

TCP202
15 Ampere AC/DC Current Probe
Instruction Manual



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Tektronix

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Instruction Manual

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Table of Contents

General Safety Summary	iv
Service Safety Summary.....	vi
Compliance Information	vii
Safety Compliance.....	vii
Environmental Considerations	ix
Getting Started	1
Features and Accessories	1
Connecting the Probe to the Oscilloscope	3
Compensating the Probe (Optional)	4
Operating Basics.....	5
Measurement Limits.....	5
Degaussing and Balancing the Probe.....	5
Measurement Procedures and Techniques	6
Reference	13
Power Measurements.....	13
Inductance Measurements	14
Continuity Test of Multiple-Conductor Cable	16
Specifications	17
Warranted Characteristics.....	17
Typical Characteristics	19
Nominal Characteristics.....	22
Maintenance.....	23
Cleaning the Probe Head.....	23
Servicing the Compensation Box	23
Probe Head Disassembly.....	30
Obtaining Replacement Parts.....	34
Preparation for Shipment	34
Performance Verification and Adjustment	35
Test Procedure Conditions	35
Equipment Required.....	36
DC Accuracy	36
Bandwidth	37
Rise Time	37
Calibrator Accuracy (Optional)	38
Replaceable Parts	39
Parts Ordering Information	39
Using the Replaceable Parts List.....	40

List of Figures

Figure 1: TCP202 Current Probe	1
Figure 2: Coarse Balance Adjustment	4
Figure 3: Connecting the Calibrator	4
Figure 4: Polarity of Current Flow	8
Figure 5: Measuring Differential Current and Nulls.....	8
Figure 6: Increasing the DC Measurement Range	10
Figure 7: Increasing Probe Sensitivity	11
Figure 8: Measuring Inductance with a Low-Impedance Source	14
Figure 9: Linear Current versus Time Ramp	15
Figure 10: Measuring Inductance with a High-Impedance Source	15
Figure 11: High-Impedance Source Current Ramp	16
Figure 12: Frequency Derating	19
Figure 13: Insertion Impedance - Magnitude - Single Conductor	20
Figure 14: Insertion Impedance - Phase Angle - Single Conductor	20
Figure 15: Insertion Impedance - Magnitude - 10-Turn #24 AWG Primary	20
Figure 16: Insertion Impedance - Phase Angle - 10-Turn #24 AWG Primary	21
Figure 17: Current Ratings	21
Figure 18: Replacing TekProbe Interface Pins	25
Figure 19: Replacing the TekProbe collar	26
Figure 20: Removing the Compensation Box Covers	27
Figure 21: Accessing the Gain Adjustment	28
Figure 22: Replacing the Compensation Box Cover	29
Figure 23: Removing the Strain Relief Boot	30
Figure 24: Removing the Top Half of the Probe	31
Figure 25: Removing the Probe Slide	32
Figure 26: Removing the Current Transformer	33
Figure 27: TCP202 and Replaceable Parts and Accessories	40
Figure 28: Replaceable Parts - Compensation Box	42
Figure 29: TCP202 Optional Accessories	42

List of Tables

Table 1: Warranted Electrical Characteristics	17
Table 2: Typical Electrical Characteristics	19
Table 3: Nominal Characteristics	22
Table 4: List of Equipment Required.....	36
Table 5: Parts List Column Descriptions	40
Table 6: TCP202 Replaceable Parts and Accessories	40
Table 7: Replaceable Parts - Compensation Box	42
Table 8: Optional Accessories	42

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.

Connect the probe reference lead to earth ground only.

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.*



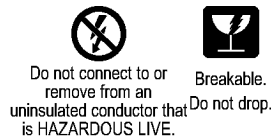
CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

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:



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.

Safety Compliance

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.

Additional Compliances

- 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

Test and measuring equipment.

Safety Class

Class 1 – grounded product.

Pollution Degree Description

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. In order 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 has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

Getting Started

This section describes the TCP202 Current Probe and gives instructions on how to install and functionally test the probe.

Features and Accessories

The TCP202 Current Probe is a 50 MHz current probe for use with Tektronix oscilloscopes that have the TekProbe interface. (See Figure 1.) The probe can measure up to 15 A (DC + peak AC).

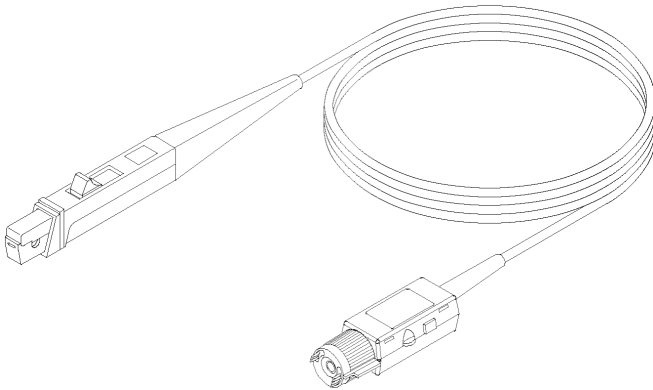
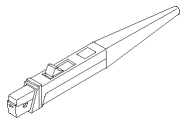


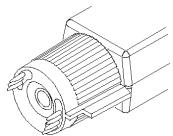
Figure 1: TCP202 Current Probe

Item

Description

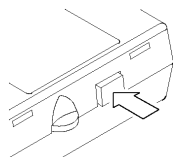


Probe Head. The probe head contains a Hall Effect device for measuring current. The jaw of the probe clamps on any wire (including insulation) that is less than or equal to 3.8 mm (0.15 inches) in diameter.

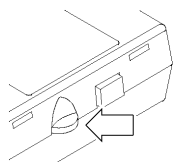


TekProbe Interface. The TekProbe interface provides power, signal, and probe characteristic data.

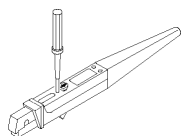
If your oscilloscope does not support the TekProbe interface, you can use the optional 1103 probe power supply as an effective interface. Contact your local Tektronix representative for more information.



Degauss. The degauss button removes residual magnetism from the probe core that would otherwise cause measurement errors.



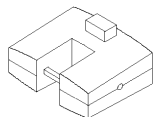
Balance Thumbwheel. The balance thumbwheel compensates for minor DC offsets of the probe output.



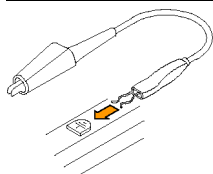
Coarse Balance Adjustment. The coarse balance adjustment centers the range of the balance thumbwheel. Use this adjustment only if the thumbwheel does not have enough range.



WARNING. To avoid electric shock, do not adjust the coarse balance when connected to a live conductor and only use the provided insulated adjustment tool for making the adjustment.



Calibrator (optional). With some TDS oscilloscopes, you can compensate the probe for maximum accuracy using the optional calibrator. Use the calibrator only if your oscilloscope displays the AΩ symbol when the current probe is connected. (For ordering information, see *Replaceable Parts*). (See page 39.)



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

Connecting the Probe to the Oscilloscope

Install the TCP202 Current Probe as follows:

1. Set the input channel to a zero reference point.
2. Connect the output of the probe to the TekProbe interface of the oscilloscope or other measurement instrument. The measurement instrument input must have a ground reference.



