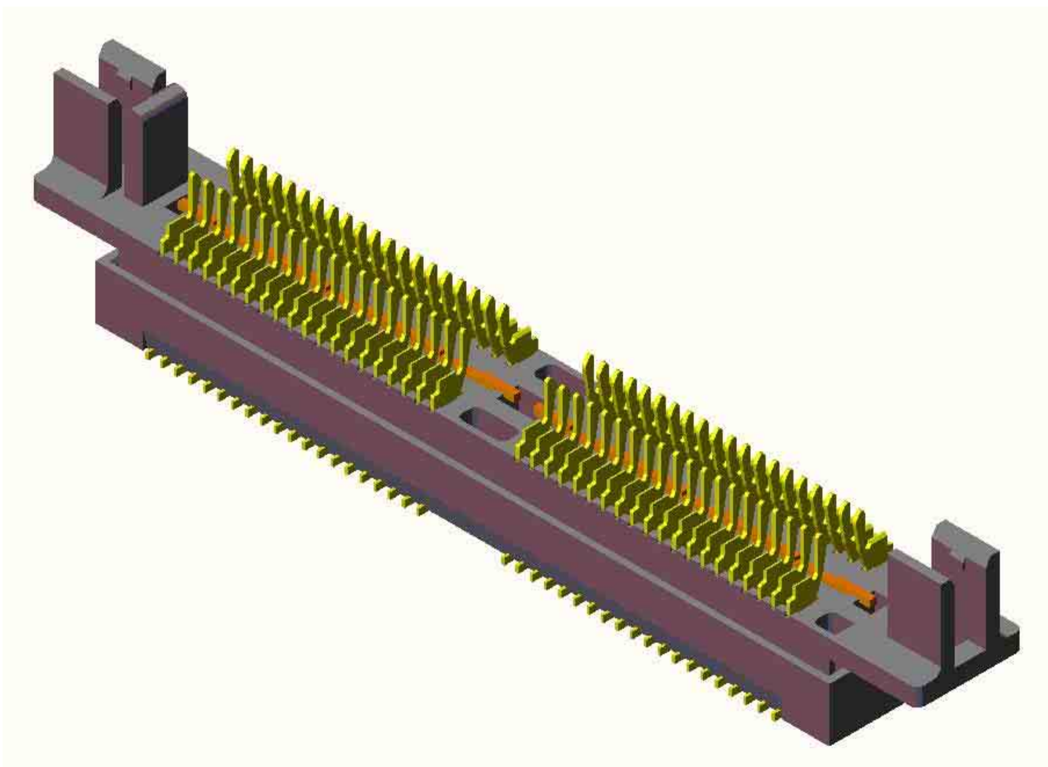
High Speed Characterization Report



QTE-xxx-01-x-D-EM2-xx **mated with** **QSE-xxx-01-x-D-A-xx**

Report Revision: May 5, 2003

Samtec Inc. WWW.SAMTEC.COM SignalIntegrityGroup@SAMTEC.COM
520 Park East Blvd. New Albany IN 47151-1147 USA
Phone: 812-944-6733, 1-800-SAMTEC-9 (US & Canada) Fax: 812-948-5047

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Samtec Inc. WWW.SAMTEC.COM SignalIntegrityGroup@SAMTEC.COM
520 Park East Blvd. New Albany IN 47151-1147 USA
Phone: 812-944-6733, 1-800-SAMTEC-9 (US & Canada) Fax: 812-948-5047

Introduction

This report summarizes the results of a series of tests developed to characterize the signal integrity characteristics of the connector. An effort was made to evaluate best-case and worst-case practical configurations. Because of the extremely low values of crosstalk measured in the worst-case configurations across the ground plane, the standard "best-case" configuration measurement was omitted. The performance in other configurations can be estimated by studying the configurations presented in this report. Multiline Spice models of this connector can be used to evaluate other configurations.

Other components in a system in which this connector would be used can have a significant impact on the observed effects of the connector. Additionally, test boards and intermediate test signal connections can cause significant masking of the connector's effects. Because of the great variety of board materials, routing schemes, compensation techniques, etc., much effort was made in these tests to isolate the mated connectors from any external effects.

Data is presented for several rise times that are typical of those encountered in current high-speed systems. For illustrative purposes, data is also provided at the "full bandwidth" of the laboratory instruments. For this test set up, this is estimated to be an equivalent of approximately 30 +/- 5 picoseconds signal rise time.

Additional testing may be possible for other signal ground configurations, for different electrical parameters such as frequency domain S-parameters, or with specific board assemblies or system configurations. Please contact Samtec for further information.

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Connector Application Summary

Differential Applications

Maximum Impedance Mismatch & Crosstalk	System Bandwidth	Signal Rise Time
5%:	**Up to 1.4 GHz**	**No Faster than 250 ps**
10%:	**Up to 3.5 GHz**	**No Faster than 100 ps**
Data Valid Up To:	**12 GHz**	**30 ps**

Single Ended Applications

Maximum Impedance Mismatch & Crosstalk	System Bandwidth	Signal Rise Time
5%:	**Up to 400 MHz**	**No Faster than 875 ps**
10%:	**Up to 933 MHz**	**No Faster than 375 ps**
Data Valid Up To:	**12 GHz**	**30 ps**

Determination of Suitability for Specific Frequency and Rise Time Applications

The frequencies listed above refer to sinusoidal signals. In general, it is not possible to directly relate a system's data transfer rate to the system's frequency bandwidth. This relationship is influenced by many factors, such as signaling/encoding schemes, parallel vs. serial transmission, multilevel signaling, filtering, scrambling and other signal processing techniques. Therefore, it is often convenient to base performance decisions on the rise time of the signal. In this report, we utilize 10% to 90% levels exclusively. The values stated above refer to the rise time of the signal at the point where the signal first encounters the connector. Because of rise time degradation effects in most signal transmission systems, the rise time at the connector is often significantly slower than the rise time of the signal at the exit point from the driver. To avoid over-design, these effects should be considered when determining connector suitability.

