Report 1

Cable Phase and Amplitude Response

Prepared by

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1 Problem Statement

The cables are phase balanced and calibrated so that 'zero' downrange is at the feedpoint of the antennas. However, when the cables move and flex during the scanning operation, a change in the amplitude and/or phase response of the cables occurs. A variation in amplitude of more than 0.1dB and in phase of greater than 2 degrees with position would be considered significant.

2 Test Performed

The following experiment was carried out to check out the phase and amplitude variation in response to different antenna positions constituting the 1.25m by 1.25m array aperture. Cables 1 and 2 were disconnected from the antennas and were connected together using an adapter[1] for "thru" measurements (S12 and S21). Similarly, cables 3 and 4 were connected together for a "thru" S34 measurement. Cables 1 and 2 were still connected to the carriage on the scanner while the cables 3 and 4 were placed on the ground. Instead of the 57-by-57 array locations used in the original data collection experiments, the scanner was set up to scan a sparse 21-by-21 uniformly-spaced square aperture of size 1.25m-by-1.25m. Note that the total extent of the array aperture is the same as for the original experiments in both x and y dimensions. The Network Analyzer was set up to operate in the stepped-frequency mode from 2GHz to 3GHz with a step size of 5MHz, resulting in 201 steps. The Network Analyzer was programmed to measure S12, S21, and S34 at all 441 scanner positions. Note that position 1 is closer to the top left corner of the scanner frame and position 441 is towards the bottom right corner of the scanner (See Figure 1).

3 Results

Figure 2 show the amplitude and phase response of the S12, S21, and S34 measurements versus the position of the antenna carriage at a frequency of 2GHz. The amplitude and phase responses of these measurements at 2.5GHz and 3GHz are shown in Figures 3 and 4 respectively. We can see that for all three frequencies, the variations in amplitude are within a few hundredths of a dB and those in phase are less than 2 degrees. For S12 and

[1] We fabricated an N-barrel adapter using between-series (SMA-to-N) connectors.

S21 measurements at 2, 2.5 and 3GHz, the phase patterns show that beyond position 252, the cables are relaxed whereas they are under strain in the earlier positions. That is understandable because while scanning the lower half of the array aperture, the cables will not be as stretched as for the upper half of the array. The responses for S34 basically give the system noise as cables 3 and 4 are not attached to the carriage and hence do not move at all during the scanning process. Note that the phase responses at 2, 2.5, and 3GHz for both S12 and S21 show cyclic behavior consistent with raster-scanning of array positions.

When comparing the phase responses of the S12, S21, and S34 measurements, we note that the average phase value for the S34 measurement is much higher than that for S12 and S21 measurements. This is because the adapter connecting 3 and 4 was different from the one used for cables 1 and 2. Figure 5 shows the frequency response of S12, S21, and S34 at position 1. We note that both adapters act as pure delay, evident from the linear phase responses for S12, S21, and S34 measurements.

4 Conclusions

Based on the results, we conclude that variations in cable amplitude and phase responses for scanner movement encompassing full extent of the array are within prescribed limits.

