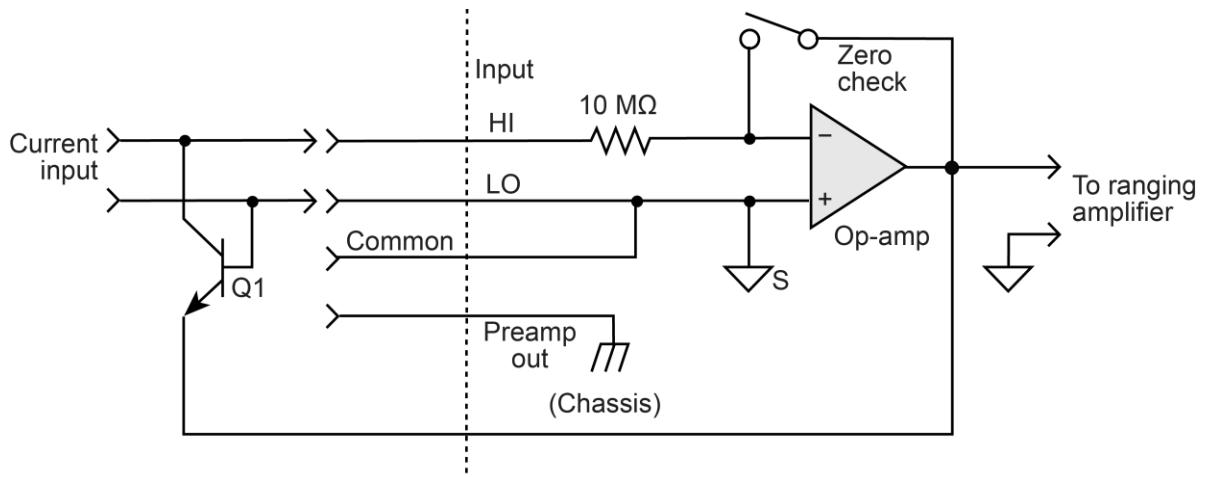
Where:

- q = Unit of charge (1.6022×10^{-19})
- k = Boltzmann constant (1.3806×10^{-23})
- T = Temperature (K)

The limitations in this equation center on the factors I_0 , m , and R_B . I_0 is the extrapolated current for V_o . An empirical proportional constant, m , accounts for the different character current conduction (recombination and diffusion mechanisms) within the junction, typically varying between 1 and 2. Finally, R_B constitutes the ohmic bulk resistance of the diode junction material. I_0 and R_B limit the usefulness of the junction diode at low and high currents, respectively. The factor m introduces nonlinearities between those two extremes. Because of these limitations, most diodes have a limited range of logarithmic behavior.

A solution to these constraints is to use a transistor configured as a transdiode in the feedback path, as shown in the following figure.

Figure 19: Transdiode logarithmic current configuration



Analyzing the transistor in this configuration leads to the relationship:

$$V = kT/q[\ln(I/I_0) - \ln(h_{FE}/(1 + h_{FE}))]$$

Where:

- h_{FE} = The current gain of the transistor

From this equation, proper selection of Q1 requires a device with high current gain (h_{FE}), which is maintained over a wide range of emitter currents. Suitable devices for this application include Analog Devices AD812 and Precision Monolithics MAT-01. Use the enclosure in [Shielded fixture construction](#) (on page 3-18) to shield the device.

Frequency compensation and stabilization is accomplished by adding a feedback capacitor, C_{FB} . The value of this capacitor depends on the transistor being used and the maximum current level expected. Compensation at maximum current is required because the dynamic impedance is minimal at this point. It should be noted that the response speed at lower currents is compromised due to the increasing dynamic impedance, which is given by the following formula:

$$Z = \frac{dV}{dI} = kT/qI = 0.026 / I \text{ (@25 } ^\circ\text{C)}$$

Using the above transistors, a minimum RC time constant of 100 μ s at maximum input current is used. At I_{IN} (max) of 100 μ A, this value would correspond to 0.4 μ F. At 100 nA, this value increases the RC response time constant to 100 ms. A minimum capacitance of 100 pF is recommended.

Although the input signal to this particular circuit is assumed to be a current, conversion to voltage input could be performed by placing a shunt resistor across the input. However, you must consider the nominal voltage burden of 1 mV as an error signal.

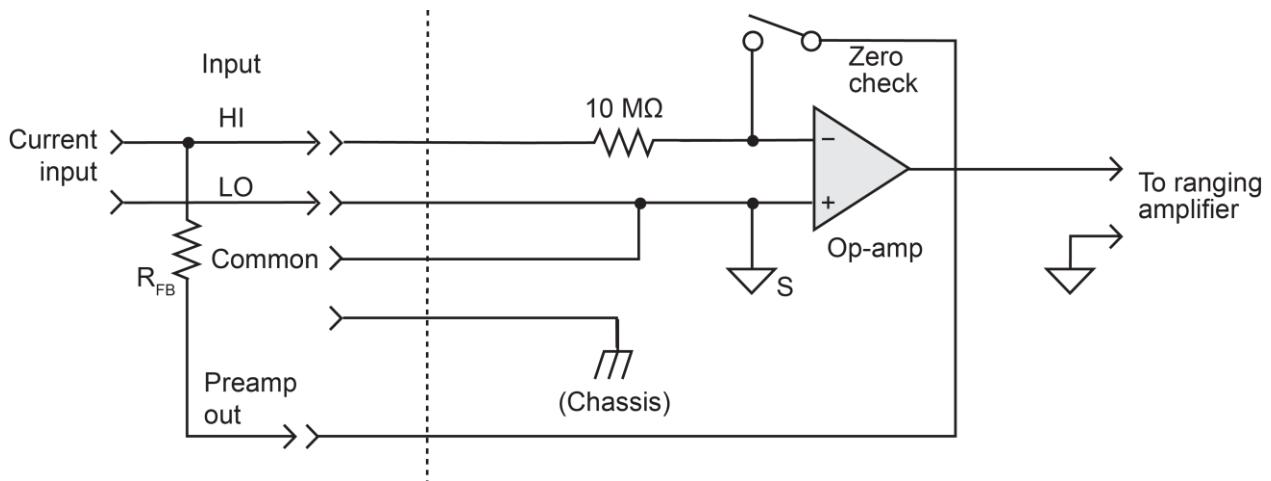
Further processing of the current response can be achieved by using the suppress feature. For example, relative offset could be enabled with a reference input current applied. For all subsequent currents, the natural logarithm of the ratio of the measured current to the suppressed current is then displayed:

$$\begin{aligned} V_{DISP} &= V_{REL} kT/q (\ln (I_{READ}/I_0) - \ln (I_{REL}/I_0)) \\ &= kT/q (\ln (I_{READ}/I_{REL})) \\ &= 0.26/I (\ln (I_{READ}/I_{REL})) \text{ at } 25 \text{ } ^\circ\text{C} \end{aligned}$$

The circuit topology shown in the figure above works for positive input currents only. For bipolar input signals, an external offset bias must be applied. You can also use a PNP transistor for Q1.

Nondecade current gains

The 6517B electrometer input uses internal decade resistance feedback networks for the current ranges. In some applications, you may need nondecade current gains. You can use an external feedback resistor, R_{FB} , for this purpose, as shown in the following figure. Limitations on the magnitude of the feedback current require that the value of R_{FB} be greater than 100 Ω .

Figure 20: Nondecade current gains

Measurement range

The measurement range affects the accuracy of the measurement and the maximum signal that can be measured. The measurement ranges for each function are listed in the specifications.

The maximum input signal level for voltage, current, and charge measurements is 105 percent of the measurement range. For example, the maximum signal level on the 2 V range is 2.1 V ($2\text{ V} \times 1.05 = 2.1\text{ V}$).

For the resistance function, each measurement range has a lower reading limit that is one decade below the selected range. For example, the 20 MΩ range has a lower reading limit of 2 MΩ.

Resistance measurements are performed by sourcing voltage and measuring current, so resistance ranges are current ranges calculated to show ohms units.

When autorange is selected, the instrument goes to the most sensitive range to make the measurement. To prevent erroneous readings, allow sufficient time for settling if the instrument is autoranging over multiple ranges or down to the lower current ranges. For the resistance function, when autorange is selected, the instrument cannot go to the 2 TΩ, 20 TΩ, or 200 TΩ ranges because a hazardous voltage level (400 V) may be selected by the instrument. You must select these resistance ranges manually.

For the current, resistance, and charge functions, you can set autorange limits to speed up measurements. Setting limits eliminates upper and lower ranges from the autorange search. For example, if you know that readings do not exceed 1 μA, you can specify the 2 μA range to be the maximum range. When the instrument autoranges, it does not search into the current ranges above 2 μA.

If using autorange causes the instrument to rapidly alternate between ranges, you can reduce the autorange speed. Change the speed to **NORMal** to delay measurements after a range change. The delay helps avoid oscillation between ranges.

To set the autorange limits:

1. Press the **CONFIG** key.
2. Press the key for the function (**I**, **R**, or **Q**).
3. Select **AUTORANGE**.
4. For the current and resistance functions, you can select:
 - **USE-ALL-RANGES**: Use all ranges when autoranging.
 - **SET-LIMITS**: Limit the ranges used in the autorange search. Select a minimum (**MIN-AUTO**) and maximum autorange (**MAX-AUTO**) value.
5. For the charge function, select:
 - **LO**: Limit the autorange search to the low measurement ranges (2 nC to 20 nC).
 - **HIGH**: Limit the autorange search to the high measurement ranges (200 nC to 2 μ C).
6. Press the **ENTER** key.

To set the autorange limits:

1. Press the **MENU** key.
2. Select **GENERAL**. Press the **ENTER** key.
3. Select **A/D CONTROLS**. Press the **ENTER** key.
4. Select **AUTORANGE-SPEED**. Press the **ENTER** key.
5. Select **NORMAL** to delay measurement after a range change. Select **FAST** to use the fastest autorange.

Range messages

The following display messages may occur when making measurements: OVERFLOW, UNDERFLOW, and OUT OF LIMIT. The causes of these messages and solutions are provided in the following topics.

OVERFLOW messages

The OVERFLOW message is displayed when the integrated (average) input signal level (voltage, current, or charge) exceeds 105% of full scale for the selected measurement range. For example, on the 20 nA measurement range, the OVERFLOW message occurs when the integrated input level exceeds 21 nA.

To resolve an overflow condition, select a higher measurement range, use autorange, or reduce the magnitude of the input signal.

The OVERFLOW message does not occur during resistance or resistivity measurements.

UNDERFLOW messages

This condition is similar to an overflow condition, but pertains to resistance and resistivity measurements. When the resistance of the device under test (DUT) is too low for the selected resistance range, the resulting current exceeds full scale and causes the UNDERFLOW message to be displayed. This message indicates that the measured resistance is below the lower reading limit of the selected range.

The underflow condition can usually be resolved by selecting a lower resistance range or by using autorange.

Measuring a device that is less than $2\text{ M}\Omega$ also causes the UNDERFLOW message to be displayed. This problem can be resolved by manually selecting the next lower range or by using autorange.

Since AUTO resistance uses the source voltage, measure current measurement method, a current measurement overflow results in an UNDERFLOW error. Conversely, a 0 A measured current results in an OVERFLOW error.

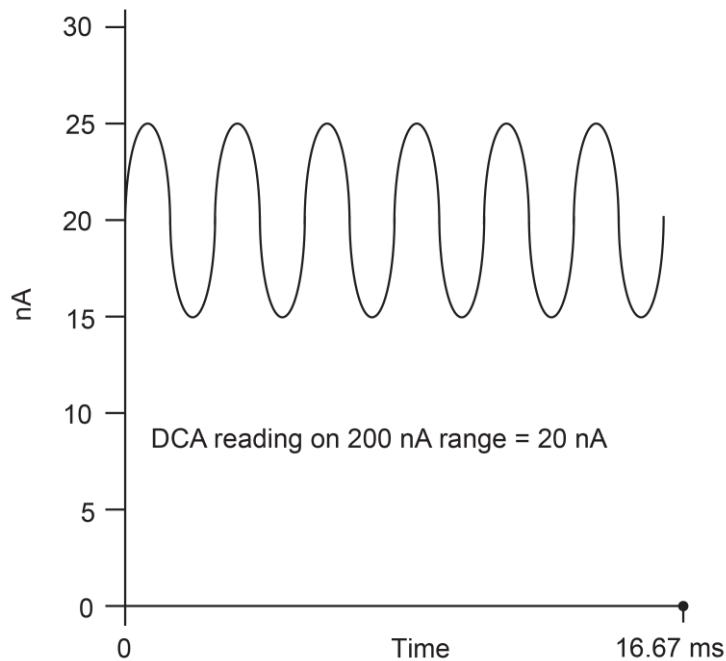
OUT OF LIMIT messages

An OUT OF LIMIT message indicates that a momentary or transient out-of-range condition appeared at the input, even though the integrated (average) signal was within the full-scale range of the analog to digital converter (A/D). It usually indicates that there is too much noise on the input signal for a valid measurement or that the signal exceeds 120 percent of the range.

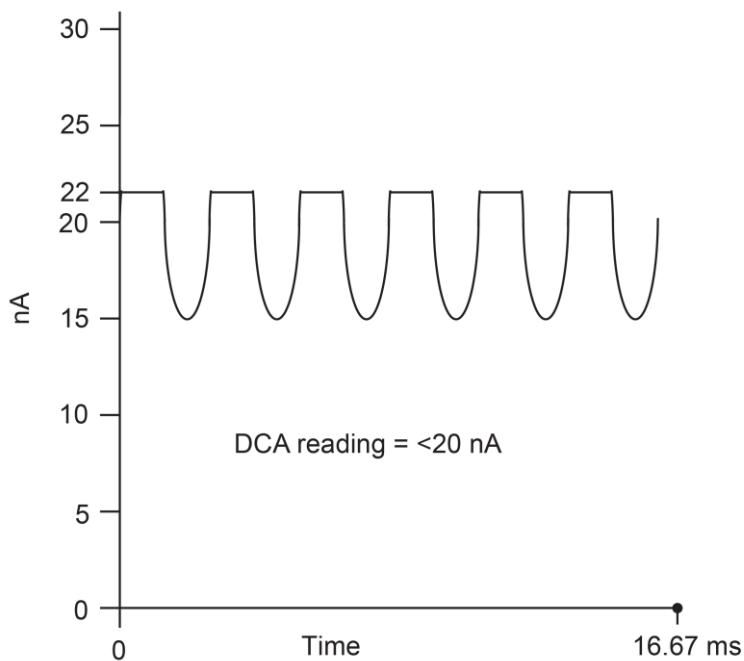
Generally, you can eliminate the out-of-limit condition by better shielding of the signal source or by using other noise reduction methods. Refer to "Shielding and guarding" in the *Model 6517B User's Manual* for more detail.

Another solution is to select the next higher range (or lower resistance range) to keep the transients less than full scale. The 2 nA, 20 nA, and 200 nA ranges, and the resistance measurements that use these current ranges, are particularly susceptible to this condition because of the combination of speed and sensitivity.

A sine wave signal riding by a dc bias level demonstrates an OUT OF LIMIT reading. The following figure shows a sine wave riding on a 20 nA bias level.

Figure 21: Input signal

If this signal is measured on the 200 nA range at normal speed, it would read 20 nA (which is the dc average). If, however, you use the 20 nA range, the positive peaks of the sine wave are clipped as shown in the following figure.

Figure 22: Measurement on 20 nA range

Clipping occurs at 110 percent of full range (22 nA on the 20 nA range). Because of clipping, the measurement of the input signal is significantly less than 20 nA. The 6517B displays the OUT OF LIMITS message instead of the inaccurate reading.

The positive peaks of the input signal (which exceed full scale) do not cause an overflow condition on the 20 nA range because the average reading over the 16.67 ms integration period is less than full scale.

You can disable the A/D hardware limit detection circuit, which in turn disables the OUT OF LIMIT message. However, the presence of out of limit readings may result in measurements that are slightly, moderately, or completely inaccurate. When both overflow and out of limit conditions occur, the OUT OF LIMIT message is displayed.

To enable or disable the A/D hardware limit circuit:

1. Press the **MENU** key.
2. Select the **GENERAL** menu.
3. Select **A/D CONTROLS**.
4. Select **LIMIT-CTRL**.
5. Select **TEMPERATURE**.
6. Use the **RANGE** keys to choose **ON** (enabled) or **OFF** (disabled).
7. Press the **ENTER** key.

Damping

High capacitance at the input increases reading noise. This capacitance can be attributed to a long input cable or to the capacitance of the source, or a combination of both. For the current and resistance functions, you can enable damping to reduce this type of noise. However, damping also slows down the response of the measurement.

Damping is not the same as filtering. Damping reduces noise caused by input capacitance. Filtering reduces noise caused by a noisy input signal.

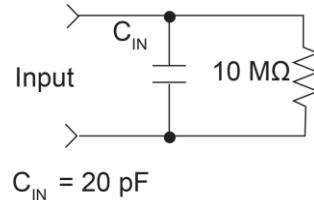
To enable or disable damping:

1. Press the **CONFIG** key.
2. Press the **I** or **R** key. The CONFIGURE CURRENT menu is displayed.
3. Select **DAMPING**.
4. Press the **ENTER** key.
5. Select **ON** to enable damping or **OFF** to disable it.
6. Press the **ENTER** key.
7. Press the **EXIT** key to return to the measurement display.

Zero check

When zero check is enabled, the input amplifier is configured to shunt the input signal to low, as shown in the following figure.

Figure 23: Equivalent input impedance with zero check enabled for voltage measurements



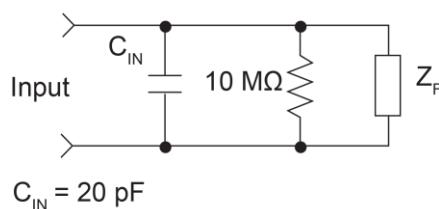
When you enable or disable zero check, that state is assumed regardless of the selected function. You cannot set a unique zero check state for each function.

To ensure proper operation, always enable zero check before changing functions (V, I, R, or Q). Press the **Z-CHK** key to toggle zero check. When it is enabled, the `ZeroCheck` message is displayed.

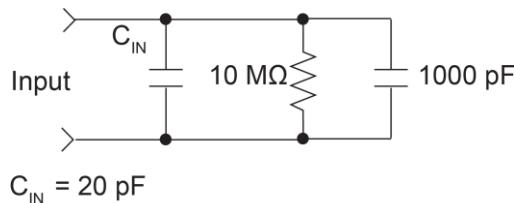
For voltage, current, and resistance measurements, leave zero check enabled when connecting or disconnecting input signals.

Figure 24: Equivalent input impedance with zero check enabled for current and resistance measurements

$$\begin{aligned} Z_F &= 100 \Omega (\text{mA}) \\ &100 \text{ k}\Omega \parallel 1000 \text{ pF} (\mu\text{A}) \\ &100 \text{ M}\Omega \parallel 220 \text{ pF} (\text{nA}) \\ &100 \text{ G}\Omega \parallel 5 \text{ pF} (\text{pA}) \end{aligned}$$



When the charge function is selected, enabling zero check dissipates the charge, so the charge reading is reset to zero. When zero check is disabled, a sudden change in the charge reading (zero check hop) occurs. You can cancel this effect by enabling relative offset immediately after zero check is disabled. For charge measurements, disable zero check before connecting the input signal. If zero check is left enabled when you connect the input signal, the charge dissipates through the $10\text{ M}\Omega$ resistor, as shown in the following figure.

Figure 25: Equivalent input impedance with zero check enabled for charge measurements

You can display the readings in zero check. Press the **CONFIG** key, then press the **Z-CHK** key to select **Yes** to show zero check readings or **No** to hide them. When Yes is selected, ZC is displayed next to the units of measure on the display.

Relative offset

The relative offset operation subtracts a reference value from actual readings. When relative offset is enabled, the instrument uses the present reading as a relative value. Subsequent readings are the difference between the actual input value and the relative offset value:

$$\text{Reading with offset applied} = \text{actual input value} - \text{relative value}$$

If math is applied, the math operation acts on the reading with offset applied:

$$\text{Reading with math applied} = \text{math operation} (\text{reading with offset applied})$$

A relative offset value can be established for each measurement function. A relative offset value can be as large as the highest allowable reading for the function. The state and value of relative offset for each measurement function are saved when you change functions.

Selecting a range that cannot accommodate the offset value does not cause an overflow condition, but it also does not increase the maximum allowable input for that range. For example, on the 2 mA range, the 6517B still overflows for a 2.1 mA input.

Once a relative offset value is established for a measurement function, the value is the same for all ranges. For example, if 15 V is set as the relative offset value on the 20 V range, then the offset is also 15 V on the 200 V and 2 V ranges. Correcting zero on the lowest range corrects all ranges because of internal scaling.

⚠️ WARNING

When relative offset is enabled, the voltage on the input may be significantly larger than the displayed value. For example, if a 150 V relative offset value is stored, an applied voltage of +175 V results in a displayed value of +25 V.

Configuring relative offset manually

NOTE

A bench or GPIB reset clears any stored relative offset values and disables relative offset for all functions. Enabling relative offset also clears the existing relative offset value and selects a new value.

If you try to enter an invalid relative offset value, a message that shows the limit for relative offset is displayed and the operation is canceled.

To configure the relative offset manually:

1. Press the **REL** key to enable relative offset (the **REL** indicator is displayed).
2. Press the **CONFIG** key.
3. Press the **REL** key. The relative offset value for the present measurement function is displayed.
4. To change the value, use the cursor keys and the **RANGE ▲** and **▼** keys.
5. Press the **ENTER** key. The instrument returns to the measurement display state with the new relative offset applied.

Enabling relative offset and setting relative offset automatically

From the normal reading display, the **REL** key toggles the relative offset operation on and off. Each time relative offset is enabled by the **REL** key, the present reading becomes the new relative offset value for that function. To make a new reading of the relative offset value, you must disable relative offset and then enable it.

You cannot use an overflow reading to set a relative offset.

To automatically select a relative offset value:

1. Select the lowest measurement range (2 V).
2. Press the **REL** key. The **REL** indicator turns on and the **ZCor** message is displayed.

NOTE

If guard is enabled, the **ZCor** message replaces the **Grd** message. Guard is still enabled.

Display reading with and without relative offset applied

The ACTUAL display allows you to view the reading without relative offset applied on the bottom line of the display and the reading with offset applied on the top line.

To access this display, press either the **PREV** or **NEXT DISPLAY** key to scroll through the displays for the selected function. An example of the relative offset and actual reading display is shown in the following figure.

Figure 26: Relative offset and actual reading display



Zero correct

The **Z-CHK** and **REL** keys work together to cancel (zero correct) any internal offsets that might upset accuracy for voltage and current measurements.

The instrument remains zero corrected even if a higher range is selected. If a lower range is selected, press the **REL** key to zero correct the instrument again.

To zero correct the voltage or current function:

1. Select the **V** or **I** key.
2. Press the **Z-CHK** key to enable Zero Check.
3. Select the range for the measurement.
4. Press the **REL** key to zero correct the instrument. The **REL** indicator is lit and **ZCor** is displayed.

NOTE

For the voltage function, **ZCor** replaces the display of **Grd** if guard is enabled.

5. Press the **Z-CHK** key to disable zero check.
6. Make readings.

To disable zero correct:

1. Press the **Z-CHK** key to enable zero check.
2. Press the **REL** key to turn off zero correct.

Specification considerations

For making measurements "when properly zeroed", per instrument specifications:

1. Perform the zero correct procedure described in [Zero correct](#) (on page 3-31).
2. Provide a zero input from a calibration source, or short leads in the voltage function, or open leads in the current function.
3. Press the **REL** key to reset the remaining measurement offsets to zero.
4. Make readings normally. The **REL** indicator remains on.

Repeat these steps whenever the measurement range is changed. To disable relative offset, disable zero check and press the **REL** key.

Accuracy calculations

The following information discusses how to calculate accuracy.

Calculating voltage accuracy

From the specifications, voltage is calculated as follows:

$$\text{Accuracy} = \pm (\% \text{ reading} + \text{counts})$$

The following example shows how to compute accuracy for the 2 V range.

Assume that the voltage you are measuring is reading exactly 1.00000 V on the 2 V range. Four counts on the 2 V range equals 0.00004 V.

From the specifications:

$$\begin{aligned}\text{Accuracy} &= \pm (0.025\% \text{ of } 1 \text{ V} + 4 \text{ counts}) \\ &= \pm (0.00025 \text{ V} + 4 \text{ counts}) \\ &= \pm (0.00025 \text{ V} + 0.00004 \text{ V}) \\ &= \pm 0.00029 \text{ V}\end{aligned}$$

Therefore, the accuracy range for the 1.00000 V reading is 0.99971 V to 1.00029 V.

Calculating current accuracy

From the specifications, current is calculated as follows:

$$\text{Accuracy} = \pm (\% \text{ reading} + \text{counts})$$

The following example shows how to compute accuracy for the 20 mA range.

Assume that the current you are measuring is reading exactly 10.0000 mA on the 20 mA range. Five counts on the 20 mA range equals 0.0005 mA.

From the specifications:

$$\begin{aligned}\text{Accuracy} &= \pm (0.1\% \text{ of } 10 \text{ mA} + 5 \text{ counts}) \\ &= \pm (0.01 \text{ mA} + 5 \text{ counts}) \\ &= \pm (0.01 \text{ mA} + 0.0005 \text{ A}) \\ &= \pm 0.0105 \text{ mA}\end{aligned}$$

Therefore, the accuracy range for the 10.0000 mA reading is 9.9895 mA to 10.0105 mA.

Calculating resistance accuracy

The following information shows how to calculate autovoltage source resistance accuracy.

From the specifications, accuracy is calculated as follows:

$$\text{Accuracy} = \pm (\% \text{ reading} + \text{counts})$$

The following example shows how to compute autovoltage source resistance accuracy for the 2 MΩ range.

Assume that the resistor you are measuring is reading exactly 1.00000 MΩ on the 2 MΩ range. One count on the 2 MΩ range (0.00001 MΩ) equals 10 Ω.

From the specifications:

$$\begin{aligned}\text{Accuracy} &= \pm (0.125\% \text{ of } 1 \text{ M}\Omega + 1 \text{ count}) \\ &= \pm (1250 \Omega + 1 \text{ count}) \\ &= \pm (1250 \Omega + 10 \Omega) \\ &= \pm 1260 \Omega\end{aligned}$$

Therefore, the accuracy range for the 1.00000 MΩ autovoltage source reading is 0.99874 MΩ to 1.00126 MΩ.

Calculating charge accuracy

From the specifications, charge is calculated as follows:

$$\text{Accuracy} = \pm (\% \text{ reading} + \text{counts})$$

The following example shows how to compute accuracy for the 2 μC range.

Assume that the charge you are measuring is reading exactly 1.00000 μC on the 2 μC range. Five counts on the 2 μC range equals 0.00005 μC.

From the specifications:

$$\begin{aligned}\text{Accuracy} &= \pm (0.4\% \text{ of } 1 \mu\text{C} + 5 \text{ counts}) \\ &= \pm (0.004 \mu\text{C} + 5 \text{ counts}) \\ &= \pm (0.004 \mu\text{C} + 0.00005 \mu\text{C}) \\ &= \pm 0.00405 \mu\text{C}\end{aligned}$$

Therefore, the accuracy range for the 1.00000 μC reading is 0.99595 μC to 1.00405 μC.

Calculating resistance/resistivity accuracy and repeatability using the alternating polarity method

From the specifications, accuracy and repeatability when using a Model 8009 test fixture are calculated as follows:

$$\text{Repeatability: } \Delta I_{BG} \times R / V_{ALT} + 0.1\% \text{ (1 } \sigma\text{)}$$

(instrument temperature constant $\pm 1^\circ\text{C}$)

$$\text{Accuracy: } (V_{SRC}\text{Err} + I_{MEAS}\text{Err} \times R) / V_{ALT}$$

Where:

- ΔI_{BG} is a measured, typical background current noise from the sample and fixture
- V_{ALT} is the alternating polarity voltage used
- $V_{SRC}\text{Err}$ is the accuracy (in volts) of the voltage source using V_{ALT} as the setting
- $I_{MEAS}\text{Err}$ is the accuracy (in amperes) of the ammeter using V_{ALT}/R as the reading

The following example shows how to calculate accuracy and repeatability for a 10^{13} ohms sample measured in a Model 8009 test fixture with 50 V stimulus and a background current of 4 pA. The user-selected measurement time for the alternating polarity measurement is 15 seconds.

ΔI_{BG} is measured with no voltage applied, under normal measurement conditions, and 15 seconds of readings are stored to the buffer. Normal conditions require 1 PLC, the same current range that is used for the alternating polarity measurement and similar preconditioning to the normal measurements (if the samples are normally inserted into the fixture and immediately measured, the stored readings should be performed similarly after lid closure). After the storage is complete, the standard deviation (1 sigma) of these values is taken. This can be done by retrieving the standard deviation of the buffer over the bus or by pressing the **RECALL** key once and the **NEXT** key repeatedly, scrolling through the second-line displays to the standard deviation. This is ΔI_{BG} . Assume, for example, that the result was 55 fA or 5.5×10^{-14} A.

$$\text{Repeatability} = 5.5 \times 10^{-14} \text{ A} \times 10^{13} \Omega / 50 \text{ V} + 0.1\% = 0.011 + 0.1\% \text{ or } 1.2\%$$

NOTE

With normal resistance methods, the 4 pA total background current contributes as much as 400 percent error.

$$V_{SRC}\text{Err} = 0.15\% \times 50 \text{ V} + 10 \text{ mV} = 0.085 \text{ V} \text{ (from 100 V voltage source range specifications)}$$

$$I_{MEAS}\text{Err} = 1\% \times (50 \text{ V} / 10^{13} \Omega) + 30 \text{ counts} \times 10^{-16} \text{ A} / \text{count} = 5.3 \times 10^{-14} \text{ A} \text{ (from 20 pA specification)}$$

$$\text{Accuracy} = (0.085 \text{ V} + 5.3 \times 10^{-14} \text{ A} \times 10^{13} \Omega) / 50 \text{ V} = 0.0123 \text{ or } 1.23\%$$

Section 4

Measurement considerations

In this section:

Introduction	4-1
Voltage measurement considerations.....	4-1
Current measurement considerations	4-4
Resistance measurement considerations	4-10
Charge measurement considerations	4-11
Other measurement considerations	4-12

Introduction

The following topics describe some considerations you should be aware of when making measurements.

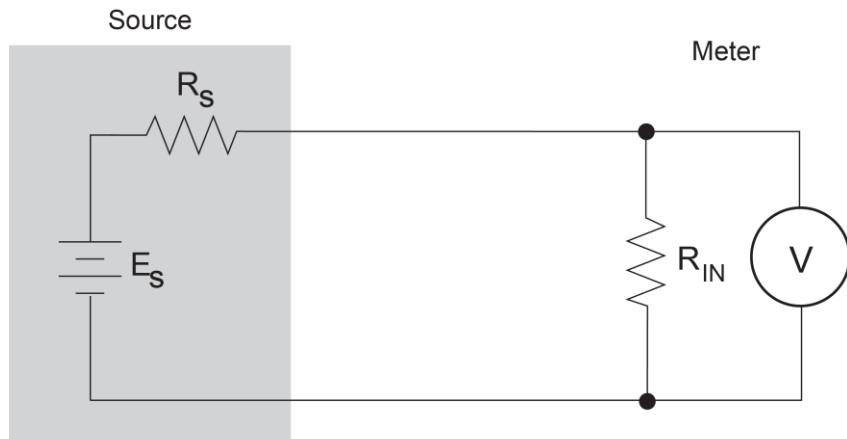
Voltage measurement considerations

Some considerations for making accurate voltage measurements are summarized in the following paragraphs. For comprehensive information on precision measurements, refer to the *Low Level Measurements Handbook*, available at tek.com/keithley.

For high-impedance voltage measurements and for voltage measurements that use long input cables, you should use guarding.

Loading effects

Circuit loading can be detrimental to high-impedance voltage measurements. To see how meter loading can affect accuracy, refer to the following figure. R_s represents the resistance component of the source and R_{IN} represents the input resistance of the meter. You can calculate the percent error due to loading using the formula in the figure. To keep the error under 0.1 percent, the input resistance (R_{IN}) must be about 1000 times the value of the source resistance (R_s). The input resistance of the 6517B is $>2 \times 10^{14} \Omega$. Therefore, to keep the error under 0.1 percent, the source resistance of the measured voltage must be $<2 \times 10^{11} \Omega$.

Figure 27: Meter loading

$$\% \text{ Error} = \frac{100R_S}{R_S + R_{IN}}$$

Guarding

To understand the concept of guarding, review the unguarded circuit shown in the following figure. E_S and R_S represent the resistance and voltage components of the source. R_L and C_L represent the leakage resistance and cable capacitance of the triaxial input cable. The equivalent circuit shows the divider that is formed. If R_S is large enough, the divider significantly attenuates the voltage at the input of the 6517B (see [Cable leakage resistance](#) (on page 4-4)). Also, R_S and C_L could create a long resistor-capacitor (RC) time constant, resulting in a slow measurement response (see [Input capacitance](#) (on page 4-4)).

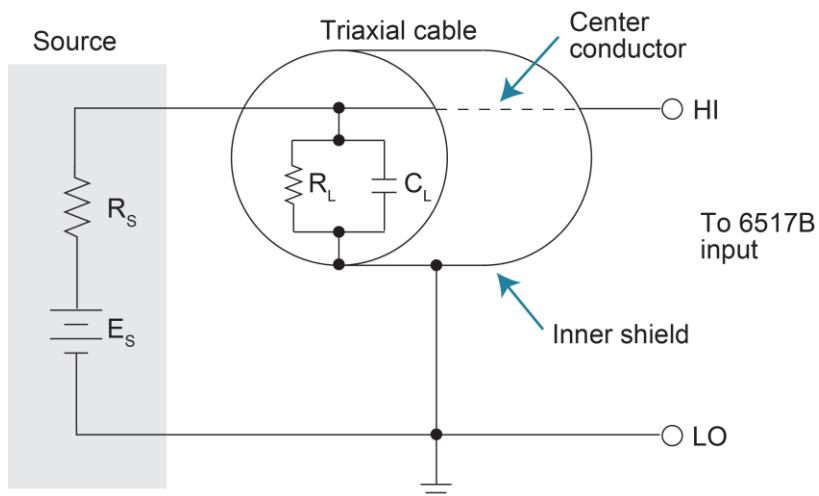
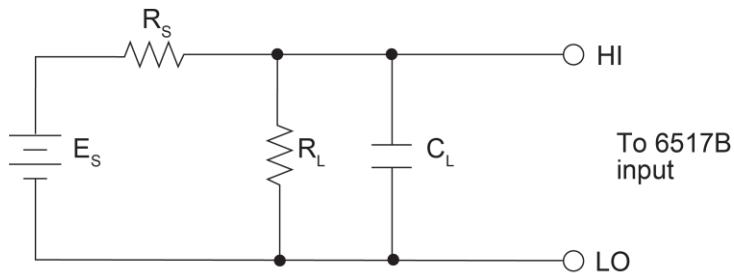
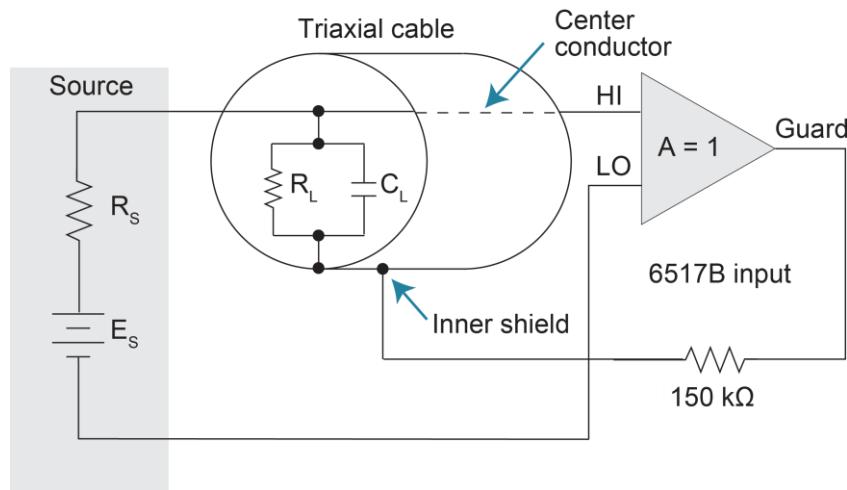
Figure 28: Unguarded voltage measurements

Figure 29: Unguarded voltage measurements - equivalent circuit

Guarding the circuit minimizes these effects by driving the inner shield of the triaxial cable at signal potential, as shown in the following figure. Here, a unity gain amplifier with a high input impedance and low output impedance is used. Since the center conductor (HI) and the inner shield (guard) of the cable are at virtually the same potential, the potential across R_L is zero, so no current flows. With a zero potential across C_L , there is also no capacitor charging process to slow down the measurement response.

Not shown in the figure is the outer shield of the triaxial cable, which is connected to chassis ground. The leakage between the inner shield and the outer shield is of no consequence because that current is supplied by the low impedance source, rather than by the signal itself.

Figure 30: Guarded voltage measurements

For information on creating a guard shield, refer to “Shielding and guarding” in the *Model 6517B User's Manual*.

Cable leakage resistance

In an unguarded voltage measurement, leakage current occurs in the input triaxial cable between the center conductor (HI) and the inner shield (LO). This leakage resistance shunts the voltage source to be measured. If the resistance of the source is not significantly less than the leakage resistance of the cable, measurement errors occur.

The effects of leakage resistance can be eliminated by using guard to make high-impedance voltage measurements. In general, guarding should be used when the resistance of the voltage source is $10^9 \Omega$ or greater. Refer to [Guarding](#) (on page 4-7) for more information.

Input capacitance

At very high resistance levels, the large time constants created by even a minimal amount of capacitance can slow down response time. For example, measuring a source with an internal resistance of $100 \text{ G}\Omega$ results in an RC time constant of one second when measured through a cable with a nominal capacitance of 10 pF . If 1 percent accuracy is required, a single measurement requires at least five seconds.

To minimize this problem:

- Keep the input cable as short as possible
- Use guarding

There is a limit to how short the cable can be. Using guard can reduce these effects by up to a factor of 1000. Refer to [Guarding](#) (on page 4-7) for more information.

Current measurement considerations

Some considerations for making accurate current measurements are summarized in the following paragraphs. Refer to [Other measurement considerations](#) (on page 4-12) for additional measurement considerations.

For comprehensive information on precision measurements, refer to the *Low Level Measurements Handbook*, which is available at tek.com/keithley.

Input bias current

An ideal ammeter would read 0 A with an open input. In practice, however, ammeters have some current that flows when the input is open. This current is known as the input bias (offset) current and may be large enough to corrupt low-current measurements.

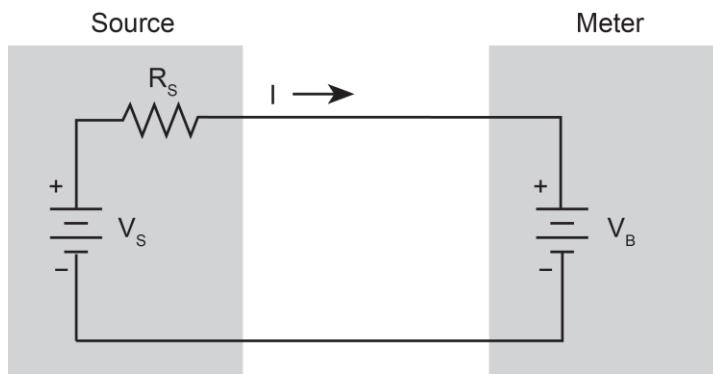
The input bias current for the 6517B is listed in the specifications. Input bias current may be reduced by performing the relative offset adjustment procedure. See [Relative offset](#) (on page 3-29) for more information.

Voltage burden

The input resistance of the ammeter causes a small voltage drop across the input terminals. This voltage is known as the voltage burden. If the voltage burden is large in relation to the voltage of the measured circuit, then significant measurement errors occur.

The following figure shows how voltage burden (V_B) affects current measurements.

Figure 31: Voltage burden



Assume V_s is 5 mV and R_s is 5 k Ω to configure a 1 μ A current source ($5 \text{ mV}/5 \text{ k}\Omega = 1 \text{ }\mu\text{A}$). An ideal ammeter with zero voltage burden would measure the current source as follows:

$$I_M = \frac{V_s}{R_s} = \frac{5 \text{ mV}}{5 \text{ k}\Omega} = 1 \text{ }\mu\text{A}$$

In practice however, every ammeter has a voltage burden. If the voltage burden (V_B) is 1 mV, the current is measured as follows:

$$I_M = \frac{V_s - V_B}{R_s} = \frac{5 \text{ mV} - 1 \text{ mV}}{5 \text{ k}\Omega} = 0.8 \text{ mA}$$

The 1 mV voltage burden caused a 20 percent measurement error. To calculate the error percentage in a measured reading (I_M) due to voltage burden:

$$I_M \% \text{ error} = \frac{100\%}{(V_s/V_B)}$$

The voltage burden of the 6517B depends on the selected range. Refer to the specifications for detail. Voltage burden may be reduced by performing the offset adjustment procedure.

Noise

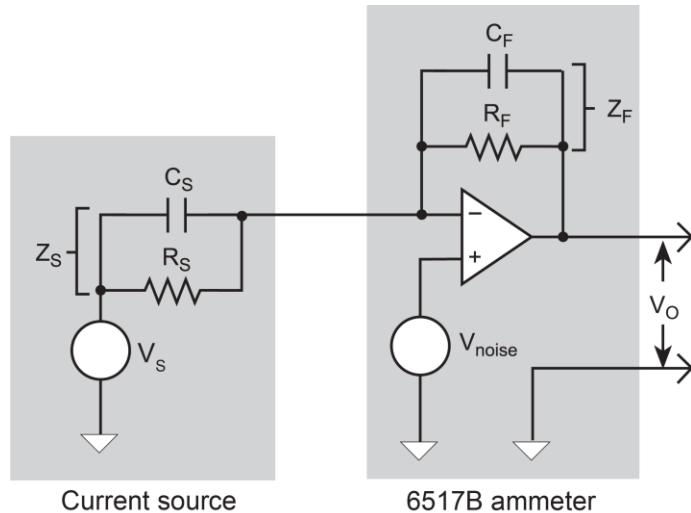
Noise can seriously affect sensitive current measurements. The following paragraphs discuss how source resistance and source capacitance affect noise performance.

Source resistance

The source resistance of the device under test affects the noise performance of current measurements. As the source resistance is reduced, the noise gain of the ammeter increases.

The following figure shows a simplified model of the feedback ammeter.

Figure 32: Source resistance and capacitance



R_S and C_S represent the source resistance and source capacitance, V_S is the source voltage, and V_{NOISE} is the noise voltage. R_F and C_F are the feedback resistance and capacitance, respectively.

The source noise gain of the circuit can be given by the following equation:

$$\text{Output } V_{NOISE} = \text{Input } V_{NOISE} (1 + R_F / R_S)$$

As R_S decreases in value, the output noise increases. For example, when $R_F = R_S$, the input noise is multiplied by a factor of two. Since decreasing the source resistance can have a detrimental effect on noise performance, there are usually minimum recommended source resistance values based on measurement range. The following table summarizes minimum recommended source resistance values for various measurement ranges. The recommended source resistance varies by measurement range because the R_F value also depends on the measurement range.

Range	Minimum recommended source resistance
pA	1 GΩ to 100 GΩ
nA	1 MΩ to 100 MΩ
μA	1 kΩ to 100 kΩ
mA	1 Ω to 100 Ω

Source capacitance

DUT source capacitance also affects the noise performance of the 6517B ammeter. In general, as source capacitance increases, the noise also increases. To see how changes in source capacitance can affect noise gain, refer to the simplified ammeter model in [Source resistance](#) (on page 4-6).

The elements of interest for this discussion are the source capacitance, C_S , and the feedback capacitance, C_F . To take the capacitive reactance of these two elements into account, the previous noise gain formula must be modified as follows:

$$\text{OutputV}_{\text{NOISE}} = \text{InputV}_{\text{NOISE}}(Z_F/Z_S)$$

Here, Z_F represents the feedback impedance made up of C_F and R_F . Z_S is the source impedance formed by R_S and C_S . Furthermore:

$$Z_F = \frac{R_F}{\sqrt{(2\pi f R_F C_F)^2 + 1}}$$

and

$$Z_S = \frac{R_S}{\sqrt{(2\pi f R_S C_S)^2 + 1}}$$

As C_S increases in value, Z_S decreases in value, thereby increasing the noise gain. At the point where $Z_S = Z_F$, the input noise is amplified by a factor of two.

The maximum value of source capacitance (C_S) for the 6517B ammeter is 10,000 pF. You can, however, usually measure at higher source capacitance values by inserting a resistor in series with the ammeter input. Be aware that any series resistance increases the voltage burden by a factor of $I_{IN} * R_{SERIES}$. For example, the range of resistance listed in the table of minimum recommended source resistance values (see [Source resistance](#) (on page 4-6)) results in voltage burden values in the range of 1 mV to 1 V. A useful alternative to a series resistor is a series diode, or two diodes in parallel back-to-back. The diodes can be small-signal types and should be in a light-tight enclosure.

Guarding

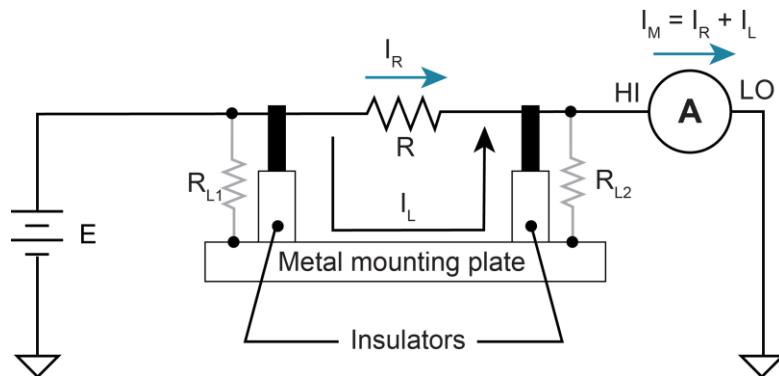
For current measurements, guarding greatly reduces leakage currents in high-impedance test circuits. The ammeter input LO (inner shield of the triaxial cable) is used as the guard.

For information on connections for guard and enabling guard, refer to “Shielding and guarding” in the *Model 6517B User’s Manual*.

High impedance current measurements

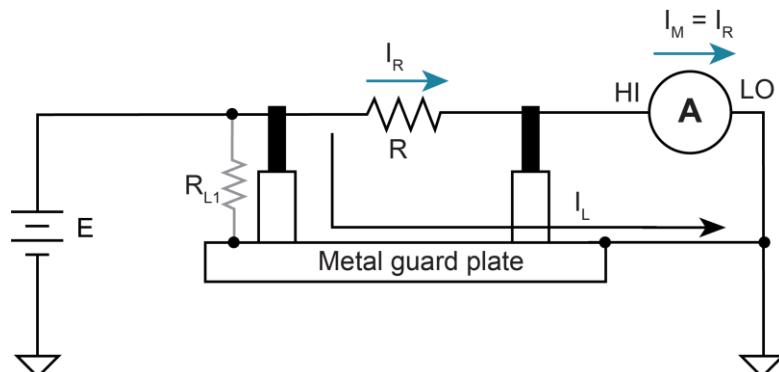
Significant leakage could occur across a high impedance ($\geq 1 \text{ G}\Omega$) DUT through the insulators, as shown in the following figure, where R_{L1} and R_{L2} represent the leakage resistance. So instead of measuring the current (I_R) through R (which is $\geq 1 \text{ G}\Omega$), you are also measuring the leakage current (I_L). The current measured by the ammeter is $I_M = I_R + I_L$.

Figure 33: High impedance current measurements - unguarded



By connecting ammeter input LO to the metal mounting (guard) plate, as shown in the following figure, the leakage current (I_L) is shunted to ammeter input LO and is not measured by the ammeter. The ammeter only measures I_R .

Figure 34: High impedance current measurements - guarded



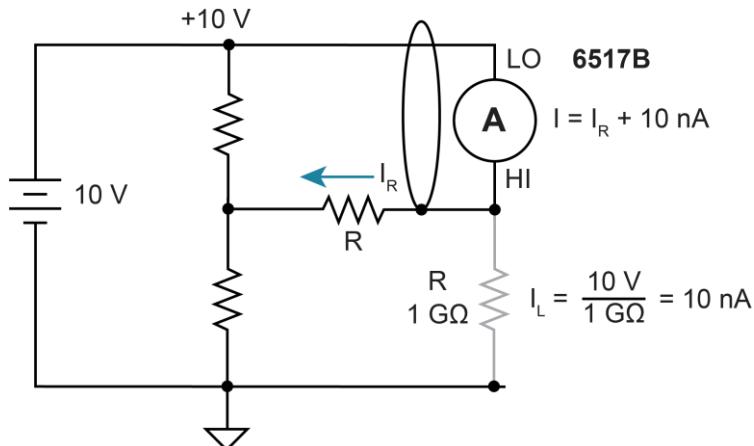
Floating current measurements

Guarding uses a conductor at essentially the same potential as the sensitive input to drastically reduce leakage currents in high impedance test circuits. No current can flow when there is a 0 V drop across a leakage resistance.

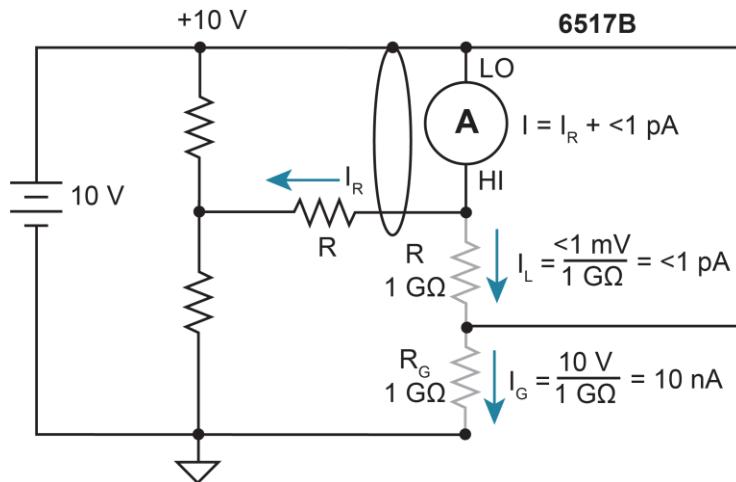
For floating current measurements, ammeter input low is used as the guard since it totally surrounds input high (through the input triaxial cable) and it is at nearly the same potential as input high. In reality, the ammeter drops <1 mV and is known as the voltage burden.

The following figure shows an unguarded floating current measurement in a high impedance circuit. The goal is to measure the current (I_R) through resistor R. However, a leakage path (R_L) exists from ammeter input LO to test circuit common. Since the ammeter drops < 1 mV, approximately 10 V is dropped by R_L . The current through R_L is approximately 10 nA ($10 \text{ V}/1 \text{ G}\Omega = 10 \text{ nA}$), so the current that is measured by the 6517B is the sum of the two currents ($I = I_R + 10 \text{ nA}$). If I_R is a low-level current, the 10 nA leakage current corrupts the measurement.

Figure 35: Floating current measurements - unguarded



The following figure shows the guarded version of the same circuit. Notice that the only difference is that the connections to the 6517B are reversed. Resistor R_L now represents the leakage from ammeter input HI to ammeter input LO, and resistor R_G represents the leakage from ammeter input LO (guard) to test circuit common. As previously mentioned, the ammeter drops < 1 mV. It then follows that there is a < 1 mV drop across R_L , so the current through R_L is < 1 pA (< 1 mV/1 GΩ = < 1 pA). The current that is measured by the 6517B is the sum of the two currents ($I = I_R + < 1 \text{ pA}$). The use of guarding reduced the leakage current from 10 nA to < 1 pA. The 10 nA leakage current (I_G) from ammeter input LO to test circuit low still exists, but it is inconsequential because it is not measured by the 6517B.

Figure 36: Floating current measurements - guarded

Resistance measurement considerations

Some considerations for making accurate resistance and resistivity measurements are summarized in the following paragraphs. High resistance measurements (above 1 M Ω) may exhibit problematic background currents and can be improved by using the alternating polarity test sequence. Refer to [Alternating polarity resistance/resistivity test](#) (on page 5-13) for more detail.

See [Other measurement considerations](#) (on page 4-12) for additional information.

For comprehensive information on precision measurements, refer to the *Low Level Measurements Handbook*, which is available from tek.com.

Leakage resistance

Even though the source voltage, measure current (SVMI) method for resistance measurements minimizes the effects of leakage resistance, there are some cases where leakage can affect the measurement. For example, test fixture leakage paths may appear in parallel with the device being measured, introducing errors in the measurement. These errors can be minimized by using proper insulating materials (such as Teflon) in test fixture terminals and by keeping them clean and moisture free.

Leakage currents in the test fixture can be canceled by using relative offset on the current component of the measurement.

Voltage coefficient

The measured value of a high-megohm resistor often varies with the applied voltage. This variation in resistance is known as the voltage coefficient, and is usually expressed in percent/volt or ppm/volt values. To obtain consistent test results, these resistors should always be biased at the same voltage.

You can use the 6517B to characterize these resistance changes by measuring the resistance with a number of different applied voltages. Once the variations are known, the voltage coefficient of the resistor being tested can be determined.

Test voltage and electrification time

The test voltages that are typically specified to be applied to the insulator sample are 100 V, 250 V, and 1000 V. Higher test voltages are sometimes used, however, the maximum voltage that can be applied to the Model 8009 is 1000 V, which is the maximum output of the 6517B voltage source. Unless otherwise specified, the applied direct voltage to the insulator sample should be 500 V.

Electrification time, also known as bias time, is the total time that the specified voltage is applied to the insulator sample when the measurement is made. For example, for an electrification time of 60 seconds, the measurement is made after the insulator sample is subjected to the applied test voltage for 60 seconds. The conventional arbitrary electrification time is 60 seconds, but special studies or experimentation may dictate a different electrification time.

Current measurement considerations

Resistance measurements are performed by sourcing voltage and measuring current, so accurate measurements require accurate current measurements. Refer to [Current measurement considerations](#) (on page 4-4) for more information.

Capacitive inputs increase preamplifier noise, resulting in increased noise across the voltage source terminals.

Charge measurement considerations

Some considerations for making accurate charge measurements are summarized in the following paragraphs.

See [Other measurement considerations](#) (on page 4-12) for additional information.

For comprehensive information on precision measurements, refer to the *Low Level Measurements Handbook*, which is available from tek.com.

Input bias current

A primary consideration when making charge measurements is the input bias (offset) current of the integrating amplifier. Input bias current is integrated with the input signal and reflected in the final reading. The maximum input bias for the charge function of the 6517B 4 fA (4×10^{-15} A) at 23 °C. This input offset translates into a charge of 4 fC per second at a temperature of 23 °C. This value must be subtracted from the final reading to obtain the correct value.

You can reduce the input bias current by performing the offset adjustment procedure. Refer to [Relative offset](#) (on page 3-29).

External voltage source

When using an external voltage source, the input current should be limited to less than 1 mA by placing a resistor in series with the high input lead. The value of this resistor should be at least:

$$R = 1000 \times V \text{ (ohms)}$$

Where V is the voltage across the resistor or the compliance of the current being integrated.

Measurement times

Long measurement times may degrade charge measurement accuracy. See the 6517B specifications, available at tek.com/keithley.

Zero check hop and autodischarge hop

Switching from the enabled to disabled state of the zero check feature causes a sudden change in the charge reading, known as zero check hop. This sudden change in charge also occurs when the autodischarge feature resets the charge reading to zero. To eliminate this hop in charge, enable the relative offset immediately after zero check is disabled or when autodischarge resets the charge reading. This action nulls out the charge reading caused by the hop.

You can also make a reading immediately when zero check is disabled or when an autodischarge occurs and subtract that reading from all subsequent readings.

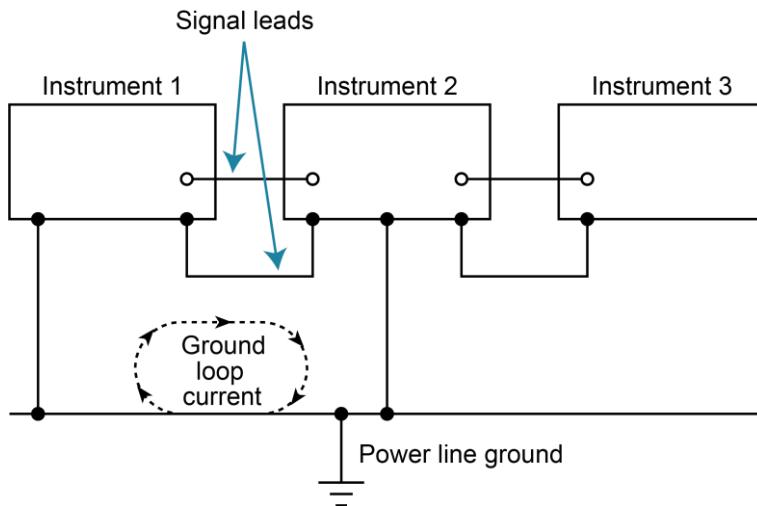
Other measurement considerations

The following measurement considerations apply to all precision measurements. For comprehensive information on all measurement considerations, refer to the *Low Level Measurements Handbook*, which is available from tek.com/keithley.

Ground loops

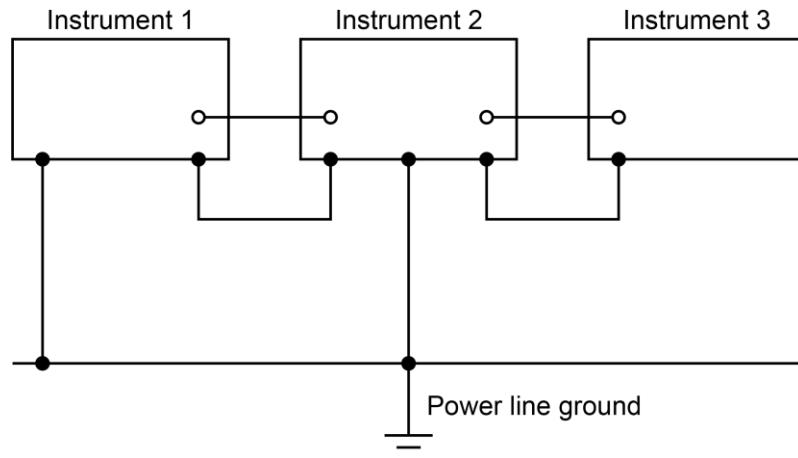
Ground loops that occur in multiple-instrument test setups can create error signals that cause erratic or erroneous measurements. The configuration shown in the following figure introduces errors in two ways. Large ground currents flowing in one of the wires encounter small resistances, either in the wires, or at the connecting points. This small resistance results in voltage drops that can affect the measurement. Even if the ground loop currents are small, magnetic flux cutting across the large loops formed by the ground leads can induce sufficient voltages to disturb sensitive measurements.

Figure 37: Power-line ground loops



To prevent ground loops, instruments should be connected to ground at a single point, as shown in the following figure, where a single instrument is connected directly to power line ground. Experimentation is the best way to determine an acceptable arrangement. For this purpose, measuring instruments should be placed on their lowest ranges. The configuration that results in the lowest noise signal is the one that should be used.

Figure 38: Eliminating ground loops



Triboelectric effects

Triboelectric currents are generated by charges created between a conductor and an insulator due to friction. Free electrons rub off the conductor and create a charge imbalance that causes the current flow. For example, bending a triaxial cable causes friction between the center conductor (HI) and its surrounding insulator, resulting in triboelectric currents.

To minimize triboelectric currents:

- Use low noise cables. These cables are designed to minimize charge generation and use graphite to reduce friction. The Keithley Instruments Model 7078-TRX triaxial cables are low noise.
- Use the shortest cables possible.
- Secure cables (for example, tape or tie) to a nonvibrating surface.

Piezoelectric and stored charge effects

Piezoelectric currents are generated when mechanical stress is applied to certain insulating materials, such as crystalline. In some plastics, pockets of stored charge cause the material to behave in a similar manner.

When building test fixtures, choose good insulating materials and make connecting structures as rigid as possible. Make sure there are no mechanical stresses on the insulators.

Electrochemical effects

Error currents can arise from electrochemical effects when ionic chemicals create weak batteries on a circuit board. These batteries can generate a few nanoamps of current between conductors. Ionic contamination may be the result of body oils, salts, or solder flux. The problem is further enhanced by high humidity (moisture) that decreases insulation resistance.

When building test fixtures, select insulators that resist water absorption and use the fixture in a moderate humidity environment. Keep all insulators clean and free of contamination.

Humidity

Excess humidity can reduce insulation resistance on printed circuit boards and in test connection insulators. Reduction in insulation resistance can seriously affect high-impedance measurements.

Moisture can combine with contaminants to produce offset currents caused by electrochemical effects. To minimize the effects of moisture, keep humidity to a minimum (ideally < 50 percent), and keep components and connectors in the test system clean.

Light

Some components, such as semiconductor junctions and MOS capacitors on semiconductor wafers, are excellent light detectors. Consequently, these components must be tested in a light-free environment. Many test fixtures provide adequate light protection, but others may allow enough light penetration to affect the test results. Areas to check for light leaks include doors and door hinges, tubing entry points, and connectors or connector panels.

Electrostatic interference

Electrostatic interference occurs when an electrically charged object is brought near an uncharged object, inducing a charge on the previously uncharged object. Usually, effects of such electrostatic action are not noticeable because low impedance levels allow the induced charge to dissipate quickly. However, the high impedance levels of many 6517B measurements do not allow these charges to decay rapidly, which may result in erroneous or unstable readings. These erroneous or unstable readings may be caused in the following ways:

- DC electrostatic field can cause undetected errors or noise in the reading.
- AC electrostatic fields can cause errors by driving the input preamplifier into saturation or through rectification that produces dc errors.

Electrostatic interference is first recognizable when hand or body movements near the experiment cause fluctuations in the reading. Pick-up from ac fields can also be detected by observing the 6517B preamplifier output on an oscilloscope. Line frequency signals on the output are an indication that electrostatic interference is present.

To minimize electrostatic interference:

- Use shielding. Possibilities include a shielded room, a shielded booth, shielding the sensitive circuit, and using shielded cable. Refer to "Shielding and guarding" in the *Model 6517B User's Manual* for detail.
- Reduce electrostatic fields. Move power lines or other sources away from the device under test.

Magnetic fields

A magnetic field passing through a loop in a test circuit generates a magnetic EMF (voltage) that is proportional to the strength of the field, the loop area, and the rate at which these factors are changing.

To minimize magnetic fields:

- Locate the test circuit as far away as possible from magnetic field sources such as motors, transformers, and magnets.
- Avoid moving any part of the test circuit within the magnetic field.
- Minimize the loop area by keeping leads as short as possible and twisting them together.

Electromagnetic interference

The electromagnetic interference (EMI) characteristics of the 6517B comply with the electromagnetic compatibility (EMC) requirements of the European Union as denoted by the CE mark. However, it is still possible for sensitive measurements to be affected by external sources. In these instances, special precautions may be required in the measurement setup.

Sources of EMI include:

- Radio and TV broadcast transmitters.
- Communications transmitters, including mobile phones and handheld radios.
- Devices incorporating microprocessors and high-speed digital circuits.
- Impulse sources, such as arcing in high-voltage environments.

The effect of EMI on instrument performance can be considerable if enough of the unwanted signal is present. The effects of EMI can be seen as an unusually large offset. If the EMI is from impulse sources, there will be erratic variations in the displayed reading.

To avoid the effects of EMI, keep the instrument and experiment as far away as possible from any EMI sources. Additional shielding of the instrument, experiment, and test leads often reduces EMI to an acceptable level. In extreme cases, a specially constructed screen room may be required to sufficiently attenuate the troublesome signal.

External filtering of the input signal path may be required. In some cases, a simple one-pole filter may be sufficient. In more difficult situations, multiple notch or band-stop filters, tuned to the EMI frequency range, may be required. Connecting multiple capacitors of widely different values in parallel maintains a low impedance across a wide frequency range. Be aware that filtering may have detrimental effects (such as increased response time) on the measurement.

Section 5

Test sequences

In this section:

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Introduction

The 6517B has the following built-in test sequences:

- Device characterization tests:
 - Diode leakage current
 - Capacitor leakage
 - Cable insulation resistance
 - Resistor voltage coefficient
- Resistivity tests:
 - Normal (surface and volume)
 - Alternating polarity
- Surface insulation resistance (SIR) test
- Sweep tests:
 - Square wave
 - Staircase

The following information describes each test, shows the connections to the 6517B, and explains how to set up the 6517B for the measurements.

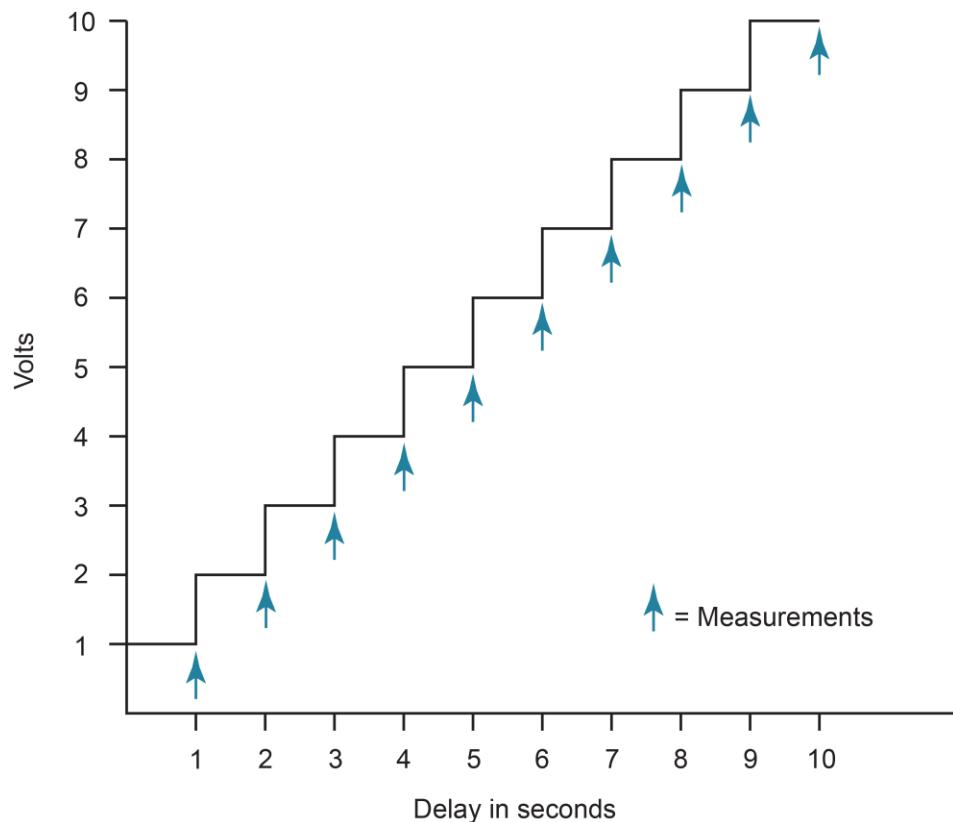
The results of a test are stored in the buffer. For example, if a test performs 10 measurements, those 10 readings are stored in the buffer at locations 0 through 9. If a test only performs one measurement, that single reading is stored at memory location 0. When a test is performed, previous data stored in the buffer is cleared.

Diode leakage current test

This test measures the leakage current for a diode and allows you to measure the current at various voltage levels.

The following figure shows an example using the default test parameters. When the test is run, 10 current measurements are made (one at each voltage step) and stored in the buffer.

Figure 39: Diode leakage current test default measurement points



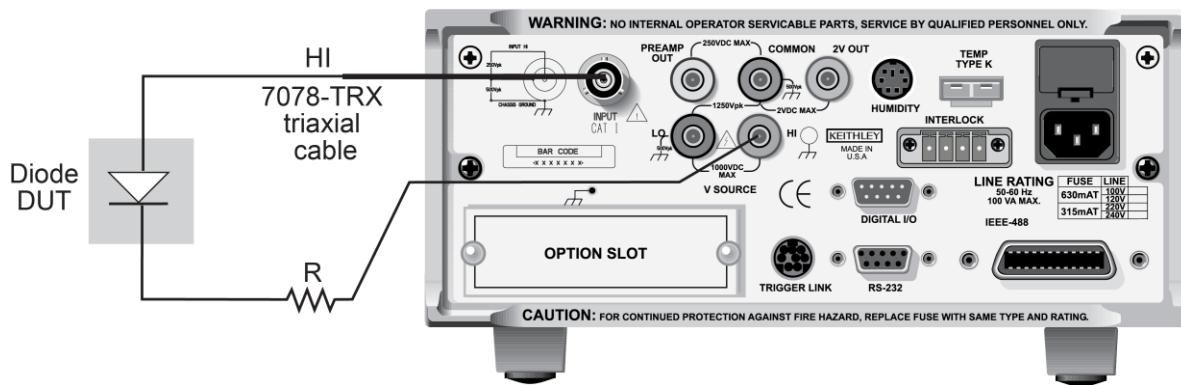
Test parameters:

- **START V:** +1 V
- **STOP V:** +10 V
- **STEP V:** +1 V
- **DELAY:** 1 s

Diode leakage current test connections

The following figure shows the connections and the simplified schematic for this test.

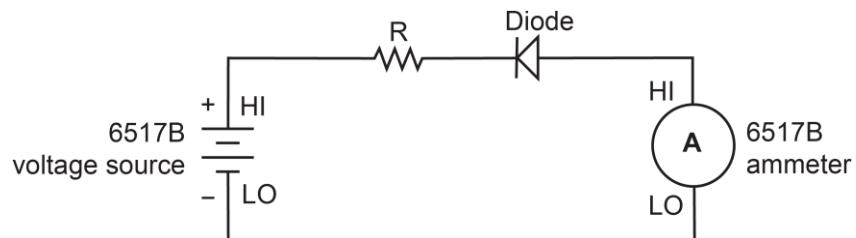
Figure 40: Diode leakage current test connections



NOTE

Ammeter LO is internally connected to V-SOURCE LO.

Figure 41: Diode leakage current test equivalent circuit



This test sources a positive voltage to measure the leakage current through the diode. If you source a negative voltage, you forward bias the diode. Resistor R limits the current if the diode shorts out or becomes forward biased. Select a value of R that limits current to 20 mA or less.

Run the diode leakage current test

To run the diode leakage current test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **APPLICATIONS**. Press the **ENTER** key.
6. Select **DEV-CHAR**. Press the **ENTER** key.
7. Select **DIODE**. Press the **ENTER** key.
8. Select **LEAKAGE-CURRENT**. Press the **ENTER** key.
9. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **START V**: The start voltage.
 - **STOP V**: The stop voltage.
 - **STEP V**: The step voltage.
 - **DELAY**: The delay in seconds.
10. Press the **EXIT** key to return to the CONFIGURE SEQUENCE menu.
11. Select **CONTROL**. Press the **ENTER** key.
12. Set the event that triggers the test to start:
 - **MANUAL**: Start when the **TRIG** key is pressed.
 - **IMMEDIATE**: Start as soon as the test is armed.
 - **LID-CLOSURE**: Start when the test fixture lid is closed.
 - **GPIB**: Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL**: Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK**: Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
13. Press the **ENTER** key.
14. Press the **EXIT** key to return to the measurement display.
15. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
16. When the test is finished, zero check remains disabled and the voltage source goes into standby.
17. To access the measured readings, press the **RECALL** key.

Capacitor leakage current test

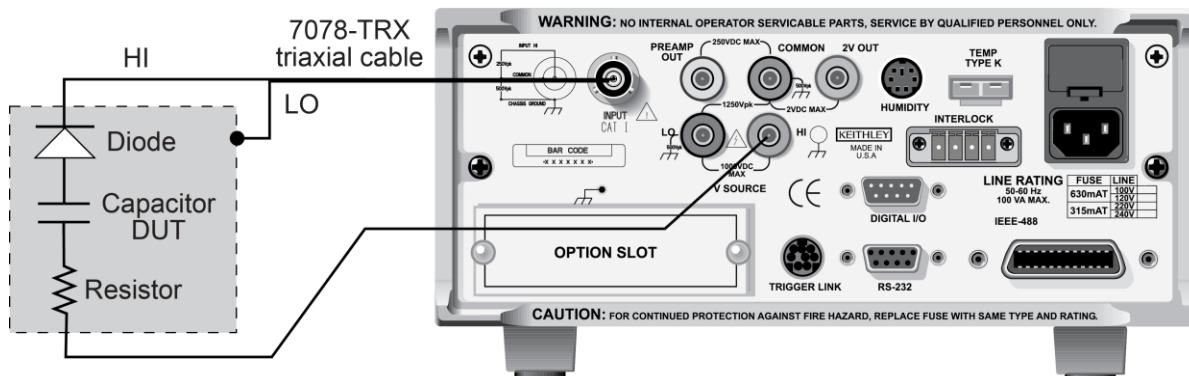
This test measures the leakage current of a capacitor. The magnitude of the leakage depends on the type of dielectric and the applied voltage.

For this test, a fixed voltage (BIAS V) is applied to the capacitor for specified time intervals to allow the capacitor to charge (current decays exponentially with time). The leakage current is measured at each interval and stored in the buffer.

Capacitor leakage current test connections

The following figure shows the connections for this test. The resistor and diode limit noise for the measurement.

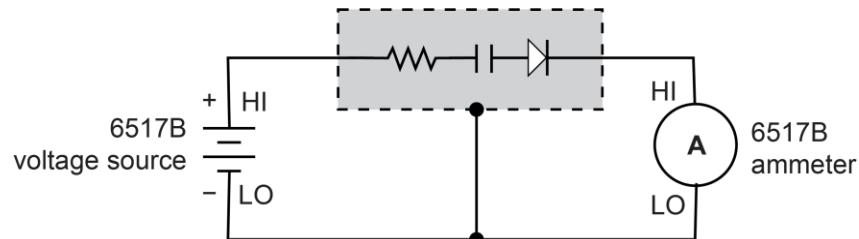
Figure 42: Capacitor leakage current test connections



NOTE

Ammeter LO is internally connected to V-SOURCE LO.

Figure 43: Capacitor leakage current test connections - equivalent circuit



Run the capacitor leakage current test

To run the capacitor leakage current test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **DEV-CHAR**. Press the **ENTER** key.
6. Select **CAPACITOR**. Press the **ENTER** key.
7. Select **LEAKAGE-CURRENT**. Press the **ENTER** key.
8. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **BIAS V**: The bias voltage.
 - **STORE nnnnn READINGS**: The number of readings to make.
 - **INTERVAL**: The interval between readings in seconds.
9. Press the **EXIT** key to return to the previous menu.
10. Set the event that triggers the test to start:
 - **MANUAL**: Start when the **TRIG** key is pressed.
 - **IMMEDIATE**: Start as soon as the test is armed.
 - **LID-CLOSURE**: Start when the test fixture lid is closed.
 - **GPIB**: Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL**: Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK**: Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
11. Press the **ENTER** key.
12. Press the **EXIT** key to return to the measurement display.
13. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
14. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs.
15. When the test is finished, zero check remains disabled and the voltage source goes into standby.
16. To access the measured readings, press the **RECALL** key.

Cable insulation resistance test

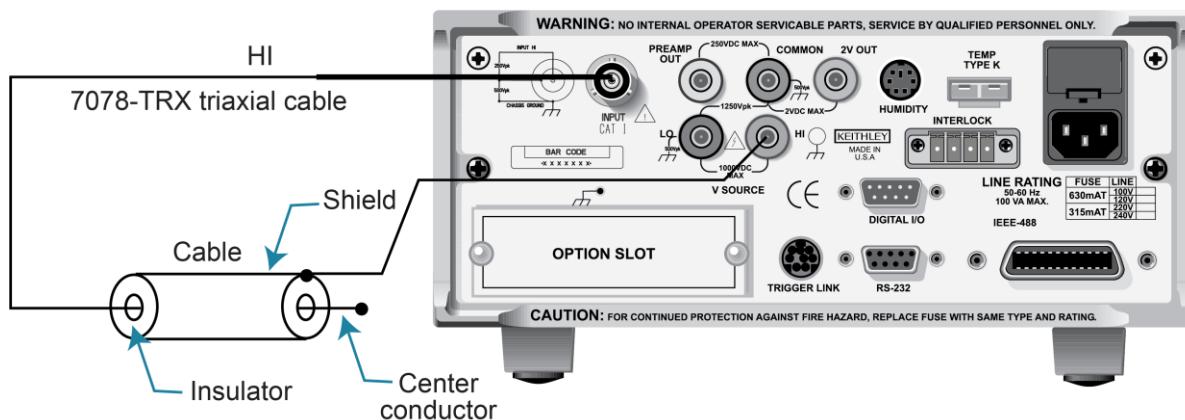
The test measures the resistance of the insulator of a cable between the shield and the inner conductor.

Cable insulation resistance test connections

The following figure shows the connections for this test.

Keep the cable sample as short as possible to minimize input capacitance to the ammeter.

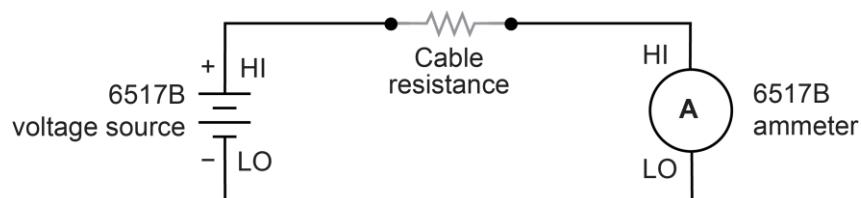
Figure 44: Cable insulation resistance test connections



NOTE

Ammeter LO is internally connected to V-SOURCE LO.

Figure 45: Cable insulation resistance test connections - equivalent circuit



Run the cable insulation resistance test

To run the cable insulation resistance test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **DEV-CHAR**. Press the **ENTER** key.
6. Select **CABLE**. Press the **ENTER** key.
7. Select **INSULATION-RESISTANCE**. Press the **ENTER** key.
8. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **BIAS V**: The bias voltage. The bias voltage is applied across the insulator for a specified time to allow the charging effects of cable capacitance to stabilize.
 - **STORE READINGS**: The number of readings to make.
 - **INTERVAL**: The interval between readings in seconds.
9. Press the **EXIT** key to return to the previous menu.
10. Set the event that triggers the test to start:
 - **MANUAL**: Start when the **TRIG** key is pressed.
 - **IMMEDIATE**: Start as soon as the test is armed.
 - **LID-CLOSURE**: Start when the test fixture lid is closed.
 - **GPIB**: Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL**: Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK**: Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
11. Press the **ENTER** key.
12. Press the **EXIT** key to return to the measurement display.
13. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
14. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs.
15. When the test is finished, zero check remains disabled and the voltage source goes into standby.
16. To access the measured readings, press the **RECALL** key.

Resistor voltage coefficient test

High valued resistors often have a change in resistance with applied voltage. This change in resistance is characterized as the voltage coefficient. Voltage coefficient is defined as the percent change in resistance per unit change in applied voltage:

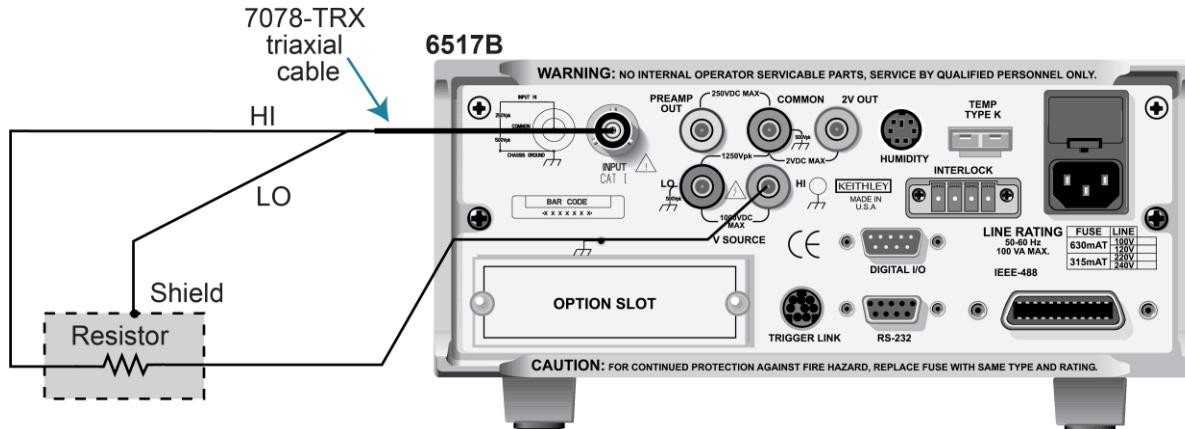
$$\text{Voltage Coefficient} = \frac{R_1 - R_2}{R_1} \times \frac{1}{V_2 - V_1}$$

This test makes two resistance measurements at two different voltage levels and calculates the voltage coefficient.

Resistor voltage coefficient test connections

The test circuit is shown in the following figure. The resistor should be placed in a shielded test fixture that is designed to minimize leakage resistance.

Figure 46: Resistor voltage coefficient test circuit



NOTE

Ammeter LO is internally connected to V-SOURCE LO.

Run the resistor voltage coefficient test

To run the resistor voltage coefficient test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **DEV-CHAR**. Press the **ENTER** key.
6. Select **RESISTOR**. Press the **ENTER** key.
7. Select **VOLTAGE-COEFFICIENT**. Press the **ENTER** key.
8. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **SOURCE V1**: The first test voltage.
 - **DELAY 1**: The first delay in seconds.
 - **SOURCE V2**: The second test voltage.
 - **DELAY 2**: The second delay in seconds.
9. Press the **EXIT** key to return to the previous menu.
10. Set the event that triggers the test to start:
 - **MANUAL**: Start when the **TRIG** key is pressed.
 - **IMMEDIATE**: Start as soon as the test is armed.
 - **LID-CLOSURE**: Start when the test fixture lid is closed.
 - **GPIB**: Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL**: Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK**: Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
11. Press the **ENTER** key.
12. Press the **EXIT** key to return to the measurement display.
13. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
14. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. SOURCE V1 is applied to the resistor. After DELAY 1, a resistance measurement is made. SOURCE V2 is then applied. After DELAY 2, a second resistance measurement is made. The 6517B then automatically calculates the voltage coefficient and stores it in the buffer.
15. When the test is finished, zero check remains disabled and the voltage source goes into standby.
16. To access the measured readings, press the **RECALL** key.

Standard method resistivity tests

This test measures the resistivity (surface or volume) of an insulator sample. When used with the Keithley Instruments Model 8009 Resistivity Test Fixture, the test conforms to the ASTM D-257 standard.

Resistivity test connections

Refer to the following figure for connections to the Model 8009 for these tests. Refer to the instruction manual for the Model 8009 to install the insulator sample in the test fixture.

NOTE

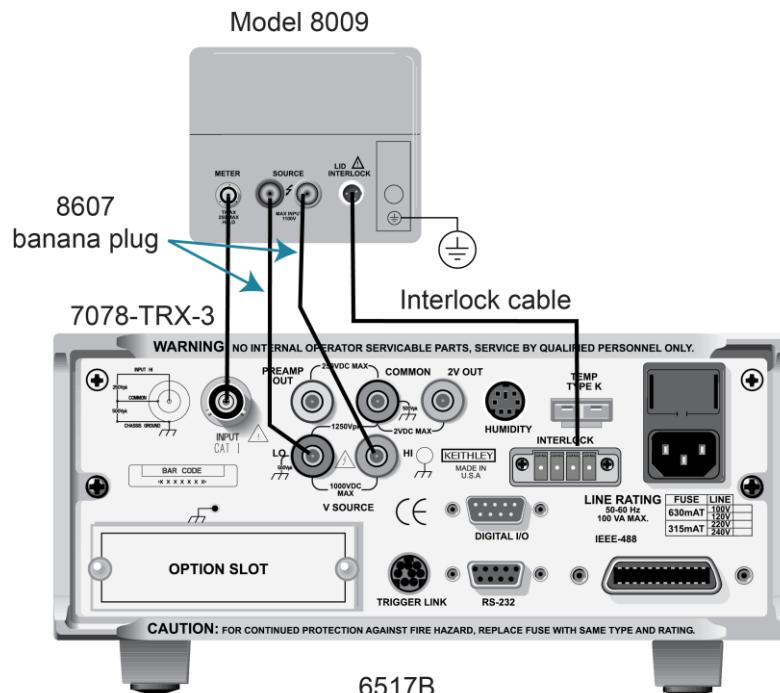
If the 6517B is configured to use the Model 8009 Resistivity Test Fixture, the interlock cable must be connected to the 8009 test fixture. The measurement type (surface or volume) is automatically selected by the switch position on the test fixture. Attempts to change the measurement type from the 6517B menu are ignored. If the interlock cable is not connected, the settings for volume or surface do not work properly.

