

Keysight 16089A, B, C, D Kelvin/Alligator Clip Leads

Operation and
Service Manual



Notices

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Safety Notices

CAUTION

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

WARNING

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

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS given elsewhere in this manual may impair the protection provided by the equipment. Such noncompliance would also violate safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these precautions.

- DO NOT Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of inflammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a safety hazard.

- Keep Away from Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltage levels may remain even after the power cable has been disconnected. To avoid injuries, always disconnect the power and discharge circuits before touching them.

- DO NOT Service or Adjust the Instrument Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

- DO NOT Substitute Parts or Modify the Instrument.

To avoid the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument. Return the instrument to a Keysight Technologies Sales and Service Office for service and repair to ensure that safety features are maintained in operational condition.

- Dangerous Procedure Warnings.

Warning, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages level, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting this instrument.

Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution's calibration facility, or to the calibration facilities of other International Standards Organization members.

Warranty

This Keysight Technologies instrument product is warranted against defects in material and workmanship for a period of one year from the date of shipment, except that in the case of certain components listed in ***Instrument Specifications*** of this manual, the warranty shall be for the specified period. During the warranty period, Keysight Technologies will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Keysight Technologies. The Buyer shall prepay shipping charges to Keysight Technologies and Keysight Technologies shall pay shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Keysight Technologies from another country.

Keysight Technologies warrants that its software and firmware designated by Keysight Technologies for use with an instrument will execute its programming instruction when properly installed on that instrument. Keysight Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

No other warranty is expressed or implied. Keysight Technologies specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

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The remedies provided herein are Buyer's sole and exclusive remedies. Keysight Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.










Assistance

Product maintenance agreements and other customer assistance agreements are available for Keysight Technologies products.

For any assistance, contact your nearest Keysight Technologies Sales and Service Office.

Safety Symbols

General definitions of safety symbols used on the instrument or in manuals.

-  Instruction Manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instrument manual in order to protect against damage to the instrument.
-  Alternating current.
-  Direct current.
-  On (Supply).
-  Off (Supply).
-  In-position of push-button switch.
-  Out-position of push-button switch.
-  A chassis terminal: a connection to the instrument's chassis, which includes all exposed metal structure.
-  Standby.

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1 General Information

Introduction

The purpose of this manual is to enable you to use your Keysight 16089A, B, C, Kelvin Clip Leads and Keysight 16089D Alligator Clip Leads efficiently and confidently. This manual contains both general and specific information. To use the 16089A, B, C, D to perform a specific function (without having to read the entire manual), follow the directions in "**Using the 16089A, B, C, D**".

Using the 16089A, B, C, D

The 16089A, B, C, D has been designed to operate specifically with the LCR Meter.

- To install the 16089A, B, C, D, turn to **Chapter 2**.
- To operate the 16089A, B, C, D, turn to **Chapter 3**.
- To order replaceable parts for the 16089A, B, C, D, turn to "**Replaceable Parts**" in **Chapter 4**.

Product Description

The 16089A, B, C, D has been designed to operate specifically with the following four-terminal-pair type LCR meters and impedance analyzers.

The 16089A, B, C, D make it possible to measure odd-shaped components that cannot be measured with conventional test fixtures. The 16089A, 16089B, and 16089C consist of a direct attachment, four-terminal-pair type test leads that are equipped with two insulated Kelvin clips. Three sizes of Kelvin clips are provided. The 16089A Kelvin Clip Leads is equipped with two large Kelvin clips, the 16089B Kelvin Clip Leads is equipped with middle size clips and the 16089C Kelvin Clip Leads is equipped with small size clips. The 16089D consist of a direct attachment, four-terminal-pair type test leads that are equipped with four alligator clips.

Accessories Supplied

The following accessories are supplied with the 16089A, B, C, D:

Table 1-1

Furnished Accessories

Description	Part Number	Quantity
Operation and Service Manual	This manual	1

Operating and Safety Precautions

Operating

You need to observe only normal precautions in handling and operating the 16089A, B, C, D. Do not exceed the operating input power, voltage, and current level and signal type appropriate for the instrument being used, refer to your instrument's operation manual.

