

P6021A
60 MHz, 15 Amp AC Current Probe
Instruction Manual



071-3004-00

Tektronix

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Instruction Manual

www.tektronix.com
071-3004-00

Tektronix

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Contacting Tektronix

Tektronix, Inc.
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P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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General safety summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

To avoid fire or personal injury

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Connect and disconnect properly. De-energize the circuit under test before connecting or disconnecting the current probe.

Connect and disconnect properly. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Connect the probe reference lead to the circuit under test before connecting the probe input. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement instrument.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not connect a current probe to any wire that carries voltages above the current probe voltage rating.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

Terms in this manual

These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbol(s) may appear on the product:



CAUTION
Refer to Manual



Do not connect to or
remove from an
uninsulated conductor that
is HAZARDOUS LIVE.



Breakable.
Do not drop.

Service safety summary

Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Compliance Information

This section lists the safety and environmental standards with which the instrument complies.

Certifications and Compliances

EC Declaration of Conformity - Low Voltage

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities:

Low Voltage Directive 2006/95/EC.

- EN 61010-1:2001. Safety requirements for electrical equipment for measurement control and laboratory use.
- EN 61010-2-032:2002. Particular requirements for handheld current clamps for electrical measurement and test equipment.

U.S. Nationally Recognized Testing Laboratory Listing

- UL 61010-1 2004, 2nd Edition. Standard for electrical measuring and test equipment.
- IEC 61010-2-032:2002. Particular requirements for handheld current clamps for electrical measurement and test equipment.

Canadian Certification

- CAN/CSA C22.2 No. 61010-1-04. Particular requirements for electrical equipment for measurement, control, and laboratory use. Part 1.
- CAN/CSA C22.2 No. 61010-2-032:04. Particular Requirements for Hand Held Current Clamps for Electrical Measurement and Test.

Additional Compliance

- IEC 61010-1:2001. Safety requirements for electrical equipment for measurement, control, and laboratory use.
- IEC 61010-2-032:2002. Particular requirements for handheld current clamps for electrical measurement and test equipment.

Equipment Type

Measurement

Pollution Degree Descriptions

A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.

- Pollution Degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
- Pollution Degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
- Pollution Degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.
- Pollution Degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.

Pollution Degree

Pollution Degree 2 (as defined in IEC 61010-1). Note: Rated for indoor use only.

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Preface

This manual describes the installation and operation of the P6021A current probe. Basic probe operations and concepts are presented in this manual. You can also access the Tektronix Web site for this document and other related information.

Documentation

To read about	Use these documents *
First time operation, functional check, operating basics, specifications, performance verification	Read this Instruction Manual.
In-depth oscilloscope operation, user interface help, GPIB commands	Access the online help from the Help menu on the host instrument.

* To access the documentation that is installed on your instrument, click **Start** in the taskbar and select **Programs > TekApplications**.

Conventions Used in This Manual

The following icon is used throughout this manual to indicate a step sequence.

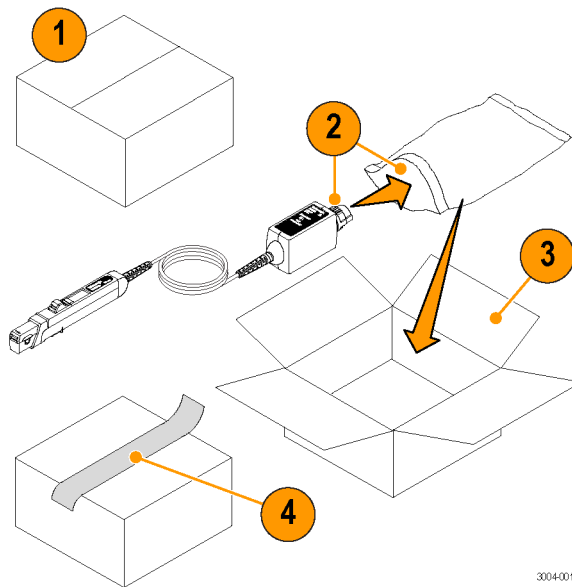


Returning the Probe for Servicing

If your probe requires servicing, you must return the probe to Tektronix. If the original packaging is unfit for use or not available, use the following packaging guidelines:

Preparation for Shipment

1. Use a corrugated cardboard shipping carton having inside dimensions at least one inch greater than the probe dimensions. The box should have a carton test strength of at least 200 pounds.
2. Put the probe into an antistatic bag or wrap it to protect it from dampness.
3. Place the probe into the box and stabilize it with light packing material.
4. Seal the carton with shipping tape.
5. Refer to *Contacting Tektronix* at the beginning of this manual for the shipping address.

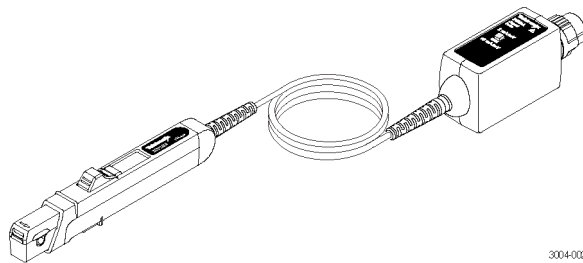


3004-001

Key Features

Use the P6021A current probe to make accurate measurements up to 60 MHz. Key features include:

- >60 MHz bandwidth, ≤ 5.8 ns rise time
- 15 A p-p continuous rating (de-rated with frequency)
- 250 A peak pulse current (pulse widths < 10 μ s)
- 150 V CAT II (bare wire)
300 V CAT II (insulated wire)

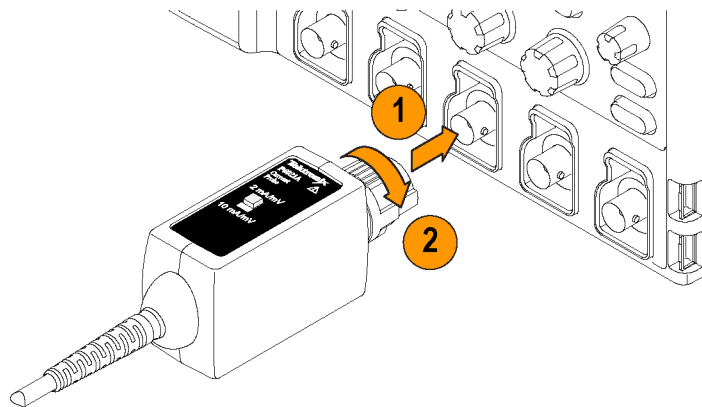


3004-012

Installation

1. Align the BNC connector on the probe to the oscilloscope input connector.
2. Push in the probe connector and turn it to the right to lock it in place.

To disconnect the probe, turn the probe connector to the left and pull the probe away from the instrument.



3004-003

Controls and Indicators

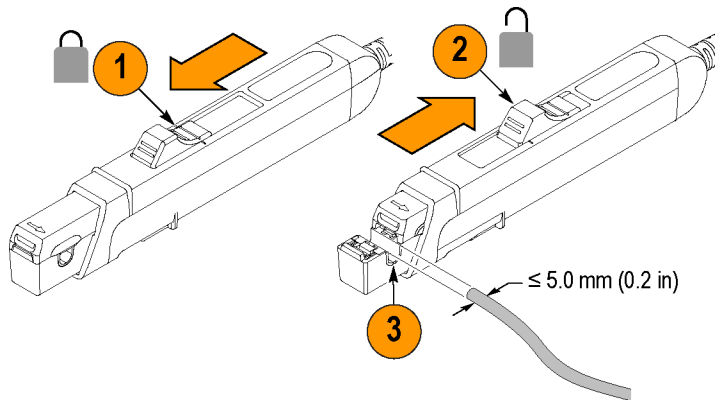
Controls and indicators for the probe are covered in the sections that follow.

Slider and Conductor Jaw

1. When the slider is in the locked position, you can degauss the probe and take measurements.
2. Move the slider to the unlocked position to insert and remove conductors to and from the jaw.
3. The jaw can accept a 5 mm (0.2 in) diameter maximum conductor size.



WARNING. To prevent probe damage, do not force conductors larger than 5 mm (0.2 in) diameter into the jaw.



