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

Notices

© Keysight Technologies, Inc. 2016, 2017, 2019, 2020, 2021, 2023

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Keysight Technologies, Inc. as governed by United States and international copyright laws.

Manual Part Number

N2830-97012

Edition

Fifteenth Edition, February 2023

Published by:
Keysight Technologies, Inc.
1900 Garden of the Gods Road
Colorado Springs, CO 80907 USA

Warranty

The material contained in this document is provided “as is,” and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Keysight disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Keysight shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Keysight and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

U.S. Government Rights

The Software is “commercial computer software,” as defined by Federal Acquisition Regulation (“FAR”) 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement (“DFARS”) 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at <http://www.keysight.com/find/sweula>. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data. 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

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	5
Inspecting the Probe and Its Accessories	6
Introduction	9
Compatible Oscilloscopes	15
To Avoid Damaging the Probe	17
To Ensure Maximum Measurement Accuracy	22
To Use InfiniiMode	23
To Probe Ungrounded Devices	26
To Probe Single-Ended Signals with a Differential Head	27
To Measure Small Signals on a Large DC Level	28
Slew Rate Requirements for Different Technologies	31
Available Accessories	33
Safety Information	36
Service	39
2 Using InfiniiMax III+ Probe Heads	41
Recommended Configurations at a Glance	42
N5444A InfiniiMax III 2.92 mm/3.5 mm/SMA Probe Head	44
N5439A InfiniiMax III ZIF Probe Head	47
N5445A InfiniiMax III Differential Browser Probe Head	53
MX0109A and N2836A InfiniiMode Solder-In Heads	59
N5441A InfiniiMax III Solder-In Head (discontinued)	65
N2848A QuickTip InfiniiMode Probe Head	68
N2835A InfiniiMax III+ Differential Connectivity Kit and Accessories	72
Strain Relieving the Probe Heads	74
Soldering Tips	76
3 Maintaining Probe Heads	77
Replacing Axial Resistor Tips	78
Replacing N5441A Probe Head Wires	82
4 Calibration / Deskew Procedure	87
Procedure	88

5 Specifications and Characteristics	95
InfiniiMax III+ Warranted Specifications	96
N2830A/1A/2A and N7000/1/2/3A Probe Amplifiers Characteristics	97
N7000A/1A/2A InfiniiMax III+ Probe Heads Characteristics	99
N2830/1/2A InfiniiMax III+ Probe Heads Characteristics	100
Environmental	102
Safety and Regulatory Information	103
Probe Dimensions	104
Probe Heads Dimensions	105
6 Performance Plots	109
InfiniiMax III+ Probe System Responses	110
N2848A QuickTip Head with N2849A QuickTip	113
N2836A and MX0109A Solder-In Probe Heads (Flat Orientation)	114
7 Performance Verification for N2830A-Series Probes	117
Bandwidth Performance Verification	118
DC Input Resistance Performance Verification	135
Performance Test Record	137
8 Performance Verification for N7000-Series Probes	139
Bandwidth Performance Verification	140
DC Input Resistance Performance Verification	149
Performance Test Record	151
9 SPICE Models	153
N2848A QuickTip Head with N2849A QuickTip Tip	154
N5439A ZIF Probe Head with N5440A ZIF Tip	155
N5439A ZIF Probe Head with N2838A ZIF Tip	156
MX0109A and N2836A 26 GHz Solder-In Probe Heads	157
N5441A 16 GHz Solder-In Probe Head	158
N5445A Browser Probe Head	159
N5444A SMA Probe Head	161

1 Using InfiniiMax III+ Series Probes

Inspecting the Probe and Its Accessories	6
Introduction	9
Compatible Oscilloscopes	15
To Avoid Damaging the Probe	17
To Ensure Maximum Measurement Accuracy	22
To Use InfiniiMode	23
To Probe Ungrounded Devices	26
To Probe Single-Ended Signals with a Differential Head	27
To Measure Small Signals on a Large DC Level	28
Slew Rate Requirements for Different Technologies	31
Available Accessories	33
Safety Information	36
Service	39

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**.

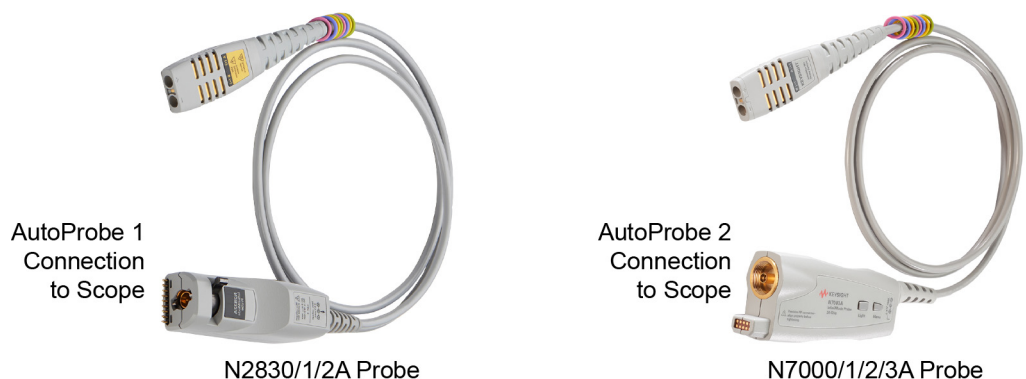


Figure 1 InfiniiMax III+ Series Probes

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.

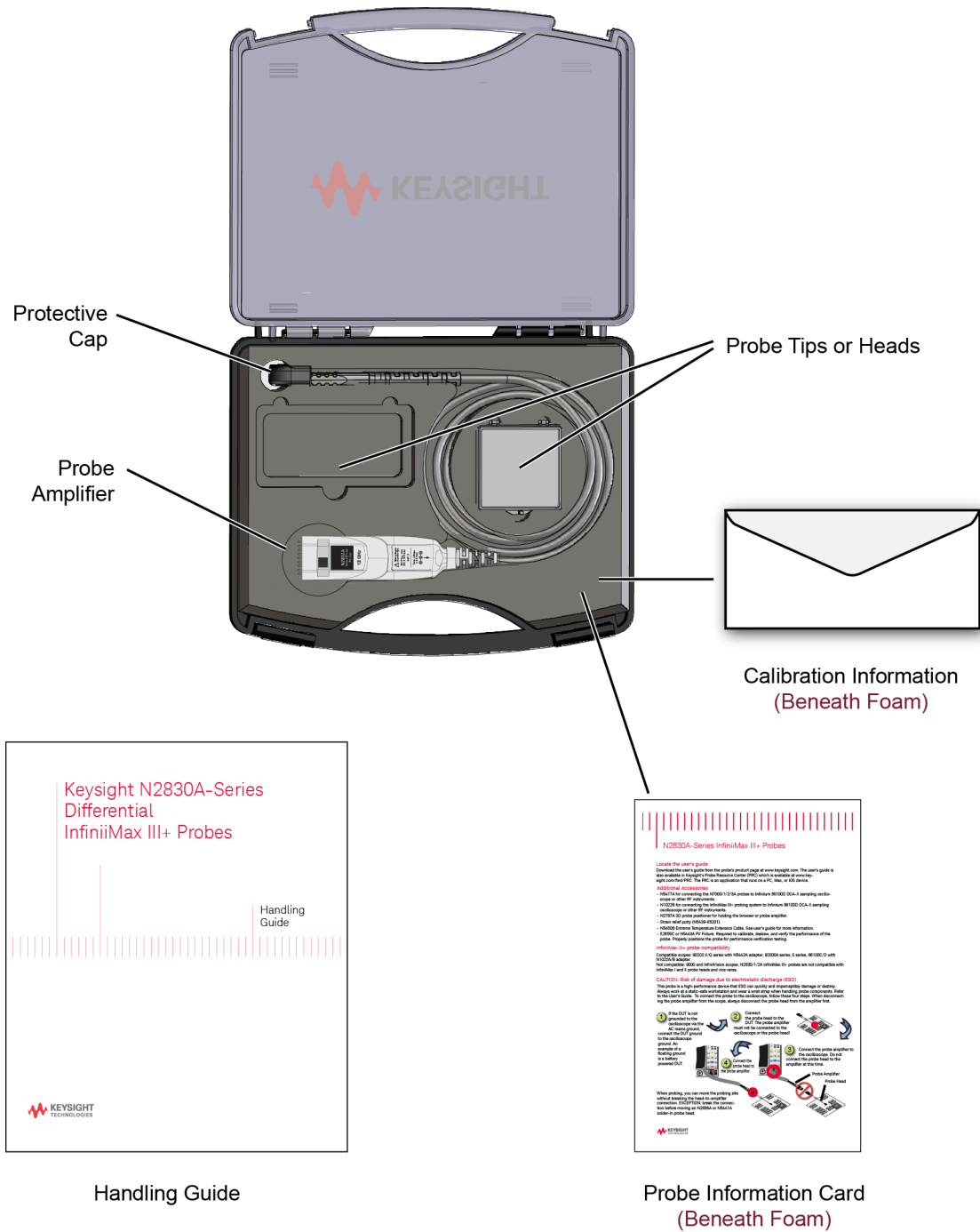


Figure 2 N2830A-Series Probe and Accessories in Supplied Case

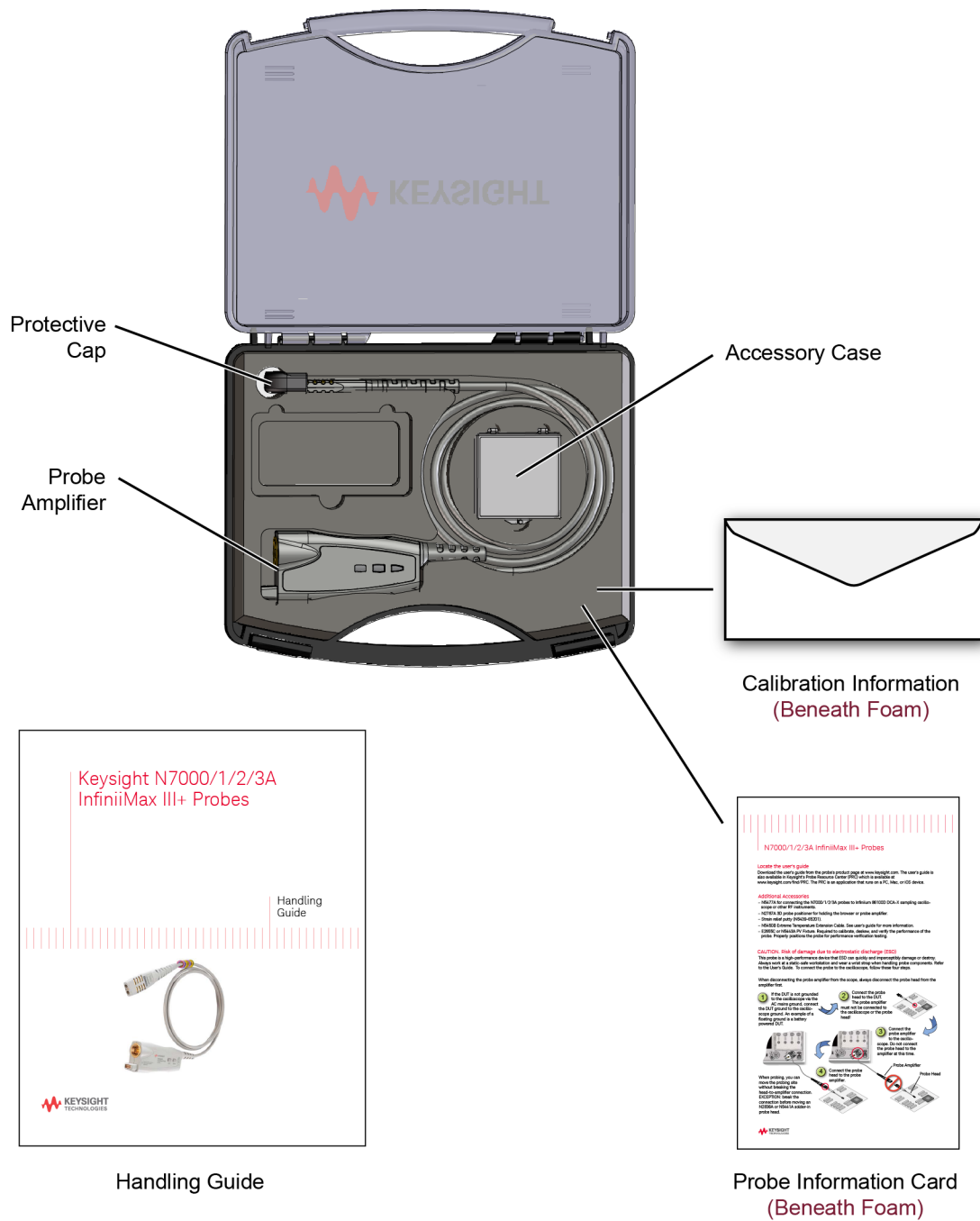


Figure 3 N7000A-Series Probe and Accessories in Supplied Case

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, MX0109A Extreme Temperature Solder-in 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 23.

WARNING

Before using the probe, refer to "Safety Information" on page 36.

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 17.

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.

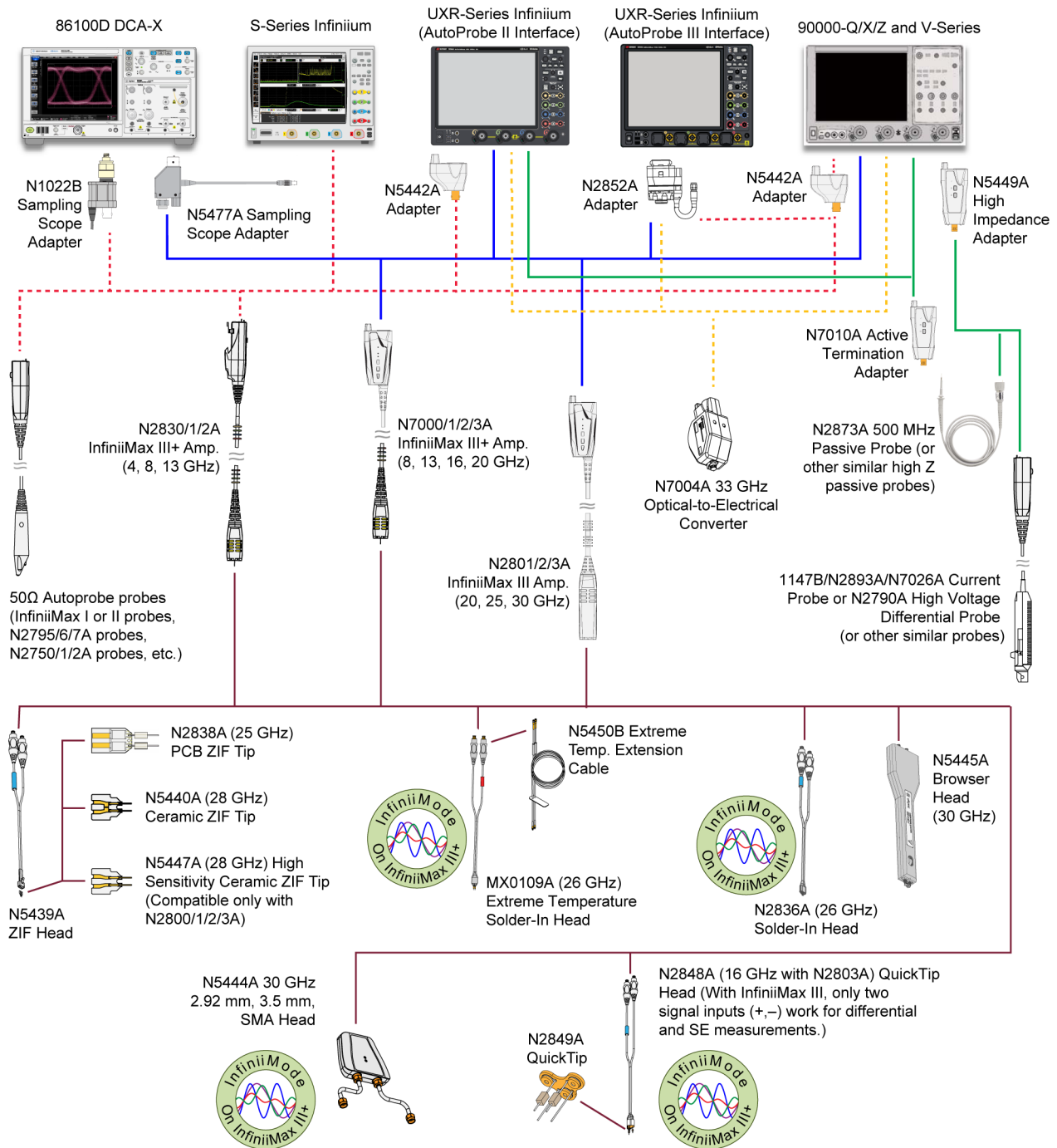


Figure 4 InfiniiMax III and III+ Family Diagram with Compatible Scopes and Probe Heads
(not to scale)

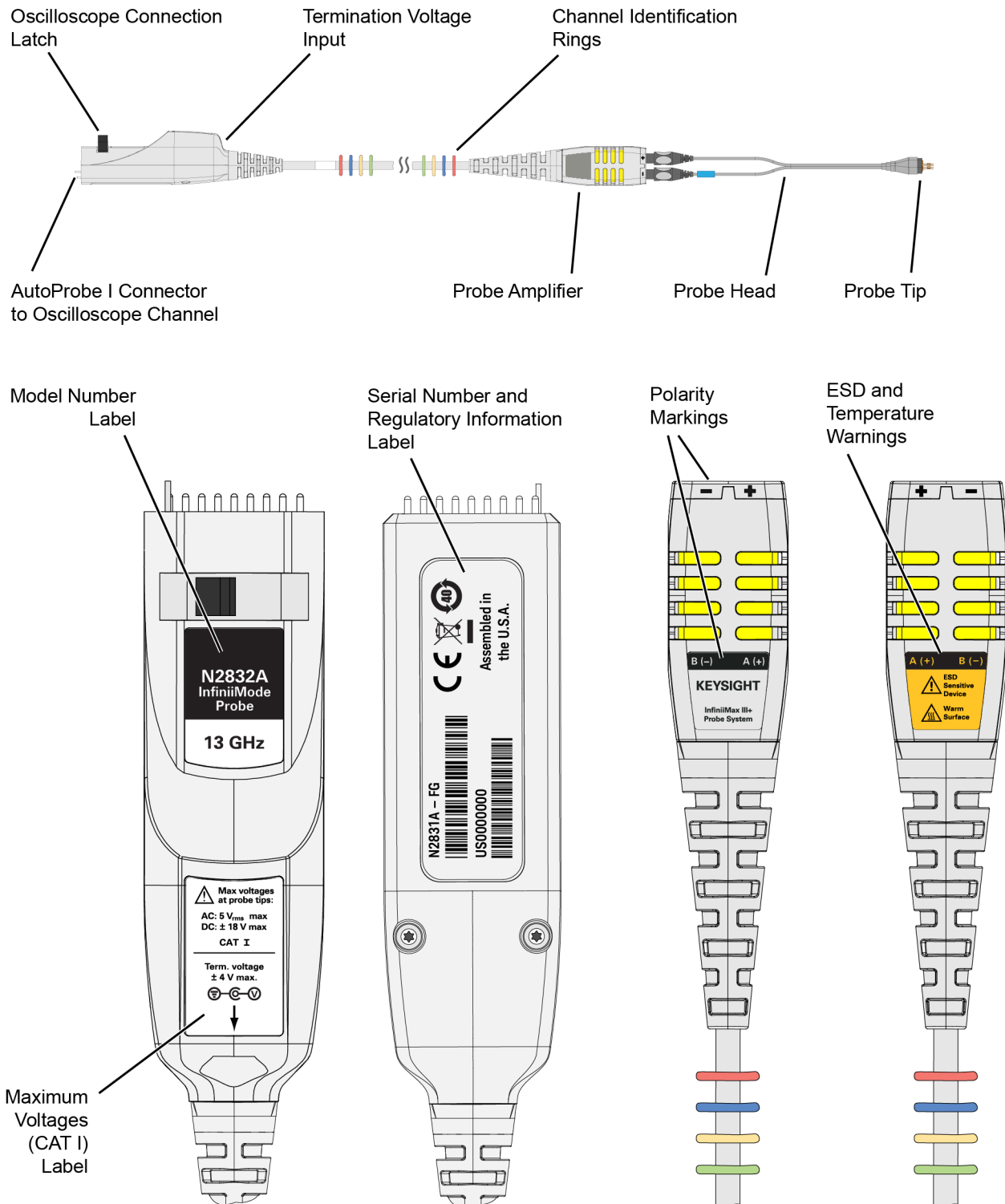


Figure 5 N2830/1/2A Probes

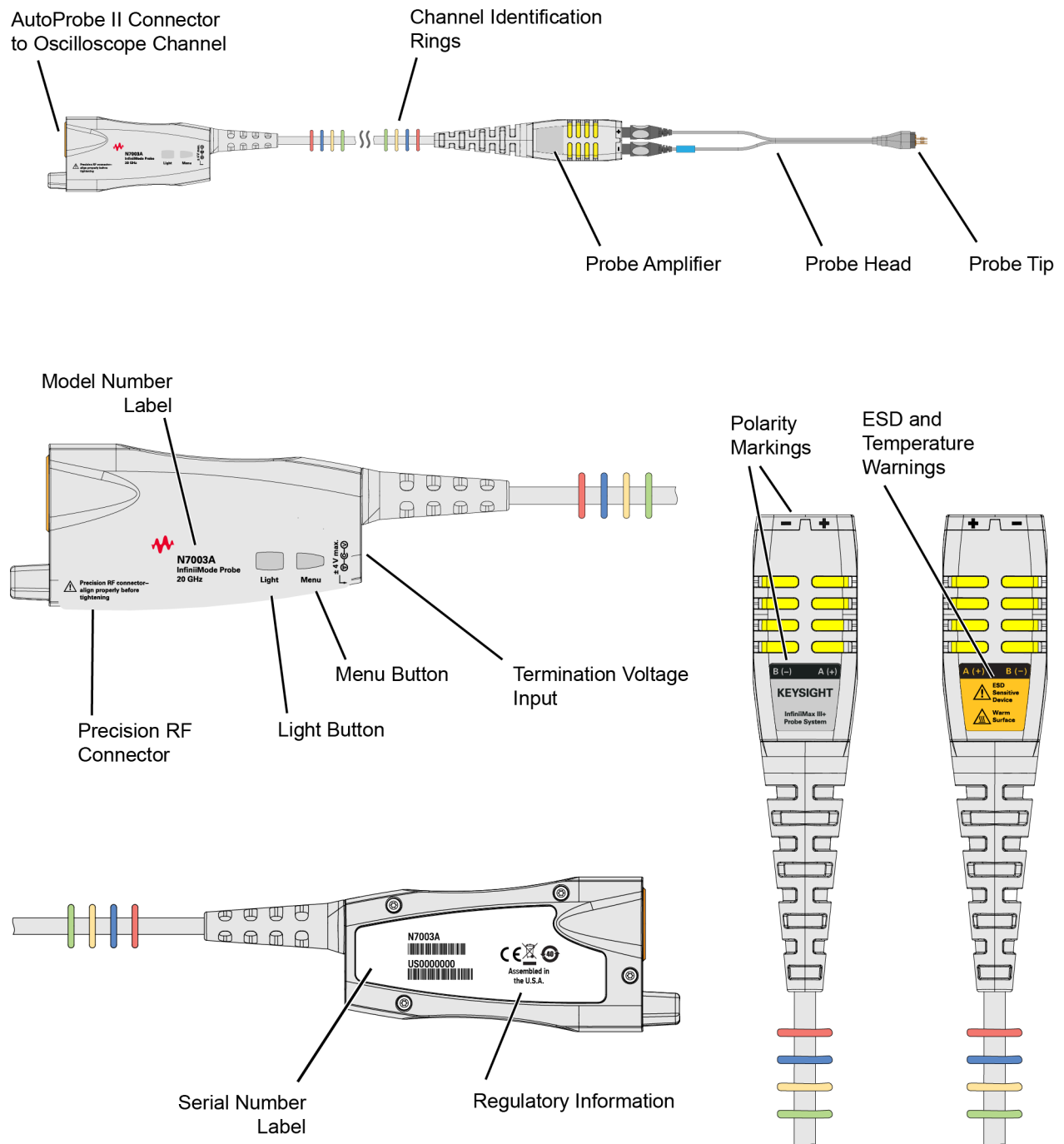


Figure 6 N7000/1/2/3A Probes

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 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

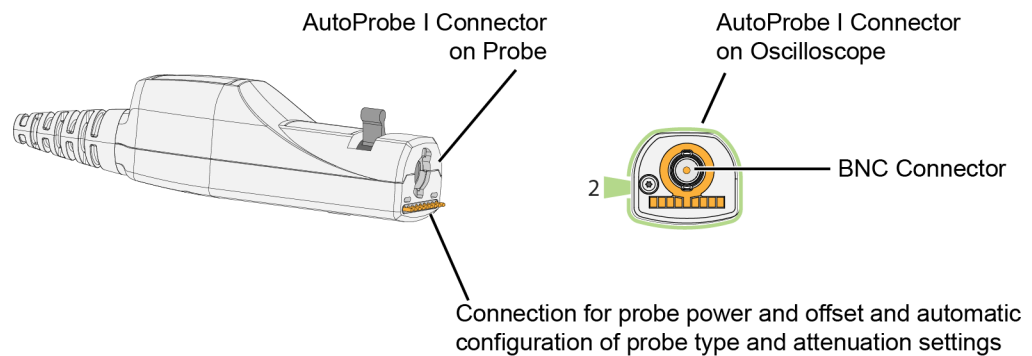


Figure 7 N2830/1/2A's AutoProbe I Interface Connector

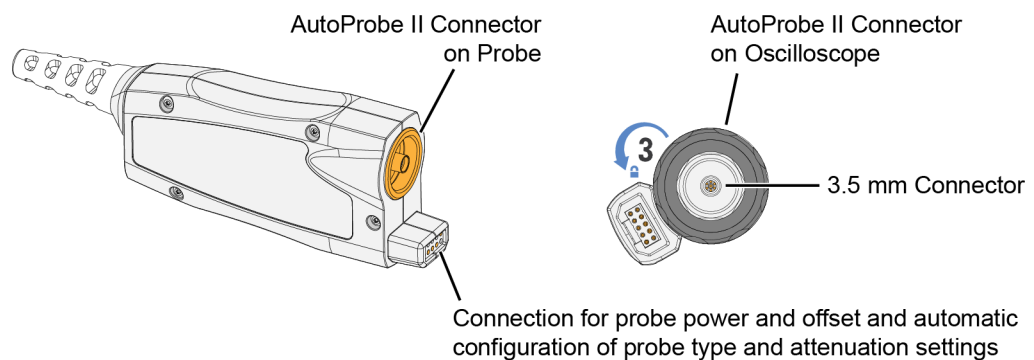


Figure 8 N7000/1/2/3A's AutoProbe II Interface Connector

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: $\pm 18V$

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.

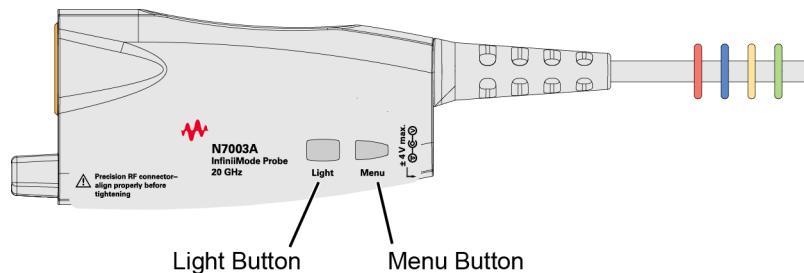


Figure 9 Buttons on 7000/1/2/3A Probe

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 the S-series oscilloscope.

- 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.
- Use an N5442A (50 Ω) / N5449A (1M Ω) AutoProbe I to II adapter connected to the N2852A AutoProbe II to AutoProbe III Interface adapter to connect to the UXR-series (40 - 110 GHz) Infiniium oscilloscope.

Table 2 N2830A-Series Probes and Compatible Infiniium Oscilloscopes

Oscilloscope	Adapter(s) Required	Minimum Required Firmware Version
90000 Q, V, X, and Z-Series	N5442A	5.00
S-Series	none	5.00
86100C/D Series	N1022A/B	—
UXR-Series (13-33GHz)	N5442A (50 Ω) adapter	10.0
UXR-Series (40GHz or higher)	N5442A (50 Ω) adapter cascaded with the N2852A adapter	10.10

The N7000/1/2/3A probe's AutoProbe II interface connects directly to 90000 Q, V, X, Z-series, and UXR-series (13 - 33 GHz) Infiniium oscilloscopes.

- Use an N5477A adapter to connect to the 86100D oscilloscope.
- Use an N2852A AutoProbe II to AutoProbe III Interface adapter to connect to the UXR-series (40 - 110 GHz) Infiniium oscilloscope.

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	—
UXR-Series (13-33GHz)	none	10.0
UXR-Series (40GHz or higher)	N2852A	10.10

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.

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 <http://www.keysight.com/find/esd-best-practices-demo>.

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 amplifier, 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**.

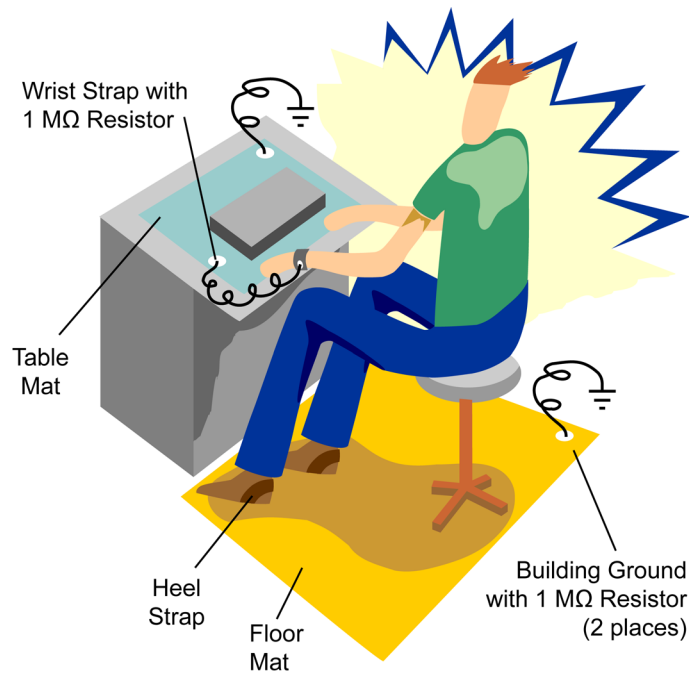


Figure 10 Static-Safe Work Station

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.

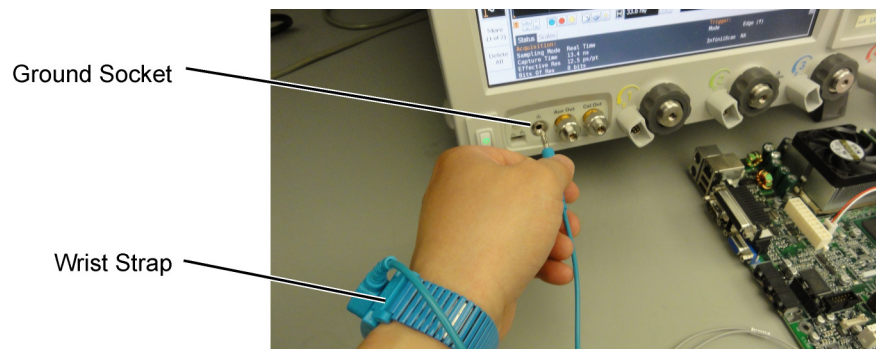


Figure 11 Wrist Strap Connected to Oscilloscope Ground Socket

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 M Ω 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 20 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 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 MX0109A, N2836A or 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.

To connect the probe to the oscilloscope...

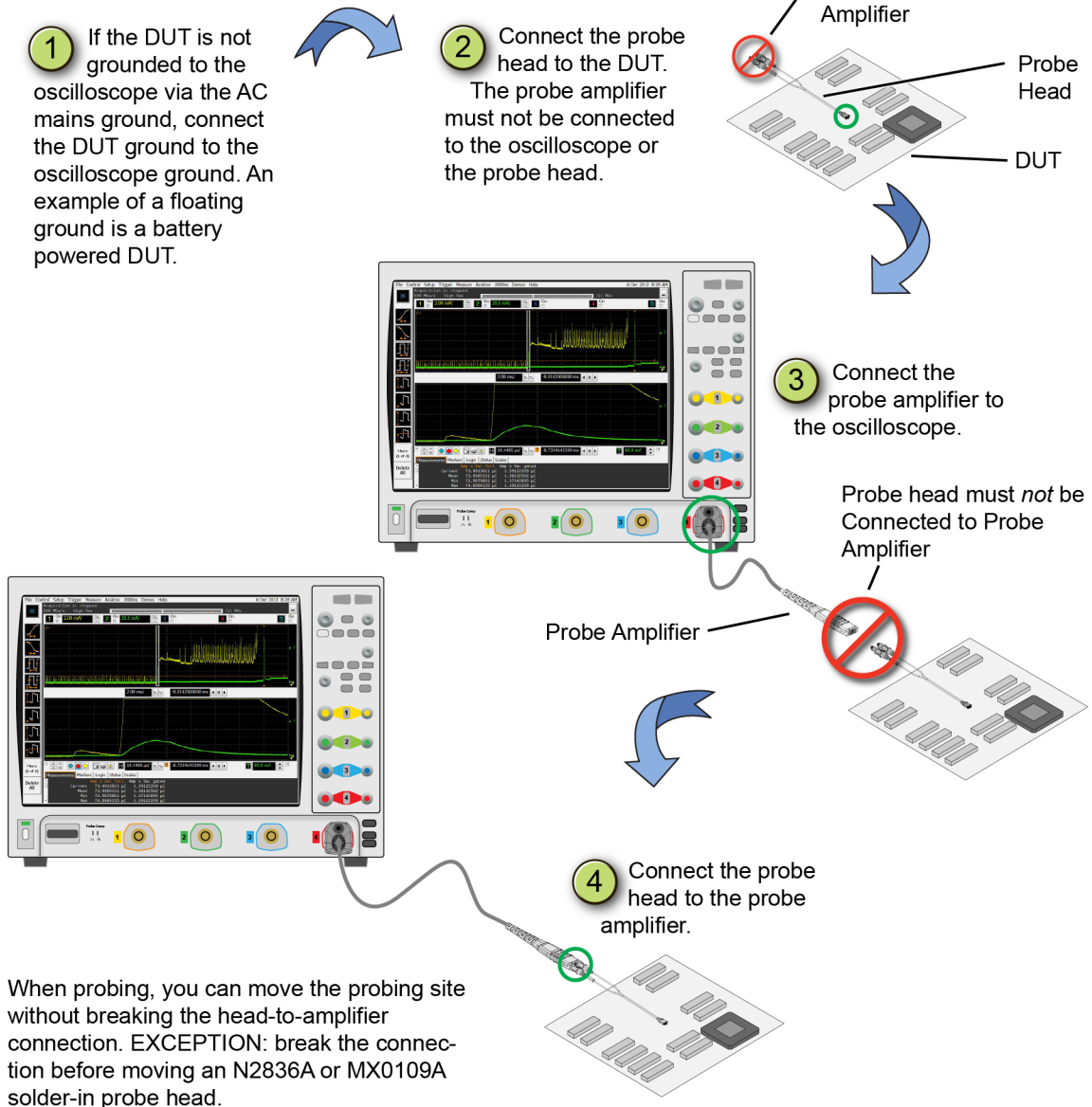


Figure 12 Connecting the Probe to the Oscilloscope

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.

