TELEDYNE LECROY
Everywhereyoulook™

Operator's Manual

CP150 and CP500
Current Probes

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CP150 and CP500 Current Probes

Operator's Manual

July, 2017

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CP150 and CP500 Current Probes Operator's Manual

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Safety Instructions

Follow these instructions to keep the probe operating in a correct and safe condition. Observe generally accepted safety procedures in addition to the precautions specified here. **The overall safety of any system incorporating this accessory is the responsibility of the assembler of the system.**

Symbols

These symbols appear on the probe body or in documentation to alert you to important safety considerations.

	**CAUTION**, possibility of electric shock.
	**CAUTION** of damage to probe or instrument, or **WARNING** of hazard to health. Attend to the accompanying information to protect against personal injury or damage. Do not proceed until conditions are fully understood and met.
	Do not apply around or remove from **UNINSULATED HAZARDOUS LIVE** conductors which may render electric shock, electric burn, or arc flash.
	Equipment protected by double insulation or reinforced insulation.
	**CAUTION**, hot surface.

Precautions

Comply with the following safety precautions to avoid personal injury or damage to your equipment:

Use only as specified. The probe is intended to be used only with compatible Teledyne LeCroy instruments. Using the probe and/or the equipment it is connected to in a manner other than specified may impair the protection mechanisms.

Do not use the probe for measurements on Mains circuits. The probe should only be applied around or removed from insulated limited energy circuit conductors that are not directly connected to the mains.

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Do not overload; observe all ratings. To avoid electric shock or fire, do not connect the current probe to any wire that carries voltages or currents that exceed the ratings of the probe.

Connect and disconnect properly. Connect the probe to the measurement instrument before connecting to the circuit/conductor being measured. Avoid damaging the cable through excessive bending.

Never install or remove the probe on bare conductors which are energized. The transformer core and shield are grounded but not insulated and may contact the conductor when the locking lever is open.

Be careful not to damage the insulation surface when making measurements. Before clamping to the conductor being measured, check that the insulation on the conductor is undamaged, and take care not to damage the insulation when clamping the conductor. Any damage to the insulation could cause an electric shock.

Use only indoors and within the operational environment listed. Do not use in wet or explosive atmospheres.

Do not remove the probe's casing. Touching exposed connections may result in electric shock.

Keep product surfaces clean and dry.

Comply with the maximum input current vs. frequency derating when measuring current that includes a high frequency component. Using the probe at high frequencies or strong magnetic fields may cause the device to become abnormally hot, resulting in fire, equipment damage or burns.

Do not operate with suspected failures. Before each use, inspect the probe and accessories for any damage such as tears or other defects in the probe body, cable jacket, accessories, etc. If any part is damaged, cease operation immediately and sequester the probe from inadvertent use.

NOTE: Depending on the amplitude and frequency of the current being measured, the sensor head may emit a resonant sound. This sound may also occur during demagnetizing operation, but it does not represent a malfunction (device failure).

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Introduction

The CP150 and CP500 current probes are designed for easy, highly accurate current measurements. The compact probes offer wide bandwidth with over-current protection.

The probes utilize a combination of Hall-effect and transformer technology which enables measurements to be made on DC, AC and impulse currents.

The CP150 has a 10 MHz bandwidth and is designed to measure continuous currents up to 150 Amps. The CP150-6M has a 5 MHz bandwidth and is designed to measure continuous currents up to 150 Amps.

NOTE: All CP150 probes, regardless of cable length, will indicate default probe bandwidth of 10 MHz in the Attributes section of the Probe dialog.

The CP500 has a 2 MHz bandwidth and is designed to measure continuous currents up to 500 Amp.

The probes can be used with any Teledyne LeCroy instrument with a ProBus interface, or by using a ProBus interface adapter. With the ProBus interface, the probe becomes an integral part of the measuring instrument. The bandwidth limit, Auto Zero and Degauss functions are all controlled from the instrument's touch screen user interface. The interface provides power to the probe, so no external power supply is needed.

