Keysight N2830/1/2A and N7000/1/2/3A InfiniiMax III+ Probes

KEYSIGHT TECHNOLOGIES

User's Guide

Notices

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

1 Using InfiniiMax III+ Series Probes

This user's guide covers the N2830/1/2A and N7000/1/2/3A InfiniiMax III+ series differential probes that are shown in Figure 1.

Figure 1 InfiniiMax III+ Series Probes

Inspecting the Probe and Its Accessories

The N2830/1/2A and N7000/1/2/3A InfiniiMax III+ probes are shipped with a case, calibration information, probe handling guide, and probe information card that are shown in Figure 2 on page 7 or Figure 3 on page 8. Most, but not all, of the shipped items are shown in these figures. After opening the case, lift out the foam cutout and flip the cutout over to reveal an calibration envelope and a handling guide.

When you receive your probe, check the following items:

- 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 Keysight Technologies Sales Office.
- Inspect the probe. If there is mechanical damage or defect, or if the probe does not operate properly or pass calibration tests, notify your Keysight Technologies Sales Office.

If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier as well as your Keysight Technologies Sales Office. Keep the shipping materials for the carrier's inspection. The Keysight Technologies office will arrange for repair or replacement at Keysight Technologies' option without waiting for claim settlement.

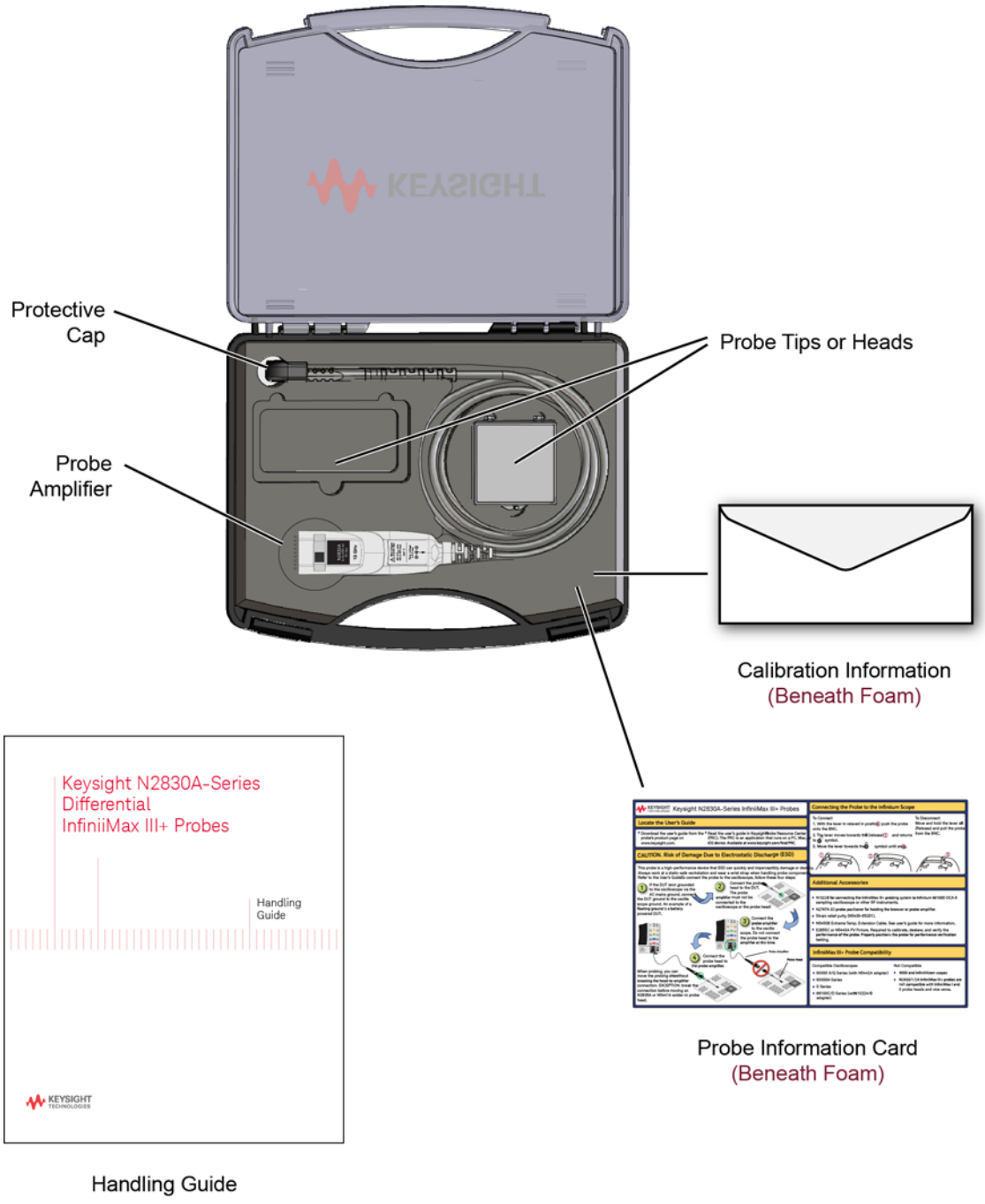


Figure 2 N2830A-Series Probe and Accessories in Supplied Case

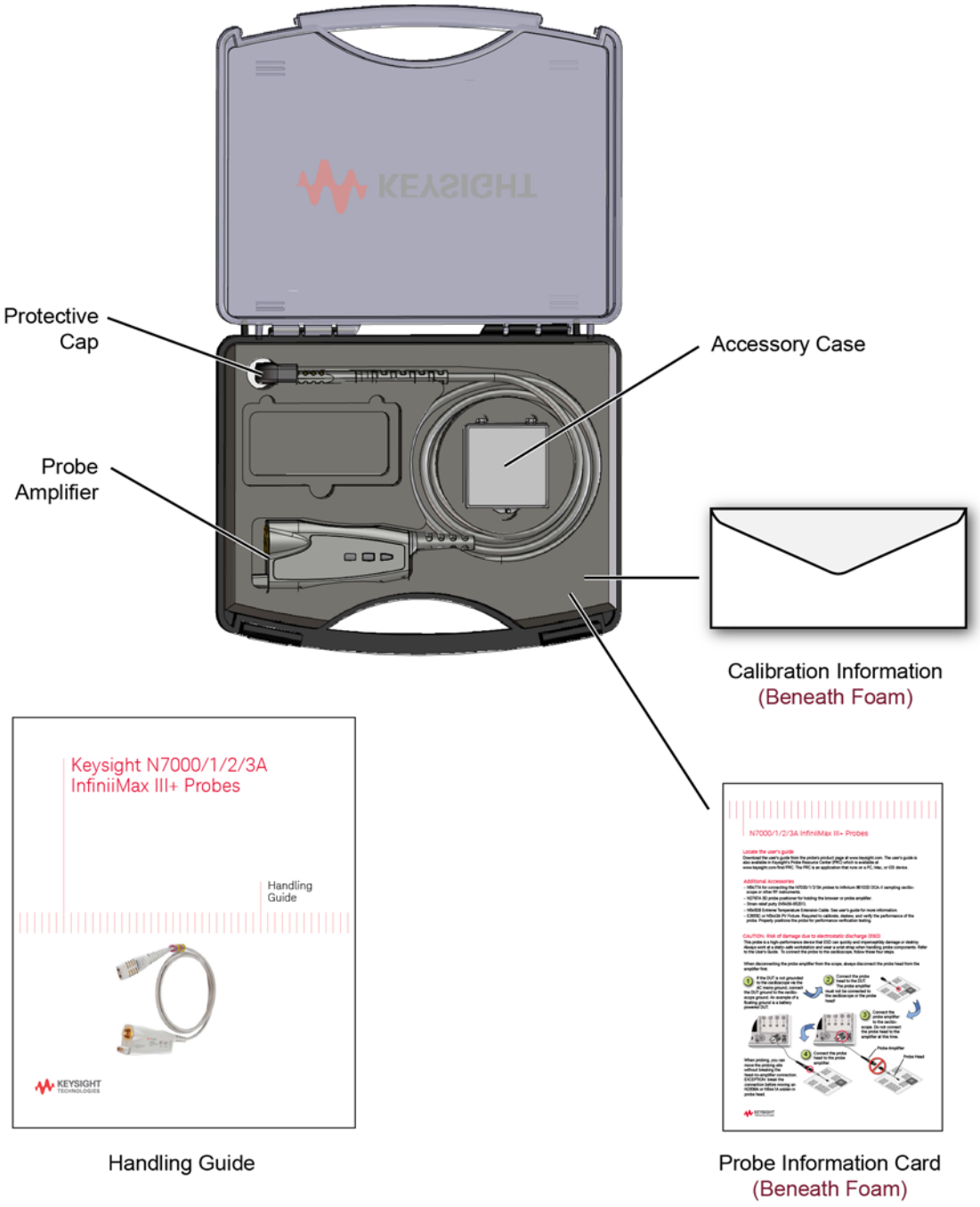


Figure 3 N7000A-Series Probe and Accessories in Supplied Case

Introduction

The InfiniiMax III and III+ Probing System Family Diagram, Figure 4 on page 10, shows compatible oscilloscopes, probes, and probe heads. The N2830/1/2A probes connect to the oscilloscope using a precision-BNC connection (AutoProbe 1). The N7000/1/2/3A probes connect to the oscilloscope using a 3.5 mm connection (AutoProbe 2). Figure 5 on page 11 and Figure 6 on page 12 identify most of the probe parts.

Table 1 Probe Bandwidths

AutoProbe 1 (Precision BNC) Scope Connection		AutoProbe 2 (3.5 mm) Scope Connection	
Probe	**Bandwidth**	**Probe**	**Bandwidth**
N2832A	13 GHz	N7003A	20 GHz
N2831A	8 GHz	N7002A	16 GHz
N2830A	4 GHz	N7001A	13 GHz
		N7000A	8 GHz

Both the InfiniiMax III+ N2830/1/2A and N7000/1/2/3A probes support InfiniiMode when using the N2848A QuickTip probe head, N2836A Solder-in head or N5444A 2.92 mm/SMA head. InfiniiMode allows you to switch between differential, single-ended, and common mode measurements without needing to change or reconnect the probe or probe leads. Switching measurements is accomplished using the oscilloscope's probe configuration dialog box. For more information, refer to "To Use InfiniiMode" on page 22.

WARNING **Before using the probe, refer to "Safety Information" on page 34.**

Probe heads

Before you can use the probe, you must connect one of the available probe heads that are shown in Figure 4 on page 10 and documented in Chapter 2, "Using InfiniiMax III+ Probe Heads". These probe heads are also compatible with the InfiniiMax III N2800A-series probes.

CAUTION **Before using the probes, refer to "To Avoid Damaging the Probe" on page 16.**

Differential probe heads offer easy measurement of differential signals and greatly improve the measurement of single-ended signals. Single-ended probe heads offer extremely small size for probing single-ended signals in confined spaces.

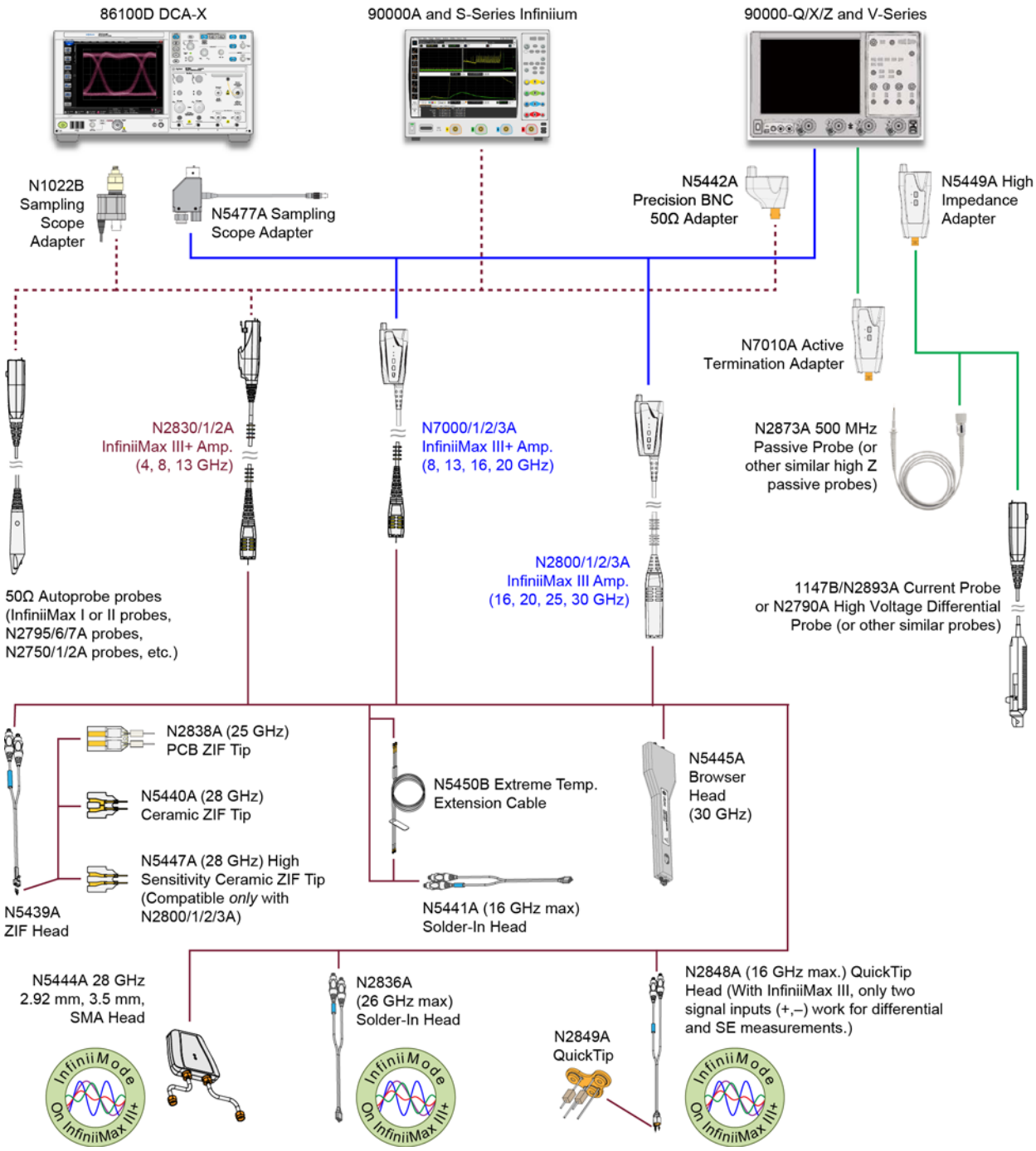


Figure 4 InfiniiMax III and III+ Family Diagram with Compatible Scopes and Probe Heads (*not to scale*)

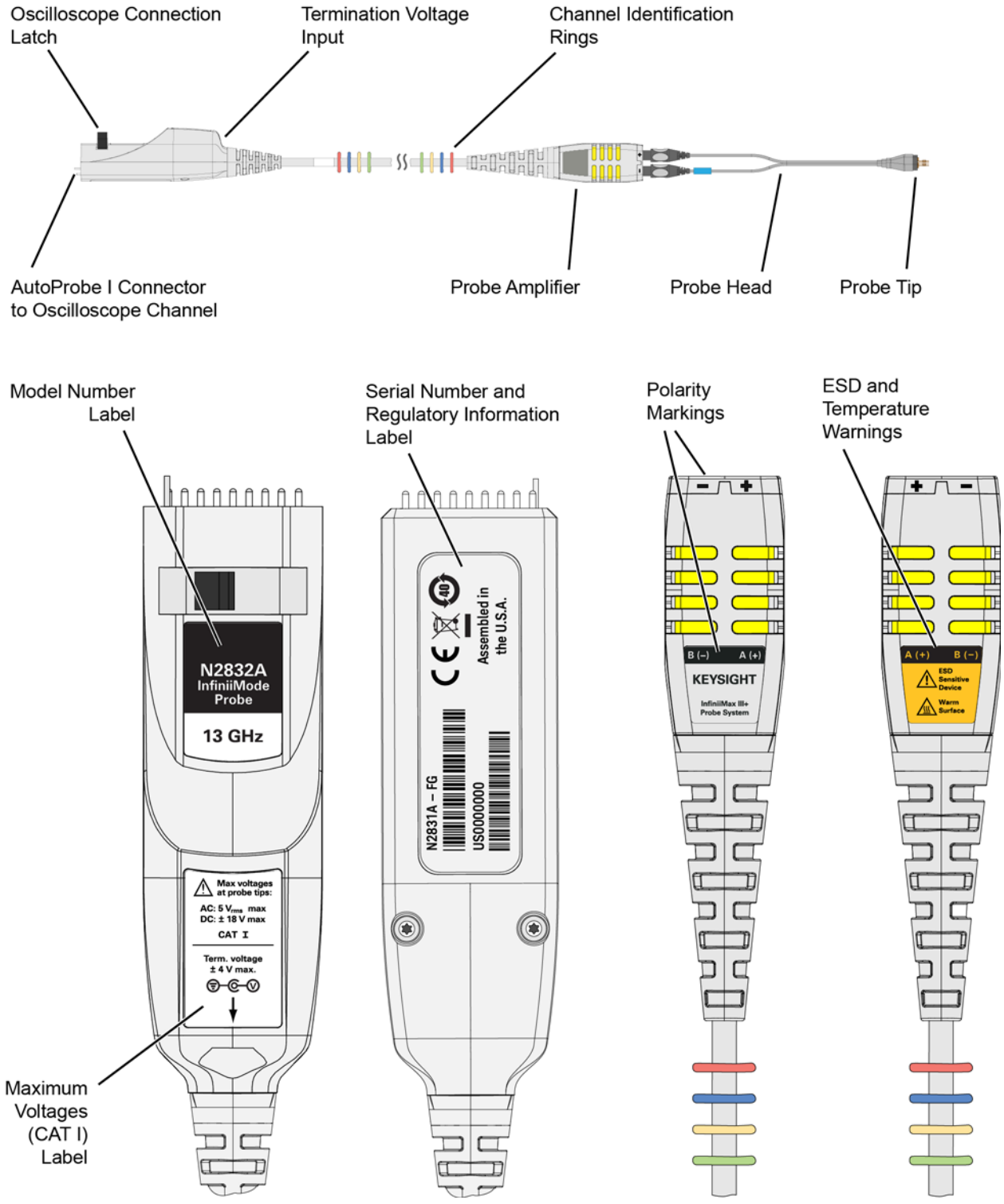


Figure 5 N2830/1/2A Probes

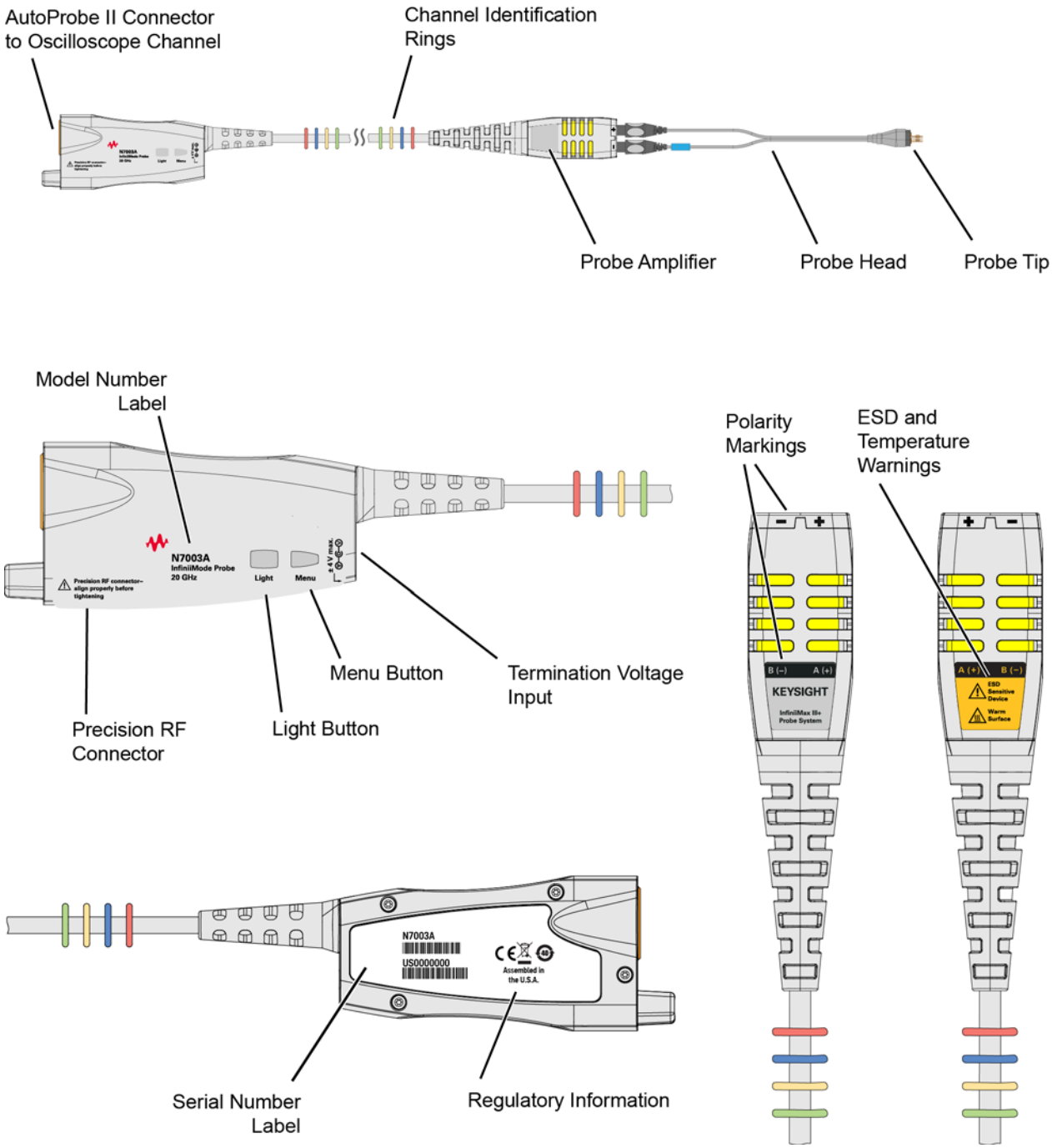


Figure 6 N7000/1/2/3A Probes

AutoProbe Interface Connectors

Figure 7 and Figure 8 show the AutoProbe interface connectors that connect the probes to the oscilloscope. The N2830/1/2A probes use the AutoProbe I interface which connects to precision BNC oscilloscope channel inputs. It is compatible with Infiniium oscilloscopes such as the 90000A and S-series. Of course, the probe model must be also supported by the oscilloscope software.

The N7000/1/2/3A probes use the AutoProbe II 3.5 mm interface, which is compatible with 90000 Q/V/X/Z-series oscilloscopes without the use of an adapter

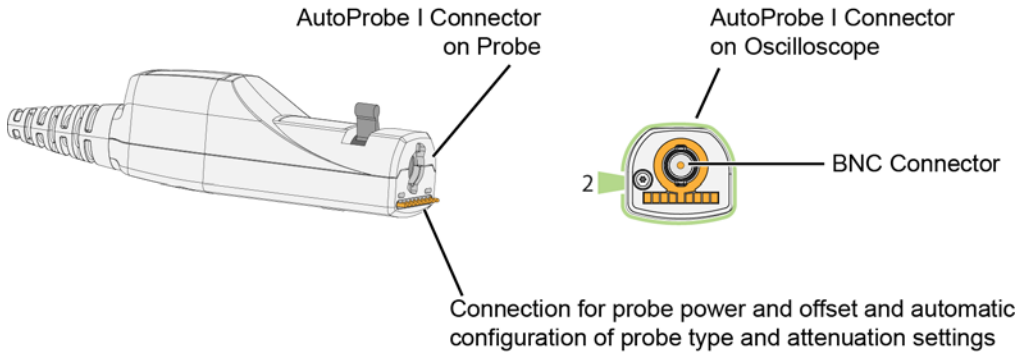


Figure 7 N2830/1/2A's AutoProbe I Interface Connector

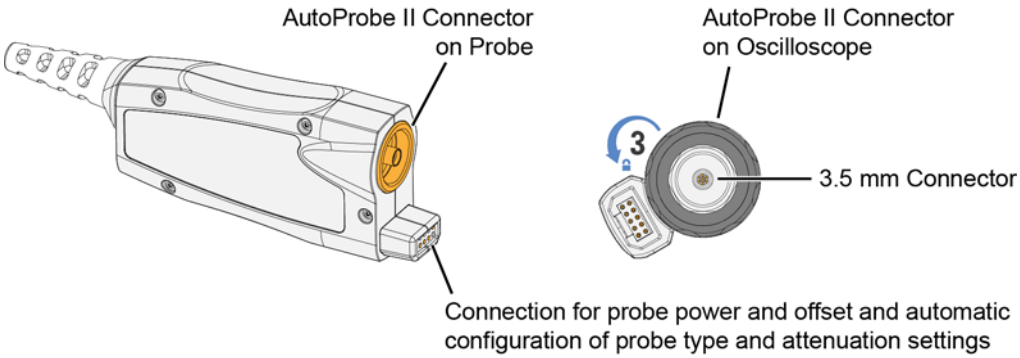


Figure 8 N7000/1/2/3A's AutoProbe II Interface Connector

Voltage Limits

The N2830/1/2A and N7000/1/2/3A probes are designed for Measurement Category I (CAT I). Measurement Category I is for measurements performed on circuits not directly connected to a mains supply. Observe the following voltage limits:

Maximum AC at probe tips: . . . . . $5V_{rms}$

Maximum DC at probe tips: . . . . . ±18V

WARNING **Always observe the ESD, temperature, maximum voltage, and maximum terminal voltages listed on the probe labels.**

N7000/1/2/3A probe buttons

Press the **Menu** button to bring up the oscilloscope's Probe dialog box.

When using the N5445A browser head, press the **Light** button to turn on and off the browser's LED headlight. Pressing and holding this button will ramp the intensity of the LED headlights so that you can adjust the brightness to accommodate different lighting or glare conditions.

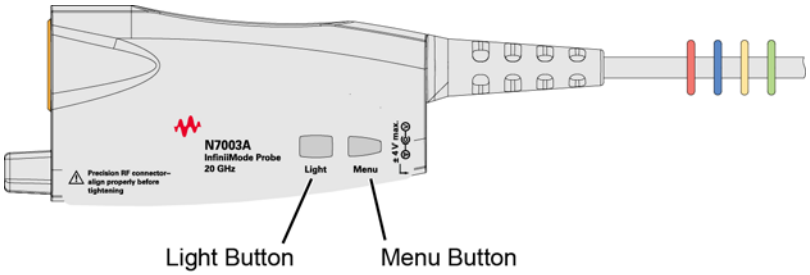


Figure 9 Buttons on 7000/1/2/3A Probe

Cleaning the probe

If the probe requires cleaning, disconnect it from the oscilloscope 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 the oscilloscope.

Channel identification rings

When multiple probes are connected to the oscilloscope, use the channel identification rings to associate the channel inputs with each probe. Place one colored ring near the probe's channel connector and place an identical color ring near the probe head.

Compatible Oscilloscopes

The N2830/1/2A probe's precision BNC AutoProbe I interface connects directly to S-series and 90000A oscilloscopes. Use an N5442A adapter to connect to series 90000 Q, V, X, and Z-series Infiniium oscilloscopes. Use an N1022B adapter to connect to the 86100D oscilloscope.

The N7000/1/2/3A probe's AutoProbe II interface connects directly to series 90000 Q, V, X, and Z-series Infiniium oscilloscopes. Use an N5477A adapter to connect to the 86100D oscilloscope.

The N2830/1/2A and N7000/1/2/3A probes are *not* compatible with Infiniium 9000 Series, InfiniiVision and any old generation Keysight, Agilent, or HP oscilloscopes.

Table 2 N2830A-Series Probes and Compatible Infiniium Oscilloscopes

Oscilloscope	Adapter Required	Minimum Required Firmware Version
90000 Q, V, X, and Z-Series	N5442A	5.00
90000A Series	none	5.00
S-Series	none	5.00
86100C/D Series	N1022A/B	–

Table 3 N7000A-Series Probes and Compatible Infiniium Oscilloscopes

Oscilloscope	Adapter Required	Minimum Required Firmware Version
90000 Q, V, X, Z-Series	none	5.50
86100C/D Series	N5477A	–

Is your oscilloscope software up-to-date?

Keysight periodically releases software updates to support your probe, fix known defects, and incorporate product enhancements. To download the latest firmware, go to www.Keysight.com and search for your oscilloscope's model number. Click on the "Drivers, Firmware & Software" tab under the Technical Support link.

86100C/D sampling oscilloscope

The probes can be used with the 86100C/D sampling scope with degraded performance, depending on the probe head used. Use only in differential 1x mode (10:1 attenuation). For N2830/1/2A probes, use the N1022B adapter. For N7000/1/2/3A probes, use the N5477A adapter.

To Avoid Damaging the Probe

In this section, you'll learn to properly handle your probes to prevent damage and maintain high performance. For more safe-handling information, go to **www.keysight.com/find/scope-demo**, click on **See Keysight's probes in action**, and then *InfiniiMax III ESD Best Practices demo video* listed under the Document Library tab.

CAUTION Electrostatic discharge (ESD) can quickly and imperceptibly damage or destroy high-performance probes, resulting in costly repairs. Always wear a wrist strap when handling probe components.

CAUTION Probes are sensitive devices and should be treated with care. Do not bend or kink the probe amplifier cable. Do not drop heavy objects on the probe, drop the probe from large heights, spill liquids on the probe, etc. Any of these examples can significantly degrade the performance of the probe.

CAUTION When storing the probe, it is best to coil the cable in a large radius and avoid a net twist in the cable during the process. This can be done in a similar manner to how garden hoses or extension cords are typically coiled.

CAUTION InfiniiMax I and II probe heads cannot be used with Infiniimax III+ probe amplifiers and InfiniiMax III+ probe heads cannot be used with InfiniiMax I and II amplifiers.

CAUTION Never allow the probe head to be connected to the probe amplifer, if the probe amplifier is *not* connected to the oscilloscope channel.

CAUTION Always disconnect an N2836A or N5441A solder-in probe head from the probe amplifier before unsoldering, moving to a new position, and resoldering the head.

Using a static-safe work station

InfiniiMax probes and accessories are ESD sensitive devices and should be treated with care. Before using or handling the probe or accessories, always wear a grounded ESD wrist strap and ensure that cables and probe heads are discharged before being connected.

All work, including connecting probe amplifiers to the oscilloscope, should be performed at a static-safe work station as shown in Figure 10.

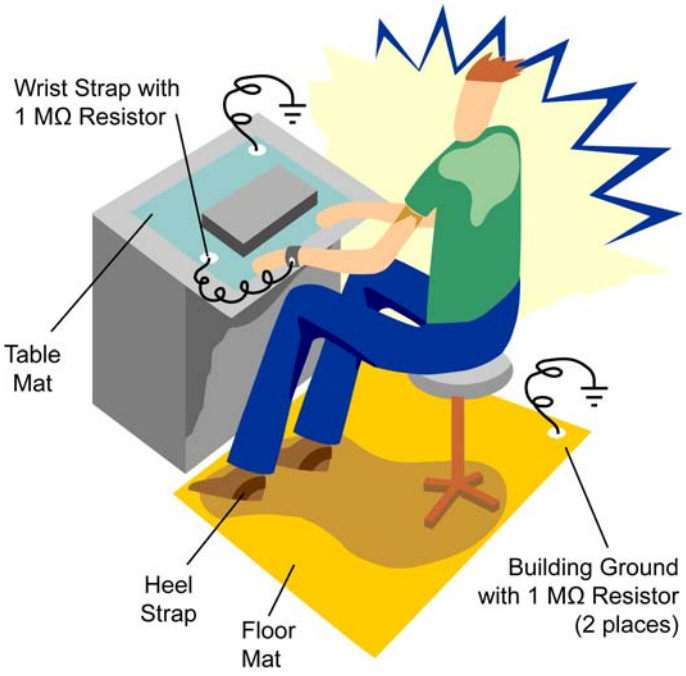


Figure 10 Static-Safe Work Station

Many scopes including Keysight's 90000X or V series have a front-panel ground socket. You can plug the wrist strap into the ground socket as seen in the following picture.

