

Agilent 4291B 1.8 GHz Impedance/Material Analyzer

Product Overview

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A complete test solution combining wide impedance measurement range, high accuracy, and easy fixturing



Agilent Technologies

A solution you have been waiting for...

For surface-mount component evaluation and material testing, the Agilent 4291B Impedance/Material Analyzer is an integrated package designed to provide accurate testing using standard fixtures at frequencies up to 1.8 GHz.

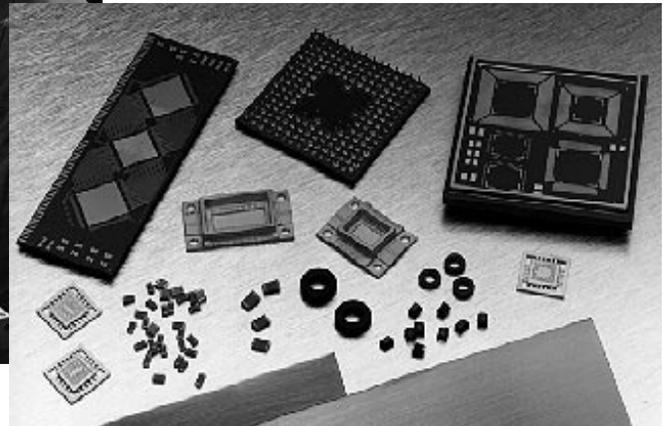
For component manufacturers, RF and digital equipment designers, and material researchers, the 4291B offers these new capabilities and accessories:

- Broad frequency coverage from 1 MHz to 1.8 GHz for testing RF components and materials¹

- Improved measurement accuracy and repeatability over an impedance range of 0.1 Ω to 50 k
- Surface-mount-device (SMD) test fixtures for different sizes of chip capacitors and inductors
- Dielectric test fixture and built-in function for measuring permittivity, including Cole-Cole plot and relaxation time
- Magnetic test fixture and built-in function for measuring permeability
- Direct impedance and material parameter measurement versus frequency, time, humidity, or temperature²

The 4291B analyzer combines performance, flexibility, and ease of use for testing the following:

- SMDs such as chip capacitors, chip inductors, coils, varactor diodes, and other passive components
- IC packages and packaging materials
- Multichip module (MCM) substrates and interconnects
- Printed circuit boards
- Dielectric and magnetic materials



The Agilent 4291B and its test features comprise a complete solution for RF component evaluation and material analysis.

The analyzer offers high accuracy over a wide impedance measurement range for testing a variety of RF components and materials.

1. Opt. 002 adds material testing capability, when using the 16453A dielectric and 16454A magnetic test fixtures (1 MHz to 1 GHz).

2. With IBASIC (built-in) and an external temperature chamber.

Combine measurement accuracy and ease of use

The 4291B analyzer is a major breakthrough that extends impedance measurement technology to the RF range, while maintaining accuracy.

The analyzer measures impedance as a one-port, lumped element from a ratio of voltage and current. This proprietary technique, unlike reflection measurement, ensures higher measurement accuracy through a wide frequency and impedance range.

Standard SMD and material test fixtures, sold separately, simplify DUT and MUT (material-under-test) connection and offer measurement flexibility. The test fixtures are interchangeable, attaching to the 7 mm connector on the test head. Advanced calibration and error compensation remove fixture parasitics to help ensure high accuracy.

With fifteen built-in impedance parameters and seven optional material parameters, the Agilent 4291B gives you quick answers without complex calculation. To automate testing, you can program directly on the instrument and control external test equipment with the analyzer's built-in IBASIC capability.

