

Keysight N2893A 100 MHz Current Probe

User's
Guide



Notices

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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.

DANGER

A **DANGER** notice that incorrect operation presents extreme danger of accident resulting in death or serious injury to the user.

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Keysight N2893A 100 MHz Current Probe User's Guide

Introduction

The N2893A is a wide-band, DC to 100 MHz, active current probe. The probe features low noise and low circuit insertion loss. It also features the AutoProbe interface which makes current measurements as simple as those made with active voltage probes. The N2893A has two operating regions that provide a wide, flat frequency response. In the DC to low frequency AC region, the probe operation is based on the negative feedback of the amplifier system that includes the thin film Hall element as a detector. In the high frequency region, the probe operates as a current transformer. The N2893A is ideal for acquiring high transient time signals such as those found in motor controllers, in switching power supplies, and in current amplifiers driving inductive loads. In order to use this product effectively and to ensure a long operational life, read this user's guide carefully and retain it for future reference.

Features

- Highly accurate current detection
- Split-core construction allows easy circuit connection
- Broadband frequency characteristics DC to 100 MHz
- Connects directly to InfiniiVision and Infiniium oscilloscopes with 1 M Ω AutoProbe interface
- Auto degauss and offset elimination
- Easy protect function at excessive input

Scope Compatibility

- 3000 X-Series oscilloscopes
- 5000, 6000 (except 100 MHz models), and 7000 Series oscilloscopes with software version 6.10 or higher
- 9000A Series with software version 3.0 or higher
- 90000 X-Series with the N5449A adapter

Inspection

When the unit is delivered, check and make sure that it has not been damaged in transit. If the unit is damaged, or fails to operate according to the specifications, contact your dealer or Keysight representative.

Safety

This manual provides information and warnings essential for operating this equipment in a safe manner and for maintaining it in safe operating condition. Before using this equipment, be sure to carefully read the following safety notes.

WARNING

This equipment is designed according to IEC 61010-1 Safety Standards, and has been tested for safety prior to shipment. Incorrect measurement procedures could result in injury or death, as well as damage to the equipment. Please read this manual carefully and be sure that you understand its contents before using the equipment. The manufacturer disclaims all responsibility for any accident or injury except that resulting due to defect in its product.

WARNING

Only trained service personnel who are aware of the hazard involved (for example, fire and electric shock) should perform maintenance on the instrument. When maintenance can be performed without power applied, the power cord must be disconnected from the instrument.

DANGER

To avoid short circuits and accidents that could result in injury or death, use the N2893A only with power lines carrying 300V or less.

DANGER

When conductors being measured carry in excess of the safe voltage level (SELV-E) and not more than 300V, to prevent short circuits and electric shock while the core section is open, make sure that conductors to be measured are insulated with material conforming to (1) Overvoltage Category I, (2) Basic Insulation Requirements for Working Voltages of 300 V, and (3) Pollution Degree 2. Never use this sensor on bare conductors, the core and shield case are not insulated. If a bare conductor is inevitable to be measured, make sure that the power to the wire must be turned off, when opening the jaws of the probe to insert or remove the bare wire so that 300V CAT I is always satisfied.

DANGER

Avoid damaging the cable insulation surfaces while taking measurements.

DANGER

This instrument is only made for use with the Infiniium. Do not plug the probe into any interface other than the AutoProbe interface, of which Infiniium has a protective earthing with double-insulation construction.

DANGER

Take the following precautions to ensure that the Infiniium does not form a bridge between the probe and any hazardous live part:

- Isolate the AutoProbe interface to which the probe is connected from other AutoProbe interfaces using basic insulation conforming to the overvoltage category, working voltage, and pollution degree requirements of the circuit being tested.
 - If basic insulation requirements cannot be met between the AutoProbe interface to which this unit is connected and other AutoProbe interfaces of the measuring instrument, make sure that the voltage input to the AutoProbe interfaces does not exceed the safe voltage level (SELV-E).
 - Read and observe all warnings and precautions relating to electrical safety for the Infiniium.
-

DANGER

Refer to the following standards regarding the meanings of underlined terms: IEC61010-1, IEC61010-2-031, and IEC61010-2-032.

WARNING

To prevent electric shock, do not allow the unit to become wet and do not use the unit when your hands are wet.

WARNING

Do not subject the unit to vibrations or shocks during transport or handling. Be especially careful to avoid dropping the unit.

