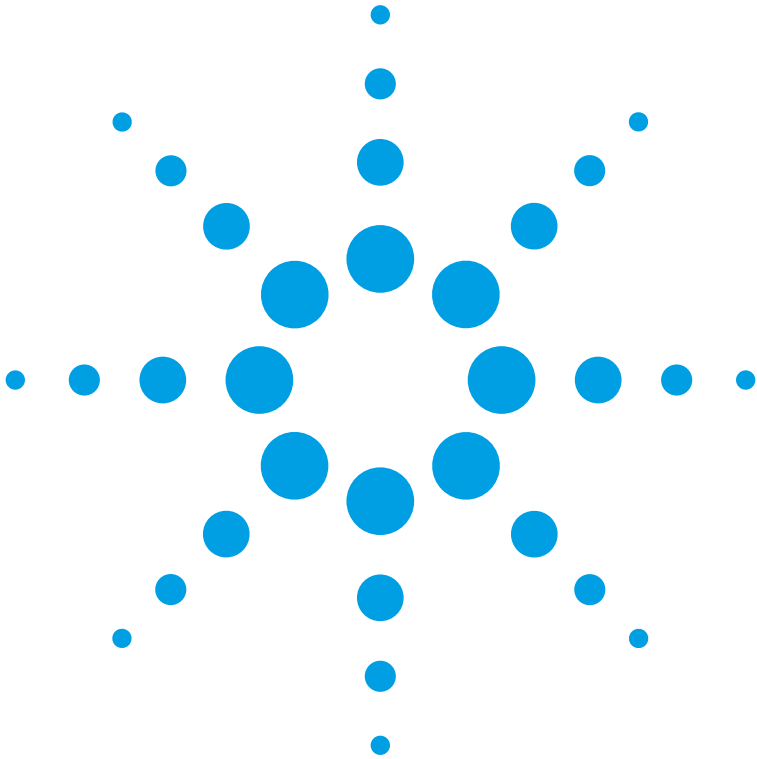
Agilent N1025A
1 GHz Active Differential Probe
User's Guide



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CAUTION
The *caution* sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

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The *warning* sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.

The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.


The laser radiation symbol. This warning symbol is marked on products which have a laser output.


The AC symbol is used to indicate the required nature of the line module input power.


The ON symbols are used to mark the positions of the instrument power line switch.


The OFF symbols are used to mark the positions of the instrument power line switch.


The CE mark is a registered trademark of the European Community.


The CSA mark is a registered trademark of the Canadian Standards Association.


The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.

ISM1-A
This text denotes the instrument is an Industrial Scientific and Medical Group 1 Class A product.

General Safety Considerations

This product has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Before performing any procedure, review the safety information for cautions and warnings.

WARNING **If this instrument is not used as specified, the protection provided by the equipment could be impaired. This instrument must be used in a normal condition (in which all means for protection are intact) only.**

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

WARNING **To prevent electrical shock, disconnect the Agilent N1025A from the Agilent 86100A before cleaning. Use a dry cloth to clean the external case parts. Do not attempt to clean internally.**

CAUTION This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 61010-1 and 664 respectively.

CAUTION Install the instrument according to the enclosure protection provided. This instrument does not protect against the ingress of water. This instrument protects against finger access to hazardous parts within the enclosure.

Contents

Inspect the Probe

❒ Inspect the shipping container for damage.

Keep the shipping container or cushioning material until the contents of the shipment have been checked for completeness and the probe has been checked mechanically and electrically.

❒ Check the accessories.

Any accessories that were supplied with the probe are listed in "Probe Accessories Kit" on page 11.

- If the contents are incomplete or damaged notify your Agilent Technologies Sales Office. Refer to "Agilent Technologies service offices" on page 28.

❒ Inspect the instrument.

- If there is mechanical damage or defect, or if the probe does not operate properly or pass performance tests, notify your Agilent Technologies sales office.
- If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier as well as your Agilent Technologies Sales Office. Keep the shipping materials for the carrier's inspection. Agilent Technologies will arrange for repair or replacement at Agilent's option without waiting for claim settlement.

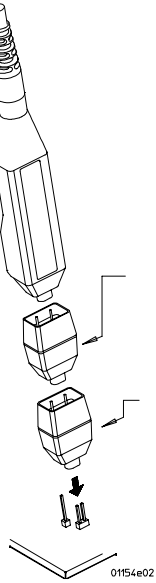
Introduction

The Agilent N1025A is a wide-band differential active probe. The probe features low noise, low input capacitance, high common mode rejection, and Field Effect Transistor (FET) buffered inputs in the probe head. User-selectable offset gives the probe flexibility to measure a large range of signal types. Plug-on attenuators and AC coupling accessories further extend the application range. Included interconnect accessories allow connection to surface mount and through-hole components with minimal signal degradation. The input receptacles in the probe head are compatible with standard 0.025" (0.635 mm) square pins, which provide a convenient low-cost method of creating device characterization test fixtures.

