

Impedance Measuring Instruments

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RF Impedance Material Analyzer, 1 MHz to 1.8 GHz

HP 4291B

- Basic accuracy $\pm 0.8\%$
- Advanced calibration and error compensation
- Four component test fixtures (DUT size: 0.5 mm to 20 mm)
- Independent parameter selection in 2 channels
- Direct read-out permittivity, permeability (option)
- Two material fixtures (operating temperature: -55° to $+200^\circ$ C)
- Versatile analysis (temperature, cole-cole plot, relaxation time)
- Sweep parameters (frequency, ac level, dc bias, temperature)



HP 4291B

HP 4291B RF Impedance/ Material Analyzer



Excellent Performance

The HP 4291B RF impedance/material analyzer provides a total solution for high-accuracy and easy measurement of surface-mount components and dielectric/magnetic materials. The HP 4291B uses a direct current-voltage measurement technique, opposing the reflection measurement technique, for more accurate impedance measurement over wide impedance range. Basic impedance accuracy is $\pm 0.8\%$. High Q accuracy enables low-loss component analysis. An internal synthesizer sweeps frequency from 1 MHz to 1.8 GHz with 1 mHz resolution. A 1.8-m error-less cable connects the analyzer to a test station so you can extend your test point away from the analyzer without losing accuracy. Advanced calibration and error compensation function eliminate measurement error factors in fixtures and assure high accuracy and repeatability at DUT/MUT.

The HP 4291B also provides automatic level control and monitor of test signals by using IBASIC programming function; devices can be measured under a constant voltage or current. Measure bias-dependent impedance characteristics with optional dc bias (up to 40 V and 100 mA). At the push of a button, the built-in Equivalent Circuit Analysis Function automatically calculates the circuit constant values of five circuit models.

The HP 4291B has two measurement channels; each channel can be set to measure a single (e.g. Z) or dual (e.g. Z-theta) impedance parameter. The color TFT with split-display can show both active traces and memory traces (stored in RAM). A built-in floppy disk drive stores programs and test data in either LIF or MS-DOS format.

With built-in IBASIC, you can control external test equipment such as a temperature chamber or wafer prober directly from the HP 4291B. You do not need a separate instrument controller.

Material Evaluation

The HP 4291B enables easy and sophisticated material evaluation and improves material evaluation quality and efficiency. The HP 4291B provides the total dielectric/magnetic material measurement solutions in wide frequency range (1 MHz to 1 GHz). See page 477 for more information.

Key Features

- Direct material parameter read-out (permittivity, permeability)
- Material analysis functions (Cole-Cole plots, relaxation time analysis)
- Versatile evaluation using a variety of swept parameters (frequency, signal level, temperature, etc.)

Test Fixtures

Select from four types of component test fixtures: HP 16191A, HP 16192A, HP 16193A, and HP 16194A. These test fixtures directly connect to the test station's APC-7 connector. Each fixture is designed for a different component size range, from 0.5 mm to 20 mm, and can handle different types of termination. These adjustable fixtures simplify device connection. For temperature coefficient testing, the HP 16194A high-temperature component test fixture can be used in a temperature oven from -55° to $+200^\circ$ C. Together with the HP 4291B's built-in compensation software, the fixtures ensure impedance accuracy and measurement repeatability. The HP 16453A dielectric material test fixture and HP 16454A magnetic material test fixture improve the accuracy and ease of use for permittivity or permeability measurements. These material fixtures have wide operating temperature of -55° to $+200^\circ$ C.

For measuring thin-film devices and semiconductors, the HP 4291B easily interfaces to a wafer prober. An extension cable connects the HP 4291B's test head to a probe station. For temperature and humidity testing, the HP 4291B can control an external temperature humidity chamber via GPIB and display the measurement result vs. temperature or humidity.

Ease of Use

With the HP 4291B, impedance testing is easy. The analyzer comes with on-line calibration and compensation routine to simplify the task. Markers and limit-line function offer quick data analysis.