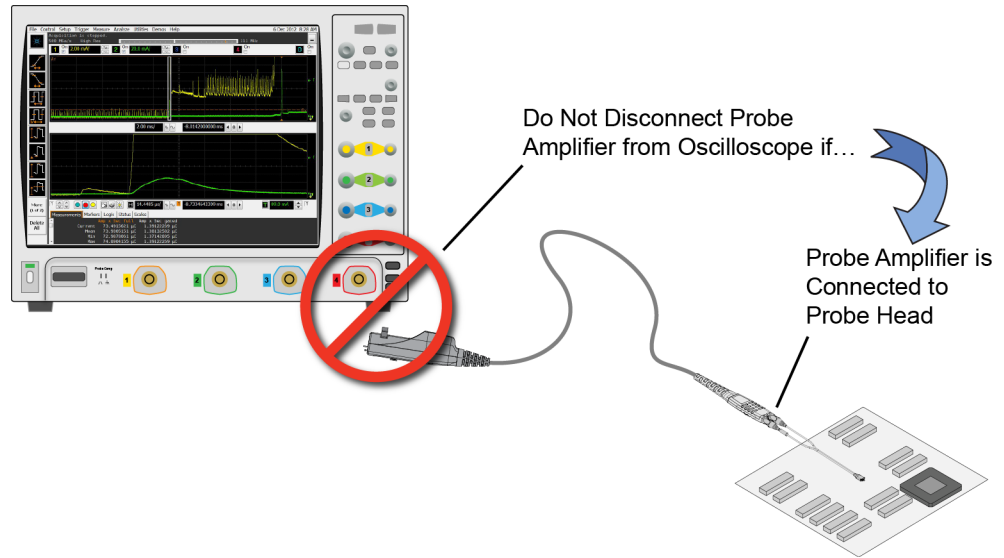


Figure 13 Probe Improperly Disconnected from Oscilloscope while Probe Head is Connected to the Probe Amplifier

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**.

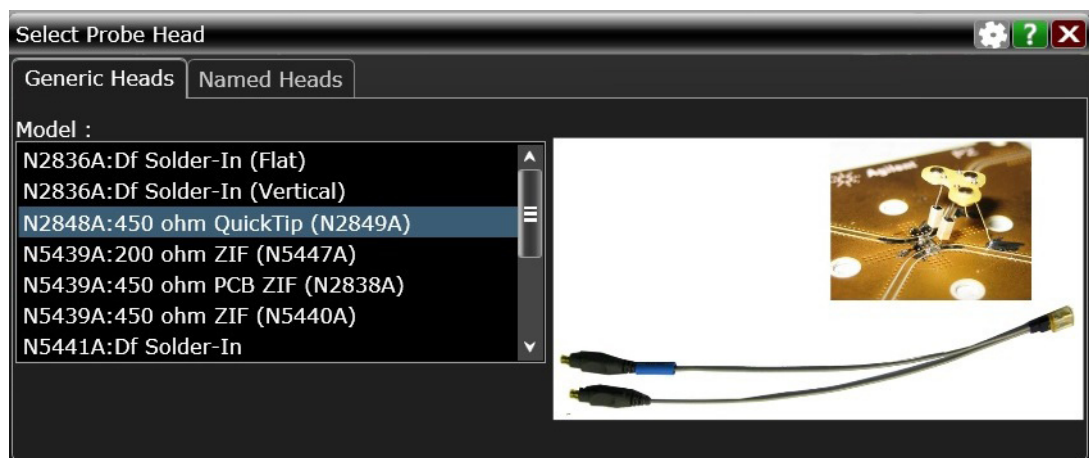


Figure 14 Select Probe Head Dialog Box

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, MX0109A Extreme Temperature Solder-In head, 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 (<i>full BW</i>) *	Browser (<i>full BW</i>)
	Solder-In (<i>lower BW</i>)	Solder-In (<i>lower BW</i>)
	QuickTip (<i>lower BW</i>)	QuickTip (<i>lower BW</i>)
Single-Ended	Browser (<i>not supported</i>)	Browser (<i>not supported</i>)
	Solder-In	Solder-In
	QuickTip	QuickTip
Common-Mode	Browser (<i>not supported</i>)	Browser (<i>not supported</i>)
	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.

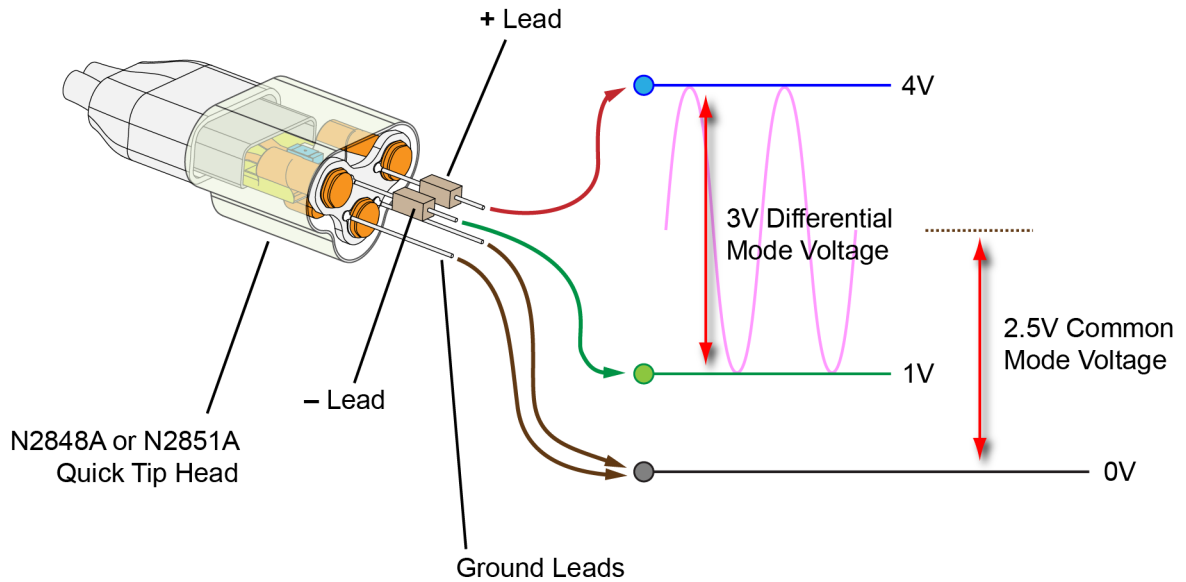


Figure 15 Example InfiniiMode Probe Circuit Connections

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**.

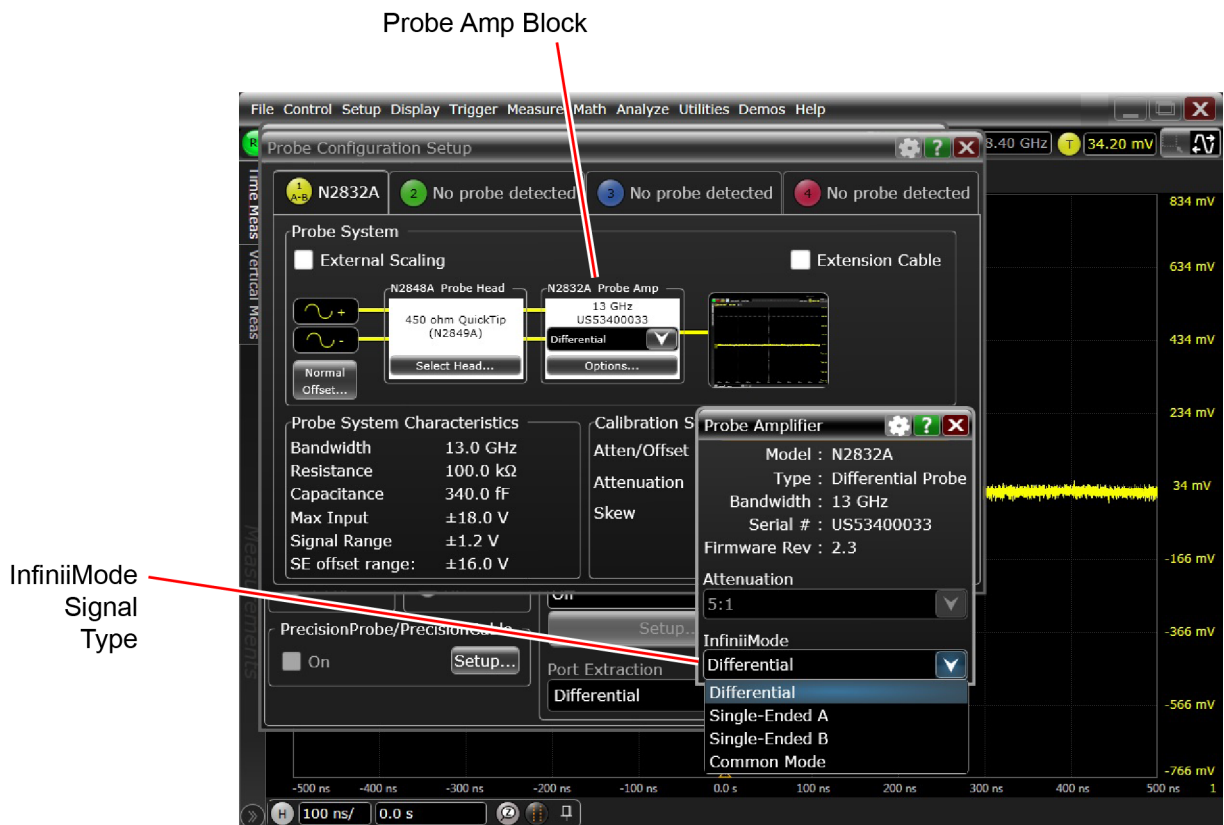


Figure 16 Probe Configuration Dialog Box and Probe Amplifier Dialog Box

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.

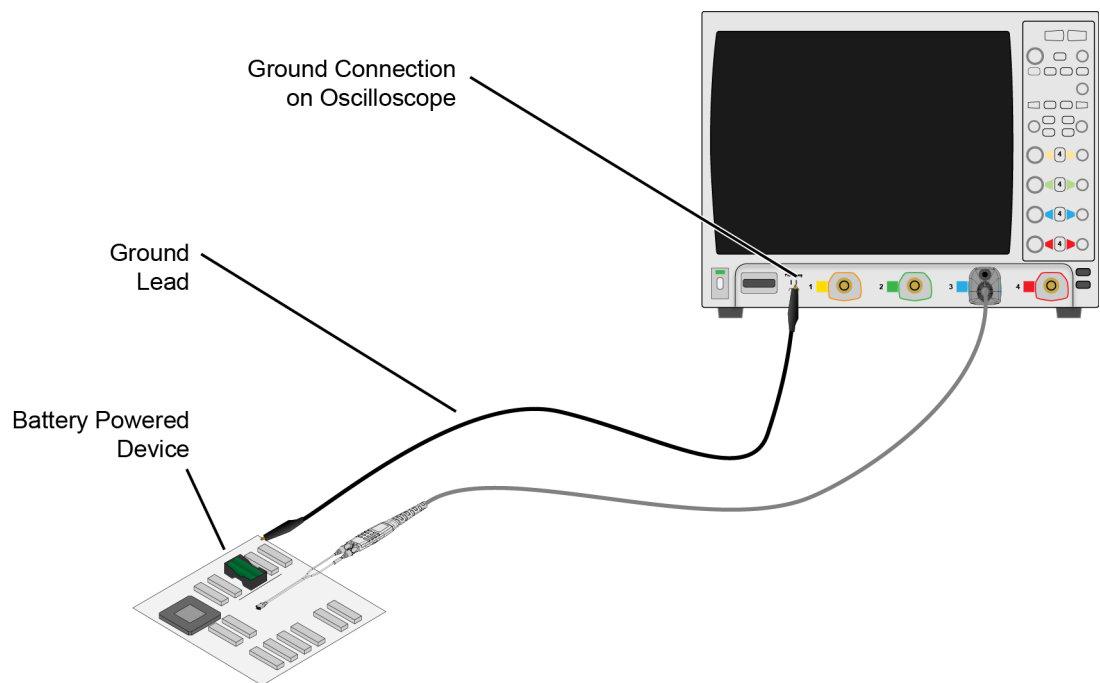


Figure 17 Grounding the DUT to an S-Series Oscilloscope

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 28.

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.

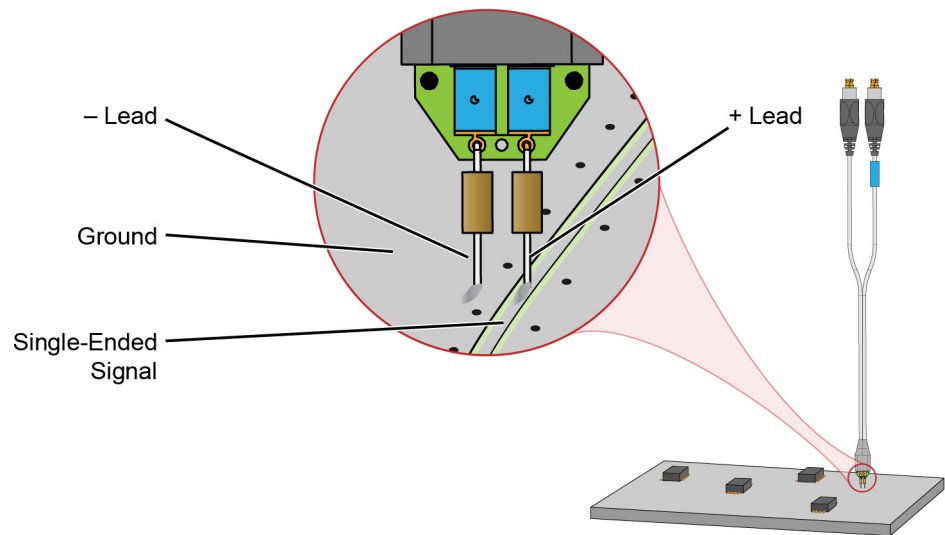


Figure 18 Connecting a Differential Head to a Single-Ended Signal

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.

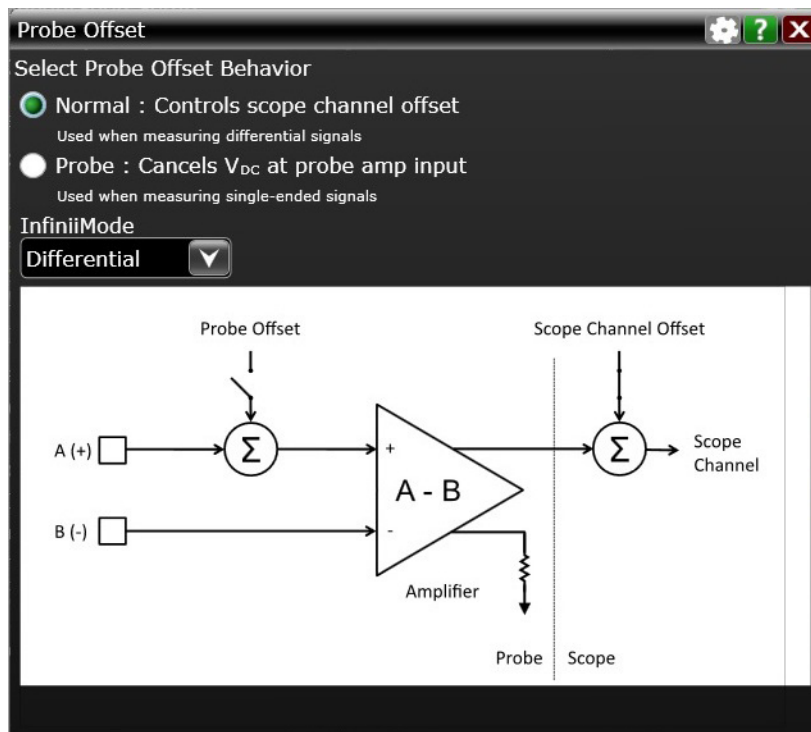


Figure 19 Probe Offset Dialog Box (Normal Setting)

Probe Offset Behavior

When **Probe** is selected as shown in **Figure 20** on page 29, the InfiniiMax III/III+ probe provides a very large offset range (up to $\pm 16\text{V}$) 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.

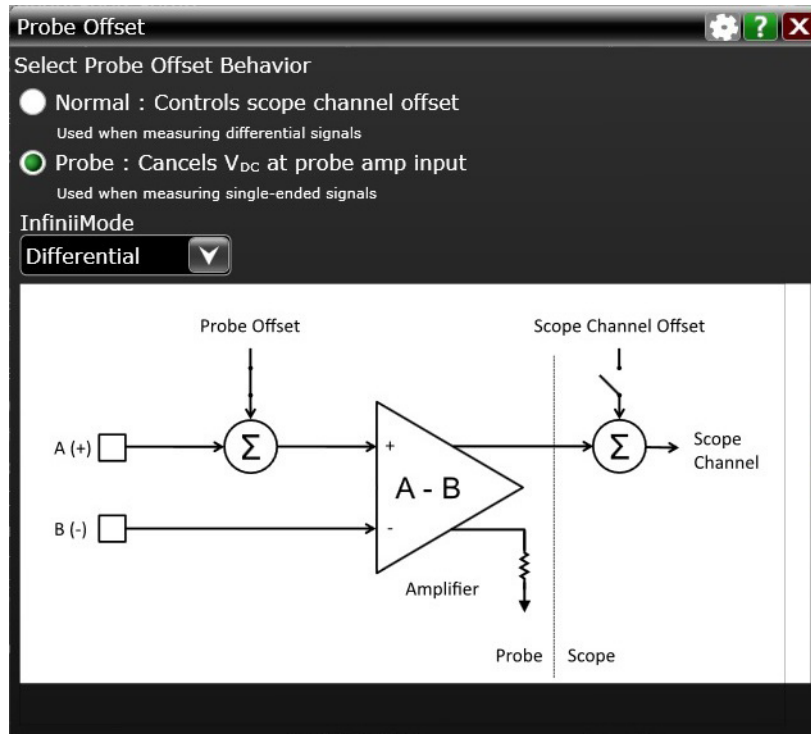


Figure 20 Probe Offset Dialog Box (Probe Setting)

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 30 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	$\pm 16V$ (with 450 ohm probe head)	$\pm 2.5V$
Description	<p>The offset voltage is subtracted from the input signal before the probe's differential amplifier. Since this subtraction is done <i>before</i> any active circuits, the offset range is large.</p> <p>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.</p> <p>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.</p>	

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 than 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

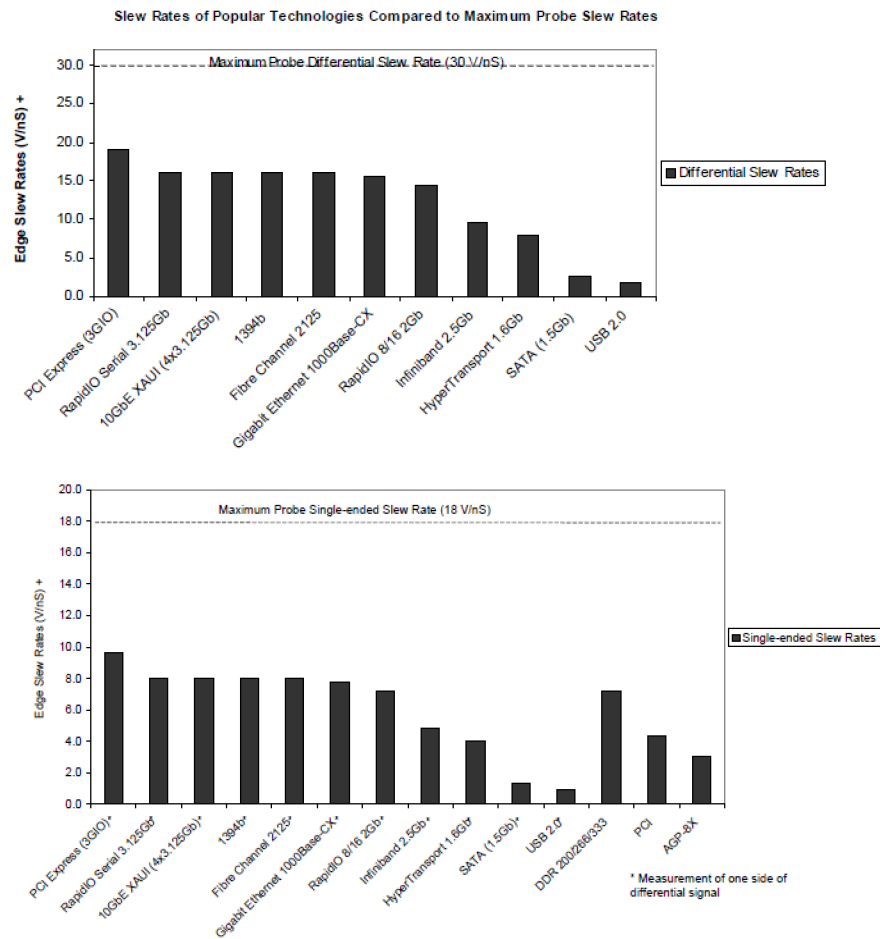


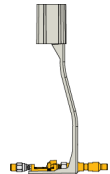
Figure 21 Slew Rates of Popular Technologies Compared to Maximum Probe Slew Rates

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 MX0109A / N5441A solder-in heads.

Keysight's Infiniimax probe amplifiers have a specified operating temperature range from 5° C to 40° C, but the MX0109A and N5441A probe heads can withstand temperatures from –55°C to +150°C for up to 750 and 250 test cycles respectively. 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 MX0109A and N5441A probe heads, *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.

N2852A AutoProbe II to AutoProbe III Interface Adapter

This adapter allows you to connect a probe with AutoProbe II interface such as the N7000A / N7001A / N7002A / N7003A InfiniiMax III+ probe to a Keysight UXR-Series (40GHz or higher) Infiniium oscilloscope that has the AutoProbe III interface.

The adapter also allows you to connect a probe with AutoProbe I interface such as the N2830A-series InfiniiMax III+ probe to a Keysight UXR-Series (40GHz or higher) Infiniium oscilloscope. To do this, you need to connect the N5442A (50 Ω) / N5449A (1M Ω) AutoProbe I to II adapter to the N2852A adapter.

To know more about the N2852A adapter, visit

<http://www.keysight.com/find/N2852A> and then download the adapter's user guide available in the *Document Library* tab.

CAUTION

Care should be taken while handling the N2852A adapter's RF cable. Avoid bending this cable backwards or kinking the cable in order to ensure measurements accuracy.

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 ($\sim \pm 2\%$).
- 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

Recommended Configurations at a Glance	42
N5444A InfiniiMax III 2.92 mm/3.5 mm/SMA Probe Head	44
N5439A InfiniiMax III ZIF Probe Head	47
N5445A InfiniiMax III Differential Browser Probe Head	53
N5441A InfiniiMax III Solder-In Head (discontinued)	65
MX0109A and N2836A InfiniiMode Solder-In Heads	59
N2848A QuickTip InfiniiMode Probe Head	68
N2835A InfiniiMax III+ Differential Connectivity Kit and Accessories	72
Strain Relieving the Probe Heads	74
Soldering Tips	76

This chapter describes 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 44.)				
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 47.)				
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 53.)				
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 browsing Variable pitch spacing from 20 mil to 125 mil
MX0109A InfiniiMax III Extreme Temperature Solder-In Head (Refer to page 59.)				
4	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 Also suitable for Extreme Temperature testing

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 68.)				
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

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

The N5444A InfiniiMax III 2.92mm/3.5mm/SMA probe head provides 30 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 $\pm 4V$ 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.

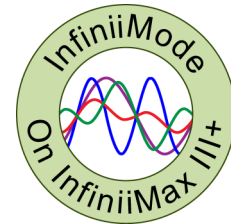
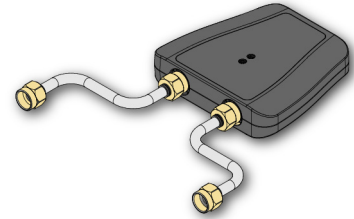


Table 8 Bandwidth

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.”

N5448B Coaxial Phase Matched Cable Pair

For extending the cable length of the N5444A InfiniiMax III probe head and add flexibility and convenience to the probing setup, you can order N5448B 10 inches (25 cm) long coaxial phase matched cable pair. This cable pair supports 2.92 mm male-to-2.92 mm male connection.

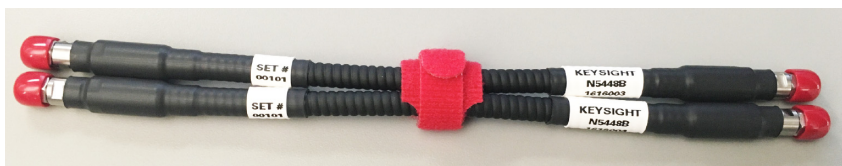


Figure 23 N5448B Coaxial Phased Matched Cable Pair

Before connecting these cables to the N5444A probe head, you must first remove the supplied rigid cables of the N5444A probe head. **Figure 24** on page 45 shows the N5448B cables attached to the N5444A probe head.

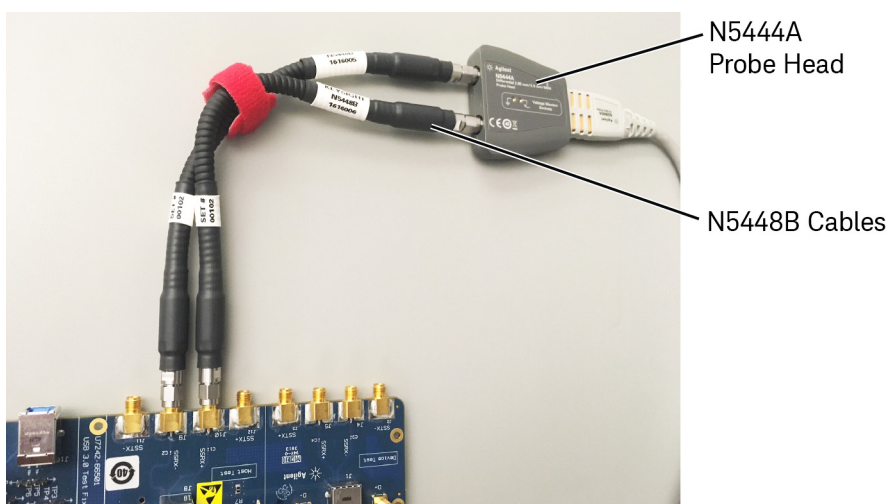


Figure 24 N5444A Probe Head With N5448B Cables Attached

CAUTION

The maximum bend radius for the N5448B coaxial cable pair is 30 mm. Bending these cables at too tight a radius or twisting the cables can cause damage, reduce performance, and impact the precision of these cables.

Also, ensure that the plastic caps that are provided with these cables are installed when the cables are not in use.

For details on the N5448B cable, refer to its guide available in the Document Library tab of this product's page on www.keysight.com.

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.



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.

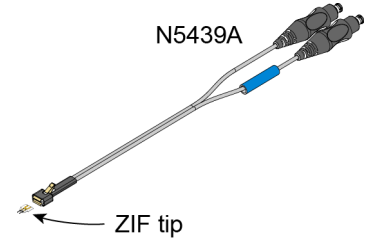
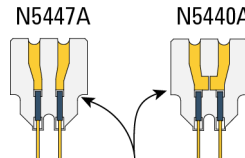
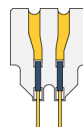
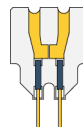
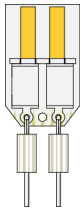


Table 9 Bandwidth

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.	5 mil to 80 mil (0.127 mm to 2 mm)	5
N5447A	The N5447A ZIF tip is <i>not</i> compatible with the N2830/1/2A or N7000/1/2/3A probes. Compatible <i>only</i> with InfiniiMax III N2800/1/2/3A probes.	5 mil to 80 mil (0.127 mm to 2 mm)	5



These ZIF tips have different gold patterns

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 78.

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 43**, 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.

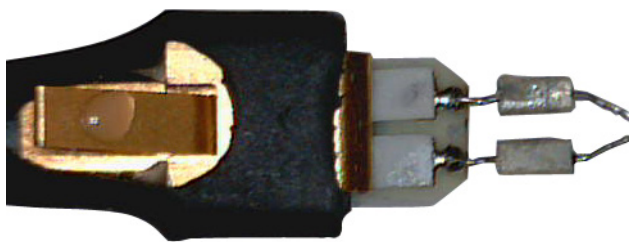


Figure 25 Proper Position of Resistors

Soldering a ZIF tip to the DUT

Before using the following procedure, refer to “**Soldering Tips**” on page 76.

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 26 Five ZIF Tips on Packaging

- 2 Flux and tin the leads on the target DUT.



Figure 27 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 28** on page 50 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.

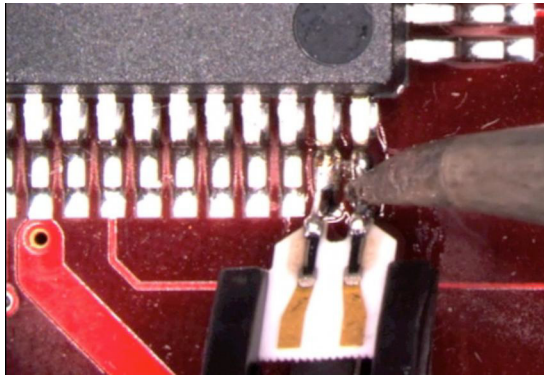


Figure 28 Soldering the ZIF Tip

- 6 Pull the ZIF handle from the ZIF tip in the direction shown in **Figure 29**. ZIF tips can be carefully handled with your fingertips and reinserted into a plastic handle if necessary.

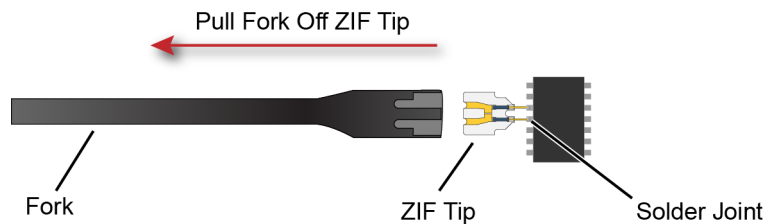


Figure 29 Removing the Handle from the ZIF Tip

- 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 74.

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 74.
- 2 Form the coaxial cables to bring the probe head near the tip. Press the lever down on the ZIF probe head (see **Figure 30**) 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.

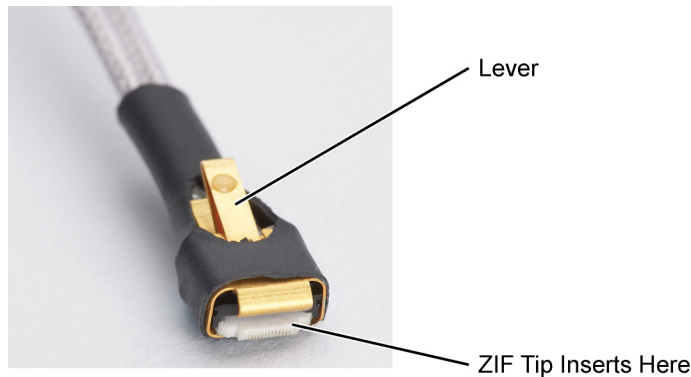


Figure 30 Probe Head with Location of the Lever

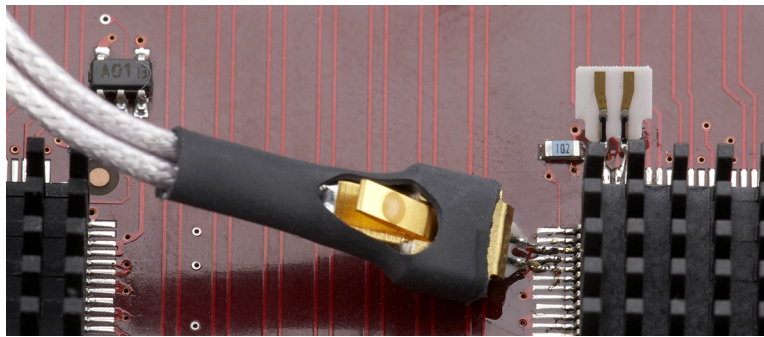


Figure 31 Probe Head Connected to a Soldered ZIF Tip

NOTE

For more repeatable results, orient the probe connection perpendicular to the device as shown in [Figure 32](#) on page 52.

- 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 32 Probe Oriented Perpendicular to Device

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 33](#)).



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.”

