



Operator's Manual

LeCroy HFP3500

REVISION B – APRIL 2002



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Warranty

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, 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 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. LeCroy will return all products under warranty with transportation charges prepaid.

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HFP3500-OM-E Rev B 0402





DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014:1998

Manufacturer's Name: LeCroy Corporation

Manufacturer's Address: 700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

herewith declare that

Product(s) Name: Active Voltage Probe

Model Number(s): HFP 3500, HFP2500, HFP1500, HFP1000

including all their options are in conformity with the provisions of the following EC directive(s), including the latest amendments, and with national legislation implementing these directives:

73/23/EEC Low Voltage Directive
89/336/EEC EMC Directive

and that conformity with Council Directive 73/23/EEC is based on

EN 61010-2-031:2002 Safety requirements for electrical equipment for measurement control and laboratory use

Part 031: Particular requirements for hand-held probe assemblies for electrical test and measurement

and that conformity with Council Directive 89/336/EEC is based on

EN 61326/A3:2003 EMC requirements for electrical equipment for measurement control and laboratory use

| | | |
|-----------|----------------------|------------------------------------|
| Emissions | EN 55011/A2:2002 | Conducted and Radiated Emissions |
| Immunity | EN 61000-4-2/A2:2001 | Electrostatic Discharge |
| | EN 61000-4-3/A1:2003 | RF Radiated Electromagnetic Field |
| | EN 61000-4-4:2004 | Electrical Fast Transient/Burst |
| | EN 61000-4-5/A1:2001 | Surge |
| | EN 61000-4-6/A1:2001 | RF Conducted Electromagnetic Field |

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Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

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1 Safety Information

OPERATOR SAFETY

To avoid personal injury and to prevent damage to the probe or any products connected to it, review the following safety precautions. To avoid potential hazards, use the probe only as specified.



Warning



To avoid fire or personal injury, comply with the following:

Connect probe to the measurement instrument before connecting test leads to a voltage source.

Do not disconnect probe from instrument while test leads are connected to a voltage source.

Use of the probe and/or the oscilloscope it is connected to in a manner other than that specified may impair the protection mechanisms.

Do not apply a potential to any input that exceeds the maximum rating of that input. (Section 9, Specifications.)

When measuring high frequency signals, be sure to comply with the voltage vs. frequency derating curve. (Section 9, Specifications.)

Do not use in wet or explosive atmospheres.

Do not use the probe if any part is damaged. All maintenance should be referred to qualified service personnel.

CONVENTIONS USED IN THIS MANUAL

The following conventions may appear in this manual:

Note

A Note contains information relating to the use of the product.

HFP3500 High Frequency Probe

CAUTION

A Caution contains information that should be followed to avoid possible damage to the instrument or the device under test.

WARNING

A Warning alerts you to a potential hazard. Failure to adhere to the statement in a WARNING message could result in personal injury.

The following symbols may appear on the product:



CAUTION: Refer to accompanying documents

This refers you to additional information contained in this manual. The corresponding information in the manual is similarly denoted.



CAUTION: Risk of electric shock

This is a reminder that high voltage may be present and that appropriate caution should be taken.



This is the symbol for earth ground.

###

2 Overview

PRODUCT DESCRIPTION

The 3.5 GHz HFP3500 is a small, high frequency active probe designed to meet today's increasing demand for measurements on a variety of test points.

With very low input capacitance and high input resistance, circuit loading is minimized.

The HFP3500 can be used with LeCroy's WaveMaster™ oscilloscope with firmware version 1.0.0.1 or higher.

When the probe is used with this oscilloscope, the AutoColor ID feature automatically illuminates the probe head in the default trace color of the channel to which the probe is connected, eliminating the need for color bands or other markers.

With the ProBus interface, the HFP3500 becomes an integral part of the oscilloscope. The probe can be controlled from the oscilloscope's front panel. The oscilloscope provides power to the probe, so there is no need for a separate power supply or batteries.

When used in combination with an ADPPS power supply, the HFP3500 probe can be used with non-LeCroy instruments. (See Section 4 for detailed operation with an ADPPS adapter).

KEY BENEFITS

- High frequency performance
- Low input capacitance
- Wide dynamic range
- ProBus interface
- AutoColor ID feature matches the probe color to the oscilloscope's default trace color
- Five interchangeable tips for probing a variety of test points
- Replaceable probe tip socket
- Hands free probing with *FreeHand* probe holder

HFP3500 High Frequency Probe

STANDARD ACCESSORIES

The HFP3500 is shipped with the following standard accessories:

| Item: | Quantity: |
|------------------------------|------------------|
| Straight Tip | 4 |
| Sharp Tip | 4 |
| IC Lead Tip | 4 |
| SMD Discrete Tip | 4 |
| Bent Sharp Tip | 4 |
| Micro Clip, 0.5 mm | 2 |
| Clip, 0.8 mm | 2 |
| Ground Spring with Hook | 1 |
| Square Pin Ground Spring | 1 |
| Offset Pin | 2 |
| Short Right Angle Lead | 2 |
| Long Right Angle Lead | 2 |
| Short Single lead | 2 |
| Long Single Lead | 2 |
| <i>FreeHand</i> Probe Holder | 1 |
| Soft Accessory Case | 1 |
| Instruction Manual | 1 |
| Certificate of Calibration | 1 |

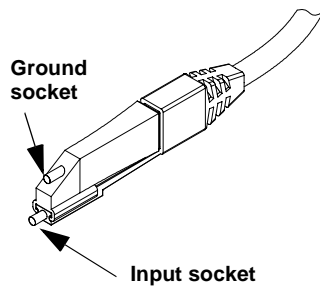
For part number information for standard and optional accessories refer to Section 6, Care and Maintenance, Replaceable Parts List.

###

3 Features and Accessories

The HFP3500 probe is provided with numerous features and accessories to make probing and connecting to different test points easier than ever.

PROBE HEAD

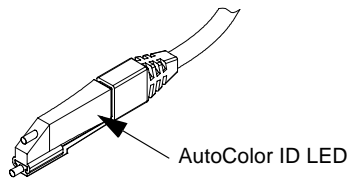


The small, low mass probe head is designed for ease of use and high performance.

The probe tip socket fits easily onto 0.025 inch square pins for direct access to test points. Several different adapters are available which connect directly in the probe socket.

The ground socket will accept several different ground leads to provide a short ground path for high frequency performance.

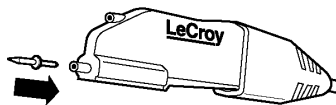
AUTOCOLOR ID



The AutoColor ID consists of an LED inside the probe head which illuminates the probe body in the default trace color of the channel to which the probe is connected.

The AutoColor ID will only function when the probe is connected to a LeCroy oscilloscope supplied with the ProBus interface and firmware version 8.7.0 or higher. The colors are correct when factory default color scheme 1 is selected.

DESCRIPTION OF STANDARD AND OPTIONAL ACCESSORIES

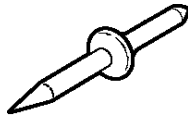


The following Tip and Clip accessories can be pushed into the probe tip socket, ground socket or any other socketed lead or adapter.

HFP3500 High Frequency Probe

A. Tips

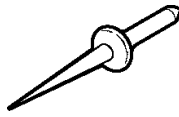
Straight Tip



The straight tip is rugged and designed for general probing. Fits in either probe socket.

PACC-PT001, package of 4.

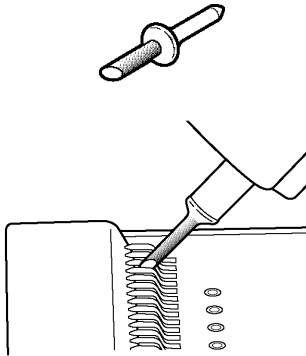
Sharp Tip



Rugged, titanium tip designed to connect to the smallest vias and small test points. Fits in either probe socket.

PACC-PT002, package of 4.

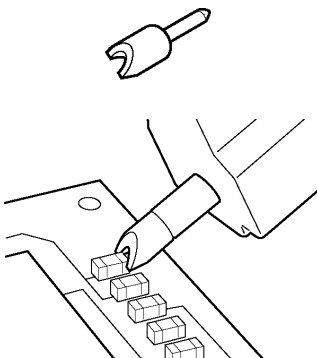
IC Lead Tip



Covered in insulation on all sides (except for a small edge), this tip was designed to prevent shorting neighboring IC leads. The gold part of the tip is not insulated and should touch the IC lead to be tested. It is one-size-fits-all and will work with any IC lead pitch. Fits in either probe socket.

PACC-PT003, package of 4.

