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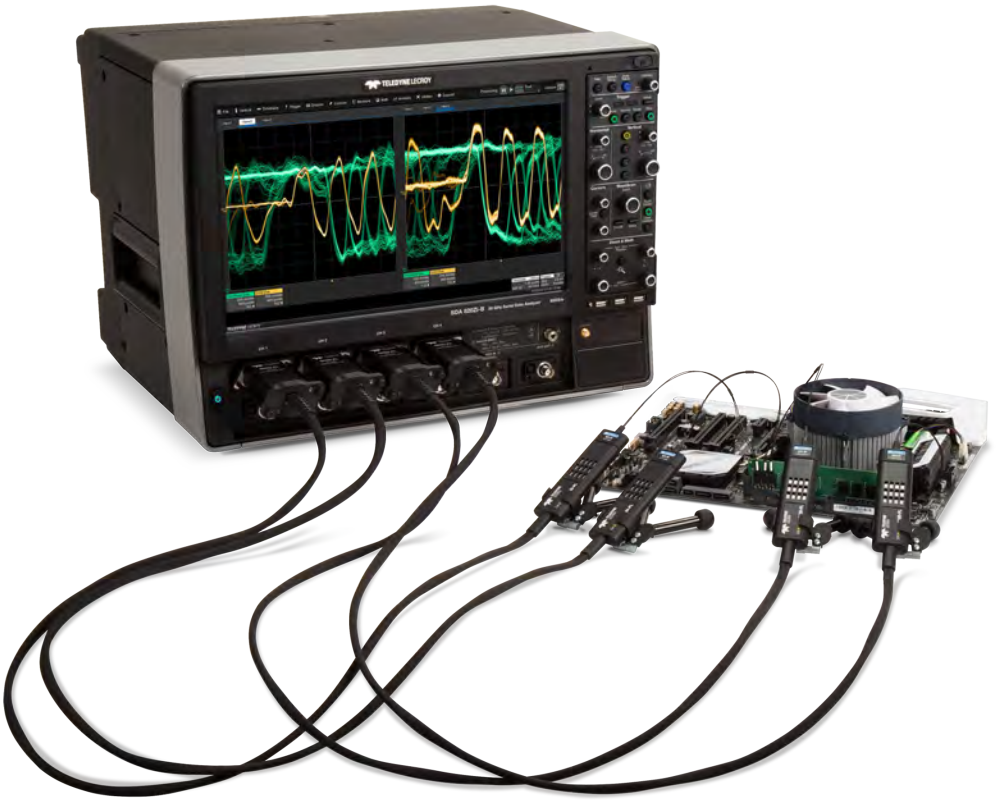

User Manual
DH Series
Differential
High-bandwidth Probes
(8 to 30 GHz)

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DH Series Differential High-bandwidth Probes (8 GHz to 30 GHz) User Manual

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Contents

Safety

To maintain the probe in a correct and safe condition, observe generally accepted safety procedures in addition to the precautions specified in this section. The overall safety of any system incorporating this product is the responsibility of the assembler of the system.

Symbols

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

CAUTION of damage to 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.

ESD CAUTION Risk of Electrostatic Discharge (ESD) that can damage the probe or instrument if anti-static measures are not taken.

Precautions

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

Before use, test the probe with a known source to ensure it is operating correctly.

Do not overload; observe all terminal ratings. Do not connect the probe to any circuit that exceeds the CAT, voltage or current ratings of the oscilloscope terminal, probe or probe-accessory combination.

Use only accessories shipped with the probe and rated for the application. Using other accessories may create an electrical hazard.

Connect and disconnect properly. Connect the probe to the oscilloscope before connecting tips to a de-energized circuit. Ensure connections are secure before applying voltage.

Keep the probe body and output cable away from the circuits being measured. Only tips are intended for contact with electrical sources.

Do not excessively bend cables. Avoid tight radius bends, crushing, crimping, twisting or otherwise stressing cables.

Do not disassemble the probe or remove inside parts. Refer all service to Teledyne LeCroy personnel.

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

Keep product surfaces clean and dry.

Do not use with damaged cables. Before each use, check all cables for damage to the protective insulation.

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 secure the probe from inadvertent use.

Operating Environment

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

	DH-HITEMP	Probe and All Other Tips
Operating Temperature	-40 °C to 125 °C	0 °C to 40 °C
Non-operating Temperature	-40 °C to 70 °C	
Operating Humidity	5% to 80% RH (Non-condensing), 50% RH above 30 °C	
Non-operating Humidity	5% to 95% RH (Non-condensing), 75% RH above 30 °C, 45% RH above 40 °C	
Altitude	Up to 10,000 ft (3,048 m).	

Probe Handling

The DH Series probes are precision test instruments. Exercise care when handling and storing the probe. Avoid sharply bending or putting excessive strain on any cable or lead.

ESD Sensitive: The tips of the probe are sensitive to Electrostatic Discharge (ESD). Always follow anti-static procedures when using or handling the probe.

CAUTION: Store tips in the plastic protective storage case when not in use.

Specifications

Full probe specifications are in the datasheet available from the Differential High-bandwidth Probes product page on our website at: teledynelecroy.com/dh-series-probes

Note: Specifications are subject to change without notice.

Introduction

Teledyne LeCroy's DH series differential probes offer the bandwidth, input range and offset capability to address any high-speed probing requirement–from debugging serial interfaces to validating DDR memory systems.

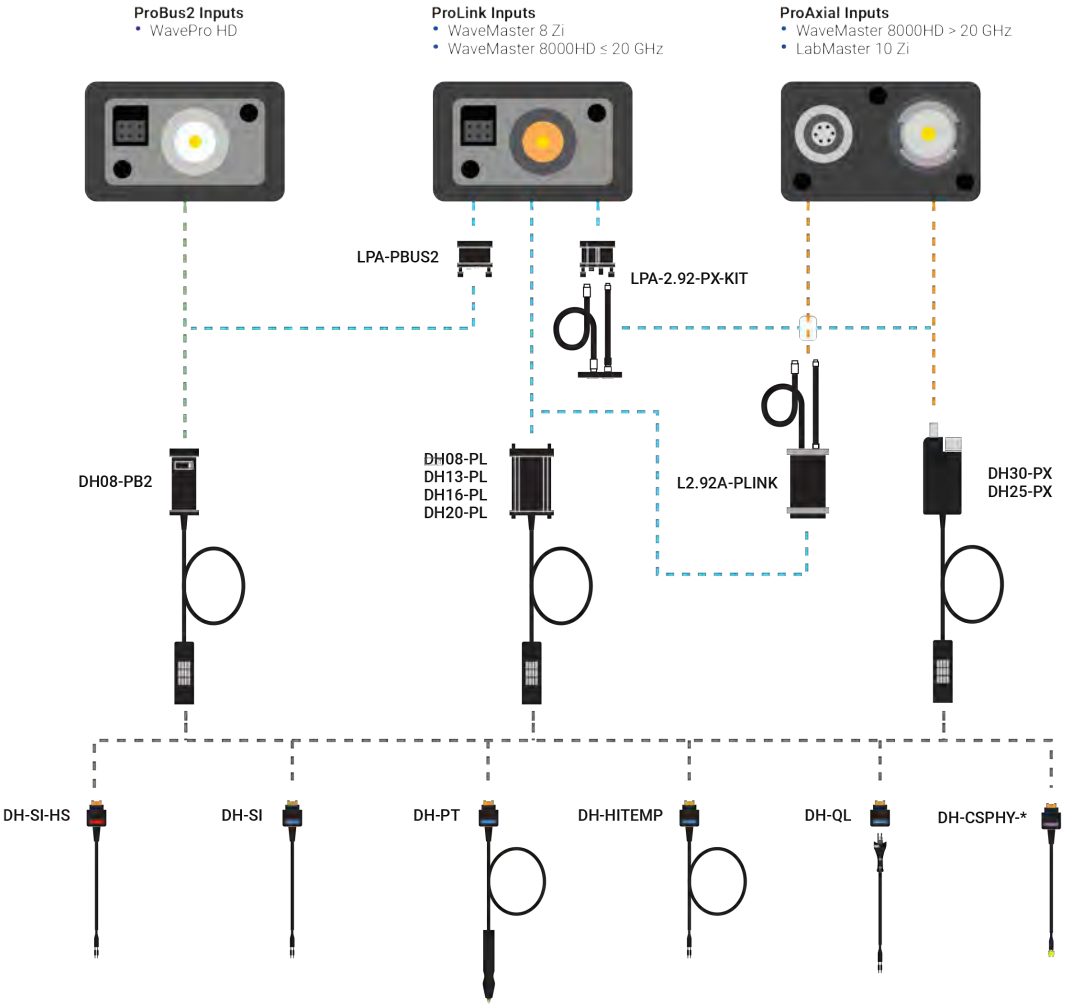
DH series probes provide superior loading characteristics and are calibrated with a custom "fine-tuned" frequency response. The ultra-low loading and flat frequency response ensure accurate measurements.

Two 30 GHz solder-in tips let you choose between a 3.5 Vpp input range for general-purpose applications or high sensitivity with exceptionally low noise. Also available are a 1-meter long, 16 GHz high-temperature tip and a QuickLink adapter for connecting mixed-signal probe tips.

Each DH Series probe is composed principally of an amplifier of the desired interface and bandwidth, and a set of standard probe accessories (listed on p.8). All tips are purchased optionally. All solder-in, high-temperature, *Cross*Sync PHY and QuickLink tips are compatible with all DH series probes and can be interchanged between any probes in the series for ultimate flexibility in the lab.

Each DH series tip has its own data on board–the oscilloscope software automatically selects the correct tip type and precisely corrects for its effects. The result is superior signal fidelity and superior ease-of-use.

Differential High Bandwidth probe amplifier and standard accessories



Differential High Bandwidth probe family

DH08-PB2 Probe

The DH08-PB2 probe is an 8 GHz bandwidth probe featuring the ProBus2 interface, which is compatible with all 8 GHz and up Teledyne LeCroy oscilloscopes equipped with either legacy ProBus or ProBus2 interfaces. The probe can be connected to oscilloscopes with ProLink interfaces with the addition of the LPA-PBUS2 adapter.

