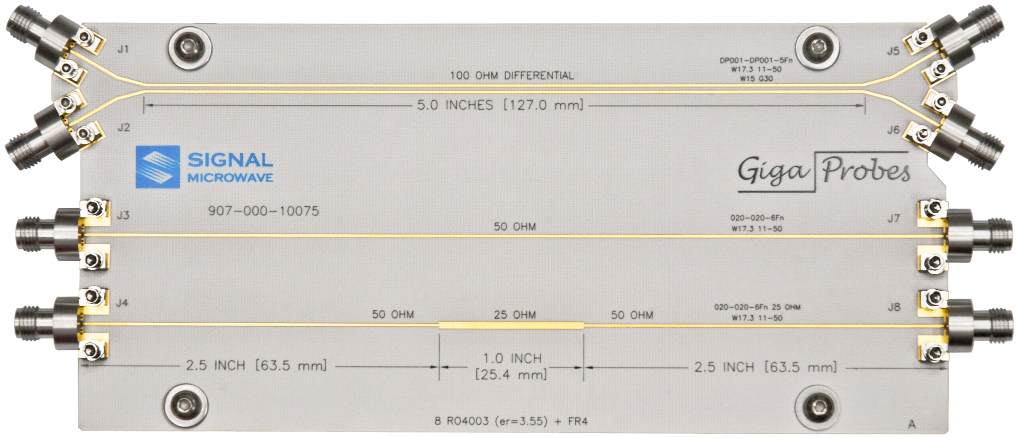
40GHz VNA Calibration Verification Board

Reference Waveforms for DB40-003

From Signal Microwave and Giga-Probes®



This document contains reference waveforms measured from the 100 ohm differential, 50 ohm single ended and 50-25-50 ohm Beatty line traces on the DB40-003 40GHz VNA Calibration Verification Board for use with VNAs. These measurements provide a known performance response over frequency which can be used to verify VNA calibrations, check for measurement drift, and are teaching tools for VNA users. This high bandwidth board design can also be used as model for developing 70GHZ PCB designs as describe later in this document.

Verify VNA Calibrations

Once the VNA is calibrated, measure the 100ohm differential trace (4 ports VNA) or the 50 ohm single ended trace (2 ports VNA) and compare the measurement against the waveforms that are contained in this document. If they do not correlate, VNA functions affecting the measurement have been left on and the source must be determined before accurate measurement can be performed.

Measurement drift

A common measurement error that can be caused by changing room temperature, moving the cable or the VNA is out of calibration. To avoid inaccurate frequency measurements, measure a 50 or 100 ohm trace and store the results in a ref memory. Prior to making measurements that day, recall the previous stored measurement and make a new measurement from the board and the two should correlate. If not, recalibrate the VNA or successive measurements will not correlate with the previous day measurements.

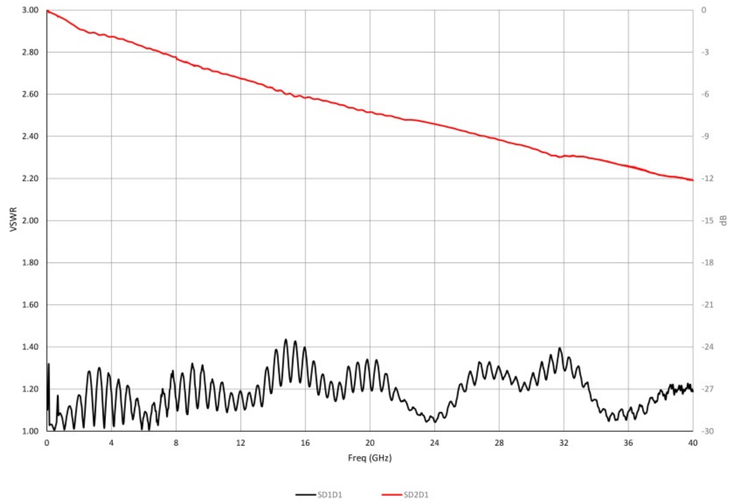
Calibrate VNA to measure both time (impedance) and frequency domain S-parameters

Attach two ports to the Beatty line. The Er value is stamped on the board that can be used to calibrate the cursers to accurately measure distance and impedance. If you have calibrated the VNA correctly, your cursers will be calibrated to physically locate the impedance change of this trace when it goes from 25 to 50 ohms.