⚠ WARNING

Hazardous voltages may be present on the output and guard terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the 6517B while the output is on. Power off the equipment from the front panel or disconnect the main power cord from the rear of the 6517B before handling cables connected to the outputs. Putting the equipment in standby mode does not guarantee that the outputs are not powered if a hardware or software fault occurs.

⚠ WARNING

Connect earth ground of the test fixture to protective earth (safety ground) using safety ground wire.

Figure 47: Connections for resistivity measurements using the Model 8009 test fixture

Run the surface or volume resistivity test

To run the surface or volume resistivity test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **APPLICATIONS**.
6. Select **R/RESISTIVITY**. Press the **ENTER** key.
7. Select **NORMAL**. Press the **ENTER** key.
8. Select **SURFACE** or **VOLUME**. Press the **ENTER** key.
9. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **PRE-DISCH**: The predischarge time in seconds.
 - **BIAS V**: The bias voltage.
 - **BIAS-TIME**: The bias time in seconds.
 - **MEAS-V**: The measurement voltage. This is typically set to the same level as **BIAS V**.
 - **MEAS-TIME**: The measurement time in seconds.
 - **DISCHARGE**: The discharge time in seconds.

10. Press the **EXIT** key to return to the previous menu.
11. Set the event that triggers the test to start:
 - **MANUAL:** Start when the **TRIG** key is pressed.
 - **IMMEDIATE:** Start as soon as the test is armed.
 - **LID-CLOSURE:** Start when the test fixture lid is closed.
 - **GPIB:** Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL:** Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK:** Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
12. Press the **ENTER** key.
13. Press the **EXIT** key to return to the measurement display.
14. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
15. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs.

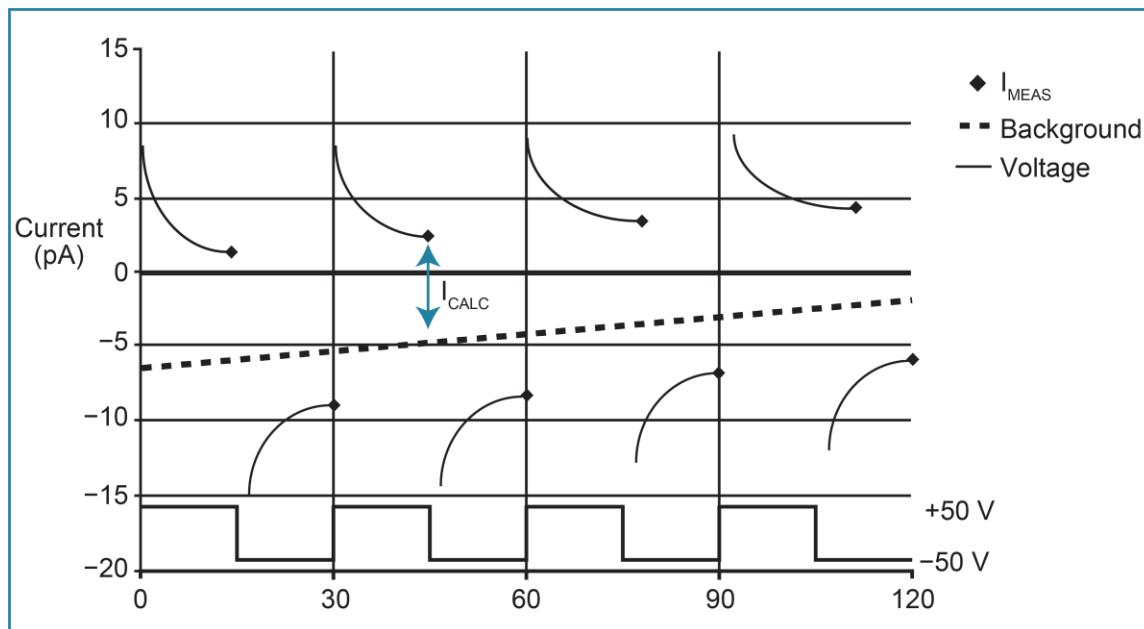
When this test is run, the voltage source is initially set to source 0 V for PRE-DISCH time to allow any charge to dissipate. The voltage source then applies BIAS V to the electrodes of the test fixture for the BIAS-TIME. This bias period allows currents in the test circuit to stabilize. The voltage source then applies MEAS-V. After MEAS-TIME, the 6517B measures the resistivity of the sample and stores the reading in the buffer.
16. When the test is finished, zero check remains disabled and the voltage source goes into standby.
17. To access the measured readings, press the **RECALL** key.

Alternating polarity resistance/resistivity test

The alternating polarity resistance/resistivity test improves high resistance/resistivity measurements. These measurements are prone to large errors due to background currents. By using an alternating stimulus voltage, it is possible to eliminate the effects of these background currents.

Refer to [Resistivity test connections](#) (on page 5-11) for test connections.

The following figure shows an example of the alternating polarity test using the test parameters shown and the resulting sample current from a typical high resistance sample. Notice that the sample currents shown exhibit some capacitive decay, as many high-resistance samples tend to have significant capacitance.

Figure 48: Alternating polarity test example

Run the alternating polarity resistance/resistivity test

The alternating polarity test is re-armed upon completion of a sequence. You can recall readings or reconfigure the sequence while the 6517B waits for the trigger.

When this test is run, the voltage source alternates between two voltages ($V_{OFS} + V_{ALT}$) and ($V_{OFS} - V_{ALT}$) at the interval set by MEAS-TIME. Current measurements are made at the end of each of these alternations and after calculation of I_{CALC} resistance values. I_{CALC} is a weighted average of the latest four current measurements, each at the end of a separate alternation. The resistance value is then converted to a resistivity value if the meter has been configured for resistivity measurements. The alternation continues until a specified number of readings are stored in the buffer. The time required to complete a sequence is:

$$(STORE + DISCARD + 4) * MEAS-TIME$$

For example, a sequence alternating at 15 second intervals, discarding three readings, and storing three readings takes 2.5 minutes.

When the alternating polarity sequence is first armed, the settings for the current measurements made internally to the sequence are preset to the settings for the current function. If the current function is set to a specific range, the sequence defaults to that range. If the current function is autoranging, the sequence defaults to autoranging. The range can be changed after the sequence is armed by pressing the manual or AUTO range keys. The alternating polarity sequence does not autorange past the 2 nA range. If the resistance/resistivity to be measured is high and a more sensitive range is required, you must set this range manually using the manual RANGE keys. For the 20 pA and 200 pA ranges, use a measure time of at least 15 seconds.

While the test is in the armed condition, you can press the CONFIG key followed by the SEQ key to change parameters. You can change the range, the output result type (resistance or surface or volume resistivity), and the resistivity parameters.

During execution, the sequence displays ----- until the first reading becomes available and is sent to the buffer. After this, the latest calculated value is displayed. If, at the end of any alteration, the current exceeds the current range in use, the error +618 Resistivity Out Of Limit occurs and the sequence aborts, returning it to the function in use before it was last armed. If the alternating polarity sequence calculates a current of zero, <Infinity> is displayed, but the sequence continues. A lower current range should be selected.

To run the alternating polarity resistance/resistivity test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **R** key.
5. Select **MEAS-TYPE**. Press the **ENTER** key.
6. Select **RESISTIVITY**. Press the **ENTER** key.
7. Select **SURFACE** or **VOLUME**. Press the **ENTER** key.
8. Press the **CONFIG** key.
9. Press the **SEQ** key.
10. Select **R/RESISTIVITY**. Press the **ENTER** key.
11. Select **ALT-POLARITY**. Press the **ENTER** key.
12. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **V-OFS:** The offset voltage.
 - **V-ALT:** The alternating voltage.
 - **MEAS-TIME:** The measurement time in seconds.
 - **DISCARD RDGS:** The readings to discard. This allows you to reject the first few readings as the sample or resistance achieves a steady-state response to the alternating voltage.
 - **STORE RDGS:** The number of readings to store.
13. Press the **EXIT** key to return to the previous menu.

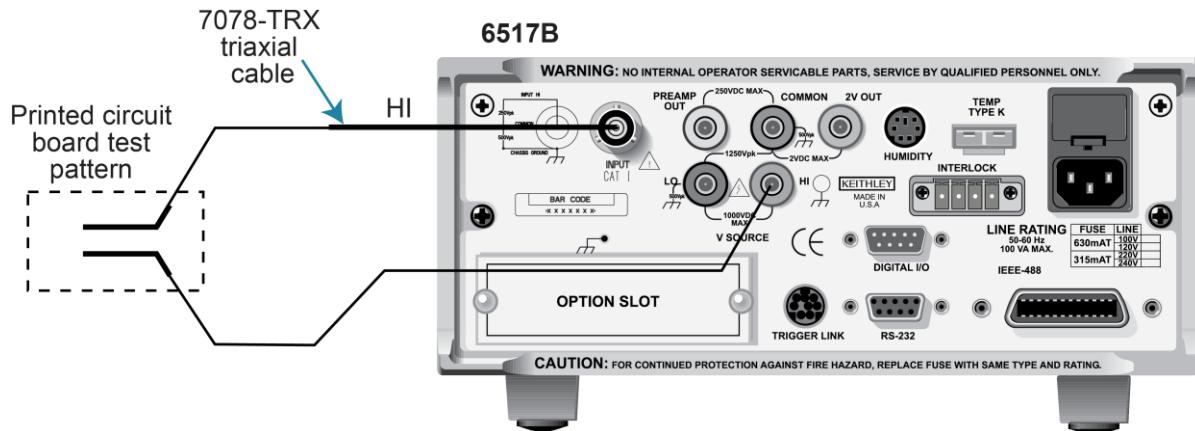
14. Set the event that triggers the test to start:
 - **MANUAL:** Start when the **TRIG** key is pressed.
 - **IMMEDIATE:** Start as soon as the test is armed.
 - **LID-CLOSURE:** Start when the test fixture lid is closed.
 - **GPIB:** Start on GPIB trigger (**GET** or ***TRG**) or when the **TRIG** key is pressed.
 - **EXTERNAL:** Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK:** Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
15. Press the **ENTER** key.
16. Press the **EXIT** key to return to the measurement display.
17. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
18. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. The test is re-armed at the completion of a sequence.
19. Trigger the next sequence to continue. To end the sequences, press the **EXIT** key to return to normal operation.
20. When the test is finished, zero check remains disabled and the voltage source goes into standby.
21. To access the measured readings, press the **RECALL** key.

Surface insulation resistance (SIR) test

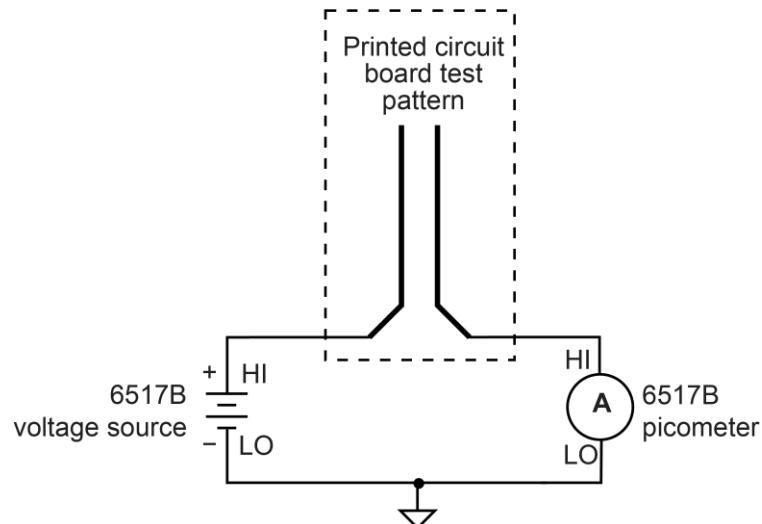
This test measures the insulation resistance between printed circuit board traces.

Surface insulation resistance connections

The following figures show the connections and the equivalent circuit. The "Y" test pattern for the measurement is a typical test pattern for SIR tests.

Figure 49: Surface insulation test connections**NOTE**

Ammeter LO is internally connected to V-SOURCE LO.

Figure 50: Surface insulation test connections - equivalent circuit

Run the surface insulation resistance test

To run the surface insulation resistance test:

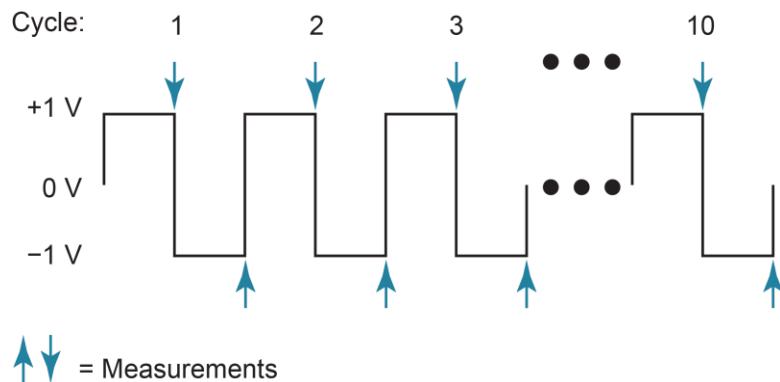
1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **SUR-INSUL-RES-TEST**. Press the **ENTER** key.
6. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **BIAS V**: The bias voltage
 - **BIAS-TIME**: The bias time in seconds.
 - **MEAS-V**: The measurement voltage.
 - **MEAS-TIME**: The measurement time in seconds.
7. Press the **EXIT** key to return to the previous menu.
8. Set the event that triggers the test to start:
 - **MANUAL**: Start when the **TRIG** key is pressed.
 - **IMMEDIATE**: Start as soon as the test is armed.
 - **LID-CLOSURE**: Start when the test fixture lid is closed.
 - **GPIB**: Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL**: Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK**: Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
9. Press the **ENTER** key.
10. Press the **EXIT** key to return to the measurement display.
11. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero.
12. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs.
BIAS V is applied to the test pattern for BIAS-TIME. This bias period polarizes the test pattern. The MEAS-V is then applied for the MEAS-TIME, then the 6517B measures the resistance and stores the reading in the buffer.
13. When the test is finished, zero check remains disabled and the voltage source goes into standby.
14. To access the measured readings, press the **RECALL** key.

Square wave sweep test

The voltage and measure square wave sweep test can be used for any type of measurement: Voltage, current, resistance, or charge.

The square wave sweep test allows you to make a series of measurements at an alternating high and low voltage level. The following figure shows an example using the default test parameters. When the test is run, 20 measurements are performed (at each high and low level) and stored in the buffer.

Figure 51: Square wave sweep test default measurement points



Test parameters:

- **HI-LEVEL:** +1 V
- **HI-TIME:** 1 s
- **LO-LEVEL:** -1 V
- **LO-TIME:** 1 s
- **CYCLE COUNT:** 10

Run the square wave sweep test

To run the square wave sweep test:

1. Press the **Z-CHK** key to enable zero check.
2. Press the function key (**V**, **I**, **R**, or **Q**) for the measurement type.
3. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
4. Press the **CONFIG** key.
5. Press the **SEQ** key.
6. Select **SWEEP**. Press the **ENTER** key.
7. Select **SQUARE-WAVE**. Press the **ENTER** key.

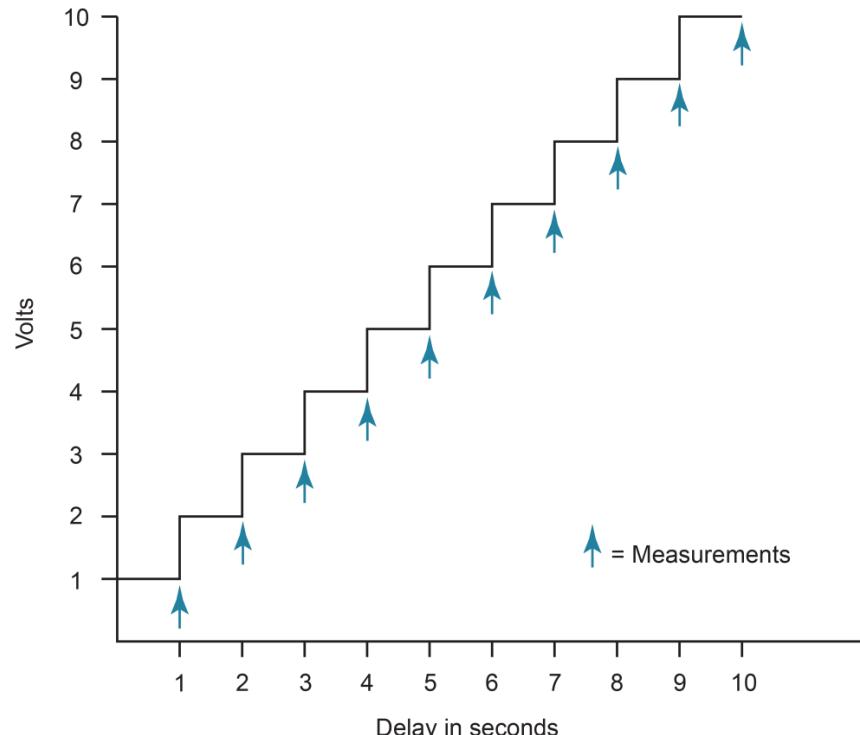
8. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **HI-LEVEL:** The high-level voltage.
 - **HI-TIME:** The amount of the time at the high level in seconds.
 - **LO-LEVEL:** The low-level voltage.
 - **LO-TIME:** The amount of the time at the low level in seconds.
 - **CYCLE COUNT:** The number of times to repeat the cycle.
9. Press the **EXIT** key to return to the previous menu.
10. Press **ENTER** to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs.
11. When the test is finished, zero check remains disabled and the voltage source goes into standby.
12. To access the measured readings, press the **RECALL** key.

Staircase sweep test

The staircase sweep test can be used for any type of measurement, voltage, current, resistance, or charge.

The staircase sweep test allows you to make measurements at staircased voltage levels. The following figure shows an example using the default test parameters.

Figure 52: Staircase sweep test default measurement points



Test parameters:

- **START:** +1 V
- **STOP:** +10 V
- **STEP:** +1 V
- **STEP-TIME:** 1 s
- **CYCLE COUNT:** 10

Run the staircase sweep test

To run the staircase sweep test:

1. Press the **Z-CHK** key to enable zero check.
2. Make sure the voltage source is in standby (VOLTAGE SOURCE OPERATE LED off).
3. Press the **CONFIG** key.
4. Press the **SEQ** key.
5. Select **SWEEP**. Press the **ENTER** key.
6. Select **STAIRCASE**. Press the **ENTER** key.
7. Set the following parameters. Press the **ENTER** key after each setting to advance to the next menu item.
 - **START:** The start voltage.
 - **STOP:** The stop voltage.
 - **STEP:** The step voltage.
 - **STEP TIME:** The delay time between steps.
8. Press the **EXIT** key to return to the previous menu.
9. Select **CONTROL**.
10. Set the event that triggers the test to start:
 - **MANUAL:** Start when the **TRIG** key is pressed.
 - **IMMEDIATE:** Start as soon as the test is armed.
 - **LID-CLOSURE:** Start when the test fixture lid is closed.
 - **GPIB:** Start on GPIB trigger (GET or *TRG) or when the **TRIG** key is pressed.
 - **EXTERNAL:** Start when an external trigger is received or when the **TRIG** key is pressed.
 - **TRIGLINK:** Start when a trigger is received through the specified trigger-link line or when the **TRIG** key is pressed.
11. Press the **ENTER** key.
12. Press the **EXIT** key to return to the measurement display.

13. Press the **SEQ** key to arm the test. When the selected trigger source event occurs, zero check is disabled and the test runs. **SEQ** flashes on the display while the test is running. Readings are automatically stored in the buffer starting at memory location zero. The measurements are made, one at each voltage step, and readings are stored in the buffer.
14. When the test is finished, zero check remains disabled and the voltage source goes into standby.
15. To access the measured readings, press the **RECALL** key.

Configure sequence menu

The CONFIGURE SEQUENCE menu selects and configures test sequences and is summarized in the following table. The top level of the menu is displayed by pressing the **CONFIG** key and then the **SEQ** key.

Configure sequence menu

Menu item	Description	Default parameter
APPLICATIONS	Select type of test:	
DEV-CHAR	Device characterization tests:	
DIODE		
LEAKAGE-CURRENT	Diode leakage current test:	
START V	Specify start voltage	+1 V
STOP V	Specify stop voltage	+10 V
STEP V	Specify step voltage	+1 V
DELAY	Specify delay	1 s
CAPACITOR		
LEAKAGE-CURRENT	Capacitor leakage current test:	
BIAS V	Specify bias voltage	+1 V
STORE nnnn READINGS	Specify number of readings	10
INTERVAL	Specify time interval	1 s
CABLE		
INSULATION-RESISTANCE	Cable insulation resistance test:	
BIAS V	Specify bias voltage	+1 V
STORE READINGS	Specify number of readings	5
INTERVAL	Specify time interval	1 s
RESISTOR		
VOLTAGE-COEFFICIENT	Resistor voltage coefficient test:	
SOURCE V1	Specify 1st test voltage	+1 V
DELAY 1	Specify 1st delay	1 s
SOURCE V2	Specify 2nd test voltage	+2 V
DELAY 2	Specify 2nd delay	1 s

Menu item	Description	Default parameter
R/RESISTIVITY NORMAL SURFACE PRE-DISCH BIAS V BIAS-TIME MEAS-V MEAS-TIME DISCHARGE VOLUME PRE-DISCH BIAS V BIAS-TIME MEAS-V MEAS-TIME DISCHARGE	Resistance/resistivity tests: Standard method resistivity tests: Surface resistivity test: Specify predischarge time Specify bias voltage Specify bias time Specify measurement voltage Specify measurement time Specify discharge time Volume resistivity test: Specify pre-discharge time Specify bias voltage Specify bias time Specify measurement voltage Specify measurement time Specify discharge time	0.2 s +500 V 1 s +500 V 0 s 2 s 10 s +500 V 1 s +500 V 0 s 2 s
ALT-POLARITY V-OFS V-ALT MEAS-T DISCARD STORE RDGS SIR SUR-INSUL-RES-TEST BIAS V BIAS-TIME MEAS-V MEAS-TIME	Alternate polarity test: Specify offset voltage Specify alternating voltage Specify measurement time Specify discarded readings Specify readings to store Surface insulation resistance test: Specify bias voltage Specify bias time Specify measurement voltage Specify measurement time	0 V 10 V 15 s 3 1 +50 V 1 s +100 V 1 s
SWEEP SQUARE-WAVE HI-LEVEL HI-TIME LO-LEVEL LO-TIME CYCLE COUNT STAIRCASE START STOP STEP STEP TIME	Sweep tests: Square wave sweep test: Specify high level voltage Specify time at high level Specify low level voltage Specify time at low level Specify number of cycles Staircase sweep test: Specify start voltage Specify stop voltage Specify step voltage Specify step time	+1 V 1 s -1 V 1 s 10 +1 V +10 V +1 V 1 s
CONTROL MANUAL IMMEDIATE LID-CLOSURE GPIB EXTERNAL TRIGLINK	Select trigger source to start test: Start when TRIG key pressed Start immediately Start when test fixture lid is closed Start on GPIB trigger (GET or *TRG) Start when external trigger received Start when trigger is received through the specified trigger link line	Manual Line #1

Section 6

Triggering

In this section:

Introduction	6-1
Trigger configuration menu	6-1
Basic trigger model	6-3
Advanced trigger model	6-5
External triggering.....	6-17

Introduction

This section discusses front-panel triggering, trigger configuration, and external triggering. It includes example setups.

The sequence of events when triggering is controlled by a trigger model. The 6517B has basic and advanced trigger models. The basic trigger model provides the trigger options used for many instrument operations.

The advanced trigger model provides more triggering options. It is used for more complex instrument operations, such as scanning.

Trigger configuration menu

The 6517B triggers are set up from the **CONFIGURE TRIGGER** menu. The menu is summarized in the following table.

There are two trigger configuration structures: **BASIC** and **ADVANCED**. The basic menu structure is used for simple trigger operations. The advanced menu structure contains options for more sophisticated trigger operations, such as scanning. The differences between basic and advanced triggering are explained in the following section.

Trigger configuration menu

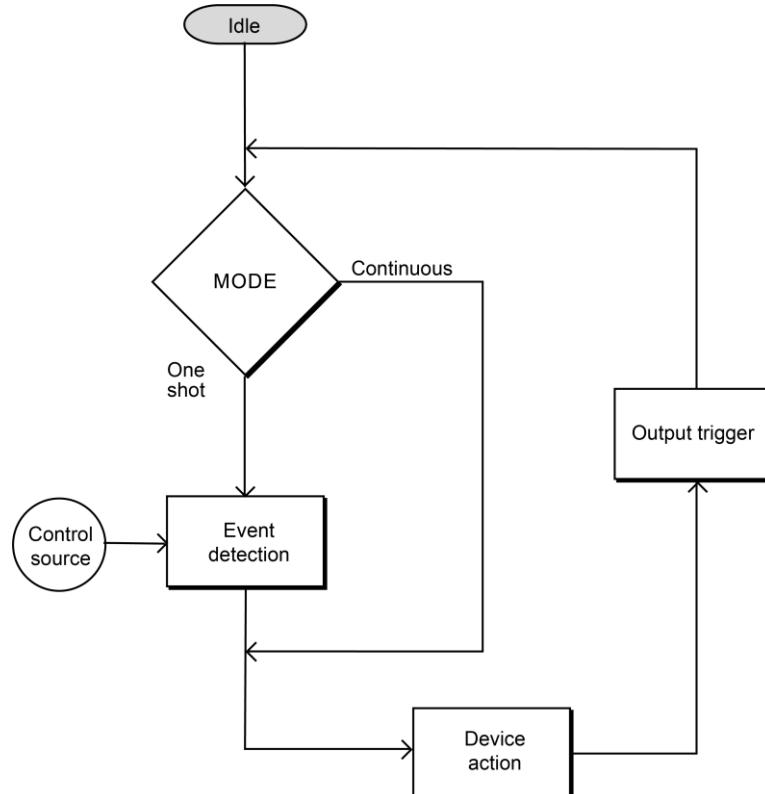
Menu item	Description
BASIC MODE CONTINUOUS ONE-SHOT SOURCE IMMEDIATE MANUAL GPIB EXT TIMER	Select and configure basic triggering: Select trigger mode: Use for continuous triggering Use for one-shot triggering Select source of triggers: Use to make measurements immediately Use TRIG key to control measuring Use bus triggers to control measuring Use external triggers to control measuring Use a timer to control measuring; enter trigger interval (0.001 seconds to 999999.999 seconds)
ADVANCED MEASURE SOURCE IMMEDIATE EXTERNAL MANUAL GPIB TRIGLINK TIMER HOLD DELAY COUNT INFINITE ENTER-CHAN-COUNT CONTROL SOURCE ACCEPTOR	Select and configure advanced triggering: Measure layer menu: Select measure source: Use to make measurements immediately Use external trigger to control measuring Use TRIG key to control measuring Use bus triggers to control measuring Use trigger-link triggers to control measuring; enter trigger-link mode and lines Use a timer to control measuring and enter interval between triggers (0.001 seconds to 999999.999 seconds) Use to hold up the measurement in the measure layer Use to delay measurement in the measure layer (0.001 seconds to 999999.999 seconds) Define the number of measurements to make: Repeat measuring indefinitely Specify count (1 to 99999) Select trigger control mode: Enable source bypass Disable source bypass
SCAN SOURCE IMMEDIATE EXTERNAL MANUAL GPIB TRIGLINK TIMER HOLD DELAY COUNT INFINITE ENTER-SCAN-COUNT CONTROL SOURCE ACCEPTOR	Scan layer menu: Select scan source: Use to pass operation immediately into the measure layer Use external triggers to control scanning Use TRIG key to control scanning Use bus triggers to control scanning Use trigger-link triggers to control scanning Enter trigger-link lines Use a timer to control scanning and enter interval between scans (0.001 seconds to 999999.999 seconds) Use to hold up the measurement in the scan layer Use to delay scan in the layer (0.001 seconds to 999999.999 seconds) Define the number of scans to be performed: Repeat scanning indefinitely Specify count (1 to 99999) Select trigger control mode: Enable source bypass Disable source bypass

Menu item	Description
ARM	Arm layer menu:
SOURCE	Select arm source:
IMMEDIATE	Use to arm meter immediately and pass operation into the scan layer
EXTERNAL	Use external triggers to arm meter
MANUAL	Use TRIG key to arm meter
GPIB	Use bus triggers to arm meter
TRIGLINK	Use trigger-link triggers to arm meter; enter trigger-link lines
RT-CLOCK	Use clock to arm instrument; enter time and date
HOLD	Use to hold up the measurement in the arm layer
COUNT	Define the number of times to arm meter:
INFINITE	Continuously re-arm meter
ENTER-ARM-COUNT	Specify count (1 to 99999)
CONTROL	Select trigger control mode:
SOURCE	Enable source bypass
ACCEPTOR	Disable source bypass
INIT	Enable or disable continuous initiation
HALT	Use to halt triggers; press the TRIG key to resume triggering

Basic trigger model

The following graphic illustrates the basic trigger model. It provides the fundamental trigger options needed for many instrument operations.

Figure 53: Basic trigger model



When the instrument is in the idle state, it cannot perform measurements. The front-panel ARM indicator is off when the instrument is in idle.

You can set the mode to be either continuous or one-shot. When the continuous trigger mode is selected, operation continuously loops around the control source to make measurements (the device action). This trigger mode provides continuous reading conversions. When the one-shot trigger mode is selected, operation waits for the selected control source event to occur before making a measurement. A measurement occurs every time the source event is detected.

With the one-shot trigger mode selected, the measurement does not occur until the selected control source event is detected. You can select the following control sources:

- **IMMEDIATE:** With this control source selected, event detection is immediately satisfied, allowing operation to continue. Using this selection is effectively the same as using the continuous trigger mode. Once the 6517B starts measuring, it makes readings as fast as its measurement configuration allows. Events (such as TIMER triggers) do not control the measurement interval.
- **MANUAL:** Event detection is satisfied by pressing the TRIG key. The 6517B must be taken out of remote operation before it responds to the TRIG key. Press the LOCAL key to take the instrument out of remote.
- **GPIB:** Event detection is satisfied when a bus trigger (GET or *TRG) is received by the 6517B.
- **EXT:** Event detection is satisfied when an input trigger through the rear-panel external trigger connector is received by the 6517B.
- **TIMER:** Event detection is immediately satisfied on the initial pass through the layer. Each subsequent detection is satisfied when the programmed timer interval (0.001 s to 999999.999 s) elapses. If the programmed timer interval is shorter than the time it takes to complete a single measurement, the next measurement does not start until the previous one is complete.

NOTE

The front-panel TRIG key is active when EXTERNAL, GPIB, or TIMER is selected. Pressing the TRIG key after the completion of a measurement starts the next measurement.

After every measurement, an output trigger pulse is applied to the trigger link connector on the rear panel of the instrument. You can use this outgoing trigger pulse to trigger another instrument to perform an operation.

Basic trigger model configuration

To configure basic trigger operation:

1. Press the **CONFIG** key.
2. Press the **TRIG** key.
3. Select **BASIC**. Press the **ENTER** key.
4. Select **MODE**. Press the **ENTER** key.

5. Select **CONTINUOUS** or **ONE-SHOT**. Press the **ENTER** key.
6. If you selected **ONE-SHOT**, select the control source. Press the **ENTER** key.
7. Press the **EXIT** key to return to the display.
8. Press the **TRIG** key to start the trigger model (take the instrument out of idle). The ARM indicator is displayed.

Advanced trigger model

The following figures provide flow charts of the advanced trigger model for front panel and remote operation. The advanced trigger model provides more triggering options than the basic trigger model, including scanning operations. Descriptions of the actions of the trigger model components are described in the topics that follow the figures.

Front-panel trigger model

Figure 54: Advanced trigger model - Idle and Arm Layers

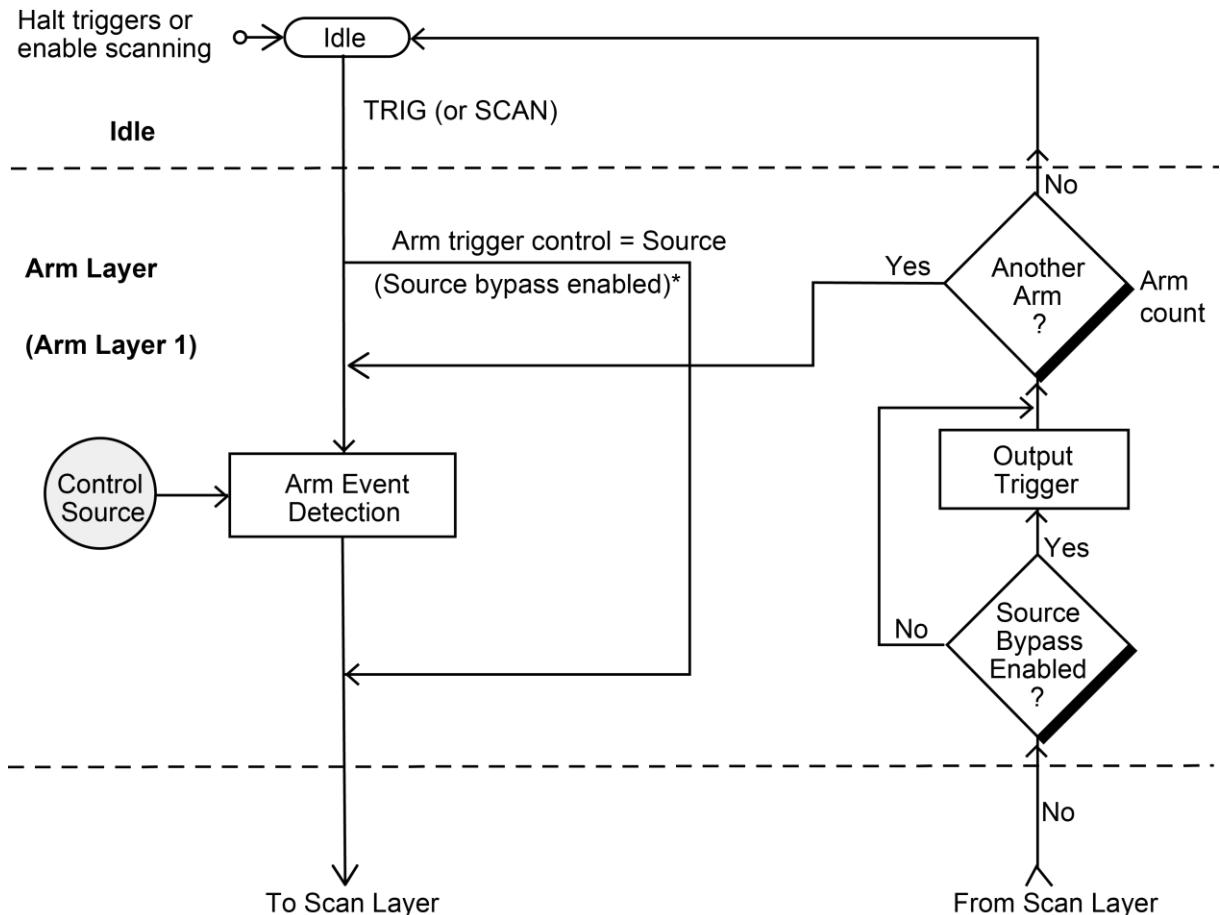


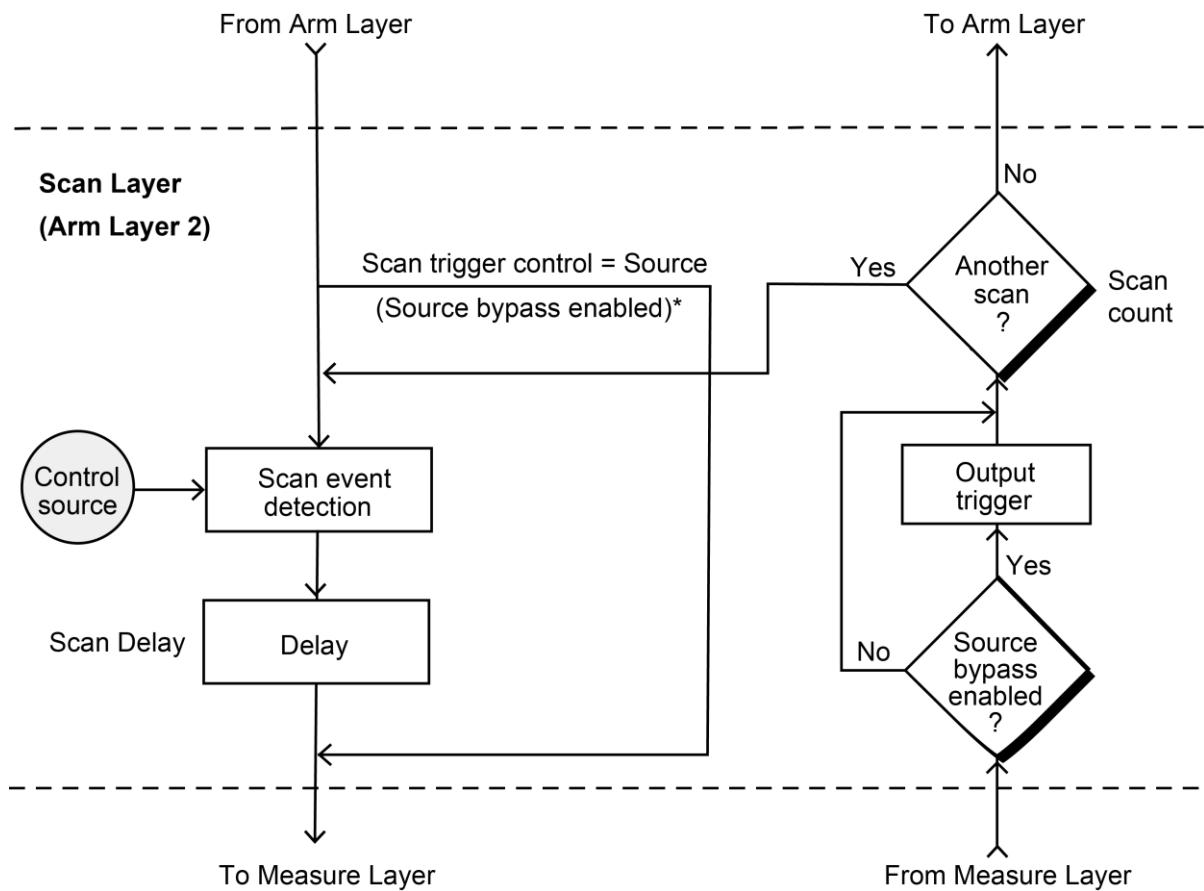
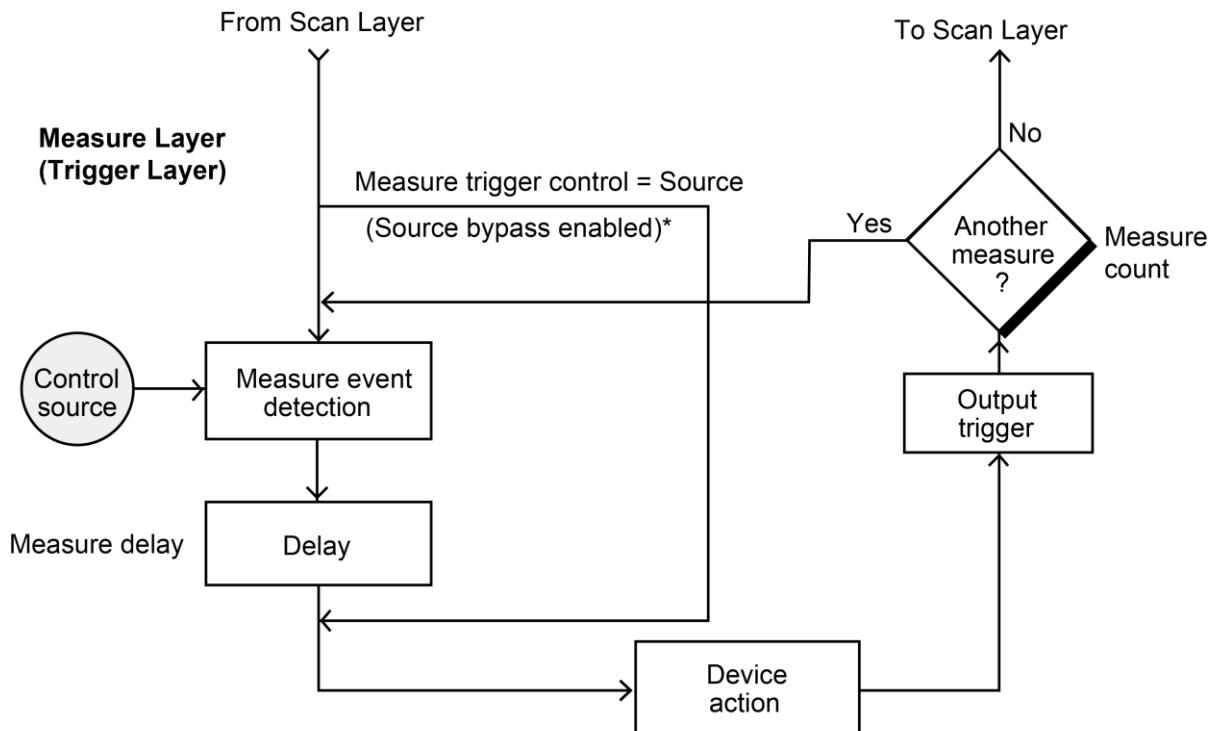
Figure 55: Advanced trigger model - Scan Layer

Figure 56: Advanced trigger model - Measure Layer

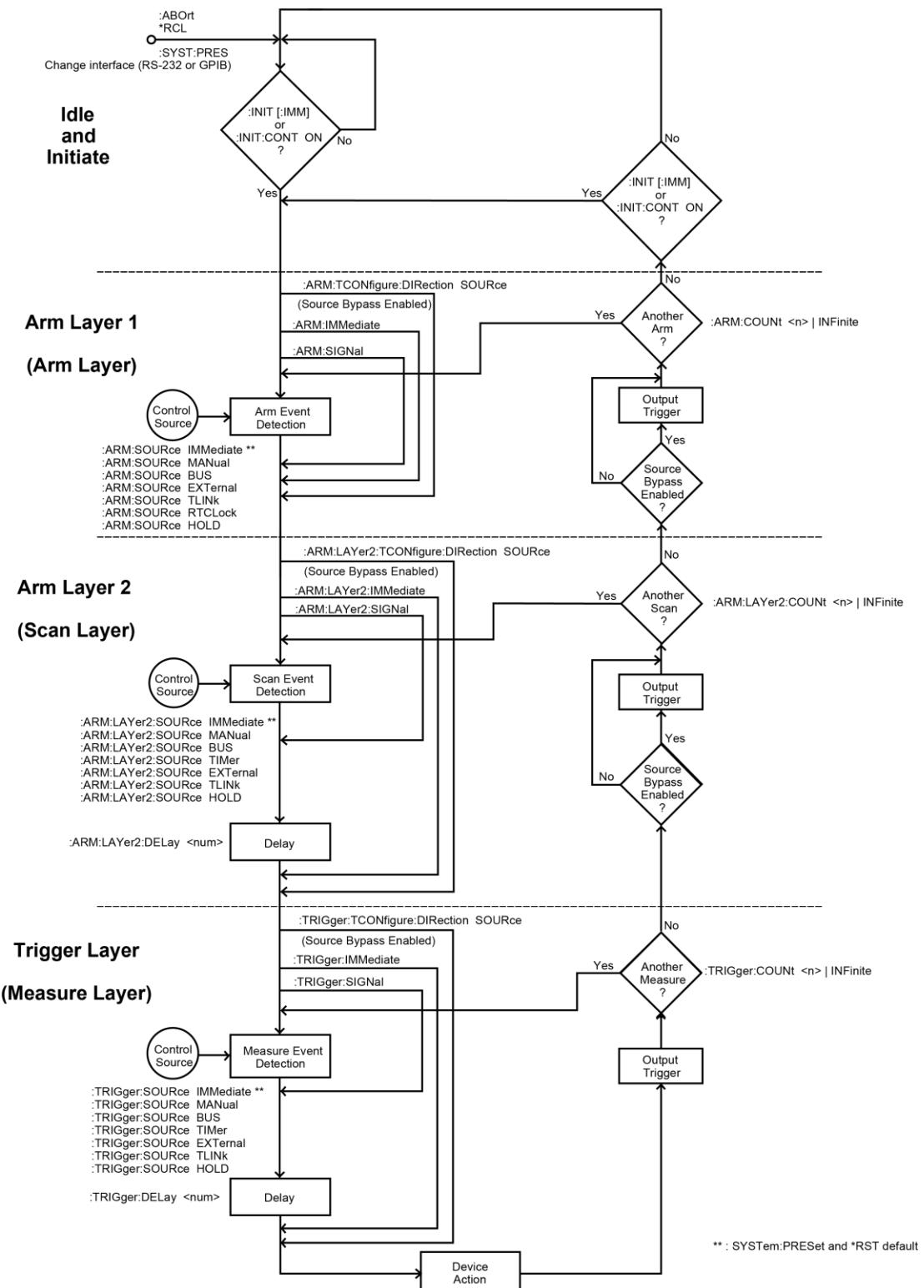
* Take bypass path the first time a layer is entered

IEEE-488 trigger model

The following information describes the operation process of the 6517B over the IEEE-488 bus. The following figure summarizes operation over the bus and is called the trigger model. Operation of the trigger model is controlled by SCPI commands from the Trigger subsystem. The key SCPI commands are included in the figure. Refer to the [SCPI command reference](#) (on page 11-1) for descriptions of the commands.

See [Triggering](#) (on page 6-1) for additional trigger information.

Figure 57: IEEE-488 trigger model



Idle

The instrument is in the idle state whenever it is not operating in one of the layers of the trigger model. The front-panel ARM indicator is off when the instrument is in the idle state.

The following front-panel actions put the instrument into the idle state:

- Press the **MENU** key. Select the **SAVESETUP** option, select the **RESET** option, then select the **GPIB** option. To make a reading, press the **TRIG** key. After each reading, the instrument returns to the idle state.
- Press the **CONFIG** key. Press the **TRIG** key. Select the **ADVANCED** option. Select the **HALT** option. To resume triggering, press the **TRIG** key. You can also resume triggering by selecting **ADVANCED > INIT > ON**.
- Press the **OPTION CARD** key to place the 6517B in the scan mode. Triggering resumes when the scan is started or if the scan is aborted by pressing the **EXIT** key.

To take the instrument out of idle, press the **TRIG** key or send a trigger. If you are using remote commands, you can use the following SCPI commands to take the instrument out of the idle state:

- `:INITiate`
- `:INITiate:CONTinuous ON`

NOTE

When continuous initiation is enabled (`:INIT:CONT ON`), the instrument does not remain in the idle state after all programmed operations are completed. However, the instrument can be returned to the idle state at any time by sending the `*RST` command, the `*RCL` command, or the `SYST:PRES` command.

Trigger model layers

The advanced trigger model uses an arm layer, scan layer, and measure layer to control scan and measure operations.

NOTE

If you are using remote commands, these layers are also referred to as Arm Layer 1, Arm Layer 2, and Trigger Layer, respectively.

When the 6517B is taken out of the idle state, operation proceeds through the layers of the trigger model to the device action, where a measurement occurs.

Arm layer

You set up the arm layer to determine control source (SOURCE) that begins action in the arm layer.

The arm layer determines the number of times the trigger model is repeated (COUNT) and if the source is bypassed.

Scan layer

The scan layer sets up the scan operations of the instruments. The following operations occur in the scan layer:

- The scanning event (SOURCE) for the scan layer.
- Scan delays (DELAY).
- The configured number of scan sequences (COUNT).
- Enable or disable of the source bypass.

Measure layer

The measure layer is used for the following operations:

- Waits for the measuring event (SOURCE) for the measure layer.
- Waits for the delay time of the measure layer (DELAY).
- Makes the number of measurements defined by COUNT.
- Enables or disables the source bypass.

Advanced trigger model configuration

The following information explains how to configure the trigger model layers. Detailed descriptions of the options follow these procedures.

To configure advanced trigger ARM operation:

1. Press the **CONFIG** key.
2. Press the **TRIG** key.
3. Select **ADVANCED**. Press the **ENTER** key.
4. Select **ARM**. Press the **ENTER** key.
5. Select **SOURCE**. Press the **ENTER** key.
6. Select the control source. Press the **ENTER** key.
7. Select **COUNT**. Press the **ENTER** key.
8. Set the counter to **INFINITE** to continuously loop in the layer or **ENTER-ARM-COUNT** to specify the number of loops. Press the **ENTER** key.
9. Select **CONTROL**. Press the **ENTER** key.
10. Set the source bypass to **SOURCE** or **ACCEPTOR**. Press the **ENTER** key.
11. Press the **EXIT** key to return to the display. The ARM indicator is displayed.

To configure advanced trigger scan layer operation:

1. Press the **CONFIG** key.
2. Press the **TRIG** key.
3. Select **ADVANCED**. Press the **ENTER** key.
4. Select **SCAN**. Press the **ENTER** key.
5. Select **SOURCE**. Press the **ENTER** key.
6. Select the control source. Press the **ENTER** key.
7. Select **DELAY**. Press the **ENTER** key.
8. Enter the delay time in seconds. Press the **ENTER** key.
9. Select **COUNT**. Press the **ENTER** key.
10. Set the counter to **INFINITE** to continuously loop in the layer or **ENTER-SCAN-COUNT** to specify the number of loops in the scan layer. Press the **ENTER** key.
11. Select **CONTROL**. Press the **ENTER** key.
12. Set the source bypass to **SOURCE** or **ACCEPTOR**. Press the **ENTER** key.
13. Press the **EXIT** key to return to the previous menu.

To configure advanced trigger measure layer operation:

1. Press the **CONFIG** key.
2. Press the **TRIG** key.
3. Select **ADVANCED**. Press the **ENTER** key.
4. Select **MEASURE**. Press the **ENTER** key.
5. Select **SOURCE**. Press the **ENTER** key.
6. Select the control source. Press the **ENTER** key.
7. Select **DELAY**. Press the **ENTER** key.
8. Enter the delay time in seconds. Press the **ENTER** key.
9. Select **COUNT**. Press the **ENTER** key.
10. Set the counter to **INFINITE** to continuously loop in the layer or **ENTER-CHAN-COUNT** to specify the number of loops in the scan layer. Press the **ENTER** key.
11. Select **CONTROL**. Press the **ENTER** key.
12. Set the source bypass to **SOURCE** or **ACCEPTOR**. Press the **ENTER** key.
13. Press the **EXIT** key to return to the display.
14. Press the **TRIG** key to start the trigger model (take the instrument out of idle).

Control sources

Each layer contains a control source that determines how operation proceeds when a programmed event occurs. The control sources are described in the following topics.

NOTE

The front-panel TRIG key is active when the EXTERNAL, GPIB, TRIGLINK, or TIMER control source is selected. In the measure layer, pressing the TRIG key after the completion of a measurement starts the next measurement. In the arm layer, pressing the TRIG key passes operation to the next layer. In the scan layer, pressing the TRIG key after the completion of a scan sequence starts the next scan sequence if the 6517B is programmed for another scan sequence.

IMMEDIATE

When IMMEDIATE is selected, operation is passed immediately to the next layer or the action in the layer starts immediately. Using this selection is effectively the same as using the continuous trigger mode.

In the measure layer, when the 6517B starts measuring, it makes readings as fast as its measurement configuration allows. Events (such as timers and external triggers) do not control the measurement interval.

EXTERNAL

When EXTERNAL is selected, the instrument uses an external trigger to pass operation to the next layer or to control measurements. Event detection is satisfied when an input trigger through the rear-panel TRIGGER LINK connector is received by the 6517B. Each trigger stimulus applied to the 6517B performs a device action, as defined by the trigger model.

MANUAL

When the MANUAL control source is selected, event detection is satisfied by pressing the TRIG key. Use the TRIG key to arm the meter and pass operation to the next layer, start the scan, or start the device action.

NOTE

You must take the 6517B out of remote control before it responds to the TRIG key. Press the LOCAL key to take the instrument out of remote control.

GPIB

When the control source is set to GPIB, event detection is satisfied when a bus trigger (GET or *TRG) is received by the 6517B. When a bus trigger is received, the meter is armed or the device action defined by the trigger model proceeds.

TRIGLINK

When TRIGLINK is selected, event detection is satisfied when an input trigger through the trigger link is received by the 6517B. Trigger link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments.

When the 6517B receives a trigger over the trigger link, it passes operation to the next layer or performs a device action, as defined by the trigger model.

For the arm layer and scan layer, after selecting TRIGLINK, you are prompted to select an input line and an output line. The input and output lines must use different trigger lines.

When you select TRIGLINK for the measure layer, you can also select the trigger-link mode:

- **ASYNCHRONOUS:** Use the asynchronous trigger-link mode trigger configurations that require input and output triggers to be routed on separate lines. After selecting this trigger-link mode, you are prompted to select an input line and an output line. You must use different trigger lines for the input and output lines.
- **SEMI-SYNCHRONOUS:** Assigns the input and output triggers for the 6517B to the same line. After selecting this trigger-link mode, you are prompted to select the trigger line.

Refer to [External triggering](#) (on page 6-17) for more information on using trigger link.

TIMER

Only available for the scan and measure layers. When the control source is set to TIMER, event detection is immediately satisfied on the initial pass through the layer. Each subsequent detection is satisfied when the programmed timer interval elapses. You can use the timer to control the time interval between scan and measure sequences.

You can set the timer interval from 0.001 seconds to 999999.999 seconds (1 ms resolution).

The timer resets to its initial state when operation loops to a higher layer or goes to the idle state.

If the programmed timer interval is shorter than the time it takes to complete a single measurement or scan, the next device action or scan does not start until the previous one is complete.

RT-CLOCK

Only available for the arm layer. When the control source is set to RT-CLOCK, the instrument is armed at a specific date and time. When the programmed time and date occurs, the 6517B passes operation to the scan layer.

You are prompted to enter the time and date:

- **SET-TIME:** Set the time (hour, minute, and second) for the arm event. Set the time using the 12-hour format if AM or PM is displayed. Otherwise, set the time using the 24-hour format.
- **SET-DATE:** Sets the date (month, day, and year) for the arm event.

Refer to [Set the real-time clock](#) (on page 7-5) for more information on setting the date and time of the instrument.

HOLD

When the control source is set to HOLD, event detection is not satisfied by any of the control source events. Operation is held until another control source is selected.

Source bypasses

Each layer has a source bypass path that allows operation to loop around the control source for that layer. This allows operation to proceed to the delay and device action without having to wait for the programmed event.

When a source bypass is enabled and the external or trigger-link control source is selected, operation loops around the control source on the initial pass through the layer. If the instrument is programmed for another event detection in the layer, the bypass loop is not in effect even though it is still enabled. The bypass loop is reset if operation loops to a higher layer or to idle.

In the arm layer and scan layer, enabling a source bypass also enables the respective output trigger. In the trigger layer, its output trigger is always enabled and occurs after every device action. See [Output triggers](#) (on page 6-15) for more information.

From the front panel, the following options are available:

- **SOURCE:** Enables source bypass. The arm, measure, or scan control source is bypassed on the first pass through the layer.
- **ACCEPTOR:** Disables source bypass.

If you are using remote commands, bypass is set by sending the SIGNAL and DIRECTION commands for the layer.

NOTE

If the instrument is operating remotely, the source bypass is set using the `DIRection` command for the layer. Refer to [:ARM\[:SEQUence\[1\]\]\[:LAYer\[1\]\]:TCONfigure:DIRection](#) (on page 11-187), [:ARM\[:SEQUence\[1\]\]\[:LAYer2\]:TCONfigure:DIRection](#) (on page 11-183), and [:TRIGger\[:SEQUence\[1\]\]:TCONfigure:DIRection](#) (on page 11-198).

Delays

The scan layer and the measure layer have a programmable delay (0 seconds to 999999.999 seconds) that is enforced after an event detection.

In the measure layer, after the measure event occurs, the instrument waits until the delay period times out before performing a device action.

In the scan layer, after the scan event occurs, the instrument waits until the delay period times out before proceeding to the measure layer.

Output triggers

In the arm layer and scan layer, the output triggers are enabled only if their respective source bypasses are also enabled.

In the measure layer, the output trigger is always enabled and occurs after every device action. After every device action, a trigger pulse is applied to the trigger-link connector on the rear panel of the instrument. You can use this outgoing trigger pulse to trigger another instrument to perform an operation.

If the control source is set for EXTERNAL, IMMEDIATE, MANUAL, GPIB, or TIMER, the output trigger pulse is available at the trigger link connector.

If the control source is set for TRIGLINK, the output trigger action occurs on the selected trigger-link output line as follows:

- If the asynchronous trigger-link mode is selected, the output trigger pulse is available on the programmed output line.
- If the semi-synchronous trigger-link mode is selected and the source bypass is disabled, the trigger-link line is released (goes high).
- If the semi-synchronous trigger-link mode is selected and the source bypass is enabled, the trigger-link line is pulled low and then released.

Counters

All three layers use programmable counters that allow operation to return to or stay in the respective layer for a specific number of counts or for an infinite number of counts.

For example, programming the measure layer counter to 10 counts keeps operation in the measure layer until 10 measurements are made. After each device action and subsequent output trigger, operation loops to the trigger layer control source. The counter is reset when operation proceeds to the previous layer or returns to idle.

In the scan layer, the count specifies the number of scans. The programmed count can be smaller, equal to, or larger than the number of channels in the scan list. For example, if the scan list is made up of four channels, you can program a count of 12. With this count value, the instrument repeats the scan three times. An advantage of repeating channels (rather than scans) is that delays in the scan layer of operation are avoided. The measure layer delays among all 12 channels are the same.

You can select the following options:

- **INFINITE:** Continuously loop in the layer.
- **ENTER-ARM-COUNT:** Arm layer. Set the number of times operation returns to the arm layer (1 to 99,999).
- **ENTER-CHAN-COUNT:** Measure layer. Set the number of device actions to perform (1 to 99,999).
- **ENTER-SCAN-COUNT:** Scan layer. Set the number of times to repeat the scan and measure layers (1 to 99,999).

Continuous initiation

The INIT item of the ADVANCED TRIGGERING menu enables or disables continuous initiation. You can select the following options:

- **ON:** Enables continuous initiation. The instrument repeats the trigger model until INIT is set to OFF.
- **OFF:** Disables continuous initiation. After all advanced trigger model operations are done, the instrument goes into idle.

Halting triggers

The HALT option of the ADVANCED TRIGGERING menu disarms the instrument and places it in the idle state.

To resume operation of the trigger model, press the **TRIG** key. You can also resume operation by enabling continuous initiation.

Device action

The primary device action is a measurement. However, the device action could include a range change, filtering, calculations, data storage, and a function change. If the scanner is enabled, it can include a channel scan. A channel is closed and scanned before a measurement is made. When scanning internal channels, the previous channel opens and the next channel closes (break-before-make). The device action includes the internal settling time delay for the relay.

External triggering

The trigger link provides enhanced external triggering capabilities. In general, trigger-link input triggers to the 6517B control the measure operation.

For the 6517B to respond to trigger-link compatible triggers, the appropriate layers of the trigger model must be programmed for it. For example, to use trigger-link input triggers to control the measurement process, you must program the measure source for TRIGLINK trigger events. Typically, a trigger-link output trigger from the 6517B triggers a scanner to close the next channel.

There are two modes of operation for trigger link:

- **Asynchronous:** Separate lines are used for input and output triggers.
- **Semi-synchronous:** The same line is used for both input and output triggers.

Trigger-link connector

The trigger link has six lines that allow up to six instruments to be controlled over this trigger bus. The pin layout of the 8-pin micro-DIN sockets used for the trigger link is shown in the following figure and table.

Figure 58: Rear-panel trigger-link connector



Pin	Trigger-link line
1	1
2	2
3	3
4	4
5	5
6	6
7	Digital common
8	Digital common

Asynchronous operation

The asynchronous mode uses separate lines for input and output triggers. The specifications for the input and output trigger signals of asynchronous mode are shown in the following figures.

Figure 59: Asynchronous trigger-link input pulse specifications

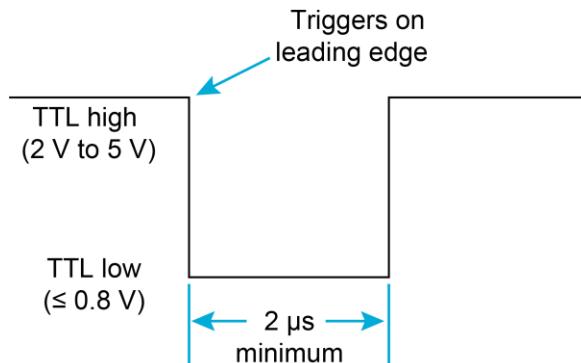
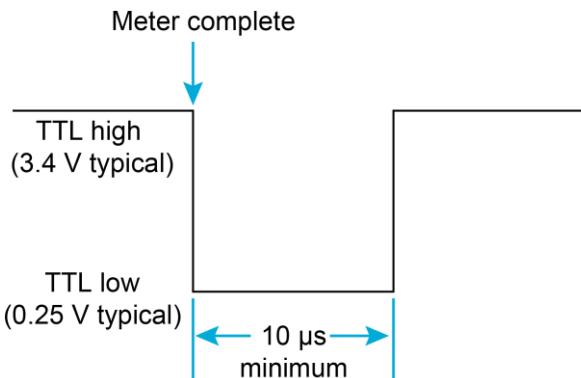


Figure 60: Asynchronous trigger-link output pulse specifications



For typical asynchronous trigger-link operation, the measure layer is configured with measure source set to TRIGLINK and trigger-link mode set to ASYNCHRONOUS. You must also select input and output lines for the measure layer. Input and output triggers can be set to any of the six lines, but they cannot use the same line. For example, if you select line #1 for input triggers, then output triggers must use one of the other five lines (#2 through #6).

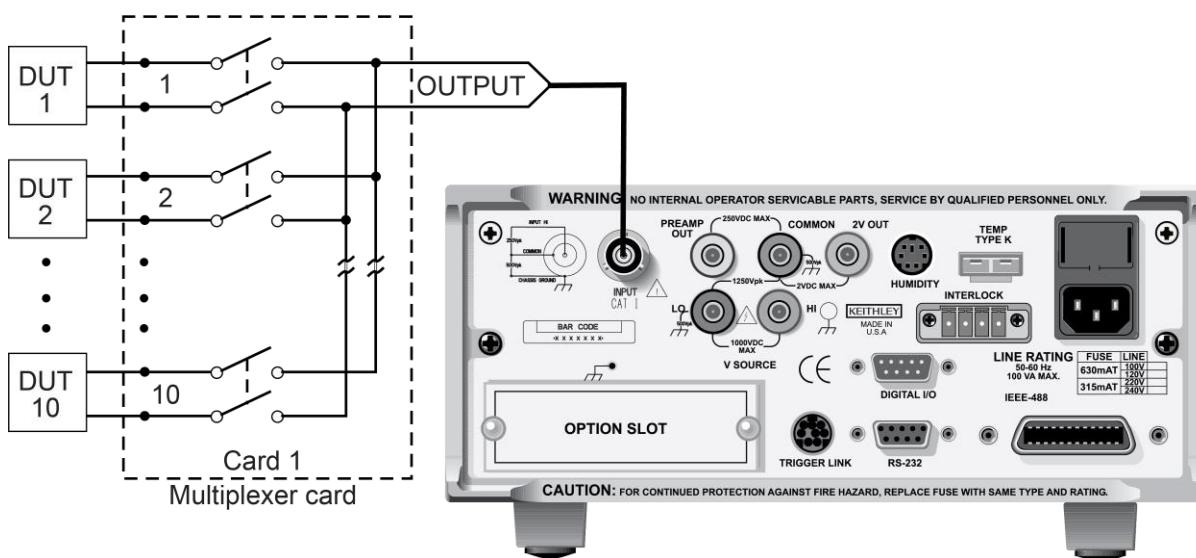
During operation in the measure layer, each trigger-link input trigger makes a measurement. After the user-programmed DELAY and the measurement settling time, the 6517B outputs a trigger-link completion pulse (typically to a scanner to close the next channel).

You can also program the scan layer and arm layer to use the trigger link as the scan and arm sources. When using trigger link in these layers, you must also select input and output lines as you did in the measure layer. You can use the same lines in the scan and arm layers as you do in the measure layer.

Asynchronous trigger-link example

In a typical test system, you may need to close a channel and then use a meter to measure the device under test (DUT) that is connected to the channel. An example of this type of test system is shown in the following figure. This example uses a 6517B to measure ten DUTs switched by a 10-channel multiplexer card in a Model 7001/7002 Switch System.

Figure 61: DUT test system



The 6517B for this example is configured as follows:

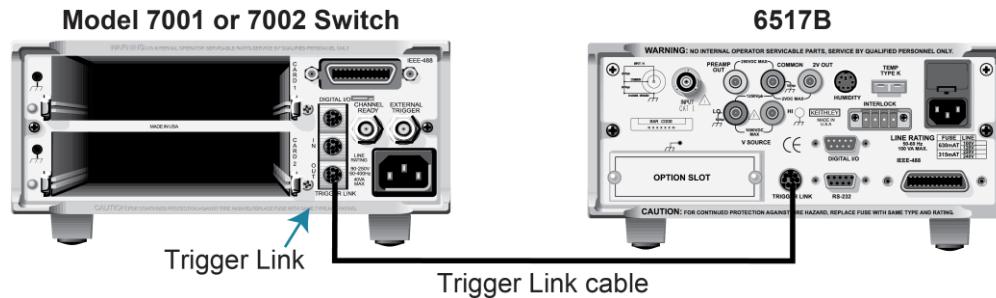
- Idle state:
 - Bench reset = :INIT:CONT ON*
- Arm layer:
 - Arm source = Immediate*
 - Arm count = 1*
 - Arm trigger control = Acceptor*
- Scan layer:
 - Scan source = Immediate*
 - Scan count = Infinite*
 - Scan trigger control = Acceptor*

- Measure layer:
 - Measure source = TrigLink
 - Trigger-link mode = Asynchronous
 - Input line = #3
 - Output line = #4
 - Measure count = 20
 - Measure trigger control = Acceptor*

* This setting is the bench reset and factory default condition.

The trigger-link connections for this test system are shown in the following figure. The trigger link of the 6517B is connected to trigger link of the Model 7001/7002 Switch System. Notice that only one trigger-link cable is needed. For this example, the 6517B and 7001/7002 are configured as follows.

Figure 62: Trigger link connections (asynchronous example)



The Model 7001 or 7002 for this example is configured as follows:

- Idle state:
 - Reset = :INIT:CONT OFF*
- Scan list = 1!1-1!10,
- Arm layer:
 - Arm spacing = Immediate*
 - Arm count = 1*
 - Arm trigger control = Acceptor*
- Scan layer:
 - Scan spacing = Immediate*
 - Number of scans = 1
 - Scan trigger control = Acceptor*

- Channel layer:
 - Channel spacing = TrigLink
 - Trigger-link mode = Asynchronous
 - Input line = #4
 - Output line = #3
 - Number of channels = 20
 - Channel trigger control = source*

* Indicates that the setting is the reset and factory default condition.

Notice that the 6517B is reset to BENCH defaults, so the 6517B remains in the armed state. Because the arm source and scan source are set to immediate, the 6517B waits in the measure layer for a trigger.

With the channel trigger control of the Model 7001/7002 set for source, scan operation initially bypasses the need for a trigger-link trigger to close the first channel. Because arm spacing and scan spacing are set to Immediate, the scan starts as soon as the scanner is taken out of the idle state by pressing the **STEP** key.

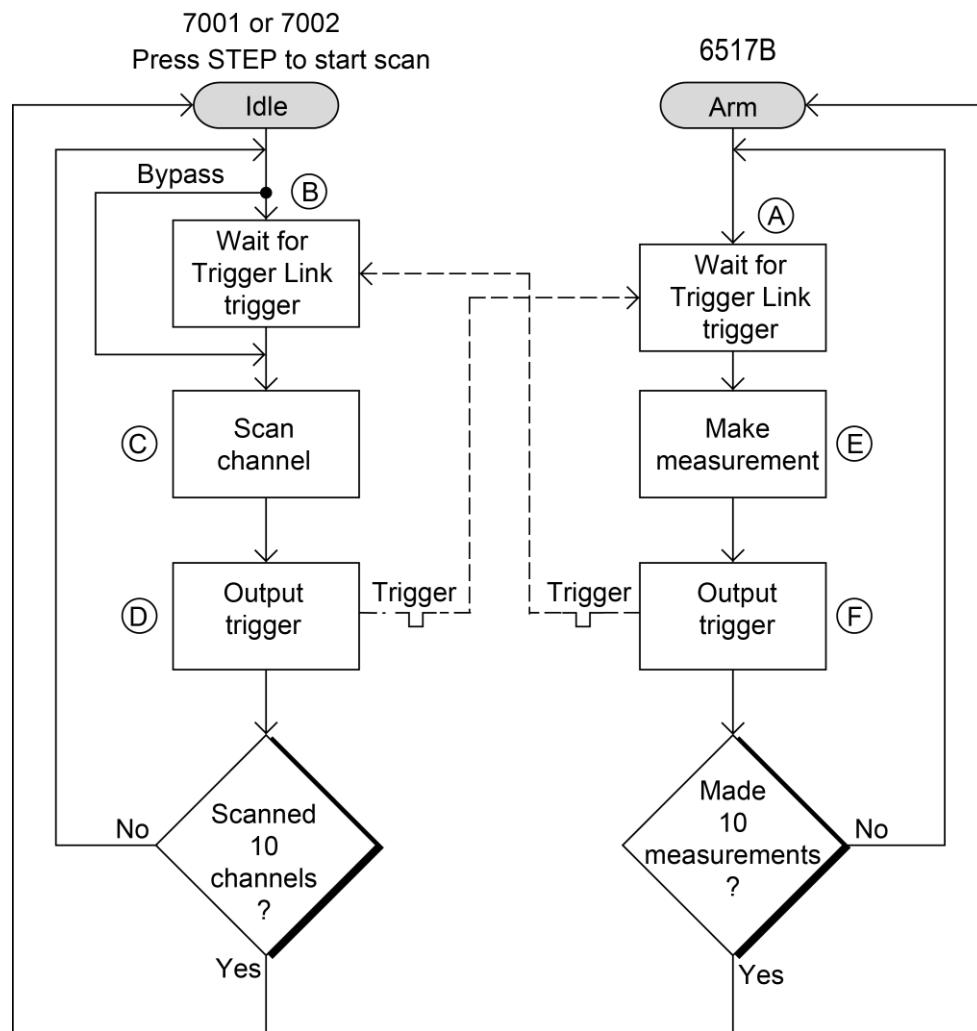
To run the test and store the readings in the 6517B, press **STORE** on the 6517B, enter the number of readings (ten), and press **ENTER**. The 6517B waits (with the asterisk annunciator lit) for a trigger-link trigger from the Model 7001/7002.

Press **STEP** on the Model 7001/7002 to start the scan. The output pulse of the scanner triggers the 6517B to make a reading, store it, and send a trigger pulse. The following steps on operation are referenced to the operation model shown in the next figure.

- A The BENCH RESET condition arms the 6517B and places 6517B operation at point A in the flowchart, where it is waiting for a trigger-link trigger. Because both the arm layer and scan layer are programmed for immediate source, operation immediately drops down to the measure layer at point A.
- B Pressing STEP takes the Model 7001/7002 out of the idle state and places operation at point B in the flowchart. Because both the arm layer and scan layers are programmed for immediate spacing, operation drops down to the channel layer at point B.
- C Because channel trigger source is set to source, the scan does not wait at point B for a trigger. Instead, it bypasses "Wait for trigger link Trigger" and closes the first channel (point C). The bypass is in effect only on the first pass through the trigger model.
- D After the relay settles, the Model 7001/7002 outputs a channel-ready pulse (point D). Since the instrument is programmed to scan ten channels, operation loops to point B, where it waits for an input trigger. Bypass is no longer in effect.
- E The 6517B operation is at point A waiting for a trigger. The output channel-ready pulse from the Model 7001/7002 triggers the 6517B to measure DUT 1 (point E). After the measurement is complete, the 6517B outputs a completion pulse

- F The pulse then loops to point A, where it waits for another input trigger. The trigger applied to the Model 7001/7002 from the 6517B closes the next channel in the scan. This triggers the 6517B to measure the next DUT. The process continues until all ten channels are scanned and measured.

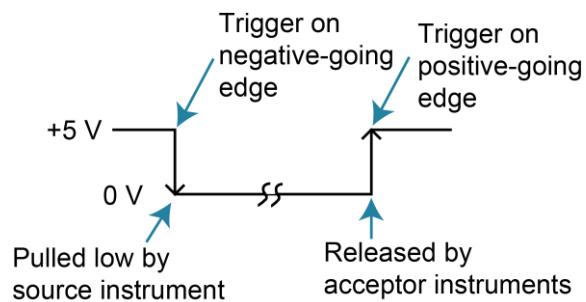
Figure 63: Operation model for asynchronous trigger link example



Semi-synchronous operation

In the semi-synchronous trigger link mode, all triggering (input and output) is controlled by a single line. When the normally high (+5 V) trigger line is pulled low (0 V), a trigger occurs on the negative-going edge. When the trigger line is released, a trigger occurs on the positive-going edge. See the following figure for an example.

Figure 64: Semi-synchronous trigger link specifications



The advantage of this single line trigger is that as long as one of the instruments in the system holds the line low, the trigger does not occur until all instruments in the system are ready.

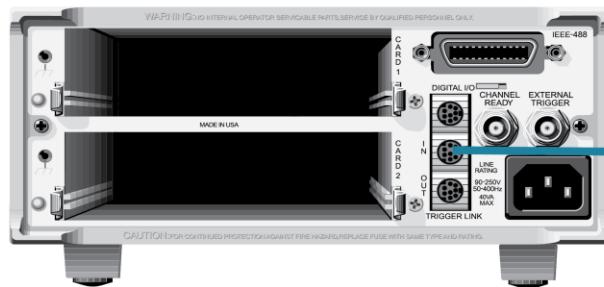
Semi-synchronous trigger-link example

The semi-synchronous trigger-link example uses the same test system as the Asynchronous trigger-link example. The only difference is that triggering is done using the semi-synchronous mode.

In this example, a 6517B is connected to two Model 7001 or 7002 Switch Systems for semi-synchronous operation, as shown in the following figure. All three instruments are programmed to use trigger line 1. The two Model 7001s/7002s have relay settling times of 10 ms and 50 ms, respectively. The 6517B is designated as the trigger control source and the two Model 7001/7002 instruments as trigger control acceptors.

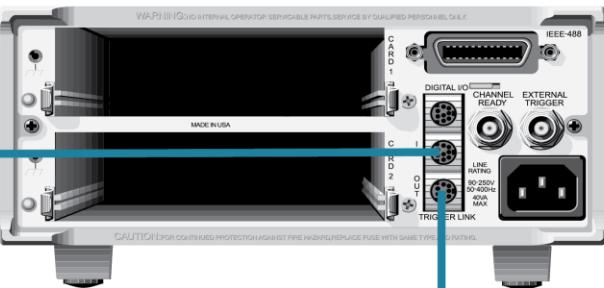
Figure 65: Typical semisynchronous mode connections

7001 or 7002 Switch System



Trigger link cable

7001 or 7002 Switch System

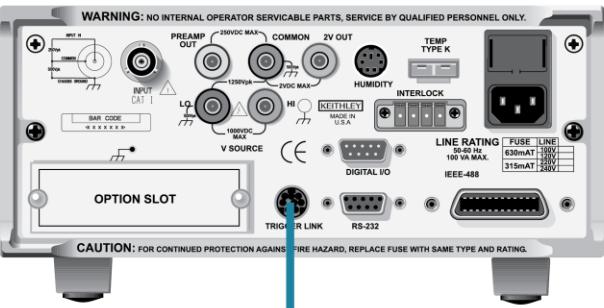


Line 1

Trigger link cable

Line 1

6517B



Assume that the 6517B initially performs a measurement. After the reading is made, the 6517B drives the trigger line low. The negative-going edge triggers both Model 7001s/7002s to close a channel. While the Model 7001s/7002s are in the process of closing a channel, they hold the trigger line low. Ten milliseconds after switch closure, the first Model 7001/7002 releases the trigger line. However, the second Model 7001/7002 continues to hold the line low because it is not finished. Fifty milliseconds after switch closure, the second Model 7001/7002 releases the trigger line. The positive-going edge triggers the 6517B to make a measurement and subsequently pulls the trigger line down to close the next channels. This process continues until all channels are scanned and measured.

The two instruments are configured as follows:

6517B:

- Idle state:
 - Bench reset = :INIT:CONT ON*
- Arm layer:
 - Arm source = Immediate*
 - Arm count = 1*
 - Arm trigger control = Acceptor*
- Scan layer:
 - Scan source = Immediate*
 - Scan count = Infinite*
 - Scan trigger control = Acceptor*
- Measure layer:
 - Measure source = TrigLink
 - Trigger-link mode = Semi-synchronous
 - Semi-synchronous line = 1*
 - Measure count = 10
 - Measure trigger control = Acceptor*

* Indicates that the setting is the bench reset and factory default condition.

Model 7001 or 7002:

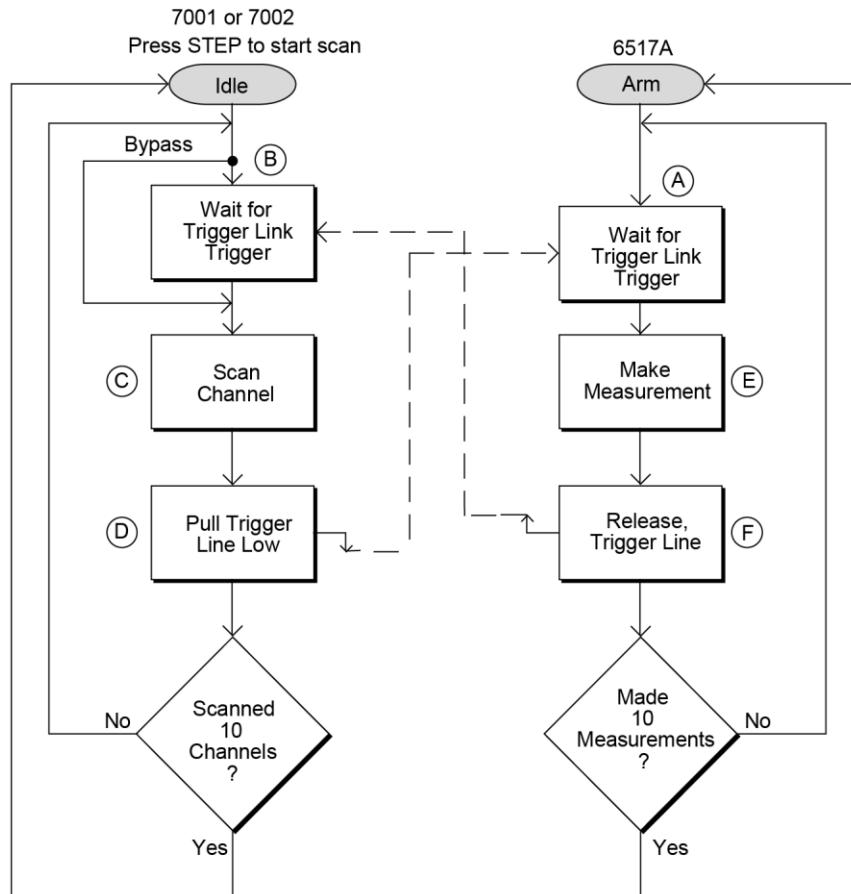
- Idle state:
 - Reset = :INIT:CONT OFF*
- Scan list = 1!1-1!10,
- Arm layer:
 - Arm spacing = Immediate*
 - Arm count = 1*
 - Arm trigger control = Acceptor*
- Scan layer:
 - Scan spacing = Immediate*
 - Number of scans = 1
 - Scan trigger control = Acceptor*

- Channel layer:
 - Channel spacing = TrigLink
 - Trigger-link mode = Semi-synchronous
 - Semi-synchronous line = #1
 - Number of channels = Use Scanlist length*
 - Channel trigger control = Source*

* Indicates that the setting is the reset and factory default condition.

To run the test and store the readings in the 6517B, press **STORE** on the 6517B, enter the number of readings (10), and press **ENTER**. The 6517B waits (with the asterisk annunciator lit) for a trigger-link trigger from the Model 7001/7002. Press **STEP** on the Model 7001/7002 to start the scan.

Figure 66: Operational model for semi-synchronous trigger-link example



- A The BENCH RESET condition arms the 6517B and places 6517B operation at point A in the flowchart, where it is waiting for a trigger-link trigger. Because both the arm layer and scan layer are programmed for immediate source, operation immediately goes to the measure layer at point A.

- B Pressing STEP takes the Model 7001/7002 out of the idle state and places operation at point B in the flowchart. Because both the arm layer and scan layers are programmed for Immediate Spacing, operation goes to the Channel Layer at point B.
- C Because the Channel Trigger source is set to source, the scan does not wait at point B for a trigger. Instead, it bypasses "Wait for Trigger Link Trigger" and closes the first channel (point C). The bypass is in effect only on the first pass through the trigger model.
- D After the relay settles, the Model 7001/7002 pulls down the trigger-link trigger line (point D). Because the instrument is programmed to scan ten channels, operation returns to point B, where it waits for an input trigger. Bypass is no longer in effect.
- E The 6517B operation is at point A waiting for a trigger. When the trigger line is pulled low by the Model 7001/7002, the leading negative-going edge triggers the 6517B to measure DUT 1 . The 6517B holds the trigger line low. After the measurement is complete, the 6517B releases the trigger line.
- F The trigger line returns to point A, where it waits for another input trigger.

When the 6517B releases the trigger line, the leading positive-going edge triggers the Model 7001/7002 to close the next channel in the scan. This pulls the trigger line low, triggering the 6517B to measure the next DUT. The process continues until all ten channels are scanned and measured.

Buffer (data store)

In this section:

Buffer overview	7-1
Set the type of buffer control	7-1
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Set the real-time clock	7-5
Set up timestamps	7-6
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Clear all buffer readings	7-8
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Buffer overview

This section discusses the buffer, or data store, which stores measurement readings. The buffer can store up to 50,000 data readings. The following paragraphs discuss the configuration of the buffer and how to recall buffer data.

Set the type of buffer control

You can specify if the buffer fills continuously, runs until it is filled, or runs when a trigger is received.

You can select:

- **FILL-AND-STOP:** Fill the buffer then stop. The number of readings is specified by COUNT. Refer to [Number of readings to store](#) (on page 7-4) to set the count.
- **PRETRIGGER:** The buffer stores readings continuously until the programmed pretrigger event occurs. When the pretrigger event occurs, the section of the buffer specified for post-trigger readings fills with new readings. The storage process stops when the post-trigger portion of the buffer is filled with new readings. For example, with a buffer size of 100 readings, there can be 50 readings stored before the trigger event and 50 readings stored after the trigger. In the buffer, the first reading after the trigger is reading zero. Pretrigger readings have reading numbers and relative timestamps with a minus sign. Post-trigger readings have reading numbers and relative timestamps with a plus sign.
- **CONTINUOUS:** Readings are stored in the buffer continuously. When the buffer is full, the new readings overwrite the oldest readings.
- **NEVER:** No readings are stored in the buffer. This is automatically set if data storage has been interrupted. Press the **STORE** key to change NEVER to FILL-AND-STOP.

The buffer settings apply to all functions.

Buffer control step sequence

The following tables detail the sequence of steps for the modes of buffer control when the pretrigger event is set to MANUAL.

NOTE

During data storage, the reading number on the bottom line of the display is one ahead of the reading on the top line.

There are multiple displays available when recalling buffered readings. These are described in the following tables.

Fill-and-stop sequence

Action	Result	Annunciator
STORE ENTER	STORE 00100 READINGS Storing reading #xx of 100	(* on) (* off)
RECALL	Storage complete; press RECALL Reading#+00000 @Time=+000.000000 s ...	
EXIT	Reading#+00099 @Time=+002.700473 s (normal reading display)	

Continuous sequence

Action	Result	Annunciator
STORE ENTER	STORE 00100 READINGS Storing reading #xx of 100 100 readings stored; continuous ON	(* on)
RECALL	Reading#+00000 @Time=+003.903546 s ...	
EXIT RECALL	100 readings stored; continuous ON Reading#+00000 @Time=+067.709331 s ...	
EXIT EXIT	100 readings stored; continuous ON STORAGE INTERRUPTED Acquired 100 of 100 readings (normal reading display)	(* off)

Pretrigger sequence

Action	Result	Annunciator
STORE	STORE 00100 READINGS	
ENTER	Waiting for pretrigger event	(* on)
TRIG	Storing reading #xx of 50	
	Storage complete; press RECALL	(* off)
RECALL	Reading#-00050 @Time=-004.999990 s	
	...	
	Reading#+00000 @Time=+000.000000 s	
	...	
	Reading#+00049 @Time=+004.899996 s	
EXIT	(normal reading display)	

Set up a fill-and-stop buffer

When you select FILL-AND-STOP, the readings are made and stored in the buffer until the buffer reaches the number of readings specified by the buffer count.

