PE44951 Phase Shifter and DSA EVK: Optimizing the Phase and Insertion Loss Bench Measurements

Application Note 111

Introduction

The PE44951 includes highly integrated phase shifters with digitally controlled step attenuators for use across the 6.025 to 7.525 GHz frequency range. Due to the high resolution of the digital phase shifters and digital step attenuators, the loss and phase shift associated with the PCB traces of the evaluation board must be accounted for to ensure that only the associated phase and insertion of the PE44951 is evaluated. This application note demonstrates the method of bifurcation of the thru trace to accurately remove the phase and associated insertion loss of the PCB traces on the PE44951 evaluation kit (EVK).

Bifurcation method

pSemi designed this application note using the Keysight PNA-X N5245B, License S93007B — Automatic Fixture Removal (AFR) for the bifurcation of the thru trace into two separate traces where each trace has its own phase and associated trace loss. Although this application note is based on the Keysight PNA-X, other vector network analyzers (VNAs) offer similar features.

VNA E-calibration

The first step is to run ECAL on the VNA to remove the associated phase and insertion loss of the port extensions for Port 1, Port 2, and Port 3. The AFR requires the start and step of the E-calibration to be equivalent, so configure your E-calibration sweep for 10 MHz to 10 GHz and 1000 points.
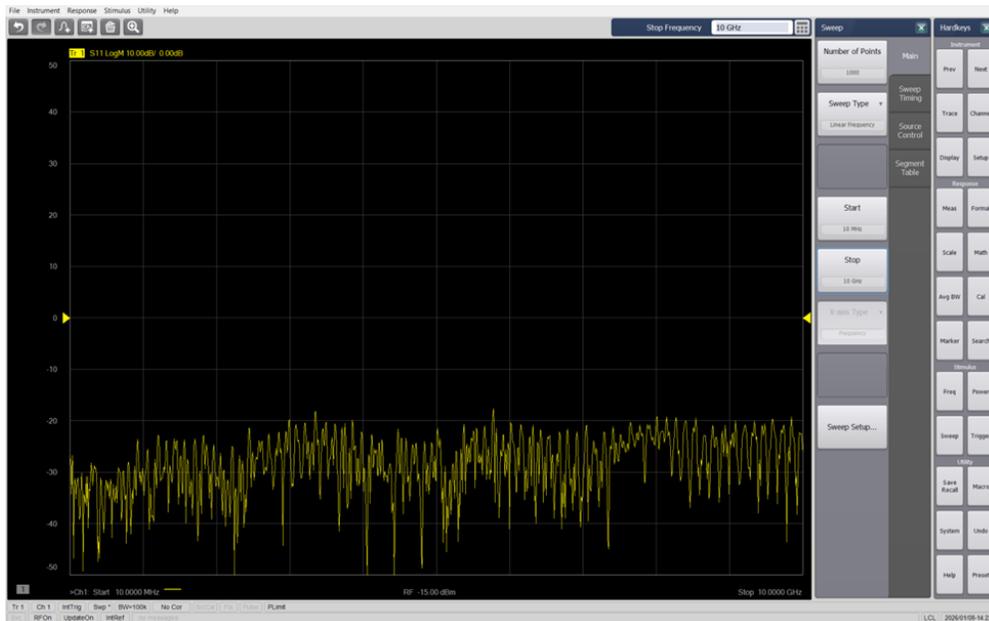

Figure 1: E-calibration sweep

After you complete the E-calibration, make the following connections, as shown in Figure 2:

