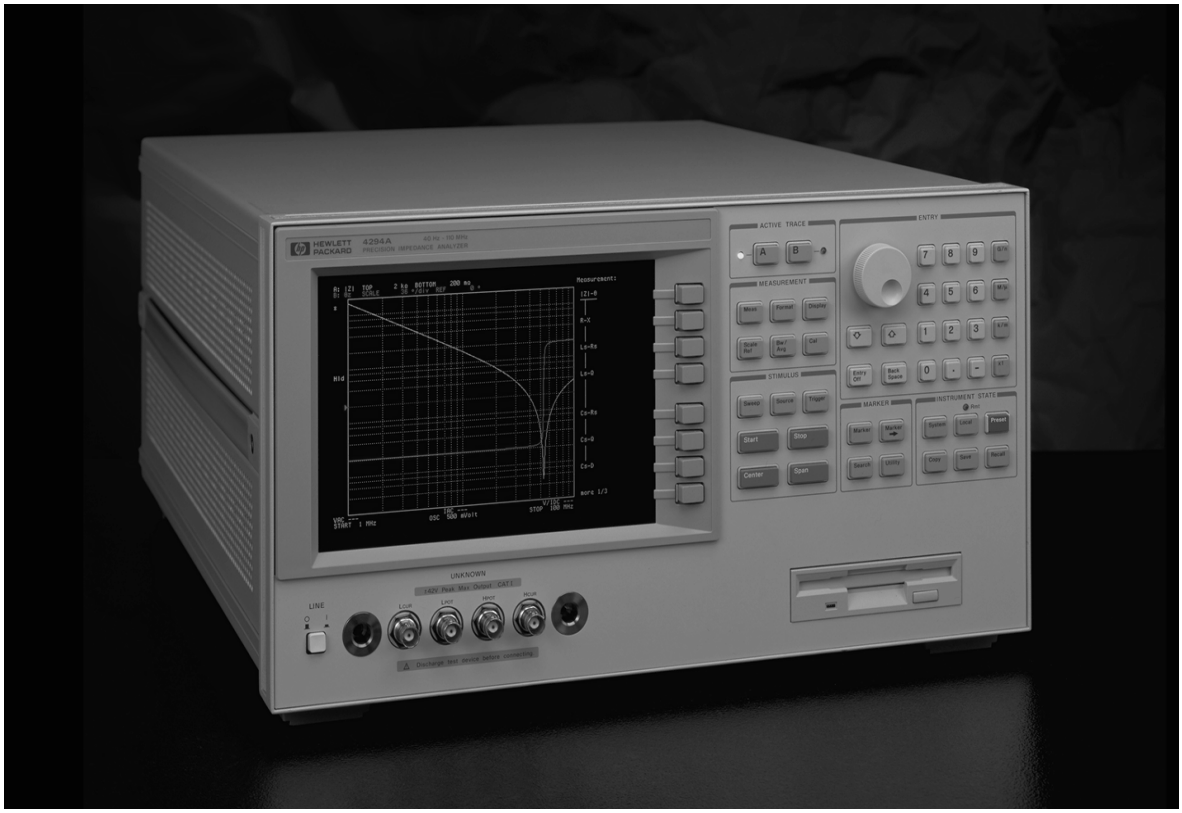
profile

HEWLETT PACKARD
Expanding Possibilities

HP | 4294A | Precision Impedance Analyzer

New Generation Precision Impedance Analyzer for functionality and efficiency in engineering

40 Hz to 110 MHz



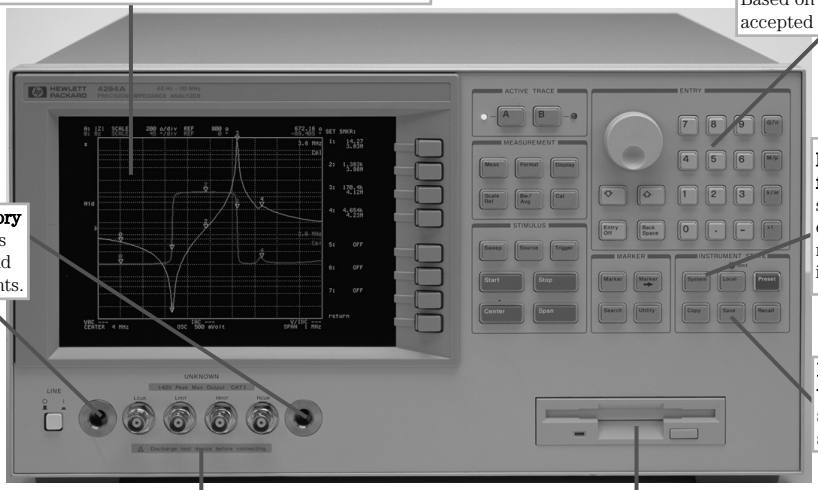
HP 4294A Precision Impedance Analyzer, NEW FEATURES

The HP 4294A Precision Impedance Analyzer greatly supports accurate impedance measurement and analysis of a wide variety of electronic devices (components and circuits) as well as electronic and non-electronic material.

