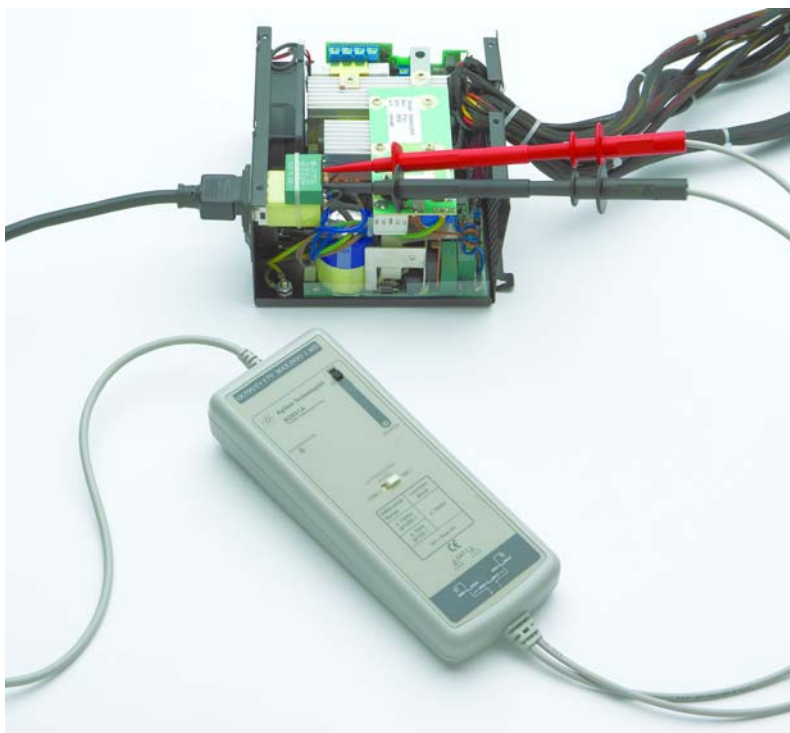


# N2791A 25 MHz and N2891A 70 MHz High-Voltage Differential Probes

## User's Guide



For Safety, Regulatory, and publishing information, see the pages at the back of this book.

© Copyright Agilent Technologies 2009  
All Rights Reserved.



**Agilent Technologies**

---

# Contents

|  |    |
|--|----|
| Inspecting the Probe                             | 3  |
| Cleaning the Probe                               | 3  |
| Handling the Probe                               | 3  |
| N2791A/N2891A High-Voltage Differential Probes   | 4  |
| Contents and Accessory Kits                      | 5  |
| Characteristics and Specifications               | 7  |
| Safety Information                               | 9  |
| Using the N2791A High-Voltage Differential Probe | 10 |
| Using the N2891A High-Voltage Differential Probe | 11 |
| N2791A Plots                                     | 12 |
| N2891A Plots                                     | 16 |
| Using the Accessories                            | 20 |

---

## Inspecting the Probe

- o 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.

- o Check the accessories.
  - If the contents are incomplete or damaged, notify your Agilent Technologies Sales Office.
- o Inspect the instrument.
  - If there is mechanical damage or defect, or if the probe does not operate properly or pass calibration tests, notify your Agilent Technologies Sales Office.
  - If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier as well as your Agilent Technologies Sales Office. Keep the shipping materials for the carrier's inspection. The Agilent Technologies office will arrange for repair or replacement at Agilent Technologies' option without waiting for claim settlement.

---

## Cleaning the Probe

Disconnect the probe and clean it with a soft cloth. Make sure the probe is completely dry before reconnecting it to an oscilloscope. Avoid using abrasive cleaners and chemicals containing benzene or similar solvents.



## Handling the Probe

Handle the probe with care and refer to the safety notices at the back of this manual and on page 9. Note that the probe cable is a sensitive part of the probe and, therefore, you should be careful not to damage it through excessive bending or pulling. You should also avoid any mechanical shocks to this product in order to guarantee accurate performance and protection.

---

### N2791A/N2891A High-Voltage Differential Probes

The N2791A/N2891A high-voltage differential probes allow conventional earth-grounded oscilloscopes to be used for floating signal measurements (up to 700 V of differential or common mode voltage for the N2791A and up to 7000 V of differential or common mode voltage for the N2891A). The N2791A offers users selectable attenuation settings of 10:1 and 100:1 while the N2891A offers attenuation settings of 100:1 and 1000:1, making both probes highly versatile and usable for a broad range of applications including power supply measurements and motor controls. Both probes are compatible with any oscilloscope with a 1 M $\Omega$  BNC input. The probes can be powered by any USB port on an oscilloscope or computer, or by internal batteries (4x AA included with the probe).