Specifications

Specifications are subject to change without notice.

Warranted Characteristics

	CP150	CP150-6M	CP500
Amplitude Accuracy	±1.0 % of reading at 0-150 Amp ±2.0% of reading at 150-300 Apeak		±1.0 % of reading at 0-500 Amp ±2.0% of reading at 500-700 Apeak
Bandwidth (probe only)	DC to 10 MHz	DC to 5 MHz	DC to 2 MHz

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Nominal Characteristics

	CP150	CP150-6M	CP500
Max Continuous Input Current	150 Arms		500 Arms
Max Peak Current	300 Apeak non-continuous		700 Apeak non-continuous
Intended Output Load	1 MΩ		1 MΩ
Measured Conductors	Insulated Conductors only		Insulated Conductors only
Sensitivity *	100 mA/div to 100 A/div		100 mA/div to 200 A/div

* Values are based on oscilloscopes with 1 mV/div sensitivity. Numbers will be higher on instruments with lower sensitivity.

Typical Characteristics

	CP150	CP150-6M	CP500
Output voltage	0.01 V/A		0.01 V/A
Sensitivity Temperature Coefficient	±2% or less (0^0C to +40^0C)		±2% or less (0^0C to +40^0C)
Noise (at 20 MHz BW)	6.0 mArms or less		8.0 mArms or less
Rise Time	≤ 35 ns	≤ 70 ns	≤ 175 ns

Environmental Characteristics

	CP150	CP150-6M	CP500
Operating Temperature	0 ^{0}C to 40 ^{0}C		0 ^{0}C to 40 ^{0}C
Operating RH	≤ 80% (non-condensing)		≤ 80% (non-condensing)
Storage Temperature	-10 ^{0}C to 50 ^{0}C		-10 ^{0}C to 50 ^{0}C
Storage RH	≤ 80% (non-condensing)		≤ 80% (non-condensing)
Max Altitude	2000 m		2000 m
Effect of External Magnetic Field	Maximum of 150 mA in a DC/60 Hz, 400 A/m magnetic field		Maximum of 800 mA in a DC/60 Hz, 400 A/m magnetic field

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Physical Characteristics

	CP150	CP150-6M	CP500
Probe Head Length	175 mm (6.9 inch)		175 mm (6.9 inch)
Probe Head Width	27 mm (1.1 inch)		27 mm (1.1 inch)
Probe Head Height	69 mm (2.6 inch)		69 mm (2.7 inch)
Maximum diameter of conductors measured	20 mm (0.79 inch)		20 mm (0.79 inch)
Cable Length	2 m (6.5 feet)	6 m (19.6 feet)	6 m (19.6 feet)

Safety Ratings

Probe Designation[1]	Type D
Measurement Category [2]	No rated measurement category
Safe Voltage Rating [3]	Use only on fully insulated conductors
Pollution Degree [4]	2

Definitions (per IEC/EN 61010-2-032:2012)

1. Type D current probe is intended to be applied around or removed from insulated conductors.
2. No rated measurement category; not intended for measurements on circuits directly connected to the Mains supply. Not rated for measurements within Measurement Categories II, III, or IV.
3. Not rated for measurements on uninsulated conductors.
4. Pollution Degree 2 refers to operating environment where normally only dry, non-conductive pollution occurs. Temporary conductivity caused by condensation must be expected.

NOTE: Because of the marking requirements per safety standard EN 61010-2-032:2012 (Third Edition), the measurement category rating that was on the CPxxx probes originally certified per EN 61010-2-032:2002 (Second Edition) has been removed from the product label. However, this change does not reduce the measurement capability or the level of protection offered by the new probe design.