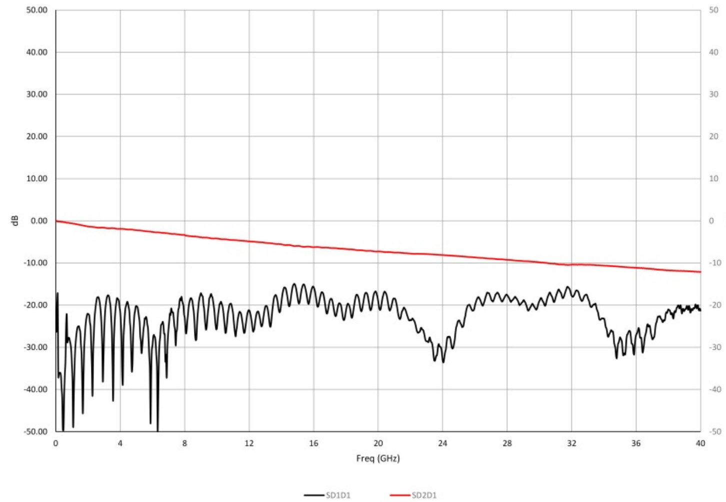
Teaching tools for VNA users

Haven't used the VNA in months or ever? Practice setting up the VNA to measure the 50, 100 and Beatty lines and compare the measurements with those that come with the board <u>prior</u> to making measurement on your prototypes

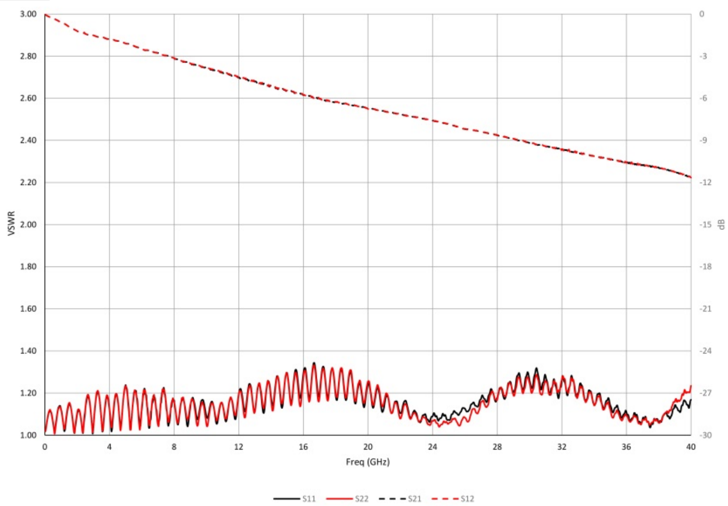
100 Ohm Differential Pair
VSWR



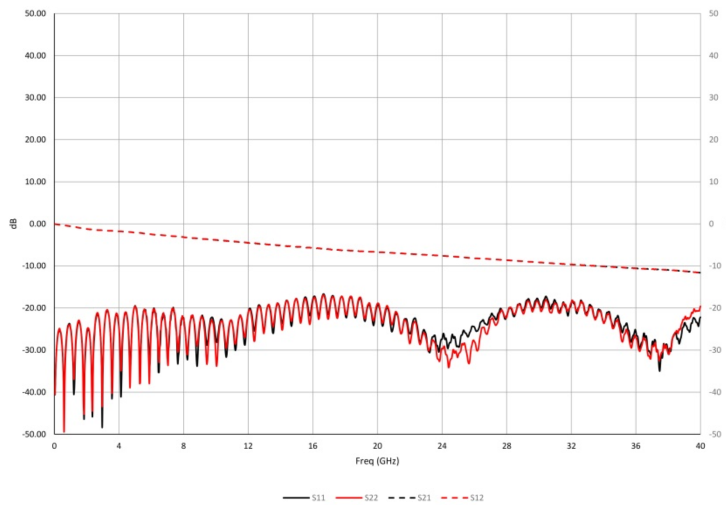
100 Ohm Differential Pair
Return and Insertion Loss