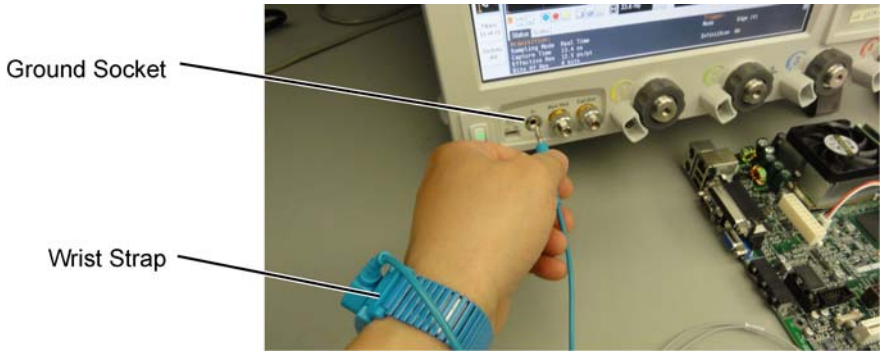


Figure 11 Wrist Strap Connected to Oscilloscope Ground Socket

The static-safe work station shown in Figure 10 uses two types of ESD protection:

- Conductive table-mat and wrist-strap combination.
- Conductive floor-mat and heel-strap combination.

Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone. To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Purchase acceptable ESD accessories from your local supplier.

WARNING **These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**

Safely connecting the probe to an oscilloscope

To protect against ESD damage, always use the four steps shown in Figure 12 on page 19 when connecting your probe to the oscilloscope.

CAUTION **When connecting a probe head to a probe amplifier, push straight in. When disconnecting a probe head from an amplifier, pull the probe head connectors straight out of the sockets. Never bend the probe head in order to pry it loose from the amplifier. Also, do not wiggle the probe head up and down or twist it to remove the connectors from the sockets. This can damage the pins in the amplifier or the probe head itself.**

Probing the DUT

When making your measurements, you'll often need to probe different locations on the DUT. You can safely move any of the following three probe heads *without* having to first break the amplifier-to-head connection:

- N5445A differential browser head
- N5439A ZIF head,
- N5444A 2.92 mm/3.5 mm/SMA head.
- N2848A QuickTip InfiniiMode head.

The only exception is when the DUT is *not* grounded to the oscilloscope via the AC mains ground. In this case, connect the DUT ground to the oscilloscope ground *before* moving the probe. An example of a device having a floating ground would be a battery-powered DUT.

CAUTION **When probing with an N2836A and N5441A, always disconnect the probe head from the amplifier *before* unsoldering, moving to a new position, and resoldering the head. This is because some soldering-iron tips can hold a charge which can damage the probe amplifier.**

CAUTION **When probing with an N2848A, always disconnect the probe head from probe tip *before* unsoldering, moving to a new position, and resoldering the tip. This is because some soldering-iron tips can hold a charge which can damage the probe amplifier.**

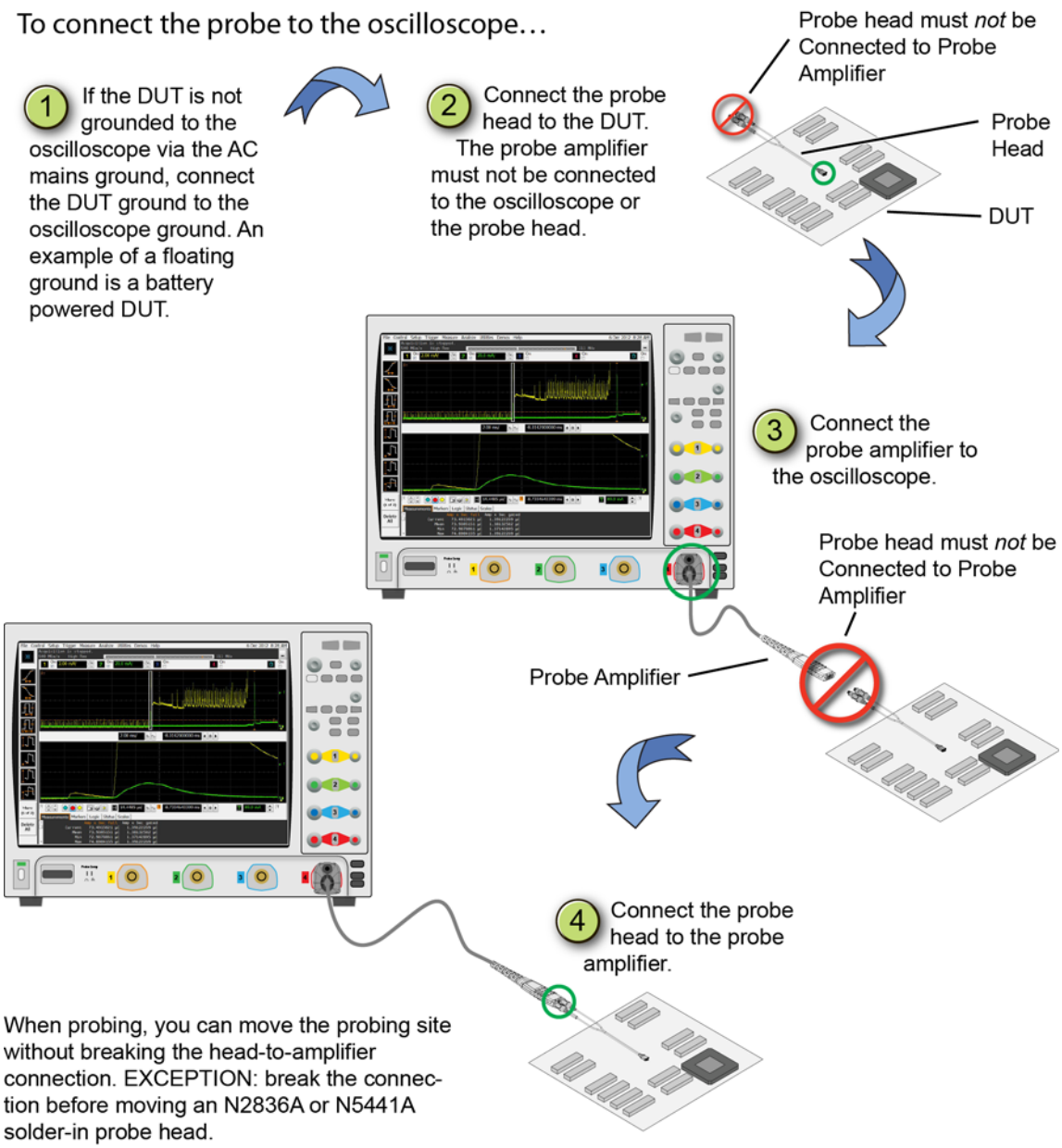


Figure 12 Connecting the Probe to the Oscilloscope

Safely disconnecting the probe from an oscilloscope

Always disconnect the probe head from the probe amplifier *before*:

- disconnecting the probe amplifier from the oscilloscope.
- switching the probe amplifier from one oscilloscope channel to another.

CAUTION Never allow the probe head to be connected to the probe amplifier, if the probe amplifier is *not* connected to the oscilloscope channel.

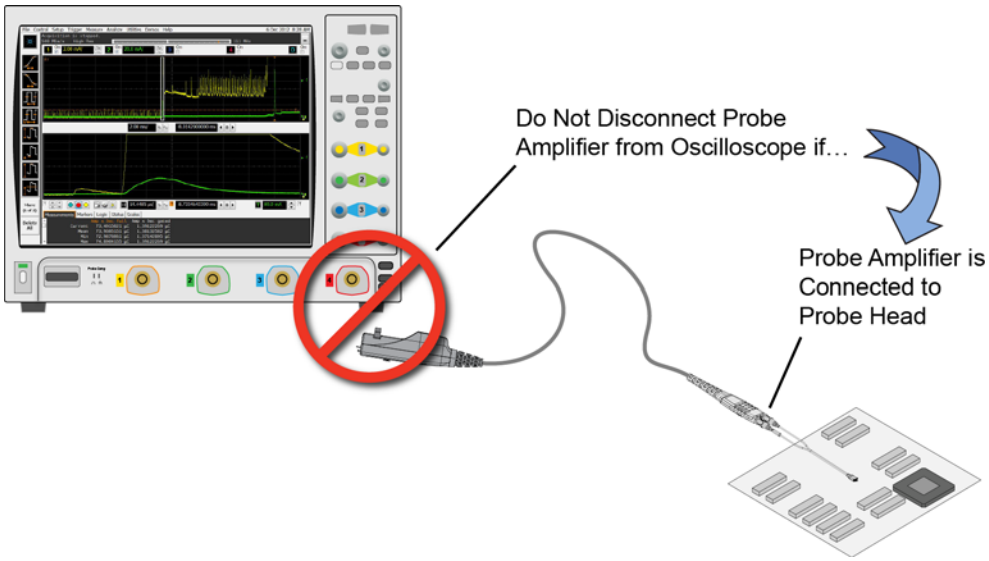


Figure 13 Probe Improperly Disconnected from Oscilloscope while Probe Head is Connected to the Probe Amplifier

To Ensure Maximum Measurement Accuracy

To increase measurement accuracy, use the oscilloscope's **Select Probe Head** dialog box to indicate the type of probe head that is attached to the probe amplifier. Making this selection allows the oscilloscope to apply the proper type of correction filter (S parameter) for your measurement case. The correction filter increases accuracy by flattening the magnitude and phase response of the probe. The following two sources of S parameters are automatically used for the filter:

- S parameters of the InfiniiMax III+ probe amplifier. These S parameters are unique to and stored on the probe amplifier.
- S parameters of the specific probe-head model. For example, the **N2836A: DF Solder-In (Vertical)** selection applies S parameters for the N2836A head held in a vertical position (perpendicular to the surface of the DUT).

To display the dialog box, click **Probes** > **Channel Setup Menu**.

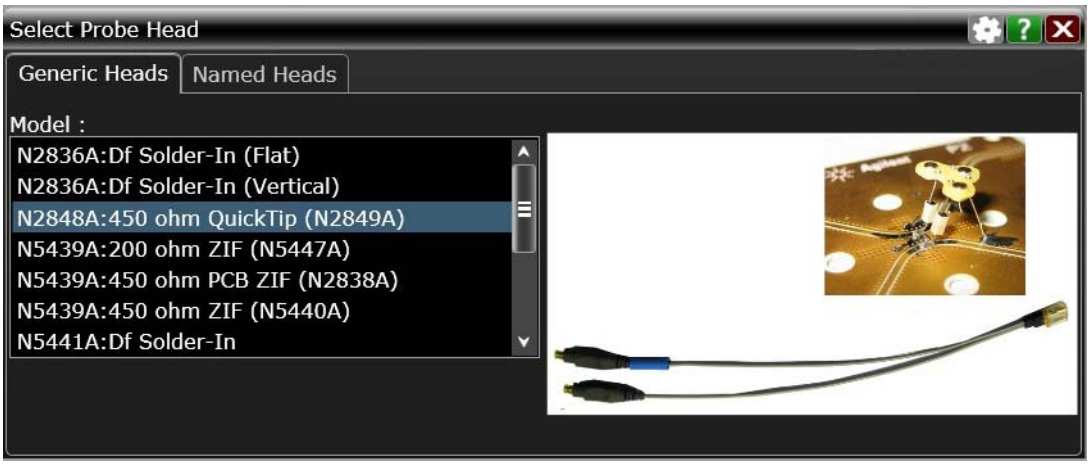


Figure 14 Select Probe Head Dialog Box

To Use InfiniiMode

InfiniiMode allows you to switch between differential, single-ended, and common mode measurements without needing to change or reconnect the probe or probe leads. Switching measurements is accomplished using the oscilloscope's probe configuration dialog box.

NOTE InfiniiMode is available when using InfiniiMax III+ N2830/1/2A and N7000/1/2/3A probes. InfiniiMode is not available when using InfiniiMax I, II, or III probe amplifiers.

The N2848A QuickTip, N2836A Solder-In head, and N5444A SMA head are InfiniiMode compatible.

The following table shows, depending on the probe tip and InfiniiMode setting, which signal types can be measured.

Table 4 Supported InfiniiMode Measurements by Probe Tip

InfiniiMode Setting	Signal Being Measured	
	Single-Ended	**Differential**
Differential	Browser *(full BW)* *	Browser *(full BW)*
	Solder-In *(lower BW)*	Solder-In *(lower BW)*
	QuickTip *(lower BW)*	QuickTip *(lower BW)*
Single-Ended	Browser *(not supported)*	Browser *(not supported)*
	Solder-In	Solder-In
	QuickTip	QuickTip
Common-Mode	Browser *(not supported)*	Browser *(not supported)*
	Solder-In	Solder-In
	QuickTip	QuickTip

* Full bandwidth obtained by touching one tip to ground.

NOTE Because the N5445A browser tip has two leads instead of three, it is not InfiniiMode compatible. However, you can still use the browser tip to measure single-ended signals by selecting differential mode and touching one tip to ground.

Making InfiniiMode connections

When probing a differential or common mode signal, connect the probe tips as shown in Figure 15. The positive (+) and negative (–) leads can be reversed by swapping the connections at the probe amplifier.

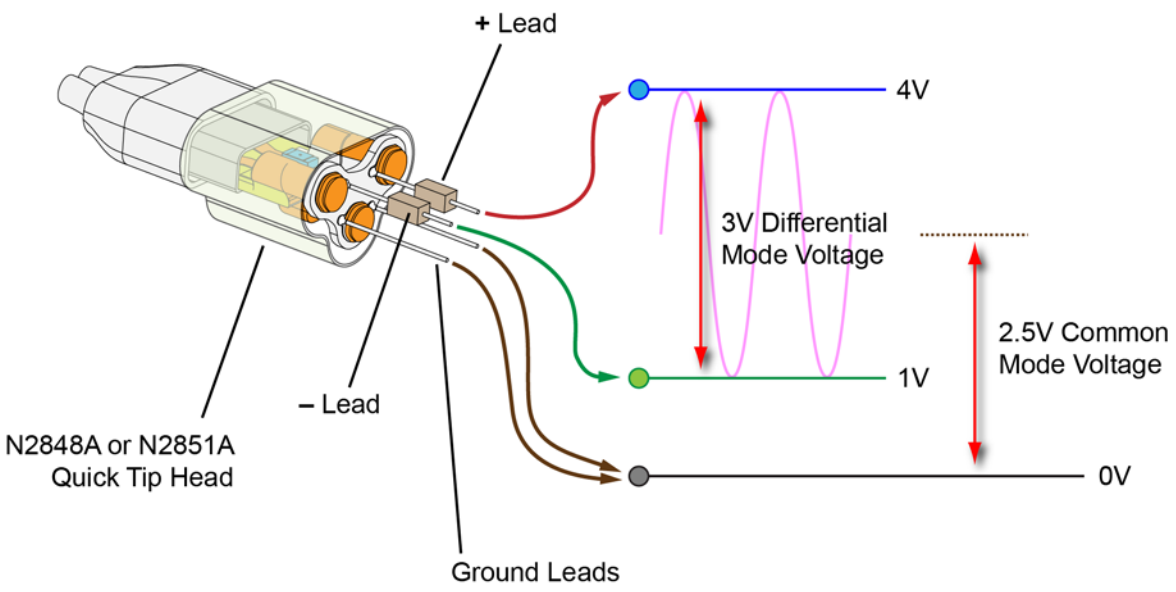


Figure 15 Example InfiniiMode Probe Circuit Connections

NOTE Soldering the ground wires is not required when making differential or single-ended (+ or – leads) measurements.

The following measurements can be made *without* reconnecting the probe tips. These equations use the voltages shown in Figure 15.

Differential Measurement

$$V_{+lead} - V_{-lead} = 4V - 1V = 3V$$

Common Mode Measurement

$$\frac{V_{+lead} + V_{-lead}}{2} = \frac{4V + 1V}{2} = 2.5V$$

Single-Ended Measurement with +Lead

$$V_{+lead} - gnd = 4V - 0V = 4V$$

Single-Ended Measurement with –Lead

$$V_{-lead} - gnd = 1V - 0V = 1V$$

Selecting the InfiniiMode mode

With the probe connected to an S-series, 90000 series, 90000 X, Q, Z, or V-series Infiniium oscilloscope, perform the following steps:

1. Click **Setup** > **Probe Configuration** to open the **Probe Configuration Setup** dialog box shown in Figure 16.
2. In the dialog box, click the **Probe Amp** block to open the **Probe Amplifier** dialog box.
3. Select the InfiniiMode measurement mode: **Differential**, **Single-Ended A**, **Single-Ended B**, or **Common Mode**. The default setting is **Differential**.

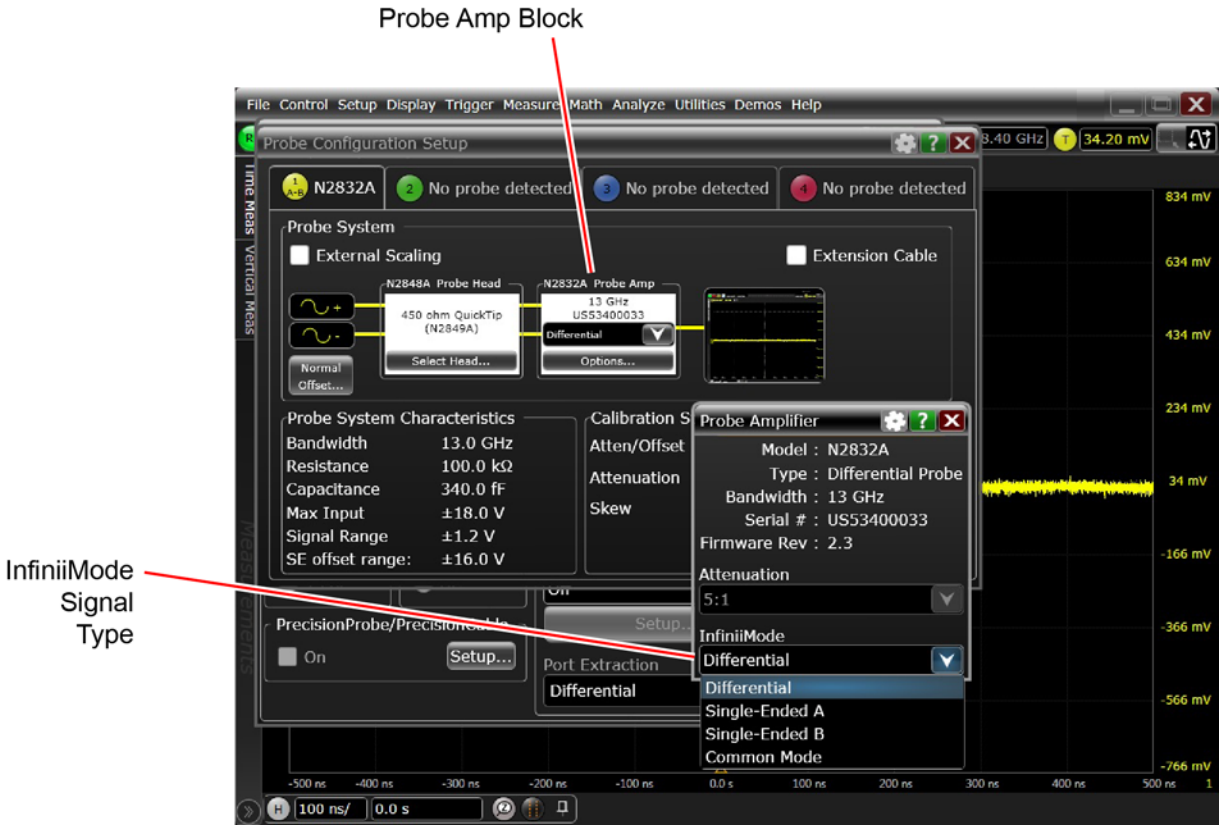


Figure 16 Probe Configuration Dialog Box *and* Probe Amplifier Dialog Box

To Probe Ungrounded Devices

If the DUT is not grounded to the oscilloscope via the AC mains ground, connect the DUT ground to the oscilloscope ground. An example of a floating ground is a battery-powered device.

Without the ground connection, the common mode voltage is not guaranteed to be within the common mode range of the probe amplifiers.

NOTE Failure to connect the ground may result in the display of inaccurate waveforms.

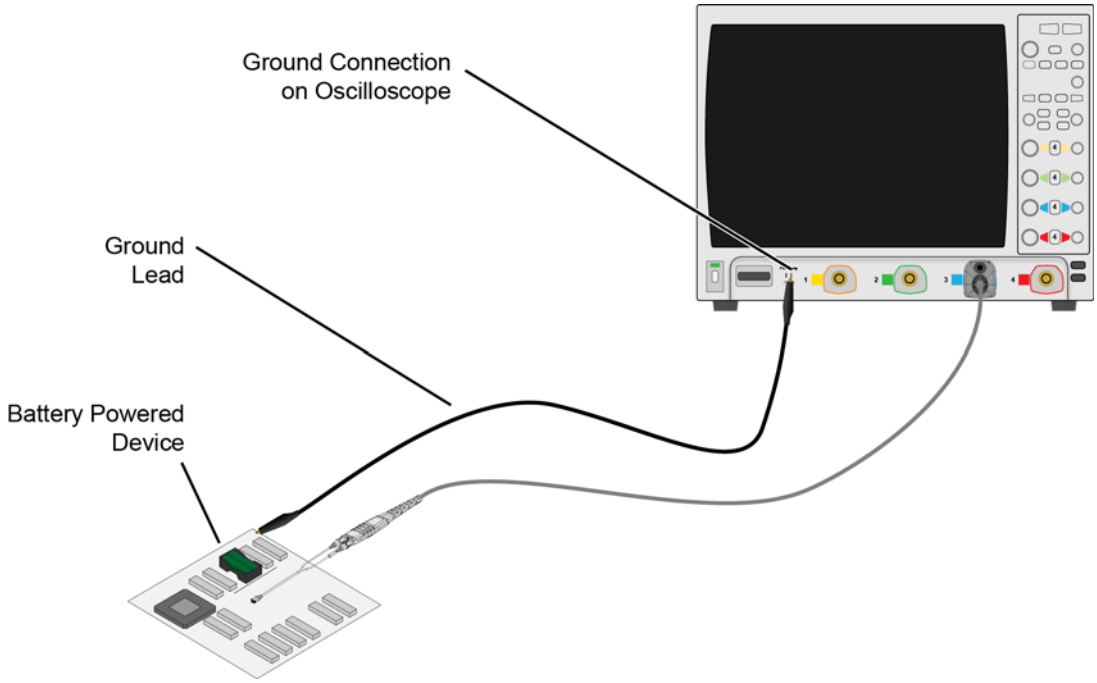


Figure 17 Grounding the DUT to an S-Series Oscilloscope

To Probe Single-Ended Signals with a Differential Head

Using a differential probe head rather than a single-ended probe head to probe single-ended signals results in the advantages of higher bandwidth and increased accuracy. Also no offset range is sacrificed when using a differential probe head, as any supplied offset is applied only to the probe head's plus side. To learn more about applying a DC offset when probing, refer to "To Measure Small Signals on a Large DC Level" on page 27.

If possible, orient the probe head vertically as shown in Figure 18. Laying the probe head flat over a single-ended signal will cause coupling to the tip that can degrade the performance. Notice that the head's "–" lead is connected to ground.

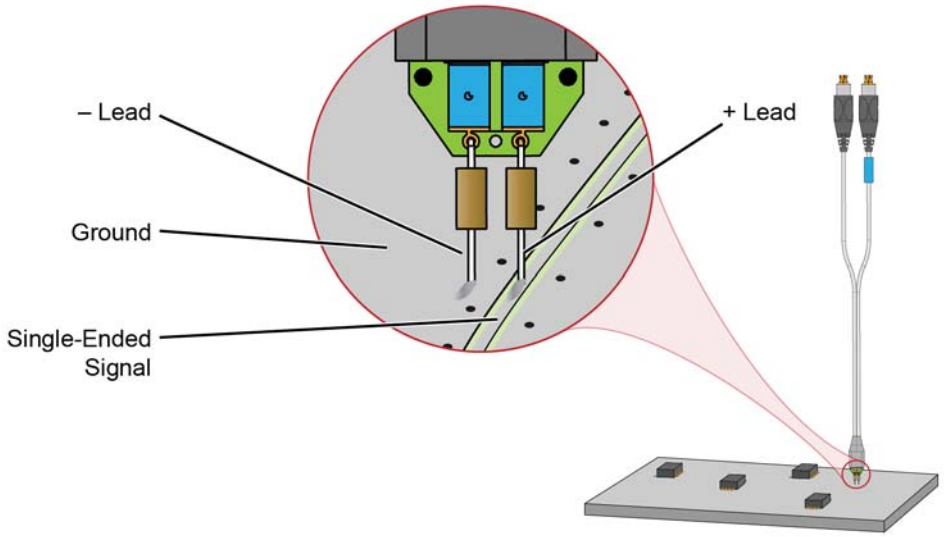


Figure 18 Connecting a Differential Head to a Single-Ended Signal

To Measure Small Signals on a Large DC Level

Measuring small AC signals riding on top of a large DC can be challenging. By subtracting out most or all of the DC component, the signal can be positioned to better utilize the input's available dynamic range. This is accomplished by applying an offset by either the probe or oscilloscope channel. Scope channel offset is applied when viewing differential signals. Probe offset is applied when viewing single-ended signals.

Normal Offset Behavior

Figure 19 shows **Normal** selected in the Probe Offset dialog box. When probing differential signals **Normal** allows you to apply probe offset using the oscilloscope's front-panel vertical offset controls.

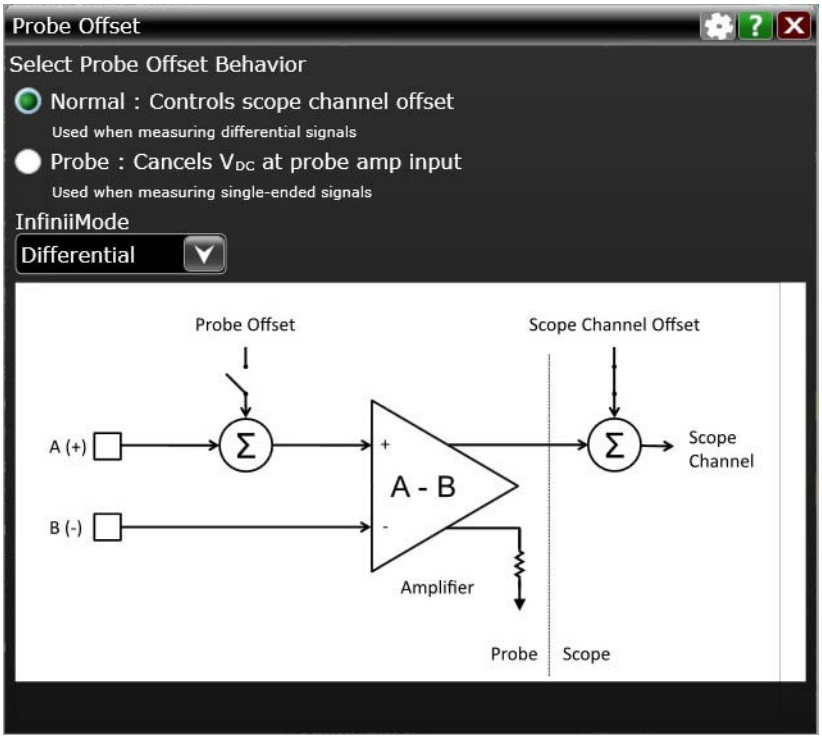


Figure 19 Probe Offset Dialog Box (Normal Setting)

Probe Offset Behavior

When **Probe** is selected as shown in Figure 20 on page 28, the InfiniiMax III/III+ probe provides a very large offset range (up to ±16V) for probing single-ended signals and a large common-mode range for probing differential signals. Use this offset range to subtract most or all of the DC component of the input signal so that the signal can better utilize the dynamic range of the input. This is possible due to the designs having summing nodes at the amplifier input. For information

on properly using probe offset to ensure that you can get the maximum performance and dynamic range from the InfiniiMax probe, refer to Keysight application note 5988-9264EN.

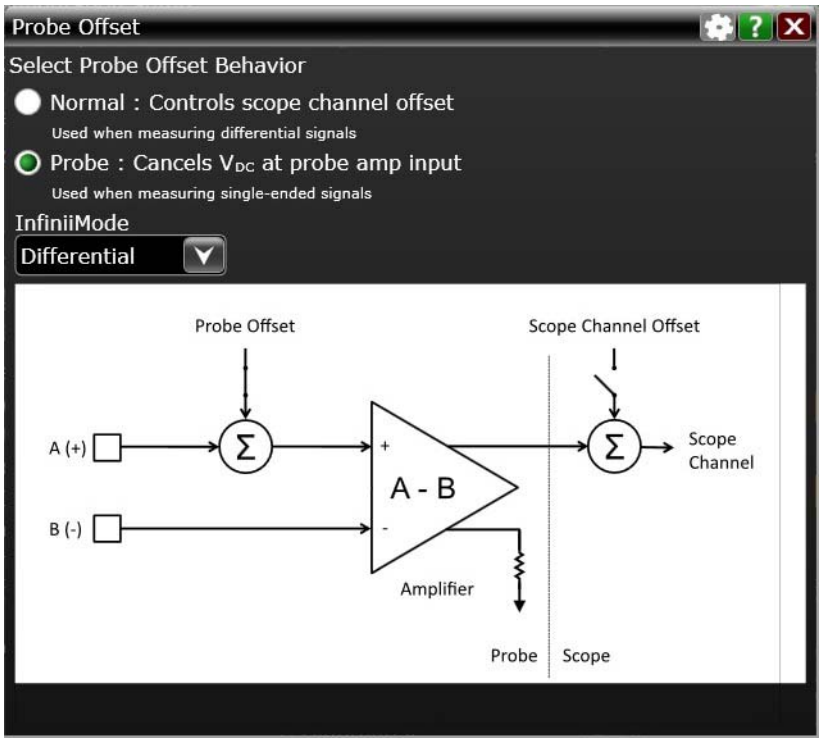


Figure 20 Probe Offset Dialog Box (Probe Setting)

Understanding how to properly use offset for your application can ensure that you get the maximum performance and dynamic range from your probes. The unique method of applying probe offset in InfiniiMax differential probes allows the full benefits of differential probing for single-ended signals without sacrificing offset range. Table 5 on page 29 lists the interactions between the signal type and the different offsets.

Table 5 Signal Type and Available Offset Range

	Signal Being Probed	
	Single Ended	**Differential**
Probe Head Type	Differential or Single Ended Head	Differential Head
Offset Applied To	Probe (channel offset is set to 0V)	Oscilloscope Channel (probe offset is set to 0V)
Offset Range	±16V (with 450 ohm probe head)	±2.5V
Description	The offset voltage is subtracted from the input signal before the probe's differential amplifier. Since this subtraction is done *before* any active circuits, the offset range is large. Differential Probe Head. A differential probe can make higher bandwidth and more accurate measurements on single-ended signals than a single-ended probe and this method of applying offset to only the plus side of a differential probe means that there is no sacrificing of offset range. All of the InfiniiMax III+ heads are differential. Single-Ended Probe Head. Single-ended probe tips do not have a minus lead so nothing is plugged into the probe amplifier's "–" input. This is normal and does not cause any problems.	Since the plus and minus sides of differential signals have the same dc component, the dc component is subtracted out and the probe's output by definition is centered around ground. The channel offset allows the waveform seen on screen to be moved as desired. The allowable dc component in the plus and minus signals is determined by the common mode range of the probe. Any voltage applied to the probe's offset input jack is not used and has no effect on the signal.

Slew Rate Requirements for Different Technologies

The following table shows the slew rates for several different technologies. The maximum allowed input slew rate is 18 V/ns for single-ended signals and 30 V/ns for differential signals. Table 6 shows that the maximum required slew rate for the different technologies is much less that of the probe.