To set up a fill-and-stop buffer:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select **CONTROL**. Press the **ENTER** key.
4. Select **FILL-AND-STOP**.
5. Press the **ENTER** key.
6. Refer to [Number of readings to store](#) (on page 7-4) to set the count.

Set up a pretrigger buffer

When PRETRIGGER is selected, the buffer stores readings continuously until the programmed pretrigger event occurs. When the pretrigger event occurs, the section of the buffer specified for post-trigger readings fills with new readings. The storage process stops when the post-trigger portion of the buffer is filled with new readings. For example, with a buffer size of 100 readings, there can be 50 readings stored before the trigger event and 50 readings stored after the trigger. In the buffer, the first reading after the trigger is reading zero. Pretrigger readings have reading numbers and relative timestamps with a minus sign. Post-trigger readings have reading numbers and relative timestamps with a plus sign.

When you set up the pretrigger buffer, you also configure the number of pretrigger readings to store before the trigger occurs and the trigger event.

The number of pretrigger readings can be set as a percentage (PERCENTAGE) of the maximum buffer size or as a fixed number of readings (READING-COUNT).

The pretrigger event can be set to one of the following options:

- **MANUAL:** Front-panel TRIG key.
- **GPIB:** GPIB bus trigger (GET or *TRG).
- **TRIGLINK:** Input trigger through the trigger link. When you select TRIGLINK, you also need to set the input line.
- **EXTERNAL**

To set the type of buffer control:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select **CONTROL**. Press the **ENTER** key.
4. Select **PRETRIGGER**. Press the **ENTER** key.
5. Set the number of pretrigger readings to **PERCENTAGE** or **READING-COUNT**. Press the **ENTER** key.
6. Set the percentage or count. Press the **ENTER** key.
7. Select **EVENT**. Press the **ENTER** key.
8. If you selected TRIGLINK, select the input line. Press the **ENTER** key.
9. Press the **EXIT** key as needed to return to the measure display.

Set up a continuous buffer

When the buffer is set to CONTINUOUS, readings are stored in the buffer continuously. When the buffer is full, the new readings overwrite the oldest readings.

To set the up a continuous buffer:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select **CONTROL**. Press the **ENTER** key.
4. Select **CONTINUOUS**. Press the **ENTER** key.
5. Press the **EXIT** key as needed to return to the measure display.

Set the number of readings to store

You can specify the number of readings to store.

You can enter a value or use the measure count value in the trigger model.

When the specified number of readings is stored in the buffer, the buffer is considered to be full.

To set the number of readings to store:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select the **COUNT** option. Press the **ENTER** key.
4. Select the readings to store:
 - **ENTER-COUNT:** Specify the buffer size.
 - **USE-TRIGGER-MODEL:** Use the measure count in the present trigger configuration if the measure count is a finite value.
5. Press the **ENTER** key. If you selected USE-TRIGGER-MODEL, the change is complete.
6. Enter the buffer size. Press the **ENTER** key.

Set the real-time clock

The 6517B has a real-time clock that adds a timestamp to the bus and buffer readings (if the real-time timestamp is selected). It can also be used as a control source for the arm layer of the trigger model. You can set the time, date, and format (12-hour or 24-hour) for the real-time clock.

Real-time timestamps for bus readings are always provided in the 24-hour format, regardless of the clock **FORMAT** selection.

To set the clock:

1. On the front panel, press the **MENU** key.
2. Select the **GENERAL** menu.
3. Select **CLOCK**.
4. Select **DATE**.
5. Use the **◀** and **▶** cursor keys and the **RANGE** keys to set the date. The day of the week (such as Sun or Mon) is automatically calculated and displayed for the date.
6. Press the **ENTER** key.
7. Select **FORMAT**.
8. Select **12-HOUR** or **24-HOUR**.
9. Press the **ENTER** key.
10. Select **TIME**.
11. Use the **◀** and **▶** cursor keys and the **RANGE** keys to set the time (hours:minutes:seconds). To set the seconds to zero, press the **AUTO** key. If 12-HOUR is set for the **FORMAT**, change the hour until **AM** or **PM** is displayed correctly.
12. Press the **ENTER** key.

Set up timestamps

You can include a timestamp with each buffer reading through the GENERAL menu or the CONFIGURE DATA STORE menu.

The following options are available from the GENERAL menu and the CONFIGURE DATA STORE menu. Changing a setting from one menu also changes it in the other menu.

TYPE: Checks or changes the timestamp type. Note that changing the timestamp type clears the buffer. The timestamp types are described as follows:

- **RELATIVE-TIME:** Timestamps are oriented to a timer with the first buffer reading timestamped at 0.000000 seconds. Each following timestamp is then based on the presently selected format (see FORMAT). After 99,999.999999 seconds, the timer resets to zero seconds and starts over. With the ABSOLUTE format selected, the timestamp for each reading is referenced (in seconds) to the first buffer reading. With the DELTA format selected, each timestamp is referenced (in seconds) to the previous timestamp.
- **REAL-TIME:** Timestamps are oriented to the real-time clock and are based on the presently selected format (see FORMAT). With the ABSOLUTE format selected, each reading is timestamped with the actual time and date. Time can be expressed in the 12-hour (AM, PM) format or the 24-hour format.

Through GENERAL menu, you can also set the following options:

- **RESET-TIME:** Resets the relative timestamp to 0.000000 seconds. The timestamp also resets to zero seconds when the instrument is turned on. Resetting the time has no effect on the real-time clock.
- **RESET-RDG#:** Resets the reading number to zero. The reading number also resets to zero when the instrument is turned on.

Through the CONFIGURE DATA STORE menu, you can also set the following options.

- **FORMAT:** Checks or changes the timestamp format. If there are readings in the buffer, the timestamps of those readings change to reflect the alternate format. You can select:
 - **ABSOLUTE:** If REAL-TIME type is selected, each timestamp provides the time and date when the reading was made. If the RELATIVE-TIME type is selected, each timestamp provides the number of seconds from the first buffer reading when the reading was made.
 - **DELTA:** Each timestamp is referenced to the timestamp of the previous reading. This provides the time between buffer readings. If the REAL-TIME type is selected, timestamps are provided in days, hours, minutes, and seconds. If the RELATIVE-TIME type is selected, timestamps are provided in seconds. The first buffer reading is timestamped at 00000d 00h 00m 00.00s (zero days, hours, minutes, and seconds). Each subsequent timestamp is referenced (in days, hours, minutes, and seconds) to the previous timestamp.

NOTE

To include the timestamp with the reading, **TIMESTAMP** must be selected as a data element. Refer to [Include data elements in the buffer reading](#) (on page 7-7) for more information.

To set the timestamp from the GENERAL menu:

1. On the front panel, press the **MENU** key.
2. Select the **GENERAL** menu. Press the **ENTER** key.
3. Select **TIMESTAMP**. Press the **ENTER** key.
4. Select **TYPE**. Press the **ENTER** key. A message is displayed for a few seconds.
5. Use the **◀** and **▶** keys to select **RELATIVE-TIME** or **REAL-TIME**. Press the **ENTER** key.
6. To reset the time, select **RESET-TIME**. Press the **ENTER** key.
7. To reset the reading number to 0, select **RESET-RDG#**. Press the **ENTER** key.

To set the timestamp from the CONFIGURE DATA STORE menu:

1. On the front panel, press the **CONFIG** key.
2. Press the **STORE** key.
3. Select **TIMESTAMP**. Press the **ENTER** key. A message is displayed for a few seconds.
4. Select **TYPE**. Press the **ENTER** key.
5. Use the **◀** and **▶** keys to select **RELATIVE-TIME** or **REAL-TIME**. Press the **ENTER** key.
6. To change the format, select **FORMAT**. Press the **ENTER** key.
7. Select **ABSOLUTE** or **DELTA**. Press the **ENTER** key.

Include data elements in the buffer reading

Every reading in the buffer includes the reading, status (overflow or underflow), reading number, and unit of measure. The recalled data includes statistical information, such as the minimum, maximum, average, and standard deviation, which are part of the NEXT displays. The reading number indicates the location of the reading in the buffer.

You can also include the following data elements:

- **Timestamp:** When selected, the timestamp is displayed on the primary display for each stored reading. You can set the timestamp format. Refer to [Set up timestamps](#) (on page 7-6).
- **Humidity:** When selected, the humidity reading is displayed on a NEXT display. The appropriate sensor must be connected to the instrument and it must be enabled through the **DATA-STAMP** item of **GENERAL** menu.
- **External temperature:** When selected, the external temperature reading is displayed on a NEXT display. The appropriate sensor must be connected to the instrument and it must be enabled through the **DATA-STAMP** item of **GENERAL** menu.

- **Channel number:** If a scan was performed, the channel number is displayed with the reading. If a scan was not performed, a channel number is not displayed even though it is a selected data element.
- **Voltage source:** The sourced voltage level is available as a NEXT display.

To change which data elements are included:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select the **ELEMENTS** option. Press the **ENTER** key.
4. Use **◀** and **▶** to select each element and **▲** and **▼** to select **y** or **n**. A **y** indicates that the element is included, and an **n** indicates that the element is not included.
5. Press the **ENTER** key.

Clear all buffer readings

You can clear all stored readings and buffer statistics.

To clear the buffer:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select the **CLEAR-ALL** option. Press the **ENTER** key.

Reading buffer display during storage

This menu item enables or disables the display during the storage process.

When this is set to YES, the display is enabled and readings are displayed with the message that indicates that readings are being stored.

When this is set to NO, the display and front panel are disabled and the message FRONT PANEL DISABLED is displayed. This option optimizes speed and provides a more uniform interval between readings. To return to displaying the display and front panel to normal, press LOCAL during the storage process.

To change the reading buffer display:

1. Press the **CONFIG** key.
2. Press the **STORE** key.
3. Select the **DISPLAY** option. Press the **ENTER** key.
4. Select **YES** or **NO**. Press the **ENTER** key.

Data store configuration menu

The buffer is configured from the **CONFIG DATA STORE** menu. This menu is displayed by pressing the **CONFIG** key and then the **STORE** key.

The data storage configuration menu is used for the following operations:

- To select the buffer control
- To clear the buffer of readings and statistics
- To specify the number of readings to store
- To specify the source of readings to be stored
- To select optional data elements

CONFIGURE DATA STORE menu

Menu item	Description
COUNT	Select buffer size
ENTER-COUNT	Enter number of readings to store
USE-TRIGGER-MODEL	Use (finite) measure count from trigger model
CONTROL	Select type of buffer control
FILL-AND-STOP	Fill buffer with readings and stop
PRETRIGGER	Wait for pretrigger event; store before and after readings
PERCENTAGE	Enter percentage of stored readings before trigger
READING-COUNT	Enter count of stored readings before trigger
EVENT	Select source for pretrigger event
CONTINUOUS	Store readings in buffer continuously
NEVER	Readings are not stored
CLEAR-ALL	Clear all stored readings and buffer statistics
TIMESTAMP	Configure timestamp:
TYPE	Check or change type:
RELATIVE-TIME	Reference timestamp to relative time
REAL-TIME	Reference timestamp to real time
FORMAT	Select timestamp format:
ABSOLUTE	Reference each timestamp to the first buffer reading (relative), or to the time and date (real)
DELTA	Reference each timestamp to the previous buffer reading
ELEMENTS	Enable or disable optional data elements; timestamp, humidity, external temperature, channel, and voltage source
DISPLAY	Enable or disable storage display

View buffer readings from the front panel

You can view buffer readings from the front panel.

Press the DISPLAY **PREV** or **NEXT** key to cycle through the options. You can view the following displays:

- Relative humidity and external temperature if the appropriate sensors are enabled.
- Voltage source value.
- Maximum reading.
- Minimum reading.
- Average reading.
- Standard deviation.
- Timestamp.

An example of the maximum reading is shown in the following figure.

Figure 67: Buffer display of maximum reading



An example of the average reading is shown in the following figure.

Figure 68: Buffer display of average reading



Section 8

Filters and math

In this section:

Introduction	8-1
Filters	8-1
Math.....	8-7

Introduction

This section discusses the digital and median filters and the math functions, such as polynomial and ratio.

Filters

Filtering stabilizes noisy measurements caused by noisy input signals.

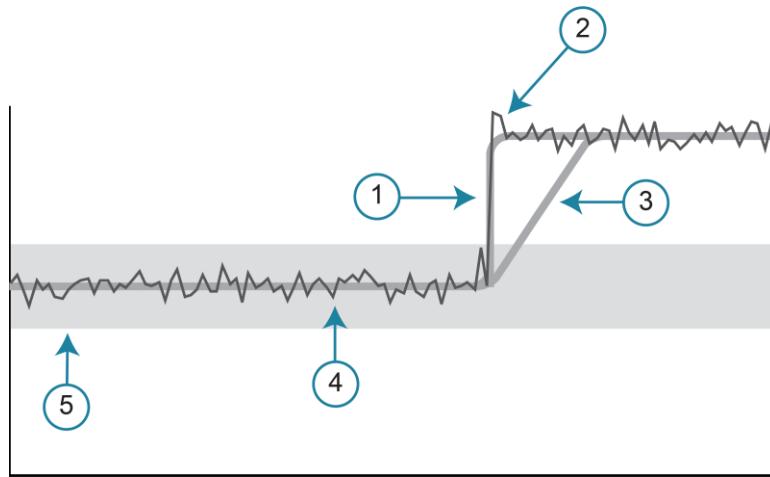
The 6517B has digital and median filters. When filters are enabled, the displayed, stored, or transmitted reading is the result of the filtering processes. You can use the digital and median filters at the same time. The median filter is applied first, then the results of the median filter are fed into the digital filter.

Filtering is performed only on primary display measurements. It has no effect on the NEXT and PREV displays.

Digital filters

The 6517B has two types of digital filters: Averaging and advanced. Both types are a simple average of one to 100 reading conversions. For the advanced filter, you can define a noise window.

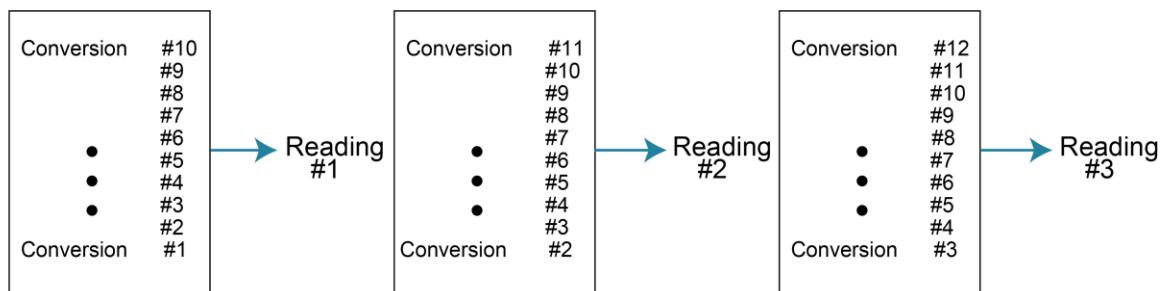
The noise window, which is expressed as a percentage of range (0 percent to 100 percent), allows a faster response time to large signal step changes, such as scanned readings. A reading conversion outside the plus or minus noise window fills the filter stack immediately. The following figure shows the difference between the response with no noise window and with a noise window.

Figure 69: Filter response and noise window

1	Response with the noise window enabled. The response shifts when the input signal moves beyond the specified range.
2	The input signal.
3	The response with no noise window.
4	Value displayed with filtering.
5	Limits of the user-specified noise window.

If the noise does not exceed the selected percentage of range, the reading is based on an average of reading conversions. In this case, the advanced filter works the same as the averaging filter. If the noise exceeds the selected percentage, the reading is a single reading conversion, and new averaging starts from this point.

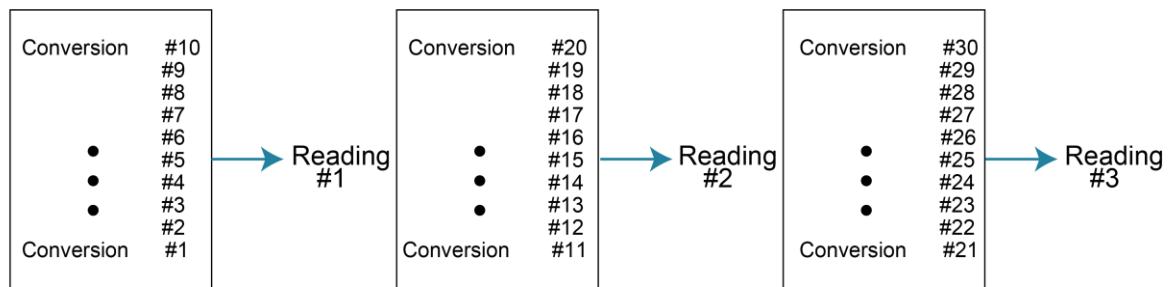
You can also select the filter mode, moving or repeating. A moving filter is a first-in, first-out stack, where the newest reading conversion replaces the oldest. An average of the stacked reading conversions yields a reading. After a selected number of conversions, a moving filter gives a new reading for every new conversion. The following figure demonstrates how the readings move through the stack.

Figure 70: Digital filter - moving filter mode

Type - Average, Readings = 10

A repeating filter makes a selected number of reading conversions, averages them, and yields a reading. It then empties the stack and starts over. This characteristic is useful when scanning channels. The following figure demonstrates how the readings move through the stack.

Figure 71: Digital filter - repeating filter mode



Type - Average, Readings = 10

The following figures provide detail on the differences between averaging and advanced filters with moving and repeating filter modes applied.

Figure 72: Filtering example

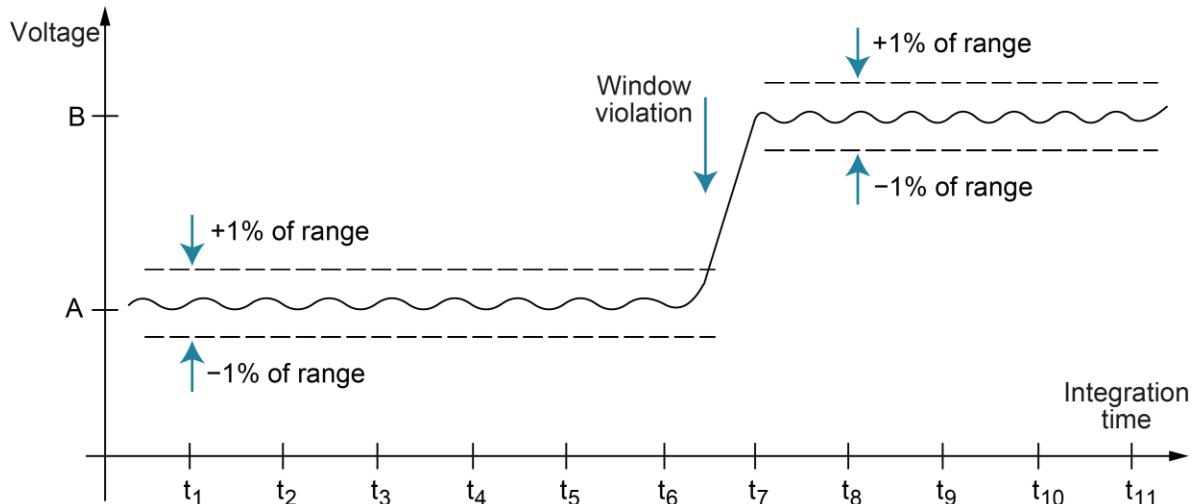
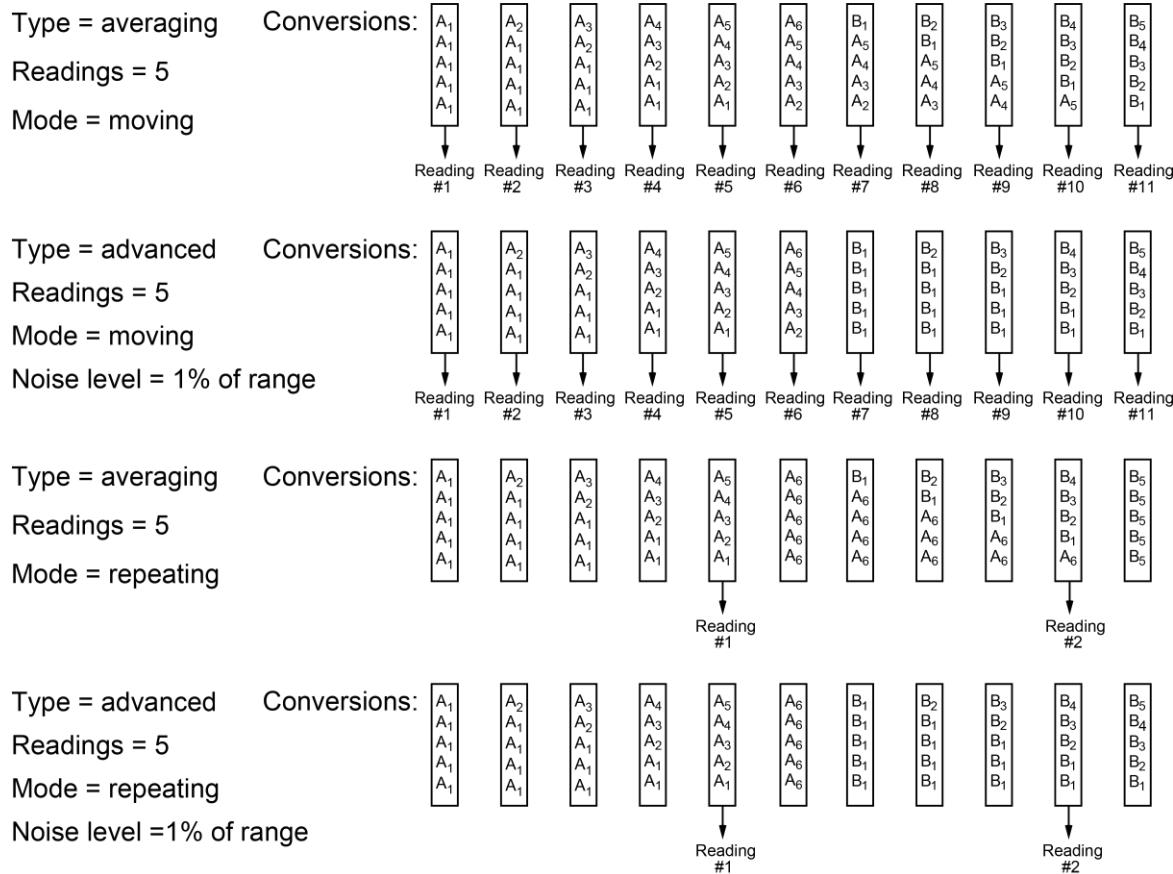


Figure 73: Digital filter types

Response time

The filter parameters have the following effects on the time needed to display, store, or output a filtered reading:

- Filter type: The time to the first reading is the same for all filters. Moving yields a faster reading than repeating. Also, advanced mode has a faster response to changes in the input signal than averaging.
- Number of reading conversions: Speed and accuracy are inversely dependent. For example, greater speed results in reduced accuracy.
- Noise window: For the advanced type, speed, accuracy, and response to input signal changes are related in the same way as speed and accuracy in the number of reading conversions.

Median filter

The median filter determines the reading at the midpoint of a group of readings that are arranged according to size. For example, assume the following readings:

20 mA, 1 mA, 3 mA

The readings are rearranged in an ascending order as follows:

1 mA, 3 mA, 20 mA

From the above readings, it is apparent that 3 mA is the median (middle-most) reading. The number of sample readings used for the median calculation is determined by the selected rank (1 to 5) as follows:

$$\text{Sample readings} = (2 \times R) + 1$$

Where R is the selected rank (1 to 5)

For example, a rank of 5 uses the last 11 readings to determine the median:

$$(2 \times 5) + 1 = 11$$

Each new reading replaces the oldest reading. The median is determined from the updated sample of readings.

NOTE

When the median filter is enabled, a sudden change in signal level may not immediately appear in the readings. To ensure the signal is reported correctly, at least $2 \times R$ readings need to be made to make the reading consistent with the signal level.

Configuring the filters

Each measurement function has its own filter configuration. The filter options are summarized in the following table.

NOTE

Filters are enabled or disabled for all functions, but the filter settings for each function can be different.

NOTE

The number of readings set for the averaging filter is coupled to the value for the advanced filter. If you change the number for one filter, it is changed for the other filter.

Filter configuration menu

Menu item	Description
FILTER	The filter menu:
AVERAGING	Configure digital averaging filter:
TYPE	Select type of average filter:
NONE	No average filtering performed.
AVERAGING	Program a simple average filter (1 to 100 readings).
ADVANCED	Program a simple average filter (1 to 100 readings) with noise tolerance window (0 to 100% of range).
AVERAGING-MODE	Select moving average or repeating average mode.
MEDIAN	Configure median filter:
DISABLE	Disable median filter.
ENABLE	Enable median filter and specify rank (1 to 5).

Choosing the filter parameters for each function follows the same procedure. You can use the following methods to display a filter configuration menu:

- To configure the filter of the presently selected function, press the **CONFIG** key, then press the **FILTER** key.
- To configure the filter of another function and remain in the present function, press the **CONFIG** key, then the appropriate function key. From the menu for that function, select **FILTER**.

When FILTER is enabled, the status of the two filters is briefly displayed. For example, if the advanced filter set to average 10 readings and the median filter is on for this function, the displayed status is:

```
Filter Enabled
Digital = ADV(10)    Median ON
```

If no digital filter is selected (NONE) and the median filter is off, the message **No Filters Selected** is displayed. In this case, enabling FILTER has no effect on the input signal.

To configure the filter for a selected function:

1. Select the function (**V**, **I**, **R**, or **Q**) key.
2. Press the **CONFIG** key.
3. Select the **FILTER** key.
4. Select **MEDIAN**. Press the **ENTER** key.
5. Select **ENABLE** or **DISABLE**. Press the **ENTER** key.
6. If you enabled the median filter, select the **RANK**. Press the **ENTER** key.
7. Press the **EXIT** key to return to the previous menu.
8. Select **TYPE**. Press the **ENTER** key.
9. Select **AVERAGING** or **ADVANCED**.
10. Select the number of readings to use for the average. Press the **ENTER** key.
11. For ADVANCED, select the **LEVEL**. This defines the noise window. Press the **ENTER** key.

12. Select **AVERAGING-MODE**. Press the **ENTER** key.
13. Select **MOVING** or **REPEAT**. Press the **ENTER** key.
14. Press the **EXIT** key to return to the measurement display.
15. Press the **FILTER** key to enable or disable the filters. When filters are enabled, the filter settings for the selected function are briefly displayed and the FILT annunciator is on.

Math

The 6517B math operations are divided into the following categories:

- Math performed on single readings (polynomial, percent, percent deviation, deviation, ratio, and logarithmic). These math functions are set up in the CONFIGURE MATH menu.
- Math performed on buffered readings (maximum and minimum values, average, and standard deviation). These math functions are viewed in the PREV and NEXT displays.
- Math performed on single readings as a part of a pass/fail limits test.

This section describes math performed on single and buffered readings. For information on limit testing, refer to [Limits](#) (on page 9-1).

When MATH is enabled, it is in effect for all functions.

The 6517B uses IEEE-754 floating-point format for math calculations.

If $n \leq 1$, the result is NAN (not a number). These statistics are invalid if the measurement function changed when the readings were stored into the buffer (for example, when scanning different functions).

The last display in this series allows you to send the buffered readings to a printer.

Polynomial

This math operation allows you to mathematically manipulate normal display readings (X) according to the following polynomial calculation:

$$Y = (a_2)X^2 + (a_1)X + (a_0)$$

Where:

- Y is the displayed result
- a_2 , a_1 , and a_0 are user-entered constants
- X is the normal display reading

You can change the value of the a_2 , a_1 , and a_0 constants through the CONFIGURE MATH menu. The before and after calculation can be viewed with one of the NEXT displays. When necessary, the resulting Y value is displayed in scientific notation.

To set up the polynomial math operation:

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **POLYNOMIAL**. Press the **ENTER** key. The **a2** constant displayed.
4. Set the **a2** constant. Press the **ENTER** key.
5. Set the **a1** constant. Press the **ENTER** key.
6. Set the **a0** constant. Press the **ENTER** key. You are returned to the reading display.
7. Press the **MATH** key to enable the math function. **POLY** is displayed.

Percent

This operation lets you specify a target reading value. The displayed reading is expressed as a percentage of the target value. The percentage calculation is performed as follows:

$$\text{Percent} = \frac{\text{Input Reading}}{\text{Target Value}} \times 100$$

Where:

- *Percent* is the displayed result
- *Input Reading* is the normal display reading
- *Target Value* is the user-entered constant

For example, consider the default target value for percentage calculations, where:

100% = +1.000000e+00

Therefore, a 1 V input is 100 percent of the target value and a typical reading is displayed as follows:

+100.000 V %

On the math NEXT display, the display is:

+100.000 V %
Reading = +1.00000

The bottom line displays the actual reading before the percentage calculation is performed.

To set up the percent math operation:

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **PERCENT**. Press the **ENTER** key. The percentage is displayed.
4. Set the percentage. Press the **ENTER** key. You are returned to the reading display.
5. Press the **MATH** key to enable the math function. **%** is displayed.

Percent deviation

The following math calculation provides the percent deviation between the normal display reading and a user-specified reference value:

$$\%Dev = \frac{(X - Y)}{Y} \times 100$$

Where:

- $\%Dev$ is the display result (percent deviation)
- X is the normal display reading
- Y is the specified reference value

On the math NEXT display, the display is:

```
+100.000 V %
Reading = +1.00000
```

The bottom line displays the actual reading before the percentage calculation is performed.

To set up the percent deviation math operation:

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **%DEV**. Press the **ENTER** key. The reference value is displayed.
4. Set the **Ref**. Press the **ENTER** key. You are returned to the reading display.
5. Press the **MATH** key to enable the math function. **%DEV** is displayed.

Deviation

You can select a deviation between the normal display reading and a user-specified reference value. The following calculation provides the deviation between the normal reading and the reference value:

$$Deviation = \frac{(X - Y)}{Y}$$

Where:

- *Deviation* is the displayed result
- X is the normal display reading
- Y is the specified reference value

To set up the deviation math operation:

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **DEVIATION**. Press the **ENTER** key. The reference value is displayed.
4. Set the **Ref**. Press the **ENTER** key. You are returned to the reading display.
5. Press the **MATH** key to enable the math function. **DEV** is displayed.

Ratio

The ratio calculation divides the normal display reading by the user-specified reference value:

$$Ratio = \frac{X}{Y}$$

Where:

- *Ratio* is the displayed result
- *X* is the normal display reading
- *Y* is the specified reference value

To set up the ratio math operation:

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **RATIO**. Press the **ENTER** key. The reference value is displayed.
4. Set the **Ref**. Press the **ENTER** key. You are returned to the reading display.
5. Press the **MATH** key to enable the math function. **RAT** is displayed.

Logarithmic

This calculation converts input readings to logarithmic base 10 values. The calculation is shown as follows:

$$\log_{10} X = Y$$

Where:

- *X* is the input reading
- *Y* is the logarithmic result

Example: Assume that 1 mA is measured by the 6517B:

```
log10 1.000000 mA = -3
```

This calculation uses the absolute value of the normal input reading because you cannot compute the log of a negative number.

To set up the logarithmic math operation:

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **LOG10**. Press the **ENTER** key. You are returned to the reading display.
4. Press the **MATH** key to enable the math function. **LOG** is displayed.

Set up no math function

You can set no math operation to occur when MATH is enabled. The MATH annunciator lights, but NONE is displayed on the top line.

To set up **NONE as the math operation:**

1. Press the **CONFIG** key.
2. Press the **MATH** key.
3. Select **NONE**. Press the **ENTER** key. You are returned to the reading display.
4. Press the **MATH** key to enable the math function. **NONE** is displayed.

Math annunciators

The MATH annunciator is on when calculations are enabled. The 6517B displays the result of the calculation, using scientific notation where necessary.

Menu item	Description	Annunciator on display
None	Select no calculation when MATH key is enabled	NONE
Polynomial	Select polynomial calculation and enter constants	POLY
Percent	Select percent calculation and enter target (reference) value	%
%DEV	Select percent deviation calculation and enter reference value	%DEV
DEVIATION	Select deviation calculation and enter reference value	DEV
Ratio	Select ratio calculation and enter reference value	RAT
Log10	Select logarithmic base 10 calculation	LOG

Math and actual reading display

The math display includes the actual reading on the bottom line of the display and the result of the calculation on the top line.

To view this display, repeatedly press the **NEXT** or **PREV DISPLAY** key to scroll through the displays. An example of the display when polynomial is selected is shown in the following figure.

Figure 74: Math display



The display resolution and units of measure on the bottom line match the top line. For example, if the top line displays μ A, the units on the bottom line are μ A.

View math readings from the front panel

You can view readings that are stored in the buffer from the front panel, including the minimum, maximum, average, and standard deviation. To view the readings with math operations, press **NEXT DISPLAY**. The math operations are shown on the bottom line of front-panel display in the following order.

Maximum and minimum

The MAX reading is the maximum reading in the buffer, for example:

```
MAX=+1.635968e+00 at RDG# +00090
```

The display response may be slow due to calculation of statistics for large buffers. The exponents are the same as the units on the top line (for example, mA).

The MIN reading is the minimum reading in buffer, for example:

```
MIN=+1.627611e+00 at RDG# +00012
```

Average

This math operation displays the mean value of the buffered readings, for example:

```
Average = +1.6345e+00
```

The equation used to calculate the mean is:

$$y = \frac{\sum_{i=1}^n x_i}{n}$$

Where:

- x_i is a stored reading
 - n is the number of stored readings
- If n = 0, the result is NAN (not a number).

Standard deviation

The StdDev operation displays the standard deviation of the stored readings, for example:

```
StdDev = 1.4944e-03
```

The equation used to calculate the standard deviation is:

$$y = \sqrt{\frac{\sum_{i=1}^n x_i^2 - \left(\frac{1}{n} \left(\sum_{i=1}^n x_i\right)\right)^2}{n-1}}$$

Where:

- x_i is a stored reading
- n is the number of stored readings

Section 9

Limits, digital I/O, and scanning

In this section:

Introduction	9-1
Limits	9-1
Digital I/O	9-5
Scanning	9-9

Introduction

This section discusses limits tests, use of the digital I/O port, and internal and external scanning with the 6517B.

Limits

The LIMITS menu is used for the following operations:

- To set and control the limit values that determine the PASS/FAIL and HI/LO status of subsequent measurements.
- To set the digital output patterns that signify passing or failing limit checks.
- To enable or disable a binning strobe signal on digital output #4 for triggering a user-supplied device handler.

There are two sets of limits, each with high and low limit values. You can program one or both limit sets. With both sets enabled, the values can overlap. The only restriction is that within the same set, the high limit must be greater than the low limit.

The limit test is performed after MATH operations.

Unit prefixes are applied before the limit test, for example:

- Low Limit = -10.0, High limit = 10.0. A 1.5 V reading passes (PASS)
- Low Limit = -10.0, High limit = 10.0. A 0.6 MΩ reading equals 600,000 (FAIL)

You can program the digital output lines to reflect the results of limit tests. The first test that fails sets a programmable digital output pattern, where the test execution order is LOW1, HIGH1, LOW2, HIGH2. If all tests pass, another programmable pattern is set.

Setting limits

Limits are controlled with the LIMIT-SET-1 and LIMIT-SET-2 selections.

To access the limit options:

1. Press the **MENU** key.
2. Select **LIMITS**. Press the **ENTER** key.

The following options are available:

- **CONTROL:** Enables or disables control of the digital output lines by the results of either or both limit set tests.
- **LOLIM1, HILIM1, LOLIM2, HILIM2:** Allow you to set values for the low and high limits and the action performed on the digital output lines for each limit test failure. After selecting a limit, the value for that limit is displayed. To change the limit, use the cursor keys and the **RANGE** keys to display the value. You must enter values in scientific notation. After you press the **ENTER** key to select the value, the digital output action options are displayed.
- **STROBE-CONTROL:** Enables or disables the use of digital output #4 as a binning strobe signal. When strobe control is enabled, the strobe signal is set TRUE for greater than 10 microseconds after all limit tests have been performed on a new reading. You can use the FALSE to TRUE transition to trigger an external device handler to check digital outputs 1 to 3 for sorting parts into bins. When external device handler binning is enabled from the front panel or with the bus command :CALCulate3:BSTRobe:STATE ON, the binning strobe signal is set to FALSE. When binning is disabled, the strobe signal is left unchanged.
- **PASS-PATTERN:** Programs the on and off states of the digital output lines when all limit tests pass. To change the pattern, use the cursor keys to select the digital output and the **RANGE** keys to toggle the parameter values between **OFF** and **ON**. When the binning strobe is enabled, digital output line #4 cannot be used.

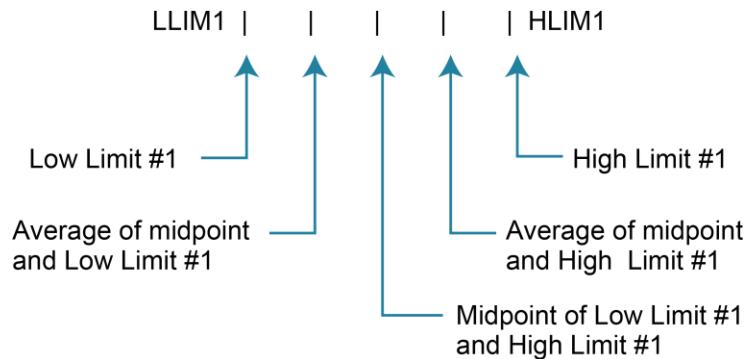
View limit test 1 results on the front panel

Limit 1 results are available on the front-panel display. They are shown as a bar graph and a pass/fail indication for the measurements. While the limits bar graph is displayed, you can view the programmed values for limit 1.

The NEXT displays of limit values do not use unit prefixes. For example, voltage is shown in volts, not millivolts.

The ticks on the bar graph are defined in the following figure.

Figure 75: Limits bar graph example - defined points of display



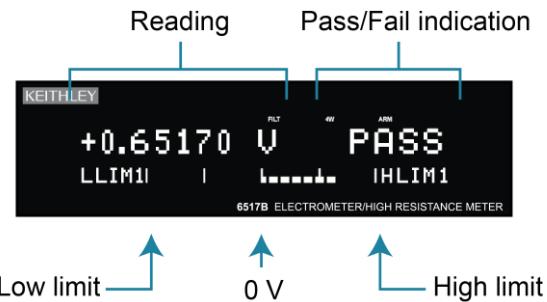
If Low Limit 1 is greater than or equal to high limit #1, the following message is shown on the bottom line of the limits bar graph display:

```
No bar graph: LLIM1 >= HLIM1
```

To view the limit 1 results on the display:

1. Press the DISPLAY NEXT key until the limits graph is displayed. An example is shown in the following figure.

Figure 76: Limits bar graph example - Example display with limits ± 1 V



2. To view the programmed values for limit 1, press the INFO key.
3. Press the EXIT key to return to the graph.

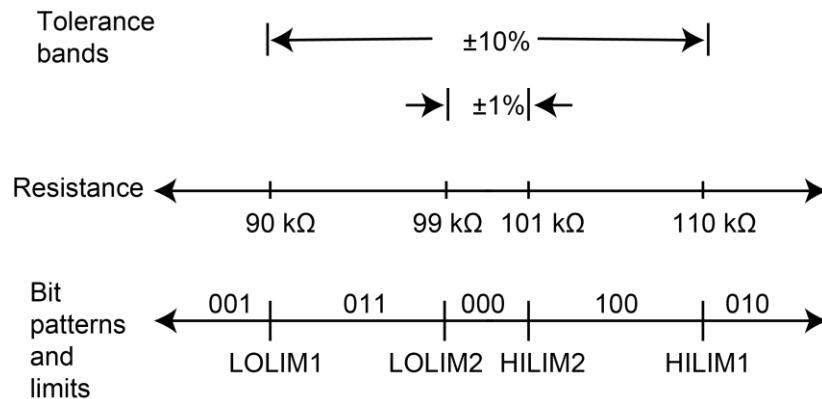
Limits example

This example sorts a quantity of 100 kΩ resistors into five bins, according to the following tolerances:

- Values less than 90 kΩ (outside -10% tolerance)
- Values greater than 110 kΩ (outside $+10\%$ tolerance)
- Values between 90 kΩ and 99 kΩ (meets -10% tolerance)
- Values between 101 kΩ and 110 kΩ (meets $+10\%$ tolerance)
- Values between 99 kΩ and 101 kΩ (meets $\pm 1\%$ tolerance)

The test is shown in the following figure.

Figure 77: Using a limit test to sort 100 kΩ resistors



In this example, since binning is enabled, digital output #4 is OFF.

NOTE

The actual state (high or low) of the digital output lines depends on the selected polarity (ACTIVE-HIGH or ACTIVE-LOW) for the line. Refer to [Digital I/O](#) (on page 9-5) for more information.

To set the limits using the front panel:

1. Press the **MENU** key.
2. Select **LIMITS**. Press the **ENTER** key.
3. Select **LIMIT-SET-1**. Press the **ENTER** key.
4. Select **CONTROL**. Press the **ENTER** key.
5. Select **ENABLE**. Press the **ENTER** key.
6. Select **LOLIM1**. Press the **ENTER** key.
7. Set the low limit value to **90 kΩ**. Press the **ENTER** key.
8. Set the low limit 1 action to **DIGOUT1=ON**. Press the **ENTER** key.
9. Repeat these steps for the other low and high limits. Select the values and actions shown in the following table.

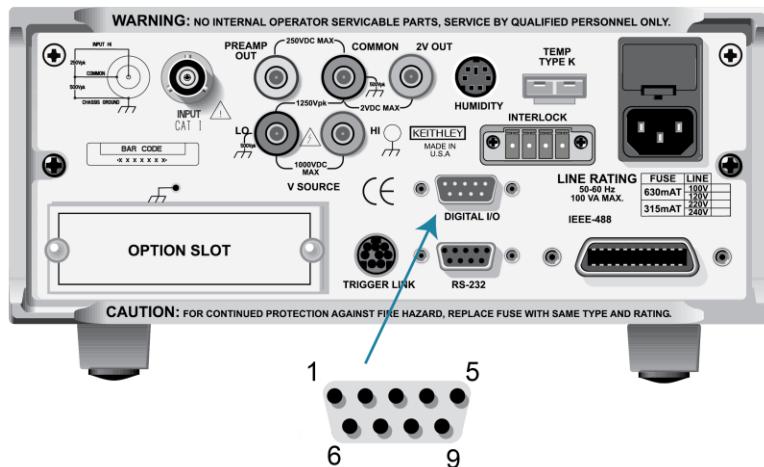
Limit	Value	Action
LOLIM1	90 kΩ	DIGOUT1=ON, others OFF
HILIM1	110 kΩ	DIGOUT2=ON, others OFF
LOLIM2	99 kΩ	DIGOUT1=ON, DIGOUT2=ON, others OFF
HILIM2	101 kΩ	DIGOUT3=ON, others OFF

10. Press the **EXIT** key to return to the LIMITS MENU.
11. Select **STROBE-CONTROL**. Press the **ENTER** key.
12. Select **ENABLED**. Press the **ENTER** key.
13. Select **PASS PATTERN**. Press the **ENTER** key.
14. Set all lines to **OFF**. Press the **ENTER** key.

Digital I/O

You can use the Digital I/O port to control external circuitry. The port provides four output lines and one input line (input line is for calibration use only). Each open-collector output can be set high (+5 V) or low (0 V) and sinks up to 100 mA. The four output lines can also operate external supplies from +5 V to +30 V.

The Digital I/O port is a male DB-9 connector on the rear panel. The following graphic shows the port location and pin designations.

Figure 78: Digital I/O port

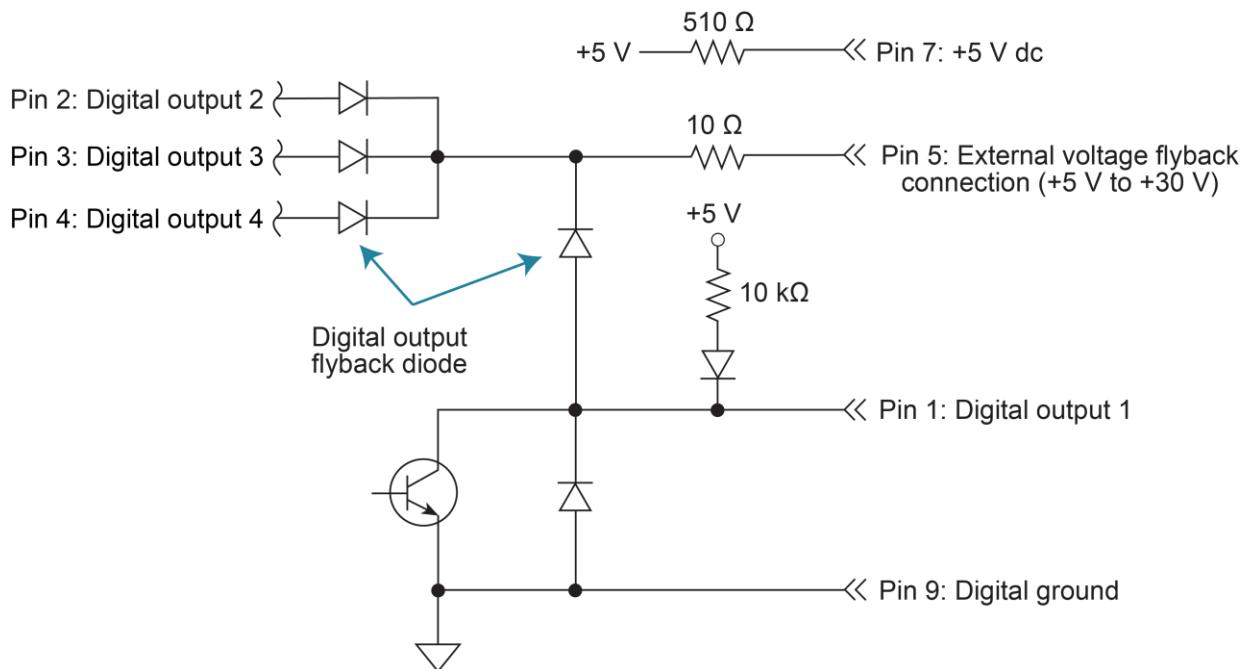
Pin	Description
1	Digital output 1
2	Digital output 2
3	Digital output 3
4	Digital output 4
5	External voltage clamp
6	Calibration input
7	+5 V
8	Not used
9	Ground

Controlling digital circuitry

Each of the four digital open-collector outputs includes a built-in pull up resistor to +5 V. The output transistor can sink up to 100 mA from voltages up to +30 V. The outputs can be controlled independently or tied to one of four limit values (two high, two low).

External voltage supply

Each output can be operated from external voltage supplies (voltage range from +5 V to +30 V applied through the external device being driven). Refer to the following figure below for a simplified schematic of the digital I/O.

Figure 79: Digital I/O schematic

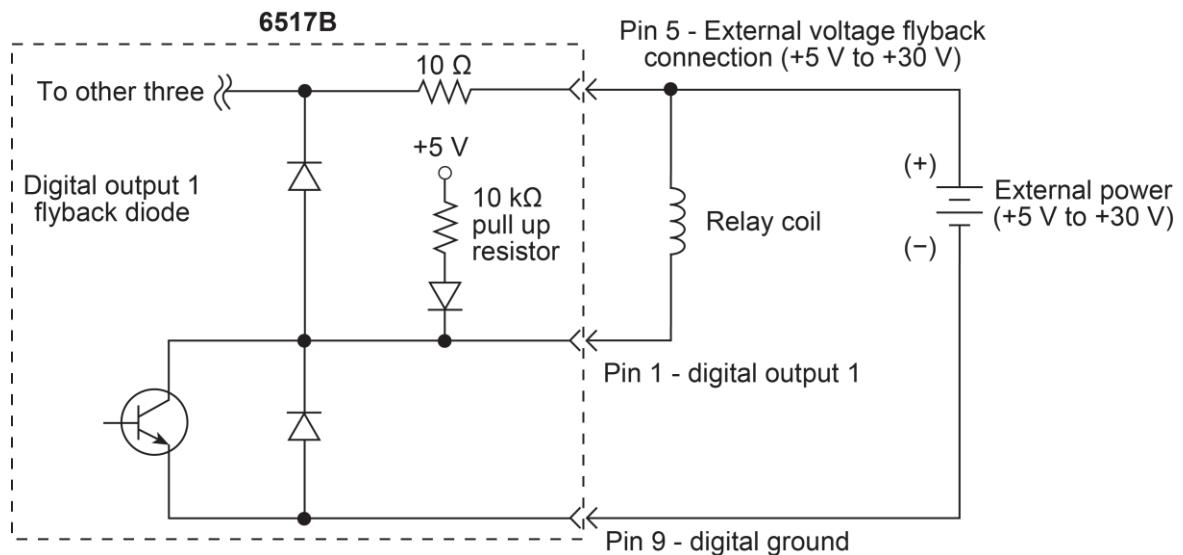
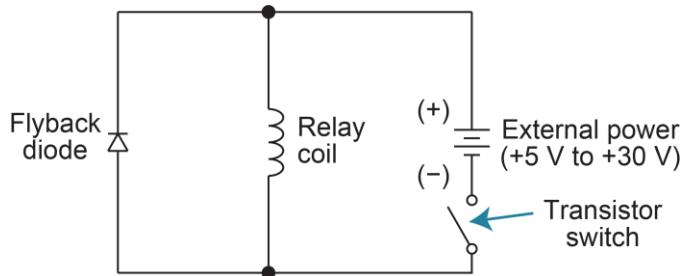
The high-current sink capacity of the output driver allows direct control of relays, solenoids, and lamps. No additional circuitry is needed.

Each output channel contains a flyback diode for protection when switching inductive loads such as a low-power solenoid or relay coils. To use these flyback diodes, connect the external supply voltage to pin 5 of the digital I/O port. Make sure the external supply voltage is between +5 V and +30 V and the current required by the device does not exceed 100 mA.

CAUTION

Do not apply more than 100 mA maximum current or exceed +30 V maximum voltage on pin 5 of the digital I/O port. Applying current or voltage exceeding these limits may damage the instrument.

An externally powered relay connected to the digital output port is shown in the following figure. Other externally powered devices can be similarly connected by replacing the relay with the device.

Figure 80: Digital I/O external relay control**Figure 81: Digital I/O external relay control - equivalent circuit**

Outputs used as logic inputs

When the output is low (0 V), the output sink can drive at least 10 standard TTL inputs. When the output is high (+5 V), the 10 kΩ pull-up resistor sources >100 µA while remaining at a > 3.75 V output (a reliable logic high). The sense of each line can be active-high (ON = +5 V) or active-low (ON = 0 V).

When using the collector outputs of the 6517B to activate externally powered devices, set the corresponding digital output line parameters as follows:

- STATE: ON
- LOGIC-SENSE: ACTIVE-LOW

In the low state (0 V), the output transistor sinks current through the external device. In the high state, the output transistor is off (transistor switch is open). This interrupts current flow through the external device. Most applications use the active-low (ON = 0 V) logic sense.

To use the digital outputs as logic inputs to active TTL, low-power TTL, or CMOS inputs:

1. Connect the 6517B digital outputs to the logic inputs.
2. Connect the digital grounds.
3. Press the **MENU** key.
4. Select **GENERAL**. Press the **ENTER** key.
5. Select **DIGOUT**. Press the **ENTER** key.
6. Select **STATE**. Press the **ENTER** key.
7. Set the value for each output to **ON**. Press the **ENTER** key.
8. Select the **LOGIC-SENSE** menu. Press the **ENTER** key.
9. Select a **TTL** line. Press the **ENTER** key.
10. Set the line to **ACTIVE-HIGH** or **ACTIVE-LOW**.
11. Set the other TTL lines as needed.

Scanning

The 6517B can be used with an internal scanner card (for example, Keithley Instruments Models 6521 or 6522) or with external scanner cards installed in switching mainframes such as the Keithley Instruments Models 7001 and 7002.

A scanner allows you to switch among a number of input signals to the 6517B for measurement. The channel control and scanning capabilities depend on whether an internal or external scanner card is used and on the capabilities of the scanner card.

Internal scanning

When a scanner card is installed in the rear panel option slot, the 6517B can close and open individual channels or scan through the channels.

Detailed operating instructions for internal scanning are provided in the instruction manual for the scanner card.

External scanning

When using external scanning, you can configure the 6517B to measure up to 400 channels. To synchronize 6517B measurements with external channel closure, connect the 6517B trigger link to the external switching mainframe trigger link. For more information on triggering, including descriptions of the trigger source, refer to [Triggering](#) (on page 6-1). The TRIG key is always active to allow you to step through the scan.

Use the following information to configure the 6517B for external scanning and to start the external scan. Refer to the documentation supplied with the switching mainframe and the scanner card for specific configuration and connection information.

External scanning with a card in the option slot

NOTE

The CHANNEL-CLOSURES option opens or closes channels on the scanner card installed in the option slot. For details, see the instruction manual for that card.

To configure the instrument for external scanning from the front panel when a card is installed in the option slot:

1. Set up the 6517B for the measurement (for example, set the function and range).
2. Press the **CONFIG** key and then the **CARD** key.
3. Select **EXTERNAL-INPUTS (CHANNELS)**. Press the **ENTER** key.
4. Specify the number of external channels (inputs) to scan. Press the **ENTER** key.
5. Press the **CARD** key.
6. Select **PERFORM-SCAN**. Press the **ENTER** key.
7. Select **EXTERNAL** scanning. Press the **ENTER** key.
8. Press the **ENTER** key to reset the external scanner.
9. Press the **ENTER** key to set the channel count (CHAN COUNT) of the external scanner to infinite.
10. Select the trigger source. Press the **ENTER** key.
11. Press the **ENTER** key to set the external scanner to the trigger source.
12. Press the **ENTER** key to set the scan list of the external scanner for the appropriate number of channels. This is the value that was set for EXTERNAL-INPUTS.
13. Press the **ENTER** key to **STEP** the external scanner to the first channel.
14. Press the **ENTER** key to set the scan count for the 6517B. The scan count specifies how many times you wish to repeat the scan. For example, if the scan list has 40 channels, and the scan count is 5, then 40 channels are scanned five times.
15. Press the **ENTER** key.
16. Select **YES** or **NO** to use the scan timer. If you selected TIMER as the trigger source, select **YES**. You are prompted to enter the interval between triggers (0.001 second to 999999.999 seconds). Otherwise, select **NO**.
17. Select **YES** or **NO** to store the readings in the buffer. If you select **YES**, the number of readings that are stored in the buffer are displayed.
18. Press the **ENTER** key to start the external scan. The selected trigger source controls the scan.

External scanning without a card in the option slot

To configure the instrument for external scanning from the front panel when no card is installed in the option slot:

1. Set up the 6517B for the measurement (for example, set the function and range).
2. Press the **CONFIG** key and then the **CARD** key.
3. Select **EXTERNAL-INPUTS (CHANNELS)**. Press the **ENTER** key.
4. Specify the number of external channels (inputs) to scan. Press the **ENTER** key.
5. Select the **CARD** key.
6. Select **PERFORM-SCAN**. Press the **ENTER** key.
7. Select **EXTERNAL**. Press the **ENTER** key.
8. Press the **ENTER** key to reset the external scanner.
9. Set the channel count (CHAN COUNT) of the external scanner to infinite. Press the **ENTER** key.
10. Select the trigger source. Press the **ENTER** key.
11. Select the external scanner to the trigger source. Press the **ENTER** key.
12. Set the scan list of the external scanner for the appropriate number of channels. This is the same as the EXTERNAL-INPUTS value set previously. Press the **ENTER** key.
13. Press the **ENTER** key to accept the message prompts.
14. Set the scan count. The scan count specifies how many times you wish to repeat the scan. For example, if the scan list has 40 channels, and the scan count is 5, then 40 channels are scanned five times. Press the **ENTER** key.
15. Select **YES** or **NO** to use the scan timer. If you selected TIMER as the trigger source, select **YES**. You are prompted to enter the interval between triggers (0.001 second to 999999.999 seconds). Otherwise, select **NO**.
16. Select **YES** or **NO** to store the readings in the buffer. If you select **YES**, the number of readings that are stored in the buffer are displayed.
17. Press the **ENTER** key to start the external scan. The selected trigger source controls the scan.

Section 10

Introduction to SCPI commands

In this section:

Programming syntax	10-1
Using the SCPI command reference.....	10-7

Programming syntax

The Standard Commands for Programmable Instruments (SCPI) standard is a syntax and set of commands that are used to control test and measurement devices. For more information, see the IEEE-488.2 and SCPI standards.

The following information describes some basic SCPI command information and how SCPI is used with the 6517B and presented in the 6517B documentation.

Commands that are listed as SCPI compliant have commands and parameters that are SCPI confirmed. Other commands are SCPI commands, but do not conform to the SCPI standard set of commands. It is not a recognized command by the SCPI consortium. SCPI confirmed commands that use one or more non-SCPI parameters are explained in the “Details” section of the command description.

Command words

Program messages are made up of one or more command words.

Some command words are enclosed in brackets ([]). These brackets denote an optional command word that does not need to be included in the program message. For example:

:INITiate[:IMMEDIATE]

These brackets indicate that :IMMEDIATE is an optional command word and does not have to be used. When using optional command words in your program, do not include the brackets. For example, the above command can be sent in either of these ways:

:INITiate

:INITiate:IMMEDIATE

Commands and command parameters

Common commands and SCPI commands may or may not use a parameter. Parameters are shown in angle brackets (< >). The following are some examples:

*SAV <NRf>	Parameter (NRf) required.
*RST	No parameter used.
:INITiate:CONTinuous 	Parameter required.
:SYSTem:PRESet	No parameter used.

Put at least one space between the command word and the parameter. Do not include the angle brackets when sending the command.

Parameter types

The following table lists the common parameter types.

	Boolean. Enables or disables an instrument operation. 0 or OFF disables the operation, and 1 or ON enables the operation. For example, the following command enables continuous initiation: :INITiate:CONTinuous ON
<name>	Name parameter. Select a parameter name from a listed group. For example, to select the percentage calculation: :CALCulate:FORMAT PERCent
<NRf>	Numeric representation format. A number that can be expressed as an integer (such as 8), a real number (such as 23.6), or an exponent (2.3e6). For example, to set the buffer size to 20: :TRACE:POINTS 20
<n>	Numeric value. Can consist of an NRf number or one of the following name parameters: DEFault, MINimum, or MAXimum. When the DEFault parameter is used, the instrument is programmed to the *RST default value. When the MINimum parameter is used, the instrument is programmed to the lowest allowable value. When the MAXimum parameter is used, the instrument is programmed to the largest allowable value. For example, to set the timer to 100 ms: :TRIGger:TIMER 0.1 To set the timer to the default of 0.1 s: :TRIGger:TIMER DEFault To set the timer to the minimum of 1 ms: :TRIGger:TIMER MINimum To set the timer to the maximum of 999999.999 s: :TRIGger:TIMER MAXimum
<list>	Specify one or more switching channels. For example, to specify a scan list of channels 1 to 5, send: :ROUTE:SCAN (@1:5)

Long-form and short-form versions

This documentation shows SCPI commands with both uppercase and lowercase letters. The uppercase letters are the required elements of a command. The lowercase letters are optional. If you choose to include the letters that are shown in lowercase letters, you must include all of them.

When you send a command to the instrument, letter case is not important. You can mix uppercase and lowercase letters in program messages.

For example, you can send the command :SYSTem:PRESet in any of the following formats:

```
:SYSTem:PRESet  
:SYST:PRES  
:SYSTem:PRES  
:syst:pres
```

Query commands

SCPI queries have a question mark (?) after the command. You can use the query to determine the present value of the parameters of the command or to get information from the instrument.

For example, to determine what the present setting for the timer is, you can send:

```
:TRIGger:TIMer?
```

This query returns the present setting.

If the command has MINimum, MAXimum, and DEFault options, you can use the query command to determine what the minimum, maximum, and default values are. In these queries, the ? is placed before the MINimum, MAXimum, or DEFault parameter. For example, to determine the default value for the timer, you can send:

```
:TRIGger:TIMer? DEFault
```

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.

Program messages

A program message consists of one or more command words sent by the computer to the instrument.

Each common command is a three-letter acronym preceded by an asterisk (*). Common commands are described in [Common commands](#) (on page 12-1).

SCPI commands consist of several levels. The following discussion uses the :STATUs subsystem to explain how command words are structured to create program messages.

Command structure

:STATUs	Path (root)
:OPERation	Path
:ENABLE <NRf>	Command and parameter
:ENABLE?	Query command
:PRESet	Command

Single command messages

The :STATUs command structure has three levels. The first level is made up of the root command (:STATUs) and serves as a path. The second level is made up of another path (:OPERation) and a command (:PRESet). The third level is made up of one command for the :OPERation path. You can execute these commands by sending the following program messages:

```
:STAT:OPER:ENAB 1  
:STAT:OPER:ENAB?  
:STAT:PRES
```

In each of these program messages, the path pointer starts at the root command (:STAT) and moves down the command levels until the command is executed.

Multiple command messages

You can send multiple command messages in the same program message if they are separated by semicolons (;). The following is an example showing two commands in one program message:

```
:STAT:OPER; :STAT:OPER:ENAB 1
```

When this command is sent, the first command word is recognized as the root command (:STAT).

When the next colon is detected, the path pointer moves to the next command level and executes the command. When the path pointer sees the colon after the semicolon (;), it resets to the root level.

Commands that are on the same command level can be executed without having to retype the entire command path. For example:

```
:STAT:OPER:ENAB 1; ENAB?
```

After the first command (:ENAB) is executed, the path pointer is at the third command level in the structure.

Command path rules

- Each new program message must begin with the root command unless it is optional, such as [:SENSe]. If the root is optional, treat the command word on the next level as the root.
- The colon (:) at the beginning of a program message is optional.
- The path pointer can only move down. It cannot be moved up a level. Executing a command at a higher level requires that you start over at the root command.

Using common commands and SCPI commands in the same message

You can use common commands and SCPI commands in the same message if they are separated by semicolons (;). A common command can be executed at any command level and does not affect the path pointer.

```
:STAT:OPER:ENAB 1; *ESE 1
```

Program message terminator (PMT)

Each program message must be terminated with a line feed (LF), end or identify (EOI), or LF+EOI. The bus hangs if your computer does not provide this termination. The following example shows how a program message must be terminated:

```
:ROUT:SCAN (@1:5) <PMT>
```

Command execution rules

- Commands execute in the order that they are presented in the program message.
- An invalid command generates an error and is not executed.
- Valid commands that precede an invalid command in a multiple command program message are executed.
- Valid commands that follow an invalid command in a multiple command program message are ignored.

Sending strings

If you are sending a string, it must begin and end with matching quotes (either single quotes or double quotes). To include a quote character as part of the string, type it twice with no characters in between.

Response messages

A response message is the message sent by the instrument to the computer in response to a query command program message.

After sending a query command, the response message is placed in the Output Queue. When the 6517B is addressed to talk, the response message is sent from the Output Queue to the computer.

Each response is terminated with a line feed (LF) and end or identify (EOI). The following example shows how a multiple response message is terminated:

```
0; 1; 1; 0; <RMT>
```

Multiple response messages

GPIB: If you send more than one query command in the same program message, the response messages for all the queries are sent to the computer when the 6517B is addressed to talk. The responses are sent in the order that the query commands were sent and are separated by semicolons (;). Items in the same query are separated by commas (,). The following example shows the response message for a program message that contains four single item query commands:

```
0; 1; 1; 0
```

RS-232 interface: Instead of commas, a <CR>, <LF> separates each response from multiple queries in the same program message.

Message exchange protocol

These rules summarize the message exchange protocol:

1. Always tell the 6517B what to send to the computer. To send information from the instrument to the computer:
 - a. Send the appropriate query commands in a program message.
 - b. Address the 6517B to talk.
2. The complete response message must be received by the computer before another program message can be sent to the 6517B.

Using the SCPI command reference

The SCPI command reference contains detailed descriptions of each of the SCPI commands that you can use to control your instrument. Each command description is broken into several standard subsections. The following figure shows an example of a command description.

Figure 82: SCPI command description example

:EXAMple:COMMAND:STATE

This command is an example of a typical SCPI command that turns an instrument feature on or off.

Type	Affected by	Where saved	Default value
Command and query	Recall settings Instrument reset Power cycle	Save settings	1 (ON)

Usage

:EXAMple:COMMAND:STATE <state>
:EXAMple:COMMAND:STATE?

<state>	Disable the example feature: 0 or OFF Enable the example feature: 1 or ON
---------	--

Details

This command is an example of a typical SCPI command that enables or disables a feature.

Example

:EXAMple:COMMAND:STATE ON	Turn the example feature on.
---------------------------	------------------------------

Also see

[:EXAMple:COMMAND:UNIT](#) (on page 6-100)

Each command listing is divided into five subsections that contain information about the command:

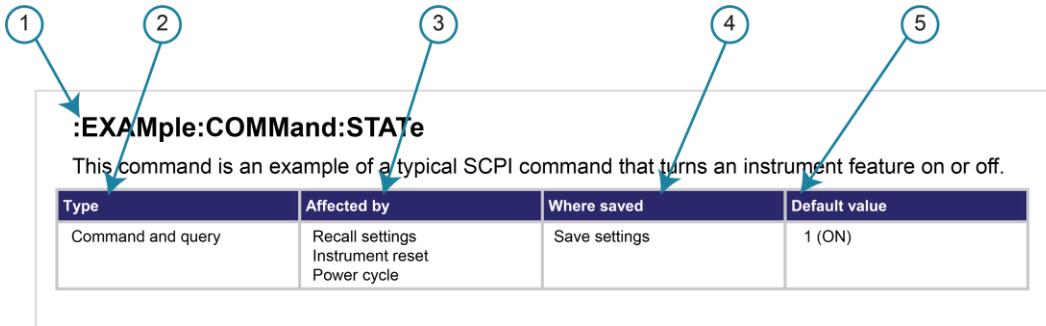
- Command name and summary table
- Usage
- Details
- Example
- Also see

The content of each of these subsections is described in the following topics.

Command name and summary table

Each instrument command description starts with the command name, followed by a table with relevant information for each command. Definitions for the numbered items are listed following the figure.

Figure 83: SCPI command name and summary table

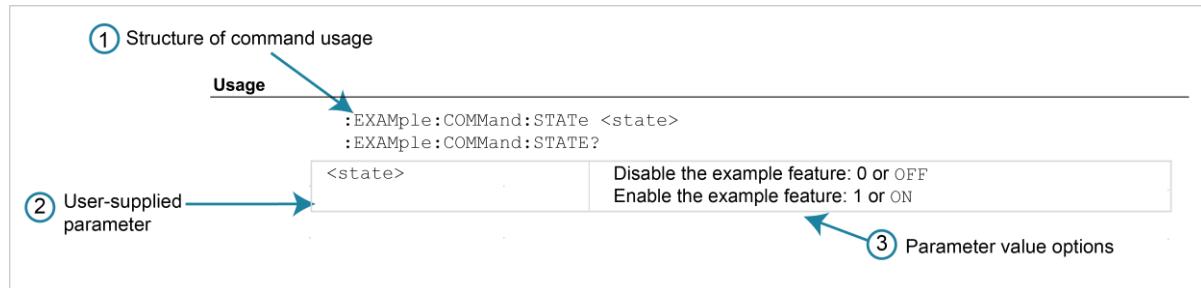


- 1 **Instrument command name.** Signals the beginning of the command description and is followed by a brief description of what the command does.
- 2 **Type of command.** Options are:
 - **Command only.** There is a command but no query option for this command.
 - **Command and query.** The command has both a command and query form.
 - **Query only.** This command is a query.
- 3 **Affected by.** Commands or actions that have a direct effect on the instrument command.
 - **Recall settings.** If you send *RCL to recall the system settings, this setting is changed to the saved value.
 - **Instrument reset.** When you reset the instrument, this command is reset to its default value. Reset can be done from the front panel or when you send *RST.
 - **Power cycle.** When you power cycle the instrument, this command is reset to its default value.
- 4 **Where saved.** Indicates where the command settings reside once they are used on an instrument. Options include:
 - **Not saved.** Command is not saved and must be sent each time you use it.
 - **Nonvolatile memory.** The command is stored in a storage area in the instrument where information is saved even when the instrument is turned off.
 - **Save settings.** This command is saved when you send the *SAV command.
- 5 **Default value:** Lists the default value for the command. The parameter values are defined in the Usage or Details sections of the command description.

Command usage

The Usage section of the remote command listing shows how to properly structure the command. Each line in the Usage section is a separate variation of the command usage; all possible command usage options are shown here.

Figure 84: SCPI command description usage identification

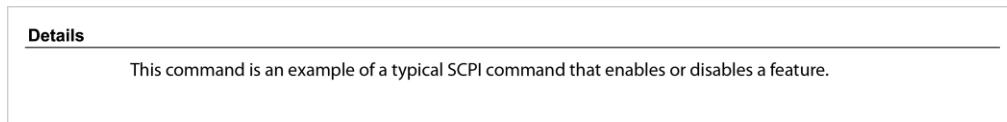


1. **Structure of command usage:** Shows the organization of the parts of the command.
2. **User-supplied parameters:** Indicated by angle brackets (< >).
3. **Parameter value options:** Descriptions of the options that are available for the parameter.

Command details

This section lists additional information you need to know to successfully use the command.

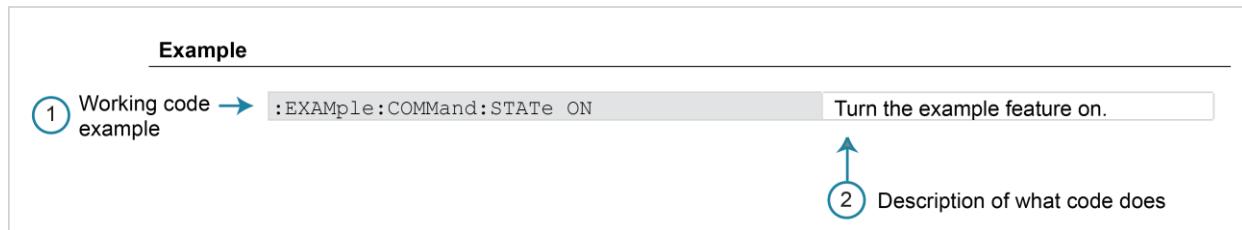
Figure 85: Details section of command listing



Example section

The Example section of the command description shows some simple examples of how the command can be used.

Figure 86: SCPI command description code examples



1. Example code that you can copy from this table and paste into your own application. Examples are generally shown using the short forms of the commands.
2. Description of the code and what it does. This may also contain the output of the code.

Related commands list

The **Also see** section of the remote command description provides links to commands that are related to the command.

Figure 87: SCPI related commands list example



Section 11

SCPI command reference

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Introduction

This section provides detailed information on the Keithley Instruments 6517B Electrometer Standard Communications for Programmable Instrumentation (SCPI) commands, including signal-oriented commands.

Signal-oriented measurement commands

The commands in the signal-oriented command group acquire readings using a set of high-level instructions to control the measurement process, as summarized in the following table.

Signal-oriented measurement command summary

Command	Description
:CONFigure:<function>	Places the 6517B in a one-shot measurement mode for the specified function
:FETCh?	Requests the latest reading
:MEASure[:<function>] ?	Performs an :ABORT, :CONFigure:<function>, and a :READ?
:READ?	Performs an :ABORT, :INITiate, and a :FETCh?

