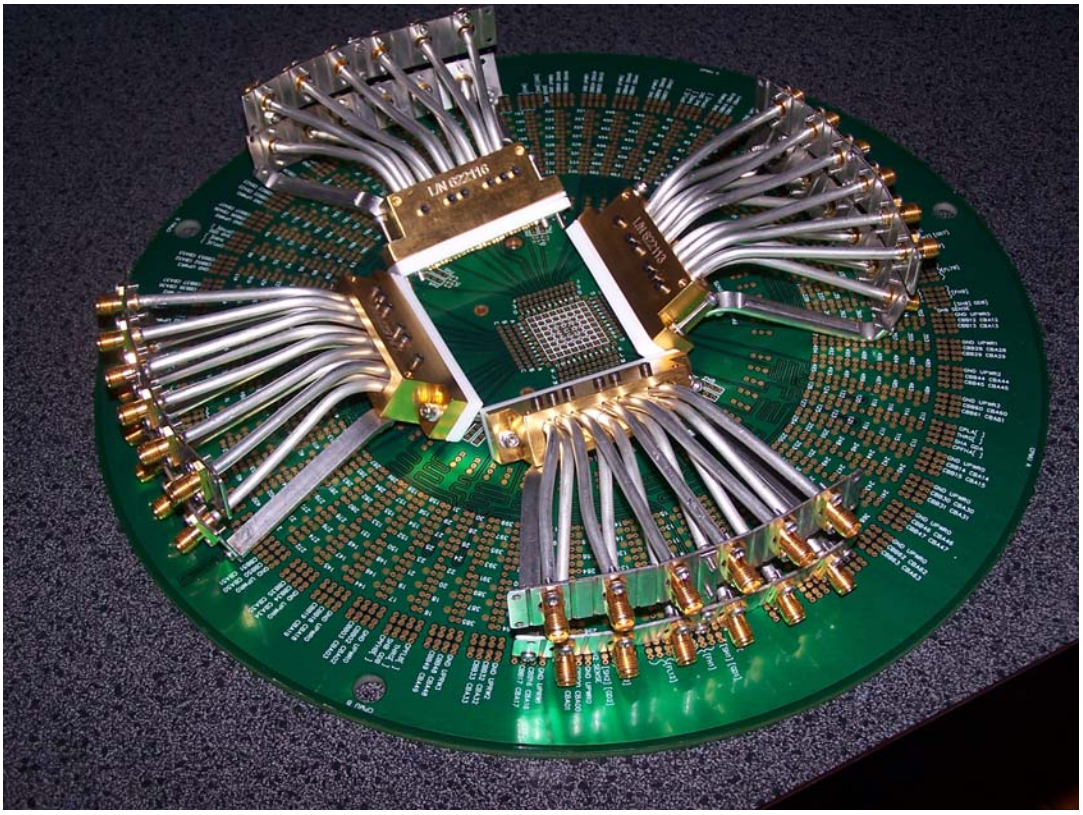
Trident 2
Performance Report:

Engineering Recommendations and Specifications

Signal Integrity Inc.
October, 2008.



Section 1: Product Description

This report will describe the performance and report on the operating parameters and specifications of the Trident2 High bandwidth probe system. The Trident 2 target application is to deliver and measure 12Gb/s Serdes signals on highly integrated, multi-lane enterprise server chips. This probe system is mounted to a high frequency PC board to attach instrumentation to the Serdes lanes under test.

Background Problem

This probe was designed to alleviate the problems encountered with mounting many (>200) high frequency test points (>12 GHz) on DUT boards used to characterize next generation 10 Gb/s and beyond Serdes IO macros used in enterprise server CPU modules. The goal was to build a second generation interconnect system consisting of a multi-channel board mount probe set and develop a connector standard that would be portable and takes us through 12Gb/s IO bit rates.

Probe Description

The Probe consists of 12 channels with matched delays and a compliant mounting housing. The probe is meant to mate to a connector pattern on a circuit board on one end and a standard SMA male connector on the other end. It is designed for measuring physical layer parameters on 10-12 Gb/s Serdes memory transfer ports that are used on SOC integrated chips and modules. It is targeted for ATE and lab bench environments for characterization and production screening.

Key features of this probe:
1) Small footprint: 12 channels in 2.36"x0.365" of board real estate
2) Insertion loss better than -2dB cutoff at >12GHz
3) Return Loss <= -10dB at 10 GHz
4) High Reliability single insertion SMA female cable receptacle
5) Top down board mount hardware allows connector mobility without un-docking DUT board

Probe Characterization Results

The following AC parameters were measured for each channel. Note we use round trip parameters to accurately model the transmit/receive nature of the Serdes parts that this unit is targeted to test. Also, round trip parameters allow us to assess the performance of test modes such as far end and blunt end loopback operation.