The images below show some key parts of the N2891A probe body. The N2791A has similar switches/LEDs, but they are arranged differently.



#### Battery Use

- Insert 4 AA batteries in the back of the unit as indicated within the chassis (see pages 10-11 for information on accessing the battery location)
- When battery life has expired, remove the batteries
- When the batteries gets close to running out, the power indicator will start to flicker and dim
- Note the WEEE label on the batteries and dispose of properly

---

## Contents and Accessory Kits

The following table lists the parts included with the N2791A high-voltage differential probe.

| <b>Part</b>                      | <b>Quantity</b> |
|----------------------------------|-----------------|
| N2791A 25 MHz differential probe | 1               |
| Safety Hook, Red                 | 1               |
| Safety Hook, Black               | 1               |
| Alligator Clip, Red              | 1               |
| Alligator Clip, Black            | 1               |
| USB Power Cord (2 m)             | 1               |
| AA Battery                       | 4               |
| User's Guide                     | 1               |

For N2791A replacement accessories, you can order the N2791-68700 Differential Probe Accessory Kit. It includes:

| <b>Part</b>           | <b>Quantity</b> |
|-----------------------|-----------------|
| Safety Hook, Red      | 1               |
| Safety Hook, Black    | 1               |
| Alligator Clip, Red   | 1               |
| Alligator Clip, Black | 1               |
| USB Power Cord (2 m)  | 1               |

T

## Contents and Accessory Kits

The following table lists the parts included with the N2891A high-voltage differential probe.

| <b>Part</b>                        | <b>Quantity</b> |
|------------------------------------|-----------------|
| N2891A 70 MHz differential probe   | 1               |
| Safety Hook, Red                   | 1               |
| Safety Hook, Black                 | 1               |
| High Voltage Alligator Clip, Red   | 1               |
| High Voltage Alligator Clip, Black | 1               |
| USB Power Cord (2 m)               | 1               |
| AA Battery                         | 4               |
| User's Guide                       | 1               |

For N2891A replacement accessories, you can order the N2891-68700 Differential Probe Accessory Kit. It includes:

| <b>Part</b>                        | <b>Quantity</b> |
|------------------------------------|-----------------|
| Safety Hook, Red                   | 1               |
| Safety Hook, Black                 | 1               |
| High Voltage Alligator Clip, Red   | 1               |
| High Voltage Alligator Clip, Black | 1               |
| USB Power Cord (2 m)               | 1               |

## Characteristics and Specifications

Characteristics and specifications for the N2791A and N2891A high-voltage differential probes are shown below. The probe / oscilloscope should be warmed up for at least 20 minutes before any testing and the environmental conditions should not exceed the probe's specified limits.

### Electrical Characteristics

|  | <b>N2791A</b>   | <b>N2891A</b>   |
|--|---|---|
| Bandwidth (-3 dB)  | >25 MHz (driving 1 MΩ oscilloscope input)   | 70 MHz (driving 1 MΩ oscilloscope input)  |
| Attenuation ratio  | 10:1, 100:1 (switchable)  | 100:1, 1000:1 (switchable)  |
| Probe Risetime (10%-90%)                                   | 14 ns   | 5 ns  |
| Absolute Maximum Rated Input Voltage (each side to ground) | 1000 Vrms CAT II  | 5000 Vrms CAT I   |
| Maximum Differential Input Voltage (DC + AC Peak)          | ±70 V at 10:1 attenuation<br>±700 V at 100:1 attenuation  | ±700 V at 100:1 attenuation<br>±7000 V at 1000:1 attenuation  |
| Maximum Common Mode Input Voltage                          | ±70 V at 10:1 attenuation<br>±700 V at 100:1 attenuation  | ±7000 V at 10:1 attenuation<br>±7000 V at 1000:1 attenuation  |
| Input Impedance  | 4 MΩ, 10 pF (each side to ground)<br>8 MΩ, 8 pF (between inputs)                                      | 50 MΩ, 7 pF (each side to ground)<br>100 MΩ, 5 pF (between inputs)                                    |
| Output Voltage Swing                                       | ±7 V (driving 1 MΩ oscilloscope input)  | ±7 V (driving 1 MΩ oscilloscope input)  |
| Offset (typical)   | ±7.5 mV   | ±5 mV   |
| CMRR (typical)   | -80 dB at 60 Hz, -40 dB at 1 MHz  | -80 dB at 50 Hz, -60 dB at 20 kHz   |
| Power Requirements   | 4 AA batteries or USB power adapter (5 V/200 mA, 9 V/120 mA)  | 4 AA batteries or USB power adapter (5 V/200 mA, 9 V/120 mA)  |
| Battery Life   | 15 hours (alkaline battery)   | 11.5 hours (alkaline battery)   |
| Battery/Power Cord   | The supplied voltage must be less than 12 V and greater than 4.4 V or else the probe could be damaged | The supplied voltage must be less than 12 V and greater than 4.4 V or else the probe could be damaged |

