Agilent
4268A 120 Hz/1 kHz Capacitance Meter
Technical Overview

High speed testing of high-value ceramic capacitors at constant test signal levels

Agilent Technologies

Best Solution for High-Speed Testing of High-Value Ceramic Capacitor

The Agilent Technologies 4268A 120 Hz/1 kHz capacitance meter offers the best solution for necessary high-speed production testing of high-value multi-layer ceramic capacitors (MLCCs). Testing the 10 µF to 100 µF class of high-value ceramic capacitors requires new measurement methods and techniques which are appropriate for their properties.

The 4268A is equipped with advanced functions that resolve problems on production testing and inspection of these components. It is designed to be a standard measurement tool for MLCCs, and complies with new measurement conditions being standardized, in addition to the current measurement standard of 1 kHz/1 Vrms. High-value capacitors with low impedance can be measured at a minimum measurement time of 25 ms (even at 120 Hz), with a constant voltage test signal matched to standards.

The 4268A measures capacitance and a loss parameter (D, Q, Rs, Rp, or G) simultaneously. The display is capable of 5-digit resolution. A built-in comparator sorts the measurement results into a maximum of 9 bins. The optically isolated handler interface and GPIB interface (in compliance with SCPI) make it easy to integrate the instrument into component handler systems, and to build a centralized/distributed network for data processing. The measurement functions tailored to MLCCs and high speed measurement of the 4268A allow vast improvements in test throughput, while attaining excellent component quality and production test cost-reduction.

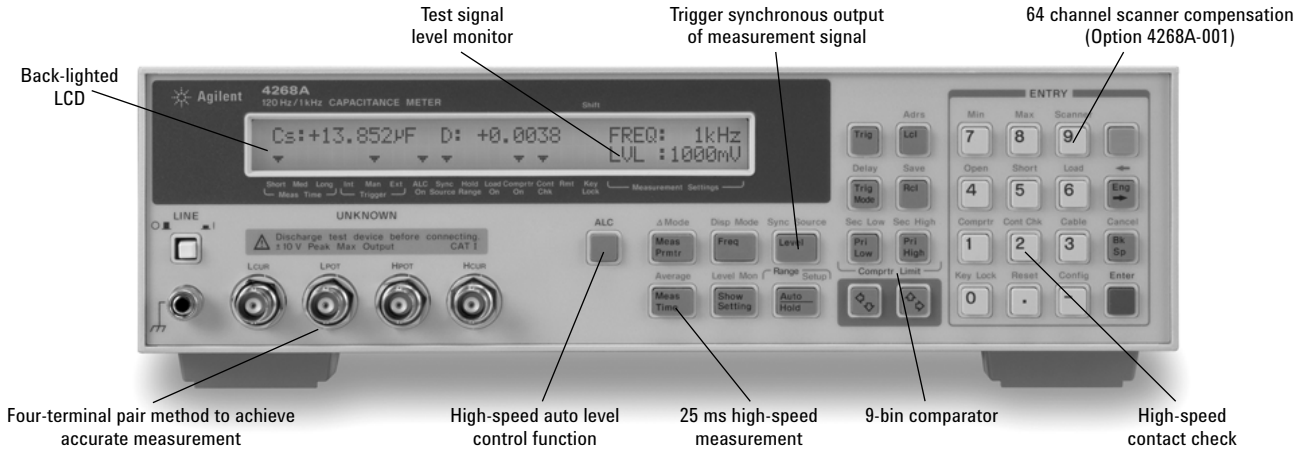
Primary Features

- Test frequency: 120 Hz and 1 kHz
- Test signal level in compliance with standard for high value MLCC testing
- High-speed auto level control function to assure constant test signal level
- Test signal level selectable from 0.1 V to 1 Vrms in 0.01 V steps
- Test signal level monitoring function
- 25 ms high-speed measurement
- Contact check function (add 5 ms to measurement time)
- Synchronous signal source function to minimize damages at contact pins
- Open/short/load compensation
- Trigger delay/source delay function
- 9-bin comparator
- Resume function to restore measurement settings at power-on
- Save and recall for up to 10 measurement setups
- Handler interface (optically isolated)
- GPIB interface (SCPI)
- Scanner compensation (Option 4268A-001)

