Model 6517B
Electrometer

User's Manual

6517B-900-01 Rev. B August 2022

6517B-900-01B

KEITHLEY
A Tektronix Company

Model 6517B

Electrometer

User's Manual

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 (Hg) 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.

Table of contents

Introduction

In this section:

Welcome

The 6½-digit 6517B Electrometer/High Resistance Meter offers 1 fA sensitivity and > 200TΩ input impedance on voltage measurements and charge measurements down to 10 fC.

This manual provides basic instrument information to help you get started using the 6517B. It also provides information about the front and rear panels to familiarize you with the instrument.

Capabilities and features overview

The 6517B has the following measurement capabilities:

- DC voltage measurements from 1 µV to 200 V.

- DC current measurements from 10 aA to 20 mA.

- Charge measurements from 1 fC to 2 µC.

- Resistance measurements from 1 Ω to 10^{18} Ω.

- Surface resistivity measurements.

- Volume resistivity measurements.

- External temperature measurements from –25 °C to 150 °C using the supplied Model 6517-TP thermocouple.

- Relative humidity measurements from 0% to 100% using the optional Model 6517-RH humidity probe.

Additional capabilities of the 6517B include:

- Built-in voltage source: The 100 V range provides up to ±100 V at 10 mA, while the 1000 V range provides up to ±1000 V at 1 mA.

- Data storage (50,000 points).

- Built-in math functions.

- Average and median filtering.

- Built-in test sequences.

- Remote operation using the IEEE-488 (GPIB) bus or the RS-232 interface.

- Scan (measure) channels of an external scanner.

- Scan (measure) channels of an internal scanner card (for example, Model 6521 or Model 6522) installed in the option slot.

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.

General ratings

The 6517B instrument's general ratings and connections are listed in the following table.

Category	Specification
Supply voltage range	100 to 240 V ac, 50 Hz or 60 Hz 100 VA maximum
Input and output connections	See Rear-panel overview (on page 2-4).
Environmental conditions	For indoor use only **Altitude:** Maximum 2000 meters (6562 feet) above sea level **Operating:** 0 °C to 50 °C (32 °F to 122 °F), 70% relative humidity, noncondensing, up to 35 °C (95 °F) **Storage:** −25 °C to 65 °C (−13 °F to 149 °F) **Pollution degree:** 1 or 2

Unpacking and inspection for damage

The 6517B was carefully inspected electrically and mechanically before shipment.

There may be a protective film over the display lens, which can be removed.

Before removing the 6517B from the antistatic bag, observe the following handling precautions:

- Always grasp the 6517B by the cover.

- After removing the 6517B from its antistatic bag, inspect it for any obvious signs of physical damage. Report any damage to the shipping agent immediately.

- When the 6517B is not installed and connected, keep the instrument in its antistatic bag and store it in the original packing carton.

Save the original packing carton for future shipment.

Returning instrument for service

If you need to return the 6517B for repair or calibration, call 1-800-408-8165 or complete the form at https://www.tek.com/en/services/repair/rma-request.

When you request service, you need the serial number and firmware or software version of the instrument.

Shipment contents

The following items are included with every 6517B order:

- Model 6517B Electrometer with line cord

- 237-ALG-2 Low Noise Triaxial Cable, 3-slot triaxial to alligator clips, 2 m (6.6 ft)

- 8607 Safety High Voltage Test Leads

- 6517-TP Thermocouple Bead Probe

- CS-1305 Interlock Connector

- Accessories as ordered

- Certificate of calibration

Options and accessories

Check tek.com/keithley for options and accessories that are available for use with the 6517B.

Getting started

In this section:

Introduction

This section provides power-up information and descriptions of the controls and components of the 6517B.

Front-panel overview

The front panel of the 6517B is shown below. The descriptions of the front panel controls follow.

Figure 1: 6517B front panel
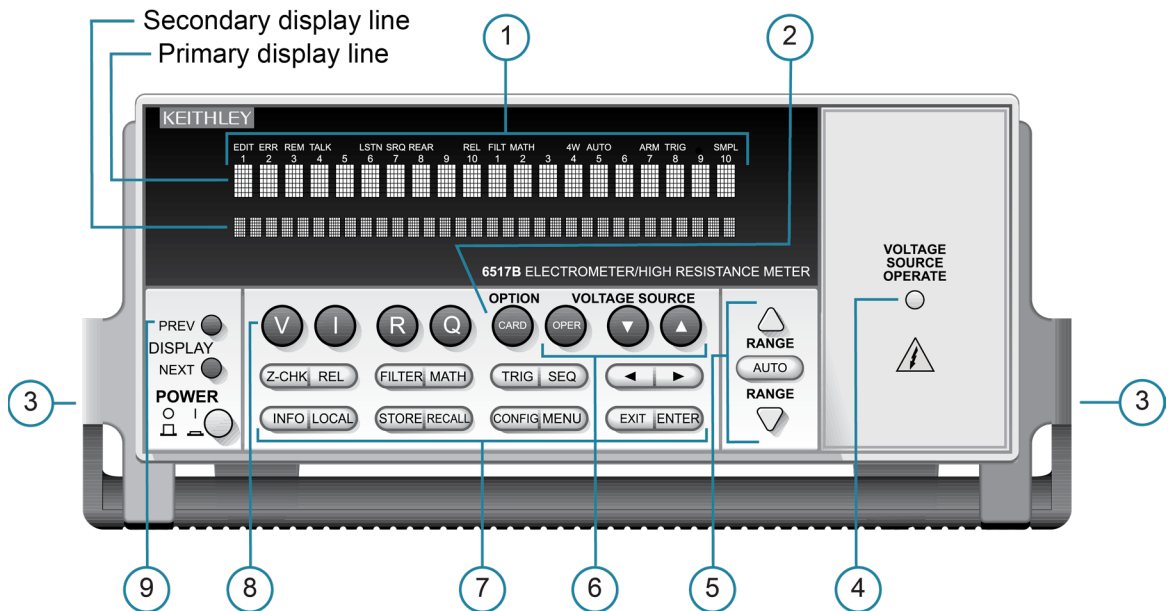
1   ANNUNCIATORS

EDIT: Editing voltage source values.

ERR: Questionable reading.

REM: In remote.

TALK: Addressed to talk.

LSTN: Addressed to listen.

SRQ: Service Request.

REL: Displayed reading has relative offset applied.

FILT: Digital filter enabled.

MATH: Math calculation enabled.

AUTO: Autoranging enabled.

ARM: Trigger armed; not in idle.

* (asterisk): Reading is being stored.

2   OPTION

Programs and operates an installed option card. Also used to scan external scanner channels.

3   HANDLE

Pull out and rotate to change the handle position.

4   VOLTAGE SOURCE OPERATE

Indicator is on when the voltage source is on. Off when in standby.

5   RANGE and AUTO

▲: When used to select a range, moves to a higher range. When used while editing values, it increments the selected digit.

▼: When used to select a range, moves to lower range. When used while editing values, decrements the selected digit.

AUTO: Enables or disables autorange.

6   VOLTAGE SOURCE

OPER: Toggles the voltage source between operate and standby.

▲ and ▼: Adjust the voltage source value.

7   OPERATION KEYS

Z-CHK: Enables or disables zero check. You must enable zero check before changing functions.

REL: Enables or disables a relative offset reading.

FILTER: Displays the digital filter status for the present function and toggles the filter.

MATH: Displays math calculation and toggles math if configured.

TRIG: Triggers the instrument to make a measurement.

SEQ: Performs the selected test sequence.

◄ and ►: Move cursor among data entry digits, menu selections, and information displays.

INFO: Shows context-sensitive information about the present display.

LOCAL: Cancels remote operation.

STORE: Enables data storage.

RECALL: Displays reading data (reading, number, time). Use the PREV and NEXT keys to display the maximum, minimum average, and standard deviation of information in the buffer.

CONFIG: Configures functions and operations.

MENU: Saves or restores instrument conditions; sets up communications; performs calibration and self-tests; defines limits; sets up the digital output; and other operations.

EXIT: Cancels selection or moves to previous menu option.

ENTER: Holds reading, enters selection, or moves down within the menu structure.

8   FUNCTION KEYS

Select the measurement function: Voltage (V), current (I), resistivity (R), or coulombs (Q).

9   DISPLAY KEYS

PREV and NEXT: Scroll through multiple displays of a function.

Rear-panel overview

The rear panel of the 6517B is shown in the following figure. The descriptions of the rear-panel components follow the figure.

Figure 2: Model 6517B rear panel
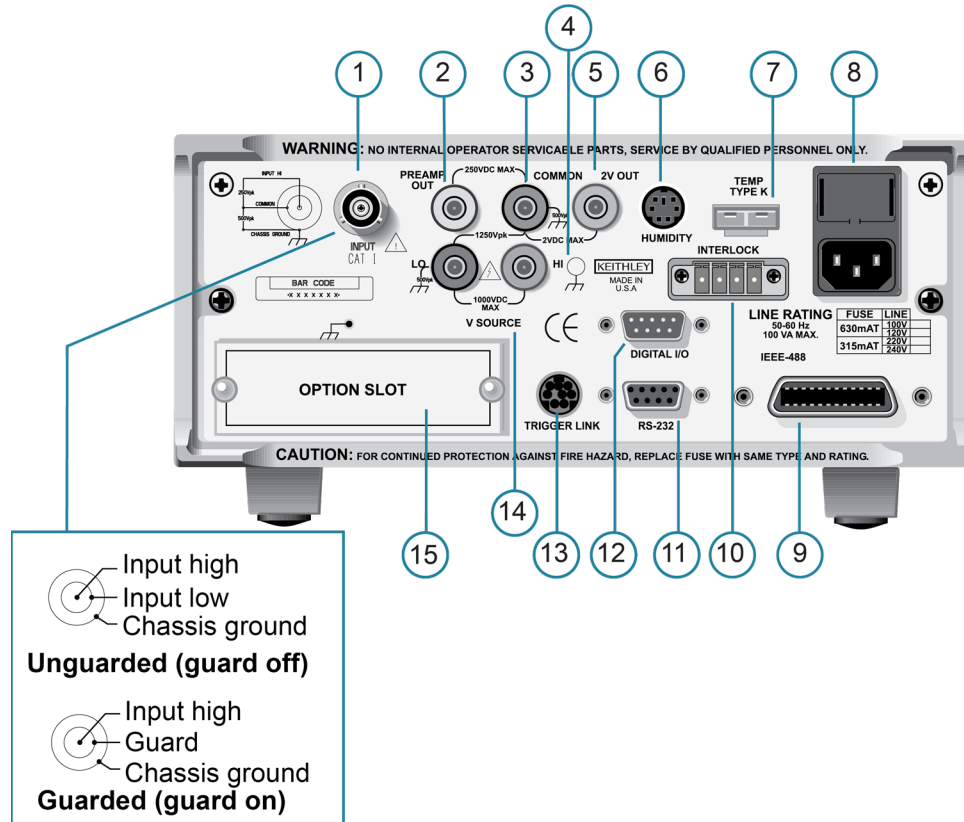
1   INPUT CONNECTOR

Unguarded configuration: Disable GUARD for current, resistance, charge, and unguarded voltage measurements.

Guarded configuration: Enable GUARD for guarded voltage measurements.

Refer to Input configurations (on page 3-1) for more information.

2   PREAMP OUT

Follows the signal amplitude applied to the INPUT terminal. When GUARD is on, PREAMP OUT is internally connected to the inner shell of the INPUT triaxial connector to configure the input for guarded voltage measurements. See "Preamplifier output" in the *Model 6517B Reference Manual* for more information.

3 COMMON

Connector that is internally connected to INPUT low.

4 Chassis ground

Connects the chassis to ground through the power line cord. For use with a noise shield, refer to Noise shield (on page 3-7).

COMMON can also be grounded by plugging the chassis ground cable into COMMON.

For safety concerns when making floating measurements, refer to Floating circuits (on page 3-10).

5 2V OUT

Connector that provides a scaled 0 V to 2 V analog output that is referenced to COMMON. Typically connected to a measuring device such as a chart recorder. Rated at 2 V dc maximum. See "2 V analog output" in the *Model 6517B Electrometer Reference Manual* for more information.

6 HUMIDITY

Connect the optional Model 6517-RH humidity probe to this connector for relative humidity measurements. See Relative humidity (on page 4-26) for more information.

7 TEMP TYPE K

Connect the Model 6517-TP type K thermocouple to this connector for temperature measurements. See External temperature (on page 4-27) for more information.

8 Power line input module

Provides connections for the power line input and contains the line fuse. If the fuse needs to be replaced, refer to Line fuse replacement (on page 5-2, on page 5-1).

9 IEEE-488 CONNECTOR

Connects the instrument to the IEEE-488 (GPIB) bus. Refer to "Remote operations" in the *Model 6517B Electrometer Reference Manual*.

10 INTERLOCK

Connects the safety interlock to a test fixture using an appropriate cable. See Interlock (on page 3-12) for more information.

11 RS-232

DB-9 connector for the RS-232 interface. Refer to "Remote operations" in the *Model 6517B Electrometer Reference Manual*.

12 DIGITAL I/O

A male DB-9 connector for the four TTL-compatible digital output lines. Refer to "Digital I/O" in the *Model 6517B Electrometer Reference Manual*.

13 TRIGGER LINK

An 8-pin micro DIN connector for sending and receiving trigger pulses to and from other instruments.

14 V-SOURCE HI and LO

Safety banana jacks for the voltage source. Rated at 1000 V maximum.

15 OPTION SLOT

A slot for option cards, such as the Model 6521 or Model 6522 scanner card.

Power the instrument on or off

⚠ WARNING

The power cord supplied with the 6517B contains a separate protective earth (safety ground) wire for use with grounded outlets. When proper connections are made, the instrument chassis is connected to power-line ground through the ground wire in the power cord. In the event of a failure, not using a properly grounded protective earth and grounded outlet may result in personal injury or death due to electric shock.

Do not replace detachable mains supply cords with inadequately rated cords. Failure to use properly rated cords may result in personal injury or death due to electric shock.

Before powering the instrument, verify that line input voltage is set to the correct range for the power supply used to power the 6517B. See Change the line voltage (on page 5-3) if you need to change the line input voltage.

CAUTION

Operating the instrument on an incorrect line voltage may cause damage to the instrument, possibly voiding the warranty.

To connect the power cord:

1. Make sure that the front-panel POWER switch is in the off (O) position.
2. Connect the socket of the supplied power cord to the ac receptacle on the rear panel.
3. Connect the plug of the power cord to a grounded ac outlet.

To turn a 6517B on or off:

*   Before turning the instrument on, disconnect any devices under test (DUTs) from the 6517B.
*   To turn your instrument on, press the front-panel POWER switch to place it in the on (|) position.
*   To turn your instrument off, press the front-panel POWER switch to place it in the off (O) position.

Power-up sequence

When the 6517B is powered up, it performs the following tests:

- Self-tests on its EEPROM and RAM

- Checksum tests on data stored in nonvolatile memory

If a failure is detected, the instrument momentarily displays an error message and the **ERR** annunciator turns on.

If the instrument passes the tests, the firmware revision levels and the communications status are briefly displayed. An example of this display is shown as follows:

```
Model 6517B
Rev. A01 700x SCPI: 27
```

The firmware revision levels (left to right) are for the main microcontroller and display microcontroller. In the example above, `SCPI` indicates that the SCPI language is selected and `27` is the IEEE-488 address. If the RS-232 interface is selected, the message `RS-232 MODE` is displayed instead of the IEEE-488 address.

If the instrument is configured to display the calibration due date when it is turned on, the calibration due date is displayed. The format is `mm/dd/yy`, where `mmm` is the month abbreviation, `dd` is the day, and `yy` is the year. If no calibration date is set, the display shows that it is due now.

After the power-up sequence, the instrument opens to the main display with `ZeroCheck` displayed.

To achieve rate accuracies, allow the instrument to warm up for at least one hour before use.

Power-up error messages

The 6517B performs the following checksum tests on power-up.

Data	Type of storage
IEEE-488 address	Electrically-erasable PROM
Power-up default	Electrically-erasable PROM
Calibration constants	Electrically-erasable PROM
Calibration dates	Electrically-erasable PROM
Instrument setups	Ten in electrically-erasable PROM
Reading buffer	Nonvolatile RAM

The error messages that may be displayed during the power-up sequence are summarized in the following table. These are shown when one of the checksum tests fails.

Message	Description	Action
Error −314	Save/recall memory lost	Instrument setup is reset to bench defaults, which are stored in EEPROM.
Error +510	Reading buffer data lost	The reading buffer controls are reset to factory defaults, but they are not stored into NVRAM. To store the values, store readings in the buffer.
Error +511	GPIB address lost	GPIB address is reset to factory default (27) and stored into EEPROM.
Error +512	Power-up state lost	Power-up defaults are reset to factory defaults (bench) and stored into EEPROM.
Error +514	Calibration lost	Calibration constants are set to factory default values, but they are not stored into EEPROM. To store the values, perform a comprehensive calibration.
Error +515	Calibration dates lost	The calibration dates are set to factory default values, but they are not stored into EEPROM. To store the values, perform a comprehensive calibration.

Set the power-on defaults

You can select the instrument defaults that go into effect when the instrument is powered on.

For more information on the PRESET and *RST options, refer to <u>Reset the instrument</u> (on page 2-21). For more information on user setups, refer to <u>Saving setups</u> (on page 2-20).

To set the power-on defaults:

1. Press the **MENU** key to display the main menu.
2. Select **SAVESETUP**.
3. Press the **ENTER** key. The Setup Menu is displayed.
4. Select **POWERON**. Press the **ENTER** key.
5. Select the power-on default:
    - **PRESET:** Set the instrument to a state optimized for front-panel operation.
    - ***RST:** Set the instrument to a state optimized for remote operation.
    - **USER-SETUP-NUMBER**: Select a user set up. Press the **ENTER** key, then use the **RANGE** ▲ and ▼ keys to select a user setup (0 to 9).
6. Press the **ENTER** key to save the power-on default setting.

Using the menus

The 6517B has main and configure menus. The main menu accesses items for which there are no dedicated keys. The configure menus set up measurement functions and other instrument operations.

To access the main menu, press the **MENU** key. The top level of the main menu is displayed. The main menu options are described in the following topics.

To access a configure menu, press the **CONFIG** key and then the function key (**V**, **I**, **R**, or **Q**) or operation key (such as **TRIG**, **SEQ**, or **STORE**). The configure menu options are described in the sections that describe the functions or options that you can configure.

To select a menu item, use the ◄ and ► keys to move the cursor, then press the **ENTER** key. The blinking menu item or parameter indicates the cursor position.

If there are additional items you can select, an arrow (◄ or ►) is displayed. Use the ◄ and ► keys to display them.

To enter a numeric value, move the cursor to the digit to be changed and use the **RANGE** ▲ or ▼ key to increment or decrement the digit.

Press the **CONFIG** key and then the ▲ or ▼ keys to display the **CONFIGURE V-SOURCE** menu.