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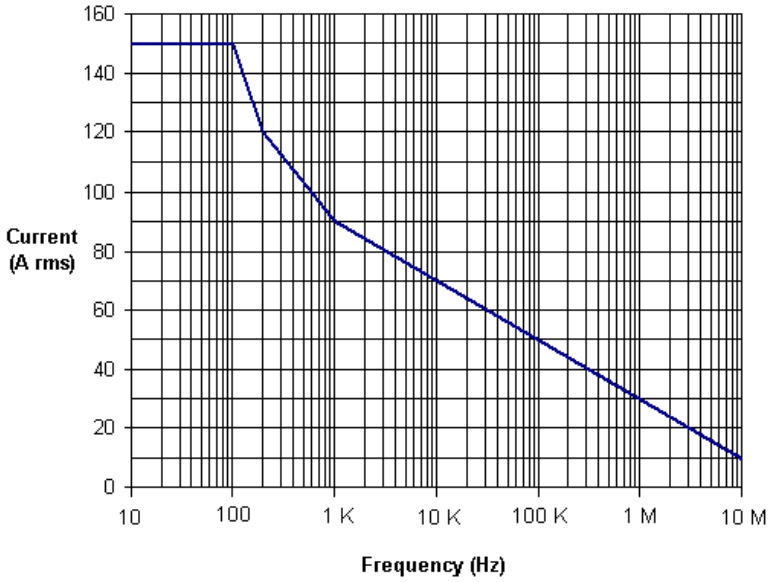
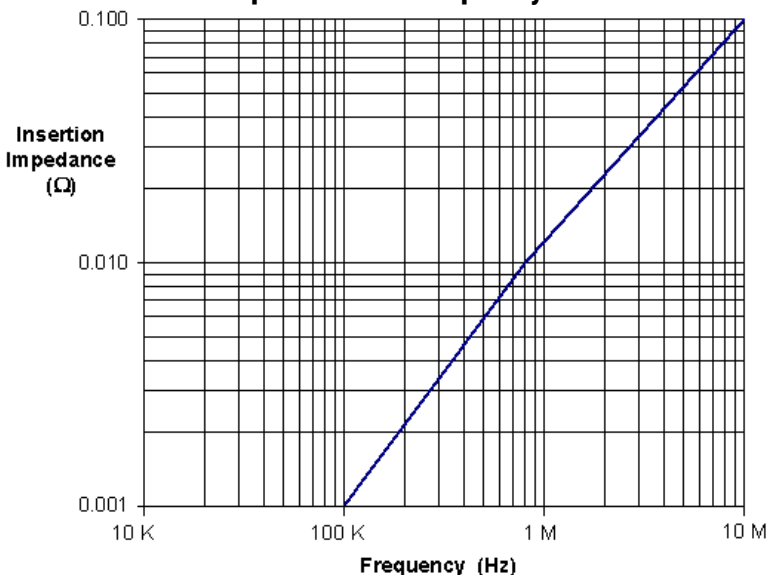
CP150 Derating Curve - Maximum Input Current vs. Frequency *



