



QA Technology Company, Inc.

A p p l i c a t i o n s N o t e

Frequency Response of Wireless Probing Configurations

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Background:

Ever-increasing circuit performance challenges all aspects of test technology. Getting a clean and accurate signal from the tester electronics to the board under test is critical for high-speed testing. Fixture wiring can be a major contributor of distortion and noise to the signal transmission path. QA's wireless X Probes and Double-Ended Sockets address the limitations of fixture wiring by eliminating the wire.

Scope:

To better understand the possibilities of wireless fixturing, QA has examined the high frequency performance of wireless X Probes as well as Double-Ended Sockets and Probes. A network analyzer was used to measure the frequency response characteristics of a wide variety of probe configurations. Initial testing of Double-Ended Sockets utilized an RF network analyzer covering the frequency range of 300 KHz to 3 GHz. Subsequent testing using a newer microwave network analyzer covered the frequency range of 50 MHz to 20 GHz. For consistency, graphs of the more recent tests extrapolate data below 50 MHz and omit data above 10 GHz. A TDR oscilloscope was used to look at the impedance of the signal path through the test fixture. Time domain impedance information was also obtained by use of the time domain transform option of the microwave network analyzer.

Procedure:

Test fixtures were constructed for .100 [2.54], .075 [1.91], and .050 [1.27] Double-Ended Socket products. These fixtures consisted of a .250 [6.35] G-10 socket mounting plate, a .062 [1.57] G-10 socket spacer plate and two electrical interface boards attached to the socket mounting plate with non-conducting standoffs. Test fixtures for the wireless .075 [1.91], .050 [1.27] and .039 [1.00] X Probes were built up from numerous G10 plates totaling 1.562 [39.67] thick. This stack-up was then sandwiched between two electrical interface boards. In all the fixtures, the electrical interface boards provided the SMA connectors for the test equipment and copper traces to contact the various probe/socket configurations. Configurations consisted of different spacings for the ground and signal probes, multiple ground probes and arrangements to measure cross-talk where one pair of probes was "driven" and the "pick up" on an adjacent pair measured.

Results:

The following graphs study the performance of the .075 [1.91] center X Probes. Comparable data for .050 [1.27] and .039 [1.00] center X Probes as well as .100 [2.54], .075 [1.91] and .050 [1.27] Double-Ended assemblies appear in Appendices A thru F.

Figure 1 shows the frequency response of two X75 probes on 1.00 [25.4] centers. This might be representative of the signal probe to ground probe separation for an IC package. Note the bandwidth roll-off below 100 MHz. This response is dominated by the separation between the signal and ground probe. Plots for the other wireless probe families tested on 1.00 [25.4] centers have very similar performance. In Figure 2, the probes are on their nominal .075 [1.91] centers. On these closer centers, a -1dB frequency response to over 400 MHz is achieved. This improvement results from the more closely-spaced probes providing a better match to the impedance of the 50 Ohm test environment.

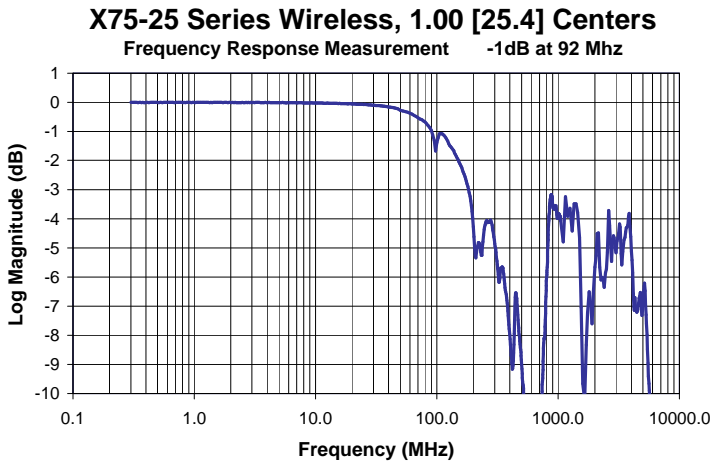


Figure 1: Frequency response of two .075 [1.91] wireless X Probes (signal and ground) on 1.00 [25.4] centers.

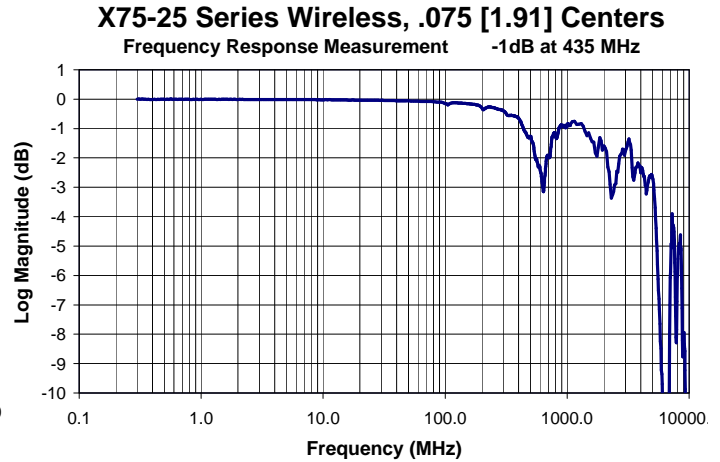


Figure 2: Frequency response of two .075 [1.91] wireless X Probes (signal and ground) on .075 [1.91] centers.

The TDR option of the microwave network analyzer allows measurement of the impedance of a transmission line at any point along its length. Figure 3 shows the impedance of two wireless .075 [1.91] X Probes on .075 [1.91] centers. In this TDR graph, the transmitted signal has an effective rise time of 50 picoseconds, which equates to a 7 GHz test frequency. The impedance extremes are exaggerated by the high bandwidth of the measurement; at lower frequencies the impedance differences would be less apparent. These high frequency measurements show three distinct physical regions: the termination pin, the transition from the termination pin to the X Probe and the X Probe itself. These changes of impedance are caused by the differing diameters of the termination pins and probes as well as the drilled clearances surrounding them. The nature of the dielectric material separating the probes also plays a critical role in determining the characteristic impedance of the transmission line.