DHxx-PL Probe

Offered in bandwidths of 8, 13, 16 and 20 GHz, the DHxx-PL probe is designed for Teledyne LeCroy oscilloscopes with ProLink interfaces. The addition of the L2.92A-PLINK adapter makes it possible to connect the probe to oscilloscopes with ProAxial (2.92 mm) interfaces.

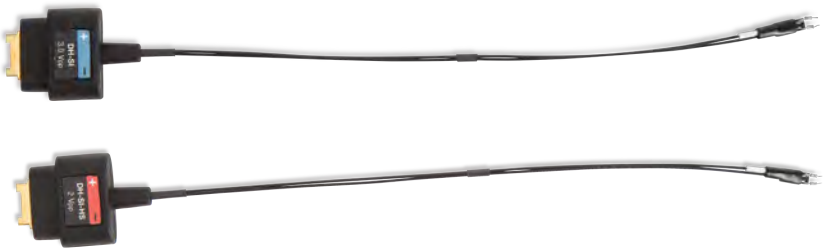
DHxx-PX Probe

The DHxx-PX probe is a 25 or 30 GHz bandwidth probe designed for Teledyne LeCroy oscilloscopes with ProAxial (2.92 mm) interfaces. The addition of the LPA-2.92-PX-KIT adapter makes it possible to connect the probe to oscilloscopes with ProLink interfaces for operation at bandwidths up to 20 GHz.

Solder-in Tips (DH-SI and DH-SI-HS)

Solder-in tips provide the highest possible performance at the expense of a non-movable installation. The tips consist of two small, pre-installed and pre-trimmed attenuating (damping) resistors connected to a flexible transmission line, terminating in a connector that mates with the amplifier. The resistors are soldered directly into the connection points of the circuit under test, providing a reliable, intermittence-free connection. Because the resistor lengths are small, this tip provides maximum signal fidelity and minimum circuit loading at high frequencies.

The standard DH-SI tip offers 3.5 Vpp input range for general-purpose probing. The high-sensitivity DH-SI-HS tip features exceptionally low noise with a 2 Vpp input range. Both tips offer up to 30 GHz of bandwidth (when used with the appropriate probe).



DH-SI (top) and DH-SI-HS (bottom) tips

*Cross*Sync PHY Tips (DH-CSPHY-*)

Teledyne LeCroy *Cross*Sync™ PHY technology enables cross-probing of the same high-speed serial interface by both a protocol analyzer and an oscilloscope, through the use of special interposers. Most *Cross*Sync PHY interposers require a specialized, DH-CSPHY probe tip to connect a DH series probe to a high-speed data lane on the interposer.

The table below shows the tip models compatible with each interposer. The interposer must be upgraded as shown to support the new tip.

Table 1: DH-CSPHY-* Tip Compatibility

Probe Tip	Compatible Interposers	Required Interposer Upgrade
DH-CSPHY-PCIE5-CEMx16	PE230UIA-X PCI Express 5.0 x 16 CEM	PE120ACA-X
DH-CSPHY-PCIE5-EDSFF	PE243UIA-X G5x4 EDSFF E1.S, PE241UIA-X G5x8 EDSFF E1.L, or PE240UIA-X G5x16 EDSFF E3.x	PE135ACA-X
DH-CSPHY-PCIE5-U2-U3	PE221UIA-X PCI Express 5.0 U.2/U.3	PE130ACA-X

High Temperature Tip (DH-HITEMP)

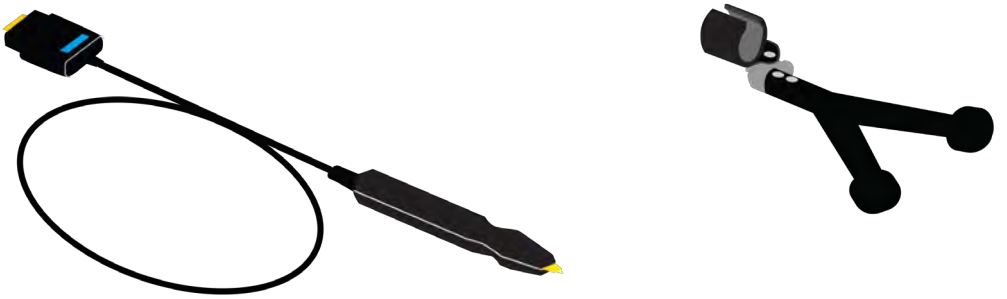
The High Temperature Tip (DH-HITEMP) is used for controlled situations where the differential amplifier normally needs to be removed from an extreme temperature environment. Ideally suited for testing scenarios where the temperature can fluctuate from -40 °C to +125 °C, the 1-meter long solder-in lead provides an easy and robust connection to the circuit under test, allowing access into environmental chambers. The high temperature tip may be used with any DH probe for up to 16 GHz bandwidth, excellent signal fidelity and superior noise performance.

QuickLink Adapter (DH-QL)

The QuickLink Probe Adapter (DH-QL, p.30) enables you to connect low-cost 8 GHz QuickLink solder-in (QL-SI) tips to DH amplifiers. QL-SI tips may be used with the HDA125 Digital Analyzer for digital signal input or switched to a DH amplifier for analog signal input of the same probing point. The adapter can be purchased individually or as a set with three QL-SI tips (DH-QL-3SI). Replacement QL-SI tips are also available for purchase separately.

Positioner Tip/Browser (DH-PT)

The Positioner Tip (Browser) combines high performance with quick access to a variety of probe points when it's used as a hand-held browser, or as a fast and convenient method to re-position a fixed test point when used with the Hands-free Mount.



DH-PT (left) and Hands-free Mount (right)

Table 2: DH Series Probes Accessories Table

Part	DH08-PB2	DHxx-PL	DHxx-PX
Standard Parts			
ProBus2 Probe (amplifier and connector)	1		
ProLink Probe (amplifier and connector)		1	
ProAxial Probe (amplifier and connector)			1
Ground Lead	1	1	1
Ground Clip	1	1	1
Freehand Probe Holder	1	1	1
PCF200 Probe Deskew Fixture	1	1	1
Soft Carrying Case, including protective storage case and plastic storage trays	1	1	1
Quick Start Guide	1	1	1
Accessory Info Sheet	1	1	1
Calibration Certificates	1	1	1
Optional Accessories			
LPA-PBUS2 ProBus to ProLink Adapter	1		
L2.92A-PLINK ProLink to 2.92 mm Adapter		1	
LPA-2.92-PX-KIT 2.92MM/ProAxial to ProLink Adapter Kit			1
DH-SI and DH-SI-HS Solder-In Tips (with 8 spare damping resistors)	1	1	1
DH-HITEMP Tip (with 8 spare damping resistors)	1	1	1
DH-CSPHY-PCIE5-CEMx16 Tip	1	1	1
DH-CSPHY-PCIE5-EDSFF Tip	1	1	1
DH-CSPHY-PCIE5-U2-U3 Tip	1	1	1
DH-QL QuickLink Adapter (no tips)	1	1	1
DH-QL-3SI QuickLink Adapter Kit (with 3 QL-SI Tips)	1	1	1
DH-PT Positioner Tip Kit (with Hands-free mount)	1	1	1

Probe Set Up

Connecting Adapters to the Oscilloscope

LPA-PBUS2 ProBus to ProLink Probe Adapter

This adapter allows you to connect the DH08-PB2 probe to oscilloscopes with ProLink interfaces, such as the SDA/ WaveMaster 8 Zi family.

Press the adapter over the ProLink interface until you hear a click, then tighten the thumbscrews until they are just finger tight. Attach the probe's connector box to the ProBus input on the adapter.

L2.92A-PLINK ProLink to 2.92 mm Probe Adapter

This adapter allows you to connect DHxx-PL probes to oscilloscopes with 2.92 mm interfaces, such as the LabMaster 10 Zi family.

First, snap the adapter onto the probe connector box, and finger-tighten the thumbscrews to secure it to the probe.

Push the adapter's LEMO plug into the oscilloscope input power interface.

Attach the signal lead to the oscilloscope input 2.92 mm interface. Use an appropriate torque wrench to tighten to 8 in-lbs.

Note: To disconnect LEMO plugs, first pull back on the knurled sleeve to unlock it, then pull the plug from the receptacle.

LPA-2.92-PX-KIT 2.92MM/ProAxial to ProLink Probe Adapter Kit

This kit provides a method to connect legacy DHxx-2.92MM probes or DHxx-PX probes to oscilloscopes with ProLink interfaces.

Press the LPA-2.92 adapter over the oscilloscope ProLink interface until you hear a click, then tighten the thumbscrews until just finger tight.

For DHxx-PX probes, first attach the L2.92A-PX extender cable with LEMO plug and signal lead to the probe's connector box. DHxx-2.92MM probes can attach directly to the LPA-2.92 adapter.

Push the LEMO plug into the adapter power interface.

Insert the signal lead onto the adapter signal interface. Use an appropriate torque wrench to tighten to 8 in-lbs.

Connecting the Amplifier to the Oscilloscope

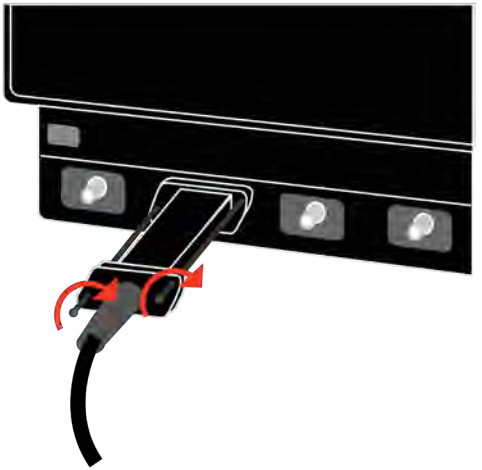
The amplifier forms the foundation of the probe. It is offered in three configurations for different oscilloscope interfaces: ProBus, ProLink and ProAxial. The amplifier is powered from the oscilloscope and in turn communicates to the oscilloscope the identifying characteristics of itself and the connected tip. This ensures the oscilloscope channel is automatically set to the correct probe attenuation and the displayed signal can be corrected to compensate for the tip's effects.