Table 6 Slew Rate Requirements

Name of Technology	Differential Signal	Max Single-Ended Slew Rate* (V/ns)	Max Differential Slew Rate† (V/ns)	Driver Min Edge Rate (20%-80% ps)	Max Transmitter Level (Diff V)
PCI Express (3GIO)	YES	9.6	19.2	50	1.6
RapidIO Serial 3.125Gb	YES	8.0	16.0	60	1.6
10GbE XAUI (4x3.125Gb)	YES	8.0	16.0	60	1.6
1394b	YES	8.0	16.0	60	1.6
Fibre Channel 2125	YES	8.0	16.0	75	1
Gigabit Ethernet 1000Base-CX	YES	7.8	15.5	85	2.2
RapidIO 8/16 2Gb	YES	7.2	14.4	50	1.2
Infiniband 2.5Gb	YES	4.8	9.6	100	1.6
HyperTransport 1.6Gb	YES	4.0	8.0	113	1.5
SATA (1.5Gb)	YES	1.3	2.7	134	0.6
USB 2.0	YES	0.9	1.8	375	1.1
DDR 200/266/333	NO	7.2	n/a	300	3.6
PCI	NO	4.3	n/a	500	3.6
AGP-8X	NO	3.1	n/a	137	0.7

* The probe specification is 18 V/ns

† The probe specification is 30 V/ns

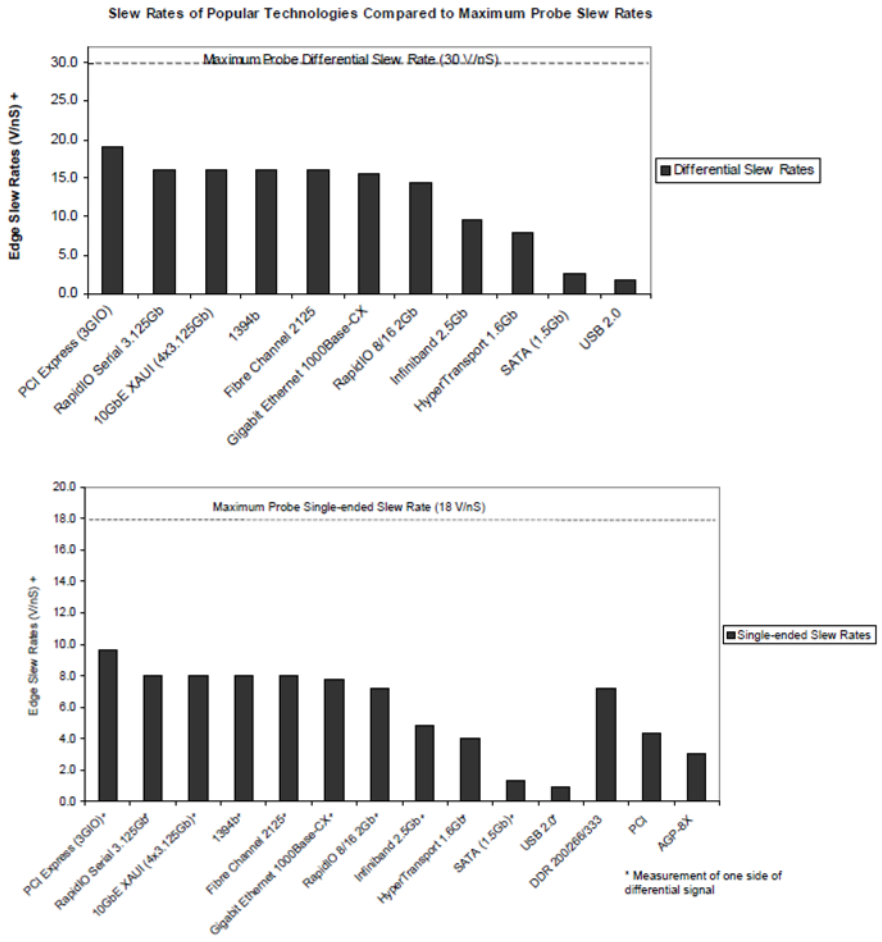


Figure 21 Slew Rates of Popular Technologies Compared to Maximum Probe Slew Rates

Available Accessories

The following is a partial list of available probe and oscilloscope accessories.

Performance verification fixture

An E2655C or N5443A Performance Verification (PV) fixture is an accessory that is used to properly position the probe during performance verification testing as described in Chapter 7 and Chapter 8.

N5450B Extreme temperature cable extension kit

For extreme temperature testing, such as monitoring a device in a temperature chamber, order the N5450B InfiniiMax extreme temperature extension cable for use with the N5441A solder-in head.

Keysight's Infiniimax probe amplifiers have a specified operating temperature range from 5° C to 40° C, but the N5441A probe head can withstand temperatures from –55°C to +150°C for up to 250 test cycles. Use the extension cables to physically separate the amplifier from the probe head which allows you to operate the probe head inside a temperature chamber while the probe amplifier remains outside the chamber.

CAUTION **None of the N2830/1/2A or N7000/1/2/3A probe amplifiers can withstand the extreme temperatures (–55°C to +150°C) that the N5450B can withstand. When using the N5450B extension cable, do not subject the InfiniiMax III+ probe amplifier to extreme temperatures.**

CAUTION **Besides the N5441A probe head, *none* of the other probe heads are designed for extreme temperature testing. For more information about the extreme temperature probing solution for Keysight oscilloscopes, check out the Keysight data sheet with the literature number, 5990-3504EN.**

To ensure a high-quality measurement, the N5450B cable set have been phase-matched at the factory. A coupling tag is included with the cables to ensure the cables stay as a matched pair. To install the coupling tag, slip the small end of each cable through the holes in the tag. The tag can be positioned anywhere along the length of the cable and can withstand the temperature ranges specified.

CAUTION Avoid rapid changes in temperature that can lead to moisture accumulating in the form of condensation on the probe components, as well as the DUT. If this occurs, wait until the moisture has evaporated before making any measurements.

CAUTION Additional care must be taken when handling probe heads used during extreme temperature cycling because this process makes the probe heads less robust.

CAUTION Secure the ends of the extension cable near the probe head in the temperature chamber such that the probe head legs are not tugged or moved around significantly.

CAUTION Prevent abrasion and tears in the cable's jacket, do not rest the extension cables on any metal objects or objects with sharp edges.

CAUTION Do not kink the cables. The cables are designed to be flexible, but are not designed to be bent sharply.

NOTE Keep your extreme temperature testing probes separate from the probes that you use under milder conditions. This is because cycling probe heads through extreme temperature ranges has a marked affect on their lifetimes. Only the lifetime of the probe head is affected by temperature cycling. The extension cables and probe amplifier should not need to be replaced with extended temperature cycling.

NOTE Discoloration or texture changes are possible with the extension cables. These changes do not, however, affect the performance or the quality of a measurement.

N5449A high impedance adapter

The N5449A high impedance adapter includes one N2873A 10:1 passive probe. The adapter is specifically tuned for the N2873A probe. Similar probes (1 MΩ input) can be used. Other probes may not meet the bandwidth specification.

86100D sampling scope adapters

Two adapters are available for connecting probes to the Infiniium 86100D DCA-X sampling oscilloscope or other RF instruments. The N1022B sampling scope adapter allows you to connect N2830/1/2A probes. The N5477A sampling scope adapter allows you to connect N7000/1/2A probes.

Safety Information

This manual provides information and warnings essential for operating this probe in a safe manner and for maintaining it in safe operating condition. Before using this equipment and to ensure safe operation and to obtain maximum performance from the probe, carefully read and observe the following warnings, cautions, and notes.

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Note the external markings on the probe that are described in this document.

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.

WARNING

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.

WARNING

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.

WARNING

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 found in this manual.

WARNING

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

WARNING

Do Not Operate With Suspected Failures. Refer to qualified service personnel.

WARNING

Never leave the probe connected to a conductor while it is not connected to an oscilloscope or voltage measuring instrument.

WARNING **Do not use a probe which is cracked, damaged or has defective leads.**

WARNING **Do not install substitute parts or perform any unauthorized modification to the probe.**

WARNING **Do not operate the probe or oscilloscope in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.**

WARNING **Do not use the probe or oscilloscope in a manner not specified by the manufacturer.**

WARNING **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.**

CAUTION 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. Avoid any mechanical shocks to this product in order to guarantee accurate performance and protection.

Concerning the Oscilloscope or Voltage Measuring Instrument to Which the Probe is Connected

WARNING **Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.**

WARNING **If you energize the instrument by an auto transformer (for voltage reduction or mains isolation), the ground pin of the input connector terminal must be connected to the earth terminal of the power source.**

WARNING **Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.**

WARNING **Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.**

WARNING **Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.**

Service

The following symptoms may indicate a problem with the probe or the way it is used. The probe is a high frequency device with many critical relationships between parts. For example, the frequency response of the amplifier on the hybrid is trimmed to match the output coaxial cable. As a result, to return the probe to optimum performance requires factory repair. If the probe is under warranty, normal warranty services apply.

Probe calibration fails

Probe calibration failure with an oscilloscope is usually caused by improper setup. If the calibration will not pass, check the following:

- Check that the probe passes a waveform with the correct amplitude.
- If the probe is powered by the oscilloscope, check that the offset is approximately correct. The probe calibration cannot correct major failures.
- Be sure the oscilloscope passes calibration without the probe.

Incorrect pulse response (flatness)

If the probe's pulse response shows a top that is not flat, check for the following:

- Output of probe must be terminated into a proper 50Ω termination. If you are using the probe with an Infiniium oscilloscope, this should not be a problem. If you are using the probe with other test gear, insure the probe is terminated into a low reflectivity 50Ω load (~ ±2%).
- If the coax or coaxes of the probe head in use has excessive damage, then reflections may be seen within ~ 1 ns of the input edge. If you suspect a probe head, swap it with another probe head and see if the non-flatness problem is fixed.
- If the one of the components in the tip have been damaged there may be a frequency gain non-flatness at around 40 MHz. If you suspect a probe head, swap it with another probe head and see if the non-flatness problem is fixed.

Incorrect input resistance

The input resistance is determined by the probe head in use. If the probe head is defective, damaged, or has been exposed to excessive voltage, the input resistor may be damaged. If this is the case, the probe head is no longer useful. A new probe head will need to be obtained either through purchase or warranty return.

Incorrect offset

Assuming the probe head in use is properly functioning, incorrect offset may be caused by defect or damage to the probe amplifier or by lack of probe calibration with the oscilloscope.

Returning the probe for service

If the probe is found to be defective we recommend sending it to an authorized service center for all repair and calibration needs. Perform the following steps before shipping the probe back to Keysight Technologies for service.

1. Contact your nearest Keysight sales office for information on obtaining an RMA number and return address.
2. Write the following information on a tag and attach it to the malfunctioning equipment.

- Name and address of owner
- Product model number (for example, N2830A)
- Product Serial Number (for example, MYXXXXXXXX)
- Description of failure or service required

NOTE Include probing and browsing heads if you feel the probe is not meeting performance specifications or a yearly calibration is requested.

3. Protect the probe by wrapping in plastic or heavy paper.
4. Pack the probe in the original carrying case or if not available use bubble wrap or packing peanuts.
5. Place securely in sealed shipping container and mark container as "FRAGILE".

NOTE If any correspondence is required, refer to the product by serial number and model number.

Contacting Keysight Technologies

For technical assistance, contact your local Keysight Call Center.

- In the Americas, call 1 (800) 829-4444
- In other regions, visit http://www.keysight.com/find/assist

Before returning an instrument for service, you must first call the Call Center at 1 (800) 829-4444.

2 Using InfiniiMax III+ Probe Heads

This chapter describes the various probe heads. The probe configurations are listed in the order of the best performance to the least performance in terms of bandwidth and input loading characteristics. The recommended configurations are designed to give the best probe performance for different probing situations. This allows you to quickly make the measurements you need with confidence in the performance and signal fidelity. Using the recommended connection configurations is your key to making accurate oscilloscope measurements with known performance levels.

NOTE

Graphs showing the performance of the heads for each probe amplifier are shown in Chapter 6,

Recommended Configurations at a Glance

Table 7 Configurations at a Glance (Sheet 1 of 2)

Recommended Order of Use	BW (GHz)	Cdiff * (pF)	Cse † (pF)	Usage
N5444A InfiniiMax III 2.92 mm Head (Refer to page 42.)				
1	N2830A: 4 N2831A: 8 N2832A: 13 N7000A: 8 N7001A: 13 N7002A: 16 N7003A: 20	–	–	Differential and Single-ended signals InfiniiMode compatible For cabled measurements. Can terminate to a non-ground voltage.
N5439A InfiniiMax III ZIF Head (Refer to page 44.)				
2	N2830A: 4 N2831A: 8 N2832A: 13 N7000A: 8 N7001A: 13 N7002A: 16 N7003A: 20	32 fF	44 fF	Single-ended signals only Solder-in hands free connection when physical size is critical Extremely low loading measurement with N5440A/47A ZIF tips Hard to reach targets Very small fine pitch targets
N5445A InfiniiMax III Browser (Refer to page 50.)				
3	N2830A: 4 N2831A: 8 N2832A: 13 N7000A: 8 N7001A: 13 N7002A: 16 N7003A: 20	35 fF	50 fF	Differential and Single-ended signals General purpose troubleshooting of signals Handheld browing Variable pitch spacing from 20 mil to 125 mil
N5441A InfiniiMax III Solder-In Head (Refer to page 56.)				
4	N2830A: 4 N2831A: 8 N2832A: 13 N7000A: 8 N7001A: 13 N7002A: 16 N7003A: 20	77 fF	105 fF	Differential and Single-ended signals Economical semi-permanent connection Extreme Temperature

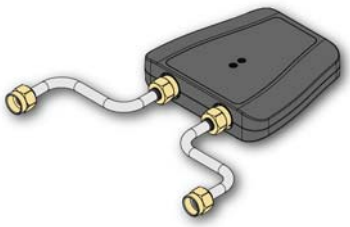
Table 7 Configurations at a Glance (Sheet 2 of 2)

Recommended Order of Use	BW (GHz)	Cdiff * (pF)	Cse † (pF)	Usage
N2836A InfiniiMode Solder-In Head (Refer to page 59.)				
5	N2830A: 4 N2831A: 8 N2832A: 13 N7000A: 8 N7001A: 13 N7002A: 16 N7003A: 20	108 fF	140 fF	Differential and Single-ended signals InfiniiMode Compatible Solder-in hands free connection
N2848A QuickTip Head (Refer to page 64.)				
6	N2830A: 4 N2831A: 8 N2832A: >12 N7000A: 8 N7001A: 13 N7002A: 16 N7003A: >16	340 fF	200 fF	Differential and Single-ended signals InfiniiMode Compatible Easy head-to-tip connection in tight space Solder-in hands free connection

* Capacitance seen by differential signals

† Capacitance seen by single-ended signals

1 N5444A InfiniiMax III 2.92 mm/3.5 mm/SMA Probe Head



The N5444A InfiniiMax III 2.92mm/3.5mm/SMA probe head provides 28 GHz bandwidth and allows you to connect two 2.92mm, 3.5mm, or SMA cables to make a differential measurement on a single oscilloscope channel.

The N5444A provides for a termination to a common DC voltage rather than to ground, which is required for many signal standards. It is implemented such that from DC to approximately 1 kHz, the termination is 55 Ohms to the termination voltage, and above approximately 10 kHz, the termination is 50 Ohms to 0.9 times the termination voltage. The termination voltage range is ±4V with a minimum step of 5 mV and a maximum current of 80 mA. The termination voltage can be controlled internally by the oscilloscope or applied externally using the supplied DC jack.

Table 8 Bandwidth

Probe Amplifier	BW	Probe Amplifier	BW
N2830A	4 GHz	N7000A	8 GHz
N2831A	8 GHz	N7001A	13 GHz
N2832A	13 GHz	N7002A	16 GHz
		N7003A	20 GHz

Figure 22 N5444A InfiniiMax III 2.92mm/3.5mm/SMA Probe Head

NOTE For performance plots, refer to Chapter 6, “Performance Plots.

N5448A Head Flex Cables

Order N5448A 2.92 mm head flex cables (10” or 25 cm long) to extend the cable length and add convenience. Figure 23 on page 43 shows the N5448A cables attached to the N5444A probe head. You must first remove the supplied rigid cables before connecting the N5448A cables.

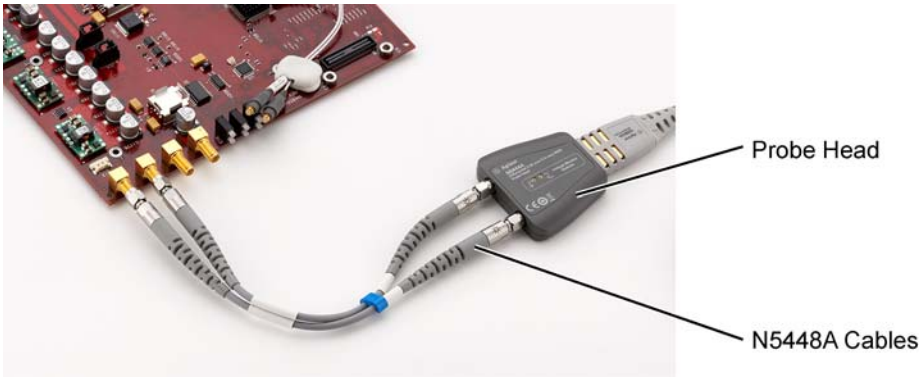


Figure 23 N5444A with N5448A Head Flex Cables Attached

Probe Offset Calibration with the N5444A

To achieve more accurate probe offset calibration with the N5444A, an SMA shorting adapter (Keysight part number: 1250-3999) is required. This adapter is provided with the N5444A (with unit serial number US50072545 or higher) and should be connected to the N5444A's "–" input connector during the calibration. The latest Infiniium firmware includes instructions on the Probe Calibration dialog box to remind you to install the adapter. If the Infiniium oscilloscope's firmware is older than version 5.50.33, you can still attach the adapter and the resulting calibration will be valid.

2 N5439A InfiniiMax III ZIF Probe Head

The N5439A Zero Insertion Force (ZIF) probe head supports the three types of economical replaceable tips that are shown in Table 10. Solder as many tips onto your DUT as needed. Because of the ZIF tip's extremely low loading, the tips can remain on the DUT as you easily move the probe head from one probing site to the next.

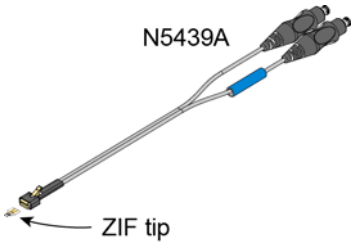
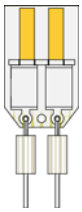
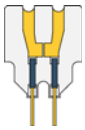
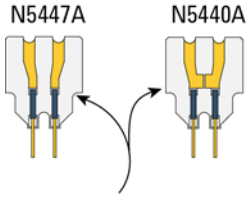
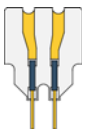


Table 9 Bandwidth

Probe Amplifier	BW	Probe Amplifier	BW
N2830A	4 GHz	N7000A	8 GHz
N2831A	8 GHz	N7001A	13 GHz
N2832A	13 GHz	N7002A	16 GHz
		N7003A	20 GHz

Table 10 Available ZIF Tips

ZIF Tip	Description		Variable Tip Spacing	Qty
N2838A 	25 GHz 450Ω PC board tip provides robust design with high bandwidth.		5 mil to 250 mil (0.127 mm to 6.35 mm)	5
N5440A 	28 GHz 450Ω ceramic (normal sensitivity) for extremely low probe loading.	 These ZIF tips have different gold patterns	5 mil to 80 mil (0.127 mm to 2 mm)	5
N5447A 	The N5447A ZIF tip is *not* compatible with the N2830/1/2A or N7000/1/2/3A probes. Compatible *only* with InfiniiMax III N2800/1/2/3A probes.		5 mil to 80 mil (0.127 mm to 2 mm)	5

NOTE The N5439A does not include any ZIF tips. You must order either the N2838A or N5440A in addition to N5439A.

NOTE The N5447A ZIF tip is *not* compatible with N2830/1/2A or N7000/1/2/3A probes.

NOTE  To install or repair N2838A resistor leads, refer to "Replacing Axial Resistor Tips" on page 72.

NOTE For performance plots, refer to Chapter 6, "Performance Plots.

Ensuring maximum N2838A tip performance

The specifications and performance plots of the N2838A ZIF tip were measured with a nominal spacing of 40 mil (1 mm). In order to achieve the proper response as shown in the performance plots, keep the mini-axial lead resistors roughly parallel as shown in Figure 47, and use the tip wires on the mini-axial leads to get the desired span.

If you need to position the resistors different than shown in this figure (that is, resistor bodies close together or spread apart), use N2807A and N2808A PrecisionProbe products to perform an AC calibration of the probe, which properly captures the response. Increasing the spacing to 250 mil degrades the performance some, but PrecisionProbe can be used to compensate or qualify the effect.

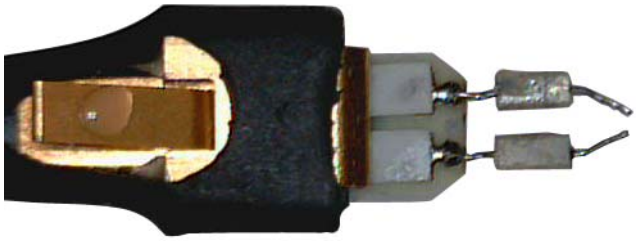


Figure 24 Proper Position of Resistors

Soldering a ZIF tip to the DUT

Before using the following procedure, refer to "Soldering Tips" on page 70.

CAUTION The ceramic ZIF tips are very fragile. They must be manufactured in this way in order to meet the high-performance, high bandwidth applications they are intended for. Be extremely careful when handling.

1 Break off a ZIF tip/handle combination from the packaging holder at the point shown in the figure.

Figure 25 Five ZIF Tips on Packaging

2 Flux and tin the leads on the target DUT.

Figure 26 Preparing the DUT Leads

3 While holding the plastic form, form the ZIF tip wires to match the DUT's pitch and angle.

4 Flux the ZIF tip wires and DUT leads.

5 Position the ZIF tip with the gold traces facing up as shown in Figure 27 on page 47 and carefully re-flow the solder. This orients the tip so that it will properly mate with the probe head.

NOTE When soldering the tip to your DUT, use the tip handle to hold the tip. This allows you to position these small tips without damaging them.

CAUTION Do not dwell on this solder joint.

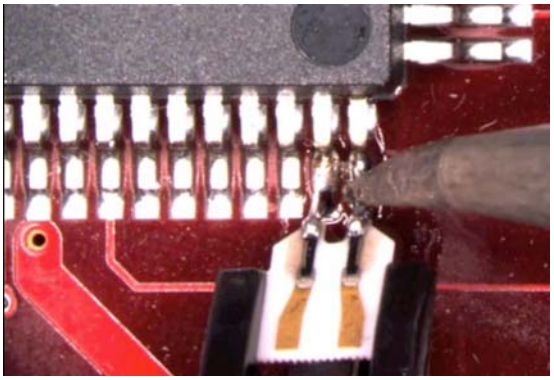


Figure 27 Soldering the ZIF Tip

6 Pull the ZIF handle from the ZIF tip in the direction shown in Figure 28. ZIF tips can be carefully handled with your fingertips and reinserted into a plastic handle if necessary.

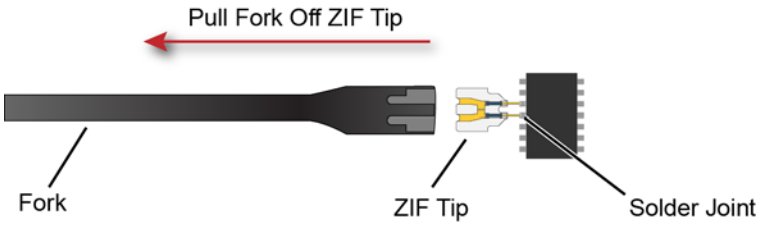


Figure 28 Removing the Handle from the ZIF Tip

7 You can connect ZIF tips to any of the locations on a DUT that you need to probe. The probe head can be quickly moved between the tips.

CAUTION Always mechanically strain-relieve the ZIF head *before* using to protect both your probe accessories and DUT from damage. Refer to "Strain Relieving the Probe Heads" on page 68.

CAUTION Be careful not to damage the tip wires when handling the ZIF tips. Wires can be carefully reshaped with tweezers or fingers if necessary.

Connecting the probe head to the ZIF tip

1 Add strain relieve for the ZIF probe head as described in "Strain Relieving the Probe Heads" on page 68.

2 Form the coaxial cables to bring the probe head near the tip. Press the lever down on the ZIF probe head (see Figure 29) and slide the probe head onto the tip. Pressing on this lever removes the clamping force of the connector and enables you to insert or remove ZIF tips.

CAUTION Stop if you encounter any resistance at all when sliding the probe head over the ZIF tip. Check your alignment, make sure the lever is pressed, and try again. Inserting the ZIF tip should require “zero” insertion force.

CAUTION Always use the lever when inserting or removing ZIF tips.

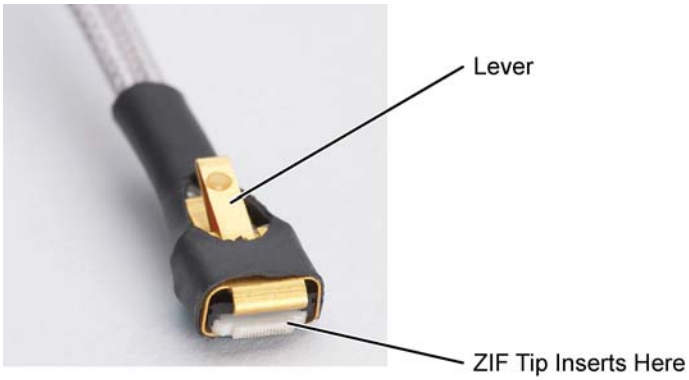


Figure 29 Probe Head with Location of the Lever

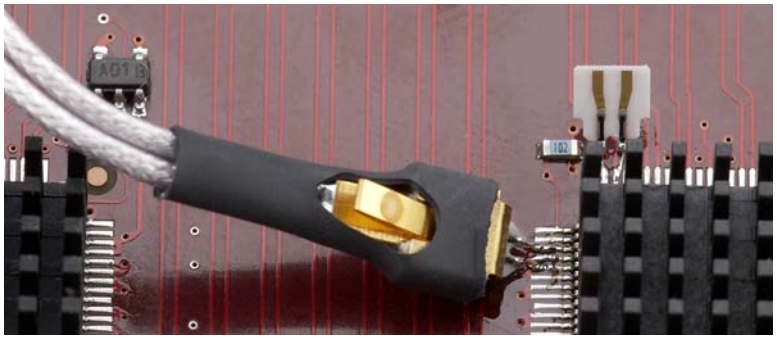


Figure 30 Probe Head Connected to a Soldered ZIF Tip

NOTE For more repeatable results, orient the probe connection perpendicular to the device as shown in Figure 31 on page 49.

3 To move the probe head to a different tip, press the lever and remove the probe head from the ZIF tip. The ZIF tip remains soldered to the DUT. Then, simply connect the ZIF head to another ZIF tip at a different location on the DUT.

Figure 31 Probe Oriented Perpendicular to Device

3 N5445A InfiniiMax III Differential Browser Probe Head

The N5445A browser head (30 GHz) is the best choice for the general-purpose trouble shooting of differential signals with spring-loaded tips and variable spacing from 20 mil to 125 mil (or 0.5 mm to 3.1 mm).

The span between the signal tips is easily adjusted with a thumb wheel on the browser (see Figure 32).

Table 11 Bandwidth

Probe Amplifier	BW	Probe Amplifier	BW
N2830A	4 GHz	N7000A	8 GHz
N2831A	8 GHz	N7001A	13 GHz
N2832A	13 GHz	N7002A	16 GHz
		N7003A	20 GHz

NOTE For performance plots, refer to Chapter 6, “Performance Plots.

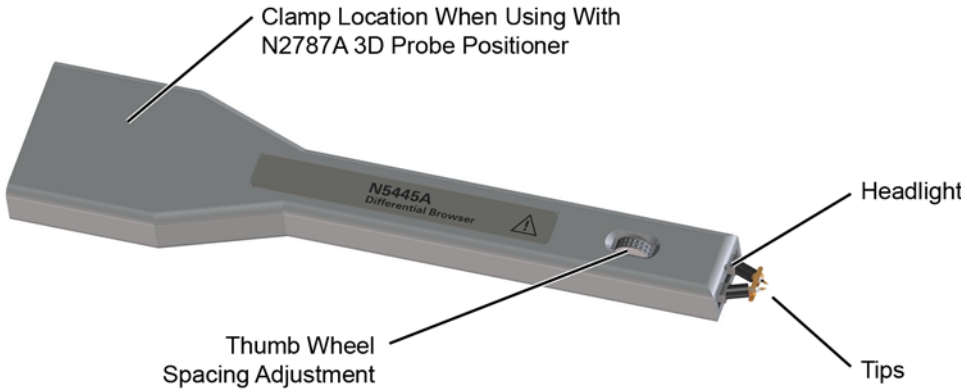


Figure 32 N5445A InfiniiMax III Differential Browser Head

Using the LED headlights

The browser’s tip includes an LED headlight that illuminates the probing area for better visibility. The headlight intensity can be controlled from the oscilloscope’s **Probe Amplifier** dialog box when using an N2830/1/2A or N7000/1/2/3A probes. On N7000/1/2/3A probes, you can also use the **Light** button. Pressing and holding this button will ramp the intensity of the headlight.

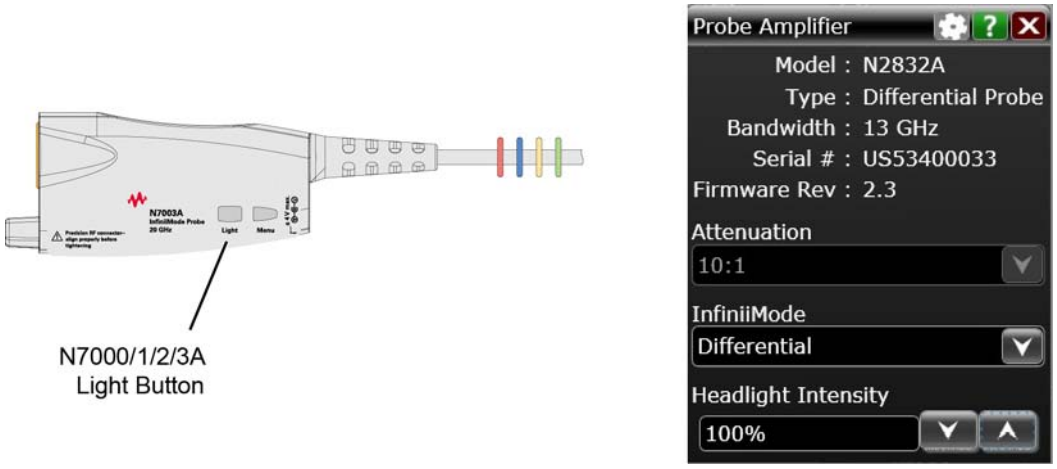


Figure 33 Headlight Intensity from N7000/1/2/3A Light Button or Dialog Box

Adjusting the tip span

Turn the browser's thumb wheel (see Figure 34) to adjust the tip spacing from 20 to 125 mil (0.5 mm to 3.1 mm). Do not force the adjustment near the end of its range.

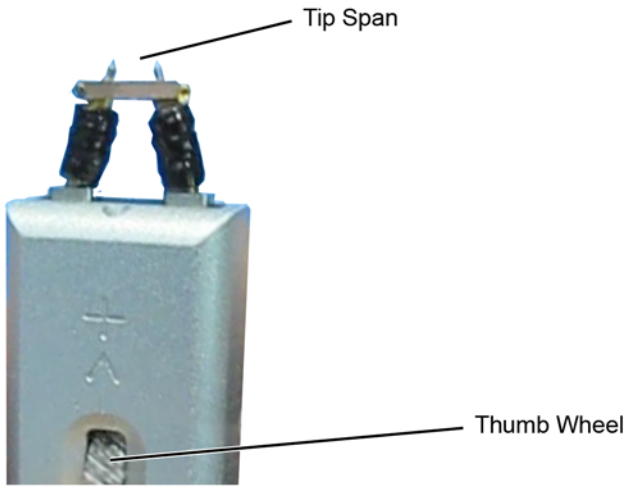


Figure 34 Adjusting the Tip Span

Tip-span entry for probe calibration

When calibrating the probe, you will be prompted to enter the span setting on the oscilloscope's Probe Calibration dialog box. To determine the tip span, do the following steps:

1. Adjust the browser's tip span for your measurement.
2. Locate the tip-span gauge on the browser's protective cap as shown in Figure 35.
3. Determine which of the three possible tip-span settings most closely matches the browser's tip span.