:CONFigure:<function>

This command selects the active measurement function to be used for subsequent measurements.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:CONFigure:<function>
:CONFigure?
```

<function>	The function: <ul style="list-style-type: none"> ■ VOLtage [:DC]: Voltage function ■ CURrent [:DC]: Current function ■ RESistance: Resistance function ■ CHARge: Charge function
------------	--

Details

This command places the instrument in a one-shot measurement mode. You can then use the :READ? command to trigger a measurement and acquire a reading.

When this command is sent, the 6517B is configured as follows:

- The function specified by this command is selected. The input channel remains the same.
- All controls related to the selected function are defaulted to their *RST values.
- Continuous initiation is disabled (:INITiate:CONTinuous OFF).
- The control source of the trigger model is set to immediate.
- The count values of the trigger model are set to one.
- The delay of the trigger model is set to zero.
- The 6517B is placed in the idle state.
- All math calculations are disabled.
- Buffer operation is disabled. If a storage operation is in process, it is aborted.
- Autozero controls are set to the *RST default values.
- The acquisition method is set to normal.
- All operations associated with switching cards (scanning) are disabled.

This command is automatically asserted when the :MEASure? command is sent.

Also see

- [:MEASure?](#) (on page 11-3)
- [:READ?](#) (on page 11-4)

:FETCh?

This command requests the latest post-processed reading.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:FETCh?

Details

This command requests the latest post-processed reading. After sending this command and addressing the 6517B to talk, the reading is sent to the computer. This command does not affect the instrument setup.

This command does not trigger a measurement. It requests the last available reading and can repeatedly return the same reading until there is a new reading. If your application requires a new reading, use the :SENSe:DATA:FRESH? command.

This command is automatically asserted when the :READ? or :MEASure? command is sent.

Also see

- [:MEASure?](#) (on page 11-3)
- [:READ?](#) (on page 11-4)
- [:SENSe:DATA:FRESH?](#) (on page 11-93)

:MEASure[:<function>]?

This command combines the signal-oriented measurement commands to perform a one-shot measurement and acquire the reading.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

:MEASure[:<function>]?

<function>	The function: <ul style="list-style-type: none"> ■ VOLtage [:DC]: Voltage function ■ CURRent [:DC]: Current function ■ RESistance: Resistance function ■ CHARge: Charge function
------------	--

Details

This command performs an :ABORT, :CONFigure:<function>, and a :READ?

If you include the function parameter, the instrument changes to the function and makes a measurement for that function.

Example 1

Make a measurement using the presently selected function.

:MEAS?

Example 2

Make a measurement using the charge function.

:MEAS:CHAR?

Also see

[:CONFigure:<function>](#) (on page 11-2)

[:FETCH?](#) (on page 11-3)

[:READ?](#) (on page 11-4)

:READ?

This command is typically used to acquire a post-processed reading after the instrument has been configured by the :CONFigure command.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

:READ?

Details

The :CONFigure command places the instrument in a one-shot measurement mode. Every time the :READ? command is sent, a measurement conversion occurs and a reading is acquired.

When this command is sent, the following commands are executed in this order:

- :ABORT
- :INITiate
- :FETCH?

When :ABORT is executed, the instrument goes into the idle state if continuous initiation is disabled. Otherwise, operation restarts at the beginning of the trigger model.

If the instrument is in the idle state, `:INITiate` takes the instrument out of the idle state. If continuous initiation is enabled, (`:INITiate:CONTinuous ON`), the `:INITiate` command generates an error and ignores the command. An `Init ignored` error does not cancel the execution of the `:FETCH?` command.

See `:FETCH?` for additional detail.

Also see

- [:CONFigure:<function>](#) (on page 11-2)
- [:FETCH?](#) (on page 11-3)

SCPI conformance and command summary

The Keithley Instruments 6517B Electrometer complies with SCPI version 1996.0. The information in the “[SCPI command reference](#) (on page 11-1)” section lists the SCPI confirmed commands and the non-SCPI commands implemented by the 6517B.

SCPI commands are summarized by subsystem in the following table.

Subsystem	Summary table	Subsystem reference
CALCulate	CALCulate command summary (on page 11-6)	CALCulate subsystems (on page 11-28)
DISPlay	DISPlay command summary (on page 11-8)	DISPlay subsystem (on page 11-51)
FORMAT	FORMAT command summary (on page 11-10)	FORMAT subsystem (on page 11-57)
OUTPut	OUTPut command summary (on page 11-10)	OUTPut subsystems (on page 11-63)
ROUTE	ROUTE command summary (on page 11-11)	ROUTE subsystem (on page 11-65)
SENSe	SENSe command summary (on page 11-11)	SENSe[1] subsystem (on page 11-71)
SOURce	SOURce command summary (on page 11-18)	SOURce subsystem
STATus	STATus command summary (on page 11-19)	STATus subsystem (on page 11-113)
SYSTem	SYSTem command summary (on page 11-21)	SYSTem subsystem (on page 11-154)
TRACe	TRACe command summary (on page 11-22)	TRACe subsystem (on page 11-168)
Trigger	TRIGger command summary (on page 11-23)	TRIGger subsystem (on page 11-177)
TSEQence	TSEQunce command summary (on page 11-25)	TSEQunce subsystem (on page 11-199)
UNIT	UNIT command summary (on page 11-28)	UNIT subsystem (on page 11-224)

General notes

- Brackets ([]) denote optional character sets. These optional characters do not have to be included in the program message. Do not use brackets in the program message.
- Angle brackets (< >) indicate the parameter type. Do not use angle brackets in the program message.
- The Boolean parameter () enables or disables an instrument operation. 1 or ON enables the operation and 0 or OFF disables the operation.
- Upper case characters indicate the short-form version for each command word.
- The Default Parameter column lists the *RST and :SYSTem:PRESet defaults, unless noted otherwise. Parameter notes are located at the end of each table.
- In the SCPI column, a check mark (✓) indicates that the command and its parameters are SCPI-confirmed. An unmarked command indicates that it is non-SCPI. SCPI-confirmed commands that use one or more non-SCPI parameters are explained by notes.

CALCulate command summary

Command	Description	Default parameter	SCPI
:CALCulate[1]	Subsystem to control CALC1:		✓
:FORMAT <name>	Select math format (NONE, POLynomial, PERCent, RATio, DEViation, PDEViation, LOG10)	POLynomial	✓
:FORMAT?	Query math format		✓
:KMATh	Path to control math calculations:		
:MA0Factor <NRf>	Set a0 for POLynomial (-9.99999e30 to +9.99999e30)	0	
:MA0Factor?	Query a0 factor		
:MA1Factor <NRf>	Set a1 for POLynomial (-9.99999e20 to +9.99999e20)	1	
:MA1Factor?	Query a1 factor		
:MA2Factor <NRf>	Set a2 for POLynomial (-9999999e30 to +9.99999e30)	0	
:MA2Factor?	Query a2 factor		
:PERCent <NRf>	Specify target value for percent calc (-9.99999e35 to +9.99999e35)	1	
:PERCent?	Query target value		
:REFerence <NRf>	Set reference value for ratio, deviation, and % deviation (-9.99999e35 to +9.99999e35)	1	
:REFerence?	Query reference value		

Command	Description	Default parameter	SCPI
:STATE <state>	Enable or disable calculation	*RST: ON :SYSTem:PRESet: OFF	✓
:STATE?	Query state of math function		✓
:DATA	Path to read math result of calculation		✓
[:LATest] ?	Return last reading		✓
:FRESh?	Return new reading		✓
:IMMEDIATE	Recalculate input data		✓
:IMMEDIATE?	Recalculate input data and query the result		✓
:CALCulate2	Subsystem to control CALC 2:		✓
:FORMAT <name>	Select math format: (MINimum, MAXimum, MEAN, SDEVIation, PKPK, or NONE)	NONE	✓
:FORMAT?	Query math format		✓
:STATE 	Enable or disable calculation	*RST: ON :SYSTem:PRESet: OFF	✓
:STATE?	Query state of math function		✓
:IMMEDIATE	Recalculate raw input data in buffer		✓
:IMMEDIATE?	Performs calculation and returns the result		✓
:DATA?	Read math result of CALC 2		✓
:CALCulate3	Subsystem to control CALC 3 (limit tests):		✓
:LIMIT[1]	Path to control LIMIT 1 test:		
:UPPer	Path to configure upper limit:		✓
[:DATA] <n>	Set upper limit (-9.999999e35 to +9.999999e35)	1	✓
[:DATA] ?	Query upper limit		✓
:SOURce <NRf>	Specify digital output (0 to 15)	0	✓
:SOURce?	Query source		✓
:LOWER	Path to configure lower limit:		✓
[:DATA] <n>	Set lower limit (-9.999999e35 to +9.999999e35)	-1	✓
[:DATA] ?	Query lower limit		✓
:SOURce <NRf>	Specify digital output (0 to 15)	0	✓
:SOURce?	Query digital output		✓
:STATE <state>	Enable or disable limit test	OFF	✓
:STATE?	Query state of limit test		✓
:FAIL?	Query test result (1 = pass, 0 = fail)		✓
:CLEAR	Path to clear failed test:		✓
[:IMMEDIATE]	Clear failed test indication		✓
:AUTO <state>	Enable or disable autoclear	ON	✓
:AUTO?	Query autoclear		✓

Command	Description	Default parameter	SCPI
:LIMIT2	Path to control LIMIT 2 test:		✓
:UPPer	Path to configure upper limit:		✓
[:DATA] <n>	Set upper limit (-9.999999e35 to +9.999999e35)	1	✓
[:DATA] ?	Query upper limit		✓
:SOURce <NRf>	Set digital output (0 to 15)	0	✓
:SOURce?	Query source (digital output value)		✓
:LOWER	Path to configure lower limit:		✓
[:DATA] <n>	Specify lower limit (-9.999999e35 to +9.999999e35)	-1	✓
[:DATA] ?	Query lower limit		✓
:SOURce <NRf>	Specify digital output (0 to 15)	0	✓
:SOURce?	Query source (digital output value)		✓
:STATE <state>	Enable or disable limit test	OFF	✓
:STATE?	Query state of limit test		✓
:FAIL?	Query test result (1 = pass, 0 = fail)		✓
:CLEAR	Path to clear failed test:		✓
[:IMMEDIATE]	Clear failed test indication		✓
:AUTO <state>	Enable or disable autoclear	ON	✓
:AUTO?	Query autoclear		✓
:PASS	Path to define pass digital output pattern:		
:SOURce <NRf>	Specify digital output (0 to 15)	0	
:SOURce?	Query digital output value		
:CLIMits	Command path for composite results of limit tests:		✓
:FAIL?	Query composite result of LIMIT 1 and LIMIT 2 tests (1 = pass; 0 = fail)		✓
:BSTRobe	Path to control limit-binning strobe:		
:STATE 	Enable or disable strobe	OFF	
:STATE?	Query state of binning strobe		
:IMMEDIATE	Recalculate the limit tests		✓

DISPlay command summary

Command	Description	Default parameter	SCPI
:DISPlay			✓
[:WINDOW[1]]	Path to locate message to top display		
:ATTRibutes?	Query attributes of display characters; 1=blinking character, 0=other		
:TEXT	Path to control user text messages	(Note 1)	✓
:DATA <a>	Define ASCII message "a" (up to 20 characters)		✓
:DATA?	Query text message		✓
:STATE 	Enable or disable message mode	(Note 2)	✓
:STATE?	Query text message state		✓
:DATA?	Read data on top portion of display		
:WINDOW2	Path to locate message to bottom display		✓
:ATTRibutes?	Query attributes of display characters; 1=blinking character, 0=other		
:TEXT	Path to control user text messages		✓
:DATA <a>	Define ASCII message "a" (up to 32 characters)	(Note 1)	✓
:DATA?	Query text message		✓
:STATE 	Enable or disable message mode	(Note 2)	✓
:STATE?	Query text message state		✓
:DATA?	Read data on bottom portion of display		
:CNDisplay	Clear the NEXT or PREV display messages and cancel associated operations		
:SMESSage 	Enable or disable status message mode	OFF	
:SMESSage?	Query status message state		
:ENABLE 	Enable or disable the front-panel display	(Note 3)	✓
:ENABLE?	Query state of the display		✓

Notes:

1. *RST and :SYSTem:PRESet have no effect on a user-defined message. Cycling power cancels all user-defined messages.
2. *RST and :SYSTem:PRESet have no effect on the state of the message mode. Cycling power disables (OFF) the message mode.
3. *RST and :SYSTem:PRESet have no effect on the display circuitry. Cycling power enables (ON) the display circuitry.

FORMat command summary

Command	Description	Default parameter	SCPI
:FORMat [:DATA] <type> [,<length>] [:DATA] ?	Select data format: <type>: ASCII, REAL, SREAL, or DREAL; <length>: 32 or 64 Query data format	ASCII, 32	✓
:ELEMENTs <item list>	Specify data elements: READING, CHANNEL, RNUMBER, UNITS, TStamp, STATUS, ETEMPerature, HUMidity, and VSOURCE)	READING, CHANNEL, RNUMBER, UNITS, TStamp, STATUS	✓
:ELEMENTs?	Query data elements		
:BORDer <name>	Select binary byte order: NORMAL or SWAPPED	SWAPPED	✓
:BORDer?	Query byte order		✓

OUTPut command summary

Command	Description	Default Parameter	SCPI
:OUTPut1 [:STATe] 	Enable (operate) or disable (standby) voltage source output	OFF	✓
[:STATe] ?	Query state of voltage source output		✓
:OUTPut2 :TTL[1] :LSENse <name>	Path to set polarity of digital output line 1: Select polarity; active high (AHIGH) or active low (ALOW) Query polarity of line 1	AHIGH	
:LSENse? :TTL2 :LSENse <name>	Path to set polarity of digital output line 2: Select polarity; active high (AHIGH) or active low (ALOW) Query polarity of line 2	AHIGH	
:LSENse? :TTL3 :LSENse <name>	Path to set polarity of digital output line 3: Select polarity; active high (AHIGH) or active low (ALOW) Query polarity of line 3	AHIGH	
:LSENse? :TTL4 :LSENse <name>	Path to set polarity of digital output line 4: Select polarity; active high (AHIGH) or active low (ALOW) Query polarity of line 4	AHIGH	
:LSENse?			

ROUTe command summary

Command	Description	Default parameter	SCPI
:ROUTE	Command path to control channels:		
:CLOSE <list>	Command to close specified channel (1 to 10)	Not applicable	✓
:CLOSE? <list>	Query closed channels (1 to 10); 1 = closed, 0 = open		
:STATE?	Query closed channel		✓
:OPEN <list>	Open specified channel or all channels		✓
:OPEN:ALL	Open all channels		✓
:OPEN? <list>	Query specified channels (1 to 10); 1 = open, 0 = closed		✓
:SCAN	Command path to configure and control scan operations		✓
[:INTERNAL] <list>	Specify internal scan list (2 to 10 channels)	All 10 channels	✓
[:INTERNAL]?	Query the internal scan list		
:EXTERNAL <n>	Specify external scan list (1 to 400 channels)	10	
:EXTERNAL?	Query the external scan list		
:LSELect <name>	Select scan operation: INTERNAL, EXTERNAL, or NONE	NONE	
:LSELect?	Query scan operation		
:STIMe <n>	Specify settling time for internal card (0 to 99999.9999 seconds)		
:STIMe?	Query settling time		
:SMETHOD <name>	Select scan method for internal scan (VOLTage or CURRent)	VOLTage	
:SMETHOD?	Query scan method		
:VSLimit 	Enable or disable 200 V limit for internal card	ON	
:VSLimit?	Query state of 200 V limit		

SENSe command summary - general commands

Command	Description	Default parameter	SCPI
[:SENSe[1]]			
:FUNCTION <name>	Select measurement function: 'VOLTage[:DC]', 'CURRent[:DC]', 'RESistance', 'CHARge'	'VOLT:DC'	✓
:FUNCTION?	Query function		✓
:DATA	Path to return readings:		✓
[:LATest]?	Return the last instrument reading		✓
:FRESH?	Query fresh readings		✓

SENSe command summary - voltage commands

Command	Description	Default parameter	SCPI
[:SENSe[1]] :VOLTage [:DC]	Path to configure voltage:		✓
:APERture <n>	Set integration rate in seconds (166.67e-6 to 200e-3)	60 Hz: 16.67 ms 50 Hz: 20 ms	✓
:APERture?	Query aperture (integration rate)		✓
:AUTo 	Enable or disable auto-aperture	OFF	
:AUTo ONCE	Enable and then disable auto-aperture		
:AUTo?	Query auto-aperture		
:NPLCycles <n>	Set integration rate (line cycles; 0.01 to 10)	1	✓
:NPLCycles?	Query line cycle integration rate		✓
:AUTo 	Enable or disable automatic NPLC	OFF	
:AUTo ONCE	Enable and then disable automatic NPLC		
:AUTo?	Query automatic line cycle integration		
:RANGE	Path to configure measurement range:		✓
[:UPPer] <n>	Select the range (0 to 200)	200	✓
[:UPPer]?	Query the range		✓
:AUTo 	Enable or disable autorange	Reset: ON Preset: OFF	✓
:AUTo ONCE	Set range based on present input signal		✓
:AUTo?	Query autorange		✓
:ULIMit <n>	Set upper limit for autorange (0 to 200)	200	
:ULIMit?	Query upper limit		
:LLIMit <n>	Set lower limit for autorange (0 to 200)	2	
:LLIMit?	Query lower limit		
:REFerence <n>	Specify reference (-200 to +200)	0	✓
:REFerence?	Query reference value		✓
:STATE 	Enable or disable reference	OFF	✓
:STATE?	Query state of reference (0 or 1)		✓
:ACQuire	Use input signal as reference		✓
:DIGits <n>	Specify measurement resolution (4 to 7)	6	
:DIGits?	Query resolution		
:AUTo 	Enable or disable autoresolution	OFF	
:AUTo ONCE	Enable and then disable autoresolution		
:AUTo?	Query autoresolution		
:AVERage	Path to control the average filter:		
:TYPE <name>	Select filter type (NONE, SCALar, ADVanced)	SCALar	
:TYPE?	Query filter type		
:TCONtrol <name>	Select filter type: (MOVing or REPeat)	Reset: REPeat Preset: MOVing	
:TCONtrol?	Query filter type		
:COUNT <n>	Specify filter count (1 to 100)	10	
:COUNT?	Query filter count		

Command	Description	Default parameter	SCPI
:ADVanced	Path to configure and control advanced filter:		
:NTOLerance <n>	Specify noise tolerance level (0 to 100%)	1	
:NTOLerance?	Query noise tolerance level		
[:STATe] 	Enable or disable digital filter	OFF	
[:STATe]?	Query state of digital filter		
:MEDian	Path to control the median filter:		
[:STATe] 	Enable or disable median filter	ON	
[:STATe]?	Query state of median filter		
:RANK <NRf>	Specify rank for median filter (1 to 5)	1	
:RANK?	Query rank		
:GUARD 	Enable or disable guard	OFF	
:GUARD?	Query state of guard		
:XFEedback 	Enable or disable external feedback	OFF	
:XFEedback?	Query state of external feedback		

SENSe command summary - current commands

Command	Description	Default parameter	SCPI
[:SENSe[1]] :CURRent [:DC]	Path to configure current:		
:APERture <n>	Set integration rate in seconds (166.67e-6 to 200e-3)	60 Hz: 16.67 ms 50 Hz: 20 ms	✓
:APERture?	Query aperture (integration rate)		✓
:AUTo 	Enable or disable autoaperture	OFF	✓
:AUTo ONCE	Enable and then disable autoaperture		
:AUTo?	Query autoaperture		
:NPLCycles <n>	Set integration rate in line cycles (0.01 to 10)	1	✓
:NPLCycles?	Query line cycle integration rate		✓
:AUTo 	Enable or disable automatic NPLC	OFF	
:AUTo ONCE	Enable and then disable automatic NPLC		
:AUTo?	Query automatic line cycle integration		
:RANGE	Path to configure measurement range:		
[:UPPer] <n>	Select range (0 to 20e-3)	20e-3	✓
[:UPPer]?	Query range		✓
:AUTo 	Enable or disable autorange	Reset: ON Preset: OFF	✓
:AUTo?	Query autorange		✓
:ULIMit <n>	Set upper limit for autorange (0 to 20e-3)	20e-3	
:ULIMit?	Query upper limit		
:LLIMit <n>	Set lower limit for autorange (0 to 20e-3)	2e-12	
:LLIMit?	Query lower limit		

Command	Description	Default parameter	SCPI
:REFerence <n>	Specify reference (-20e-3 to +20e-3)	0	✓
:REFerence?	Query reference value		✓
:STATE 	Enable or disable reference	OFF	✓
:STATE?	Query state of reference		✓
:ACQuire	Use input signal as reference		
:DIGits <n>	Specify measurement resolution (4 to 7)	6	
:DIGits?	Query resolution		
:AUTO 	Enable or disable autoresolution		
:AUTO ONCE	Enable and then disable autoresolution		
:AUTO?	Query autoresolution		
:AVERage	Path to control the average filter:		
:TYPE <name>	Select filter type (NONE, SCALar, ADVanced)	SCALar	
:TYPE?	Query filter type		
:TCONTROL <name>	Select filter type: (MOVing or REPeat)	Reset: REPeat Preset: MOVing	
:TCONTROL?	Query filter type		
:COUNT <n>	Specify filter count (1 to 100)	10	
:COUNT?	Query filter count		
:ADVanced	Path to configure and control advanced filter:		
:NTOLerance <n>	Specify noise tolerance level (0 to 100%)	1	
:NTOLerance?	Query noise tolerance level		
[:STATE] 	Enable or disable digital filter	OFF	
[:STATE]?	Query state of digital filter		
:MEDian	Path to control the median filter:		
[:STATE] 	Enable or disable median filter	ON	
[:STATE]?	Query state of median filter		
:RANK <NRf>	Specify rank for median filter	1	
:RANK?	Query rank		
:DAMPing 	Enable or disable damping	OFF	
:DAMPing?	Query state of damping		

SENSe command summary - resistance commands

Command	Description	Default parameter	SCPI
[:SENSe[1]]:RESistance	Path to configure resistance:		✓
:APERture <n>	Set integration rate in seconds (166.67e-6 to 200e-3)	60 Hz: 16.67 ms 50 Hz: 20 ms	✓
:APERture?	Query aperture		✓
:AUTO 	Enable or disable auto-aperture	OFF	
:AUTO ONCE	Enable and then disable auto-aperture		
:AUTO?	Query auto-aperture		

Command	Description	Default parameter	SCPI
:NPLCycles <n>	Set integration rate in line cycles (0.01 to 10)	1	✓
:NPLCycles?	Query line cycle integration rate		✓
:AUTO 	Enable or disable automatic NPLC	OFF	
:AUTO ONCE	Enable and then disable automatic NPLC		
:AUTO?	Query automatic line cycle integration		
[:AUTO]	Path to configure autovoltage source ohms:		
:RANGE	Measurement ranges:		
[:UPPer] <n>	Select range (0 to 100e18)	2e6	
[:UPPer]?	Query range		
:AUTo 	Enable or disable autorange	Reset: ON Preset: OFF	
:AUTo ONCE	Set range based on present input signal		
:AUTo?	Query autorange		
[:ULIMit] <n>	Set upper limit for autorange (0 to 100e18)	200e12	
[:ULIMit]?	Query upper limit		
[:LLIMit] <n>	Set lower limit for autorange (0 to 100e18)	2e6	
[:LLIMit]?	Query lower limit		
:MANual	Path to configure manual voltage source ohms:		
:CRAnge	Path to configure measurement range:		
[:UPPer] <n>	Select range (0 to 20e-3)	20e-3	
[:UPPer]?	Query range		
:AUTo 	Enable or disable autorange	Reset: ON Preset: OFF	
:AUTo ONCE	Set range based on present input signal		
:AUTo?	Query autorange		
:VSOURCE	Path to control the voltage source:		
[:AMPLitude] <n>	Specify voltage source level (0 V to 1000 V)	100	
[:AMPLitude]?	Query voltage source level		
:RANGE <n>	Select voltage source range; ≤100 selects 100 V range, >100 selects 1000 V range	0	
:RANGE?	Query voltage source range		
:OPERate 	Enable (operate) or disable (standby) voltage source output	OFF	
:OPERate?	Query state of voltage source		
:REFerence <n>	Specify resistance reference (0 to +100e18)	0	✓
:REFerence?	Query resistance reference value		✓
:STATE 	Enable or disable resistance reference	OFF	✓
:STATE?	Query state of resistance reference		✓
:ACQuire	Use input signal as resistance reference		
:IREFerence 	Enable or disable current reference	OFF	
:IREFerence?	Query state of current reference		
:DIGits <n>	Specify measurement resolution (4 to 7)	6	
:DIGits?	Query resolution		
:AUTo 	Enable or disable autoresolution	OFF	
:AUTo ONCE	Enable and then disable autoresolution		
:AUTo?	Query autoresolution		

Command	Description	Default parameter	SCPI
:AVERage :TYPE <name>	Path to control average filter: Select filter type (NONE, SCALar, ADVanced)	SCALar	
:TYPE? :TControl <name>	Query filter type Select filter type: (MOVing or REPeat)	Reset: REPeat Preset: MOVing	
:TControl? :COUNT <n> :COUNT? :ADVanced	Query filter type Specify filter count (1 to 100) Query filter count Path to configure and control advanced filter:	10	
:NTOLerance <n> :NTOLerance? [:STATE] [:STATE]?	Specify noise tolerance level (0 to 100%) Query noise tolerance level Enable or disable digital filter Query state of digital filter	1	
:MEDian [:STATE] [:STATE]?	Path to control median filter Enable or disable median filter Query state of median filter	ON	
:RANK <NRf> :RANK?	Specify range (1 to 5) Query rank	1	
:DAMPing :DAMPing? :VSControl <name>	Enable or disable damping Query state of damping Select resistance voltage source mode (MANual or AUTO)	OFF	
:VSControl? :MSElect <name>	Query resistance voltage source mode Select resistance measurement type (NORMAL or RESistivity)	NORMAL	
:MSElect? :RESistivity :STHickness <NRf>	Query resistance measurement type Path to configure resistivity: Volume; specify sample thickness (0.0001 mm to 99.9999 mm)		
:STHickness? :FSELect <name> :FSELect?	Query sample thickness Specify test fixture (M8009 or USER) Query test fixture	M8009	
:M8009 :RSwitch? :USER	Path to query the Model 8009 test fixture: Query switch setting (surface or volume) Path to configure user test fixture:		
:RSELect <name> :RSELect?	Specify measurement type (SURFace or VOLUME) Query measurement type	SURFace	
:KSURface <NRf> :KSURface? :KVOLume <NRf> :KVOLume?	Surface; specify Ks (0.001 to 999.999) Query, Ks Volume; specify Kv (0.001 to 999.999) Query Kv	1.000	

SENSe command summary - charge commands

Command	Description	Default parameter	SCPI
<code>[:SENSe[1]] :CHARge</code>			✓
<code>:APERture <n></code>	Set integration rate in seconds (166.67e-6 to 200e-3)	60 Hz: 16.67 ms 50 Hz: 20 ms	✓
<code>:APERture?</code>	Query aperture (integration rate)		✓
<code>:AUTO </code>	Enable or disable auto-aperture	OFF	
<code>:AUTO ONCE</code>	Enable and then disable auto-aperture		
<code>:AUTO?</code>	Query auto-aperture		
<code>:NPLCycles <n></code>	Set integration rate (line cycles; 0.01 to 10)	1	✓
<code>:NPLCycles?</code>	Query line cycle integration rate		✓
<code>:AUTO </code>	Enable or disable automatic NPLC	OFF	
<code>:AUTO ONCE</code>	Enable and then disable automatic NPLC		
<code>:AUTO?</code>	Query automatic line cycle integration		
<code>:RANGE</code>	Path to configure measurement range:		✓
<code>[:UPPer] <n></code>	Select range (0 to +2.0e-6)	2e-6	✓
<code>[:UPPer]?</code>	Query range		✓
<code>:AUTO </code>	Enable or disable autorange	Reset: ON Preset: OFF	✓
<code>:AUTO ONCE</code>	Set range based on present input signal		✓
<code>:AUTO?</code>	Query autorange		✓
<code>:LGrouP <name></code>	Specify HIGH or LOW autorange limit	HIGH	
<code>:LGrouP?</code>	Query autorange limit		
<code>:REFerence <n></code>	Specify reference (-2.0e-6 to +2.0e-6)	0	✓
<code>:REFerence?</code>	Query reference value		✓
<code>:STATe </code>	Enable or disable reference	OFF	✓
<code>:STATe?</code>	Query state of reference		✓
<code>:ACQuire</code>	Use input signal as reference		
<code>:DIGits <n></code>	Specify measurement resolution (4 to 7)	6	
<code>:DIGits?</code>	Query resolution		
<code>:AUTO </code>	Enable or disable autoresolution	OFF	
<code>:AUTO ONCE</code>	Enable and then disable autoresolution		
<code>:AUTO?</code>	Query autoresolution		
<code>:AVERage</code>	Path to control the average filter:		
<code>:TYPE <name></code>	Select filter type (NONE, SCALar, or ADVanced)	SCALar	
<code>:TYPE?</code>	Query filter type		
<code>:TCONtrol <name></code>	Select filter type (MOVing or REPeat)	Reset: REPeat Preset: MOVing	
<code>:TCONtrol?</code>	Query filter type		
<code>:COUNT <n></code>	Specify filter count (1 to 100)	10	
<code>:COUNT?</code>	Query filter count		
<code>:ADVanced</code>	Path to configure advanced filter:		
<code>:NTOLerance <n></code>	Specify noise tolerance level (0 to 100%)	1	
<code>:NTOLerance?</code>	Query noise tolerance level		
<code>[:STATe] </code>	Enable or disable filter	OFF	
<code>[:STATe]?</code>	Query state of digital filter		

Command	Description	Default parameter	SCPI
:MEDian	Path to control the median filter:		
[:STATe] 	Enable or disable median filter	ON	
[:STATe]?	Query state of median filter		
:RANK <NRf>	Specify rank for median filter	1	
:RANK?	Query rank		
:ADIScharge	Path to control autodischarge:		
[:STATe] 	Enable or disable autodischarge	OFF	
[:STATe]?	Query state of autodischarge		
:LEVel <NRf>	Specify level (0 to 2.2e6)	2e-6	
:LEVel?	Query level		

SOURce command summary

Command	Description	Default parameter	SCPI
:SOURce		(Note 1)	
:TTL[1]	Path to set digital output line #1:		
[:LEVel] 	Enable or disable line #1		
[:LEVel]?	Query state of line #1		
:TTL2	Path to set digital output line #2:		
[:LEVel] 	Enable or disable line #2		
[:LEVel]?	Query state of line #2		
:TTL3	Path to set digital output line #3:		
[:LEVel] 	Enable or disable line #3		
[:LEVel]?	Query state of line #3		
:TTL4	Path to set digital output line #4:		
[:LEVel] 	Enable or disable line #4		
[:LEVel]?	Query state of line #4		
:VOLTage	Path to set voltage source level:		✓
[:LEVel]			✓
[:IMMediate]			✓
[:AMPLitude] <n>	Set voltage source level (0 to ±1000)	0	✓
[:AMPLitude]?	Query voltage source level		✓
:RANGe <n>	Select voltage source range; ≤100 selects 100 V range, >100 selects 1000 V range	100	✓
:RANGe?	Query voltage source range		✓
:LIMIT	Path to control voltage source voltage limit:		✓
[:AMPLitude] <n>	Set voltage limit in volts (0 to 1000)	1000	✓
[:AMPLitude]?	Query voltage limit		✓
:STATE 	Enable or disable voltage limit	OFF	✓
:STATE?	Query state of voltage limit		✓
:MCONnect 	Enable or disable voltage source LO to ammeter LO connection	OFF	
:MCONnect?	Query low connection		

Command	Description	Default parameter	SCPI
:CURRent	Path for current limit:		
:RLIMit	Path to control resistive current limit:		
:STATE 	Enable or disable resistive current limit		
:STATE?	Query resistive current limit		
:LIMit	Path to check current compliance:		
[:STATe] ?	Query the state of current compliance		

Note:

1. *RST and :SYSTem:PRESet have no effect on the state of the output lines. However, cycling power sets all output lines OFF (false).

STATus command summary

Command	Description	Default parameter	SCPI
:STATUs			✓
:MEASurement			
[:EVENT] ?	Path to control measurement event registers:		
:ENABLE <NRf>	Read the event register	(Note 1)	
:ENABLE?	Program the enable register	(Note 2)	
:PTRansition <NRf>	Read the enable register		
:PTRansition?	Program the positive transition register	(Note 3)	
:NTRansition <NRf>	Read the positive transition register		
:NTRansition?	Program the negative transition register	(Note 2)	
:CONDITION?	Read the negative transition register		
:OPERation	Read the condition register		
[:EVENT] ?			✓
:ENABLE <NRf>	Read the event register	(Note 1)	✓
:ENABLE?	Program the enable register	(Note 2)	✓
:PTRansition <NRf>	Read the enable register		✓
:PTRansition?	Program the positive transition register	(Note 3)	✓
:NTRansition <NRf>	Read the positive transition register		✓
:NTRansition?	Program the negative transition register	(Note 2)	✓
:CONDITION?	Read the negative transition register		✓
:ARM	Read the condition register		✓
[:EVENT] ?	Path to control arm event registers:		✓
:ENABLE <NRf>	Read the event register	(Note 1)	✓
:ENABLE?	Program the enable register	(Note 3)	✓
:PTRansition	Read the enable register		✓
:PTRansition?	Program the positive transition register	(Note 3)	✓
:NTRansition <NRf>	Read the positive transition register		✓
:NTRansition?	Program the negative transition register	(Note 2)	✓
:CONDITION?	Read the negative transition register		✓
:SEQUence	Read the condition register		✓
[:EVENT] ?	Path to control sequence status registers		✓
:ENABLE <NRf>	Read the event register	(Note 1)	✓
:ENABLE?	Program the enable register	(Note 3)	✓
	Read the enable register		✓

Command	Description	Default parameter	SCPI
:PTRansition <NRf>	Program the positive transition register	(Note 3)	✓
:PTRansition?	Read the positive transition register		✓
:NTRansition <NRf>	Program the negative transition register	(Note 2)	✓
:NTRansition?	Read the negative transition register		✓
:CONDITION?	Read the condition register		✓
:OPERation			
:TRIGger	Path to control trigger status registers:		✓
[:EVENT] ?	Read the event register	(Note 1)	✓
:ENABLE <NRf>	Program the enable register	(Note 3)	✓
:ENABLE?	Read the enable register		✓
:PTRansition <NRf>	Program the positive transition register	(Note 3)	✓
:PTRansition?	Read the positive transition register		✓
:NTRansition <NRf>	Program the negative transition register	(Note 2)	✓
:NTRansition?	Read the negative transition register		✓
:CONDITION?	Read the condition register		✓
:QUESTIONable	Path to control questionable status registers:		✓
[:EVENT] ?	Read the event register	(Note 1)	✓
:ENABLE <NRf>	Program the enable register	(Note 2)	✓
:ENABLE?	Read the enable register		✓
:PTRansition <NRf>	Program the positive transition register	(Note 3)	✓
:PTRansition?	Read the positive transition register		✓
:NTRansition <NRf>	Program the negative transition register	(Note 2)	✓
:NTRansition?	Read the negative transition register		✓
:CONDITION?	Read the condition register		✓
:PRESet	Return status registers to default states		✓
:QUEue	Path to access error queue:		✓
[:NEXT] ?	Read the most recent error message	(Note 5)	✓
:ENABLE <list>	Specify error and status messages for queue	(Note 5)	✓
:ENABLE?	Read the enabled messages		✓
:DISable <list>	Specify messages not to be placed in queue	(Note 5)	
:DISable?	Read the disabled messages		
:CLEar	Clears all messages from error queue		

Notes:

Commands in this subsystem are not affected by *RST and :SYSTem:PRESet. The effects of cycling power, *CLS, and :STATus:PRESet are explained by the following notes.

1. Event registers: Power-up and the *CLS command clear all bits of the registers; the :STATus:PRESet command has no effect.
2. Enable and NTR registers: Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.
3. Enable and PTR registers: Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.
4. Error queue: Power-up and *CLS clear the error queue; :STATus:PRESet has no effect.
5. Enable or disable error queue messages: Power-up clears the list of messages; *CLS and :STATus:PRESet have no effect.

SYSTem command summary

Command	Description	Default parameter	SCPI
:SYSTem			✓
:PRESet	Return to :SYST:PRES defaults		
:POSetup <name>	Select power-on setup (RST, PRESet, or SAV0 to SAV9)	RST	
:POSetup?	Query power-on setup		✓
:VERSION?	Query revision level of SCPI standard		✓
:ERRor?	Query error queue	(Note)	✓
:LSYNC	Path to control line synchronization:		
:STATE 	Enable or disable line sync	ON	
:STATE?	Query line sync		
:KEY <NRf>	Simulate key-press (1 to 31)	Not applicable	
:KEY?	Query the last pressed key		
:CLEar	Clears messages from the error queue		✓
:DATE <yr>, <mo>, <day>	Set date		✓
:DATE?	Query date		✓
:TIME <hr>, <min>, <sec>	Set time (24-hour format)		✓
:TIME?	Query time		✓
:TStamp	Path to configure and control timestamp:		
:TYPE <name>	Select timestamp type (RELative or RTClock)		
:TYPE?	Query timestamp type		
:RELative	Path to reset timestamp:		
:RESET	Reset relative timestamp to 0 s		
:RNUmber	Path to reset reading number:		
:RESET	Reset reading number to zero		
:ZCHeck 	Enable or disable zero check	OFF	
:ZCHeck?	Query state of zero check		
:ZCORrect	Path to control zero correct		
[:STATE] 	Enable or disable zero correct	OFF	
[:STATE]?	Query state of zero correct		
:ACQuire	Acquire zero correction value		
:ARSPEED <name>	Set autoranging speed (FAST or NORMAl)	FAST	
:TSControl 	Enable or disable external temperature readings	ON	
:TSControl?	Query state of external temperature readings		
:HLControl 	Enable or disable the A/D hardware limit	OFF	
:HLControl?	Query state of hardware limit		
:HSControl 	Enable or disable humidity readings	OFF	
:HSControl?	Query state of humidity readings		

Command	Description	Default parameter	SCPI
:LOCal	Take 6517B out of remote (RS-232 only)		
:REMote	Place 6517B in remote (RS-232 only)		
:LLOCKout 	Enable or disable local lockout (RS-232 only)	OFF	
:LLOCKout?	Query lockout state		
:MACRo			
:TRIGger	Paths to configure basic triggering:		
[:EXECute]	Select basic triggering		
:MODE <name>	Specify trigger mode (CONTinuous or ONESHOT)	CONTinuous	
:SOURce <name>	Specify source (IMMediate, MANUAL, BUS, EXTERNAL, or TIMer)	IMMediate	
:TIMer <n>	Specify timer interval in seconds (0.001 to 99999.999)	0.1	
:INTerlock?	Query if interlock cable connected to fixture (1 = yes)		

Note: Clearing the error queue: Power-up and *CLS clear the error queue. *RST, :SYSTem:PRESet, and :STATus:PRESet have no effect.

TRACe command summary

Command	Description	Power-up defaults*	SCPI
:TRACe	Use :TRACe or :DATA as root command		
:DATA			
:CLEar	Clear readings from buffer	✓	
:FREE?	Query bytes available and bytes in use	✓	
:POINts <n>	Specify size of buffer	✓	
:POINTS?	Query buffer size	✓	
:AUTO 	Enable or disable automatic buffer sizing.	✓	
:AUTO?	Query state of automatic buffer sizing	✓	
:ACTual?	Query number of readings stored in the buffer	✓	
:FEED	Path to control feed commands:		
:PRETrigger	Path to configure pretrigger storage:		
:AMOut	Path to specify number of pretrigger readings:		
[:PERCent] <n>	Specify % (0 to 100) of buffer		
[:PERCent]?	Query percentage		
:READings <n>	Specify as a number		
:READings?	Query number of readings		
:SOURce <name>	Select pre-trigger source event (EXTERNAL, TLINK, BUS, or MANUAL)		
:SOURce?	Query pre-trigger source event		
:CONTrol <name>	Select buffer control mode (NEVER, NEXT, ALWAYS, or PRETrigger)	✓	
:CONTrol?	Query buffer control mode	✓	
:DATA?	Read all readings in the buffer	✓	

Command	Description	Power-up defaults*	SCPI
:LAST?	Read the last reading stored in buffer by the alternating polarity test		
:TStamp	Path to select timestamp format for buffer readings:		
:FORMAT <name>	Select timestamp format (ABSolute or DELTa)		
:FORMAT?	Query timestamp format		
:ELEMENTs <name>	Select reading elements (TStamp, HUMidity, CHANnel, ETEmperature, VSOURCE, NONE)		

*:SYSTem:PRESet and *RST have no effect on the commands in this subsystem.

TRIGger command summary - general commands

Command	Description	Default parameter	SCPI
:INITiate	Subsystem command path:		✓
[:IMMEDIATE]	Initiate one trigger cycle		✓
:CONTinuous 	Enable or disable continuous initiation	PRESet: Enabled Reset: Disabled	✓
:CONTinuous?	Query continuous initiation		✓
:POFLag <name>	INCLude or EXCLude no pending flag for initiate commands	INCLude	
:POFLag?	Query pending operation flag		
:ABORT	Reset trigger system		✓

TRIGger command summary - ARM commands

Command	Description	Default parameter	SCPI
:ARM[:SEQUENCE[1]]	Path to configure arm layers:		✓
[:LAYer[1]]	Path to program Arm Layer 1:		✓
:IMMEDIATE	Loop around control source		✓
:COUNT <n>	Specify arm count (1 to 99999 or INF)	1	✓
:COUNT?	Query arm count		✓
:SOURce <name>	Select control source (HOLD, IMMEDIATE, RTCLOCK, MANUAL, BUS, TLINK, or EXTERNAL)	IMMEDIATE	(Note)
:SOURce?	Query control source		✓
:SIGNal	Loop around control source		✓
:TCONFIGURE	Path to configure triggers:		
:DIRECTION <name>	Enable (SOURce) or disable (ACCEPtor)	ACCEPtor	
:DIRECTION?	Query direction		
:ASYNchronous	Path to configure asynchronous trigger link:		
:ILINE <NRf>	Select input line (1 to 6)	2	
:ILINE?	Query input line		
:OLINE <NRf>	Select output line (1 to 6)	1	
:OLINE?	Query output line		

Command	Description	Default parameter	SCPI
:RTCLOCK	Path to configure the RTCLOCK control source:		
:DATE <yr>, <mo>, <day>	Specify the date for the clock event		
:DATE?	Query the date for the clock event		
:TIME <hr>, <min>, <sec>	Specify the time for the clock event		
:TIME?	Query the time for the clock event		
:LAYer2	Path to program Arm Layer 2:		✓
:IMMEDIATE	Loop around control source		✓
:COUNT <n>	Specify scan count (1 to 99999 or INF)	PRESet: INF RESET: 1	✓
:COUNT?	Query scan count		✓
:DElay <n>	Program delay in seconds (0 to 999999.999)	0	✓
:DElay?	Query delay		✓
:SOURce <name>	Select control source (HOLD, IMMEDIATE, TIMER, MANUAL, BUS, TLINK, or EXTERNAL)	IMMEDIATE	(Note)
:SOURce?	Query control source		
:TImer <n>	Set timer interval in seconds (0 to 999999.999)	0.1	✓
:TImer?	Query timer		✓
:SIGNal	Loop around control source		✓
:TCONfigure	Path to configure triggers:		✓
:DIRECTION <name>	Enable (SOURCE) or disable (ACCEPTOR) bypass	ACCEPTOR	
:DIRECTION?	Query direction		
:ASYNchronous	Path to configure asynchronous trigger link:		
:ILINE <NRF>	Select input line (1 to 6)	2	
:ILINE?	Query input line		
:OILINE <NRF>	Select output line (1 to 6)	1	
:OILINE?	Query output line		

Note:
TLINK and RTCLOCK are non-SCPI parameters for the :SOURce command. The command (:SOURce) and the other parameters are SCPI confirmed.

TRIGger command summary - SEQuence commands

Command	Description	Default parameter	SCPI
:TRIGger[:SEQUENCE[1]]	Path to program trigger layer:		✓
:IMMEDIATE	Loop around control source		✓
:COUNT <n>	Set measure count (1 to 99999 or INF)	Preset: INF Reset: 1	✓
:COUNT?	Query measure count		✓
:DElay <n>	Set delay in seconds (0 to 999999.999)	0	✓
:DElay?	Query delay		

Command	Description	Default parameter	SCPI
:SOURce <name>	Select control source (HOLD, IMMEDIATE, TIMER, MANUAL, BUS, TLINK, or EXTERNAL)	IMMEDIATE	(Note)
:SOURce?	Query control source		✓
:TMR <n>	Set timer interval in seconds (0 to 999999.999)	0.1	✓
:TMR?	Request the programmed timer interval		✓
:SIGNal	Loop around control source		✓
:TCONFigure	Path to configure triggers:		
:PROTOCOL <name>	Select protocol (ASYNchronous or SSYNchronous)	ASYNchronous	
:PROTOCOL?	Query protocol		
:DIRECTION <name>	Enable (SOURce) or disable (ACCEptor) source bypass	ACCEptor	
:DIRECTION?	Query direction		
:ASYNchronous	Path to configure asynchronous trigger link:		
:ILINe <NRf>	Select input line (1 to 6)	2	
:ILINe?	Query input line		
:OLINe <NRf>	Select output line (1 to 6)	1	
:OLINe?	Query output line		
:SSYNchronous	Path to configure semi-synchronous trigger link:		
:LINE <NRf>	Select trigger line (1 to 6)	1	
:LINE?	Query trigger line		

Note: TLINK and RTCLOCK (Arm Layer 1) are non-SCPI parameters for the :SOURce command. The command (:SOURce) and the other parameters are SCPI confirmed.

TSEQUence command summary

Command	Description	Default parameter	SCPI
:TSEQUence	Path to program test sequences:		
:ARM	Arms selected test sequence		
:ABORT	Stops a test sequence in process		
:TYPE <name>	Specify test: DLEakage, CLEakage, CIResistance, RVCoefFicient, SRESistivity, VRESistivity, SIRESistivity, SQSweep, STSsweep, ALTPolarity	DLEakage	
:TYPE?	Query test type		
:TSource <name>	Specify trigger source: MANUAL, IMMEDIATE, BUS, TLINK, EXTERNAL, LCLOSURE	MANUAL	
:TSource?	Query trigger source		
:TLINe <NRf>	Specify trigger link line (1 to 6)	1	
:TLINe?	Query trigger link line		

Command	Description	Default parameter	SCPI
:DLEakage :START <NRf> :START? :STOP <NRf> :STOP? :STEP <NRf> :STEP? :MDELay <NRf> :MDELay?	Diode leakage test path: Specify start voltage (-1000 to 1000) Query start voltage Specify stop voltage (-1000 to 1000) Query stop voltage Specify step voltage (-1000 to 1000) Query step voltage Specify measure delay in seconds (0 to 10000.0) Query measure delay	+1 V +10 V +1 V 1 s	
:CLEakage :SVOLtage <NRf> :SVOLtage? :SPOints <NRf> :SPOints? :SPINterval <NRf> :SPINterval?	Capacitor leakage test path: Specify bias voltage (-1000 to 1000) Query bias voltage Number points (1 to maximum buffer) Query number of points Interval between points in seconds (0 to 99999.9) Query interval	+1 V 10 1 s	
:CIResistance :SVOLtage <NRf> :SVOLtage? :SPOints <NRf> :SPOints? :SPINterval <NRf> :SPINterval?	Cable insulation resistance test path: Specify bias voltage (-1000 to 1000) Query bias voltage Number of points (1 to maximum buffer) Query number of points Interval between points in seconds (0 to 99999.9) Query interval	+1 V 5 1 s	
:RVCoefficient :SVOLTage[1] <NRf> :SVOLTage[1]? :MDELay[1] <NRf> :MDELay[1]? :SVOLTage2 <NRf> :SVOLTage2? :MDELay2 <NRf> :MDELay2?	Resistor voltage coefficient test path: Specify source voltage 1 (-1000 to 1000) Query source voltage Specify measure delay 1 in seconds (0 to 99999.9) Query measure delay Specify source voltage 2 (-1000 to 1000) Query source voltage Specify measure delay 2 in seconds (0 to 99999.9) Query measure delay	+1 V 1 s +2 V 1 s	
:SRESistivity :PDTime <NRf> :PDTime? :SVOLTage <NRf> :SVOLTage? :STIME <NRf> :STIME? :MVOLTage <NRf> :MVOLTage?	Surface resistivity test path: Specify predischarge time in seconds (0 to 9999.9) Query predischarge time Specify bias voltage (-1000 to 1000) Query bias voltage Specify bias time in seconds (0 to 99999.9) Query bias time Specify measure voltage (-1000 to 1000) Query measure voltage	0.2 s +500 V 1 s +500 V	

Command	Description	Default parameter	SCPI
:MTIME <NRf> :MTIME? :DTIME <NRf> :DTIME?	Specify measure time in seconds (0 to 9999.9) Query measure time Specify discharge time in seconds (0 to 99999.9) Query discharge time	1 s 2 s	
:VRESistivity :PDTIME <NRf> :PDTIME? :SVOLTage <NRf> :SVOLTage? :STIME <NRf> :STIME? :MVOLTage <NRf> :MVOLTage? :MTIME <NRf> :MTIME? :DTIME <NRf> :DTIME?	Volume resistivity test path: Specify predischarge time in seconds (0 to 99999.9) Query predischarge time Specify bias voltage (-1000 to 1000) Query bias voltage Specify bias time in seconds (0 to 99999.9) Query bias time Specify measure voltage (-1000 to 1000) Query measure voltage Specify measure time in seconds (0 to 9999.9) Query measure time Specify discharge time in seconds (0 to 99999.9) Query discharge time	10 s +500 V 1 s +500 V 1 s 2 s	
:ALTPolarity :OFSVoltage <NRf> :OFSVoltage? :ALTVoltage <NRf> :ALTVoltage? :MTIME <NRf> :MTIME? :DISCard <NRf> :DISCard? :READings <NRf> :READings?	Alternating polarity resistance/resistivity test path: Specify offset voltage (-1000 to 1000) Query offset voltage Specify alternating voltage (-1000 to 1000) Query alternating voltage Specify measurement time in seconds (0.5 to 9999.9) Query measurement time Specify number of initial readings to discard (0 to 9999) Query number of initial readings to discard Specify number of readings to store Query number of readings to store	0 V 10 V 15 s 3 1	
:SIResistance :SVOLTage <NRf> :SVOLTage? :STIME <NRf> :STIME? :MVOLTage <NRf> :MVOLTage? :MTIME <NRf> :MTIME?	Surface insulation resistance test path: Specify bias voltage (-1000 to 1000) Query bias voltage Specify bias time in seconds (0 to 99999.9) Query bias time Measure voltage (-1000 to 1000) Query measure voltage Specify measure time in seconds (0 to 9999.9) Query measure time	+50 V 1 s +100 V 1 s	

Command	Description	Default parameter	SCPI
:SQSWeep :HLEVel <NRf> :HLEVel? :HTIME <NRf> :HTIME? :LLEVel <NRf> :LLEVel? :LTIME <NRf> :LTIME? :COUNT <NRf> :COUNT?	Square wave sweep test path: High-level voltage (-1000 to 1000) Query high-level voltage Specify high-level time in seconds (0 to 9999.9) Query high-level time Specify low-level voltage (-1000 to 1000) Query low-level voltage Specify low-level time in seconds (0 to 9999.9) Query low-level time Specify number of cycles Query cycle count	+1 V 1 s -1 V 1 s	
:STSWeep :START <NRf> :START? :STOP <NRf> :STOP? :STEP <NRf> :STEP? :STIME <NRf> :STIME?	Staircase sweep test path: Specify start voltage (-1000 to 1000) Query start voltage Specify stop voltage (-1000 to 1000) Query stop voltage Specify step voltage (-1000 to 1000) Query step voltage Specify step time in seconds (0 to 9999.9) Query step time	+1 V +10 V +1 V 1 s	

UNIT command summary

Command	Description	Power-up defaults
:UNIT	Path to configure temperature units:	
:TEMPerature <name>	Select temperature units (C, CEL, F, FAR, or K)	C
:TEMPerature?	Query temperature units	

CALCulate subsystem

The commands in this subsystem configure and control the Calculate subsystems and are summarized in the [CALCulate command summary](#) (on page 11-6).

CALCulate[1] subsystem

The commands in this subsystem configure and control the polynomial and percent calculations. Refer to [Filters and math](#) (on page 8-1) for more information.

:CALCulate[1]:DATA?

This command returns the last calculation result or refreshes the result.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:CALCulate[1]:DATA[:LATest]?
:CALCulate[1]:DATA:FRESH?
```

Details

FRESH triggers a reading and returns the resulting calculated result.

When calculations are enabled, the return from [:SENSe[1]]:DATA:FRESH? is the reading before calculations are applied and :CALCulate[1]:DATA:FRESH? is the reading after calculations are applied. If calculations are disabled, the [:SENSe[1]]:DATA:FRESH? and :CALCulate[1]:DATA:FRESH? readings are the same.

SCPI compliant.

Also see

[\[:SENSe\[1\]\]:DATA:FRESH?](#) (on page 11-93)

:CALCulate[1]:FORMAT

This command specifies which math operation is performed on measurements when math operations are enabled for the selected measurement function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	POLynomial

Usage

```
:CALCulate[1]:FORMAT <name>
:CALCulate[1]:FORMAT?
```

<name>	The math operation: <ul style="list-style-type: none"> ▪ No math operation: NONE ▪ Percent: PERCent ▪ Polynomial: POLynomial ▪ Ratio: RATio ▪ Deviation: DEViation ▪ Percent deviation: PDEViation ▪ Logarithmic base 10: LOG10
--------	--

Details

The calculated reading is refreshed every time the instrument makes a reading. Math calculations are applied to the input signal after relative offset and before limit tests.

SCPI compliant.

Also see

[:CALCulate\[1\]:STATE](#) (on page 11-33)

:CALCulate[1]:IMMEDIATE

This command recalculates the present input data to reflect a new calculation.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

`:CALCulate[1] :IMMEDIATE`
`:CALCulate[1] :IMMEDIATE?`

Details

When you change the math calculation when math is enabled, the next instrument reading reflects the new calculation. If the instrument is not in a continuous measurement mode (for example, waiting for a trigger), the displayed reading does not update to reflect the new calculation until the next reading conversion occurs.

`:CALCulate[1] :IMMEDIATE` reprocesses the present input data to reflect a new calculation. For example, assume the instrument is in a noncontinuous measurement mode and requires a manual trigger to cause the next reading conversion. Changing the calculation does not affect the presently displayed reading. However, sending the `:IMMEDIATE` command reprocesses that displayed reading to reflect the new calculation.

When `:CALCulate[1] :IMMEDIATE?` command is sent, the calculation is performed and the result is queried.

SCPI compliant.

Also see

None

:CALCulate[1]:KMATH:MA0Factor

This command specifies the a0 factor in a polynomial calculation.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:CALCulate[1]:KMATH:MA0Factor <NRf>
:CALCulate[1]:KMATH::MA0Factor?
<NRf> -9.999999e30 to +9.999999e30
```

Also see

[:CALCulate\[1\]:FORMAT](#) (on page 11-29)

:CALCulate[1]:KMATH:MA1Factor

This command specifies the a1 factor in a polynomial calculation.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:CALCulate[1]:KMATH:MA1Factor <NRf>
:CALCulate[1]:KMATH:MA1Factor?
<NRf> -9.999999e20 to +9.999999e20
```

Also see

[:CALCulate\[1\]:FORMAT](#) (on page 11-29)

:CALCulate[1]:KMATH:MA2Factor

This command specifies the a₂ factor in a polynomial calculation.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:CALCulate[1]:KMATH:MA2Factor <NRf>
:CALCulate[1]:KMATH:MA2Factor?
<NRf> -9.999999e30 to +9.999999e30
```

Also see

[:CALCulate\[1\]:FORMAT](#) (on page 11-29)

:CALCulate[1]:KMATH:PERCent

This command specifies the reference constant that is used when math operations are set to percent.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:CALCulate[1]:KMATH:PERCent <NRf>
:CALCulate[1]:KMATH:PERCent?
<NRf> The reference value for percent: -9.999999e35 to +9.999999e35
```

Also see

[:CALCulate\[1\]:FORMAT](#) (on page 11-29)

:CALCulate[1]:REFerence

This command sets the reference value for ratio, deviation, and percent deviation calculations.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:CALCulate[1]:REFerence <NRf>
:CALCulate[1]:REFerence?
<NRf> -9.999999e35 to +9.999999e35
```

Also see

[:CALCulate\[1\]:FORMAT](#) (on page 11-29)

:CALCulate[1]:STATE

This command enables or disables the selected math operation.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	System reset: ON Preset: OFF

Usage

```
:CALCulate:STATE <b>
:CALCulate:STATE?
<b> Disable math operations: OFF or 0
Enable math operations: ON or 1
```

Details

SCPI compliant.

Also see

[:CALCulate:FORMAT](#) (on page 11-29)

CALCulate2 subsystem

The commands in this path configure and control math calculations on buffer data. For additional information, see [Buffer operations](#) (on page 7-1).

:CALCulate2:DATA?

This command reads the result of the last statistic calculation.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:CALCulate2:DATA?

Details

The :CALCulate2:DATA? command does not initiate a calculate operation. If new data is stored in the buffer, you must send the :CALCulate2:IMMEDIATE or :CALCulate2:IMMEDIATE? command to recalculate the statistic from that new data.

SCPI compliant.

Also see

[:CALCulate2:IMMEDIATE](#) (on page 11-35)

:CALCulate2:FORMAT

This command selects the statistics that are applied to the data in the buffer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	NONE

Usage

:CALCulate2:FORMAT <name>
:CALCulate2:FORMAT?

<name>	<p>The buffer statistic:</p> <ul style="list-style-type: none"> ■ Lowest reading in buffer: MINimum ■ Largest reading in buffer: MAXimum ■ Mean value of readings in buffer: MEAN ■ Standard deviation of readings in buffer: SDEVIation ■ Peak-to-peak value of readings in buffer: PKPK ■ No calculation: NONE
--------	--

Details

With **NONE** selected, no **CALC 2** calculation is performed. With one of the other formats selected and **CALC 2** enabled, the calculation is performed when **:CALCulate2:IMMEDIATE** or **:CALCulate:IMMEDIATE?** is executed.

The peak-to-peak value is calculated as:

$$PKPK = MAX - MIN$$

Where: **MAX** is the largest reading in the buffer and **MIN** is the lowest reading in the buffer.

SCPI compliant.

Also see

- [:CALCulate2:IMMEDIATE](#) (on page 11-35)
- [:CALCulate2:STATE](#) (on page 11-36)

:CALCulate2:IMMEDIATE

This command recalculates raw input data in the buffer.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:CALCulate2:IMMEDIATE
:CALCulate2:IMMEDIATE?
```

Details

The query performs a calculation and reads the result.

After the selected statistic is enabled, **IMMEDIATE** or **IMMEDIATE?** must be sent to calculate the statistic from the data in the buffer.

After performing the calculation, the result can be read by using the **:CALCulate2:DATA?** query command.

You can also perform the calculation and read the result by using the query form of the command.

SCPI compliant.

Also see

- [:CALCulate:FORMAT](#) (on page 11-29)

:CALCulate2:STATE

This command enables or disables the statistic calculation.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Reset: ON Preset: OFF

Usage

```
:CALCulate2:STATE <b>
:CALCulate2:STATE?
```

	Disable math operations: OFF or 0 Enable math operations: ON or 1
-----	--

Details

When enabled, the selected CALC 2 format is calculated when the :CALCulate2:IMMEDIATE or :CALCulate2:IMMEDIATE? command is executed.

SCPI compliant.

Also see

[:CALCulate2:FORMAT](#) (on page 11-34)
[:CALCulate2:IMMEDIATE](#) (on page 11-35)

CALCulate3 subsystem

The commands in the CALCulate3 subsystem to configure and control limit testing. Refer to [Limits](#) (on page 9-1) for more information on limit testing.

:CALCulate3:BSTRobe:STATE

This command enables or disables the binning strobe for a binning operation.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:CALCulate3:BSTRobe:STATE <state>
:CALCulate3:BSTRobe:STATE?
```

<state>	Disable binning strobe: 0 or OFF Enable binning strobe: 1 or ON
---------	--

Details

When enabled, digital output line 4 is used for the binning strobe pulse. After the appropriate digital pattern is placed on the other three lines of the output port, the >10 µs strobe pulse is asserted on line 4. The strobe signals the external binning circuit that the output port (lines 1, 2, and 3) is ready to be read.

Also see

None

:CALCulate3:CLIMits:FAIL?

This command reads the composite result of limit tests.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:CALCulate3:CLIMits:FAIL?

Details

This command returns the composite result of the LIMIT 1 and LIMIT 2 tests. The composite result is the logical ORed summary of LIMIT 1 and LIMIT 2:

- One or both tests have failed: 0
- Both tests have passed: 1

If a test failed, you can use the fail command for each test to determine which test failed.

This command does not clear the fail indication for LIMIT 1 or LIMIT 2.

Also see

[:CALCulate3:LIMit2:FAIL? \(on page 11-39\)](#)
[:CALCulate3:LIMit\[1\]:FAIL? \(on page 11-45\)](#)

:CALCulate3:IMMEDIATE

This command recalculates the limit tests.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:CALCulate3:IMMEDIATE

Details

When the instrument is not in a continuous measurement mode (waiting for a trigger), you can change the limits and retest the last reading. After changing the limits, send **CALCulate3:IMMEDIATE** to perform the limit tests on the last reading.

Sending **IMMEDIATE** does not trigger a reading. It repeats the limit tests on the last reading. SCPI compliant.

Also see

None

:CALCulate3:LIMit2:CLEar:AUTO

This command enables or disables autoclear for limit 2 when a new trigger model cycle starts.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ON

Usage

```
:CALCulate3:LIMit2:CLEar:AUTO <state>
:CALCulate3:LIMit2:CLEar:AUTO?
```

<state>	Disable autoclear: OFF Enable autoclear: ON
---------	--

Details

With autoclear enabled, the fail message (0) is cleared when the instrument returns to the idle state. If the test is programmed not to return to idle, you can manually clear the fail condition by sending the **CLEAR[:IMMEDIATE]** command. If autoclear is disabled, the fail condition must be cleared manually.

SCPI compliant.

Also see

[:CALCulate3:LIMit2:CLEar\[:IMMEDIATE\]](#) (on page 11-39)

:CALCulate3:LIMit2:CLEar[:IMMEDIATE]

This command clears the fail indication for limit 2.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:CALCulate3:LIMit2:CLEar[:IMMEDIATE]

Details

Use this command to clear the test results when the limit automatic clear option is turned off. Both the high and low test results are cleared.

SCPI compliant.

Also see

[:CALCulate3:LIMit2:CLEar:AUTO](#) (on page 11-38)

:CALCulate3:LIMit2:FAIL?

This command queries the results of a limit test.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:CALCulate3:LIMit2:FAIL?

Details

Query test result:

- Pass: 1
- Fail: 0

The fail message (0) for a limit test indicates that the reading is outside the specified limits.

The response message only tells you if a limit test passed or failed. It does not tell you whether the upper or lower limit failed. To determine which limit failed, you must read the transition filter event register.

Reading the results of a limit test does not clear the fail indication of the test. To clear the fail indication, send the :CALCulate3:LIMit2:CLEar[:IMMEDIATE] command.

A fail indication for LIMIT 2 is also cleared when the respective limit test is disabled.

SCPI compliant.

Also see

[:CALCulate3:LIMit2:CLEar\[:IMMEDIATE\]](#) (on page 11-39)

:CALCulate3:LIMit2:LOWER:SOURce

This command specifies the LIMIT 2 failure pattern for the lower limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:CALCulate3:LIMit2:LOWER:SOURce <NRf>
:CALCulate3:LIMit2:LOWER:SOURce?
<NRf>          Specify digital pattern for the output port: 0 to 15
```

Details

This command specifies which lines of the digital output port go true when a limit test failure occurs. The first failure in the test sequence determines the digital output pattern. Subsequent failures in the test sequence do not change the digital output pattern on the output port. Each output line is assigned a decimal weight as shown in the following table.

Digital output line	Decimal weight
1	1
2	2
3	4
4	8

The parameter value for the digital pattern is determined by adding the decimal weights of the output lines. For example, to set output lines #2 and #3 to go true when the upper limit of LIMIT 1 is the first failure in the test sequence, use a parameter value of 6 (2 + 4).

The actual true state (high or low) of each digital output line depends on its programmed polarity. Polarity is programmed from the OUTPut subsystem.

NOTE

When the binning strobe is enabled, output line 4 is not considered to be part of the digital output pattern. The binning strobe uses line 4. With the binning strobe enabled, parameters 8 through 15 are treated the same as parameters 0 through 7.

SCPI compliant.

Also see

[:CALCulate3:BSTRobe:STATE](#) (on page 11-36)

:CALCulate3:LIMit2:LOWer[:DATA]

This command specifies the lower limit for a limit test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	-1

Usage

```
:CALCulate3:LIMit2:LOWer[:DATA] <value>
:CALCulate3:LIMit2:LOWer[:DATA] <DEF|MIN|MAX>
:CALCulate3:LIMit2:LOWer[:DATA]?
:CALCulate3:LIMit2:LOWer[:DATA]? <DEF|MIN|MAX>
```

<value>	The value of the lower limit: -9.99999e35 to +9.99999e35
---------	--

Details

This command sets the low limit for the selected measurement function. The actual limit depends on the measurement function that is presently selected. For example, a limit value of 0.000001 is 1 µA for the current function and 1 µC for the charge function.

A limit value is not range sensitive. A limit of 2 for volts is 2 V on all measurement ranges.

SCPI compliant.

Also see

[:CALCulate3:LIMit2:STATE](#) (on page 11-41)
[:CALCulate3:LIMit2:UPPer\[:DATA\]](#) (on page 11-43)

:CALCulate3:LIMit2:STATE

This command enables or disables the limit 2 test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:CALCulate3:LIMit2:STATE <state>
:CALCulate3:LIMit2:STATE?
```

<state>	Disable the limit 2 test: 0 or OFF Enable the limit 2 test: 1 or ON
---------	--

Details

When enabled, the test sequence for limits is performed every time the instrument makes a measurement. Testing is performed in the following sequence: Low Limit 1, High Limit 1, Low Limit 2, and High Limit 2. Only limit tests that are enabled are performed.

When a limit test is enabled, the digital output port cannot be controlled from the :SOURce subsystem.

A fail indication for LIMIT 2 is cleared when the respective limit test is disabled.

SCPI compliant.

Also see

[:CALCulate3:LIMit2:LOWER](#) (on page 11-41)

[:CALCulate3:LIMit2:UPPer](#) (on page 11-43)

:CALCulate3:LIMit2:UPPer:SOURce

This command specifies the LIMIT 2 failure pattern for the upper limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

:CALCulate3:LIMit2:UPPer:SOURce <NRF>

:CALCulate3:LIMit2:UPPer:SOURce?

<NRF>	Specify digital pattern for the output port: 0 to 15
-------	--

Details

This command specifies which lines of the digital output port go true when a limit test failure occurs. The first failure in the test sequence determines the digital output pattern. Subsequent failures in the test sequence do not change the digital output pattern on the output port. Each output line is assigned a decimal weight as shown in the following table.

Digital output line	Decimal weight
1	1
2	2
3	4
4	8

The parameter value for the digital pattern is determined by adding the decimal weights of the output lines. For example, to set output lines #2 and #3 to go true when the upper limit of LIMIT 1 is the first failure in the test sequence, use a parameter value of 6 (2 + 4).

The actual true state (high or low) of each digital output line depends on its programmed polarity. Polarity is programmed from the OUTPut subsystem.

NOTE

When the binning strobe is enabled, output line 4 is not considered to be part of the digital output pattern. The binning strobe uses line 4. With the binning strobe enabled, parameters 8 through 15 are treated the same as parameters 0 through 7.

SCPI compliant.

Also see

[:CALCulate3:BSTRobe:STATE](#) (on page 11-36)

:CALCulate3:LIMit2:UPPer[:DATA]

This command specifies the upper limit for a limit test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:CALCulate3:LIMit2:UPPer[:DATA] <value>
:CALCulate3:LIMit2:UPPer[:DATA] <DEF|MIN|MAX>
:CALCulate3:LIMit2:UPPer[:DATA] ?
:CALCulate3:LIMit2:UPPer[:DATA] ? <DEF|MIN|MAX>
```

<value>	The value of the upper limit: -9.999999e35 to +9.999999e35
---------	--

Details

This command sets the high limit for the selected measurement function. The actual limit depends on the measurement function that is presently selected. For example, a limit value of 0.000001 is 1 µA for the current function and 1 µC for the charge function.

A limit value is not range sensitive. A limit of 2 for volts is 2 V on all measurement ranges.

SCPI compliant.

Also see

[:CALCulate3:LIMit2:LOWER\[:DATA\]](#) (on page 11-41)
[:CALCulate3:LIMit2:STATE](#) (on page 11-41)

:CALCulate3:LIMit[1]:CLEar:AUTO

This command enables or disables autoclear, which clears the limit test results when a new trigger model cycle starts.

Type	Affected by	Where saved	Default value
Command and query	Recall settings Instrument reset Power cycle	Save settings	ON

Usage

```
:CALCulate3:LIMit[1]:CLEar:AUTO <state>
:CALCulate3:LIMit[1]:CLEar:AUTO?
```

<state>	Disable autoclear: OFF Enable autoclear: ON
---------	--

Details

With autoclear enabled, the fail message (0) is cleared when the instrument returns to the idle state. If the test is programmed not to return to idle, you can manually clear the fail condition by sending the CLEar [:IMMEDIATE] command. If autoclear is disabled, the fail condition must be cleared manually.

SCPI compliant.

Also see

[:CALCulate3:LIMit\[1\]:CLEar\[:IMMEDIATE\]](#) (on page 11-44)

:CALCulate3:LIMit[1]:CLEar[:IMMEDIATE]

This command clears the fail indication for LIMIT 1.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:CALCulate3:LIMit[1]:CLEar[:IMMEDIATE]
```

Details

Use this command to clear the test results when the limit autoclear option is turned off. Both the high and low test results are cleared.

SCPI compliant.

Also see

None

:CALCulate3:LIMit[1]:FAIL?

This command queries the results of a limit test.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

`:CALCulate3:LIMit[1]:FAIL?`

Details

Query test result:

- Pass: 1
- Fail: 0

The fail message (0) for a limit test indicates that the reading is outside the specified limits.

The response message only tells you if a limit test passed or failed. It does not tell you whether the upper or lower limit failed. To determine which limit failed, you must read the transition filter event register.

Reading the results of a limit test does not clear the fail indication of the test. To clear the fail indication, send the `:CALCulate3:LIMit[1]:CLEar[:IMMEDIATE]` command.

A fail indication for LIMIT 1 is cleared when the respective limit test is disabled.

SCPI compliant.

Also see

[:CALCulate3:LIMit\[1\]:CLEar\[:IMMEDIATE\]](#) (on page 11-44)

:CALCulate3:LIMit[1]:LOWer:SOURce

This command specifies the LIMIT 1 failure pattern for the lower limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

`:CALCulate3:LIMit[1]:LOWer:SOURce <NRf>`
`:CALCulate3:LIMit[1]:LOWer:SOURce?`

<NRf>	Specify digital pattern for the output port: 0 to 15
-------	--

Details

This command specifies which lines of the digital output port go true when a limit test failure occurs. The first failure in the test sequence determines the digital output pattern. Subsequent failures in the test sequence do not change the digital output pattern on the output port. Each output line is assigned a decimal weight as shown in the following table.

Digital output line	Decimal weight
1	1
2	2
3	4
4	8

The parameter value for the digital pattern is determined by adding the decimal weights of the output lines. For example, to set output lines #2 and #3 to go true when the upper limit of LIMIT 1 is the first failure in the test sequence, use a parameter value of 6 (2 + 4).

The actual true state (high or low) of each digital output line depends on its programmed polarity. Polarity is programmed from the OUTPut subsystem.

NOTE

When the binning strobe is enabled, output line 4 is not considered to be part of the digital output pattern. The binning strobe uses line 4. With the binning strobe enabled, parameters 8 through 15 are treated the same as parameters 0 through 7.

SCPI compliant.

Also see

[:CALCulate3:BSTRobe:STATE](#) (on page 11-36)

:CALCulate3:LIMit[1]:LOWer[:DATA]

This command specifies the lower limit for a limit test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	-1

Usage

```
:CALCulate3:LIMit[1]:LOWer[:DATA] <value>
:CALCulate3:LIMit[1]:LOWer[:DATA] <DEF|MIN|MAX>
:CALCulate3:LIMit[1]:LOWer[:DATA] ?
:CALCulate3:LIMit[1]:LOWer[:DATA] ? <DEF|MIN|MAX>
```

<value>	The value of the lower limit: -9.999999e35 to +9.999999e35
---------	--

Details

This command sets the low limit for the selected measurement function. The actual limit depends on the measurement function that is presently selected. For example, a limit value of 0.000001 is 1 µA for the current function and 1 µC for the charge function.

A limit value is not range sensitive. A limit of 2 for volts is 2 V on all measurement ranges.

SCPI compliant.

Also see

- [:CALCulate3:LIMit\[1\]:STATE](#) (on page 11-47)
- [:CALCulate3:LIMit\[1\]:UPPer\[:DATA\]](#) (on page 11-49)

:CALCulate3:LIMit[1]:STATE

This command enables or disables the limit 1 test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:CALCulate3:LIMit[1]:STATE <state>
:CALCulate3:LIMit[1]:STATE?
```

<state>	Disable the limit 1 test: 0 or OFF Enable the limit 1 test: 1 or ON
---------	--

Details

When enabled, the test sequence for limits is performed every time the instrument makes a measurement. Testing is performed in the following sequence: Low Limit 1, High Limit 1, Low Limit 2 and High Limit 2. Only limit tests that are enabled are performed.

When a limit test is enabled, the digital output port cannot be controlled from the :SOURce subsystem.

A fail indication for LIMIT 1 is cleared when the respective limit test is disabled.

SCPI compliant.

Also see

- [:CALCulate3:LIMit2:LOWer](#) (on page 11-41)
- [:CALCulate3:LIMit2:UPPer](#) (on page 11-43)

:CALCulate3:LIMit[1]:UPPer:SOURce

This command specifies the LIMIT 1 failure pattern for the upper limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:CALCulate3:LIMit[1]:UPPer:SOURce <NRf>
:CALCulate3:LIMit[1]:UPPer:SOURce?
<NRf>          Specify digital pattern for the output port: 0 to 15
```

Details

This command specifies which lines of the digital output port go true when a limit test failure occurs. The first failure in the test sequence determines the digital output pattern. Subsequent failures in the test sequence do not change the digital output pattern on the output port. Each output line is assigned a decimal weight as shown in the following table.

Digital output line	Decimal weight
1	1
2	2
3	4
4	8

The parameter value for the digital pattern is determined by adding the decimal weights of the output lines. For example, to set output lines #2 and #3 to go true when the upper limit of LIMIT 1 is the first failure in the test sequence, use a parameter value of 6 (2 + 4).

The actual true state (high or low) of each digital output line depends on its programmed polarity. Polarity is programmed from the OUTPut subsystem.

NOTE

When the binning strobe is enabled, output line 4 is not considered to be part of the digital output pattern. The binning strobe uses line 4. With the binning strobe enabled, parameters 8 through 15 are treated the same as parameters 0 through 7.

SCPI compliant.

Also see

[:CALCulate3:BSTRobe:STATE](#) (on page 11-36)

:CALCulate3:LIMit[1]:UPPer[:DATA]

This command specifies the upper limit for a limit test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:CALCulate3:LIMit[1]:UPPer[:DATA] <value>
:CALCulate3:LIMit[1]:UPPer[:DATA] <DEF|MIN|MAX>
:CALCulate3:LIMit[1]:UPPer[:DATA]?
:CALCulate3:LIMit[1]:UPPer[:DATA]? <DEF|MIN|MAX>
```

<value>	The value of the upper limit: -9.99999e35 to +9.99999e35
---------	--

Details

This command sets the high limit for the selected measurement function. The actual limit depends on the measurement function that is presently selected. For example, a limit value of 0.000001 is 1 µA for the current function and 1 µC for the charge function.

A limit value is not range sensitive. A limit of 2 for volts is 2 V on all measurement ranges.

SCPI compliant.

Also see

[:CALCulate3:LIMit\[1\]:LOWER](#) (on page 11-46)
[:CALCulate3:LIMit\[1\]:STATE](#) (on page 11-47)

:CALCulate3:PASS:SOURce

This command specifies the digital pattern for the output port.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:CALCulate3:PASS:SOURce <NRf>
:CALCulate3:PASS:SOURce?
```

<NRf>	Specify digital pattern for the output port: 0 to 15
-------	--

Details

This command specifies which lines of the digital output port go true when there are no failures in the limit tests.

Each output line is assigned a decimal weight as shown in the following table.

Digital output line	Decimal weight
1	1
2	2
3	4
4	8

The parameter value for the digital pattern is determined by adding the decimal weights of the output lines. For example, to set output lines #2 and #3 to go true when all enabled limit tests pass, use a parameter value of 6 (2 + 4).

The actual true state (high or low) of each digital output line depends on its programmed polarity. Polarity is programmed from the OUTPut subsystem.

NOTE

When the binning strobe is enabled, output line 4 is not considered to be part of the digital output pattern. The binning strobe uses line 4. With the binning strobe enabled, parameters 8 through 15 are treated the same as parameters 0 through 7.

Also see

[:CALCulate3:BSTRobe:STATE](#) (on page 11-36)

[:OUTPut subsystems](#) (on page 11-63)

DISPlay subsystem

The display subsystem controls the display of the 6517B and is summarized in the [DISPlay command summary](#) (on page 11-8).

:DISPlay:CNDisplay

This command clears the NEXT or PREV DISPLAY messages and cancels the operations associated with them.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

`:DISPlay:CNDisplay`

Details

This command does not affect any other message types.

Also see

None

:DISPlay:ENABLE

This command turns the front-panel display on or off.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Nonvolatile memory	ON

Usage

`:DISPlay:ENABLE `
`:DISPlay:ENABLE?`

<code></code>	Disable the front-panel display: OFF or 0 Enable the front-panel display: ON or 1
------------------------	--

Details

When the front-panel display is disabled, the instrument operates at a higher speed.

When the display is disabled, the following message is displayed:

FRONT PANEL DISABLED Press **LOCAL** to resume.

All front-panel controls except the LOCAL key are disabled. To resume normal display operation, send `:DISPlay:ENABLE ON` or press the **LOCAL** key.

SCPI compliant.

Also see

None

:DISPlay:SMESSage

This command controls the status messages.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	OFF

Usage

```
:DISPLAY:SMESSAGE <b>
:DISPLAY:SMESSAGE?
```

	Disable status messages: 0 or OFF Enable status messages: 1 or ON
-----	--

Details

When status messages are displayed, the instrument displays real-time messages that relate to the present operating state of the instrument.

Also see

"Status and error messages" in the *Model 6517B User's Manual*

:DISPlay:WINDOW2:ATTRibutes?

This command queries attributes for the secondary displays.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:DISPLAY:WINDOW2:ATTRIBUTES?
```

Details

This query command returns the characters on the display that are and are not blinking. The response message provides the status of each character position for the specified display. The primary display consists of 20 characters and the secondary display consists of 32 characters.

1 = Character is blinking

0 = Character is not blinking

Example

If the following menu is displayed:
MAIN MENU
SAVESETUP COMMUNICATION TEST
The response message for the secondary display displays 1s at the character positions for SAVESETUP.
:DISP:WIND2:ATTR?
1111111100000000000000000000000000000000

Also see

[:DISPLAY\[:WINDOW\[1\]\]:ATTRIBUTES?](#) (on page 11-55)

:DISPlay:WINDOW2:DATA?

This command reads the bottom display message.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:DISPlay:WINDOW2:DATA?

Details

After sending this command and addressing the 6517B to talk, the displayed data (message or reading) is sent to the computer.

Also see

None

:DISPlay:WINDOW2:TEXT:DATA

This command defines the bottom display message.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	Not applicable

Usage

```
:DISPLAY:WINDOW2:TEXT:DATA "<a>"  
:DISPLAY:WINDOW2:TEXT:DATA?
```

<a> ASCII characters for message, up to 32 characters

Details

Spaces are counted as characters.

The characters must be enclosed in either double quotes (" ") or single quotes (' ').

Types can be:

- String: 'aa...a' or "aa...a"
- Indefinite block: #0aa...a
- Definite block: #XYaa...a, where X is the number of digits that make up Y (1 or 2)

An indefinite block message must be the only command in the program message or the last command in the program message. If you include a command after an indefinite block message (on the same line), it is treated as part of the message and is displayed instead of executed.

*RST and :SYSTem:PRESet have no effect on a user-defined message. Pressing the LOCAL key or cycling power cancels all user-defined messages.

SCPI compliant.

Also see

None

:DISPlay:WINDOW2:TEXT:STATE

This command controls the bottom display of the message.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	OFF

Usage

:DISPLAY:WINDOW2:TEXT:STATE
:DISPLAY:WINDOW2:TEXT:STATE?

	Disable test message mode for the bottom of the display: OFF Enable test message mode for the bottom of the display: ON
-----	--

Details

When enabled, a defined message is displayed. When disabled, the message is removed from the display. Messages are disabled when power is cycled.

GPIB operation: A user-defined text message is displayed while the instrument is in remote. Taking the instrument out of remote (by pressing the LOCAL key or sending LOCAL 27) cancels the message and disables the text message mode.

RS-232 operation: A user-defined text message is displayed until it is disabled with this command.

SCPI compliant.

Also see

[:DISPLAY:WINDOW2:TEXT:DATA](#) (on page 11-53)

:DISPlay[:WINDOW[1]]:ATTRibutes?

This command queries attributes for the primary display.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:DISPlay[:WINDOW[1]]:ATTRibutes?
```

Details

This query command returns which characters on the display are blinking and which are not. The response message provides that status of each character position for the primary display. The primary display consists of 20 characters.

The return is:

- Character is blinking: 1
- Character is not blinking: 0

Example

If the following menu is displayed: MAIN MENU The response message for the primary display results in 20 zeroes. :DISP:ATTR? 000000000000000000000000

Also see

[:DISPlay:WINDOW2:ATTRibutes? \(on page 11-52\)](#)

:DISPlay[:WINDOW[1]]:DATA?

This command reads the top display message.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:DISPlay[:WINDOW[1]]:DATA?
```

Details

After sending this command and addressing the 6517B to talk, the displayed data (message or reading) is sent to the computer.

Also see

None

:DISPlay[:WINDOW[1]]:TEXT:DATA

This command defines the top display message.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	Not applicable

Usage

```
:DISPlay[:WINDOW[1]]:TEXT:DATA "<a>"  
:DISPlay[:WINDOW[1]]:TEXT:DATA?
```

<a>	ASCII characters for message, up to 20 characters
-----	---

Details

Spaces are counted as characters.

The characters must be enclosed in either double quotes (" ") or single quotes (' ').

Types can be:

- String: 'aa....a' or "aa....a"
- Indefinite block: #0aa....a
- Definite block: #XYaa....a, where X is the number of digits that make up Y (1 or 2)

An indefinite block message must be the only command in the program message or the last command in the program message. If you include a command after an indefinite block message (on the same line), it is treated as part of the message and is displayed instead of executed.

*RST and :SYSTem:PRESet have no effect on a user-defined message. Pressing the LOCAL key or cycling power cancels all user-defined messages.

SCPI compliant.

Also see

None

:DISPlay[:WINDOW[1]]:TEXT:STATE

This command controls the top display of the message.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	OFF

Usage

```
:DISPlay[:WINDOW[1]]:TEXT:STATE <b>  
:DISPlay[:WINDOW[1]]:TEXT:STATE?
```

	Disable test message mode for the top of the display: OFF or 0 Enable test message mode for the top of the display: ON or 1
-----	--

Details

When enabled, a defined message is displayed. When disabled, the message is removed from the display. Messages are disabled when power is cycled.

GPIB operation: A user-defined text message is displayed while the instrument is in remote. Taking the instrument out of remote (by pressing the **LOCAL** key or sending **LOCAL 27**) cancels the message and disables the text message mode.

RS-232 operation: A user-defined text message is displayed until it is disabled with this command.

SCPI compliant.

Also see

[:DISPlay\[:WINDOW\[1\]\]:TEXT:DATA](#) (on page 11-56)

FORMat subsystem

The commands for this subsystem select the data format that is used to transfer instrument readings over the remote interface.

:FORMat:BORDer

This command sets the byte order for the IEEE Std 754 binary formats.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	SWAPped

Usage

:FORMat:BORDer <name>
:FORMat:BORDer?

<name>

The binary byte order:

- Normal byte order: **NORMAL**
- Reverse byte order for binary formats: **SWAPPED**

Details

This attribute selects the byte order in which data is written.

The ASCII data format can only be sent in the normal byte order. If the ASCII format is selected, the **SWAPPED** selection is ignored.

When you select **NORMAL** byte order, the data format for each element is sent as follows:

Byte 1 Byte 2 Byte 3 Byte 4

(Single precision)

Byte 1 Byte 2 ... Byte 8

(Double precision)

When you select SWAPped, the data format for each element is sent as follows:

Byte 4 Byte 3 Byte 2 Byte 1

(Single precision)

Byte 8 Byte 7 ... Byte 1

(Double precision)

The #0 header is not affected by this command. The header is always sent at the beginning of the data string for each measurement conversion.

This command affects readings that are transferred from the buffer. Commands that are not transferred from the buffer, such as :SENSe:DATA? and :CALC:DATA?, are always sent in ASCII.

SCPI compliant.

Also see

[:FORMat:DATA](#) (on page 11-60)

:FORMat:ELEMents

This command specifies the elements to include in a data string for each measurement.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	READing, CHANnel, RNUMber, UNITs, TStamp, STATus

Usage

<pre>:FORMAT:ELEMENTS <item list> :FORMAT:ELEMENTS?</pre>	
<item list>	<p>Data elements to include:</p> <ul style="list-style-type: none"> ■ Reading: READING ■ Reading number: RNUMBER ■ Units: UNITS ■ Channel number: CHANNEL ■ Relative humidity: HUMidity ■ External temperature: ETEMperature ■ Timestamp: TStamp ■ Status of the reading: STATUS ■ Voltage source output: VSource

Details

You can specify any combination of the <item list> parameters. Each item in the list must be separated by a comma.

READING includes the instrument reading. The resolution of the reading tracks the display resolution of the instrument. An overflow reading reads as +9.9e37 with no units; zero-check reads as +9.91E37; underflow reads as 0.00E00.

CHANnel correlates the instrument reading to the channel number. If not scanning, the channel number is 000.

TSTamp includes the timestamp of the measurement. The timestamp is either real-time or relative, as defined by :SYSTem:TSTamp:TYPE. TSTamp is also available for buffer readings. TSTamp can be referenced to the first reading stored in the buffer (absolute format) that is timestamped at 0 seconds or can provide the time between each reading (delta format). The :TRACe:TSTamp:FORMAT command selects the absolute or delta format. For the delta format, the real-time timestamp is expressed as the days, hours, minutes, and seconds between each reading and the relative timestamp is expressed as seconds between each reading. When the absolute format is used for the relative timestamp, any pretrigger readings have a negative timestamp.

RNUMber returns the number of the reading. The instrument keeps track of the number of readings it has made. This reading counter starts at zero when the instrument is turned on or when :SYSTem:RNUMber:RESet is sent over the bus. The instrument also keeps track of the number of readings it has stored in the buffer. When buffer readings are sent over the bus (:TRACe:DATA?), each reading number is referenced to the first reading, which is #0, stored in the buffer. If using the pretrigger to store readings, the pretrigger readings are assigned negative numbers.

UNITS attaches the function unit to the reading, the time unit (seconds) to the timestamp, and the channel unit (internal or external) to the channel number. An internal channel refers to an internally installed switching card channel. An external channel refers to the channel for an external switch system. This element is not available for the binary formats.

STATus indicates if the reading is normal (N), overflowed (O) or referenced (R) to another value, zero (Z), underflow (U), or out-of-limits (L). This element is not available for the binary formats.

HUMidity includes the relative humidity, which can be read by connecting and enabling the Model 6517-RH humidity probe to the instrument. The humidity probe is enabled or disabled from the :SYSTem subsystem. A reading of 999.99 means humidity is disabled. This data element includes the humidity reading (in %) in the data string.

ETEMperature includes the external temperature, which can be measured by connecting and enabling the Model 6517-TP temperature sensor to the instrument. The temperature sensor is enabled or disabled using the :SYSTem:TSControl command. A reading of 9999.99 means temperature is disabled. This data element includes the temperature reading (in °C, °F, or K) in the data string. Temperature units are selected using the :UNIT:TEMPerature command.

VSource element indicates the voltage that is sourced. In standby, 0 V is sourced.

The ASCII format shown in the "ASCII data format" figure in :FORMAT [:DATA] shows the byte order of the data string. The byte order can only be reversed for the binary formats.

When using this command to add an element, you must include all elements that you want in the format. For example, if the reading is already specified and you want to add the timestamp, you must include the READING parameter. For example:

```
:FORM:ELEM TIME, READ
```

Data elements for the item list can be listed in any order, but are always sent in the order shown in the "ASCII data format" figure.

Also see

- [:FORMat\[:DATA\] \(on page 11-60\)](#)
- [:SYSTem:TSTamp:TYPE \(on page 11-165\)](#)

:FORMat[:DATA]

This command specifies the data format that is used when transferring readings over the remote interface.

Type	Affected by	Where saved	Default value
Command and query	Recall settings Instrument reset Power cycle	Save settings	ASCIi

Usage

```
:FORMat [:DATA] <type>
:FORMat [:DATA] REAL, <length>
:FORMat [:DATA] ?
```

<type>	The data format: <ul style="list-style-type: none"> ■ ASCII: ASCii ■ IEEE Std 754 single-precision: REAL ■ IEEE Std 754 single-precision: SREAL ■ IEEE Std 754 double-precision: DREAL
<length>	32 or 64 (default 32)

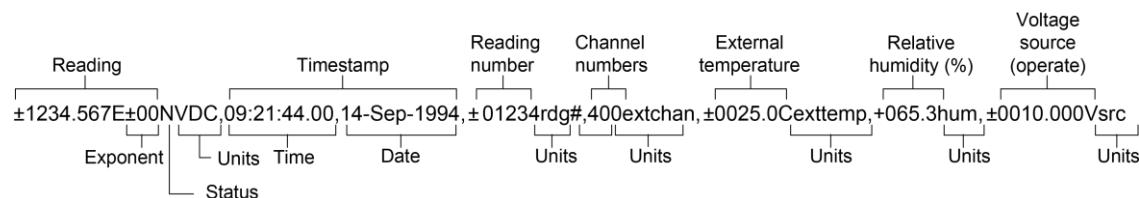
Details

NOTE

The RS-232 interface only supports the ASCII data format. If the RS-232 interface is selected, the data format defaults to ASCII and cannot be changed.

For every reading conversion, the data string sent over the bus contains the elements specified by the :FORMat:ELEMents command. The specified elements are sent in a particular order.

The ASCII data format is in a direct readable form for the operator. Most BASIC languages convert ASCII mantissa and exponent to other formats. However, some speed is compromised to accommodate the conversion. The following figure shows the ASCII format that includes all the data elements.

Figure 88: ASCII data format

Reading units can be:

- **VDC:** Voltage
- **ADC:** Amperes
- **OHM:** Ohms
- **OHMCM:** Volume
- **OHMSQ:** Surface
- **%/V:** Voltage coefficient
- **COUL:** Charge

The timestamp is shown as the real-time clock.

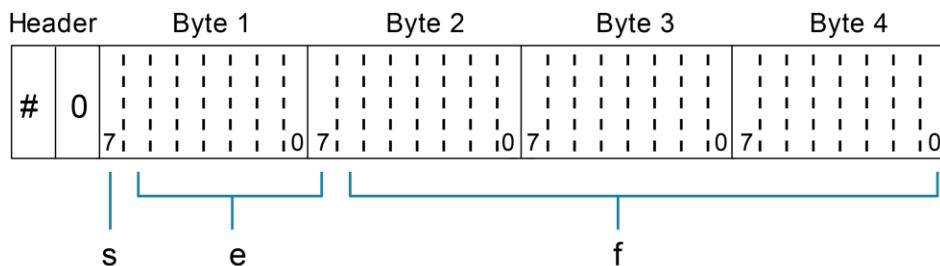
Status can be:

- **N:** Normal
- **Z:** Zero check enabled
- **O:** Overflow
- **U:** Underflow
- **R:** Reference (relative offset)
- **L:** Out of limit

The channel number is 000 if there is no channel or 001 to 400 for a specific channel. Channel units are extchan for external channels or intchan for internal channels.

The external temperature units can be C for °C, F for °F, or K.

REAL, 32 or **SREAL** selects the binary IEEE Std 754 single-precision data format and is shown in the following figure. The figure shows the normal byte order format for each data element. For example, if three valid elements are specified, the data string for each reading conversion is made up of three 32-bit data blocks. The data string for each reading conversion is preceded by a 2-byte header that is the binary equivalent of an ASCII # sign and 0.

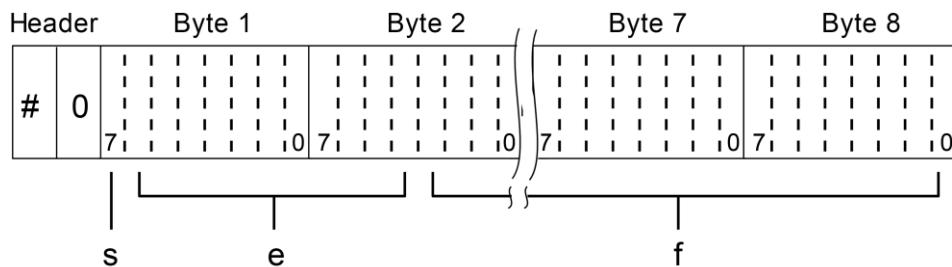
Figure 89: IEEE Std 754 single-precision data format (32 data bits)

This figure shows:

- s = sign bit (0 = positive, 1 = negative)
- e = exponent bits (8)
- f = fraction bits (23)

The normal byte order is shown. For the swapped byte order, the bytes are sent in the order: Header, Byte 4, Byte 3, Byte 2, Byte 1. The Header is only sent once for each measurement conversion.

`REAL, 64` or `DREAL` selects the binary IEEE Std 754 double-precision data format and is shown in the following figure (normal byte order shown). This format is similar to the single-precision format except that it is 64 bits long.

Figure 90: IEEE Std 754 double precision data format (64 data bits)

This figure shows:

- s = sign bit (0 = positive, 1 = negative)
- e = exponent bits (11)
- f = fraction bits (52)

Bytes 3, 4, 5, and 6 are not shown. Normal byte order shown. For swapped byte order, the bytes are sent in the order Header, Byte 8, Byte 7 ... Byte 1. The Header is only sent once for each measurement conversion.

Also see

[:FORMAT:ELEMENTS](#) (on page 11-58)

OUTPut subsystems

The OUTPut1 and OUTPut2 subsystems control the voltage source (standby or operate) and set polarities for the digital output port. Commands for these subsystems are summarized in [OUTPut command summary](#) (on page 11-10).

:OUTPut1[:STATe]

This command enables or disables the voltage source.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

:OUTPut1[:STATe] 	Enable the voltage source (operate): 1 or ON
:OUTPut1[:STATe] ?	Disable the voltage source (standby): 0 or OFF

Details

The voltage source is configured from the :SOURce subsystem.

SCPI compliant.

Also see

[:SOURce subsystem](#) (on page 11-108)

:OUTPut2:TTLX:LSENse

This command sets the polarity of digital output lines 1 through 4.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	AHIGH

Usage

:OUTPut2:TTLX:LSENse <name>

:OUTPut2:TTLX:LSENse?

X	Digital output line 1: [1] Digital output line 2: 2 Digital output line 3: 3 Digital output line 4: 4
<name>	Sets polarity of specified line to active high: AHIGH Sets polarity of specified line to active low: ALOW

Details

When set for active high polarity, the specified output line is true (ON) when the output level is high. The output line is false (OFF) when the output level is low.

When set for active low polarity, the output line is true (ON) when the output level is low. The output line is false (OFF) when the output level is high.

The logic levels (true or false) of the digital output lines are set from the SOURCE subsystem.

Also see

- [:SOURce subsystem](#) (on page 11-108)
- [:SOURce:TTL\[1\]:\[LEVel\]](#) (on page 11-109)

ROUTe subsystem

The commands in this subsystem configure and control switching and are summarized in [ROUTe command summary](#) (on page 11-11).

