



# N2870A Series Passive Probes

## User's Guide



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# Contents

Inspecting the Probe	3
Cleaning the Probe	3
Handling the Probe	3
Introduction	4
Models	5
Standard Accessories	6
Characteristics and Specifications	7
Safety Information	11
Adjustment Procedures - Using the Trimmer Tool	12
Accessories	14

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## Inspecting the Probe

- ❑ Inspect the shipping container for damage.

Keep the damaged 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.

- If the contents are incomplete or damaged, notify your Agilent Technologies Sales Office.

- ❑ Inspect the instrument.

- If there is mechanical damage or defect, or if the probe does not operate properly or pass calibration 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. The Agilent Technologies office will arrange for repair or replacement at Agilent Technologies' option without waiting for claim settlement.

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## Cleaning the Probe

Disconnect the probe and clean it with a soft cloth dampened with a mild soap and water solution. Make sure the probe is completely dry before reconnecting it to an oscilloscope.

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## Handling the Probe



Handle the probe with care to avoid injury, especially when it is fitted with the extra thin and sharp spring contact tip. Note that the probe cable is a sensitive part of the probe and, therefore, you should be careful not to damage it through excessive bending or pulling. You should also avoid any mechanical shocks to this product in order to guarantee accurate performance and protection.

### N2870A Passive Probes

When used with an Agilent oscilloscope, the N2870A Series passive probe family sets a new standard for “high performance” probing of up to 1.5 GHz. These seven general purpose probes and accessories are a great choice if you are looking for high quality at a very reasonable price.

#### **Faithful Reproduction of Signals**

The N2870A Series passive probes offer bandwidths of 35 MHz, 200 MHz, 350 MHz, 500 MHz, and 1.5 GHz along with various attenuation ratios to address a wide range of measurement needs. For general purpose probing, the N2873A's superior 10 M $\Omega$  input resistance, 9.5 pF of low input capacitance, and low inductance ground connection keep probe loading low enough to achieve high signal integrity measurements. The 1.5 GHz passive probe offers an even lower input capacitance for measuring faster edges more accurately, making it a good low-cost alternative to an active probe.

All N2870A Series probes come with the probe ID readout feature that allows the probe to automatically be recognized when connected to Agilent InfiniiVision and Infiniium Series oscilloscopes.

#### **Easy Access to Signals**

The compact design along with a 2.5 mm probe tip diameter provide better visibility of the circuit under test when compared to the conventional 5 mm or 3.5 mm probes. This makes it easier to probe today's fine pitched ICs and components. The probe comes with two varieties of replaceable tips: rigid or spring loaded (see image below). The replaceable spring tip is spring loaded which keeps it from slipping off of the device being probed. Additionally, the probes come with standard accessories to make probing even easier (see pages 6 and 16 for details). For a broader range of useful accessories, you can also order several different accessory kits (see page 14).



## Models

The following models are part of the N2870A Series.

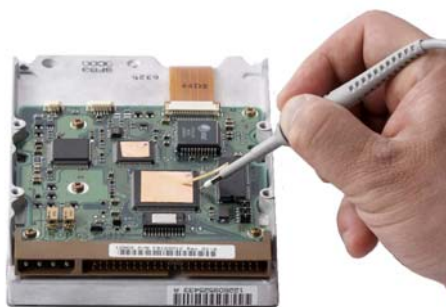
Model	Bandwidth (-3 dB)	Attenuation Ratio <sup>1</sup>	Input C (+scope)	Input R <sup>1</sup> (scope + probe)	Max Input Voltage (AC RMS)	Scope Input Coupling	Scope Comp Range
N2870A	35 MHz	1:1	39 pF	1 M $\Omega$	55 V CAT II	1 M $\Omega$	-
N2871A	200 MHz	10:1	9.5 pF	10 M $\Omega$	400 V CAT I* 300 V CAT II**	1 M $\Omega$	10 - 25 pF
N2872A	350 MHz	10:1	9.5 pF	10 M $\Omega$	400 V CAT I* 300 V CAT II**	1 M $\Omega$	10 - 25 pF
N2873A	500 MHz	10:1	9.5 pF	10 M $\Omega$	400 V CAT I* 300 V CAT II**	1 M $\Omega$	10 - 25 pF
N2874A	1.5 GHz	10:1	2 pF	500 $\Omega$	8.5 V CAT I***	50 $\Omega$	-
N2875A	500 MHz	20:1	5.6 pF	20 M $\Omega$	400 V CAT I* 300 V CAT II**	1 M $\Omega$	7-20 pF
N2876A	1.5 GHz	100:1	2.6 pF	5 k $\Omega$	21 V CAT I***	50 $\Omega$	-

