

KEITHLEY

Model 5156 Electrometer Calibration Standard Instruction Manual

A GREATER MEASURE OF CONFIDENCE



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Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

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Model 5156 Electrometer Calibration Standard Instruction Manual

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

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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 non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified 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 manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product 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 manual. 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, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

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 30V RMS, 42.4V peak, or 60VDC 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 volts, **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, make sure 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.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

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

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

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth 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  or  is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

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

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage 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 Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. 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 Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth 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., 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.

Specifications

STANDARD SPECIFICATION

Nominal Value of Standard	Accuracy of Characterization ppm	Temperature Coefficient ppm/°C	Voltage Coefficient ppm/Volt	Nominal Tolerance ± %
100 MΩ	200	<25	<1	2
1 GΩ	300	<25	<1	2
10 GΩ	400	<25	<1	2
100 GΩ	500	<100	<1	2
1 nF	1000	<120	<5	5
100 nF	1000	<120	<5	5

STABILITY (ppm/Yr. Max.)

100 MΩ	200
1 GΩ	500
10 GΩ	500
100 GΩ	800
1 nF	1000
100 nF	1000

GENERAL

DATA PORT: For downloading of 5156 characterized data to 6517 Electrometer.

MAX. INPUT VOLTAGE: 200V peak.

CONNECTORS: One 3-Lug Triax for meter, Six BNC's for Calibrator connection.

ENVIRONMENT:

Operating: 23°C ±3°C, 30–60% R.H. non-condensing.

TEMPERATURE STABILIZATION: 4 hours in Environment.

PHYSICAL:

Case Dimensions: 114mm high × 165mm wide × 184mm deep
(4.5 in × 6.5 in × 7.2 in).

Net Weight: <1.7kg (<3.8 lb).

Shipping Weight: <4.1kg (<9 lb).

ACCESSORIES SUPPLIED:

Certificate of Calibration.

Charge Filter.

7078-TRX-3 3-Lug Triax Cable.

8501-1 Data Transfer Cable.

Operators Manual.

Specifications subject to change without notice.

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General Information

Introduction

This section contains general information about the Model 5156 Electrometer Calibration Standard. The Model 5156 contains precision resistance and capacitance standards and is intended for use with voltage calibrators to calibrate or verify the current and charge measurement accuracy of sensitive instruments such as the Model 6517 Electrometer. The unit may also be used in applications requiring accurate resistance standards.

Features

Model 5156 features include:

- Highly stable, characterized standard resistors and capacitors ensure verification and calibration integrity. Characterization data is supplied with the unit.
- Internal memory stores standards values to simplify calibrating the Model 6517 Electrometer.
- Triax and BNC connectors simplify connections to the desired standard.
- Supplied charge filter minimizes the effects of rapid voltage calibrator signal rise times.

Manual addenda

Any improvements or changes concerning the calibration standard or manual will be explained in an addendum. Be sure to note these changes and update this document accordingly before using the unit.

Safety symbols and terms

The following symbols and terms may be found on an instrument or used in this manual.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the instruction manual.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the calibration standard. Such damage may invalidate the warranty.

Specifications

Model 5156 specifications are located at the front of this document.

Unpacking and inspection

Inspection for damage

Upon receiving the Model 5156, carefully inspect it for any signs of obvious physical damage. Report any such damage to the shipping agent immediately.

Handling precautions

When handling the calibration standard, take care not to touch the connector insulators as doing so could degrade performance. Leave the protective caps on the connectors when the unit is not being used.

Shipment contents

The following items are included with every Model 5156 order:

- Model 5156 Electrometer Calibration Standard
- Charge filter
- Model 7078-TRX-3 triax connecting cable
- Model 8501-1 data transfer cable
- Additional accessories as ordered

Documentation

If an additional copy of this document is required, order the complete package, Keithley part number 5156-901-00. The package includes an instruction manual and any pertinent addenda.

Repacking for shipment

When returning the Model 5156 for calibration or repair, carefully pack the unit in its original packing carton or the equivalent, and include the following information:

- Call the Repair Department at 1-800-552-1115 for a Return Material Authorization (RMA) number.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.
- Advise as to the warranty status of the unit.
- Fill out and include the service form located at the back of this manual.

Optional accessories

The following optional accessories are recommended for use with the Model 5156.

Model 4851 BNC Shorting Plug: Shorts HI and LO terminals of Model 5156 BNC jacks when using the unit as a resistance or capacitance standard.

Model 6171 3-Slot Male to 2-Lug Female Triax Adapter: Allows connection of 2-slot triax cables to the Model 5156 triax OUTPUT jack.