WARNING

Do not store the unit where it will be exposed to direct sunlight, high temperature, high humidity, or condensation. If exposed to such conditions, the unit may be damaged, the insulation may deteriorate, and the unit may no longer satisfy its specifications.

WARNING

Before using the unit, inspect it and check the operation to make sure that the unit was not damaged due to poor storage or transport conditions. If damage is found, contact your dealer or Keysight representative.

WARNING

This unit is not constructed to be waterproof or dustproof, so do not use it in a very dusty environment or in one where it will get wet.

WARNING

The sensor head is a precision assembly including a molded component, a ferrite core, and a Hall effect element. It may be damaged if subjected to sudden changes in ambient temperature, or mechanical strain or shock, and therefore great care should be exercised in handling it.

WARNING

The matching surfaces of the sensor head are precision ground, and should be treated with care. If these surfaces are scratched, performance may be impaired.

WARNING

Do not bend or pull the sensor cable and power supply cable in order to avoid damaging the sensor cables.

WARNING

Gently wipe dirt from the surface of the unit with a soft cloth moistened with a small amount of water or mild detergent. Do not try to clean the unit using cleaners containing organic solvents such as benzene, alcohol, acetone, ether, ketones, thinners, or gasoline. They may cause discoloration or damage.

WARNING

To avoid scratching the surfaces of the Hall effect elements, keep the core section of the sensor closed, except when clamping it around the conductor to be measured.

NOTE

Accurate measurement may be impossible in locations subject to strong external magnetic fields, such as transformers and high-current conductors, or in locations subject to strong external electric fields, such as radio transmission equipment.

Concerning the Oscilloscope

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 fuseholders. To do so could cause a shock or fire hazard.

WARNING

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.

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

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.

WARNING

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

WARNING

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

WARNING

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.

WARNING

Do not use the instrument in a manner not specified by the manufacturer.

WARNING

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.



Risk of Electric Shock. Refer to the manual for more information.



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

Description of Parts

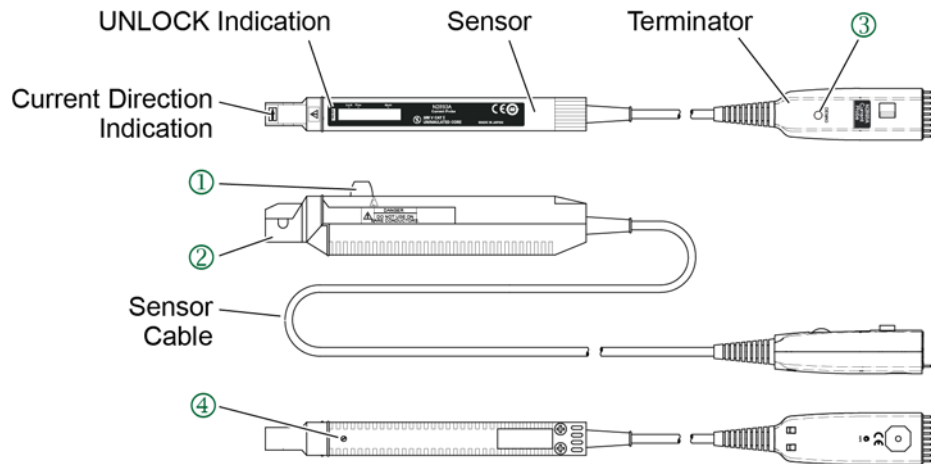


Figure 1 Probe Parts Identification

① Opening Lever

Operating lever for opening the sensor head. Always use this lever to open the sensor head.

② Sensor Head

This clamps the conductor being measured, and carries out the actual current measurement. It is a precision assembly including a molded component, a ferrite core, and a Hall effect element. It may be damaged if subjected to sudden changes in ambient temperature, or mechanical strain or shock. Care should be exercised when handling the sensor head.

③ Demagnetizing Switch (DEMAG)

This demagnetizes the core if it has been magnetized by switching the power on and off, or by an excessive input. Always carry out demagnetizing before measurement. The demagnetizing process takes about one second. During demagnetizing, a demagnetizing waveform is output. Refer to ["Demagnetization and Zero Offset"](#) on page 17

④ Coarse Adjustment Trimmer

This adjustment should only be carried out if the probe offset is outside the range of the zero adjustment dial.

