Agilent N2893A 100 MHz Current Probe



User's Guide

Publication number N2893-97000
January 2011

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

© Copyright Agilent Technologies 2011
All Rights Reserved.

Agilent Technologies

N2893A 100 MHz Current Probe 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
- Easy current measurement
- Broadband frequency characteristics DC to 100 MHz
- Compact
- Permits measurement of low current levels
- Easy protect function at excessive input

Scope Compatibility

- 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 Agilent representative.

Contents

Note on Safety 4
Safety Symbols 4
Safety Considerations 5
Description of Parts 7
Characteristics and Specifications 9
Measurement Characteristics 9
Power Supply Characteristics 9
Mechanical Characteristics 10
Environmental Characteristics 10
Plots 11
Preparations for Measurement 13
Demagnetization Procedure 14
Demagnetization and Zero Offset Procedure 14
Measurement Procedure 14
Service Strategy 18
To return the Probe to Agilent Technologies for Service 18
Calibration Testing Procedures 19
Test Equipment Required 19
Preliminary procedure 19
(1) AC Accuracy 20
Calibration Test Record 21

Note on Safety

⚠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.

Safety Symbols

This User's Guide 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.

	Caution refer to accompanying documents.
	Indicates DC (Direct Current) or AC (Alternating Current).

The following symbols are used in this User's Guide to indicate the relative importance of cautions and warnings.

⚠DANGER	Indicates that incorrect operation presents extreme danger of accident resulting in death or serious injury to the user.
⚠WARNING	Indicates that incorrect operation presents significant danger of accident resulting in death or serious injury to the user.
⚠ CAUTION	Indicates that incorrect operation presents possibility of injury to the user or damage to the equipment.
NOTE	Denotes items of advice related to performance of the equipment or to its correct operation.

Safety Considerations

⚠WARNING

Only trained service personnel who are aware of the hazard involveds (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.

To ensure safe operation and to obtain maximum performance from the unit, observe the cautions listed below.

⚠DANGER

- To avoid short circuits and accidents that could result in injury or death, use the N2893A only with power lines carrying 300 V or less.
- When conductors being measured carry in excess of the safe voltage level (SELV-E) and not more than 300 V, 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.
- Avoid damaging the cable insulation surfaces while taking measurements.
- 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.
- Take the following precautions to ensure that the Infiniium does not form a bridge between the probe and any hazardous live part.
  1. 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.
  2. 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).
  3. Read and observe all warnings and precautions relating to electrical safety for the Infiniium.
- Refer to the following standards regarding the meanings of underlined terms.

  IEC61010-1
  IEC61010-2-031
  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.

⚠ CAUTION

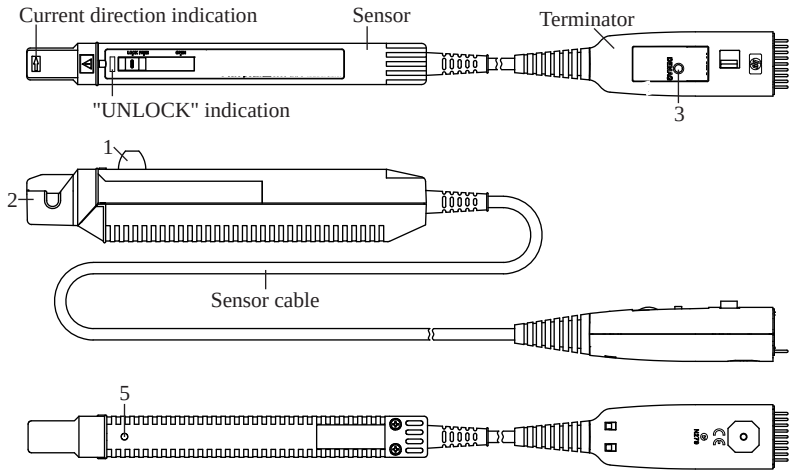
- Do not subject the unit to vibrations or shocks during transport or handling. Be especially careful to avoid dropping the unit.

- 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.
- 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 Agilent representative.
- 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.
- 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.
- 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.
- Do not bend or pull the sensor cable and power supply cable in order to avoid damaging the sensor cables.
- 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 benzine, alcohol, acetone, ether, ketones, thinners, or gasoline. They may cause discoloration or damage.
- 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.

Description of Parts



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 handing 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.

4 Coarse adjustment trimmer

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

NOTE

- The output of this unit is terminated internally. The high-impedance such as 1 MΩ 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.
- 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.

Characteristics and Specifications

Measurement Characteristics

See note 1 below.