WARNING. To reduce risk of electric shock, do not float the oscilloscope or other measurement instrument (for example, an 1103 TekProbe Power Supply) by removing or isolating the ground pin from the AC power cord. This probe is intended for use with ground-referenced oscilloscopes and measurement instruments.

NOTE. If your oscilloscope does not display amperes/division directly, the volts/division can be interpreted as amperes/division.

If you are using the 1103 TekProbe Power Supply, you must set the oscilloscope input coupling to DC and the input impedance to 50 Ω . Interpret V/division as 10 A/division. For example, interpret 100 mV/division as 1 A/division.

3. With the probe jaw empty, push the slide on the probe until it locks in the CLOSED position.
4. Press the DEGAUSS button.
5. Balance the probe as follows:
 - a. Set the oscilloscope vertical scale to 10 mA/division.
 - b. Open and close the probe jaw.
 - c. Adjust the BALANCE thumbwheel until the displayed signal is zero.
6. If you cannot zero the display as described in step 5 c, use the coarse balance adjustment to center the range of the thumbwheel. (See Figure 2.)



WARNING. To avoid electric shock, do not adjust the coarse balance when connected to a live conductor and only use the provided insulated adjustment tool for making the adjustment.



Figure 2: Coarse Balance Adjustment

Compensating the Probe (Optional)

With some TDS oscilloscopes, you can compensate the probe for maximum accuracy using the optional calibrator. Perform this procedure only if your oscilloscope displays the $A\Omega$ symbol when you connect the probe output to the oscilloscope input.

1. To connect the calibrator, press the release button and connect the calibrator to the probe compensation output of the oscilloscope. (See Figure 3.)

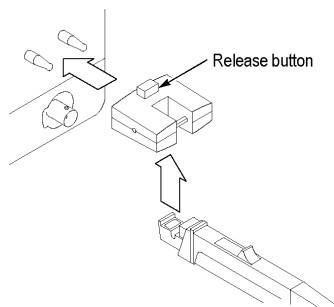


Figure 3: Connecting the Calibrator

2. Close and lock the probe jaw over the calibrator loop.
3. Adjust the oscilloscope to display the signal.
4. Press VERTICAL MENU → Cal Probe → OK Compensate Gain.

If the probe passes the compensation routine, the probe is accurate to within $\pm 1\%$ from 50 mA to 5 A, and within $\pm 2\%$ from 5 A to 15 A.

If the probe fails the compensation routine, refer to the procedure for checking the DC accuracy of the probe and the procedure for accessing the internal gain adjustment. (See page 36, *DC Accuracy*.) (See page 28, *Accessing the Gain Adjustment*.)

Repeat this procedure whenever you move the current probe to another input.

Operating Basics

This section contains important precautions and techniques for clamping the probe on a circuit and taking basic measurements.

Measurement Limits

Before you clamp the probe on a circuit to measure current, observe the precautions for the maximum current ratings.

Maximum Current Rating

There are two basic current ratings: maximum *peak* current and maximum *continuous* current. In addition, the maximum peak current is limited by the A/second rating. A graph of these limits is shown. (See Figure 17 on page 21.)

The maximum peak current is 50 A with a pulse width $\leq 10 \mu\text{s}$ (500 mA seconds). This 500 mA seconds rating applies to any peak current over 15 A. The product of the peak current and pulse width (at 50% of peak) must be 500 mA seconds or less. For example, the maximum pulse width is 20 ms for a pulse of 25 A peak.

The maximum continuous current that this probe can measure is 15 A (DC + peak AC). This limit derates with frequency; as the frequency increases, the maximum current rating decreases. A graph of this relationship is shown. (See Figure 12 on page 19.)

Multiple Current Probes

Up to four TCP202 current probes may be used simultaneously on one TDS Series oscilloscope if the total in-phase current measured by all of the probes does not exceed 40 amperes. Above 40 amperes, the TekProbe interface may overload and cause measurement or display errors.

When one or two TCP202 current probes are used on a TDS Series oscilloscope, the ratings are as shown. (See Figure 17 on page 21.)

NOTE. *When using more than two TCP202 current probes on a single TekProbe Interface oscilloscope, the total in-phase current measured by all of the probes should not exceed 40 amperes. Exceeding 40 amperes may overload the TekProbe interface and cause measurement or display errors.*

Degaussing and Balancing the Probe

For accurate measurements, you must occasionally degauss and balance the probe. Degaussing removes residual magnetization from the probe core that would otherwise shift the zero point and cause measurement errors. Balancing the probe compensates for any DC offset that remains on the probe output after degaussing.

Degauss and balance your probe in each of the following cases:

- After turning on the oscilloscope and allowing a 20-minute warm-up period
- Whenever an overload condition occurs
- Whenever the probe is subjected to a strong external magnetic field
- Whenever there is a measurable DC offset that does not come from the conductor under test

To degauss and balance the probe, follow the installation procedure. (See page 3, *Connecting the Probe to the Oscilloscope*.)

You may degauss the probe with a conductor in the jaw if you first disconnect the power to the conductor. This technique compensates for any offsets caused by stray DC magnetic fields around the circuit under test.



CAUTION. *To prevent damage to circuit under test when degaussing with the probe connected, ensure the circuit under test is de-energized and capable of handling the degauss current before proceeding with probe degaussing.*

NOTE. *While the degauss occurs, the probe will induce a small voltage in a high impedance unpowered circuit (for example, 33 mV in series with 1.5 M Ω). However, with low impedance circuits, several amperes may be induced in the circuit under test which may cause damage to components or very small conductors.*

Ensure that the circuit under test is able to absorb this induced voltage and current.

Measurement Procedures and Techniques

This section presents procedures and techniques for basic current measurements.

Basic Procedure Measure AC or DC current in a single conductor as follows:

1. Observe the safety precautions and operating limits.
2. If necessary, degauss and balance the probe.



WARNING. *To reduce risk of electric shock and fire, use only insulated conductors with this probe on circuits with voltages above 30 Vrms, 42 Vpk, or 60 VDC. These probes are not rated for bare wire voltages above 30 Vrms, 42 Vpk, or 60 VDC.*



CAUTION. *To reduce risk of fire, do not connect or disconnect the current probe to or from a live, uninsulated conductor. The core is not insulated. Always remove power before you connect or disconnect the probe to or from bare conductors.*



CAUTION. *To prevent damage to the probe, do not drop the probe, subject it to physical shock or rapid temperature changes, and do not insert insulated conductors larger than 3.8 mm into the probe jaw or damage may result. If the slider will not close around the conductors, do not force the slide closed; either reduce the number of conductors, or use a smaller conductor if possible without exceeded the amperage rating of the wire.*



CAUTION. *To reduce risk of fire, do not apply any voltage above earth ground potential to the probe common lead. The probe common is grounded through the oscilloscope or 1103 when installed.*

3. Close and lock the probe jaw over the conductor. Conventional current flows from positive to negative. For the correct polarity reading, connect the probe so that the current flow, from positive to negative, is aligned with the arrow on the probe jaw. (See Figure 4 on page 8.)
4. When making high frequency measurements, snap the optional ground lead to the probe transformer post and attach the alligator clip directly to RF ground to improve EMI rejection at high frequencies (2 MHz and above). This will reduce ringing and help bypass capacitively-coupled RF currents which can flow into the probe cable.
5. Read the measurement. Adjust the display of the measurement instrument as necessary.
6. If necessary, adjust the oscilloscope offset control to offset a DC level. (AC coupling is automatically disabled on TDS oscilloscopes when the probe is connected.)

