

TCP202A
50 MHz, 15 A AC/DC Current Probe
Instruction Manual



071-3003-00

Tektronix

TCP202A
50 MHz, 15 A AC/DC Current Probe
Instruction Manual

Revision A

www.tektronix.com
071-3003-00

Tektronix

Copyright © Tektronix. All rights reserved. Licensed software products are owned by Tektronix or its subsidiaries or suppliers, and are protected by national copyright laws and international treaty provisions.

Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specifications and price change privileges reserved.

TEKTRONIX and TEK are registered trademarks of Tektronix, Inc.

Contacting Tektronix

Tektronix, Inc.
14150 SW Karl Braun Drive
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.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

[W2 – 15AUG04]

Table of Contents

General safety summary	v
Service safety summary	viii
Compliance Information	ix
Certifications and Compliances	ix
Environmental Considerations	xii
Preface	xiii
Documentation	xiii
Conventions Used in this Manual	xiii
Returning the Probe for Servicing	xiv
Key Features	1
Connecting the Probe	2
.....	2
Degaussing the Probe	5
Probe Controls and Features	6
Compensation Box Controls	6
Probe Head Controls and Features	8

Functional Check	10
Basic Operation.....	11
Application Examples.....	13
Inductance Measurements	14
Measuring Inductor Turns Count	17
Accessories and Options	19
Optional Accessories	22
Options.....	26
Probing Principles	27
Degaussing a Probe with an Unpowered Conductor in the Jaws	27
Measuring Differential Current.....	28
Extending Current Range.....	30
Increasing Sensitivity	33
Common Mode Noise/Magnetic Field Errors.....	34
Maximum Current Limits.....	35
Specifications	39
Warranted Characteristics	39
Typical Characteristics.....	40
Nominal Characteristics	46
Performance Verification	47
Equipment Required	48
Making the DC Current Loop	49

Set up the Equipment	50
DC Gain Accuracy	51
Rise Time and Bandwidth	54
Test Record	56
Adjustments	57
Equipment Required & Setup.....	57
Adjustment Procedures.....	58
Maintenance	61
Troubleshooting.....	61
Cleaning.....	62
Index	

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.

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.

Ground the product. This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

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 6010B-2-032:2003. Particular requirements for handheld current clamps for electrical measurement and test equipment.
- UL 61010-1 (2nd Edition)- Safety requirements for Electrical Equipment for measurement, Control, and Laboratory use - Part 1: General Requirements

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).

Restriction of Hazardous Substances

This product is classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

Preface

This manual describes the installation and operation of the TCP202A 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

TCP202A Probe: First Time Operation, Functional Check, Operating Basics, Specifications, Performance Verification

In-depth oscilloscope operation, user interface help, GPIB commands

Use these documents *

Read this Instruction Manual.

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.

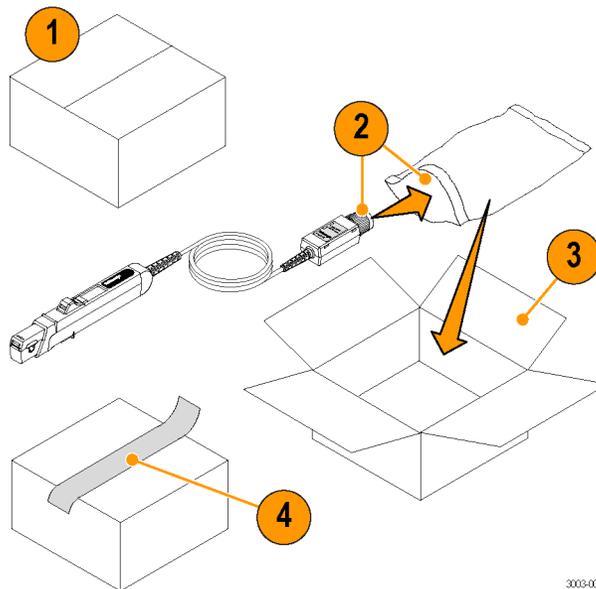


Returning the Probe for Servicing

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.

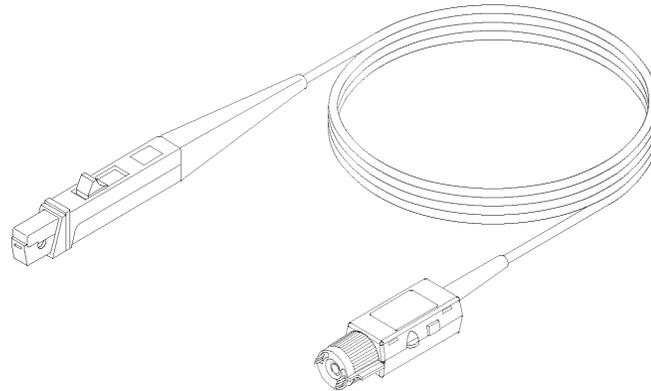


3003-003

Key Features

The TCP202A current probe can make accurate measurements from DC to 50 MHz. The probe combines proven Hall-effect technology with the Tektronix TekProbe oscilloscope interface. Key features include:

- >50 MHz bandwidth, <7.0 ns rise time
- AC/DC Measurement capability
- 3% DC Accuracy (typical)
- One-button degauss/autozeroing
- Direct scaling and unit readout on host instruments



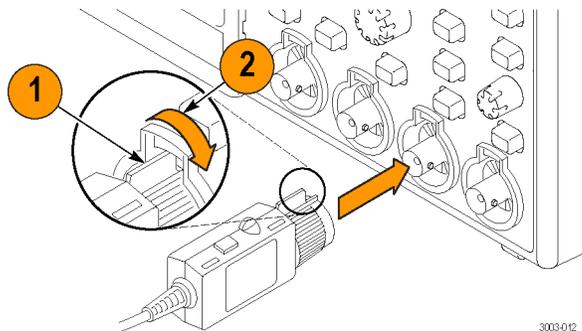
Connecting the Probe

The TCP202A current probe can be used with oscilloscopes that feature the Tektronix TekProbe and TekVPI interfaces.

Connecting to Oscilloscopes with the TekProbe Interface

The TCP202A current probe mates directly to oscilloscopes that feature the Tektronix TekProbe Interface.

1. Align the tab on the probe connector with the slot on the oscilloscope input connector and push in the connector.
2. Turn the probe connector clockwise to secure the probe to the oscilloscope.



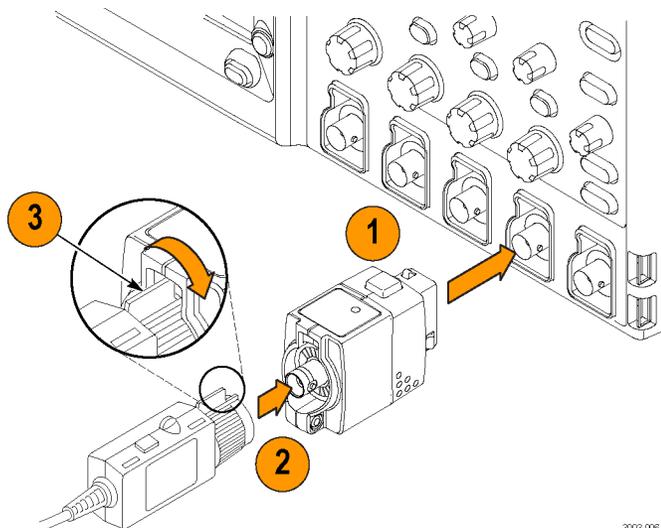
3003-012

Connecting to Oscilloscopes with the TekVPI Interface

You can also use the probe with oscilloscopes that use the Tektronix TekVPI interface, using the optional TPA-BNC Adapter shown.

The adapter allows TekVPI-interface oscilloscopes to recognize TekProbe-interface probes and to supply the necessary power, serial communication, and offset control to the probe.

1. Connect the TPA-BNC adapter to the oscilloscope. The adapter snaps in when fully engaged.
2. Connect the probe to the input of the adapter.
3. Turn the probe connector clockwise to secure it.