Press the **ENTER** key to save changes.

The **EXIT** key performs several functions:

- Returns to previous menus.

- Exits the menu.

- Discards changes. Any change that is not entered is canceled when EXIT is pressed.

- Cancels display of messages and returns to the menu or reading display.

- Cancels reading display hold and resumes the normal reading display.

- Disables scanning and stops data storage.

- Stops data storage (the message `STORAGE INTERRUPTED` is displayed).

Menu

The main menu accesses the various instrument operations for which there are no dedicated keys, such as storage setup, communication setup, calibration, self-test, and limits. The main menu structure is summarized in the following table, along with the reference section number that includes more detailed information on that menu selection.

To display the top level of the main menu, press the **MENU** key. Refer to <u>Using the menus</u> (on page 2-9) for more information.

The main menus of the 6517B are described in the following topics.

SAVESETUP

The SAVESETUP option of the main menu is used for the following operations:

- To save the present instrument configuration in nonvolatile memory

- To restore the instrument to a previously saved instrument configuration

- To set the power-up configuration of the instrument

- To reset the instrument to a factory default configuration

The SAVESETUP menu options are described in the following table.

Menu item	Description	Refer to:
SAVE	Save the present setup at a memory location (0 to 9)	[Saving setups](#) (on page 2-20)
RESTORE	Return the instrument to a setup that was previously stored in memory.	[Saving setups](#) (on page 2-20)
POWERON	Select the instrument setup that goes into effect when the instrument is turned on. The options are: ■ **PRESET:** Return to the bench default conditions. ■ ***RST:** Return to the remote operation default conditions. ■ **USER-SETUP-NUMBER:** Select a user setup as the power-on default conditions.	[Set the power on defaults](#) (on page 2-8)
RESET	Resets the instrument to the bench or GPIB default conditions. The **RESET** options are: ■ **BENCH:** The instrument returns to the bench default conditions. ■ **GPIB:** The instrument returns to the GPIB default conditions.	[Reset the instrument](#) (on page 2-21)

COMMUNICATION

The COMMUNICATION menu option allows you to select and configure the GPIB or RS-232 bus.

Menu item	Description	Refer to the following section in the *Model 6517B Electrometer Reference Manual*
GPIB	Options to select and configure GPIB operations: ■ **ADDRESS:** Check or change IEEE-488 bus address (0 to 30) ■ **ELEMENTS:** Selects GPIB data elements, including readings, units, reading number, relative humidity, channel number, timestamp, status, and temperature)	Remote operations
RS-232	Options to select and configure RS-232 operations: ■ **BAUD:** Selects the baud rate. ■ **TERMINATOR:** Select the terminating character. ■ **FLOW-CTRL:** Select the flow control. ■ **ELEMENTS:** Select the data elements to send, such as reading, units, reading number, relative humidity, channel number, timestamp, internal temperature, external temperature, and status.	RS-232 serial interface

CAL

The CALIBRATION menu displays the calibration dates and allows you to set the option to display calibration dates on power up.

For more information on calibration, refer to "Calibration procedure" in the *Model 6517B Electrometer Reference Manual*.

Menu item	Description
VIEW	View calibration dates.
DISPLAY-AT-POWERUP	Select whether to show calibration dates at powerup.

TEST

Select TEST to open a SELF-TEST menu. The options in this menu provide diagnostic tools to isolate problems with the 6517B front-panel display.

Menu item	Description
DISPLAY-TESTS	Select to open the FRONT PANEL TESTS menu.
KEYS	Verify operation of the front-panel keys. When you press a key, the name of the key is displayed.
DISPLAY-PATTERNS	Displays all annunciators and characters on the display and runs a check of the display. Press the ► key to move through the displays for this test.
CHAR-SET	Display the entire character set. Press the ► key to move through the displays for this test.

LIMITS

The LIMITS menu sets and controls the limit values that determine the PASS or FAIL and HI or LO status of subsequent measurements and sets the digital output patterns that signify passing or failing limit checks.

For more information on these options, refer to "Limits" in the *Model 6517B Electrometer Reference Manual*.

Menu item	Description
LIMIT-SET-1	Settings for limit 1: ■ **CONTROL:** Enable or disable the limit 1 setting. ■ **LOLIM1:** Set the value of low limit 1. ■ **HILIM1:** Set the value of high limit 1.
LIMIT-SET-2	Settings for limit 2: ■ **CONTROL:** Enable or disable the limit 2 setting. ■ **LOLIM2:** Set the value of low limit 2. ■ **HILIM2:** Set the value of high limit 2.
STROBE-CONTROL	Enable or disable the limit strobe signal of digital output 4 when a trigger occurs.
PASS-PATTERN	Specify patterns on digital outputs to signify limit pass.

STATUS-MSG

This selection enables or disables the status messages. When enabled, status messages are displayed to identify specific operations that are performed. You can select:

- **ON:** Enable status messages.
- **OFF:** Disable the status messages.

NOTE

When the status messages are enabled, the instrument may become so busy displaying status messages that key presses are no longer acknowledged. To clear the messages, press the **EXIT** key. You can also send the bus command `:DISPlay:SMESsage OFF` to stop displaying messages.

GENERAL

The GENERAL menu:

- Controls the state and sense of the digital outputs.
- Allows you to view the serial number, SCPI version, and firmware revision levels of the 6517B.
- Sets line synchronization of readings, displays the frequency of the line power, and configures the A/D to measure humidity and external temperature.

- Configures timestamp.

- Chooses the characters displayed for decimal and select measurement units.

- Sets the real-time clock.

Menu item	Description	Refer to:
DIGOUT	Sets up the digital output lines: ■ **STATE:** Checks or changes the states of the digital output lines. ■ **LOGIC_SENSE:** Displays or changes the sense of digital output lines.	"Digital I/O" in the *Model 6517B Electrometer Reference Manual*
SERIAL #	Displays serial number, memory option SCPI version, and firmware revisions.	Display instrument information (on page 2-15)
A/D-CONTROLS	Settings for the analog-to-digital converter: ■ **LINE-SYNC:** Enables or disables line synchronization. Also displays the power-line frequency. ■ **DATA-STAMP:** Configures the A/D to measure the humidity and external temperature. ■ **LIMIT-CTRL:** Enables or disables the A/D hardware limit. ■ **AUTORANGE SPEED:** Select NORMAL or FAST autorange speed.	"Line synchronization" in in the *Model 6517B Electrometer Reference Manual* Relative humidity and external temperature readings (on page 4-26) "OUT OF LIMIT messages" and "Measurement range" in in the *Model 6517B Electrometer Reference Manual*
TIMESTAMP	Configures the timestamp: ■ **TYPE:** Check or change type. RELATIVE-TIME references the timestamp to relative time. REAL-TIME references the timestamp to real time. ■ **RESET-TIME:** Resets the relative timestamp to zero. ■ **RESET-RDG#:** Resets the reading number to zero.	"Set up timestamps" in the *Model 6517B Electrometer Reference Manual*
DISPLAY	Display menu: ■ **NUMERIC-FORMAT:** Selects measurement units (engineering or scientific). ■ **TEMP-UNITS:** Selects temperature units (C, K, or F).	Display (on page 2-14)
CLOCK	Clock menu: ■ **TIME:** Checks or sets time of day. ■ **DATE:** Checks or sets date. ■ **FORMAT:** Selects clock format: (12-hour or 24-hour format)	Time, day, and date (on page 2-16)

Display

The display of the 6517B provides measurement readings with their units and types of measurements. It also displays informational messages, such as menu headings and selections. The top of the display has annunciators that indicate states of operation.

The top line of the display shows readings and units. It can also display the measurement type, hold, the math operation type, channel number, menu headings, and messages.

The bottom line of the display shows the range, voltage source value, menu items, messages, and NEXT displays. Longer text strings are indicated by arrows on either side of the text. Use the ◄ and ► keys to display the additional information.

Exponent mode (engineering or scientific)

Readings on the display can be expressed in engineering units or in scientific notation. Examples are shown in the table below. When scientific notation is selected, the exponent can be fixed to a specified value or it can be floating. When the exponent is set to float, the instrument automatically selects the exponent value.

Typical display exponent values			
Engineering units		**Scientific notation**	
Value	**Display**	**Value**	**Display**
Picoamperes	pA	10^{-12} A	e-12A
Nanoamperes	nA	10^{-9} A	e-9A
Microamperes	μA	10^{-6} A	e-6A
Milliamps	mA	10^{-3} A	e-3A
Nanocoulombs	nC	10^{-9} C	e-9C
Microcoulombs	μC	10^{-6} C	e-6C
Kilo-ohms	kΩ	10^{3} Ω	e3Ω
Mega-ohms	MΩ	10^{6} Ω	e6Ω
Giga-ohms	GΩ	10^{9} Ω	e9Ω
Tera-ohms	TΩ	10^{12} Ω	e12Ω
Peta-ohms	PΩ	10^{15} Ω	e15Ω

To change how the readings are displayed:

1. Press the **MENU** key.

2. Select **GENERAL**.

3. Select **DISPLAY**.

4. Select **NUMERIC-FORMAT**.

5. To select:

    - Engineering units: Select **ENGR**.

    - Scientific notation: Select **SCIENTIFIC**.

6. Press the **ENTER** key.

7. If you select SCIENTIFIC, you can also select:

    - Change value automatically to best fix data: **FLOATING**.

    - A fixed value: **FIXED**.

8. Press the **ENTER** key.

Messages

Press the **INFO** key to view context-sensitive information on the display. An arrow on the bottom line indicates that there is more information. Use the ◄ and ► keys to view the complete line. To exit an INFO display, press the **INFO**, **ENTER**, **EXIT**, or a function key.

During 6517B operation and programming, the instrument may display front-panel status and error messages. To momentarily display the most recent status or error message, press the **MENU** key and press the **PREV** display key. The display is blank if no message is queued. For more information on status and error message, refer to <u>Status and error messages</u> (on page 5-3).

Display instrument information

This item displays the serial number, SCPI version, and firmware revision levels of the instrument. The following information is displayed:

```
Serial #XXXXXXX
Rev AYY.Y Disp:ZZZx A:E D:B H:E SCPI:1999.0
```

Where:

- #*XXXXXXX* is the serial number of the instrument

- *AYY* is the firmware level for the main microcontroller

- *ZZZ* is the firmware level for the display microcontroller

You can also use *IDN?* to retrieve the serial number and firmware revision information.

To display instrument information:

1. Press the **MENU** key.

2. Select the **GENERAL** menu.

3. Select **SERIAL #**.

4. Press the **ENTER** key.

Measurement function displays

Each measurement function has its own set of displays, shown in the bottom line of the front-panel display. Use the PREV and NEXT keys to scroll through the selections for the presently selected function.

The displays show a reading in a different form or give additional information about the reading. For example:

● Top line shows a reading.

● Bottom line shows a zero-center bar graph with adjustable limits.

● Calculations display if math is enabled.

Displays that are specific to a particular function or operation are discussed with that function or operation. The displays that are common to all measurement functions are:

● Time, day, and date

● Bar graph

● Zero-centered bar graph

● Maximum and minimum values

● Actual value without relative offset

● Calculated and actual values

● Limits bar graph

● Relative humidity and external temperature stamp

● Range and voltage source

Time, day, and date

This display provides the time, day of week, and the date. The time, date, and format (12-hour or 24-hour) are set using the CLOCK menu option. An example of the time and date display is shown in the following figure.

Figure 3: Time, day, and date display

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.

Bar graph

The normal bar graph is a graphical representation of a reading as a portion of a range, as shown in the following figure. The vertical lines displayed along the bar designate 0%, 25%, 50%, 75%, and 100% of full scale. Each full segment of the bar represents approximately 4% of the range limit.

The right endpoint of the bar graph is + full scale of the present range for positive readings and − full scale for negative readings. When the 100% line changes to an arrow, the reading exceeds the current range.

Figure 4: Bar graph display
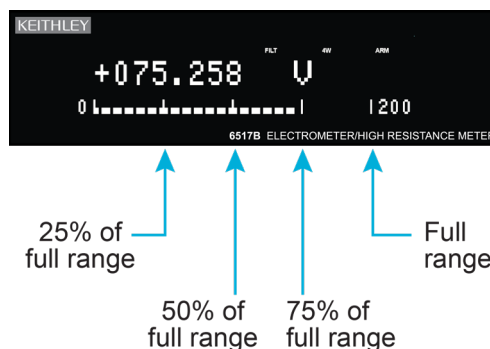
Zero-centered bar graph

The zero-centered bar graph is a graphical representation of a reading with positive and negative limits, as shown in the figure below. The limits are expressed in a user-selectable percentage of range.

The vertical lines displayed along the bar designate the positive and negative limits, zero, and halfway to either limit. There are ten full segments between zero and each end, so each full segment represents 10% of the limit. When a line at the limit changes to an arrow, the reading exceeds the programmed range.

Figure 5: Zero-centered bar graph display
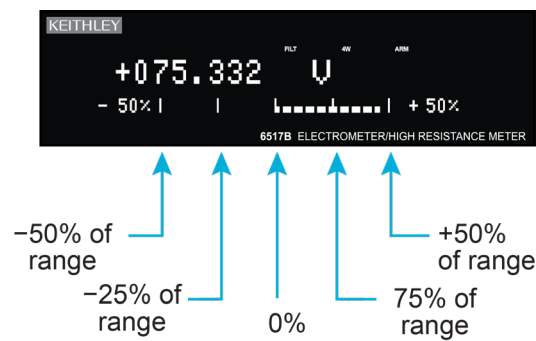
The plus and minus percentage of range that is programmed (0.01% to 99.99%) applies to all functions. Because of rounding, values greater than 99.5% are shown as 100% and, likewise, values greater than 1% (such as 1.67%) are shown rounded to the nearest integer percent.

To view or change the percentage of range:

1. On a measurement function display, press the **CONFIG** key.
2. Press the **NEXT** or **PREV** key. The following is displayed:

    `ZERO-BARGRAPH±50.00%`
3. Use the cursor keys and the **RANGE** keys to enter a numeric value (0.01% to 99.99%).
4. Press the **ENTER** key to change the bar graph.

Maximum and minimum

The maximum and minimum display shows the maximum and minimum readings since the display was entered. Math functions are not applied to the minimum and maximum. An example of the display is shown in the following figure.

Figure 6: Maximum and minimum display
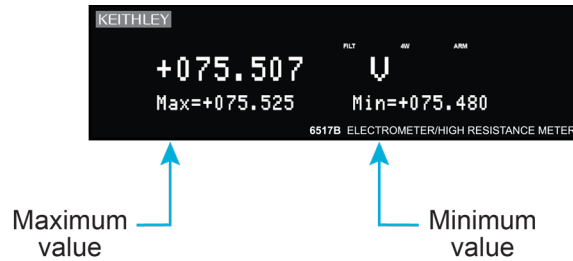
Relative humidity and external temperature

This display can provide relative humidity and external temperature readings if the appropriate sensors are connected to the instrument and enabled.

You can change the display of the temperature readings to be °C, K, or °F.

An example of the relative humidity and temperature display is shown in the following figure.

Figure 7: Relative humidity and external temperature display

For more information, refer to Relative humidity and external temperature readings (on page 4-26)

To change the temperature units:

1. Press the **MENU** key.

2. Select the **GENERAL** menu. Press the **ENTER** key.

3. Select the **DISPLAY** menu. Press the **ENTER** key.

4. Select **TEMP-UNITS**. Press the **ENTER** key.

5. Set the units to **°C**, **K**, or **°F**. This setting also affects the display of internal temperature measurements.

6. Press the **ENTER** key.

Saving setups

The 6517B can save up to ten user setups in nonvolatile memory.

NOTE

You can set one of the user-saved setups as the defaults when the instrument is powered on. Refer to <u>Set the power-on defaults</u> (on page 2-8).

Save a user setup

To save a user set up:

1. Press the **MENU** key to display the main menu.

2. Select **SAVESETUP**. Press the **ENTER** key. The Setup Menu is displayed.

3. Select **SAVE**. Press the **ENTER** key.

4. Use the **RANGE** keys to select the memory location, 0 to 9.

5. Press the **ENTER** key to save the setup.

Restore a user setup

Use the RESTORE menu item to return the instrument to a setup that was previously stored in memory.

To restore a user set up:

1. Press the **MENU** key to display the main menu.

2. Select **SAVESETUP**. Press the **ENTER** key. The Setup Menu is displayed.

3. Select **RESTORE**.

4. Use the **RANGE** keys to select the memory location, 0 to 9.

5. Press the **ENTER** key to restore the setup.

Reset the instrument

You can reset the instrument to the bench or GPIB defaults.

The bench defaults are optimized for bench operation. These defaults are the same as the `SYSTem:PRESet` defaults. This setup selects the advanced trigger model, takes the 6517B out of idle, set the control source of all layers to Immediate, and set the measure layer counter to infinite. With this trigger model setup, operation goes to the measure layer and stays there to make continuous measurements. Refer to "Triggering" in the *Model 6517B Reference Manual* for additional information.

The GPIB defaults are optimized for remote communications. These defaults are the same as the `*RST` defaults.

After resetting the instrument, the instrument returns to the normal display of readings. If you selected GPIB, the instrument is returned to the Idle state.

NOTE

The basic measurement procedures in this manual assume the BENCH defaults.

To reset the instrument to a set of defaults:

1. Press the **MENU** key to display the main menu.
2. Select **SAVESETUP**. Press the **ENTER** key. The Setup Menu is displayed.
3. Select **RESET**. Press the **ENTER** key.
4. Select the defaults:
    ▪   To select the defaults optimized for bench use: Select **BENCH**.
    ▪   To select the defaults optimized for remote communications: Select **GPIB**.
5. Press the **ENTER** key. A message is displayed while the instrument is resetting.

Factory default settings

The factory default settings for the bench and GPIB default selections are shown in the following table.

