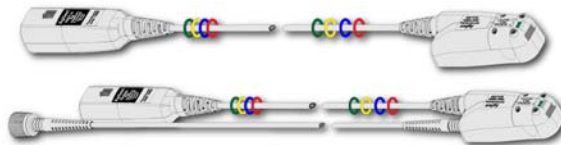


# Keysight N2820/1A High-Sensitivity Current Probes

User's Guide



# Notices

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## Safety Notices

### CAUTION

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### 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.

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# 1 General Information

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The N2820A and N2821A high-sensitivity current probes allow you to measure AC and DC currents from 50  $\mu\text{A}$  to 5A. These high dynamic-range probes are designed to be used on devices that have very tight geometry constraints. Since these probes do not need to be degaussed and do not require frequent calibration, you can focus on making your measurements. The probes accurately construct the current waveform by measuring the voltage across either an internal or external DUT-mounted  $R_{\text{SENSE}}$  resistor, which results in highly repeatable measurements.

---

**CAUTION** Before using the probe, refer to “**Safety Information**” on page 15.

---

# 1 General Information

## Introduction

# Introduction

The N2820A and N2821A probes are shipped in the case that is shown in **Figure 1**. When you receive the probe, inspect it as described in “**Inspecting the Probe**” on page 12. When opening the case, lift out the foam cutout and flip the cutout over to reveal the ground lead and secondary cable as shown in the following figure. The secondary cable is only provided with N2820A probes.

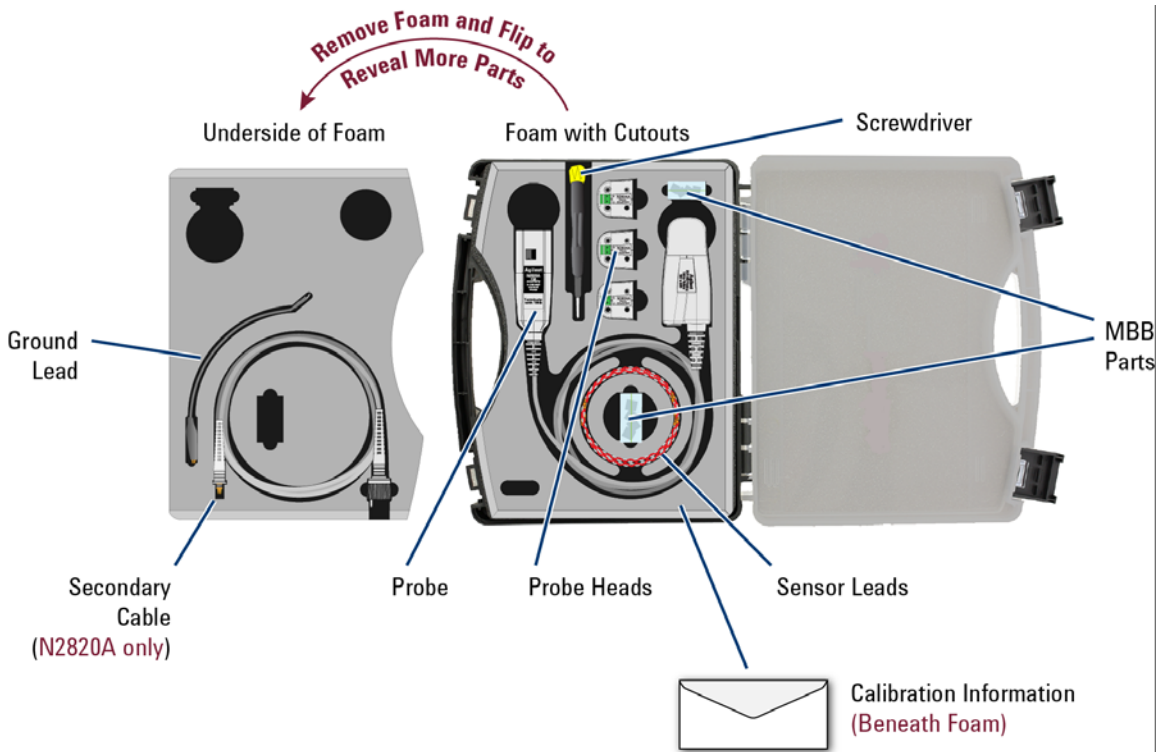


Figure 1 Probe in Supplied Case

**To Clean the Probe**

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

Figure 2 shows the different components of the N2820A and N2821A probes. The N2820A two-channel probe, with its two internal, parallel differential amplifiers, provides simultaneous low and high gain views. The N2821A also includes two amplifiers and its main output can be switched between these two views. Before using an N2820A probe, connect the secondary cable as described in “Quick Start” on page 23. The N2821A single-channel probe looks identical to the N2820A but *does not* include the secondary cable. The accessories provided with the probes are shown in Figure 3 on page 10.

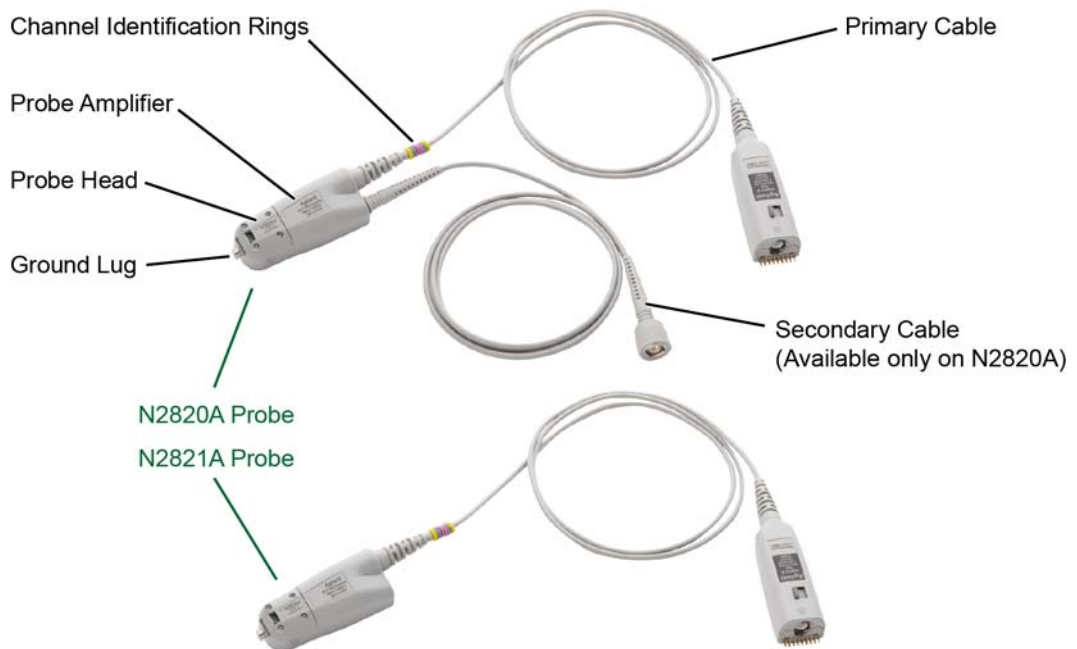


Figure 2 Probe Parts Identification

# 1 General Information

## Introduction

### CAUTION

Probes are ESD sensitive devices, particularly at the probe heads. Follow standard ESD precautions when handling. Remove head accessories when storing the probe.

## Oscilloscope Compatibility

The N2820A and N2821A probes are compatible with the Keysight oscilloscopes shown in [Table 1](#). The table also lists the minimum required firmware version for the oscilloscope.

### NOTE

The N2820A and N2821A probes are designed for oscilloscopes with 1 M $\Omega$  AutoProbe-interface channel inputs.

### Is Your Oscilloscope Software Up-to-Date?

Keysight periodically releases software updates to support your probe, fix known defects, and incorporate product enhancements. To download the latest firmware, go to [www.keysight.com](http://www.keysight.com) and search for your oscilloscope's topic. Click on the "Drivers, Firmware & Software" tab.

Table 1 Compatible Oscilloscopes with Number of Probes Supported

Oscilloscope	Number of Probes Supported	
	N2820A 2 Channel Probe	N2821A 1 Channel Probe
<b>Infiniium Oscilloscopes (<i>firmware version 4.2 or above</i>)</b>		
90000A, X-, and Q-Series	not supported	not supported
9000 H-Series	2 <sup>a</sup> or 4 <sup>b</sup>	4 <sup>c</sup>
9000A-Series	2 <sup>a</sup> or 4 <sup>b</sup>	4 <sup>c</sup>
<b>InfiniiVision Oscilloscopes (<i>4000 X firmware version 3.10 or above, 3000 X firmware version 2.30 or above</i>)</b>		
4000 X-Series	2 or 4 <sup>b</sup>	4 <sup>c</sup>
3000 X-Series	2	2 <sup>d</sup>
2000 X-Series	not supported	not supported

- a Dual-Grid View available.
- b If secondary cables are *not* connected.
- c On four channel oscilloscope.
- d Maximum of 2 probes on two or four channel oscilloscope.



Infiniium Dual-Grid View The N2820A probe provides two channel-input cables which allow two simultaneous views of the current waveform: a high-gain zoomed-in and a low-gain zoomed-out view. On Infiniium oscilloscopes, both zoomed-in and zoomed-out waveforms can be simultaneously displayed in *dual-grid view*, where each waveform can be viewed in a different time span. To learn more about dual-grid view, refer to [“To Simultaneously View Zoomed-In/Zoomed-Out Waveforms”](#) on page 36. InfiniiVision oscilloscopes do not support dual-grid views. The zoomed-in channel has 500 kHz bandwidth and the zoomed-out channel has 3 MHz bandwidth. N2821A probes, having only one channel-input cable, do not support the simultaneous display of zoomed-out and zoomed-in views.

---

NOTE There is *no* upgrade available to convert an N2821A (1 channel) probe to an N2820A (2 channel) probe.

---

Probe Heads The probe is supplied with the N2822A, N2824A, and N2825A interchangeable  $R_{SENSE}$  probe heads. The N2822A and N2824A heads include different  $R_{SENSE}$  resistor values. The N2825A user-defined head does *not* include an  $R_{SENSE}$  resistor and is selected in situations when you want to use your own  $R_{SENSE}$  resistor that you have mounted on your DUT. To learn about configuring and using the heads, refer to [Chapter 2](#), “Making Measurements”.

Make-Before-Break (MBB) Connectors Five Make-Before-Break (MBB) connectors are provided with the probes. The MBB connectors allow you to quickly probe multiple locations on your DUT without interrupting the circuit under test. Refer to [“To Make Measurements Without Interrupting Your DUT”](#) on page 38 for more information.

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

# 1 General Information Accessories

## Accessories

Supplied Accessories The N2820A and N2821A probes come with the accessories shown in [Figure 3](#). To learn how to use these accessories, refer to [Chapter 2](#), “Making Measurements”.

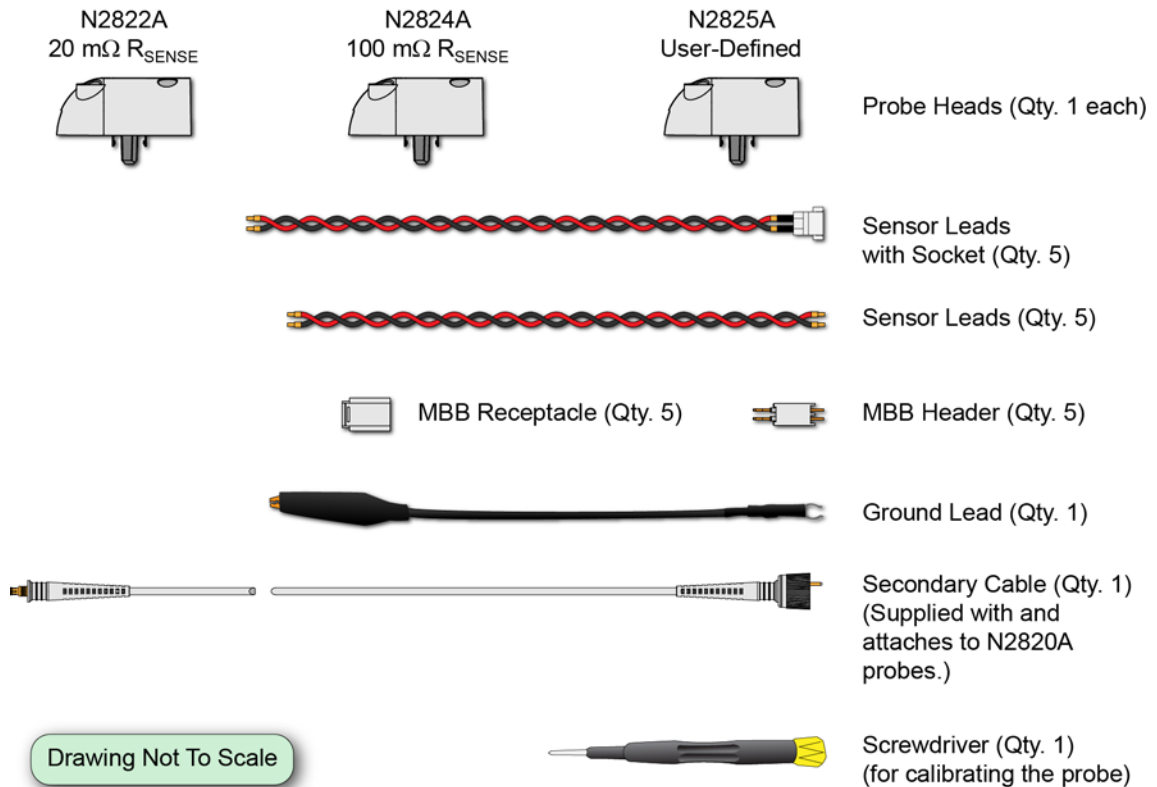


Figure 3 Supplied Accessories

NOTE

To ensure the display of accurate waveforms, *always* connect the supplied ground lead when probing battery-powered devices, such as mobile phones. Refer to “**To Measure Battery-Powered Devices**” on page 31.

Replacement Accessories [Table 2](#) shows the available replacement accessories and parts.

Table 2 Replacement Accessories

Model Number	Description	Quantity
N2822A	20 mΩ R <sub>SENSE</sub> Head	1
N2824A	100 mΩ R <sub>SENSE</sub> Head	1
N2825A	User-defined R <sub>SENSE</sub> Head	1
N2826A	Replacement unsocketed sensor leads (22 AWG)	5
N2827A	Secondary Cable for use with N2820A probe	1
N2828A	Replacement MBB Headers	5
N2829A	Replacement MBB Receptacles and socketed sensor leads (22 AWG)	5

## Inspecting the Probe

- Inspect the shipping container for damage.

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

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

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

## Returning the Probe for Service

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

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

- Name and address of owner
- Product model number (for example, N2820A)
- Product Serial Number (for example, MYXXXXXXXX)
- Description of failure or service required

---

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

---

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

---

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

---

### Contacting Keysight Technologies

For technical assistance, contact your local Keysight Call Center.

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

## **1 General Information**

### **Returning the Probe for Service**

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

## Safety Information



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

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

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

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

---

**WARNING**

**Use Only Grounded Instruments.**

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

---

**WARNING**

**Connect and Disconnect Properly.**

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

---

**WARNING**

**Observe Probe Ratings.**

**Do not apply any electrical potential to the probe input which exceeds the maximum rating of the probe. Make sure to comply with the voltage versus frequency derating curve found in this manual.**

---

## 1 General Information

### Safety Information

---

**WARNING**

**Keep Away From Live Circuits.**  
Avoid open circuitry. Do not touch connections or components when power is present.

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

**Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.**

---

**CAUTION**

The probe cable is a sensitive part of the probe and, therefore, you should be careful not to damage it through excessive bending or pulling. Avoid any mechanical shocks to this product in order to guarantee accurate performance and protection.

---



---

NOTE

Avoid, if possible, the proximity of other conductors which may create noise.

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**WARNING**

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

---

**1 General Information**  
**Safety Information**

# 2

## Making Measurements

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In this chapter, you'll learn how to connect the probe to the oscilloscope and how to perform several measurements. The probe accessories are very flexible and can be configured to match your unique probing requirements regarding convenience versus accuracy.

Refer to [Chapter 3](#), "Using N2825A Probe Heads", for additional information regarding the N2822A, N2824A, and N2825A probe heads.

## Introduction

The probes are supplied with three interchangeable  $R_{\text{SENSE}}$  probe heads: N2822A, N2824A, and N2825A. To begin using the probe, refer to “Quick Start” on page 23. Figure 4 on page 21 illustrates the relative merits of using the three different heads with the different sensor leads.

### N2822A and N2824A Probe Heads

The N2822A and N2824A heads include built-in internal  $R_{\text{SENSE}}$  resistors. Because the oscilloscope recognizes when these probes are connected, the oscilloscope automatically knows the value of the  $R_{\text{SENSE}}$  resistor when calculating measurements.

Table 3 Description of Heads

Description	N2822A	N2824A
$R_{\text{SENSE}}$ Resistor	20 m $\Omega$	100 m $\Omega$
$R_{\text{SENSE}}$ Tolerance	$\pm 1\%$	$\pm 1\%$
Maximum Power Dissipation <sup>a</sup>	500 mW	500 mW
Current Range	250 $\mu$ A to 5A	50 $\mu$ A to 2.2A
Added Benefit	Smaller voltage drop (lower burden voltage).	For higher sensitivity (ie. lower noise).

a Temperature coefficient is 20 ppm / °C

### CAUTION

The maximum sensor resistor power rating is 500 mW. The maximum acceptable average current for the N2822A is 5  $A_{\text{rms}}$  and N2824A is 2.2  $A_{\text{rms}}$ .

### N2825A Probe Head

The N2825A user-defined head does *not* include an  $R_{\text{SENSE}}$  resistor and is selected in situations when you want to use your own external DUT-mounted  $R_{\text{SENSE}}$  resistor. Chapter 3, “Using N2825A Probe Heads”, provides additional information on using the N2825A head.

