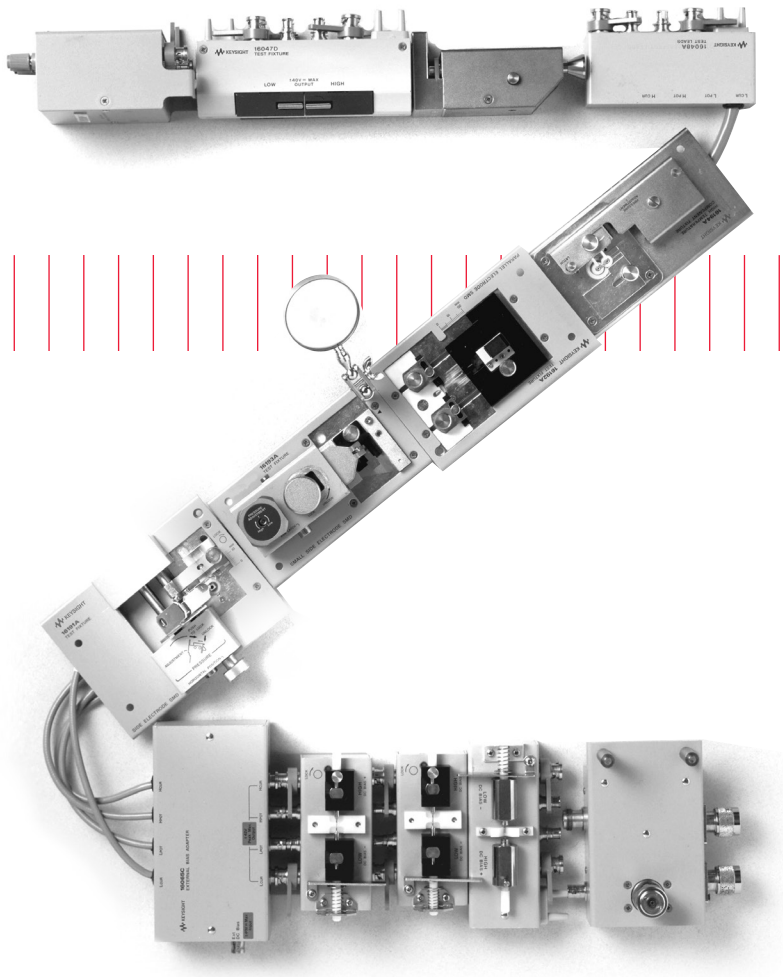
Keysight Technologies
Accessories Catalog for Impedance Measurements

Catalog



KEYSIGHT TECHNOLOGIES

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Introduction

When a device under test (DUT) is measured, a test fixture must be used to connect the instrument to the DUT. A test fixture is an interface specifically designed to connect the instrument and the contact tips of the DUT.

1. What are Keysight Technologies accessories?

Keysight Technologies offers a variety of accessories suitable for many applications. They are designed to make measurements simple and reliable. For example, a mechanically and electrically precise test fixture is required to measure the impedance of SMD components. For this measurement, Keysight offers dedicated SMD fixtures for impedance measurement instruments that minimize the measurement errors. Also, specially designed fixtures for other specific applications (such as DC bias test, dielectric material test, and others.) are available. Keysight accessories facilitate a shorter time-to-market with increased confidence by providing accurate and repeatable measurements.

2. Types of accessories

Keysight accessories can be divided into the following five categories:

Test fixtures

A test fixture is used to hold the electronic components or materials (physically and electrically) for the measurements. Keysight offers various kinds of 4-Terminal Pair test fixtures and 7 mm test fixtures. Some of them connect directly to the measurement instrument, while others require adapters.

Test leads

Test leads are used to extend the measurement ports from the UNKNOWN terminals of the instrument to the DUT. Using a flexible test lead, a DUT that cannot be held with test fixtures can be measured regardless of its size or shape. The test leads can also be used as cable extensions when the test sample is located away from the measurement instrument.

Probes

Probes are helpful in measuring components which are already connected to PC boards or have one terminal grounded.

Adapters

Adapters are used to adapt the dedicated circuits between the instrument and the test fixtures. The 42942A is a terminal conversion adapter that can convert a 4-Terminal Pair configuration to a 7 mm configuration. The 16065C is an external DC bias adapter that can apply DC bias to the DUT from an external DC bias source.

Others

Also available are DC bias accessories and performance test equipment.

Introduction *continued*

3. The Benefits of Keysight accessories

Each accessory is designed to ensure highly accurate measurements without degrading the performance of the measurement instrument.

- Minimum residual error preserves the accuracy of the measurement instruments.
- Clearly defined error compensation allows easy calculation of error corrections.
- Strict measurement specifications, such as test frequencies and signal levels provide safe and accurate measurements.

This document introduces a group of Keysight accessories that are well suited for the following measurement instruments:

LCR meters

- E4980A Precision LCR Meter, 20 Hz to 2 MHz
- E4980AL Precision LCR Meter, 20 Hz to 300 kHz/500 kHz/1 MHz
- E4982A LCR Meter, 1 MHz to 300 M/500 M/1G/ 3 GHz

Capacitance meters

- E4981A Capacitance Meter

Impedance analyzers

- E4990A Impedance Analyzer, 20 Hz to 10/20/30/50/120 MHz
- E4991B Impedance Analyzer, 1 MHz to 500 MHz/1 GHz/3 GHz

Network analyzer

- E5061B-3L3/3L4/3L5 LF-RF Network Analyzer, 5 Hz to 500 M/1.5 G/3 GHz

4. ISO 9000 quality management

ISO 9000 is a set of international standards for quality management and quality assurance. These standards were developed with the goal of documenting and implementing effective quality systems within companies. ISO standards are consistent with Keysight's quality system; in fact, the standards within Keysight Technologies' Quality Maturity System (QMS) exceed the intent of ISO 9000.

Tips for Selecting Appropriate Accessories

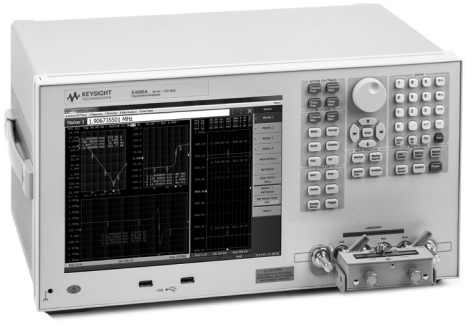
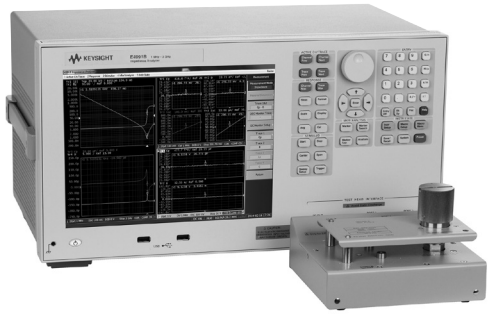
The following topics comprise a helpful guideline for selecting an appropriate accessory for the measurement instrument to be used.

1. Selection by measurement application

Keysight accessories can be used in a wide variety of measurement applications. These applications range from basic measurements (such as impedance measurements for discrete devices) to advanced measurements (such as measurement of resistivities or dielectric constants.)

2. Compatibility with measurement instruments

Test fixtures/leads are compatible with the measurement instruments when they have the same type of terminal configuration and useable measurement frequency range. The measurement instruments described in this guide are divided into the following three categories based on frequency.

Frequency range	**Up to 120 MHz (Terminal configuration: 4-Terminal pair)**	**Up to 3 GHz (Terminal configuration: 7 mm)**
		
Measurement instruments	E4980A/AL, E4981A, E4990A	E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 w/Opt. 005 + 16201A * Option E4990A-120 is required.

Tips for Selecting Appropriate Accessories *continued*

3. Frequency, DC bias, and operating temperature/humidity

each of the Keysight accessories has its own specific operating range. Any measurement performed outside this range can increase residual errors and can cause problems. Be sure that your measurement environment fits the accessory's specific operating range. In the case of humidity, Keysight's accessories can operate at a relative humidity of 95% or less at 40°C. (These same requirements apply to most LCR Meters and Impedance Analyzers.) When the ambient temperature is not approximately 40°C, use an accessory that has no condensation on its surface.

4. DUT (device under test) dimensions

The DUT can vary from chip components, axial/radial leads, or ICs to general electrical materials. Select a test fixture/lead that is suitable for the shape and size of your components or materials.

5. Open & short repeatability and proportional error

Since a test fixture induces an additional error when measuring, the total measurement error is the sum of the measurement instrument's measurement accuracy and the fixture's additional error. Generally, a test fixture's additional error consists of three terms: open repeatability, short repeatability and proportional error. Open and short repeatability exhibit the error factors of the open and short residual impedances which affect the measurements of extremely high and low impedances respectively. Proportional error exhibits the error factor, which is proportional to the value of the impedance being measured. For more details on this subject, please refer to the Appendix.

6. Furnished accessories

Each test fixture is shipped with a manual and various other accessories needed for measuring. For example, the 42941A impedance probe kit is furnished with a pin probe, an adapter (BNC-SMA), 3 spare pins, a carrying case and an operation and service manual.

Tips for Selecting Appropriate Accessories *continued*

7. Terminal adapters

Terminal Adapters convert the instruments terminal configuration into a 7 mm terminal configuration. This means that instruments that do not have a 7 mm terminal connector can use test fixtures with a 7 mm terminal connector. The 42942A converts a 4-Terminal Pair configuration into a 7 mm terminal connector, which can only be used with the E4990A*.

42942A Terminal adapter



Dimensions (approx.):
190 (W) x 55 (H) x 140 (D) [mm]
Weight (approx.): 800 g

Applicable instrument: E4990A*
Frequency: 20 Hz to 120 MHz
Maximum voltage: ±42 V peak max. (AC +DC)
Operating temperature: 0to 40°C
Furnished accessories:

Description	P/N	Qty.
Carrying case	42942-60011	1
Operation and service manual	42942-90020	1

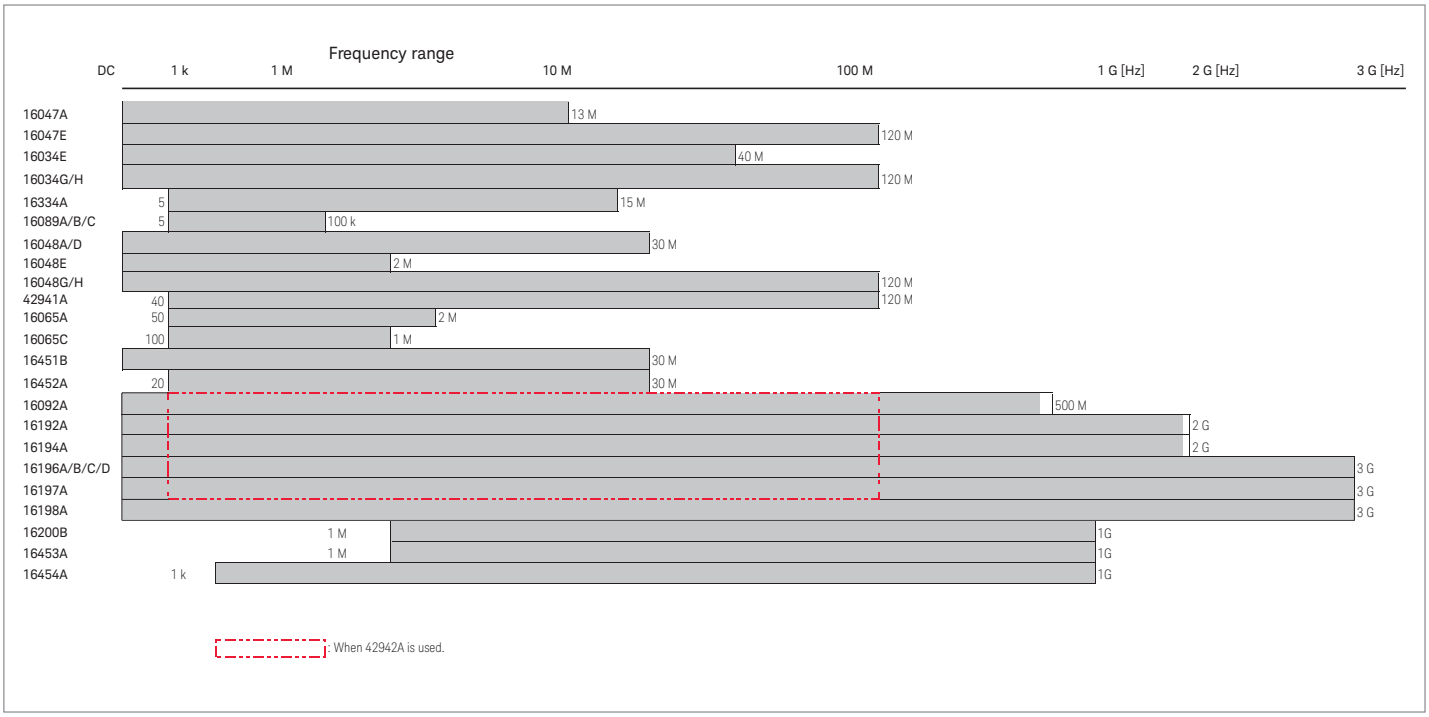
* Option E4990A-120 is required

Options:
42942A-700: Add 7 mm open/short/load set

Description	P/N	Qty.
Open termination	04191-85302	1
Short termination	04191-85300	1
Load termination	04291-60043	1

Accessories Catalog

Applicable frequency ranges



Accessories Catalog

Accessories organization

This document is organized by measurement frequency and DUT to enable quick selection of an appropriate test fixture for a particular measurement application. The following tables show the various categories in each primary group:

Up to 120 MHz (Terminal configuration: 4-Terminal pair)

Lead components	16047A/E
SMD components	16034E/G/H, 16334A
Other components	16089A/B/C
Port/Cable extension	16048A/D/E/G/H
DC bias accessories	16065A/C
Material	16451B, 16452A

Up to 3 GHz (Terminal configuration: 7 mm connector)

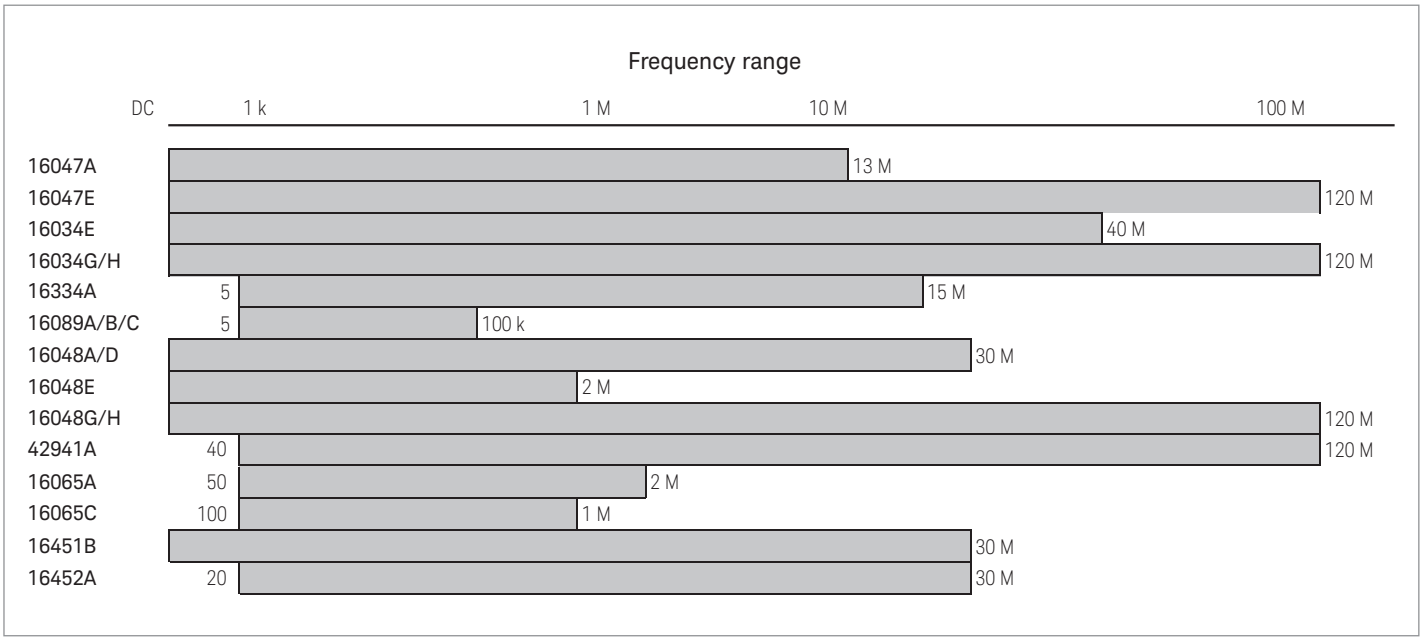
Lead components	16092A,16194A
SMD components	16092A, 16192A, 16194A, 16196A/B/C/D, 16197A, 16198A
DC bias accessories	16200B
Material	16453A, 16454A

Other accessories

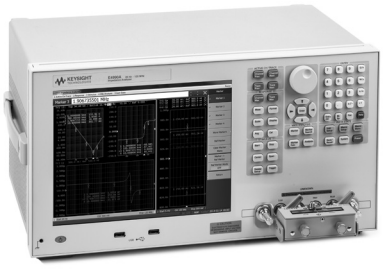
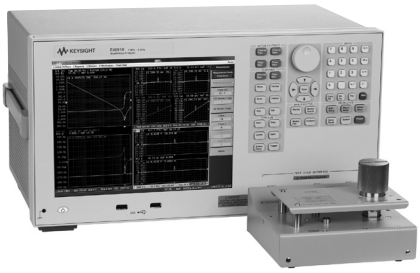
Miscellaneous	16190B, 16380A/C, 42030A, 42090/1A

Up to 120 MHz (4-Terminal Pair)

Test fixtures (4-Terminal pair) for impedance measurements up to 120 MHz

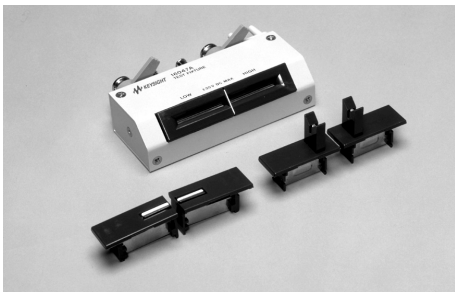


Applicable instrument

Frequency range	Up to 120 MHz (Terminal configuration: 4-Terminal pair)	Up to 3 GHz (Terminal configuration: 7 mm)
		
Measurement instruments	E4980A/AL, E4981A, E4990A	E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 w/Opt. 005 + 16201A *Option E4990A-120 is required

Up to 120 MHz (4-Terminal Pair): Lead Components

16047A Test fixture

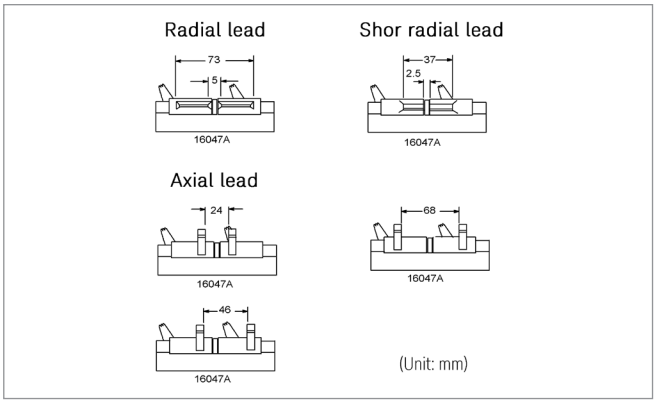


Terminal connector: 4-Terminal pair, BNC
DUT connection: 4-Terminal
Dimensions (approx.):
124 (W) x 31 (H) x 62 (D) mm
Weight (approx.): 205 g
Additional error:

Type of error	Impedance
Proportional error	±5 x (f/10)^2

f: [MHz]

Description: This test fixture is designed for impedance evaluation of axial/radial lead type devices. The 16047A employs Kelvin contacts which realize a wide impedance measurement range. The contact tip can be changed according to the device shape.
Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: DC to 13 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size: See figure with module sizes.



16047A module sizes

Furnished accessories:

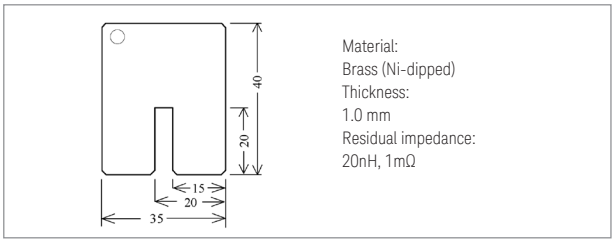
Description	P/N	Qty.
Module for axial lead	16061-70022	2
Module for radial lead mounting on fixture	16061-70021	2
Module for short radial lead	16047-65001	2
Operating note	16047-90011	1

Each module size for the 16047A is shown above.

Option:
16047A-701: Add Shorting plate P/N 16047-00640

Compensation and measurement: Select one of these modules suitable for the DUT's shape. Open and short compensations are recommended before measurement. Short compensation is performed by shorting the contacts of the test fixture with a shorting plate. After performing open and short compensations, the DUT is connected to the test fixture.

