LCR Meters, Impedance Analyzers and Test Fixtures

Material, Semiconductor, Component and In-Circuit Measurement Solutions

Achieve Success with The Industry Standard for Impedance Measurements

Hewlett Packard, Agilent Technologies, and Technologies, Inc. have contributed innovations and
product excellence in impedance analysis for over half a century. Whether your application is in R&D, production, quality assurance, or incoming inspection, we take pride in contributing to your success. We strive to deliver complete solutions to meet your needs, from impedance analyzers to a wide variety of test accessories. Achieve success with Keysight's impedance measurement solutions. offers:

Superior product performance: products provide the best in class accuracy and the repeatability with the fast measurement speed. Three types of impedance measure-ment solutions as shown in Table 1 are available meeting the various measurement needs.

Complete solution: Covering frequencies from 5 Hz to 3 GHz along with the wide variety of test accessories, Keysight's impedance product line offers you the widest selection of equipment for your application. This selection guide gives an overview of all the products and accessories you can choose from.

Appropriate frequency range for your application: products provide the best performance in the industry with frequency options to meet your needs at an affordable price. You can select the most appropriate
frequency range for your application. Flexible frequency upgrade options are also available. You can choose just what you require today with the least amount of investment and upgrade later as needs arise.

Technical expertise: has decades of experience providing impedance measurement solutions. Years of experi-ence and continuing technical innovations go into the design and manufacturing of each LCR meter and im-pedance analyzer. also has a list of technical publication to assist you in many different applications (see page 15 for full listing.)

Advanced measurement techniques for a wide range of applications

Figure 1 is a comparison of different measurement techniques used in Keysight's LCR meters and impedance analyzers. As you can see, each technique has special measurement advantages:

- Auto-balancing bridge offers widest impedance measurement range with typical frequency range of 20 Hz to 120 MHz. This technique is best for low-frequency, general-purpose testing.

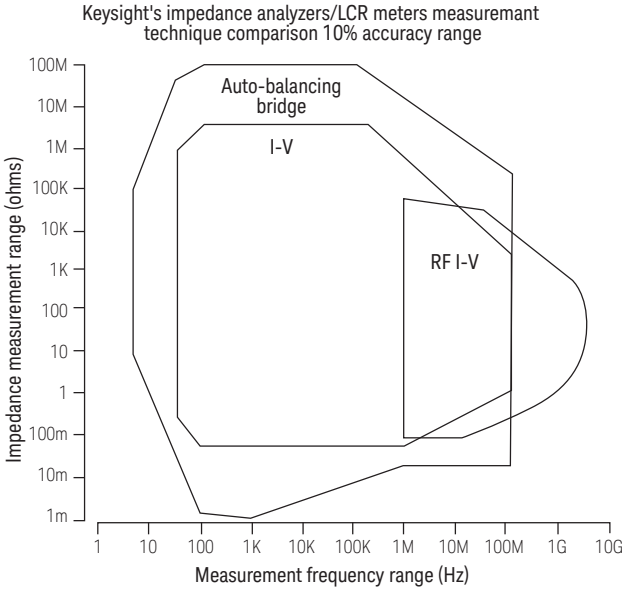


Figure 1. Impedance measurement techniques of impedance analyzers/ LCR meters

Table 1. Impedance measurement product type

	Product Type		
Product Highlights	**LCR Meter**	**Impedance Analyzer**	**Network Analyzer**
Frequency Sweep Capability	Spot/List	Continuous (Start/Stop, Center/Span)	Continuous (Start/Stop, Center/Span)
Display	Numeric Only	Graphics	Graphics
Others	Handler interface, comparator	Equivalent circuit analysis built in, material measurements, in-circuit measurements	Equivalent circuit analysis built in, multiple function in one instrument
Advantages	Low-cost solution, ease of use, high speed	Widest measurement range, resonant analysis, circuit modeling	Cost-effective, versatile

– I-V technique covers from 20 Hz to 120 MHz with a more focused impedance measurement range. I-V technique also allows probing for in-circuit testing.