3003-006

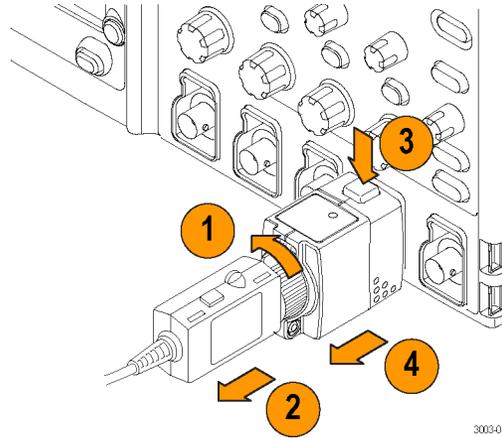
Disconnecting the Probe

To disconnect the probe:

1. Turn the probe connector counterclockwise.
2. Pull the probe away from the adapter (or instrument if directly connected).

To disconnect the adapter:

3. Press down the latch button.
4. Pull the adapter away from the instrument.



3003-014

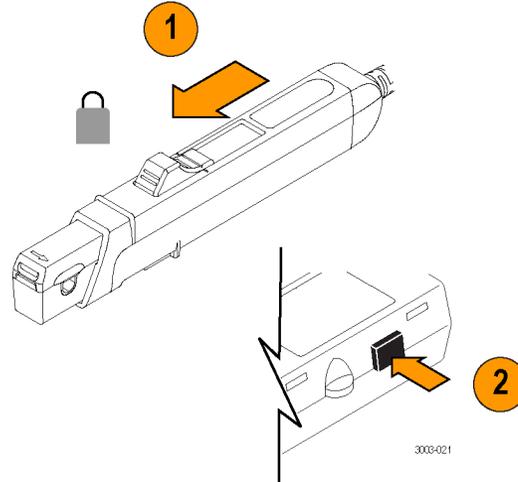
Degaussing the Probe

1. To degauss the probe, first verify that the probe jaw is fully closed.
2. Press the **DEGAUSS** button on the side of the probe.

Quick Tip

To maintain measurement accuracy, degauss your probe in each of these cases:

- After you turn on the measurement system and allow a 20-minute warm-up period
- Before you connect the probe to a conductor
- Whenever you subject the probe to a strong external magnetic field



Probe Controls and Features

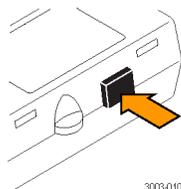
The TCP202A probe has controls in both the compensation box and at the probe head.

Compensation Box Controls

Degauss Button

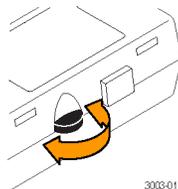
To degauss the probe, do the following:

1. Disconnect the probe from the current source.
2. Close and lock the slider.
3. Press the **DEGAUSS** button to initiate the degauss routine.



Balance Control

Rotate the **BALANCE** control to null out small DC offsets in the probe output. If the balance control cannot completely remove the DC offset, then degauss the probe.



3003-011

NOTE. *If you cannot set the DC offset to zero with the thumb wheel, a coarse balance adjustment is accessible through an opening on the underside of the probe head. (See page 9, Coarse Balance Control.)*

Probe Head Controls and Features

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.

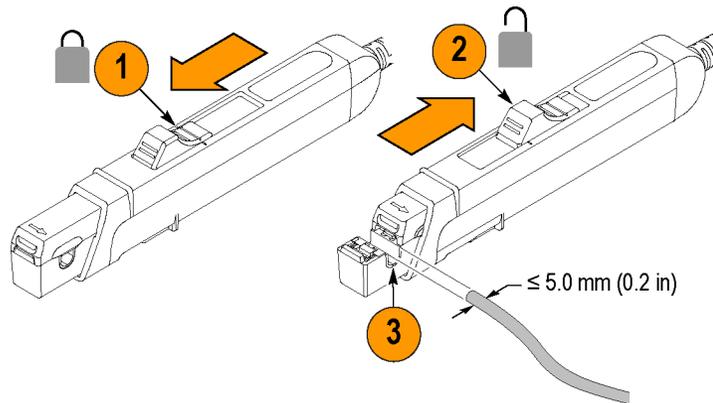


WARNING. To prevent probe damage, do not force conductors larger than 5 mm (0.2 in) diameter into the jaw.

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



CAUTION. The probe head is a precision assembly. Do not drop the probe or subject it to physical shock, strain, or sudden changes in ambient conditions. Do not insert conductors larger than 5.0 mm (0.20 in) diameter into the probe jaw. Damage to the probe may result.

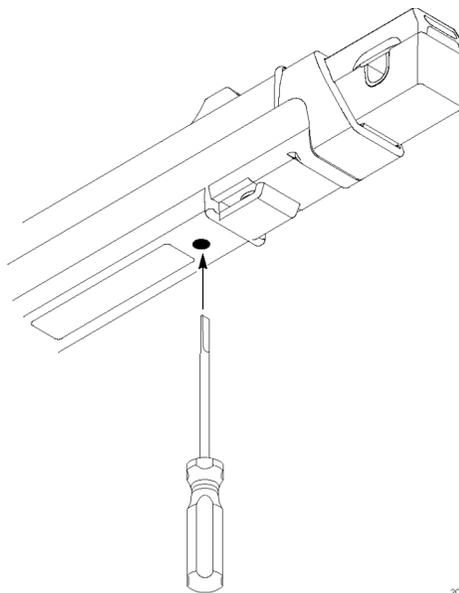


Coarse Balance Control

Use this control to adjust the probe balance when the fine-balance thumb wheel does not have enough range to zero the probe output.

The coarse balance adjustment is accessible through an opening on the underside of the probe head.

First, set the thumb wheel to the midway point, and then use an insulated, straight-edge tool on the coarse balance adjustment to set the offset to zero.



3002.033

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 47.)

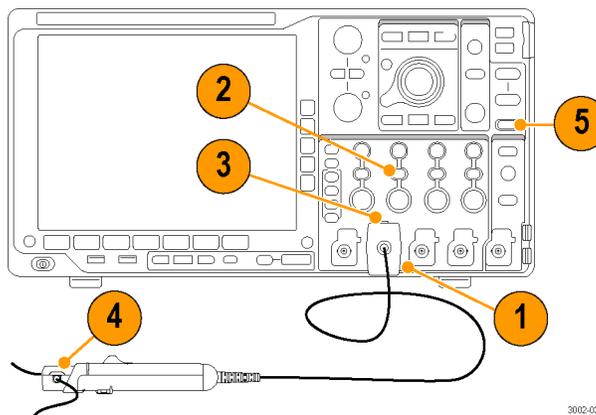


CAUTION. The probe jaw opening accommodates insulated conductors with a diameter of 5.0 mm (0.20 in) or less. Do not insert conductors larger than 5.0 mm diameter into the probe jaw. Damage to the probe may result.

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. Press the **DEGAUSS** button.
4. Clamp the probe to your circuit.
5. Adjust the oscilloscope or use the Autoset function to display a stable waveform.

When you see a stable waveform, your probe is functioning correctly.



3002-059

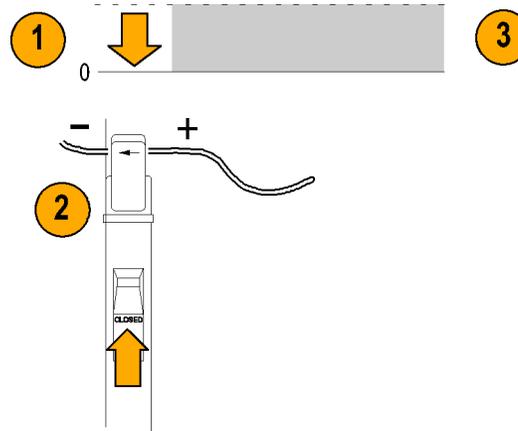
Basic Operation



CAUTION. Do not force conductors larger than 5.0 mm (0.20 in) diameter 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.