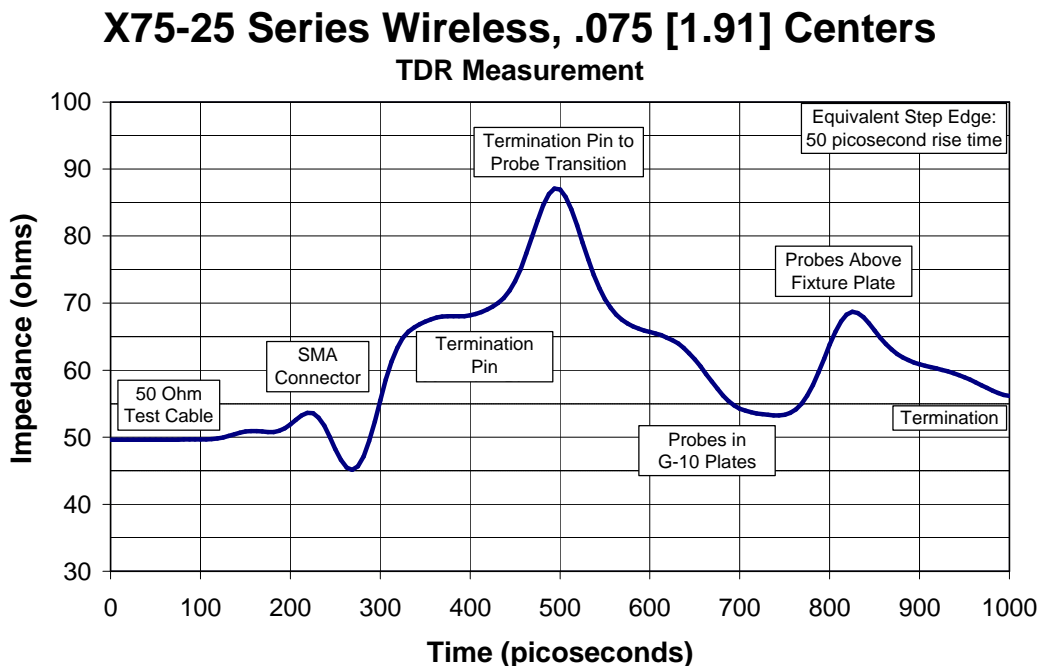


Figure 3: Impedance of the transmission line created by two .075 [1.91] wireless X Probes (signal and ground) on .075 [1.91] centers. Note: the 50-picosecond equivalent rise time equates to an effective test frequency of 7 GHz.

Figure 4 shows the performance of a three-probe in-line configuration on .075 [1.91] centers with the signal probe placed between two grounds. Although this configuration may not always be practical, its –1dB performance to greater than 1400 MHz is excellent. Figure 5 shows the corresponding TDR plot for the same three-probe configuration.

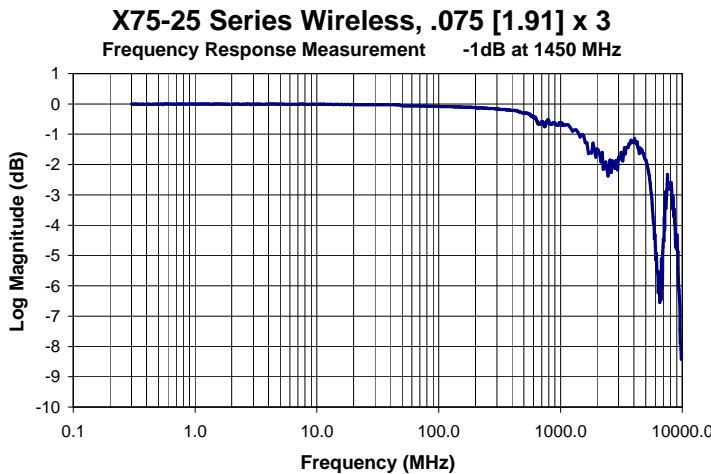


Figure 4: For a three-probe configuration (signal between two grounds) excellent performance to more than 1400MHz was achieved.

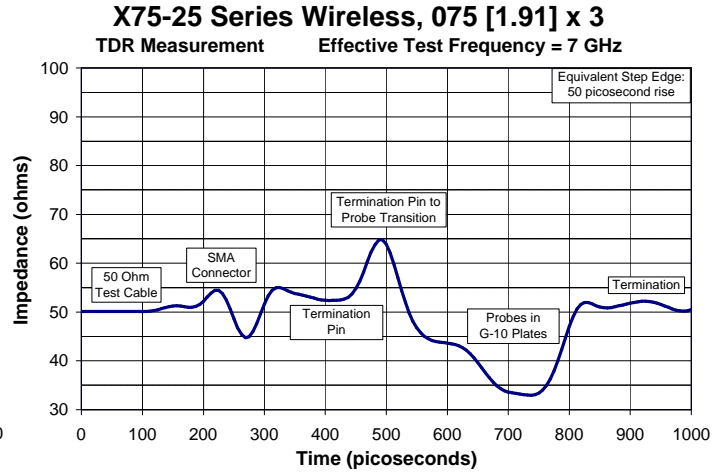


Figure 5: The TDR plot for the three-probe configuration shows a better match to the 50-ohm test environment. This results in a higher bandwidth frequency response.

Crosstalk in a conventional fixture is a complex function of many variables: the characteristics of the test signals, the length and type of wiring used, how the wiring is (or isn't) dressed, and the relative locations of the probes themselves.

Wiring problems are the reason for the existence of wireless probing solutions. Replacing fixture wiring with a translator board provides a more repeatable and controllable environment for routing test signals between the UUT and the test electronics.

The test signals and probe locations are driven by the needs of the UUT. For reference purposes, a plot of the crosstalk between two pairs of .075 [1.91] wireless X Probes on .075 [1.91] centers appears in Figure 6.