<sup>1</sup>Denotes warranted specs, all others are typical (attenuation ratio:  $\pm 2\%$  at DC; Input R (probe only, N2870A excluded):  $\pm 1\%$ )

\* Measurement Category I, 1250 V transient overvoltage

\*\* Measurement Category II

\*\*\* Measurement Category I, 0 V transient overvoltage



### Probe Accessories Supplied


The following table shows the standard accessories supplied with each of the N2870A Series probes. There are some minor differences in the standard accessories supplied depending on the exact probe model you have so the table below also specifies which accessories are included with which model. Some of these accessories are discussed in greater detail starting on page 16.

Accessory	Quantity	N2871A, N2872A, N2873A, N2875A	N2870A	N2874A, N2876A
Spring-loaded probe tips	2	◆	◆	◆
Rigid probe tips	2	◆	◆	◆
Ground blade 2.5 mm	1	◆	◆	◆
Ground spring 2.5 mm	1	◆	◆	◆
Sprung hook 2.5 mm	1	◆	◆	
Short sprung hook 2.5 mm	1			◆
Ground lead 15 cm	1	◆	◆	◆
Copper pads	2	◆	◆	◆
IC cap 2.5 - 0.5 mm green	1	◆	◆	◆
IC cap 2.5 - 0.65 mm blue	1	◆	◆	◆
IC cap 2.5 - 0.8 mm grey	1	◆	◆	◆
IC cap 2.5 - 1.0 mm brown	1	◆	◆	◆
IC cap 2.5 - 1.27 mm black	1	◆	◆	◆
BNC adapter 2.5 mm	1	◆	◆	◆
Insulating cap 2.5 mm	1	◆	◆	◆
Protection cap 2.5 mm	1	◆	◆	◆
Trimmer tool	1	◆		
Color coding rings	3x4 colors	◆	◆	◆
User's Guide	1	◆	◆	◆

## Characteristics and Specifications

Characteristics and specifications for the N2870A Series Passive Probes are shown below. The probe / oscilloscope should be warmed up for at least 20 minutes before any testing and the environmental conditions should not exceed the probe's specified limits.

### Electrical Characteristics

Attenuation ratio <sup>1</sup>	N2870A: 1:1 N2871A: 10:1 N2872A: 10:1 N2873A: 10:1 N2874A: 10:1 N2875A: 20:1 N2876A: 100:1
Bandwidth (-3 dB)	N2870A: 35 MHz N2871A: 200 MHz N2872A: 350 MHz N2873A: 500 MHz N2874A: 1.5 GHz N2875A: 500 MHz N2876A: 1.5 GHz
Probe Risetime (10%-90%)	N2870A: 10 ns N2871A: 1.4 ns N2872A: 1.0 ns N2873A: 700 ps N2874A: 240 ps N2875A: 700 ps N2876A: 240 ps
 Maximum Rated Input Voltage	N2870A: 55 V CAT II N2871A: 400 V CAT I*, 300 V CAT II** N2872A: 400 V CAT I*, 300 V CAT II** N2873A: 400 V CAT I*, 300 V CAT II** N2874A: 8.5 V CAT I*** N2875A: 400 V CAT I*, 300 V CAT II** N2876A: 21 V CAT I***
Input Resistance <sup>1</sup> (scope + probe)	N2870A: 1 MΩ N2871A: 10 MΩ N2872A: 10 MΩ N2873A: 10 MΩ N2874A: 500 Ω N2875A: 20 MΩ N2876A: 5 KΩ

