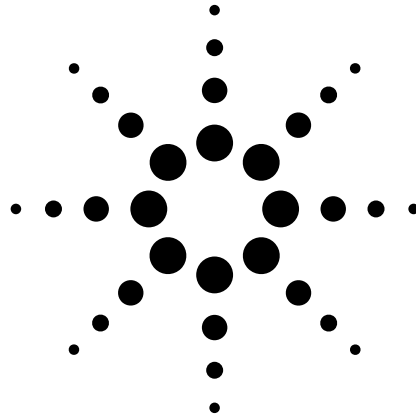


# Agilent 4288A Capacitance Meter 1 kHz/1 MHz

## Product Overview



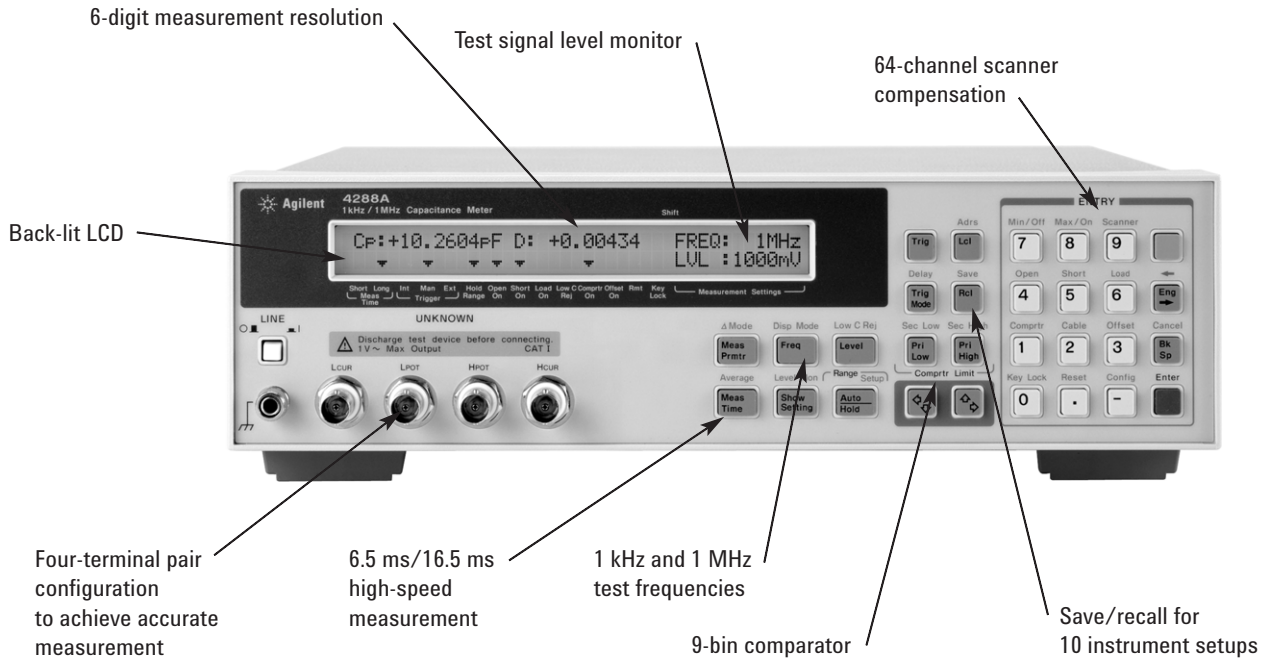
A new standard  
in high-speed measurement solutions  
for ceramic capacitor production tests.



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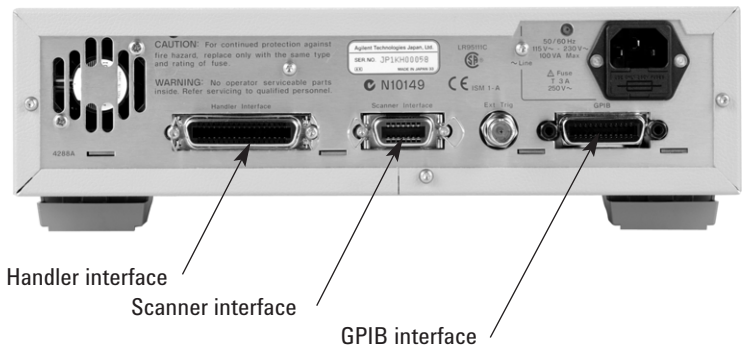
Innovating the HP Way