– RF I-V, an enhancement of the I-V technique, offers some of the high-frequency benefit of network analysis while retaining some of the impedance measurement range of the I-V technique. Designed for accuracy and high-frequency performance, the RF I-V technique is excellent for RF component analysis, especially for small inductance and capacitance values.

– In addition, Keysight's network analyzer offers an impedance measurement solution using the combination of three measurement techniques (reflection, series-thru, and shunt-thru) based on the S-parameter and gain-phase measurements.

How to use this selection guide

Table 2 is a summary of all of Keysight's impedance products. It is designed to assist you in better comparing Keysight's wide range of instrumentation and in choosing possible solutions for your applications, depending on your requirements in the following areas:

– Test frequency range
– Device type or application type
– Accuracy requirement (measurement technique)
– Any other special needs

If you find several possible solutions for your application, go to the corresponding pages to find more details about each product.

Table 2. impedance measurement products

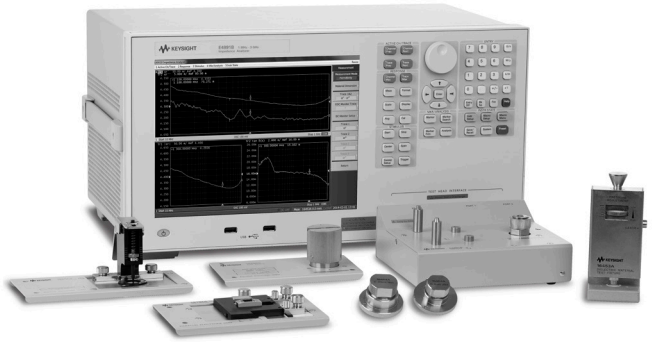
Product Type	Freq. range	Positioning	Model	Frequency range (Hz)	Basic Z accuracy[1] (%)	Measurement display range (Ω)	Feature[4]	Measurement technique[5]	Main application
Impedance analyzer	RF	High peformance/ material/high temperature	E4991B	1 M to 3 G	0.65 (0.45 typical)	120 m to 52 k[3]	A,B	RF-IV	LCR component, material, semiconductor
		Multi function	E5061B Option 3L3/3L4/ 3L5 w/005	5 to 3 G	2 (typical)	1 to 2 k/5 to 20 k/1 m to 5 [3] (typical)	A,B	Ref/Series/Shunt	LCR component, PDN
	LF/HF	High peformance/ material/C-V	E4990A	20 to 120 M	0.08 (0.045 typical)	25 m to 40 M [3]	A,B	ABB	LCR component, material, semiconductor
		In-circuit (grounded), C-V	E4990A with 42941A	20 to 120 M	1	50 m to 4 M[3]	A,B	IV	In-circuit, semiconductor
LCR meter	RF	High performance/ high speed measurement	E4982A	1M to 3G	0.8 (0.45 typical)	140 m to 4.8 k[3]	C	RF I-V	LCR component
	LF	High performance/ material/C-V	E4980A/AL	20 to 2 M	0.05	4 m to 100 M[3]	D	ABB	LCR component, material, semiconductor
Application specific	LF	For capacitor/ high speed measurement	E4981A[2]	120, 1 k and 1M only	0.07 (0.042 typical)	10 fF to 2 mF[3]	D	ABB	MLCC

1. Basic Z accuracies are best-case values and vary depending on measurement conditions. See product data sheet for detail.
2. Capacitance measurement only.
3. Z range shows the 10% accuracy range.
4. Feature code:
   A: Built-in equivalent circuit analysis
   B: Frequency sweep with color LCD display
   C: Spot frequency with color LCD display
   D: Spot frequency with LCD display
5. Measurement technique code:
   ABB: Auto-balancing bridge
   I-V: I-V methodC: Spot frequency with color LCD display
   D: Spot frequency with LCD display
   RF I-V: RF I-V method
   Ref: Reflection method
   Series: Series-thru method
   Shunt: Shunt-thru method

Impedance Analyzers

Only impedance analyzers provide unparalleled accu-racy from mOhm to Mohm, from 5 Hz to 3 GHz. You can select the appropriate frequency range for your application.