SMD Discrete Tip

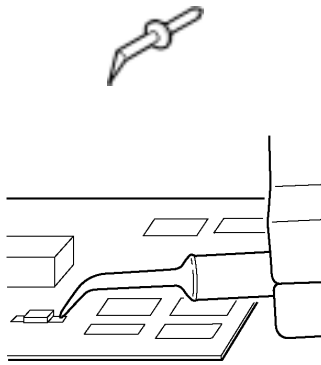


The crescent shape of this tip is designed to fit tightly on capacitors, resistors, transistors and other surface mount components with discrete leads. Fits in either probe socket.

PACC-PT004, package of 4.

Features and Accessories

Bent Sharp Tip

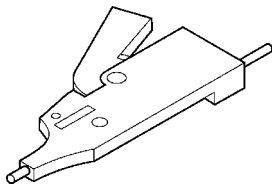


Made out of titanium, this tip is ideal for situations that require the user to hold the probe parallel to the circuit board under test. Also gives the user more control when holding the probe like a pencil. Fits in either probe socket.

PACC-PT005, package of 4.

B. Clips

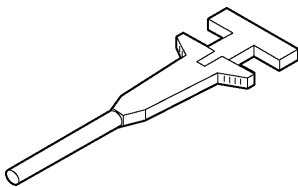
Micro Clip (0.5 mm)



A pincher like tip designed to hold onto fine pitch leads and small components, commonly found in SMD ICs. Fits in either probe socket, or can be used with a lead.

PACC-CL001, package of 4.

Clip (0.8 mm)

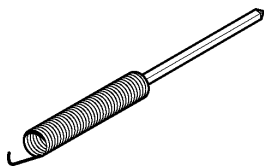


A pincher like tip designed to hold onto larger wires and components than possible with the Micro Clip, including through-hole mounted components.

This clip cannot be connected directly into either of the probe head sockets; it must be connected to a lead.

PK006-4, package of 2.

Ground Spring with Hook

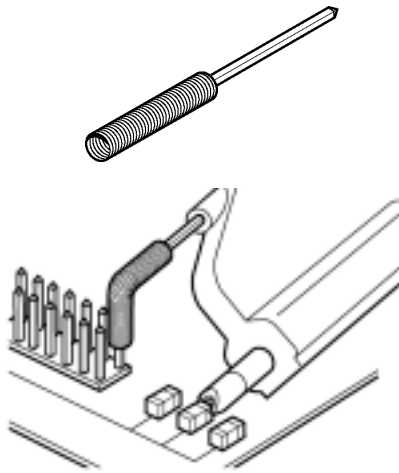


A flexible spring connected to a square pin that fits into either of the probe head sockets. Designed to be used as a ground lead, there is a hook on the end of the spring so that it can probe general circuits.

PACC-LD001, package of 4.

HFP3500 High Frequency Probe

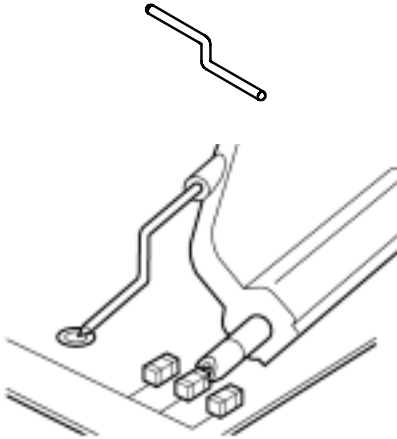
Square Pin Ground Spring



A flexible spring connected to a square pin that fits into either of the probe sockets. Designed to be attached to a square pin on the circuit under test.

PACC-LD002, package of 4.

Offset Pin



The offset pin is designed to be attached to either socket of the probe head. The offset pin is the highest quality grounding solution and is recommended in high frequency applications.

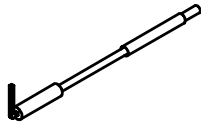
405400003, package of 1.

C. Leads

While longer leads provide greater flexibility when connecting the probe to a circuit, the added inductance may degrade the fidelity of high frequency signals. See Section 4 for additional information.

Features and Accessories

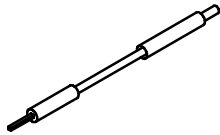
Short and Long Right Angle Lead



This lead has a socket on one end and a bent square pin on the other to connect to the input or ground socket of the probe body, and may be used for general purpose probing.

PACC-LD003 (short), PACC-LD004 (long), packages of 4.

Short and Long Single Lead



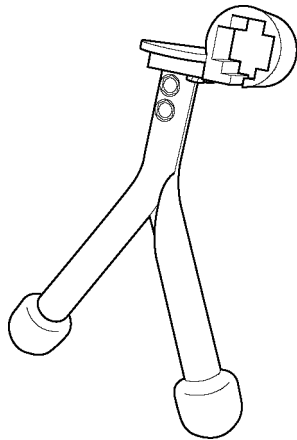
This lead can be used for either ground or input lead.

It has a socket on one end and a square pin on the other and may be used for general purpose probing.

PACC-LD005 (short), PACC-LD006 (long), packages of 4.

D. Probe Holder

FreeHand Probe Holder



FreeHand lets you focus on the oscilloscope screen instead of on maintaining contact to multiple test points. It allows the user to concentrate on what is really important – the waveform.

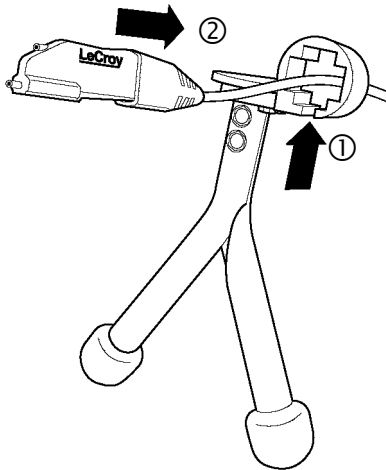
It is designed to keep most of the weight on the probe tip and will prevent lost contact when a bump to the table shakes the circuit under test.

Additionally, the HFP probe can be mounted horizontally or vertically in the *FreeHand*, giving added measurement flexibility.

PACC-MS001, package of 1.

HFP3500 High Frequency Probe

To use the FreeHand probe holder



1. Slide the probe cable through the slot on the bottom of the translucent holder section.
2. Slide probe backwards in the probe holder.

Installing probe into *FreeHand*

###

4 Operation

HANDLING THE PROBE

Exercise care when handling and storing the probe. Always handle the probe by the probe body or compensation box. Avoid putting excessive strain or exposing the probe cable to sharp bends.

CONNECTING THE PROBE TO THE TEST INSTRUMENT

The HFP3500 probe has been designed for use with LeCroy's WaveMaster™ oscilloscopes equipped with the ProBus interface. When you attach the probe output connector to the oscilloscope's input connector, the oscilloscope will recognize the probe, provide proper termination and activate the probe control functions in the user interface.

CONNECTING THE PROBE TO THE TEST CIRCUIT

To maintain the high performance capability of the probe in measurement applications, care must be exercised in connecting the probe to the test circuit. Increasing the parasitic capacitance or inductance in the input paths may introduce a "ring" or slow the rise time of fast signals. Input leads which form a large loop area will pick up any radiated electromagnetic field which passes through the loop and may induce noise into the probe input.

Using one of the available accessories makes the HFP3500 probe with its small profile and low mass head ideally suited for applications in dense circuitry.

OPERATION WITH A LECROY OSCILLOSCOPE

When the HFP3500 probe is connected to any LeCroy oscilloscope, the displayed scale factor and measurement values will be automatically adjusted.

Control through the oscilloscope's interface can be found in the 'Coupling' menu of the channel to which the probe is connected.

Turning the **Volts/Div** knob will control the oscilloscope's scale factor to give full available dynamic range up to 2 V/div.

HFP3500 High Frequency Probe

OFFSET

The HFP3500 has true offset capability. This allows you to remove a DC bias voltage from the input signal while maintaining DC coupling. By using probe offset rather than the 'position' control on the oscilloscope, the full dynamic range of the probe remains centered around the offset level, preventing the oscilloscope from being overdriven and causing inaccurate measurements.