# Test speed and accuracy advances for ceramic capacitor production testing



## 4288A Capacitance meter highlights

- 1 kHz and 1 MHz measurement capabilities comply with standards
- Basic measurement accuracy:
  - C accuracy:  $\pm 0.07\%$
  - D accuracy:  $\pm 0.0005$
- 6.5 ms/16.5 ms high-speed measurement
- Selectable test levels from 0.1 V to 1 V rms, in 0.1 V rms steps
- 6-digit resolution for precise measurements
- Four-terminal pair configuration achieves high accuracy
- Open/short/load compensation function
- 9-bin comparator
- Resume function to restore measurement setups
- Save/recall for up to 10 measurement setups
- Standard interfaces for ease of system integration
  - Optically-isolated handler interface
  - GPIB interface (SCPI)
  - Scanner interface
- 64-channel multi-compensation
- Selectable frequency shift at 2, 1, and -1% avoids test signal interference
- Compact instrument size



## Typical applications

- Accelerate sorting test throughput on production lines
- Upgrade accuracy of measurement data for production process control
- Improve efficiency and reliability of shipping inspection
- Enhance efficiency of high-volume capacitor incoming inspection

## Realize higher accuracy and 30% higher speeds with a compact instrument

With the overwhelming growth of the wireless communications industry, sorting tests in ceramic capacitor production lines continue to require higher and higher test throughput and test efficiency. Agilent's 4288A 1 kHz/1 MHz capacitance meter offers an optimum measurement solution for high-speed and accuracy in sorting tests. The 4278A set the standard and the 4288A builds on that tradition, offering faster measurement speeds, while attaining excellent measurement accuracy and stability.

The 4288A has two measurement speeds; short and long modes. Measurement time is only 6.5 ms in short mode. Short mode ensures a 30% shorter measurement time, with better accuracy, than the 4278A previously attained in its medium mode. Long mode provides the best accuracy with a measurement time of only 16.5 ms and improves test throughput in precise sorting tests for narrow tolerance and low-dissipation factor capacitors.

The 4288A achieves a basic capacitance measurement accuracy of  $\pm 0.07\%$  and dissipation factor measurement accuracy of  $\pm 0.0005$  with a 6-digit display resolution at both 1 kHz and 1 MHz. The 4288A meter specifies accuracy involving the uncertainty of calibration standards, while the 4278A specifies accuracy relative to standards (the uncertainty of calibration standards is not included in quoted specifications for 4278A.) As a result, the 4288A's substantial accuracy is better than the 4278A's. Further specification details are provided in Agilent's 4288A data sheet, publication number 5980-0362E. The accuracy ( $\pm 0.085\%$ ,  $\pm 0.00065$  D) in the short mode delivers highly reliable test results, allowing a significant improvement in test throughput, without compromise between the measurement accuracy and test speed.

The 4288A is the smallest and lightest capacitance meter available, which provides the most efficient use of space inside parts-handler systems. The instrument requires only a three-quarter rack space versus the full-rack space required by the 4278A, weighs only 3 kg (6.6 lb.), versus 15 kg (33 lb.) for its predecessor, and consumes typically half the power.

The 4288A is designed to offer increased speed, higher accuracy, and a space-saving instrument size to solve the needs of today's and future production testing requirements.

### Key specifications

Frequency	1 kHz and 1 MHz
Parameter	C, D, Q, G, Rs, Rp
Display range:	
C (1 kHz)	0.00001 pF to 20.0000 $\mu$ F
C (1 MHz)	0.00001 pF to 1.50000 nF
D	0.00001 to 9.99999
Test voltage	0.1 V to 1.0 V rms
Basic accuracy:	
C	$\pm 0.07\%$
D	$\pm 0.0005$
Measurement time	6.5 ms/16.5 ms
Compensation	Open/short/load/offset
Comparator	9 bins + aux + out of bins
Interfaces:	GPIB Handler interface Scanner interface
Other functions:	Averaging Delay Resume Save/recall

Note: Basic accuracy applies to the measurement time long mode.

## Features

### 6.5 ms/16.5 ms high speed measurement

The measurement time of 6.5 ms in the short mode and 16.5 ms in the long mode enable new breakthroughs in test throughput of ceramic capacitors. The 4288A simultaneously measures capacitance and dissipation factor, while able to achieve a 30% faster measurement speed. (Figure 1). The display is capable of showing results with 6-digit resolution. Users can select display resolution of 6, 5 or 4 digits and hold it, as desired. In the default mode setting, the 4288A always displays a full 6 digits. The analog measurement time, when the device must be in contact, is as short as 4.5 ms (short mode) and 14.5 ms (long mode). This allows optimization of the handler's operating speed. The delay function makes it easy to adjust the measurement timing appropriately to avoid chattering (unstable contact) time of the handler's contact probes. Delay time, from trigger to the start of the measurement, can be set from 0 to 1000 ms in 1 ms steps.

