# *VNA COMPARISON AGILENT FIELDFOX N9923A (DEMO) AND AGILENT E5061A*

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## ***Description:***

- ➢ There is a new VNA available in our lab, an AGILENT FIELDFOX N9923A, and it was compared to the AGILENT E5061A, we have been using until now.
- ➢ The comparison consisted of the accuracy of the measurement of four attenuators (3dB-BW-S3W2+,6dB-BW-S6W2+,10dB-BW-S10W2+, and 15dB-BW-S15W2+), after correction using the expectations for the open, short, and match (Male,85033E). The temperature at all moments was23.5±0.5◦C
- ➢ With measurements specifications as follows:

i. Power: 0dBm
ii. bandwidth: 100 Hz (300 Hz Field-Fox: Lowest Setting)
iii. Max Frequency: 200MHz
iv. Min Frequency: 40MHz
v. AVG: 10 traces
vi. Points: 641
vii. Frequency Step (MHz): 0.250

- ➢ The steps in the testing at each VNA are:

i. Calibrate the VNA at its SMA port (with open, short, & match).
ii. Measure the S11 of the open, short, & match, AGAIN after calibration.
iii. Measure the S11 of the four attenuators.
iv. Repeat steps ii and iii for repeatability.

- ➢ Perform uncalibrated VNA measurements to determine uncorrected S11 parameters.

i. Measure open STD using uncorrected VNA measurement and save S1p_open
ii. Measure Short STD and save S1p_short
iii. Measure Load STD and save S1p_load
iv. Using the calibration coefficients of the OPEN, Short and load standards (found on the VNA, called C0, C1..., L0, L1...), we can compute the S parameters of a 2-port network called the "error network" (it is a hypothetical 2 port network between the VNA and DUT)
v. Measure the S11 of the DUT (attenuator) and "de-embed" the error network from the measured data, you will be left only with the S11 (complex) of the DUT.
vi. The equation you will need is this: (it is the S11 of a [S_error] network terminated with Gamma_dut)
S11_Measured = S11_error + (S21_Error * Gamma_dut*S12_error) / (1 - S22_error * Gamma_dut)
vii. Solve for the S parameters of the error network [S_error]: S11_error, S12_error, S21_error and S22_error by solving the above 4 unknowns equation for:
Gamma_dut = Gamma_open_std
Gamma_dut = Gamma_short_std
Gamma_dut = Gamma_load_std
viii. assume reciprocity: S21_error = S12_error (reasonable assumption as the error network is reciprocal, meaning that S12=S21). The results will give 3 equations to solve for the 3 unknowns.

