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TELEDYNE LECROY
Everywhereyoulook™

Instruction Manual

CP500 Current Probe

CP500 Current Probe
Instruction Manual

January 2013

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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.

922176-00 Rev A

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Safety Instructions

This section contains instructions that must be observed to keep this oscilloscope accessory operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the precautions specified in this section.

The overall safety of any system incorporating this accessory is the responsibility of the assembler of the system.

Symbols

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

WARNING. High Voltage, risk of electric shock.

CAUTION. Potential for damage to probe or instrument it is connected to. Attend to the accompanying information to protect against personal injury or damage. Do not proceed until conditions are fully understood and met.

ELECTROSTATIC DISCHARGE (ESD) HAZARD. The probe is susceptible to damage if anti-static measures are not taken.

DOUBLE INSULATION

PROTECTIVE (EARTH) TERMINAL

Precautions

- **Connect and disconnect properly.** Connect probe to the measurement instrument before connecting the test leads to a circuit/signal being tested.
- **Use only within operational environment listed.** Do not use in wet or explosive atmospheres.
- **Use indoors only.**
- **Keep product surfaces clean and dry.**
- **Be careful with sharp tips.** The tips may cause bodily injury if not handled properly.
- **Do not operate with suspected failures.** Do not use the probe if any part is damaged. Cease operation immediately and sequester the probe from inadvertent use.
- **Be careful not to damage the insulation surface** when making measurements.

- **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.
- To avoid short circuits and accidents that could result in injury or death, use the CP500 current probe only with conductors carrying 600 V (CAT II) or 300 V (CAT III) or less.
- To prevent short circuits and electric shock when conductors being measured carry less than 600 V (CAT II) or 300 V (CAT III), but more than the safe voltage level (SELV-E) make sure that the conductors to be measured are insulated with material conforming to:
    - Overvoltage Category III, basic insulation requirement for working voltage of 300 V
    - Pollution degree 2

Operating Environment

The accessory is intended for indoor use and should be operated in a clean, dry environment. Before using this product, ensure that its operating environment is maintained within these parameters:

Temperature: 0° to 40° C

Humidity: ≤ 80% relative humidity (non-condensing)

Altitude: up to 2000 m (6562 feet)

Overview

Description

The CP500 uses a combination of Hall effect and transformer technology which enables measurements to be made on DC, AC and impulse currents. It has a 2 MHz bandwidth and is designed to measure continuous currents up to 500 Amp.

The probe can be used with a WaveRunner, WavePro, or LC series oscilloscope with firmware 4.3.0.0 or higher. With the ProBus interface, the CP500 becomes an integral part of the oscilloscope. The bandwidth limit, auto zero and degauss functions are all controlled from the oscilloscope's graphical user interface. The oscilloscope provides power to the probe, so no external power supply is needed.

Key Features

- Highly accurate current measurements
- Easy current measurements
- Wide bandwidth
- Compact
- Over-current protected

Accessories

Certificate of Calibration

Instruction Manual CP500-OM-E

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.

Connecting the Probe to the Test Instrument

The CP500 probe has been designed for use with the WaveRunner, WavePro and LC series Teledyne Lecroy oscilloscopes equipped with the ProBus interface. Attach the probe output connector to the oscilloscope input connector. The oscilloscope will recognize the probe, set the oscilloscope input termination to 1 MΩ and activate the probe control functions in the user interface.

Connecting the Probe to the Test Circuit

The CP500 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 the locking lever, 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. Press the probe jaws together around the conductor until the jaws click shut.
4. Slide the locking lever on the sensor head towards the front of the probe until the "UNLOCK" indication disappears and the "LOCK" indication appears.

NOTE: 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.

Operation with a Teledyne LeCroy Oscilloscope

The probe can be controlled through the Vertical Setup dialog for the channel to which the probe is connected.

Turning the **VOLTS/DIV** knob will control the oscilloscope's scale factor to give full dynamic range.