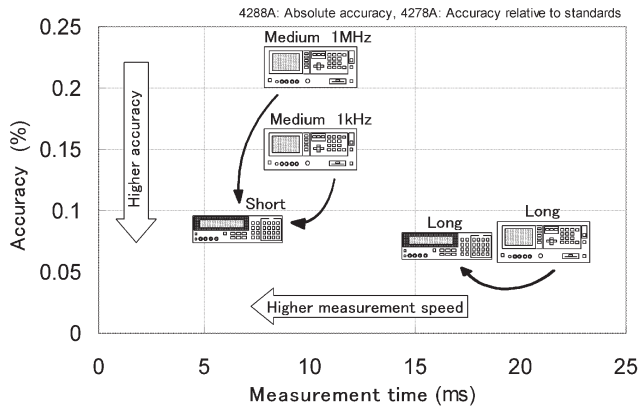


Figure 1. Comparison of the 4288A to 4278A (measurement time and accuracy)

### 1 kHz/1 MHz measurements comply with standards

The 4288A covers both 1 MHz measurement for low-value capacitors and 1 kHz measurement for medium to high-value capacitors. Test signal levels can be selected ranging from 0.1 V to 1 V rms, in 0.1 V steps to meet the desired test conditions. The level monitor function allows the confirmation of the actual test voltage across the device. Since test signal level accuracy is  $\pm 5\%$  over the entire capacitance measurement range up to 20  $\mu\text{F}$ , sorting tests in compliance with the IEC 60384 and JIS C5101 standards can be performed.

### Frequency shift avoids test signal interference

When two or more 4288A units need to be integrated into a system such as the array-type capacitor test system, using the test frequency shift function at 1 MHz prevents possible interference of test signals between adjacent measurement terminals. To avoid overlapping test frequencies, the frequency shift can be selected from  $-1\%$ ,  $+1\%$  and  $+2\%$ .

### 0.07% C accuracy and 0.0005 D accuracy

Basic measurement accuracy is  $\pm 0.07\%$  for capacitance and  $\pm 0.0005$  for dissipation factor at both 1 kHz and 1 MHz in long measurement mode. Since the 4288A's accuracy is specified for absolute accuracy that includes the uncertainty of calibration standard values, the guaranteed accuracy substantially surpasses the 4278A (specified with accuracy relative to standards). The short mode also provides incomparable accuracy of  $\pm 0.085\%$  (C) and  $\pm 0.00065$  (D) at the fastest measurement speed, enabling reliable sorting tests with high throughput.

When the 4288A is integrated into a component handler or combined with a component scanner, measurement accuracy can be easily optimized because the compensation functions eliminate measurement errors due to test leads and fixtures. Since the accuracy does not vary depending on the test cables used (0 m or standard 1 m or 2 m test cables), you can effectively utilize the 4288As advanced measurement performance.

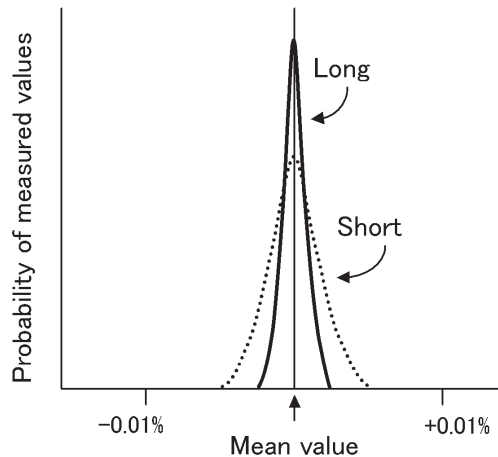


Figure 2. Measurement time and accuracy.

The advanced measurement circuit design of the 4288A ensures the same mean values of measured parameters for a device compared between short and long modes. This feature contributes to the small difference in specified accuracy between the short and long modes.