Probe Bandwidth	DC to 100MHz (-3 dB)
Accuracy (Probe Only)*	±1% of reading ±1mV (DC or 45Hz to 66Hz)
Risetime[2]	≤ 7ns
Maximum continuous current	15A (DC + ACrms) continuous (Refer to frequency derating curve, Fig. 2)
Maximum peak current	50A (for Pulse Widths ≤ 10µs)
Probe sensitivity	0.1V/A
Noise	≤ 2.5mArms(with 20MHz Bandwidth limiting)
Insertion impedance	Refer to Fig. 3
Temperature coefficient	≤ ±2% (0°C to 40°C)
Effect of external magnetic fields	Equivalent to ≤ 20mA (for a 400A/m magnetic field, DC to 60Hz)
Maximum circuit voltage	300V Cat I (refer to safety considerations and product compliances)

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

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

2. Rise time is calculated as: Tr = 0.35/Bandwidth.

Power Supply Characteristics

DC supply voltage requirements	±12Vdc ±1V
Probe power consumption	Increases with measured current. 3 VA when measuring 15 A

Mechanical 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.
	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	

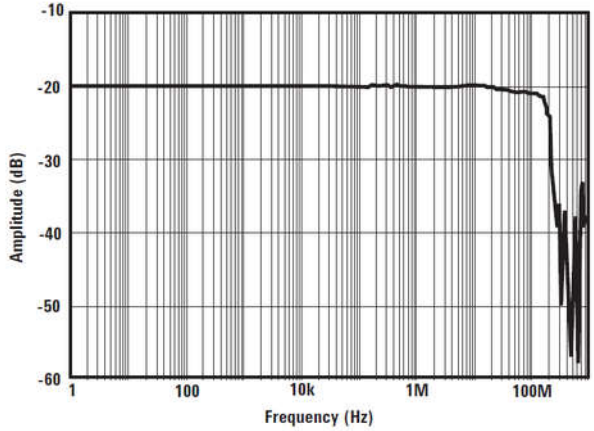
Environmental Characteristics

See note 3 below.

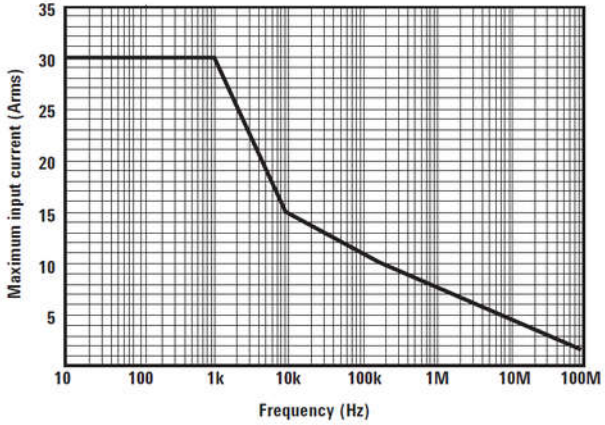
Operating temperature range	0°C to 40°C (32°F to 104°F)	
Storage temperature range	-10°C to 50°C (14°F to 122°F)	
Maximum relative humidity (operating or storage)	80% (no condensation)	
Vibration	10 to 55 Hz:	30 min/axis 10 octave/min Amplitude 0.3 mm
	55 Hz:	30 min/axis Amplitude 0.3 mm Acceleration 17.91 m/s^2
Maximum Altitude	2000 m	