1) Round Trip Insertion Loss
2) Round Trip Return Loss
3) Average Impedance of channel into open
4) Peak impedance of channel into 50 ohms
5) Peak Impedance of channel into short

Round Trip Insertion Loss

The following are the results of a typical channel for insertion loss. The measurement setup is shown in figure 1.

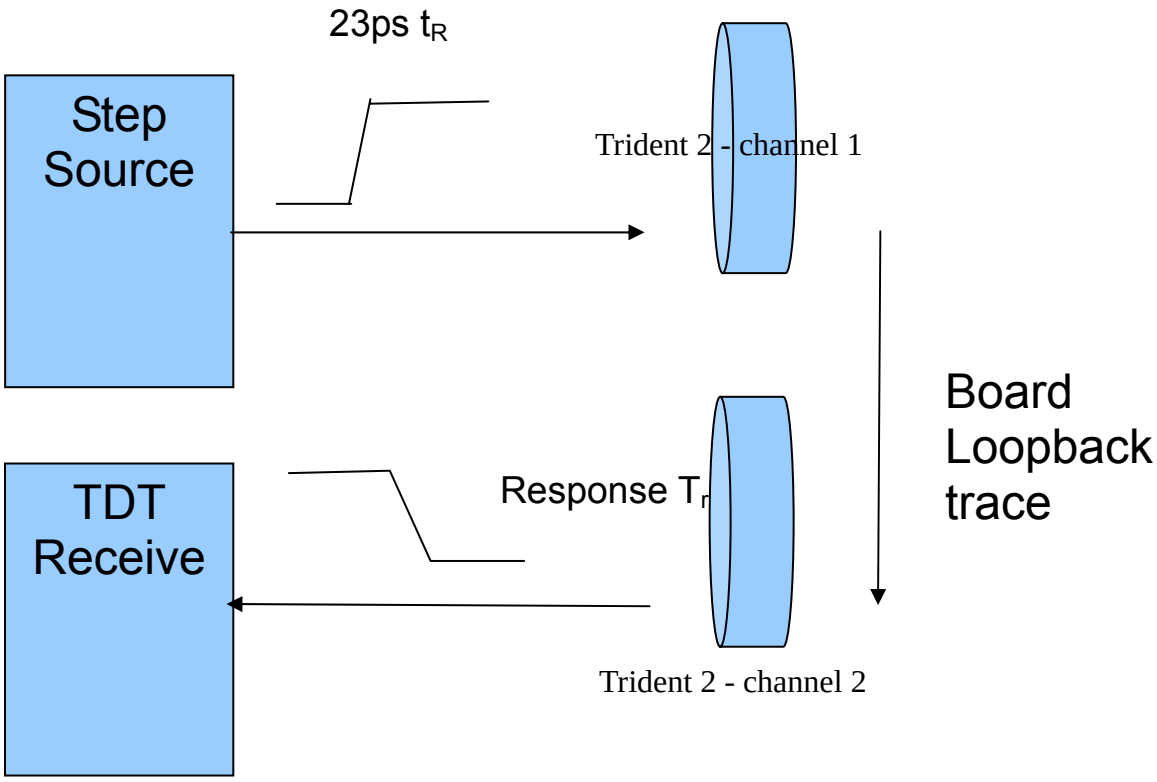


Figure 1

This measurement setup is used to gather the plots for S21 (insertion loss) and S11 (Return loss) using the DCA-J 54750 TDR plug-ins and s-parameter software. Figure 2 is a typical S21 plot for a Trident loopback channel.

