E4990A Impedance Analyzer

20 Hz to 10/20/30/50/120 MHz
Keysight Impedance Analyzer Series

Achieve success with the industry standard for impedance measurements

Hewlett Packard, Agilent and Keysight 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.

Real characteristics – achieved only with an impedance analyzer

Only Keysight impedance analyzers provide unparalleled accuracy for component evaluation mΩ to MQ, from 5 Hz to 3 GHz. Add an impedance analyzer to your lab and achieve real characteristics of high quality components.

Select the appropriate frequency range and features for your application

Keysight’s impedance analyzers provide the best performance in the industry with frequency and function options to meet your needs at an affordable price. You can select the most appropriate frequency range for your application, from 10 MHz to 3 GHz. Flexible 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. Select what’s best for you – and achieve both your engineering and business goals.

E4990A Impedance analyzer

- Impedance analyzer
- Auto balancing bridge
- Basic accuracy 0.08% (typ. 0.045%)
- Z-range: 25 mΩ to 40 MQ (10% accuracy)

Option 120
20 Hz to 120 MHz
Option 050
20 Hz to 50 MHz
Option 030
20 Hz to 30 MHz
Option 020
20 Hz to 20 MHz
Option 010
20 Hz to 10 MHz

E4991B Impedance analyzer

- Impedance analyzer
- RF-IV method
- Basic accuracy 0.65% (typ. 0.45%)
- Z-range: 120 mΩ to 52 kΩ (10% accuracy)
- Direct readout of material parameters

Option 300
1 MHz to 3 GHz
Option 100
1 MHz to 1 GHz
Option 050
1 MHz to 500 MHz

E5061B ENA Series network analyzer with Options 3L5 and 005

- LF-RF network analyzer (Option 3L5) with impedance analysis (Option 005)
- Basic accuracy 2% (typical)
- Z-range: 1 Ω to 2 kΩ
  (10% accuracy, typical S-parameter port)
- Gain/Phase evaluation

5 Hz to 3 GHz
The E4990A impedance analyzer has a frequency range of 20 Hz to 120 MHz. The E4990A provides an industry best 0.045% (typical) basic accuracy over a wide impedance range with a 40 V built-in DC bias source. The equivalent circuit analysis function supports seven different multi-parameter models and helps you to simulate your own equivalent parameter values of components.

Five frequency options (20 Hz to 10/20/30/50/120 MHz) and frequency upgrades allow you to choose the most appropriate option with the least amount of investment.

The E4990A supports a variety of test accessories that are designed to make measurements simple and reliable.

Whether you are in R&D, QA, or inspection, the E4990A is an ideal solution for characterizing and evaluating electronic components, semiconductor devices, and materials.

**Application examples**

**Passive components**

Impedance measurement of capacitors, inductors, ferrite beads, resistors, transformers, or crystal/ceramic resonators.

**Semiconductor components**

C-V characteristics analysis of varactor diodes. Impedance evaluation of diodes, transistors, amplifiers, or MEMS.

**Other components**

Impedance evaluation of components on printed circuit boards.

**Materials measurements**

Dielectric and magnetic materials can be measured on the E4990A up to 120 MHz with the appropriate fixtures. The N1500A Option 005/006 provides versatile materials measurements using the 16451B, 16452A and 16454A fixtures. The easy-to-use user interface for calibration, limit test, and report generation functions assure comprehensive and accurate measurements on the E4990A. The N1500A software can run either on E4990A or an external PC.