* Does not apply to CP150-6M

CP150 Insertion Impedance vs. Frequency *



* Does not apply to CP150-6M

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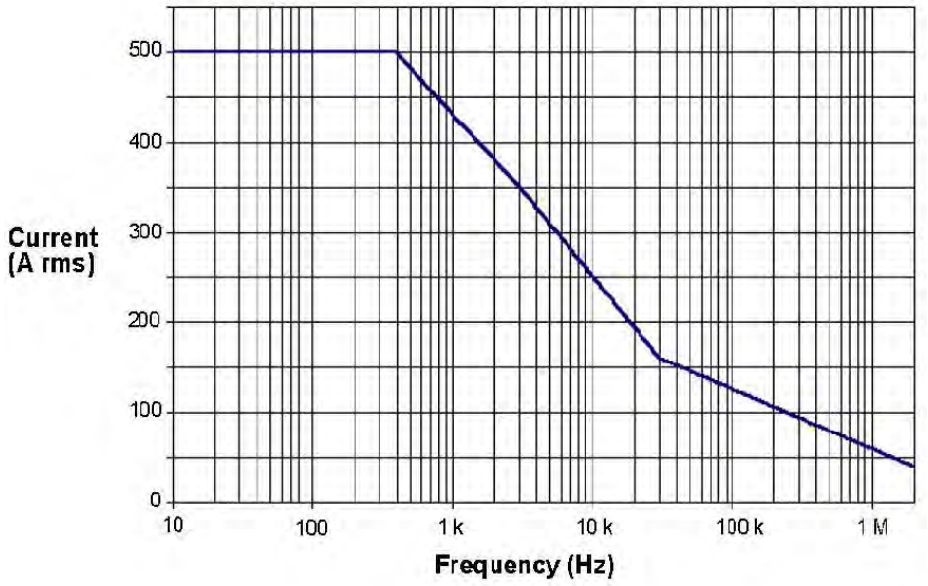
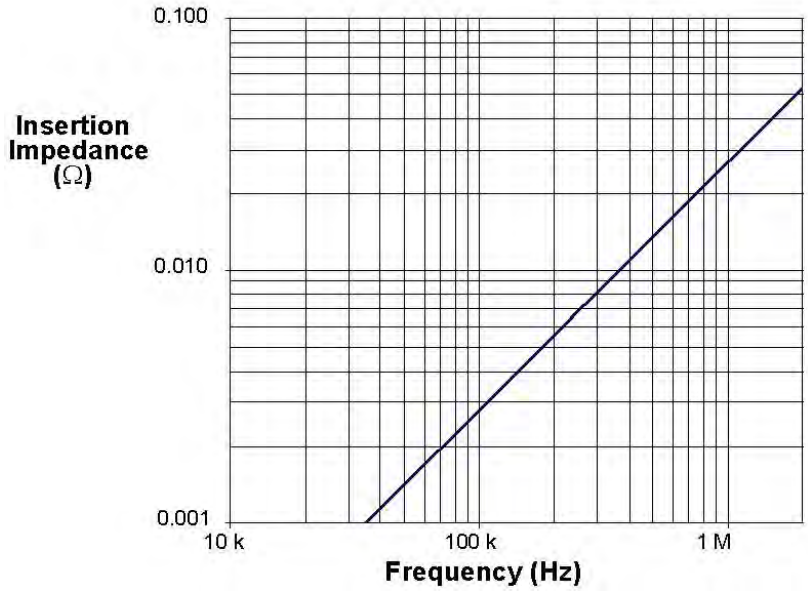
CP500 Derating Curve - Maximum Input Current vs. Frequency



CP500 Insertion Impedance vs. Frequency



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Operation

Precautions

The sensor head is a precision assembly consisting of a molded component with a ferrite core and a Hall effect element. It may be damaged if subjected to sudden changes in temperature, mechanical strain or shock.

The mating surfaces of the sensor are precision ground and should be treated with care. If there is any type of dust or dirt on the mating surfaces of the sensor head, measurements may be impaired.

Accurate measurements may not be possible in locations subject to strong magnetic fields such as transformers and high-current conductors, or in locations subject to strong external electric fields.

WARNING: Comply with the derating characteristics of the probe when measuring current that includes a high frequency component, and never measure any current that exceeds the rated current. Using the probe at high frequencies or in strong magnetic fields may cause the probe head to become abnormally hot, resulting in fire, equipment damage or burns.

CAUTION: Do not touch the probe head until it has had sufficient time to cool after disconnecting the probe from the circuit. Using the probe near the current and ambient temperature upper limits for extended lengths of time may cause the probe head surface to become hot to the touch.

CAUTION: Do not use this probe for making measurements on Mains Circuits. Using the probe on uninsulated hazardous live conductors may result in electric shock, electric burn, or arc flash.

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Connecting to the Test Instrument

The probe has been designed for use with the Teledyne LeCroy instruments equipped with the ProBus interface. When you attach the probe output connector to the instrument's input connector, the instrument will:

- Recognize the probe model
- Set the input termination to 1 MΩ
- Activate the probe control functions in the touch screen user interface.