- all are typical

## Characteristics and Specifications

---

### Mechanical Characteristics

---

|                        | <b>N2791A</b>   | <b>N2891A</b>   |
|------------------------|---|---|
| Weight (probe only)    | 400 g (probe and PVC jacket)                                      | 500 g   |
| BNC Cable Length       | 95 cm (37 inches)   | 90 cm (35 inches)   |
| Length of Input Leads  | 45 cm (18 inches)   | 60 cm (24 inches)   |
| Dimensions (L x W x H) | 170 mm x 63 mm x 21 mm<br>(6.7 inches x 2.5 inches x 0.83 inches) | 202 mm x 83 mm x 38 mm (8.0 inches x 3.3 inches x 1.5 inches) |

---

### Environmental Specifications (same for both N2791A and N2891A)

---

|                  |   |
|------------------|---|
| Temperature      | Operating: -10 °C to +40 °C<br>Nonoperating: -30 °C to +70 °C             |
| Altitude         | Operating: 3,000 m<br>Nonoperating: 15,300 m                              |
| Humidity         | Operating: 25 - 85% room humidity<br>Nonoperating: 25 - 85% room humidity |
| Pollution Degree | Pollution Degree 2  |

---

### Safety Specifications

---

CEI/IEC 61010-031 CAT II (N2791A)

CEI/IEC 61010-031 CAT I (N2891A)

---



---

## Safety Information

---

### Warning



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

#### **Observe Maximum Working Voltage**

To avoid injury, do not use the N2791A probe above 1000 Vrms CAT II (both 10:1 and 100:1 attenuation settings) between each input lead and earth or between the two input leads. Do not use the N2891A probe above 5000 Vrms CAT I (1000:1 attenuation) or 500 Vrms CAT I (100:1 attenuation) between the two input leads. Do not use the N2891A probe above 5000 Vrms CAT I (both 100:1 and 1000:1 attenuation settings) between each input lead and earth.

#### **Must be Grounded**



Before making connections to the input leads of this probe, ensure that the output BNC connector is attached to the BNC channel input of the oscilloscope and the oscilloscope is properly grounded.

#### **Use Fused Test Prods if Necessary**

If this probe is intended to be used with circuits of installation category II, it should incorporate the fused test prods.

#### **Do Not Operate Without Covers**

To avoid electrical shock or fire hazard, do not operate this probe with the covers removed.

#### **Do Not Operate in Wet / Damp Conditions**

To avoid electrical shock, do not operate this probe in wet or damp conditions.

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

To avoid injury or fire hazard, do not operate this probe in an explosive atmosphere.

#### **Avoid Exposed Circuit**

To avoid injury, remove jewelry such as rings, watches, and other metallic objects. Do not touch exposed connections and components when power is present.

#### **Use Proper Power Source**

To ensure this probe functions well, use four AA batteries or the supplied USB power cord.

#### **For Indoor Use Only**

Only use this probe indoors.

## Using the N2791A High-Voltage Differential Probe

### Do Not Operate With Suspected Failures

If you suspect there is damage to this probe, have it inspected by a qualified service personnel.



---

## Using the N2791A High-Voltage Differential Probe

- To use this probe, first insert the four AA batteries into the probe or connect the USB power cord to the probe and a USB port (see page 4 to see where the USB power cord input is located on the probe).