For the 5% and 10% limits, the connectors are rated per 1:1 S/G ratio impedance mismatch or crosstalk in the time domain, whichever is worse. (G-S-G for Single Ended, G-S-S-G for Differential Pair) Frequency domain limits are calculated from time domain measurement through $0.35/T_r$, which approximates the half-bandwidth power level for a sinusoidal signal. This does not typically directly relate to the system clock frequency. We assume a system impedance of 100 ohms for differential applications, and 50 ohms for single ended applications. Performance will be different in other impedance environments.

For applications under the 5% limits, the connector should have minimal impact on system performance if standard signal integrity principles are followed in the system design.

Applications falling between the 5% and 10% ratings could necessitate the use of more advanced techniques in the system design. Special board materials, extra board layers, active signal processing, cross talk or impedance compensation, etc., could be required.

For applications at frequencies or speeds above the 10% ratings, the connector should only be used after analysis through simulation or measurement in the specific application environment. The connector can function well in such applications, but signal enhancement and/or processing techniques might be required to ensure adequate system performance. The test data provided in this report is considered valid to the higher limit of the frequencies listed above.

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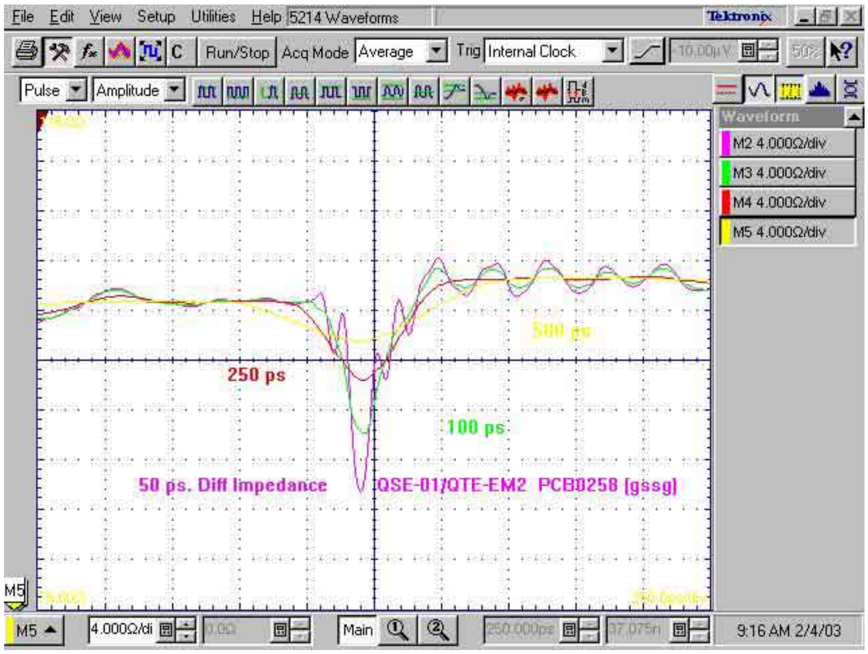
Differential Data

Impedance, QSE-01 on the near end



	Differential Impedance (Ω)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
Maximum Impedance	112.1	101.4	100.0	100.0	100.0	100.0	100.0
Minimum Impedance	81.3	85.4	90.2	94.4	97.5	98.7	99.4

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Crosstalk

In pin out descriptions, "G" represents terminals tied to ground, as is the ground plane. For differential measurements, "D1" and "D2" represent driven pair terminals, and "M1" and "M2" represent measured pair terminals.

Worst Case Differential Crosstalk Across Ground Plane

G	D1	D2	G
G	M1	M2	G

	Crosstalk (%)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
NEXT	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable
FEXT	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable

Worst Case Differential Crosstalk on One Side of Ground Plane

G	D1	D2	M1	M2	G

	Crosstalk (%)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
NEXT	3.7	3.6	3.2	1.8	1.0	0.7	0.5
FEXT	1.97	1.46	0.91	0.41	0.23	0.16	0.11

Best Case Differential Crosstalk on One Side of Ground Plane

G	D1	D2	G	M1	M2	G

	Crosstalk (%)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
NEXT	0.5	0.4	0.3	0.2	0.11	0.065	0.064
FEXT	1.44	0.99	0.70	0.33	0.15	0.11	0.07

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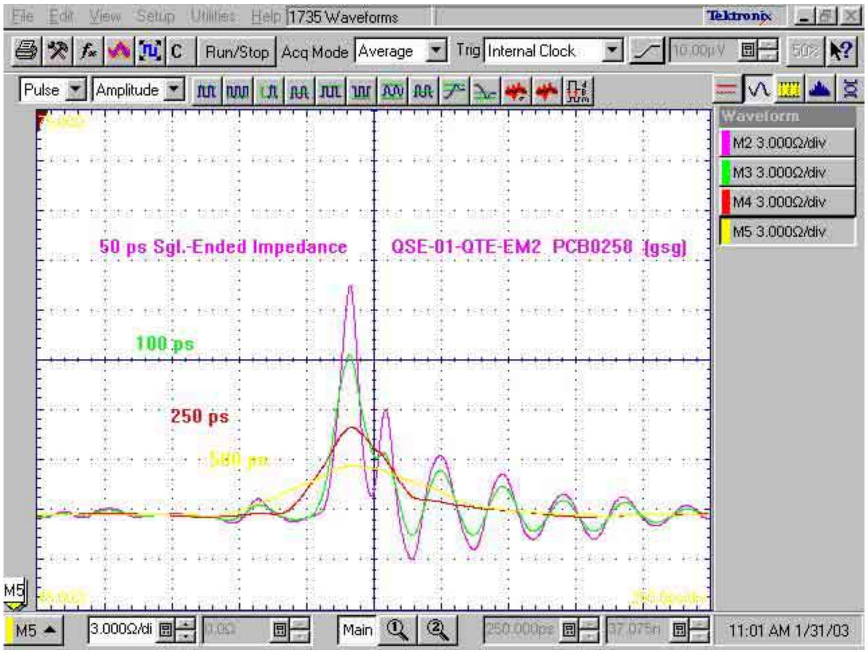
Single Ended Data

Impedance, QSE-01 on the near end



	Single Ended Impedance (Ω)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
Maximum Impedance	72.5	64.4	60.3	56.0	53.7	52.8	52.3
Minimum Impedance	50.0	50.0	50.0	50.0	50.0	50.0	50.0

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Crosstalk

In pin out descriptions, "G" represents terminals tied to ground. For single ended measurements, "D" represents the driven terminal; "M" represents the monitored terminal.