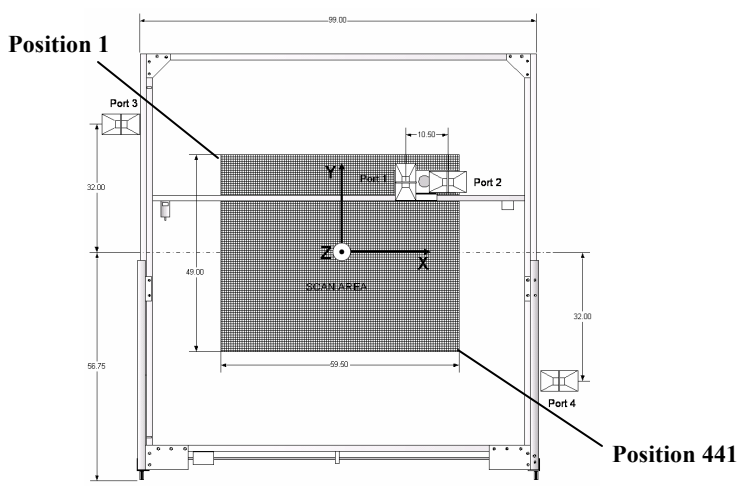

Figure 1: 2-D Scanner

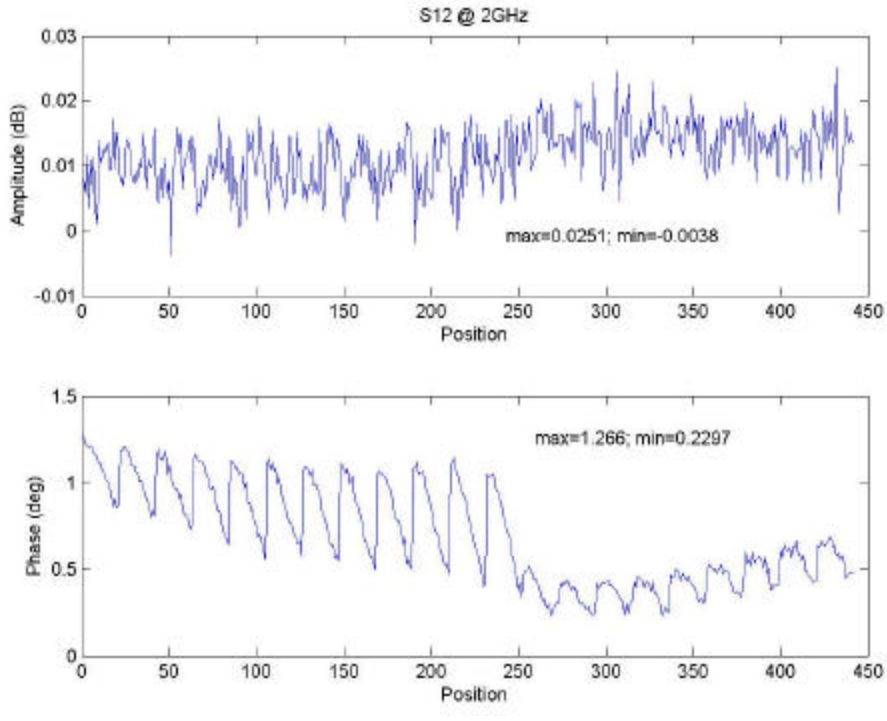

Figure 2 (a): Amplitude and Phase of S12 versus carriage positions at 2GHz.