Function or operation	Bench default (SYSTem:PRESet)	GPIB default (*RST)
A/D Controls:		
Line Synchronization	On	On
Data Stamp:		
Temperature (external)	Off	Off
Humidity	Off	Off
Hardware Limit	On	On

Function or operation	Bench default (SYSTem:PRESet)	GPIB default (*RST)
Buffer:		
Control	Fill and stop	Fill and stop
Count	No effect	No effect
Timestamp	No effect	No effect
Elements	No effect	No effect
Display	Yes	Yes
Clock	No effect	No effect
Communications:		
Interface (GPIB or RS-232)	No effect	No effect
GPIB:		
Address	No effect	No effect
Language	No effect	No effect
Talk-Only (printer setup):		
Interface	IEEE-4888	IEEE-4888
Interval	1	1
Formfeed	Off	Off
Page Size	60 Lines	60 Lines
Elements	(see note)	(see note)
RS-232:		
Control (send/receive or talk-only)	No effect	No effect
Talk-Only (printer setup):		
Interval	1	1
Formfeed	Off	Off
Page Size	60 Lines	60 Lines
Baud Rate	No effect	No effect
Terminator	No effect	No effect
Flow Control	No effect	No effect
Elements	No effect	No effect
Digital Output:		
States	No effect	No effect
Logic Sense	No effect	No effect
Display		
Display resolution	5½	5½
Numeric Format	Engineering	Engineering
Scientific Format	Floating Exp	Floating Exp
Decimal Character	Period	Period
Temperature Units	°C	°C
Filter	On	Off
Digital filter	On	On
Averaging	On	On
Readings	10	10
Advanced	Off	Off
Readings	10	10
Noise Tolerance Level	1%	1%
Filter Mode	Moving	Repeat

Function or operation	Bench default (SYSTem:PRESet)	GPIB default (*RST)
Median Filter	On	On
Rank	1	1
Current (Amps)		
Damping	Off	On
Range	Manual (20 mA)	Manual (20 mA)
Autorange	Off	Off
Limits	Use all ranges	Use all ranges
Limits:		
Limit Set #1 and #2	Off	Off
Low Limit	-1.0	-1.0
Action	0	0
High Limit	1.0	1.0
Action	0	0
Strobe Control	Off	Off
Pass Pattern	0	0
Math	Off	On
Function	Polynomial	Polynomial
Percent Target Value	1.0	1.0
Polynomial Constants:		
"a0"	0.0	0.0
"a1"	1.0	1.0
"a2"	0.0	0.0
% Deviation Reference	1.0	1.0
Deviation Reference	1.0	1.0
Ratio Reference	1.0	1.0
Q (Coulombs):		
Auto Discharge	Off	Off
Range	Manual (2 µC)	Manual (2 µC)
Autorange	Off	On
Limits	High	High
R (Ohms):		
Amps Rel	Off	Off
Damping	Off	Off
Measurement Type	Resistance	Resistance
Resistivity Type	Surface	Surface
Fixture	User	User
Ks, Kv	1.0	1.0
Thickness	1.0 mm	1.0 mm
R (Ohms):		
Auto V-source Ohms		
Range	2 MΩ	2 MΩ
Autorange	Off	On
Limits	Use all ranges	Use all ranges
Manual V-source Ohms		
Range	Manual (200 kΩ)	Manual (200 kΩ)
Autorange	Off	Off
Limits	N/A	N/A
V-source	Manual	Manual

Function or operation	Bench default (SYSTem:PRESet)	GPIB default (*RST)
Relative	Off	Off
Value Auto	0.0	0.0
Resolution	Auto (5.5 d)	Auto (5.5 d)
Scanning:		
Scan Type	Internal	Internal
Internal Scan:		
Channels	All	All
Count	10	10
Memory	Yes	Yes
Scan Mode	Voltage	Voltage
Settling Time	0.0 s	0.0 s
Timer	No	No
Interval	2.5 s	2.5 s
V-source Limit	Yes	Yes
External Scan:		
External Inputs	10	10
Trigger source	Triglink	Triglink
Scan Count	10	10
Timer	No	No
Interval	2.5 s	2.5 s
Memory	Yes	Yes
Speed	Normal (1 PLC)	Normal (1 PLC)
Status Messages	Off	Off
Timestamp	No effect	No effect
Test sequence	Diode	Diode
Diode:		
Start Voltage	1 V	1 V
Stop Voltage	10 V	10 V
Step Voltage	1 V	1 V
Delay	1 s	1 s
Capacitor:		
Bias Voltage	1 V	1 V
Points	10	10
Interval	1 s	1 s
Cable:		
Bias Voltage	1 V	1 V
Points	5	5
Interval	1 s	1 s
Resistor:		
Source V1	1 V	1 V
Delay 1	1 s	1 s
Source V2	2 V	2 V
Delay 2	1 s	1 s
Surface Resistivity:		
Pre-discharge Time	0.2 s	0.2 s
Bias Voltage	500 V	500 V
Bias Time	1 s	1 s
Measure Voltage	500 V	500 V
Measure Time	1 s	1 s
Discharge Time	2 s	2 s

Function or operation	Bench default (SYSTem:PRESet)	GPIB default (*RST)
Volume Resistivity:	10 s	10 s
Pre-discharge Time	500 V	500 V
Bias Voltage	1 s	1 s
Bias Time	500 V	500 V
Measure Voltage	1 s	1 s
Measure Time	2 s	2 s
Discharge Time		
Alternating polarity:	0 V	0 V
Offset Voltage	10 V	10 V
Alternating Voltage	15 s	15 s
Measurement Time	3	3
Discarded Readings	1	1
Stored Readings		
Test sequence		
SIR:		
Bias Voltage	50 V	50 V
Bias Time	1 s	1 s
Measure Voltage	100 V	100 V
Measure Time	1 s	1 s
Square Wave Sweep:		
High Level	1 V	1 V
High Time	1 s	1 s
Low Level	-1 V	-1 V
Low Time	1 s	1 s
Cycle Count	10	10
Staircase Sweep:		
Start	1 V	1 V
Stop	10 V	10 V
Step	1 V	1 V
Step Time	1 s	1 s
Start source	Manual	Manual
Triglink Line	Line #1	Line #1
Triggers	Advanced (armed)	Advanced (idled)
Advanced:		
Measure layer:		
Source	Immediate	Immediate
Triglink Mode	Asynchronous	Asynchronous
Triglink Input	Line #2	Line #2
Triglink Output	Line #1	Line #1
Delay	0.0 s	0.0 s
Count	Infinite	1
Control	Acceptor	Acceptor
Scan layer:		
Source	Immediate	Immediate
Triglink Input	Line #2	Line #2
Triglink Output	Line #1	Line #1
Delay	0.0 s	0.0 s
Count	Infinite	1
Control	Acceptor	Acceptor
Arm layer:		

Function or operation	Bench default (SYSTem:PRESet)	GPIB default (*RST)
Source	Immediate	Immediate
Triglink Input	Line #2	Line #2
Triglink Output	Line #1	Line #1
Count	1	1
Control	Acceptor	Acceptor
Basic:		
Trigger Mode	Continuous	Continuous
Trigger source	Immediate	Immediate
Timer Interval	0.1 s	0.1 s
V (Volts):		
External Feedback	Off	Off
Guard	Off	Off
Range	Manual (200 V)	Manual (200 V)
Autorange	Off	On
V-source:		
Range	100 V	100 V
Voltage Limit	Off	Off
Value	1000 V	1000 V
Resistive Current Limit	Off	Off
Meter Connect	Off	Off
Zero Check	On	On

NOTE

The default selects all elements except HUM, DT, and ET.

Connections

In this section:

Introduction

This section contains basic information on electrometer, high-resistance meter, and voltage source connections. It also describes the use of test fixtures, low-noise cables, shielding, guarding, and floating circuits.

⚠ 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.

Electrometer input connector

The rear-panel triaxial INPUT connector is a 3-lug female triaxial connector that mates to a cable terminated with a 3-slot male triaxial connector.
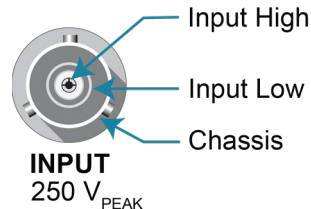
Input configurations

For the voltage function, you can configure the input connector with guard off or guard on. For the resistance, current, and charge functions, guard is always disabled (off).

The INPUT triaxial connector is also used for the source voltage, measure current configuration. This configuration uses the voltage source make resistance measurements and current measurements.

When guard is off, input low is connected to the inner shell of the connector, as shown in the following figure. Use this configuration for current, resistance, coulombs, and unguarded voltage measurements.

Where possible, make input low connections directly to the INPUT connector low terminal instead of using COMMON. This avoids internal voltage drops that may affect measurement accuracy.

Figure 8: Input connector configuration - unguarded (voltage, resistance, current, and charge)

When guard is on, guard is connected to the inner shell of the triaxial connector, as shown in the following figure. Input low is accessed through the COMMON connector on the rear panel. Use this configuration for guarded voltage measurements only. Refer to Guard shield (on page 3-8) for more information.

Figure 9: Input connector configuration - guarded (voltage only)
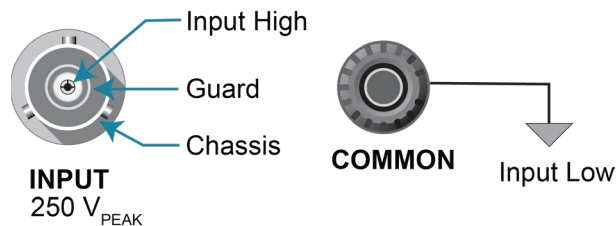
Maximum input levels

The maximum input levels of the 6517B are summarized in the following figure. The maximum input signal is −250 V_{RMS}, dc to 60 Hz sine wave (10 seconds maximum in the mA ranges).
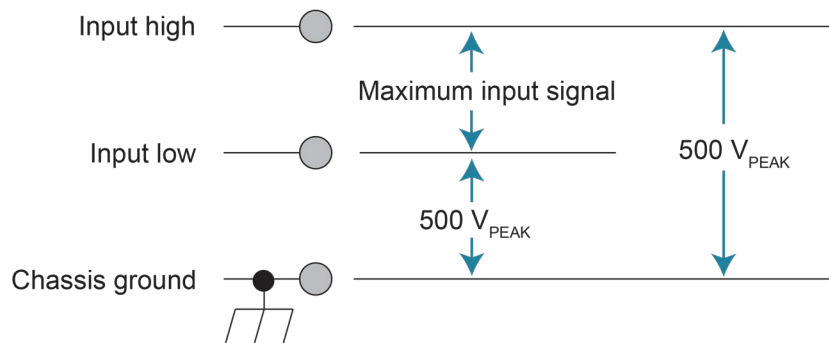
⚠ WARNING

The maximum common-mode input voltage (the voltage between input low and chassis ground) is 500 V_{PEAK}. To prevent electrical shock that could cause injury or death, do not exceed this value.

CAUTION

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

Figure 10: Maximum input levels

Input protection

The 6517B incorporates protection circuitry against nominal overload conditions. However, a high voltage (>250 V) and resultant current surge could damage the input circuitry. A typical test circuit to measure the leakage current of a capacitor is shown below. When the switch is closed, an initial surge of charging current flows and the high voltage is seen across the input of the 6517B.

Figure 11: Capacitor test circuit without protection
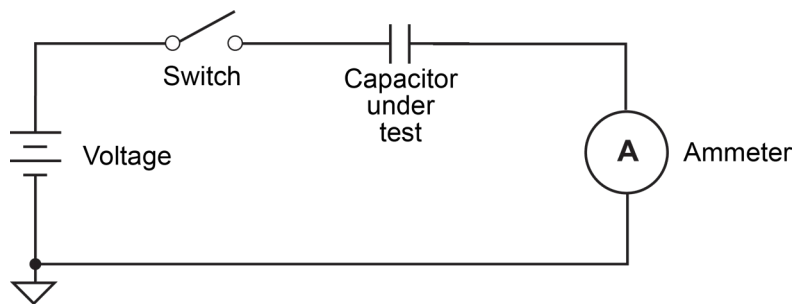
Adding a resistor and two diodes (1N3595), as shown in the following figure, provides considerable extra protection. The resistor must be large enough to limit the current through the diodes to 10 mA or less. It must also be large enough to withstand the supply voltage. The protection circuit should be enclosed in a light-tight conductive shield.

This protection circuit is also useful when measuring the insulation resistance of films or high-voltage cables. Without the added protection, a pinhole or other defect could cause an arc, damaging the 6517B input.

**Figure 12: Capacitor test circuit with protection**
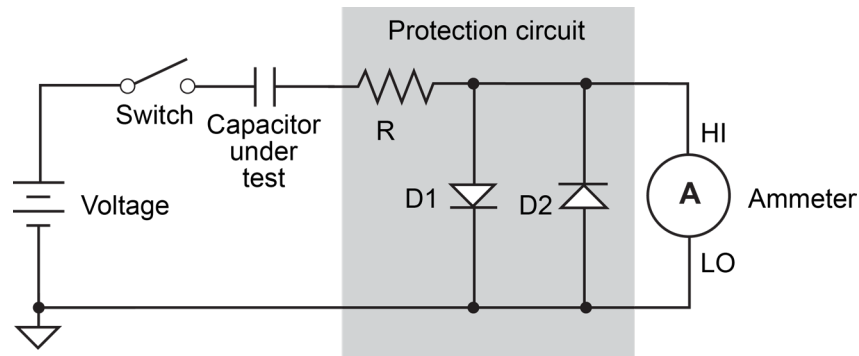
High-resistance meter connections

The 6517B uses the source voltage, measure current (SVMI) configuration to measure resistance. From the known voltage and measured current, the resistance is calculated (R = V/I) and displayed.

The resistance to be measured is connected to the center conductor of the INPUT triaxial connector and the V SOURCE OUT HI binding post, as shown in the following figure.

Figure 13: Source voltage, measure current - basic connections
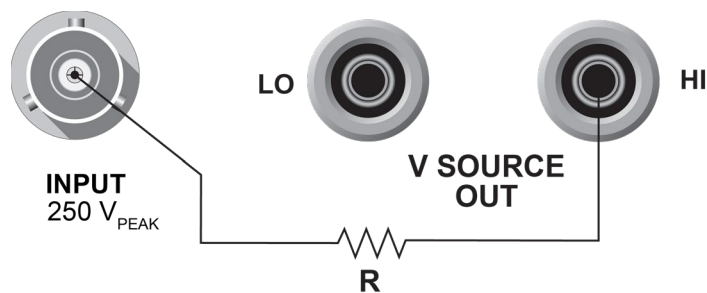
The equivalent circuit for this configuration is shown in the following figure.

Figure 14: Source voltage, measure current - equivalent circuit
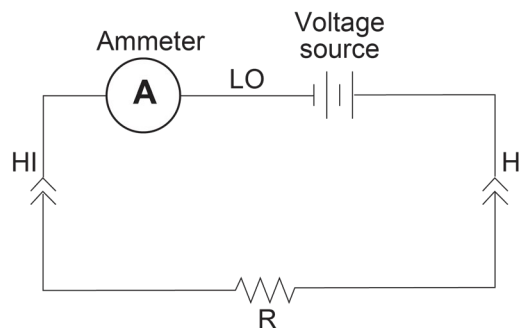
This configuration assumes the METER-CONNECT setting is enabled, which internally connects the voltage source LO to ammeter LO.

To enable METER-CONNECT:

1. Press the **CONFIG** key.

2. Press the **OPER** key. The CONFIG V-SOURCE menu is displayed.

3. Select **METER-CONNECT**. Press the **ENTER** key.

4. Select **ON** to enable the internal voltage source LO to ammeter LO connection. Press the **ENTER** key.

⚠ WARNING

The maximum common-mode input voltage (the voltage between input low and chassis ground) is 500 V$_{PEAK}$. To prevent electrical shock that could cause injury or death, do not exceed this value.

Voltage source output connections

The voltage source output is accessed at the V SOURCE OUT LO and HI binding posts on the rear panel, as shown in the following figure.

Figure 15: Volage source output basic connections

Using these terminals places the independent voltage source in series with the external circuit (R$_L$), as shown in the following figure.

Figure 16: Voltage source output - equivalent circuit

You can also use the voltage source to form the source voltage, measure current configuration, as described in High-resistance meter connections (on page 3-4).
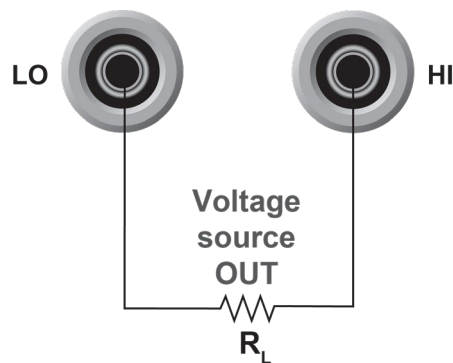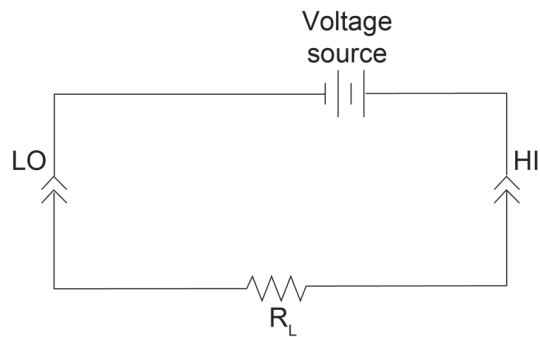

⚠ WARNING

The maximum common-mode input voltage (the voltage between input low and chassis ground) is 500 V$_{PEAK}$. To prevent electrical shock that could cause injury or death, do not exceed this value.

Low-noise input cables

Triaxial cables can generate enough triboelectric currents to corrupt the measurement. These currents are caused by friction between the center conductor and the inner shield when the cable is flexed or allowed to move around. The use of low-noise cables helps minimize these triboelectric currents.

Refer to the 6517B datasheet, available at tek.com/keithley, for recommended cables.

For voltage measurements, always use the shortest possible triaxial input cable and use guarding. The increased input capacitance caused by a long input cable can significantly slow down the reading response.

For current and resistance measurements, always use the shortest possible triaxial input cable and enable damping. The increased input capacitance caused by a long input cable can result in noisy readings. Damping reduces the noise but it also slows down the response time of the measurement.

Shielding and guarding

The following information describes the basics of using noise shields, guard shields, and safety shields. When making precision measurements, you should always use low-noise cables and use proper shielding and guarding techniques.

Noise shield

A noise shield prevents unwanted signals from being induced on the electrometer input. Effective shielding encloses the circuit or device under test (DUT) and extends to the 6517B input through a triaxial cable. The generic connection for the noise shield is shown in the following figure.

Figure 17: Noise shield
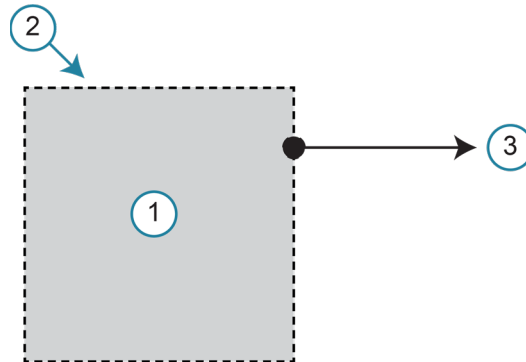
1	Device or circuit under test
2	Metal noise shield
3	Connect to 6517B LO, chassis ground, or both using a triaxial cable

Use a noise shield for:

- Unguarded voltage measurements

- Unguarded current measurements (below 1 µA)

- Low-level charge measurements

Typically, the noise shield is connected to 6517B input LO. However, sometimes better noise performance can be achieved by connecting the noise shield to both 6517B LO and chassis ground. The 6517B LO can be connected to chassis ground at the rear panel of the 6517B by installing the ground link between the COMMON binding post and the chassis ground binding post. You may have to experiment to determine which method provides the best noise performance.
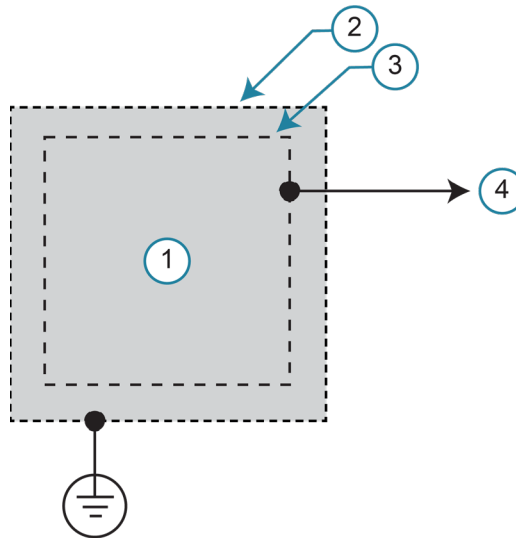
CAUTION

Do not make floating measurements with 6517B LO connected to chassis ground. If the rear-panel ground link is installed between COMMON and chassis ground, remove it before floating the instrument.