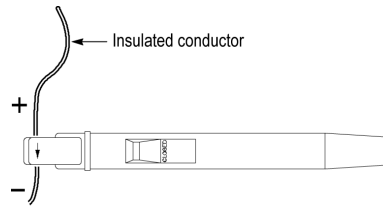


Figure 4: Polarity of Current Flow

Measuring Differential Current

You can place two conductors in a current probe to provide a differential or null current measurement. This avoids the necessity of using two current measurement systems with a differential oscilloscope amplifier.

1. Orient the two conductors under test so that the polarities oppose each other. Clamp the current probe around the two conductors as shown. (See Figure 5.)
2. Measure the current. A waveform above the baseline indicates the conductor with the conventional current flow in the direction of the probe arrow is carrying the greater current.
3. To adjust for a current null, adjust the current in one of the conductors until the displayed measurement is zero.

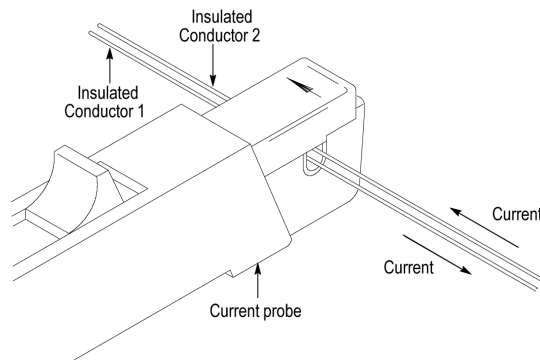


Figure 5: Measuring Differential Current and Nulls

Extending the DC Current Range

You may encounter situations where your measurement exceeds the maximum current rating of the connected probe. This section discusses methods for extending DC current ranges without exceeding specified limits.



WARNING. To avoid personal injury or equipment damage, do not exceed the specified electrical limits of the oscilloscope or any applicable accessories. When using multiple conductors, ensure that there is adequate insulation between conductors and do not exceed the current limits on either conductor.

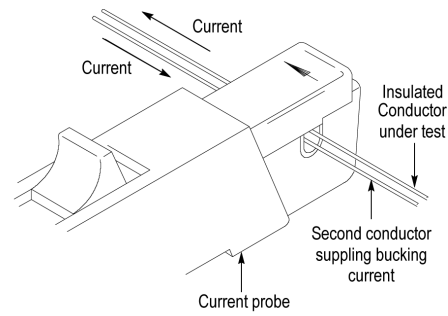
If you want to measure a low-amplitude AC component that is superimposed on an extremely large steady state DC component (such as in a power supply), or if you want to extend the DC current range of your probe, you can add offset (bucking) current with a second conductor.

By adding bucking current, the amount of DC current that you measure is the difference between the DC component of the signal and the bucking current. You can then calculate the amount of DC current in the conductor under test by adding the value of the measured current to the value of the bucking current.

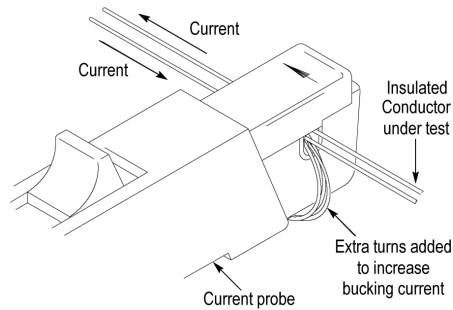
To supply additional bucking current, place a second conductor that has a pure DC component of known value in the probe jaw with the conductor under test. (See Figure 6 on page 10.) Orient the second conductor so that the bucking current flows in the opposite direction of the DC flow in the conductor under test.

You can increase the value of the bucking current by winding multiple turns of the second conductor around the probe. (See Figure 6 on page 10.) 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.

NOTE. *Adding a second conductor to the probe reduces the upper bandwidth limit of the probe.*



(a) Adding a second conductor



(b) Adding multiple turns

Figure 6: Increasing the DC Measurement Range

Increasing Measurement 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 winding several turns of the conductor under test around the probe as shown. (See Figure 7.) The signal is multiplied by the number of turns around the probe.

When viewing the signal on the oscilloscope screen, divide the displayed amplitude by the number of turns to obtain the actual current value. For example, if a conductor is wrapped around the probe five times and the oscilloscope shows a reading of 50 mA DC, the actual current flow is 50 mA divided by 5, or 10 mA DC.

NOTE. *Winding multiple turns around the probe increases the insertion impedance of the probe which can affect the accuracy of your measurements and the circuit under test. See the graphs of insertion impedance. (See Figure 13 on page 20.) (See Figure 15.)*

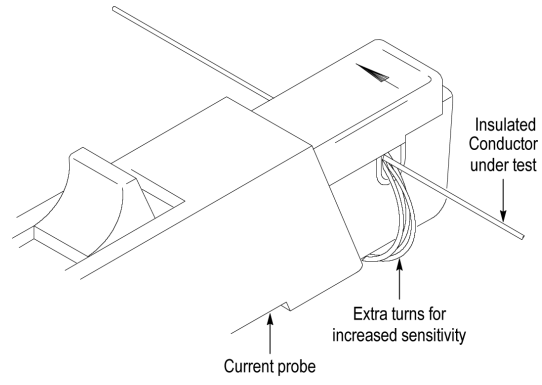


Figure 7: Increasing Probe Sensitivity

Reference

This section describes extended measurement applications of the TCP202 Current Probes:

- Power Measurements
- Inductance Measurements
- Continuity Test of Multiple-Conductor Cable
- Measuring Inductor Turns Count

Power Measurements

You can measure the instantaneous power delivered to the load of a two-wire circuit using a digital oscilloscope that allows you to multiply two channels.

1. Connect the output of a differential voltage probe (such as the P5205) to one channel and the output of the TCP202 Current Probe to the other channel of the oscilloscope.

NOTE. *For high-frequency measurements, the time (propagation) delays of both probes should match. (The P5205 and TCP202 probes, for example, have matching propagation delays.) You can also use the deskew function available on some TDS oscilloscopes to match the time delays.*

2. Connect the + input of the differential probe to the first terminal and – input to the second (reference) terminal.
3. Close and lock the current probe around the conductor of the first terminal with the arrow on the probe head pointing in the direction of the reference.
4. So that the voltage and current waveforms are phase-related, select only one channel as the trigger source and acquire the two waveforms.
5. After acquiring the current and voltage waveforms, set the two channels to multiply together. (On the TDS Series oscilloscopes that have this capability, select MORE→Change Math waveform definition→Dual Wfm Math→Set operator to *→OK Create Math Wfm.) The oscilloscope displays the power waveform.

Other functions on TDS oscilloscopes allow you to measure the average power for one cycle (Cycle Mean) or the average power for the entire record (Mean). Refer to the user manual of your oscilloscope for more information.

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

A measurement setup using a constant-voltage pulse generator of extremely low output impedance is shown connected to an inductor that has low resistance. (See Figure 8.) The inductor is connected across the output terminals of the pulse source and a constant voltage is maintained across the inductor. The current probe is clamped over one of the source leads and the current ramp is measured.