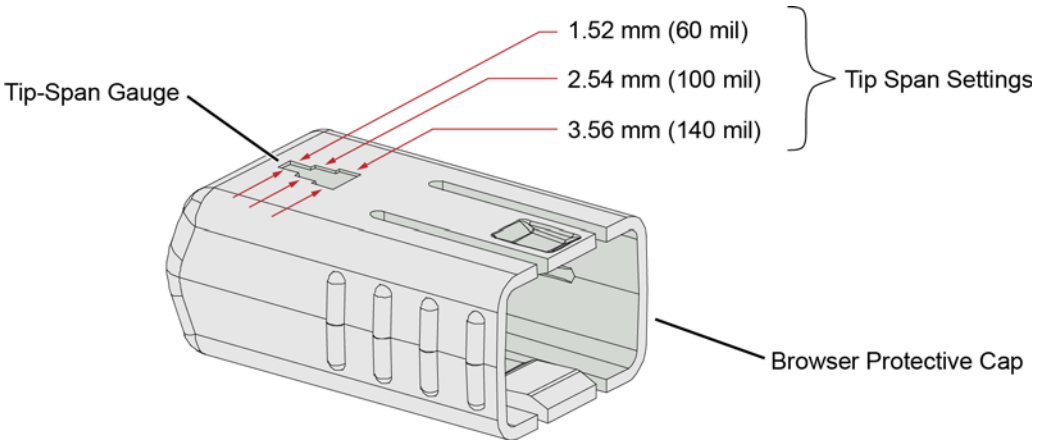


Figure 35 Tip Span Gauge on Browser Protective Cap

Mounting the Browser

There are two holes on the back side of the browser. Use these holes to mount the browser to a customer designed holder. Figure 36 below shows the dimensions of these mounting holes.

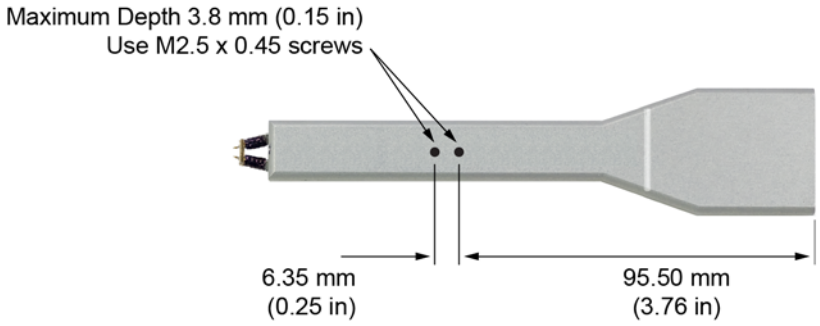


Figure 36 Dimensions of Mounting Holes

Probe along the browser's axis

To prevent tip damage, probe along the browser's axis as shown in Figure 37. Hold the probe vertical and perpendicular to the circuit board.

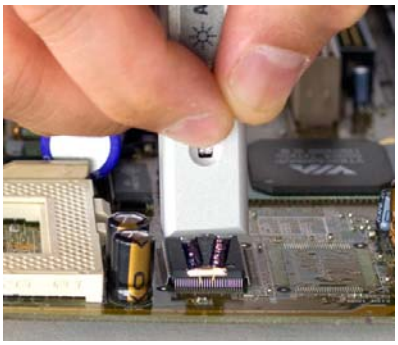


Figure 37 Proper Probe Handling

CAUTION To avoid damaging the browser's tips, do not apply a side load to the browser.

Figure 38 Improper Probe Handling

CAUTION Do not apply too much force when browsing. The weight of the probe in your hand should be sufficient. The axial travel of the probe is about 15 mils (0.4 mm).

CAUTION The browser's protective cap should be kept on the browser at all times except when probing.

CAUTION Always remove the browser from the device under test (DUT) before disconnecting the probe amp from the oscilloscope.

Replaceable parts

Figure 39 shows the replaceable parts for th N5445A.

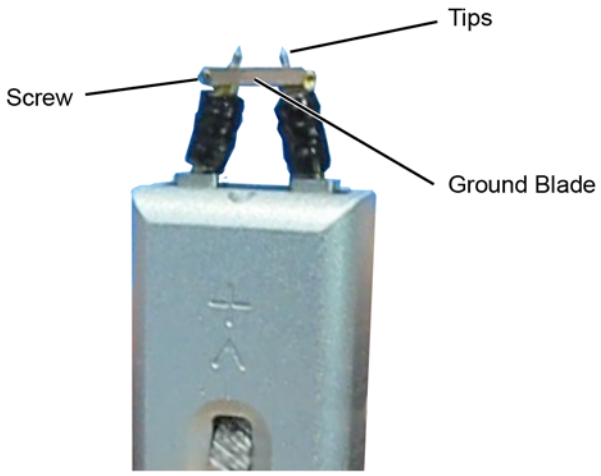


Figure 39 Browser Tips and Ground Blade

Table 12 N5445A Replaceable Parts

Description	Qty	Part Number
Browser tips	4	N5476A
Ground Blade	1	N4855A
Ground Blade Screws	1	N4856A

N2787A 3D probe positioner

Using the N2787A 3D probe positioner with the N5445A browser probe head reduces the chance of breaking the browser tips and ensures that the tips maintain solid contact. Use the following steps to position the probe using the N2787A:

1. Lock the vertical compliance of the probe positioner.
2. Clamp the browser into the positioner, aligning the browser's slot with the positioner's gripping pad.
3. While holding the browser, loosen the main knob and position the probe.
4. Use the browser's own weight to depress the tips, and tighten the main knob to lock the probe's position.

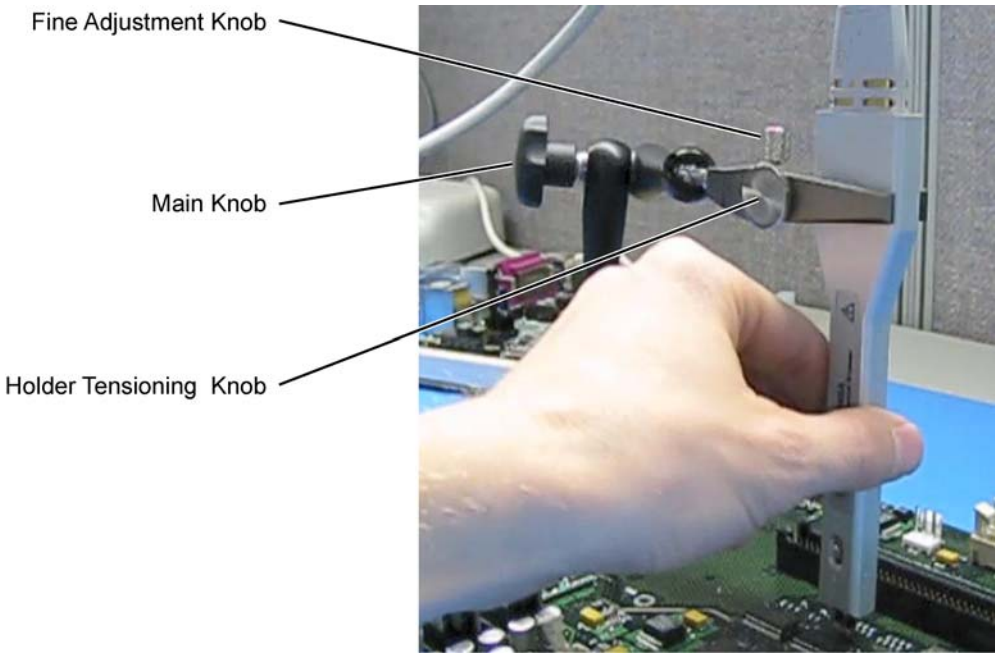


Figure 40 Using the Browser with the N2787A 3D Probe Positioner

4 N5441A InfiniiMax III Solder-In Head

The N5441A InfiniiMax III solder-in probe head is an economical semi-permanent connection that provides up to 16 GHz of system bandwidth. Variable span of the leads ranges from 5 mil to 80 mil (0.127 mm to 2 mm).

The N5441A probe head can be used with the N5450B InfiniiMax extreme temperature extension cable. This is the *only* InfiniiMax III probe head that can withstand the –55°C to +150°C extreme temperature range (for up to 250 test cycles).

Table 13 Bandwidth

Probe Amplifier	BW	Probe Amplifier	BW
N2830A	4 GHz	N7000A	8 GHz
N2831A	8 GHz	N7001A	13 GHz
N2832A	13 GHz	N7002A	16 GHz
		N7003A	20 GHz

CAUTION When using the N5450B extension cable, do not subject the InfiniiMax III probe amplifier or probe head (other than the N5441A solder-in probe head) to extreme temperatures.

Replaceable parts

Extra wire (for solder-in probe head only). 01169-81301 (7 mil), 01169-21306 (5 mil)

NOTE  To install or repair N2838A resistor leads, refer to "Replacing N5441A Probe Head Wires" on page 76.

CAUTION The wires on the N5441A are fragile. They must be manufactured in this way in order to meet the high-performance, high bandwidth applications they are intended for. Be careful when handling.

Soldering the probe head to the DUT

Before using the following procedure, refer to "Soldering Tips" on page 70.

To solder the probe head to your DUT, complete the following steps. The procedure is very similar to that for the ZIF probe tips used with the N5439A probe head.

1. Position the probe head near the location on the DUT where you want to solder the probe.
2. Add strain relieve for the probe head as described in "Strain Relieving the Probe Heads" on page 68.
3. Apply flux to your target leads as shown in Figure 41.

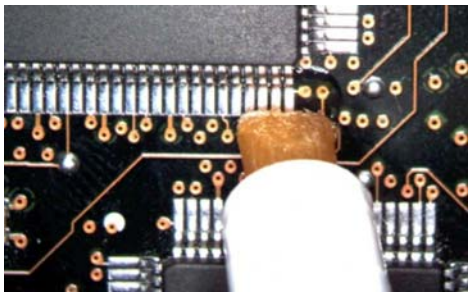


Figure 41 Applying Flux

4. Tin the leads with a small amount of solder.

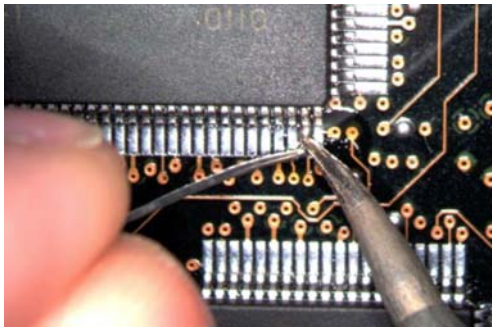


Figure 42 Tin the Leads

5. Use tweezers to form the probe head wires to fit your DUT's geometry.
6. Flux the DUT leads and your probe head wires.

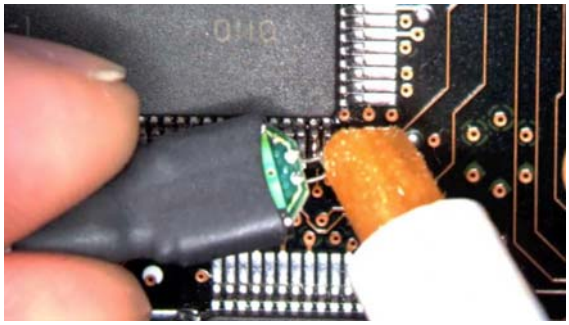


Figure 43 Applying Flux to Leads and Wires

7 Position the probe head wires on the DUT leads and quickly re-flow the solder as shown in Figure 44.

CAUTION Do not leave the iron in contact with the probe head for more than a few seconds at a time.

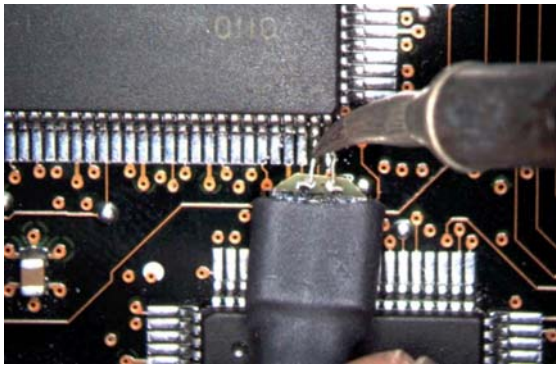
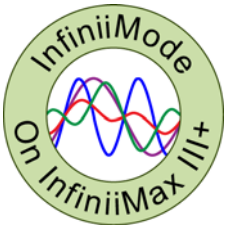


Figure 44 Positioning Wires

5 N2836A InfiniiMode Solder-In Head



The N2836A InfiniiMax III solder-in probe head (26 GHz) is an economical semi-permanent connection. This is an InfiniiMode probe head (like the N2848A) which allows you to make differential, common mode, and single ended measurements without having to re-solder the tip leads. Because this is an InfiniiMode compatible head, the tip has two signal leads and two ground leads. To learn about InfiniiMode, refer to "To Use InfiniiMode" on page 22.

The ground leads have minimal effect on differential measurements. However, if you are making only differential measurements you can optionally cut off the ground leads or fold them out of the way. If you have older N2836A probe heads, you can easily add ground leads.

The variable span of the tip leads ranges from 5 mil to 250 mil (0.127 mm to 6.35 mm).

Table 14 Bandwidth

Probe Amplifier	BW	Probe Amplifier	BW
N2830A	4 GHz	N7000A	8 GHz
N2831A	8 GHz	N7001A	13 GHz
N2832A	13 GHz	N7002A	16 GHz
		N7003A	20 GHz

NOTE

To install or repair N2838A resistor leads, refer to "Replacing Axial Resistor Tips" on page 72.

NOTE

For performance plots, refer to Chapter 6, "Performance Plots.

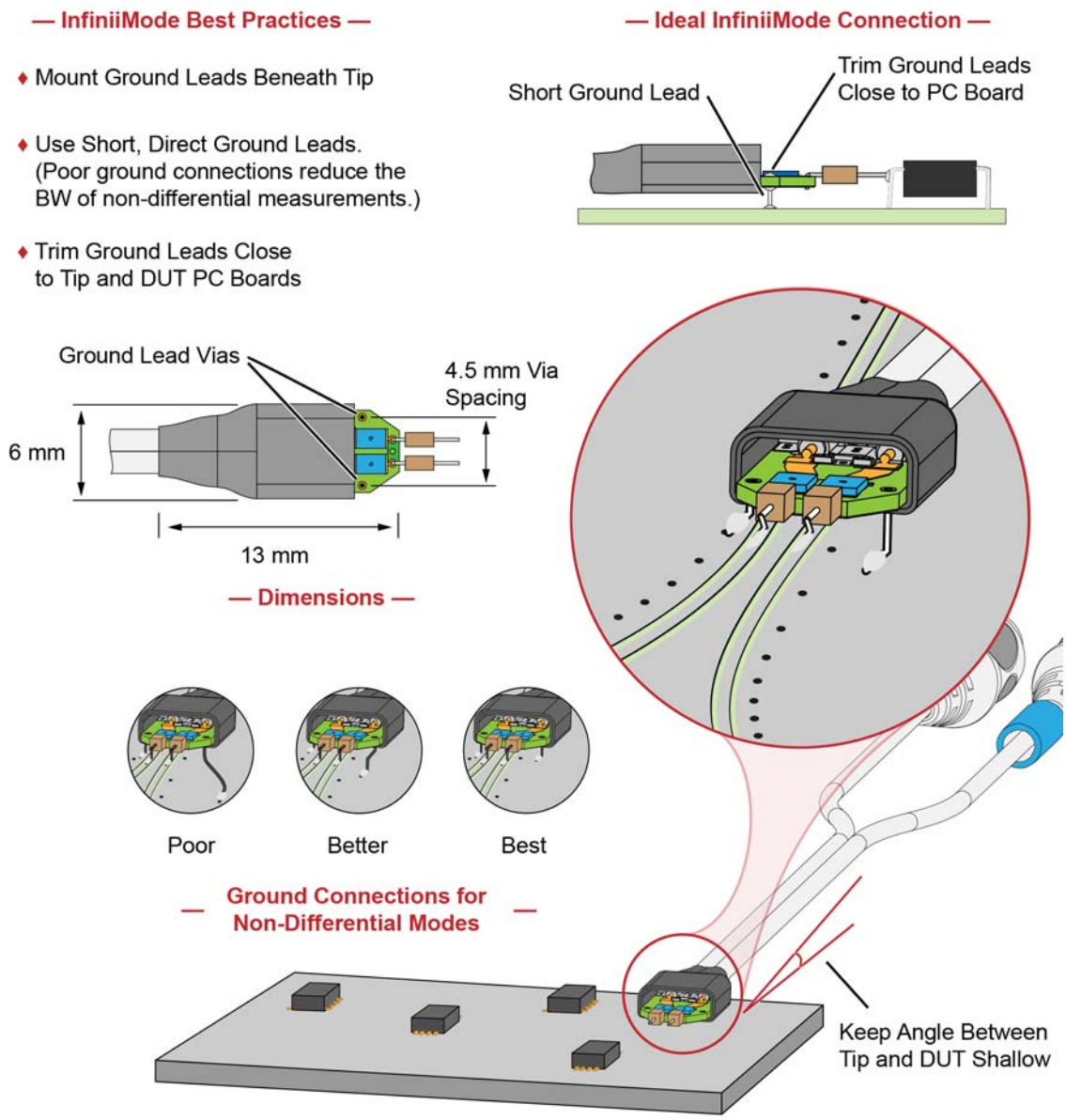


Figure 45 Probe Head Connection to DUT (*InfiniiMode*)

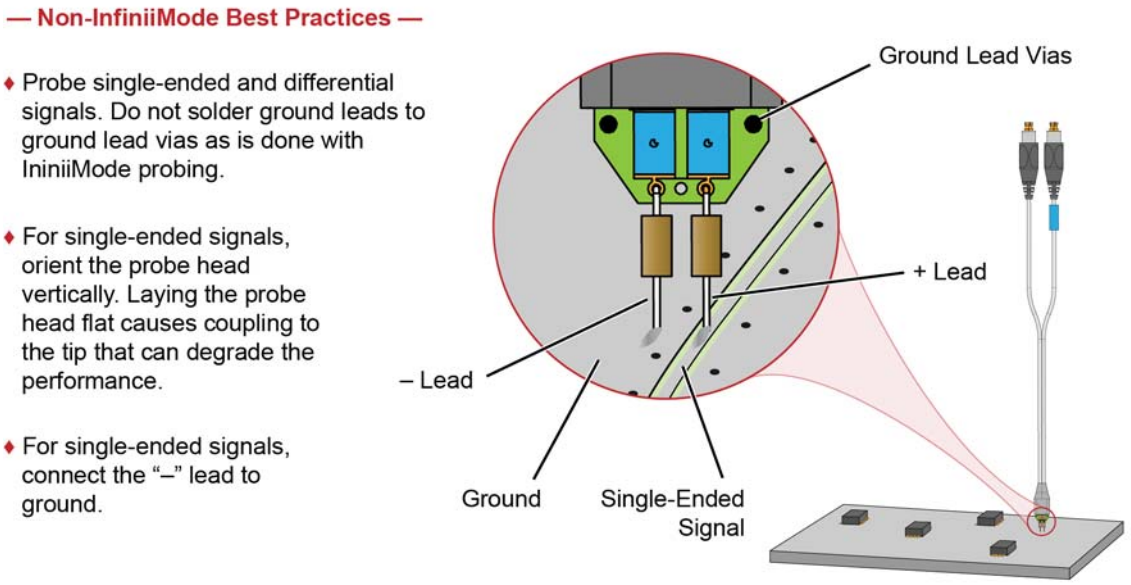


Figure 46 Probe Head Connection to DUT (*Non-InfiniiMode*)

Ensuring maximum performance

The specifications and performance plots of the N2836A probe head were measured with a nominal spacing of 40 mil (1 mm). In order to achieve the proper response as shown in the performance plots, keep the mini-axial lead *resistors* roughly parallel as shown in Figure 47, and use the tip wires on the mini-axial leads to get the desired span.

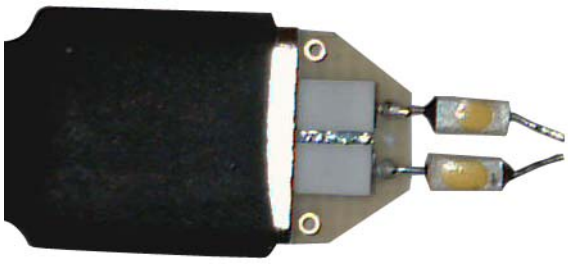


Figure 47 Proper Position of Resistors

If you need to position the mini-axial lead resistors different than shown in this figure (that is, resistor bodies close together or spread way apart), use N2807A and N2808A PrecisionProbe products to perform an AC calibration of the probe.

The AC calibration will properly capture the response. Increasing the spacing to 250 mil will degrade the performance some, but Precision Probe can be used to compensate or qualify the effect.

CAUTION

The axial resistors on the N2836A solder-in probe head are fragile. They must be manufactured in this way in order to meet the high-performance, high bandwidth applications they are intended for. Be careful when handling.

Soldering the probe head to the DUT

Before using the following procedure, refer to "Soldering Tips" on page 70.

To solder the probe head to your DUT, complete the following steps. The procedure is very similar to that for the ZIF probe tips used with the N5439A probe head. This procedure does not show soldering the ground leads, but the same techniques are used.

1 Apply flux to your target leads as shown in Figure 48.

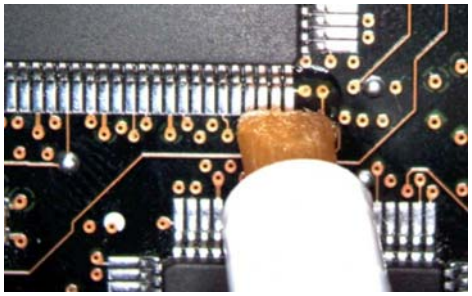


Figure 48 Applying Flux

2 Tin the leads with a small amount of solder.

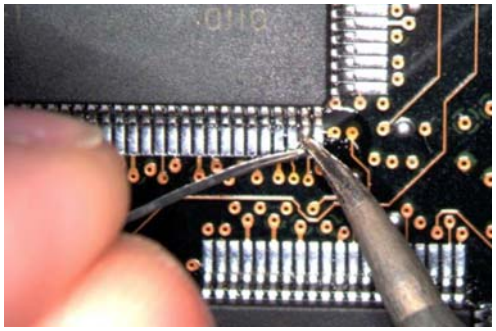


Figure 49 Tin the Leads

3 Use tweezers to form the probe head wires to fit your DUT's geometry.

4 Flux the DUT leads and your probe head wires.

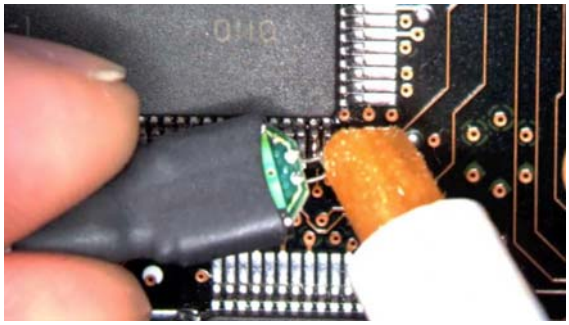


Figure 50 Applying Flux to Leads and Wires

5 Position the probe head wires on the DUT leads and quickly re-flow the solder as shown in Figure 51.

CAUTION Do not leave the iron in contact with the probe head for more than a few seconds at a time.

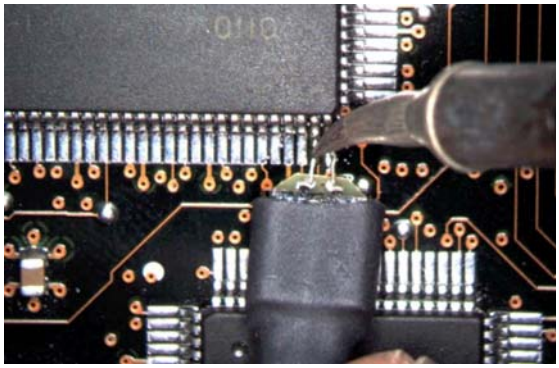


Figure 51 Positioning Wires

6 N2848A QuickTip InfiniiMode Probe Head

The N2848A QuickTip probe head is used with an N2849A QuickTip and together they provide the following advantages:

- InfiniiMode on InfiniiMax III+ (N2830/1/2A and N7000/1/2/3A probe amplifiers). InfiniiMode allows you to make differential, common mode, and single ended measurements without having to re-solder the tip leads.
- Easy-to-make secure magnetic mechanical connection between the probe head and QuickTip. Three magnets in the head connect the two sides of a differential signal and a ground. No latch lever is used!

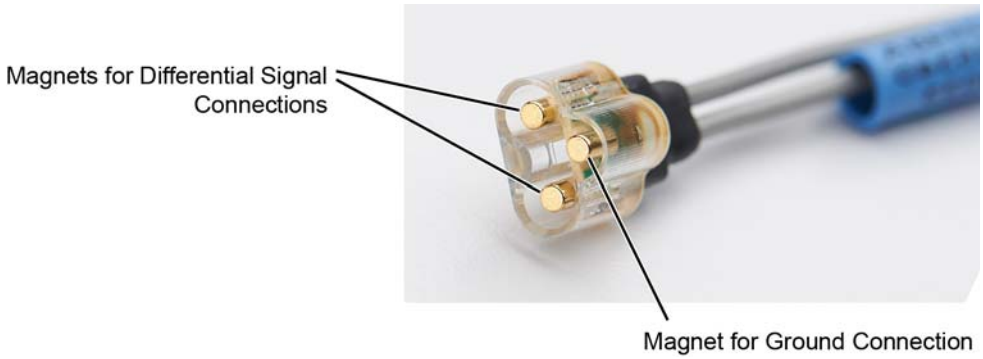


Figure 52 Magnet Connections in Probe Head

- Extreme temperature environments such as temperature chambers.

Table 15 Bandwidth

Probe Amplifier	BW	Probe Amplifier	BW
N2830A	4 GHz	N7000A	8 GHz
N2831A	8 GHz	N7001A	13 GHz
N2832A	>12 GHz	N7002A	16 GHz
		N7003A	>16 GHz

Permanently solder any number of QuickTips to your DUT as shown in Figure 53 on page 65. Because the probe head is magnetically connected (instead of mechanically connected) to the QuickTip, you can effortlessly connect and disconnect to each QuickTip. For best performance, position the QuickTip vertically on the DUT. Because this is an InfiniiMode compatible head, the tip has two signal leads and two ground leads. To learn about InfiniiMode, refer to "To Use

InfiniiMode" on page 22. The ground leads have minimal effect on your differential measurements. However, if you are making only differential measurements you can optionally cut off the ground leads or fold them out of the way. Be aware that without the ground leads, the mechanical stability of the QuickTip will be reduced and you will need to stabilize the probe head.

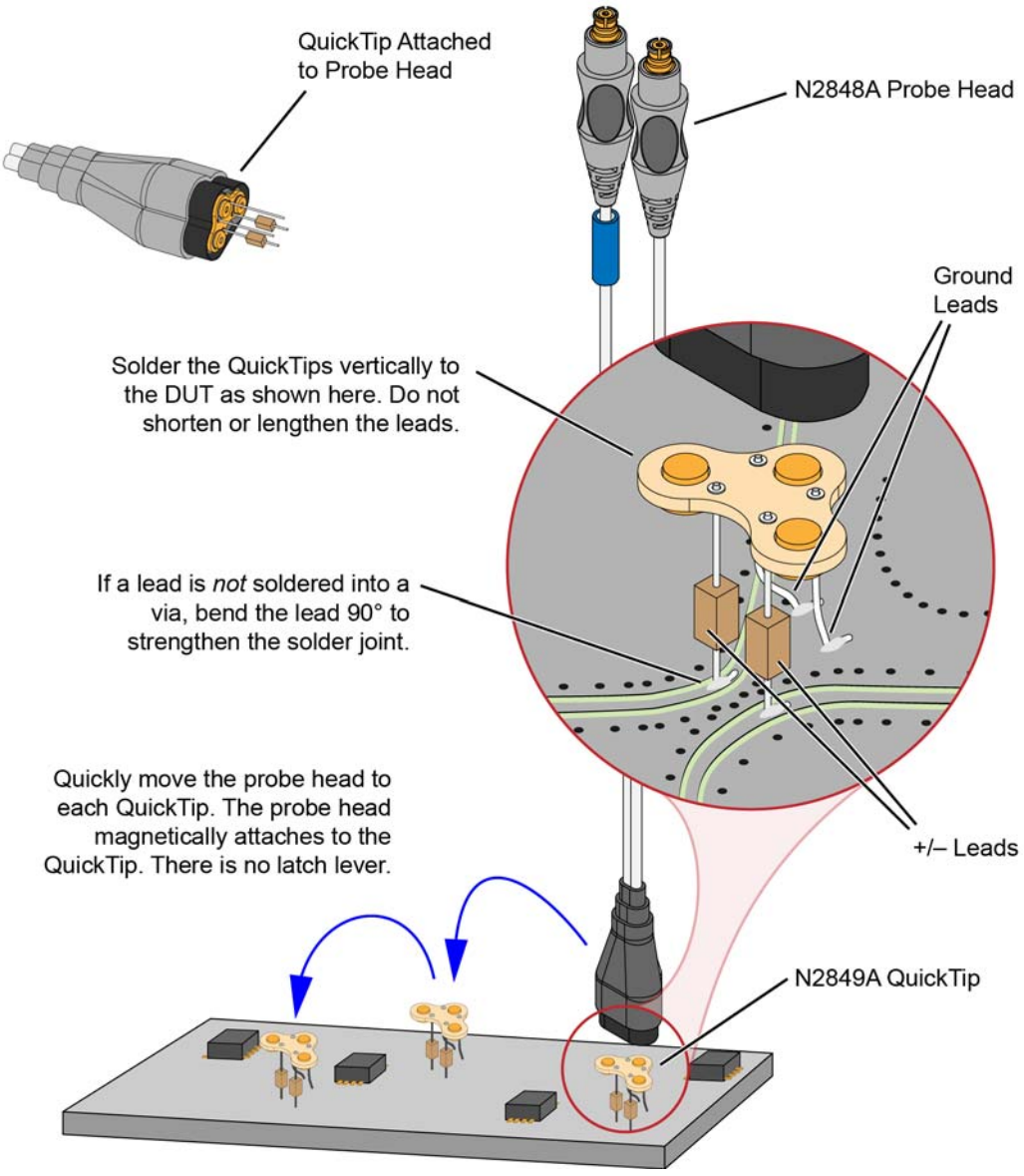


Figure 53 Probing with the N2848A Probe Head and QuickTip

NOTE N2849A QuickTips are also compatible with N2851A QuickTip Probe Heads, which are designed for 1130/1/2/4A InfiniiMax I and 1168/9A InfiniiMax II probes.

CAUTION Do not replace or repair the N2849A QuickTip's resistor or ground leads. Attempting to do so will damage the ability of the tip to mate with the N2848A probe head.

NOTE The N2848A does not include any N2849A QuickTips. The N2849A must be ordered separately.

NOTE Before connecting the QuickTip head to the tip, use the tack-putty (N5439-65201) included with the N2848A QuickTip probe head or the N2787A 3D probe positioner for securing the probe amplifier to a rigid body near the DUT.

NOTE For performance plots, refer to Chapter 6, "Performance Plots.

Connecting a QuickTip to the DUT

Use the following tips when soldering the QuickTips to your DUT:

- Orient the QuickTip vertically as shown in Figure 53 on page 65.
- Solder the four leads to vias or surfaces.

CAUTION Always mechanically strain-relieve the QuickTip head *before* using to protect both your probe accessories and DUT from damage. Refer to "Strain Relieving the Probe Heads" on page 68.

NOTE Resistor and wire leads on the QuickTip are factory trimmed to the proper length for use. Adding wire length to the tip of the mini-axial lead resistors or to the ground leads will degrade the performance of the probe.

NOTE Soldering the ground wires is not required when making differential or single-ended (+ or – leads) measurements.

- When soldering to a via, always trim the lead close to the via's underside.
- If a lead is to be soldered to a surface and *not* a via, make a stronger solder joint by bending the end of the lead 90°. For signal leads, bend the wire approximately half way between the resistor and the end of the wire. Bend the ground leads at about the same distance.

CAUTION Be careful not to damage the tip wires when handling the QuickTips. Wires can be carefully reshaped with tweezers or fingers if necessary.

CAUTION The QuickTips are very fragile. They must be manufactured in this way in order to meet the high-performance, high bandwidth applications they are intended for. Be extremely careful when handling.

Cleaning the Magnetic Connections

If the three magnetic connections in the head become dirty, clean the connections using the following steps:

1. Use compressed air or a cloth to remove any loose dirt.
2. Gently rub a small piece of tack putty (supplied with the probe) against the magnetic connections to clean off any remaining surface grime.