Guard shield

The GUARD option enables or disables guard for voltage measurements. For current, resistance, and charge measurements, guard is always disabled. When guard is disabled, the inner shell (shield) of the triaxial connector and cable is connected to meter input LO.

When guard is enabled, the inner shell (shield) of the triaxial connector and cable is connected to guard, which follows the potential of meter input HI. Guarding greatly reduces leakage current in a high-impedance test circuit. Leakage resistance exists in the input cable between conductor paths and in the test fixture at connectors and insulators. The concept of guarding is to surround the input high node or DUT with a guard shield that is at the same potential. Current cannot flow through a leakage resistance that has a 0 V drop across it. A typical connection for the guard shield is shown in the following figure. A safety shield is also used because guarded measurements can place hazardous voltages on the guard shield (see Safety shield (on page 3-9)).

Figure 18: Guard shield

1	Device or circuit under test
2	Metal safety shield
3	Metal guard shield
4	Connect to 6517B guard using a triaxial cable
⏚	Safety earth ground

Use guard for:

- Guarded voltage measurements

- Guarded floating current measurements

- High-impedance (≥1 GΩ) voltage measurements

- Voltage measurements that use long input cables

- Current measurements when the test circuit impedance is ≥1 Ω

- Without guarding, significant leakage could occur across a DUT through insulators and corrupt the measurement. Input LO (inner shield of the input triaxial cable) is used as the guard.

For floating current measurements, a unique guard technique is used in a high-impedance test circuit where significant leakage current may exist between the ammeter input and test circuit common.

The voltage function does not have to be selected when you configure the guard. When the voltage function is selected, the new settings are used.

For additional information, refer to "Guarding" in the *Model 6517B Electrometer Reference Manual*.

To enable guard for voltage measurements:

1. Press the **CONFIG** key.

2. Press the **V** key.

3. Select the **GUARD** menu. Press the **ENTER** key.

4. Select **ON**. Press the **ENTER** key.

Safety shield

A safety shield is required whenever a hazardous voltage is present on the noise shield or guard shield, or when a test circuit is floated above earth ground at a hazardous voltage level. A shock hazard exists at a voltage level equal to or greater than 30 V_{RMS}. Hazardous voltages up to 500 V may appear on the noise/guard shield when performing floating measurements or guarded measurements.

Typical connections for the safety shield are shown in the following figure. The metal safety shield must completely surround the noise or guard shield and must be connected to safety earth ground using #18 AWG or larger wire.

⚠ WARNING

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.

Figure 19: Safety shield
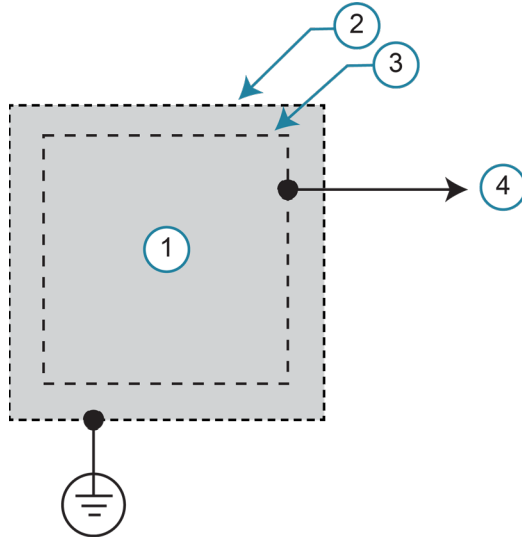
1	Device or circuit under test
2	Metal safety shield
3	Noise or guard shield
4	Connect to 6517B guard using a triaxial cable
⏚	Safety earth ground

Floating circuits

Many measurements are performed above earth ground and, in some test situations, can result in safety concerns. The following figures show examples where the 6517B floats at a hazardous voltage level.

In the following figure, a shock hazard (100 V) exists between meter input LO and chassis ground. If meter input LO is connected to a noise shield, the shock hazard is also present on that shield.

Figure 20: Floating measurements - voltage measurement
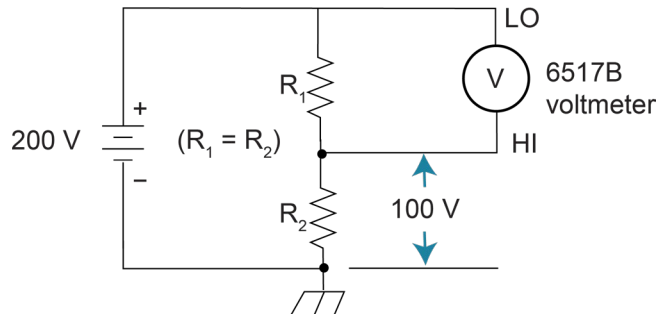
In the following figure, a shock hazard (200 V) exists between the meter input (HI and LO) and chassis ground. If meter input LO is connected to a noise or guard shield, the shock hazard is also present on that shield.

Figure 21: Floating measurements - current measurement

Floating voltage source

The voltage source of the 6517B can be operated above earth ground, as shown in the following figure. In this circuit, the voltage source is floating 100 V above ground. Therefore, a shock hazard (100 V) exists between voltage source LO and chassis ground. A shock hazard exists at a voltage level equal to 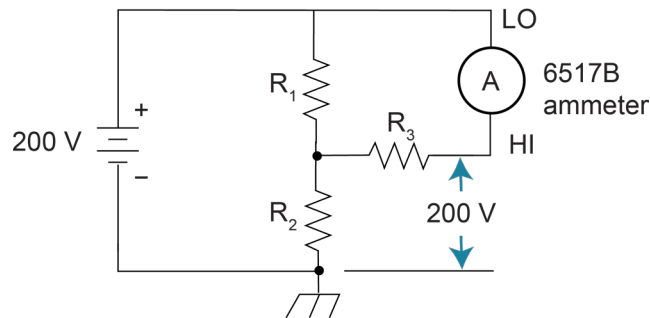or greater than 30 V_{RMS}. To avoid possible shock hazards, always surround exposed floating circuits and shields with a safety shield. See Safety shield (on page 3-9) for more information.

⚠ WARNING

The maximum common-mode voltage between electrometer LO and chassis ground is 500 V. The maximum voltage between V-source LO and earth (chassis) ground is 750 V. Exceeding these values may create a shock hazard that could cause injury or death. When floating input LO above 30 V from earth ground, hazardous voltage is present at the analog outputs (PREAMP OUT and 2V OUT). Hazardous voltage may also be present when the input voltage exceeds 30 V when the voltage function is active.

CAUTION

Connecting PREAMP OUTPUT, COMMON, or 2V ANALOG OUTPUT to earth (chassis) ground while floating the input may damage the instrument.

Figure 22: Floating voltage source
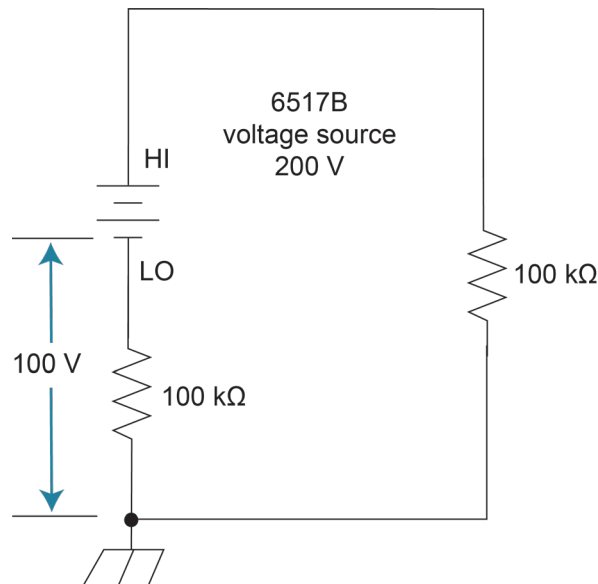
Test fixtures

Whenever possible, use shielded low-leakage test fixtures to make precision measurements.

The Model 8009 test fixture allows volume resistivity in the range of 10^3 Ω-cm to 10^{18} Ω-cm, and surface resistivity in the range of 10^3 Ω to 10^{17} Ω. Features include:

*   A 3-lug triaxial connector and dual binding posts to simplify connections to the 6517B.

*   Guarded electrodes that can accommodate samples up to 1/8" thick and 4" × 4".

*   Safety Interlock: When connected to the 6517B, the voltage-source goes into standby when the test fixture lid is open.

*   Screw terminal on the test fixture chassis for connection to safety earth ground.

You can also build a custom test fixture. The following topics provide guidelines when building a test fixture.

Interlock

When a normally-open SPST momentary switch is properly implemented as a safety interlock, the voltage source goes into standby whenever the test fixture lid is open or ajar. The switch must be mounted inside the test box and must close when the lid of the test fixture is closed. Opening the lid must cause the interlock switch to open. There must never be enough clearance to allow finger access inside the box while the switch is closed. The interlock must be designed so that it cannot be defeated. The Keithley Instruments Model 8009 test fixture provides an interlock that meets these requirements.

Interlock is automatically enabled when the appropriate interlock cable is connected to the 6517B. Use the interlock cable as shown in General measurement procedure (on page 4-18). This cable uses an extra line to detect which resistivity measurement type is selected at the test fixture (surface or volume).

⚠ WARNING

Do not connect the interlock of the 6517B to the interlock of another instrument. The interlock is designed to be connected to a single-pole interlock switch of a test fixture. If you are connecting two or more 6517Bs to a single test fixture, an isolated interlock switch for each instrument is required. Connecting multiple instrument interlocks to the same switch could cause the safety interlock system to fail, which could result in electrical shock that could cause injury or death.

See the following figure for typical interlock connections.

Figure 23: Interlock connections
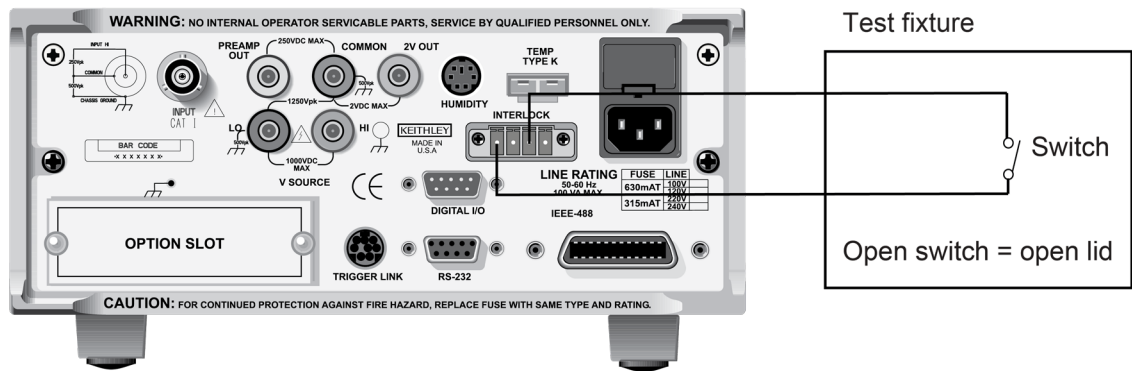
See the following figure for typical connections for resistance measurements to the Model 8009 test fixture.

Figure 24: Connections for resistivity measurements using the Model 8009 test fixture
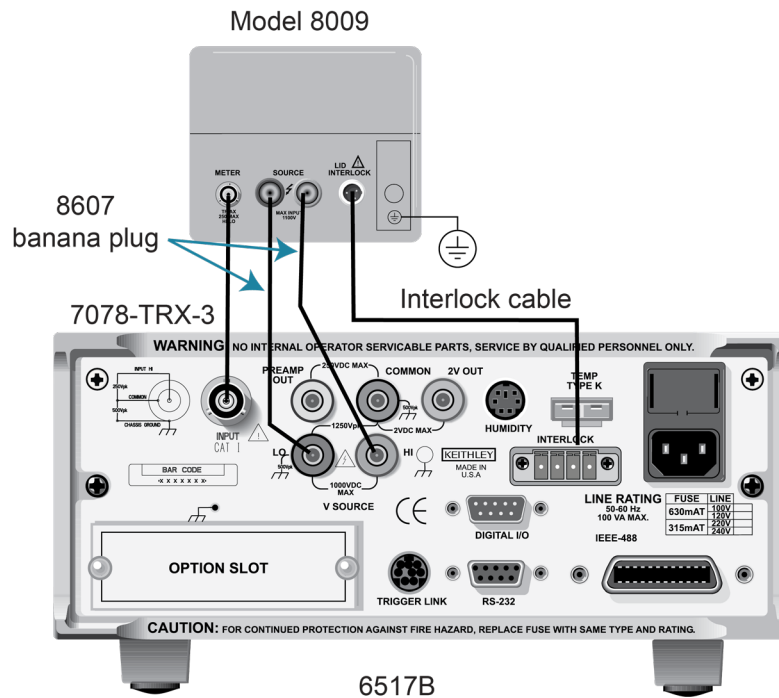
⚠ WARNING

Connect the enclosure of all metal test fixtures to protective earth (safety ground). Nonconductive test fixtures must be rated to double the maximum capability of the test equipment in the system. Failure to attach the ground wires to a known protective earth may result in electric shock.

The interlock connector on the 6517B is rated at 50 Hz to 60 Hz, 140 VA maximum. The CS-1305 connector of the interlock includes four pins (left to right as viewed from rear of the 6517B):

- Pin 1: Interlock safe
- Pin 2: Ground
- Pin 3: +5 V dc output
- Pin 4: Surface/volume select (low = volume, high = surface)

Custom-built test fixtures

The following topics describe custom-built test fixtures. The following requirements, recommendations, and guidelines are provided so you can build a quality test fixture that is safe to use. After building a test fixture, you must clean it as described in Handling and cleaning test fixtures (on page 3-18).

Test fixture chassis

The chassis of the test fixture should be metal so that it can function as a shield for the DUT or test circuit mounted inside. The chassis of the test fixture is connected to chassis ground of the 6517B through the triaxial cable.

The test box must have a lid that closes to prevent contact with live circuitry inside.

⚠ WARNING

Safe operation requires that a safety interlock switch be used to place the voltage source in standby when the test fixture lid is open or ajar (see Interlock (on page 3-12)). Failure to use a safety interlock switch may result in electric shock that could result in injury or death.

The test fixture chassis must have a screw terminal that is used exclusively for connection to safety earth ground.

⚠ WARNING

To provide protection from shock hazards, the test fixture chassis must be properly connected to safety earth ground. A grounding wire (#18 AWG or larger) must be attached securely to the test fixture at a screw terminal designed for safety grounding. The other end of the ground wire must be attached to a known safety earth ground. Failure to attach the ground wire to a known protective earth may result in electric shock that could result in injury or death.

A metal guard plate provides guarding or noise shielding for the DUT or test circuit. It also serves as a mounting panel for the DUT or test circuits. The guard plate must be insulated with 1000 V spacing from the chassis of the test fixture.

Connectors, terminals, and internal wiring

The following figures show the types of connectors that are needed to use the test fixtures with the 6517B. All connectors, except the triaxial connector, must be insulated from the chassis of the test fixture. The outer shell of the triaxial connector must be referenced to chassis ground. Do not insulate the outer shell of the triaxial connector from the metal chassis of the test fixture.

The DUT and test circuits are to be mounted on the guard plate using insulated terminals. To minimize leakage, select terminals that use virgin Teflon insulators.

Inside the chassis of the test fixture, you may use coaxial cable to extend guard from the triaxial connector to the DUT. The shield (guard) of the cable should extend as far as possible to the DUT.

Dedicated test fixture

The following figure is a dedicated test fixture for resistance measurements. It is intended for a test that sources voltage and measures current to a single device under test (DUT).

Figure 25: Test fixture to source voltage and measure current

1	Interlock switch. When the lid is open, the switch is also open.
2	Guard plate.
3	Insulated terminal.
4	Screw terminal for safety earth ground. Use #18 AWG wire or larger for connections from the test fixture to safety earth ground.
5	Three-lug female triaxial to 6517B input.
6	To 6517B voltage source OUT HI banana jack.
7	Interlock connector to 6517B interlock.
⏚	Safety earth ground.

Multipurpose test fixture

The following figure shows a multipurpose test fixture that can be used to make any 6517B measurement.

Use #18 AWG wire or larger for connections from the test fixture to safety earth ground.

Figure 26: Multipurpose test fixture

1	Interlock switch. When the lid is open, the switch is also open.
2	Guard plate.
3	Insulated terminal.
4	Screw terminal for safety earth ground. Use #18 AWG wire or larger for connections from the test fixture to safety earth ground.
5	Device under test (DUT) or test circuit.
6	To 6517B COMMON banana jack.
7	Three-lug female triaxial connector to 6517B input.
8	To 6517B voltage source OUT dual banana jacks.
9	Interlock connector to 6517B interlock.
⏚	Safety earth ground.

The multipurpose test fixture assumes that ammeter input LO is connected to voltage source LO inside the 6517B.

To set the LO-to-LO connection:

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.

Handling and cleaning test fixtures

Dust, body oil, solder flux, and other contaminants on connector and terminal insulators can significantly decrease the leakage resistance, resulting in excessive leakage currents. Also, contaminants on DUT and test circuit components can create a leakage path. These leakage currents may be large enough to corrupt low-level measurements.

Handling tips:

• Do not touch the bodies of devices-under-test (DUTs) or test circuit components. If you must handle them by their leads, use clean cotton gloves to install them in the test fixture.

• Do not touch any connector or terminal insulator.

• If you are installing a test circuit that is on a printed circuit board, handle the board by the edges. Do not touch any board traces or components.

Cleaning tips:

• Use dry nitrogen gas to clean dust from connector and terminal insulators, DUT, and other test circuit components.

• For newly build fixtures, remove any solder flux using methanol and clean foam-tipped swabs or a soft, clean brush.

• To clean contaminated areas, use methanol and clean foam-tipped swabs. After cleaning a large area, you may want to flush the area with methanol. Blow dry the test fixture with dry nitrogen gas.