Agilent 4291B Key Specifications

Operating Frequency: 1 MHz to 1.8 GHz*

Impedance Parameters: $|Z|$, θ_z , $|Y|$, θ_y , R , X , G , B , C_p , C_s , L_p , L_s , R_p , R_s , D , Q

Converted Parameters: $|\Gamma|$, θ , Γ_x , Γ_y

Material Parameters (opt. 002): $|\epsilon|$, θ , ϵ' , ϵ'' , $|\mu|$, μ' , μ''

Basic Measurement Accuracy:

Frequency (Hz)	Impedance Accuracy (%)	Phase Accuracy (in radians)
1 M – 100 M	0.8	8 m
200 M	1.0	10 m
500 M	1.5	15 m
1.0 G	2.5	25 m
1.8 G	4.0	40 m

Typical Accuracy for material measurements
 ϵ_r : $\pm 8\%$ ($@\epsilon_r < 10$)
 $\tan\delta$: ± 0.005
 μ_r : $\pm 4\%$
 $\tan\delta$: ± 0.002

Impedance Range: 0.1 Ω to 50 k Ω

DC bias (opt. 001) 0 to ± 40 V,
0 to ± 100 mA

No. of points per sweep: 2 to 801 pts.

Other Features: Two independent measurement channels, built-in floppy disk drive, limit-line testing, equivalent circuit analysis, and the IBASIC

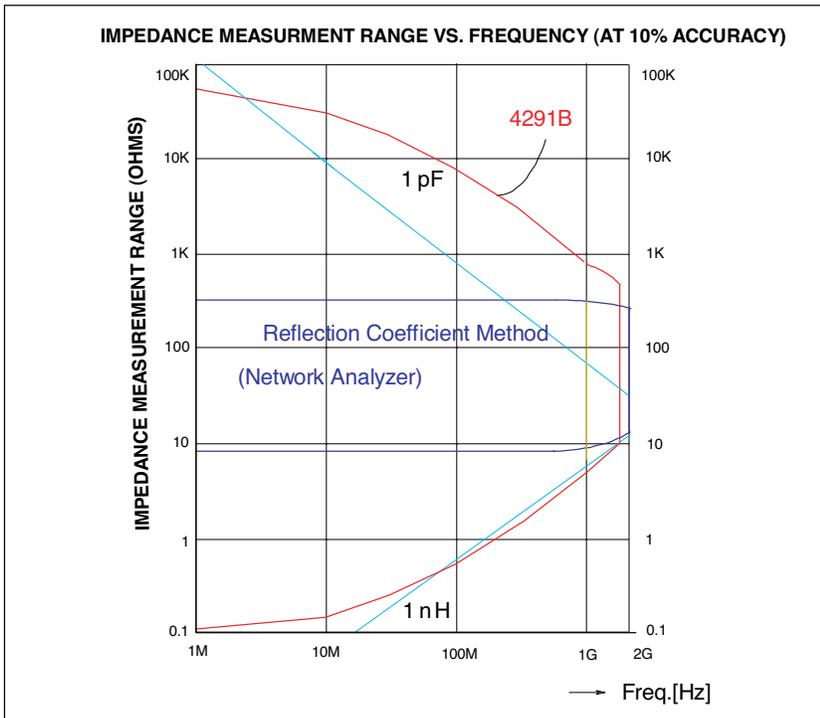


Figure 1. More of today's devices have extremely low inductance or capacitance (as shown by the dashed lines). When measuring these non-50- Ω impedance values, the 4291B gives you high accuracy over a wide impedance range.

* 1 MHz to 1 GHz when using the 16453A dielectric and 16454A magnetic test fixtures.

Introducing the Agilent 4291B

The impedance/material analyzer designed to meet your needs

Dual capabilities:

Perform both impedance and material testing with one analyzer.