Table 1. VNA and EVK connections

VNA port	Connect to EVK connector
1	J5
2	J4

Figure 2: PE44951 EVB setup

Auto fixture removal tool setup

To ensure that the phase and associated loss of the thru trace is removed, change the measurement on the VNA to S21 and update the marker to reflect measuring the associated phase and loss of the trace using the following VNA settings:
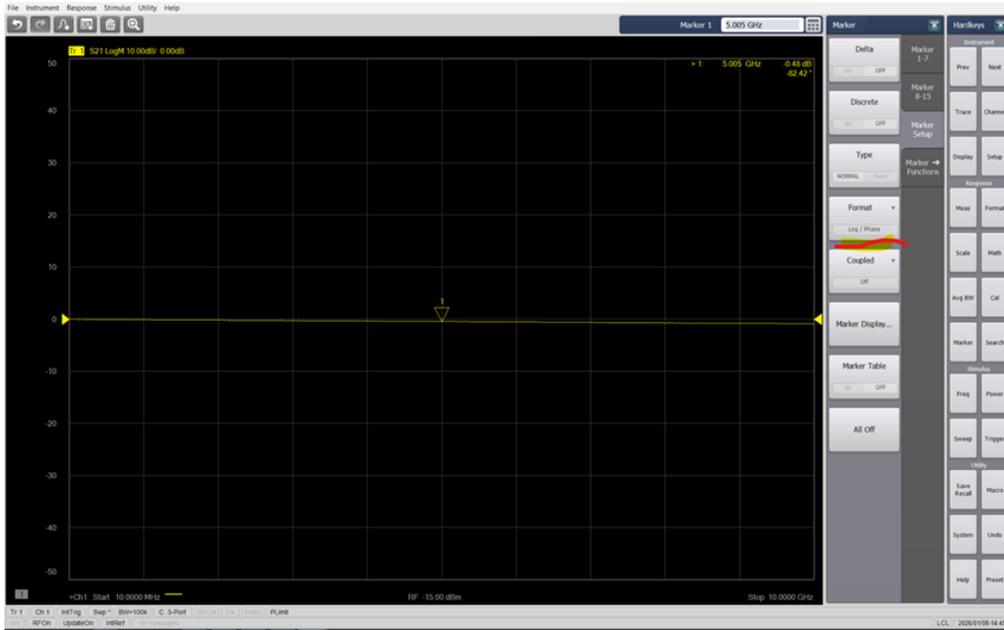
Marker → Marker Setup → Format Log/Phase

Figure 3: Update the VNA marker for AFR

To compensate for the THRU trace, go to the AFR tool location:
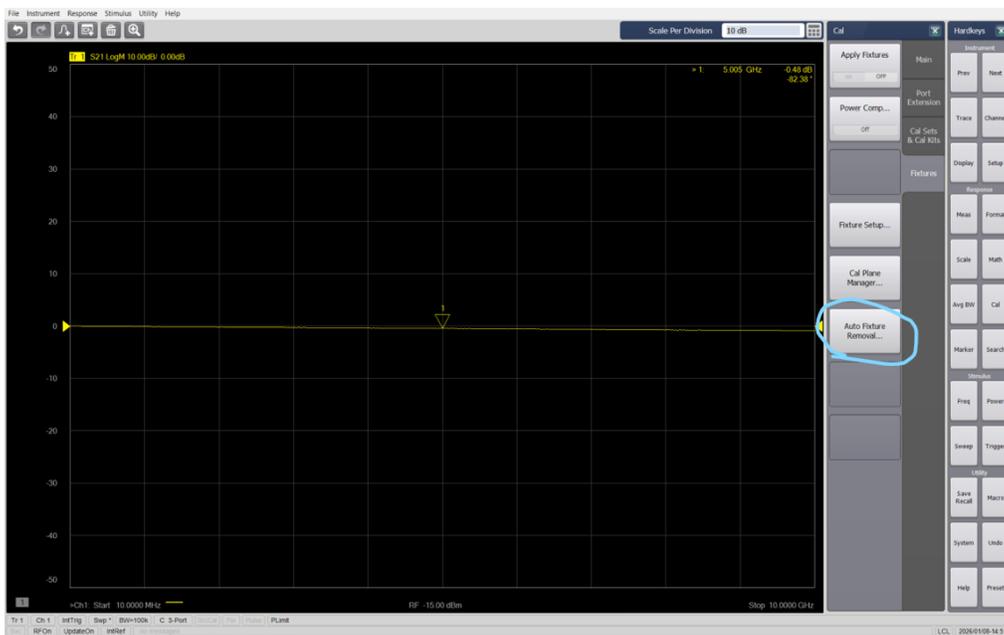
CAL → Fixtures → Auto Fixture Removal

