

TCP0020 & TCP2020
50 MHz, 20 Amp AC/DC Current Probes
Instruction Manual



071-3002-00

Tektronix

TCP0020 & TCP2020
50 MHz, 20 Amp AC/DC Current Probes
Instruction Manual

Revision A

www.tektronix.com
071-3002-00

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	ix
Compliance Information	x
EMC Compliance	x
Certifications and Compliances	xii
Environmental Considerations.....	xv
Preface.....	xvii
Documentation	xvii
Conventions Used in This Manual.....	xvii
Returning the Probe for Servicing	xviii
Key Features	1
Installation	3
Degaussing the Probes.....	5
Controls and Indicators.....	8
Probe Head	8
TCP0020 Probe	10
TCP2020 Probe.....	20

Functional Check	24
Accessories and Options	25
Standard Accessories	26
Optional Accessories	29
Options	31
Basic Operation	32
Probing Principles	34
Degaussing a Probe with an Unpowered Conductor in the Jaws	34
Measuring Differential Current	35
Extending Current Range	37
Increasing Sensitivity	40
Common Mode Noise/Magnetic Field Errors	41
AC and DC Coupling	42
Maximum Current Limits	43
Application Examples	47
Inductance Measurements	48
Measuring Inductor Turns Count	51
Specifications	53
Warranted Characteristics	53
Typical Characteristics	54
Nominal Characteristics	60

Performance Verification	61
Equipment Required	62
Making the DC Current Loop	63
Equipment Setup.....	64
DC Gain Accuracy	65
Rise Time and Bandwidth	69
Test Record	71
Adjustments.....	72
Prerequisites	72
DC Gain Accuracy	73
Maintenance	74
Troubleshooting.....	74
Cleaning.....	76
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.

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

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

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.

Power disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

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.

Use proper AC adapter. Use only the AC adapter specified for this product.

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 EMC (electromagnetic compliance), safety, and environmental standards with which the instrument complies.

EMC Compliance

EC Declaration of Conformity – EMC (Applies Only to the TCP2020 Probe)

Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326-1 2006. EMC requirements for electrical equipment for measurement, control, and laboratory use.^{1 2 3}

- CISPR 11:2003. Radiated and conducted emissions, Group 1, Class A
- IEC 61000-4-2:2001. Electrostatic discharge immunity
- IEC 61000-4-3:2002. RF electromagnetic field immunity
- IEC 61000-4-4:2004. Electrical fast transient / burst immunity
- IEC 61000-4-5:2001. Power line surge immunity
- IEC 61000-4-6:2003. Conducted RF immunity
- IEC 61000-4-11:2004. Voltage dips and interruptions immunity⁴

EN 61000-3-2:2006. AC power line harmonic emissions

EN 61000-3-3:1995. Voltage changes, fluctuations, and flicker

European contact.

Tektronix UK, Ltd.
Western Peninsula
Western Road
Bracknell, RG12 1RF
United Kingdom

- 1 **This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.**
- 2 **Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.**
- 3 **For compliance with the EMC standards listed here, high quality shielded interface cables should be used.**
- 4 **Performance Criterion C applied at the 70%/25 cycle Voltage-Dip and the 0%/250 cycle Voltage-Interruption test levels (IEC 61000-4-11).**

Australia / New Zealand Declaration of Conformity – EMC

Complies with the EMC provision of the Radiocommunications Act per the following standard, in accordance with ACMA:

CISPR 11:2003. Radiated and Conducted Emissions, Group 1, Class A, in accordance with EN 61326-1:2006 and EN 61326-2-1:2006.

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 TCP0020 & TCP2020 current probes. 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 *

TCP0020 & TCP2020 Probes: 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.

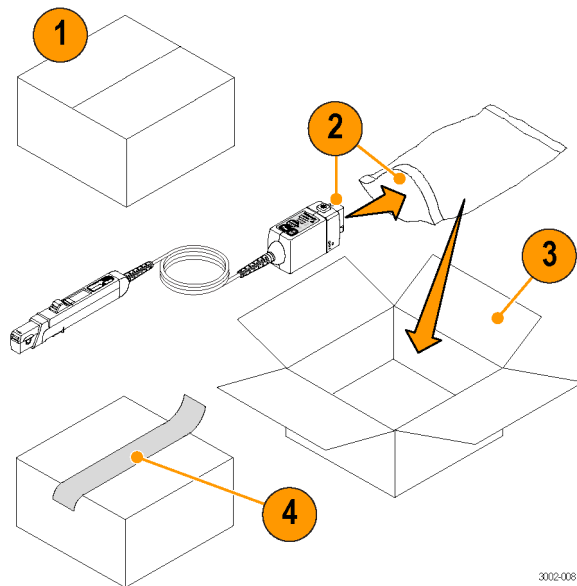


Returning the Probe for Servicing

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.



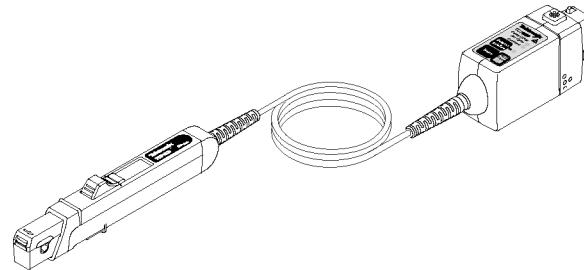
3002-008

Key Features

Use the TCP0020 & TCP2020 current probes to make accurate measurements from DC to 50 MHz. The probes combine proven Hall-effect technology with the Tektronix TekVPI oscilloscope interface. Key features include:

TCP0020 Current Probe

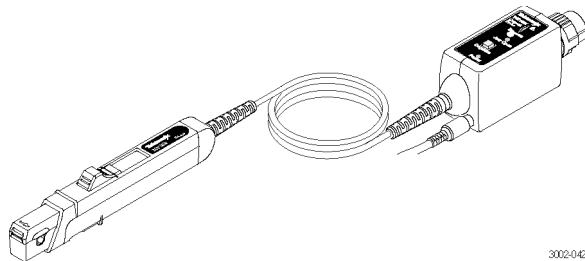
- AC coupling (on TekVPI oscilloscopes that support AC coupling)
- 10 mA sensitivity (on TekVPI oscilloscopes that support the 1 mV/div setting)
- 100 A peak pulse current (pulse widths <math><10 \mu\text{s}</math>)
- Direct scaling and unit readout on host instruments
- Probe control through the TekVPI oscilloscope menus or remotely through the oscilloscope
- 150V CAT II (Bare wire), 300V CAT II (Insulated wire)



3002-041

TCP2020 Current Probe

- >50 MHz bandwidth, <7 ns rise time
- AC/DC measurement capability
- 20 A RMS continuous rating (de-rated with frequency)
- 100 A peak pulse current (pulse widths <10 μ s)
- 1% DC accuracy (typical)
- One-button degauss
- 150V CAT II (Bare wire), 300V CAT II (Insulated wire)
- External power supply allows use on any 1 M Ω -input measuring instrument



3002-042

Installation

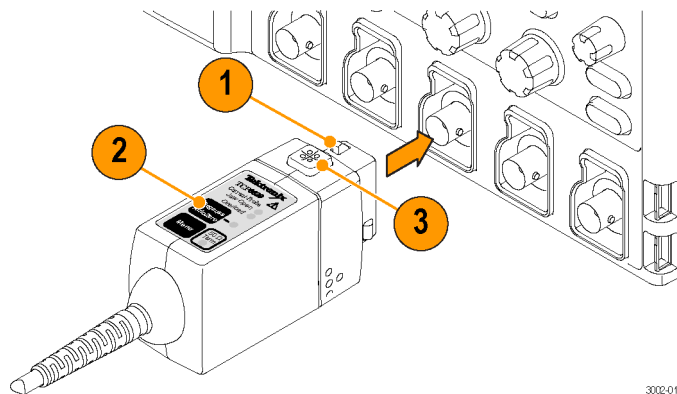
TCP0020 Probe

1. Slide the TCP0020 probe into the oscilloscope input. The probe snaps in when fully engaged.

All of the probe LEDs light briefly for a quick visual check, and then the **Degauss** LED flashes red to indicate a degauss is required.

The **50 Ω Term** LED glows green until the degauss is run, when the probe senses and adjusts per the host attenuation setting.

2. Degauss the probe. (See page 5, *Degaussing the Probes.*)
3. To disconnect the probe, press the latch button and pull the probe away from the instrument.



3002-010

TCP2020 Probe

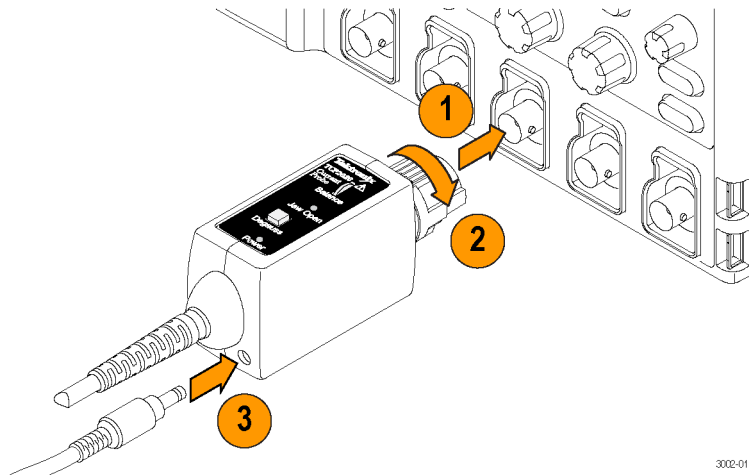
1. Align the BNC connector on the probe to the oscilloscope input connector.
2. Push in the probe connector and turn it to the right to lock it in place.
3. Connect the AC adapter to a line source and then connect it to the probe.

NOTE. The AC adapter can also be connected to the probe before connecting the probe to the oscilloscope.

When the probe is connected to the oscilloscope and the AC adapter, the probe **Power** LED lights green.