### Summary of Key Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating frequency</td>
<td>20 Hz to 10/20/30/50/120 MHz (Option 010/020/030/050/120 respectively)</td>
</tr>
<tr>
<td>Basic impedance accuracy</td>
<td>± 0.08% (typical ± 0.045%)</td>
</tr>
<tr>
<td>Q accuracy</td>
<td>± 3% (typical) at Q = 100, frequency ≤ 10 MHz</td>
</tr>
<tr>
<td>Impedance range</td>
<td>25 mΩ to 40 MΩ (10% accuracy)</td>
</tr>
<tr>
<td>Measurement time 1</td>
<td>3 msec/point at Option 120, and 010/020/030/050 with Option 001, frequency ≥ 100 kHz, measurement time = 1 (fast)</td>
</tr>
<tr>
<td>Measurement type</td>
<td>Four-terminal-pair measurement (standard)</td>
</tr>
<tr>
<td>Voltage/current signal level</td>
<td>5 mVrms to 1 Vrms /200 μArms to 20 mA, 1 mV/20 μA resolution</td>
</tr>
<tr>
<td>DC bias</td>
<td>0 to ± 40 V/± 100 mA, 1 mV/40 μA resolution</td>
</tr>
<tr>
<td>Auto level control (ALC)</td>
<td>Signal level voltage/current, DC bias voltage/current</td>
</tr>
<tr>
<td>Sweep parameters</td>
<td>Frequency, signal voltage/current, DC bias voltage/current</td>
</tr>
<tr>
<td>Sweep type</td>
<td>Linear frequency, log frequency, linear signal level, linear DC bias, log DC bias, segment</td>
</tr>
<tr>
<td>Number of measurement points</td>
<td>2 to 1601</td>
</tr>
<tr>
<td>Number of channels/traces</td>
<td>4-channel/4-trace</td>
</tr>
<tr>
<td>Marker</td>
<td>10 independent markers per trace, delta marker, marker search, marker analysis</td>
</tr>
<tr>
<td>Data analysis</td>
<td>Equivalent circuit analysis, limit line test</td>
</tr>
<tr>
<td>Interface</td>
<td>USB (front 2, rear 4), LAN, USBTMC, GPIB, 24 bit I/O</td>
</tr>
<tr>
<td>Display</td>
<td>10.4 inch TFT color LCD with touch screen</td>
</tr>
</tbody>
</table>

1. Option 001 is available with the E4990A-010, 020, 030, 050 only.
2. Option 120 only.
Truly User Friendly – Front Panel

The E4990A has a simple and intuitive user interface that allows you to make accurate repeatable measurements. View multiple parameters under various conditions at the same time on the large touch screen display. Frequently used functions are easily accessed through front panel hardkeys and softkeys that are organized for quick and easy navigation. Sophisticated analysis functions are available for better insight into your designs.

View 4-channels/4-traces on the 10.4 inch XGA color LCD with touch screen
User-friendly interface and help menu using the front-panel keys, or mouse and keyboard
Quick access to all necessary functions for basic measurements with Instr Setup key
Embedded context-sensitive help

Two USB ports located on the front of the instrument
Rigid fixture/accessory connection
Four-terminal-pair measurement configuration and auto-balancing technique
Quick save and recall data and setup files on SSD

Get answers quickly with the comprehensive context sensitive embedded help

- Context-sensitive help allows you to quickly get information about selected softkeys
- When using command finder in the programming manual, you can quickly find SCPI commands with a one-key operation
Truly User Friendly – Side and Rear Panel

Powerful yet compact, the E4990A will complement any existing testing environment and requires a minimal amount of space.

The high stability frequency reference (Option 1E5) allows you to improve the frequency accuracy and stability of the E4990A.

The E4990A provides flexible connectivity for remote control and easy test automation. Load measurement data from the E4990A to your PC via GPIB, LAN, or USB (type-B) interface. Digital I/O port (24 bit) is also available for data transfer with an external device, such as a handler.

Web server/control example

Conveniently control the E4990A with your PC and web browser via a LAN interface.

Remotely control the E4990A and acquire measurement data without any programming experience.
Real-World Characterization Under Various Operating Conditions

Comprehensive analysis using multi-channel/multi-trace

The 4-channel/4-trace capability helps you setup and measure multiple parameters under various operating conditions, such as frequency, test signal level, and DC level dependency. The measurement results can be enlarged on the display with one touch.

Frequency dependency

Frequency dependency is common in all components because of the existence of parasitics. The E4990A can sweep test frequencies from 20 Hz to 120 MHz over a wide impedance range. It enables accurate evaluation of the frequency response including the self-resonant frequency point of components, such as capacitors and inductors.

Test signal level dependency

The test signal (AC) applied may affect the impedance characteristics of some devices. The E4990A can sweep test signal voltage from 5 mVrms to 1 Vrms (1 mV resolution), or test signal current from 200 μArms to 20 mArms (20 μA resolution) to evaluate test signal level dependency. The E4990A's ALC function accurately maintains the applied test signal voltage or test signal current. While the impedance of a device might change during a sweep, the ALC function insures that the signal level setting is the actual signal level applied to the DUT.

