



M-PHY GEAR5 Solder-In Probe Quick Start / User Guide

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Introduction

The M-PHY GEAR5 Protocol Insight Solder-In Probe allows developers using an embedded bus in the PCB design to tap into the signal traces directly and capture bus traffic for protocol analysis and debugging. The probe connects to a Protocol Insight G500C/G550C Analyzer via the Probe Amplifier. Figure 1 shows the complete assembly of the M-PHY GEAR5 Solder-In Probe and its components.

The M-PHY GEAR5 has FG5PSD05 - Solder-In probe tip (**A** in Figure 2), FG5PSD01 - GEAR5 Amplifier (**B**), FG5PSD08 - 40GHz SMP to SMP differential cable (**C**) and FG5PSD07, Molex to Lemo Power Cable (**D**).

This probing solution supports M-PHY systems including GEAR1, GEAR2, GEAR3, GEAR4 and GEAR 5, rates A and B.

- One Probe Amplifier is required for link widths of up to x1, [Figure 1](#) shows the amplifier versions.
- Two Probe Amplifiers are required for link width of up to x2. See [Cable Configuration](#) for analyzer cable configurations and lane mapping.



Figure 1 – M-PHY GEAR5 Solder-In Probe System x1

[Figure 1](#) shows amplifiers FG5PSD01 (Dec 2022 and prior) and FG5PSD01E (late Dec 2022).



Components

The Protocol Insight M-PHY GEAR5 Solder-In Probe has the following components, [Figure 2](#).

Part Number	Description	Dimensions
FG5PSD05 (A)	Solder-In tip	254 mm (10 inches)
FG5PSD01 (B) FG5PSD01E	M-PHY GEAR5 Probe Amplifier	91.694 x 50.8 x 15.24 mm (3.61 x 2.61 x 0.6 inches)
FG5PSD08 (C)	40 GHz SMP to SMP Differential Coax Cable	609.6 mm (24 inches)
FG5PSD07 (D)	Molex to Lemo Power Cable	609.6 mm (24 inches)

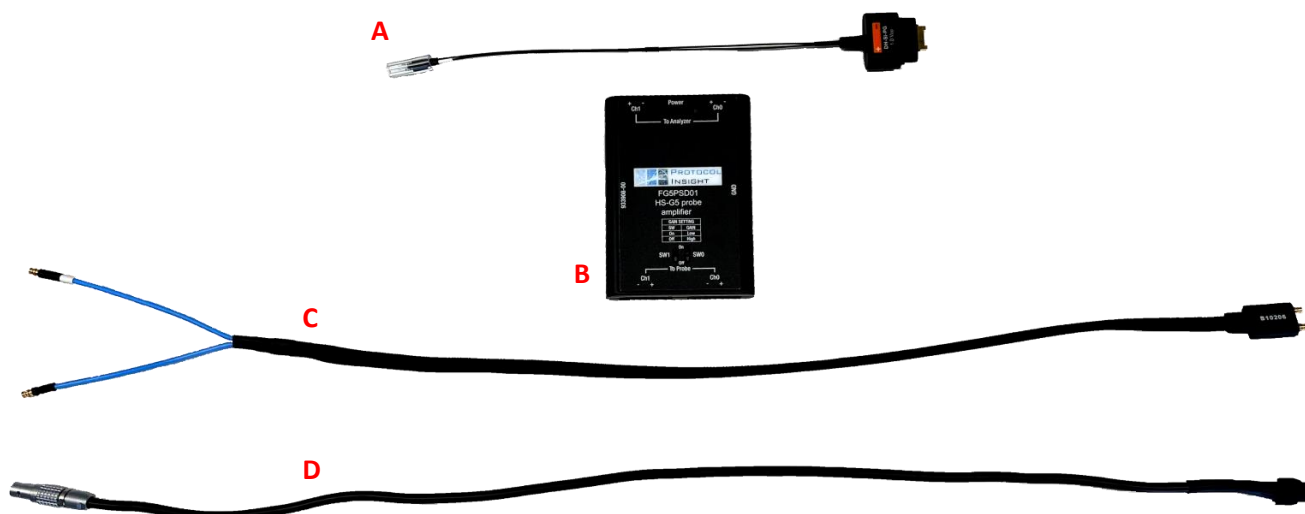


Figure 2 - Components

Because of their small size, these probe tips provide the maximum signal fidelity at the highest frequency response. The + (P) input is indicated by a small + symbol on the tip and a white marker on the corresponding side of the tip lead.

The FG5PSD05 tips are supplied with two pre-installed 50-ohm resistors. The probe tip kit also includes spare tip resistors: six (6) 100-ohm and four (4) 50-ohm.



Replacement damping resistors are included with the probe. These are precision cut to the correct lead lengths. 50-ohm resistors provide a stronger signal compared to the 100-ohm resistors. We recommend trying 100-ohm resistors if Host to DUT M-PHY has link issues.

The external damping resistors are subject to mechanical stress and may periodically need to be replaced, even if proper stress-relief precautions are taken. Refer to [Figure 3](#).