DH08-PB2

Align the connector box with the oscilloscope input and push the connector onto the instrument interface. You should hear a click when the connector latches to the interface. Switch the locking lever on the top of the connector box to the right (locked) position.

Be sure to unlock the connector box before disconnecting the probe by returning the locking lever to the left (unlocked) position.

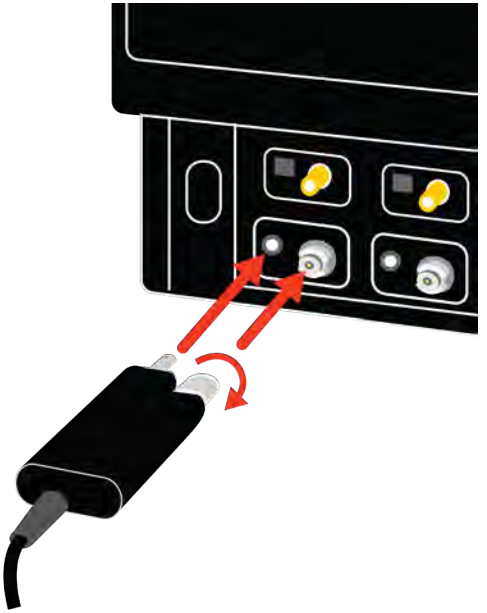
DHxx-PL



Align the connector box with the oscilloscope input and push the connector onto the instrument interface. You should hear a click when the connector latches to the interface. Tighten the thumbscrews to secure the connector box to the instrument. Do not overtighten the thumbscrews.

Remove the connector from the instrument by unscrewing the thumbscrews, then moving it up and down while pulling gently until a click is heard. This click indicates the connector box is detached from the instrument.

DHxx-PX



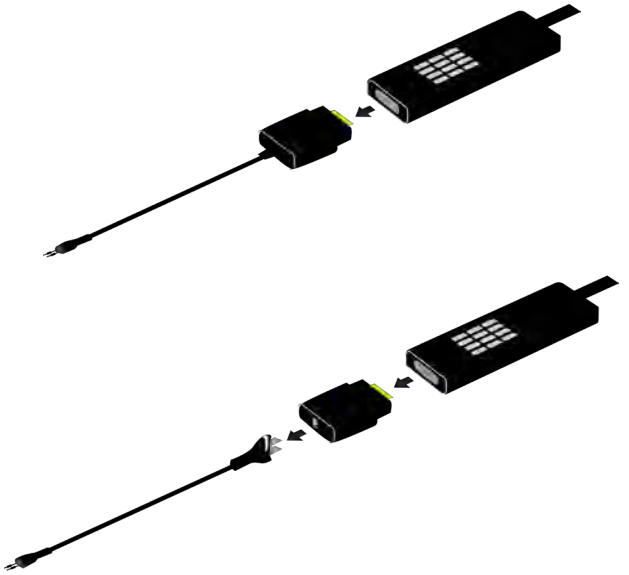
If present, remove the Planar-Crown®-to-2.92mm adapter from the ProAxial input. Insert the probe power connector (left side) into the oscilloscope input. Be sure the keying grooves on the connector and receptacle align. Hold the connector box square to the oscilloscope input as you start to tighten the RF connector screw (right side) to ensure proper alignment of the thread. Keeping the connector box square to the oscilloscope, finger tighten the Planar Crown connector screw.

Remove the connector from the instrument by unscrewing the Planar Crown connector screw, then pulling the box away from the instrument.

Connecting Tips to the Amplifier

To connect the tips to the amplifier, simply position the tip so that the label is on the same side as the amplifier label, then press the connector pins into the receptacle on the amplifier.

For QL-SI tips, first insert the adapter into the amplifier, then insert the SI tip to the adapter.



Connecting SI/HITEMP/CrossSync PHY tips (top) and QL-SI tips (bottom)

Using the Solder-in Tips

The DH-SI and DH-SI-HS tips are supplied with two pre-installed resistors, which are intended to be soldered to the runs or pad test points on the board under test. Because of their small size, these tips provide the maximum signal fidelity at the highest frequency response.

Exercise care when connecting the tips to maintain the high frequency capability of the probe. Increasing the parasitic capacitance or inductance in the input path may introduce a ring or slow the rise time of fast-rising signals. Any extension of the signal path with extra wire leads, etc. adversely affects probe performance.

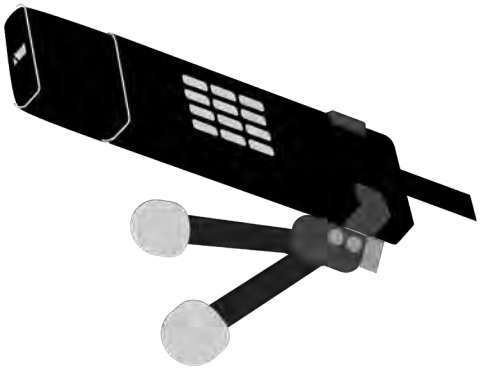
Connecting SI Tips to the Board

The SI tip should be positioned with the resistor side facing away from the PCB plane. Using a small soldering iron tip, attach the free wires of the resistors to the appropriate test points. The + input is indicated by a small + symbol on the tip, and by a white marker on the corresponding side of the tip lead.

Note: Where possible, keep a 45° angle between the ends of the tips and the PCB plane. This will improve signal fidelity performance with high frequency signals.

Properly bending the tips results in a more consistent response.The goal is to have the resistor bodies be parallel and the tips bent as needed to sit on the test board traces (see p.14). Bend the tips in toward the center about 60° from straight, making the bend as close to the resistor body as possible, then bend the tips out from their mid-points so they are parallel to each other (p.14). Perform a final check to ensure proper tip spacing before soldering to the PCB.

CAUTION: The small resistors are not sturdy enough to bear the weight of the probe. Use a means of mechanical attachment, such as hot-glue, to support the probe tip.



We recommend that positioning tools be used to support the probe amplifier when using the SI tips, reducing the risk of damaging runs or pads on the board. The Freehand Probe Holder is provided as a standard accessory with the HD probes. It is designed to maintain a steady weight on the probe tip to prevent loss of contact with the circuit under test, while bearing most of the weight of the amplifier.

Normally the performance of the SI tips is not affected by the position of the amplifier. It can be mounted straight upright or on an angle. However, when it is necessary to mount the amplifier parallel to the board, the maximum performance is obtained when the **+** input is upward facing.

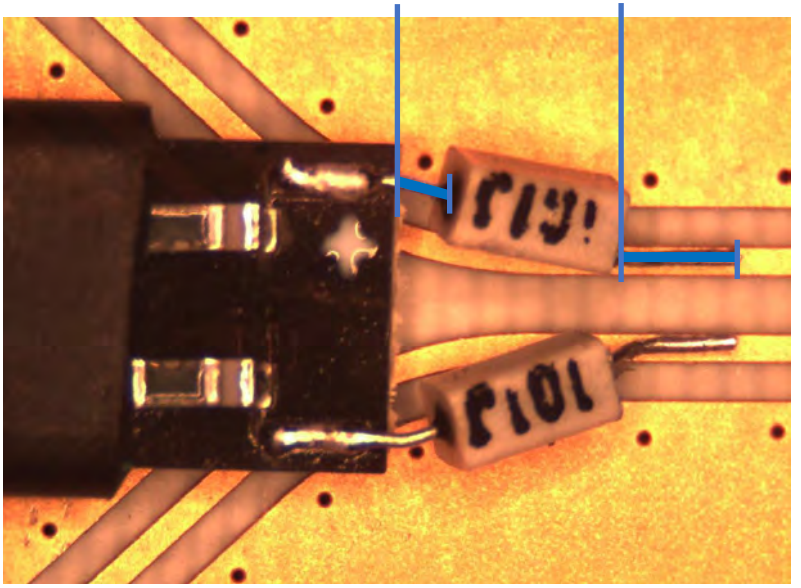
Note: The flexible cable connecting the SI tip to the amplifier is reasonably insensitive to placement but can be affected by large signal emitters on the device under test, so avoid placing it near these types of signals.

Replacing Damping Resistors on the SI Tips

The external damping resistors are subject to mechanical stress and may periodically need to be replaced even if proper stress-relief precautions are taken. Replacement damping resistors are included with the probe, already precision cut to the correct lead lengths.

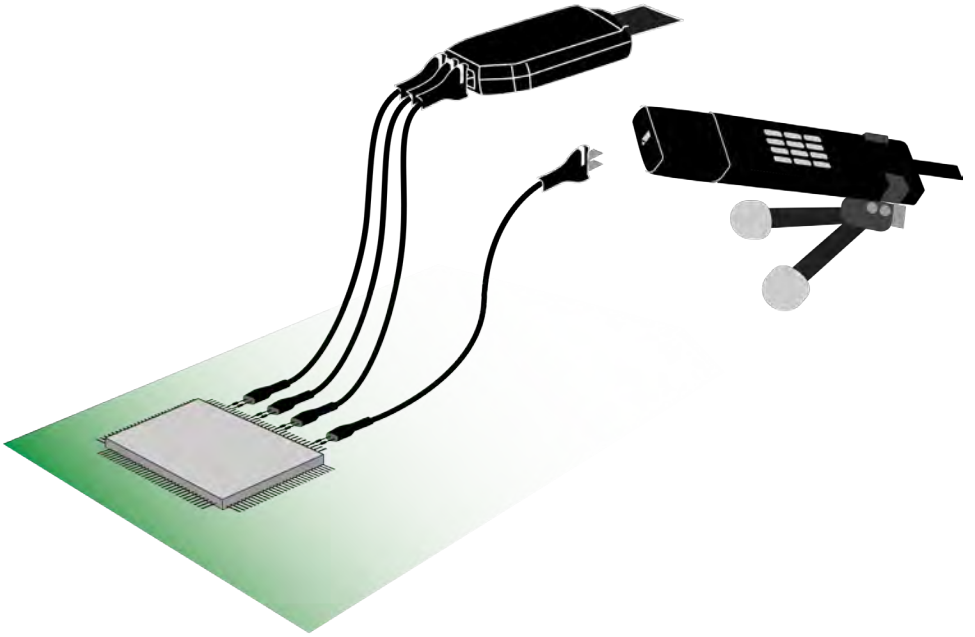
Remove the old resistor tip and any remaining solder from the long solder pad using a fine-tip soldering iron, taking care not to de-solder the SMT resistors. Avoid using excessive amounts of solder when attaching the new damping resistors to the pad. Verify the dimensions shown for resistor lead length and gap to PCB edge.