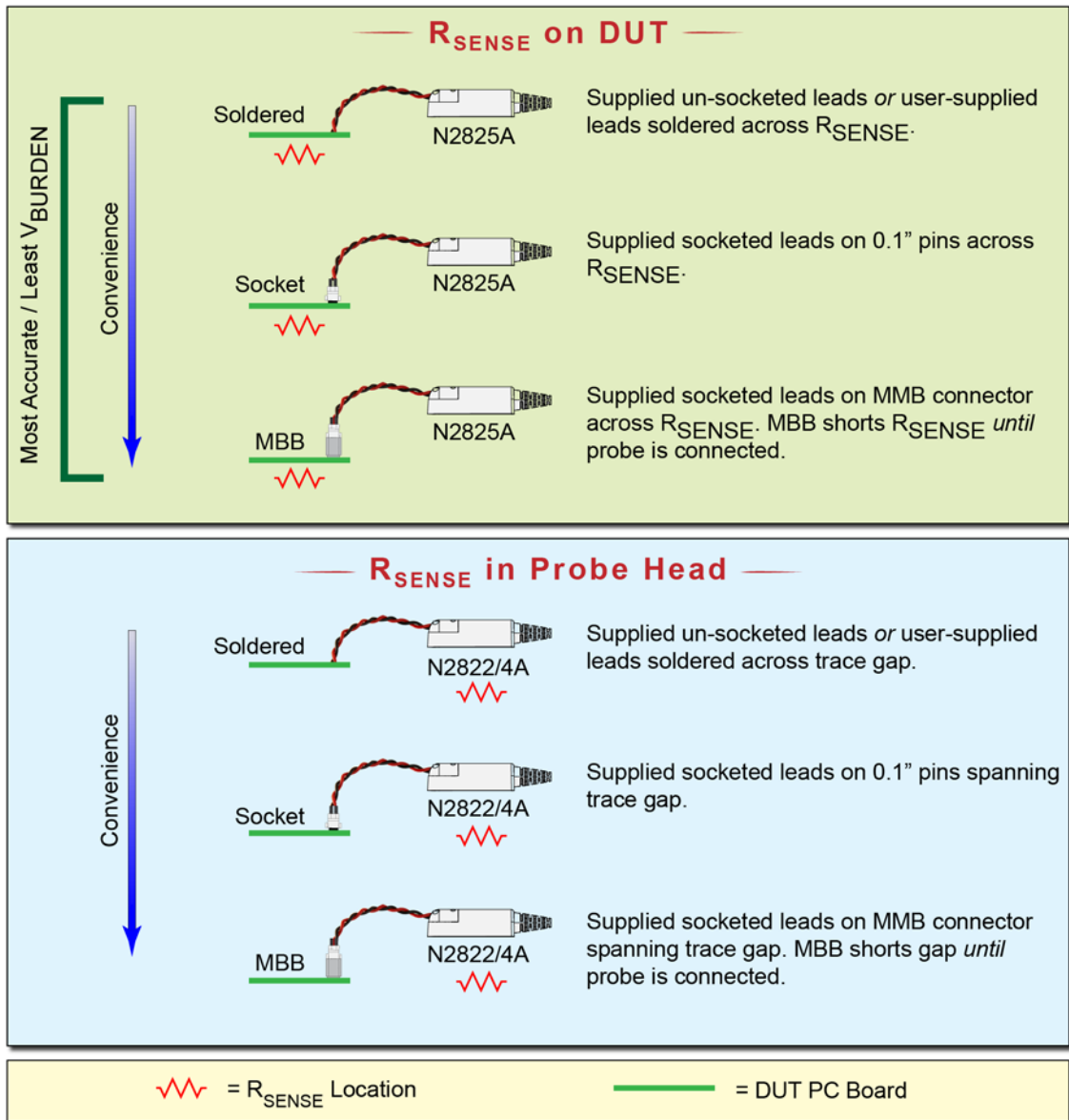


Figure 4 Different Probing Connections With Relative Merit

## 2 Making Measurements

### Introduction

Sensor Leads    The probe heads do not come with the sensor leads soldered on them. Instead, you must solder on the appropriate leads as described in “Quick Start” on page 23.

---

**CAUTION**

---

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

## Quick Start

### Step 1. Attach the Sensor Leads

The probe heads do not come with the leads soldered on them. Instead, you must solder on one of the following types of sensor leads to the probe head.

- Accessory un-socketed leads (22 AWG).
- Accessory socketed leads (22 AWG).
- Your own leads.

The socketed leads are designed to plug directly onto the following items:

- Standard PC board headers with 2.54 mm (0.1") contact-pitch spacing.
- MBB accessory headers mounted on the PC board. You can quickly snap the socketed lead on and off the MBB header. To learn about the MBB accessory, refer to [“To Make Measurements Without Interrupting Your DUT”](#) on page 38.

- 1 Position the sensor leads into the head’s access hole as shown in [Figure 5](#).

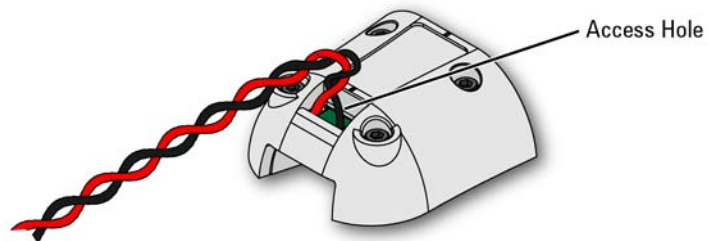


Figure 5 Placing the Leads into the Tip’s Access Hole

- 2 Flip the head as shown in [Figure 6](#) and insert the leads up through the PC board’s solder holes **TP1** and **TP2**. Insert the **RED (+)** lead at TP2 and the **BLACK** lead at TP1. Solder the leads in place.

## 2 Making Measurements Quick Start

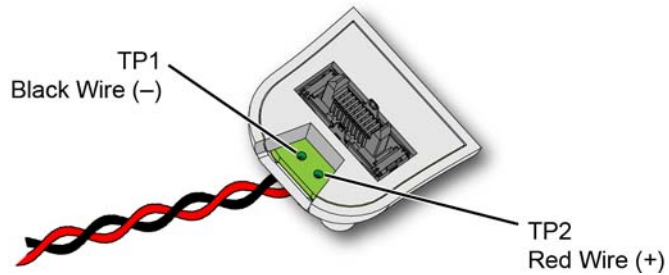


Figure 6 Lead Positions on PC Board

### Step 2. Attach the Probe Head

Gently press the head into position on the probe amplifier while carefully mating the connector as shown in [Figure 7](#).

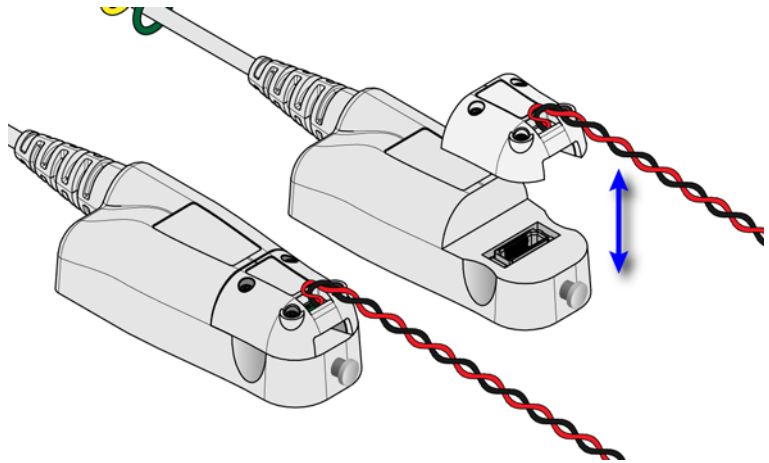


Figure 7 Attaching and Removing a Head from the Probe

---

NOTE

Never apply excessive force when attaching the head. To remove a head, pull the head straight off the probe in the direction shown.

---

NOTE

Do not remove the four head screws when removing the head.



---

NOTE

You can safely change a probe head while the probe is connected to an oscilloscope that is powered on.

---

CAUTION

If lead wires are attached, do not pull on the wires as this could damage the head.

---

Step 3.  
Attach the Secondary  
Cable

This step is for N2820A two-channel probes only. N2821A probes are not designed for use with the secondary cable and cannot be upgraded.

- Gently snap the secondary cable into the probe amplifier as shown in [Figure 8](#).

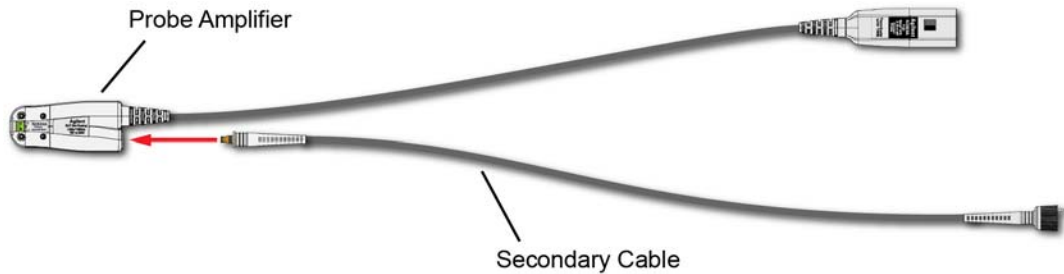


Figure 8 Connecting the N2820A's Secondary Cable

## 2 Making Measurements Quick Start

### Step 4. Connect Probe to Scope

- 1 Connect the probe to any available oscilloscope channel.

---

#### NOTE

For N2820A probes *always* connect the primary cable first *promptly* followed by the secondary cable. This enables the oscilloscope to automatically associate the two inputs to the same probe. **Figure 9** is an example of connecting two N2820A probes to non-adjacent channel inputs.

---

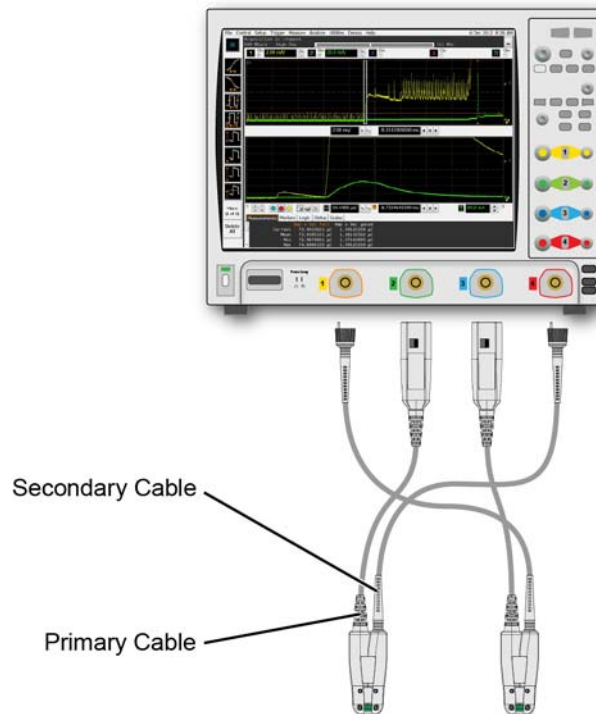


Figure 9 Example of Connecting Two N2820A Probes to the Oscilloscope

---

NOTE N2820A Probes. Although connecting the primary and secondary cables to adjacent channels may reduce clutter, this is not a requirement. For example, you could connect an N2820A's primary cable to channel 2 and its secondary cable to channel 4.

---

NOTE To ensure the display of accurate waveforms, *always* connect the supplied ground lead when probing battery-powered devices. Refer to **"To Measure Battery-Powered Devices"** on page 31.

---

- 2 If you are using an Infiniium oscilloscope, continue with **"Step 5. Configuring the Probe on Infiniium Oscilloscopes"** on page 27.
- 3 If you are using an InfiniiVision oscilloscope, continue with **"Step 6. Configuring the Probe on InfiniiVision Oscilloscopes"** on page 29.

### Step 5. Configuring the Probe on Infiniium Oscilloscopes

- 1 On the oscilloscope, click the **Setup > Probe Configuration** menu command to view the Probe Configuration dialog box.

---

NOTE For N2820A probes, the probe's primary channel tab in the Probe Configuration dialog box configures both the primary and secondary channel. The secondary channel is listed on another tab but is not controlled from that tab.

---

## 2 Making Measurements Quick Start

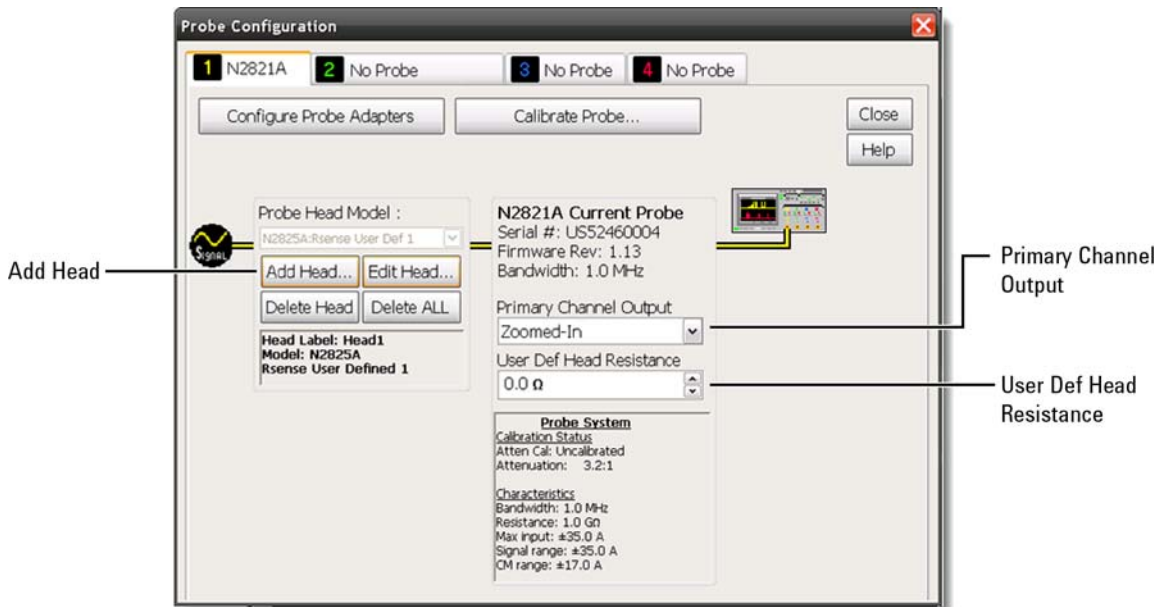


Figure 10 Probe Configuration Dialog Box (N2821A Probe)

- 2 Click the tab that represents the probe. In the case of N2820A probes, the probe's primary channel.
- 3 If you are using an N2821A probe, use the **Primary Channel Output** field to configure the input channel as a zoomed-in or zoomed-out channel.
- 4 If you are using an N2825A user-defined head, which uses a DUT-mounted  $R_{SENSE}$  resistor, enter the resistance of the external  $R_{SENSE}$  resistor in the **User Def Head Resistance** field.

---

### NOTE

The above step manually enters the N2825A's associated external  $R_{SENSE}$  resistance. But, when using multiple  $R_{SENSE}$  resistors on your DUTs, you will find more convenient procedures in [Chapter 3](#), "Using N2825A Probe Heads".

---

## Step 6. Configuring the Probe on InfiniiVision Oscilloscopes

- 1 Press the front-panel channel key that is associated with the probe. In the case of N2820A probes, the probe's primary channel.
- 2 Press the **Probe** softkey.
- 3 If you are using an N2821A probe, press the **Zoom-In** softkey to toggle between zoomed-in (blue selection box on softkey) or zoomed-out (clear selection box) for the channel. This softkey is shown at the bottom of [Figure 11](#) on page 30.
- 4 If you are using an N2825A user-defined head, which uses a DUT-mounted  $R_{\text{SENSE}}$  resistor, press the **R-Sense** softkey, shown in [Figure 11](#) on page 30. Then, enter the resistance of the  $R_{\text{SENSE}}$  resistor that you are using.

---

NOTE

The above step manually enters the N2825A's associated external  $R_{\text{SENSE}}$  resistance. But, when using multiple  $R_{\text{SENSE}}$  resistors on your DUTs, you will find more convenient procedures in [Chapter 3](#), "Using N2825A Probe Heads".

---

NOTE

For N2820A probes, softkeys for the probe's primary channel configure *both* the primary and secondary channel. Unlike Infiniium oscilloscopes, InfiniiVision oscilloscopes do *not* support the assigning of names to identify N2825A/ $R_{\text{SENSE}}$  combinations.

---

## 2 Making Measurements Quick Start

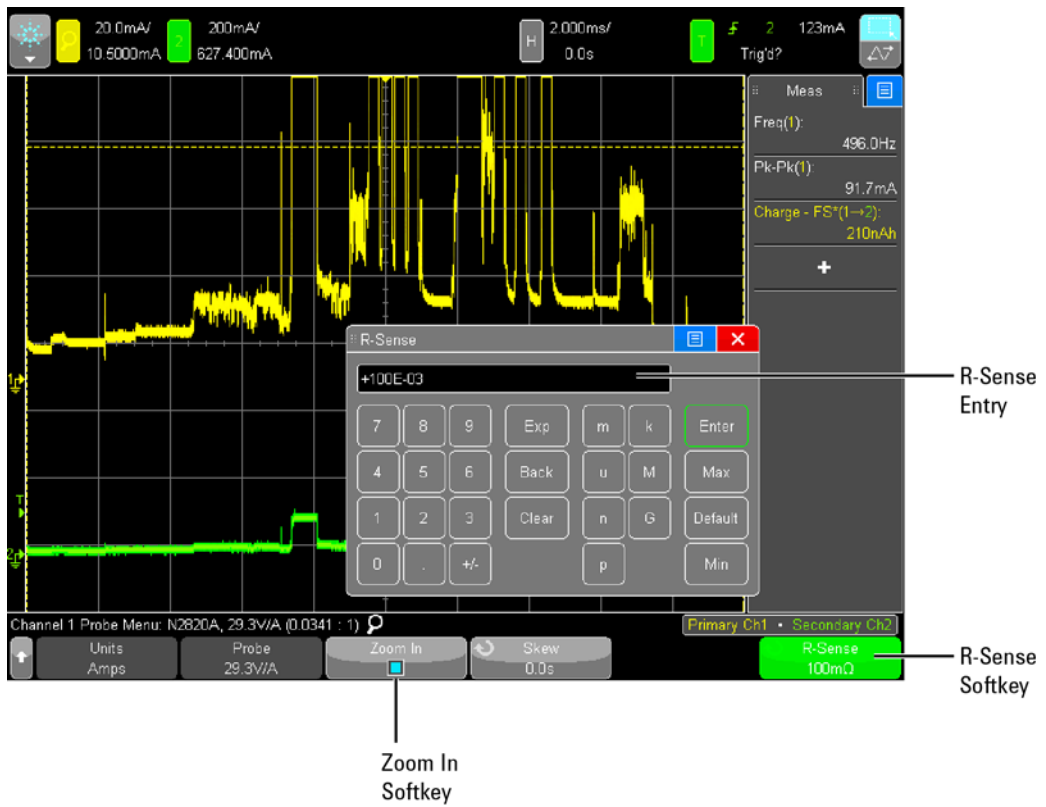


Figure 11 R-Sense Entry Box

## To Measure Battery-Powered Devices

When making measurements on a battery-powered (floating) device, such as a mobile phone, *always* connect the supplied ground lead between ground on your device and the probe's ground connector as shown in [Figure 12](#). Simply snap the end of the ground lead onto the probe's connector. Without the ground connection, the common mode voltage is not guaranteed to be within the common mode range of the amplifiers.