The inductance is effectively defined by the slope of the current ramp. (See Figure 9 on page 15.) It is mathematically expressed by the following formula:

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

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

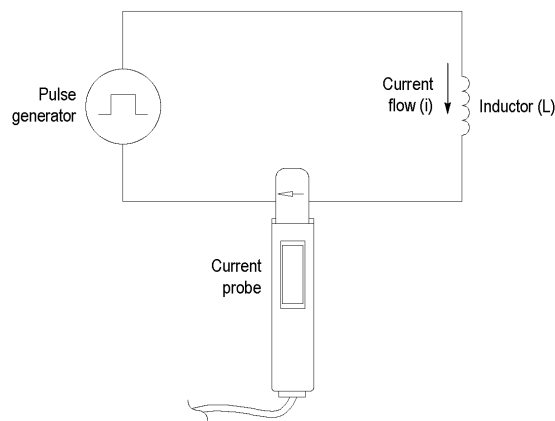


Figure 8: Measuring Inductance with a Low-Impedance Source

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.*

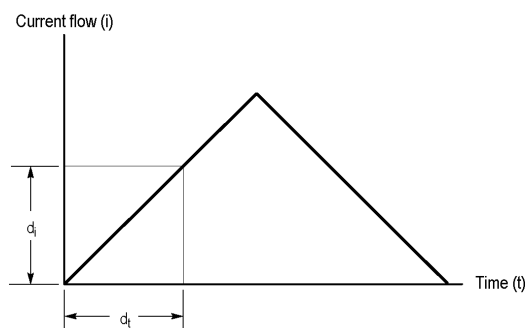


Figure 9: Linear Current versus Time Ramp

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 setup diagram is shown, which is similar to the previous example. (See Figure 10.) The current ramp shows how the values for the inductance formula are obtained. (See Figure 11.)

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

$$L = \tau R$$

where L is the inductance in henries, t 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.

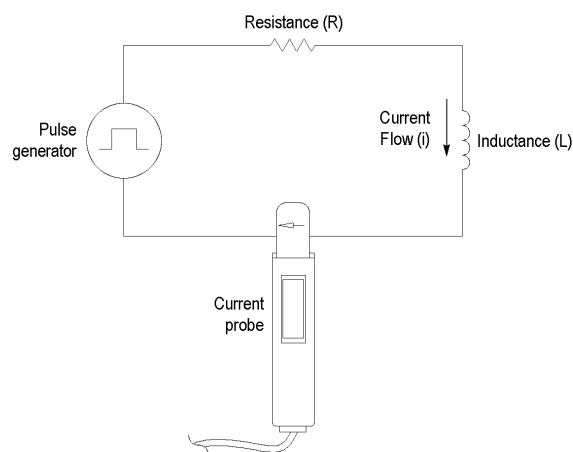


Figure 10: Measuring Inductance with a High-Impedance Source

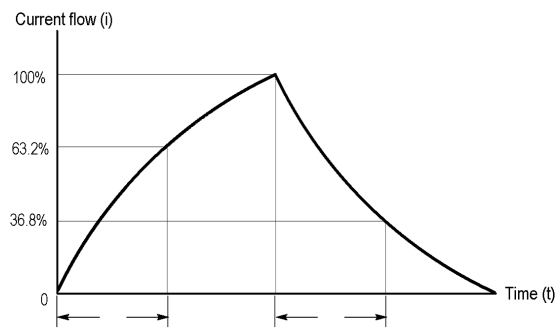


Figure 11: High-Impedance Source Current Ramp

Continuity Test of Multiple-Conductor Cable

You can test single conductors in a multiconductor cable. To check a conductor, clamp the current probe around the cable bundle and check for a specific, known current signal. If there is no current or the current is abnormally low, then the conductor has a continuity problem. If the current is abnormally high, then the conductor may have a short to ground.

Specifications

The specifications in the tables that follow apply to a TCP202 Current Probe installed on a Tektronix TDS 520B Oscilloscope. (See Table 1.) through (See Table 3.) The tables also list the specifications for the calibrator that can be used on some TDS oscilloscopes to increase the DC accuracy. (See Table 8 on page 42.)

When the probe is used with another oscilloscope, the oscilloscope must have a bandwidth of at least 200 MHz. Oscilloscopes without the TekProbe interface must use a Tektronix 1103 TekProbe Power Supply.

The probe must have a warm-up period of at least 20 minutes and be in an environment that does not exceed the temperature and humidity limits described. (See Table 1.)

Specifications for the TCP202 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. (See Table 1.) Warranted characteristics that have checks in the *Performance Verification and Adjustment* section appear in boldface type.

Table 1: Warranted Electrical Characteristics

Characteristic	Description
DC Accuracy	$\pm 3\%$ (correctable to $\pm 1\%$ from 50 mA to 5 A and $\pm 2\%$ from 5 A to 15 A when used with calibrator on self-calibrating TDS series oscilloscopes)
Calibrator Resistance	42 Ω
Calibrator Amp-turns	0.500 Amp-turns
System Bandwidth	DC to 50 MHz (oscilloscope bandwidth ≥ 200 MHz)
System Rise Time	< 7 ns (oscilloscope rise time < 1.75 ns)
Maximum DC and Low Frequency Current	15 A (DC + peak AC) (See Figure 17 on page 21.)
Maximum Peak Current	50 A with pulse width ≤ 10 μ s (See Figure 17 on page 21.)
Maximum Voltage on Uninsulated Wire	Insulated wire only for voltages above 30 VAC, 42 Vpk, and 60 VDC.
Temperature	Operating: $+5$ $^{\circ}$ to $+50$ $^{\circ}$ C Nonoperating: -10 $^{\circ}$ to $+60$ $^{\circ}$ C

Table 1: Warranted Electrical Characteristics (cont.)

Characteristic	Description
Humidity	Operating: tested at 90 to 95% RH, +30 ° to +50 °C Nonoperating: tested at 90 to 95% RH, +30 ° to +60 °C
Altitude	Operating: Up to 3000 meters (10,000 feet) Nonoperating: Up to 12,192 meters (40,000 feet)

Typical Characteristics

Typical characteristics describe typical but not guaranteed performance.

Table 2: Typical Electrical Characteristics

Characteristic	Description
Frequency Derating	(See Figure 12.)
System Noise	<2.5 mA _{RMS} , bandwidth of measurement device limited to 20 MHz (At higher bandwidths, the noise is a function of the oscilloscope front end noise)
System Aberrations	10% p-p
Insertion Impedance	Phase angle: (See Figure 14 on page 20.) (See Figure 16 on page 21.) Magnitude: (See Figure 13 on page 20.) (See Figure 15 on page 20.)
Time (Propagation) Delay	17 ns
Amp-second Product	500 μ A-s (See Figure 17 on page 21.)