Resistor Gap to PCB Edge	Resistor Lead Length
0.050 to 0.025 (in)	0.090 +0.000 / -0.010 (in)
1.270 to 0.635 (mm)	2.286 +0.000 / -0.254 (mm)



Using the QuickLink Probe Adapter and QL-SI Tips

Attach QL-SI Tips as you would any SI tip. Once soldered to the board, the QL-SI tips can be switched from the DH probe to an HDA125 High-speed Digital Analyzer by pulling the tip head from the amplifier and plugging it into the digital leadset pod, or vice versa.



Switching leads between probe and digital leadset

Using the High-temperature Tip

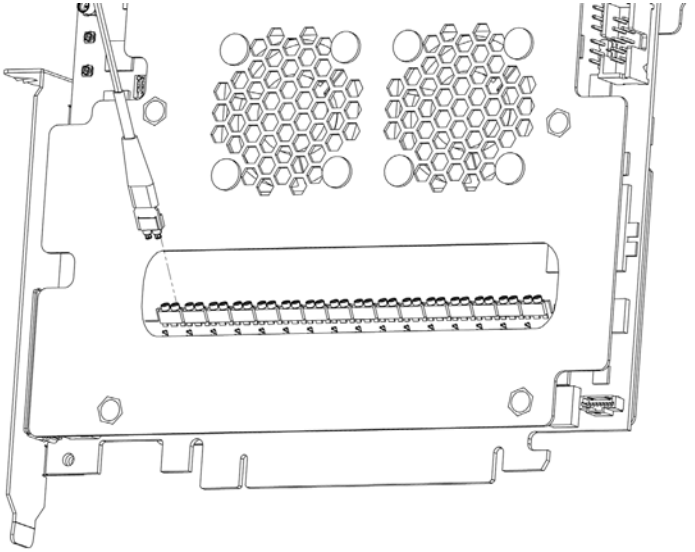
The HITEMP tip can be attached to the amplifier and soldered to the test board the same as you would the SI tips.

Using the CrossSync PHY Tip

DH-CSPHY tips are intended only for connection to the compatible *Cross*Sync PHY-capable interposer (see Table 1 on p.6). First, connect the tip to the amplifier as shown on p.12.

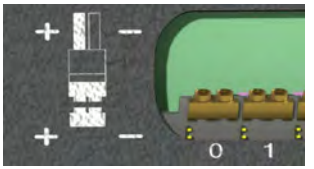
Connecting CSPHY Tips to the Interposer

Next, press the tip into the high-speed lane connector on the interposer.



Connecting DH-CSPHY tip to interposer (CEM interposer shown in example)

A polarity indicator is printed directly on the interposer next to the high-speed probing points. This indicates the side of the connector that should align with the side of the DH-CSPHY tip denoted by the matching white indicator.



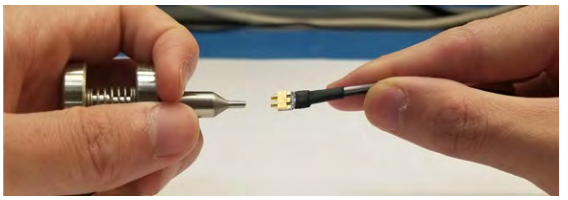
Polarity indicator for high-speed probing points

Note: Devices in a PCIe link may invert the polarity of any given lane. This indicator on the interposer and probe tip is provided for consistency, not as an absolute indication of signal polarity.

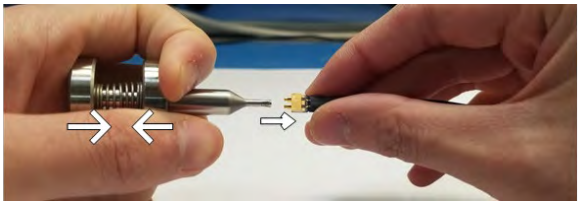
Replacing Bullets on CSPHY Tips

The CSPHY tip connectors are fitted with SMPS female bullets that may need to be replaced if they become damaged. Replacement bullets are shipped with the tip. To replace the bullets, you will need an SMPS Female Bullet Removal tool, which can be obtained from https://www.svmicrowave.com/parts/smps-female-bullet-removal-tool/500-38-004. Follow the steps below carefully.

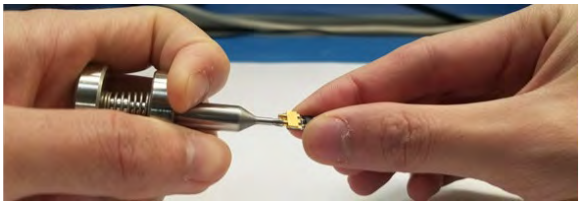
1. Hold the tool in one hand and the tip in the other as shown in the image below.



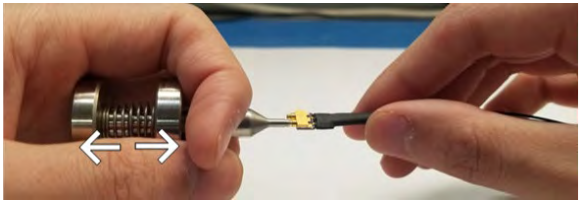
2. Squeeze the tool to compress the spring before seating the tool over the bullet.



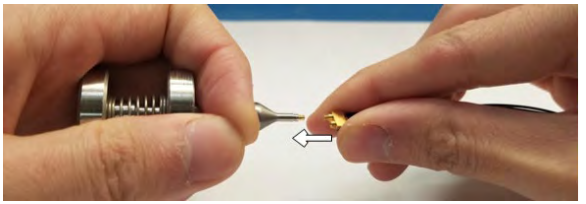
3. While continuing to squeeze the tool, seat the tip of the tool over the bullet.



4. Release the spring to pull the bullet from the connector.



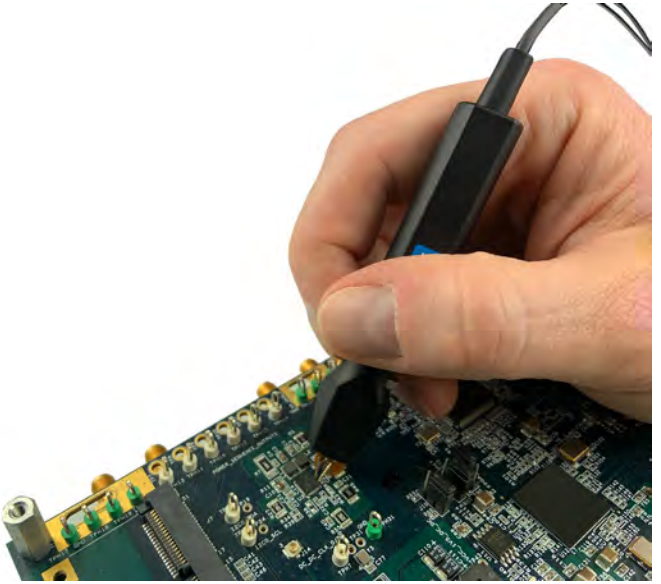
5. Carefully remove the tool from the connector head.



6. Reverse these steps to install the new bullet:
    a. Insert the new bullet into the tip of the tool
    b. Seat the tool over the connector head.
    c. Squeeze to insert the bullet.

Using the Positioner Tip (Browser)

The Positioner Tip (DH-PT) has a very small form factor with very low mass. It is a good, all-around browsing or mounted solution for probing in areas with a high concentration of test points or limited free space to fit a probe.



DH-PT used as a hand-held browser

Tip Adjustment

Connect the positioner tip lead to the DH series amplifier before adjusting the tip.

Rotate the thumbwheel to adjust the tip spacing up to 3.5 mm (0.14"). There is a positive stop on the thumbwheel to prevent it from being rotated too far in either direction.

The tip is spring mounted to accommodate 0.6 mm of Z-Axis compliance. This aids in applications where more than one DH-PT is required to make measurements in a crowded area, and the tips need to be mounted at an angle to the board under test.

CAUTION: Avoid applying excessive lateral pressure on the tip as it may break. Do not use the tip to scrape the circuit. If the tip does break, it may be replaced in the socket.

Using the Positioner Tip Hands-Free

To use the DH-PT hands-free:

1. Slide the DH-PT lead and then body into the head of the hands-free mount.
2. If necessary, adjust the tip spacing by rotating the thumb wheel on the side.
3. Tilt the DH-PT toward the board to form a sufficient “A” frame to support the tip.
4. Rotate the DH-PT in the mount so that it touches the appropriate probing points.

Mounting the DH-PT for hands-free use.

DH-PT set above board. Turn the thumbwheel to adjust the tip spacing.

Probe Operation

Note: For proper operation, DH08-PB2 and DHxx-PL probes require MAUI firmware v.9.3.x.x. or later. DHxx-PX probes require MAUI firmware v.10.4.1 or later. For best performance, install the latest firmware version supported by your oscilloscope. Free firmware upgrades are available from teledynelecroy.com/support/softwaredownload.

Probe Loading and Frequency Response

Teledyne LeCroy probes are calibrated at the factory using a network analyzer to measure a system (probe plus test fixture) frequency response. The test fixture is de-embedded from the measurement using Teledyne LeCroy's Eye Doctor tools, so the remaining frequency response is due to the combination of the test signal and the probe loading on the test circuit. The system frequency response is then calculated for these remaining circuit elements.