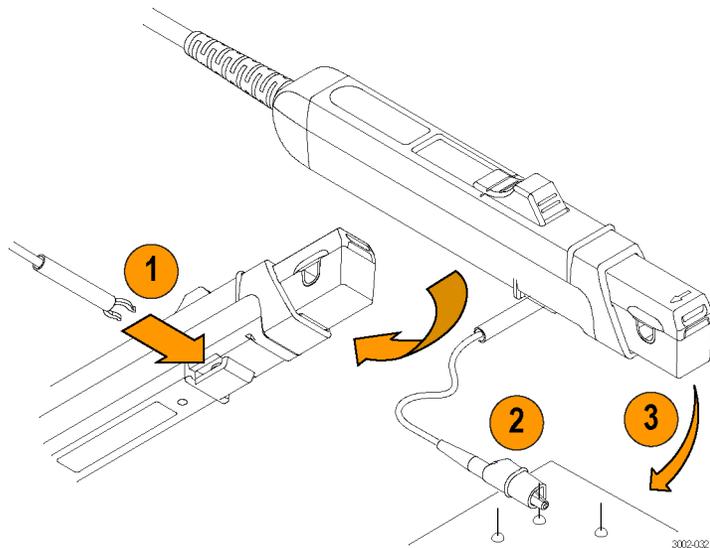
1. Check the oscilloscope display before connecting the probe to a conductor.
If there is a DC offset, degauss and zero the probe. (See page 5, *Degaussing the Probe.*)
2. Close and lock the probe jaw over the conductor.
For correct polarity reading, connect the probe so that the current flow, from positive to negative, is aligned with the arrow on the probe jaw.
3. Read the measurement on the oscilloscope display.



Grounding the Probe

Use the ground lead to improve EMI rejection at high frequencies.

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. Connect the probe to the circuit.



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

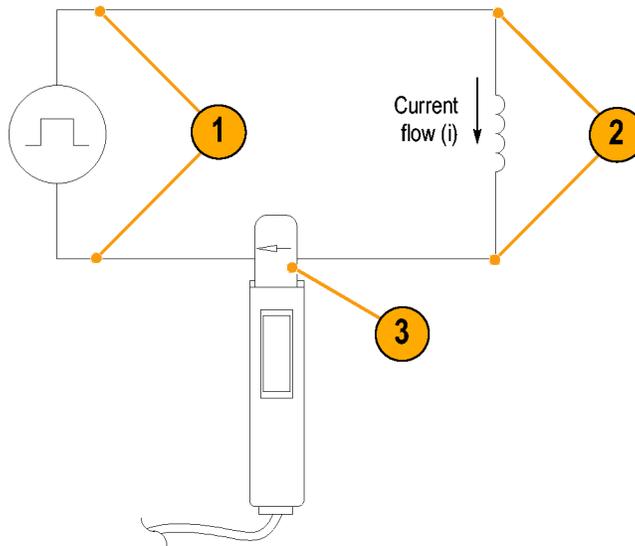
You can use the current probe to measure the inductance of coils that have either a low-impedance or high-impedance pulse source of a known value.

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.*

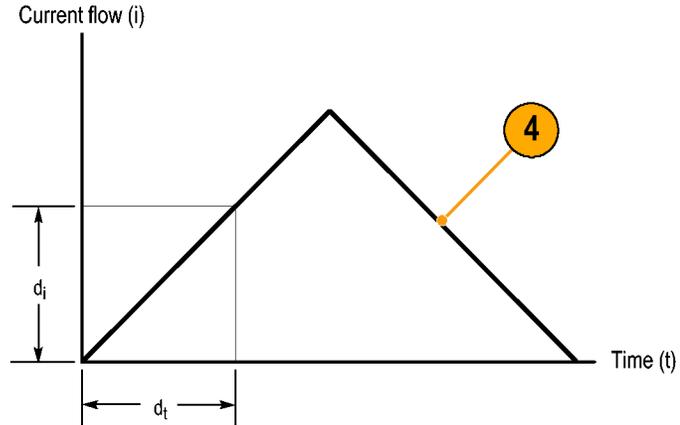


4. Measure the current ramp. The inductance is effectively defined by the slope of the current ramp shown here.
5. Calculate the inductance using the following formula:

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

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.

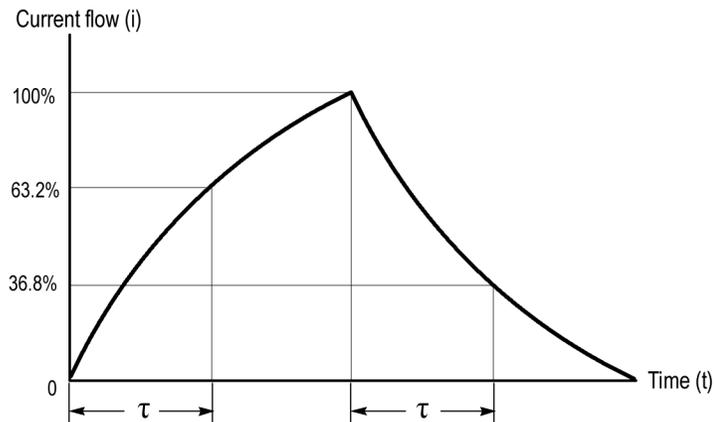
The current ramp shows how the values for the inductance formula are obtained.

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.



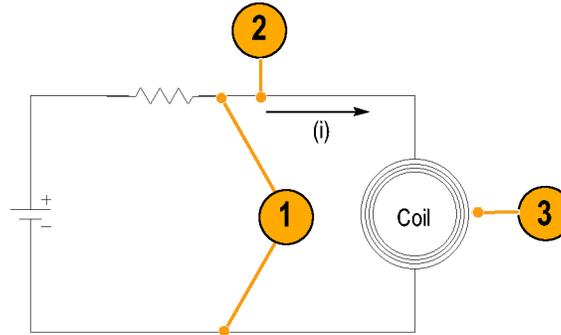
Measuring Inductor Turns Count

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.



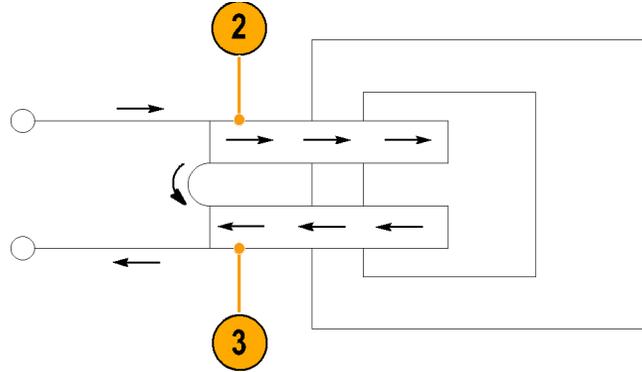
For a more precise turns count, you need a coil with a known number of turns to use as a reference. Do the following:

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.



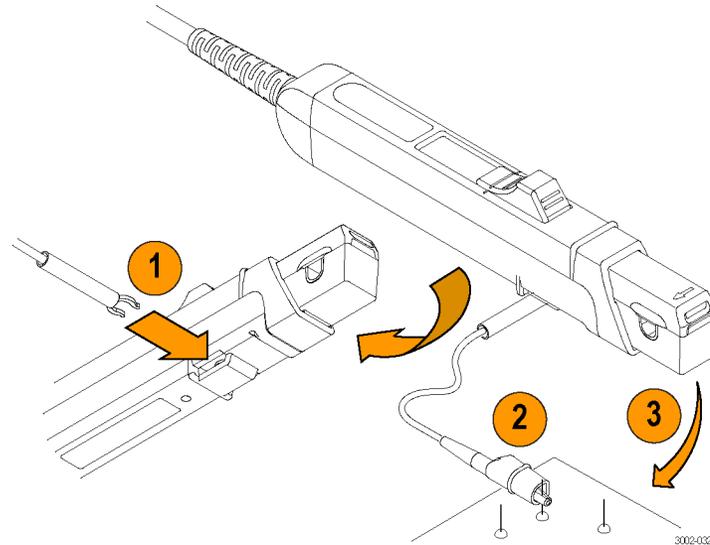
Accessories and Options

This section lists the standard accessories 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.

Probe Ground Lead

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

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

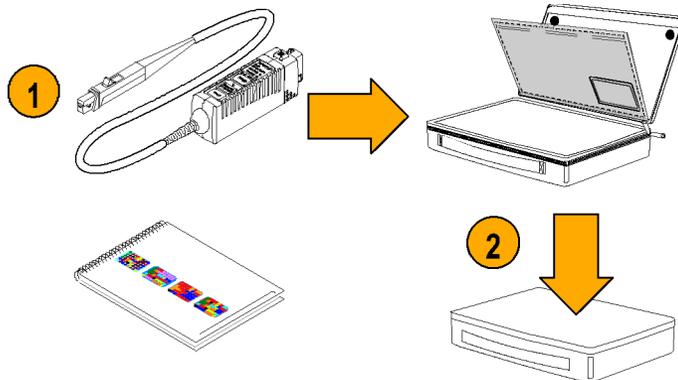


Nylon Carrying Case with Pouch and Inserts

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:
071-3003-xx

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

- Japanese
- Simplified Chinese



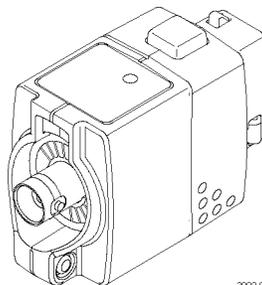
Optional Accessories

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

TPA-BNC Adapter

Use the TPA-BNC Adapter to connect the probe to oscilloscopes that use the Tektronix TekVPI interface.