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

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Determining Sample Points

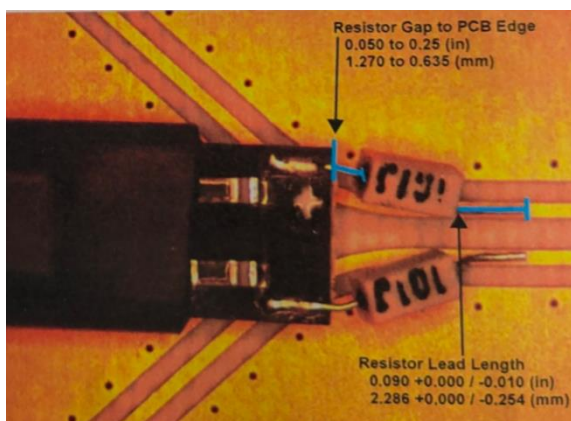


Figure 3 - Example of Resistor Gaps and Leads

Installing a Solder-In probe system requires some advanced planning. Since the Solder-In probe system is designed for use with PCB configuration that may not have been specifically laid out with probing in mind, probe points must be identified and selected to allow the protocol analyzer system to access the M-PHY bus contained within the board.

Typical probe points might include exposed pins of components, or exposed traces or vias on the board along the M-PHY channel. Refer to [Figure 3](#).

To capture data traffic going in each direction on the M-PHY bus, the probe tips must connect to four signals (RX+, RX-, TX+, TX-). Four signals (two probe tips) must be sampled for a x1 design, and eight signals (four probe tips) must be sampled for a x2 design.

The GEAR5 Solder-In probe tip is designed to sample two points in close proximity.

- The Rx+ and Rx- differential pair
- The Tx+ and Tx- differential pair

Once possible probe locations are identified, you must consider the following criteria before making your selection.

1. The probe locations must be within sufficient physical proximity to each other so the probe cables and tips can easily reach back to the probe amplifier, which amplifies the signals prior to passing them to the analyzer. For best results, the ground cable on the amplifier should not be extended and should be connected as closely as possible to the sample point.



CAUTION: The amplifier must be powered before signals are applied to the probe tips. If signals are applied to the probe tips and the amplifier is unpowered it may be damaged.

Each probe amplifier handles up to two (2) probe tips. The probe amplifiers are connected to the analyzer using phase matched, differential SMP to SMP cables.

If an oscilloscope is available for measurements, the probe requires the following minimum differential signal requirements at the probe point, [Figure 4](#).

- Inner eye width = 100ps Minimum for GEAR3, 60ps for GEAR4 and 30ps for GEAR5.
- Inner eye height = 90 mVpp Minimum.
- Eye Amplitude = 620 mVpp Maximum.

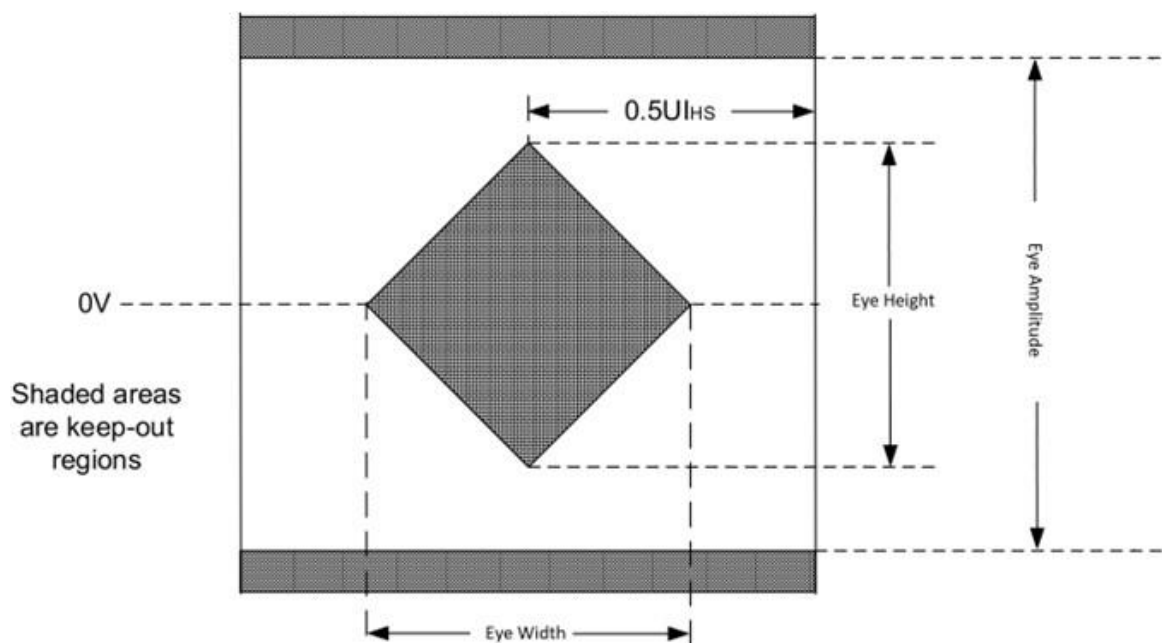


Figure 4 - EYE Diagram at the Probing Point

Once probe points have been selected, you are now ready to prepare for installation of the M-PHY GEAR5 Solder-In Probe.

2. The probe locations should be selected to provide the best possible signal with minimum distortion to the M-PHY channel. If measurements or simulations are not available, as a rule of thumb, this location is typically as near as possible to the Tx output pins. Refer to [Figure 5](#).

