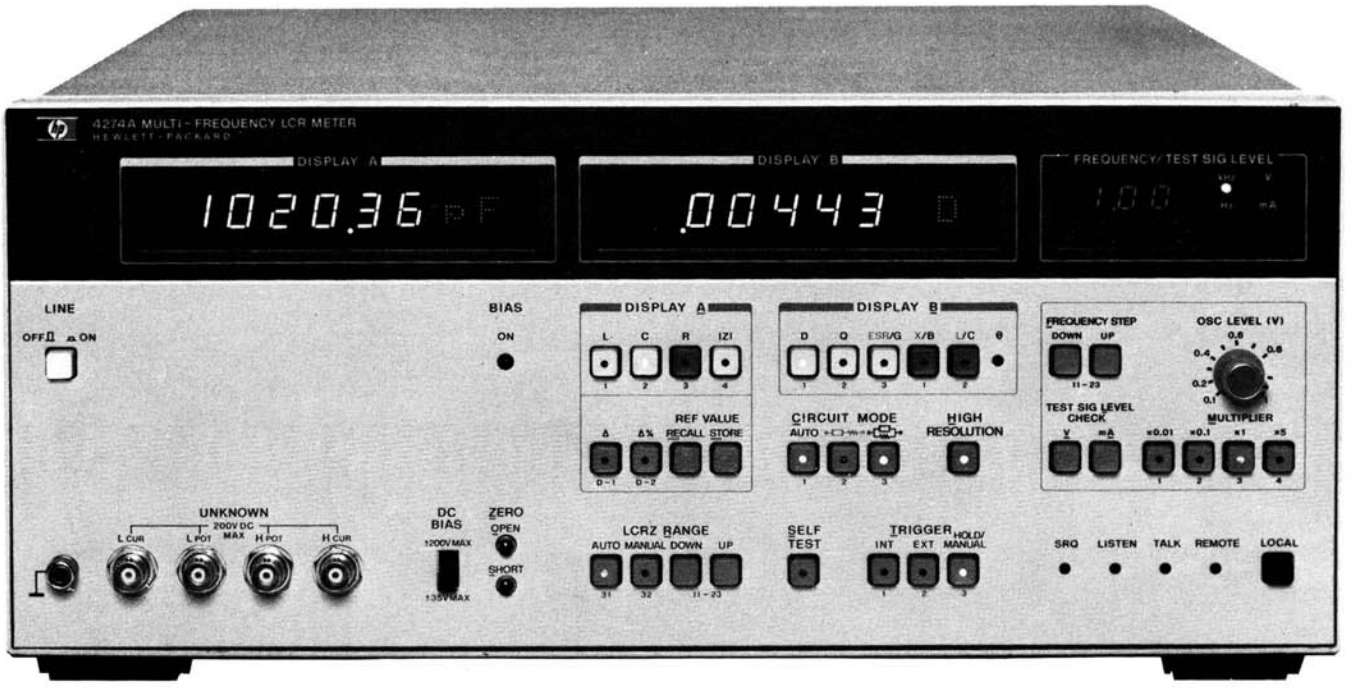
COMPONENT MEASUREMENT

Multi-Frequency LCR Meters

Models 4274A & 4275A

Model 4274A

- Test frequencies – 100 Hz to 100 kHz
- Test signal level – 1 mV to 5 Vrms
- High resolution – 5½ digit: D=0.00001
- Measure L/C – D/Q/ESR/G; |Z| – Θ, R-X/B/L/C; ΔLCRZ, Δ%
- 0.1% basic accuracy



HP 4274A

DESIGNED FOR HP-IB SYSTEMS

Description

The HP 4274A and HP 4275A Multi-frequency LCR Meters are recent additions to Hewlett-Packard's new generation of microprocessor-based impedance measuring instrumentation. Both instruments offer a new measuring concept for the evaluation of LCR components, complex components, electronic circuits "tested under actual working conditions", and semiconductor materials. A measurement under conditions similar to the intended use contributes to the improvements in quality and reliability of electronic components, devices and circuits.