Connecting to the Test Circuit

The probe has been designed with a movable split core, eliminating the need to break the conductor for the core to slip around the conductor. To connect:

1. Pull back the slider so that the clamp opens.
2. Align the sensor so that the current direction indicator corresponds to the direction of current flow in the conductor.
3. Close the probe jaws around the conductor until the jaws click shut.
4. Close the slider on the sensor head until the "UNLOCK' indication disappears and the "LOCK" indication appears.
5. Verify that the opening lever is firmly locked and the clamp is securely closed.

CAUTION: Never use this probe on bare conductors. The core and shield are grounded and any voltage applied to the conductor may cause damage the probe or the circuit under test.

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Operating with an Oscilloscope

When connected to a Teledyne LeCroy oscilloscope, the displayed scale factor and measurement values will be adjusted to account for the effective gain of the probe.

A/div, Offset, and Coupling, and Bandwidth (BWL) are controlled from the Channel setup (Cx) dialog.

Channel setup dialog with Probe dialog behind it.

The probe's attributes are shown on the Probe dialog, which appears behind the Channel dialog when a probe is detected. The Probe dialog also contains controls for Auto Zero and Degauss.

Probe dialog.

Probe A/div and Attenuation

The front panel Volts/div knob controls the oscilloscope's scale factor and the probe's internal attenuation to give full available dynamic range from 100mA/div to 200 A/div for the CP500 and 100mA/div to 100 A/div for the CP150.

Alternatively, A/div may be controlled from the channel setup dialog (Cx).

Bandwidth Limit

The probe is capable of switching from Full (maximum bandwidth) to 20 MHz bandwidth by changing the Bandwidth setting on the Cx dialog.

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AC Coupling

In general, using offset to adjust a DC current on the screen is the preferred method to measure transient signals in the presence of a larger DC currents. The offset has limits that will cause a signal that is beyond the linear operating range of the probe to go off the screen, preventing measurement errors.

There are times, however, when it is convenient to use AC coupling to remove the DC component of the measured signal from the measurement. Selecting AC uses the scope AC coupling at the probe output to remove any steady state value from the displayed voltage.

NOTE: Since this AC coupling is on the probe output, DC current beyond the linear range of the probe will cause the probe to saturate and make the displayed waveform inaccurate. It is important not to exceed the maximum linear input values when using AC coupling.

Auto Zero

The Probe dialog incorporates an Auto Zero function to remove the DC offset from the current probe. Auto Zero must be invoked by the user. After several minutes of warm-up, or when the probe is exposed to a large shift in ambient temperature, some DC offset drift may occur. Open the Probe dialog and touch **AUTO ZERO**.

Degauss

If the probe has been magnetized by external magnetic field or by excessive input, the core can be demagnetized by degaussing. The demagnetizing process takes about 5 seconds and should always be performed before taking a measurement.

Without clamping the probe around a conductor, slide the opening lever to close and lock the probe. Open the Probe dialog and touch **DEGAUSS**.

An Auto Zero is automatically performed as part of the degauss cycle.

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Performance Verification

This procedure can be used to verify the warranted characteristics of the probe. The recommended calibration interval for the models CP150 and CP500 Current Probes is one year. The complete performance verification procedure should be performed as the first step of annual calibration. Performance verification can be completed without removing the probe covers or exposing the user to hazardous voltages. Test results can be recorded on a photocopy of the Test Record provided at the end of the manual.

The warranted characteristics of the probe are valid at any temperature within the Environmental Characteristics listed in the Specifications. However, some of the other test equipment used to verify the performance may have environmental limitations required to meet the accuracy needed for the procedure. Make sure that the ambient conditions meet the requirements of all the test instruments used in his procedure.

NOTE: Operation of the probe as described requires software version 4.3.0.0 or higher. To confirm the version installed, choose Utilities > Utilities Setup from the oscilloscope menu bar, then open the Status tab.

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Test Equipment Required

The following table lists the test equipment and accessories (or their equivalents) which are required for performance verification of the CP150/CP0500 Current Probes. Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required.