Model 7051 BNC Cables: BNC to BNC cables (RG-58C), available in 0.6m (2 ft.), 1.5m (5 ft.), and 3.0m (10 ft.) lengths as Models 7051-2, 7051-5, and 7051-10 respectively. Useful for connecting equipment such as voltage calibrators to the Model 5156 BNC jacks.

Model 7078 Triax Cables: Low-noise triax cables terminated with male 3-slot triax connectors, available in 0.9m (3 ft.), 3.0m (10 ft.), and 6.0m (20 ft.) lengths as Models 7078-3, 7078-10, and 7078-20 respectively. Use to connect equipment to the Model 5156 triax OUTPUT jack.

2

Operation

Introduction

This section contains detailed information on Model 5156 operation, including connections when using the unit as a current, charge, resistance, and capacitance standard.

WARNING

The procedures in this section are intended only for qualified service personnel. Some of these procedures may expose you to potentially lethal voltages.

Definition of a standard

A standard is a component whose value has been accurately measured and whose stability (variation in value over time) can be accurately predicted. Generally, such standards are measured by equipment with uncertainty that is traceable to NIST (National Institute of Standards and Technology) standard values.

Model 5156 specifications stated at the front of this document take into account both the measured value and the stability of each component resistor or capacitor.

Panel familiarization

Top panel

Figure 2-1 shows the top panel of the Model 5156. The various components include:

BNC Standard Jacks: Each of the four standard resistors and two standard capacitors is connected to its own individual BNC jack. When used as a current or charge standard, a DC voltage calibrator is connected to the appropriate jack. When used as a resistance standard, a BNC shorting plug is connected to the appropriate jack. Note that each standard is connected to the center conductor, while the shell of each jack is connected to chassis ground.

OUTPUT Jack: This 3-lug triax jack is normally connected to the input of the instrument being tested. The center conductor is internally connected to each of the resistance and capacitance standards, the inner ring is connected to SHIELD, and the outer ring is at chassis ground.

WARNING

To assure proper safety grounding, always connect the OUTPUT jack to the electrometer INPUT jack before applying voltage to the Model 5156.

CAUTION

Do not exceed 200V peak maximum input voltage.

Characterization Value Label: A label that contains the characterized values of the standard resistors and capacitors is affixed to the top panel.

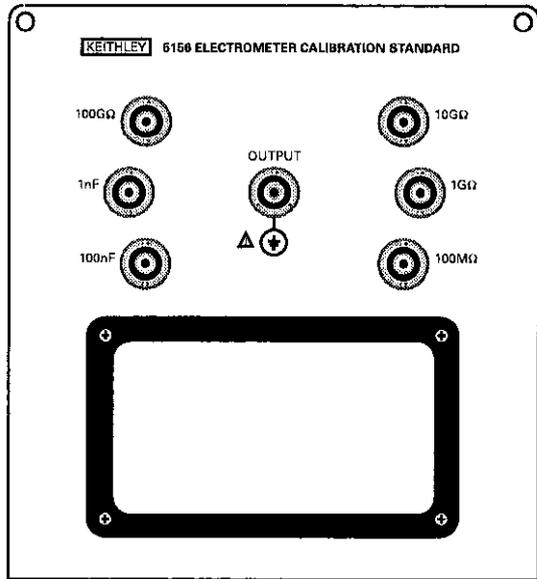


Figure 2-1
Top panel

Front panel

Figure 2-2 shows the front panel. Various components include:

SHIELD: This jack is internally connected to the inner conductor of the triax OUTPUT jack.

CHASSIS: This jack is connected to Model 5156 chassis.

NOTE

For all operating modes except guarded ohms, SHIELD and CHASSIS must be jumpered together using the supplied shorting link. (See *Resistance standard operation* later in this section for details on guarded ohms connections.)

TO 6517 DIGITAL I/O Jack: This DIN jack connects the unit to the Model 6517 Electrometer when calibrating that instrument. Use the supplied data transfer cable to make the connection.

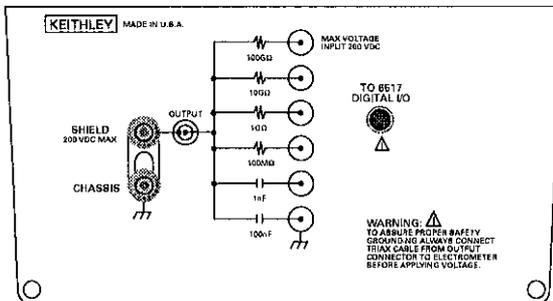


Figure 2-2
Front panel

Charge filter

Figure 2-3 shows the configuration of the supplied charge filter. The purpose of the filter is to minimize the effects of rapid voltage calibrator rise times that would otherwise affect charge measurements.