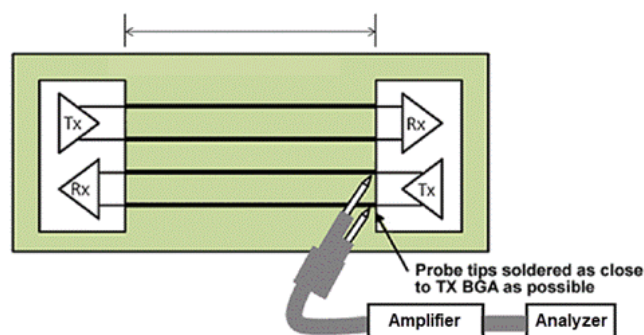


Figure 5 - Probe Tips to the Tx BGA



Probe Grounding

Capacitive coupling from AC mains may cause truly floating devices (like battery operated devices) to exceed the common mode range. You must connect the probe ground to the device under test (DUT).

You must either connect the amplifier ground to the system or connect the probe tip ground to the system.

Connecting the Amplifier Ground to the DUT

1. Connect the plug of the ground lead to the receptacle on the side of the amplifier body (marked GND), refer to Figure 6.
2. Connect the tip of the ground lead to the DUT.
 - In floating devices, connect the ground lead to the DUT reference or common voltage.
 - In high ambient noise RF environments, connect the ground lead to a good RF ground near the point where the signal is being measured.



CAUTION: Always use a ground lead when testing floating circuits, such as circuits powered from laboratory bench power supplies. Do not extend the ground cable as this will affect the ability of the probe to accurately acquire the signal. If a ground connection is not used, the probe may be damaged by exceeding the common mode input voltage. **The amplifier must be powered before signals are applied to the probe tips.**

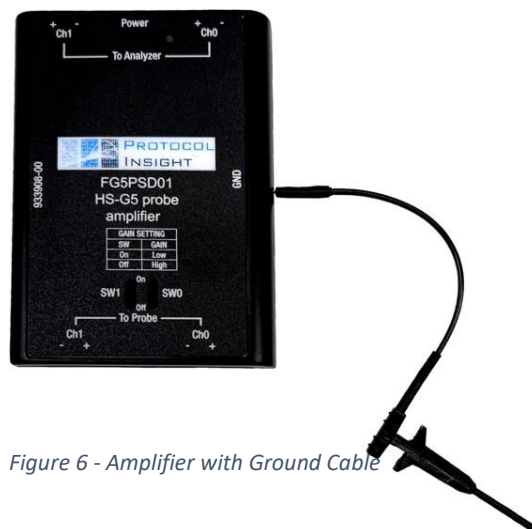


Figure 6 - Amplifier with Ground Cable

Connecting the Probe Tip Ground to the DUT

On the center of the probe tip, between the two resistor connections, there is a pad that is ground. A red arrow points to this pad in Figure 7. Connect this to ground using a short wire, this wire should be as short as possible, use a ground connection point very near the signal solder points.




Figure 7 - Probe Tip Ground Pad



Connect Tips to the Board

Using a small soldering iron tip, attach the free wires of the resistor to the appropriate test points. The FG5PSD05 tip should be positioned with the resistor side facing away from the PCM plane.

 When possible, keep a 45-degree angle between the ends of the tips and the PCB plane. This will improve signal fidelity performance with high frequency signals.

Connect Tips to the Amplifier

To connect the tips to the amplifier, simply position the tip so the label is on the same side as the amplifier label. Then press the connector pins into the receptacle on the amplifier, as shown by the blue arrow in [Figure 8](#).


 CH0 or CH1 can be used for TX or RX signal probing. Ensure the correct sublink channel is connected to the Analyzer. **Ensure the P (+) and N (-) polarity is maintained from the solder tip to the probe amplifier connections.**



Figure 8 - Insert Tips

Connect SMP & Power Cables to the Amplifier

1. Position the SMP cable so the + and – polarity label connections match. With the FG5PSD01, the SMP cable label and amplifier label will be on the same side. The FG5PSD01E amplifier label will be on top and the SMP label will be on the bottom side, refer to [Figure 1](#). Press the connector into the receptable on the amplifier.
2. The power cable has a Molex NanoFit connector on the amplifier end. Simply insert it into the Molex header on the middle. Refer to [Figure 9](#), the yellow arrows point to the cable.



Figure 9 - Insert SMP Power Cable

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Connect SMP & Power Cables to the Falcon G500C/G550C Analyzer

1. Locate the correct Sublink SMP connectors on the front of the Analyzer.
 - The + signal is indicated by the white marker on the corresponding side of the SMP cable pair.
 - Ensure the correct polarity is maintained from solder-in tip installation to the SMP connectors on the Analyzer.
2. Position the individual SMP connector and press it into the receptable connector on the Analyzer.
3. Similarly, locate the Probe power connectors on the Analyzer and position the Lemo connector end of the power cable, then plug it into the receptacle connector.
4. The power LED on the amplifier will glow solid green when the Analyzer is turned on and the probe has power.