Description	Minimum Requirements	Example Equipment
Wide Band Oscilloscope	200 MHz bandwidth ProBus interface equipped	Teledyne LeCroy WaveRunner 6 Zi
Digital Multimeter (2)	DC: 0.1% Accuracy 5½ digit resolution	Agilent Technologies 34401A Fluke 8842A-09
Function Generator	50 Hz sine wave output 3 Vrms into 50 Ω	Teledyne LeCroy WaveStation 3082 Stanford Research Model DS340
Calibration Fixture	500 turn loop in series with 0.5Ω ±0.1% resistor with sense terminals	Teledyne LeCroy CP150-CF02 Teledyne LeCroy CP500-CF02
Calibration Fixture	ProBus Extension Cable	Teledyne LeCroy PROBUS-CF01
Banana Plug Adapter	Female BNC to Dual Banana Plug	Pomona 1269
Patch Cables (4)	Male Banana to Male Banana, 12"	Pomona B-12-0 (black) Pomona B-12-2 (red)
BNC Adapter	BNC Male to Dual Banana Jack	Pomona 1296

Preliminary Procedure

1. Connect the probe to the C1 input of the instrument and completely close the probe slider.
2. Turn on the instrument and allow at least 30 minutes warmup time for the probe before performing the verification procedure.
3. Turn on the other test equipment and allow these to warm up for the time recommended by the manufacturer.
4. While the instruments are reaching operating temperature, make a photocopy of the Performance Verification Test Record and fill in the necessary data.

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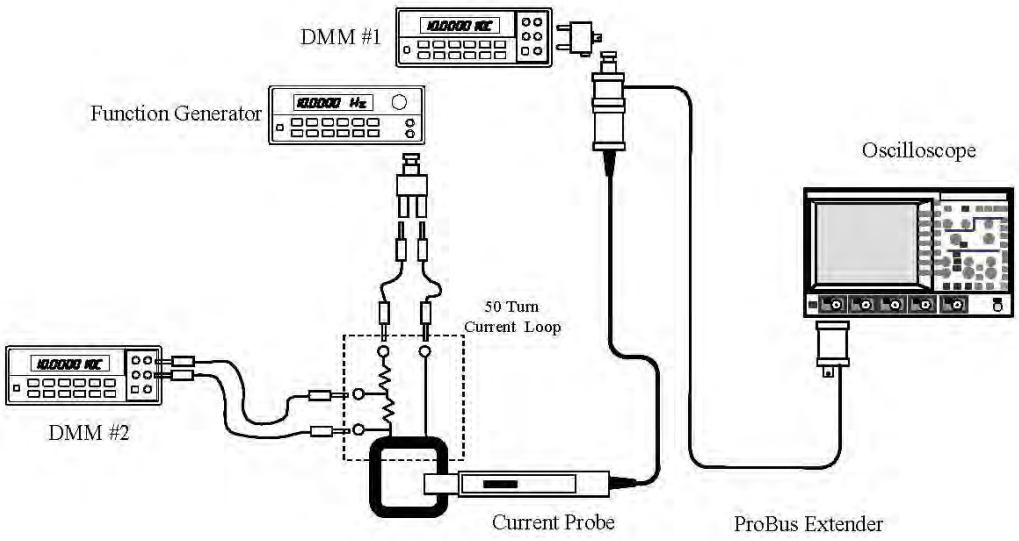
Functional Check

The functional check will verify the basic operation of the probe functions. It is recommended to perform the functional check prior to the performance verification procedure.

1. Open the C1 setup dialog and confirm that the bandwidth is set to **Full (**BWL OFF).
2. Verify that the probe is sensed and the probe dialog (**CP150 or CP500 tab**) appears behind the C1 setup dialog.
3. Open the probe dialog and degauss the probe by touching **DEGAUSS**, then **OK**.
4. Confirm that the message **"Performing Degauss on CPxxx...."** is displayed in the message bar and that no error messages are displayed.

Check LF Accuracy



LF Accuracy Test set up.