Multi-Frequency Capability

To insure the high reliability in circuits and devices, it is most important that they be tested and evaluated at test signals similar to those of actual operating conditions.

The HP 4274A covers the wide frequency range of 100 Hz to 100 kHz in 11 spot frequencies and the HP 4275A has 10 spot frequencies from 10 kHz to 10 MHz, in 1-2-4 step sequence with 1-3-5 as an option. This feature produces the frequency characteristics of components or devices. In addition, two optional special frequencies (for example, 455 kHz and 10.7 MHz) are available within the frequency range of each instrument. This wide frequency range selection offers evaluation of circuit design with a continuously variable test signal over the range of 1 mV to 5 Vrms (to 1 Vrms for the HP 4275A), and with internal dc bias optionally available with 1 mV maximum resolution. The test voltage or current values can be monitored on the 3-digit display for accurately setting the actual conditions under which the device-under-test will operate.

Multi-Parameter Measurements

The HP 4274A and HP 4275A measure equivalent series resistance (ESR), impedance (|Z|), phase angle (Θ), reactance (X), susceptance (B), and conductance (G), in addition to the conventional L,C,R,D and Q parameters in certain combinations with a dual 5½ digit display, and an HP-IB standard for systems integration.

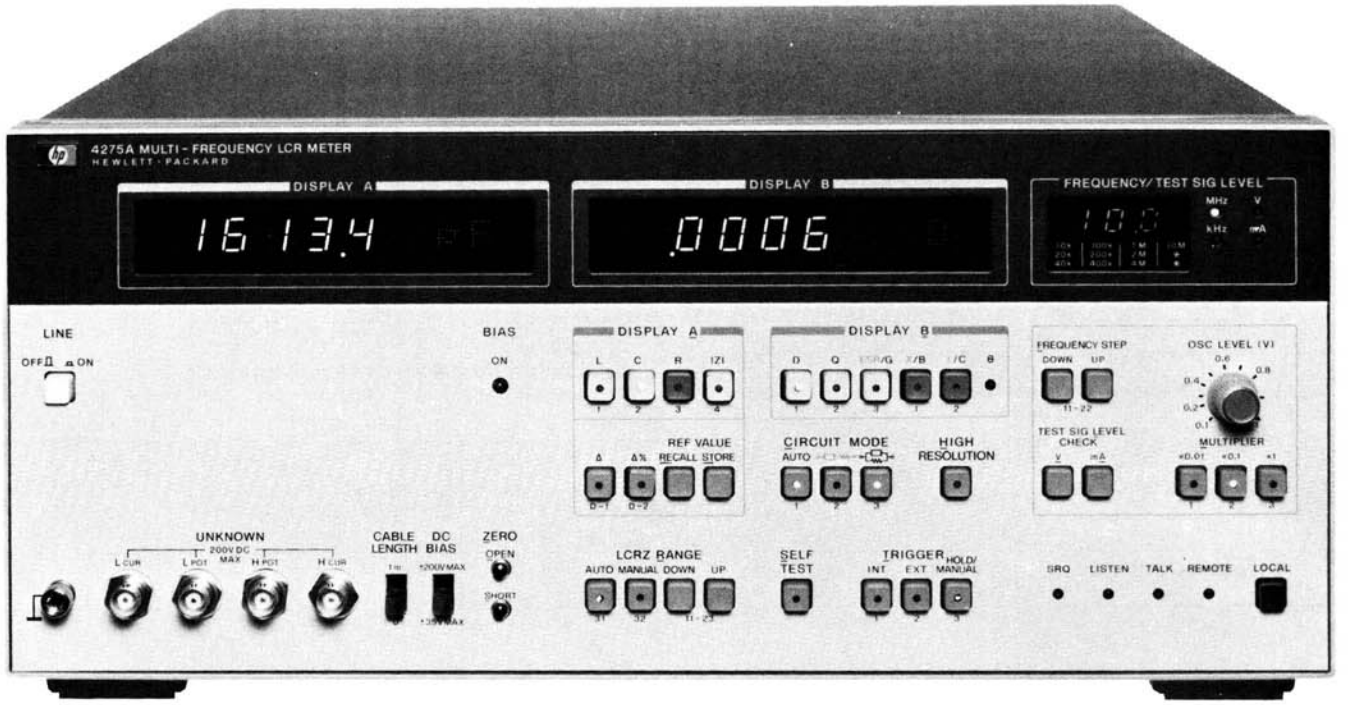
This wide selection of 11 parameters provides for more accurate evaluation of electronic materials or components with high measurement speed for most needed combined parameters; for example, the C-G measurement of semiconductors, an R-X measurement in circuit design, or the C-ESR or |Z| -Θ measurement of tantalum capacitors.