## Ranging method for achieving high accuracy over the entire range

The 1 MHz measurement covers the 1 pF to 1 nF range (measurement values are effective up to 1.5 nF) and the 1 kHz measurement covers the 100 pF to 10  $\mu$ F range (measurement values are effective up to 20  $\mu$ F). Capacitance ranges are selectable in 1, 2.2, 4.7 and 10 steps and have 3 ranges per decade. (See measurement accuracy Table 1 on page 7.) This ranging method allows most capacitors to be measured in the region near the full-scale value (above 50% of range value) of the appropriate range. Using this method, accurate measurements are achieved over the entire range including capacitance regions where accuracy often became insufficient using the generic decade ranging method.<sup>1</sup>

## 9-bin comparator

The built-in comparator sorts capacitance measurement results into one of a maximum of 9-bins, an “Out of Bins”, and can perform pass/fail decisions for D, Q, G, Rs or Rp at the same time (Figure 3). The limit values can be entered in either of three modes; absolute value, deviation and percent deviation. Comparison results can be output on the handler and GPIB interfaces as well as the instrument display. If the device is sorted to “out of bins”, a status signal is displayed representing the status of the capacitance as being too low or too high, dissipation factor being out of limits, or other appropriate status signals allowing users to statistically analyze the defects of devices. Bin count and low-C-reject functions are also equipped. The comparator function can perform the same bin-sort decisions as the 4278A.

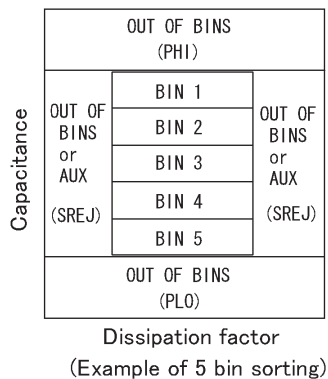


Figure 3. Comparator decisions

1. At 1 kHz measurement, the accuracy is superior to the 4278A when decade ranges are used to maintain compatibility with the 4278A's ranging method.
2. The comparator and handler interface functions are compatible with the 4278A option 201 and involve expanded capabilities.
3. The 4288A employs similar GPIB commands to the 4268A 120 Hz/1 kHz capacitance meter which was developed for testing high-value ceramic capacitors.
4. The scanner interface is compatible with the 4278A option 301.

## System interfaces

The standard 4288A is equipped with GPIB, handler and scanner interfaces that facilitate integration into handler systems and applications requiring a component scanner. GPIB programming commands comply with standard commands for programmable instruments (SCPI). Handler and scanner interfaces have basic compatibility with current instruments to ease integration of the 4288A into systems. The 4288A is equipped with an optically-isolated handler interface. Since this interface is basically compatible<sup>2</sup> with the 4278A, the 4288A can be easily integrated into the handler systems (Figure 4). The GPIB incorporates generic SCPI<sup>3</sup>. The GPIB data buffer can store and output a maximum of 1000 sets of measurement data. The 64-channel scanner interface is also standard<sup>4</sup>. A multi-channel scanner system can be easily configured for inspection of array-type capacitors and for improving the efficiency of sampling tests for quality assurance. For the scanning measurement, the multi-compensation function enables open/short/load compensations to be performed independently for each scanner channel (Figure 5). This minimizes inconsistency in measured values between channels and enables accurate measurements on the scanner system.

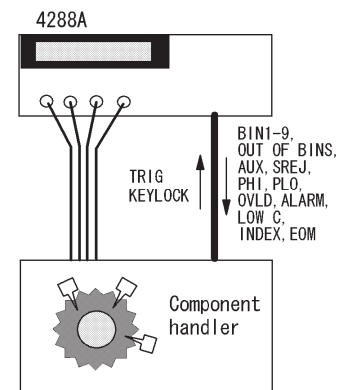


Figure 4. Handler interface

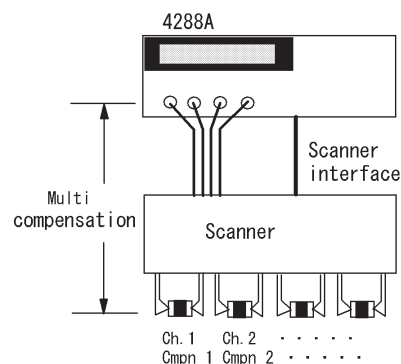


Figure 5. Scanner interface and multi-compensation

## Compact size for saving installation space

Continuous expansion in large-scale ceramic capacitor production, requires instrumentation aimed at resolving new problems, such as the installation space for the increasing test systems, running costs of equipment, increasing throughput and more. To support development of a highly efficient and space-saving test system, the 4288A offers uncompromising high performance with a compact footprint. The 4288A, which is 10 cm (3.9 inches) high and 32 cm (12.6 inches) wide, saves handler integration space because it is 1/4 the size of previous instruments, allowing the downsizing of the systems and the retrenchment of system installation areas. Component manufacturers can save space, time and money with the integration benefits provided by this new meter.

## Resume and save/recall functions

The 4288A is equipped with convenient back-up functions to quickly re-start systems. These functions include: the resume function, which automatically restores instrument setup immediately powering on, and the save/recall function, which can store 10 instrument setups.