The adapter allows TekVPI-interface oscilloscopes to recognize TekProbe-interface probes and to supply the necessary power, serial communication, and offset control to the probe.



3002-035



WARNING. To reduce risk of shock or fire, do not exceed the ratings of the TPA-BNC adapter; it is not intended to be connected to voltages above 30 VAC, 42 Vpk, or 60 VDC.

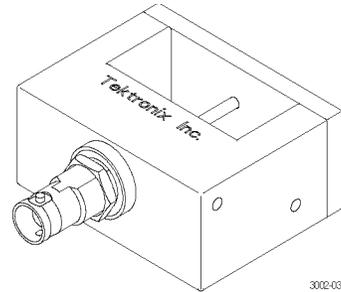
Order Tektronix part number:
TPA-BNC

HF Current Loop

Use the high-frequency, 50 Ω current loop for the performance verification procedures. The BNC connector allows for easy connections to current sources.

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

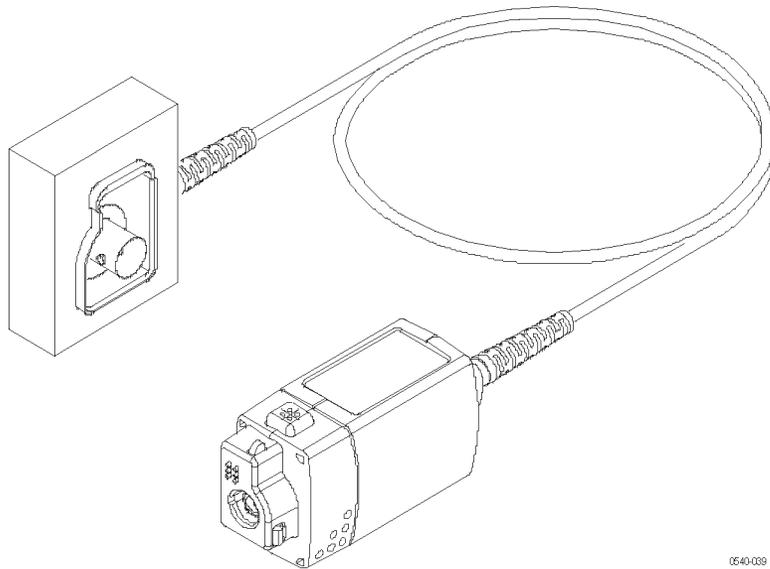
Order Tektronix part number:
067-2396-xx



TekVPI Calibration Fixture

This calibration fixture is required to complete a performance verification and gain accuracy adjustment procedures on the probe. It provides power to the probe and routes the probe output signal out through an SMA connector on the back of the fixture. The signal can then be measured with another instrument, such as a precision DMM, to check and adjust the gain accuracy of the probe.

Order Tektronix part number 067-1701-xx.

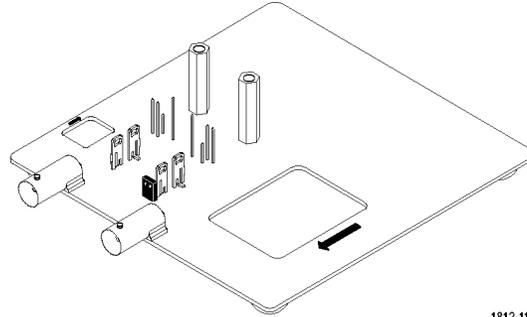


067-009

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

Probing Principles

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

Degaussing a Probe with an Unpowered Conductor in the Jaws

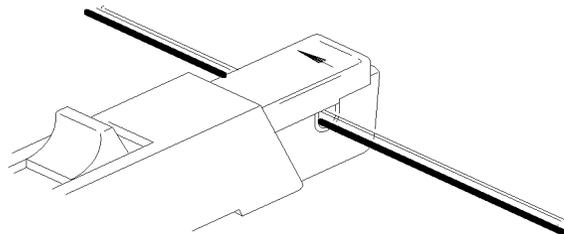
You can degauss your current probe while a conductor of an unpowered circuit is clamped in the jaws. The advantage of degaussing with an unpowered circuit is that any offset from stray DC magnetic fields is compensated. Degaussing with the conductor in the probe jaws eliminates the need to manually remove the probe.

NOTE. *Be certain that the conductor in the probe jaws is completely unpowered. Any current flowing through the conductor will cause a residual offset in the current probe and may cause an inaccurate measurement or an error condition.*

The impedance of your circuit must be higher than 10 m Ω for the degauss procedure to work. (The probe core will not saturate with a circuit impedance of less than 10 m Ω). While degauss occurs, the probe will induce a 60 mV, 200 Hz signal in the unpowered circuit. Your circuit must be able to absorb this induced voltage. With low impedance circuits, several amperes may be induced in the circuit being measured. This may be of concern when you are using very small conductors.

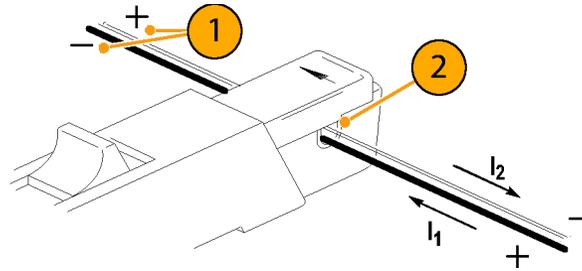
Measuring Differential Current

To simplify your differential or null current measurements, you can place two conductors in one current probe.



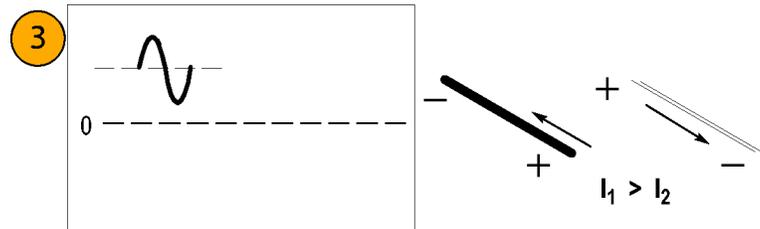
WARNING. Do not force the slide closed. Damage to the probe may result. If you cannot close the slide around the conductor(s), either reduce the number of conductors you are measuring, or, if possible, take your measurement on a smaller conductor.

1. Orient the two conductors under test so that the polarities (+ and -) oppose each other.
2. Clamp the current probe around the two conductors. Be careful not to pinch a conductor in the probe jaws.

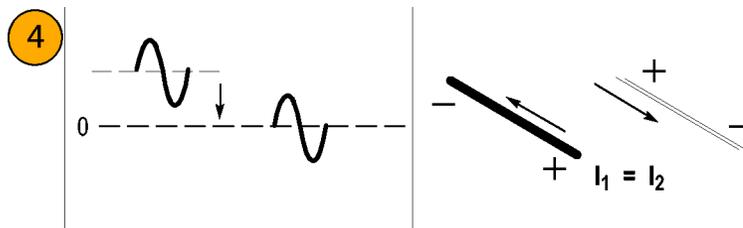


3. Measure the current.

Conventional current flows from positive to negative. A waveform above the baseline indicates that the conductor with the conventional current flow in the direction of the probe arrow is carrying the greater current.



4. To adjust for a current null, adjust the current in one of the conductors until the displayed measurement is zero.



Extending Current Range

If your measurement exceeds the maximum current rating of the connected probe, you can extend the AC and DC current ranges without exceeding specified limits by using the following methods.



WARNING. To avoid personal injury or equipment damage, do not exceed the specified electrical limits of the probe or any applicable accessories. When using multiple conductors, do not exceed current limits on either conductor.