## Characteristics and Specifications

Input Capacitance (system)	N2870A: 39 pF (+ scope)
	N2871A: 9.5 pF
	N2872A: 9.5 pF
	N2873A: 9.5 pF
	N2874A: 2 pF
	N2875A: 5.6 pF
Compensation Range	N2876A: 2.6 pF
	N2870A: -
	N2871A: 10 - 25 pF
	N2872A: 10 - 25 pF
	N2873A: 10 -25 pF
	N2874A: -
Input Coupling of the Measuring Instrument	N2875A: 7 - 20 pF
	N2876A: -
	N2870A: 1 M $\Omega$
	N2871A: 1 M $\Omega$
	N2872A: 1 M $\Omega$
	N2873A: 1 M $\Omega$
	N2874A: 50 $\Omega$
	N2875A: 1 M $\Omega$
	N2876A: 50 $\Omega$

\* Measurement Category I, 1250 V transient overvoltage, \*\* Measurement Category II

\*\*\*Measurement Category I, 0 V transient overvoltage

<sup>1</sup>Warranted Specification (attenuation ratio:  $\pm 2\%$  at DC; input R (probe only, N2870A excluded):  $\pm 1\%$ )

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### Mechanical Characteristics

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Weight (probe only)	48 g
Cable Length	1.3 m
Probe Barrel Diameter	2.5 mm

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### Environmental Specifications

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Temperature	Operating: 0 °C to +50 °C
	Nonoperating: -40 °C to +70 °C
Altitude	Operating: 2,000 m (6,561 ft)
	Nonoperating: 15,000 m (49,212 ft)
Humidity	Operating: 80% room humidity for temperatures up to 31 °C, decreasing linearly to 40% at 50 °C
	Nonoperating: 95% room humidity for temperatures up to 40 °C
Pollution Degree	Pollution Degree 2



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**Safety Specifications**

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Low Voltage Directive

2006/95/EC

CEI/IEC 61010-031:2008-08



**Typical Voltage Derating for Each Probe Model (Measurement Category I)**

Note that the maximum input voltage rating of the probe decreases as the frequency of the applied signal increases.

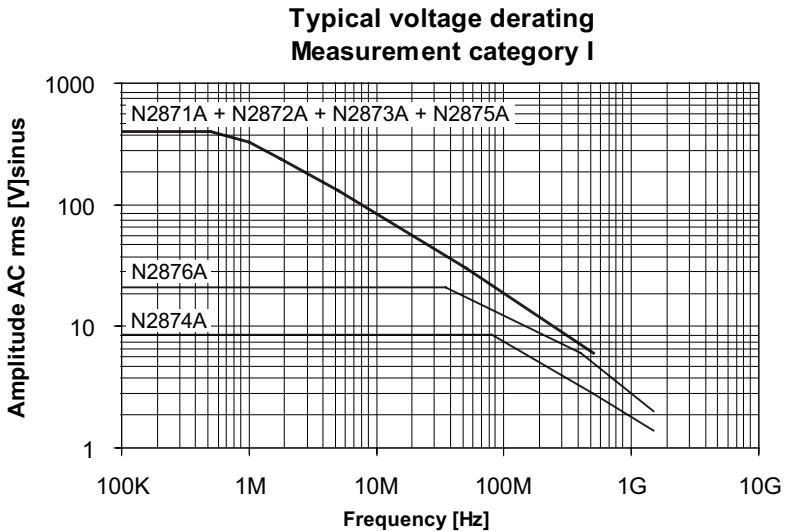


Figure 1

Typical Voltage Derating plot



Refer to the oscilloscope documentation for the oscilloscope's acceptable input range and do not exceed this limit when using N2870A Series probes.

## Characteristics and Specifications

### Typical Input Impedance for Each Probe Model



Note that the input impedance of the probe decreases as the frequency of the applied signal increases.