3002-028

4. Safe handling zone – keep fingers behind demarcations when taking measurements.



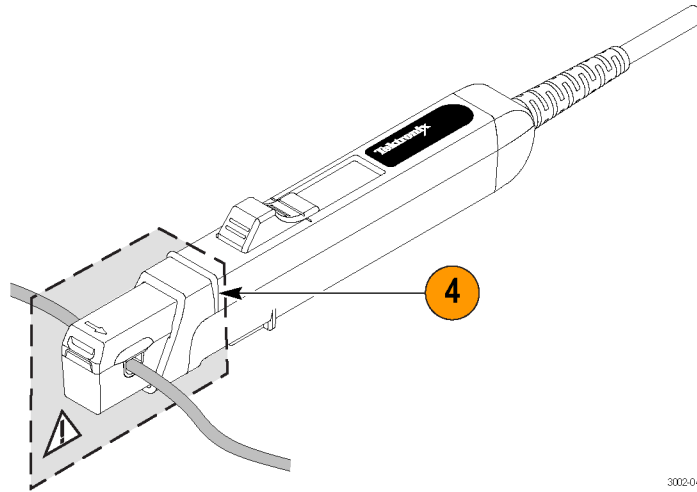
WARNING. To avoid electrical shock, do not access the area beyond the safe handling zone (indicated by the shaded area) when you take measurements.



WARNING. To prevent probe damage, do not drop the probe or subject it to impact.



WARNING. Do not connect the current probe to any wire that carries voltages or currents that exceed the rating of the probes.



3002-043

Range Select

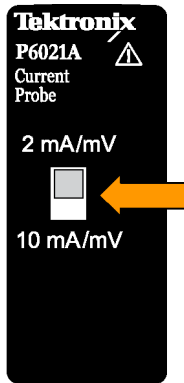
Use the range select switch to change the probe sensitivity between 2 mA/mV and 10 mA/mV.

NOTE. Some oscilloscopes have an attenuation control to match the oscilloscope scaling to the probe sensitivity (range).

The correct oscilloscope attenuation settings to use with the P6021A probe are:

2X for the 2 mA/mV range

10X for the 10 mA/mV range



Functional Check

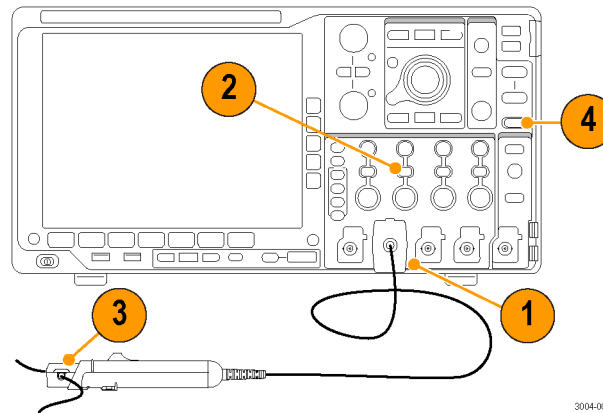
The following procedure checks that your probe is functioning properly. To verify that your probe meets the warranted specifications, refer to the *Performance Verification* procedures. (See page 37.)



CAUTION. The probe jaw opening accommodates insulated conductors with a diameter of 5.0 mm or less. Do not insert conductors larger than 5.0 mm diameter into the probe jaw. Damage to the probe may result.

To check that your probe functions correctly, do the following:

1. Connect the probe to any channel of the oscilloscope.
2. Set the oscilloscope to display the probe channel.
3. Clamp the probe to your circuit.
4. Adjust the oscilloscope or use the Autoset function to display a stable waveform.
When you see a stable waveform, your probe is functioning correctly.



3004-005

Accessories and Options

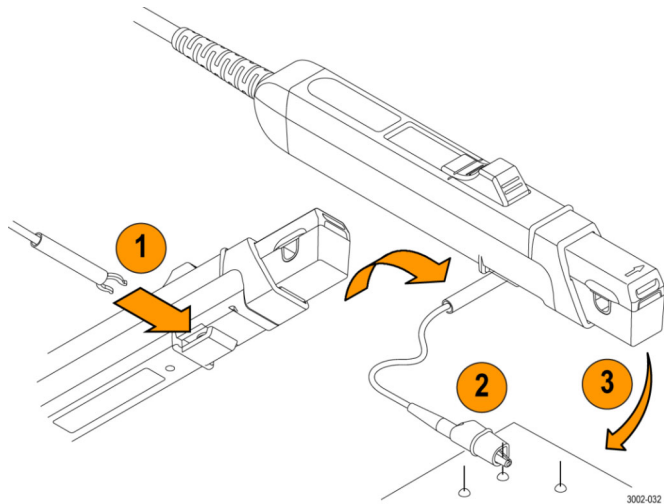
This section lists the standard and optional accessories available for the probe, and provides information on how to use the accessories. Specifications are provided where appropriate so that you can choose the accessory that best fits your needs.

Standard Accessories

Probe Ground Lead

1. Fasten the small clip to the ground stub on the probe body.
2. Clip the alligator clip to your circuit ground.
3. Attach the probe to your circuit.

Reorder Tektronix part number:
196-3521-xx, qty. 1

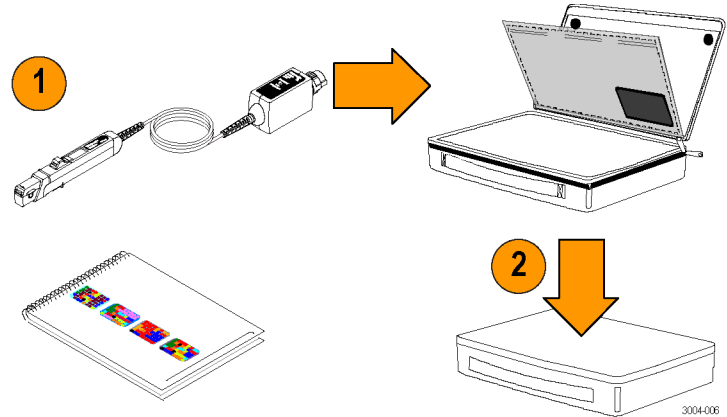


Nylon Carrying Case with Pouch and Inserts

Use the carrying case to hold the probe, the accessories, and the instruction manual.

1. Place the probe, accessories, and manual in the carrying case.
2. Close the carrying case to transport the accessories to another location or for storage.

Reorder Tektronix part number:
016-1952-xx



Instruction Manual

The instruction manual provides operating and maintenance instructions.

Reorder Tektronix part number:
071-3004-xx

Manuals in the languages listed below are available for this product. Other languages may also be available; check the Tektronix Web site at www.tektronix.com/manuals.

- (Japanese)
- (Simplified Chinese)



Optional Accessories

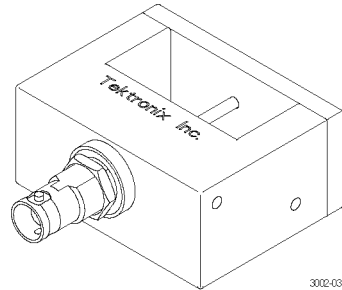
This section lists the optional accessories that you can purchase to help you with your probing tasks.

Current Loop

This 1-turn, 50 Ω current loop is required for the performance verification procedures. The BNC connector allows for easy connections to current sources, and the conductor bar inside the fixture fits in the jaw of the current probe.

To use the current loop, follow the procedure for the specific task that you are performing (for example, Performance Verification or Adjustments).

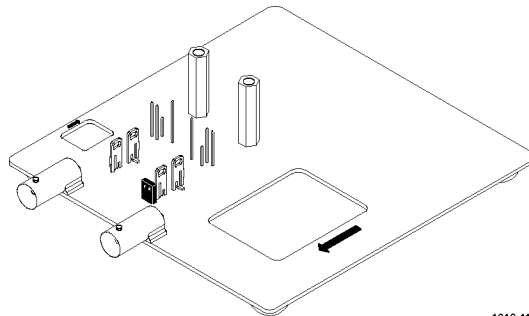
Order Tektronix part number:
067-2396-xx



Deskew/Calibration Fixture

Connect this fixture to host instruments that support the probe calibration or deskew procedures. The deskew procedures compensate for gain errors and timing differences between current and voltage probes. Refer to your oscilloscope manual or fixture documentation for instructions.