P/N 16047-00640



Shorting plate

Up to 120 MHz (4-Terminal Pair): Lead Components *continued*

16047E Test fixture

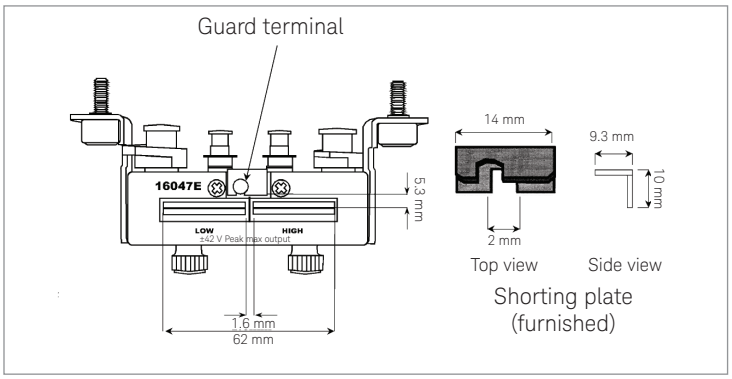


Terminal connector: 4-Terminal Pair, BNC
DUT connection: 2-Terminal
Dimensions (approx.):
135 (W) x 40 (H) x 65 (D) [mm]
Weight (approx.): 200 g
Additional error:

Type of error	Impedance
Proportional error f ≤ 15 MHz	0.2 x (f/10)^2[%]
Proportional error f > 15 MHz	4 x (f/100)[%]
Open repeatability	2 n+10 µ x (f/100) [S]
Short repeatability	2 m+600 m x (f/100) [Ω]

f: [MHz]

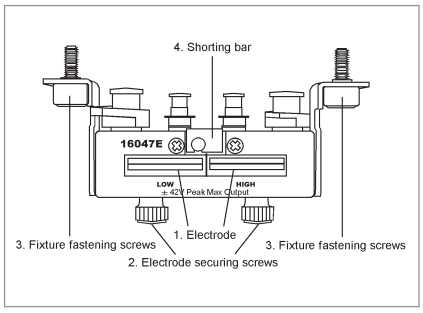
Description: This test fixture is designed for impedance evaluation of lead type devices up to 120 MHz. A guard terminal is available for three terminal devices and a shorting plate comes secured on this fixture.
Applicable instruments: E4980A/AL, E4981A, E4990A, E5061B-3L3/3L4/3L5 with Opt. 005
Frequency: DC to 120 MHz
Maximum voltage: ±42 V peak max.(AC+DC)
Operating temperature: –20 to 75°C
DUT size: See figure below with 16047E's electrode size.



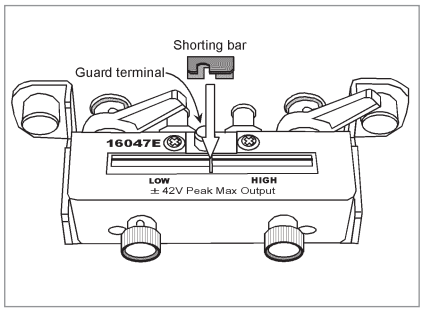
Furnished accessories:

Description	P/N	Qty.
Angle (right-side)	16047-01221	1
Angle (left-side)	16047-01222	1
Screws	0515-1229	4
Shorting plate	16047-00621	1
Operating and service manual	16047-90040	1

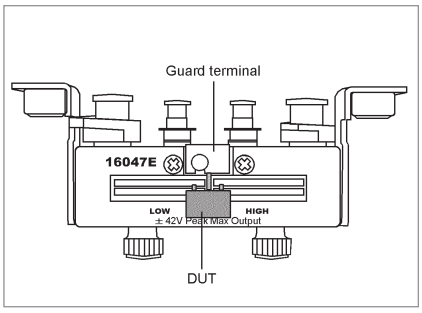
Compensation and measurement: Open and short compensations are recommended before measurement. Short compensation is performed by shorting the contacts of the test fixture with a shorting plate. After performing open and short compensations, the DUT is connected to the test fixture. The following figures show how compensation and measurement are performed.



Test fixture overview



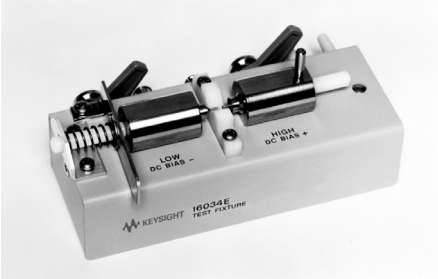
Connecting a shorting plate



Measuring 3-Terminal device

Up to 120 MHz (4-Terminal Pair): SMD

16034E Test fixture

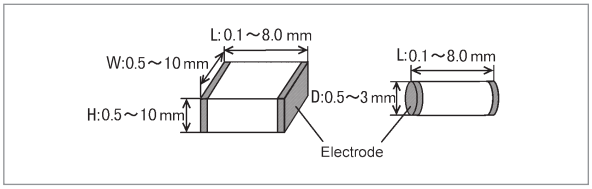


Terminal connector: 4-Terminal Pair, BNC
DUT connection: 2-Terminal
Dimensions (approx.):
128 (W) x 60 (H) x 71 (D) [mm]
Weight (approx.): 270 g
Additional error:

Type of error	Impedance
Proportional error	±1.5 x $(f/10)^2$

f: [MHz]

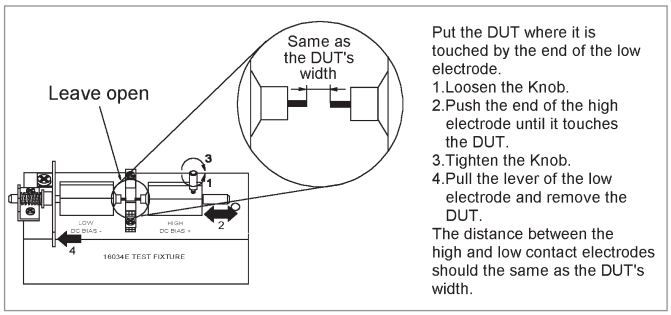
Description: This test fixture is designed for impedance evaluations of SMD. The minimum SMD size that this fixture is adapted to evaluate is 1.6(L) x 0.8(W) [mm].
Applicable instruments: E4980A/AL, E4981A, E4990A, E5061B-3L3/3L4/3L5 with Opt. 005
Frequency: DC to 40 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0°C to 55°C
DUT size: See figure below



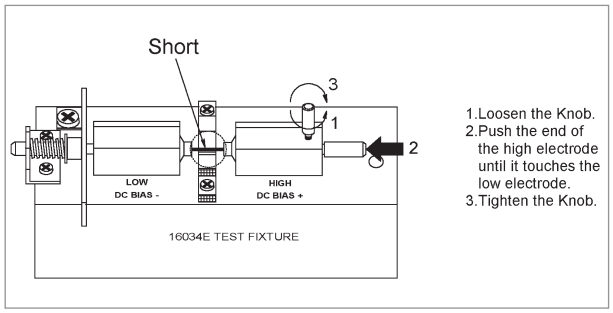
Furnished accessories:

Description	P/N	Qty.
Operating manual	16034-90041	1

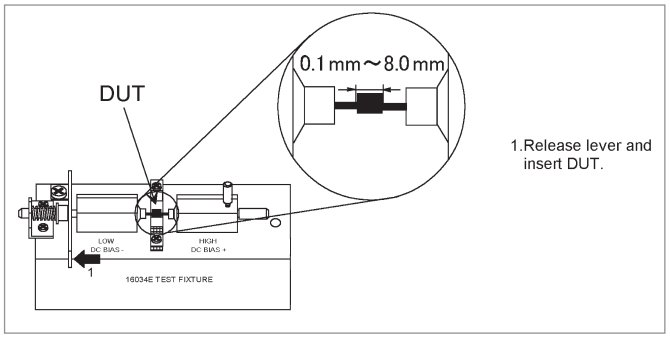
Compensation and measurement: Open and short compensations are recommended before measurement. Open compensation is performed by separating the high and low electrodes from each other. The separation should be equivalent in size to the DUT's width. Short compensation is performed by contacting the high and low electrodes together. After performing open and short compensations, the DUT is inserted into the test fixture. The following figures show how compensation and measurement are performed.



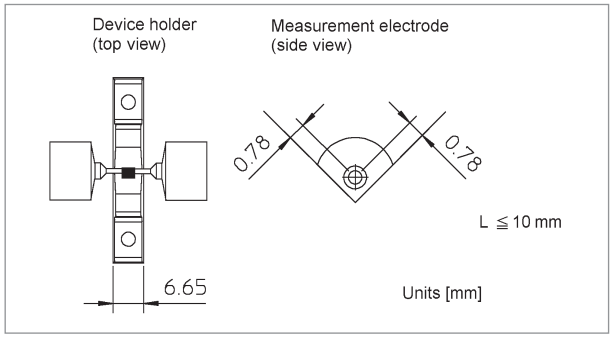
Open compensation



Short compensation



Inserting a DUT



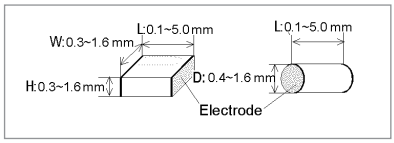
Electrode dimensions

Up to 120 MHz (4-Terminal Pair): SMD *continued*

16034G Test fixture



Description: This test fixture is designed for impedance evaluations of SMD. The minimum SMD size that this fixture is adapted to evaluate is 0.6 (L) x 0.3 (W) [mm].
Applicable instruments: E4980A/AL, E4981A, E4990A, E5061B-3L3/3L4/3L5 with Opt. 005
Frequency: DC to 120 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size: See figure below



Terminal connector: 4-Terminal Pair, BNC
DUT connection: 2-Terminal
Dimensions (approx.):
120 (W) x 50 (H) x 70 (D) [mm]
Weight (approx.): 200 g
Additional error:

Type of error	Impedance
Proportional error	0.5 x $(f/10)^2$[%]
Open repeatability	5 + 500 x (f/10) [nS]
Short repeatablity	10 + 13 x (f/10) [mΩ]

f: [MHz]

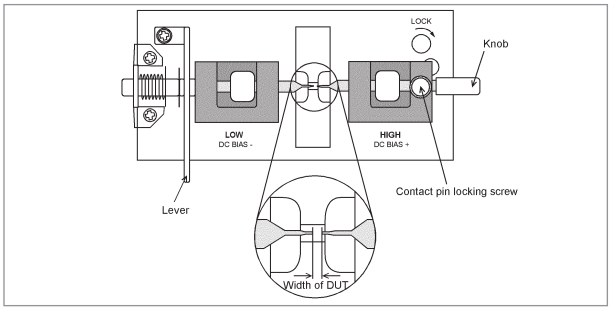
Furnished accessories:

Description	P/N	Qty.
Case for 100 Ω SMD resistance	1540-0692	1
100 Ω chip resistor	0699-2488	10
Operating manual	16034-90011	1

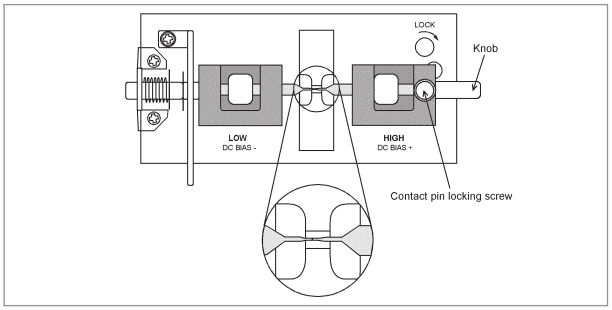
Compensation and measurement: Open and short compensations are recommended before measurement. When measuring above 3 MHz, load compensation is also recommended. Open compensation is performed by separating the high and the low electrodes from each other. The separation size should be equivalent to the DUT's width. Short compensation is performed placing the high and low electrodes in contact together. Load compensation is performed by using the furnished 100 Ω SMD chip resistor. After performing open, short and load compensations, the DUT is inserted into the test fixture. The following figures show how compensation and measurement are performed.



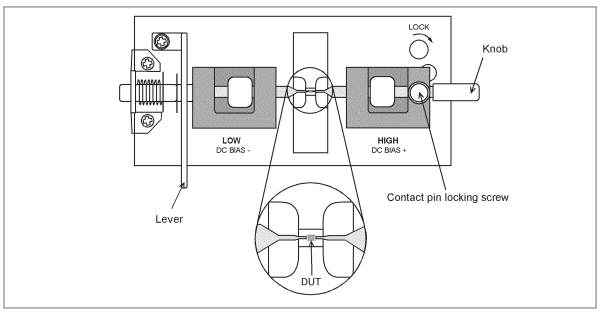
E4980A with 16034G



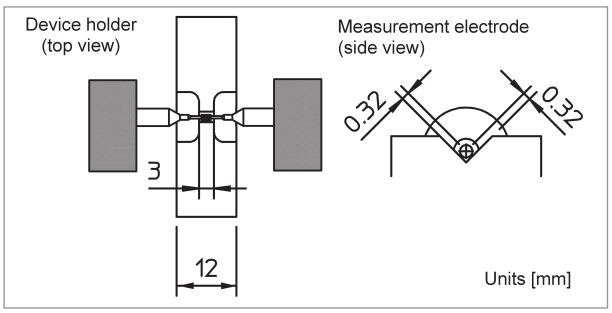
Open compensation



Short compensation



DUT measurement



Dimensions

Up to 120 MHz (4-Terminal Pair): SMD *continued*

16034H Test fixture

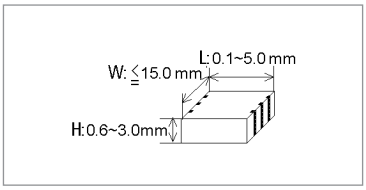


Terminal connector: 4-Terminal Pair, BNC
DUT connection: 2-Terminal
Dimensions (approx.):
120 (W) x 50 (H) x 70 (D) [mm]
Weight (approx.): 200 g
Additional error:

Type of error	Impedance
Proportional error	0.5 x (f/10)^2[%]
Open repeatability	5 + 500 x (f/10) [nS]
Short repeatablity	10 + 13 x (f/10) [mΩ]

f: [MHz]

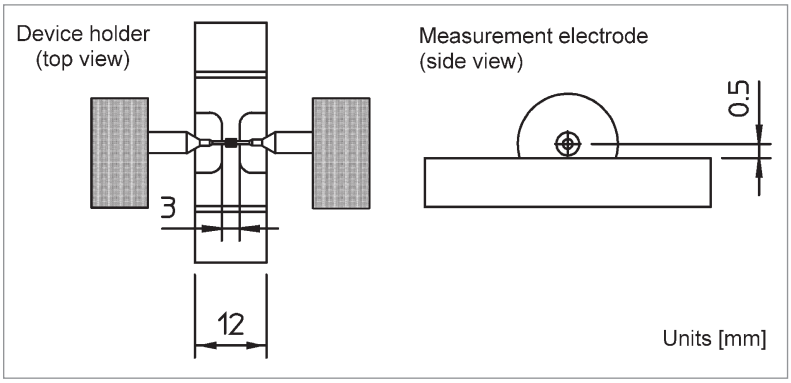
Description: This test fixture is designed for impedance evaluations of array-type SMD. The minimum SMD size that this fixture is adapted to evaluate is 1.6(L) x 0.8(W) [mm]. Since the tip of the measurement electrodes are very thin and the device holder is extremely flat, the device can be shifted and the measurement electrodes can contact the each element of the array-type component.
Applicable instruments: E4980A/AL, E4981A, E4990A, E5061B-3L3/3L4/3L5 with Opt. 005
Frequency: DC to 120 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size: See figure below



Furnished accessories:

Description	P/N	Qty.
Case for 100 Ω SMD resistance	1540-0692	1
100 Ω chip resistor	0699-2488	10
Operating manual	16034-90012	1

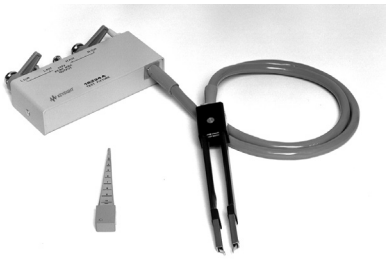
Compensation and measurement: Open and short compensations are recommended before measurement. When measuring above 3 MHz, load compensation is also recommended. Open compensation is performed by separating the high and the low electrodes from each other. The separation should be equivalent in size to the DUT's width. Short compensation is performed by placing the high and low electrodes in contact together. Load compensation is performed by using the furnished 100 Ω SMD chip resistor. After performing open, short and load compensations, the DUT is inserted into the test fixture. Refer to the 16034G figures to see how compensation and measurement are performed.



Electrode dimensions

Up to 120 MHz (4-Terminal Pair): SMD *continued*

16334A Tweezers contact test fixture

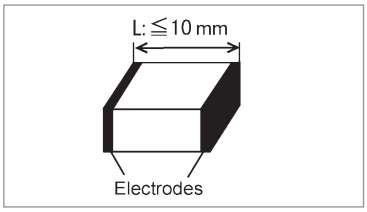


Terminal connector: 4-Terminal Pair, BNC
DUT connection: 2-Terminal
Cable length (approx.): 1 m (from BNC connectors to the top of tweezers)
Weight (approx.): 290 g
Additional error:

Type of error	Impedance
Proportional error	$\pm 2 \times (f/10)^2$

f: [MHz]

Description: This test fixture is designed for impedance evaluations of SMD. The minimum SMD size that this fixture is adapted to evaluate is 1.6(L) x 0.8(W) [mm]. The tweezers' contacts on this fixture makes it easy to hold the DUT.
Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: 5 Hz to 15 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size: ≤10 mm (width)
See figure below



Furnished accessories:

Description	P/N	Qty.
Compensation block	16334-60001	1
Operating note	16334-90000	1

Compensation and measurement: Open and short compensations are recommended before measurement. Open and short compensations are performed by using the furnished compensation block. After performing open and short compensations, the DUT is sandwiched by the tweezers' contacts and is measured.

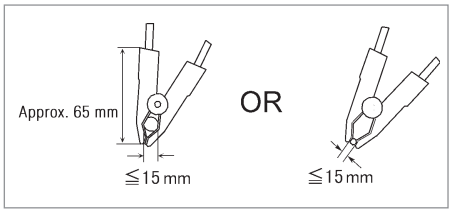
Up to 120 MHz (4-Terminal Pair): Other Components

16089A Large Kelvin clip leads



Terminal connector:
4-Terminal Pair, BNC
DUT connection: 4-Terminal
Cable length (approx.):
0.94 m (from connector to clip's tip)
Weight (approx.): 300 g
Additional error: The additional error is negligible when compared to the instrument's accuracy.

Description: This test fixture makes it possible to measure odd-shaped components that cannot be measured with conventional fixtures. It is equipped with two insulated Kelvin clips.
Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: 5 Hz to 100 kHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size:
See figure below



Furnished accessories:

Description	P/N	Qty.
Operating and service manual	16089-90020	1

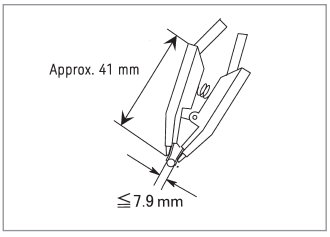
Compensation and measurement: Open and short compensations are recommended before measurement. For open compensation, do not connect the Kelvin clips to anything. Short compensation is performed by holding a shorting plate with the Kelvin clips. After performing open and short compensations, the DUT is held with the Kelvin clips.

16089B Medium Kelvin clip leads



Terminal connector: 4-Terminal Pair, BNC
DUT connection: 4-Terminal
Cable length (approx.):
0.94 m (from connector to clip's tip)
Weight (approx.): 300 g
Additional error: The additional error is negligible when compared to the instrument's accuracy.

Description: This test fixture makes it possible to measure odd-shaped components that cannot be measured with conventional fixtures. It is equipped with two insulated Kelvin clips.
Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: 5 Hz to 100 kHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size: See figure below



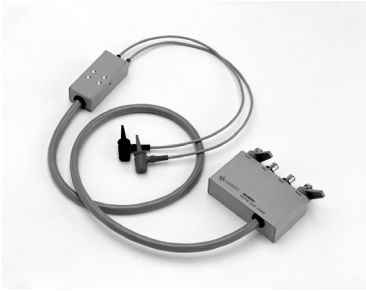
Furnished accessories:

Description	P/N	Qty.
Operating and service manual	16089-90020	1

Compensation and measurement: Open and short compensations are recommended before measurement. For open compensation, do not connect the Kelvin clips to anything. Short compensation is performed by connecting the Kelvin clips together. After performing open and short compensations, the DUT is held with the Kelvin clips.

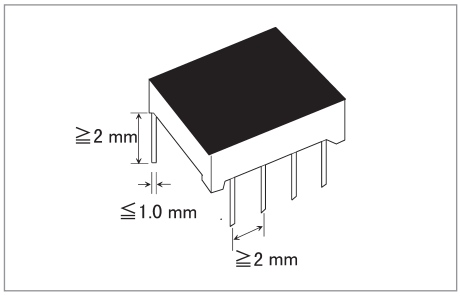
Up to 120 MHz (4-Terminal Pair): Other Components *continued*

16089C Kelvin IC clip leads



Terminal connector: 4-Terminal Pair, BNC
DUT connection: 4-Terminal
Cable length (approx.):
1.3 m (from connector to clip's tip)
Weight (approx.): 300 g
Additional error: The additional error is negligible when compared to the instrument's accuracy.