• After cleaning, the test fixture (and any other cleaned devices or test circuits) should be allowed to dry in a 50°C low-humidity environment for several hours.

Basic measurements

In this section:

Introduction

This section describes the basic procedures for making voltage, current, resistance, and charge measurements.

NOTE

To ensure proper operation, always use the Z-CHK key to enable zero check (`ZeroCheck` displayed) before selecting another function. The Z-CHK key toggles zero check between the on and off states. The input circuit configuration changes when zero check is enabled. Refer to "Zero check" in the *Model 6517B Electrometer Reference Manual* for more information.

Voltage measurements

The 6517B can make unguarded or guarded voltage measurements from 1 μV to 210 V.

There are issues to be considered for making accurate voltage measurements. Refer to "Voltage measurement considerations" in the *Model 6517B Electrometer Reference Manual* for more information. For comprehensive information on precision measurements, refer to the Low Level Measurements Handbook. Both documents are available at tek.com/keithley.

To reduce leakage current when making high-impedance voltage measurements and when making voltage measurements that use long input cables, use guarding. Refer to Guard shield (on page 3-8) and "Guarding" in the *Model 6517B Electrometer Reference Manual*.

Basic voltage measurement procedure

The voltage measurement procedure is summarized in this topic.

This procedure provides instruction on how to apply an automatic relative offset. To achieve optimum accuracy for low voltage measurements, it is recommended that you apply a relative offset. For more information, refer to "Relative offset" in the *Model 6517B Electrometer Reference Manual*.

⚠ WARNING

Hazardous voltages may be present on the inner shield of the triaxial cable when GUARD is on. 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. Refer to Shielding and guarding (on page 3-6) for detail.

CAUTION

Do not apply more than 250 V$_{PEAK}$ (dc to 60 Hz) to the input. Applying voltages above 250 V$_{PEAK}$ can damage the 6517B.

To make a voltage measurement:

1. Press the **Z-CHK** key until zero check is enabled (`ZeroCheck` displayed).
2. Press the **V** key to select the voltage function.
3. Press the **CONFIG** key.
4. Press the **V** key.
5. Select the **GUARD** menu.
6. Select **ON** or **OFF**. Press the **ENTER** key.
7. Press the **EXIT** key to return to the measurement display. When guard is enabled, `Grd` is displayed.
8. Use the **Range ▼** key to select the lowest measurement range (2 V).
9. Press the **REL** key. The `ZCor` message is displayed. If guard is enabled, the `ZCor` message replaces the `Grd` message. Guard is still enabled.
10. Press the **AUTO** key to enable autorange.
11. Connect the 6517B to the voltage to be measured. Refer to the following figures for typical connections for unguarded and guarded measurements.
12. Press the **Z-CHK** key to disable zero check and start making readings.

Figure 27: Unguarded voltage measurement connections
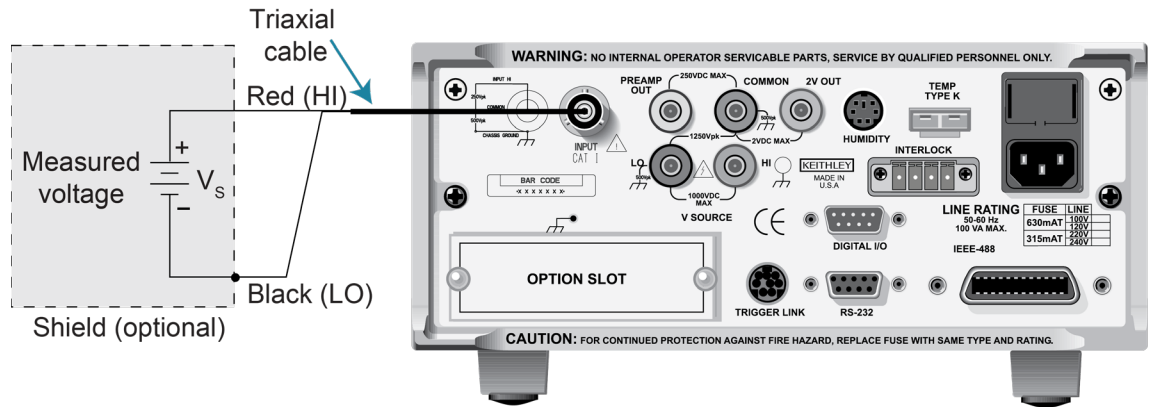
Figure 28: Unguarded voltage measurements - equivalent circuit
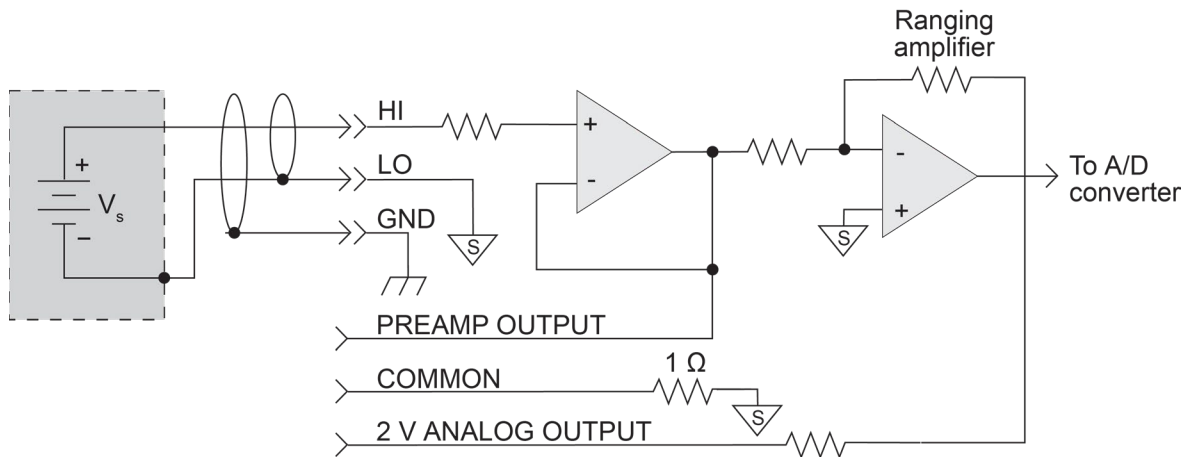
Figure 29: Guard voltage measurement connections
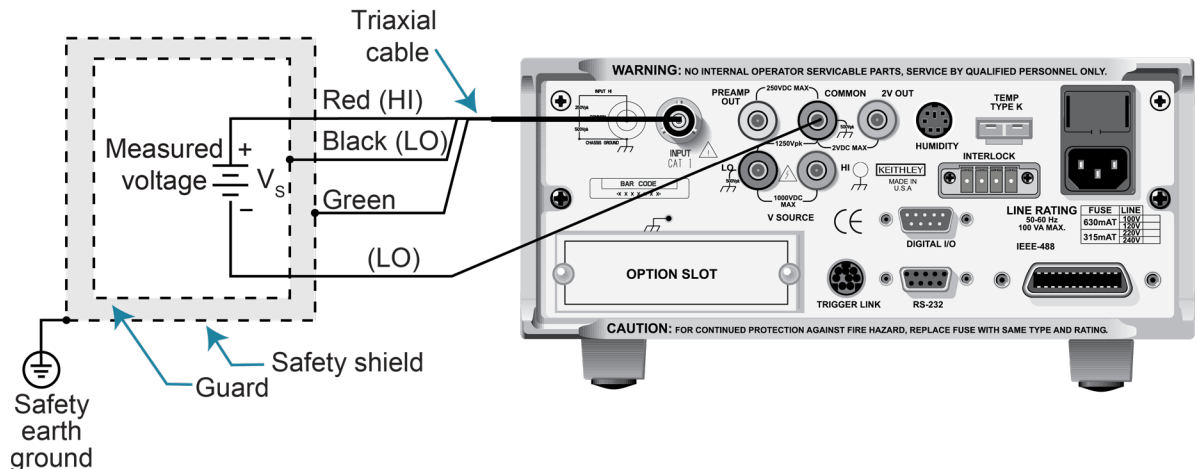
Figure 30: Guarded voltage measurements - equivalent circuit
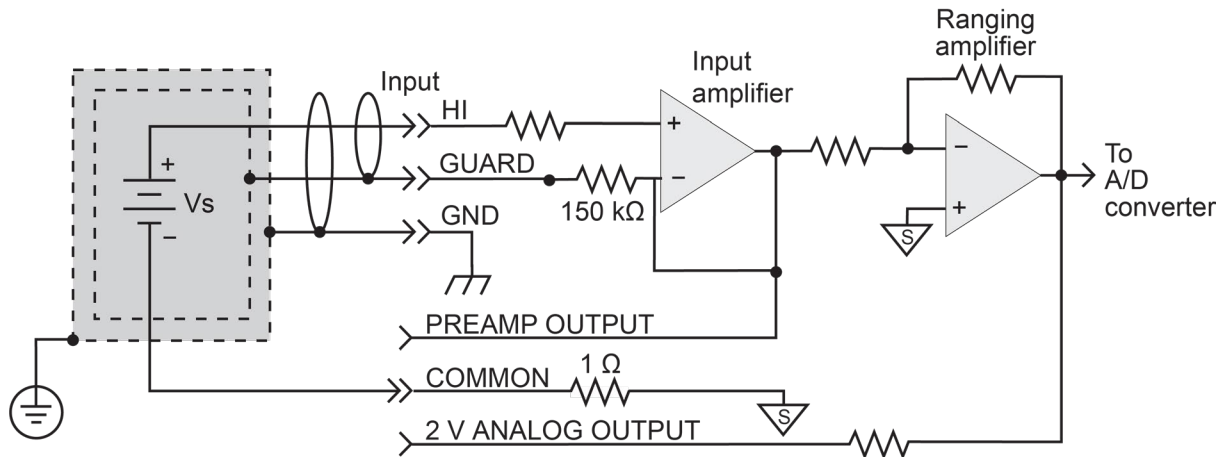
Voltage configuration

The following information describes the configuration options for the voltage function. The options in the voltage configuration menu are summarized in the following table. To access the voltage configuration menu, press **CONFIG** and then **V**.

You can configure a function if it is not the active function. When the function is selected, the saved settings are used.

NOTE

The voltage source value is not set in the configuration menu. Use the **VOLTAGE SOURCE ▲** and ▼ keys to adjust the voltage source value. Place cursor on the digit and use the ▲ or ▼ key to change the value. To change the polarity, move the cursor to the sign and use ▲ or ▼ to toggle the polarity. For more information on setting up the voltage source, refer to "Voltage source" in the *Model 6517B Electrometer Reference Manual*.

Voltage configuration menu

Menu item	Description
GUARD	Enable or disable guard. Only available for voltage measurements. Refer to Guard shield (on page 3-8) for detail.
EXT-FDBK	Enable or disable the external feedback feature. Refer to "Using external feedback" in the *Model 6517B Electrometer Reference Manual*.
SPEED	Measurement speed (integration time) menu:
NORMAL	1 power line cycle (PLC, 16.67 ms for 60 Hz, 20 ms for 50 Hz and 400 Hz).
FAST	Select 0.01 PLC.
MEDIUM	Select 0.1 PLC.
HIACCURACY	Select 10 PLC.
SET-SPEED-EXACTLY	Set integration in PLC (0.01 to 10).
SET-BY-RSLN	Optimizes the integration time for the selected resolution.
	Refer to "Integration time" in the *Model 6517B Electrometer Reference Manual* for detail.
FILTER	Filter menu for setting the averaging and median filters:
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 the median filter:
DISABLE	Disable the median filter.
ENABLE	Enable median filter and specify rank (1 to 5).
	Refer to "Filters" in the *Model 6517B Electrometer Reference Manual* for detail.
RESOLUTION	Resolution menu:
AUTO	Default to resolution appropriate for the integration time.
3.5, 4.5, 5.5, 6.5	Select a specific resolution.
	Refer to "Display resolution" in the *Model 6517B Electrometer Reference Manual* for detail.

Current measurements

The 6517B can make current measurements from 10 aA to 21 mA.

For other factors to consider when making current measurements, refer to "Current measurement considerations" in the *Model 6517B Electrometer Reference Manual*.

Basic current measurement procedure

The following procedure describes how to make a current measurement.

To achieve optimum precision for low-level current measurements, input bias current and voltage burden can be minimized by applying a relative offset. This procedure includes steps to apply a relative offset. Refer to "Relative offset" in the *Model 6517B Electrometer Reference Manual* for more information.

NOTE

After measuring high voltage using the voltage function, it may take a few minutes for the input current to drop to within specified limits. Input current can be verified by placing the protection cap on the INPUT triaxial connector and then connecting a jumper between COMMON and chassis ground. With the instrument on the 20 pA range and zero check disabled, allow the reading to settle until the input bias current is within specifications.

⚠ WARNING

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. Refer to Safety shield (on page 3-9) for more information.

CAUTION

Do not apply more than 250 V$_{PEAK}$ (dc to 60 Hz; 10 seconds per minute maximum on the mA ranges) to the input. Applying voltages above 250 V$_{PEAK}$ can damage the 6517B.

To make current measurements:

1. Press the **Z-CHK** key to enable zero check (`ZeroCheck` displayed).

2. Select the **I** key to select the current function.

3. Use the **Range ▼** key to select the lowest measurement range (20 pA).

4. Press the **REL** key. The REL indicator turns on and the `ZCor` message is displayed.

5. Press the **AUTO** key to enable autorange.

6. Connect the 6517B to the current to be measured. The following figure shows typical connections for current measurements.

7. Press the **Z-CHK** key to disable zero check and make a reading from the front panel.

Figure 31: Current measurements - typical connections
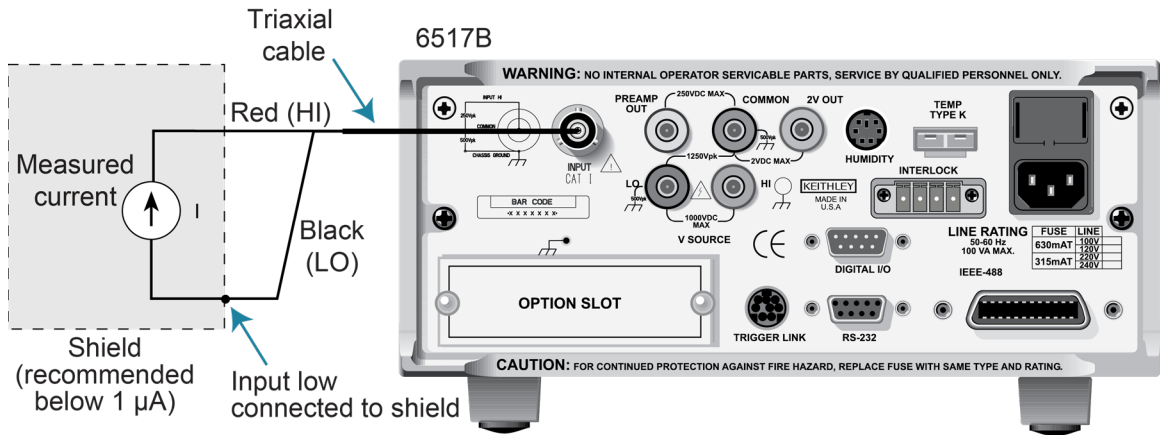
Figure 32: Current measurements - equivalent circuit
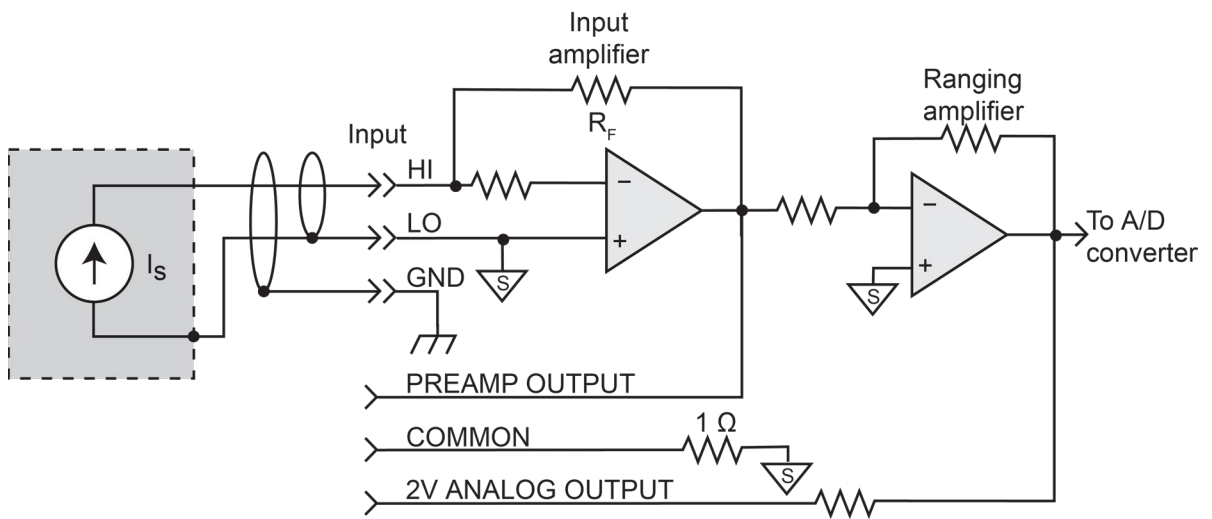
If you are measuring current in a floating circuit where significant leakage may exist between the ammeter input and circuit low, connect the 6517B to the circuit as shown in the following figure. Notice that ammeter input LO is connected to circuit high.

Figure 33: Guarded floating current measurement connections
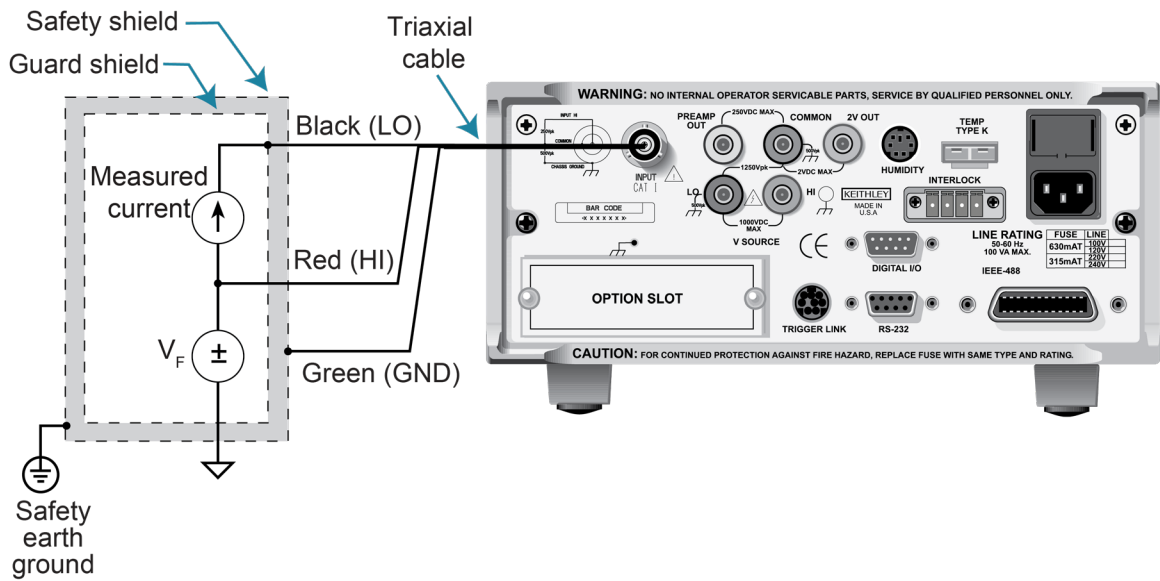
Current configuration

The following information explains the configuration options for the current function. The configuration menu is summarized in the following table. To access this menu, press the **CONFIG** key and then the **I** key.