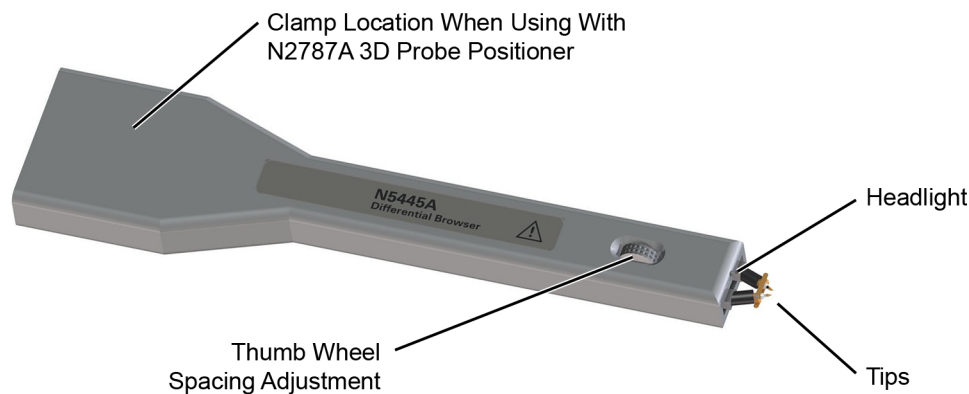


Figure 33 N5445A InfiniiMax III Differential Browser Head

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.

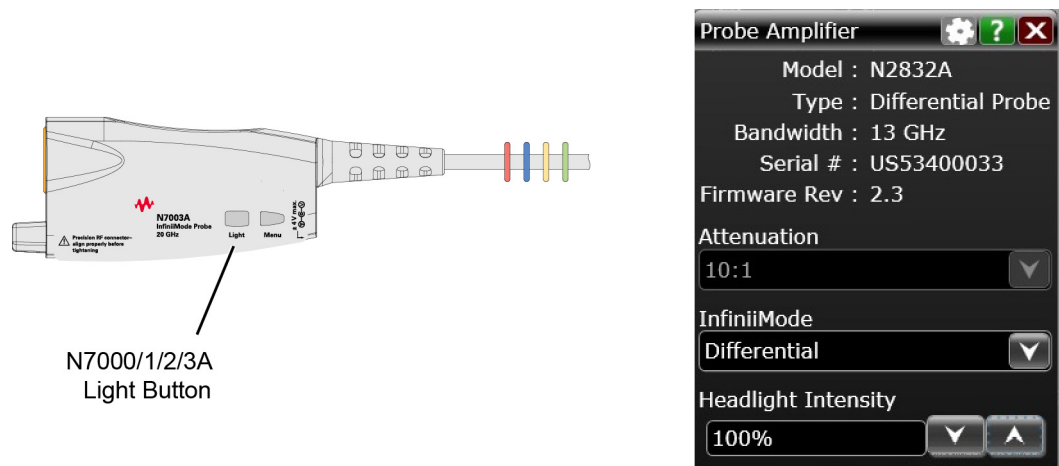


Figure 34 Headlight Intensity from N7000/1/2/3A Light Button or Dialog Box

Adjusting the tip span

Turn the browser's thumb wheel (see **Figure 35**) 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.

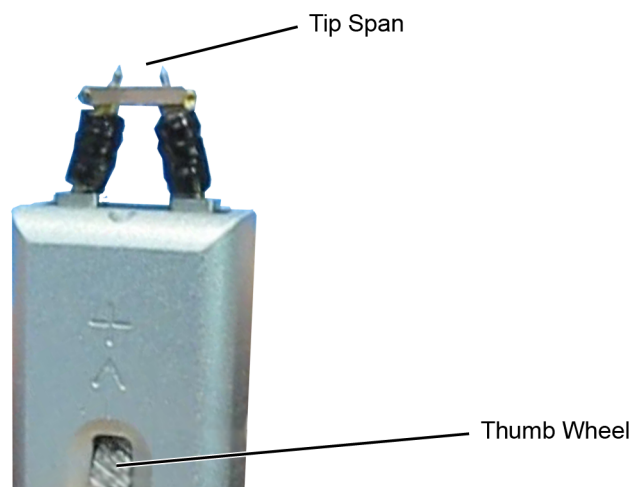


Figure 35 Adjusting the Tip Span

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 36**.
- 3 Determine which of the three possible tip-span settings most closely matches the browser's tip span.

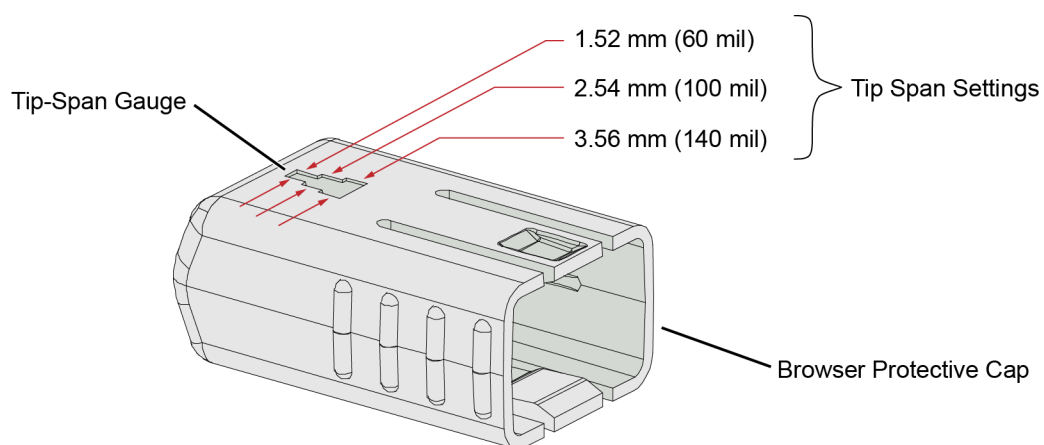


Figure 36 Tip Span Gauge on Browser Protective Cap

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 37** below shows the dimensions of these mounting holes.

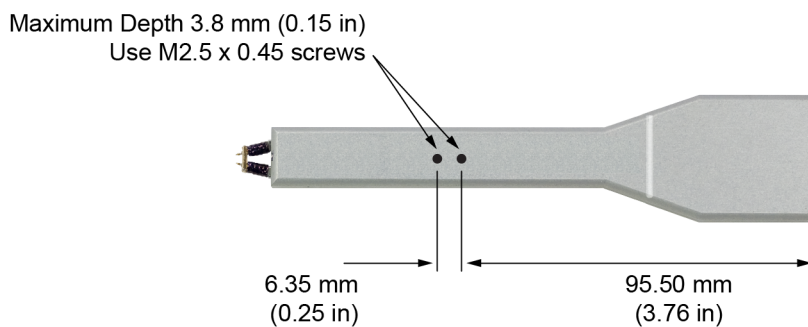


Figure 37 Dimensions of Mounting Holes

Probe along the browser's axis

To prevent tip damage, probe along the browser's axis as shown in **Figure 38**. Hold the probe vertical and perpendicular to the circuit board.

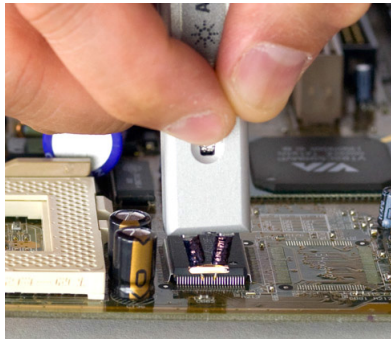


Figure 38 Proper Probe Handling

CAUTION

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



Figure 39 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 40 shows the replaceable parts for the N5445A.

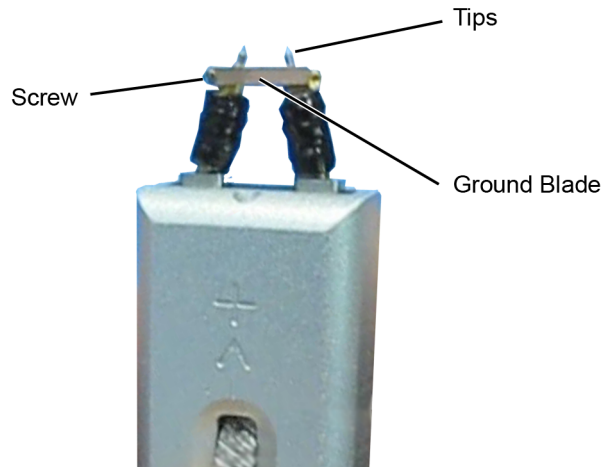


Figure 40 Browser Tips and Ground Blade

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.

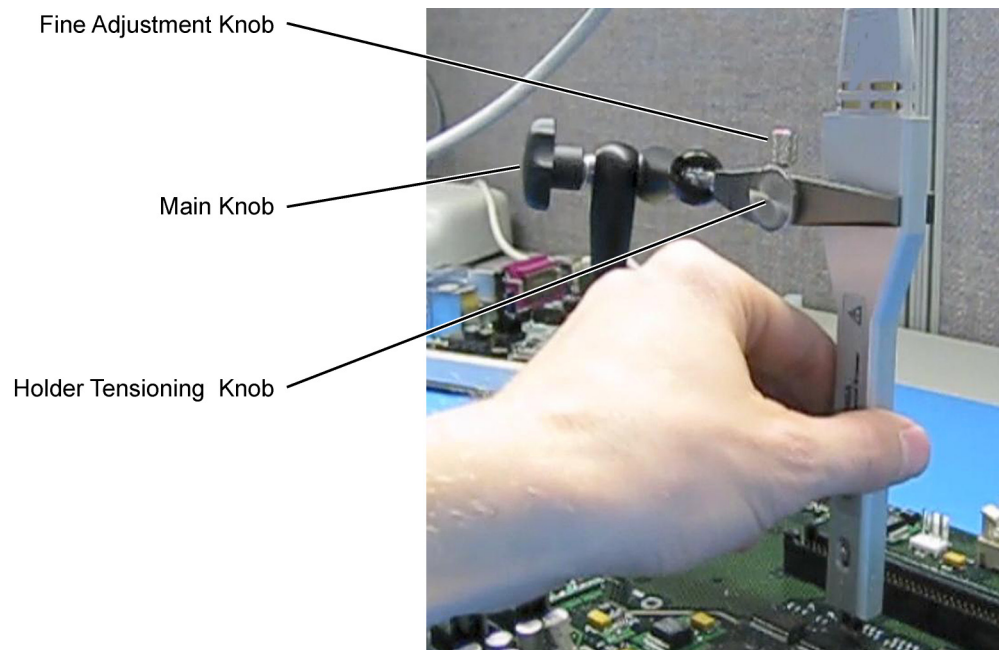


Figure 41 Using the Browser with the N2787A 3D Probe Positioner

MX0109A and N2836A InfiniiMode Solder-In Heads

The following two solder-in probe heads are available for InfiniiMax III+ amplifiers.

- MX0109A Extreme Temperature Solder-in probe head
- N2836A InfiniiMax III+ Solder-in probe head

These probe heads are economical semi-permanent connections that provide up to 26 GHz of system bandwidth.



Figure 42 MX0109A and N2836A InfiniiMax III solder-in probe heads

The following table highlights the key features of these probe heads.

MX0109A	N2836A
Supports testing in extreme temperature ranges. Can withstand -55°C to $+150^{\circ}\text{C}$ temperature range for up to 750 test cycles. Refer to the topic “Extreme Temperature Testing with MX0109A Probe Head” on page 64 to know more.	Can withstand -40°C to $+85^{\circ}\text{C}$ temperature range.
InfiniiMode capable.(InfiniiMode allows you to make differential, common mode, and single ended measurements without having to re-solder the tip leads. Because these are InfiniiMode compatible heads, the tip has two signal leads and two ground leads. To learn about InfiniiMode, refer to “To Use InfiniiMode” on page 23. 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.	
The span of leads can be adjusted from 5 mil - 250 mil (0.127 mm - 6.35 mm).	
User replaceable resistor leads. To know how to install / repair resistor leads, refer to “Replacing Axial Resistor Tips” on page 78.	
MX0109A and N2836A have different S parameters stored in the oscilloscope’s firmware. On selecting the probe head in the oscilloscope’s Select Probe Head dialog box, the appropriate S parameter file for the probe head is loaded. This file is used in conjunction with the probe amplifier’s S parameters to compute the overall probe correction for your measurement case.	

NOTE

The minimum required Infiniium software version for the MX0109A probe head is as follows:

- 10.10 or higher (for Infiniium UXR-Series oscilloscopes)
- 6.40 or higher (for all other compatible oscilloscopes)

NOTE

Refer to [Table 20](#) on page 99 and [Table 21](#) on page 100 to know about the characteristics of these probe heads.

For performance plots, refer to “[N2836A and MX0109A Solder-In Probe Heads \(Flat Orientation\)](#)” on page 114.

Ensuring Maximum Performance for MX0109A / N2836A Probe Heads

Tip Spacing

The specifications and performance plots of the MX0109A / N2836A probe heads 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 43](#), and use the tip wires on the mini-axial leads to get the desired span.

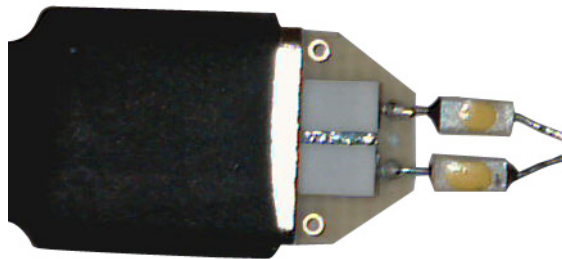


Figure 43 Proper Position of Resistors

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 Precision Probe 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 MX0109A / N2836A solder-in probe heads 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.

Best Practices for MX0109A and N2836A Connection to DUT

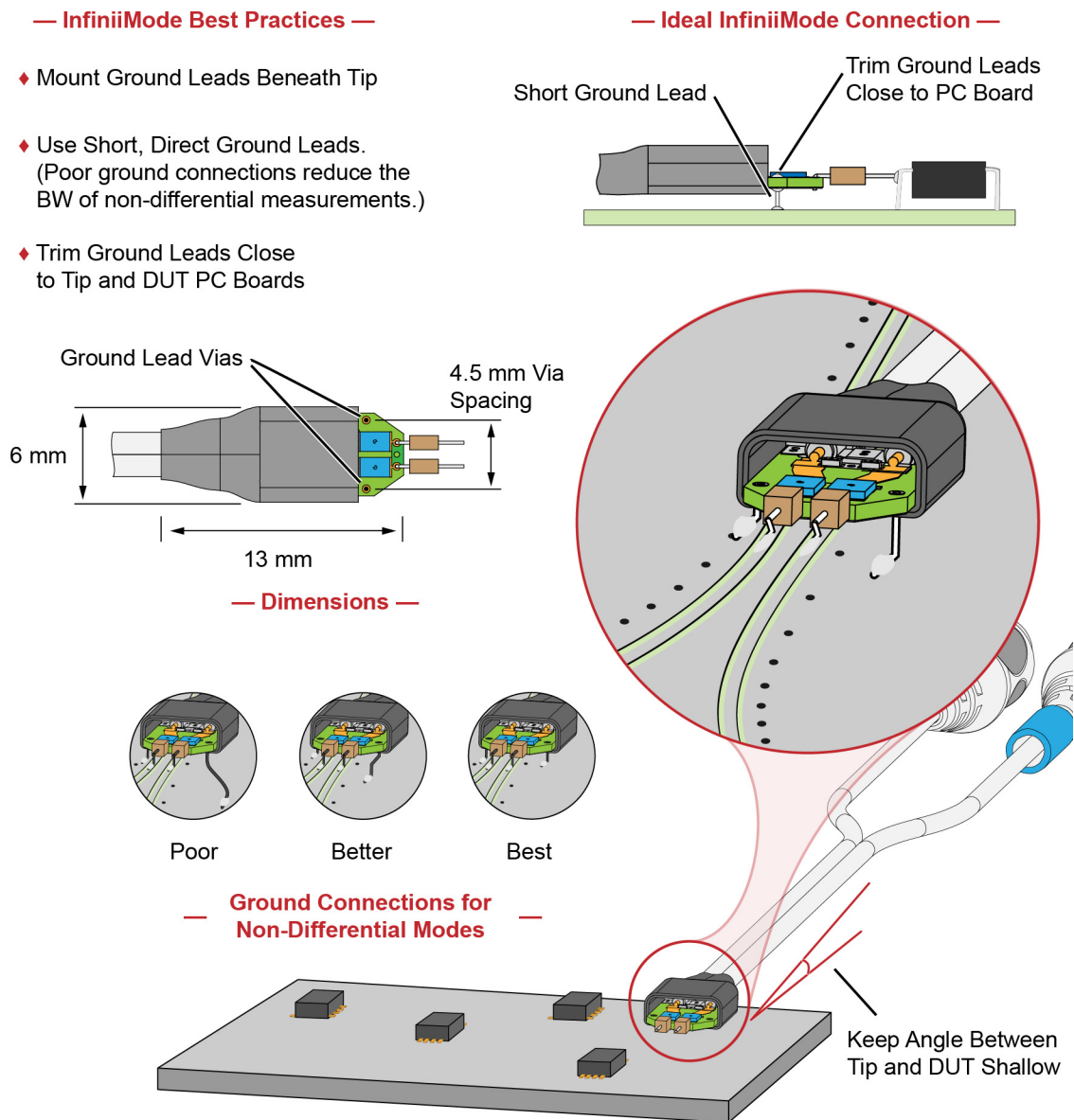


Figure 44 Probe Head Connection to DUT (*InfiniiMode*)

— Non-InfiniiMode Best Practices —

- ◆ Probe single-ended and differential signals. Do not solder ground leads to ground lead vias as is done with InfiniiMode probing.
- ◆ For single-ended signals, orient the probe head vertically. Laying the probe head flat causes coupling to the tip that can degrade the performance.
- ◆ For single-ended signals, connect the “–” lead to ground.

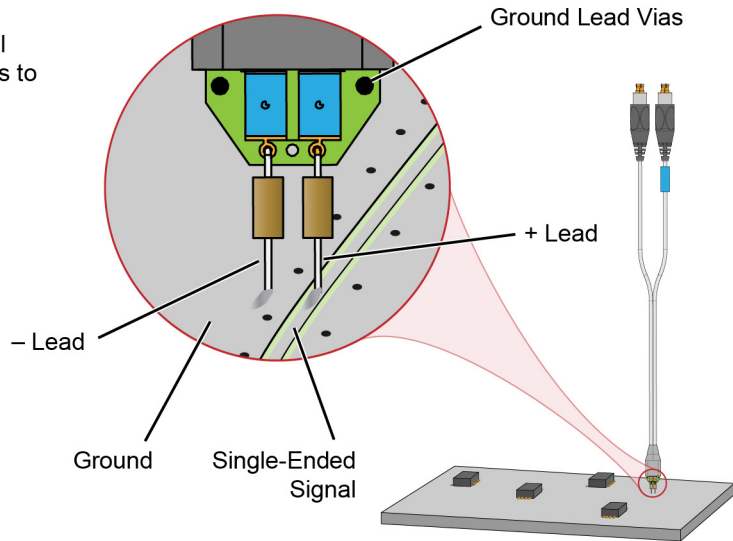


Figure 45 Probe Head Connection to DUT (*Non-InfiniiMode*)

Soldering the MX0109A / N2836A Probe Head to the DUT

Before using the following procedure, refer to “**Soldering Tips**” on page 76.

To solder the probe head to your DUT, complete the following steps. This procedure does not show soldering the ground leads, but the same techniques as described in this procedure are used.

CAUTION

Always mechanically strain-relieve the probe head to protect both your probing equipment and DUT from damage. Refer to “**Strain Relieving the Probe Heads**” on page 74.

- 1 Apply flux to your target leads as shown in **Figure 46**.

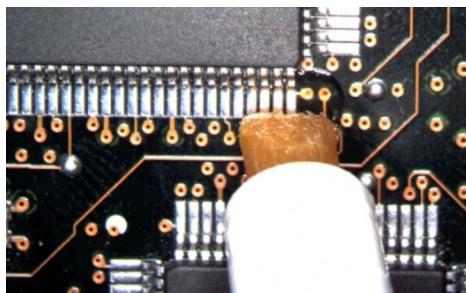


Figure 46 Applying Flux

- 2 Tin the leads with a small amount of solder.

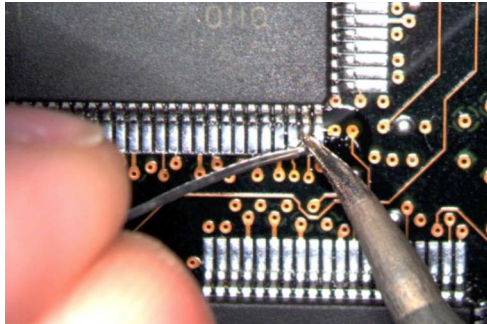


Figure 47 Tin the Leads

- 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.

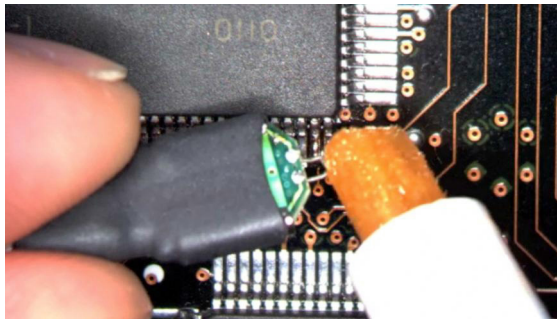


Figure 48 Applying Flux to Leads and Wires

- 5 Position the probe head wires on the DUT leads and quickly re-flow the solder as shown in **Figure 49**.

CAUTION

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

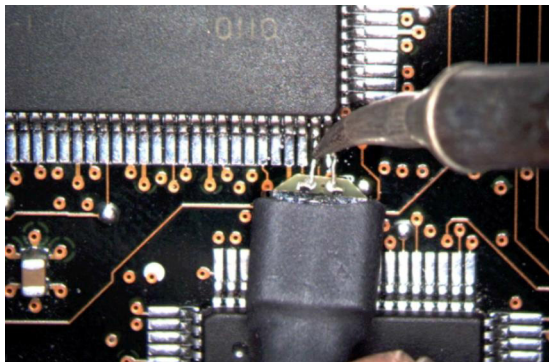


Figure 49 Positioning Wires

Extreme Temperature Testing with MX0109A Probe Head

The MX0109A probe head can withstand temperatures from -55°C to $+150^{\circ}\text{C}$ thereby making it suitable for extreme temperature environments such as temperature chambers. For extreme temperature testing, use the MX0100A probe head with the N5450B InfiniiMax extreme temperature extension cable.

CAUTION

InfiniiMax probe amplifiers cannot withstand extreme temperatures (-55°C to $+150^{\circ}\text{C}$) that the MX0109A probe head can withstand. Be cautious not to subject these probe amplifiers to extreme temperatures. Using the N5450B extension cable with the MX0109A probe head physically separates the amplifier from the probe head and therefore eliminates the chances of the amplifier's exposure to extreme temperatures.

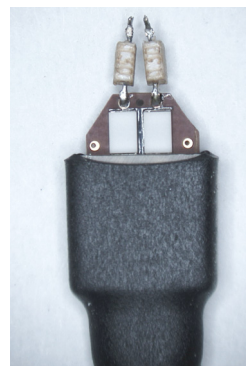
To know more about the N5450B extension cable and cautions associated with using an InfiniiMax probe head in extreme temperature testing, refer to [“N5450B Extreme temperature cable extension kit”](#) on page 33.

Probe Head Configuration	Operating Temperature Range ($^{\circ}\text{C}$)	Expected Lifetime of the Probe Head (cycles)
MX0109A (attached to the N5450B extension cable)	-55°C dwell, 1000 hours minimum $+150^{\circ}\text{C}$ dwell, 1000 hours minimum -55°C to 150°C cycles, 750 cycles minimum (as per JEDEC JESD22-A104 revision E)	>750

The MX0109A probe head components may undergo discoloration when used under high temperatures. Such changes do not, however, affect the probe head's performance or measurement quality. The probe head maintains its specified frequency response and bandwidth over the operating temperature range (-55°C to $+150^{\circ}\text{C}$), without any need for compensation or correction.



MX0109A - Before usage under high temperatures



MX0109A - After usage under high temperatures

N5441A InfiniiMax III Solder-In Head (discontinued)

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 $+150^{\circ}\text{C}$ 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 82.

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 76.

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 74.
- 3 Apply flux to your target leads as shown in **Figure 50**.

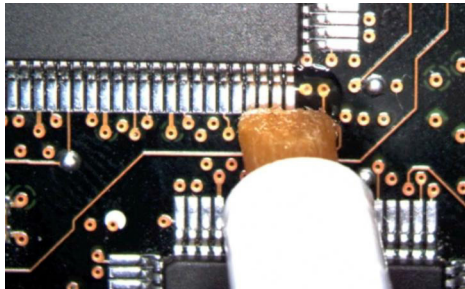


Figure 50 Applying Flux

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

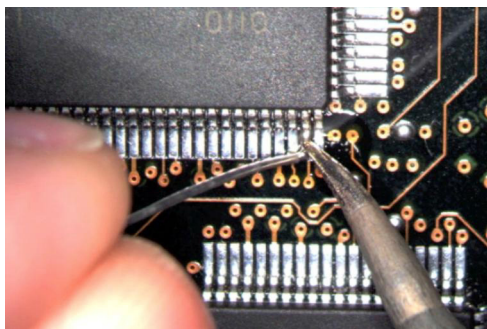


Figure 51 Tin the Leads

- 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.

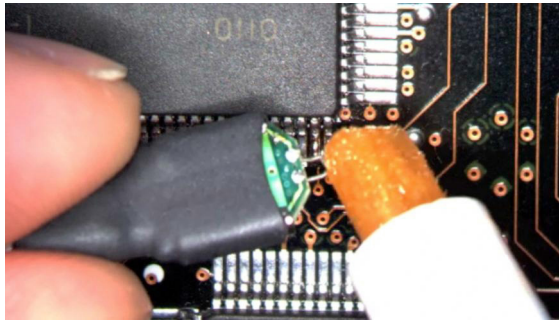


Figure 52 Applying Flux to Leads and Wires

- 7 Position the probe head wires on the DUT leads and quickly re-flow the solder as shown in **Figure 53**.

CAUTION

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

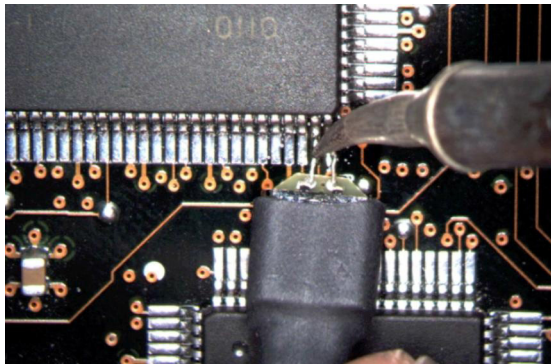
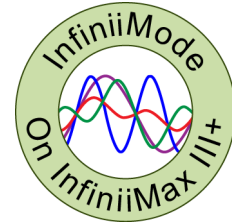


Figure 53 Positioning Wires

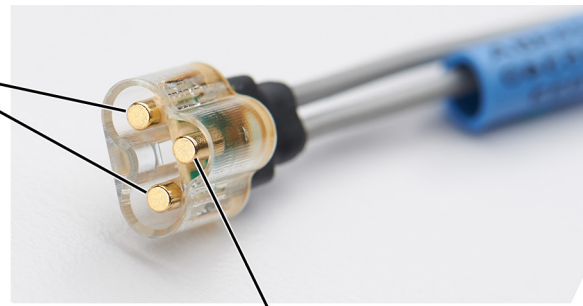
6 N2848A QuickTip InfiniiMode Probe Head

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!



Magnets for Differential Signal Connections



Magnet for Ground Connection

Figure 54 Magnet Connections in Probe Head

- Extreme temperature environments such as temperature chambers.

Table 14 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 55](#) on page 69. 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 23. 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.

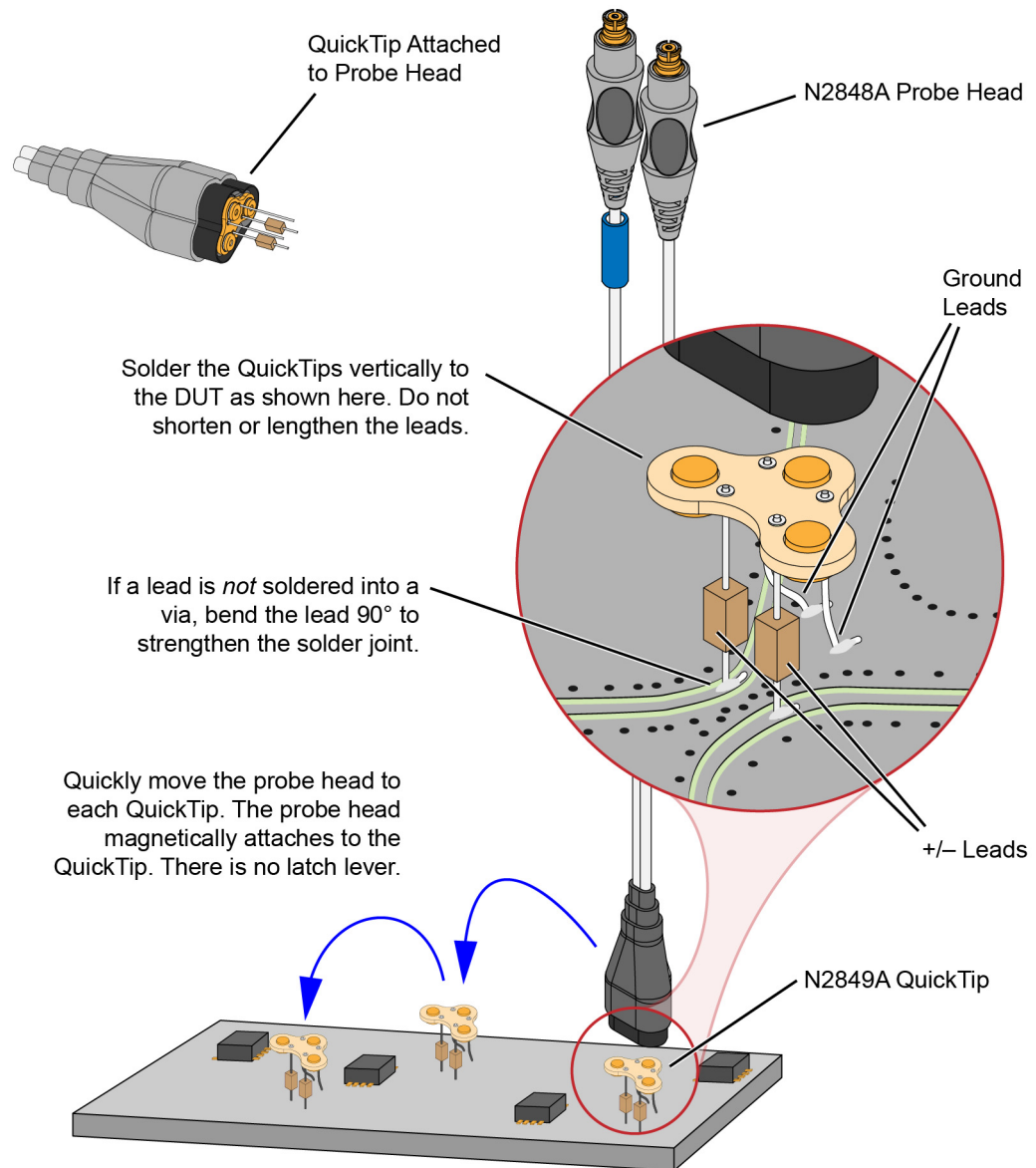


Figure 55 Probing with the N2848A Probe Head and QuickTip

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 55](#) on page 69.
- 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 74.

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.

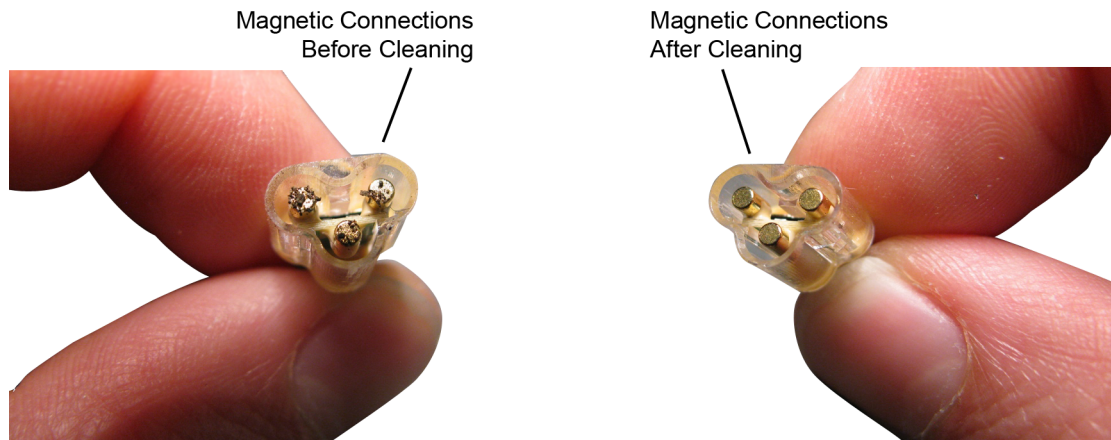


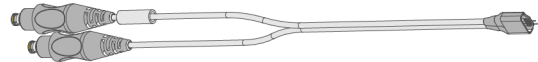
Figure 56 N2848A Head Before and After Cleaning

N2835A InfiniiMax III+ Differential Connectivity Kit and Accessories

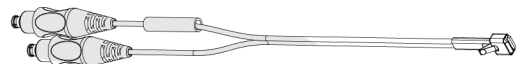
In addition to the individual probe heads described in the previous topics, the N2835A differential connectivity kit is also available for the InfiniiMax III+ probes.

This kit provides multiple quantities of the four InfiniiMax III+ probe heads as shown in **Figure 57**. You can order this kit either at the same time as InfiniiMax III+ probe amplifiers or separately later.