To use the charge filter, connect the OUTPUT jack to the 1nF or 100nF BNC jack of the Model 5156, and connect the INPUT jack to the DC voltage calibrator using a suitable BNC cable. Note that the charge filter should be used only for



Figure 2-3
Charge filter

charge measurements and should not be connected when the Model 5156 is being used as a current, resistance, or capacitance standard.

Figure 2-4 shows a schematic of the charge filter, which is a simple RC network that forms a single-pole, low-pass filter.

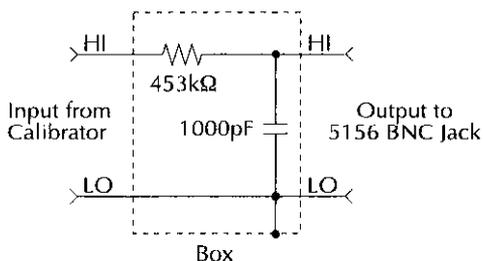


Figure 2-4
Charge filter schematic

Test considerations

- Use the Model 5156 at an ambient temperature of $23^{\circ} \pm 3^{\circ}\text{C}$.
- Do not touch triax or BNC jack insulators. If the insulators become contaminated, they should be carefully cleaned as covered in Section 3.
- Keep caps on connecting jacks when not in use.
- Use only quality connecting cables, and keep cables as short as possible.
- Do not flex or vibrate cables while making measurements.
- Perform all tests at a stable ambient temperature and humidity recommended by equipment manufacturers.

Recommended voltage calibrators

A DC voltage calibrator is required when using the Model 5156 as a current or charge standard. Table 2-1 summarizes recommended calibrators.

Table 2-1
Recommended voltage calibrators

Manufacturer and Model	Uncertainty	Typical voltages
Fluke 5700A	10-15ppm	0.2V, 2V, 20V, 200V
Datron 4800	10-15ppm	0.2V, 2V, 20V, 200V

Current standard operation

Current connections

Figure 2-5 shows connections for operation as a current standard. When making connections:

- Connect the Model 5156 OUTPUT jack to the INPUT jack of the instrument being tested using a suitable triax cable.

WARNING

To assure proper grounding, connect the Model 5156 OUTPUT jack to the instrument INPUT jack before applying voltages to the standard.

- Connect the appropriate resistance standard jack to the DC voltage calibrator using a BNC cable and adapter.
- Be sure that the Model 5156 SHIELD and CHASSIS jacks on the front panel are connected together.

CAUTION

Do not apply more than 200V peak to the Model 5156.

Current calculations

The generated current value may be calculated from the standard resistance and calibrator voltage as follows:

$$I = V/R$$

Where: I = generated current.
 V = calibrator voltage.
 R = resistance standard value.

Example: Assume that the calibrator voltage is 20V, and that the actual value of the 10GΩ resistor is 9.9GΩ. The generated current is:

$$I = 20V/9.9G\Omega$$

$$I = 2.020202nA$$

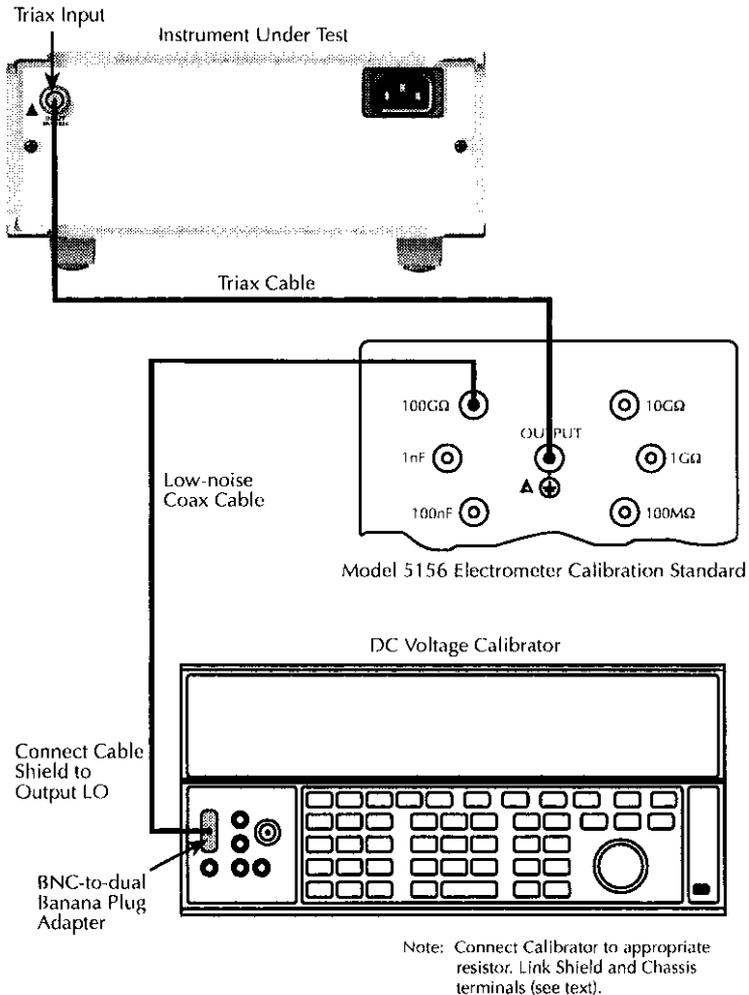


Figure 2-5
Current standard connections

Typical calibrator voltages

Table 2-2 summarizes typical calibrator voltages, resistance standards used, and the resulting currents. Currents are based on nominal resistance values.

Table 2-2

Typical calibrator voltages for current standard operation

Nominal current	Calibrator voltage	Standard resistance
2pA	0.2V	100G Ω
20pA	2V	100G Ω
200pA	2V	10G Ω
2nA	2V	1G Ω
20nA	20V	1G Ω
200nA	20V	100M Ω
2 μ A	200V	100M Ω

Charge standard operation

Charge connections

Figure 2-6 shows connections for operation as a charge standard. When making connections, be sure to:

- Connect the Model 5156 OUTPUT jack to the INPUT jack of the instrument being tested using a suitable triax cable.

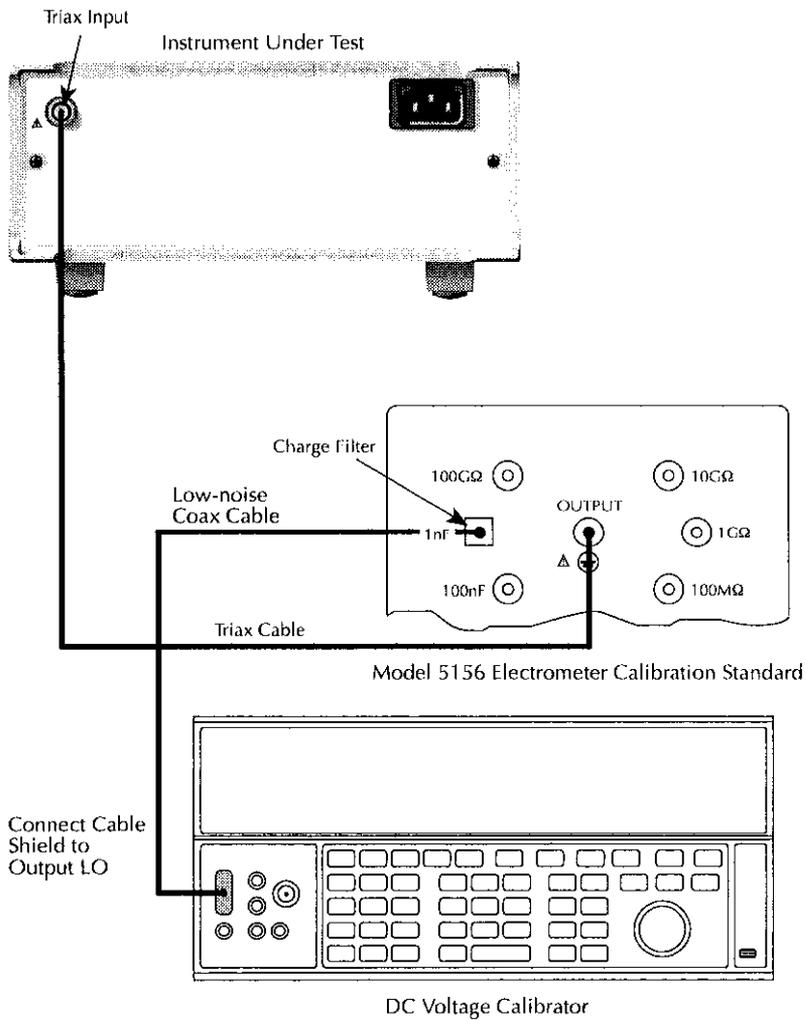
WARNING

To assure proper grounding, connect the Model 5156 OUTPUT jack to the instrument INPUT jack before applying voltages to the standard.