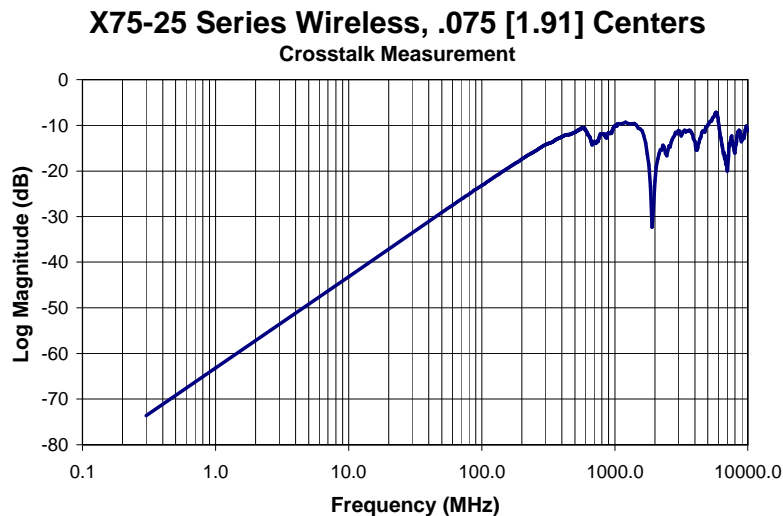


Figure 6: Crosstalk between two pairs of X75 probes on a .075 [1.91] grid.



Conclusions:

A wireless probing solution is capable of delivering excellent high frequency performance. Signal-to-ground probe spacing and the dielectric material separating the probes both play a major role in determining the impedance and the bandwidth of the transmission path. In general, a more constant probe diameter and consistent dielectric material separating the probes makes for fewer impedance changes in the signal path and better overall high frequency performance.

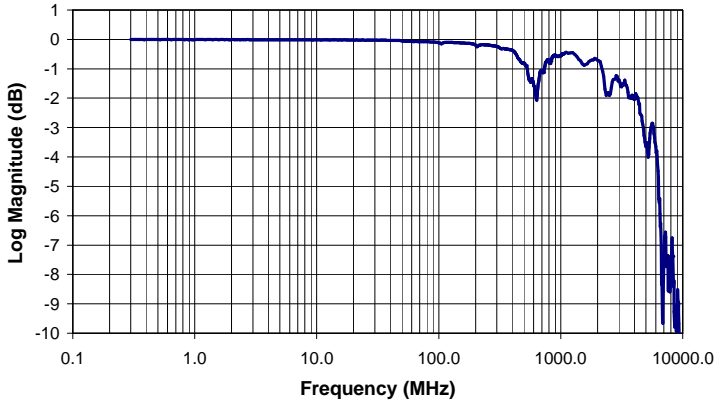
Replacing fixture wiring with a translator board allows the test engineer greater control of length and impedance characteristics of the signal path to the unit under test. This results in cleaner, distortion-free test signals and higher performance testing.



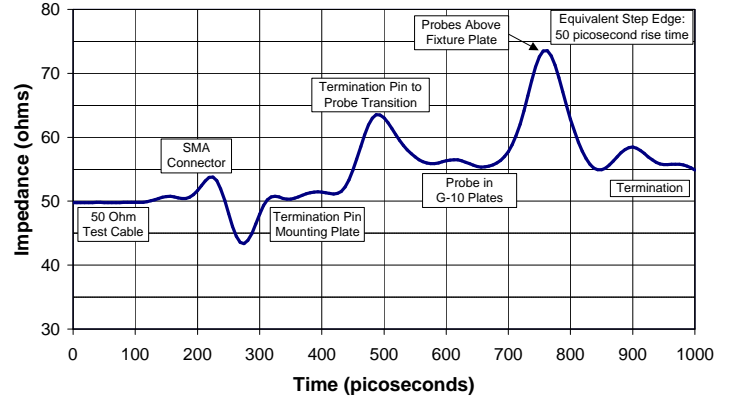
Appendix A

X50-25 Series Wireless

X50-25 Series Wireless, .050 [1.27] Centers
Frequency Response Measurement -1dB at 530 MHz

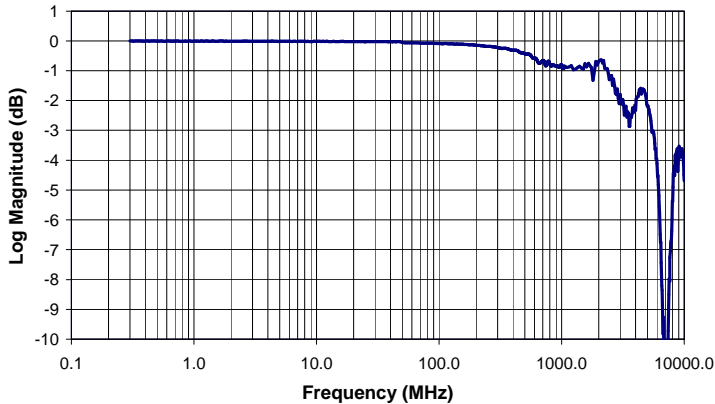


X50-25 Series Wireless, .050 [1.27] Centers
TDR Measurement Effective Test Frequency = 7GHz

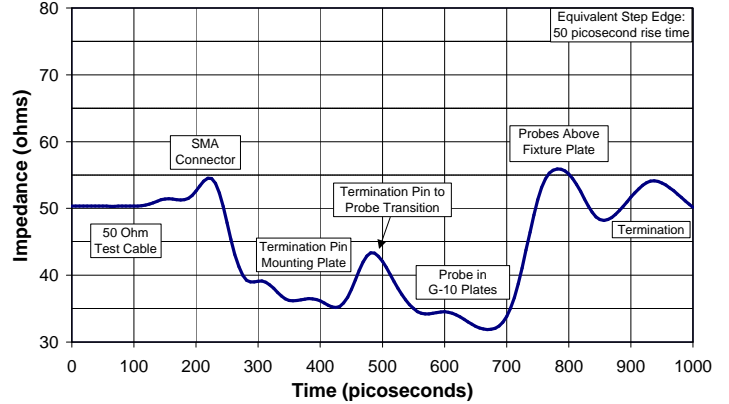


Two X50 wireless probes (signal and ground) on .050 [1.27] centers.