A function does not have to be selected to be configured. When the function is selected, it assumes the pre-programmed status.

Current configuration menu

Menu item	Description
SPEED	Measurement speed (integration time) menu:
NORMAL	1 PLC (power line cycle, 16.67 ms for 60 Hz, 20 ms for 50 Hz and 400 Hz).
FAST	0.01 PLC.
MEDIUM	0.1 PLC.
HIACCURACY	10 PLC.
SET-SPEED-EXACTLY	Set integration in PLC (0.01 to 10).
SET-BY-RSLN	Optimizes the integration time for the selected resolution.
	Refer to "Integration time" in the *Model 6517B Electrometer Reference Manual* for detail.
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).

Menu item	Description

AVERAGING-MODE
MEDIAN
  DISABLE
  ENABLE
	Select moving average or repeating average mode.
	Configure median filter:
	  Disable median filter.
	  Enable median filter and specify rank (1 to 5).
	Refer to "Filters" in the *Model 6517B Electrometer Reference Manual* for detail.

RESOLUTION
  AUTO
  3.5, 4.5, 5.5, 6.5
	Display resolution menu:
	  Default to resolution appropriate for integration time.
	  Select a specific resolution.
	Refer to "Display resolution" in the *Model 6517B Electrometer Reference Manual* for more detail.

AUTO-RANGE
  USE-ALL-RANGES
  SET-LIMITS
    MIN-AUTO
    MAX-AUTO
	Autorange menu:
	  Use all current ranges when autoranging.
	  Limit the ranges used in the autorange search:
	    Specify the minimum range in the search.
	    Specify the maximum range in the search.
	Refer to "Measurement range" in the *Model 6517B Electrometer Reference Manual* for more detail.

DAMPING	Enable or disable damping.
	  ON: Enable current damping.
	  OFF: Disable current damping.
	Refer to "Damping" in the *Model 6517B Electrometer Reference Manual* for more detail.

Resistance and resistivity measurements

The 6517B can make resistance measurements and resistivity measurements (surface and volume). High resistance measurements (above 1 MΩ) may exhibit problematic background currents and can be improved using the alternating polarity test sequence.

Automatic voltage source

The 6517B has an automatic voltage source mode for resistance and resistivity measurements.

When the automatic voltage source is selected, the 6517B automatically sets the voltage source range and level to an optimum test voltage level, either 40 V or 400 V, for the measurement range. The selected test voltage and current measurement range depends on which resistance measurement range is used. The 6517B displays the resistance measurement range and the voltage source value.

When MANUAL voltage source is selected, the current range for the measurement and the voltage source value is displayed.

When the automatic voltage source is selected, you cannot manually adjust the voltage source or change the voltage source range of the resistance function.

If voltage source ohms is set to AUTO, the voltage limit of the voltage source is < 400 V, and a resistance range that requires 400 V is selected, an error occurs and the voltage source is turned off.

The published specifications for resistance only apply for the specified AUTO voltage source test voltages. If you are using the MANUAL voltage source setting, you must add the voltage source errors to the current measurement range errors to determine the total resistance errors.

When the voltage source setting is set to MANUAL, you can set the voltage source to any value and change the voltage source range while using the resistance function. The 6517B displays the current range that is used for the measurement and the voltage source value.

⚠ WARNING

A hazardous voltage (400 V) may automatically be set for the resistance function when AUTO voltage source is selected. See the table in Resistance ranges (on page 4-10) for the resistance ranges that use the high voltage.

To set the voltage source:

1. Press the **CONFIG** key.
2. Press the **R** key.
3. Select **VSOURCE**. Press the **ENTER** key.
4. Select **AUTO** or **MANUAL**. Press the **ENTER** key.

Resistance ranges

The reading ranges for the resistance function are listed in the following table.

To optimize range selection:

• Use autorange.

• Select the next lower range when UNDERFLOW is displayed.

• With the manual voltage source selected, press the **NEXT** key until the actual measured current is displayed. This allows you to verify that the selected current range is the lowest range that can handle the measured current.

Refer to "Measurement range" in the *Model 6517B Electrometer Reference Manual* for additional detail.

Resistance reading ranges and automatic voltage source

Reading range	Automatic voltage source	
	Test voltage	Current range
200 kΩ to 2 MΩ	40 V	200 µA
2 MΩ to 20 MΩ	40 V	20 µA
20 MΩ to 200 MΩ	40 V	2 µA
200 MΩ to 2 GΩ	40 V	200 nA
2 GΩ to 20 GΩ	40 V	20 nA
20 GΩ to 200 GΩ	40 V	2 nA
200 GΩ to 2 TΩ	400 V	2 nA
2 TΩ to 20 TΩ	400 V	200 pA
20TΩ to 200TΩ	400 V	20 pA

Resistance measurements

The 6517B can make resistance measurements up to 1017 Ω using the source voltage, measure current (SVMI) technique. From the known sourced voltage and measured current, the 6517B calculates and displays the resultant resistance (R = V/I). The voltage source level can be set automatically by the 6517B or it can be manually set by the user.

The following procedure summarizes the basic steps to measure resistance. To ensure proper operation, always enable zero check (`ZeroCheck` displayed) before changing functions (V, I, R, or Q). The Z-CHK key controls zero check.

NOTE

When autorange is selected, the instrument does not go to the 2 TΩ, 20 TΩ, or 200 TΩ ranges. For optimum accuracy, leakage currents in the test fixture can be canceled by performing relative offset on the current component of the measurement. To cancel leakage current, see Canceling test fixture leakage current (on page 4-13).

NOTE

Accurate high resistance measurements require the use of a low-leakage test fixture.

⚠ 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.

To measure resistance:

1. Press the **Z-CHK** key to enable zero check (`ZeroCheck` displayed).

2. Select the **R** key to select the resistance function.

3. Press the **CONFIG** key.

4. Press the **R** key. The resistance configuration menu is displayed.

5. Select **MEAS-TYPE**. Press the **ENTER** key.

6. Select **RESISTANCE**. Press the **ENTER** key.

7. Select **VSOURCE** to select the voltage source adjustment mode. Press the **ENTER** key.

8. Select the voltage source setting:

   - **AUTO:** The instrument automatically selects the optimum voltage source value (40 V or 400 V) for the measurement range.

   - **MANUAL:** You select the voltage source range and value.

9. Press the **ENTER** key.

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

11. Connect the resistance to be measured to the 6517B, as shown in the following figure.

Figure 34: Typical connections for resistance measurements
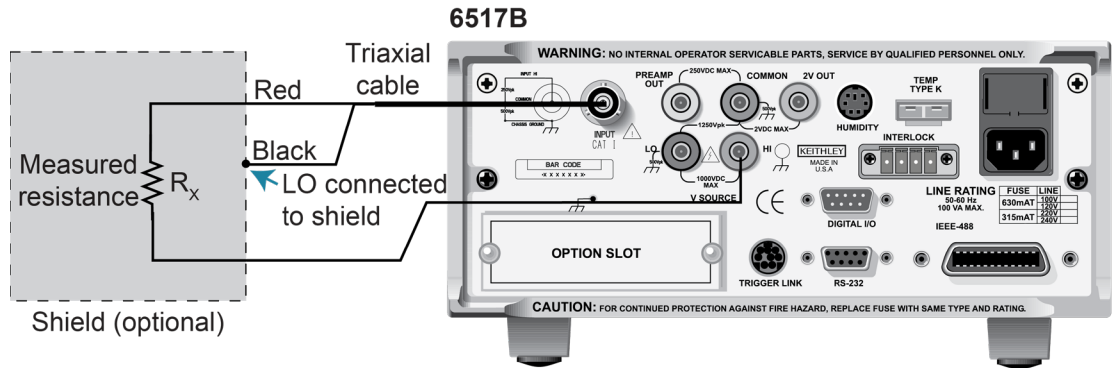
NOTE

Voltage source low is internally connected to 6517B low.

Figure 35: Typical connections for resistance measurements - equivalent circuit
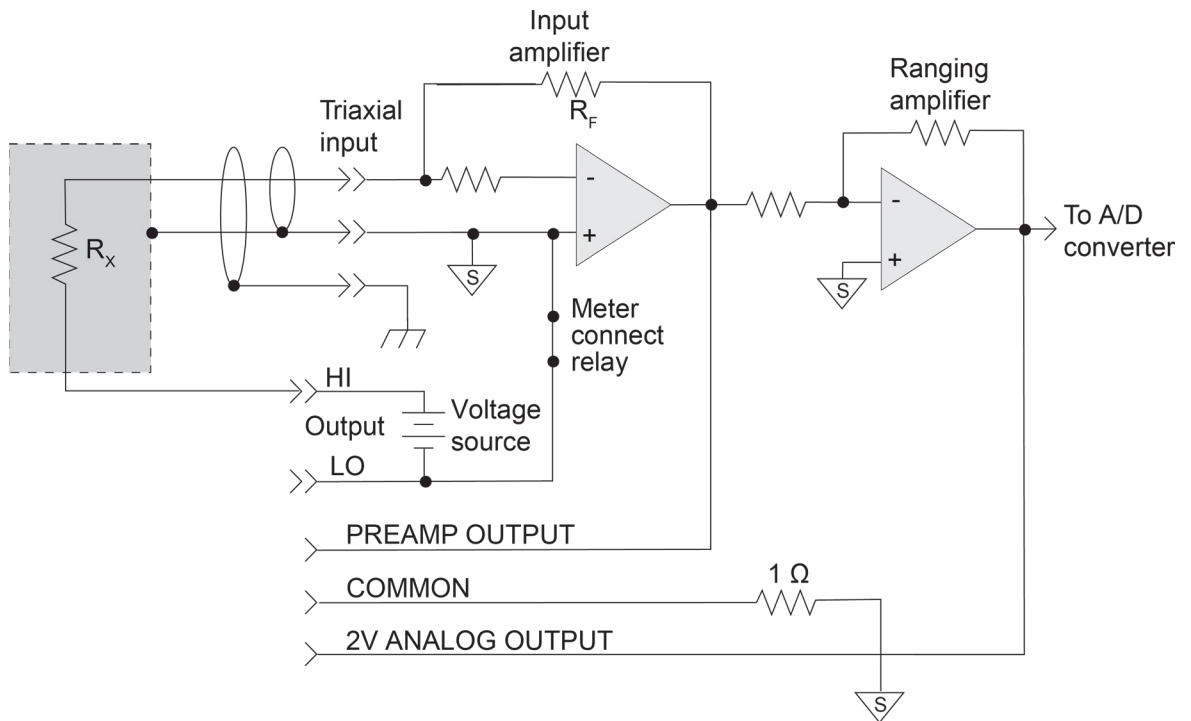
12. If VSOURCE is set to MANUAL, use the cursor keys and the **VOLTAGE SOURCE** adjustment keys to set the voltage level.

13. To change the voltage source range:

    a. Press the **CONFIG** key.

    b. Press the **OPER** key.

    c. Select **RANGE**. Press the **ENTER** key.

    d. Set the value. Press the **ENTER** key.

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

⚠ WARNING

To avoid a possible shock hazard that could cause injury or death, do not use a voltage level that exceeds the maximum input voltage rating of the test fixture.

14. Use the manual **RANGE** keys ▲ and ▼ to select the resistance measurement range or press the **AUTO** key to select autorange.

15. Press the **OPER** key to source voltage to the DUT.

16. Press the **Z-CHK** key to disable zero check and start measurements.

17. When measurements are complete, press the **OPER** key again to place the voltage source in standby.

NOTE

If the flashing VOLTAGE SOURCE OPERATE LED flashes, it indicates that the voltage source has gone into current limit and the programmed voltage is not being applied to the load. In this situation, try using a lower voltage for the measurement.

Canceling test fixture leakage current

Significant leakage in the test fixture can corrupt a resistance measurement. You can cancel this leakage current by performing a relative offset on the current component of the resistance measurement.

The following procedure assumes that you have completed the steps before disabling zero check in the procedure in <u>Resistance measurements</u> (on page 4-11).

To cancel leakage current:

1. Press the **OPER** key to place the voltage source in standby (VOLTAGE SOURCE OPERATE LED off).

2. Remove the device from the test fixture.

3. Press the **ZCHK** key to enable zero check.

4. Press the **I** key to select the current function.

5. Press the **OPER** key to source the programmed voltage source level to the test fixture.

6. Use the **RANGE ▼** key to select the lowest possible measurement range. The displayed reading is the leakage current in the test fixture.

7. Press the **ZCHK** key to disable zero check.

8. Press the **REL** key to cancel the leakage current.

9. Press the **OPER** key to place the voltage source in standby and enable zero check.

10. Press the **CONFIG** key.

11. Press the **R** key. The CONFIGURE OHMS menu is displayed.

12. Select **AMPSREL**. Press the **ENTER** key.

13. Select **ENABLED** to establish the relative offset value for the current reading. Press the **ENTER** key.

14. Use the **EXIT** key to return to the measurement display.

15. Re-install the device under test (DUT) in the test fixture.

16. Press the **R** key and proceed to the step in that disables zero check.

Resistivity measurements

The 6517B can make surface resistivity measurements from 10^3 to 10^{17} ohms and volume resistivity measurements from 10^3 to 10^{18} ohms-cm.

Typical resistivity test fixtures, such as the Keithley Instruments Model 8009, use circular electrodes. To use these test fixtures, the insulator sample must be large enough that all the surfaces of the electrodes make contact with the sample. For volume resistivity, you need to know the thickness (in mm) of the sample. The 6517B automatically performs the calculation and displays the reading.

For additional information on resistivity measurements, refer to the application note "Volume and Surface Resistivity Measurements of Insulating Materials Using the 6517B Electrometer/High Resistance Meter," document number 1KW-61175, available at tek.com.

NOTE

For detail on calculating the effective area and effective perimeter, refer to the ASTM International *Standard Test Methods for DC Resistance or Conductance of Insulating Materials*, ASTM Designation D257.

Surface resistivity

Surface resistivity is the electrical resistance of the surface of an insulator material. It is measured from electrode to electrode along the surface of the insulator sample. Since the surface length is fixed, the measurement is independent of the physical dimensions (for example, thickness and diameter) of the insulator sample.

Surface resistivity is measured by applying a voltage potential across the surface of the insulator sample and measuring the resultant current, as shown in the following figure.

Figure 36: Surface resistivity measurement technique
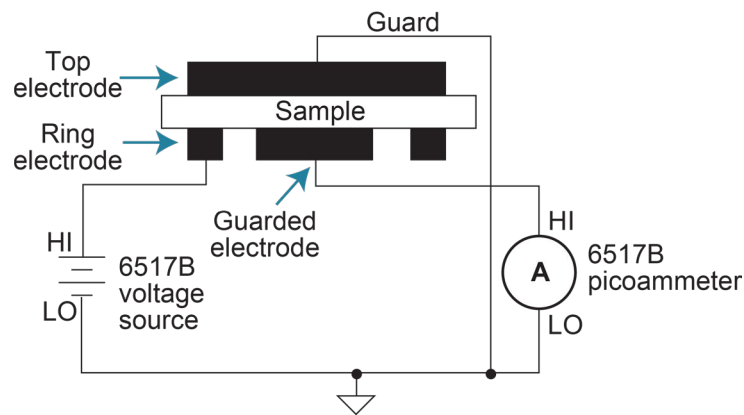
The 6517B automatically performs the following calculation and displays the surface resistivity reading:

$$\rho_S = K_S R$$

Where:

- ρ_S is the surface resistivity (per square).

- R is the measured resistance in ohms (V/I).

- $K_S = P/g$, where:

    - P is the effective perimeter of the guarded electrode (mm).

    - g is the distance between the guarded electrode and the ring electrode (mm). Refer to the following figure to determine dimension g.

For circular electrodes:

$$P = \pi D_0$$

Where $D_0 = D_1 + g$. Refer to the following figure to determine the dimension D_0.

Figure 37: Circular electrode dimensions

$$g = \frac{D_2 - D_1}{2} \qquad D_0 = D_1 + g$$
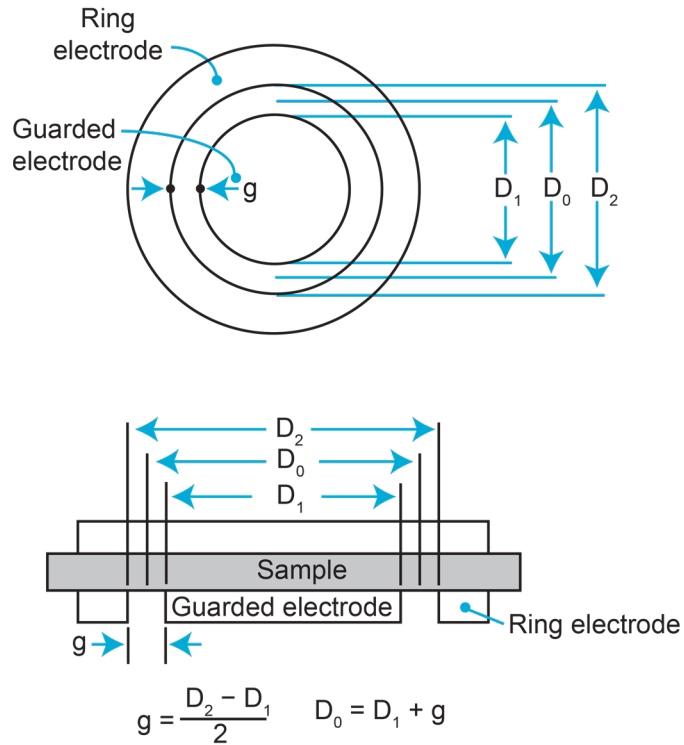
Test fixture dimensions	
	Model 8009
D_1	2.000 in.
D_0	2.125 in.
D_2	2.250 in.
g	0.125 in.

Volume resistivity

Volume resistivity is defined as the electrical resistance through a cube of insulating material. When expressed in ohm-centimeters, it is the electrical resistance through a one-centimeter cube of insulating material. When expressed in ohm-inches, it is the electrical resistance through a one-inch cube of insulating material.

The 6517B automatically performs the following calculation and displays the volume resistivity reading:

$$\rho_V = \frac{K_V}{\tau}R$$

Where:

- ρ_V = Volume resistivity.