## ***Images of VNA connections:***

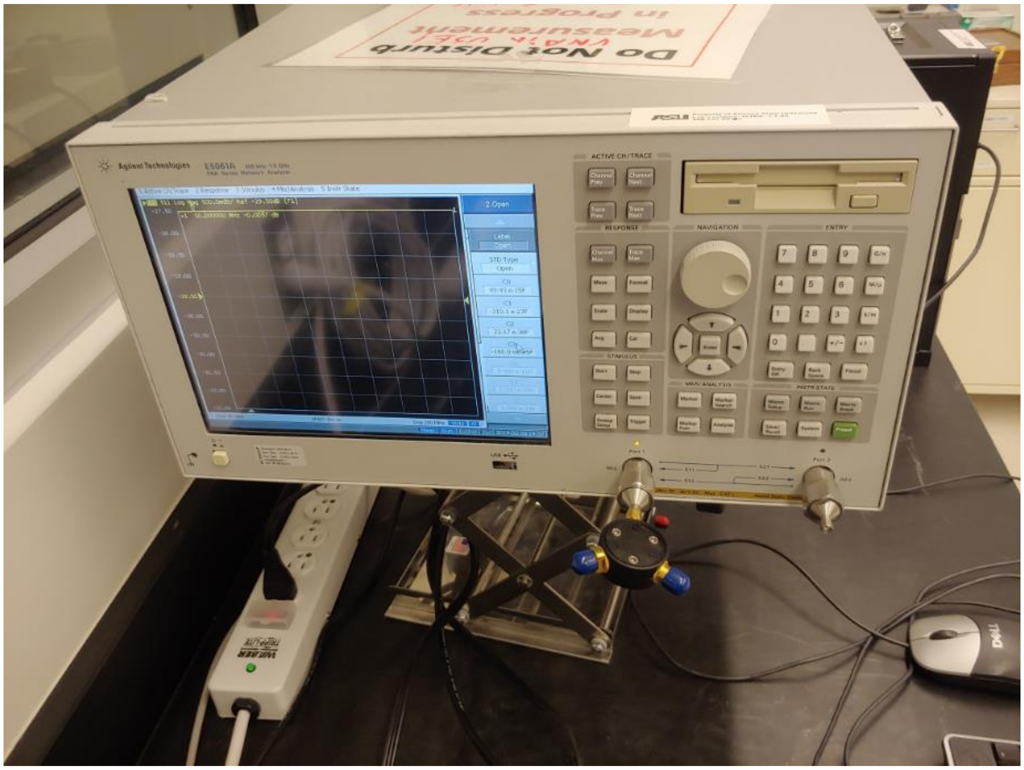


***Figure1:*** AGILENT E5061A Calibration arrangement utilizing the male 85033E Calibration kit


***Figure2:*** AGILENT FIELDFOX N9923A Calibration arrangement. utilizing the male 85033E Calibration kit

## ***Results:***

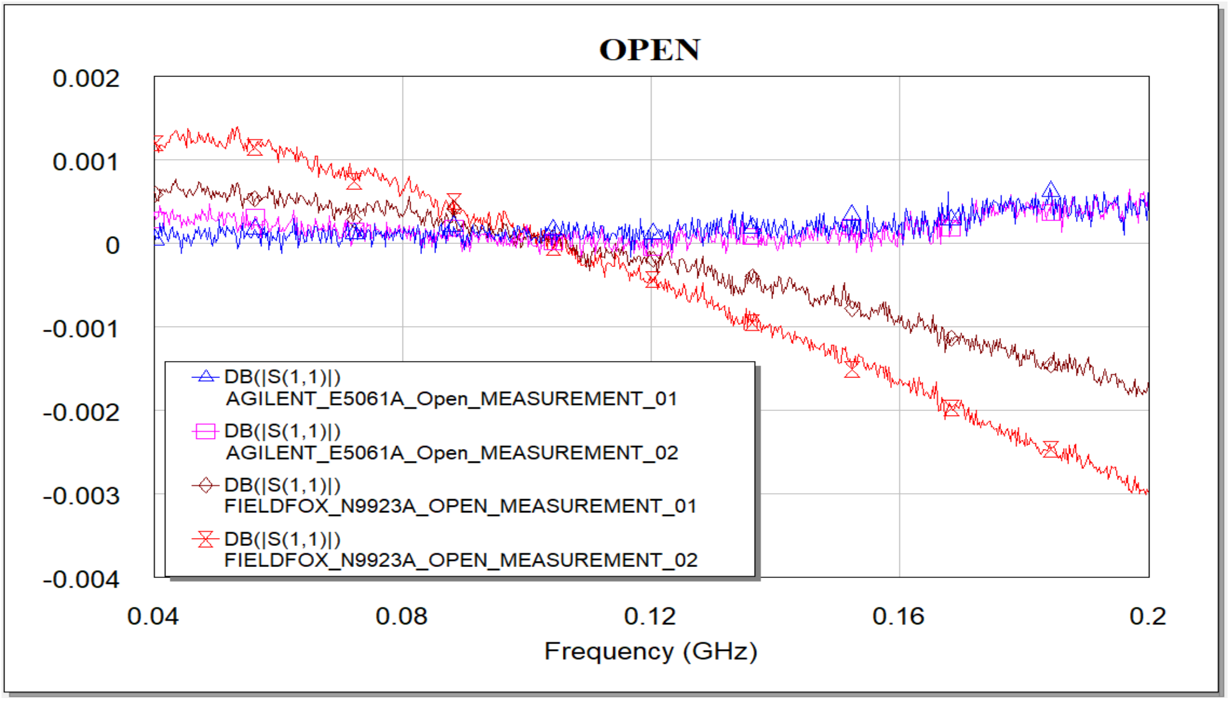


***Figure3:*** Magnitude of the Open after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. The difference in repeatability between the two VNAs with the same settings is favoring the Agilent E5061A VNA. The AGILENT_E5061A have closer tolerances and consistent curvature.