## Reducing calibration costs

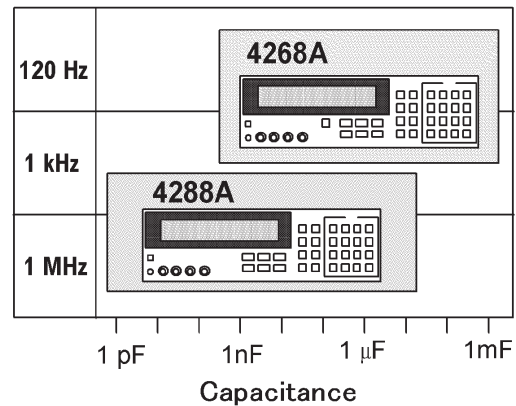
As a result of its improved stability, the 4288A only requires a periodic calibration once a year. This minimizes the system intermission required for calibration and reduces calibration costs.

## 4268A 120 Hz/1 kHz capacitance meter



Agilent 4268A front view

The 4268A, which is the family product of the 4288A, is designed for sorting tests of high-value ceramic capacitors.



Test frequencies and measurement ranges for the 4268A and 4288A.

# Specifications

Specification is the performance of the instrument guaranteed under a temperature environment between 0°C and 45°C, unless otherwise noted. Data described as “typical”, “approximately”, or “nominal” are not guaranteed specifications, but supplemental performance characteristics (SPC) for effective use of the instrument.

## Measurement accuracy

**Table 1. Measurement accuracy (D≤0.1)**

C Range (Cf)		Measurement Parameters							
1 kHz	1 MHz	Cp, Cs	D	G	Rs				
100 pF	1 pF	0.055%+0.07a%	0.00035+0.0007a	(3.5+4.5a)Cx nS	(90+120a)/Cx Ω				
		0.055%+0.03a%	0.00035+0.0003a	(3.5+2a)Cx nS	(90+50a)/Cx Ω				
220 pF	2.2 pF	0.055%+0.045a%	0.00035+0.00045a	(3.5+3a)Cx nS	(90+75a)/Cx Ω				
		0.055%+0.02a%	0.00035+0.0002a	(3.5+1.5a)Cx nS	(90+35a)/Cx Ω				
470 pF	4.7 pF	0.055%+0.03a%	0.00035+0.0003a	(3.5+2a)Cx nS	(90+50a)/Cx Ω				
1 nF	10 pF								
2.2 nF	22 pF								
4.7 nF	47 pF								
10 nF	100 pF								
22 nF	220 pF								
47 nF	470 pF					0.055%+0.015a%	0.00035+0.00015a	(3.5+1a)Cx nS	(90+25a)/Cx Ω
100 nF	1 nF								
220 nF	n/a								
470 nF	n/a								
1 μF	n/a								
2.2 μF	n/a								
4.7 μF	n/a								
10 μF	n/a								

Note: The accuracy in Table 1 applies for measurement time as follows:

- Top row: Accuracy in short mode spec
- Bottom row: Accuracy in long mode spec
- n/a: No measurement ranges available.

Unit for Cx is nF @ 1 kHz and pF @ 1 MHz.

## Measurement range

Capacitance range: Refer to Table 1.

1 kHz: 100 pF to 10 μF, 16 ranges

Overrange: 150% of range value except for 200% at 10 μF range

1 MHz: 1 pF to 1 nF, 10 ranges

Overrange: 150% of range value

## Measurement accuracy

Accuracy: Refer to Table 1.

Accuracy is represented as:

C ±(% of reading)

D, G and Rs: ±(Error value)

a = (Cf/Cx)(1/Vs)

where, Cx is measured C value, Cf is nominal capacitance range and Vs is test signal level setting (V rms). a = (1/Vs) in case of Cf < Cx.

[Calculation example for a]: When Cf = 10 pF, Cx = 7.3 pF and Vs = 0.8 V, a = (10/7.3)(1/0.8) = 1.7

Q accuracy:

$$\pm \frac{Qx^2 \times De}{1 \mp (Qx \times De)}$$

(Where, Qx × De < 1)

Where, Qx: measured Q value

De: D accuracy

Rp accuracy:

$$\pm \frac{Rpx^2 \times Ge}{1 \mp (Rpx \times Ge)} (\Omega)$$

(Where, Rpx × Ge < 1)

Where, Rpx: measured Rp value (Ω)

Ge: G accuracy (S)

Measurement accuracy is guaranteed at the unknown terminals when all the measurement conditions listed below are satisfied:

1. Warm-up time: ≥ 10 min.
2. Ambient temperature: 23°C ±5°C
3. Cable length: 0 m, 1 m or 2 m (16048A/B/D)
4. Open compensation performed
5. Measured D value: Dx ≤ 0.1  
In case of 0.1 < Dx ≤ 0.5, multiply (1 + Dx<sup>2</sup>) for Cs, Cp, G and Rs accuracy and (1 + Dx) for D accuracy.