X50-25 Series Wireless, .050 [1.27] x 3
Frequency Response Measurement -1dB at 1800 MHz

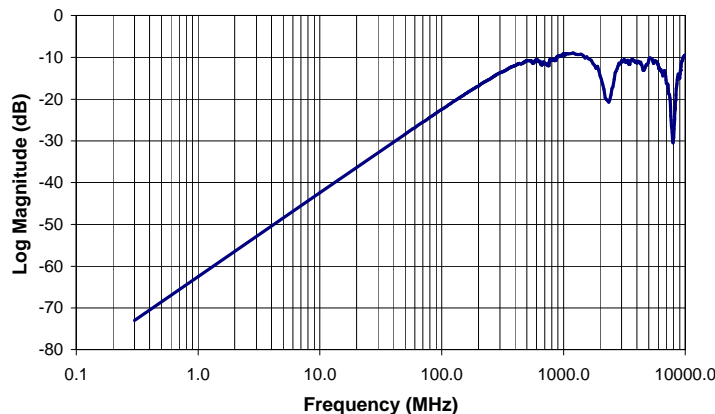


X50-25 Series Wireless, .050 [1.27] x 3
TDR Measurement Effective Test Frequency = 7GHz



Three X50 wireless probes (ground-signal-ground) on .050 [1.27] centers.

X50-25 Series Wireless, .050 [1.27] Centers
Crosstalk Measurement

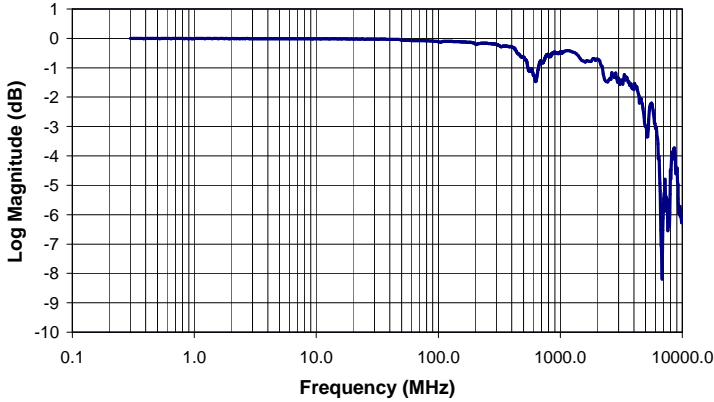


Cross talk for two pairs of X50 wireless probes on a .050 [1.27] grid.



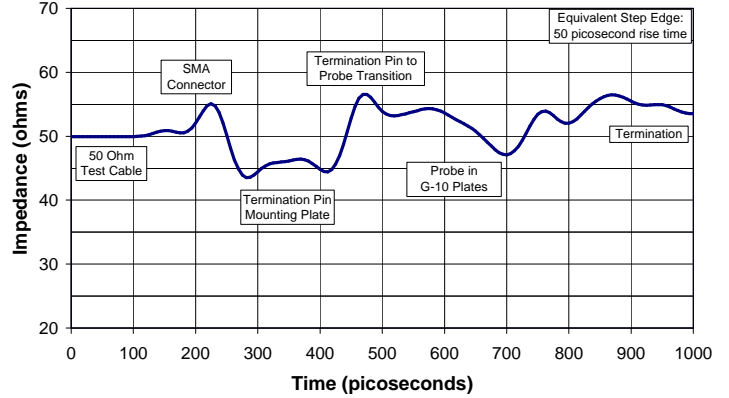
Appendix B X39-25 Series Wireless

X39-25 Series Wireless, .039 [1.00] Centers
Frequency Response Measurement -1dB at 540 MHz

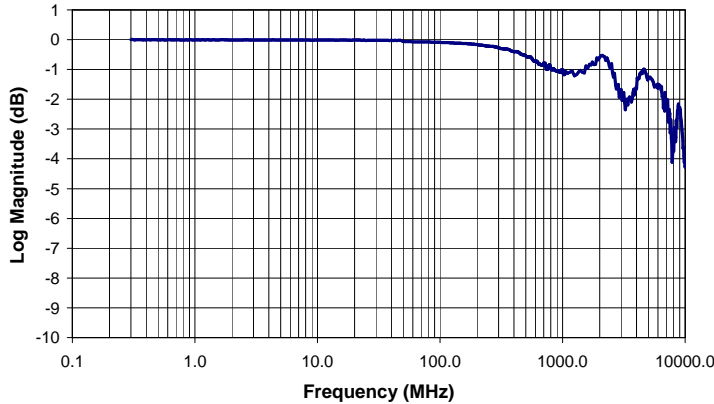


Two X39 wireless probes (signal and ground) on .039 [1.00] centers.

X39-25 Series Wireless, .039 [1.00] Centers
TDR Measurement Effective Test Frequency = 7 GHz

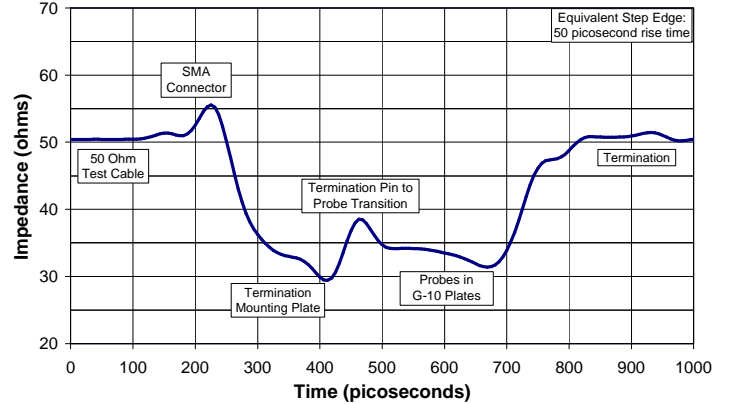


X39-25 Series Wireless, .039 [1.00] x 3
Frequency Response Measurement -1dB at 740 MHz

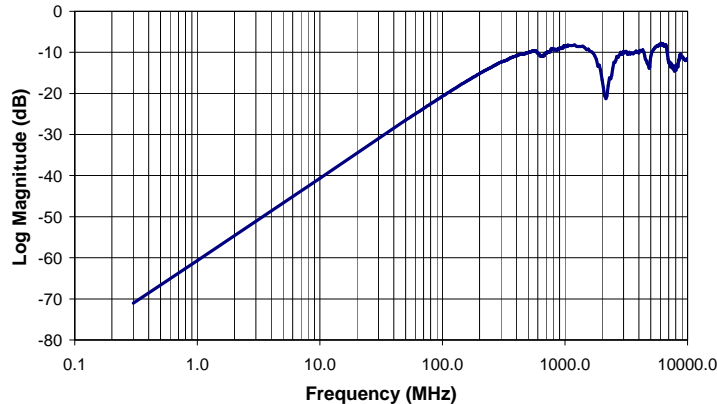


Three X39 wireless probes (ground-signal-ground) on .039 [1.00] centers.