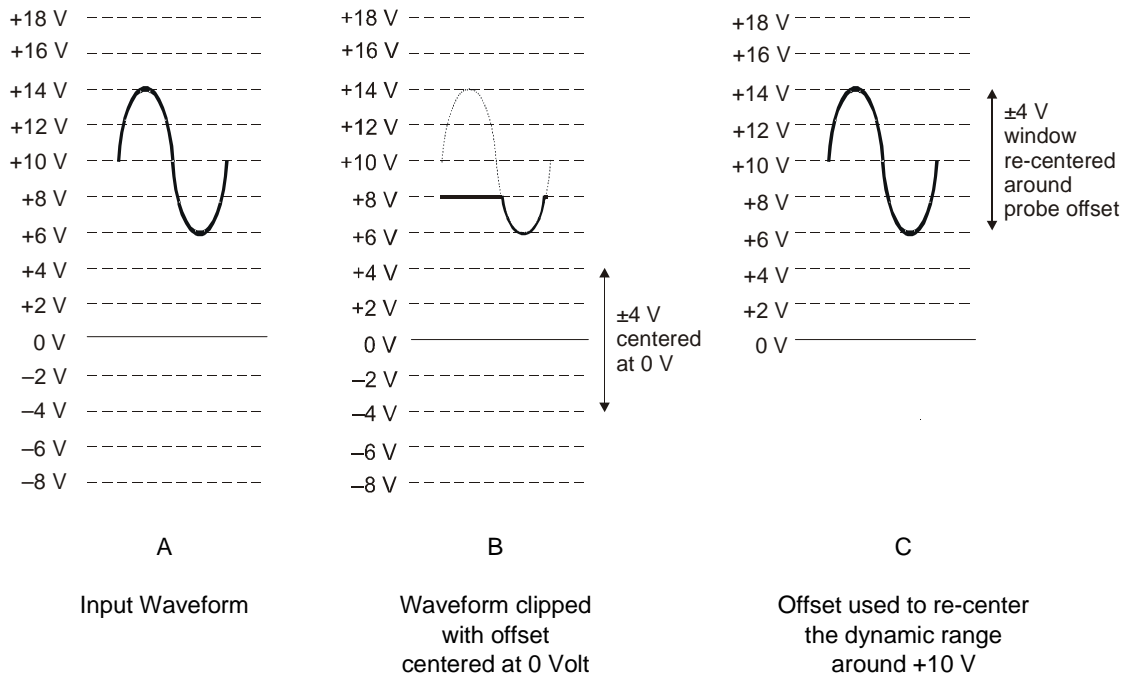


Figure 4-1. Dynamic Range and Offset Effects.

With ± 4 V dynamic range and ± 12 V offset, the HFP3500 has a measurement range of ± 16 V.

When the HFP3500 is used with a LeCroy oscilloscope equipped with ProBus interface, the probe offset is controlled with the channel **OFFSET** knob.

Note:

At higher frequencies the maximum linear input voltage is reduced. Refer to Section 9, Specifications, for the derating curve.

USE WITH NON-LECROY INSTRUMENTS

The HFP3500 can be used with other instruments with the optional ADPPS power supply. The output of the ADPPS must be terminated into 50 Ω .

AutoColor ID feature and probe offset will be disabled when the probe is used with an ADPPS adapter.

When used with an ADPPS adapter, the probe's performance will be limited to 1 GHz and offset is only possible by using the oscilloscope's internal offset control.

Because the probe offset is not being used, the linear operating range is limited to ± 4 Volt.

DESIGNING TEST FIXTURES FOR THE HFP3500

Often it is desirable to connect the probe directly to user-fabricated test fixture, such as those used for semiconductor characterization. To facilitate use with custom test fixturing, the input receptacles used in the HFP3500 probe are compatible with commercially available 0.635 mm (0.025") square pins. The receptacles do not require a specific rotational alignment for the square pin. The dimensions listed below can be used as a layout guide for a test fixture circuit board. The recommended insertion depth of the pins into the probe is 3.56 – 6.35 mm (0.140 – 0.250").

HFP3500 High Frequency Probe

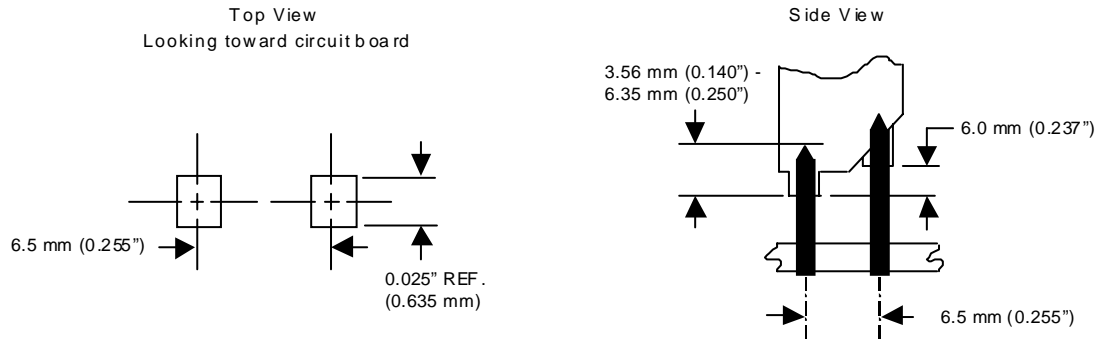


Figure 4-2. Circuit board pin spacing and insertion depth.

To allow room for the probe body to make contact with the test pins, a certain area around the test points should be free of any components. The figure 4-3 shows the outline of the probe as a "keep out area" where no components should be placed. The dimensions of the "keep out area" have been rounded up to allow for tolerances. There is no need to increase to "keep out area".

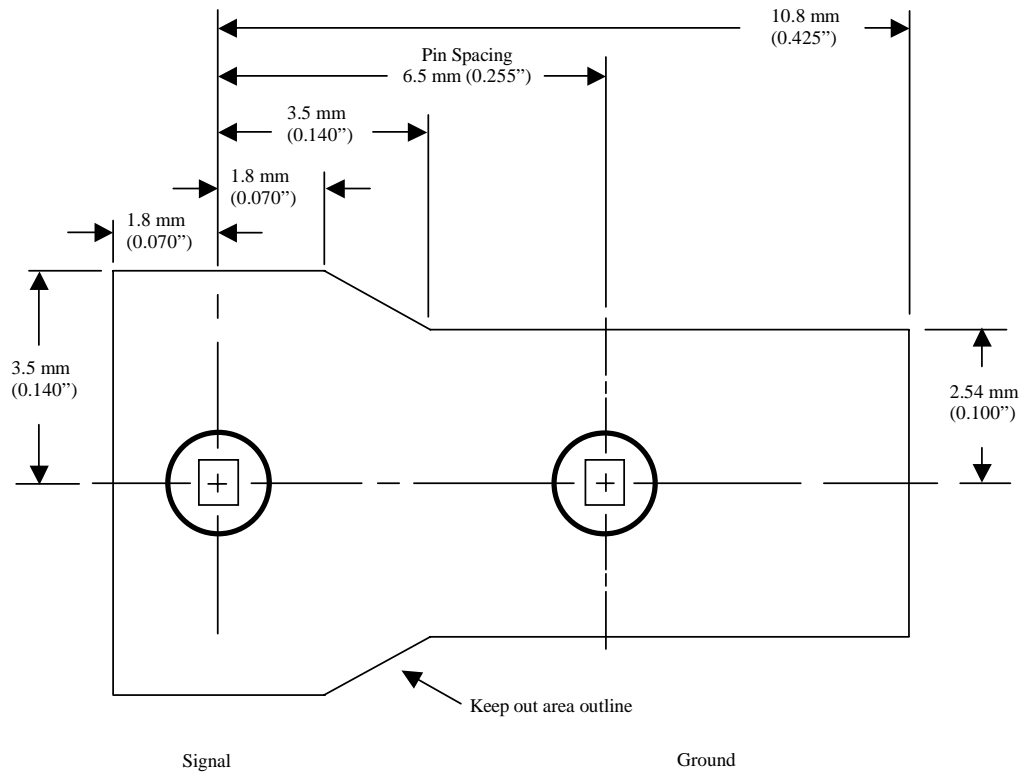


Figure 4-3. "Keep out area"

###

HFP3500 High Frequency Probe

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5 High Frequency Measurements

INPUT LOADING

When you touch a probe to the circuit under test, the probe will affect your measurement because of the probe's input impedance introduced into the circuit. All probes present resistive, capacitive and inductive loading.

INDUCTIVE LOADING (LEAD LENGTH)

A significant element in this circuit is the inductance shown in the input ground leads of the oscilloscope probe.

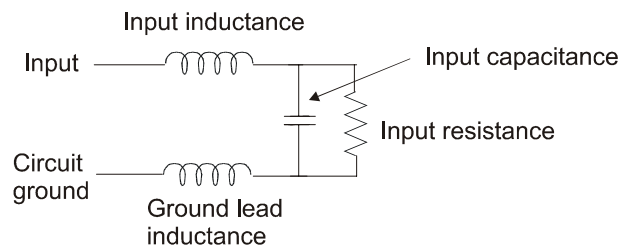


Figure 5-1. Probe Input Equivalent Circuit

The ground lead is the primary return path for the current resulting from the input voltage acting on the probe's input impedance. The ground lead and input lead inductances act with the probe's input capacitance to form a series LC network. The impedance of a series LC network will drop dramatically at its resonant frequency. This is the cause of the "ring" we often see after the leading edge of pulses in measured waveforms. This effect is referred to as ground lead corruption. Because it is impossible to eliminate either the L or C from this circuit, the method to improve waveform fidelity is to raise the resonant frequency beyond the bandwidth of interest in the measurement.

