



100G Backplane Link Feasibility Study: Time Domain Simulations Using Frequency Domain Measurement Data

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Objective:

To study the signal integrity characteristics of electrical backplanes focusing on 25Gbps serial transmission applicable to the 100Gb/s Ethernet backplane reach objective.

Configurations:

Daughter card → Backplane → Daughter card channels of multiple lengths (1m, 0.77m, 0.6m, 0.54m, and 0.42m) and material combinations (Megtron 6 and FR408).

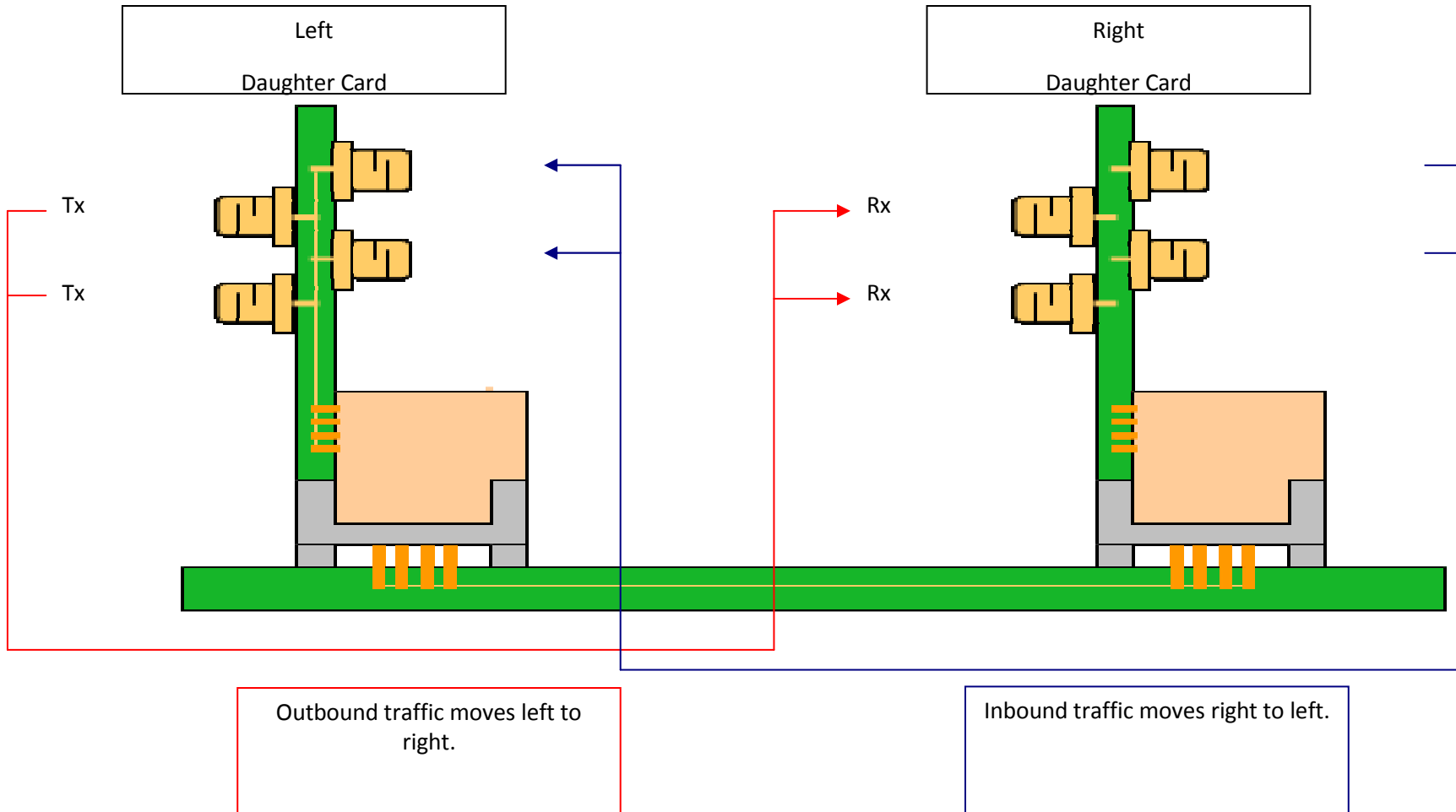
Methodology:

1. Frequency domain measurement and construction of Sparameters for Thru and Crosstalk
2. Silicon based time domain simulation using the measurement based Sparameters.