CAUTION

Electrostatic discharge (ESD) can damage the highly sensitive microcircuits in your instrument. ESD damage is most likely to occur as the test leads are being connected or disconnected. Protect them from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any static charge built-up by touching the outer shell of any grounded instrument chassis before touching the test port connectors.

Never touch the test clip contacts.

Use a work station equipped with an anti-static work surface.

Service

The voltage levels found in these test leads when used with the intended instruments do not warrant more than normal safety precautions for operator safety. Nevertheless, service should be performed only by qualified personnel.

Specifications

This section lists the complete 16089A, B, C, D specifications. These specifications are the performance standards and limits against which the 16089A, B, C, D is tested. When shipped from the factory, the 16089A, B, C, D meets the following specifications:

Common Specifications for the 16089A, B, C, D

Maximum dc Bias Voltage	±42V peak max
Frequency Range	5 Hz to 100 kHz
Operating Temperature	0 to 55°C
Operating Humidity	≤95% RH (@40°C)
Non-operating Temperature	- 40 to 70°C
Non-operating Humidity	≤95% RH (@40°C)
Weight	300 g

Specifications for the 16089A, B, C

Cable length	0.94m
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Specifications for the 16089D

Cable length	1.3m
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Supplemental Performance Characteristics

This section gives supplemental performance characteristics. Supplemental performance characteristics are not specifications, but are typical characteristics included as additional information for the operator. Supplemental performance characteristics are not guaranteed.

Supplemental Performance Characteristics of 16089A

Applicable DUT size	
Diameter of DUT's terminals	$\leq 15\text{mm}$

Supplemental Performance Characteristics of 16089B

Applicable DUT size	
Diameter of DUT's terminals	$\leq 7.9\text{mm}$
Length of DUT's terminals	$\geq 3\text{mm}$

Supplemental Performance Characteristics of 16089C

Applicable DUT size	
Diameter of DUT's terminals	$\leq 1\text{mm}$
Space between DUT's terminals	$\geq 2\text{mm}$
Length of DUT's terminals	$\geq 2\text{mm}$

Supplemental Performance Characteristics of 16089D

Applicable DUT size	
Diameter of DUT's terminals	$\leq 5\text{mm}$

General Information
Supplemental Performance Characteristics

2 Preparation for Use

Introduction

This chapter explains how to install the Keysight 16089A, B, C Kelvin Clip Leads and Keysight 16089D Alligator Clip Leads. The topics covered include initial inspection, ambient environmental considerations, connecting the test leads for use, and repackaging the test leads for shipment.

Initial Inspection

These test leads have been carefully inspected electrically and mechanically before being shipped from the factory. They should be in perfect physical condition, no scratches, dents or the like. They should also be in perfect electrical condition. Verify this by carefully performing an incoming inspection to check the test lead set for signs of physical damage and missing contents. If any discrepancy is found, notify the carrier and Keysight Technologies. Your Keysight Technologies sales office will arrange for repair and replacement without waiting for the claim to be settled.

- Inspect the shipping container for damage. Keep the shipping materials until the inspection is completed.
- Verify that the shipping container contains everything shown in [Figure 2-1](#), [Figure 2-2](#), [Figure 2-3](#), and [Figure 2-4](#) and listed in [Table 2-1](#), [Table 2-2](#), [Table 2-3](#), and [Table 2-4](#).
- Inspect the exterior of the 16089A, B, C, D for any signs of damage.