The Agilent N1025A is ideal for acquiring high speed differential signals such as those found in Rambus®[a] clock lines, LVDS, Fibre Channel, gigabit Ethernet, and so on. The high impedance characteristics of both inputs allow you to use the probe as a FET probe to make single-ended measurements in digital systems without introducing a ground loop as a conventional FET probe would.

Before using the Agilent N1025A probe it must reach operating temperature, which is 30 minutes with power applied in an environment with a stable ambient temperature.

a. Rambus is a registered trademark of Rambus, Incorporated.



Differential amplifiers and CMRR

The Agilent N1025A differential probe is a high input impedance amplifier. A characteristic of differential amplifiers is the ability to reject signals that are common to the two inputs. The common mode rejection ratio (CMRR) is the measurement of this ability. It is expressed as the ratio between the amplitudes of the common mode and differential signals that produce equal outputs. If the differential gain is known, these measurements can be referred to the probe input. CMRR is usually expressed in dB:

$$CMRR\ in\ dB\ =\ 20\log\left(\frac{V\ common\ mode\ input\ \times Gain}{V\ common\ mode\ output}\right)$$

The ability to reject common mode signals depends on the balance designed into the probe amplifier. As the frequency of the common mode signal increases, it becomes harder to balance the amplifier parasitic parameters. This leads to degradation of the CMRR.

The CMRR of the Agilent N1025A differential probe is specified from the probe tip. This method of specifying the probe CMMR eliminates the effects of source impedance, provided the connections from the probe tip to the signal source are symmetrical.

Probe Accessories Kit

The following diagram and table show the accessories supplied with the Agilent N1025A differential probe. The probe accessories kit can be ordered as Agilent part number 01154-60004.

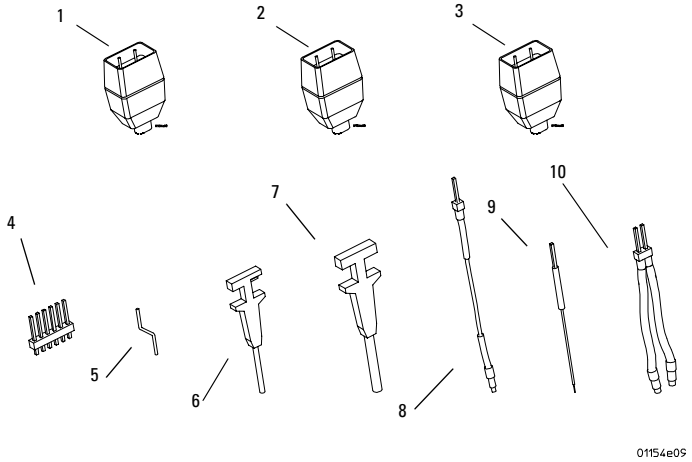


Table 1. Probe Accessories Kit (Agilent part number 01154-60004)

Item	Description	Qty.
1	AC coupler	1
2	÷10 Attenuator	1
3	÷20 Attenuator	1
4	Header	1
5	Offset Pin	4
6	0.5 mm Grabber (1 red, 1 black)	2
7	0.8 mm Grabber (1 red, 1 black)	3
8	Ground Lead	1
9	SMT Lead	4
10	Signal Lead (1 red, 1 black)	2

To order replaceable parts

To order a replaceable part, in the United States and Canada call our toll-free hotline at 1-877-447-7278, or call your local Agilent Technologies Sales Office.

Table 2. Replaceable Parts

Item	Description	Qty.	Agilent Part Number
1	Probe Accessory Kit (includes attenuators)	1	01154-60004
2	Agilent N1025A User's Guide	1	N1025-90001

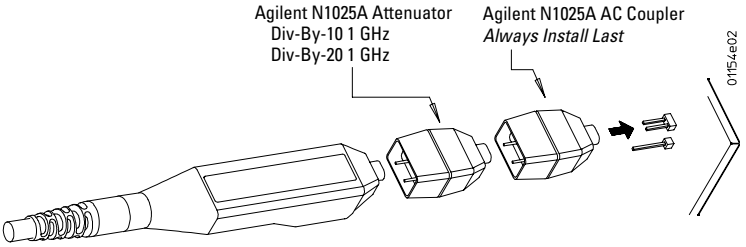
Using the accessories

The Agilent N1025A differential probe and accessories provide a variety of ways to connect to circuitry under test. Any method used to connect the probe signal inputs to the circuit under test degrades the performance of the probing solution. Take the following precautions to optimize common mode rejection.

- Make the tip connection lead length as short as possible and of the same length.
- Follow the same path for wires used to connect the inputs of the probe to the circuit under test.
- Probes do not have infinite input impedance and do load the circuit under test. If the impedance of the test points is not identical, unequal loading will occur. This degrades common mode rejection.
- The ground lead length is not usually critical with a differential probe.
- Carefully consider the ground potential relative to the DCA ground potential. The potential difference must be within the common mode range of the probe.
- The DC potential between the AC coupling adapter and the *DCA ground* must not exceed 42 Vpk.
- Do not cascade the external attenuators.
- Cascade the external AC coupling adapter in the following order: *probe*, *attenuator*, and *AC coupling adapter*.

