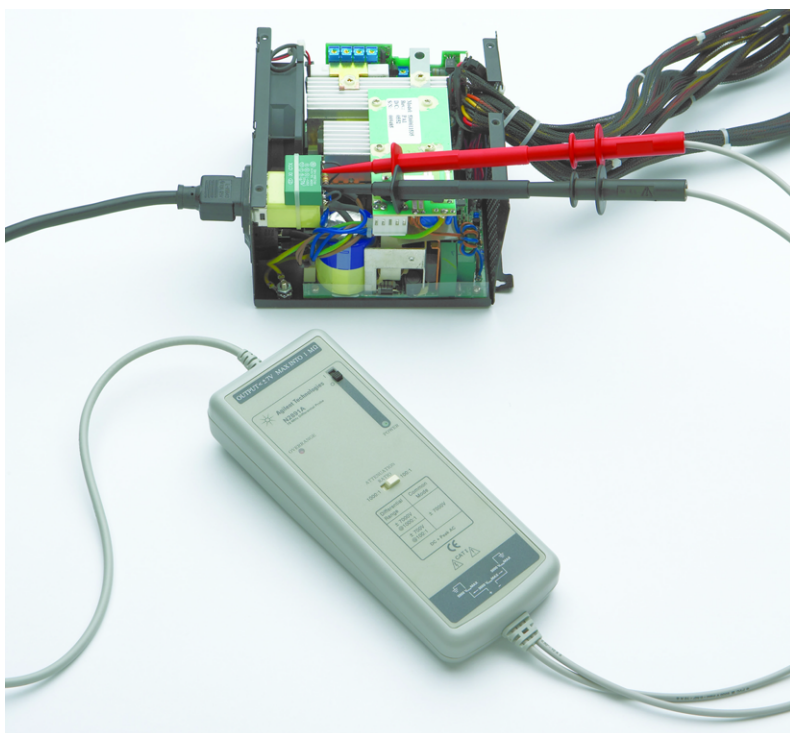




N2791A 25 MHz and N2891A 70 MHz High-Voltage Differential Probes

User's Guide



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

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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 Agilent Technologies Sales Office.

- ❑ 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.



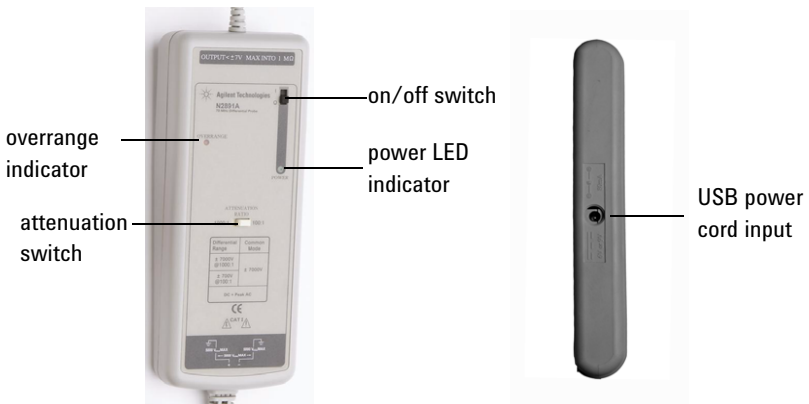
Handling the Probe

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 Ω 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 get 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.

Part	Quantity
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:

Part	Quantity
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.

Part	Quantity
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:

Part	Quantity
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

Characteristics 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

	N2791A	N2891A
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 ±700 V at 100:1 attenuation	±700 V at 100:1 attenuation ±7000 V at 1000:1 attenuation
Maximum Common Mode Input Voltage	±70 V at 10:1 attenuation ±700 V at 100:1 attenuation	±7000 V at 10:1 attenuation ±7000 V at 1000:1 attenuation
Input Impedance	4 MΩ, 10 pF (each side to ground) 8 MΩ, 8 pF (between inputs)	50 MΩ, 7 pF (each side to ground) 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

Mechanical Characteristics

	N2791A	N2891A
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 (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 Nonoperating: -30 °C to +70 °C
Altitude	Operating: 3,000 m Nonoperating: 15,300 m
Humidity	Operating: 25 - 85% room humidity 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 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.