Powerful graphics:

Get easy-to-understand results quickly with:

- The color LCD with independent dual-channel display
- Up to sixteen memory traces per channel
- User-defined graphics

Expandability and compatibility:

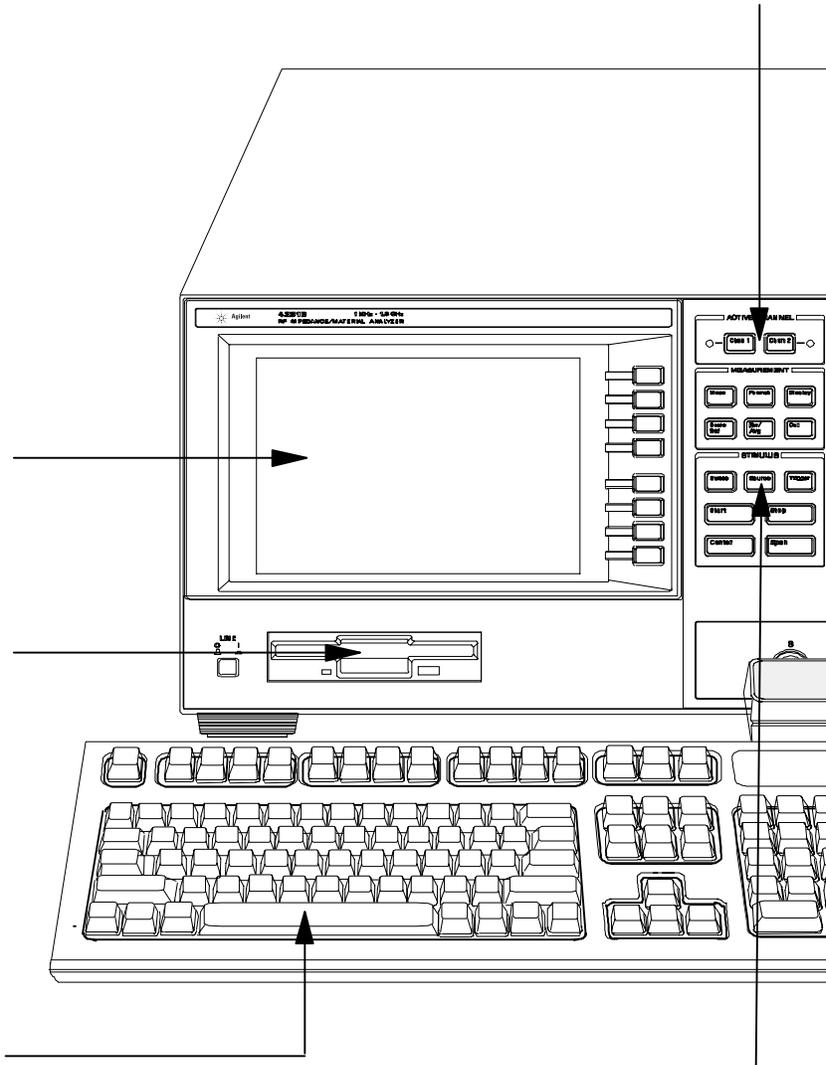
Store test programs, calibration data, and measurement data on the MS-DOS®- and LIF-compatible 1.44-MB disk drive. The data stored in built-in 448 KB RAM disk memory can also be saved into non-volatile flash disk memory for quick start-up.

Programmability with IBASIC (Built-in as standard):

- Temperature/humidity testing with an external temperature chamber
- Test automation

Flexibility:

Use two measurement channels to test any two parameters independently

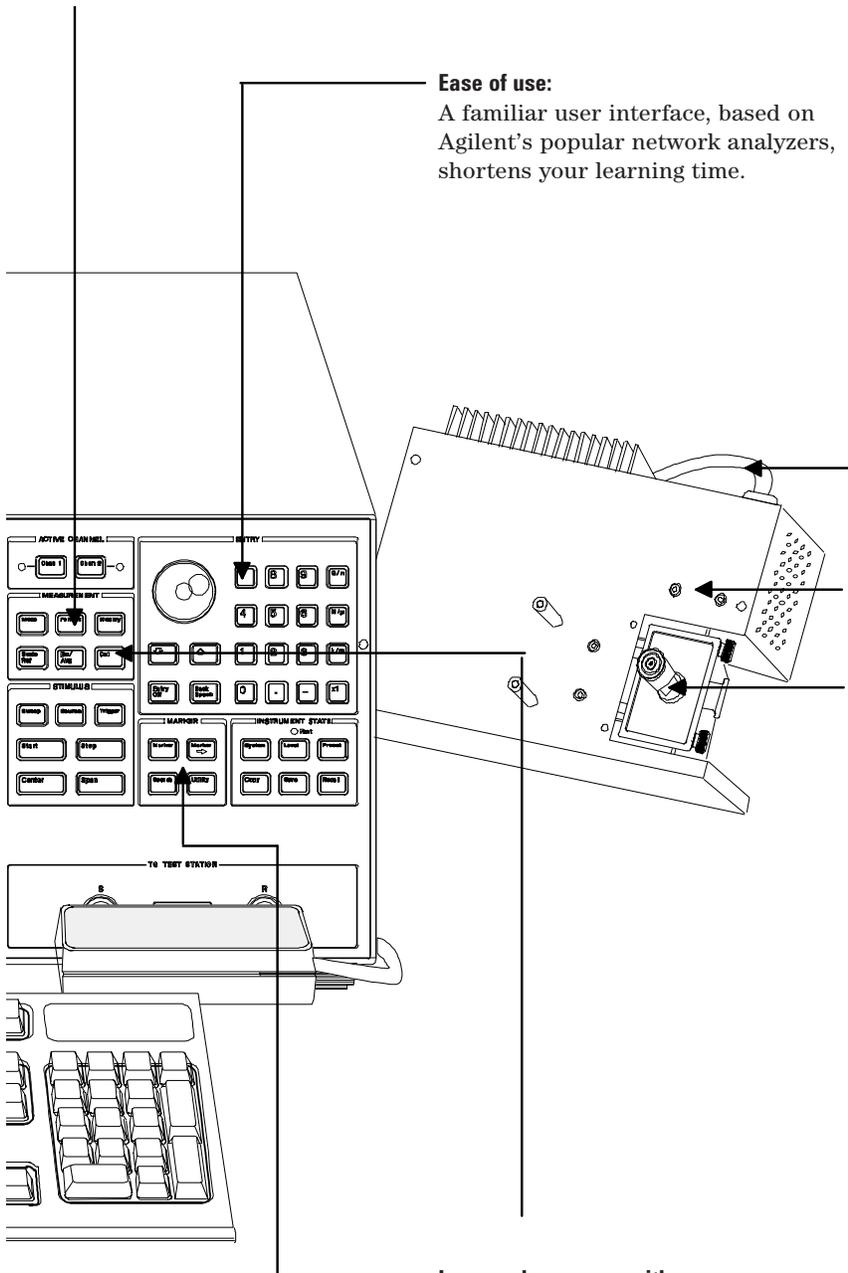


Complete testing that includes:

- Frequency linear/log sweep
- Bias sweep (Opt. 001)
- Temperature, humidity, or time sweep
- Test signal monitoring: ac/dc current or voltage

Standard data formats:

Choose from rectangular, Cole-Cole plot, polar, Smith chart, admittance chart, and complex plane.



Adaptability and accuracy enhanced by:

- A 1.8-m error-free cable that extends the measurement point away from the instrument without decreasing accuracy
- A test station that connects to a high- or low-impedance test head for optimal testing
- A test head with 7 mm connector that adapts easily to a variety of test fixtures

Quick data analysis using:

- Markers and marker utilities
- Limit lines for go/no-go testing

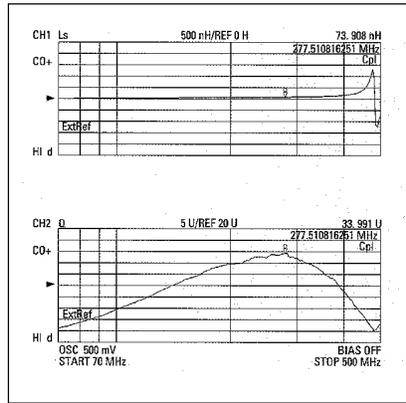
Improved accuracy with:

- Advanced calibration: open, short, load, and low-loss capacitor
- Fixture compensation: open, short, and load

