



# N2790A Differential Voltage Probe

## User's Guide



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**Agilent Technologies**

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# Contents

Inspecting the Probe	3
Compatibility	4
Probe Parts Supplied	5
Characteristics and Specifications	6
Cleaning the Probe	8
Using the N2790A Probe	9
Service Strategy	10
Characterization Plots	11
Performance Verification Procedures	13

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## Inspecting the Probe

- ❑ Inspect the shipping container for damage.

Keep a 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.

Any accessories that were supplied with the probe are listed in the “Probe Parts Supplied” section of this manual.

- 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.

# N2790A Differential Voltage Probe

The N2790A differential probe allows you to safely measure high-voltage floating circuits with the oscilloscope grounded. It is ideal for many applications such as motor speed controls, power supply designs, and electronic high-power converters. The N2790A offers sufficient dynamic range and bandwidth for your application to make the floating measurements found in high-speed power electronic circuits safely and accurately.

With 100 MHz bandwidth, switchable attenuation of 50:1 and 500:1, and a maximum differential voltage input of 1400V (DC + peak AC), it provides the versatility for a broad range of applications including high-voltage circuits. Each probe comes with sharp browser probe tips for use on small components and in tight places, alligator clips for connecting to larger cables, and pincher clips.

The probe is powered by the autoprobe interface.

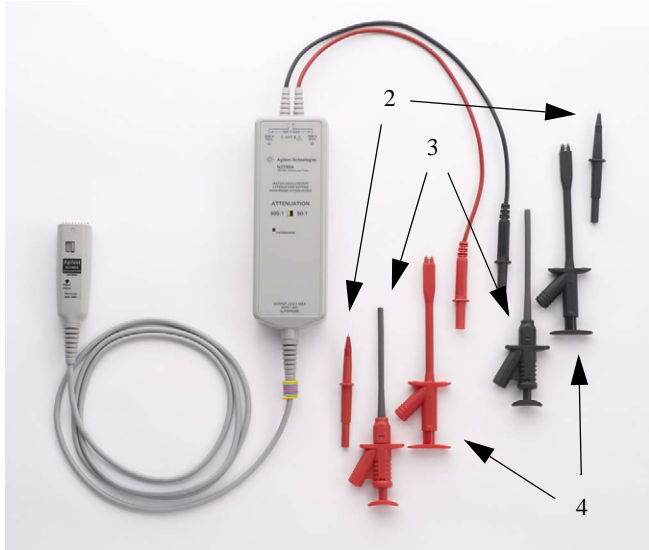
### **Compatibility**

The N2790A differential probe is compatible with the following Agilent oscilloscopes:

- InfiniiVision Series 5000, 6000 (except 100 MHz), and 7000 with version 5.2 software or later
- Infiniium 9000 (with version 2.00 software or later), 8000 (with version 5.61 software or later), and 54830 Series (with version 5.61 software or later)

**Probe Parts Supplied**

The following diagram and table show the parts supplied with the N2790A Probe.



The probe tips you receive may look slightly different than the ones shown in this picture.

**Parts for N2790A Probe**

Item	Description	Part Number
1	Differential voltage probe	N2790-68701
2	Probe tips - browser tip (x2) (black and red pair)	A054*
3	Probe tips - pincher clip (x2) (black and red pair)	
4	Probe tips - alligator plunger clip (x2) (black and red pair)	
5	Plastic pouch	
6	Offset adjustment tool	

**To order the Probe Tip Accessory Kit (consisting of 2 browser tips, 2 pincher clips, and 2 alligator plunger tips), order part number N2790-68700. Probe tips are only for use with the N2790A differential voltage probe.**

\*Probe tips are not orderable separately.

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### Characteristics and Specifications

Characteristics and specifications for the N2790A Differential Voltage Probe are shown below.