During calibration, each probe amplifier and each tip has a response file created and stored on-board. When the probe is connected to your Teledyne LeCroy oscilloscope, the on-board response file is read by your oscilloscope, and a combined optimized tip + probe + oscilloscope response is created for your oscilloscope and the channel to which the probe is connected. The response is identical to that of the oscilloscope channel. All that is left to do is de-embed the probe loading from the circuit.

Since the Teledyne LeCroy probe impedance is very high across the passband, probe de-embedding is often not necessary. To de-embed probe loading, use the appropriate equivalent circuit model in the Reference section and, if desired, Teledyne LeCroy's Eye Doctor tools. You can also use Teledyne LeCroy's VirtualProbe software, which allows you to select from a list of supported tips. Your selection applies a corresponding S-parameter file that is derived from the equivalent circuit model of the tip.

Probe Grounding

Capacitive coupling from AC mains may cause truly floating devices (like battery operated devices) to exceed the common mode range. In such cases, it is recommended to connect the probe ground to the device under test.

Connect the plug of the ground lead to the receptacle on the side of the amplifier body, then, connect the tip of the ground lead to the DUT:

- With floating devices, connect the ground lead to the DUT's reference or common voltage.
- In high RF ambient noise environments, connect the ground lead to a good RF ground near the point where the signal is measured.

CAUTION: Always use a ground lead when testing floating circuits, such as circuits powered from laboratory bench power supplies, which normally have floating outputs. These may damage the probe by exceeding the common mode input voltage.

In most cases, when the common mode portion of the signal consists mainly of lower frequencies, the probe does not need to be connected to the DUT ground. This minimizes the effects of ground loop currents. Any signal corruption caused by not having the probe connected to ground of the signal under test is common to both inputs and is rejected by the differential operation of the probe.

Dynamic Range

Probe gain and attenuation can be controlled either by adjusting the Vertical Scale setting on the oscilloscope or changing tips. The system attenuation ranges from approximately 1.7 to 6.8 depending on the tip and Vertical Scale used. The actual attenuation for each probe is indicated on the probe dialog, which is displayed when the probe is connected to the oscilloscope (p.23).

DH Series probes are always DC coupled (no AC coupling is provided). Therefore, care must be exercised to avoid exceeding the common mode range (see p. 36). Because the common mode signal is rejected by the probe and is not displayed, changes in the amplitude of the common mode component are not apparent to the user. Exceeding the common mode range may introduce distortion to the probe's output signal.

Offset

The offset for the DH Series probes is in the probe amplifier. Thus, the probes have full offset capability over their entire Vertical range. When a DH Series probe is used with a Teledyne LeCroy oscilloscope, the probe offset is controlled using the oscilloscope Vertical OFFSET knob or software setting.

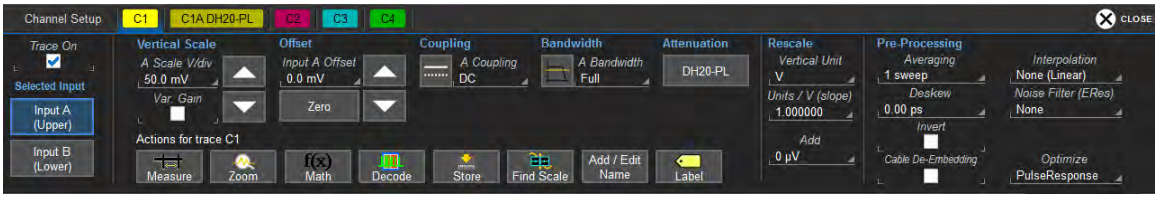
Controlling the Probe from the Oscilloscope

Before Using the Probe

- Ensure the oscilloscope's Windows updates are current.
- Download and install the latest version of MAUI oscilloscope firmware.

Controlling Vertical Response

When the probe is connected to a MAUI oscilloscope, the oscilloscope recognizes the probe and opens the respective Channel (C*n*) dialog. You can use this dialog to set the V/div, Offset and Coupling, which are controlled directly through the oscilloscope. Refer to your oscilloscope Operator's Manual for specific operation of the Vertical controls on the Channel dialog.



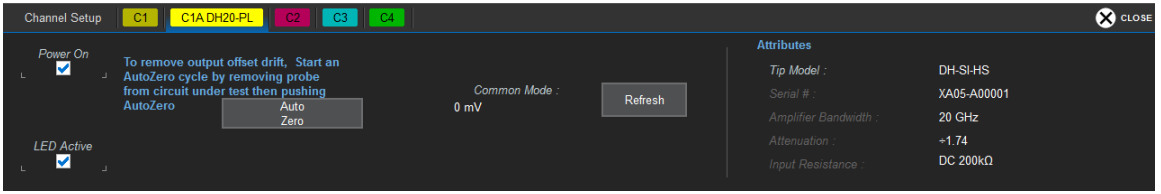
Channel dialog with tab corresponding to attached amplifier model.

Behind the C*n* dialog is a dialog of probe controls. The dialog tab shows:

- The amplifier model and the input to which the amplifier has been connected, if the oscilloscope has multiple input rows.
- "No Tip" warning if the amplifier does not yet have a tip attached.

When the probe is fully connected, the Probe dialog **Attributes** frame shows all the characteristics of the probe, such as the **Tip Model** connected, tip **Serial #**, **Amplifier Bandwidth**, **Attenuation** and **Input Resistance** of the probe.

The **Power On** checkbox controls the operational state of the probe. Check this to supply power to the probe and begin acquiring; deselect it to "turn off" the probe.



Probe dialog after fully connecting probe.

AutoColor ID

The AutoColor ID LED built into the amplifier illuminates in the color of the channel to which the probe is connected. In some applications, it may be desirable to turn off the probe's AutoColor ID by deselecting the LED Active checkbox on the Probe dialog.

AutoColor ID LED

AutoZero

Auto Zero corrects for DC offset drifts that naturally occur from thermal effects in the amplifier. The probe incorporates Auto Zero capability to remove the DC offset from the probe's amplifier output to improve the measurement accuracy. Always perform Auto Zero after the probe is warmed up (recommended time is 20 minutes).

To invoke Auto Zero, touch the Auto Zero control on the Probe dialog.

CAUTION: Disconnect the probe from the circuit before Auto Zero, or else any DC component that is part of the signal to be measured will be zeroed out.

Depending on the measurement accuracy desired and/or changes in temperature where the probe is located, it may be necessary to perform Auto Zero more often. If the probe is reconnected to the oscilloscope after being disconnected, repeat Auto Zero after a suitable warm-up time.

Common Mode Voltage

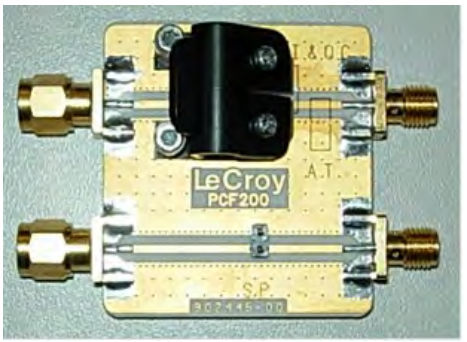
During operation, the Common Mode voltage of the input is shown. Click the Refresh button to update the Common Mode voltage reading.

Deskewing

The Probe Characterization Fixture (PCF200) is provided as a standard accessory with DH Series platform/cable assemblies. The fixture can be used as a convenient way to deskew probes/oscilloscope channels.

Note: The fixture has an inherent rise time limitation of ~70ps. Deskew of very high frequency signals may require a faster rise time than this fixture can provide. In this case, utilize one of your signals as a reference point, and then deskew all additional signals to the reference signal.

REQUIRED EQUIPMENT

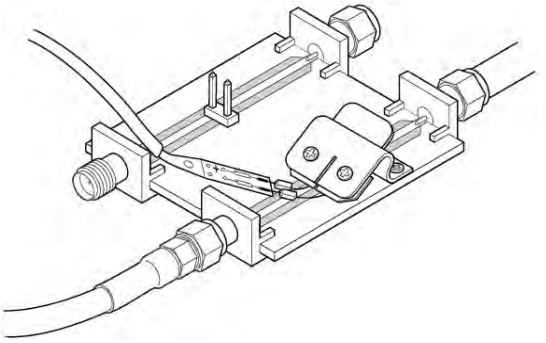


- PCF200
- 50 Ω terminator
- Any solder-in lead

Note: Alternatively, an LPA-K-A adapter and an SMA cable can be used to terminate the PCF200 to a 50 Ω oscilloscope input.

CONNECTING TO THE PCF200

Press the black plastic tab on the PCF200 to open the clamp, placing the resistor tips under the clamp so that the + tip contacts the center microstrip and the – tip contacts the ground plane. Release the clamp so it holds the wires securely in place.



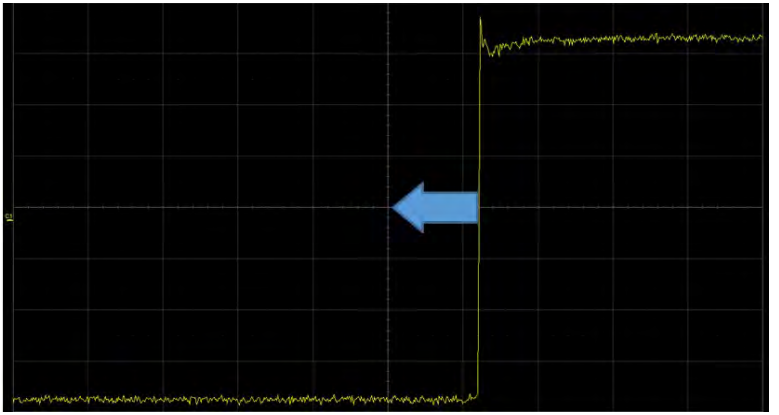
Connecting solder-in tips to PCF200

DESKEW PROCEDURE

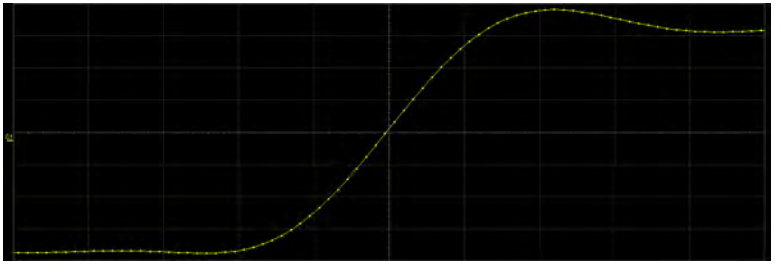
1. Warm the oscilloscope for at least 20 minutes.
2. Connect the PCF200 to the oscilloscope's Fast Edge output using the signal path indicated by the type of probe tip being used for the measurement:

   Tip: The tip does not matter as long as you use the *same* tip to deskew each probe. On some oscilloscope models, the Fast Edge signal is output over the Aux Out interface. Go to Utilities > Utilities Setup > Aux Output to configure the output for Fast Edge.
3. Connect probes electrically in a single-ended arrangement using their designated area on the fixture:
4. Connect the positive side, indicated by a plus sign on the probe tip, to the signal trace (between the two white strips).
5. Connect the negative side to the ground plane (outside the white strips).
6. To minimize reflection, apply a 50 Ω terminator to the end of the signal path used.
7. Connect the probe cable to C1.
8. Set the oscilloscope trigger type to "Edge", trigger source to "Fast Edge", timebase to 10 ns/div, and delay to zero. Start acquisition.

