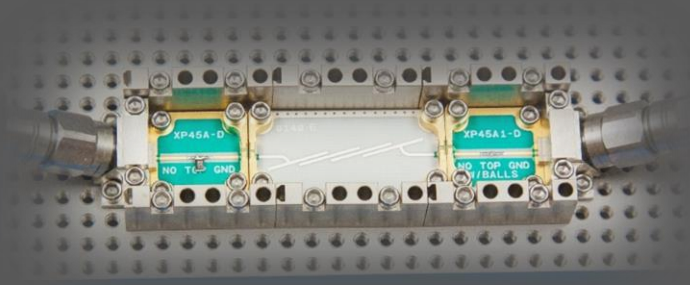
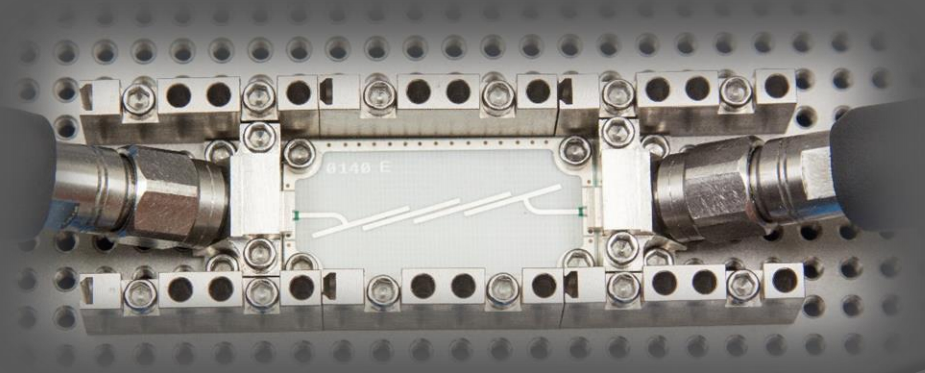
AFR:
First Impressions





15 September, 2014

By: Ray Page

Purpose

X microwave

One of the challenges of RF and microwave design is to accurately de-embed "S" and "X" parameter models of on-circuit-board devices. One must somehow peal away the effects of the "Fixture" including copper traces and any connectors or probes between the device and the reference plane.

This process is known as "Fixture Removal".

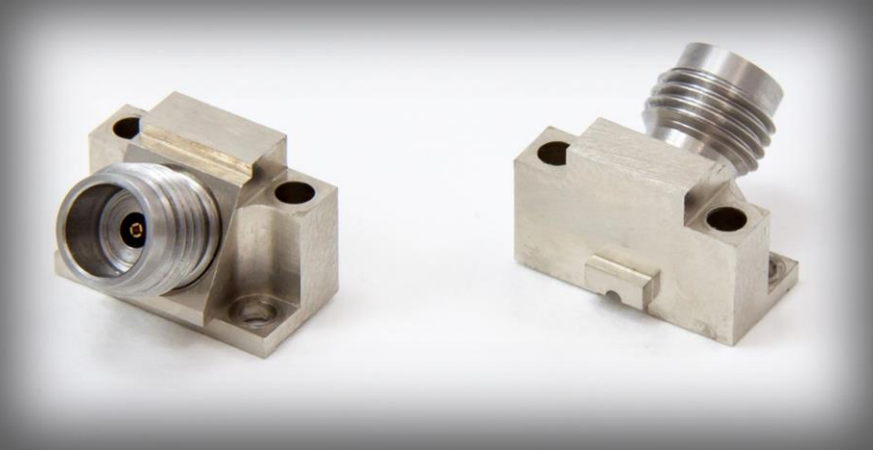
Conventional microwave fixture characterization methodologies require well-characterized standards, which are often not available given the custom nature of fixtures.

Since Keysight's Automatic Fixture Removal (AFR) software only requires an open or a short for a standard, it offers the promise of a fast method of exposing embedded devices so accurate linear and non-linear models can be extracted. This short presentation catalogs X-Microwave's "First Impressions" of using AFR to de-embed such models.