Figure 4: Automatic fixture removal location

Auto fixture removal tool application

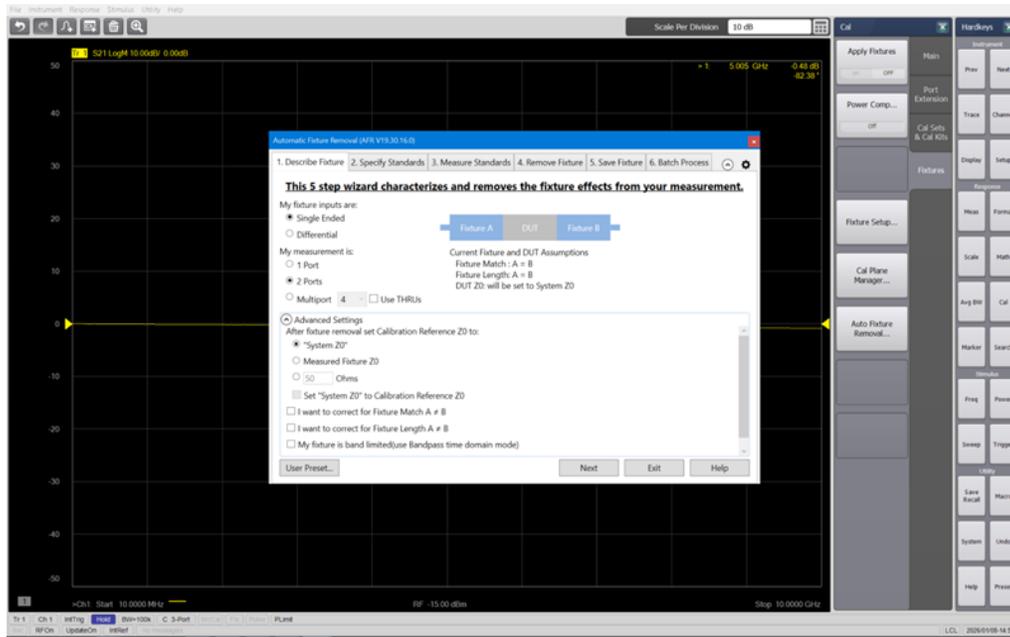In the Auto Fixture Removal application, configure tabs 1–5 as shown in Figure 5–Figure 9.
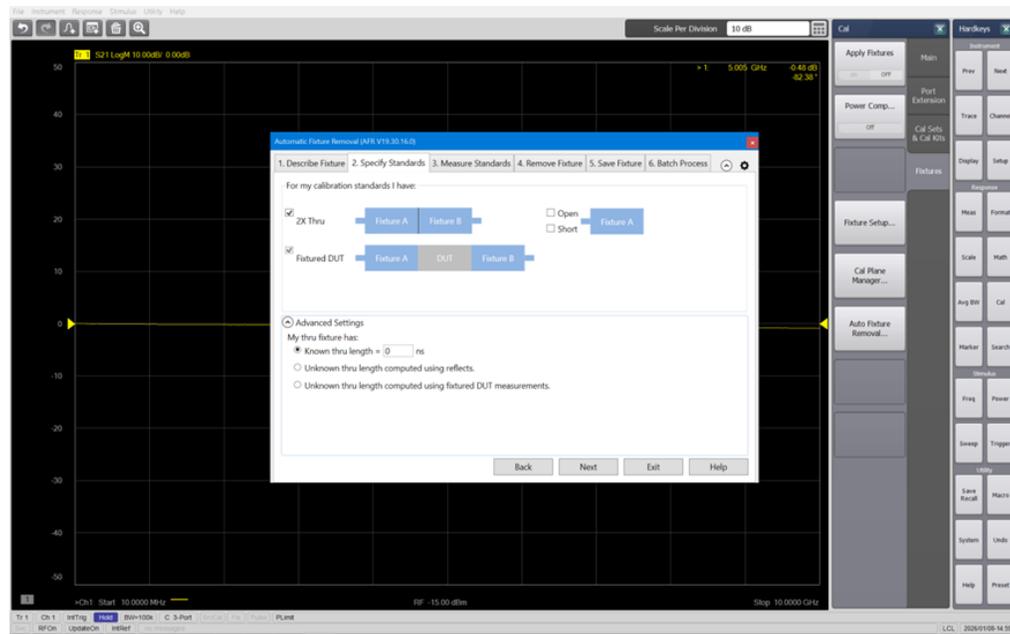