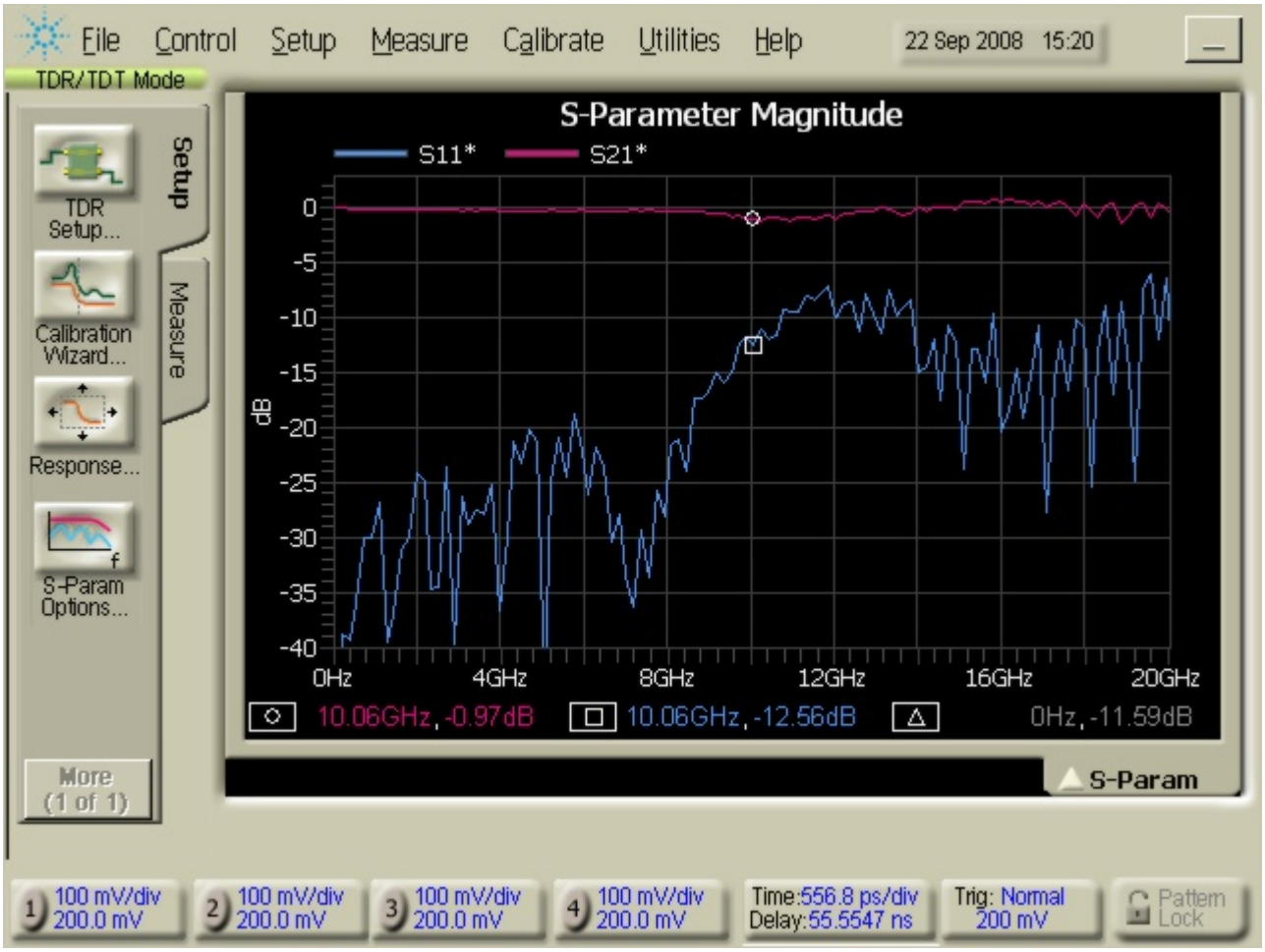


Figure 2
S21 plot for Connector Channels J1-J7

The S21 is flat through the frequency range of the measurement equipment , having -097dB loss at 10 GHz. In addition, the return loss at 10 GHz is -12.5dB indicating good impedance match through the connector and short board trace that connects the adjacent connector channels together.

Table 1 below lists the insertion loss and return loss for each channel pair in the connector.

Trident 2 S-Parameter Results

Connector Pair	S21 @10GHz	S11 @10GHz	S21 -3dB cutoff
J1-> J7	-0.97dB	-12.65dB	>20GHz
J2-> J3	-0.28dB	-15.63dB	>20GHz
J4->J5	-0.77dB	-14.17dB	18GHz
J6->J12	-0.37dB	-17.06dB	>20GHz
J8->J9	-0.48dB	-24.68dB	>20GHz
J10->J11	-0.66dB	-17.23dB	>20GHz

Table 1
S-parameter Results

Noted Anomalies

There are a couple of test anomalies that should be noted. On the test board used to collect this data, there is a reflection that shows up on the s-parameter plots that is due to the back drill and impedance match of the via structures used in the loopback trace. These occur on j6-j12, j8-j9 and j10-j11. These appear as a notch on the s21 plot as shown in figure 3.