Extending DC Range

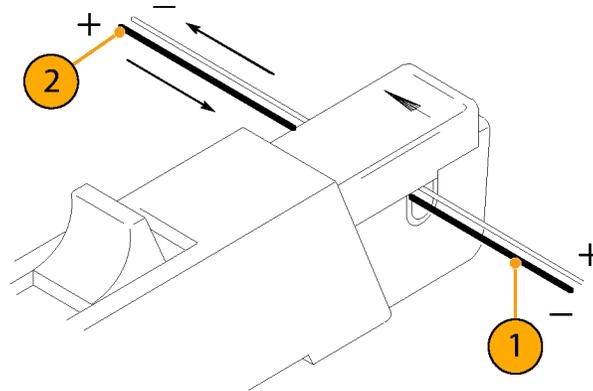
If you want to measure a low-amplitude AC component that is superimposed on an extremely large steady-state DC component (such as in a power supply), or if you want to extend the DC current range of your probe, you can add offset (bucking) current with a second conductor.



WARNING. Do not put more than one uninsulated conductor at a time in the probe jaws. An uninsulated conductor is any conductor without insulation or without insulation rated for the voltage present on the conductor under test.

To supply additional bucking current:

1. Place a second conductor that has a pure DC component of known value in the probe jaw with the conductor under test.
2. Orient the second conductor so that the bucking current flows in the opposite direction of the DC flow in the conductor under test.
3. To determine measurement values, add the value of the bucking current to the displayed measurement.



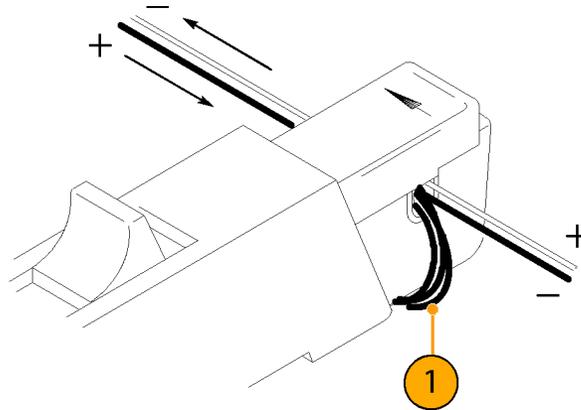
NOTE. Adding a second conductor to the probe increases the insertion impedance and reduces the upper bandwidth limit of the probe. Winding multiple turns further increases the insertion impedance, further reducing the upper bandwidth limit.

To increase the value of the bucking current:

1. Wind multiple turns of the second conductor around the probe.

The bucking current is equal to the current flowing in the conductor, multiplied by the number of turns wound around the probe.

For example, if the second conductor has a current of 100 mA DC and is wrapped around the probe five times, the DC bucking current is 100 mA multiplied by 5, or 500 mA DC.

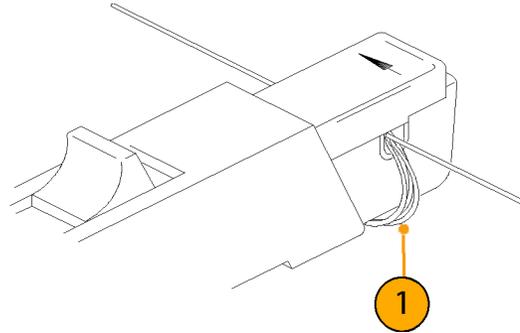


Increasing Sensitivity

If you are measuring DC or low-frequency AC signals of very small amplitudes, you can increase measurement sensitivity of your current 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. To obtain the actual current value, 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 DC, the actual current flow is 3 mA divided by 3, or 1 mA DC.

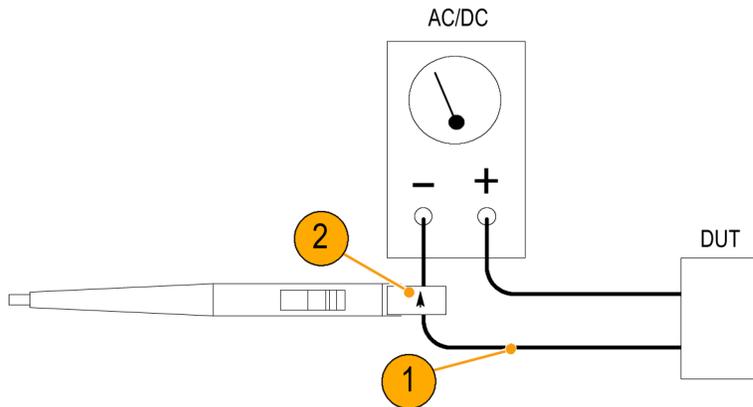


NOTE. Winding more turns around the probe increases the insertion impedance and reduces the upper bandwidth limit of the probe.

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:

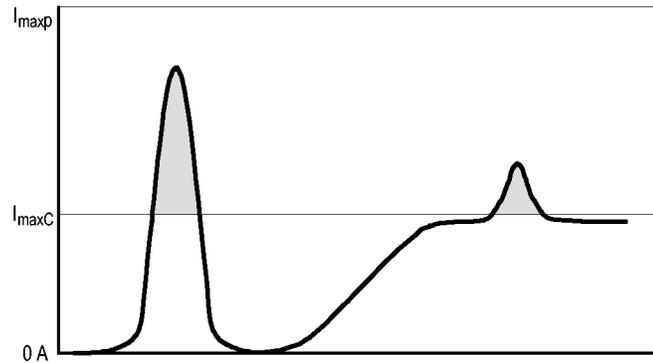
1. Measure on the low or ground side of your circuit.
2. Orient the probe to measure conventional current flow.



Maximum Current Limits

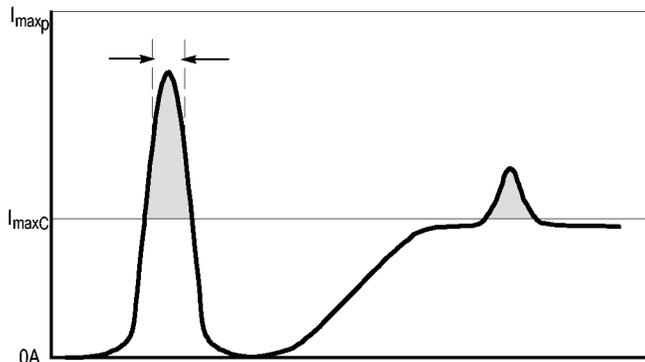
Current probes have three maximum current ratings: pulsed, continuous, and Ampere-second product. Exceeding any of these ratings can saturate the probe core, which magnetizes the core and causes measurement errors. Refer to the specifications for the maximum current ratings of the probe. (See Table 2 on page 40.)

- Maximum Pulsed Current ($I_{\max P}$) 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 ($I_{\max C}$) is the maximum current that can be continuously measured at DC or 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.



NOTE. Always degauss the probe after measuring a current that exceeds the maximum continuous current, maximum pulsed current, or Ampere-second product rating of the probe. Exceeding these ratings can magnetize the probe and cause measurement errors.

Maximum Allowable Pulse Width

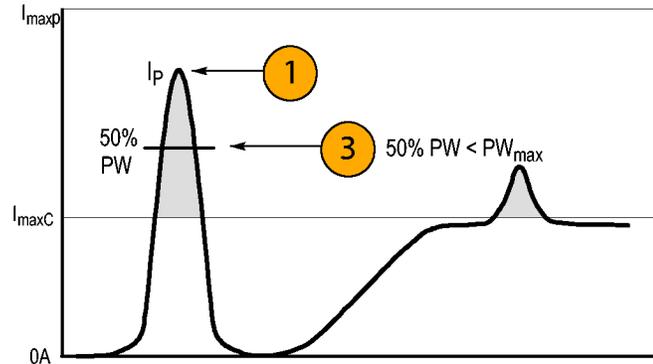
To determine the maximum allowable pulse width do the following:

1. Measure the peak current of the pulse.
2. Divide the Ampere-second (or Ampere-microsecond) specification for the range setting of the TCP202A 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}).