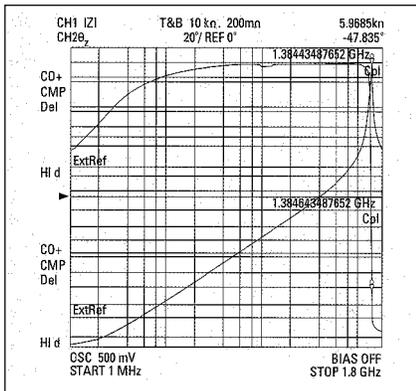
Precise impedance testing
When testing chip capacitors, inductors, and other passive components, the Agilent 4291B meets your most demanding testing requirements.

Using the 4291B impedance/material analyzer, you can reduce design uncertainty by measuring your device's true impedance characteristics at higher frequencies. Furthermore, the 4291B's wide impedance measurement range lets you test non-50-Ω components accurately and conveniently.

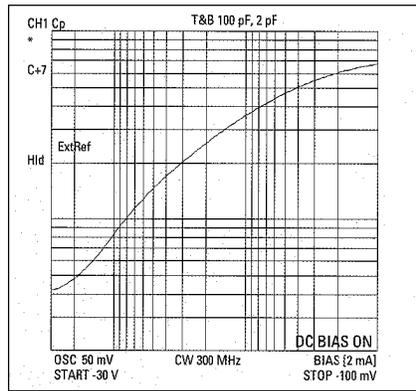
The analyzer works with standard test fixtures for testing SMDs, so you no longer have to build an elaborate setup to measure small, non-50-Ω devices.



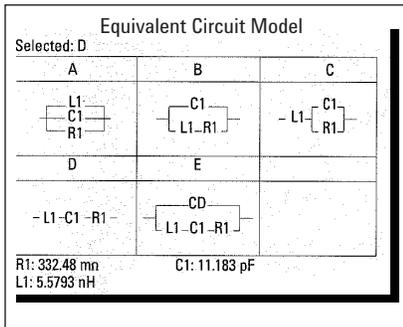
Two independent measurement channels let you test multiple parameters easily.



The 4291B's wide impedance range is ideal for RF inductor testing.



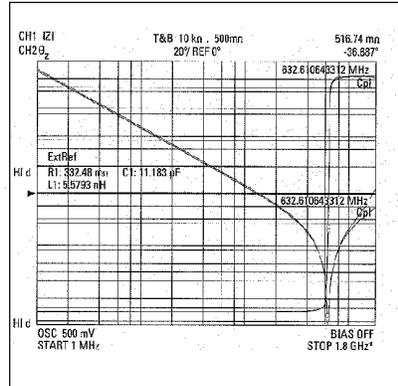
Characterize varactor diodes using internal dc bias function (Opt. 001).



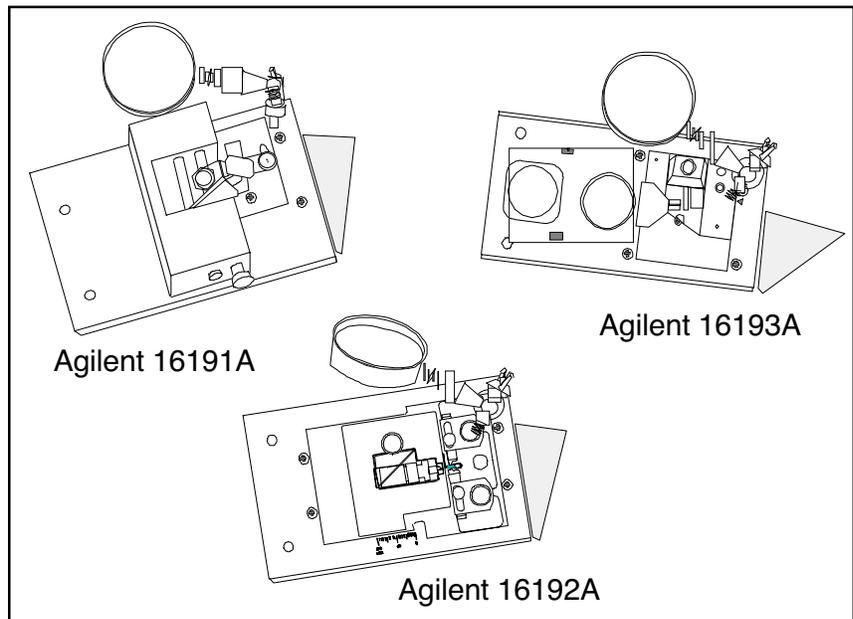
Equivalent circuit analysis offers five circuit models to simulate your component. The equivalent-circuit parameters are calculated automatically for the circuit model selected.