- Connect the charge filter OUTPUT jack to the BNC jack of the capacitance standard being used.
- Connect the charge filter INPUT jack to the DC voltage calibrator using a BNC cable and adapter.
- Be sure that the Model 5156 SHIELD and CHASSIS jacks on the front panel are connected together.

CAUTION

Do not apply more than 200V peak to the charge filter or the Model 5156.



Note: Connect voltage calibrator to appropriate capacitor through charge filter. Be sure Shield to Chassis link is connected (see text).

Figure 2-6
Charge standard connections

Charge calculations

The generated charge value may be calculated from the standard capacitance and calibrator voltage as follows:

$$Q = CV$$

Where: Q = generated charge.
V = calibrator voltage.
C = capacitance standard value.

Example: Assume that the calibrator voltage is 2V, and that the actual value of the 100nF capacitor is 101.3nF. The generated charge is:

$$Q = 2V \times 101.3nF$$
$$Q = 202.6nC$$

Typical calibrator voltages

Table 2-3 summarizes typical calibrator voltages, capacitance standards used, and the resulting charge values, which are based on nominal capacitance values.

Table 2-3
Typical calibrator voltages for charge standard operation

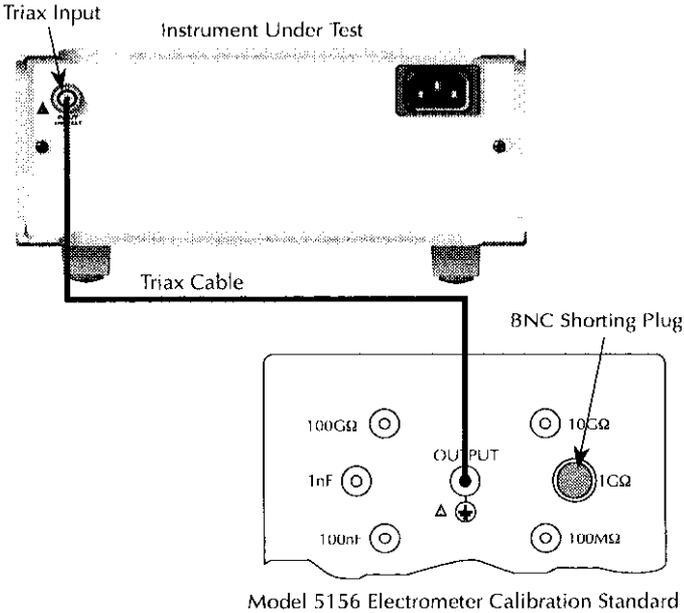
Nominal current	Calibrator voltage	Standard capacitor
2nC	2V	1nF
20nC	20V	1nF
200nC	2V	100nF
2μC	20V	100nF

Resistance standard operation

Unguarded operation

Figure 2-7 shows unguarded connections when using the Model 5156 as a resistance standard. When making connections:

- Connect the Model 5156 OUTPUT jack to the instrument INPUT jack using a suitable triax cable.
- Connect the Model 4851 BNC Shorting Plug to the BNC jack associated with the desired resistance standard.
- Be sure the SHIELD and CHASSIS jacks on the front panel are connected together.



Note: Connect BNC shorting plug to appropriate resistor. Link Chassis and Shield (see text).