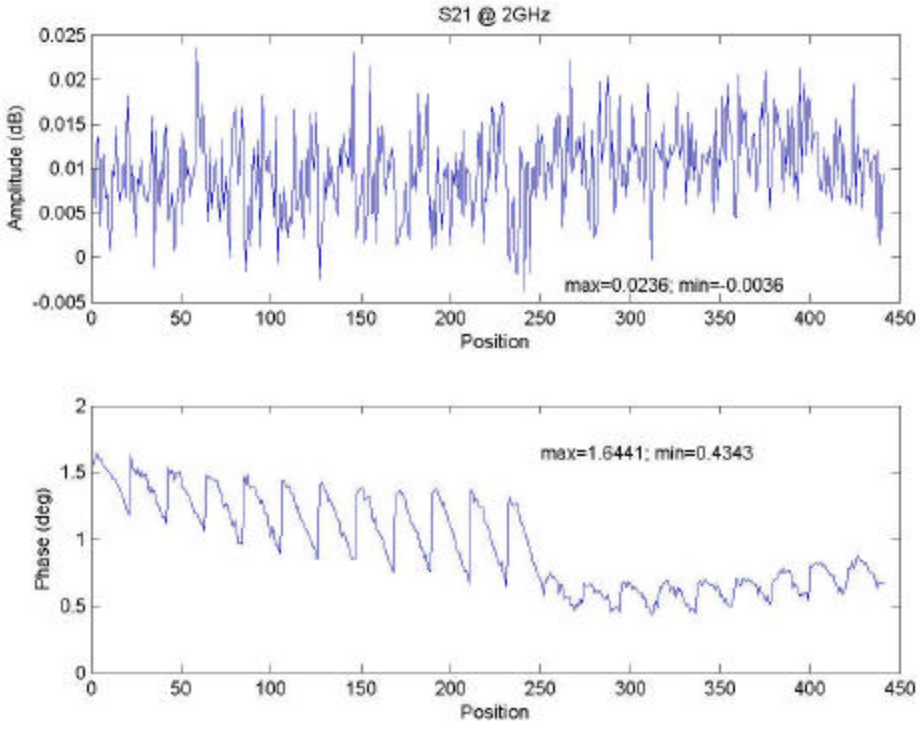

Figure 2 (b): Amplitude and Phase of S21 versus carriage position at 2GHz.

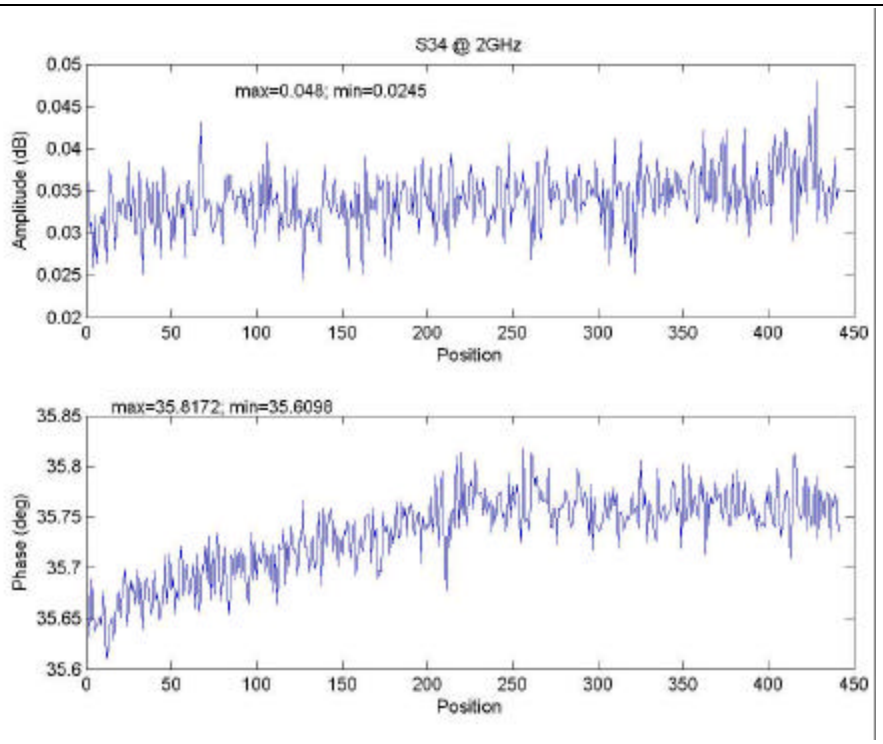

Figure 2(c): Amplitude and Phase of S34 versus carriage position at 2GHz.