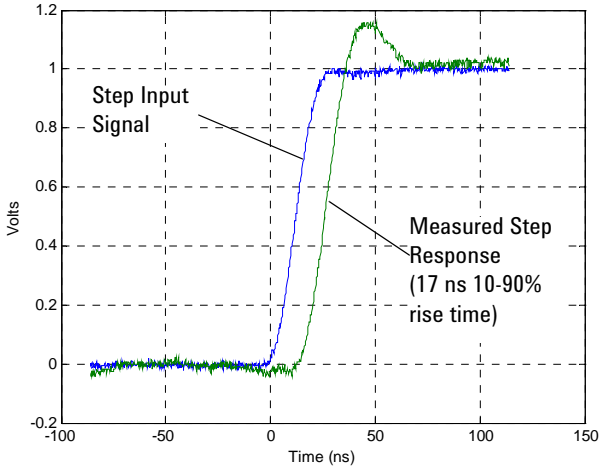


To protect against electrical shock, use only the accessories supplied with this probe or in the accessory kit.

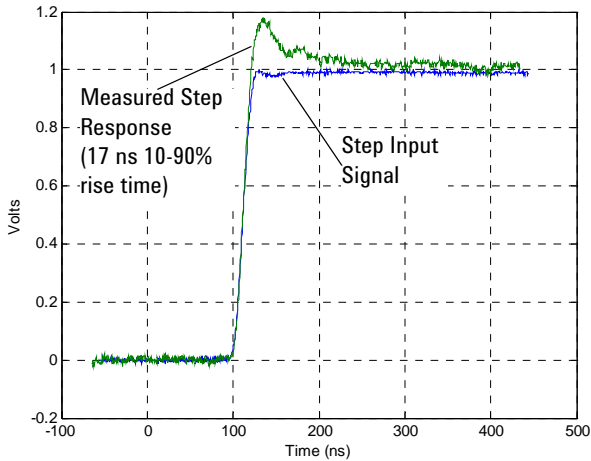


This probe is to carry out differential measurements between two points on the circuit under test. This probe is not for electrically insulating the circuit under test and the measuring instrument.

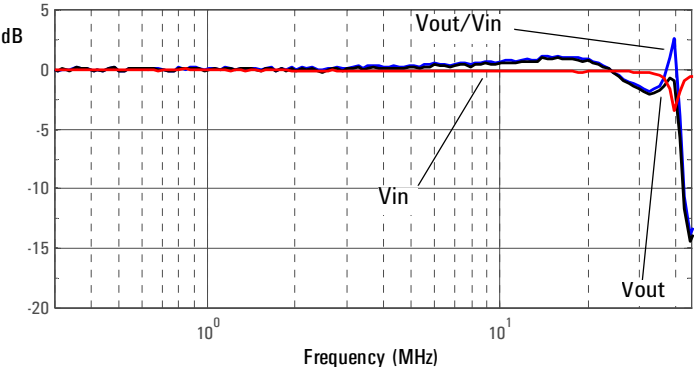
N2791A Plots



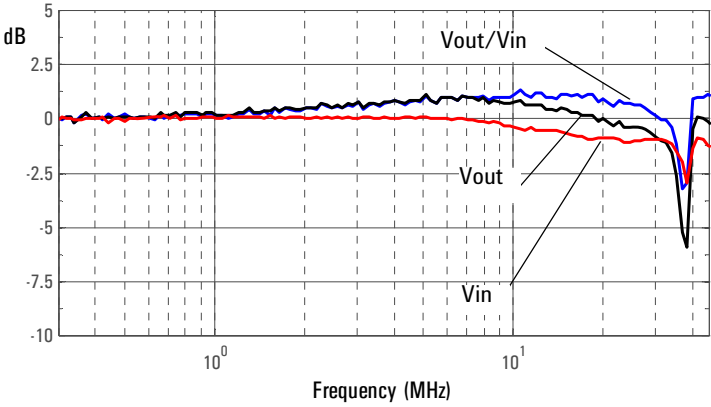
Graph of normalized step response (50Ω, 16.5 ns rising edge step generator), 17 ns normalized rising edge (10-90%), 10:1 attenuation



