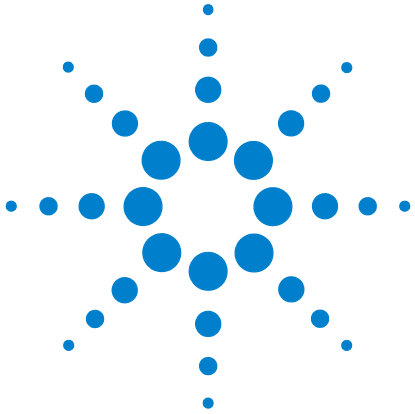


Agilent InfiniiMax III Series Probes

User's Guide

Agilent Technologies

Notices

Manual Part Number

N2800-97001

Edition

First Edition, April 2011

Printed in USA

Agilent Technologies, Inc.
1601 California Street
Palo Alto, CA 94304 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, Agilent 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. Agilent 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 Agilent 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.

Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as "Commercial computer software" as defined in DFAR 252.227-7014 (June 1995), or as a "commercial item" as defined in FAR 2.101(a) or as "Restricted computer software" as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 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

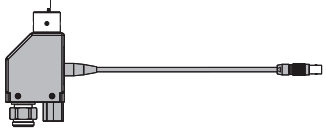
A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

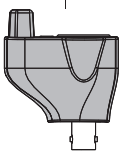
InfiniiMax III probing system family diagram

DCA-J 86100 Wideband Oscilloscope

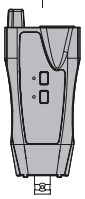
90000-X Series Oscilloscope



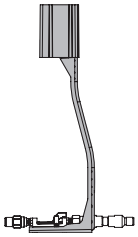
N5477A
Sampling Scope Adapter



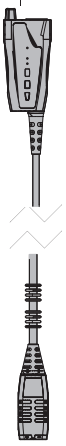
N5442A
Precision BNC
50 Ω Adapter



N5449A
High Impedance
Adapter



PV/Deskew Fixture
and Stand
(properly positions
probe for PV testing)



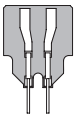
InfiniiMax III Amplifiers
N2800A (16 GHz)
N2801A (20 GHz)
N2802A (25 GHz)
N2803A (30 GHz)

50 Ω Autoprobe Probes
(InfiniiMax I or II probes,
1156A-58A probes, etc.)

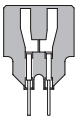
N2873A
500 MHz Passive Probe
(or other similar probes**)

1147A Current Probe
or
N2790A High Voltage
Differential Probe
(or other similar probes***)

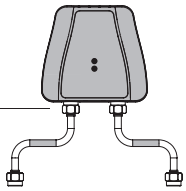
N5439A
ZIF Probe Head



N5447A
200 Ω ZIF Tip
(high sensitivity)

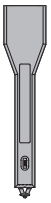


N5440A
450 Ω ZIF Tip
(normal sensitivity)



N5444A
2.92mm/3.5mm/SMA
Probe Head

N5441A
Solder-in Probe Head
(16 GHz max)



N5445A
Browser Probe Head

N5448A 2.92mm Extension Cables
(optional - used in place of supplied semi-rigid cable set)

*Components are not drawn to scale.

**The N5449A includes one N2873A probe. The adapter is specifically tuned for the N2873A probe, but other similar probes (1 MΩ input) can be used. Other probes may not meet the bandwidth specification.

***The N5449A is also compatible with other similar active probes with the Autoprobe interface and outputs designed to drive 1 MΩ inputs.

1 InfiniiMax III User Documentation

This chapter contains documentation on using the InfiniiMax III probing system.

The InfiniiMax III probing system offers you the highest performance available for measuring differential and single-ended signals, with flexible connectivity solutions for today's high-density ICs and circuit boards. Four different InfiniiMax III probe amplifiers ranging from 16 GHz to 30 GHz are available for matching your probing solution to your performance and budget requirements. A proprietary 200 GHz fT InP (indium phosphide) IC process with backside ground vias and novel thick film technology is utilized to accommodate your highest performance needs.

The family diagram for the InfiniiMax III probing system is shown on the previous page. This system is designed to give you the maximum flexibility in matching your probe to your setup. The following pages will discuss each of the adapters, probe amplifiers, and probe heads in detail.

InfiniiMax III Probe Amplifiers

There are four InfiniiMax III amplifier models:

- N2800A: 16 GHz
- N2801A: 20 GHz
- N2802A: 25 GHz
- N2803A: 30 GHz

Each probe amplifier is pre-loaded with its specific measured s-parameters. When used with the Infiniium 90000 X-Series, the oscilloscope downloads these parameters and automatically corrects the response of the unique probe system.

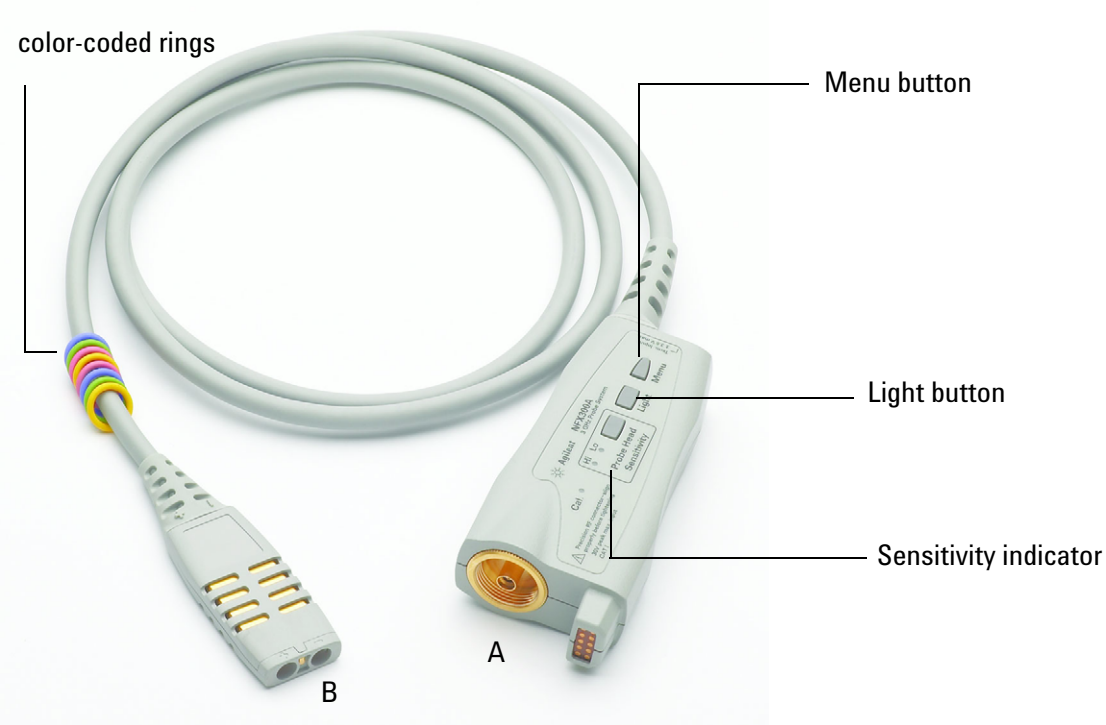


Figure 1 InfiniiMax III Probe Amplifier

Menu button

Press this button to bring up the Probe dialog box in the oscilloscope GUI.

Light button

Press this button to turn the LED headlights on the browser probe head on/off. Pressing and holding this button will ramp the intensity of the LED headlights. You may want to adjust the brightness to accommodate different lighting or glare conditions.

Sensitivity indicator

If you are using the ZIF probe head, the sensitivity indicator tells you which ZIF tip is connected to the probe head. If the N5447A 200 Ohm ZIF tip is connected then the “Hi” sensitivity LED will be illuminated. If the N5440A 450 Ohm ZIF tip is connected then the “Normal” sensitivity LED will be illuminated. This will assist you in ensuring that the correct ZIF tip is selected in the oscilloscope GUI’s probe dialog box.

CAUTION: If you select the wrong pairing of ZIF probe head and ZIF probe tip in the oscilloscope GUI’s probe menu, your waveforms will look incorrect.

Color-coded rings

The color-coded rings can be used to match each probe to the color of the oscilloscope’s input channel to which it is connected. This enables you to quickly know which probe is connected to each channel without having to trace cables back to the oscilloscope inputs.

Connecting / Disconnecting

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.

The connector labeled **A** in Figure 1 plugs into one of the oscilloscope channel inputs. If connecting it directly to an Infiniium 90000 X-Series oscilloscope, plug it into the channel and then turn the grey clutch/dial around the input (Figure 2) until it clicks. To disconnect the probe amplifier, loosen the clutch on the oscilloscope input and disconnect the probe amplifier. If you are using an InfiniiMax III probe amplifier with an Agilent

sampling oscilloscope, you will need to use the N5477A Sampling Scope Adapter.

The connector labeled **B** in Figure 1 connects to one of the InfiniiMax III probe heads. **CAUTION: InfiniiMax I and II probe heads are not compatible with the InfiniiMax III probe amplifiers and vice versa.**

Whenever you connect components of your probing system, always start at the probe head and work your way back to the oscilloscope input. For example, if connecting a probe head, extension cables, and a probe amplifier to an oscilloscope, first connect the probe head to the extension cables. Then connect the extension cables to the probe amplifier and lastly, connect the probe amplifier to the oscilloscope.

Figure 2 Image showing clutches on an Infiniium 90000 X-Series oscilloscope

NOTE: The clutches on the Infiniium 90000 X-Series do not require a mechanical calibration. They will maintain the same tolerance as the Agilent torque wrench (8 in lbs +/- 1 in lbs).

Handling Advice / Tips

Properly handling of your probe amplifier can significantly improve how long your probe lasts and performs.

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: Whenever you disconnect a probe head from an InfiniiMax amplifier, pull the probe head connectors straight out of the sockets. When connecting a probe head to an amplifier, push in straight. Never bend the probe head in order to "pop" 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.

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: 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.

Probe Amplifier Bandwidth Upgrades

The InfiniiMax III probe amplifiers are upgradeable. The bandwidth upgrades are:

- N5446A-001: 16 GHz to 20 GHz
- N5446A-002: 20 GHz to 25 GHz
- N5446A-003: 25 GHz to 30 GHz
- N5446A-004: 16 GHz to 25 GHz
- N5446A-005: 16 GHz to 30 GHz
- N5446A-006: 20 GHz to 30 GHz

NOTE: When you order a probe bandwidth upgrade, you receive a new probe with a new model number and new serial number.

N5445A InfiniiMax III Differential Browser Probe Head

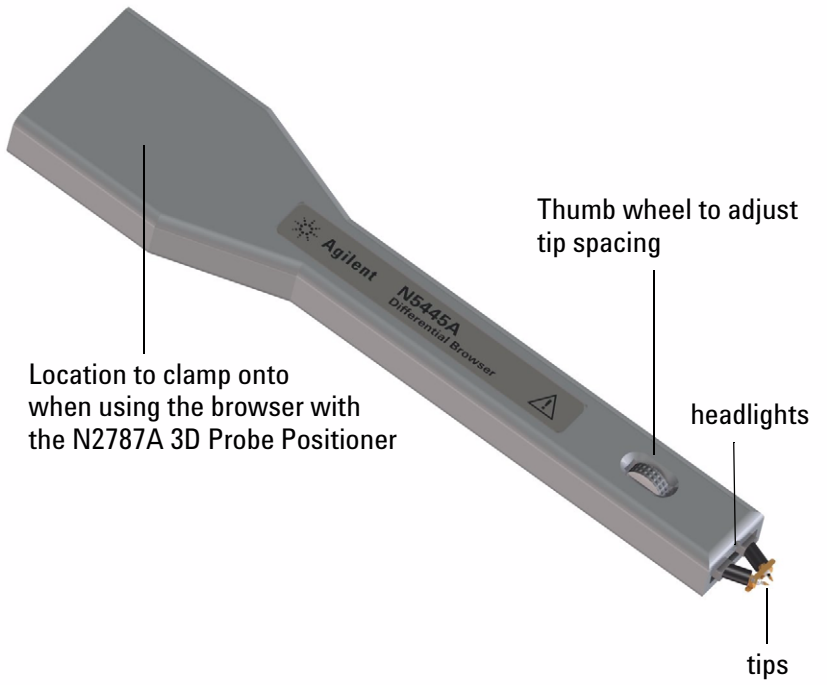


Figure 3 N5445A InfiniiMax III Differential Browser Head

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 – 125 mil (or 0.5 mm – 3.1 mm). The span between the signal tips is easily adjusted with a thumb wheel on the browser (see Figure 3).

Using the LED Headlights

A pair of LED headlights are integrated into the tip of the browser to illuminate the probing area for better visibility. The headlights are controlled via the Light button on the InfiniiMax III probe amplifier (see Figure 1 on page 8). Pressing this button turns the headlights on / off while pressing the button and holding it down ramps the intensity of the headlights.

Adjusting the Tip Span

The thumb wheel on the browser (see Figure 3) is used to adjust the spacing of the tips between 20 mil – 125 mil (or 0.5 mm – 3.1 mm). Stop adjusting the span of the tips when the end of the range is reached and do not force anything.

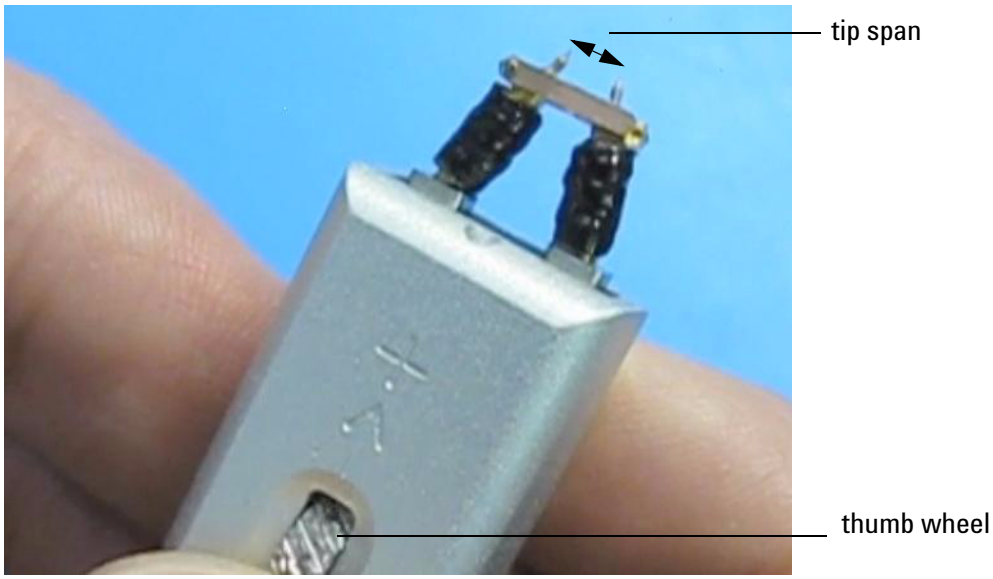


Figure 4 Location of thumb wheel and definition of tip span

You will need to tell the oscilloscope GUI what span you are using when calibrating the probe. To do this, set your span and then use the browser's protective cap to measure which of the possible values your span most closely matches. Then set this value in the Probe Calibration dialog box on the oscilloscope.

Using the Browser Mounting Holes

There are two holes on the back side of the browser. These holes are there for mounting the browser to a holder using a bracket or holder designed by the customer.

Figure 5 below shows the dimensions of these mounting holes.

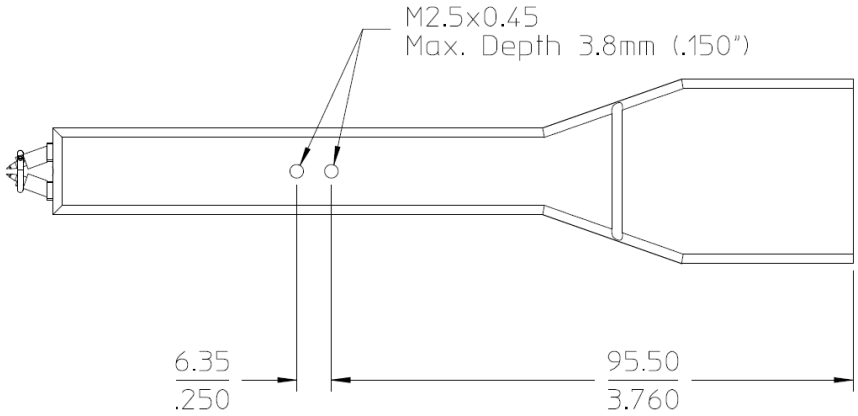
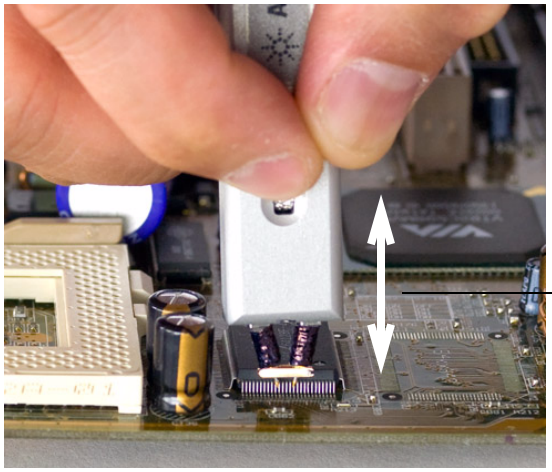


Figure 5 Dimensions of mounting holes on browser

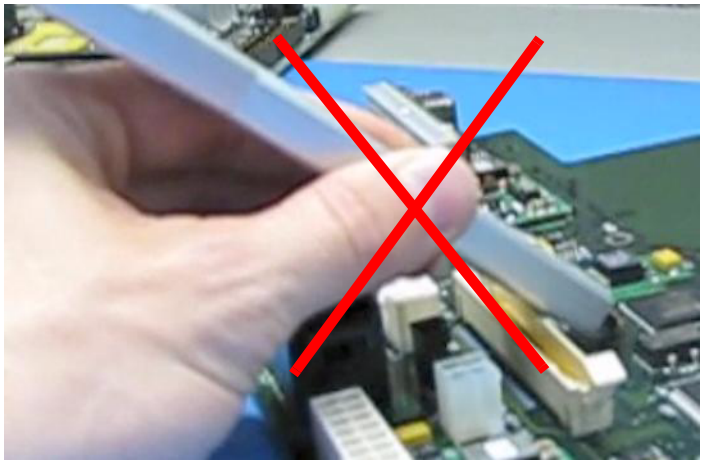
Tips for Using the Browser Probe Head

- Probe along the browser's axis to prevent tip damage.



Probe straight up and down, holding the browser perpendicular to the board

- **CAUTION: Do not apply side load to the browser.**



- **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.**

• Use the N2787A 3D Probe Positioner to help in positioning the browser.
- First, lock the vertical compliance of the probe positioner
- Clamp the browser into the positioner, aligning the browser's slot with the positioners gripping pad
- While holding the browser, loosen the main knob and position the probe
- Use the browser's own weight to depress the tips, and tighten the main knob to lock the probe's position

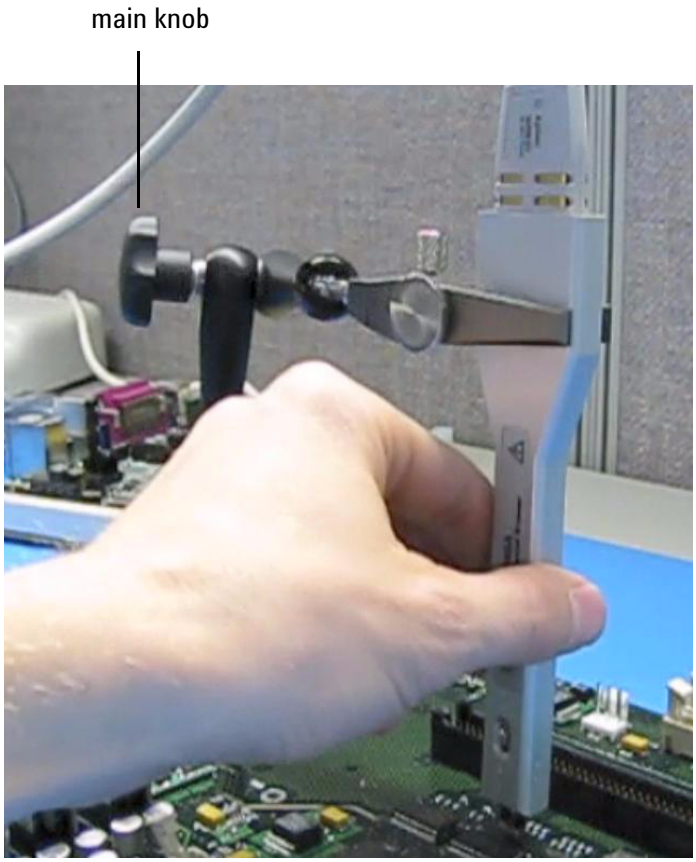


Figure 6 Using the browser with the N2787A 3D Probe Positioner

Replaceable Parts

The following parts are replaceable:

- Replacement browser tips (qty. 4)
  - N5476A
- Replacement browser ground blades (qty. 4)
  - N5445-68700
- Replacement browser screws (qty. 4)
  - N5445-68701

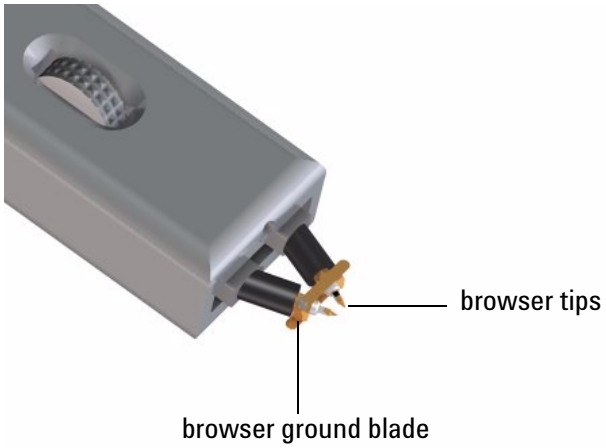


Figure 7 Browser tips and ground blade

N5439A InfiniiMax III ZIF (Zero Insertion Force) Probe Head

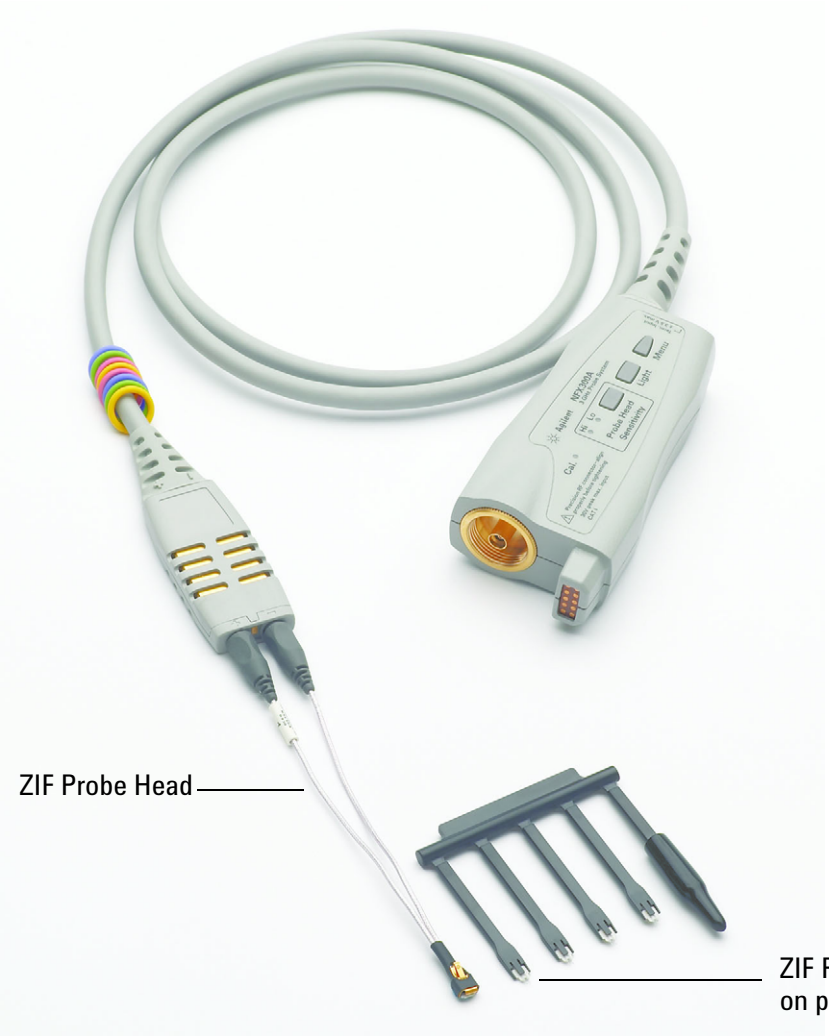


Figure 8 N5439A InfiniiMax III ZIF Probe Head and N5440A/N5447A ZIF Probe Tips

The N5439A ZIF probe head provides 28 GHz bandwidth in an economical replaceable tip form factor. Because of their extremely low loading, the ZIF tips can be left on the DUT as the probe head is moved from one probing site to the next. Order N5440A (450 Ω) or N5447A (200 Ω) for a set of 5 ZIF tips with plastic forks to aid in soldering the tips to your DUT. The N5439A does not include any ZIF probe tips. Variable spacing from 5 mil – 80 mil (or 0.127 mm – 2 mm).