3. This probe is intended for indoor use only.

Plots

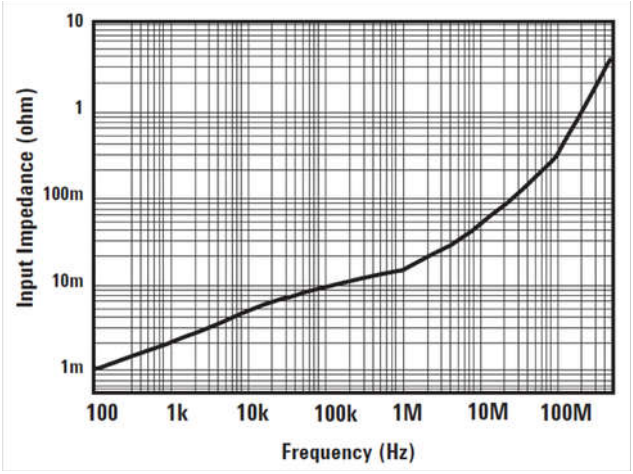


Frequency response of N2893A

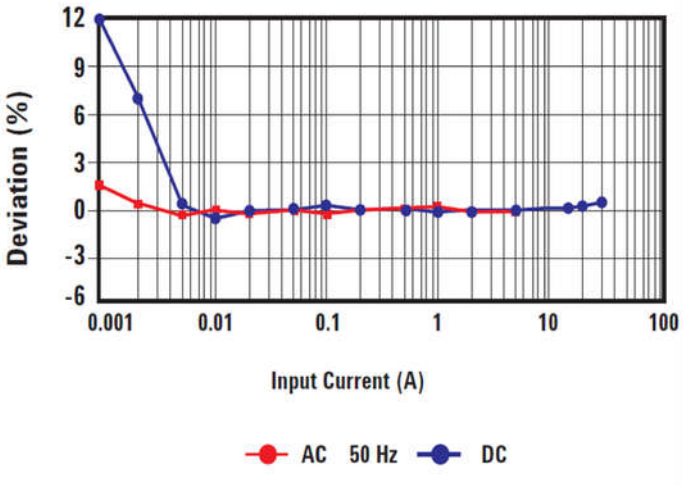


Continuous maximum input rating of N2893A

Plots



Insert impedance of N2893A



Amplitude accuracy characteristic of N2893A

Measurement Procedure

Preparations for Measurement

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

   When the probe is connected to a scope channel, the AutoProbe interface will recognize the probe as an N2893A and will automatically make several settings on the channel to which the probe is connected:

NOTE

- This probe is NOT compatible with 50Ω only Infiniium oscilloscopes (e.g. the 90000A series oscilloscopes) unless there is an adapter such as with the 90000 X-Series.The input coupling is automatically selected to DC, as the terminator is plugged into the AutoProbe interface.

Measurement Procedure

Demagnetization Procedure

Refer to the Description of Parts section of this manual when performing this procedure

1. Allow both the Infiniium oscilloscope and the probe to warm up for at least 30 minutes before making these adjustments.
2. Ensure that the channel offset is set to 0 V on the oscilloscope channel to which the probe is connected.
3. Ensure that the probe sensor is NOT clamped around any conductors.
4. Slide the probe sensor Opening Lever into the Locked position.
5. Press the **DEMAG** button on the terminator.

   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.

Demagnetization and Zero Offset Procedure

1. **For InfiniiVision Oscilloscopes:** Press the input channel button (1, 2, 3, or 4) on the front panel of the oscilloscope for the channel you are using and then press the Probe softkey under the display. You will then see a softkey for automatically setting the demagnetization and offset. Press this key. The oscilloscope will then guide you through the process.

   For Infiniium Oscilloscopes: In the Infiniium application, go to **Setup** > **Probes** and click the button in the GUI to automatically start the demagnetization and zero offset process. The GUI will then guide you through the procedure.

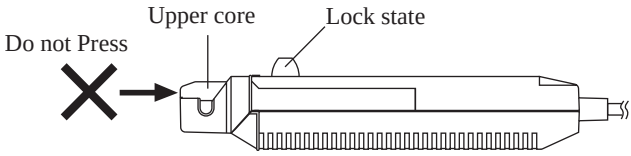
Measurement Procedure

⚠ CAUTION Ensure all safety warnings and precautions are followed.

1. Perform the Demagnetization and Zero Adjustment procedure above.
2. Clamp the sensor head around the conductor to be measured.
3. To obtain the best accuracy, ensure that:
   - **a** The current direction indicator on the sensor aligns with actual current direction in the conductor.
   - **b** The sensor opening lever is in the Locked position
   - **c** The cable is centered in the sensor head.

⚠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.
- The maximum continuous input range varies according to the frequency of the current being measured. See figure 2 in “Characteristics and Specifications”
- 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.
- 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.
- At high ambient temperatures, the built-in safety circuit may activate at current input levels below the rated continuous maximum.
- Continuous input of current exceeding the rated maximum or repeated activation of the safety function may result in damage to the unit.
- When opening the sensor head of the probe, be sure to operate with the opening lever. If an upper core is forced to open when the sensor head is locked, the open-close mechanism can be damaged.



- 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 4.

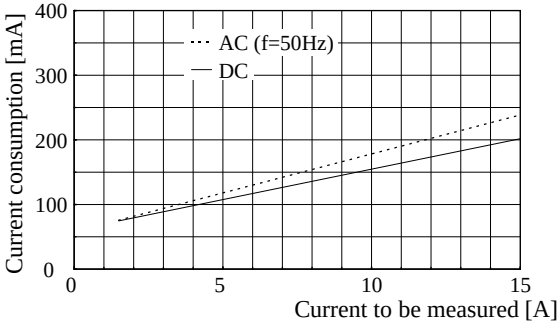


Figure 4. Typical probe consumption

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.
- When performing continuous measurements, it is necessary to be aware that the zero offset voltage will drift if the ambient temperature changes.
- 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.
- At some frequencies, some sound may be produced by resonance, this has no effect on measurements.
- 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.
- 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.
- 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.
- 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 waveform measuring instrument or clamp onto the low-voltage side of the circuit (as shown in figure 5), as appropriate.