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

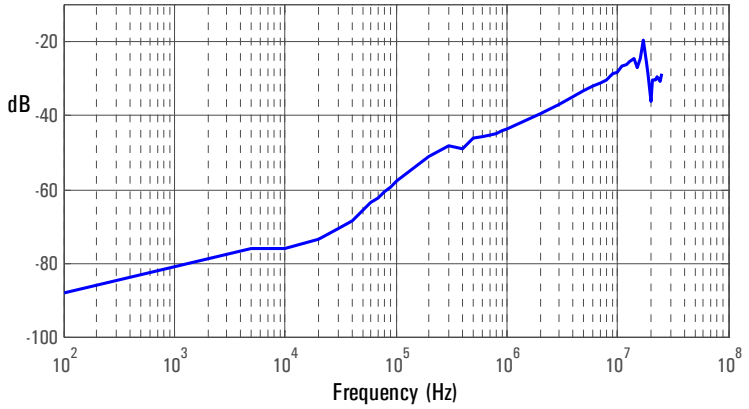


Graph of $\text{dB}(V_{in})$, $\text{dB}(V_{out}) + 20\text{dB}$, and $\text{dB}(V_{out}/V_{in}) + 20\text{dB}$ frequency response, 10:1 attenuation

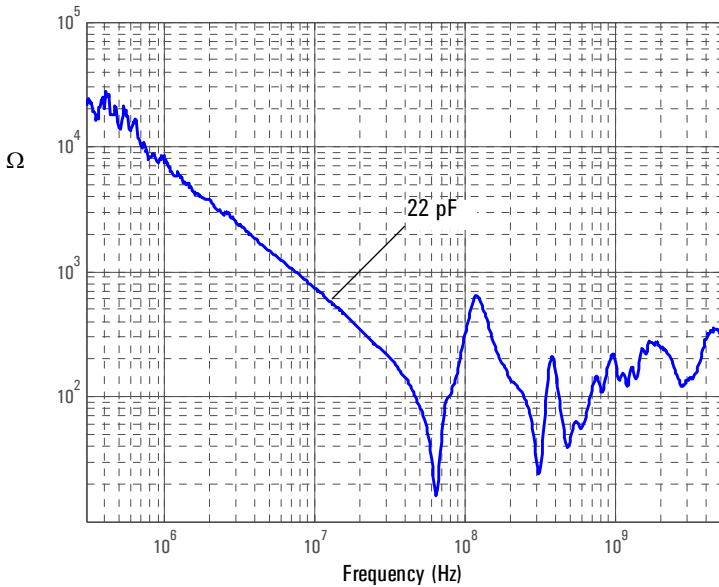


Graph of $\text{dB}(V_{in})$, $\text{dB}(V_{out}) + 40\text{dB}$, and $\text{dB}(V_{out}/V_{in}) + 40\text{dB}$ frequency response, 100:1 attenuation