DC level dependency

DC level dependency is common in semiconductor components such as diodes and transistors. Some passive components are also DC level dependent. The E4990A can sweep DC voltage bias from –40 V to +40 V (1 mV resolution), or DC current bias from –100 mA to +100 mA (40 μA resolution) to evaluate DC signal dependency. The ALC automatically maintains the applied DC voltage bias or current bias.

Left: Frequency dependency (0.1 μF capacitor, frequency swept from 20 Hz to 120 MHz, OSC level = 500 mV)
Upper right: Test signal level dependency (0.1 μF capacitor, signal-level swept from 100 mV to 500 mV, frequency = 1 kHz)
Lower right: DC level dependency (0.1 μF capacitor, DC-level swept from 0 V to 10 V, frequency = 1 kHz, OSC level = 500 mV)
Segment Sweep for Efficient Analysis

The segment sweep function allows you to divide the sweep range into segments. Each segment, including the frequency range, number of points, averaging factor, test signal level, and DC bias can be set independently. This can be achieved with a single sweep. The segment sweep setting can also be exported to a CSV file.

Evaluation of a crystal resonator requires that the nominal resonant/anti-resonant frequencies and some spurious frequencies be determined. You can perform a sweep measurement for a specific range, eliminating the ranges that aren’t needed.

Equivalent circuit analysis

The purpose of equivalent circuit analysis is to model the impedance versus frequency characteristics with three or four elements.

Seven different multi-parameter models accommodate different types of devices such as capacitors, inductors or resonators. You can simulate the impedance trace of your own equivalent circuit parameter values and then compare it with an actual measurement trace. The equivalent circuit parameters can also be saved as a text file.
Unparalleled Accuracy

The E4990A offers the highest level of impedance measurement accuracy and repeatability over a wide impedance/frequency range up to 120 MHz.

- 0.08% (0.045%, typical) basic impedance measurement accuracy
- 25 mΩ to 40 MΩ impedance measurement range (10% measurement accuracy range)
- Small trace noise

Benefits of Keysight Accessories

Keysight offers a variety of accessories suitable for many applications. They are designed to make measurements simple and reliable. Each accessory is designed to ensure highly accurate measurements without degrading the performance of the measurement instrument.

- 42941A Impedance probe kit, convert four-terminal-pair port to a one-port probe (Option 120 only)
- 42942A Terminal adapter, convert four-terminal-pair port to a 7-mm port (Option 120 only)
- 16048G/H Four-terminal-pair test leads, extend the four-terminal-pair port

10% impedance measurement accuracy range at Four-terminal-pair of E4990A’s Front Panel (Test signal level = 0.5 Vrms, measurement Time = 5)
Choose Your Test Fixture

**16047A (DC to 13 MHz)**
- For leaded.

**16047E (DC to 120 MHz)**
- For leaded.

**16034G (DC to 120 MHz)**
- For side electrode SMD.
- 0603 (mm)/0201 (inch) to 3216 (mm)/1206 (inch) size.

**16092A (DC to 500 MHz)**
- For leaded or SMD.
- The 42942A adapter is required.

**16192A (DC to 2 GHz)**
- For side electrode SMD.
- 1608 (mm)/0603 (inch) or larger size. The 42942A adapter is required.

**16196A/B/C/D (DC to 3 GHz)**
- Coaxial fixture specialized for the following SMD sizes:
  - 16196A: 1608 (mm)/0603 (inch)
  - 16196B: 1005 (mm)/0402 (inch)
  - 16196C: 0603 (mm)/0201 (inch)
  - 16196D: 0402 (mm)/01005 (inch)
- The 42942A adapter is required.

**16197A (DC to 3 GHz)**
- For bottom electrode SMD.
- 0603 (mm)/0201 (inch) to 3225 (mm)/1210 (inch).
- The 42942A adapter is required.

**16451B (DC to 30 MHz)**
- For dielectric material.

**16452A (20 Hz to 30 MHz)**
- For liquid material.

**16454A (1 kHz to 1 GHz)**
- For triboal magnetic material.
- The 42942A adaptor is required.
Migrating from 4294A to E4990A

The E4990A includes all the functionality of the industry-standard 4294A impedance analyzer while exceeding the performance and providing more powerful functions, intuitive user interface and PC connectivity. Five frequency options (20 Hz to 10/20/30/50/120 MHz) and frequency upgrades allow you to choose the most appropriate frequency option with the least amount of investment.