Objectives

- **Extract a 60 GHz S2P model of our X-MWprobe.**
- **Test AFR's ability to extract an accurate S-Parameter model of an "embedded" 10 GHz bandpass filter.**

Extract S2P Model of X-MWprobe



X-Probe Model Extraction

X microwave

X-Microwave's modular microwave building block system requires PCB port level S and X parameter models of each of it's X-MWblock Components to support accurate online simulation.

Therefore, a good S-parameter model of our solderless contact probe (X-MWprobe) is required.

The following slides show how AFR was used to extract a 60 GHz S2P model of the X-MWprobe.

X-Probe Measurement Procedure

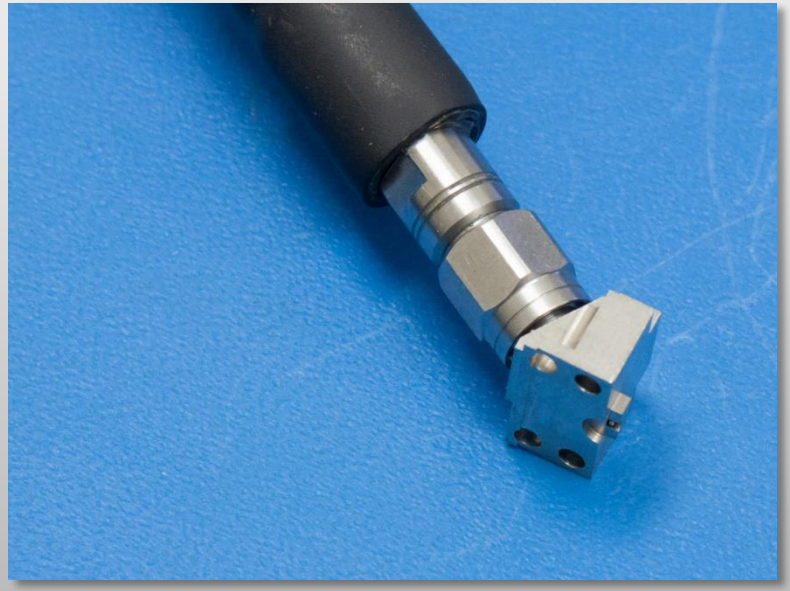
1) **Perform a 10M to 67G (6700-points) ECAL on PNA-X (N5247A).**

2) **Invoke AFR and select the following options:**
   - **Single Ended**
   - **Two Port with A = B**
   - **Select both OPEN and SHORT standards**