- K_V = The effective area of the guarded electrode for the electrode arrangement.

- τ = Average thickness of the sample (cm).

- R = Measured resistance in ohms (V/I).

For circular electrodes:

$$K_V = \pi\left(\frac{D_1}{2} + B\frac{g}{2}\right)^2$$

- D_1 = Outside diameter of guarded electrode.

- B = Effective area coefficient.

- g = Distance between the guarded electrode and the ring electrode.

Volume resistivity is measured by applying a voltage potential across opposite sides of the insulator sample and measuring the resultant current through the sample as shown in the following figure.

Figure 38: Volume resistivity measurement technique
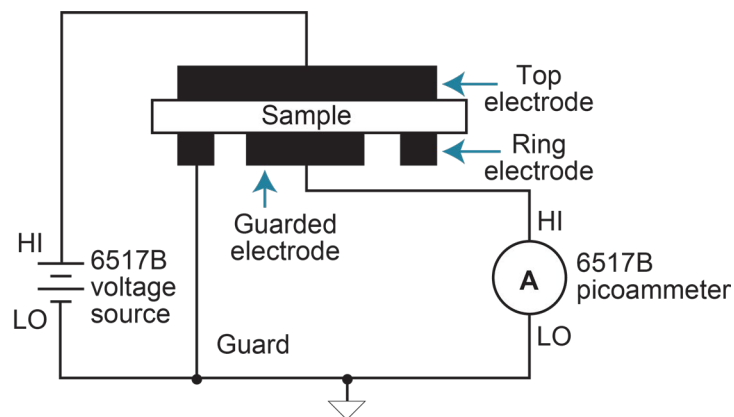
Refer to the "Circular electrode dimensions" figure in Surface resistivity (on page 4-15) to determine dimensions D_1 and g.

NOTE

To calculate the effective area coefficient (B), refer to ASTM International *Standard Test Methods for DC Resistance or Conductance of Insulating Materials*, ASTM Designation D257-14.

General resistivity measurement procedure

The following steps summarize the basic steps to measure resistivity when a Model 8009 test fixture is used.

NOTE

If the 6517B is already 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 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 and you cannot change the measurement type from the menu.

⚠ 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.

To measure resistivity:

1. Press the **Z-CHK** key to enable zero check (`ZeroCheck` displayed).

2. Select the **R** key to select the resistance function.

3. Press the **CONFIG** key.

4. Press the **R** key. The resistance configuration menu is displayed.

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. If you selected VOLUME:

    a. Select **THICKNESS**. Press the **ENTER** key.

    b. Set the thickness. Press the **ENTER** key.

9. Select **FIXTURE-MODEL**. Press the **ENTER** key.

10. Select **MODEL-8009**. Press the **ENTER** key.

11. Press the **EXIT** key twice to return to the CONFIGURE OHMS menu.

12. Select **VSOURCE**. Press the **ENTER** key.

13. Select AUTO or MANUAL:

    ▪ **AUTO:** The instrument automatically selects the optimum voltage source value (40 V or 400 V) for the measurement range.

    ▪ **MANUAL:** You select the voltage source range and value.

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

15. If VSOURCE is set to MANUAL:

    a. Use the cursor keys and the **VOLTAGE SOURCE** adjustment keys to set the voltage level.

    b. To change the voltage source range, press the **CONFIG** key and then the **OPER** key, then select **RANGE**.

16. Connect the sample to be measured to the 6517B, as shown in the following figure.

Figure 39: Connections for resistivity measurements using the Model 8009 test fixture
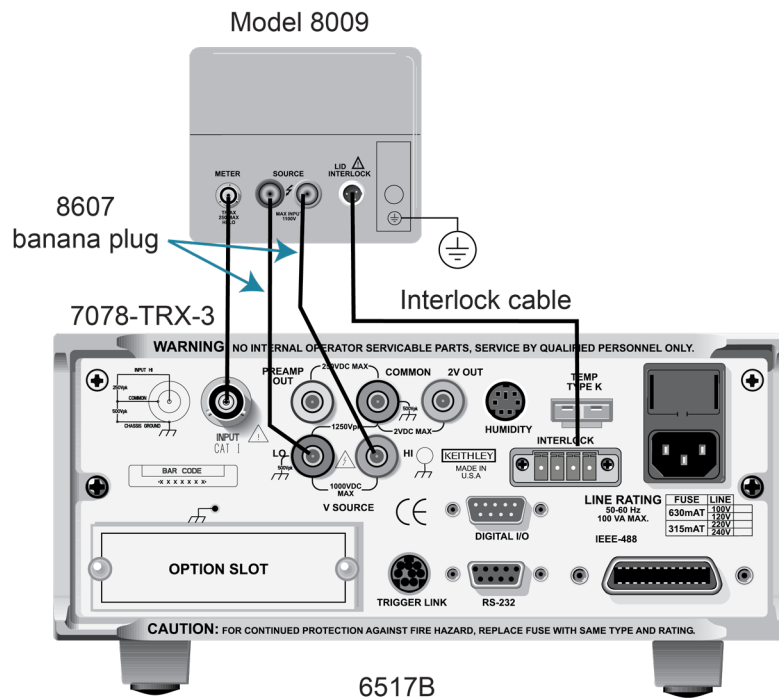
⚠ WARNING

Connect the enclosure of all metal test fixtures to protective earth (safety ground). Nonconductive test fixtures must be rated to double the maximum capability of the test equipment in the system. Failure to attach the ground wires to a known protective earth may result in electric shock.

17. Use the manual **RANGE** keys to select the resistance measurement range or press the **AUTO** key to select autorange. When autorange is selected, the instrument does not go the 2 TΩ, 20 TΩ, and 200 TΩ ranges.

18. Press the **Z-CHK** key to disable zero check.

19. Press the **OPER** key to place the voltage source in operate.

20. Wait an appropriate electrification period (bias time). Typically, a bias time of 60 seconds is used.

21. Observe the resistivity reading.

22. Press the **OPER** key to place the voltage source in standby.

23. Press the **Z-CHK** key to enable zero check.

NOTE

If the VOLTAGE SOURCE OPERATE LED flashes, the voltage source is current limited and the programmed voltage is not applied to the load. If this occurs, try using a lower voltage for the measurement.

Resistance configuration

The following information explains the various configuration options for the resistance function. The configuration menu is summarized in the following table. To access this menu, press the **CONFIG** key and then the **R** key.

You do not have to select a function to configure it. When the function is selected, it assumes the programmed status.

Resistance configuration menu

Menu item	Description
SPEED	Measurement speed (integration time) menu:
NORMAL	1 PLC (power line cycle, 16.67 ms for 60 Hz, 20 ms for 50 Hz and 400 Hz).
FAST	0.01 PLC.
MEDIUM	0.1 PLC.
HIACCURACY	10 PLC.
SET-SPEED-EXACTLY	Set integration in PLC (0.01 to 10).
SET-BY-RSLN	Optimizes the integration time for the selected resolution.
	Refer to "Integration time" in the *Model 6517B Electrometer Reference Manual* for detail.
FILTER	Filter menu for setting the averaging and median filters:
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 the median filter:
DISABLE	Disable the median filter.
ENABLE	Enable median filter and specify rank (1 to 5).
	Refer to "Filters" in the *Model 6517B Electrometer Reference Manual* for detail.
RESOLUTION	Resolution menu:
AUTO	Default to resolution appropriate for the integration time.
3.5, 4.5, 5.5, 6.5	Select a specific resolution.
	Refer to "Display resolution" in the *Model 6517B Electrometer Reference Manual* for detail.
AMPSREL	Enable or disable relative offset for current.
	Refer to [Canceling test fixture leakage current](#) (on page 4-13) for more information.
AUTORNG	Autorange menu:
USE-ALL-RANGES	Use all ranges except the 2 TΩ, 20 TΩ, and 200 TΩ ranges when autoranging.
SET-LIMITS	Limit the ranges used in the autorange search:
MIN-AUTO	Specify the minimum range in the search.
MAX-AUTO	Specify the maximum range in the search.
	Refer to [Resistance ranges](#) (on page 4-10) for additional information.

Menu item	Description
DAMP	Enable or disable damping. Refer to "Damping" in the *Model 6517B Electrometer Reference Manual* for more information.

MEAS-TYPE
  RESISTANCE
  RESISTIVITY
    SURFACE
    VOLUME
      THICKNESS
FIXTURE-MODEL
	Resistance measurement type menu:
	  Select the resistance measurement mode.
	  Select the resistivity measurement mode.
	    Configure surface resistivity measurements.
	    Configure volume resistivity measurements.
	      Use to specify (in millimeters) the thickness of the sample.
	Displayed for the SURFACE and VOLUME menus
	  Select the test fixture:
	    MODEL-8009: The Model 8009 Resistivity Test Fixture. This option automatically sets the parameters for the volume resistivity calculation since the electrode dimensions are known.
	    USER: Another manufacturer's test fixture or a custom-built test fixture. This option is also used for the Model 8009 test fixture if using an effective area coefficient less than one (B < 1). After selecting this option you are prompted to enter the value for Ks or Kv.
	Refer to Resistivity measurements (on page 4-14) for more information.

VSOURCE	Select AUTO or MANUAL voltage source. Refer to Automatic voltage source (on page 4-9) for more information.

Resistance display

When a resistance function is selected, you can display the current measurement and voltage source values.

When you press the DISPLAY **NEXT** key, the current measurement and voltage source values are displayed, as shown in the following figure. The resistance measurement is shown on the top line of the display.

Figure 40: Resistance measurement and source display

Charge measurements

The 6517B has four charge ranges to resolve charges as low as 10 fC (10^{-14}C) and measure as high as 2.1 µC. In the charge function, an accurately known capacitor is placed in the feedback loop of the amplifier so that the voltage developed is proportional to the integral of the input current in accordance with the following formula:

$$V = \frac{1}{C}\int i\, dt = \frac{Q_S}{C}$$

The voltage is scaled and displayed as charge.

Basic charge measurement procedure

NOTE

After measuring high voltage in the voltage function, it may take a few minutes for input current to drop to within specified limits. Input current can be verified by placing the protection cap on the INPUT triaxial connector and then connecting a jumper between COMMON and chassis ground. With the instrument on the 20 pA range and zero check disabled, allow the reading to settle until the input bias current is within specifications.

CAUTION

Do not apply more than 250 V$_{PEAK}$ (dc to 60 Hz) to the input. Applying voltages above 250 V$_{PEAK}$ can damage the 6517B.

The 6517B has an autodischarge feature for the charge function. When enabled, autodischarge resets the charge reading to zero when the charge reading reaches the specified level. After the integrator resets, the charge measurement process restarts at zero.

To make charge measurements:

1. Press the **Z-CHK** key to enable zero check (`ZeroCheck` displayed).
2. Select the **Q** key to select the charge function.
3. Press the **CONFIG** key.
4. Press the **Q** key.
5. Select **AUTO-DISCHARGE**. Press the **ENTER** key.
6. Select:
   - **OFF**: Disable autodischarge. You can use zero check to reset the integrator.
   - **ON**: Enable autodischarge. You are prompted to enter the discharge level. The charge reading resets every time the specified charge level is reached.
7. Press the **ENTER** key.
8. Press the **EXIT** key to return to the measurement display.
9. Press the **AUTO** key to select autorange. You can also use the RANGE keys to select a manual range.
10. Connect the test cable to the 6517B.
11. Press the **Z-CHK** key to disable zero check.
12. Press the **REL** key to set the relative offset (zero the instrument).
13. Connect the circuit to the INPUT of the 6517B as shown in the following figure.
14. Make the charge reading from the display.

Figure 41: Typical connections for charge measurements
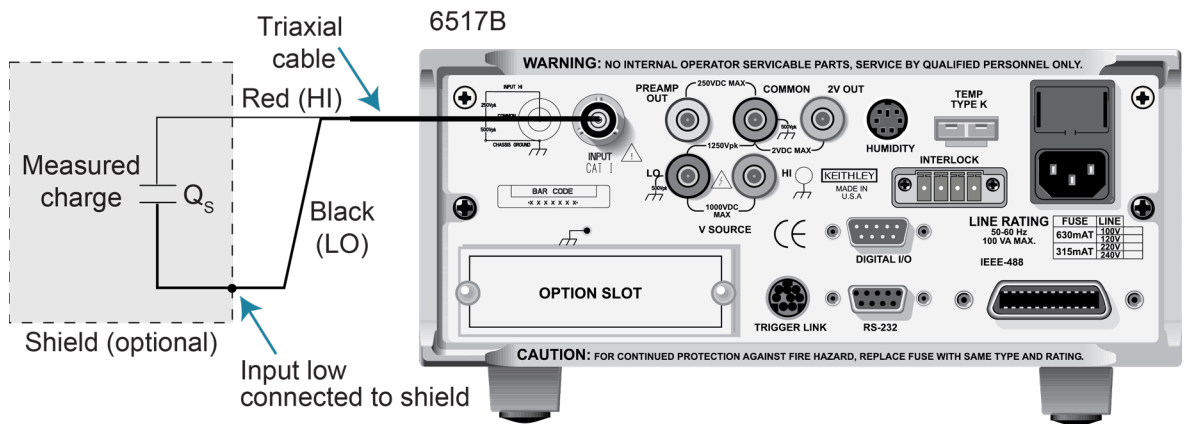
Figure 42: Typical connections for charge measurements - equivalent circuit
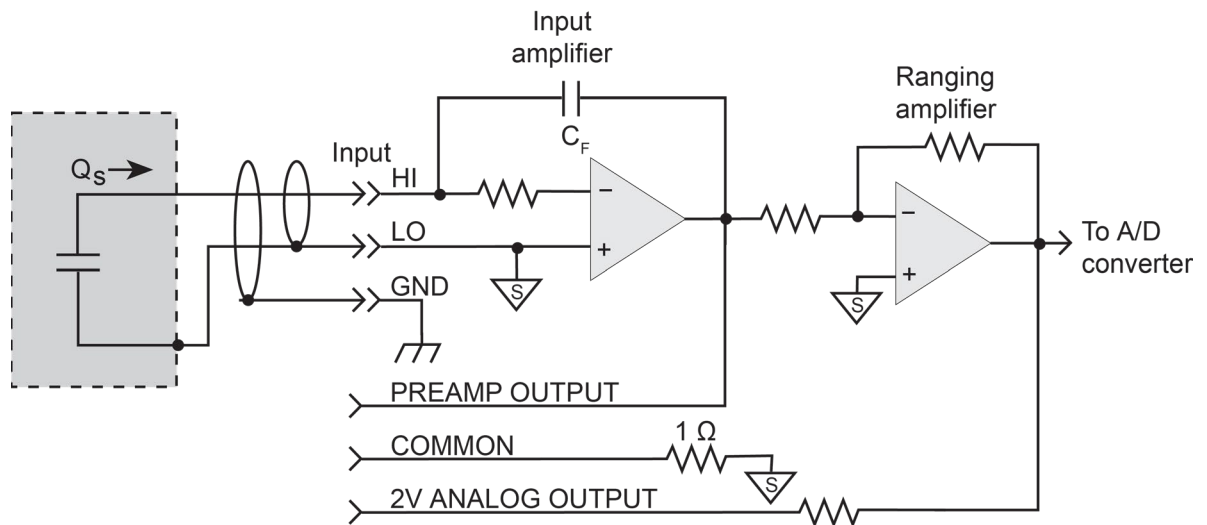
Charge configuration

The following information explains the various configuration options for the charge function. The configuration menu is summarized in the following table. This menu is accessed by pressing the **CONFIG** key and then the **Q** key.

You do not have to select a function to configure it. When the function is selected, it assumes the programmed status.

Charge configuration menu

Menu item	Description

SPEED
  NORMAL
 	
  FAST
  MEDIUM
  HIACCURACY
  SET-SPEED-EXACTLY
  SET-BY-RSLN
	Measurement speed (integration time) menu:
	  Select 1 PLC (power line cycle, 16.67 ms for 60 Hz, 20 ms for 50 Hz
	  and 400 Hz).
	  Select 0.01 PLC.
	  Select 0.1 PLC.
	  Select 10 PLC.
	  Set integration in PLC (0.01 to 10).
	  Optimizes the integration time for the selected resolution.
	Refer to "Integration time" in the *Model 6517B Electrometer Reference Manual*
	for detail.

FILTER
  AVERAGING
    TYPE
      NONE
      AVERAGING
      ADVANCED
 	
    AVERAGING-MODE
  MEDIAN
    DISABLE
    ENABLE
	Filter menu for setting the averaging and median filters:
	  Configure digital averaging filter:
	    Select type of average filter:
	      No average filtering performed.
	      Program a simple average filter (1 to 100 readings).
	      Program a simple average filter (1 to 100 readings) with noise tolerance
	        window (0 to 100% of range).
	    Select moving average or repeating average mode.
	  Configure the median filter:
	    Disable the median filter.
	    Enable median filter and specify rank (1 to 5).
	Refer to "Filters" in the *Model 6517B Electrometer Reference Manual* for detail.

RESOLUTION
  AUTO
  3.5, 4.5, 5.5, 6.5
	Resolution menu:
	  Default to resolution appropriate for the integration time.
	  Select a specific resolution.
	Refer to "Display resolution" in the *Model 6517B Electrometer Reference Manual* for detail.

AUTO-DISCHARGE	Enable or disable autodischarge. When enabled, autodischarge resets the charge reading to zero at the specified level. After the integrator resets, the charge measurement process restarts at zero.
	  OFF: Disable autodischarge. You can use zero check to reset the integrator.
	  ON: Enable autodischarge. You are prompted to enter the discharge level.
	  The charge reading resets every time the specified charge level is reached.
	  If you specify a level that exceeds the measurement range, the display
	  overflows before the integrator resets.

AUTORANGE	Select high or low autorange limits.
	  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 µC).
	Refer to "Measurement range" in the *Model 6517B Electrometer Reference Manual* for detail.

Relative humidity and temperature readings

With the appropriate equipment connected, the 6517B can measure relative humidity and external temperature. To view the humidity and external temperature readings on the front panel, select the NEXT display. An example of the display is shown in the following figure.

Figure 43: Relative humidity and external temperature display

These readings can also be included as data elements for the bus interfaces (GPIB and RS-232) and the buffer.

Relative humidity

The Keithley Instruments Model 6517-RH humidity probe measures relative humidity. This sensor plugs into the HUMIDITY connector on the rear panel of the 6517B. You can measure relative humidity from 0% to 100% using the Model 6517-RH.