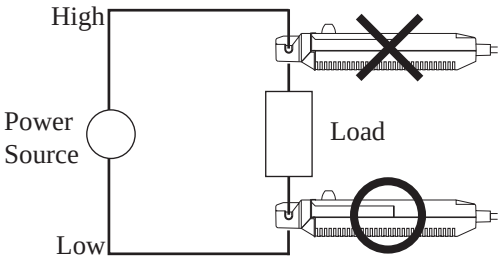


Figure 5. Low-voltage side of the circuit

Service Strategy

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

To return the Probe to Agilent Technologies for Service

Call (877) 447-7278 for further details and the location of your nearest Agilent Technologies Service Office or go to www.agilent.com 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 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 shipping container securely.
5. Mark the shipping container as FRAGILE. In all correspondence, refer to the instrument by model number and full serial number.

Calibration Testing Procedures

These procedures are used 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 the “Test Equipment Required” section to complete the Calibration Testing Procedure.

Test Equipment Required

Description	Minimum Requirements	Recommended test equipment	Used at
Infiniium	Bandwidth ≥ 250 MHz Amplitude accuracy: ≤0.4 %	Any oscilloscope with 1MΩ input	(1), (2), (3), (4)
Current loop wire	16 AWG, Convenient length	30 cm	(1)
AC current generator	AC 10 Arms, 50 Hz, sine wave Amplitude accuracy: ≤0.3 %	Wavetek 9100	(1)
50Ω current loop		N2774-23801	(4)

Preliminary procedure

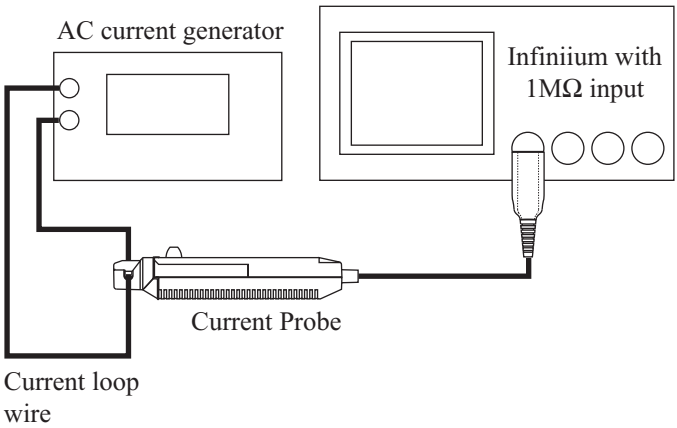
1. Turn on the oscilloscope and then connect the N2893A probe to the it. Turn on the other equipment.
2. Wait 30 minutes to warm up the equipment.

(1) AC Accuracy

1 Press the DEMAG button on the Terminator.
2 Connect the wire to the current terminals of the AC current generator.
3 Clamp the wire with the N2893A and lock the sensor head.
4 Set the Infiniium setups as follows:

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

5 Set the Generator setups to AC 10 Arms, 50 Hz, and sine wave.
6 Generate the wave, measure the current and record it.
7 Remove the wire and the generator from the N2893A.



Calibration Test Record

Agilent Technologies N2893A DC to 100 MHz Current Probe Recommended Test Interval: 1 year Serial No.: _____ Certification Date: _____ Tested By: _____ Certification Temperature: _____ Recommended Date of Next Certification: _____			
Test	**Limit Minimum**	**Results**	**Limit Maximum**
(1) 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.

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.

Agilent Technologies
P.O. Box 2197
1900 Garden of the Gods Road
Colorado Springs, CO 80901

Notices

© Agilent Technologies, Inc. 2011

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Agilent Technologies, Inc. as governed by United States and international copyright laws.

Manual Part Number

N2893-97000, January 2011

Print History

N2893-97000, January 2011

Agilent Technologies, Inc.
1900 Garden of the Gods Road
Colorado Springs, CO 80907
USA

Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as "Commercial computer software" as defined in DFAR 252.227-7014 (June 1995), or as a "commercial item" as defined in FAR 2.101(a) or as "Restricted computer software" as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Document Warranty

The material contained in this document is provided "as is," and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Agilent disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

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.

CAUTION

A CAUTION 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 damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

www.agilent.com

© Agilent Technologies, Inc. 2011

First edition, January 2011

N2893-97000

Agilent Technologies