The Agilent 4291B gives you these powerful capabilities:

- Evaluate components at operating frequencies up to 1.8 GHz, and with dc bias up to ± 100 mA and ± 40 V (Opt. 001).



- Get stable Q measurements up to 1.8 GHz for low-loss components.
- Monitor test signals applied to your DUTs.
- Simulate a component with equivalent circuit analysis (similar to the Agilent 4294A's equivalent circuit analysis function).
- Select from standard SMD test fixtures designed for accuracy and device adaptability.
- Perform temperature coefficient testing.
- The 4291B analyzer gives you everything you expect from an Agilent impedance analyzer and much more.



SMD test fixtures simplify DUT connection and ensure measurement repeatability.

Material analysis made easy ...

The Agilent 4291B provides an integrated solution for simplifying permittivity and permeability measurements.

Ready-to-use test fixtures

New dielectric and magnetic test fixtures eliminate the time-consuming task of designing custom fixtures. These test fixtures, combined with the analyzer's built-in calibration and compensation routines, ensure measurement accuracy.

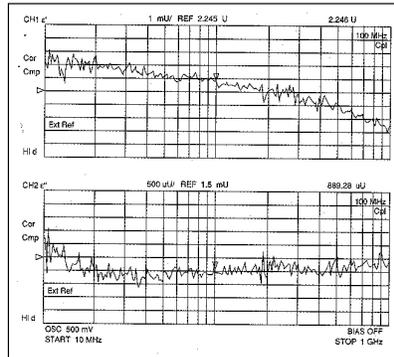
The fixtures accept common types of sheet samples (for dielectric testing) and toroidal-shaped samples (for magnetic testing).

Sophisticated firmware

Using measured impedance values and user-specified sample dimensions, the 4291B automatically calculates permittivity and permeability parameters. IBASIC (built-in) lets you control an external environmental chamber for temperature and humidity testing. (See page 9.)

Dielectric material testing

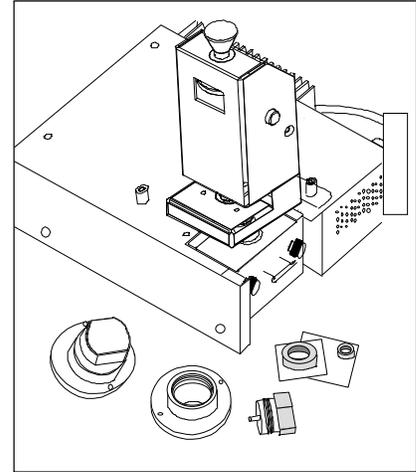
Test ceramic substrates, printed circuit boards, polymer films, and other dielectric materials.¹



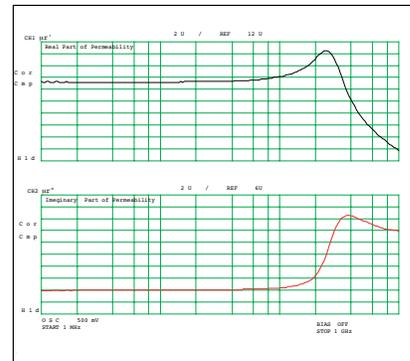
Get frequency-swept permittivity measurements easily with the 4291B.