- Accurate measurement over wide impedance range and wide frequency range.
- Powerful impedance analysis functions.
- Ease of use and versatile PC connectivity.

8.5 inch TFT color display Powerful analysis tools available. 801 sweep points, 4 traces (2 data traces and 2 memory traces), 8 markers, marker analysis functions, and equivalent circuit analysis function.

User-friendly interface Based on HP's widely accepted user-interface.



HP IBASIC programming function Automatic setup, measurement and computation as well as remote instrument control is possible.

Rigid fixture/accessory connection Provides highly repeatable and reliable measurements.

Built-in 10Mbyte non-volatile memory Data or setup files can be quickly saved or recalled.

Impedance measurement ports Four-Terminal-pair measurement configuration and the newest auto-balancing bridge technique enable high accuracy and wide impedance range.

3.5 inch floppy disk drive Screen images, data and setup files can be easily saved, recalled, and shared (1.44Mbyte).

External VGA Output Display measurements on a large VGA monitor. Reduces eyestrain, improves team work and communication.

Two digital I/O ports Control other instrument(s) or use an external controller (instrument or computer) via 8bit or 24bit programmable I/O port.

HP-IB Interface Automatic measurement system is easily configured with an external instrument or computer.

LAN Interface (10 Base-T) Another instrument control method or simplified file sharing.

External keyboard Interface Makes HP IBASIC program development easier (mini DIN keyboard).

Printer (Centronics) Interface Connects PCL3 printers directly to the instrument.

40 Hz to 110 MHz

The HP 4294A is a powerful tool for design, qualification, quality control, and production testing of electronic components. Circuit designers and developers can also benefit from the performance/functionality offered.

Moreover, the HP 4294A's high measurement performance and capable functionality delivers a powerful tool to circuit design and development as well as materials research and development (both electronic and non-electronic materials) environments.

The following are application examples:

Electronic Devices:

Passive component:
・Impedance measurement of two terminal components such as capacitors, inductors, ferrite beads, resistors, transformers, crystal/ceramic resonators, multi-chip modules or array/network components.

Semiconductor components:
・C-V characteristic analysis of Varactor Diodes
・Parasitic analysis of a diode, transistor, or IC package terminal/leads.
・Amplifier input/output impedance measurement.

Other components:
・Impedance evaluation of printed circuit boards, relays, switches, cables, batteries, etc.

Materials:

Dielectric material:
・Permittivity and loss tangent evaluation of plastics, ceramics, printed circuit boards and other dielectric materials.

Magnetic material:
・Permeability and loss tangent evaluation of ferrite, amorphous and other magnetic materials.

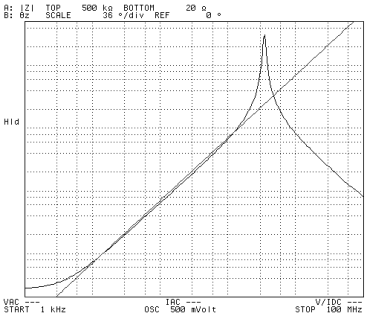
Semiconductor material:
・Permittivity, conductivity and C-V characterization of semiconductor materials.

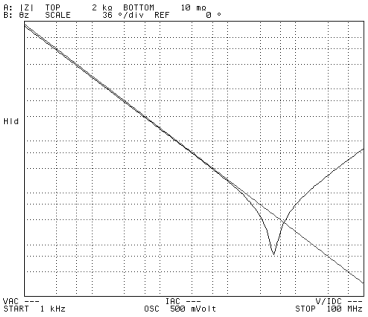
HP 4294A Key Specifications

Operating Frequency:	40Hz to 110MHz, 1mHz resolution
Basic Impedance Accuracy:	±0.08%
Q Accuracy:	±3% (typical) @ Q=100, ≤10MHz
Impedance Range:	3mΩ to 500MΩ (*1)
Measurement Time:	3 m sec / point @ f ≥ 500kHz, BW = 1 (Fast)
Number of points per sweep:	2 to 801 points
Measurement Type:	4 terminal pair measurement (Standard) APC-7 One port measurement with HP 42942A (Measurable grounded devices) Impedance probe measurement with HP 42941A (Measurable grounded devices)
Impedance Parameters:	|Z|, |Y|, θ, R, X, G, B, L, C, D, Q
DC Bias:	0 to±40 V / 100 mA , 1mV / 40 μA resolution Constant voltage / constant current mode, DC bias V/I monitor function
OSC Level:	5 mV to 1 Vrms / 200 μA to 20 mArms OSC level V/I monitor function
Sweep Parameter:	Frequency, OSC level (V/I), DC bias (V/I)
Sweep Type:	Linear, Log, List : Manual sweep mode : Up/Down sweep
Other Function:	Equivalent circuit analysis function , Limit line function Trace accumulate mode
Marker:	8 markers (one main marker and 7 sub markers) Delta marker function, Marker search function (Max, Min, Peak, Next peak etc.) Marker analysis function