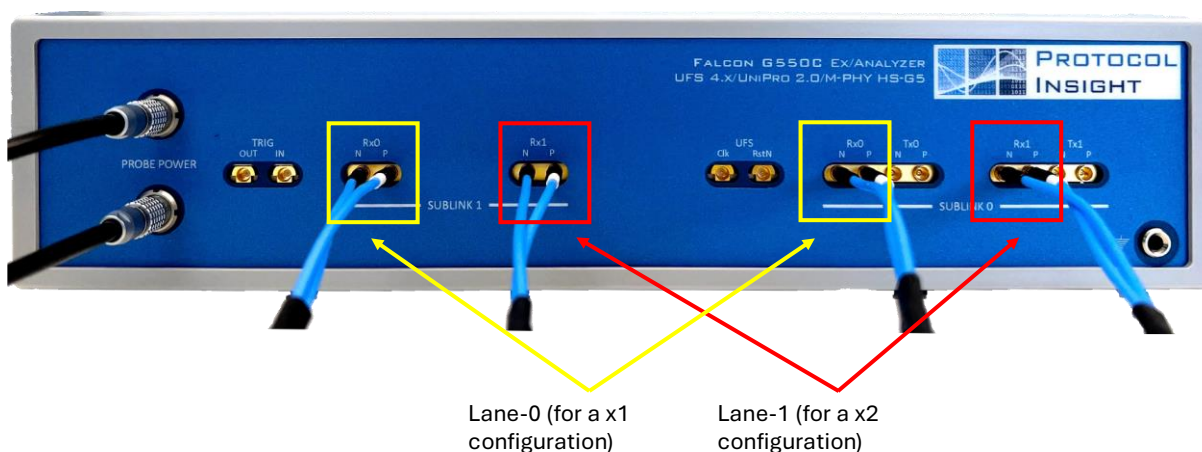



Figure 10 - Cabling Between Probe Amplifier and Analyzer

Cable Configuration

Probe Cable Configuration for x1 Design

 The x1 configuration uses one Probe Amplifier.

1. Connect the FG5PSD05 Solder-In Probe tips to the Amplifier according to the following:
 - M-PHY design that use a x1 link use one M-PHY GEAR5 Amplifier. Plug the two SMP cables into Sublink 0 Lane 0 and Sublink 1 Lane 0.
 - The SMP and power cables are connected to the Analyzer.
2. Use two matched pairs of the SMP-to-SMP cables to connect the Analyzer Sublink 0 Lane 0 and Sublink 1 Lane 0 to the corresponding SMP connectors on the Analyzer in x1 configuration.

Probe Cable Configuration for x2 Design

 The x2 configuration uses two Probe Amplifiers, four SMPs and two power cables.

1. Plug the four SMP cables into Sublink 0 Lane 0 and Lane 1, Sublink 1 Lane 0 and 1 ports. The output SMPT ports on the Amplifier attach to the Analyzer front end SMP receptable connectors, as shown in [Figure 10](#).

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2. Use the four phase matched pairs of the SMP-to-SMP cables to connect to the Analyzer Sublink 0 Lane 0 and Lane 1 and Sublink 1 Lane 0 and Lane 1, to the corresponding SMP connectors on the Analyzer.

Tuning the Probes and Analyzer

The FG5PSD01 (pre-Dec 2022) amplifier version has a gain switch for each channel. You can select low (switch on) or high (switch off), refer to [Figure 1](#). The FG5PSD01E amplifier version allows the gain for each channel to be configured in the Protocol Insight software, under Tools, Probe Configuration.

 The FG5PSD01E powers up using the “Preset2-LargeMidBand-10GHzDip-Factory-Default” setting. Refer to [Figure 21](#) for details on the frequency response for the preset selections.

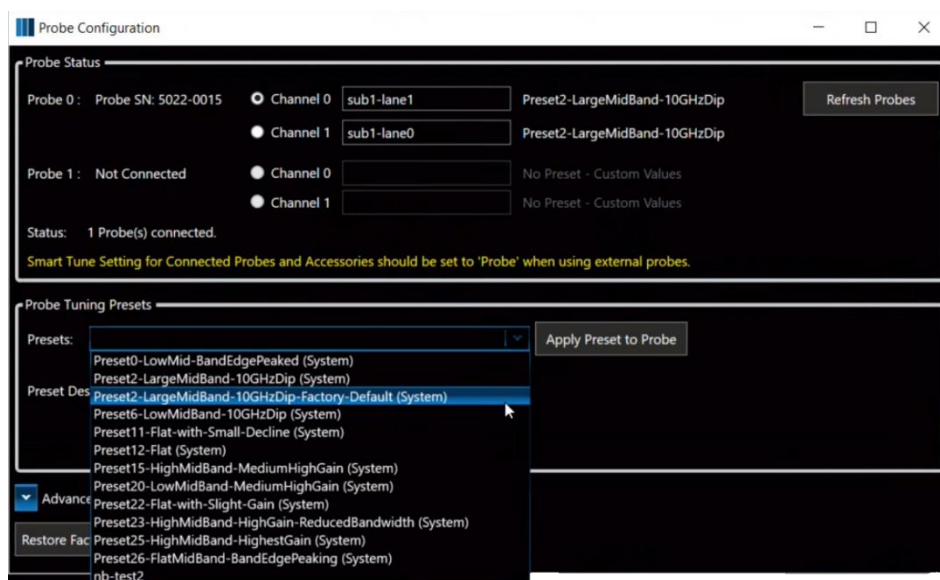


Figure 11 - Probe Software Configuration Dialog



The FG5PSD01E amplifier supports several preset configurations, as shown in [Figure 11](#), and it also supports custom configuration of the gain parameters under Advanced Tuning, refer to [Figure 12](#).

The screenshot displays the 'Probe Configuration' window, which is divided into two main sections: 'Probe Status' and 'Advanced Tuning'.

Probe Status: This section shows the status of two probes. Probe 0 is connected with SN 5022-0015. It has Channel 0 set to 'Host-Lane0' and Channel 1 set to 'Host-Lane1', both using the 'Preset2-LargeMidBand-10GHzDip' preset. Probe 1 is 'Not Connected'. A 'Refresh Probes' button is located in the top right. The status at the bottom indicates '1 Probe(s) connected'.

