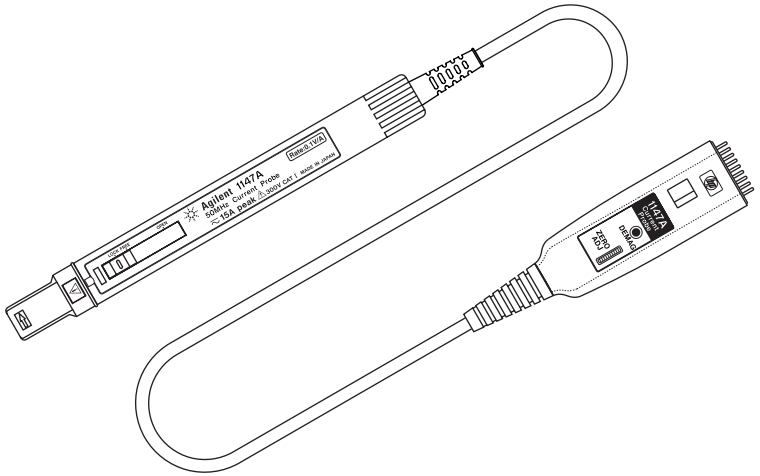


User's Guide

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

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1147A 50 MHz Current Probe

1147A 50 MHz Current Probe introduction

The 1147A is a wide-band, DC to 50 MHz, active current probe. The probe features low noise and low circuit insertion loss. The intelligent interface makes the probe ideal for use with the Infiniium products using the intelligent interface. This unique probe interface makes current measurements as simple as that is available with the active voltage probes.

The 1147A is a two-path system in the fundamental operation. In a DC and low frequency 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 a high frequency region, the probe operates as a current transformer. The probe has intrinsically the feedback effect including the magnetic core in these two signal regions. 1147A gives not only wide and flat frequency response, but also highly accurate and stable output.

The 1147A 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 that it enjoys a long operational life, read this User's Guide carefully and then retain it for future reference.

Features

- Highly accurate current detection
- Easy current measurement
- Broadband frequency characteristics DC to 50 MHz
- Compact and permits measurement of low current levels
- Easy protect function at excessive input

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.

Supplied accessories:

User's Guide 1

Carrying case 1

Contents

Note on Safety	4
Safety Symbols	4
Safety Considerations	5
Description of Parts	7
Specifications and Standards Applying	9
Electrical Specifications	9
General Specifications	10
Environmental Specifications	10
Measurement Procedure	12
Preparations for Measurement	12
Demagnetization and Zero Adjustment	13
Measurement Procedure	13
Service Strategy	17
To return the Probe to Agilent Technologies for Service	17
Calibration Testing Procedures	18
Test Equipment Required	18
Preliminary procedure	18
(1) AC Accuracy	19
(2) Demagnetization	20
(3) Zero Adjustment	20
(4) Rise Time	21
Calibration Test Record	22

Note on Safety

Note on Safety

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.

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

Safety Considerations

⚠WARNING

Trained service personnel 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 removed from the instrument.

In order 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 1147A 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.
- Be careful to avoid damaging the insulation surface 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
- To prevent electric shock, do not allow the unit to become wet and do not use the unit when your hands are wet.