Attaching External Attenuators to the Probe

The external attenuators plug directly on to the probe tip. They are calibrated at the factory to provide the optimum common mode rejection and should not be swapped between probes.



Specifications and Characteristics

This chapter lists specification and characteristics of the instrument. The distinction between these terms is described as follows:

- Specifications describe warranted performance over the temperature range 0°C to +40°C and relative humidity <80% (unless otherwise noted). All specifications apply after the temperature of the probe has been stabilized after 30 minutes of continuous operation.
- *Characteristics* provide useful information by giving functional, but nonwarranted, performance parameters. *Characteristics are printed in italics.*

Calibration Cycle

This instrument requires periodic verification of performance. The instrument should have a complete verification of specifications once every year.

Specifications

Table 3. Specifications

Input Configuration	Ground Connector True Differential (+ and – inputs), with shield
Input Coupling	DC AC coupling obtained by installing an AC coupling adapter
Gain Accuracy at 1 kHz	2%
Differential Range Times 1 Gain No attenuator [a]	>±400 mV
Common Mode Range Times 1 Gain No attenuator [a]	±16 V
Maximum Input Voltage Either input from ground	>±42 V

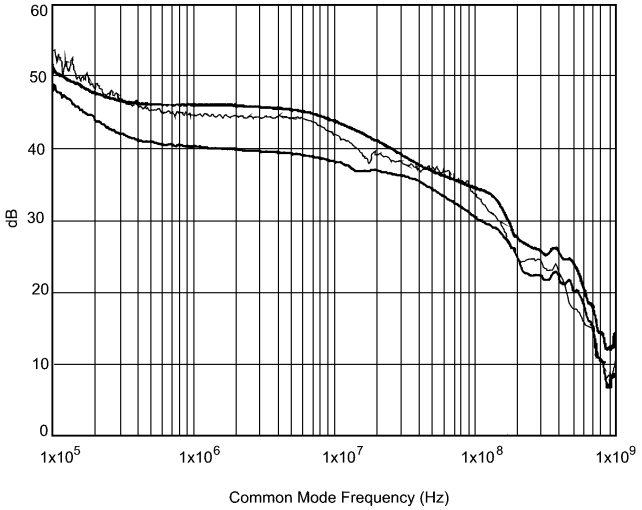
a. Range multiplied by attenuation of external attenuator.
Attenuators available with the Agilent N1025A: ÷10 and ÷20.
AC coupling is obtained by installing the AC coupling adapter.

Performance characteristics

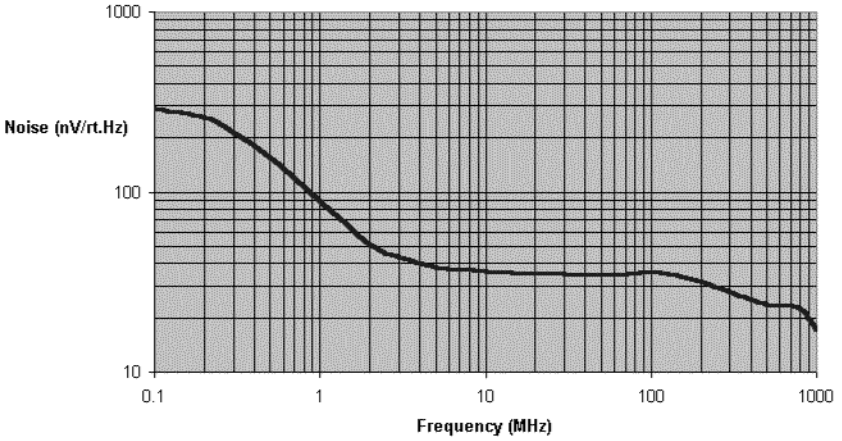
Before you use the Agilent N1025A probe it must reach operating temperature, which is 30 minutes with power applied in an environment with a stable ambient temperature.

Table 4. Performance Characteristics

Probe Bandwidth (–3 dBb)	*DC to 1 GHz*
Offset Range	*± 1.6 V*
Rise Time (Probe only) *1:1 Attenuation* *Internal switched attenuation only*	*< 350 ps*
Input Resistance *(each side to ground)*	*1 MΩ*
Input Capacitance (between inputs) *1:1 Attenuation* *No external attenuators*	*< 0.85 pF*
Input Capacitance (each side to ground) *1:1 Attenuation* *No external attenuators*	*< 1.5 pF*
CMRR	*at 70 Hz: 70 dB* *at 1 MHz: 40 dB* *at 100 MHz: 25 dB* *at 500 MHz: 19 dB*



Typical CMRR versus Frequency (Hz)