- Frequency, DC bias, and AC voltage/current sweep capability lets you customize where and how test data will be taken.
- Built-in equivalent-circuit analysis computes a multi-element circuit model of the device under test.
- Advanced calibration and compensation methods reduce measurement errors.
- Accessories for permittivity & permeability of materials, high-temperature characterization, various passive components, and impedance probe for grounded measurements available



E4991B impedance analyzer

- Three frequency options: 1 MHz to 500 M/1 G/3 GHz, upgradable
- ±0.65% (typical ±0.45%) basic accuracy and 120 mΩ to 52 kΩ impedance range (10% measurement accuracy range)
- Measurement parameters: |Z|, |Y|, **θ**, R, X, G, B, L, C, D, Q, |Γ|, Γx, Γy, **θΓ**, Vac, Iac, Vdc [1], Idc [1]
- Built-in DC bias (Option 001): 0 V to ±40 V, 0 A to ±100 mA
- 4-chnannel & 4-trace on 10.4 inch color LCD with touch screen
- Data analysis function: Equivalent circuit analysis, limit line test
- Dielectric/magnetic material measurement (Option 002): |εr|, εr', εr'', tan**δ**(ε), |μr|, μr', μr'', tan**δ**(μ)
- Temperature characteristics measurement (Option 007) and reliable on -wafer measurement (Option 010) capabilities

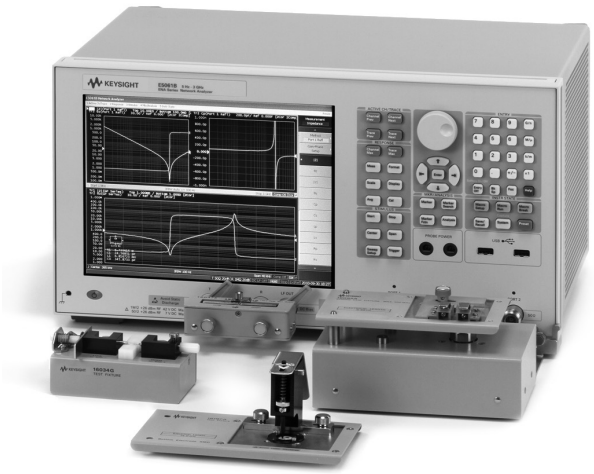
E4990A impedance analyzer

- Five frequency options; 20 Hz to 10/20/30/50/120 MHz, upgradable
- ±0.08% (typical ±0.045%) basic impedance measurement accuracy
- 25 mΩ to 40 MΩ wide impedance measurement range (10% measurement accuracy range)
- Measurement parameters: |Z|, |Y|, **θ**, R, X, G, B, L, C, D, Q, Complex Z, Complex Y, Vac, Iac, Vdc, Idc
- Built-in DC bias range: 0 V to ±40 V, 0 A to ±100 mA
- 4-chnannel & 4-trace on 10.4 inch color LCD with touch screen
- Data analysis function: Equivalent circuit analysis, limit line test
- In-circuit or grounded measurement with the 42941A impedance probe (Option 120 only)
- 7-mm test fixtures combined with 42942A Terminal Adapter (Option 120 only)
- Measurement speed: 3 ms~ / point (Option 120, and 010/020/030/050 with option 001)

1. Option 001 is required.

Network Analyzer

E5061B-3L3/3L4/3L5 LF-RF network analyzer



The E5061B-3L3/3L4/3L5 LF-RF network analyzer with the option 005 impedance analysis function offers the network and impedance analysis capabilities in a single instrument. The E5061B-3L3/3L4/3L5 with option 005 is a versatile and cost-effective solution suitable for general R&D use where various kinds of electronic components and circuits need to be evaluated:

- Three frequency options; 5 Hz to 500 M/1.5 G/3 GHz, upgradable
- S-parameter test port (5 Hz to 3 GHz) and gain-phase test port (5 Hz to 30 MHz, 1 M Ω/50 Ω inputs)
- The E5061B-005 supports reflection, series-thru, and shunt-thru methods using the S-parameter test port or gain-phase test port. These methods are suitable for low-to-middle, middle-to-high, and very low milliohm impedance ranges, respectively. [1]
- Keysight's 7 mm type and 4-terminal pair type component test fixtures can be used in the reflection method (at the S-parameter test port) and the series-thru method (at the gain-phase test port).
- Impedance measurement parameters: |Z|, |Y|, **θ**, R, X, G, B, C, L, D, Q
- Built-in DC voltage bias source (0 to ±40 V, max ±100 mA)

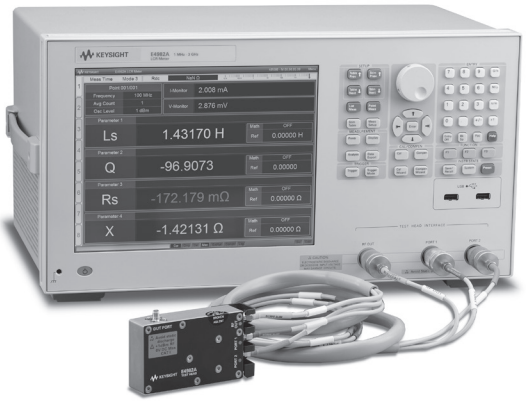
LCR Meters

The LCR meters provide the best combination of accuracy, speed, and versatility at an affordable price for both R&D and production applications.

- Wide frequency range from 20 Hz to 3 GHz
- Frequency list sweep for continuous testing at multiple frequency points
- Unparalleled measurement accuracy at both high and low impedance range
- With the widest variety of accessories, great for testing of leaded components, surface-mount components, semi-conductors, and materials
- Fast measurement speed with superior measurement repeatability
- Handler interface with BIN sorting function for easy test automation in production environment

E4982A LCR meter

- 1 MHz to 300 M/500 M/1 G/3 GHz with 100 kHz resolution
- High speed measurement: selectable from 0.9 ms (Mode 1), 2.1 ms (Mode 2), and 3.7 ms (Mode 3)
- 0.8% (typical ±0.45%) basic accuracy
- RF I-V technique provides a wide impedance range (0.14 Ω to 4.8 kΩ, 10% measurement accuracy)
- Highly stable measurement of low-inductance and excellent Q accuracy for meeting chip inductor test requirements
- Handler interface suitable for production testing
- Measurement parameter |Z|, |Y|, θ, R, X, G, B, L, C, D, Q, Rdc, Idc, Vdc, in user-definable combinations of parameters (up to 4 parameters)
- Versatile PC connectivity – GPIB, LAN, USB



E4980A precision LCR meter

- 20 Hz to 2 MHz with 4-digit resolution
- 0.05% basic accuracy with superior measurement repeatability at low and high impedance
- Measurement time (at 1MHz): 5.6 ms (SHORT), 88 ms (MED), 220 ms(LONG)
- Option E4980A-001 adds ±20 Vrms/±100 mArms test signal, ±40 V/±100 mA internal dc bias, 2nd DC source, and Vdc/Idc measuremnet
- Option 201 and 301 add handler interface and scanner interface respectively
- Measurement parameters:
  |Z|, |Y|, θ, R, X, G, B, L, C, D, Q, Rdc, Vdc [1], Idc [1]
- Versatile PC connectivity, LAN, USB (memory/USBTMC), GPIB

