

N2790A Differential Voltage Probe

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 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.

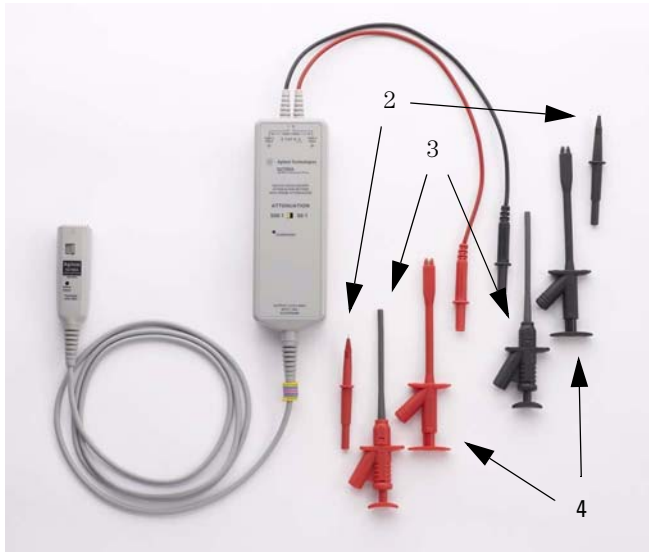
Compatibility

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.**

Characteristics and Specifications

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

Electrical Characteristics

| | |
|---------------------------|---|
| Attenuation ratios | 50:1 and 500:1 (Selectable via switch on probe.) |
| Bandwidth (-3 dB)* | 100 MHz |
| Gain Accuracy* | $\pm 4\%$ @ 0-20 °C, $\pm 2\%$ @ 20-30 °C, $\pm 4\%$ @ 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 M Ω , 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

Input Characteristics

| | |
|--|--------------------------------|
| 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) ¹ | 600V CAT III 1000V CAT II |
| Maximum common mode operating voltage derating frequency ² | 2 MHz |
| Maximum differential mode operating voltage (DC + peak AC) ¹ | 1400 V @ 500:1 140 V @ 50:1 |

¹Refer to the warnings on page 8 for further details on the input voltage safety rating.

²Refer to the derating plot on page 12

Output Characteristics

| | |
|------------------------------|--|
| Output cable | Safety designed BNC cable |
| Maximum output voltage range | ± 2.8 V into 1 M Ω at 500:1 |

Environmental Specifications

| | |
|------------------|---|
| 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 |

Safety Specifications

| | |
|-----------------|---------------|
| Compliant with: | IEC 61010-031 |
|-----------------|---------------|

Cleaning the Probe

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.

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.

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

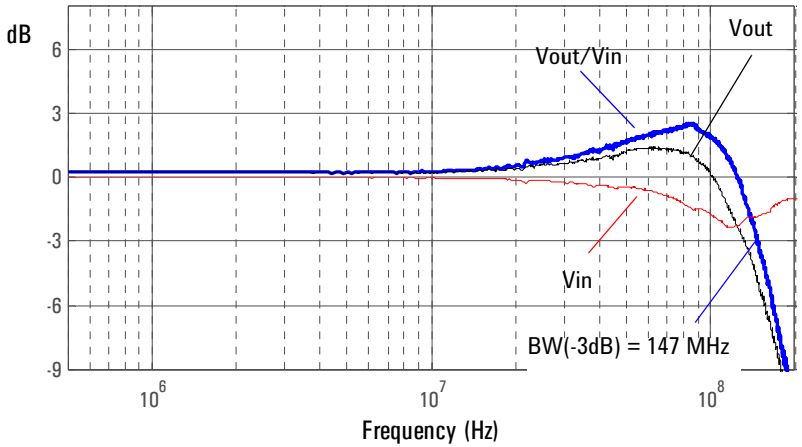
For repair, calibration, and to ensure the N2790A performs to its warranted specifications, send the probe to an Agilent Service Center for calibration testing procedures. The probe should be tested once a year or as required by other standards. If repair is needed and the N2790A is under warranty, normal 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