NOTE

The output of this unit is terminated internally. The high-impedance such as 1 M Ω input impedance will be automatically selected on the Infiniium, as the Terminator is plugged into the AutoProbe interface. With an input impedance of 50 Ω , accurate measurement is not possible.

NOTE

The probe output sensitivity 0.1 V/A will be automatically selected, as the Terminator is plugged into the AutoProbe interface. With an different output sensitivity, accurate measurement is not possible.

Using the Probe

WARNING

Ensure all safety warnings and precautions are followed. Before using the probe, study the warning and precautions in **"Safety"** on page 6.

NOTE

This probe is NOT compatible with 50 Ω only Infiniium oscilloscopes (for example, the 90000A series oscilloscopes). Use the N5449A high impedance probe adapter for use with Infiniium 90000X Series oscilloscope. The input coupling is automatically selected to DC, as the terminator is plugged into the AutoProbe interface.

Making Measurements

- 1 Power on the oscilloscope.
- 2 Connect the probe terminator to one of the scope's channels.

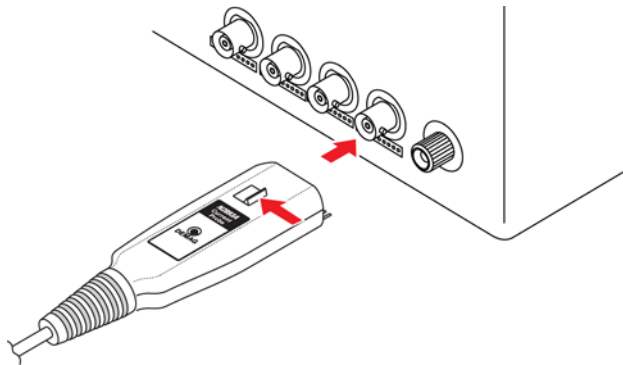


Figure 2 Connecting the Probe to the Oscilloscope

NOTE

When the probe is connected to a scope channel, the AutoProbe interface recognizes the probe as an N2893A and automatically configures several settings on the channel to which the probe is connected.

- 3 Perform the steps in **"Demagnetization and Zero Offset"** on page 17.
- 4 With the probe's sensor head around the conductor to be measured, slide the Opening Lever into the **Locked** position as shown in **Figure 3**.

CAUTION

Always use the opening lever when opening the probe's sensor head. If an upper core is forced to open when the sensor head is locked, the open-close mechanism can be damaged.

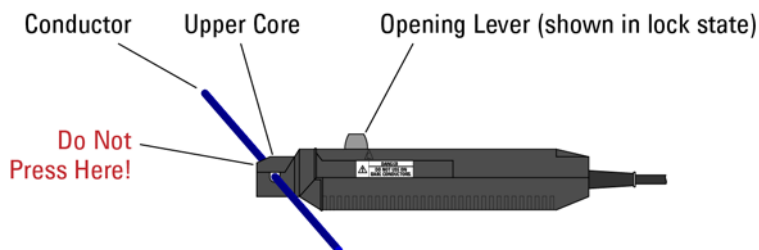


Figure 3 Use the Opening Lever

- 5 To obtain the best accuracy, ensure that:
 - The current direction indicator on the sensor aligns with actual current direction in the conductor.
 - The sensor opening lever is in the Locked position
 - The cable is centered in the sensor head.
- 6 At high frequencies, common mode noise may affect measurements taken on the high voltage side of circuits. If this occurs, reduce the frequency range of the measuring instrument or clamp onto the low-voltage side of the circuit as shown in Figure 4, as appropriate.

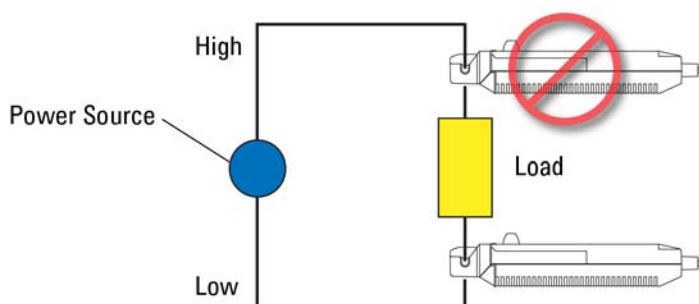


Figure 4 Clamp Onto the Low-Voltage Side of Circuit

WARNING

The maximum continuous input range is based on heat that is internally generated during measurement. Never input current in excess of this level. Exceeding the rated level may result in damage to the probe.