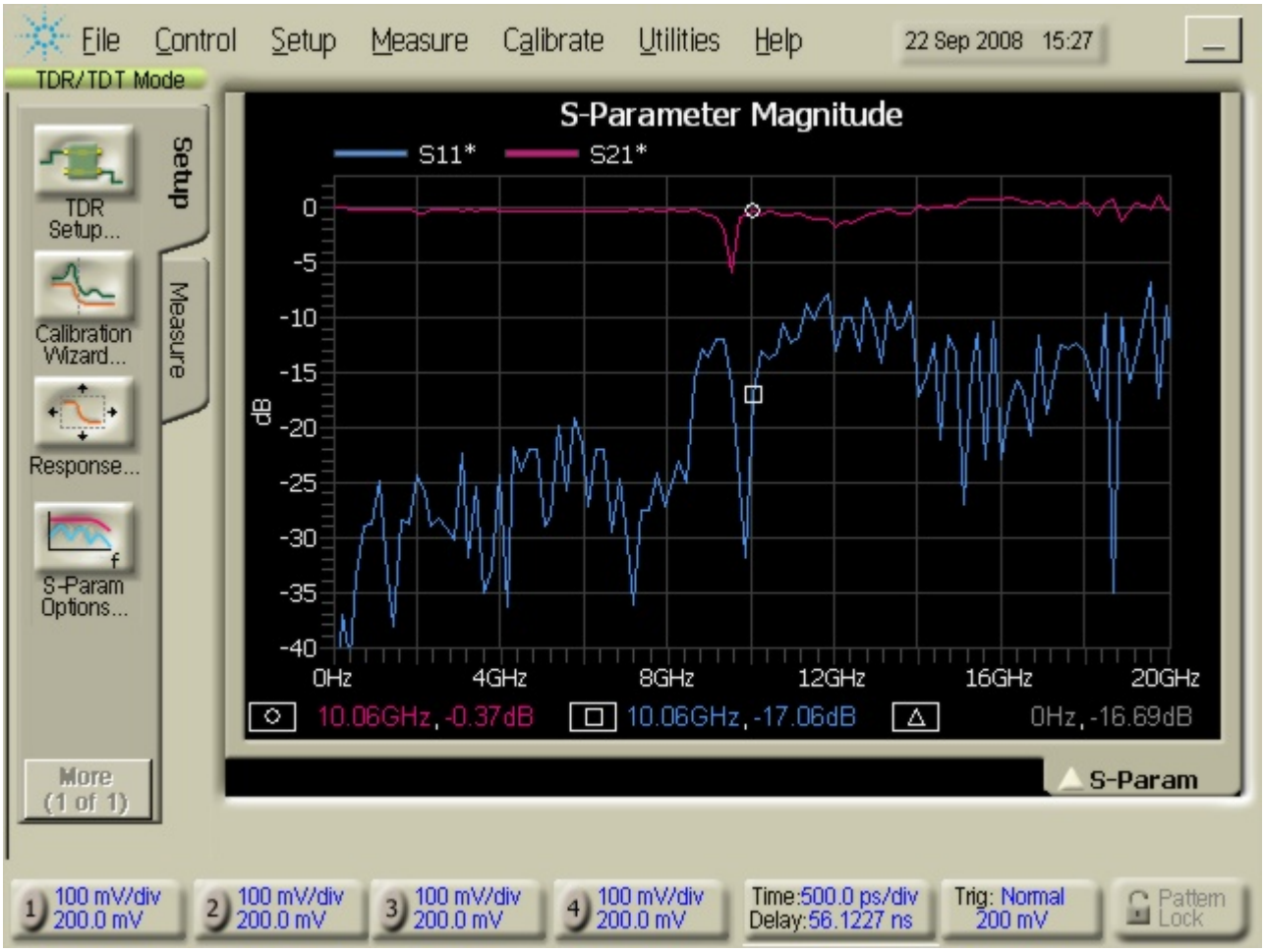


Figure 3
Test Board Via Notch.

This is not a function of the connector construction but a board to connector issue that is fixed in the final test board designs. This notch understates the return loss on connector j8-j9 by -7dB. Normalized for a good via, the return loss at 10GHz for the j8-j9pair is -17dB.

Impedance Measurements

The impedance measurements were taken under the same loopback conditions as the insertion loss measurements. A TDR measurement of maximum and minimum impedance was taken under three termination conditions and S11 return loss was also measured. These termination conditions were: 1) TDR into open, 2) TDR into short to GND, 3) TDR into 50 ohm load. Figure 4 shows the instrument setup for these measurements.