:ROUTe:CLOSE

This command closes the specified channel on a scanner card installed in the 6517B.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:ROUTe:CLOSE <list>
:ROUTe:CLOSE? <list>
```

<list>	Specify channel (1 to 10) to be closed; see Details
--------	--

Details

Only one channel can be closed at a time. <list> must consist of only one channel. When this command is sent, any other closed channel opens and the specified channel closes.

You can use the query to determine the state of multiple channels. The following examples demonstrate the various forms for expressing the channel list.

- Single channel: (@ 2)
- Multiple channels (separated by commas): (@ 2, 4, 6)
- Range of channels (separated by colon): (@ 1:10)
- Combination of range and single entry: (@ 1:5, 7)

A value of 1 indicates that the channel is closed. A 0 indicates that the channel is not closed.

SCPI compliant.

Also see

None

:ROUTE:CLOSE:STATE?

This command queries the closed channel.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:ROUTE:CLOSE:STATE?

Details

This query command returns the channel on the internal scanner card that is closed, if any.

SCPI compliant.

Also see

None

:ROUTE:OPEN

This command opens a channel on the internal scanner card.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

:ROUTE:OPEN (@ <list>
:ROUTE:OPEN? (@ <list>)

<list>

- The channel to open: 1 to 10
- Open all channels: ALL

Details

Because only one channel can be closed, <list> for this command can only consist of one channel. You can also use the ALL parameter, which opens the closed channel.

The query command determines the state (opened or not opened) of each channel specified by the list parameter. See :ROUTE:CLOSE for examples of how to express a channel list. A return of 1 indicates that the channel is open. 0 indicates that the channel is not open.

SCPI compliant.

Also see

[:ROUTE:CLOSE \(on page 11-65\)](#)

:ROUTE:OPEN:ALL

This command opens a closed channel on the internal scanner card.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:ROUTE:OPEN:ALL

Details

This command performs the same function as the :ROUTE:OPEN ALL command.

SCPI compliant.

Also see

[:ROUTE:CLOSE \(on page 11-65\)](#)
[:ROUTE:OPEN \(on page 11-66\)](#)

:ROUTE:SCAN:EXTernal

This command specifies the number of external channels.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	10

Usage

```
:ROUTE:SCAN:EXTernal <n>
:ROUTE:SCAN:EXTernal <DEF|MIN|MAX>
:ROUTE:SCAN:EXTernal?
:ROUTE:SCAN:EXTernal? <DEF|MIN|MAX>
```

<n>	Specify number of external channels: 1 to 400
-----	---

Details

The 6517B can operate with an external switch system, such as the Keithley Instruments Model 7001 or 7002. The 6517B can measure up to 400 channels that are switched by the external switching system. This command specifies the number of external channels to scan.

The external scan by the 6517B is enabled by the :ROUTE:SCAN:LSELect command.

Also see

[:ROUTE:SCAN:LSELect \(on page 11-68\)](#)

:ROUTe:SCAN:LSELect

This command selects the type of scan operation.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	NONE

Usage

```
:ROUTE:SCAN:LSELect <name>
:ROUTE:SCAN:LSELect?
```

<name>	The scan operation: <ul style="list-style-type: none"> ▪ Disable all scan operations: NONE ▪ Enable an internal scan: INTernal ▪ Enable an external scan: EXTernal
--------	---

Details

When INTernal is selected, the 6517B scans the channels of the internal switching card according to how the scan is configured.

When EXTERNAL is selected, the 6517B scans the channels of the external scanner card. The :ROUTE:SCAN:EXTERNAL command specifies the number of external channels to scan.

The NONE selection disables all operations associated with a scan.

Also see

[:ROUTE:SCAN:EXTERNAL \(on page 11-67\)](#)
[:ROUTE:SCAN:INTERNAL \(on page 11-70\)](#)

:ROUTe:SCAN:SMETHOD

This command selects the switching method during an internal scan.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	VOLTage

Usage

```
:ROUTE:SCAN:SMETHOD <name>
:ROUTE:SCAN:SMETHOD?
```

<name>	Break-before-make switching method: VOLTage Normal switching method: CURRent
--------	---

Details

The VOLTage method ensures that each switch opens (breaks) before the next switch in the scan closes (makes). This method ensures that two or more channels cannot be closed at the same time.

The CURRent switching method provides optimum speed in applications where break-before-make is not necessary.

Also see

None

:ROUTE:SCAN:STIMe

This command specifies the settling time for the relay switches on the internal scanner card.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:ROUTE:SCAN:STIMe <n>
:ROUTE:SCAN:STIMe <DEF|MIN|MAX>
:ROUTE:SCAN:STIMe?
:ROUTE:SCAN:STIMe? <DEF|MIN|MAX>
```

<n>	Specify settling time in seconds: 0 . 003 to 99999 . 999
-----	--

Details

After each switch closes, a measurement does not occur until after the specified settling time expires.

Also see

None

:ROUTE:SCAN:VSLimit

This command controls the 200 V voltage source limit.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	ON

Usage

```
:ROUTE:SCAN:VSLimit <b>
:ROUTE:SCAN:VSLimit?
```

	Disable 200 V voltage source limit: 0 or OFF Enable 200 V voltage source limit: 1 or ON
-----	--

Details

The 200 V voltage source limit helps protect internal scanner cards from high voltage that could damage them. With the 200 V limit enabled, the voltage source can never source more than ± 200 V.

The :SOURce:VOLTage:LIMit command is also used to set the voltage limit of the voltage source. When both voltage limit methods are set, the one that is set to the lower limit value (absolute) is the one that is in effect.

Also see

[:SOURce:VOLTage:LIMit\[:AMPLitude\]](#) (on page 11-110)

:ROUTe:SCAN[:INTernal]

This command defines the internal scan list and enables a scan.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	All 10 channels

Usage

```
:ROUTe:SCAN[:INTernal] <list>
:ROUTe:SCAN[:INTernal]?

<list>          Channel (1 to 10) to be closed; see Details
```

Details

The scan list can contain 2 to 10 channels. The following examples demonstrate the various forms for expressing the channel list.

- Multiple channels (separated by commas): (@ 2, 4, 6)
- Range of channels (separated by colon): (@ 1:10)
- Combination of range and single entry: (@ 1:5, 7)

A value of 1 indicates that the channel is closed. A 0 indicates that the channel is not closed.

Refer to the instruction manual for the scanner card for details on scanning.

SCPI compliant.

Also see

[Scanning](#) (on page 9-9)

SENSe[1] subsystem

The SENSe[1] subsystem commands configure and control the measurement functions of the instrument.

[SENSe[1]]:<function>:APERture

This command sets the aperture for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	60 Hz: 16.67 ms 50 Hz and 400 Hz: 20 ms

Usage

```
:SENSe[1]:<function>:APERture <n>
:SENSe[1]:<function>:APERture <DEF|MIN|MAX>
:SENSe[1]:<function>:APERture?
:SENSe[1]:<function>:APERture? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLtage [:DC] ▪ Current: CURRent [:DC] ▪ Resistance: RESistance ▪ Charge: CHARGE
<n>	Specify integration rate in seconds: 166.666666667e-6 to 200e-3

Details

NOTE

The measurement time can also be set as NPLCs. Changing the NPLC value changes the aperture time and changing the aperture time changes the NPLC value.

SCPI compliant.

Also see

[Integration time \(on page 3-1\)](#)
[\[:SENSe\[1\]\]:<function>:NPLCycles \(on page 11-83\)](#)

[SENSe[1]]:<function>:APERture:AUTO

This command controls auto-aperture for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[SENSe[1]]:<function>:APERture:AUTO <b>
[SENSe[1]]:<function>:APERture:AUTO ONCE
[SENSe[1]]:<function>:APERture:AUTO?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLTage[:DC] ▪ Current: CURRENT[:DC] ▪ Resistance: RESistance ▪ Charge: CHARGE
	<ul style="list-style-type: none"> ▪ Enable auto-aperture: 1 or ON ▪ Disable auto-aperture: 0 or OFF ▪ Enable and then disable auto-aperture: ONCE

Details

With auto-aperture enabled, the instrument automatically optimizes the aperture value for the present resolution setting. This is the same as selecting SET-BY-RSLN from the front panel.

See [Display resolution](#) (on page 3-3) for the integration times when auto-aperture is set to ON.

The ONCE parameter is analogous to a momentary toggle switch. When ONCE is sent, auto-aperture turns on momentarily, set the aperture value, and is then disabled.

:APERture:AUTO is coupled to the command that sets the aperture value. When auto-aperture is enabled, the parameter value for [SENSe[1]]:<function>:APERture changes to the automatically selected aperture value. This means that when auto-aperture is disabled, the aperture remains at the automatically selected value. A valid aperture value sent using the [SENSe[1]]:<function>:APERture command disables auto-aperture.

Auto-aperture is also coupled to automatic NPLC. Enabling or disabling auto-aperture also enables or disables automatic NPLC. A valid NPLC value sent using the [SENSe[1]]:<function>:NPLCycles command disables auto-aperture.

Also see

- [Display resolution](#) (on page 3-3)
- [Integration time](#) (on page 3-1)
- [\[SENSe\[1\]\]:<function>:APERture](#) (on page 11-71)
- [\[SENSe\[1\]\]:<function>:NPLCycles](#) (on page 11-83)
- [\[SENSe\[1\]\]:<function>:NPLCycles:AUTO](#) (on page 11-84)

[SENSe[1]]:<function>:AVERage:ADVanced:NTOLerance

This command specifies the noise tolerance for the advanced filter for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:SENSe[1]:<function>:AVERage:ADVanced:NTOLerance <n>
:SENSe[1]:<function>:AVERage:ADVanced:NTOLerance <DEF|MIN|MAX>
:SENSe[1]:<function>:AVERage:ADVanced:NTOLerance?
:SENSe[1]:<function>:AVERage:ADVanced:NTOLerance? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLTage[:DC] ■ Current: CURRENT[:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<name>	The noise tolerance in percent (\pm): 1 to 100

Details

The advanced filter is an averaging filter with a noise tolerance window to allow faster response times to large signal step changes. The noise tolerance setting sets the window.

The noise tolerance level is expressed as a percent of the last averaged reading. In general, if the noise is within this window, the reading is based on the normal averaging algorithm. If a reading is outside this window, the advanced averaging algorithm is used.

Also see

- [Digital filters \(on page 8-1\)](#)
- [\[:SENSe\[1\]\]:<function>:AVERage:COUNt \(on page 11-74\)](#)
- [\[:SENSe\[1\]\]:<function>:AVERage:TCONrol \(on page 11-75\)](#)
- [\[:SENSe\[1\]\]:<function>:AVERage:TYPE \(on page 11-76\)](#)
- [\[:SENSe\[1\]\]:<function>:AVERage\[:STATE\] \(on page 11-77\)](#)

[:SENSe[1]]:<function>:AVERage:COUNt

This command selects the filter count for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	10

Usage

```
:SENSe[1]:<function>:AVERage:COUNt <n>
:SENSe[1]:<function>:AVERage:COUNt <DEF|MIN|MAX>
:SENSe[1]:<function>:AVERage:COUNt?
:SENSe[1]:<function>:AVERage:COUNt? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage[:DC] ■ Current: CURrent[:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<n>	The filter count: 1 to 100

Details

The filter count is the number of readings that are acquired and stored in the filter buffer for the averaging calculation. The larger the filter count, the more filtering that is performed.

Also see

[Digital filters](#) (on page 8-1)
[\[:SENSe\[1\]\]:<function>:AVERage:ADVanced:NTOlerance](#) (on page 11-73)
[\[:SENSe\[1\]\]:<function>:AVERage:TCONtrol](#) (on page 11-75)
[\[:SENSe\[1\]\]:<function>:AVERage:TYPE](#) (on page 11-76)
[\[:SENSe\[1\]\]:<function>:AVERage\[:STATe\]](#) (on page 11-77)

[SENSe[1]]:<function>:AVERage:TCONtrol

This command selects the filter mode for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Reset: REPeat System preset: MOVing

Usage

```
:SENSe[1]:<function>:AVERage:TCONtrol <name>
:SENSe[1]:<function>:AVERage:TCONtrol?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage[:DC] ■ Current: CURrent[:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<name>	Select the repeating filter mode: REPeat Select the moving filter mode: MOVing

Details

Using the moving filter during a scan or test sequence generates a settings conflict error. To prevent this error, the filter mode is automatically set to REPeat during a scan or test sequence if the filter is ON for the active function.

Also see

[Digital filters](#) (on page 8-1)

[SENSe[1]]:<function>:AVERage:TYPE

This command selects the filter type for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	SCALar

Usage

```
:SENSe[1]:<function>:AVERage:TYPE <name>
:SENSe[1]:<function>:AVERage:TYPE?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLTage [:DC] ▪ Current: CURRENT [:DC] ▪ Resistance: RESistance ▪ Charge: CHARGE
<name>	The filter type: <ul style="list-style-type: none"> ▪ No digital filter selected: NONE ▪ Select scalar filter: SCALar ▪ Select advanced filter: ADVanced

Details

The SCALar filter is a simple averaging type filter. The ADVanced filter is similar except that it incorporates a noise window to allow faster response time to large signal step changes. The [:SENSe[1]]:<function>:AVERage:ADVanced:NTOLerance command sets the window for the ADVanced filter.

The number of readings that are averaged by the filter is set with the [:SENSe[1]]:<function>:AVERage:COUNT command. The [:SENSe[1]]:<function>:AVERage:TCONtrol selects the filter type (moving or repeating). The [:STATE] command enables or disables the filter.

If the averaging type is set to NONE and the median state is set to OFF, the [:SENSe[1]]:<function>:AVERage[:STATE] is set to OFF.

Also see

- [Digital filters](#) (on page 8-1)
- [\[:SENSe\[1\]\]:<function>:AVERage:ADVanced:NTOLerance](#) (on page 11-73)
- [\[:SENSe\[1\]\]:<function>:AVERage:COUNT](#) (on page 11-74)
- [\[:SENSe\[1\]\]:<function>:AVERage:TCONtrol](#) (on page 11-75)
- [\[:SENSe\[1\]\]:<function>:AVERage\[:STATE\]](#) (on page 11-77)

[:SENSe[1]]:<function>:AVERage[:STATe]

This command enables or disables the digital averaging filter for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SENSe[1]:<function>:AVERage[:STATe] <b>
:SENSe[1]:<function>:AVERage[:STATe] ?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLTage [:DC] ■ Current: CURRENT [:DC] ■ Resistance: RESistance ■ Charge: CHARGE
	Disable the digital filter: OFF or 0 Enable the digital filter: ON or 1

Details

When enabled, readings are filtered using the filter configuration.

If the state is set to ON, averaging type is set to NONE, and the median state is set to OFF, a settings conflict error occurs.

Using the moving filter during a scan or test sequence generates a settings conflict error. To prevent this error, the filter mode is automatically set to REPeat during a scan or test sequence if the filter is ON for the active function.

Also see

- [Digital filters](#) (on page 8-1)
- [\[:SENSe\[1\]\]:<function>:AVERage:TCONtrol](#) (on page 11-75)
- [\[:SENSe\[1\]\]:<function>:AVERage:TYPE](#) (on page 11-76)
- [\[:SENSe\[1\]\]:<function>:MEDian\[:STATe\]](#) (on page 11-82)

[:SENSe[1]]:<function>:DAMPing

This command controls the damping for current and resistance functions.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[:SENSe[1]]:<function>:DAMPing <b>
[:SENSe[1]]:<function>:DAMPing?
```

<function>	The function to which the setting applies: <ul style="list-style-type: none"> ▪ Current: CURRENT[:DC] ▪ Resistance: RESistance
	Disable damping: OFF or 0 Enable damping: ON or 1

Details

Damping decreases noise caused by high input capacitance. However, damping also slows down the response of the measurements.

Damping is only valid for the 20 pA and 200 pA ranges.

Also see

None

[:SENSe[1]]:<function>:DIGits

This command determines the number of digits that are displayed for measurements on the front panel.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	6

Usage

```
:SENSe[1]:<function>:DIGits <value>
:SENSe[1]:<function>:DIGits <DEF|MIN|MAX>
:SENSe[1]:<function>:DIGits?
:SENSe[1]:<function>:DIGits? <DEF|MIN|MAX>
```

<function>	The function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage[:DC] ■ Current: CURRent[:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<value>	Display digits: <ul style="list-style-type: none"> ■ 6½: 7 ■ 5½: 6 ■ 4½: 5 ■ 3½: 4
<DEF MIN MAX>	The DEFault, MINimum, or MAXimum value

Details

This command affects how the reading for a measurement is displayed on the front panel of the instrument. It does not affect the number of digits returned in a remote command reading. It also does not affect the accuracy or speed of measurements.

The display digits setting is saved with the function setting, so if you use another function, then return to the function for which you set display digits, the display digits setting you set previously is retained.

The change in digits occurs the next time a measurement is made.

You can use [:SENSe[1]]:<function>:DIGits:AUTO to set the resolution automatically.

Also see

[\[:SENSe\[1\]\]:<function>:DIGits:AUTO \(on page 11-80\)](#)

[SENSe[1]]:<function>:DIGits:AUTO

This command controls the automatic resolution for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[SENSe[1]]:<function>:DIGits:AUTO <b>
[SENSe[1]]:<function>:DIGits:AUTO ONCE
[SENSe[1]]:<function>:DIGits:AUTO?
```

<function>	The function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLTage[:DC] ▪ Current: CURRENT[:DC] ▪ Resistance: RESistance ▪ Charge: CHARGE
	<ul style="list-style-type: none"> ▪ Enable autoresolution: 1 or ON ▪ Disable autoresolution: 0 or OFF ▪ Enable and then disable autoresolution: ONCE

Details

With autoresolution selected, the instrument automatically selects the optimum resolution for the present integration time setting.

The ONCE parameter is analogous to a momentary toggle switch. When ONCE is sent, autoresolution turns on momentarily, selects the resolution, and then disables.

[SENSe[1]]:<function>:DIGits is set to the new value.

Also see

[\[SENSe\[1\]\]:<function>:DIGits](#) (on page 11-79)

[:SENSe[1]]:<function>:MEDian:RANK

This command specifies the median rank for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:SENSe[1]:<function>:MEDian:RANK <NRF>
:SENSe[1]:<function>:MEDian:RANK?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLTage [:DC] ■ Current: CURRENT [:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<NRF>	The rank: 1 to 5

Details

The number of sample readings used for the median calculation is determined by the selected range as follows:

$$\text{Sample readings} = (2 \times R) + 1$$

Where: R is the selected range (1 to 5)

For example, a rank of 5 uses the last 11 readings to determine the median: $(2 \times 5) + 1 = 11$.

Each new reading replaces the oldest reading and the median is then determined from the updated sample of readings.

Also see

[\[:SENSe\[1\]\]:<function>:MEDian\[:STATe\]](#) (on page 11-82)
[Median filter](#) (on page 8-5)

[SENSe[1]]:<function>:MEDian[:STATe]

This command controls the median filter for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ON

Usage

```
:SENSe[1]:<function>:MEDian[:STATe] <state>
:SENSe[1]:<function>:MEDian[:STATe]?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage [:DC] ■ Current: CURrent [:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<state>	Disable the median filter: OFF or 0 Enable the median filter: ON or 1

Details

When enabled, the instrument determines and displays the median reading for the specified number of readings. The :RANK command specifies the number of readings used to determine the median.

You can use the median filter with the average filter. When both of these filters are enabled, each displayed reading reflects the median for the average readings.

Setting STATe to OFF with AVERage:TYPE set to NONE sets AVERage:STATe to OFF.

Also see

- [\[:SENSe\[1\]\]:<function>:AVERage:TYPE](#) (on page 11-76)
- [\[:SENSe\[1\]\]:<function>:AVERage\[:STATe\]](#) (on page 11-77)
- [\[:SENSe\[1\]\]:<function>:MEDian:RANK](#) (on page 11-81)
- [Median filter](#) (on page 8-5)

[:SENSe[1]]:<function>:NPLCycles

This command sets the time that the input signal is measured.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:SENSe[1]:<function>:NPLCycles <n>
:SENSe[1]:<function>:NPLCycles <DEF|MIN|MAX>
:SENSe[1]:<function>:NPLCycles?
:SENSe[1]:<function>:NPLCycles <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage[:DC] ■ Current: CURrent[:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<n>	The number of power-line cycles for each measurement: 0 . 01 to 10

Details

SCPI compliant.

NOTE

The measurement time can also be set as an aperture time. Changing the NPLC value changes the aperture time and changing the aperture time changes the NPLC value.

Also see

[Integration time \(on page 3-1\)](#)
[\[:SENSe\[1\]\]:<function>:APERture \(on page 11-71\)](#)

[SENSe[1]]:<function>:NPLCycles:AUTO

This command controls automatic NPLC for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[SENSe[1]]:<function>:NPLCycles:AUTO <b>
[SENSe[1]]:<function>:NPLCycles:AUTO ONCE
[SENSe[1]]:<function>:NPLCycles:AUTO?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLtage[:DC] ▪ Current: CURRent[:DC] ▪ Resistance: RESistance ▪ Charge: CHARGE
	<ul style="list-style-type: none"> ▪ Enable automatic NPLC: 1 or ON ▪ Disable automatic NPLC: 0 or OFF ▪ Enable and then disable automatic NPLC: ONCE

Details

With automatic NPLC enabled, the instrument automatically optimizes the aperture value for the present resolution setting. This is the same as selecting SET-BY-RSLN from the front panel.

See [Display resolution](#) (on page 3-3) for the integration times when automatic NPLC is set to ON.

When ONCE is sent, automatic NPLC turns on momentarily, selects the appropriate NPLC value, and is then disabled. When automatic NPLC is disabled, the NPLC remains at the selected value.

This command is coupled to the command that manually sets the NPLC value. When automatic NPLC is enabled, the parameter value for [:SENSe[1]]:<function>:NPLCycles changes to the automatically selected NPLC value, so when automatic NPLC is disabled, NPLC remains at the automatically selected value. A valid NPLC value sent using the [:SENSe[1]]:<function>:NPLCycles command disables automatic NPLC.

Automatic NPLC is also coupled to auto-aperture. Enabling or disabling automatic NPLC also enables or disables auto-aperture. A valid aperture value sent using the [:SENSe[1]]:<function>:APERture command disables automatic NPLC.

Also see

- [Display resolution](#) (on page 3-3)
- [Integration time](#) (on page 3-1)
- [\[:SENSe\[1\]\]:<function>:APERture](#) (on page 11-71)
- [\[:SENSe\[1\]\]:<function>:APERture:AUTO](#) (on page 11-72)
- [\[:SENSe\[1\]\]:<function>:NPLCycles](#) (on page 11-83)

[SENSe[1]]:<function>:RANGe:AUTO

This command determines if the measurement range is set manually or automatically for the selected measure function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Reset: ON (1) Preset: OFF (0)

Usage

[SENSe[1]]:<function>:RANGe:AUTO <state>
[SENSe[1]]:<function>:RANGe:AUTO?

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLtage [:DC] ▪ Current: CURRent [:DC] ▪ Charge: CHARge
<state>	Set the measurement range manually: OFF or 0 Set the measurement range automatically: ON or 1 Enable and then disable autorange: ONCE

Details

When autorange is enabled, the instrument automatically goes to the most sensitive range to perform the measurement.

The ONCE parameter enables autorange and selects the most sensitive range for the input signal. Autorange is then disabled, but the selected measurement range is retained. The instrument must be set to the specified function for ONCE to be effective. Using ONCE while on any other function results in an error.

When autorange is enabled, the parameter value for **[SENSe[1]]:<function>:RANGe[:UPPer]** changes to the automatically selected range value. When autorange is disabled, the instrument remains at the automatically selected range. If a manual range is set, autorange is disabled.

When using autorange with voltage and current measurements, you can set upper and lower range limits to prevent the instrument from autoranging to inappropriate ranges.

To prevent erroneous readings, allow sufficient time for settling when autoranging over multiple ranges or to the lower current ranges.

SCPI compliant.

Also see

- [Measurement range](#) (on page 3-23)
- [\[:SENSe\[1\]\]:<function>:RANGe:AUTO:LLIMit](#) (on page 11-86)
- [\[:SENSe\[1\]\]:<function>:RANGe:AUTO:ULIMit](#) (on page 11-87)
- [\[:SENSe\[1\]\]:<function>:RANGe\[:UPPer\]](#) (on page 11-88)

[:SENSe[1]]:<function>:RANGe:AUTO:LLIMit

This command sets the lower limit for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Voltage: 2 Current: 2e-12

Usage

```
[:SENSe[1]]:<function>:RANGE:AUTO:LLIMit <n>
[:SENSe[1]]:<function>:RANGE:AUTO:LLIMit <DEF|MIN|MAX>
[:SENSe[1]]:<function>:RANGE:AUTO:LLIMit?
[:SENSe[1]]:<function>:RANGE:AUTO:LLIMit? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLTage [:DC] ■ Current: CURRENT [:DC]
<n>	The lower limit: <ul style="list-style-type: none"> ■ Voltage: 0 to 200 ■ Current: 0 to 20e-3

Details

Automatic range changes slow down the reading rate. By setting upper and lower measurement range limits, you can prevent inadvertent range changes to ranges that you are not going to use.

For the upper range limit, specify the maximum expected reading that you expect to measure. For example, if the maximum expected reading is 1 mA, set the upper limit to 0.001. The lowest (most sensitive) range that can measure 1 mA is the 2 mA range. Therefore, the 2 mA range is selected as the upper range limit. With this upper limit, the instrument cannot increase the range to the 20 mA measurement range.

Also see

[\[:SENSe\[1\]\]:<function>:RANGE:AUTO](#) (on page 11-85)
[\[:SENSe\[1\]\]:<function>:RANGE:AUTO:ULIMit](#) (on page 11-87)

[SENSe[1]]:<function>:RANGe:AUTO:ULIMit

This command sets the upper limit for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Voltage: 200 Current: 20e-3

Usage

```
[SENSe[1]]:<function>:RANGE:AUTO:ULIMit <n>
[SENSe[1]]:<function>:RANGE:AUTO:ULIMit <DEF|MIN|MAX>
[SENSe[1]]:<function>:RANGE:AUTO:ULIMit?
[SENSe[1]]:<function>:RANGE:AUTO:ULIMit? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLtage [:DC] ▪ Current: CURrent [:DC]
<n>	The upper limit: <ul style="list-style-type: none"> ▪ Voltage: 0 to 200 ▪ Current: 0 to 20e-3

Details

Automatic range changes slow down the reading rate. By setting upper and lower measurement range limits, you can prevent inadvertent range changes to ranges that you are not going to use.

To select the lower range limit, specify the lowest reading that you expect to measure.

Also see

[\[:SENSe\[1\]\]:<function>:RANGE:AUTO](#) (on page 11-85)
[\[:SENSe\[1\]\]:<function>:RANGE:AUTO:LLIMit](#) (on page 11-86)

[SENSe[1]]:<function>:RANGe[:UPPer]

This command sets the measurement range for selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Voltage: 200 V Current: 20e-3 A Charge: 2e-6 C

Usage

```
[SENSe[1]]:<function>:RANGe[:UPPer] <n>
[SENSe[1]]:<function>:RANGe[:UPPer] <DEF|MIN|MAX>
[SENSe[1]]:<function>:RANGe[:UPPer]?
[SENSe[1]]:<function>:RANGe[:UPPer]? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage [:DC] ■ Current: CURRENT [:DC] ■ Charge: CHARGE
<n>	Range: <ul style="list-style-type: none"> ■ Voltage in volts: 0 to 200 ■ Current in amperes: 0 to 20e-3 ■ Charge in coulombs: 0 to 2.0e-6

Details

The range is selected by specifying the expected reading as an absolute value. The 6517B then goes to the most sensitive range that accommodates the expected reading. For example, if you expect a reading of approximately 10 mA, set the range to 0.01 to select the 20 mA range.

SCPI compliant.

Also see

[Measurement range](#) (on page 3-23)
[\[SENSe\[1\]\]:<function>:RANGe:AUTO](#) (on page 11-85)

[:SENSe[1]]:<function>:REFerence

This command contains the relative offset value for the selected function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
[ :SENSe[1]]:<function>:REFerence <n>
[ :SENSe[1]]:<function>:REFerence <DEF|MIN|MAX>
[ :SENSe[1]]:<function>:REFerence?
[ :SENSe[1]]:<function>:REFerence? <DEF|MIN|MAX>
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ■ Voltage: VOLtage[:DC] ■ Current: CURrent[:DC] ■ Resistance: RESistance ■ Charge: CHARGE
<n>	The relative offset value: <ul style="list-style-type: none"> ■ Voltage (volts): -200 to 200 ■ Current (amperes): -20e-3 to 20e-3 ■ Resistance (ohms): 0 to 100e18 ■ Charge (coulombs): -2.0e-6 to 2.0e-6

Details

When making measurements, you may need to subtract an offset value from a measurement.

The relative offset feature subtracts a set value or a baseline reading from measurement readings.

When you enable relative offset, all measurements are recorded as the difference between the actual measured value and the relative offset value. The formula to calculate the offset value is:

$$\text{Displayed value} = \text{Actual measured value} - \text{Relative offset value}$$

On the resistance function, the input signal is the computed resistance value seen at the input. The final result is the algebraic difference between the input resistance and the reference. You can establish a reference for the current component of a resistance measurement.

When `:SENSe[1]:<function>:REFerence:ACQuire` is sent, this is changed to the acquired value.

SCPI compliant.

Also see

[Relative \(REL\) \(on page 3-29\)](#)

[\[:SENSe\[1\]\]:<function>:REFerence:ACQuire \(on page 11-90\)](#)

[\[:SENSe\[1\]\]:<function>:REFerence:STATe \(on page 11-91\)](#)

[SENSe[1]]:<function>:REFerence:ACQuire

This command acquires a measurement and stores it as the relative offset value.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

[SENSe[1]]:<function>:REFerence:ACQuire

<function>	Select the function to which the setting applies: <ul style="list-style-type: none">■ Voltage: VOLtage[:DC]■ Current: CURrent[:DC]■ Resistance: RESistance■ Charge: CHARge
------------	--

Details

This command uses the input signal on the selected channel as the relative offset value.

This command is functional only if the instrument is set to the selected measurement function. Sending this command while in any other function causes an error.

[SENSe[1]]:<function>:REFerence is set to the acquired value.

[SENSe[1]]:VOLTage[:DC]:REFerence:ACQuire is SCPI compliant.

Also see

[Relative \(REL\) \(on page 3-29\)](#)

[\[SENSe\[1\]\]:<function>:REFerence \(on page 11-89\)](#)

[\[SENSe\[1\]\]:<function>:REFerence:STATe \(on page 11-91\)](#)

[:SENSe[1]]:<function>:REFerence:STATE

This command enables or disables the application of a relative offset value to the measurement.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SENSe[1]:<function>:REFerence:STATE <state>
:SENSe[1]:<function>:REFerence:STATE?
```

<function>	Select the function to which the setting applies: <ul style="list-style-type: none"> ▪ Voltage: VOLTage[:DC] ▪ Current: CURRent[:DC] ▪ Resistance: RESistance ▪ Charge: CHARGE
<state>	Disable the relative offset: OFF Enable the relative offset: ON

Details

When relative measurements are enabled, all subsequent measured readings are offset by the relative offset value. You can enter a relative offset value or have the instrument acquire a relative offset value.

Each returned measured relative reading is the result of the following calculation:

$$\text{Displayed reading} = \text{Actual measured reading} - \text{Relative offset value}$$

SCPI compliant.

Also see

- [Relative \(REL\) \(on page 3-29\)](#)
- [\[:SENSe\[1\]\]:<function>:REFerence \(on page 11-89\)](#)
- [\[:SENSe\[1\]\]:<function>:REFerence:ACQuire \(on page 11-90\)](#)

[SENSe[1]]:CHARge:ADIScharge:LEVel

This command specifies the coulombs level for autodischarge.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2e-6

Usage

```
[SENSe[1]]:CHARge:ADIScharge:LEVel <NRf>
[:SENSe[1]]:CHARge:ADIScharge:LEVel?
```

<NRf>	Discharge level: 0 to 2.2e-6
-------	------------------------------

Details

Charge resets when the charge reading reaches the specified level.

Also see

[\[:SENSe\[1\]\]:CHARge:ADIScharge\[:STATe\]](#) (on page 11-92)

[SENSe[1]]:CHARge:ADIScharge[:STATe]

This command controls autodischarge for the charge function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[SENSe[1]]:CHARge:ADIScharge[:STATe] <b>
[:SENSe[1]]:CHARge:ADIScharge[:STATe]?
```

	Enable autodischarge: 1 or ON Disable autodischarge: 0 or OFF
-----	--

Details

When enabled, the charge measurement resets to zero when the specified level is reached.

Also see

[\[:SENSe\[1\]\]:CHARge:ADIScharge:LEVel](#) (on page 11-92)

[:SENSe[1]]:CHARge:RANGE:AUTO:LGroup

This command selects the charge autorange limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	HIGH

Usage

```
[ :SENSe[1] ] :CHARge:RANGE:AUTO:LGroup <name>
[ :SENSe[1] ] :CHARge:RANGE:AUTO:LGroup?
```

- | | |
|--------|--|
| <name> | <ul style="list-style-type: none"> ■ 200 nC to 2 μC autorange limit: HIGH ■ 2 nC to 20 nC autorange limit: LOW |
|--------|--|

Details

With HIGH selected, the instrument only autoranges between the two high charge ranges (200 nC and 2 μC). With LOW selected, the instrument only autoranges between the two low charge ranges (2 nC and 20 nC).

Also see

None

[:SENSe[1]]:DATA:FRESH?

This command triggers a measurement and returns the 6517B reading.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
[ :SENSe[1] ] :DATA:FRESH?
```

Details

This command returns a new reading. It waits for a reading to complete if a reading is in progress.

If you send this command before the instrument is finished processing previous commands, the 6517B may become unresponsive. One way to prevent this is to add a delay of up to six seconds in the program.

You can also use the *OPC? command to incorporate a delay. *OPC? waits for all previous commands to finish before executing :DATA:FRESH?.

Humidity, external temperature, and change from calibration temperature readings can be included in the data string if they are included as data elements. See [FORMAT subsystem](#) (on page 11-57) to select data elements.

SCPI compliant.

Also see

[:CALCulate\[1\]:DATA?](#) (on page 11-29)

[SENSe[1]]:DATA[:LATest]?

This command returns the latest 6517B reading.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

[:SENSe[1]] :DATA[:LATest] ?

Details

This command returns the raw reading or a reading that is the result of the reference offset operation. For example, if a reference offset of 1.0 is established, the reading returned by this command is the raw reading minus 1.0.

Humidity, external temperature, and change from calibration temperature readings can be included in the data string if they are included as data elements. See [FORMat subsystem](#) (on page 11-57) to select data elements.

Calculated (MATH) readings cannot be read with this command.

The reading is returned in exponent form. For example, a 10 V dc reading is returned as follows:

+1.000000E+01

The measurement function is not included in the response message. To read the measurement function, send a function query after a reading query.

SCPI compliant.

Also see

[CALCulate subsystems](#) (on page 11-28)

[\[:SENSe\[1\]\]:FUNCTION](#) (on page 11-95)

[:SENSe[1]]:FUNCTION

This command selects the active measure function, voltage, current, resistance, or charge.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	VOLT

Usage

```
:SENSe[1]:FUNCTION "<function>"  
:SENSe[1]:FUNCTION?
```

<function>	A string that contains the measure function: <ul style="list-style-type: none"> ■ Voltage: VOLTage [:DC] ■ Current: CURRENT [:DC] ■ Resistance: RESistance ■ Charge: CHARGE
------------	--

Details

Enclose the <function> parameter in single or double quotes. For example, these two commands are equivalent:

```
:func 'volt'  
:func "volt"
```

Each measurement function stores its own unique setup configuration, such as range, speed, resolution, filter, and relative offset. This eliminates the need to reprogram setup conditions when you switch from one function to another.

NOTE

A function does not have to be selected to set the configuration. When the function is later selected, it uses the programmed states.

SCPI compliant.

Example

SENS:FUNC "RES"	Make the resistance function the active function.
-----------------	---

Also see

None

[:SENSe[1]]:RESistance:IREFerence

This command controls the current reference for resistance measurements.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[ :SENSe[1]]:RESistance:IREFerence <b>
[ :SENSe[1]]:RESistance:IREFerence?
```


- Enable the current reference: 1 or ON
- Disable the current reference: 0 or OFF

Details

This command allows you to use an established current reference for the resistance measurement. When a current reference is established and enabled, the current value used to compute resistance (I_{OHM}) is the algebraic difference between the input current and the reference:

$$I_{OHM} = I_{INPUT} - I_{REFERENCE}$$

Resistance (R) is then computed using I_{OHM} and the voltage output (V).

$$R = V/I_{OHM}$$

Typically, the current reference represents the leakage current in a test fixture. This command allows you to eliminate this leakage current for the resistance calculation.

Also see

None

[:SENSe[1]:RESistance:MANual:CRAnge:AUTO]

This command controls the autorange for manual voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Reset: ON Preset: OFF

Usage

```
[ :SENSe[1] ]:RESistance:MANual:CRAnge:AUTO <b>
[ :SENSe[1] ]:RESistance:MANual:CRAnge:AUTO?
```


- Enable autorange: ON or 1
- Disable autorange: OFF or 0
- Enable and then disable autorange: ONCE

Details

When autorange is enabled, the instrument automatically goes to the most sensitive range to make the measurement.

The ONCE parameter is analogous to a momentary toggle switch. When ONCE is sent, autorange is enabled and the most sensitive range is selected for the input signal. Autorange is then disabled but the selected measurement range is retained. The instrument must be set to the resistance measurement function before using ONCE. Using ONCE while any other function is set results in an error.

The autorange command is coupled to the commands that manually select the measurement range. When autorange is enabled, the parameter value for the manual range command changes to the automatically selected range value. When autorange is disabled, the instrument remains at the automatically selected range until it is changed. When a valid manual range command is sent, autoranging is disabled.

Also see

[\[:SENSe\[1\]:RESistance:MANual:CRAnge\[:UPPer\]\] \(on page 11-98\)](#)

[SENSe[1]]:RESistance:MANual:CRAnge[:UPPer]

This command sets the measurement range for manual voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	20e-3

Usage

```
[SENSe[1]]:RESistance:MANual:CRAnge[:UPPer] <n>
[SENSe[1]]:RESistance:MANual:CRAnge[:UPPer] <DEF|MIN|MAX>
[SENSe[1]]:RESistance:MANual:CRAnge[:UPPer]?
[SENSe[1]]:RESistance:MANual:CRAnge[:UPPer]? <DEF|MIN|MAX>
```

<n>	Expected reading in ohms: 0 to 20e-3
-----	--------------------------------------

Details

The range is selected by specifying the expected reading as an absolute value. The 6517B chooses the most sensitive range that accommodates that expected reading. For example, if you expect a reading of approximately 100 MΩ, set the range to 100e6 to select the 200 MΩ range.

Also see

None

[SENSe[1]]:RESistance:MANual:VSOURCE:OPERate

This command enables or disables the voltage source for manual voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
[SENSe[1]]:RESistance:MANual:VSOURCE:OPERate <n>
[SENSe[1]]:RESistance:MANual:VSOURCE:OPERate?
```

	Enable the voltage source (operate): ON or 1 Disable voltage source (standby): OFF or 0
-----	--

Details

When enabled, the voltage source is placed in operate. When disabled, the voltage source is placed in standby.

Also see

None

[:SENSe[1]]:RESistance:MANual:VSource:RANGE

This command sets the optimum voltage source range for manual voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

[:SENSe[1]]:RESistance:MANual:VSource:RANGE <n>

[:SENSe[1]]:RESistance:MANual:VSource:RANGE?

<n>	Specify output in volts: 0 to 1000
-----	------------------------------------

Details

Specifying the output voltage value automatically selects the most sensitive range. For example, specifying a value less than or equal to 100 selects the 100 V range. Specifying a value greater than 100 selects the 1000 V range.

You cannot select the 100 V range if the programmed amplitude is greater than 100 V.

Also see

[\[:SENSe\[1\]\]:RESistance:MANual:VSource\[:AMPLitude\]](#) (on page 11-99)

[:SENSe[1]]:RESistance:MANual:VSource[:AMPLitude]

This command sets the voltage source level for manual voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	100

Usage

[:SENSe[1]]:RESistance:MANual:VSource[:AMPLitude] <n>

[:SENSe[1]]:RESistance:MANual:VSource[:AMPLitude] <DEF|MIN|MAX>

[:SENSe[1]]:RESistance:MANual:VSource[:AMPLitude]?

[:SENSe[1]]:RESistance:MANual:VSource[:AMPLitude] <DEF|MIN|MAX>

<n>	Voltage source level: 0 to 1000
-----	---------------------------------

Details

The amplitude level is limited by the selected voltage source range. When on the 100 V range, if you attempt to set the amplitude to a value that exceeds 100 V, a settings conflict error occurs. The amplitude may also be limited by the :SOURce:VOLTage:LIMit[:AMPLitude] setting. Attempts to set an amplitude that exceeds this programmed limit sets the amplitude to that limit.

The `MINimum` and `MAXimum` parameters are also affected by range and voltage limit. Setting the voltage source to the `MINimum` or `MAXimum` amplitude selects the greatest negative or positive value allowed by the programmed limit or range. The voltage source output (operate or standby) is controlled from the `:OPERate` command.

Also see

[\[:SENSe\[1\]\]:RESistance:MANual:VSOurce:OPERate](#) (on page 11-98)
[\[:SENSe\[1\]\]:RESistance:MANual:VSOurce:RANGE](#) (on page 11-99)

[:SENSe[1]]:RESistance:MSElect

This command selects the resistance measurement type.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	NORMAl

Usage

```
[ :SENSe[1] ]:RESistance:MSElect <name>
[ :SENSe[1] ]:RESistance:MSElect?

<name>          Normal resistance measurements: NORMAl
                  Resistivity measurements: RESistivity
```

Details

To make normal resistance measurements, select `NORMAl`.

To make surface and volume (resistivity) measurements, select `RESistivity`.

Also see

"Resistivity measurements" in the *Model 6517B User's Manual*

[:SENSe[1]]:RESistance:RESistivity:FSELect

This command specifies the test fixture that is used for resistivity measurements.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	M8009

Usage

```
[ :SENSe[1] ]:RESistance:RESistivity:FSELect <name>
[ :SENSe[1] ]:RESistance:RESistivity:FSELect?

<name>          Model 8009 Resistivity Test Fixture: M8009
                  User-supplied test fixture: USER
```

Details

When using the Model 8009, the only parameter that needs to be entered is the sample thickness for volume resistivity.

Specify `USER` when using any other resistivity test fixture. When using this type of test fixture, you must enter the other parameters for resistivity measurements.

Also see

[\[:SENSe\[1\]\]:RESistance:RESistivity:STHickness](#) (on page 11-102)
[\[:SENSe\[1\]\]:RESistance:RESistivity:USER:RSELect](#) (on page 11-103)
“Resistivity measurements” in the *Model 6517B User’s Manual*

[:SENSe[1]]:RESistance:RESistivity:M8009:RSWitch?

This command queries the switch setting on the Model 8009.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

`[:SENSe[1]] :RESistance:RESistivity:M8009:RSWitch?`

Details

When using the Model 8009 Resistivity Test Fixture, the 6517B senses the switch setting (surface or volume) of the test fixture through the safety interlock cable and automatically configures the instrument for that resistivity measurement type.

This query command returns the switch setting, Surface or Volume.

Also see

“Resistivity measurements” in the *Model 6517B User’s Manual*

[:SENSe[1]]:RESistance:RESistivity:STHickness

This command specifies the sample thickness of the sample for volume resistivity measurements.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
[ :SENSe[1]]:RESistance:RESistivity:STHickness <NRf>
[:SENSe[1]]:RESistance:RESistivity:STHickness?
```

<NRf>	Sample thickness in millimeters: 0.0001 to 99.9999
-------	--

Details

Sample thickness is not required for surface resistivity.

Also see

“Resistivity measurements” in the *Model 6517B User’s Manual*

[:SENSe[1]]:RESistance:RESistivity:USER:KSURface

This command specifies the Ks parameter for surface resistivity when using a user-supplied test fixture.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1.000

Usage

```
[ :SENSe[1]]:RESistance:RESistivity:USER:KSURface <NRf>
[:SENSe[1]]:RESistance:RESistivity:USER:KSURface?
```

<NRf>	Ks parameter: 0.001 to 999.999
-------	--------------------------------

Details

The Ks parameter is calculated as follows:

$$Ks = P/g$$

Where:

- P = Effective perimeter (in mm) of the guarded electrode.
- g = Distance (mm) between the guarded electrode and the ring electrode.

This command is not needed when using the Model 8009 test fixture.

Also see

"Resistivity measurements" in the *Model 6517B User's Manual*

[SENSe[1]]:RESistance:RESistivity:USER:KVOLume

This command specifies the Kv parameter for volume resistivity measurements when using a user-supplied test fixture.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1.000

Usage

```
[SENSe[1]]:RESistance:RESistivity:USER:KVOLume <NRf>
[SENSe[1]]:RESistance:RESistivity:USER:KVOLume?
```

<NRf>	Kv parameter: 0.001 to 999.999
-------	--------------------------------

Details

This command is not needed when using the Model 8009 test fixture.

Also see

"Resistivity measurements" in the *Model 6517B User's Manual*

[SENSe[1]]:RESistance:RESistivity:USER:RSELect

This command specifies the resistivity type for the user-supplied test fixture.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	SURFace

Usage

```
[SENSe[1]]:RESistance:RESistivity:USER:RSELect <name>
:RSELect?
```

<name>	Surface resistivity: SURFace Volume resistivity: VOLUME
--------	--

Details

If you are using the Model 8009 Resistivity Test Fixture, the measurement type (surface or volume) is automatically sensed by the 6517B through the safety interlock cable.

Also see

"Resistivity measurements" in the *Model 6517B User's Manual*

[:SENSe[1]]:RESistance:VSControl

This command selects the ohms voltage source mode for resistance measurements.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	MANual

Usage

```
[ :SENSe[1]]:RESistance:VSControl <name>
[ :SENSe[1]]:RESistance:VSControl?
```

<name>	MANual: Manual voltage source ohms AUTO: Voltage source ohms
--------	---

Details

With **MANual** selected, you can set the voltage source level for resistance measurements.

With **AUTO** selected, the voltage source level is automatically set for the resistance measurement (40 V or 400 V).

Also see

None

[:SENSe[1]:RESistance[:AUTO]:RANGE:AUTO

This command controls the autorange for autovoltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Reset: ON Preset: OFF

Usage

```
[ :SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO <b>
[ :SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO?
```

	<ul style="list-style-type: none"> ▪ Enable autorange: ON or 1 ▪ Disable autorange: OFF or 0 ▪ Enable and then disable autorange: ONCE
-----	---

Details

When autorange is enabled, the instrument automatically goes to the most sensitive range to make the measurement.

The ONCE parameter is analogous to a momentary toggle switch. When ONCE is sent, autorange is enabled and the most sensitive range is selected for the input signal. Autorange is then disabled but the selected measurement range is retained. The instrument must be set to the resistance measurement function before using ONCE. Using ONCE while any other function is set results in an error.

The autorange command is coupled to the commands that manually select the measurement range. When autorange is enabled, the parameter value for the manual range command changes to the automatically selected range value. When autorange is disabled, the instrument remains at the automatically selected range until it is changed. When a valid manual range command is sent, autoranging is disabled.

You can set upper and lower range limits for autorange for automatic voltage source ohms to keep the instrument from autoranging to ranges that are not going to be used.

Also see

- [\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE:AUTO:LLIMit\]\(on page 11-105\)](#)
- [\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE:AUTO:ULIMit\]\(on page 11-106\)](#)
- [\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE\[:UPPer\]\]\(on page 11-106\)](#)

[:SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:LLIMit

This command sets the lower limit for automatic voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2e6

Usage

```
[ :SENSe[1] ]:RESistance[:AUTO]:RANGE:AUTO:LLIMit <n>
[:SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:LLIMit <DEF|MIN|MAX>
[:SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:LLIMit?
[:SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:LLIMit? <DEF|MIN|MAX>
```

<n>	Range limit for automatic voltage source ohms: 0 to 100e18
-----	--

Details

Automatic range changes slow down the reading rate. By setting upper and lower measurement range limits, you can prevent inadvertent range changes to ranges that you are not going to use.

Set the lower range limit to the lowest reading that you expect to measure.

Also see

- [\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE:AUTO\]\(on page 11-104\)](#)
- [\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE:AUTO:ULIMit\]\(on page 11-106\)](#)

[SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:ULIMit

This command sets the upper limit for the automatic voltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	200e12

Usage

```
[SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:ULIMit <n>
[SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:ULIMit <DEF|MIN|MAX>
[SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:ULIMit?
[SENSe[1]]:RESistance[:AUTO]:RANGE:AUTO:ULIMit? <DEF|MIN|MAX>
```

<n>

Range limit for automatic voltage source ohms: 0 to 100e18

Details

Automatic range changes slow down the reading rate. By setting upper and lower measurement range limits, you can prevent inadvertent range changes to ranges that you are not going to use.

The upper range limit is selected by specifying the maximum reading that you expect to measure. For example, if the maximum expected reading is approximately 1 GΩ, set the upper limit to 1e9. The most sensitive range that can measure 1 GΩ is the 2 GΩ range, so the 2 GΩ range is selected as the upper range limit. With this upper limit, the instrument cannot increase to the 20 GΩ or a higher measurement range.

Also see

[\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE:AUTO\]\(on page 11-104\)](#)
[\[:SENSe\[1\]:RESistance\[:AUTO\]:RANGE:AUTO:LLIMit\]\(on page 11-105\)](#)

[SENSe[1]]:RESistance[:AUTO]:RANGE[:UPPer]

This command sets the measurement range for autovoltage source ohms.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2e6

Usage

```
[SENSe[1]]:RESistance[:AUTO]:RANGE[:UPPer] <n>
[SENSe[1]]:RESistance[:AUTO]:RANGE[:UPPer] <DEF|MIN|MAX>
[SENSe[1]]:RESistance[:AUTO]:RANGE[:UPPer]?
[SENSe[1]]:RESistance[:AUTO]:RANGE[:UPPer]? <DEF|MIN|MAX>
```

<n>

Expected reading in ohms: 0 to 100e18

Details

The range is selected by specifying the expected reading as an absolute value. The 6517B chooses the most sensitive range that accommodates that expected reading. For example, if you expect a reading of approximately 100 MΩ, set the range to `100e6` to select the 200 MΩ range.

Also see

None

[SENSe[1]]:VOLTage[:DC]:GUARD

This command controls the guard for the voltage function.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SENSe[1]:VOLTage[:DC]:GUARD <b>
:SENSe[1]:VOLTage[:DC]:GUARD?
```

	Disable guard: OFF or 0 Enable guard: ON or 1
-----	--

Details

When enabled, the preamplifier output high (which is used as guard) is placed on the inner shell of the triaxial input connector. When disabled, input LO is placed on the inner shell of the triaxial connector.

Also see

"Shielding and guarding" in the *Model 6517B User's Manual*

[SENSe[1]]:VOLTage[:DC]:XFEedback

This command controls external feedback.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SENSe[1]:VOLTage[:DC]:XFEedback <state>
:SENSe[1]:VOLTage[:DC]:XFEedback?
```

<state>	Disable external feedback: OFF or 0 Enable external feedback: ON or 1
---------	--

Also see

[Using external feedback](#) (on page 3-17)

SOURce subsystem

The commands in this subsystem control the voltage source settings, the current limit settings, and the logic level (true or false) of each digital output line.

These commands are summarized in the [:SOURce command summary](#) (on page 11-18).

NOTE

The voltage source is controlled from the :OUTPUT1 subsystem.

:SOURce:CURRent:LIMit[:STATe]?

This command queries the current compliance.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:SOURce:CURRent:LIMit[:STATe]?

Details

Use this command to determine if the voltage source has reached its current compliance limit of 1 mA. The response message is:

- Current compliance not reached: 0
- Current compliance reached: 1

Also see

None

:SOURce:CURRent:RLIMit:STATe

This command enables or disables the resistance current limit for the voltage source.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

:SOURce:CURRent:RLIMit:STATe
:SOURce:CURRent:RLIMit:STATe?

	<ul style="list-style-type: none"> ▪ Disable resistance current limit: 0 or OFF ▪ Enable resistance current limit: 1 or ON
-----	--

Details

When the resistance current limit is enabled, a 20 MΩ resistor is placed in series with the HI V-SOURCE lead to extend the current limit capabilities of the voltage source. When it is disabled, a normal current limit occurs at 1 mA.

Also see

None

:SOURce:TTLX:[LEVel]

This command sets the logic levels for the digital output lines 1 through 4.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	Not applicable

Usage

:SOURce:TTLX: [LEVel]
 :SOURce:TTLX: [LEVel] ?

X	Digital output line: [1], 2, 3, or 4
	<ul style="list-style-type: none"> ■ Set output line true: 1 or ON ■ Set output line false: 0 or OFF

Details

The actual level (high or low) of a digital output line depends on its programmed polarity. If the polarity of a line is active high, that line is high when it is set to be true and low when it is set to be false. Conversely, if polarity is active low, the line is low when it is set to be true and high when it is set to be false.

If a LIMITS control is enabled from the front panel (LOLIM1 or 2, HILIM1 or 2—High, Low, or Pass), this command does not check or change the output status.

Cycling power sets all output lines to OFF (false).

Also see

[OUTPut subsystems](#) (on page 11-63)

:SOURce:VOLTage:LIMit:STATE

This command controls the voltage limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

<pre>:SOURce:VOLTage:LIMit:STATE ::SOURce:VOLTage:LIMit:STATE?</pre>	
	<ul style="list-style-type: none"> ■ Disable voltage limit: 0 or OFF ■ Enable voltage limit: 1 or ON

Details

This command enables or disables the voltage limit. When enabled, the programmed voltage limit is in effect. When disabled, voltage limit is determined by the selected range.

Attempts to enable voltage limit when the present voltage source level (amplitude) exceeds the limit value generates a settings conflict error.

SCPI compliant.

Also see

[:SOURce:VOLTage:LIMit\[:AMPLitude\]](#) (on page 11-110)

:SOURce:VOLTage:LIMit[:AMPLitude]

This command sets the absolute voltage limit for the voltage source.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1000

Usage

<pre>:SOURce:VOLTage:LIMit[:AMPLitude] <n> :SOURce:VOLTage:LIMit[:AMPLitude] <DEF MIN MAX> :SOURce:VOLTage:LIMit[:AMPLitude]? :SOURce:VOLTage:LIMit[:AMPLitude]? <DEF MIN MAX></pre>	
<n>	Voltage limit: 0 to 1000

Details

For example, setting a limit of 75 V limits the voltage source output to ± 75 V.

The specified voltage limit is only in effect if the limit is enabled. If disabled, the limit is dictated by the selected range.

SCPI compliant.

Also see

[:SOURce:VOLTage:LIMit:STATe](#) (on page 11-110)

:SOURce:VOLTage:MCOnnect

This command controls the internal voltage source LO to ammeter LO connection.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SOURce:VOLTage:MCOnnect <b>
::SOURce:VOLTage:MCOnnect?
```

	Enable LO connection: ON or 1 Disable LO connection: OFF or 0
-----	--

Details

When enabled, the voltage source LO is connected to ammeter LO. This connection simplifies the connection requirements for resistance measurements and source voltage, measure current measurements. When disabled, this connection is broken.

Also see

None

:SOURce:VOLTage:RANGe

This command selects the optimum range for the voltage source.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	100

Usage

```
:SOURce:VOLTage:RANGe <n>
:SOURce:VOLTage:RANGe <DEF|MIN|MAX>
:SOURce:VOLTage:RANGe?
:SOURce:VOLTage:RANGe? <DEF|MIN|MAX>
```

<n>	Output in volts: 0 to 1000
-----	----------------------------

Details

Specifying the output voltage value automatically selects the most sensitive range. For example, specifying a value \leq 100 selects the 100 V range. Specifying a value $>$ 100 selects the 1000 V range.

You cannot select the 100 V range if the programmed amplitude value is greater than 100. A settings conflict error results.

SCPI compliant.

Also see

None

:SOURce:VOLTage[:LEVel][:IMMEDIATE][:AMPLitude]

This command sets the voltage source amplitude.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:SOURce:VOLTage[:LEVel][:IMMEDIATE][:AMPLitude] <n>
:SOURce:VOLTage[:LEVel][:IMMEDIATE][:AMPLitude] <DEF|MIN|MAX>
:SOURce:VOLTage[:LEVel][:IMMEDIATE][:AMPLitude]?
:SOURce:VOLTage[:LEVel][:IMMEDIATE][:AMPLitude]? <DEF|MIN|MAX>
```

<n>	<ul style="list-style-type: none"> ■ Voltage amplitude for 100 V range: -100 to +100 ■ Voltage amplitude for the 1000 V range: -1000 to +1000
-----	---

Details

The amplitude level is limited by the selected range and programmed voltage limit. When on the 100 V range, attempts to set the amplitude to a level that exceeds the 100 V range results in a settings conflict error. Attempts to set an amplitude that exceeds a programmed voltage limit sets the amplitude to that limit.

The MINimum and MAXimum parameters are also affected by range and voltage limit. Setting the voltage source to the MINimum (or MAXimum) amplitude selects the greatest negative (or positive) value allowed by the programmed limit or range.

The voltage source output (operate and standby) is controlled from the :OUTPut1 subsystem.

SCPI compliant

Also see

- [:SOURce:VOLTage:RANGE \(on page 11-112\)](#)
- [:SOURce:VOLTage:LIMit\[:AMPLitude\] \(on page 11-110\)](#)
- [OUTPut subsystems \(on page 11-63\)](#)

STATus subsystem

The STATus subsystem controls the status registers of the 6517B. These registers and the overall status structure is explained in [Status model \(on page 13-1\)](#).

:STATus:MEASurement:CONDition?

This command reads condition registers.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:STATus:MEASurement:CONDition?

Details

This command reads content of the measurement condition register. Each set of event registers (except the standard event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument. For register bit descriptions, refer to :STATus:MEASurement[:EVENT] ?.

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :STAT:MEAS:COND? returns a decimal value of 512 (binary 0000001000000000), bit B9 of the Measurement Condition Register is set, indicating that the trace buffer is full.

Also see

- [:STATus:MEASurement\[:EVENT\]? \(on page 11-120\)](#)

:STATus:MEASurement:ENABLE

This command sets or reads the contents of the Measurement Event Enable Register of the status model.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:MEASurement:ENABLE <NRf>
:STATus:MEASurement:ENABLE?
```

<NRf>	The status of the Measurement Status Register; see Details
-------	---

Details

Send the command with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the appropriate register.

The event enable register is used as a mask for events. When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked, so it cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure sets.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits. Set <NRf> to 65535 to set all bits.

Measurement event enable register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	HL2	LL2	HL1	LL1	ROF
<n> (decimal weighting)	128 (2^7)	64 (2^5)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	VSC	FLC	OL	BPT	SRA	BFL	BHF
<n> (decimal weighting)	—	16384 (2^{14})	8192 (2^{13})	4096 (2^{12})	2048 (2^{11})	1024 (2^{10})	512 (2^9)	256 (2^8)
Value	—	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Values are:

- 1 = Event Bit Set
- 0 = Event Bit Cleared

Events are listed in the following table.

ROF	Reading overflow
LL1	Low limit 1
HL1	High limit 1
LL2	Low limit 2
HL2	High limit 2
RAV	Reading available
RUF	Reading underflow
BAV	Buffer available
BHF	Buffer half full
BFL	Buffer full
SRA	Sequence reading available
BPT	Buffer pretriggered
OL	Out of limit
FLC	Fixture lid closed
VSC	Voltage source compliance

Power-up and the `:STATus:PRESet` command clear all bits of the registers; the `*CLS` command has no effect.

Example

```
:STAT:MEAS:ENAB 544
```

Sets the BFL and RAV bits of the Measurement Event Enable Register, where:

- BFL (bit B9) is decimal 512
 - RAV (bit B5) is decimal 32
- So $<n>$ is $512+32 = 544$

Also see

[Measurement Event Status Register \(on page 13-7\)](#)

:STATus:MEASurement:NTRansition

This command programs the negative transition filters (NTR) of the measurement event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATUS:MEASurement:NTRansition <NRf>
:STATUS:MEASurement:NTRansition?
```

<NRf>

- Set Bit B0: 1
- Set Bit B1: 2
- Set Bit B2: 4
- Set Bit B3: 8
- Set Bit B4: 16
- Set Bit B5: 32
- Set Bit B6: 64
- Set Bit B7: 128
- Set Bit B8: 256
- Set Bit B9: 512
- Set Bit B10: 1024
- Set Bit B11: 2048
- Set Bit B12: 4096
- Set Bit B13: 8192
- Set Bit B14: 16384
- Set Bit B15: 32768
- Set all bits: 65535

Details

A negative transition is a 1 to 0 state change in the condition register. Therefore, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 1 to 0. For example, if Bit B9 of the Negative Transition Register of the transition filter is set, the buffer full event is programmed for a negative transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer is no longer full.

The NTR registers are shown in the following table. Included is the decimal weight of each bit. The sum of the decimal weights of the bits to set is the parameter (<NRF>) that is sent with the command. For example, to program RAV (B5) and BFL (B9) measurement events for negative transitions, send the following command:

```
:STAT:MEAS:NTR 544
```

Where:

- BFL (Bit B9) = Decimal 512
- RAV (Bit B5) = Decimal 32
- <NRF> = 544

Negative transition effect on measurement event register

Measurement event	Negative transition effect on measurement event register
Reading overflow	Sets B0 when a reading has gone from overflow to normal
Low limit 1	Sets B1 when the reading is no longer less than the low limit 1 setting
High limit 1	Sets B2 when the reading is no longer greater than the low limit 1 setting
Low limit 2	Sets B3 when the reading is no longer less than the low limit 2 setting
High limit 2	Sets B4 when the reading is no longer greater than the high limit 2 setting
Reading available	Sets B5 when the next reading is being made
Reading underflow	Sets B6 when the reading underflow condition has cleared
Buffer available	Sets B7 when the trace buffer has become empty
Buffer half-full	Sets B8 when the trace buffer is no longer half-full
Buffer full	Sets B9 when the trace buffer is no longer full
Sequence reading available	Sets B10 when an alternating polarity measurement is being read
Buffer pretriggered	Sets B11 when the trace buffer pretrigger operations are completed
Out of limits error	Sets B12 when the out of limits error has cleared
Fixture lid closed	Sets B13 when fixture lid is opened
Voltage source compliance	Sets B14 when voltage source comes out of compliance

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	HL2	LL2	HL1	LL1	ROF
<n> (decimal weighting)	128 (2 ⁷)	64 (2 ⁵)	32 (2 ⁵)	16 (2 ⁴)	8 (2 ³)	4 (2 ²)	2 (2 ¹)	1 (2 ⁰)
Value	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	VSC	FLC	OL	BPT	SRA	BFL	BHF
<n> (decimal weighting)	—	16384 (2 ¹⁴)	8192 (2 ¹³)	4096 (2 ¹²)	2048 (2 ¹¹)	1024 (2 ¹⁰)	512 (2 ⁹)	256 (2 ⁸)
Value	—	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Values are:

- 1 = Enable negative transition
- 0 = Disable negative transition

Power-up and the :STATUs:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATUs:MEASurement:PTRansition

This command programs the positive transition filter (PTR) for the measurement event register.

Type	Affected by	Where saved	Default value
Command and query	STATUs:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATUs:MEASurement:PTRansition <NRf>
:STATUs:MEASurement:PTRansition?
```

<NRf>	<ul style="list-style-type: none"> ■ Set Bit B0: 1 ■ Set Bit B1: 2 ■ Set Bit B2: 4 ■ Set Bit B3: 8 ■ Set Bit B4: 16 ■ Set Bit B5: 32 ■ Set Bit B6: 64 ■ Set Bit B7: 128 ■ Set Bit B8: 256 ■ Set Bit B9: 512 ■ Set Bit B10: 1024 ■ Set Bit B11: 2048 ■ Set Bit B12: 4096 ■ Set Bit B13: 8192 ■ Set Bit B14: 16384 ■ Set Bit B15: 32768
-------	---

Details

A positive transition is a 0 to 1 state change in the condition register. When an event is programmed for a positive transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 0 to 1. For example, if Bit B9 of the positive transition register of the transition filter is set, the buffer full event is programmed for a positive transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer becomes full.

The PTR registers are shown in the following table, which includes the decimal weight of each bit. The sum of the decimal weights of the bits to set is the parameter (<NRF>) that is sent with the command. For example, to program RAV (B5) and BFL (B9) measurement events for positive transitions, send the following command:

```
:STAT:MEAS:PTR 544
```

Where: BFL (Bit B9) = Decimal 512

RAV (Bit B5) = Decimal32

<NRF> = 544

Positive transition effect on transition filter event register

Measurement event	Positive transition effect on transition filter event register
Reading overflow	Sets B0 when reading exceeds range limits
Low limit 1	Sets B1 when reading is less than the low limit 1 setting
High limit 1	Sets B2 when reading is greater than the low limit 1 setting
Low limit 2	Sets B3 when reading is less than the low limit 2 setting
High limit 2	Sets B4 when reading is greater than the high limit 2 setting
Reading available	Sets B5 after a reading is made and processed
Reading underflow	Sets B6 when an ohms reading is below the lower range limit
Buffer available	Sets B7 when the trace buffer has at least two readings
Buffer half-full	Sets B8 when the trace buffer becomes half-full
Buffer full	Sets B9 when the trace buffer becomes full
Sequence reading available	Sets B10 when an alternating polarity test sequence is being read
Buffer pretriggered	Sets B11 when the trace buffer pretrigger event occurs
Out of Limits	Sets B12 when a noise spike occurs
Fixture lid closed	Sets B13 when fixture lid is closed
Voltage source compliance	Sets B14 when voltage source goes in compliance

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRF> parameter. Set <NRF> to 0 to clear all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	HL2	LL2	HL1	LL1	ROF
<n> (decimal weighting)	128 (2^7)	64 (2^5)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	VSC	FLC	OL	BPT	SRA	BFL	BHF
<n> (decimal weighting)	—	16384 (2^{14})	8192 (2^{13})	4096 (2^{12})	2048 (2^{11})	1024 (2^{10})	512 (2^9)	256 (2^8)
Value	—	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Values are:

- 1 = Enable positive transition
- 0 = Disable positive transition

Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.

Also see

None

:STATus:MEASurement[:EVENT]?

This command reads the Measurement Event Register of the status model.

Type	Affected by	Where saved	Default value
Query	STATus:PRESet Power cycle	Not applicable	Not applicable

Usage

:STATus:MEASurement [:EVENT]?

Details

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. Reading an event register clears the bits in that register.

For example, assume that reading the transition filter event register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, Bits B5 and B9 of the transition filter event register are set.

The significance of a set bit in these registers depends on how the transition filter is programmed. If an event is programmed for a positive transition (PTR), the corresponding bit in this register sets when the event occurs. If the event is instead programmed for a negative transition (NTR), the bit sets when the event becomes not true.

Measurement event register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	HL2	LL2	HL1	LL1	ROF
<n> (decimal weighting)	128 (2 ⁷)	64 (2 ⁵)	32 (2 ⁴)	16 (2 ³)	8 (2 ²)	4 (2 ¹)	2 (2 ⁰)	1 (2 ⁰)
Value	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	VSC	FLC	OL	BPT	SRA	BFL	BHF
<n> (decimal weighting)	—	16384 (2 ¹⁴)	8192 (2 ¹³)	4096 (2 ¹²)	2048 (2 ¹¹)	1024 (2 ¹⁰)	512 (2 ⁹)	256 (2 ⁸)
Value	—	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Values are:

- 1 = Event Bit Set
- 0 = Event Bit Cleared

Events and the meanings of set bits are listed in the following table.

Bit	Event	Meaning of set bit
B0	Reading overflow (ROF)	The reading exceeds the measurement range of the instrument (PTR) or the instrument has gone from an overflow condition to a normal reading condition (NTR).
B1	Low limit 1	The reading is less than the low limit 1 setting (PTR) or a subsequent reading is no longer less than the low limit 1 setting (NTR).
B2	High limit 1	The reading is greater than the high limit 1 setting (PTR) or a subsequent reading is no longer greater than the high limit 1 setting (NTR).
B3	Low limit 2	The reading is less than the low limit 2 setting (PTR) or a subsequent reading is no longer less than the low limit 2 setting (NTR).
B4	High limit 2	The reading is greater than the high limit 2 setting (PTR) or a subsequent reading is no longer greater than the high limit 2 setting (NTR).
B5	Reading available	A reading was made and processed (PTR) or a subsequent reading is in process (NTR).
B6	Reading underflow	The ohms reading is less than the lower range limit (PTR) or the instrument has gone from an underflow condition to a normal reading condition (NTR).

Bit	Event	Meaning of set bit
B7	Buffer available	There are at least two readings in the trace buffer (PTR) or the buffer has become empty (NTR).
B8	Buffer half full	The trace buffer is half-full (PTR) or the buffer is no longer half-full (NTR).
B9	Buffer full	The trace buffer is full (PTR) or the buffer is no longer full (NTR).
B10	Sequence reading available	A fresh reading from the alternating polarity test sequence is available and has been placed in the buffer (PTR).
B11	Buffer pretriggered	The trace buffer pretrigger event has occurred (PTR) or the operations associated with the pretrigger have been completed (NTR).
B12	Out of limit	Signal transients (for example, noise spikes) exceed the range limit (PTR).
B13	Fixture lid closed	A fixture using the interlock cable is closed or no interlock cable is connected to the 6517B. If the interlock cable is connected to the 6517B but not to the fixture, the bit is not set (PTR).
B14	Voltage source compliance	The voltage source is in compliance (PTR).
B15	—	Always zero.

Power-up and the *CLS command clear all bits of the registers; the :STATUs:PRESet command has no effect.

Example

```
:STAT:MEAS?
```

Assume that reading the Measurement Event Register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, bits B5 and B9 of the Measurement Event Register are set.

Also see

None

:STATUs:OPERation:ARM:CONDition?

This command reads the operation condition registers.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:STATUs:OPERation:ARM:CONDition?
```

Details

This command reads the content of the operation condition register. Each set of event registers (except the standard event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument. For register bit descriptions, refer to :

```
:STATUs:OPERation[:EVENT]?
```

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :STAT:MEAS:COND? returns a decimal value of 512 (binary 0000001000000000), bit B9 of the Measurement Condition Register is set, indicating that the trace buffer is full.

The condition registers precede the transition filters, so only the PTR descriptions apply to the condition registers.

SCPI compliant.

Also see

[:STATus:OPERation:ARM\[:EVENT\]?](#) (on page 11-131)

:STATus:OPERation:ARM:ENABLE

This command sets or reads the contents of the Operation Arm Event Enable Register of the status model.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation:ARM:ENABLE <NRf>
:STATus:OPERation:ARM:ENABLE?

<NRf>	The status of the Measurement Status Register; see Details
-------	---

Details

Send the command with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the appropriate register.

The event enable register is used as a mask for events. When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked, so it cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure sets.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits. Set <NRf> to 65535 to set all bits.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2^1)	—
Value	—	0/1	—

Values are:

- 1 = Enable arm event
- 0 = Disable (mask) arm event

Power-up and the `:STATUs:PRESet` command set all bits of the registers; the `*CLS` command has no effect.

SCPI compliant.

Also see

None

:STATUs:OPERation:ARM:NTRansition

This command programs the negative transition filters (NTR) of the Operation Arm Event Register.

Type	Affected by	Where saved	Default value
Command and query	STATUs:PRESet Power cycle	Not applicable	See Details

Usage

`:STATUs:OPERation:ARM:NTRansition <NRf>`
`:STATUs:OPERation:ARM:NTRansition?`

<NRf>	Set Bit B0: 1 Set Bit B1: 2 Set all bits: 65535
-------	---

Details

A negative transition is a 1 to 0 state change in the condition register. Therefore, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 1 to 0. For example, if Bit B9 of the Negative Transition Register of the transition filter is set, the buffer full event is programmed for a negative transition. The `BFL` bit (B9) in the transition filter event register sets when the trace buffer is no longer full.

The decimal weighting of the bit is shown in the following table. The sum of the decimal weights of the bits to set is sent as the `<NRf>` parameter. Set `<NRf>` to 0 to clear all bits.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2^1)	—
Value	—	0/1	—

Values are:

- 1 = Enable negative transition
- 0 = Disable negative transition

Negative transition effect on operation arm event register

Arm event	Negative transition effect on arm event register
Sequence 1	Sets B1 when leaving an arm layer

Power-up and the :STATUs:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATUs:OPERation:ARM:PTRansition

This command programs the positive transition (PTR) registers for the Operation Arm Event Register.

Type	Affected by	Where saved	Default value
Command and query	STATUs:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATUs:OPERation:ARM:PTRansition <NRf>
:STATUs:OPERation:ARM:PTRansition?
```

<NRf>	See Details
-------	-------------

Details

A positive transition is a 0 to 1 state change in the condition register. When an event is programmed for a positive transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 0 to 1. For example, if Bit B9 of the positive transition register of the transition filter is set, the buffer full event is programmed for a positive transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer becomes full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2 ¹)	—
Value	—	0/1	—

Values are:

- 1 = Enable positive transition
- 0 = Disable positive transition

Positive transition effect on arm event register

Arm event	Positive transition effect on arm event register
Sequence 1	Sets B1 when in an arm layer

Power-up and the :STATUs:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATUs:OPERation:ARM:SEQuence:CONDition?

This command reads condition registers.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:STATUs:OPERation:ARM:SEQuence:CONDition?

Details

This command reads the content of the operation condition register. Each set of event registers (except the standard event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument. For register bit descriptions, refer to :STATUs:OPERation[:EVENT] ?.

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :STAT:MEAS:COND? returns a decimal value of 512 (binary 0000001000000000), bit B9 of the Measurement Condition Register is set, indicating that the trace buffer is full.

SCPI compliant.

Also see

[:STATUs:OPERation:ARM:SEQuence\[:EVENT\]? \(on page 11-130\)](#)

:STATus:OPERation:ARM:SEQUence:ENABLE

This command sets or reads the contents of the operation arm sequence enable register of the status model.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:ARM:SEQUence:ENABLE <NRf>
:STATus:OPERation:ARM:SEQUence:ENABLE?
```

<NRf>	See Details
-------	-------------

Details

Send the command with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the appropriate register.

The event enable register is used as a mask for events. When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked, so it cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure sets.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits. Set <NRf> to 65535 to set all bits.

The decimal weighting of the bit is shown in the following table.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2^1)	—
Value	—	0/1	—

Values are:

- 1 = Enable arm event
- 0 = Disable (mask) arm event

Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:ARM:SEQuence:NTRansition

This command programs the negative transition filters (NTR) of the measurement event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:ARM:SEQuence:NTRansition <NRf>
:STATus:OPERation:ARM:SEQuence:NTRansition?
```

<NRf>	<ul style="list-style-type: none"> ■ Set Bit B0: 1 ■ Set Bit B1: 2 ■ Set Bit B2: 4 ■ Set all bits: 65535
-------	--

Details

A negative transition is a 1 to 0 state change in the condition register. Therefore, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 1 to 0. For example, if Bit B9 of the Negative Transition Register of the transition filter is set, the buffer full event is programmed for a negative transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer is no longer full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B15 to B3	B2	B1	B0
Event	—	Lay2	Lay1	—
Decimal weighting	—	4 (2^2)	2 (2^1)	—
Value	—	0/1	0/1	—

Values are:

- 1 = Enable negative transition
- 0 = Disable negative transition

Negative transition effect on sequence event register

Sequence event	Negative transition effect on sequence event register
Layer 1	Sets B1 when leaving arm layer 1
Layer 2	Sets B2 when leaving arm layer 2

Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:ARM:SEQUence:PTRansition

This command programs the positive transition (PTR) registers for the sequence event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:ARM:SEQUence:PTRansition <NRf>
:STATus:OPERation:ARM:SEQUence:PTRansition?
```

<NRf>	See Details
-------	-------------

Details

A positive transition is a 0 to 1 state change in the condition register. When an event is programmed for a positive transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 0 to 1. For example, if Bit B9 of the positive transition register of the transition filter is set, the buffer full event is programmed for a positive transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer becomes full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B15 to B3	B2	B1	B0
Event	—	Lay2	Lay1	—
Decimal weighting	—	4 (2^2)	2 (2^1)	—
Value	—	0/1	0/1	—

Values are:

- 1 = Enable positive transition
- 0 = Disable positive transition

Positive transition effect on sequence event register

Sequence event	Positive transition effect on sequence event register
Layer 1	Sets B1 when in Arm Layer 1
Layer 2	Sets B2 when in Arm Layer 2

Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:ARM:SEQuence[:EVENT]?

This command reads the sequence event register of the status model.

Type	Affected by	Where saved	Default value
Query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation:ARM:SEQuence [:EVENT] ?

Details

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. Reading an event register clears the bits in that register.

For example, assume that reading the transition filter event register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, Bits B5 and B9 of the transition filter event register are set.

The significance of a set bit in these registers depends on how the transition filter is programmed. If an event is programmed for a positive transition (PTR), the corresponding bit in this register sets when the event occurs. If the event is instead programmed for a negative transition (NTR), the bit sets when the event becomes not true.

The decimal weighting of the bit is shown in the following table.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2^1)	—
Value	—	0/1	—

Values are:

- 1 = Event bit set
- 0 = Event bit cleared

Arm event register:

Bit B1, sequence 1 (Seq1): Set bit indicates that the instrument is in an arm layer (PTR) or that the instrument has exited from the arm layers (NTR).

Bit B15: Always zero.

Power-up and the *CLS command clear all bits of the registers; the :STATus:PRESet command has no effect.

SCPI compliant.

Also see

- [:STATus:OPERation:ARM:SEQuence:NTRansition](#) (on page 11-128)
- [:STATus:OPERation:ARM:SEQuence:PTRansition](#) (on page 11-129)

:STATus:OPERation:ARM[:EVENT]?

This command reads the operation arm event register of the status model.

Type	Affected by	Where saved	Default value
Query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation:ARM[:EVENT]?

Details

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. Reading an event register clears the bits in that register.

For example, assume that reading the transition filter event register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, Bits B5 and B9 of the transition filter event register are set.

The significance of a set bit in these registers depends on how the transition filter is programmed. If an event is programmed for a positive transition (PTR), the corresponding bit in this register sets when the event occurs. If the event is instead programmed for a negative transition (NTR), the bit sets when the event becomes not true.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2^1)	—
Value	—	0/1	—

Values are:

- 1 = Event bit set
- 0 = Event bit cleared

When Bit B1, sequence 1 (Seq1), is set, indicates that the instrument is in an arm layer (PTR) or that the instrument has exited from the arm layers (NTR).

Bit B15 is always zero.

Power-up and the *CLS command clear all bits of the registers; the :STATus:PRESet command has no effect.

SCPI compliant.

Also see

[:STATus:OPERation:ARM:NTRansition](#) (on page 11-124)

[:STATus:OPERation:ARM:PTRansition](#) (on page 11-125)

:STATus:OPERation:CONDition?

This command reads the operation condition register.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:STATus:OPERation:CONDition?

Details

This command reads the content of the operation condition register. Each set of event registers (except the standard event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument. For register bit descriptions, refer to :STATus:OPERation[:EVENT] ?.

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :STAT:MEAS:COND? returns a decimal value of 512 (binary 0000001000000000), bit B9 of the Measurement Condition Register is set, indicating that the trace buffer is full.

In the status structure, the condition registers precede the transition filters, so only the PTR descriptions apply to the condition registers.

SCPI compliant.

Also see

[:STATus:OPERation\[:EVENT\]?](#) (on page 11-141)

[6517B status structure](#) (on page 13-1)

:STATus:OPERation:ENABLE

This command sets or reads the contents of the Operation Event Enable Register of the status model.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation:ENABLE <NRF>
:STATus:OPERation:ENABLE?

<NRF>	The status of the operation status register; see Details
-------	---

Details

Send the command with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the appropriate register.

The event enable register is used as a mask for events. When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked, so it cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure sets.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits. Set <NRf> to 65535 to set all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	—	Arm	Trig	—	—	—	—	Cal
<NRf> (decimal weighting)	—	64 (2^5)	32 (2^4)	—	—	—	—	1 (2^0)
Value	—	0/1	0/1	—	—	—	—	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	—	—	—	Seq	Idle	Calc	—
<NRf> (decimal weighting)	—	—	—	—	2048 (2^{11})	1024 (2^{10})	512 (2^9)	—
Value	—	—	—	—	0/1	0/1	0/1	—

Values are:

- 1 = Enable operation event
- 0 = Disable (mask) operation event

Events are listed in the following table.

RS-232	RS-232 interface error
Idle	Idle state of the 6517B
Arm	Waiting for arm
Trig	Waiting for trigger
Meas	Measuring
Cal	Calibrating

Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:NTRansition

This command programs the negative transition filters (NTR) of the operation event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:NTRansition <NRf>
:STATus:OPERation:NTRansition?
```

<NRf>	See Details
-------	-------------

Details

A negative transition is a 1 to 0 state change in the condition register. Therefore, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 1 to 0. For example, if Bit B9 of the Negative Transition Register of the transition filter is set, the buffer full event is programmed for a negative transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer is no longer full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	—	Arm	Trig	—	—	—	—	Cal
<NRf> (decimal weighting)	—	64 (2^5)	32 (2^5)	—	—	—	—	1 (2^0)
Value	—	0/1	0/1	—	—	—	—	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	—	—	—	Sq	Idle	Calc	—
<NRf> (decimal weighting)	—	—	—	—	2048 (2^{11})	1024 (2^{10})	512 (2^9)	—
Value	—	—	—	—	0/1	0/1	0/1	—

Values are:

- 1 = Enable negative transition
- 0 = Disable negative transition

Negative transition effect on operation event register

Operation event	Negative transition effect on operation event register
Calibrating	Sets B0 at the end of calibration
Trigger layer	Sets B5 when leaving the trigger layer
Arm layer	Sets B6 when leaving an arm layer
Calculating	Sets B9 when the reading calculation is completed
Idle	Sets B10 when leaving the idle state
Sequence test running	Sets B11 when the aborted test is restarted

Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:PTRansition

This command programs the positive transition (PTR) registers for the operation event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:PTRansition <NRf>
:STATus:OPERation:PTRansition?
```

<NRf>	See Details
-------	-------------

Details

A positive transition is a 0 to 1 state change in the condition register. When an event is programmed for a positive transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 0 to 1. For example, if Bit B9 of the positive transition register of the transition filter is set, the buffer full event is programmed for a positive transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer becomes full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	—	Arm	Trig	—	—	—	—	Cal
<NRf> (decimal weighting)	—	64 (2^5)	32 (2^5)	—	—	—	—	1 (2^0)
Value	—	0/1	0/1	—	—	—	—	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	—	—	—	Seq	Idle	Calc	—
<NRf> (decimal weighting)	—	—	—	—	2048 (2^{11})	1024 (2^{10})	512 (2^9)	—
Value	—	—	—	—	0/1	0/1	0/1	—

Values are:

- 1 = Enable positive transition
- 0 = Disable positive transition

Positive transition effect on operation event register

Operation event	Positive transition effect on operation event register
Calibrating	Sets B0 at the start of calibration
Trigger layer	Sets B5 when waiting in the trigger layer
Arm layer	Sets B6 when waiting in an arm layer
Calculating	Sets B9 when a reading is being calculated
Idle	Sets B10 when entering the idle state
Sequence test running	Sets B11 when a sequence test is running

Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:TRIGger:CONDition?

This command reads the operation trigger condition register.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:STATus:OPERation:TRIGger:CONDition?

Details

This command reads the content of the operation condition register. Each set of event registers (except the standard event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument. For register bit descriptions, refer to :STATus:OPERation[:EVENT] ?.

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :STAT:MEAS:COND? returns a decimal value of 512 (binary 0000001000000000), bit B9 of the Measurement Condition Register is set, indicating that the trace buffer is full.

SCPI compliant.

Also see

[:STATus:OPERation:TRIGger\[:EVENT\]? \(on page 11-140\)](#)

:STATus:OPERation:TRIGger:ENABLE

This command sets or reads the contents of the Operation Trigger Enable register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation:TRIGger:ENABLE <NRf>
:STATus:OPERation:TRIGger:ENABLE?

<NRf>	The status of the status register; see Details
-------	---

Details

Send the command with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the appropriate register.

The event enable register is used as a mask for events. When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked, so it cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure sets.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits. Set <NRf> to 65535 to set all bits.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2 ¹)	—
Value	—	0/1	—

Values are:

- 1 = Enable trigger event
- 0 = Disable (mask) trigger event

Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:TRIGger:NTRansition

This command programs the negative transition filters (NTR) of the operation trigger event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:TRIGger:NTRansition <NRf>
:STATus:OPERation:TRIGger:NTRansition?
```

<NRf>	See Details
-------	-------------

Details

A negative transition is a 1 to 0 state change in the condition register. Therefore, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 1 to 0. For example, if Bit B9 of the Negative Transition Register of the transition filter is set, the buffer full event is programmed for a negative transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer is no longer full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRF> parameter. Set <NRF> to 0 to clear all bits.

Bit position	B15 to B2	B1	B0
Event	—	Seq1	—
Decimal weighting	—	2 (2 ¹)	—
Value	—	0/1	—

Values are:

- 1 = Enable negative transition
- 0 = Disable negative transition

Negative transition effect on trigger event register

Trigger event	Negative transition effect on trigger event register
Sequence 1	Sets B1 when leaving the trigger layer

Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:TRIGger:PTRansition

This command programs the positive transition filter (PTR) for the operation trigger event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:OPERation:TRIGger:PTRansition <NRF>
:STATus:OPERation:TRIGger:PTRansition?
```

<NRF>	See Details
-------	-------------

Details

A positive transition is a 0 to 1 state change in the condition register. When an event is programmed for a positive transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 0 to 1. For example, if Bit B9 of the positive transition register of the transition filter is set, the buffer full event is programmed for a positive transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer becomes full.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRF> parameter. Set <NRF> to 0 to clear all bits.

Bit position	B15 to B2	B1	B0
Event	—	Seq1	—
Decimal weighting	—	2 (2 ¹)	—
Value	—	0/1	—

Values are:

- 1 = Enable positive transition
- 0 = Disable positive transition

Positive transition effect on trigger event register

Trigger event	Positive transition effect on trigger event register
Sequence 1	Sets B1 when waiting in trigger layer

Power-up and the :STATus:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:OPERation:TRIGger[:EVENT]?

This command reads the operation trigger event register of the status model.

Type	Affected by	Where saved	Default value
Query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation:TRIGger[:EVENT]?

Details

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. Reading an event register clears the bits in that register.

For example, assume that reading the transition filter event register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, Bits B5 and B9 of the transition filter event register are set.