The CP500 probe dialog (a tab behind the channel setup dialog) allows for the selection of the probe's coupling (**DC, Grounded** or **AC**), **AUTO ZERO, DEGAUSS PROBE** and **Probe BWL** functions, limiting the system bandwidth to 20 MHz or maximum bandwidth (BWL Off).

Bandwidth Limit

The CP500 is capable of switching the bandwidth from **Full** (maximum bandwidth) to **20 MHz** by selecting the bandwidth adjustment on the CP500 dialog.

AC Coupling

DC, Ground or AC coupling can be selected through the CP500 dialog. AC coupling occurs at the input of the oscilloscope and not at the probe input. When using the CP500 in the AC coupling mode and measuring AC signals with a DC component, care must be taken to assure that the dynamic range of the probe will not be exceeded. There will be no warning if the dynamic range is exceeded. If clipping of the waveform occurs, check to see if the operating range of the probe has been exceeded. This can be done by changing the coupling back to DC and setting the scale factor to the maximum Amp/Div.

Auto Zero

The CP500 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. To initiate an Auto Zero cycle, touch the CP500 tab (behind the Channel Vertical Setup dialog), then touch **AUTO ZERO**.

Degauss Probe

If the probe has been magnetized by external magnetic field or by excessive input, the core can be demagnetized by opening the CP500 dialog and touching **DEGAUSS PROBE**.

Prior to use, the CP500 probe should be degaussed to eliminate any residual magnetization from the probe core. Residual magnetism in the core is a major cause of measurement errors when used at high sensitivities. 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, and touch **DEGAUSS PROBE** twice.

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

NOTE: 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.

Degauss the probe in any of these cases:

- After turning on the oscilloscope and probe
- After connecting the probe to the oscilloscope
- Before connecting the probe to the circuit under test
- Whenever an overload conditions occurred
- Whenever the probe is subjected to strong magnetic field

Insertion Impedance

Connecting a current probe to a circuit under test may alter the characteristics of this circuit because of the impedance represented by the current probe.

In the case of an AC current probe, or open loop AC/DC current probe, two elements are added: the leakage inductance and magnetizing inductance shunted with a small resistance. Refer to Figure 1.

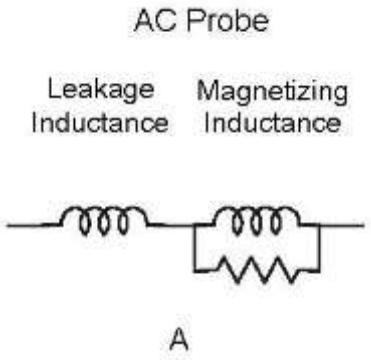

Figure 1. Insertion Impedance A

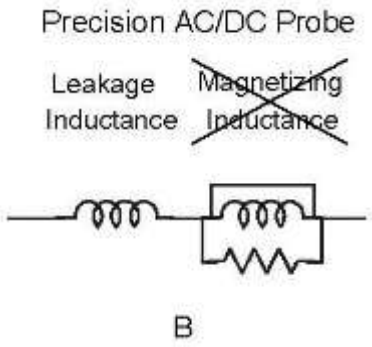

Figure 2. Insertion Impedance B

In a closed loop AC/DC current probe, the magnetizing inductance term drops out because the bucking coil prevents the core from being magnetized (Figure 2). In addition to the impedance resulting from probe insertion, any loop wire added to the conductor to gain access to the conductor will increase the total impedance of the conductor.

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.

Cleaning Core Surfaces

To clean the transformer core surfaces, open the locking lever and clean the exposed core surfaces with a cotton swab dampened with isopropyl or ethyl alcohol.

In no case should the core surfaces be lubricated. Any lubrication between the mating surfaces will degrade the performance of the current probe should be removed with isopropyl or ethyl alcohol.