Order Tektronix part number: 067-1686-xx



1812-118

Options

Service Options

- **Option C3.** Calibration Service 3 years
- **Option C5.** Calibration Service 5 years
- **Option D1.** Calibration Data Report
- **Option D3.** Calibration Data Report, 3 years (with Option C3)
- **Option D5.** Calibration Data Report, 5 years (with Option C5)
- **Option R3.** Repair Service 3 years
- **Option R5.** Repair Service 5 years

Basic Operation



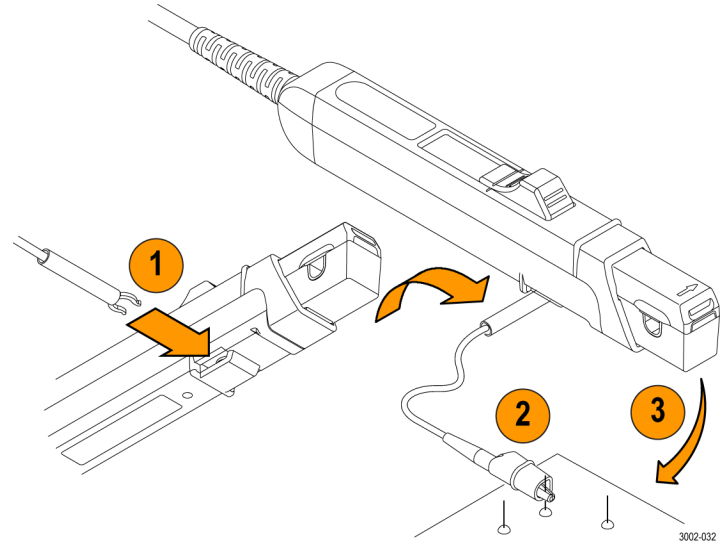
CAUTION. Do not force conductors larger than 5.0 mm (0.20 in) into the probe jaws. Damage to the probe may result. The mating surfaces of the probe head transformer are precision-polished and should be handled with care. Measurements may be degraded by dirt on the mating surfaces of the probe head transformer. Refer to the Maintenance section of this manual for information on how to properly clean the probe head transformer surfaces.

Grounding the Probe

The 6-inch ground lead grounds the shield around the probe transformer at the probe end of the cable. This allows you to move the ground connection closer to the circuit you are measuring, thereby improving high frequency response. The ground lead clips onto the ground connector on the bottom of the probe.

When you take high frequency measurements, connect the probe ground lead to the probe ground connector and attach the alligator clip directly to RF ground to improve EMI rejection at high frequencies (2 MHz and above). This will help bypass capacitively-coupled RF currents which can flow into the probe cable. In some cases, it may be helpful to move the ground lead or reposition the probe away from noise sources in the circuit under test.

1. Clip the ground lead to the ground post at the bottom of the probe head.
2. Connect the alligator end of the clip to the circuit ground.
3. Clamp the probe around the circuit conductor.



Probing Principles

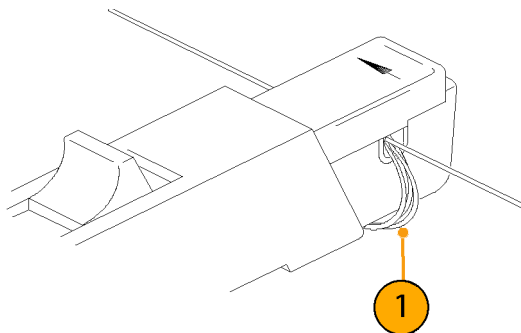
The following information is provided to help you use the full potential of your current probe.

Increasing Sensitivity

If you are measuring low-frequency AC signals of very small amplitudes, you can increase measurement sensitivity of your probe by doing the following:

1. Wind several turns of the conductor under test around the probe as shown. The signal is multiplied by the number of turns around the probe.
2. Divide the displayed amplitude by the number of turns.

For example, if a conductor is wrapped around the probe three times and the oscilloscope shows a reading of 3 mA, the actual current flow is 3 mA divided by 3, or 1 mA.



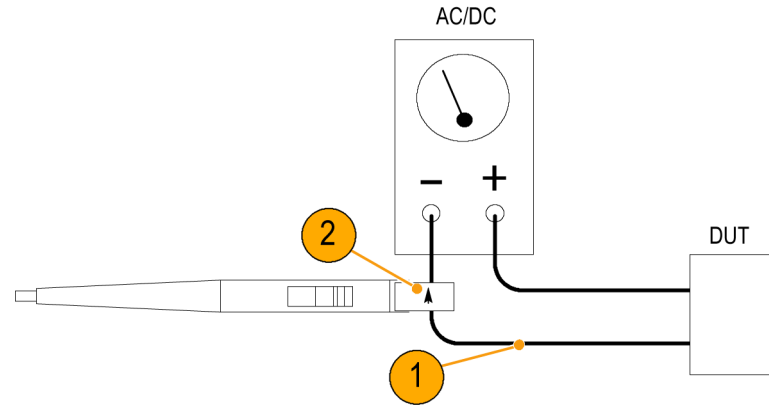
NOTE. Winding more turns around the probe increases the insertion impedance and reduces the upper bandwidth limit of the probe.

Common Mode Noise/Magnetic Field Errors

Common-mode noise at high frequencies and strong magnetic fields on the supply side of your circuit can cause measurement errors. To avoid this:

1. Measure on the low or ground side of your circuit.
2. Orient the probe to measure conventional current flow (from positive to negative).

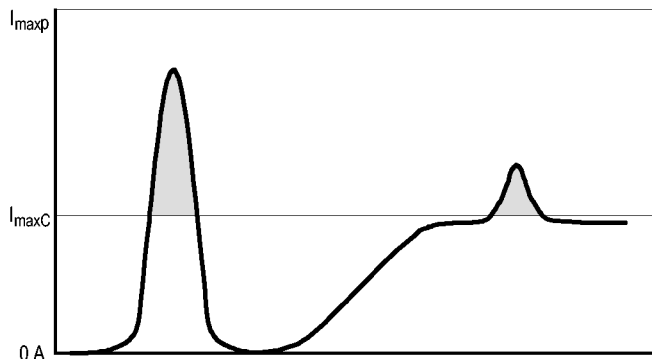
NOTE. This method works best when the negative terminal shown in the diagram is tied to earth ground.



Maximum Current Limits

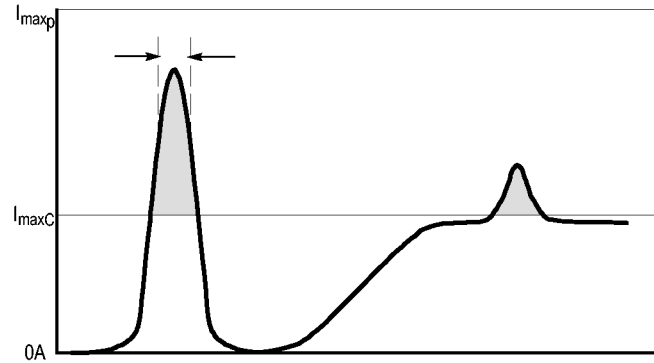
Current probes have three maximum current ratings: pulsed, continuous, and Ampere-second product. Exceeding any of these ratings can saturate the probe core, which magnetizes the core and causes measurement errors. Refer to the specifications for the maximum current ratings of the probe. (See Table 2 on page 29.)

- Maximum Pulsed Current (I_{maxP}) is the maximum peak value of pulsed current the probe can accurately measure, regardless of how short (within bandwidth limitations) the pulse duration is.
- Maximum Continuous Current (I_{maxC}) is the maximum current that can be continuously measured at a specified AC frequency. The maximum continuous current value is derated with frequency; as the frequency increases, the maximum continuous current rating decreases.



- Ampere-Second Product is the maximum width of pulsed current that you can measure when the pulse amplitude is between the maximum continuous and maximum pulsed current specifications. The maximum continuous specification varies by frequency.

To determine if your measurement exceeds the Ampere-second product, you must first determine the maximum allowable pulse width or maximum allowable pulse amplitude, as described in the following section.



Maximum Allowable Pulse Width

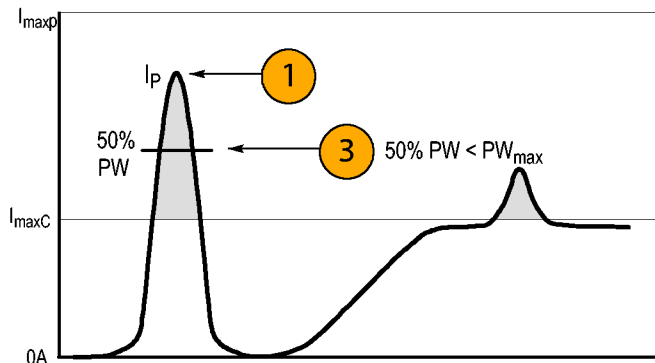
To determine the maximum allowable pulse width do the following:

1. Measure the peak current of the pulse.
2. Divide the Ampere-second (or Ampere-microsecond) specification for the probe by the measured peak current of the pulse:

$$\frac{A \cdot \mu s}{I_P} = PW_{max}$$

The quotient is the maximum allowable pulse width (PW_{max}).

3. Check that the pulse width at the 50% point of the measured signal is less than the calculated maximum allowable pulse width (PW_{max}).