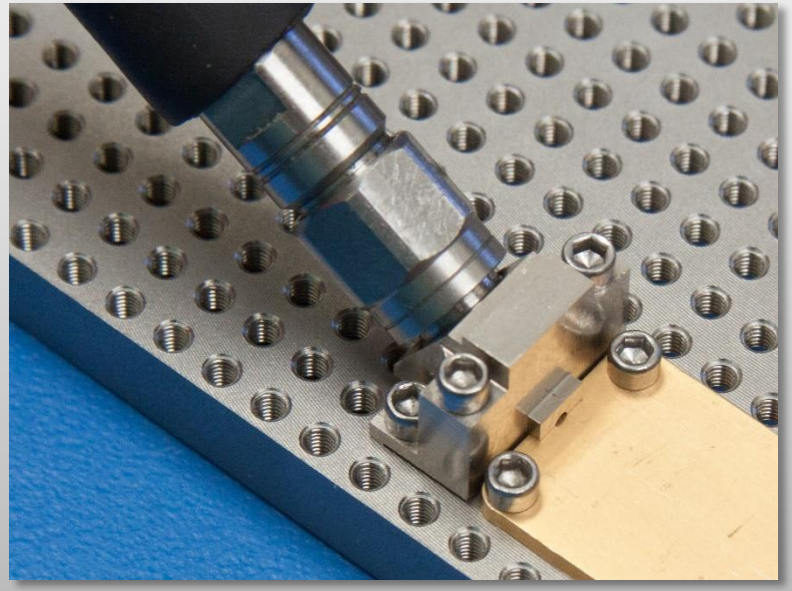
X-Probe Measurement Procedure

3) **Measure the probe with an open and a short and save the results.**

OPEN

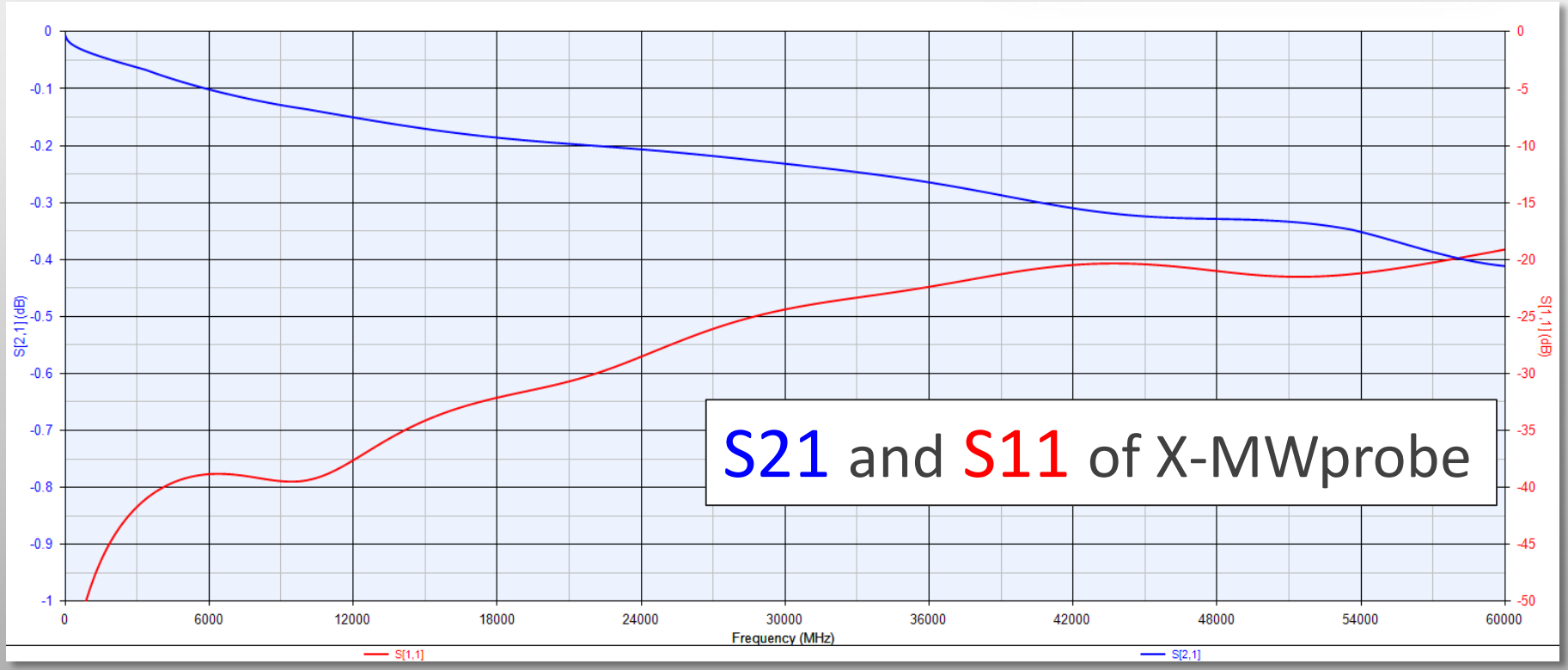


SHORT



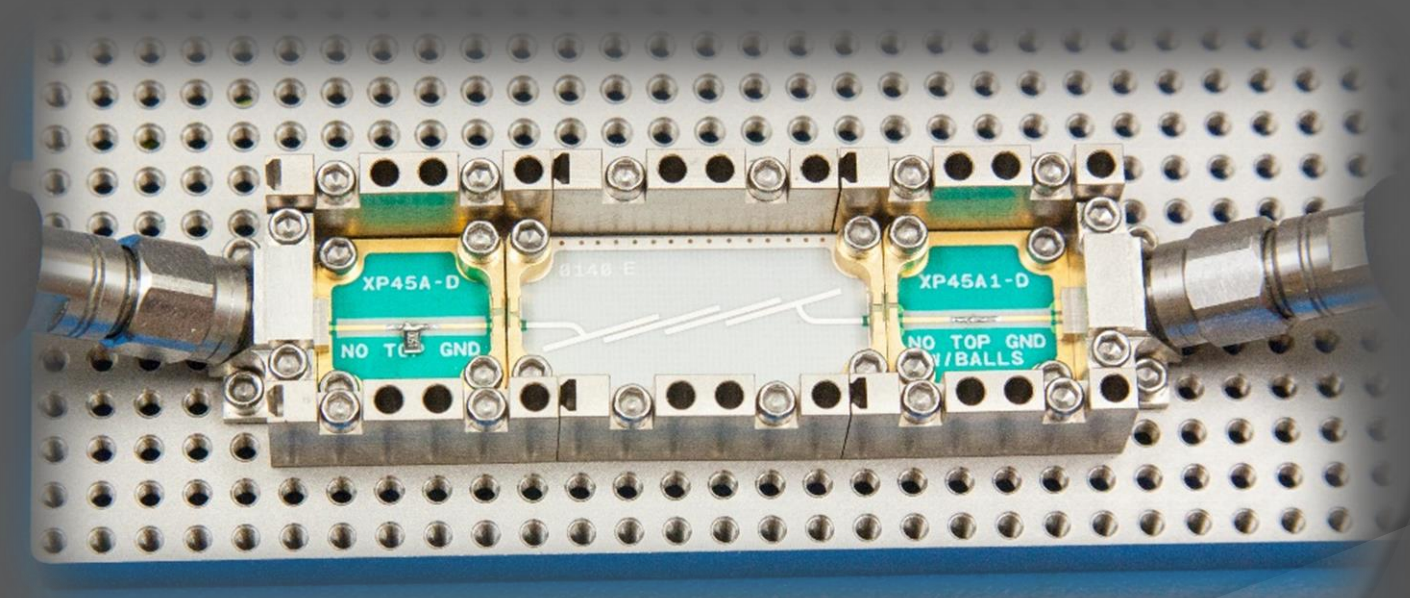