The significance of a set bit in these registers depends on how the transition filter is programmed. If an event is programmed for a positive transition (PTR), the corresponding bit in this register sets when the event occurs. If the event is instead programmed for a negative transition (NTR), the bit sets when the event becomes not true.

The decimal weighting of the bit is shown in the following table.

Bit position	B15 to B2	B1	B0
Event	—	Sequence 1	—
Decimal weighting	—	2 (2^1)	—
Value	—	0/1	—

Values are:

- 1 = Event bit set
- 0 = Event bit cleared

Arm event register:

Bit B1, sequence 1 (Seq1): Set bit indicates that the instrument is in an arm layer (PTR) or that the instrument has exited from the arm layers (NTR).

Bit B15: Always zero.

Bit	Event	Meaning of set bit
B1	Sequence 1 (Seq1)	Indicates that the instrument is in the trigger layer (PTR) or that the instrument has exited from the trigger layer (NTR).
B15	—	Always zero.

Power-up and the *CLS command clear all bits of the registers; the :STATus:PRESet command has no effect.

SCPI compliant.

Also see

- [:STATus:OPERation:TRIGger:NTRansition](#) (on page 11-138)
[:STATus:OPERation:TRIGger:PTRansition](#) (on page 11-139)

:STATus:OPERation[:EVENT]?

This command reads the operation event register of the status model.

Type	Affected by	Where saved	Default value
Query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:OPERation[:EVENT]?

Details

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. Reading an event register clears the bits in that register.

For example, assume that reading the transition filter event register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, Bits B5 and B9 of the transition filter event register are set.

The significance of a set bit in these registers depends on how the transition filter is programmed. If an event is programmed for a positive transition (PTR), the corresponding bit in this register sets when the event occurs. If the event is instead programmed for a negative transition (NTR), the bit sets when the event becomes not true.

Operation event register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	—	Arm	Trig	—	—	—	—	Cal
<n> (decimal weighting)	—	64 (2^5)	32 (2^4)	—	—	—	—	1 (2^0)
Value	—	0/1	0/1	—	—	—	—	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	—	—	—	Seq	Idle	Calc	—
<n> (decimal weighting)	—	—	—	—	2048 (2^{11})	1024 (2^{10})	512 (2^9)	—
Value	0	—	—	—	0/1	0/1	0/1	—

Values are:

- 1 = Event Bit Set
- 0 = Event Bit Cleared

Events and the meanings of set bits are listed in the following table.

Bit	Event	Meaning of set bit
B0	Calibrating (Cal)	Set bit indicates that the instrument is calibrating (PTR) or calibration is complete (NTR).
B5	Waiting for trigger (Trig)	Set bit indicates that the instrument is waiting in the trigger layer (PTR) of the trigger model or that it has left the trigger layer (NTR).
B6	Waiting for arm (Arm)	Set bit indicates that the instrument is waiting in an arm layer of the trigger model (PTR), or operation has proceeded from the arm layers into the trigger layer (NTR).
B9	Calculating (Calc)	Set bit indicates that the instrument is calculating a reading (PTR), or that the calculation is completed (NTR).
B10	Idle	Set bit indicates that the instrument is in the idle state (PTR), or has left the idle state to perform an operation (NTR).
B11	Sequence test running (Seq)	Set bit indicates that a sequence test is running (PTR), or that the test has finished (NTR).
B15	—	Always zero.

Power-up and the `*CLS` command clear all bits of the registers; the `:STATus:PRESet` command has no effect.

SCPI compliant.

Also see

[:STATus:OPERation:NTRansition](#) (on page 11-134)
[:STATus:OPERation:PTRansition](#) (on page 11-135)

:STATus:PRESet

This command returns registers to their default conditions.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

`:STATus:PRESet`

Details

When this command is sent, the SCPI event registers are affected as follows:

- All bits of the positive transition filter registers are set to one (1)
- All bits of the negative transition filter registers are cleared to zero (0)
- All bits of the following registers are cleared to zero (0):
 - Operation event enable register
 - Questionable event enable register
 - Measurement event enable register
- All bits of the following registers are set to one (1):
 - Trigger event enable register
 - Arm event enable register
 - Sequence event enable register

NOTE

Registers not included in the above list are not affected by this command.

SCPI compliant.

Also see

None

:STATus:QUESTIONable:CONDition?

This command reads the Questionable Condition Register of the status model.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:STATus:QUESTIONable:CONDition?

Details

This command reads the content of the operation condition register. Each set of event registers (except the standard event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument. For register bit descriptions, refer to :STATus:OPERation[:EVENT] ?.

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :STAT:MEAS:COND? returns a decimal value of 512 (binary 0000001000000000), bit B9 of the Measurement Condition Register is set, indicating that the trace buffer is full.

SCPI compliant.

Also see

[:STATus:QUESTIONable\[:EVENT\]?](#) (on page 11-149)

:STATus:QUESTIONable:ENABLE

This command sets or reads the contents of the Questionable Enable Register of the status model.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:QUESTIONable:ENABLE <NRf>
:STATus:QUESTIONable:ENABLE?

<NRf>	The status of the questionable enable register; see Details
-------	---

Details

Send the command with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the appropriate register.

The event enable register is used as a mask for events. When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked, so it cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure sets.

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits. Set <NRf> to 65535 to set all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	Temp	—	—	Amp	Volt
<NRf> (decimal weighting)	128 (2 ⁷)	64 (2 ⁵)	32 (2 ⁴)	16 (2 ³)	—	—	2 (2 ¹)	1 (2 ⁰)
Value	0/1	0/1	0/1	0/1	—	—	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	Warn	—	Seq	Coul	Ohm	Hum	Cal
<NRf> (decimal weighting)	—	16384 (2 ¹⁴)	—	4096 (2 ¹²)	2048 (2 ¹¹)	1024 (2 ¹⁰)	512 (2 ⁹)	256 (2 ⁸)
Value	—	0/1	—	0/1	0/1	0/1	0/1	0/1

Values are:

- 1 = Enable questionable event
- 0 = Disable (mask) questionable event

Events and the meanings of set bits are listed in the following table.

Bit	Event
B0	Volts summary
B1	Amp summary
B4	Temperature summary (Temp)
B5	Reading available (RAV)
B6	Reading underflow (RUF)
B7	Buffer available (BAV)
B8	Calibration summary (Cal)
B9	Humidity summary (Hum)
B11	Coulombs summary (Coul)
B12	Sequence test summary (Seq)
B14	Command warning (Warn)

Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:QUEStionable:NTRansition

This command programs the negative transition filters (NTR) of the Questionable Event Register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATus:QUEStionable:NTRansition <NRf>
:STATus:QUEStionable:NTRansition?
```

<NRf>	See Details
-------	-------------

Details

A negative transition is a 1 to 0 state change in the condition register. Therefore, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 1 to 0. For example, if Bit B9 of the Negative Transition Register of the transition filter is set, the buffer full event is programmed for a negative transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer is no longer full.

Negative transition effect on questionable event register

Questionable event	Negative transition effect on questionable event register
Voltage summary	Sets B0 when a subsequent valid voltage measurement occurs
Current summary	Sets B1 when a subsequent valid current measurement occurs
Temperature summary	Sets B4 when a subsequent valid external temperature reading occurs
Humidity summary	Sets B9 when a subsequent valid relative humidity reading occurs
Resistance summary	Sets B10 when a subsequent valid resistance measurement occurs
Charge summary	Sets B11 when a subsequent valid charge measurement occurs
Sequence test summary	Sets B12 when the sequence test is restarted

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	Temp	—	—	Amp	Volt
<NRf> (decimal weighting)	128 (2^7)	64 (2^5)	32 (2^5)	16 (2^4)	—	—	2 (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	—	—	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	Warn	—	Seq	Coul	—	Hum	Cal
<NRf> (decimal weighting)	—	16384 (2^{14})	—	4096 (2^{12})	2048 (2^{11})	—	512 (2^9)	256 (2^8)
Value	—	0/1	—	0/1	0/1	—	0/1	0/1

Values are:

- 1 = Enable negative transition
- 0 = Disable negative transition

Power-up and the :STATus:PRESet command clear all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:QUEStionable:PTRansition

This command programs the positive transition filter (PTR) for the questionable event register.

Type	Affected by	Where saved	Default value
Command and query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

```
:STATUS:QUEStionable:PTRansition <NRf>
:STATUS:QUEStionable:PTRansition?
```

<NRf>	See Details
-------	-------------

Details

A positive transition is a 0 to 1 state change in the condition register. When an event is programmed for a positive transition, the appropriate bit in the corresponding event register sets when the corresponding bit in the condition register changes from 0 to 1. For example, if Bit B9 of the positive transition register of the transition filter is set, the buffer full event is programmed for a positive transition. The BFL bit (B9) in the transition filter event register sets when the trace buffer becomes full.

Positive transition effect on questionable event register

Questionable event	Positive transition effect on questionable event register
Voltage summary	Sets B0 when an invalid voltage measurement occurs
Current summary	Sets B1 when an invalid current measurement occurs
Temperature summary	Sets B4 when an invalid external temperature reading occurs
Reading available	Sets B5 after a reading is made and processed
Reading underflow	Sets B6 when a resistance reading is below the lower range limit
Buffer available	Sets B7 when the trace buffer has at least two readings
Humidity summary	Sets B9 when an invalid relative humidity reading occurs
Charge summary	Sets B11 when an invalid charge measurement occurs
Sequence test summary	Sets B12 when a sequence test is aborted
Warning	Sets B14 when a command warning occurs

The decimal weighting of the bits is shown in the following table. The sum of the decimal weights of the bits to set is sent as the <NRf> parameter. Set <NRf> to 0 to clear all bits.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	Temp	—	—	Amp	Volt
<NRf> (decimal weighting)	128 (2^7)	64 (2^5)	32 (2^5)	16 (2^4)	—	—	2 (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	—	—	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	Warn	—	Seq	Coul	—	Hum	Cal
<NRf> (decimal weighting)	—	16384 (2^{14})	—	4096 (2^{12})	2048 (2^{11})	—	512 (2^9)	256 (2^8)
Value	—	0/1	—	0/1	0/1	—	0/1	0/1

Values are:

- 1 = Enable positive transition
- 0 = Disable positive transition

Power-up and the :STATUS:PRESet command set all bits of the registers; the *CLS command has no effect.

SCPI compliant.

Also see

None

:STATus:QUESTIONable[:EVENT]?

This command reads the Questionable Event Register of the status model.

Type	Affected by	Where saved	Default value
Query	STATus:PRESet Power cycle	Not applicable	See Details

Usage

:STATus:QUESTIONable[:EVENT]?

Details

After sending this command and addressing the 6517B to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. Reading an event register clears the bits in that register.

For example, assume that reading the transition filter event register results in an acquired decimal value of 544. The binary equivalent is 0000001000100000. For this binary value, Bits B5 and B9 of the transition filter event register are set.

The significance of a set bit in these registers depends on how the transition filter is programmed. If an event is programmed for a positive transition (PTR), the corresponding bit in this register sets when the event occurs. If the event is instead programmed for a negative transition (NTR), the bit sets when the event becomes not true.

The decimal weighting of the bits is shown in the following table.

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	BAV	RUF	RAV	Temp	—	—	Amp	Volt
<n> (decimal weighting)	128 (2^7)	64 (2^5)	32 (2^4)	16 (2^3)	—	—	2 (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	—	—	0/1	0/1

Bit position	B15	B14	B13	B12	B11	B10	B9	B8
Event	—	Warn	—	Seq	Coul	Ohm	Hum	Cal
<n> (decimal weighting)	—	16384 (2^{14})	—	4096 (2^{12})	2048 (2^{11})	1024 (2^{10})	512 (2^9)	256 (2^8)
Value	0	0/1	—	0/1	0/1	0/1	0/1	0/1

Values are:

- 1 = Questionable event bit set
- 0 = Questionable event bit cleared

Events and the meanings of set bits are listed in the following table.

Bit	Event	Meaning of set bit
B0	Voltage summary	An invalid voltage measurement has occurred (PTR) or a subsequent valid voltage measurement has occurred (NTR).
B1	Current summary	An invalid current measurement has occurred or a subsequent valid current measurement has occurred (NTR).
B4	Temperature summary (Temp)	An invalid external temperature measurement has occurred (PTR), or a subsequent valid temperature measurement has occurred (NTR).
B5	Reading available (RAV)	A reading was made and processed (PTR) or a subsequent reading is in process (NTR).
B6	Reading underflow (RUF)	The resistance reading is less than the lower range limit (PTR) or the instrument has gone from an underflow condition to a normal reading condition (NTR).
B7	Buffer available (BAV)	There are at least two readings in the trace buffer (PTR) or the buffer has become empty (NTR).
B8	Calibration summary (Cal)	An invalid calibration constant was detected during the power-up sequence (PTR). The instrument instead uses a default calibration constant. This error clears after successful calibration of the instrument.
B9	Humidity summary (Hum)	An invalid relative humidity measurement has occurred (PTR) or a subsequent valid temperature measurement has occurred (NTR).
B10	Resistance summary (Ohm)	An invalid resistance measurement has occurred (PTR) or a subsequent valid resistance measurement has occurred (NTR).
B11	Charge summary (Coul)	An invalid charge measurement has occurred or a subsequent valid charge measurement has occurred (NTR).
B12	Sequence test summary (Seq)	A sequence test has been aborted (PTR).
B14	Command warning	A signal oriented transition filter command parameter has been ignored (PTR) or a subsequent signal oriented transition filter Command has executed successfully (NTR).
B15	—	Always zero.

NOTE

Whenever a questionable event occurs, the ERR annunciator turns on. The annunciator turns off when the questionable event clears.

Power-up and the *CLS command clear all bits of the registers; the :STATus:PRESet command has no effect.

SCPI compliant.

Also see

- [:STATus:QUESTIONable:NTRansition \(on page 11-146\)](#)
- [:STATus:QUESTIONable:PTRansition \(on page 11-147\)](#)

:STATus:QUEue:CLEar

This function clears all messages from the error queue.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:STATus:QUEue:CLEar

Also see

[Queues](#) (on page 13-12)

:STATus:QUEue:DISable

This function specifies the messages that are not to be placed in the error queue.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	Not applicable

Usage

:STATus:QUEue:DISable <list>
:STATus:QUEue:DISable?

<list>

The messages to disable; see **Details**

Details

The query reads the disabled messages.

On power-up, all error messages are enabled and go into the error queue as they occur. This command specifies the messages you want to disable. Disabled messages are prevented from entering the queue. To disable all messages from entering the error queue, send the command:

:STAT:QUE:DIS ()

NOTE

Status messages are not enabled and do not go into the queue.

Messages are specified by number. Refer to “Status and error messages” in the *Model 6517B User’s Manual* for message numbers.

Power-up clears the list of messages. *CLS and :STATus:PRESet have no effect.

Example

:STATus:QUEue:DISable -110	Disable single message.
:STATus:QUEue:DISable -110, -140, -222	Disable multiple messages (separated by commas).
:STATus:QUEue:DISable -110:-222	Disable a range of messages (start and end separated by a colon).
:STATus:QUEue:DISable -110:-222, -230	Disable a range (separated by a colon) and a single entry (separated by a comma).

Also see[Queues](#) (on page 13-12)[:STATus:QUEue:ENABLE](#) (on page 11-152)**:STATus:QUEue:ENABLE**

This function returns the most recent error queue message.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	Not applicable

Usage

```
:STATus:QUEue:ENABLE <list>
:STATus:QUEue:ENABLE?
```

<list>	A specified list of messages to enable for the error queue; see Details
--------	--

Details

On power-up, all error messages are enabled and go into the error queue as they occur. This command specifies which messages you want to enable. Messages that are not specified are disabled and prevented from entering the queue.

NOTE

Status messages are not enabled and do not go into the queue.

When this command is sent, all messages are disabled, then the specified messages are enabled. The query contains all the enabled messages. To enable all messages to enter the error queue, send the command:

```
:STAT:QUE:ENAB ()
```

Messages are specified by numbers. A list of messages is provided in “Status and error messages” in the *Model 6517B User’s Manual*.

The list of messages is cleared on power up. *CLS and :STATus:PRESet have no effect.

Example

:STATus:QUEue:ENABLE -110	Enable single message.
:STATus:QUEue:ENABLE -110, -140, -222	Enable multiple messages (separated by commas).
:STATus:QUEue:ENABLE -110:-222	Enable a range of messages (start and end separated by a colon).
:STATus:QUEue:ENABLE -110:-222, -230	Enable a range (separated by a colon) and a single entry (separated by a comma).

Also see

[Queues](#) (on page 13-12)
[:STATus:QUEue:DISable](#) (on page 11-151)

:STATus:QUEue[:NEXT]?

This function returns the oldest error queue message from the Event Queue and removes it.

Type	Affected by	Where saved	Default value
Command and query	Power cycle	Not applicable	See Details

Usage

`:STATus:QUEue [:NEXT] ?`

Details

As error and status messages occur, they are placed in the error queue. This command reads those messages. The error queue is a first-in, first-out (FIFO) register that can hold up to 10 messages. Each time you read the queue, the oldest message is read, and that message is then removed from the queue.

If the queue is full, the 350, Queue Overflow message occupies the last memory location in the register. When the error queue is empty, the message 0, No error is placed in the error queue.

The messages in the queue are preceded by a number. Negative (-) numbers indicate SCPI-defined messages and positive (+) numbers indicate messages defined by Keithley. Refer to "Status and error messages" in the *Model 6517B User's Manual* for the list of messages.

Power-up clears the list of messages. *CLS and :STATus:PRESet have no effect.

SCPI compliant.

NOTE

The :STATus:QUEue [:NEXT] ? query command performs the same function as the :SYSTem:ERRor? query command.

Example

STAT:QUE?
Returns information on the oldest error in the event log. For example, if you sent a command without a parameter, the return is: -109,"Missing parameter;1;2017/05/06 12:57:04.484"

Also see

[:SYSTem:ERRor?](#) (on page 11-155)

SYSTem subsystem

The SYSTem subsystem contains miscellaneous commands.

:SYSTem:ARSPEED

This command controls autoranging speed.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	FAST

Usage

```
:SYSTem:ARSPEED <name>
:SYSTem:ARSPEED?
```

<name>	Fast autoranging: FAST Normal autoranging: NORMAL
--------	--

Details

If using autorange causes the instrument to rapidly alternate between ranges, you can change the speed to NORMAL to delay measurements after a range changes. The delay helps avoid oscillation between ranges.

Also see

None

:SYSTem:CLEAR

This command clears messages from the error queue.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:CLEAR
```

Details

SCPI compliant.

Also see

[:SYSTem:ERROR?](#) (on page 11-155)

:SYSTem:DATE

This command sets the date for the real-time clock.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Not applicable

Usage

```
:SYSTem:DATE <yr>, <mo>, <day>
:SYSTem:DATE?
```

<yr>	Specify year: 2005 to 2104
<mo>	Specify month: 1 to 12
<day>	Specify day: 1 to 31

Details

Setting an invalid date (for example, February 30, 2007) results in an error and the previous date is retained.

SCPI compliant.

Also see

None

:SYSTem:ERRor?

This command returns the oldest unread error message from the event log and removes it from the log.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:ERRor?
```

Details

As error and status messages occur, they are placed in the error queue. This command reads those messages. The error queue is a first-in, first-out (FIFO) register that can hold up to 10 messages. Each time you read the queue, the oldest message is read, and that message is then removed from the queue.

If the queue is full, the 350, Queue Overflow message occupies the last memory location in the register. When the error queue is empty, the message 0, No error is placed in the error queue.

The messages in the queue are preceded by a number. Negative (-) numbers indicate SCPI-defined messages and positive (+) numbers indicate messages defined by Keithley. Refer to "Status and error messages" in the *Model 6517B User's Manual* for the list of messages.

The error queue is cleared at power-up and when *CLS is sent. *RST, :SYSTem:PRESet, and :STATus:PRESet have no effect on the error queue.

NOTE

The :SYSTem:ERRor? query command is similar to the :STATus:QUEue? command.

Example

```
SYST:ERR?
```

Returns information on the oldest error in the event log. For example, if you sent a command without a parameter, the return is:
-109,"Missing parameter;1;2017/05/06 12:57:04.484"

Also see

[Queues](#) (on page 13-12)

[:STATus:QUEue\[:NEXT\]?](#) (on page 11-153)

:SYSTem:HLControl

This command enables or disables the A/D hardware limit.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SYSTem:HLControl <b>
:SYSTem:HLControl?
```

	Disable A/D hardware limit: 0 or OFF
	Enable A/D hardware limit: 1 or ON

Details

With the hardware limit ON, the OutOfLimit error message is enabled to indicate that an out-of-range noise spike occurred.

Disabling the hardware limit disables the error message. With the hardware limit OFF, noise spikes may cause erroneous readings.

Also see

None

:SYSTem:HSControl

This command enables or disables humidity readings.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SYSTem:HSControl <b>
:SYSTem:HSControl?
```

	Disable humidity readings: 0 or OFF Enable humidity readings: 1 or ON
-----	--

Details

When enabled when the Model 6517-RH is connected to the instrument, the 6517B makes humidity readings.

HUMidity must be a selected data element to include the humidity reading in the data string.

Also see

[TRACe:ELEMents](#) (on page 11-169)

:SYSTem:INTerlock?

This command returns the connection status of the safety interlock cable.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:INTerlock?
```

Details

If the response message is 1, the interlock cable connected to the 6517B and fixture or not connected to the 6517B at all.

If the message is 0, one of the following situations occurred:

- The interlock cable is connected to the 6517B but it is not connected to the fixture.
- The interlock cable is connected to the 6517B but the fixture lid is open.

If the interlock cable is not connected, the 6517B cannot determine the state of the test fixture lid (open or closed) or read the test fixture switch settings. A potential safety hazard is present when the fixture lid is open.

Also see

None

:SYSTem:KEY

This command simulates a front-panel key press using remote commands.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	Not applicable

Usage

```
:SYSTem:KEY <NRf>
:SYSTem:KEY?
```

<NRf>	The number that corresponds to the key press; see Details
-------	--

Details

For example, to select V (volts) you can send the following command to simulate pressing the **V** key:

```
:syst:key 15
```

The queue for :SYSTem:KEY? holds one key-press value. When :SYSTem:KEY? is sent over the bus and the 6517B is addressed to talk, the key-press code number for the last key pressed (either physically or with :SYSTem:KEY?) is sent to the computer.

The SYST:KEY command allows you to select the NEXT displays over the bus. Sending :SYSTem:KEY 16 over the bus is same as a single press of the **NEXT** key. Sending :SYSTem:KEY 8 is the same as a single press of the **PREV** key. The NEXT display that is selected depends on how many times the **NEXT** key is pressed using the SYST:KEY command. The instrument can always be returned to the normal display by pressing the **PREV** key a similar number of times or by sending the :DISPLAY:CNDisplay command.

For example, you can display the bar graph by pressing the **NEXT** key twice as follows:

```
:syst:key 16; key 16
```

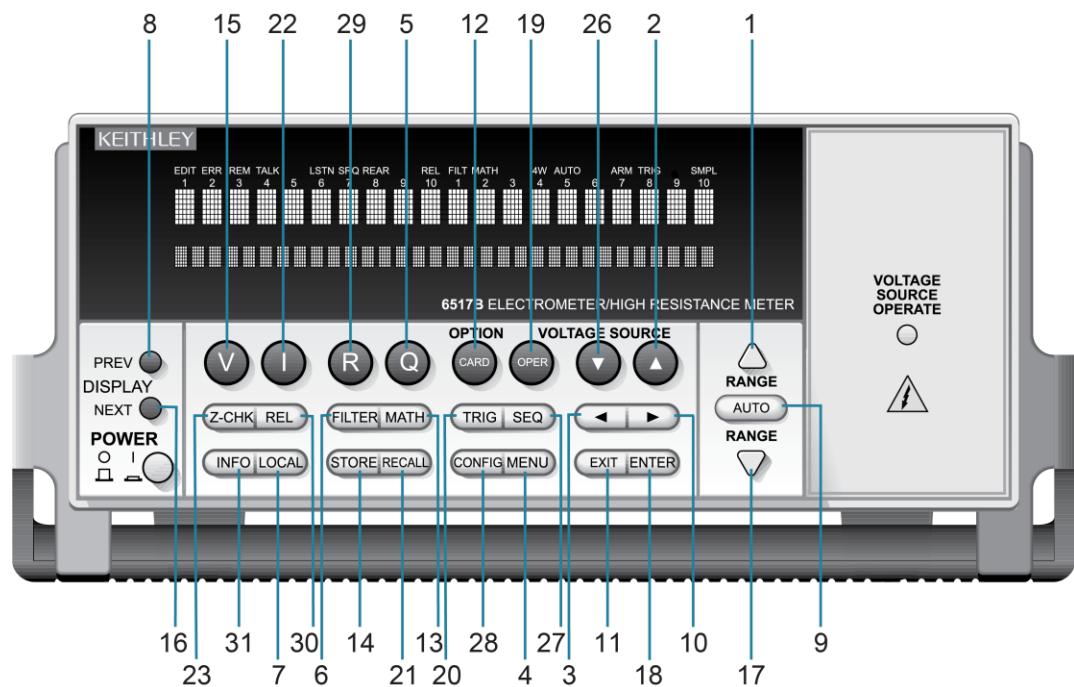
To return to the normal display, press the **PREV** key twice as follows:

```
:syst:key 8; key 8
```

The value of <NRf> that corresponds to each key is listed in the following table. The <NRf> values are also shown in the figure that follows the table.

<NRf>	Key
1	Range ▲
2	Voltage source ▲
3	◀
4	MENU
5	Charge (Q)
6	FILTER
7	LOCAL
8	PREV
9	AUTO
10	▶
11	EXIT
12	CARD
13	MATH
14	STORE
15	Voltage (V)
16	NEXT
17	Range ▼
18	ENTER
19	OPER
20	TRIG
21	RECALL
22	Current (I)
23	Z-CHK
26	Voltage source ▼
27	SEQ
28	CONFIG
29	Resistance (R)
30	REL
31	INFO

Figure 91: Key press codes

**Also see**

None

:SYSTem:LLOCKout

This command enables or disables local lockout.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

:SYSTem:LLOCKout 	
:SYSTem:LLOCKout?	
	Disable local lockout: 0 or OFF Enable local lockout: 1 or ON

Details

If enabled, the front-panel keys are locked out (nonoperational) when the instrument is in remote. If disabled, the front-panel keys are operational when the instrument is controlled remotely.

The instrument must be in remote to use this command. This command can only be sent over the RS-232 interface.

Taking the instrument out of remote restores front-panel key operation, but does not change the status of the :LLOCKout command.

Also see

- [:SYSTem:LOCAL](#) (on page 11-160)
- [:SYSTem:REMote](#) (on page 11-162)

:SYSTem:LOCAL

This command takes 6517B out of remote control.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:SYSTem:LOCAL

Details

This command takes the 6517B out of the remote state and enables the operation of front-panel keys.

This command can only be sent over the RS-232 interface.

Also see

- [:SYSTem:LLOCKout](#) (on page 11-160)

:SYSTem:LSYNc:STATE

This command enables or disables line synchronization.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ON

Usage

```
:SYSTem:LSYNc:STATE <state>
:SYSTem:LSYNc:STATE?
```

<state>	Disable line cycle synchronization: OFF or 0 Enable line cycle synchronization: ON or 1
---------	--

Details

When enabled, the integration period does not start until the beginning of the next power line cycle. For example, if a reading is triggered at the positive peak of a power line cycle, the integration period starts when that power line cycle is completed. The integration period starts when the positive-going sine wave crosses zero.

With line synchronization disabled, the integration period starts when the reading is triggered.

Also see

None

:SYSTem:POSetup

This command selects the defaults when you power on the instrument.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Nonvolatile memory	RST

Usage

```
:SYSTem:POSetup <name>
:SYSTem:POSetup?
```

<name>	Which setup to restore when you power on the instrument: <ul style="list-style-type: none"> ▪ *RST defaults: RST ▪ :SYSTem:PRESet defaults: PRESet ▪ Stored setup: SAV0 to SAV9
--------	--

Details

When you select RST, the instrument restores settings to their default values when the instrument is powered on.

When you select PRESet, the instrument restores settings to the :SYSTem:PRESet default conditions when the instrument is powered on.

When you select a SAV setting, the settings in the saved setup are applied when the instrument is powered on. The settings are saved using the *SAV command.

Default settings are listed in the SCPI command descriptions.

Example

`SYST:POS SAV1`

Set the instrument to restore the settings that are saved in stored setup 1 when the instrument is powered on.

Also see

[*RST](#) (on page 12-10)

[*SAV](#) (on page 12-11)

[:SYSTem:PRESet](#) (on page 11-162)

:SYSTem:PRESet

This command returns the instrument to states optimized for front-panel operation.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

`:SYSTem:PRESet`

Details

SCPI compliant.

Example

`:SYST:PRES`

Set the instrument to states optimized for front-panel operation.

Also see

[*RST](#) (on page 12-10)

:SYSTem:REmote

This command places the 6517B in remote control.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

`:SYSTem:REmote`

Details

In remote, the front-panel keys are locked out if local lockout is enabled.

This command can only be sent over the RS-232 interface.

Also see

[:SYSTem:LLOCKout](#) (on page 11-160)

:SYSTem:RNUMber:RESet

This command resets the reading number to zero.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:RNUMber:RESet
```

Details

When the reading number is included as a GPIB data element, each reading sent over the bus is assigned a number, starting at #0. The reading number resets to zero when the instrument is turned on or when this command is asserted.

Also see

[FORMAT subsystem](#) (on page 11-57)

:SYSTem:TIME

This command sets the time for the real-time clock.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:TIME <hr>, <min>, <sec>
:SYSTem:TIME?
```

<hr>	Specify hour (24-hour format): 0 to 23
<min>	Specify minute: 0 to 59
<sec>	Specify second (rounded to 1/100 seconds): 0.00 to 59.9

Details

The time must be set using the 24-hour format (for example, hour 13 is 1 PM). Setting an invalid time results in an error and the previous time is retained.

SYST:TIME? returns the time to the nearest hundredth of a second.

SCPI compliant.

Also see

None

:SYSTem:TSControl

This command enables or disables external temperature readings.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ON

Usage

```
:SYSTem:TSControl <b>
:SYSTem:TSControl?

<b>          Disable external temperature readings: 0 or OFF
Enable external temperature readings: 1 or ON
```

Details

When enabled and the Model 6517-TP is connected to the instrument, the 6517B makes external temperature readings.

To include the temperature reading in the data string, :FORMAT:ELEMENTS must include ETEMPerature.

Also see

[:FORMAT:ELEMENTS](#) (on page 11-58)

:SYSTem:TStamp:RELative:RESet

This command resets the relative timestamp to 0 seconds.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:TStamp:RELative:RESet
```

Also see

[:SYSTem:TStamp:TYPE](#) (on page 11-165)

:SYSTem:TStamp:TYPE

This command selects the timestamp type.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:TStamp:TYPE <name>
:SYSTem:TStamp:TYPE?

<name>      Select relative-time timestamp: RELative
              Select real-time timestamp: RTClock
```

Details

RELative selects the relative-time timestamp. Readings are referenced (in seconds) to a timer. The timer starts at zero seconds when the instrument is turned on or when the timestamp is reset.

RELative is a 55-day (maximum) clock with 1 μ s resolution. After 99,999.999999 seconds, the timer resets to zero and starts over.

RTClock selects the real-time clock timestamp. Readings are referenced to a date and time (24-hour clock format). **RTClock** is a 100-year maximum calendar with 10 ms resolution.

Also see

[:SYSTem:TStamp:RELative:RESet \(on page 11-164\)](#)

:SYSTem:VERSION?

This command returns the present SCPI version.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:SYSTem:VERSION?
```

Details

This query command returns the SCPI version.

SCPI compliant.

Example

SYSTem:VERSION?	Query the version. An example of a return is: 1996.0
-----------------	---

Also see

None

:SYSTem:ZCheck

This command enables or disable zero check.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

:SYSTem:ZCheck 	
:SYSTem:ZCheck?	
	Disable zero check: 0 or OFF
	Enable zero check: 1 or ON

Also see

[Zero check](#) (on page 3-28)

:SYSTem:ZCORrect:ACQuire

This command acquires zero correct value for zero correction.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:SYSTem:ZCORrect:ACQuire

Details

The value can only be acquired when zero check is enabled. The internal offset becomes the correction value.

Zero correction can be performed when zero check is disabled.

Example

:SYSTem:ZCheck ON	Enable zero check.
:SYSTem:ZCORrect:ACQuire	Acquire zero correct value.
:SYSTem:ZCORrect ON	Perform zero correction.

Also see

None

:SYSTem:ZCORrect[:STATE]

This command enables or disables zero correct.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	OFF

Usage

```
:SYSTem:ZCORrect[:STATE] <b>
:SYSTem:ZCORrect[:STATE] ?
```

	Disable zero correct: 0 or OFF
	Enable zero correct: 1 or ON

Details

There are two methods to perform zero correction. The first method is to enable zero check and then enable zero correct. This command sequence is shown in Example 1. This does not work if the instrument is in one-shot mode.

The second method is to enable zero check, acquire the zero correct value, and then use this command to enable zero correct. Example 2 demonstrates this method.

Example 1

:SYSTem:ZCheck ON	Enable zero check.
:SYSTem:ZCORrect ON	Perform zero correction.

Example 2

:SYSTem:ZCheck ON	Enable zero check.
:SYSTem:ZCORrect:ACQuire	Acquire zero correct value.
:SYSTem:ZCORrect ON	Perform zero correction.

Also see

[:SYSTem:ZCORrect:ACQuire](#) (on page 11-166)

TRACe subsystem

The commands in this subsystem configure and control data storage into the buffer. The commands are summarized in :[TRACe command summary](#) (on page 11-22). See Buffer (data store) for more information about the buffer.

NOTE

You can use either :TRACe or :DATA as the root command for this subsystem. In most cases, the documentation in this manual uses :TRACe. If you prefer to use :DATA, replace the :TRACe command words with :DATA.

:TRACe:CLEar

This command clears readings from the buffer.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:TRACe:CLEar
:DATA:CLEar

Details

If you do not clear the buffer, a subsequent store overwrites the old readings. If the subsequent store is aborted before the buffer becomes full, some old readings may still be in the buffer.

Also see

None

:TRACe:DATA?

This command reads all readings in the buffer.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

:TRACe:DATA?
:DATA:DATA?

Details

When this command is sent and the 6517B is addressed to talk, all the readings stored in the buffer are sent to the computer. The format in which the readings are sent over the bus is controlled by the FORMat subsystem.

NOTE

The buffer elements selected by :TRACe:ELEMents must match the bus elements selected by :FORMAT:ELEMents. Otherwise, the following error occurs when using this command to send buffer readings over the bus: +313 Buffer & format element mismatch.

SCPI compliant.

Also see

[FORMAT subsystem](#) (on page 11-57)
[:ELEMents <item list>](#) (on page 11-58)

:TRACe:ELEMents

This command selects the elements that are included in the buffer.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

<pre>:TRACe:ELEMents <item list> :TRACe:ELEMents? :DATA:ELEMents <item list> :DATA:ELEMents?</pre>	<ul style="list-style-type: none"> ▪ Include timestamp: TStamp ▪ include humidity: HUMidity ▪ Include channel number: CHANnel ▪ Include external temperature: ETEMperature ▪ Include voltage source: VSOURCE ▪ None of the above elements: NONE
--	---

Details

READING, STATUS, RNUMBER (reading number), and UNIT are always enabled for the buffer and are included in the response for the query.

This command includes additional elements for each buffer reading. The [FORMAT:ELEMents](#) command provides a detailed description for each element.

NOTE

Items in the list must be separated by commas.

Also see

[:FORMAT:ELEMents](#) (on page 11-58)
[:SYSTem:TStamp:TYPE](#) (on page 11-165)

:TRACe:FEED:CONTrol

This command specifies the type of buffer control.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:TRACe:FEED:CONTrol <name>
:TRACe:FEED:CONTrol?
:DATA:FEED:CONTrol <name>
:DATA:FEED:CONTrol?
```

<name>

- Disables buffer storage: NEVER
- Fills buffer and stops: NEXT
- Continuously stores readings in buffer: ALWAYS
- Use pretrigger mode to store readings: PRETrigger

Details

When NEVER is selected, storage into the buffer is disabled.

When NEXT is selected, the storage process starts, fills the buffer, and then stops. The buffer size is specified by the :TRACE:POINTS command.

When ALWAYS is selected, the storage process starts and continues to store readings even after the buffer fills. After the buffer fills, readings overwrite the previously stored readings.

When PRETrigger is selected, the buffer stores readings continuously until the programmed pretrigger event occurs. When the pretrigger event occurs, the section of the buffer specified for post-trigger readings fills with new readings. The storage process stops when the post-trigger portion of the buffer is filled with new readings. For example, with a buffer size of 100 readings, there can be 50 readings stored before the trigger event and 50 readings stored after the trigger. In the buffer, the first reading after the trigger is reading zero. Pretrigger readings have reading numbers and relative timestamps with a minus sign. Post-trigger readings have reading numbers and relative timestamps with a plus sign. See the :TRACe:FEED:PRETrigger parameters for more information on the options.

SCPI compliant.

Also see

- [Buffer \(data store\) \(on page 7-1\)](#)
- [:TRACe:FEED:PRETrigger:AMOUNT:READings \(on page 11-171\)](#)
- [:TRACe:FEED:PRETrigger:AMOUNT\[:PERCENT\] \(on page 11-171\)](#)
- [:TRACe:FEED:PRETrigger:SOURce \(on page 11-172\)](#)
- [:TRACe:POINTs \(on page 11-174\)](#)

:TRACe:FEED:PRETrigger:AMOut:READings

This command specifies the number of pretrigger readings.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:TRACe:FEED:PRETrigger:AMOut:READings <n>
:TRACe:FEED:PRETrigger:AMOut:READings <DEF|MIN|MAX>
:DATA:FEED:PRETrigger:AMOut:READings?
:DATA:FEED:PRETrigger:AMOut:READings? <DEF|MIN|MAX>
```

<n>	Number of readings: 0 to MAXimum; see Details
-----	---

Details

This command specifies how much of the defined buffer set by :TRACe:POINTS is used to store pretriggered readings. This command is essentially the same as the :TRACe:FEED:PRETrigger:AMOut[:PERCent] command except the amount is expressed as an exact value rather than as a percent.

The MAXimum parameter is the buffer size as set by :TRACe:POINTS.

Sending a value that exceeds the defined size of the buffer generates an error and the command is ignored.

Also see

[:TRACe:FEED:PRETrigger:AMOut\[:PERCent\]](#) (on page 11-171)
[:TRACe:POINTS](#) (on page 11-174)

:TRACe:FEED:PRETrigger:AMOut[:PERCent]

This command specifies the percent of pretrigger readings.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	50

Usage

```
:TRACe:FEED:PRETrigger:AMOut[:PERCent] <n>
:TRACe:FEED:PRETrigger:AMOut[:PERCent] <DEF|MIN|MAX>
:DATA:FEED:PRETrigger:AMOut[:PERCent]?
:DATA:FEED:PRETrigger:AMOut[:PERCent]? <DEF|MIN|MAX>
```

<n>	Percent of buffer for pretrigger readings: 0 to 100
-----	---

Details

This command specifies how much of the defined buffer (set by :TRACe:POINTS) stores pretriggered readings. When a pretrigger store is started, readings are continuously stored in the buffer. When the pretrigger event occurs, post-trigger readings fill the part of the buffer that is not reserved for pretrigger readings.

For example, assume 25% of a 100-point buffer is reserved for pretrigger readings. When the pretrigger store is started, readings continuously fill the buffer. When the trigger event occurs, subsequent readings are stored starting at buffer location 26 and continue until buffer location 100 is filled. Storage stops after buffer location 100 is filled. The result is 25 pretrigger readings and 75 post-trigger readings.

Also see

- [:SYSTem:MACRo:TRIGger:SOURce](#) (on page 11-191)
- [:TRACe:FEED:CONTrol](#) (on page 11-170)
- [:TRACe:POINts](#) (on page 11-174)

:TRACe:FEED:PRETrigger:SOURce

This command specifies the event for the pretrigger storage mode.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

<pre>:TRACe:FEED:PRETrigger:SOURce <name> :TRACe:FEED:PRETrigger:SOURce? :DATA:FEED:PRETrigger:SOURce <name> :DATA:FEED:PRETrigger:SOURce?</pre>	
<name>	<ul style="list-style-type: none"> ■ Use trigger link as pretrigger event: TLINK ■ Use bus trigger as pretrigger event: BUS ■ Use TRIG key as pretrigger event: MANual ■ EXternal

Details

When the pretrigger mode is selected, readings are stored in the buffer while waiting for the pretrigger source event.

When **TLINK** is selected, an input trigger through the trigger link provides the pretrigger event. The trigger link line used for the input trigger is programmed from the trigger subsystem.

When **BUS** is selected, a GPIB bus trigger (GET or *TRG) provides the pretrigger event.

When **MANual** is selected, pressing the front-panel TRIG key provides the pretrigger event.

Also see

- [:TRACe:FEED:CONTrol](#) (on page 11-170)
- [:TRIGger\[SEQuence\[1\]\]:TCONfigure:PROTocol](#) (on page 11-198)

:TRACe:FREE?

This command reads the status of storage memory.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:TRACe:FREE?  
:DATA:FREE?
```

Details

After sending this command and addressing the 6517B to talk, two values separated by commas are sent to the computer. The first value indicates how many bytes of memory are available, and the second value indicates how many bytes are reserved to store readings.

SCPI compliant.

Also see

None

:TRACe:LAST?

This command reads the last alternating polarity reading stored in the buffer.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:TRACe:LAST?  
:DATA:LAST?
```

Details

When this query command is sent and the 6517B is addressed to talk, the last reading stored in the buffer from the alternating polarity resistance/resistivity test sequence is sent to the computer. The format that the reading is sent over the bus is controlled from the :FORMAT subsystem.

This command only works while the alternating polarity test sequence is running or waiting for a control source event to start the test sequence.

Also see

[FORMAT subsystem](#) (on page 11-57)

:TRACe:POINts

This command sets the number of readings a buffer can store.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	10564

Usage

```
:TRACe:POINTS <n>
:TRACe:POINTS <DEF|MIN|MAX>
:TRACe:POINTS?
:TRACe:POINTS? <DEF|MIN|MAX>
:DATA:POINTS <n>
:DATA:POINTS <DEF|MIN|MAX>
:DATA:POINTS?
:DATA:POINTS? <DEF|MIN|MAX>
```

<n>	Number of readings: 1 to 50000
-----	--------------------------------

Details

When the specified number of readings are stored in the buffer, the buffer is considered to be full.

NOTE

For compatibility with the 6517B, the MAX parameter results in buffer sizes that match the 6517A. The 6517B allows up to 50,000 points to be used if specified.

Maximum buffer readings

Buffer elements					
Channel	Timestamp	Temperature	Humidity	Voltage source	Maximum buffer size
0	0	0	0	0	15847
0	0	0	1	0	11885
0	0	1	0	0	11885
0	0	1	1	0	9507
0	1	0	0	0	10564
0	1	0	1	0	8643
0	1	1	0	0	8643
0	1	1	1	0	7313
1	0	0	0	0	13583
1	0	0	1	0	10564
1	0	1	0	0	10564
1	0	1	1	0	8643
1	1	0	0	0	9507
1	1	0	1	0	7923
1	1	1	0	0	7923
1	1	1	1	0	6791
0	0	0	0	1	11885

Buffer elements					
Channel	Timestamp	Temperature	Humidity	Voltage source	Maximum buffer size
0	0	0	1	1	9507
0	0	1	0	1	9507
0	0	1	1	1	7923
0	1	0	0	1	8643
0	1	0	1	1	7313
0	1	1	0	1	7313
0	1	1	1	1	6338
1	0	0	0	1	10564
1	0	0	1	1	8643
1	0	1	0	1	8643
1	0	1	1	1	7313
1	1	0	0	1	7923
1	1	0	1	1	6791
1	1	1	0	1	6791
1	1	1	1	1	5942

0 = N (not included)
1 = Y (included)

SCPI compliant.

Also see

None

:TRACe:POINts:ACTual?

This command queries the number of readings that are presently stored in the buffer.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

```
:TRACe:POINTS:ACTual?
:DATA:POINTS:ACTual?
```

Details

After sending this command, the number of readings stored in the buffer is sent to the computer when the 6517B is addressed to talk. You can use this command to monitor the storage process.

Also see

None

:TRACe:POINts:AUTO

This command controls the automatic buffer sizing.

Type	Affected by	Where saved	Default value
Command and query	:TRACe:POINts	Not applicable	Not applicable

Usage

```
:TRACe:POINTS:AUTO <b>
:TRACe:POINTS:AUTO?
:DATA:POINTS:AUTO <b>
:DATA:POINTS:AUTO?
```

	Disable automatic buffer sizing: 0 or OFF Enable automatic buffer sizing: 1 or ON
-----	--

Details

When enabled, the buffer size defaults to the measure count value in the trigger model. If the measure count changes, the buffer size changes to match.

If the count value is greater than the maximum buffer size, the buffer is adjusted to the maximum size and the following message is displayed:

```
+314 "Buffer sizing error; sized to MAX" (MAX may be to 50,000 readings)
```

When automatic buffer sizing is disabled, the buffer size is determined by the setting of :TRACe:POINTS.

If you use the :TRACe:POINTS command to change the buffer size when automatic buffer sizing is enabled, the buffer size changes to that value and automatic buffer sizing is automatically disabled.

If you try to enable automatic buffer sizing while the measure count is programmed for infinite, an error occurs and the command is ignored. You cannot have an infinite buffer size.

SCPI compliant.

Also see

[:ARM\[:SEQUence\[1\]\]\[:LAYer\[1\]\]:COUNT](#) (on page 11-184)
[:TRACe:POINTS](#) (on page 11-174)

:TRACe:TSTamp:FORMAT

This command selects the timestamp format for buffer readings.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:TRACe:TSTamp:FORMAT <name>
:TRACe:TSTamp:FORMAT?
:DATA:TSTamp:FORMAT <name>
:DATA:TSTamp:FORMAT?
```

<name>	Reference to first buffer reading: ABSolute Time between buffer readings: DELTa
--------	--

Details

With ABSolute selected, each timestamp is referenced to the first reading stored in the buffer. With DELTa selected, timestamps provide the time between each buffer reading.

Also see

- [:FORMAT:ELEMENTS](#) (on page 11-58)
- [:SYSTem:TSTamp:RELative:RESet](#) (on page 11-164)
- [:SYSTem:TSTamp:TYPE](#) (on page 11-165)
- [:TSEQUence:TYPE](#) (on page 11-221)

TRIGger subsystem

The trigger subsystem includes commands and subsystems that configure the layers of the trigger model. These commands and subsystems are summarized in [:TRIGger command summary](#) (on page 11-23). For more information on trigger models, refer to Trigger models.

:ABORT

This command aborts the operation.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:ABORT
```

Details

When this command is sent, the 6517B aborts the operation and returns to the top of the trigger model. If continuous initiation is disabled, the instrument goes the idle state. If continuous initiation is enabled, operation continues into Arm Layer 1.

The abort command resets the source bypasses of the trigger model. If the instrument is scanning, the scan pointer resets to the first channel in the scan list.

SCPI compliant.

Also see

None

:ARM:[SEQUence[1]]:LAYer2:TImer

This command sets the interval for the scan layer timer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0.1

Usage

```
:ARM:[SEQUence[1]]:LAYer2:TImer <n>
:ARM:[SEQUence[1]]:LAYer2:TImer <DEF|MIN|MAX>
:ARM:[SEQUence[1]]:LAYer2:TImer?
:ARM:[SEQUence[1]]:LAYer2:TImer? <DEF|MIN|MAX>
```

<n>	Timer interval in seconds: 0.001 to 999999.999
-----	--

Details

The timer is in effect only if the timer is the selected control source.

SCPI compliant.

Also see

[:ARM\[:SEQUence\[1\]\]\[:LAYer\[1\]\]:SOURce](#) (on page 11-185)

:ARM[:SEQUence[1]]:LAYer2:COUNt

This command sets the scan layer count.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	See Details

Usage

```
:ARM[:SEQUence[1]]:LAYer2:COUNt <n>
:ARM[:SEQUence[1]]:LAYer2:COUNt <DEF|MIN|MAX>
:ARM[:SEQUence[1]]:LAYer2:COUNt?
:ARM[:SEQUence[1]]:LAYer2:COUNt? <DEF|MIN|MAX>
```

<n>	Count: 1 to 99999 or set to infinite (INF)
-----	--

Details

This command specifies how many times operation loops around the scan and measure layers. For example, if the scan count is set to 10, operation continues to loop around in the scan and measure layer until 10 scans are performed. After the 10th scan, operation proceeds to the arm layer.

:SYSTem:PRESet sets the count to INF. *RST sets the count to 1.

SCPI compliant.

Also see

None

:ARM[:SEQUence[1]]:LAYer2:DELay

This command sets the scan layer delay.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:ARM[:SEQUence[1]]:LAYer2:DELay <n>
:ARM[:SEQUence[1]]:LAYer2:DELay <DEF|MIN|MAX>
:ARM[:SEQUence[1]]:LAYer2:DELay?
:ARM[:SEQUence[1]]:LAYer2:DELay? <DEF|MIN|MAX>
```

<n>	Specify delay in seconds: 0 to 999999.999
-----	---

Details

This command delays operation in the scan layer. After the programmed event occurs, the instrument waits until the delay period expires before proceeding in the trigger model.

SCPI compliant.

Also see

[IEEE-488 trigger model](#) (on page 6-7)

:ARM[:SEQUence[1]]:LAYer2:IMMEDIATE

This command bypasses the scan control source and delay.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:ARM[ :SEQUence[1] ] :LAYer2:IMMEDIATE
```

Details

Use this command to bypass the scan control source of the trigger model.

The instrument must be waiting for the appropriate event when this command is sent. Otherwise, an error occurs and the command is ignored. When the command is sent, the bypass occurs and operation continues.

SCPI compliant.

Also see

None

:ARM[:SEQUence[1]]:LAYer2:SIGNAl

This command bypasses the arm control source.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:ARM[ :SEQUence[1] ] :LAYer2:SIGNAl
```

Details

This command allows you to bypass the specified control source or programmed event. The instrument must be waiting for the event when the command is sent. Otherwise, an error occurs and this command is ignored.

SCPI compliant.

Also see

None

:ARM[:SEQUence[1]]:LAYer2:SOURce

This command specifies the event control source for the scan layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	IMMEDIATE

Usage

```
:ARM[:SEQUence[1]]:LAYer2:SOURce <name>
:ARM[:SEQUence[1]]:LAYer2:SOURce?
```

<name>

- Hold operation in specified layer: HOLD
- Pass operation through specified layer: IMMEDIATE
- Select manual event: MANUAL
- Select GPIB trigger as event: BUS
- Select trigger link as event: TLINK
- Select external triggering as event: EXTERNAL
- Select timer as event: TIMER

Details

With TIMER selected for the scan layer, the event occurs at the beginning of the timer interval and every time it times out. For example, if the scan layer timer is programmed for a 30-second interval, the first pass through the scan layer control source occurs immediately. Subsequent scan events occur every 30 seconds. The interval for the timer is set using the

:ARM[:SEQUence[1]]:LAYer2:TIMER command.

When HOLD is selected, operation stops and waits indefinitely in the scan layer. While in HOLD, you can continue operation by sending :ARM[:SEQUence[1]]:LAYer2:IMMEDIATE or :ARM[:SEQUence[1]]:LAYer2:SIGNAl. If the layer count is more than 1, HOLD is enforced when operation loops back.

When IMMEDIATE is selected, operation immediately passes through the scan layer.

When BUS is selected, you can send a GPIB trigger (GET or *TRG) to continue operation through the scan layer.

When TLINK is selected, operation continues when an input trigger through the trigger link is received.

TLINK is a non-SCPI parameter. All other parameters are SCPI confirmed.

Also see

[:ARM\[:SEQUence\[1\]\]:LAYer2:IMMEDIATE](#) (on page 11-180)
[:ARM\[:SEQUence\[1\]\]:LAYer2:SIGNAl](#) (on page 11-180)
[:ARM\[:SEQUence\[1\]\]:LAYer2:TIMER](#) (on page 11-178)

:ARM[:SEQUence[1]]:LAYer2:TCONfigure:ASYNchronous:ILINe

This command selects the input trigger line for the scan layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2

Usage

```
:ARM[:SEQUence[1]]:LAYer2:TCONfigure:ASYNchronous:ILINe <NRF>
:ARM[:SEQUence[1]]:LAYer2:TCONfigure:ASYNchronous:ILINe?
```

<NRF>	The input trigger line: 1 to 6
-------	--------------------------------

Details

This command selects an input line for the asynchronous trigger link of the scan layer.

The asynchronous trigger link input and output cannot share the same line. If you assign the input to a line that is used for the output, an error occurs and the command is ignored.

Also see

[:ARM\[:SEQUence\[1\]\]:LAYer2:TCONfigure:ASYNchronous:OLINe](#) (on page 11-182)

:ARM[:SEQUence[1]]:LAYer2:TCONfigure:ASYNchronous:OLINe

This command selects the output trigger for the scan layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:ARM[:SEQUence[1]]:LAYer2:TCONfigure:ASYNchronous:OLINe <NRF>
:ARM[:SEQUence[1]]:LAYer2:TCONfigure:ASYNchronous:OLINe?
```

<NRF>	The output trigger line: 1 to 6
-------	---------------------------------

Details

This command selects an output line for the asynchronous trigger link of the scan layer.

The asynchronous trigger link input and output cannot share the same line. If you assign the input to a line that is used for the output, an error occurs and the command is ignored.

Also see

[:TRIGger\[:SEQUence\[1\]\]:TCONfigure:ASYNchronous:ILINe](#) (on page 11-197)

:ARM[:SEQUence[1]]:LAYer2:TCONfigure:DIRECTION

This command controls the source bypass for the scan layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ACCeptor

Usage

```
:ARM[:SEQUence[1]]:LAYer2:TCONfigure:DIRECTION <name>
:ARM[:SEQUence[1]]:LAYer2:TCONfigure:DIRECTION?
```

<name>	Enable source bypass: SOURce Disable source bypass: ACCeptor
--------	---

Details

When a source bypass is enabled and the external or trigger link control source is selected, operation loops past the appropriate control source on the initial pass through the layer. The source bypass also loops past the delay.

If the trigger mode is set to make another pass through the layer (count is more than 1), the bypass loop is not in effect. The bypass loop is in effect if operation first returns to the previous layer or idle.

Enabling the source bypass for the scan layer also enables the output trigger. When operation leaves the scan layer, the appropriate output trigger pulse occurs. If the trigger link control source is selected, the output trigger is available on the programmed trigger link output line. The output trigger is disabled when the source bypass is disabled.

With ACCeptor selected, the bypass is disabled, which means that operation does not proceed through the scan layer until the appropriate event occurs.

Also see

[:ARM\[:SEQUence\[1\]\]:LAYer2:SOURce](#) (on page 11-181)

:ARM[:SEQUence[1]][:LAYer[1]]:COUNT

These commands set the arm layer count.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:ARM[:SEQUence[1]][:LAYer[1]]:COUNT <n>
:ARM[:SEQUence[1]][:LAYer[1]]:COUNT <DEF|MIN|MAX>
:ARM[:SEQUence[1]][:LAYer[1]]:COUNT?
:ARM[:SEQUence[1]][:LAYer[1]]:COUNT? <DEF|MIN|MAX>
```

<n>	Count: 1 to 99999 or set to infinite (INF)
-----	--

Details

This command specifies how many times operation loops around the arm layer. For example, if the count is set to 10, operation continues to loop around in the arm layer until 10 arms occur. After the 10th arm, operation proceeds to idle.

Also see

None

:ARM[:SEQUence[1]][:LAYer[1]]:IMMEDIATE

This command bypasses the arm control source and delays.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:ARM[:SEQUence[1]][:LAYer[1]]:IMMEDIATE
```

Details

Use this command to bypass the arm control source of the trigger model.

The instrument must be waiting for the appropriate event when this command is sent. Otherwise, an error occurs and the command is ignored. When the command is sent, the bypass occurs and operation continues.

SCPI compliant.

Also see

None

:ARM[:SEQUence[1]][:LAYer[1]]:SIGNal

This command bypasses the arm control source.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:ARM[:SEQUence[1]][:LAYer[1]]:SIGNal
```

Details

This command allows you to bypass the specified control source or programmed event. The instrument must be waiting for the event when the command is sent. Otherwise, an error occurs and this command is ignored.

SCPI compliant.

Also see

None

:ARM[:SEQUence[1]][:LAYer[1]]:SOURce

This command specifies the event control source for the arm layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	IMMEDIATE

Usage

```
:ARM[:SEQUence[1]][:LAYer[1]]:SOURce <name>
:ARM[:SEQUence[1]][:LAYer[1]]:SOURce?
```

<name>	<ul style="list-style-type: none"> ▪ Hold operation in specified layer: HOLD ▪ Pass operation through specified layer: IMMEDIATE ▪ Select real-time clock as event: RTCLOCK ▪ Select manual event: MANUAL ▪ Select GPIB trigger as event: BUS ▪ Select trigger link as event: TLINK ▪ Select external triggering as an event: EXTERNAL
--------	---

Details

When HOLD is selected, operation stops and waits indefinitely in the arm layer. While in HOLD, you can continue operation by sending :ARM[:SEQUence[1]][:LAYer[1]]:IMMEDIATE or :ARM[:SEQUence[1]][:LAYer[1]]:SIGNal. If the layer count is more than 1, HOLD is enforced when operation loops back.

When `IMMEDIATE` is selected, operation immediately passes through the arm layer.

When `RTCLOCK` is selected, event detection is satisfied at the date and time set by the `:ARM[:SEQUENCE[1]][:LAYER[1]]:RTCLOCK:DATE` and `RTCLOCK:TIME` commands, allowing operation to continue in the trigger model (see the “IEEE-488 trigger model”).

When `BUS` is selected, you can send a GPIB trigger (`GET` or `*TRG`) to continue operation through the arm layer.

When `TLINK` is selected, operation continues when an input trigger through the trigger link is received.

`TLINK` and `RTCLOCK` are non-SCPI parameters. All other parameters are SCPI confirmed.

Also see

- [:ARM\[:SEQUENCE\[1\]\]\[:LAYER\[1\]\]:IMMEDIATE](#) (on page 11-184)
- [:ARM\[:SEQUENCE\[1\]\]\[:LAYER\[1\]\]:RTCLOCK:DATE](#) (on page 11-188)
- [:ARM\[:SEQUENCE\[1\]\]\[:LAYER\[1\]\]:RTCLOCK:TIME](#) (on page 11-189)
- [:ARM\[:SEQUENCE\[1\]\]\[:LAYER\[1\]\]:SIGNAL](#) (on page 11-185)
- [IEEE-488 trigger model](#) (on page 6-7)

:ARM[:SEQUENCE[1]][:LAYER[1]]:TCONFIGURE:ASYNCHRONOUS:ILINE

This command selects the input trigger line for the arm layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2

Usage

```
:ARM[:SEQUENCE[1]][:LAYER[1]]:TCONFIGURE:ASYNCHRONOUS:ILINE <NRF>
:ARM[:SEQUENCE[1]][:LAYER[1]]:TCONFIGURE:ASYNCHRONOUS:ILINE?
```

<NRF>	The input trigger line: 1 to 6
-------	--------------------------------

Details

This command selects an input line for the asynchronous trigger link of the arm layer.

The asynchronous trigger link input and output cannot share the same line. If you assign the input to a line that is used for the output, an error occurs and the command is ignored.

Also see

- [:ARM\[:SEQUENCE\[1\]\]\[:LAYER\[1\]\]:TCONFIGURE:ASYNCHRONOUS:OLINE](#) (on page 11-187)

:ARM[:SEQUence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:OLINe

This command selects the output trigger line of the arm layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:ARM[:SEQUence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:OLINe <NRF>
:ARM[:SEQUence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:OLINe?
```

<NRF>	The output trigger line: 1 to 6
-------	---------------------------------

Details

This command selects an output line for the asynchronous trigger link of the arm layer.

The asynchronous trigger link input and output cannot share the same line. If you assign the input to a line that is used for the output, an error occurs and the command is ignored.

Also see

[:ARM\[:SEQUence\[1\]\]\[:LAYer\[1\]\]:TCONfigure:ASYNchronous:ILINe](#) (on page 11-186)

:ARM[:SEQUence[1]][:LAYer[1]]:TCONfigure:DIRECTION

This command controls the source bypass for the arm layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ACCeptor

Usage

```
:ARM[:SEQUence[1]][:LAYer[1]]:TCONfigure:DIRECTION <name>
::ARM[:SEQUence[1]][:LAYer[1]]:TCONfigure:DIRECTION?
```

<name>	Enable source bypass: SOURce Disable source bypass: ACCeptor
--------	---

Details

When a source bypass is enabled and the external or trigger link control source is selected, operation loops past the appropriate control source on the initial pass through the layer.

If the trigger mode is set to make another pass through the layer (count is more than 1), the bypass loop is not in effect. The bypass loop is in effect if operation first returns to the previous layer or idle.

Enabling the source bypass for the arm layer also enables the output trigger. When operation leaves the arm layer, the appropriate output trigger pulse occurs. If the trigger link control source is selected, the output trigger is available on the programmed trigger link output line. The output trigger is disabled when the source bypass is disabled.

With **ACCeptor** selected, the bypass is disabled, which means that operation does not proceed through the arm layer until the appropriate event occurs.

Also see

[:ARM\[:SEQUence\[1\]\]\[:LAYer\[1\]\]:SOURce](#) (on page 11-185)

:ARM[:SEQUence[1]][:LAYer[1]]:RTCLock:DATE

This command sets the date for the RTCLock control source.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

`:ARM[:SEQUence[1]][:LAYer[1]]:RTCLock:DATE <yr>, <mo>, <day>`
`:ARM[:SEQUence[1]][:LAYer[1]]:RTCLock:DATE?`

<yr>	Year: 2005 to 2104
<mo>	Month: 1 to 12
<day>	Day: 1 to 31

Details

Setting an invalid date (for example, February 30, 2007) results in an error and the previously set date is retained.

Also see

[:ARM\[:SEQUence\[1\]\]\[:LAYer\[1\]\]:SOURce](#) (on page 11-185)

:ARM[:SEQUence[1]][LAYer[1]]:RTCLOCK:TIME

This command sets the time for the RTCLOCK control source.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:ARM[:SEQUence[1]][LAYer[]]:RTCLOCK:TIME <hr>, <min>, <sec>
:ARM[:SEQUence[1]][LAYer[]]:RTCLOCK:TIME?
```

<hr>	Hour (24-hour format): 0 to 23
<min>	Minute: 0 to 59
<sec>	Second (round to 1/100 seconds): 0.00 to 59.99

Details

The time must be set using the 24-hour format (for example, hour 13 is 1 pm).

Setting an invalid time results in an error. The instrument ignores the new setting and retains the previously set time.

The query returns the time to the nearest hundredth of a second.

Also see

[:ARM\[:SEQUence\[1\]\]\[LAYer\[1\]\]:SOURce](#) (on page 11-185)

:INITiate:CONTinuous

This command enables or disables continuous initiation.

Type	Affected by	Where saved	Default value
Command and query	SYSTem:PRESet Reset	Not applicable	See Details

Usage

```
:INITiate:CONTinuous <b>
:INITiate:CONTinuous?
```

	Disable continuous initiation: OFF or 0 Enable continuous initiation: ON or 1
-----	--

Details

When continuous initiation is selected (ON), the instrument is taken out of the idle state. At the conclusion of all programmed operations, the instrument returns to Arm Layer 1.

Defaults for continuous initiation:

- SYSTem:PRESet enables continuous initiation.
- *RST disables continuous initiation.

SCPI compliant.

Also see

None

:INITiate:POFLag

This command controls the no-operation-pending flag.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	INCLude

Usage

```
:INITiate:POFLag <name>
:INITiate:POFLag?
```

<name>	Include no-operation-pending flag: INCLUDE Exclude no-operation-pending flag: EXCLUDE
--------	--

Details

This command determines if the no-operation-pending flag is included in the internal process of determining whether all pending operations of an initiate command are complete.

Also see

[*OPC](#) (on page 12-7)
[*OPC?](#) (on page 12-8)

:INITiate[:IMMEDIATE]

This command takes the 6517B out of the idle state and initiates a trigger cycle.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:INITiate[:IMMEDIATE]
```

Details

After all programmed operations are completed, the instrument leaves the trigger layers and returns to the idle state if continuous initiation is disabled.

SCPI compliant.

Also see

[:INITiate:CONTinuous](#) (on page 11-189)

:SYSTem:MACRo:TRIGger:MODE

This command specifies the basic trigger mode.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	CONTinuous

Usage

```
:SYSTem:MACRo:TRIGger:MODE <name>
:SYSTem:MACRo:TRIGger:MODE?
```

<name>	Continuous trigger mode: CONTinuous One-shot trigger mode: ONEshot
--------	---

Details

When CONTinuous triggering is selected, the 6517B continuously triggers readings after the selected source event occurs.

When ONEshot triggering is selected, a single reading is triggered every time the selected source event occurs.

Also see

[:SYSTem:MACRo:TRIGger:SOURce \(on page 11-191\)](#)

:SYSTem:MACRo:TRIGger:SOURce

This command specifies the trigger control source.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	IMMEDIATE

Usage

```
:SYSTem:MACRo:TRIGger:SOURce <name>
```

<name>	Immediate triggering: IMMEDIATE Manual trigger event: MANUAL Bus trigger event: BUS External trigger event: EXTERNAL Timer trigger event: TIMER
--------	---

Details

This command specifies the control source that is used as the trigger event for instrument readings. If the instrument is in the continuous trigger mode, the instrument continuously makes readings when the specified event occurs. If it is in the one-shot trigger mode, each event causes a single reading to occur.

With **IMMediate** selected, the trigger event is satisfied immediately. In **IMMediate**, readings are made continuously.

With **MANual** selected, the trigger event occurs when the front-panel **TRIG** key is pressed and the instrument is in local control.

With **BUS** selected, the trigger event occurs when a bus trigger (*TRG or GET) is sent.

With **EXTernal** selected, the trigger event occurs when an input trigger is received through the rear-panel EXT TRIG IN connector.

While in the one-shot mode with **TIMer** selected, trigger events occur at a programmed timer interval. Each time the programmed interval elapses, a reading is triggered. Use

`:ARM:[SEQUence[1]]:LAYer2:TIMer` to set the timer interval.

Also see

[:ARM:\[SEQUence\[1\]\]:LAYer2:TIMer \(on page 11-178\)](#)

[:SYSTem:MACRo:TRIGger:MODE \(on page 11-193\)](#)

:SYSTem:MACRo:TRIGger:TImer

This command sets the interval for the timer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0.1

Usage

```
:SYSTem:MACRo:TRIGger:TImer <n>
:SYSTem:MACRo:TRIGger:TImer <DEF|MIN|MAX>
:SYSTem:MACRo:TRIGger:TImer?
:SYSTem:MACRo:TRIGger:TImer? <DEF|MIN|MAX>
```

<n>

Timer interval in seconds: 0.001 to 99999.999

Details

To select the timer as the control source, send :SYSTem:MACRo:TRIGger:SOURce TIMer.

Also see

[:SYSTem:MACRo:TRIGger:SOURce \(on page 11-191\)](#)

:SYSTem:MACRo:TRIGger[:EXECute]

This command exits from advanced triggering and selects basic triggering.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

`:SYSTem:MACRo:TRIGger[:EXECute]`

Details

If the instrument is already in basic triggering, sending this command has no effect on the instrument.

Also see

None

:TRIGger:[SEQUence[1]]:TImer

This command sets the interval for the measure layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0.1

Usage

```
:TRIGger:[SEQUence[1]]:TImer <n>
:TRIGger:[SEQUence[1]]:TImer <DEF|MIN|MAX>
:TRIGger:[SEQUence[1]]:TImer?
:TRIGger:[SEQUence[1]]:TImer? <DEF|MIN|MAX>
```

<n>	Timer interval in seconds: 0.001 to 999999.999
-----	--

Details

The timer is in effect only if the timer is the selected control source.

SCPI compliant.

Also see

[:TRIGger:\[SEQUence\[1\]\]:SOURce](#) (on page 11-196)

:TRIGger[:SEQUence[1]]:COUNT

These commands set the measure layer count.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	See Details

Usage

```
:TRIGger[:SEQUence[1]]:COUNT <n>
:TRIGger[:SEQUence[1]]:COUNT <DEF|MIN|MAX>
:TRIGger[:SEQUence[1]]:COUNT?
:TRIGger[:SEQUence[1]]:COUNT? <DEF|MIN|MAX>
```

<n>	Count: 1 to 99999 or set to infinite (INF)
-----	--

Details

This command specifies how many times operation loops around the measure layer. For example, if the count is set to 10, operation continues to loop around in the measure layer until 10 measurements are made. After the 10th measurement, operation proceeds to the scan layer.

:SYSTem:PRESet sets the count to INF. The *RST command sets the count to 1.

SCPI compliant.

Also see

None

:TRIGger[:SEQUence[1]]:DELay

This command sets the measure layer delay.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0

Usage

```
:TRIGger[:SEQUence[1]]:DELay <n>
:TRIGger[:SEQUence[1]]:DELay <DEF|MIN|MAX>
:TRIGger[:SEQUence[1]]:DELay?
:TRIGger[:SEQUence[1]]:DELay? <DEF|MIN|MAX>
```

<n>	Specify delay in seconds: 0 to 999999.999
-----	---

Details

This command delays operation in the measure layer. After the programmed event occurs, the instrument waits until the delay period expires before proceeding in the trigger model.

SCPI compliant.

Also see

[IEEE-488 trigger model](#) (on page 6-7)

:TRIGger[:SEQUence[1]]:IMMEDIATE

This command bypasses the measure control source and delay.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:TRIGger[:SEQUence[1]]:IMMEDIATE

Details

Use this command to bypass the measure control source of the trigger model.

The instrument must be waiting for the appropriate event when this command is sent. Otherwise, an error occurs and the command is ignored. When the command is sent, the bypass occurs and operation continues.

SCPI compliant.

Also see

None

:TRIGger[:SEQUence[1]]:SIGNAl

This command bypasses the measure control source.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

:TRIGger[:SEQUence[1]]:SIGNAl

Details

This command allows you to bypass the specified control source or programmed event. The instrument must be waiting for the event when the command is sent. Otherwise, an error occurs and this command is ignored.

SCPI compliant.

Also see

None

:TRIGger[:SEQUence[1]]:SOURCE

This command specifies the event control source for the measure layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	IMMEDIATE

Usage

```
:TRIGger[:SEQUence[1]]:SOURCE <name>
:TRIGger[:SEQUence[1]]:SOURCE?
```

<name>

- Hold operation in specified layer: HOLD
- Pass operation through specified layer: IMMEDIATE
- Select manual event: MANUAL
- Select GPIB trigger as event: BUS
- Select trigger link as event: TLINK
- Select external triggering as event: EXTERNAL
- Select timer as event: TIMER

Details

When HOLD is selected, operation stops and waits indefinitely in the measure layer. While in HOLD, you can continue operation by sending :TRIGger[:SEQUence[1]]:IMMEDIATE or :SIGNAl. If the layer count is more than 1, HOLD is enforced when operation loops back.

When IMMEDIATE is selected, operation immediately passes through the measure layer.

When BUS is selected, you can send a GPIB trigger (GET or *TRG) to continue operation through the measure layer.

When TLINK is selected, operation continues when an input trigger through the trigger link is received.

With TIMER selected for the measure layer, the event occurs at the beginning of the timer interval and every time it times out. For example, if the measure layer timer is programmed for a 30-second interval, the first pass through the measure layer control source occurs immediately. Subsequent scan events occur every 30 seconds. The interval for the timer is set using the :ARM[:SEQUence[1]]:LAYer2:TIMER command.

TLINK is a non-SCPI parameter. All other parameters are SCPI confirmed.

Also see

[:TRIGger\[:SEQUence\[1\]\]:IMMEDIATE](#) (on page 11-195)
[:TRIGger\[:SEQUence\[1\]\]:SIGNAl](#) (on page 11-195)
[:TRIGger\[:SEQUence\[1\]\]:TIMER](#) (on page 11-193)

:TRIGger[:SEQUence[1]]:TCOnfigure:ASYNchronous:ILINe

This command selects the input trigger line for the measure layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2

Usage

```
:TRIGger[:SEQUence[1]]:TCOnfigure:ASYNchronous:ILINe <NRF>
:TRIGger[:SEQUence[1]]:TCOnfigure:ASYNchronous:ILINe?
```

<NRF>	The input trigger line: 1 to 6
-------	--------------------------------

Details

This command selects an input line for the asynchronous trigger link of the measure layer.

The asynchronous trigger link input and output cannot share the same line. If you assign the input to a line that is used for the output, an error occurs and the command is ignored.

Also see

[:ARM\[:SEQUence\[1\]\]:LAYer2:TCOnfigure:ASYNchronous:OLINe](#) (on page 11-182)

:TRIGger[:SEQUence[1]]:TCOnfigure:ASYNchronous:OLINe

This command selects the output trigger for the measure layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:TRIGger[:SEQUence[1]]:TCOnfigure:ASYNchronous:OLINe <NRF>
:TRIGger[:SEQUence[1]]:TCOnfigure:ASYNchronous:OLINe?
```

<NRF>	The output trigger line: 1 to 6
-------	---------------------------------

Details

This command selects an output line for the asynchronous trigger link of the measure layer.

The asynchronous trigger link input and output cannot share the same line. If you assign the input to a line that is used for the output, an error occurs and the command is ignored.

Also see

[:TRIGger\[:SEQUence\[1\]\]:TCOnfigure:ASYNchronous:ILINe](#) (on page 11-197)

:TRIGger[:SEQUence[1]]:TCONfigure:DIRECTION

This command controls the source bypass for the measure layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ACCeptor

Usage

```
:TRIGger[:SEQUence[1]]:TCONfigure:DIRECTION <name>
:TRIGger[:SEQUence[1]]:TCONfigure:DIRECTION?
```

<name>	Enable source bypass: SOURce Disable source bypass: ACCeptor
--------	---

Details

When a source bypass is enabled and the external or trigger link control source is selected, operation loops past the appropriate control source on the initial pass through the layer. The source bypass for the measure layer also loops past the delay.

If the trigger mode is set to make another pass through the layer (count is more than 1), the bypass loop is not in effect. The bypass loop is in effect if operation first returns to the previous layer or the idle state.

The output trigger in the measure layer is always enabled and occurs after the device action.

With ACCeptor selected, the bypass is disabled, which means that operation does not proceed through the measure layer until the appropriate event occurs.

Also see

[:TRIGger\[:SEQUence\[1\]\]:SOURce](#) (on page 11-196)

:TRIGger[:SEQUence[1]]:TCONfigure:PROTOCOL

This command specifies the trigger link protocol for the measure layer trigger link.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	ASYNchronous

Usage

```
:TRIGger[:SEQUence[1]]:TCONfigure:PROTOCOL <name>
:TRIGger[:SEQUence[1]]:TCONfigure:PROTOCOL?
```

<name>	Asynchronous trigger link mode: ASYNchronous Semi-synchronous trigger link mode: SSYNchronous
--------	--

Details

When ASYNchronous is selected, the input and output triggers use separate trigger lines.

With SSYNchronous selected, the input and output triggers use a single trigger line.

NOTE

The arm and scan layers only use the asynchronous trigger link mode.

Also see

None

:TRIGger[:SEQUence[1]]:TCOnfigure:SSYNchronous:LINE

This command specifies the semi-synchronous trigger link for the measure layer.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:TRIGger[:SEQUence[1]]:TCOnfigure:SSYNchronous:LINE <NRf>
:TRIGger[:SEQUence[1]]:TCOnfigure:SSYNchronous:LINE?
```

<NRf>	Trigger link line: 1 to 6
-------	---------------------------

Details

This command selects one of the six trigger lines for the semi-synchronous trigger link.

Also see

[:TRIGger\[:SEQUence\[1\]\]:TCOnfigure:PROTocol](#) (on page 11-198)

TSEQUence subsystem

The commands in this subsystem configure and control the built-in test sequences and are summarized in [:TSEQUence command summary](#) (on page 11-25). For detailed information on the test sequences, refer to [Test sequences](#) (on page 5-1).

In your test programs, use the *OPC? command before arming (:TSEQUence:ARM) the test. The *OPC? command allows previous command operations to finish before arming the test. Failure to do so may cause unfavorable results.

Use SRQ to indicate when a test sequence is finished.

:TSEQuence:ABORt

This command stops the test sequence that is in process.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
:TSEQuence:ABORT
```

Details

You can restart the test sequence by arming the test and providing the programmed source event.

Also see

[:TSEQuence:ARM](#) (on page 11-203)

:TSEQuence:ALTPolarity:ALTVoltage

This command specifies the alternating voltage for the alternating polarity resistance/resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	10 V

Usage

```
:TSEQuence:ALTPolarity:ALTVoltage <NRF>
:TSEQuence:ALTPolarity:ALTVoltage?
```

<NRF>	Alternating voltage: -1000 to 1000
-------	------------------------------------

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:ALTPolarity:DISCard

This command specifies the number of initial readings to discard for the alternating polarity resistance/resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	3

Usage

```
:TSEQuence:ALTPolarity:DISCard <NRf>
:TSEQuence:ALTPolarity:DISCard?
```

<NRf>	Number of readings to discard: 0 to 9999
-------	--

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:ALTPolarity:MTIMe

This command specifies the measure time for the alternating polarity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	15 s

Usage

```
:TSEQuence:ALTPolarity:MTIMe <NRf>
:TSEQuence:ALTPolarity:MTIMe?
```

<NRf>	The measure time in seconds: 0.5 to 9999.9
-------	--

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:ALTPolarity:OFSVoltage

This command specifies the offset voltage for the alternating polarity resistance/resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0 V

Usage

```
:TSEQuence:ALTPolarity:OFSVoltage <NRf>
:TSEQuence:ALTPolarity:OFSVoltage?
<NRf>          Offset voltage: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:ALTPolarity:READings

This command specifies the number of readings to store for the alternating polarity resistance/resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:TSEQuence:ALTPolarity:READings <NRf>
:TSEQuence:ALTPolarity:READings <DEF|MIN|MAX>
:TSEQuence:ALTPolarity:READings?
:TSEQuence:ALTPolarity:READings? <DEF|MIN|MAX>
<NRf>          Number of readings: 1 to the maximum number of readings
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:ARM

This command arms the selected test sequence.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

`:TSEQuence:ARM`

Details

The test starts when the programmed source event occurs.

When using this command for the alternating polarity high resistance/resistivity transition filters, wait at least 0.3 seconds before using the *TRG trigger command.

Also see

[:TSEQuence:TSOrce](#) (on page 11-220)
[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:CIResistance:SPINterval

This command specifies the time interval between measurement points for the cable insulation resistance test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

`:TSEQuence:CIResistance:SPINterval <NRf>`
`:TSEQuence:CIResistance:SPINterval?`

<NRf>	Time interval between measurement points in seconds: 0 to 99999.9
-------	---

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:CIResistance:SPOints

This command specifies the number of measurement points for the cable insulation resistance test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	5

Usage

```
:TSEQuence:CIResistance:SPOints <NRf>
:TSEQuence:CIResistance:SPOints?
```

<NRf>

Number of points in test sequence: 1 to the maximum buffer size

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:CIResistance:SVOLtage

This command specifies the bias voltage for the cable insulation resistance test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:CIResistance:SVOLtage <NRf>
:TSEQuence:CIResistance:SVOLtage?
```

<NRf>

Bias voltage for 100 V range: -100.0 to 100.0
Bias voltage for 1000 V range: -1000 to 1000

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:CLEakage:SPINterval

This command specifies the time interval between measurement points for the capacitor leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:CLEakage:SPINterval <NRf>
:TSEQuence:CLEakage:SPINterval?

<NRf>           Interval in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:TSOrce](#) (on page 11-220)

:TSEQuence:CLEakage:SPOints

This command specifies the number of leakage test points for the capacitor leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	10

Usage

```
:TSEQuence:CLEakage:SPOints <NRf>
:TSEQuence:CLEakage:SPOints?

<NRf>           Number of points in the test sequence: 1 to the maximum buffer size
```

Also see

None

:TSEQuence:CLEARge:SVOLtage

This command specifies the bias voltage for the capacitor leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:CLEARge:SVOLtage <NRf>
:TSEQuence:CLEARge:SVOLtage?

<NRf>          Bias voltage for 100 V range: -100.0 to 100.0
                           Bias voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:DLEARge:MDELay

This configuration command specifies the measure delay for the diode leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:DLEARge:MDELay <NRf>
:TSEQuence:DLEARge:MDELay?

<NRf>          Delay in seconds: 0 to 10000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:DLEakage:STARt

This command specifies the start voltage for the diode leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:DLEakage:STARt <NRf>
:TSEQuence:DLEakage:STARt?

<NRf>          Start voltage for 100 V range: -100.0 to 100.0
                           Start voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:DLEakage:STEP

This command specifies the step voltage for the diode leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:DLEakage:STEP <NRf>
:TSEQuence:DLEakage:STEP?

<NRf>          Step voltage for 100 V range: -100.0 to 100.0
                           Step voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:DLEakage:STOP

This command specifies the stop test voltages and queries the stop voltage for the diode leakage test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	10 V

Usage

```
:TSEQuence:DLEakage:STOP <NRf>
:TSEQuence:DLEakage:STOP?
```

<NRf>	Stop voltage for 100 V range: -100.0 to 100.0 Stop voltage for 1000 V range: -1000 to 1000
-------	---

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:RVCoefficient:MDELay2

This configuration command specifies measure delay 2 for the resistor voltage coefficient test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:RVCoefficient:MDELay2 <NRf>
:TSEQuence:RVCoefficient:MDELay2?
```

<NRf>	Delay in seconds: 0 to 99999.9
-------	--------------------------------

Also see

[:TSEQuence:RVCoefficient:MDELay\[1\]](#) (on page 11-209)
[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:RVCoefficient:MDELay[1]

This configuration command specifies measure delay 1 for the resistor voltage coefficient test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:RVCoefficient:MDELay[1] <NRf>
:TSEQuence:RVCoefficient:MDELay[1]?

<NRf>           Delay in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:RVCoefficient:MDELay2](#) (on page 11-208)
[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:RVCoefficient:SVOLTage2

This command specifies bias voltage 2 for the resistor voltage coefficient test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2 V

Usage

```
:TSEQuence:RVCoefficient:SVOLTage2 <NRf>
:TSEQuence:RVCoefficient:SVOLTage2?

<NRf>           Bias voltage for 100 V range: -100.0 to 100.0
                  Bias voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:RVCoefficient:SVOLTage\[1\]](#) (on page 11-210)
[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:RVCoefficient:SVOLTage[1]

This command specifies bias voltage 1 for the resistor voltage coefficient test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:RVCoefficient:SVOLTage[1] <NRf>
:TSEQuence:RVCoefficient:SVOLTage[1]?

<NRf>          Bias voltage for 100 V range: -100.0 to 100.0
                           Bias voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SIResistance:MTIMe

This command specifies the measure time for the surface insulation resistance test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:SIResistance:MTIMe <NRf>
:TSEQuence:SIResistance:MTIMe?

<NRf>          The measure time in seconds: 0 to 9999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SIResistance:MOVoltage

This command specifies the measure voltage for the surface insulation resistance test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	100 V

Usage

```
:TSEQuence:SIResistance:MOVoltage <NRf>
:TSEQuence:SIResistance:MOVoltage?

<NRf>          Measure voltage for 100 V range: -100.0 to 100.0
                           Measure voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SIResistance:STIMe

This command specifies the bias time for the surface insulation resistance test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:SIResistance:STIMe <NRf>
:TSEQuence:SIResistance:STIMe?

<NRf>          Bias time in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SIResistance:SVOLtage

This command specifies the bias voltage for the surface insulation resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	50 V

Usage

```
:TSEQuence:SIResistance:SVOLtage <NRf>
:TSEQuence:SIResistance:SVOLtage?

<NRf>          Bias voltage for 100 V range: -100.0 to 100.0
                           Bias voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SQSWeep:COUNt

This command specifies how many times to repeat the programmed square wave cycle.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	Not applicable

Usage

```
:TSEQuence:SQSWeep:COUNT <NRf>
:TSEQuence:SQSWeep:COUNT?

<NRf>          The number of times to repeat the cycle: 1 to MAX
```

Also see

None

:TSEQuence:SQSWeep:HLEVel

This command specifies the high-level voltage for the square wave sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:SQSWeep:HLEVel <NRf>
:TSEQuence:SQSWeep:HLEVel?