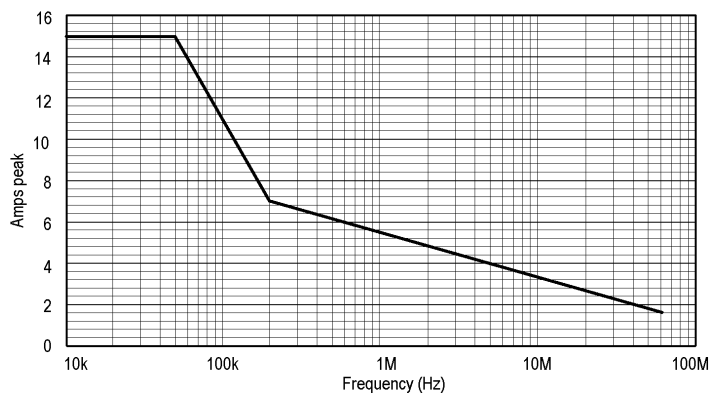


Figure 12: Frequency Derating

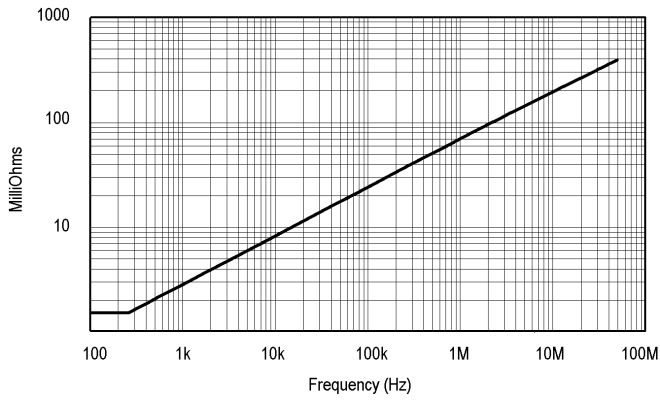


Figure 13: Insertion Impedance - Magnitude - Single Conductor

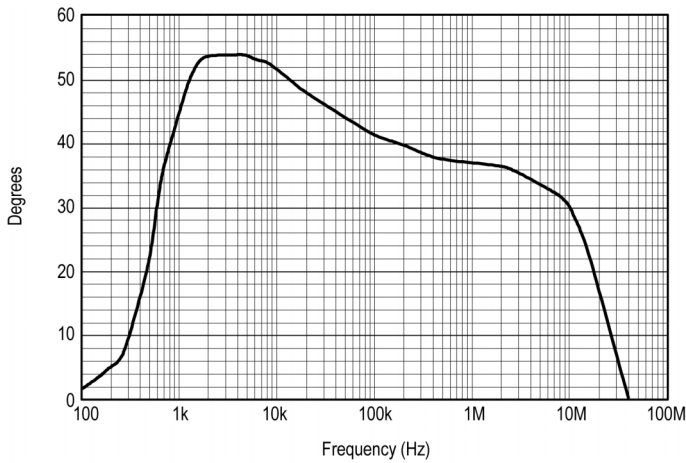


Figure 14: Insertion Impedance - Phase Angle - Single Conductor

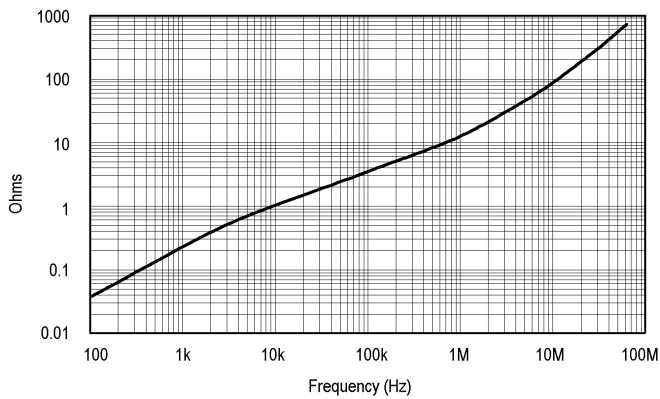


Figure 15: Insertion Impedance - Magnitude - 10-Turn #24 AWG Primary

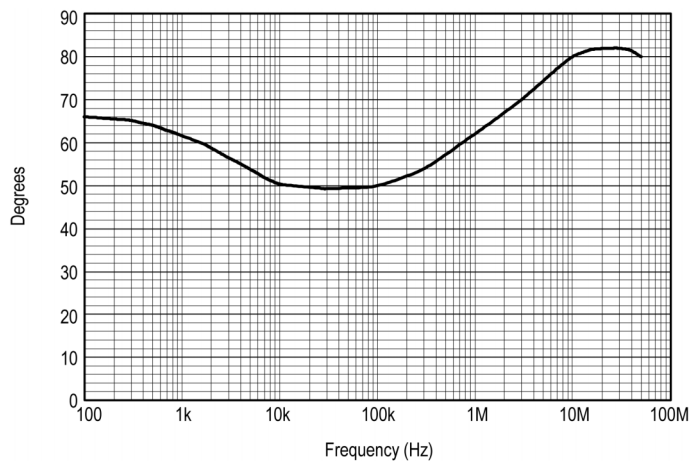


Figure 16: Insertion Impedance - Phase Angle - 10-Turn #24 AWG Primary

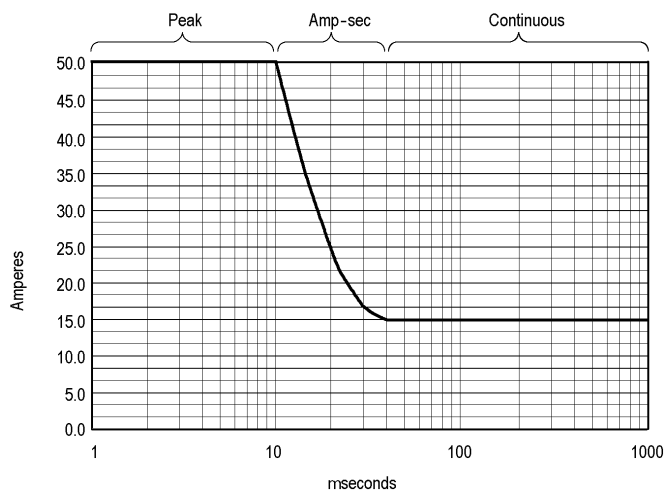


Figure 17: Current Ratings

Nominal Characteristics

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

Table 3: Nominal Characteristics

Characteristic	Description
Current Transfer Ratio	0.1 Volt/Amp into 50 Ω
Maximum Conductor Diameter	3.8 mm (0.15 in) diameter
Dimensions, Probe Head	Length: 200 mm (7.76 in) Width: 16 mm (0.62 in) Height: 32 mm (1.25 in)
Unit Weight (probe only)	0.19 kg (0.44 lbs)
Cable Length	2.16 m (85 in)
Calibrator Turns	42

Maintenance

This section explains how to access and maintain components of the probe. Only qualified service personnel should perform the disassembly procedures in this section.

Cleaning the Probe Head

The jaw of the probe head consists of a slider and current sensing transformer. When the jaw is closed, the core of the transformer is electrically complete and the probe head can sense current flowing through a conductor in the jaw. If the DC accuracy is not within specified limits, it may be due to an accumulation of debris on the mating surfaces of the core.

To partially clean the mating surfaces of the core, open the jaw and clean the exposed surfaces with a cotton swap dampened with isopropyl alcohol. In most cases this should be enough to restore the accuracy of the probe.

To fully clean all mating surfaces of the core you must disassemble the probe head. (See page 30, *Probe Head Disassembly*.)

Do not lubricate the mating surfaces of the core. Any lubricant between the core pieces should be removed with a recommended solvent.

To clean the probe body, use a soft cloth dampened in a solution of 75% Isopropyl alcohol (IPA) and water.