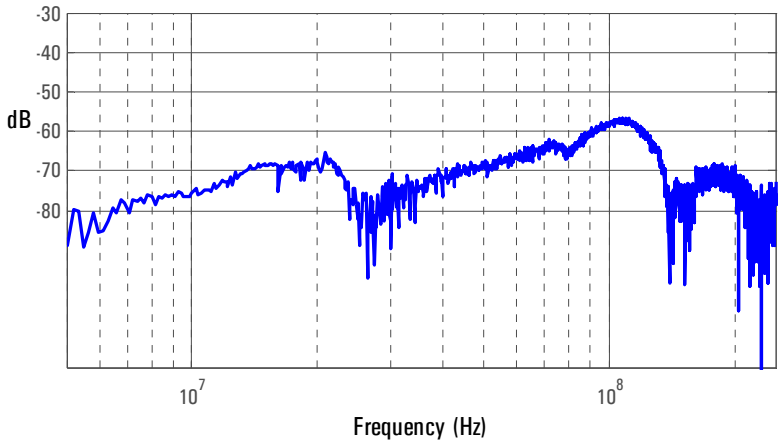
Call (877) 477-7278 for further details and the location of your nearest Agilent Technologies Service Office.

- 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

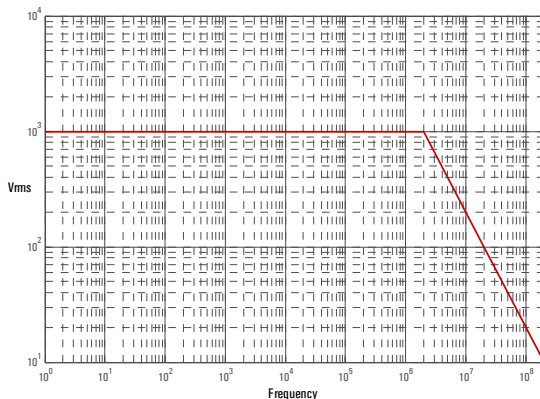


Graph of $\text{dB}(V_{in})$, $\text{dB}(V_{out})$, and $\text{dB}(V_{out}/V_{in})$ frequency response



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

Calibration Testing Procedures



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

Calibration Testing Procedures

These procedures are used to test the warranted specifications for the N2790A Differential Probe. The recommended calibration test interval for the N2790A is once a year or as required. Use the equipment listed in the “Test Equipment Required” section to complete the Calibration Testing Procedures.

Required Test Equipment

| Description | Minimum Requirements | Part Number |
|---|------------------------------|-------------------------------------|
| Multimeter | 8.5 digits of resolution | 3458A |
| Oscilloscope | 500 MHz | Agilent DS07054A |
| Calibrator | DC Voltage 0 to ± 1100 V | Fluke 5700A |
| Programmable Function Generator | 240 MHz sine wave | 81150A |
| External Power Supply | No substitute | Agilent 1143A |
| Probe Power Extension Cable | No substitute | Agilent 01143-61602 |
| Autoprobe Interface Adapter | No substitute | Agilent N1022A |
| Outside Thread 3.5 mm (male) to 3.5 mm (female) adapter | No substitute | Agilent 5062-1247 |
| Adapter | SMA (m) to BNC (f) | Agilent E2655-83201 (in E2655B kit) |
| Cable | BNC (m) to BNC (m) | Agilent 8120-1838 |

| Description | Minimum Requirements | Part Number |
|--------------|--|-------------------|
| N2790A probe | | |
| Adapter | BNC (f) to banana (m) | Agilent 1251-2277 |
| Adaptation 2 | 50 W termination + BNC (m) to banana (f) | |

Setup Files for testing

Setup for Bandwidth at 100 MHz, 50:1 Setting on Probe

| | |
|-------------------------|----------------|
| CH1 | ON |
| CH1 Sensitivity | 100 mV/div, AC |
| Timebase | 20 ns/div |
| BWL (Bandwidth Limiter) | OFF |
| Trigger on | CH1 |

Setup for Bandwidth at 100 MHz, 500:1 Setting on Probe

| | |
|-------------------------|---------------|
| CH1 | ON |
| CH1 Sensitivity | 10 mV/div, AC |
| Timebase | 20 ns/div |
| BWL (Bandwidth Limiter) | OFF |
| Trigger on | CH1 |