In addition, a deviation measurement capability (Δ,Δ%) for the L,C,R, and |Z| functions displays the difference between the actual value and a stored reference, either as a difference value or in percent. Deviation applications include, for example, a temperature dependence measurement of devices in environmental tests.

Reliable Measurements with 5½ Digit Resolution

The HP 4274A and HP 4275A measure only the value of the component and/or device under test, with 5½ resolution and 0.1% basic accuracy by reducing the possibility of errors due to self or mutual inductance, stray capacitance and/or residual inductance in the test leads or test fixture used. This measurement is obtained by a state-of-the-art four terminal pair configuration and a built-in automatic ZERO-offset capability to compensate for these errors.

Model 4275A
- Test frequencies – 10 kHz to 10 MHz
- Test signal level – 1 mV to 1 Vrms
- 0.1% basic accuracy
- High resolution – 5½ digit; D=0.00001
- Measure L/C – D/Q/ESR/G; |Z| – Θ, R–X/B/L/C; ΔLCRZ, Δ%



HP 4275A

DESIGNED FOR HP-IB SYSTEMS

The fast measurement speed, high resolution, and high accuracy can make major contributions for the component manufacturer and user who is concerned about reducing his costs, improving quality, and throughput efficiency. In these areas, the HP 4274A and the HP 4275A are ideal for D-measurements of film capacitors or insulation material (with the high resolution of 0.00001), the C-G measurements of semiconductors (with maximum resolutions of 0.01 fF, 0.01 nS, respectively), and for the low impedance measurement of aluminum electrolytic capacitors (with a maximum resolution of 0.001 mΩ).

Automatic Semiconductor and Component Measurements with HP-IB

Integrating the HP 4274A and the HP 4275A into an HP-IB controlled system is an excellent method for improving efficiency and cost savings both in the laboratory and on the production line. These automatic measurement systems are assembled by connecting the HP-IB cables between the instruments to be utilized for a specific task.

A system built around the HP 4274A and/or HP 4275A allows the user to obtain useful data for many diverse applications. For example, the evaluation of semiconductors based on the frequency dependence of its C-V characteristics that requires a wide range and fast measurement speeds is easily accomplished with these instruments. The four-terminal pair input configuration and the automatic zero offset capability insures that the measured data is accurate, even in a systems environment.

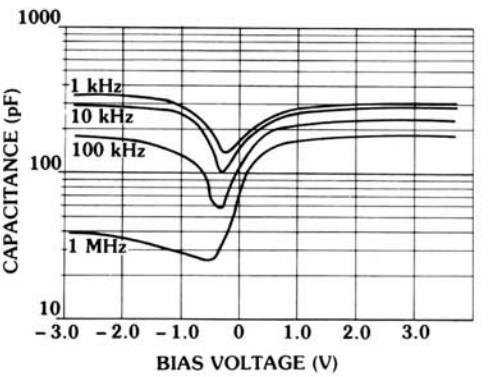
Sample Applications

Semiconductor Measurements

The evaluation of a semiconductor can be done with a C-V or G-V measurement with the multi-spot frequencies featured in the HP 4274A and HP 4275A, (with C resolution of 0.01 fF and G resolution of 0.01 nS), their two programmable bias sources (maximum resolution 1 mV) and their continuously variable test signal levels (from 1 mVrms).