Specifications

Measurement Parameters

Impedance Parameters: $|Z|$, $|Y|$, Θ , R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q
Converted Parameters: $|\Gamma|$, U, Γ_x , Γ_y
Material Parameters: $|\epsilon|$, Θ , ϵ' , ϵ'' , $|\mu|$, μ' , μ''
Operating Frequency: 1 MHz to 1.8 GHz
Frequency Resolution: 1 mHz
Frequency Reference Accuracy: $< \pm 10$ ppm/year @ $\pm 5^\circ$ C
Precision Frequency Reference (Option 1D5)
Accuracy: $< \pm 1$ ppm/year @ 0° to 55° C, referenced to 23° C

Basic Measurement Accuracy

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

Source Characteristics

OSC Level:

0.2 mV to 1 V rms (1 MHz to 1 GHz)
 (Output terminal open)

0.2 mV to 0.5 V rms (1 GHz to 1.8 GHz)

Basic OSC Level Accuracy: 2 dB + 6 dB X f [MHz]/1800 @ $23 \pm 5^\circ$ C;
 (terminated with 50 Ω) @ $V \geq 250$ mV

Display Level Unit: V, I, dBm

Level Monitor Function: Voltage, current

Connector: APC-7

Output Impedance (nominal value): 50 Ω

DC Bias

DC Level: 0 to ± 40 V, 0 to ± 100 mA

DC Level Accuracy:

Voltage Level: 0.1% + 4 mV + (I_{dc}[mA] X 5 [Ω] mV @ $23 \pm 5^\circ$ C

Current Level: 0.5% + 30 μ A + (V_{dc} [V]/10 [k Ω]) mA @ $23 \pm 5^\circ$ C

DC Level Monitor Function: DCV, DCI

Sweep Characteristics

Sweep Parameter: Frequency, ac signal level,
 dc bias voltage/current (temperature by using IBASIC)

Capacitor Calibration

Open/Short/50 Ω Calibration, low loss CAL

Open/Short/Load Compensation, port extension, fixture electrical length

Key Specifications of Test Fixtures

Type of fixture	HP 16191A	HP 16192A	HP 16193A	HP 16194A
Operating freq. (typ.)	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz
Operating temperature	-55° to $+55^\circ$ C	-55° to $+85^\circ$ C	-55° to $+85^\circ$ C	-55° to $+200^\circ$ C
DUT size (length: mm)	2.0 to 12.0	1.0 to 20.0	0.5 to 3.2	2.0 to 15.0

Display

CRT

Type: Color TFT

Size: 8 inch

Number of Display Channels: 2

Format: Single, dual, active + memory, graphic, and tabular

Storage

Type: Built-in 3 $\frac{1}{2}$ -inch floppy disk drive; volatile RAM disk memory

Disk Format: LIF, DOS

Programming: Instrument BASIC (built-in)

Input and Output Characteristics

External Reference Input: 10 MHz \pm 100 Hz typically

Internal Reference Output: 10 MHz nominal

Reference Oven Output (Option 1D5): 10 MHz nominal

External Trigger Input: BNC female, TTL Level

General Specifications

Operating Temperature/Humidity: 10° to 50° C/15% to 80% RH

Warm-Up Time: 30 min.

Power Requirements: 90 V to 132 V, or 198 V to 264 V, 47 to 66 Hz,

500 VA max.

Size/Weight

Mainframe: 426 mm W x 234 mm H x 537 mm D/24.2 kg

Test Station: 275 mm W x 95 mm H x 205 mm D/3.7 kg

Key Literature

HP 4291B 1.8GHz Impedance/Material Analyzer Product Overview,
 p/n 5966-1501E

HP 4291B 1.8GHz Impedance/Material Analyzer Technical
 Specifications, p/n 5966-1543E

Ordering Information

HP 4291B RF Impedance/Material Analyzer

Furnished Accessories: High-Impedance Test Head,
 Calibration Kit, Operation Manual, Floppy Disk, and
 Power Cable. (No test fixture is supplied with the
 HP 4291B.)

Options

Opt 1D5 Add High-Stability Frequency Reference

Opt 001 Add DC Bias

Opt 002 Add Material Measurement Software

Opt 011 Delete High-Impedance Test Head

Opt 012 Add Low-Impedance Test Head

Opt 013 Add High-Temperature High-Impedance
 Test Head

Opt 014 Add High-Temperature Low-Impedance
 Test Head

Support Options

Opt W30 Extended Repair Service

Opt W32 Calibration Service

Accessories

HP 16190A HP 4291B Performance Test Kit

HP 16191A Side Electrode Test Fixture

HP 16192A Parallel Electrode Test Fixture

HP 16193A Small Side Electrode Test Fixture

HP 16194A High-Temperature Component Test Fixture

HP 16453A Dielectric Material Test Fixture

HP 16454A Magnetic Material Test Fixture