WARNING

The maximum continuous input range varies according to the frequency of the current being measured. See [Figure 9](#) on page 24.

WARNING

If excess current is input, generated heat activates a built-in safety function that blocks normal output. If this happens, remove the input immediately (unclamp the sensor from the conductor being measured or reduce the input current to zero). Wait until the sensor has had sufficient time to cool before resuming operation.

WARNING

Even if the input current does not exceed the rated continuous maximum, continuous input for an extended period of time may result in activation of the safety circuit to prevent damage resulting from heating of the sensor.

WARNING

At high ambient temperatures, the built-in safety circuit may activate at current input levels below the rated continuous maximum.

WARNING

Continuous input of current exceeding the rated maximum or repeated activation of the safety function may result in damage to the unit.

WARNING

Do NOT measure current such that the total probe current consumption exceeds the allowable AutoProbe interface current consumption. The excess current consumption causes a temporary shutdown of the Infiniium power supply for safety. Quit the measurement and cycle the power of the Infiniium, if the shutdown occurs. The typical probe current consumption from the AutoProbe interface is shown in [Figure 5](#).

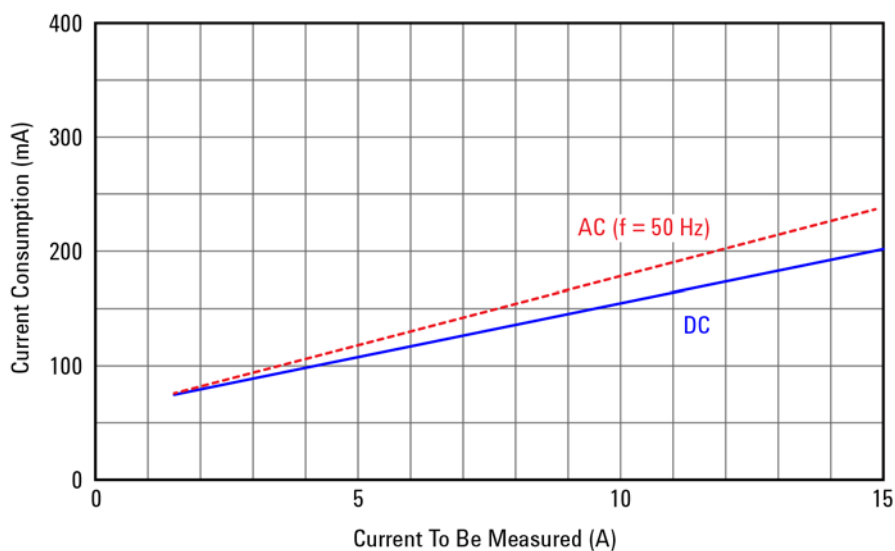


Figure 5 Typical Probe Consumption

NOTE

Immediately after powering on, this unit may be subject to an appreciable offset drift due to the effect of self-heating. To counteract this, allow the unit to warm up for about 30 minutes before carrying out measurement.

NOTE

When performing continuous measurements, it is necessary to be aware that the zero offset voltage will drift if the ambient temperature changes.

NOTE

Under certain circumstances, oscillation may occur if the probe is connected to the AutoProbe interface while the Infiniium is on. This does not indicate a malfunction. Oscillation can be stopped and operation restored to normal by opening and closing the sensor head.

NOTE

At some frequencies, some sound may be produced by resonance, this has no effect on measurements.

NOTE

Measurement accuracy is affected by the position of the conductor being measured within the clamp aperture. The conductor should be in the center of the clamp aperture.

NOTE

Before making a measurement, press the opening lever until the "UNLOCK" indication disappears and check that the sensor head is properly closed. If the sensor head is not properly closed, accurate measurement will not be possible.

NOTE

Accurate measurement may be impossible in locations subject to strong external magnetic fields, such as transformers and high-current conductors, or in locations subject to strong external electric fields, such as radio transmission equipment.

Demagnetization and Zero Offset

NOTE

Allow both the Infiniium oscilloscope and the probe to warm up for at least 30 minutes before making these adjustments.

- 1 Set the channel offset to 0V for the oscilloscope channel to which the probe is connected.
- 2 Ensure that the probe sensor is NOT clamped around any conductors.
- 3 Slide the probe's Opening Lever into the **Locked** position as shown in [Figure 6](#).