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#### Electrical Characteristics

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Attenuation ratios	50:1 and 500:1 (Selectable via switch on probe.)
Bandwidth (-3 dB)*	100 MHz
Gain Accuracy*	±4% @ 0-20 °C, ±2% @ 20-30 °C, ±4% @ 30-55 °C
DC CMRR	-70 dB @ 500VDC
AC CMRR	-80 dB @ 50/60 Hz -50 dB @ 100 kHz -50 dB @ 1 MHz
Input impedance	Between inputs: 8 MΩ , 3.5 pF
Noise referenced to input	< 300 mVrms @ 500:1 < 50 mVrms @ 50:1
Propagation Delay	14.0 ns @ 50:1, 12.8 ns @ 500:1
Switch positions	500:1, 50:1
Internal power	Autoprobe interface

\*Denotes warranted specification after 20 minute warm-up

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#### Input Characteristics

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Cable length	170 cm (66.9 inches)
Length of input leads	40 cm (15.7 inches)
Maximum common mode operating voltage (rms or DC + peak AC) <sup>1</sup>	600V CAT III 1000V CAT II
Maximum common mode operating voltage derating frequency <sup>2</sup>	2 MHz
Maximum differential mode operating voltage (DC + peak AC)	1400 V @ 500:1 140 V @ 50:1

<sup>1</sup>Refer to the warnings on page 8 for further details on the input voltage safety rating

<sup>2</sup>Refer to the derating plot on page 12

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### Output Characteristics

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Output cable	Safety designed BNC cable
Maximum output voltage range	$\pm 2.8$ V into 1 M $\Omega$ at 500:1

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### Environmental Specifications

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Temperature	Operating: -10 °C to +50 °C Nonoperating: -51 °C to +71 °C
Altitude	Operating: 2,000 m (6,561 ft) Nonoperating: 15,300 m (50,200 ft)
Humidity	Operating: 80% room humidity @ 40 °C Nonoperating: 90% room humidity @ 65 °C
Pollution Degree	Pollution Degree 2

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### Safety Specifications

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UL Listed:	File No. E326557
Compliant with:	UL 61010-031, CSA 22.2 No. 61010-031-07

## Cleaning the Probe

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### WARNING

#### SHOCK HAZARD!



These probes are designed for use with oscilloscopes that have a common terminal at *GROUND POTENTIAL* (in accordance with OSHA requirements and the National Electric Code). Exposed metallic surfaces of the probe and the oscilloscope *MUST BE GROUNDED*. Failure to ground the common terminal during certain applications, such as those requiring the oscilloscope to be powered from an external battery, might expose the operator to an electrical shock hazard that could be lethal (depending on voltage and current conditions.)



The probe inputs are safety rated to a maximum of 1000 Vrms CAT II and 600 Vrms CAT III between either input and earth ground. These maximum ratings apply regardless of the attenuation setting of the probe. Do not apply voltages greater than 1000 Vrms CAT II or 600 Vrms CAT III between either input and ground.



The probe tips that are provided are rated for 1000 Vrms CAT II and 600 Vrms CAT III usage. Other probe tips may be used if they have the appropriate ratings and the same style connectors.

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## Cleaning the Probe

Disconnect the probe from all power sources and clean it with a soft cloth dampened with a mild soap and water solution. Be careful not to get water in the attenuation switch. Make sure the probe is completely dry before reconnecting it to a power source.



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## Using the N2790A Probe

### Powering the N2790A

The N2790A probe is powered by the autoprobe interface found on Agilent InfiniiVision and Infiniium Series oscilloscopes.

### Selecting the Correct Attenuation on the Probe and the Oscilloscope

The probe has two modes of operation, 50:1 and 500:1 attenuation. Select the desired attenuation on the probe (via the switch on the probe) and the correct probe attenuation setting on the oscilloscope. This will ensure that accurate voltage readings can be made directly from the oscilloscope.

### Adjusting the Probe Offset Level

The probe offset level is adjusted using the tool provided with the N2790A probe. Adjust the offset level by turning the potentiometer adjustment located on the autoprobe pod.



### Measurement Tips

- Use the 50:1 range on the differential voltage probe for smaller signals, such as ripple on a high voltage reference lead.
- Connect the red probe cable to a more positive or more negative voltage level than the black probe cable.
- There is an overrange LED on the probe to indicate when you have exceeded the maximum voltage of the probe.