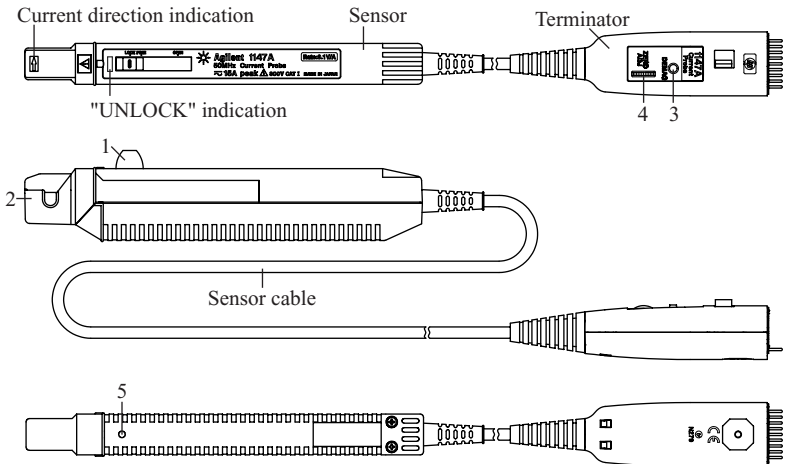
⚠WARNING

Safety Considerations**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.
- If there is any type of dust or dirt on the matching surfaces of the sensor head, measurements may be affected. Wipe it away gently with a soft cloth.
- 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.
- When the power is on, keep the core section of the sensor closed, except when clamping them the conductor to be measured. The facing surface of the core section can be scratched while it is open.
- 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.

NOTE

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 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.

4 Zero adjustment dial (ZERO ADJ)

Use the zero adjustment dial to correct for the effect of a voltage offset or temperature drift on the unit. The probe should be always be zeroed after demagnetization.

5 Coarse adjustment trimmer

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

Description of Parts

NOTE

- The output of this unit is terminated internally. The high-impedance such as $1\text{ M}\Omega$ input impedance will be automatically selected on the Infiniium, as the Terminator is plugged into the AutoProbe interface. With an input impedance of $50\ \Omega$, 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.

Specifications and Standards Applying

The following specifications are guaranteed at 23 °C ± 3 °C (73 °F ± 5 °F).

Electrical Specifications

Bandwidth	DC to 50MHz (-3 dB) (Typical characteristic shown in Figure 1)
Rise time	7 ns or less
Rated current	15 A peak (AC+DC components) (Derating according to frequency shown in Figure 2)
Maximum peak current value	30 A peak; Non-continuous 50 A peak; at pulse width ≤ 10 μs
Output voltage rate	0.1 V/A
Amplitude accuracy	± 0.5 % rdg. ± 1 mV (DC and 45 to 66 Hz, rated current)
Noise	Equivalent to 2.5 mA rms or less (for 20 MHz band measuring instrument)
Insertion impedance	(Typical characteristics shown in Figure 3)
Temperature coefficient for sensitivity	± 2 % or less (within a range of 0 °C to 40 °C or 32 °F to 104 °F)
Effect of external magnetic fields	Equivalent to a maximum of 20 mA (in a DC or 60 Hz, 400 A/m magnetic field)
Maximum rated power	3 VA (with rated current)
Interface	AutoProbe

Specifications and Standards Applying**General Specifications**

Diameter of measurable conductors	5mm dia. (0.2" dia.)
Cable lengths	Sensor cable: Approx. 1.5 m (59.0")
External dimensions	Sensor: Approx. 175 (W) x 18 (H) x 40 (D) mm Approx 6.89" (W) x 0.71" (H) x 1.58" (D) Terminator: Approx. 28 (W) x 81 (H) x 24 (D) mm Approx. 1.10" (W) x 3.19" (H) x 0.94" (D)
Weight	Approx. 210 g (7.4 oz.)
Accessories	User's Guide, case

Environmental Specifications

Operating temperature and humidity range	0 °C to 40 °C (32 °F to 104 °F) 80 %rh or less (no condensation)
Storage temperature and humidity range	-10 °C to 50 °C (14 °F to 122 °F) 80 %rh or less (no condensation)
Bearable storage vibration	1. Vibration 10 to 55 Hz, 30 min per axis, 1 octave/min sweep rate, Amplitude 0.3 mm 2. Vibration 55 Hz, 30 min per axis, Amplitude 0.3 mm, Vibration acceleration 17.91 m/s ²
Altitude for use	Indoor, up to 2,000 m (6,500 ft)
Maximum permitted circuit voltage	300V, CAT I