---

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

---

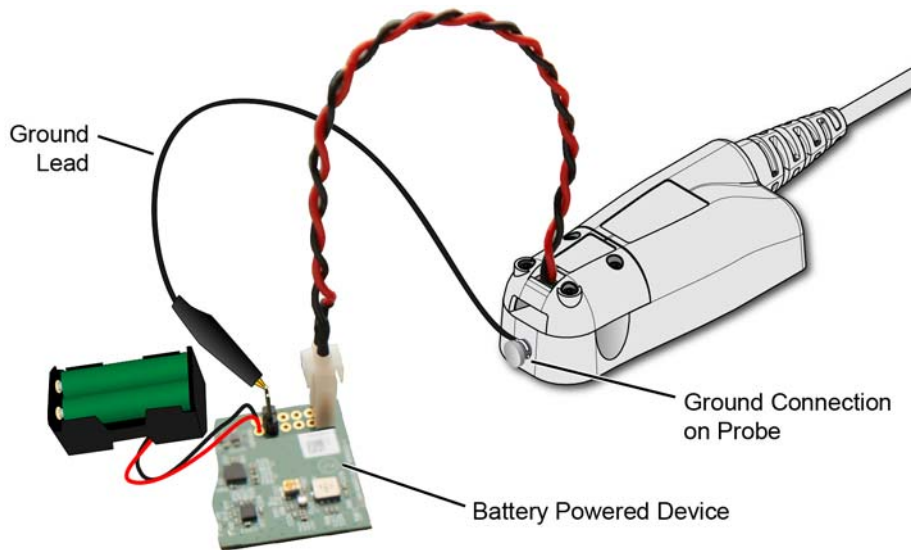


Figure 12 Supplied Ground Lead on Device

## 2 Making Measurements To Measure Charge on an Infiniium Oscilloscope

# To Measure Charge on an Infiniium Oscilloscope



A new measurement, **Charge**, is available on Infiniium oscilloscopes. This measurement determines the total current consumption over time with the results listed in Ampere-hours (**Ah**). For N2820A probes, the measurement includes the area under the curve across both zoomed-in and zoomed-out waveforms.

Figure 13 shows a **Charge** measurement with Zoom Mode applied and zoom window gating enabled.

### NOTE

Always connect the ground lead when probing mobile phones, as explained in **“To Measure Battery-Powered Devices”** on page 31.

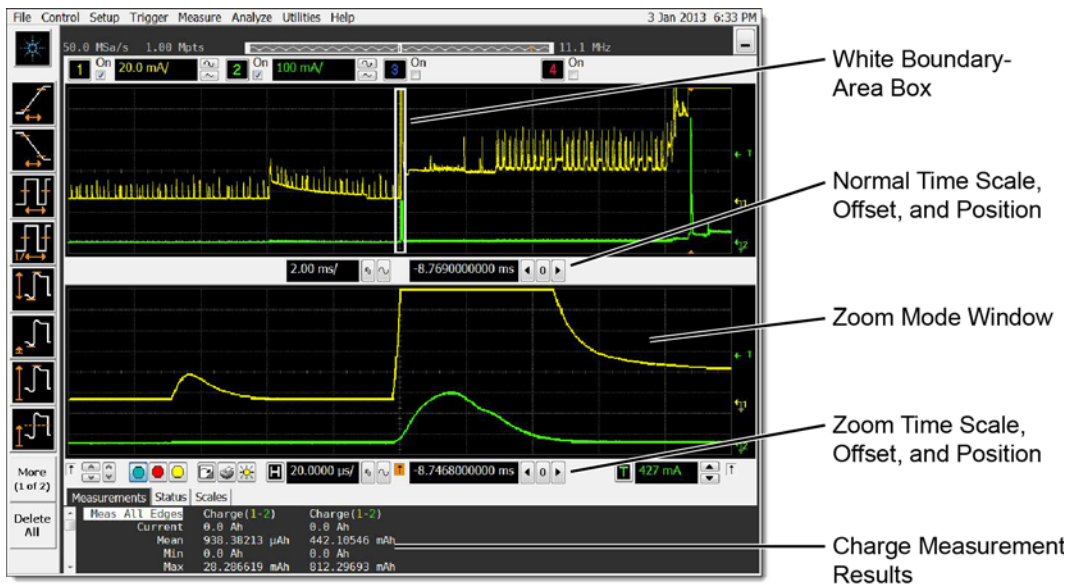



Figure 13 Charge Measurement of Mobile Phone Current in Standby State with Zoom Mode



To make a Charge measurement

- 1 Connect the probe. If an N2825A user-defined head is used, enter the  $R_{SENSE}$  resistance as explained in “Step 5. Configuring the Probe on Infiniium Oscilloscopes” on page 27.
- 2 If desired, click the oscilloscope’s **Zoom** button to turn on zoom mode. 

---

NOTE With Zoom Mode turned on, you can use gating to show a reduced zoom-window time span compared to the normal window. This is indicated on the non-zoomed waveform by a white boundary-area box.

---

NOTE Zoom mode is a software only expansion and results in the same vertical resolution and accuracy between the zoom and non-zoom waveforms.

---

- 3 Click **Measure > Mixed > Charge (N282XA)** to view the Enter Measurement Info dialog box.

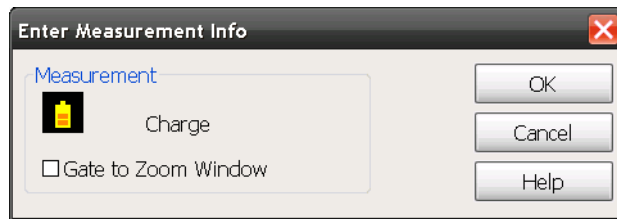


Figure 14 Enter Measurement Info Dialog Box

- 4 If Zoom Mode is turned on, select **Gate to Zoom Window** to enable a reduced zoom-window time span. If Zoom Mode is turned off, this field is not selectable (grayed out).
- 5 If more than one N2820/1A probe is connected in the oscilloscope, the dialog box allows you to select the probe used for the measurement.

## 2 Making Measurements To Measure Charge on an InfiniiVision Oscilloscope

### To Measure Charge on an InfiniiVision Oscilloscope



A new measurement, **Charge**, is available on InfiniiVision oscilloscopes. This measurement determines the total current consumption over time with the results listed in Ampere-hours (**Ah**). For N2820A probes, the measurement includes the area under the curve across both zoomed-in and zoomed-out waveforms.

Figure 15 shows a **Charge** measurement.

#### NOTE

Always connect the ground lead when probing mobile phones, as explained in “[To Measure Battery-Powered Devices](#)” on page 31.

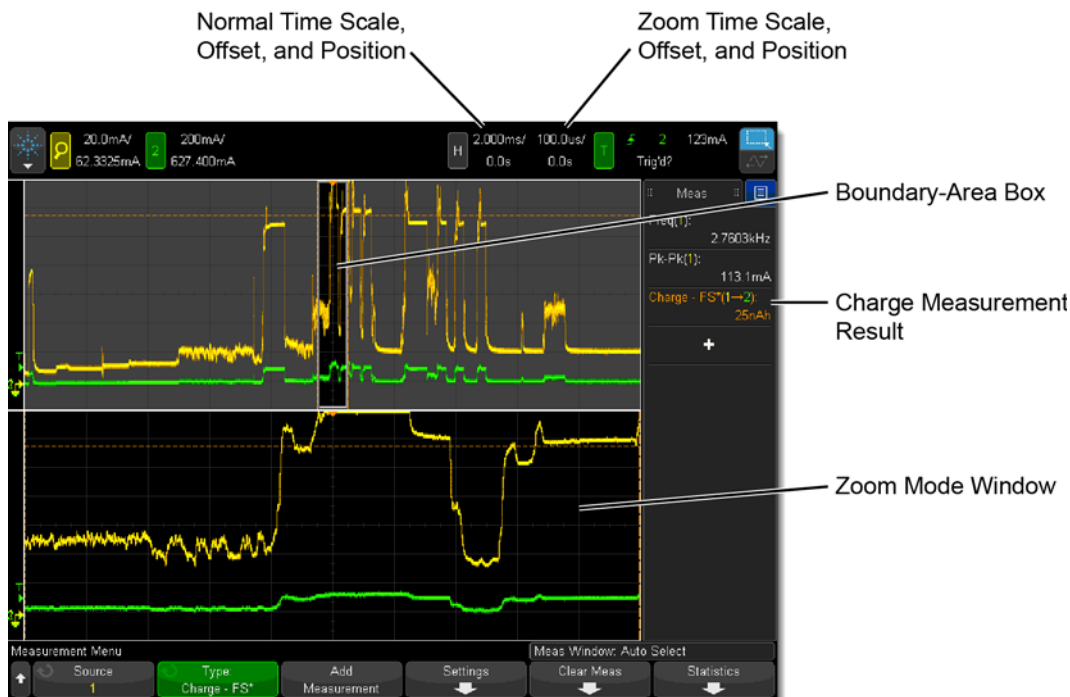



Figure 15 Full Screen Charge Measurement with Zoom Mode

To make a Charge measurement

- 1 Connect the probe. If an N2825A user-defined head is used, enter the  $R_{SENSE}$  resistance as explained in “[Step 6. Configuring the Probe on InfiniiVision Oscilloscopes](#)” on page 29.
- 2 If desired, click the oscilloscope’s **Zoom** button to turn on zoom mode. 

---



NOTE

With Zoom Mode turned on, you can use gating to show a reduced zoom-window time span compared to the normal window. This is indicated on the non-zoomed waveform by a non-shaded boundary-area box.

---

NOTE

Zoom mode is a software only expansion and results in the same vertical resolution and accuracy between the zoom and non-zoom waveforms.

- 3 Press the front-panel **Meas** key.
- 4 Press the **Type:** softkey.
- 5 Select one of two measurements:
  -  **Charge - Full Screen.** The Full Screen measurement interval variation measures the value on all displayed data points. For more information, refer to the oscilloscope’s Help system.
  -  **Charge - N Cycles.** The N Cycles measurement interval variation measures the value on an integral number of periods of the displayed signal. If less than three edges are present, the measurement shows “No edges”. For more information, refer to the oscilloscope’s Help system.
- 6 If more than one N2820/1A probe is connected to the oscilloscope, softkeys appear that allow you to specify the channel on which to perform the measurement.

## 2 Making Measurements To Simultaneously View Zoomed-In/Zoomed-Out Waveforms

# To Simultaneously View Zoomed-In/Zoomed-Out Waveforms

When using an N2820A probe, zoomed-in and zoomed-out waveforms can be simultaneously viewed on:

- 9000 H-Series Infiniium oscilloscopes, and
- 9000A Series Infiniium oscilloscopes

In dual-grid view (shown in [Figure 16](#)), the zoomed-out waveform originates from the probe's low-gain amplifier, and the zoomed-in waveform originates from the probe's high-gain amplifier. The zoomed-in waveform has less noise and dynamic range than the zoomed-out waveform.

**NOTE** Dual-Grid View is not supported in InfiniiVision oscilloscopes.

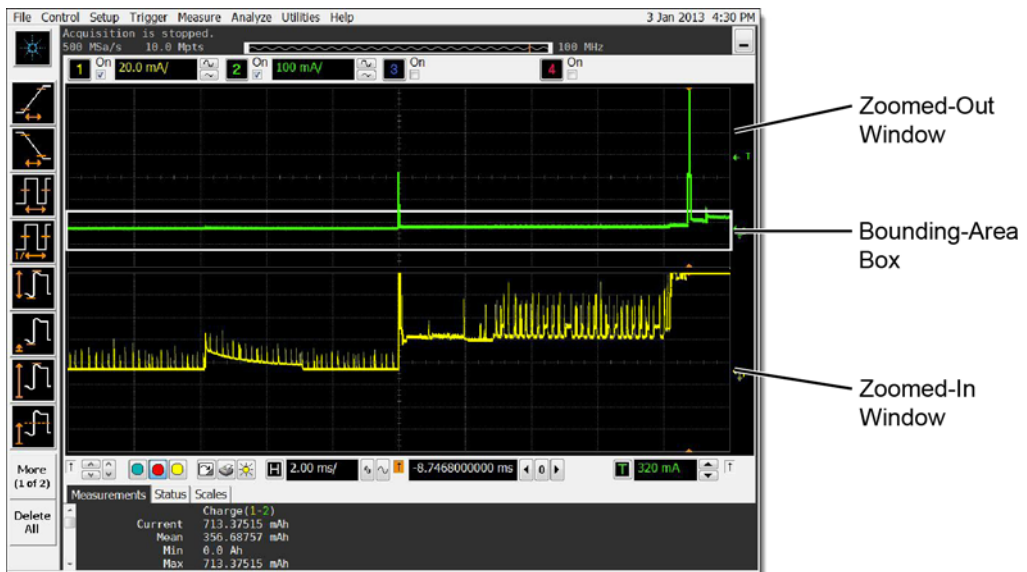


Figure 16 Displayed Zoom Windows

### Oscilloscope's Zoom Mode

If you're familiar with the oscilloscope's Zoom Mode, you may be interested to know that while Zoom Mode uses software to expand the zoomed-in waveform, dual-grid view uses hardware amplification applied by the probe's high-gain amplifier.

On the display, the bounding-area box identifies the portion of the zoomed-out waveform that is displayed in the zoomed-in window. This is shown in **Figure 16**. The bounding-area box does not indicate waveform clipping.

If the border of the bounding-area box is red, this indicates that output clamping is active. When the border is white, output clamping is disabled.

Dual-grid view allows simultaneous viewing of high sensitivity and high dynamic-range inputs. One example of using dual-grid view is to quickly identify and view a specific pulse and perform a DC power measurement on that pulse.

To view only one window

- 1 Click **Setup > Display** to open the Display Setup dialog box.
- 2 In the **Quantity** field, select **1**.

---

NOTE

---

For best measurement results, click **Setup > Acquisition** and select one of the **High Resolution** settings.

## 2 Making Measurements To Make Measurements Without Interrupting Your DUT

# To Make Measurements Without Interrupting Your DUT

The supplied Make-Before-Break (MBB) connectors allow you to easily connect and disconnect your probe without interrupting the Device-Under-Test (DUT). With the MBB connector you can quickly probe multiple locations on your DUT without having to solder or unsolder the leads. The MBB can be used with all  $R_{SENSE}$  probe heads including the N2825A user-defined probe head.

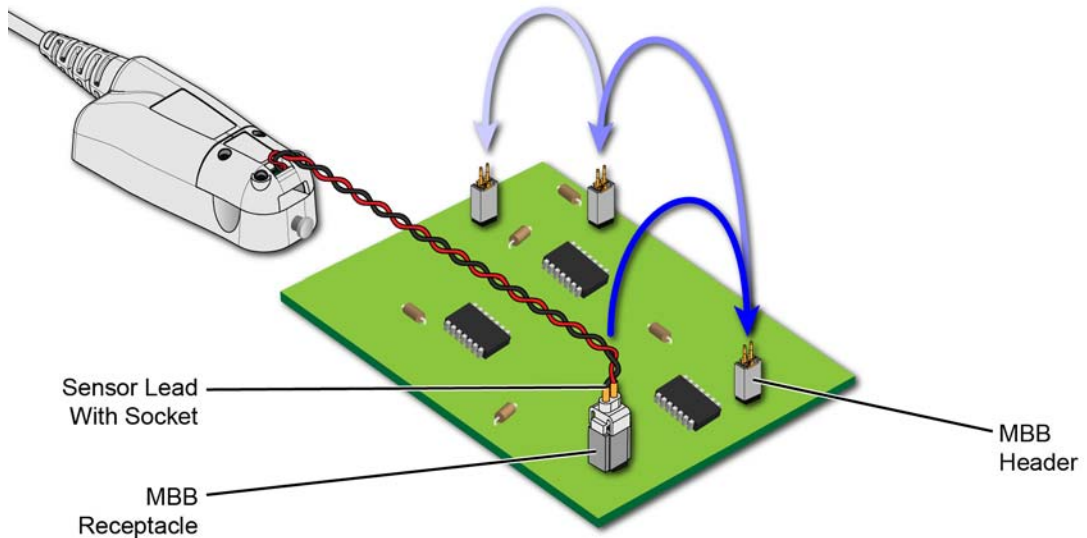


Figure 17 Probing with MBB Connector on DUT

As shown in [Figure 18](#) on page 39, MBB connectors consist of a receptacle and header. A sensor lead with socket snaps onto the receptacle. The header has two 0.025" square pins that are soldered onto pads with 2.54 mm (0.1") contact-pitch spacing.

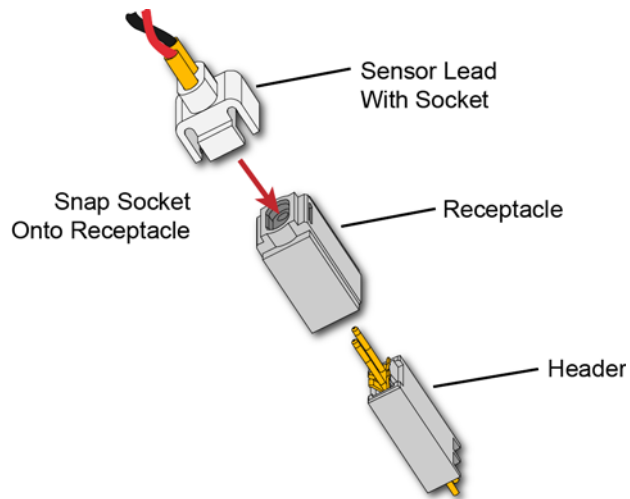


Figure 18 Socketed Lead Snaps Onto the MBB Receptacle

### To Use the MBB Connector

- 1 Solder one or more headers onto your DUT.
- 2 Snap the sensor lead's socket onto the receptacle.

---

**NOTE** Once attached to the receptacle, the socket cannot easily be removed without deforming the receptacle. For information on ordering additional socketed sensor leads, receptacles, and headers, refer to [Table 2](#) on page 11.

- 3 Repeatedly plug the lead with MBB receptacle onto different headers as you probe your DUT.

[Figure 19](#) illustrates how the MBB connection changes as you gently push the receptacle onto the header while using an N2822/4A head. [Figure 20](#) on page 41 shows the schematic when using the MBB with an N2825A user-defined head.