Key specifications and function comparison

<table>
<thead>
<tr>
<th></th>
<th>E4990A</th>
<th>4294A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>20 Hz to 10/20/30/50/120 MHz, five frequency options are available</td>
<td>40 Hz to 110 MHz</td>
</tr>
<tr>
<td><strong>Basic accuracy</strong></td>
<td>± 0.08% (typical ± 0.045%)</td>
<td>± 0.08%</td>
</tr>
<tr>
<td><strong>Z measurement range</strong></td>
<td>25 mΩ to 40 MΩ (± 10% measurement accuracy)</td>
<td>25 mΩ to 40 MΩ (± 10% measurement accuracy)</td>
</tr>
<tr>
<td><strong>Signal level</strong></td>
<td>5 mVrms to 1 Vrms/200 μArms to 20 mArms</td>
<td>5 mVrms to 1 Vrms/200 μArms to 20 mArms</td>
</tr>
<tr>
<td><strong>DC bias</strong></td>
<td>0 to ± 40 V/100 mA, 1 mV/40 μA resolution</td>
<td>0 to ± 40 V/100 mA, 1 mV/40 μA resolution</td>
</tr>
<tr>
<td><strong>Auto level control (ALC)</strong></td>
<td>Signal level (V/I), DC bias (V/I)</td>
<td>DC bias (V/I)</td>
</tr>
<tr>
<td><strong>Measurement time (≥ 100 kHz)</strong></td>
<td>3 ms/point at 1 fast (Option 120, and 010/020/030/050 with Option 001)</td>
<td>3 ms/point at BW = 1</td>
</tr>
<tr>
<td><strong>Number of points</strong></td>
<td>2 to 1601</td>
<td>2 to 801</td>
</tr>
<tr>
<td><strong>Trace noise example (100 Ω at 1 MHz, 1 sigma with 200 times measurement)</strong></td>
<td>&lt; 0.002 Ω (0.002%) at measurement time = 1</td>
<td>&lt; 0.02 Ω (0.02%) at measurement time = 1</td>
</tr>
<tr>
<td><strong>Channels/traces</strong></td>
<td>4-channel/4-trace</td>
<td>1-channel/2-trace</td>
</tr>
<tr>
<td><strong>Display (type, resolution)</strong></td>
<td>10.4 inch TFT color LCD with touch screen, XGA (1024 x 768)</td>
<td>8.4 inch TFT color LCD, VGA (640 x 480)</td>
</tr>
<tr>
<td><strong>Data storage</strong></td>
<td>SSD (built-in), external devices connected via USB ports</td>
<td>Non-volatile memory (built-in), 1.44 MB FDD</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>USB (front 2, rear 4), GPIB, LAN, 24 Bit I/O, USBTMC</td>
<td>GPIB, LAN, 24 Bit I/O</td>
</tr>
<tr>
<td><strong>Control commands</strong></td>
<td>E4990A unique SCPI</td>
<td>4294A unique</td>
</tr>
<tr>
<td><strong>Size (mm), weight</strong></td>
<td>425 (W) x 235 (H) x 296 (D), 14 kg</td>
<td>425 (W) x 235 (H) x 445 (D), 25 kg</td>
</tr>
</tbody>
</table>

Select appropriate options for your applications

You can choose just what you require today from five frequency options, and upgrade later as new needs arise. Select what’s best for you — and achieve both your engineering and business goals.

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Support fixtures</th>
<th>42941A impedance probe</th>
<th>42942A + 7mm fixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 120</td>
<td>20 Hz to 120 MHz</td>
<td>Support</td>
<td>Support</td>
</tr>
<tr>
<td>Option 050</td>
<td>20 Hz to 50 MHz</td>
<td>Support</td>
<td>Support</td>
</tr>
<tr>
<td>Option 030</td>
<td>20 Hz to 30 MHz</td>
<td>Support</td>
<td>Not support</td>
</tr>
<tr>
<td>Option 020</td>
<td>20 Hz to 20 MHz</td>
<td>Not support</td>
<td>Not support</td>
</tr>
<tr>
<td>Option 010</td>
<td>20 Hz to 10 MHz</td>
<td>Not support</td>
<td>Not support</td>
</tr>
</tbody>
</table>
Ordering Information