Magnetic material testing

Evaluate ferrite materials easily with built-in firmware and test fixture integrated for high performance.



Easy-to-use material test fixtures save sample preparation and connection time.



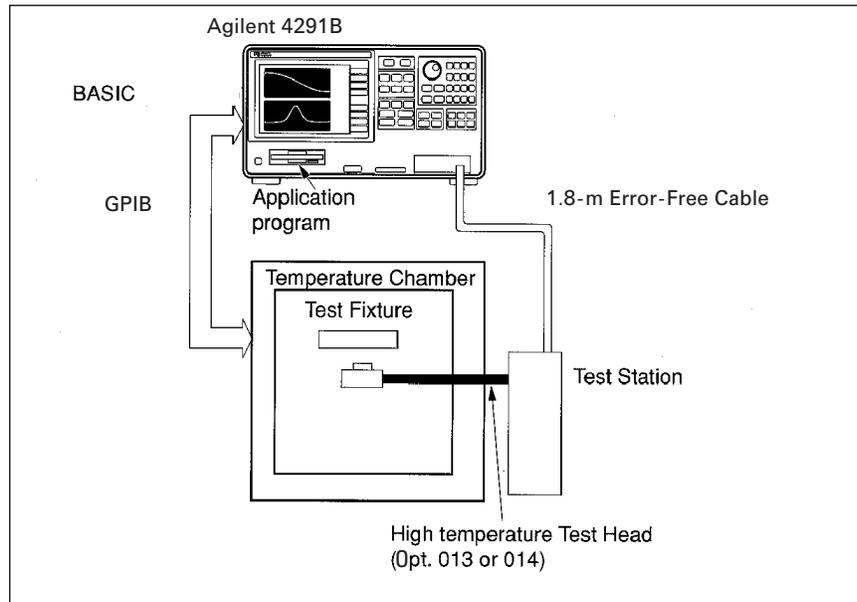
Measure permeability up to 1 GHz with precision and ease.

1. The 4291B and 16453A are best suited for measuring dielectric materials, and provide best measurement results at frequencies from 1 MHz to 1 GHz.

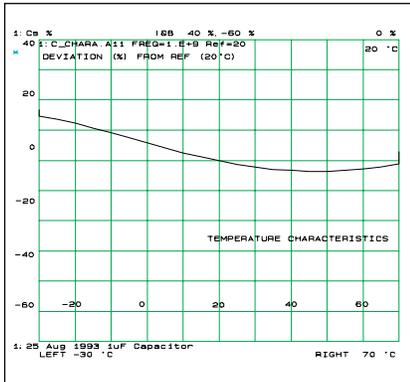
Integrated temperature and humidity testing with your Agilent 4291B

With the 4291B and its IBASIC capability (built-in), you can perform temperature and humidity testing in three easy steps:

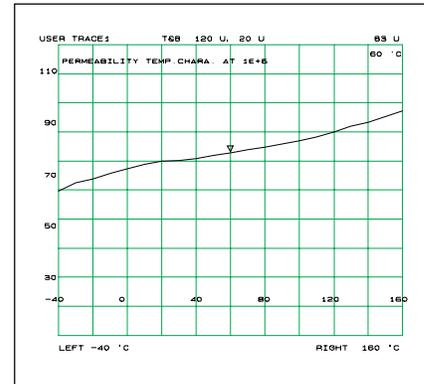
1. Connect a GPIB-programmable temperature or humidity chamber to the 4291B via GPIB.
2. Control the chamber from the 4291B with IBASIC¹.
3. Display measured data versus temperature or humidity directly on the 4291B. The analyzer's flexible firmware lets you define your own display parameters.



The 4291B and its built-in IBASIC simplify test system integration.



Temperature testing of components takes less time and effort.



Temperature testing of materials is quicker and easier.