X-Probe S2P Results

S21 and S11 plots of the X-MWprobe.



*It's hard not to be happy about these results!

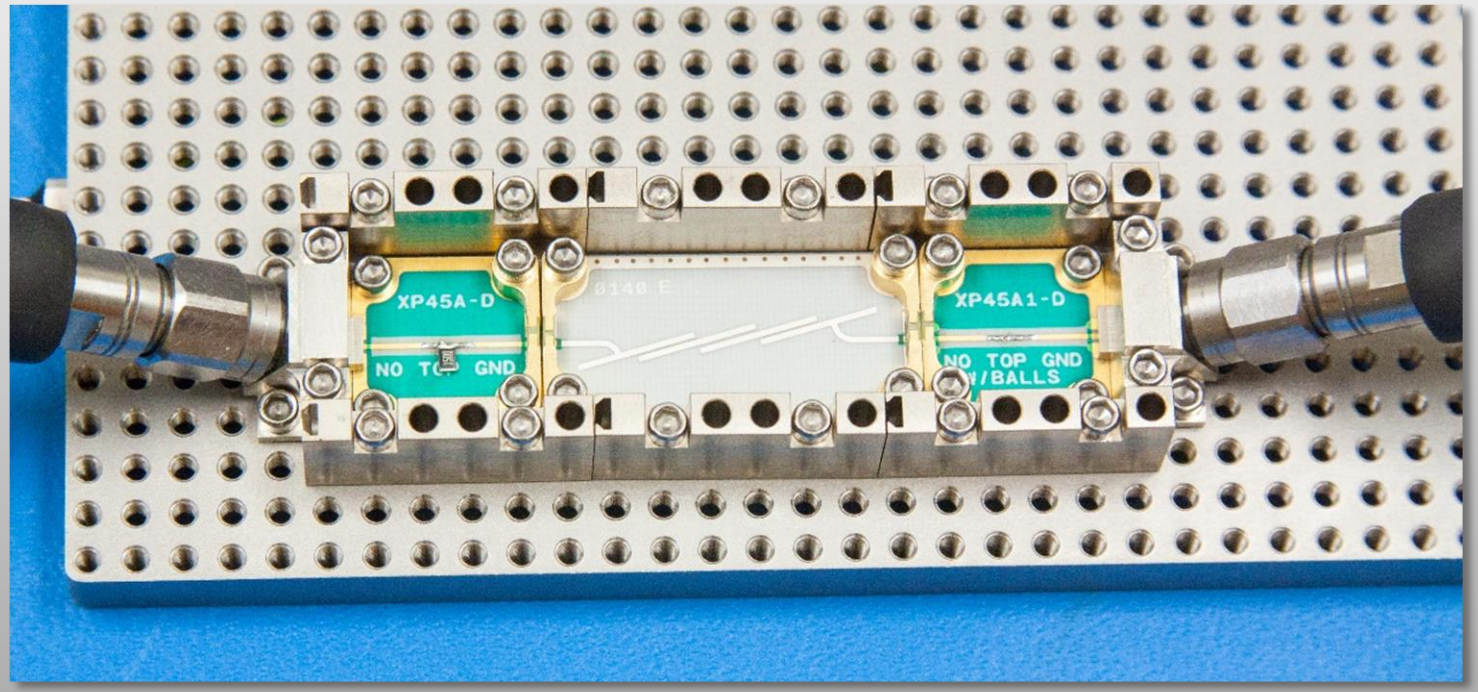
Test the Ability of AFR to Characterize an Embedded Filter