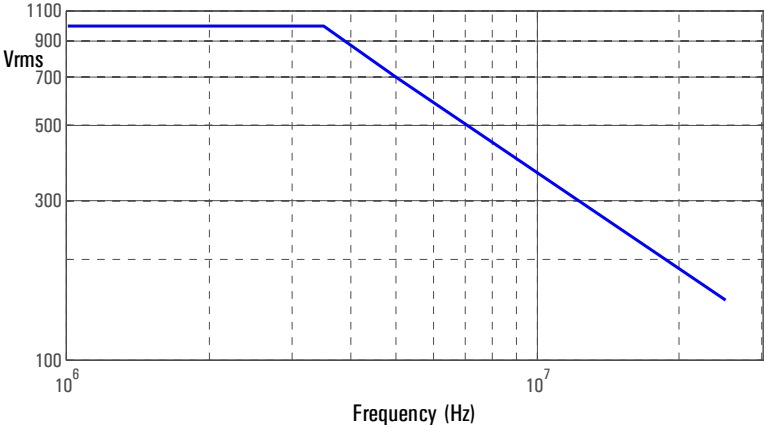
N2791A Plots



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

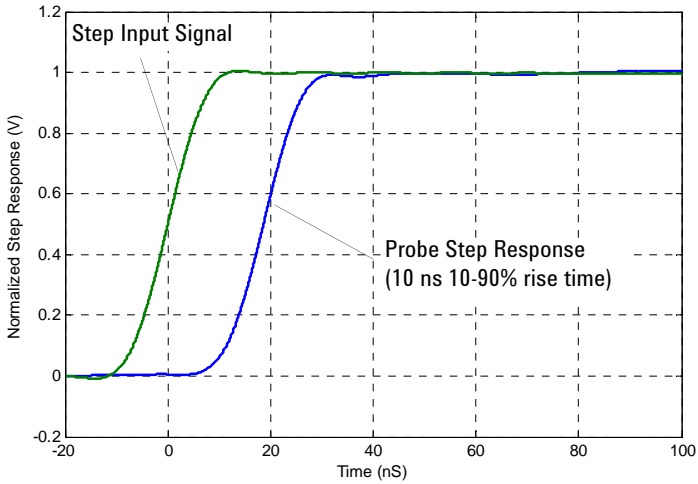


Magnitude plot of probe input impedance versus frequency (single-ended mode)