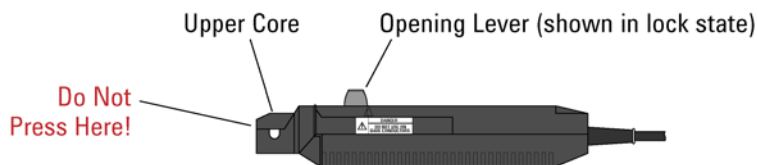


Figure 6 Use the Opening Lever

- 4 Press the probe's **DEMAG** button shown in [Figure 1](#) on page 10. A demagnetization waveform will be displayed for a short time on the channel to which the probe is connected. Wait until this waveform is no longer displayed.
- 5 On InfiniiVision Oscilloscopes:
 - a Press the scope's channel button (1, 2, 3, or 4) for the channel you are using.
 - b Click the **Probe** softkey (under the display) and then press the key to automatically start the demagnetization and zero offset process. Follow the on-screen instructions.
- 6 For Infiniium Oscilloscopes:
 - a Click **Setup > Probes**.
 - b In the dialog box click the button to automatically start the demagnetization and zero offset process. Follow the on-screen instructions.

Calibration Testing Procedure

Use the following procedure to test the warranted specifications for the N2893A Differential Probe. The recommended calibration test interval for the N2893A is once a year or as required. Use the equipment listed in [Table 1](#).

Table 1 Required Test Equipment

Description	Minimum Requirements	Recommended Test Equipment
Oscilloscope	Bandwidth \geq 250 MHz Amplitude accuracy: \leq 0.4%	Infiniium or InfiniiVision with 1 M Ω input
Current loop wire	16 AWG, Convenient length	30 cm
AC current generator	AC 10 A _{rms} , 50 Hz, sine wave Amplitude accuracy: \leq 0.3%	Wavetek 9100
50 Ω current loop	–	N2774-23801

AC Accuracy

- 1 Turn on the oscilloscope then connect the N2893A probe to the oscilloscope.
- 2 Turn on the other equipment.
- 3 Wait 30 minutes to warm up the equipment.
- 4 Press the **DEMAG** button on the probe.
- 5 Connect the wire to the current terminals of the AC current generator as shown in [Figure 7](#).
- 6 Clamp the wire with the N2893A and lock the sensor head.

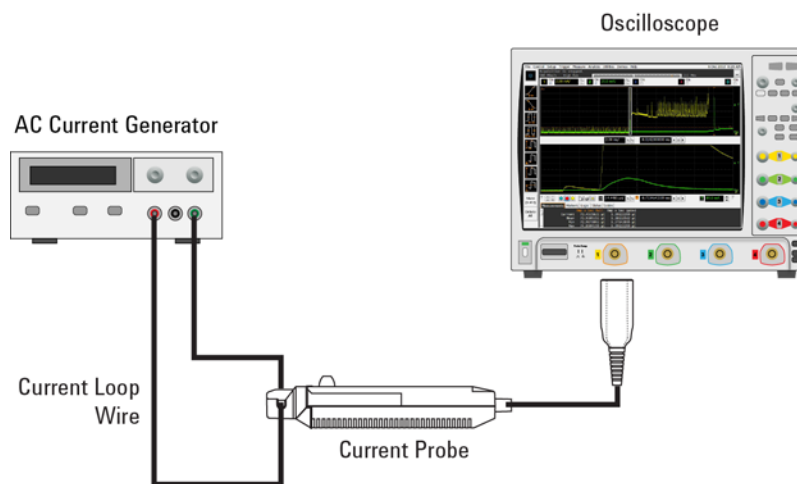


Figure 7 Sensor Head Clamped to Wire

- 7 Set the Infiniium to the following settings:

Averaging:	16
Time:	5 ms/div
Vertical axis:	5A/div
Trigger level:	0 mV
Trigger slope:	Rise
Measurement mode:	Vrms (Voltage)
Measurement Area:	Entire Display
RMS Type:	AC
Other setups:	APPROPRIATE

- 8 Set the generator to AC 10 A_{rms}, 50 Hz, and sine wave.
- 9 Generate the wave, measure the current and record it.
- 10 Remove the wire and the generator from the N2893A.

Calibration Test Record

The recommended test interval is one year.

Table 2 Test Record

Test	Limit Minimum	Results	Limit Maximum
AC Accuracy (Arms)	9.75		10.25

NOTE

The AC Accuracy range is based on the Infiniium oscilloscope's accuracy. Calculate the minimum and the maximum limits corresponding to the accuracy of your Infiniium oscilloscope.