Probe Tuning Presets: This section shows the current preset is 'Preset2-LargeMidBand-10GHzDip (System)'. An 'Apply Preset to Probe' button is present. The preset description states: 'This preset is up ~3dB in the midband (50MHz-500MHz). It has a ~-3dB dip around 10GHz and recovers above 10GHz to about 3dB at the band edge.'

Advanced Tuning: This section allows for custom configuration of gain parameters. It is divided into 'Current Values' and 'New Values'.

Current Values: Shows the current settings: Low Freq Zero: 0, Mid Freq Zero: 255, High Freq Zero: 205, Gain: 32, First Pole: 76, Second Pole: 64, and BW Control: 255. A 'Copy To New Values' button is available.

New Values: This section features sliders for each parameter, with numerical input fields on the right. The sliders are currently set to the same values as the 'Current Values' section: Low Freq Zero (0), Mid Freq Zero (255), High Freq Zero (205), Gain (32), First Pole (76), Second Pole (64), and BW Control (255).

At the bottom of the 'Advanced Tuning' section, there are three buttons: 'Apply Values to Probe', 'Save As Preset', and 'Delete Selected Preset'. A 'Restore Factory Default' button is located at the very bottom left of the window.

Figure 12 - Probe Advanced Tuning



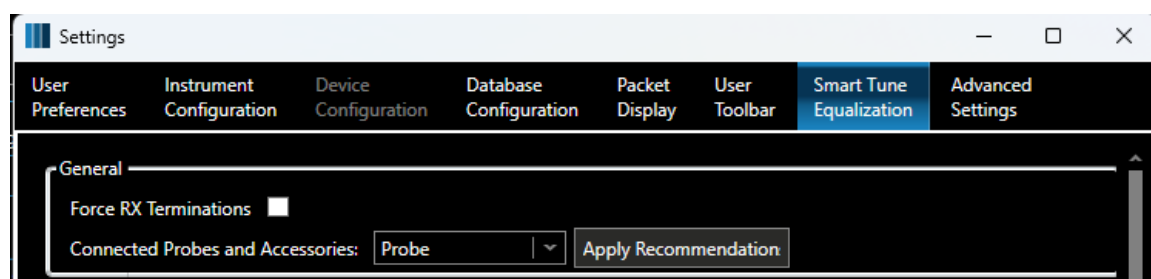
Probe Tuning Procedure

You can use the Instrument Status pane to monitor the symbol errors you receive on each lane.



Lower speed gears (HS-G1 through HS-G4) should work without error and not require any gain adjustment. If you notice symbol errors at these rates, check the signal integrity of the system using an oscilloscope. Remember you also have two values of probe tip resistance you can try. In our experience, most systems work best with the 50-ohm probe tip resistors.

1. In the Protocol Insight software, select Settings and SmartTune Equalization. Under General, make sure “Probe” is selected and click on “Apply Recommendation”.



This will zero out the ATT (attenuation), VGA (broadband gain) and CTLE (continuous time linear equalization) settings on the Analyzer PHY for all channels.

2. Adjust the gain settings on the amplifier to minimize the number of symbol errors you see in the Instrument Status pane. If this pane is not visible either select View, Instrument Status or View, Restore Default layout to reveal the Instrument Status pane.
 - a. On the FG5PSD01 amplifier you can select between on (low gain) and off (high gain) for each channel, refer to [Figure 1](#).
 - b. On the FG5PSD01E amplifier you can select from one of the presets, [Figure 11](#). Make sure you connect the amplifier to the host system using the USB-C connector, [Figure 13](#).



Figure 13 - FG5PSD01E USB-C

3. Only adjust lanes that have symbol errors. If a lane is error free there is no need to alter the settings.



4. If you still have some symbol errors after adjusting the probe gain, you can adjust the SmartTune equalization settings for each sublink lane individually.
 - a. In general, the recommendation is to step through VGA, CTLE and ATT individually in coarse steps to see if these settings have a positive impact on the symbol errors. If adjustments to any of the values are not beneficial, return the setting to 0x0 before moving to the next setting. For instance:
 - i. Try stepping through VGA (0x0 to 0xF) in coarse steps of 0x4 to see if this improves the symbol errors.
 - ii. Try setting CTLE (0x0 to 0xF, values above 0xF typically are not beneficial) in coarse steps of 0x4 to see if this improves the symbol errors.
 - iii. Try stepping through ATT (0x0 to 0x7) in coarse steps of 0x2 to see if this improves the symbol errors.
 - b. If you notice improvements in symbol rates with the adjustments in 3a, you can use finer steps to optimize the channel.
 - c. You can also try to set Force RX Terminations to see if this improves symbol errors.
5. Once you have minimized the errors on a channel, you can repeat this procedure for each channel.



Probe Firmware Updates and Restoring Defaults

The FG5PSD01 amplifier does not require calibration or updates.

The FG5PSD01E amplifier does not require calibration and may update itself when the Protocol Insight software is updated. The probe must be connected to the host PC over the USB-C cable, refer to [Figure 13](#). After the update is complete you will see a dialog box, refer to [Figure 14](#). Follow the instructions to complete the update.