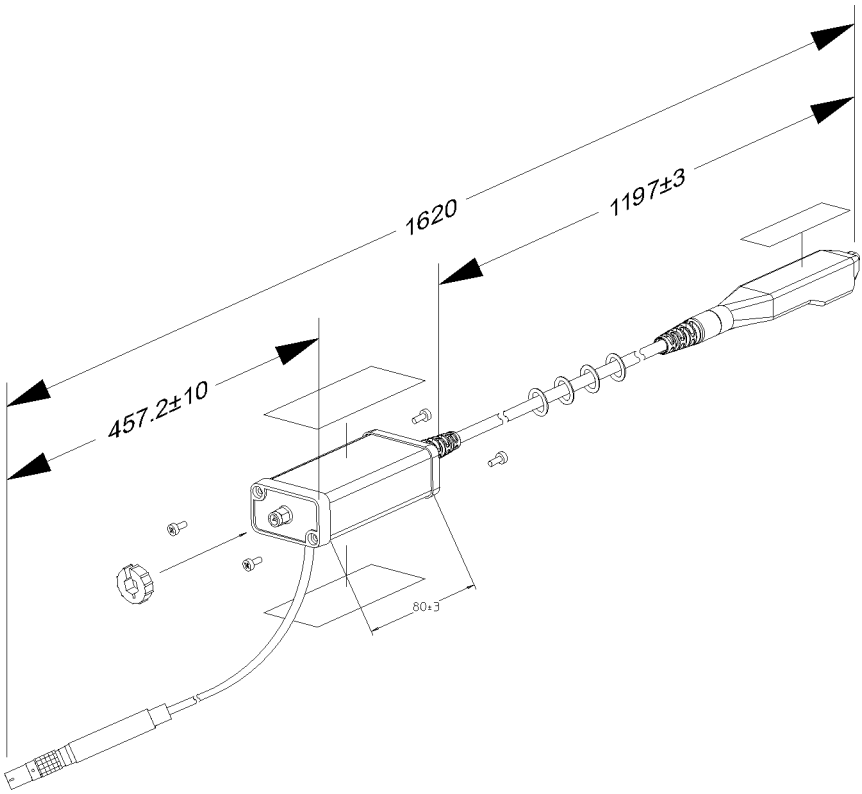
Typical Noise

Operating specifications

Table 5. Operating Specifications

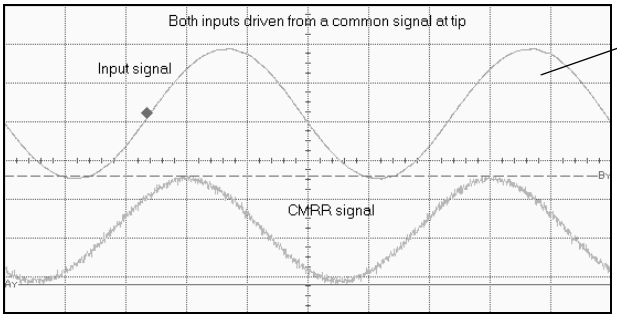
	Operating	**Non-Operating**
Use	Indoor	
Temperature	0 to 40° C	–40 to 75° C
Humidity	Up to 80% RH at 40° C	Up to 80% RH at 75° C
Altitude	Up to 4,600 meters (15,000 feet)	Up to 15,000 meters (50,000 feet)
Vibration	Random vibration 5 to 500 Hz, 10 minutes per axis, 0.3 g_{rms}	Random vibration 5 to 500 Hz, 10 minutes per axis, 2.41 g_{rms}. Resonant search 5 to 500 Hz swept sine, 1 octave/min. sweep rate, (0.75 g), 5 minutes resonant dwell at 4 resonance's per axis.
Weight	Approximately 226 g	
Dimensions	Refer to the drawing shown below	

Dimensions



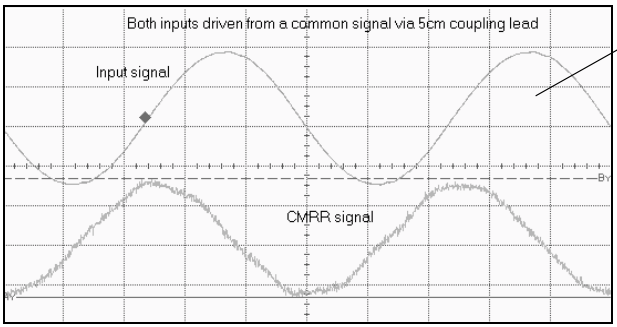
To Connect the Probe to the Circuit Under Test

The method you use to connect the probe to the circuit under test is critical for ensuring accurate measurements. The following examples examine the effect of using different lengths of wire to connect the signal source to the probe tip at 100 MHz.



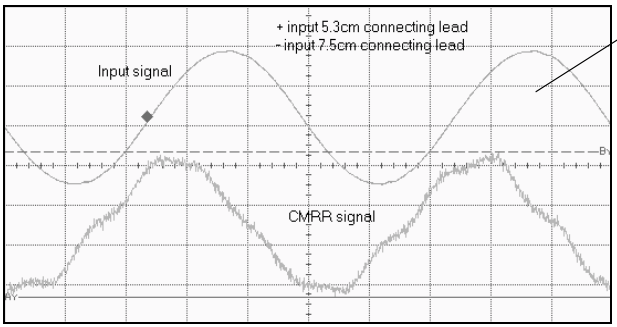
Both inputs derived from a common signal at probe tip.

CMRR = 35.6 dB



Both inputs derived from a common signal via 5 cm coupling lead.