Description: This test fixture makes it possible to measure odd-shaped components that cannot be measured with conventional fixtures. It is equipped with two insulated Kelvin clips.
Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: 5 Hz to 100 kHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size:
See figure below



Furnished accessories:

Description	P/N	Qty.
Operating and service manual	16089-90020	1

Compensation and measurement: Open and short compensations are recommended before measurement. For open compensation, do not connect the Kelvin clips to anything. Short compensation is performed by connecting the Kelvin clips together. After performing open and short compensations, the DUT is held with the Kelvin clips.

Up to 120 MHz (4-Terminal Pair): Port/Cable Extension

16048A Test leads



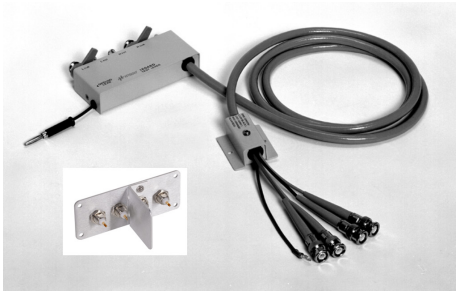
Terminal connector: 4-Terminal Pair, BNC
Cable length (approx.):
0.94 m (from connector to cable tip)
Cable tip: BNC (male)
Weight (approx.): 315 g
Additional error: For detailed information, refer to the measurement instrument's specifications.

Description: The test leads extend the measurement port with a 4-Terminal Pair configuration. It is provided with a BNC female connector board to allow the attachment of user-fabricated test fixtures.
Applicable instruments: E4980A/AL, E4981A
Frequency: DC to 30 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
Furnished accessories:

Description	P/N	Qty.
Terminal board with BNC(f)x4	16032-60071	1
Operating manual	16089-90001	1

Compensation and measurement: Cable length compensation is recommended before measurement. Set the instrument's cable length compensation function to 1 m.

16048D Test leads



Terminal connector: 4-Terminal Pair, BNC
Cable length (approx.):
1.89 m (from connector to cable tip)
Cable tip: BNC (male)
Weight (approx.): 460 g
Additional error: For detailed information, refer to the measurement instrument's specifications.

Description: The test leads extend the measurement port with a 4-Terminal Pair configuration. It is provided with a BNC female connector board to allow the attachment of user-fabricated test fixtures.
Applicable instruments: E4980A/AL, E4981A
Frequency: DC to 30 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
Furnished accessories:

Description	P/N	Qty.
Terminal board with BNC(f)x4	16032-60071	1
Operating manual	16048-90031	1

Compensation and measurement: Cable length compensation is recommended before measurement. Set the instrument's cable length compensation function to 2 m.

Up to 120 MHz (4-Terminal Pair): Port/Cable Extension *continued*

16048E Test leads



Terminal connector: 4-Terminal Pair, BNC
Cable length (approx.): 3.8 m (from connector to cable tip)
Cable tip: BNC (male)
Weight (approx.): 690 g
Additional Error: For detailed information, refer to the measurement instrument's specifications.

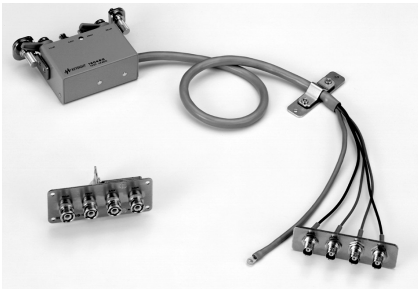
Description: The test leads extend the measurement port with a 4-Terminal Pair configuration. It is provided with a BNC female connector board to allow the attachment of user-fabricated test fixtures.
Applicable instruments: E4980A/AL
Frequency: DC to 2 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
Furnished accessories:

Description	P/N	Qty.
Terminal board with BNC(f)x4	16032-60071	1
Operating manual	16048-90041	1

Compensation and measurement: Cable length compensation is recommended before measurement. Set the instrument's cable length compensation function to 4 m.

Up to 120 MHz (4-Terminal Pair): Port/Cable Extension *continued*

16048G Test leads

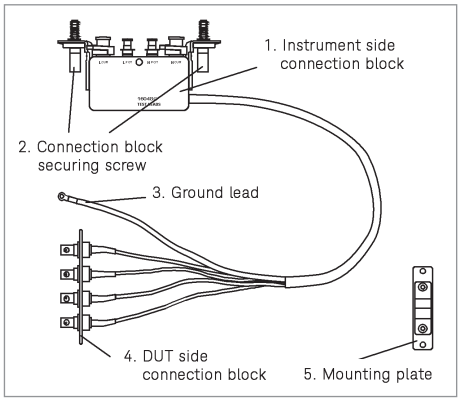


Terminal connector: 4-Terminal pair, BNC
Cable length (approx.): 1 m
Cable tip: BNC (female)
Weight (approx.): 460 g
Additional error: For detailed information, refer to the operation manual or the specifications of E4990A.

Description: The test leads extend the measurement port with a 4-Terminal Pair configuration. It is provided with a BNC male connector board to allow the attachment of user-fabricated test fixtures.
Applicable instrument: E4990A
Frequency: DC to 120 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: –20 to 150°C
Furnished accessories:

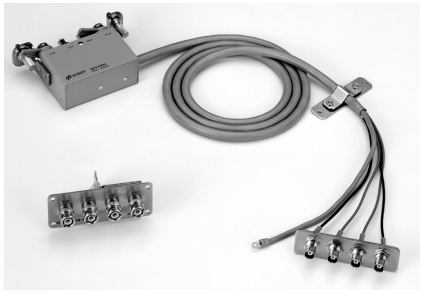
Description	P/N	Qty.
Mounting plate	NA	1
Operating and service manual	16048-90050	1

Options:
16048G-001: Add BNC Bracket* (P/N 16048-60003)
* Here the BNC Bracket refers to the terminal board with four BNC (m)connectors.
Compensation and measurement: Adapter setup is recommended before measurement. In the adapter setup menu, select 4TP 1M. Then use the 100 Ω resistor furnished with the E4990A to perform phase compensation and load data measurement.



Test fixture overview

16048H Test leads



Terminal connector: 4-Terminal pair, BNC
Cable length (approx.): 2 m
Cable tip: BNC (female)
Weight (approx.): 690 g
Additional error: For detailed information, refer to the operation manual or the specifications of E4990A.

Description: The test leads extend the measurement port with a 4-Terminal Pair configuration. It is provided with a BNC male connector board to allow the attachment of user-fabricated test fixtures.
Applicable instrument: E4990A
Frequency: DC to 120 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: –20 to 150°C
Furnished accessories:

Description	P/N	Qty.
Mounting plate	NA	1
Operating and service manual	16048-90050	1

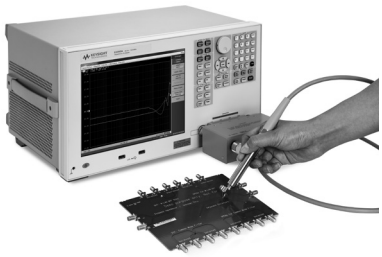
Options:
16048H-001: Add BNC Bracket* (P/N 16048-60003)
* Here the BNC Bracket refers to the terminal board with four BNC (m) connectors.
Compensation and measurement: Adapter setup is recommended before measurement. In the adapter setup menu, select 4TP 2M. Then use the 100 Ω resistor furnished with the E4990A to perform phase compensation and load data measurement.

Up to 120 MHz (4-Terminal Pair): Probes

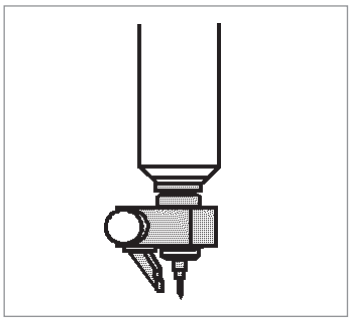
42941A Impedance probe kit



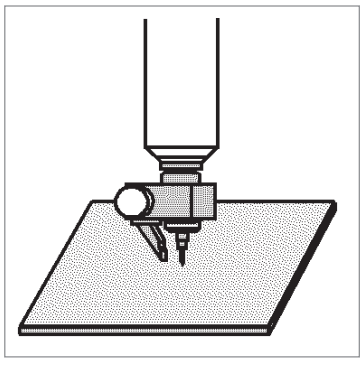
Terminal connector: 4-Terminal pair, BNC
Cable length (approx.): 1.5 m
Weight (approx.): 2400 g
Basic measurement accuracy: ±1%
For detailed information, refer to the operation manual or the specifications of E4990A-120.



E4990A-120 with 42941A



Open compensation

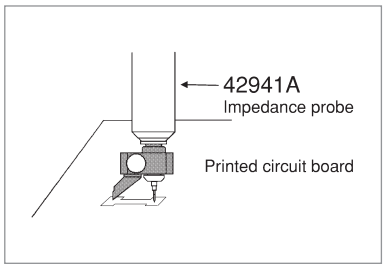


Short compensation

Description: This impedance probe kit is designed for use with the E4990A-120. It provides the capability to perform in-circuit measurements (printed circuit patterns, the input/output impedance of circuits, etc.) with better accuracy and wider impedance coverage from 20 Hz to 120 MHz. DUTs can be connected by either using the pin probe, the clip lead (alligator clip adapter) or the BNC adapter. All probe adapter can be used from 20 Hz to 120 MHz. The pin probe is best for in-circuit, board-mounted components, The clip lead is for components too large for the pin probe. The BNC adapter is used to connect circuits or networks equipped with BNC connectors.
Applicable instrument: E4990A-120
Frequency: 20 Hz to 120 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: –20 to +75°C (probe only)
Furnished accessories:

Description	P/N	Qty.
Pin probe	42941-60002	1
Adapter BNC-SMA	1250-2375	1
Spare pin Set (3 ea.)	42941-60004	1
3.5 mm SHORT	1250-2840	1
3.5 mm LOAD	0955-1105	1
Clip lead	8121-0003	1
Ground lead	04193-61679	1
Carrying case	42941-60011	1
Operating and service manual	42941-90010	1

Compensation and measurement: Adapter setup and compensation is required before measurement. In the Adapter setup menu, select PROBE 42941A. Use the furnished 3.5 mm short and load standards. The open condition can be created by not connecting the probe to anything. Perform phase compensation, short and load data measurements. For compensation, open and short compensation is recommended. Short compensation is performed by shorting the probe. To short the probe it is recommended to use a shorting device with gold-plated surfacing (which provides stable contact resistance).



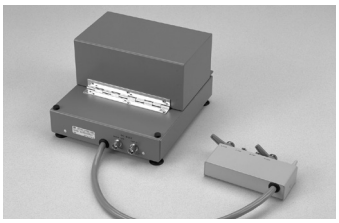
In-circuit measurement

Up to 120 MHz (4-Terminal Pair): DC Bias Accessories

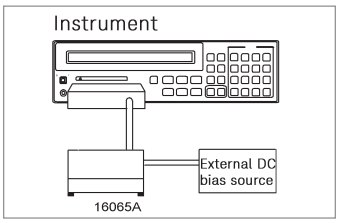
16065A 200 Vdc external voltage bias fixture



Terminal connector: 4-Terminal Pair, BNC
DUT connection: 4-Terminal
External bias input connector: High Voltage BNC(f)
Dimensions (approx.): 180 (W) x 120 (H) x 200 (D) [mm]
Cable length (approx.): 40 cm
Weight (approx.): 1500 g



High Voltage BNC(f) connector for external bias input
BNC(f) connector for voltage monitor output



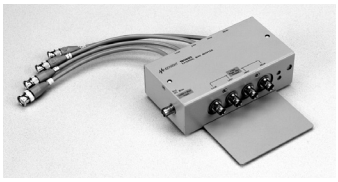
LCR meter with 16065A

Description: This test fixture makes it possible to measure a DUT with up to ±200 V DC bias. The same modules of 16047A can be used to allow measurements of axial/radial lead components.
Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: 50 Hz to 2 MHz
Maximum DC bias: ±200 V DC max. /15 V peak AC max.
Blocking capacitor of 5.6 µF is connected in with the Hc terminal.
Operating temperature: 0 to 55°C
DUT Size: See the 16047A figure with module sizes.
Furnished accessories:

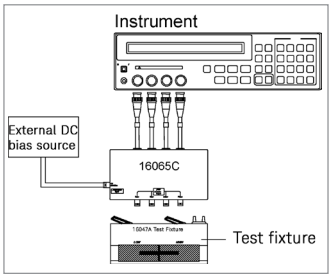
Description	P/N	Qty.
Module for axial lead	16061-70022	1
Module for radial lead mounting on fixture	16061-70021	1
Module for short radial lead	16047-65001	1
Shorting bar	16047-00640	1
Operating and service manual	16065-90011	1

Compensation and measurement: Open, short and load compensations are recommended before measurement. Short compensation is performed by shorting the contacts of the test fixture with a shorting plate as described for the 16047A. Load compensation is performed by inserting a known standard device. After performing open, short and load compensations, the DUT is connected to the test fixture.

16065C 40 Vdc external voltage bias adapter



Terminal connector: 4-Terminal Pair, BNC
External bias input connector: BNC(f)
Dimensions (approx.): 160 (W) x 50 (H) x 150 (D) [mm]
Cable length (approx.): 210 mm
Weight (approx.): 450 g



LCR meter with 16065C

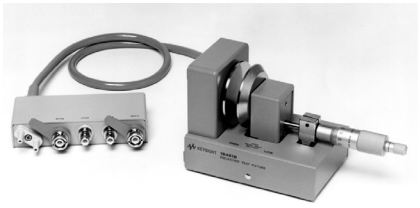
Description: This adapter is designed to operate specifically with the E4981A and the E4980AL. By connecting an external DC voltage source to this adapter, a bias voltage of up to ±40 V can be supplied to a DUT. The DUT can be inserted by connecting any direct attachment 4-Terminal Pair test fixture to the adapter.
Applicable instruments: E4981A and E4980AL
Frequency: 100 Hz to 1 MHz
Maximum DC bias: ±42 V peak max. (AC+DC)
Blocking Capacitor of 100 µF is connected in series with the Hc terminal.
Operating temperature: 0 to 55°C
Applicable fixtures: 16034E/G/H, 16047A/E, 16048A/D, 16089A/B/C
Furnished accessories:

Description	P/N	Qty.
Operating and service manual	16065-90020	1

Compensation and measurement: Open and short compensations are recommended before measurement. Short compensation is performed by shorting the contacts of the test fixture that is in use. After performing open and short compensations, the DUT is connected to the test fixture.

Up to 120 MHz (4-Terminal Pair): Material

16451B Dielectric test fixture



Terminal connector: 4-Terminal pair, BNC
Dimension (approx.): See page 26
Cable length (approx.):
0.8 m(from connector to electrodes)
Weight (approx.): 3700 g
Measurement accuracy

ε'_r accuracy $\left(\frac{\Delta\varepsilon'_{rm}}{\varepsilon'_{rm}}\right)$

tan δ < 0.1:

$$A_Z + 0.04\, f^2 \varepsilon'_{rm} \varepsilon_0 \left(\frac{\pi\left(\frac{d}{2}\right)^2}{t}\right) + \frac{100\,(\varepsilon'_{rm} - 1)}{\left(\varepsilon'_{rm} - \frac{t}{0.01}\right)}\ [\%]$$

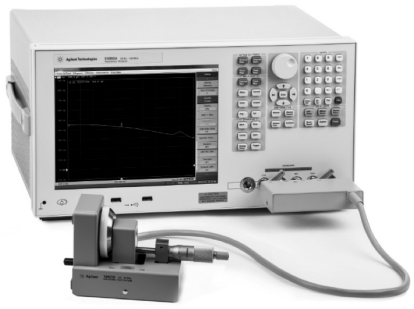
ε* Loss Tangent Accuracy (Δ tan δ)
tan δ < 0.1 : Ad + Ea + Eb

$$E_a = 0.005 + 0.0004\, f^2 \varepsilon'_{rm} \varepsilon_0 \left(\frac{\pi\left(\frac{d}{2}\right)^2}{t}\right)$$

$$E_b = \frac{\tan\delta}{100} \frac{\Delta\varepsilon'_{rm}}{\varepsilon'_{rm}}$$

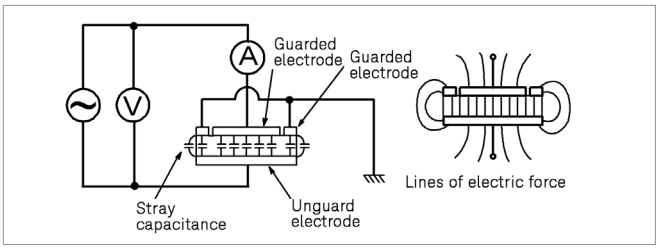
(supplemental performance characteristics):
f: measured frequency [Hz] f ≤ 30 MHz
ε'_{rm}: measured permittivity
tan δ: measured dissipation factor
ε_0 : permittivity of air 8.854 × 10^{-12}[F/m]
d: diameter of electrode {A,B}
t: thickness of material [mm]
Az: Impedance measurement error of instrument
Ad: D measurement error of instrument

The material is assumed to be ideally flat.
The above equation is applicable for electrodes A and B when using the contacting electrode method.



E4990A with 16451B

Description: The 16451B is used to evaluate the dielectric constant of solid dielectric materials accurately, and complies with ASTM D150. The 16451B employs the parallel plate method, which sandwiches the material between two electrodes to form a capacitor. LCR meter or an Impedance Analyzer is then used to measure the capacitance created from the fixture. A measurement block diagram of the parallel plate method is shown below:

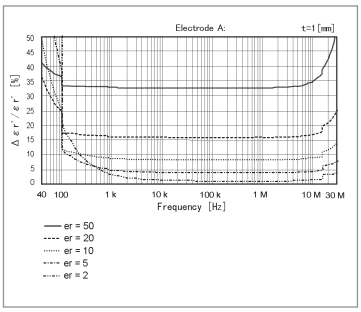


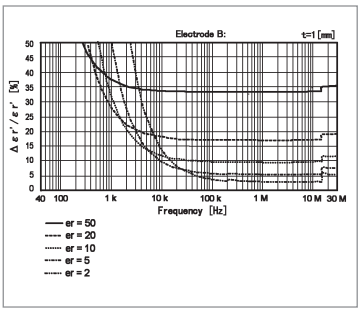
Parallel plate method

Notice the stray capacitance, which is formed on the test material as shown in the figure above. The guard electrode helps to eliminate the stray capacitance at the edge of the electrode.

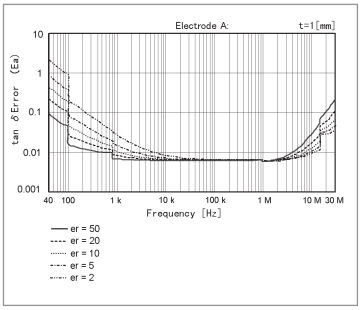
Basic measurement accuracy (including the E4990A):

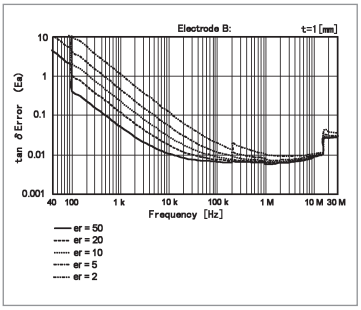
Typical Permittivity (εr') Measurement Accuracy:





Typical Loss Tangent (tan δ) Measurement Accuracy:





E4990A Measurement settings;

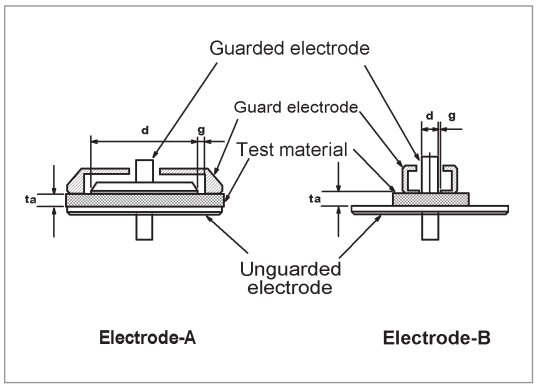
1. Osc level : 500 mV
2. Meas Time: 5 Precise
3. Adapter setup : 1 m
4. Compensation : Open, short and load

Up to 120 MHz (4-Terminal Pair): Material *continued*

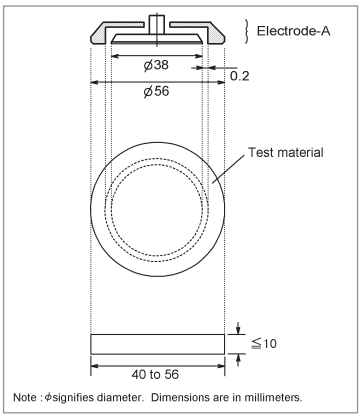
16451B Dielectric test fixture *continued*

Applicable instruments: E4980A/AL, E4981A, E4990A
Frequency: DC to 30 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C

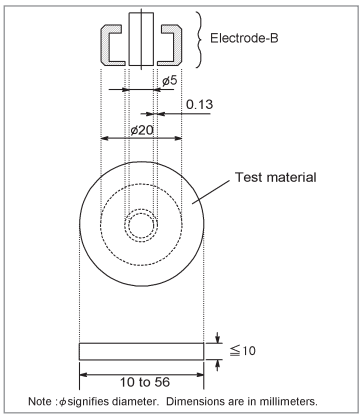
Material size:



Electrodes for contacting electrode method (Rigid Metal Electrode)



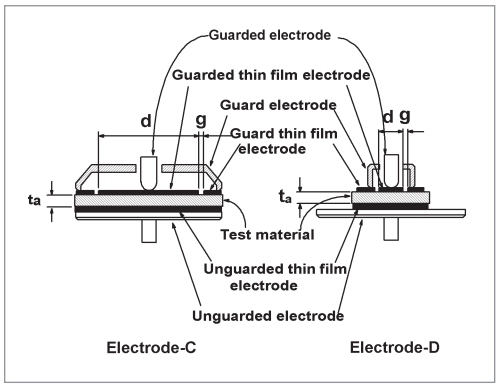
Material size for electrode-A



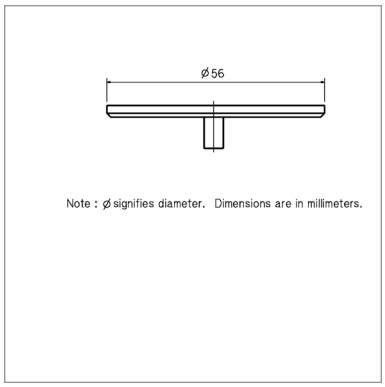
Material size for electrode-B

Equipped with Electrodes A and B for flat and smooth materials.