Embedded Filter Model Extraction

The effectiveness of AFR for extracting an accurate S2P model from an embedded component was evaluated.

An X-MWblock 10GHz filter was “embedded” by flanking it with a “Fixture” comprised of two X-MWprobes and two purposely degraded transmission line boards.



Embedded Filter Measurement

X microwave

1) **Perform a 10M to 67G (6700-points) ECAL on PNA-X (N5247A).**

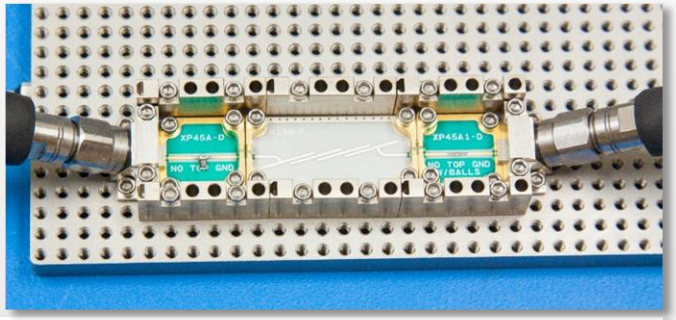
2) **Invoke AFR and select the following options:**
   - **Single Ended**
   - **Two Port with A != B**
   - **Select just the SHORT standard**