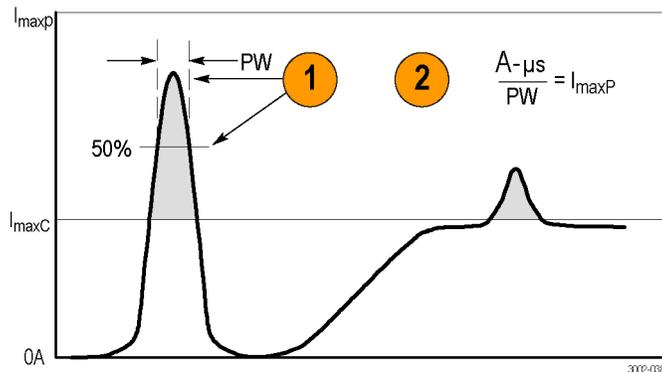
Maximum Allowable Pulse Amplitude

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 TCP202A 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 TCP202A 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.



Specifications

The specifications in the tables in this section 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 $50\ \Omega$.
- 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 TCP202A 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 have checks in the *Performance Verification* section.

Table 1: Warranted electrical characteristics

Characteristic	Description
DC gain accuracy	<3% (typical <1% at $+23\text{ }^{\circ}\text{C}$, $\pm 5\text{ }^{\circ}\text{C}$)
Rise time (10% to 90%)	$\leq 7.0\text{ ns}$
Bandwidth	DC to 50 MHz

Typical Characteristics

Typical characteristics describe typical but not guaranteed performance.

Table 2: Typical electrical characteristics

Characteristic	Description
Maximum continuous current – DC and low frequency (See Figure 3 on page 43.)	15 A DC + peak AC
Maximum peak current (See Figure 3 on page 43.)	50 A maximum peak pulse (pulse width <10 us)
Displayed RMS noise	≤2.5 mA RMS (limit measurement bandwidth to 20 MHz)
Insertion impedance	(See Figure 2 on page 42.)
Signal delay	~17 ns
Maximum voltage on bare wire	150 V CAT II
Maximum voltage on insulated wire	300 V CAT II
Maximum Amp·Second product	500 μA·s

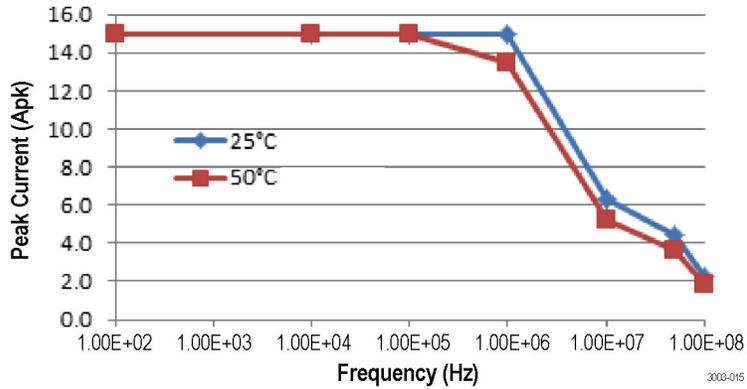


Figure 1: Frequency derating at 25 °C and 50 °C ambient temperatures

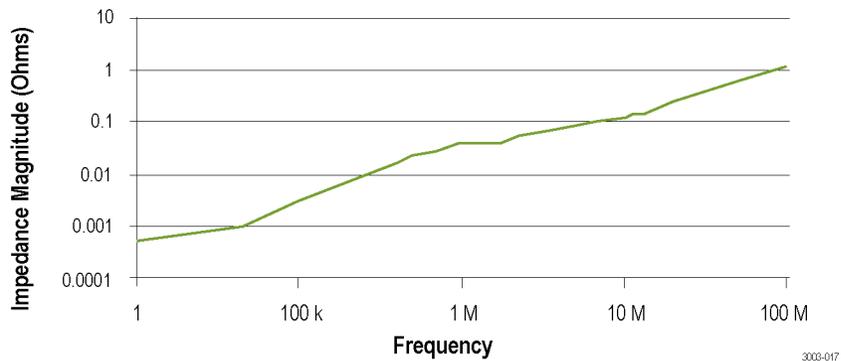


Figure 2: Typical input impedance versus frequency

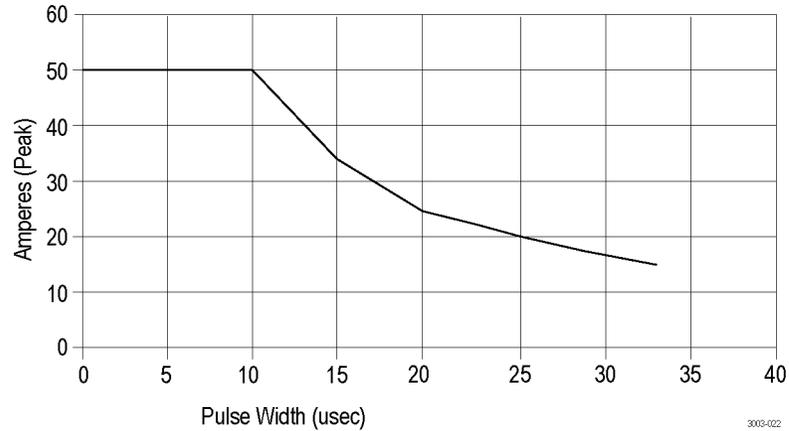


Figure 3: Maximum peak pulse versus pulse width

Table 3: Environmental characteristics

Characteristic	Description
Temperature	Operating: +5 to +50 °C (+41 to +122 °F) Nonoperating: -10 to +50 °C (+14 to +122 °F)
Humidity	Operating: 5-95% RH, tested at +30 °C to +50 °C (+86 °F to +122 °F) Nonoperating: 5-95% RH, tested at +30 °C to +60 °C (+86 °F to +140 °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	Description
Dimensions, compensation box	107 mm × 41 mm × 26 mm (4.2 in × 1.6 in × 1.0 in)
Dimensions, probe head	197 mm × 1.6 cm × 3.2 cm (7.77 in × 0.625 in × 1.25 in)
Dimensions, cable length	2 m (79 in) (from the probe head to the compensation box)
Unit weight	1.550 g (3.44 lbs) (probe, accessories, and packaging)

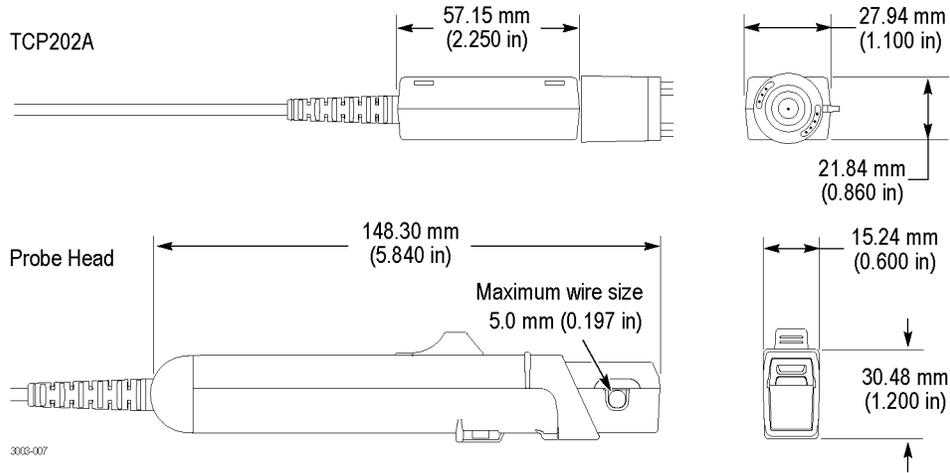


Figure 4: Probe dimensions

Nominal Characteristics

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

Table 5: Nominal electrical characteristics

Characteristic	Description
Input coupling	DC
Current range	15 A
Termination	Terminate output into 50 Ω
Compatibility	Oscilloscopes equipped with the TekProbe interface Oscilloscopes equipped with the TekVPI interface, when used with the TPA-BNC adapter (See page 22, <i>TPA-BNC Adapter</i> .)

Performance Verification

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

- DC gain accuracy
- Rise time
- Bandwidth

Perform the following verification procedures in the order listed.

Equipment Required

The equipment required for the performance verification procedures are listed below.