(*1) 30% typical accuracy range: 3mΩ (100 Hz to 110MHz), 500MΩ (100Hz to 200kHz)

Accurate, real-world characterization of electronic components





There is no ideal inductor (L), capacitor(C), or resistor(R). In reality, operating conditions such as signal level and frequency determine the real-world performance of a device based on the electronic characteristics of the device. An ideal component of high quality could be considered to posses a single, perfect circuit element over some frequency range. However, in reality, most components will resonate as shown in these figures as the frequency increases.

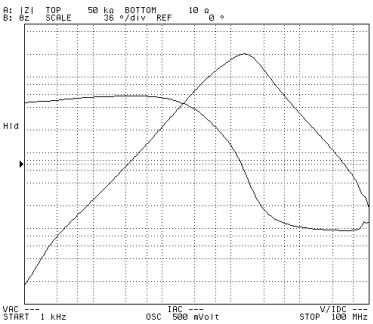
This is due to the fact that there are both capacitive and inductive elements present in real world components. Component characteristics cannot be expressed correctly with a two-element model when the model contains only one single reactive element. The HP 4294A equivalent circuit function enables modeling of the impedance vs. frequency characteristics with three or four elements. This function helps you design quality circuits and effective components.

Equivalent Circuit Analysis:

The equivalent circuit function is used to fit a circuit model to measured data, or to simulate device performance based on the value of each circuit model element.

1

After taking a measurement,

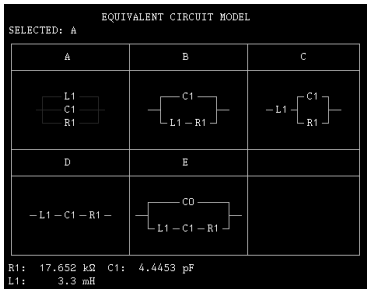


The HP 4294A has been programmed with five equivalent circuit models to choose from. This function automatically extracts equivalent circuit parameters from actual measurement data. The characteristics of the device under test (DUT) or the material under test (MUT) can be analyzed with extracted model element values.

NOTE: The simulation result and the actual measurement data can be displayed on the same screen.

2

select an appropriate circuit model

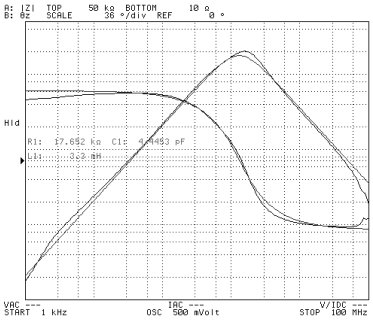


3

and extract the circuit model parameters.

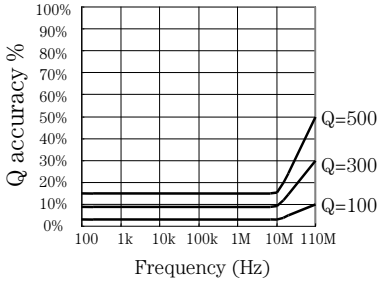
4

Then compare the simulation to the actual measurement data. If the data does not match, select a different equivalent circuit model and try again.



State-of-the-art technology for improved measurement performance

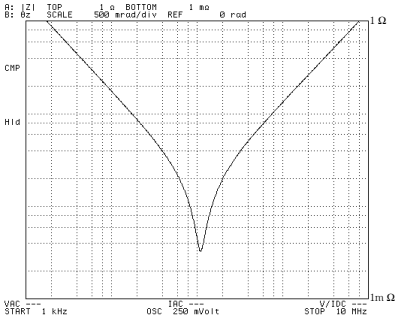
The HP 4294A employs a state-of-the-art auto-balancing-bridge technique in a four-terminal-pair (4TP) measurement configuration. Meticulous circuit design against distortion and instability resulted in a highly accurate and stable measurement system for a wide impedance range.



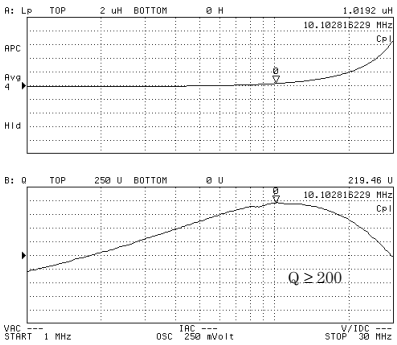
HP 4294A Q accuracy (typical)
OSC level = 250mV

For evaluation of low-loss devices:

With the trend toward lower power consumption and compact equipment, inductors and capacitors are becoming smaller with lower loss. The efficiency improvement in power conversion for switching power supply applications is an example. These applications require low-loss inductors and capacitors.