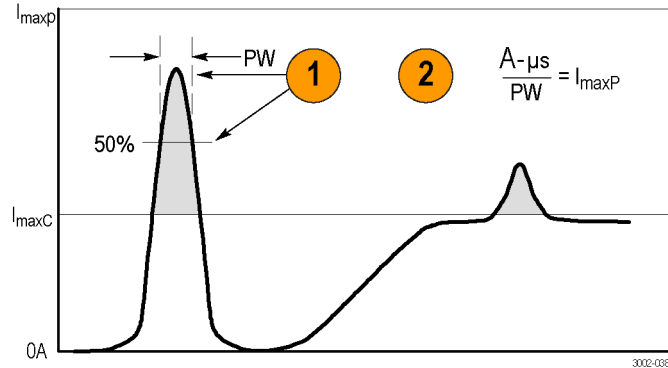
Maximum Allowable Pulse Amplitude

To determine the maximum allowable pulse amplitude do the following:

1. Measure the pulse width at the 50% points.
2. Divide the Ampere-second (or Ampere-microsecond) specification for the range setting of the probe by the pulse width.

The quotient is the maximum allowable pulse amplitude; the peak amplitude of the measured pulse must be less than this value.

For example, the P6021A probe has a maximum Ampere-second product of 500 A- μ s. If a pulse measured with the probe has a width of 11 μ s, the maximum allowable peak current would be 500 A- μ s divided by 11 μ s, or 45.5 A.



Application Examples

This section explains ways to use your probe in common troubleshooting tasks and how to extend the use of your measurement system.

Inductance Measurements

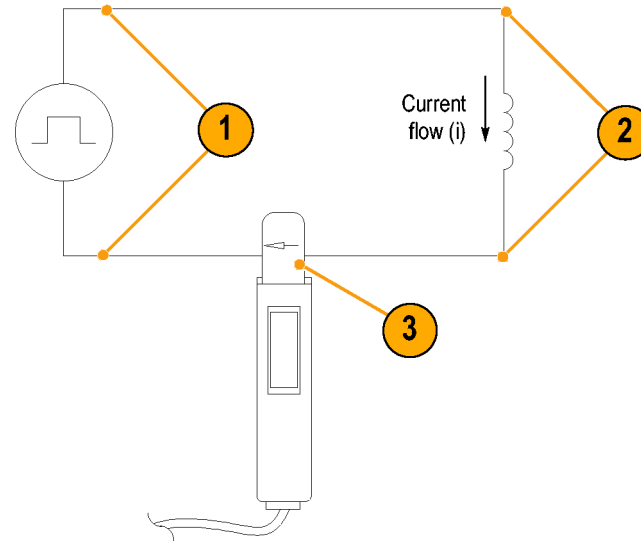
You can use the current probe to measure the inductance of coils that have either a low-impedance or high-impedance pulse source of a known value.

Low-Impedance Pulse Sources

This figure shows a constant-voltage pulse generator of extremely low output impedance connected to an inductor that has low resistance.

1. Connect the inductor across the output terminals of the pulse generator.
2. Maintain a constant voltage across the inductor.
3. Clamp the current probe over one of the source leads.

NOTE. *If the probe impedance is a significant part of the total circuit inductance, measurement accuracy will be affected. Refer to the probe specifications for probe insertion impedance.*

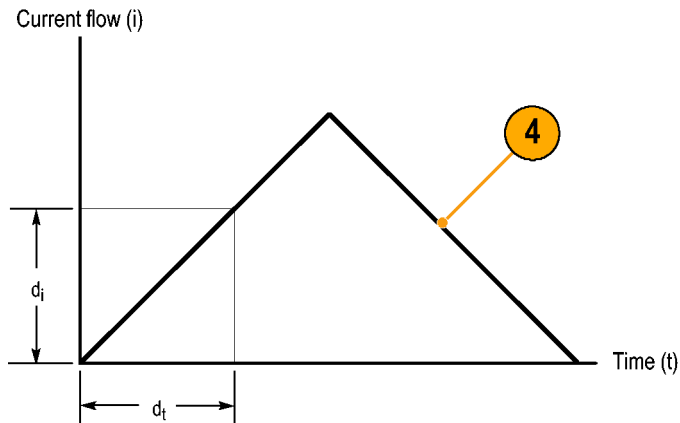


4. Measure the current ramp. The inductance is effectively defined by the slope of the current ramp shown here.
5. Calculate the inductance using the following formula:

$$L = \frac{-E}{\frac{di}{dt}}$$

where:

L is the inductance in henries,
 E is the voltage of the pulse generator,
 dt is the change in time, and
 di is the change in current.



High-Impedance Pulse Sources

If the pulse source has a higher impedance of known resistance, such that the output voltage drops as the current increases, the inductance of a coil can be calculated by the time constant of the charge curve.

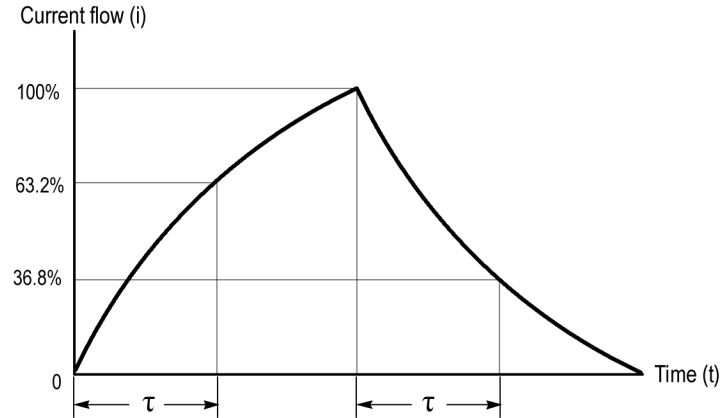
The current ramp shows how the values for the inductance formula are obtained.

Use this formula to calculate the inductance based on the current measurement:

$$L = \tau R$$

where:

L is the inductance in henries,
 τ is the time required for the current to rise or fall 63.2% of the total current value, and
 R is the source resistance of the pulse generator.



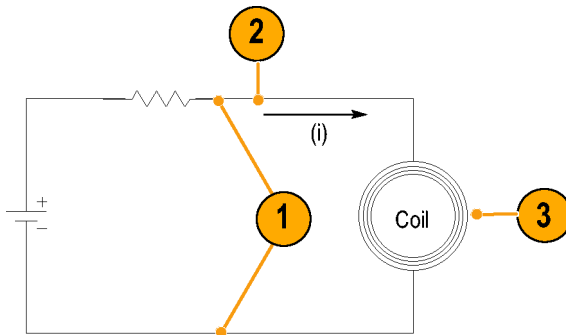
Measuring Inductor Turns Count

To obtain an approximate turns count of an inductor, do the following:

1. Connect the inductor to a current limited source, as shown.
2. Measure the input current on one of the inductor leads.
3. Clamp the current probe around the inductor and note the current value.

The number of turns is equal to the ratio of coil current to input current.

The accuracy of this method is limited by the current measurement accuracy.



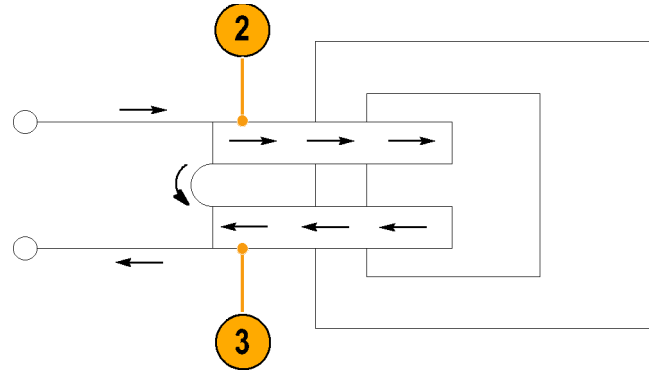
For a more precise turns count, you need a coil with a known number of turns to use as a reference. Do the following:

1. Repeat steps 1 and 2 above and make the following changes:
2. Insert the reference coil into the current probe.
3. Insert the test coil into the current probe so that the currents oppose each other as shown. You must observe the polarity of coil current to determine whether the test coil has less or more turns than the reference coil. The turns are calculated by using the formula:

$$N_2 = N_1 \times (I_m \div I_1)$$

where:

N_2 is the number of turns in the test coil,
 N_1 is the number of turns in the reference coil,
 I_m is the measured coil current, and
 I_1 is the input current.



Specifications

The specifications in Tables 1 through 5 are valid under the following conditions:

- The probe has been calibrated at an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.
- The probe is connected to a host instrument with an input impedance of $1\text{ M}\Omega$.
- The probe must have a warm-up period of at least 20 minutes and be in an environment that does not exceed the limits described. (See Table 1).

Specifications for the current probe fall into three categories: warranted, typical, and nominal characteristics.