Data Presentations:

- Frequency Domain: IL(25GHz), ILD(16GHz), RL(16GHz), and ICR(12.5GHz)
- Time Domain: HEYE(%), VEYE(mV)

Backplane Configurations:



Connector Footprint and Grouping:

			1	2	3	4	5	6	7	8	9	10
A			G	S	G	S	G	L	G	S	G	S
B			S	S	S	S	L	L	S	S	S	S
C			S	G	S	G	L	G	S	G	S	G
D			G	S	G	S	G	L	G	S	G	S
E			S	S	S	S	L	L	S	S	S	S
F			S	G	S	G	L	G	S	G	S	G
G			G	S	G	S	G	L	G	S	G	S
H			S	S	S	S	L	L	S	S	S	S
J			S	G	S	G	L	G	S	G	S	G
K			G	S	G	S	G	L	G	S	G	S
L			S	S	S	S	L	L	S	S	S	S
M			S	G	S	G	L	G	S	G	S	G

TX LS RX

S: High-speed Signal

L: Low-speed Signal

Outbound-Inbound Mapping:



Mapping

Outbound



Inbound

AB

GH

BC

HJ

DE

KL

EF

LM

GH

AB

HJ

BC

KL

AB

LM

EF

Thru (victim) and crosstalk configuration:

DC columns under tests are wafers 8, 9, and 10. Corresponding BP columns are wafers 2,3, and 4. Pair definition is in terms of BP.

THRU:

Outbound H3J3 → Inbound B3C3B

Crosstalk, 3 wafers, 8 aggressors (FEXT):

A2B2

D2E2

K2L2

E3F3

L3M3

A4B4

D4E4

K4L4



PCB Construction, DC:

Board thickness = ~ 110 mil, 14 layers

Trace Length=5.1”

Optimal backdrilling used, stubs ~ 10 mil

Signal and ground vias

- Drilled hole = 0.457mm
- Finished hole = 0.371mm

Routing –

- AB, BC: Layer 12 – Signal 4
- DE, EF: Layer 10 – Signal 3
- GH, HJ: Layer 5 – Signal 2
- KL, LM: Layer 3 – Signal 1

PCB Construction, BP:

Board thickness = ~250.0 mil, 26 layers

Optimal backdrilling used, stubs ~ 10 mil

Signal and ground vias

- Drilled hole = 0.457mm
- Finished hole = 0.371mm

Routing:

- AB, BC: Layer 21
- DE, EF: Layer 19
- GH, HJ: Layer 17
- KL, LM: Layer 15

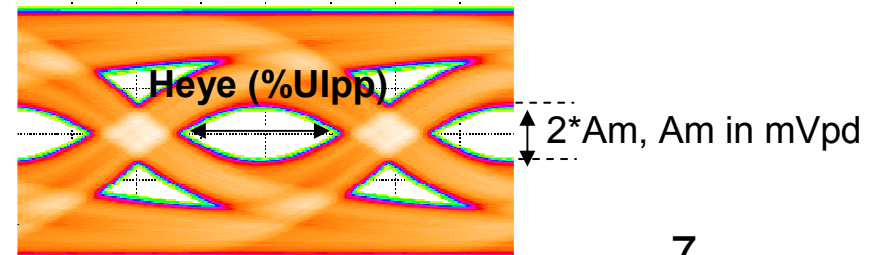
Comprehensive NRZ WC IC Model and Description of main parameters:

<u>Transmitter Characteristics</u>	<u>Receiver Characteristics</u>
<ul style="list-style-type: none"> ▪ 1T FFE4 (2pre, 1 post) ▪ 900mVppd launch amplitude ▪ Analog front end loss and reflections (S-parameters) 	<ul style="list-style-type: none"> ▪ DFE, Peaking amplifier ▪ AGC with actual min and max VGA DC gain values ▪ Analog front end loss and reflections (S-parameters) ▪ CDR actual behavior (includes algorithmic and quantization jitter)
<u>Degradation Model</u>	
<ul style="list-style-type: none"> ▪ 350fs rms RJ, 10% DJ (sine PM), 2% DCD ▪ 2.75mV rms Gaussian noise ▪ 20mVppd minimum receiver latch overdrive ▪ 50mm package model (25mm 100Ohms differential Tline) 	

Simulation results

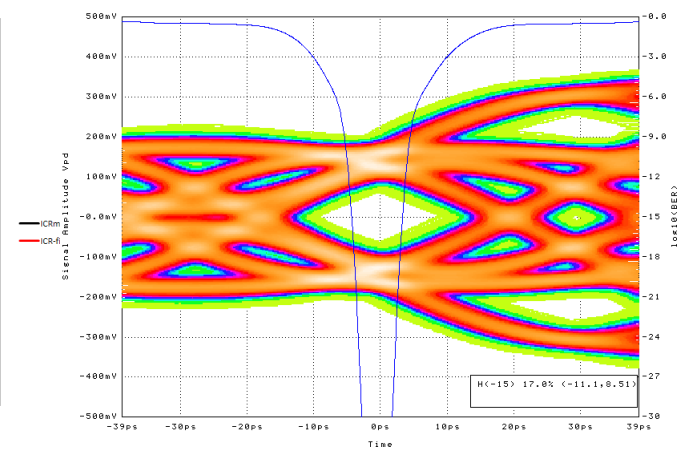
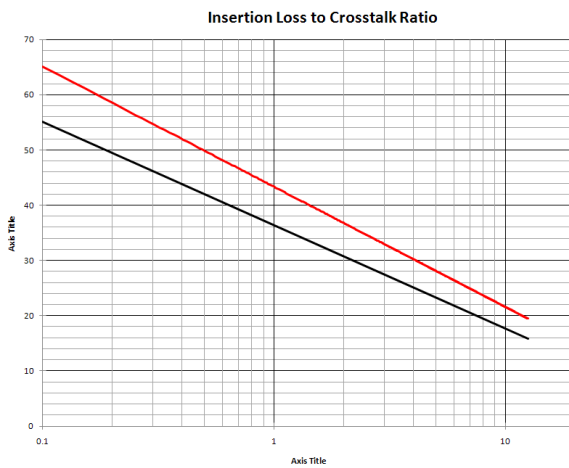
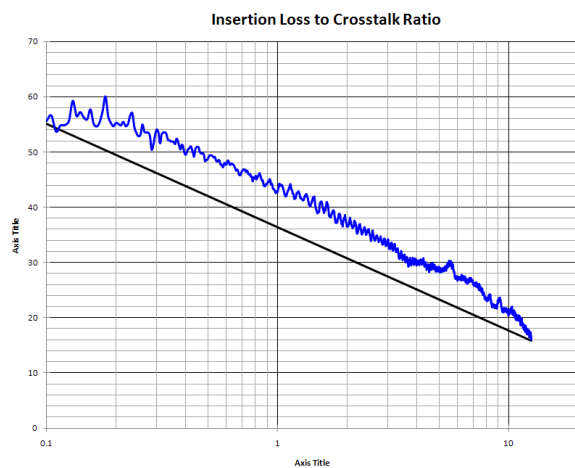
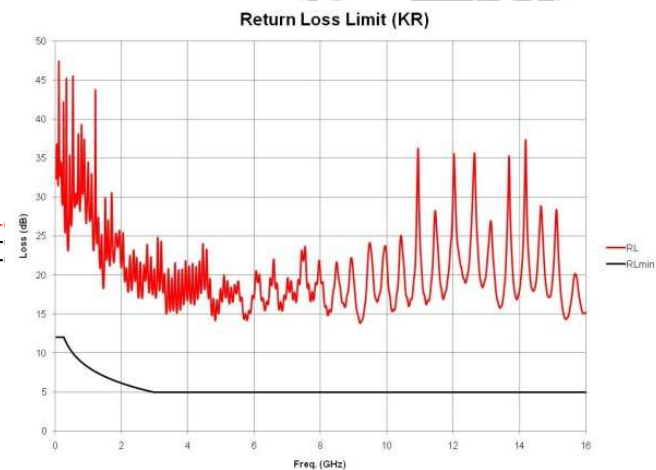
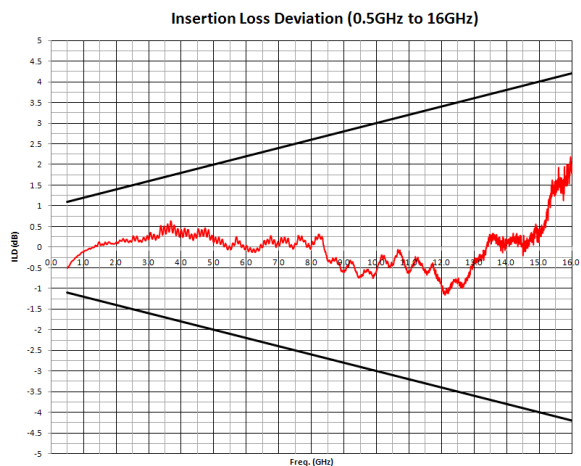
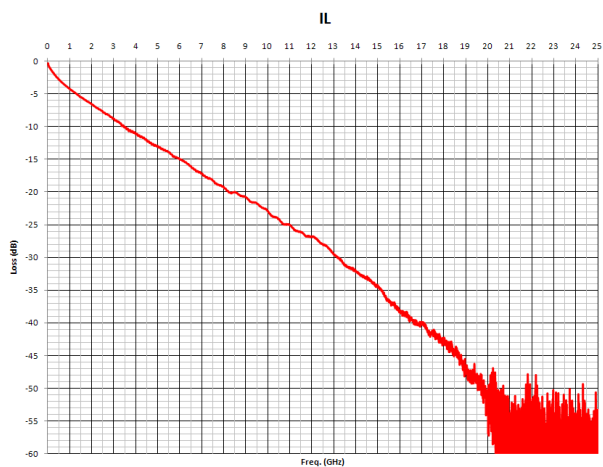
- Vertical (A_m) and Horizontal (Heye) eye opening margins at Rx sampling latch input, $1e-15$ BER
- 2.5M bits simulated, PRBS 31,
- 25.78125Gbaud