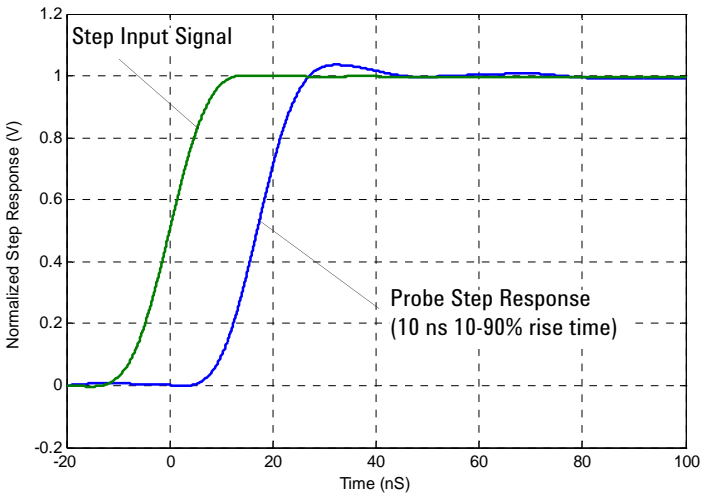


Typical derating plot of the absolute maximum input voltage in common mode

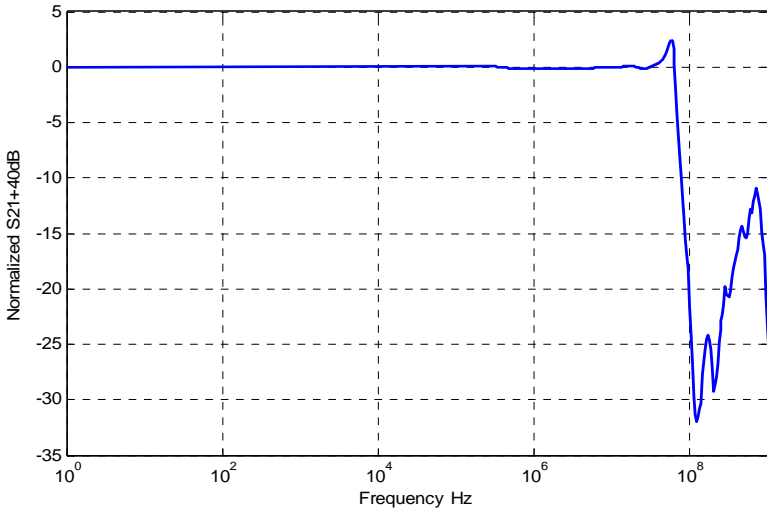
N2891A Plots



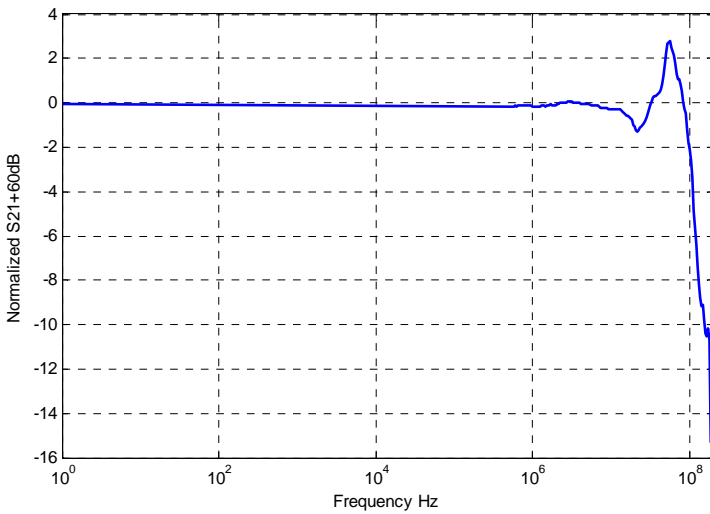
Graph of normalized step response (50 Ω , 10 ns rising edge step generator), 10 ns normalized rising edge (10-90%), 100:1 attenuation