Preparation for Use
Initial Inspection

16089A

Figure 2-1

16089A Product Overview

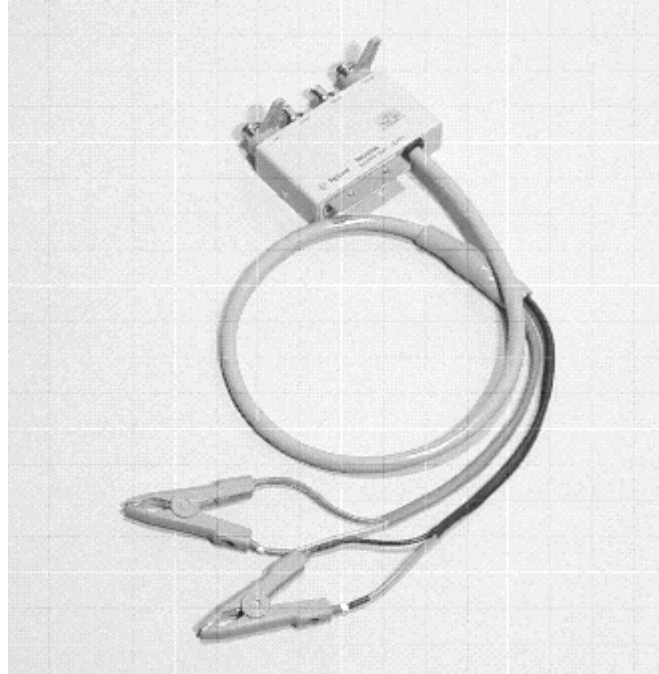


Table 2-1

Contents of 16089A

Description	Keysight Part Number	Quantity
Kelvin Clip Leads	16089-60001 ¹	1
Operation and Service Manual ²	16089-90030	1

¹ Keysight internal-only part number.

² Operation and Service Manual is not shown in Figure 2-1.

Preparation for Use
Initial Inspection

16089B

Figure 2-2

16089B Product Overview



Table 2-2

Contents of 16089B

Description	Keysight Part Number	Quantity
Kelvin Clip Leads	16089-60002 ¹	1
Operation and Service Manual ²	16089-90030	1

¹ Keysight internal-only part number.

² Operation and Service Manual is not shown in Figure 2-2.

Preparation for Use
Initial Inspection

16089C

Figure 2-3

16089C Product Overview

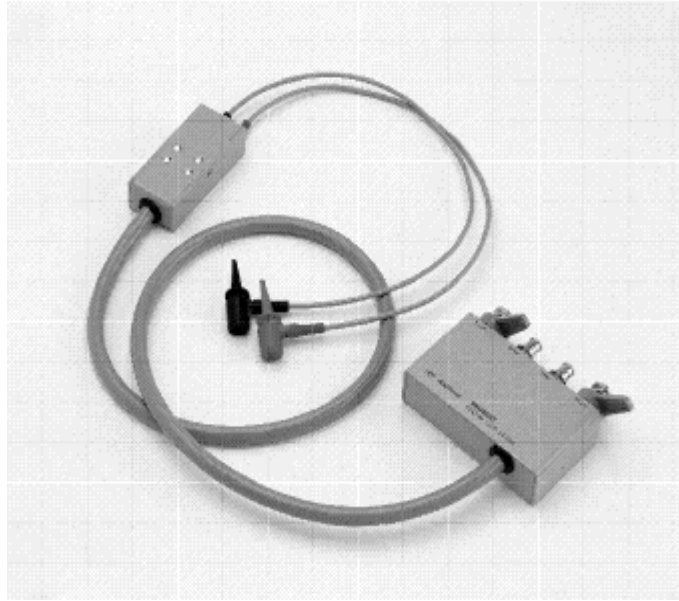


Table 2-3

Contents of 16089C

Description	Keysight Part Number	Quantity
Kelvin Clip Leads	16089-60003 ¹	1
Operation and Service Manual ²	16089-90030	1

¹ Keysight internal-only part number.

² Operation and Service Manual is not shown in Figure 2-3.