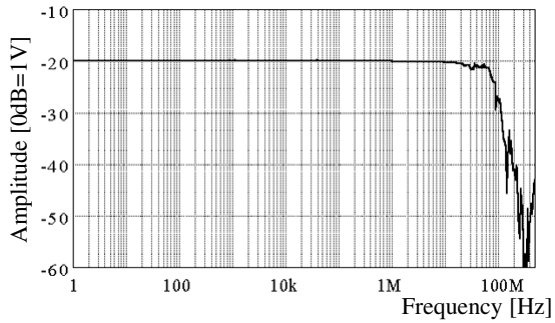


Fig. 1 Frequency characteristic

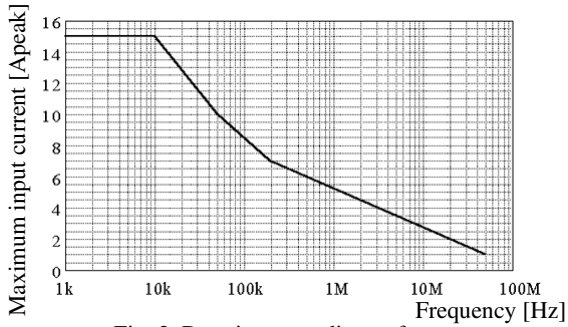


Fig. 2 Derating according to frequency

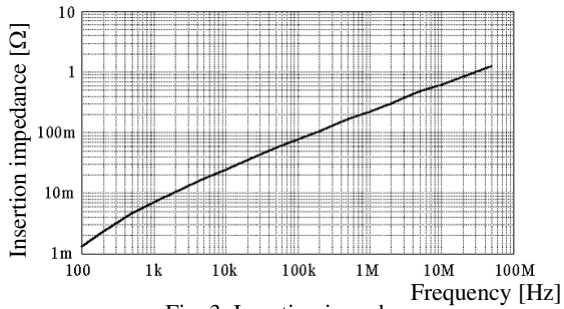
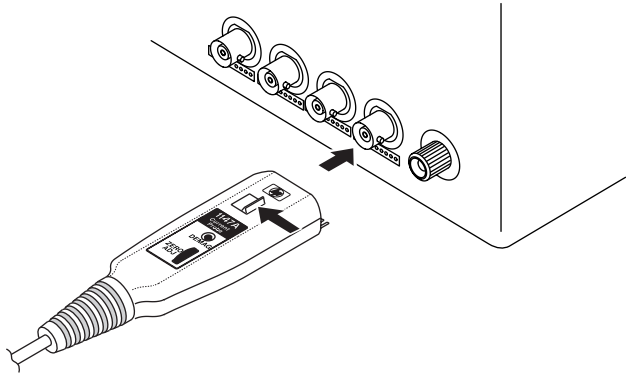


Fig. 3 Insertion impedance

Measurement Procedure

Preparations for Measurement

- 1 Have the Infiniium ready.
- 2 Attach the 1147A Terminator to the Infiniium AutoProbe interface.



NOTE

- The output of this unit is terminated internally. The high-impedance such as $1\text{ M}\Omega$ input impedance will be automatically selected on the Infiniium, as the Terminator is plugged into the AutoProbe interface. With an input impedance of $50\ \Omega$, accurate measurement is not possible.
- The input coupling is automatically selected to DC, as the Terminator is plugged into the AutoProbe interface.
- The probe output sensitivity 0.1 V/A will be automatically selected, as the Terminator is plugged into the AutoProbe interface.

Demagnetization and Zero Adjustment

- 1 With the Infiniium input at ground, adjust the trace to the zero position.