2 Making Measurements  
To Make Measurements Without Interrupting Your DUT

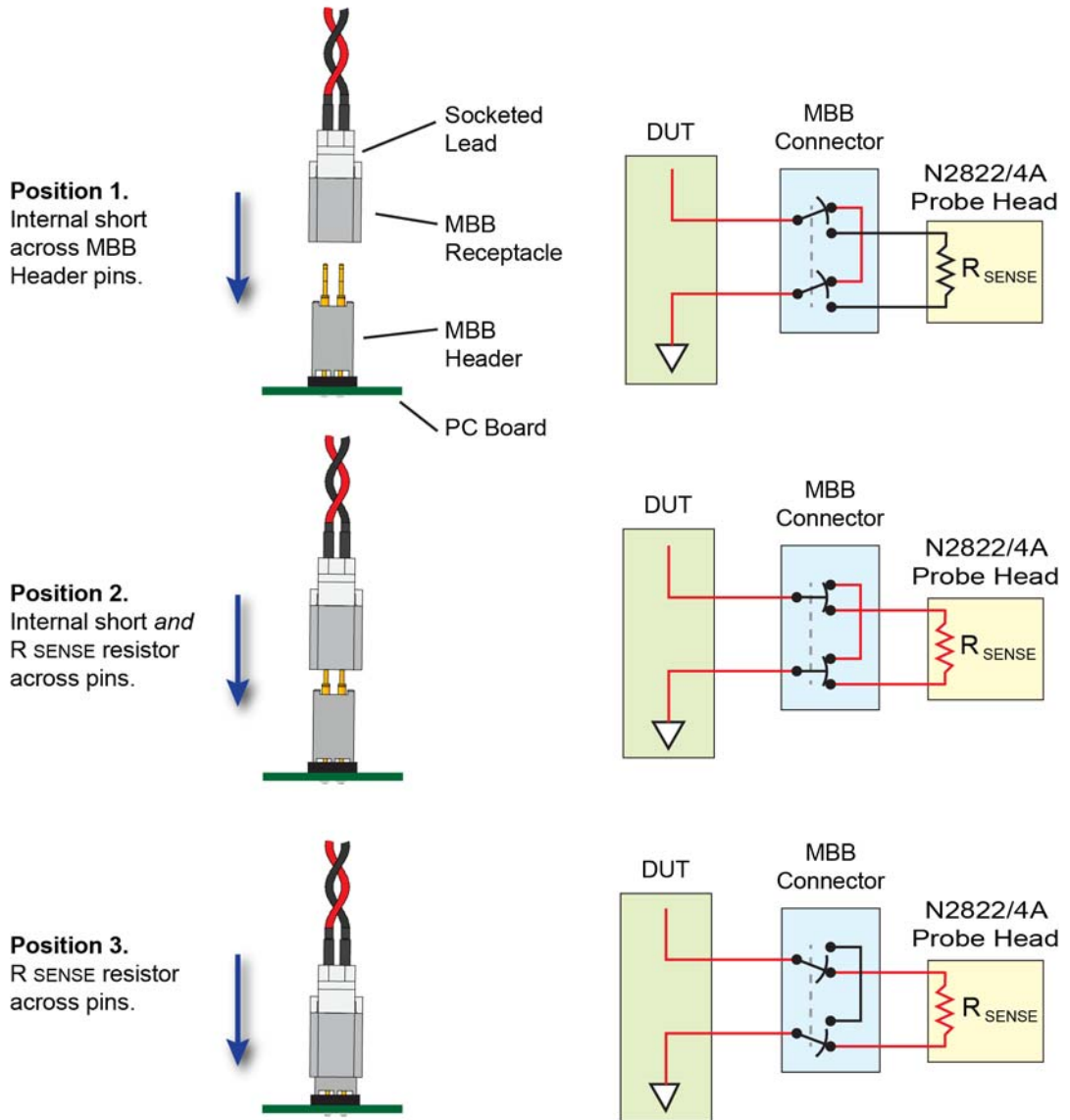


Figure 19 Connecting the MBB Connector with N2822/4A Head



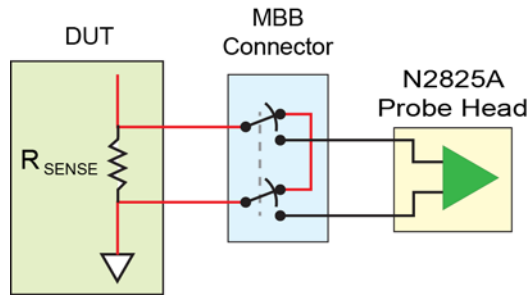


Figure 20 MBB Connector With N2825A User-Defined Head

To Download the Header  
Gerber File

You can download a Gerber file from Keysight that defines many of the parameters needed to design the PC board connection for the MBB header. Gerber files can be imported into many PC board layout applications. You can download this file using the following URL:

[www.keysight.com/find/N2828A](http://www.keysight.com/find/N2828A)

For information on the physical dimensions of the MBB header and MBB socket/receptacle, refer to [Figure 39](#) on page 79.

**2 Making Measurements**  
**To Determine Maximum Input Voltage and Current**

## To Determine Maximum Input Voltage and Current

The probe's maximum input voltage and current values are derived using the equations in this section. Exceeding these values may result in the signal being clipped on the screen. To perform the calculations, you need the probe's maximum output voltage (linear operation) and the Gain, which are documented in [Chapter 5](#), "Characteristics and Specifications" ([Table 9](#) on page 72) and listed here:

Maximum Output Voltage: .....	12V
$A_{\text{probe}}$ (Zoom-In) .....	300
$A_{\text{probe}}$ (Zoom-Out) .....	2

### Maximum Input Voltage

The maximum input voltage is given by the following equation. For a zoomed-in signal, the maximum input voltage would be 40 mV. For a zoomed-out signal, the maximum input voltage would be 6V.

$$V_{\text{max. input}} \leq \frac{V_{\text{max. output}}}{A_{\text{probe}}}$$

### Maximum Input Current

The following equation gives the maximum input current:

$$I_{\text{max. input}} \leq \frac{V_{\text{max. output}} \times R_{\text{SENSE}}}{A_{\text{probe}}}$$

The value of the  $R_{\text{SENSE}}$  resistor depends on the probe head that is installed on the probe:

N2822A probe head: .....	20 mΩ
N2824A probe head: .....	100 mΩ
N2825A probe head: .....	user defined

For example, when using an N2824A probe head with a zoom-in signal, the maximum input current would be 4 mA.

## Extreme Temperature Probing

By constructing your own long sensor leads, you can use the N2820/1A probes for extreme temperature probing, such as monitoring a product in an environmental chamber. The following two sensor lead examples provide accurate measurements:

- 6 feet of twisted-pair wire using two turns-per-inch. The DUT should be grounded to the probe.
- 10 feet of shielded twisted-pair wire using two turns-per-inch. Ground to the probe both the DUT and the shield.

---

NOTE

Do not directly subject the probe amplifier, head, or cable to extreme temperatures. The probe's operating temperature range is 0°C to 40°C (32°F to 104°F).

---

## 2 Making Measurements

### Burden Voltage of N2822/4A Probe Heads

# Burden Voltage of N2822/4A Probe Heads

When an N2822/4A head is used, the resistance of the head's connectors, sensor leads, and internal  $R_{\text{SENSE}}$  resistor is connected in series with the DUT's circuit and current is flowing through the probe head, as shown in [Figure 21](#).

$$V_{\text{burden}} = I_{\text{measured}} \times R_{\text{shunt}}$$

Therefore, a burden voltage (IR) is introduced into your circuit. Burden voltages may affect the circuit and will tend to increase the noise. Burden voltages do *not* affect the measurement. [Table 4](#) on page 45 lists the resistances added by various probing components.

---

NOTE

N2825A heads do not contribute a burden voltage as the current is *not* flowing through the head.

---

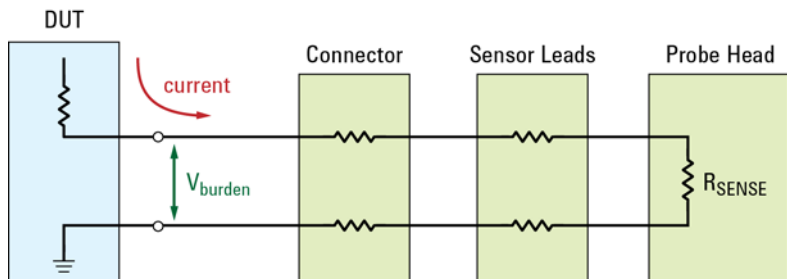


Figure 21  $V_{\text{burden}}$  Developed Across Probing Components

Table 4 Resistance Added by Head Components

Component	Resistance Contribution (Round Trip)
Sensor Leads Without Socket	20 mΩ
Sensor Leads With Socket	40 mΩ
MBB Header Only (Not Connected)	20 mΩ
MBB Header/Receptacle/Socket	40 mΩ
R <sub>SENSE</sub> (N2822A Head)	20 mΩ
R <sub>SENSE</sub> (N2824A Head)	100 mΩ

## Dynamic Range

The N2820A and N2821A probes provide a large dynamic measurement range (>20,000:1 or 86 dB on the zoomed-in channel) that allows you to observe both the entire current waveform and extremely small current fluctuations. As shown in [Figure 22](#), you could simultaneously view a mobile phone's 135 mA receive current pulses and 2 mA idle current in the presence of 2A transmit current pulses, with a single acquisition. When using N2820A probes on Infiniium oscilloscopes, use the powerful new dual-grid view as explained in ["To Simultaneously View Zoomed-In/Zoomed-Out Waveforms"](#) on page 36.

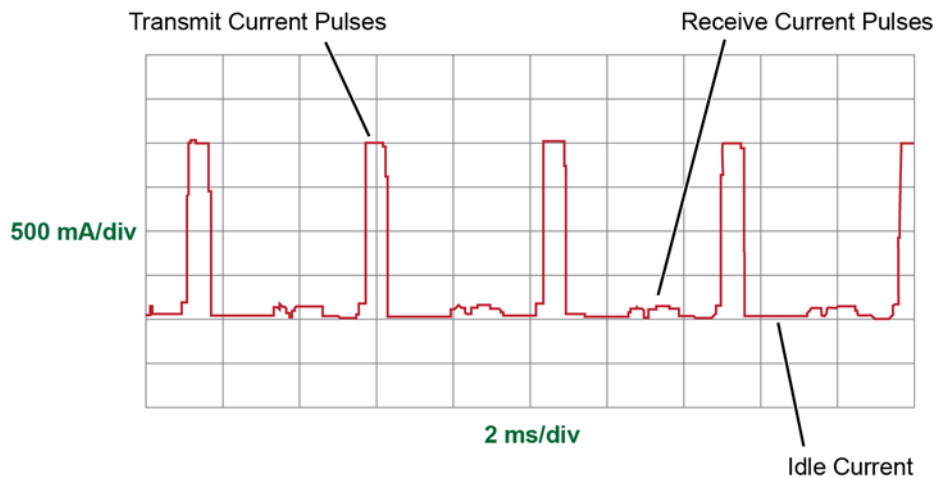


Figure 22 Small Pulses in the Presence of Large Pulses

### $R_{SENSE}$ Value and Dynamic Range

Since the N2820A probe has two outputs, each with a different gain, dynamic range encompasses both channels while using a single  $R_{SENSE}$  value. For example, with a  $100\text{ m}\Omega$   $R_{SENSE}$  resistor, the zoomed-in waveform can display about  $50\text{ }\mu\text{A}$  and the zoomed-out channel can display about  $2.2\text{ A}$  for a dynamic range of approximately 93 dB:

$$93\text{dB} = 20\log\frac{2.2\text{A}}{50\ \mu\text{A}}$$

The value of the  $R_{\text{SENSE}}$  resistor can range from 1 m $\Omega$  to 1 M $\Omega$  as shown in [Figure 34](#), “Current Range of N2822/4A Heads,” on page 74. Using these two  $R_{\text{SENSE}}$  values in different measurements, the dynamic range could be increased to 100 dB.

### Effects Other Than Dynamic Range

Selecting the proper  $R_{\text{SENSE}}$  resistance is often a compromise between a value that is large enough to obtain accurate measurements while small enough to avoid negatively affecting the circuit under test. Increasing the resistance

- *decreases* the noise,
  - *increases* sensitivity, and
  - *increases* the burden voltage across the  $R_{\text{SENSE}}$  resistor (IR).
- Decreasing the resistance will have the opposite effect.

### Channel Position on the Screen

This probe does not have voltage offset. Use the oscilloscope’s position controls to adjust the location of the waveform on the screen. Vertical scaling occurs about zero amperes.

## 2 Making Measurements

### Dynamic Range



# 3

## Using N2825A Probe Heads

- To Manually Identify the R<sub>SENSE</sub> Resistance On Infiniium Oscilloscopes 50
- To Manually Identify the R<sub>SENSE</sub> Resistance On InfiniVision Oscilloscopes 51
- To Identify the R<sub>SENSE</sub> Resistance Using a Unique Name 52
- To Identify the R<sub>SENSE</sub> Resistance Using an ID Resistor 53
- To Add a Custom Internal R<sub>SENSE</sub> Resistor 58

The N2825A user-defined head is normally selected in situations where a DUT-mounted R<sub>SENSE</sub> resistor is used. In this chapter, you'll learn how to perform the following tasks, which enables the oscilloscope to make accurate measurements:



- On Infiniium oscilloscopes, assign a custom name to the N2825A. This name identifies the resistance of a specific DUT-mounted R<sub>SENSE</sub>.
- Change the N2825A's internal ID resistor. This resistor identifies the N2825A with a specific DUT-mounted R<sub>SENSE</sub>.
- If the R<sub>SENSE</sub> values of the N2822A and N2824A probe heads do not meet your measurement needs, you can add an internal R<sub>SENSE</sub> resistor to the N2825A.

### 3 Using N2825A Probe Heads To Manually Identify the $R_{SENSE}$ Resistance

## To Manually Identify the $R_{SENSE}$ Resistance

If you are using multiple, different DUT-mounted  $R_{SENSE}$  resistances, the following procedures show you how to enter the resistance each time that you use the N2825A head with a new  $R_{SENSE}$ .

On Infiniium Oscilloscopes This method is used in “[Step 5. Configuring the Probe on Infiniium Oscilloscopes](#)” on page 27 and is repeated here.

- 1 Click the **Setup > Probe Configuration** menu command to view the Probe Configuration dialog box, shown in [Figure 23](#).

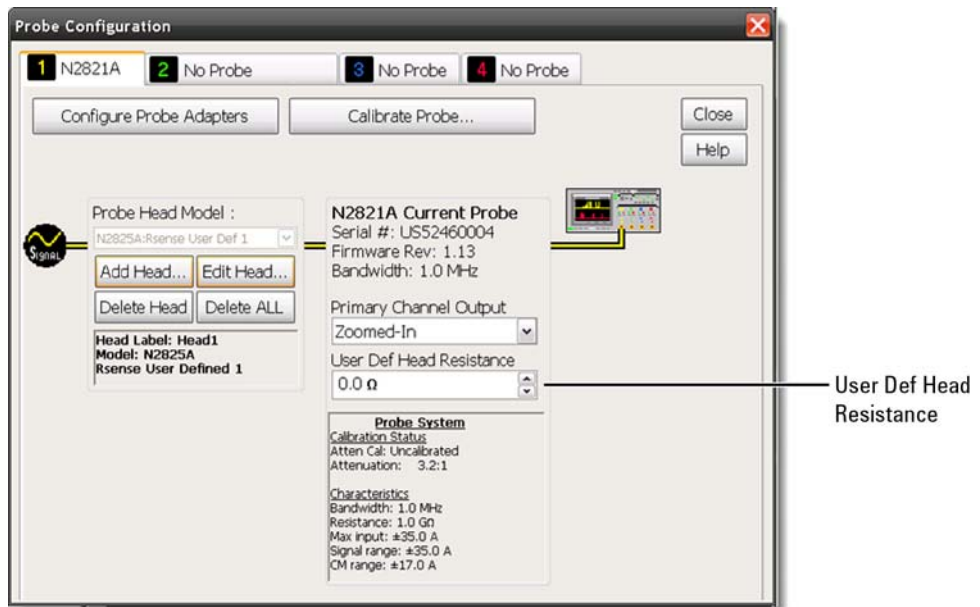


Figure 23 Infiniium Dialog Box With N2825A Heads

- 2 Click the tab that represents the probe. In the case of N2820A probes, the probe's primary channel.

- 3 In the dialog box, enter the  $R_{SENSE}$  resistance in the **User Def Head Resistance** field.

On InfiniiVision  
Oscilloscopes

This method is used in “[Step 6. Configuring the Probe on InfiniiVision Oscilloscopes](#)” on page 29 and is repeated here.

- 1 Press the front-panel channel key that is associated with the probe. In the case of N2820A probes, the probe’s primary channel.
- 2 Click the **Probe** softkey followed by the **R-Sense** softkey.
- 3 Enter the resistance of the  $R_{SENSE}$  resistor that you are using.

### 3 Using N2825A Probe Heads To Identify the $R_{SENSE}$ Resistance Using a Unique Name

## To Identify the $R_{SENSE}$ Resistance Using a Unique Name

---

**NOTE** This procedure is for Infiniium oscilloscopes, only. InfiniiVision oscilloscopes do *not* support the assigning of names to identify N2825A/ $R_{SENSE}$  combinations.

---

This procedure allows you to identify the external DUT-mounted  $R_{SENSE}$  by a unique name. After completing the procedure, simply connect the probe with the N2825A probe head, and select the unique name on the oscilloscope. The proper  $R_{SENSE}$  value is used for the measurements. Selecting a unique name is easier than manually entering the  $R_{SENSE}$  resistance each time that you use the N2825A head with a new  $R_{SENSE}$ .

- 1 Click the **Setup > Probe Configuration** menu command to view the Probe Configuration dialog box.
- 2 Use the **Add Head** field to assign a unique name for each of your N2825A/ $R_{SENSE}$  resistance associations.
- 3 Each time that you connect the probe, select the appropriate name in the dialog box.

## To Identify the $R_{SENSE}$ Resistance Using an ID Resistor

By changing the N2825A's internal ID resistor, the probe head can automatically indicate to the oscilloscope the value of the DUT-mounted  $R_{SENSE}$  being used. Up to five dedicated N2825A probe heads can be configured in this manner using the ID resistor values shown in [Table 5](#).

Table 5 Valid N2825A ID Resistors

Resistor Value	Description
16.2 k $\Omega$	Default value. Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
19.6 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
26.1 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
42.4 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
61.9 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT

For example, you might install a 19.6 k $\Omega$  ID resistor in one N2825A to identify measurements using a 50 m $\Omega$   $R_{SENSE}$  and a 26.2 k $\Omega$  ID resistor in another N2825A to identify measurements using a 300 m $\Omega$   $R_{SENSE}$ . The first time that you use the modified N2825A, you must perform a one-time entry of the associated  $R_{SENSE}$  resistance on the oscilloscope. For subsequent uses, the oscilloscope automatically uses the specified  $R_{SENSE}$  value for each N2825A head. You can order additional N2825A heads from Keysight.

**CAUTION**

In the following procedure, always wear an ESD wrist strap and work at a static-safe workstation. Not doing so can result in the probe head becoming permanently damaged.