Calibration Interval

The recommended calibration interval is one year. Adjustment should only be performed by qualified personnel. (A Performance Verification / Adjustment 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 Teledyne Lecroy oscilloscope is running firmware 4.3.0.0 or higher. The firmware version of your oscilloscope can be verified by selecting **Utilities** > **Utilities Setup** > **Status** tab.
2. Waveform is inverted — Make sure the arrow on the slider is in the direction of the current flow.
3. If the displayed signal shows a high offset — The probe locking lever may not be fully closed and locked or the probe may need to be degaussed.
4. Attenuated signals or poor frequency response may be caused by contaminated core surfaces or the probe locking lever may not be fully closed and locked.
5. No signal — Make sure the slider is closed and locked and that the ProBus connector is fully engaged.

Returning a Defective Probe

Contact your local Teledyne Lecroy sales representative to find out where to return the product. All returned products should be identified by model number and serial number. Provide your name and contact number and if possible describe the defect or failure. In case of products returned to the factory, a Return Authorization Number (RAN) must be used. Contact your nearest Teledyne Lecroy office, or the New York Customer Care Center, to receive a RAN.

Return shipment should be prepaid. Teledyne Lecroy cannot accept COD or Collect Return shipments. We recommend air-freighting.

1. Contact your local Teledyne Lecroy sales or service representative to obtain a Return Authorization Number.
2. Remove all accessories from the probe. Do not include the manual.
3. Pack the probe in its case, surrounded by the original packing material (or equivalent) and box.
4. Label the case with a tag containing:
    - The RAN
    - Name and address of the owner
    - Probe model and serial number
    - Description of failure
5. Package the probe case in a cardboard shipping box with adequate padding to avoid damage in transit.
6. Mark the outside of the box with the shipping address given to you by the Teledyne Lecroy representative; be sure to add the following:
    - ATTN: <RAN assigned by the Teledyne Lecroy representative>
    - FRAGILE
7. Insure the item for the replacement cost of the probe.
8. **If returning a probe to a different country, also:**
    - Mark shipments returned for service as a “Return of US manufactured goods for warranty repair/recalibration.”
    - If there is a cost involved in the service, put the service cost in the value column and the replacement value in the body of the invoice marked “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.

Performance Verification

This procedure can be used to verify the warranted characteristics of the CP500 Current Probe.

The recommended calibration interval for the model CP500 Current Probe 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.

Adjustment should only be attempted if a parameter measured in the Performance Verification Procedure is outside the specification limits. Adjustment should only be performed by qualified personnel.

The warranted characteristics of the CP500 Current 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: The correct operation of the CP500 controls requires software version 4.3.0.0 or higher. The software version in the test oscilloscope can be verified by selecting **Utilities** > **Utilities Setup** > **Status tab**. Contact your local Teledyne Lecroy representative if the software in your oscilloscope requires updating.

Test Equipment Required

The following table lists the test equipment and accessories (or their equivalents) which are required for performance verification of the CP500 Current Probe.

Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required.

Table 1. List of Performance Verification test equipment.

Description	Minimum Requirements	Test Equipment Examples
Wide Band Oscilloscope	Any oscilloscope with ProBus interface and Software version 4.3.0.0 or higher	Teledyne LeCroy LT322
Digital Multimeter (2 required)	DC: 0.1% Accuracy 5½ digit resolution	Agilent Technologies 34401A or Fluke 8842A-09

Description	Minimum Requirements	Test Equipment Examples
Function Generator	50 Hz sine wave output 3 Vrms into 50Ω	Agilent Technologies 33120A or Stanford Research Model DS340
Calibration Fixture, 500 Turn Loop	500 Turn loop in series with 0.5Ω ± 0.1% resistor with sense terminals	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 required)	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 CP500 to the channel 1 input of the oscilloscope and completely close the probe locking lever.
2. Turn the oscilloscope on and allow at least 30 minutes warmup time for the CP500 and test equipment 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 (located in Appendix A), and fill in the necessary data.

Functional Check

The functional check will verify the basic operation of the probe functions. It is recommended that the Functional Check be performed prior to the Performance Verification Procedure.