Major Specifications

Test frequency	120 Hz, 1 kHz	
Meas. parameter	C, D, Q, R, G	
Display range	C: 0.0001 nF to 9.9999 mF D: 0.0001 to 9.9999	
Test signal level	0.10 V to 1.0 Vrms	
Test signal output mode	Continuous, trigger synchronous	
ALC operating range	0.5 Vrms	1 Vrms
120 Hz	≤ 1200 µF	≤ 600 µF
1 kHz	≤ 140 µF	≤ 70 µF
Basic accuracy	±0.2% (see page 6 for details)	
Meas. time	25 ms, 45 ms, 60 ms	
Error compensation	Open, short, load	
Comparator	9 bins + AUX + OUT OF BINS	
Contact check	≤ 5 ms (added to measurement time)	
Interface	GPIB, handler interface	
Option 4268A-001	Scanner compensation	
Others	Averaging, trigger delay, resume, save/recall	

Improve Efficiency and Reliability in Testing High-Value Ceramic Capacitors



The Agilent 4268A's advanced features make breakthroughs in production tests.

Features

Test signal level complies with standards

When measuring high-value capacitors with low impedance, conventional capacitance meters cause a large decrease in actual test signal voltage across a device due to the low output current limit of the test signal source. (For example, when measuring a 50 µF capacitor at 1 kHz using a capacitance meter with a 100 Ω source impedance, the test signal level across the device drops almost 97% from the setting value.)

The Agilent 4268A's powerful signal source ensures the required test level. Its auto level control (ALC) function automatically adjusts the applied signal level to the setting value. The test signal level is selectable from the range of 0.1 V to 1 Vrms in 0.01 Vrms steps. The ALC function enables application of a constant 1 Vrms test signal at 1 kHz to devices for up to 70 µF, and a 0.5 Vrms signal for up to 140 µF. At 120 Hz, it is possible to apply 1 Vrms for up to 600 µF and 0.5 Vrms for up to 1200 µF (as shown in Figure 1).

This instrument offers enough capability to not only satisfy the current test signal requirements for high-value MLCCs, but also to satisfy the requirements of future devices.

25 ms high-speed measurement

The Agilent 4268A resolves the test throughput problem associated with high-value capacitor tests. At 1 kHz and 120 Hz, the 4268A performs C-D (capacitance-dissipation factor) measurements and comparator decisions for bin sorting within 25 ms. The measurement time can be selected from 25 ms, 45 ms, or 60 ms.

Reliable measurement for MLCC

A new measurement technique developed for the 4268A ensures a measurement less susceptible to test signal distortion. Even if the test signal is distorted by test level dependency of the capacitance of MLCCs, it provides measurement results with improved accuracy and reliability. Without regard to the dielectric properties of a device, the 4268A assures reliable measurement results.

High-speed auto level control function

The Agilent 4268A has an advanced and innovative high-speed ALC (auto level control) function, which enables the application of a constant voltage test signal to the device. As the name implies, this function automatically adjusts the applied test voltage to DUT for setting value within a few milliseconds. In this way, the device can be tested with the appropriate signal level without sacrificing measurement speed. This function eliminates the need to adjust test levels for individual capacitors, and resolves the problem that the resistance of test cables causes a test voltage drop.

Reducing contact abrasion

The synchronous signal Source function enables the test signal to be output after measurement is triggered. Also, this function ensures that the signal is applied to the device only for the period required to perform a measurement. This method reduces contact pin abrasion due to large test current, because the test signal is not applied at the moments the device is contacted and removed.