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

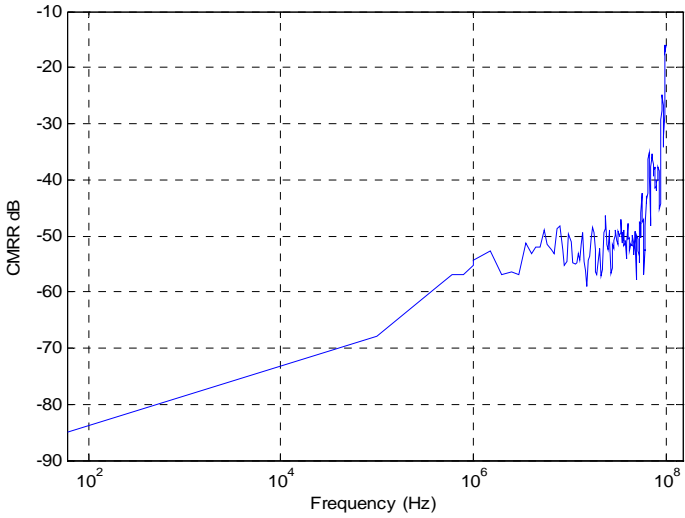


Graph of dB (S21) + 40 dB frequency response, 100:1 attenuation

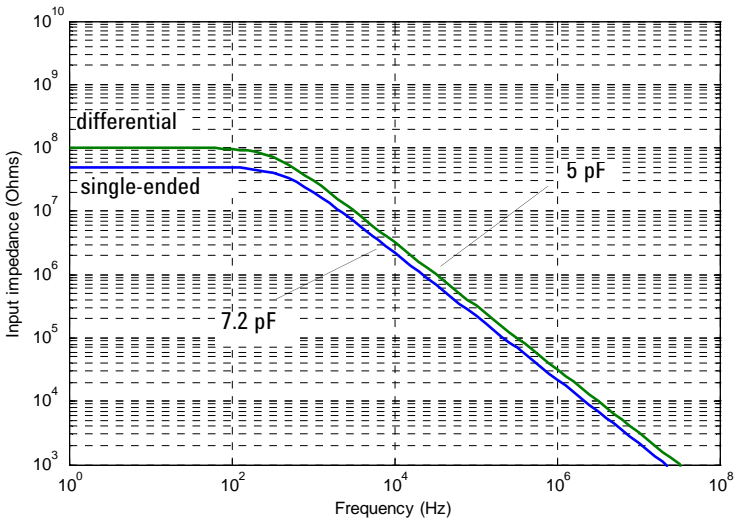


Graph of dB (S21) + 60 dB frequency response, 1000:1 attenuation

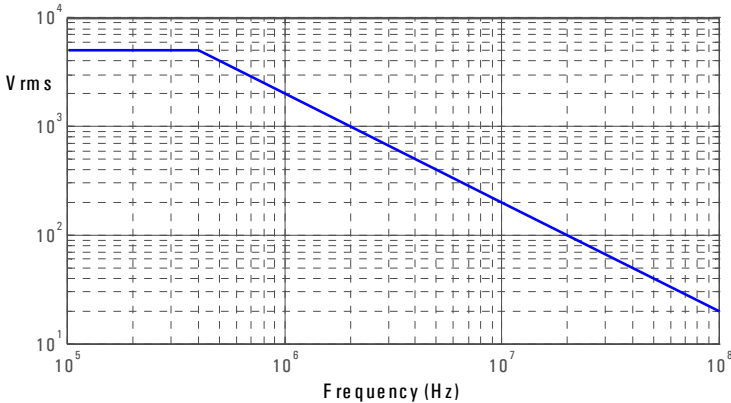
N2891A Plots



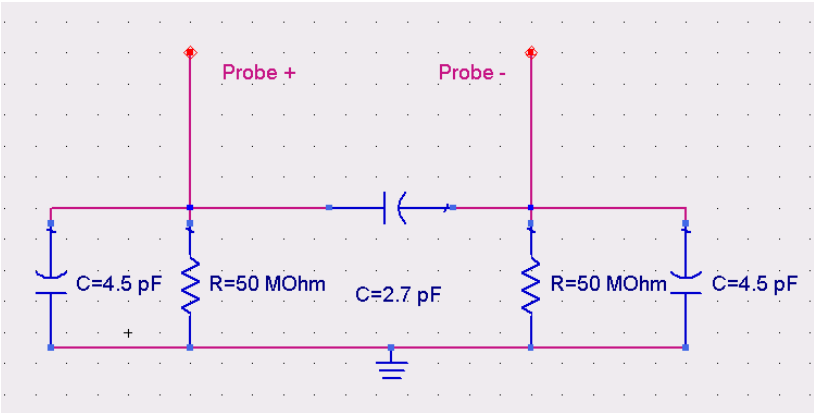
Graph of dB (S21) + 40 dB frequency response when inputs driven in common mode (common mode rejection), 100:1 attenuation



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



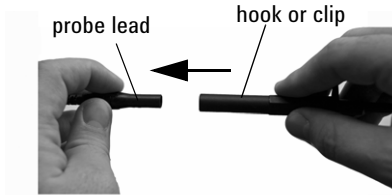
Typical derating plot of the absolute maximum input voltage in common mode



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

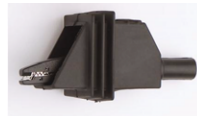
The following accessories are supplied with the N2891A probe and with the N2891-68700 Accessory Kit.

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

N2791A Performance Verification Procedures

The following procedure can be used to test the DC differential gain accuracy and bandwidth of the N2791A differential probe. Please note that these procedures do not indicate that these characteristics are warranted. Instead, these procedures are meant to give you an idea of how your probe performs.

Required Test Equipment

Description	Critical Specifications	Recommended Model Part Number	Functions
Digitizing Oscilloscope	Bandwidth: >50 MHz 1 M Ω /50 Ω selectable input	Agilent MSO9254A	Display probe output
Signal Generator Precision DC voltage source	Amplitude accuracy: less than or equal to 0.25% 1 M Ω /50 Ω selectable load Sine wave greater than or equal to 25 MHz	Fluke 9500B	Signal source for DC gain and bandwidth
BNC Adapter	BNC (f) to Dual Banana (m) Adapter	Agilent 1251-2277	Interconnection between probe and generator
50 Ω BNC Feed Through Adapter	50 Ω precision feed through	Agilent 11048C	Termination between probe and calibrator for bandwidth verification

DC Differential Gain Accuracy

- 1 Set the volts/division on channel 1 of the oscilloscope to 20 mV/div. Set the seconds/div to 200 μ s and the acquisition mode to average 64.
- 2 Set the volts/division on channel 2 of the oscilloscope to 500 mV/div. Trigger on channel 2, select 50 Ω impedance.
- 3 Set the calibrator 9500B's channel 2 as the trigger channel (50 Ω load). Connect the calibrator's channel 2 active head to channel 2 of the oscilloscope.
- 4 Connect the active head channel 1 from the Fluke 9500B to channel 1 of the oscilloscope. Set the calibrator channel 1 to 0.1V peak-to-peak amplitude and 1 KHz (square wave, 1 M Ω load), enable the output.
- 5 Select the amplitude measurement on the oscilloscope and record the DC amplitude (approximately 100 mV) of the square wave. This measurement is only on the oscilloscope.
- 6 Disable the Fluke calibrator output, disconnect the channel 1 active head from channel 1 of the oscilloscope.
- 7 Connect the output of the N2791A probe to channel 1 of the oscilloscope.
- 8 Attach the BNC adapter to the Fluke channel 1 active head.