Table 6: Test equipment

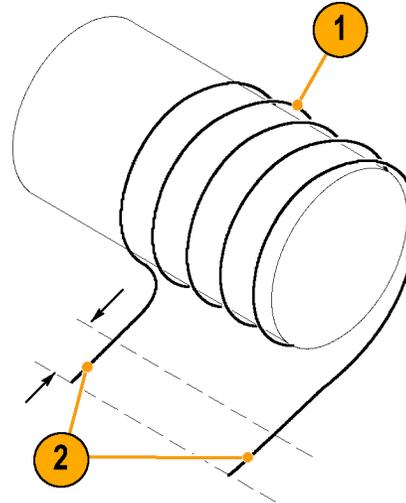
Description and quantity	Performance requirement	Recommended example ¹
Oscilloscope	TekVPI interface, 500 MHz or greater bandwidth	Tektronix DPO4000
High amplitude pulse generator	Rise time <500 ps, pulse width >100 ns, amplitude >10 V _{pp} into 50 Ω	Picosecond Labs 2600
Calibrator	DCV: 0.2% accuracy, 0 to ±1.5 V, square wave output ACA: 0.25% accuracy, 0 to ±6 A, square wave output	Fluke 9100
Digital Multimeter (DMM)	0.02% accuracy	Tektronix DMM4040/4050
Adapter	TekVPI calibration/verification adapter	067-1701-xx
Adapter	TekVPI-to-BNC interface adapter	TPA-BNC
DC current loop	5 turns 18 AWG coated wire on 3 inch form	See instructions that follow
HF current loop	50 Ω ±0.5%, BNC male	067-2396-xx
Adapter	BNC-to-dual banana plug	103-0090-xx
Adapter	SMA male-to-BNC-female	015-1018-xx
BNC cable	50 Ω, 0.76 m (30 in) length	012-0117-xx

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

Making the DC Current Loop

Construct the loop using #18 coated wire and a cylindrical form approximately 3 inches in diameter:

1. Wind *exactly* 5 turns of #18 coated wire around the form.
2. Scrape about a half-inch of coating off of the ends of the wire.

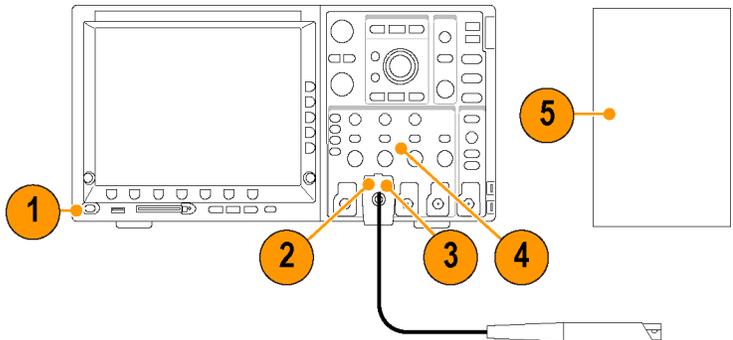


NOTE. Ensure that the current loop has exactly 5 turns. A significant error will result for each turn variance from 5 turns.

Set up the Equipment

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. Press the **DEGAUSS** button.
4. Set the oscilloscope coupling to DC.
5. Power on the current source and the pulse generator.
6. Allow 20 minutes for the equipment to warm up.
7. Photocopy the test record and use it to record the test results. (See page 56.)

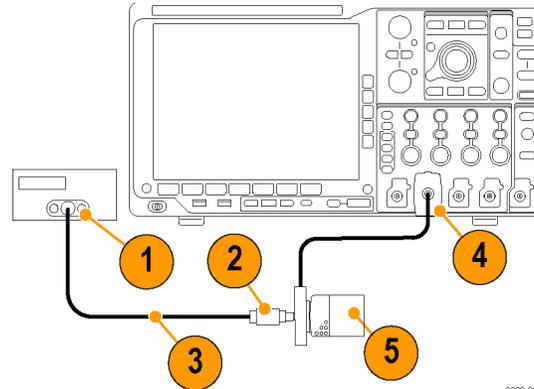


DC Gain Accuracy

This test checks the DC gain accuracy of the probe. If the measurements are out of the specified limits in the test record, refer to the *Adjustments* section. (See page 57.)

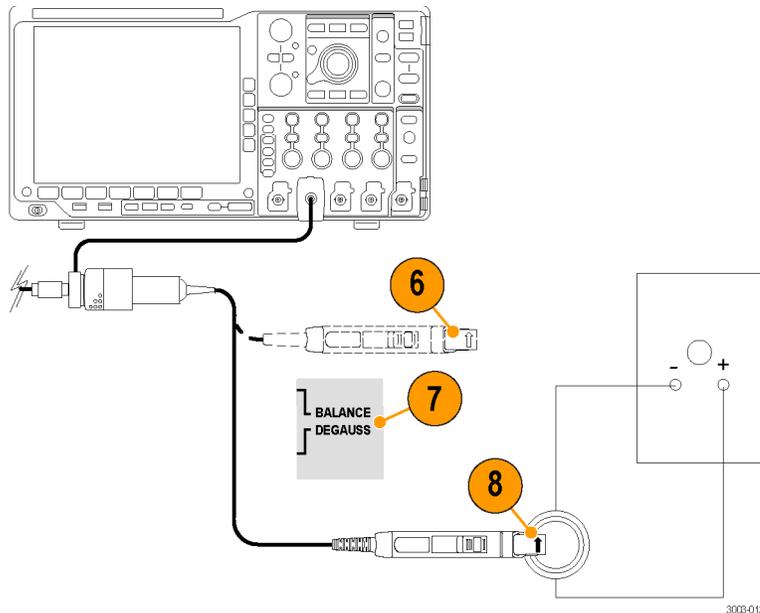
1. Connect a BNC-to-Dual Banana adapter to the digital multimeter (DMM) input.
2. Connect the SMA M-to-BNC-F adapter to the SMA output of the TekVPI Calibration/Verification adapter.
3. Connect the BNC cable between the BNC adapter on the TekVPI Calibration/Verification adapter and the BNC adapter attached to the DMM.
4. Connect the TekVPI Calibration/Verification adapter to any channel (1–4) of the oscilloscope.
5. Connect the TPA-BNC adapter to the TekVPI Calibration/Verification adapter.

NOTE. *The adapters are only used to supply power to the probe; measurements are taken on the DMM.*



3000-020

6. Connect the probe to the TPA-BNC adapter and then make sure that the probe jaw is in the locked position.
7. Degauss the probe by pressing the **DEGAUSS** button.
8. Connect the 5-turn current loop to the current source, and then clamp the current probe around the 5-turn current loop as shown. The arrow indicator on the probe should point away from the (+) terminal of the current source.
9. Set the current source output to +0.50 A.
10. Set the DMM to measure DC volts, on ≥ 2 volt range (or use Autoset).
11. Enable the output of the current source.



12. Record the exact measurement of the DMM as M1.
13. Set the current source output to -0.50 A.
14. Record the exact measurement of the DMM as M2.

15. Compute the % Error using the measured amplitude values and the formula shown.
For example, you might measure values of 0.250 V for M1 and -0.255 V for M2. With an expected output voltage (V_e) of 0.250 V, compute the % Error as shown.

16. Record the computed %Error values in the Test Record.
17. Disable the calibrator output.

Test current = ± 2.500 A (± 0.50 A source output x 5 coil turns)
Expected output voltage (V_e) = 0.250 V

$$\%Error = \frac{[(M1 - M2) - 2 V_e]}{2 V_e} \times 100$$

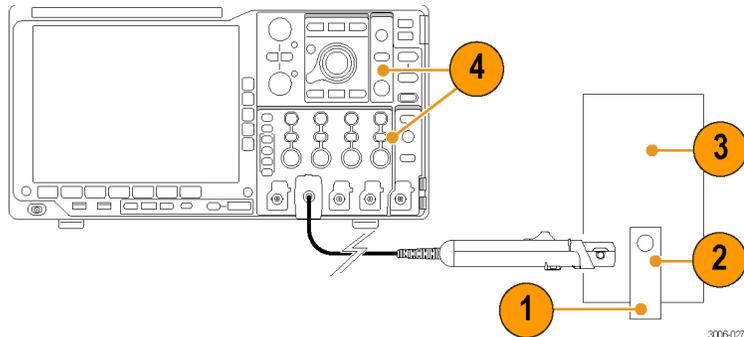
Example:

$$\frac{[(0.250 V - (-0.255 V)) - 2 (0.25 V)]}{0.50 V} \times 100 = 1.0\%$$

Rise Time and Bandwidth

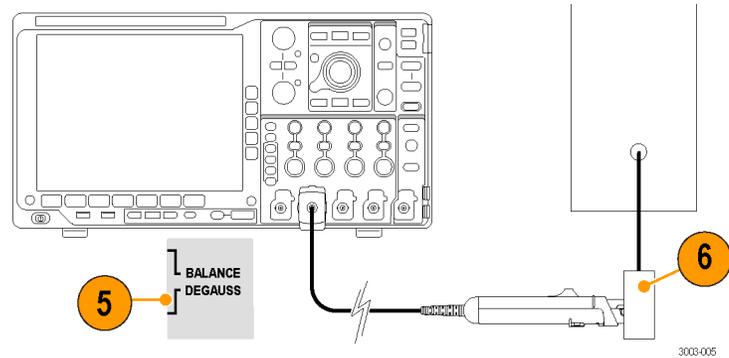
This procedure verifies that the probe meets the rise time specification. The bandwidth of the probe is then calculated using the measured probe rise time.