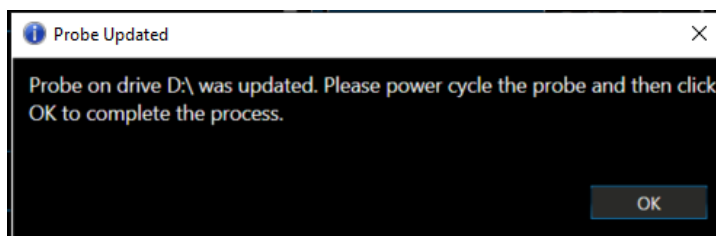


Figure 14 - Probe Updated Dialog

You can manually restore the FG5PSD01E amplifier to the Factory Default settings when it is connected to the host PC over USB-C. In the Probe Configuration dialog box, click on “Restore Factory Defaults”. You will be prompted to select a probe amplifier to update, as shown in [Figure 15](#). Select the probe you wish to restore and click on Ok. Another dialog box will confirm your selection and you will be asked to power cycle the probe. In the below example you will see the probe does not need an update, as it says “UpToDate”.

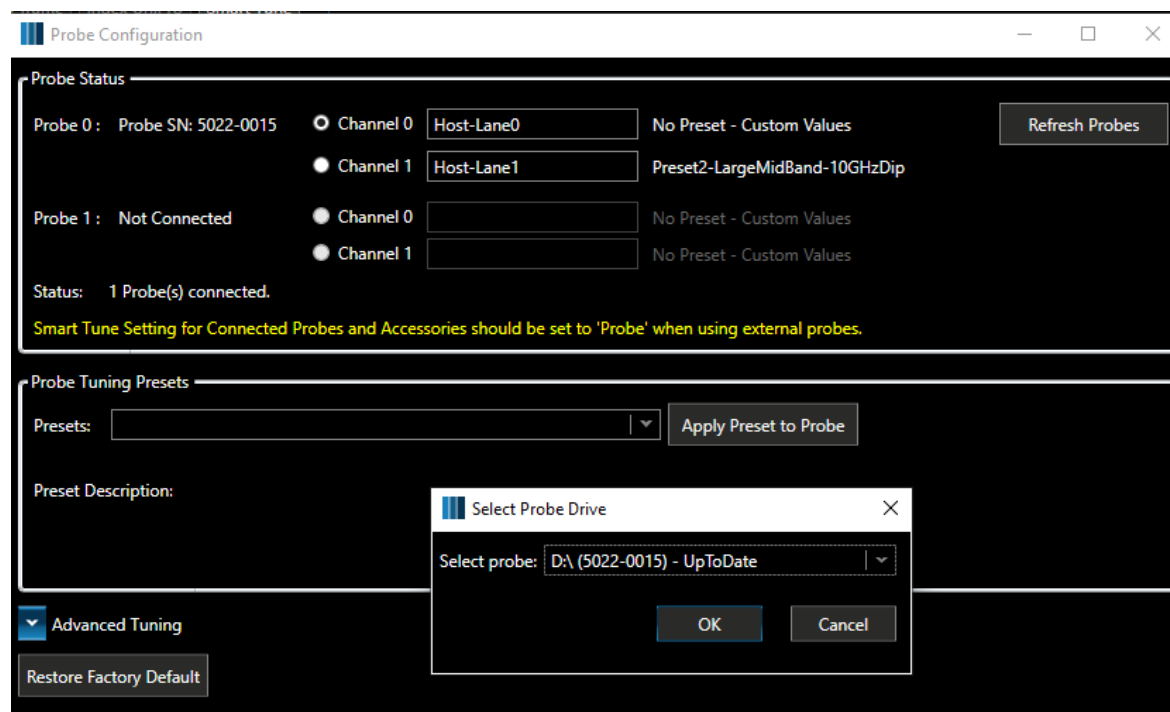


Figure 15 - FG5PSD01E Restore Factory Defaults



Recording Traffic

After the Falcon G500C/G550C Analyzer and FG5AMPGR Grypper Interposer are properly set up you can capture traces. Refer to the [Falcon G500C/G550C User Manual](#) for more information.