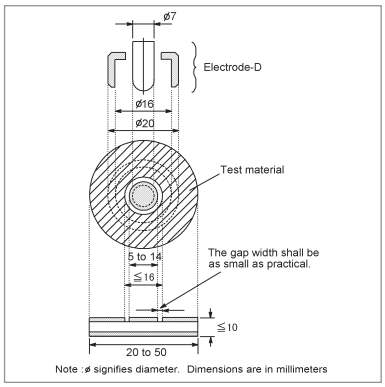
Electrode type	Diameter of MUT	Thickness of MUT	Diameter of electrode	Max. frequency
A	40 mm ~ 56 mm	t ≤ 10 mm	38 mm	30 MHz
B	10 mm ~ 56 mm	t ≤ 10 mm	5 mm	30 MHz



Electrodes for contacting electrode method (Thin Film Electrode)



Material size for electrode-C



Material size for electrode-D

Equipped with Electrodes C and D for rough or extremely thin materials.

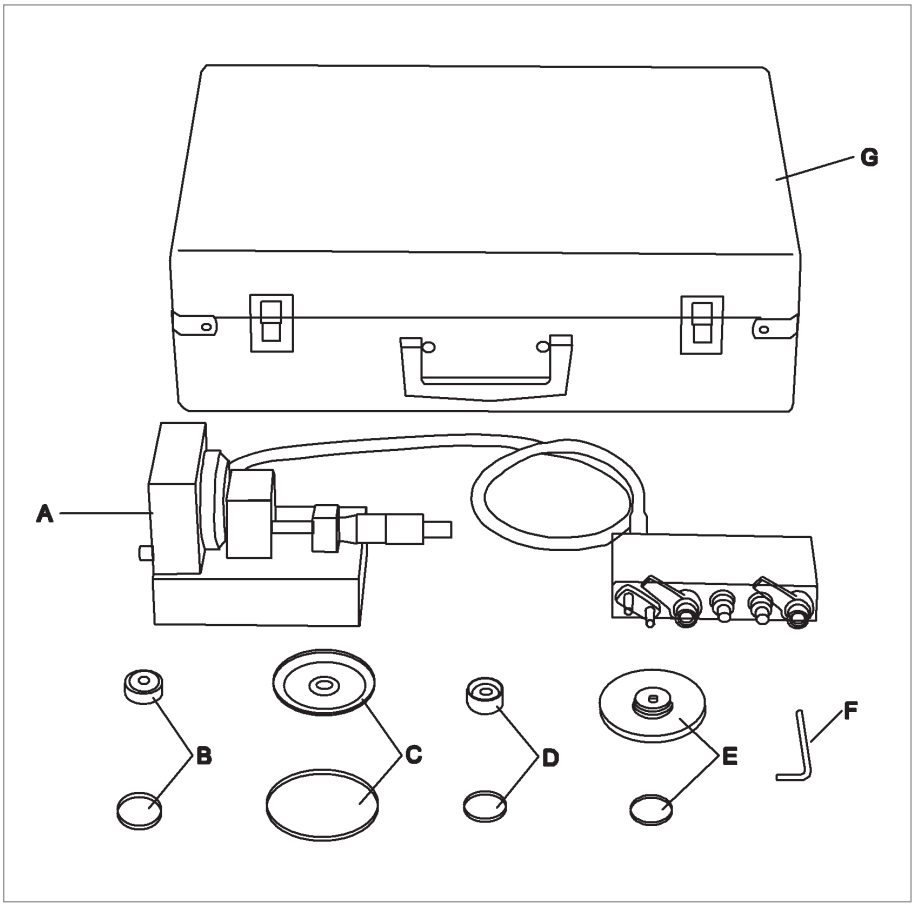
Electrode type	Diameter of MUT	Thickness of MUT	Diameter of electrode	Max. frequency
C	56 mm	t ≤ 10 mm	5 ~ 50 mm	30 MHz
D	20 mm ~ 56 mm	t ≤ 10 mm	5 ~ 14 mm	30 MHz

* diameter of applied thin film electrode

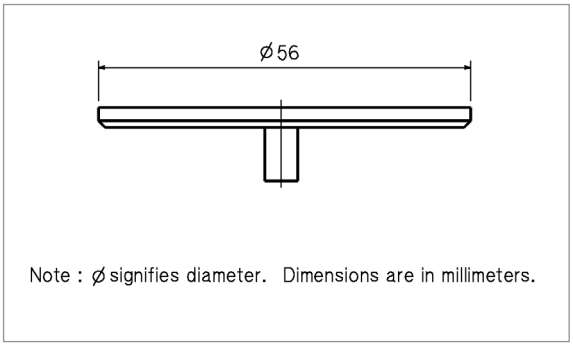
Up to 120 MHz (4-Terminal Pair): Material *continued*

16451B Dielectric test fixture *continued*

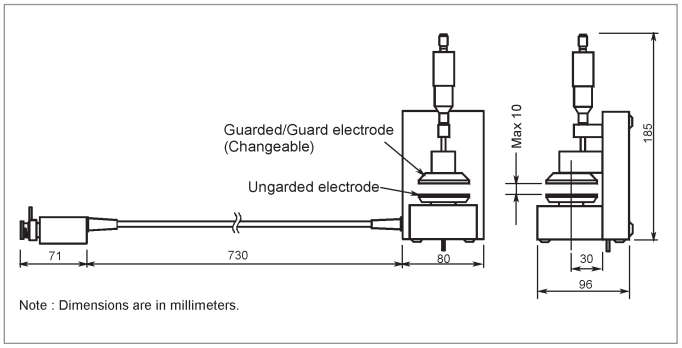
Furnished accessories:



Description	P/N	Qty.	
Test Fixture including Electrode-A, unguarded electrode and cover	N/A	1	A
Electrode-B and cover	16451-60013	1	B
Electrode-C and cover	16451-60012	1	C
Electrode-D and cover	16451-60014	1	D
Attachment for error compensation and cover	16451-60021	1	E
Hex key (for replacing electrodes)	5188-4452	1	F
Carrying Case	16451-60001	1	G



Dimensions of unguarded electrode



Dimensions of fixture assembly

Up to 120 MHz (4-Terminal Pair): Material *continued*

16451B Dielectric test fixture *continued*

Compensation and measurement: There are three measurement methods for the 16451B. They are the Contacting Electrode Method (used with 16451B's rigid metal electrode, without any electrodes on the material under test), the Contacting Electrode Method (used with thin film electrodes made on the material under test), and the Non-Contacting Electrode (Air Gap method). Select the suitable measurement method and the suitable electrode for the material under test according to the following table.

Summary of measurement method

Measurement method	Contacting electrode method (used with rigid metal electrode)	Contacting electrode method (used with thin film electrode)	Non-contacting electrode method
Accuracy	Low ----------> High		
Operation	Simple ----------> Complex		
Applicable materials	Thick, solid and smooth materials	Materials on which thin film can be applied without changing its characteristics	Thick, and soft materials Rough materials also

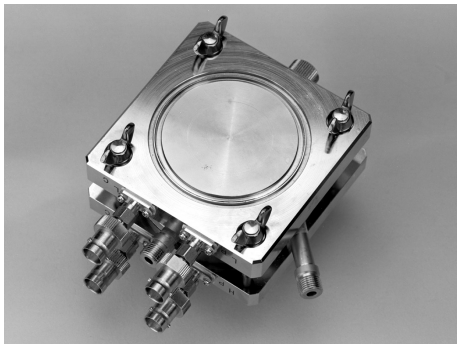
Open and short compensations are recommended in combination with the cable length compensation before measurement. When measuring above 5 MHz with the E4990A, load compensation is also recommended. First, set the instrument's cable length compensation function to 1 m. Then, open and short compensation is performed by using the furnished electrode attachment. Load compensation is performed, by preparing a working standard. After performing open, short and load compensations, the MUT is sandwiched by the parallel electrodes and the capacitance is measured. Relative permittivity is calculated from the measured capacitance in the following manner:

$$\varepsilon r' = \frac{t_a \times C_p}{\pi \times (\frac{d}{2})^2 \times \varepsilon_o}$$

$\varepsilon r'$: Relative permittivity
C_p: Capacitance (measurement data)
ε_o : 8.854×10^{-12} [F/m]
t_a : Average thickness of test material
d : Diameter of guarded electrode

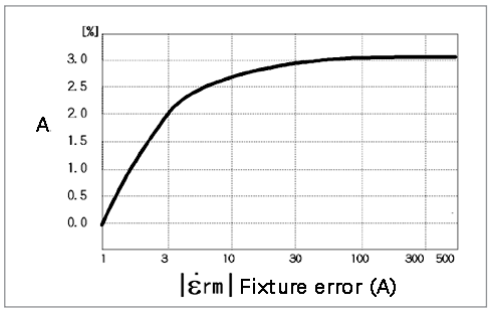
Up to 120 MHz (4-Terminal Pair): Material *continued*

16452A Liquid dielectric test fixture

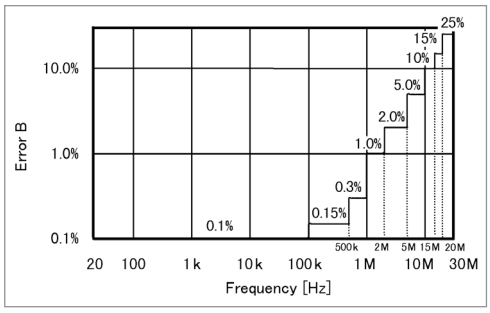


Terminal connector: 4-Terminal Pair, SMA
Dimensions (approx.): 8
5 (H) x 85 (W) x 37 (D) [mm]
Weight (approx.): 1400 g
Measurement accuracy: A + B + C [%]

Error A [%]



Error B [%]



Error C [%] = Measurement Error of Instrument



LCR meter with 16452A

Description: This test fixture provides accurate dielectric constant and impedance measurements of liquid materials. The 16452A employs the parallel plate method, which sandwiches the liquid material between two electrodes to form a capacitor. A LCR meter or an impedance analyzer is then used to measure the capacitance created from the fixture.
Applicable instruments: E4980A/AL, E4990A
Frequency: 20 Hz to 30 MHz
Operating temperature: –20 to 125°C
Maximum voltage: 30 Vrms
Material capacity: Required sample liquid capacity depends on the gap of the electrodes.

Gap of electrodes	0.3 mm	0.5 mm	1 mm	2 mm
Air capacitance	34.9 pF ±25%	21.2 pF ±15%	10.9 pF ±10%	5.5 pF ±10%
Sample liquid capacity	3.4 ml	3.8 ml	4.8 ml	6.8 ml
Applicable frequency	20 Hz – 30 MHz			



Furnished accessories:

Description	P/N	Qty.	
Shorting plate	16092-08010	1	E
O-ring for liquid outlet	0905-1277	1	D
Spacer (1.3 mm thickness)	16452-00601	1	F
Spacer (1.5 mm thickness)	16452-00602	1	F
Spacer (2.0 mm thickness)	16452-00603	1	F
Spacer (3.0 mm thickness)	16452-00604	1	F
Lid of liquid outlet	16452-24002	1	G
SMA-BNC adapter	1250-1200	4	H
Waterproof cap for BNC connector	1252-5821	4	I
Carrying case	16452-60111	1	–
Operation and service manual	16452-90020	1	–
Angle iron of stand body for fixture stand	16452-01201	2	–
Screw of stand body or fixture stand	0515-0914	4	C
Screw for fixture stand	0515-0914	4	–
Stand foot	16452-00611	1	–
Electrode (high and low)	NA	2	A.B

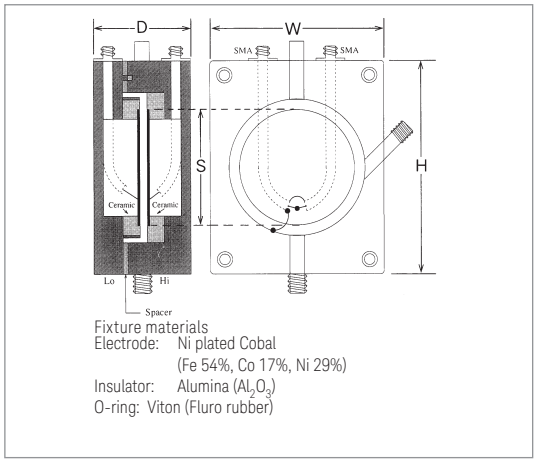
Requires the following interface cables to connect to a measurement instrument. Select accordingly to the required temperature conditions.

Temperature	Model# or P/N	Cable length (approx.)
0 to 55°C	16048A	0.94 m
–20 to 150°C	16048G* for E4990A only	1 m
–20 to 150°C	16048H* for E4990A only	2 m

* Four BNC(m) to BNC(m) adapters (P/N 1250-0216) are needed to connect the 16048G/H and 16452A.

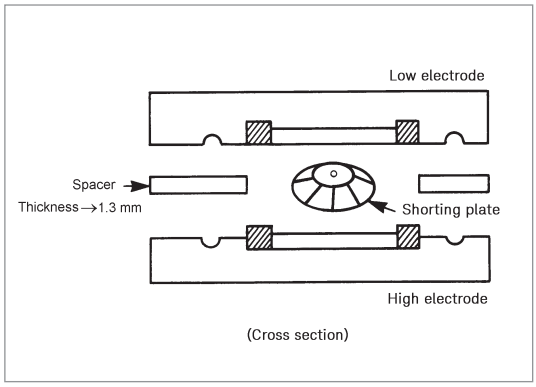
Up to 120 MHz (4-Terminal Pair): Material *continued*

16452A Liquid dielectric test fixture *continued*

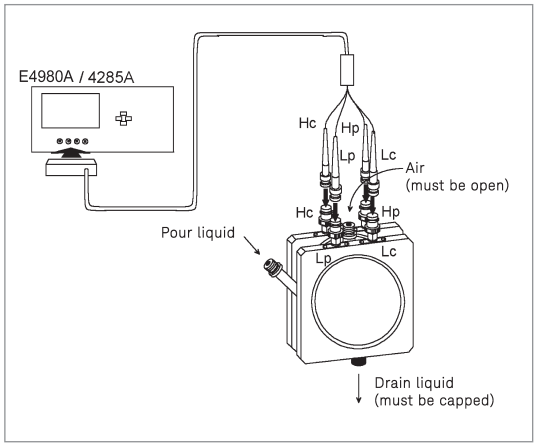


Fixture materials
Electrode: Ni plated Cobal
(Fe 54%, Co 17%, Ni 29%)
Insulator: Alumina (Al_2O_3)
O-ring: Viton (Fluro rubber)

Test fixture overview



Short compensation



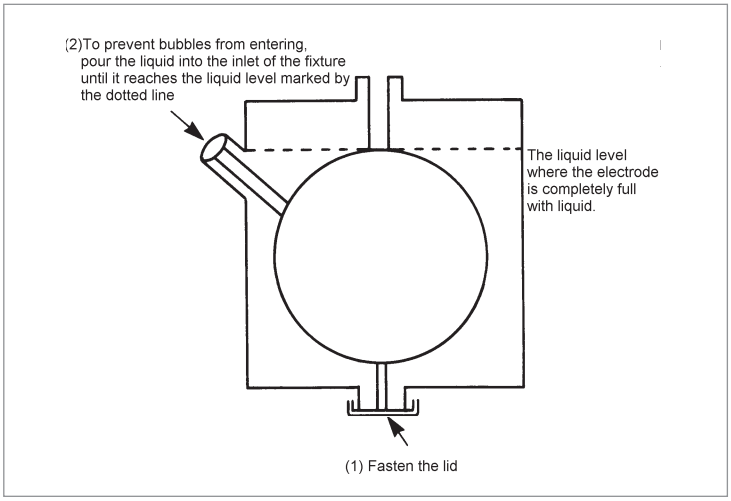
Method of connection

Compensation and measurement: Short compensation is recommended in combination with the cable length compensation before measurement. First, set the instrument's cable length compensation function to 1 m. Then, short compensation is performed by using the furnished shorting plate. Open compensation is not performed, but its values are used in the dielectric constant equation as shown below:

$$\varepsilon_r = \alpha \left(\frac{Cp}{Co} - j \frac{1}{\omega CoRp} \right)$$

α : Correction coefficient
ε_r : Relative dielectric constant
Cp : Liquid capacitance (measurement data)
Co : Air capacitance (measurement data) or open compensation data
Rp : Equivalent parallel resistance (measurement data)
ω : Angular frequency ($\omega = 2\pi f$)

The following figures below show how compensation and measurement is performed.

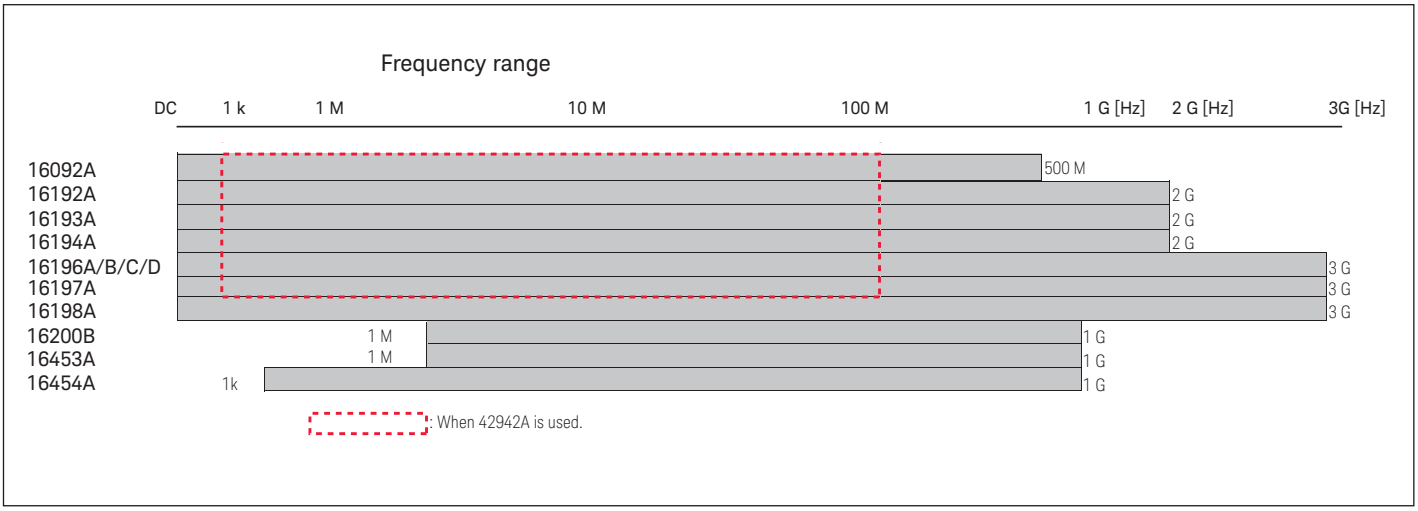


Pouring the liquid into the fixture

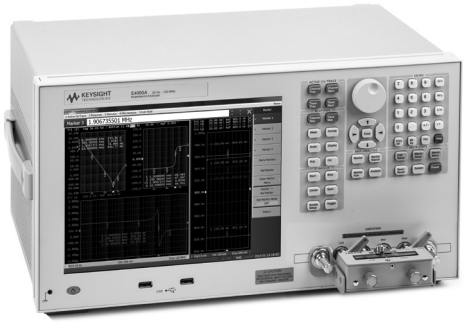
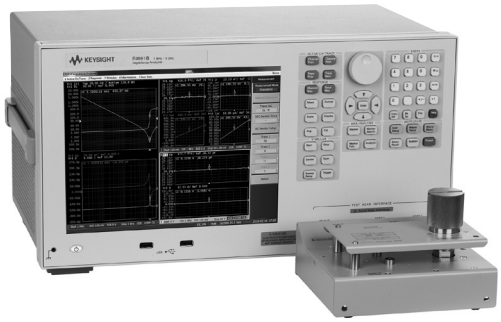
Note: The 16452A is not capable of measuring salt or ionic solutions or other liquids with bulk conductivity due to the electrode polarization phenomenon.