1. Select Channel 1 and verify that the probe bandwidth is set to **Full (**BWL **OFF)**.
2. Verify that the CP500 is sensed and the **CP500** tab appears behind the channel setup dialog.
3. On the CP500 tab, degauss the probe by touching **DEGAUSS,** then **OK.**
4. Verify that **"Performing Degauss on CP500...."** is displayed at the bottom of the screen and no error message remains displayed.
5. Lock the probe by pushing the locking lever fully towards the probe head.
6. Verify that the message disappears.

7. Degauss the probe by touching **DEGAUSS** (on the CP500 dialog), then **OK**.
8. Verify that "**Degaussing CP500 probe**..." is displayed at the top of the screen and no error message remains displayed.

Check LF Accuracy

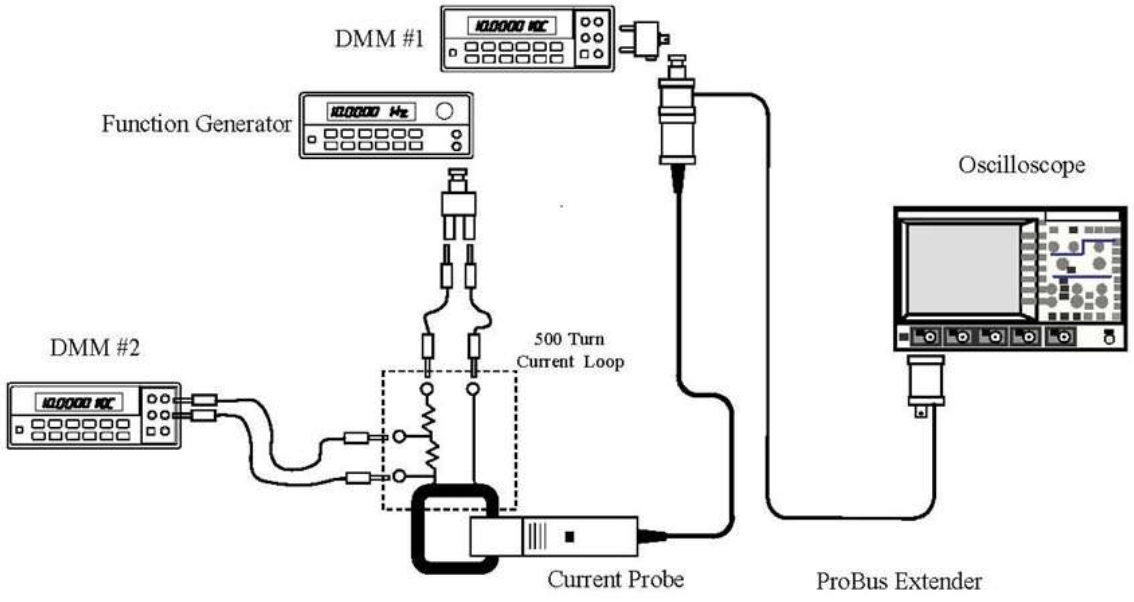

Figure 3. LF Accuracy Test set up.

1. Set the Function generator to 50 Hz sine wave. Output voltage at 3 Vrms with 50Ω output.
2. Remove the CP500 from the oscilloscope 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 (Figure 3).
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 CP500 removed from any signal and the locking lever returned to the LOCKED position, degauss the probe by touching **DEGAUSS** (located on the CP500 dialog), then **OK**.

7. Open the CP500 locking lever and position the probe input around the 500 Turn loop. Close and LOCK the locking lever.
8. Adjust the Function generator voltage until the voltage measured at the 'Current Sense' terminals (DMM #2) reads 50 mV ±0.05 mV. (This corresponds to 500 A at the probe head).
9. Record the voltage measured by DMM #1 on the Test Record.
10. Verify that the measured voltage is between 0.495 volt and 0.505 volt.

Adjustment Procedure

This procedure can be used to adjust the warranted characteristics of the CP500 Current Probe. This procedure should be used if a parameter measured in the Performance Verification Procedure is outside of the specification limits. Adjustment should only be performed by qualified personnel.