CAUTION. Do not use chemicals containing benzene, benzene, toluene, xylene, acetone, or similar solvents.

Do not use a petroleum based lubricant on the plastic. If the plastic slide assembly requires lubrication, use a silicone based grease sparingly.

Do not immerse the probe in liquids or use abrasive cleaners.

Servicing the Compensation Box

Some components of the compensation box can be serviced. These components include the TekProbe interface pins, probe collar, compensation box covers, and the gain adjustment.



WARNING. The probe must only be serviced by qualified service personnel. Refer to General Safety Summary and Service Safety Summary before starting any disassembly, replacement, or repair.



WARNING. *To avoid personal injury and damage to the probe, remove the probe from any signal source before attempting to adjust or service the probe. Do not service electrical equipment alone. If you must service or adjust equipment that is attached to a signal or power source, do so only when another person capable of rendering first aid and resuscitation is present.*

Replacing TekProbe Interface Pins

TekProbe interface pins can stick and fail to make contact after time. Periodically check each of the interface pins. Replace any pin that fails to move freely and fully extend.



CAUTION. To prevent risk of fire or damage to the probe, ensure the collar is properly installed. Note the orientation of the collar before and after installation; there is no key to prevent improper installation. If the collar is installed backwards, the TekProbe Power pins will be reversed and damage to the probe will result.

To remove a TekProbe interface pin, firmly grasp the pointed tip with pliers and pull the pin out of the connector. (See Figure 18.)

No tools are required to install a replacement pin. Insert a new pin into the connector socket as far as possible using finger pressure. If necessary, seat the pin into the connector by pressing the tip of the pin gently but firmly against a hard surface.

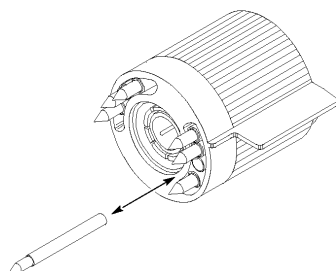


Figure 18: Replacing TekProbe Interface Pins

Removing and Replacing the TekProbe Interface Collar

To remove the TekProbe interface collar, firmly grasp the compensation box body with one hand and the TekProbe interface collar with the other hand. Firmly pull the interface collar off.

To replace the collar, note the pin configuration on the compensation box and their holes in the interface collar. The group of three pins fit through the smaller of the two holes in the interface collar. (See Figure 19.)

Align the tab to the slot and gently press the two pieces together.

Once installed, the TekProbe collar should rotate freely to lock and unlock.

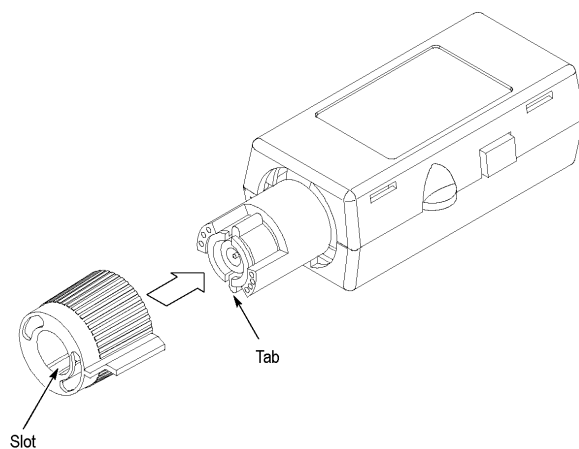


Figure 19: Replacing the TekProbe collar

Removing the Compensation Box Covers



CAUTION. To prevent damage to internal components by means of electrostatic discharge (ESD), wear a grounded anti-static wrist strap.

To open the compensation box, follow these steps:

1. Press the optional release tool pins into the compensation box cover catches and gently lift the cover off a small distance. (See Figure 20.)
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.

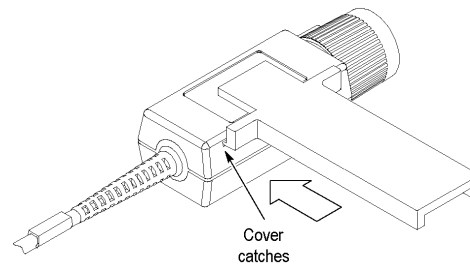


Figure 20: Removing the Compensation Box Covers

Accessing the Gain Adjustment

1. Open the compensation box with the release tool. Remove the top cover.
2. Carefully lift the back edge of the circuit board to access the gain adjustment. (See Figure 21.)
3. Connect the output of the probe to the oscilloscope.
4. Adjust the probe using the setup for the DC accuracy test. (See page 36, *DC Accuracy*.) You can also use a $0.5 A_{p-p}$ signal that is accurate to within $\pm 2\%$ and set the DC gain to exactly 5 divisions.

NOTE. *The gain of the probe must be within $\pm 2\%$ for the compensation routine to work properly.*

5. After adjusting the probe, disconnect the probe from the setup.

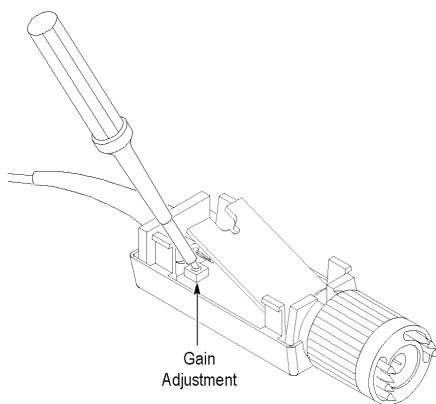


Figure 21: Accessing the Gain Adjustment

Replacing the Compensation Box Covers

To replace the covers, follow these steps:

1. Align the TekProbe interface and the strain relief notches with the tabs on the cover. (See Figure 22.)
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.

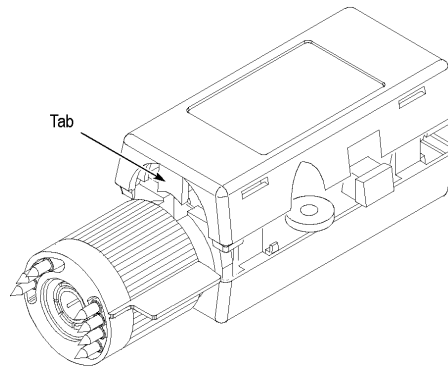


Figure 22: Replacing the Compensation Box Cover

Probe Head Disassembly



CAUTION. *Probe disassembly should only be performed by qualified service personnel.*

1. Remove the two screws from the bottom of the probe and pull the strain relief boot back. (See Figure 23.)

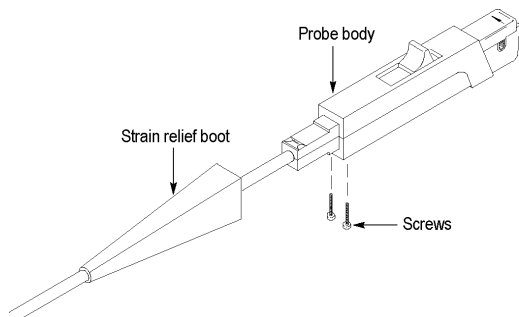


Figure 23: Removing the Strain Relief Boot

2. Move the probe slide assembly to the open position.

NOTE. *The probe slide contains a tiny metal ball. In step 3, be careful not to lose the ball by accidentally letting it fall out.*