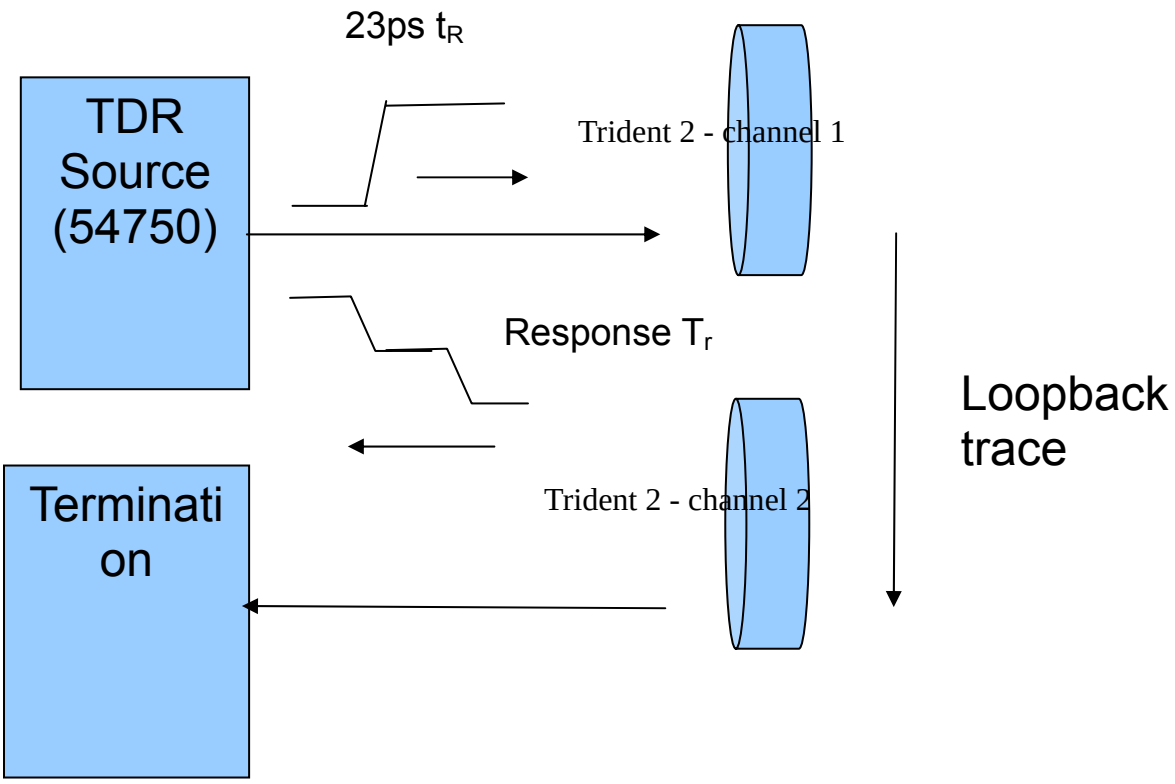


Figure 4
TDR Measurement Setup

A typical connector pair,TDR response into on open circuit is shown in figure 5.

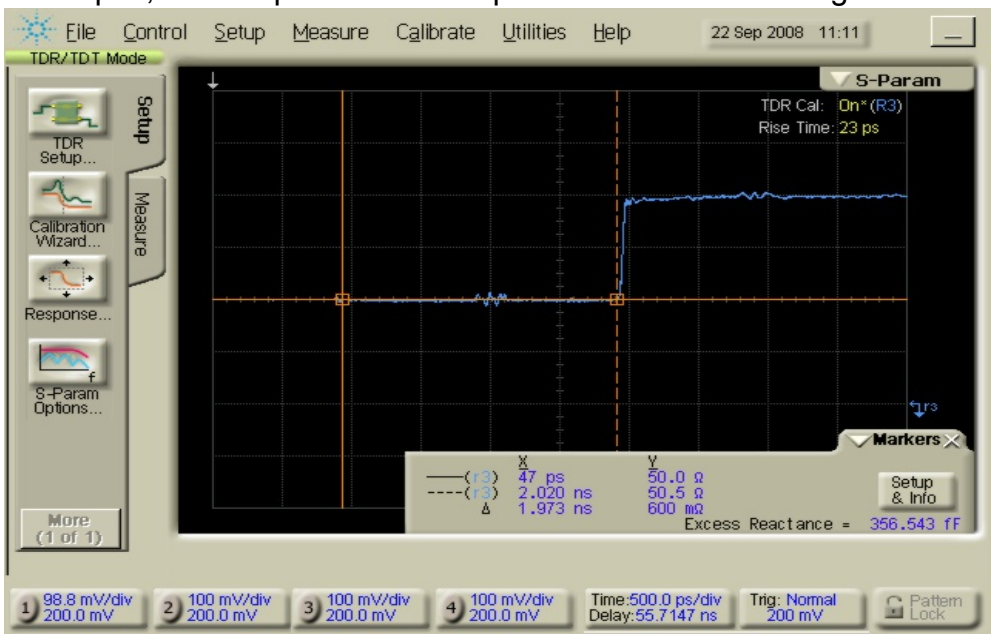


Figure 5
Nominal Connector TDR
into Open Circuit pair J1-J7

Note the board to connector response at the midpoint of the connector pair TDR. The nominal end to end average impedance is 50.25 ohms.

Zooming in on the connector/compliant pogo impedance we can see the signal pass through the connector to the board/via (figure 6).