Preparation for Use
Initial Inspection

16089D

Figure 2-4

16089D Product Overview

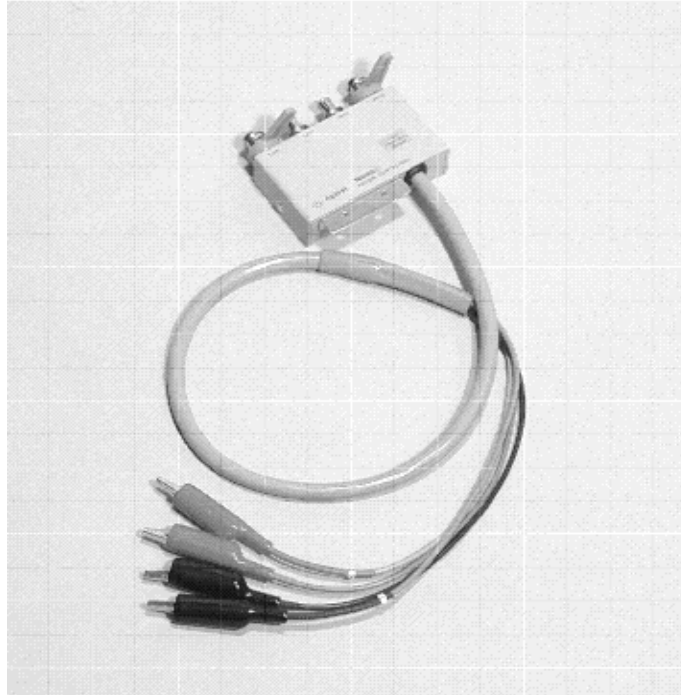


Table 2-4

Contents of 16089D

Description	Keysight Part Number	Quantity
Kelvin Clip Leads	16089-60004 ¹	1
Operation and Service Manual ²	16089-90030	1

¹ Keysight internal-only part number.

² Operation and Service Manual is not shown in Figure 2-4.

Ambient Environmental Considerations

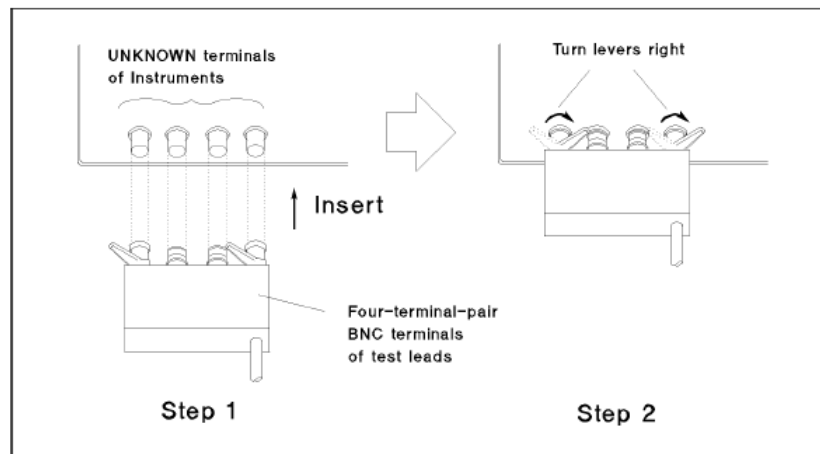
Operating and Storage

The 16089A, B, C, D must be operated within an ambient temperature range of 0°C to 55°C and relative humidity up to 95% at 40°C (non-condensing).

The 16089A, B, C, D may be stored within a temperature range of -40°C to +70°C, and at a relative humidity of up to 95% at +40°C (non-condensing).

Connecting the Test Leads for Use

Figure 2-5 Connecting the Test Leads



Packaging the Test Leads

If shipment to a Keysight Technologies service center is required, each test lead set should be repackaged using the original factory packaging materials.

Alternatively, comparable packaging materials may be used. Wrap the test leads in heavy paper and pack in anti-static plastic packing material. Use sufficient shock absorbing material on all sides of the 16089A, B, C, D to provide a thick, firm cushion and to prevent movement. Seal the shipping container securely and mark it FRAGILE.

3 Operation

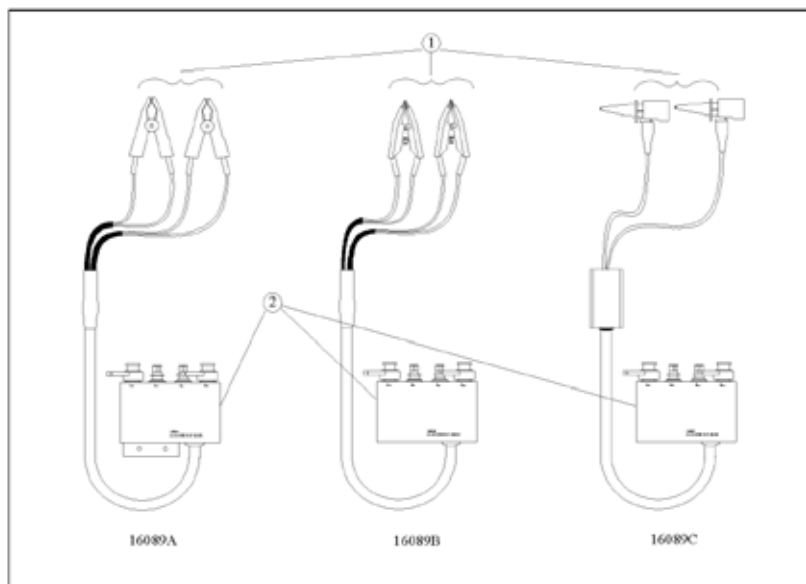
Introduction

This chapter describes using the test leads and compensation techniques for these test leads.