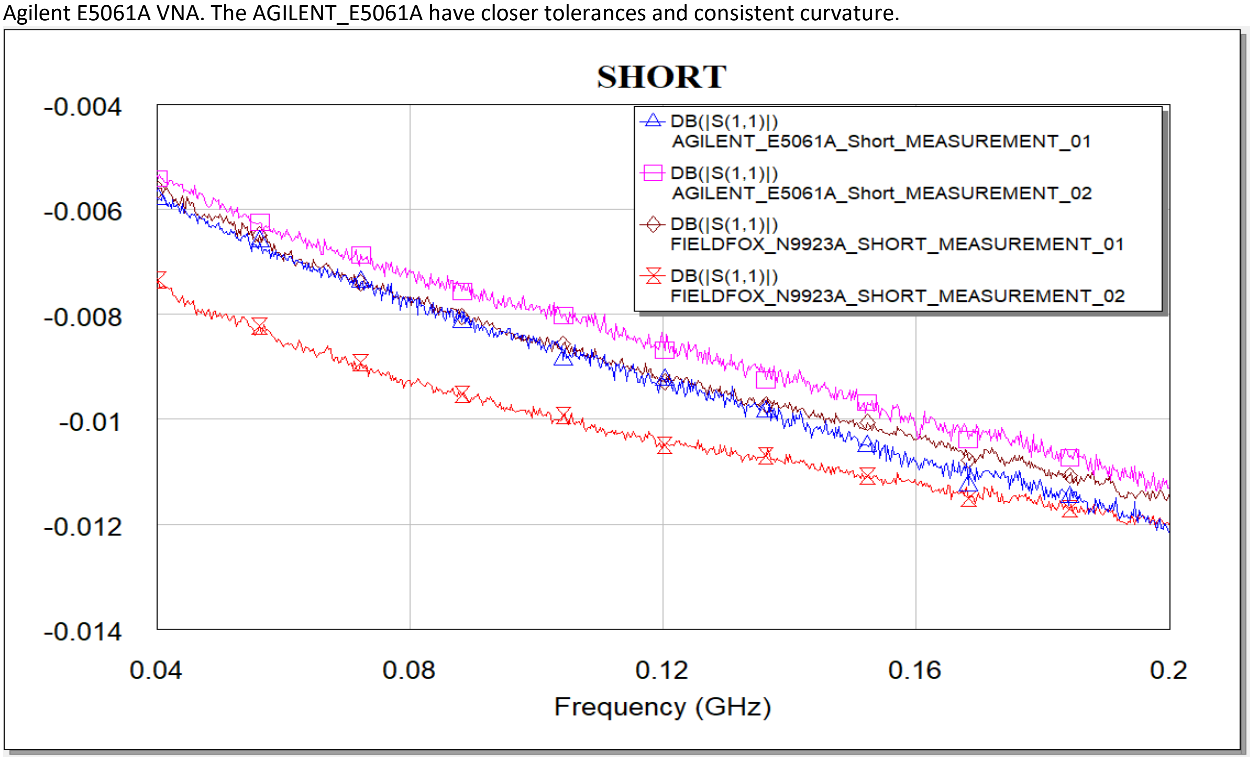


***Figure4:*** Magnitude of the Short after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. Both VNAs measurements are within .001dB from one another