Keysight is not responsible for any damage (e.g., corrosion, smear) to the 16452A caused by the reaction between the liquid under test and the 16452A.

Up to 3 GHz (7 mm)



Applicable instrument

Frequency range	Up to 120 MHz (Terminal configuration: 4-Terminal Pair)	Up to 3 GHz (Terminal configuration: 7 mm)
		
Measurement instruments	E4980A/AL, E4981A, E4990A	E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 w/Opt. 005 + 16201A * Option E4990A-120 is required

Up to 3 GHz (7 mm): Lead Components

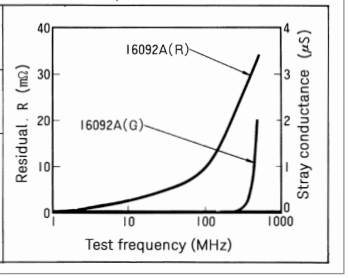
16092A Spring clip fixture

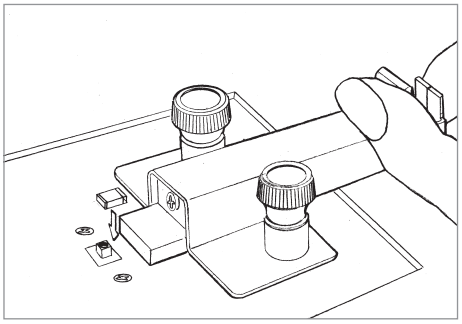


Terminal connector: 7 mm
DUT connection: 2-Terminal
Electrical length: 3.4 mm
Dimensions (approx.): 150 (W) x 70 (H) x 80 (D) [mm]
Weight (approx.): 180 g
Additional error: See figure below

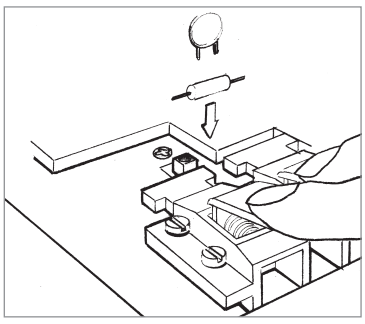
Model 16092A Residual parameters

Stray C	1.1 pF	
Residual L	1.3 nH	
Residual R	See graph	
Stray G		



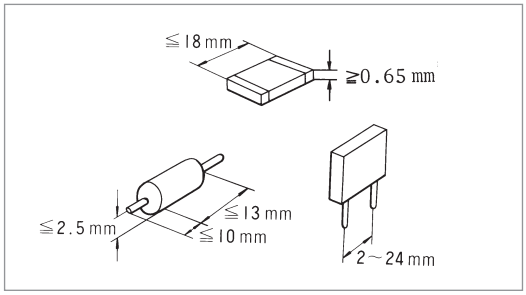


Inserting the SMD



Inserting the leaded component

Description: This test fixture is designed for impedance evaluation of both lead and SMD. It is furnished with two modules that can be readily screwed onto the plate to measure either lead or SMD.
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: DC to 500 MHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: 0 to 55°C
DUT size: See figure below



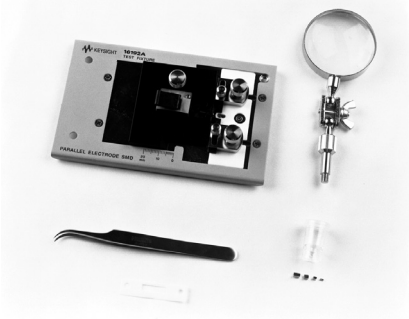
Furnished accessories:

Description	P/N	Qty.
Shorting plate	16092-08010	1
Operating note	16092-90010	1

Compensation and measurement: Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. When using the SMD module, open compensation is performed by separating the high and the low electrodes from each other. The separation should be equivalent in size to the DUT's width. Short compensation is performed by usinf the furnished shorting plate. When using the lead component module, open compensation is performed by not having the module-electrodes be connected to anything. Short compensation is performed by using the furnished shorting plate. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture.

Up to 3 GHz (7 mm): SMD

16192A Parallel electrode SMD test fixture

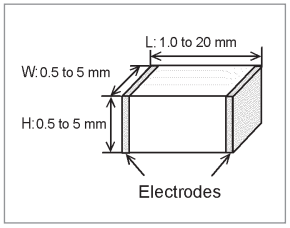


Terminal connector: 7 mm
DUT connection: 2-Terminal
Electrical length: 11 mm
Dimensions (approx.):
150 (W) x 70 (H) x 90 (D) [mm]
Weight (approx.): 400 g
Additional error:

Type of error	Impedance
Proportional error	1.5 x f^2 [%]
Open repeatability	2 + 30 x f [μS]
Short repeatability	30 + 250 x f [mΩ]

f: [GHz]

Description: This test fixture is designed for impedance evaluations of parallel electrode SMD. The minimum SMD size that this fixture is adapted to evaluate is 1 (L) [mm].
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
*Option E4990A-120 is required
Frequency: DC to 2 GHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: –55 to +85°C
DUT size: 1 mm to 20 mm (length)

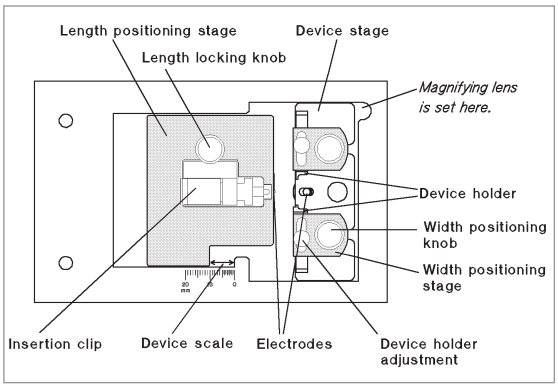


Furnished accessories:

Description	P/N	Qty.	Option
Operation and service manual	16192-90040	1	Standard
General sized			
Shorting device (1 x 1 x 2.4 (mm))	16191-29001	1	16192A-701
Shorting device (1.6 x 2.4 x 2 (mm))	16191-29002	1	16192A-701
Shorting device (2.4 x 2.4 x 3.2 (mm))	16191-29003	1	16192A-701
Shorting device (2.4 x 2.4 x 4.5 (mm))	16191-29004	1	16192A-701
EIA/EIAJ industrial standard sized			
Shorting device (1 x 0.5 x 0.5 (mm))	16191-29005	1	16192A-010
Shorting device (1.6 x 0.8 x 0.8 (mm))	16191-29006	1	16192A-010
Shorting device (2.0 x 1.2 x 0.8 (mm))	16191-29007	1	16192A-010
Shoring device (3.2 x 1.6 x 0.8 (mm))	16191-29008	1	16192A-010
Case for shorting devices	1540-0692	1	16192A-010/701
Magnifying lens	16193-60002	1	16192A-710
Tweezers	8710-2081	1	16192A-710

Up to 3 GHz (7 mm): SMD *continued*

16192A Parallel electrode SMD test fixture *continued*



Test fixture overview

Options:
16192A-010: Add EIA/EIAJ industrial standard sized shorting bar set
16192A-701: Add general sized shorting bar set
16192A-710: Add the magnifying lens and tweezers

Compensation and measurement: Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. Then open compensation is performed by separating the high and the low electrodes from each other. The separation should be equivalent in size to the DUT's width. Short compensation is performed by using option 16192A-010/701 shorting bar set. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture. The following figures show how compensation and measurement is performed.

a. Place the shorting device/DUT so that it contacts the electrode.

b. Adjust the two knobs and the two device holders to hold the shorting device/DUT.

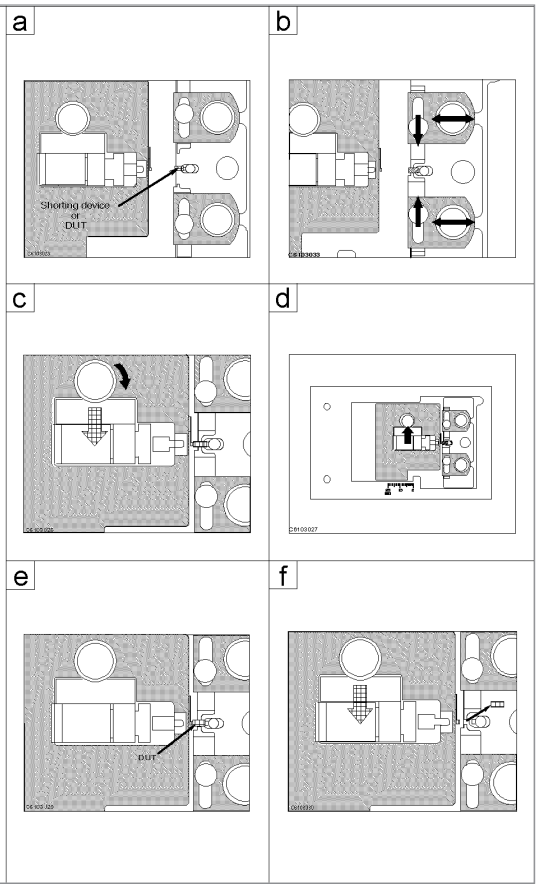
c. Tighten knob while pushing the lever.

d. Release the lever to hold the shorting device/DUT. Perform short compensation or measure the DUT.

e. Set the DUT on the test fixture just as you set the shorting device in the SHORT compensation.

f. Push the black lever and remove the DUT. Perform open compensation.

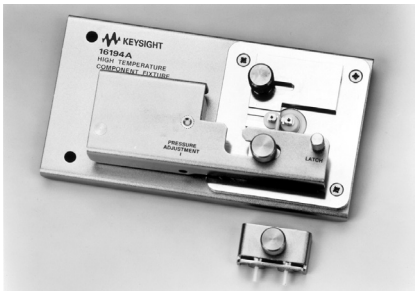
For more details, please refer to 16192A operation manual.



Open/short compensation

Up to 3 GHz (7 mm): SMD *continued*

16194A High temperature component test fixture



Terminal connector: 7 mm
DUT connection: 2-Terminal
Electrical length: 50 mm
Dimensions (approx.):
150 (W) x 40 (H) x 80 (D) [mm]
Weight (approx.): 350 g
Additional error:
SMD:

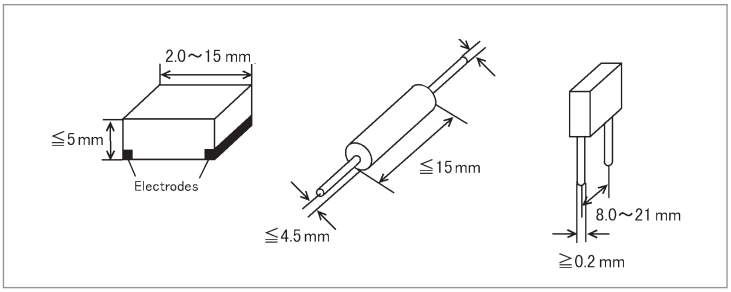
Type of error	Impedance
Proportional error	20 x f^2 [%]
Open repeatability	80 + 250 x f [μS]
Short repeatability	0.2 + 2.5 x f [Ω]

Leaded device:

Type of error	Impedance
Proportional error	20 x f^2 [%]
Open repeatability	80 + 500 x f [μS]
Short repeatability	0.4 + 12.5 x f [Ω]

f: [GHz]

Description: This test fixture is designed for measuring both axial/radial leaded devices and SMD within the temperature range from –55 to +200 °C (when used with the E4991B-007 Temperature Characteristic Test Kit, –55 to +150 °C).
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency:
DC to 500 MHz (with open and short compensation)
DC to 2 GHz (with open and short and load compensation)
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: –55 to +200°C
DUT size: See figure below.



Furnished accessories:

Description	P/N	Qty.	Option
Wrench	8710-1181	1	Standard
Tweezers	8710-2081	1	Standard
50Ω SMD resistor	0699-2829	10	Standard
Operation and service manual	16194-90030	1	Standard
General sized			
Shorting device (1 x 1 x 2.4 (mm))	16191-29001	1	16192A-701
Shorting device (1.6 x 2.4 x 2 (mm))	16191-29002	1	16192A-701
Shorting device (2.4 x 2.4 x 3.2 (mm))	16191-29003	1	16192A-701
Shorting device (2.4 x 2.4 x 4.5 (mm))	16191-29004	1	16192A-701
EIA/EIAJ industrial standard sized			
Shorting device (1 x 0.5 x 0.5 (mm))	16191-29005	1	16192A-010
Shorting device (1.6 x 0.8 x 0.8 (mm))	16191-29006	1	16192A-010
Shorting device (2.0 x 1.2 x 0.8 (mm))	16191-29007	1	16192A-010
Shoring device (3.2 x 1.6 x 0.8 (mm))	16191-29008	1	16192A-010
Case for shorting devices	1540-0692	1	16192A-010/701

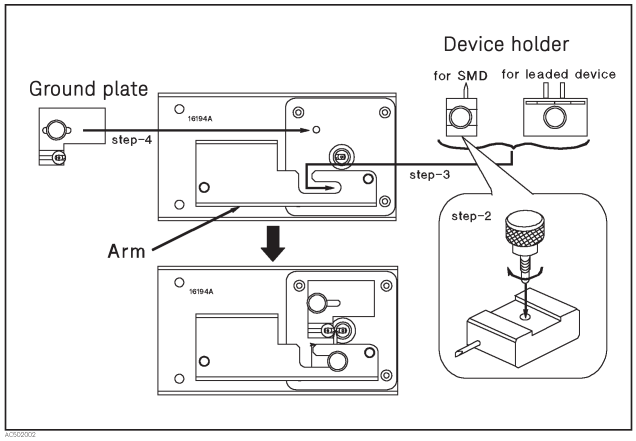
Up to 3 GHz (7 mm): SMD *continued*

16194A High temperature component test fixture *continued*

Options:
16194A-010: Add EIA/EIAJ industrial standard sizedshorting bar set
16194A-701: Add general sized shorting bar set

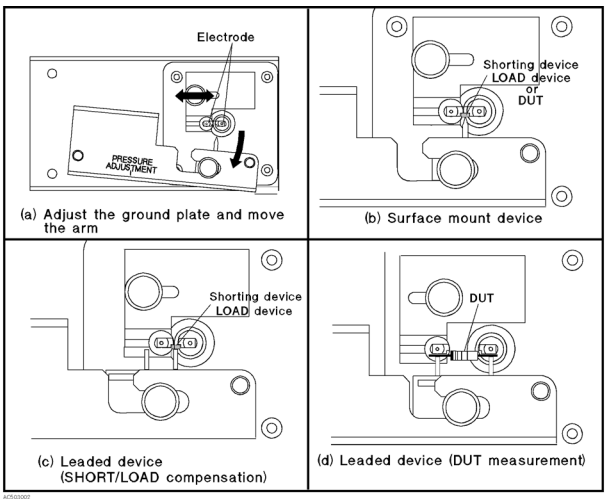
Compensation and measurement: Before beginning the measurement, the appropriate device holder (for a SMD or lead component) must be prepared with the text fixture. The following figure shows how the device holder is exchanged to match the device type. The next step is to perform open and short compensations in combination with the electrical length compensation. When measuring above 500 MHz, load compensation

1. Remove the ground plate
2. When measuring SMD, attach the knob on the device holder.
3. Select the device holder suitable for the device type. Loosen its knob and insert into the arm.
4. Set the ground plate.



Exchanging the device holder

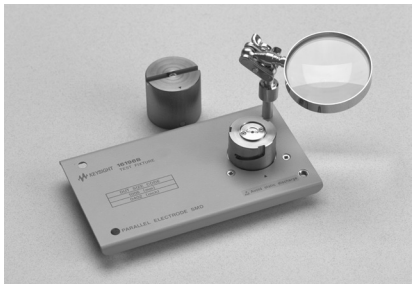
is also recommended. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. Then open compensation is performed by separating the high and the low electrodes from each other. The separation should be equivalent in size to the DUT's width. Short compensation is performed by using the option 16194A-010/701 shorting bar set. Load compensation is performed by using the furnished 50 Ω SMD chip resistor. After performing open, short, and load compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture. The following figures show how measurement is performed.



Placing the device

Up to 3 GHz (7 mm): SMD *continued*

16196A Parallel electrode SMD test fixture



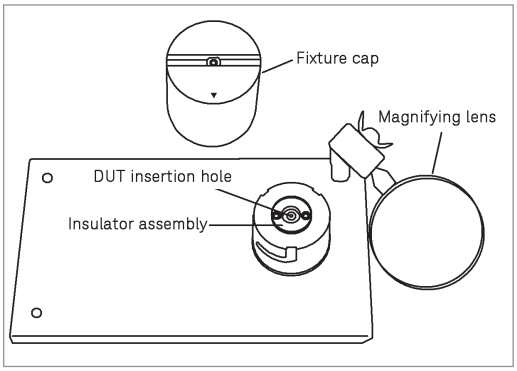
Terminal connector: 7 mm
DUT connection: 2-Terminal
Electrical length: 26.2 mm
Dimensions (approx.):
140 (W) x 48 (H) x 78 (D) [mm]
Weight (approx.): 250 g
Additional error:

Type of error	Impedance
Proportional error	1.0 x f^2 [%]
Open repeatability	5 + 40 x f [μS]
Short repeatability	30 + 125 x f [mΩ]

f: frequency [GHz]

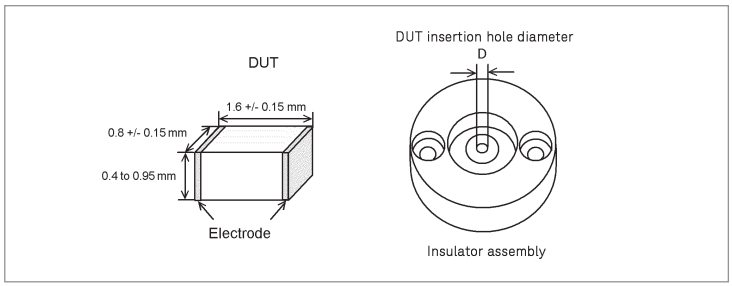


E4982A with 16196A



Fixture overview

Description: This test fixture is designed for impedance evaluations of parallel electrode SMDs. It achieves stable frequency characteristics up to 3 GHz and provides highly repeatable measurements. The applicable SMD size code is 0603 (inch)/1608 (mm).
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: DC to 3 GHz
Maximum voltage: ±42 V peak max. (AC +DC)
Operating temperature: –55 to +85°C
DUT size: The applicable SMD size is 0603 (inch)/1608 (mm). For details, see the figure below.



The 16196A is furnished with three different insulator assemblies, since any gaps between the DUT and the cylindrical insulator will result in improper positioning and subsequent measurement errors. Select an insulator assembly that reduces the gap the most. See the table below for dimensions of the insulator assemblies.

	Hole diameter of insulator assembly (mm)	SMD case size examples Length, width, height (mm)
16196A	ϕ 1.34	1.6 x 0.8 x 0.8
	ϕ 1.14	1.6 x 0.8 x 0.6
	ϕ 1.08	1.6 x 0.8 x 0.5

Furnished accessories:

Description	P/N	Qty.
Operation and service manual	16196-90040	1
Insulator assembly ϕ 1.34 mm	16196-60112	1
Insulator assembly ϕ 1.14 mm	16196-60113	1
Insulator assembly ϕ 1.08 mm	16196-60114	1
Open plate	16196-29002	1
Short plate	16196-29026	1
Push ring	16196-24004	1
Magnifying Lens[1]	16193-60002	1
Tweezers	8710-2081	1
Wrench	8710-0909	1
Cleaning rod	5182-7586	1
Carrying case	16196-60150	1

1. Opt. 16196A-710 only

Up to 3 GHz (7 mm): SMD *continued*

16196A Parallel electrode SMD test fixture *continued*

Options:
16196A-710 : Add the magnifying lens and tweezers

To maintain adequate measurement performance, keep the electrodes and the short plate in good condition. Contaminants and abrasion on these parts considerably affect measurement results, especially for low value measurements. Periodic fixture cleaning and part replacement is recommended to avoid deterioration of measurement performance. The 16196x fixtures are designed with simplicity in mind, so that an operator can easily replace parts. Spare parts, which are likely to be abraded, are supplied with the 16196U Maintenance Kit.