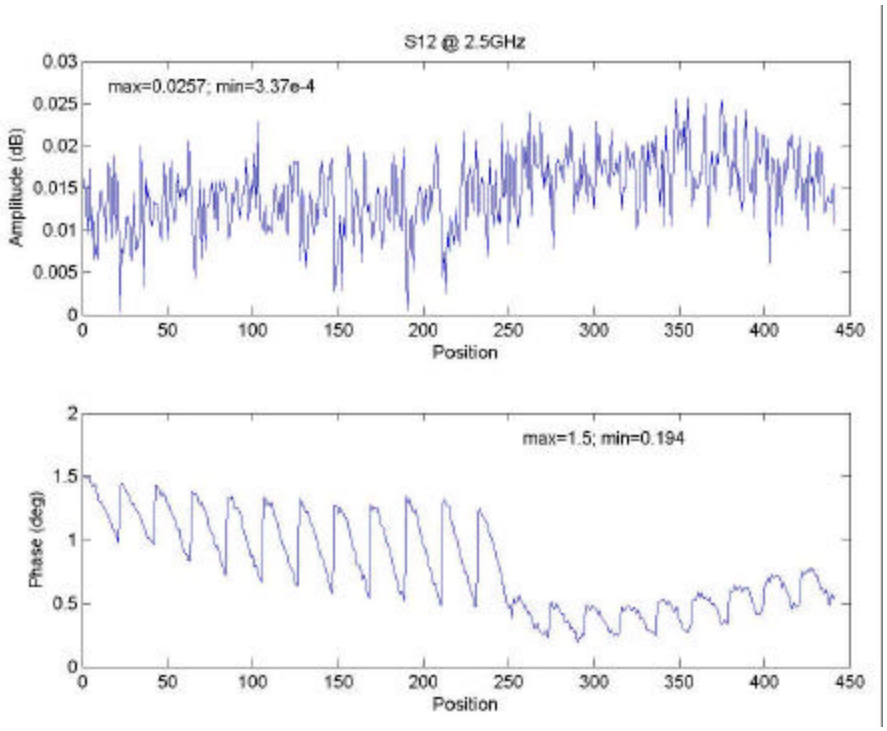

Figure 3 (a): Amplitude and Phase of S12 versus carriage position at 2.5 GHz.

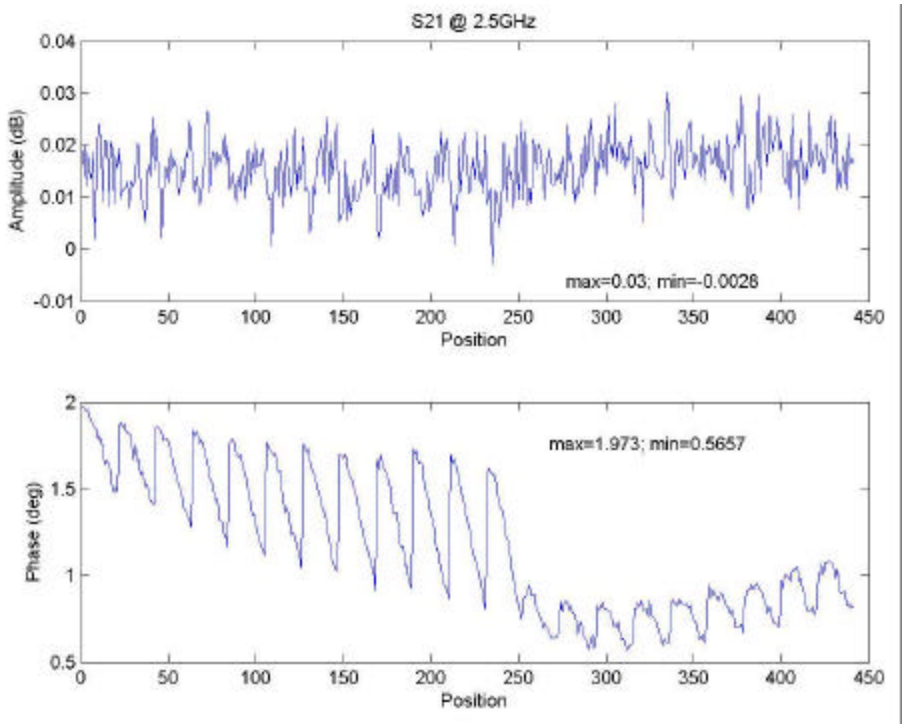

Figure 3(b): Amplitude and Phase of S21 versus carriage position at 2.5 GHz.