CMRR = 35 dB



Probe coupling leads of different length. Positive input 5.3 cm. Negative input 7.5 cm.

CMRR = 33 dB

The impedance of the source

This is another instance where the symmetry of the differential circuit is important. The impedance of the source forms a network with the input impedance of the connection and the probe. This network determines the frequency response for the measurement. If each side of the differential source has a different impedance, the frequency response of each side will be different. This lack of balance is reflected in reduced CMRR. The higher the impedance of the source, the more critical these parasitic effects.

The ground connection

A poorly located ground connection allows ground loops to add to the common mode signal. The differential probe measures the potential difference between two locations on a PC board. Usually, it is not necessary to ground the probe. Whether or not to ground the probe depends on the magnitude and frequency of the voltage difference between the DCA ground and the board ground. It is good practice to maintain a board ground. Without this ground reference, you could easily exceed the common mode range of the probe.

Probe offset

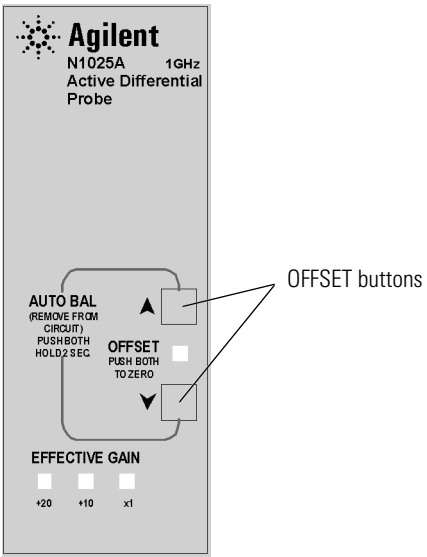
The offset can be controlled with the buttons on the front-panel of the probe. The offset can be returned to zero at any time by briefly pushing both the ↑ and ↓ OFFSET buttons at the same time. Depressing both the ↑ and ↓ OFFSET buttons for more than two seconds will initiate an AutoBalance cycle.

Moving the displayed waveform with the channel offset, rather than probe offset, will not recenter the dynamic operating range of the probe. Offsetting the trace with the DCA channel offset allows the possibility of erroneous waveforms resulting from overloading the probe.

AutoBalance

The Agilent N1025A incorporates an AutoBalance function to remove the DC offset error from the output. AutoBalance must be invoked by the user. When power is first applied, the probe will return to the internal values resulting from the last AutoBalance cycle. For AutoBalance to function properly, all signals must be removed from the input.

After 30 minutes of warm-up, or when the probe is exposed to a large shift in ambient temperature, some DC offset drift may occur from thermal effects in the amplifier circuitry. To initiate an AutoBalance cycle, remove the probe from the test circuit and then push and hold both the OFFSET buttons for two seconds.



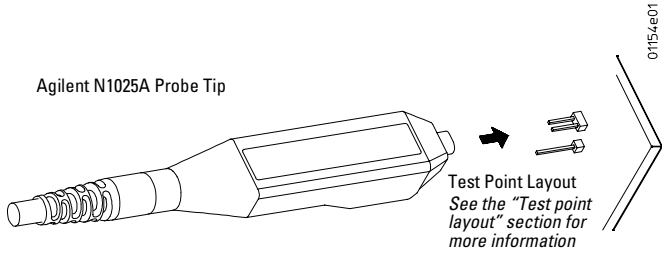
Upon successful completion of the AutoBalance cycle, all three of the `EFFECTIVE GAIN` indicators will be briefly illuminated. If an input signal is present during auto balance and the routine fails, the `EFFECTIVE GAIN` indicators will not illuminate. The probe will then revert to the offset values resulting from the last successful completion of the AutoBalance cycle. In many situations, this will be adequate to make routine measurements.

Recommended Probe Configurations

For best performance, use the following configurations. They are presented in the recommended order from the most desirable to the least.

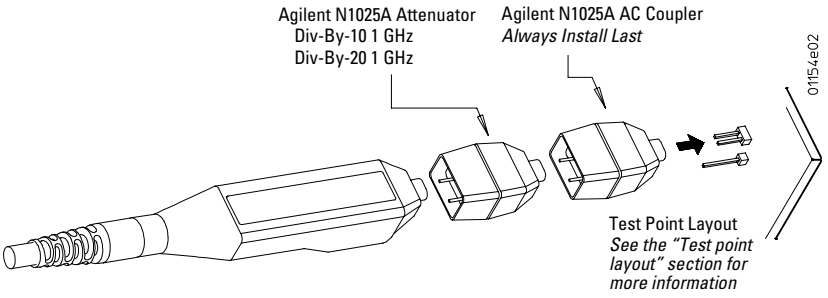
> **Note**
>
> The use of the ground connection is optional for all configurations.