The resonant frequency of a simple LC circuit can be represented by:

$$F_{Resonance} = \frac{1}{2\pi\sqrt{LC}}$$

HFP3500 High Frequency Probe

The resonant frequency of a series LC circuit can be raised by decreasing the inductance, capacitance or both.

Since the input capacitance is already very low and cannot be reduced, you can only try to reduce the inductance. This can be accomplished by using the shortest possible input lead as well as the shortest possible ground lead.

For example, to obtain the shortest possible ground lead when measuring IC related signals, attach a small piece of copper clad material to the top of the IC package and connect this to the package grounding wires. Using the shortest ground lead and input lead available makes probing signals on the package easier and makes for the shortest lead length for the best signal fidelity.

To illustrate how dramatic this effect is, we will work a simple example.

Assuming an input capacitance of 0.7 pF and a total lead length (input and ground) of 2 inches (inductance of ≈ 25 nH/inch) such a setup may cause ringing with a resonant frequency (f_0) of:

$$f_0 = \frac{1}{2\pi\sqrt{50 \times 10^{-9} \times 0.7 \times 10^{-12}}} = 851 \text{ MHz}$$

This frequency is well within the passband of the probe and will therefore show up as part of the measured signal at faster time/div settings.

To determine how fast a waveform to be measured can be without causing ringing on a probe like, this divide the BW (ringing frequency) of the probe into 0.35:

$$t_{rise} = \frac{0.35}{BW} = \frac{0.35}{851 \text{ MHz}} = 0.4 \text{ nsec}$$

Any input signal with a rise time faster than 0.4 nsec can cause ringing.

High Frequency Measurements

CAPACITIVE LOADING

Capacitive loading is usually the most troublesome of the three loading effects.

It can affect the rise time, bandwidth and delay time measurements.

At higher frequencies the capacitive loading can affect the amplitude as well as the waveshape of the measured signal by introducing an exponential response to the waveform.

For a simple RC network the time constant of this exponential response is:

$$t_{rise} = 2.2 \times C_{total} \times R_{total}$$

where C_{total} is the combined probe and circuit capacitance and R_{total} is combined circuit and probe resistance.

In a setup where $C_t = 0.7$ pF and the source resistance is 100Ω , the measured rise time will be 0.154 nsec, which will correspond to a bandwidth of 2.27 GHz, assuming no inductive loads.

$$(t_{rise} = 2.2 \times 0.7 \times 10^{-12} \times 100 \Omega = 0.154 \text{ nsec})$$

(parallel combination of 100Ω and $100 \text{ k}\Omega$ is still 100Ω)

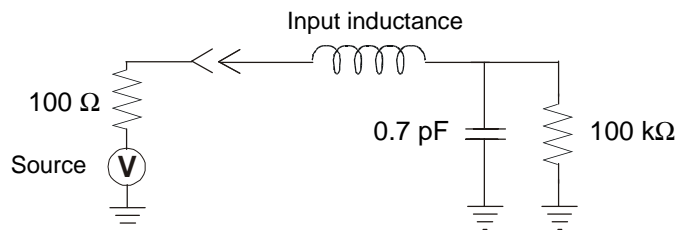


Figure 5-2. Probe input equivalent circuit

To illustrate the effect of capacitive loading at higher frequencies:

At a frequency of 851 MHz the reactance of the 0.7 pF capacitance is 267Ω , and at 2.5 GHz the reactance has been lowered to 91Ω

HFP3500 High Frequency Probe

If, at a given frequency, the source impedance is large with respect to the input impedance, a measurable reduction in the output signal amplitude may occur.

$$V_{out} = \frac{Z_{probe}}{Z_{probe} + Z_{source}} \times V_{in}$$

where: Z_{probe} is the probe's input impedance and

Z_{source} is the source impedance

As an example:

At 851 MHz, where the probe input impedance has reduced to 267 Ω , and a source resistance of 250 Ω the probe output amplitude is reduced to:

$$V_{out} = \frac{267}{267 + 250} = 0.52 \times V_{in}$$

###

6 Care and Maintenance

CLEANING

The exterior of the probe and cable should be cleaned only using a soft cloth lightly moistened with water or isopropyl alcohol. The use of abrasive agents, strong detergents, or other solvents may damage the probe. Always ensure that the input leads are free of debris.

Note

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

CALIBRATION INTERVAL

The recommended calibration interval is one year. (Performance Verification and Adjustment Procedures are included in this manual.)

SERVICE STRATEGY

The HFP3500 probe utilizes fine pitch surface mount devices. It is therefore impractical to attempt to repair in the field. Defective probes must be returned to a 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 for a modest fee. You must return the defective probe in order to receive credit for the probe core.

RETURNING A DEFECTIVE PROBE

The procedure for returning a defective probe is as follows:

Contact your local 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) should be used. The RAN can be established by contacting your nearest LeCroy office, or the New York Customer Care Center.

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

HFP3500 High Frequency Probe

It is important that the RAN be clearly shown on the outside of the shipping package for prompt redirection to the appropriate department.

1. Contact your local 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 LeCroy representative; be sure to add the following:
 - ATTN: <RAN assigned by the LeCroy representative>
 - FRAGILE
7. Insure the item for the replacement cost of the probe.
8. Ship the package to the appropriate address.

REPLACEMENT PARTS

The probe connection accessories and other common parts can be ordered through the regional customer care centers. Refer to list below for LeCroy part numbers. Defective probes can be replaced on an exchange basis. The replacement exchange probe will have been factory repaired, inspected and calibrated to the same standards as a new product. In order to obtain an exchange probe, you must return the defective probe. The returned probe should be sent back to the regional customer care center without any accessories, manual or case.

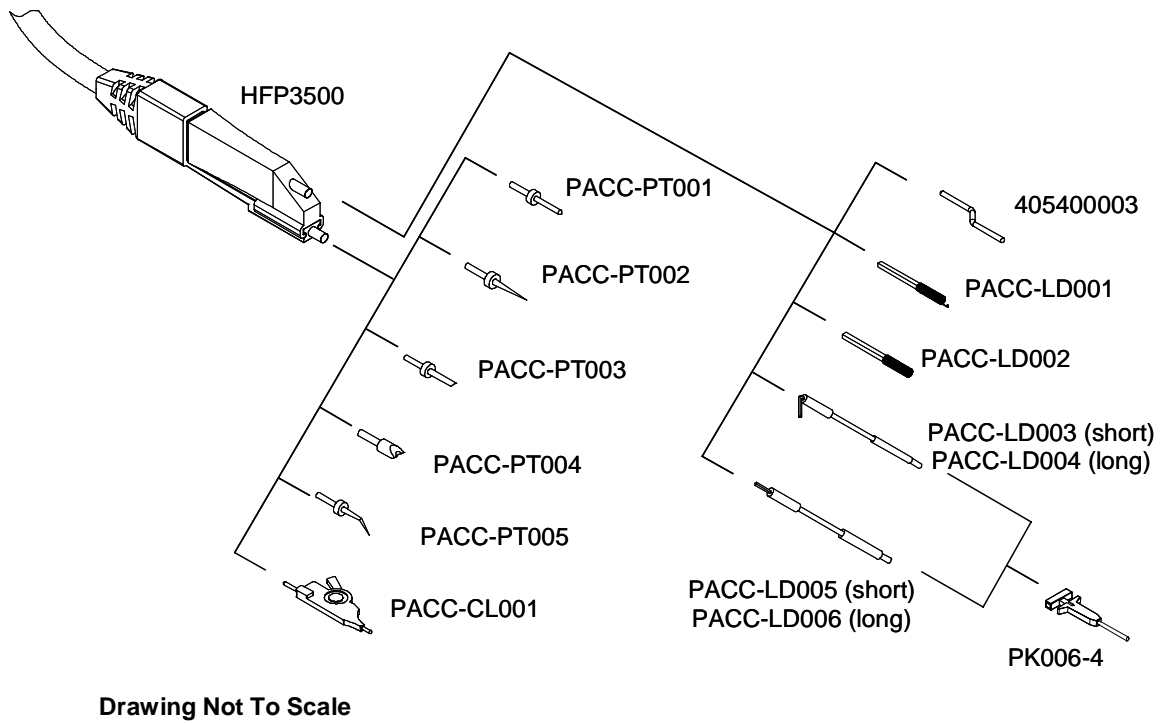


Figure 6-1. Replaceable Parts Selected by Input and Ground Accessory

HFP3500 High Frequency Probe

Table 6-1. Replaceable Parts List

| Item | LeCroy P/N | Replacement Quantity |
|------------------------------|--------------|----------------------|
| Straight Tip | PACC-PT001 | 4 |
| Sharp Tip | PACC-PT002 | 4 |
| IC Lead Tip | PACC-PT003 | 4 |
| SMD Discrete Tip | PACC-PT004 | 4 |
| Bent Sharp Tip | PACC-PT005 | 4 |
| Micro Clip | PACC-CL001 | 4 |
| Clip | PK006-4 | 2 |
| Ground Spring with Hook | PACC-LD001 | 4 |
| Square Pin Ground Spring | PACC-LD002 | 4 |
| Offset Pin | 405400003 | 1 |
| Short Right Angle Lead | PACC-LD003 | 4 |
| Long Right Angle Lead | PACC-LD004 | 4 |
| Short Single Lead | PACC-LD005 | 4 |
| Long Single Lead | PACC-LD006 | 4 |
| <i>FreeHand</i> Probe Holder | PACC-MS001 | 1 |
| Soft Accessory case | SAC-01 | 1 |
| Instruction Manual | HFP3500-OM-E | 1 |

###

7 Performance Verification

This procedure can be used to verify the warranted characteristics of the HFP3500 High Frequency Probe.