1. Connect the BNC cable to the output of the pulse generator.
2. Connect the other end of the BNC cable to the HF current loop.
3. Set the pulse generator output and pulse width to maximum.
4. Set the oscilloscope:
 - Vertical sensitivity to 200 mA/div
 - Horizontal to 20 ns/div
 - Trigger at 50%
 - Averaging on (32)
 - Coupling to DC
 - Automeasurement to Rise Time



5. Connect the probe to any channel (1–4) of the oscilloscope, and then degauss the probe.
 6. Clamp the current probe around the HF current loop. Verify that the arrow-shaped indicator on the probe points away from the pulse generator.
 7. Record the rise time measurement in the Test Record.
 8. Calculate the probe bandwidth using the measured rise time in the following formula:

$$BW = \frac{0.35}{t_r}$$
 9. Record the calculated bandwidth value in the test record.
- End of procedures.



Test Record

Probe Model/Serial Number:

Certificate Number:

Temperature:

RH %:

Date of Calibration:

Technician:

Performance test	Expected output	Minimum	Incoming	Outgoing	Maximum
DC gain accuracy	0.250 V	0.2425 V			0.2575 V
Rise time	<7.0 ns	NA			7.0 ns
Bandwidth	>50 MHz	50 MHz			NA

Adjustments

The procedures that follow describe adjustments to the probe to bring the DC gain accuracy performance within the warranted specifications.

Equipment Required & Setup

Refer to the equipment list and the DC gain accuracy procedure in the *Performance Verification* to set up the equipment. You also need the tools listed below to complete the adjustments.

Table 7: Adjustment tools

Item	Description	Tektronix part number
Release tool	Compensation box cover removal tool	003-1383-xx
Adjustment tool	Insulated, slotted (straight) head	003-1433-xx



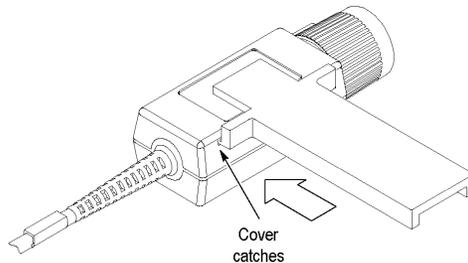
CAUTION. To avoid ESD damage to the probe, use an antistatic wrist strap and work at a static-approved workstation when handling the probe

Adjustment Procedures

You must first remove the cover from the compensation box to access the gain adjustment.

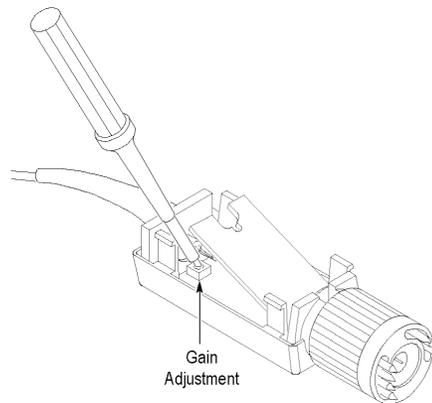
Removing the Compensation Box Cover

1. Press the release tool pins into the compensation box cover catches and gently lift the cover off a small distance.
2. Hold the open edge apart, and use the tool to open the other side of the compensation box.
3. With both sides of the box open, gently separate the two halves of the compensation box.



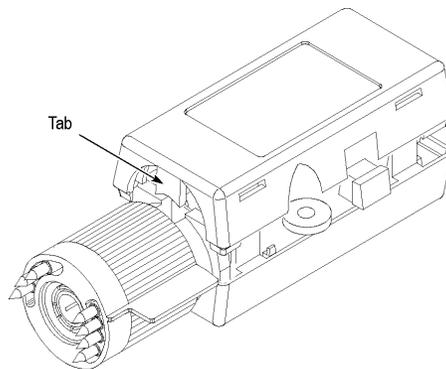
Adjusting the Gain

1. Carefully lift the back edge of the circuit board to access the gain adjustment.
2. Set up the probe for the DC accuracy test. (See page 51, *DC Gain Accuracy*.)
3. Set the current source output to +0.50 A.
4. Adjust the probe output to 250 mV, ± 5 mV.
5. Disconnect the probe from the setup.



Replacing the Compensation Box Cover

1. Align the TekProbe interface and the strain relief notches with the tabs on the cover.
2. Press the catches of the cover in and lower the cover.
3. Slide the tab into the notch.
4. Firmly press the pieces together until the cover catches snap into place.



Maintenance

This section contains maintenance information for your probe.

Troubleshooting

The TCP202A current probe is designed to work with all oscilloscopes equipped with the TekProbe interface, and with the TekVPI interface when used with the TPA-BNC adapter. If some of the probe functions do not work properly, an error condition may exist, and the oscilloscope may alert you to the error or status conditions affecting the probe. See the following table.

Table 8: Probe troubleshooting

Symptom	Possible cause
The oscilloscope does not display a current measurement from the probe	<p>The conductor jaw is not fully closed: Close the jaw completely.</p> <p>The oscilloscope channel that the probe is connected to may not be selected. Check your connections and oscilloscope settings.</p> <p>The oscilloscope channel may be bad: Try another channel or another oscilloscope.</p> <p>If the probe functions correctly on another channel or oscilloscope, the contacts on the input channel that exhibits the problem may need to be cleaned. Refer to your oscilloscope manual for the proper cleaning procedure.</p> <p>If the probe does not work on another channel or oscilloscope, the probe is defective, and must be returned to Tektronix for repair.</p>
An error message displays on the oscilloscope	The message will describe the cause and solution. For example, if the <i>Probe degauss needed</i> message appears, perform the degauss procedure.

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 benzine, 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.

Index

A

- Accessories
 - optional, 19, 22
- Adjustments, 57
- Amp-second product, 36
- Application examples, 13

B

- Basic operation, 11
- Bucking current, 30

C

- Cleaning, 62
- Common mode noise, 34
- Connect the probe, 2
- Current limitations
 - amp-second product, 36
 - maximum continuous, 35
 - maximum pulsed, 35
- Current loop, 49

D

- DC
 - gain accuracy check, 51
- Degaussing, 5
 - while connected to a conductor, 27
- Differential current, 28
- Documentation, xiii

E

- Equipment required
 - adjustments, 57
 - performance verification, 48
- Equipment setup, 50
- Extending the current range of the probes, 30

F

- Features, 1
- Frequency derating, 35
- Functional check, 10

G

- Grounding the probe, 12

I

- Increasing bucking current, 30
- Increasing probe sensitivity, 33
- Indicators, 6

J

- Jaw, 8

M

- Magnetic field errors, 34
- Maintenance, 61
- Maximum
 - allowable pulse amplitude, 38
 - allowable pulse width, 37
 - continuous current rating, 35
 - pulsed current rating, 35
- Measuring current
 - current nulls, 28
 - differential current, 28

N

Null current, 28

O

Options, 26

P

Performance verification, 47

Probe

- connecting, 2
- controls and indicators, 6
- extending the current range, 30
- grounding, 12

- increasing the current limit, 30
- maximum current limits, 35
- saturation, 35

R

- Record, test, 56
- Related documentation, xiii
- Rise time check, 54

S

- Safety Summary, v
- Service options, 26
- Slider and conductor jaw, 8

- Specifications, 39
 - environmental, 44
 - mechanical, 44
 - nominal, 46
 - typical, 40
 - warranted, 39

T

- TekVPI, 3
- Test record, 56
- Troubleshooting, 61