Warranted Characteristics

Warranted characteristics describe guaranteed performance within tolerance limits or certain type-tested requirements. Warranted characteristics that have checks in the *Performance Verification* section are marked with the ✓ symbol.

Table 1: Warranted electrical characteristics

Characteristic	Description
✓ Midband accuracy	±3%
✓ Rise time (10% to 90%)	≤5.8 ns
Bandwidth (-3 dB)	2 mA/mV: 1 kHz to 60 MHz guaranteed, 450 Hz to 60 MHz typical (20 to 30 °C) 10 mA/mV: 300 Hz to 60 MHz guaranteed, 150 Hz to 60 MHz typical (20 to 30 °C)
✓ Probe time constant	2 mA/mV: >159 μs guaranteed, >355 μs typical (20 to 30 °C) 10 mA/mV: >530 μs guaranteed, >1 ms typical (20 to 30 °C)

Typical Characteristics

Typical characteristics describe typical but not guaranteed performance.

Table 2: Typical electrical characteristics

Characteristic	Description
Maximum continuous current	2 mA/mV - 5 A _{p-p} sine wave between 450 Hz and 10 MHz 10 mA/mV - 15 A _{p-p} sine wave between 150 Hz and 100 kHz
Maximum DC saturation current	0.5 A
Maximum peak pulse current	10 mA/mV range: 250 A peak 2 mA/mV range: 150 A peak not to exceed 500 A μ s, or 5 A _{RMS} (See Figure 3 on page 32.)
Insertion impedance	0.035 Ω @ 1 MHz 0.09 Ω @ 10 MHz 0.5 Ω @ 60 MHz (See Figure 2 on page 31.)
Signal delay	11.8 ns
Tilt	2 mA/mV: 2.8% or less within 10 μ s of step 10 mA/mV: 7.5% or less within 100 μ s of step
Phase response	Between $\pm 90^\circ$ from 100 Hz to 20 MHz, greater than -270° at 60 MHz

Characteristic	Description
Maximum voltage on bare wire	150 V CAT II
Maximum voltage on insulated wire	300 V CAT II
Maximum Amp·Second product	500 A· μ s (See page 17, <i>Maximum Current Limits.</i>)

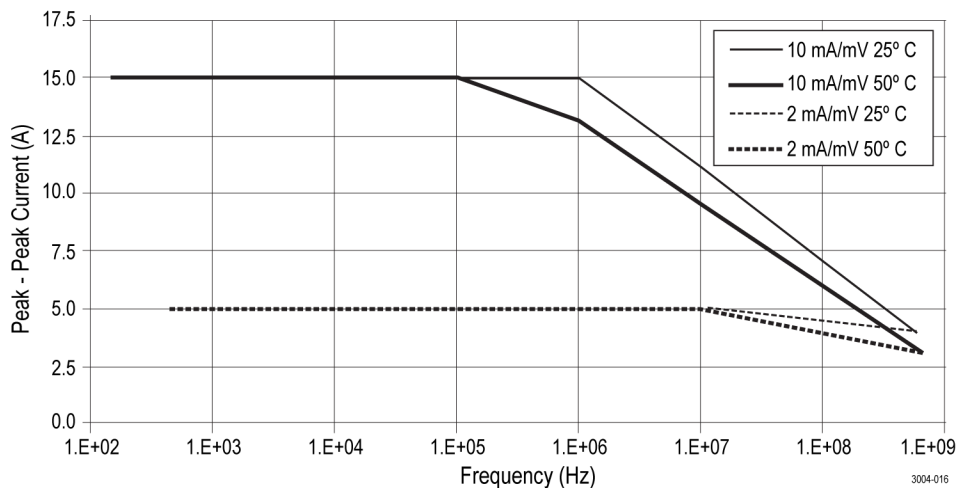


Figure 1: Frequency derating (continuous peak current versus frequency)

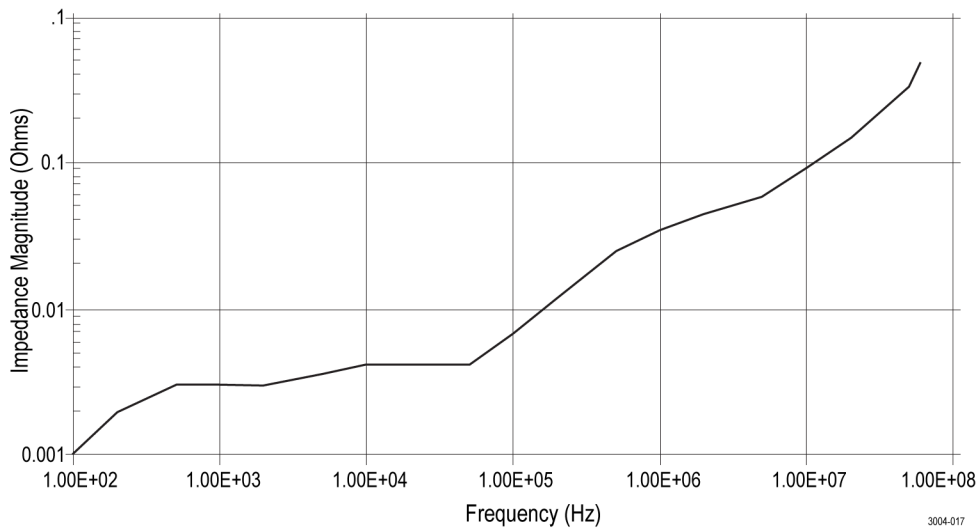


Figure 2: Typical insertion impedance versus frequency

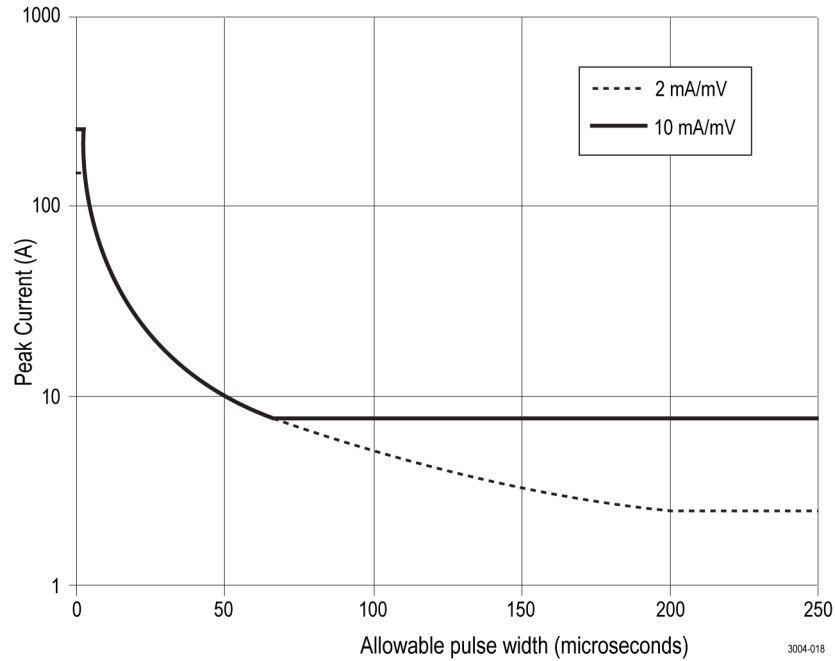


Figure 3: Maximum peak pulse versus pulse width

Table 3: Environmental characteristics

Characteristic	Description
Temperature	Operating: 0 to +50 °C (+32 to +122 °F) Nonoperating: -40 to +75 °C (-40 to +167 °F)
Humidity	Operating: 5-95% RH, tested up to +30 °C (+86 °F) 5-85% RH, tested at +30 °C to +50 °C (+86 °F to +122 °F) Nonoperating: 5-95% RH, tested up to +30 °C (+86 °F) 5-85% RH, tested at +30 °C to +75 °C (+86 °F to +167 °F)
Altitude	Operating: Up to 3000 meters (10,000 feet) Nonoperating: Up to 12,192 meters (40,000 feet)

Table 4: Typical mechanical characteristics

Characteristic	Specification
Dimensions (See Figure 4 on page 35.)	
Compensation box	73 mm × 30.5 mm × 40.6 mm (2.9 in × 1.2 in × 1.6 in)
Probe head	148 mm × 15.2 mm × 30.5 mm (5.8 in × 0.6 in × 1.2 in)
Jaw opening (maximum measurable conductor size)	5 mm (0.20 in)
Cable length (from probe head to compensation box)	1.5 m (59 in)
Unit weight	
Probe only	279 g (10.0 oz)
Probe, accessories, and packaging	700 g (1.5 lb)