Probe Dimensions

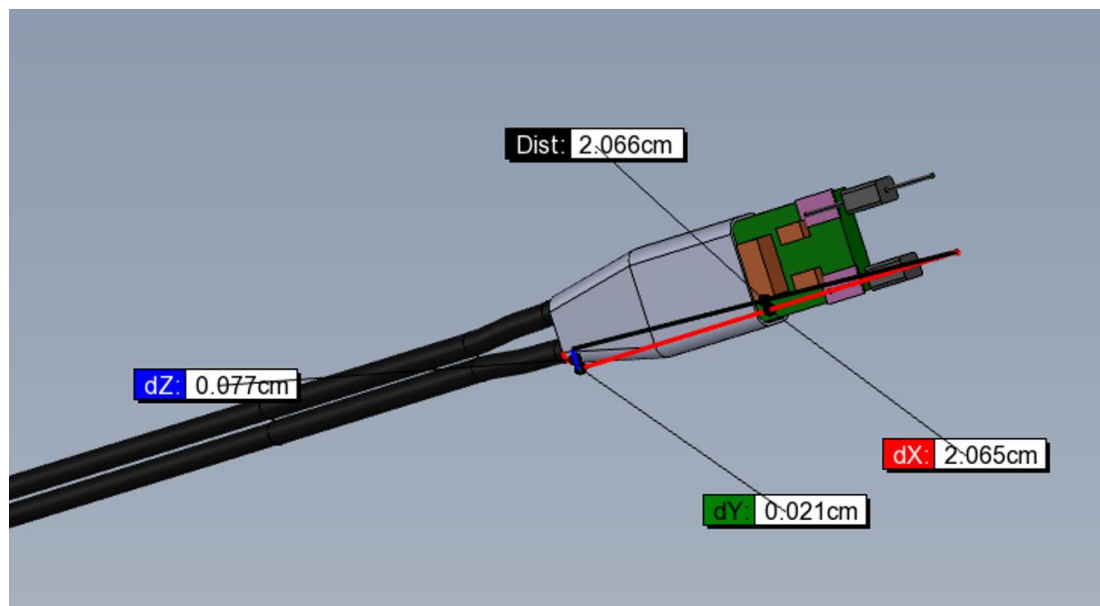


Figure 16 - Probe Head Dimensions

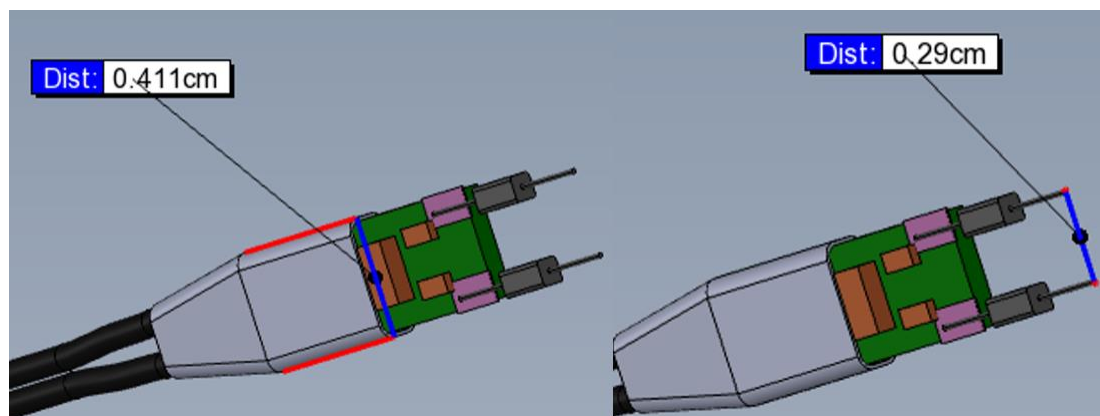


Figure 17 - Probe Tip Dimensions

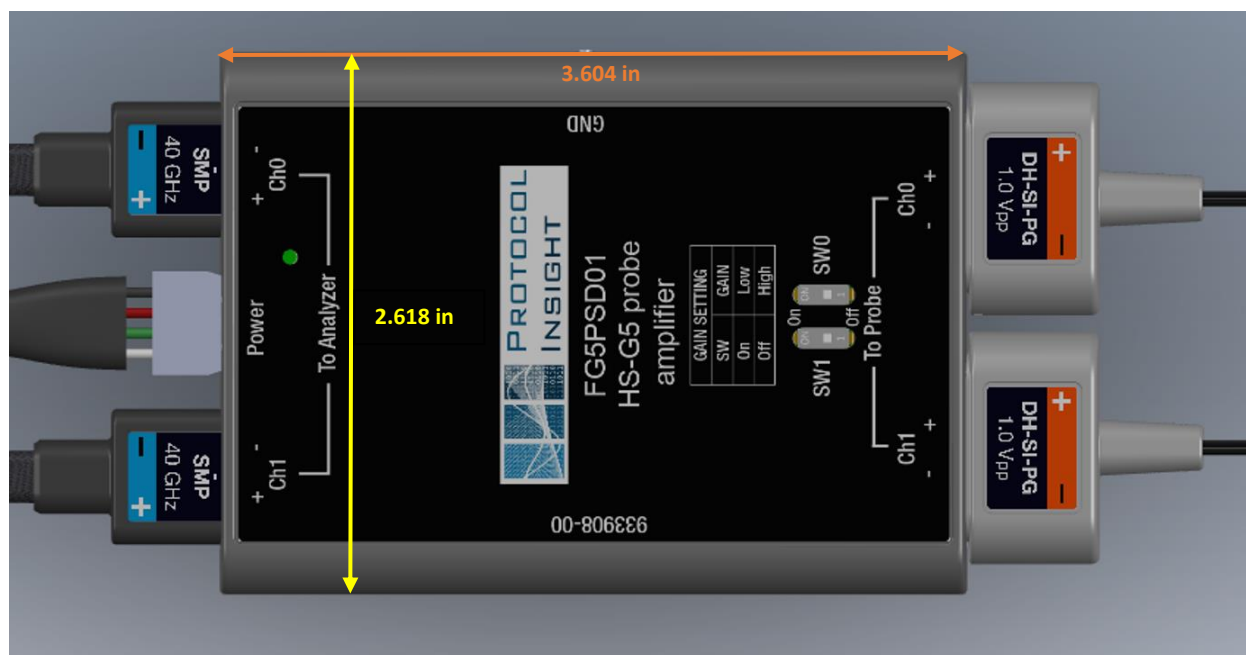


Figure 18 - Probe Amplifier Dimensions



Figure 19 - Probe Cable Dimensions



Figure 20 - Signal and Power Cable Dimensions

The signal and power cables are ~22.97 inches in length. The probe cable is ~9.62 inches in length.



Probe Preset Response Curves

The reset curves for the probe present values are shown in [Figure 21](#). For example, what is listed as “Preset2-LargeMidBand-10GHzDip (System)” is shown as “Sweep=Preset-Value=2”.