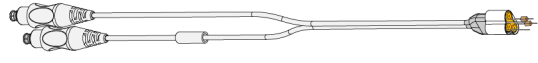
N2836A Differential Solder-In
(quantity 2)



N5439A Differential ZIF Solder-In
(quantity 2)



N2848A QuickTip
(quantity 2)



N5445A Differential Browser
(quantity 1)

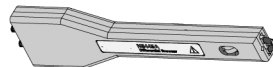


Figure 57 Probe Heads Included in the N2835A Differential Connectivity Kit (*not to scale*)

Table 15 Supplied Accessories (Sheet 1 of 2)

Description	Qty Supplied	Part Number
N2836A InfiniiMax III 26 GHz Differential Solder-In Probe Head	2	N2836A
Replacement Axial Resistors Kit	10	N2836-68701
N5439A InfiniiMax III 28 GHz Differential ZIF Solder-in Probe Head	2	N5439A
N2838A InfiniiMax III 25 GHz ZIF Tip Kit	2 kits (5 tips in each kit)	N2838A
N2848A InfiniiMax III QuickTip Probe Head	2	N2848A
N2849A InfiniiMax QuickTip Tips Kit	2 kits (4 tips in each kit)	N2849A
N5445A InfiniiMax III Browser Probe Head	1	N5445A
Replacement Tips	4	N5476A
Tweezer for replacing tips	1	N5445-23801
Screw Driver	1	N5445-23802
Protective End Cap	1	N5445-44101

Table 15 Supplied Accessories (Sheet 2 of 2)

Description	Qty Supplied	Part Number
Ground Blades	4	N5445-68700

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 near 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.

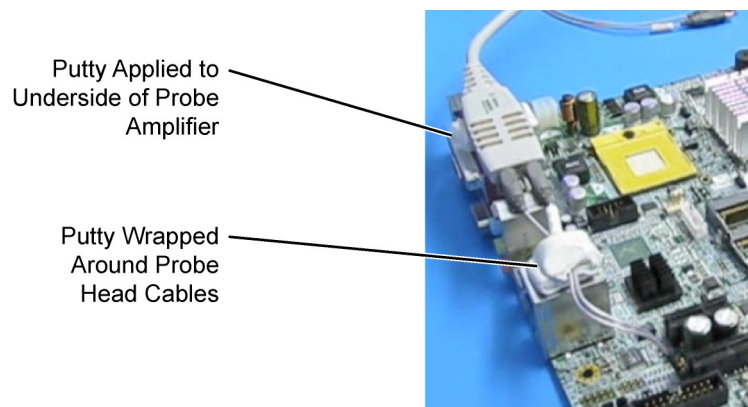


Figure 58 Probe Secured Using Tack Putty

You can also use putty with a positioner, such as the N2787A as shown in [Figure 59](#).

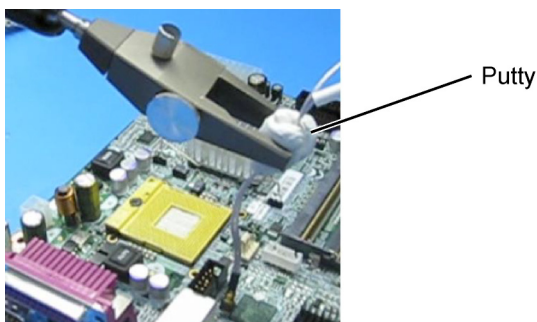


Figure 59 Using Putty With the N2787A 3D Probe Positioner

The same positioner can also be used to support your probe amplifier as shown in [Figure 41](#) on page 58.

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 60 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.

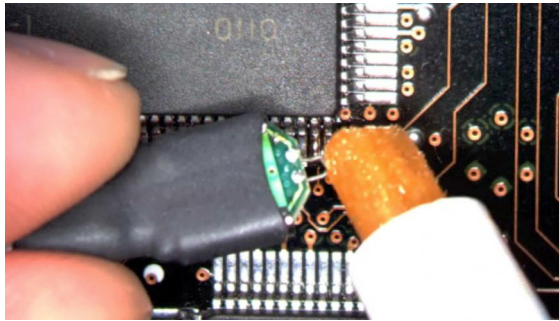


Figure 61 Applying Flux to Leads and Wires

3 Maintaining Probe Heads

Replacing Axial Resistor Tips **78**

Replacing N5441A Probe Head Wires **82**

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:

- MX0109A probe heads
- 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:

- MX0109A extreme temperature solder-in probe head
- 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 MX0109A and 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 62**, 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.

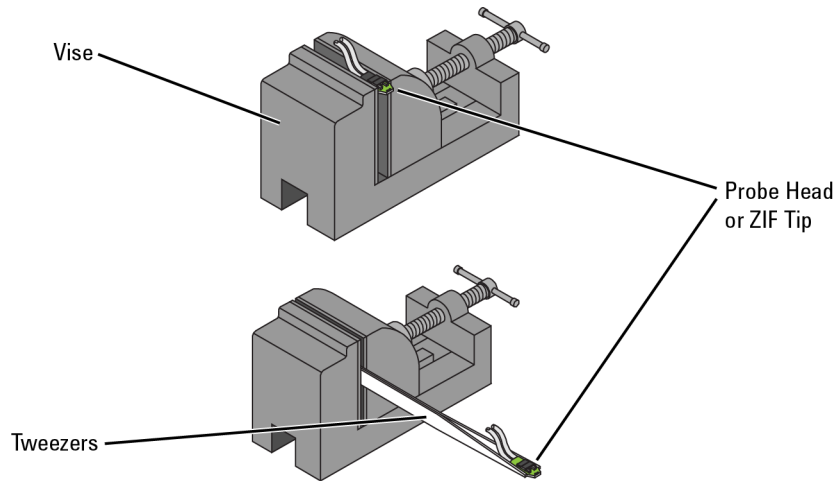


Figure 62 Clamping the Part

- 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.

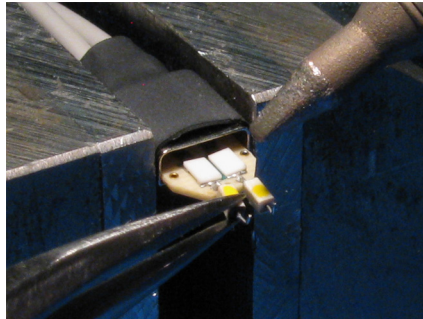


Figure 63 Removing the Resistor

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 64**. 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.

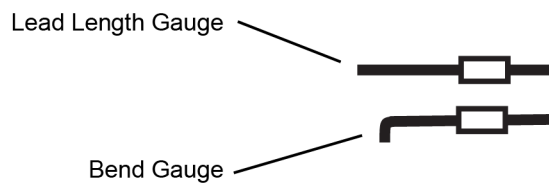


Figure 64 Trim Gauge

- 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.

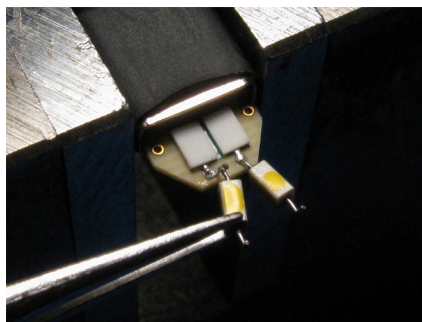


Figure 65 Soldering in a new axial resistor

- 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.

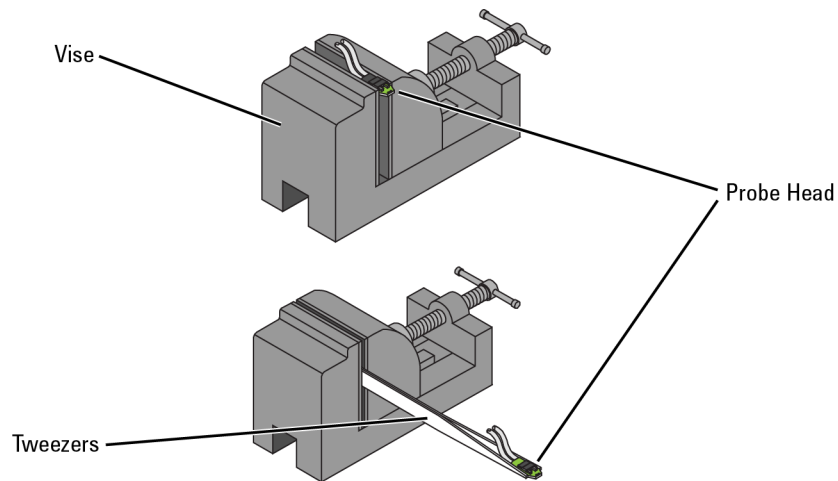


Figure 66 Clamping the Probe Head

- 2 As shown in **Figure 67**, 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.

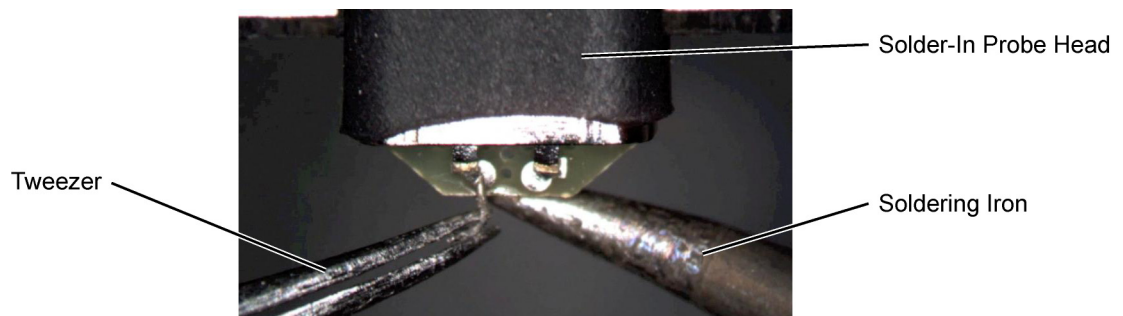


Figure 67 Removing the Old Wire

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

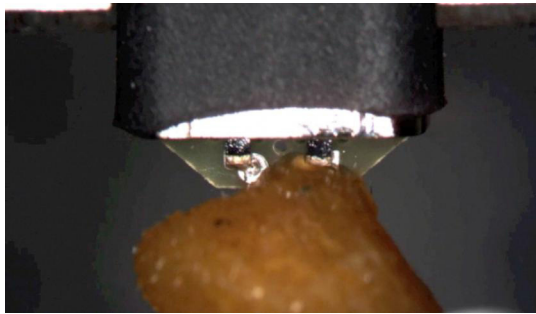


Figure 68 Adding Solder and Flux

- 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.

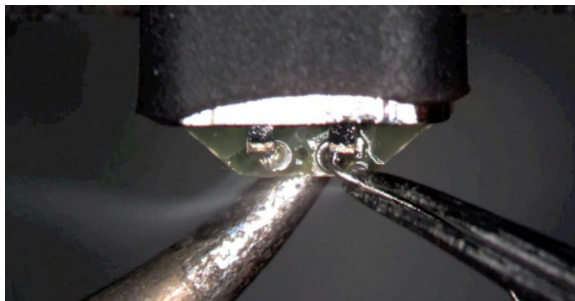


Figure 69 Adding a New Wire

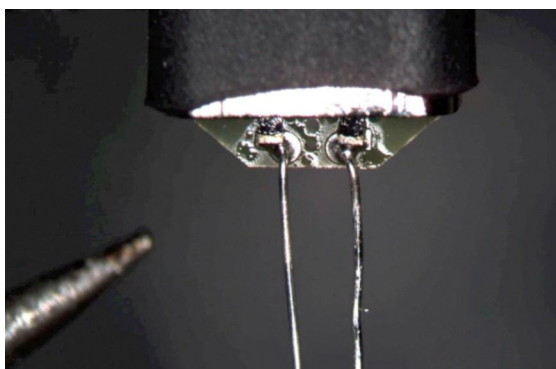


Figure 70 New Wires Properly Attached

- 5 Trim any wire stubs on the probe head underside.

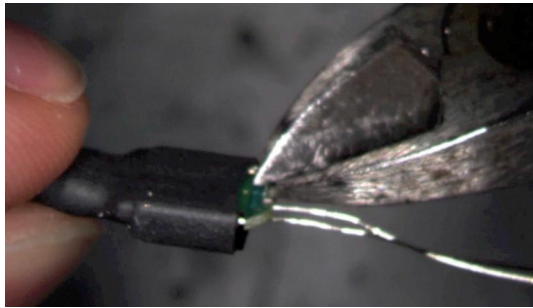


Figure 71 Trim Wire Stubs

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

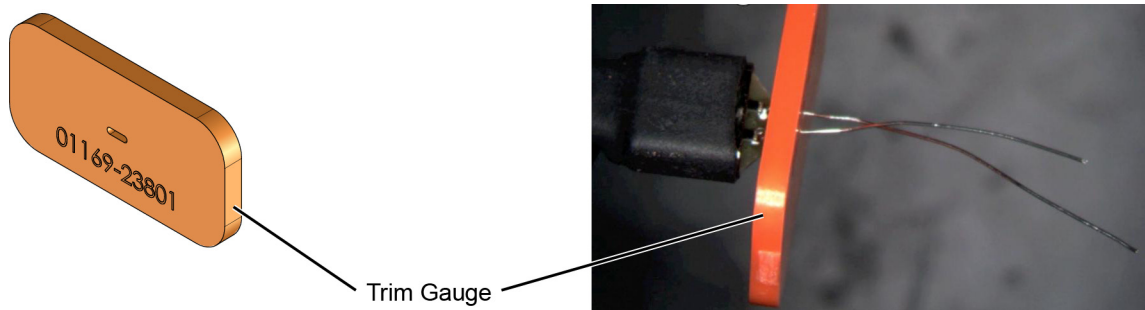


Figure 72 Trim Gauge Placed on Wires

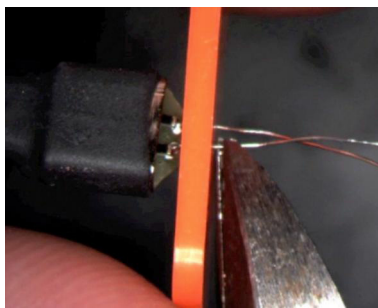


Figure 73 Removing Excess Wire

- 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 Calibration/Deskew procedure described in this chapter is applicable to both N2830/1/2A and N7000/1/2/3A InfiniiMax III+ probes.

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 50 Ω termination.

NOTE

The N5443A fixture promotes the proper 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

The procedure is applicable to both N2830/1/2A and N7000/1/2/3A InfiniiMax III+ probes.

- 1 Connect the InfiniiMax III+ probe to an oscilloscope channel.

NOTE

Allow the probe to warm up for 20 minutes before performing calibration and measurements for optimized bandwidth, input resistance, and offset.

- 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 74**. The termination is provided with the N5443A.

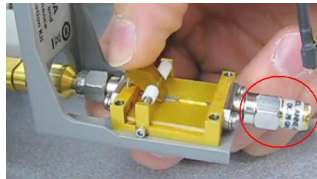


Figure 74 50Ω Terminator on N5443A

- 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 75**.
- 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 76**.
- d Detach the probe head from the probe and Insert the probe into the top of the fixture holder as shown in **Figure 77**. The probe can slide up and down in the holder to adjust the probe head position.



Figure 75 Attaching the N5443A Fixture



Figure 76 Tighten to 8 in. lbs.



Figure 77 Inserting the Probe Head

- e Form the N5439A probe head ZIF tip wires as shown **Figure 78**. If you are using the browser probe head, you do not need to adjust the shape of the tips.

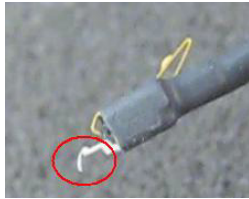


Figure 78 Forming the Probe Head's Tip

- f Connect the probe head's two lead cables to the probe amplifier as shown in **Figure 79**.



Figure 79 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 80**.



Figure 80 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 81**.

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.

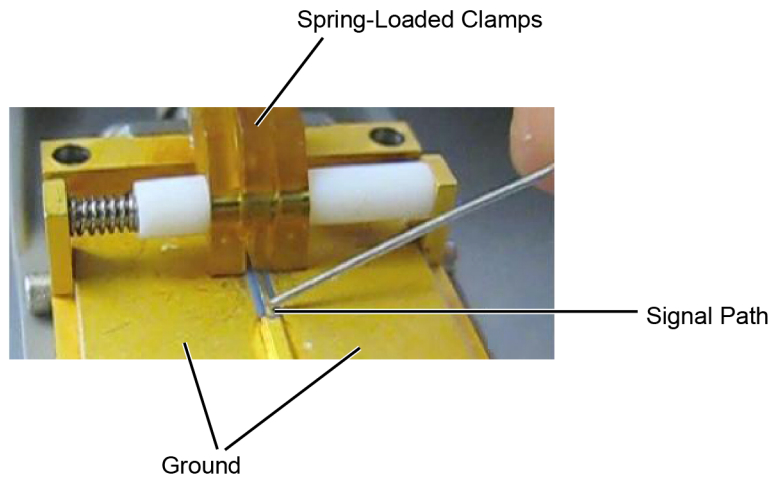


Figure 81 Closeup of Fixture's Signal Path, Ground, and Clamps

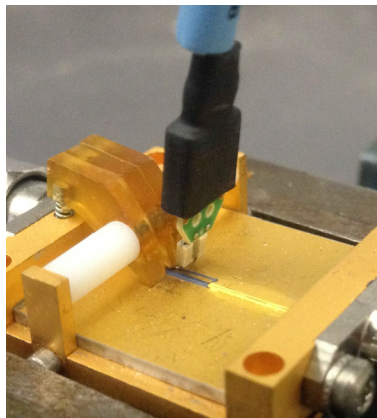
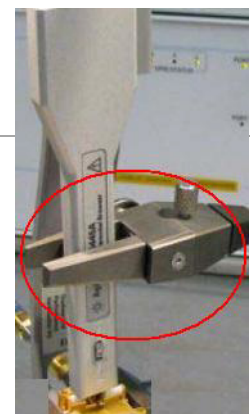


Figure 82 Clamping the Probe Head's Leads

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

InfiniiMax III+ Warranted Specifications	96
N2830A/1A/2A and N7000/1/2/3A Probe Amplifiers Characteristics	97
N7000A/1A/2A InfiniiMax III+ Probe Heads Characteristics	99
N2830/1/2A InfiniiMax III+ Probe Heads Characteristics	100
Environmental	102
Safety and Regulatory Information	103
Probe Dimensions	104
Probe Heads Dimensions	105

NOTE

All entries included in this chapter are characteristics unless otherwise noted. These are the typical performance values of the InfiniiMax probes using the InfiniiMax III+ probe amplifiers and each different probe head except otherwise specified.

Bandwidth and DC input resistance (R_{se} and R_{diff}) are the only specifications.

InfiniiMax III+ Warranted Specifications

Table 18 Warranted Specifications

Probe Head	Probe Amplifier	Bandwidth	DC Input Resistance
N2836A / MX0109A 450 Ω solder-in probe head vertical orientation with no ground wires	Differential mode N7003A 20 GHz probe amp	20 GHz	$R_{diff}=100\text{ k}\Omega \pm 2\%$, $R_{se}=50\text{ k}\Omega \pm 2\%$

N2830A/1A/2A and N7000/1/2/3A Probe Amplifiers Characteristics

The characteristics listed in **Table 19** are mainly determined by the probe amplifier.

Table 19 N2830A/1A/2A and N7000/1/2/3A InfiniiMax III+ Probe Amplifier Characteristics
(Sheet 1 of 2)

Feature	N2830A/1A/2A and N7000/1/2/3A InfiniiMax III+ Probe Amplifiers	
	With 450 Ω Probe Heads (N5439A, N5445A, N5441A, N2838A, N2836A, MX0109A, N2848A)	With N5444A 2.92 mm / 3.5 mm / SMA Probe Head
DC Input Resistance	$R_{se} = 50 \text{ k}\Omega \pm 2\%$ each input to ground $R_{diff} = 100 \text{ k}\Omega \pm 2\%$ $R_{cm} = 25 \text{ k}\Omega \pm 2\%$	55Ω to V_{term}
Input Resistance (>10 KHz)	$R_{se} = 500\Omega \pm 2\%$ each input to ground $R_{diff} = 1 \text{ k}\Omega$ $R_{cm} = 250\Omega$	50Ω to $0.901 * V_{term}$
Input Voltage Range (Differential or Single Ended)	2.5 Vpp or $\pm 1.25 \text{ V}$ at 5:1 attenuation 5.0 Vpp or $\pm 2.50 \text{ V}$ at 10:1 attenuation	2.5 Vpp or $\pm 1.25 \text{ V}$ at 5:1 attenuation 5.0 Vpp or $\pm 2.50 \text{ V}$ at 10:1 attenuation without violating max 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	$\pm 7 V_{DC}$ to 100 Hz $\pm 1.25 \text{ V}$ > 100 Hz at 5:1 attenuation $\pm 2.5 \text{ V}$ > 100 Hz at 10:1 attenuation	$\pm 6 V_{DC}$ to 100 Hz $\pm 1.25 \text{ V}$ > 100 Hz at 5:1 attenuation $\pm 2.5 \text{ V}$ > 100 Hz at 10:1 attenuation without violating max input power
DC Attenuation Ratio	5:1 or 10:1 Automatically selected based on volts/division (all modes)	5:1 or 10:1 Automatically selected based on volts/division (all modes)
Offset Range (for probing a single-ended signal)	$\pm 16\text{V}$	$\pm 6\text{V}$ without violating maximum input power

Table 19 N2830A/1A/2A and N7000/1/2/3A InfiniiMax III+ Probe Amplifier Characteristics
(Sheet 2 of 2)

Feature	N2830A/1A/2A and N7000/1/2/3A InfiniiMax III+ Probe Amplifiers	
	With 450 Ω Probe Heads (N5439A, N5445A, N5441A, N2838A, N2836A, MX0109A, N2848A)	With N5444A 2.92 mm / 3.5 mm / SMA Probe Head
Input Referred Noise Spectral Density	Diff 5:1 atten 33.5 nV/rt (Hz) Diff 10:1 atten 53.9 nV/rt (Hz) SE A or B 5:1 atten 27.8 nV/rt (Hz) SE A or B 10:1 atten 47.7 nV/rt (Hz) CM 5:1 atten 21.8 nV/rt (Hz) CM 10:1 atten 38.4 nV/rt (Hz)	
Input Referred Noise Example	4.5 mV _{rms} in diff mode 5:1 atten with ≥ 18 GHz probe head and 13 GHz probe amp	4.5 mV _{rms} in diff mode 5:1 atten with 30 GHz N5444A probe head and 13 GHz probe amp
Maximum Input Voltage	18 V _{peak} CAT 1	8 V _{peak} without violating maximum input power

N7000A/1A/2A InfiniiMax III+ Probe Heads Characteristics

The characteristics listed in **Table 20** are for the N7003A 20 GHz probe amplifier using different probe heads. These characteristics are mainly determined by the probe heads.

Performance listed in this table is with the highest bandwidth probe amp (N7003A 20 GHz) model in N700XA InfiniiMax III+ probe family. Performance with lower bandwidth amps (N7000A/1A/2A) is the lower of the following:

- Amplifier BW
- 0.434/Amplifier BW
- .308/Amplifier BW
- bandwidth measured with the highest bandwidth amplifier (N7003A) in the family.

Table 20 Characteristics for Probe Heads Using N7003A Probe Amplifier

Probe Head		Input Capacitance		Mode	Bandwidth (-3 dB)	10 - 90% Transition Time	20 - 80% Transition Time
		C _{diff}	C _{se}				
N5439A ZIF	N5440A 450Ω ZIF tip	32 fF	44 fF	Differential	20 GHz	21.7 ps	15.4 ps
	N2838A 450Ω ZIF tip	95 fF	130 fF		20 GHz	21.7 ps	15.4 ps
N5445A 450Ω Browser		35 fF	50 fF		20 GHz	21.7 ps	15.4 ps
N5441A 450Ω Solder-In		77 fF	105 fF		20 GHz	21.7 ps	15.4 ps
MX0109A 450Ω Solder-In Head (Vertically orientation with no ground wires) Or (Flat orientation with minimum length ground wires)		108 fF	140 fF		20 GHz	21.7 ps	15.4 ps
N2836A 450Ω Solder-In Head (Vertically orientation with no ground wires) Or (Flat orientation with minimum length ground wires)		108 fF	140 fF		20 GHz	21.7 ps	15.4 ps
N2848A QuickTip (with ground wires connected)	N2849A 450Ω QuickTip	200 fF	340 fF		20 GHz	21.7 ps	15.4 ps
N5444A 2.92 /3.5 mm /SMA		N/A	N/A		20 GHz	21.7 ps	15.4 ps

N2830/1/2A InfiniiMax III+ Probe Heads Characteristics

The characteristics listed in the **Table 21** are for the N2832A InfiniiMax III+ probe amplifier using different probe heads. These characteristics are mainly determined by the probe head.

Performance listed in this table is with the highest bandwidth probe amp (N2832A) model in N283XA InfiniiMax III+ probe family. Performance with lower bandwidth amps (N2830A/1A) is the lower of the following:

- Amplifier BW
- 0.434/Amplifier BW
- .308/Amplifier BW
- bandwidth measured with the highest bandwidth amplifier (N2832A) in the family.

Table 21 Characteristics for Probe Heads Using N2832A Amplifier (Sheet 1 of 2)

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 — —
MX0109A 450Ω Solder-In Head (Vertically orientation with no ground wires) Or (Flat orientation with minimum length ground wires)		108 fF	140 fF	Differential: Single Ended: Common:	13 GHz — —	33.4 ps — —	23.7 ps — —

Table 21 Characteristics for Probe Heads Using N2832A Amplifier (Sheet 2 of 2)

Probe Head	Tip	Input Capacitance		Mode	Bandwidth (-3 dB)	10 – 90% Transition Time	20 – 80% Transition Time
		C _{diff}	C _{se}				
N2836A 450Ω Solder-In Head (<i>Vertically orientation with no ground wires</i>) Or (<i>Flat orientation with minimum length ground wires</i>)		108 fF	140 fF	Differential:	13 GHz	33.4 ps	23.7 ps
				Single Ended:	13 GHz	33.4 ps	23.7 ps
				Common:	13 GHz	33.4 ps	23.7 ps
N2848A QuickTip	N2849A 450Ω QuickTip	200 fF	340 fF	Differential:	13 GHz	33.4 ps	23.7 ps
				Single Ended:	13 GHz	33.4 ps	23.7 ps
				Common:	13 GHz	33.4 ps	23.7 ps
N5444A 2.92, 3.5 mm, SMA		–	–	Differential:	13 GHz	33.4 ps	23.7 ps
				Single Ended:	13 GHz	33.4 ps	23.7 ps
				Common:	13 GHz	33.4 ps	23.7 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 104.	
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 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

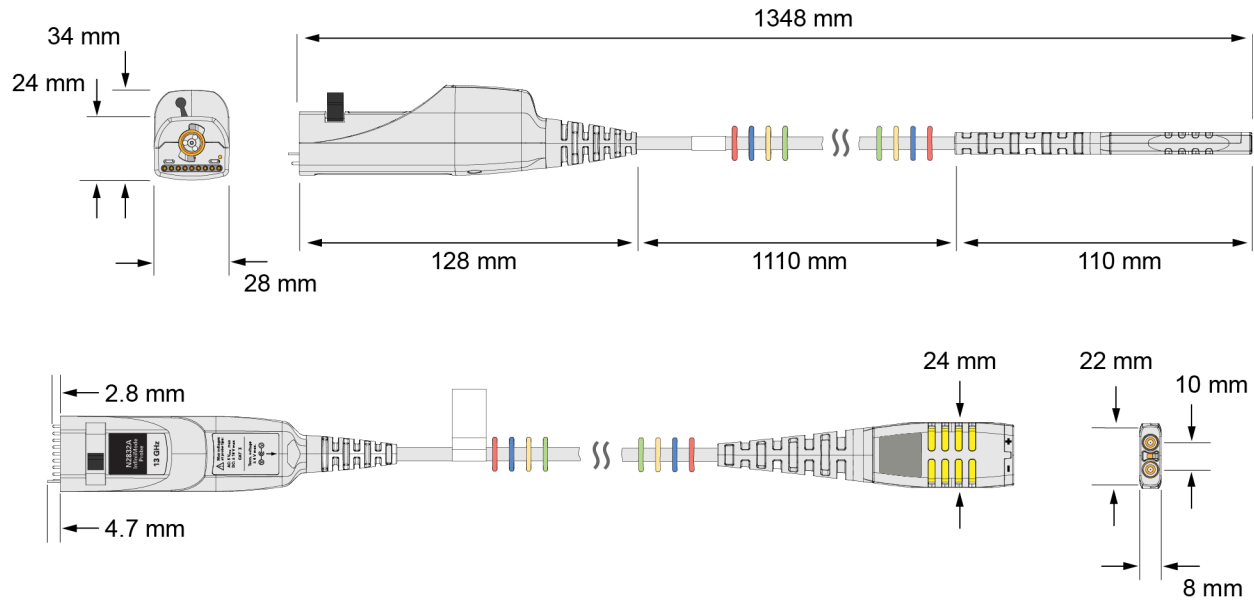


Figure 83 N2830/1/2A Probe Dimensions

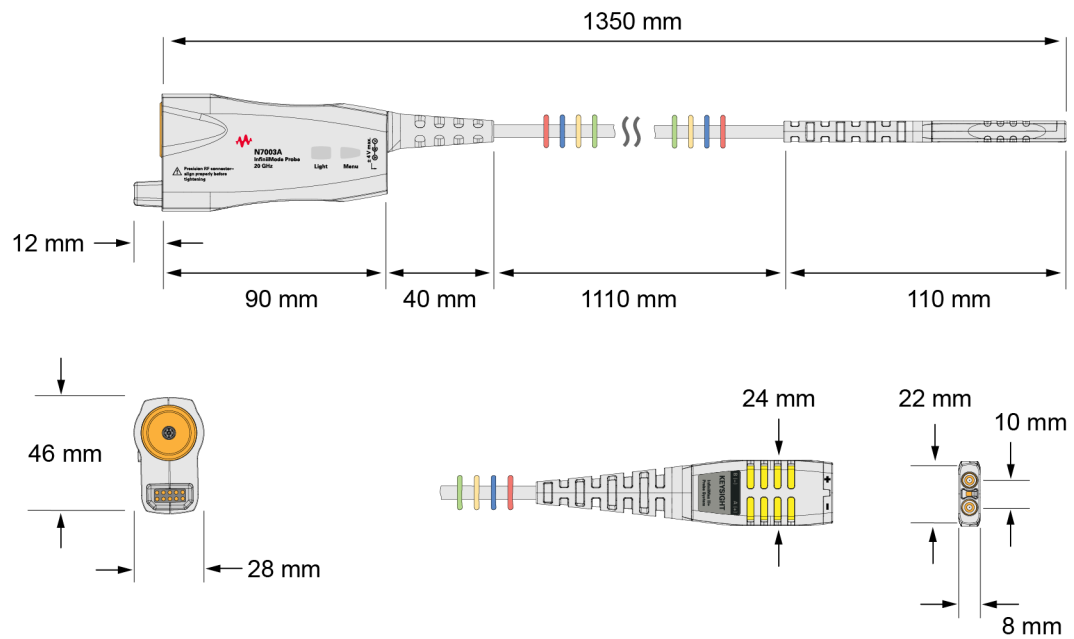
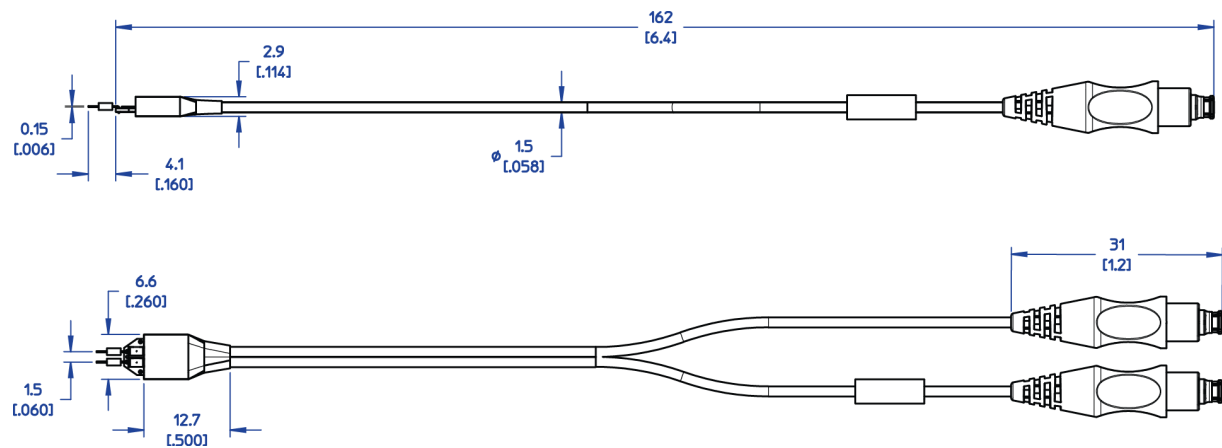


Figure 84 N7000/1/2/3A Probe Dimensions

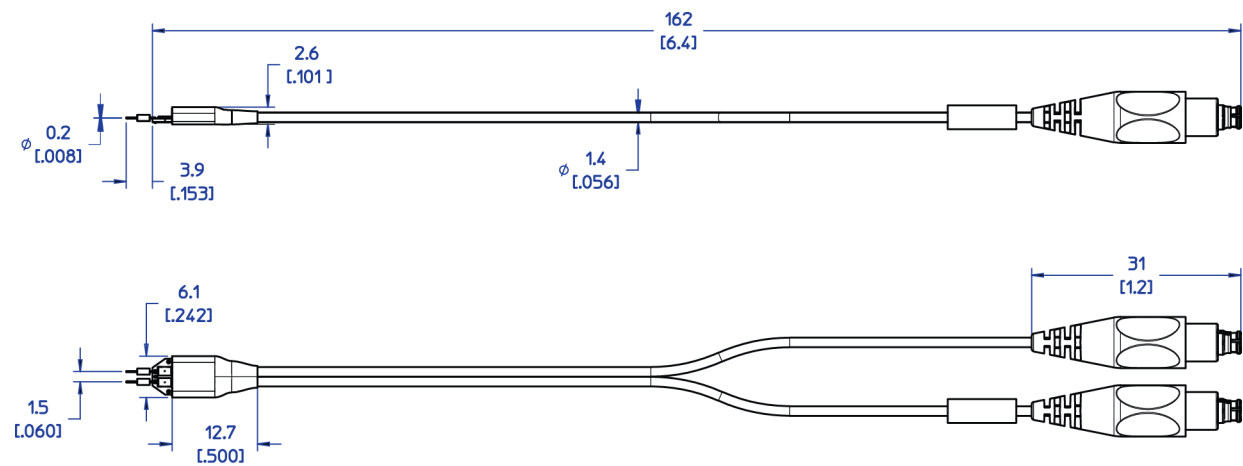
Probe Heads Dimensions

All dimensions included in this section are in millimeters [inches].