Characteristics and Specifications

Table 3 Measurement Characteristics

Item	Characteristic ^a
Probe Bandwidth	DC to 100 MHz (-3 dB)
Accuracy (Probe Only) ^b	±1% of reading ±1 mV (DC or 45 Hz to 66 Hz)
Risetime ^c	≤ 3.5 ns
Maximum Continuous Current	<p>With InfiniiVision 3000X/T, 5000/6000/7000 Series: 15A peak (DC+AC peak), 15A_{DC}, 10A_{rms} continuous Max. peak: 30A peak non-continuous (when upto two probes are used) 30A peak (DC+AC peak), 30 A_{DC}, 24A_{rms} continuous Max. peak: 32A peak non-continuous (when one probe is used)</p> <p>With Infiniium or InfiniiVision 4000X, 6000X Series: 15A peak (DC+AC peak), 15A_{DC}, 10A_{rms} continuous, 30A peak non-continuous (per each channel) (Refer to frequency derating curve, Figure 9 on page 24)</p>
Maximum Peak Current	50A (for Pulse Widths ≤ 10μs)
Probe Sensitivity	0.1V/A
Noise	≤ 2.5 mA _{rms} (with 20 MHz Bandwidth limiting)
Insertion Impedance	See Figure 10 on page 25.
Temperature Coefficient	≤ ±2% (0°C to 40°C)
Effect of External Magnetic Fields	Equivalent to ≤ 20 mA (for a 400 A/m magnetic field, DC to 60 Hz)
Maximum Circuit Voltage	300V Cat I (refer to safety considerations and product compliances)

a Requires 1MΩ termination. Valid for 23°C ±3°C (73°F ±5°F), at least 30 minutes after power on.

b This is a specification and is guaranteed at 23°C ±3°C (73°F ±5°F).

c Rise time is calculated as: $Tr = 0.35/\text{Bandwidth}$.

Table 4 Power Supply Characteristics

Item	Characteristics
DC supply Voltage Requirements	$\pm 12\text{Vdc} \pm 1\text{V}$
Probe Power Consumption	Increases with measured current. 3 VA when measuring 15A

Table 5 Mechanical Characteristics

Item	Characteristics
Maximum Cable Diameter	5 mm (0.2 inch)
Sensor Cable Length	1.5 m (59 inches)
Power Cable Length	1 m (39 inches)
Dimensions (Sensor)	175 mm x 18 mm x 40 mm 6.89 in. x 0.71 in. x 1.6 in.
Dimensions (Terminator)	28 mm x 81 mm x 24 mm 1.1 in. x 3.2 in. x 0.94 in
Weight	210 g (7.4 oz.)
Accessories Supplied	Storage case, calibration certificate

Table 6 Environmental Characteristics

Item	Characteristics
Use	Indoor
Operating Temperature Range	0°C to 40°C (32°F to 104°F)
Storage Temperature Range	-10°C to 50°C (14°F to 122°F)
Maximum Relative Humidity (Operating or Storage)	80% (no condensation)
Vibration (10 to 55 Hz)	30 min/axis 10 octave/min Amplitude 0.3 mm
Vibration (55 Hz)	30 min/axis Amplitude 0.3 mm Acceleration 17.91 m/s ²
Maximum Altitude	2000m