### 3 Using N2825A Probe Heads To Identify the $R_{\text{SENSE}}$ Resistance Using an ID Resistor

- 1 Remove the probe head by gently pulling the head straight off the probe in the direction shown.

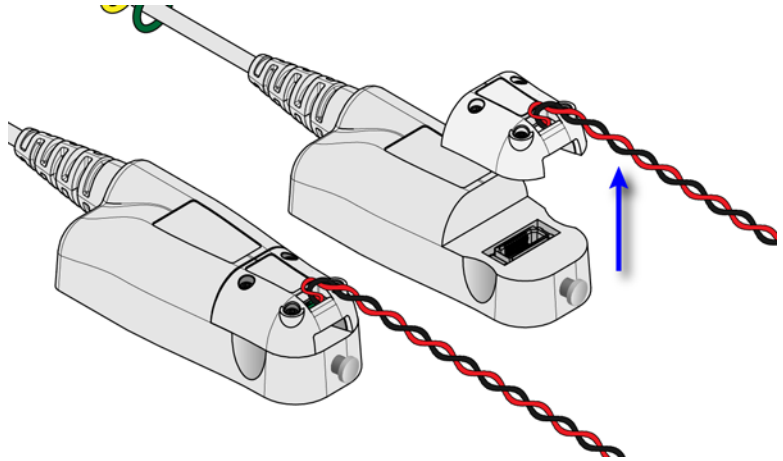


Figure 24 Removing the Probe Head

- 2 Remove the four hex screws that secure the cover of the N2825A  $R_{\text{SENSE}}$  head and remove the cover.

Screws (Qty. 4)



Figure 25 Removing the N2825A Cover

- 3 Remove the PC board from the head.

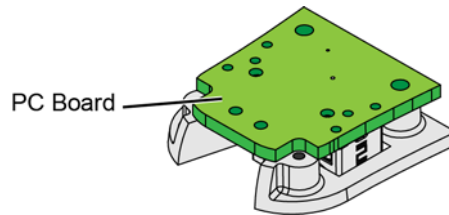


Figure 26 Remove PC Board

- 4 On the reverse side of the PC board, locate ID resistor, **R2**, as shown in [Figure 27](#).

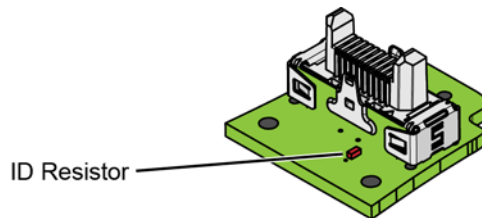


Figure 27 Location of ID Resistor (R2)

- 5 Replace the ID resistor with any of the values listed in [Table 6](#). The default value loaded on the board is 16.2 k $\Omega$ . You can purchase a resistor from a supplier such as Digi-Key corporation.

---

**CAUTION**

---

If you are *not* skilled in soldering, ask a trained assembler to change the resistor.

### 3 Using N2825A Probe Heads To Identify the $R_{SENSE}$ Resistance Using an ID Resistor

Table 6 Valid N2825A ID Resistors

Resistor Value	Description
16.2 k $\Omega$	Default value. Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
19.6 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
26.1 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
42.4 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT
61.9 k $\Omega$	Resistor, $\pm 1\%$ , 0.063W, TC $\pm 100$ thick film 0402 SMT

- 6 Replace the N2825A's cover using the four screws. (M1.6 x 0.35, 5 mm long, Keysight part number 0515-5210)

#### CAUTION

To avoid damaging the aluminum casting, do not over tighten the screws.

- 7 Connect the N2825A to an N2820/1A probe and connect the probe to the oscilloscope.
- 8 On Infiniium oscilloscopes,
  - a Click the **Setup > Probe Configuration** menu command.
  - b Select the tab for the probe's primary channel. N2821A probes only have a primary channel.
  - c In the **User Def Head Resistance** field, enter the resistance of the DUT's  $R_{SENSE}$  resistor in ohms.
  - d In the dialog box, click **Add Head** to give your head with associated external  $R_{SENSE}$  resistor a unique name.
- 9 On InfiniiVision oscilloscopes,
  - a Press the front-panel channel key that is associated with the probe's primary input.
  - b Click the **Probe** softkey.
  - c Press the **R-Sense** softkey and enter the resistance of the  $R_{SENSE}$  resistor that you are using.
- 10 For future reference, mark your different N2825A heads using a marker pen or tape and record the information in [Table 7](#) on



page 57. In the table's fourth column, record the name that you entered in the Probe Configuration dialog box.

---

**NOTE** Remember to mark your different N2825A heads, using a marker pen or tape, so that you can distinguish between them.

---

Table 7 N2825A Identification

N2825A Marking	Associated DUT R <sub>SENSE</sub> Resistor Value	ID Resistor Value	Probe Name Registered on the Oscilloscope

### 3 Using N2825A Probe Heads To Add a Custom Internal $R_{\text{SENSE}}$ Resistor

## To Add a Custom Internal $R_{\text{SENSE}}$ Resistor

If you need to use a different  $R_{\text{SENSE}}$  resistance than provided by the N2822A and N2824A heads, you can convert an N2825A head to an internal  $R_{\text{SENSE}}$  head. For example, suppose that you require a 400 m $\Omega$  *internal*  $R_{\text{SENSE}}$ , but the N2822A has a 20 m $\Omega$   $R_{\text{SENSE}}$  and the N2824A has a 100 m $\Omega$   $R_{\text{SENSE}}$ . You simply need to install your 400 m $\Omega$   $R_{\text{SENSE}}$  into an N2825A probe head.

---

**NOTE**

---

Do not change the  $R_{\text{SENSE}}$  resistor in N2822A or N2824A heads.

---

**CAUTION**

---

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

- 1 Select a resistor of type  $\pm 1\%$ , 0.5W, TC  $\pm 600$ , thick film 2010 SMT. The value of the precision resistor can range from 1 m $\Omega$  to 1 M $\Omega$  in 1 m $\Omega$  increments.

---

**WARNING**

---

**When selecting the resistance value, you must observe the 500 mW maximum power rating of the head.**

- 2 Remove the probe head by gently pulling the head straight off the probe in the direction shown.

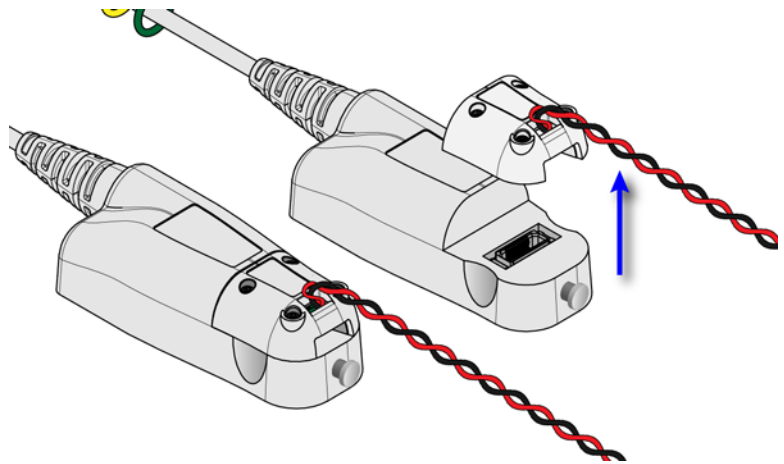


Figure 28 Removing the Probe Head

- 3 Remove the four hex screws that secure the head's cover and remove the cover.

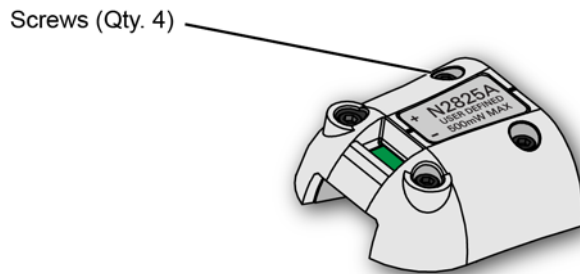


Figure 29 Removing the Cover

- 4 Change or add the  $R_{SENSE}$  resistor (**R1**) as shown in [Figure 30](#).

**CAUTION**

If you are *not* skilled in soldering, ask a trained assembler to change the resistor.

### 3 Using N2825A Probe Heads To Add a Custom Internal $R_{\text{SENSE}}$ Resistor

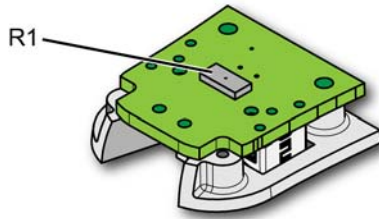


Figure 30 Location of  $R_{\text{SENSE}}$  Resistor (R1)

- 5 Replace the head's cover using the four screws. (M1.6 x 0.35, 5 mm long, Keysight part number 0515-5210)

---

**CAUTION**

To avoid damaging the aluminum casting, do not over tighten the screws.

- 6 Connect the N2825A to an N2820/1A probe and connect the probe to the oscilloscope.
- 7 On Infiniium oscilloscopes,
  - a Click the **Setup > Probe Configuration** menu command.
  - b Select the tab for the probe's primary channel. N2821A probes only have a primary channel.
  - c In the **User Def Head Resistance** field, enter the resistance of the DUT's  $R_{\text{SENSE}}$  resistor in ohms.
  - d In the dialog box, click **Add Head** to give your head with associated external  $R_{\text{SENSE}}$  resistor a unique name.
- 8 On InfiniiVision oscilloscopes,
  - a Press the front-panel channel key that is associated with the probe's primary input.
  - b Click the **Probe** softkey.
  - c Press the **R-Sense** softkey and enter the resistance of the  $R_{\text{SENSE}}$  resistor that you are using.

You could also change the head's internal ID resistor as explained "To Identify the RSENSE Resistance Using an ID Resistor" on page 53.

### 3 Using N2825A Probe Heads To Add a Custom Internal $R_{\text{SENSE}}$ Resistor

# 4

## Probe Calibration

This chapter provides a procedure for calibrating the probe on an Infiniium oscilloscope.

**“To Calibrate the Probe on Infiniium Oscilloscopes” on page 64**

**“To Calibrate the Probe InfiniiVision Oscilloscopes” on page 68**

Always calibrate the probe before making any critical measurements. A probe calibration removes attenuation, offset, and gain errors as well as timing delays that are introduced by the probe. The calibration applies to a specific probe (identified by serial number) that is connected to a specific oscilloscope channel. If you connect the probe to a different channel, the calibration will no longer be valid.

---

**CAUTION**

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


---

## 4 Probe Calibration To Calibrate the Probe on Infiniium Oscilloscopes

# To Calibrate the Probe on Infiniium Oscilloscopes

During this calibration, you may be prompted to make one or more adjustments. These adjustments, located on the underside of the probe amplifier, are shown in [Figure 32](#) on page 67.

Table 8 Required Calibration Test Equipment

Test Equipment	Recommended Model
N2825A User-Defined Probe Head	Provided with probe.
E2655C Performance Verification (PV) Fixture	This fixture is included with the de-skew Kit which is shipped with Infiniium oscilloscopes. 
Adapters	SMA, BNC, BNC cables, and cable clips as needed.
Phillips Screwdriver	For making adjustments during the procedure. This tool is provided with the probe.

---

### NOTE

**Redirecting the probe-comp signal.** On 9000-series Infiniium oscilloscopes, you can redirect the Probe Comp signal to the rear-panel's Aux Output BNC connector, which can then be connected to the PV fixture. Click **Utilities > Calibration** and in the *Aux Output* drop-down list select **Probe Comp**.

---

- 1 Turn the oscilloscope on.
- 2 Solder the sensor leads onto the N2825A user-defined head as explained in ["Quick Start"](#) on page 23.
- 3 Attach an N2825A user-defined head to the probe.
- 4 Connect the equipment as shown in [Figure 31](#) on page 66. Observe the following requirements:
  - Connect the probe to the channel that you will use during probing. Connect the PV fixture to any available channel.



## To Calibrate the Probe on Infiniium Oscilloscopes

- ❑ Connect the PV fixture to the Oscilloscope's **Probe Comp** output using an adapter.
- ❑ On N2820A probes, do not connect the secondary cable at this time.
- ❑ Connect both of the N2825A's leads to the PV fixture's *ground plane* as shown in **Figure 31**. Use the PV fixture's spring board to hold the leads in place.

---

**CAUTION**

---

NEVER solder probe leads to the PV fixture's thick-film gold. The gold will immediately dissolve into the solder and disappear.

- 5 Let the probe warm up for 15 minutes.
- 6 On the oscilloscope, click **Setup** > **Channel** to open the Channel Setup dialog box and select the channel tab for the connected probe.

#### 4 Probe Calibration To Calibrate the Probe on Infiniium Oscilloscopes

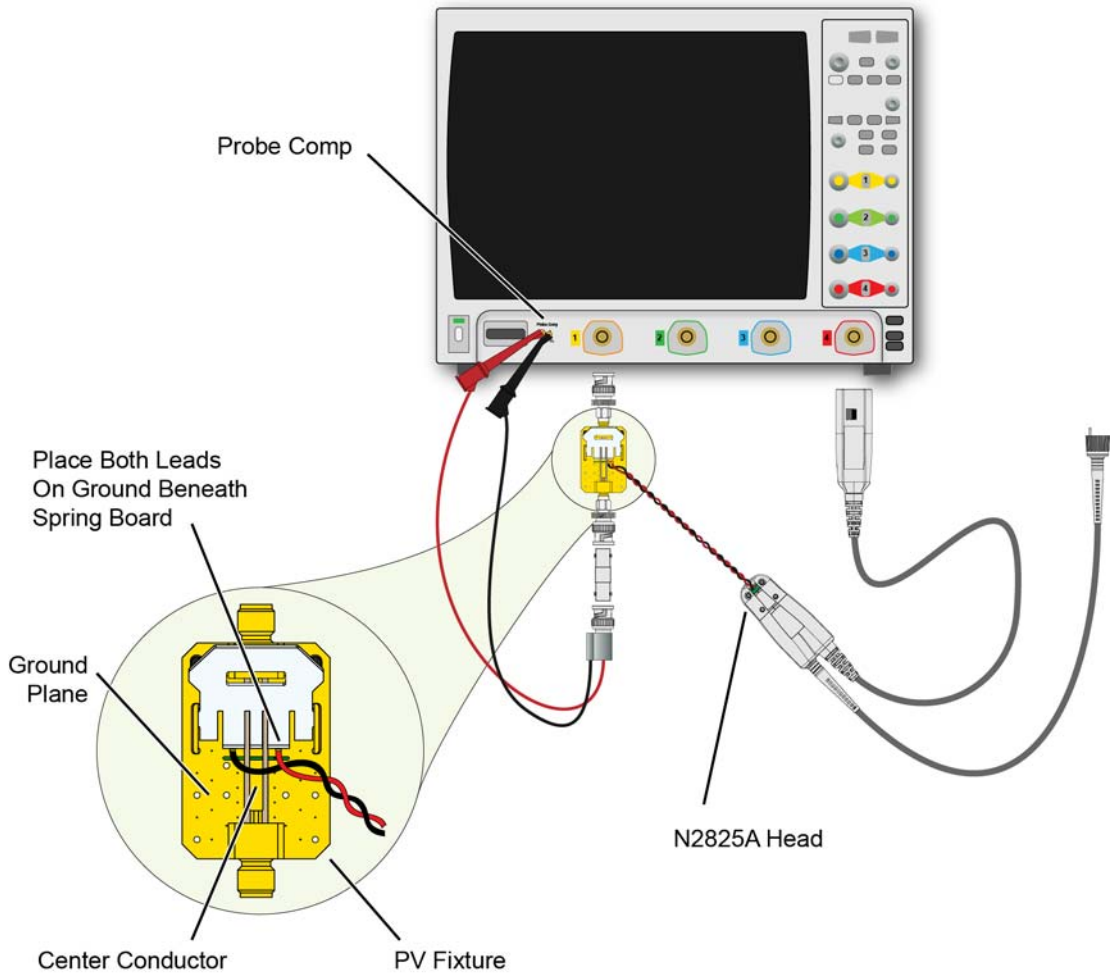


Figure 31 Example of Initial Calibration Setup

- 7 Click **Probes...** to open the Probe Setup dialog box. Then, click the **Calibrate Probe...** button.
- 8 Follow the steps that are displayed on the oscilloscope. If you are prompted to make an adjustment, refer to [Figure 32](#). The adjustments are located on the underside of the probe amplifier.

---

NOTE The screwdriver provided with the probe is the preferred adjustment tool.

---

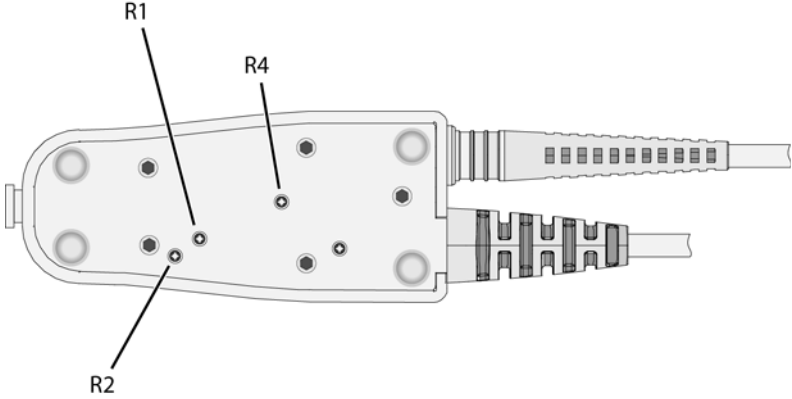


Figure 32 Location of Calibration Adjustments

## 4 Probe Calibration To Calibrate the Probe InfiniiVision Oscilloscopes

# To Calibrate the Probe InfiniiVision Oscilloscopes

Allow the oscilloscope and probe to warm up for 20 minutes before performing the probe calibration.

### Procedure

- 1 Connect the probe to one of the oscilloscope channels.

---

#### NOTE

When you connect the probe, the **Calibrate Probe** softkey in the Channel Probe Menu becomes active.

- 2 Connect the probe to the calibration terminals. On 3000 X-series oscilloscopes, connect the probe's signal tip to the front-panel **Demo 2 / Probe Comp** terminal and the ground tip to the ground terminal.

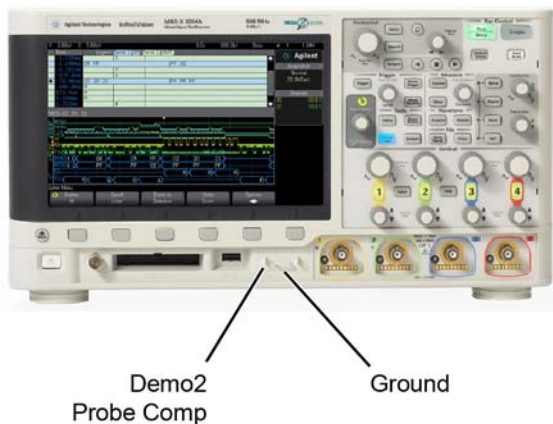


Figure 33 Probe Calibration Terminals on 3000 X-Series Oscilloscope

- 3 Press the Channel on/off key to turn the channel on (if the channel is off).
- 4 In the Channel Menu, press the **Probe** softkey.