E4980AL precision LCR meter

- 20 Hz to 300 kHz/500 kHz/1 MHz with 4-digit resolution
- 0.05% basic accuracy with superior measurement repeatability at low and high impedance
- Measurement time (at 1MHz): 12 ms (SHORT), 118 ms (MED), 343 ms(LONG)
- Measurement parameters:
  |Z|, |Y|, θ, R, X, G, B, L, C, D, Q, Rdc
- Versatile PC connectivity, LAN, USB (memory/USBTMC), GPIB

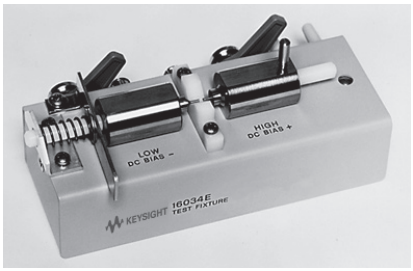
E4981A 120 Hz/1 kHz/1 MHz capacitance meter

- 120 Hz, 1 kHz and 1 MHz test frequencies
- High speed measurement: 2.3 ms (1 MHz), 3.0 ms (1 kHz), 11.0 ms (120 Hz)
- Basic accuracy C: 0.07%, (typical ±0.042%) D: 0.0005 (typical ±0.0003)
- Handler and scanner interfaces suitable for production testing
- Measurement parameters: C, D, Q, ESR, G
- SLC feature provides constant test voltage for high-value capacitor measurements.

1. Option E4980A-001 is required.

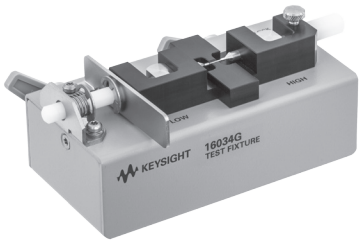
Test Fixtures and Accessories (Four-Terminal-Pair)

Basic test fixtures



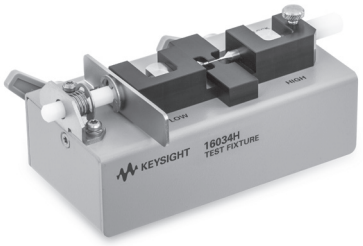
16034E SMD/chip test fixture

Frequency: ≤ 40 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)



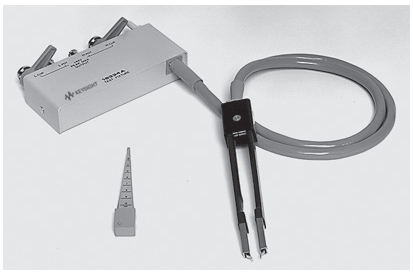
16034G small SMD/chip test fixture

Frequency: ≤ 120 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)



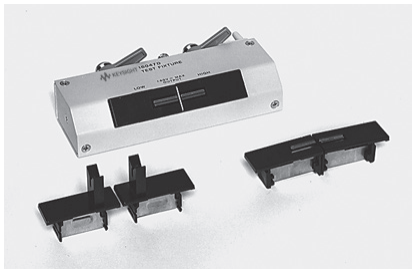
16034H SMD/chip test fixture

Frequency: ≤ 120 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)
Suitable for array-type devices



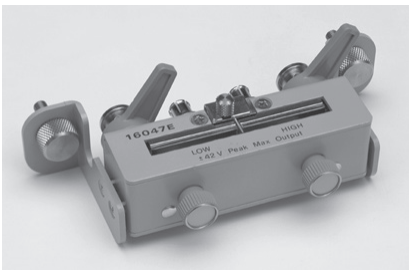
16334A SMD/chip tweezers test fixture

Frequency: ≤ 15 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)



16047A axial & radial test fixture

Frequency: ≤ 13 MHz (Kelvin contact)
Maximum Voltage: ±42 V peak max. (AC+DC)