X39-25 Series Wireless, .039 [1.00] x 3
TDR Measurement Effective Test Frequency = 7 GHz



X39-25 Series Wireless, .039 [1.00] Centers
Crosstalk Measurement

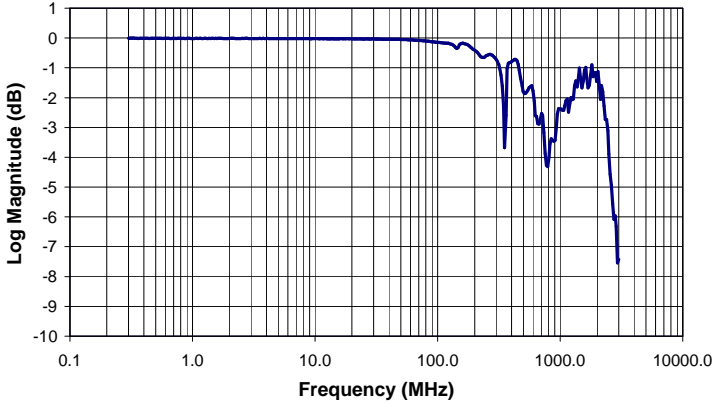


Crosstalk for two pairs of X39 wireless probes on a .039 [1.00] grid.



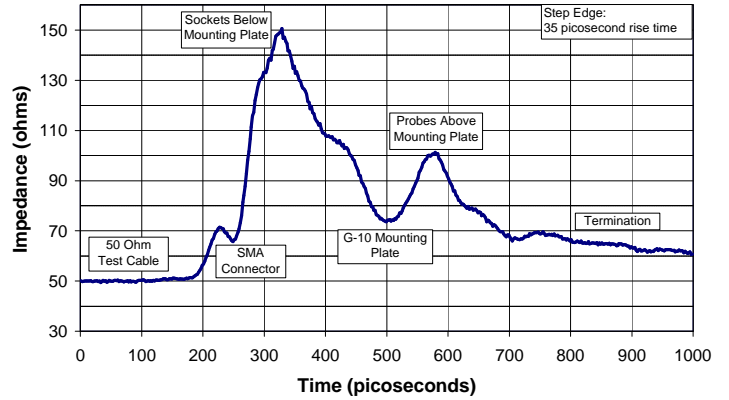
Appendix C 100-25 Series Double-Ended Data

100-25 Series Double-Ended, .100 [2.54] Centers
Frequency Response Measurement -1dB at 320 MHz

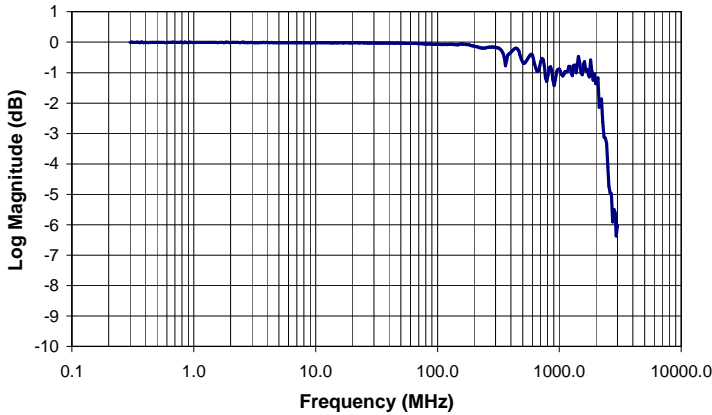


Two 100-25 Series Double-Ended Socket assemblies (signal and ground) on .100 [2.54] centers.

100-25 Series Double-Ended, .100 [2.54] Centers
TDR Measurement Effective Test Frequency = 10 GHz

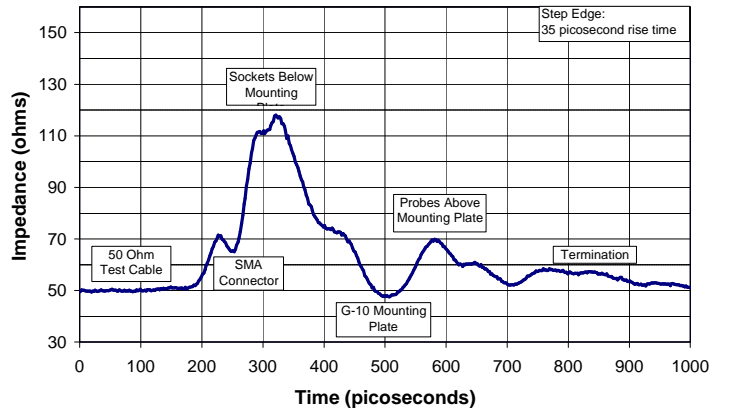


100-25 Series Double-Ended, .100 [2.54] x 3
Frequency Response Measurement -1dB at 770 MHz

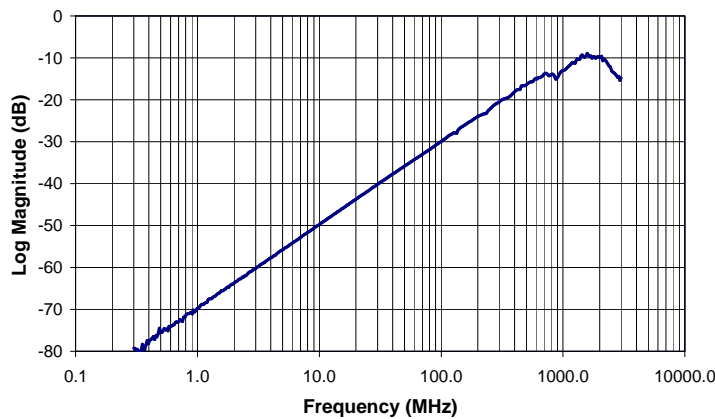


Three 100-25 Series Double-Ended Socket assemblies (ground-signal-ground) on .100 [2.54] centers.