To replace batteries, first slip off the cover



Then slide the battery cover off on the rear of the probe

- Then connect the BNC output connector to the channel input of the oscilloscope. The oscilloscope must have a ground referenced.
- Select the proper attenuation ratio (10:1 or 100:1) on the probe via the attenuation switch and **specify the attenuation and probe configuration on your oscilloscope.**

TIP: When measuring signals below 70 V, switch the attenuation ratio to 10:1 in order to obtain a higher resolution signal with less noise. Otherwise set the attenuation ratio to 100:1.

## Using the N2891A High-Voltage Differential Probe

- Using the appropriate probe accessories, connect the inputs to the circuit under test.



To protect against electrical shock, use only the accessories supplied with this probe or in the accessory kit.



This probe is to carry out differential measurements between two points on the circuit under test. This probe is not for electrically insulating the circuit under test and the measuring instrument.

---

## Using the N2891A High-Voltage Differential Probe

- To use this probe, first insert the four AA batteries into the probe or connect the USB power cord to the probe and a USB port (see page 4 to see where the USB power cord input is located on the probe).



Slide the battery cover off the rear of the probe body

- Then connect the BNC output connector to the channel input of the oscilloscope. The oscilloscope must have a ground referenced.
- Select the proper attenuation ratio (100:1 or 1000:1) on the probe via the attenuation switch (see the picture on page 4) and **specify the attenuation and probe configuration on your oscilloscope.**

TIP: When measuring signals below 700 V, switch the attenuation ratio to 100:1 in order to obtain a higher resolution signal with less noise. Otherwise set the attenuation ratio to 1000:1.

- Using the appropriate probe accessories, connect the inputs to the circuit under test.



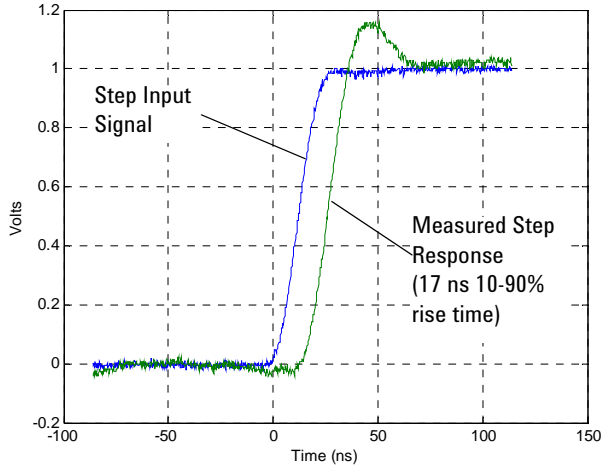
To protect against electrical shock, use only the accessories supplied with this probe or in the accessory kit.



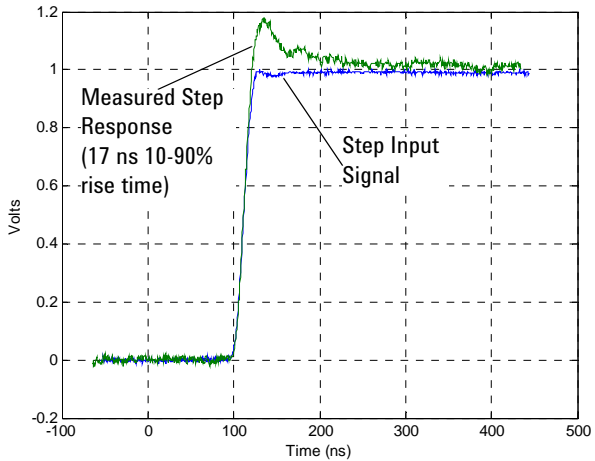
This probe is to carry out differential measurements between two points on the circuit under test. This probe is not for electrically insulating the circuit under test and the measuring instrument.