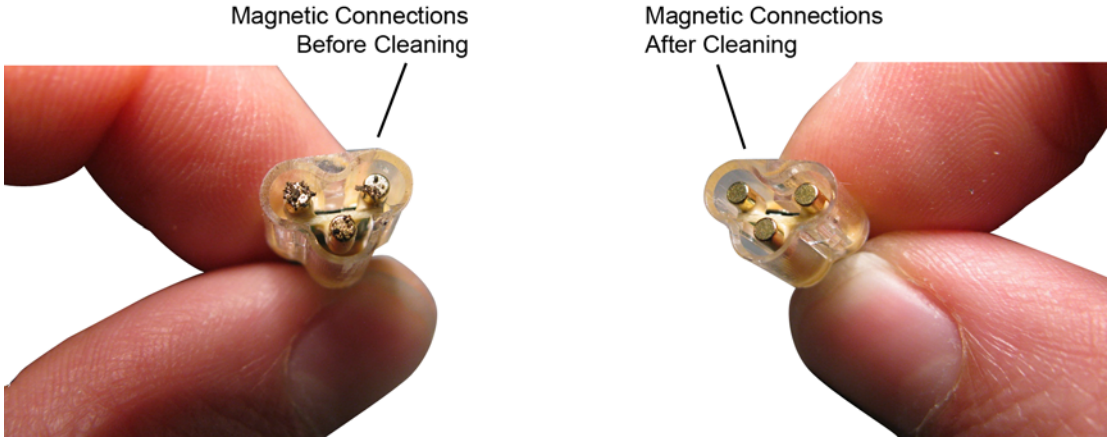


Figure 54 N2848A Head Before and After Cleaning

Strain Relieving the Probe Heads

High-performance probes have small physical geometries to ensure the lowest possible loading and best electrical response. Because of their small size, probing accessories are often delicate. It is important to mechanically secure your probes to protect both your equipment and designs from damage. Although tack putty and low-temperature hot glue are recommended, you can also use other methods such as tape or hook-and-loop strain relief. Keep in mind that different accessories have different cable stiffness. You should choose a strain relief method appropriate for the cable stiffness. For instance, it is best to secure the stiffer N5439A near the SMP connectors and form the cable to the optimal location.

CAUTION **Do not kink cables. Do not crush cables. Do not use aggressive adhesives or high temperatures.**

Tack-putty

Keysight recommends the use of tack putty for securing both probe heads and amplifiers. Tack putty can be ordered using part number N5439-65201. Wrap a small amount of tack-putty around your probe head cables, taking care to not pinch them. The mass can then be secured to a rigid body neat your DUT.

Similar techniques can be used to secure probe amplifiers where you apply some tack-putty to the underside of the probe amplifier body and attach it to a rigid body near your DUT.

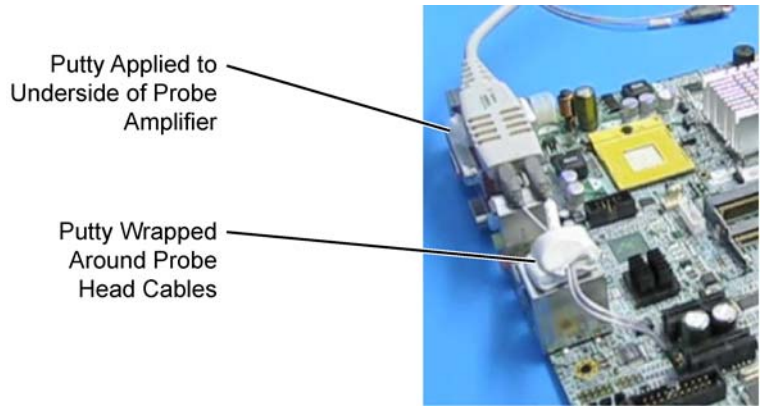


Figure 55 Probe Secured Using Tack Putty

You can also use putty with a positioner, such as the N2787A as shown in Figure 56.

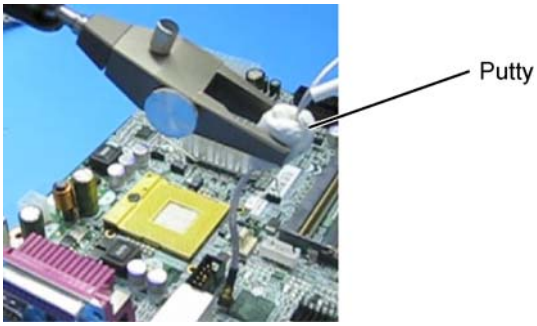


Figure 56 Using Putty With the N2787A 3D Probe Positioner

The same positioner can also be used to support your probe amplifier as shown in Figure 40 on page 55.

Low-temperature hot glue

You can also use low-temperature hot glue to secure cables.

CAUTION

Only use *low-temperature* hot glue. To remove the hot glue, warm it with a heat gun set on low. Only heat the hot glue enough to remove it.

Figure 57 Probe Secured Using Low-Temperature Hot Glue

Soldering Tips

When using the N5441A and N2836A solder-in heads and N5439A ZIF probe heads, be sure to observe the following guidelines. For more information, refer to the user's guide.

- Use a temperature-controlled soldering iron station, if possible.
- Set the temperature of the soldering iron's tip to between 370° C and 420° C (for non RoHS standards).
- Use the smallest tip possible.
- Use an optical aid of some sort (microscope preferred).
- Employ minimal dwell times on the solder joint (< 2 seconds).
- Solder only the tip of the wire onto your DUT. The solder should not get close to the existing solder ball on the tip.
- Use enough flux when soldering the tips into a DUT.

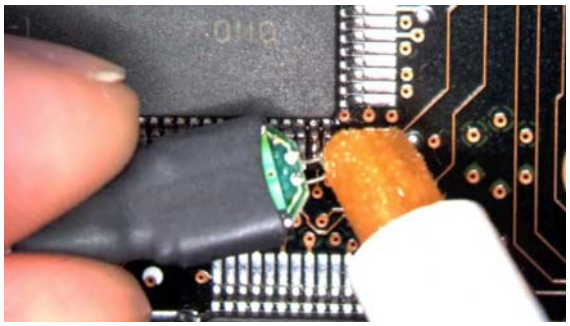


Figure 58 Applying Flux to Leads and Wires

3 Maintaining Probe Heads

Many probe heads come equipped with replaceable resistor or wire tips which can be replaced or repaired. Using the procedures in this chapter, you can extend the life of the following items:

- N2836A probe heads
- N5441A probe heads
- N2838A ZIF tips

CAUTION **Do not replace or repair the N2849A QuickTip's resistor or ground leads. Attempting to do so will damage the ability of the tip to mate with the N2848A probe head.**

Replacing Axial Resistor Tips

The procedure in this sections shows you how to replace the 130 ohm axial resistors that are located at the tip of the

- N2836A solder-in probe head and
- N2838A ZIF tip.

These resistors can become worn or damaged with use. Order the replacement axial resistor kit (N2836-68701) which provides 10 resistors.

NOTE **The pictures in the following procedure show the N2836A solder-in probe head, but the same procedure applies to the N2838A ZIF tip.**

Recommended equipment

- Vise or clamp for holding tip.
- Metcal STTC-022 (600 °C) or STTC-122(700 °C) tip soldering iron or equivalent. The 600 °C tip will help limit burning of the FR4 tip PC board.
- 0.381 mm (0.015 in) diameter RMA flux standard tin/lead solder wire.
- Fine stainless steel tweezers.
- Rosin flux pencil, RMA type (Kester #186 or equivalent).
- Diagonal cutters.
- Magnifier or low power microscope.
- Ruler.

CAUTION **As the probe heads and tips are easily damaged, only experienced soldering technicians should attempt this repair.**

Procedure

1 As shown in Figure 59, clamp the probe head or ZIF tip in a vise. Tweezers can be used to hold the probe head or ZIF tip away from the vise. When using tweezers, grip the tip either on the sides or top and bottom.

CAUTION **When tightening the vise, use light force to avoid damaging the solder-in probe head.**

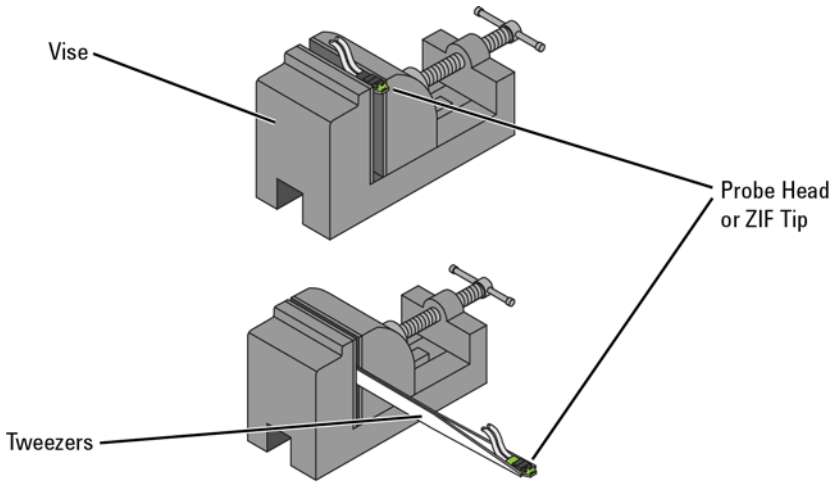


Figure 59 Clamping the Part

2 Grab each resistor lead or wire with tweezers and pull very gently up. Touch the soldering iron to solder joint just long enough for the resistor to come free of the probe head tip.

Figure 60 Removing the Resistor

NOTE Clean the soldering iron tip of any excess solder before using.

NOTE The solder joint has very low thermal mass so the joint will quickly melt and release.

CAUTION To limit burning and damage to the PC board, do not keep the soldering iron in contact with the tip any longer than is necessary.

CAUTION Excessive dwell time with the iron will permanently damage the flip-chip resistor.

3 Use the soldering iron and solder to fill the holes in preparation for mounting the new resistors (or wires).

CAUTION Do not leave the iron in contact with the tip any longer than necessary.

4 Use the flux pencil to coat the solder joint area with flux.

5 Locate the trim gauge which is supplied with the N2836-68701 replacement axial resistor kit.

   a Place a resistor over the lead length gauge shown in Figure 61. Trim the leads to match the drawing. The orientation of the lead is not important.

   b Place a resistor over the bend gauge and bend the leads to match the drawing. This bend fits in the hole in the tip's PC board.

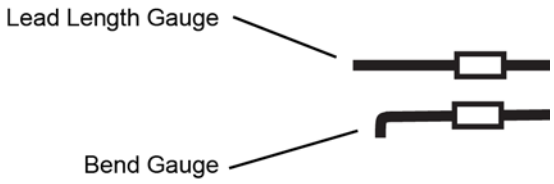


Figure 61 Trim Guage

6 Holding the resistor lead or wire in one hand and soldering iron in the other, position the end of the resistor lead (after the 90 degree bend) over the solder filled hole.

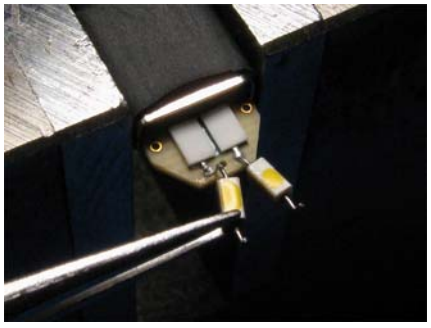


Figure 62 Soldering in a new axial resistor

7 Touch the soldering iron to the side of the hole. When the solder in the hole melts, the resistor lead will fall into the hole.

CAUTION Remove the soldering iron as soon as the lead falls into the hole.

NOTE Because the thermal mass of the joint is very small, extra dwell time with the soldering iron is not needed to ensure a good joint.

8 Using a digital volt meter, measure the resistance from the coax center conductor to the resistor tip. The DC resistance should measure 450 ohms.

Replacing N5441A Probe Head Wires

Use the following procedure to install or replace the wire leads on the N5441A solder-in probe head. Depending on your probing application, you can order either 5 mil or 7 mil wire as listed in the following table. For example, use the 5 mil wire for attaching to small vias.

Table 16 Required Wire Type

Wire Diameter	Part Number
0.007 inch (tin-plated nickel wires)	01169-81301
0.005 inch (tin-plated nickel wires)	01169-21306

Table 17 Recommended Equipment

Equipment
Vise or clamp for holding tip
Metcal STTC-022 (600 °C) or STTC-122 (700 °C) tip soldering iron or equivalent. The 600 °C tip will help limit burning of the FR4 tip PC board.
0.381 mm (0.015 in) diameter RMA flux standard tin/lead solder wire
Fine stainless steel tweezers
Rosin flux pencil, RMA type (Kester #186 or equivalent)
Flush cutting wire cutters
Magnifier or low power microscope
Keysight supplied trim gauge (01169-23801)

Procedure

1 Use the vise or clamp to position the tip an inch or so off the work surface for easy access.

CAUTION If using a vise, grip the tip on the sides with light force. When tightening the vise, use light force to avoid damaging the solder-in probe head If using a tweezers clamp, grip the tip either on the sides or at the top and bottom.

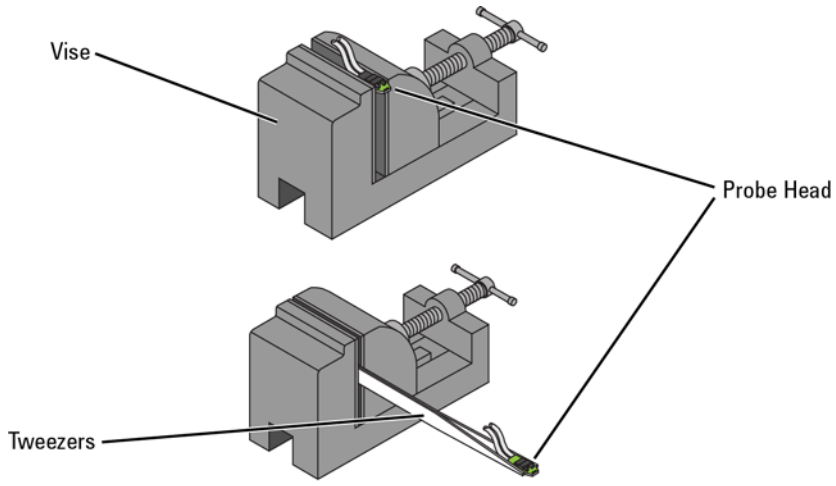


Figure 63 Clamping the Probe Head

2 As shown in Figure 64, remove the old wires with tweezers while re-flowing the solder from the underside of the probe.

CAUTION Apply heat quickly to avoid damaging your probe.

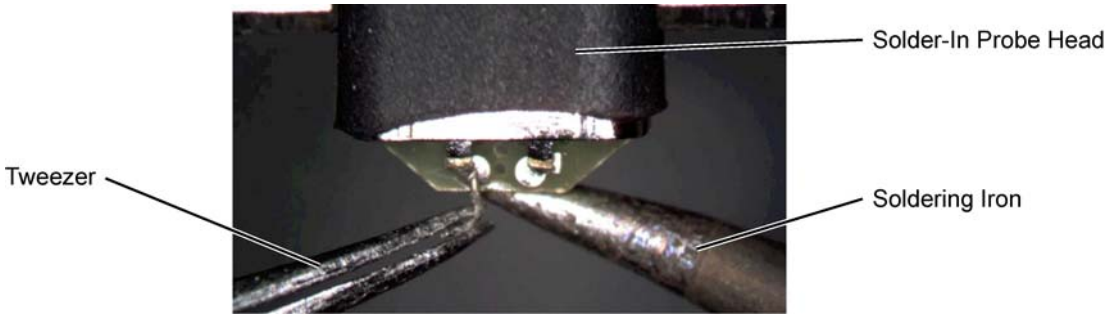


Figure 64 Removing the Old Wire

3 If necessary, add a small amount of solder to the holes and apply flux.

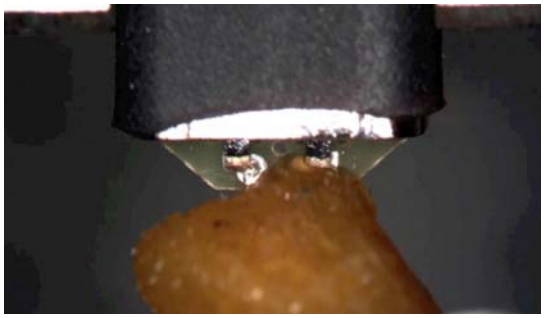


Figure 65 Adding Solder and Flux

4 Re-flow the solder from the underside and insert a new piece of wire. It is best to shape the wire into an "L" before attempting to insert.

CAUTION Do not dwell with the iron in contact with the probe head.

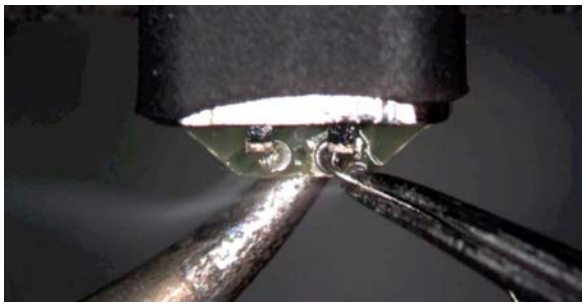


Figure 66 Adding a New Wire

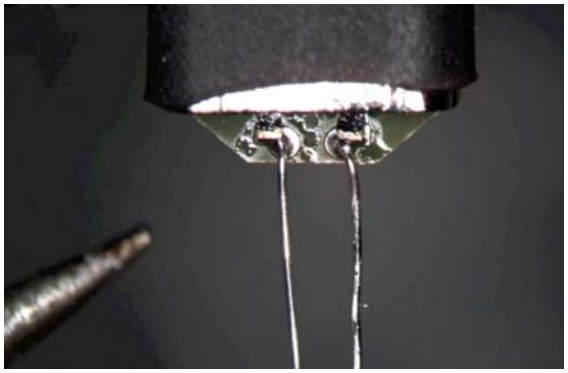


Figure 67 New Wires Properly Attached

5 Trim any wire stubs on the probe head underside.

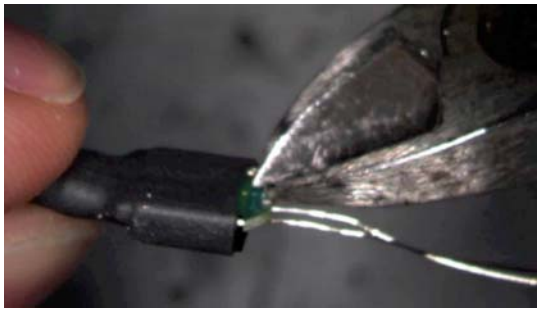


Figure 68 Trim Wire Stubs

6 Use the included trim gauge to cut the wire lengths. Doing so ensures the best performance from your probe head.

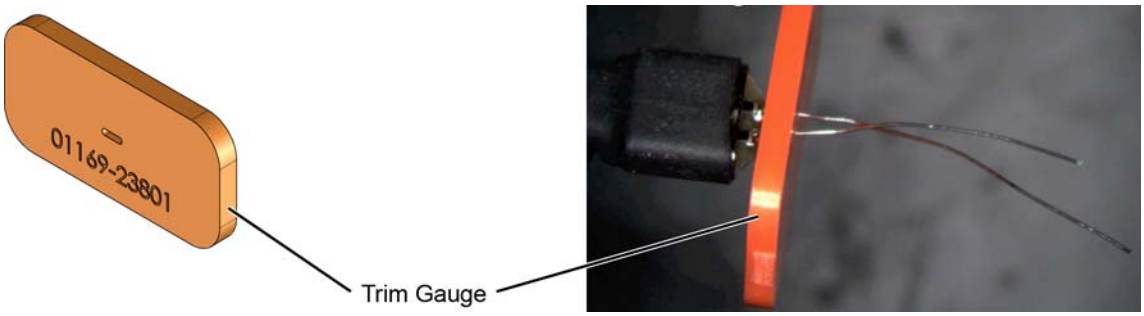


Figure 69 Trim Gauge Placed on Wires

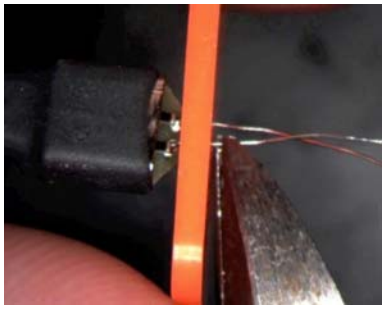


Figure 70 Removing Excess Wire

7 Check the DC resistance of each probe leg when you have replaced the wires. The correct resistance should be 450 ohms.

4 Calibration / Deskew Procedure

The probe calibration and deskew is a guided procedure that you start from the oscilloscope's Probe Calibration dialog box. Depending on the oscilloscope model, you will be instructed to connect the probe head to either of the following oscilloscope outputs:

- Front-panel **Probe Comp** terminals
- **Aux Out** BNC connector or **Cal Out** connector using the N5443A Calibration/Deskew Fixture with 50Ω termination.

NOTE The N5443A fixture promotes the properly position the probe head during the procedure. If you prefer, you can remove the plastic holder from the fixture by removing the four screws on the bottom side of the holder.

CAUTION Always wear an ESD wrist strap when working with active probes. Not doing so can result in the probe becoming permanently damaged.

Procedure

1. Connect the probe to an oscilloscope channel.
2. On the oscilloscope menu, click Setup > Probe Calibration. If you have an N7000/1/2/3A probe, you can press the probe's **Menu** button instead to access the guided calibration procedure.
3. In the dialog box, select the tab that represents the channel for the probe being tested. In the dialog box, click **Start Atten/Offset Cal...**.
4. The dialog box indicates that you can use the oscilloscope's **Probe Comp** terminals or the oscilloscope's **Cal Out** or **Aux Out** connector for the calibration. If you are using the **Probe Comp**, touch the probe head's leads to the **Probe Comp** terminals. If you are using the **Cal Out** (or **Aux Out)** connector, use the N5443A fixture as shown in the following steps:
   a. Connect a 50 ohm termination to the fixture as shown in Figure 71. The termination is provided with the N5443A.

Figure 71 50Ω Terminator on N5443A

   b. As described in the dialog box, connect the fixture to the **Cal Out** or **Aux Out** connector. Turn the nut on the **Cal Out** counter-clockwise to tighten as shown in Figure 72.
   c. While holding the fixture upright with one hand, use an 8 in. lbs. torque wrench to fully tighten the connector as shown in Figure 73.
   d. Detach the probe head from the probe and Insert the probe into the top of the fixture holder as shown in Figure 74. The probe can slide up and down in the holder to adjust the probe head position.

Figure 72 Attaching the N5443A Fixture

Figure 73 Tighten to 8 in. lbs.

Figure 74 Inserting the Probe Head

e Form the N5439A probe head ZIF tip wires as shown Figure 75. If you are using the browser probe head, you do not need to adjust the shape of the tips.

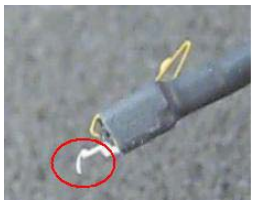


Figure 75 Forming the Probe Head's Tip

f Connect the probe head's two lead cables to the probe amplifier as shown in Figure 76.

Figure 76 Connect the Head to the Probe

g Position the probe head wires (if you are using the ZIF or Solder-in probe heads) so they curl towards the scope as shown in Figure 77.

Figure 77 Positioning the Probe Head Wires

h While pressing down on the N5443A fixture's spring-loaded clamps, insert the probe wires beneath the clamps. The N5443A's clamps, ground, and signal path are identified in Figure 78.

NOTE To check that the wires are connected correctly, press the oscilloscope's autoscale button and confirm that a stable step on screen. You will need to re-open the Probe Calibration dialog box).

CAUTION When connecting the probe head to the fixture, do not press down with much force or you could snap off the fixture from the **Cal Out** or **Aux Out** connection. Light contact is all that is needed for the calibration.

CAUTION Never solder a probe tip to the thickfilm gold. The gold will immediately dissolve into the solder and disappear.

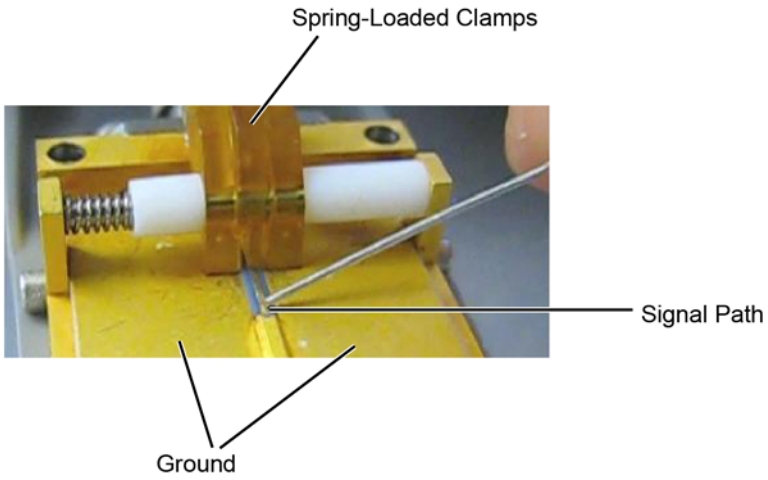


Figure 78 Closeup of Fixture's Signal Path, Ground, and Clamps

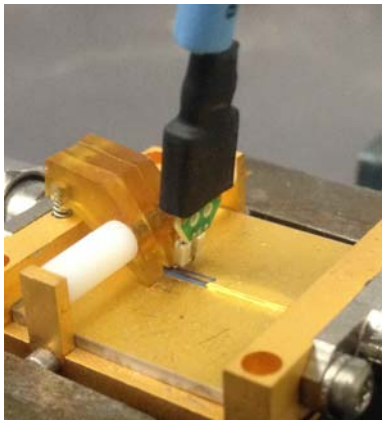
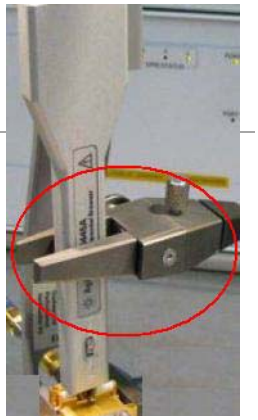


Figure 79 Clamping the Probe Head's Leads

NOTE

If you are using the browser probe head, it is recommended that you use the N2787A 3D Probe Positioner to hold the browser in place as shown here. The browser uses spring-loaded tips so you do not need much force to get a solid contact.



5 In the Probe Calibration dialog box, start the calibration.

6 When the calibration has completed, perform the skew calibration.

5 Specifications and Characteristics

All characteristics are the typical performance values of the InfiniiMax probes using the InfiniiMax III+ probe amplifiers and each different probe head except otherwise specified.

N2830/1/2A Probe Amplifier Specifications and Characteristics

The characteristics listed in the Table 18 are mainly determined by the N2830/1/2A probe amplifiers.

NOTE All entries are characteristics unless otherwise noted. Bandwidth and DC input resistance (R_{se} and R_{diff}) are the only specifications.

Table 18 Probe Amplifier Characteristics (Sheet 1 of 2)

Item	N5439A, N5441A, N2836A, N2848A	With N5444A Probe Head (2.92 mm, SMA, 3.5 mm)
Bandwidth *(specification)*		
N2832A	13 GHz	
N2831A	8 GHz	
N2830A	4 GHz	
DC Input Resistance *(specification)*	R_{se} = 50 kΩ ± 2% each input to ground R_{diff} = 100 kΩ ± 2% R_{cm} = 25 kΩ ± 2% *(characteristic)*	55Ω to V_{term} *(characteristic)*
Input Resistance (> 10 KHz)	R_{se} = 500Ω ± 2% each input to ground R_{diff} = 1 kΩ R_{cm} = 250Ω	50Ω to 0.901 * V_{term}
Input Voltage Range (Differential or Single Ended)	2.5 Vpp or ±1.25V @ 5:1 attenuation 5.0 Vpp or ±2.50V @ 10:1 attenuation	2.5 Vpp or ±1.25V @ 5:1 attenuation 5.0 Vpp or ±2.50V @ 10:1 attenuation without violating maximum input power
Maximum Input Power	N/A	125 mW calculated with the following equation for each input: $P_{max} = \frac{(\text{rms}_{(V_{in} - V_{term})})^2}{55}$
Input Common Mode Range	±7 V_{DC} to 100 Hz, ±1.25V > 100 Hz at 5:1 attenuation ±2.5V > 100 Hz at 10:1 attenuation	±6 V_{DC} to 100 Hz, ±1.25V > 100 Hz at 5:1 attenuation ±2.5V > 100 Hz at 10:1 attenuation without violating maximum input power
DC Attenuation Ratio	5:1 or 10:1. Automatically selected based on volts-per-division (all modes)	5:1 or 10:1. Automatically selected based on volts-per-division (all modes)
Offset Range (for probing a single-ended signal)	±16V	±6V without violating maximum input power

Table 18 Probe Amplifier Characteristics (Sheet 2 of 2)

Item	N5439A, N5441A, N2836A, N2848A	With N5444A Probe Head (2.92 mm, SMA, 3.5 mm)
Input Referred Noise Spectral Density	Diff 5:1 attenuation 33.5 nV/rt(Hz), Diff 10:1 attenuation 53.9 nV/rt(Hz), SE A or B 5:1 attenuation 27.8 nV/rt(Hz), SE A or B 10:1 attenuation 47.7 nV/rt(Hz), CM 5:1 attenuation 21.8 nV/rt(Hz), CM 10:1 attenuation 38.4 nV/rt(Hz)	
Input Referred Noise Example	4.5 mV_{rms} in diff mode 5:1 attenuation with ≥18 GHz probe head and N2832A 13 GHz probe amplifier	4.5 mV_{rms} in diff mode 5:1 attenuation with 28 GHz N5444A probe head and N2832A 13 GHz probe amplifier
Maximum Input Voltage	18 V_{peak} CAT 1	8 V_{peak} without violating maximum input power

N2830/1/2A Probe Head Characteristics

The characteristics listed in the Table 19 are for the N2832A InfiniiMax III+ probe amplifier using different probe heads. The characteristics are mainly determined by the probe head. Performance with the lower bandwidth amplifiers (N2830/1A) is the *lower* of the following values:

- Amplifier BW, 0.434 / amplifier BW, 0.308 / amplifier BW
- Bandwidth measured with the highest bandwidth amplifier (N2832A).

Table 19 Characteristics for Probe Heads Using N2832A

Probe Head	Tip	Input Capacitance		Mode	Bandwidth (–3 dB)	10 – 90% Transition Time	20 – 80% Transition Time
		C_{diff}	C_{se}				
N5439A ZIF	N5440A 450Ω ZIF	32 fF	44 fF	Differential: Single Ended: Common:	13 GHz – –	33.4 ps – –	23.7 ps – –
	N2838A 450Ω ZIF	95 fF	130 fF	Differential: Single Ended: Common:	13 GHz – –	33.4 ps – –	23.7 ps – –
	N5447A 200Ω ZIF	Not compatible with N2830/1/2A probes.					
N5445A 450Ω Browser		35 fF	50 fF	Differential: Single Ended: Common:	13 GHz – –	33.4 ps – –	23.7 ps – –
N5441A 450Ω Solder-In		77 fF	105 fF	Differential: Single Ended: Common:	13 GHz – –	33.4 ps – –	23.7 ps – –
N2836A 450Ω Solder-In Head vertically oriented with no ground wires		108 fF	140 fF	Differential: Single Ended: Common:	13 GHz – –	33.4 ps – –	23.7 ps – –
N2836A 450Ω Solder-In Head oriented flat with minimum length ground wires		108 fF	140 fF	Differential: Single Ended: Common:	13 GHz 13 GHz 13 GHz	33.4 ps 33.4 ps 33.4 ps	23.7 ps 23.7 ps 23.7 ps
N2848A QuickTip	N2849A 450Ω QuickTip	200 fF	340 fF	Differential: Single Ended: Common:	13 GHz 13 GHz 13 GHz	33.4 ps 33.4 ps 33.4 ps	23.7 ps 23.7 ps 23.7 ps
N5444A 2.92, 3.5 mm, SMA		–	–	Differential: Single Ended: Common:	13 GHz 13 GHz 13 GHz	33.4 ps 33.4 ps 33.4 ps	23.7 ps 23.7 ps 23.7 ps

N7000/1/2/3A Probe Amplifier Specifications and Characteristics

The characteristics listed in the Table 20 are mainly determined by the N7000/1/2/3A probe amplifiers.