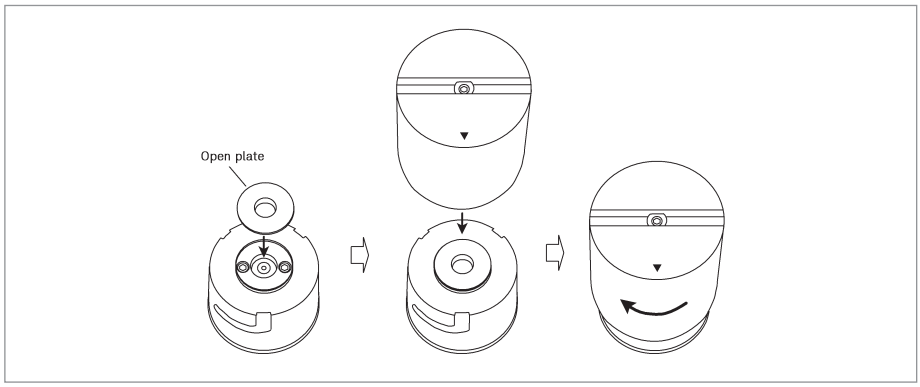
16196U Maintenance kit
Opt. 16196U-010: Upper electrode, 5 piece set (common to 16196A/B/C models)
Opt. 16196U-100: Short plate for 0603 (inch)/1608 (mm) size, 5 piece set (for 16196A)
Opt. 16196U-110: Lower electrode, 5 piece set (for 16196A)

Compensation and measurement: First of all, install the appropriate insulator assembly into the fixture. Then, perform compensation. Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. Next, open compensation is performed by placing the furnished open plate on top of the insulator assembly. Short compensation is performed by placing the furnished shorting plate on top of the insulator assembly. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture. Once the measurement of the DUT is complete, remove the DUT from the fixture, by using the furnished push ring. The following figures show how compensation and measurement is performed.

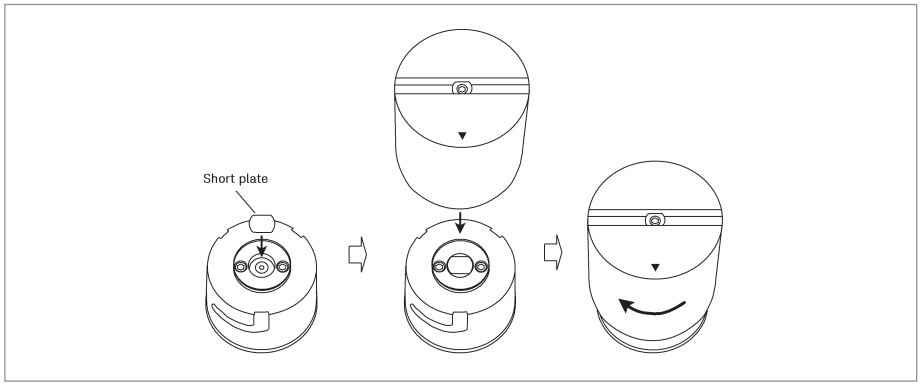
Up to 3 GHz (7 mm): SMD *continued*

16196A Parallel electrode SMD test fixture *continued*

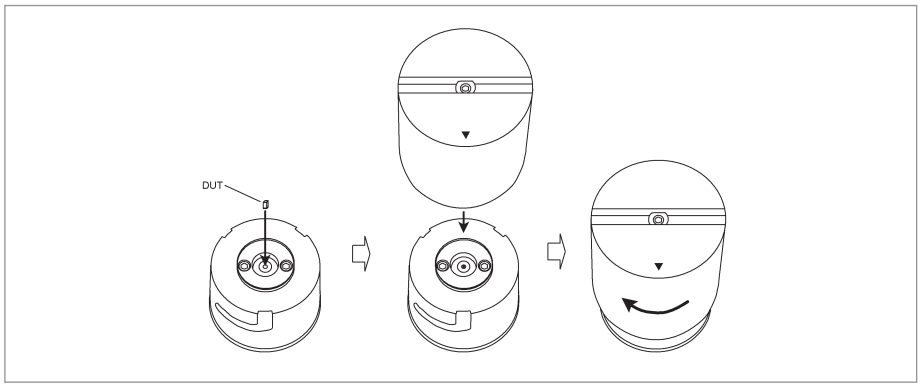
Compensation and measurement



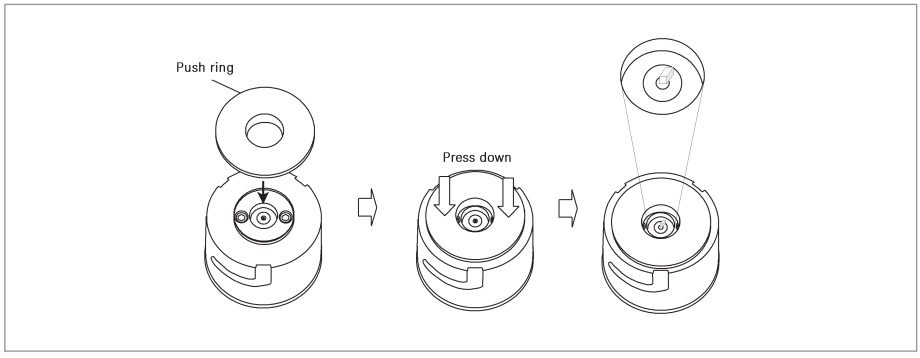
Open compensation



Short compensation



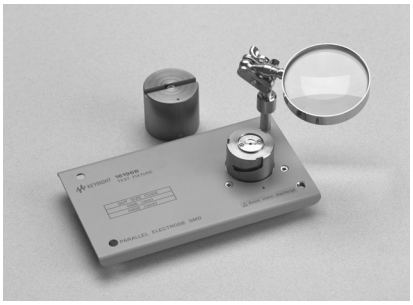
DUT measurement



Removing a DUT

Up to 3 GHz (7 mm): SMD *continued*

16196B Parallel electrode SMD test fixture

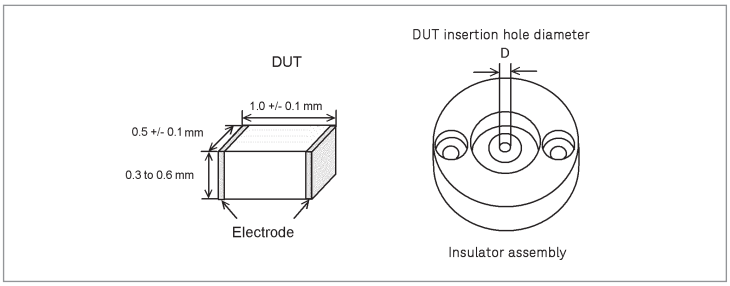


Terminal connector: 7 mm
DUT connection: 2-Terminal
Electrical length: 26.9 mm
Dimensions (approx.):
140 (W) x 48 (H) x 78 (D) [mm]
Weight (approx.): 250 g
Additional error:

Type of error	Impedance
Proportional error	1.0 x f^2 [%]
Open repeatability	5 + 40 x f [μS]
Short repeatability	30 + 125 x f [mΩ]

f: frequency [GHz]

Description: This test fixture is designed for impedance evaluations of parallel electrode SMDs. It achieves stable frequency characteristics up to 3 GHz and provides highly repeatable measurements. The applicable SMD size code is 0402 (inch)/1005 (mm).
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: DC to 3 GHz
Maximum voltage: ±42 V peak max. (AC +DC)
Operating temperature: –55 to +85 °C
DUT size: The applicable SMD size is 0402 (inch) /1005 (mm).
For details, see the figure below.



The 16196B is furnished with three different insulator assemblies, since any gaps between the DUT and the cylindrical insulator will result in improper positioning and subsequent measurement errors. Select an insulator assembly that reduces the gap the most. See the table below for dimensions of the insulator assemblies.

	Hole diameter of insulator assembly (mm)	SMD case size examples Length, width, height (mm)
16196B	ϕ 0.85	1.0 x 0.5 x 0.5
	ϕ 0.75	1.0 x 0.5 x 0.35
	ϕ 0.68	1.0 x 0.5 x 0.35

Furnished accessories:

Description	P/N	Qty.
Operation and service manual	16196-90040	1
Insulator assembly ϕ 0.85 mm	16196-60212	1
Insulator assembly ϕ 0.75 mm	16196-60213	1
Insulator assembly ϕ 0.68 mm	16196-60214	1
Open plate	16196-29002	1
Short plate	16196-29027	1
Push ring	16196-24004	1
Magnifying lens[1]	16193-60002	1
Tweezers[1]	8710-2081	1
Wrench	8710-0909	1
Cleaning rod	5182-7586	1
Carrying case	16196-60250	1

1. Opt. 16196B-710 only

Up to 3 GHz (7 mm): SMD *continued*

16196B Parallel electrode SMD test fixture *continued*

Options:
16196B-710: Add the magnifying lens and tweezers

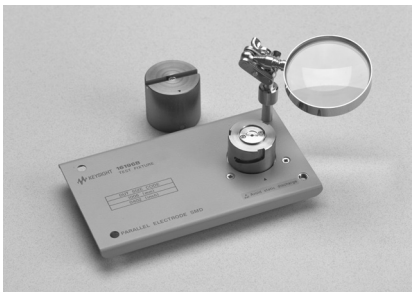
To maintain adequate measurement performance, keep the electrodes and the short plate in good condition. Contaminants and abrasion on these parts considerably affect measurement results, especially for low value measurements. Periodic fixture cleaning and part replacement is recommended to avoid deterioration of measurement performance. The 16196x fixtures are designed with simplicity in mind, so that an operator can easily replace parts. Spare parts, which are likely to be abraded, are supplied with the 16196U Maintenance Kit.

16196U Maintenance kit
Opt. 16196U-010: Upper electrode, 5 piece set (common to 16196A/B/C models)
Opt. 16196U-200: Short plate for 0402 (inch)/1005 (mm) size, 5 piece set (for 16196B)
Opt. 16196U-210: Lower electrode, 5 piece set (for 16196B)

Compensation and measurement: First of all, install the appropriate insulator assembly into the fixture. Then, perform compensation. Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. Next, open compensation is performed by placing the furnished open plate on top of the insulator assembly. Short compensation is performed by placing the furnished shorting plate on top of the insulator assembly. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture. Once the measurement of the DUT is complete, remove the DUT from the fixture, by using the furnished push ring. Refer to the 16196A figures to see how compensation and measurement is performed.

Up to 3 GHz (7 mm): SMD *continued*

16196C Parallel electrode SMD test fixture

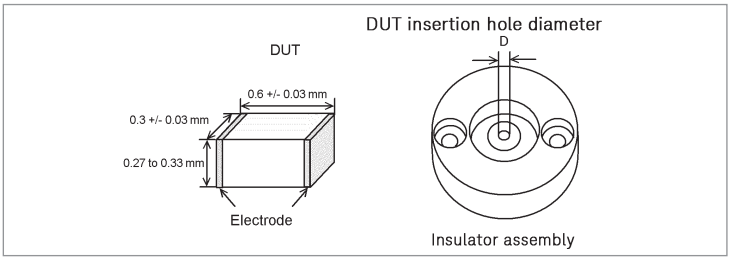


Terminal connector: 7 mm
DUT connection: 2-Terminal
Electrical length: 27.1 mm
Dimensions (approx.):
140 (W) x 48 (H) x 78 (D) [mm]
Weight (approx.): 250 g
Additional error:

Type of error	Impedance
Proportional error	1.0 x f^2 [%]
Open repeatability	5 + 40 x f [μS]
Short repeatability	30 + 125 x f [mΩ]

f: frequency [GHz]

Description: This test fixture is designed for impedance evaluations of parallel electrode SMDs. It achieves stable frequency characteristics up to 3 GHz and provides highly repeatable measurements. The applicable SMD size code is 0201 (inch)/0603 (mm).
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: DC to 3 GHz
Maximum voltage: ±42 V peak max. (AC +DC)
Operating temperature: –55 to +85°C
DUT size: The applicable SMD size is 0201 (inch)/0603 (mm). For details, see the figure below.



The 16196C is furnished with one insulator assembly. See the table below for the dimensions of the insulator assembly.

	Hole diameter of insulator assembly (mm)	SMD case size examples Length, width, height (mm)
16196C	ϕ 0.48	0.6 x 0.3 x 0.3

Furnished accessories:

Description	P/N	Qty.
Operation and service manual	16196-90040	1
Insulator Assembly ϕ 0.48 mm	16196-60312	1
Open plate	16196-29002	1
Short plate	16196-29028	1
Push ring	16196-24004	1
Magnifying lens[1]	16193-60002	1
Tweezers[1]	8710-2081	1
Wrench	8710-0909	1
Cleaning rod	5182-7586	1
Carrying case	16196-60350	1

1. Opt. 16196C-710 only

Up to 3 GHz (7 mm): SMD *continued*

16196C Parallel electrode SMD test fixture *continued*

Options:
16196C-710: Add the magnifying lens and tweezers

To maintain adequate measurement performance, keep the electrodes and the short plate in good condition. Contaminants and abrasion on these parts considerably affect measurement results, especially for low value measurements. Periodic fixture cleaning and part replacement is recommended to avoid deterioration of measurement performance. The 16196x fixtures are designed with simplicity in mind, so that an operator can easily replace parts. Spare parts, which are likely to be abraded, are supplied with the 16196U Maintenance Kit.

16196U Maintenance kit
Opt. 16196U-010: Upper electrode, 5 piece set (common to 16196A/B/C models)
Opt. 16196U-300: Short plate for 0201 (inch)/0603 (mm) size, 5 piece set (for 16196C)
Opt. 16196U-310: Lower electrode, 5 piece set (for 16196C)

Compensation and measurement: Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. Next, open compensation is performed by placing the furnished open plate on top of the insulator assembly. Short compensation is performed by placing the furnished shorting plate on top of the insulator assembly. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture. Once the measurement of the DUT is complete, remove the DUT from the fixture, by using the furnished push ring. Refer to the 16196A figures to see how compensation and measurement is performed.

Up to 3 GHz (7 mm): SMD *continued*

16196D Parallel electrode SMD test fixture

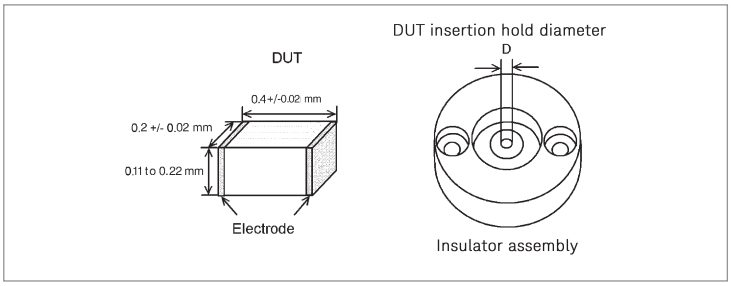


Terminal connector: 7 mm
DUt connection: 2-Terminal
Electrical length: 27.3 mm
Dimensions (approx.):
140 (W) x 48 (H) x 78 (D) [mm]
Weight (approx.): 250 g
Additional error:

Type of error	Impedance
Proportional error	1.0 x f^2 [%]
Open repeatability	5 + 40 x f [μS]
Short repeatability	30 + 125 x f [mΩ]

f: frequency [GHz]

Description: This test fixture is designed for impedance evaluations of parallel electrode SMDs. It achieves stable frequency characteristics up to 3 GHz and provides highly repeatable measurements. The applicable SMD size code is 01005 (inch)/0402 (mm).
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: DC to 3 GHz
Maximum voltage: ±42 V peak max. (AC +DC)
Operating temperature: –55 to +85 °C
DUT size: The applicable SMD size is 01005 (inch) /0402 (mm). For details, see the figure below.



The 16196D is furnished with two different insulator assemblies, since any gaps between the DUT and the cylindrical insulator will result in improper positioning and subsequent measurement errors. Select an insulator assembly that reduces the gap the most. See the table below for dimensions of the insulator assemblies.

	Hole diameter of insulator assembly (mm)	SMD case size examples Length, width, Height (mm)
16196D	ϕ 0.34	0.4 x 0.2 x 0.2
	ϕ 0.30	0.4 x 0.2 x 0.13/0.2

Furnished accessories:

Description	P/N	Qty.
Operation and service manual	16196-90040	1
Insulator assembly ϕ 0.34 mm	16196-60412	1
Insulator assembly ϕ 0.30 mm	16196-60414	1
Open plate	16196-29002	1
Short plate	16196-29030[2]	1
Push ring	16196-24004	1
Magnifying lens[1]	16193-60002	1
Tweezers[2]	8710-2081	1
Wrench	8710-0909	1
Cleaning rod	5182-7586	1
Carrying case	16196-60450	1

1. Opt. 16196D-710 only
2. 16196-15101 as replacement part number

Up to 3 GHz (7 mm): SMD *continued*

16196D Parallel electrode SMD test fixture *continued*

Options:
16196D-710: Add the magnifying lens and tweezers

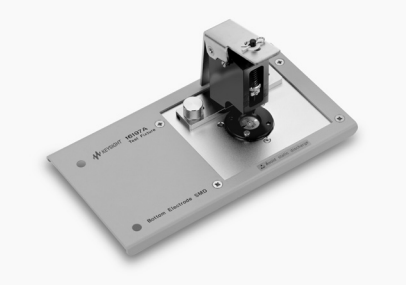
To maintain adequate measurement performance, keep the electrodes and the short plate in good condition. Contaminants and abrasion on these parts considerably affect measurement results, especially for low value measurements. Periodic fixture cleaning and part replacement is recommended to avoid deterioration of measurement performance. The 16196x fixtures are designed with simplicity in mind, so that an operator can easily replace parts. Spare parts, which are likely to be abraded, are supplied with the 16196U Maintenance Kit.

16196U Maintenance kit
Opt. 16196U-020: Upper electrode, 5 piece set for 16196D
Opt. 16196U-400: Short plate for 01005 (inch)/0402 (mm) size, 5 piece set (for 16196D)
Opt. 16196U-410: Lower electrode, 5 piece set (for 16196D)

Compensation and measurement: First of all, install the appropriate insulator assembly into the fixture. Then, perform compensation. Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement instrument first. Next, open compensation is performed by placing the furnished open plate on top of the insulator assembly. Short compensation is performed by placing the furnished shorting plate on top of the insulator assembly. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the test fixture. Once the measurement of the DUT is complete, remove the DUT from the fixture, by using the furnished push ring. Refer to the 16196A figures to see how compensation and measurement is performed.

Up to 3 GHz (7 mm): SMD *continued*

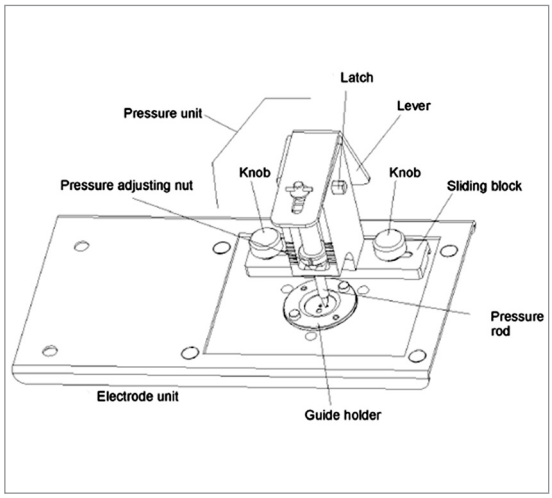
16197A Bottom electrode SMD test fixture



Terminal connector: 7 mm
DUt connection: 2-Terminal
Electrical length: 14 mm
Dimensions (approx.):
160 (W) x 70 (H) x 86 (D) [mm]
Weight (approx.): 300 g
Additional error:

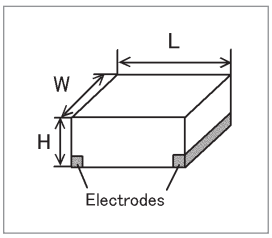
Type of error	Impedance
Proportional error	1.0 x f^2 [%]
Open repeatability	5 + 40 x f [μS]
Short repeatability	30 + 125 x f [mΩ]

f: frequency [GHz]



Test fixture overview

Description: This test fixture is designed for impedance evaluations of bottom electrode SMDs. It achieves stable frequency characteristics up to 3 GHz and provides highly repeatable measurements. This test fixture supports various SMD sizes, as small as 1005 (mm)/0402 (inch) and as large as 3225 (mm)/1210 (inch). Accommodation of the 0603 (mm)/0201 (inch) size is available with option 001.
Applicable instrument: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: DC to 3 GHz
Maximum voltage: ±42 V peak max. (AC +DC)
Operating temperature: –55 to +85°C
DUT size: See figure and table below:



Standard option SMD size code	Applicable SMD size L x W [mm]	 H [mm]
3225 (mm)/1210 (inch)	(3.2 ±0.15) x (2.5 ±0.15)	H ≥ 0.4
3216 (mm)/1206 (inch)	(3.2 ±0.15) x (1.6 ±0.15)	H ≥ 0.4
2012 (mm)/0805 (inch)	(2.0 ±0.15) x (1.25 ±0.15)	H ≥ 0.4
1608 (mm)/0603 (inch)	(1.6 ±0.15) x (0.8 ±0.15)	H ≥ 0.4
1005 (mm)/0402 (inch)	(1.0 ±0.1) x (0.5 ±0.1)	H ≥ 0.4

Option 16197A-001 SMD size code	Applicable SMD size L x W [mm]	 H [mm]
0603 (mm)/0201 (inch)	(0.6 ±0.03) x (0.3 ±0.03)	H ≥ 0.25

Furnished accessories:

Description	P/N	Qty.
Operation and service manual	16197-90000	1
Device guide[1]	16197-25005	2
Electrode plate[2]	16197-00603	1
Cleaning rod	5182-7586	1
Blank device guide	16197-25006	3
Magnifying glass	16193-60002	1
Tweezers	8710-2081	1
Wrench	8710-0909	1
Carrying case	16197-60060	1

1. One is delivered attached to the test fixture
2. Delivered attached to the fixture

Up to 3 GHz (7 mm): SMD *continued*

16197A Bottom electrode SMD test fixture *continued*

EIA/EIAJ Size shorting bar set (furnished)

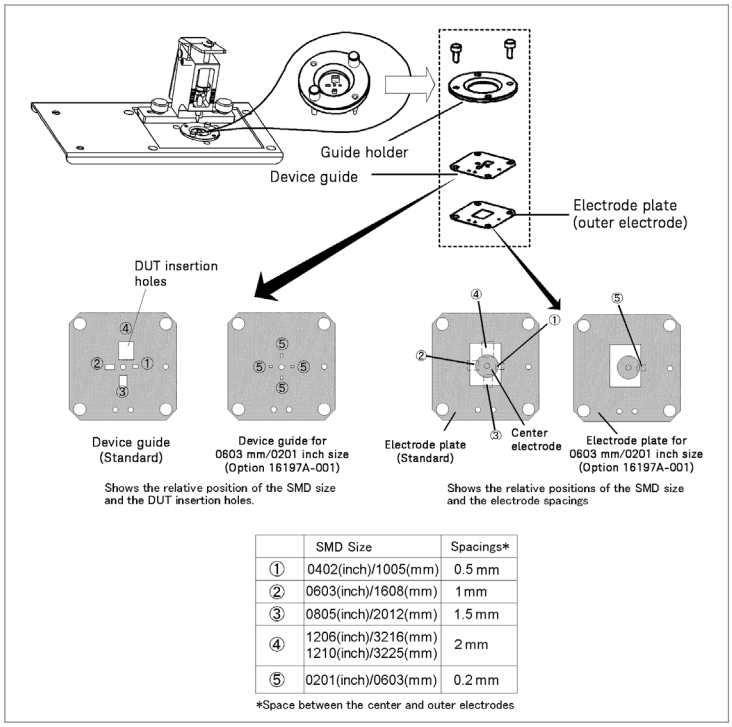
Size	P/N	Qty.
1 x 0.5 x 0.5 (mm)	16191-29005	1
1.6 x 0.8 x 0.8 (mm)	16191-29006	1
2.0 x 1.2 x 0.8 (mm)	16191-29007	1
3.2 x 1.6 x 0.8 (mm)	16191-29008	1
Device Guide	16197-25007	1
Electrode Plate	16197-00604	1

16197A-001 Shorting bar

Size	P/N	Qty.
0.6 x 0.3 x 0.3 (mm)	16197-29001	4

Options:
16197A-001: Add 0603 (mm)/0201 (inch) Device guide set

The 16197A's electrode spaces are 0.5 mm, 1 mm, 1.5 mm and 2 mm and the device guide matches these spaces with appropriate insertion holes for the applicable SMD. The 0.2 mm electrode spacing is available with option 001, which includes a device guide with 0603 mm/0201inch insertion holes, an electrode plate and 4 shorting devices.