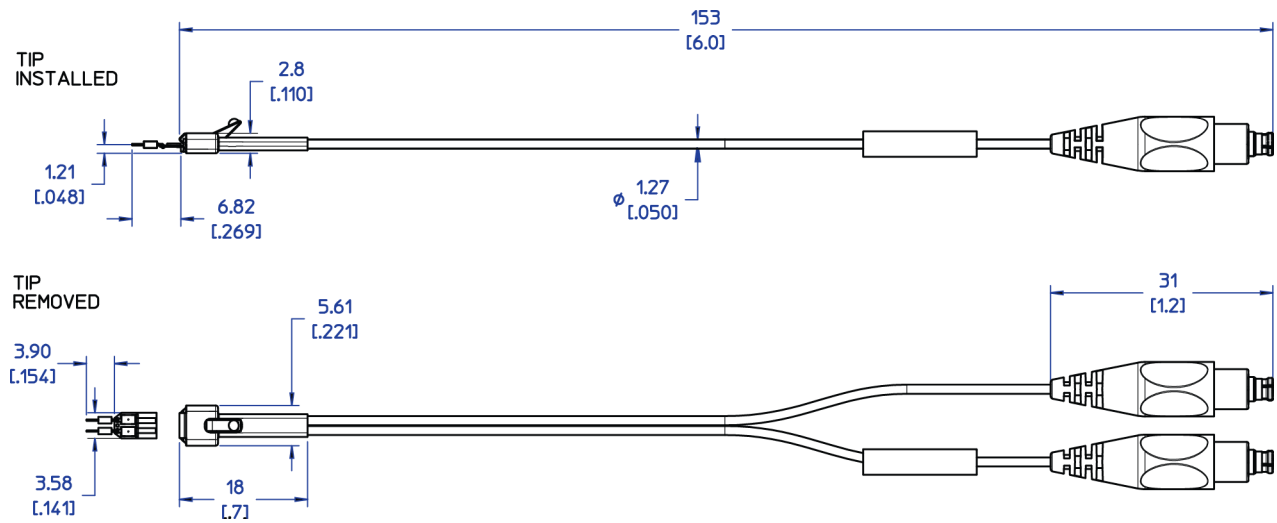
MX0109A Extreme Temperature Solder-in Head Dimensions



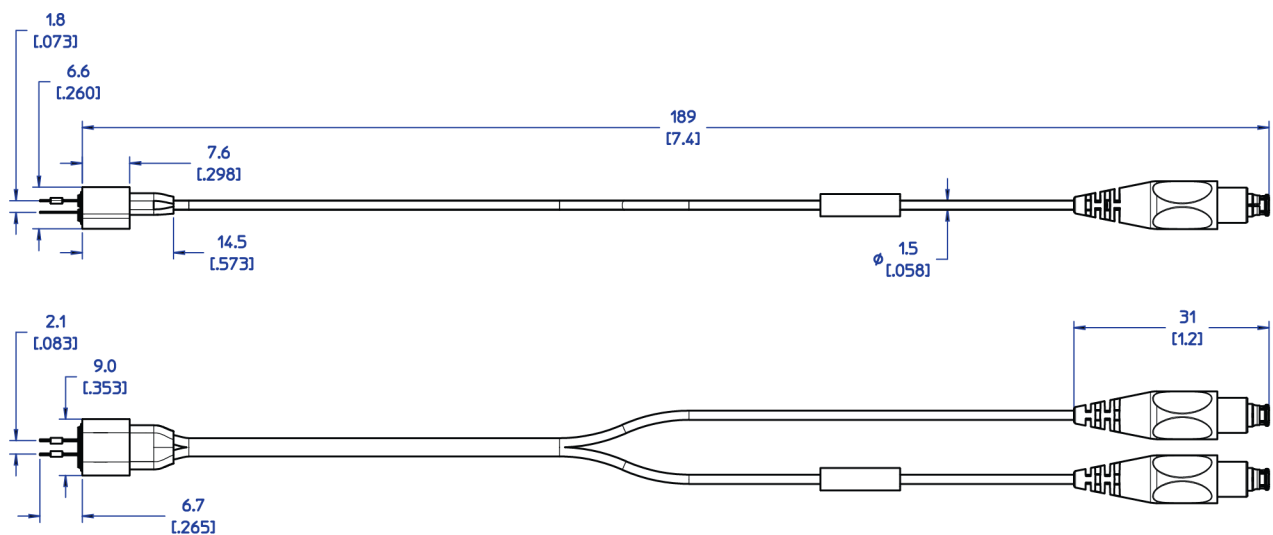
N2836A InfiniiMax III Solder-in Head Dimensions



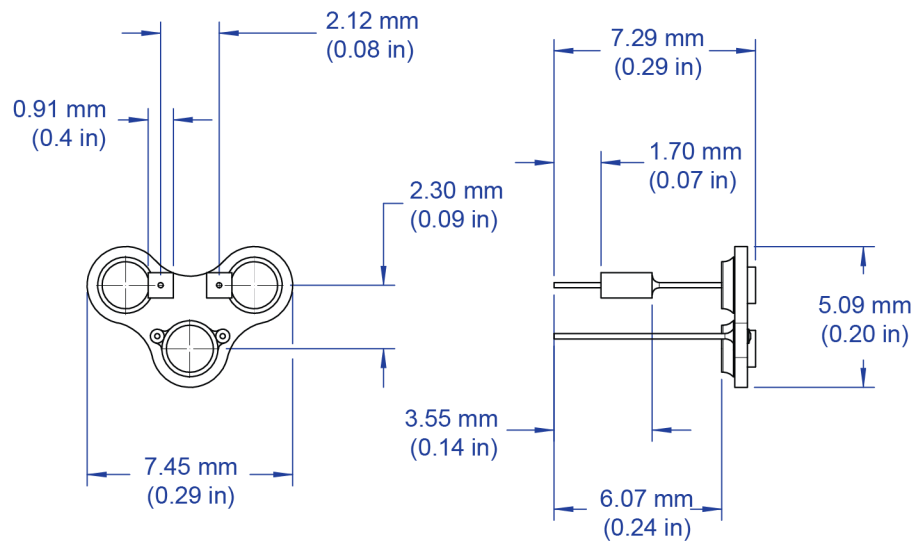
N2838A InfiniiMax III PCB ZIF Tip with N5439A ZIF Head Dimensions



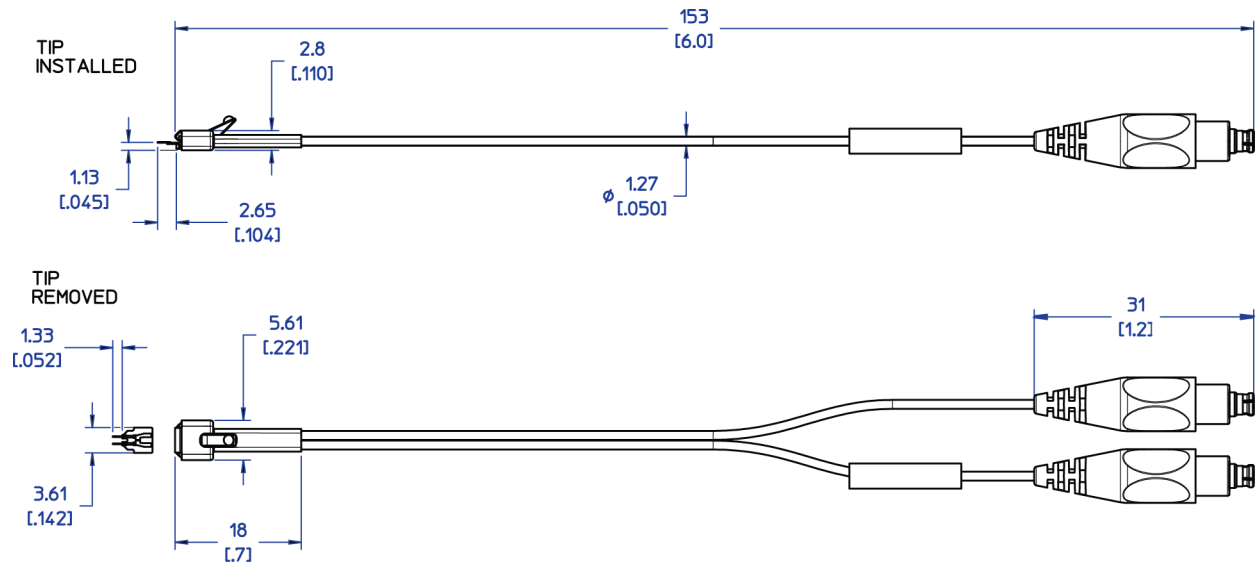
N2848A InfiniiMax III QuickTip Probe Head with N2849A QuickTip
Dimensions



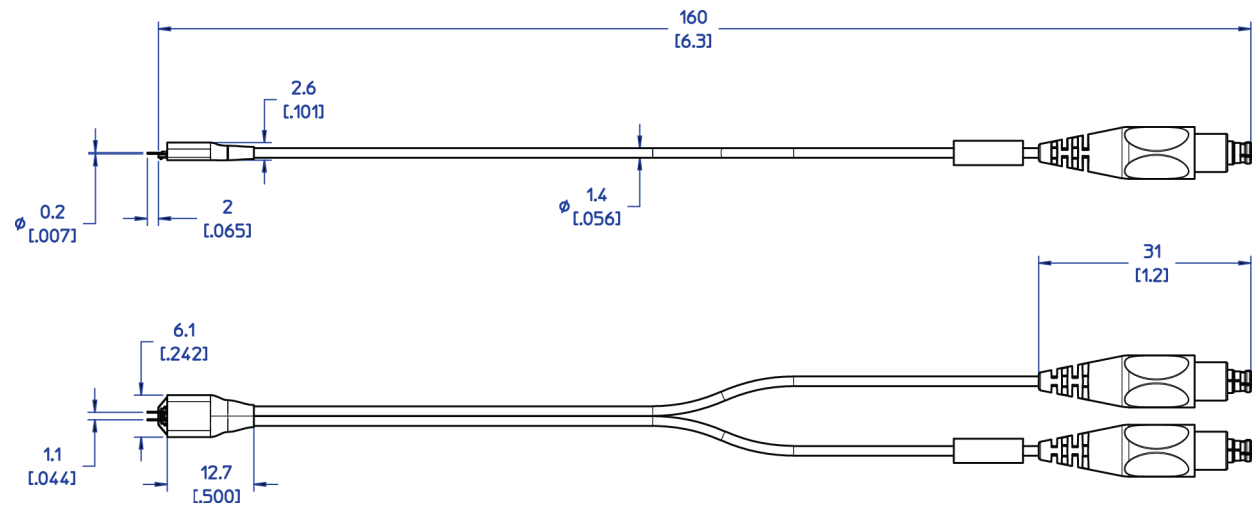
— N2849A QuickTip —



N5440A/N5447A InfiniiMax III Ceramic ZIF Tip with N5439A ZIF Head Dimensions



N5441A InfiniiMax III Solder-in Head Dimensions



6 Performance Plots

InfiniiMax III+ Probe System Responses	110
N2848A QuickTip Head with N2849A QuickTip	113
N2836A and MX0109A Solder-In Probe Heads (Flat Orientation)	114

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 85 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 86** on page 111 shows the step response of the corrected system.

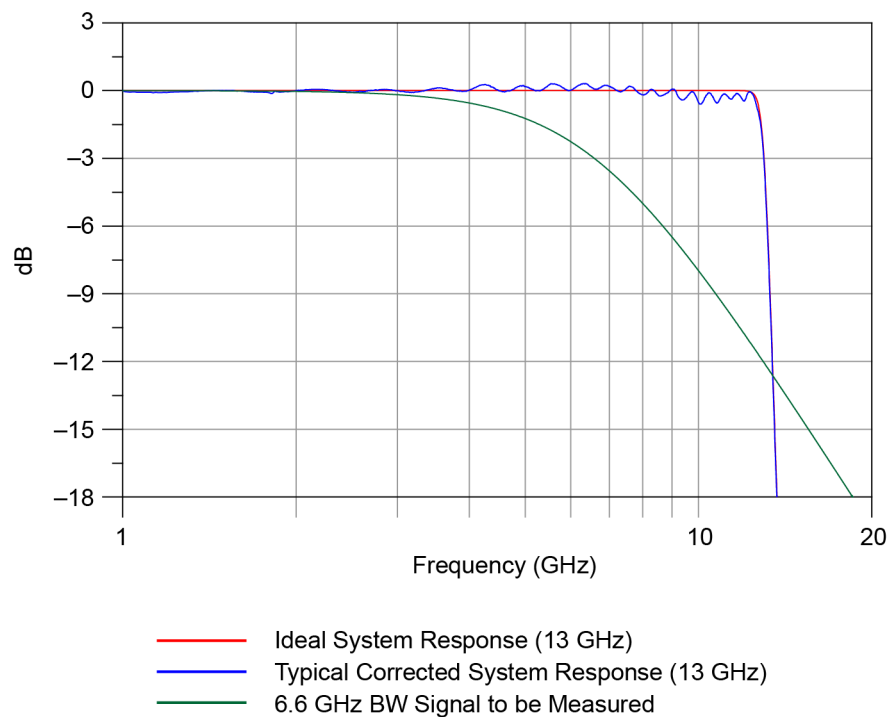


Figure 85 Corrected System Frequency Response (N2836A Solder-In Head and N2832A Amplifier)

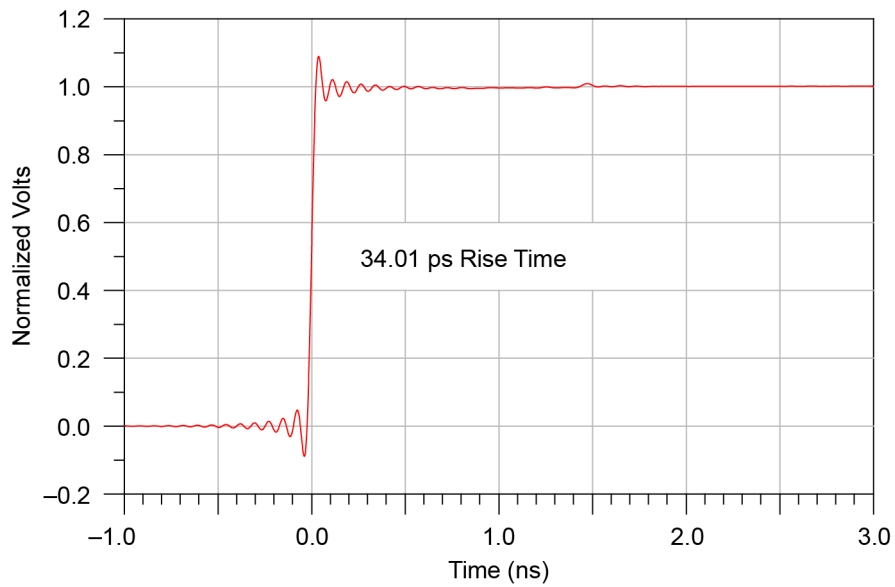


Figure 86 Step Response of Corrected System

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 87** on page 112 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%.

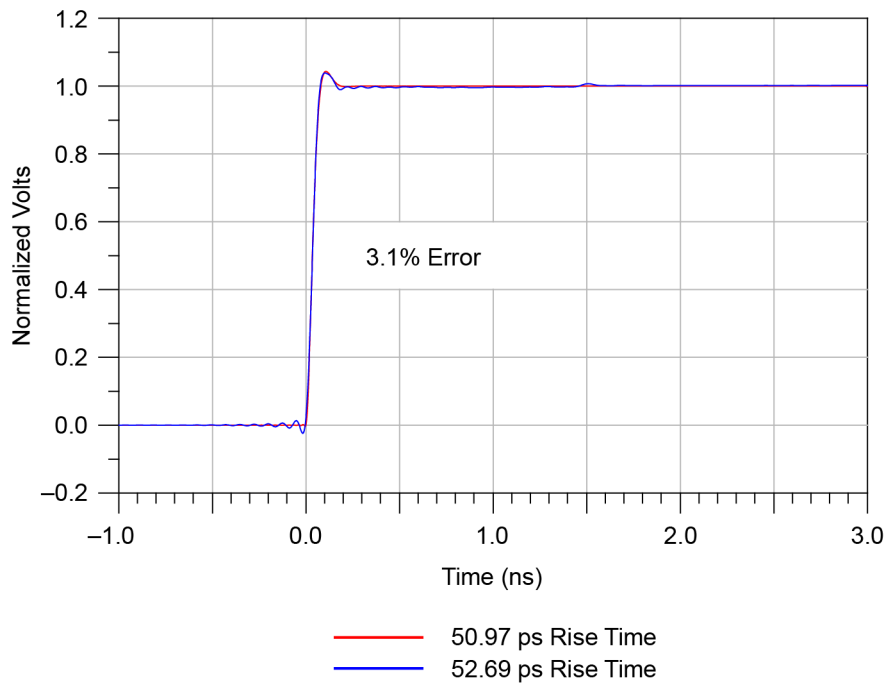


Figure 87 Fidelity of Step Response (Probe System Versus Input Signal)

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

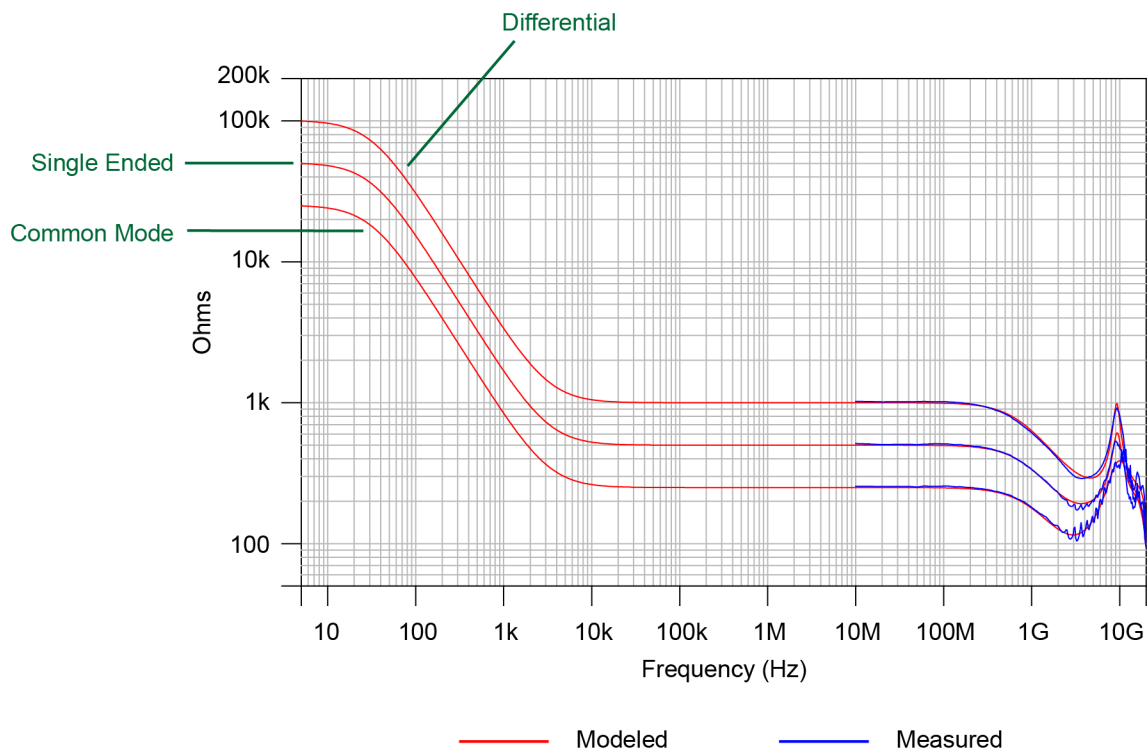
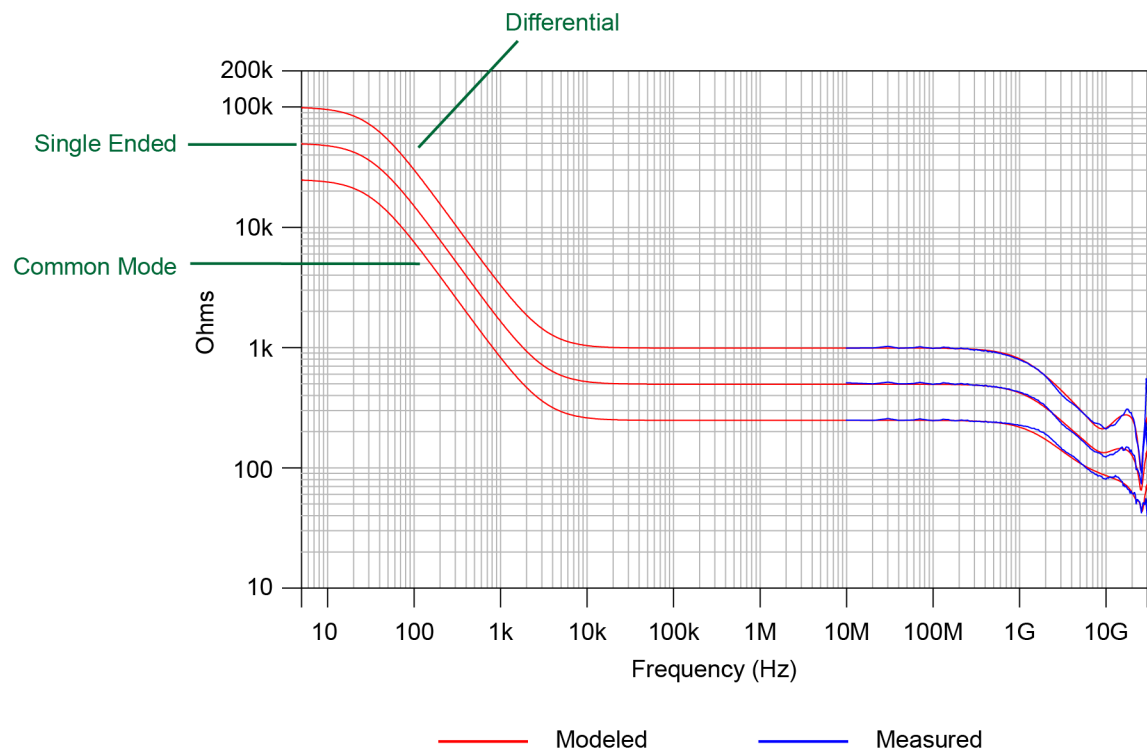


Figure 88 Input Impedances (Modeled and Measured)

N2836A and MX0109A Solder-In Probe Heads (Flat Orientation)

**Figure 89** Input Impedances (Modeled and Measured)

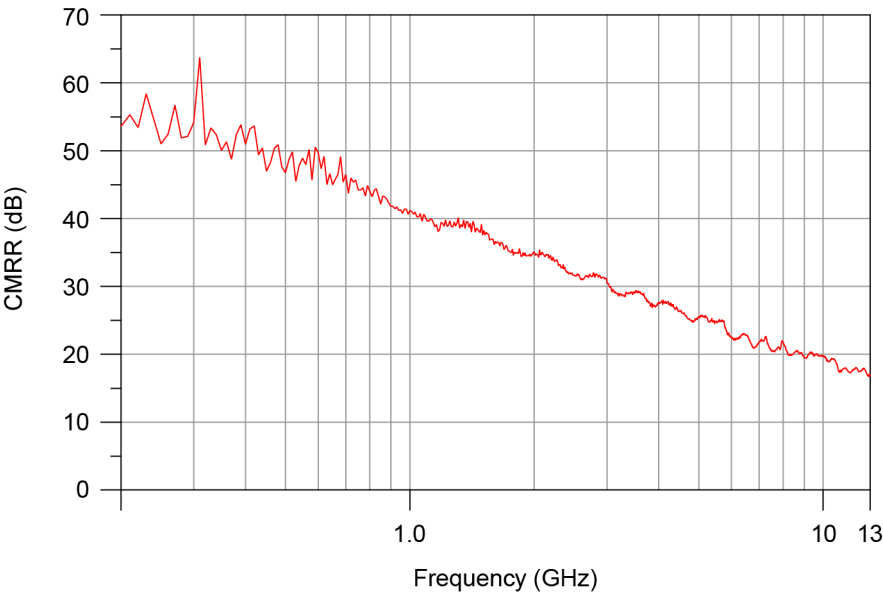


Figure 90 Common Mode Rejection Ratio (CMRR) of MX0109A / N2836A Solder-In Probe Head with N2832A Probe Amplifier

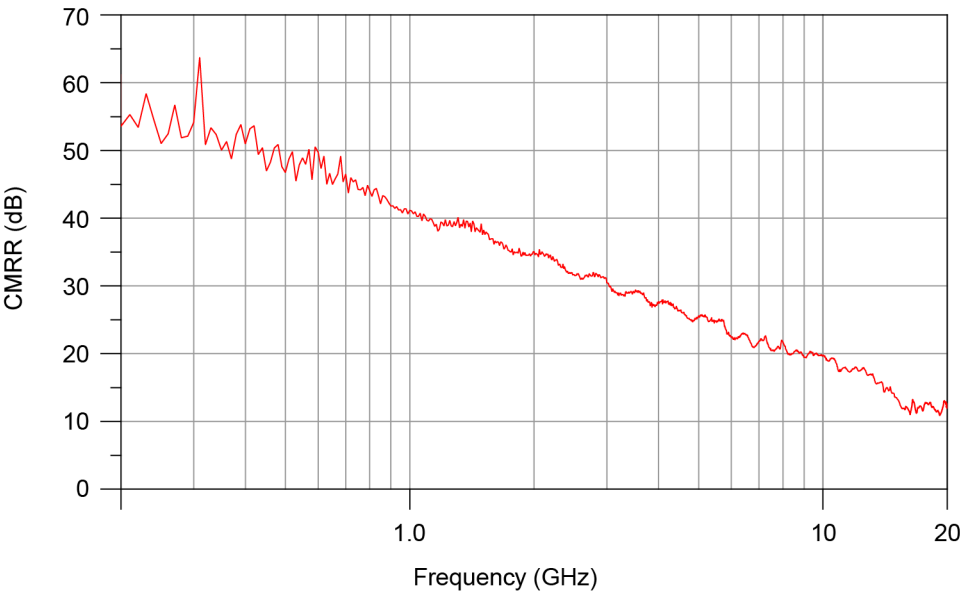


Figure 91 Common Mode Rejection Ratio (CMRR) of MX0109A / N2836A Solder-In Probe Head with N7003A Probe Amplifier

7 Performance Verification for N2830A-Series Probes

Bandwidth Performance Verification	118
Touchstone File (1250-1749 & N5443A)	127
Touchstone File (5062-1247 & N5477A)	131
DC Input Resistance Performance Verification	135
Performance Test Record	137

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 MX0109A or N2836A solder-in probe head.

NOTE

The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A or MX0109A 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 / MX0109A solder-in probe head for connection to the PV fixture as shown in **Figure 92**. Shape the leads as shown.

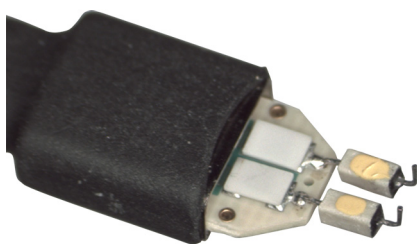


Figure 92 N2836A ZIF Probe Head

- 3 Connect the APC 3.5 (f-f) adapter, provided with the N5443A PV fixture, to the N5443A. as shown in **Figure 93** on page 120. Use a small bench vise to steady the N5443A PV fixture on the test surface.

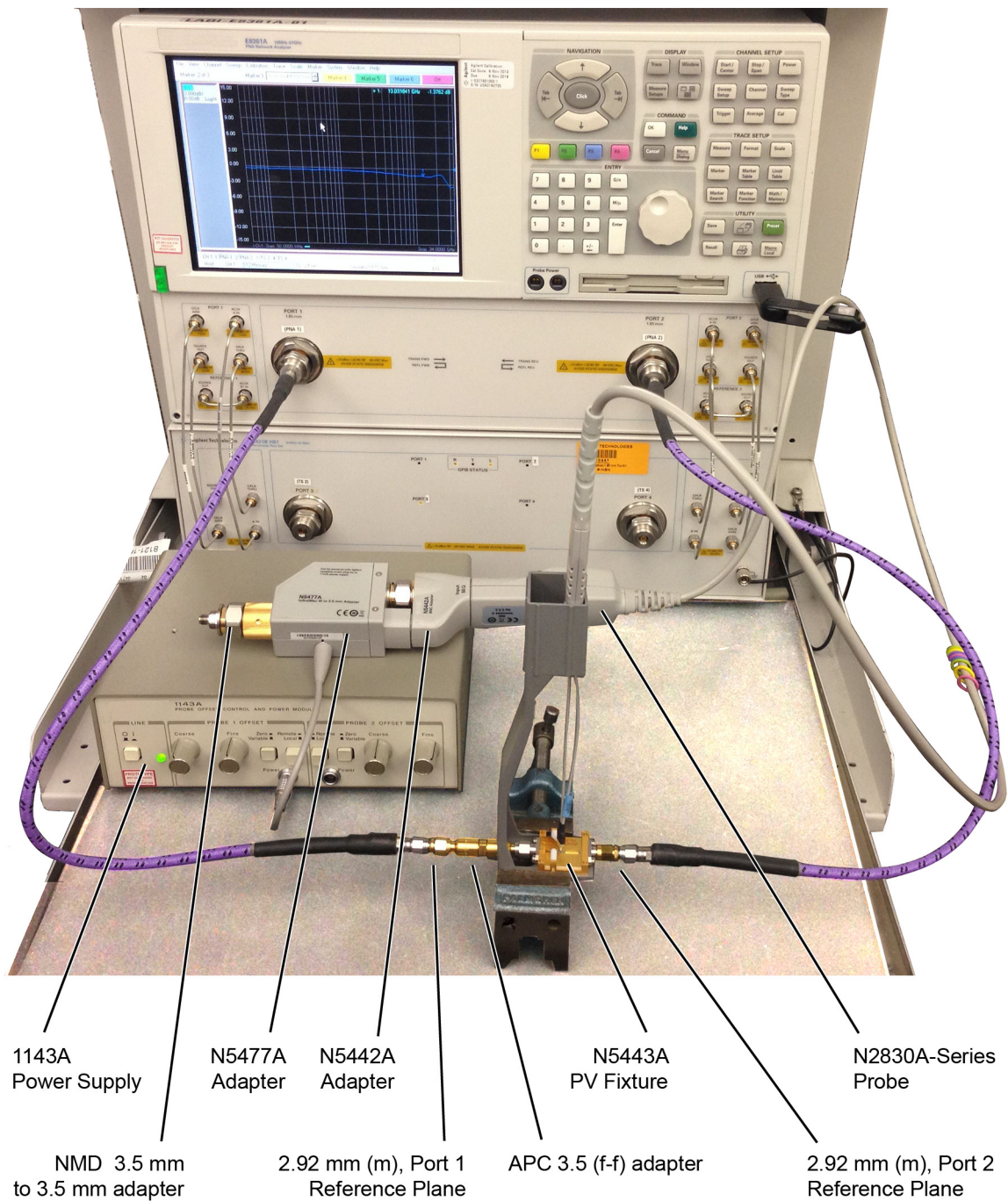


Figure 93 Test Setup for Measuring V_{in} of Probe

- 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 94** on page 122 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 127. 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.

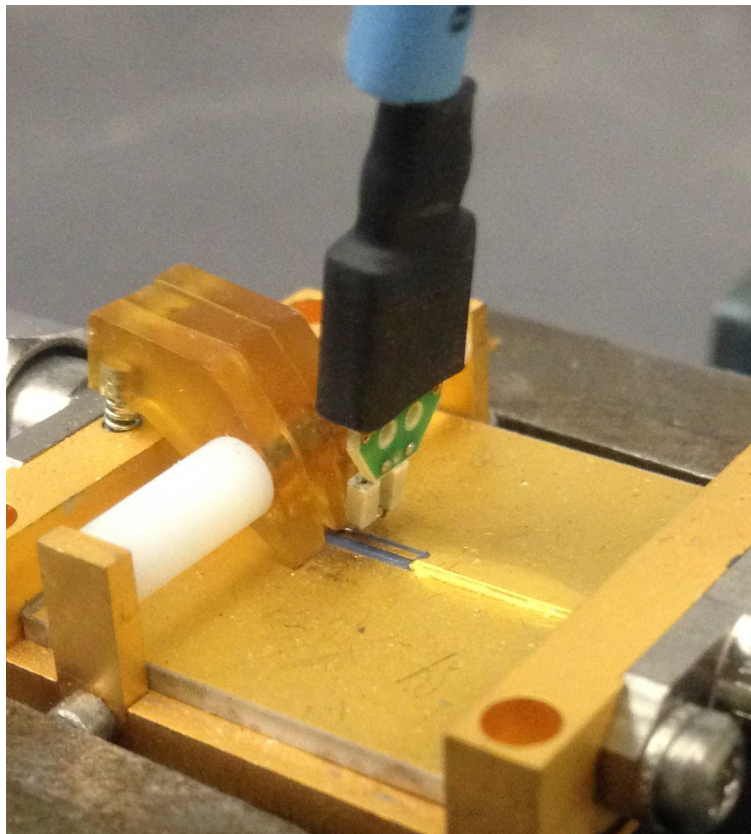


Figure 94 Close-Up of Tip Wires Positioned Under Pincher

- 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 95** on page 123. 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.