Of significant use is the evaluation of the doping process and the measurement of the characteristics of MOS or bipolar semiconductor materials which employ a C or G measurement with varying dc bias voltage.

A sample plot of a semiconductor measurement is shown in the figure below. Such measurements at high speed can offer high reliability and high throughput efficiency in the semiconductor manufacturing processes.



COMPONENT MEASUREMENT

Multi-Frequency LCR Meters

Models 4274A & 4275A (cont.)

Common Specifications (HP 4274A & HP 4275A) Refer to the HP 4274A & HP 4275A data sheet for details.

Parameters Measured

L: inductance C: capacitance R: resistance Z: impedance D: dissipation factor	Q: =1/D ESR: equivalent series resistance G: conductance X: reactance B: susceptance	θ: phase angle Δ: deviation for L, C, R, Z, Δ%: % of deviation Test frequency Test signal level (voltage or current)

Parameter Combinations

Display A	Display B	
	⊸□⊸	⊸□⊸
L	D / Q / ESR	D / Q / G
C		
R	X / L	B / C
|Z|	θ	

Measurement Frequencies, Test Signal Levels, and Full Scale Range

MODEL		HP 4274A	HP 4275A
Measurement frequencies		100 Hz–100 kHz, 11 spots (100 Hz, 120 Hz, 200 Hz, 400 Hz, 1 kHz, 2 kHz, 4 kHz, 10 kHz, 20 kHz, 40 kHz, 100 kHz; ±0.01%)	10 kHz–10 MHz, 10 spots (10 kHz, 20 kHz, 40 kHz, 100 kHz, 200 kHz, 400 kHz, 1 MHz, 2 MHz, 4 MHz, 10 MHz; ±0.01%)
Test signal levels		4-ranges (1 mVrms–5 Vrms) continuously variable	3-ranges (1 mVrms–1 Vrms) continuously variable
Full scale range	L	100.00 nH – 1000.0 H	100.00 nH – 10.00 H
	C	1.0000 pF – 1.00 F	1.0000 pF – 100.00 μF
	R, |Z|, ESR, & X	100.00 mΩ – 10.000 MΩ	1.0000 Ω – 10.000 MΩ
	D	0.00001 – 9.9999	0.00001 – 9.9999
	Q (1/D)	0.01 – 9900	0.01 – 9900
	G & B	1.0000 μS – 100.00 S	1.0000 μS – 10.00 S
	θ	0 – ±180°	0 – ±180°

Displays: dual 5½-digit and single 3-digit; maximum display 199999 (full scale and overrange in high resolution mode), and 4½-digit: maximum display 19999 in normal mode. (Number of digits depends on measurement frequency, test level, and range).

Circuit modes: ⊸□⊸ series equivalent circuit and ⊸□⊸ parallel equivalent circuit. Automatic selection available in AUTO mode.

Deviation measurement: difference between recallable stored reference and displayed is deviation value (count or percent).

Display range: −199999 to +199999 counts in AUTO range. −199999 to +199999 counts in MANUAL range (the sample should be measurable at the selected range).

Percent display range: −199.99% to +199.99%

Ranging: AUTO or MANUAL (UP/DOWN).

Trigger: internal, external or manual.

Measurement terminals: four-terminal pair with guard.

Auto zero adjustment: automatic normalization of the readout offset due to residuals of the test fixture by pushbutton operation.

Normalization range: C < 20 pF, L < 2000 nH, R < 0.5 Ω, G < 5 μS.

Self test: automatic operational verification check indicates pass or fail condition.

HP-IB data output and remote control: standard.

Memory back-up for storing measurement conditions: standard.

Accuracy (HP 4274A only): typical C–D, L–D, R–X and |Z|–Θ measurement accuracy values are given below.

Range: full scale range, accuracy: % of reading + counts (D: accuracy: % of reading + absolute D value + count).