Test Leads Features

16089A, B, C

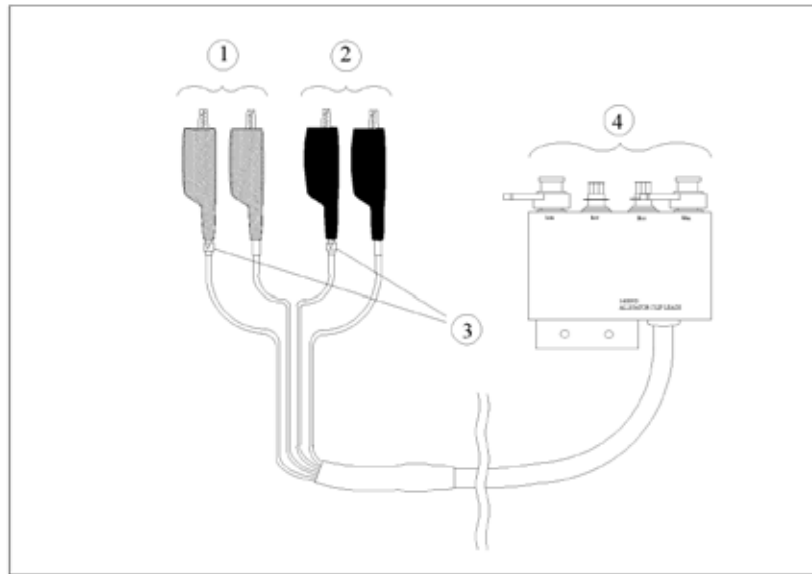
Figure 3-1 16089A, B, C Test Leads Features



1. **Kelvin Clips.** These are connected to the DUT.
2. **Four-terminal-pair BNC terminals.** These terminals are connected to the UNKNOWN terminals of your measurement instrument.

16089D

Figure 3-2 16089D Test Leads Features

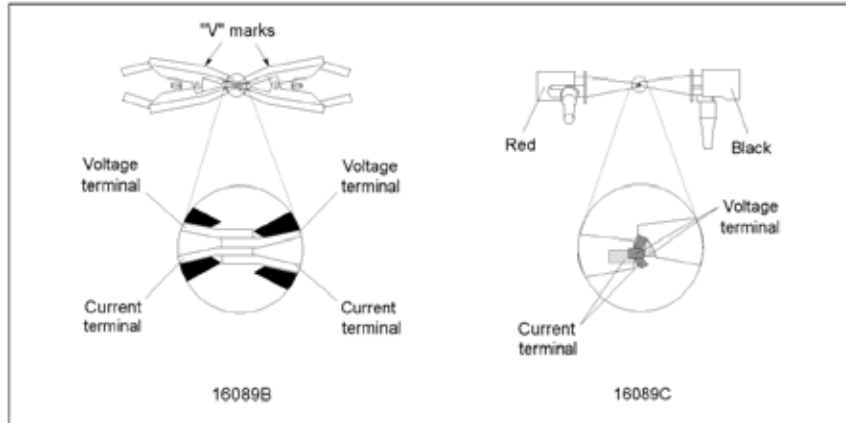


1. **Alligator Clips (red)**. These are connected to the high terminal of the DUT.
2. **Alligator Clips (black)**. These are connected to the low terminal of the DUT.
3. **V markers**. These show the H_{pot} and L_{pot} terminals.
4. **Four-terminal-pair BNC terminals**. These terminals are connected to the UNKNOWN terminals of your instrument.