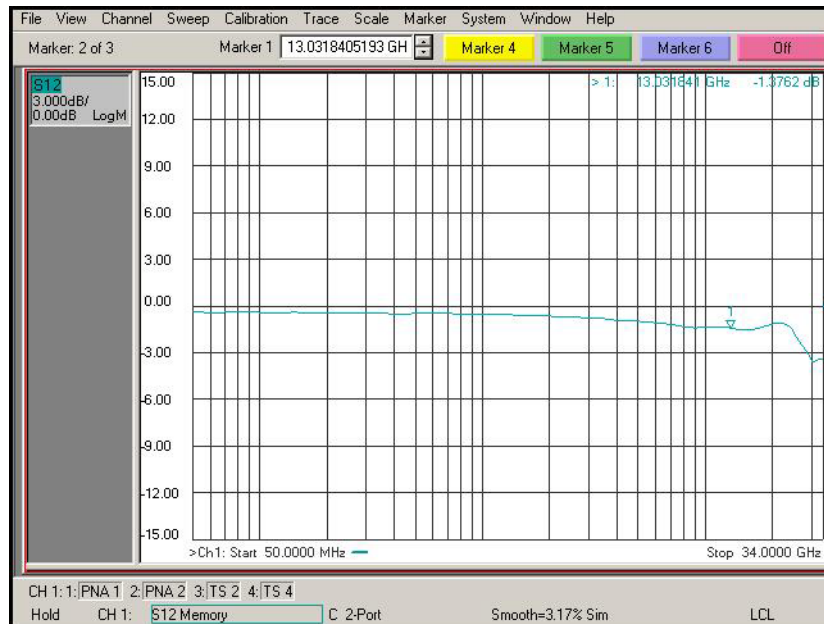


Figure 95 De-Embedded V_{in} Trace

- 12 As shown in **Figure 96** on page 124, 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 131. Name the file **Adapter_5062_1247__Adapter_N5477A.s2p**.

NOTE

You can also copy the data from the Keysight's Probe Resource Center (PRC). Copying this data from the PRC is the simplest and most reliable method to get the data. To access 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.

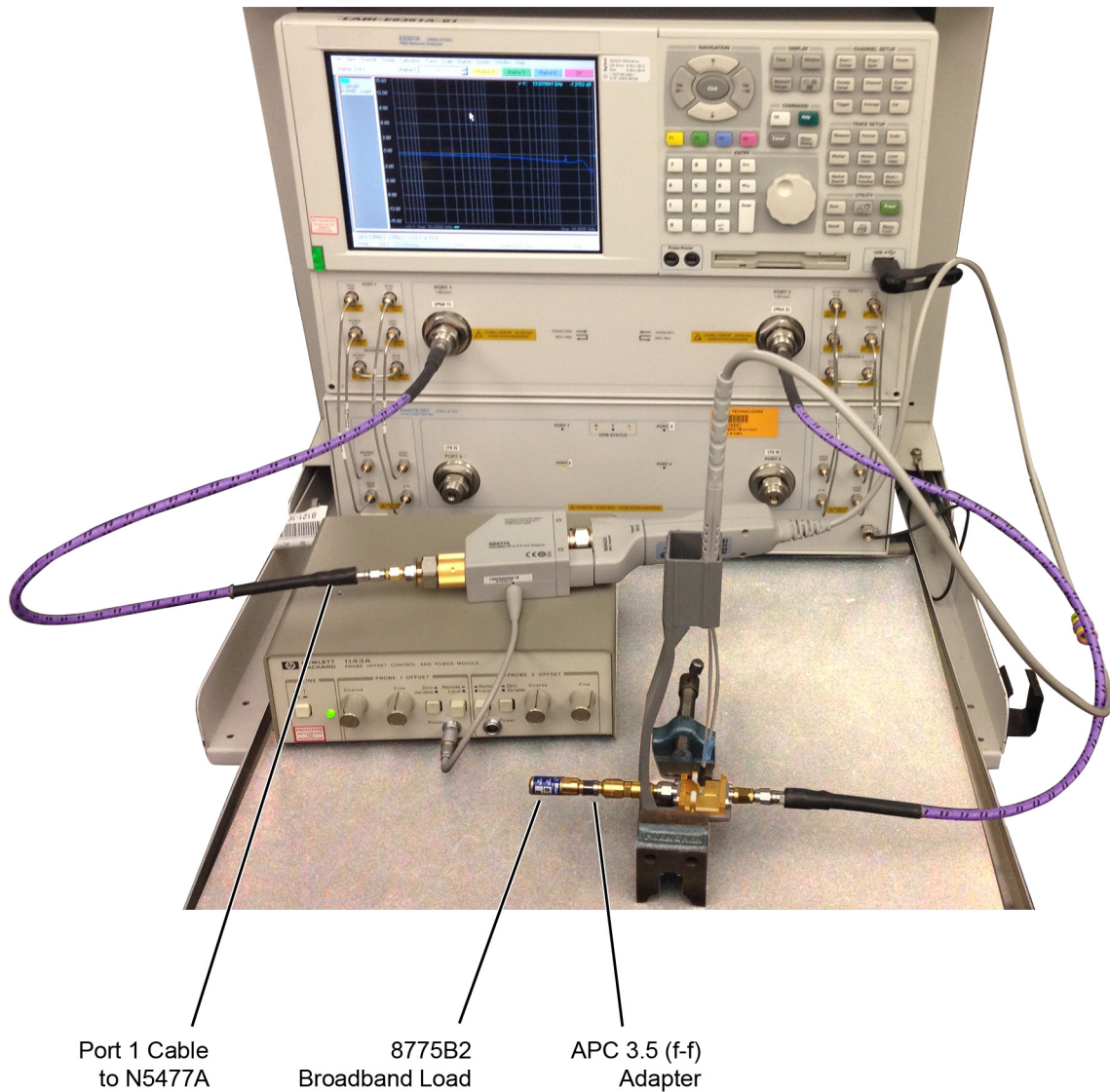


Figure 96 Test Setup to Measure V_{out} of Probe

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 97**. 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/Math” 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 98** on page 126.
 - 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 / MX0109A solder-in probe head and N2832A 13 GHz probe amp combination.

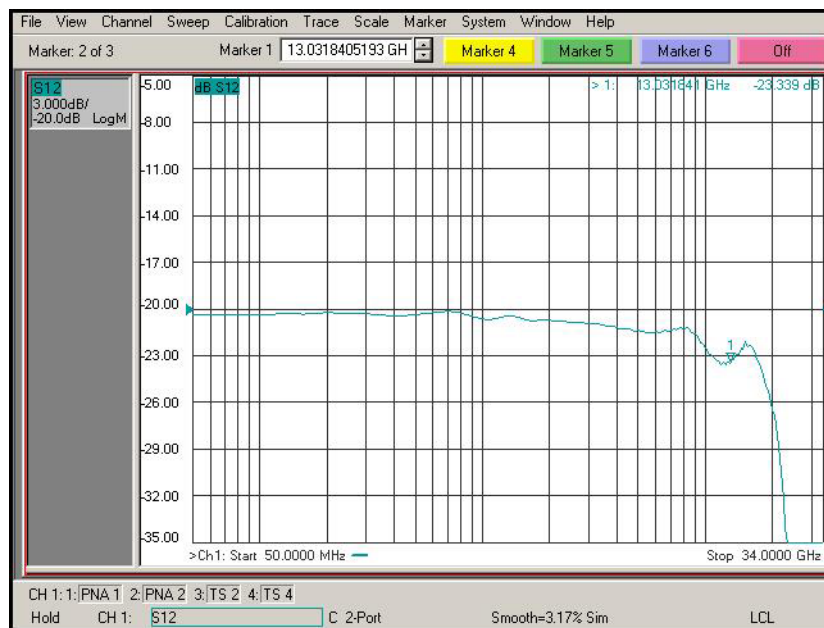


Figure 97 De-Embedded V_{out} Trace

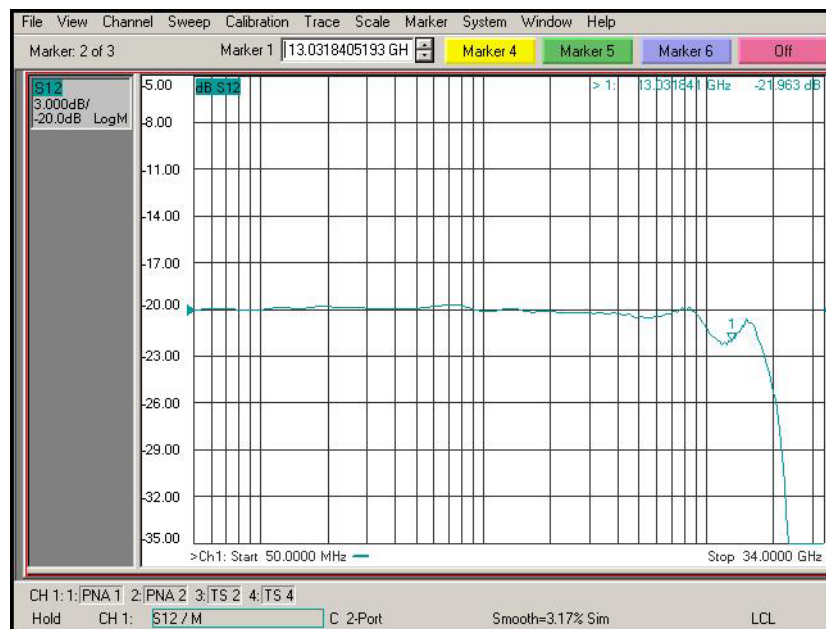


Figure 98 De-Embedded V_{out}/V_{in} Response of the Probe

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 121. 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
869332621.122130 -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
134694920.169152 -53.880297 59.647516 -0.029793 -11.213741 -0.030773 -11.214700 -53.052945 55.558900
137835181.557386 -53.486272 52.104536 -0.029372 -11.485216 -0.029957 -11.481720 -52.622790 56.157336
141048654.627056 -53.508282 45.730461 -0.030159 -11.752986 -0.030107 -11.751715 -52.284361 56.421252
144337046.226616 -54.420700 42.364200 -0.033536 -12.005802 -0.032342 -12.021139 -52.117964 55.931890
147702102.997784 -55.470568 39.211352 -0.036994 -12.264512 -0.034630 -12.296845 -51.951089 55.430858
151145612.303275 -55.576811 37.842963 -0.039670 -12.539287 -0.036049 -12.583748 -51.944456 54.446241
154669403.176167 -53.732676 40.105390 -0.040639 -12.841065 -0.035607 -12.887130 -52.278075 52.497820
158275347.291397 -52.178102 42.969822 -0.041630 -13.149878 -0.035156 -13.197584 -52.635093 50.550437
161965359.959910 -52.004259 45.986266 -0.041770 -13.470541 -0.034641 -13.513759 -52.766109 50.989381
165741401.145982 -53.013032 48.920340 -0.041128 -13.802856 -0.034066 -13.835944 -52.680124 53.568723
169605476.508267 -54.185614 51.938022 -0.040471 -14.142918 -0.033479 -14.165639 -52.594837 56.183902
173559638.465103 -53.353535 46.144495 -0.039591 -14.466058 -0.034106 -14.495652 -52.681223 53.054380
177605987.284668 -52.395549 39.070167 -0.038666 -14.793912 -0.034887 -14.832523 -52.797494 49.218907
181746672.200541 -52.169589 35.688968 -0.038595 -15.133923 -0.035919 -15.178503 -53.030384 48.315967
185983892.553281 -52.903697 37.808367 -0.039749 -15.488188 -0.037303 -15.534312 -53.432713 51.562899
```

190319898.958608	-53.671016	40.107673	-0.040862	-15.851057	-0.038670	-15.897833	-53.787995	54.424805
194756994.502833	-53.801795	43.465778	-0.041123	-16.226810	-0.039438	-16.262335	-53.156789	52.243875
199297535.966146	-53.943086	46.823120	-0.041390	-16.611323	-0.040225	-16.635334	-52.557852	50.013514
203943935.074433	-53.374619	45.618787	-0.044122	-16.994561	-0.041601	-17.016611	-52.209576	52.395133
208698659.780268	-52.713418	43.564007	-0.047367	-17.384868	-0.043113	-17.406702	-51.910498	55.677837
213564235.573780	-53.477228	35.859633	-0.049667	-17.770211	-0.046242	-17.803783	-51.477695	53.799018
218543246.824077	-55.032566	26.702114	-0.051641	-18.159282	-0.050036	-18.209336	-51.013276	49.886314
223638338.151939	-53.869091	26.218432	-0.052370	-18.572260	-0.051093	-18.629032	-51.239963	47.730420
228852215.834522	-51.902344	30.275653	-0.052588	-19.000945	-0.051017	-19.060434	-51.778596	46.370604
234187649.242808	-51.933827	29.735652	-0.051672	-19.458329	-0.050622	-19.511235	-52.618817	43.686630
239647472.312564	-52.501771	27.821456	-0.050415	-19.931623	-0.050130	-19.975167	-53.656204	40.914797
245234585.049599	-51.831039	34.835393	-0.052075	-20.398897	-0.050775	-20.408282	-54.529939	34.582488
250951955.070115	-51.206936	39.614303	-0.053717	-20.877562	-0.050675	-20.855888	-54.904078	27.538703
256802619.176963	-50.965190	28.605202	-0.054066	-21.375945	-0.046274	-21.351120	-52.552449	17.284825
262789684.972659	-50.758459	28.217659	-0.053702	-21.875920	-0.045857	-21.868062	-51.711832	15.564753
268916326.509994	-50.587835	35.16894	-0.052486	-22.375796	-0.050221	-22.408982	-52.202077	23.079380
275185815.981130	-51.754800	32.581293	-0.054937	-22.906560	-0.050202	-22.929332	-52.401581	27.377763
281601465.446084	-52.426237	23.436322	-0.057360	-23.444084	-0.049220	-23.461590	-52.225369	30.372145
288166688.601492	-50.141722	22.093874	-0.057147	-23.964218	-0.048206	-24.027394	-51.161468	31.686174
294884972.590629	-49.853653	30.887087	-0.057999	-24.535771	-0.050035	-24.592002	-51.268626	22.265828
301759885.855612	-49.776989	38.708272	-0.059389	-25.124388	-0.052090	-25.164841	-51.422057	12.143268
308795080.032796	-48.347696	33.823620	-0.061131	-25.692961	-0.051459	-25.752786	-50.227178	13.737775
315994291.892351	-48.485936	29.549305	-0.059722	-26.288759	-0.054400	-26.334640	-49.610356	17.239374
323361345.323065	-48.665429	24.275657	-0.058597	-26.902100	-0.056825	-26.949053	-49.521928	23.486824
330900153.363414	-48.490653	18.844559	-0.058508	-27.532108	-0.057357	-27.600499	-49.949091	29.735275
338614720.279990	-48.115523	23.731233	-0.057500	-28.187494	-0.055355	-28.226210	-50.295079	15.284824
346509143.694381	-47.416900	25.416394	-0.058853	-28.843482	-0.058986	-28.876449	-49.620245	11.560046
354587616.759638	-47.838026	23.437700	-0.061373	-29.502109	-0.060345	-29.544775	-49.384503	7.983506
362854430.387485	-48.753096	20.588112	-0.064328	-30.185369	-0.060547	-30.226722	-49.304935	5.118950
371313975.527454	-48.438196	19.789363	-0.066839	-30.908078	-0.063211	-30.919712	-48.959273	7.111174
379970745.499151	-47.335734	18.341686	-0.067669	-31.598820	-0.062202	-31.629439	-50.947829	8.447970
388829338.378905	-47.288518	18.480970	-0.069668	-32.364173	-0.063655	-32.378360	-49.035406	3.520875
397894459.442048	-47.186291	13.294545	-0.075098	-33.096733	-0.066338	-33.140263	-47.851278	4.310910
407170923.662146	-46.940356	14.281384	-0.073798	-33.866977	-0.066345	-33.855087	-48.397382	2.145757
416663658.268484	-47.171461	14.761701	-0.075883	-34.639733	-0.070645	-34.639129	-48.716178	1.898130
426377705.363190	-46.365553	7.572152	-0.076247	-35.447314	-0.071046	-35.477949	-48.899175	2.468785
436318224.599360	-46.701580	7.151913	-0.076870	-36.265959	-0.071287	-36.319100	-49.620160	4.118647
446490495.921630	-47.160978	13.689850	-0.075994	-37.111578	-0.072545	-37.175224	-50.397815	8.680461
456899922.370640	-47.396507	5.107440	-0.077071	-37.989362	-0.073385	-38.033366	-49.617133	15.929710
467552032.952879	-46.077313	2.865178	-0.082064	-38.861189	-0.075185	-38.898976	-49.133541	14.551426
478452485.577434	-45.259095	-4.008123	-0.080006	-39.743034	-0.076419	-39.807567	-49.683609	21.223063
489607070.061218	-45.485801	0.581757	-0.083491	-40.697038	-0.079818	-40.709941	-50.060529	34.194193
501021711.204246	-46.603526	-10.039365	-0.083755	-41.665129	-0.077315	-41.682717	-48.792928	16.944997
512702471.936616	-45.029650	-7.000027	-0.081662	-42.639573	-0.084559	-42.668191	-47.488874	20.655839
524655556.538861	-44.514984	-6.354720	-0.079332	-43.615551	-0.083707	-43.641378	-48.492928	32.031639
536887313.937376	-44.290770	-6.568840	-0.082138	-44.648013	-0.083945	-44.653837	-48.957638	36.719941
549404241.076669	-43.504772	-8.685522	-0.083652	-45.691901	-0.084815	-45.691684	-49.515830	29.325183
562212986.370243	-43.481121	-10.960529	-0.085501	-46.733135	-0.082668	-46.765101	-49.399910	23.211836
575320353.231926	-43.193036	-11.045160	-0.084422	-47.837255	-0.085212	-47.869091	-48.549704	24.186062
588733303.689526	-43.579719	-5.409896	-0.088905	-48.969584	-0.085630	-48.973225	-47.693589	29.030108
602458962.082744	-43.188600	-6.651222	-0.088581	-50.106860	-0.090320	-50.094811	-47.786787	31.167939
616504618.847291	-42.930989	-6.216016	-0.089156	-51.257875	-0.092166	-51.276355	-47.608082	38.990988
630877734.387229	-43.378333	-4.283740	-0.093976	-52.437082	-0.089960	-52.477553	-47.686557	37.227422
645585943.037598	-42.988551	-8.753781	-0.093823	-53.639519	-0.091066	-53.698415	-46.547666	40.593444
660637057.119418	-42.596030	-12.785888	-0.103544	-54.904243	-0.095545	-54.940053	-47.106751	48.137651
676039071.089234	-42.679026	-16.442780	-0.100600	-56.176567	-0.092255	-56.223911	-47.286734	45.912639
691800165.785404	-43.248582	-16.783776	-0.101186	-57.495739	-0.095262	-57.497232	-48.306455	50.044404
707928712.773379	-42.415380	-19.285387	-0.103842	-58.815086	-0.098396	-58.854555	-47.089721	60.118742
724433278.792294	-41.987336	-27.097520	-0.102116	-60.184767	-0.100383	-60.223125	-47.381752	64.403202
741322630.305226	-42.380172	-26.675550	-0.103107	-61.606922	-0.099178	-61.610960	-47.908203	66.412340
758605738.155530	-42.072895	-29.384976	-0.104426	-63.042400	-0.101633	-63.063497	-47.780003	67.506873
776291782.331738	-41.656096	-32.657305	-0.107282	-64.497662	-0.106240	-64.506014	-46.469069	72.198347
794390156.843548	-41.748908	-30.061058	-0.109317	-66.001852	-0.105904	-66.011789	-47.270100	73.483172
812910474.711483	-41.239790	-29.316570	-0.111042	-67.520247	-0.104695	-67.553979	-46.437563	75.346862
831862573.072888	-40.820512	-28.868361	-0.110486	-69.092396	-0.106359	-69.109196	-46.689929	71.382011
851256518.406959	-40.299703	-33.428087	-0.112605	-70.722280	-0.107949	-70.719090	-44.864237	79.807143
871102611.881596	-40.581509	-33.326230	-0.117064	-72.357940	-0.111254	-72.364310	-45.374639	83.129710
891411394.824904	-40.118229	-36.220425	-0.117204	-74.035916	-0.111664	-74.040042	-45.840643	83.576746
912193654.324260	-39.532418	-35.546012	-0.117644	-75.756995	-0.111502	-75.761397	-45.992895	89.364030
933460428.955917	-39.179015	-40.983687	-0.117874	-77.510221	-0.113750	-77.547756	-47.068488	100.546539
955223014.648186	-39.364010	-46.292129	-0.118168	-79.321186	-0.116241	-79.345373	-46.697516	107.536739
977492970.681309	-39.278675	-46.564818	-0.119686	-81.179525	-0.117531	-81.189173	-47.024828	111.261956
1000282125.827218	-39.194967	-51.270372	-0.123784	-83.060780	-0.122650	-83.091199	-46.955841	115.95987
1023602584.632427	-38.638711	-50.107386	-0.127481	-84.951909	-0.124243	-84.986961	-45.812369	116.830342
1047466733.847416	-38.254716	-50.795831	-0.130664	-86.951714	-0.126013	-86.984689	-46.398595	124.148154
1071887249.005892	-38.159836	-50.090886	-0.129842	-88.962105	-0.122894	-88.985826	-45.298698	117.918878
1096877101.157453	-38.225707	-53.761634	-0.132812	-91.046094	-0.128113	-91.085312	-45.697061	122.970507
1122449563.757208	-37.836836	-52.245928	-0.132701	-93.180867	-0.128419	-93.190744	-45.762256	131.225754

1148618219.716024	-37.144353	-57.251248	-0.140371	-95.308530	-0.133202	-95.358212	-44.877794	-135.721493
1175396968.615140	-36.980899	-62.823348	-0.137923	-97.548113	-0.134986	-97.590029	-45.036304	-146.770725
1202800034.088982	-36.556652	-64.800739	-0.142085	-99.804380	-0.134988	-99.843209	-44.642492	-151.036760
1230841971.380104	-36.368154	-66.008920	-0.139317	-102.172138	-0.135905	-102.176340	-45.350402	-159.255608
1259537675.070255	-36.484368	-70.298488	-0.140443	-104.535698	-0.138102	-104.561407	-45.199506	-167.298406
1288902386.991699	-36.100137	-71.663451	-0.143996	-106.965470	-0.140718	-106.990081	-44.237343	-167.377205
1318951704.322966	-35.647399	-70.676147	-0.143407	-109.444778	-0.141530	-109.473265	-44.479826	-166.526112
1349701587.873357	-35.473004	-76.169267	-0.144837	-111.996785	-0.140095	-112.024550	-44.898263	-168.705245
1381168370.560588	-35.397257	-76.199011	-0.151281	-114.619927	-0.143939	-114.641006	-44.459548	-179.894988
1413368766.086080	-34.861640	-79.603023	-0.149326	-117.283372	-0.147051	-117.307324	-44.548533	-166.433716
1446319877.812507	-34.675802	-83.685975	-0.154729	-120.021826	-0.148112	-120.068082	-43.870957	-156.340597
1480039207.848310	-34.403859	-87.183840	-0.154624	-122.809345	-0.149335	-122.837405	-43.122876	-147.931664
1514544666.344010	-34.182262	-87.576024	-0.156786	-125.682377	-0.148638	-125.705803	-43.408595	-145.144573
1549854581.005252	-33.860562	-89.317043	-0.159620	-128.583658	-0.151584	-128.632751	-42.575215	-145.798996
1585987706.827638	-33.879884	-90.737689	-0.160755	-131.597325	-0.154725	-131.631979	-43.172777	-140.875243
1622963236.058510	-33.429276	-94.739265	-0.163689	-134.669991	-0.157934	-134.692000	-43.227570	-129.498215
1660800808.390988	-33.329643	-99.088811	-0.168803	-137.806336	-0.161831	-137.822013	-41.965972	-120.296582
1699520521.395668	-33.017248	-104.260619	-0.168570	-141.018492	-0.160178	-141.044358	-40.920686	-110.637802
1739142941.195521	-32.875921	-105.450952	-0.171025	-144.279383	-0.166273	-144.317413	-40.643020	-104.699352
1779689113.389672	-32.708201	-107.063801	-0.172504	-147.660075	-0.162445	-147.682016	-40.660603	-105.009991
1821180574.231843	-32.495401	-108.239493	-0.175914	-151.100173	-0.165749	-151.139895	-40.823790	-97.679422
1863639362.069423	-32.536928	-113.587393	-0.175658	-154.611897	-0.171416	-154.640531	-39.630700	-90.191237
1907088029.049217	-32.190830	-117.633228	-0.178971	-158.232186	-0.173995	-158.258872	-39.196315	-79.035112
1951549653.096104	-31.667674	-122.733655	-0.181069	-161.898184	-0.177993	-161.940825	-38.680786	-73.511229
1997047850.170966	-31.681756	-124.558337	-0.184890	-165.657486	-0.180560	-165.712594	-37.957528	-67.017074
2043606786.814396	-31.524438	-126.951023	-0.176373	-169.592160	-0.173181	-169.599395	-37.812786	-61.527222
2091251192.982845	-31.508596	-130.420301	-0.180521	-173.557368	-0.178375	-173.563860	-37.808832	-56.560157
2140006375.184037	-31.352237	-136.421437	-0.182092	-177.562606	-0.175784	-177.610847	-36.745367	-46.399887
2189898229.918614	-30.957173	-139.919378	-0.185269	-178.278037	-0.182462	-178.249234	-35.930516	-41.270528
2240953257.435161	-30.915880	-143.280497	-0.187083	-174.043814	-0.180237	-174.012118	-35.847724	-33.647802
2293198575.805914	-31.061429	-144.990888	-0.191682	-169.730086	-0.184977	-169.668447	-35.634129	-29.520399
2346661935.330630	-30.824427	-150.030321	-0.192955	-165.294346	-0.189879	-165.273329	-35.125695	-22.434121
2401371733.276259	-30.711442	-156.357424	-0.197804	-160.749968	-0.192822	-160.694478	-34.275816	-15.555756
2457357028.960266	-30.566130	-160.978173	-0.201637	-156.109425	-0.195571	-156.089533	-34.044506	-8.331749
2514647559.185594	-30.654376	-163.493462	-0.202645	-151.350193	-0.195381	-151.336136	-33.871825	-2.995640
2573273754.035484	-30.868012	-167.269004	-0.201011	-146.492195	-0.199719	-146.482637	-33.560073	-3.085006
2633266753.036525	-30.504435	-174.012549	-0.208266	-141.533091	-0.201261	-141.478510	-32.905976	-9.045197
2694658421.698535	-30.565645	-179.635901	-0.213505	-136.435012	-0.206057	-136.409120	-32.473140	-17.052285
2757481368.440050	-30.888540	-178.123883	-0.212627	-131.244547	-0.206352	-131.171938	-32.817005	-22.286160
2821768961.908402	-31.000935	-173.076123	-0.216103	-125.922630	-0.207124	-125.858070	-32.522002	-29.243728
2887555348.703612	-30.820364	-164.663900	-0.216900	-120.465559	-0.214475	-120.405217	-31.889321	-37.253951
2954875471.515481	-31.194821	-157.495083	-0.222818	-114.879439	-0.217917	-114.825549	-31.703250	-42.176641
3023765087.683534	-31.613614	-154.780887	-0.224451	-109.162326	-0.218786	-109.121034	-31.941295	-48.431775
3094260788.189668	-31.796838	-146.311906	-0.226799	-103.305582	-0.224308	-103.266298	-31.457066	-56.483986
3166400017.093591	-31.937066	-139.710902	-0.231513	-97.343919	-0.225841	-97.298244	-31.292167	-62.802144
3240221091.421377	-32.735810	-136.690560	-0.229408	-91.225431	-0.226339	-91.187290	-31.803209	-68.565004
3315763221.517697	-32.788337	-127.148230	-0.234935	-84.975796	-0.232753	-84.906730	-31.708453	-77.299513
3393066531.872549	-33.014330	-119.823287	-0.242433	-78.548909	-0.237244	-78.516779	-31.108277	-85.015548
3472172082.433529	-34.005375	-113.845028	-0.240921	-71.997363	-0.237719	-71.959359	-31.855179	-90.700221
3553121890.414979	-34.816189	-103.990424	-0.244164	-65.290197	-0.240996	-65.246553	-32.001168	-98.192167
3635958952.615593	-35.105861	-94.193941	-0.246572	-58.422508	-0.242729	-58.387463	-31.806572	-106.082540
3720727268.256326	-36.503975	-88.649973	-0.249350	-51.414339	-0.246198	-51.364288	-32.770003	-112.053147
3807471862.350752	-37.228873	-78.216506	-0.256868	-44.217344	-0.244479	-44.167759	-33.099110	-120.642460
3896238809.620269	-37.544174	-66.083577	-0.253101	-36.850849	-0.245735	-36.806509	-33.192652	-128.417644
3987075258.966864	-40.090566	-56.386585	-0.258835	-29.348649	-0.254203	-29.278340	-34.643781	-132.259926
4080029458.516430	-37.750793	-2.224422	-0.260607	-21.663441	-0.261353	-21.598986	-37.416299	-109.955732
4175150781.245943	-38.306256	-20.930305	-0.264999	-13.749029	-0.262660	-13.714183	-37.508574	-112.927722
4272489751.208107	-38.992465	-21.937013	-0.269200	-5.686750	-0.263206	-5.651466	-38.060422	-118.893984
4372098070.367394	-39.217001	-27.624172	-0.269100	-2.579554	-0.269574	-2.594578	-38.809091	-129.345686
4474028646.061748	-40.149979	-40.384312	-0.273686	-10.994380	-0.273280	-11.051676	-40.144064	-127.770439
4578335619.104504	-40.601274	-34.171278	-0.277064	-19.695293	-0.278657	-19.700671	-42.311538	-144.891342
4685074392.541502	-43.205765	-40.322856	-0.279730	-28.552810	-0.278856	-28.574421	-43.995810	-141.108417
4794301661.078618	-42.538447	-21.332713	-0.284355	-37.536946	-0.278354	-37.626859	-51.818605	-154.415610
4906075441.195374	-45.752896	-2.922590	-0.290174	-46.835316	-0.284636	-46.895577	-60.526640	-82.129460
5020455101.960610	-41.864321	-12.489806	-0.290412	-56.328197	-0.285892	-56.386899	-50.065291	-0.805957
5137501396.566599	-39.862849	-18.819510	-0.295713	-66.021077	-0.291194	-66.064093	-44.122777	-9.819186
5257276494.598325	-36.786600	-13.268906	-0.296811	-75.969290	-0.297777	-76.011129	-39.151223	-15.068204
5379844015.055103	-34.743516	-12.176967	-0.292950	-86.174406	-0.298485	-86.205499	-36.219599	-22.147158
5505269060.142051	-32.656780	-3.531112	-0.301576	-96.552772	-0.296909	-96.605714	-34.165003	-30.703875
5633618249.849370	-31.050201	-3.309197	-0.305076	-107.205913	-0.303673	-107.259105	-32.325093	-43.053532
5764959757.337812	-29.294480	-15.083051	-0.308585	-118.102159	-0.307424	-118.139488	-30.668067	-52.998555
5899363345.149107	-28.523285	-24.310538	-0.316044	-129.264232	-0.313430	-129.288252	-29.410317	-63.439229
6036900402.260610	-27.187902	-35.419668	-0.317003	-140.655917	-0.317401	-140.693816	-28.259852	-74.373278
6177643982.003820	-26.649348	-47.200422	-0.324087	-152.310378	-0.323289	-152.322435	-27.505381	-85.086106
6321668840.866945	-25.835170	-58.476787	-0.330668	-164.240450	-0.327882	-164.265167	-26.752500	-97.664878
6469051478.202085	-25.391882	-72.229600	-0.332763	-176.461341	-0.334055	-176.477867	-26.292509	-107.946307
6619870176.858158	-25.364054	-84.427633	-0.338164	-171.041972	-0.339505	-171.032422	-26.232417	-120.500485
6774205044.761139	-24.948364	-98.914889	-0.341380	-158.272547	-0.341366	-158.242604	-26.023987	-132.326935