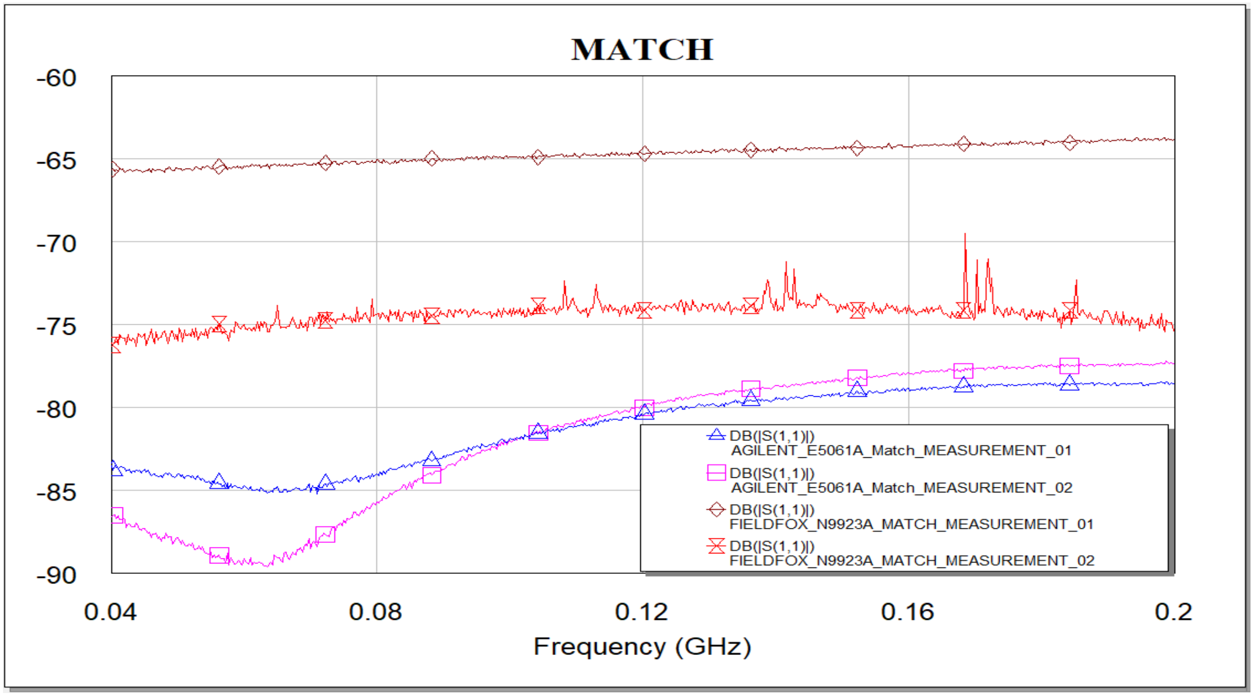


***Figure5:*** Magnitude of the Match after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. The difference in repeatability between the two VNAs with the same settings is favoring the AGILENT FIELDFOX N9923A VNA due to closer tolerances and less noise. However, the AGILENT FIELDFOX N9923A has better linear curvature.