Worst Case Single Ended Crosstalk Across Ground Plane

G	D1	G
G	M1	G

	Crosstalk (%)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
NEXT	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable
FEXT	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable	undetectable

Worst Case Single Ended Crosstalk on One Side of Ground Plane

G	D	M	G

	Crosstalk (%)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
NEXT	14.2	13.5	11.7	7.4	5.0	3.6	2.8
FEXT	5.7	4.8	3.1	1.4	0.8	0.6	0.5

Best Case Single Ended Crosstalk on One Side of Ground Plane

G	D	G	M	G

	Crosstalk (%)						
Signal Rise time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**	**750 ps**	**1 ns**
NEXT	3.6	3.1	2.4	1.5	0.9	0.6	0.5
FEXT	3.7	3.1	2.1	0.9	0.5	0.34	0.27

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Propagation Delay
Measured at full bandwidth rise time.

Single-Ended	pSec
GSG	52.3
Differential	
GSSG	52.4

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Characterization Procedures

All measurements were performed using a Tektronix CSA 8000 Digitizing Oscilloscope with 80E04 Differential TDR Sampling heads. All equipment met current factory calibration standards.

Significant efforts were made to minimize effects of fixturing so that the connectors could be evaluated with the fastest rise times possible. Short lengths (4-6 inches) of 50 ohm, +/- 1 ohm, 0.020 inch OD, semi-rigid cable assemblies were used in making connection from the sampling heads directly to the discrete connector or PCB mounted connector. For differential measurements, signal delay was adjusted to obtain phase matching between conductors of a pair of approximately +/- 0.5 picoseconds.

Grounding plates, which matched the grounding scheme for each particular configuration tested, were fabricated out of 0.010" copper alloy. These plates were soldered to both sides of the mated connector pair where appropriate. Measurements were made on terminals located in the middle of the connector. Similar patterns near the edge of the connector can indicate slightly different results, with impedance values typically being higher.

Semi rigid center conductors were soldered to the connector terminals under test. Approximately 0.032 +/- 0.005 inches of the outer shield and dielectric was removed from the semi rigid cable. The shield of the semi rigid cable was soldered to the ground plane nearest the center conductor. In all measurements, the socket connector was on the near end of the test set up.

Ten gigahertz broadband coaxial 50-ohm terminations are used to terminate the ends of driven signal lines. Measurement related signal terminals not currently under test are terminated in the appropriate impedance using a low inductance chip resistor or 50-ohm coaxial terminations, whichever produces the lower residual effects.

All data was transferred from the CSA 8000 to a PC for data presentation. No mathematical functions or post processing was performed on the data after transfer. All tests were performed at a rise time estimated to be 30 +/-5 picoseconds at the connector. Data reported for slower rise times was obtained by using the internal filtering capabilities of the CSA 8000. Crosstalk percentage values were calculated from the maximum steady state magnitude of the voltage levels of the incident test pulse and cross talk signals. All rise times refer to 10% to 90% levels.

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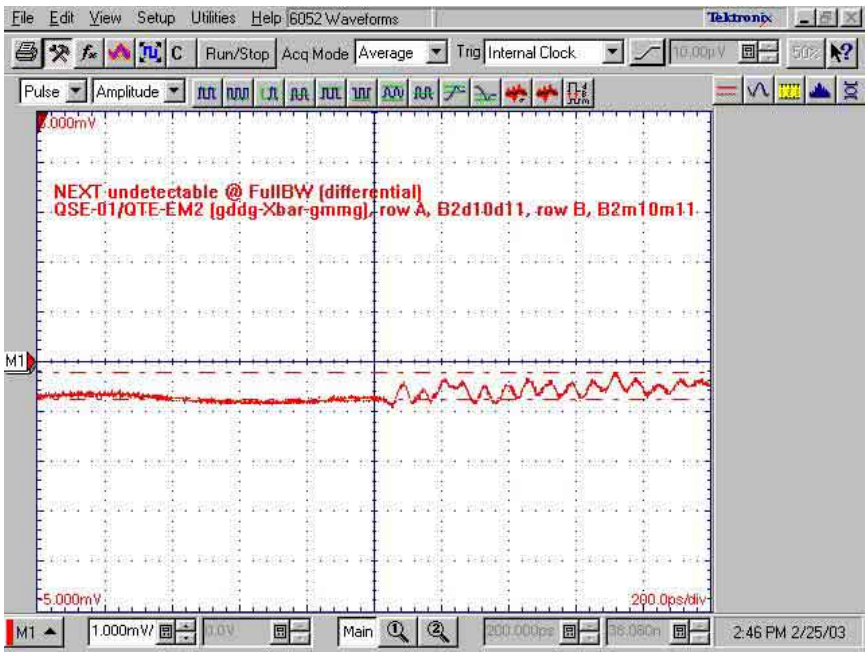
APPENDIX A: Differential Crosstalk Plots

Worst Case Differential Crosstalk Across Ground Plane

Pattern:

G	D1	D2	G
G	M1	M2	G

NEXT



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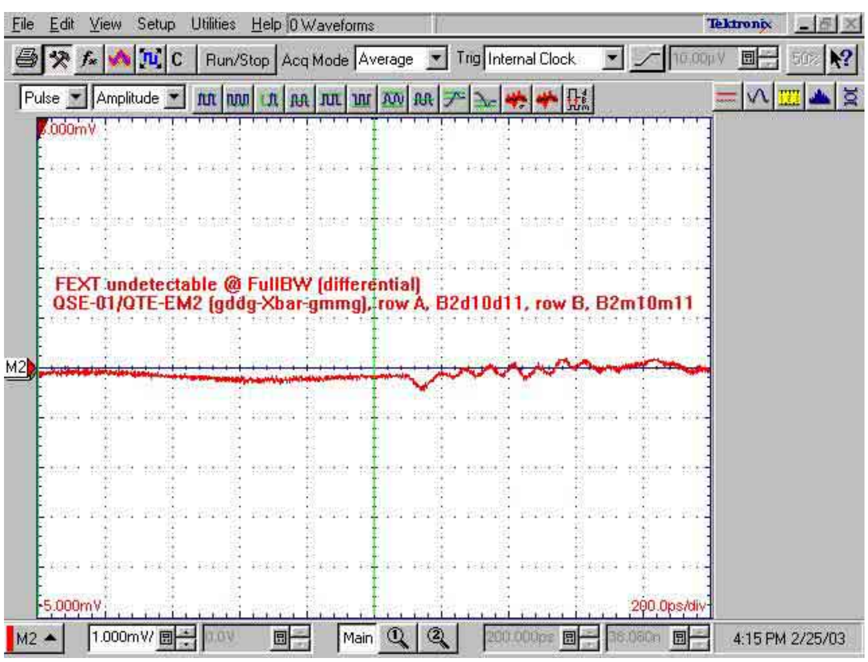

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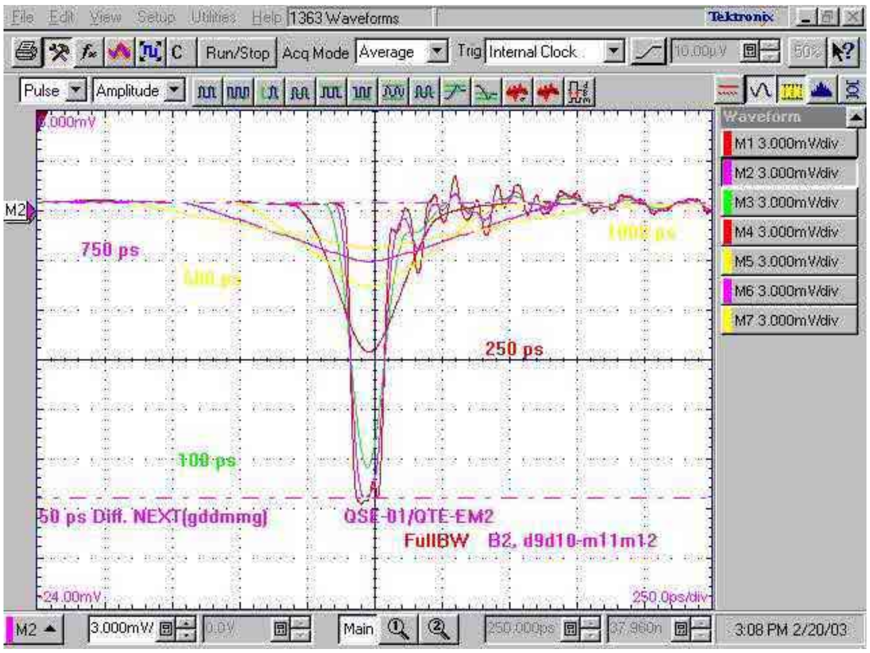
APPENDIX A: Differential Crosstalk Plots (cont.)

Worst Case Differential Crosstalk on One Side of Ground Plane

Pattern:

G	D1	D2	M1	M2	G

NEXT



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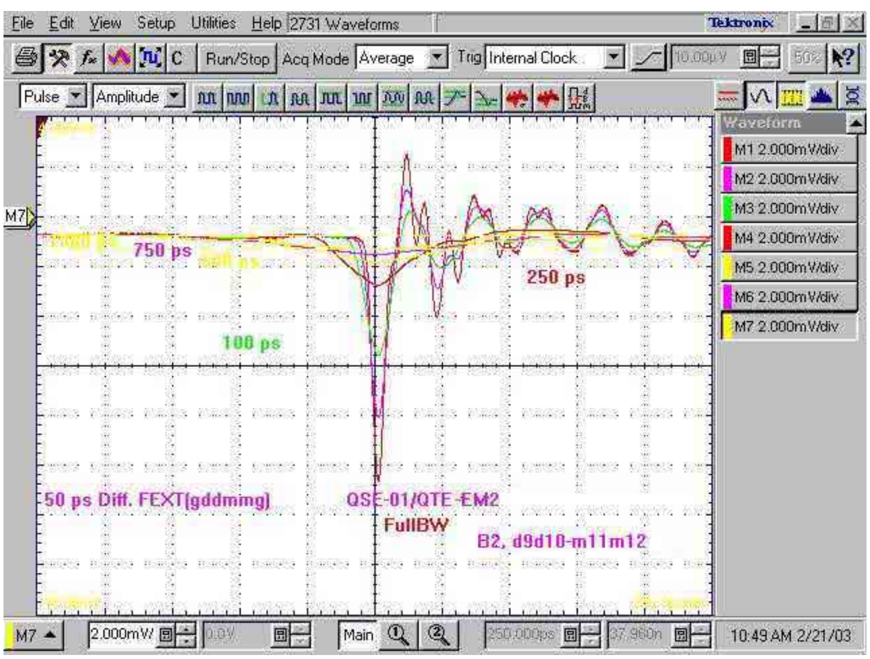