16047E test fixture

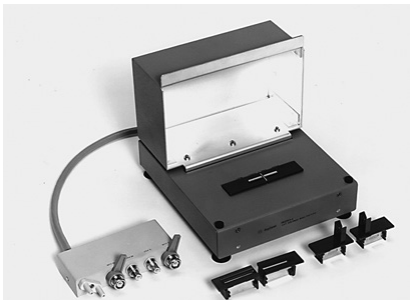
Frequency: ≤ 120 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)

16089A/B/C clip leads

Clip type: A/B/C: Kelvin
Frequency: 5 Hz to 100 kHz
Cable length: A/B/C: 0.94 m
Maximum Voltage: ±42 V peak max. (AC+DC)

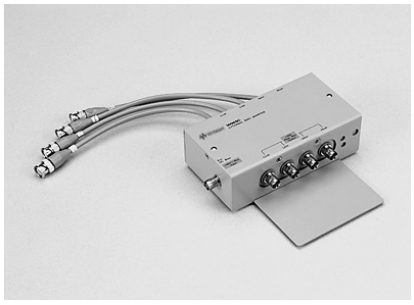
Test Fixtures and Accessories (Four-Terminal-Pair)

External DC bias fixtures



16065A axial and radial test fixture with safety cover

Frequency: 50 Hz to 2 MHz
Maximum external dc bias: ±200 V
Blocking capacitor of 5.6 µF is connected in series with the Hc terminal



16065C external bias adapter

Frequency: 100 Hz to 1 MHz
Maximum external dc bias: ±40 V
Blocking capacitor of 100 µF is connected in series with the Hc terminal

Terminal adapters

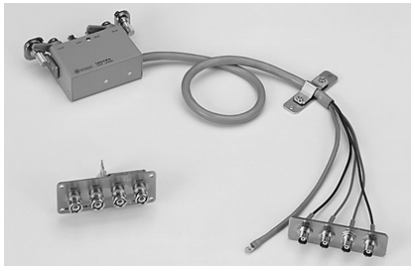
42942A four-terminal-pair to 7 mm terminal adapter

Frequency: ≤ 120 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)
Use with only E4990A-120

Test leads

16048A/D/E BNC test leads

Frequency: A: ≤ 30 MHz, D: ≤ 30 MHz, E: ≤ 2 MHz
Cable length: A: 0.94 m, D: 1.89 m, E: 3.8 m
Maximum Voltage: ±42 V peak max. (AC+DC)

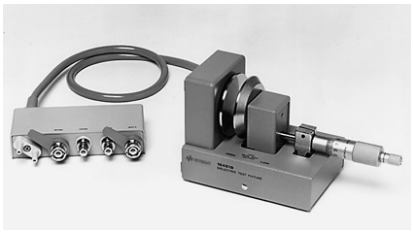


16048G/H BNC test leads

Frequency: ≤ 120 MHz
Cable length: G: 1 m, H: 2 m
Maximum Voltage: ±42 V peak max. (AC+DC)
Use with only E4990A

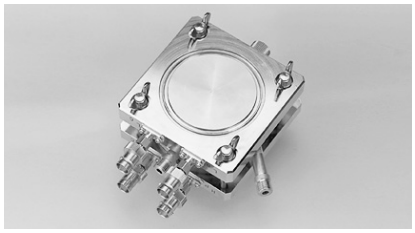
Test Fixtures and Accessories (Four-Terminal-Pair)

Material measurements



16451B dielectric test fixture

Measurement parameters:
capacitance (C), dissipation factor (D), and dielectric constant (εr', εr'')
Material-under-test size:
thickness: ≤ 10 mm
diameter: 10 to 56 mm
Frequency: ≤ 30 MHz



16452A liquid test fixture

Measurement parameter:
capacitance (C), dielectric constant (εr', εr'') Liquid sample
Quantity: ≤ 6.8 ml
Frequency: 20 Hz to 30 MHz