4. Degauss the probe. (See page 5, *Degaussing the Probes.*)

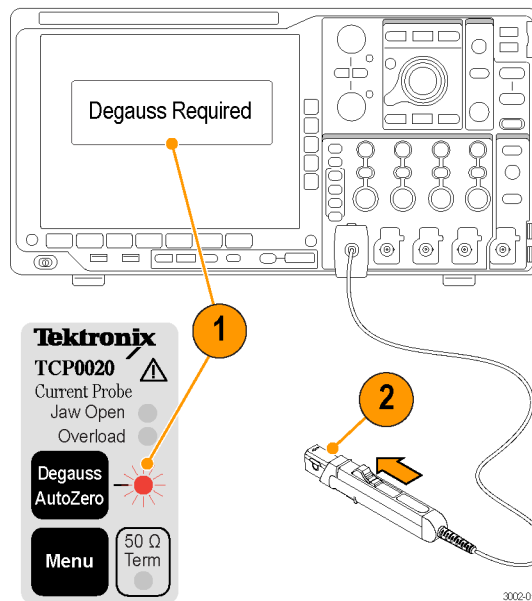
To disconnect the probe, turn the probe connector to the left and pull the probe away from the instrument.



3002-011

Degaussing the Probes

1. After the TCP0020 probe is connected to the oscilloscope, the multicolor **Degauss/AutoZero** status LED flashes red to indicate a degauss is required.
The oscilloscope screen display may also prompt you to degauss the probe.
The TCP2020 probe does not indicate that a degauss is needed, but you should always degauss a current probe after connecting it to the oscilloscope.
2. To degauss the probe, first verify that the **Jaw Open** LED is not lit. If it is lit, push the probe slider forward to lock the jaw closed.

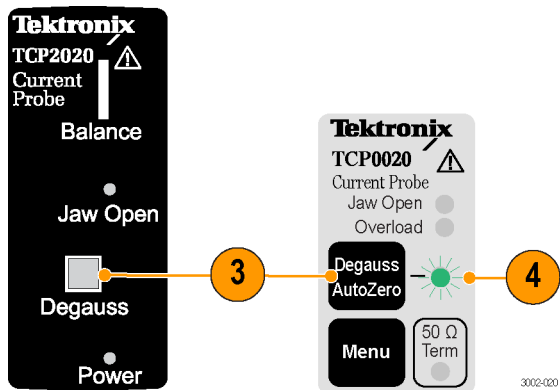


3. Press the **Degauss** or **Degauss/AutoZero** button on the probe or in the Degauss window on the host instrument.

As degauss runs, the **50 Ω Term** LED may go on or off as the termination is set for proper current measurements.

NOTE. The DC gain and offset errors are not guaranteed when the multicolor Degauss/AutoZero status LED flashes red.

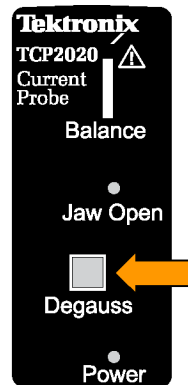
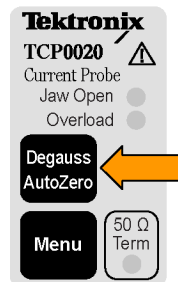
4. The multicolor **Degauss/AutoZero** status LED on the TCP0020 probe glows green to indicate a successful degauss routine was run, and that the probe is in normal operating mode.



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 a current or thermal overload condition occurs
- Whenever you subject the probe to a strong external magnetic field



3002-001

Controls and Indicators

The TCP0020 and TCP2020 probes share the same probe head design and some common features. Controls and indicators that are unique to each probe model are covered in the separate sections that follow.

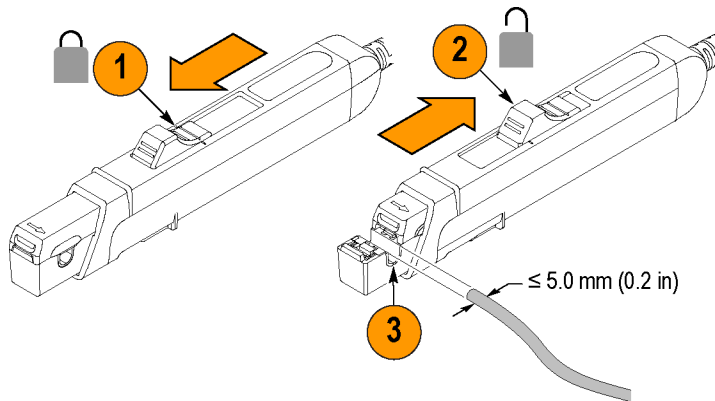
Probe Head

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.



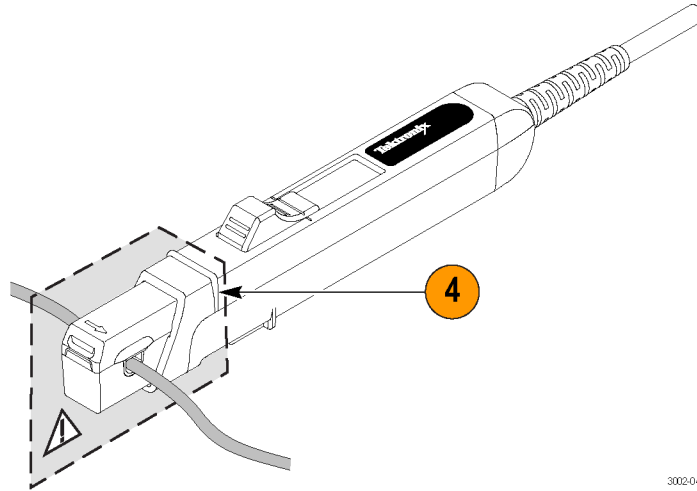
WARNING. To avoid electrical shock, do not access the area beyond the safe handling zone (indicated by the shaded area) when you take measurements.



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

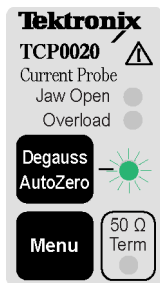
TCP0020 Probe

This section describes the controls and indicators for the TCP0020 probe. The following section covers the TCP2020 probe. (See page 20, *TCP2020 Probe*.)

Power On Indication

When the TCP0020 probe is powered on, all of the indicator LEDs light briefly, and then the **Degauss/AutoZero** LED on the probe flashes red to indicate that a degauss is required.

After you degauss the probe, the **Degauss/AutoZero** LED glows green to indicate a successful degauss. This LED also functions as a power on indicator.



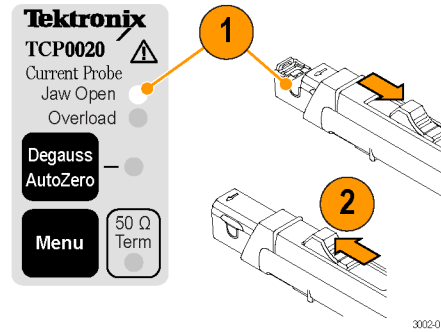
3002-029

Jaw Open LED

1. The **Jaw Open** LED glows when the probe slider is unlocked.
2. Push the probe slider forward to lock it and to turn off the LED. In the locked position, you can degauss the probe, or when connected to a conductor, accurately measure current.



CAUTION. Do not measure conductors larger than 5.0 mm (0.20 in) diameter. Damage to the probe jaw may result.



Overload LED

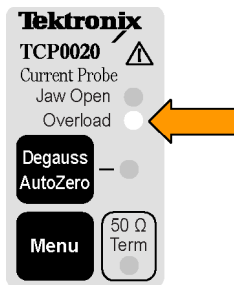
The **Overload** LED alerts you that the probe specifications are being exceeded. When the LED glows red, the maximum input continuous current limit has been exceeded.



CAUTION. Do not subject the probe to conditions that cause the Overload LED to light for extended periods.

Quick Tip

- An input current overload can magnetize the probe. Always degauss the probe after an overload.



3002-018

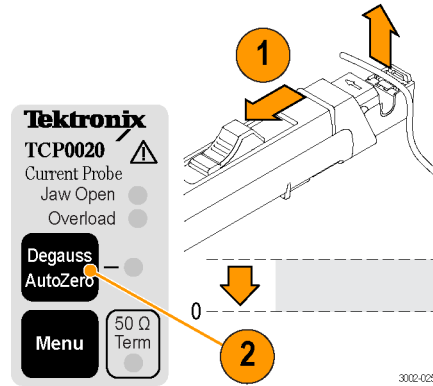
Degauss/AutoZero Button

The **Degauss/AutoZero** button degausses and nulls any DC offset in the probe.

To degauss the probe, do the following:

1. Disconnect the probe from any conductors, and then close and lock the slider.
2. Press the **Degauss/AutoZero** button to initiate the degauss routine.

After successfully completing the Degauss routine, the **Degauss/AutoZero** LED on the probe glows green.



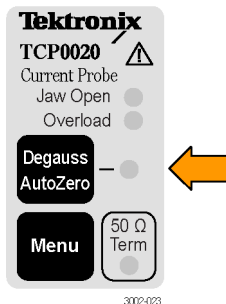
3002-005

Degauss/AutoZero LED

When the multicolor **Degauss/AutoZero** status LED flashes red, you must degauss the probe. The Degauss/AutoZero function also nulls any DC offset in the probe.

If the LED flashes orange, you should degauss the probe. The DC gain and offset errors are not guaranteed when this LED flashes orange.

The LED glows green after successfully completing the Degauss/AutoZero routine.

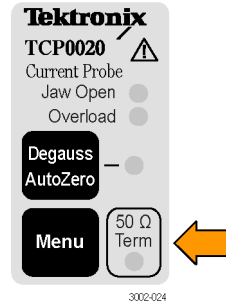


50 Ω Term LED

This LED lights when the output signal path in the probe is actively terminated to 50 Ω . For the LED to correctly indicate the probe termination, you must degauss the probe after you connect it to the oscilloscope, or if you change the oscilloscope termination while the probe is connected to the oscilloscope.