3) **Place shorts on the embedded ports of the filter and measure.**

4) **Save the resulting fixture files.**

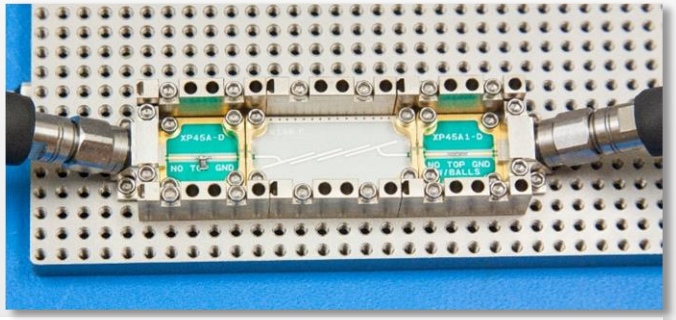
Measure Filter without AFR

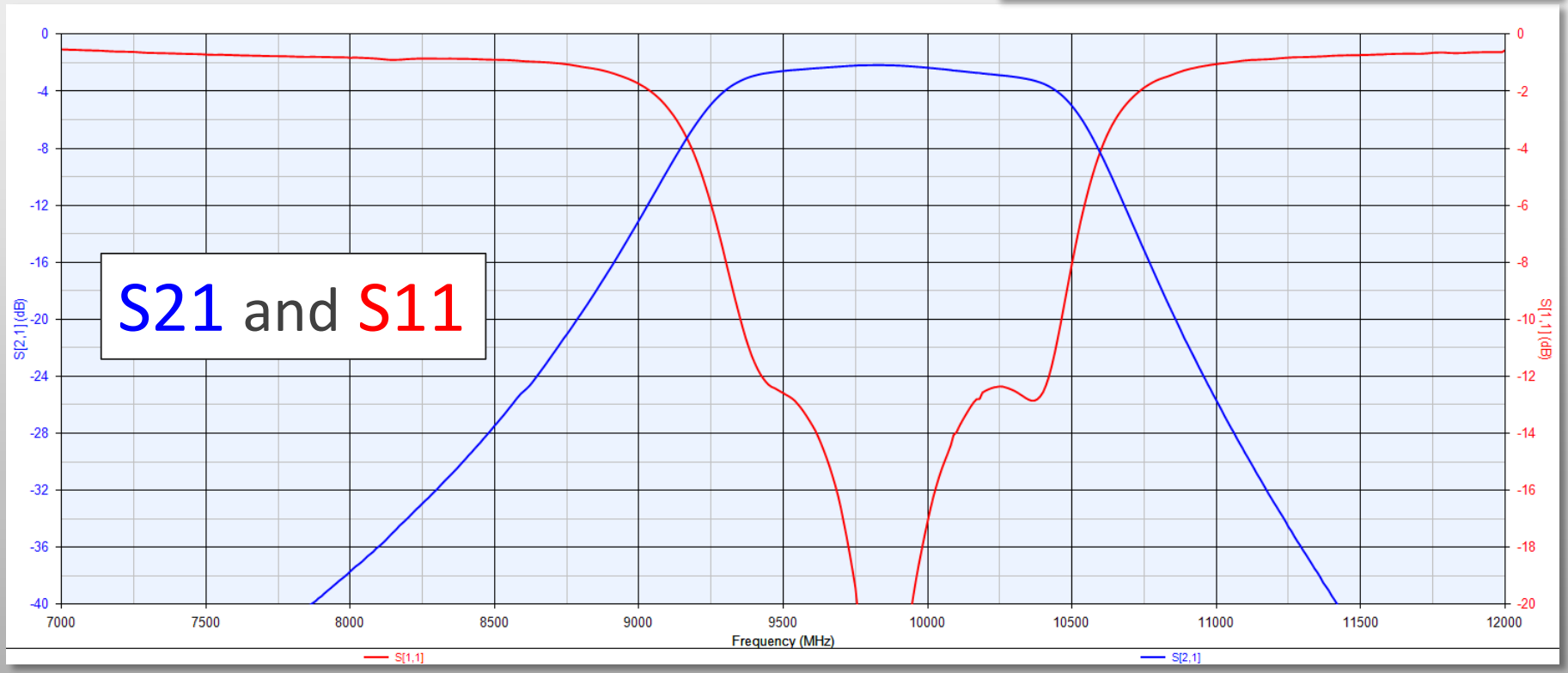
S21 and S11 for the embedded 10 GHz filter before using AFR to remove the effects of the fixtures.



Use AFR to remove the Fixtures

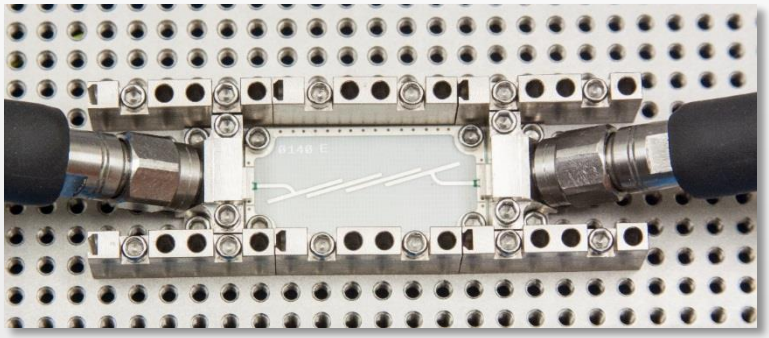
S21 and S11 of the 10 GHz filter after using AFR to remove the effects of the fixtures.