NOTE All entries are characteristics unless otherwise noted. Bandwidth and DC input resistance (R_{se} and R_{diff}) are the only specifications.

Table 20 Probe Amplifier Characteristics (Sheet 1 of 2)

Item	N5439A, N5441A, N2836A, N2848A	With N5444A Probe Head (2.92 mm, SMA, 3.5 mm)
Bandwidth *(specification)*		
N7003A	20 GHz	
N7002A	16 GHz	
N7001A	13 GHz	
N7000A	8 GHz	
DC Input Resistance *(specification)*	R_{se} = 50 kΩ ± 2% each input to ground R_{diff} = 100 kΩ ± 2% R_{cm} = 25 kΩ ± 2% *(characteristic)*	55Ω to V_{term} *(characteristic)*
Input Resistance (> 10 kHz)	R_{se} = 500Ω ± 2% each input to ground R_{diff} = 1 kΩ R_{cm} = 250Ω	50Ω to 0.901 * V_{term}
Input Voltage Range (Differential or Single Ended)	2.5 Vpp or ±1.25V @ 5:1 attenuation 5.0 Vpp or ±2.50V @ 10:1 attenuation	2.5 Vpp or ±1.25V @ 5:1 attenuation 5.0 Vpp or ±2.50V @ 10:1 attenuation without violating maximum input power
Maximum Input Power	N/A	125 ,mW calculated with the following equation for each input: $P_{max} = \frac{(\text{rms}_{(V_{in} - V_{term})})^2}{55}$
Input Common Mode Range	±7 V_{DC} to 100 Hz, ±1.25V > 100 Hz at 5:1 attenuation ±2.5V > 100 Hz at 10:1 attenuation	±6 V_{DC} to 100 Hz, ±1.25V > 100 Hz at 5:1 attenuation ±2.5V > 100 Hz at 10:1 attenuation without violating maximum input power
DC Attenuation Ratio	5:1 or 10:1. Automatically selected based on volts-per-division (all modes)	5:1 or 10:1. Automatically selected based on volts-per-division (all modes)
Offset Range (for probing a single-ended signal)	±16V	±6V without violating maximum input power

Table 20 Probe Amplifier Characteristics (Sheet 2 of 2)

Item	N5439A, N5441A, N2836A, N2848A	With N5444A Probe Head (2.92 mm, SMA, 3.5 mm)
Input Referred Noise Spectral Density	Diff 5:1 attenuation 33.5 nV/rt(Hz), Diff 10:1 attenuation 53.9 nV/rt(Hz), SE A or B 5:1 attenuation 27.8 nV/rt(Hz), SE A or B 10:1 attenuation 47.7 nV/rt(Hz), CM 5:1 attenuation 21.8 nV/rt(Hz), CM 10:1 attenuation 38.4 nV/rt(Hz)	
Input Referred Noise Example	4.5 mV_{rms} in diff mode 5:1 attenuation with ≥18 GHz probe head and N7001A 13 GHz probe amplifier	4.5 mV_{rms} in diff mode 5:1 attenuation with 28 GHz N5444A probe head and N7001A 13 GHz probe amplifier
Maximum Input Voltage	18 V_{peak} CAT 1	8 V_{peak} without violating maximum input power

N7000/1/2/3A Probe Head Characteristics

The characteristics listed in the Table 21 are for the N7003A InfiniiMax III+ probe amplifier using different probe heads. The characteristics are mainly determined by the probe head. Performance with the lower bandwidth amplifiers (N7000/1/2A) is the *lower* of the following values:

- Amplifier BW, 0.434 / amplifier BW, 0.308 / amplifier BW
- Bandwidth measured with the highest bandwidth amplifier (N7003A).

Table 21 Characteristics for Probe Heads Using N7003A

Probe Head	Tip	Input Capacitance		Mode	Bandwidth (–3 dB)	10 – 90% Transition Time	20 – 80% Transition Time
		C_{diff}	C_{se}				
N5439A ZIF	N5440A 450Ω ZIF	32 fF	44 fF	Differential: Single Ended: Common:	20 GHz – –	21.7ps – –	15.4 ps – –
	N2838A 450Ω ZIF	95 fF	130 fF	Differential: Single Ended: Common:	20 GHz – –	21.7 ps – –	15.4 ps – –
	N5447A 200Ω ZIF	Not compatible with N7000/1/2/3A probes.					
N5445A 450Ω Browser		35 fF	50 fF	Differential: Single Ended: Common:	20 GHz – –	21.7 ps – –	15.4 ps – –
N5441A 450Ω Solder-In		77 fF	105 fF	Differential: Single Ended: Common:	20 GHz – –	21.7 ps – –	15.4 ps – –
N2836A 450Ω Solder-In Head vertically oriented with no ground wires		108 fF	140 fF	Differential: Single Ended: Common:	20 GHz – –	21.7 ps – –	15.4 ps – –
N2836A 450Ω Solder-In Head oriented flat with minimum length ground wires		108 fF	140 fF	Differential: Single Ended: Common:	20 GHz 20 GHz 20 GHz	21.7 ps 21.7 ps 21.7 ps	15.4 ps 15.4 ps 15.4 ps
N2848A QuickTip	N2849A 450Ω QuickTip with minimum length ground wires	200 fF	340 fF	Differential: Single Ended: Common:	20 GHz 20 GHz 20 GHz	21.7 ps 33.4 ps 33.4 ps	15.4 ps 23.7 ps 23.7 ps
N5444A 2.92 mm, 3.5 mm, SMA		–	–	Differential: Single Ended: Common:	20 GHz 20 GHz 20 GHz	21.7 ps 21.7 ps 21.7 ps	15.4 ps 15.4 ps 15.4 ps

Environmental

The following general characteristics apply to the active probe.

Table 22 Environmental Characteristics

Environmental Conditions	Operating	Non-Operating
Temperature	5 °C to +40 °C	–40 °C to +70 °C
Humidity	up to 95% relative humidity (non-condensing) at +40 °C	up to 90% relative humidity at +65 °C
Altitude	Up to 4,600 meters	Up to 15,300 meters
Power Requirements	Voltages supplied by Keysight oscilloscope AutoProbe Interface.	
Weight	approximately 0.69 kg	
Dimensions	Refer to “Probe Dimensions" on page 96.	
Pollution degree 2	Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.	
Use	Indoor Only	

Safety and Regulatory Information

Table 23 N7010A Safety and Regulatory Information

Description	
CAT I	Measurement Category I (CAT I). Measurement category I is for measurements performed on circuits not directly connected to a mains supply. For example, measurements in circuits not derived from a mains supply and specially protected (internal) circuits derived from a mains supply. In the latter case, transient stresses are variable. For that reason, it is required that the transient withstand capability of the equipment is made known to the user.
	This symbol indicates the Environmental Protection Use Period (EPUP) for the product's toxic substances for the China RoHS requirements.
	The CE mark is a registered trademark of the European Community. ISM GRP 1-A denotes the instrument is an Industrial Scientific and Medical Group 1 Class A product. ICES/NMB-001 indicates product compliance with the Canadian Interference-Causing Equipment Standard.
	This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product. Do not dispose in domestic household. To return unwanted products, contact your local Keysight office, or refer to www.keysight.com for more information.

Probe Dimensions

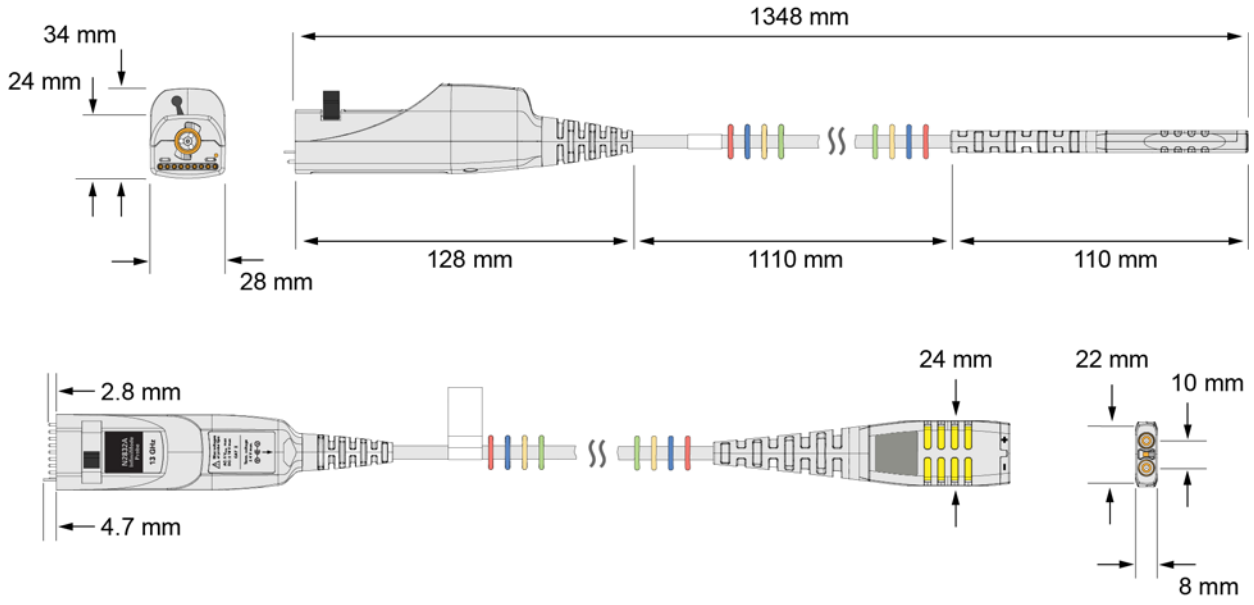


Figure 80 N2830/1/2A Probe Dimensions

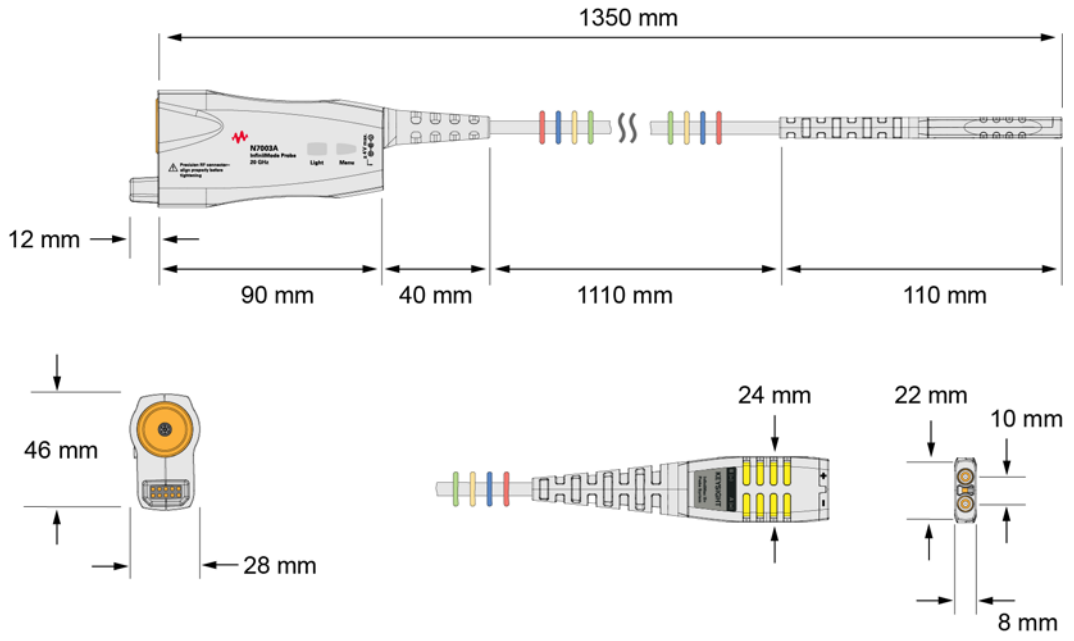


Figure 81 N7000/1/2/3A Probe Dimensions

6 Performance Plots

InfiniiMax III+ Probe System Responses

InfiniiMax III+ high-bandwidth active probes for use with Infiniium real-time oscilloscopes utilize DSP correction filters to enhance the accuracy of measurements. InfiniiMax III+ probe amplifiers store their unique s parameters in on board memory for the scope to readout when needed. Probe heads are simple passive devices and, with careful manufacture, their s-parameters don't vary significantly so they are stored as nominal s-parameters in the oscilloscope.

When a probe is connected to an oscilloscope channel and the proper probe head is selected, the oscilloscope calculates a DSP correction filter that includes the probe head, probe amplifier, and oscilloscope channel. This provides the maximum measurement accuracy for the complete probe and scope channel system.

Since there are so many different probe amplifiers and probe head combinations, it is not reasonable to show the responses of all these combinations and the responses would all be very much the same because they are all corrected to same target system response. The target system response is a flat magnitude, flat phase response high order low-pass filter that maximizes measurement accuracy.

Figure 82 shows an example of corrected system frequency response of an N2836A solder-In probe head used with an N2832A 13 GHz InfiniiMax III+ probe amplifier. Figure 83 on page 99 shows the step response of the corrected system.

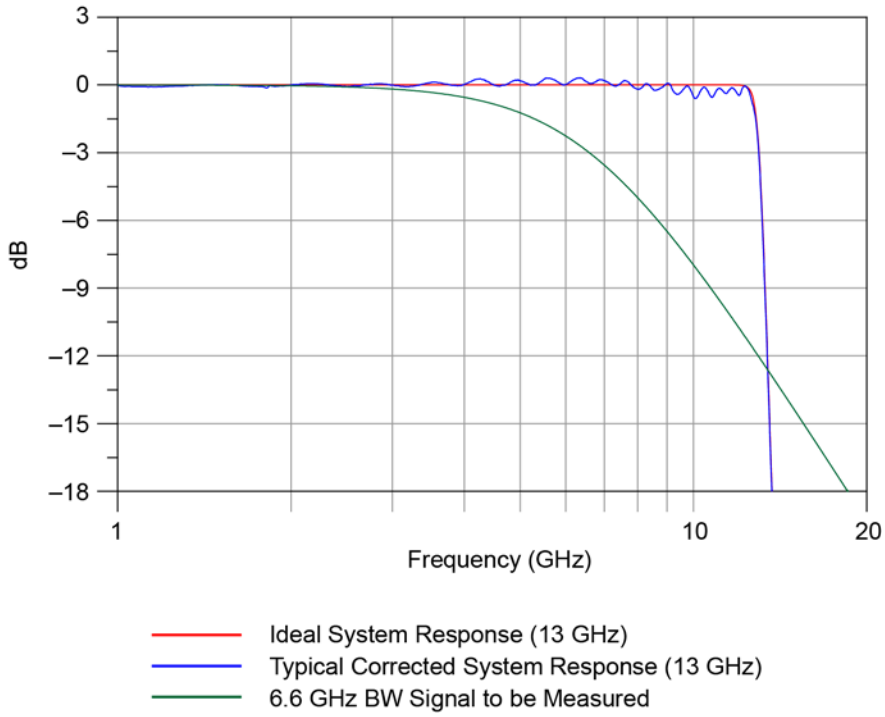


Figure 82 Corrected System Frequency Response (N2836A Solder-In Head and N2832A Amplifier)

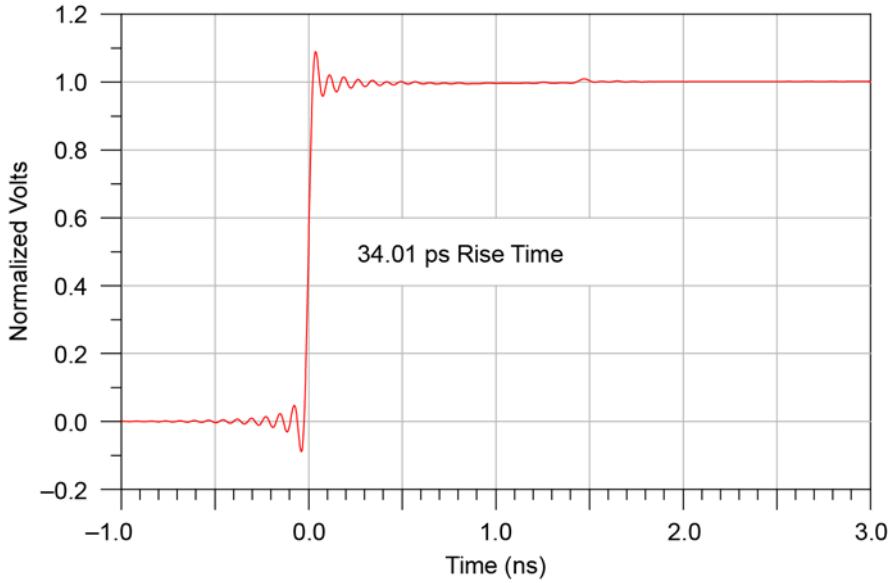


Figure 83 Step Response of Corrected System

Since the corrected system response has flat magnitude and phase, the step response is very flat and has equal pre-shoot and over-shoot. The flat phase will not distort the phase of the signal under test and therefore provides the truest reproduction of the signal. The reflection at 1.5 ns (twice the electrical length of the probe head) is very small indicating that the probe amplifier input termination is good.

The measure of the quality of a probe system is how well it reproduces the signal at the probe tip on the oscilloscope screen. Figure 84 on page 100 shows the step response of the 6.6 GHz BW signal in red, and blue shows how well the probe system reproduces that step. The BW of the signal being measured is as high as it can be while limiting the measured rise time error to about 3%.

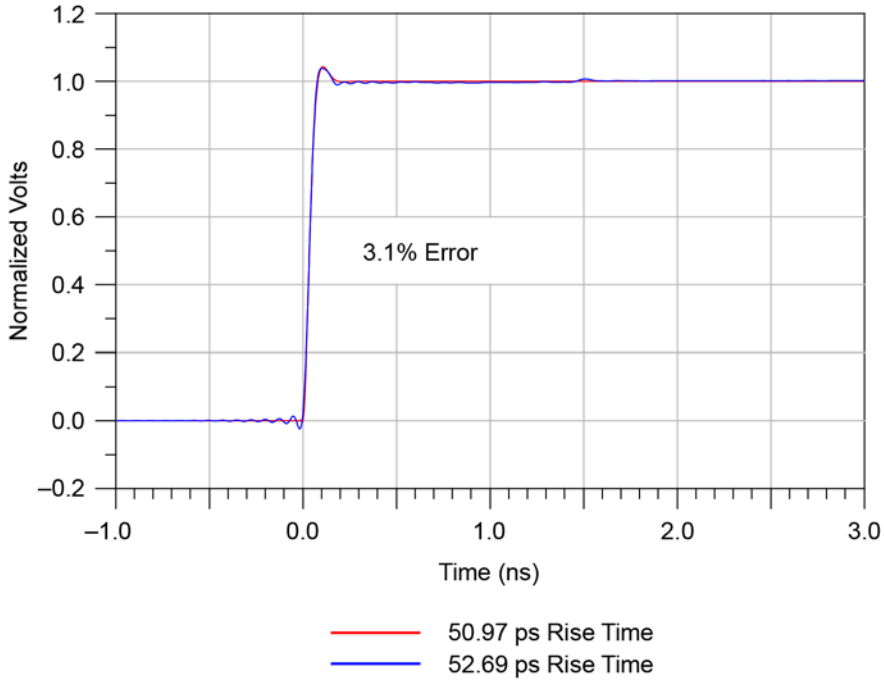


Figure 84 Fidelity of Step Response (Probe System Versus Input Signal)

This example was for a 13 GHz system (N2832A probe) measuring a 6.6 GHz signal. This ratio can be used to determine the measurement bandwidth needed for other bandwidth signals (for a 3% rise time measurement error):

$$BW_{\text{probe-scope system}} \cong \frac{13\ \text{GHz} \times BW_{\text{signal}}}{6.6\ \text{GHz}}$$

$$BW_{\text{probe-scope system}} \cong 1.97 \times BW_{\text{signal}}$$

This equation can be used to determine the probe-scope system BW needed to measure a certain BW signal.

N2848A QuickTip Head with N2849A QuickTip

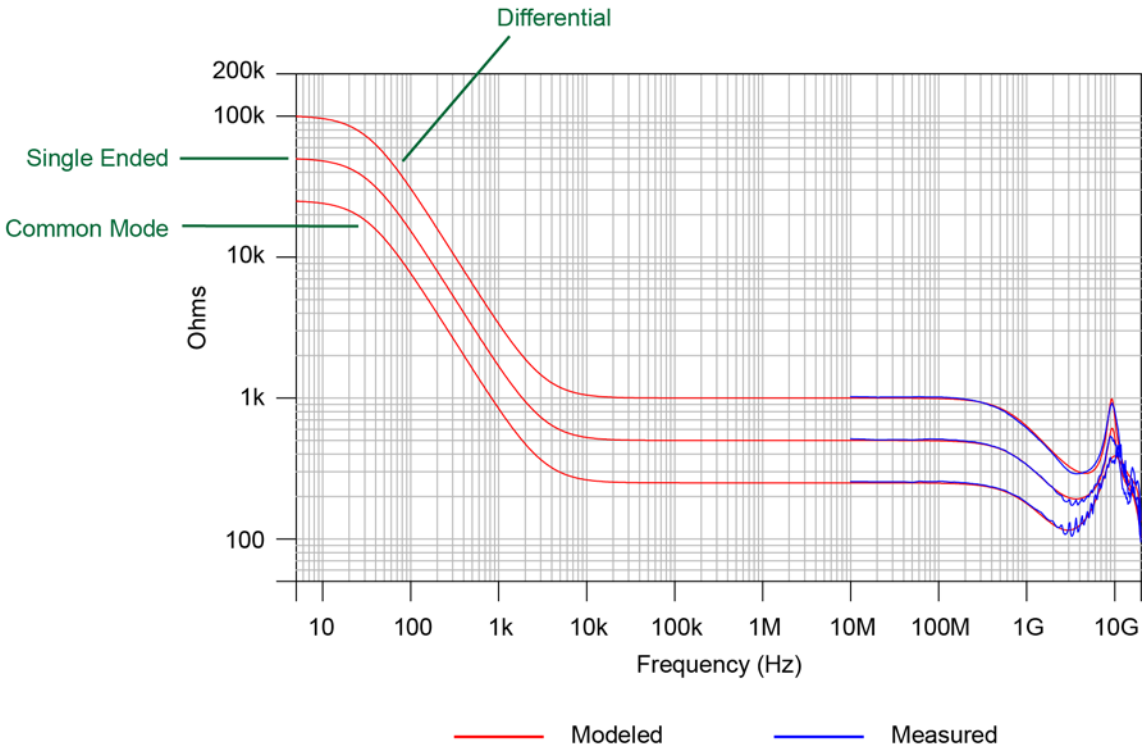


Figure 85 Input Impedances (Modeled and Measured)

N2836A Solder-In Probe Head (Flat Orientation)

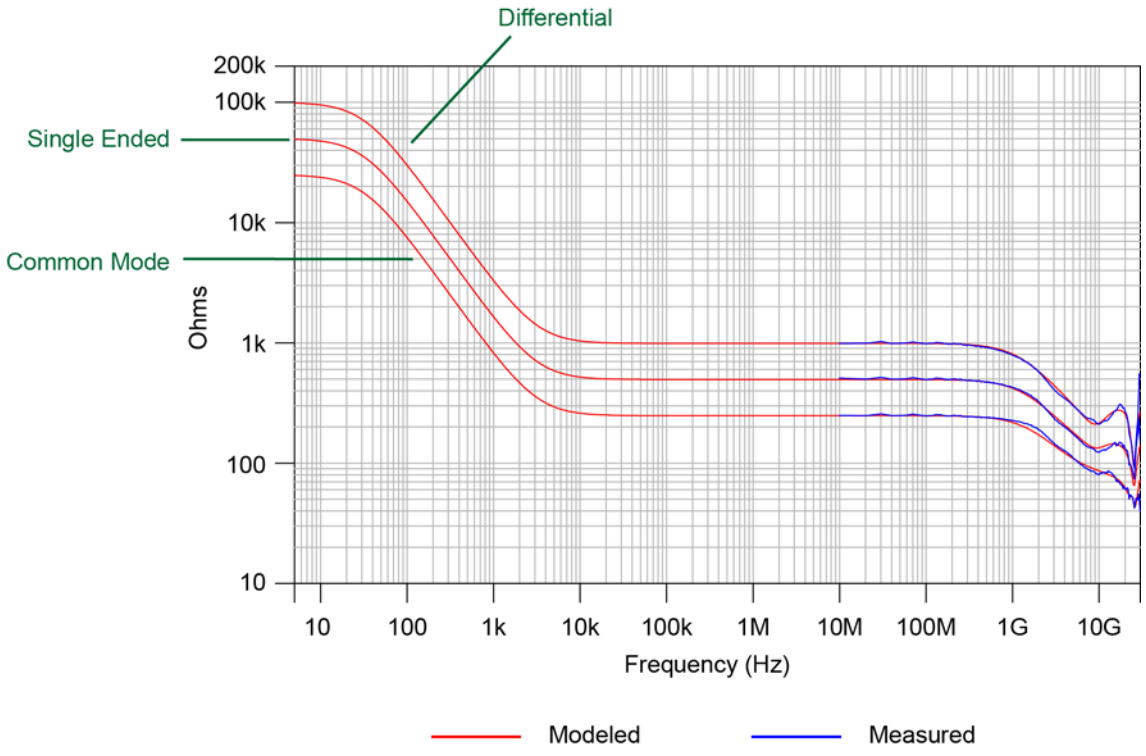


Figure 86 Input Impedances (Modeled and Measured)

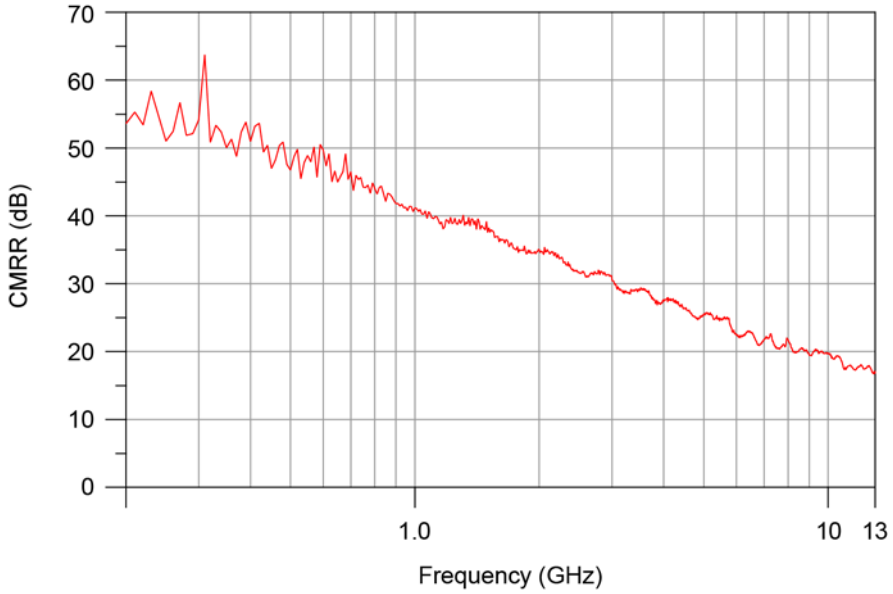


Figure 87 Common Mode Rejection Ratio (CMRR) of N2836A Solder-In Probe Head with N2832A Probe Amplifier

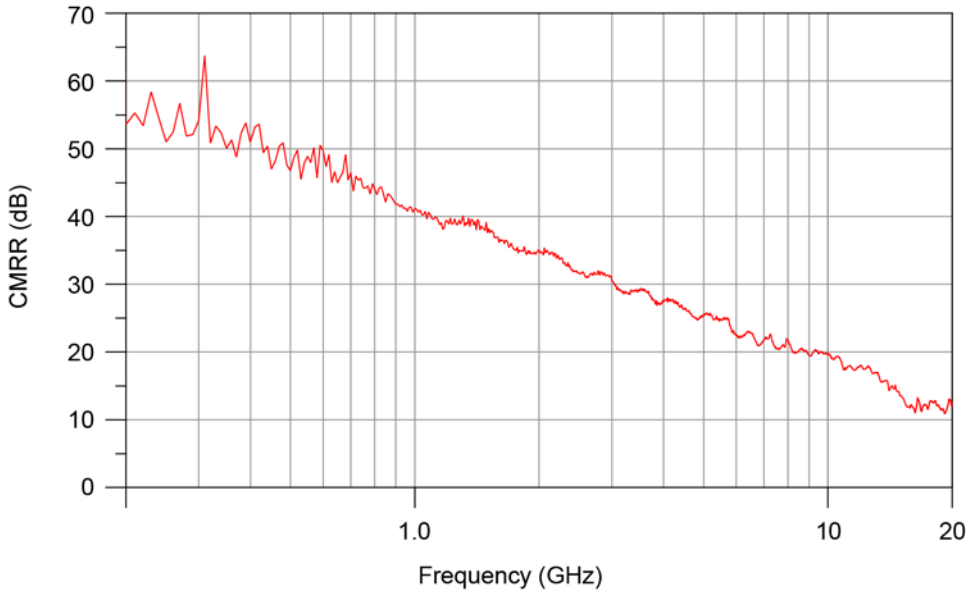


Figure 88 Common Mode Rejection Ratio (CMRR) of N2836A Solder-In Probe Head with N7003A Probe Amplifier

7 Performance Verification for N2830A-Series Probes

This chapter describes the equipment and procedures needed to verify the performance of the N2830/1/2A InfiniiMax III+ probes. The performance measured in this chapter is of the probe by itself. Keysight high performance real-time scopes (and sampling scopes under certain conditions) will apply probe correction that will further enhance the performance of the probes.

NOTE Due to the very high frequency of the InfiniiMax III+ probing system, it is important to carefully adhere to the techniques and procedures described in this chapter to accurately measure the performance.

CAUTION Electrostatic discharge (ESD) can quickly and imperceptibly damage or destroy high performance probes, resulting in costly repairs. Always wear a wrist strap when handling probe components and insure that cables are discharged before being connected.

Bandwidth Performance Verification

This procedure documents the bandwidth performance of the N2832A InfiniiMax III+ probe amplifier with the N2836A solder-in probe head.

NOTE The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A solder-in probe head.
- Keysight 2 port E8361A/C Vector Network Analyzer or equivalent VNA that covers at least a 50 MHz to 13 GHz range. The VNA must have the following capability:
  - Ability to use a Touchstone file to de-embed at a port.
  - A bias port for port 1 of the VNA. That is it must have an internal bias T's and a BNC port that allows bias to be applied to port 1.

NOTE This procedure is written assuming the E8361A/C PNA. If a different VNA is used, references that are specific to the PNA will need to be modified.

- Keysight N4692A-00F 2.92 mm (female/female) ECal module. Or, other 2.92 mm calibration kit that can calibrate to the 2.92 mm male connectors at the test ports.
- Proper test port cables, with adapters as needed, to provide male 2.92 mm connectors at reference planes. If 2.4 mm or 1.85 mm test port cables are used, the following Keysight adapters can be used to convert to 2.92 mm male connectors:

  11904A . . . . . 2.4 mm (m) to 2.92 mm (m)

  11904D . . . . . 2.4 mm (f) to 2.92 mm (m)
- Keysight N5443A Performance Verification (PV) Fixture. The N5443A includes an APC 3.5 (f-f) adapter (1250-1749).
- Maury Microwave 8775B2 2.92 mm (m) broadband load. Or other 2.92 mm (m) load with similar or better return loss. A high quality 2.92 mm adapter to a 2.4 mm or 1.85 mm VNA calibration load with required return loss could be used.
- Keysight N5477A AutoProbe II to 3.5 mm (f) Adapter. The N5477A comes with a required NMD 3.5 mm (m) to 3.5 mm (f) adapter (5062-1247).
- Keysight N5442A AutoProbe I (BNC) to AutoProbe II Adapter.
- Keysight 1143A Probe Offset Control and Power Module.
- BNC 50 ohm male terminator. Or equivalent; not a critical part. For example, a Pomona number 3840-50 or 4119-50.

VNA Setup

Power level: . . . . . –6 dBm
Sweep: . . . . . Log
Frequency: . . . . . 50 MHz to 34 GHz
Points:. . . . . 284 (100 pts/decade)
IF BW: . . . . . 1 kHz
Trace/Smoothing: . . . . . 9 points (3.17%)

1 Connect Test port cables and adapters (if needed) to provide male 2.92 mm connectors at the measurement planes. Install the BNC 50 ohm terminator to the E8361A/C VNA's rear-panel bias input for port 1. This provides a DC 50 ohm termination for the probe amplifier output.