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1. Set the Function generator to 50 Hz sine wave, output voltage at 1.7 Vrms for CP150 or 3 Vrms for CP500 with 50 Ω output.
2. Remove the probe from the instrument and reconnect using the ProBus extension cable. Connect the BNC male connector of the ProBus extension to DMM #1 using a BNC Female to Dual Banana adapter.
3. Using Banana Patch cords and the BNC to Dual Banana Plug adapter, connect the 'V Source' and 'V Return' terminals of the 500 Turn Calibration Loop to the output of the Function Generator.
4. Connect the Current Sense terminals of the 500 Turn Calibration Loop to the voltage inputs of DMM #2.
5. Set both DMMs to measure AC Volt.
6. With the probe removed from any signal and the slider returned to the LOCKED position, degauss the probe by pressing the **DEGAUSS** button.
7. Open the probe slider and position the probe input around the 500 Turn loop. Close and LOCK the slider.
8. Adjust the Function generator voltage until the voltage measured at the 'Current Sense' terminals (DMM #2) reads 10 mV ±0.01 mV (10 A at the probe head) for CP150 or 50 mV ±0.05 mV (500 A at the probe head) for CP500.
9. Record the voltage measured by DMM #1 on the Test Record.
10. Verify that the measured voltage is between 99 mV and 101 mV for CP150, or 0.495 V and 0.505 V for CP500.

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CPxxx Test Record

Model: _____

Serial Number: _____

Asset/Tracking Number: _____

Date: _____

Technician: _____

Equipment	Model	Serial Number	Calibration Due Date
Digital Multimeter #1			
Digital Multimeter #2			
Function Generator*			N/A

* The function generator is used for making relative measurements. The output of the generator is measured with a DMM or oscilloscope. Thus, the generator is not required to be calibrated.

Step	Description	Intermediate Data	Test Result
10	Probe Output Limits: 99 - 101 mV for CP150 0.495 - 0.505 V for CP500		_____ V

Permission is granted to photocopy this page and record the results of the performance verification procedure on the copy. File the completed record as required by applicable internal quality procedures.

Results recorded under "Test Result" are the actual specification limit check. The test limits are included in all of these steps. Record other measurements and intermediate calculations that support the limit check under "Intermediate Data".

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Care and Maintenance

Cleaning

The exterior of the probe and cable should be cleaned only using a soft cloth moistened with water or isopropyl alcohol. The use of abrasive agent, strong detergents or other solvents may damage the probe.

CAUTION: The probe case is not sealed and should never be immersed in any fluid.

Calibration Interval

The recommended calibration interval is one year. Adjustment should only be performed by qualified personnel. (A performance verification procedure is included in this manual.)

Service Strategy

Defective probes must be returned to a Teledyne LeCroy service facility for diagnosis and exchange. A defective probe under warranty will be replaced with a factory refurbished probe. A probe that is not under warranty can be exchanged for a factory refurbished probe. A modest fee is charged for this service. A defective probe must be returned in order to receive credit for the probe core.

Troubleshooting

If the probe is not operating properly the problem may be the way in which it is used. Before assuming the probe is defective, perform the following troubleshooting procedures:

1. Verify the test instrument is running the required firmware (4.3.0.0 or higher).
2. If the waveform is inverted, check that the arrow on the slider is in the direction of the current flow.
3. If there is no signal, check that the slider is closed and locked.

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Returning a Product for Service

Contact your regional Teledyne LeCroy service center for calibration or other service. If the product cannot be serviced on location, the service center will give you a Return Material Authorization (RMA) code and instruct you where to ship the product. All products returned to the factory must have an RMA. Return shipments must be prepaid.

Teledyne LeCroy cannot accept COD or Collect shipments. We recommend air-freighting. Insure the item you're returning for at least the replacement cost.