<NRf>          Voltage for 100 V range: -100.0 to 100.0
                           Voltage for 1000 V range: -1000 to 1000
```

Also see

None

:TSEQuence:SQSWeep:HTIMe

This command specifies the high-level time for the square wave sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:SQSWeep:HTIMe <NRf>
:TSEQuence:SQSWeep:HTIMe?

<NRf>          The time in seconds: 0 to 9999.9
```

Also see

None

:TSEQuence:SQSWeep:LLEVel

This command specifies the low-level voltage for the square wave sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	-1 V

Usage

```
:TSEQuence:SQSWeep:LLEVel <NRf>
:TSEQuence:SQSWeep:LLEVel?

<NRf>          Voltage for 100 V range: -100.0 to 100.0
                           Voltage for 1000 V range: -1000 to 1000
```

Also see

None

:TSEQuence:SQSWeep:LTIMe

This command specifies the low-level time for the square wave sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:SQSWeep:LTIMe <NRf>
:TSEQuence:SQSWeep:LTIMe?

<NRf>          Time in seconds: 0 to 9999.9
```

Also see

None

:TSEQuence:SRESistivity:DTIMe

This command specifies the discharge time for the surface resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2 s

Usage

```
:TSEQuence:SRESistivity:DTIMe <NRf>
:TSEQuence:SRESistivity:DTIMe?
<NRf>          The discharge time in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SRESistivity:MTIMe

This command specifies the measure time for the surface resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:SRESistivity:MTIMe <NRf>
:TSEQuence:VRESistivity:MTIMe <NRf>
:TSEQuence:SIResistance:MTIMe <NRf>
:TSEQuence:ALTPolarity:MTIMe <NRf>
:MTIMe?
<NRf>          The measure time in seconds: 0 to 9999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SRESistivity:MVOLtage

This command specifies the measure voltage for the surface resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	500 V

Usage

```
:TSEQuence:SRESistivity:MVOLtage <NRf>
:TSEQuence:SRESistivity:MVOLtage?

<NRf>          Measure voltage for 100 V range: -100.0 to 100.0
                           Measure voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SRESistivity:PDTIme

This command specifies the predischarge time for the surface resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	0.2 s

Usage

```
:TSEQuence:SRESistivity:PDTIme <NRf>
:TSEQuence:SRESistivity:PDTIme?

<NRf>          The predischarge time in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SRESistivity:STIMe

This command specifies the bias time for the surface resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:SRESistivity:STIMe <NRf>
:TSEQuence:SRESistivity:STIMe?
<NRf>          Bias time in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:SRESistivity:SVOLTage

This command specifies the bias voltage for the surface resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	500 V

Usage

```
:TSEQuence:SRESistivity:SVOLTage <NRf>
:TSEQuence:SRESistivity:SVOLTage?
<NRf>          Bias voltage 100 V range: -100.0 to 100.0
                           Bias voltage 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:STSWeep:STARt

This command specifies the start voltage for the staircase sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:STSWeep:START <NRf>
:TSEQuence:STSWeep:START?

<NRf>          Start voltage for 100 V range: -100.0 to 100.0
                           Start voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:STSWeep:STEP

This command specifies the step voltage of the staircase sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 V

Usage

```
:TSEQuence:STSWeep:STEP <NRf>
:TSEQuence:STSWeep:STEP?

<NRf>          Step voltage for 100 V range: -100.0 to 100.0
                           Step voltage for 1000 V range: -1000 to 1000
```

Also see

None

:TSEQuence:STSWeep:STIMe

This command specifies the step time for the staircase sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:STSWeep:STIMe <NRf>
:TSEQuence:STSWeep:STIMe?
<NRf>           Step time in seconds: 0 to 99999.9
```

Also see

None

:TSEQuence:STSWeep:STOP

This command specifies the stop voltage for the staircase sweep test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	10 V

Usage

```
:TSEQuence:STSWeep:STOP <NRf>
:TSEQuence:STSWeep:STOP?
<NRf>           Stop voltage for 100 V range: -100.0 to 100.0
                           Stop voltage for 1000 V range: -1000 to 1000
```

Also see

None

:TSEQuence:TLIne

This command specifies and queries the trigger link line for the trigger link control source.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1

Usage

```
:TSEQuence:TLIne <NRf>
:TSEQuence:TLIne?
```

<NRf>	Trigger link line: 1 to 6
-------	---------------------------

Details

This command is ignored if another control source is selected.

Also see

[:TSEQuence:TSOrce](#) (on page 11-220)

:TSEQuence:TSOrce

This command selects and queries the control source that starts the test sequence.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	MANual

Usage

```
:TSEQuence:TSOrce <name>
:TSEQuence:TSOrce?
```

<name>	Manual control source: MANual Immediate control source: IMMEDIATE Bus trigger control source: BUS External trigger control source: EXTERNAL Trigger link control source: TLINK Test fixture lid closure: LCLOSURE
--------	--

Details

When the selected control source event occurs, the test starts.

When **MANual** is selected, the test starts when the SEQ key is pressed.

When **IMMEDIATE** is selected, the test starts as soon as the instrument is taken out of the idle state.
The :INITiate and :INITiate:CONTinuous ON commands take the instrument out of the idle

state. If the instrument is already in the continuous measurement mode, the test starts as soon as IMMEDIATE is selected.

When BUS is selected, the test starts when a bus trigger (*TRG or GET) is sent over the bus.

When TLINK is selected, the test starts when an external trigger is received through the TRIG LINK connector on the rear panel. The :TSEQUENCE:TLINE command selects the trigger link line to use for the input trigger.

When LCLOSURE is selected, the test starts when the test fixture lid is closed. This is only available for test fixtures (such as the Model 8009) that incorporate the safety interlock feature. If any sequence is armed when this command is sent, it does not take effect until the next sequence arm event.

Also see

- [:INITiate:CONTinuous \(on page 11-189\)](#)
- [:INITiate\[:IMMEDIATE\] \(on page 11-190\)](#)
- [:TSEQUENCE:TLINE \(on page 11-220\)](#)

:TSEQUENCE:TYPE

This command selects and queries a test sequence.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	DLEakage

Usage

```
:TSEQUENCE:TYPE <name>
:TSEQUENCE:TYPE?
```

<name>	The test sequence: <ul style="list-style-type: none"> ▪ Diode leakage test: DLEakage ▪ Capacitor leakage test: CLEakage ▪ Cable insulation resistance test: CIResistance ▪ Resistor voltage coefficient test: RVCoefficient ▪ Surface resistivity test: SRESistivity ▪ Volume resistivity test: VRESistivity ▪ Surface insulation resistance test: SIResistance ▪ Square wave sweep test: SQSweep ▪ Staircase sweep test: STSweep ▪ Alternating polarity resistance/resistivity test: ALTPolarity
--------	---

Details

When test sequence is started, the selected test runs according to its configuration.

Also see

- [:TSEQUENCE:TSOURCE \(on page 11-220\)](#)

:TSEQuence:VRESistivity:DTIMe

This command specifies the discharge time for the volume resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	2 s

Usage

```
:TSEQuence:VRESistivity:DTIMe <NRf>
:TSEQuence:VRESistivity:DTIMe?

<NRf>           The discharge time in seconds: 0 to 99999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:VRESistivity:MTIMe

This command specifies the measure time for the volume resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:VRESistivity:MTIMe <NRf>
:TSEQuence:VRESistivity:MTIMe?

<NRf>           The measure time in seconds: 0 to 9999.9
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:VRESistivity:MVLtage

This command specifies the measure voltage for the volume resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	500 V

Usage

```
:TSEQuence:VRESistivity:MVLtage <NRf>
:TSEQuence:VRESistivity:MVLtage?

<NRf>           Measure voltage for 100 V range: -100.0 to 100.0
                  Measure voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:VRESistivity:PDTIme

This command specifies the predischarge time for the volume resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	10 s

Usage

```
:TSEQuence:VRESistivity:PDTIme <NRf>
:TSEQuence:VRESistivity:PDTIme?
```

<NRf>	The predischarge time in seconds: 0 to 99999.9
-------	--

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:VRESistivity:STIMe

This command specifies the bias time for the volume resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	1 s

Usage

```
:TSEQuence:VRESistivity:STIMe <NRf>
:TSEQuence:VRESistivity:STIMe?
```

<NRf>	Bias time in seconds: 0 to 99999.9
-------	------------------------------------

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

:TSEQuence:VRESistivity:SVOLTage

This command specifies the bias voltage for the volume resistivity test.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	500 V

Usage

```
:TSEQuence:VRESistivity:SVOLTage <NRf>
:TSEQuence:VRESistivity:SVOLTage?

<NRf>          Bias voltage for 100 V range: -100.0 to 100.0
                           Bias voltage for 1000 V range: -1000 to 1000
```

Also see

[:TSEQuence:TYPE](#) (on page 11-221)

UNIT subsystem

The UNIT subsystem selects measurement units for temperature readings.

:UNIT:TEMPerature

This command sets the unit of measurement used for temperature readings.

Type	Affected by	Where saved	Default value
Command and query	Recall settings SYSTem:PRESet Instrument reset Power cycle	Save settings	C

Usage

```
:UNIT:TEMPerature <unitOfMeasure>
:UNIT:TEMPerature?

<unitOfMeasure>          The unit of measurement:
                           ■ Celsius: C or CEL
                           ■ Fahrenheit: F or FAR
                           ■ Kelvin: K
```

Details

This command selects the units for temperature readings (internal and external). This command controls the temperature reading units for the displays, buffer readings, and readings sent over the bus.

Also see

None

Section 12

Common commands

In this section:

Introduction	12-1
Common command summary.....	12-1
Common command descriptions	12-2

Introduction

This section provides detailed information on common IEEE-488.2 commands for the 6517B.

Common command summary

Common commands are device commands that are common to all devices on the bus. These commands are designated and defined by the IEEE-488.2 standard.

Common commands begin with *. Commands consist of three letters. Queries have three letters followed by ?.

The common commands that are available for the 6517B are provided in the following table.

IEEE-488.2 common commands and queries

Command	Name	Description*
*CLS	Clear status	Clears the event registers and queues.
*ESE <NRf>	Event enable command	Sets bits in the standard event enable register.
*ESE?	Event enable query	Reads the standard event enable register.
*ESR?	Event status register query	Reads the standard event status register and clears it.
*IDN?	Identification query	Retrieves the identification string of the instrument.
*OPC	Operation complete command	Sets the operation complete (OPC) bit after all pending commands, including overlapped commands, have been executed.
*OPC?	Operation complete query	Places a 1 in the output queue after all pending operations are completed.
*OPT?	Option identification query	Returns the model number of the option installed in the option slot of the 6517B or 0 if no option is installed.
*RCL <NRf>	Recall command	Returns the instrument to the setup that was stored in a specified memory location.
*RST	Reset command	Resets the instrument settings to their default values.
*SAV <NRf>	Save command	Saves the present instrument settings as a user-saved setup.

Command	Name	Description*
*SRE <NRf>	Service request enable command	Programs the service request enable register.
*SRE?	Service request enable query	Reads the service request enable register.
*STB?	Read status byte query	Reads the status byte register.
*TRG	Trigger command	Sends a bus trigger to the 6517B.
*TST?	Self-test query	Runs self test and reads the result.
*WAI	Wait-to-continue command	Postpones the execution of subsequent commands until all previous overlapped commands are finished.

* See [Status Structure](#) (on page 13-1) for status structure details.

Common command descriptions

*CLS

This command clears the event registers and queues.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

*CLS

Details

Use the *CLS command to clear (reset to 0) the bits of the following registers in the 6517B:

- Operation Event Register
- Error Queue
- Questionable Event Register
- Standard Event Register

Example

```
*CLS
Clear the event registers and queues.
```

Also see

- [Status model](#) (on page 13-1)
- [*ESR?](#) (on page 12-5)
- [*STB?](#) (on page 12-13)

*ESE

This command sets and queries bits in the status enable register of the standard event register.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	See Details

Usage

*ESE <NRF>

*ESE?

<NRF>	The value of the status enable register: <ul style="list-style-type: none"> ■ 0: Clear register ■ 1: Set OPC (B0) ■ 4: Set QYE (B2) ■ 8: Set DDE (B3) ■ 16: Set EXE (B4) ■ 32: Set CME (B5) ■ 64: Set URQ (B6) ■ 128: Set PON (B7) ■ 255: Set all bits
-------	--

Details

The *ESE command programs the standard event enable register. This command is sent with the decimal equivalent of the binary value that determines the state (0 or 1) of the bits in the register. This register is cleared on power-up.

This register is used as a mask for the standard event status register. When a standard event is masked, the occurrence of that event does not set the event summary bit (ESB) in the status byte register. Conversely, when a standard event is unmasked (enabled), the occurrence of that event sets the ESB bit.

A cleared bit (0) in the enable register prevents (masks) the ESB bit in the status byte register from setting when the corresponding standard event occurs. A set bit (1) in the enable register enables the ESB bit to set when the corresponding standard event occurs.

The standard event enable register is shown in the following table and includes the decimal weight of each bit. The sum of the decimal weights of the bits to be set is the parameter value that is sent with the *ESE command.

If a command error (CME) occurs, bit B5 of the standard event status register sets. If a query error (QYE) occurs, bit B2 of the standard event status register sets. Because both events are unmasked (enabled), the occurrence of any one of them causes the ESB bit in the status byte register to set.

The standard event status register can be read by using the `*ESE?` query command.

Standard event enable register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	PON	URQ	CME	EXE	DDE	QYE	—	OPC
Decimal weighting	128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	—	1 (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	—	0/1

Bits B8 through B15 are not shown because they are not used.

Values are:

- 1 = Enable Standard Event
- 0 = Disable (Mask) Standard Event

Events are:

- PON = Power On
- URQ = User Request
- CME = Command Error
- EXE = Execution Error
- DDE = Device-dependent Error
- QYE = Query Error
- OPC = Operation Complete

Example

*ESE 36	Sets the CME and QYE bits of the Standard Event Register, where: <ul style="list-style-type: none"> ■ CME (bit B5) = Decimal 32 ■ QYE (bit B2) = Decimal 4 ■ The Status Enable register is 36
---------	--

Also see

- [*CLS \(on page 12-2\)](#)
[Status model \(on page 13-1\)](#)

*ESR?

This command reads the standard event status register and clears it.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

*ESR?

Details

This command acquires the value of the standard event status register (see the following table). The binary equivalent of the returned decimal value determines which bits in the register are set. This register is cleared on power-up or when *CLS is sent.

A set bit in this register indicates that a particular event has occurred. For example, for an acquired decimal value of 48, the binary equivalent is 00110000. For this binary value, bits B4 and B5 of the standard event status register are set. These set bits indicate that a device-dependent error and command error have occurred.

Standard event status register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	PON	URQ	CME	EXE	DDE	QYE	—	OPC
Decimal weighting	128 (2 ⁷)	64 (2 ⁶)	32 (2 ⁵)	16 (2 ⁴)	8 (2 ³)	4 (2 ²)	—	1 (2 ⁰)
Value	0/1	0/1	0/1	0/1	0/1	0/1	—	0/1

Bits B8 through B15 are not shown because they are not used.

Values are:

- 1 = Event Bit Set
- 0 = Event Bit Cleared

Events are:

- PON = Power On
- URQ = User Request
- CME = Command Error
- EXE = Execution Error
- DDE = Device-dependent Error
- QYE = Query Error
- OPC = Operation Complete

The bits of the standard event status register are described as follows:

Bit B0, operation complete (OPC): Set bit indicates that all pending selected device operations are completed and the 6517B is ready to accept new commands; this bit only sets in response to the *OPC? query command.

Bit B1: Not Used

Bit B2, query error (QYE): Set bit indicates that you attempted to read data from an empty output queue.

Bit B3, device-dependent error (DDE): Set bit indicates that an instrument operation did not execute properly due to some internal condition (such as Settings Conflict errors and buffer-sizing and mismatch errors).

Bit B4, execution error (EXE): Set bit indicates that the 6517B detected an error when trying to execute a command.

Bit B5, command error (CME): Set bit indicates that a command error has occurred. Command errors include:

- IEEE-488.2 syntax error: 6517B received a message that does not follow the defined syntax of the IEEE-488.2 standard.
- Semantic error: 6517B received a command that was misspelled or received an optional IEEE-488.2 command that is not implemented.
- The instrument received a group execute trigger (GET) inside a program message.

Bit B6, user request (URQ): Set bit indicates that the LOCAL key on the 6517B front panel was pressed.

Bit B7, power on (PON): Set bit indicates that the 6517B was turned off and turned back on since the last time this register was read.

Also see

None

*IDN?

This command retrieves the identification string of the instrument.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

* IDN?

Details

The identification string includes the manufacturer, model number, serial number, and firmware revision of the instrument. The string is formatted as follows:

```
KEITHLEY INSTRUMENTS, MODEL nnnn, xxxxxxxx, yyyy/zzzz
```

Where:

- *nnnn* is the model number
- *xxxxxxxx* is the serial number
- *yyyy/zzzz* is the firmware revision levels of the digital board ROM and display board ROM

Example

*IDN?	Output: KEITHLEY INSTRUMENTS, MODEL 6517B, 01234567/1.0.0i
-------	--

Also see

None

***OPC**

This command sets the operation complete (OPC) bit after all pending commands, including overlapped commands, have been executed.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

```
*OPC
```

Details

On power-up, or when ***CLS** or ***RST** is executed, the 6517B goes into the operation complete command idle state (OCIS). In this state, there are no pending overlapped commands. The overlapped commands used by the 6517B are:

- :INITiate:CONTinuous ON
- :INITiate
- *TRG

When the ***OPC** command is sent, the 6517B exits from OCIS and enters the operation complete command active state (OCAS). In OCAS, the instrument continuously monitors the no-operation-pending flag. After the last pending overlapped command is complete (no-operation-pending flag set to true), the operation complete (OPC) bit in the standard event status register sets and the instrument goes back into OCIS.

The instrument always goes into OCAS when ***OPC** is executed. If there are no pending command operations (for example, the trigger model is in the idle state), the 6517B immediately sets the OPC bit and returns to OCIS.

When used with the :INITiate or :INITiate:CONTinuous ON command, the OPC bit of the standard event status register does not set until the 6517B returns to the idle state. The initiate operations are not considered to be complete until the instrument is in the idle state.

The :INITiate:POFLag command includes or excludes the no-operation-pending flag in the internal process of determining if all pending operations of an initiate command are complete.

When used with the *TRG command, the OPC bit is not set until the operations associated with the *TRG command (and the initiate command) are finished. The *TRG command is considered to be finished when the device action block completes or when operation stops a control source to wait for an event.

To use the *OPC exclusively with the *TRG command, first force the completion of the initiate command so that only the *TRG command is pending. To do this, send the :ABORT command to place the instrument in idle, which completes the initiate command. If continuous initiation is on, operation continues into the trigger model. After sending the *TRG command, the OPC bit sets when the *TRG command is finished.

Also see

[:INITiate:POFLag](#) (on page 11-190)

*OPC?

This command places a 1 in the output queue after all pending operations are completed.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

*OPC?

Details

On power-up, or when *CLS or *RST is executed, the 6517B goes into the operation complete command query idle state (OQIS). In this state there are no pending overlapped commands. The overlapped commands used by the 6517B are:

- :INITiate:CONTinuous ON
- :INITiate
- *TRG

When the *OPC? command is sent, the 6517B exits from OQIS and enters the operation complete command active state (OQAS). In OQAS, the instrument continuously monitors the no-operation-pending flag. After the last pending overlapped command is completed (no-operation-pending flag set to true), an ASCII character 1 is placed into the output queue, the message available (MAV) bit in the status byte sets, and the instrument goes back into OQIS. Addressing the 6517B to talk sends the ASCII 1 to the computer.

The instrument always goes into OQAS when *OPC? is executed. If there are no pending command operations (for example, the trigger model in the idle state), the 6517B immediately places an ASCII 1 in the output queue, sets the MAV bit, and returns to OQIS.

When used with the :INITiate or :INITiate:CONTinuous ON command, an ASCII 1 is not sent to the output queue and the MAV bit is not set until the 6517B returns to the idle state. The initiate operations are not considered to be finished until the instrument goes into the idle state.

The :INITiate:POFLag command includes or excludes the no-operation-pending flag in the internal process of determining whether all pending operations of an initiate command are completed.

When used with the *TRG command, an ASCII 1 is not placed into the output queue and the MAV bit is not set until the operations associated with the *TRG command (and the initiate command) are complete. The *TRG command is considered to be finished when the device action completes or when operation stops at a control source to wait for an event (see [IEEE-488 trigger model](#) (on page 6-7) for more information).

To use *OPC? exclusively with the *TRG command, force the completion of the initiate command so that only the *TRG command is pending. To do this, send the :ABORT command to place the instrument in idle, which completes the initiate command. If continuous initiation is on, operation continues into the trigger model. After sending the *TRG command, an ASCII 1 is placed in the Output Queue and the MAV bit sets when the *TRG command is finished.

After *OPC? executes, you cannot send additional commands to the 6517B until the pending overlapped commands are finished. For example, :INITiate:CONTinuous ON followed by *OPC? locks up the instrument and requires a device clear (DCL or SDC) before it accepts any more commands.

Also see

- [:INITiate:CONTinuous](#) (on page 11-189)
- [:INITiate:POFLag](#) (on page 11-190)
- [*OPC](#) (on page 12-7)
- [*TRG](#) (on page 12-15)
- [*WAI](#) (on page 12-16)

*OPT?

This command determines which option is installed.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

*OPT?

Details

The response message provides the model number of the option installed in the option slot of the 6517B. If there is no option installed, a zero (0) is returned.

Also see

- None

*RCL

This command returns the instrument to the setup that was stored in a specified memory location.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

*RCL <n>

<n>

An integer from 0 to 9 that represents the saved setup

Details

This command returns the 6517B to a setup configuration stored at a memory location. The *SAV command stores a setup configuration at a memory location.

The 6517B is shipped from the factory with :SYSTem:PRESet defaults loaded into the available setup memories. If a recall error occurs, the setup memories default to the :SYSTem:PRESet values.

Example

*RCL 3

Restores the settings stored in memory location 3.

Also see

“Saving setups” in the *Model 6517B User’s Manual*

[:SYSTem:PRESet](#) (on page 11-162)

[*SAV](#) (on page 12-11)

*RST

This command resets the instrument settings to their default values.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

*RST

Details

Returns the instrument to default settings, cancels all pending commands, and cancels the response to any previously received *OPC and *OPC? commands.

NOTE

For RS-232 operation (and in some cases, GPIB operation), use *OPC or *OPC? with *RST, which is a command that responds slowly.

Also see

[*OPC](#) (on page 12-7)

[*OPC?](#) (on page 12-8)

*SAV

This command saves the present instrument settings as a user-saved setup.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Nonvolatile memory	Not applicable

Usage

*SAV <n>

<n>	The memory location: 0 to 9
-----	-----------------------------

Details

Save the present instrument settings as a user-saved setup. You can restore the settings with the *RCL command.

Any control affected by *RST is saved by the *SAV command.

You can save up to ten user-saved setups. Any settings that had been stored previously as <n> are overwritten.

Example

*SAV 2	Saves the instrument settings in memory location 2.
--------	---

Also see

“Saving setups” in the *Model 6517B User’s Manual*

[*RCL \(on page 12-10\)](#)

*SRE

This command sets or clears the bits of the service request enable register.

Type	Affected by	Where saved	Default value
Command and query	Not applicable	Not applicable	See Details

Usage

*SRE <NRf>

*SRE?

<NRf>	0: Clear enable register 1: Set MSB bit (bit 0) 4: Set EAV bit (bit 2) 8: Set QSB bit (bit 3) 16: Set MAV bit (bit 4) 32: Set ESB bit (bit 5) 128: Set OSB bit (bit 7) 255: Set all bits
-------	---

Details

The `*SRE` command programs the service request enable register. This command is sent with the decimal equivalent of the binary value that determines the state (0 or 1) of each bit in the register. This register is cleared on power-up.

This enable register is used with the status byte register to generate service requests (SRQ). With a bit in the service request enable register set, an SRQ occurs when the corresponding bit in the status byte register is set by an appropriate event. For details on register structure, refer to [Status model](#) (on page 13-1).

The service request enable register is shown in the following table. The sum of the decimal weights of the bits to set is the value that is sent with the `*SRE` command.

You can read the contents of the service request enable register using the `*SRE?` query command.

Service request enable register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	OSB	—	ESB	MAV	QSB	EAV	—	MSB
Decimal weighting	128 (2^7)	—	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	—	1 (2^0)
Value	0/1	—	0/1	0/1	0/1	0/1	—	0/1

Values are:

- 1 = Enable Service Request Event
- 0 = Disable (Mask) Service Request Event

Events are:

- OSB = Operation Summary Bit
- ESB = Event Summary Bit
- MAV = Message Available
- QSB = Questionable Summary Bit
- EAV = Error Available
- MSB = Measurement Summary Bit

Example

`*SRE 48`

Set the ESB and MAV bits of the service request enable register, where:

- ESB (bit B5) = 32
- MAV (bit B4) = 16
- $\langle \text{NRF} \rangle = 48$

Also see

None

*STB?

This command reads the status byte register.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

*STB?

Details

The *STB? query command acquires the value of the status byte register. The status byte register is shown in the following table. The binary equivalent of the decimal value determines which bits in the register are set.

All bits except bit 6 in this register are set by other event registers and queues. Bit 6 sets when one or more enabled conditions occur.

The *STB? query command does not clear the status byte register. This register can only be cleared by clearing the related registers and queues. Register and queue structure are explained in [Status structure](#) (on page 13-1).

For example, for an acquired decimal value of 48, the binary equivalent is 00110000. This binary value indicates that bits 4 and 5 of the status byte register are set.

Status byte register

Bit position	B7	B6	B5	B4	B3	B2	B1	B0
Event	OSB	MSS, RQS	ESB	MAV	QSB	EAV	—	MSB
Decimal weighting	128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	—	1 (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	—	0/1

Values are:

- 1 = Event Bit Set
- 0 = Event Bit Cleared

Events are:

- OSB = Operation Summary Bit
- MSS = Master Summary Status
- RQS = Request Service
- ESB = Event Summary Bit
- MAV = Message Available
- QSB = Questionable Summary Bit
- EAV = Error Available
- MSB = Measurement Summary Bit

The bits of the status byte register are described as follows:

Bit 0, measurement status (MSB): Set bit indicates that a measurement event has occurred. The event can be identified by reading the measurement event status register using the :STATus:MEASurement? command (see [SCPI command reference](#) (on page 11-1)).

Bit 1: Not used.

Bit 2, error available (EAV): Set bit indicates that an error or status message is present in the error queue. The message can be read using one of the following SCPI commands (see [SCPI command reference](#) (on page 11-1)):

```
:SYSTem:ERRor?  
:  
:STATus:QUEue?
```

Bit 3, questionable summary bit (QSB): Set bit indicates that a calibration error has occurred.

Bit 4, message available (MAV): Set bit indicates that a message is present in the output queue. The message is sent to the computer when the 6517B is addressed to talk.

Bit 5, event summary bit (ESB): Set bit indicates that an enabled standard event has occurred. The event can be identified by reading the standard event status register using the *ESE? query command.

Bit 6, master summary status (MSS) / request service (RQS): Set bit indicates that one or more enabled status byte conditions have occurred. The MSS bit can be read using the STB? query command, or the occurrence of a service request (RQS bit set) can be detected by performing a serial poll.

Bit 7, operation summary bit (OSB): Set bit indicates that an enabled operation event has occurred. The event can be identified by reading the Operation Event Status Register using the :STATus:OPERation? query command (see [SCPI command reference](#) (on page 11-1) for details).

Also see

None

***TRG**

This command sends a bus trigger to the 6517B.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

*TRG

Details

Use the *TRG command to issue a GPIB trigger to the 6517B. It has the same effect as a group execute trigger (GET).

The *TRG command is used as an arm, scan, and measure event to control operation. The 6517B reacts to this trigger if GPIB is the programmed control source. The control source is programmed from the :TRIGger subsystem.

*TRG can also be used as the pretrigger for buffer operation.

Also see

[:TRIGger subsystem](#) (on page 11-177)

***TST?**

This command runs self test and reads the result.

Type	Affected by	Where saved	Default value
Query only	Not applicable	Not applicable	Not applicable

Usage

*TST?

Details

This query command performs a checksum test on ROM and places the coded result (0 or 1) in the output queue. When the 6517B is addressed to talk, the coded result is sent from the output queue to the computer.

A returned value of zero (0) indicates that the test passed. A value of one (1) indicates that the test has failed.

Also see

None

*WAI

This command postpones the execution of subsequent commands until all previous overlapped commands are finished.

Type	Affected by	Where saved	Default value
Command only	Not applicable	Not applicable	Not applicable

Usage

*WAI

Details

There are two types of instrument commands:

- **Overlapped commands:** Commands that allow the execution of subsequent commands while instrument operations of the overlapped command are still in progress.
- **Sequential commands:** Commands whose operations must finish before the next command is executed.

The *WAI command suspends the execution of commands until the instrument operations of all previous overlapped commands are finished. The *WAI command is not needed for sequential commands.

The 6517B has three overlapped commands:

- :INITiate
- :INITiate:CONTinuous ON
- *TRG

The :INITiate commands remove the 6517B from the idle state. The device operations of :INITiate do not complete until the 6517B returns to idle. You can send the *WAI command after the :INITiate command to wait until the 6517B returns to idle before executing subsequent commands.

The *TRG command issues a bus trigger that can be used to provide the arm, scan, and measure events for the trigger model. By sending the *WAI command after the *TRG command, subsequent commands execute when the trigger model moves in response to *TRG and settles at its next state.

Also see

- [*OPC \(on page 12-7\)](#)
- [*OPC? \(on page 12-8\)](#)
- [*TRG \(on page 12-15\)](#)

Status model

In this section:

Introduction	13-1
Status structure.....	13-1
Queues	13-12
Status byte and service request (SRQ).....	13-13

Introduction

This section provides detailed information on the Keithley Instruments 6517B Electrometer status structure.

For information on the common commands associated with the status structure, refer to [Common commands](#) (on page 12-1). For information on Standard Commands for Programmable Instrumentation (SCPI) commands that pertain to the status structure, refer to the [SCPI command reference](#) (on page 11-1).

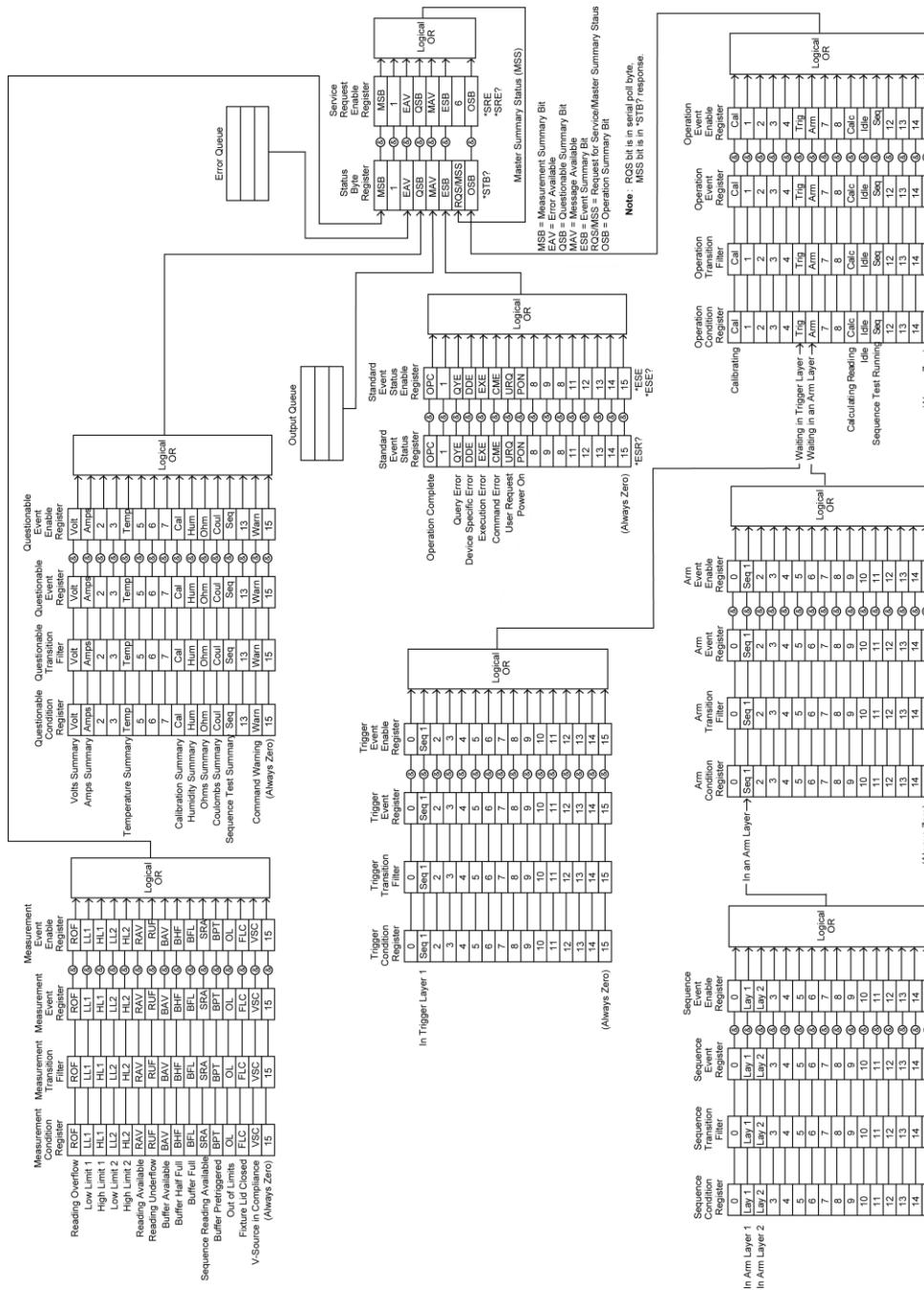
Status structure

Instrument events, such as errors, are monitored and manipulated by seven status register sets that feed directly or indirectly into the status byte register.

The status structure for the 6517B is summarized in the following figure. More detailed illustrations of these register sets are provided by these figures:

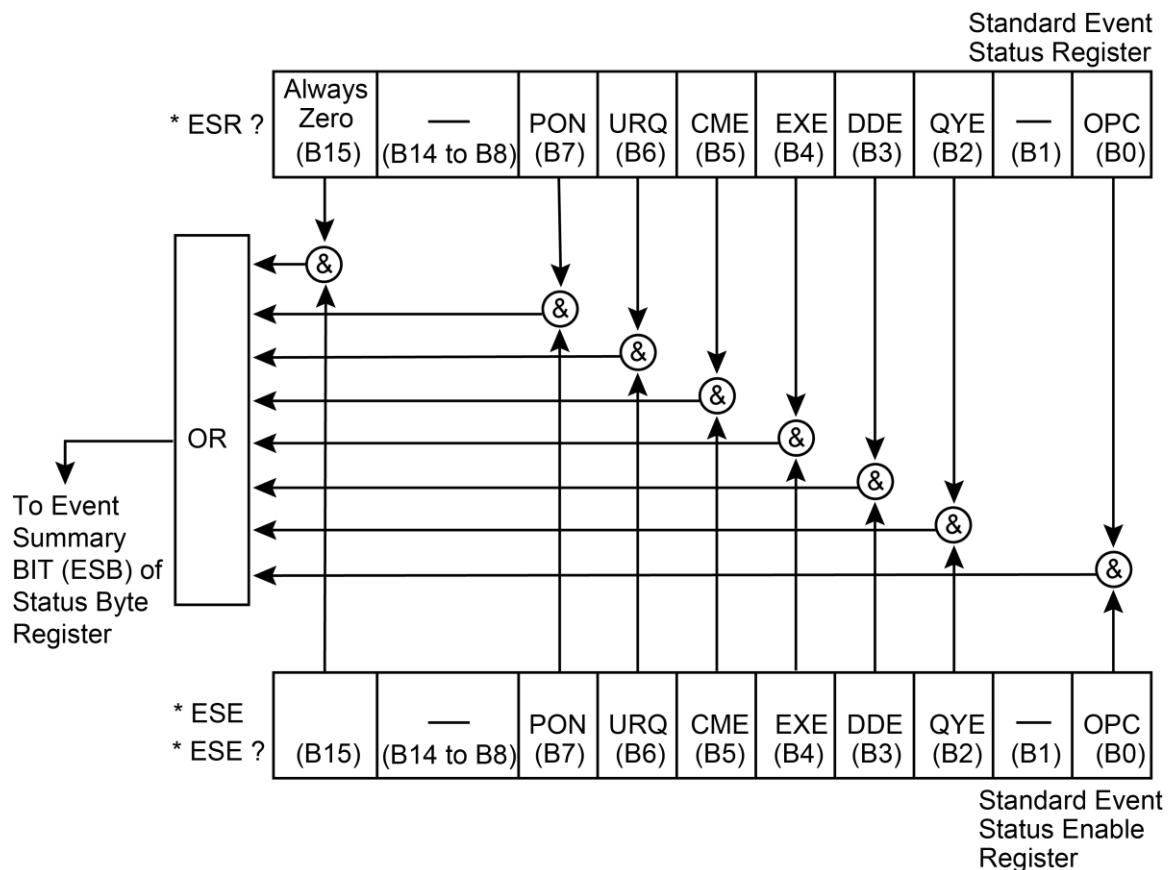
- [Standard event status registers](#) (on page 13-3)
- [Operation event status registers](#) (on page 13-4)
- [Arm event status registers](#) (on page 13-4)
- [Sequence event status registers](#) (on page 13-5)
- [Trigger event status registers](#) (on page 13-6)
- [Measurement event status registers](#) (on page 13-7)
- [Questionable event status registers](#) (on page 13-8)

Figure 92: Model 6517B status structure



Standard event status registers

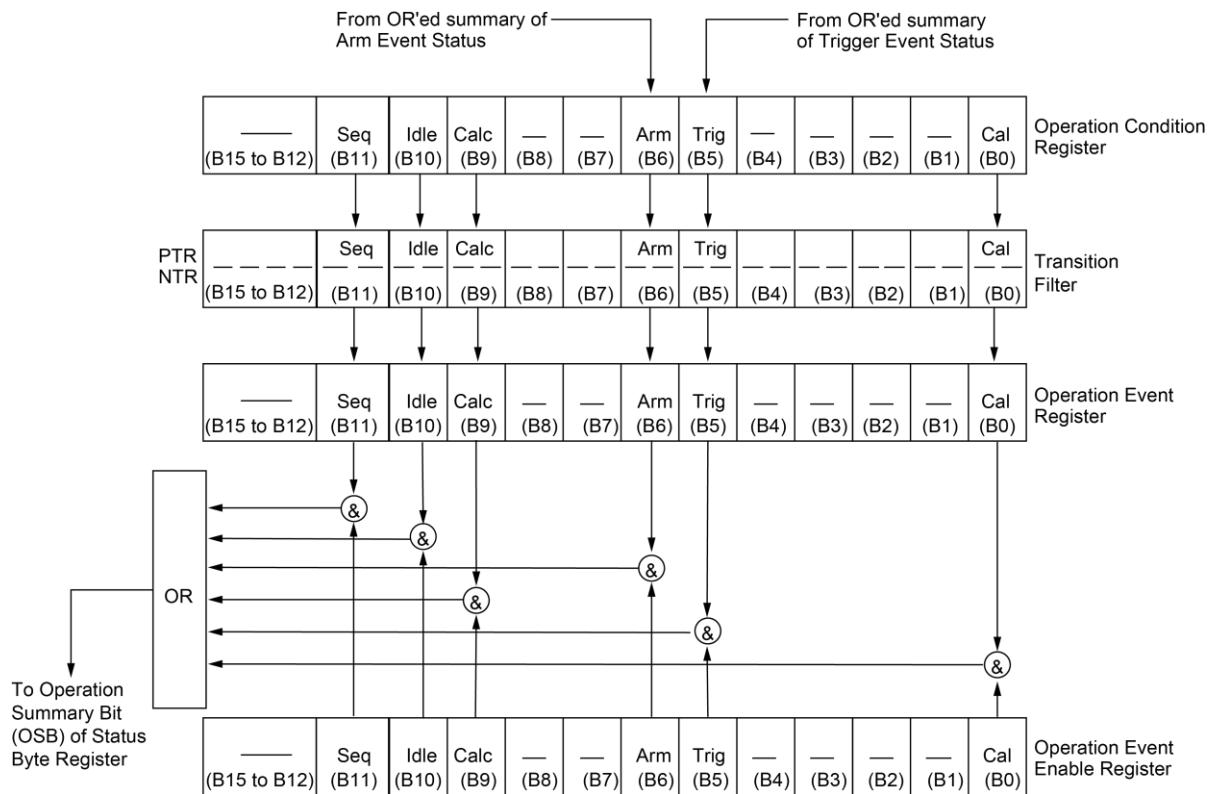
Figure 93: Standard event status registers



PON	Power on	&	Logical AND
URQ	User request	OR	Logical OR
CME	Command error		
EXE	Execution error		
DDE	Device-dependent error		
QYE	Query error		
OPC	Operation complete		

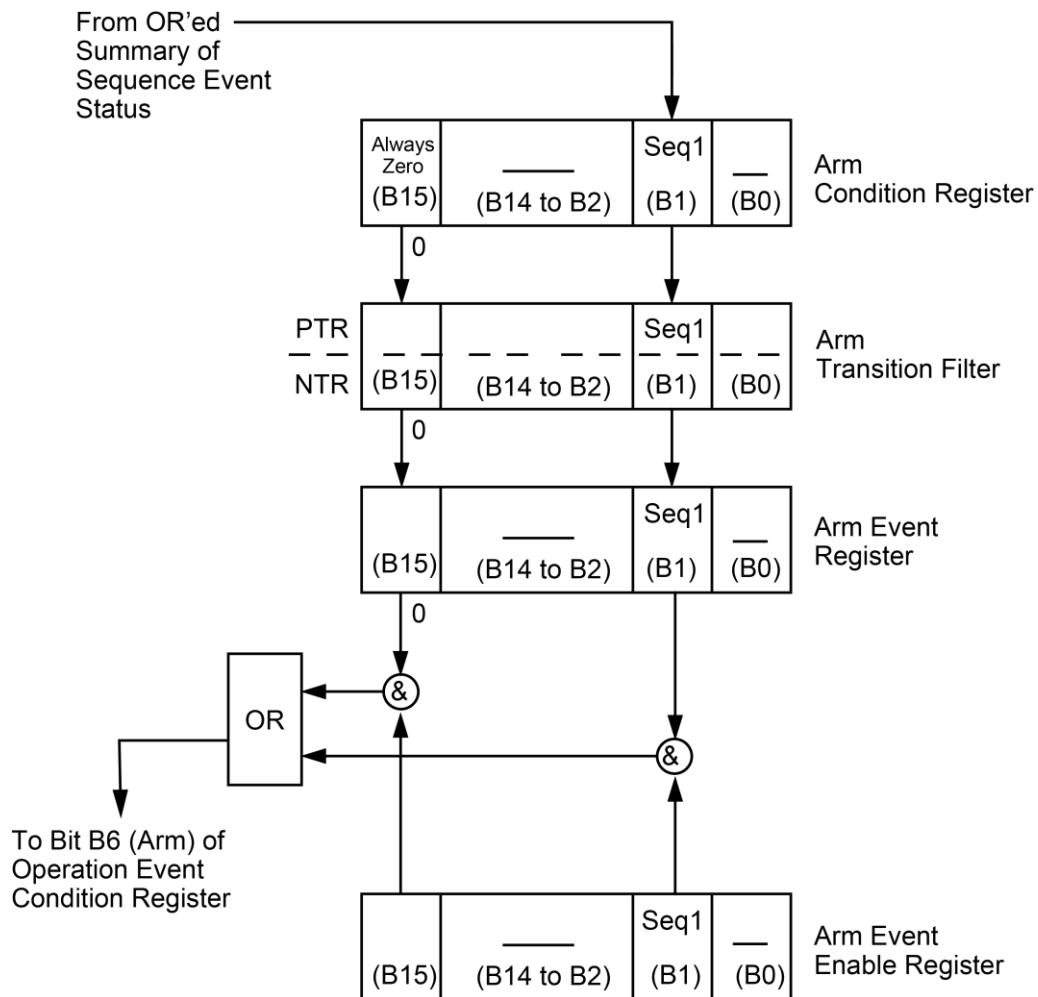
Operation event status registers

Figure 94: Operation event status registers

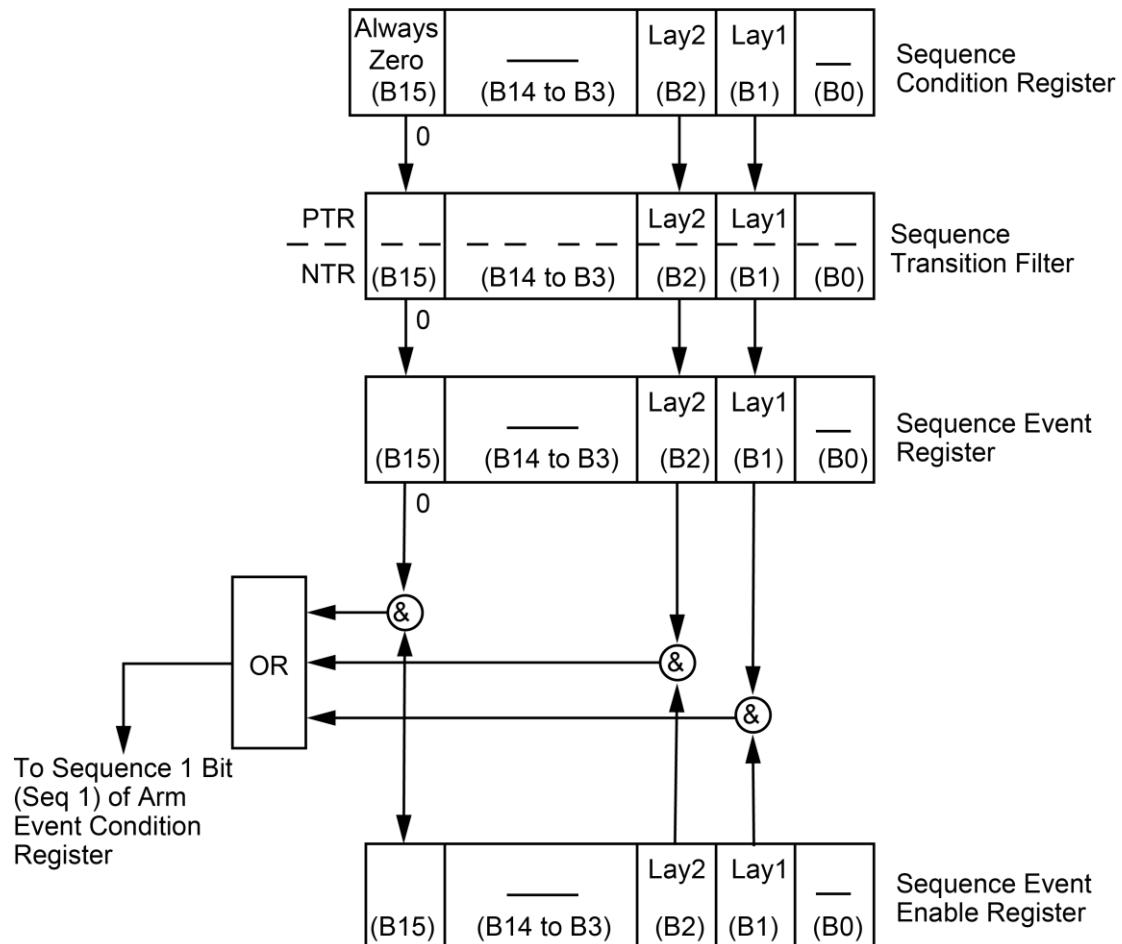


Seq	Sequence test running	&	Logical AND
Calc	Calculating reading	OR	Logical OR
Idle	Idle state of the 6517B		
Arm	Waiting in an arm layer		
Trig	Waiting in trigger layer		
Cal	Calibrating		
PTR	Positive Transition Register		
NTR	Negative Transition Register		

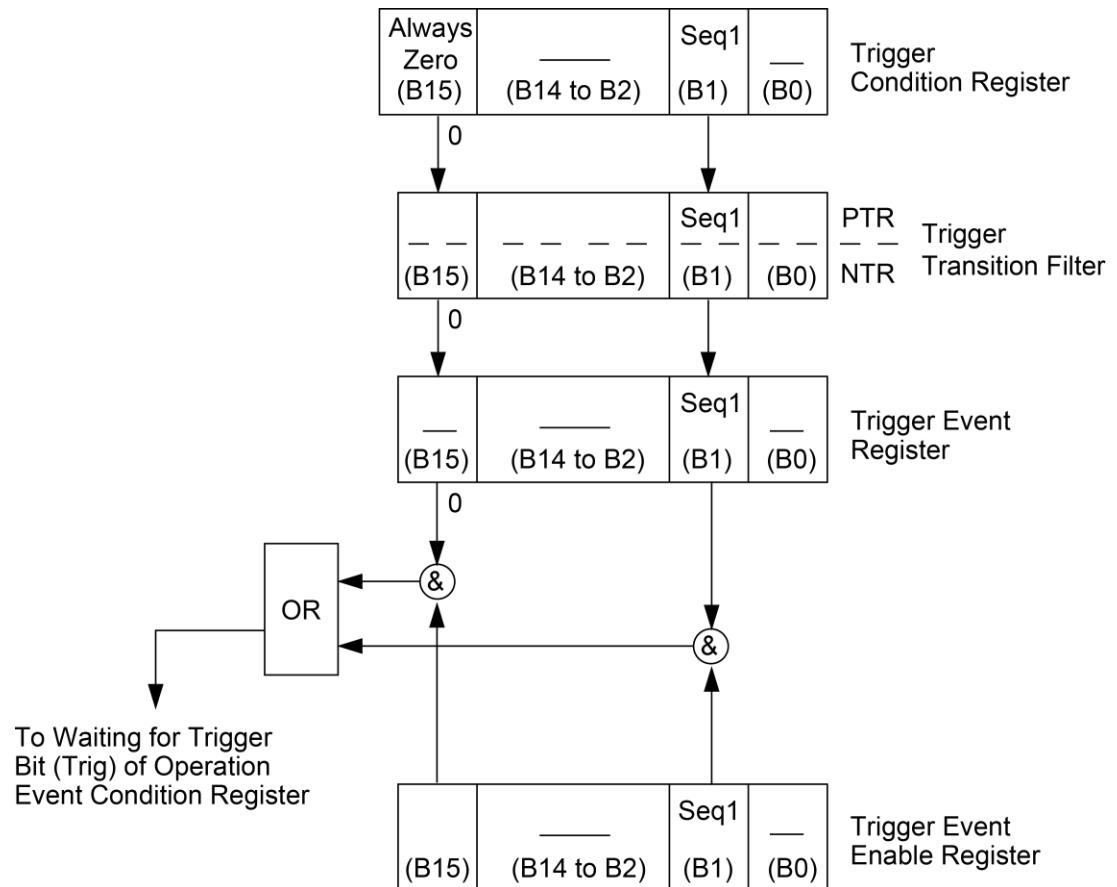
Figure 95: Arm event status registers



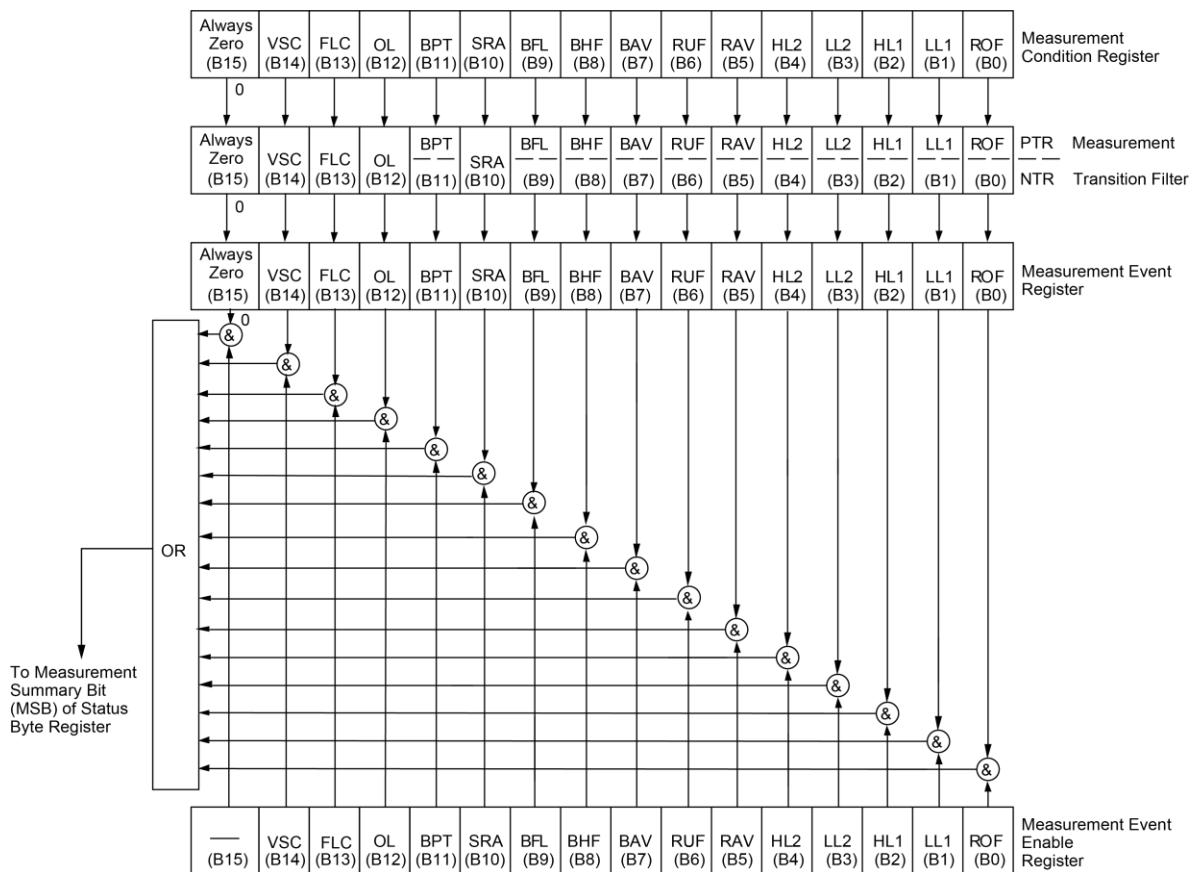
PTR	Positive Transition Register	&	Logical AND
NTR	Negative Transition Register	OR	Logical OR
Seq 1	Sequence 1 (set bit indicates that the 6517B is in the arm layer of Sequence 1)		

Figure 96: Sequence event status registers

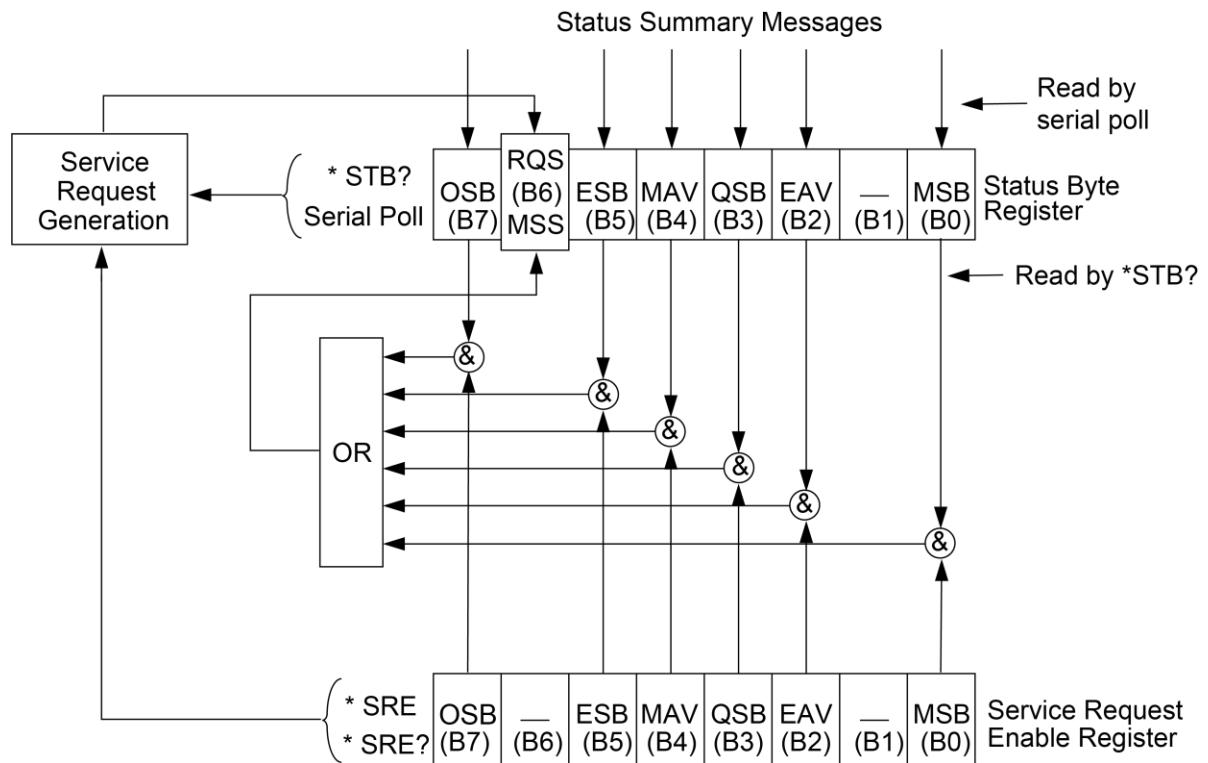
PTR	Positive Transition Register	&	Logical AND
NTR	Negative Transition Register	OR	Logical OR
Lay1	Layer 1. Set bit indicates that 6517B is in arm layer 1.		
Lay2	Layer 1. Set bit indicates that 6517B is in arm layer 2.		

Figure 97: Trigger event status registers

PTR	Positive Transition Register	&	Logical AND
NTR	Negative Transition Register	OR	Logical OR
Seq1	Sequence 1. Set bit indicates that the 6517B is in the trigger layer of Sequence 1.		

Figure 98: Measurement event status register

VSC	Voltage source compliance		
FLC	Fixture lid closed	LL2	Low limit 2
OL	Out of limits	HL1	High limit 1
BPT	Buffer pretriggered	HL2	High limit 2
SRA	Sequence reading available	ROF	Reading overflow
BFL	Buffer full	&	Logical AND
BHF	Buffer half full	OR	Logical OR
BAV	Buffer available	PTR	Positive Transition Register
RUF	Reading underflow	NTR	Negative Transition Register
RAV	Reading available		

Figure 99: Questionable event status registers

OSB	Operation Summary Bit	&	Logical AND
MSS	Master Summary Status	OR	Logical OR
RQS	Request for Service		
ESB	Event Summary Bit		
MAV	Message Available		
QSB	Questionable Summary Bit		
EAV	Error Available		
MSB	Measurement Summary Bit		

Condition registers

As shown in the illustrations, all status register sets, except the standard event status register set, have a condition register. A condition register is a real-time read-only register that is constantly updated to reflect the present operating conditions of the instrument. For example, while a calculation is performed, Bit B9 (Calc) of the Operation Condition Register is set. When the calculation is completed, Bit B9 clears.

The `:CONDITION?` query commands in the STATus subsystem read the condition registers (see [SCPI command reference](#) (on page 11-1) for details).

Transition filters

As shown in the illustrations, all status register sets, except the standard event status register set, have a transition filter. A transition filter is made up of two registers that are programmed by the user. The filter specifies which transition (0 to 1 or 1 to 0) in the condition register sets the corresponding bit in the event register.

A filter can be programmed for positive transitions (PTR), negative transitions (NTR), or both. When an event is programmed for a positive transition, the bit in the event register sets when the corresponding bit in the condition register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the event register sets when the corresponding bit in the condition register changes from 1 to 0.

The `:PTR` and `:NTR` commands in the Status subsystem set or clear the individual bits of the transition filter registers. The `:PTR?` and `:NTR?` query commands read the registers (see [SCPI command reference](#) (on page 11-1) for details). Reading a transition filter register does not affect its bit pattern.

The following operations set (1) all bits of all PTR registers and clear (0) all bits of all NTR registers:

- Cycling power
- Sending `:STATus:PRESet`

Event registers

As shown in the illustrations, each status register set has an event register. An event register is a latched, read-only register whose bits are set by the corresponding condition register and transition filter. Once a bit in an event register is set, it remains set (latched) until the register is cleared by a specific clearing operation. The bits of an event register are logically ANDed with the bits of the corresponding enable register and applied to an OR gate. The output of the OR gate is applied to another register set or to the status byte register.

The *ESR? common command reads the standard event register (see [Common commands](#) (on page 12-1)). All other event registers are read using the [:EVENT] ? query commands in the STATus subsystem (see [SCPI command reference](#) (on page 11-1)).

An event register is cleared when it is read. The following operations clear all event registers:

- Cycling power
- Sending *CLS

Enable registers

As shown in the illustrations, each status register set has an enable register. An enable register is programmed by the user and serves as a mask for the corresponding event register. An event bit is masked when the corresponding bit in the enable register is cleared (0). When masked, a set bit in an event register cannot set a bit in a following register set or in the status byte register ($1 \text{ AND } 0 = 0$).

To use the status byte register to detect events (for example, serial poll), you must unmask the events by setting the appropriate bits of the enable registers to 1.

The standard event status enable register is programmed and queried using the *ESE and *ESE? common commands, respectively (see [Common commands](#) (on page 12-1)). All other enable registers are programmed and queried using the :ENABLE and :ENABLE? commands in the STATus subsystem (see [SCPI command reference](#) (on page 11-1)).

An enable register is not cleared when it is read. The enable registers are affected by the following operations:

- Cycling power: Clears all enable registers
- :STATus:PRESet clears the following enable registers:
 - Operation event enable register
 - Questionable event enable register
 - Measurement event enable register
- :STATus:PRESet sets all bits of the following enable registers:
 - Trigger event enable register
 - Arm event enable register
 - Sequence event enable register
- *ESE 0 clears the standard event status enable register

Queues

The 6517B queues are first-in, first-out (FIFO) registers. The Output Queue holds reading and response messages. The Error Queue holds error and status messages.

Refer to [Status structure](#) (on page 13-1) for a figure that shows how the queues are structured with the other registers.

The output queue holds data that pertains to the normal operation of the instrument. For example, when a query command is sent, the response message is placed in the output queue.

When data is placed in the output queue, the Message Available (MAV) bit in the Status Byte Register is set. A data message is cleared from the output queue when it is read. The output queue is considered cleared when it is empty. An empty output queue clears the MAV bit in the Status Byte Register.

Read a message from the output queue by addressing the 6517B to talk after the appropriate query is sent.

The error queue holds error and status messages. When an error or status event occurs, a message that defines the error or status is placed in the error queue. This queue holds up to ten messages.

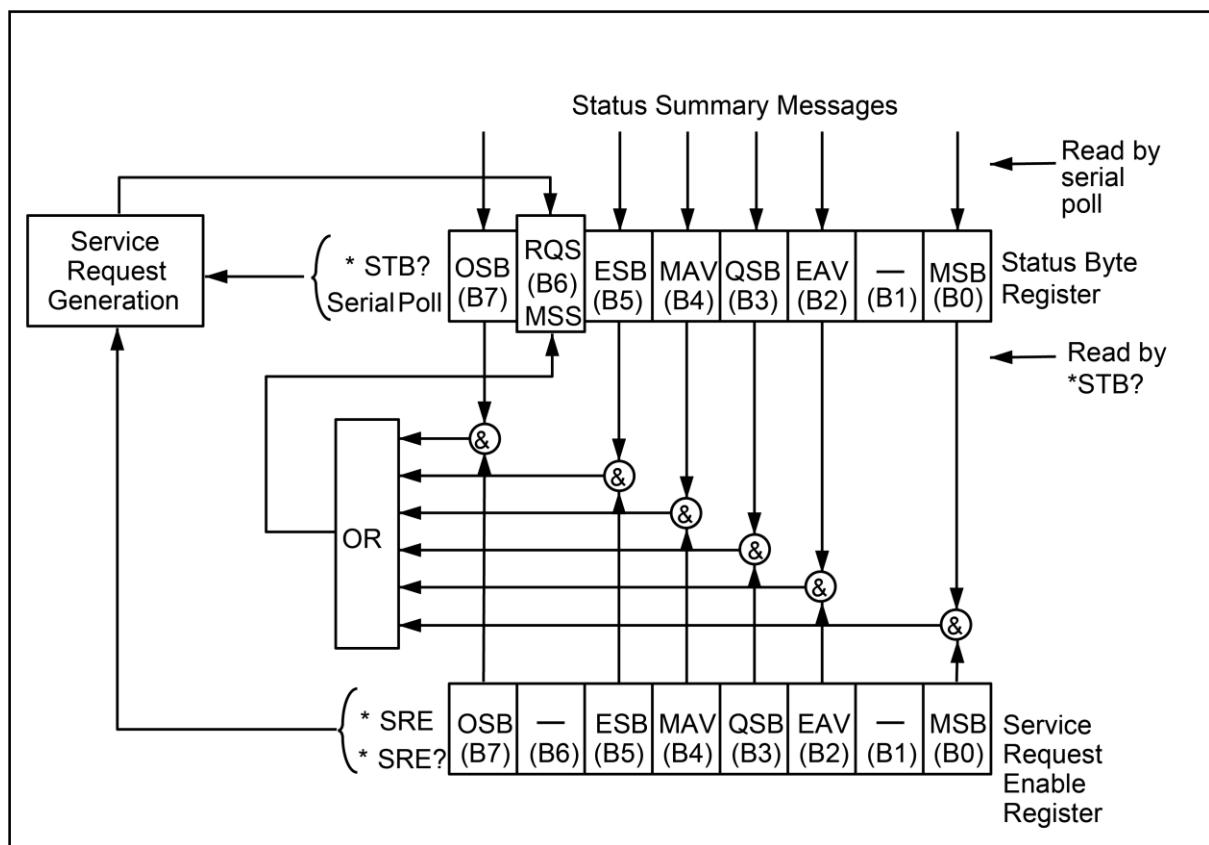
When a message is placed in the error queue, the Error Available (EAV) bit in the Status Byte Register is set. An error message is cleared from the error queue when it is read. The error queue is considered cleared when it is empty. An empty error queue clears the EAV bit in the Status Byte Register. To read an error message from the error queue, send either of the following SCPI query commands and then address the 6517B to talk:

- :SYSTem:ERRor?
- :STATus:QUEue?

Status byte and service request (SRQ)

Service request is controlled by the 8-bit registers Status Byte Register and Service Request Enable Register. The following figure shows the structure of these registers.

Figure 100: Status byte and service request



Status byte and service request definitions

OSB	Operation Summary bit	&	Logical AND
MSS	Master Summary Status	OR	Logical OR
RQS	Request for Service		
ESB	Event Summary bit		
MAV	Message available		
QSB	Questionable Summary bit		
EAV	Error available		
MSB	Measurement Summary bit		

Status byte register

The summary messages from the status registers and queues set or clear the appropriate bits (B0, B2, B3, B4, B5, and B7) of the Status Byte Register. These bits do not latch, and their states (0 or 1) are solely dependent on the summary messages (0 or 1). For example, if the Standard Event Status Register is read, its register clears. As a result, its summary message resets to 0, which clears the ESB bit in the Status Byte Register.

Bit B6 in the Status Byte Register is one of the following:

- The Master Summary Status (MSS) bit, sent in response to the *STB? command, indicates the status of any set bits with corresponding enable bits set.
- The Request for Service (RQS) bit, sent in response to a serial poll, indicates which device was requesting service by polling on the SRQ line.

For a description of the other bits in the Status Byte Register, see [Common commands](#) (on page 12-1).

The IEEE-488.2 standard uses the *STB? common query command to read the Status Byte Register.

When reading the Status Byte Register using the *STB? command, bit B6 is called the MSS bit. None of the bits in the Status Byte Register are cleared when using the *STB? command to read it.

The IEEE-488.1 standard has a serial poll sequence that also reads the Status Byte Register and is better suited to detecting a service request (SRQ). When using the serial poll, bit B6 is called the RQS bit. Serial polling causes bit B6 (RQS) to reset. Refer to [Serial poll and SRQ](#) (on page 13-16).

The following operations clear all bits of the Status Byte Register:

- Cycling power.
- Sending the *CLS common command

The MAV bit may or may not be cleared.

Service request enable register

This register is programmed by you and serves as a mask for the Status Summary Message bits (B0, B2, B3, B4, B5, and B7) of the Status Byte Register. When masked, a set summary bit in the Status Byte Register cannot set bit B6 (MSS/RQS) of the Status Byte Register. Conversely, when unmasked, a set summary bit in the Status Byte Register sets bit B6.

A Status Summary Message bit in the Status Byte Register is masked when the corresponding bit in the Service Request Enable Register is cleared (0). When the masked summary bit in the Status Byte Register sets, it is ANDed with the corresponding cleared bit in the Service Request Enable Register. The logic 1 output of the AND gate is applied to the input of the OR gate, so it sets the MSS/RQS bit in the Status Byte Register.

A status summary message bit in the status byte register is unmasked when the corresponding bit in the service request enable register is set (1). When the unmasked summary bit in the status byte register sets, it is ANDed with the corresponding set bit in the service request enable register. The logic "1" output of the AND gate is applied to the input of the OR gate and sets the MSS/RQS bit in the status byte register.

The individual bits of the Service Request Enable Register can be set or cleared by using the *SRE <NRf> common command.

To read the Service Request Enable Register, use the *SRE? query command. The Service Request Enable Register clears when power is cycled or when *SRE 0 is sent. See [Common commands](#) (on page 12-1) for details.

Serial poll and SRQ

Any enabled event summary bit that goes from 0 to 1 sets RQS and generates a service request (SRQ). In your test program, you can periodically read the Status Byte Register to check if a service request (SRQ) occurred and what caused it. If an SRQ occurred, the program can, for example, branch to an appropriate subroutine that services the request. Typically, service requests (SRQs) are managed by the serial poll sequence of the 6517B. If an SRQ did not occur, bit B6 (RQS) of the Status Byte Register remains cleared, and the program proceeds normally after the serial poll is performed. If an SRQ did occur, bit B6 of the Status Byte Register sets, and the program can branch to a service subroutine when the SRQ is detected by the serial poll.

The serial poll automatically resets RQS of the Status Byte Register. This allows subsequent serial polls to monitor bit B6 for an SRQ occurrence generated by other event types. After a serial poll, the same event can cause another SRQ, even if the event register that caused the first SRQ has not been cleared.

A serial poll clears RQS but does not clear MSS. The MSS bit stays set until all Status Byte event summary bits are cleared.

Section 14

Calibration procedure

In this section:

Introduction	14-1
Warmup time and environment.....	14-1
Calibration procedure.....	14-2
Calibration command reference	14-15

Introduction

This section discusses the calibration procedure for the Keithley Instruments 6517B.

WARNING

The information in this topic is intended only for qualified service personnel, as described by the types of product users in the [Safety precautions](#). Some of the procedures may expose you to hazardous voltages that could result in personal injury or death. Do not attempt to perform these procedures unless you are qualified to do so.

NOTE

If the instrument is still under warranty and its performance is outside specified limits, contact your Keithley Instruments representative or the factory to determine the correct course of action.

Warmup time and environment

The 6517B should be turned on and allowed to warm up for at least two hours at an ambient temperature of 18° C to 28° C, 70 percent or lower relative humidity. If the instrument has been subjected to temperature extremes outside the ambient temperature, allow additional time for the temperature to stabilize. Typically, it takes one additional hour to stabilize an instrument that is 10° outside the specified temperature range.

Calibration procedure

This section describes the four-part procedure for calibrating the 6517B:

- Meter calibration (voltage, current, and charge ranges)
- Voltage source calibration
- Temperature calibration
- Humidity calibration

The calibration procedure must be performed remotely using SCPI commands, so a computer with software for controlling the instrument over RS-232 or GPIB is required.

Recommended calibration equipment

- Fluke 5700A calibrator
- Keithley Model 2002 Digital Multimeter
- Thermocouple calibrator
- Precision resistors with a value known to the listed uncertainty:
 - 100 GΩ, 850 ppm
 - 10 GΩ, 550 ppm
 - 1 GΩ, 550 ppm
 - 100 MΩ, 250 ppm
- Uncalibrated precision resistors:
 - 10 MΩ
 - 1 MΩ
 - 10 kΩ
 - 1 kΩ
 - 10 Ω
 - 1 Ω
- Precision capacitors with a value known to the listed uncertainty:
 - 1 nF, 1000 ppm
 - 100 nF, 1000 ppm
- Triaxial shielding capacitor

Comprehensive calibration procedure

The following calibration procedure should only be performed by qualified service personnel, and only after the instrument has met the warmup criteria described in [Warmup period](#) (on page 14-1).

The following steps are for a complete calibration. For a partial calibration, see [Partial calibration](#) (on page 14-13) for considerations when performing a subset of the complete calibration.

Restoring factory defaults

To restore the 6517B factory-default settings, send the following remote command:

```
:SYST:PRES
```

Unlock calibration

To unlock the 6517B calibration, send the following remote command:

```
:CAL:PROT:CODE 'K1006517'
```

NOTE

K1006517 is the default password. Supply the appropriate password if it has been changed.

Voltage offset calibration

The following steps calibrate the internal voltage offsets of the 6517B input. Connect the digital multimeter to the PREAMP OUT terminals of the 6517B. Ensure that the ground link is attached to INPUT LO.

20 pA to 200 pA range voltage offset

To calibrate the voltage offset for each range:

1. Set the DMM range to 1 V dc, with an integration rate of 10 NPLC and a repeating filter count of 10. Connect a 10 GΩ resistor between the 6517B input HI and input LO.

```
:CAL:PROT:VOFF:STEP 1  
:CAL:PROT:VOFFSETZ2
```

2. Allow the input to settle for 120 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFFZERO <dmm voltage reading>
```

3. Connect a 1 GΩ resistor between the 6517B input HI and input LO.

```
:CAL:PROT:VOFF1
```

4. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF2 <dmm voltage reading>  
:CAL:PROT:VOFF3
```

5. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF4 <dmm voltage reading>
```

2 nA to 200 nA range voltage offset

To calibrate the voltage offset for each range:

1. Connect a 10 MΩ resistor between the 6517B input HI and input LO. Set the DMM range to 1 V dc.

```
:CAL:PROT:VOFF:STEP 2  
:CAL:PROT:VOFFSETZ
```

2. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFFZERO <dmm voltage reading>
```

3. Connect a 1 MΩ resistor between the 6517B input HI and input LO.

```
:CAL:PROT:VOFF1
```

4. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF2 <dmm voltage reading>  
:CAL:PROT:VOFF3
```

5. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF4 <dmm voltage reading>
```

2 μA to 200 μA range voltage offset

To calibrate the voltage offset for each range:

1. Connect a 10 kΩ resistor between the 6517B input HI and input LO. Set the DMM range to 1 V dc.

```
:CAL:PROT:VOFF:STEP 3  
:CAL:PROT:VOFFSETZ
```

2. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFFZERO <dmm voltage reading>
```

3. Connect a 1 kΩ resistor between the 6517B input HI and input LO. Set the DMM range to 1 V dc.

```
:CAL:PROT:VOFF1
```

4. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF2 <dmm voltage reading>  
:CAL:PROT:VOFF3
```

5. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF4 <dmm voltage reading>
```

2 mA to 20 mA range voltage offset

To calibrate the voltage offset for each range:

1. Connect a 10 Ω resistor between the 6517B input HI and input LO. Set the DMM range to 1 V dc.

```
:CAL:PROT:VOFF:STEP 4  
:CAL:PROT:VOFFSETZ
```

2. Allow the input to settle for 10 seconds, then take the DMM voltage reading.

```
:CAL:PROT:VOFFZERO <dmm voltage reading>
```

3. Connect a 1 Ω resistor between the 6517B input HI and input LO. Set the DMM range to 1 V dc.

```
:CAL:PROT:VOFF1
```

4. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF2 <dmm voltage reading>  
:CAL:PROT:VOFF3
```

5. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF4 <dmm voltage reading>
```

Voltage ranges voltage offset

To calibrate the voltage offset for each range:

1. Connect the DMM to the 6517B preamp output.

2. Set the DMM range to 1 V dc.

3. Connect the 6517B input HI to input LO (short the input).

4. Send:

```
:CAL:PROT:VOFF:STEP 5  
:CAL:PROT:VOFF1
```

5. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF2 <dmm voltage reading>  
:CAL:PROT:VOFF3
```

6. Allow the input to settle for 10 seconds, then make the DMM voltage reading.

```
:CAL:PROT:VOFF4 <dmm voltage reading>
```

Charge ranges voltage offset

To calibrate the voltage offset for each range:

1. Connect the DMM to the 6517B preamplifier output. Set the DMM range to 1 V dc. Place the triaxial cap on the 6517B input.

```
:CAL:PROT:VOFF:STEP 6  
:CAL:PROT:VOFF1
```

2. Allow the input to settle for 10 seconds.

3. Make the DMM voltage reading.

```
:CAL:PROT:VOFF2 <dmm voltage reading>  
:CAL:PROT:VOFF3
```

4. Allow the input to settle for 10 seconds.

5. Make the DMM voltage reading.

```
:CAL:PROT:VOFF4 <dmm voltage reading>
```

Current offset calibration

NOTE

The following three commands are automated and require extra time to complete:

- :CAL:PROT:IOFF:STEP 3 takes approximately two minutes
- :CAL:PROT:IOFF:STEP 4 takes approximately five minutes
- :CAL:PROT:IOFF:STEP 5 takes approximately two minutes

2 nA to 200 nA range current offset

To calibrate the current offset for each range:

1. Connect the DMM to the 6517B preamplifier output and place the triaxial cap on the 6517B input.

```
:CAL:PROT:IOFF:STEP 1  
:CAL:PROT:IOFF1
```

2. Allow the input to settle for 120 seconds, then make the DMM voltage reading.

```
:CAL:PROT:IOFF2 <dmm voltage reading>  
:CAL:PROT:IOFF3
```

3. Allow the input to settle for 120 seconds, then make the DMM voltage reading.

```
:CAL:PROT:IOFF4 <dmm voltage reading>
```

20 pA to 200 pA range current offset

To calibrate the current offset for each range:

1. Connect the DMM to the 6517B preamplifier output and place the triaxial cap on the 6517B input.

```
:CAL:PROT:IOFF:STEP 2  
:CAL:PROT:IOFF1
```

2. Allow the input to settle for 120 seconds, then make the DMM voltage reading.

```
:CAL:PROT:IOFF2 <dmm voltage reading>  
:CAL:PROT:IOFF3
```

3. Allow the input to settle for 120 seconds, then make the DMM voltage reading.

```
:CAL:PROT:IOFF4 <dmm voltage reading>
```

4. Disconnect the DMM from the preamplifier output and place a triaxial cap on the 6517B input.

2 nC to 20 nC ranges current offset

To calibrate the current offset for each range:

```
:CAL:PROT:IOFF:STEP 3
```

200 nC to 2 uC ranges current offset

To calibrate the current offset for each range:

```
:CAL:PROT:IOFF:STEP 4
```

Voltage ranges current offset

To calibrate the current offset for each range:

```
:CAL:PROT:IOFF:STEP 5
```

Current ranges calibration

Current range zeros

To calibrate the zero for each current range, place the triaxial cap on the 6517B input terminal. Send the following commands to calibrate each current zero.

Current range calibration commands

Command	Description
:CAL:PROT:AZERO20M	Obtains measured A/D zero for 20 mA range, 1 s delay
:CAL:PROT:AZERO2M	Obtains measured A/D zero for 2 mA range, 1 s delay
:CAL:PROT:AZERO200U	Obtains measured A/D zero for 200 mA range, 3 s delay
:CAL:PROT:AZERO20U	Obtains measured A/D zero for 20 mA range, 3 s delay
:CAL:PROT:AZERO2U	Obtains measured A/D zero for 2 mA range, 3 s delay
:CAL:PROT:AZERO200N	Obtains measured A/D zero for 200 nA range, 10 s delay
:CAL:PROT:AZERO20N	Obtains measured A/D zero for 20 nA range, 10 s delay
:CAL:PROT:AZERO2N	Obtains measured A/D zero for 2 nA range, 10 s delay
:CAL:PROT:AZERO200P	Obtains measured A/D zero for 200 pA range, 30 s delay
:CAL:PROT:AZERO20P	Obtains measured A/D zero for 20 pA range, 30 s delay

Calculate the calibration current for the range

Determine the appropriate calibration current for the range.

For the ± 20 pA to ± 2 mA current ranges, use the following table to determine the appropriate calibration current. Calculate the actual current using the formula:

$$I = V / R$$

where:

- I = Actual current
- V = Calibrator voltage
- R = Measured value of the calibrated precision resistor, as shown in the following table

Detailed calibration information for the ± 20 pA to ± 2 mA ranges

6517B range	Calibrator voltage	Resistance standard	Nominal current
20 pA	2.0 V	100 G Ω	20 pA
200 pA	2.0 V	10 G Ω	200 pA
2 nA	2.0 V	1 G Ω	2 nA
20 nA	2.0 V	100 M Ω	20 nA
200 nA	20.0 V	100 M Ω	200 nA
2 mA	200.0 V	100 M Ω	2 mA

Calibrate the current ranges

NOTE

All currents applied to the input of the 6517B during calibration must be within ± 5 percent of the nominal value.

To calibrate the ± 20 μ A to ± 20 mA ranges:

1. Turn the 6517B zero-check on.
2. Turn the dc current calibrator output on.
3. For each polarity, apply the currents between ± 20 μ A and ± 20 mA listed in the 6517B range/full scale current column of the following table to the 6517B input.
4. For each polarity, send the command in the negative or positive polarity calibration command column of the following table with the actual current value to the 6517B.

To calibrate the $\pm 20 \text{ pA}$ to $\pm 2 \mu\text{A}$ ranges:

1. Calculate the ranges or note the actual current.
2. Turn the 6517B zero-check on.
3. Turn the dc current calibrator output on.
4. For each polarity, apply the currents between $\pm 20 \text{ pA}$ and $\pm 2 \mu\text{A}$ listed in the 6517B range/full scale current column of the following table to the 6517B input.
5. For each polarity, send the command in the negative or positive polarity calibration command column of the following table with the actual current value to the 6517B.

Calibration currents and commands

6517B range/full scale current	Negative polarity calibration command	Positive polarity calibration command
$\pm 20 \text{ pA}$:CAL:PROT:AN20P <value>	:CAL:PROT:A20P <value>
$\pm 200 \text{ pA}$:CAL:PROT:AN200P <value>	:CAL:PROT:A200P <value>
$\pm 2 \text{ nA}$:CAL:PROT:AN2N <value>	:CAL:PROT:A2N <value>
$\pm 20 \text{ nA}$:CAL:PROT:AN20N <value>	:CAL:PROT:A20N <value>
$\pm 200 \text{ nA}$:CAL:PROT:AN200N <value>	:CAL:PROT:A200N <value>
$\pm 2 \mu\text{A}$:CAL:PROT:AN2U <value>	:CAL:PROT:A2U <value>
$\pm 20 \mu\text{A}$:CAL:PROT:AN20U <value>	:CAL:PROT:A20U <value>
$\pm 200 \mu\text{A}$:CAL:PROT:AN200U <value>	:CAL:PROT:A200U <value>
$\pm 2 \text{ mA}$:CAL:PROT:AN2M <value>	:CAL:PROT:A2M <value>
$\pm 20 \text{ mA}$:CAL:PROT:AN20M <value>	:CAL:PROT:A20M <value>

Charge range calibration

Determine the calibration charge to be used during calibration. For the 2 nC to 2 mC charge ranges, use the following table to calculate the appropriate calibration charge. Calculate the actual charge using the formula:

$$Q = C V$$

Where:

- Q = Actual charge in coulombs
- C = Measured value of the precision capacitor
- V = Calibrator voltage

Charge range calibration values

6517B charge range	Calibrator voltage	Standard capacitance	Nominal charge
2 nC	2.0 V	1 nF	2 nC
20 nC	20.0 V	1 nF	20 nC
200 nC	2.0 V	100 nF	200 nC
2 mC	20.0 V	100 nF	2 mC

To calibrate each charge range:

1. Connect the capacitor stated in the standard capacitor column in the above table.
2. Set the calibrator voltage output to 0.0 V.
3. Calculate the actual charge and send the command in the charge full scale calibration command column in the following table.
4. Set the calibrator voltage to the value in the charge full scale calibration command column in the following table.

Charge range calibration commands

6517B charge range	Calibrator voltage	Charge zero calibration command	Charge full scale calibration command
-2 mC	-20.0 V	:CAL:PROT:CZEROB2U	:CAL:PROT:CN2U <value>
2 mC	20.0 V	:CAL:PROT:CZEROA2U	:CAL:PROT:C2U <value>
-200 nC	-2.0 V	:CAL:PROT:CZEROB200N	:CAL:PROT:CN200N <value>
200 nC	2.0 V	:CAL:PROT:CZEROA200N	:CAL:PROT:C200N <value>
-20 nC	-20.0 V	:CAL:PROT:CZEROB20N	:CAL:PROT:CN20N <value>
20 nC	20.0 V	:CAL:PROT:CZEROA20N	:CAL:PROT:C20N <value>
-2 nC	-2.0 V	:CAL:PROT:CZEROB2N	:CAL:PROT:CN2N <value>
2 nC	2.0 V	:CAL:PROT:CZEROA2N	:CAL:PROT:C2N <value>

Voltage measurement ranges calibration**To calibrate the voltage measurement ranges:**

1. Connect the dc voltage calibrator to the 6517B input.
2. Apply 0.0 V.
3. Send the following commands to calibrate the zero value for each range:


```
:CAL:PROT:VZERO2
:CAL:PROT:VZERO20
:CAL:PROT:VZERO200
```
4. Leave the dc voltage calibrator connected and calibrate each polarity of each range:
 - a. Apply the voltage listed in the first column of the following table.
 - b. Send the calibration command listed in the second column of the following table with the voltage reading from the dc voltage calibrator.