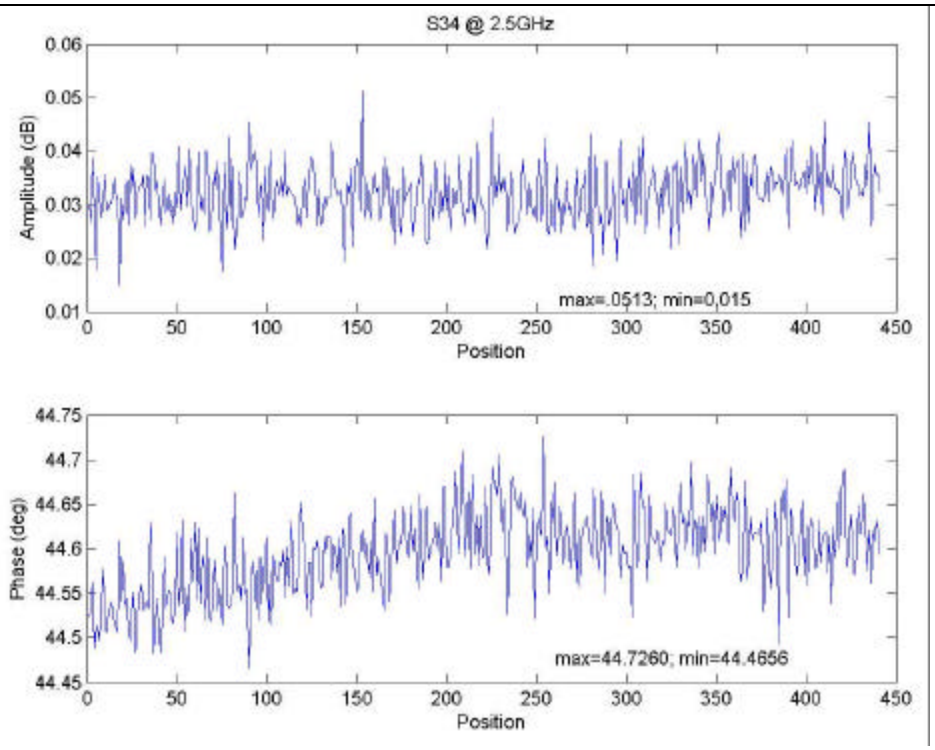

Figure 3 (c): Amplitude and Phase of S34 versus carriage position at 2.5GHz.

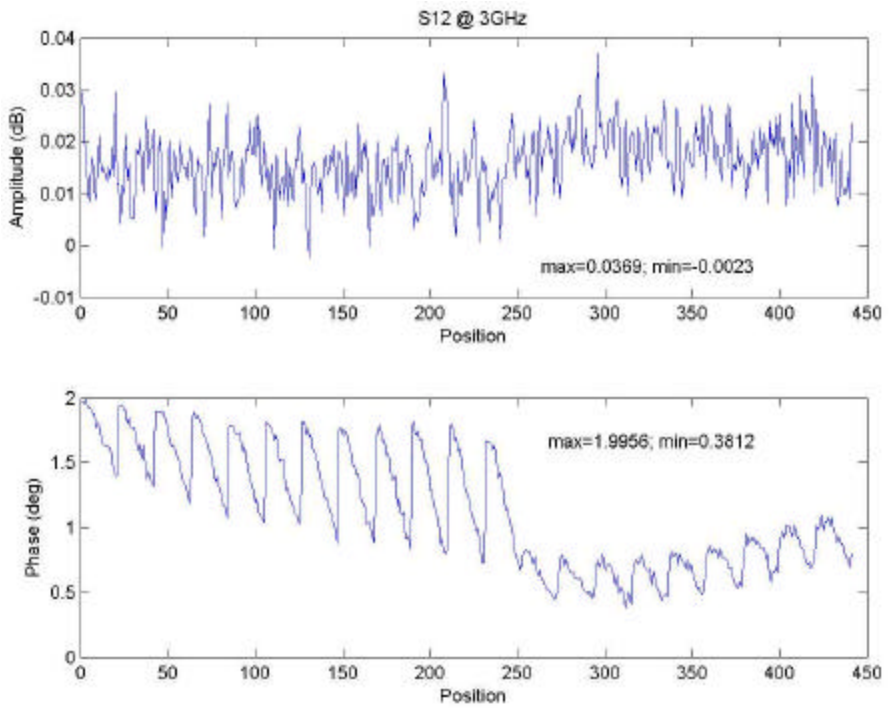

Figure 4(a): Amplitude and Phase of S12 versus carriage position at 3GHz.