100-25 Series Double-Ended, .100 [2.54] x 3
TDR Measurement Effective Test Frequency = 10 GHz



100-25 Series Double-Ended, .100 [2.54] Centers
Crosstalk Measurement

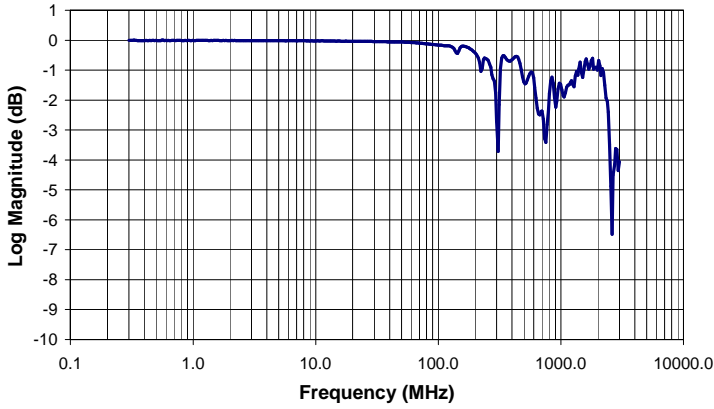


Crosstalk for two pairs of 100-25 Series Double-Ended Socket assemblies on a .100 [2.54] grid.

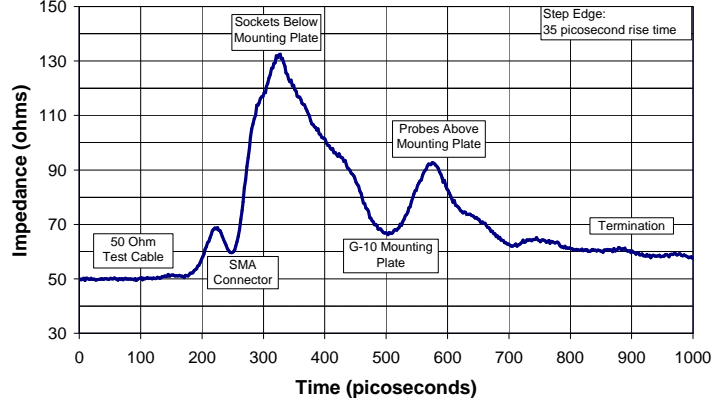


Appendix D 075-25 Series Double-Ended Data

075-25 Series Double-Ended, .075 [1.91] Centers
Frequency Response Measurement -1dB at 220 MHz

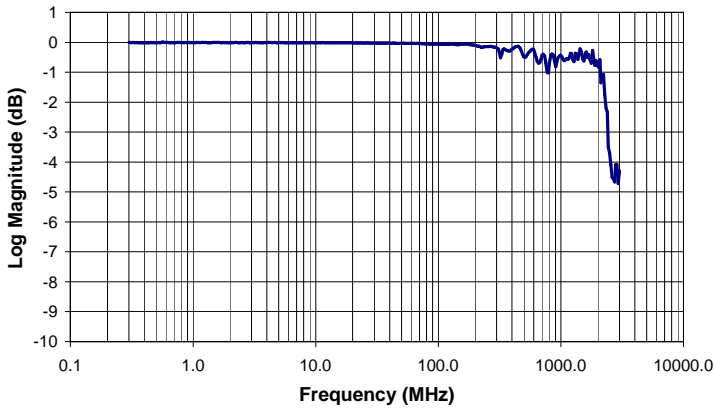


075-25 Series Double-Ended, .075 [1.91] Centers
TDR Measurement Effective Test Frequency = 10 GHz

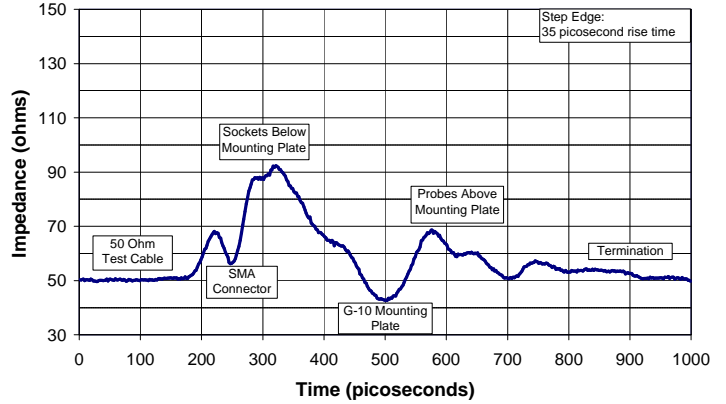


Two 075-25 Series Double-Ended Socket assemblies (signal and ground) on .075 [1.91] centers.

075-25 Series Double-Ended, .075 [1.91] x 3
Frequency Response Measurement -1dB at 770 MHz

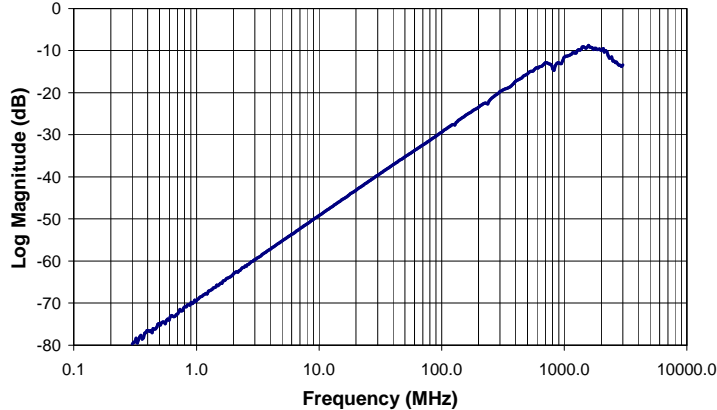


075-25 Series Double-Ended, .075 [1.91] x 3
TDR Measurement Effective Test Frequency = 10 GHz



Three 075-25 Series Double-Ended Socket assemblies (ground-signal-ground) on .075 [1.91] centers.