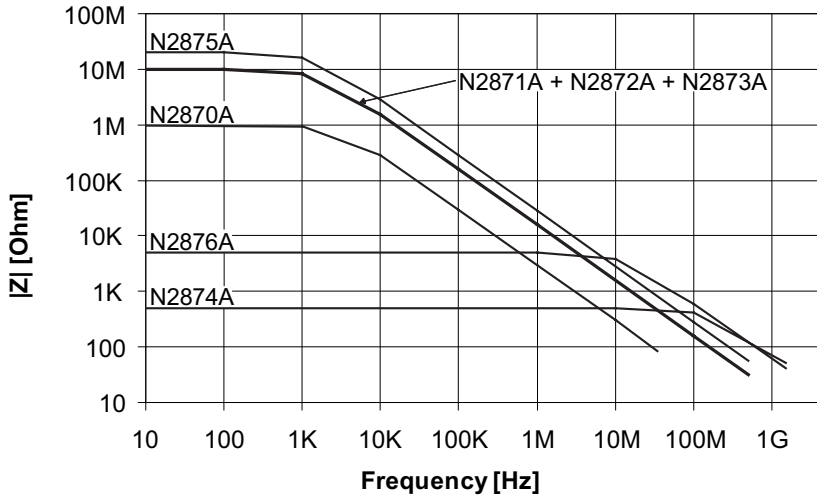


Figure 2

Typical input impedance

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## Safety Information

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### Warning



To avoid personal injury and to prevent fire or damage to this product or products connected to it, review and comply with the following safety precautions. Be aware that if you use this probe assembly in a manner not specified, the protection this product provides may be impaired.

#### **Handle Probe Tips / Accessories Carefully**

Some of the probe tips / accessories are very sharp (the spring tips and ground spring, for example). You should handle these with care to avoid personal injury.

#### **Use Only Grounded Instruments**

Do not connect the probe's ground lead to a potential other than earth ground. Always make sure the probe and the oscilloscope are grounded properly.

#### **Connect and Disconnect Properly**

Connect the probe to the oscilloscope and connect the ground lead to earth ground before connecting the probe to the circuit under test. Disconnect the probe input and the probe ground lead from the circuit under test before disconnecting the probe from the oscilloscope.

#### **Observe Probe Ratings**

Do not apply any electrical potential to the probe input which exceeds the maximum rating of the probe. Make sure to comply with the voltage versus frequency derating curve on page 9.

#### **Keep Away From Live Circuits**

Avoid open circuitry. Do not touch connections or components when power is present.

#### **Indoor Use Only**

Do not operate in wet/damp environments. Keep product surfaces dry and clean.

#### **Do Not Operate With Suspected Failures**

Refer to qualified service personnel.

#### **Do Not Operate in an Explosive Environment**



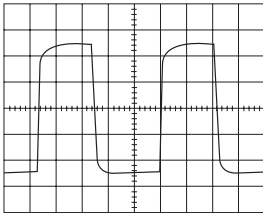
## Adjustment Procedures - Using the Trimmer Tool

The N2871A, N2872A, N2873A, and N2875A can be adjusted for low frequency (LF) compensation. The N2870A, N2874A, and N2876A cannot be adjusted.

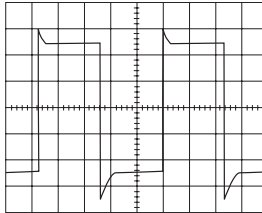
### LF Compensation

LF needs to be adjusted when the probe is connected to an oscilloscope input for the first time. LF compensation matches the probe cable capacitance to the oscilloscope input capacitance. This matching assures good amplitude accuracy from DC to the upper bandwidth limit frequencies. A poorly compensated probe clearly influences the overall system performance (probe + oscilloscope) and introduces measurement errors resulting in inaccurate readings and distorted waveforms.

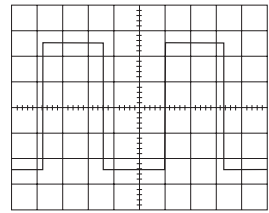
LF compensation is performed by connecting the probe to the Cal output on the oscilloscope front panel (a square wave label is usually seen near this output) and adjusting the LF compensation using the trimmer tool to an optimum square wave response. Below are a series of plots showing an undercompensated waveform, an overcompensated waveform, and the optimum waveform.