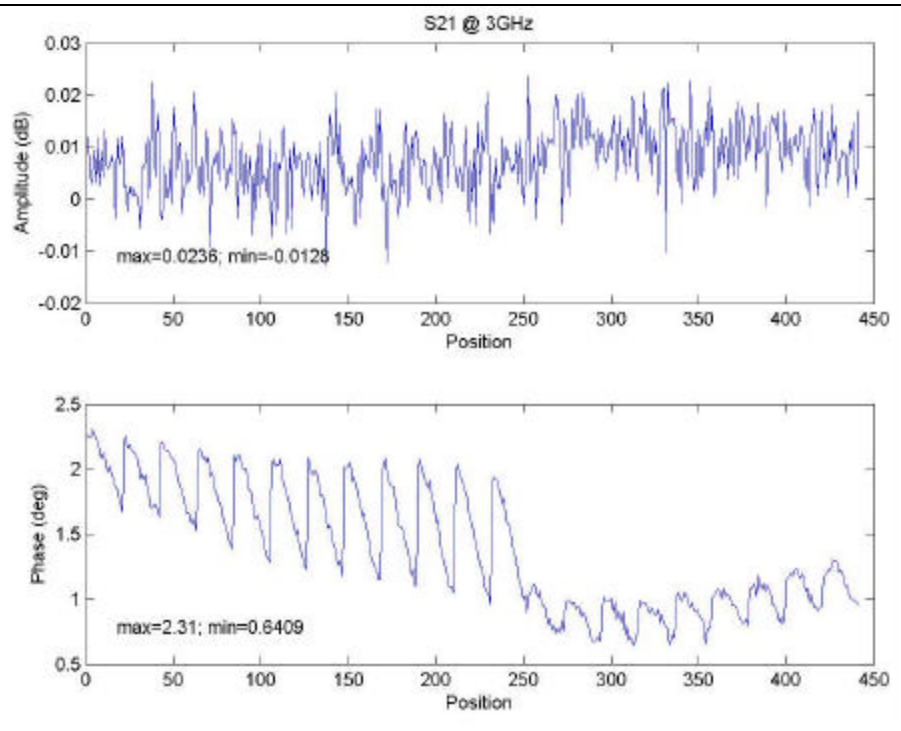

Figure 4(b): Amplitude and Phase of S21 versus carriage position at 3GHz.