Plots

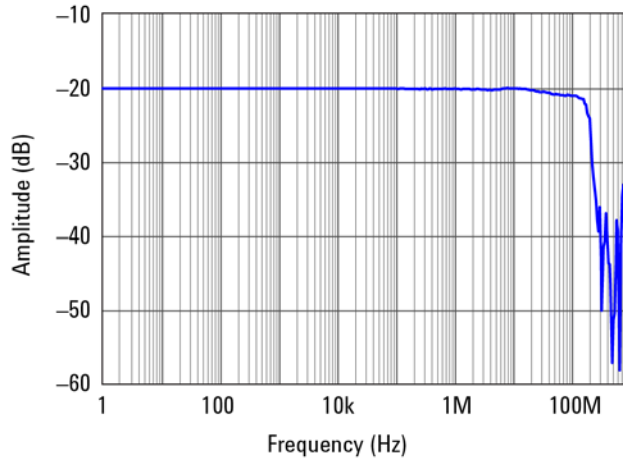


Figure 8 Frequency Response of N2893A

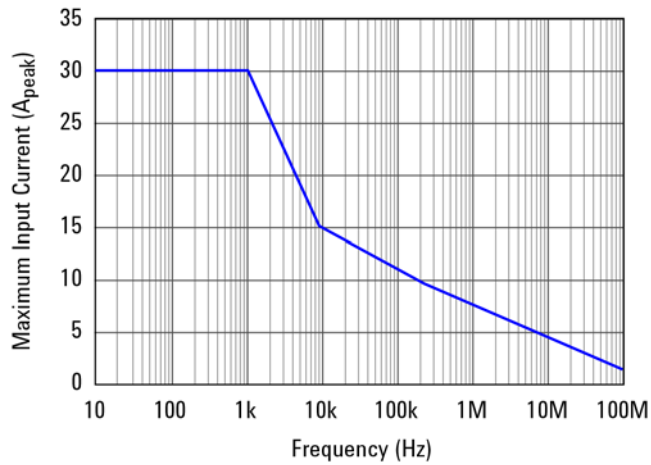


Figure 9 Continuous Maximum Input Rating of N2893A

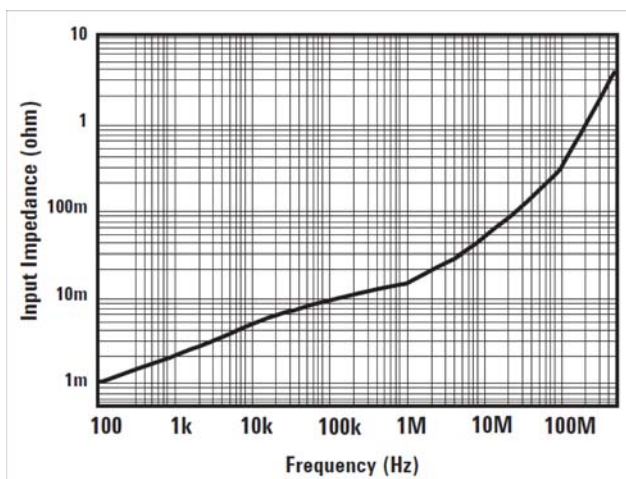


Figure 10 Insert Impedance of N2893A

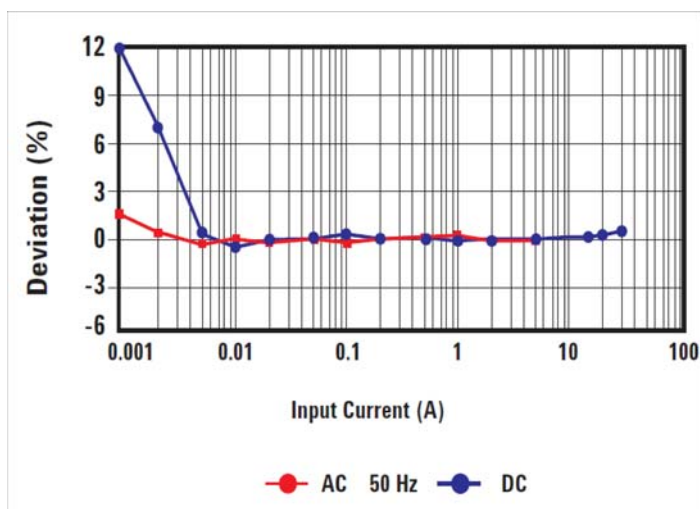







Figure 11 Amplitude Accuracy Characteristic of N2893A

Product Markings and Labels

Table 7 Instrument Markings

Marking	Description
	Indicates the maximum circuit voltage and product compliance.
	This symbol indicates the Environmental Protection Use Period (EPUP) for the product's toxic substances for the China RoHS requirements.
	The CE symbol indicates the European Community.
	CAUTION. Risk of Danger. Refer to this manual for more information.
	Indicates DC (Direct Current) or AC (Alternating Current).

Service Strategy

For calibration testing, return the N2893A probe to a Keysight Service Center. If the probe is under warranty, normal warranty services apply. If the probe is not under warranty, repair costs will be applied.

To return the Probe to Keysight Technologies for Service

Call (800) 829-4444 for further details and the location of your nearest Keysight Technologies Service Office or go to www.keysight.com/find/assist for contact information.

- 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 indications
- 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 Keysight 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 shipping container securely.
- 5 Mark the shipping container as FRAGILE. In all correspondence, refer to the instrument by model number and full serial number.

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