Accuracy for 0°C to 45°C (SPC): multiply the accuracy by the following multipliers.

Temperature (°C)	0	8	18	28	38	45
Multiplier at 1 kHz		x3	x2	x1	x2	x3
Multiplier at 1 MHz		x3	x2	x1	x2	x3

## Measurement parameter and range

Measurement parameter

Cp	Equivalent parallel capacitance
Cs	Equivalent series capacitance
D	Dissipation factor
Q	= 1/D
Rs	Equivalent series resistance
Rp	Equivalent parallel resistance

Parameter combinations:

Cp-D, Cp-Q, Cp-G, Cp-Rp,

Cs-D, Cs-Q, Cs-Rs

Parameter	Display range
Cs, Cp (1 kHz)	0.00001 pF to 20.0000 μF
(1 MHz)	0.00001 pF to 1.50000 nF
D	0.00001 to 9.99999
Q	0.1 to 99999.9
Rs, Rp	0.01 mΩ to 999.999 MΩ
G	0.00001 μS to 9.99999 kS
Δ%	-999.999% to +999.999%

Q displays 1/D. Capacitance range applies when D ≤ 0.5.

Rs, Rp and G ranges vary depending on capacitance reading:

Effective ranges are Rs ≤ 0.5/(w Cs), Rp ≥ 2/(w Cp), G ≤ 0.5w Cp

## Measurement functions

Test frequency (frequency accuracy):

1 kHz (±0.01%), 1 MHz (±0.01%)

Frequency shift: 1 MHz can be varied to 990 kHz, 1.01 MHz or 1.02 MHz.

Test signal level: 0.1 V to 1.0 V rms in 0.1 V rms steps.

Test signal level accuracy: ±5% @ all C ranges

Source impedance (nominal):

220 nF to 10 μF ranges @ 1 kHz: 1 Ω

100 pF to 100 nF ranges @ 1 kHz: 20 Ω

1 pF to 1 nF ranges @ 1 MHz: 20 Ω

Measurement terminals: Four-terminal pair

Ranging: Auto and manual

Display digits: Selectable from 4, 5 and 6 digits

Deviation measurement: Deviation and percent deviation from a reference

Measurement time mode: Short and long

Averaging: 1 to 256

Trigger mode: Internal, external, manual and GPIB

Delay time: Programmable delay from the trigger to the measurement start;

0 to 1000 ms in 1 ms steps

Cable length: 0 m, 1 m and 2 m



## Measurement time

The measurement time in each measurement mode is shown below (units in ms).

Mode	T1	T2	Meas time (T3)
Short	4.5	2	6.5±0.5
Long	14.5	2	16.5±1

1. T1 is the time in which the device must be connected and represents the time between the trigger and the index signal output on the handler interface.
2. T2 is the time in which the digital calculation and comparison are made.
3. Measurement time T3 (=T1+T2) is the time between the trigger and the end of measurement (EOM) signal output on the handler interface.
4. Measurement range control: manual, Display: off, Average: 1, Delay: 0 ms, Offset: off, Test level monitor: off, Bin count: off
5. At display on, the measurement can be started when approximately 4 ms of display data processing time has elapsed after the previous EOM signal is output.

## Other functions

**Display:** Measured values, measurement conditions, limit values, comparator decision results, error messages and self-test messages are displayed.

**Test signal level monitor:** Test signal voltage applied to the device is monitored and displayed.

**Compensation (error correction):**

**Open/short compensation:** Eliminates measurement errors due to stray admittance and residual impedance of the test fixture. Correction ranges are:

Stray C and residual L: No limits

Residual G:  $\leq 20 \mu\text{S}$

Residual R:  $\leq 20 \Omega$

**Load compensation:** Measured values are corrected in reference to a capacitor whose values are known.

Compensation is valid at a selected frequency only.

**Offset compensation:** Subtracts desired compensation values from measured values.

**Circuit protection:** Protects measurement circuit against a harmful discharge when a charged capacitor is connected to the measurement terminals.

**Maximum withstanding discharge voltage (typical):**

$\sqrt{2/C}$  (V) and  $\leq 1000$  V. C is the capacitance value of measured device.