The warranted characteristics of the CP500 Current 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 this procedure.

NOTE: The correct operation of the controls of the CP500 requires oscilloscope software version 4.3.0.0 or higher. The software version in the test oscilloscope can be verified by selecting Utilities, Utilities Setup, then the Status tab. Contact your local Teledyne Lecroy representative if the software in your oscilloscope requires updating.

Test Equipment Required

The following table lists the test equipment and accessories, or their equivalents, which are required for adjustment of the CP500 Current Probe.

Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required.

Table 2. List of Adjustment Procedure equipment.

Description	Minimum Requirements	Test Equipment Examples
Wide Band Oscilloscope	Minimum 200 MHz bandwidth ProBus interface equipped Software version 4.3.0.0 or higher	Teledyne LeCroy WaveRunner 6030A
Digital Multimeter (2 required)	DC: 0.1% Accuracy 5½ digit resolution	Agilent Technologies 34401A, or Fluke 8842A-09
Function Generator	50 Hz sine wave output 3 Vrms into 50 Ω	Agilent Technologies 33120A, or Stanford Research Model DS340
Calibration Fixture, 100 Turn Loop	100 Turn loop in series with 0.5 Ω ±0.1% resistor with sense terminals	Teledyne LeCroy CP500-CF02
Banana Plug Adapter	Female BNC to Dual Banana Plug	Pomona 1269
Calibration Fixture	ProBus Extension Cable	Teledyne LeCroy PROBUS-CF01
Patch Cables (4 required)	Male Banana to Male Banana, 12"	Pomona B-12-0 (black) or Pomona B-12-2 (red)
BNC Adapter	BNC Male to Dual Banana Jack	Pomona 1296

Preliminary Procedure

1. Remove the probe compensation box circuit board by removing the two screws from the cable end of the compensation box and sliding the circuit board out of the box.
2. Connect the CP500 compensation board to the channel 1 input of the oscilloscope through the ProBUS extension cable, and close and lock the probe jaws.
3. Turn the oscilloscope on and allow at least 30 minutes warmup time for the CP500 and test equipment before performing the Verification Procedure.