**Undercompensated**



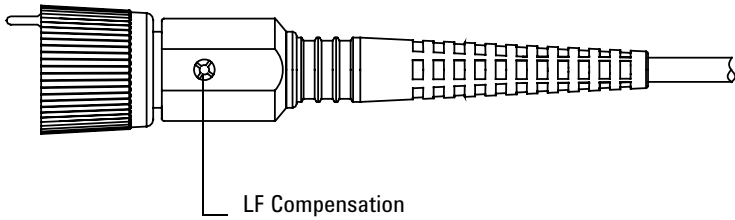
**Overcompensated**



**Optimum**

## Adjustment Procedures - Using the Trimmer Tool

The pictures below show where to insert the trimmer tool so you can rotate it clockwise / counterclockwise until the optimum waveform is displayed.



## Accessories

The table below shows all of the optional accessories as well as which accessory kit(s) they are included with. To see the list of standard accessories that are included with each probe, please refer to the table on page 6.

Optional Accessory	Quantity	N2877A Deluxe Kit	N2879A Fine Pitch Kit	N2878A General Purpose Kit	N2885A PCB Socket Adapter Kit
IC Cap 2.5 - 0.5 green	3 - N2877A, N2879A 1 - N2878A	◆	◆	◆	
IC Cap 2.5 - 0.65 blue	3 - N2877A, N2879A 1 - N2878A	◆	◆	◆	
IC Cap 2.5 - 0.8 grey	3 - N2877A, N2879A 1 - N2878A	◆	◆	◆	
IC Cap 2.5 - 1.9 brown	3 - N2877A, N2879A 1 - N2878A	◆	◆	◆	
IC Cap 2.5 - 1.27	3 - N2877A, N2879A 1 - N2878A	◆	◆	◆	
Insulating Cap 2.5 mm	1	◆	◆	◆	
Protection Cap 2.5 mm	1	◆	◆	◆	
Bernstein Adjustment Tool	1	◆			
HF Compensated Ground Lead 22 cm	1	◆			
Ground Lead 22 cm to 4 mm banana plug	1	◆			
Ground Lead 22 cm to 2 mm banana plug	1	◆			
Ground Lead 11 cm to miniclip	1	◆			
Ground Lead 11 cm to 0.8 mm socket	1	◆			
Ground Spring 2.5	3	◆	◆		
Self-adhesive Cu-pads (2x2 cm)	10	◆	◆	◆	
Ground Blade 2.5	3 - N2877A, N2879A 1 - N2878A	◆	◆	◆	

Optional Accessory	Quantity	N2877A Deluxe Kit	N2879A Fine Pitch Kit	N2878A General Purpose Kit	N2885A PCB Socket Adapter Kit
Ground Lead 2.5 to mini Alligator Clip	1	◆			
Ground Lead 2.5 to 0.8 mm socket	1	◆			
Set of 5 Spring Tips Gold-plated 0.5 mm	1	◆	◆	◆	
Set of 5 Solid Tips CuBe 0.5 mm	1	◆	◆	◆	
Adapter 2.5 to 2 mm banana plug	1	◆			
Adapter 2.5 to 0.8 mm socket	1	◆			
Dual Adapter 2.5 to 0.8 mm sockets	2	◆	◆		
Sprung Hook 2.5 mm	1	◆		◆	
Short Sprung Hook 2.5 mm	1	◆			
Adapter 2.5 to 4 mm banana plug		◆			
Pico Hook black	2	◆	◆		
Pico Hook red	2	◆	◆		
BNC Adapter 2.5	1	◆		◆	
PCB Adapter Kit 2.5 mm	Refer to number in ( )	◆(1)	◆(10)		◆(25)
QFP IC-Clips 13 mm long down o 0.5 mm pitch (1 pair yellow/green)	2	◆	◆		
QFP IC-Clips short down to 0.5 mm pitch (1 pair yellow/green)	2	◆	◆		
Ground Lead 15 cm	1	◆		◆	
Color Coded Rings	3x4 colors	◆		◆	
2-leg Probe Positioner	1	◆	◆		
Micro SMD Clip	1 - N2877A 2 - N2879A	◆	◆		

## Accessories

Below is some information regarding some of the standard accessories shipped with the N2870A Series probes.