**Comparator:** 9 bins and out of bins for C. Pass/fail decision for D, Q, G, Rs and Rp.

AUX, P-Hi, P-Lo, S-Reject and Low C Reject

Limit setting: Absolute value, deviation and % deviation

Bin count: 0 to 999999

**Resume function:** Measurement setup status is saved in memory while the instrument is turned off, and is automatically recalled when the instrument is turned on.

**Memory period (typical):** 72 hours @ 23°C  $\pm 5^\circ\text{C}$

**Save/Recall:** 10 instrument setups can be stored into and recalled from the internal non-volatile memory.

**Key lock:** Front panel keys can be locked to prevent undesired operation.

**GPIB:** Complies with IEEE-488.1 and 488.2. The programming language is SCPI.

**Data buffer:** A maximum of 1000 sets of measured values and comparator decision results can be stored and output.

**Handler interface:** All input/output are negative true logic and optically-isolated open collector signals.

**Output signal:** Bin 1 to 9, out of bins, aux bin, P-Hi, P-Lo, S-reject, Low C, index, EOM, Ready for Trigger, Overload and Alarm.

**Input signal:** External trigger and keylock

**Scanner interface:** Open/short/load compensation for a maximum of 64 channels

**Output signal:** Index and EOM

**Input signal:** CH0 to CH5 (channel identification signals), external trigger and CH VALID.

## General

**Power requirement:** 90 V to 132 V, 198V to 264V ac, 47 Hz to 66 Hz, 35 W/100 VA max.

**Operating temperature/humidity:** 0°C to 45°C, 15% to 95% RH @  $\leq 40^\circ\text{C}$  and no condensation.

**Dimensions:** 320 (W) mm  $\times$  100 mm (H)  $\times$  300 mm (D)  
(12.6 inches  $\times$  3.9 inches  $\times$  11.8 inches)

**Weight:** Approximately 3 kg (6.6 lbs)

## Supplemental data

Supplemental data is not guaranteed.

**Test signal level monitor:**

Voltage resolution: 1 mV rms

Voltage monitor accuracy:  $\pm(3\%$  of reading + 1 mV)

**Measurement stability:**

At constant temperature and long mode

C:  $\leq 0.005\%/24$  hours

D:  $\leq 0.00005/24$  hours

**Temperature coefficient:**

C:  $\leq 0.001\%/^\circ\text{C}$

D:  $\leq 0.00001\%/^\circ\text{C}$

**Settling time (when the setting is changed):**

Frequency: 10 ms

Test signal level: 10 ms

## Accessories

### 16048A/B/D Test leads



#### Four-terminal pair test leads

The connectors on the instrument side are BNC.  
Connectors on the other side correspond to in the table below.

	Length (approx.)	Cable length setting	Connector
16048A	94 cm	1 m	BNC
16048B	94 cm	1 m	SMC
16048D	189 cm	2 m	BNC

### 16044A Test fixture

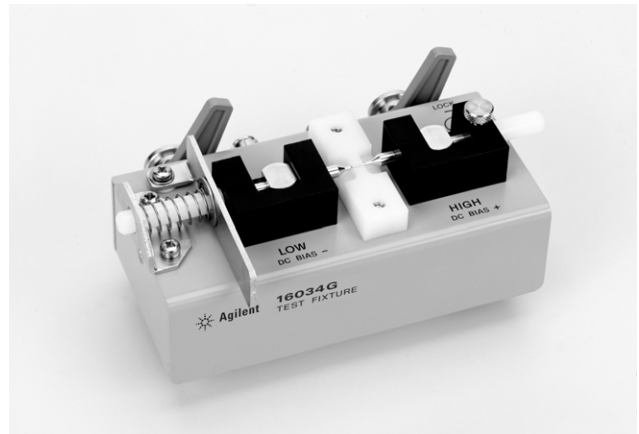


#### Test fixture for SMD components

4-terminal configuration, DC to 10 MHz  
Component dimensions (L x W):  
1.6 x 0.8 mm to 8.0 x 8.0 mm (0.063 x 0.032 inches to 0.32 x 0.32 inches)

A chip component test fixture with 4-terminal configuration is well-suited for measurement of low impedance devices such as high-value capacitors.