FREQUENCY RANGE	C-D/Q	L-D/Q	R-X	|Z|-θ
	D-range: 0.00001–9.9999 Q-range: 0.01–9900 (=1/D) (C & D accuracies apply only when C: full scale and D: ≤ 0.1)	D-range: 0.00001–9.9999 Q-range: 0.01–9900 (=1/D) (L & D accuracies apply only when L: full scale and D: ≤ 0.1)	(R accuracies apply only when R: full scale) (X accuracies apply only when R: 1/10 of full scale and X: full scale)	θ-range: −180° – +180.00° (|Z| & θ accuracies apply only when |Z|: full scale)
100 Hz 120 Hz	C: 1000 pF–1000 mF, 0.1% + 3 D: 0.33% + 0.0008 + 1	L: 100 μH–10 kH, 0.1% + 3 D: 0.33% + 0.0013 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
200 Hz	C: 1000 pF–1000 mF, 0.1% + 2 D: 0.32% + 0.0007 + 1	L: 100 μH–10 kH, 0.1% + 3 D: 0.32% + 0.0012 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
400 Hz	C: 100 pF–100 mF, 0.14% + 1 D: 0.34% + 0.0013 + 1	L: 100 μH–10 kH, 0.1% + 3 D: 0.31% + 0.0011 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
1 kHz	C: 100 pF–100 mF, 0.1% + 3 D; 0.33% + 0.0008 + 1	L: 10 μH–1000 H, 0.1% + 3 D: 0.33% + 0.0013 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
2 kHz	C: 100 pF–100 mF, 0.1% + 2 D: 0.32% + 0.0007 + 1	L: 10 μH–1000 H, 0.1% + 3 D: 0.32% + 0.0012 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
4 kHz	C: 10 pF–10 mF, 0.14% + 1 D: 0.34% + 0.0013 + 1	L: 10 μH–1000 H, 0.1% + 3 D: 0.31% + 0.0011 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
10 kHz	C: 10 pF–10 mF, 0.1% + 3 D: 0.33% + 0.0008 + 1	L: 1 μH–100 H, 0.1% + 3 D: 0.33% + 0.0013 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
20 kHz	C: 10 pF–10 mF, 0.1% + 2 D: 0.32% + 0.0007 + 1	L: 1 μH–100 H, 0.1% + 3 D: 0.32% + 0.0012 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
40 kHz	C: 1 pF–1000 μF, 0.14% + 1 D: 0.34% + 0.0013 + 1	L: 1 μH–100 H, 0.1% + 3 D: 0.31% + 0.0011 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°
100 kHz	C: 1pF–1000μF, 0.1% + 3 D: 0.33% + 0.0008 + 1	L: 100 nH–10 H, 0.1% + 3 D: 0.33% + 0.0013 + 1	R: 100 mΩ–10 MΩ, 0.1% + 3 X: 100 mΩ–10 MΩ, 0.1% + 13	|Z|: 100 mΩ–10 MΩ, 0.1% + 3 θ: ±0.1°

(Conditions: Warm-up time ≥ 30 minutes, environment temperature: 23°C ± 5°C). Refer to technical data sheet for accuracy details.

Accuracy (HP 4725A only): typical C-D, L-D, R-X and |Z|-Θ measurement accuracy values are given below.

Range: full scale range, accuracy: % of reading + counts (D accuracy: % of reading + absolute D value + count).