Figure 2-7
Unguarded resistance connections

Guarded operation

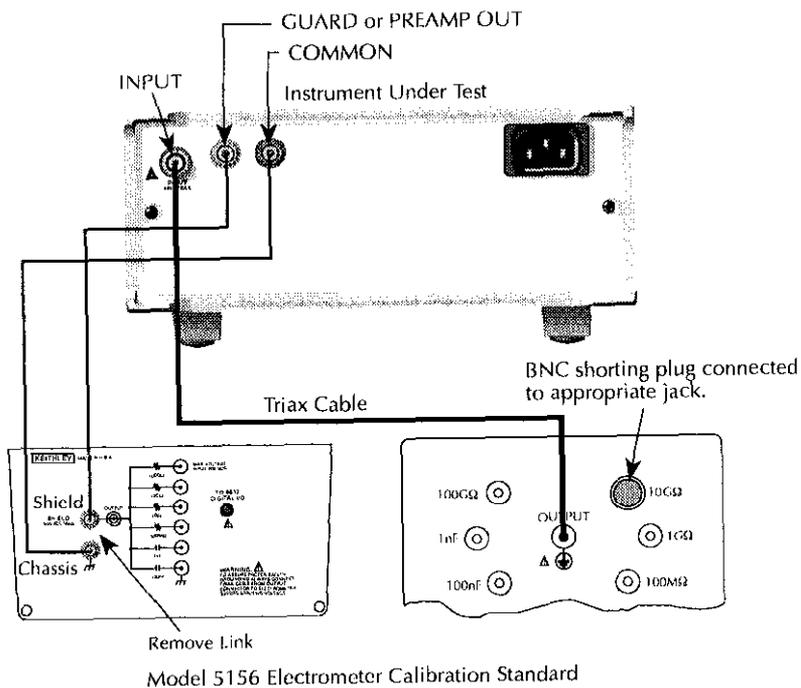
Guarded connections are recommended for resistances $10G\Omega$ and above, and only when using the Model 5156 as a resistance standard to test instruments that measure resistance using the source current, measure voltage resistance measurement method. Guarding is neither required nor recommended when used with instruments that use the source voltage, measure current resistance measurement method, such as the Model 6517 Electrometer.

Figure 2-8 shows guarded resistance connections. When making connections:

- Connect the Model 5156 OUTPUT jack to the instrument INPUT jack using a suitable triax cable.
- Connect the Model 4851 BNC Shorting Plug to the BNC jack associated with the desired resistance standard.
- Remove the link between the SHIELD and CHASSIS jacks.
- If instrument common is not connected to chassis ground, connect the Model 5156 CHASSIS jack to the instrument common input terminal.
- If the test instrument does not automatically apply the guard signal to the inner shield of the triax connecting cable, connect the Model 5156 SHIELD jack to the guard or preamp output terminal of the test instrument.

WARNING

Hazardous voltage may be present on the Model 5156 SHIELD and OUTPUT jacks when using guarding.



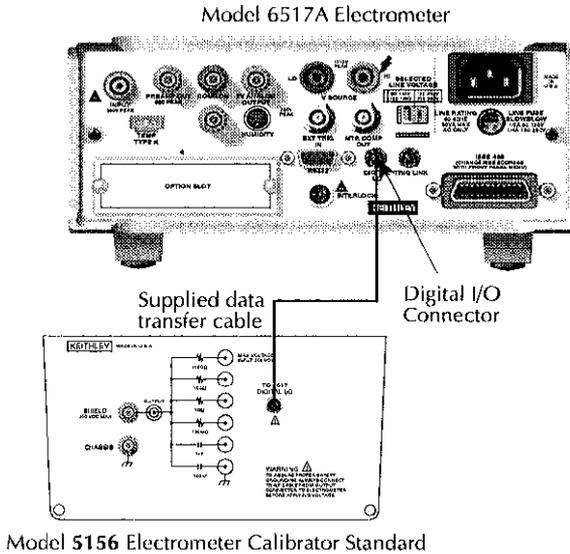
WARNING: Hazardous voltages may be present on SHIELD and OUTPUT.

Figure 2-8
Guarded resistance connections

Calibrating/verifying the Model 6517A Electrometer

The Model 5156 was designed primarily to aid in calibrating and verifying the accuracy of the Model 6517A Electrometer. In order to calibrate the Model 6517A, the Model 5156 must be connected to the DIGITAL I/O jack of the electrometer as shown in Figure 2-9.

For detailed information on using the Model 5156 for Model 6517A verification and calibration, refer to the Model 6517A Calibration Manual.



Note: Make connections with power off.

Figure 2-9
Digital I/O connections

3

Maintenance

Introduction

This section contains information on connector cleaning, standards characterization, and factory service.

Connector cleaning

Connector insulators must be kept clean and free of contamination, or performance of the calibration standard may be degraded. Should connectors become contaminated through touching, or from air-borne deposits, they may be cleaned with a lint-free swab dipped in clean methanol. Once all contamination is removed, allow the unit to dry for several hours in a 50°C, low-humidity environment before use.

Factory characterization

Model 5156 resistance and capacitance standards should be characterized at least once a year to ensure calibration integrity. Because of the difficulty in obtaining test equipment with sufficient accuracy, it is strongly recommended that the unit be returned to the factory for characterization. See *Factory service* below for information on returning the unit for calibration or repair

User characterization

Those who wish to characterize the Model 5156 can do so using appropriate test equipment. Procedures and choice of test equipment are left up to the technician.

NOTE

Test equipment certainty should be at least four times better than equivalent Model 5156 specifications.