CAUTION

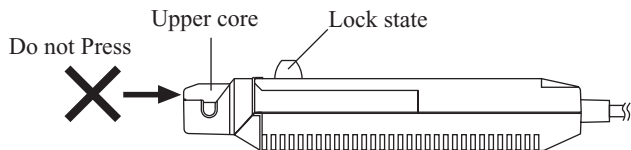
- When disconnecting the Terminator, be sure to release the lock, then pull the Terminator. Forcibly pulling the Terminator without releasing the lock, or pulling on the cable will result in damage to the Terminator.
 - Do not demagnetize while the conductor being measured is clamped. This could damage the components of the circuit being measured.
 - Check that the conductor being measured is not clamped when supplying power to the 1147A for the same reason. Demagnetized waveforms are generated when attaching on the Infiniium.
- 2 Without clamping the conductor to be measured, press the opening lever until the "UNLOCK" indication disappears, and check that the sensor head is properly closed.
 - 3 Press the demagnetizing switch (DEMAG) on the Terminator.
 - 4 Turn the zero adjustment dial on the terminator to adjust the trace to the zero position.
 - 5 If zero adjustment is not possible in step 4, turn the coarse adjustment trimmer to bring the trace within the range of adjustment by the zero adjustment dial.

Measurement Procedure

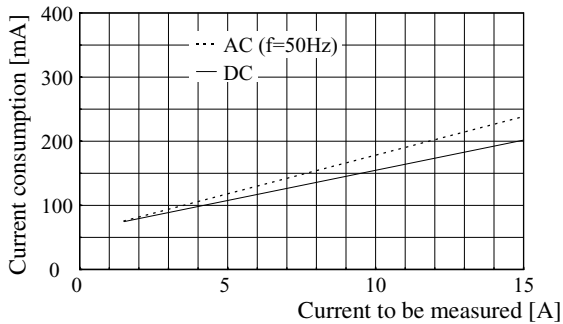
- 1 Check that the system is safe and that the preparations described in the preceding section have been carried out.
- 2 Pull the sensor opening lever with the sensor head opens.
- 3 Align the sensor so that the current direction indication corresponds to the direction of current flow through the conductor to be measured. Also, align the clamp so that the conductor is in the center of the sensor aperture.
- 4 Press the opening lever on the sensor head until the "UNLOCK" indication disappears. Also check that the opening lever is firmly locked and the sensor head securely closed.
- 5 It is now possible to monitor the current waveform.

Measurement Procedure**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 the figures in "Specifications and Standards Applying"
- If excess current is input, generated heat activates a built-in safety function that blocks normal output. If this happens, remove the input immediately (remove 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.
- The probe is rated for maximum input under two conditions in addition to the input maximums shown in the "Specifications and Standards Applying". These are (1) 30 Apeak for non-continuous input and (2) 50 Apeak for pulse widths $\leq 10 \mu\text{s}$. (1) indicates an upper waveform response limit of 30 Apeak. Use the sensor at RMS current input levels that are within the rated continuous maximums. (2) indicates the upper response limit for a single input pulse.
- 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.



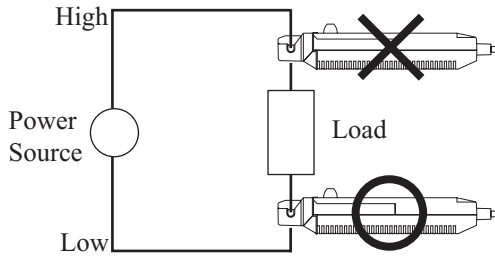
- Do NOT measure current such that the total probe current consumption exceeds the allowable AutoProbe interface current consumption. The excess current consumption causes a temporal shutdown of the Infiniium power supply for safety. Quit the measurement and recycle the power of the Infiniium, if the shutdown occurs. The typical probe current consumption from the AutoProbe interface is shown below.



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 offset voltage drifts, depending on factors such as the ambient temperature.
- 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.
- Depending on the measured current frequency, some sound may be produced by resonance, but has no effect on measurements.
- The reading may be affected by the position within the clamp aperture of the conductor being measured. The conductor should be in the center of the clamp aperture.
- When carrying out 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 appropriate.