Figure 5: AFR tool tab 1
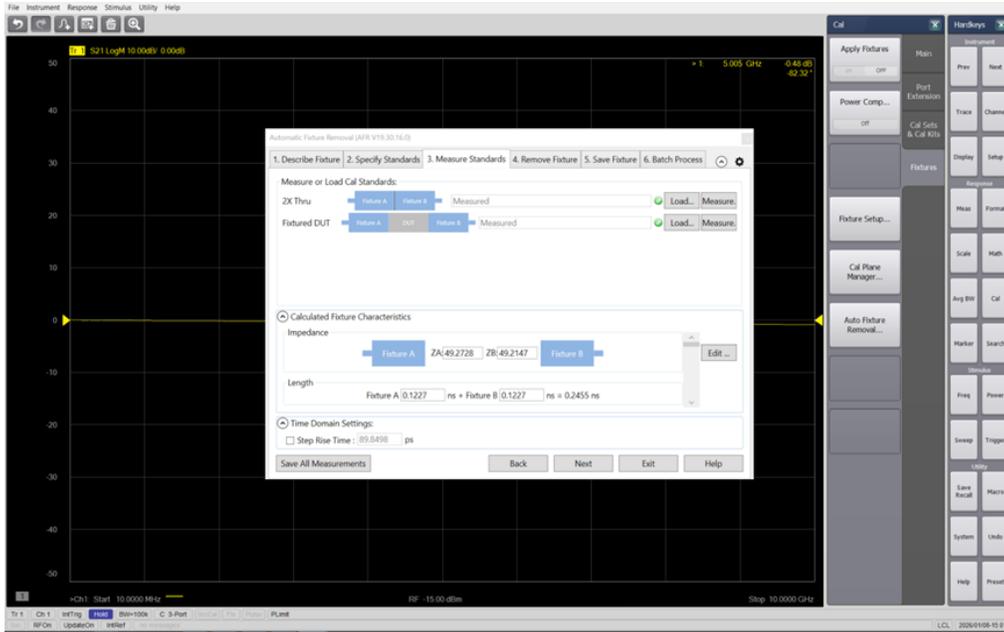

Figure 6: AFR tool tab 2

Figure 7: AFR tool tab 3

On tab 3, run **2X Thru** and **Fixed DUT**. After the measurements complete, the characteristics of the bifurcated trace display. For example, section A displays the following:

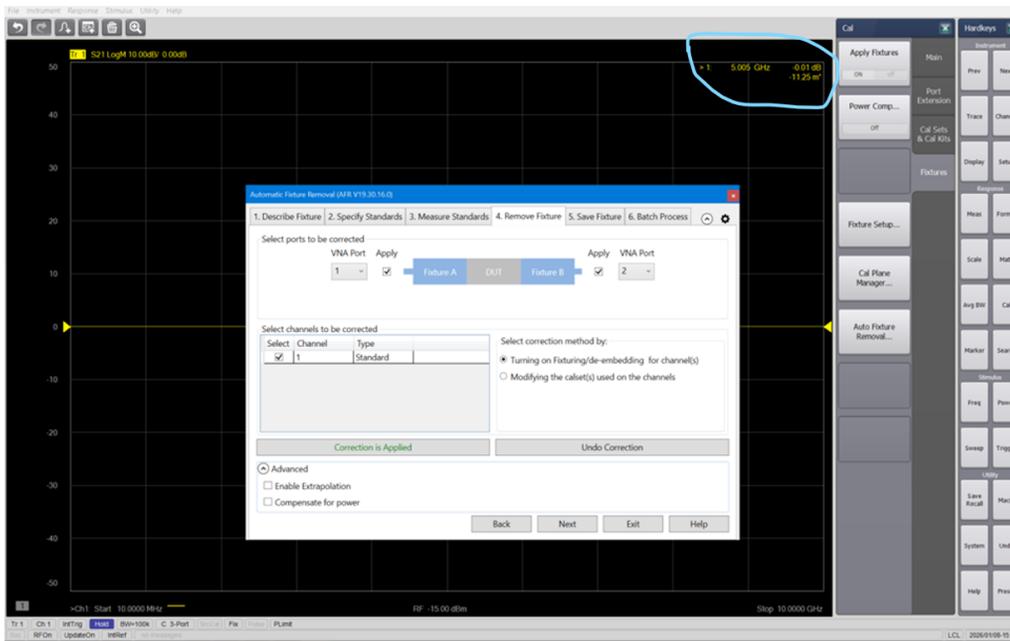- Impedance: 49.27Ω
- Delay: 0.12 ns

Figure 8: AFR tool tab 4

On tab 4, select **Apply Correction** and verify that the magnitude and the phase of the trace are removed from the S21 measurement with a loss of 0.01 dB and a phase of 11.22 m degrees.