Voltage range calibration commands

6517B range full scale voltage	Voltage range calibration command
+2 V	:CAL:PROT:V2 <actual voltage value>
-2 V	:CAL:PROT:VN2 <actual voltage value>
+20 V	:CAL:PROT:V20 <actual voltage value>
-20 V	:CAL:PROT:VN20 <actual voltage value>
+200 V	:CAL:PROT:V200 <actual voltage value>
-200 V	:CAL:PROT:VN200 <actual voltage value>

Voltage source calibration

For all voltage source ranges, to calibrate the voltage source:

1. Connect the DMM to the voltage source output.
2. Set the DMM to measure dc voltage.
3. Turn autoranging on.

100 V range calibration

To calibrate the 100 V source range:

1. Send this command to the 6517B to select the 100 V source range zero calibration:

```
:CAL:PROT:VSETZ100
```

2. Make the DMM voltage reading, and then send the following commands:

```
:CAL:PROT:VSRCZ100 <DMM voltage reading>  
:CAL:PROT:VSET100
```

3. Make the DMM voltage reading, and then send the following commands:

```
:CAL:PROT:VSRC100 <DMM voltage reading>  
:CAL:PROT:VSETN100
```

4. Make the DMM voltage reading, and then send the following commands:

```
:CAL:PROT:VSRCN100 <DMM voltage reading>  
:CAL:PROT:VSET40
```

5. Make the DMM voltage reading, and then send the following command:

```
:CAL:PROT:VSRC40 <DMM voltage reading>
```

1000 V range calibration

To calibrate the 1000 V source range:

1. Send this command to the 6517B to start the 1000 V source range calibration:

```
:CAL:PROT:VSETZ1000
```

2. Make the DMM voltage reading, and then send the following commands:

```
:CAL:PROT:VSRCZ1000 <DMM voltage reading>  
:CAL:PROT:VSET1000
```

3. Make the DMM voltage reading, and then send the following commands:

```
:CAL:PROT:VSRC1000 <DMM voltage reading>  
:CAL:PROT:VSETN1000
```

4. Make the DMM voltage reading, and then send the following command:

```
:CAL:PROT:VSRCN1000 <DMM voltage reading>  
:CAL:PROT:VSET400
```

5. Make the DMM voltage reading, and then send the following command:

```
:CAL:PROT:VSRC400 <DMM voltage reading>
```

Temperature calibration

To calibrate temperature measurements:

1. Connect the thermocouple calibrator to the temperature input connector using a type K input connector.
2. Allow the input connector to stabilize in temperature for five minutes.
3. Set the calibrator to 100 °C.
4. Send the following command to calibrate +100 °C (4.096 mV).
`:CAL:PROT:T100 0.004096`
5. Set the calibrator to 0 °C.
6. Send the following command to calibrate 0 °C.
`:CAL:PROT:TZERO`
7. Set the calibrator to -25 °C.
8. Send the following command to calibrate -25 °C (-0.968 mV).
`:CAL:PROT:TN25 -0.000968`

Humidity calibration

To calibrate humidity measurements:

1. Connect the dc voltage calibrator to the humidity input connector.
2. Send the following command to apply 0.0 V:
`:CAL:PROT:HUMZERO`
3. Send the following command to apply +1.0 V:
`:CAL:PROT:HUM1 <actual voltage value>`

Set calibration dates

To set the calibration dates:

1. Use the following command to set the date the unit was calibrated:
`:CAL:PROT:DATE yyyy,mm,dd`
2. Use the following command to set the due date for the next calibration:
`:CAL:PROT:NDUE yyyy,mm,dd`

Save calibration

To save the calibration information:

Use the following command to save the calibration after completing all calibration steps:

```
:CAL:PROT:SAVE
```

Lock calibration

To prevent changes to the calibration information:

Use the following command to lock the calibration after saving the calibration:

```
:CAL:PROT:LOCK
```

Partial calibration

Perform all calibration steps if possible. You can calibrate individual ranges if the following requirements are met:

- The instrument has already been completely calibrated once.
- All required steps of a partial calibration are performed without error.

NOTE

If you perform a partial calibration without meeting these conditions, you cannot save the calibration information.

Once a partial calibration is performed, the calibration date and the next calibration due date must be set before the calibration can be saved.

Voltage offset partial calibration

All calibration steps are to be performed if you are performing individual voltage offset steps. If a single voltage offset step is performed, the ranges affected by the voltage offset calibration require recalibration before a valid calibration can be saved.

Ranges affected by partial voltage offset calibration

Voltage offset step performed	Ranges that require recalibration
1	20 pA and 200 pA current ranges
2	2 nA, 20 nA, and 200 nA current ranges
3	2 mA, 20 mA, and 200 mA current ranges
4	2 mA and 20 mA current ranges
5	2 V, 20 V, and 200 V voltage ranges
6	2 nC, 20 nC, 200 nC, and 2 mC charge ranges

Current offset partial calibration

It is recommended that all calibration steps be performed if performing individual current offset steps. If a single current offset step is performed, the ranges affected by the voltage offset calibration require recalibration before a valid calibration can be saved.

Ranges affected by partial current offset calibration

Current offset step performed	Ranges that require recalibration
1	All current ranges except 20 pA and 200 pA
2	20 pA and 200 pA current ranges
3	2 nC and 20 nC charge ranges
4	200 nC and 2 uC charge ranges
5	2 V, 20 V, and 200 V voltage ranges

Current ranges partial calibration

If an individual current range of the 6517B is calibrated, these steps corresponding to a single current range need to be performed:

1. Calibration of the range zero.
2. Calibration of the positive full scale range.
3. Calibration of the negative full scale range.

Voltage ranges partial calibration

If an individual voltage range of the 6517B is calibrated, the steps corresponding to a single voltage range need to be performed:

1. Calibration of the range zero.
2. Calibration of the positive full scale range.
3. Calibration of the negative full scale range.

Charge ranges partial calibration

If an individual charge range of the 6517B is calibrated, the steps corresponding to a single charge range need to be performed:

1. Starting the positive full scale calibration step.
2. Calibration of the positive full scale range.
3. Starting the negative full scale calibration step.
4. Calibration of the negative full scale range.

Voltage source partial calibration

If an individual range of the 6517B voltage source is calibrated, the following steps corresponding to a single voltage source range need to be performed:

1. Starting the voltage source zero calibration step.
2. Calibrating the voltage source zero point.
3. Starting the voltage source positive full scale calibration step.
4. Calibrating the voltage source positive full scale point.
5. Starting the voltage source negative full scale calibration step.
6. Calibrating the voltage source negative full scale point.
7. Starting the voltage source positive 40% calibration step.
8. Calibrating the voltage source positive 40% calibration point.

Humidity partial calibration

The humidity input has the following calibration points, both of which need to be performed:

1. Calibration of the humidity zero point.
2. Calibration of the humidity +1 V point.

Temperature partial calibration

The temperature input has the following calibration points, all of which need to be performed:

1. Calibration of the temperature +100° C point.
2. Calibration of the temperature zero point.
3. Calibration of the temperature –25° C point.

Calibration command reference

Voltage offset calibration commands

Set the step for the voltage offset calibration with this command:

```
:CAL:PROT:VOFF:STEP <step number>
```

The steps are numbered from 1 through 6, and correspond to the following instrument ranges:

1. 20 pA and 200 pA current ranges
2. 2 nA, 20 nA, and 200 nA current ranges
3. 2 mA, 20 mA, and 200 mA current ranges
4. 2 mA and 20 mA current ranges
5. 2 V, 20 V, and 200 V voltage ranges
6. 2 nC, 20 nC, 200 nC, and 2 mC charge ranges

For each voltage offset calibration step, execute the following commands after setting the voltage offset calibration step:

```
:CAL:PROT:VOFF1
```

Start the first measurement for the voltage offset calibration.

```
:CAL:PROT:VOFF2 <preamp out voltage reading>
```

Calibrate the first voltage offset point.

```
:CAL:PROT:VOFF3
```

Start the second measurement for the voltage offset calibration.

```
:CAL:PROT:VOFF4 <preamp out voltage reading>
```

Calibrate the second voltage offset point.

Current offset calibration commands

Set the current offset calibration step by sending the following command:

```
:CAL:PROT:IOFF:STEP <step number>
```

This sets the step of the current offset calibration procedure. Steps are numbered from 1 to 5, and correspond to the following instrument ranges:

1. All current ranges except 20 pA and 200 pA
2. 20 pA and 200 pA current ranges
3. 2 nC and 20 nC charge ranges
4. 200 nC and 2 mC charge ranges
5. 2 V, 20 V, and 200 V voltage ranges

NOTE

For current offset calibration steps 1 and 2 only, the commands in the following table must be executed after setting the current offset calibration step.

Current offset calibration commands for steps 1 and 2

Command	Description
:CAL:PROT:IOFF1	Start the first measurement for the current offset calibration
:CAL:PROT:IOFF2 <preamp out voltage reading>	Calibrate the first current offset point
:CAL:PROT:IOFF3	Start the second measurement for the current offset calibration
:CAL:PROT:IOFF4 <preamp out voltage reading>	Calibrate the second current offset point

Charge calibration commands

When calibrating the 20 mA to 20 mA ranges, use a dc current calibrator. For all current ranges, the actual current supplied must be within ± 5 percent of the nominal value otherwise a calibration error occurs.

Charge calibration commands

Command	Description
:CAL:PROT:CZEROA2N	Start +2 nC range calibration
:CAL:PROT:C2N <+2nC value>	Calibrate the +2 nC range
:CAL:PROT:CEROB2N	Start -2 nC range calibration
:CAL:PROT:CN2N <-2nC value>	Calibrate the -2 nC range
:CAL:PROT:CZEROA20N	Start +20 nC range calibration
:CAL:PROT:C20N <+20nC value>	Calibrate the +20 nC range
:CAL:PROT:CEROB20N	Start -20 nC range calibration
:CAL:PROT:CN20N <-20nC value>	Calibrate the -20 nC range
:CAL:PROT:CZEROA200N	Start +200 nC range calibration
:CAL:PROT:C200N <+200nC value>	Calibrate the +200 nC range
:CAL:PROT:CEROB200N	Start -200 nC range calibration
:CAL:PROT:CN200N <-200nC value>	Calibrate the -200 nC range
:CAL:PROT:CZEROA2U	Start +2 uC range calibration
:CAL:PROT:C2U <+2uC value>	Calibrate the +2 uC range
:CAL:PROT:CEROB2U	Start -2 uC range calibration
:CAL:PROT:CN2U <-2uC value>	Calibrate the -2 uC range

Current calibration commands

This is a list of the current calibration commands. For all current ranges, the actual current supplied must be within ± 5 percent of the nominal value to prevent a calibration error.

Current calibration commands

Command	Description
:CAL:PROT:AZERO20p	Calibrate the 20 pA range zero
:CAL:PROT:A20P <+20 pA value>	Calibrate the +20 pA range
:CAL:PROT:AN20P <-20 pA value>	Calibrate the -20 pA range
:CAL:PROT:AZERO200P	Calibrate the 200 pA range zero
:CAL:PROT:A200P <+200 pA value>	Calibrate the +200 pA range
:CAL:PROT:AN200P <-200 pA value>	Calibrate the -200 pA range
:CAL:PROT:AZERO2N	Calibrate the 2 nA range zero
:CAL:PROT:A2N <+2 nA value>	Calibrate the +2 nA range
:CAL:PROT:AN2N <-2 nA value>	Calibrate the -2 nA range
:CAL:PROT:AZERO20N	Calibrate the 20 nA range zero
:CAL:PROT:A20N <+20 nA value>	Calibrate the +20 nA range
:CAL:PROT:AN20N <-20 nA value>	Calibrate the -20 nA range
:CAL:PROT:AZERO200N	Calibrate the 200 nA range zero

Command	Description
:CAL:PROT:A200N <+200 nA value>	Calibrate the +200 nA range
:CAL:PROT:AN200N <-200 nA value>	Calibrate the -200 nA range
:CAL:PROT:AZERO2U	Calibrate the 2 μA range zero
:CAL:PROT:A2U <+2 uA value>	Calibrate the +2 μA range
:CAL:PROT:AN2U <-2 uA value>	Calibrate the -2 μA range
:CAL:PROT:AZERO20U	Calibrate the 20 μA range zero
:CAL:PROT:A20U <+20 uA value>	Calibrate the +20 μA range
:CAL:PROT:AN20U <-20 uA value>	Calibrate the -20 μA range
:CAL:PROT:AZERO200U	Calibrate the 200 μA range zero
:CAL:PROT:A200U <+200 uA value>	Calibrate the +200 μA range
:CAL:PROT:AN200U <-200 uA value>	Calibrate the -200 μA range
:CAL:PROT:AZERO2M	Calibrate the 2 mA range zero
:CAL:PROT:A2M <+2 mA value>	Calibrate the +2 mA range
:CAL:PROT:AN2M <-2 mA value>	Calibrate the -2 mA range
:CAL:PROT:AZERO20M	Calibrate the 20 mA range zero
:CAL:PROT:A20M <+20 mA value>	Calibrate the +20 mA range
:CAL:PROT:AN20M <-20 mA value>	Calibrate the -20 mA range

Voltage measurement calibration commands

This is a list of the 6517B voltage measurement calibration commands.

Voltage measurement calibration commands

Command	Description
:CAL:PROT:VZERO2	Calibrate the 2 V range zero
:CAL:PROT:V2 <+2 V value>	Calibrate the +2 V range
:CAL:PROT:VN2 <-2 V value>	Calibrate the -2 V range
:CAL:PROT:VZERO20	Calibrate the 20 V range zero
:CAL:PROT:V20 <+20 V value>	Calibrate the +20 V range
:CAL:PROT:VN20 <-20 V value>	Calibrate the -20 V range
:CAL:PROT:VZERO200	Calibrate the 200 V range zero
:CAL:PROT:V200 <+200 V value>	Calibrate the +200 V range
:CAL:PROT:VN200 <-200 V value>	Calibrate the -200 V range

Voltage source calibration commands

This is a list of all voltage source calibration commands for the 6517B.

Voltage source calibration commands

Command	Description
:CAL:PROT:VSETZ100	Start the 100 V range zero calibration
:CAL:PROT:VSRCZ100 <measured voltage>	Calibrate the 100 V range zero
:CAL:PROT:VSET100	Start the +100 V range calibration
:CAL:PROT:VSRC100 <measured voltage>	Calibrate the +100 V range

Command	Description
:CAL:PROT:VSETN100	Start the -100 V range calibration
:CAL:PROT:VSRCN100 <measured voltage>	Calibrate the -100 V range
:CAL:PROT:VSET40	Start the +40 V calibration
:CAL:PROT:VSRC40 <measured voltage>	Calibrate the +40 V output
:CAL:PROT:VSETZ1000	Start the 1000 V range zero calibration
:CAL:PROT:VSRCZ1000 <measured voltage>	Calibrate the 1000 V range zero
:CAL:PROT:VSET1000	Start the +1000 V range calibration
:CAL:PROT:VSRC1000 <measured voltage>	Calibrate the +1000 V range
:CAL:PROT:VSETN1000	Start the -1000 V range calibration
:CAL:PROT:VSRCN1000 <measured voltage>	Calibrate the -1000 V range
:CAL:PROT:VSET400	Start the +400 V calibration
:CAL:PROT:VSRC400 <measured voltage>	Calibrate the +400 V output

Humidity calibration commands

This is a list of the 6517B humidity calibration commands

Humidity calibration commands

Command	Description
:CAL:PROT:HUMZERO	Calibrate the humidity input zero
:CAL:PROT:HUM1 <1 volt value>	Calibrate the humidity +1 V range

Temperature calibration commands

This is a list of the 6517B temperature calibration commands.

Temperature calibration commands

Command	Description
:CAL:PROT:TZERO	Calibrate the temperature input zero
:CAL:PROT:T100 0.004096	Calibrate the temperature 100 °C range
:CAL:PROT:TN25 -0.000968	Calibrate the temperature -25 °C range

Miscellaneous calibration commands

This is a list of the 6517B calibration commands that return the count, set the calibration dates, and lock and unlock calibration.

Miscellaneous calibration commands

Command	Description
:CAL:PROT:COUNT?	Query the number of times the instrument has been calibrated
:CAL:PROT:DATE yyyy,mm,dd	Set the calibration date
:CAL:PROT:DATE?	Query the calibration date

Command	Description
:CAL:PROT:NDUE <i>yyyy,mm,dd</i>	Set the calibration due date
:CAL:PROT:NDUE?	Query the next calibration due date
:CAL:PROT:CODE 'KInnnnnnn'	Unlock the calibration using the password (default is 006517)
:CAL:PROT:SAVE	Save the calibration
:CAL:PROT:LOCK	Lock the calibration

Calibration error codes

Commands that did not work as described return a numeric error code. Refer to the following table for a description of the calibration error codes. For other error codes, refer to “Status and error messages” in the *Model 6517B User’s Manual*.

Error Code	Description
+307	Reading underflow
+311	Test sequence measurement done
+350	2 V offset out of specification
+351	2 V positive gain out of specification
+352	2 V negative gain out of specification
+353	20 V offset out of specification
+354	20 V positive gain out of specification
+355	20 V negative gain out of specification
+356	200 V offset out of specification
+357	200 V positive gain out of specification
+358	200 V negative gain out of specification
+359	20 pA offset out of specification
+360	20 pA positive gain out of specification
+361	20 pA negative gain out of specification
+362	200 pA offset out of specification
+363	200 pA positive gain out of specification
+364	200 pA negative gain out of specification
+365	2 nA offset out of specification
+366	2 nA positive gain out of specification
+367	2 nA negative gain out of specification
+368	20 nA offset out of specification
+369	20 nA positive gain out of specification
+370	20 nA negative gain out of specification
+371	200 nA offset out of specification
+372	200 nA positive gain out of specification
+373	200 nA negative gain out of specification
+374	2 mA offset out of specification
+375	2 mA positive gain out of specification
+376	2 mA negative gain out of specification
+377	20 mA offset out of specification
+378	20 mA positive gain out of specification

Error Code	Description
+379	20 mA negative gain out of specification
+380	200 mA offset out of specification
+381	200 mA positive gain out of specification
+382	200 mA negative gain out of specification
+383	2 mA offset out of specification
+384	2 mA positive gain out of specification
+385	2 mA negative gain out of specification
+386	20 mA offset out of specification
+387	20 mA positive gain out of specification
+388	20 mA negative gain out of specification
+389	2 nC positive gain out of specification
+390	2 nC negative gain out of specification
+391	20 nC positive gain out of specification
+392	20 nC negative gain out of specification
+393	200 nC positive gain out of specification
+394	200 nC negative gain out of specification
+395	2 mC positive gain out of specification
+396	2 mC negative gain out of specification
+397	Charge zero excessive
+399	Temp offset out of specification
+400	Temp gain out of specification
+410	Humidity offset out of specification
+412	Humidity gain out of specification
+413	Int. Temp out of specification
+415	VSRC 100 V offset out of specification
+416	VSRC 100 V positive gain out of specification
+417	VSRC 100 V negative gain out of specification
+418	VSRC 1000 V offset out of specification
+419	VSRC 1000 V positive gain out of specification
+420	VSRC 1000 V negative gain out of specification
+421	Current offset not converging
+422	Voltage offset not converging
+423	Date of calibration not set
+424	Next date of calibration not set
+425	Calibration data invalid
+426	Not permitted with calibration locked
+427	Not permitted with calibration unlocked

Section 15

Verification procedure

In this section:

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Introduction

Use the procedures in this section to verify that the 6517B accuracy is within the limits stated in the one-year accuracy specifications of the instrument. Perform the verification procedures:

- When you first receive the instrument to make sure that it was not damaged during shipment
- To verify that the instrument meets factory specifications
- To determine if calibration is required
- After calibration to make sure it was performed properly

WARNING

The information in this section is intended for qualified service personnel only, as described by the types of product users in the Safety precautions pages, provided at the beginning of this document. Do not attempt these procedures unless you are qualified to do so.

Some of these procedures may expose you to hazardous voltages, that if contacted, could cause personal injury or death. Use appropriate safety precautions when working with hazardous voltages.

NOTE

If the instrument is still under warranty and its performance is outside specified limits, contact your Keithley Instruments representative or the factory to determine the correct course of action.

Equipment needed for verification

- Fluke 5700A calibrator
- Keithley Model 2002 Digital Multimeter
- Thermocouple calibrator
- Precision resistors with a value known to the listed uncertainty:
 - 100 GΩ, 850 ppm
 - 10 GΩ, 550 ppm
 - 1 GΩ, 550 ppm
 - 100 MΩ, 250 ppm
- Uncalibrated precision resistors:
 - 10 MΩ
 - 1 MΩ
 - 10 kΩ
 - 1 kΩ
 - 10 Ω
 - 1 Ω
- Precision capacitors with a value known to the listed uncertainty:
 - 1 nF, 1000 ppm
 - 100 nF, 1000 ppm
- Triaxial shielding capacitor

Warmup time and environment

The 6517B should be turned on and allowed to warm up for at least two hours at an ambient temperature of 18° C to 28° C, 70 percent or lower relative humidity.

Considerations

Always used fixed ranges for verifying voltage, current, and charge, because autoranging hysteresis may cause the instrument to be on the incorrect range.

To restore the instrument to factory defaults:

1. Press the **MENU** key; the following menu is displayed:

MAIN MENU
SAVESETUP COMMUNICATION CAL

2. Select **SAVESETUP**. Press the **ENTER** key. The following menu is displayed:

SETUP MENU
SAVE RESTORE POWERON RESET

3. Select **RESET**. Press the **ENTER** key. The following menu is displayed:

RESET ORIGINAL DFLTS
BENCH GPIB

4. Select **BENCH**. Press the **ENTER** key. The following message is displayed:

Restoring PRESET

Verification procedures

NOTE

All test configurations must be properly grounded. If the triaxial to BNC adapter ties the BNC ground to the triaxial inner shield, the DC Volts Guard must be off for the operation to be correct. If the triaxial to BNC adapter ties the BNC ground to the outer shield of the triaxial connector, a separate path to ground must be supplied to obtain the correct measurement. To accomplish this, do one of the following actions:

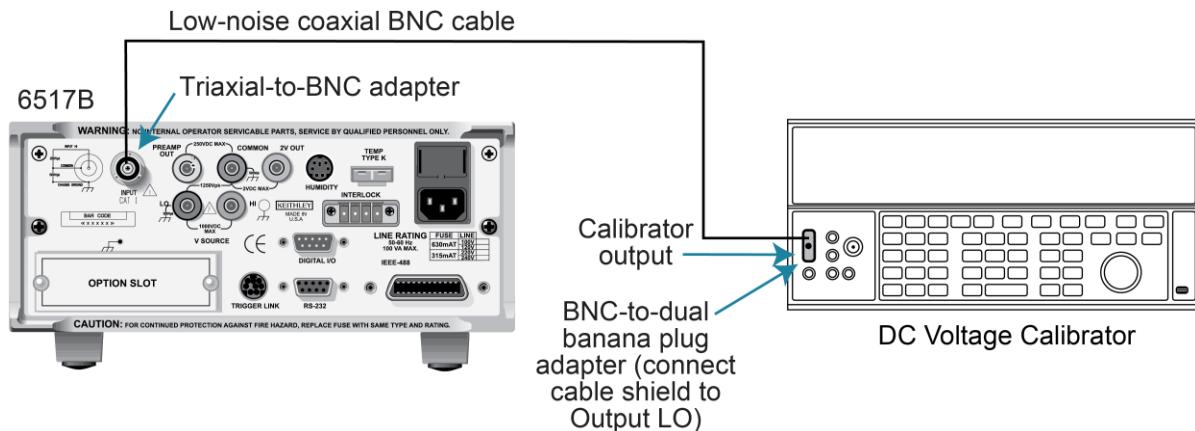
- Preferred: Take the ground lead (on the rear panel of the 6517B, connected to the ground screw next to the Keithley logo) and plug it into the common terminal of the 6517B (located between Preamp Out and 2V Out). This is preferred because it minimizes the loop area for noise pickup.
 - Connect a separate wire from the 6517B common to the low terminal of the dc voltage calibrator.
-

DC voltage verification

To verify dc voltage:

1. Connect the calibrator output to the 6517B as shown in the following figure. Ensure that the configuration is properly grounded as noted at the beginning of this section.

Figure 101: DC voltage verification configuration



2. Turn on the 6517B and allow it to warm up for at least two hours before making measurements.
3. Restore the instrument to factory default settings using the procedure described under [Considerations](#) (on page 15-3).
4. Select the DCV 2 V range from the front panel. Refer to [Measurement range](#) (on page 3-23) for more information.
5. With zero check enabled, press the **REL** key to turn on the zero correct function. Refer to [Relative offset](#) (on page 3-29) for more information.
6. Set the calibrator to 0.0 V and then turn off zero check. Allow the reading to settle completely before continuing.
7. Press the **REL** key to enable the 6517B relative offset function.
8. Set the calibrator to the voltages shown in the following table.
9. Set the 6517B range according to the following table. Verify the reading is within the range specified.
10. Press the **REL** key to turn off the relative offset function and then turn zero check on. Repeat steps 4 to 9 for the 20 V and 200 V ranges.

Limits for dc voltage verification

Calibrator output	6517B range	Allowed reading range 18° C to 28° C, 1 year
+1.9 V	2 V	+1.89949 V to +1.900515 V
-1.9 V	2 V	-1.900515 V to -1.89949 V
+19 V	20 V	+18.9950 V to +19.0050 V
-19 V	20 V	-19.0050 V to -18.9950 V
+190 V	200 V	+189.883 V to +190.117 V
-190 V	200 V	-190.117 V to -189.883 V

NOTE

Allowed reading limits are calculated from the 6517B one-year uncertainty, and do not include test equipment uncertainties.

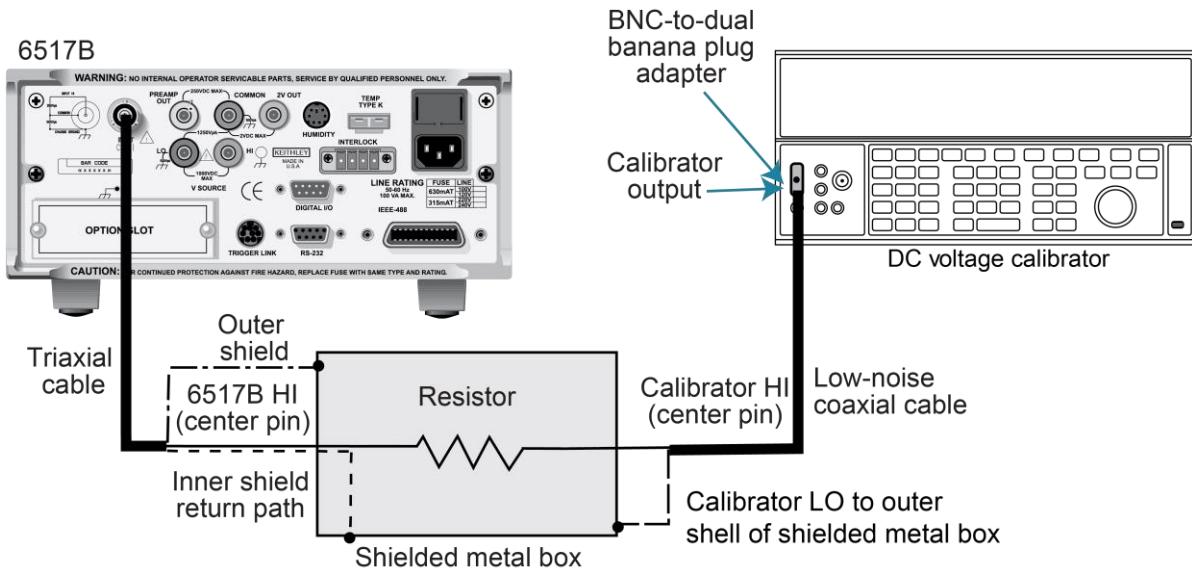
DC amps verification

The dc amps verification procedure is performed by applying known currents to the 6517B input and verifying that the reading falls within acceptable limits. There are two procedures used. The procedure for the 20 pA to 2 μ A ranges uses a dc voltage calibrator and precision resistors. The procedure for the 20 μ A to 20 mA ranges uses a dc current calibrator.

20 pA to 2 μ A ranges

To verify the current ranges from 20 pA to 2 μ A:

1. Connect the 6517B according to the following figure using the corresponding standard resistor value from the table that follows this procedure.

Figure 102: Model 6517B 20 pA to 2 μ A current range verification configuration

2. Turn on the 6517B and allow it to warm up for at least two hours before making measurements.
3. Restore the 6517B to factory default settings using the procedure described in the topic [Considerations](#) (on page 15-3).
4. Select the current function and the 20 pA range on the 6517B. Refer to “Current configuration” in the *Model 6517B User’s Manual* for more information.
5. With zero check enabled, press the **REL** key to turn on the zero correct function.
6. Set the calibrator to 0.0 V and then turn off zero check. Allow the reading to stabilize completely before continuing.
7. Press **REL** to enable the 6517B relative offset function.
8. Using the formula:

$$V = I R$$

Calculate the actual calibrator voltage to achieve the target current using the known value of the precision resistors. Record the calibrator voltage.

9. Set the calibrator to the actual voltage. See the calibrator documentation for detailed instructions.
10. Make sure the calibrator is in operate.
11. Allow the reading to settle completely. Note the reading on the 6517B. Verify that the reading is within the limits specified in the following table.
12. Reverse the calibrator polarity and verify the magnitude of the current reading is within the limits.
13. Turn zero check on.
14. Repeat steps 4 through 13 for the 200 pA to 2 μ A ranges using the appropriate dc voltage and standard resistor listed in the following table.

Reading limits for verification of 20 pA to 2 µA ranges

6517B range	Nominal dc voltage value	Standard resistor value	Applied current	Reading limits 18° C to 28° C, 1 year
20 pA	1.9 V	100 GΩ	19 pA	18.8070 pA to 19.1930 pA
200 pA	1.9 V	10 GΩ	190 pA	188.095 pA to 191.905 pA
2 nA	1.9 V	1 GΩ	1.9 nA	1.89590 nA to 1.91410 nA
20 nA	1.9 V	100 MΩ	19 nA	18.9615 nA to 19.0385 nA
200 nA	19 V	100 MΩ	190 nA	189.615 nA to 190.385 nA
2 µA	190 V	100 MΩ	1.9 µA	1.89800 µA to 1.90200 µA

20 µA to 20 mA ranges

To verify the current ranges from 20 µA to 20 mA:

1. Connect the 6517B to the dc current calibrator as shown in [DC voltage verification](#) (on page 15-4).
2. Turn on the 6517B and allow it to warm up for at least two hours before making measurements.
3. Restore the 6517B to factory default settings using the procedure described in the topic [Considerations](#) (on page 15-3).
4. Select the current function and 20 µA range on the 6517B.
5. With zero check enabled, press the **REL** key to turn on the zero correct function.
6. Set the calibrator to 0.0 A, then turn off zero check. Allow the reading to stabilize completely before continuing.
7. Press **REL** to enable the 6517B relative offset function.
8. Set the calibrator to output +19.0 µA.
9. Allow the reading to settle completely. Note the reading on the 6517B. Verify that the reading is within the limits specified in the following table.
10. Reverse the calibrator polarity, then verify the magnitude of the current reading is within the specified limits.
11. Repeat steps 4 through 10 for the 200 µA, 2 mA, and 20 mA ranges.

Limits for 2 µA to 20 mA range verification

6517B range	Applied dc current	Reading limits 18 °C to 28 °C, 1 year
20 µA	19 µA	18.9805 µA to 19.0195 µA
200 µA	190 µA	189.805 µA to 190.195 µA
2 mA	1.9 mA	1.89800 mA to 1.90200 mA
20 mA	19 mA	18.9805 mA to 19.0195 mA

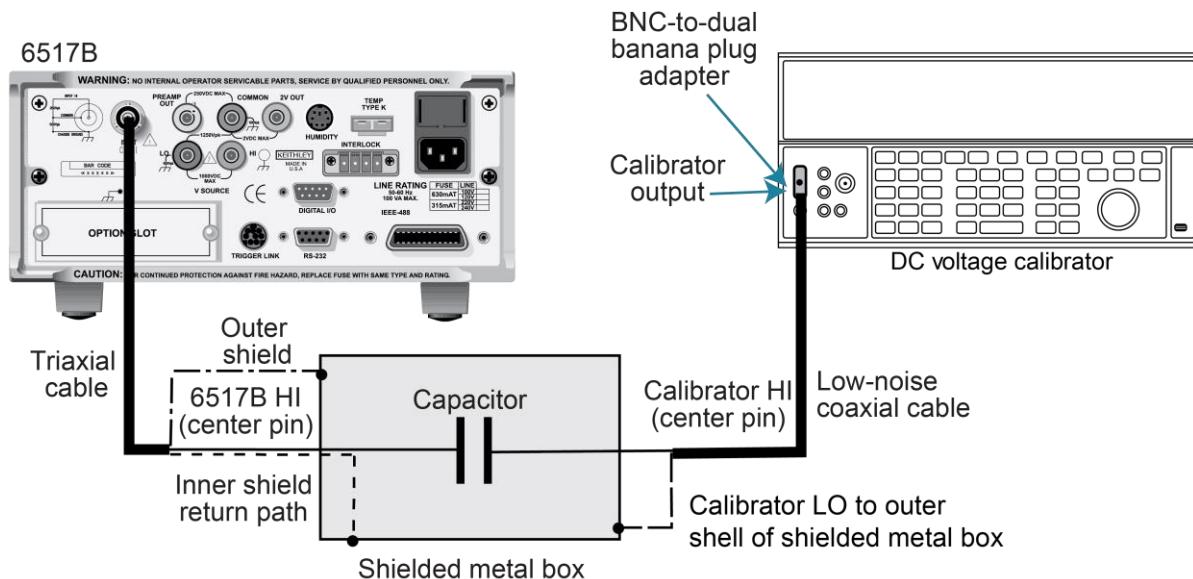
Charge verification

Charge verification is performed by applying accurately known charge values (derived from a voltage source and capacitor) to the 6517B input jack, and then verifying that the 6517B readings fall within specified limits.

To perform charge verification:

1. Connect the 6517B to the calibrator and capacitor as shown in the following figure, using the appropriate capacitor value from the standard capacitor column in the following table.

Figure 103: Model 6517B coulombs verification



2. Turn on the 6517B and allow it to warm up for at least two hours before making measurements.
3. Restore the 6517B to factory default settings using the procedure described in the topic [Considerations](#) (on page 15-3).
4. Select the charge function and 2 nC range on the 6517B. Refer to “Charge configuration” in the *Model 6517B User’s Manual* for more information.
5. Compute the calibrator voltages using the formula:

$$V = Q / C$$

Where:

- V is the calibrator voltage
- Q is the charge in coulombs
- C is the capacitance in farads

6. With zero check enabled, press the **REL** key to turn on the zero correct function.
7. Set the calibrator to 0.0 V, using the same range as the nominal value to be used.
8. Turn off zero check, and then set the calibrator output to the appropriate voltage. Allow the reading to settle completely.
9. Verify that the 6517B reading is within the limits specified in the following table.
10. Set the calibrator to 0.0 V and turn on zero check.
11. Turn off zero check, and then set the calibrator to the reverse polarity of the voltage. Allow the reading to settle completely.
12. Verify that the 6517B reading magnitude is within the specified limits.
13. Turn zero check on.
14. Repeat steps 4 through 13 for the 20 nC, 200 nC, and 2 μ C ranges.

Limits for 2 nC to 2 μ C range verification

6517B range	Standard capacitor	Nominal voltage value	Charge	Reading Limits 18° C to 28° C, 1 year
2 nC	1 nF	1.9 V	1.9 nC	1.89235 nC to 1.90765 nC
20 nC	1 nF	19 V	19 nC	18.9235 nC to 19.0765 nC
200 nC	100 nF	1.9 V	190 nC	189.235 nC to 190.765 nC
2 μ C	100 nF	19 V	1.9 μ C	1.89235 μ C to 1.90765 μ C

Voltage source verification

Voltage source output accuracy is verified by programming the voltage source to specific voltage values and measuring the output voltage using a precision digital multimeter.

To verify the voltage source:

1. Turn on the 6517B and the digital multimeter. Allow both to warm up for at least two hours before making measurements.
2. Set the DMM to the VDC function.
3. Turn autoranging on.
4. Temporarily short the DMM input leads together.
5. Enable the DMM REL mode. Leave REL enabled for the remainder of the voltage source verification.
6. With the 6517B voltage source turned off, connect the DMM input leads to the 6517B V-SOURCE OUT connector. Be sure to connect the DMM input HI to the output HI, and the DMM input LO to the output LO.
7. Set the 6517B voltage source range to the 100 V range and turn the voltage source on.
8. Set the voltage source to 0.0 V, and then verify the readings are within the range specified in the following table.
9. Repeat step 8 for each voltage listed in the 100 V range of the following table.

10. Set the 6517B voltage source off.
11. Set the 6517B voltage source range to the 1000 V range and turn VOLTAGE SOURCE OPERATE on.
12. Program the voltage source to 0.0 V and verify the readings are within the range specified in the following table.
13. Repeat step 12 for each voltage listed in the 1000 V range of the following table.
14. Repeat the procedure for negative output voltages using the same magnitudes listed in the following table.

Voltage source verification limits

6517B voltage source range	6517B programmed source output	Reading limits 18 °C to 28 °C, 1 year
100 V	0.0 V	-0.01 V to 0.01 V
100 V	25 V	24.9525 V to 25.0475 V
100 V	50 V	49.915 V to 50.085 V
100 V	75 V	74.8775 V to 75.1225 V
100 V	100 V	99.84 V to 100.16 V
1000 V	0 V	-0.1 V to 0.1 V
1000 V	250 V	249.525 V to 250.475 V
1000 V	500 V	499.15 V to 500.85 V
1000 V	750 V	748.775 V to 751.225 V
1000 V	1000 V	998.4 V to 1001.6 V

Temperature verification

Accuracy of the 6517B temperature measurement is verified by connecting a thermocouple calibrator to the 6517B and verifying that the temperature readings are within specified limits.

To verify temperature measurement:

1. Connect a K-type thermocouple calibrator to the 6517B EXT TEMP terminal.
2. Turn on the 6517B and allow it to warm up for at least two hours before making measurements.
3. Enable the 6517B temperature measurements by turning on the temperature data stamp:
 - a. Press **MENU**.
 - b. Select **GENERAL** on the second page of the lower display and press the **ENTER** key.
 - c. Use the right arrow key to select **A/D-CONTROLS** and press the **ENTER** key.
 - d. Select **DATA-STAMP** and press the **ENTER** key.
 - e. Use the left or right arrow keys to select **TEMPERATURE** and use the range up or range down key to select **ON**.
 - f. Press the **ENTER** key, then press **EXIT** three times to return to the measurement display. Press **PREV** to view the external temperature.
4. Set the thermocouple calibrator to output -25 °C and allow the reading to stabilize.
5. Verify the 6517B temperature reading is within the limits specified in the following table.
6. Repeat steps 4 and 5 for each temperature listed in the following table.

Temperature verification limits

Calibration temperature	Reading limits
	18° C to 28° C, 1 year
-25 °C	-26.42 °C to -23.58 °C
0 °C	-1.5 °C to 1.5 °C
50 °C	48.35 °C to 51.65 °C
100 °C	98.2 °C to 101.8 °C
150 °C	148.05 °C to 151.95 °C

Humidity verification

To check humidity measurement accuracy, apply an accurate 0 V dc to 1 V dc to the 6517B and verify that the humidity readings are within specified limits.

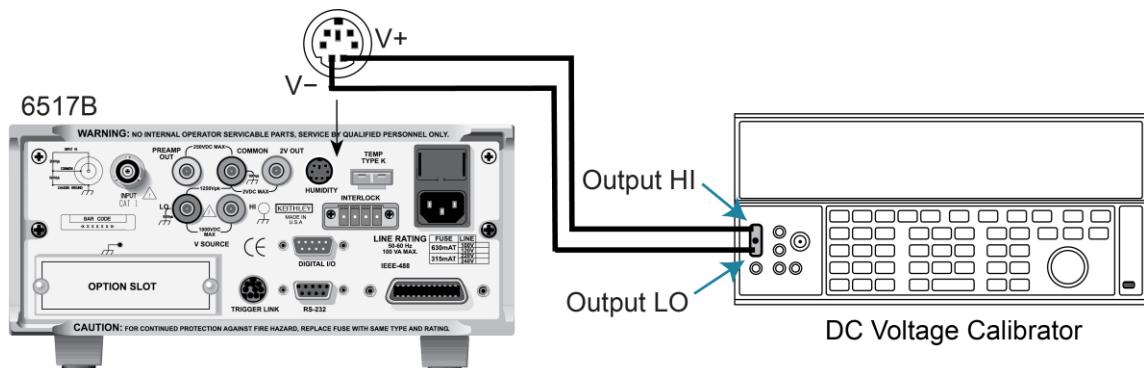
To verify humidity readings:

- With the power off, connect the dc calibrator to the 6517B **HUMIDITY** connector, as shown in the following figure.

NOTE

Connect Calibrator HI to V+ and Calibrator LO to V-.

Figure 104: Model 6517B humidity verification configuration



- Turn on the power to the 6517B and allow it to warm up for at least two hours before making measurements.
- Enable the 6517B humidity measurements by turning on the humidity data stamp.
 - Press **MENU**, use the right arrow key to select **GENERAL** on the second page of the lower display, and then press **ENTER**.
 - Use the right arrow key to select **A/D-CONTROLS**, and then press **ENTER**.
 - Select **DATA-STAMP**, and then press **ENTER**.
 - Use the left or right arrow keys to select **HUMIDITY**, and then use the range up or range down key to select **ON**.
 - Press **ENTER**, and then press **EXIT** three times to return to the measurement display.
 - Press **PREV** to view the relative humidity (RH) reading.
- Set the calibrator output to 0.0 V.
- Allow the reading to settle, then verify that the 6517B humidity reading is within the limits in the following table.
- Repeat step 5 for each of the voltage settings in the table.

Limits for humidity verification

Applied voltage	Humidity reading limits (1 year, 18° to 28°C)
0.0 V	0% to 1%
0.25 V	24% to 26%
0.5 V	49% to 51%
0.75 V	74% to 76%
1.0 V	99% to 100%

Resistance verification

Resistance function accuracy is verified by connecting accurate resistance standards to the 6517B and then verifying that the readings on the display fall within the required ranges. The following paragraphs discuss the required resistance standards and how to compute voltage source values. They also provide detailed procedures for verifying accuracy of the resistance function.

NOTE

Resistance specifications are derived from current and voltage source specifications, so it is not necessary to verify resistance separately. However, the following procedure is provided if you want to perform an artifact standard verification.

Required standard resistors

Resistance standards required include:

- Resistance calibrator (2 MΩ to 200 MΩ ranges)
- Model 5156 Electrometer Calibration Standard (2 GΩ to 200 GΩ ranges)
- Characterized resistors (2 TΩ to 200 TΩ ranges)

See the [Equipment needed for verification](#) (on page 15-2) topic for detailed information on the recommended standard resistors.

Calculating ohms reading limits

Ohms reading limits must be calculated from the actual standard resistance value and the appropriate 6517B specifications. For example, assume that the 2 GΩ range is being tested, and the specifications are:

- 6517B 2 GΩ range accuracy: $\pm(0.225\% \text{ of reading} + 1 \text{ count})$
- 1 GΩ resistor actual value: 1.025 GΩ

Calculated reading limits are as follows:

$$\text{Reading limits} = 1.025 \text{ G}\Omega \pm [(1.025 \text{ G}\Omega \times 0.225\%) + 10 \text{ k}\Omega]$$

$$\text{Reading limits} = 1.025 \text{ G}\Omega \pm 2.31625 \text{ M}\Omega$$

$$\text{Reading limits} = 1.02268 \text{ G}\Omega \text{ to } 1.02732 \text{ G}\Omega$$

NOTE

Before performing the ohms verification procedures, calculate the reading limits for each range and enter the limits where indicated in the following verification table.

6517B range	Nominal resistance*	Reading limits** (1 year, 18 °C to 28 °C)
2 MΩ	1.9 MΩ	_____ to _____ MΩ
20 MΩ	19 MΩ	_____ to _____ MΩ
200 MΩ	100 MΩ	_____ to _____ MΩ
2 GΩ	1 GΩ	_____ to _____ GΩ
20 GΩ	10 GΩ	_____ to _____ GΩ
200 GΩ	100 GΩ	_____ to _____ GΩ
2 TΩ	1 TΩ	_____ to _____ TΩ
20 TΩ	10 TΩ	_____ to _____ TΩ
200 TΩ	100 TΩ	_____ to _____ TΩ

* Resistance calibrator used for 2 MΩ to 200 MΩ ranges. Characterized resistance standards used for 200 GΩ to 200 TΩ ranges. Standards must be characterized to uncertainty at least four times better than equivalent 6517B specifications and mounted in a shielded test box. Refer to the "Shielded fixture construction" figure in [2 TΩ to 200 TΩ range verification](#) (on page 15-17).

** Reading limits calculated from actual resistance value and 6517B specifications.

Instrument setup

Before performing the ohms verification procedures, make sure the instrument is properly configured as follows. Failure to do so will result in erroneous or erratic measurements.

Step 1: Select the autovoltage source mode

1. Press **CONFIG** and then **R**.
2. Select **VSOURCE**. Press the **ENTER** key.
3. Select **AUTO**. Press the **ENTER** key.
4. Press the **EXIT** key to return to the measurement display.

Step 2: Select internal voltage source connections

1. Press the **CONFIG** key.
2. Press the **OPER** key.
3. Select **METER-CONNECT**. Press the **ENTER** key.
4. Select **ON**. Press the **ENTER** key.
5. Press the **EXIT** key to return to the measurement display.

Step 3: Disable voltage source resistive limit

1. Press the **CONFIG** key.
2. Press the **OPER** key.
3. Select **RESISTIVE-LIMIT**. Press the **ENTER** key.
4. Select **OFF**. Press the **ENTER** key.
5. Press the **EXIT** key to return to the measurement display.

Step 4: Remove ground link

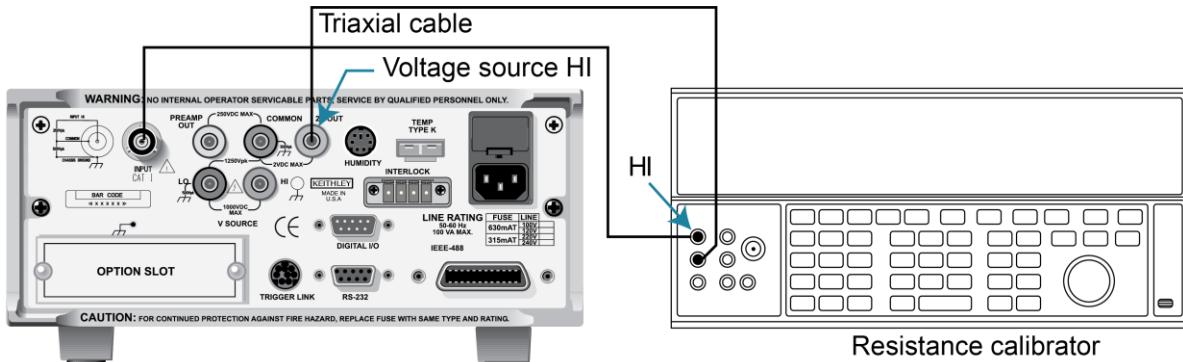
Remove the shorting link between COMMON and chassis ground on the rear panel. Floating COMMON eliminates ground loops that might result in noise problems.

2 MΩ to 200 MΩ range verification

To perform 2 MΩ to 200 MΩ range verification:

1. Connect the 6517B to the resistance calibrator, as shown in the following figure.

Figure 105: Connections for ohms verification: 2 MΩ to 200 MΩ range



2. Turn on the 6517B and the calibrator.
3. Allow a two-hour warmup period before making measurements.
4. Restore 6517B factory default conditions, as explained in [Considerations](#) (on page 15-3).
5. Press the **R** key to select the resistance function.
6. Select the 6517B 2 MΩ range.
7. Press the **FILTER** key until the filter is enabled.
8. Set the calibrator resistance to a nominal 1.9 MΩ resistance value.
9. Press the **OPER** key to place the voltage source in operate.
10. Press the **Z-CHK** key to disable zero check.
11. Allow the reading to settle. Verify that the displayed resistance reading is within limits for the selected range listed in the table in [Calculating ohms reading limits](#) (on page 15-13).
12. Repeat steps 6 through 11 for the 20 MΩ and 200 MΩ ranges.
13. Press the **OPER** key to put the voltage source in standby.
14. Disconnect the resistance calibrator from the 6517B.

2 GΩ to 200 GΩ range verification

NOTE

Standard resistors must be characterized to an uncertainty at least four times better than the equivalent 6517B accuracy specifications. These resistors must be mounted in specially shielded test fixtures to minimize noise. See the “Shielded fixture construction” figure in [2 TΩ to 200 TΩ range verification](#) (on page 15-17) for details on test fixture construction.

To perform 2 GΩ to 200 GΩ range verification:

1. Connect the nominal 1 GΩ characterized resistor to the 6517B as shown in the figure in [2 TΩ to 200 TΩ range verification](#) (on page 15-17).
2. Press the **R** key to select the resistance function.
3. Press the **OPER** key to place the voltage source in operate.
4. Select the 2 GΩ range on the 6517B.
5. Press the **Z-CHK** key to disable zero check.
6. Allow the reading to settle.
7. Verify that the displayed reading is within the calculated reading limits listed in the table in [Calculating ohms reading limits](#) (on page 15-13).
8. Repeat steps 4 through 7 for the 20 GΩ and 200 GΩ ranges.
9. Press the **OPER** key to place the voltage source in standby.
10. Disconnect the standard resistor from the 6517B.

2 TΩ to 200 TΩ range verification

NOTE

Standard resistors must be characterized to an uncertainty at least four times better than the equivalent 6517B accuracy specifications. These resistors must be mounted in specially shielded test fixtures to minimize noise. See the “Shielded fixture construction” figure in the following for details on test fixture construction.

⚠ WARNING

Hazardous voltage (400 V) is used in the following steps. Do not touch connecting cables or test leads when the voltage source is in operate.

To perform 2 T Ω to 200 T Ω range verification:

1. Connect the nominal 1 T Ω characterized resistor to the 6517B as shown in the following figures.

Figure 106: Connections for ohms verification: 2 T Ω to 200 T Ω ranges

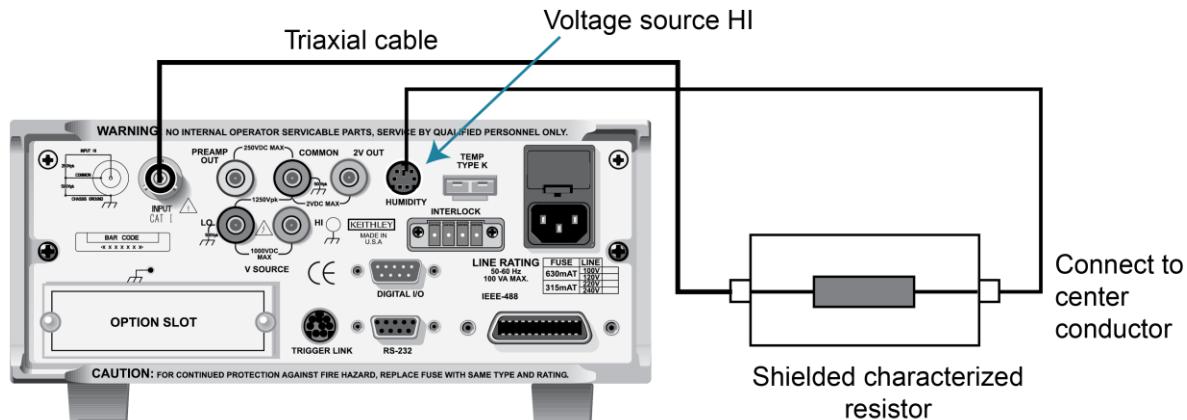
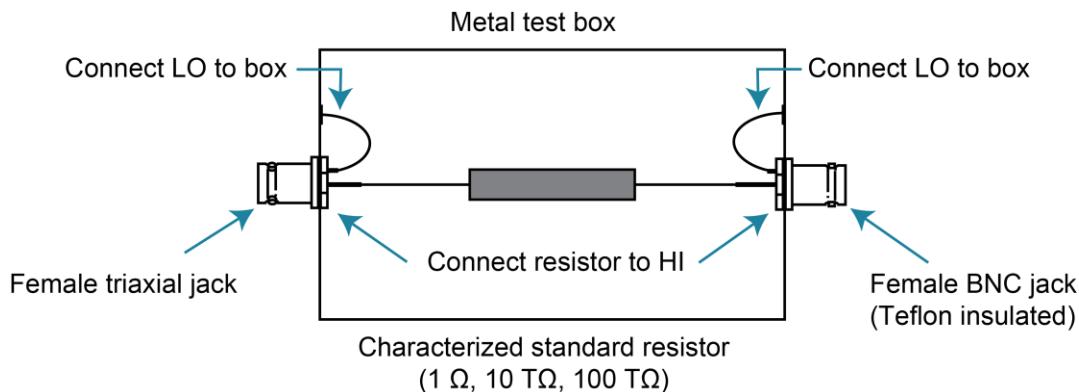


Figure 107: Shielded fixture construction



2. Select the 2 T Ω range on the 6517B.
3. Press the **OPER** key to place the voltage source in operate.
4. Press the **Z-CHK** key to disable zero check.
5. Allow the reading to settle.
6. Verify that the displayed reading is within the calculated reading limits listed in the table in [Calculating ohms reading limits](#) (on page 15-13).
7. Repeat steps 2 through 6 for the 20 T Ω and 200 T Ω ranges.
8. Press the **OPER** key to place the voltage source in standby.
9. Disconnect the standard resistor from the 6517B.

Section 16

ASCII character codes

In this section:

Introduction	16-1
ASCII character codes (decimal 0 to 31)	16-1
ASCII character codes (decimal 32 to 95).....	16-2
ASCII character codes (decimal 96 to 127).....	16-3

Introduction

The following tables summarize ASCII character codes and corresponding IEEE-488 (GPIB) multiline messages for the Keithley Instruments 6517B Electrometer.

ASCII character codes (decimal 0 to 31)

Decimal	Hexadecimal	ASCII	IEEE-488 messages*	Decimal	Hexadecimal	ASCII	IEEE-488 messages*
0	00	NUL		16	10	DLE	
1	01	SOH	GTL	17	11	DC1	LLO
2	02	STX		18	12	DC2	
3	03	ETX		19	13	DC3	
4	04	EOT	SDC	20	14	DC4	
5	05	ENQ	PPC	21	15	NAK	DCL
6	06	ACK		22	16	SYN	PPU
7	07	BEL		23	17	ETB	
8	08	BS	GET	24	18	CAN	SPE
9	09	HT	TCT	25	19	EM	SPD
10	0A	LF		26	1A	SUB	
11	0B	VT		27	1B	ESC	
12	0C	FF		28	1C	FS	
13	0D	CR		29	1D	GS	
14	0E	SO		30	1E	RS	
15	0F	SI		31	1F	US	

* Message sent or received with ATN true. Numbers shown represent primary address resulting in MLA (My Listen Address).

ASCII character codes (decimal 32 to 95)

Decimal	Hexadecimal	ASCII	IEEE-488 messages*	Decimal	Hexadecimal	ASCII	IEEE-488 messages*
32	20	SP	MLA 0	64	40	@	MTA 0
33	21	!	MLA 1	65	41	A	MTA 1
34	22	"	MLA 2	66	42	B	MTA 2
35	23	#	MLA 3	67	43	C	MTA 3
36	24	\$	MLA 4	68	44	D	MTA 4
37	25	%	MLA 5	69	45	E	MTA 5
38	26	&	MLA 6	70	46	F	MTA 6
39	27	'	MLA 7	71	47	G	MTA 7
40	28	(MLA 8	72	48	H	MTA 8
41	29)	MLA 9	73	49	I	MTA 9
42	2A	*	MLA 10	74	4A	J	MTA 10
43	2B	+	MLA 11	75	4B	K	MTA 11
44	2C	,	MLA 12	76	4C	L	MTA 12
45	2D	-	MLA 13	77	4D	M	MTA 13
46	2E	.	MLA 14	78	4E	N	MTA 14
47	2F	/	MLA 15	79	4F	O	MTA 15
48	30	0	MLA 16	80	50	P	MTA 16
49	31	1	MLA 17	81	51	Q	MTA 17
50	32	2	MLA 18	82	52	R	MTA 18
51	33	3	MLA 19	83	53	S	MTA 19
52	34	4	MLA 20	84	54	T	MTA 20
53	35	5	MLA 21	85	55	U	MTA 21
54	36	6	MLA 22	86	56	V	MTA 22
55	37	7	MLA 23	87	57	W	MTA 23
56	38	8	MLA 24	88	58	X	MTA 24
57	39	9	MLA 25	89	59	Y	MTA 25
58	3A	:	MLA 26	90	5A	Z	MTA 26
59	3B	;	MLA 27	91	5B	[MTA 27
60	3C	<	MLA 28	92	5C	\	MTA 28
61	3D	=	MLA 29	93	5D]	MTA 29
62	3E	>	MLA 30	94	5E	«	MTA 30
63	3F	?	UNL	95	5F	æ	UNL

* Message sent or received with ATN true. Numbers shown represent primary address resulting in MLA (My Listen Address).

ASCII character codes (decimal 96 to 127)

Decimal	Hexadecimal	ASCII	IEEE-488 messages*	Decimal	Hexadecimal	ASCII	IEEE-488 messages*
96	60	«	MSA 0, PPE	112	70	p	MSA 16, PPD
97	61	a	MSA 1, PPE	113	71	q	MSA 17, PPD
98	62	b	MSA 2, PPE	114	72	r	MSA 18, PPD
99	63	c	MSA 3, PPE	115	73	s	MSA 19, PPD
100	64	d	MSA 4, PPE	116	74	t	MSA 20, PPD
101	65	e	MSA 5, PPE	117	75	u	MSA 21, PPD
102	66	f	MSA6, PPE	118	76	v	MSA 22, PPD
103	67	g	MSA 7, PPE	119	77	w	MSA 23, PPD
104	68	h	MSA 8, PPE	120	78	x	MSA 24, PPD
105	69	i	MSA 9, PPE	121	79	y	MSA 25, PPD
106	6A	j	MSA 10, PPE	122	7A	z	MSA 26, PPD
107	6B	k	MSA 11, PPE	123	7B	{	MSA 27, PPD
108	6C	l	MSA 12, PPE	124	7C		MSA 28, PPD
109	6D	m	MSA 13, PPE	125	7D	}	MSA 29, PPD
110	6E	n	MSA 14, PPE	126	7E	~	MSA 30, PPD
111	6F	o	MSA 15, PPE	127	7F	DEL	

* Message sent or received with ATN true. Numbers shown represent primary address resulting in MLA (My Listen Address).

Section 17

IEEE-488 bus overview

In this section:

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Introduction

The IEEE-488 bus is a communication system between two or more electronic devices. A device can be either an instrument or a computer. When a computer is used on the bus, it serves to supervise the communication exchange between all the devices and is known as the controller. Supervision by the controller consists of determining which device talks and which device listens. As a talker, a device outputs information and as a listener, a device receives information. To simplify the task of keeping track of the devices, a unique address number is assigned to each one.

On the bus, only one device can talk at a time and is addressed to talk by the controller. The device that is talking is known as the active talker. The devices that need to listen to the talker are addressed to listen by the controller. Each listener is then referred to as an active listener. Devices that do not need to listen are instructed to unlisten. The reason for the unlisten instruction is to optimize the speed of bus information transfer since the task of listening takes up bus time. Through the use of control lines, a handshake sequence takes place in the transfer process of information from a talker to a listener. This handshake sequence helps ensure the credibility of the information transfer. The basic handshake sequence between an active controller (talker) and a listener is as follows:

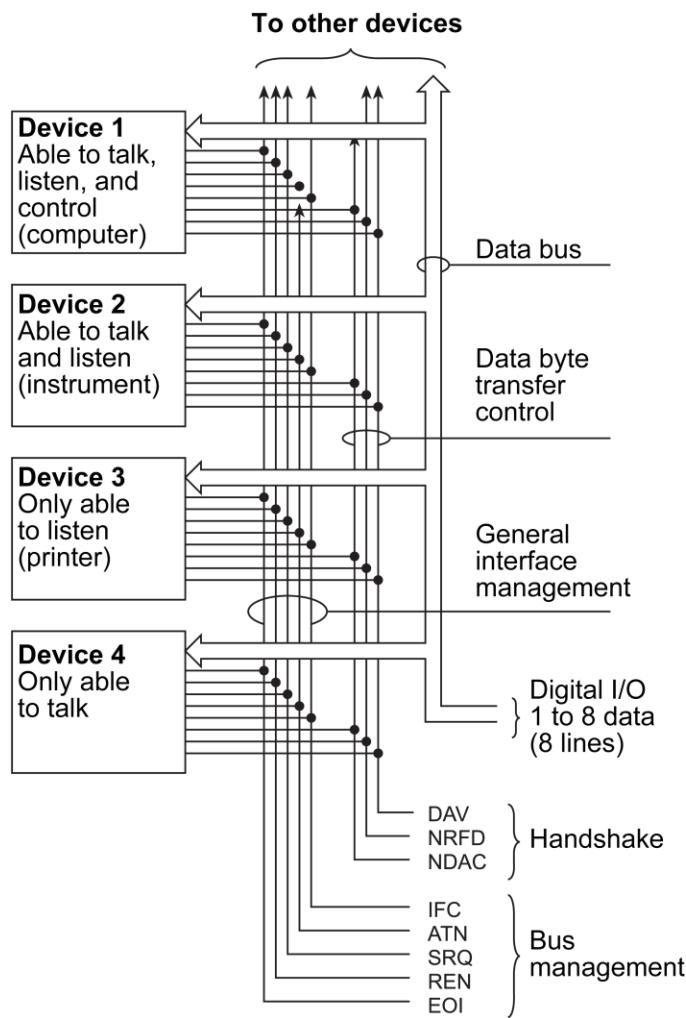
1. The listener indicates that it is ready to listen.
2. The talker places the byte of data on the bus and indicates that the data is available to the listener.
3. The listener, aware that the data is available, accepts the data and indicates that the data has been accepted.
4. The talker, aware that the data has been accepted, stops sending data and indicates that data is not being sent.
5. The listener, aware that there is no data on the bus, indicates that it is ready for the next byte of data.

Bus description

The IEEE-488 bus, which is also referred to a general purpose interface bus (GPIB), is a parallel transfer medium that optimizes data transfer without using an excessive number of bus lines. In keeping with this goal, the bus has only eight data lines that are used for both data and with most commands. Five bus management lines and three handshake lines round out the complement of bus signal lines.

A typical setup for controlled operation is shown in the following figure. Generally, a system contains one controller and a number of other instruments to which the commands are given. Device operation is categorized into three operators: Controller, talker, and listener. The controller controls the instruments on the bus. The talker sends data and a listener receives data. Depending on the type of instrument, any particular device can be a talker only, a listener only, or both a talker and listener.

Figure 108: IEEE-488 bus configuration



There are system controllers and basic controllers. Both can control other instruments, but only the system controller has absolute authority in the system. In a system with more than one controller, only one controller may be active at any given time. Certain protocol is used to pass control from one controller to another.

The IEEE-488 bus is limited to 15 devices, including the controller. Therefore, any number of talkers and listeners up to that limit may be present on the bus at one time. Although several devices may be commanded to listen simultaneously, the bus can have only one active talker.

A device is placed in the talk or listen state by sending an appropriate talk or listen command. These talk and listen commands are derived from the primary address of the instrument. The primary address may have any value between 0 and 31. The actual listen address value sent out over the bus is obtained by performing an OR operation of the primary address with \$20. For example, if the primary address is \$27, the actual listen address is \$47 ($\$47 = \$27 + \20). The talk address is obtained by performing an OR operation of the primary address with \$40. With the present example, the talk address derived from a primary address of 27 decimal is \$67 ($\$67 = \$27 + \40).

The IEEE-488 standards also include another addressing mode called secondary addressing. Secondary addresses are in the range of \$60 to \$7F. The 6517B does not use secondary addressing.

Once a device is addressed to talk or listen, the appropriate bus transactions take place. For example, if the instrument is addressed to talk, it places its data string on the bus one byte at a time. The controller reads the information and the appropriate software can be used to direct the information to the correct location.

Bus lines

The signal lines on the IEEE-488 bus are grouped into data lines, management lines, and handshake lines. The data lines handle bus data and commands. The management and handshake lines ensure that proper data transfer and operation takes place. Each bus line is active low, with approximately zero volts representing a logic 1 (true). The following paragraphs describe the operation of these lines.

Data lines

The IEEE-488 bus uses eight data lines that transfer data one byte at a time. DIO1 (data input/output) through DIO8 (data input/output) are the eight bidirectional data lines used to transmit both data and multiline commands. The data lines operate with low true logic.

Bus management lines

The bus management lines help to ensure proper interface control and management. These lines send the uniline commands.

ATN (attention): The **ATN** line is one of the more important management lines because the state of this line determines how information on the data bus is interpreted.

IFC (interface clear): The **IFC** line controls clearing of instruments from the bus.

REN (remote enable): The **REN** line places the instrument on the bus in the remote mode.

EOI (end or identify): The **EOI** is usually used to mark the end of a multibyte data transfer sequence.

SRQ (service request): This line is used by devices when they require service from the controller.

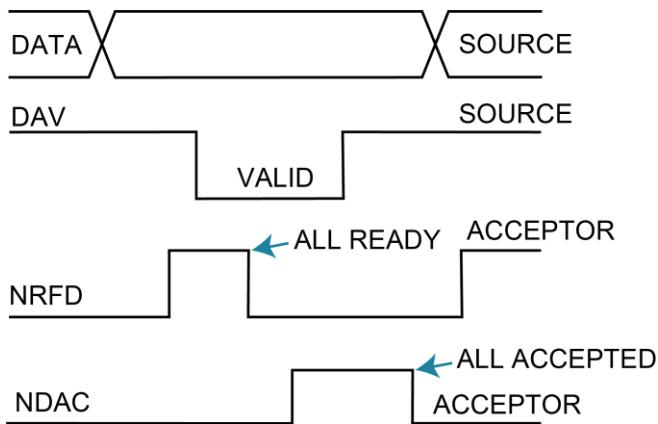
Handshake lines

The bus handshake lines operate in an interlocked sequence. This method ensures reliable data transmission regardless of the transfer rate. Generally, data transfer occurs at a rate determined by the slowest active device on the bus.

One of the three handshake lines is controlled by the source (the talker sending information). The other two lines are controlled by accepting devices (the listener or listeners receiving the information). The three handshake lines are:

- **DAV (data valid):** The source controls the state of the **DAV** line, which indicates whether data bus information is valid for any listening lines.
- **NRFD (not ready for data):** The acceptor controls the state of **NRFD**. It signals the transmitting device to pause the byte transfer sequence until the accepting device is ready.
- **NDAC (not data accepted):** **NDAC** is also controlled by the accepting device. The state of **NDAC** tells the source whether or not the device has accepted the data byte.

The complete handshake sequence for one data byte is shown in the following figure. Once data is placed on the data lines, the source checks to see that **NRFD** is high, indicating that all active devices are ready. At the same time, **NDAC** should be low from the previous byte transfer. If these conditions are not met, the source must wait until **NDAC** and **NRFD** have the correct status. If the source is a controller, **NRFD** and **NDAC** must be stable for at least 100 ns after **ATN** is set true. Because of the possibility of a bus interruption, many controllers have time-out routines that display messages if the transfer sequence stops for any reason.

Figure 109: IEEE-488 handshake sequence

Once all NDAC and NRFD are properly set, the source sets DAV low, signaling to accepting devices that the byte on the data lines is now valid. NRFD then goes low, and NDAC goes high once all devices have accepted the data. Each device releases NDAC at its own rate, but NDAC is not released to go high until all devices have accepted the data byte.

The sequence described above is used to transfer data, talk and listen addresses, and multiline commands. The state of the ATN line determines whether the data bus contains data, addresses, or commands.

Bus commands

The instrument may be given a number of special bus commands through the IEEE-488 interface. This section briefly describes the purpose of the bus commands, which are grouped into the following categories:

- **Uniline commands:** Sent by setting the associated bus lines true. For example, to assert REN (remote enable), the REN line is set low (true).
- **Multiline commands:** General bus commands that are sent over the data lines with the ATN line true (low).
- **Common commands:** Commands that are common to all devices on the bus; sent with ATN high (false).
- **SCPI commands:** Commands that are particular to each device on the bus; sent with ATN (false).

These bus commands and their general purposes are summarized in the following table.

IEEE-488 bus command summary

Command type	Command	State of ATN line	Comments
Uniline	REN (remote enable)	X	Sets up devices for remote operation
	EOI	X	Marks end of transmission
	IFC (interface clear)	X	Clears interface
	ATN (attention)	Low	Defines data bus contents
	SRQ	X	Controlled by external device
Multiline Universal	LLO (local lockout)	Low	Locks out local operation
	DCI (device clear)	Low	Returns device to default conditions
	SPE (serial enable)	Low	Enables serial polling
	SPD (serial poll disable)	Low	Disables serial polling
Addressed	SDC (selective device clear)	Low	Returns instrument to default conditions
	GTL (go to local)	Low	Returns device to local
Unaddressed	UNL (unlisten)	Low	Removes all listeners from the bus
	UNT (untalk)	Low	Removes any talkers from the bus
Common	—	High	Programs IEEE-488.2 compatible instruments for common operations
SCPI	—	High	Programs SCPI compatible instruments for specific operations

Uniline commands

ATN, IFC, and REN are asserted only by the controller. SRQ is asserted by an external device. EOI may be asserted either by the controller or other devices, depending on the direction of data transfer. The following is a description of each command. Each command is sent by setting the corresponding bus line true.

REN (remote enable): REN is sent to set up instruments on the bus for remote operation. When REN is true, devices are removed from the local mode. Depending on device configuration, all front-panel controls except the LOCAL key may be locked out when REN is true. Generally, send REN before attempting to program instruments over the bus.

EOI (end or identify): EOI positively identifies the last byte in a multibyte transfer sequence, allowing data words of various lengths to be transmitted easily.

IFC (interface clear): IFC clears the interface and returns all devices to the talker and listener idle states.

ATN (attention): The controller sends ATN when transmitting addresses or multiline commands.

SRQ (service request): SRQ is asserted by a device when it requires service from a controller.

Universal multiline commands

Universal commands are multiline commands that require no addressing. All devices equipped to implement such commands do so simultaneously when the commands are transmitted. All multiline commands are transmitted with ATN true.

LLO (local lockout): LLO is sent to the instrument to lock out the LOCAL key and all front-panel controls of the instrument.

DCL (device clear): DCL returns instruments to a default state. Usually, instruments return to their power-up conditions.

SPE (serial poll enable): SPE is the first step in the serial polling sequence that determines which device has requested service.

SPD (serial poll disable): SPD is used by the controller to remove all devices on the bus from the serial poll mode and is generally the last command in the serial polling sequence.

Addressed multiline commands

Addressed commands are multiline commands that must be preceded by the device listen address before that instrument responds to the command. Only the addressed device responds to these commands. Both the commands and the address preceding it are sent with ATN true.

SDC (selective device clear): The SDC command performs essentially the same function as the DCL command, except that only the addressed device responds. Generally, instruments return to their power-up default conditions when responding to the SDC command.

GTL (go to local): The GTL command removes instruments from the remote mode. With some instruments, GTL also unlocks front-panel controls if they were previously locked out with the LLO command.

GET (group execute trigger): The GET command triggers devices to perform a specific action that depends on device configuration (for example, make a reading). Although GET is an addressed command, many devices respond to GET without addressing.

Addressed commands

Addressed commands include two primary command groups and a secondary address group. `ATN` is true when these commands are asserted. The commands include:

- **LAG** (listen address group): These listen commands are derived from the primary address of the instrument and address devices to listen. The actual command byte is obtained by performing an OR of the primary address with \$20.
- **TAG** (talk address group): The talk commands are derived from the primary address by performing an OR of the address with \$40. Talk commands address devices to talk.
- **SCG** (secondary command group): Commands in this group provide additional addressing capabilities. Many devices (including the 6517B) do not use these commands.

Unaddressed commands

The controller uses the unaddressed commands to remove any talkers or listeners from the bus. `ATN` is true when these commands are asserted.

UNL (unlisten): Listeners are placed in the listener idle state by the `UNL` command.

UNT (untalk): Any previously commanded talkers are placed in the talker idle state by the `UNT` command.

Common commands

Common commands are commands that are common to all devices on the bus. These commands are designated and defined by the IEEE-488.2 standard.

Generally, these commands are sent as one or more ASCII characters that tell the device to perform a common operation, such as reset. The IEEE-488 bus treats these commands as data because `ATN` is false when the commands are transmitted.

SCPI commands

SCPI commands are commands that are particular to each device on the bus. These commands are designated by the instrument manufacturer and are based on the instrument model defined by the Standard Commands for Programmable Instruments (SCPI) Consortium's SCPI standard.

Generally, these commands are sent as one or more ASCII characters that tell the device to perform a particular operation, such as setting a range or closing a relay. The IEEE-488 bus treats these commands as data because `ATN` is false when the commands are transmitted.

Command codes

Command codes for the various commands that use the data lines are summarized in the following figure.

Figure 110: Command codes

*PPC (PARALLEL POLL CONFIGURE) PPU (PARALLEL POLL UNCONFIGURE),
 and TCT (TAKE CONTROL) not implemented by Model 6517B.
 Note: $D_0 = D_{101} \dots D_7 = D_{108}$; X = Don't Care.

Typical command sequences

For the multiline commands, a specific bus sequence must take place to properly send the command. In particular, the correct listen address must be sent to the instrument before it responds to addressed commands. The following table lists a typical bus sequence for sending the addressed multiline commands. In this instance, the SDC command is sent to the instrument. UNL is generally sent as part of the sequence to ensure that no other active listeners are present. ATN is true for both the listen command and the SDC command byte.

Typical addressed command sequence

Step	Command	ATN state	Data bus		
			ASCII	Hex	Decimal
1	UNL	Set low	?	3F	63
2	LAG*	Stays low	;	3B	59
3	SDC	Stays low	EOT	04	4
4		Returns high			

*Assumes primary address = 27

The following table gives a typical common command sequence. In this instance, ATN is true while the instrument is being addressed, but it is set high while sending the common command string.

Typical common command sequence

Step	Command	ATN state	Data bus		
			ASCII	Hex	Decimal
1	UNL	Set low	?	3F	63
2	LAG*	Stays low	;	3B	59
3	Data	Set high	*	2A	42
4	Data	Stays high	R	52	82
5	Data	Stays high	S	53	83
6	Data	Stays high	T	54	84

*Assumes primary address = 27

IEEE command groups

Command groups supported by the 6517B are listed in the following table. Common commands and SCPI commands are not included in this list.

IEEE command groups

Handshake command group	
	NDAC = Not data accepted NRFD = Not ready for data DAV = Data valid
Universal command group	
	ATN = Attention DCL = Device clear IFC = Interface clear REN = Remote enable SPD = Serial poll disable SPE = Serial poll enable
Address command group	
LISTEN	LAG = Listen address group MLA = My listen address UNL = Unlisten
TALK	TAG = Talk address group MTA = My talk address UNT = Untalk OTA = Other talk address
Addressed command group	
	ACG = Addressed command group GTL = Go to local SDC = Selective device clear
Status command group	
	RQS = Request service SRQ = Serial poll request STB = Status byte EOI = End

IEEE-488 conformance

The IEEE-488.2 standard requires specific information about how the Keithley Instruments 6517B Electrometer implements the standard. Paragraph 4.9 of the IEEE-488.2 standard (Std 488.2-1987) lists the documentation requirements. The following tables provides a summary of the requirements and provides the information or references the manual for that information.

IEEE-488 documentation requirements

Item Number	Requirement	Description or reference
(1)	IEEE-488 interface function codes	Refer to Interface function codes (on page 17-15)
(2)	Behavior of 6517B when the address is set outside the range of 0 to 30	Cannot enter an invalid address
(3)	Behavior of 6517B when valid address is entered	Address changes and bus resets
(4)	Power-on setup conditions	Determine by :SYSTem:POSetup (on page 11-161)
(5)	Message exchange options:	
(a)	Input buffer size	256 bytes
(b)	Queries that return more than one response message unit	None
(c)	Queries that generate a response when parsed	All queries (common commands and SCPI)
(d)	Queries that generate a response when read	None
(e)	Coupled commands	See Coupled commands (on page 17-13)
(6)	Functional elements required for SCPI commands	Contained in SCPI command subsystem tables (see SCPI command reference (on page 11-1))
(7)	Buffer size limitations for block data	Block display messages: Top display = 20 characters maximum, bottom display = 32 characters maximum
(8)	Syntax restrictions	See Remote operations (on page 2-1)
(9)	Response syntax for every query command	See Remote operations (on page 2-1)
(10)	Device-to-device message transfer that does not follow rules of the standard	None
(11)	Block data response size	See Remote operations (on page 2-1)
(12)	Common commands implemented by 6517B	See Common commands (on page 12-1)
(13)	Calibration query information	See Calibration procedure (on page 14-1)
(14)	Trigger macro for *DDT	Not applicable
(15)	Macro information	Not applicable
(16)	Response to *IDN (identification)	See Common commands (on page 12-1)
(17)	Storage area for *PUD and *PUD?	Not applicable
(18)	Resource description for *RDT and *RDT?	Not applicable
(19)	Effects of *RST, *RCL, and *SAV	See Common commands (on page 12-1) and SCPI Command Reference (on page 11-1)
(20)	*TST information	See Common commands (on page 12-1)
(21)	Status register structure	See Status structure (on page 13-1)
(22)	Sequential or overlapped commands	All are sequential except :INIT and :INIT:CONT ON, which are overlapped
(23)	Operation complete messages	See Common commands (on page 12-1)

Coupled commands

Command	Also changes	To	If
:TRIG:COUN	:TRAC:POIN:AUTO :TRAC:POIN :TRAC:FEED:PRET:AMO:READ	OFF TRIG:COUN TRIG:COUN * TRAC:FEED:PRET:AMO:PERC / 100	TRAC:POIN:AUTO is ON and TRIG:COUN is an illegal buffer size TRAC:POIN:AUTO is ON TRAC:POIN:AUTO is ON
:TRAC:FEED:CONT	:TRIG:SOUR	TIM	TRAC:FEED:CONT is PRET and TRIG:SOUR is neither IMM nor TIM
:TRAC:POIN	:TRAC:POIN:AUTO :TRAC:FEED:CONT :TRAC:FEED:PRET:AMO:READ	OFF NEV TRAC:POIN * TRAC:FEED:PRET:AMO:PERC / 100	
:TRAC:FEED:PRET:AMO:PERC	:TRAC:FEED:PRET:AMO:READ :TRAC:FEED:CONT	TRAC:POIN * TRAC:FEED:PRET:AMO:PERC / 100 NEV	
:TRAC:FEED:PRET:AMO:READ	:TRAC:FEED:PRET:AMO:PERC :TRAC:FEED:CONT	TRAC:FEED:PRET:AMO:READ / TRAC:POIN * 100 NEV	
:TRAC:CLE	:TRAC:FEED:CONT	NEV	
....:APER:APER:AUTO:NPLC:AUTO:NPLC:DIG	OFF OFF APER*line-frequency varies per functionDIG:AUTO is ON
....:NPLC:APER:AUTO:NPLC:AUTO:APER:DIG	OFF OFF NPLC/line-frequency varies per functionDIG:AUTO is ON
....:DIG:DIG:AUTO:APER:NPLC	OFF varies per function varies per functionAPER:AUTO is ONNPLC:AUTO is ON
....:RANG:UPP:RANG:AUTO	OFF	
....:REF:ACQ:REF	presently displayed reading	
....:DET:FUNC:APER:DIG:AVER:STAT:AVER:COUN n:AVER:TCON n:AVER:ADV:STAT n:AVER:ADV:NTOL n	varies per function varies per function varies per function varies per function varies per function varies per function varies per functionAPER:AUTO is ONDIG:AUTO is ONAVER:AUTO is ONAVER:AUTO is ONAVER:AUTO is ONAVER:AUTO is ONAVER:AUTO is ON

Command	Also changes	To	If
:RES:OCOM	:RES:RANG:UPP :RES:RANG:AUTO:ULIM :RES:RANG:AUTO:LLIM	200k 200k 200k	RES:OCOM is ON and RES:RANG:UPP > 200k RES:OCOM is ON and RES:RANG:AUTO:ULIM > 200k RES:OCOM is ON and RES:RANG:AUTO: LLIM > 200k
:CURR:DC:METH	:CURR:DC:RANG:UPP :CURR:DC:RANG:AUTO :CURR:DC:AVER:STAT :CURR:DC:AVER:COUN :CURR:DC:AVER:TCON :CURR:DC:AVER:ADV:STAT :CURR:DC:AVER:ADV:NTOL	12 OFF varies per function varies per function varies per function varies per function varies per function	CURR:DC:METH is ICIR CURR:DC:METH is ICIR CURR:DC:AVER:AUTO is ON CURR:DC:AVER:AUTO is ON CURR:DC:AVER:AUTO is ON CURR:DC:AVER:AUTO is ON CURR:DC:AVER:AUTO is ON CURR:DC:AVER:AUTO is ON
:FREQ:THR:VOLT:TTL	:FREQ:THR:VOLT:RANG :FREQ:THR:VOLT:LEV	10 0.8	
:TEMP:TRAN	:ROUT:SCAN:INT :ROUT:SCAN:INT:FUNC :TEMP:DIG	complicated algorithm complicated algorithm varies per transducer	TEMP:DIG:AUTO is ON
:TEMP:RTD:TYPE	:TEMP:RTD:ALPH :TEMP:RTD:BETA :TEMP:RTD:DELT :TEMP:RTD:RZER	varies per RTD type varies per RTD type varies per RTD type varies per RTD type	TEMP:RTD:TYPE is not USER TEMP:RTD:TYPE is not USER TEMP:RTD:TYPE is not USER TEMP:RTD:TYPE is not USER
:TEMP:RTD:ALPH	:TEMP:RTD:TYPE	USER	
:ROUT:CLOS	:ROUT:SCAN:LSEL	NONE	
:ROUT:OPEN	:ROUT:SCAN:LSEL	NONE	The command opens a channel
:ROUT:OPEN:ALL	:ROUT:SCAN:LSEL	NONE	
:ROUT:SCAN:INT	:ROUT:SCAN:LSEL	INT	

... = Valid function command words (for example, :VOLT:DC, :RESistance)

Interface function codes

The interface function codes, which are part of the IEEE-488 standards, define the ability of an instrument to support various interface functions and should not be confused with programming commands found elsewhere in this manual. The interface function codes for the 6517B are listed in the following table.

6517B interface function codes and descriptions

Code	Interface function	Code description
SH1	Source handshake capability	Defines the ability of the instrument to initiate the transfer of message/data over the data bus.
AH1	Acceptor handshake capability	Defines the ability of the instrument to guarantee proper reception of message/data transmitted over the data bus.
T5	Talker	Basic talker, talk-only, serial poll, unaddressed to talk on listen address group (LAG). This function provides the ability of the instrument to send data over the bus to other devices. Instrument talker capabilities (T5) exist only after the instrument has been addressed to talk.
L4	Listener	Basic listener, unaddressed to listen on TAG. This function provides the ability for the instrument to receive device-dependent data over the bus from other devices. Listener capabilities (L4) of the instrument exist only after it has been addressed to listen.
SR1	Service request capability	Defines the ability of the instrument to request service from the controller.
RL1	Remote/local capability	Defines the ability of the instrument to be placed in the remote or local modes.
PP0	No parallel poll capability	The instrument does not have parallel polling capabilities (PP0).
DC1	Device clear capability	Defines the ability of the instrument to be cleared (initialized).
DT1	Device trigger capability	Defines the ability of the 6517B to have readings triggered.
C0	No controller capability	The instrument does not have controller capabilities (C0).
E1	Open collector bus drivers	The instrument has open-collector bus drivers (E1).
TE0	No extended talker capability	The instrument does not have extended talker capabilities (TE0).
LE0	No extended listener capability	The instrument does not have extended listener capabilities (LE0).

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