---

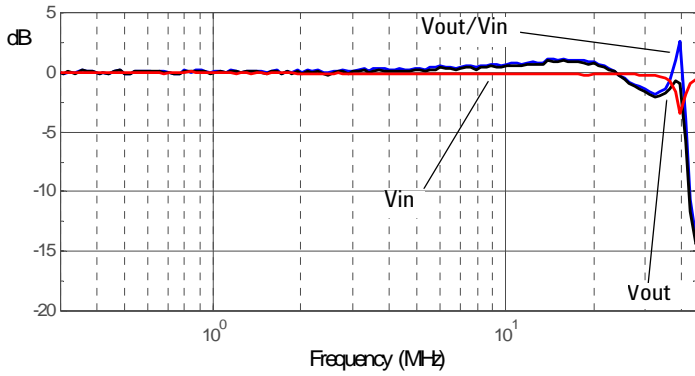
N2791A Plots



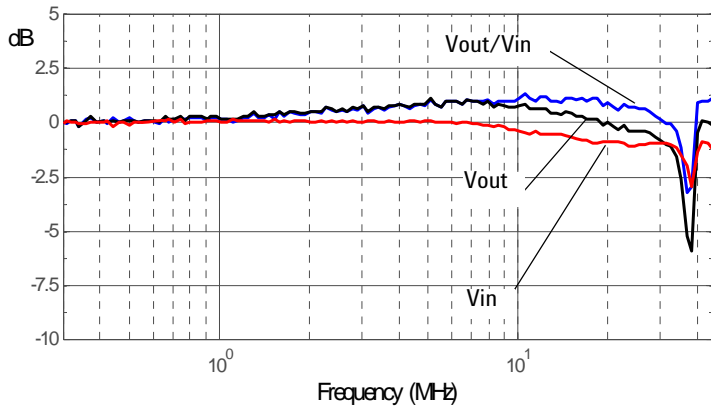
Graph of normalized step response ( $50\Omega$ , 16.5 ns rising edge step generator), 17 ns normalized rising edge (10-90%), 10:1 attenuation



Graph of normalized step response ( $50\Omega$ , 17 ns rising edge step generator), 17 ns normalized rising edge (10-90%), 100:1 attenuation

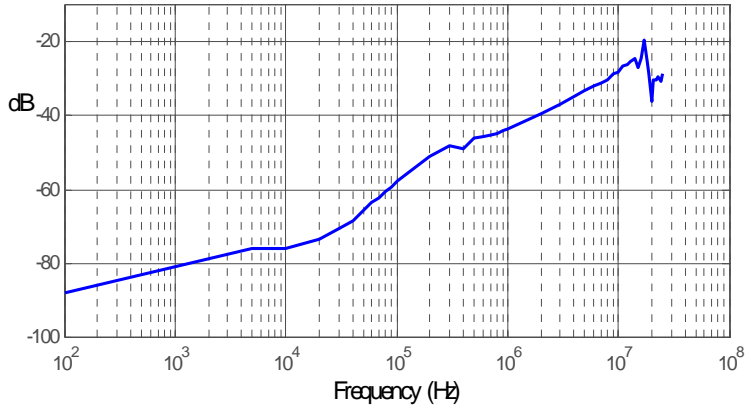


Graph of  $\text{dB}(V_{in})$ ,  $\text{dB}(V_{out}) + 20\text{dB}$ , and  $\text{dB}(V_{out}/V_{in}) + 20\text{dB}$  frequency response, 10:1 attenuation

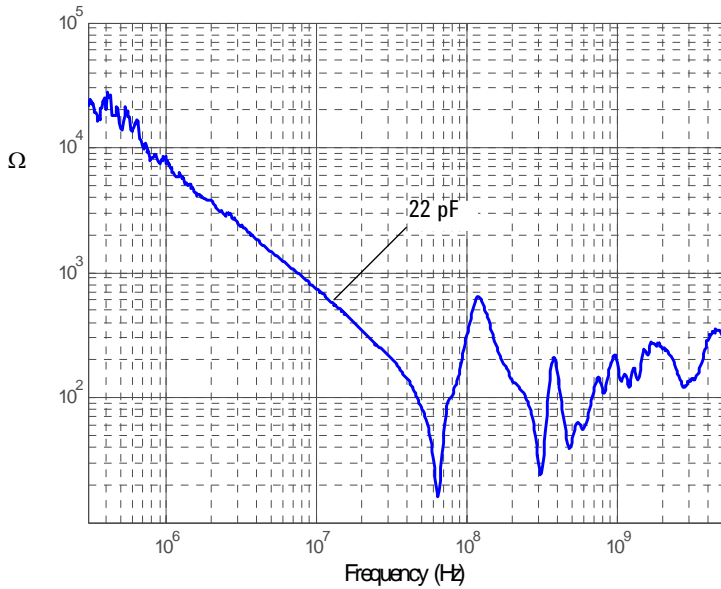


Graph of  $\text{dB}(V_{in})$ ,  $\text{dB}(V_{out}) + 40\text{dB}$ , and  $\text{dB}(V_{out}/V_{in}) + 40\text{dB}$  frequency response, 100:1 attenuation