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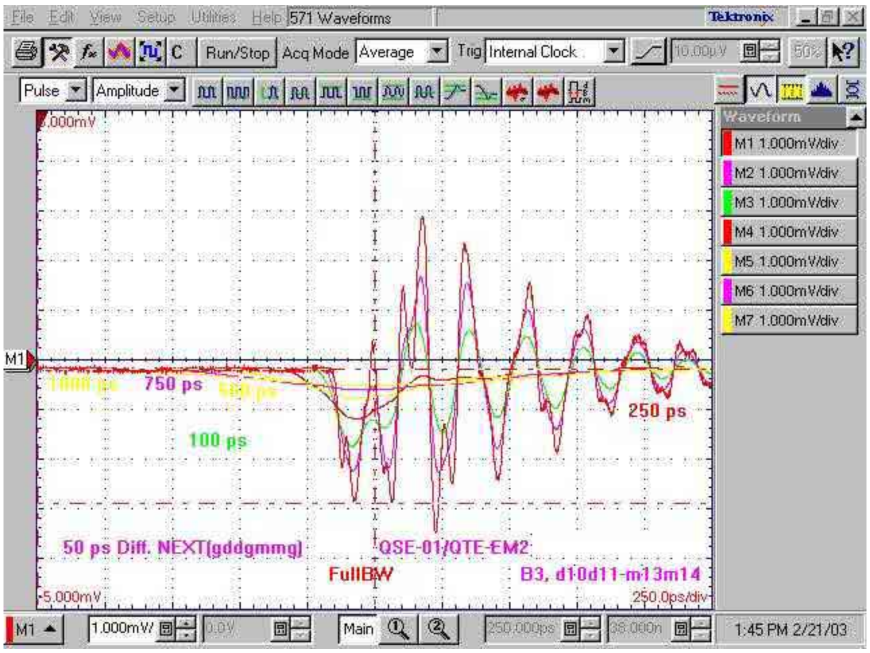
APPENDIX A: Differential Crosstalk Plots (cont.)

Best Case Differential Crosstalk on One Side of Ground Plane

Pattern:

G	D1	D2	G	M1	M2	G

NEXT



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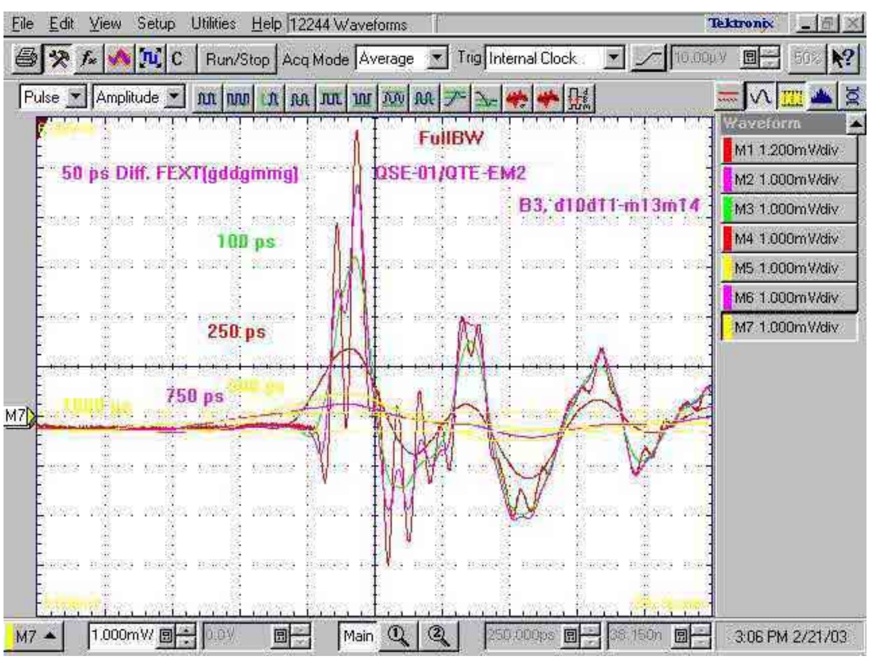

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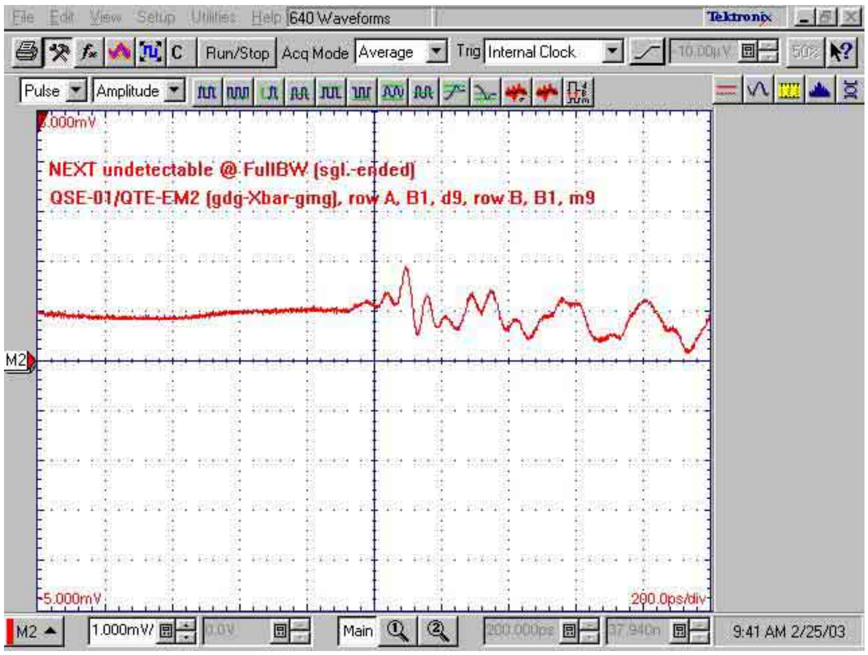
APPENDIX B: Single-Ended Crosstalk Plots