   When properly set up, the oscilloscope display should look similar to the figure below. If there is no propagation delay due to the probe, and no internal oscilloscope channel propagation delay, the 50% trigger level will appear exactly centered on the oscilloscope grid. Any visible delay represents the amount of skew to be corrected.



9. Adjust the C1 Deskew value so that the 50% rising edge point is centered on the grid.
10. From the C1 setup dialog, enable Sinx/x (or 5 pt Sinx/x) Interpolation and set Averaging to 50 sweeps.
11. Adjust the Deskew value to move the rising edge of the trace to the center of the grid.
12. Decrease the timebase to around 20 ps/div, and adjust the Deskew value so that the 50% rising edge point is centered on the grid, as shown in the image below:



13. Repeat this procedure for each probe using the same probe tip.

Note: Before deskewing the next probe, reset Averaging to 1 sweep and turn off Sinx/x Interpolation.

Care and Maintenance

Cleaning

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

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

Service Options

Defective probes or probe tip modules must be returned to a Teledyne LeCroy service facility for diagnosis and repair or replacement. Defective products under warranty may be repaired or replaced at the discretion of Teledyne LeCroy.

Note: For warranted accuracy, amplifiers must be returned to factory for calibration with leads.

The following service options are available for your Teledyne LeCroy DH probe:

Table 3: DH Probe Service Options

Service Option	Product Code
Three-Year Warranty	DHxx-W3
Five-Year Warranty	DHxx-W5
Three-Year Annual NIST Calibration	DHxx-C3
Five-Year Annual NIST Calibration	DHxx-C5
Three-Year Warranty with Annual NIST Calibration	DHxx-T3
Five-Year Warranty with Annual NIST Calibration	DHxx-T5
NIST Traceable Calibration with Test Data	DHxx-CCNIST

Returning a Product for Service

Contact your local 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.
2. Pack the probe in its case. If possible, include all tips. Do not include the manual.
3. Pack the case in its original shipping box, or an equivalent carton with adequate padding to avoid damage in transit.
4. 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 Teledyne LeCroy*>
   - FRAGILE
5. If returning a probe to a different country: contact Teledyne LeCroy Service for instructions on completing your import/export documents.

Extended warranty, calibration and upgrade plans are available for purchase. Contact your Teledyne LeCroy sales representative to purchase a service plan.

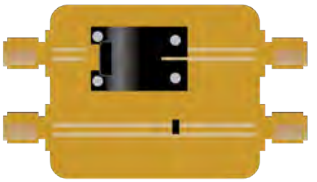
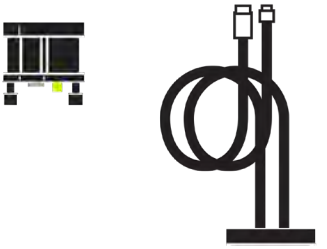
For a complete list of Teledyne LeCroy offices by country, including our sales and distribution partners, visit: teledynelecroy.com/support/contact.

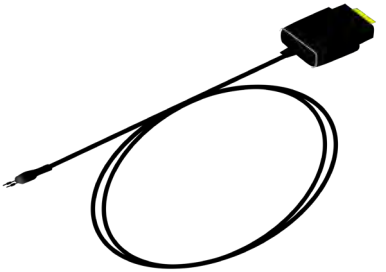
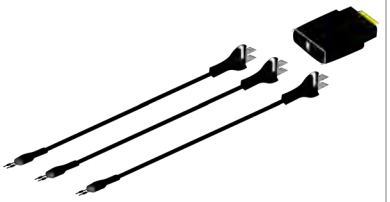
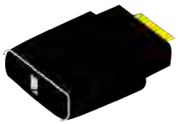
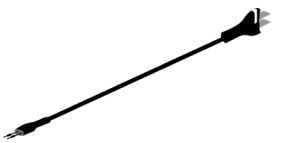
Optional and Replacement Parts

The following parts may be ordered individually as replacements from your Teledyne LeCroy sales representative or Teledyne LeCroy Service Center.

Table 4: DH Series Probes Orderable Parts

Item		Product Code
Standard Solder-in Tips		DH-SI
High-Sensitivity Solder-in Tips		DH-SI-HS
Spare Solder-in Tip Resistors (Qty. 10)		DH-SI-RESISTORS
CrossSync PHY Tips		DH-CSPHY-* See Table 1 on p.6 for product codes
Ground Lead (Qty. 4)		PACC-LD005
Ground Clip (Qty. 2)		PK006-4

Item		Product Code
Probe Deskew Fixture		PCF200
Freehand Probe Holder		PACC-MS006
ProLink to 2.92 mm Adapter		L2.92A-PLINK
2.92 mm/ProAxial to ProLink Adapter Kit		LPA-2.92-PX-KIT

Item		Product Code
ProBus to ProLink Adapter		LPA-PB2
High Temperature Tip		DH-HITEMP
QuickLink Adapter Kit		DH-QL-3SI
QuickLink Adapter		DH-QL
QL-SI Tips (1- or 9-tip pack)		QL-SI-1PACK QL-SI-9PACK

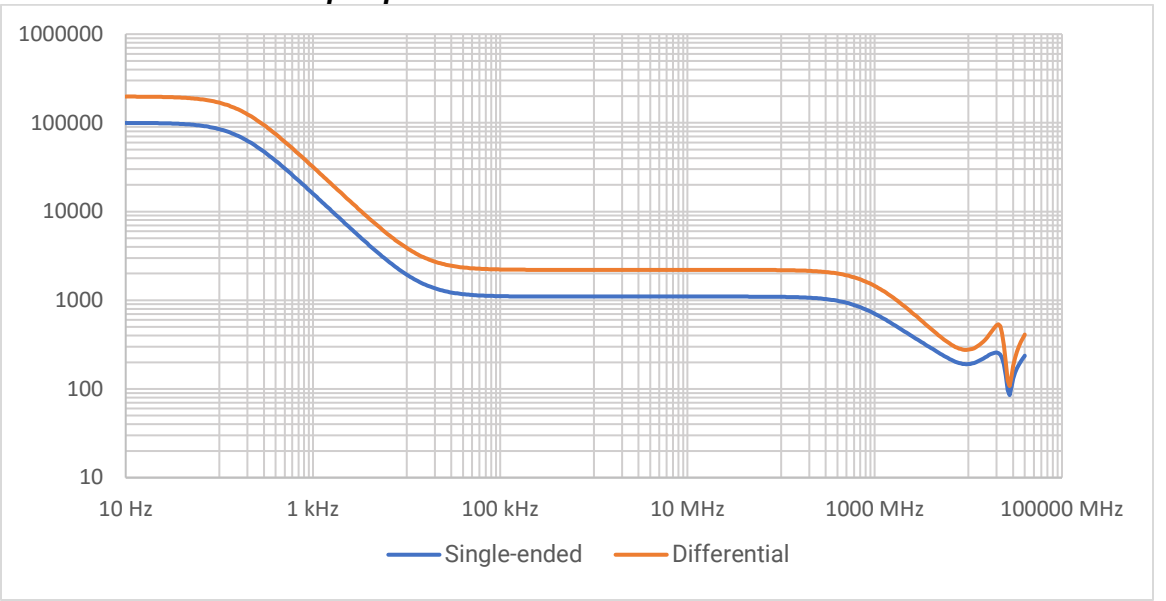
Item		Product Code
Positioner Tip Kit		DH-PT

Reference Material

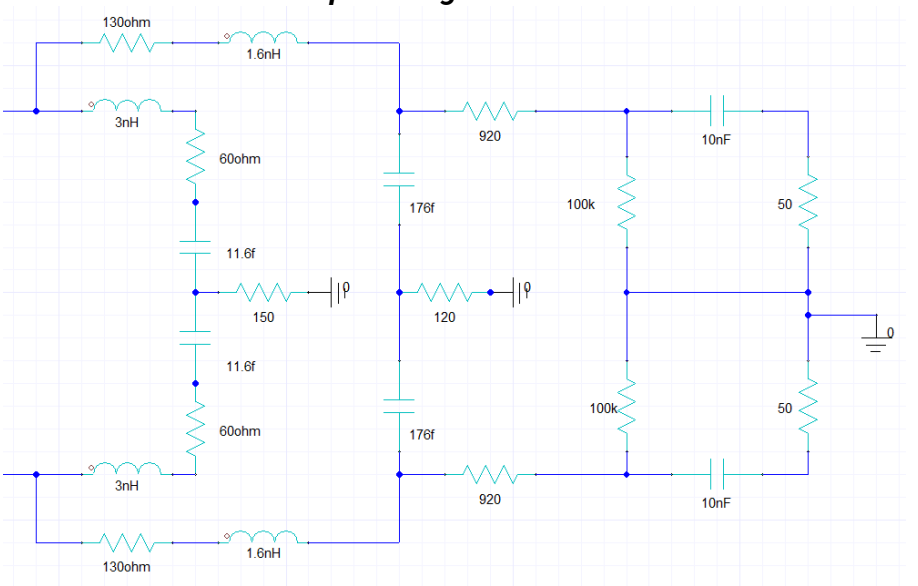
Probe Input Impedance and Loading

DH probes are designed to minimize loading due to capacitive reactance at high frequencies. The solder-in tips use a construction in which the tip termination consists of a damping resistor with very short lead length (to minimize inductance) that is soldered to the circuit. These damping resistors connect to a special distributed resistor on the lead. The distributed resistors compensate for the inherent transmission loss of the probe system. The result is very broad frequency response with relatively high impedance.