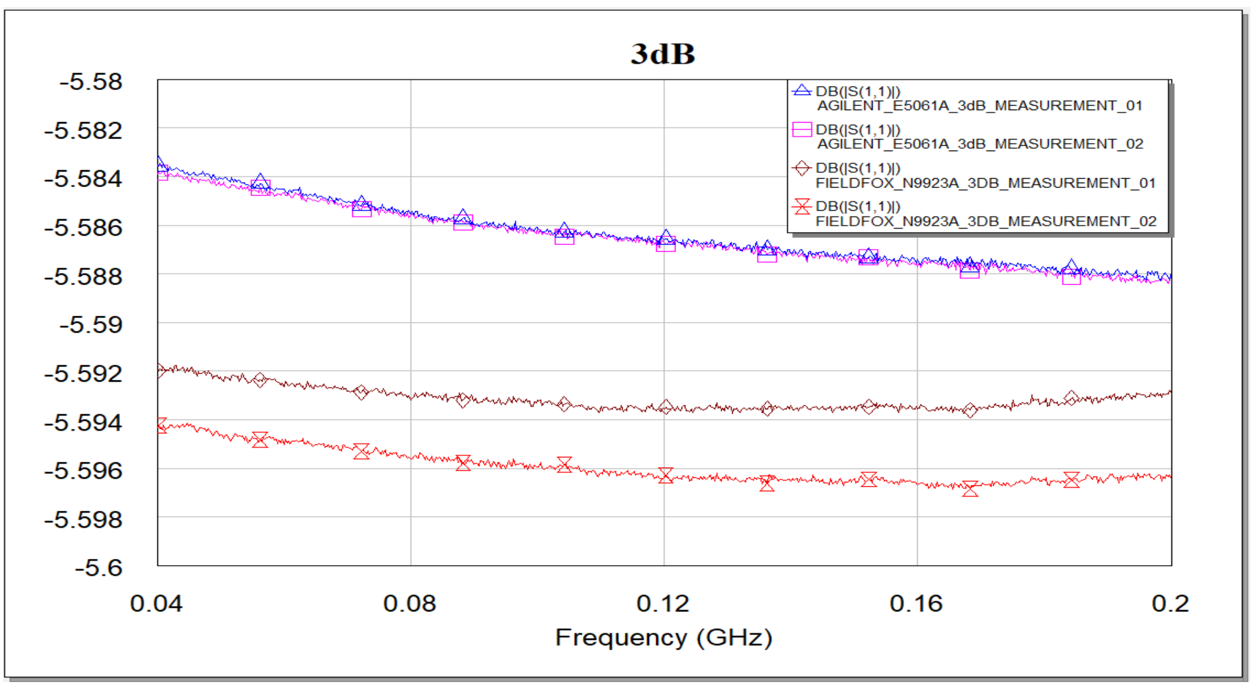


***Figure6:*** Magnitude of the 3dB Attenuator after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. The difference in repeatability between the two VNAs with the same settings is favoring the Agilent E5061A VNA due to closer tolerances and consistent curvature that is more predictable.