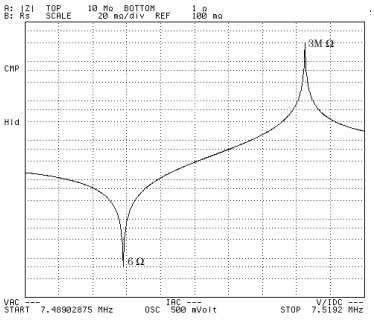
Low-loss capacitor ESR (Equivalent Series Resistance) measurement (100μF ceramic C)



High Q inductor measurement (Low-loss)

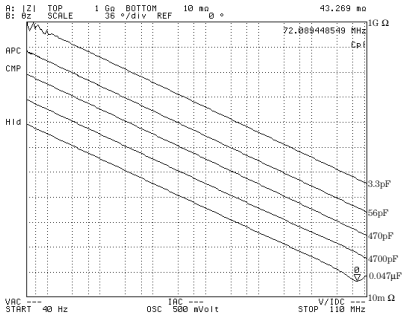
For evaluating devices with wide impedance range

A wide impedance range is required to accurately measure both resonant impedance and anti-resonant impedance of crystal/ceramic resonators.



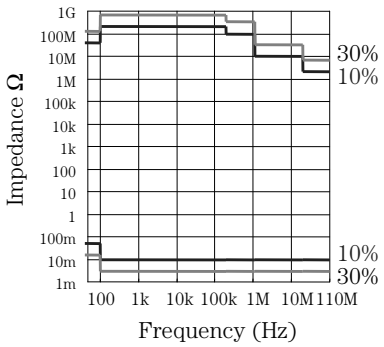
Crystal resonator impedance measurement

The HP 4294A covering several decades (m Ω to hundreds of M Ω) of impedance can measure resonator characteristics accurately.



SMD capacitor impedance measurement (using the HP 42942A)

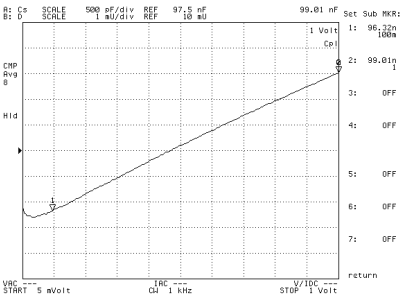
The dynamic range of the HP 4294A in terms of impedance is more than 200dB. When compared to that of a general network analyzer with a directional bridge, at 80dB, it is clear, the HP 4294A has an extremely broad impedance-measurement range.



Impedance measurement range (typical)

Impedance Analysis under Various Operating Conditions

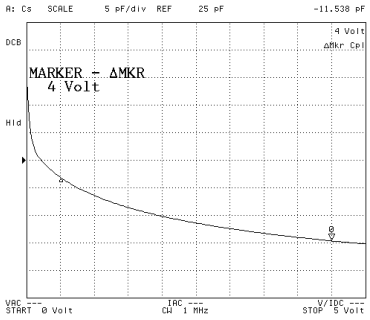
Signal level dependency:



Signal level dependency of a ceramic capacitor with high permittivity (signal-level swept from 5mV to 1V, 0.1 µF capacitor at 1kHz)

The impedance characteristics of some devices change drastically as a function of the signal level. The HP 4294A can sweep test signal voltage, 5mVrms to 1Vrms(1mV resolution), or test signal current 200µArms to 20µArms(20µA resolution) to evaluate signal level dependency.

DC level dependency:

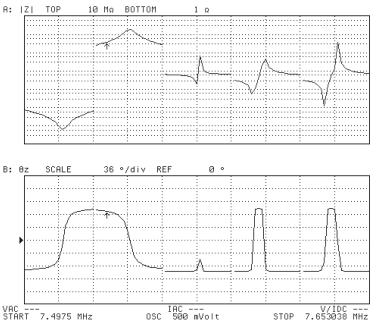


Varactor diode capacitance vs. DC voltage characteristic. DC bias sweep from 0V DC to 5V DC. f=1MHz

The DC component of an applied signal often affects device impedance. The HP 4294A can sweep either the DC voltage bias from -40V to +40V (with 1mV resolution) or the DC current bias from -100mA to +100mA (with 40µA resolution) to evaluate DC signal dependency. This capability also empowers analysis of the DC-voltage bias dependency for C-V characterization of varactor diodes or other DC-voltage bias dependent devices. The DC level dependency figure shows an example of varactor diode measurement.