N2791A Performance Verification Procedures

- 9 Attach the differential probe input leads by clipping the alligator clamp to the BNC adapter banana post.
- 10 Set the probe to 100:1. Set the Fluke calibrator to 10 V and 1 KHz standard amplitude output (channel 1, square wave, 1 M Ω load).
- 11 Enable the output of the calibrator.
- 12 Record the DC amplitude of the square wave and divide 100 into just the amplitude of the oscilloscope. Verify that the probe gain accuracy is $\pm 2\%$ + scope gain accuracy.
- 13 Set the calibrator to 1 V output and set the attenuation button on the probe to 10:1.
- 14 Record the DC amplitude of the square wave and divide 10 into just the amplitude of the oscilloscope. Verify that the probe gain accuracy is $\pm 2\%$ + scope gain accuracy.
- 15 Disable the calibrator output and leave the setup connected for the next procedure.

Bandwidth

- 1 Connect the 50 Ω BNC feed through adapter to the calibrator's active head channel 1.
- 2 Attach the BNC (f)-to-banana post adapter to the BNC feed through adapter.
- 3 Attach the differential probe input leads by clipping the alligator clamp to the BNC adapter banana post.
- 4 Set the probe to 10:1 attenuation.
- 5 Set the volts/division on channel 1 of the oscilloscope to 50 mV/div and seconds/division to 50 ns/div. Set the trace to the center of the oscilloscope. Input impedance should be set to 1 M Ω . Set the average mode to 16 points.
- 6 Set the calibrator to sine wave, 3 V peak-to-peak amplitude. Set the frequency to 25 MHz, 50 Ω load.
- 7 Write down the peak-to-peak amplitude measured by the oscilloscope. It should be greater than or equal to 210 mV - scope vertical accuracy.
- 8 Disable the generator output and disconnect the probe input.

N2791A Performance Verification Test Record

<p>Agilent Technologies</p> <p>Recommended Test Interval: 1 Year Recommended Date of Next Certification: _____ Certification Temperature: _____</p>		<p>N2791A 25 MHz Differential Probe Serial No.: _____ Certification Date: _____ Tested By: _____ _____ _____</p>	
Test	Probe Settings	Limits	Results
Gain	100:1	98 mV to 102 mV	
Gain	10:1	98 mV to 102 mV	
Bandwidth	10:1	Greater than or equal to 210 mV - scope vertical accuracy	

N2891A Performance Verification Procedures

The following procedure can be used to test and verify the DC differential gain accuracy and bandwidth of the N2891A high voltage differential probe. Please note that these procedures do not indicate that these characteristics are warranted. Instead, these procedures are meant to give you an idea of how your probe performs.

Required Test Equipment

Description	Critical Specifications	Recommended Model Part Number	Functions
Digitizing Oscilloscope	Bandwidth: >50 MHz 1 M Ω /50 Ω selectable input	Agilent MSO9254A	Display probe output
Signal Generator Precision DC voltage source	Amplitude accuracy: less than or equal to 0.25% 1 M Ω /50 Ω selectable load Sine wave greater than or equal to 25 MHz	Fluke 9500B	Signal source for DC gain and bandwidth
BNC Adapter	BNC (f) to Dual Banana (m) Adapter	Agilent 1251-2277	Interconnection between probe and generator
50 Ω BNC Feed Through Adapter	50 Ω precision feed through	Agilent 11048C	Termination between probe and calibrator for bandwidth verification

DC Differential Gain Accuracy

WARNING: Generator produces hazardous voltages. To avoid shock, do not touch exposed metal parts after generator output is enabled.