3. Hold the probe in a top-up horizontal position and slide the top half of the probe body off. (See Figure 24.)

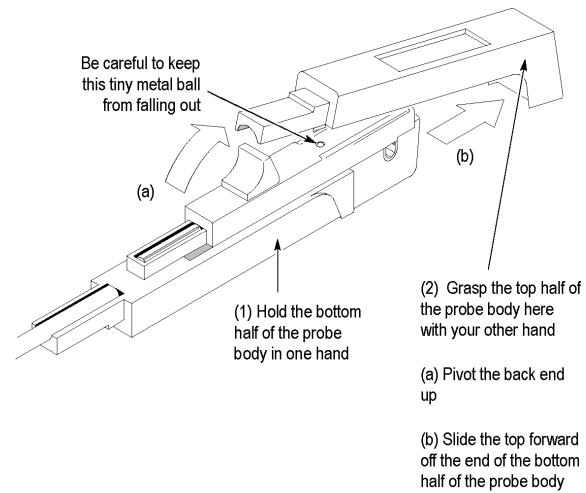


Figure 24: Removing the Top Half of the Probe

4. Remove the metal ball.

5. Turn the probe upside down, push the slide back slightly, and remove the slide. (See Figure 25.)

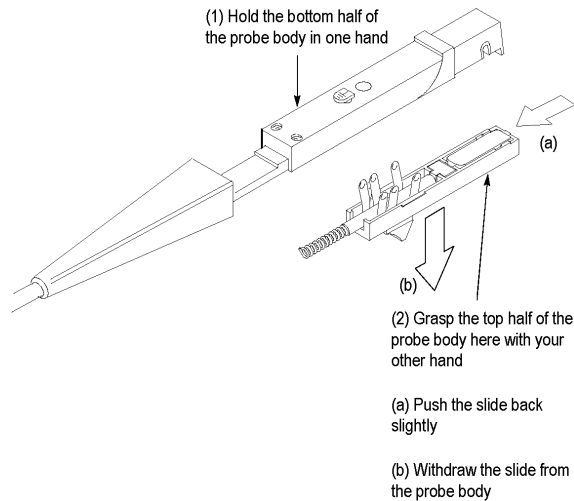


Figure 25: Removing the Probe Slide

NOTE. *The circuit board might be soldered to a ground post attached to the body half. If necessary, carefully desolder the connection before attempting to remove the circuit board.*



CAUTION. *To prevent damage to the circuit board when desoldering, use only enough heat to separate or attach connections. Excess heat may cause irreparable damage to the circuit board.*

6. If you need to replace the current transformer, lift the transformer out of the probe and pull it out of the circuit board socket. (See Figure 26.) The circuit board may be removed by lifting out the strain relief and the circuit board from the body half.

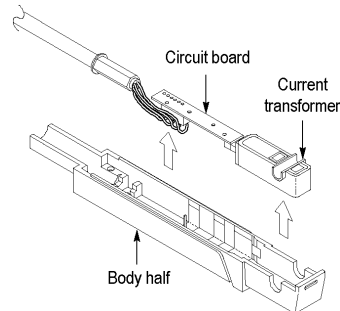


Figure 26: Removing the Current Transformer

7. Before reassembling the probe, be sure that the gap between the stationary and moveable core pieces is clean. If necessary, use isopropyl alcohol or a similar cleaning agent to clean the pieces. Also, clean the contacts of the slide switch, if necessary. Should the plastic slide assembly require lubrication, sparingly apply silicone-based grease to the parts.

Probe reassembly is the reverse of steps 1 through 7.

NOTE. Exercise care when fitting the slide back into the probe body; aligning the switch contacts can require patience.

Obtaining Replacement Parts

Replacement parts may be obtained through your local Tektronix field office or representative. (See page 39, *Replaceable Parts*.)

Preparation for Shipment

If you must ship your Tektronix product, please use the original packaging if possible. If the original packaging is unfit for use or not available, use the following packaging guidelines:

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 a plastic bag or wrap 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.

Performance Verification and Adjustment

The procedures in this section allow you to demonstrate that the TCP202 Current Probe and the optional calibrator meet the specified levels of performance and to adjust them if necessary.

Test Procedure Conditions

These procedures are valid only under the following conditions:

- The system has been calibrated at an ambient temperature between +20 °C and +30 °C (68 °F to 86 °F)
- The system is operating in an environment whose limits are described in the Specifications section. (See Table 1 on page 17.)
- The system, including probe, has had a warm-up period of at least 20 minutes
- The probe degauss and balance routine has been performed after the 20-minute warm-up period

Equipment Required

The following procedure verifies the warranted electrical characteristics of the TCP202 Current Probe. The equipment required, an example or part number of the equipment, and an explanation of the purpose of the equipment is shown below. (See Table 4.)

NOTE. *These procedures assume that you are using an oscilloscope that automatically displays the correct amperes/division. If not, you must take the scale factor of the probe into account when setting the volts/division on the oscilloscope. (See page 3, Connecting the Probe to the Oscilloscope.)*

Table 4: List of Equipment Required

Description	Minimum Requirements	Example or Part Number	Purpose
Test oscilloscope	Bandwidth: ≥ 200 MHz TekProbe interface vertical accuracy: $\leq 1.5\%$	TDS 520B	Display probe output
Calibration generator	Amplitude accuracy: $\leq 0.25\%$ Rise time: ≤ 3 ns	Wavetek 9100 with oscilloscope option	Check probe DC accuracy, bandwidth, and rise time
BNC adapter	BNC-female-to-dual banana	103-0090-00	Interconnection, current loop and generator
Current loop, 50 Ω	50 $\Omega \pm 0.5\%$, BNC male	015-0601-50 or 067-0559-00	Bandwidth and rise time checks
Current loop, 0 Ω	18 AWG insulated wire, 8 cm (3 in) long	—	DC Accuracy check
Precision meter	0.02% accuracy with sense inputs (4 terminals)	Fluke 8840A	Check and adjust input resistance of optional calibrator

DC Accuracy

1. Connect a zero-ohm current loop to the output connectors of the calibration generator.
2. Set the calibration generator for a 1 A, DC output.
3. Set the amperes/division on the oscilloscope to 0.2 A with the display at a zero reference point at least two divisions below center screen.
4. Clamp the jaw of the probe head around the current loop.
5. Check that the DC accuracy is $\pm 3\%$ (4.85 to 5.15 divisions).
6. Disconnect the setup.

For higher accuracy, refer to page 4 and perform the probe compensation routine using the optional calibrator, then verify that the DC accuracy is $\pm 1\%$ (4.95 to 5.05 divisions).

NOTE. *For the compensation routine to work properly, the DC accuracy of the probe must be at least $\pm 2\%$ before you begin. If the probe fails the compensation routine, try cleaning the probe head. (See page 23, Maintenance.) Also read the information on accessing the gain adjustment. (See page 28, Accessing the Gain Adjustment.)*

Bandwidth

1. Connect a 50 Ω current loop to the output connector of the calibration generator.
2. Clamp the jaw of the current probe around the current loop.
3. Set the amperes/division on the oscilloscope to 10 mA and time/division to 20 μ s. (If you are using a digitizing oscilloscope, set the acquisition mode to Average and the number of samples to 16.)
4. Set the calibration generator to 50 kHz and the amplitude to display 6 divisions on screen.
5. Set the generator to 50 MHz and the oscilloscope to 5 ns/division.
6. Check for ≥ 4.2 divisions peak to peak.
7. Disconnect the setup.