OPEN and SHORT Compensation

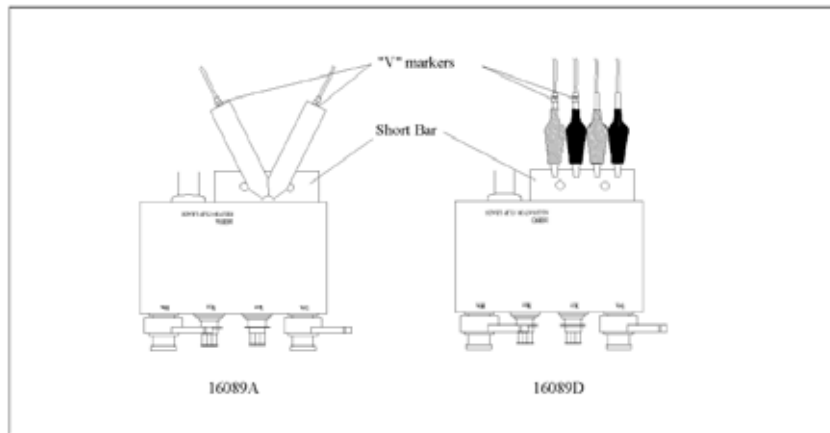
The 16089A, B, C, D have inherent stray capacitance, residual inductance, and residual resistance that affect the measurement. To cancel the effects caused by these residuals and thus minimize their effect on measurement accuracy, the measurement instrument's OPEN and SHORT compensation capabilities must be used. The procedures are described in the measurement instrument's operation manual.

Figure 3-3 Making a Short Condition for the 16089B and 16089C



When you perform SHORT compensation for the 16089A or 16089D, use the furnished short bar as shown in [Figure 3-4](#).

Figure 3-4 Making a Short Condition for the 16089A and 16089D



NOTE

If the furnished short bar of 16089A or 16089D is corroded, worn or damaged, reverse the position or replace it with a new short bar. To reverse the short bar, remove the 2 screws that fixes the short bar and reverse the position.

Operation

Step-by-step instructions on how to make a measurement with the 16089A, B, C, D are:

1. Set the Cable Length setting according to the LCR meter/ Impedance Analyzer operation manuals.
2. Connect the test leads of 16089A, B, C, D to the measurement instrument's UNKNOWN terminals.
3. Perform OPEN and SHORT compensation as described in the measurement instrument's operation manual. **Figure 3-3** and **Figure 3-4** show how to make short condition for the SHORT compensation.
4. Connect the component to be tested into the test clips.

NOTE

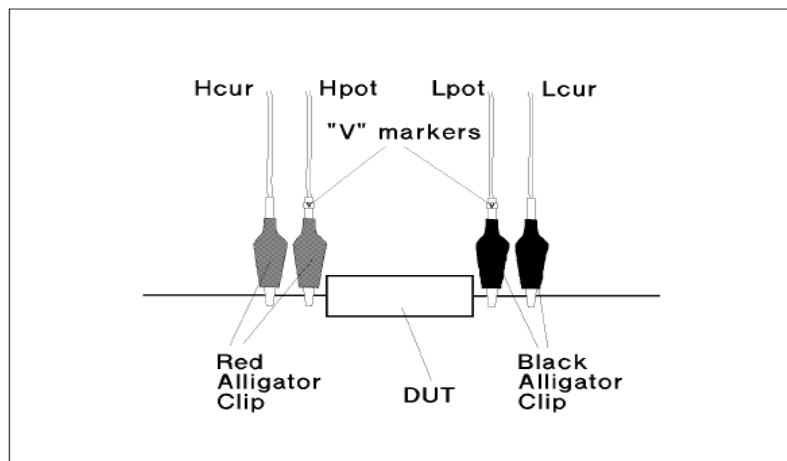
When 16089D is used, connect the test clips to the DUT correctly as follows:

- Connect all test clips to the DUT.
- Connect the same color test clips to the same terminal of the DUT.
- Connect the H_{pot} and L_{pot} clips (marked "V") closer to the DUT than H_{cur} and L_{cur} clips.

Figure 3-5 also shows how to connect a DUT using the alligator clips of the 16089D.

Figure 3-5

Connecting the DUT to the 16089D



4 Service

Introduction

This chapter gives replaceable parts information for the 16089A, 16089B, 16089C and 16089D.

Replaceable Parts

Table 4-1, **Table 4-2**, **Table 4-3** and **Table 4-4** list the replaceable parts for the 16089A, B, C, and D, respectively. **Figure 4-1** shows the connection from the cable to the clip assembly of the 16089C. The parts listed can be ordered from your nearest Keysight Technologies office. Ordering information should include the Keysight part number and the quantity required.