The DC Bias Auto Level Control (ALC) function, based on a feedback loop technique, accurately maintains the applied DC voltage bias or current bias. While the impedance of a device might change during a sweep, this ALC function insures that the signal level setting is the actual signal level applied to the DUT.

Efficient analysis with the list sweep function



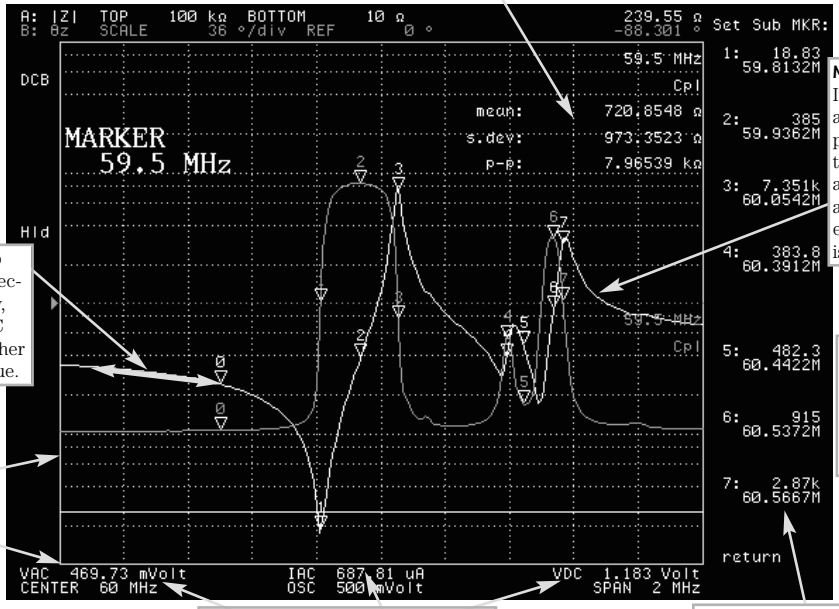
SEG	START	STOP	NOP	OSC	BIAS	BW	AVG
1	7.4975MHz	7.498MHz	21	500mV	0V	5	1
2	7.51355MHz	7.51405MHz	20	500mV	0V	5	1
3	7.53963MHz	7.54963MHz	20	500mV	0V	3	1
4	7.60035MHz	7.61035MHz	20	500mV	0V	3	1
> 5	7.64304MHz	7.65304MHz	20	500mV	0V	3	1

The list sweep function enables different measurement setups in a single sweep by dividing the sweep range into segments. The measurement setup, including the frequency range, averaging time, measurment bandwidth, test signal level (V or A), and DC bias can be different for each segment. The frequency range of each segment can be continuous, separated or overlapped.

Evaluation of a crystal resonator requires that the nominal resonant frequency, the nominal anti-resonant frequency and some spurious frequencies be determined. These parameters can be efficiently measured by setting an appropriate frequency range for each segment.

Powerful functions for Efficient Evaluation

Sweep, Display and Markers



Trace Statistics
Average, standard deviation and peak of each trace.

Manual Sweep function
Iterative measurements at a user designated point. After measuring the overall performance of a device within a wide range, you can evaluate the characteristic at a specific point.

Up Sweep / Down Sweep
Control the sweep direction. Sweep frequency, test signal level, or DC bias from lower to higher or higher to lower value.

Marker functions
Peak search, Next Peak search, Max/Min search, bandwidth search, and other marker

Scale
Log or Linear

Sweep type
Log, Linear or List

DC Bias / Test Signal Level Monitor
Accurate reading of the DC Bias or test signal level.

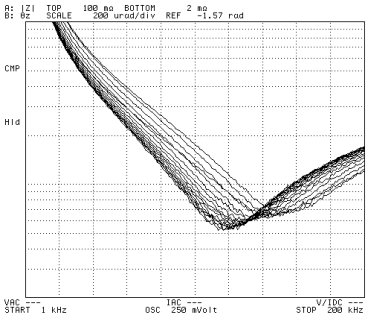
Ceramic resonator measurement

7 sub markers
Measurement and frequency data are displayed as sub marker softkey labels.

3 multi-trace modes for comparison evaluation

Superimpose Trace (Accumulate) mode

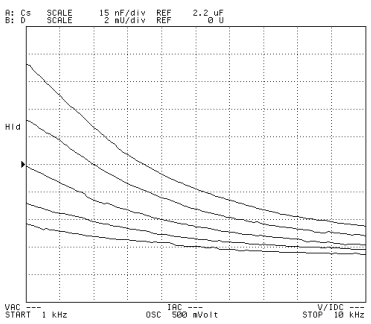
This mode is used to observe an intermittent event or a change in the characteristic performance of a device over time.