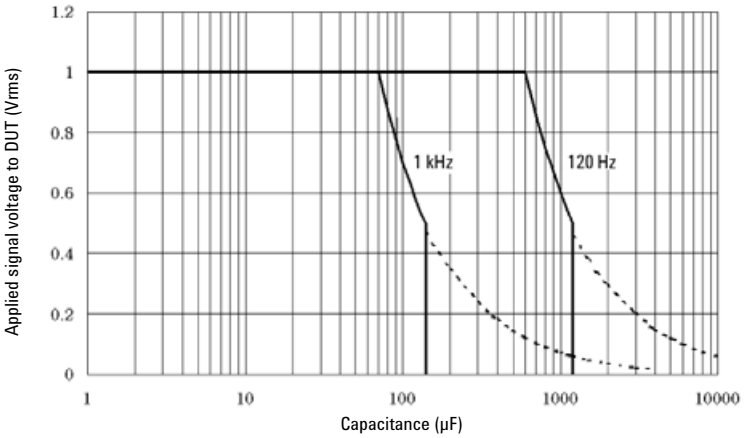


Figure 1. ALC Operating Range (typical)

Remarks:
DUT's dissipation factor ≤0.2
Dotted lines show the signal voltage without ALC

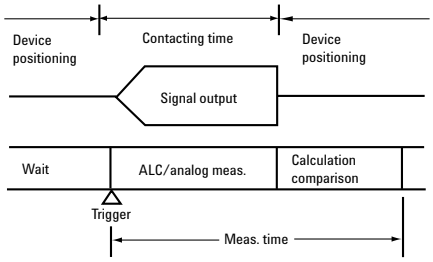


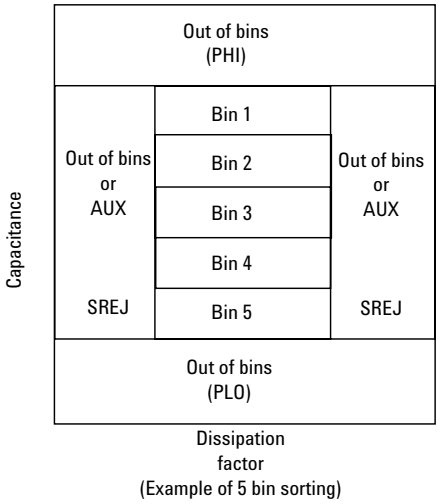
Figure 2. Test signal timing chart for synchronous signal source

Contact check

In production, contact failures between the device and the contacts of a component handler can be a significant cause of sorting output errors. The 4268A's contact check function permits detection of possible contact failures in the 4-terminal connection method (adds 5 ms to measurement time). The contact error signal is output to the handler interface and GPIB to prevent incorrect measurements, thus assuring reliable component sorting tests. The trigger delay function allows for the timing of the measurement start to be optimized, thereby avoiding the unstable contact time (chattering time) just after the device is contacted.

Measurement circuit protection

If a charged high-value capacitor is connected to measurement terminals, the internal measurement circuit may be damaged by harmful discharge from the device. Preventing damage to the measurement circuit is important for measurement of high value MLCCs. The Agilent 4268A has a protective circuit enhanced for the ability to prevent the instrument from being damaged by discharge.



(Example of 5 bin sorting)

9 bin comparator[1]

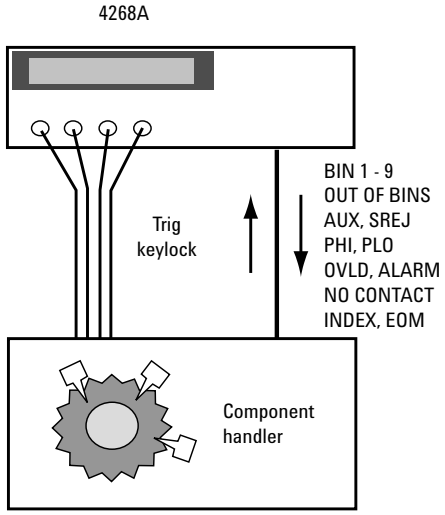
The built-in comparator function can sort the measured capacitance values into a maximum of 9 bins and make pass/fail decisions for D, Q, R, and G. The limit values can be entered in one of three modes: absolute value, deviation, and percent deviation. Comparison results can be output on the handler and GPIB interfaces. If the device is sorted to OUT OF BINS, status signals are output to represent the status of capacitance too low, too high, dissipation factor outside limits, etc., thus allowing you to statistically analyze the defects of components.