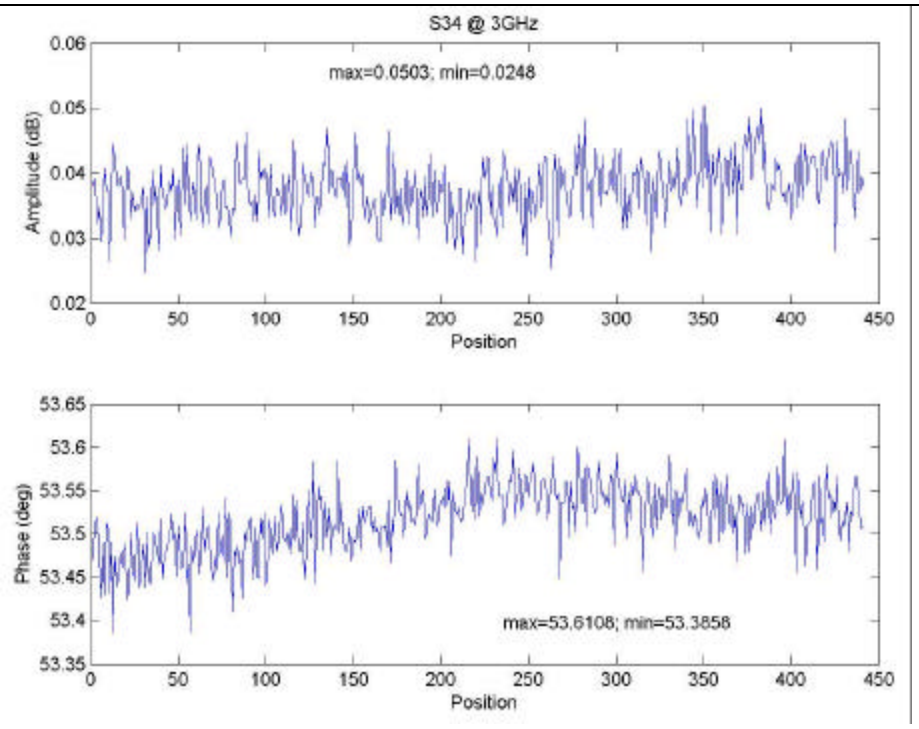

Figure 4(c): Amplitude and Phase of S34 versus carriage position at 3GHz.

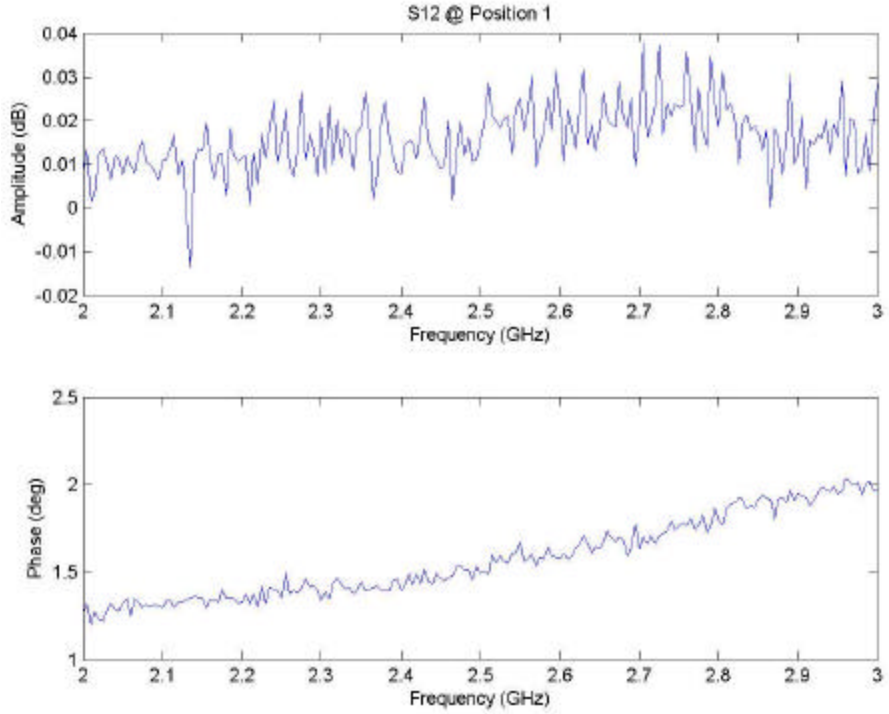

Figure 5 (a): Frequency Response of S12 at Position 1.