Accumulation of resonance vs. temperature data for a ceramic capacitor

List Sweep mode

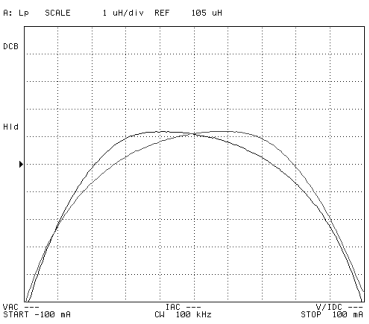
Superimpose and compare measurement data on the same display by setting the list sweep segments to the same frequency range with different DC Bias or test signal levels. Markers can be used on each trace.



Capacitance variations of ceramic capacitor (2.2µF) with high permittivity measured by stepping the test signal level from 0.1V to 0.9V in 0.2V step (five list sweep segments).

Data/Memory trace

A data trace and a memory trace are available at each channel. The underlying data can be saved as the memory trace. Some simple calculations are possible with Data Math functions.



Inductor DC dependency characteristics (100µH inductor at 100kHz) UP and DOWN DC current bias sweep from -100mA to +100mA Hysteresis is observed.

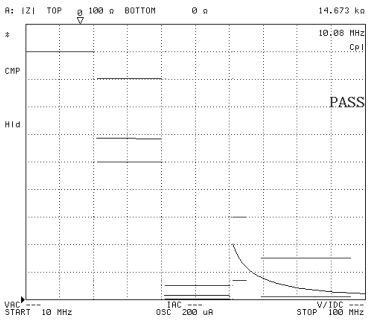
Easy, automatic measurement system configurations

Labs today often require system configurations in which test instruments interact with other instruments or handshake with external computers.

HP 4294A functions that support efficient systems:

- HP Instrument BASIC programming function for automatic measurement or external measurement instrument control without an external computer.
- List Sweep function for measuring only at desired points.
- Limit line function for Go/No-Go testing.
- Built-in 10Mbyte non-volatile memory for quickly save/recall data/setup.
- Two types programmable digital I/O port (24bit and 8 bit) for data transfer with external device such as sensor, and for external device control.
- LAN interface for networking with computers.

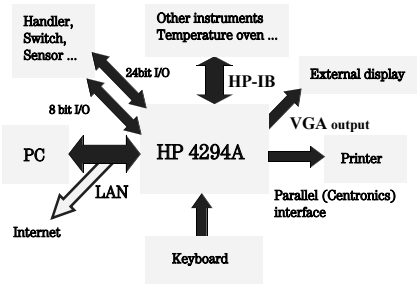
The LAN I/F dramatically expands the ability to share files, data, or instrument control. Measurement setup, result, and graphics files can be transferred via FTP (File Transfer Protocol) to or from the instrument.



Limit Test

Limit test of PIN diode impedance.
4 segment list sweep with different DC bias voltages and different frequency ranges using constant DC bias voltage (ALC) mode.

HP 4294A Interfaces



HP IBASIC programming function

HP Instrument BASIC (HP IBASIC) is a programming language developed from HP BASIC programming language. The keystroke recording function helps to easily develop automatic measurement program with front panel keys. When a key is pressed, the HP-IB command corresponding to the key is automatically recorded in the program. Writing or editing programs the old fashioned way is made easier with the mini-DIN keyboard.

One touch HP IBASIC program execution

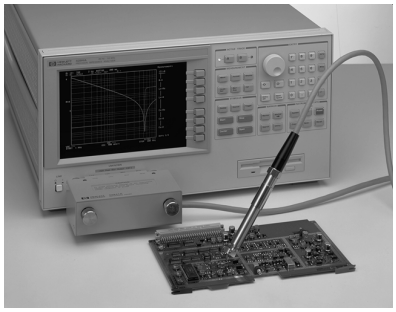
When you press the softkey with the file name of an IBASIC program saved in either internal memory or floppy disk, the program is automatically downloaded and executed. Once customized IBASIC programs are developed, quick measurement and data analysis is possible because each program works as if it is a built-in function.

A Feature with high visibility

The HP 4294A has VGA output on the rear panel. Automatic test or component adjustment in production line or QA test can easily be performed with a large external monitor.

Accessories for various measurement needs

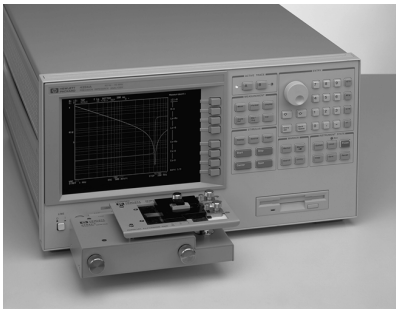
HP 42941A Impedance probe



The HP 42941A Impedance Probe enables in-circuit impedance measurement of electronic circuits or components. Grounded devices can also be measured.