	SMD Size	Spacings*
①	0402(inch)/1005(mm)	0.5 mm
②	0603(inch)/1608(mm)	1 mm
③	0805(inch)/2012(mm)	1.5 mm
④	1206(inch)/3216(mm) 1210(inch)/3225(mm)	2 mm
⑤	0201(inch)/0603(mm)	0.2 mm

*Space between the center and outer electrodes

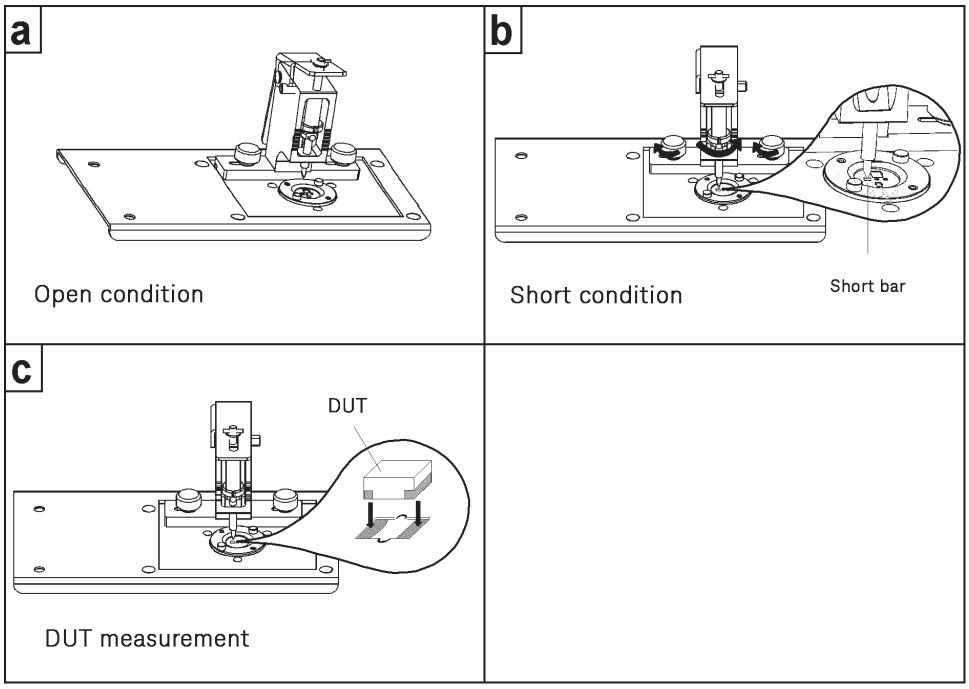
Electrodes configuration and SMD size

Compensation and measurement: First of all, select the appropriate device insertion hole. If the device insertion hole is not positioned in the pressure arm's contact range, reposition the device guide and the electrode plate. Once this is prepared, perform compensation. Open and short compensations are recommended in combination with the electrical length compensation before measurement. The fixture's electrical length must be entered into the electrical length compensation function of the measurement

Up to 3 GHz (7 mm): SMD *continued*

16197A Bottom electrode SMD test fixture *continued*

instrument first. Next, open compensation is performed by not placing anything in the device insertion hole. Short compensation is performed by placing the furnished shorting device in the device insertion hole. After performing open and short compensations in combination with the electrical length compensation, the DUT is inserted into the device insertion hole. Once the measurement of the DUT is complete, remove the DUT from the fixture. The following figures show how compensation and measurement is performed.



Compensation and measurement

Up to 3 GHz (7 mm): SMD *continued*

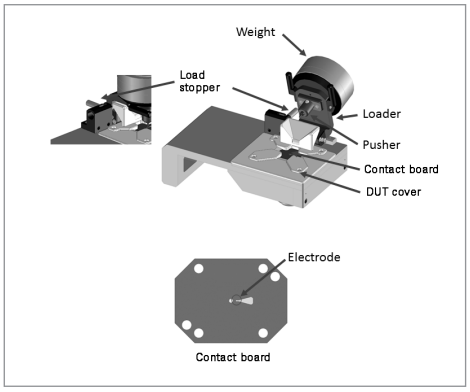
16198A Bottom electrode SMD test fixture

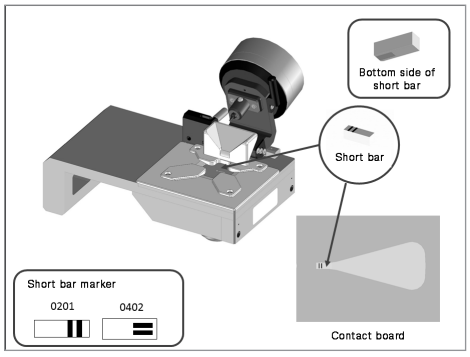


Terminal connector: 7 mm
DUt connection: 2-Terminal
Dimensions (approx.):
145 (W) × 80 (D) × 110 (H) [mm]
Weight (approx.): 870 g (with weight of 300 g)
Additional error:

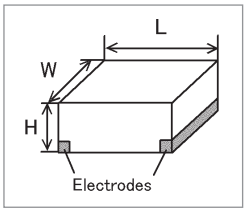
Error factor	Formula
Proportional error	1.2 x f^2 [%]
Open repeatability	5 + 40 x f [µS]
Short repeatability	60 + 125 x f [mΩ]

f: frequency [GHz]





Description: This test fixture is designed for impedance evaluations of bottom electrode SMDs. It achieves stable frequency characteristics up to 3 GHz and provides highly repeatable measurements. This test fixture supports two SMD sizes, 0201 (mm)/ 008004 (inch) and 0402 (mm)/01005 (inch).
Applicable instrument: E4982A, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
Frequency: DC to 3 GHz
Maximum voltage: ±40 V peak max. (AC +DC)
Operating temperature: –55 to +85°C
DUT size: See figure and table below:



Standard option SMD size code	Applicable SMD size L [mm]	W [mm]	H [mm]
0402 (mm)/01005 (inch)	(0.38 to 0.42) ±0.02	(0.18 to 0.22) ±0.02	≥ 0.11
0201 (mm)/008004 (inch)	(0.2 to 0.25) ±0.013	(0.1 to 0.125) 0.013	≥ 0.1

Furnished Accessory

Description	P/N
Cleaning rod	5182-7586

Optional accessories

Standard set	P/N	Qty.
Standard set, 0201	16198A-100	
Contact board (Guide PCA 0201 70 micrometer)		1
Contact board (Guide PCA 0201 100 micrometer)		1
0201 Short bar 5-piece set		1
Weight 50 g		1
Weight 100 g		1
Weight 200 g		1
Standard set, 0402	16198A-200	
Contact board (Guide PCA 0402 100 micrometer)		1
0402 Short bar 5-piece set		1
Weight 50 g		1
Weight 100 g		1
Weight 200 g		1

Note: A standard set of either 0201 or 0402 can be ordered, but not both.
If necessary, the parts can be ordered individually.

Up to 3 GHz (7 mm): SMD *continued*

16198A Bottom electrode SMD test fixture *continued*

Optional accessories	P/N
Contact board (Guide PCA 0201, 70 micrometer)	16198A-101
Contact board (Guide PCA 0201, 100 micrometer)	16198A-102
Contact board (Guide PCA 0402, 100 micrometer)	16198A-201
0201 Short bar 5-piece set	16198A-110
0402 Short bar 5-piece set	16198A-210
Weight 50 g	16198A-520
Weight 100 g	16198A-521
Weight 200 g	16198A-522
Carrying case	16198A-530
Torque driver	16198A-531
User manual English	16198A-ABA
User manual Japanese	16198A-ABJ

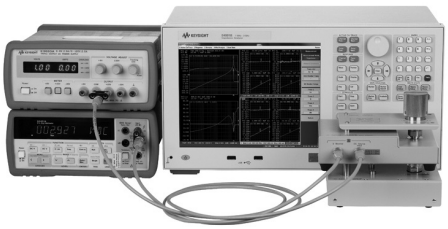
Retrofit/service parts	P/N
Contact board (Guide PCA 0201, 70 micrometer)	16198AU-101
Contact board (Guide PCA 0201, 100 micrometer)	16198AU-102
Contact board (Guide PCA 0402, 100 micrometer)	16198AU-201
Contact board 8-piece set (Guide PCA 0201, 70 micrometer)	16198AU-103
Contact board 8-piece set (Guide PCA 0201, 100 micrometer)	16198AU-104
Contact board 8-piece set (Guide PCA 0402, 100 micrometer)	16198AU-202
0201 Short bar 5-piece set	16198AU-110
0402 Short bar 5-piece set	16198AU-210
Weight 50 g	16198AU-520
Weight 100 g	16198AU-521
Weight 200 g	16198AU-522
Carrying case	16198AU-530
Torque driver	16198AU-531
Pusher unit	16198AU-540
DUT cover ass'y	16198AU-544
Connector APC3.5	16198AU-545

Up to 3 GHz (7 mm): DC Bias Accessories

16200B external DC bias adapter



Terminal connector: 7 mm
DC BIAS input connector: BNC(f)
Voltage monitor connector: BNC(f)
Dimensions (approx.):
170 (W) x 70 (H) x 130 (D) [mm]
Weight (approx.): 900 g



Connection example

Description: This test fixture is designed to measure a DUT with DC bias. By connecting an external DC current source to the 16200B, it can supply a bias current across the DUT of up to ±5 Adc through a 7 mm port.
Applicable instruments: E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 with Opt. 005 + 16201A
* Option E4990A-120 is required
Frequency: 1 MHz to 1 GHz
DC bias: Up to 5A, 40 V (Input)
Operating temperature: 0 to 55°C
Applicable fixtures: 16192A, 16194A, 16196A/B/C/D, 16197A, 16092A

Furnished accessories:

Description	P/N	Qty.
Operation and service manual	13200-90011	1

16200B-001 Shorting device set

Size	P/N	Qty.
0.6 x 0.3 x 0.3 (mm)	16197-29001	2
1 x 0.5 x 0.5 (mm)	16191-29005	2
1.6 x 0.8 x 0.8 (mm)	16191-29006	2
2.0 x 1.2 x 0.8 (mm)	16191-29007	2
3.2 x 1.6 x 0.8 (mm)	16191-29008	2

16200B-001 Load device set

Size	P/N	Qty.
0.6 x 0.3 x 0.3 (mm)	0699-6926	5
1 x 0.5 x 0.5 (mm)	5182-0433	5
1.6 x 0.8 x 0.8 (mm)	5182-0434	5
2.0 x 1.2 x 0.8 (mm)	5182-0435	5
3.2 x 1.6 x 0.8 (mm)	5182-0436	5

Options:
16200B-001: Add Working std set

Compensation and measurement: When using the 4291B, follow these instructions:
Perform open, short, load and low-loss calibration at the 7 mm test port of the 4291B. Connect the 16200B to the 7 mm test port, and connect the test fixture onto the 16200B. Open, short, and load compensations are recommended before measurement. Use the short bars and 51 Ω SMD resistors furnished with 16200B-001 to perform short and load compensation respectively.

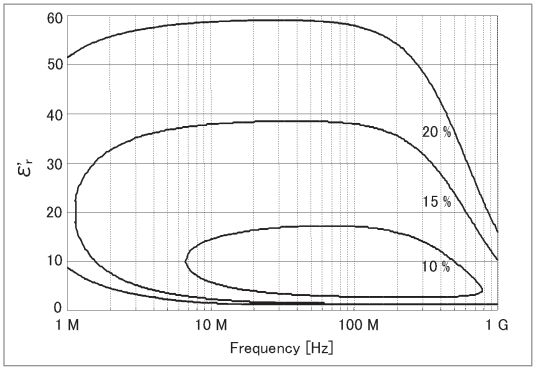
When using other instruments, follow these instructions:
Connect the 16200B to the 7 mm test port of the measurement instrument. Perform open, short, load (and low-loss calibration) at the 7 mm test port of the 16200B. Then, connect the test fixture onto the 16200B and perform open, short, and electrical length compensations in the usual manner.

Up to 3 GHz (7 mm): Material

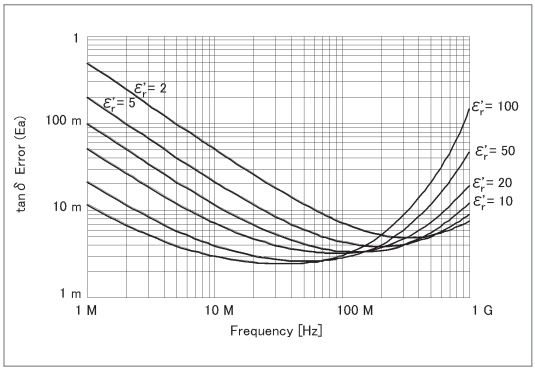
16453A Delectric material test fixture



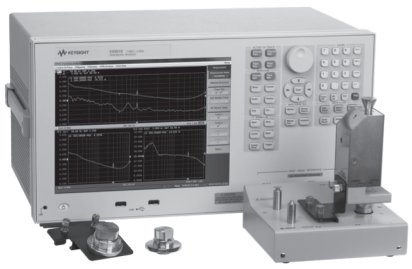
Terminal connector: 7 mm
Dimensions (approx.):
130 (H) x 50 (W) x 60 (D) [mm]
Weight (approx.): 600 g
Measurement accuracy (including the E4991B):



Typical permittivity (er′) Measurement accuracy
(@ thickness = 1 mm)

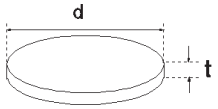


Typical loss tangent (tan δ) Measurement accuracy
(@ thickness = 1 mm)



E4991B with 16453A

Description: The 16453A is designed for accurate dielectric constant and loss tangent measurements on the E4991B. It employs the parallel plate method, which sandwiches the material between two electrodes to form a capacitor. E4991B measures the capacitance created from the fixture, and option E4991B-002 firmware calculates the relative complex permittivity. Adjustment to insure parallel electrodes is required when using the 16451B. This adjustment is not required with 16453A because the fixture has a flexible electrode that adjusts automatically to the material surface.
Applicable instruments: E4991B with Opt. E4991B-002
Frequency: 1 MHz to 1 GHz
Maximum voltage: ±42 V peak max. (AC+DC)
Operating temperature: –55 to 200°C
When Option E4991B-007 temperature characteristic test kit is used with E4991B, the operating temperature range is between –55°C and +150°C.
Material size:



Diameter	≥ 15 mm
Thickness	0.3 mm ~ 3 mm

Furnished accessories:

Description	P/N	Qty.
Fixture holder	16453-01213	1
Load	16453-60021	1
Tweezers	8710-2081	1
Carrying case	16453-60011	1
Operation and service manual	16453-90010	1

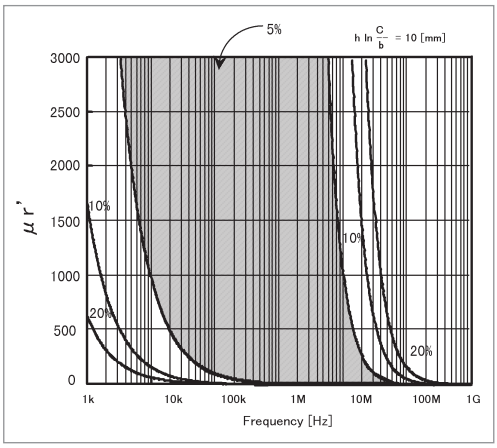
Compensation and measurement: Open, short and load compensations are recommended before measurement. Open compensation is performed by separating the high and the low electrodes from each other. Short compensation is performed by connecting the high and low electrodes together. Load compensation is performed by using the furnished load material. After performing open, short and load compensations, the material under test is inserted into the test fixture.

Up to 3 GHz (7 mm): Material *continued*

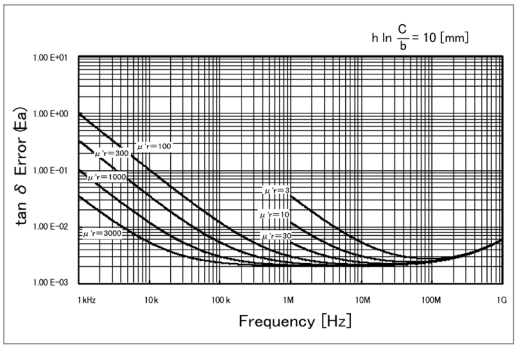
16454A magnetic material test fixture



Terminal connector: 7 mm
Dimensions (approx.):
(Large test fixture) 30(D) x 35(H) [mm]
(Small test fixture) 24(D) x 30(H) [mm]
Weight (approx.):
(Large test fixture) 140 g
(Small test fixture) 120 g
Measurement accuracy (typical.):

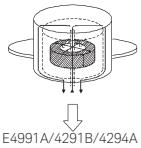


Typical permeability (μr') Measurement accuracy (@ h* ln c/b = 10)



Typical loss tangent (tan δ) Measurement accuracy (@ h* ln c/b = 10)

Description: The 16454A is designed for accurate permeability measurements of toroidal-shaped magnetic materials. Since the construction of this fixture creates one turn around the toroid (with no magnetic flux leakage), the need of winding a wire around the toroid is unnecessary. The following figure shows the one-turn mechanism and how complex permeability is calculated from it.

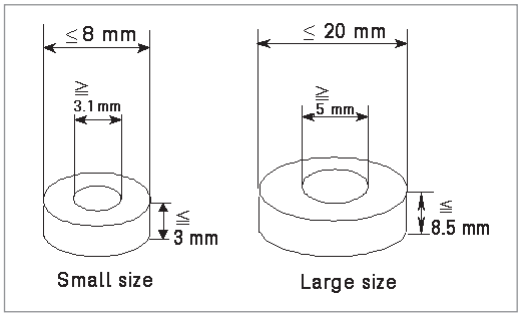


$$\dot{\mu} = \frac{\dot{Z}m - \dot{Z}sm}{j\omega\mu_0} \frac{2\pi}{h \ln \frac{c}{b}} + 1$$

$\dot{\mu}$	Relative permeability
$\dot{Z}m$	Measured impedance with toroidal core
$\dot{Z}sm$	Measured impedance with toroidal core
μ_0	Permeability of free space
h	Height of MUT (Material Under Test)
c	Outer diameter of MUT
b	Inner diameter of MUT

Permeability measurement method of 16454A

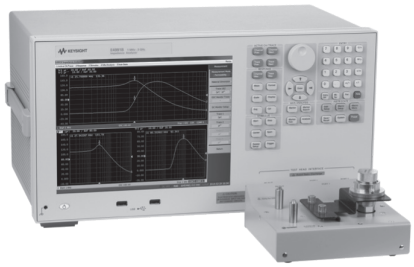
Complex permeability is calculated from the inductance with and without the toroid. When E4991B with option E4991B-002 is used as the measurement instrument, direct readouts of complex permeability are possible. In addition, it is furnished with a small and a large fixture to adapt to a wide range of sizes.
Applicable instruments: E4990A + 42942A*, E4991B with Opt. E4991B-002
* Option E4990A-120 is required
Frequency: 1 kHz to 1 GHz,
DC bias: –500 mA to +500 mA (max)
Operating temperature: –55 to 200°C
When Option E4991B-007 temperature characteristic test kit is used with E4991B, the operating temperature range is between –55 and +150°C. The temperature characteristic test kit is unavailable for the E4990A.
Material size: See figure below.