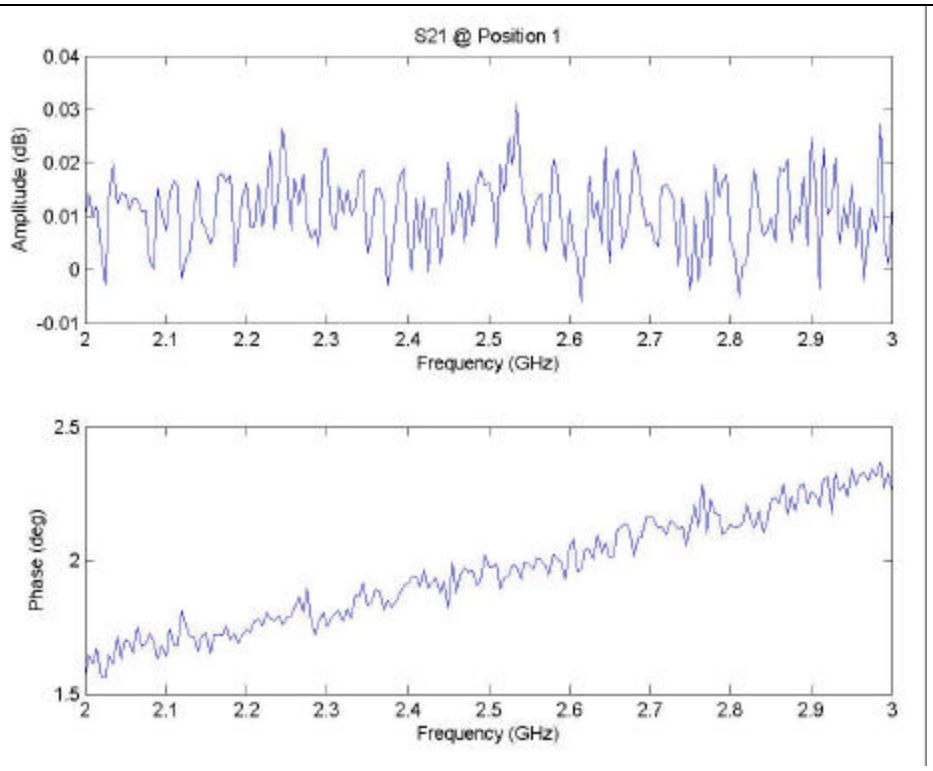

Figure 5(b): Frequency Response of S21 at Position 1.

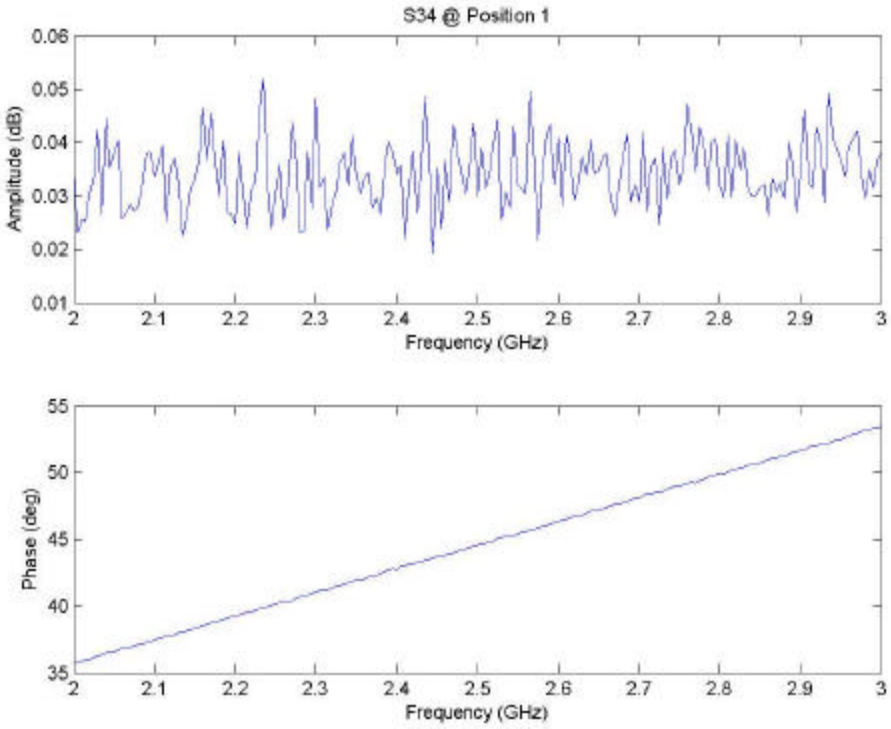

Figure 5 (c): Frequency Response of S34 at Position 1.