When you connect the probe to a 1M Ω input host, the **50 Ω Term** LED lights after you degauss the probe. When the probe is connected to a 50 Ω input host, the **50 Ω Term** LED turns off after you degauss the probe.

NOTE. When you are using the probe with an oscilloscope input termination of 50 Ω , the maximum peak current that you can measure is 50 amps, with a pulse duration of no more than 20 us.



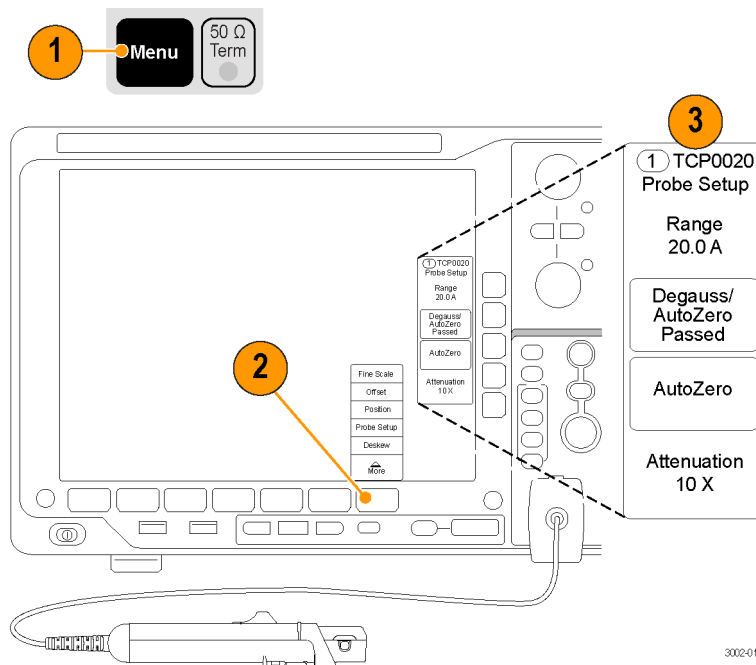
Menu Button

Press the **Menu** button on the TCP0020 probe to access additional probe functions, such as probe offset and deskew.

The following menus may appear on the oscilloscope screen, depending on the model. An MSO/DPO4000 series oscilloscope is used in this example.

1. Press the **Menu** button on the probe.

The lower-bezel menu appears at the bottom of the screen, above the lower-bezel buttons.
2. Press the **More** button to scroll through the lower-bezel menu.
3. As each lower-bezel menu item is highlighted, a side-bezel menu appears for that function, next to the right-bezel buttons. The Probe Setup menu is shown.
4. Press the probe **Menu** button again to close the menu.



3002-015

Menu-Driven Probe Functions

The following probe functions are available through menu screens on many Tektronix oscilloscopes. An MSO/DPO4000 series oscilloscope is used in these examples.

Fine Scale. This feature allows you to adjust the vertical mA/div setting to a custom scale that is between the fixed 1–2–5 scales on many oscilloscopes.

For example, to display a 320 mA signal over exactly 8 vertical divisions (40 mA/div), first set the fixed scale to 50 mA/div. Next, select Fine Scale from the lower-bezel menu and then use the Multipurpose knob to adjust the Fine Scale down to 40 mA/div, as displayed on-screen.

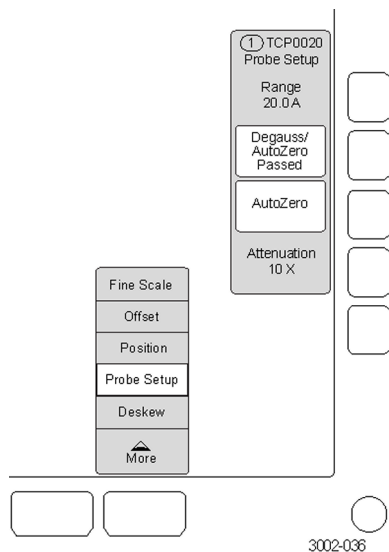
Offset and Position. Each of these selections allow you to adjust that parameter and to return the value to zero by pressing a side-bezel button.



3002-037

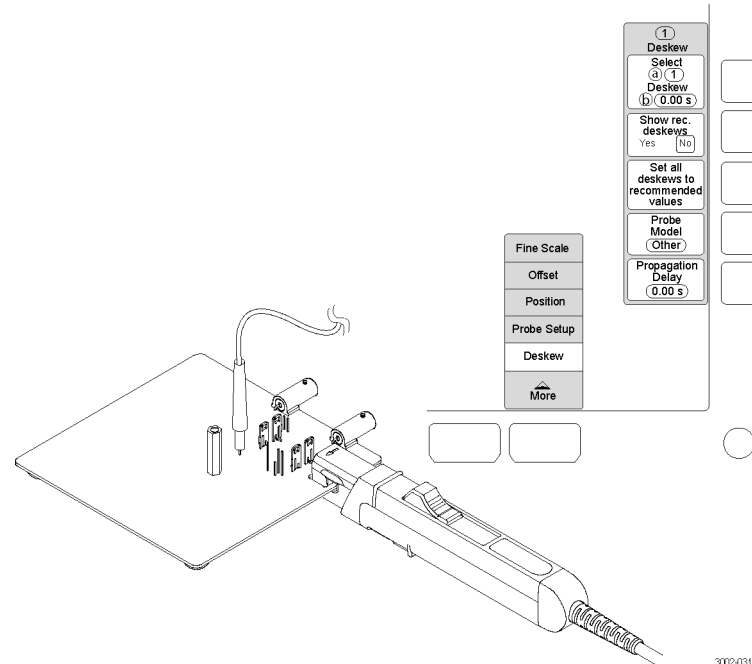
Probe Setup. The Probe Setup menu displays the current range and attenuation (20 amperes and 10X for the TCP0020 and TCP2020 probes).

Side-bezel buttons allow you to run the Degauss and AutoZero routines. The buttons also display the degauss status of the probe.



Deskew. To deskew the TCP0020 and TCP2020 probes to other probes, select this function and connect the probes to the optional deskew fixture. (See page 30, *Deskew/Calibration Fixture.*)

The deskew procedure measures the channel-to-channel delay time, including the probes, and provides manual and automatic steps to align the delay (skew). Refer to your oscilloscope manual or deskew fixture documentation for instructions.



TCP2020 Probe

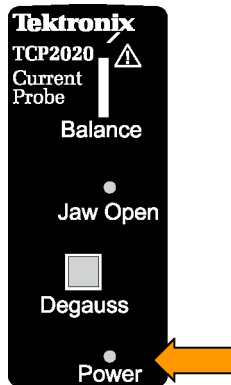
This section describes the controls and indicators for the TCP2020 probe.

Power LED

The TCP2020 probe is powered by an external DC power supply that is included with the probe.

NOTE. *The probe will pass through AC signals without the external power supply connected, but the performance is not guaranteed.*

When the external DC power supply is connected to the TCP2020 probe, the **Power** LED glows green.



3002-040

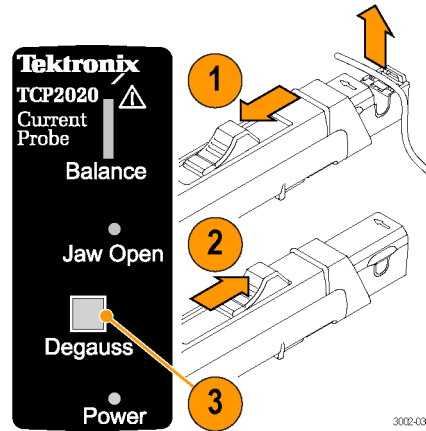
Degauss Button

The Degauss button degausses and nulls any DC offset in the probe.

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.

A decaying oscillation appears on the oscilloscope as the degauss operation completes.

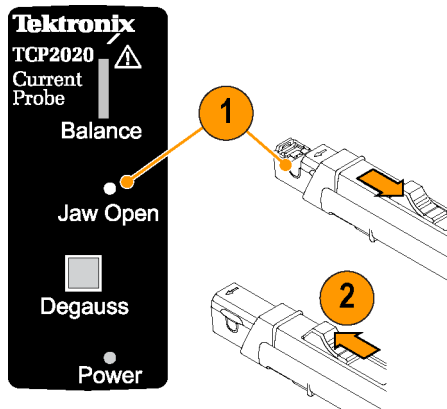


Jaw Open LED

1. When the **Jaw Open** LED glows, the probe slider is unlocked.
2. Push the probe slider forward to lock it and to turn off the LED. In the locked position, you can degauss the probe, or when connected to a conductor, accurately measure current.



CAUTION. Do not measure conductors larger than 5.0 mm (0.20 in) diameter. Damage to the probe jaw may result.

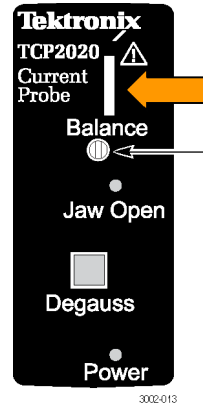


3002-026

Balance Control

Use the Balance control (thumb wheel) to make minor adjustments to DC offsets present on the probe output. To use the control:

1. Disconnect the probe from the current source.
2. Lock the probe slider closed.
3. Press the **Degauss** button.
4. Set the oscilloscope vertical scale to 10 mA/div, or the most-sensitive setting on the instrument.
5. Open and close the probe slider.
6. Adjust the **Balance** control to zero the displayed signal.



NOTE. If you cannot set the DC offset to zero with the thumb wheel, a coarse balance adjustment is accessible through the opening below the thumb wheel (see small arrow, above). 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.

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 61.)