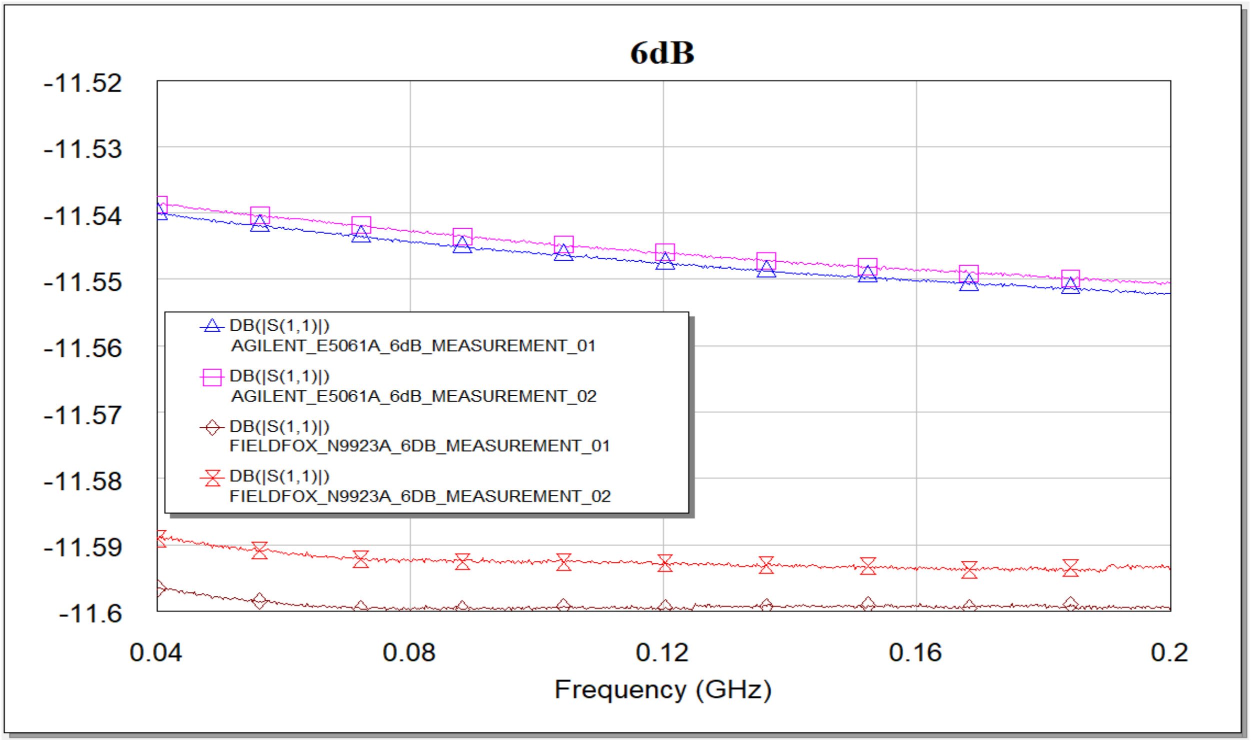


***Figure7:*** Magnitude of the 6dB Attenuator after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. The difference in repeatability between the two VNAs with the same settings is favoring the Agilent E5061A VNA due to closer tolerances. Both VNAs have consistent curvature making calibrations more predictable.

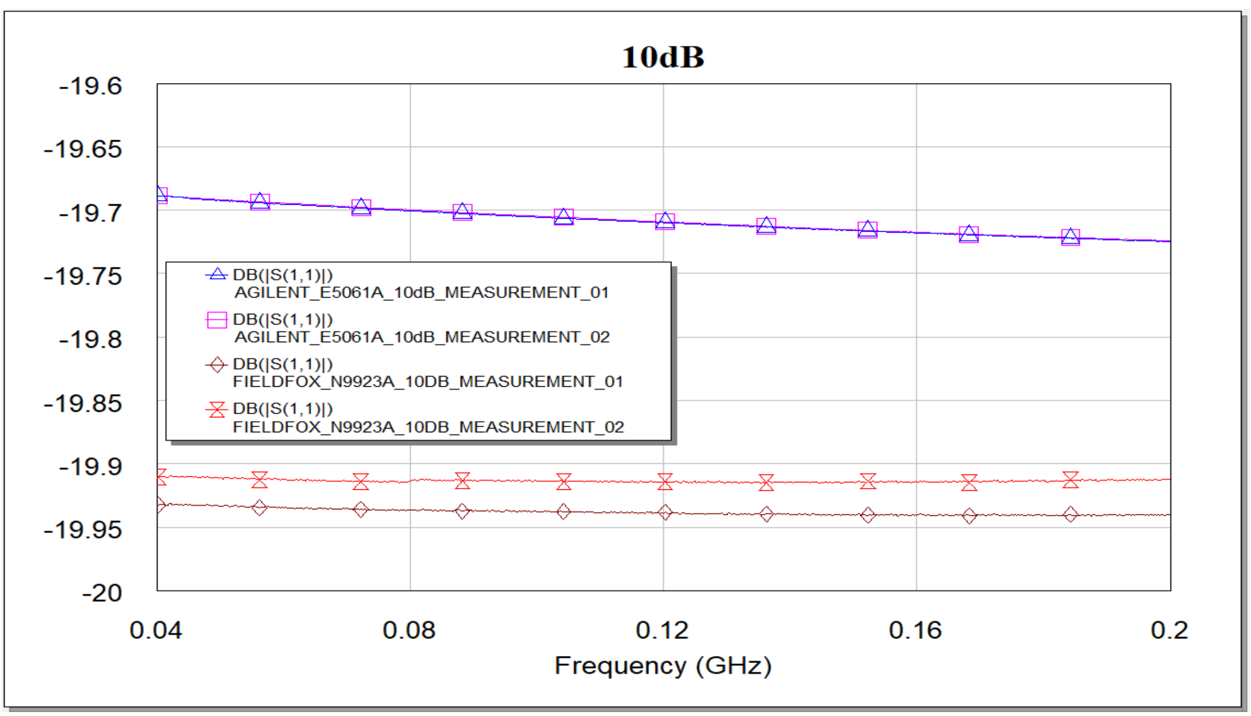


***Figure8:*** Magnitude of the 10dB Attenuator after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. The difference in repeatability between the two VNAs with the same settings is favoring the Agilent E5061A VNA due to closer tolerances. Both VNAs have consistent curvature making calibrations more predictable.