075-25 Series Double-Ended, .075 [1.91] Centers
Crosstalk Measurement

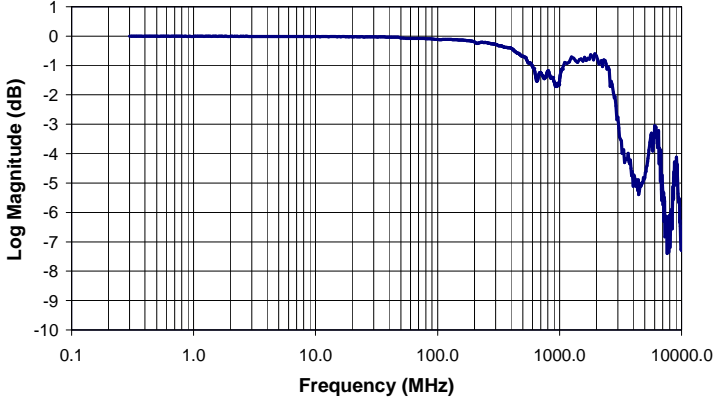


Crosstalk for two pairs of 075-25 Series Double-Ended Socket assemblies on a .075 [1.91] grid.



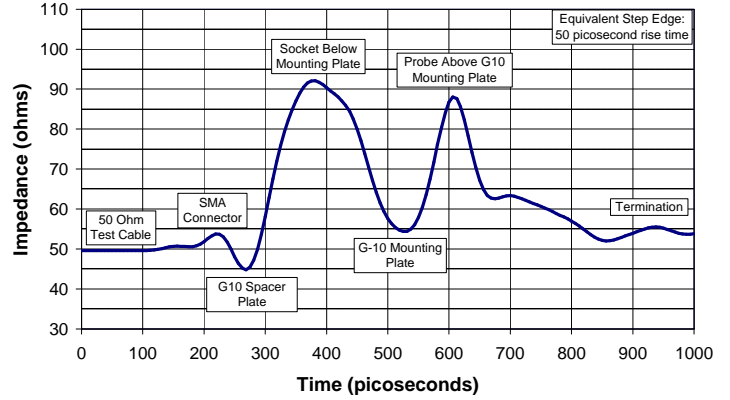
Appendix E 050-25 Series Double-Ended Data

050-25 Series Double-Ended, .050 [1.27] Centers
Frequency Response Measurement -1dB at 585 MHz

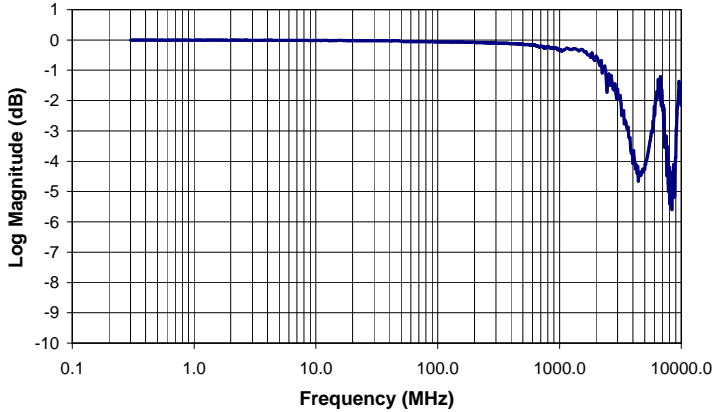


Two 050-25 Series Double-Ended Socket assemblies (signal and ground) on .050 [1.27] centers.

050-25 Series Double-Ended, .050 [1.27] Centers
TDR Measurement Effective Test Frequency = 7 GHz

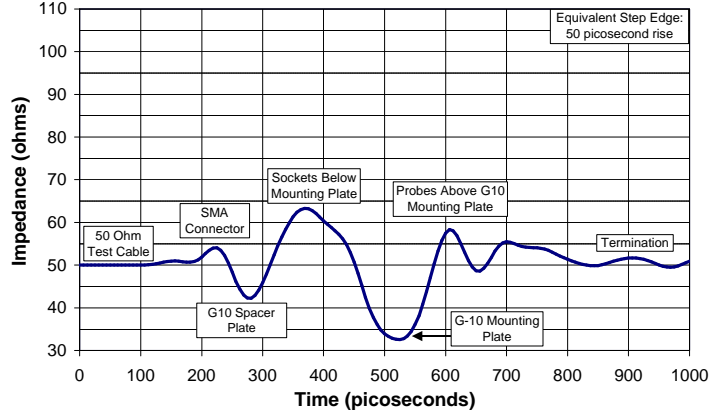


050-25 Series Double-Ended, .050 [1.27] x 3
Frequency Response Measurement -1dB at 2250 MHz

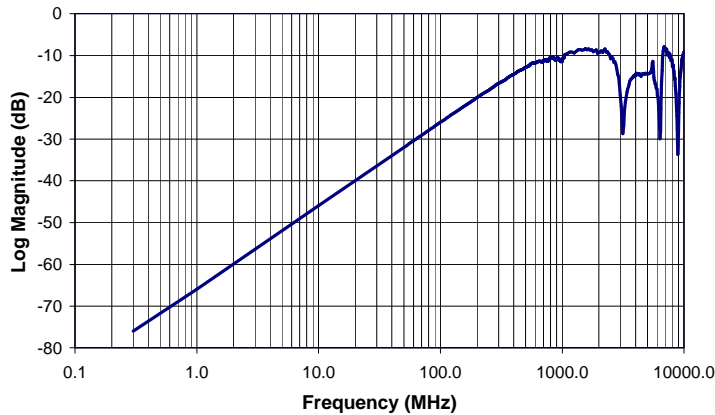


Three 050-25 Double-Ended Socket assemblies (ground-signal-ground) on .050 [1.27] centers.