WARNING: These procedures require the application of high voltage to the inputs of the N2891A probe. Because this adapter has exposed metal surfaces, only qualified personnel should perform any testing with voltage levels exceeding 30 Vrms. All pertinent safety rules and guidelines for elevated voltage measurements should be followed and adhered to.

- 1 Set the volts/division on channel 1 of the oscilloscope to 20 mV/div. Set the seconds/div to 200 μ s and the acquisition mode to average 32.

- 2 Set the volts/division on channel 2 of the oscilloscope to 500 mV/div. Trigger on channel 2, select 50 Ω impedance.
- 3 Set the calibrator 9500B's channel 2 as the trigger channel (50 Ω load). Connect the calibrator's channel 2 active head to channel 2 of the oscilloscope.
- 4 Connect the active head channel 1 from the Fluke 9500B to channel 1 of the oscilloscope. Set the calibrator channel 1 to 0.1V peak-to-peak amplitude and 1 KHz (square wave, 1 M Ω load), enable the output.
- 5 Select the amplitude measurement on the oscilloscope and record the DC amplitude (approximately 100 mV) of the square wave. This measurement is only the oscilloscope.
- 6 Disable the Fluke calibrator output, disconnect the channel 1 active head from channel 1 of the oscilloscope.
- 7 Connect the output of the N2891A probe to channel 1 of the oscilloscope.
- 8 Attach the BNC adapter to the Fluke channel 1 active head.
- 9 Attach the differential probe input leads by clipping the alligator clamp to the BNC adapter banana post.
- 10 Set the probe to 100:1. Set the Fluke calibrator to 10 V and 1 KHz standard amplitude output (channel 1, square wave, 1 M Ω load).
- 11 Enable the output of the calibrator.
- 12 Record the DC amplitude of the square wave and divide 100 into just the amplitude of the oscilloscope. Verify that the probe gain accuracy is +/-2% + scope gain accuracy.
- 13 Set the calibrator to 100 V output and set the attenuation button on the probe to 1000:1.
- 14 Record the DC amplitude of the square wave and divide 10 into just the amplitude of the oscilloscope. Verify that the probe gain accuracy is +/-2% + scope gain accuracy.
- 15 Disable the calibrator output and leave the setup connected for the next procedure.

Bandwidth

- 1 Connect the 50 Ω BNC feed through adapter to the calibrator's active head channel 1.
- 2 Attach the BNC (f)-to-banana post adapter to the BNC feed through adapter.
- 3 Attach the differential probe input leads by clipping the alligator clamp to the BNC adapter banana post.
- 4 Set the probe to 100:1 attenuation.
- 5 Set the volts/division on channel 1 of the oscilloscope to 10 mV/div and seconds/division to 20 ns/div. Set the trace to the center of the oscilloscope. Input impedance should be set to 1 M Ω . Disable average mode.
- 6 Set the calibrator to sine wave, 5 V peak-to-peak amplitude. Set the frequency to 70 MHz, 50 Ω load.
- 7 Write down the peak-to-peak amplitude measured by the oscilloscope. It should be greater than or equal to 35 mV - scope vertical accuracy.
- 8 Disable the generator output and disconnect the probe input.

N2891A Performance Verification Test Record

<p>Agilent Technologies</p> <p>Recommended Test Interval: 1 Year Recommended Date of Next Certification: _____ Certification Temperature: _____</p>		<p>N2891A 70 MHz Differential Probe Serial No.: _____ Certification Date: _____ Tested By: _____ _____ _____</p>	
Test	Probe Settings	Limits	Results
Gain	100:1	98 mV to 102 mV	
Gain	1000:1	98 mV to 102 mV	
Bandwidth	100:1	Greater than or equal to 35 mV - scope vertical accuracy	

Safety Notices

Safety Symbols



Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product or personal injury.



Hazardous voltage symbol.

This apparatus has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

Warnings

- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- 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.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not use the instrument in a manner not specified by the manufacturer.

Notices

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Manual Part Number
N2791-97002, Feb 2011

Print History
N2791-97002, Feb 2011
N2791-97001, Nov 2009
N2791-97000, May 2009

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Agilent Technologies, Printed in the Philippines February 2011
Manual Part Number: N2791-97002