Direct connection



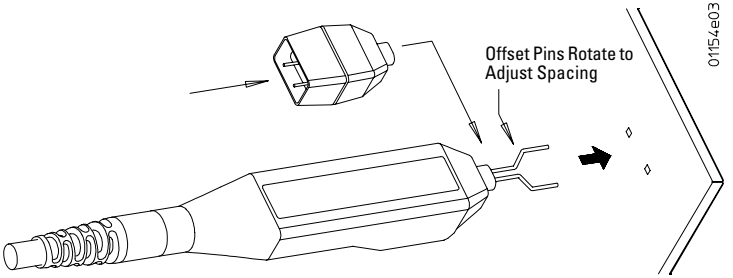
AC adapter/attenuator

Use the attenuator shipped with the probe and marked with the same serial number for accurate measurements. Do not use the attenuators with other probes.



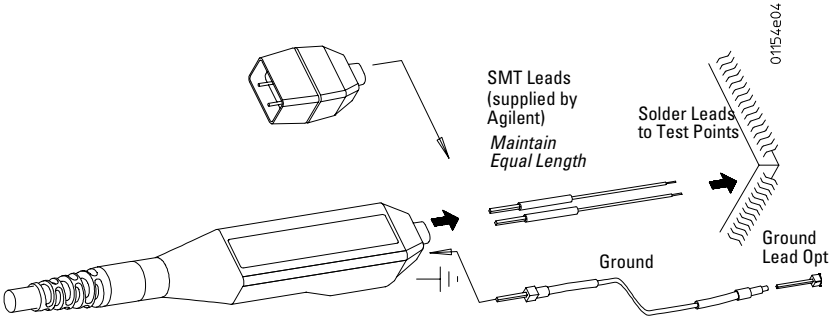
Offset pins

You may use offset pins with any of the tip adapters.



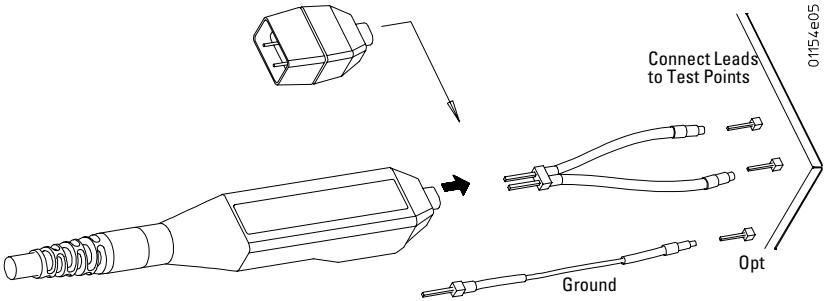
SMT lead

You may use SMT leads with any of the tip adapters.



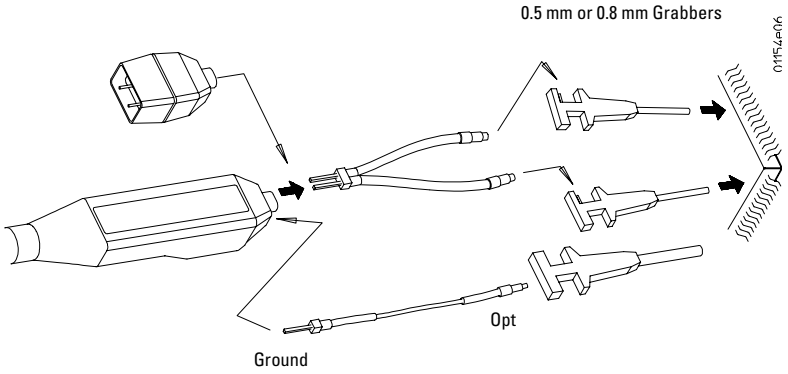
Signal leads

You may use signal leads with any of the tip adapters.

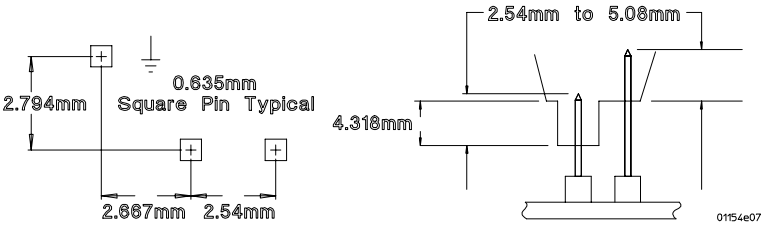


Grabbers

Using grabbers and signal leads results in significant lead length. Expect measurement quality degradation with fast signals.



Test point layout



Service

To return the Agilent N1025A 1 GHz differential probe to optimum performance requires factory repair. Return all probes to the service group for repair and calibration. If the probe is under warranty, normal warranty services apply. If the probe is not under warranty, you can exchange a failed probe for a reconditioned one at a nominal cost.

To return the probe to Agilent for service

Refer to “Agilent Technologies service offices” on page 28 for the location of your nearest Agilent Service Office.

1 Write the following information on a tag and attach it to the probe.

- Name and address of owner.
- Probe model number.
- Probe serial number.
- Description of the service required or failure indications.

2 Return the following accessories with the probe:

- Attenuators
- AC coupling adapter

Retain all other accessories.

3 Return the probe in its case or pack the probe in foam or other shock absorbing material and place it in a strong shipping container.

You can use the original shipping materials or order materials from an Agilent Sales Office. If neither are available, place 3 to 4 inches of shock-absorbing material around the instrument and place it in a box that does not allow movement during shipping.