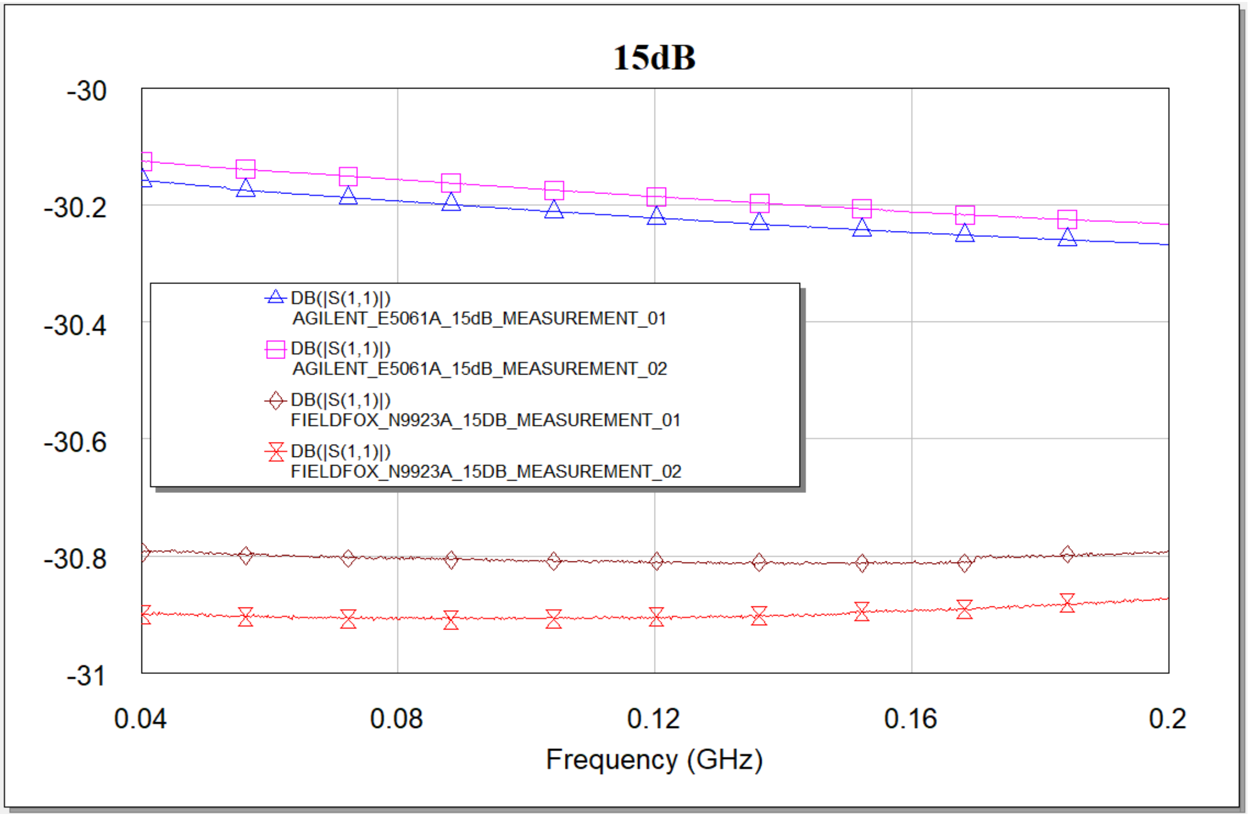


***Figure9:*** Magnitude of the 15dB Attenuator after calibration. AGILENT FIELDFOX N9923A measurement one brown trace, AGILENT FIELDFOX N9923A measurement two red trace, AGILENT_E5061A measurement one blue trace, and AGILENT_E5061A measurement two pink trace. The difference in repeatability between the two VNAs with the same settings is favoring the AGILENT E5061A VNA due to closer tolerances. Both VNAs have consistent curvature making calibrations more predictable.

## ***Discussion:***

- The measurements with the two VNAs show good agreement
  3-dB attenuator (-5.584 dB), variance.010 dB
  6-dB attenuator (-11.54 dB), variance 0.005 dB
  10-dB attenuator (-19.69 dB), variance 0.3 dB
  15-dB attenuator (-30.1 dB), variance 0.7 dB
  Overall, most measurements are precise to one another varying slightly from one another.