Key specification:
Frequency: 40Hz - 110 MHz
DC BIAS: 0 to ± 40 V
Operation temperature range: -20° to 75° C
Basic Impedance Accuracy: ±0.8%

HP 42942A Terminal Adapter:

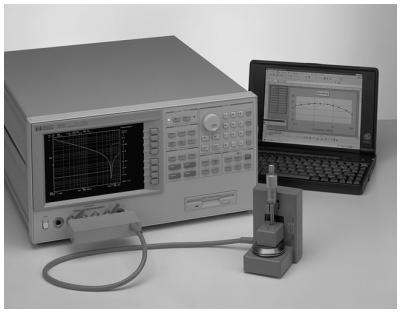


The HP 42942A Terminal Adapter converts the four-terminal-pair port configuration to an APC-7 port. This adapter permits the use of familiar APC-7 (7mm) test fixtures.

Again, grounded measurement is available.

Key specification:
Frequency: 40Hz - 110 MHz
DC Bias: 0 to ± 40 V
Operation temperature range: 0° to 40° C
Basic Impedance accuracy: ±0.6%

Material Test Fixtures:



Use of a dielectric material fixture such as the HP 16451B or the HP 16452A allows accurate dielectric material measurement. Permeability of magnetic materials can also be evaluated with the HP 42942A and HP 16454A magnetic material test fixture. Automatic measurement and permittivity/permeability analysis can easily be performed by using built-in IBASIC or by I/O to a computer where the analysis can be performed.

Other accessories:

When a DUT cannot be positioned near the instrument, a 4TP extension (HP 16048G: 1m or HP 16048H: 2m) can be used to extend the test station to the DUT. These HP extension accessories operate over the entire frequency and temperature range (40 Hz to 110 MHz, -20° C to +150° C) of the HP 4294A.

Ordering Information:

HP 4294A Precision Impedance Analyzer

Accessories Included:
- 100Ω Load Resistor for Four-Terminal-Pair Extension
- Mini DIN Keyboard for HP IBASIC
- Sample Program Disk
- Operation Manual
- Power Cable

Options:
- 1A2 Delete Mini DIN Keyboard
- 1D5 High-stability Frequency Reference
- ABA English Localization
- UK6 Commercial Calibration Certificate with test data
- 1CM Rack Mount Kit
- 1CN Front Handle Kit
- 1CP Rack Mount and Front Handle Kit

Accessories Available:

Four-terminal-pair test leads (HP 16048G / HP 16048H):

1m/2m four-terminal-pair port extension cable with BNC connectors.
Frequency: 40Hz - 110 MHz
DC Bias: 0 ± 40 V
Operation Temperature range: -20° to 150° C
Cable length: 1m (HP 16048G)
2m (HP 16048H)

Accessories Available:

HP 42941A Impedance Probe kit
Convert four-terminal-pairs port configuration to a one port probe.

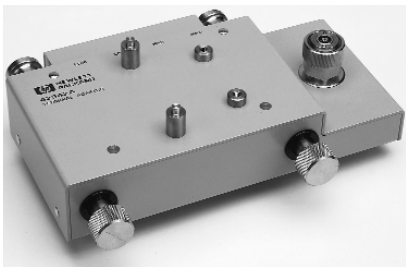
Furnished items:
- Impedance Probe with 1.5m cable
- Short reference
- 50Ω reference
- BNC Adapter
- Ground lead
- Clip lead
- Three spare pins
- Operation manual and specification sheet

HP 42942A Terminal Adapter

Converts four-terminal-pair port configuration to an APC-7 port.

Items Included:
- APC-7 Open reference
- APC-7 Short reference
- APC-7 50Ω reference
- Operation manual/Specification sheet

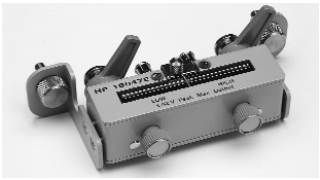
Option:
001 Delete Open/Short/50Ω references



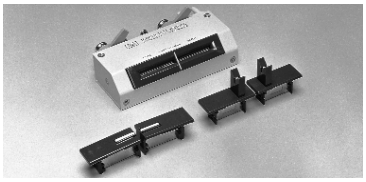
Fixtures for leaded components

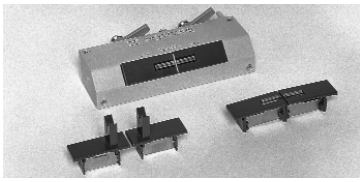
HP 16047E (DC - 110 MHz)
For leaded components. This fixture features the capability to clamp the leads between the electrodes and adjust the pressure. A guard terminal is provided for three port device measurements.