- 5** Press the **Calibrate Probe** softkey and follow the instructions on the display.

**4 Probe Calibration**  
**To Calibrate the Probe InfiniiVision Oscilloscopes**

# 5

## Characteristics and Specifications

Current Range Graphs	74
Zoomed-In Input Voltage Range Versus Supply Voltage	76
Zoomed-In Input Current Range Versus Supply Voltage	77
Dimensions	79

This chapter provides the characteristics and specifications for the N2820A and N2821A probes. The probe should be warmed up for at least 20 minutes before any testing and the environmental conditions should not exceed the probe's specified limits.

## 5 Characteristics and Specifications

Table 9 Characteristics and Specifications

Item	Characteristic
Bandwidth (-3 dB)	Zoom-Out Channel: DC to 3 MHz Zoom-In Channel: DC to 500 kHz
Risetime ( $T_r = 0.35/BW$ , 10% – 90%)	Zoom-Out Channel: < 0.116 $\mu$ s Zoom-In Channel: < 0.7 $\mu$ s
Minimum Measurable Current	250 $\mu$ A (with N2822A 20 m $\Omega$ ,) 50 $\mu$ A (with N2824A 100 m $\Omega$ ,) 5 mA (with N2825A user defined 1 m $\Omega$ ,) 100 nA (with N2825A user defined 1 k $\Omega$ ,) <sup>a</sup>
Maximum Measurable Current	5A (with N2822A 20 m $\Omega$ , 500 mW) 2.2A (with N2824A 100 m $\Omega$ , 500 mW) 5A (with N2825A, 1 m $\Omega$ installed) 1.2 mA (with N2825A user defined 1 k $\Omega$ ,)
Output Voltage Rate	Zoom-In Channel: 6 V/A (with N2822A 20 m $\Omega$ ) 30 V/A (with N2824A 100 m $\Omega$ ) Zoom-Out Channel: 0.04 V/A (with N2822A 20 m $\Omega$ ) 0.2 V/A (with N2824A 100 m $\Omega$ )
Maximum Input Voltage	$\pm 12$ V
Maximum Output Voltage (Linear Operation)	12V <sup>b</sup>
Burden Voltage (voltage drop on R <sub>SENSE</sub> )	Measured current * R <sub>SENSE</sub>
Dynamic Range	20,000:1, 86 dB (N2820A) 1,000:1, 60 dB (N2821A)
Oscilloscope Input Impedance	1 M $\Omega$
Input Impedance	1.5 G $\Omega$ single ended 3.0 G $\Omega$ differential
Gain <sup>c</sup> (warranted specification)	Zoom-In: 300 $\pm$ 3% Zoom-Out: 1.97 $\pm$ 3%
Noise, AC <sub>rms</sub>	150 $\mu$ A (with N2822A 20 m $\Omega$ , (hi res mode on) <sup>d</sup> 240 $\mu$ A (with N2822A 20 m $\Omega$ , (hi res mode off) <sup>d</sup> 30 $\mu$ A (with N2824A 100 m $\Omega$ , (hi res mode on) <sup>d</sup> 50 $\mu$ A (with N2824A 100 m $\Omega$ , (hi res mode off) <sup>d</sup>
Sensor Resistor Accuracy	$\pm 1\%$ (N2822A, N2824A)
Sensor Resistor Power Rating	500 mW (N2822A, N2824A)
Temperature Coefficient of Sensor Resistor	< 20 ppm/ $^{\circ}$ C
Cable Lengths	Sensor leads: 16 cm Probe cable: 1.2m

a Probe loading (1.5G $\Omega$ ) contributes 3% error at V<sub>supply</sub> equal to 5V.

b Clipping occurs for higher voltages, which may appear on the screen.



- c Denotes warranted spec after 20 minute warm up. All others entries in the table are characteristics.
- d With scope with high resolution mode on, sampling rate < 2.5 MSa/s, 20 MHz low-pass filter on.

Table 10 Environmental Characteristics

Item	Characteristic
Temperature (operating)	Operating: 0° C to 40° C Non-Operating: -40° C to 70° C
Humidity (operating)	Operating: tested at 95% RH @ +40° C Non-Operating: tested at 90% RH, +65° C
ESD	8 kV HBM
Indoor Use	This probe is rated for indoor use only

Table 11 Compatible Oscilloscopes

InfiniiVision Oscilloscopes
3000 X-Series (with software version 2.30 or higher)
4000 X-Series (with software version 3.10 or higher)
Infiniium <sup>a</sup> Oscilloscopes
9000A and 9000 H-Series (with software version 4.20 or higher)

- a Infiniium 9000A and 90000 X/Q-Series oscilloscopes are not compatible with N2820/1A current probes.

## Current Range Graphs

The following graphs show the minimum and maximum current ranges versus  $R_{SENSE}$  resistance.

NOTE

These graphs represent a condition where the sensor leads are solder attached to the  $R_{SENSE}$  resistor, the maximum probe-head power rating of 500 mW is observed, and the oscilloscope is set to high-resolution.

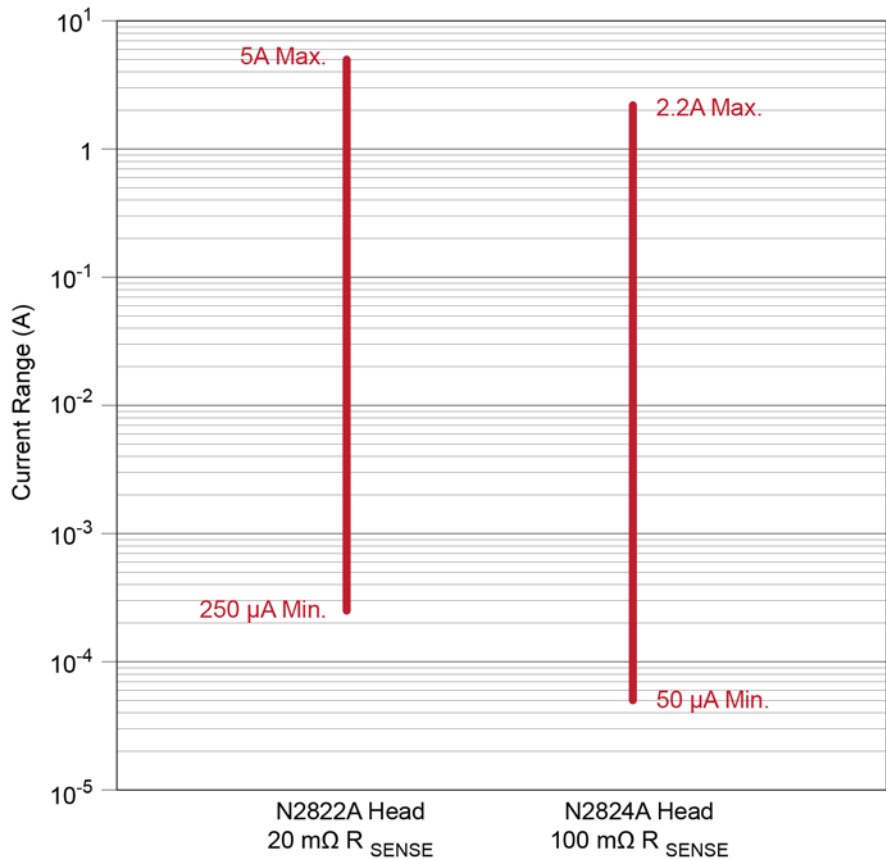


Figure 34 Current Range of N2822/4A Heads

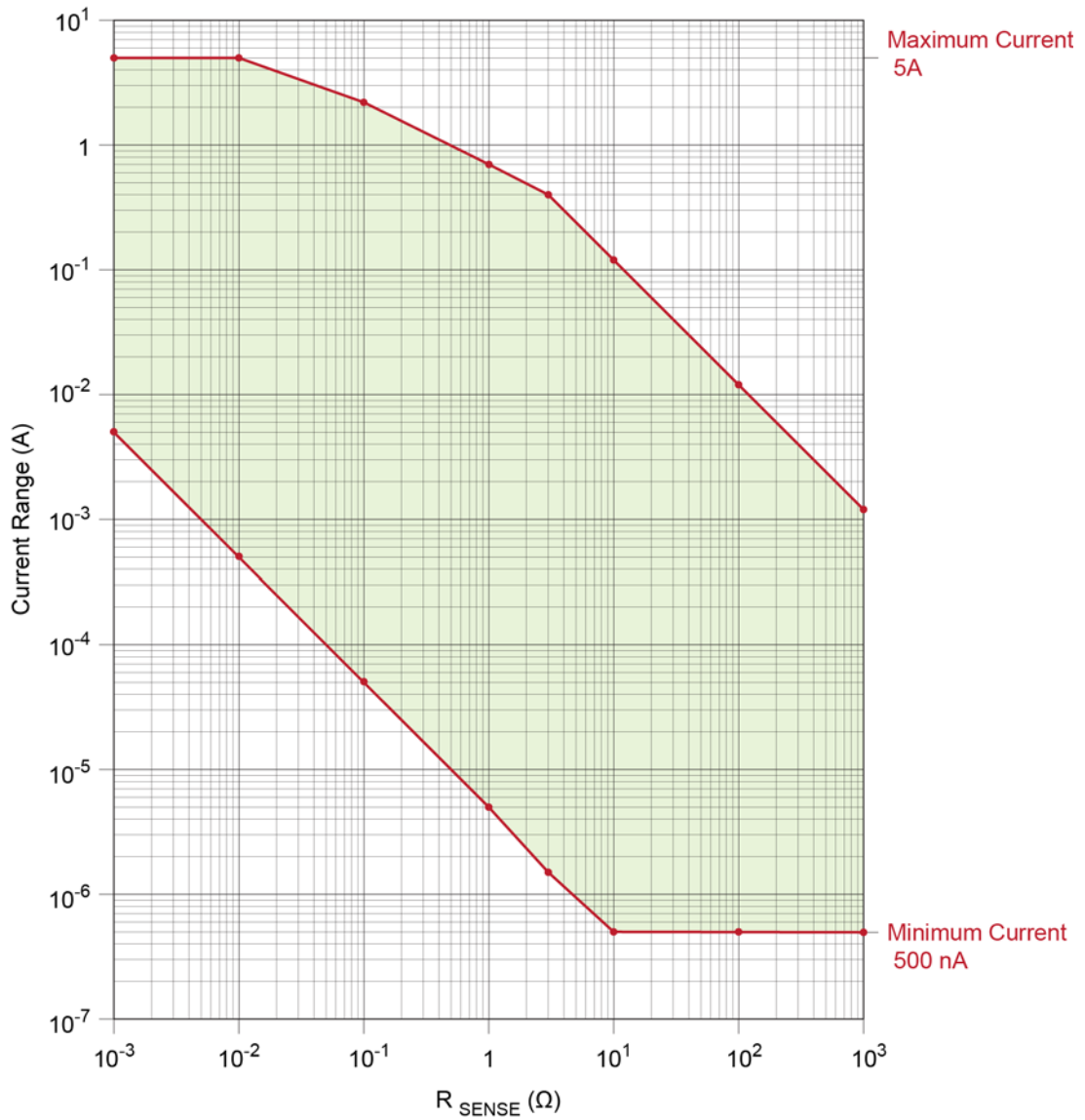


Figure 35 Current Range of N2825A User-Defined Head

## 5 Characteristics and Specifications

### Zoomed-In Input Voltage Range Versus Supply Voltage

# Zoomed-In Input Voltage Range Versus Supply Voltage

For the zoomed-in probe input, the following graph shows the *typical* input voltage range allowed based on the supply voltage that you are measuring. For example, when measuring a 5V input, the input voltage range is  $\pm 45$  mV.

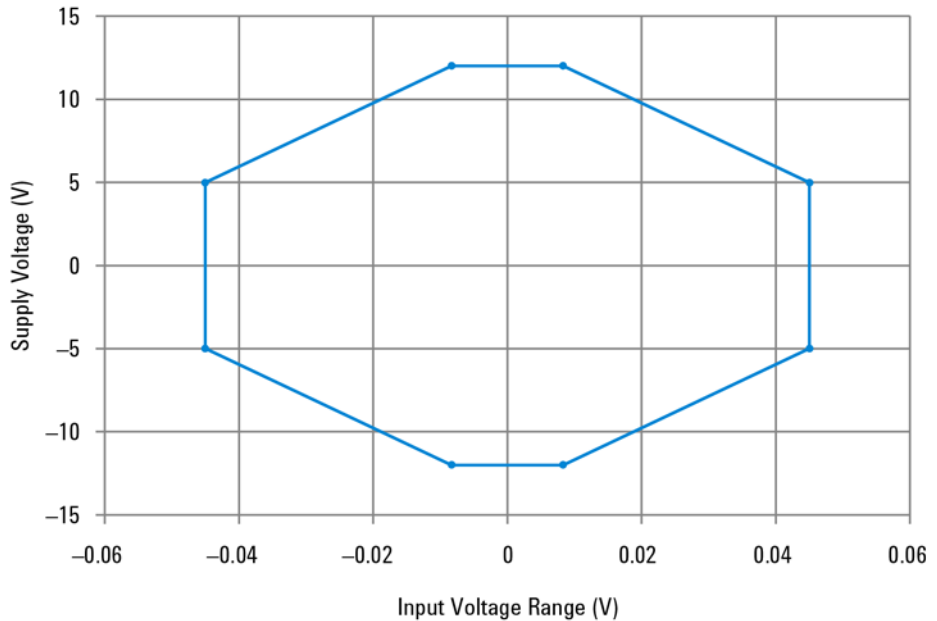


Figure 36 Zoomed-In Input Voltage Range Versus Supply Voltage

---

**NOTE**

This plot can be used with N2825A heads (user-defined  $R_{\text{SENSE}}$ ) to verify current range versus supply voltage.

---

## Zoomed-In Input Current Range Versus Supply Voltage

For the zoomed-in probe input, the following two graphs show the *typical* input current range allowed based on the supply voltage that you are measuring. For example, when using an N2824A head and measuring a 5V input, the current range is  $\pm 0.54\text{A}$ . When using an N2822A head and measuring a 5V input, the current range is  $\pm 1.0\text{A}$ .

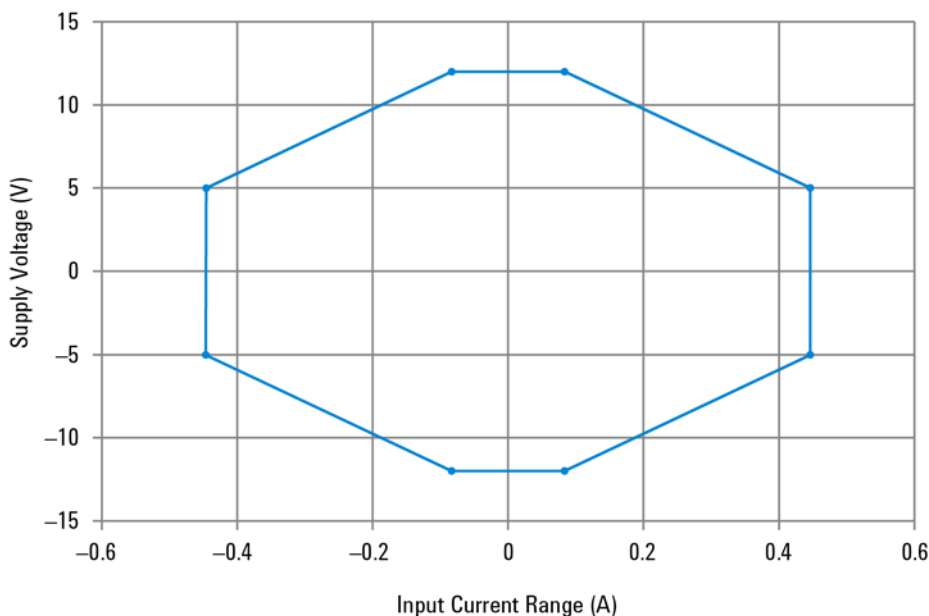


Figure 37 Zoomed-In Input Current Range Versus Supply Voltage (N2824A 100 mΩ Head)

## 5 Characteristics and Specifications

### Zoomed-In Input Current Range Versus Supply Voltage

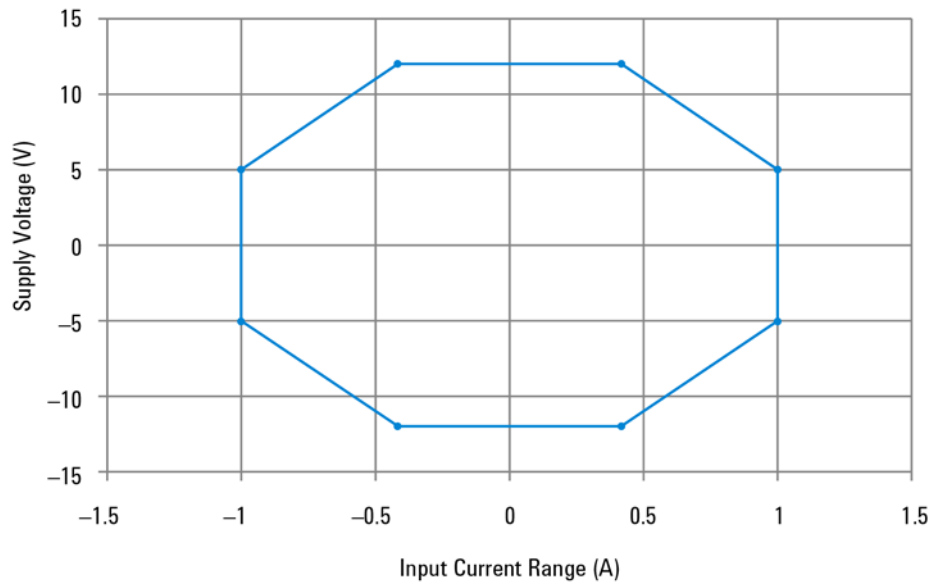
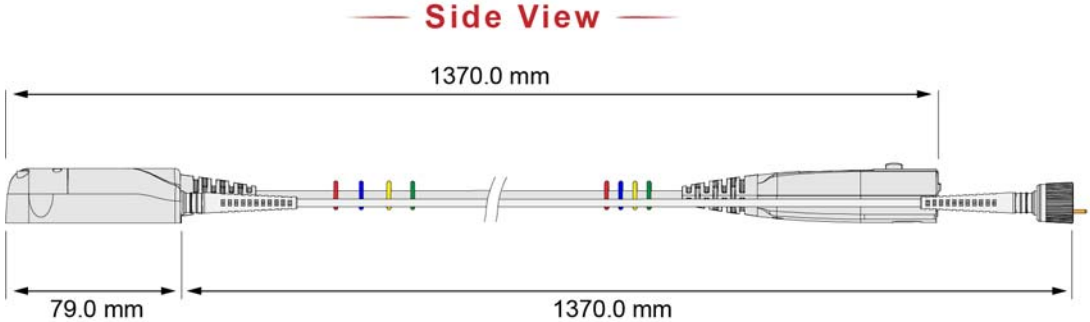
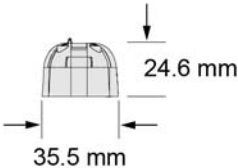


Figure 38 Zoomed-In Input Current Range Versus Supply Voltage  
(N2822A 20 m $\Omega$  Head)

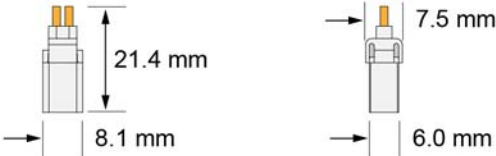
# Dimensions



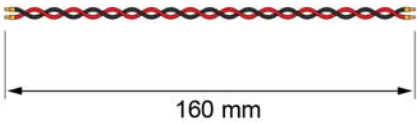
**Front View**



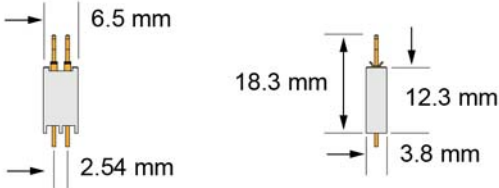
**Socket / MBB Receptacle**



**Sensor Leads**



**MBB Header**



Drawing Not To Scale

Figure 39 Probe and Tip Dimensions

## **5 Characteristics and Specifications Dimensions**



# 6

## Performance Data Plots

N2820A Frequency Response	82
N2820A Common Mode Rejection Ratio	84
N2820A Step Response	85
N2820A Step Tracking	86
N2820A Input Impedance	88
Input Load Model	89

This chapter provides the performance plots for the N2820A.