NOTE: The N5439A does not include any ZIF tips. You must order either N5440A or N5447A in addition to N5439A.

Using the ZIF Probe Tips

There are two different models of ZIF probe tips:

- N5440A - 450 Ω normal sensitivity ZIF tip
- N5447A - 200 Ω high sensitivity ZIF tip

To tell these two models apart from each other, look at the gold pattern etched on each of the tips (see the areas enclosed by blue rectangles in Figure 9 below).

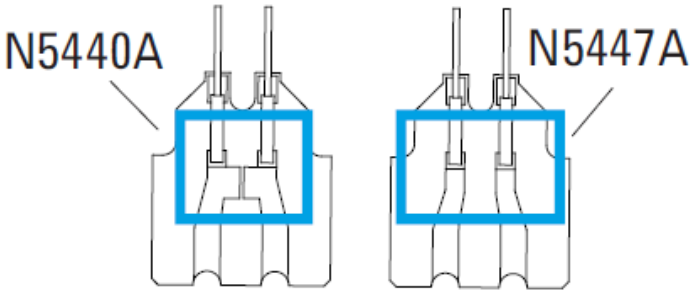


Figure 9 Differentiating between the N5440A and N5447A ZIF tips

These tips come in groups of five, with each tip being attached to the end of a plastic fork as shown in Figure 10. You can break each plastic fork off its frame and use it as a handle when soldering the ZIF tip to your DUT since the tips themselves are very small and can be difficult to handle.

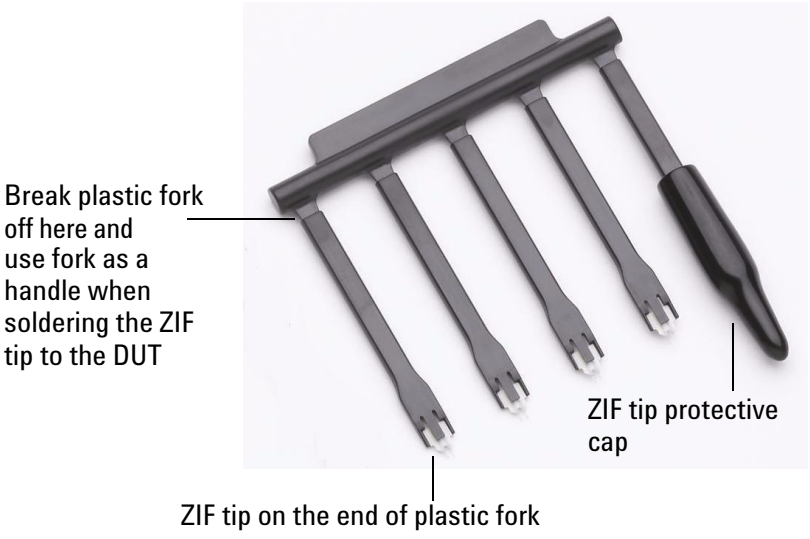


Figure 10 InfiniiMax III ZIF tips

ZIF tips can be carefully handled with your fingertips and reinserted into a plastic fork if necessary.

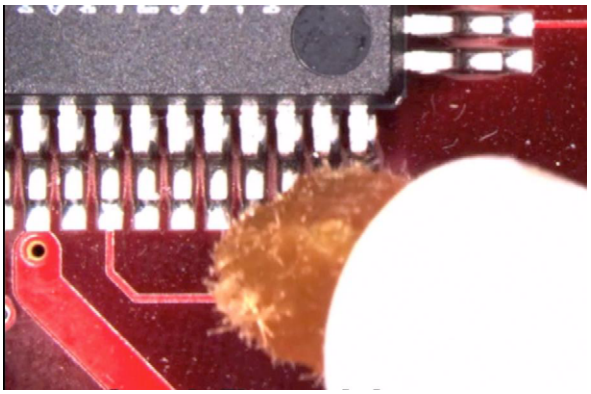
CAUTION: Be careful not to damage the tip wires when handling the ZIF tips. Wires can be carefully reshaped with tweezers or fingers if necessary.

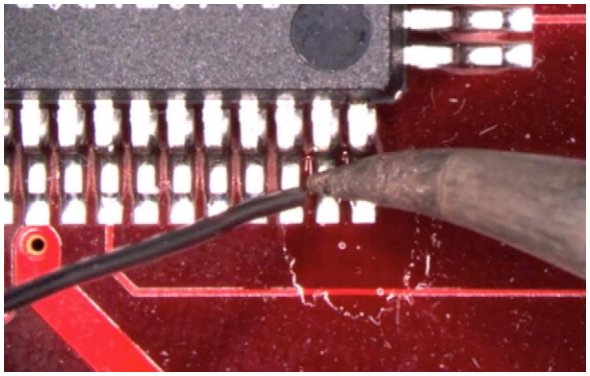
CAUTION: The ZIF probe tips are very fragile. They must be manufactured in this way in order to meet the high-performance, high bandwidth applications they are intended for. Be extremely careful when handling.

Soldering the ZIF Tips

This is the recommended soldering procedure:

1 Flux and tin your target DUT leads.



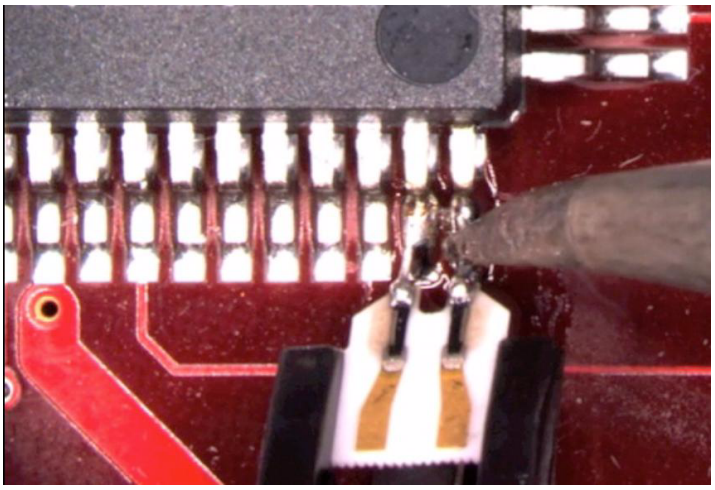


2 Form the ZIF tip wires to match the DUT's pitch / angle (recommended to keep the ZIF tip in the plastic fork so it is easy to hold on to).

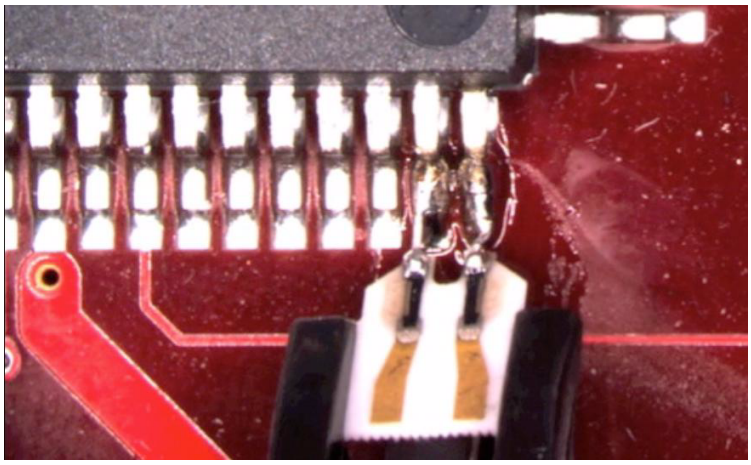
3 Flux the ZIF tip wires and DUT leads.

4 Position the ZIF tip and carefully reflow the solder. **Make sure the gold traces on the ZIF tip are facing up as this will be important later.**

CAUTION: Do not dwell on this solder joint.



5 Pull the plastic fork back away from the tip to remove it from the tip. Your tip is now ready to connect to a N5439A probe head.



Pull the black plastic fork in this direction to pull it away from the ZIF tip. The ZIF tip will remain behind.

6 You can connect ZIF tips to any of the locations on a DUT that you need to probe and then move the ZIF probe head between them for quick, easy access to multiple probing locations.

Strain Relieving the ZIF Probe Head

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. There are several methods that Agilent recommends:

1 **Tack-putty:** Agilent recommends the use of tack-putty for securing both probe heads and amplifiers. Wrap a small amount of tack-putty around your probe head cables, taking care to not pinch them. The mass can then be secured to a rigid body neat your DUT.

   A 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.

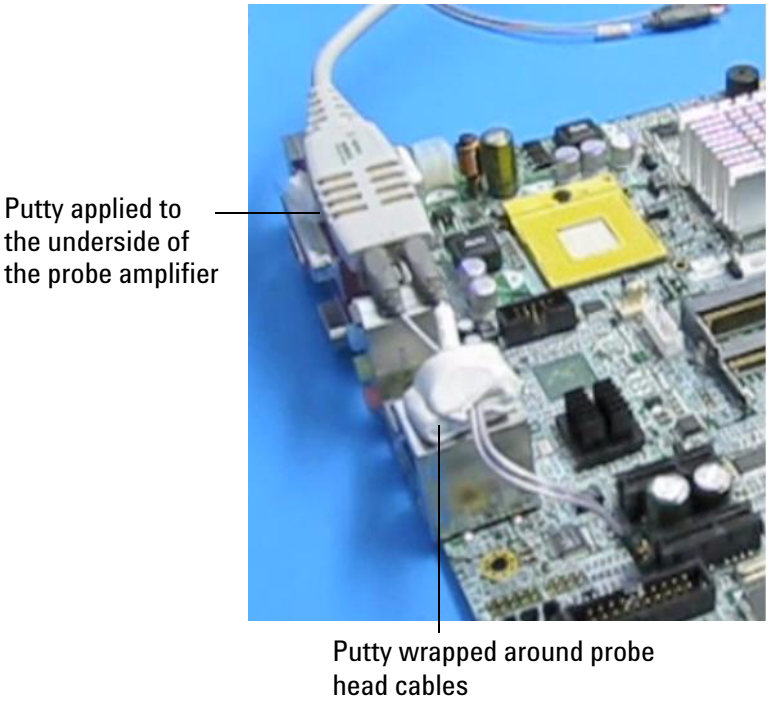


Figure 11 Using tack-putty to strain relieve a probe head and amplifier

You can also use putty with a positioner, such as the Agilent N2787A.

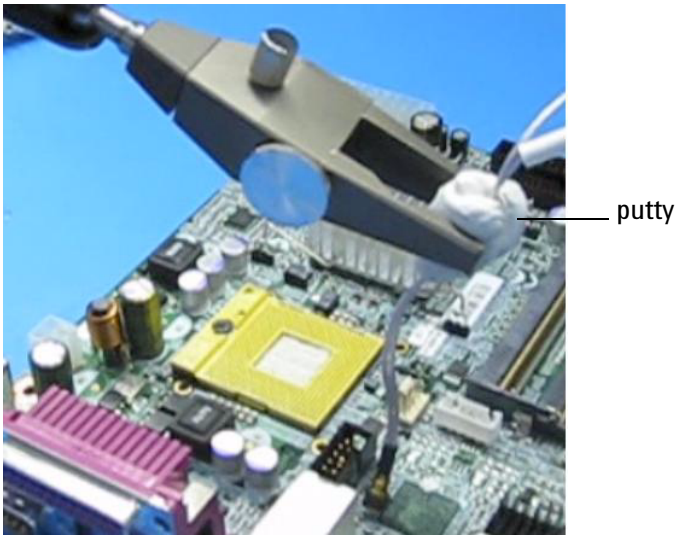


Figure 12 Using putty with the N2787A 3D Probe Positioner

The same positioner can also be used to support your probe amplifier as shown in Figure 6 on page 16.

2 **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.**

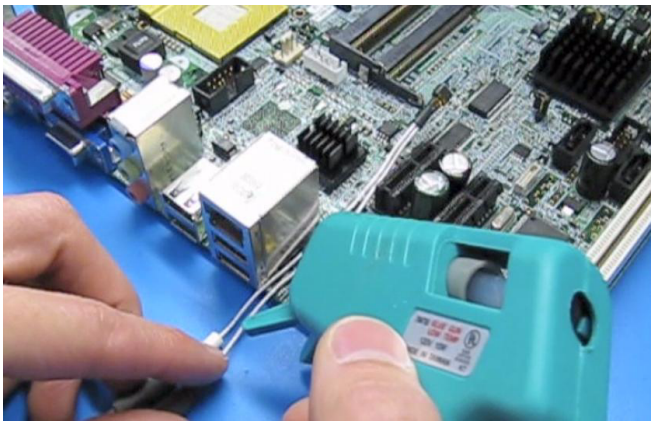


Figure 13 Using low-temperature hot glue to secure a probe head

General Tips on 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.

- Other strain-relief options like tape or hook-and-loop work fine as well, but keep the following guidelines in mind to protect your probing investment.

CAUTION

- Do not kink cables
- Do not crush cables
- Do not use aggressive adhesives or high temperatures

Connecting the ZIF Probe Head to the ZIF Tips

To connect a ZIF probe head to a ZIF tip, first solder the ZIF tip to the DUT and strain relieve the ZIF probe head as described in previous sections. Then form the coaxial cables to bring the probe head near the tip. Press the lever down on the ZIF probe head (Figure 14) 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: If you encounter any resistance at all when sliding the probe head over the ZIF tip, STOP! Check your alignment, make sure the lever is pressed, and try again. The ZIF heads and tips should have "zero" insertion force

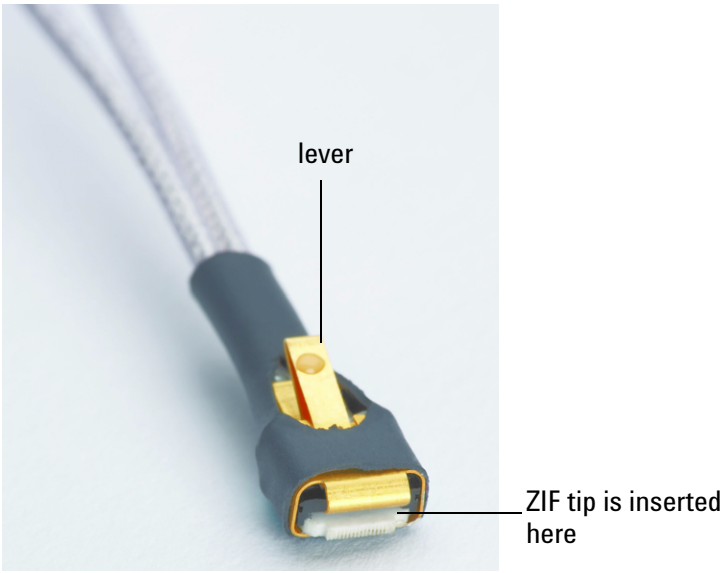


Figure 14 InfiniiMax III ZIF Probe Head - location of lever

After the probe head is connected to the soldered ZIF tip, it should look similar to the following:

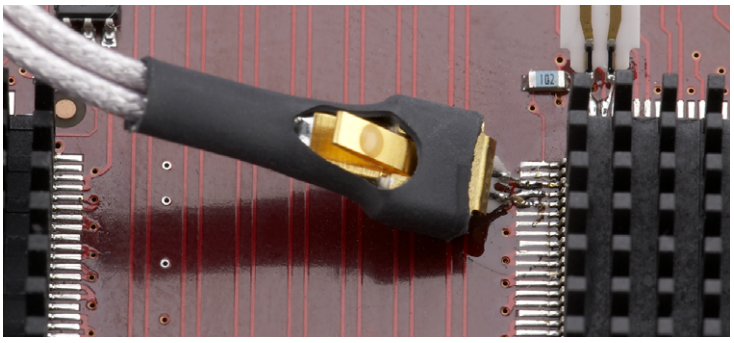


Figure 15 ZIF probe head connected to a soldered ZIF tip

NOTE: Please note in the solder procedure that you were instructed to have the gold traces on the ZIF tip facing up. This is so it will properly mate with the ZIF probe head. The gold traces on the tips should be on the same side as the lever.

TIP: You will get more repeatable results if you orient your connection perpendicular to your device as shown in Figure 16.

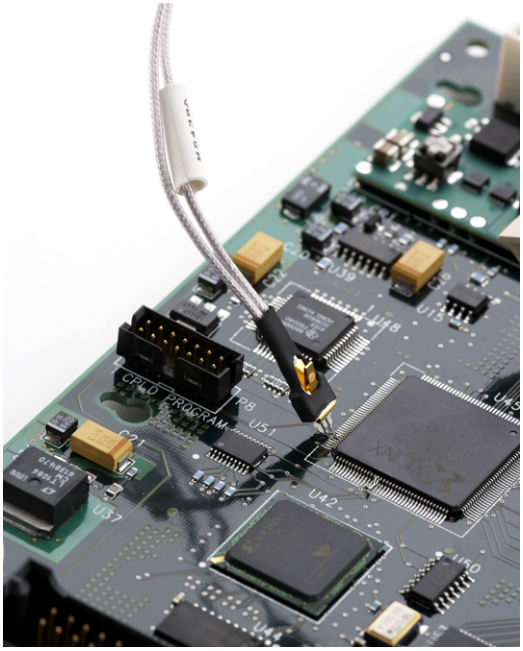


Figure 16 InfiniiMax III ZIF probe head connected to ZIF tip at more of a perpendicular angle than shown in Figure 15

TIP: You can use tweezers to actuate the lever in tight places.

To then move the probe head to a different tip, press the lever and remove the ZIF probe head from the ZIF tip (the ZIF tip will remain soldered to the DUT). Then simply connect the ZIF head to another ZIF tip at a different location on the DUT.

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

Replaceable Parts

- Strain Relief Putty
  - N5439-65201
- 450 Ohm ZIF tip, normal sensitivity (qty. 5)
  - N5440A
- 200 Ohm ZIF tip, high sensitivity (qty 5)
  - N5447A

N5441A InfiniiMax III Solder-in Probe Head

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

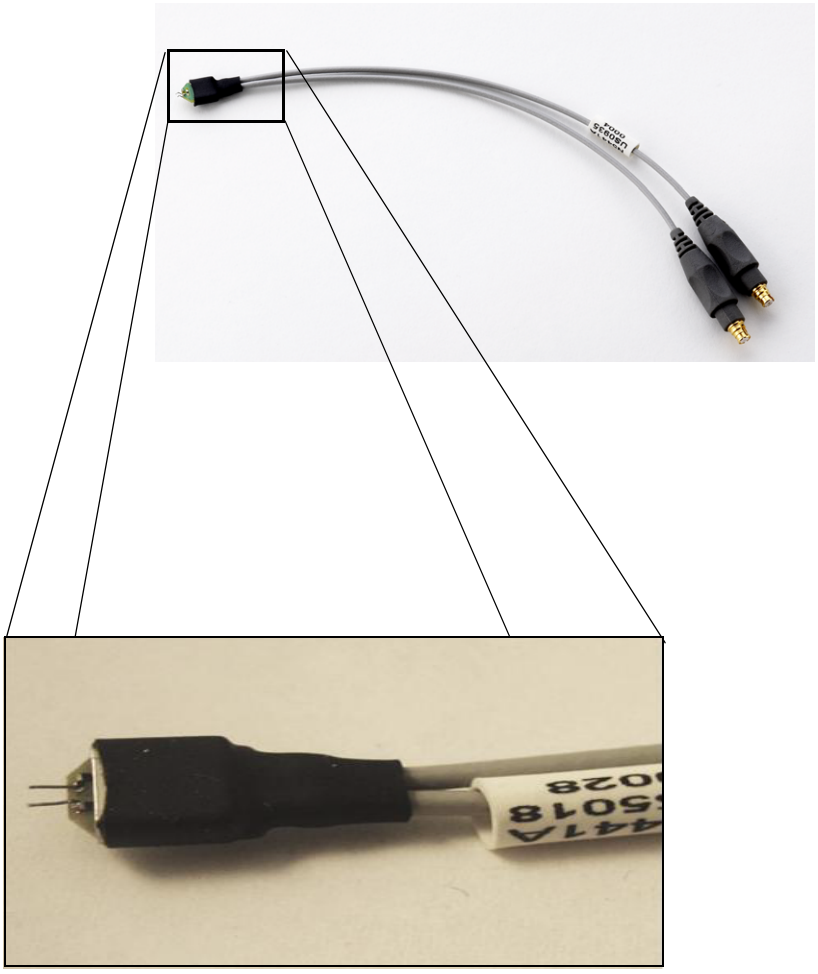


Figure 17 N5441A InfiniiMax III solder-in probe head

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.

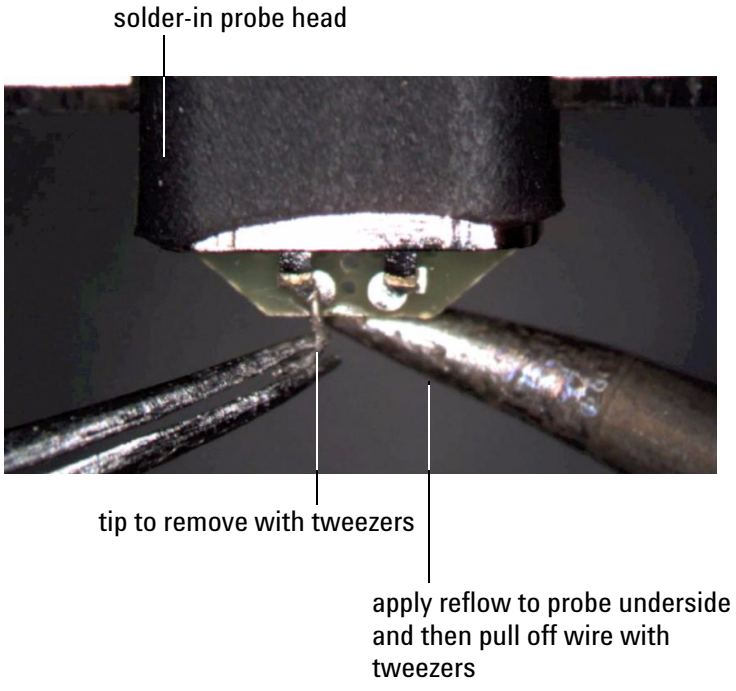
Replacing Wires on the Solder-in Probe Head

The N5441A's tip wires can be replaced when they are worn out or damaged. 0.005" and 0.007" wire kits are included with each N5441A probe head. 0.005" wire can be used for attaching to small vias.