Material size

Up to 3 GHz (7 mm): Material *continued*

16454A magnetic material test fixture *continued*



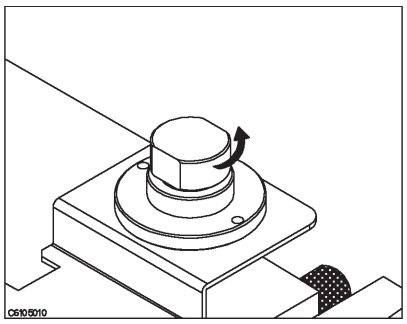
E4991B with 16454A

Furnished accessories:

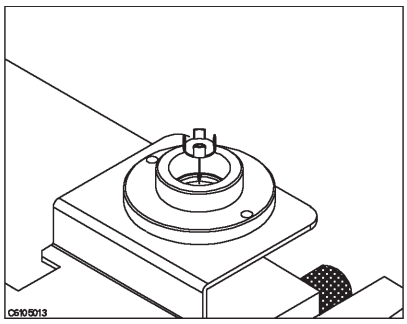
Description	P/N	Qty.
Fixture holder	16454-00601	1
Tweezers	8710-2081	1
Screw, hex recess	0515-1050	1
Holder A	16454-25002	1
Holder B	16454-25001	1
Holder C (Without hole)	16454-25004	1
Holder D (With hole)	16454-25003	1
Holder case	1540-0622	1
Hex key (for replacing fixtures)	8710-1181	1
Carrying case	16454-60101	1
Operation and service manual	16454-90020	1

Compensation and measurement: Short compensation is required before measurement. Short compensation is performed by only inserting the MUT holder into the test fixture. After performing short compensation, the MUT is inserted into the fixture as shown below.

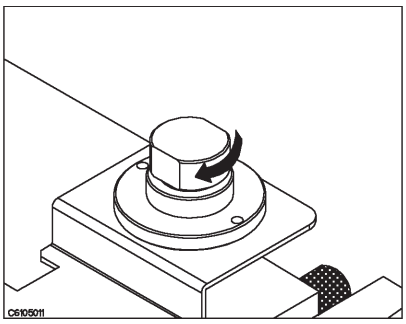
Short compensation



Remove the cap of the fixture

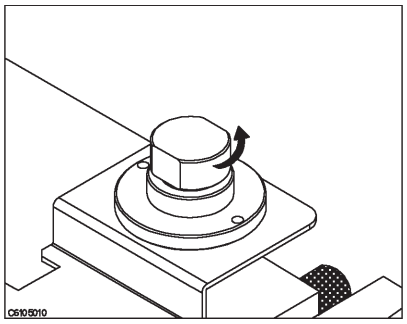


Place a MUT holder only in the fixture

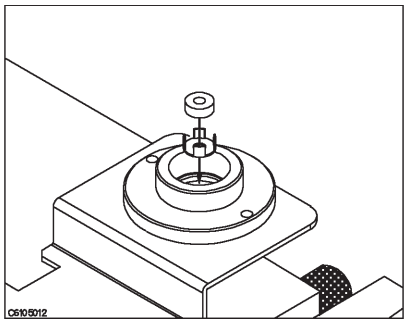


Replace the cap by screwing tightly

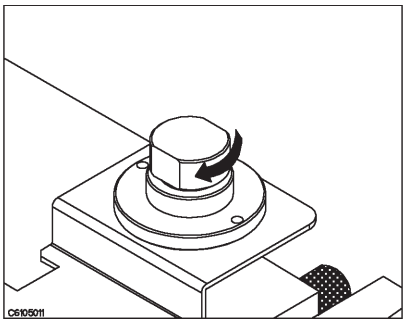
Placing the MUT on the test fixture as follows:



Remove the cap of the fixture



Place a MUT onto the MUT holder and insert it into the fixture.



Replace the cap by screwing tightly

Other Accessories

16190B Performance test kit



Terminal connector: 7 mm
Dimensions (approx.):
350 (W) x 100 (H) x 270 (D) [mm]
Weight (approx.): 2.0 kg

Description: The 16190B is a performance test kit designed to verify the impedance measurement accuracy of LCR meters or impedance analyzers that have a 7 mm measurement terminal. Refer to the instrument's operation/service manual for the method of using these standards.
Applicable instrument: E4982A, E4990A + 42942A*, E4991B
* Option E4990A-120 is required

Furnished accessories:

Description	P/N	Qty.
Airline, 50 Ω, 7 mm	N/A	1
Cap, Protection	1401-0123	2
50 Ω termination	N/A	1
Open termination	N/A	1
Short termination	N/A	1
Cap, termination protection	16190-25011	3
Wrench, 1/2 and 8/15, open end	8710-1770	1
Carrying case	N/A	1
Floppy diskette for calibration data	N/A	1
Calibration report	N/A	1
Operating note	16190-90020	1

Other Accessories *continued*

16380A Standard capacitor set



Terminal connector: 4-Terminal Pair, BNC
Dimensions (approx.):
142 (W) x 88 (H) x 112 (D) [mm] (capacitors)
Weight (approx.): 8.0 kg (including case and 4 capacitors)

Description: The 16380A is a standard capacitor set consisting of four precision capacitors -1 pF (16381A), 10 pF (16382A) 100 pF (16383A), 1000 pF (16384A). These capacitors are primarily used for performance tests of Keysight's 4-Terminal Pair LCR meters and impedance analyzers. Refer to the instrument's operation/service manual for the method of using these standards.
Applicable instrument: E4980A/AL, E4981A, E4990A

	16381A	**16382A**	**16383A**	**16384A**
Capacitance	1 pF	10 pF	100 pF	1000 pF
Nominal accuracy	0.10 %			
Calibration stability	≤ 300 ppm/year			
Dissipation factor	≤ 0.0001			

Furnished accessories:

Description	**P/N**	**Qty.**
16381A (1 pF)	N/A	1
16382A (10 pF)	N/A	1
16383A (100 pF)	N/A	1
16384A (1000 pF)	N/A	1
BNC (f) - (f) Adapters	1250-0080	4
Calibration report	N/A	1
Carrying case	16380-85101	1
Operating note	16380-90011	1

Other Accessories *continued*

16380C Standard capacitor set



Terminal connector: 4-Terminal Pair, BNC
Dimensions (approx.):
142 (W) x 88 (H) x 112 (D) [mm] (capacitors)
Weight (approx.): 7.0 kg (including case and 3 capacitors)

Description: The 16380C is a standard capacitor set consisting of three precision capacitors -0.01 µF (16385A), 0.1 µF (16386A), and 1 µF (16387A). These capacitors are primarily used for performance tests of Keysight's 4-Terminal Pair LCR meters and impedance analyzers. Refer to the instrument's operation/service manual for the method of using these standards.
Applicable instrument: E4980A/AL, E4981A, E4990A

	16385A	16386A	16387A	16388A
Capacitance	0.01 µF	0.1 µF	1 µF	10 µF
Nominal accuracy	0.10 %	0.10 %	0.10 %	0.05 %
Calibration stability	≤ 50 ppm/year			
Dissipation factor	≤ 0.0004	≤ 0.0005	≤ 0.0007	≤ 0.0005

Furnished accessories:

Description	P/N	Qty.
16385A (0.01 µF)	N/A	1
16386A (0.1 µF)	N/A	1
16387A (1 µF)	N/A	1
BNC (f) - (f) Adapters	1250-0080	4
Calibration report	N/A	1
Carrying case	16380-85104	1
Operating note	16380-90221	1

Option:
16380C-001: Add 10 µF standard capacitor (16388A)

Other Accessories *continued*

42030A Four-Terminal pair standard resistor set



Terminal connector: 4-Terminal pair, BNC
Dimensions (approx.):
94 (W) x 31 (H) x 67 (D) [mm] (resistors)
Weight (approx.): 3.7 kg (including case and 9 resistors)

Description: The 42030A is a standard resistor set consisting of nine precision resistor standards which range from 1 mΩ to 100 kΩ. These resistors are primarily used for performance tests of Keysight's 4-Terminal Pair LCR meters and impedance analyzers. Refer to the instrument's operation/service manual for the method of using these standards.

Applicable instrument: E4980A/AL, E4981A, E4990A

Model	DC resistance
42031A	1 mΩ ± 0.2%
42032A	10 mΩ ± 0.2%
42033A	100 mΩ ± 0.2%
42034A	1 Ω ± 0.2%
42035A	10 Ω ± 0.1%
42036A	100 Ω ± 0.1%
42037A	1 kΩ ± 0.1%
42038A	10 kΩ ± 0.1%
42039A	100 kΩ ± 0.1%

Furnished accessories:

Description	P/N	Qty.
42031A (1 mΩ)	N/A	1
42032A (10 mΩ)	N/A	1
42033A (100 mΩ)	N/A	1
42034A (1 Ω)	N/A	1
42035A (10 Ω)	N/A	1
42036A (100 Ω)	N/A	1
42037A (1 kΩ)	N/A	1
42038A (10 kΩ)	N/A	1
42039A (100 kΩ)	N/A	1
Calibration report	N/A	1
Carrying case	42030-60100	1
Operating and service manual	42030-90001	1

Other Accessories *continued*

42090A Open termination



Description: The 42090A is an open termination and is primarily used for performance tests of Keysight's 4-Terminal Pair LCR meters and impedance analyzers. Refer to the instrument's operation/service manual for the method of using this standard.
Applicable instrument: E4980A/AL, E4981A, E4990A

Terminal connector: 4-Terminal Pair, BNC
Dimensions (approx.):
94(W) x 31(H) x 67(D) [mm]
Weight (approx.): 120 g

42091A Short termination



Description: The 42091A is a short termination and is primarily used for performance tests of Keysight's 4-Terminal Pair LCR meters and impedance analyzers. Refer to the instrument's operation/service manual for the method of using this standard.
Applicable Instrument: E4980A/AL, E4981A, E4990A

Terminal connector: 4-Terminal Pair, BNC
Dimensions (approx.):
94(W) x 31(H) x 67(D) [mm]
Weight (approx.): 120 g

Index

Model number	Name	Applicable measurement instrument (s)	Page (s)
16034E	SMD/Chip test fixture	E4980A/AL, E4981A, E4990A, E5061B-3L3/3L4/3L5 (w/Opt. 005)	11
16034G	SMD/Chip test fixture, small	refer to 16034E	12
16034H	SMD/Chip test fixture, general	refer to 16034E	13
16047A	Axial and radial test fixture	E4980A/AL, E4981A, E4990A	9
16047E	Axial and radial test fixture, 120 MHz	refer to 16034E	10
16048A	One meter test leads, BNC	E4980A/AL, E4981A	17
16048D	Two meter test leads, BNC	E4980A/AL, E4981A	17
16048E	Four meter test leads, BNC	E4980A/AL	18
16048G	One meter test leads, BNC, 120 MHz	E4990A	19
16048H	Two meter test leads, BNC, 120 MHz	E4990A	19
16065A	Ext. Voltage bias with safety cover (≤ 200 vdc)	E4980A/AL, E4981A, E4990A	21
16065C	External bias adapter (≤ 40 vdc)	E4981A, E4980AL	21
16089A/B/C	Kelvin clip leads	E4980A/AL, E4981A, E4990A	15–16
16092A	RF spring clip : axial, radial and SMD	E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 (w/Opt. 005)) + 16201A	29
16190B	Performance test kit	E4982A, E4990A-120*, E4991B	52
16192A	Parallel electrode SMD test fixture	E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 (w/Opt. 005) + 16201A	30–31
16194A	High temperature component test fixture	refer to 16192A	32–33
16196A/B/C/D	Parallel electrode SMD test fixture	refer to 16192A	34–42
16197A	Bottom electrode SMD test fixture	refer to 16192A	43–45
16198A	Bottom electrode SMD test fixture	E4982A, E4991B, E5061B-3L3/3L4/3L5 (w/Opt. 005) + 16201A	46–47
16200B	External DC bias adapter	E4982A, E4990A + 42942A*, E4991B, E5061B-3L3/3L4/3L5 (w/Opt. 005) + 16201A	48
16334A	SMD/chip tweezers	E4980A/AL, E4981A, E4990A	14
16380A	C Standards set	E4980A/AL, E4981A, E4990A	53
16380C	C Standards set	E4980A/AL, E4981A, E4990A	54
16451B	Dielectric material test fixture	E4980A/AL, E4981A, E4990A	22–25
16452A	Liquid test fixture	E4980A/AL, E4990A	26–27
16453A	Dielectric material test fixture	E4991B (w/Option 002)	49
16454A	Magnetic material test fixture	E4990A + 42942A*, E4991B (w/Option 002)	50–51
42030A	Four-Terminal pair standard resistor set	E4980A/AL, E4981A, E4990A	55
42090A	Open termination	E4980A/AL, E4981A, E4990A	56
42091A	Short termination	E4980A/AL, E4981A, E4990A	56
42941A	Impedance probe kit	E4990A*	20
42942A	Four-Terminal pair to 7 mm	E4990A*	5

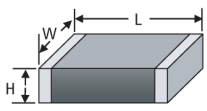
* Option E4990A-120 is required

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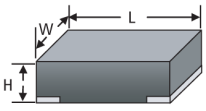
Test fixture selection by SMD size

Classi-fication	Test fixture type	Model number	Electrode type	Maximum usable frequency	* Applicable SMD size [code in mm / (EIA code in inch)]*5											Minimum L x W x H (mm)	Maximum L x W x H (mm)
					0201 / (008005)	0402 / (01005)	0603 / (0201)	1005 / (0402)	1608 / (0603)	2012 / (0805)	3216 / (1206)	3225 / (1210)	4520 / (1808)	4532 / (1812)	5750 / (2220)		
LF, 4TP*1	SMD, General	16034E	Parallel	40 GHz					▪	▪	▪	▪	▪	▪	▪	0.1 x 0.5 x 0.5	8 x 10 x 10
	SMD, General	16034G	Parallel	120 MHz			▪	▪	▪	▪	▪					0.1 x 0.3 x 0.3	5 x 1.6 x 1.6
	SMD, General	16034H	Parallel	120 MHz					▪	▪	▪	▪	▪	▪		0.1 x 0.6 x 0.6	5 x 15 x 3
	SMD, Tweezers*3	16334A	Parallel	15 MHz					▪	▪	▪	▪	▪	▪	▪	See Note 7	L < 10
RF, 7 mm*2	SMD/Lead*4	16092A	Parallel	500 MHz					▪	▪	▪	▪	▪	▪	▪	See Note 6	L < 18
	SMD, General	16192A	Parallel	2 GHz				▪	▪	▪	▪	▪	▪	▪	▪	L > 1	L < 20
	SMD/Lead*4	16194A	Bottom	2 GHz						▪	▪	▪	▪	▪	▪	L > 2	L < 15
	SMD, Coaxial	16196A	Parallel	3 GHz					▪							1608 size only	
	SMD, Coaxial	16196B	Parallel	3 GHz				▪								1005 size only	
	SMD, Coaxial	16196C	Parallel	3 GHz			▪									0603 size only	
	SMD, Coaxial	19196D	Parallel	3 GHz		▪										0402 size only	
	SMD, General	16197A	Bottom	3 GHz				▪	▪	▪	▪	▪				1005 to 3225 sizes only	
	SMD, General	16197A-001	Bottom	3 GHz			▪	▪	▪	▪	▪	▪				0603 to 3225 sizes only	
	SMD, General	16198A	Bottom	3 GHz	▪	▪										0201 to 0402 sizes only	

Notes:
1. LF, 4TP denotes test fixtures for use with four-terminal pair type LCR meters and LF impedance analyzers in low freuqncy region (< 120 MHz).
2. RF, 7 mm denotes test fixtures for use with RF impedance measureemnt instruments which have 7 mm coaxial test port.
3. Tweezers type test fixture with 1 meter test leads.
4. Test fixture for measuring SMD and leaded components.
5. Check marks in the table denote the application DUT sizes.
6. Applicable to SMD components with thickness > 0.65 mm. Not suitable for smaller SMD than 1608 type.
7. Minimum SMD size is not specified. Not recommended for smaller than 1608 type because contact repeatability degrades with the reduction of device size.



Parallel electrode



Bottom electrode

Index *continued*

Accessories vs. instruments matrix

Simplify and improve your measurements with Keysight's test accessories

Selecting a test fixture is as important as selecting the right instrument. Keysight offers a wide range of accessories for axial, radial, and SMD/Chip devices. In addition, a variety of test leads are available to simplify remote testing and systems applications. External test fixtures with safety covers are also available.

You will improve your measurement results with the proper test fixture.

- More reliable and repeatable measurement
- Higher through-put
- Fewer handling errors
- Tighter test limits
- Better measurement accuracy

For additional product information and literature, visit our Accessories Web site: **www.keysight.com/find/impedance-accessory**

Table 3. Test accessories/fixtures

			E4980A/AL	E4981A	E4982A	E4990A Option 120	E4990A Option 010/020/030/050	E4991B	E5061B Option 3L3/3L4/3L5 w/005
16034E	SMD/chip test fixture	DC-40 MHz	▪	▪		▪	▪		▪
16034G	SMD/chip test fixture, small	DC-120 MHz	▪	▪		▪	▪		▪
16034H	SMD/chip test fixture, for Array-type	DC-120 MHz	▪	▪		▪	▪		▪
16047A	Axial and radial test fixture	DC-13 MHz	▪	▪		▪	▪		
16047E	Axial and radial test fixture	DC-120 MHz	▪	▪		▪	▪		▪
16048A	One meter test leads, BNC	DC-30 MHz	▪	▪					
16048D	Two meter test leads, BNC	DC-30 MHz	▪	▪					
16048E	Four meter test leads, BNC	DC-2 MHz	▪						
16048G	One meter test leads, BNC	DC-120 MHz				▪	▪		
16048H	Two meter test leads, BNC	DC-120 MHz				▪	▪		
16065A	Ext. voltage bias with safety cover (≤ 200 Vdc)	50 Hz-2 MHz	▪	▪		▪	▪		
16065C	External bias adapter (≤ 40 Vdc)	100 Hz-1 MHz	▪[5]	▪					
16089A/B/C	Kelvin clip leads	5 Hz-100 kHz	▪	▪		▪	▪		
16092A	RF spring clip: axial, radial and SMD	DC-500 MHz			▪[1]	▪[2]		▪	▪[3]
16192A	Parallel electrode SMD test fixture	DC-2 GHz			▪[1]	▪[2]		▪	▪[3]
16194A	High temperature component test fixture	DC-2 GHz			▪[1]	▪[2]		▪	▪[3]
16196A/B/C/D	Parallel electrode SMD test fixture	DC-3 GHz			▪[1]	▪[2]		▪	▪[3]
16197A	Bottom electrode SMD test fixture	DC-3 GHz			▪[1]	▪[2]		▪	▪[3]
16198A	Bottom electrode SMD test fixture	DC-3 GHz			▪[1]			▪	▪[3]
16200B	External DC bias adapter	1 MHz-1 GHz			▪[1]	▪[2]		▪	▪[3]
16201A	N-type to 7 mm terminal adapter	5 Hz to 3 GHz							▪
16334A	SMD/chip tweezers test fixture	DC-15 MHz	▪	▪		▪	▪		
16451B	Dielectric material test fixture	DC-30 MHz	▪	▪		▪	▪		
16452A	Liquid test fixture	20 Hz-30 MHz	▪			▪	▪		
16453A	Dielectric material test fixture	1 MHz-1 GHz						▪[4]	
16454A	Magnetic material test fixture	1 kHz-1 GHz				▪[2]		▪[4]	
42941A	Impedance probe kit	DC-120 MHz				▪			
42942A	Four-terminal pair to 7-mm adapter	DC-120 MHz				▪			

Note: Refer to the accessory descriptions for frequency and operational limits.

1. 3.5-mm (M) to 7-mm adapter is required
2. 42942A is required.
3. Compatible when used in conjunction with 16201A.
4. E4991B-002 is required
5. E4980AL only

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LCR Meters/Impedance Analyzers

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Accessories for Impedance Measurements

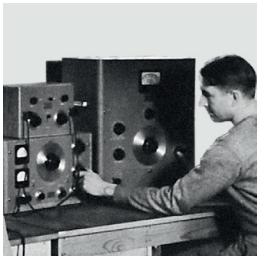
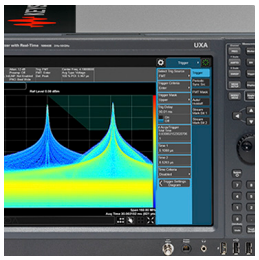
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