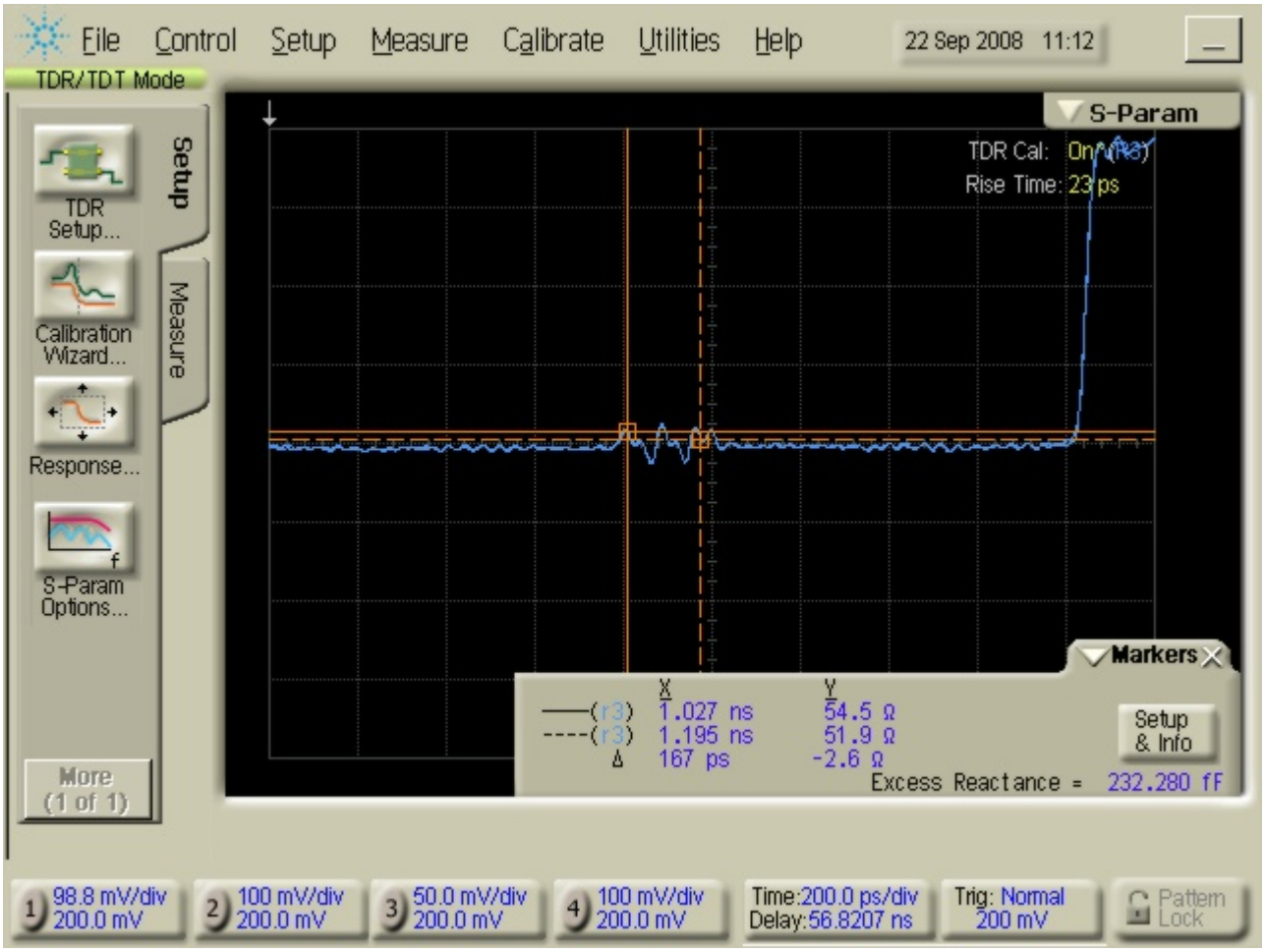


Figure 6
Connector Block to Board Impedance

The peak of the first connector to board transition is 54.5 ohms and the second channel impedance is 51.9 ohms. Future versions of this connector can improve the impedance of the pogo block to smooth this transition. Improvements will adjust the position of the GND returns and to lower the dielectric constant of the housing material slightly.

Table two summarizes the impedance measurements for the connector pairs.

Trident 2 Impedance Results

Connector Pair	Max Z_o Ch. A	Max Z_o Ch. B	Nominal Z_o
J1-> J7	54.5 Ω	52.9 Ω	50.25 Ω
J2->J3	53.5 Ω	55.4 Ω	50.70 Ω
J4->J5	51.1 Ω	55.2 Ω	50.25 Ω
J6->J12	54.7 Ω	53.2 Ω	50.20 Ω
J8->J9	54.3 Ω	54.8 Ω	50.25 Ω
J10->J11	56.0 Ω	54.5 Ω	50.15 Ω

Table 2

Channel T_{pd} and Channel to Channel Skew Measurements

Skew measurements were taken through a simple one channel TDR measurement into an open. The instrument was calibrated to one channel on the the Trident 2 connector with the skew measured against this channel for the remaining channels

A typical skew measurement is shown in figure 7.