Worst Case Single Ended Crosstalk Across Ground Plane

Pattern:

G	D1	G
G	M1	G

NEXT



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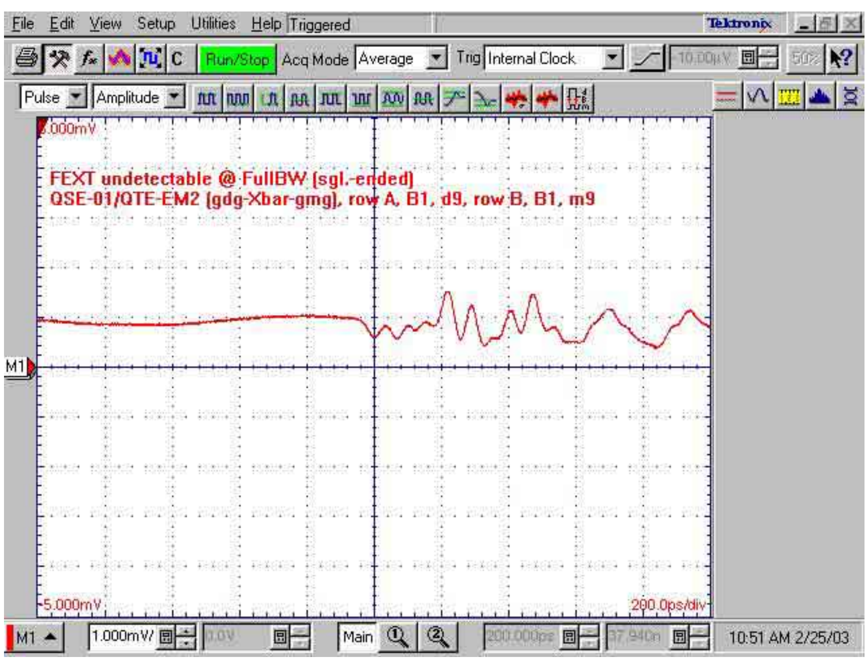

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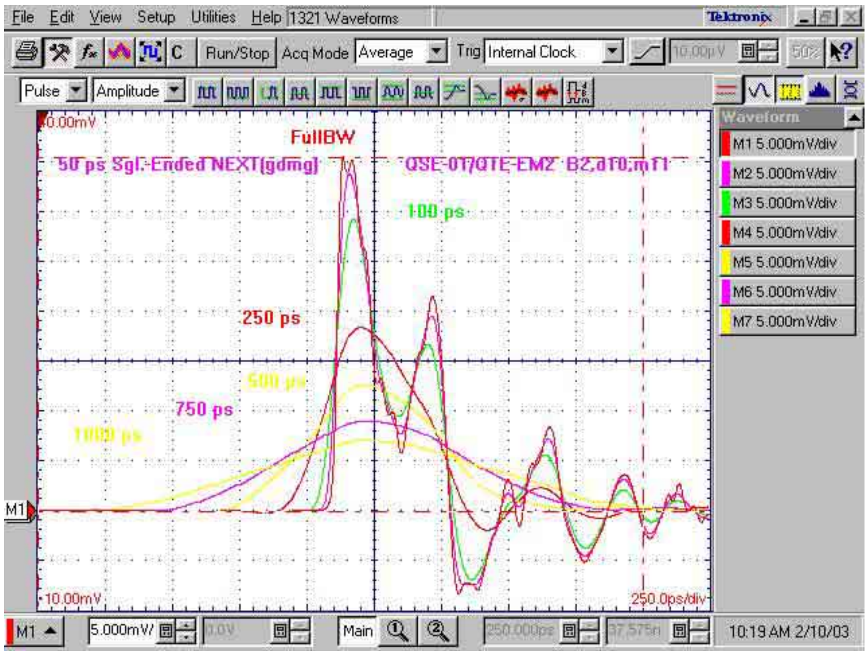
APPENDIX B: Single-Ended Crosstalk Plots (cont.)

Worst Case Single Ended Crosstalk on One Side of Ground Plane

Pattern:

G	D	M	G

NEXT



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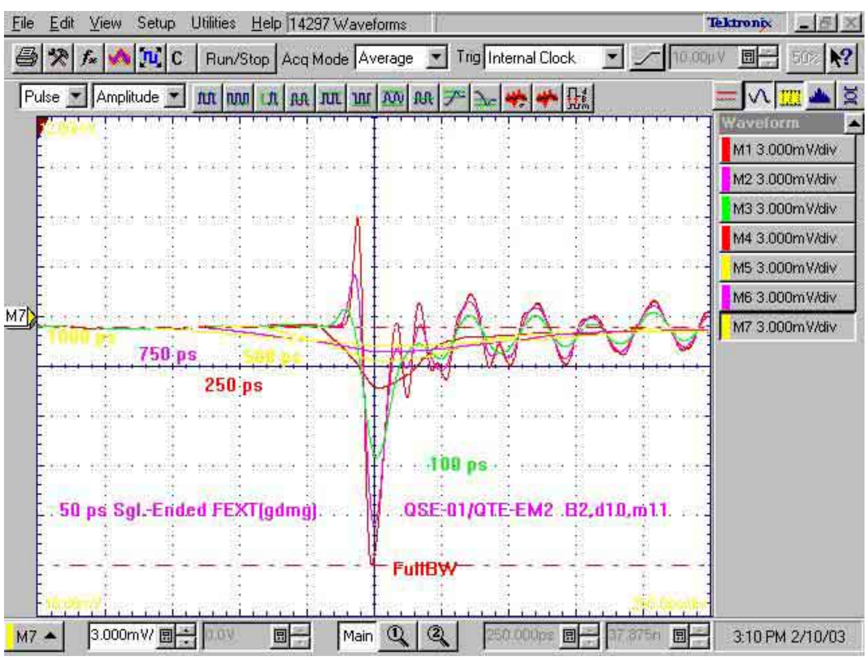