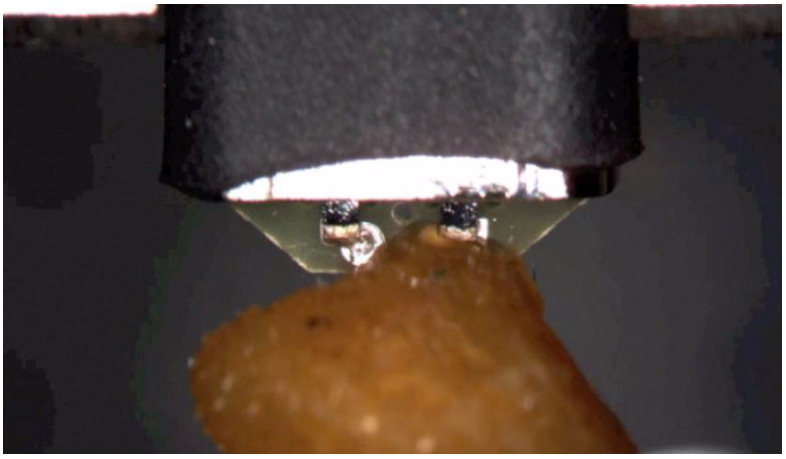
To replace wires, complete the following steps:

1 Begin by clamping the probe head GENTLY.

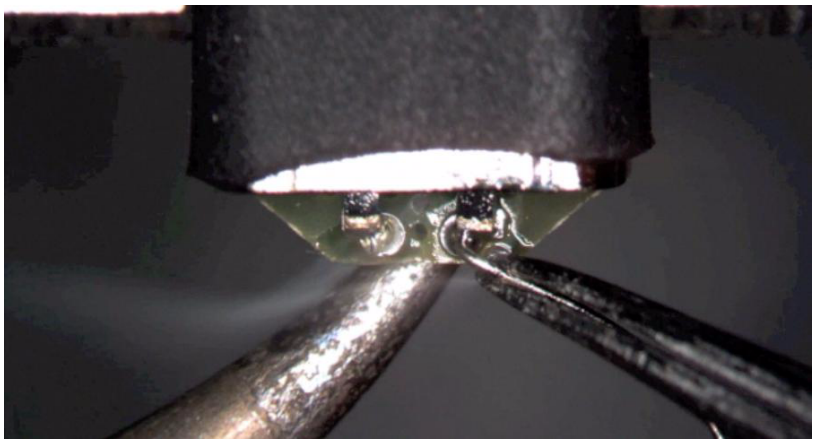
2 Remove the old wires with tweezers while reflowing the solder from the probe underside. CAUTION: **Apply heat quickly to avoid damaging your probe.**



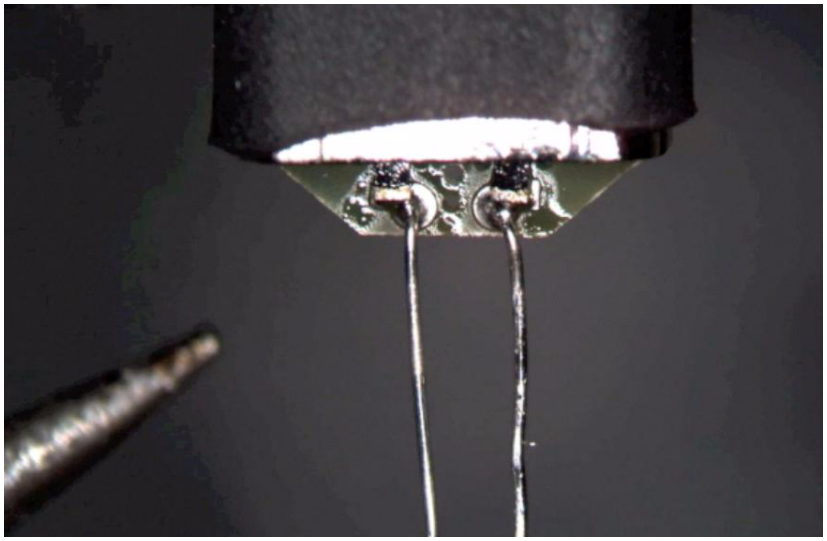
3 If necessary, add a small amount of solder to the holes and apply flux.



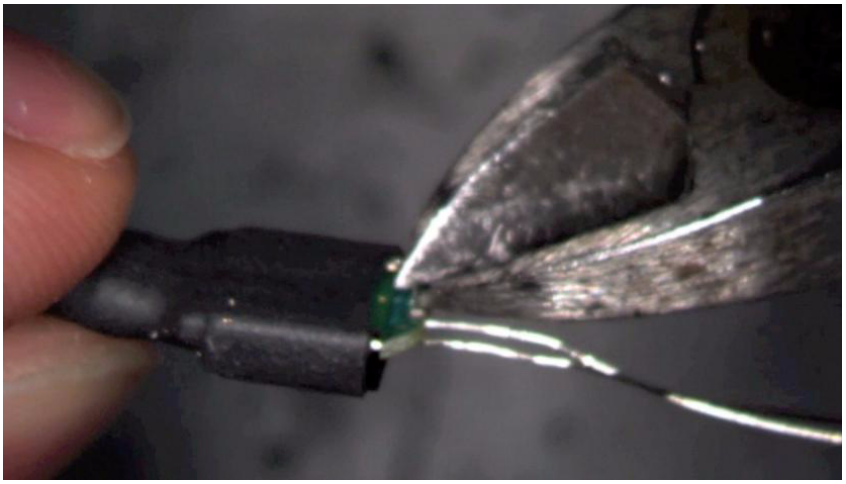
4 Reflow the solder from the underside and insert a new piece of wire. It is best to shape the wire into an "L" before attempting to insert.
CAUTION: Try not to dwell with the iron in contact with the probe head.



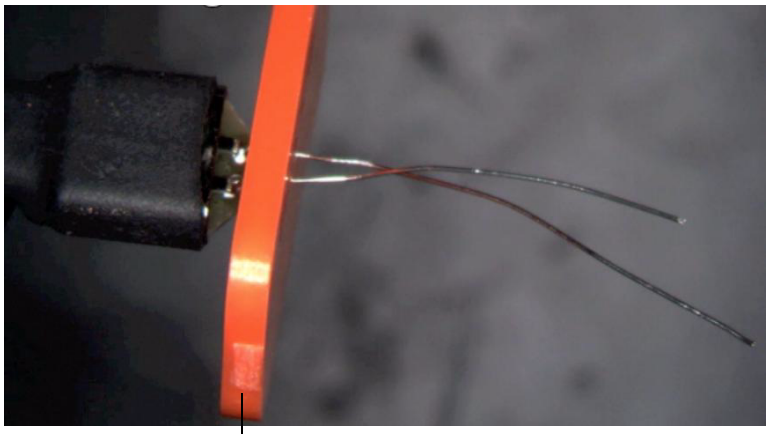
5 After attaching both the wires, they should look like the following:



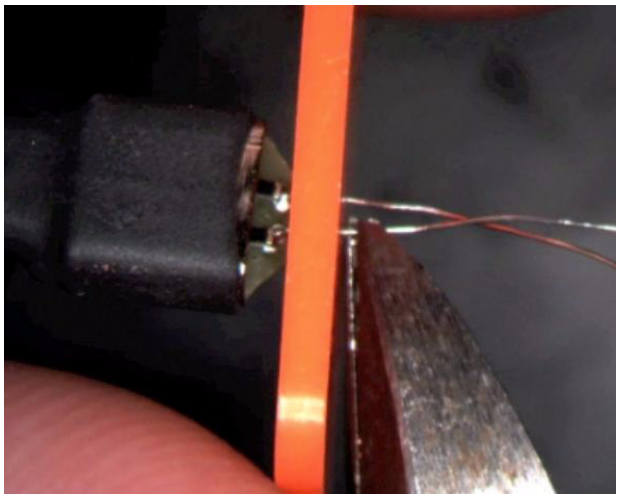
6 Trim any wire stubs on the probe head underside.



7 Use the included trim gauge to cut the wire lengths. Doing so will ensure the best performance from your probe head.



Trim gauge

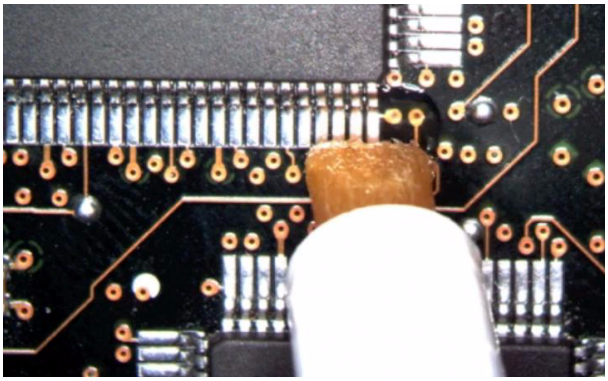


8 Check the DC resistance of each probe leg when you have replaced the wires. The correct resistance should be 450 ohms.

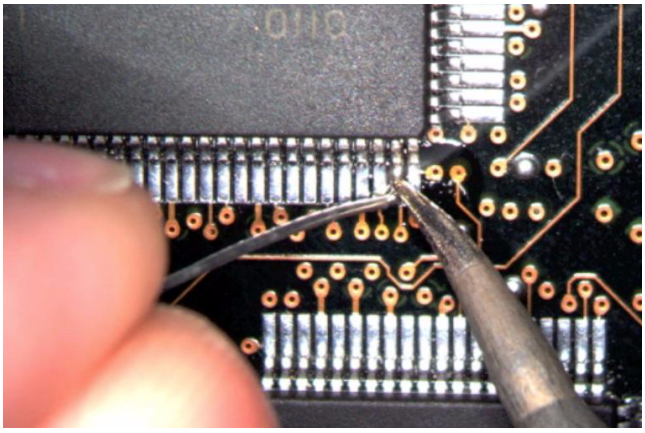
Soldering the N5441A InfiniiMax III Solder-in Probe Head

To solder the N5441A probe head to your DUT, complete the following steps (the procedure is very similar to that for the N5439A):

1 Apply flux to your target leads.

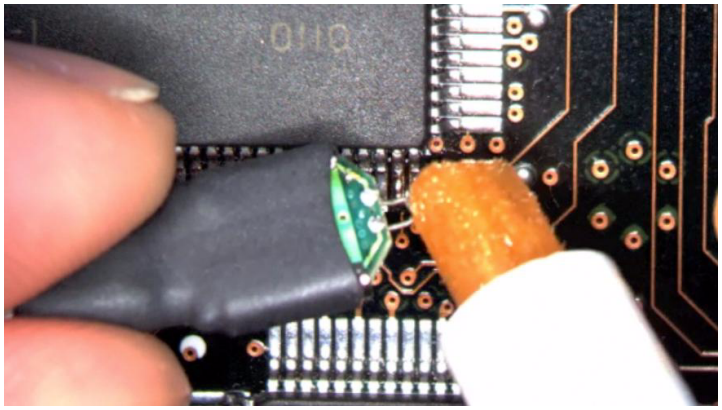


2 Tin the leads with a small amount of solder.

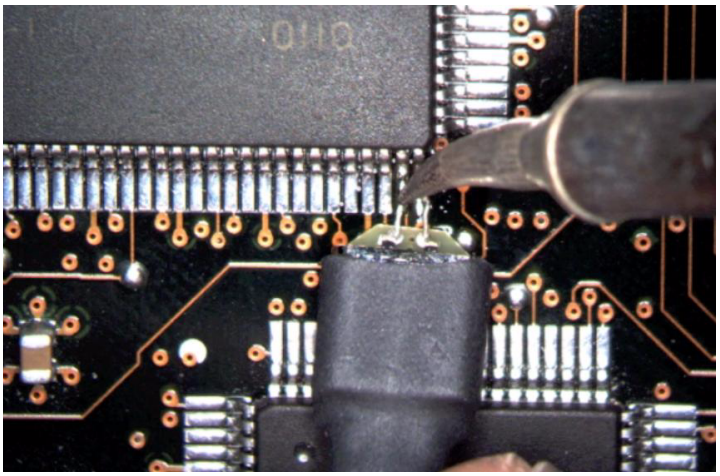


3 Use tweezers to form the probe head wires to fit your DUT's geometry.

4 Flux the DUT leads and your probe head wires.



5 Position the probe head wires on the DUT leads and reflow the solder quickly. **CAUTION: Do not leave the iron in contact with the probe head for more than a few seconds at a time.**



Strain Relieving the Solder-in Probe Head

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. There are several methods that Agilent recommends:

1 **Tack-putty:** Agilent recommends the use of tack-putty for securing both probe heads and amplifiers. Wrap a small amount of tack-putty around your probe head cables, taking care to not pinch them. The mass can then be secured to a rigid body neat your DUT.

   A 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.

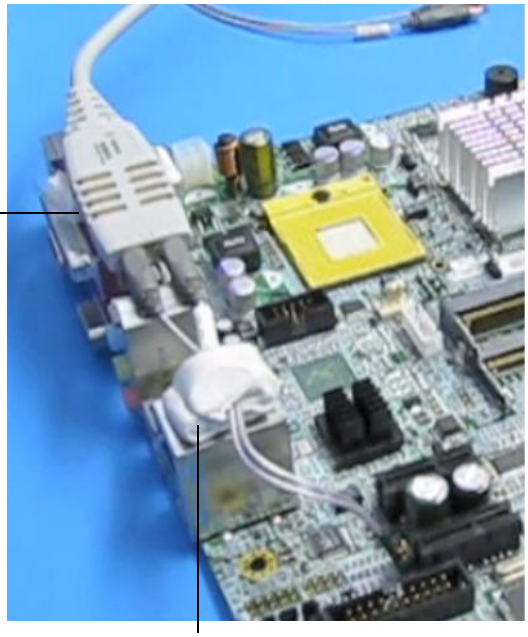


Figure 18 Using tack-putty to strain relieve a probe head and amplifier

You can also use putty with a positioner, such as the Agilent N2787A.

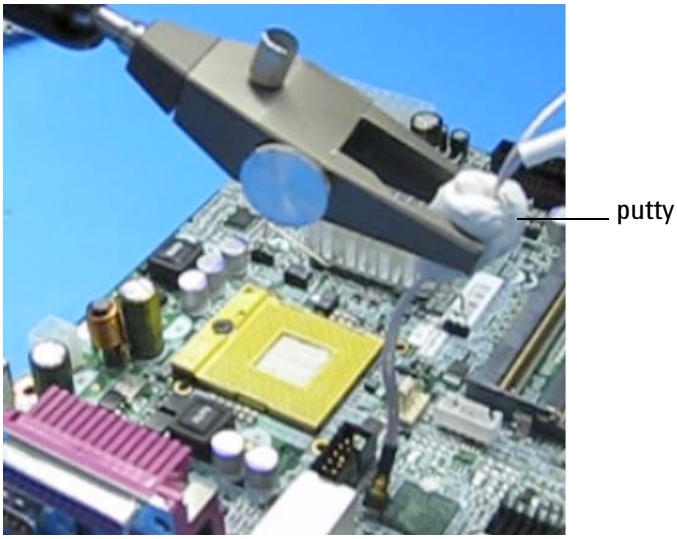


Figure 19 Using putty with the N2787A 3D Probe Positioner

The same positioner can also be used to support your probe amplifier as shown in Figure 6 on page 16.

2 **Low-temperature Hot Glue:** You can also use low-temperature hot glue to secure cables. **CAUTION: Only use LOW temperature hot glue.**

Figure 20 Using low-temperature hot glue to secure a probe head

General Tips on 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.

- Other strain-relief options like tape or hook-and-loop work fine as well, but keep the following guidelines in mind to protect your probing investment.

CAUTION

- Do not kink cables
- Do not crush cables
- Do not use aggressive adhesives or high temperatures

Replaceable Parts

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

- Strain Relief Putty
  - N5439-65201

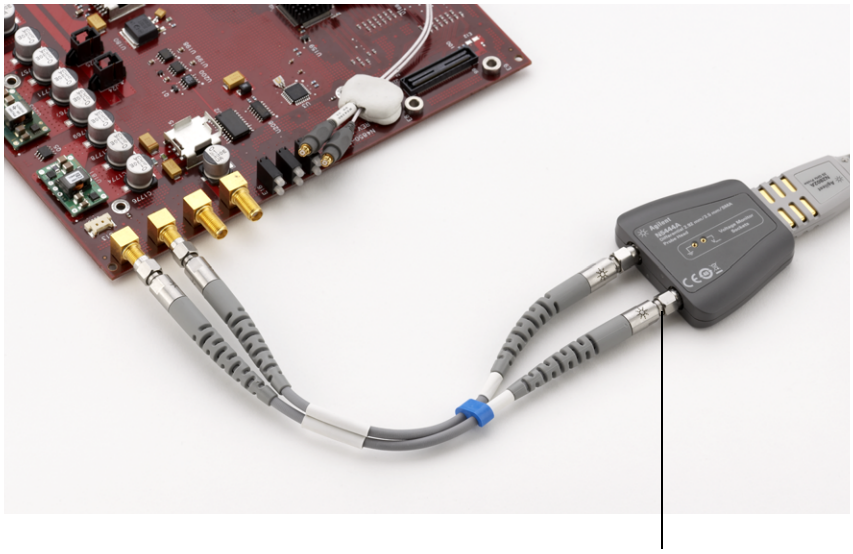
N5444A InfiniiMax III 2.92mm / 3.5mm / SMA Probe Head

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

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

Order N5448A 2.92mm head flex cables (10" or 25 cm long) to extend the cable length and add convenience.

Figure 21 N5444A InfiniiMax III 2.92mm/3.5mm/SMA Probe Head



Notice that the N5448A cables are attached to the N5444A probe head at this location (you must remove the supplied rigid cables first)

Figure 22 N5444A probe head with N5448A head flex cables attached

Replaceable Parts

- 2.92mm Extension Cables
  - N5448A

N5444A InfiniiMax III N5477A Sampling Scope Adapter

The N5477A Sampling Scope Adapter allows you to connect the InfiniiMax III probing system to the Infiniium 86100C DCA-J sampling oscilloscope or other RF instruments.

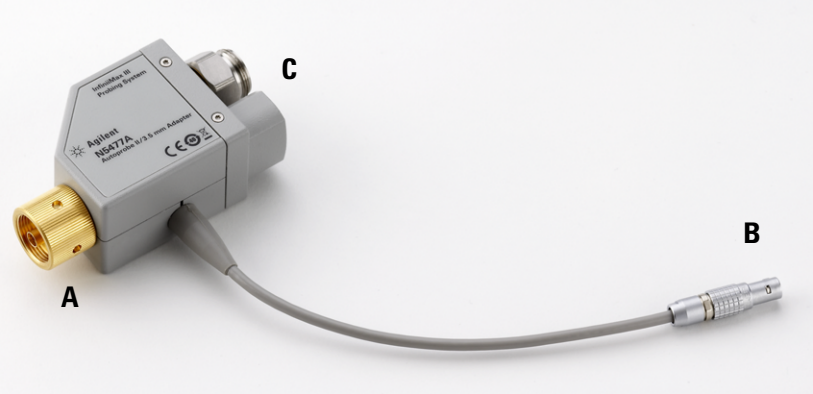


Figure 23 N5477A InfiniiMax III Sampling Scope Adapter

Connect the NMD/3.5 mm side of the adapter (**A**) to one of the channel inputs on the sampling oscilloscope. Then connect the power cord (**B**) to either the probe power output on the DCA-j 86100C wideband oscilloscope (if the module being used has this receptacle) or to the 1143A power module. Finally, connect the other side of the adapter (**C**) to the InfiniiMax III probe amplifier.

Previously, the DCA-j wideband oscilloscope was limited to 13 GHz of probing, but with the N5477A sampling oscilloscope adapter, the DCA-j can now probe up to 30 GHz.

The N5477A sampling oscilloscope adapter can also be used to connect the Infiniimax III probing system to generic 50 Ohm test equipment as long as the 1143A power supply and 5062-1247 NMD male-to-3.5mm female adapter are used. Both of these parts can be ordered through Agilent Technologies.

Performance Specifications / Characteristics

N2800A: BW = 16 GHz, tr = 27.1 ps

N2801A: BW = 20 GHz, tr = 21.7 ps

N2802A: BW = 25 GHz, tr = 17.4 ps

The performance specifications / characteristics below are with the N2803A 30 GHz probe amplifier connected to each probe head as indicated by the column headings.

	N2803A with N5439A and N5447A (ZIF 200 Ω)	**N2803A with N5439A and N5440A (ZIF 450 Ω)**	**N2803A with N5445A (browser)**	**N2803A with N5441A (solder-in)**	**N2803A with N5444A (SMA adapter)**
Probe bandwidth (-3 dB), probe only	28 GHz (typical)	28 GHz (typical), 26 GHz warranted	30 GHz (typical), 28 GHz warranted	17.2 GHz (typical)	28 GHz (typical)
Rise and fall time, probe only	20.9ps (10-90%) 13.8ps (20-80%)	20.9ps (10-90%) 13.8ps (20-80%)	16.2ps (10-90%) 10.9ps (20-80%)	34.8ps (10-90%) 26.6ps (20-80%)	15.5ps (10-90%) 11.0ps (20-80%)
System bandwidth (-3 dB) with DSO/DSAX93204A	28 GHz	28 GHz	30 GHz	16 GHz	28 GHz
Rise and fall time with DSO/DSAX93204A	15.5ps (10-90%) 11.0ps (20-80%)	15.5ps (10-90%) 11.0ps(20-80%)	14.3ps (10-90%) 10.2ps (20-80%)	27.1ps (10-90%) 19.2ps (20-80%)	15.5ps (10-90%) 11.0ps (20-80%)
Input capacitance	Cdiff=32 fF Cse=44 fF	Cdiff=32 fF Cse=44 fF	Cdiff=35 fF Cse=50 fF	Cdiff=77 fF Cse=105 fF	N/A
DC input resistance*	Rdiff=50kΩ+/-2% Rse=25kΩ+/-2%	Rdiff = 100 kΩ +/- 2% Rse = 50 kΩ +/- 2%			55 Ωto Vterm
Input resistance > 10 kHz	Rdiff=500 Ω Rse=250 Ω	Rdiff=1 kΩ Rse=500 Ω			50 Ωto 0.909x Vterm
Input voltage range (differential or single-ended)	0.8Vpp, +/-0.4V (HD2&3<-38db), 1.6Vpp, +/-0.8V (HD2&3<-34db)	1.6Vpp, +/-0.8V (HD2&3<-38db), 2.5Vpp, +/-1.25V (HD2&3<-34db)	1.6Vpp, +/-0.8V (HD2&3<-38db), 2.5Vpp, +/-1.25V (HD2&3<-34db)**		2.5 Vrms
Input common mode range	+/-6V DC to 250 Hz +/-1.25V > 250 Hz	+/-12V DC to 250 Hz +/-2.5V > 250 Hz	+/-12V DC to 250 Hz +/-2.5V > 250 Hz		+/-12V DC to 250 Hz (must not exceed max input voltage)
DC attenuation ratio	3:1		6:1		
Offset range	+/-16V when probing a single-ended signal				+/-16V when probing a single-ended signal (must not exceed max input voltage)
Noise referenced to input, probe only	2 mVrms		4 mVrms		

*Denotes warranted characteristic - all others are typical

**Harmonic distortion < -38dB is standard; <-34 dB wider input range with slightly increased distortion

	N2803A with N5439A and N5447A (ZIF 200 Ω)	N2803A with N5439A and N5440A (ZIF 450 Ω)	N2803A with N5445A (browser)	N2803A with N5441A (solder-in)	N2803A with N5444A (SMA adapter)
Maximum input voltage		18V peak CAT I			Same as input voltage range

*Denotes warranted characteristic - all others are typical

**Harmonic distortion < -38dB is standard; <-34 dB wider input range with slightly increased distortion

Cautions

In addition to the CAUTION notices below, also refer to the CAUTION notices listed in each component's documentation section in this *User's Guide*.