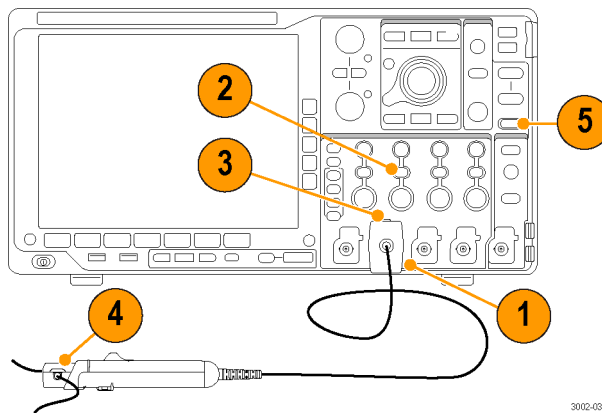


CAUTION. The probe jaw opening accommodates insulated conductors with a diameter of 5.0 mm or less. Do not insert conductors larger than 5.0 mm diameter into the probe jaw. Damage to the probe may result.

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. Degauss the probe.
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

Accessories and Options

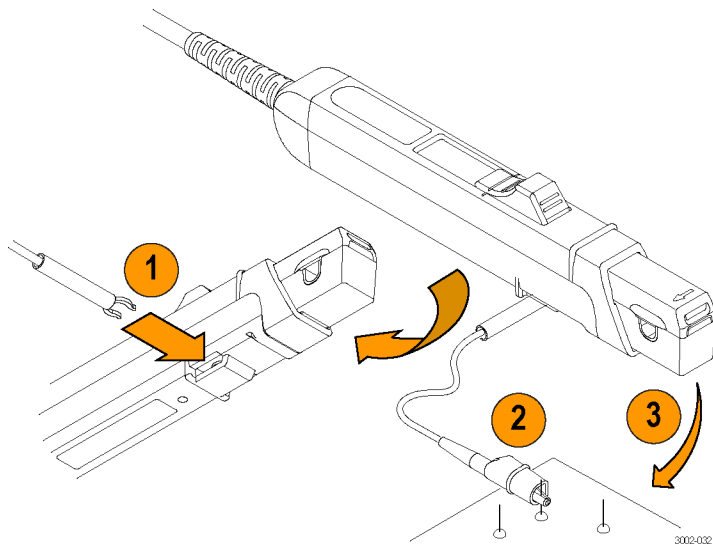
This section lists the standard and optional accessories available for the probe, and provides information on how to use the accessories. Specifications are provided where appropriate so that you can choose the accessory that best fits your needs.

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

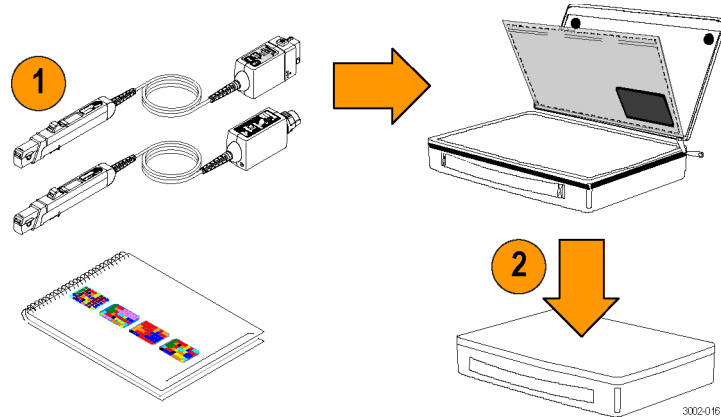


Nylon Carrying Case with Pouch and Inserts

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.

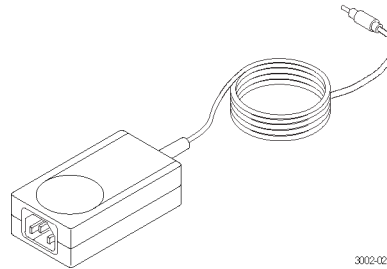
Reorder Tektronix part number:
016-1952-xx



DC Power Supply (TCP2020 Only)

The TCP2020 probe requires an external DC power supply for proper operation.

Reorder Tektronix part number:
119-7836-xx



Instruction Manual

The instruction manual provides operating and maintenance instructions.

Reorder Tektronix part number:
071-3002-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

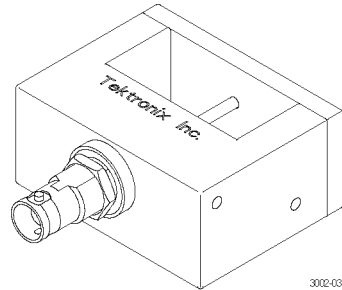
This section lists the optional accessories that you can purchase to help you with your probing tasks.

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).

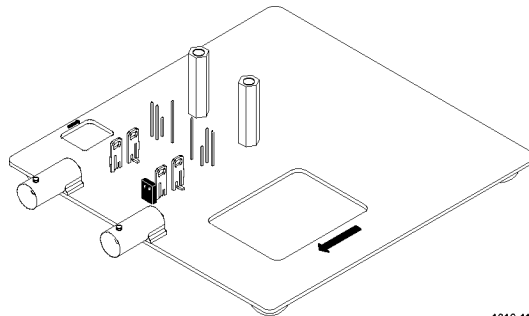
Order Tektronix part number:
067-2396-xx



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

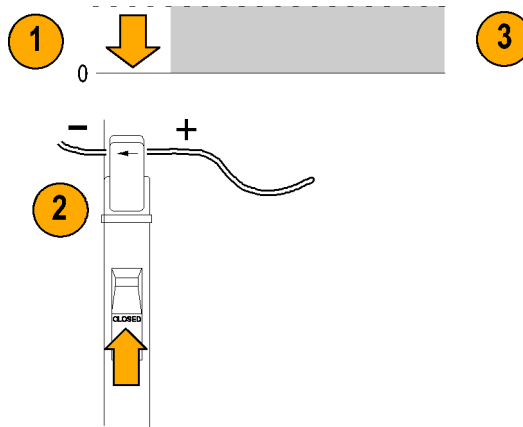
- **Option C3.** Calibration Service 3 years
- **Option C5.** Calibration Service 5 years
- **Option D1.** Calibration Data Report
- **Option D3.** Calibration Data Report, 3 years (with Option C3)
- **Option D5.** Calibration Data Report, 5 years (with Option C5)
- **Option R3.** Repair Service 3 years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

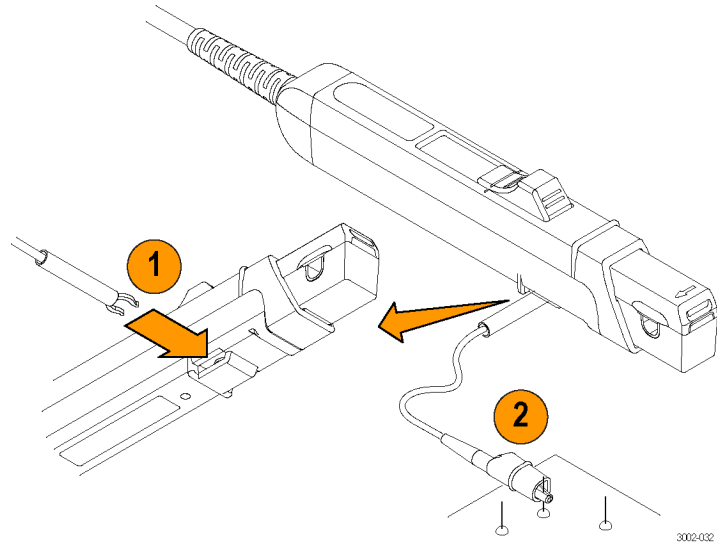
1. Check the oscilloscope display before connecting the probe to a conductor.
If there is a DC offset, degauss the probe. (See page 5, *Degaussing the Probes.*) If you are using the TCP2020 probe, you may also need to adjust the Balance control. (See page 23, *Balance Control.*)
2. Close and lock the 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.



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

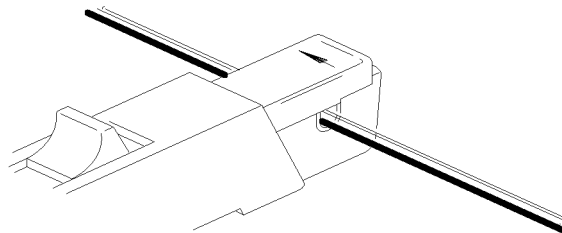
You can degauss your current probe while a conductor of an unpowered circuit is clamped in the jaws. The advantage of degaussing with an unpowered circuit is that any offset from stray DC magnetic fields is compensated. Degaussing with the conductor in the probe jaws eliminates the need to manually remove 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 should be higher than 10 m Ω for the degauss procedure to work. (The probe core might not saturate with a circuit impedance of less than 10 m Ω). While degauss occurs, the probe will induce a signal of about 50 mV into 50 Ω , at about 170 Hz 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.

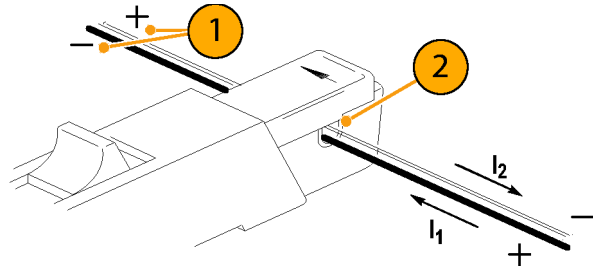


WARNING. When you are taking measurements on uninsulated conductors, do not exceed the 150 V CAT II voltage limit of the probe. An uninsulated conductor is any conductor without insulation or without insulation rated for the voltage present on the conductor under test. If the circuit voltage is above 150 V CAT II, but less than 300 V CAT II, you can take the measurement, but only on an insulated conductor. Do not exceed the 300 V CAT II voltage rating on any insulated conductor.