Rise Time

1. Connect a 50 Ω current loop to the 50 Ω fast-rise output of the calibration generator.
2. Clamp the jaw of the current probe around the current loop.
3. Set the amperes/division on the oscilloscope to 10 mA and time/division to 5 ns. (If you are using a digitizing oscilloscope, set the acquisition mode to Average and the number of samples to 16.)
4. Set the fast-rise amplitude to display 2 divisions on screen.
5. Check that the rise time is ≤ 7 ns.
6. Disconnect the setup.

Calibrator Accuracy (Optional)

1. Connect the sense and input probe tips of the precision ohmmeter across the two input terminals of the calibrator. (The probe tips of the sense leads and input leads must contact at the same two points.)
2. Check that the input resistance of the calibrator measures 42.00 Ω .
3. If the reading is not exact, insert a flat-blade adjustment tool into the hole in the left side of the calibrator and adjust the resistance to a value of 42.00 Ω .
4. Disconnect the setup.

Replaceable Parts

This section contains a list of the replaceable modules for the TCP202 Current Probe. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the TCP202 Current Probe. Use this list to identify and order replacement parts. The table below describes each column in the parts list.

Table 5: Parts List Column Descriptions

Column	Column Name	Description
1	Figure & Index Number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix Part Number	Use this part number when ordering replacement parts from Tektronix.
3	Qty	This indicates the quantity of parts used.
4	Name & Description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.

Abbreviations

Abbreviations conform to American National Standard ANSI Y1.1-1972.

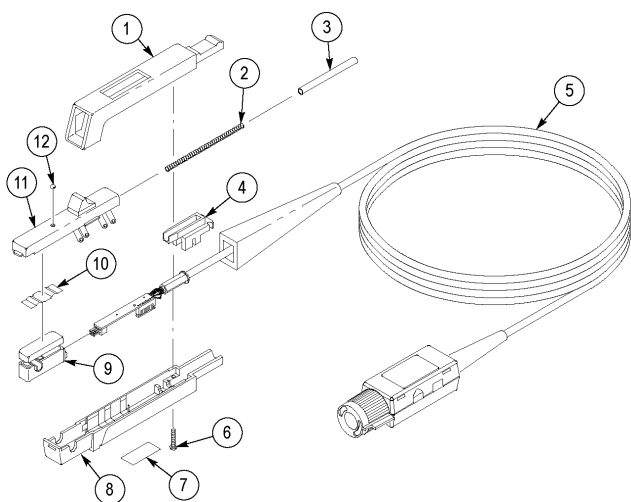


Figure 27: TCP202 and Replaceable Parts and Accessories

Table 6: TCP202 Replaceable Parts and Accessories

Fig. & Index Number	Tektronix Part Number	Qty	Name & Description
27-		1	PROBE, CURRENT: TCP202
-1	204-0288-03	1	BODY HALF, PROBE:UPPER
-2	214-0835-00	1	SPRING, HLCPS:0.127 OD X 2.65 L, SST
-3	214-0849-00	1	RTNR RETURN SPR:BRS CD PL
-4	352-0106-00	1	HOLDER, SPR RTNR:DELTRIN

Table 6: TCP202 Replaceable Parts and Accessories (cont.)

Fig. & Index Number	Tektronix Part Number	Qty	Name & Description
-5	650-3463-00	1	BD/CABLE ASSY:CABLE W/TCP202 PROBE CIRCUIT BOARD
-6	213-0087-00	2	SCREW, TPG, TC:2-32 X 0.5, TYPE BT, PANHEAD, STEEL, CADIUM PLATED, POZIDRIVE
-7	334-9171-00	1	MARKER, ID:PROBE ID, TCP202
-8	204-0714-06	1	BODY, HALF:LOWER BODY HALF W/CONTACTS
-9	120-1984-00	1	XFMR SUBASSY:UPPER & LOWER TRANSFORMER
-10	214-0854-00	1	CONTACT, ELEC:UPPER SHELF, CU BE
-11	351-0121-01	1	CONT ASSY, ELEC:PROBE SLIDE ASSY
-12	214-0997-00	1	BALL, BEARING: 0.094, SST
	070-9542-XX	1	MANUAL, TECH:INSTRUCTIONS, TCP202
	070-9543-XX	1	MANUAL, TECH:REFERENCE, TCP202

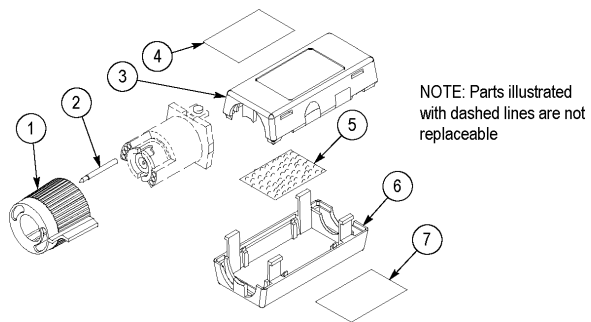


Figure 28: Replaceable Parts - Compensation Box

Table 7: Replaceable Parts - Compensation Box

Fig. & Index Number	Tektronix Part Number	Qty	Name & Description
28-1	205-0191-00	1	SHELL, ELEC CONN:BNC, ABS, DOVE GRAY
-2	131-3627-01	1	CONTACT, ELEC:GOLD PLATED TIP
-3	206-0429-06	1	COMP BOX HALF:TOP
-4	334-9139-00	1	MARKER, IDENT:FRONT IDENTIFICATION LABEL, TCP202
-5	348-1487-00	2	CUSHION:FOAM CUSHION, 30 PPI POLY FILTER FOAM, 0.005 THK ACRYLIC ADHESIVE, 1 SIDE, 0.850 X 0
-6	206-0430-00	1	COMP BOX:COVER, BOTTOM HALF
-7	334-9140-00	1	MARKER, IDENT:BACK IDENTIFICATION LABEL, GE LEXAN, POLY, TCP202

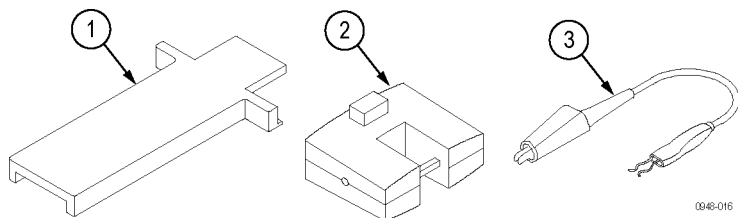


Figure 29: TCP202 Optional Accessories

Table 8: Optional Accessories

Fig. & Index Number	Tektronix Part Number	Qty	Name & Description
29-1	003-1383-00	1	RLSE TOOL, COVER: COMP BOX, POLYCARBONATE
-2	015-0672-50	1	ADAPTER, CALIBRATOR: 50 TURN CURRENT LOOP, 50 OHM
-3	196-3120-XX	1	LEAD, ELECTRICAL; DISCRETE, PROBE GROUND; 23 AWG, 6.0 L, ALLIGATOR CLIP
	1103	1	TEKPROBE IF PS:W/OFFSET 2 CONN