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: Whenever you disconnect a probe head from an InfiniiMax amplifier, pull the probe head connectors straight out of the sockets. When connecting a probe head to an amplifier, push straight in also. Never bend the probe head in order to "pop" 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.

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

InfiniiMax III SPICE Models

These are SPICE models for the input impedances of the various Infiniimax III probes. Generic SPICE sub-circuit files are listed so they can be copied and pasted into user's SPICE simulations. The "Performance Plots" section of this manual shows the matching between the measured input impedance and these modeled input impedances for the various probe heads.

The following diagram shows the SPICE circuit used for the designated probe heads (NOTE: the input impedance is only a function of the probe head; the amplifier input does not affect the input impedance significantly):

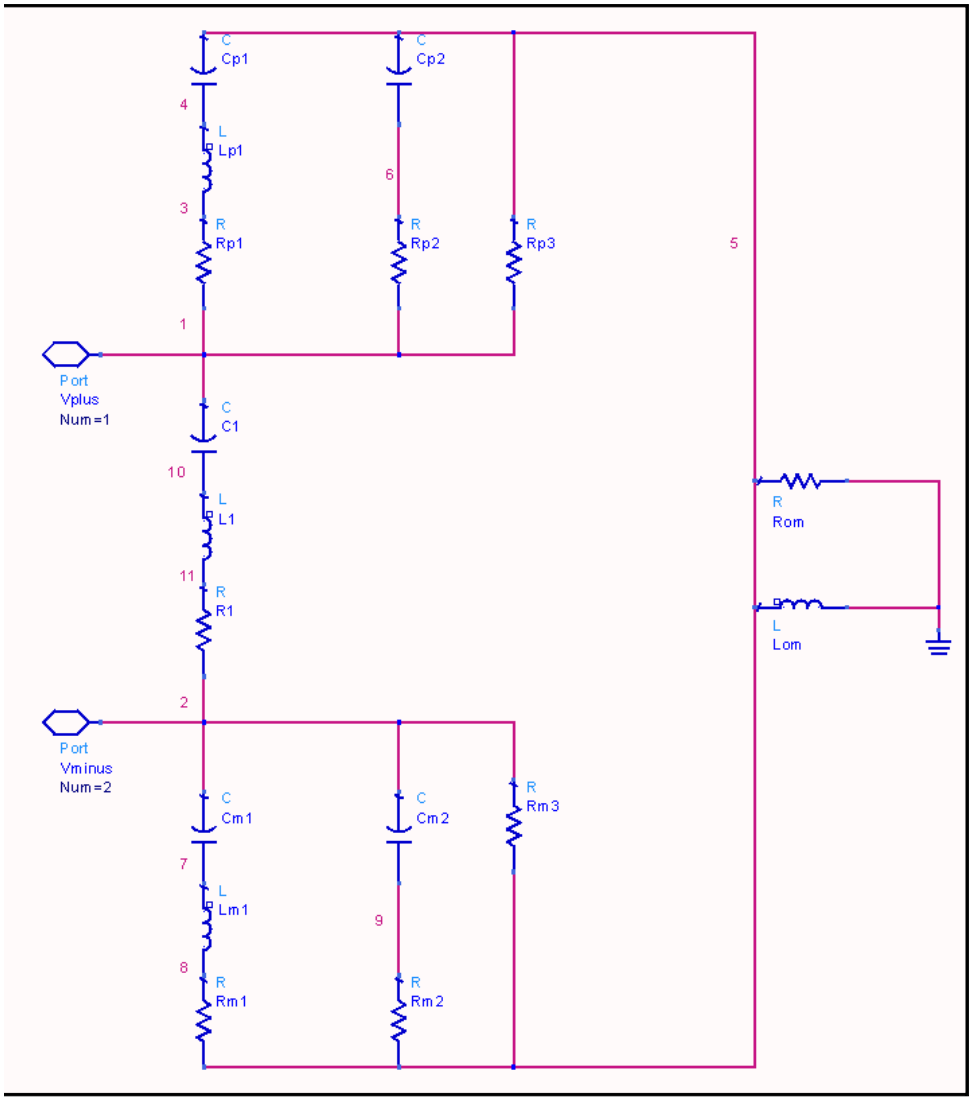


Figure 24 Circuit to use for ZIF, solder-in, and browser probe heads

```
.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

.subckt N5447A_N5439A_200ohmZIF 1 2
c1 1 10 20f
l1 10 11 2.3n
r1 11 2 250
rp1 1 3 1.2k
lp1 3 4 2.3n
cp1 4 5 24f
cp2 5 6 100n
rp2 6 1 250
rp3 5 1 25k
cm1 2 7 24f
lm1 7 8 2.3n
rm1 8 5 1.2k
cm2 2 9 100n
rm2 9 5 250
rm3 2 5 25k
rom 5 0 150
lom 5 0 30u
.ends
```

```
.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
```

Note: These three sub-circuits are for the N5445A browser with the tips set for a 1mm, 2mm, and 3mm 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

.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
```

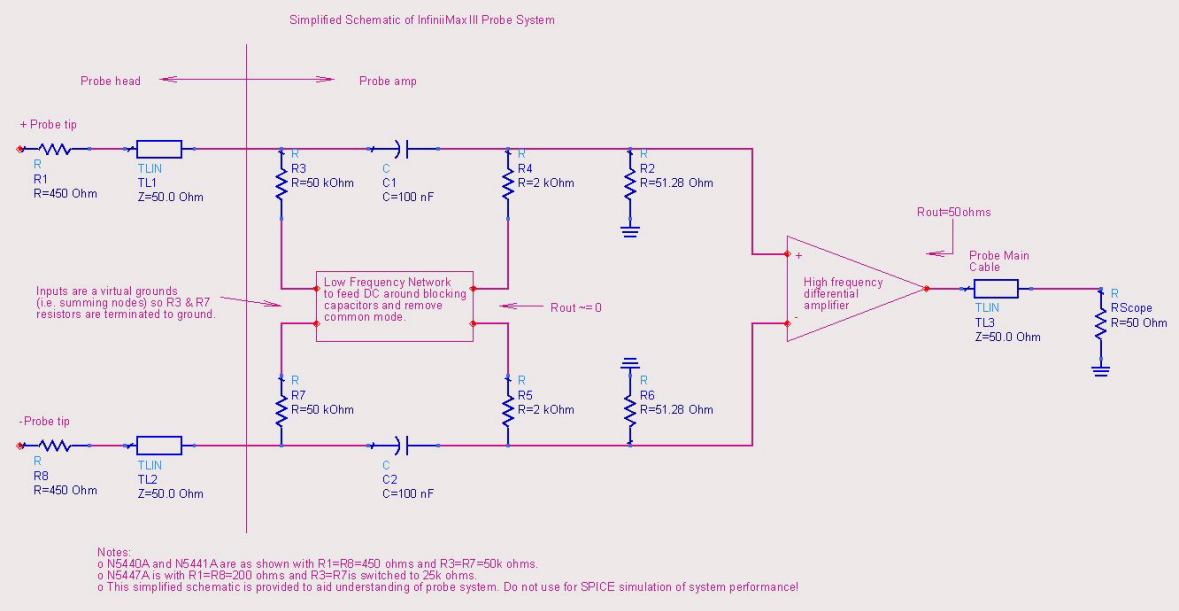
```
cp1 4 5 30f
cp2 5 6 100n
rp2 6 1 500
rp3 5 1 50k
cm1 2 7 30f
lm1 7 8 2.3n
rm1 8 5 250
cm2 2 9 100n
rm2 9 5 500
rm3 2 5 50k
rom 5 0 40
lom 5 0 30u
.ends

.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
```

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