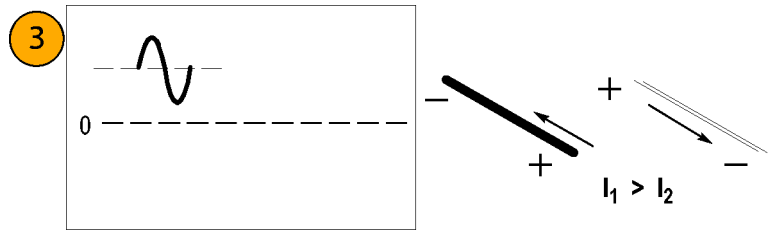
An insulated conductor is any conductor that is surrounded by an insulating material that is capable of isolating the voltage present on the conductor. Lacquer coatings like those typically found on transformer windings do not provide sufficient, reliable insulation for use with current probes. The lacquer coating can be easily nicked or damaged, compromising the insulating capabilities of the lacquer coating.

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.

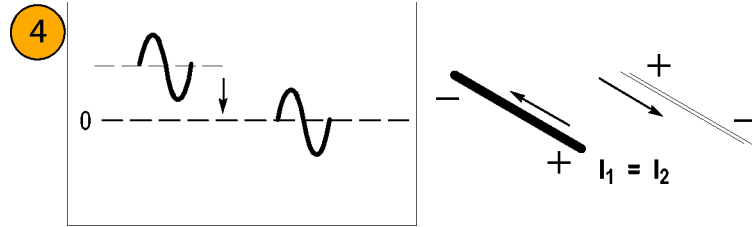
1. Orient the two conductors under test so that the polarities (+ and -) oppose each other.
2. Clamp the current probe around the two conductors. Be careful not to pinch a conductor in the probe jaws.



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 DC component of 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

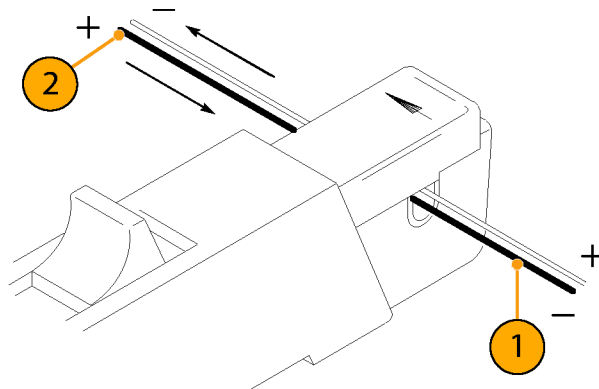
If you want to measure a low-amplitude AC component that is superimposed on an extremely large steady-state DC component (such as in a power supply), or if you want to extend the DC current range of your probe, you can add offset (bucking) current with a second conductor.



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.



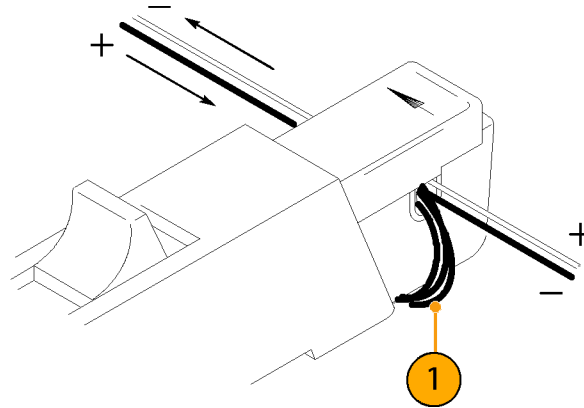
NOTE. Adding a second conductor to the probe increases the insertion impedance and reduces the upper bandwidth limit of the probe. Winding multiple turns further increases the insertion impedance, further reducing the upper bandwidth limit.

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.

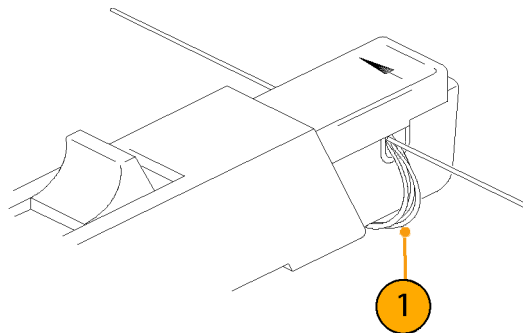


Increasing Sensitivity

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.



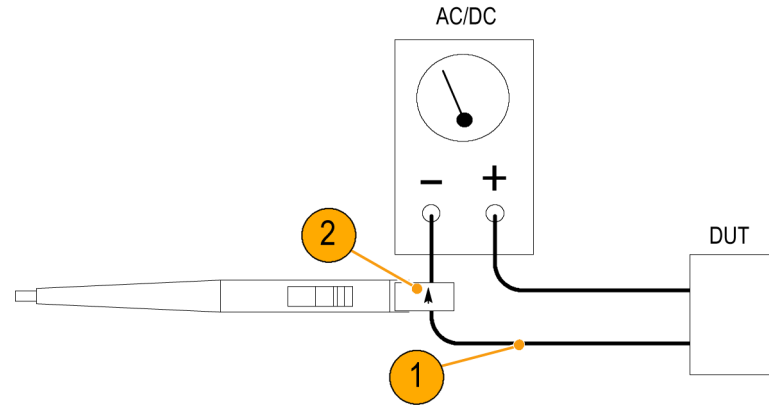
NOTE. Winding more turns around the probe increases the insertion impedance and reduces the upper bandwidth limit of the probe.

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 (from positive to negative).

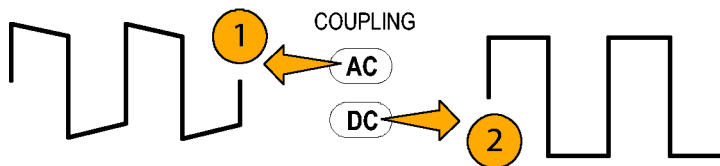
NOTE. This method works best when the negative terminal shown in the diagram is tied to earth ground.



AC and DC Coupling

You can couple the signal input to the oscilloscope with either DC or AC coupling. DC coupling shows both the DC and AC measurement components. AC coupling removes the DC component from the displayed signal. Use your oscilloscope controls to change the coupling.

1. This low-frequency square wave is displayed using AC coupling. The signal exhibits low-frequency rolloff.
2. Press the DC Coupling button to display the waveform as truly square.

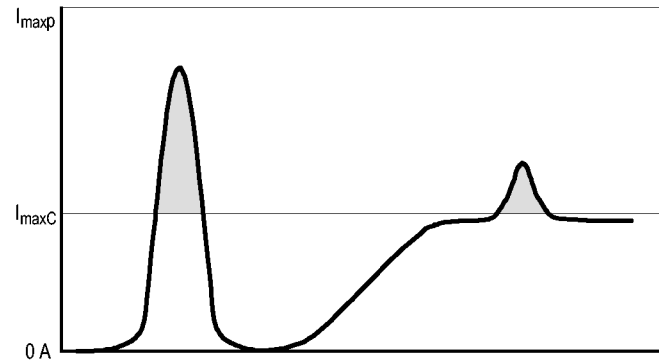


CAUTION. When you use AC coupling, make sure that the input DC current does not exceed the probe specifications.

Maximum Current Limits

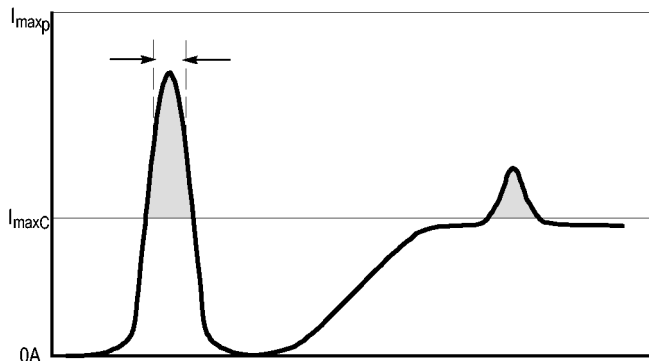
Current probes have three maximum current ratings: pulsed, continuous, and Ampere-second product. Exceeding any of these ratings can saturate the probe core, which magnetizes the core and causes measurement errors. Refer to the specifications for the maximum current ratings of the probe. (See Table 2 on page 54.)

- 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

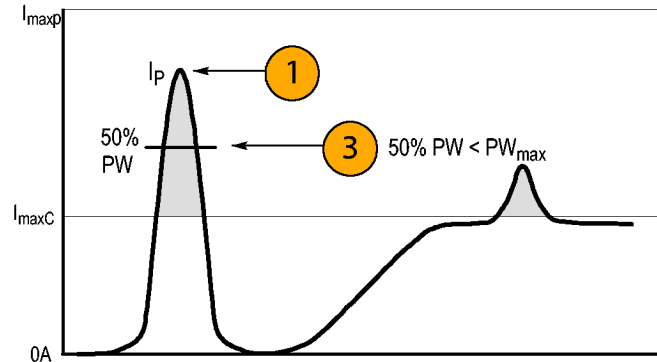
To determine the maximum allowable pulse width do the following:

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



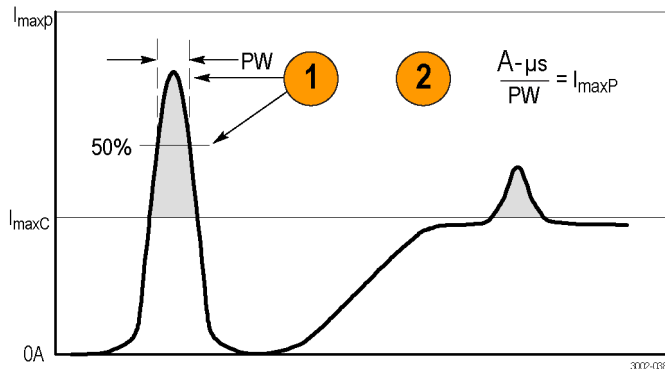
Maximum Allowable Pulse Amplitude

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 TCP0020 and TCP2020 probes have a maximum Ampere-second product of 1000 A- μ s. If a pulse measured with the probe has a width of 11 μ s, the maximum allowable peak current would be 1000 A- μ s divided by 11 μ s, or 90.9 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

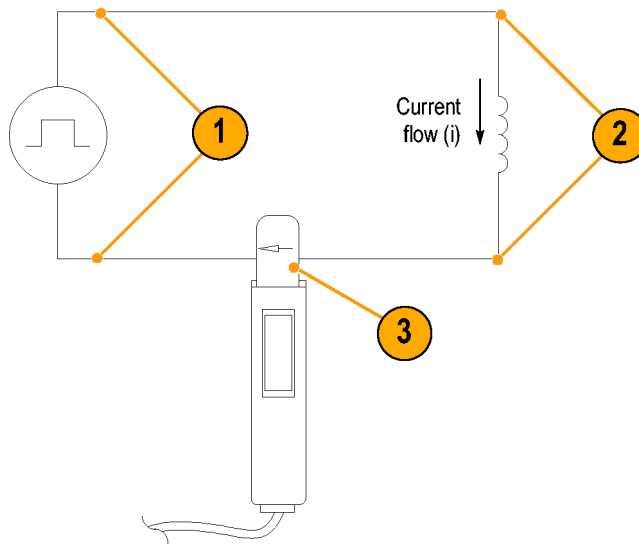
You can use the current probe to measure the inductance of coils that have either a low-impedance or high-impedance pulse source of a known value.