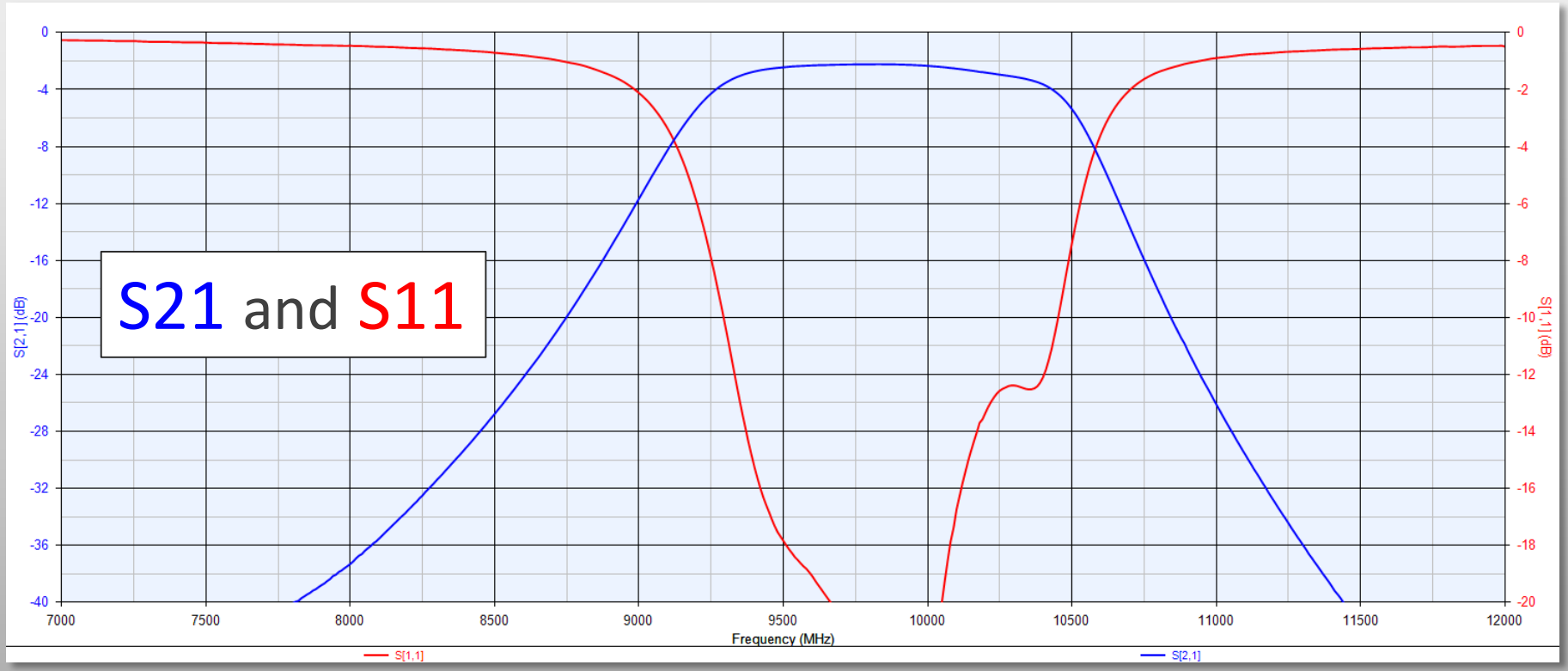




Results of Direct Measurement

A Direct measurement* of the 10 GHz filter confirms the accuracy of the AFR-enabled measurement.





*For best accuracy, the effects of the X-MWprobes were removed by de-embedding the S2P models of the probes that were previously extracted by AFR.

Conclusions

AFR is clearly a very powerful tool to use for de-embedding VNA measurements whenever a conventional calibration standard set is not a practical option.

The “Fixture” must have decent S11 and S21 performance for AFR to yield accurate results, which is reasonable when one considers the feat of extracting two-port S-parameters of a fixture from a single-port measurement. The transmission lines on X-MWblock layouts readily meet this requirement.

Other Anticipated Uses of AFR

- **De-embed the S-parameters of amplifiers (and other devices) for the purpose of synthesizing on-board microstrip-based conjugate matching networks.**
- **Record performance of every X-MWprobe X-Microwave sells by serial number.**
- **De-embed both S and X parameters of devices found on our X-MWblock modular circuit boards for use in component-level simulations.**
- **Offer S-parameter files of PCBs so IC manufacturers can de-embed to the device leads for rapid product development and first article testing.**