### Service Strategy

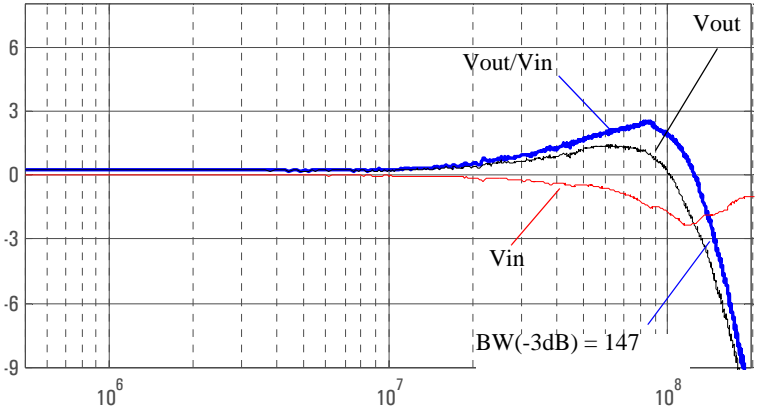
For repair, calibration, and to ensure the N2790A performs to its warranted specifications, send the probe to an Agilent Service Center for calibration testing procedures. The probe should be tested once a year or as required by other standards. If repair is needed and the N2790A is under warranty, normal warranty services will apply. If the N2790A is not under warranty, repair costs will be applied.

#### **To return the Probe to Agilent Technologies for Service**

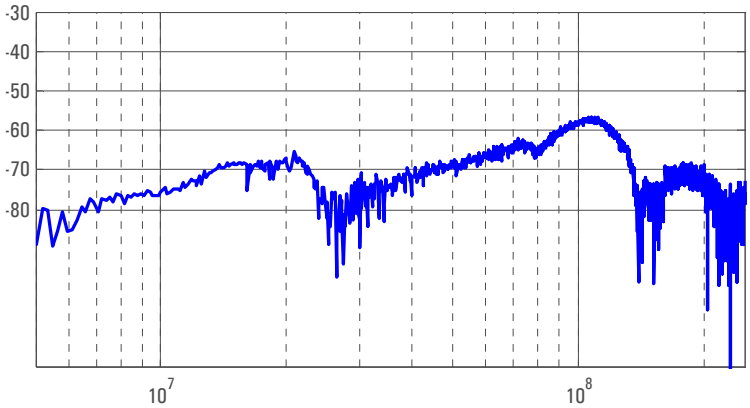
Call (877) 477-7278 for further details and the location of your nearest Agilent Technologies Service Office.

- 1 Write the following information on a tag and attach it to the probe.
  - Name and address of the owner
  - Probe model number
  - Description of service required or failure indication
- 2 Retain all accessories.
- 3 Return the probe in its case or pack the probe in foam or other shock-absorbing material and place it in a strong shipping container. You can use the original shipping materials or order materials from an Agilent Technologies Sales Office. If neither are available, place 3 to 4 inches of shock-absorbing material around the instrument and place it in a box that does not allow movement during shipping.
- 4 Seal the shipment container securely.
- 5 Mark the shipping container as **FRAGILE**. In all correspondence, refer to the instrument by model number and full serial number.

Characterization Plots

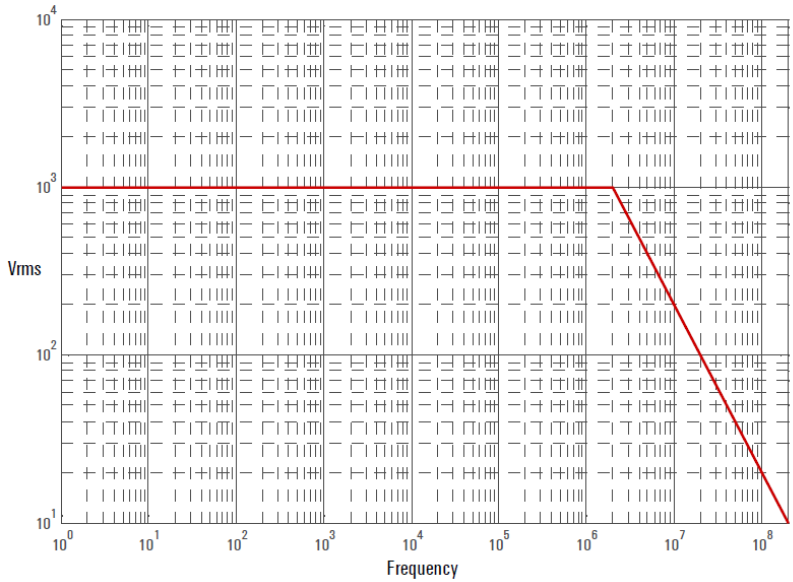


Graph of  $dB(V_{in})$ ,  $dB(V_{out})$ , and  $dB(V_{out}/V_{in})$  frequency response



Graph of  $dB(V_{out}/V_{in})$  frequency response when inputs driven in common (common mode rejection)

## Characterization Plots



**Derating plot - above 2 MHz, the maximum input operating voltage decreases as the frequency increases.**

## Performance Verification Procedures

The following procedure can be used to test and verify the DC differential gain accuracy and bandwidth of the N2790A high voltage differential probe.