1147A 50 MHz Current Probe
Measurement Procedure



Service Strategy

For repair and calibration testing, return the 1147A probe to an Agilent 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 Agilent Technologies for Service

Call (877) 447-7278 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 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 1147A Differential Probe. The recommended calibration test interval for the 1147A 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

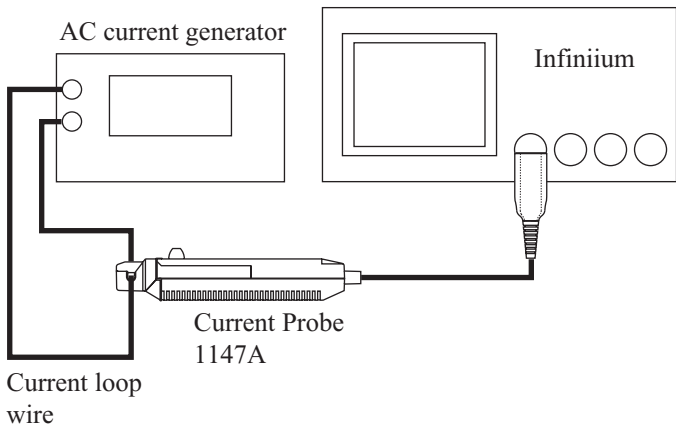
Description	Minimum Requirements	Recommended test equipment	Used at
Infiniium	Bandwidth \geq 250 MHz Amplitude accuracy: \leq 0.4 %	54825A	(1), (2), (3), (4)
Current loop wire	16 AWG, Convenient length	30 cm	(1)
AC current generator	AC 10 Arms, 50 Hz, sine wave Amplitude accuracy: \leq 0.3 %	Wavetek 9100	(1)
50 Ω current loop		N2774-23801	(4)
Pulse generator	Rise Time: \leq 3 ns Amplitude: \geq 5 Vp-p	LeCroy 9210+9211	(4)

Preliminary procedure

- 1 Turn on the Infiniium then connect the 1147A probe to the Infiniium. Turn on the other equipment.
- 2 Wait 30 minutes to warm up the equipment.

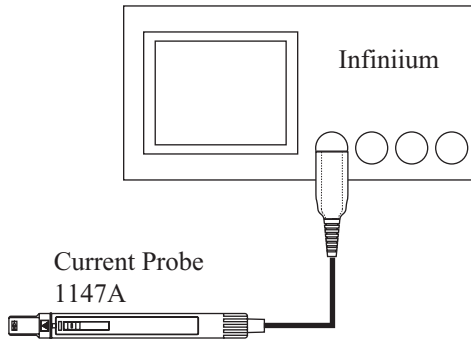
(1) AC Accuracy

- 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 1147A 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 1147A.



(2) Demagnetization

- 1 Set the Infiniium setups as follows:
 - Time: 1 ms/div
 - Vertical axis: 1 A/div
 - Trigger level: 0 mV
 - Trigger slope: Rise
 - Other setups: APPROPRIATE
- 2 Press the DEMAG button on the Terminator and confirm that the appeared demagnetization wave on the oscilloscope display is damped.

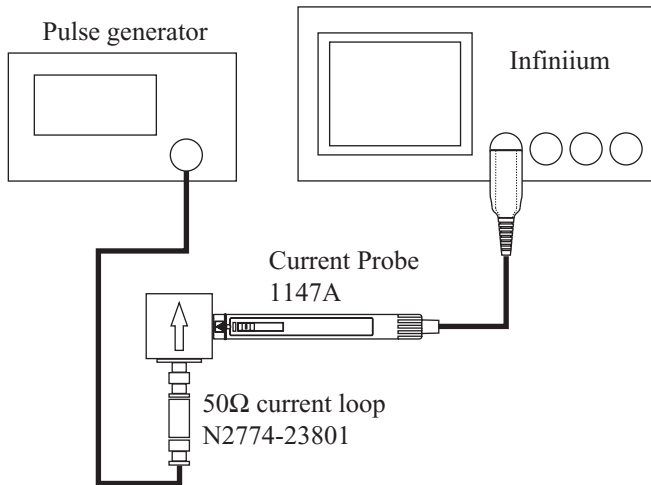


(3) Zero Adjustment

- 1 Set the Infiniium setups as follows:
 - Vertical axis: 50 mA/div
 - Other setups: APPROPRIATE
- 2 Turn the zero adjustment dial on the Terminator until the trace crosses the zero position.