Frequency Range	C - D/Q	L - D/Q	R - X	|Z| - θ
	D-range: 0.00001 - 9.9999 Q-range: 0.01-9900 (= 1/D) (C & D accuracies apply only when C: full scale and D: ≤0.1)	D-range: 0.00001 - 9.9999 Q-range: 0.01 = 9900 (= 1/D) (L & D accuracies apply only when L: full scale and D: ≤0.1)	(R accuracies apply only when R: full scale) (X accuracies apply only when R: 1/10 of full scale and X: full scale)	θ-range: –180.00° - +180.00° (Z & θ accuracies apply only when Z: full scale)
10 kHz	C: 10 pF - 100 μF, 0.1% + 3 D: 0.33% + 0.008 + 1	L: 10 μH - 100H, 0.1% + 3 D: 0.33% + 0.0013 + 1	R: 1000 mΩ - 10 MΩ, 0.1% + 3 X: 1000 mΩ - 10 MΩ, 0.1% + 13	|Z|: 1000 MΩ - 10 mΩ, 0.1% + 3 θ: ± 0.1°
20 kHz	C: 10 pF - 100 μF, 0.1% + 2 D: 0.32% + 0.0007 + 1	L: 10 μH - 100 H, 0.1% + 3 D: 0.32% + 0.0012 + 1	R: 1000 mΩ - 10 MΩ, 0.1% + 3 X: 1000 mΩ - 10 MΩ, 0.1% + 13	|Z|: 1000 MΩ - 10 mΩ, 0.1% + 3 θ: ± 0.1°
40 kHz	C: 1 pF - 10 μF, 0.14% + 1 D: 0.34% + 0.0009 + 1	L: 10 μH - 100 H, 0.1% + 3 D: 0.31% + 0.0011 + 1	R: 1000 mΩ - 10 MΩ, 0.1% + 3 X: 1000 mΩ - 10 MΩ, 0.1% + 13	|Z|: 1000 MΩ - 10 mΩ, 0.1% + 3 θ: ± 0.1°
100 kHz	C: 1 pF - 10 μF, 0.1% + 3 D: 0.33% + 0.0008 + 1	L: 1 μH - 10 H, 0.1% + 3 D: 0.33% + 0.0013 + 1	R: 1000 mΩ - 10 MΩ, 0.1% + 3 X: 1000 mΩ - 10 MΩ, 0.1% + 13	|Z|: 1000 MΩ - 10 mΩ, 0.1% + 3 θ: ± 0.1°
200 kHz	C: 10 pF - 10 μF, 0.1% + 2 D: 0.32% + 0.0007 + 1	L: 1 μH - 1000 mH, 0.2% + 3 D: 0.53% + 0.0023 + 1	R: 1000 mΩ - 1 MΩ, 0.2% + 3 X: 1000 mΩ - 1 MΩ, 0.2% + 13	|Z|: 1000 MΩ - 1 mΩ, 0.2% + 3 θ: ± 0.1°
400 kHz	C: 1 pF - 1000 nF, 0.14% + 1 D: 0.34% + 0.0009 + 1	L: 1 μH - 1000 mH, 0.2% + 3 D: 0.51% + 0.0021 + 1	R: 1000 mΩ - 1 MΩ, 0.2% + 3 X: 1000 mΩ - 1 MΩ, 0.2% + 13	|Z|: 1000 MΩ - 1 mΩ, 0.2% + 3 θ: ± 0.1°
1 MHz	C: 1 pF - 1000 nF, 0.1% + 3 D: 0.33% + 0.0008 + 1	L: 100 nH - 100 mH, 0.2% + 3 D: 0.55% + 0.0025 + 1	R: 1000 mΩ - 1 MΩ, 0.2% + 3 X: 1000 mΩ - 1 MΩ, 0.2% + 13	|Z|: 1000 MΩ - 1 mΩ, 0.2% + 3 θ: ± 0.1°
2 MHz	C: 10 pF - 100 nF, 0.3% + 3 D: 0.55% + 0.0025 + 1	L: 1 μH - 10 mH, 0.5% + 5 D: 1.0% + 0.0033 + 1	R: 10 Ω - 100 kΩ, 0.5% + 5 X: 10 Ω - 100 kΩ, 0.5% + 15	|Z|: 10 Ω - 100 kΩ, 0.5% + 5 θ: ± 0.2°
4 MHz	C: 1 pF - 10 nF, 1% + 20 + 0.002 pF D: 3.3% + 0.01 + 1	L: 1 μH - 10 mH, 1% + 5 D: 2.0% + 0.0063 + 1	R: 10 Ω - 100 kΩ, 2% + 7 X: 10 Ω - 100 kΩ, 2% + 105	|Z|: 10 Ω - 100 kΩ, 2% + 7 θ: ± 0.8°
10 MHz	C: 1 pf - 10 nF, 2% + 20 + 0.002 pF D: 4% + 0.011 + 1	L: 100 nH - 1 mH, 2% + 7 D: 3.1% + 0.002 + 1	R: 10 Ω - 100 kΩ, 2% + 7 X: 10 Ω - 100 kΩ, 2% + 105	|Z|: 10 Ω - 100 kΩ, 2% + 7 θ: ± 0.8°