Adjust LF Accuracy

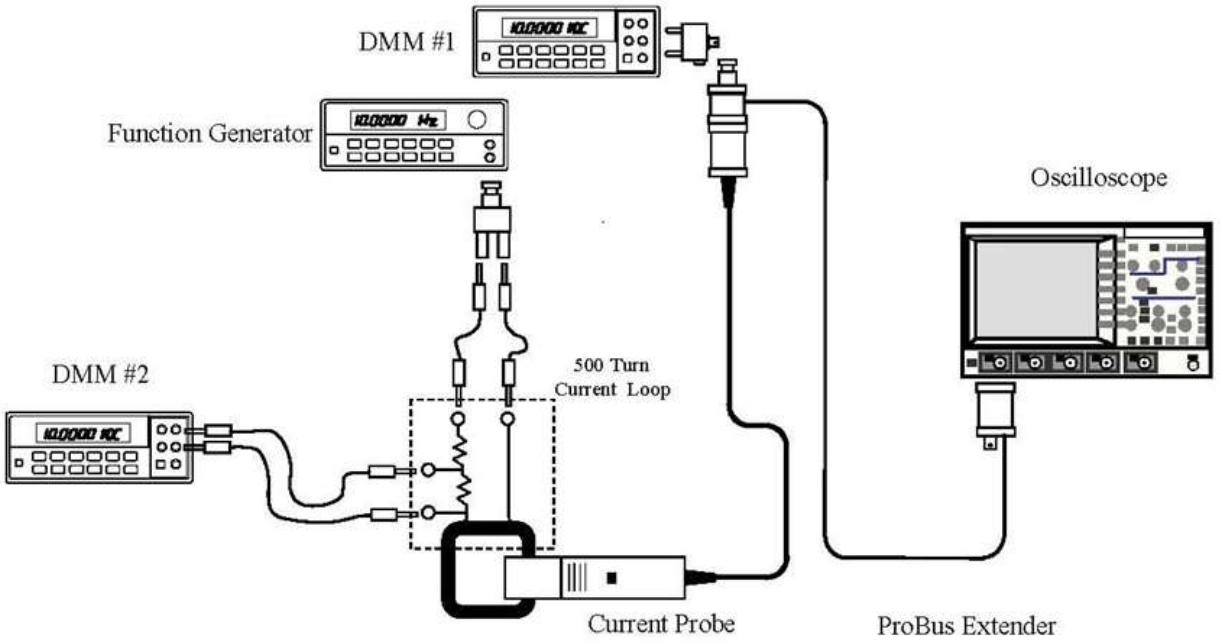

Figure 4. LF accuracy adjustment set up.

1. Set the Function Generator to 50 Hz, sinewave output at 1.7 Vrms with 50 Ω output.
2. Connect BNC male of ProBus extension to DMM #1 using BNC Female to Dual Banana adapter.
3. Using banana patch cords, connect the 'V Source' and 'V Return' terminals of the 500 Turn Calibration Loop, to the output of the Function Generator using the BNC to Dual Banana Plug Adapter output. (Refer to Figure 4.)
4. Connect the Current Sense terminals of the 100 Turn Calibration Loop to the voltage inputs of DMM #2.
5. Set both DMMs to measure AC Volt.
6. With the CP500 removed from any signal and the lever returned to the LOCKED position, degauss the probe by touching **DEGAUSS** (on the CP500 dialog), then **OK**.
7. Open the CP500 jaws and position the probe input around the 500 Turn loop. Close and LOCK the lever.
8. Adjust the Function Generator voltage until the voltage measured at the 'Current Sense' terminals (DMM #2) is 500 mV ± 0.05 mV. (This corresponds to 500 A at the probe head).

9. Adjust variable resistor VR202 on the PCB until the voltage measured on DMM #1 is as close to 10X the voltage measured on DMM #2.
10. Verify that the measured voltage is between 0.495 V and 0.505 V.
11. Disconnect the probe from the test setup.
12. Re-apply the light blue product label to the probe head using the double-sided tape.

Specifications

Nominal Characteristics

Nominal characteristics describe parameters and attributes which are guaranteed by design, but do not have associated tolerances.

Maximum Continuous Input Current	500 A_{rms} Refer to Figure 5, Maximum Input Current vs. Frequency
Maximum Peak Current	700 Amp peak, noncontinuous
Intended Output Load	1 MΩ
Maximum Permitted Circuit Voltage	600 V CAT II, 300 V CAT III (Insulated conductor)

Warranted Characteristics

Warranted characteristics describe parameters which have guaranteed performance. Unless otherwise noted, tests are provided in the Performance Verification Procedure for all warranted specifications.

Guaranteed at 23 °C ±3 °C (73 °F ±5 °F) after power has been applied for 30 minutes.

Low Frequency Accuracy

0 to 500 Amp	±1.0% of reading ±500 mA
500 to 700 Amp peak	±2.0% of reading

Typical Characteristics

Typical characteristics describe parameters which do not have guaranteed performance; however are representative of the average performance from a sample of several probes. Tests for typical characteristics are not provided in the Performance Verification procedure.

Sensitivity*	200 mA/div* to 200 A/div.
Scale Factor Temperature Coefficient	±2% or less. (from 0° to +40 °C, 32 °F to 104 °F)
Noise	Equivalent to 25 mA_{rms} or less (Bandwidth of measuring instrument: 20 MHz)
Insertion Impedence	Refer to Figure 6
Bandwidth (-3 dB)	DC to 2 MHz
Rise Time	≤ 175 ns

* Lower sensitivity may change with different oscilloscope models.