### 16034G Test fixture

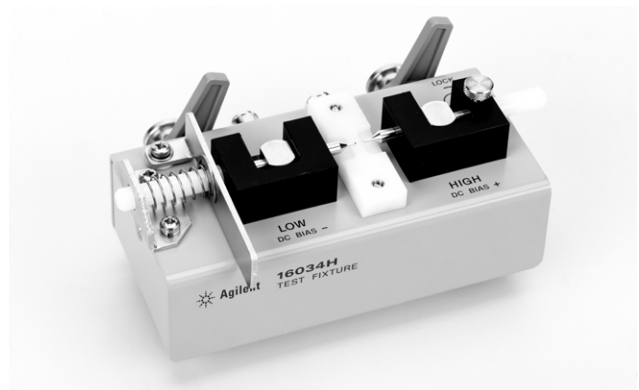


#### Test fixture for SMD components

2-terminal configuration, DC to 110 MHz  
Component dimensions (L x W):  
0.6 x 0.3 mm to 5.0 x 1.6 mm (0.024 x 0.012 inches to 0.2 x 0.063 inches)

A chip component test fixture with 2-terminal configuration. This fixture can handle SMDs as small as 0.6 mm x 0.3 mm (0.024 inches x 0.012 inches)

### 16034H Test fixture



#### Test fixture for array-type SMD components

2-terminal configuration, DC to 110 MHz  
Component dimensions (L x W):  
1.6 x 0.8 mm to 15.0 x 5.0 mm (0.063 x 0.032 inches to 0.59 x 0.2 inches)

A test fixture for array-type chip components. Contact electrodes can reach any electrode pairs on an array component by manually shifting the position of the component.

## 16334A Test fixture

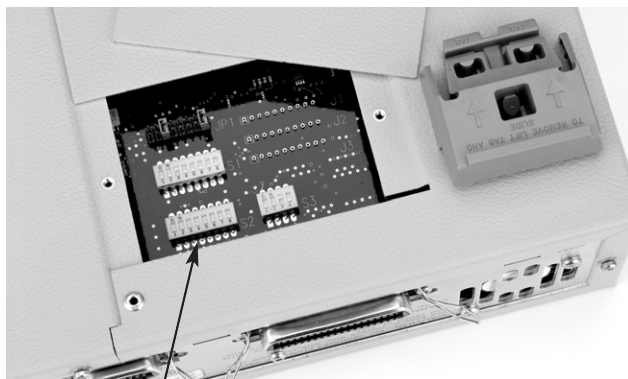


### Tweezer-type test fixture for SMD components

2-terminal configuration, DC to 15 MHz  
Component dimensions: L < 10 mm, (< 0.39 inches)

## Setting the interface operating voltage

Removing the small panel pictured allows access to the switch for setting handler and scanner interfaces operating voltages.



Voltage setting switch

## Ordering information

### Agilent 4288A 1 kHz/1 MHz capacitance meter

Furnished accessories:  
Operating manual, power cable  
Note: Test fixtures are not furnished.

## Manual options

Option ABA: English manual  
Option 0B0: Delete manual set<sup>5</sup>  
Option 0B1: Add manual set<sup>6</sup>

## Service options

Option A6J: Commercial calibration certificate with test data  
Option W30: 3 years customer return repair service  
Option W32: 3 years customer return calibration service  
Option W50: 5 years customer return repair service  
Option W52: 5 years customer return calibration service

## Cabinet options

Option 1CM: Rack mount kit  
Option 1CN: Front handle kit

## Test fixtures and test leads

16034E Test fixture (For SMD component, 2-terminal)  
16034G Test fixture  
(For small SMD component, 2-terminal)  
16034H Test fixture  
(For array-type SMD component, 2-terminal)  
16043B Test fixture (For SMD component, 2-terminal)  
16044A Test fixture (For SMD component, 4-terminal)  
16047A Test fixture (For axial/radial lead component)  
16047E Test fixture (For axial/radial lead component)  
16065A External DC bias fixture (up to 200 V dc)  
16065C External DC bias fixture (up to 40 V dc)  
16089A Kelvin clip lead (2 large clips, 1 m)  
16089B Kelvin clip lead (2 medium clips, 1 m)  
16089C Kelvin clip lead (2 IC clips, 1 m)  
16089D Alligator clip lead (4 clips, 1 m)  
16089E Kelvin clip lead (2 large clips, 1 m)  
16334A Test fixture (For SMD component, tweezer-type)  
16048A Test lead (0.94 m, BNC connector)  
16048B Test lead (0.94 m, SMC connector)  
16048D Test lead (1.89 m, BNC connector)

5. Do not need to specify localization option like ABA.

6. Obeys the selected localization option.

## Agilent Technologies'

### Test and Measurement Support, Services, and Assistance

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#### Our Promise

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## Key literature

Agilent 4288A Capacitance Meter, Data Sheet, publication number 5988-0362EN.

## Web resources

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