(Conditions: Warm-up time ≥ 30 minutes, environment temperature: 23°C ± 5°C). Refer to technical data sheet for accuracy details.

General Information

Reference Data

Test Signal Level Monitor

Model	Range		Accuracy
	Voltage	Current	
HP 4274A	0.001 V - 5.00 Vrms	0.001 mA - 100 mArms	± (3% of reading + 1 count)
HP 4275A	0.001 V - 1.00 Vrms	0.001 mA - 10.0 mArms	± (3% of reading + 1 count) at < 1 MHz ± (10% of reading + 2 counts) at ≥ 1 MHz

Measurement time: (typical) 140-180 ms (>1 kHz); 140-210 ms ≤1 kHz (measurement time depends on range, sample value and offset adjustment value).
Z – Θ measurement time: 170-210 ms >1 kHz; 170-240 ms ≤1 kHz.
High resolution mode: approximately 8 times the normal measurement time.
Auto ranging time: 100 ms - 300 ms per range change.

Options

Opt 001: 0 to ±35 internal dc bias

Range	Steps	Accuracy
± (.000 - .999) V	1 mV	± (0.5% of reading + 2 mV)
± (1.00 - 9.99)	10 mV	± (0.5% of reading + 4 mV)
± (10.0 - 35.0)	0.1 V	± (0.5% of reading + 20 mV)

Control: HP 16023B dc Bias Controller or remote control with HP-IB
Opt 002: 0 – ±99.9 V internal dc bias (for C ≤ 0.1 μF)
Range: ± (00.0 – 99.9) V, 0.1 V steps
Accuracy: ± (2% of reading + 40 mV)
Control: same as Opt 001
External dc bias: ±200 V maximum.
Bias monitor: rear panel BNC connector monitors internal or external input bias.
Opt 004: frequency steps in 1-3-5 sequence.

Special Options

One or two arbitrary test frequencies for each instrument are available. For more details, please contact nearest HP sales office.

Selectable Frequency Range

HP 4274A: 100 Hz to 100 kHz to ±0.1%. If two frequencies are added, at least one frequency must satisfy the following equation: f = 1200/N kHz where N is an integer from 12 to 12000.

HP 4275A: 10 kHz to 10.7 MHz ±0.1%.

Accessories

	Price
HP 16047A: Direct coupled test fixture. Furnished accessory with the HP 4274A and HP 4275A.	N/C
HP 16023B: dc Bias Controller, for control of dc bias Opt 001 or 002 Internal Bias Supply. Control range 0 to ±99.9 V by setting thumbwheel switch.	$340 ☎
HP 16034B: Test Fixture for chip components	$360 ☎
HP 16047B: Test Fixture with safety cover	$750 ☎
HP 16047C: Test Fixture for high frequencies	$300 ☎
HP 16048A: Test leads, BNC	$320 ☎
HP 16048B: Test leads, RF miniature	$320 ☎
HP 16048C: Test leads with alligator clips	$410 ☎

Options

Opt 001: 0 to ±35 internal dc bias, max resolution; 1 mV steps	$870
Opt 002: 0 to ±99.9 V internal dc bias, resolution: 100 mV steps.	$810
Opt 004: Frequency steps in 1-3-5 sequence	N/C

Ordering Information

	Price
HP 4274A 100 Hz - 100 kHz Multi-Frequency LCR Meter	$9800
HP 4275A 10 kHz - 10 MHz Multi-Frequency LCR Meter	$11200

☎ Fast-Ship product—see page 766.