4 Seal the shipping container securely.

5 Mark the shipping container as FRAGILE.

In all correspondence, refer to the instrument by model number and full serial number.

Agilent Technologies service offices

Before returning an instrument for service, call the Agilent Technologies Instrument Support Center at (800) 403-0801, visit the Test and Measurement Web Sites by Country page at http://www.tm.agilent.com/tmo/country/English/index.html, or call one of the numbers listed below.

Agilent Technologies Service Numbers

Austria	01/25125-7171
Belgium	32-2-778.37.71
Brazil	(11) 7297-8600
China	86 10 6261 3819
Denmark	45 99 12 88
Finland	358-10-855-2360
France	01.69.82.66.66
Germany	0180/524-6330
India	080-34 35788
Italy	+39 02 9212 2701
Ireland	01 615 8222
Japan	(81)-426-56-7832
Korea	82/2-3770-0419
Mexico	(5) 258-4826
Netherlands	020-547 6463
Norway	22 73 57 59
Russia	+7-095-797-3930
Spain	(34/91) 631 1213
Sweden	08-5064 8700
Switzerland	(01) 735 7200
United Kingdom	01 344 366666
United States and Canada	(800) 403-0801

Verifying Probe Operation

1. Set the DCA trigger to free-run mode.
2. Position the trace in the center of the display. Plug the probe output directly into any lightwave DCA input.
3. Apply a 200 mV peak-to-peak 1 kHz square wave signal to the positive input of the probe. Note that there is a 200 mV signal at the output of the probe.
4. Apply the same 200 mV signal to the negative input of the probe, while continuing to apply the signal to the positive input. Observe that there is *no* signal at the output of the probe.
5. Remove all signals from the inputs of the probe.
6. Verify the ± OFFSET buttons move the trace in both directions.
7. Verify the Offset light is illuminated.
8. Hold the two OFFSET buttons simultaneously for approximately two seconds. Verify the probe auto balances.

   Note

   If all the lights on the probe momentarily illuminate, then auto balance occurred.

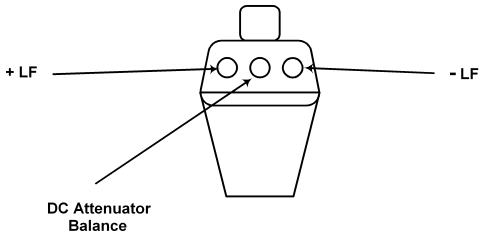
   When auto balance is complete, the Offset light goes out and the trace returns to the center of the display.

Adjustment of ÷10 and ÷20 Attenuators

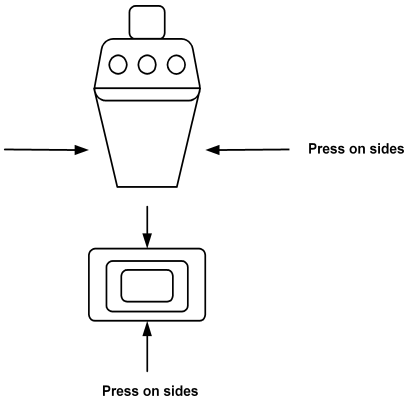
The ÷10 and ÷20 attenuators are supplied with the Agilent N1025A probe. The attenuator is matched to the probe and should require no further adjustment. Each attenuator is labeled with a serial number that matches the last four digits of the probe serial number. Identify matching probes and attenuators using this number. If you purchase new attenuators for the probe, you must adjust them to match the probe.

Optimizing CMRR for an attenuator

For optimum CMRR when the attenuator is connected to the probe, the DC and HF attenuation should be the same for both active inputs of the probe. Three trimmers are provided in the attenuator to match the two active inputs. The adjustments are located under the serial number label. Apply a new label after calibration and mark this label with the last four digits of the probe's serial number. Only adjust an attenuator if it is not the original attenuator shipped with the probe.



The attenuator's plastic covers may be removed. Take care not to damage the probe attenuator pins.



The ÷10 attenuator adjustment procedure

Use the following steps to adjust the ÷10 attenuators.

1 Connect the probe to the DCA as shown in Figure 5-1.

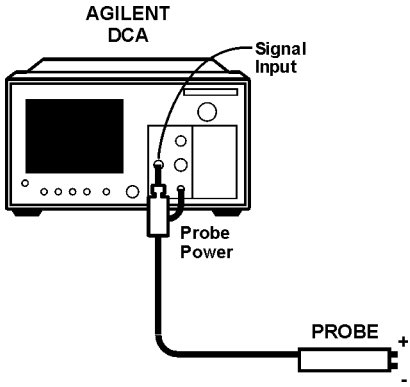


Figure 5-1. AutoBalancing the probe.

2 Turn on the test equipment.

Allow 30 minutes for the probe to warm up.

3 Place the ÷10 attenuator on the Agilent N1025A probe.

Do not connect a signal to the probe at this time.

4 AutoBalance the probe by pushing and holding both the OFFSET buttons for two seconds.

Upon successful completion of the AutoBalance cycle, all three of the `EFFECTIVE GAIN` indicators will be briefly illuminated.