The recommended calibration interval for the model HFP3500 is one year. The complete performance verification procedure should be performed as the first step of annual calibration. Test results can be recorded on a photocopy of the Test Record provided in Appendix A at the end of the manual.

Performance verification can be completed without removing the probe covers or exposing the user to hazardous voltages. Adjustment should only be attempted if a parameter measured in the Performance Verification Procedure is outside the specification limits.

Note:

Adjustment should only be performed by qualified personnel.

This procedure tests the following specifications:

- Output Zero Voltage
- Offset Accuracy
- LF Attenuation Accuracy

TEST EQUIPMENT REQUIRED

Table 7-1 lists the test equipment and accessories (or their equivalents) that are required for performance verification of the HFP3500 Probe.

This procedure has been developed to minimize the number of calibrated test instruments required.

Only the parameters listed in **boldface** in the "Minimum requirements" column must be calibrated to the accuracy indicated.

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

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Table 7-1. List of Required Equipment

| Description | Minimum Requirements | Test Equipment Examples |
|---|---|---|
| Digital Oscilloscope | ProBus interface | LeCroy WavePro960 or LeCroy LT344 |
| Digital Multimeter (DMM) with test probe leads | 4.5 digit DC: 0.1% Accuracy AC: 0.1% accuracy | Agilent Technologies 34401A or Fluke 8842A-09 |
| Function Generator | Sine Wave output amplitude adjustable to 14.14 Vp-p (5 Vrms) into 1 M Ω at 70 Hz | Agilent Technologies 33120A or Stanford Research Model DS340 |
| Power Supply | 0-12 V, settable to 10 mV | HP E3611A |
| BNC Coaxial Cable (2 ea.) | Male to Male, 50 Ω , 36" Cable | Pomona 2249-C-36 or Pomona 5697-36 |
| BNC Tee Connector | Male to Dual Female | Pomona 3285 |
| Calibration Fixture | ProBus Extender Cable | LeCroy PROBUS-CF01 |
| Terminator, Precision, BNC | 50 $\Omega \pm 0.05\%$ | LeCroy TERM-CF01 |
| Banana Plug Adapter (2 ea.) | Female BNC to Dual Banana Plug | Pomona 1269 |
| BNC to Mini-grabber | BNC Male to Mini-grabber Cable, 36" | Pomona 5187-C-36 |

PRELIMINARY PROCEDURE

1. Connect the HFP3500 probe to the female end of the ProBus Extension Cable. Connect the male end of the ProBus Extension Cable to channel 1 of the oscilloscope.
2. Turn the oscilloscope on and allow at least 30 minutes warm-up time for the HFP3500 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.
5. Select the channel to which the probe is connected. Set the

Performance Verification

oscilloscope scale factor to 20 mV/div.

6. Disconnect the ProBus Extender Cable from the oscilloscope. Verify that the scale factor changes from 20 mV/div to 2 mV/div.
7. Re-connect the ProBus extender Cable to the oscilloscope.

The warranted characteristics of the HFP3500 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 HFP3500 controls requires software version 1.0.0.1 or higher. The software version in the test oscilloscope can be verified by pushing **SCOPE STATUS**, then selecting the **System** menu option.*

Contact your local LeCroy representative if the software in your oscilloscope requires updating.

FUNCTIONAL CHECK

The functional check will verify the basic operation of the probe functions.

It is recommended the Functional Check be performed prior to the Performance Verification Procedure.

1. Return to the factory default settings by:
 - a. Pressing the oscilloscope's front panel **PANELS** button.
 - b. From the Menu buttons press **FROM DEFAULT SETUP**.
2. Select Channel 1 and enter the **Coupling** menu.
3. Verify that **Probe sensed (HFP3500)** is displayed on the right hand menu.
4. If the trace colors have been reassigned or you are unsure,

HFP3500 High Frequency Probe

restore the default colors by pressing the following menus: **DISPLAY, More Display Setup, Color Scheme** and in the Color Scheme menu press **1**.

5. Verify that the probe head LED shows basically the same color as the channel 1 trace color.
6. Disconnect the probe from channel 1 and connect respectively to channel 2, 3 and 4.
7. Verify that in each case the LED color corresponds to the trace color of the channel to which the probe is connected.

PROCEDURE

A. Output Zero Voltage

1. Connect one end of a BNC cable to the female BNC connector on the probe end of the ProBus extender cable. Connect the precision 50 Ω terminator to the other end of the BNC cable.
2. Connect the banana plugs of the Precision terminator to the input of the DMM. Make sure that the plug corresponding to the BNC shield (marked "Ground") is connected to the **LO** or **COMMON** input of the DMM. Refer to figure 7-1 for setup information.

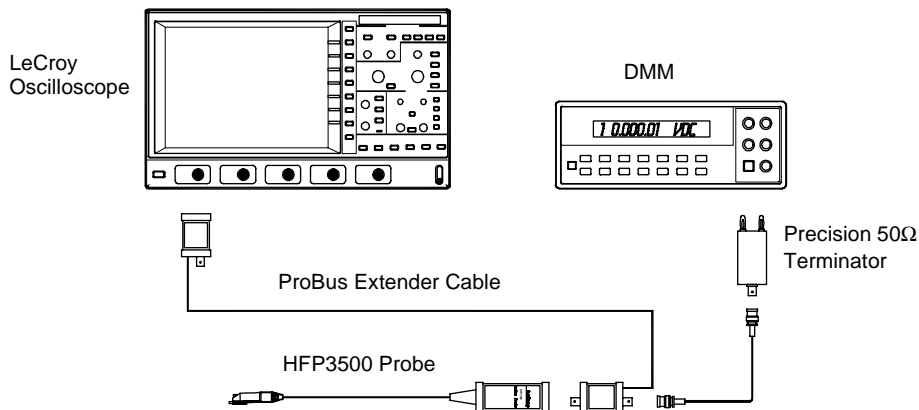


Figure 7-1. Output Zero Voltage Test Setup

Performance Verification

3. Set the **OFFSET** on the oscilloscope to zero, as indicated by on-screen display.
4. Set the DMM to read DC Volt on the most sensitive range.
5. Record the voltage measured on the DMM to 10 μV resolution as 'Output Zero Voltage' in the Test record.
6. Check that the voltage indicated by the DMM is between $\pm 800 \mu\text{V}$.
7. Disconnect the DMM from the precision 50 Ω terminator. Leave the remaining setup in place for the next step.