E4990A impedance analyzer
- 100 Ω load resistor for four-terminal-pair extension
- Power cord
- Installation guide
- CD-ROM IO libraries

<table>
<thead>
<tr>
<th>Model-option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E4990A-010</td>
<td>20 Hz to 10 MHz</td>
</tr>
<tr>
<td>E4990A-020</td>
<td>20 Hz to 20 MHz</td>
</tr>
<tr>
<td>E4990A-030</td>
<td>20 Hz to 30 MHz</td>
</tr>
<tr>
<td>E4990A-050</td>
<td>20 Hz to 50 MHz</td>
</tr>
<tr>
<td>E4990A-120</td>
<td>20 Hz to 120 MHz</td>
</tr>
</tbody>
</table>

Other options
- E4990A-001 Enhanced measurement speed option 1
- E4990A-1E5 High stability
- E4990A-810 Add keyboard
- E4990A-820 Add mouse
- E4990A-1CM Rack mount kit
- E4990A-1CN Front handle kit
- E4990A-1CP Rack mount and front handle kit
- E4990A-1A7 ISO 17025 compliant calibration
- E4990A-A6J ANSI Z540 compliant calibration

E4990AU upgrade kits
- E4990AU-020 Upgrade from 10 to 20 MHz
- E4990AU-030 Upgrade from 10 to 30 MHz
- E4990AU-050 Upgrade from 10 to 50 MHz
- E4990AU-120 Upgrade from 10 to 120 MHz
- E4990AU-031 Upgrade from 20 to 30 MHz
- E4990AU-051 Upgrade from 20 to 50 MHz
- E4990AU-121 Upgrade from 20 to 120 MHz
- E4990AU-052 Upgrade from 30 to 50 MHz
- E4990AU-122 Upgrade from 30 to 120 MHz
- E4990AU-123 Upgrade from 50 to 120 MHz
- E4990AU-001 Add enhanced measurement speed 1
- E4990AU-1E5 High stability timebase
- E4990AU-040 Upgrade from Win 7 to Win 10 operating system

Materials measurement software
- N1500A-005 Parallel plate/Inductance method up to 1 GHz 2
- N1500A-006 Parallel plate/Inductance method up to 120 MHz 2

2. Transportable with dongle key. Operation frequency is up to the maximum frequency of E4990A frequency option. Can run either on E4990A or on an external PC. When measuring the magnetic materials with the 16454A fixture, the E4990A Option 120 and 42942A adapter are required.

Accessories

42941A impedance probe kit
- Convert four-terminal-pair port configuration to a one-port probe. To use this kit, frequency Option E4990A-120 is required.

42942A terminal adapter
- Convert four-terminal-pair port configuration to an 7 mm port. To use this adapter, frequency Option E4990A-120 is required.
- Option: 42942A-700
- Add 7 mm open/short/load set

Four-terminal-pair test leads
- 16048G/16048H
- 1 m/2 m four-terminal-pair port extension cable with BNC connectors
- Cable length: 1 m (16048G)
- 2 m (16048H)
Additional Information

Websites

Have access to the following website to acquire the latest news, product and support information, application literature and more.

- [www.keysight.com/find/impedance](http://www.keysight.com/find/impedance)
- [www.keysight.com/find/e4990a](http://www.keysight.com/find/e4990a)

Literature

<table>
<thead>
<tr>
<th>Publication title</th>
<th>Publication number</th>
</tr>
</thead>
<tbody>
<tr>
<td>E4990A Impedance Analyzer - Data Sheet</td>
<td>5991-3890EN</td>
</tr>
<tr>
<td>E4990A Impedance Analyzer 20 Hz to 10/20/30/50/120 MHz - Configuration Guide</td>
<td>5991-3891EN</td>
</tr>
<tr>
<td>LCR Meters, Impedance Analyzers and Test Fixtures - Selection Guide</td>
<td>5952-1430E</td>
</tr>
<tr>
<td>Accessories Catalog for Impedance Measurements - Catalog</td>
<td>5965-4792E</td>
</tr>
<tr>
<td>Power of Impedance Analyzer - Application Note</td>
<td>5992-0338EN</td>
</tr>
</tbody>
</table>

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[www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)