```

6932138057.463680 -25.182014 -113.673081 -0.344893 145.199786 -0.343842 145.162774 -26.269667 -142.490968
7093753101.686746 -25.596734 -128.228310 -0.346129 131.803051 -0.344261 131.778055 -26.961542 -154.648383
7259136019.876357 -26.041636 -146.702019 -0.345153 118.095800 -0.345595 118.076780 -27.842369 -164.628043
7428374655.799140 -27.017620 -164.842451 -0.348642 104.090333 -0.350091 104.061237 -28.919257 -172.662528
7601558901.200872 -28.551834 174.443449 -0.347845 89.718285 -0.349058 89.706641 -31.030126 -178.119157
7778780743.552826 -29.482132 148.355026 -0.349523 75.016467 -0.358008 74.972608 -32.590336 -177.895400
7960134314.911269 -30.871044 118.843742 -0.356179 59.960289 -0.356072 59.945644 -33.687188 -170.658171
8145715941.916058 -31.950742 79.399064 -0.362965 44.538332 -0.361544 44.536516 -33.634250 -156.266570
8335624196.954902 -31.102992 41.941266 -0.368766 28.807538 -0.367519 28.749027 -31.418216 -149.846807
8529959950.520464 -29.506952 12.987833 -0.380587 12.700933 -0.371898 12.632583 -29.617847 -154.917241
8728826424.788105 -28.037976 -11.924768 -0.387358 -3.772489 -0.377158 -3.828796 -28.033121 -165.368743
8932329248.442736 -27.178655 -33.429976 -0.393930 -20.622293 -0.387888 -20.700028 -27.140427 -179.247325
9140576512.783896 -26.590219 -54.325530 -0.400342 -37.878546 -0.397504 -37.929492 -26.794476 164.982238
9353678829.138855 -26.410378 -73.335178 -0.407440 -55.528809 -0.401149 -55.588250 -26.749329 147.729718
9571749387.614246 -26.714829 -88.237234 -0.410414 -73.575672 -0.405640 -73.594043 -27.471766 127.264015
9794904017.217421 -27.784409 -102.254518 -0.413424 -92.036107 -0.405178 -92.065913 -29.288726 106.168277
10023261247.379461 -29.946849 -113.393625 -0.415196 -110.952968 -0.410031 -111.004263 -32.941982 80.431768
10256942370.912546 -33.467963 -111.933273 -0.416094 -130.366719 -0.415555 -130.393886 -39.546464 35.419669
10496071508.435085 -35.844062 -83.069634 -0.425423 -150.213792 -0.418926 -150.256785 -39.552620 -88.456959
10740775674.298862 -31.594934 -55.582996 -0.430726 -170.525020 -0.427623 -170.564105 -31.250912 -133.959009
10991184844.053186 -27.345484 -58.704648 -0.440006 168.685369 -0.439718 168.630262 -26.639771 -161.126596
11247432023.481905 -24.270939 -69.126451 -0.456322 147.439024 -0.449060 147.371764 -23.920976 172.437459
11509653319.249928 -22.222011 -85.685044 -0.470606 125.714476 -0.464162 125.646750 -21.899028 147.100182
11777988011.196802 -20.892091 -104.819406 -0.485741 103.505487 -0.482557 103.398888 -20.621755 123.860148
12052578626.315733 -19.912105 -123.956104 -0.503675 80.788596 -0.495872 80.740772 -19.692077 98.664504
12333571014.457333 -19.497816 -147.212200 -0.508376 57.572177 -0.509731 57.482576 -19.471600 76.401941
12621114425.798326 -19.543071 -170.672396 -0.512781 33.789680 -0.504274 33.733344 -19.628177 53.134740
12915361590.116354 -19.992728 160.959326 -0.511246 9.447349 -0.501680 9.367454 -20.266146 34.221120
13216468797.912968 -20.711590 126.547146 -0.502591 -15.541526 -0.499251 -15.576244 -21.010230 19.709050
13524595983.427933 -21.426162 84.306572 -0.510405 -41.123231 -0.509740 -41.200330 -21.466613 12.415942
13839906809.588905 -20.960271 35.922011 -0.519346 -67.368700 -0.517751 -67.434663 -21.004955 7.109877
14162568754.941620 -19.386936 -9.482291 -0.546208 -94.193857 -0.538859 -94.244322 -19.279569 -1.526207
14492753202.606752 -17.607733 -48.883689 -0.578799 -121.606363 -0.569568 -121.658188 -17.509474 -16.111468
14830635531.310724 -16.058479 -85.299362 -0.618100 -149.484635 -0.618535 -149.541717 -16.084639 -35.440127
15176395208.538778 -15.236915 -119.431135 -0.647631 -177.960047 -0.644491 -178.030288 -15.352338 -57.340933
15530215885.859812 -15.065709 -154.592735 -0.660264 153.014482 -0.658133 153.003053 -15.173200 -80.159018
15892285496.473612 -15.566862 168.702105 -0.644811 123.213682 -0.635579 123.149684 -15.854211 -100.792741
16262796355.032291 -17.185189 128.943209 -0.612713 92.711057 -0.605704 92.642379 -17.351408 -121.539091
16641945259.788942 -19.517598 79.609952 -0.586104 61.195419 -0.579928 61.155659 -19.345649 -133.056375
17029903597.127781 -22.052969 14.417418 -0.567689 28.875945 -0.564626 28.806397 -21.149985 -133.824999
17426967448.531292 -21.630443 -59.992319 -0.583576 -4.158770 -0.574743 -4.255992 -20.911414 -131.946593
17833257700.041199 -19.673154 -120.894595 -0.601843 -37.884863 -0.593646 -37.981253 -19.659181 -138.614133
18249020154.271370 -18.806881 -174.276372 -0.618695 -72.289682 -0.609299 -72.420566 -18.994739 -153.494312
18674475645.032219 -19.178945 134.206183 -0.619021 -107.527664 -0.614326 -107.586015 -19.447309 -168.513987
19109850154.627415 -19.950051 73.371028 -0.618376 -143.565386 -0.611954 -143.651099 -20.065279 179.863710
19555374933.885239 -20.409308 7.727679 -0.619886 179.407608 -0.622828 179.396896 -20.470586 169.575271
20011286624.988346 -19.579681 -58.016432 -0.626351 141.642169 -0.628446 141.549209 -20.272460 158.551078
20477827387.167168 -19.235856 -115.281184 -0.639397 102.910502 -0.637766 102.864098 -20.495114 142.323830
20955245025.323700 -20.044807 -172.267159 -0.636528 63.319595 -0.622112 63.277382 -21.696936 125.790595
21443793121.654022 -21.683487 128.397837 -0.638893 22.760432 -0.630205 22.758924 -22.470371 115.132339
21943731170.339451 -23.474823 60.110496 -0.639381 -18.730062 -0.644866 -18.828618 -22.521536 100.916605
22455324715.377853 -25.165813 -9.497241 -0.659748 -61.201745 -0.649063 -61.248669 -22.485450 79.355738
22978845491.628361 -27.550912 -68.306165 -0.654315 -104.664654 -0.654273 -104.699819 -24.370615 45.962002
23514571569.144375 -38.154103 -108.867665 -0.659796 -149.285435 -0.654825 -149.301469 -32.362011 14.707828
24062787500.871529 -26.705129 3.489938 -0.664487 164.941804 -0.673097 164.975383 -29.551453 127.286232
24623784473.789066 -19.960691 -37.343281 -0.709519 118.324966 -0.711951 118.268423 -20.876395 83.706187
25197860463.574921 -17.075968 -82.581482 -0.762437 70.800631 -0.752851 70.658498 -17.644528 33.508342
25785320392.876629 -16.389933 -129.665074 -0.773976 22.251711 -0.785924 22.378393 -17.091366 -14.641963
26386476293.272152 -17.740325 170.336058 -0.751568 -27.464393 -0.745351 -27.641774 -19.396216 -54.587976
27001647471.006645 -20.441710 86.953452 -0.707798 -78.927817 -0.688728 -78.963080 -22.786124 -65.976014
27631160676.593178 -18.740893 -4.202202 -0.758800 -131.434860 -0.766884 -131.560447 -19.566558 -71.685007
28275350278.367512 -16.258572 -68.478347 -0.826408 175.068642 -0.822329 175.113490 -17.059431 -116.230704
28934558440.089119 -17.148103 -113.353816 -0.822544 120.550907 -0.825989 120.585659 -18.527425 177.493812
29609135302.682766 -19.586442 -134.578145 -0.785243 64.443280 -0.793101 64.316744 -22.070782 76.512077
30299439170.217197 -17.742592 -148.982049 -0.825947 6.809963 -0.812757 6.969945 -18.819692 -28.285789
31005836700.219704 -16.903313 155.292062 -0.824193 -51.457599 -0.858126 -51.738834 -17.800752 -87.794210
31728703098.427670 -18.748424 57.068278 -0.801196 -112.022259 -0.836282 -112.293270 -20.219688 -105.626698
32468422318.080524 -14.659329 -55.335061 -0.919360 -174.054710 -0.905470 -174.339069 -15.122997 -111.544467
33225387263.857967 -11.577429 -135.909942 -1.104865 123.781065 -1.105881 123.849957 -12.199337 -156.048844
34000000000.000000 -13.297830 149.794119 -1.023492 60.693197 -1.035722 60.797201 -13.786461 155.311288

```

Touchstone File (5062-1247 & N5477A)

Cut and paste the following text and save in a text file named **Adapter_5062_1247__Adapter_N5477A.s2p**. This file is used in **Step 13** on page 123. 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
50000000.000000 -41.543761 18.199382 -0.015231 -10.158056 -0.028545 -10.064176 -41.019132 74.184681
51165694.067857 -41.582558 18.207470 -0.015602 -10.384282 -0.028789 -10.293624 -41.089383 73.495272
52358564.988911 -41.622441 18.215746 -0.015982 -10.615782 -0.029040 -10.528422 -41.161865 72.789791
53579246.361093 -41.663443 18.224215 -0.016371 -10.852680 -0.029296 -10.768693 -41.236668 72.067861
54828386.553961 -41.705603 18.232881 -0.016769 -11.095100 -0.029558 -11.014566 -41.313888 71.329101
56106649.053084 -41.748959 18.241750 -0.017177 -11.343172 -0.029827 -11.266171 -41.393626 70.573118
57414712.812455 -41.793551 18.250825 -0.017593 -11.597028 -0.030101 -11.523642 -41.475987 69.799509
58753272.615119 -41.839421 18.260112 -0.018020 -11.856802 -0.030382 -11.787116 -41.561085 69.007865
60123039.442212 -41.886612 18.269615 -0.018457 -12.122633 -0.030670 -12.056732 -41.649039 68.197764
61524740.850598 -41.935170 18.279340 -0.018903 -12.394661 -0.030964 -12.332635 -41.739975 67.368777
62959121.359318 -41.985143 18.289291 -0.019360 -12.673031 -0.031266 -12.614969 -41.834027 66.520463
64426942.845040 -42.036581 18.299475 -0.019828 -12.957891 -0.031574 -12.903886 -41.931338 65.652372
65928984.946733 -42.089534 18.309896 -0.020307 -13.249392 -0.031889 -13.199539 -42.032060 64.764041
67466045.479778 -42.144059 18.320560 -0.020797 -13.547689 -0.032212 -13.502084 -42.136353 63.855001
69038940.859729 -42.200212 18.331472 -0.021298 -13.852941 -0.032543 -13.811683 -42.244390 62.924767
70648506.535956 -42.258052 18.342639 -0.021812 -14.165309 -0.032881 -14.128500 -42.356354 61.972846
72295597.435395 -42.317642 18.354067 -0.022337 -14.484960 -0.033227 -14.452703 -42.472443 60.998732
73981088.416647 -42.379047 18.365760 -0.022874 -14.812063 -0.033581 -14.784464 -42.592867 60.001907
75705874.734666 -42.442337 18.377727 -0.023424 -15.146792 -0.033943 -15.123961 -42.717851 58.981843
77470872.516269 -42.507583 18.389972 -0.023987 -15.489325 -0.034314 -15.471372 -42.847639 57.937997
79277019.246748 -42.574861 18.402503 -0.024563 -15.839843 -0.034693 -15.826882 -42.982492 56.869814
81125274.267814 -42.644252 18.415326 -0.025152 -16.198534 -0.035081 -16.190681 -43.122690 55.776729
83016619.287160 -42.715839 18.428448 -0.025756 -16.565587 -0.035479 -16.562962 -43.268539 54.658159
84952058.899892 -42.789711 18.441876 -0.026373 -16.941198 -0.035885 -16.943922 -43.420368 53.513511
86933261.122130 -42.865962 18.455617 -0.027005 -17.325565 -0.036302 -17.333763 -43.578533 52.342177
88959357.937037 -42.944689 18.469678 -0.027651 -17.718894 -0.036728 -17.732694 -43.743424 51.143535
91033345.853589 -43.025998 18.484067 -0.028313 -18.121392 -0.037163 -18.140925 -43.915463 49.916947
93155686.478363 -43.109997 18.498792 -0.028990 -18.533275 -0.037609 -18.558673 -44.095114 48.661763
95327507.100664 -43.196804 18.513859 -0.029683 -18.954760 -0.038066 -18.986161 -44.282882 47.377316
97549961.291281 -43.286543 18.529278 -0.030393 -19.386071 -0.038533 -19.423615 -44.479324 46.062923
99824229.515220 -43.379343 18.545057 -0.031118 -19.827438 -0.039011 -19.871267 -44.685054 44.717887
102151519.758706 -43.358365 17.974030 -0.031578 -20.282679 -0.039226 -20.325455 -44.681916 43.920698
104533068.170813 -43.327264 17.340603 -0.032024 -20.748832 -0.039422 -20.789906 -44.660665 43.153346
106970139.720046 -43.295554 16.692408 -0.032481 -21.225854 -0.039624 -21.265185 -44.638973 42.368103
109464028.866236 -43.263224 16.029101 -0.032948 -21.713996 -0.039830 -21.751544 -44.616830 41.564553
112016060.248099 -43.230264 15.350329 -0.033426 -22.213520 -0.040040 -22.249242 -44.594230 40.742270
114627589.386818 -43.196665 14.655733 -0.033916 -22.724689 -0.040256 -22.758544 -44.571163 39.900816
117300003.406038 -43.162416 13.944943 -0.034416 -23.247775 -0.040477 -23.279719 -44.547622 39.039744
120034721.768639 -43.127508 13.217582 -0.034929 -23.783057 -0.040703 -23.813045 -44.523598 38.158598
122833197.030691 -43.091931 12.473263 -0.035454 -24.330818 -0.040934 -24.358805 -44.499082 37.256908
125696915.612984 -43.055675 11.711592 -0.035990 -24.891349 -0.041170 -24.917289 -44.474067 36.334197
128627398.590544 -43.018729 10.932162 -0.036540 -25.464949 -0.041413 -25.488793 -44.448542 35.389973
131626202.500562 -42.981085 10.134562 -0.037102 -26.051921 -0.041660 -26.073621 -44.422500 34.423737
134694920.169152 -42.942730 9.318366 -0.037677 -26.652579 -0.041914 -26.672084 -44.395931 33.434973
137835181.557386 -42.903656 8.483141 -0.038266 -27.267239 -0.042173 -27.284499 -44.368827 32.423157
141048654.627056 -42.863852 7.628444 -0.038869 -27.896230 -0.042439 -27.911192 -44.341178 31.387752
144337046.226616 -42.823309 6.753821 -0.039486 -28.539885 -0.042711 -28.552495 -44.312975 30.328208
147702102.997784 -42.782014 5.858807 -0.040117 -29.198546 -0.042989 -29.208750 -44.284210 29.243962
151145612.303275 -42.761443 4.946541 -0.040680 -29.873082 -0.043283 -29.881319 -44.250154 28.088307
154669403.176167 -42.784598 4.020426 -0.041087 -30.564410 -0.043606 -30.571648 -44.205805 26.811021
158275347.291397 -42.808357 3.072719 -0.041503 -31.271854 -0.043936 -31.278072 -44.160655 25.503957
161965359.959910 -42.832738 2.102918 -0.041930 -31.995792 -0.044274 -32.000965 -44.116494 24.166420
165741401.145982 -42.857758 1.110506 -0.042366 -32.736608 -0.044619 -32.740712 -44.067912 22.797700
169605476.508267 -42.883436 0.094958 -0.042812 -33.494695 -0.044973 -33.497705 -44.020299 21.397070
173559638.465103 -42.909791 -0.944266 -0.043269 -34.270456 -0.045335 -34.272347 -43.971845 19.963785
177605987.284668 -42.936844 -2.007719 -0.043736 -35.064303 -0.045706 -35.065048 -43.922539 18.497086
181746672.200541 -42.964615 -3.095965 -0.044215 -35.876657 -0.046085 -35.876231 -43.872372 16.996191
185983892.553281 -42.993126 -4.209583 -0.044704 -36.707951 -0.046473 -36.706325 -43.821333 15.460305
```

190319898.958608	-43.022399	-5.349163	-0.045205	-37.558626	-0.046870	-37.555772	-43.769413	13.888612
194756994.502833	-43.052457	-6.515311	-0.045718	-38.429133	-0.047276	-38.425023	-43.716602	12.280276
199297535.966146	-43.083324	-7.708646	-0.046242	-39.319934	-0.047692	-39.314540	-43.662891	10.634444
203943935.074433	-43.103278	-8.572691	-0.046521	-40.231587	-0.047866	-40.222535	-43.632839	9.181011
208698659.780268	-43.121602	-9.391791	-0.046759	-41.164509	-0.047999	-41.151288	-43.606664	7.735754
213564235.573780	-43.140393	-10.229988	-0.047002	-42.119181	-0.048134	-42.101693	-43.579961	6.256803
218543246.824077	-43.159664	-11.087726	-0.047251	-43.096110	-0.048273	-43.074256	-43.552719	4.743372
223638338.151939	-43.179428	-11.965461	-0.047506	-44.095815	-0.048415	-44.069494	-43.524931	3.194656
228852215.834522	-43.199700	-12.863660	-0.047767	-45.118827	-0.048560	-45.087934	-43.496586	1.609835
234187649.242808	-43.220494	-13.782799	-0.048034	-46.165690	-0.048709	-46.130118	-43.467676	-0.011936
239647472.312564	-43.241824	-14.723367	-0.048307	-47.236959	-0.048861	-47.196599	-43.438192	-1.671516
245234585.049599	-43.263706	-15.685864	-0.048586	-48.333203	-0.049017	-48.287944	-43.408123	-3.369787
250951955.070115	-43.298238	-16.681585	-0.048993	-49.454987	-0.049206	-49.405483	-43.377204	-5.024058
256802619.176963	-43.396132	-17.755774	-0.050025	-50.602831	-0.049547	-50.552919	-43.344372	-6.288675
262789684.972659	-43.497464	-18.855007	-0.051082	-51.777436	-0.049897	-51.727106	-43.310903	-7.582776
268916332.509994	-43.602397	-19.979867	-0.052164	-52.979426	-0.050255	-52.928669	-43.276786	-8.907047
275185815.981130	-43.711104	-21.130952	-0.053271	-54.209438	-0.050621	-54.158244	-43.242012	-10.262192
281601465.446084	-43.823773	-22.308872	-0.054404	-55.468127	-0.050995	-55.416485	-43.206570	-11.648931
288166688.601492	-43.940602	-23.514255	-0.055563	-56.756161	-0.051379	-56.704061	-43.170452	-13.068000
294884972.590629	-44.061804	-24.747740	-0.056750	-58.074224	-0.051771	-58.021656	-43.133646	-14.520153
301759885.855612	-44.185888	-26.135617	-0.057555	-59.421903	-0.052216	-59.369819	-43.118534	-16.493975
308795080.032796	-44.309538	-27.929515	-0.057159	-60.797690	-0.052799	-60.748967	-43.169916	-19.964677
315994291.892351	-44.437919	-29.765235	-0.056755	-62.205552	-0.053395	-62.160270	-43.222813	-23.516294
323361345.323065	-44.571288	-31.643752	-0.056341	-63.646238	-0.054006	-63.604475	-43.277279	-27.150714
330900153.363414	-44.709920	-33.566066	-0.055917	-65.120511	-0.054631	-65.082350	-43.333371	-30.869866
338614720.279990	-44.854113	-35.533196	-0.055484	-66.629155	-0.055271	-66.594680	-43.391147	-34.675726
346509143.694381	-45.004188	-37.546187	-0.055040	-68.172971	-0.055925	-68.142268	-43.450671	-38.570315
354587616.759638	-45.081293	-39.640674	-0.055604	-69.757085	-0.056555	-69.729596	-43.434565	-41.682121
362854430.387485	-45.099174	-41.810905	-0.056974	-71.381482	-0.057168	-71.356781	-43.383418	-44.186244
371313975.527454	-45.117511	-44.031733	-0.058376	-73.043750	-0.057795	-73.021901	-43.322297	-46.748747
379970745.499151	-45.136315	-46.304337	-0.059811	-74.744773	-0.058437	-74.725842	-43.260193	-49.370992
388829338.378905	-45.155600	-48.629924	-0.061279	-76.485452	-0.059094	-76.469508	-43.197098	-52.054371
397894459.442048	-45.175378	-51.009730	-0.062782	-78.266714	-0.059766	-78.253826	-43.133002	-54.800311
407170923.662146	-45.439394	-54.125157	-0.063410	-80.086549	-0.060112	-80.070659	-43.191536	-58.298819
416663658.268484	-45.795170	-57.517576	-0.063779	-81.947923	-0.060362	-81.927120	-43.289602	-62.085778
426377705.363190	-46.174984	-60.989085	-0.064156	-83.852693	-0.060617	-83.826862	-43.391114	-65.961025
436318224.599360	-46.541529	-64.541529	-0.064543	-85.801871	-0.060879	-85.770895	-43.496235	-69.926620
446490495.921630	-47.018494	-68.176794	-0.064938	-87.796491	-0.061147	-87.760251	-43.605141	-73.984668
456899922.370640	-47.449942	-71.123890	-0.065692	-89.836182	-0.062537	-89.798743	-43.791267	-78.341637
467552032.952879	-47.893175	-73.737398	-0.066647	-91.922680	-0.064540	-91.886196	-44.025196	-82.906526
478452485.577434	-48.371442	-76.411838	-0.067623	-94.057823	-0.066590	-94.022315	-44.271284	-87.577840
489607070.061218	-48.889746	-79.148628	-0.068623	-96.242744	-0.068688	-96.208235	-44.530542	-92.358060
501021711.204246	-49.429340	-82.184197	-0.069634	-98.479232	-0.070689	-98.445619	-44.777030	-97.275465
512702471.936616	-49.746024	-87.736429	-0.070542	-100.774396	-0.071209	-100.740382	-44.751497	-102.575433
524655556.538861	-50.082506	-93.418105	-0.071741	-103.123069	-0.071741	-103.088645	-44.725448	-107.998964
536887313.937376	-50.440881	-99.232242	-0.072422	-105.526499	-0.072285	-105.491656	-44.698871	-113.548938
549404241.076669	-50.823590	-105.181930	-0.073396	-107.985962	-0.072842	-107.950690	-44.671759	-119.228304
562212986.370243	-51.236245	-112.987719	-0.074730	-110.493168	-0.073954	-110.456120	-44.576441	-125.891185
575320353.231926	-51.679994	-121.061220	-0.076112	-113.058347	-0.075118	-113.019415	-44.476646	-132.751889
588733303.689526	-52.158849	-129.322945	-0.077527	-115.683331	-0.076310	-115.642471	-44.375697	-139.772542
602458962.082744	-52.577492	-139.013843	-0.078956	-118.369379	-0.077508	-118.328006	-44.288649	-147.115596
616504618.847291	-52.548698	-154.728547	-0.080325	-121.117420	-0.078632	-121.082361	-44.270677	-155.374044
630877734.387229	-52.519331	-170.809623	-0.081727	-123.929528	-0.079783	-123.900931	-44.252324	-163.825029
645585943.037598	-52.489382	-172.734390	-0.083162	-126.807198	-0.080961	-126.785213	-44.233584	-172.473039
660637057.119418	-51.781446	-161.510155	-0.083923	-129.753281	-0.081531	-129.727470	-44.043176	-179.347615
676039071.089234	-50.859704	-152.408790	-0.084403	-132.768611	-0.081843	-132.734386	-43.782386	-171.262207
691800165.785404	-50.007957	-143.095237	-0.084894	-135.854241	-0.082163	-135.811404	-43.523383	-162.988298
707928712.773379	-48.766921	-134.683084	-0.085645	-139.013922	-0.083172	-138.971241	-43.053869	-155.444490
724433278.792294	-47.259915	-127.258563	-0.086676	-142.249505	-0.084926	-142.216471	-42.390284	-148.701623
741322630.305226	-45.948345	-119.660947	-0.087732	-145.560522	-0.086720	-145.537361	-41.759953	-141.801553
758605738.155530	-44.885494	-112.469120	-0.088693	-148.944903	-0.087887	-148.931823	-41.324099	-134.506312
776291782.331738	-44.012274	-105.711097	-0.089553	-152.404239	-0.088389	-152.401450	-41.064924	-126.799230
794390156.843548	-43.201219	-98.795518	-0.090434	-155.944224	-0.088903	-155.951967	-40.807479	-118.912465
812910474.711483	-42.732197	-93.951637	-0.091013	-159.575197	-0.090377	-159.573400	-40.153097	-111.436395
831862573.072888	-42.402116	-89.987695	-0.091462	-163.294582	-0.092307	-163.273988	-39.371111	-104.050402
851256518.406959	-42.045190	-85.958163	-0.091960	-167.100407	-0.094131	-167.061891	-38.654851	-96.647804
871102611.881596	-41.257433	-82.230919	-0.093043	-170.990913	-0.093748	-170.953476	-38.216007	-91.370876
891411394.824904	-40.519077	-78.416778	-0.094151	-174.972122	-0.093356	-174.935789	-37.788771	-85.970922
912193654.324260	-39.947796	-74.635399	-0.095791	-179.045015	-0.093454	-179.005308	-37.311342	-79.558279
933460428.955917	-39.484903	-70.853568	-0.097834	-176.787954	-0.093914	-176.834359	-36.807110	-72.356956
955223014.648186	-39.042248	-66.913443	-0.099604	-172.525625	-0.094593	-172.573587	-36.334837	-65.552112
977492970.681309	-38.632476	-62.654221	-0.100376	-168.169927	-0.095959	-168.202315	-35.923312	-60.417459
100028125.827218	-38.230015	-58.285954	-0.101180	-163.712604	-0.097355	-163.729255	-35.523038	-55.150470
1023602584.632427	-37.663767	-53.020225	-0.103075	-159.145167	-0.098627	-159.161967	-35.256252	-48.729884
1047466733.847416	-37.120172	-47.631732	-0.105015	-154.471246	-0.099928	-154.488197	-34.991473	-42.159608
1071887249.005892	-36.920467	-42.777190	-0.105853	-149.692284	-0.100278	-149.711962	-34.732623	-35.894172
1096877101.157453	-36.725795	-37.887590	-0.106574	-144.802370	-0.100520	-144.825144	-34.475950	-29.536912
1122449563.757208	-36.466047	-34.944479	-0.108067	-139.791216	-0.102302	-139.813052	-34.231961	-23.929102