Interfaces for automation and systemization

The GPIB interface (IEEE-488.1, 488.2), which is critical to efficient remote control of the measurement setup as well as the centralized/distributed processing of measurement data, is furnished standard. The GPIB eases upgrades in data processing including measurement data acquisition and analysis. The handler interface is optically isolated to avoid external noise interference, thus ensuring error-free operation when the instrument is installed in a component handler.

Storing measurement setups

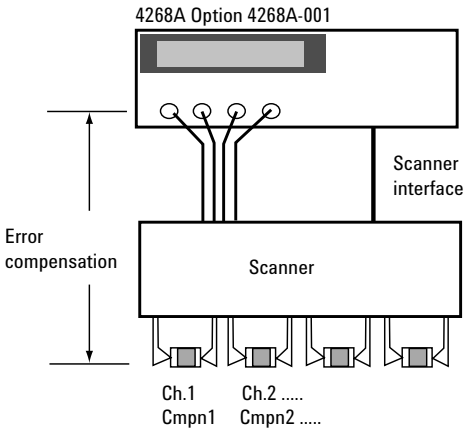
The Agilent 4268A has a resume function to protect the memory of measurement setups against possible power failures. Since the measurement setup status before instrument power is turned off is stored in the internal memory and automatically recalled right after powered on, the instrument can quickly restart measurements. The save/recall function allows a maximum of 10 measurement setups to be memorized and recalled with simple keystrokes.



Option

Scanner compensation (Option 4268A-001)

For measurement systems using a component scanner, the scanner compensation option (Option 4268A-001) enables error compensation to be performed independently for each scanner channel. This minimizes inconsistency in measured values between channels. This function can store the open/short/load compensation data for a maximum of 64 channels and apply appropriate correction data to measured values at selected channels. You can easily build a multi-channel scanner system for inspection of array type capacitors or for improving the efficiency of sampling tests for quality assurance.



1. The comparator and handler interface functions are compatible to those of the Agilent 4278A with Option 4278A-201; however, the 4278A is an obsolete product.

Specifications

The specification is the performance of the instrument guaranteed under a temperature environment between 0 °C and 45 °C unless otherwise noted. The data described as "typical," "approximately," or "nominal" are not guaranteed specifications, but supplemental performance characteristics for effective use of the instrument.

Measurement accuracy

C accuracy: Refer to Table 1.
The measurement accuracy, Ae, is represented as Ae = ±(A + B + E)% or Ae = ±(A + B)% in Table 1.

$\beta = Cr/Cx$ when Cr ≤ 100 µF(@ 120 Hz) or Cr ≤ 10 µF(@ 1 kHz)
$\beta = Cr/Cx + Cx/Cr$ when Cr = 1 mF (@ 120 Hz) or Cr = 100 µF(@ 1 kHz) (n.b. if $\beta < 1$, $\beta = 1$.)

D Accuracy: ±Ae/100 (error value)
Q Accuracy:

$$\pm \frac{Qm^2 \times De}{1 \mp (Qm \times De)} \text{ (Error value)}$$

(Where, Qm × De < 1)
Where, Qm: Measured Q value
De: D accuracy
Rs Accuracy: ±Ae/Dx %
Where, Dx: Measured D value

The measurement accuracy is guaranteed at the UNKNOWN terminal when all the measurement conditions listed below are satisfied:

1. warm up time: ≥ 30 min.
2. ambient temperature: 23 °C ± 5 °C
3. test signal level: 1 Vrms, 0.5 Vrms, or 0.3 Vrms
4. open/short correction performed
5. measured D value: Dx ≤ 0.1. In case of 0.1 < Dx ≤ 0.5, multiply $(1 + Dx^2)$ for C and Rs accuracy and $\sqrt{1 + Dx^2}$ for D accuracy. This is applied when Ae ≤ 10%.