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### Replacing Rigid/Solid Probe Tips and Spring-Loaded Probe Tips



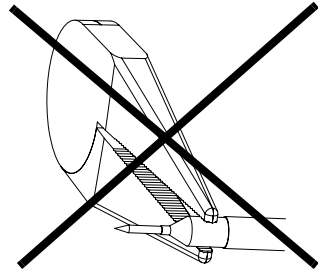
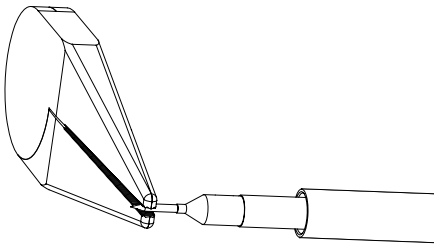
These solid tips and spring-loaded tips are replaceable. To change the probe tip, use pliers to grip the tip and pull it straight out of its contact socket along the axis of the probe. Do not grip the plastic insulator or the housing with the pliers because the tip could be crushed (see images below). This could result in being unable to remove the tip and/or damaging the probe. Once the probe tip is removed, the new tip can be inserted with pliers into the contact socket along the axis of the probe. In order to insert the probe tip completely into the housing, carefully press the probe tip against a hard surface.

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#### Warning



You should exercise caution when using these sharp probe tips to avoid personal injury.



Spring loaded probe tips offer a method of probing signals that is less susceptible to vibration or movement than traditional rigid tips. Many users find it easier to use this type of tip. The spring loaded tips work when they are either partially or fully compressed and are protected against over compression damage.



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## Short Ground Blade / Ground Spring



The short ground blade is the best performing ground connection available with the N2870A Series due to its low inductance. To attach the ground blade, simply push it over the probe tip and continue pushing until the blade is inserted into the notch located on the probe barrel (as shown in the picture below - Note that the ground blade was placed over the tip and then an IC cap was placed over it as well in the picture).

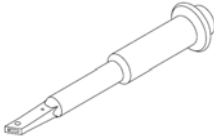


This will keep it from spinning around on the probe while in use. You can also bend and form the blade to reach your grounding location.

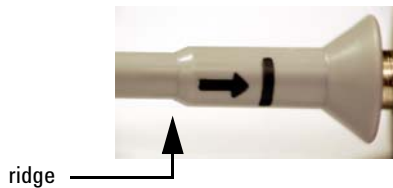
The ground spring offers similar performance as the ground blade and depending on the probing situation, may offer greater flexibility when making a ground connection. The ground spring is also inserted over the probe tip in a similar manner. It is mainly used for browsing as it is flexible and snaps back to original orientation (unlike the ground blade that you can form) which allows you to connect it to your grounding location and then move the probe tip around. It does have a slightly larger inductance than the ground blade which may result in some decrease in performance depending on the application.

---

## Sprung Hooks



You will see a grey line (shown as black in the picture below) with an arrow pointing towards it on the barrel of your N2870A Series probe.



This is used as a marker to tell you when you have pushed the sprung hook completely onto the probe. When inserting the sprung hook onto the probe barrel, push until you feel it lock onto the ridge (see picture above). If you do not push the sprung hook to this point so it can engage and “lock on” to the probe, the accessory may fall off or suffer a decrease in performance. If the sprung hook is correctly attached then the grey marking line should be covered when the hook is fully extended.

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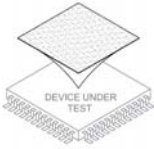
## 15 cm Ground Lead



This ground lead can be used to reach grounding locations that are farther away from the probing location than can be reached by either the ground blade or ground spring. However, the longer lead means it has a larger inductance in the ground return path which corresponds to a lower performance than these other two grounding accessories.

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## Copper Pads



These self adhesive copper pads can be attached on top of an IC and connected to its ground pins to create a convenient ground plane for the probe to connect to. When used with the ground blade, this method provides an ideal ground connection for probing signals with high frequency content. However, to maximize the performance of this setup, you need to connect the copper pad to as many grounding locations as possible.