Test Gain

- 1 Connect the N2790A probe output to the N1022A adapter.
- 2 Connect the N1022A adapter to the 3458A multimeter via the outside thread 3.5 mm (male) to 3.5 mm (female) adapter, SMA (m) to BNC (f) adapter, BNC (m) to BNC (m) cable, and BNC (f) to banana (m) adapter.
- 3 Connect the N1022A adapter to the 1143A power supply via the 01143-61602 cable.
- 4 Connect the red end of the N2790A probe to the calibrator HI output.
- 5 Connect the black end of the N2790A probe to the calibrator LO output.
- 6 Measure the output at 50:1 and 500:1 with the calibrator set to 0 V. This is the probe offset.
- 7 Measure the output as shown in the table below.
- 8 Verify the value is between the 3458A limits listed in the table below for each output signal at each probe setting. **Note:** These limits assume zero offset. The limits should be adjusted for actual offset.
- 9 Record the value displayed on the 3458A in the Calibration Test Record

Calibration Testing Procedures

| Test | Calibrator Output Signal DC | N2790A Setting | 3458A Reading Limits |
|------|-----------------------------|----------------|---|
| Gain | +10 V | 50:1 | +196 mV ... +204 mV ($\pm 2\%$ of reading) |
| Gain | +100 V | 50:1 | +1.96 V ... +2.04 V ($\pm 2\%$ of reading) |
| Gain | +100 V | 500:1 | +196 mV ... +204 mV ($\pm 2\%$ of reading) |
| Gain | +1000 V | 500:1 | +1.96 V ... +2.04 V ($\pm 2\%$ of reading) |
| Gain | -10 V | 50:1 | -196 mV ... -204 mV ($\pm 2\%$ of reading) |
| Gain | -100 V | 50:1 | -1.96 V ... -2.04 V ($\pm 2\%$ of reading) |
| Gain | -100 V | 500:1 | -196 mV ... -204 mV ($\pm 2\%$ of reading) |
| Gain | -1000 V | 500:1 | -1.96 V ... -2.04 V ($\pm 2\%$ of reading) |

Test Bandwidth

- 1 Connect the N2790A output to CH1 of the oscilloscope.
- 2 Connect adaptation 2 to the 81150A function generator output.
- 3 Connect the red N2790A probe tip to the red banana jack.
- 4 Connect the black N2790A probe tip to the black banana jack.
- 5 Load the appropriate setup file.
- 6 Verify the value complies with the oscilloscope limits listed in the table below for each output signal at each probe setting.
- 7 Record the value displayed on the oscilloscope in the Calibration Test Record

| Test | 81150A Output Signal | N2790A Setting | Oscilloscope setup & limits |
|-----------|--|----------------|-----------------------------|
| Bandwidth | Sine wave, 100 MHz, 20 V _{pp} | 50:1 | Recall setup 1: > 2.8 div |
| Bandwidth | Sine wave, 100 MHz, 20 V _{pp} | 500:1 | Recall setup 2: > 2.8 div |

Calibration Test Record

| Agilent Technologies | | N2790A 100 MHz Differential Probe | |
|---|----------------|---|---------|
| Recommended Test Interval: 1 Year | | Serial No.: _____ | |
| Recommended Date of Next Certification: _____ | | Certification Date: _____ | |
| Certification Temperature: _____ | | Tested By: _____ | |
| _____ | | _____ | |
| _____ | | _____ | |
| Test | Probe Settings | Limits | Results |
| Gain | 50:1 | +196 mV ... +204 mV ($\pm 2\%$ of reading) | |
| Gain | 50:1 | +1.96 V ... +2.04 V ($\pm 2\%$ of reading) | |
| Gain | 500:1 | +196 mV ... +204 mV ($\pm 2\%$ of reading) | |
| Gain | 500:1 | +1.96 V ... +2.04 V ($\pm 2\%$ of reading) | |
| Gain | 50:1 | -196 mV ... -204 mV ($\pm 2\%$ of reading) | |
| Gain | 50:1 | -1.96 V ... -2.04 V ($\pm 2\%$ of reading) | |
| Gain | 500:1 | -196 mV ... -204 mV ($\pm 2\%$ of reading) | |
| Gain | 500:1 | -1.96 V ... -2.04 V ($\pm 2\%$ of reading) | |
| | | | |
| Bandwidth | 50:1 | > 2.8 div Reading on oscilloscope | |
| Bandwidth | 500:1 | > 2.8 div Reading on oscilloscope | |

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.

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