Refer to the *Agilent 4268A Operation Manual* for accuracy under other conditions.

Table 1. Measurement accuracy (% of reading)

C range		120 Hz	1 kHz
1nF	S		0.18 + 0.062β
	M		0.14 + 0.052β
	L		0.14 + 0.049β
10nF	S	0.28 + 0.1β	0.18 + 0.041β
	M	0.14 + 0.05β	0.14 + 0.036β
	L	0.14 + 0.05β	0.14 + 0.035β
100nF	S	0.28 + 0.077β	0.18 + 0.041β
	M	0.14 + 0.037β	0.14 + 0.036β
	L	0.14 + 0.035β	0.14 + 0.035β
1µF	S	0.28 + 0.077β	0.18 + 0.041β
	M	0.16 + 0.037β	0.14 + 0.036β
	L	0.16 + 0.035β	0.14 + 0.035β
10µF	S	0.28 + 0.077β	0.18 + 0.041β + 377Cx
	M	0.16 + 0.037β	0.14 + 0.036β + 377Cx
	L	0.14 + 0.035β	0.14 + 0.035β + 377Cx
100µF	S	0.4 + 0.077β + 45.2Cx	0.4 + 0.066β + 377Cx
	M	0.4 + 0.037β + 45.2Cx	0.4 + 0.049β + 377Cx
	L	0.4 + 0.035β + 45.2Cx	0.4 + 0.044β + 377Cx
1mF	S	0.8 + 0.106β + 45.2Cx	
	M	0.8 + 0.052β + 45.2Cx	
	L	0.8 + 0.045β + 45.2Cx	

Accuracy in the table applies for measurement time S: short, M: medium and, L: long.
No measurement ranges are available in the shaded areas of the table.

Table 2. Measurement range

Measurement range	Measurement frequency 120 Hz	1 kHz
1nF	—	0 to 2 nF
10 nF	0 to 20 nF	0 to 20 nF
100 nF	0 to 200 nF	0 to 200 nF
1 µF	0 to 2 µF	0 to 2 µF
10 µF	0 to 20 µF	0 to 20 µF
100 µF	0 to 200 µF	0 to ∞
1 mF	0 to ∞	—

Effective measurement range shown (where the dissipation factor D ≤ 5)

Specifications (cont.)

Measurement parameter/range

Measurement parameter:
Cs-D/Q/Rs, Cp-D/Q/Rp/G

Parameter	Display range
Cs, Cp (120 Hz)	0.001 nF to 9.9999 mF
(1 kHz)	0.0001 nF to 999.99 µF
D	0.0001 to 9.9999
Q	0.1 to 9999.9
Rs, Rp	0.01 mΩ to 999.99 MΩ
G	0.0001 µS to 9.9999 kS
Δ%	–999.99% to +999.99%

Measurement functions

Test frequency (frequency accuracy):
120 Hz (±1%), 1 kHz (±0.05%)
Source impedance
(Typical value at cable length = 0m):
ALC Off: ≤ 1.5 Ω
ALC On: ≤ 0.1 Ω
Test signal level: 0.1 V to 1.0 Vrms in 10 m Vrms steps
Test signal level accuracy: ±10%
Auto level control (ALC):
Automatically adjust the applied test signal level for the setting value. Selectable for On and Off.
See Figure 1 for the ALC operating range.
Test signal output mode: Continuous and synchronous (synchronized with trigger) modes
Source delay: 0 to 1.000 s in 1 ms steps
Measurement terminal configuration: Four-terminal pair
Ranging: Auto and manual
Display digit: 5 digits (selectable from 3, 4, 5 digits)
Deviation measurement: Deviation and percent deviation from reference value
Trigger mode: Internal, external, manual, and GPIB
Measurement time mode: Short, medium, and long
Averaging: 1 to 256
Trigger delay: Programmable delay from the trigger to the measurement start; 0 to 1.000 s in 1 ms steps.
Cable length: 0 m, 1 m, and 2 m