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.*

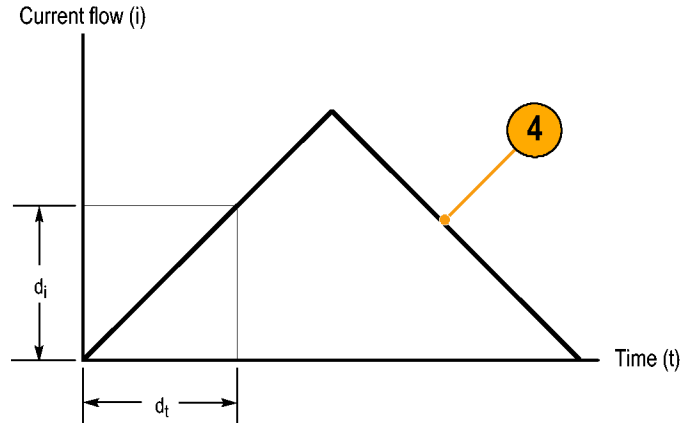


4. Measure the current ramp. The inductance is effectively defined by the slope of the current ramp shown here.
5. Calculate the inductance using the following formula:

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

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.

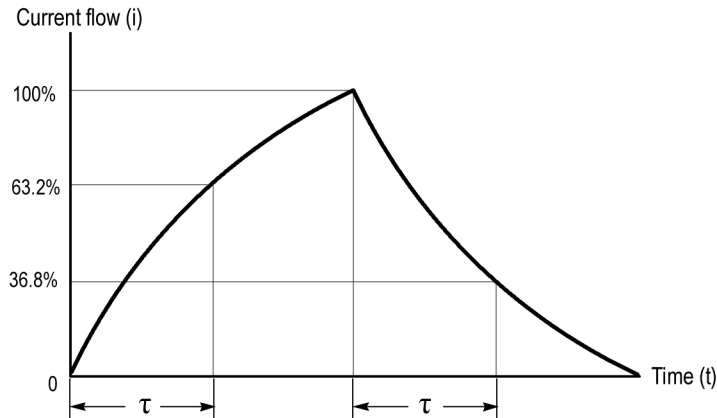
The current ramp shows how the values for the inductance formula are obtained.

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.



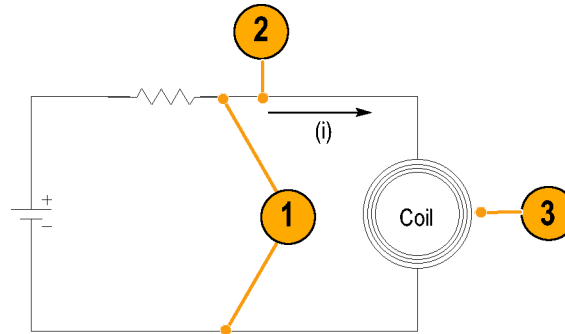
Measuring Inductor Turns Count

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.



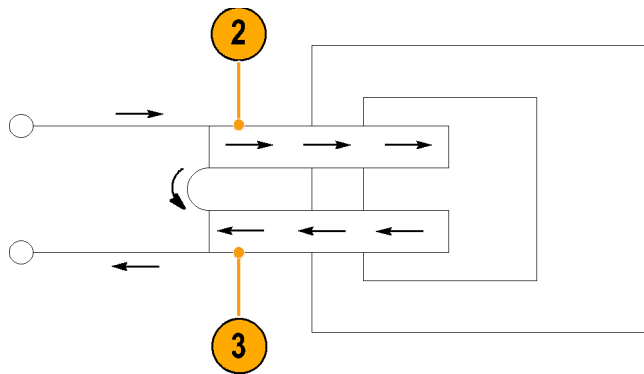
For a more precise turns count, you need a coil with a known number of turns to use as a reference. Do the following:

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 TCP0020 probe specifications are also valid on host instruments 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).
- The probe has been degaussed successfully.

Specifications for the TCP0020 & TCP2020 current probes 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
✓ DC gain accuracy	<3%
✓ Rise time (10% to 90%)	≤7 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	20 A RMS
Maximum peak current	(See Figure 3 on page 57.)
TCP0020 with 50 Ω oscilloscope termination	50 A maximum peak pulse (pulse width $\leq 20 \mu\text{s}$)
TCP0020 & TCP2020 with 1 M Ω oscilloscope termination	100 A maximum peak pulse (pulse width $\leq 10 \mu\text{s}$)
Displayed RMS noise	≤ 1.0 mA RMS (limit measurement bandwidth to 20 MHz)
Insertion impedance	(See Figure 2 on page 56.)
Signal delay	~ 14.5 ns
Maximum voltage on bare wire	150 V CAT II
Maximum voltage on insulated wire	300 V CAT II
Maximum Amp·Second product	1000 A· μs (See page 43, <i>Maximum Current Limits.</i>)

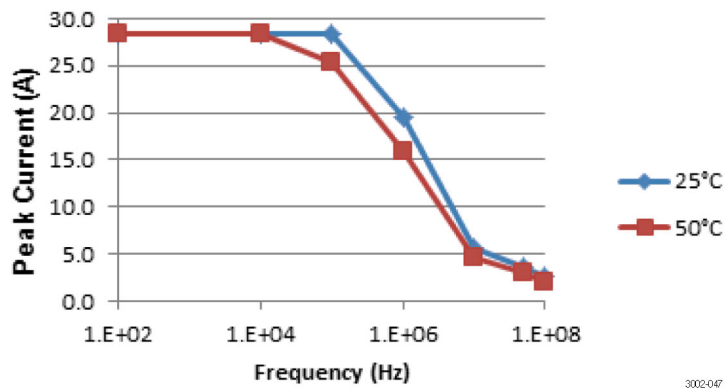


Figure 1: Frequency derating (continuous peak current versus frequency)

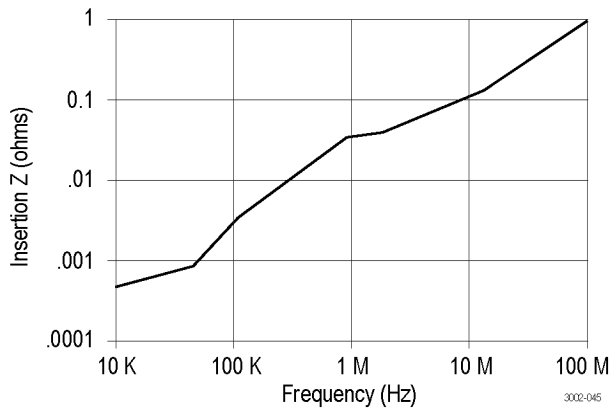


Figure 2: Typical insertion impedance versus frequency

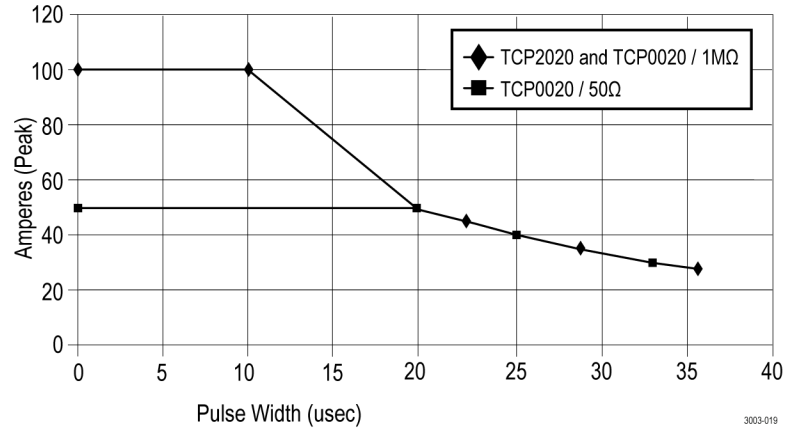


Figure 3: Maximum peak pulse versus pulse width

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	TCP0020	TCP2020
Compensation box (See Figure 4 on page 59.)	77 mm × 30.5 mm × 40.6 mm (4.2 in × 1.6 in × 1.0 in)	73.1 mm × 30.5 mm × 40.6 mm (4.2 in × 1.0 in × 1.6 in)
Probe head	148.3 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)	2 m (79 in)	
Unit weight		
Probe only	226.8 g (8 oz)	226.8 g (8 oz)
Probe, accessories, and packaging	1219 g (2 lb 11 oz)	1219 g (2 lb 11 oz)