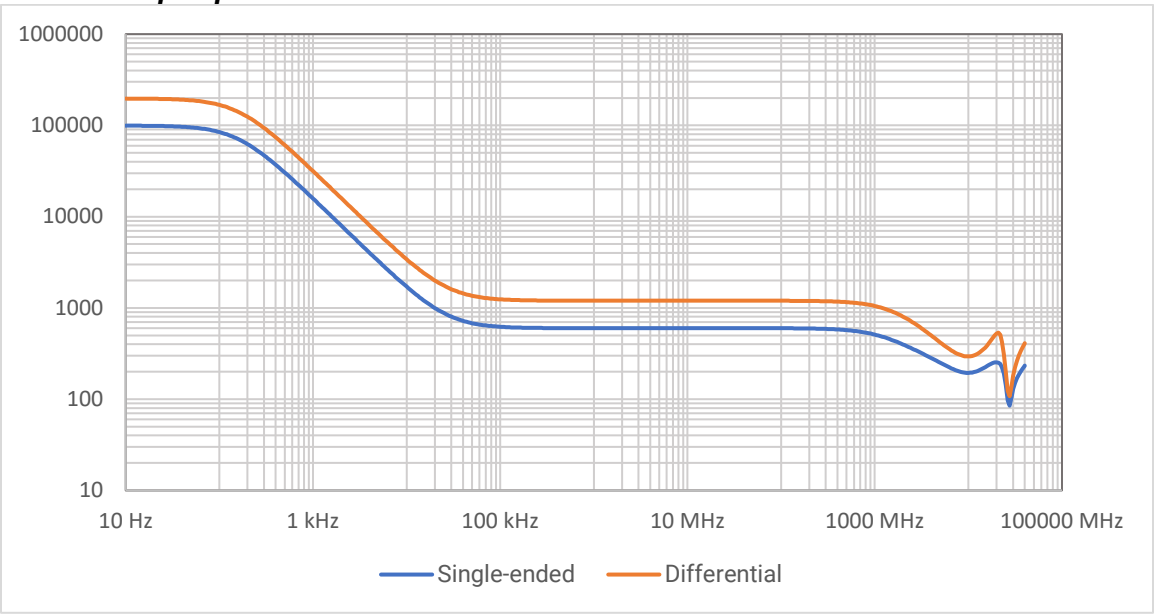
DH-SI and DH-HITEMP Tip Impedance



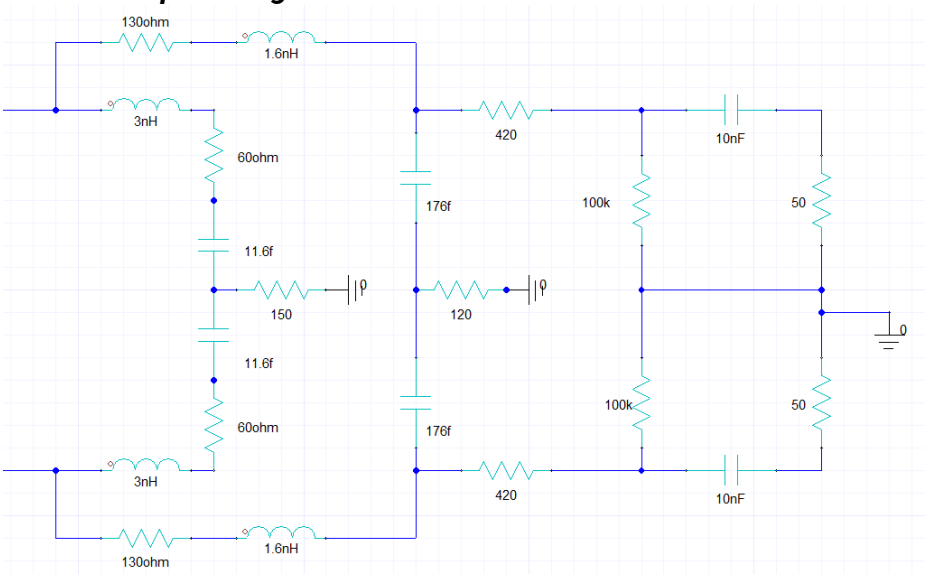
DH-SI and DH-HITEMP Tip Loading



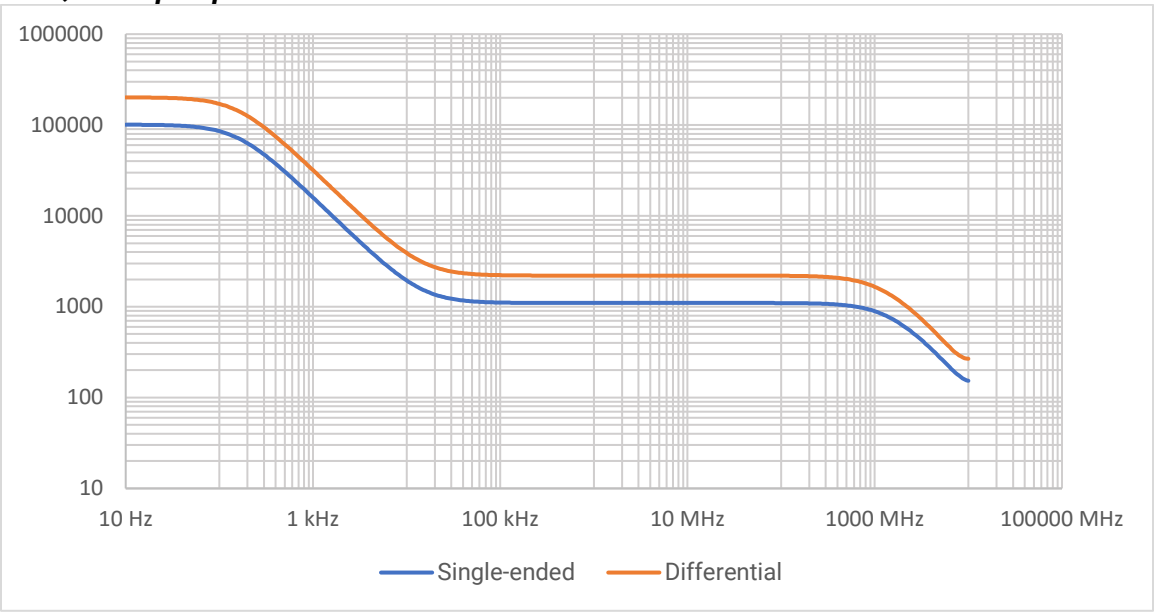
DH-SI-HS Tip Impedance



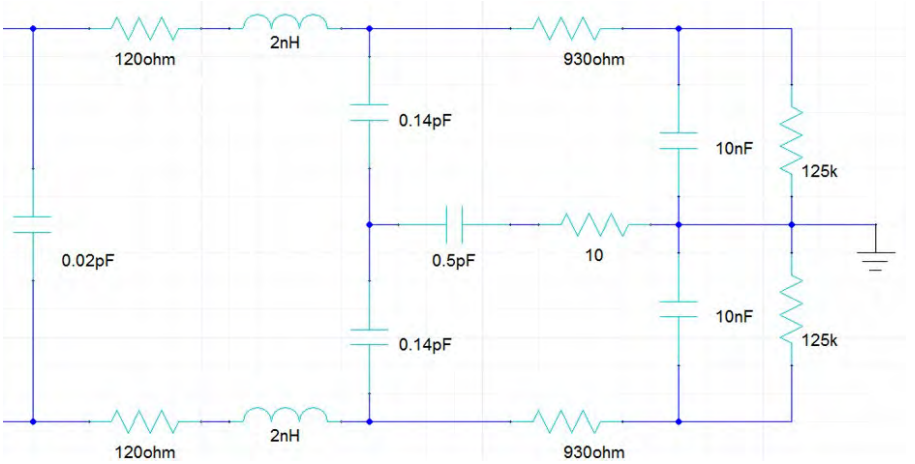
DH-SI-HS Tip Loading



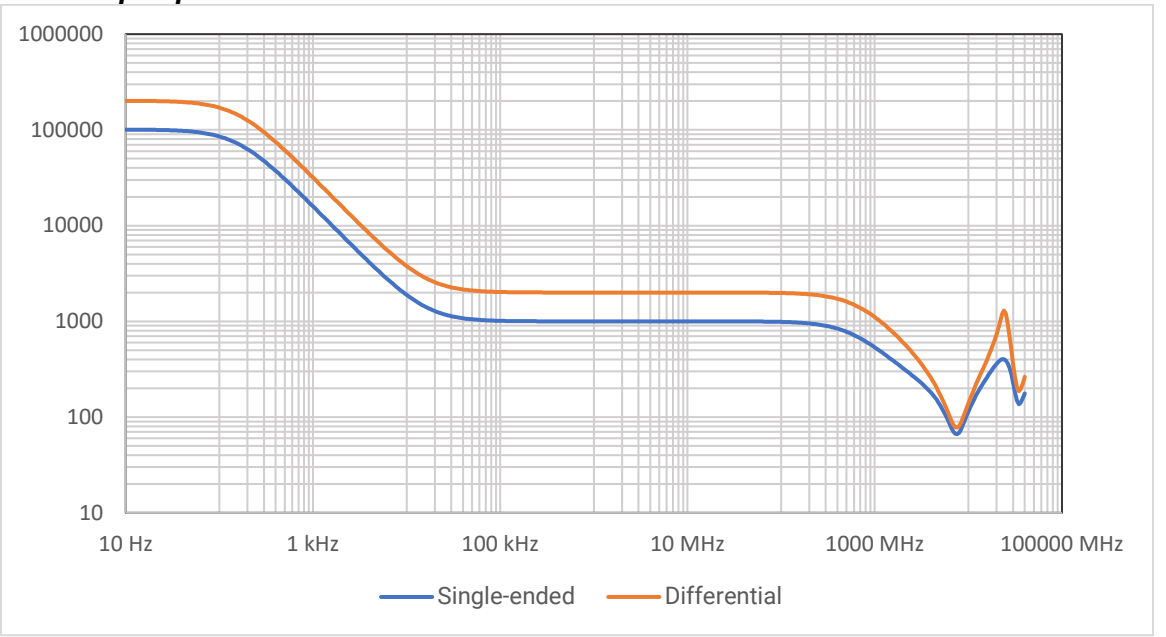
DH-QL-SI Tip Impedance



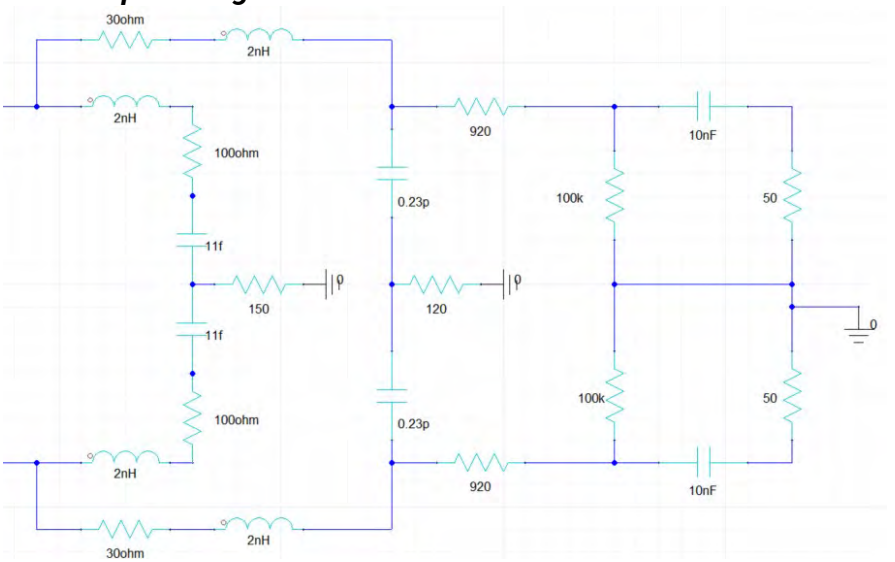
DH-QL-SI Tip Loading



DH-PT Tip Impedance



DH-PT Tip Loading



Differential Mode Range and Common Mode Range

Differential probes sense the voltage difference which appears between the **+** input and **–** input. This voltage is referred to as the Differential Mode or Normal Mode voltage. The voltage component which is referenced to earth and is identical on both inputs is rejected by the amplifier. This voltage is referred to as the Common Mode voltage and can be expressed as:

$$V_{CM} = \frac{V_{+input} + V_{-input}}{2}$$

Differential Mode range is the maximum signal that can be applied between the **+** and **-** inputs without overloading the amplifier/amplifier, which otherwise would result in clipping or distorting of the waveform measured by the oscilloscope.

The Common Mode Range is the maximum voltage with respect to earth ground that can be applied to either input. Exceeding the common mode range can result in unpredictable measurements. Because the Common Mode signal is normally rejected, and not displayed on the oscilloscope, the user needs to be careful to avoid accidentally exceeding the common mode range.

Because the input signal of a differential amplifier is not referenced to ground, the concept of V_{peak} versus $V_{peak\text{-}peak}$ may be confusing. With a ground referenced signal, V_{peak} is the maximum instantaneous voltage amplitude the signal will have with respect to ground. In a differential system, there is no ground reference. Therefore, the Differential Mode Range refers to the maximum instantaneous amplitude of the signal difference between the positive input and the negative input. Since most amplifiers have symmetrical bipolar inputs, the value is generally expressed as an absolute value, and can have either polarity.

For example, an amplifier with a differential mode rating of ±1 V can have a maximum voltage difference appearing at any instant in time of 1 V between the inputs. The polarity could be either positive or negative. However, this does not imply that the number can be doubled to 2 V. For clarity, consider the following table of absolute voltages applied to the inputs of a DH Series probe that has a differential mode range of ±800 mV and a common mode range of ±4 V.

Some amplitude is specified as peak to peak. The differential amplifier peak-peak range is twice the peak differential mode range specification (at any instant in time) as the maximum voltage amplitude signal is one-half of the peak-to-peak value.

Table 5: Maximum Voltage Ranges

Voltage on + input to ground	Voltage on - input to ground	Difference	Comment
+1.5 V	+0.8 V	+0.7 V	OK: within ±800 mV range
-1.5 V	-0.8 V	-0.7 V	OK: within ±800 mV range
+0.8 V	-0.1V	+0.9 V	Out of range: exceeds ±800 mV
+1.0 V	-1.0 V	+2.0 V	Out of range: exceeds ±800 mV
+6.5 V	+6.0 V	0.5 V	Exceeds ±4 V common mode range
1.5 $V_{pk\text{-}pk}$ sine	Ground	0.75 V_{peak}	OK: within ±800 mV range

In a balanced differential system, the signal on each output is an inverted copy of the other input. For example, an LVDS system may have a pair of outputs, each of which has a voltage swing of 0 to +370 mV. A logic 1 would be represented when the **+** output is at +370 mV, while the **-** output is at 0 V. A logic zero is the opposite polarity: the **+** output at 0 V and the **-** output at +370 mV. Note that even though both outputs swing 370 mV, the maximum difference voltage between them at any instant is still within ±370 mV. So, this signal could be measured with a differential amplifier that has a differential mode range of ±400 mV.

Common Mode Rejection Ratio

The ideal differential probe/amplifier would sense and amplify only the differential mode voltage component and reject the entire common mode voltage component. Real differential amplifiers are not perfect, and a small portion of the common mode voltage component appears at the output. Common Mode Rejection Ratio (CMRR) is the measure of how much the amplifier rejects the common mode voltage component. CMRR is equal to the differential mode gain (or normal gain) divided by the common mode gain. Common mode gain is equal to the output voltage divided by the input voltage when both inputs are driven by only the common mode signal. CMRR can be expressed as a ratio (e.g., 10,000:1) or implicitly in dB (e.g., 80 dB). Higher numbers indicate greater rejection (better performance).