B. Offset Accuracy

1. Connect the BNC end of the BNC to mini-grabber cable to a female end of the BNC tee adapter and connect a female BNC to dual banana plug adapter to the male end of the BNC tee. (Refer to figure 7-2)

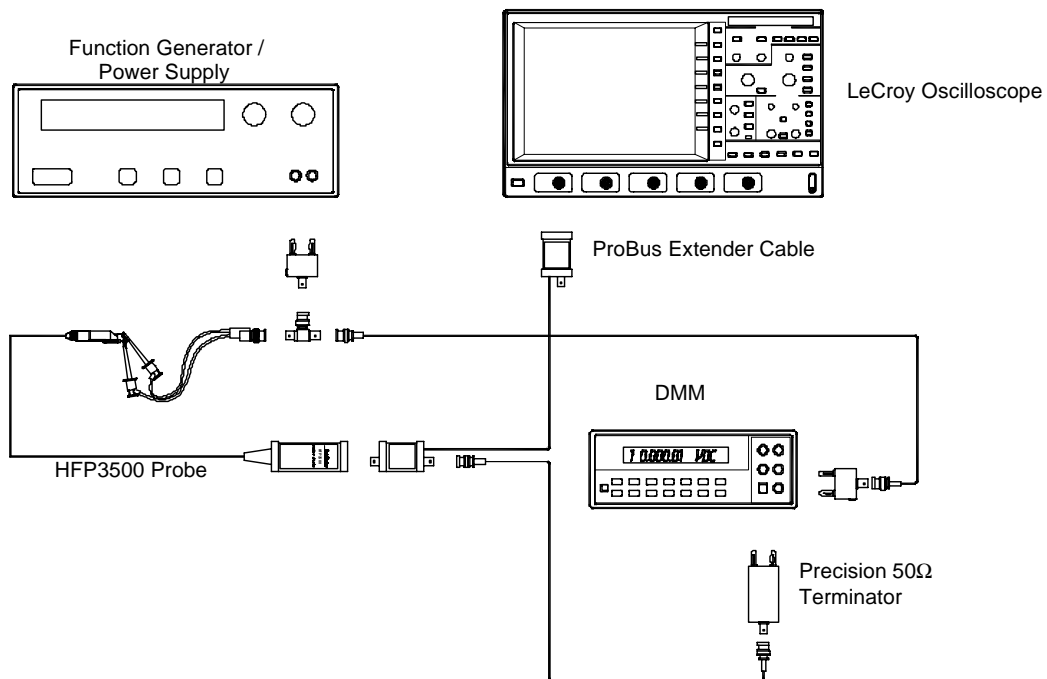


Figure 7-2. Offset and LF Attenuation Accuracy Test Setup

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2. Carefully insert the Straight Tips (supplied in accessory kit) into the sockets of the probe head. Attach the red lead of the mini-grabber to the signal input and the black lead to the ground input of the probe head.
3. Set the power supply to approximately 0 Volt.
4. Plug the dual banana plug adapter with probe attached into the output terminals of the power supply with ground side of the adapter (and the ground side of the probe head) connected to the **positive** terminal of the power supply.
5. Attach a BNC cable to the unused female port of the BNC tee and a dual banana plug adapter to the other end of the cable and plug the dual banana plug adapter into the DMM input. Make sure the side of the banana plug adapter corresponding to the BNC shield (marked "GROUND") is connected to the **LOW** or **COMMON** input of the DMM.
6. Adjust the power supply to an output of $10.0\text{ V} \pm 100\text{ mV}$ as indicated on the DMM.
7. Record the DMM reading, which should be a **negative** number, to 10 mV resolution as 'Power Supply Negative Output Voltage' in the Test Record.
8. Add 10 (to correct for the +10 V offset as described in step B-13) to the 'PS Negative Output Voltage' recorded in step B-7. (Do NOT adjust the power supply output amplitude).
9. Divide the resulting sum by 10.
10. Record the answer to three significant places as 'Expected Negative Output Voltage' in the test record.
11. Remove the banana plug adapter, connected to the power supply, from the DMM and connect the precision $50\ \Omega$ terminator to the DMM, making sure that the banana plug side marked 'GROUND' is connected to the **LOW** or **COMMON** input of the DMM.
12. Set the DMM to read DC Volt on the most sensitive range.
13. Verify that the display for channel 1 is turned ON. Turn the oscilloscope **OFFSET** knob to read +10.00 V on the oscilloscope display.
14. After the DMM has settled, record the reading to 100 μV reso-

Performance Verification

lution as 'Measured Negative Output Voltage' in the Test Record.

15. Subtract the measured voltage as recorded in step B-14 from the expected output voltage recorded in step B-10. Be sure to include the sign of each of the values in the calculation.
16. Record the answer to three significant places as 'Offset Error Voltage' in the Test Record.
17. Verify that the error is between ± 10.8 mV.

Note:

The error term is derived from the Offset Accuracy specification of $\pm 1\% \pm 8$ mV. Using a 10.0 V offset setting, the maximum error would be 108 mV referred to the input, which becomes ± 10.8 mV error referred to the output (taking into account the $\div 10$ attenuation).

18. Using the oscilloscope's **OFFSET** knob, set the probe offset to 0 V, as indicated in the on-screen display.
19. Remove the dual banana plug adapter with the HFP3500 attached from the power supply and reconnect to the supply but now with the grounded side of the banana plug (and grounded socket of the probe head) connected to the **negative** terminal of the power supply output.
20. Disconnect the DMM from the precision 50 Ω terminator and connect the DMM to the dual banana plug adapter connected to the power supply output.
21. Record the DMM reading, which should be a **positive** number, to 10 mV resolution as 'Power Supply Positive Output Voltage' in the Test Record.
22. Subtract 10 from the output voltage recorded in step B-21. Divide this number by 10.
23. Record the result to three significant places as 'Expected Positive Output Voltage' in the Test Record.
24. Set the oscilloscope **OFFSET** to -10.00 V as read on the oscilloscope display.
25. Remove the banana plug adapter from the DMM and connect

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the precision 50 Ω terminator to the DMM, making sure that the banana plug side marked 'GROUND' is connected to the **LOW** or **COMMON** input of the DMM.

26. Record the DMM reading to three significant places as 'Measured Positive Output Voltage' in the Test Record.
27. Subtract the Measured Output Voltage as recorded in step B-26 from the Expected Output Voltage recorded in step B-23. Be sure to include the sign of the values in the calculation.
28. Record the result to 100 μV resolution as 'Offset Error Voltage' in the Test Record.
29. Verify that the output error is between ± 10.8 mV.
30. Return the oscilloscope offset to 0 Volt. Leave the setup connections for the next step.

C. LF Attenuation Accuracy

1. Disconnect the BNC tee at the power supply from the dual banana plug adapter. Connect the BNC tee to the output of the function generator. (Use a 50 Ω termination if the function generator requires such a load).
2. Disconnect the DMM from the precision 50 Ω terminator and connect the DMM to the dual banana plug adapter connected to the function generator output.
3. Set the DMM to read AC Volt and set the range to measure 5.0 Vrms.
4. Set the mode of the function generator to sine wave, the frequency to 70 Hz and the output amplitude to 5 Vrms ± 10 mV as measured on the DMM.
5. Record the output voltage to 1 mV resolution as 'Generator Output Voltage' in the Test Record. Be careful not to alter the output amplitude after the reading is recorded.
6. Divide the reading recorded in step C-5 by 10 and record the result with 100 μV resolution as 'Expected Output Voltage, top range' in the Test Record.
7. Remove the banana plug adapter, connected to the function generator, from the DMM and connect the precision 50 Ω terminator to the DMM, making sure that the banana plug side

Performance Verification

marked 'GROUND' is connected to the **LOW** or **COMMON** input of the DMM.

8. After the DMM reading has stabilized, record the reading to 100 μ V resolution as 'Measured Output Voltage, top range' in the Test Record.
9. Calculate the error by dividing the measured output voltage recorded in step C-8 by the expected top output voltage recorded in step C-6. Subtract 1 from this ratio and multiply by 100% to get the error in percent.

$$Error = \left(\frac{\text{Measured Output Voltage}}{\text{Expected Output Voltage}} - 1 \right) \times 100\%$$

10. Record the calculated error to two decimal places ($\pm 0.xx\%$) as 'Gain Error, top range' in the test record.
11. Verify that the error is less than $\pm 1.0\%$.
12. Disconnect the precision 50 Ω terminator from the DMM.
13. Connect the banana plug adapter connected via a BNC cable to the BNC tee at the function generator to the DMM. Verify that the side of the plug marked 'Ground' is connected to the **LOW** or **COMMON** input of the DMM.
14. Adjust the sine wave generator output amplitude to approximately 2.5 Vrms as measured on the DMM.
15. Record the reading to 1 mV resolution as 'Generator Output Voltage, mid range' in the Test Record. Be careful not to alter the output amplitude after the reading is recorded.
16. Divide the reading recorded in step C-15 by 10.
17. Record the result to 100 μ V resolution as 'Expected Output Voltage, mid range' in the test record.
18. Remove the banana plug adapter from the DMM and connect the precision 50 Ω terminator to the DMM, making sure that the banana plug side marked 'GROUND' is connected to the **LOW** or **COMMON** input of the DMM.
19. After the DMM has stabilized, record the reading to 100 μ V

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resolution as 'Measured Output Voltage, mid range' in the Test record.

20. Calculate the error by dividing the measured output voltage recorded in step C-19 by the expected top output voltage recorded in step C-17. Subtract 1 from this ratio and multiply by 100% to get the error in percent.

$$Error = \left(\frac{Measured\ Output\ Voltage}{Expected\ Output\ Voltage} - 1 \right) \times 100\%$$

21. Record the calculated error to two decimal places ($\pm 0.xx\%$) as 'Gain Error, mid range' in the Test record.
22. Verify that the mid range gain error is less than $\pm 1.0\%$

This completes the Performance Verification of the HFP3500. Complete and file the Test Record, as required to support your internal calibration procedure.