Measurement time (typical data)

The measurement time in each measurement mode is shown below:
(Unit in ms)

Mode		T1	T2
Short	Min	16(20)	20(24)
	Max	19(23)	25(30)
Medium	Min	34(38)	38(42)
	Max	37(41)	43(48)
Long	Min	50(54)	54(58)
	Max	53(57)	59(64)

1. Measurement range setting: Manual display: Off; test level monitor: off; source delay: 0 ms; trigger delay: 0 ms
2. 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. The ALC operating time is included.
3. T2 is the time between the trigger and the EOM (end of measurement) signal on the handler interface. The ALC operating time is included.
4. Shown in parenthesis are the measurement time when the contact check function is used.

Other functions

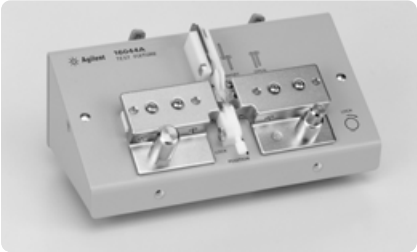
Display: Measured values, measurement conditions, limit values, comparator decision results, error messages, and self test messages are displayed. The display can be turned off.
Test signal level monitor: Test signal voltage and current applied to the device is monitored and displayed. (Current is a calculated value.)
Error correction: Open/short Correction: Eliminates measurement errors due to stray admittance and residual impedance of test fixture.
LOAD Correction: Measured values are corrected in reference to a device whose values are known. Valid at selected frequency only.
Circuit Protection: Protects measurement circuit against harmful discharge when a charged capacitor is connected to measurement terminals.
Maximum withstanding discharge Voltage: (typical value: V)
$\frac{250}{C}$ V (C < 32 µF)
$\sqrt{2/C}$ V (C ≥ 32 µF)
C is the capacitance value of measured device.
Comparator:
9 bins, OUT OF BINS, AUX BIN, P-Hi, P-Lo, S-reject
Limit setting: Absolute value, deviation, and %deviation
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
Contact check: Automatically detects contact failures between the device and measurement terminals in 4-terminal connection configuration.
Save/Recall: 10 instrument setups can be stored into and recalled from the internal non-volatile memory.
Keylock: Front panel keys can be locked to prevent undesired operation.
GPIB: Complies with IEEE-488.1 and 488.2. The programming language is SCPI.
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, INDEX, EOM, overload, contact error and alarm input signal: External trigger and keylock
Scanner compensation (option): Open/short/load compensation for a maximum of 64 channels.

General

Power requirement: 90 V to 132 V, 198 V to 264 V, 47 Hz to 66 Hz, 40 W/100 VA max.
Operating temperature/humidity: 0 °C to 45 °C, ≤ 95% RH @ 40 °C
Dimensions:
320 (W) × 100 (H) × 450 (D) mm
Weight: 5 kg (approximately)

Accessories

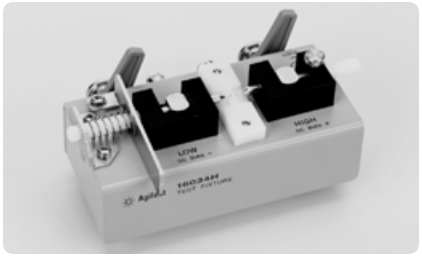
Agilent 16044A test fixture



A chip component test fixture with 4-terminal configuration suited for measurement of low impedance devices such as high-value capacitors. Built-in arm-type terminators make it possible to configure appropriate terminal connections easily and quickly for open/short compensations by simply turning the arms.