See Section 2 for information on test connections.

Updating standards values

Once resistance and capacitance values have been accurately measured, the values stored in Model 5156 NVRAM must be updated. To do so, connect the Model 5156 to the DIGITAL I/O port of the Model 6517 Electrometer (see Figure 2-8 in Section 2), then perform the appropriate procedure outlined below.

Front panel

To update standard values from the front panel, proceed as follows:

1. Press the MENU key, then choose the CAL/CAL-OPT/EDIT-CONST selection.
2. Enter the password (default = 5156), then follow the prompts on the display to enter new standard values. (Use the up range key to scroll through numbers, or use the down range key to scroll through letters.)
3. Save the new values, then press the EXIT key to return to normal display.

IEEE-488 bus

Table 3-1 summarizes Model 6517 bus commands. Follow the steps below to program new standards values:

1. Send the following command to unlock Model 5156 calibration using the password:

```
:CAL:UNPR:CARD:UNL '<Password>'
```

For example, the following command sends the default password:

```
:CAL:UNPR:CARD:UNL '5156'
```

2. Send the appropriate commands from Table 3-1 to program each standard value. For example, the following command would program a 101M Ω resistor value:

```
CAL:UNPR:CARD:R100M 101E6
```

3. Program the calibration date and due date using the following commands:

```
:CAL:UNPR:CARD:DATE <year>,<month>,<date>
```

```
:CAL:UNPR:CARD:NDUE <year>,<month>,<date>
```

4. Save new standard values and dates with the following command:

:CAL:UNPR:CARD:SAVE

5. Lock out the NVRAM from further modification by sending the following command:

:CAL:UNPR:CARD:LOCK

Table 3-1

Calibration commands

Command	Description
<p>CALibration: UNProtected: OPTion?</p> <p>CARD:</p> <p>R100M < Nrf > R100M? R1G < Nrf > R1G? R10G < Nrf > R10G? R100G < Nrf > R100G? C1000P < Nrf ></p> <p>C1000P? C100N < Nrf > C100N? DATE <Year>,<Month>,<Date></p> <p>DATE? NDUE <Year>,<Month>,<Date></p> <p>NDUE?</p>	<p>Calibration root command. Unprotected subsystem. Returns "5156-CALOPTION" if a Model 5156 is connected, or "0" if not. These commands control the Model 5156. Send 100MΩ resistor value. * Request 100MΩ resistor value Send 1GΩ resistor value. * Request 1GΩ resistor value. Send 10GΩ resistor value. * Request 10GΩ resistor value. Send 100GΩ resistor value. * Request 100GΩ resistor value. Send 1000pF (1nF) capacitor value. * Request 1000pF capacitor value. Send 100nF capacitor value. * Request 100nF capacitor value. Program cal date (Year = 1994-2093). * Request cal date. Program due date (Year = 1994-2093). * Request due date.</p>

Table 3-1 (cont.)
Calibration commands

Command	Description
<p>PASSword '<Password>'</p>	<p>Send a new password; up to 7 characters. Valid characters: "0123456789+-ABCDEFGHIJKLMNOPQRSTUVWXYZ"; all lower-case letters are converted to upper-case. **</p>
<p>UNLock '< Password>'</p>	<p>Unlock the save ability. The correct password must be sent to unlock the save ability. (Default = 5156) ***</p>
<p>LOCK</p>	<p>Relock the NVRAM; requires a new password before any saves can be made.</p>
<p>LOCK? SAVE</p>	<p>Returns: 0 = locked; 1 = unlocked. Saves all cal constants, dates, and new password in 5156 NVRAM. *</p>

* These commands cannot be executed until a successful UNLock command with the correct password has been received.

** Note that the new password will not take effect until after the execution of a successful SAVE command.

*** Note that the following error will occur if an incorrect password is sent: +428, "Incorrect password received".

Viewing characterized values

To view standards values from the front panel, select the CAL/CAL-OPT/VIEW-CONST selection, then select the desired standard value to display.

To request values over the bus, simply send the appropriate command. For example, to request the value of the 10GΩ constant, send the following:

```
:CAL:UNPR:CARD:R10G?
```

Replaceable parts

The Model 5156 has no user-serviceable parts and must be returned to the factory for repair. See *Factory service* below for details on returning the unit.