Equalized differential eye as seen at the Rx latch input



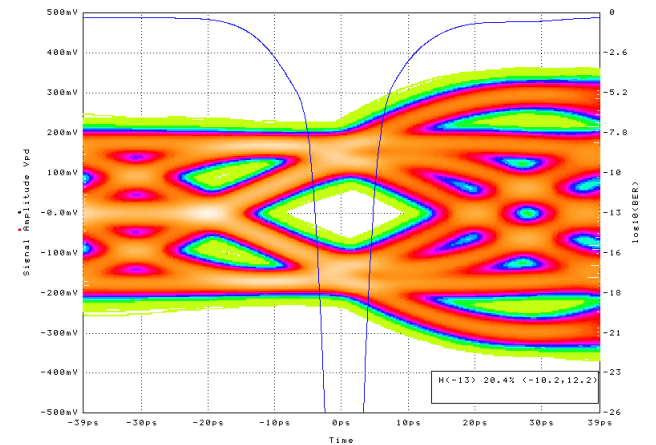
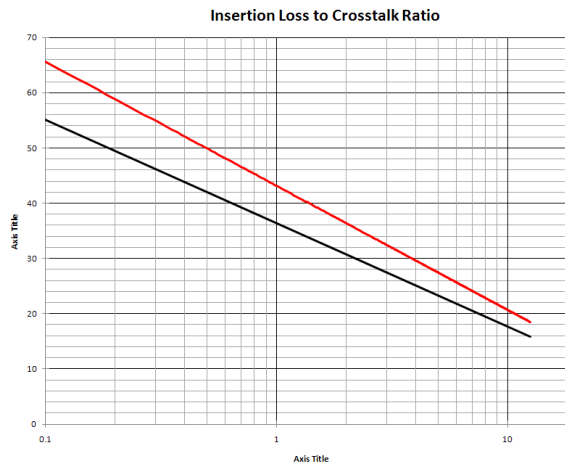
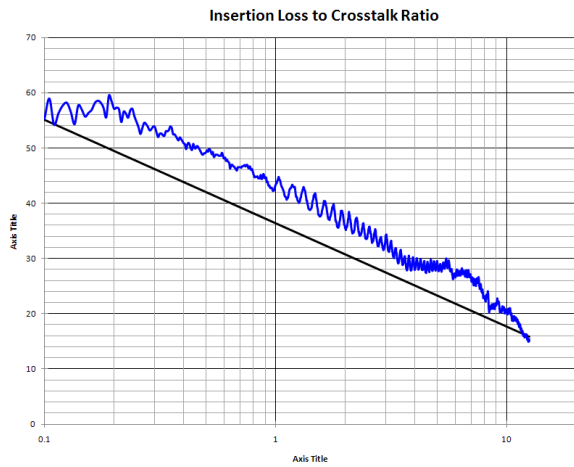
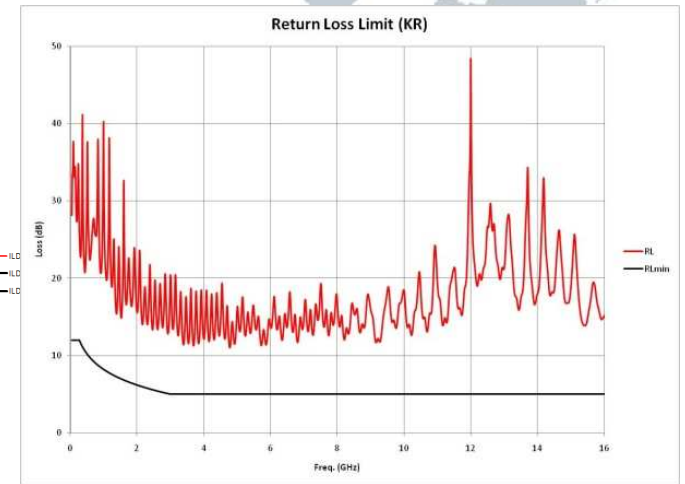
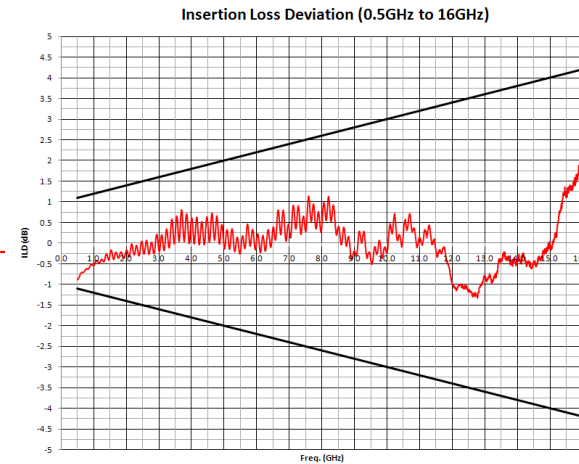
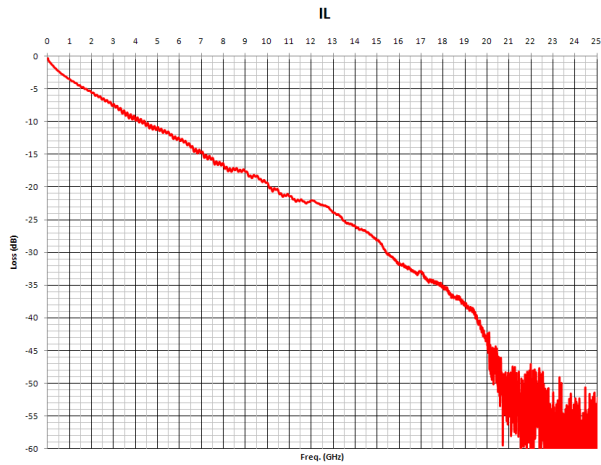