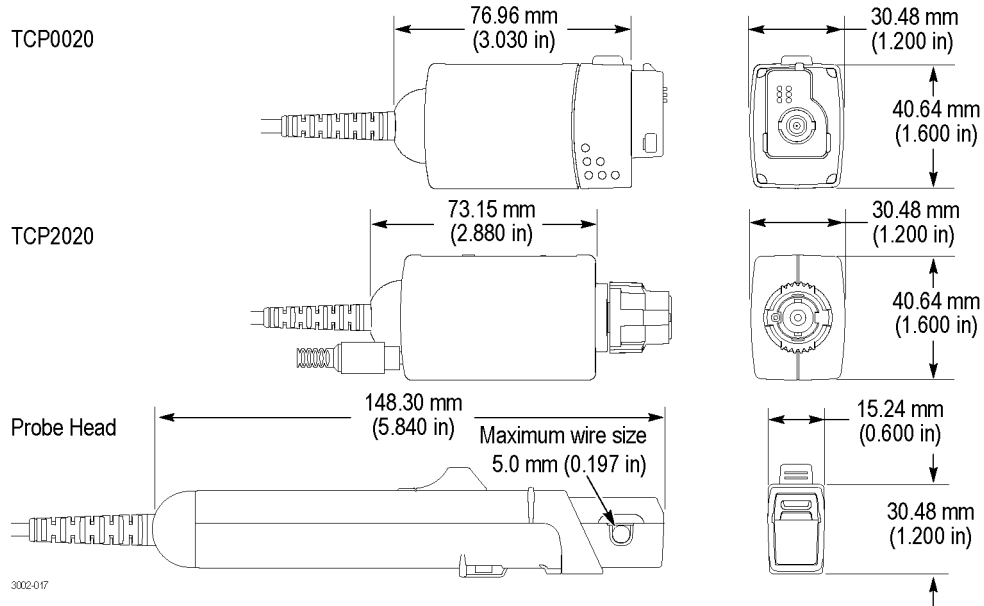


Figure 4: Mechanical dimensions

Nominal Characteristics

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

Table 5: Nominal electrical characteristics

Characteristic	Description
Input coupling	DC
Current range	20 A
Power requirement	
TCP0020	Supplied by host instrument
TCP2020	External; 12 VDC @ 300 mA (100–240 VAC, 50–60 Hz, 0.5 A input)
Termination	
TCP0020	Terminate output into 50 Ω or 1 M Ω
TCP2020	Terminate output into 1 M Ω
Oscilloscope compatibility	
TCP0020	Tektronix oscilloscopes equipped with the TekVPI interface
TCP2020	Oscilloscopes with a 1 M Ω BNC input

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

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
High Amplitude Pulse Generator	Risetime <500 ps, pulse width \geq 100 ns, amplitude >10 Vpp into 50 Ω	Picosecond Labs 2600C
Calibrator	DCV: 0.2% accuracy, 0 to \pm 1.5 V, square wave output ACA: 0.25% accuracy, 0 to \pm 6 A, square wave output	Fluke 9100
TekVPI Calibration/Verification adapter ²	TekVPI interface	067-1701-xx
Digital multimeter (DMM)	\geq 2 volt range, \geq 1% accuracy	Keithley 2700
DC current loop	5 turns 18 AWG coated wire on 3 inch form	See instructions that follow
HF current loop	50 Ω \pm 0.5%, BNC male connector	067-2396-xx
Adapter	BNC-to-dual banana	103-0090-xx
Adapter ²	SMA male-to-BNC female	015-1018-xx
BNC cable	50 Ω , 0.76 m (30 in) length	012-0117-xx

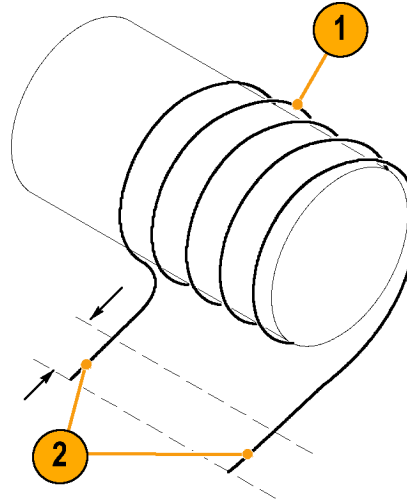
¹ Nine-digit part numbers (xxx-xxxx-xx) are Tektronix part numbers

² Required for TCP0020 probe only

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.

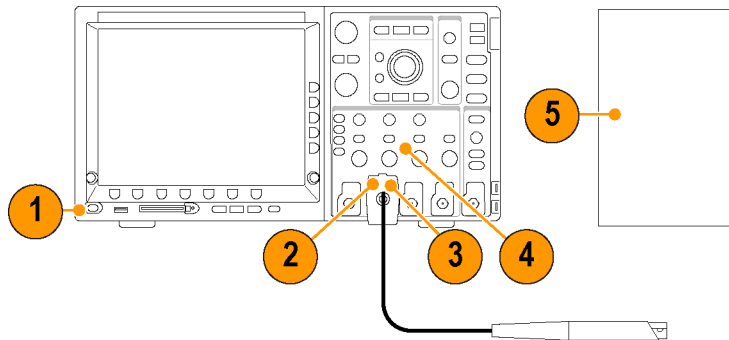


NOTE. Ensure that the current loop has exactly 5 turns. A significant error will result for each turn variance from 5 turns.

Equipment Setup

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

1. Turn on the oscilloscope.
2. Connect the probe to any channel of the oscilloscope. If you are testing a TCP2020 probe, connect the external DC power supply to the probe.
3. Degauss the probe.
4. Set the oscilloscope coupling to DC.
5. Power on the remaining test equipment.
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 71.)

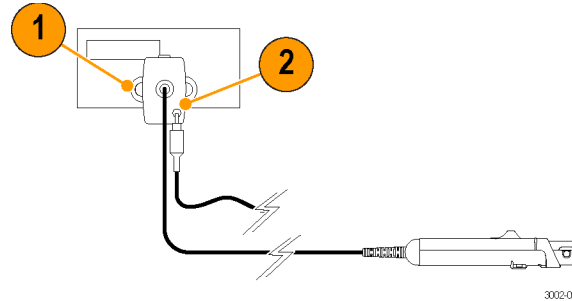


DC Gain Accuracy

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 72.)

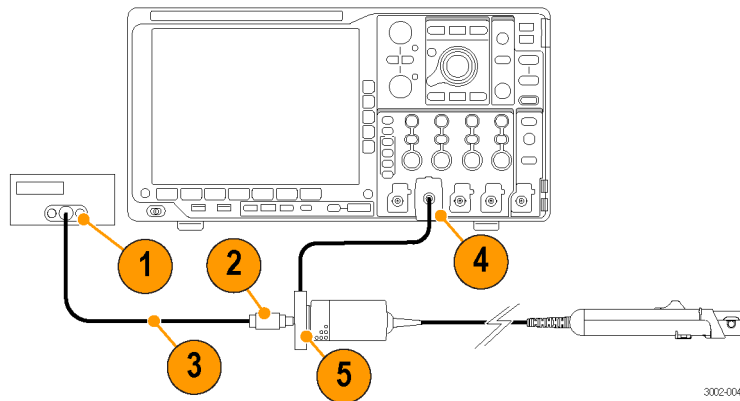
TCP2020 Setup

1. Connect a BNC-to-Dual Banana adapter to the digital multimeter (DMM) input.
2. Connect the TCP2020 probe output to the BNC adapter attached to the DMM.
3. Proceed to step 6 in the *TCP0020 & TCP2020 Test* section. (See page 67, *TCP0020 & TCP2020 Test*.)



TCP0020 Setup

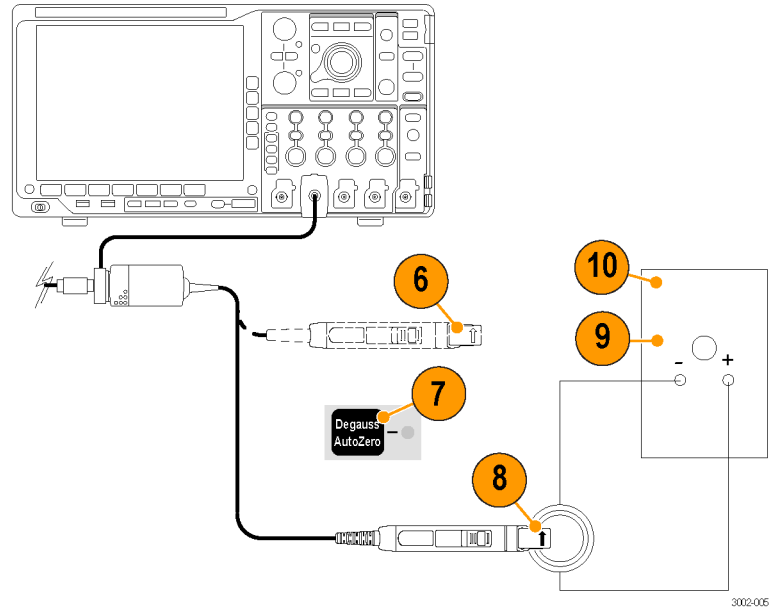
1. Connect a BNC-to-Dual Banana adapter to the digital multimeter (DMM) input.
2. Connect the SMA M-to-BNC F adapter to the SMA output of the TekVPI Calibration/Verification adapter.
3. Connect the BNC cable between the BNC adapter on the TekVPI Calibration/Verification adapter and the BNC adapter attached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



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

TCP0020 & TCP2020 Test

6. Do not clamp the current probe around any conductor, but make sure the jaw is in the locked position.
7. Degauss the probe by pressing the **Degauss** or **Degauss/AutoZero** 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 +2.00 A.
10. Set the DMM to measure DC volts, on ≥ 2 volt range (or use Autoset).
11. Enable the output of the current source.



3002-005

12. Record the exact measurement of the DMM as M1.
13. Set the current source output to -2.00 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 0.975 V for M1 and -0.995 V for M2. With an expected output voltage (V_e) of 1.000 V, compute the % Error as shown.

16. Disable the calibrator output.

If the computed % Error is out of the specified limit, the probe may require an adjustment. (See page 72, *Adjustments*.)