(4) Rise Time

- 1 Connect the 50 Ω current loop to the Pulse generator.
- 2 Set the Infiniium setups as follows:
 - Averaging: 16
 - Time: 20 ns/div
 - Vertical axis: 20 mA/div
 - Trigger level: 0 mV
 - Trigger slope: Rise
 - Measurement mode: Rise time
 - Other setups: APPROPRIATE
- 3 Clamp the inner bar of the 50 Ω current loop with 1147A.
- 4 Generate the pulse wave as follows:
 - Rise time: 3 ns
 - Frequency: 1 MHz
 - Voltage: 5 Vp-p
- 5 Confirm that the mean of the rise time is less than 7 ns.



Calibration Test Record

Agilent Technologies			
1147A DC to 50 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
(2) Demagnetization (pass or fail)	-		-
(3) Zero Adjustment (pass or fail)	-		-
(4) Rise Time [ns]	-		7

NOTE

The AC Accuracy range is based on the Infiniium 54825A's accuracy. Calculate the minimum and the maximum limits corresponding to the accuracy of your Infiniium.

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1900 Garden of the Gods Road
Colorado Springs, CO
80907, U.S.A.

Declares, that the product

Product Name: Oscilloscope Current Probe

Model Number: 1147A

Product Options: This declaration covers all options of the above product(s).

Conforms to the following product standards:

EMC:	Standard	Limit
	IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998	
	CISPR 11:1990 / EN 55011:1991	Group 1, Class A ^[1]
	IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995	4kV CD, 8kV AD
	IEC 61000-4-3:1995 / EN 61000-4-3:1995	3V/m 80-1000 MHz
	IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:1995 / EN 61000-4-5:1995	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:1996 / EN 61000-4-6:1996	3V, 0.15-80 MHz
	IEC 61000-4-11:1994 / EN 61000-4-11:1994	1 cycle, 100%
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS 2064.1	

Safety: IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995

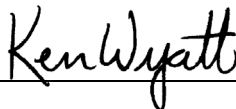
Conformity/Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC, and carries the CE-marking accordingly (European Union).

^[1]This product was tested in a typical configuration with Agilent Technologies test systems.

Date: 06/21/2000

Name



Ken Wyatt, Product Regulations Manager

For further information, please contact your local Agilent Technologies sales office, agent, or distributor.

Product Regulations

EMC

IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998	Performance Criteria
CISPR 11:1990 / EN 55011:1991	
IEC 61000-4-2:1995+A1:1998 / EN61000-4-2:1995	A
IEC 61000-4-3:1995 / EN 61000-4-3:1995	B
IEC 61000-4-4:1995 / EN 61000-4-4:1995	A
IEC 61000-4-5:1995 / EN 61000-4-5:1995	A
IEC 61000-4-6:1996 / EN 61000-4-6:1996	A
IEC 61000-4-11:1994 / EN 61000-4-11:1994	A
Canada: ICES-001:1998	

Safety IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995

Additional information

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly (European Union).

Performance Criteria:

A Pass - Normal operation, no effect.

B Pass - Temporary degradation, self recoverable.

C Pass - Temporary degradation, operator intervention required.

D Fail - Not recoverable, component damage.

Notes: (none)

Sound Pressure Level N/A

Regulatory Information for Canada

ICES/NMB-001

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Regulatory Information for Australia/New Zealand

This ISM device complies with Australian/New Zealand AS/NZS 2064.1



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 fuse-holders. 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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