Factory service

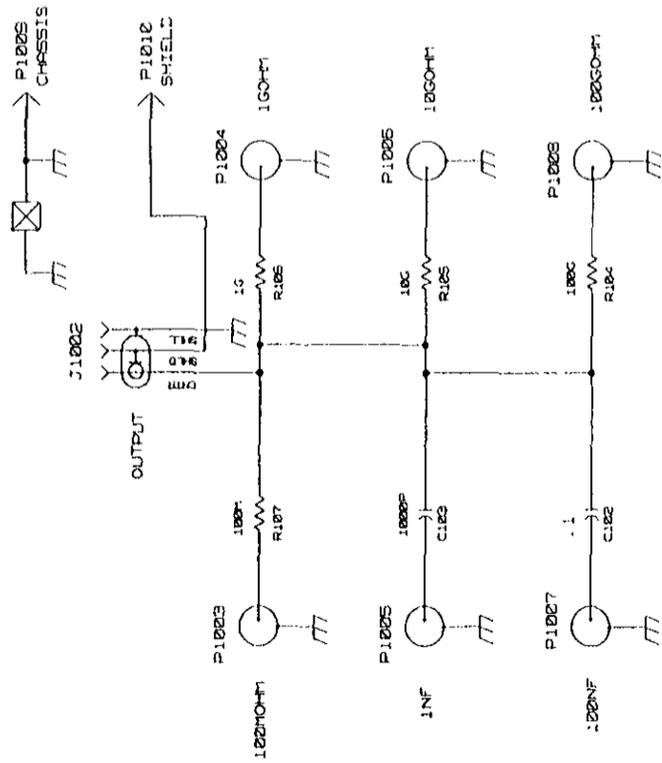
When returning the Model 5156 for characterization or repair, carefully pack the unit in its original packing carton or the equivalent, and include the following information:

- Call the Repair Department at 1-800-552-1115 for a Return Material Authorization (RMA) number.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.
- Advise as to the warranty status of the unit.
- Fill out and include the service form located at the back of this manual. Be sure to indicate the type of service required.

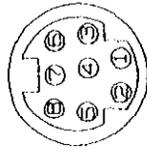
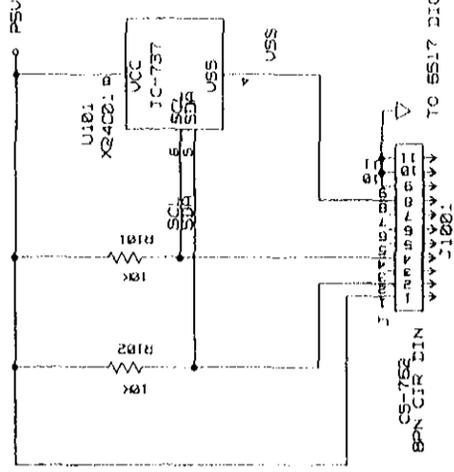
Schematic diagram

A schematic diagram of the Model 5156 is located at the end of this section.

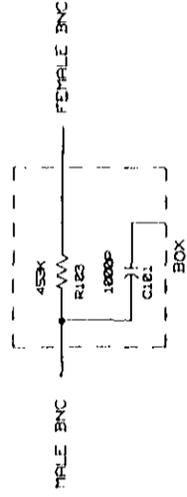
STANDARDS



MEMORY



CHARGE FILTER



DRAWING
S156-105
S156

LAST MODIFIED-Tue Sep 27 12:33:00 1994

KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	
TITLE	S156 TEST SCHEMATIC
MODEL	S155 B NO S156-105
DRAWN	KEK
APP	RV
ECO	940928
REV	A
DATE	9/8/94

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Service Form

Model No. _____ Serial No. _____ Date _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

- | | | |
|--|--|--|
| <input type="checkbox"/> Intermittent | <input type="checkbox"/> Analog output follows display | <input type="checkbox"/> Particular range or function bad; specify |
| <input type="checkbox"/> IEEE failure | <input type="checkbox"/> Obvious problem on power-up | <input type="checkbox"/> Batteries and fuses are OK |
| <input type="checkbox"/> Front panel operational | <input type="checkbox"/> All ranges or functions are bad | <input type="checkbox"/> Checked all cables |

Display or output (check one)

- | | |
|---|--|
| <input type="checkbox"/> Drifts | <input type="checkbox"/> Unable to zero |
| <input type="checkbox"/> Unstable | <input type="checkbox"/> Will not read applied input |
| <input type="checkbox"/> Overload | |
| <input type="checkbox"/> Calibration only | <input type="checkbox"/> Certificate of calibration required |
| <input type="checkbox"/> Data required | |

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.) _____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.) _____

Be sure to include your name and phone number on this service form.

Specifications are subject to change without notice.

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