EE 142/241A Lab 1 Report Re-do

Several Authors

A Calibration Details on the E5071C VNA

The E-cal and the female/male calibration triangles are broken or don't provide good enough calibrations. The failure mode seen with these calibration standards was occasional gain (more than 0dB return loss) on S_{11} at a particular band when a short or open was connected after calibration.

We also noticed that the female separated calibration standards didn't give a very good result. The only standards that work well are the male separated standards.

When using the male cal standards, (85052-60006 - Short, 85052-60008 - Open, 902C - Load), a F-F thru needs to be used with a known delay of 51 ps, and sometimes a M-M thru needs to be used with a known delay of 98.9 ps. When performing transmission calibration (2-port), use the M-M thru and the delay value of 98.9 ps. This M-M thru described above is the SMA thru, *NOT* the 3.5mm thru. You will know which one is which when inspecting the dielectric.

Conclusion: Use separated male standards from 85052E.

B Notes from Previous Lab 1 Attempt

Port extensions performed on port 1 and 2 to move reference plane to end of SMA connector:

- 38 ps delay (13.7mm equivalent electrical length on port 1 and 13.67mm on port 2)
- Loss @ DC = 0 dB
- Loss 1: 33mdB @ 1 Ghz
- Loss 2: -23mdB @ 500 Mhz

Attenuation per frequency measurements taken with the SMA dummy short:

- Port 1 (598.19 Mhz, -0.04771 dB), (1.352510 Ghz, -0.08127 dB)
- Port 2 (598.19 Mhz, -0.05873 dB), (1.352510 Ghz, -0.08767 dB)

Measurements performed with the thru board:

- Length of thru board $d_0 = 0.926$ in $= 2.352$ cm

- 156 ps of electrical delay τ_0 required to produce flat phase on S_{21}
- $v = c_p = \frac{d_0}{\tau_0} = 1.507e8$ m/s
- $\epsilon_{eff} = 3.96$ (compared to FR4 typical 4.4)
- $Z_{0,measured} = 49.2\Omega$ at 4.22 Ghz

Calibration to get a 0.7mm length transmission line:

- Port extend port 1 and 2 with 109ps to form a 0.7mm thru line on the thru board.
- To make the loss maximally flat at 0dB around 600 Mhz use:
  - Loss 1: 74 mdB @ 1 Ghz
  - Loss 2: -35 mdB @ 500 Mhz