6 Performance Data Plots  
N2820A Frequency Response

# N2820A Frequency Response

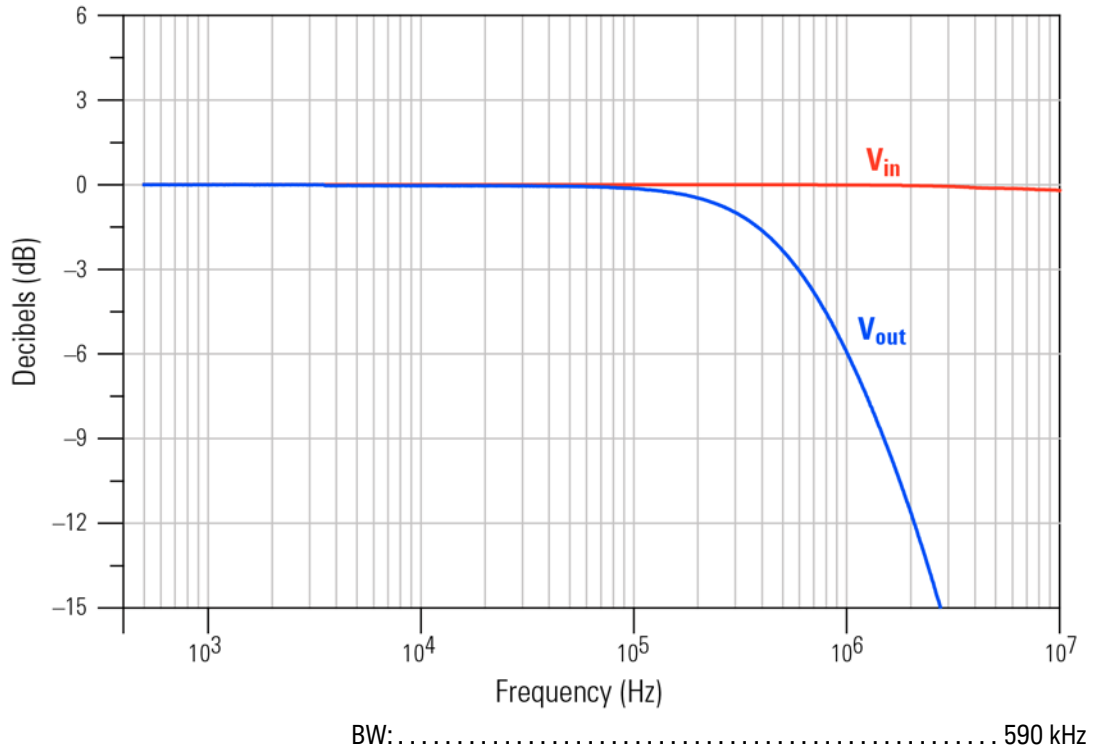
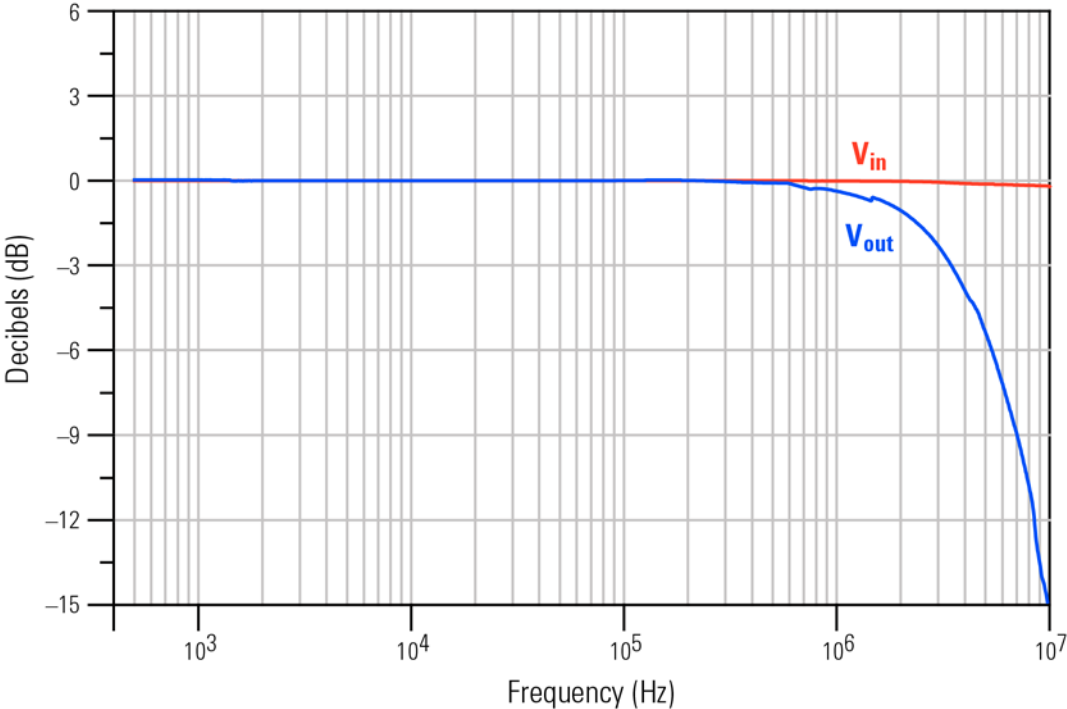


Figure 40 Frequency Response, Zoomed-In Channel



BW: ..... 3.5 MHz

Figure 41 Frequency Response, Zoomed-Out Channel

## N2820A Common Mode Rejection Ratio

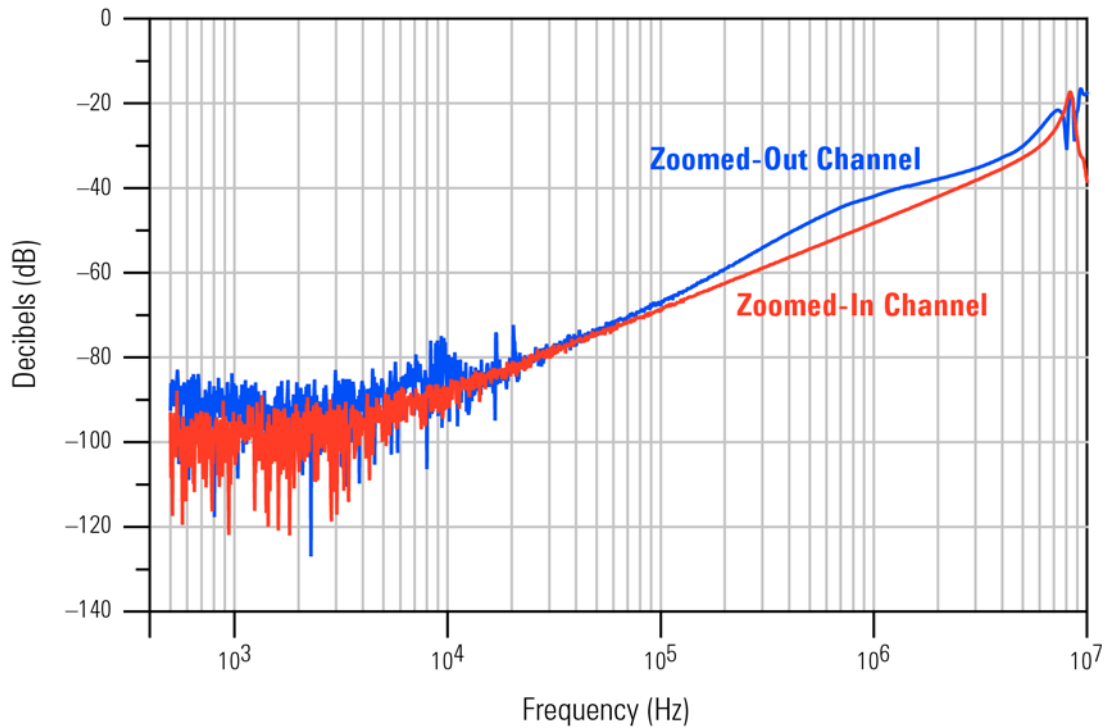
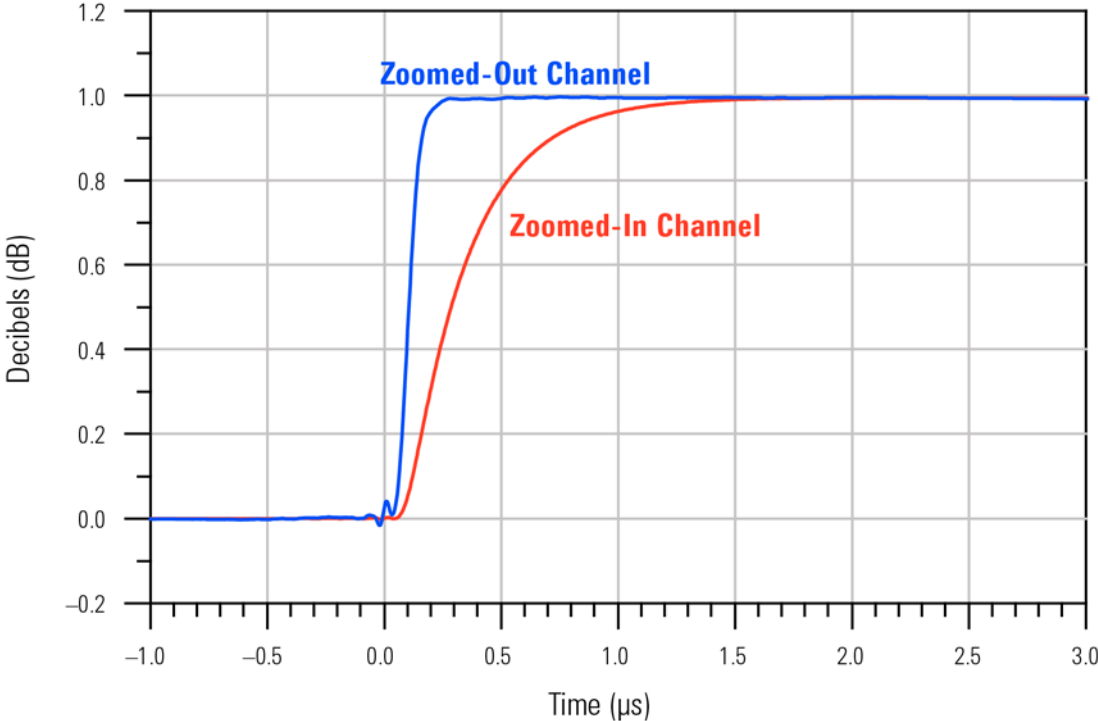


Figure 42 Common Mode Rejection Ratio (CMRR)

# N2820A Step Response



**Zoomed-In Channel**

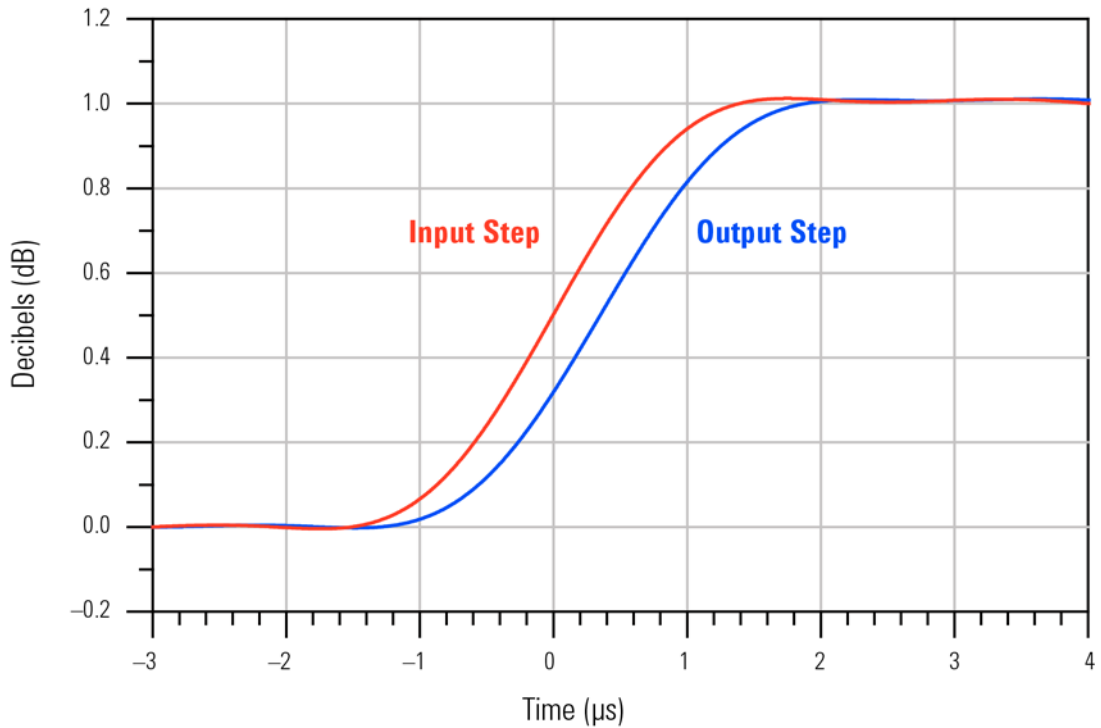
- 10–90% rising edge step: . . . . . 584.2 ns
- 20–80% rising edge step: . . . . . 365.8 ns

**Zoomed-Out Channel**

- 10–90% rising edge step: . . . . . 96.76 ns
- 20–80% rising edge step: . . . . . 63.33 ns