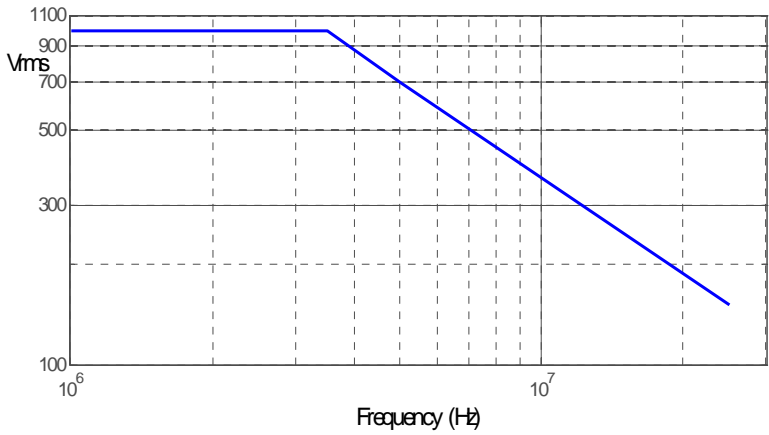
## N2791A Plots



Graph of  $\text{dB}(V_{\text{out}}/V_{\text{in}}) + 20\text{dB}$  frequency response when inputs driven in common mode (common mode rejection), 10:1 attenuation



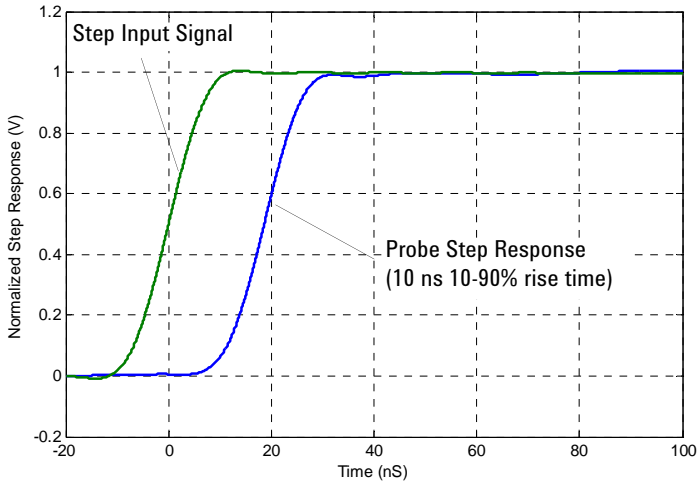
Magnitude plot of probe input impedance versus frequency (single-ended mode)



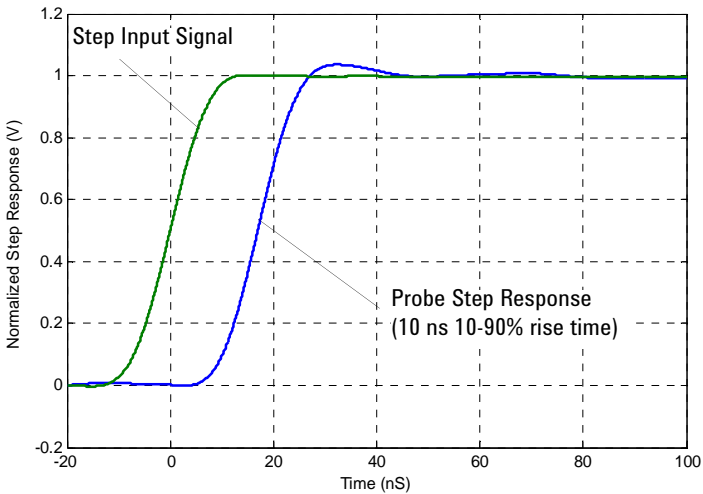
Typical derating plot of the absolute maximum input voltage in common mode