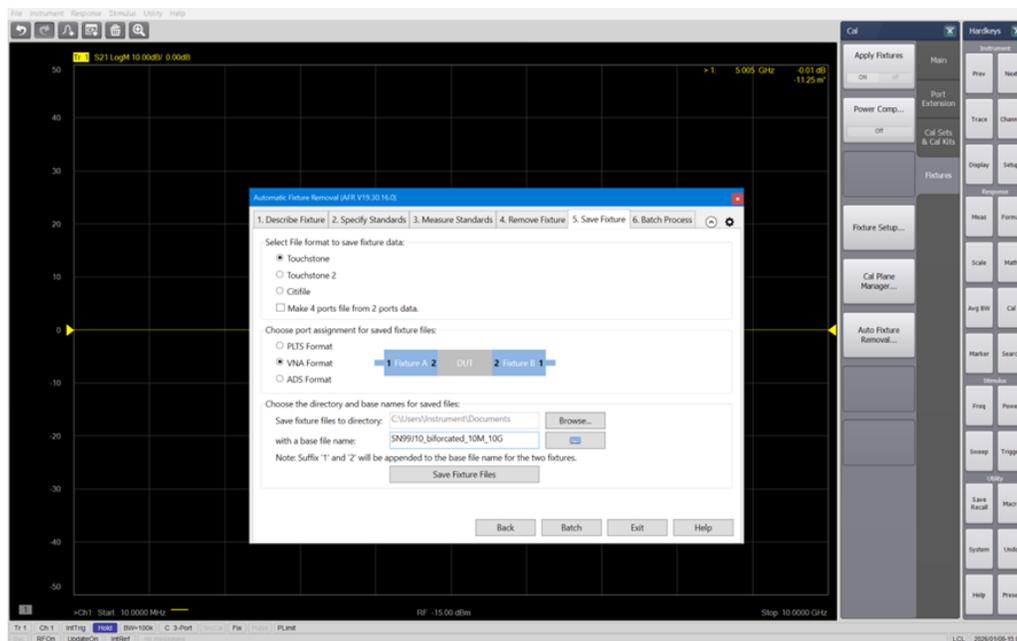*Figure 9: AFR tool tab 5*

In tab 5, save the files by following this procedure:

1. In the *Save future files to this directory* field, enter or browse to the folder.
2. In the *with a base file name* field, enter the file name. In the Figure 9 example, the specified file name is SN99J10_biforcated_10M_10G.
3. To save the files, select **Save Fixture Files**.
4. After the files are saved, select **Exit**.

Auto fixture removal tool fixture setup

Now that the bifurcation of the Thru trace and its associated SNP files have been calculated and saved, configure the fixture setup as shown below to implement the locations of the traces according to the PE44951 EVK.

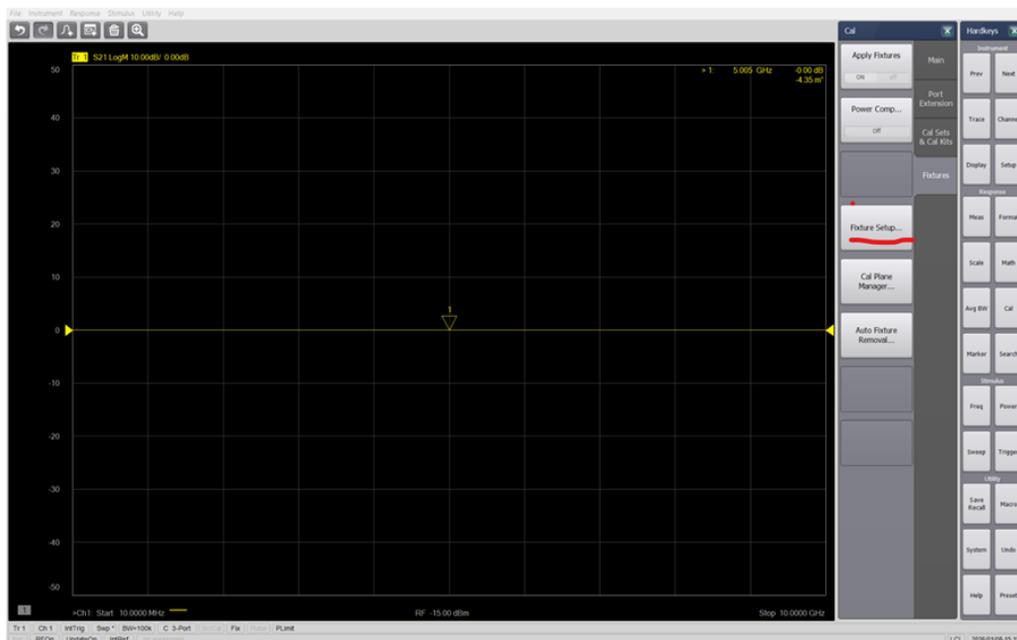*Figure 10: Fixture setup to match the EVK trace location*