1. Remove all accessories from the probe. Do not include the manual.
2. Pack the probe in its case, surrounded by the original packing material (or equivalent).
3. Label the case with a tag containing:
   - The RMA
   - Name and address of the owner
   - Probe model and serial number
   - Description of failure or requisite service
4. Package the probe case in a cardboard shipping box with adequate padding to avoid damage in transit.
5. Mark the outside of the box with the shipping address given to you by Teledyne LeCroy; be sure to add the following:
   - ATTN: <RMA code assigned by the Teledyne LeCroy>
   - FRAGILE
6. Insure the item for the replacement cost of the probe.
7. **If returning a probe to a different country**:
   - Mark the shipment as a "Return of US manufactured goods for warranty repair/recalibration."
   - If there is a cost for the service, list the cost in the value column and the original purchase price "For insurance purposes only."
   - Be very specific as to the reason for shipment. Duties may have to be paid on the value of the service.

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Warranty

Teledyne LeCroy warrants this oscilloscope accessory for normal use and operation within specification for a period of one year from the date of shipment. Spare parts, replacement parts and repairs are warranted for 90 days.

In exercising its warranty, Teledyne LeCroy, at its option, will either repair or replace any assembly returned within its warranty period to the Customer Service Department or an authorized service center. However, this will be done only if the product is determined by Teledyne LeCroy's examination to be defective due to workmanship or materials, and the defect is not caused by misuse, neglect, accident, abnormal conditions of operation, or damage resulting from attempted repair or modifications by a non-authorized service facility.

The customer will be responsible for the transportation and insurance charges for the return of products to the service facility. Teledyne LeCroy will return all products under warranty with transportation charges prepaid.

This warranty replaces all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness or adequacy for any particular purposes or use. Teledyne LeCroy shall not be liable for any special, incidental, or consequential damages, whether in contract or otherwise.

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Certifications

Teledyne LeCroy certifies compliance to the following standards as of the date of publication. As standards evolve, these may no longer be current. Please see the Declaration of Conformity certificate shipped with your product.

EMC Compliance

EC Declaration of Conformity - EMC

The probes meet the intent of EC Directive 2014/30/EU for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326-1:2013 EMC requirements for electrical equipment for measurement, control, and laboratory use. [1]

ELECTROMAGNETIC EMISSIONS:

EN 55011/A1:2010 Radiated and Conducted Emissions Group 1 Class A [2 3]

ELECTROMAGNETIC IMMUNITY:

EN 61000-4-2:2009 Electrostatic Discharge, 4 kV contact, 8 kV air, 4 kV vertical/horizontal coupling planes [4]

EN 61000-4-3/A2:2010 RF Radiated Electromagnetic Field, 3 V/m, 80-1000 MHz; 3 V/m, 1400 MHz - 2 GHz; 1 V/m, 2 GHz - 2.7 GHz

EN 61000-4-8:2010 Power Frequency Magnetic Field, 3 A/m, 50 Hz; 3 A/m, 60 Hz

1 To ensure compliance with the applicable EMC standards, use high quality shielded interface cables.

2 This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

3 Emissions which exceed the levels required by this standard may occur when the probe is connected to a test object.

4 Meets Performance Criteria "B" limits of the respective standard: during the disturbance, product undergoes a temporary degradation or loss of function or performance which is self-recoverable.

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Australia & New Zealand Declaration of Conformity - EMC

The probes comply with the EMC provision of the Radio Communications Act per the following standards, in accordance with requirements imposed by the Australian Communication and Media Authority (ACMA):

AS/NZS CISPR 11:2011 Radiated and Conducted Emissions, Group 1, Class A.

Safety Compliance

EC Declaration of Conformity – Low Voltage

The probes meet the intent of EC Directive 2014/35/EU for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

IEC/EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements

IEC/EN 61010-2-032:2012 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-032: Particular Requirements for Hand-Held and Hand Manipulated Current Sensors for Electrical Test and Measurement.

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Environmental Compliance

End-Of-Life Handling

The probe is marked with this symbol to indicate that it complies with the applicable European Union requirements to Directives 2012/19/EU and 2013/56/EU on Waste Electrical and Electronic Equipment (WEEE) and Batteries.

The probe is subject to disposal and recycling regulations that vary by country and region. Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles.

Restriction of Hazardous Substances (RoHS)

The product and its accessories conform to the 2011/65/EU RoHS2 Directive.

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