```
.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
```

Simplified InfiniiMax III Schematic



NOTE: Do not use this simplified schematic as a SPICE model.

1 1 InfiniiMax III User Documentation

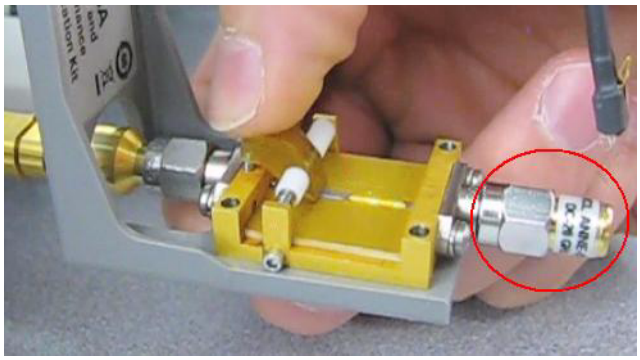
2 Calibration / Deskew Procedure

To perform a calibration/deskew for the InfiniiMax III Probing system, you will be using the N5443A Calibration/Deskew Fixture.

This fixture enables you to not only calibrate / deskew your InfiniiMax III probe, but it also ensures you properly position the probe amplifier during the procedure via the plastic holder. You can remove the plastic holder from the fixture by removing the four screws on the bottom side of the holder if you prefer.

Procedure

1 To perform a DC calibration / calibrated skew, make sure the 50 ohm terminator (included with N5443A) is connected to the fixture as shown below.



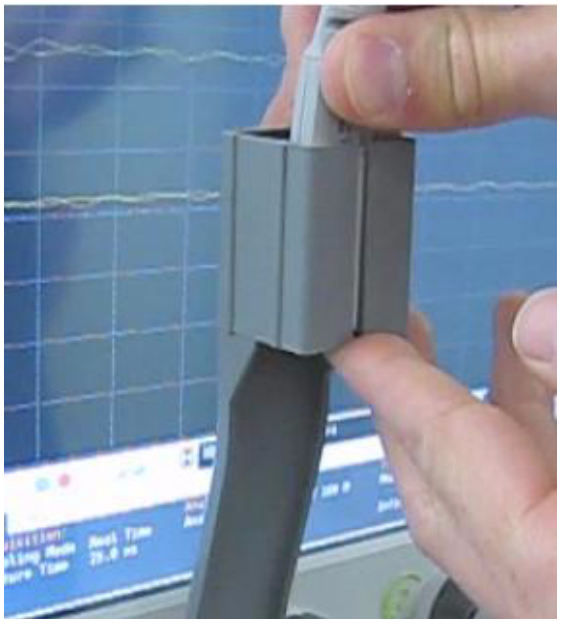
2 Hold the N5443A upright and connect the fixture to the Cal Out on the oscilloscope. Turn the nut on the Cal Out counter-clockwise to tighten.

3 While holding the fixture upright with one hand, use an 8 in. lbs. torque wrench to fully tighten the connector as shown on the next page.

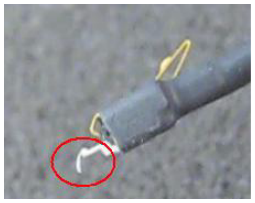
4 Connect the probe amplifier to one of the channel inputs on the oscilloscope.

5 Insert the amplifier into the top of the fixture holder. The amplifier can slide up and down in the holder to adjust the probe head position.

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



6 Before connecting to the N5443A fixture, form the N5439A probe head ZIF tip wires as shown below (if using the ZIF tip for the calibration / deskew).



Or form the wires as shown below if using the N5441A solder-in probe head.

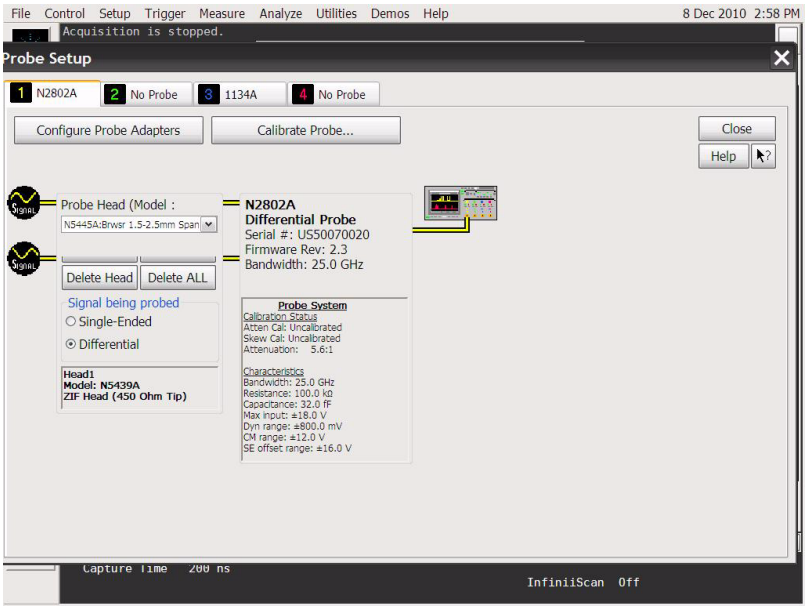
If you are using the browser probe head then you do not need to adjust the shape of the tips.

7 Connect your probe head to the amplifier.

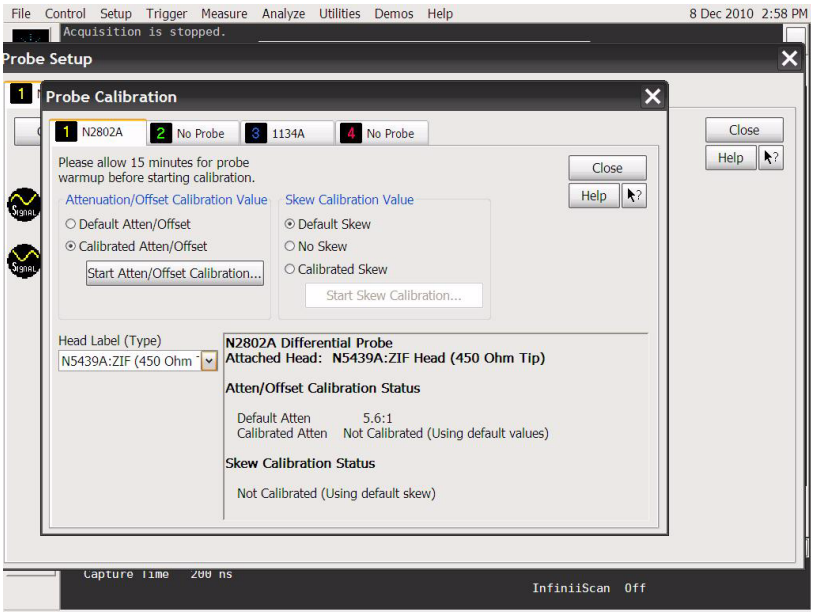
8 Position the probe head wires (if you are using the ZIF or Solder-in probe heads) so they curl towards the scope as shown below.

9 Press the **Menu** button on the probe amplifier to bring up the **Probe Setup** dialog box on the oscilloscope.

10 In the **Probe Setup** dialog box, click on the **Calibrate Probe ...** button. This will open the **Probe Calibration** dialog box.

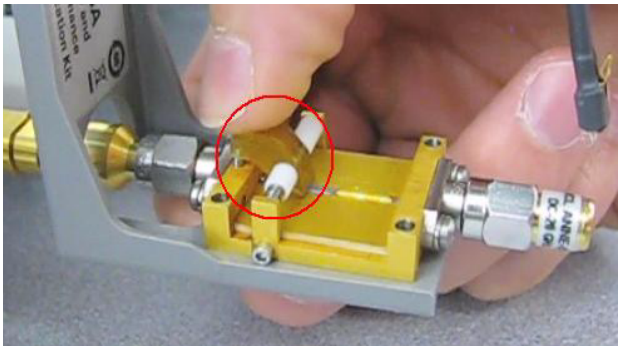


11 In the **Probe Calibration** dialog box, select the probe head you are using in the **Head Label (Type)** field, select the **Calibrated Atten/Offset** radio button, and press the **Start Atten/Offset Calibration...** button.

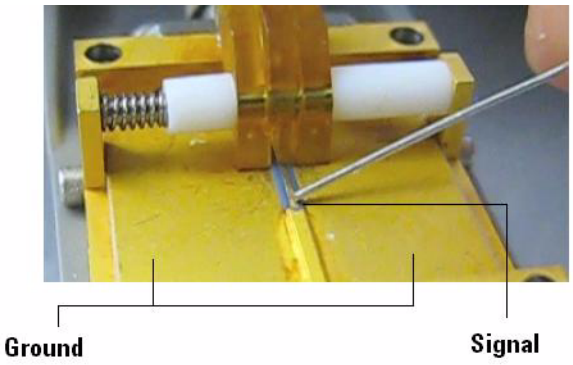


12 A dialog box will then open that tells you how to connect the probe head to the calibration/deskew fixture.

The fixture has three spring-loaded fingers (shown below) that clamp probe head wires to the fixture if you are using the ZIF probe head or the Solder-in probe head.



13 On the fixture, the center gold trace is signal and the large plates on either side are both ground as shown below.

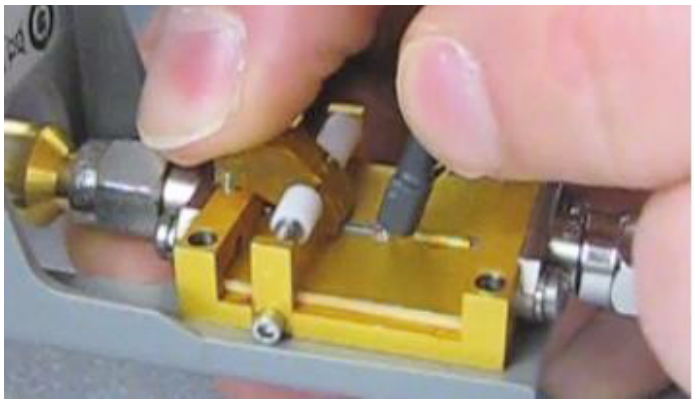


CAUTION: **NEVER solder a probe tip to the thickfilm gold. The gold will immediately dissolve into the solder and disappear.**

14 Follow the instructions on the oscilloscope to clamp the wires to either the signal or ground. When connecting the probe wires to the fixture, press down on the spring-loaded fingers described in Step 12 and insert the probe wires. You can check that the wires are connected correctly by pressing the autoscale button on the front panel and checking that you have a stable step on screen (note that pressing autoscale will close the **Probe Calibration** dialog box).

People tend to have their own preference for this step in terms of the angle to view and insert the probe wires under the spring-loaded fingers. Try different angles to determine your optimum method.

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 connection. Light contact is all that is needed for the calibration.**



15 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 below). The browser uses spring-loaded tips so you do not need much force to get a solid contact. You can check that the tips are connected correctly by pressing the autoscale button on the front panel and checking that you have a stable step on screen (note that pressing autoscale will close the **Probe Calibration** dialog box).

WARNING: 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 connection. Light contact is all that is needed for the calibration.

16 With the probe head correctly connected to the fixture, press **OK** in the dialog box on the oscilloscope and wait for the calibration to finish. It will report whether the calibration was successful or not.

17 Once the calibration has successfully completed, the **DC Cal** LED on the probe amplifier will turn green indicating that the particular combination of probe amplifier, probe head, and oscilloscope channel input has been calibrated.

Any time you use a new probe head type, a new probe amplifier, or a different channel on the oscilloscope, the **DC Cal** LED will be orange, indicating that a DC calibration is required.

18 Once the DC vertical calibration has successfully completed, select the **Calibrated Skew** radio button from the **Probe Calibration** dialog box on the oscilloscope. Then press the **Start Skew Calibration...** button and follow the on-screen instructions for the skew calibration.

3 Performance Verification

This chapter describes the equipment and procedures needed to verify the performance of InfiniiMax III probes. 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.

It is also important to note that the performance measured here is of the probe by itself. Agilent high performance real-time scopes (and sampling scopes under certain conditions) will apply probe correction that will further enhance the performance of the probes.

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 (N2803A InfiniiMax III Probe Amplifier with N5439A/N5440A ZIF tip or N5445A Browser)

Agilent recommends a test interval of one year or 2000 hours of operation.

Equipment Needed:

Agilent 2 port E8361A/C Vector Network Analyzer

- Or equivalent VNA that covers at least a 50MHz to 34GHz range. 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.
- Needs proper test port cables and/or adaptors to provide male 2.92mm connectors at reference planes. If test port cables are 2.4mm or 1.85mm cables, then Agilent 11904A and 11904D adaptors can be used to convert to 2.92mm male connectors.
- Needs to be capable of using a Touchstone file to de-embed at a port
- Needs to have bias port for port 1 of the VNA (i.e. has internal bias T's and a BNC port that allows bias to be applied to port 1)

Agilent N5443A Performance Verification Fixture

Maury Microwave 8775B2 2.92mm male broadband load

- Or other 2.92mm male load with similar or better return loss
- A high quality 2.92mm adaptor to a 2.4mm or 1.85mm VNA calibration load with required return loss could be used

Agilent N5477A Autoprobe II/3.5mm Adaptor

Agilent 1143A Power supply

Agilent 5062-1247 outside thread 3.5mm (male) to 3.5mm (female) adaptor

Agilent N4692A-00F 2.92mm (female/female) ECal module

- Or other 2.92mm calibration kit that can calibrate to the 2.92mm male connectors at the test ports.

BNC 50 ohm male terminator

- Or equivalent; not a critical part
- Example: Pomona number 3840-50 or 4119-50

InfiniiMax III Probe Head

- Either the N5439A ZIF probe head with N5440A ZIF probe tip or the N5445A Browser probe head

VNA Setup:

- Power level: -6dbm
- Sweep: Log Frequency 50MHz to 34GHz, 284 points (100 pts/decade)
- IF BW: 1kHz
- Test port cables and adaptors (if needed) to provide male 2.92mm connectors at measurement planes
- Install the BNC 50 ohm terminator to the bias input for port 1 of the VNA (on the rear panel of E8361 PNA). This provides a DC 50 ohm termination for the probe amp output.
- Clear all traces from display, then select S12 to display.
- Set scale for S12 to 3db/div, with reference level to 0db and reference position to 5 divisions.

Procedure:

1 Calibrate the PNA to the two male 2.92mm connectors (connectors can be seen in Figure 2) using the N4692A-00F ECal module (or equivalent 2.92mm cal kit). As with all precision connector interfaces, make sure to torque all connections using the proper torque wrench!

2 Prepare the 5439A Zif probe head for connection to the PV fixture as shown in Figure 1.

a. Install a N5440A 450 ohm Zif Tip into the 5439A. Make sure it is fully inserted.

b. Bend the tip wires down at their halfway point using fine tweezers

c. Slightly spread the tips wires to better match the spacing needed for the PV fixture

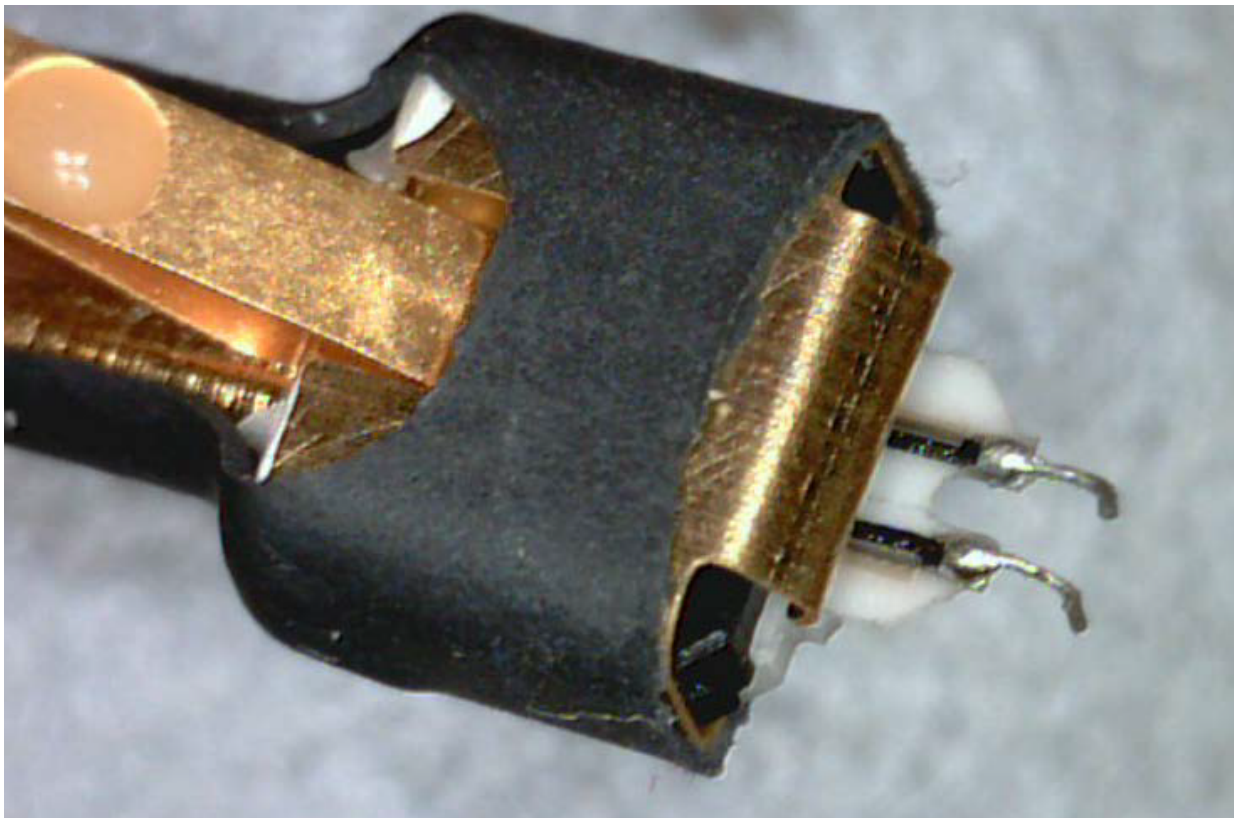


Figure 1

3 Connect the 1250_1749 adapter and N5443A PV fixture assembly to the calibrated ports of the PNA as shown in Figure 2. A small bench vise is useful to hold PV fixture steady.

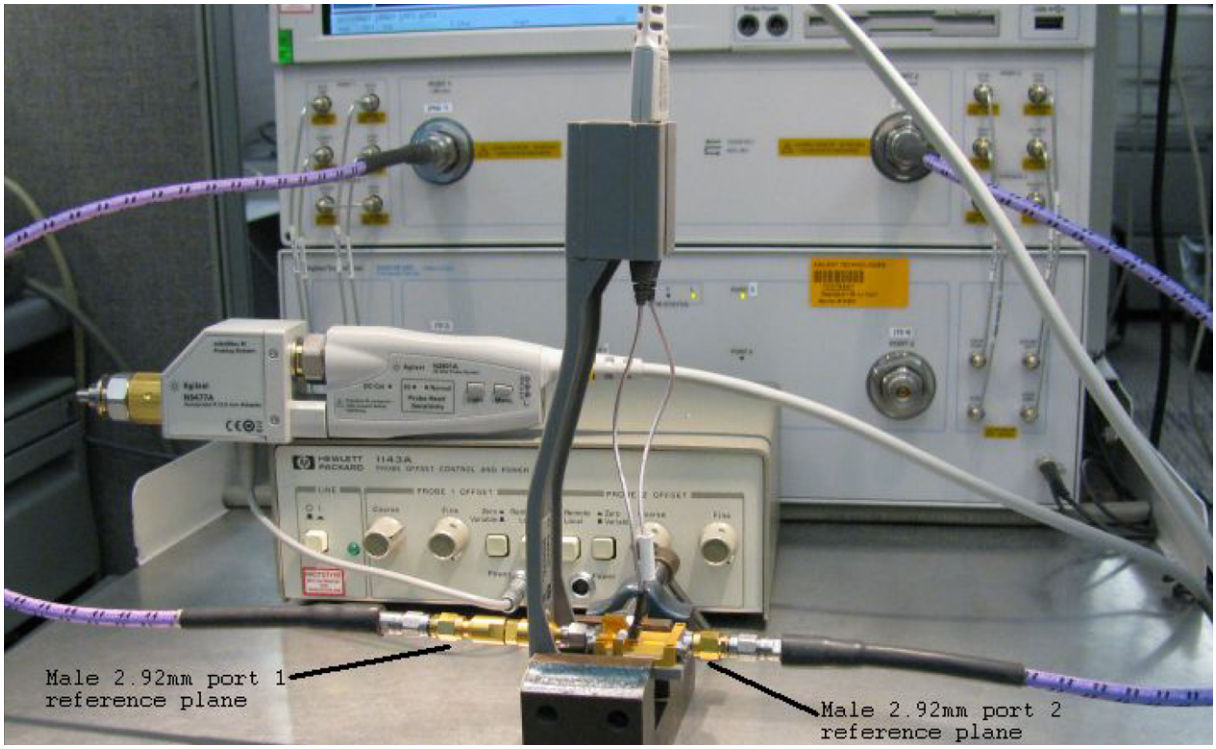


Figure 2 Setup for measuring “Vin” of probe

4 Connect the N5477A AutoProbe II adaptor to the 1143A power supply and turn on the power supply.
   a. Make sure the probe offset control button on the 1143A is set to “Zero” so no probe offset is applied.
   b. The 5062_1247 adapter should be attached to the N5477A and properly torqued.

5 Connect the probe amp pod end to the N5477A and torque connector.

6 Connect the probe to the N5443A PV fixture:
   a. Probe amp with ZIF probe head is inserted into the PV holder far enough that the tip wires can easily reach the pinchers 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 pinchers. 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 pinchers and carefully insert one wire under the center pincher and the other wire under one of the side pinchers. Either polarity of the probe can be tested and will yield the same results (but opposite phase) if the probe is working properly. Figure 3 shows a close up of the tip wires positioned under the pinchers.

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.

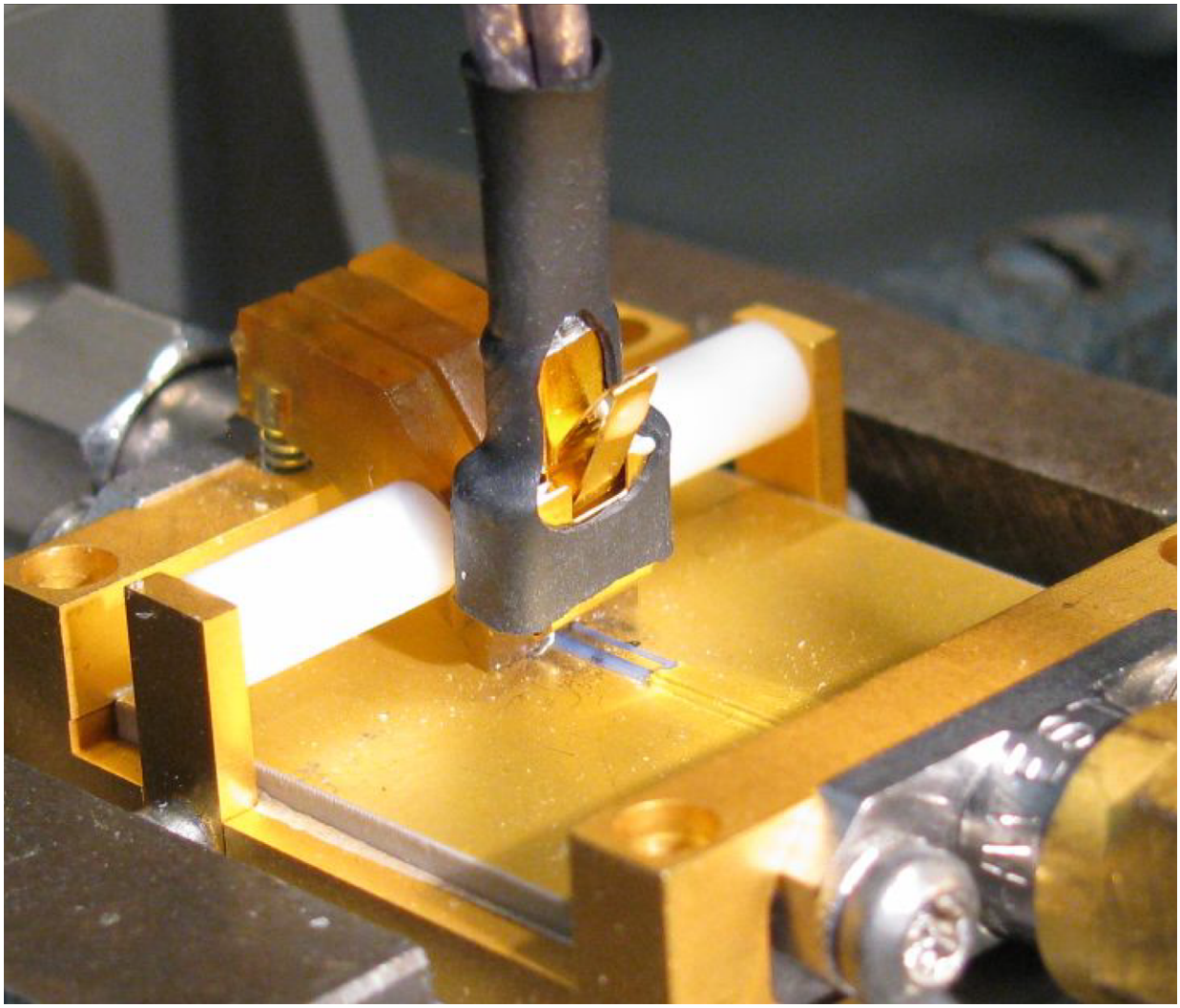


Figure 3 Close-up of tip wires positioned under pinchers

7 Install the proper file to de-embed the 1250_1749 adapter and the output side of the N5443A (i.e. the path from the male 2.92mm connector to the probe point of the N5443A) from port 1 of the VNA.

a. The Touchstone file for the 1250_1749 and N5443A PV fixture is listed at the end of this chapter. Cut and paste this file to a file named "Adaptor_1250_1749___OutputSideOfFixture_N5443A.s2p" on the PNA.

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. Check the “Enable De-embedding”

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

8 Trigger VNA to perform a single sweep. a. Press “Trigger” under Channel Setup, and then the green soft-key for “Single”. Display should look like Figure 4. If it looks noticeably different, the probe tip wires may not be making contact under the pinchers.

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

Figure 4 De-embedded “Vin” trace

10 Now move the 2.92mm male test port 1 connector to the 5062_1247 adapter and N5477A Autoprobe II adapter assembly. Connect the Maury Microwave 8775B2 2.92mm male broadband load to the 1250_1749 adaptor and N5443A PV fixture assembly. This new setup is shown in Figure 5. Torque all connections.

11 Install the proper file to de-embed the 5062_1247 adapter and N5477A adapter from port 1 of the VNA.

a. The Touchstone file for the 5062_1247 and N5477A is at the end of this chapter. Cut and paste this file to a file named “Adapter_5062_1247___Adapter_N5477A.s2p” on the VNA.

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.

12 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 -15.3db, but can vary a few tenths of a db either way.

c. Display should look like Figure 6. If it looks noticeably different, the probe tip wires may not be making contact under the pinchers.

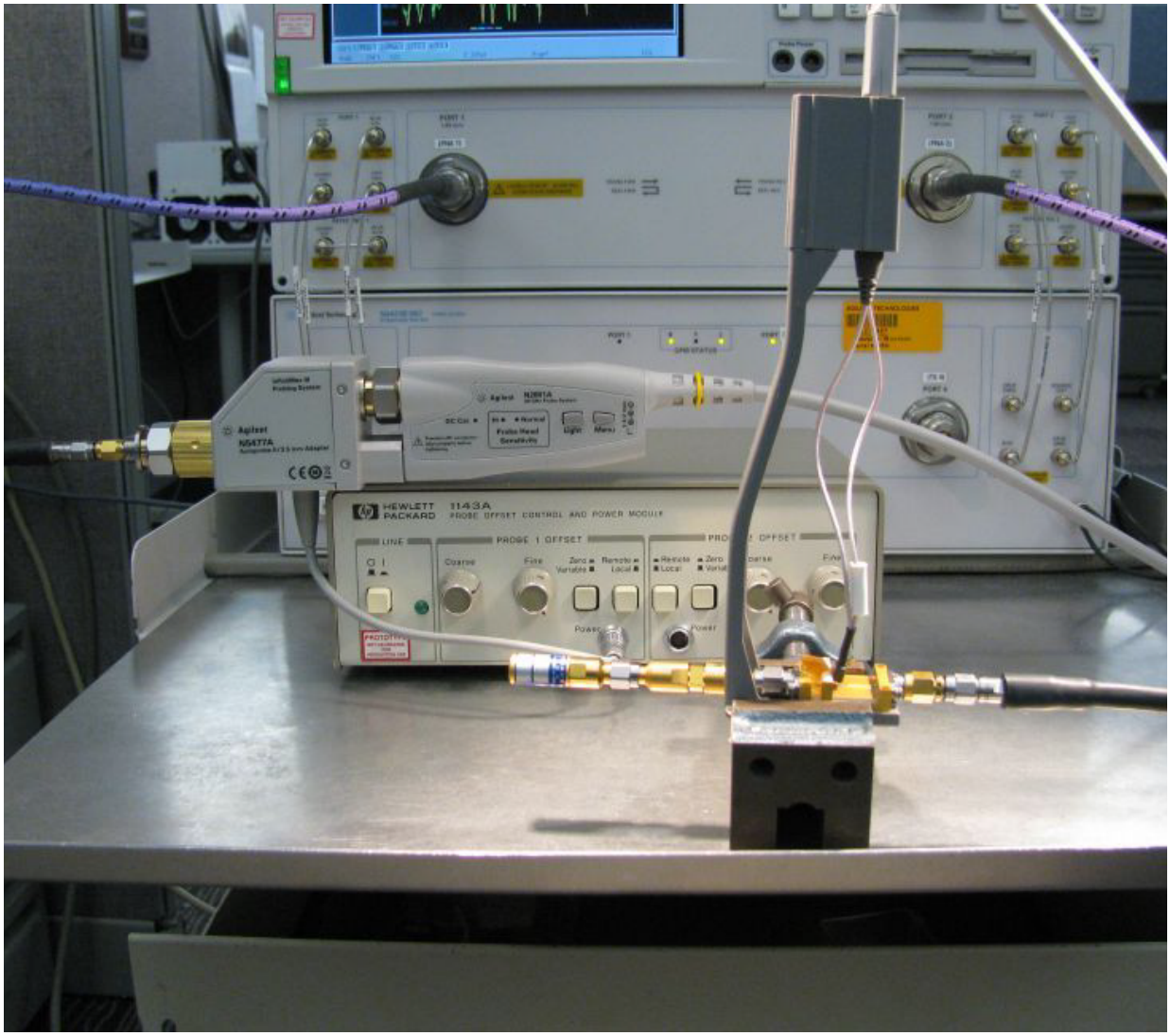


Figure 5 Setup to measure “Vout” of probe

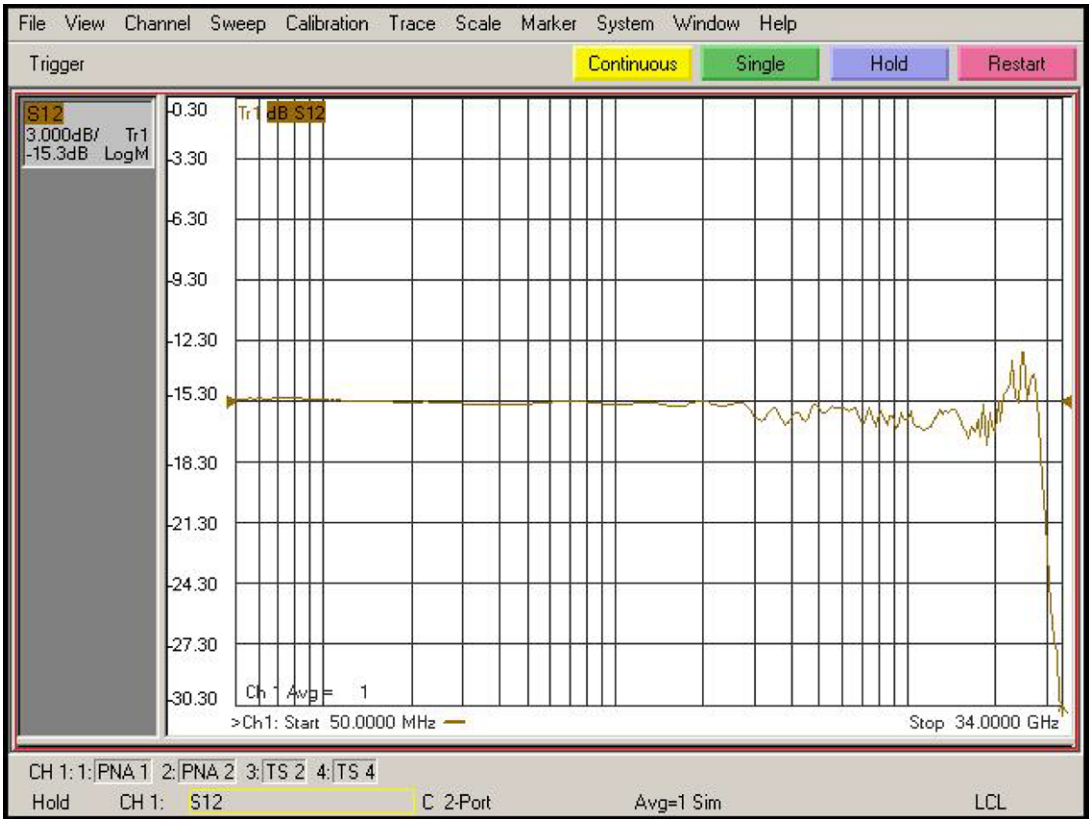


Figure 6 De-embedded "Vout" trace

13 Under menu "Trace/Math/Memory" select "Data/Memory" in the "Data Math" box.

a. This will divide the current trace (de-embedded vout trace) by the memory trace (de-embedded vin trace) and therefore show the voltage transfer function of the probe or "vout/vin".

b. Again, adjust the "Reference Level" in the scale menu so the 50MHz point is at center screen. The display should look like Figure 7.

c. Turn on a marker and adjust it to where the trace crosses 3db below the 50 MHz point (which is 1 division below center screen since screen is set to 3db/div).

d. Verify that the BW is >= 26 GHz for the N5440A Zif Tip, N5439A Zif Probe Head, and N2803A 30GHz Probe amp combination

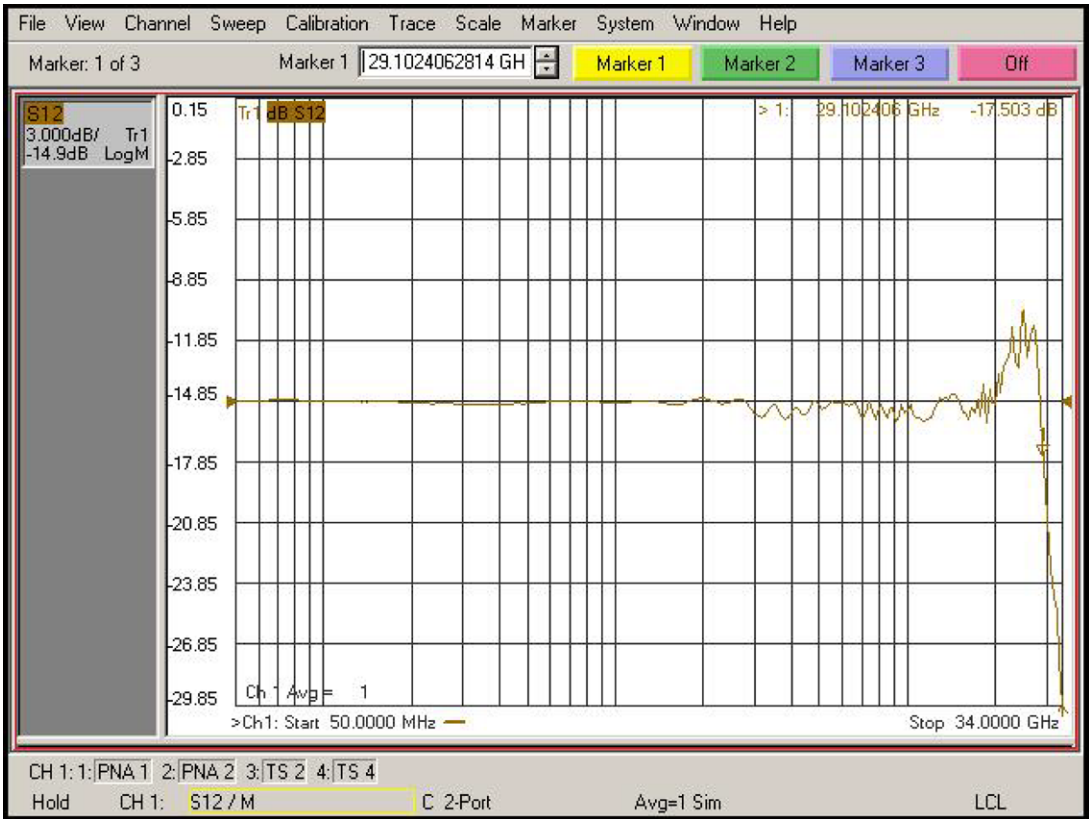


Figure 7 De-embedded "Vout/Vin" response of the probe

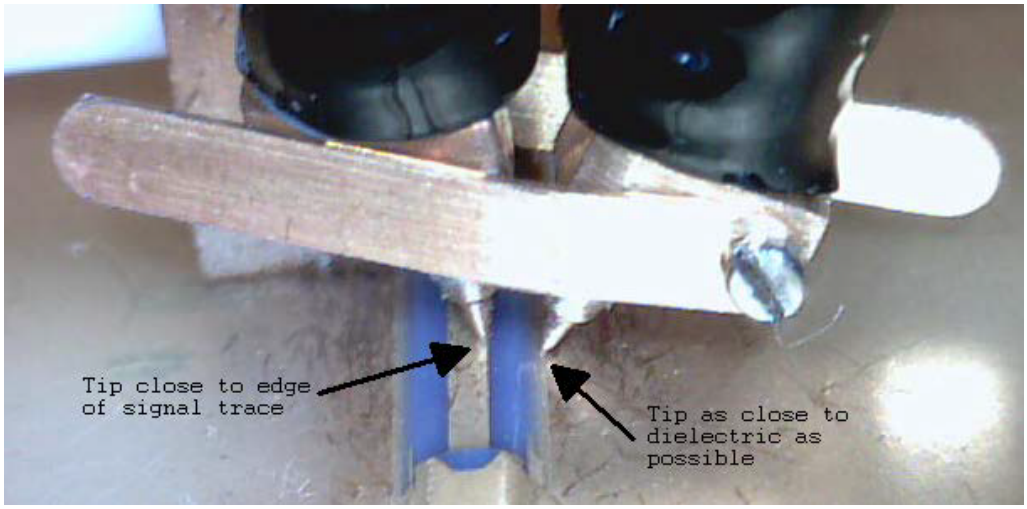
14 **NOTE: You only need to perform the Bandwidth Performance Verification test with the ZIF tip as described above. If the probe passes with the ZIF probe head then it will pass with the browser probe head as well. You are not required to test the bandwidth specification with both probe heads. If you have the choice between using the ZIF probe head or the browser, Agilent suggests using the ZIF probe head because measurements are more repeatable with it and it is easier to make a proper connection.**

To measure the performance of the N5445A Browser with the N2803A probe amp, the same procedure as described above is used except the browser is held in position with a probe positioner. This setup is shown in Figure_8 using the Agilent N2787A 3D Probe Positioner.

a. Tilt the browser slightly so the two tips touch the center trace and the ground plane on the PV fixture at about the same time.

b. Probe the halfway point between the where the pinchers are and where the microstrip transitions into the rectangular coax line.

c. Set the span of the browser to the minimum possible as should in this picture:



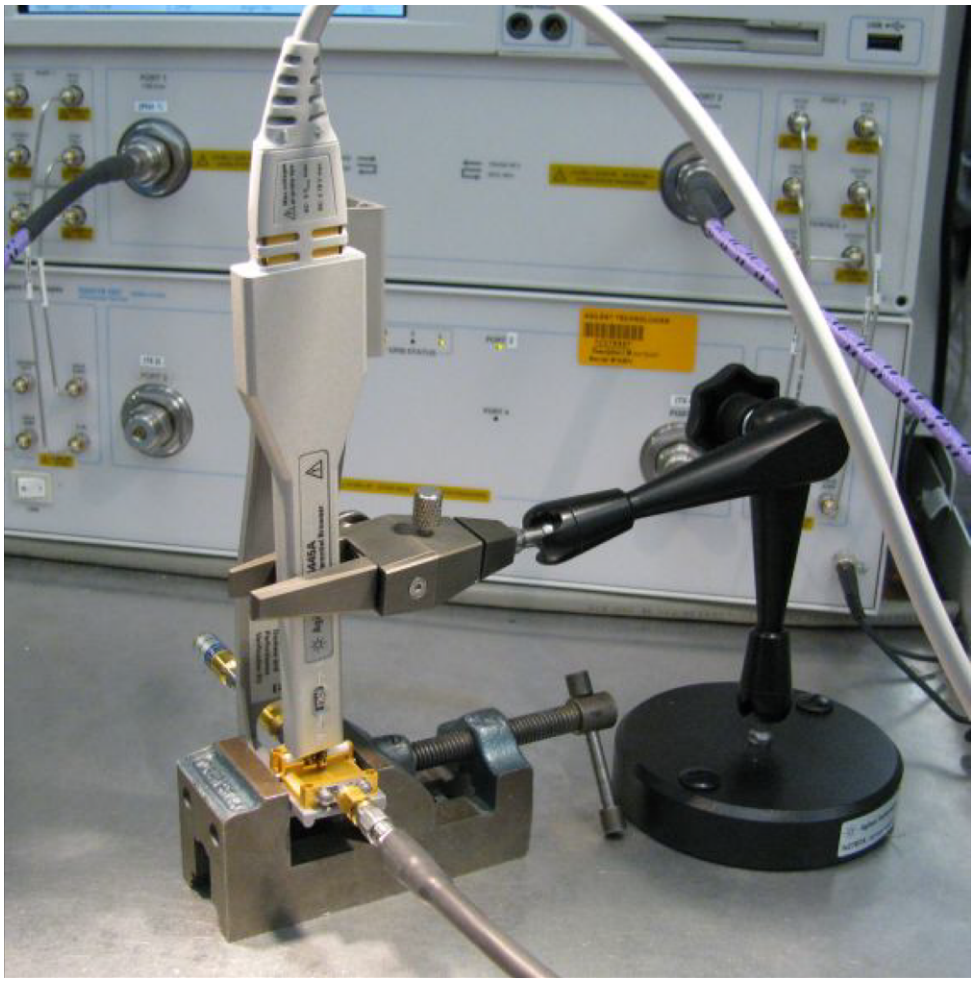


Figure 8 N2787A 3D Probe Positioner used to measure the N5445A browser with the N2803A amp

Text to cut and paste into file "Adapter_1250_1749___OutputSideOfFixture_N5443A.s2p"

Cut and paste starting at the line below.

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

122833197.030691 -57.847096 78.713336 -0.030505 -10.204469 -0.031384 -10.233007 -54.242926 55.717121
125696915.612984 -56.373050 75.635986 -0.030472 -10.445575 -0.031627 -10.465755 -54.037670 55.307462
128627398.590544 -55.090007 72.338796 -0.030439 -10.692303 -0.031876 -10.703929 -53.832682 54.888298
131626202.500562 -54.306379 66.932129 -0.030205 -10.948451 -0.031570 -10.953764 -53.494817 54.988088
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
268916332.509994 -50.587835 40.516894 -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 -49.671733 -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 -115.956987
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 -32.772003 -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 -28.523810 -0.278856 -28.574421 -43.995810 -141.108417
4794301661.078618 -42.538447 -21.332713 -0.284355 -37.556946 -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 -0.805057
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 127.264105
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
17029933597.127781 -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 63.319590 -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 -18.708938 -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

Text to cut and paste into file "Adapter_5062_1247___Adapter_N5477A.s2p"
Cut and paste starting at the line below.