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## IC Caps

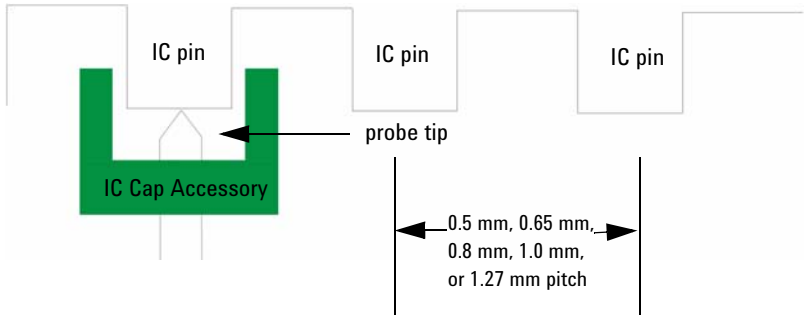


The IC caps fit over the probe tip and provide a convenient self-aligning connection to IC pins. This helps maintain contact on small fine pitch legs and prevents shorting adjacent pins by preventing the probe tip from sliding between the legs of the component.



## Accessories

The different colored IC caps correspond to different pitches (see diagram below to see how pitch is measured and refer to the table on page 6 to see what pitch each color corresponds to). The IC caps are compatible with both the rigid and spring loaded tips. Below is a simplified drawing showing how the caps fit around the IC pins and where the probe tip comes through the cap.



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## Insulator Cap



This cap is meant to fit over the probe tip and cover the ground barrel of the probe, covering any potential shorting locations near the tip. This enables you to probe in hot environments without having to worry about shorts.

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## BNC Adapter



Both the rigid and spring-loaded probe tips are compatible with this adapter.

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## Color Coding Rings



The color coding rings that can be used to keep track of which probe is connected to which channel input on your oscilloscope. Place one ring on the probe cable near the oscilloscope input and place another ring of the same color near the probe head. This ensures that you can pick up a probe and immediately know which channel it is connected to without having to track the cable back to the oscilloscope channel input.

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## PCB Adapter Kit

The PCB Adapter Kit is not included in the Standard Accessories. However, the PCB Adapter Kit does not include its own documentation so its features will be documented in this User's Guide.

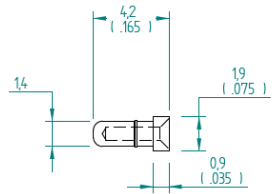
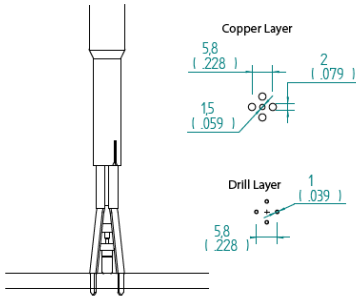
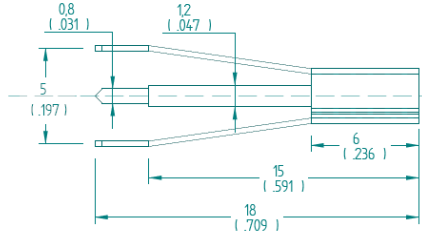
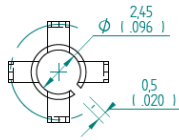


The PCB Adapter sockets are designed to solder into a printed circuit board (PCB) as test points to minimize ground inductance and maximize signal fidelity. Below is a picture showing one of these PCB sockets attached to a PCB.



## Accessories

The recommended PCB layout is shown below. The PCB socket is compatible with hand soldering and reflow processes. After soldering the socket - both the signal contact and ground contact - to the board, simply insert the probe. The PCB adapter is compatible with either the rigid or spring-loaded probe tip.





**Accessories**



# Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

## Warnings

- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not use the instrument in a manner not specified by the manufacturer.

## Safety Symbols



**Instruction manual symbol:** the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product or personal injury.



**Hazardous voltage symbol.**



**Earth terminal symbol:** Used to indicate a circuit common connected to grounded chassis.

# Notices

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Manual Part Number  
N2876-97000, April 2009

Print History  
N2876-97000, April 2009

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**Agilent Technologies**

Agilent Technologies, Printed in Germany April 2009  
Manual Part Number: N2876-97000