The first order term determining the CMRR is the relative gain matching between the **+** and **–** input paths. High CMRR values are obtained by precisely matching the input attenuators in a differential amplifier. The matching includes the DC attenuation and the capacitance which determines the AC attenuation. As the frequency of the common mode component increases, the effects of stray parasitic capacitance and inductance in determining the AC component become more pronounced. The CMRR becomes smaller as the frequency increases.

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.

Certifications

Teledyne LeCroy certifies compliance to the following standards as of the time of publication.

European Council

CE The probe bears this mark to indicate it conforms to all applicable European Council standards. Please see the EC Declaration of Conformity document shipped with your product for current certifications.

EC Declaration of Conformity - EMC

The probe meets the intent of EC Directive 2014/30/EU for Electromagnetic Compatibility.

EN IEC 61326-1:2021 EMC requirements for electrical equipment for measurement, control, and laboratory use. [1, 2]

EN IEC 61326-2-1:2021 Particular requirements for sensitive test and measurement equipment for EMC unprotected applications.

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

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

EC Declaration of Conformity – Safety

The probe meets 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:

EN 61010-1:2010+A1:2019 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements

EN IEC 61010—031:2021 Safety requirements for hand-held probe assemblies for electrical test and measurement.

End-of-Life Handling / WEEE

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

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. For more in-formation about proper disposal of your Teledyne LeCroy product, visit teledynelecroy.com/recycle.

RESTRICTION OF HAZARDOUS SUBSTANCES (ROHS)

The probe conforms to the 2011/65/EU RoHS2 Directive inclusive of any further amendments or modifications of said Directive.

IEC/EN 63000:2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

European Contact:*

Teledyne GmbH – LeCroy Division
Im Breitspiel 11c
D-69126 Heidelberg
Germany
Tel: (49) 6221 82700

Australia & New Zealand

The probe complies with the EMC provision of the Australian Communication and Media Authority (ACMA) Radio Communications Act:

AS/NZS CISPR 11:2009/A1:2010, EN 55011:2009/A1:2010 Radiated and Conducted Emissions, Group 1, Class A.

Australia / New Zealand Contacts:*

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Suite 326 The Parade West
Kent Town, South Australia 5067

RS Components Ltd.
Unit 30 & 31 Warehouse World
761 Great South Road
Penrose, Auckland, New Zealand

* Visit teledynelecroy.com/support/contact for the latest contact information.

United Kingdom

UK CA

The probe bears this mark to indicate it conforms to all applicable United Kingdom standards for EMC and Safety. The design of the product has been verified to conform to the applicable harmonized standards and technical specifications and is in conformity with the relevant Union harmonization legislation below:

UK SI 2016 No. 1101 The Electrical Equipment (Safety) Regulations 2016

UK SI 2016 No. 1091 Electromagnetic Compatibility Regulations 2016

UK SI 2012 No. 3032 Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

China

Unless otherwise specified, all materials and processes are compliant with the latest requirements of China RoHS. The hazardous substances contained in the product are disclosed in accordance with the standards:

SJ/T 11364-2014 Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products

GB/T 26572-2011 Requirements on Concentration Limits for Certain Restricted Substances in Electrical and Electronic Products).

Technical Support

Live Support

Registered users can contact their local Teledyne LeCroy service center at the number listed on our website. You can also request Technical Support via the website at:

teledynelecroy.com/support/techhelp

Resources

Teledyne LeCroy publishes a free Technical Library on its website. Manuals, tutorials, application notes, white papers, and videos are available to help you get the most out of your Teledyne LeCroy products. Visit:

teledynelecroy.com/support/techlib

Service Centers

For a complete list of offices by country, including our sales and distribution partners, visit:

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