As shown in Figure 11, the PE44951 EVK has three ports, so the bifurcation must be added as follows:

- Port A gets the first part of the bifurcation.
- Ports B and C get the second part of the bifurcation because they are after the chipset.

Figure 11: PE44951 EVK trace location

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In the Fixture Setup screen (Figure 12), use the **Add Block** feature to add the blocks as listed in Table 2.

Figure 12: PE44951 EVK fixture generator setup

Table 2: PE44951 EVK bifurcation of trace assignments summary

Fixture port	S2P file	Connect to
Port A	10M_10Gf_1.s2p	VNA port 1 — Fixture generator
Port B	10M_10Gf_2.s2p	VNA port 2 — Fixture generator
Port C	10M_10Gf_3.s2p	VNA port 3 — Fixture generator

Figure 13: VNA Port 3 fixture generator setup block contents

After you configure the Fixture Setup Block Contents as shown in Figure 12 and Figure 13, select **Apply Fixtures**, then select **OK**.

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To verify that the Fixture Setup was correctly applied, follow this procedure:

1. Set the VNA to measure the S31 S-parameter.
2. Connect VNA port 1 to the EVK J5 thru port connector.
3. Connect VNA port 3 to the EVK J4 thru port connector.
4. Verify that you can measure S31 through the thru trace as shown in Figure 14.
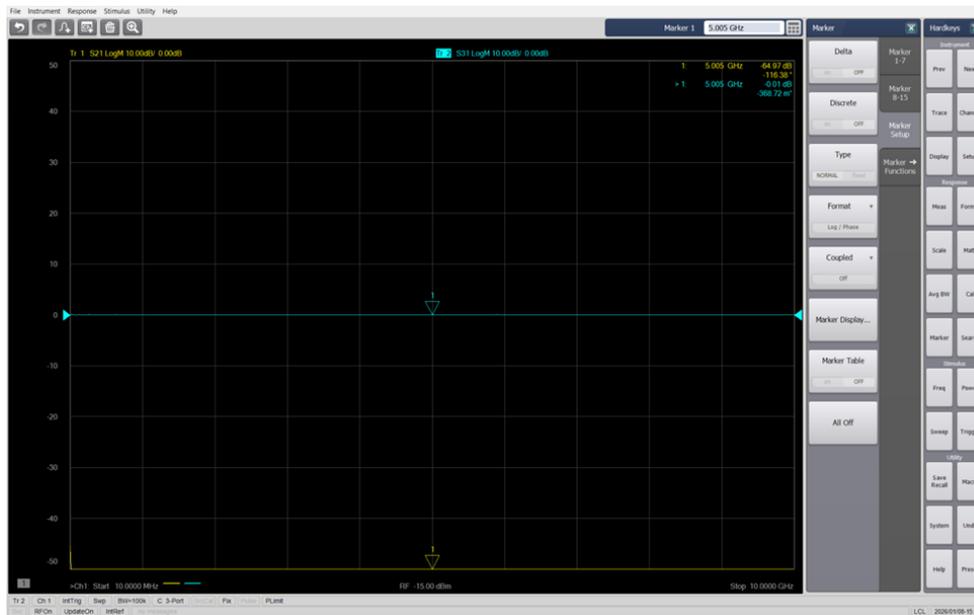

Figure 14: S31 measurement to verify the AFR fixture setup

Conclusion

This application note described how to use bifurcation to take the loss and phase shift associated with the PCB traces of the PE44951 EVK board into account.

Sales contact

For additional information, contact Sales at sales@psemi.com.

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