---

N2891A Plots

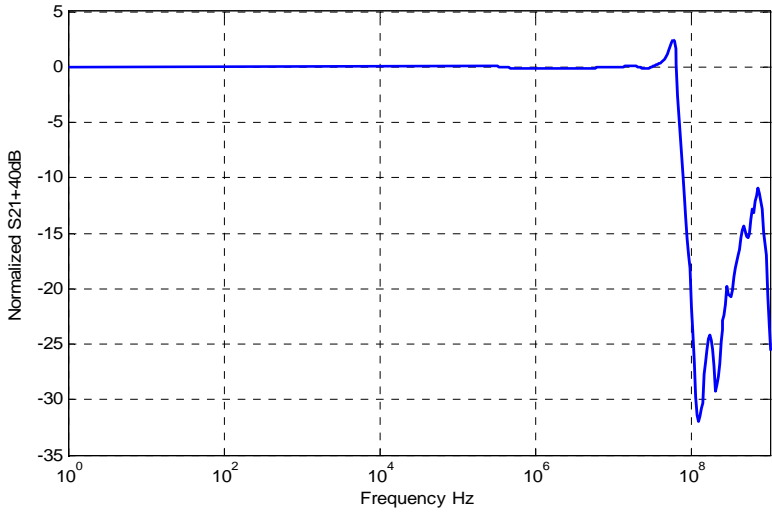


Graph of normalized step response (50  $\Omega$ , 10 ns rising edge step generator), 10 ns normalized rising edge (10-90%), 100:1 attenuation

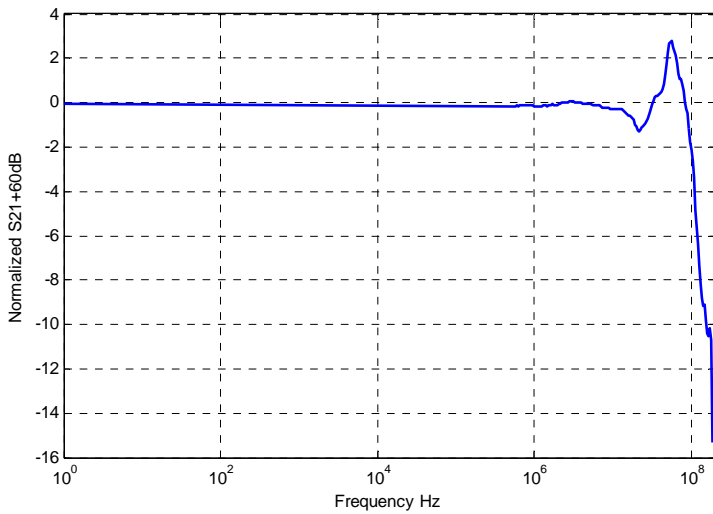


Graph of normalized step response (50  $\Omega$ , 10 ns rising edge step generator), 10 ns normalized rising edge (10-90%), 1000:1 attenuation