Test current = ± 10.00 A (± 2.00 A source output x 5 coil turns)
Expected output voltage (V_e) = 1.00 V (1 mV/10 mA)

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

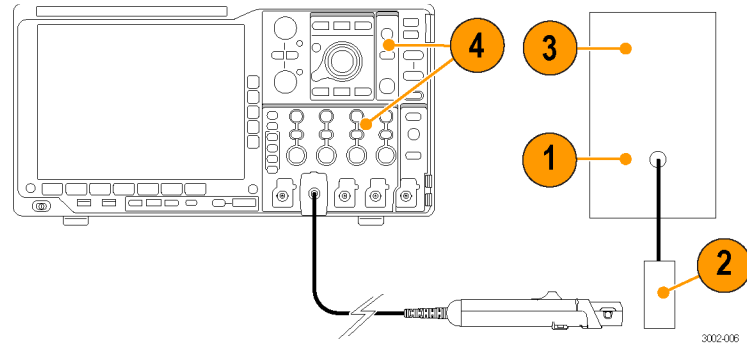
Example:

$$\frac{[(0.975 V - (-0.995 V)) - 2(1.000 V)]}{2.0 V} \times 100 = -1.5\%$$

Rise Time and Bandwidth

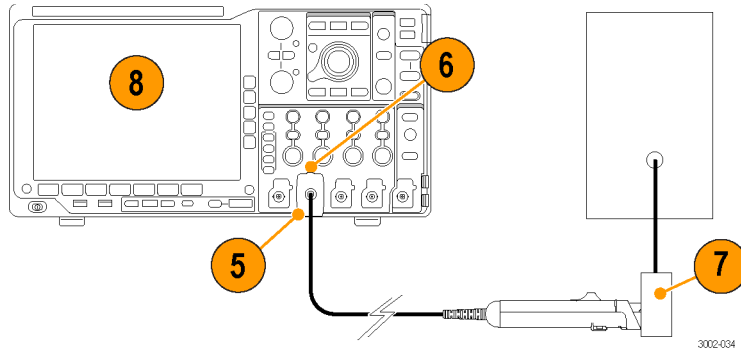
This procedure verifies that the probes meet the rise time specification by directly measuring the rise time. The bandwidth of the probe is then calculated using the measured probe rise time.

1. Connect a 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. (50 Vp-p, positive pulse, 100 ns duration, repetitive output.)
4. Set the oscilloscope to display the entire waveform on-screen:
 - Vertical sensitivity to 200 mA/div
 - Horizontal to 20 ns/div
 - Trigger at 20%
 - Averaging on (32)
 - Coupling to DC
 - Automeasurement to Rise Time



5. Connect the probe to any channel (1–4)
6. Degauss the probe.
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. Calculate the probe bandwidth using the measured rise time in the following formula:
$$BW = \frac{0.35}{t_r}$$
10. Record the calculated bandwidth value in the test record.
11. Disable the generator output.

End of procedures.



Test Record

Probe Model/Serial Number:

Certificate Number:

Temperature:

RH %:

Date of Calibration:

Technician:

Performance test	Test current	Expected output	Minimum	Incoming	Outgoing	Maximum
DC gain accuracy	±10.0 A	1.000 V	-3%			+3%
Rise time	~1 A	<7.0 ns	NA			7.0 ns
Bandwidth	NA	>50 MHz	50 MHz			NA

Adjustments

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

- DC gain accuracy

Prerequisites

Complete the *DC Gain Accuracy Test* in the *Performance Verification* procedure. (See page 65, *DC Gain Accuracy*.)

Keep the test setup intact for the adjustment procedure.

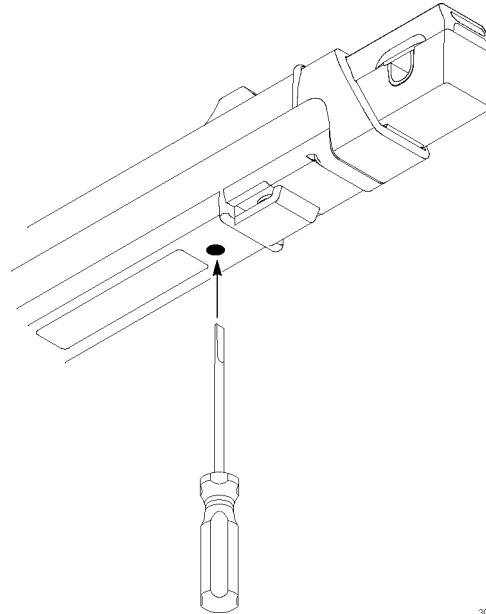


CAUTION. To avoid ESD damage to the probe, use an antistatic wrist strap and work at a static-approved workstation when handling the probe.

DC Gain Accuracy

This procedure describes the DC gain accuracy adjustments for the probe. You must complete the *DC Gain Accuracy Test* in the *Performance Verification* procedure before making this adjustment. Leave the test setup intact to perform the adjustment.

1. Set the calibrator output to 2.0 A.
2. Set the digital multimeter (DMM) to measure DC volts, ≥ 2.0 V range.
3. Measure the output amplitude on the DMM.
4. Access the DC gain control through the opening in the probe head as shown. Adjust the DC gain control to display 1.000 V, ± 10 mV on the DMM.
5. Disconnect the probe from the calibrator and disable the output.



3002-033

Maintenance

This section contains maintenance information for your probe.

Troubleshooting

The TCP2020 current probe is designed to work with all oscilloscopes that have BNC inputs. The TCP0020 current probe can only be used with Tektronix oscilloscopes that have TekVPI inputs. The LEDs on the TCP0020 probe normally indicate the operational status, but they also alert you to error conditions affecting the probe. If the probe LEDs do not light as expected, or if some of the probe features do not work properly, an error condition may exist. See the following table.

Table 7: Probe troubleshooting

Symptom	Possible cause
LEDs on the probe flash or remain on:	
Jaw Open <i>NOTE. This LED is common to both probes. The 3 remaining LED status descriptions only apply to the TCP0020 probe.</i>	Continuous red: The conductor jaw is unlocked. Move the slider forward to lock the jaw closed.
Overload	Flashing: An intermittent, repetitive overload is present on the probe. Remove the probe from the current source. (See page 37, <i>Extending Current Range</i> .) Continuous red: The measured current exceeds the limit of the probes. Remove the probe from the current source. (See page 37, <i>Extending Current Range</i> .)

Table 7: Probe troubleshooting (cont.)

Symptom	Possible cause
Degauss/AutoZero	Flashing red: The probe requires degaussing. Degauss the probe. Flashing amber: The probe is performing the degauss routine. Continuous green: The probe is degaussed and ready for use.
50 Ω Term	Off: The probe is connected to an instrument that is terminated with a 50 ohm input. Continuous green: The probe is connected to an instrument that is terminated with a 1 M ohm input. The probe is automatically set to the correct termination when the degauss routine is run.
LEDs on the probe do not light.	The oscilloscope channel may be bad: Try another channel or another oscilloscope. All LEDs should light briefly and then the Degauss/AutoZero LED should flash. 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. If the probe does not work on another channel or oscilloscope, the probe is defective, and must be returned to Tektronix for repair.
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 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.

Index

Symbols and Numbers

50 Ω Term LED
TCP0020, 15

A

AC coupling, 42
Accessories
 optional, 29
 standard, 26
Adjustments, 72
Amp-second product, 44

B

Balance control
 TCP2020, 23
Bandwidth
 calculating, 69
 specification, 53
Basic operation, 32
Bucking current, 37
Button
 Degauss/AutoZero,
 TCP0020, 13

menu, 16

C

Cleaning, 76
Common mode noise, 41
Connect the probe
 TCP0020, 3
 TCP2020, 4
Coupling modes, 42
Current limitations
 amp-second product, 44
 maximum continuous, 43
 maximum pulsed, 43

D

DC coupling, 42
DC current loop
 5 turn, 63
DC gain accuracy
 adjustment, 73
DC gain accuracy check, 65
Degauss/AutoZero
 TCP0020, 13, 14

TCP2020, 21

Degaussing
 while connected to a
 conductor, 34
Degaussing the probes, 5
Deskew
 fixture, 30
 menu, 19
Differential current, 35
Documentation, xvii

E

Equipment required
 performance verification, 62
Equipment setup, 64
Extending the current range of the
 probes, 37

F

Fine Scale
 menu, 17
Frequency derating, 43
Functional check, 24

G

Grounding the probe, 33

I

Increasing bucking current, 37
Increasing probe sensitivity, 40
Indicators, 10

J

Jaw, 8
 Jaw Open LED, TCP0020, 11
 Jaw Open LED, TCP2020, 22

L

LED
 50 Ω Term, 15
 Degauss/AutoZero,
 TCP0020, 14
 flashing, 74
 Jaw Open, TCP0020, 11
 Jaw Open, TCP2020, 22
 Overload, TCP0020, 12
 Power indicator, TCP0020, 10

M

Magnetic field errors, 41
Maintenance, 74
Maximum
 allowable pulse amplitude, 46
 allowable pulse width, 45
 continuous current rating, 43
 pulsed current rating, 43
Measuring
 current nulls, 35
 differential current, 35
 inductance, 48
 inductor turns count, 51
Menu button
 TCP0020, 16
Menu-driven probe functions, 17

N

Null current, 35

O

Offset
 menu, 17
Options, 31
Overload LED

TCP0020, 12

P

Performance verification, 61
Position
 menu, 17
Power indicator
 TCP0020, 10
 TCP2020, 20
Probe
 controls and indicators, 10
 coupling, 42
 extending the current range, 37
 maximum current limits, 43
 saturation, 43
 setup menu, 18
Probing principles, 34

R

Record, test, 71
Related documentation, xvii
Rise time check, 69

S

Safety Summary, v

Service

- options, 31
- returning the probe, xviii

Slider and conductor jaw, 8

Specifications, 53

- nominal, 60
- typical, 54
- warranted, 53

T

- Test record, 71
- Troubleshooting, 74