2 Clear all traces from display, then select S12 to display. Configure the following settings for S12:

Scale: . . . . . .3 dB/div
Reference Level:. . . . . 0 dB
Reference Position: . . . . . 5 divisions

Procedure

1 Calibrate the PNA to the two male 2.92 mm connectors using the N4692A-00F ECal module (or equivalent 2.92 mm cal kit).

CAUTION **As with all precision connector interfaces, make sure to torque all connections using the proper torque wrench!**

2 Prepare the N2836A solder-in probe head for connection to the PV fixture as shown in Figure 89. Shape the leads as shown.

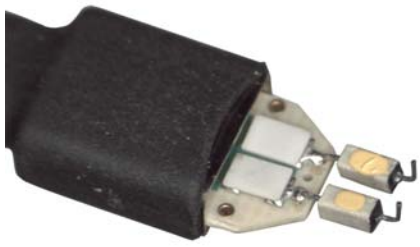


Figure 89 N2836A ZIF Probe Head

3 Connect the APC 3.5 (f-f) adapter, provided with the N5443A PV fixture, to the N5443A. as shown in Figure 90 on page 108. Use a small bench vise to steady the N5443A PV fixture on the test surface.

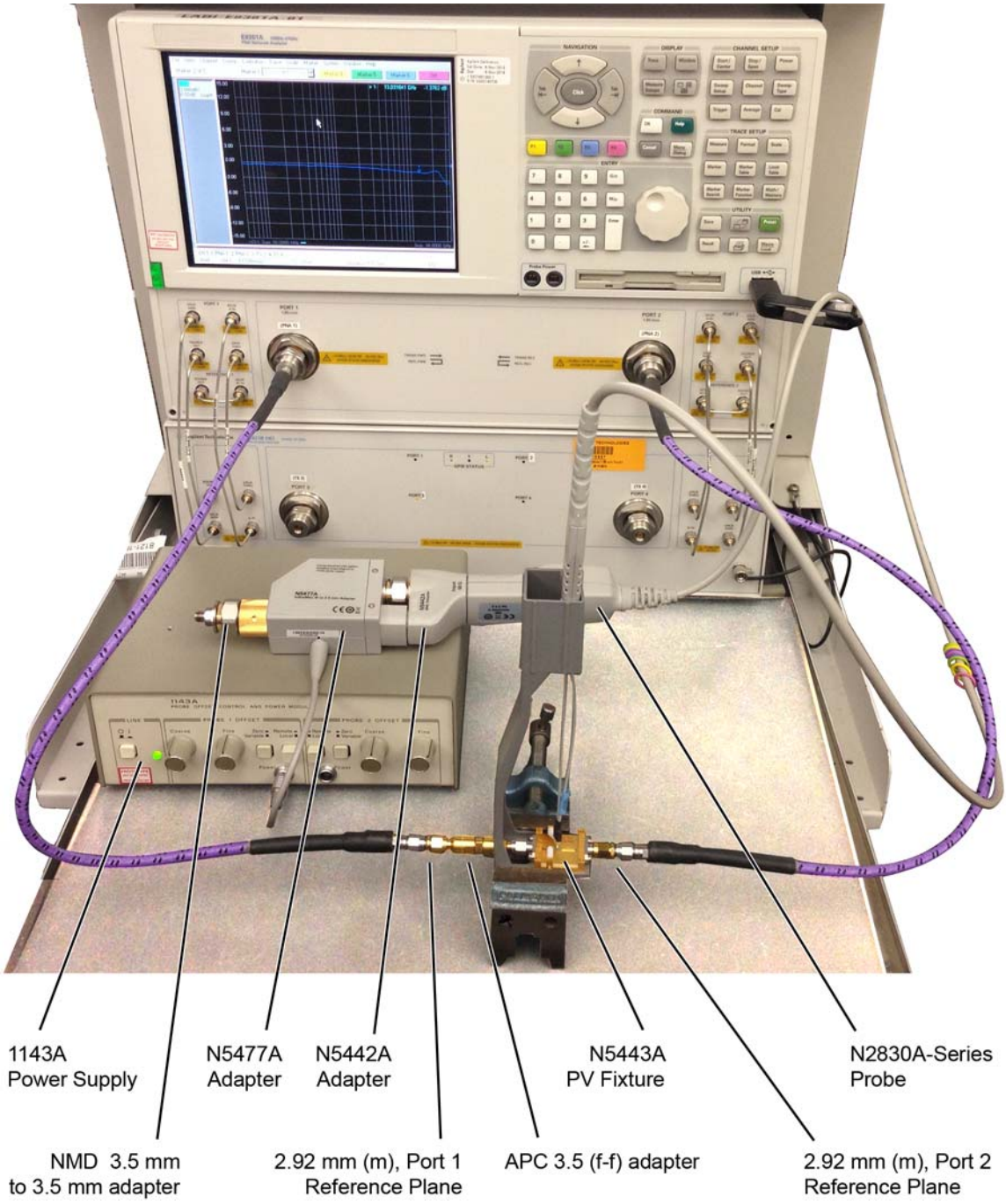


Figure 90 Test Setup for Measuring V_{in} of Probe

4 Connect the NMD 3.5 mm (m) to 3.5 mm (f) adapter to the N5477A as shown in the figure. This adapter is provided with the N5477A.

5 Connect the N5477A to the 1143A power supply and turn on the power supply.

6 Set the 1143A's probe offset control button to "Zero" so no probe offset is applied.

7 Connect the N2830A-series probe being tested to the N5442A adapter. Connect the N5442A to the N5477A adapter as shown in the figure.

8 Connect the probe to the N5443A PV fixture:

   a Insert the probe with ZIF probe head into the PV holder far enough that the tip wires can easily reach the pinches on the PV fixture.

   b Form the coax cables so that the tip wires are close to the pincher points before trying to connect the tip wires. The connectors between the probe head and the probe amp can be rotated to align the probe tip properly to the punchers. Since the center trace of the PV fixture is above the ground plane, the probe head should be tipped slightly so the tip wires touch the center trace and ground plane at the same time.

   c Depress the actuators on the pincher and carefully insert one wire under the center pincher and the other wire under one of the side pincher. Either polarity of the probe can be tested and will yield the same results (but opposite phase) if the probe is working properly. Figure 91 on page 110 shows a close up of the tip wires positioned under the pincher.

   d Ideally the probe head should not be angled toward the port 2 side of the PV fixture, but a slight angle of 5 degrees is acceptable. If angled too much, the measured BW of the probe will be degraded due to coupling from the trace to the probe tip.

9 Use the following steps to Install a file to de-embed the adapter (1250-1749) and the output side of the N5443A. This is the path from the male 2.92 mm connector to the probe point of the N5443A from Port 1 of the VNA.

   a Create the Touchstone file by cutting and pasting the text in "Touchstone File (1250-1749 & N5443A)" on page 115. Name the file: **Adaptor_1250_1749___OutputSideOfFixture_N5443A.s2p**.

NOTE

You can also copy the data from the Adobe AIR version of Keysight's Probe Resource Center (PRC). Copying this data from the PRC is the simplest most reliable method to get the data. To download the PRC, visit http://www.Keysight.com/find/PRC.

   b On the VNA, go to menu "Calibration/Fixturing Selections/2 Port De-embedding" and select Port 1.

   c Set S2P file selection to the file saved in step a.

   d Check the "Enable De-embedding".

   e Under "Calibration" menu, select "Fixturing ON/off" to turn on de-embedding.

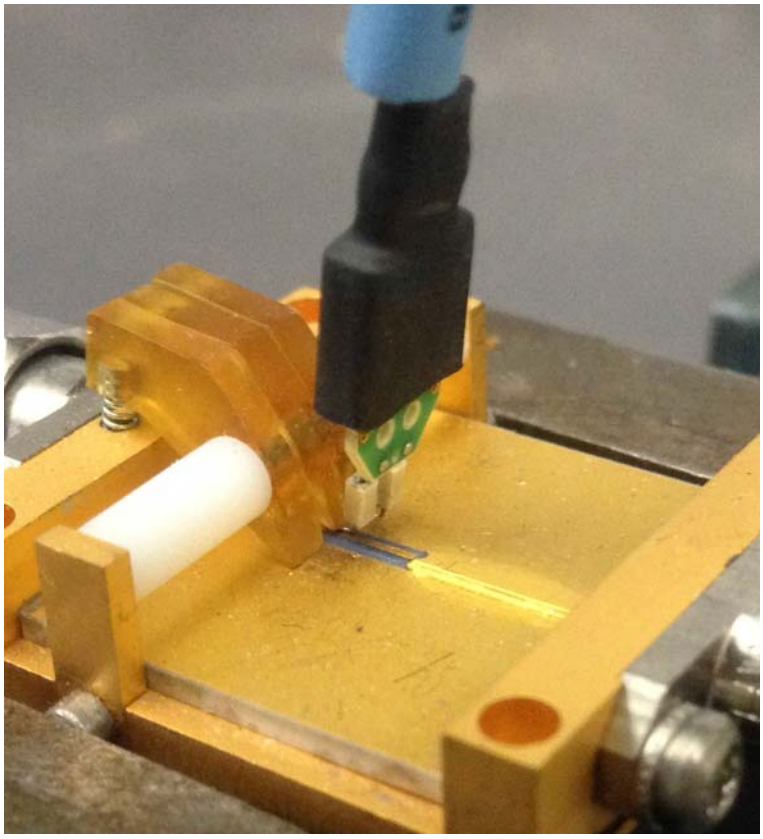


Figure 91 Close-Up of Tip Wires Positioned Under Pincher

10 Trigger the VNA to perform a single sweep. Press “Trigger” under Channel Setup, and then the green soft-key for “Single”. Display should look like Figure 92 on page 111. If it looks noticeably different, the probe tip wires may not be making contact under the pincher.

11 Under “Trace/Math/Memory” select “Data->Memory”. This saves the de-embedded input voltage trace into the memory.

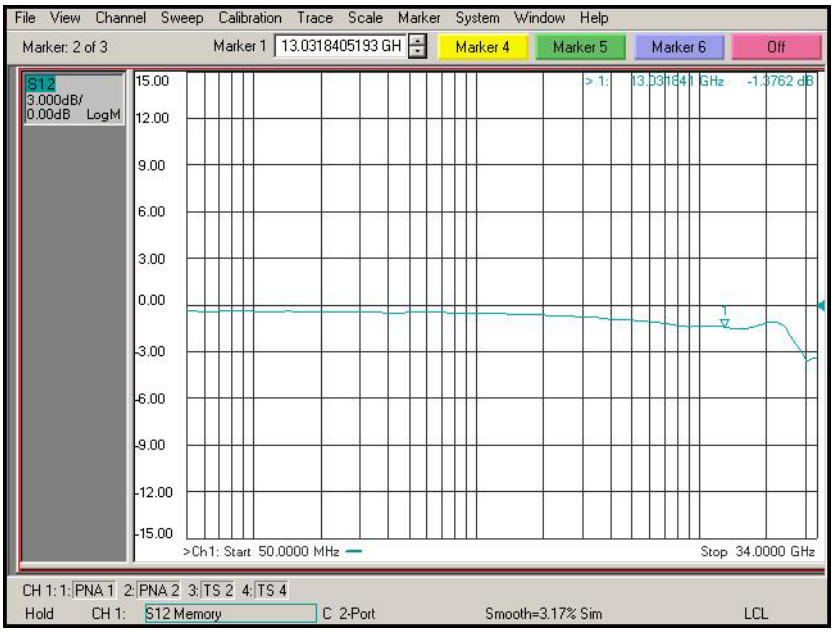


Figure 92 De-Embedded V_{in} Trace

12 As shown in Figure 93 on page 112, move the Port 1 cable N5477A. Connect the 8775B2 broadband load as shown in the figure.

13 Use the following steps to Install a file to de-embed the adapter (5062-1247) and N5477A from port 1 of the VNA.

a Create the Touchstone file by cutting and pasting the text in "Touchstone File (5062-1247 & N5477A)" on page 119. Name the file **Adapter_5062_1247___Adapter_N5477A.s2p**.

NOTE

You can also copy the data from the Adobe AIR version of Keysight's Probe Resource Center (PRC). Copying this data from the PRC is the simplest most reliable method to get the data. To download the PRC, visit http://www.Keysight.com/find/PRC.

b Go to menu "Calibration/Fixturing Selections/2 Port De-embedding" and select Port 1.

c Set S2P file selection to the file saved in step a.

d Make sure the "Enable De-embedding" box is still checked.

e Under "Calibration" menu, make sure "Fixturing ON/off" is still checked so file is being used for de-embedding.

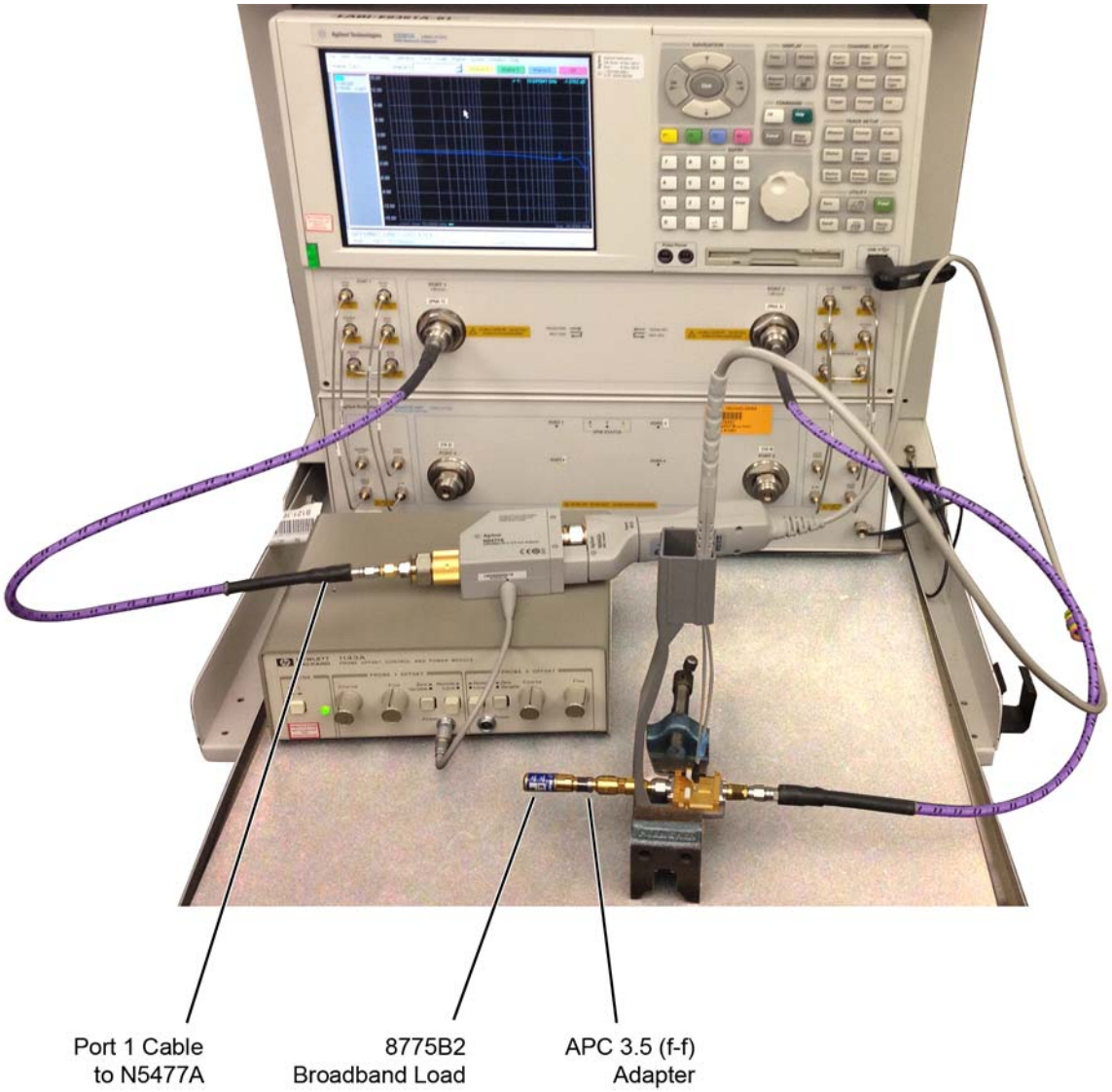


Figure 93 Test Setup to Measure V_{out} of Probe

14 Trigger VNA to perform a single sweep.

- **a** Press “Trigger” under Channel Setup, and then the green soft-key for “Single”.
- **b** Under “Scale” menu, adjust the reference level until the 50 MHz point (left side of the screen) is at center screen. Reference level should be approximately –20 dB, but can vary a few tenths of a dB either way.
- **c** Display should look like Figure 94. If it looks noticeably different, the probe tip wires may not be making contact under the pincher.

15 Under menu “Trace/Math/Memory” select “Data/Memory” in the “Data Math” box.

- **a** This will divide the current trace (de-embedded vout trace) by the memory trace (de-embedded vin trace) and therefore show the voltage transfer function of the probe or “vout/vin”.
- **b** Again, adjust the “Reference Level” in the scale menu so the 50 MHz point is at center screen. The display should look like Figure 95 on page 114.
- **c** Turn on a marker and adjust it to where the trace crosses 3 dB below the 50 MHz point (which is one division below center screen since screen is set to 3 dB/div).
- **d** Verify that the BW is ≥ 13 GHz for the N2836A solder-in probe head and N2832A 13 GHz probe amp combination.

Figure 94 De-Embedded V_{out} Trace

Figure 95 De-Embedded V_{out}/V_{in} Response of the Probe

Touchstone File (1250-1749 & N5443A)

Cut and paste the following text and save in a text file named **Adapter_1250_1749___OutputSideOfFixture_N5443A.s2p**. This file is used in Step 9 on page 109. This touchstone file is also used in Chapter 8 for the performance verification of N7000-series probes.

NOTE You'll find the following data on the Adobe AIR version of the Probe Resource Center (PRC). Copying this data from the PRC is the simplest most reliable method to get the data. To download the PRC, visit http://www.Keysight.com/find/PRC.

```
! freq S11 S21 S12 S22
!Port 1=female 3.5mm connector of 1250-1749 adaptor, Port 2=probe point on N5443A fixture
# Hz S DB R 50
50000000.000000 -49.528411 110.869328 -0.026318 -4.180881 -0.025870 -4.223772 -67.754661 -176.153454
51165694.067857 -49.988587 91.181375 -0.025517 -4.280433 -0.024720 -4.324675 -68.880923 -164.662475
52358564.988911 -50.522661 71.165730 -0.024697 -4.382306 -0.023543 -4.427929 -70.190588 -152.193533
53579246.361093 -51.148132 50.755093 -0.023858 -4.486555 -0.022339 -4.533591 -71.710672 -138.296498
54828386.553961 -51.883012 29.852775 -0.023000 -4.593234 -0.021107 -4.641716 -73.455393 -122.229302
56106649.053084 -52.745137 8.328609 -0.022122 -4.702400 -0.019846 -4.752362 -75.383422 -102.800368
57414712.812455 -53.751090 -13.985221 -0.021223 -4.814111 -0.018557 -4.865588 -77.285484 -78.453735
58753272.615119 -54.914477 -37.296089 -0.020304 -4.928426 -0.017237 -4.981454 -78.641246 -48.710849
60123039.442212 -56.136285 -60.059373 -0.019410 -5.044783 -0.015920 -5.098670 -78.505514 -17.996645
61524740.850598 -56.339746 -65.253403 -0.018972 -5.157375 -0.014907 -5.204612 -74.600997 0.238726
62959121.359318 -56.549712 -70.614809 -0.018523 -5.272593 -0.013871 -5.313024 -71.786638 16.619539
64426942.845040 -56.765722 -76.151300 -0.018064 -5.390497 -0.012811 -5.423964 -69.665881 32.555062
65928984.946733 -56.987159 -81.870529 -0.017595 -5.511150 -0.011726 -5.537491 -68.056466 48.587163
67466045.479778 -57.213226 -87.779882 -0.017115 -5.634616 -0.010616 -5.653665 -66.866526 65.023732
69038940.859729 -57.442930 -93.886209 -0.016623 -5.760962 -0.009481 -5.772548 -66.050126 82.119449
70648506.535956 -57.624590 -110.396155 -0.016195 -5.894832 -0.009445 -5.897344 -64.822182 90.200098
72295597.435395 -57.551220 -142.499775 -0.015869 -6.038769 -0.011116 -6.029813 -62.891316 82.809542
73981088.416647 -57.272309 -174.184620 -0.015537 -6.186061 -0.012827 -6.165369 -61.314332 74.543748
75705874.734666 -56.913609 155.103108 -0.015196 -6.336786 -0.014577 -6.304085 -59.987656 65.638030
77470872.516269 -56.615036 125.361237 -0.014847 -6.491025 -0.016368 -6.446035 -58.847549 56.200571
79277019.246748 -56.489319 96.190629 -0.014491 -6.648860 -0.018202 -6.591294 -57.851655 46.281987
81125274.267814 -56.086810 77.082571 -0.015125 -6.803245 -0.019025 -6.749358 -57.369635 49.668006
83016619.287160 -55.464039 64.084902 -0.016432 -6.956544 -0.019176 -6.917300 -57.199270 61.953448
84952058.899892 -54.917900 50.564549 -0.017770 -7.113416 -0.019329 -7.089158 -57.075871 74.341353
86932621.122130 -54.439335 36.470021 -0.019138 -7.273947 -0.019487 -7.265023 -57.007441 86.897368
88959357.937037 -54.018288 21.746324 -0.020539 -7.438220 -0.019648 -7.444988 -57.001200 99.698955
91033345.853589 -54.097863 14.550734 -0.021520 -7.608109 -0.020285 -7.619545 -56.504223 102.747003
93155686.478363 -54.688270 15.600999 -0.022057 -7.783797 -0.021424 -7.788273 -55.536632 95.350174
95327507.100664 -55.335875 16.745463 -0.022606 -7.963581 -0.022589 -7.960934 -54.662417 87.625100
97549961.291281 -56.051127 18.007724 -0.023168 -8.147556 -0.023782 -8.137620 -53.867407 79.587653
99824229.515220 -56.847547 19.421327 -0.023744 -8.335819 -0.025002 -8.318424 -53.140655 71.244030
102151519.758706 -57.028409 32.229328 -0.024811 -8.518103 -0.025270 -8.526257 -53.229937 71.824660
104533068.170813 -57.203696 45.767193 -0.025943 -8.703769 -0.025461 -8.740842 -53.390484 73.175172
106970139.720046 -57.452641 59.100435 -0.027102 -8.893763 -0.025657 -8.960430 -53.558351 74.544470
109464028.866236 -57.799354 72.247228 -0.028288 -9.088187 -0.025857 -9.185138 -53.734081 75.931667
112016060.248099 -58.205431 76.407713 -0.028945 -9.298506 -0.026957 -9.388528 -53.893471 72.124731
114627589.386818 -58.637120 78.159701 -0.029466 -9.516820 -0.028326 -9.589435 -54.061522 66.848820
117300003.406038 -59.105065 79.877381 -0.029999 -9.740223 -0.029727 -9.795026 -54.247548 61.492888
120034721.768639 -59.584054 81.490201 -0.030537 -9.968856 -0.031146 -10.005562 -54.448452 56.117498
122833197.030691 -57.847096 78.713336 -0.030505 -10.204469 -0.031384 -10.233007 -54.242926 55.717121
125696915.612984 -56.373050 75.635986 -0.030472 -10.445575 -0.031627 -10.465755 -54.037670 55.307462
128627398.590544 -55.090007 72.338796 -0.030439 -10.692303 -0.031876 -10.703929 -53.832682 54.888298
131626202.500562 -54.306379 66.932129 -0.030205 -10.948451 -0.031570 -10.953764 -53.494817 54.988088
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```

Touchstone File (5062-1247 & N5477A)

Cut and paste the following text and save in an text file named **Adapter_5062_1247___Adapter_N5477A.s2p**. This file is used in Step 13 on page 111. This touchstone file is also used in Chapter 8 for the performance verification of N7000-series probes.

NOTE You'll find the following data on the Adobe AIR version of the Probe Resource Center (PRC). Copying this data from the PRC is the simplest most reliable method to get the data. To download the PRC, visit http://www.Keysight.com/find/PRC.

```
! freq S11 S21 S12 S22
!Port 1=female side of 5062_1247 adaptor, Port 2=male side of N5477A
# Hz S DB R 50
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```