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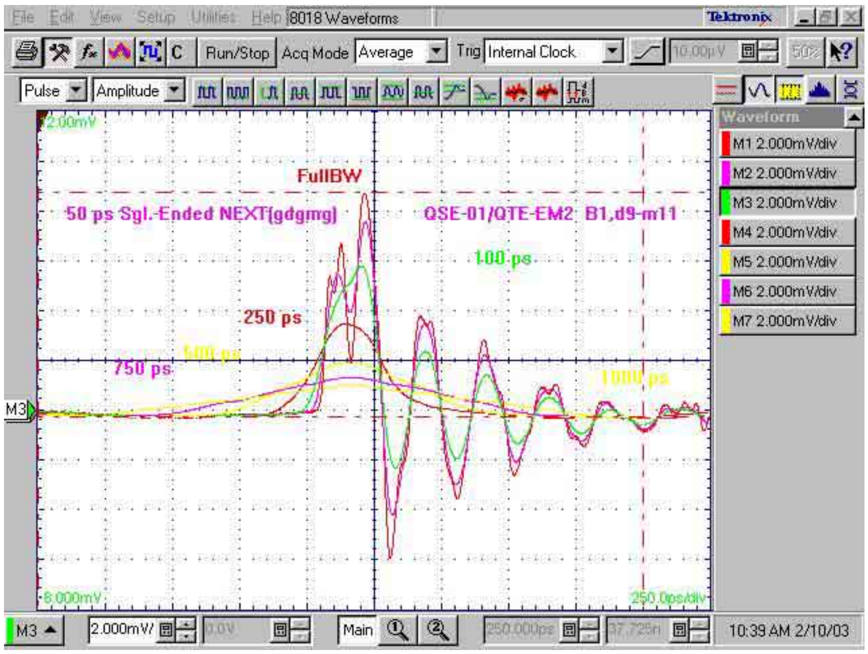
APPENDIX B: Single-Ended Crosstalk Plots (cont.)

Best Case Single Ended Crosstalk on One Side of Ground Plane

Pattern:

G	D	G	M	G

NEXT



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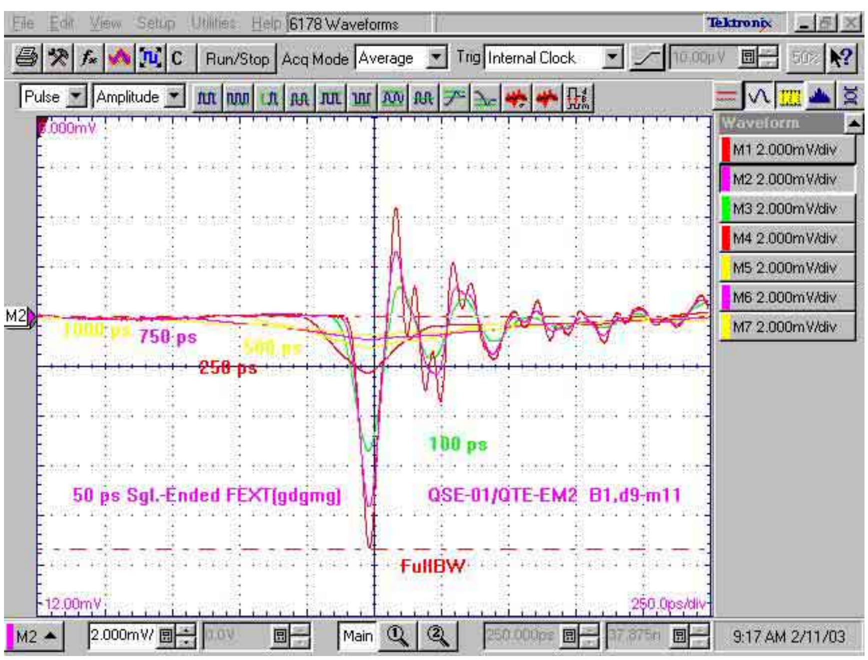