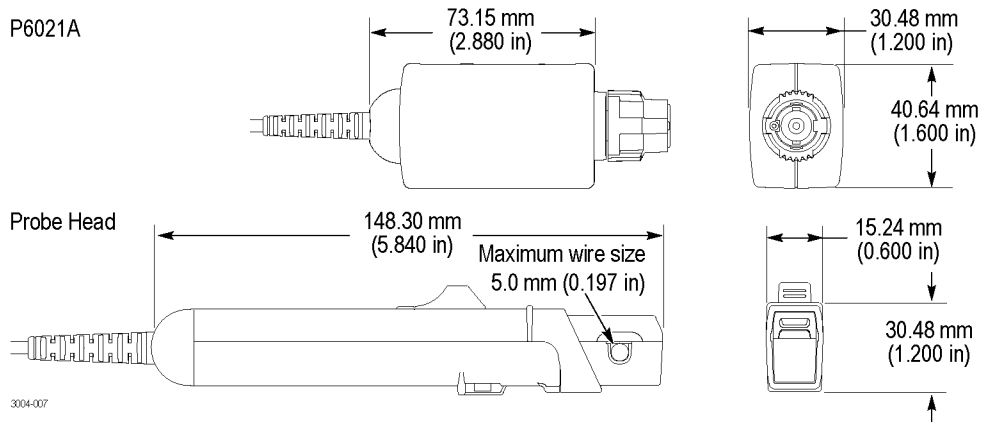


Figure 4: Mechanical dimensions

Nominal Characteristics

Nominal characteristics describe guaranteed traits, but the traits do not have tolerance limits.

Table 5: Nominal electrical characteristics

Characteristic	Description
Input coupling	AC
Current range	2 mA/mV: 5 A _{p-p} 10 mA/mV: 15 A _{p-p}
Power requirement	Supplied by host instrument
Termination	Terminate output into 1 MΩ
Oscilloscope compatibility	Oscilloscopes with a 1 MΩ BNC input

Performance Verification

The procedures that follow verify the warranted specifications of the probe, listed below. The recommended calibration interval is one year.

- Midband accuracy
- Rise time
- Bandwidth
- Time constant

Perform the following verification procedures in the order listed.

Equipment Required

Table 6 lists the equipment required for the performance verification procedure.

Table 6: Test equipment

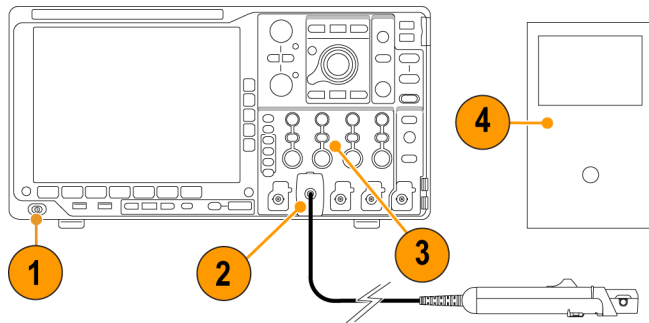
Description and quantity	Performance requirement	Recommended example ¹
Oscilloscope	TekVPI interface, 500 MHz or greater bandwidth	Tektronix DPO4000
Calibration generator	ACA: 0 to ± 1 A, 50 Hz, square wave output ACV 0 to 2 V _{RMS} , 50 kHz, sine wave output Rise time ≤ 1 ns	Fluke 9100
Digital multimeter (DMM)	≥ 2 volt range, $\geq 1\%$ accuracy	Keithley 2700
HF current loop	50 Ω $\pm 0.5\%$, BNC male connector	067-2396-xx
BNC cable (2)	50 Ω , 0.76 m (30 in) length	012-0117-xx
Test lead	Banana plugs at both ends, lead diameter not to exceed 5 mm (0.2 in)	012-0039-00
Adapter (2)	BNC-to-dual banana	103-0090-xx
Adapter	BNC-T	103-0030-xx
Adapter	SMA male-to-BNC female	015-1018-xx

¹ Nine-digit part numbers (xxx-xxxx-xx) are Tektronix part numbers

Equipment Setup

Use the following procedure to set up and warm up the equipment to test the probe.

1. Turn on the oscilloscope.
2. Connect the probe to any channel of the oscilloscope.
3. Set the oscilloscope coupling to AC.
4. Power on the remaining test equipment.
5. Allow 20 minutes for the equipment to warm up.
6. Photocopy the test record and use it to record the test results. (See page 48.)



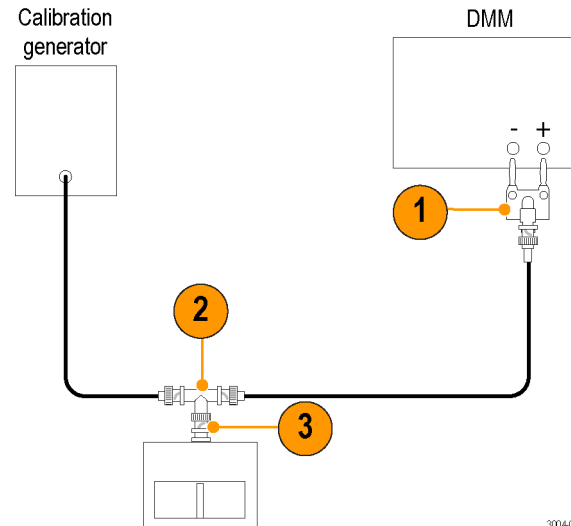
3004-020

Midband Accuracy

This test checks the midband accuracy of the probe. If the measurements are out of the specified limits in the test record, refer to the *Adjustments* section. (See page 49.)

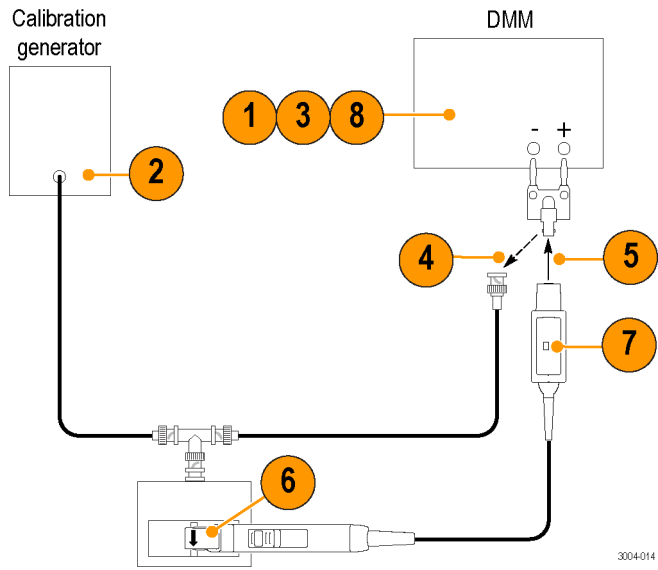
Setup

1. Connect a BNC-to-Dual Banana adapter to the digital multimeter (DMM) input.
2. Connect the Leveled Sinewave Output of the calibration generator to a BNC "T" connector and then connect the other side of the BNC "T" to the DMM input.
3. Connect the middle branch of the BNC "T" connector to the calibration fixture.



Test

1. Set the DMM to measure AC volts, on ≥ 2 volt range (or use Autoset).
2. Set the calibration generator output to $2 V_{RMS}$ @ 50 kHz, sine wave.
3. Measure the generator output on the DMM and record the output as M1. This voltage measurement is used to calculate the actual test current, I_{test} .
4. Disconnect the cable at the BNC adapter attached to the DMM.
5. Connect the probe output to the BNC adapter attached to the DMM.
6. Clamp the current probe around the calibration fixture as shown. The arrow indicator on the probe should point away from the (+) terminal of the current source.
7. Set the probe to the 2 mA/mV range.
8. Set the DMM to the 100 mV range and record the exact measurement of the DMM as M2.



3004-014

9. Compute the test current and % Error using the measured amplitude values and the formulas shown.

For example, you might measure 2.0 V for M1, which yields a test current (I_{test}), of 40 mA.

If you then measured 20.5 mV for M2, the computed % Error would result as shown.

$$I_{test} = \frac{M1}{50 \Omega}$$

$$\%Error = \frac{[(2 \text{ mA/mV} \times M2) - I_{test}]}{I_{test}} \times 100$$

Example:

$$\frac{[(2 \times 20.5 \text{ mV}) - (40 \text{ mA})]}{(40 \text{ mA})} \times 100 = 2.5\%$$

10. Record the % Error value in the Test Record.
11. Set the probe to the 10 mA/mV range.
12. Record the exact measurement of the DMM as M3.
13. Compute the % Error using the measured amplitude values and the formula shown.
14. Record the % Error value in the Test Record.
15. Disable the calibrator output.

If the computed % Error is out of the specified limit for either range, the probe may require an adjustment. (See page 49, *Adjustments*.)