Test fixture for SMD components
4-terminal configuration, DC to 10 MHz
Component dimensions (L × W):
1.6 × 0.8 mm to 8 × 10 mm

Agilent 16034H test fixture



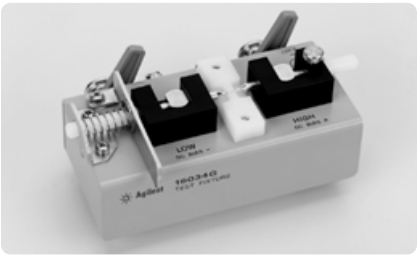
A test fixture for array-type chip components. The contact pins can reach any electrode pairs on an array component by manually shifting the position of the component.

Test fixture for array-type SMD components
2-terminal configuration,
DC to 110 MHz
Component dimensions (L × W):
1.6 mm × 0.8 mm to 15 mm × 5 mm

Agilent 16334A test fixture

A tweezer-type test fixture for SMD components
2-terminal configuration, DC to 15 MHz
Component dimensions: L < 10 mm

Agilent 16034E/G test fixture



A chip component test fixture with 2-terminal configuration. The Agilent 16034G can handle small SMDs down to 0.6 mm × 0.3 mm.

Test fixture for SMD components
2-terminal configuration, DC to 100 MHz
Component dimensions (L × W):
16034E: 1.6 × 0.8 mm to 8 × 10 mm
16034G: 0.6 × 0.3 mm to 5 mm × 1.6 mm

Rear panel of the Agilent 4268A 120 Hz/1 kHz capacitance meter (with Option 4268A-001)

Ordering Information

❍ = Choose ONE and ONLY one
❑ = Choose any combination

Agilent 4268A 120 Hz/1 kHz Capacitance Meter

Interface options

❍ Option 4268A-001: GPIB/handler/scanner interface
❍ Option 4268A-002: GPIB/handler interface

Documentation options[1]

❑ Option 4268A-ABA: add specified quantities of English manual
❑ Option 4268A-ABJ: add specified quantities of Japanese manual
❑ Option 4268A-OBW: service documentation, assembly level

Cabinet options

❑ Option 4268A-1CN: front handle kit
❑ Option 4268A-1CM: rack mount kit

Certification option

❑ Option 4268A-A6J: ANSI Z540 compliant calibration

Test fixture/test lead[2]

Agilent 16034E test fixture (for SMD, 2-terminal)
Agilent 16034G test fixture (for small SMD, 2-terminal)
Agilent 16034H test fixture (for array-type SMD, 2-terminal)
Agilent 16043B[3] test fixture (for large SMD, 2-terminal)
Agilent 16044A[3] test fixture (for SMD, 4-terminal)
Agilent 16047A test fixture (for axial/radial lead component)
Agilent 16047C test fixture (for axial/radial lead component)
Agilent 16047E[3] test fixture (for axial/radial lead component)
Agilent 16065A external DC bias fixture (up to 200 V dc)
Agilent 16065C external DC bias fixture (up to 40 V dc)
Agilent 16089A Kelvin clip lead (2 large clips, 1 m)
Agilent 16089B Kelvin clip lead (2 medium clips, 1 m)
Agilent 16089C Kelvin clip lead (2 IC clips, 1 m)
Agilent 16089D alligator clip lead (4 clips, 1 m)
Agilent 16089E Kelvin clip lead (2 large clips, 1 m)
Agilent 16334A test fixture (For SMD, tweezer-type)
Agilent 16048A test lead (0.94 m, BNC connector)
Agilent 16048B test lead (0.94 m, SMC connector)
Agilent 16048D test lead (1.89 m, BNC connector)

1. Manual is not furnished with the 4268A.
2. Test fixture is not furnished with 4268A.
3. Must specify one of the language options (ABA or ABJ) for operation manuals of these fixtures for shipment with product.

Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise
Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage
Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and onsite education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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