```
! 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
86932621.122130 -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 -44.114694 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 -43.443565 -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 -46.581649 -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 -0.071471 -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

1000282125.827218 -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 -36.904667 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 -0.122249 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 -34.476531 -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 -41.227346 -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 -37.580008 -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 -55.519768 -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
12621114425.798326 -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 -18.584633 -83.525655 -0.518071 166.056015 -0.538472 166.289380 -18.908405 -121.618048

DC Input Resistance Performance Verification

Agilent recommends a test interval of one year of 2000 hours of operation.

Equipment Needed:

Agilent N5443A Performance Verification Fixture

- No substitute

BNC(m) to SMA(m) Adapter

- Ponoma 4288 or equivalent

Banana Plug to BNC(f)

- Ponoma 1269 or equivalent

Digital Multimeter

- Agilent 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 Bandwidth Performancer Verification procedure)
- No substitute

Probe Positioner

- Agilent N2787A 3D Probe Positioner
- Critical specification: stable/accurate positioning

Small Bench Vise

InfiniiMax III Probe Head

- Either N5439A ZIF probe head with N5440A tip, N5441A solder-in probe head, or N5445A browser probe head. (You only need to perform the Performance Verification test on one of these probe heads, not all of them. If it passes for one of them then it will pass for all of them.)

Measuring Input Resistance for ZIF Probe Heads or Solder-in Probe Heads - Procedure:

Figure 9 shows the correct setup for measuring the differential input resistance for ZIF probe heads or the solder-in probe head.

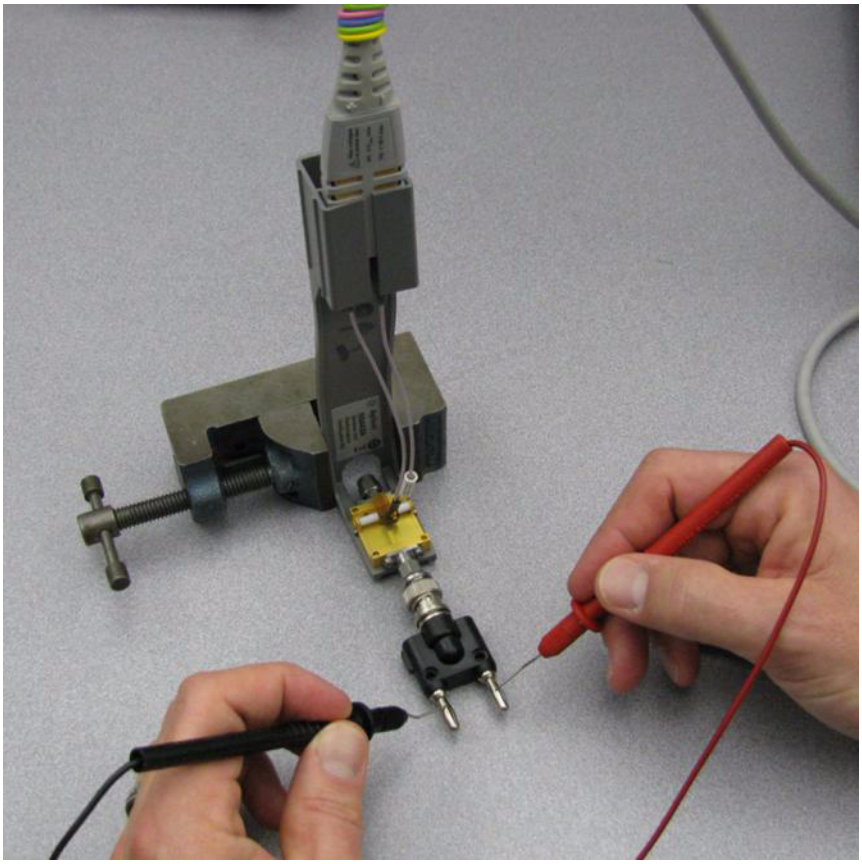


Figure 9 Measuring the differential input resistance of a ZIF or solder-in probe head

1. Connect the BNC to SMA adapter and BNC to Banana Plug adapters as shown in Figure 9.
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.
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 9.
5. Depress the pincher fingers on the PV fixture so they open and carefully insert the tip wires under the pinchers. Release the pichers once the tips are inserted.
6. As shown in Figure 9, 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 kOhms +/- 2% (98 to 102 kOhms).

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 10 (through the vent window of the probe amplifier).

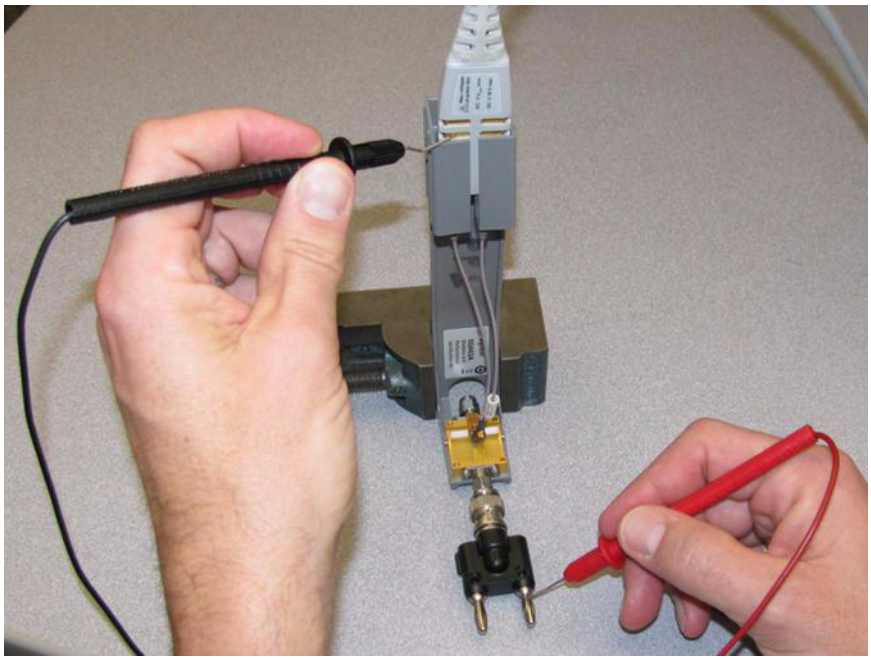


Figure 10 Measuring the single-ended input resistance of a ZIF or solder-in probe head

Measuring Input Resistance for the Browser Probe Head - Procedure:

The following image shows the correct setup for measuring the differential input resistance of the N5445A Browser probe head (Figure 11).

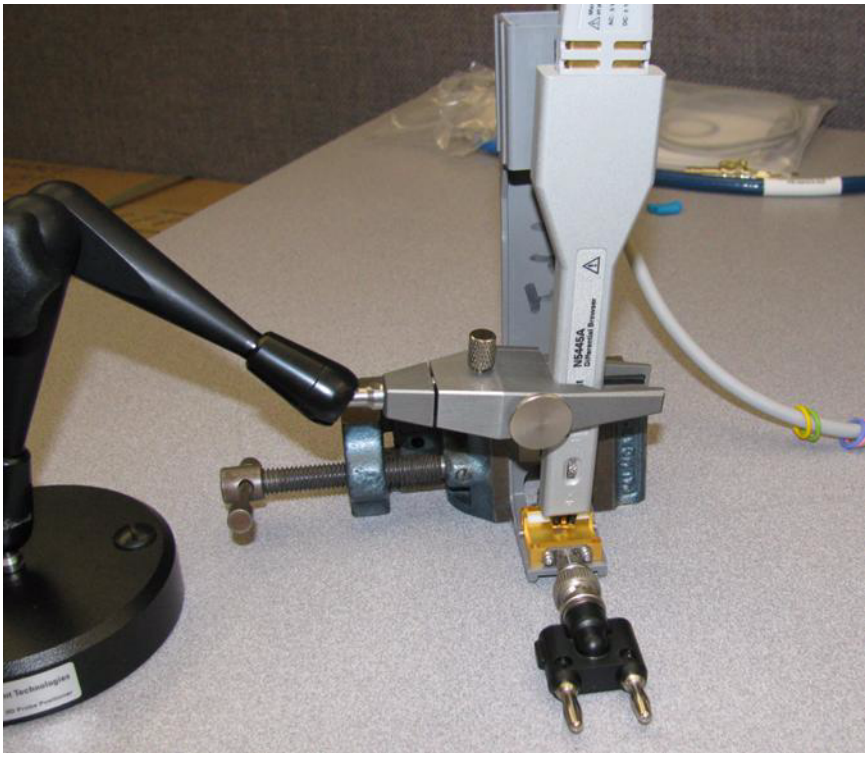


Figure 11 Setup for Measuring Input Resistance for Browser Probe Head

1. Set the browser for a fairly wide span (span does not impact this DC measurement).
2. Plug the probe amplifier into the browser.
3. Clamp the browser with the N2787A probe positioner.
4. Hold the browser with one hand and loosen the arm locking knob on the probe positioner with the other hand.
5. Carefully position one tip over the signal trace on the PV fixture and the other over the ground plane. Then let the weight of the browser slightly compress the tips so good contact is made.
6. Now the differential and single-ended input resistance can be measured in the same manner as for the ZIF and solder-in probe head procedure above.

Performance Test Record

Agilent Technologies

Agilent InfiniiMax III Series Probe

Model Number _____

Tested by_____

Serial Number _____

Work Order No._____

Recommended Test Interval - 1 Year/2000 hours

Date_____

Recommended next test date _____

Bandwidth Performance Test

Probe Head (only required to test one)	Test Limits	Result	Pass/Fail
N5439A with N5440A	greater than or equal to 26 GHz		
N5445A	greater than or equal to 28 GHz		

DC Input Resistance Performance Test

Probe Head (only required to test one)	Test Limits	Result	Pass/Fail
N5439A with N5440A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		
N5445A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		
N5441A	98 to 102 kΩ (differential mode) 49 to 51 kΩ (single-ended mode)		

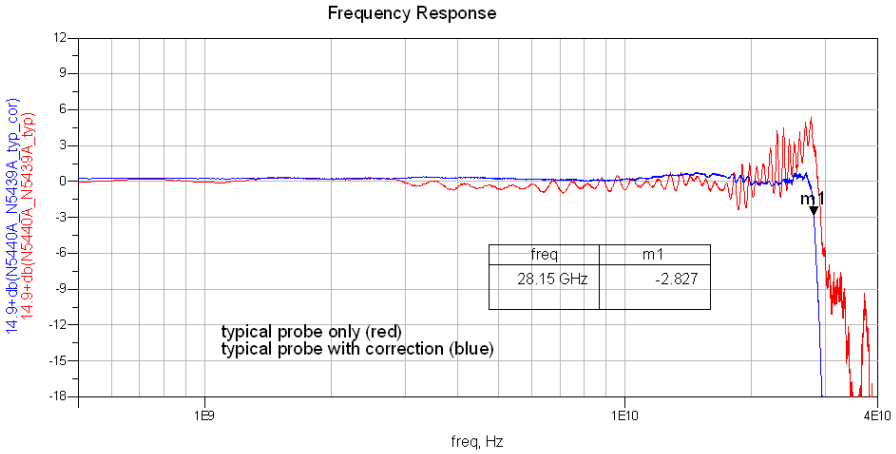
4 Performance Plots

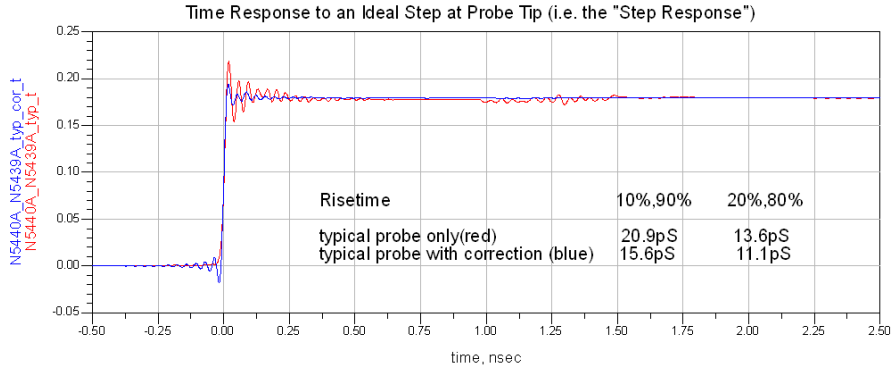
These are performance plots for the various configurations of the InfiniiMax III probing system. Items to note are:

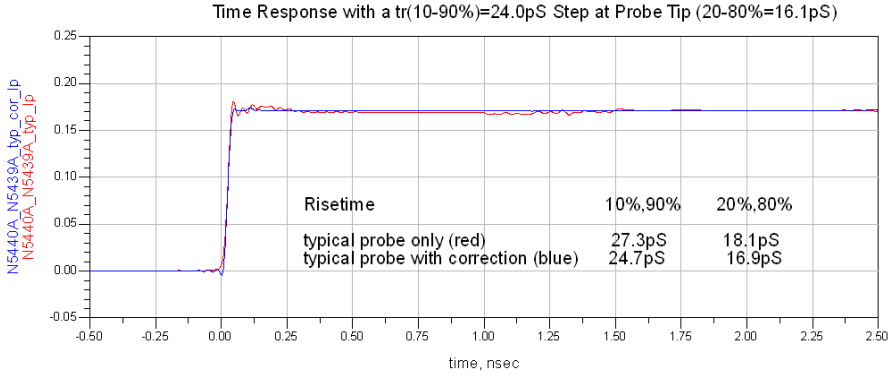
- When InfiniiMax III probes are used with Agilent Infiniium 90000 X-Series Oscilloscopes (and the Agilent DCA-X Wide-Bandwidth Sampling Scopes in some cases), probe correction is applied to enhance the probe accuracy.
- Probe correction is computed from the s parameters of the various probe components such as probe heads, probe amps, and accessories.
- Typically, the largest variation in a probe's response is due to variation in the response of the probe amplifier. For the InfiniiMax III probes, the s parameters of each probe amplifier are measured at manufacture and stored in non-volatile memory in the probe amplifier, thus allowing the removal of this component of variation.
- If care is taken in the manufacture of the probe heads and other accessories, the variation in the probe response due to these components is minimal since they tend to be simple passive devices. Therefore, the s parameters for probe heads and other accessories are based on an average of a cross-section of parts. These nominal s parameters are stored in the oscilloscopes firmware based on the model number of the probe head or accessory and used in conjunction with the measured probe amplifiers s parameters to compute the overall probe correction.
- Since InfiniiMax III probes can be used with instruments that do not apply probe correction, the plots below show the response of a typical probe head and typical probe amp with no probe correction (i.e. probe hardware only) as well as the response with probe correction based on the nominal probe head s parameters and measured probe amp s parameters.
- Measurement data used for these plots and for determining probe correction were made using Agilent vector network analyzers swept to 40GHz and calibrated with NIST traceable calibration standards.
- Two time responses are shown:
    - o "Time Response to an Ideal Step at Probe Tip" This is the classical "step response" which is defined as the time response to an ideal, zero rise-time step present at the probe tip. This can be determined accurately because the probe rolls off significantly within the 40GHz measurement range.
    - o "Time Response to a ?ps Step at Probe Tip" This is the time response of the probe when measuring a step with the indicated

10%-90% rise-time present at the probe tip. The measured step is generated using a 5th order Bessel low pass filter that has an edge shape as shown in the plot showing the loading effect of the probe. The rise-time of this test step is picked to illustrate approximately the fastest step the probe can measure with less than 3% error in the rise-time measurement.

N5440A_N5439A_N2803A (probe = 28GHz 450 ohm ZIF tip, ZIF Probe Head, 30GHz Probe Amp)

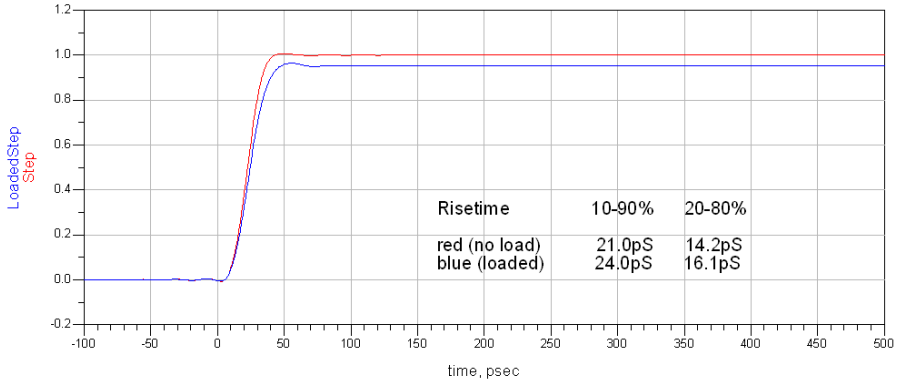




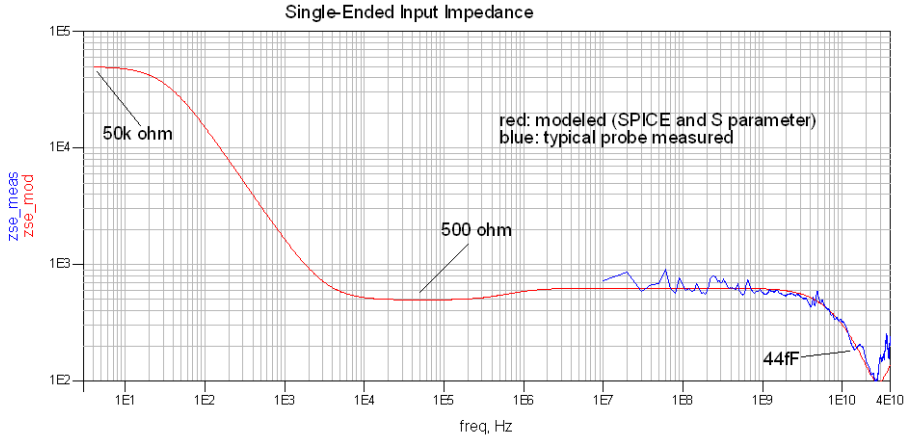


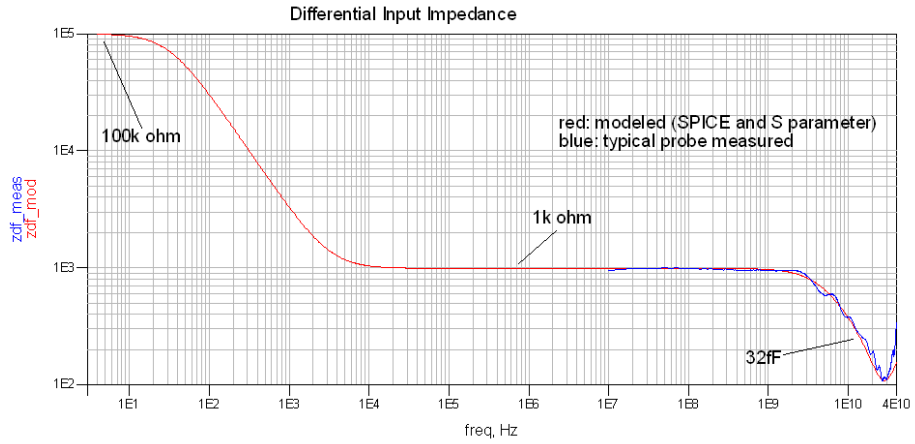
Loading Effect of Probe on tr(10-90%)=21.0pS Step