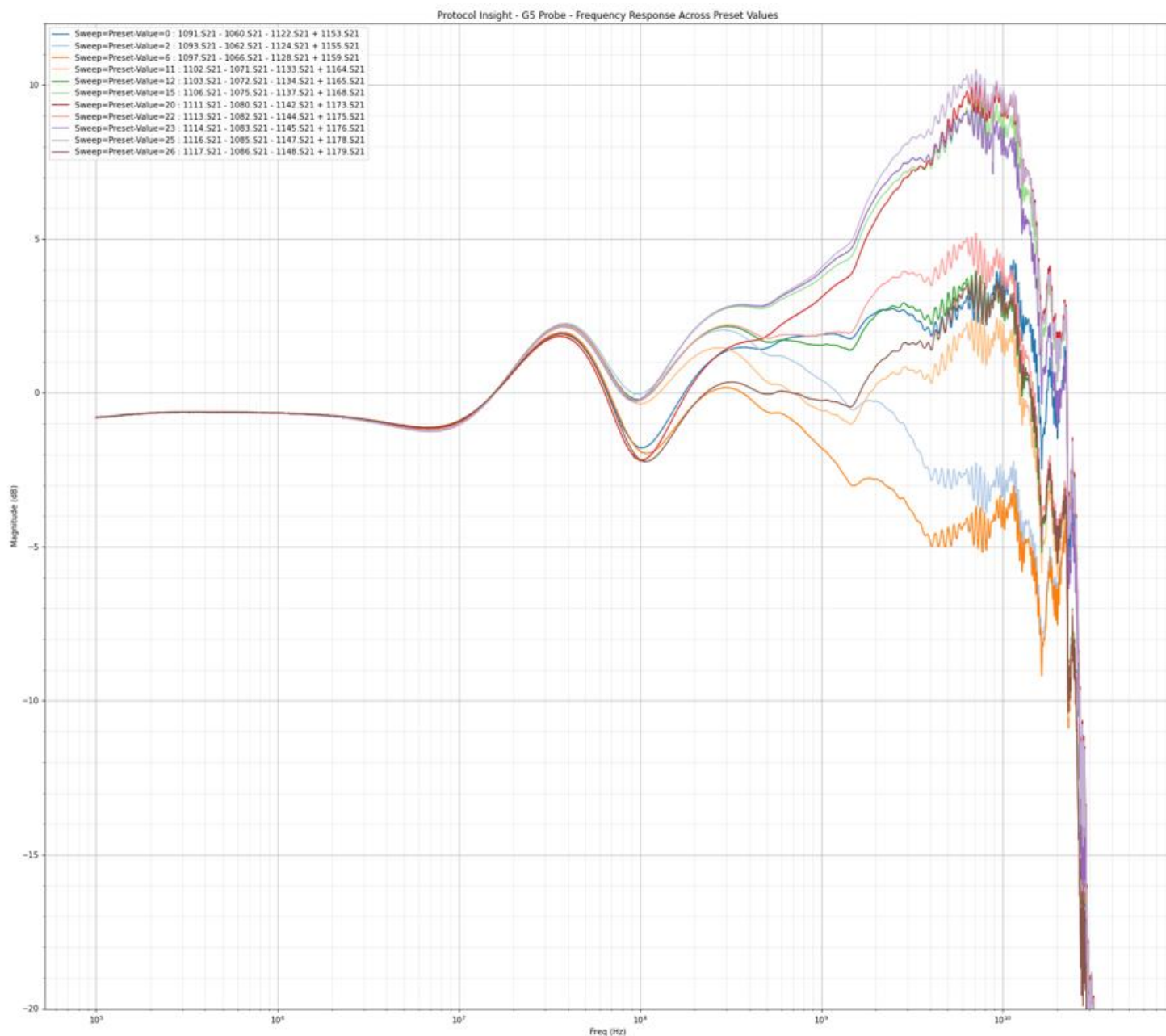

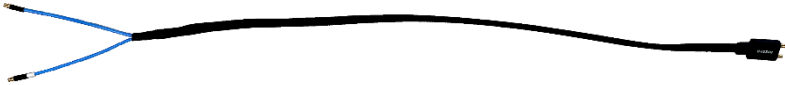


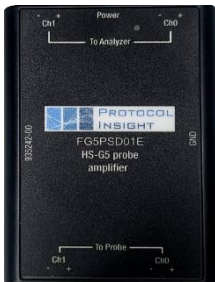


Figure 21 - Probe Preset Response Curves



Optional Replacement Parts

ITEM		Product Code
Solder-In Probe Tips		FG5PSD05 HS-G5 Probe Tip
SMP-SMP 40 GHz 24in Cable Pair		FG5PSD08 HS-G5 signal cable
Molex to Lemo Power Cable		FG5PSD07 HS-G5 power cable
M-PHY HS-G5 Probe Amplifier		FG5PSD01 (deprecated, pre-Dec 2022) HS-G5 probe amplifier
M-PHY HS-G5 Probe Amplifier		FG5PSD01E (Dec 2022, current)



Operating Conditions

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

Temperature: 5° to 40° C.

Humidity: Maximum relative humidity 90 % for temperatures up to 31° C decreasing linearly to 50 % relative humidity at 40° C.

Altitude: Up to 10,000 ft (3,048 m).

Contact Information

1. For additional information, to request a demonstration or quote, or place an order, please contact your local Protocol Insight representative or sales@protocolinsight.com
2. Support materials and examples files are available at <http://www.protocolinsight.com/support-materials/>
3. For technical support please contact your local Protocol Insight representative or support@protocolinsight.com