Accessories Provided:
Shorting Plate
HP 4294A Mounting Tool

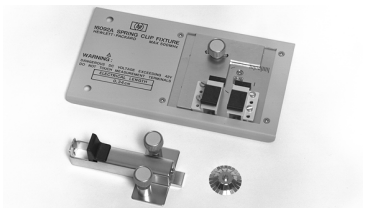


HP 16047A/D (DC - 3MHz/40MHz)
For leaded components. These fixtures use spring actuated clamps to hold device leads.

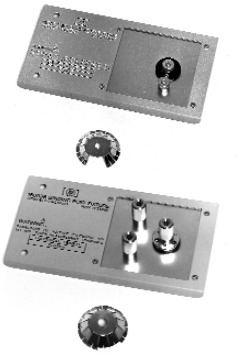




HP 16092A (DC - 500MHz)
For leaded or surface mount (SMD) components. Attachments for leaded or SMD components are provided. Notes: The HP 42942A adapter is required.

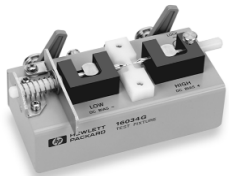


HP 16093A/B (DC-250MHz)
This is a binding post type fixture. Notes: The HP 42942A adapter is required.

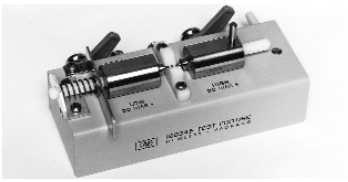


Fixtures for SMD components

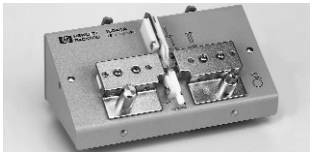
HP 16034G
0201 (0603) to 1206 (3216) size components. Maximum dimensions: 5mm(L) x 1.6mm (W) x1.6mm(H)



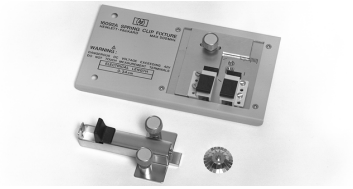
HP 16034E (DC - 40MHz)
0603 (1608) or larger size components can be measured. Maximum dimensions:
8mm(L) x 10mm(W) x 8mm(H)



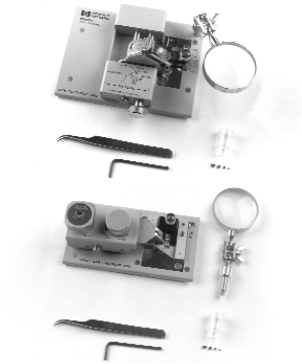
HP 16044A (DC - 10MHz)
Features a Kelvin Connection suitable for low impedance measurement of 0603 (1608) size components or larger. Maximum dimensions:
8mm(L) x 8mm(W) x 3mm(H)



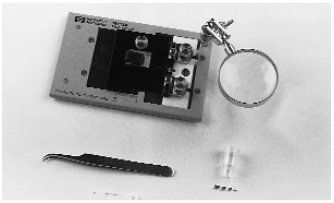
HP 16092A (DC - 500MHz)
For leaded or surface mount (SMD) components. Attachments for leaded or SMD components are provided. Notes: The HP 42942A adapter is required.



HP 16191A/16193A (DC - 2GHz)
These fixtures use surface electrode contacts, where the HP16191A is for 0805 (2012) size components or larger, and the HP16193 is for 0603 (1608) to 1206 (3216) size components. Notes: The HP 42942A adapter is required.



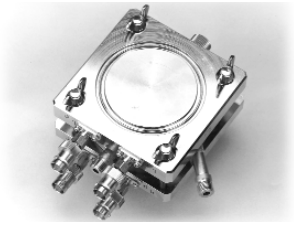
HP 16192A (DC - 2GHz)
This fixture uses side electrode contacts 0603 (1608) or larger size components. Notes: The HP 42942A adapter is required.



Material Test Fixtures:

HP 16451B
A dielectric material test fixture, with parallel plate electrodes.

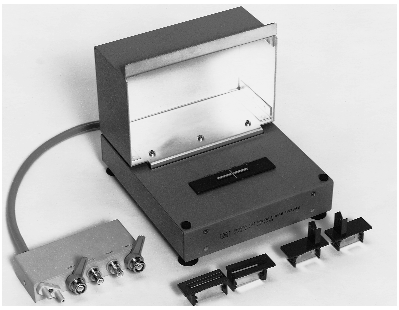
HP 16452A (20Hz - 30MHz)
Liquid test fixture.



HP 16454A (1MHz-1.8GHz)
Fixture for troidal magnetic material. Notes: The HP 42942A adapter is required.

Special Purpose Accessories:

HP 16065A (50Hz - 2MHz)
External DC bias adapter to +/- 200V. Notes: For leaded components.



(Please refer to the accessories selection guide for more details of fixtures and accessories.)

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