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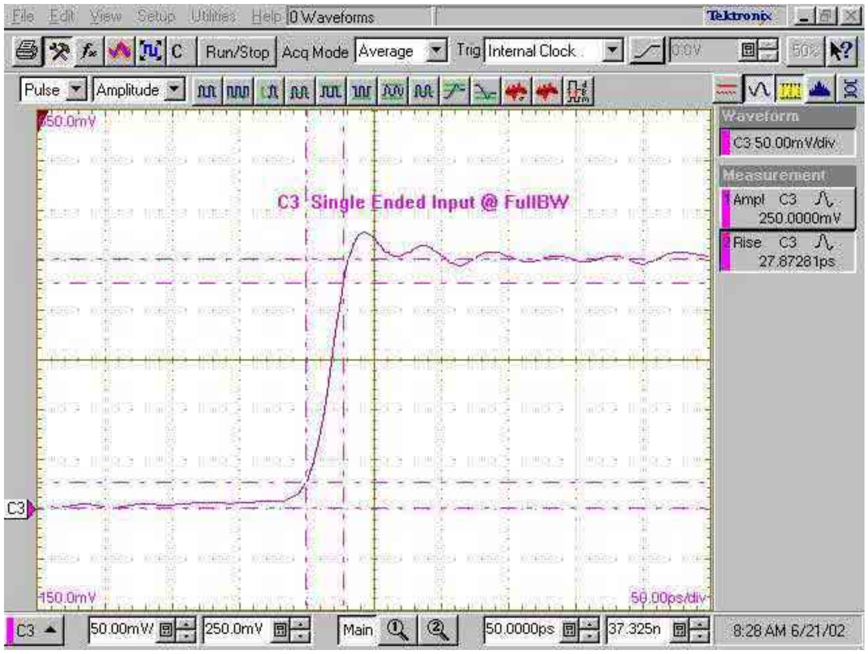
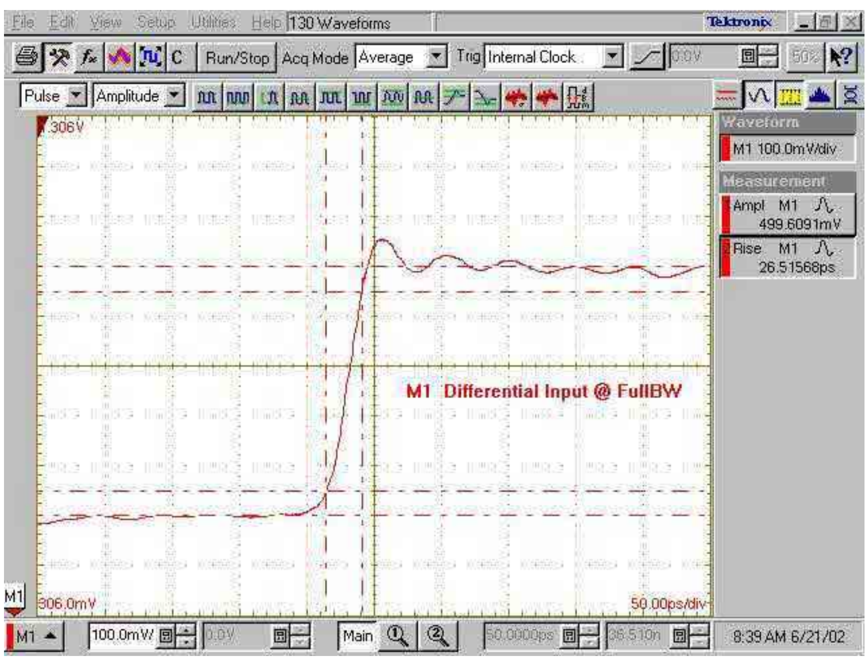
APPENDIX C: Inputs for Crosstalk Measurements

Single-Ended Input



Differential Input



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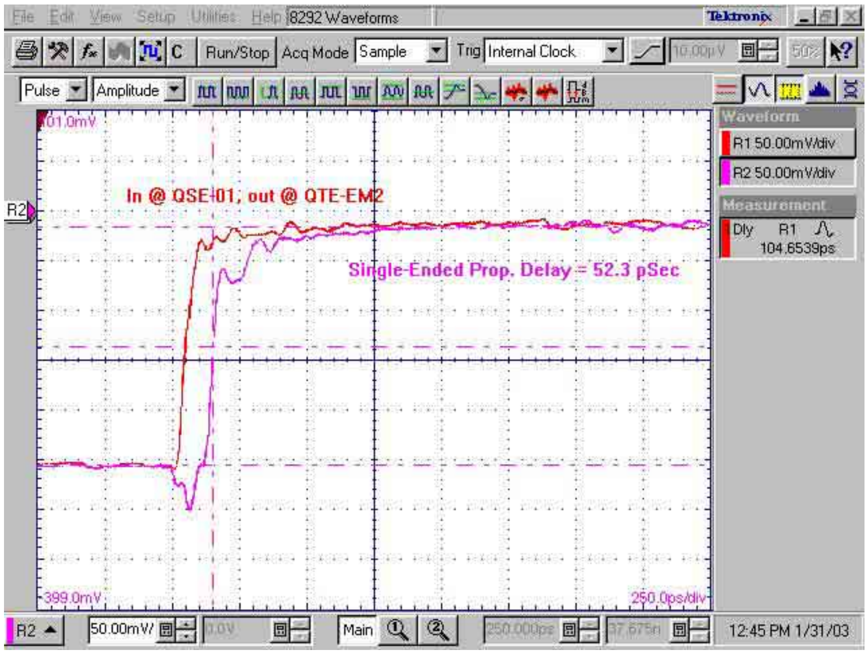
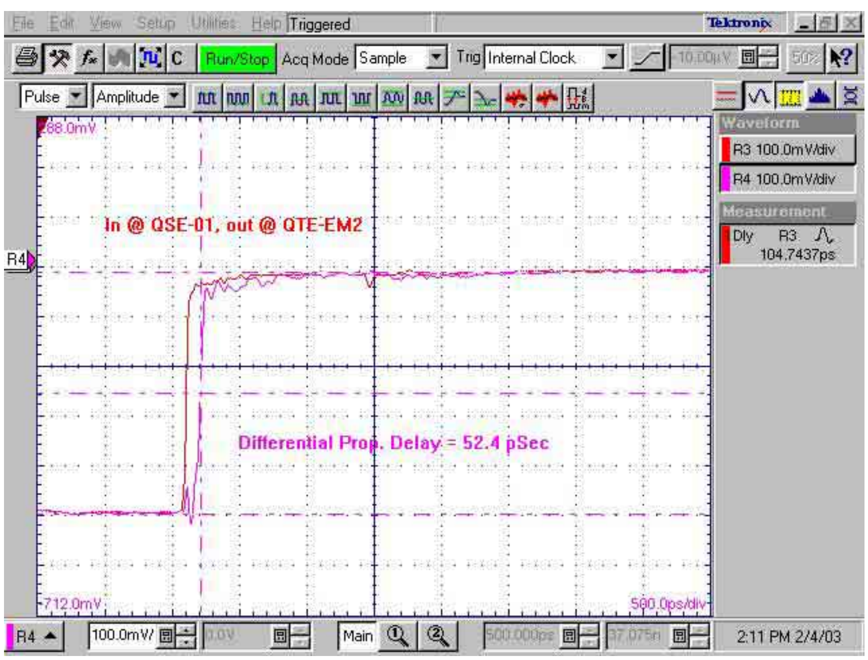
APPENDIX D: Propagation Delay Measurement Plot

Single-Ended



Differential



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