5 Connect the Agilent N1025A probe as shown in Figure 5-2.

Use the clips to make these connections. The frequency being considered has a fundamental of 5 kHz. Connect the + input of the probe to the output of the function generator. Connect the – input to ground with the probe ground socket.

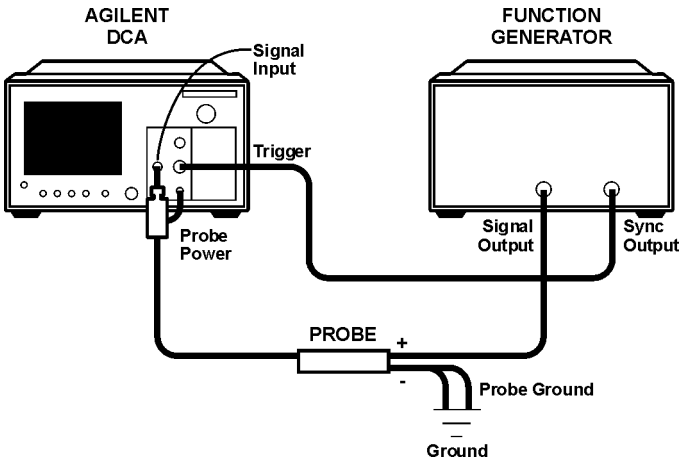


Figure 5-2. The ÷10 attenuator adjustment setup.

6 Set the function generator as shown in the following table.

Use a function with a flat top for this test.

Setting	Value
Square Wave Output Amplitude	1 V
Frequency	5 kHz
Offset	0

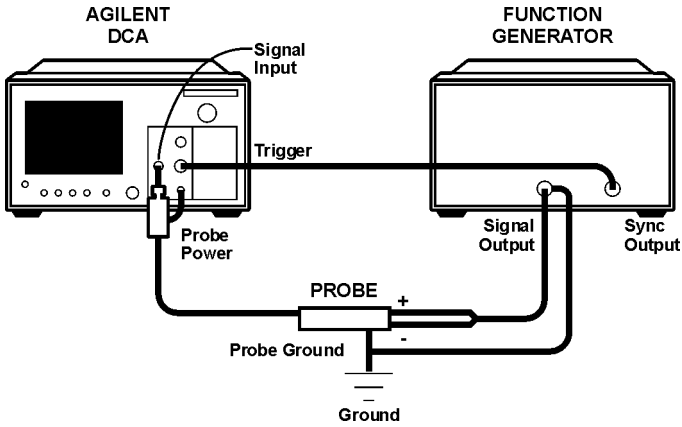
7 Set the DCA time base to 50 µs/div.

8 Use the square head trimmer tool to adjust the + LF comp to achieve the best square corner and flat top of the displayed waveform.

Adjust the compensation to achieve the best waveform characteristics when you remove the tool.

9 Connect the + and – probe inputs to the function

generator output while the probe ground is connected.



10 Set the function generator to 50 Hz and the output to 10 V amplitude.

11 Set the DCA time base to 5 mS/div.

12 Set CH1 sensitivity to maximum.

13 Adjust DC Att. Balance for the minimum square wave amplitude.

The phase of the signal will change by 180° as you adjust the balance control through zero.

14 Set the function generator to 5 kHz and amplitude to 1 V_{pp}.

15 Connect the – Probe input to the output of the function generator and the + input to the ground.

Maintain the probe ground.

16 Press Auto Scale.

17 Use the square head trimmer tool to set the + LF compensation for a minimum of overshoot and undershoot at the leading edge of the waveform.

Adjust the compensation to achieve the best waveform characteristics when you remove the tool.

18 Set the DCA time base to 50 µs/div

19 Connect the probe + and – inputs to the function generator output.

20 Set the amplitude of the function generator to 10 V and the frequency to 5 kHz.

21 Set the DCA sensitivity to maximum.

22 Use the square head trimmer tool to adjust the – LF compensation for minimum signal amplitude.

It is not possible to make the trace completely flat.

The ÷20 attenuator adjustment procedure

Use the procedure described in the previous section to adjust the ÷20 attenuator, but use twice the DCA sensitivity.

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.
Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product:

Product Name: 1 GHz Active Differential Probe

Model Number: N1025A

Product Options: This declaration covers all options of the above product.

Is in conformity with:

Safety: IEC 61010-1:1990 +A1:1992+A2:1995 / EN 61010-1:1994+A2:1995
CAN/CSA-C22.2 No. 1010.1-92

EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995, 4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995, 3 V/m, 80-1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995, 0.5 kV sig. lines, 1 kV pow. lines
IEC 61000-4-5:1995 / EN 61000-4-5:1995, 0.5 kV l-l, 1 kV l-e
IEC 61000-4-6:1996 / EN 61000-4-6:1996, 3V 80% AM, power line
IEC 61000-4-11:1994 / EN 61000-4-11:1994, 100 %, 20 ms

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly. This product was tested with Agilent Technologies products.

Santa Rosa, CA, USA 9 May 2000

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.