### Required Test Equipment

Description	Critical Specifications	Recommended Model Part Number	Functions
Digitizing Oscilloscope	Bandwidth: >100 MHz 1 M $\Omega$ /50 $\Omega$ selectable input	Agilent MSO9254A	Display probe output
Signal Generator Precision DC voltage source	Amplitude accuracy: greater than or equal to 0.25% 1 M $\Omega$ /50 $\Omega$ selectable load Sine wave greater than or equal to 25 MHz	Fluke 9500B or Fluke 5520A for DC source. Fluke 9500B or Agilent E8257D +1EU option for AC source	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 $\Omega$ BNC Feed Through Adapter	50 $\Omega$ precision feed through	Agilent 11048C	Termination between probe and calibrator for bandwidth verification

### DC Differential Gain Accuracy

**WARNING: These procedures require the application of high voltage to the inputs of the N2790A probe. Because the adapter used in this procedure has exposed metal surfaces, only qualified personnel should perform any testing with voltage levels exceeding 30 V rms. All pertinent safety rules and guidelines for elevated voltage measurements should be followed and adhered to.**

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

- 1 Set the volts/division on channel 1 of the oscilloscope to 20 mV/div. Set the seconds/div to 200  $\mu$ s and the acquisition mode to average 32.
- 2 Set the volts/division on channel 2 of the oscilloscope to 50 mV/div. Trigger on channel 2, select 50  $\Omega$  impedance.
- 3 Set the calibrator 9500B's channel 2 as the trigger channel (50  $\Omega$  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 $\Omega$  load), enable the output.

## Performance Verification Procedures

- 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 N2790A 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 50:1. Set the Fluke calibrator to 10 V and 1 KHz standard amplitude output (channel 1, square wave, 1 M $\Omega$  load).
- 11 Enable the output of the calibrator.
- 12 Record the DC amplitude of the square wave and divide 50 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 500:1.
- 14 Record the DC amplitude of the square wave and divide 500 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  $\Omega$  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 50:1 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 $\Omega$ . Disable average mode.
- 6 Set the calibrator to sine wave, 5 V peak-to-peak amplitude. Set the frequency to 100 MHz, 50  $\Omega$  load.
- 7 Write down the peak-to-peak amplitude measured by the oscilloscope. It should be greater than or equal to 71 mV + scope error.
- 8 Disable the generator output and disconnect the probe input.

Performance Verification Test Record

<b>Agilent Technologies</b>  Recommended Test Interval: 1 Year Recommended Date of Next Certification: _____ Certification Temperature: _____		N2790A 100 MHz Differential Probe Serial No.: _____ Certification Date: _____ Tested By: _____ _____ _____	
Test	Probe Settings	Limits	Results
Gain	50:1	196 mV to 204 mV	
Gain	500:1	196 mV to 204 mV	
Bandwidth	50:1	Greater than or equal to 71 mV	

## Performance Verification Test Record



# Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 1010, 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

- 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.
- 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 fuseholders. To do so could cause a shock or fire hazard.
- If you energize this instrument by an auto transformer (for voltage reduction or mains isolation), the common terminal must be connected to the earth terminal of the power source.
- 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.

## To clean the instrument

If the instrument requires cleaning: (1) Remove power from the instrument. (2) Clean the external surfaces of the instrument with a soft cloth dampened with a mixture of mild detergent and water. (3) Make sure that the instrument is completely dry before reconnecting it to a power source.

## 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..



Hazardous voltage symbol.



Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.

# Notices

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Manual Part Number  
N2790-97002, December 2010

Print History  
N2790-97002, Dec 2010  
N2790-97001, August 2010  
N2790-97000, January 2009

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Manual Part Number  
N2790-97002