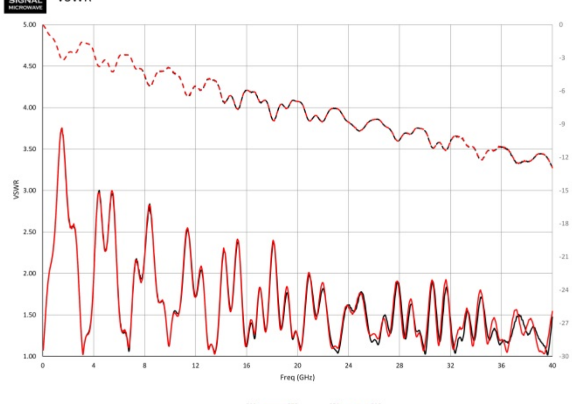
50 Ohm Thru Line
VSWR



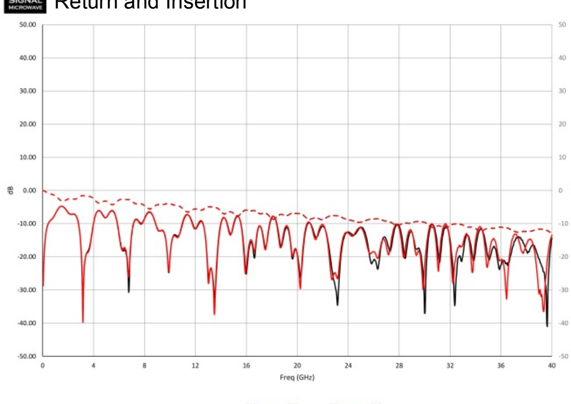
50 Ohm Thru Line
Return and Insertion Loss



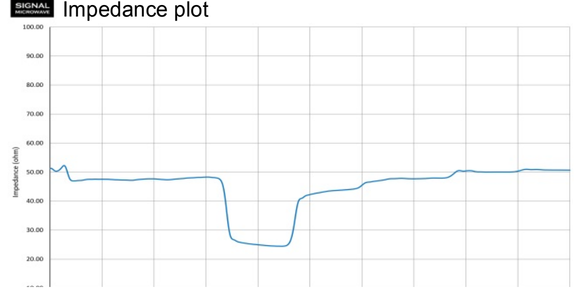
25 Ohm Beatty Standard
VSWR



25 Ohm Beatty Standard
Return and Insertion



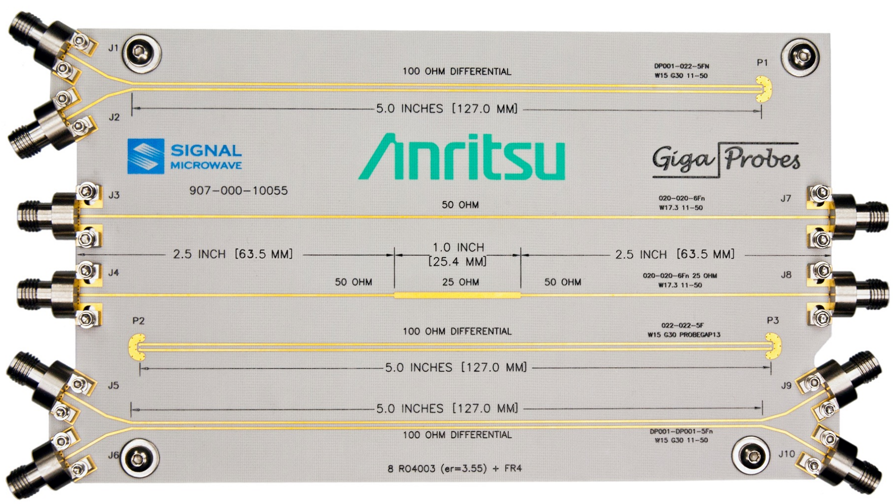
25 Ohm Beatty Standard
Impedance plot



VNA Calibration Verification:

When a VNA does a calibration, it sweeps through multiple frequency points and at every point it locks the frequency to a reference, levels the power, then makes a measurement. During calibration two major parameters are accounted for by using a calibration kit as a reference, the instrument's system noise is taken out of the measurement, and the characteristic impedance of 50 ohms is established. For VNA calibration verification many operators use only a low loss through adapter. This method only verifies that the system noise was removed by the calibration. A "golden unit" like the VNA Calibration Verification board, with known response over the frequency range of the calibration, should be used to verify that the calibration was successful in "teaching" the VNA how to make an accurate measurement over the frequency range of the calibration.

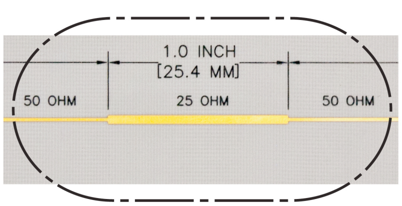
Board Versatility:
The nature of the VNA calibration verification board design lends it to easily create many versions.

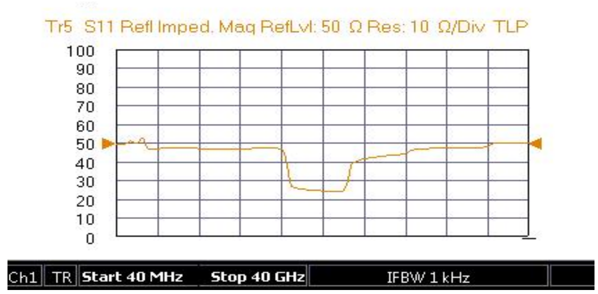


One version of the board is an expanded version of the basic board which includes test lines for the GigaProbes® 40 GHz DVT40 differential probe. The board allows a user to verify 4 port VNA calibration using a 100 ohm connector to connector test line. Then the user can move to a similar 100 ohm differential line that is connector to probe so each probe can be evaluated.

This version of the board also includes a 25 ohm "Beatty" line for verification of a TDR measurement using a VNA. This line is useful in verifying that the VNA calibration is done correctly to perform accurate TDR transformation for an impedance measurement along a transmission line.

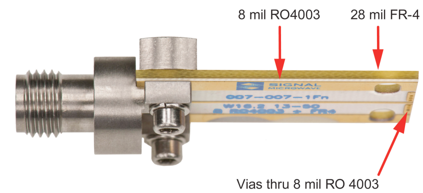
Detail A





Reasons for the high performance
It starts with the high performance connectors manufactured by Signal Microwave (www.signalmicrowave.com). These edge launch connectors are designed using 3D modeling and RF transmission line analysis instead of just a mechanical solution. The next component leading to the high performance is the board launch design. The board launch is the transition from the board to the connector. The launch structure on the board starts with a Grounded Coplanar Waveguide (GCPWG) section which incorporates a top ground launch that transitions the ground to an inner layer as it transitions to a microstrip line. The launch design is also done by Signal Microwave using 3D modeling to match the board to high

performance connectors and this service is available for customers that are using the connectors in their own products.



Another factor in the high performance of the board is the material and the way it is manufactured. The material is Rogers RO4003 with a thickness of 8 mils and ½ ounce copper. The finish on the board is electroless nickel with a top layer of immersion gold (ENIG). The Rogers material performs excellently through 70 GHz and the plating provides a corrosion free surface. The next step in the manufacturing process is the 8 mil RO4003 is processed completely by itself including drilling to vias required and the plating. Then the panel is laminated to an FR4 backer for mechanical stiffness without having to backdrill any vias which can cause problems at frequencies as high as the 70 GHz bandwidth of the board.

Magnetic feet

The board also incorporates custom design stand-off with magnets installed at the end. When placed on a magnetic plate it holds the board securely to the plate. The plates are available from DVT Solutions and are very useful in securing the board for measurements with probes.

For more information contact

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Giga Probes

SIGNAL MICROWAVE