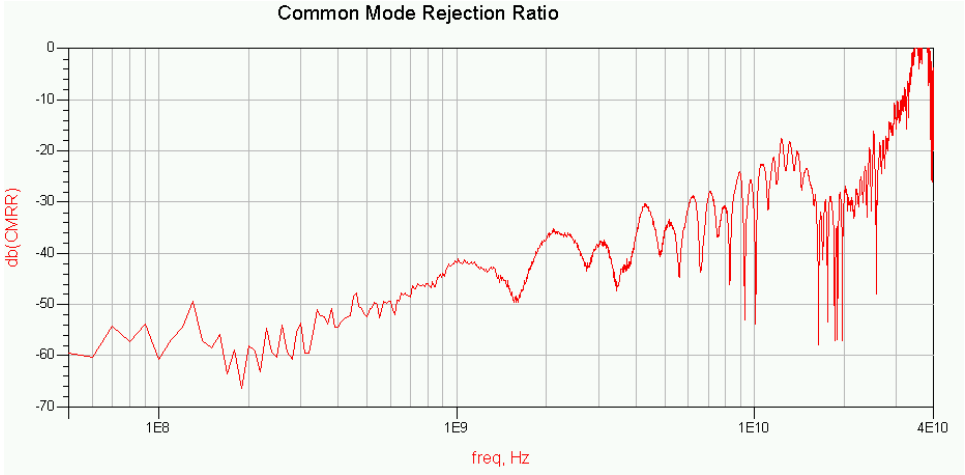
red: differential 50 ohm source (100ohm line, source and load terminated) with no load applied
blue: same source with differential probe loading applied



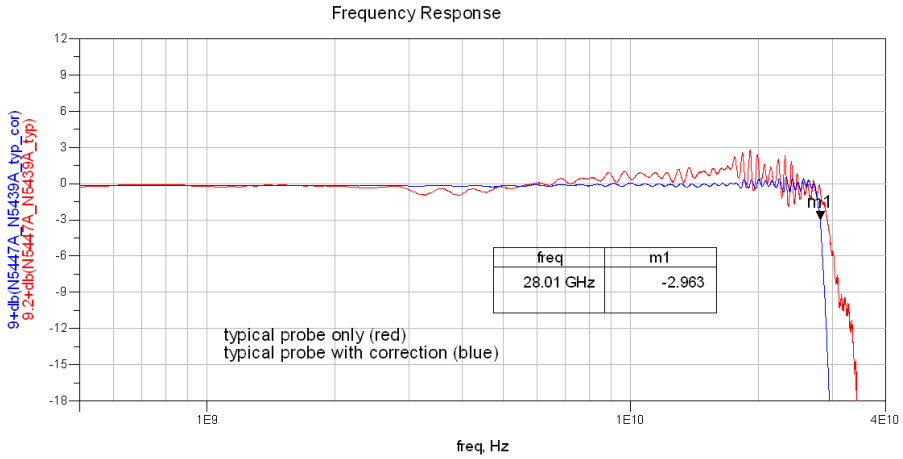
N5440A_N5439A_N2803A (probe = 28GHz 450 ohm ZIF tip, ZIF Probe Head, 30GHz Probe Amp) (continued)

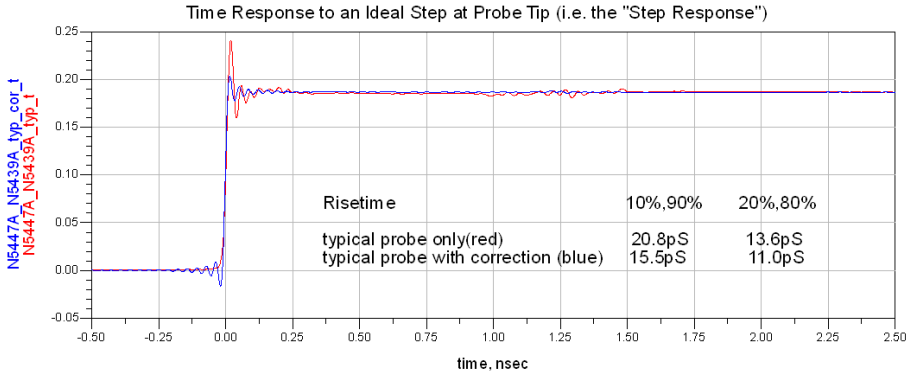


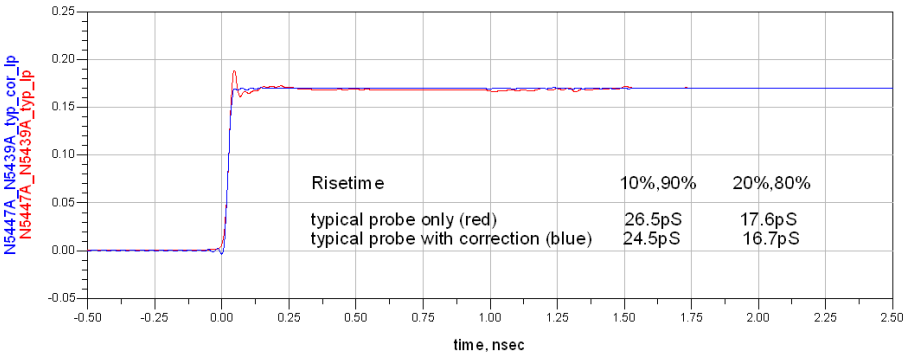




N5447A_N5439A_N2803A (probe = 28GHz 200 ohm ZIF tip, ZIF Probe Head, 30GHz Probe Amp)

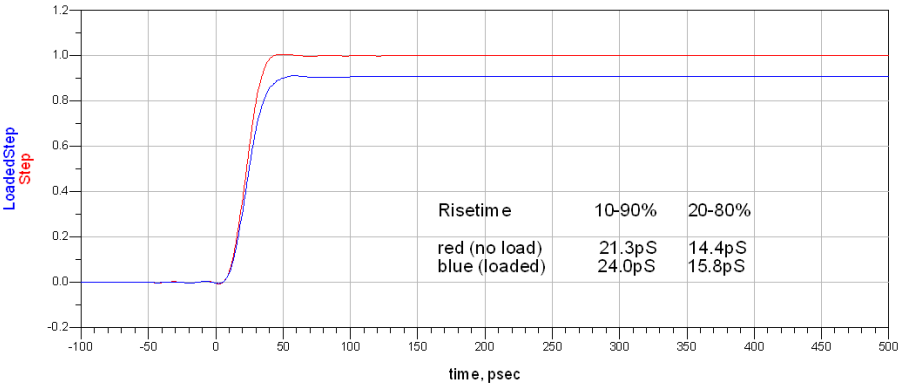




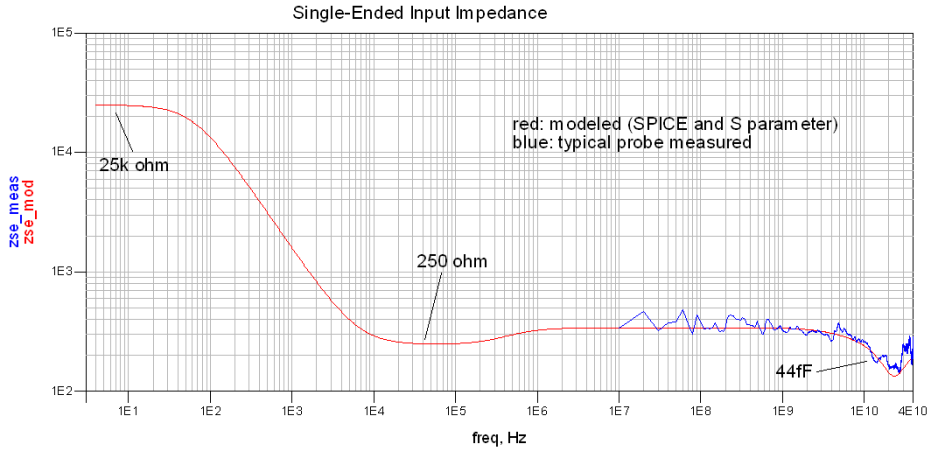


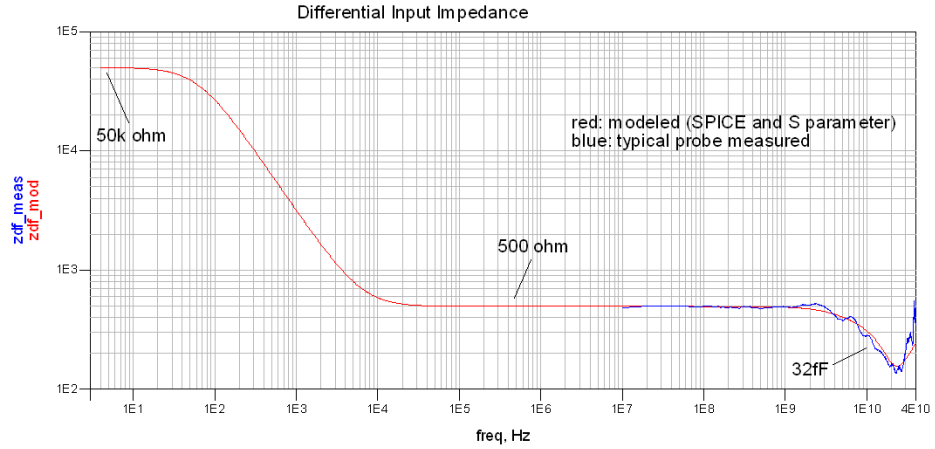
Loading effect of Probe on tr(10-90%)=21.3pS Step

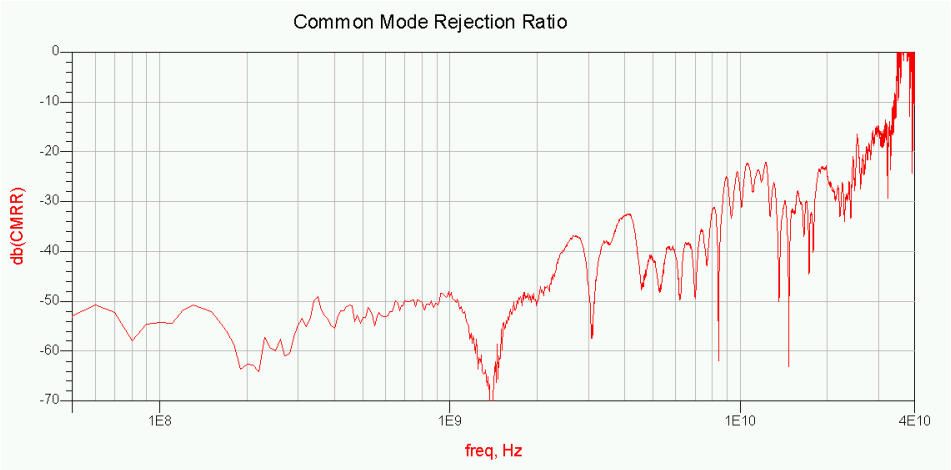
red: differential 50 ohm source (100ohm line, source and load terminated) with no load applied
blue: same source with differential probe loading applied



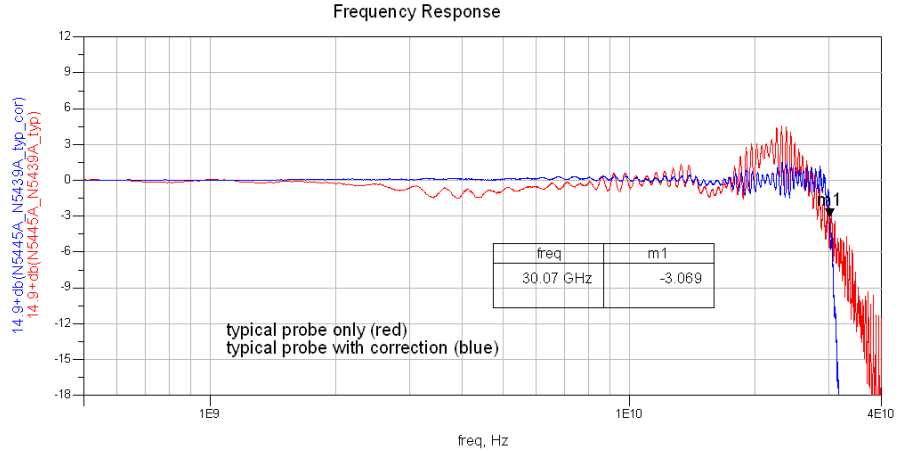
N5447A_N5439A_N2803A (probe = 28GHz 200 ohm ZIF tip, ZIF Probe Head, 30GHz Probe Amp) (continued)

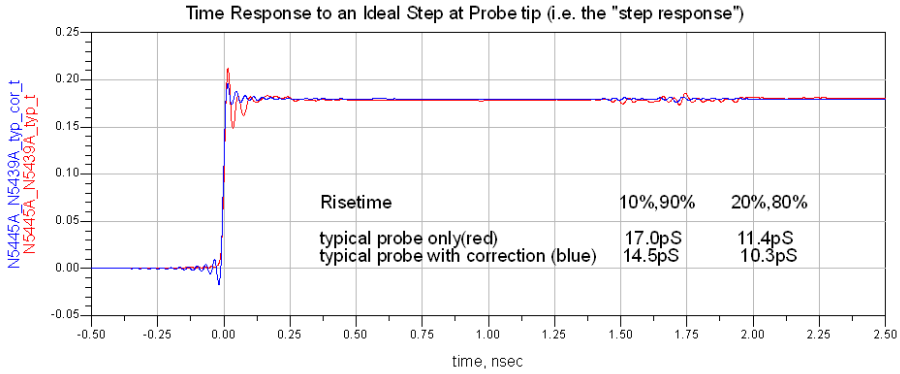


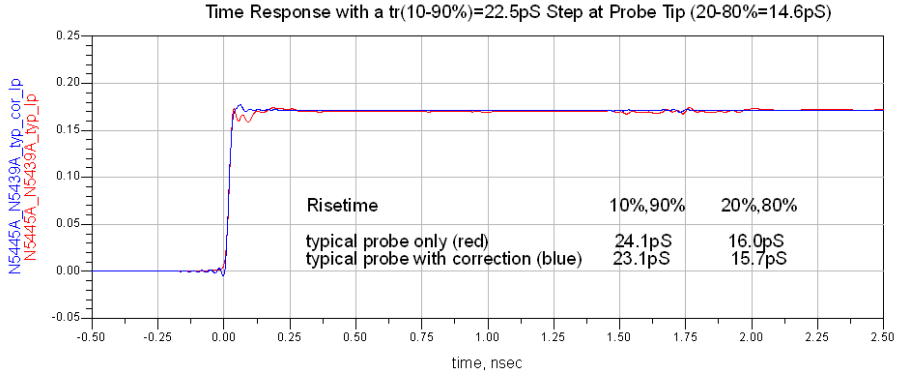




N5445A_N2803A 30GHz (probe = Browser 1mm span, 30GHz Probe Amp)

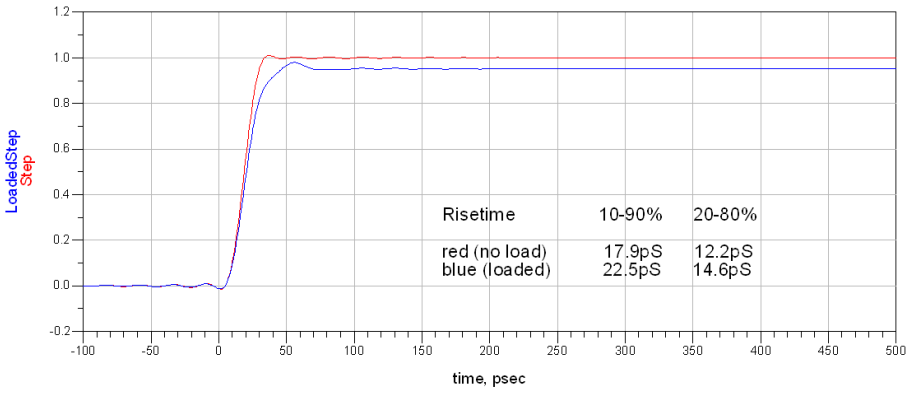




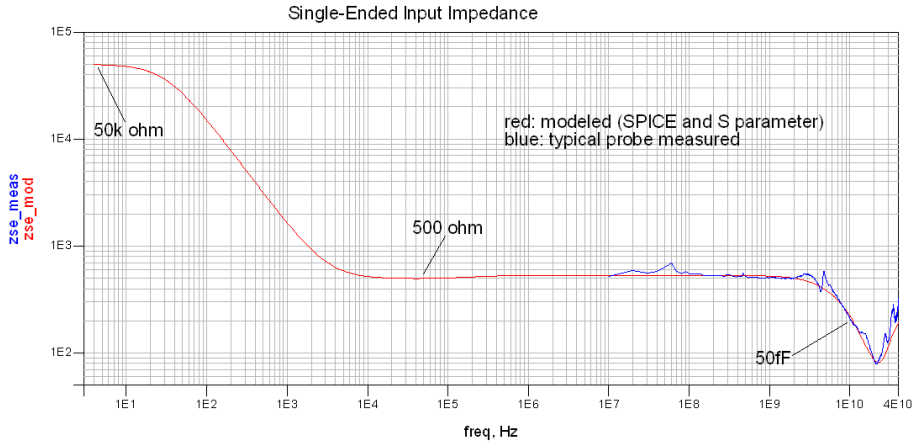


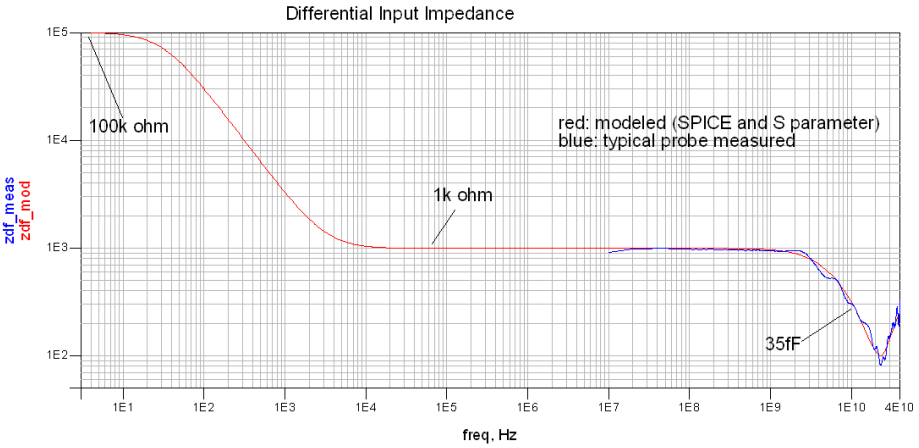
Loading Effect of Probe on tr(10-90%)=17.9pS Step

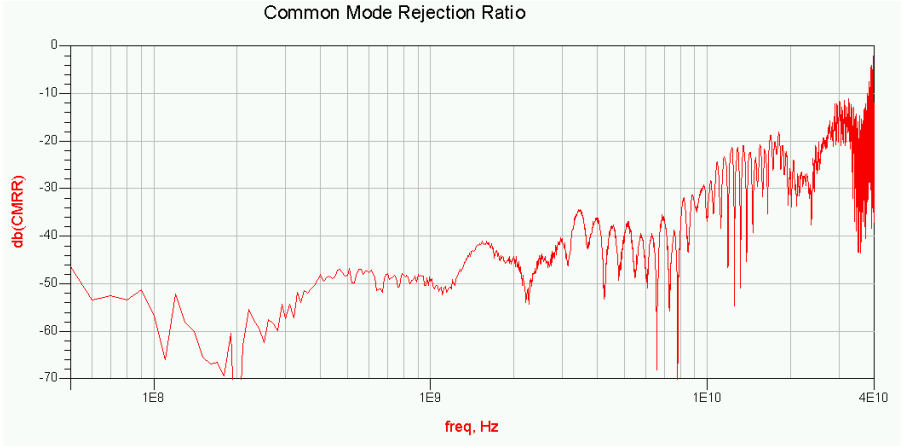
red: differential 50 ohm source (100ohm line, source and load terminated) with no load applied
blue: same source with differential probe loading applied



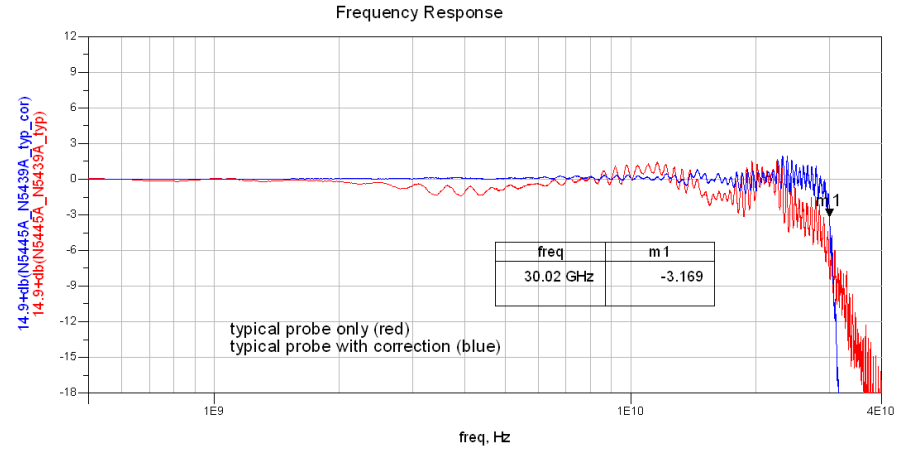
N5445A_N2803A (probe = 30GHz Browser 1mm span, 30GHz Probe Amp) (continued)

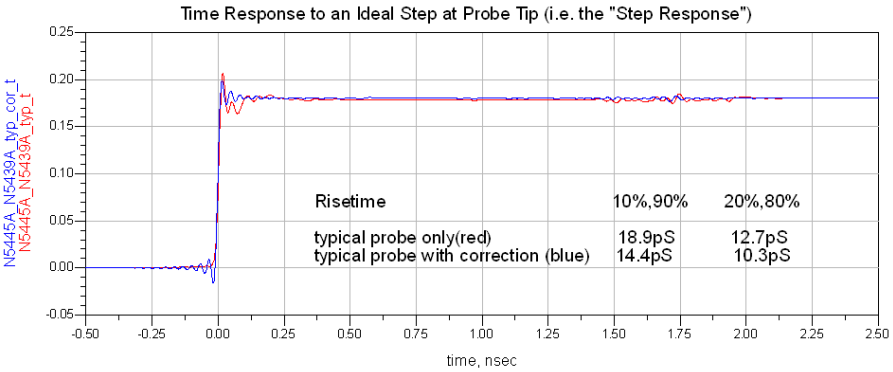


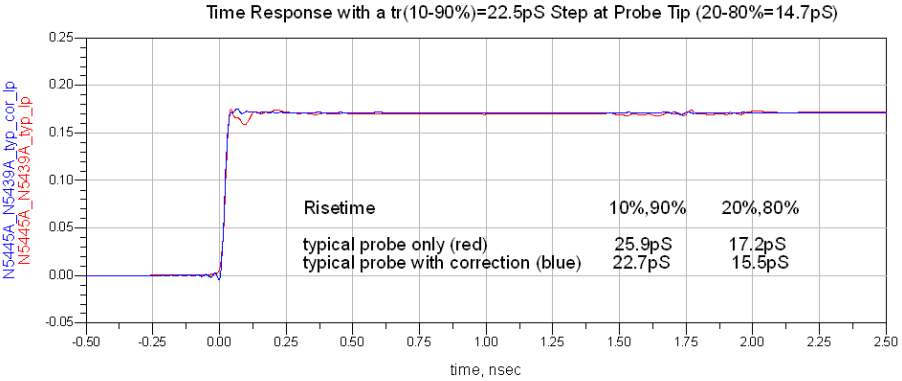




N5445A_N2803A (probe = 30 GHz Browser 2mm span, 30GHz Probe Amp)