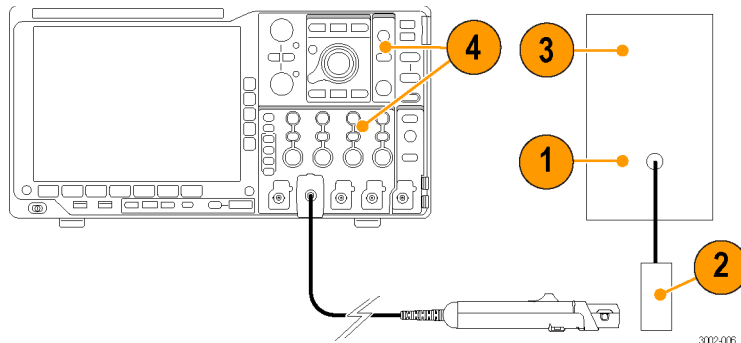
$$\%Error = \frac{[(10 \text{ mA/mV} \times M3) - I_{test}]}{I_{test}} \times 100$$

Rise Time and Bandwidth

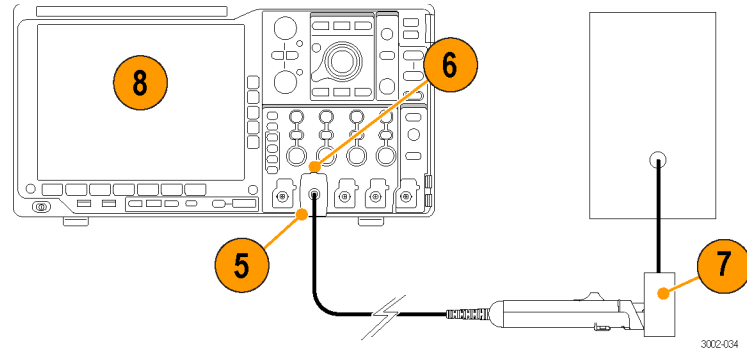
This procedure verifies that the probe meets the rise time specification by directly measuring the rise time. The high limit of the probe bandwidth is then calculated using the measured probe rise time.

Rise Time

1. Connect a BNC cable to the rear-panel signal output of the calibration generator.
2. Connect the other end of the BNC cable to the HF current loop.
3. Set the generator output to a 1.0 ns rise time pulse.
4. Set the oscilloscope to display the entire waveform on-screen:
 - Vertical sensitivity to 2 mA/div
 - Horizontal to 20 ns/div
 - Trigger at 20%
 - Averaging on (32)
 - Set Measure to Rise Time



5. Connect the probe to any channel (1–4).
6. Set the probe to the 2 mA/mV range.
7. Clamp the current probe around the HF current loop. Verify that the arrow indicator on the probe points away from the pulse generator.
8. The rise time is displayed on the oscilloscope. Record the rise time measurement in the Test Record.
9. Set the probe to the 10 mA/mV range and measure the rise time. Record the rise time measurement in the Test Record.



Bandwidth High Limit

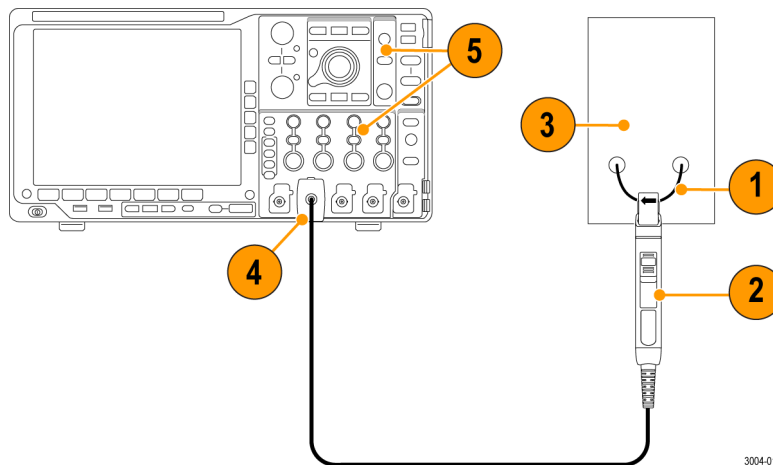
10. Calculate the high frequency limit of the probe for each range setting using the measured rise times in the formula shown:
11. Record the calculated bandwidth limit values in the Test Record.

$$BW \text{ high limit} = \frac{0.35}{t_r}$$

Time Constant

Setup

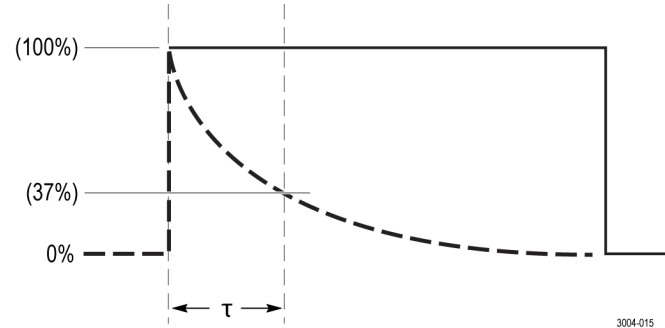
1. Connect a test lead across the + and – current output posts on the front panel of the generator.
2. Clamp the probe around the test lead on the generator output.
3. Set the generator output to 1 A_{RMS}, 50 Hz square wave.
4. Set the probe to the 2 mA/mV range.
5. Set the oscilloscope to:
 - Probe setup to current, 2X attenuation
 - Vertical sensitivity to 400 mA/div
 - Horizontal to 400 μ s/div
 - Trigger at 50%
 - Averaging on (32)
 - Set Measure to Fall Time, High Reference Level to 100%, Low Reference Level to 37%



3004-019

Test

1. Enable the generator output.
2. Use the oscilloscope cursors (shown in the figure) or the Fall Time Measurement to measure the time constant (τ), beginning from the peak of the rising edge (100%), down to the 37% amplitude level of the output waveform.
3. Record the time constant (τ) in the Test Record.
4. Calculate the low frequency limit of the probe bandwidth, using the time constant in the formula shown:
5. Record the calculated low frequency limit value for the 2 mA/mV range in the Test Record.



$$BW \text{ low limit} = \frac{1}{2\pi\tau}$$

6. Set the probe to the 10 mA/mV range.
7. Set the oscilloscope to:
 - Probe setup to current, 10X attenuation
 - Vertical sensitivity to 500 mA/div
 - Horizontal to 1 ms/div
8. Repeat steps 2 through 5 for the 10 mA/mV range.
9. Disable the generator output.

End of procedures.

Test Record

Probe Model/Serial Number:

Certificate Number:

Temperature:

RH %:

Date of Calibration:

Technician:

Performance test	Range	Minimum	Incoming	Outgoing	Maximum
Midband accuracy (% error)	2 mA/mV	-3%			+3%
	10 mA/mV	-3%			+3%
Rise time	2 mA/mV	NA			5.8 ns
	10 mA/mV	NA			5.8 ns
Bandwidth (calculated)					
High limit	2 mA/mV	60 MHz			NA
	10 mA/mV	60 MHz			NA
Low limit	2 mA/mV	NA			1 kHz
	10 mA/mV	NA			300 Hz
Time constant	2 mA/mV	159 us			NA
	10 mA/mV	530 us			NA

Adjustments

The procedures that follow describe adjustments to the probe to optimize the performance within the warranted specifications.

- Midband accuracy
- Aberrations

Prerequisites

Complete the *Performance Verification* procedures.



CAUTION. To avoid ESD damage to the probe, use an antistatic wrist strap and work at a static-approved workstation when handling the probe.

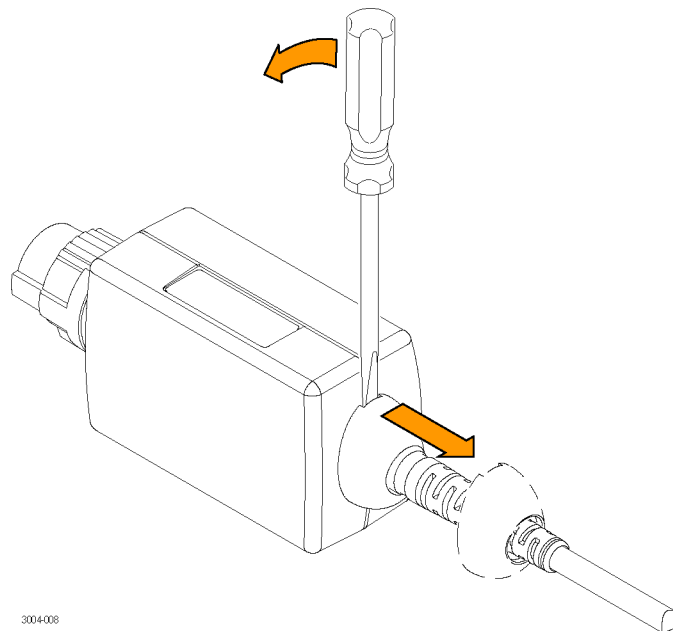
Equipment Required

Refer to the Performance Verification procedures for the equipment required. You also need a #2 flat-bladed screwdriver and an insulated, flat-bladed adjustment tool. The tool is available from Tektronix; order part number 003-1433-00.