Figure 43 Step Response

## N2820A Step Tracking



### Input Step

10–90% Rise Time: . . . . . 1.688 μs

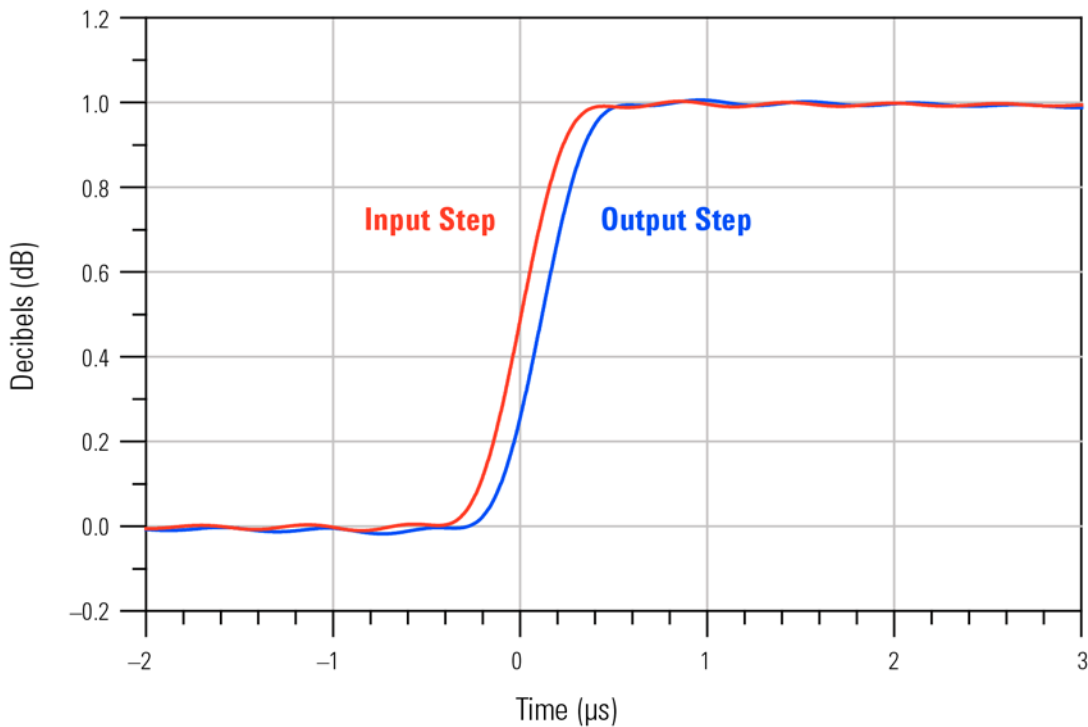
20–80% Rise Time: . . . . . 1.153 μs

### Output Step

10–90% Rise Time: . . . . . 1.769 μs

20–80% Rise Time: . . . . . 1.204 μs

Figure 44 Zoomed-In Channel Step Tracking



**Input Step**

10–90% Rise Time: . . . . . 446.9 ns  
 20–80% Rise Time: . . . . . 299.8 ns

**Output Step**

10–90% Rise Time: . . . . . 450.0 ns  
 20–80% Rise Time: . . . . . 302.6 ns

Figure 45 Zoomed-Out Channel Step Tracking

# N2820A Input Impedance

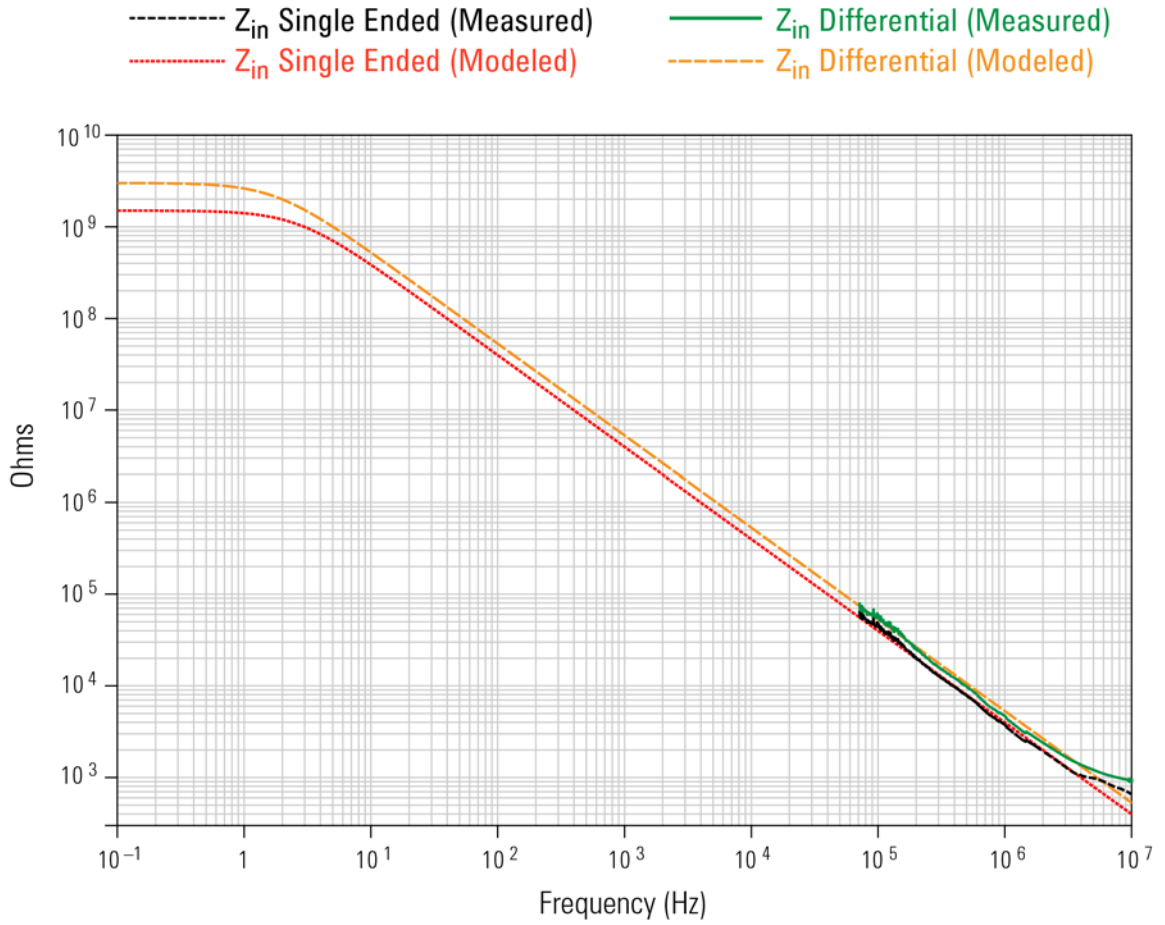


Figure 46 Input Impedance



# Input Load Model

$Z_{in}$  Single Ended: ..... 1.5 G $\Omega$   
 $Z_{in}$  Differential: ..... 3 G $\Omega$

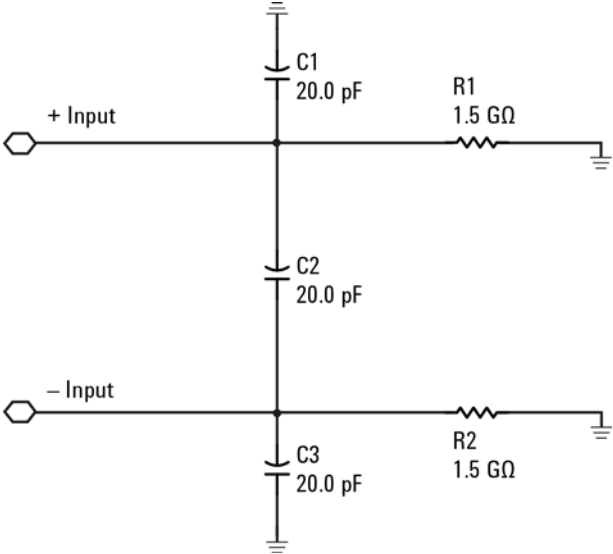


Figure 47 Input Load Model

**6 Performance Data Plots**  
**Input Load Model**

# 7

## Performance Verification

Average Gain of Zoomed-In Channel 93  
Average Gain of Zoomed-Out Channel 97  
Performance Test Record 101

This chapter describes how to verify the performance of the N2820A and N2821A probes. The performance verification requires an N2825A probe head and consists of verifying the probe's DC gain.

---

NOTE The Average Gain verified in this chapter is listed as Gain in [Table 9](#), "Characteristics and Specifications," on page 72.

---

NOTE The performance measured in this procedure is for the probe by itself. Keysight high performance real-time scopes apply probe correction that will further enhance the performance of the probes.

---

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



---

**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.

---

## 7 Performance Verification

Table 12 Required Test Equipment

Test Equipment	Recommended Model
Digital Multimeter	General purpose instrument for DC voltage measurement.
DC Power Supply	Recommended: $\pm 20V$ Maximum: $\leq \pm 35V$
Probe Power Supply	Keysight 1143A Probe Offset Control and Power Module 
Probe Adapter	Keysight N1022A/B Probe Adapter. 
Adapters	3.5 mm-to-BNC BNC-to-banana

## Average Gain of Zoomed-In Channel

This procedure applies to both N2820A and N2821A probes.

---

**NOTE** Allow the probe to warm up for at least 20 minutes.

---

- 1 Snap an N2825A head onto the N2820/1A probe and connect the test equipment as shown in [Figure 48](#). Be sure to connect the positive side of the DC supply to the red lead on the N2825A head.

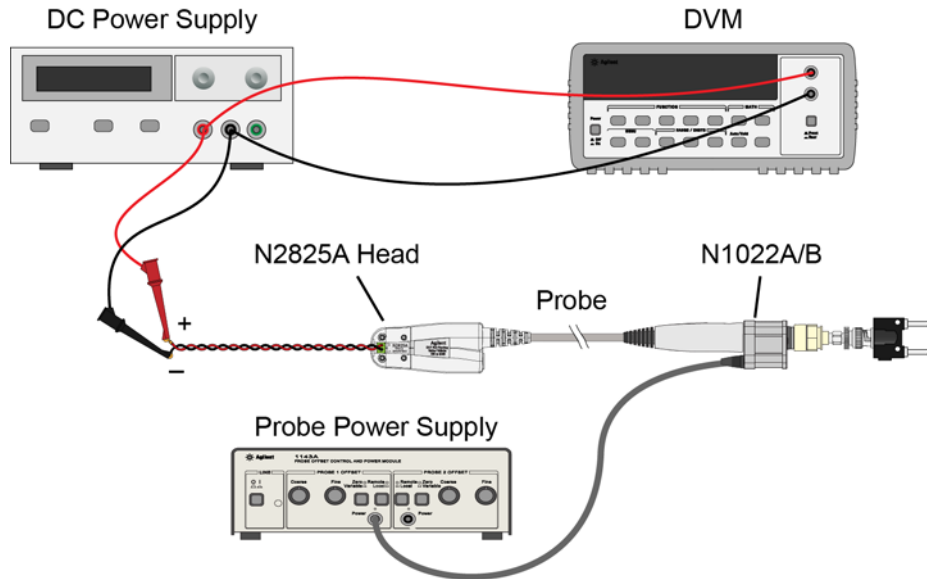


Figure 48 Test Setup for Measuring  $V_{in}$

- 2 Set the DC power supply to +20 mV.

---

**NOTE** Although this is the recommended setting, you can use any voltages up to +35 mV.

---

**7 Performance Verification**  
**Average Gain of Zoomed-In Channel**

- 3** Record the value of  $+V_{in}$  measured on the multimeter:

$+V_{in}$ : \_\_\_\_\_

- 4** Move the multimeter's leads to the banana plug on the output of the N1022A/B as shown in [Figure 49](#).

- 5** Record the value of  $+V_{out}$  measured on the multimeter:

$+V_{out}$ : \_\_\_\_\_

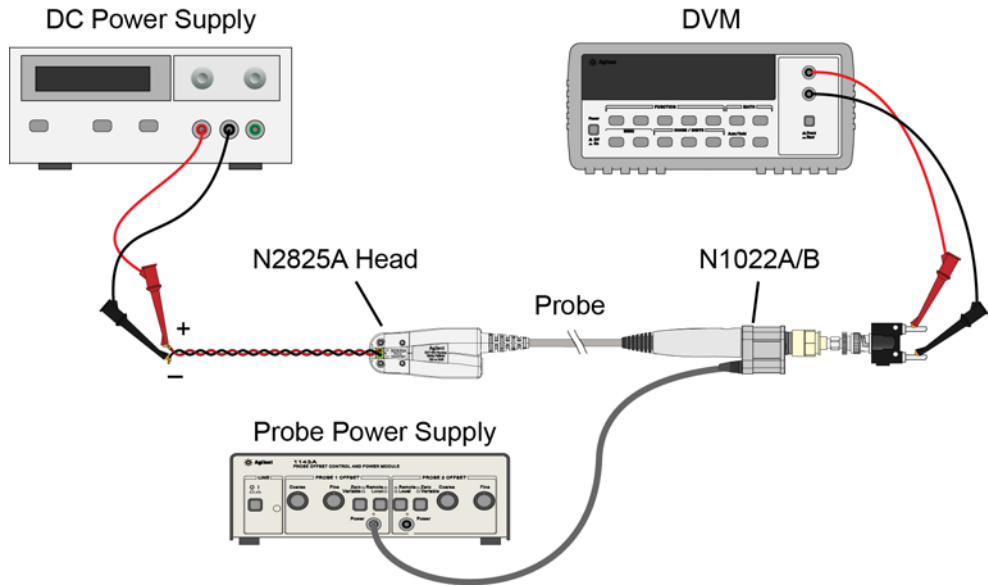


Figure 49 Test Setup for Measuring  $V_{out}$

- 6** Calculate the positive gain of the zoomed-in (primary) channel and record the result in the following line:

$$\text{positive gain} = \frac{+V_{\text{out}}}{+V_{\text{in}}}$$

positive gain: \_\_\_\_\_

- 7 Set the DC power supply to -20 mV.

---

NOTE Although this is the recommended setting, you can use any negative voltage less than -35 mV.

---

- 8 Connect the multimeter on the DC power supply as shown in [Figure 48](#) on page 93.

- 9 Record the value of  $-V_{\text{in}}$  measured on the multimeter:

$-V_{\text{in}}$ : \_\_\_\_\_

- 10 Connect the multimeter's leads to the banana plug on the output of the N1022A/B as shown in [Figure 49](#) on page 94.

- 11 Record the value of  $-V_{\text{out}}$  measured on the multimeter:

$-V_{\text{out}}$ : \_\_\_\_\_

- 12 Calculate the negative gain of the zoomed-in (primary) channel and record the result in the following line:

$$\text{negative gain} = \frac{-V_{\text{out}}}{-V_{\text{in}}}$$

negative gain: \_\_\_\_\_

- 13 Calculate the average of the two gains:

**7 Performance Verification**  
**Average Gain of Zoomed-In Channel**

$$\text{average gain} = \frac{\text{positive gain} + \text{negative gain}}{2}$$

average gain (zoomed-in): \_\_\_\_\_

- 14** The average gain (zoomed-in) should be  $300 \pm 3\%$ . Enter the value in [Table 13](#) on page 101.



## Average Gain of Zoomed-Out Channel

Perform this procedure *only* for N2820A probes.

---

NOTE Allow the probe to warm up for at least 20 minutes.

---

- 1 Snap an N2825A head onto the N2820/1A probe and connect the test equipment as shown in Figure 50. Be sure to connect the positive side of the DC supply to the red lead on the N2825A head.

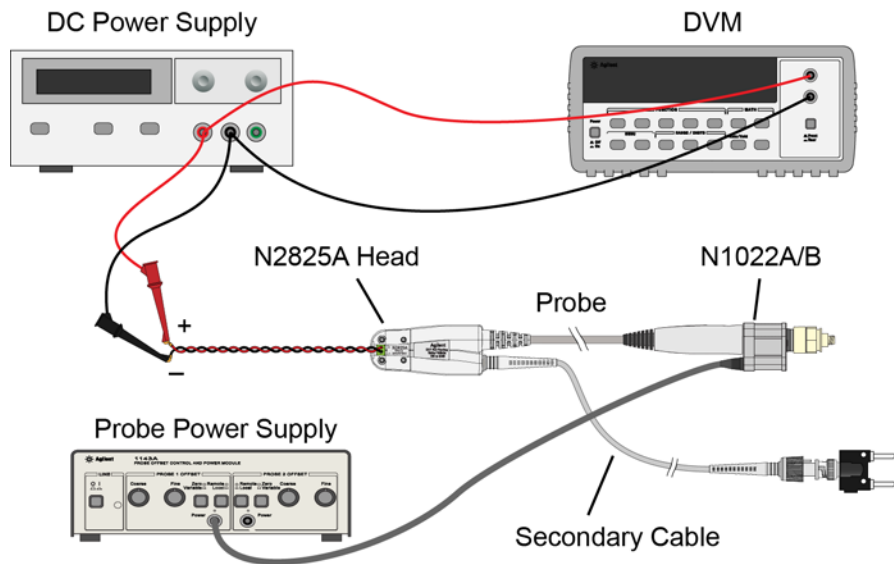


Figure 50 Test Setup for Measuring  $V_{in}$

- 2 Set the DC power supply to +500 mV.

---

NOTE Although this is the recommended setting, you can use any voltage up to +700 mV.

---

## 7 Performance Verification Average Gain of Zoomed-Out Channel

- 3 Record the value of  $+V_{in}$  measured on the multimeter:

$+V_{in}$ : \_\_\_\_\_

- 4 Move the multimeter's leads to the banana plug on the output of the N1022A/B as shown in Figure 51.

- 5 Record the value of  $+V_{out}$  measured on the multimeter:

$+V_{out}$ : \_\_\_\_\_

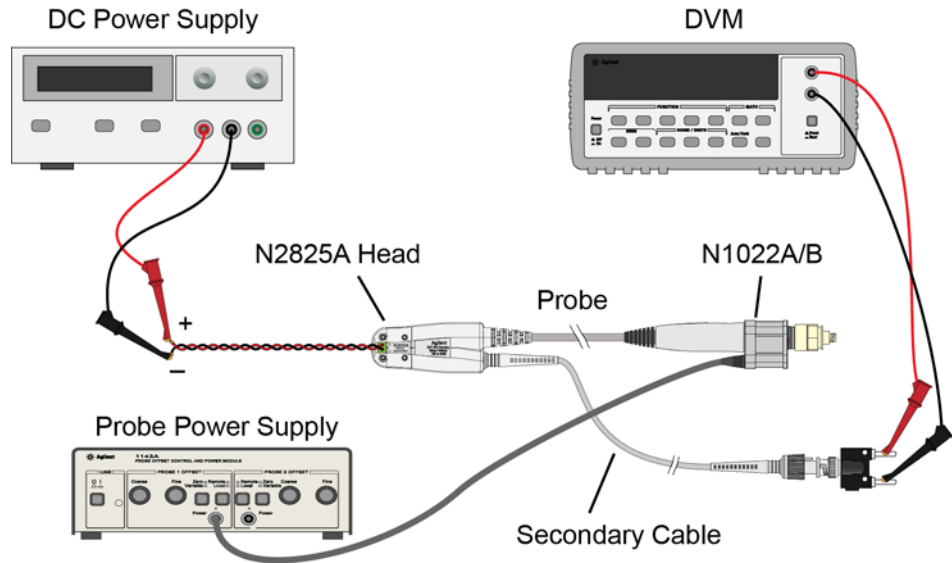


Figure 51 Test Setup for Measuring  $V_{out}$

- 6 Calculate the positive gain of the zoomed-out (secondary) channel and record the result in the following line:

$$\text{positive gain} = \frac{+V_{\text{out}}}{+V_{\text{in}}}$$

positive gain: \_\_\_\_\_

- 7 Set the DC power supply to  $-500$  mV.

---

NOTE Although this is the recommended setting, you can use any negative voltage less than  $-700$  mV.

---

- 8 Connect the multimeter on the DC power supply as shown in [Figure 50](#) on page 97.

- 9 Record the value of  $-V_{\text{in}}$  measured on the multimeter:

$-V_{\text{in}}$ : \_\_\_\_\_

- 10 Connect the multimeter's leads to the banana plug on the output of the N1022A/B as shown in [Figure 51](#) on page 98.

- 11 Record the value of  $-V_{\text{out}}$  measured on the multimeter:

$-V_{\text{out}}$ : \_\_\_\_\_

- 12 Calculate the negative gain of the zoomed-out (secondary) channel and record the result in the following line:

$$\text{negative gain} = \frac{-V_{\text{out}}}{-V_{\text{in}}}$$

negative gain: \_\_\_\_\_

- 13 Calculate the average of the two gains:

**7 Performance Verification**  
**Average Gain of Zoomed-Out Channel**

$$\text{average gain} = \frac{\text{positive gain} + \text{negative gain}}{2}$$

average gain (zoomed-out): \_\_\_\_\_

- 14** The average gain (zoomed-out) should be  $1.97 \pm 3\%$ . Enter the value gain in [Table 13](#) on page 101.

# Performance Test Record

The Average Gain recorded in [Table 13](#) is listed as Amplitude Accuracy in [Table 9](#), “Characteristics and Specifications,” on page 72.

Table 13 N2820/1A Performance Test Record

<b>Model #:</b>	<b>Date:</b>	<b>Tested by:</b>	
<b>Recommended next test date:</b>			
<b>Recommended Test Interval: 1 year / 2000 hours</b>			
<b>Probe Amplifier</b>	<b>Test Limits</b>	<b>Result</b>	<b>Pass/Fail</b>
<b>Average Gain of Zoomed-In Channel (N2820/1A)</b>			
Average Gain (zoomed-in )	300 ±3%		
<b>Average Gain of Zoomed-Out Channel (N2820A only)</b>			
Average Gain (zoomed-out)	1.97 ±3%		

**7 Performance Verification**  
**Performance Test Record**

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