Apply suitable calibration label to the HFP3500 housing as required.

###

8 Adjustment Procedure

INTRODUCTION

You can use this procedure to adjust the HFP3500 probe to meet the warranted specifications. This procedure should only be performed if the probe fails to meet the Performance verification tests for Output Zero or Offset Accuracy.

Gain which affects LF attenuation accuracy cannot be adjusted during routine calibration. Probes which fail LF frequency accuracy during performance verification must be returned to the factory for rework.

If the probe cannot be adjusted to meet the Performance verification limits, repair may be necessary.

To assure probe accuracy, check the calibration of the HFP3500 every 1000 hours or once a year if used infrequently. Before calibration, thoroughly clean and inspect the probe as outlined in the Care and Maintenance section.

To assure the probe will meet the published specifications over the entire temperature range, adjustment must be performed in a controlled ambient environment with temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.



Caution

The adjustment procedure will require removal of the probe control circuit cover. This cover is part of the ESD protection system of the HFP3500. To protect the probe, you should perform the entire procedure on a static dissipating work surface. Wear an antistatic wrist strap and follow standard static control procedures.

TEST EQUIPMENT REQUIRED

Table 8-1 lists the test equipment and accessories (or their equivalents) that are required for complete calibration of the HFP3500 Probe. Specifications given for the test equipment are the minimum necessary for accurate calibration. All test equipment is assumed to be correctly calibrated and operating within the specification listed. Detailed operating instructions for the test equip-

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ment are not given in this procedure. Refer to the test equipment manual if more information is needed

If alternate test equipment is substituted, control settings or calibration equipment setups may need to be altered.

Table 8-1. List of Required Equipment

| Description | Minimum Requirements | Test Equipment Examples |
|---|---|---|
| Digital Oscilloscope | ProBus interface | LeCroy WavePro960 or LeCroy LT344 |
| Digital Multimeter (DMM) with test probe leads | 4.5 digit DC: 0.1% Accuracy AC: 0.1% accuracy | Agilent Technologies 34401A or Fluke 8842A-09 or |
| Power Supply | 0-12 V, settable to 10 mV | HP E3611A |
| BNC Coaxial Cable (2 ea.) | Male to Male, 50 Ω , 36" Cable | Pomona 2249-C-36 or Pomona 5697-36 |
| BNC Tee Connector | Male to Dual Female | Pomona 3285 |
| Calibration Fixture | ProBus Extender Cable | LeCroy PROBUS-CF01 |
| Terminator, Precision, BNC | 50 $\Omega \pm 0.05\%$ | LeCroy TERM-CF01 |
| Banana Plug Adapter (2 ea.) | Female BNC to Dual Banana Plug | Pomona 1269 |
| BNC to Mini-grabber | BNC Male to Mini-grabber Cable, 36" | Pomona 5187-C-36 |

PRELIMINARY PROCEDURE

1. Remove the two screws that secure the plastic cover on the cable end of the ProBus interface housing.
2. Gently pull on the probe cable to slide the circuit board assembly from the metal housing.
3. Connect the HFP3500 probe to the female end of the ProBus extension cable, being careful to line up all six pins of the probe connector. Connect the male end of the ProBus extension cable to channel 1 of the oscilloscope.
4. Apply power to the oscilloscope and test equipment.
5. Allow at least 30 minutes warm-up time for the HFP3500 and test equipment before starting the calibration procedure.

Adjustment Procedure

PROCEDURE

A. Adjust Output Zero Voltage

1. Connect one end of a BNC cable to the probe end of the ProBus extension cable. Connect the Precision 50 Ω Terminator to the other end of the BNC cable.
2. Connect the banana plugs of the precision 50 Ω terminator to the input of the DMM. Make sure the plug corresponding to the BNC shield (marked 'Ground') is connected to the **LO** or **COMMON** input of the DMM. Refer to figure 8-1 for setup information.

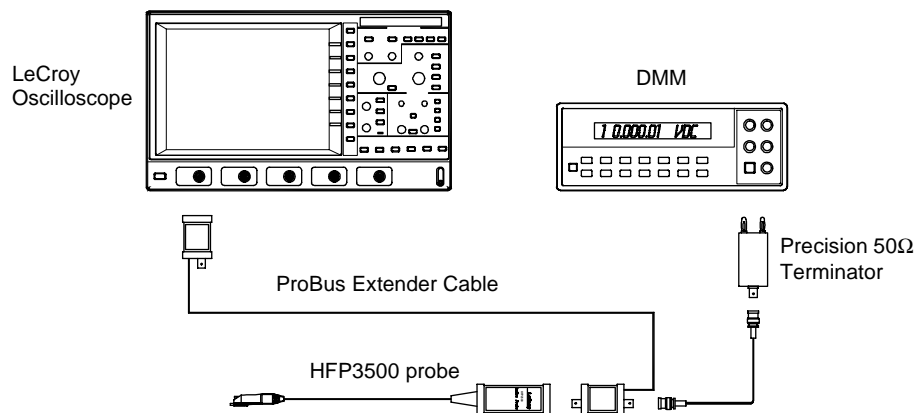


Figure 8-1. Output Zero Voltage Adjustment Setup

3. Select the channel to which the probe and ProBus extender is connected. Set **OFFSET** on the oscilloscope to zero as indicated on the on-screen display.
4. Set the DMM to read DC Volt on the most sensitive range.
5. Verify that the probe inputs are not connected to any signal.
6. Adjust **OFFSET ZERO** on the board until the DMM reads 0 V $\pm 100 \mu\text{V}$. Refer to figure 8-2 for adjustment location.
7. Leave the setup connections in place for the next step.

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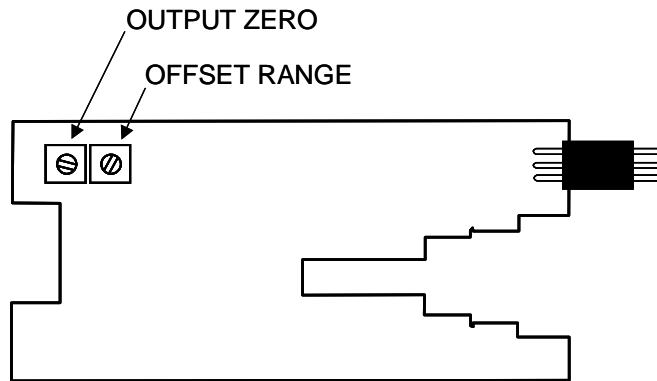


Figure 8-2 Adjustment Locations

B. Adjust Offset Range

1. Connect the BNC end of the BNC to mini-grabber cable to a female end of the BNC tee adapter and a female BNC to dual banana plug adapter to the male end of the BNC tee.
2. Carefully insert Straight Tips (supplied in the accessory kit) into the HFP3500 probe head sockets. Attach the red lead of the mini-grabber to the signal input and the black lead to the ground input of the probe.
3. Set the power supply for approximately 0 Volt.
4. Plug the dual banana plug adapter, with the probe attached, into the output terminal of the power supply. Make sure the side of the banana plug corresponding to the probe ground and BNC ground is connected to the **negative** terminal of the power supply.
5. Attach a BNC cable to the unused female port of the BNC tee and a dual banana plug adapter to the other end of the BNC cable and plug this into the DMM. Make sure the side of the banana plug corresponding to the BNC shield (marked 'GROUND') is connected to the **LO** or **COMMON** input of the DMM. Refer to figure 8-3 for setup information.
6. Using the DMM to monitor the voltage, adjust the power supply to an output of $10.00\text{ V} \pm 10\text{ mV}$. Record the reading.

Adjustment Procedure

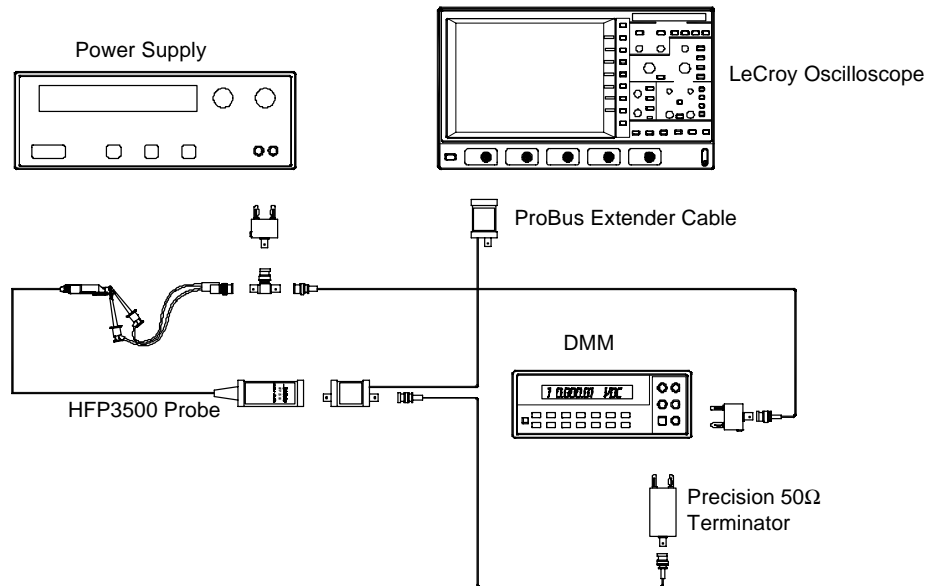


Figure 8-3. Offset Range Adjustment setup.