Remove the Compensation Box Cover

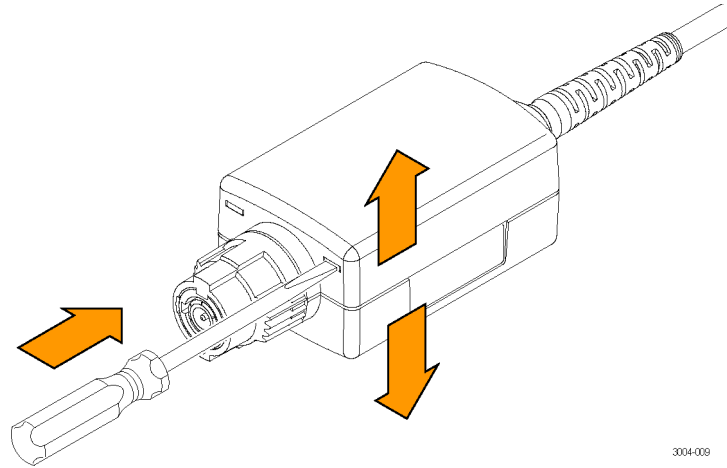
Use a #2 flat-bladed screwdriver to separate the cover halves to gain access to the adjustments:

1. Insert the screwdriver blade into the slot and gently pry the cable cover away from the compensation box.



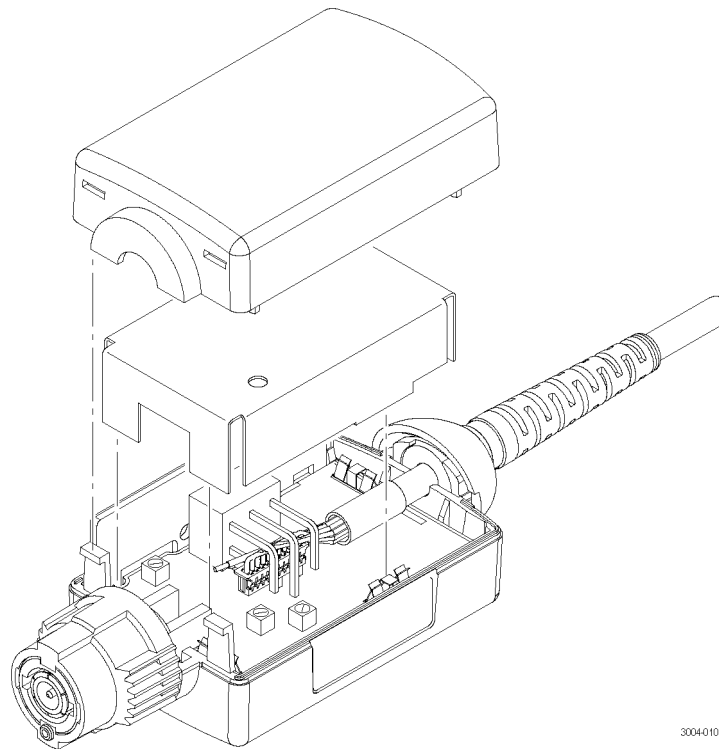
3004008

2. Use the screwdriver blade to depress each tab as you separate the cover halves.



3004-009

3. Remove the two halves and then remove the metal shield.

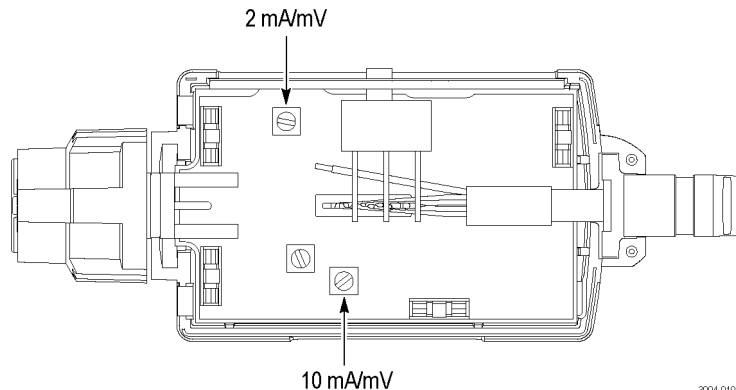


3004-010

Midband Accuracy

This procedure describes the midband accuracy adjustments for the probe. You must complete the *Midband Accuracy Test* in the *Performance Verification* procedure before making this adjustment. Keep the test setup intact to perform the adjustment.

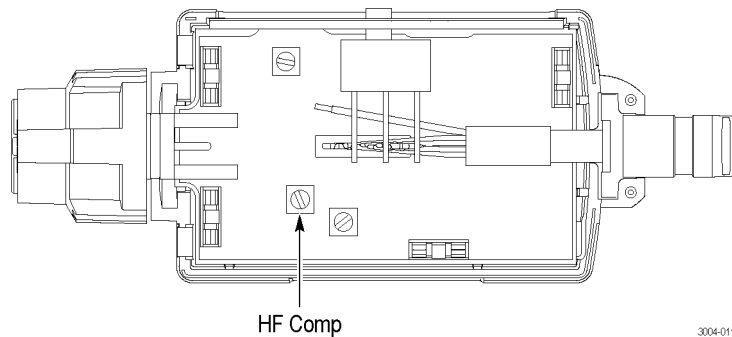
1. Set the calibrator output to $2 V_{\text{RMS}}$ @ 50 kHz.
2. Set the digital multimeter (DMM) to measure AC volts, ≥ 2.0 V range.
3. Set the probe to the 2 mA/mV range.
4. Measure the output amplitude on the DMM.
5. Adjust the 2 mA/mV control to display 20.0 mV, ± 0.6 mV on the DMM.
6. Set the probe to the 10 mA/mV range.
7. Adjust the 10 mA/mV control to display 4.0 mV, ± 0.12 mV on the DMM.
8. Disconnect the probe from the calibrator and disable the output.



3004-010

HF Compensation

1. Set up to measure rise time. (See page 43, *Rise Time and Bandwidth*.)
2. Set the probe to the 2 mA/mV range.
3. Display one waveform cycle.
4. Adjust the HF Comp control in the compensation box for the flattest response.

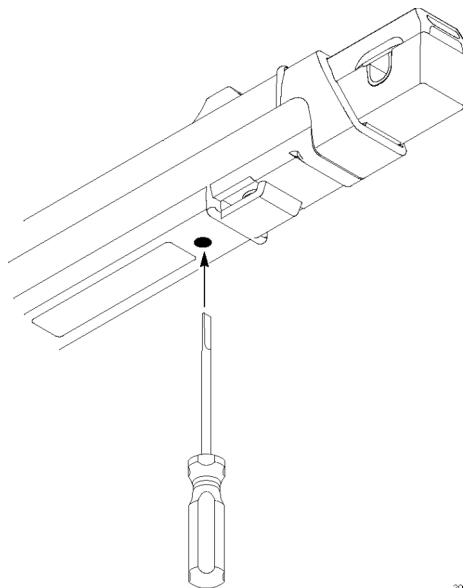


3004-011

5. Adjust the HF control in the probe head for a balance between the best rise time and flatness.

NOTE. You may need to readjust the compensation-box HF Comp adjust for optimal rise time and flatness.

6. Set the probe to the 10 mA/mV range and verify performance. If necessary, adjust the probe until risetime passes spec and flatness is acceptable in both ranges.



3002-033

Maintenance

This section contains maintenance information for your probe.

Cleaning

Protect the probe from adverse weather conditions. The probe is not waterproof.



CAUTION. *To prevent damage to the probe, do not expose it to sprays, liquids, or solvents. Avoid getting moisture inside the probe during exterior cleaning.*

Do not use chemical cleaning agents; they may damage the probe. Avoid using chemicals that contain benzene, benzene, toluene, xylene, acetone, or similar solvents.

Clean the exterior surfaces of the probe with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a soft cloth or swab dampened with a 75% isopropyl alcohol solution and rinse with deionized water. A swab is useful for cleaning narrow spaces on the probe, use only enough solution to dampen the swab or cloth. Do not use abrasive compounds on any part of the probe.

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