Others

42941A impedance probe kit

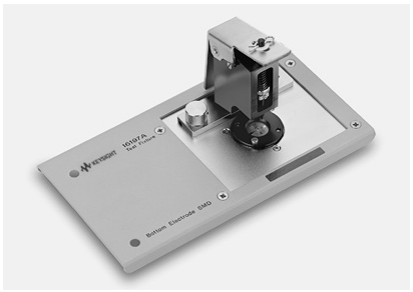
Frequency: ≤ 120 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)
Probe cable length: 1.5 m
Use with only E4990A-120

Test Fixtures and Accessories (7-mm Terminal)

RF SMD/chip components

16196A/B/C/D SMD test fixture

Coaxial fixture for parallel electrode SMDs.
Frequency: dc to 3 GHz
Maximum Voltage: ±42 V peak max. (AC+DC)
Applicable SMD size:
16196A: 1.6 mm x 0.8 mm
16196B: 1.0 mm x 0.5 mm
16196C: 0.6 mm x 0.3 mm
16196D: 0.4 mm x 0.2 mm



16197A bottom-electrode SMD test fixture

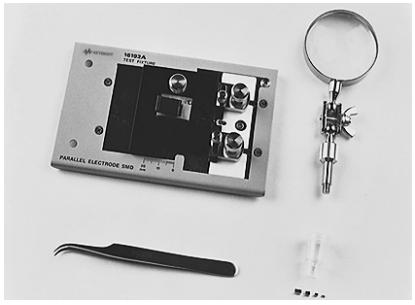
Frequency: dc to 3 GHz
Maximum Voltage: ±42 V peak max. (AC+DC)
Applicable SMD size: from 1005 (mm)/0402 (inch) to 3225 (mm)/1210 (inch).
Accommodation of the 0603 (mm)/0201 (inch) size is available with Option 001.

16092A axial, radial, and SMD test fixture

Frequency: ≤ 500 MHz
Maximum Voltage: ±42 V peak max. (AC+DC)

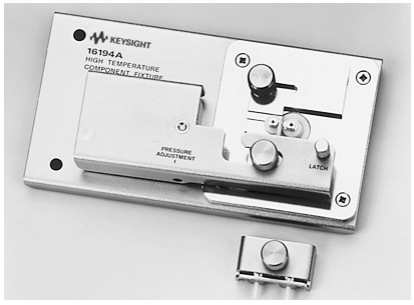
16198A bottom-electrode SMD test fixture

Frequency: dc to 3 GHz
Maximum Voltage: ±42 V peak max. (AC+DC)
Applicable SMD size: 0201 (mm)/008004 (inch) and 0402 (mm)/01005 (inch).



16192A parallel-electrode SMD test fixture

Frequency: dc to 2 GHz
Maximum Voltage: ±42 V peak max (AC+DC)



16194A high temperature component test fixture

Frequency: dc to 2 GHz
Maximum Voltage: ±42 V peak max (AC+DC)
Operating temperature: -55 °C to +200 °C

16200B external DC bias adapter

Frequency: 1 MHz to 1 GHz
Maximum external dc bias: Up to 5 A, ±40 V

Material measurements

16453A dielectric test fixture

Frequency: 1 MHz to 1 GHz
Sample size (smooth sheets only):
- thickness: 0.3 mm to 3 mm
- diameter: ≥ 15 mm

16454A magnetic test fixtures

Frequency: 1 kHz to 1 GHz
Sample size (toroids only):
- height: ≤ 8.5 mm
- inner diameter: ≥ 3.1 mm
- outer diameter: ≤ 20 mm

Test Fixtures and Accessories (E5061B)

16201A N-type to 7 mm terminal adapter

Frequency: ≤ 3 GHz
Maximum Voltage: ±42 V peak max (AC+DC)
Use with only E5061B

Simplify and Improve Your Measurements with Test Accessories

Selecting a test fixture is as important as selecting the right instrument. 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

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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