1. For a TABAI ESPEC chamber (model SU-240-Y), automatic control software is provided with no programming required.

Configuration¹

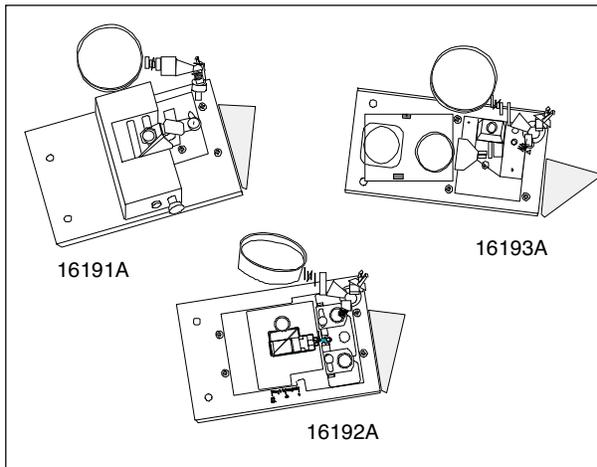
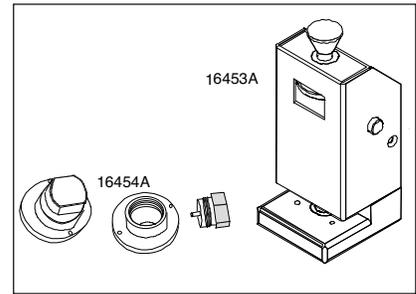
The Agilent 4291B Impedance/Material Analyzer includes: impedance measurement functions, test station, high-impedance test head, calibration kit (with open, short, 50-Ω load standards, and low-loss capacitor), and mini DIN keyboard for IBASIC (built-in).

Options²

- 001** Add dc bias (± 40 V, ± 100 mA).
- 002** Add material measurement firmware.
- 011** Delete high-impedance test head.
- 012** Add low-impedance test head³.
- 013** Add high-temperature (-55 °C to $+200$ °C) high-impedance test head and fixture stand.
- 014** Add high-temperature (-55 °C to $+200$ °C) low-impedance test head and fixture stand.
- 1A2** Delete mini DIN keyboard.
- 1D5** Add high-stability frequency reference.
- ABA** English localization.
- UK6** Commercial calibration certificate with test data.

Accessories

- 16190A** 4291B Performance test kit.
- 16191A** Side electrode SMD test fixture.
- 16192A** Parallel electrode SMD test fixture.
- 16193A** Small side electrode SMD test fixture.
- 16194A** High temperature test fixture.
- 16453A** Dielectric material test fixture⁴.
- 16454A** Magnetic material test fixture^{1,4}.

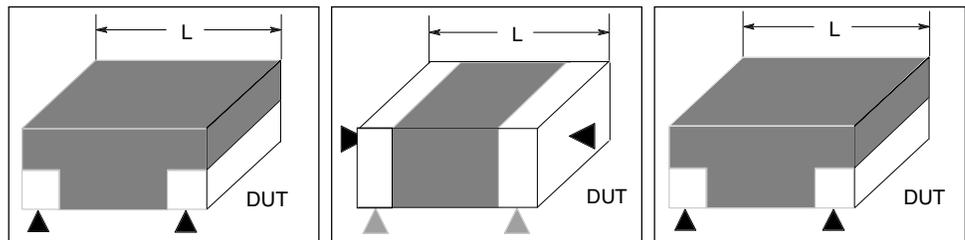


SMD Fixture Specifications	16191A	16192A	16193A
Operating Frequency:	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz
Operating Temperature:	-55 °C to $+85$ °C	-55 °C to $+85$ °C	-55 °C to $+85$ °C
DUT Size (length in mm):	2.0 to 12.0	1.0 to 20.0	0.5 to 3.2

DUT connection:

▲ = electrodes

□ = DUT termination:



1. Must be used with the 4291B option 012.
2. Options and test fixtures are priced individually, except as noted.
3. For optimal test results, use high-impedance test head for measuring impedance values > 10 Ω and or dielectric material measurement. Use the low-impedance test head for measuring impedance values ≤ 10 Ω and for magnetic material measurement.
4. Must be used with the 4291B option 002.



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