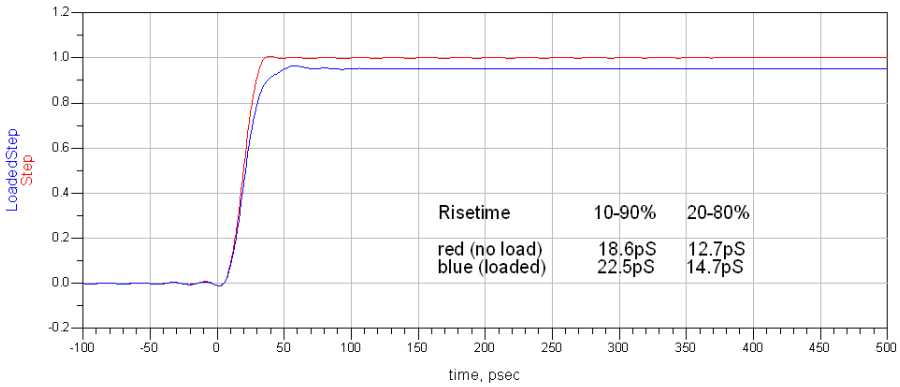




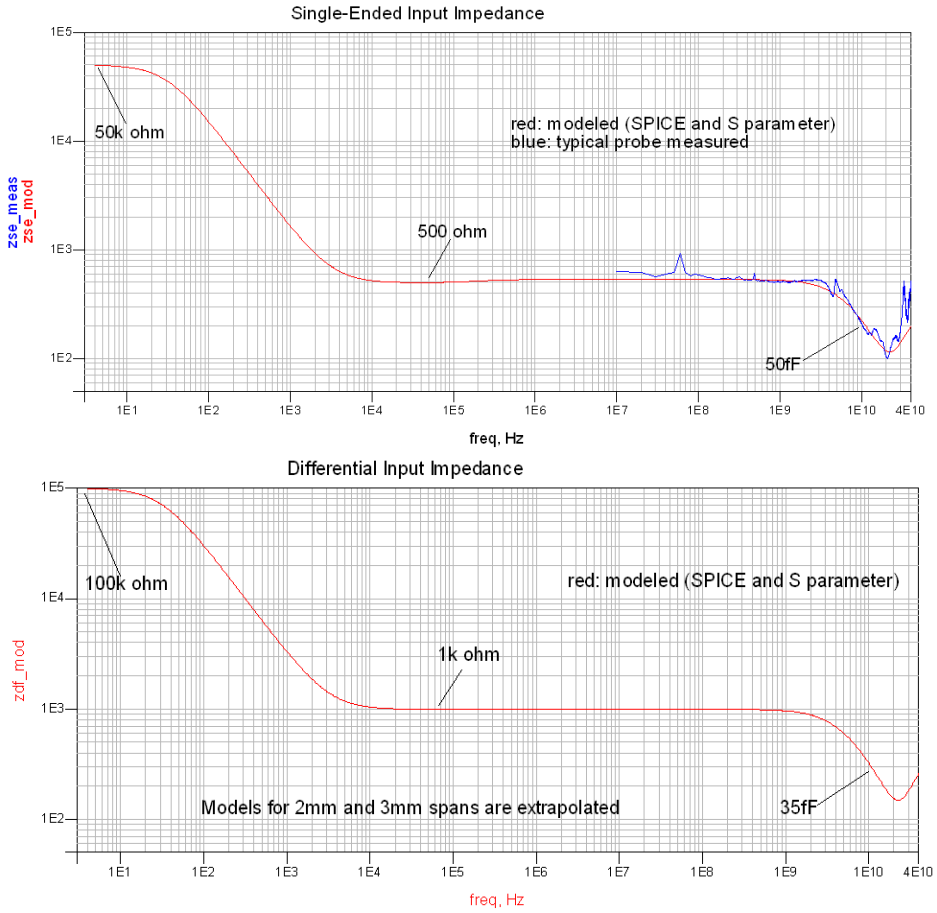


Loading Effect of Probe on tr(10-90%)=18.6pS Step

red: differential 50 ohm source (100ohm line, source and load terminated) with no load applied
blue: same source with differential probe loading applied

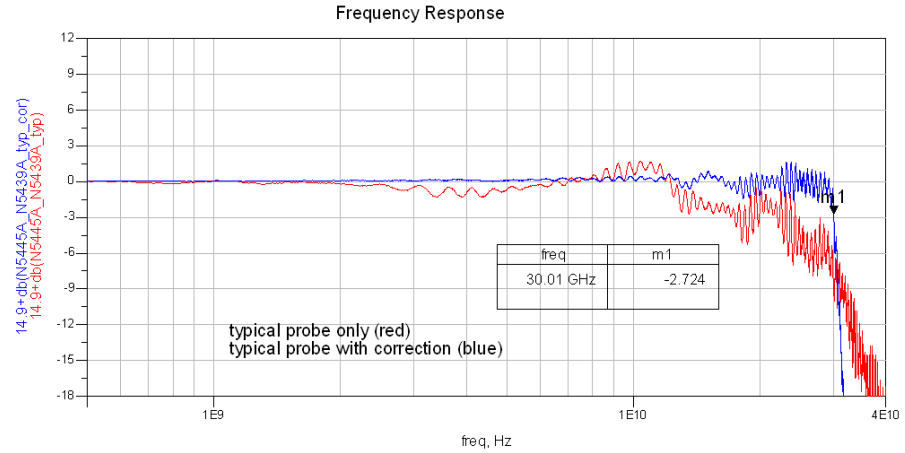


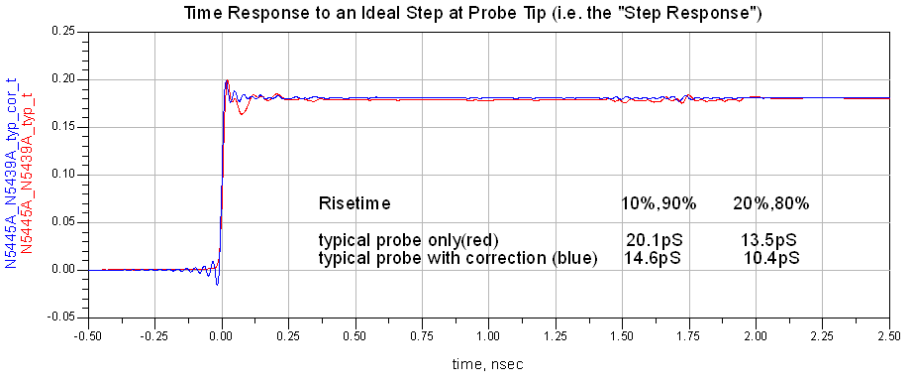
N5445A_N2803A (probe = 30 GHz Browser 2mm span, 30GHz Probe Amp) (continued)

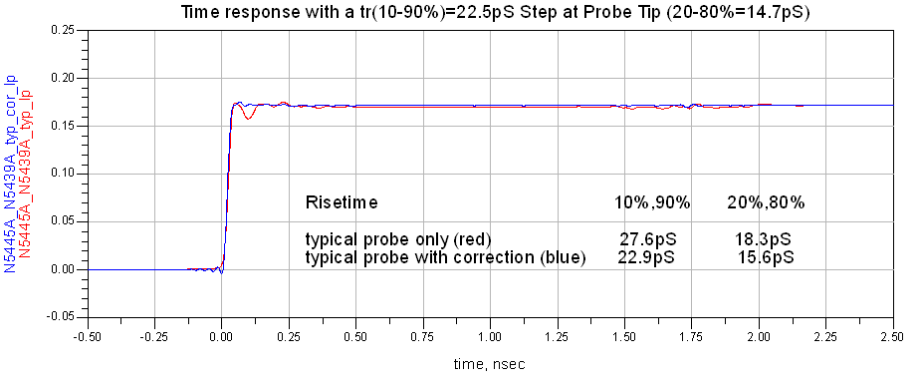


Note: For browser spans of 2 and 3mm, the biggest effect is in the frequency and time responses. The input loading is nearly the same as for the 1mm span except that the impedance minimum at ~22 GHz is slightly higher.

N5445A_N2803A (probe = 30GHz Browser 3mm span, 30GHz Probe Amp)

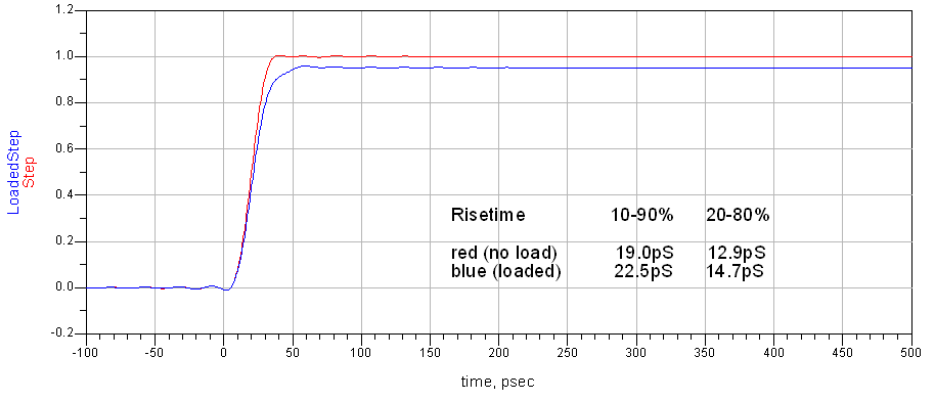




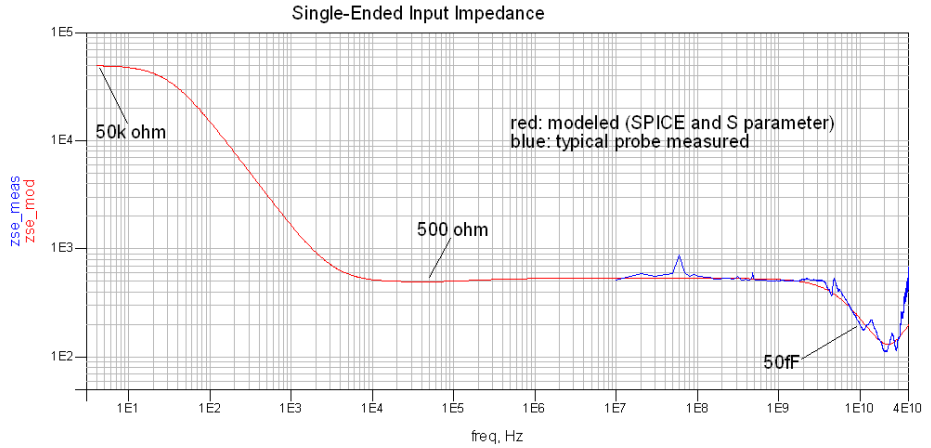


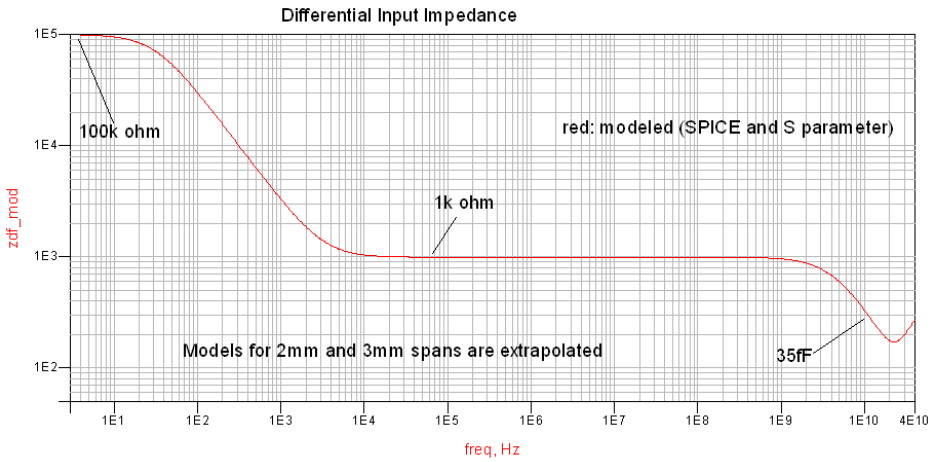
Loading Effect of Probe on tr(10-90%)=19.0pS Step

red: differential 50 ohm source (100ohm line, source and load terminated) with no load applied
blue: same source with differential probe loading applied



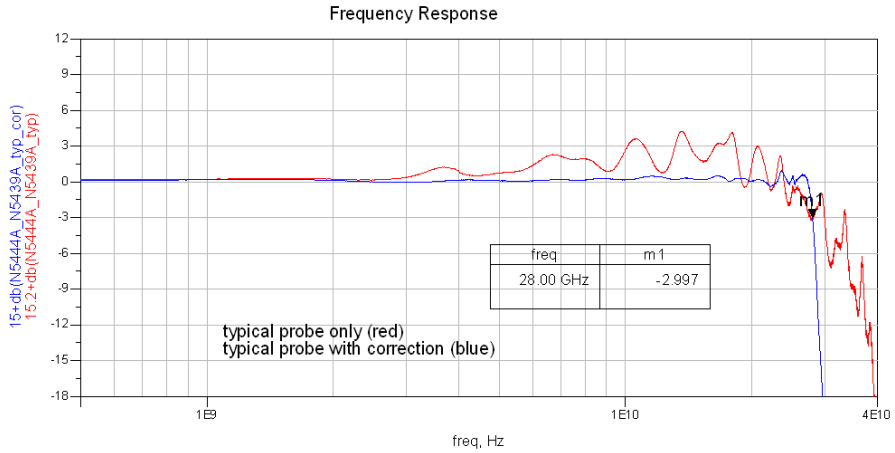
N5445A_N2803A (probe = 30GHz Browser 3mm span, 30GHz Probe Amp) (continued)

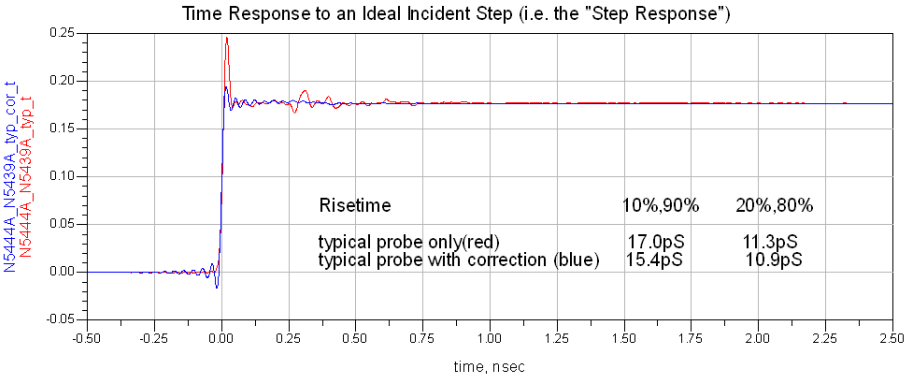


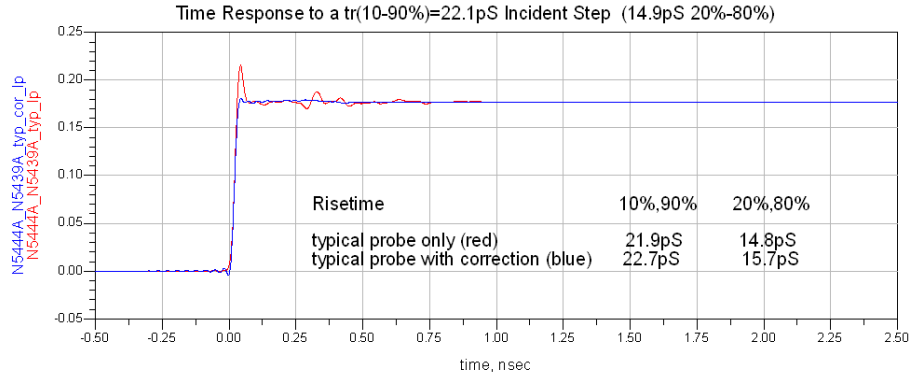


Note: For browser spans of 2 and 3mm, the biggest effect is in the frequency and time responses. The input loading is nearly the same as for the 1mm span except that the impedance minimum at ~22 GHz is slightly higher.

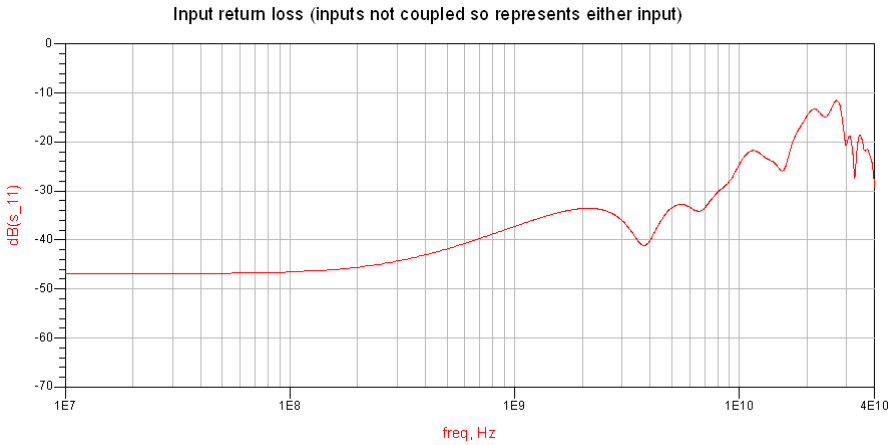
N5444A_N2803A (probe = 28GHz 2.92mm Probe Head, 30GHz Probe Amp)

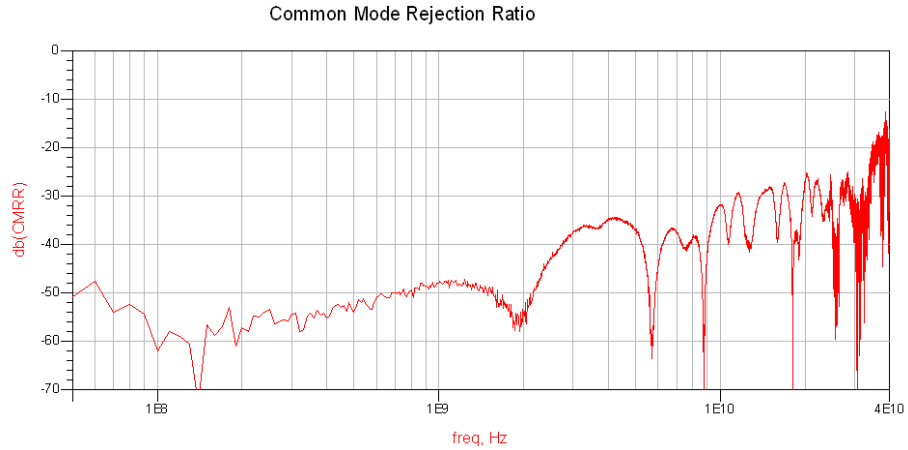




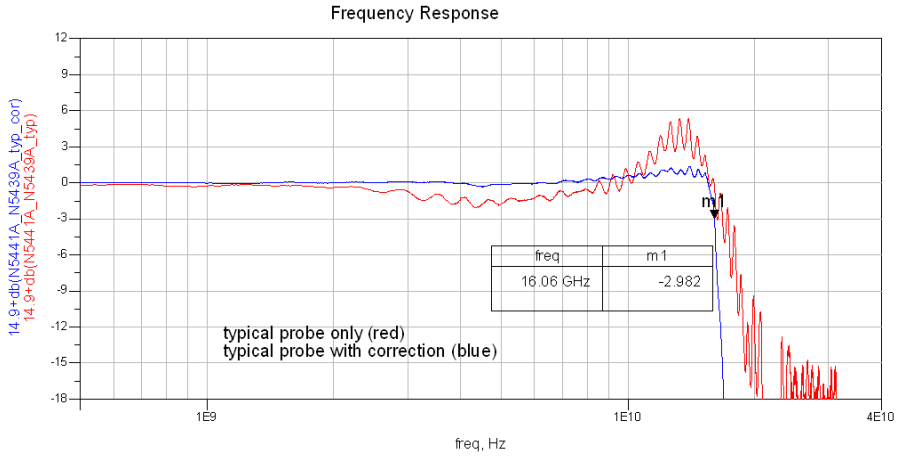


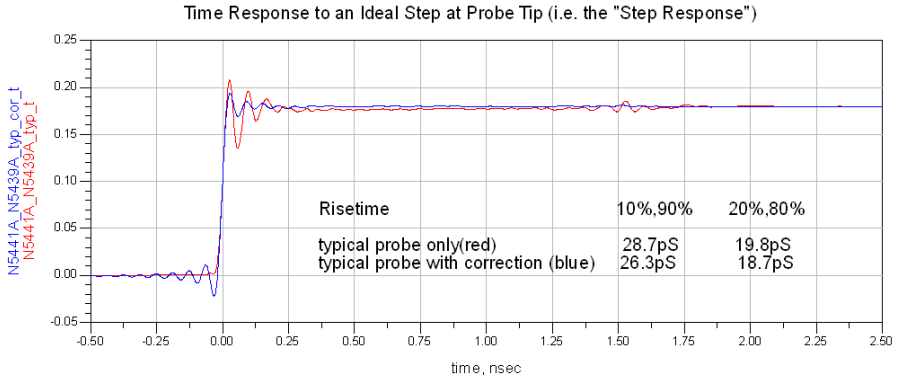
N5444A_N2803A (probe = 28GHz 2.92mm Probe Head, 30GHz Probe Amp) (continued)

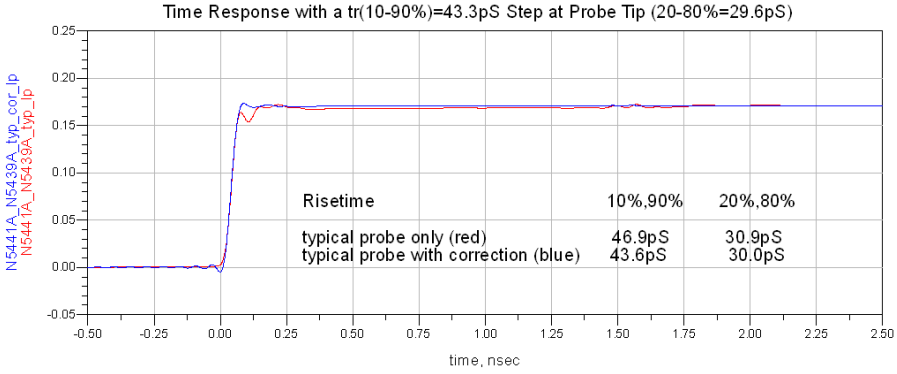




N5441A_N2803A (probe = 16GHz Solder-In Probe Head, 30GHz Probe Amp)

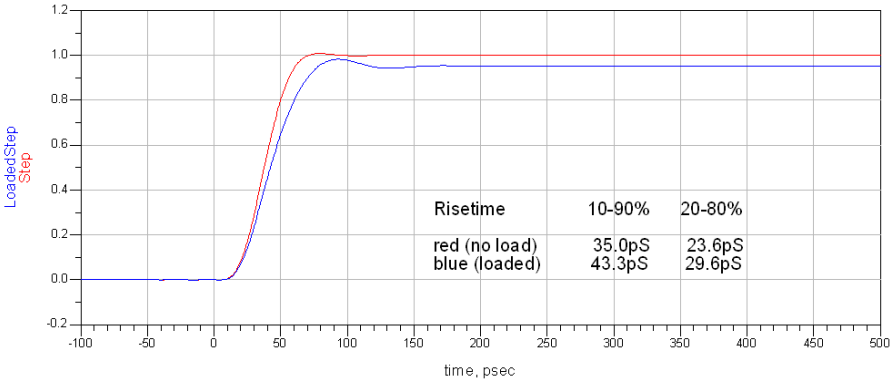






Loading Effect of Probe on tr(10-90%)=35pS Step

red: differential 50 ohm source (100ohm line, source and load terminated) with no load applied
blue: same source with differential probe loading applied



N5441A_N2803A (probe = 16GHz Solder-In Probe Head, 30GHz Probe Amp) (continued)