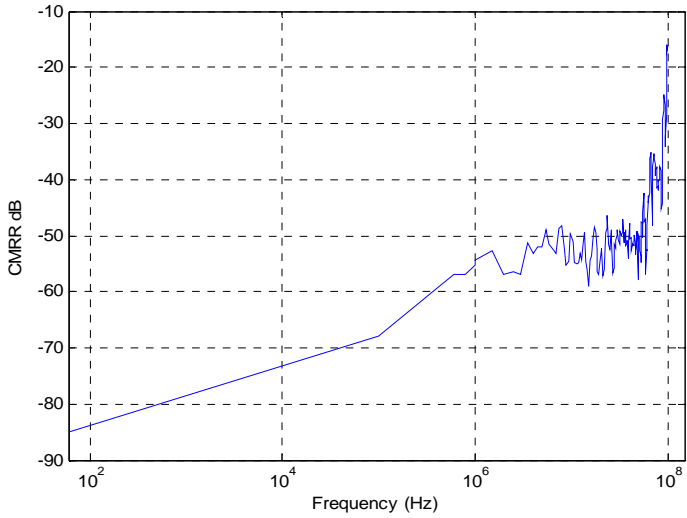


Graph of dB (S21) + 40 dB frequency response, 100:1 attenuation

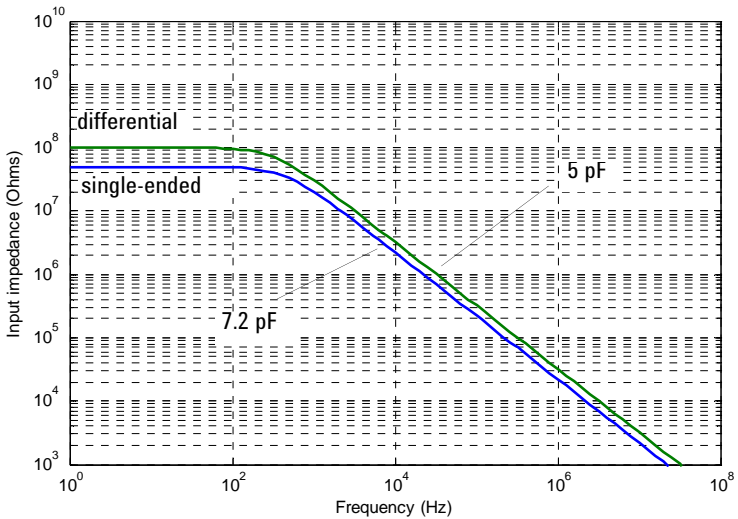


Graph of dB (S21) + 60 dB frequency response, 1000:1 attenuation

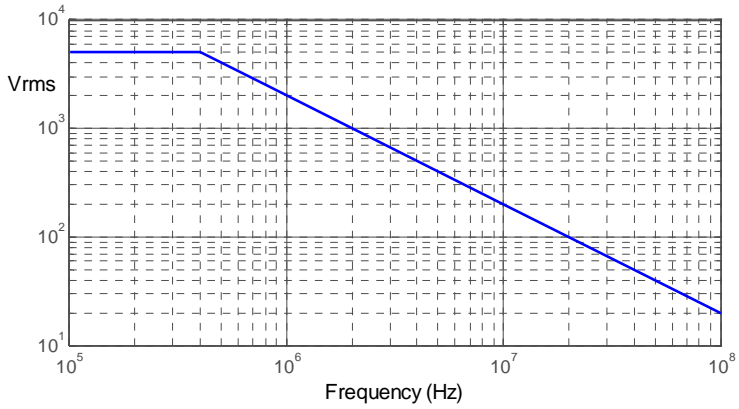
## N2891A Plots



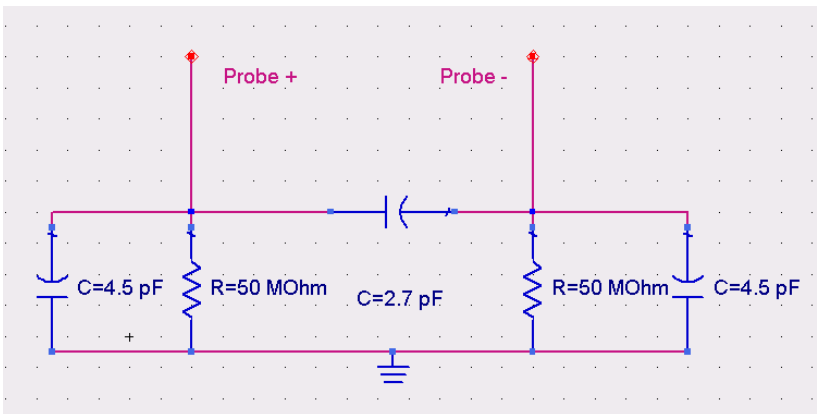
Graph of dB (S21) + 40 dB frequency response when inputs driven in common mode (common mode rejection), 100:1 attenuation



Magnitude plot of probe input impedance versus frequency, single-ended and differential



Typical derating plot of the absolute maximum input voltage in common mode

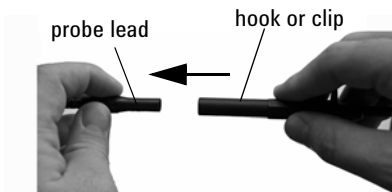


Input impedance equivalent circuit diagram

---

### Using the Accessories

The accessories supplied with the N2791A and N2891A probes are attached by pushing them onto the probe leads as shown below.



The following accessories are supplied with the N2791A probe and with the N2791-68700 Accessory Kit.

#### **Safety Hook and Alligator Clips**

Use the safety hooks to clamp onto smaller components and use the alligator clips to clamp onto thicker gauge devices



safety hook



alligator clip

The following accessories are supplied with the N2891A probe and with the N2891-68700 Accessory Kit.

#### **Safety Hook and High-Voltage Alligator Clips**

Use the safety hooks to clamp onto smaller components and use the alligator clips to clamp onto thicker gauge devices



safety hook



high-voltage alligator clip