Service
Replaceable Parts

16089A Replaceable Parts

Table 4-1 16089A Replaceable Parts

Keysight Part Number	Quantity	Description
16089-60001	1	Test Leads ¹
16089-04001	1	Cover Top
0515-0914	2	Screw Flat Head M3X0.5 L6
16089-60011	2	Large Clip Assembly
7121-2696	2	Wire Marker "V"
16089-01201	1	Short Bar
0515-1550	2	Screw

¹ The whole unit. Keysight internal-only part.

Red and orange cables are screwed on the one Kelvin clip assembly. Gray and black cables are screwed on the other Kelvin clip assembly. Orange and gray cables are marked "V".

16089B Replaceable Parts

Table 4-2 16089B Replaceable Parts

Keysight Part Number	Quantity	Description
16089-60002	1	Test Leads ¹
16089-04002	1	Cover Top
0515-0914	2	Screw Flat Head M3X0.5 L6
16005-60010	2	Kelvin Clip Assembly

¹ The whole unit. Keysight internal-only part.

On one Kelvin clip, the orange cable is screwed on the "V" marked side, and the red cable is screwed on the non-marked side. On the other Kelvin clip, the gray cable is screwed on the "V" marked side, and the black cable is screwed on the non-marked side.

Service
Replaceable Parts

16089C Replaceable Parts

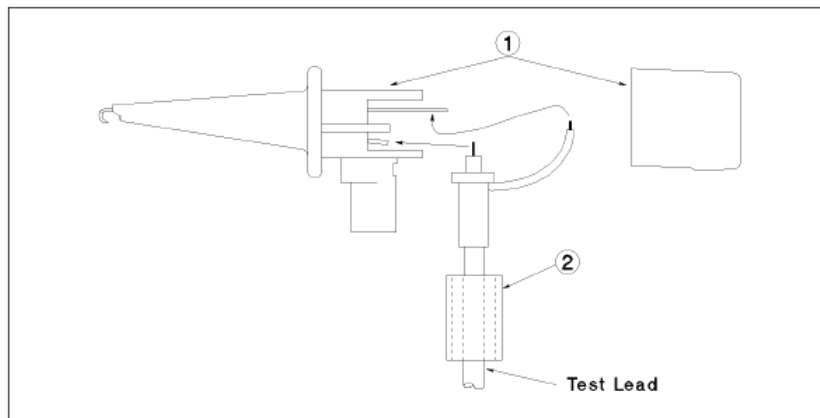
Table 4-3 16089C Replaceable Parts

Reference Designator*	Keysight Part Number	Quantity	Description
	16089-60003	1	Test Lead ¹
	16089-04003	1	Cover Top
	0515-0914	2	Screw Flat Head M3X0.5 L6
1	16005-60013	1	Test Clip Assembly Red
	16005-60015	1	Test Clip Assembly Black
2	0890-1809	2 cm	Tube Heat Shrinkable Red
	0890-1808	2 cm	Tube Heat Shrinkable Black

* Corresponding to designator in Figure 4-1.
1 The whole unit. Keysight internal-only part.

Connection from the cables to the Kelvin clip is shown in **Figure 4-1**.

Figure 4-1 Kelvin Clip Connections



Service
Replaceable Parts

16089D Replaceable Parts

Table 4-4 16089D Replaceable Parts

Keysight Part Number	Quantity	Description
16089-60004	1	Test Leads ¹
16089-04004	1	Cover Top
0515-0914	2	Screw Flat Head M3X0.5 L6
0340-1085	2	Insulator Alligator Clip Red
0340-1086	1	Insulator Alligator Clip Black
1400-1252	4	Alligator Clip
7121-2696	2	Wire Marker "V"
16089-01201	1	Short Bar
0515-1550	2	Screw

1 The whole unit. Keysight internal-only part.

Table 4-5 shows the correspondence between the Alligator Clips and the Cables.

Table 4-5 Clip and Cable Correspondence

Alligator Clip Color	Cable Color Marker
Red	Orange "V"
Red	Red
Black	Gray "V"
Black	Black

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