To make relative humidity measurements:

1. Connect the 6517-RH humidity probe to the **HUMIDITY** connector on the rear panel.

2. On the front panel, press the **MENU** key.

3. Select the **GENERAL** menu. Press the **ENTER** key.

4. Select **A/D CONTROLS**. Press the **ENTER** key.

5. Select **DATA-STAMP**. Press the **ENTER** key.

6. Select **HUMIDITY**.

7. Use the **RANGE** keys to toggle relative humidity readings to **ON**. Press the **ENTER** key.

8. Press the **EXIT** key as needed to return to the measurement display.

External temperature

The Keithley Instruments Model 6517-TP temperature probe is a K-type thermocouple sensor that measures external temperature. This sensor plugs into the TEMP TYPE K connector on the rear panel of the 6517B. You can measure temperatures from –25 °C to 150 °C using the Model 6517-TP temperature probe.

Do not allow the exposed thermocouple sensor to come in contact with chassis ground or to a voltage potential. This causes erroneous readings. The thermocouple must be electrically insulated before attaching it to a device that is at chassis ground or has a voltage on it.

To make temperature measurements:

1. Connect the 6517-TP temperature probe to the **TEMP TYPE K** connector on the rear panel.
2. On the front panel, press the **MENU** key.
3. Select the **GENERAL** menu. Press the **ENTER** key.
4. Select **A/D CONTROLS**. Press the **ENTER** key.
5. Select **DATA-STAMP**. Press the **ENTER** key.
6. Select **TEMPERATURE**.
7. Use the **RANGE** keys to toggle temperature readings to **ON**. Press the **ENTER** key.
8. Press the **EXIT** key as needed to return to the measurement display.

To change the temperature units:

1. On the front panel, press the **MENU** key.
2. Select the **GENERAL** menu. Press the **ENTER** key.
3. Select the **DISPLAY** menu. Press the **ENTER** key.
4. Select **TEMP-UNITS**. Press the **ENTER** key.
5. Set the units to **°C**, **°F**, or **K**. This setting also affects the display of internal temperature measurements.
6. Press the **ENTER** key.

Internal scanning

You can use a 6517B with a scanner card, such as the Keithley Instruments Model 6521 or Model 6522, installed in the option slot. The following topics provide basic information for scanning internal channels. If the scanner card is not already installed, refer to the scanner card instruction manual.

For complete information on scanning, refer to the scanner card instruction documentation. The scanner card must be installed in the option slot to access the scan menus.

Configure internal scanner

To configure an internal scan:

1. Press the **CONFIG** key.

2. Press the **CARD** key. The scanning options are displayed.

3. Place the cursor on **INTERNAL**. Press the **ENTER** key.

4. Select **CHANNELS**. Press the **ENTER** key. The status (on or off) for each channel is displayed. **ON** indicates that the channel is included in the scan. **OFF** indicates that the channel is not included in the scan.

5. To change the status of the channels, place the cursor on each channel and press a **RANGE ▲** or ▼ key to select the status. Press the **ENTER** key.

6. Select **SCAN-MODE**. Press the **ENTER** key.

7. Select the **VOLTAGE** scan mode. This is the fastest scan mode and can be used when break-before-make switching is not required. Press the **ENTER** key.

8. Select **VSRC-LIMIT**. Press the **ENTER** key.

9. Select **YES** to enable the 200 V voltage source limit or **NO** to disable the limit. The ±200 V limit protects the scanner card. You can also set a voltage source limit (0 to ±1000 V) from the Configure V-Source menu.

10. Select **SETTLING-TIME**. Press the **ENTER** key.

11. Set a settling time (0 to 999.999 seconds) for each channel. Press the **ENTER** key.

12. Press the **EXIT** key to return to the main menu.

Perform an internal scan

To scan internal channels:

1. Set up the 6517B for the measurement.

2. Press **CARD** to display the internal scanner options (close channel or perform scan).

3. Select **PERFORM-SCAN** to display the scan types (internal or external).

4. Select **INTERNAL** to display the scan count; the scan count indicates the number of times the scan will be repeated.

5. Set the scan count. Press the **ENTER** key. The scan timer query is displayed. The scan timer adds a set amount of time between scans.

6. Select **YES** or **NO**.

7. If you selected YES, set the interval in seconds. Press the **ENTER** key. The data to memory prompt is displayed. This determines if scan data is stored in the reading buffer.

8. Select **YES** or **NO**.

9. If you selected **YES**, set the number of readings to store in the buffer. Press the **ENTER** key. The message `Press ENTER to begin` is displayed

10. Press the **ENTER** key to start the scan. The display shows the measurement and channel. If data is stored, the reading number is displayed. When the scan is complete, `SCAN COMPLETE` is displayed.

11. If data was stored in the buffer, select **RECALL-DATA** to review the data. Press the **ENTER** key. Use the **RANGE ▲** and **▼** keys to scroll through the data points.

12. To repeat the scan, select **SCAN-AGAIN**. Press the **ENTER** key.

13. To return to the normal measurement mode, press the **EXIT** key.

NOTE

You can use the **RECALL** key to display stored readings after you exit the scan menus.

Close and open channels

To open or close a channel on an internal scanner card:

1. Press the **CARD** key to display the internal scanner options.

2. Select **CHANNEL-CLOSURES**. Press the **ENTER** key.

3. To close a channel:

    a. Select **CLOSE-CHANNEL**. Press the **ENTER** key.

    b. Use the **RANGE ▲** and **▼** keys to display the channel. Press the **ENTER** key.

4. To open all channels on the scanner card, select **OPEN-ALL-CHANNELS**. Press the **ENTER** key.

External scanning

You can use the 6517B with a scanner card that is installed in an external scanning mainframe, such as the 7001 or 7002 Switch System. With the use of external triggering, the 6517B can measure and store each scanned channel. For complete information on scanning, refer to the switch system and scanner card documentation.

The following steps assume that the 6517B is set to the BENCH reset default conditions and the Model 7001 or 7002 is set to the RESET default conditions.

Trigger connections for external scanning

Connect the 6517B to the switch system as shown in the following figure. Refer to "Triggering" in the *Model 6517B Electrometer Reference Manual* for more information on using Trigger Link.

Figure 44: Trigger Link connections between 7001 or 7002 and 6517B
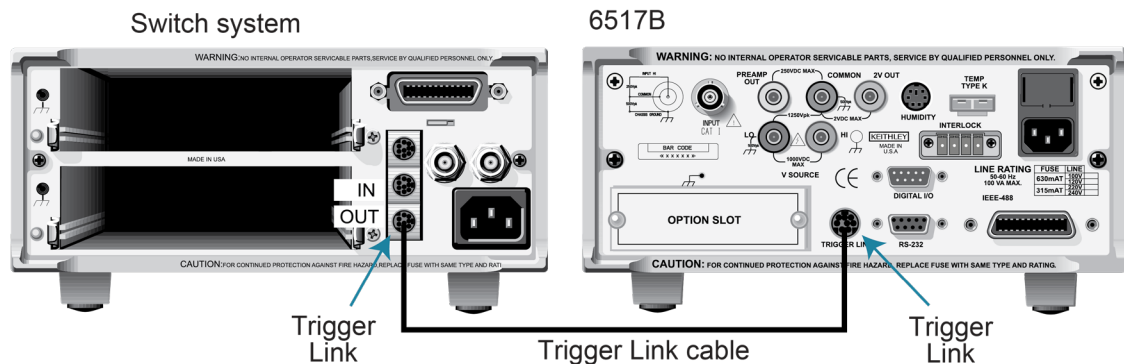
Configure external channels

To set up the scan, you specify the number of channels, or external inputs, for the scan. You can select from 1 to 400 channels.

You can set up the scan with or without a scanner card in the 6517B option slot.

To set up the scan with a scan board installed:

1. Press the **CONFIG** key.

2. Press the **CARD** key.

3. Select **EXTERNAL**. Press the **ENTER** key.

4. Enter the number of channels for the scan. Press the **ENTER** key to continue.

5. Press the **EXIT** key to return to the normal measurement display.

To set up the scan with no scan board installed:

1. Press the **CONFIG** key.

2. Press the **CARD** key.

3. Enter the number of channels for the scan. Press the **ENTER** key to continue.

Perform the scan

To scan external channels:

1. On the 6517B, press the **CARD** key.

2. If a scanner card is installed in the 6517B, select **PERFORM-SCAN**. Press the **ENTER** key.

3. Select **EXTERNAL**. Press the **ENTER** key. A message is displayed.

4. On the 7001 or 7002, perform reset:

    a. Press the **MENU** key.

    b. Select **SAVESETUP**.

    c. Select **RESET**. Press the **ENTER** key.

    d. Press the **ENTER** key.

    e. Press the **EXIT** key to leave the menu structure.

5. On the 7001 or 7002, press the **SCAN** key.

6. Select **SELECT-CONTROL > NUMBER-OF-CHANS > CHAN-COUNT > INFINITE**.

NOTE

Do not exit from the menu structure after selecting an infinite channel count.

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7. On the 6517B, press the **ENTER** key to display the next message.

8. Select the trigger source. If you are using the Trigger Link, select **TRIGLINK**. If you are using conventional external triggering, select **EXTERNAL**. Press the **ENTER** key.

9. On the 7001 or 7002, set channel spacing as follows. The message on the 6517B tells you which channel spacing option to select:

    a. Select **CHANNEL-SPACING**.

    b. Select **TRIGLINK** or **EXTERNAL**.

    c. Press the **EXIT** key to return to the main display.

10. On the 6517B, press the **ENTER** key.

11. Use the 7001 or 7002 to define the scan list.

12. On the 6517B, press the **ENTER** key to display `CONFIG EXT SCANNER; STEP scanner to first channel`.

13. On the 7001 or 7002, press **STEP** to close the first channel in the scan.

14. On the 6517B, press the **ENTER** key to display the scan count. Change the scan count as needed. The scan count specifies the number of scans to be performed. Press the **ENTER** key.

15. On the6517B, you can set a scan timer. The timer provides a time interval between each scan. If you select YES, enter the interval (in seconds). Press the **ENTER** key.

16. The DATA TO MEMORY prompt is displayed. If you select YES, message indicating the total number of readings to be stored in the buffer is displayed. Press the **ENTER** key to continue.

17. Press the **ENTER** key to start the scan process. The display shows the measurement and channel. If data is stored, the reading number is displayed. When the scan is complete, `SCAN COMPLETE` is displayed.

18. If data was stored in the buffer, select **RECALL-DATA** to review the data. Press the **ENTER** key. Use the **RANGE ▲** and ▼ keys to scroll through the data points.

19. To repeat the scan, select **SCAN-AGAIN**. Press the **ENTER** key.

20. To exit the scan, press the **EXIT** key.

NOTE

You can use the **RECALL** key to display stored readings after you exit the scan menus.

Maintenance

In this section:

Introduction

This section describes routine maintenance of the instrument that an operator can perform.

Line fuse

A fuse on the 6517B rear panel protects the power line input of the instrument. See the following instructions to replace the fuse. You do not need to return your instrument for service if the fuse is damaged.

⚠ WARNING

Disconnect the line cord at the rear panel and remove all test leads connected to the instrument before replacing a line fuse. Failure to do so could expose the operator to hazardous voltages that could result in personal injury or death.

Use only the correct fuse type. Failure to do so could result in injury, death, or instrument damage. If the instrument repeatedly blows fuses, locate and correct the cause of the problem before replacing the fuse. If the fuse continues to become damaged, return the instrument to Keithley Instruments for repair.

The powerline fuses for the 6517B are listed in the following table.

Fuse ratings

Line voltage	Fuse rating	Part number
100 V or 120 V	0.630 A, 250 V, slow blow, 5 mm × 20 mm	Keithley FU-106-.630
220 V or 240 V	0.315 A, 250 V slow blow, 5 mm × 20 mm	Keithley FU-106-.315

Line fuse replacement

To replace the line fuses:

1. Power off the instrument.

2. Remove all test leads connected to the instrument.

3. Remove the line cord.

4. Locate the fuse holder, which is on the rear panel above the ac receptacle.

5. Squeeze the tabs on the fuse holder, shown in the following figure, to release the fuse drawer.

Figure 45: Fuse tabs
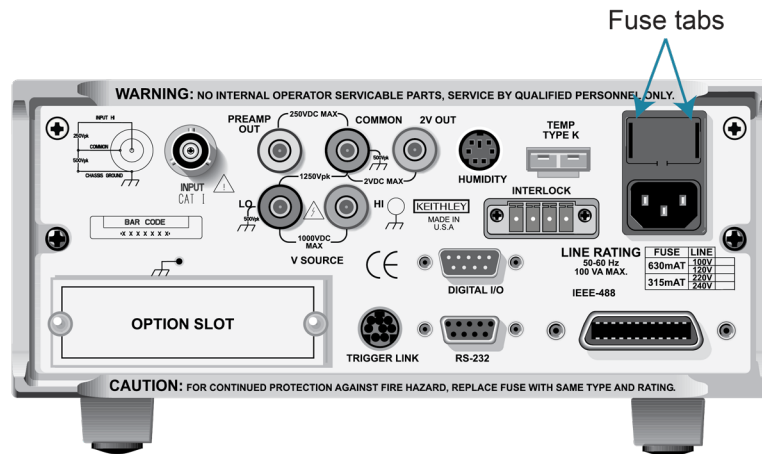
6. Slide the fuse drawer out.

7. Remove the damaged fuse from the drawer.

8. Replace the fuse with the same type. See Line fuse (on page 5-2, on page 5-1) for replacement part numbers.

9. Push the fuse drawer back into the power module. Make sure the tabs click into place.

Change the line voltage

Line voltage is preset at the factory, but may be reset in the field.

⚠ WARNING

If you change the line voltage, you also need to replace the line fuse. Use only the correct fuse type. Failure to do so could result in injury, death, or instrument damage.

To change the line voltage:

1. Remove the handle from the 6517B.

2. Use a Philips screwdriver to remove the left mounting ear (left when looking at the front panel of the 6517B).

3. Use a small coin to change the voltage setting.

4. Replace the mounting ear and handle.

5. Replace the line fuse. See Line fuse (on page 5-2, on page 5-1) for more information.

Upgrading the firmware

For instruction on upgrading the firmware, refer to the release notes for the firmware. Firmware and release notes are available on tek.com/keithley. Filter by **Software** to locate the firmware.

Status and error messages

During 6517B operation and programming, the instrument may display front-panel status and error messages. The messages are listed in the following table.

To momentarily display the most recent status or error message, press the **MENU** key and press the **PREV** display key. The display is blank if no message is queued.

Status and error messages

Number	Description	Event
−440	Query UNTERMINATED after indefinite response	EE
−430	Query DEADLOCKED	EE
−420	Query UNTERMINATED	EE
−410	Query INTERRUPTED	EE
−363	Input buffer overrun	EE
−350	Queue overflow	EE
−330	Self test failed	EE
−314	Save/recall memory lost	EE

Number	Description	Event
−285	Program syntax error	EE
−284	Program currently running	EE
−282	Illegal program name	EE
−281	Cannot create program	EE
−260	Expression error	EE
−259	Expression error	EE
−241	Hardware missing	EE
−230	Data corrupt or stale	EE
−225	Out of memory	EE
−224	Illegal parameter value	EE
−223	Too much data	EE
−222	Parameter data out of range	EE
−221	Settings conflict	EE
−220	Parameter error	EE
−215	Arm deadlock	EE
−214	Trigger deadlock	EE
−213	Init ignored	EE
−212	Arm ignored	EE
−211	Trigger ignored	EE
−210	Trigger error	EE
−203	Command protected	EE
−202	Settings lost due to rtl	EE
−201	Invalid while in local	EE
−200	Execution error	EE
−178	Expression data not allowed	EE
−171	Invalid expression	EE
−170	Expression error	EE
−168	Block data not allowed	EE
−161	Invalid block data	EE
−160	Block data error	EE
−158	String data not allowed	EE
−154	String too long	EE
−151	Invalid string data	EE
−150	String data error	EE
−148	Character data not allowed	EE
−144	Character data too long	EE
−141	Invalid character data	EE
−140	Character data error	EE
−128	Numeric data not allowed	EE
−124	Too many digits in number	EE
−123	Exponent too large	EE
−121	Invalid character in number	EE
−120	Numeric data error	EE
−114	Header suffix out of range	EE
−113	Undefined header	EE
−112	Program mnemonic too long	EE

Number	Description	Event
−111	Command header separator error	EE
−110	Command header error	EE
−109	Missing parameter	EE
−108	Parameter not allowed	EE
−105	GET not allowed.	EE
−104	Data Type Error	EE
−103	Invalid Separator	EE
−102	Syntax Error	EE
−101	Invalid Character	EE
−100	Command Error	EE
000	No Error	SE
+101	Operation complete	SE
+121	Device calibrating	SE
+122	Device settling	SE
+123	Device ranging	SE
+124	Device sweeping	SE
+125	Device measuring	SE
+126	Device calculating	SE
+161	Program running	SE
+171	Waiting in trigger Layer	SE
+172	Waiting in arm layer 1	SE
+173	Waiting in arm layer 2	SE
+174	Re-entering the idle layer	SE
+301	Reading overflow	SE
+302	Low limit 1 event	SE
+303	High limit 1 event	SE
+304	Low limit 2 event	SE
+305	High limit 2 event	SE
+306	Reading available	SE
+307	Voltmeter Complete	SE
+308	Buffer Available	SE
+309	Buffer half-full	SE
+310	Buffer full	SE
+311	Buffer Overflow	SE
+312	Buffer Pretriggered	SE
+313	Reading out of Limit	SE
+314	8009 fixture lid open	SE
+315	Voltage source compliance detected	SE
+320	Buffer and format element mismatch	EE
+321	Buffer sizing error; set to maximum	EE
+322	Buffer sizing error; set to minimum	EE
+350 to +427	Calibration commands, refer to "Calibration error codes" in the *Model 6517B Electrometer Reference Manual*	
+510	Reading buffer data lost	EE
+511	GPIB address lost	EE
+512	Power-on state lost	EE

Number	Description	Event
+513	Calibration data lost	EE
+514	DC calibration data lost	EE
+515	Calibration dates lost	
+516	Calibration tables lost	EE
+517	Voltage offset lost	EE
+518	Current offset lost	EE
+519	Installed option id lost	EE
+520	Option card not supported	EE
+521	Cal Card Data Error	EE
+522	GPIB communication language lost	EE
+610	Questionable calibration	SE
+611	Questionable temperature	SE
+612	Questionable humidity	SE
+613	Questionable voltage	SE
+614	Questionable current	SE
+615	Questionable ohms	SE
+616	Questionable charge	SE
+617	Questionable test sequence	SE
+618	Resistivity: Current out of limit	EE
+700	Low battery detected	EE
+800	RS-232 framing error detected	EE
+801	RS-232 parity error detected	EE
+802	RS-232 overrun detected	EE
+803	RS-232 break detected	EE
+804	RS-232 noise detected	EE
+805	Invalid system communication	EE
+806	RS-232 settings lost	EE
+807	RS-232 OFLO: Characters Lost	EE
+808	ASCII only with RS-232	EE
+809	Not allowed with RS-232	EE
+850	Invalid test sequence setting	EE
+851	Test sequence running	SE
+860	Interlock violation error	EE
+861	Voltage source limit too low for autoohms	EE
+900	Internal system error	EE
SE = Status event EE = Error event		

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