050-25 Series Double-Ended, .050 [1.27] x 3
TDR Measurement Effective Test Frequency = 7 GHz



050-25 Series Double-Ended, .050 [1.27] Centers
Crosstalk Measurement



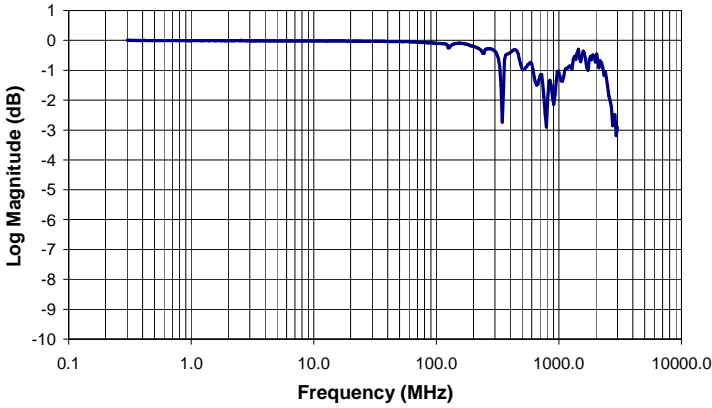
Crosstalk for two pairs of 050-25 Double-Ended Socket assemblies on a .050 [1.27] grid.



Appendix F

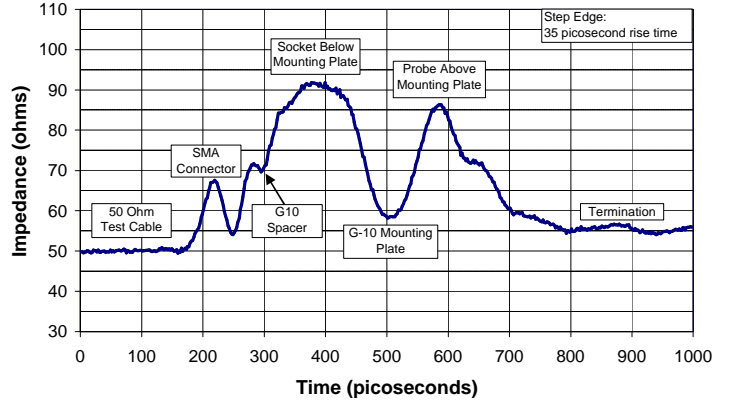
050-16 Series Double-Ended Data

050-16 Series Double-Ended, .050 [1.27] Centers
Frequency Response Measurement -1dB at 336 MHz

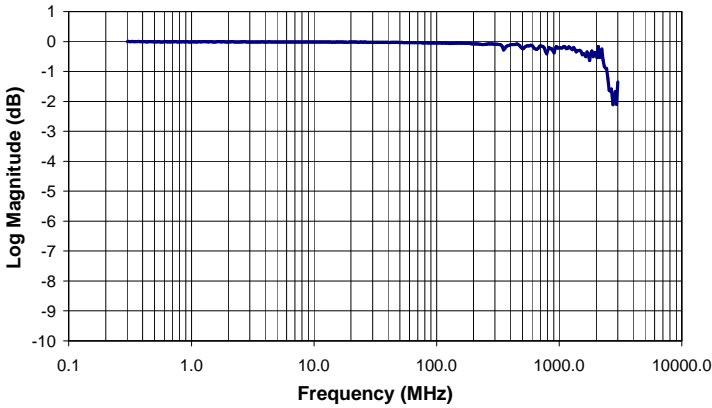


Two 050-16 Double-Ended Socket assemblies (signal and ground) on .050 [1.27] centers.

050-16 Series Double-Ended, .050 [1.27] Centers
TDR Measurement Effective Test Frequency = 10 GHz

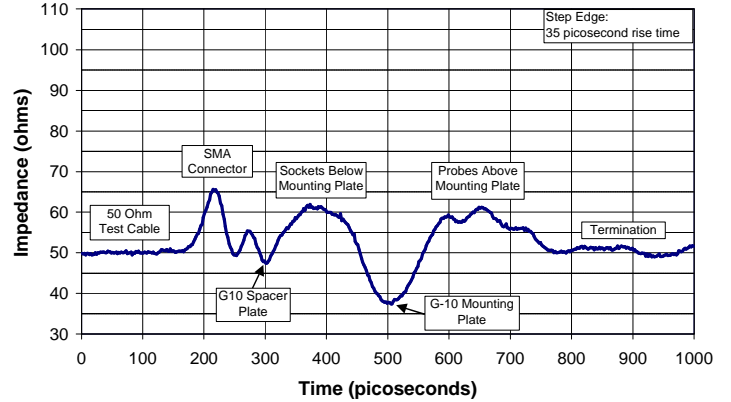


050-16 Series Double-Ended, .050 [1.27] x 3
Frequency Response Measurement -1dB at 2495 MHz

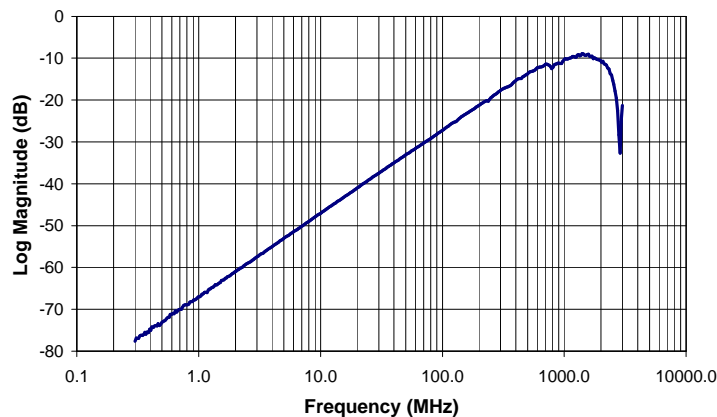


Three 050-16 Double-Ended Socket assemblies (ground-signal-ground) on .050 [1.27] centers.

050-16 Series Double-Ended, .050 [1.27] x 3
TDR Measurement Effective Test Frequency = 10 GHz



050-16 Series Double-Ended, .050 [1.27] Centers
Crosstalk Measurement



Crosstalk for two pairs of 050-16 Double-Ended Socket assemblies on a .050 [1.27] grid.