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```

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26386476293.272152 -22.711245 -101.871135 -0.471170 -133.063592 -0.457863 -133.066616 -23.104139 19.695494
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34000000000.000000 -18.584633 -83.525655 -0.518071 166.056015 -0.538472 166.289380 -18.908405 -121.618048
```

DC Input Resistance Performance Verification

NOTE The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A solder-in probe head. An N5441A solder-in probe head may be substituted.

NOTE You only need to perform the performance verification test on one of these probe heads, not both of them. If it passes for one of them, then it will pass for all of them.

- Keysight N5443A Performance Verification Fixture. No substitute.
- BNC(m) to SMA(m) Adapter. Pomona 4288 or equivalent.
- Banana Plug to BNC(f). Pomona 1269 or equivalent.
- Digital Multimeter:
- Keysight 33401A or equivalent
- Critical specification: 2 wire resistance accuracy
- Power Supply for Probe
- DSO/DSA 90000 X-series oscilloscope or 1134A power supply with N5477A Autoprobe adapter (see the "Bandwidth Performance Verification" on page 106 procedure)
- No substitute
- Probe Positioner
- Keysight N2787A 3D Probe Positioner
- Critical specification: stable/accurate positioning
- Small Bench Vise

Measuring Input Resistance of N2836A Probe Head

Figure 96 shows the correct setup for measuring the differential input resistance for the solder-in probe head.

1. Connect the BNC to SMA adapter and BNC to Banana Plug adapters as shown in Figure 96 on page 124.
2. Position the PV fixture on a table top and clamp it with a small bench vise to steady it. Ensure that the PV fixture is flush with the table top so that when the banana plugs are probed, it does not rock the PV fixture.

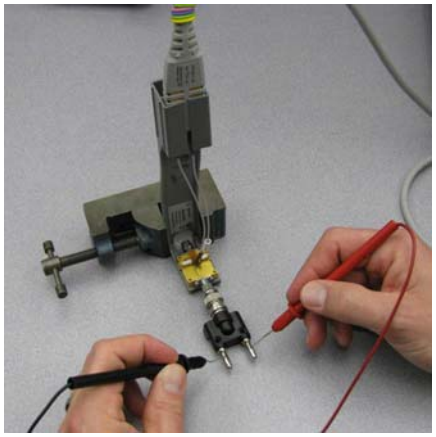

Figure 96 Measuring the Differential Input Resistance of Solder-In Probe Head

3 Connect the probe amplifier to the oscilloscope or power supply so it is powered.

4 Connect the ZIF or solder-in probe head to the probe amp and insert it into the PV fixture as shown Figure 96.

5 Depress the pincher fingers on the PV fixture so they open and carefully insert the tip wires under the pincher. Release the pincher once the tips are inserted.

6 As shown in Figure 96, measure the DC input resistance between the banana plugs. Since one tip wire is connected to the signal line and the other tip is connected to the PV fixture ground, this is a measurement of the differential input resistance. It should be 100 kΩ ±2% (98 to 102 kΩ).

7 To measure the single-ended input resistance, measure the resistance between the signal plug of the banana adapter and the probe amplifier ground, which can be accessed as shown in Figure 97 (through the vent window of the probe amplifier).

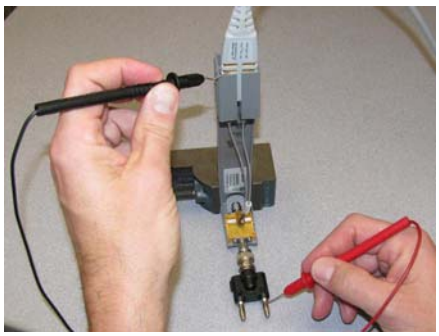

Figure 97 Measuring the Single-Ended Input Resistance the Solder-In Probe Head

Performance Test Record

NOTE The recommended test interval is one year/2000 hours.

Table 24 Test Information

Keysight Technologies	Keysight InfiniiMax III+ Series Probe
Model Number:	Tested by:
Serial Number:	Work Order Number:
Recommended next test date:	Date:

Table 25 Test Results

Test with Probe Heads (only required to test one)	Test Limits	Result	Pass/Fail
Bandwidth Performance Test			
N2836A	≥ 13 GHz		
DC Input Resistance Performance Test			
N2836A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		
N5441A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		

8 Performance Verification for N7000-Series Probes

This chapter describes the equipment and procedures needed to verify the performance of N7000/1/2/3A InfiniiMax III+ probes. The performance measured in this chapter is of the probe by itself. Keysight high performance real-time scopes (and sampling scopes under certain conditions) will apply probe correction that will further enhance the performance of the probes.

NOTE Due to the very high frequency of the InfiniiMax III+ probing system, it is important to carefully adhere to the techniques and procedures described in this chapter to accurately measure the performance.

CAUTION Electrostatic discharge (ESD) can quickly and imperceptibly damage or destroy high performance probes, resulting in costly repairs. Always wear a wrist strap when handling probe components and insure that cables are discharged before being connected.

Bandwidth Performance Verification

This procedure documents the bandwidth performance of the N7003A InfiniiMax III+ probe amplifier with the N2836A solder-in probe head.

NOTE The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A solder-in probe head.
- Keysight 2 port E8361A/C Vector Network Analyzer or equivalent VNA that covers at least a 50 MHz to 20 GHz range. The VNA must have the following capability:
  - Ability to use a Touchstone file to de-embed at a port.
  - A bias port for port 1 of the VNA. That is it must have an internal bias T's and a BNC port that allows bias to be applied to port 1.

NOTE This procedure is written assuming the E8361A/C PNA. If a different VNA is used, references that are specific to the PNA will need to be modified.

- Keysight N4692A-00F 2.92 mm (female/female) ECal module. Or, other 2.92 mm calibration kit that can calibrate to the 2.92 mm male connectors at the test ports.
- Proper test port cables, with adapters as needed, to provide male 2.92 mm connectors at reference planes. If 2.4 mm or 1.85 mm test port cables are used, the following Keysight adapters can be used to convert to 2.92 mm male connectors:

  11904A . . . . . 2.4 mm (m) to 2.92 mm (m)

  11904D . . . . . 2.4 mm (f) to 2.92 mm (m)
- Keysight N5443A Performance Verification (PV) Fixture. The N5443A includes an APC 3.5 (f-f) adapter (1250-1749).
- Maury Microwave 8775B2 2.92 mm male broadband load. Or other 2.92 mm male load with similar or better return loss. A high quality 2.92 mm adapter to a 2.4 mm or 1.85 mm VNA calibration load with required return loss could be used.
- Keysight N5477A AutoProbe II to 3.5 mm (f) Adapter. The N5477A comes with a required NMD 3.5 mm (m) to 3.5 mm (f) adapter (5062-1247).
- Keysight 1143A Probe Offset Control and Power Module.
- BNC 50 ohm male terminator. Or equivalent; not a critical part. For example, a Pomona number 3840-50 or 4119-50.

VNA Setup

Power level: . . . . . –6 dBm
Sweep: . . . . . Log
Frequency: . . . . . 50 MHz to 34 GHz
Points:. . . . . 284 (100 pts/decade)
IF BW: . . . . . 1 kHz
Trace/Smoothing: . . . . . 9 points (3.17%)

1 Connect Test port cables and adapters (if needed) to provide male 2.92 mm connectors at the measurement planes. Install the BNC 50 ohm terminator to the E8361A/C VNA's rear-panel bias input for port 1. This provides a DC 50 ohm termination for the probe amplifier output.

2 Clear all traces from display, then select S12 to display. Configure the following settings for S12:

Scale: . . . . . .3 dB/div
Reference Level:. . . . . 0 dB
Reference Position: . . . . . 5 divisions

Procedure

1 Calibrate the PNA to the two male 2.92 mm connectors using the N4692A-00F ECal module (or equivalent 2.92 mm cal kit).

CAUTION **As with all precision connector interfaces, make sure to torque all connections using the proper torque wrench!**

2 Prepare the N2836A solder-in probe head for connection to the PV fixture as shown in Figure 98. Shape the leads as shown with the resistors angled until they almost touch.

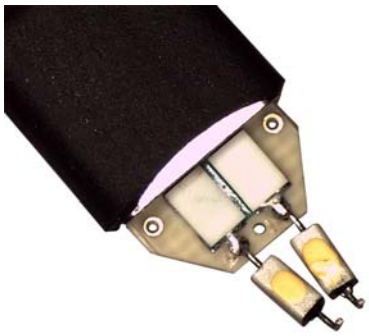

Figure 98 N2836A ZIF Probe Head

3 Connect the APC 3.5 (f-f) adapter, provided with the N5443A PV fixture, to the N5443A. as shown in Figure 99. Use a small bench vise to steady the N5443A PV fixture on the test surface.

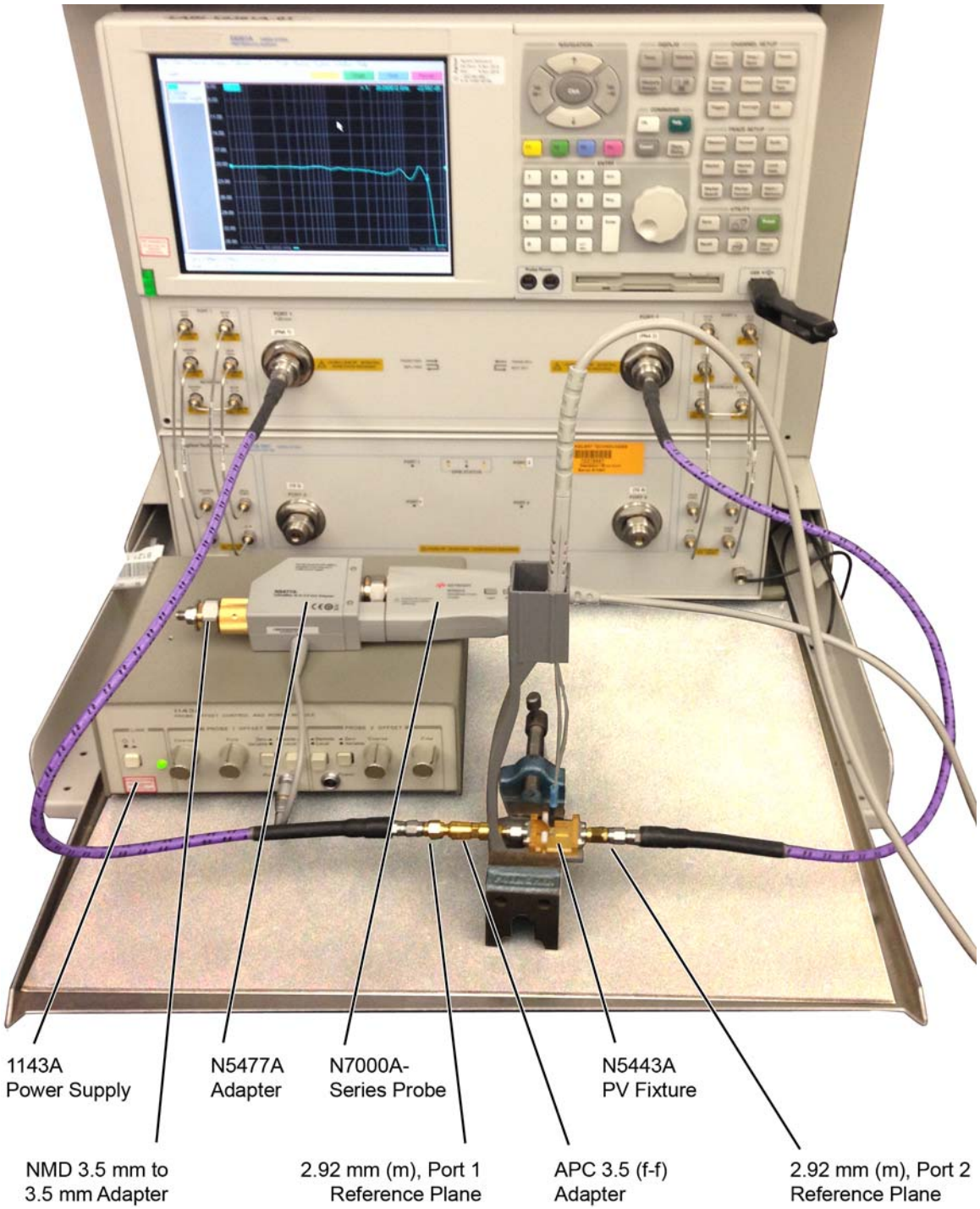

Figure 99 Test Setup for Measuring V_{in} of Probe

4 Connect the NMD 3.5 mm (m) to 3.5 mm (f) adapter to the N5477A as shown in the figure. This adapter is provided with the N5477A.

5 Connect the N5477A to the 1143A power supply and turn on the power supply.

6 Set the 1143A's probe offset control button to "Zero" so no probe offset is applied.

7 Connect the N7000A-series probe being tested to the N5477A adapter as shown in the figure.

8 Connect the probe to the N5443A PV fixture:

   a Insert the probe with ZIF probe head into the PV holder far enough that the tip wires can easily reach the pinches on the PV fixture.

   b Form the coax cables so that the tip wires are close to the pincher points before trying to connect the tip wires. The connectors between the probe head and the probe amp can be rotated to align the probe tip properly to the punchers. Since the center trace of the PV fixture is above the ground plane, the probe head should be tipped slightly so the tip wires touch the center trace and ground plane at the same time.

   c Depress the actuators on the pincher and carefully insert one wire under the center pincher and the other wire under one of the side pincher. Either polarity of the probe can be tested and will yield the same results (but opposite phase) if the probe is working properly. Figure 100 on page 132 shows a close up of the tip wires positioned under the pincher.

   d Ideally the probe head should not be angled toward the Port 2 side of the PV fixture, but a slight angle of 5 degrees is acceptable. If angled too much, the measured BW of the probe will be degraded due to coupling from the trace to the probe tip.

9 Use the following steps to Install a file to de-embed the adapter (1250-1749) and the output side of the N5443A. This is the path from the male 2.92 mm connector to the probe point of the N5443A from Port 1 of the VNA.

   a Create a Touchstone file by cutting and pasting the text in "Touchstone File (1250-1749 & N5443A)" on page 115. Name the file: **Adaptor_1250_1749___OutputSideOfFixture_N5443A.s2p**. This is the same file that is used in Chapter 7 for the performance verification of N2830A-series probes.

NOTE

You can also copy the data from the Adobe AIR version of Keysight's Probe Resource Center (PRC). Copying this data from the PRC is the simplest most reliable method to get the data. To download the PRC, visit http://www.Keysight.com/find/PRC.

b On the VNA, go to menu “Calibration/Fixturing Selections/2 Port De-embedding” and select Port 1.

c Set S2P file selection to the file saved in step a.

d Check the “Enable De-embedding”.

e Under “Calibration” menu, select “Fixturing ON/off” to turn on de-embedding.

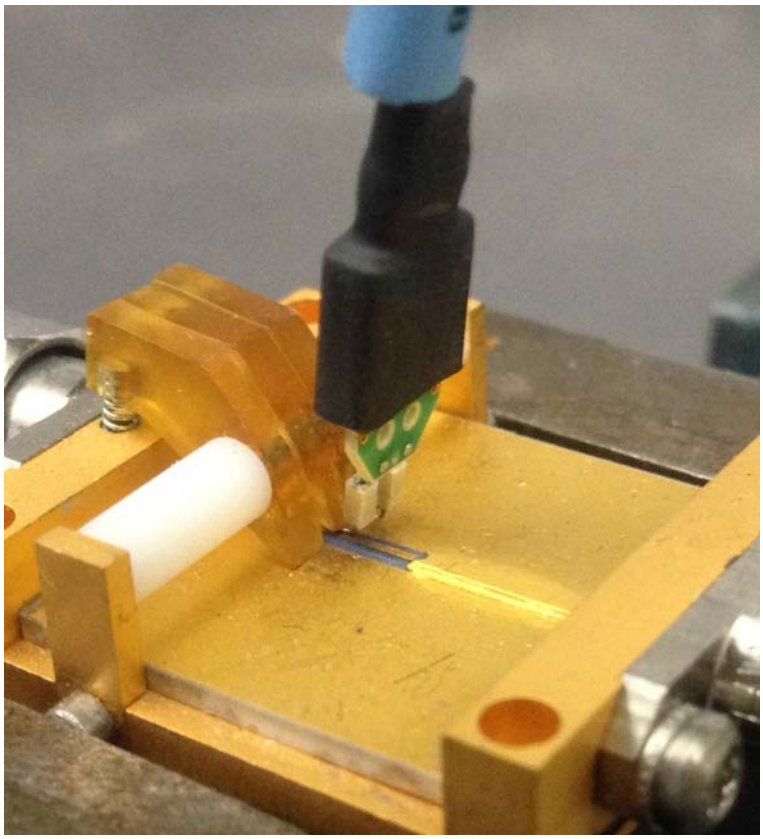

Figure 100 Close-Up of Tip Wires Positioned Under Pincher

10 Trigger the VNA to perform a single sweep. Press “Trigger” under Channel Setup, and then the green soft-key for “Single”. Display should look like Figure 101 on page 133. If it looks noticeably different, the probe tip wires may not be making contact under the pincher.

11 Under “Trace/Math/Memory” select “Data->Memory”. This will save the de-embedded input voltage trace into the memory.

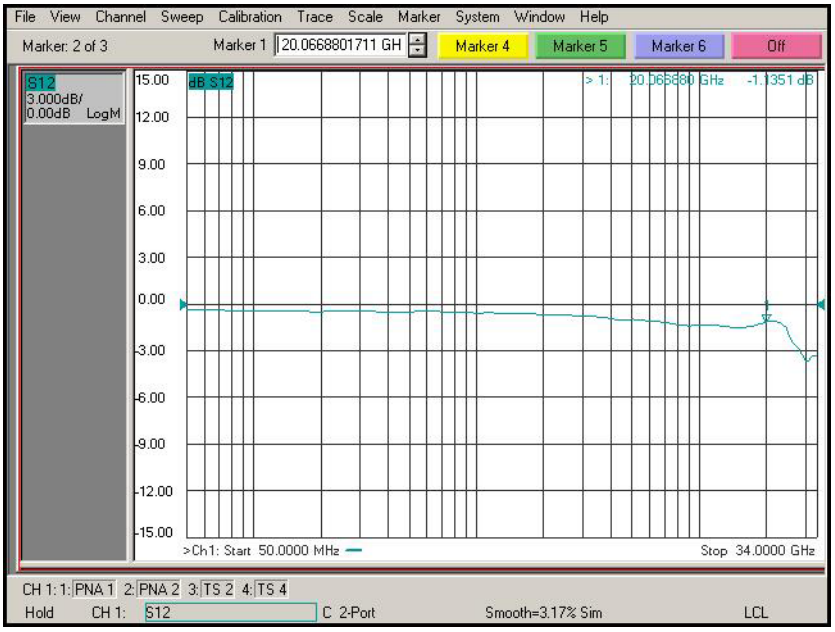

Figure 101 De-Embedded V_{in} Trace

12 As shown in Figure 102 on page 134, move the Port 1 cable the N5477A. Connect the 8775B2 broadband load as shown in the figure.

13 Use the following steps to Install a file to de-embed the adapter (5062-1247) and N5477A from port 1 of the VNA.

a Create the Touchstone file by cutting and pasting the text in "Touchstone File (5062-1247 & N5477A)" on page 119. Name the file **Adapter_5062_1247__Adapter_N5477A.s2p**. This is the same file that is used in Chapter 7 for the performance verification of N2830A-series probes.

NOTE

You can also copy the data from the Adobe AIR version of Keysight's Probe Resource Center (PRC). Copying this data from the PRC is the simplest most reliable method to get the data. To download the PRC, visit http://www.Keysight.com/find/PRC.

b Go to menu "Calibration/Fixturing Selections/2 Port De-embedding" and select Port 1.

c Set S2P file selection to the file saved in step a.

d Make sure the "Enable De-embedding" box is still checked.

e Under "Calibration" menu, make sure "Fixturing ON/off" is still checked so file is being used for de-embedding.

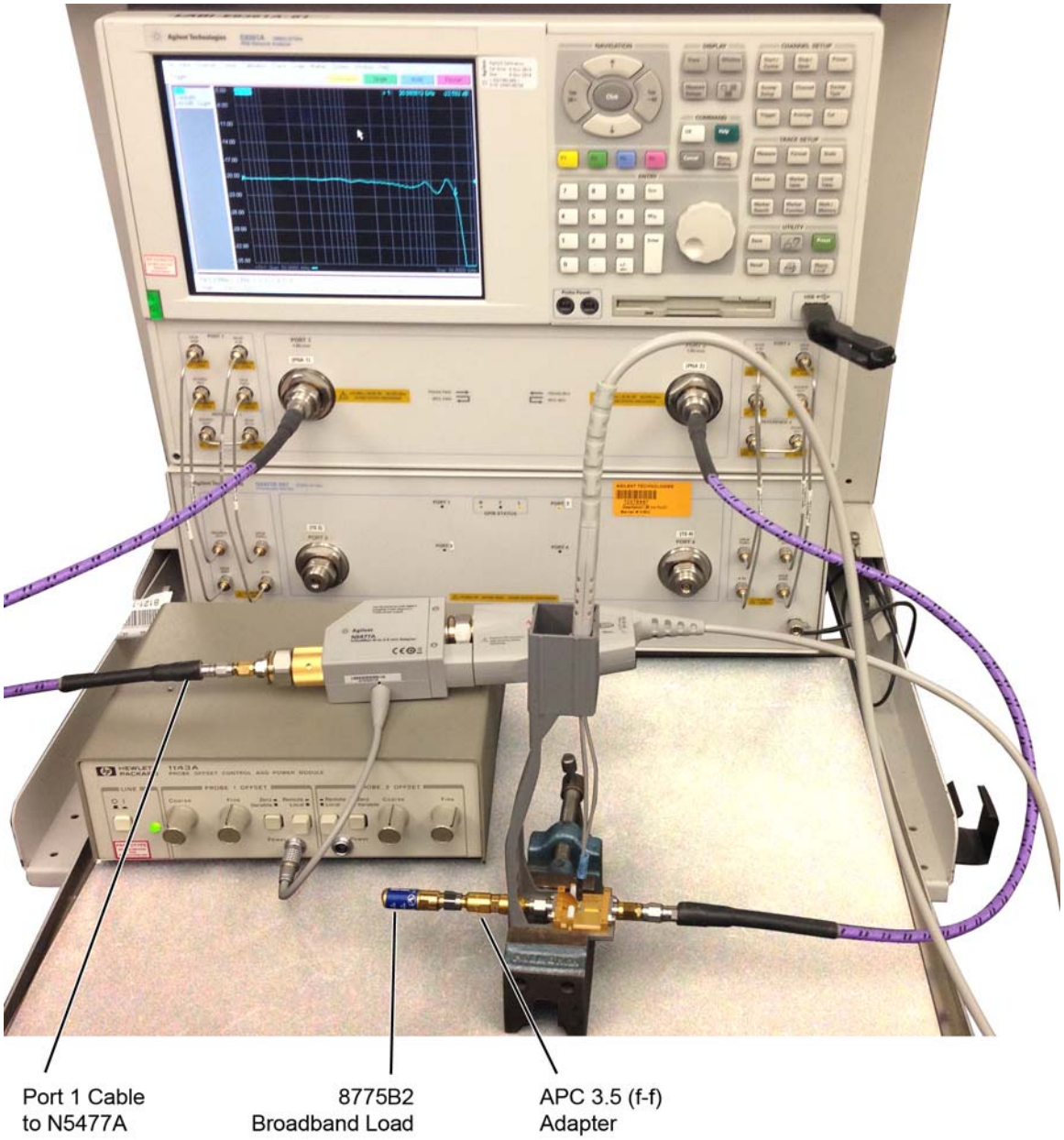

Figure 102 Test Setup to Measure V_{out} of Probe

14 Trigger VNA to perform a single sweep.

- **a** Press “Trigger” under Channel Setup, and then the green soft-key for “Single”.
- **b** Under “Scale” menu, adjust the reference level until the 50 MHz point (left side of the screen) is at center screen. Reference level should be approximately –20 dB, but can vary a few tenths of a dB either way.
- **c** Display should look like Figure 103 on page 135. If it looks noticeably different, the probe tip wires may not be making contact under the pincher.

15 Under menu “Trace/Math/Memory” select “Data/Memory” in the “Data Math” box.

- **a** This will divide the current trace (de-embedded vout trace) by the memory trace (de-embedded vin trace) and therefore show the voltage transfer function of the probe or “vout/vin”.
- **b** Again, adjust the “Reference Level” in the scale menu so the 50 MHz point is at center screen. The display should look like Figure 104 on page 136.
- **c** Turn on a marker and adjust it to where the trace crosses 3 dB below the 50 MHz point (which is one division below center screen since screen is set to 3 dB/div).
- **d** Verify that the BW is ≥ 20 GHz for the N2836A solder-in probe head and N7003A 20 GHz probe amp combination.

Figure 103 De-Embedded V_{out} Trace

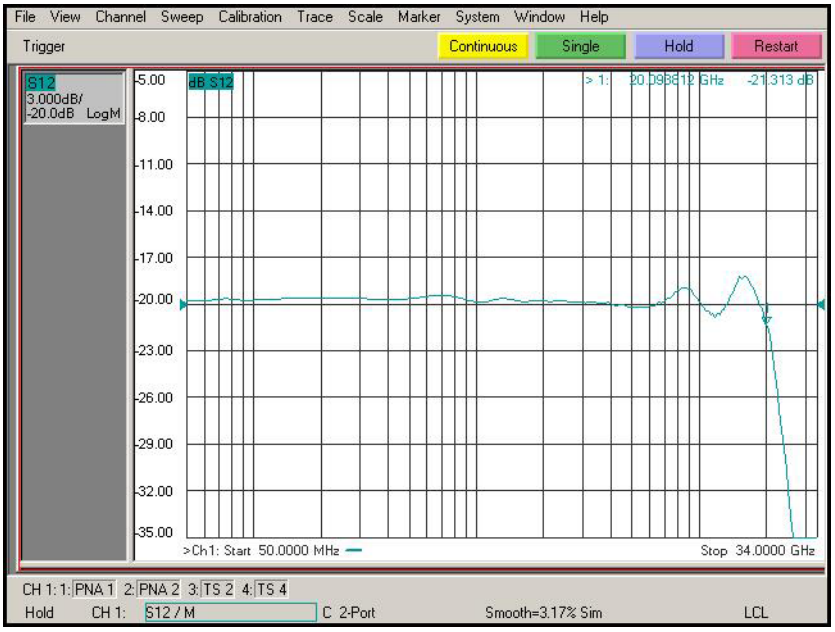

Figure 104 De-Embedded V_{out}/V_{in} Response of the Probe

DC Input Resistance Performance Verification

NOTE The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A solder-in probe head. An N5441A solder-in probe head may be substituted.

NOTE You only need to perform the performance verification test on one of these probe heads, not both of them. If it passes for one of them, then it will pass for all of them.

- Keysight N5443A Performance Verification Fixture. No substitute.
- BNC(m) to SMA(m) Adapter. Pomona 4288 or equivalent.
- Banana Plug to BNC(f). Pomona 1269 or equivalent.
- Digital Multimeter:
- Keysight 33401A or equivalent
- Critical specification: 2 wire resistance accuracy
- Power Supply for Probe
- DSO/DSA 90000 X-series oscilloscope or 1134A power supply with N5477A Autoprobe adapter (see the "Bandwidth Performance Verification" on page 128 procedure)
- No substitute
- Probe Positioner
- Keysight N2787A 3D Probe Positioner
- Critical specification: stable/accurate positioning
- Small Bench Vise

Measuring Input Resistance of N2836A Probe Head

Figure 105 shows the correct setup for measuring the differential input resistance for the solder-in probe head.

1. Connect the BNC to SMA adapter and BNC to Banana Plug adapters as shown in Figure 105 on page 138.
2. Position the PV fixture on a table top and clamp it with a small bench vise to steady it. Ensure that the PV fixture is flush with the table top so that when the banana plugs are probed, it does not rock the PV fixture.

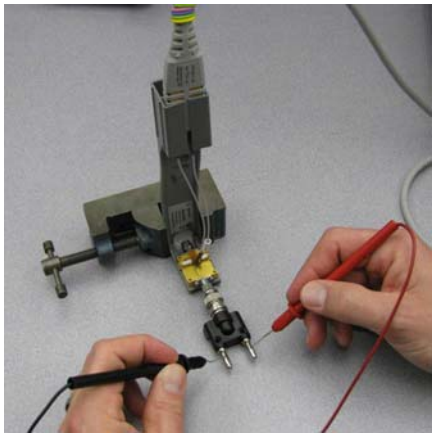

Figure 105 Measuring the Differential Input Resistance of Solder-In Probe Head

3 Connect the probe amplifier to the oscilloscope or power supply so it is powered.

4 Connect the ZIF or solder-in probe head to the probe amp and insert it into the PV fixture as shown Figure 105.

5 Depress the pincher fingers on the PV fixture so they open and carefully insert the tip wires under the pincher. Release the pincher once the tips are inserted.

6 As shown in Figure 105, measure the DC input resistance between the banana plugs. Since one tip wire is connected to the signal line and the other tip is connected to the PV fixture ground, this is a measurement of the differential input resistance. It should be 100 kΩ ±2% (98 to 102 kΩ).

7 To measure the single-ended input resistance, measure the resistance between the signal plug of the banana adapter and the probe amplifier ground, which can be accessed as shown in Figure 106 (through the vent window of the probe amplifier).

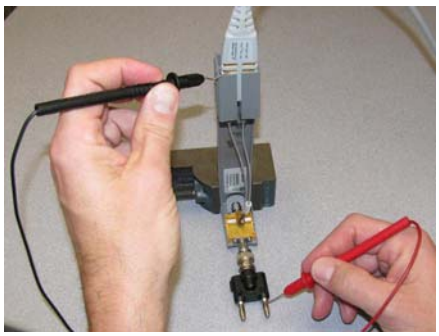

Figure 106 Measuring the Single-Ended Input Resistance the Solder-In Probe Head

Performance Test Record

NOTE The recommended test interval is one year/2000 hours.

Table 26 Test Information

Keysight Technologies	Keysight InfiniiMax III+ Series Probe
Model Number:	Tested by:
Serial Number:	Work Order Number:
Recommended next test date:	Date:

Table 27 Test Results

Test with Probe Heads (only required to test one)	Test Limits	Result	Pass/Fail
Bandwidth Performance Test			
N2836A	≥ 20 GHz		
DC Input Resistance Performance Test			
N2836A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		
N5441A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		

9 SPICE Models

The SPICE models in this chapter are for the input impedances of the various Infiniimax III+ probes heads. The input impedance is only a function of the probe head, as the amplifier input does not significantly affect the input impedance.

Chapter 6, "Performance Plots shows the matching between the measured input impedance and these modeled input impedances for the various probe heads.

N2848A QuickTip Head with N2849A QuickTip Tip

The following input-impedance SPICE subcircuit data is for the N2848A QuickTip probe head with N2849A QuickTip tip. The data models all modes of input impedance: differential, common, and A or B. The probe is vertical orientated with both ground wires connected to the DUT ground.

SPICE Subcircuit Data

```
.subckt N2849A_N2848A 1 2
r1 1 3 1e8
r2 2 3 1e8
r9 3 0 .5e8
r_srlc2 5 7 242.9
l_srlc2 7 8 5.370n
c_srlc2 8 6 52.43f
r_srlc3 4 9 68.66
l_srlc3 9 10 7.669n
c_srlc3 10 6 7.102f
r_srlc1 4 11 245.5
l_srlc1 11 12 1.550n
c_srlc1 12 6 197.9f
r3 4 13 1000
c1 13 6 50n
r5 13 6 100k
r8 6 0 1e-6
r4 14 16 500
r_srlc4 14 18 353.9
l_srlc4 18 19 10.98n
c_srlc4 19 17 230.6f
r_srlc5 14 20 110.7
l_srlc5 20 21 5.880n
c_srlc5 21 17 8.244f
r_srlc6 15 22 611.8
l_srlc6 22 23 8.632n
c_srlc6 23 17 49.18f
r6 16 17 50k
c2 16 17 100n
r7 17 0 1e-6
e1 5 0 4 0 -1
e2 4 0 1 2 1
e3 14 0 3 0 2
e4 15 0 14 0 -1
g1 1 2 6 0 1e6
g2 1 0 17 0 1e6
g3 2 0 17 0 1e6
.ends
```

N5439A ZIF Probe Head with N5440A ZIF Tip

The following SPICE subcircuit data is for the N5440A 28 GHz ceramic ZIF Tips on an N5439A ZIF probe head.

SPICE Subcircuit Data

```
.subckt N5440A_N5439A_450ohmZIF 1 2
c1 1 10 20f
l1 10 11 1.5n
r1 11 2 180
rp1 1 3 180
lp1 3 4 1.5n
cp1 4 5 24f
cp2 5 6 100n
rp2 6 1 500
rp3 5 1 50k
cm1 2 7 24f
lm1 7 8 1.5n
rm1 8 5 180
cm2 2 9 100n
rm2 9 5 500
rm3 2 5 50k
rom 5 0 180
lom 5 0 30u
.ends
```

N5439A ZIF Probe Head with N2838A ZIF Tip

The following SPICE subcircuit data is for the N2838A 25 GHz printed-circuit board ZIF Tip on an N5439A ZIF probe head.

SPICE Subcircuit Data

```
.subckt N2838A_N5439A_PcbZif 1 2
Cblkp 6 13 100n
Cblkn 2 14 100n
Cg1p 1 4 26.1f
Cg1n 5 6 26.1f
Cg2p 1 10 128.4f
Cg2n 12 6 128.4f
Cm2 2 8 3.04f
Cm3 2 3 7.05f
Rg1p 4 6 67.8
Rg1n 2 5 67.8
Rg2p 9 6 126.2
Rg2n 2 11 126.2
Rm2 1 7 225.9
Rm3 1 15 71.5
Rmbp 1 13 500
Rmbn 14 6 500
Rdcp 1 6 50k
Rdcn 2 6 50k
Rom 6 0 110
Lom 6 0 30u
Lg2p 9 10 1.21n
Lg2n 11 12 1.21n
Lm2 7 8 15.3n
Lm3 3 15 5.76n
.ends
```

N2836A 26 GHz Solder-In Probe Heads

SPICE Subcircuit Data

```
.subckt N2836A_SldrIn 1 2
Cblkp 6 13 100n
Cblkn 2 14 100n
Cg1p 1 4 20.7f
Cg1n 5 6 20.7f
Cg2p 1 10 152.2f
Cg2n 12 6 152.2f
Cm2 2 8 4.12f
Cm3 2 3 6.46f
Rg1p 4 6 52.4
Rg1n 2 5 52.4
Rg2p 9 6 142
Rg2n 2 11 142
Rm2 1 7 172.4
Rm3 1 15 67.9
Rmbp 1 13 500
Rmbn 14 6 500
Rdcp 1 6 50k
Rdcn 2 6 50k
Rom 6 0 110
Lom 6 0 30u
Lg2p 9 10 1.12n
Lg2n 11 12 1.12n
Lm2 7 8 11.2n
Lm3 3 15 5.90n
.ends
```

N5441A 16 GHz Solder-In Probe Head

SPICE Subcircuit Data

```
.subckt N5441A_SldrIn 1 2
c1 1 10 50f
l1 10 11 2.1n
r1 11 2 65
rp1 1 3 65
lp1 3 4 2.5n
cp1 4 5 55f
cp2 5 6 100n
rp2 6 1 500
rp3 5 1 50k
cm1 2 7 55f
lm1 7 8 2.5n
rm1 8 5 65
cm2 2 9 100n
rm2 9 5 500
rm3 2 5 50k
rom 5 0 130
lom 5 0 30u
.ends
```

N5445A Browser Probe Head

This section includes N5445A SPICE models for the probe tips adjusted to a 1 mm, 2 mm, and 3 mm span.

SPICE Subcircuit Data (1 mm span)

```
.subckt N5445A_Brwsr1mmSpn 1 2
c1 1 10 20f
l1 10 11 2.3n
r1 11 2 150
rp1 1 3 150
lp1 3 4 2.3n
cp1 4 5 30f
cp2 5 6 100n
rp2 6 1 500
rp3 5 1 50k
cm1 2 7 30f
lm1 7 8 2.3n
rm1 8 5 150
cm2 2 9 100n
rm2 9 5 500
rm3 2 5 50k
rom 5 0 40
lom 5 0 30u
.ends
```

SPICE Subcircuit Data (2 mm span)

```
.subckt N5445A_Brwsr2mmSpn 1 2
c1 1 10 20f
l1 10 11 2.3n
r1 11 2 250
rp1 1 3 250
lp1 3 4 2.3n
cp1 4 5 30f
cp2 5 6 100n
rp2 6 1 500
rp3 5 1 50k
cm1 2 7 30f
lm1 7 8 2.3n
rm1 8 5 250
cm2 2 9 100n
rm2 9 5 500
rm3 2 5 50k
rom 5 0 40
lom 5 0 30u
.ends
```

SPICE Subcircuit Data (3 mm span)

```
.subckt N5445A_Brwsr3mmSpn 1 2
c1 1 10 20f
l1 10 11 2.3n
r1 11 2 300
rp1 1 3 300
lp1 3 4 2.3n
cp1 4 5 30f
cp2 5 6 100n
rp2 6 1 500
rp3 5 1 50k
cm1 2 7 30f
lm1 7 8 2.3n
rm1 8 5 300
cm2 2 9 100n
rm2 9 5 500
rm3 2 5 50k
rom 5 0 40
lom 5 0 30u
.ends
```

N5444A SMA Probe Head

The N5444A 2.92 mm/3.5 mm/SMA probe head is modeled by 40 short transmission lines of varying impedance. This accurately models the temporal nature of this probe head.

SPICE Subcircuit Data

```
.subckt N5444A_2p92mm 01
t01 01 0 02 0 z0=50.1226 td=4.5p
t02 02 0 03 0 z0=48.6767 td=4.5p
t03 03 0 04 0 z0=50.0690 td=4.5p
t04 04 0 05 0 z0=50.1226 td=4.5p
t05 05 0 06 0 z0=47.8189 td=4.5p
t06 06 0 07 0 z0=48.4842 td=4.5p
t07 07 0 08 0 z0=51.5636 td=4.5p
t08 08 0 09 0 z0=51.3432 td=4.5p
t09 09 0 10 0 z0=50.1231 td=4.5p
t10 10 0 11 0 z0=50.9715 td=4.5p
t11 11 0 12 0 z0=51.2048 td=4.5p
t12 12 0 13 0 z0=49.3079 td=4.5p
t13 13 0 14 0 z0=48.3903 td=4.5p
t14 14 0 15 0 z0=50.1144 td=4.5p
t15 15 0 16 0 z0=51.9126 td=4.5p
t16 16 0 17 0 z0=51.1671 td=4.5p
t17 17 0 18 0 z0=48.7858 td=4.5p
t18 18 0 19 0 z0=49.7704 td=4.5p
t19 19 0 20 0 z0=54.9662 td=4.5p
t20 20 0 21 0 z0=55.6338 td=4.5p
t21 21 0 22 0 z0=50.6714 td=4.5p
t22 22 0 23 0 z0=47.9673 td=4.5p
t23 23 0 24 0 z0=48.6942 td=4.5p
t24 24 0 25 0 z0=51.3949 td=4.5p
t25 25 0 26 0 z0=52.4910 td=4.5p
t26 26 0 27 0 z0=50.3990 td=4.5p
t27 27 0 28 0 z0=49.9508 td=4.5p
t28 28 0 29 0 z0=50.5692 td=4.5p
t29 29 0 30 0 z0=49.8539 td=4.5p
t30 30 0 31 0 z0=51.6006 td=4.5p
t31 31 0 32 0 z0=49.4657 td=4.5p
t32 32 0 33 0 z0=51.3932 td=4.5p
t33 33 0 34 0 z0=50.6702 td=4.5p
t34 34 0 35 0 z0=50.1108 td=4.5p
t35 35 0 36 0 z0=50.9072 td=4.5p
t36 36 0 37 0 z0=50.6940 td=4.5p
t37 37 0 38 0 z0=50.1733 td=4.5p
t38 38 0 39 0 z0=50.2609 td=4.5p
t39 39 0 40 0 z0=50.1355 td=4.5p
t40 40 0 41 0 z0=51.2333 td=4.5p
rterm 41 0 50.3
.ends
```

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