Environmental Characteristics

Operating Temperature Humidity	0 to 40 °C (32 °F to 104 °F) ≤ 80% relative humidity (non-condensing)
Storage Temperature Humidity	–10 °C to 50 °C (14 °F to 122 °F) ≤ 80% relative humidity (non-condensing)
Usage	Indoor
Altitude	up to 2000 m (6562 feet)
Effect of External Magnetic Field	Equivalent to a maximum of 800 mA (in a DC or 60 Hz, 400 A/m magnetic field)

Physical Characteristics

Dimensions Probe

Length	176 mm (6.9 inch)
Width	27 mm (1.1 inch)
Height	69 mm (2.7 inch)

Dimensions Compensation Box

Length	65 mm (2.6 inch)
Width	39 mm (1.5 inch)
Height	24 mm (0.9 inch)
Weight	650 g (22.9 oz.)
Maximum diameter of conductors to be measured	6 m (19.6 ft.)

Graphs

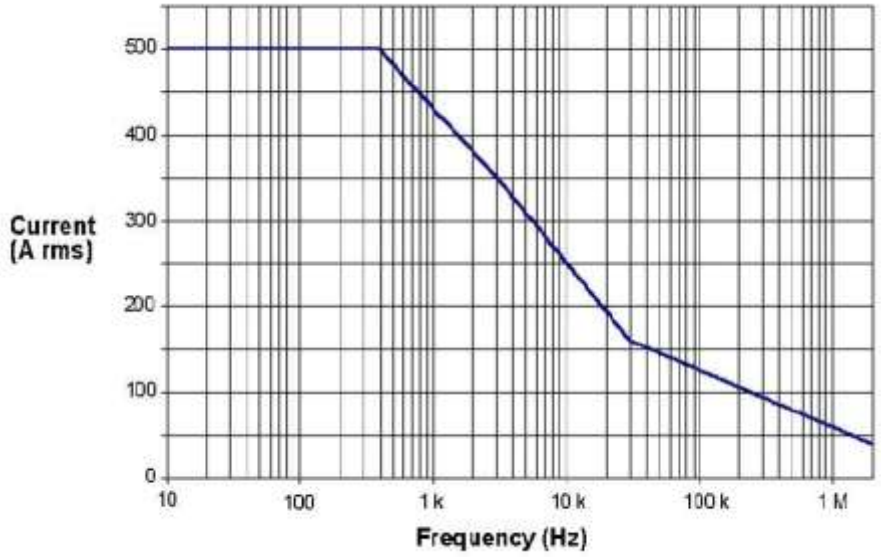

Figure 5. Maximum input current vs. frequency.

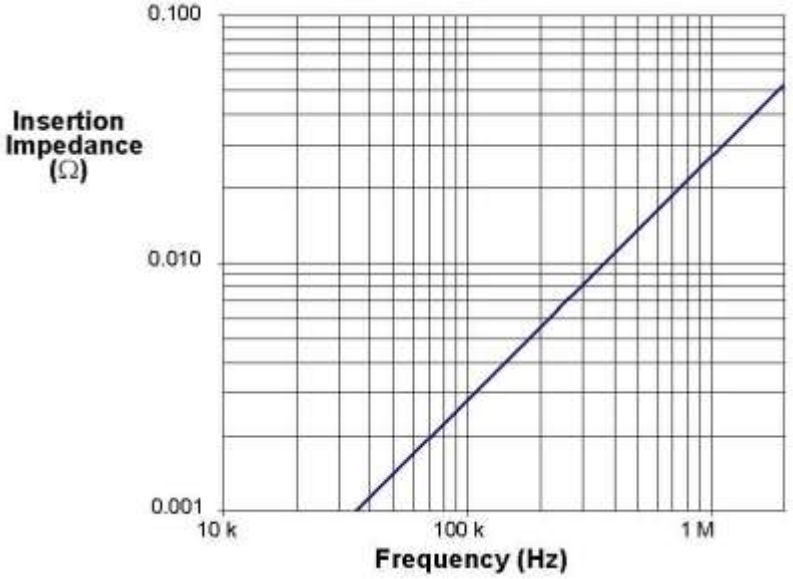

Figure 6. Insertion impedance vs. frequency.