1148618219.716024	-36.196991	32.226064	-0.109702	134.662203	-0.104345	134.682493	-33.990713	18.318334
1175396968.615140	-35.744396	26.836257	-0.108458	129.416707	-0.104734	129.450221	-33.705583	11.790557
1202800034.088982	-35.313900	21.309312	-0.107557	124.050224	-0.105270	124.093967	-33.451837	5.206736
1230841971.380104	-35.060434	16.855880	-0.111443	118.568821	-0.107905	118.585920	-33.475859	-0.272518
1259537675.070255	-34.828362	11.895752	-0.113822	112.954191	-0.109121	112.956285	-33.427845	-6.326649
1288902386.991699	-34.637028	5.991891	-0.112972	107.197490	-0.107321	107.209433	-33.232324	-13.441007
1318951704.322966	-34.516264	0.996999	-0.114511	101.309989	-0.109374	101.325896	-33.276860	-19.968521
1349701587.873357	-34.436482	-3.487187	-0.117529	95.287270	-0.113811	95.303572	-33.470614	-26.197174
1381168370.560588	-34.493597	-8.679569	-0.118776	89.117643	-0.113622	89.133122	-33.410081	-33.333905
1413368766.086080	-34.595375	-13.840873	-0.118970	82.803992	-0.114498	82.824258	-33.473961	-39.824003
1446319877.812507	-34.761786	-18.894689	-0.117636	76.342969	-0.117004	76.376265	-33.729027	-45.282698
1480039207.848310	-34.683449	-23.985368	-0.120012	69.750485	-0.117271	69.769958	-33.983310	-51.488161
1514544666.344010	-34.643457	-29.986157	-0.126841	63.000175	-0.116477	63.018015	-34.287376	-58.019144
1549854581.005252	-34.701874	-37.252563	-0.123607	56.083312	-0.114573	56.121837	-34.665369	-64.847296
1585987706.827638	-34.940988	-43.789507	-0.125267	49.005325	-0.120758	49.033538	-35.311198	-71.187679
1622963236.058510	-35.177903	-51.089352	-0.126841	41.765457	-0.122050	41.783984	-35.768420	-76.621331
1660800808.390988	-35.519415	-58.935770	-0.127939	34.360688	-0.122292	34.376234	-36.321763	-81.158578
1699520521.395668	-36.162343	-66.946802	-0.127949	26.788233	-0.127886	26.816887	-37.579532	-84.863400
1739142941.195521	-36.477155	-69.887985	-0.126770	19.003829	-0.125188	19.039695	-38.607203	-90.124304
1779689113.389672	-36.857593	-77.495968	-0.127426	11.067881	-0.126031	11.103125	-39.696117	-88.053778
1821180574.231843	-37.484598	-86.868733	-0.131161	2.947295	-0.127626	2.975836	-41.148115	-86.127153
1863639362.069423	-38.470701	-95.889722	-0.135089	-5.376359	-0.128066	-5.349385	-42.488012	-84.096415
1907088029.049217	-39.704615	-104.094238	-0.135075	-13.895484	-0.128468	-13.856227	-42.449078	-75.237556
1951549653.096104	-40.614369	-111.984792	-0.138917	-22.587718	-0.134543	-22.558186	-42.240779	-64.755905
1997047850.170966	-42.425712	-124.915668	-0.139728	-31.501746	-0.132845	-31.498284	-41.269177	-60.281875
2043606786.814396	-43.244812	-139.715927	-0.141505	-40.605372	-0.136022	-40.578073	-39.565667	-55.289600
2091251192.982845	-46.419985	-168.804094	-0.142820	-49.933922	-0.138861	-49.914555	-38.395278	-59.815346
2140006375.184037	-48.734550	167.249791	-0.140935	-59.471724	-0.136923	-59.481997	-37.011044	-67.311912
2189898229.918614	-48.019557	134.600117	-0.144310	-69.258552	-0.140995	-69.239377	-36.383132	-71.111065
2240953257.435161	-47.248780	102.425235	-0.145189	-79.250248	-0.144564	-79.241460	-35.480901	-81.284556
2293198575.805914	-45.916756	77.146501	-0.148777	-89.476920	-0.144941	-89.462778	-34.813532	-87.500030
2346661935.330630	-43.767921	61.261587	-0.150670	-99.974920	-0.145833	-99.944111	-34.501253	-99.729227
2401371733.276259	-42.463098	53.389823	-0.153049	-110.669793	-0.150102	-110.612547	-34.114911	-108.958317
2457357028.960266	-41.354489	38.467807	-0.155084	-121.637914	-0.151633	-121.612261	-34.137466	-121.379437
2514647559.185594	-40.436504	25.611295	-0.158069	-132.847241	-0.151828	-132.823699	-34.266445	-134.765994
2573273754.035484	-39.766828	18.832417	-0.158548	-144.322623	-0.155348	-144.309069	-34.749185	-149.222090
2633266753.036525	-39.585368	13.007383	-0.161523	-156.077438	-0.156830	-156.037211	-35.273691	-163.661704
2694658421.698535	-39.397286	4.998523	-0.159431	-168.064537	-0.156978	-168.048778	-36.249962	-178.210754
2757481368.440050	-39.422884	2.583521	-0.164647	179.606122	-0.161087	179.631849	-37.343959	-156.503655
2821768961.908402	-39.133671	-1.474377	-0.165444	167.036538	-0.164382	167.048923	-38.494994	-130.057288
2887555348.703612	-38.388380	-4.523180	-0.168657	154.149644	-0.165126	154.164327	-39.096794	-99.094444
2954875471.515481	-37.787643	-4.617903	-0.169225	140.976795	-0.165129	141.007201	-38.625927	-64.598987
3023765087.683534	-36.875824	-8.969005	-0.171385	127.493385	-0.169053	127.511088	-37.890176	-34.994037
3094260788.189668	-36.216647	-13.798505	-0.173015	113.691192	-0.174147	113.698220	-36.793209	-7.064576
3166400017.093591	-35.651970	-21.835071	-0.176812	99.584048	-0.173930	99.596883	-35.578155	-16.335957
3240221091.421377	-34.924153	-29.739661	-0.178530	85.137293	-0.174794	85.135728	-34.636476	-39.192361
3315763221.517697	-34.371780	-39.111948	-0.178952	70.348390	-0.180558	70.365435	-34.150715	-59.522549
3393066531.872549	-34.244780	-48.607695	-0.178870	55.208829	-0.179892	55.230806	-33.826686	-80.323358
3472172082.433529	-34.765331	-59.453308	-0.183218	39.713665	-0.183211	39.733623	-34.138716	-99.007436
3553121890.414979	-35.069284	-70.260945	-0.184614	23.861752	-0.180719	23.909153	-34.828587	-117.828641
3635958952.615593	-36.283609	-81.812327	-0.184275	7.644632	-0.180090	7.685282	-36.257912	-139.370587
3720727268.256326	-38.162718	-87.585475	-0.184604	-8.946980	-0.185385	-8.925870	-38.684389	-166.652649
3807471862.350752	-40.807807	-83.624174	-0.186601	-25.932133	-0.187600	-25.905716	-42.455757	-159.411784
3896238809.620269	-43.193297	-60.961268	-0.193428	-43.307675	-0.187482	-43.257933	-46.653312	-90.599430
3987075258.966864	-41.010692	-45.870784	-0.192793	-61.094137	-0.188944	-61.067789	-44.235095	-52.859891
4080029458.516430	-40.640132	-46.745109	-0.195417	-79.294262	-0.192825	-79.239295	-41.447195	-24.466944
4175150781.245943	-38.862843	-45.743393	-0.196459	-97.911409	-0.196690	-97.879002	-40.217427	-8.187401
4272489751.208107	-36.901436	-57.021625	-0.197539	-116.965239	-0.195362	-116.930236	-39.646265	-34.990548
4372098070.367394	-35.754995	-70.526291	-0.199881	-136.476532	-0.195821	-136.437388	-39.888195	-54.415059
4474028646.061748	-34.768135	-88.344260	-0.202932	-156.426049	-0.201514	-156.396163	-40.126155	-68.932475
4578335619.104504	-34.589201	-113.863738	-0.205685	-176.847719	-0.202715	-176.810316	-41.1227346	-83.843172
4685074392.541502	-34.676254	-139.241331	-0.211360	162.242319	-0.208298	162.288449	-42.127595	-77.657016
4794301661.078618	-35.009711	-167.056395	-0.208190	140.882701	-0.211724	140.909739	-40.683233	-70.276328
4906075441.195374	-35.241565	161.502337	-0.212061	118.955675	-0.212176	119.028308	-37.580088	-76.725099
5020455101.960610	-35.513550	128.004279	-0.216533	96.594504	-0.215281	96.645052	-35.185725	-95.538795
5137501396.566599	-35.393085	94.566784	-0.214484	73.696066	-0.216346	73.726641	-33.437199	-116.996864
5257276494.598325	-34.759185	66.761912	-0.223346	50.235591	-0.218980	50.273219	-32.207469	-144.391698
5379844015.055103	-34.104308	41.999152	-0.225775	26.257286	-0.222288	26.280343	-31.325470	-175.202148
5505269060.142051	-33.821033	20.752159	-0.226444	1.696124	-0.225462	1.744810	-31.006498	-153.013134
5633618249.849370	-32.907214	4.908341	-0.228139	-23.446243	-0.227634	-23.400351	-30.489983	-118.327948
5764959757.337812	-32.412124	-14.640849	-0.233975	-49.138791	-0.228578	-49.112934	-30.493602	-81.228288
5899363345.149107	-31.213151	-32.479317	-0.237805	-75.464072	-0.233467	-75.411570	-30.281297	-45.729291
6036900402.260610	-30.599298	-2.240676	-0.240676	-102.379635	-0.235149	-102.335755	-30.177145	-12.665458
6177643982.003820	-30.221873	-79.064439	-0.240071	-129.916937	-0.241158	-129.891246	-30.674387	-17.821421
6321668840.866945	-30.158087	-105.894970	-0.242774	-158.110579	-0.240547	-158.085414	-31.502689	-42.731734
6469051478.202085	-30.450458	-134.916128	-0.241951	173.049026	-0.242164	173.068568	-32.526933	-62.970419
6619870176.858158	-31.320042	-167.491708	-0.245335	143.495903	-0.244212	143.553909	-33.370066	-75.705119
6774205044.761139	-32.297218	155.620110	-0.249495	113.283076	-0.249397	113.324001	-32.979023	-87.930712

```

6932138057.463680 -33.984328 116.489962 -0.257361 82.365393 -0.251266 82.415968 -32.117657 -107.800948
7093753101.686746 -34.938882 77.018794 -0.256225 50.738206 -0.258156 50.771589 -31.608079 -134.719679
7259136019.876357 -36.441402 42.392469 -0.258712 18.366898 -0.257551 18.402423 -31.746710 -170.514601
7428374655.799140 -37.293649 14.340553 -0.263882 -14.759133 -0.258908 -14.695756 -32.761639 143.058679
7601558901.200872 -36.907940 3.855324 -0.267100 -48.660334 -0.266499 -48.613209 -33.766269 86.068082
7778780743.552826 -35.828061 -13.657090 -0.271380 -83.387048 -0.266894 -83.289164 -33.270815 21.805711
7960134314.911269 -33.493068 -37.569054 -0.271134 -118.872118 -0.273741 -118.805162 -31.780351 -32.970164
8145715941.916058 -32.118290 -70.028402 -0.275567 -155.198803 -0.273571 -155.161065 -30.962180 -79.289275
8335624196.954902 -31.894002 -107.235305 -0.277590 167.618358 -0.275756 167.679923 -31.479945 -118.300978
8529959950.520464 -32.709673 -149.757670 -0.279359 129.577007 -0.279958 129.627666 -33.271908 -152.082983
8728826424.788105 -34.055029 170.816461 -0.278450 90.627878 -0.278118 90.672620 -35.491196 -170.796459
8932329248.442736 -36.258756 128.748237 -0.282665 50.786153 -0.283395 50.827135 -35.932918 176.041429
9140576512.783896 -36.732617 92.598448 -0.285237 9.972934 -0.285945 10.039086 -34.847845 146.764188
9353678829.138855 -36.232488 61.014514 -0.289335 -31.720162 -0.289564 -31.670633 -34.307010 92.427431
9571749387.614246 -35.087275 25.123510 -0.293625 -74.424410 -0.293981 -74.329573 -34.448660 29.777906
9794904017.217421 -35.866841 -16.830593 -0.297243 -118.070354 -0.295732 -118.017380 -34.561003 -43.260195
10023261247.379461 -40.371336 -58.565056 -0.299652 -162.808725 -0.298000 -162.714229 -35.356462 -128.009378
10256942370.912546 -47.858119 8.883051 -0.301757 151.432559 -0.301873 151.505185 -34.497053 135.597672
10496071508.435085 -36.622941 4.554259 -0.307021 104.591699 -0.306216 104.665149 -31.849678 54.509330
10740775674.298862 -32.971346 -43.725031 -0.310831 56.700025 -0.310562 56.745140 -31.110504 -17.560468
10991184844.053186 -34.021301 -98.567108 -0.311071 7.658483 -0.313540 7.726542 -33.136970 -86.070846
11247432023.481905 -39.993838 -168.509597 -0.310230 -42.516342 -0.312171 -42.442511 -41.798286 171.688717
11509653319.249928 -50.076241 -3.651648 -0.317472 -93.894268 -0.319884 -93.812161 -36.457406 31.607998
11777988011.196802 -39.760612 -111.165462 -0.320336 -146.478896 -0.319876 -146.401224 -34.479967 -29.533247
12052578626.315733 -34.421795 142.154319 -0.322845 159.728999 -0.321560 159.765128 -39.573202 -22.198166
12333571014.457333 -28.527502 57.480125 -0.331446 104.628713 -0.331240 104.726450 -29.076002 -13.943374
1262114425.798326 -25.458389 -15.363700 -0.345952 48.348568 -0.344764 48.406678 -24.185101 -64.550120
12915361590.116354 -25.537326 -84.720027 -0.350982 -9.171222 -0.350894 -9.126921 -23.914883 -122.687993
13216468797.912968 -29.497841 -161.321749 -0.341054 -68.157091 -0.337756 -68.086689 -28.496513 175.818802
13524595983.427933 -37.523983 86.570049 -0.335982 -128.574086 -0.340256 -128.512309 -48.380436 -166.259847
13839906809.588905 -38.684722 -47.834989 -0.346287 169.594823 -0.339239 169.687215 -32.352399 -154.247275
14162568754.941620 -45.875328 -112.341572 -0.344358 106.400526 -0.343395 106.422508 -31.414879 112.460071
14492753202.606752 -38.541178 -66.509388 -0.351636 41.632441 -0.348299 41.699006 -31.751305 -6.751484
14830635531.310724 -34.024503 -135.325388 -0.356319 -24.549915 -0.359061 -24.467266 -31.213945 -112.794665
15176395208.538778 -34.741710 147.020941 -0.355504 -92.320829 -0.355349 -92.263858 -34.766455 150.931616
15530215885.859812 -35.300395 87.230844 -0.357092 -161.686627 -0.354720 -161.661329 -41.363027 107.616521
15892285496.473612 -30.792606 28.600758 -0.365286 127.262506 -0.357217 127.348334 -30.829188 78.555766
16262796355.032291 -27.166721 -58.757340 -0.374921 54.662998 -0.370241 54.704425 -24.529908 6.247539
16641945259.788942 -26.763536 -160.007113 -0.384264 -19.616642 -0.380796 -19.558669 -25.302166 -67.497161
17029933597.127781 -28.644756 87.146320 -0.372689 -95.667199 -0.369029 -95.638847 -36.512177 -114.107070
17426967448.531292 -47.848604 -54.576713 -0.375307 -173.611851 -0.371314 -173.536994 -32.117741 -37.192426
17833257700.041199 -25.373848 77.107861 -0.381565 106.681389 -0.381826 106.752623 -26.695748 -57.166454
18249020154.271370 -21.671814 -12.233474 -0.399919 25.179522 -0.406146 25.266365 -22.459690 -107.844721
18674475645.032219 -26.742937 -85.593837 -0.395158 -58.204220 -0.395133 -58.095952 -24.909696 162.854364
19109850154.627415 -28.414119 -65.676430 -0.397429 -143.696471 -0.389362 -143.605337 -27.890896 -19.577772
19555374933.885239 -24.586218 -144.108105 -0.414361 128.893776 -0.407288 129.005005 -22.618008 -141.317301
20011286624.988346 -26.045948 105.213101 -0.402389 39.501393 -0.389836 39.614344 -25.938526 122.482384
20477827387.167168 -25.898538 12.536934 -0.388736 -52.130474 -0.375999 -52.034114 -30.307011 51.901194
20955245025.323700 -25.863619 -61.341207 -0.403561 -145.804189 -0.393551 -145.786077 -26.672025 -32.965204
21443793121.654022 -31.243910 -92.221920 -0.402312 118.118322 -0.396327 118.261313 -31.028754 -177.176860
21943731170.339451 -23.158869 -142.365828 -0.443013 19.867220 -0.432500 19.917340 -22.801909 8.354422
22455324715.377853 -20.480757 91.146321 -0.465176 -80.436626 -0.462656 -80.272536 -20.450127 -78.156390
22978845491.628361 -23.350751 -42.524375 -0.439231 176.888332 -0.437659 176.972824 -24.720232 -132.556294
23514571569.144375 -29.096385 25.034429 -0.434284 71.509130 -0.415904 71.569311 -29.744440 -88.823584
24062787500.871529 -20.867025 -106.511416 -0.473044 -36.135123 -0.451251 -36.183006 -20.573606 -144.546395
24623784473.789066 -26.684148 130.707972 -0.463478 -146.321169 -0.428301 -146.096394 -24.004558 127.818009
25197860463.574921 -31.160196 61.734789 -0.446323 100.735661 -0.410981 100.913010 -39.408221 -29.991332
25785320392.876629 -25.533397 -17.272853 -0.440480 -14.729362 -0.438068 -14.647444 -26.709420 161.061882
26386476293.272152 -22.711245 -101.871135 -0.471170 -133.063592 -0.457863 -133.066616 -23.104139 19.695494
27001647471.006645 -27.253283 112.297230 -0.461232 106.068363 -0.457380 106.198584 -26.510214 -77.900230
27631160676.593178 -30.361881 -168.178401 -0.455009 -17.907822 -0.473248 -17.742401 -33.304329 -45.653780
28275350278.367512 -17.914343 -10.269666 -0.535415 -144.847239 -0.495666 -144.767531 -18.500405 -94.926037
28934558440.089119 -25.403265 -145.855952 -0.458652 85.819950 -0.471521 86.027882 -25.033409 132.887622
29609135302.682766 -21.411602 -123.245956 -0.500273 -47.265432 -0.509761 -47.235075 -21.254847 -153.392821
30299439170.217197 -27.014691 72.673095 -0.489298 176.678655 -0.474972 177.031191 -25.338474 101.072054
31005836700.219704 -26.316760 -92.472631 -0.452905 37.601195 -0.500821 37.724078 -24.884493 -3.740226
31728703098.427670 -24.576379 -122.274522 -0.482050 -105.277061 -0.496607 -105.184253 -22.985629 83.341478
32468422318.080524 -18.473439 97.257414 -0.522336 109.131590 -0.552294 109.178004 -17.832689 -62.528240
33225387263.857967 -35.956091 36.668777 -0.453368 -40.549604 -0.433040 -40.351388 -38.607656 -59.673550
34000000000.000000 -18.584631 -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 / MX0109A solder-in probe head.

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 118 procedure)
- No substitute
- Probe Positioner
- Keysight N2787A 3D Probe Positioner
- Critical specification: stable/accurate positioning
- Small Bench Vise

Measuring Input Resistance of N2836A / MX0109A Probe Head

Figure 99 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 99** on page 136.
- 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.

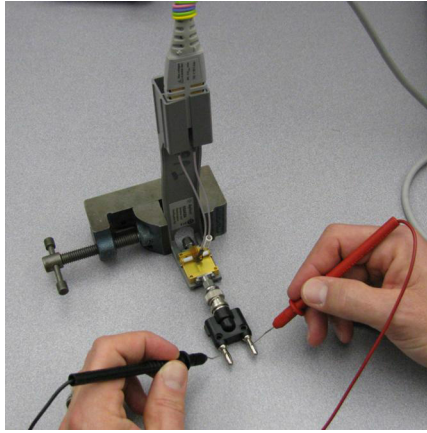


Figure 99 Measuring the Differential Input Resistance of Solder-In Probe Head

- 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 99**.
- 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 99**, 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 $100\text{ k}\Omega \pm 2\%$ (98 to $102\text{ k}\Omega$).
- 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 100** (through the vent window of the probe amplifier).

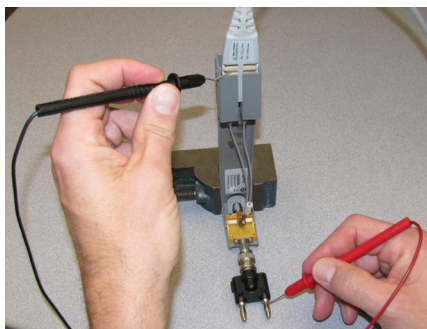


Figure 100 Measuring the Single-Ended Input Resistance the Solder-In Probe Head

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 / MX0109A	≥ 13 GHz		
DC Input Resistance Performance Test			
N2836A / MX0109A	98 to 102 k Ω (differential mode) 49 to 51 k Ω (single-ended mode)		
N5441A	98 to 102 k Ω (differential mode) 49 to 51 k Ω (single-ended mode)		

8 Performance Verification for N7000-Series Probes

Bandwidth Performance Verification	140
DC Input Resistance Performance Verification	149
Performance Test Record	151

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 MX0109A / N2836A solder-in probe head.

NOTE

The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A or MX0109A 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 MX0109A / N2836A solder-in probe head for connection to the PV fixture as shown in **Figure 101**. Shape the leads as shown with the resistors angled until they almost touch.

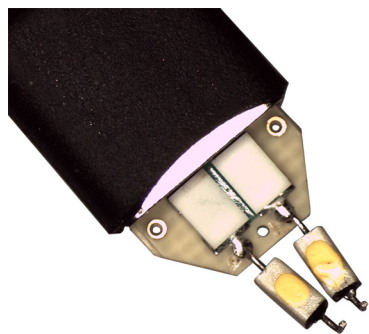


Figure 101 N2836A ZIF Probe Head

Performance Verification for N7000-Series Probes

- 3 Connect the APC 3.5 (f-f) adapter, provided with the N5443A PV fixture, to the N5443A, as shown in **Figure 102**. Use a small bench vise to steady the N5443A PV fixture on the test surface.

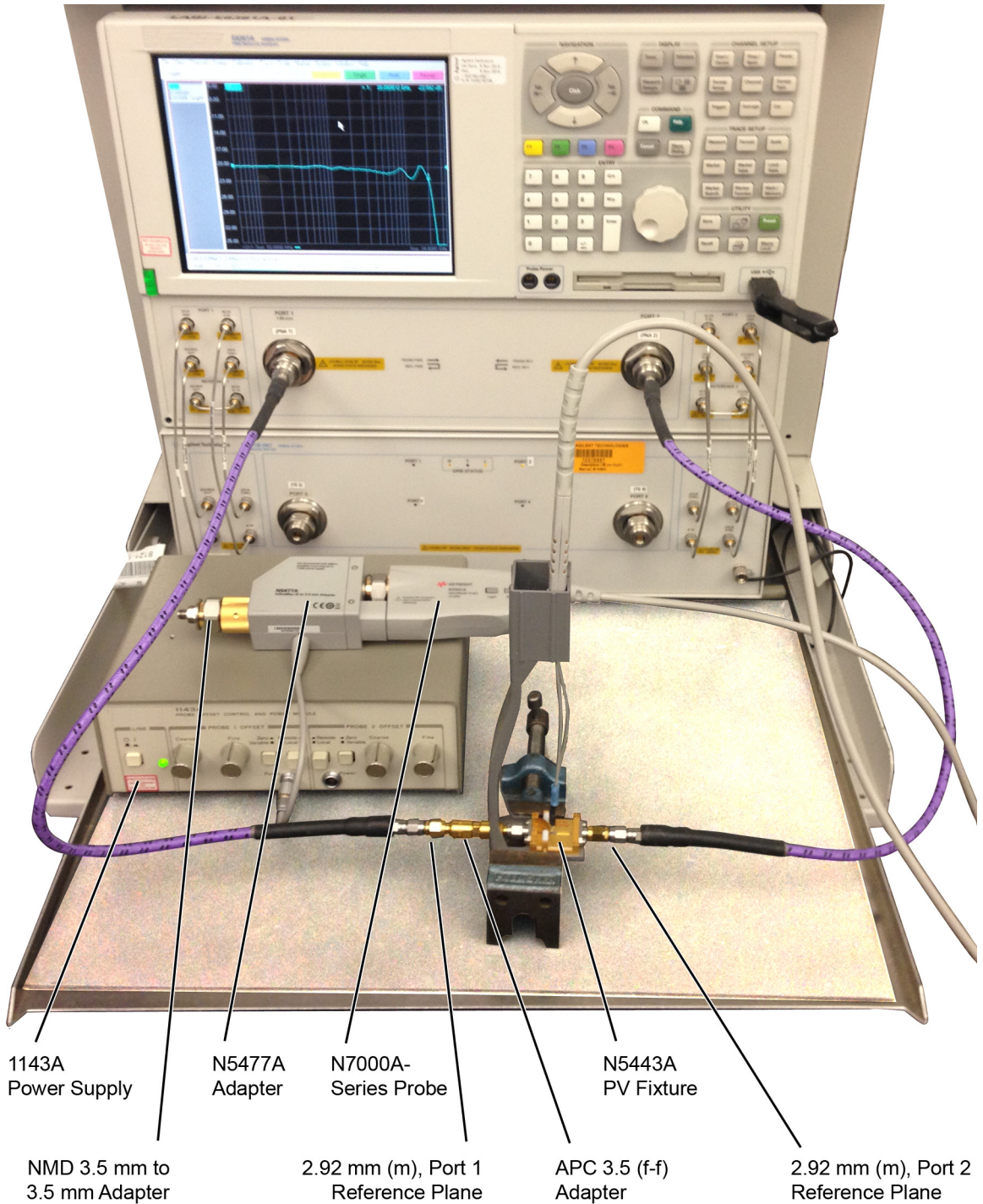


Figure 102 Test Setup for Measuring V_{in} of Probe

- 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 103** on page 144 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 127. 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.

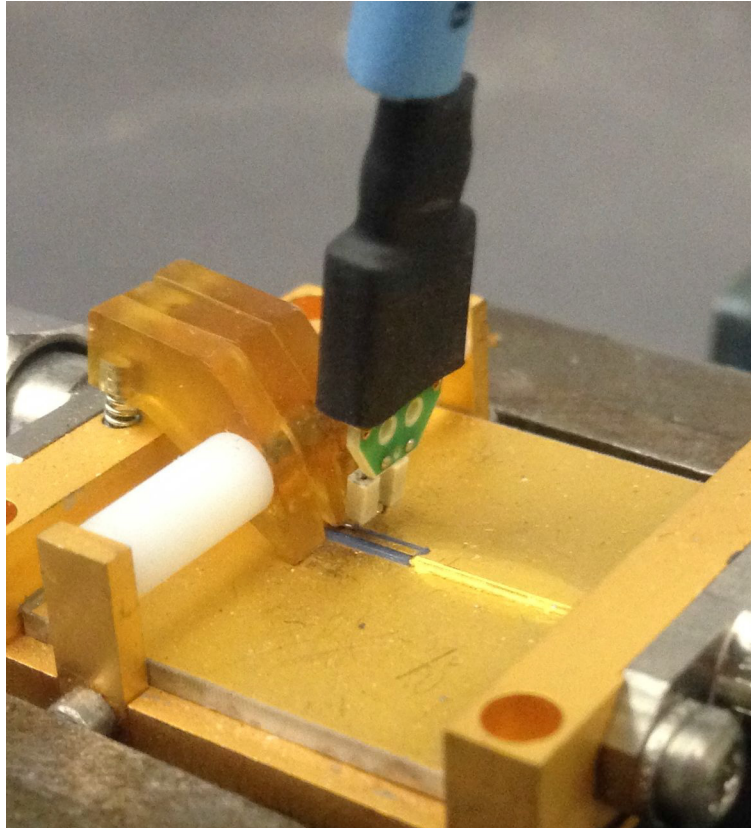


Figure 103 Close-Up of Tip Wires Positioned Under Pincher

- 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 104** on page 145. 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.

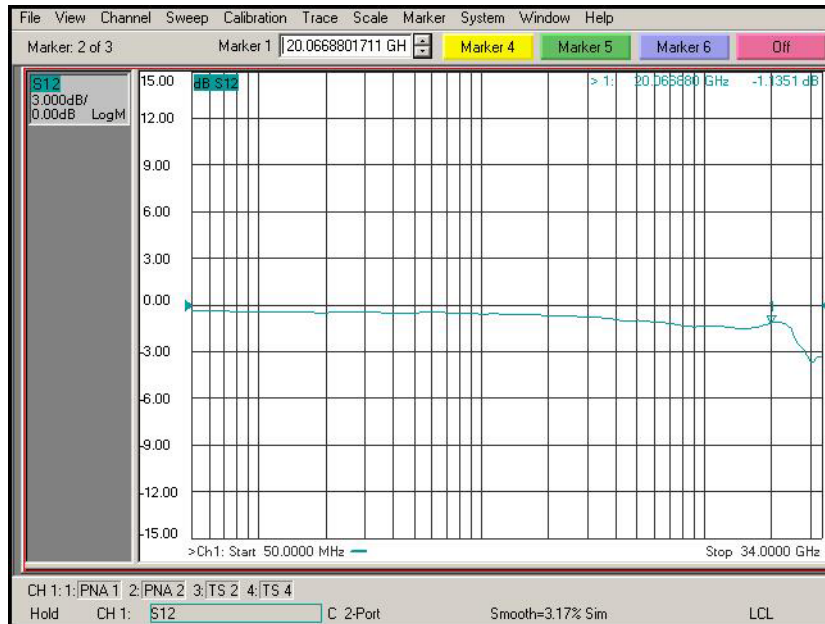


Figure 104 De-Embedded V_{in} Trace

- 12 As shown in **Figure 105** on page 146, 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 131. 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 Keysight's Probe Resource Center (PRC). Copying this data from the PRC is the simplest and most reliable method to get the data. To access 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.

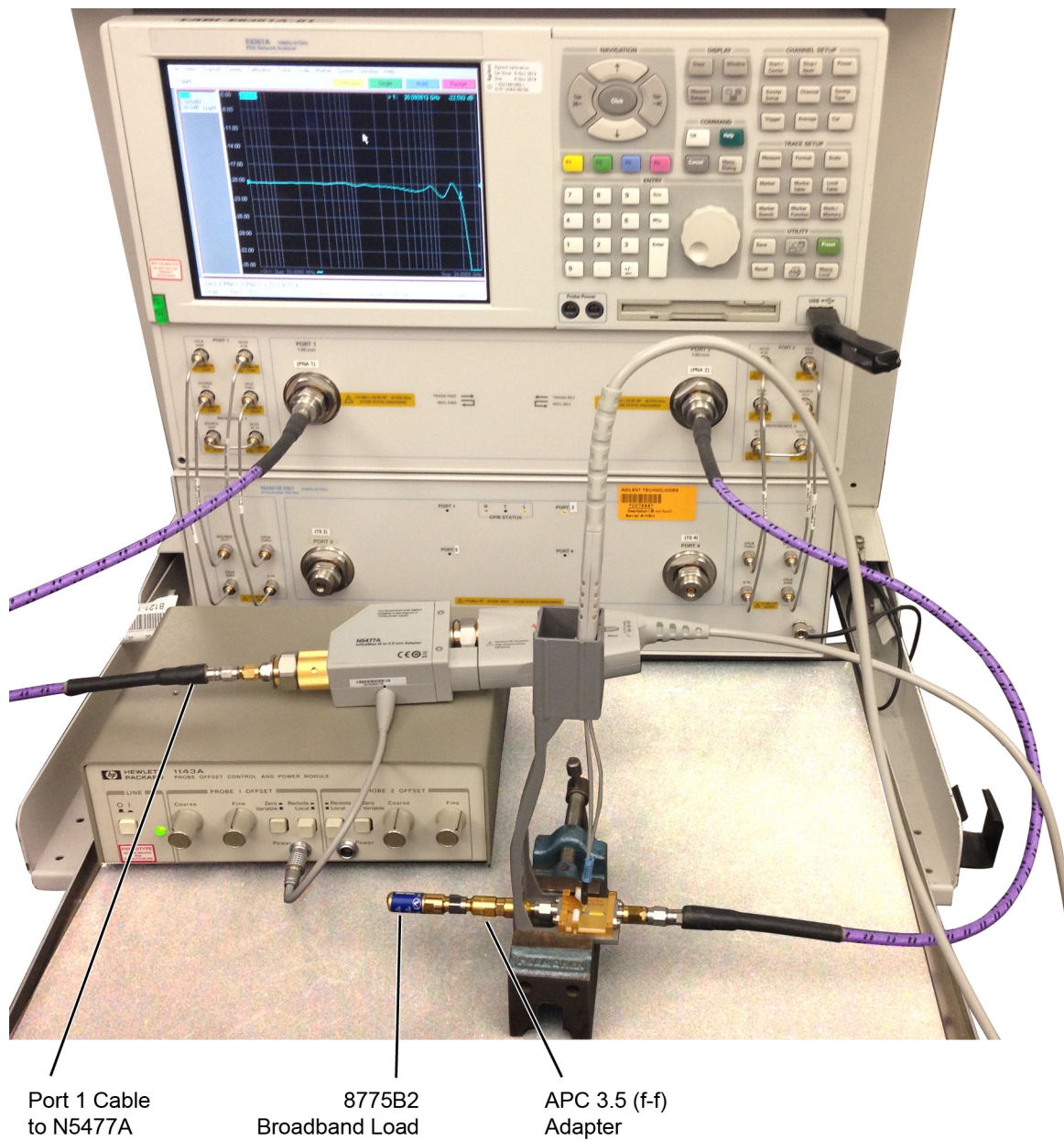


Figure 105 Test Setup to Measure V_{out} of Probe

- 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 106** on page 147. 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/Math” 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 107** on page 148.
 - 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 MX0109A / N2836A solder-in probe head and N7003A 20 GHz probe amp combination.



Figure 106 De-Embedded V_{out} Trace

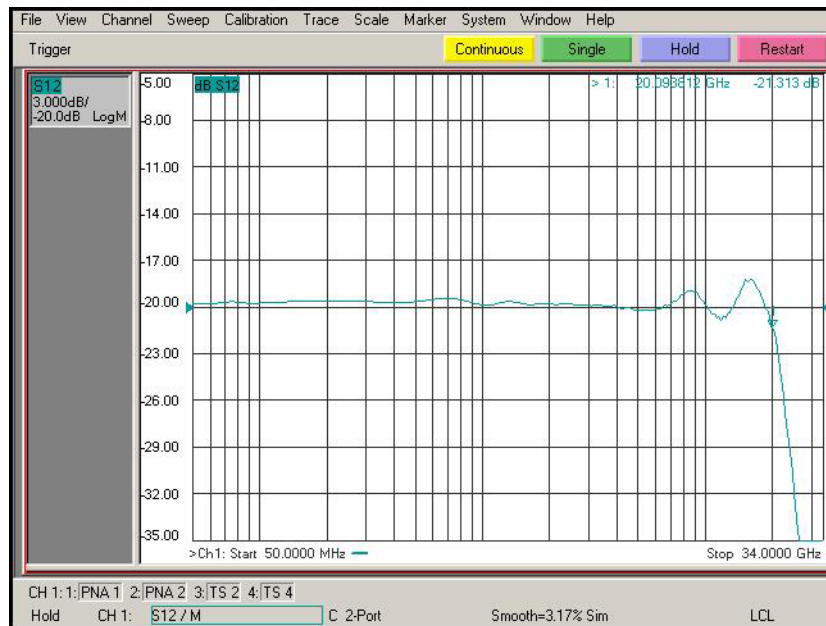


Figure 107 De-Embedded V_{out}/V_{in} Response of the Probe

DC Input Resistance Performance Verification

NOTE

The recommended test interval is one year/2000 hours.

Equipment Needed

- InfiniiMax III+ N2836A / MX0109A solder-in probe head.

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 140 procedure)
- No substitute
- Probe Positioner
- Keysight N2787A 3D Probe Positioner
- Critical specification: stable/accurate positioning
- Small Bench Vise

Measuring Input Resistance of N2836A/MX0109A Probe Head

Figure 108 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 108** on page 150.
- 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.

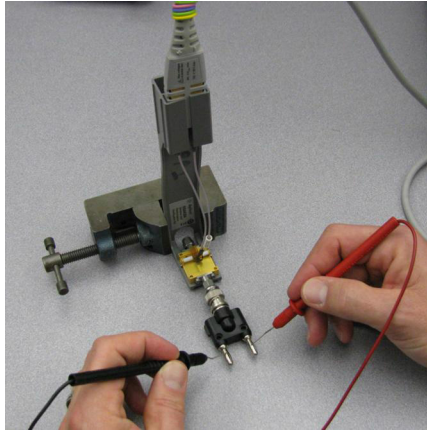


Figure 108 Measuring the Differential Input Resistance of Solder-In Probe Head

- 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 108**.
- 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 108**, 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 $100\text{ k}\Omega \pm 2\%$ (98 to $102\text{ k}\Omega$).
- 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 109** (through the vent window of the probe amplifier).

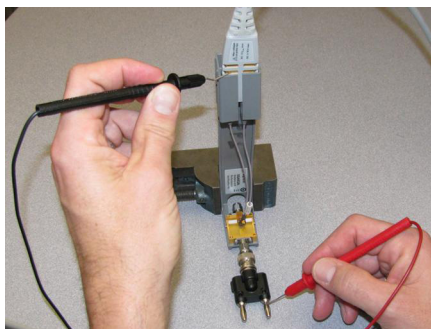


Figure 109 Measuring the Single-Ended Input Resistance the Solder-In Probe Head

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 / MX0109A	≥ 20 GHz		
DC Input Resistance Performance Test			
N2836A / MX0109A	98 to 102 k Ω (differential mode) 49 to 51 k Ω (single-ended mode)		
N5441A	98 to 102 k Ω (differential mode) 49 to 51 k Ω (single-ended mode)		

9 SPICE Models

N2848A QuickTip Head with N2849A QuickTip Tip	154
N5439A ZIF Probe Head with N5440A ZIF Tip	155
N5439A ZIF Probe Head with N2838A ZIF Tip	156
MX0109A and N2836A 26 GHz Solder-In Probe Heads	157
N5441A 16 GHz Solder-In Probe Head	158
N5445A Browser Probe Head	159
N5444A SMA Probe Head	161

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
```


MX0109A and N2836A 26 GHz Solder-In Probe Heads

SPICE Subcircuit Data

```
.subckt N2836A_SldrIn 1 2
Cb1kp 6 13 100n
Cb1kn 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
```


Index

Numerics

86100D DCA-X sampling
oscilloscope, 34

A

accessories
available, 33
static-safe, 19
altitude, 102
AutoProbe III, 15, 35
AutoProbe Interface, 13
Aux Out connector, 87
available probe heads, 10

B

bandwidth, 9
browser
mounting Holes, 55
tips, 57

C

Cal Out connector, 87
calibration
failure, 39
probe, 87
CAT I, 103
CE mark, 103
channel identification rings, 14
characteristics, 102
circuit connections, 23, 24
cleaning the probe, 14
common mode
measurements, 9, 23
Conductive table-mat, 18
connecting to DUT, 19
connecting, probe, 19
connections
circuit, 24
InfiniiMode, 23
contacting, Keysight
Technologies, 40

D

dialog box
Probe Amplifier, 25, 53
Probe Configuration
Setup, 25
Probe Offset, 28
Select Probe Head, 22
differential measurements, 9, 23
dimensions, 102, 105
probe amp, 104
DUT
connecting to, 19
ungrounded, 26

E

E2655C PV fixture, 33
Electrostatic discharge, 17
environmental conditions, 102
ESD, 17
ESD wrist strap, 17
Extreme Temperature, 64
Extreme Temperature
Extension Cable, 65
extreme temperature extension
cable, 33

G

general characteristics, 102
ground socket, 18

H

headlight, 14, 53
humidity, 102

I

InfiniiMode, 23, 59, 68
inspecting, 6
isolation, 19

K

Keysight Technologies,
contacting, 40

L

Light button, 14, 53
low temperature hot glue, 75

M

measurement category, 103
Menu button, 14
MX0109A, 42, 59
MX0109A characteristics, 99
MX0109A dimensions, 105
MX0109A extreme
temperature, 64
MX0109A InfiniiMode, 23
MX0109A replacing resistor
tips, 78
MX0109A spice model, 157

N

N2787A 3D probe
positioner, 57
N2830/1/2A probe
markings, 11
N2835A, 72
N2836-68701 replacement
axial resistor kit, 78
N2836A, 59
replacing resistor tips, 78
N2838A dimensions, 106
N2838A ZIF tip, 78
N2848A
cleaning, 71
connecting, 70
QuickTip head, 68
N2848A dimensions, 107
N2852A, 15, 35
N5439A probe head, 47
N5440A dimensions, 108

- N5441A
 - replacing head wires, 82
 - solder-in probe head, 65
 - N5441A dimensions, 108
 - N5442A, 35
 - N5443A PV fixture, 33, 87
 - N5444A SMA probe head, 44
 - N5445A
 - adjustable tip span, 54
 - adjustable tip span for calibration, 55
 - differential browser probe head, 14, 53
 - mounting holes, 55
 - N5448B 2.92 mm head flex cables, 45
 - N5449A, 35
 - N5449A high impedance adapter, 34
 - N5450B extreme temperature extension cable, 33, 65
 - N7000/1/2/3A probe markings, 12
- O
- offset, 28
 - operating environment, 102
 - oscilloscope, 20
 - compatible, 15
 - oscilloscope channel, 20
- P
- performance
 - plots, 109
 - test record, 137, 151
 - verification, 117, 139
 - pollution degree, 102
 - power requirements, 102
 - probe
 - case, calibration
 - certificate, 7, 8
 - cleaning, 14
 - connecting, 19
 - connecting to DUT, 19
 - dimensions, 104
 - heads, 10, 41
 - inspecting, 6
 - markings, 11, 12
 - offset, 28
 - service, 40
 - ungrounded DUTs, 26
 - Probe Amplifier dialog box, 53
 - probe calibration, 87
 - Probe Comp terminals, 87
 - Probe Configuration Setup dialog box, 25
 - probe head dimensions, 105
 - probe leads, 23
 - Probe Offset dialog box, 28
 - putty, 74
 - PV fixture
 - E2655C, 33
 - N5443A, 33
- Q
- QuickTip head, 68
- R
- resistor dimensions, 82
 - returning for service, 40
- S
- safety, 36
 - Safety Considerations, 36
 - safety warnings, 36
 - sampling oscilloscope, 34
 - Select Probe Head dialog box, 22
 - service, 39
 - single-ended
 - measurements, 9, 23
 - slew rate requirements, 31
 - slew rates, 31
 - SMA probe head, 44
 - solder-in probe head, 65
 - solder-in probe heads, 59
 - soldering
 - N2836A to DUT, 61
 - N2848A to DUT, 69
 - N5441A to DUT, 66
 - tips, 76
 - ZIF tip to DUT, 48
 - specifications and characteristics, 95
 - SPICE models, 153
 - static-safe accessories, 19
 - strain relieving, 74
- T
- Tack-putty, 74
 - temperature, 102
 - temperature chamber, 33
 - tip span gauge, 55
- U
- ungrounded DUTs, 26
 - UXR-series, 15
- W
- WEEE Directive, 103
 - weight, 102
 - wrist-strap, 18
- Z
- ZIF Probe Head
 - connecting, 50
 - ZIF tips, 47