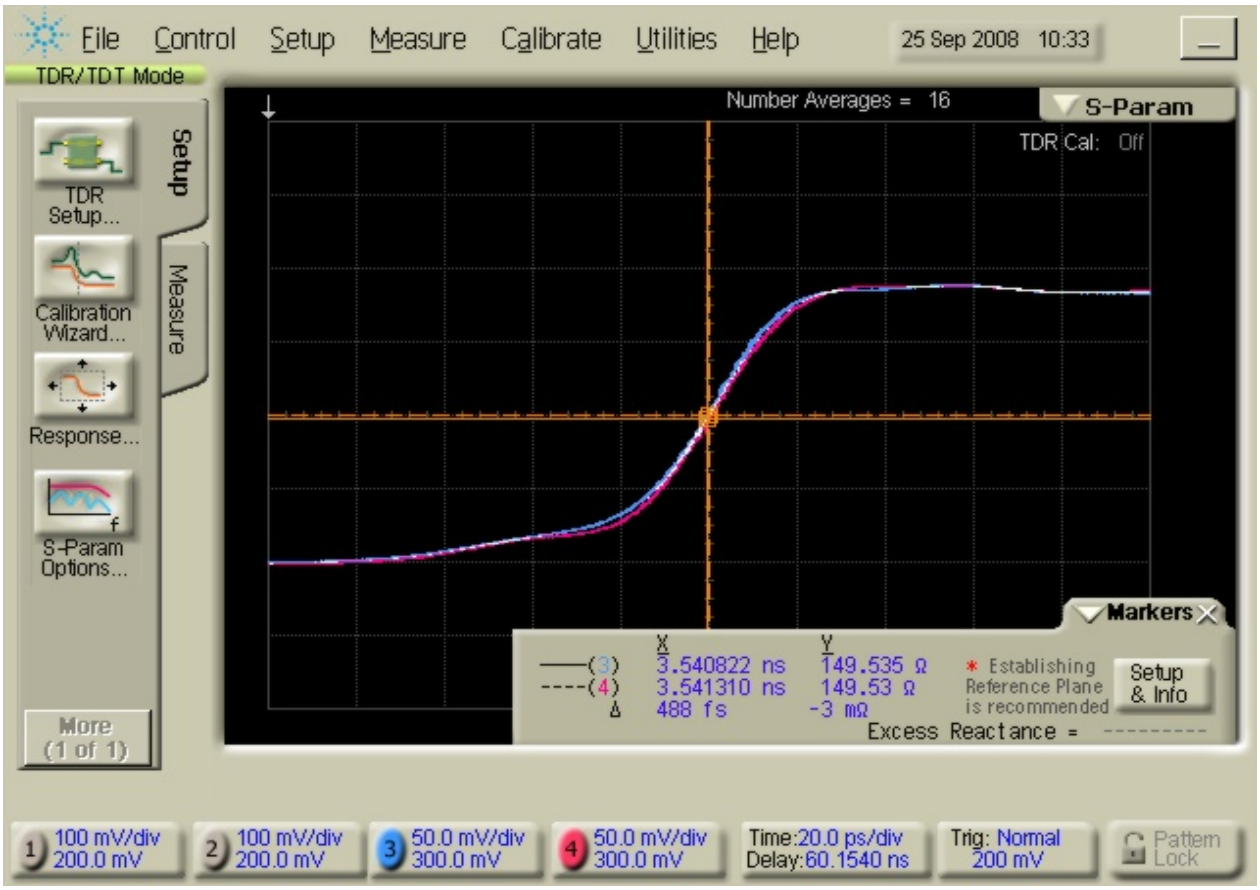


Figure 7
Typical Channel to Channel Skew J1 to J10

We can see here that the TDR reflected wave on signal J10 T_{pd} is 488fs longer than the reference signal on Trident 2 connector channel J1. Table 3 summarizes the channel to channel skew for the connector.

Trident 2 Channel to Channel Skew

Channel	Skew to Ref	
J1	0ps	reference channel
J1->J2	0.537ps	
J1->J3	1.318ps	
J1->J4	-1.611ps	
J1->J5	-0.098ps	
J1->J6	-1.573ps	
J1->J7	-2.637ps	
J1->J8	-0.439ps	
J1->J9	-0.391ps	
J1->J10	0.488ps	
J1-J11	-0.781ps	
J1-J12	0.537ps	

Table 3
Channel Skew

Operational Performance

Figure 8 consists of an EYE pattern measurement through a typical differential pair on the connector. This includes a typical 2 inch board trace to a pair of SMP test points.

This eye demonstrates clean operation and low attenuation to 12 GB/s, the project target. The eye channel length is dominated by the Trident 2 connector versus the calibrated cables and test connector.