7. Remove the banana plug adapter from the DMM connect the precision 50 Ω terminator into the DMM Input. Make sure the side of the banana plug corresponding to the BNC shield (marked 'GROUND') is connected to the **LO** or **COMMON** input of the DMM.
8. Verify that the display for channel 1 is turned on. Set the oscilloscope **OFFSET** knob to -10.00 V. as read on the oscilloscope screen.
9. Set the DMM to read DC Volt on the most sensitive range.
10. Subtract 10.0 V from the power supply output voltage recorded in step B-7. Be sure to keep track of the sign of the result.
11. Adjust **OFFSET RANGE** until the DMM reads the same voltage ± 1 mV as calculated in step B-11. Be sure the sign agrees.
12. Repeat steps A-3 through A-7 of the Adjust Offset Zero procedure.

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13. Disconnect the probe from the ProBus extender and re-install the circuit board into the probe case, being careful to align the ProBus interface connector with the opening on the other end of the case.

C. Verify Calibration

Repeat the Performance Verification procedure to ensure compliance with the warranted specifications.

Apply a calibration sticker, if required, in accordance with your quality control procedures.

###

9 Specifications

NOMINAL CHARACTERISTICS

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

| | |
|---------------------------------|--|
| Input Dynamic range | ±4 V |
| Offset Range | ±12 V ¹ |
| Maximum Input Voltage | 40 V pk |
| Attenuation | ÷10 |
| Output Connector | ProBus |
| Interface | ProBus |
| Oscilloscope Full Compatibility | LeCroy oscilloscope with firmware version 1.0.0.1 or higher. |

¹ Subject to input voltage vs. frequency derating. See figure 9-1.

WARRANTED CHARACTERISTICS

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

| | |
|------------------------------------|--|
| Low Frequency Attenuation Accuracy | ±1% plus uncertainty of 50 Ω termination |
| Output Zero | ≤ 8 mV, referred to the input |
| Offset Accuracy | ±1% ± Output Zero error, referred to the input |

TYPICAL CHARACTERISTICS

Typical characteristics are parameters with no guaranteed performance. Tests for typical characteristics are not provided in the Performance Verification Procedure.

| | |
|------------------------|-------------------------------|
| Output Zero | ≤ 4 mV, referred to the input |
| Bandwidth (Probe only) | 3.5 GHz |

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| | |
|---------------------|----------------|
| Input Capacitance | 0.7 pF |
| DC Input Resistance | 100 k Ω |

ENVIRONMENTAL CHARACTERISTICS

| | |
|----------------------------|--|
| Temperature, operating | 0 °C to 50 °C |
| Temperature, non-operating | -40 °C to 71 °C |
| Relative Humidity | 80% max up to 31 °C, decreasing linearly to 20% max at 50 °C |

PHYSICAL CHARACTERISTICS

| | |
|------------------|---|
| Probe Head Size: | |
| Length | 61 mm (2.4 in) |
| Width | 7.3 mm (0.29 in) |
| Height | 13.1 mm (0.52 in) |
| Cable Length | 1.3 m (51.1 in) |
| Weight: | |
| Probe only | 100 g (3.5 oz.) |
| Shipping | 1.45 kg (3.19 lbs) |
| Input Sockets | Signal and ground sockets are compatible with 0.635 mm (0.025 in) square pins, and 0.91 mm (0.036 in) maximum diameter round pins |

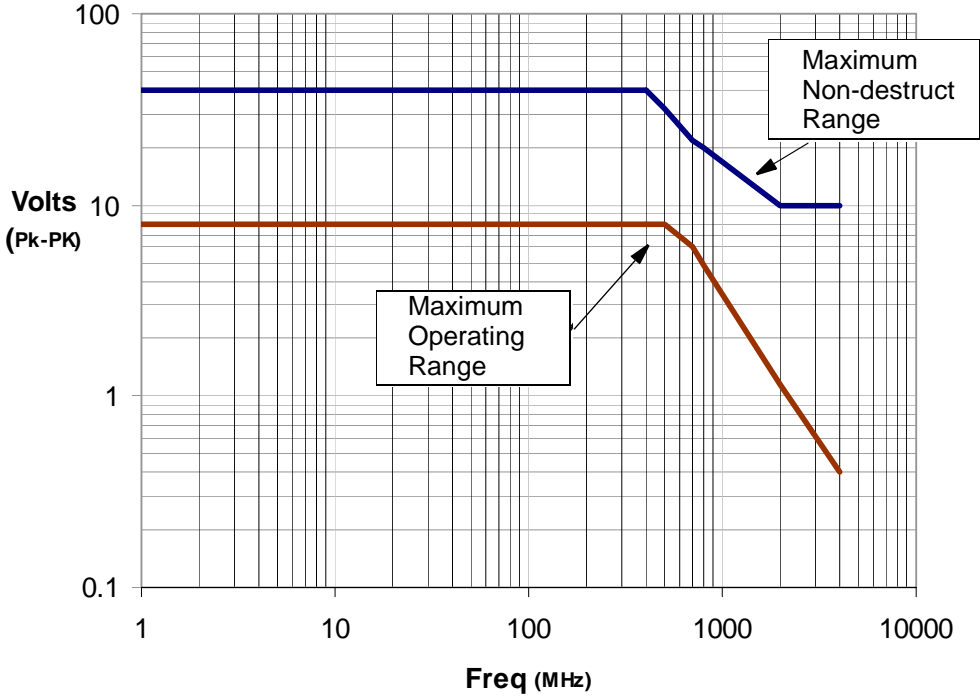


Figure 9-1. Input Voltage vs. Frequency

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COMPLIANCE AND CERTIFICATIONS

CE Declaration of Conformity



- Low Voltage Directive: EN 61010-1:1993+Amd2:1995
Safety requirements for electrical equipment for measurement control and laboratory use.
Part 1: General requirements.
- EN61010-2-031:1994
Particular requirements for hand-held probe assemblies for electrical measurement and test.
- EMC Directive: EN 61326-1:1997+Amd1:1998
EMC requirements for electrical equipment for measurement control and laboratory use.
- Electromagnetic Emissions: EN 55011:1998+A1:1999 Radiated Emissions (Class A)
- Electromagnetic Immunity: EN 61000-4-2:1995+A2:2002 Electrostatic Discharge.
(Air/Contact Discharge: 4 kV)
- EN 61000-4-3:1996+A2:2002 RF Radiated Electromagnetic Field (80 MHz...1 GHz; 3 V/m)

###

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HFP3500 TEST RECORD

| Step | Description | Intermediate data | Test Result |
|--------------------------------|--|-------------------|-------------|
| Output Zero Voltage | | | |
| A-5 | Output Zero Voltage (Test limit $\leq \pm 800 \mu\text{V}$) | _____ | _____ V |
| Offset Accuracy | | | |
| B-7 | Power Supply Negative Output Voltage | _____ | V |
| B-10 | Expected Negative Output Voltage | _____ | V |
| B-14 | Measured Negative Output Voltage | _____ | V |
| B-16 | Offset Error Voltage (Test limit $\leq \pm 10.8 \text{ mV}$) | _____ | _____ mV |
| B-21 | Power Supply Positive Output Voltage | _____ | V |
| B-23 | Expected Positive Output Voltage | _____ | V |
| B-26 | Measured Positive Output Voltage | _____ | V |
| B-28 | Offset Error Voltage (Test limit $\leq \pm 10.8 \text{ mV}$) | _____ | _____ mV |
| LF Attenuation Accuracy | | | |
| C-5 | Generator Output Voltage | _____ | V |
| C-6 | Expected Output Voltage, top range | _____ | V |
| C-8 | Measured Output Voltage, top range | _____ | V |
| C-10 | Gain Error , top range (Test limit $\leq \pm 1.0\%$) | _____ | _____ % |
| C-15 | Generator Output Voltage | _____ | V |
| C-17 | Expected Output Voltage, mid range | _____ | V |
| C-19 | Measured Output Voltage, mid range | _____ | V |
| C-21 | Gain Error , mid range (Test limit $\leq \pm 1.0\%$) | _____ | _____ % |

###

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