Note the following:

T_{rise} is 43.85 ps versus the input signal at 39ps. The Eye height is 369mV versus the input eye height of 410mV and the eye opening is 70ps versus the calibrated input eye opening of 72ps. This performance is well beyond what is required to operate the device and leaves enough margin to perform the IO characterization tests this interface was designed to support.

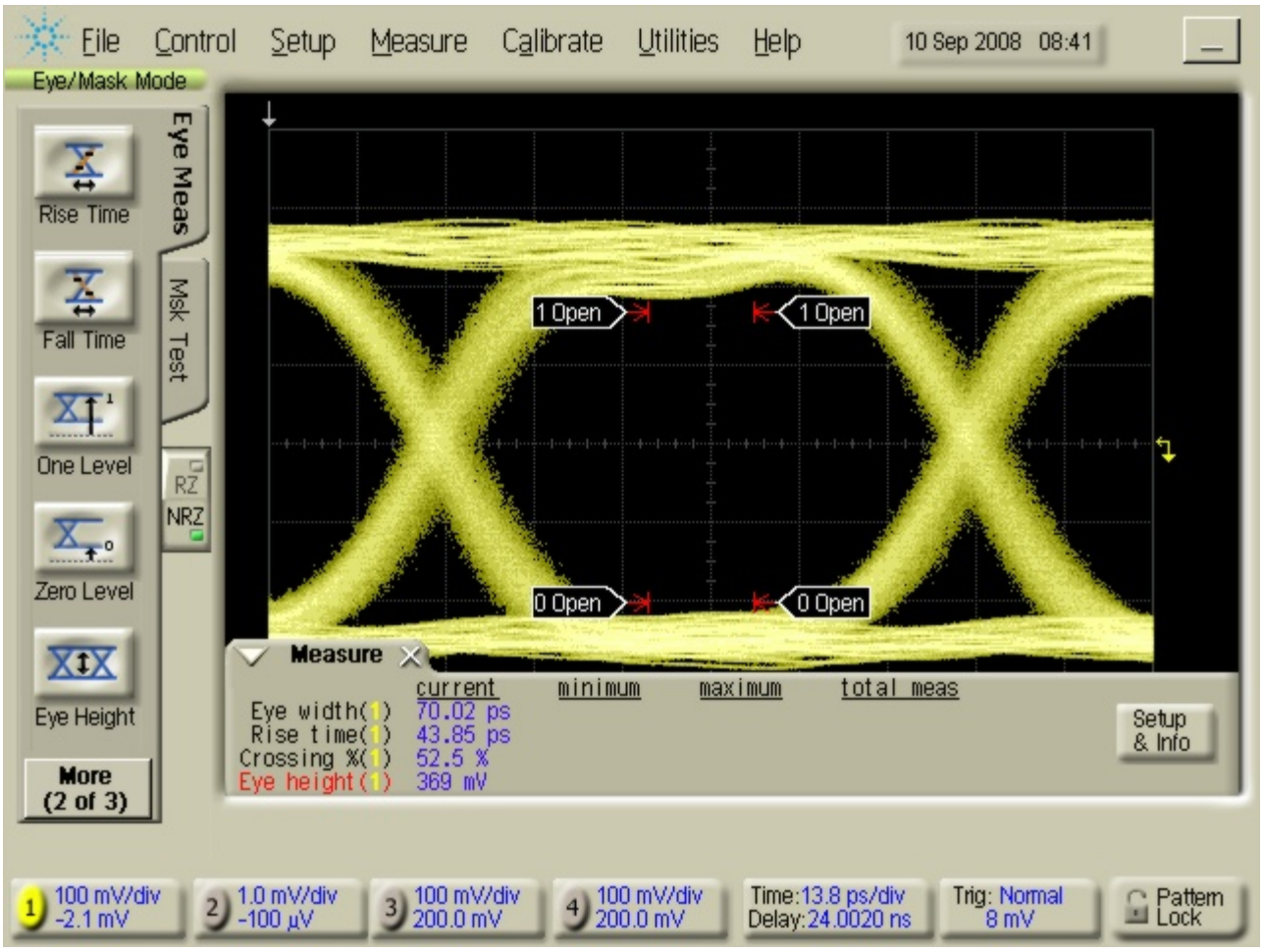


Figure 8
12 Gb/s Interface PRBS 2^7 Operational
Eye Pattern

Trident 2 Operating Specifications

In conclusion, the following are the operating parameters that we will base the Trident2 connector performance against. These are used for acceptance of new material and performance against calibrated standards (reference cable).

Trident 2 Operating Specifications

Specification	Value
Insertion Loss at 10 GHz	-1.2dB max
-3dB cutoff frequency	>18 GHz
Return Loss at 10 GHz	-15dB max
Channel to Channel Skew	+/- 2ps
Maxium Impedance deviation	55 ohms
Nominal Impedance Avg.	50.2 ohms
Typical Rise Time (1V differential)	43ps