1.0 m Channel (Megtron6->Megtron6->Megtron6):



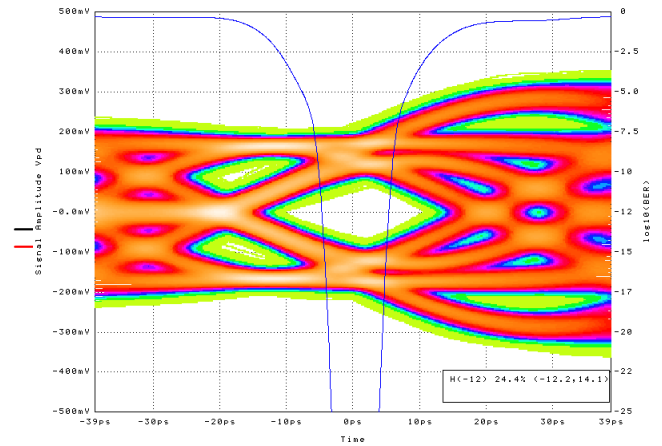
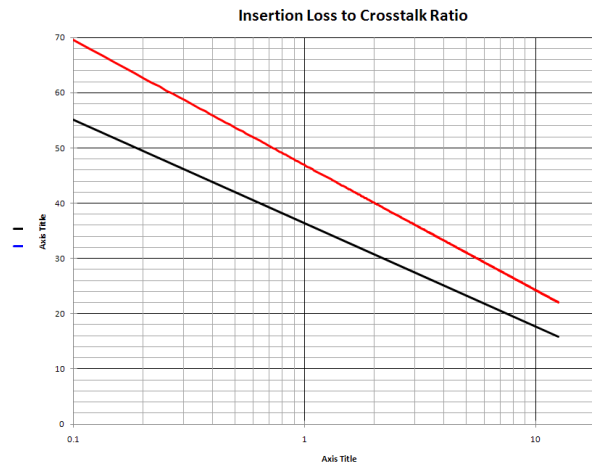
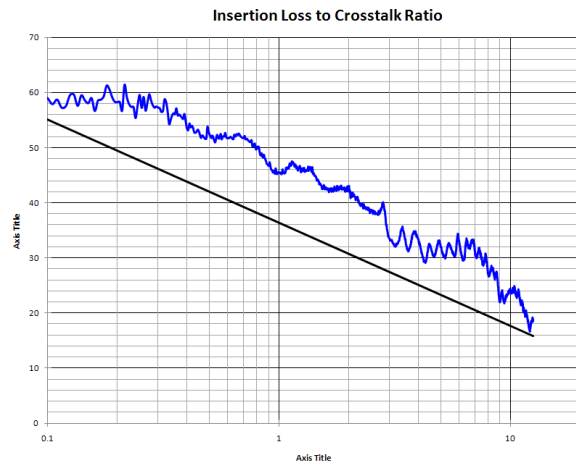
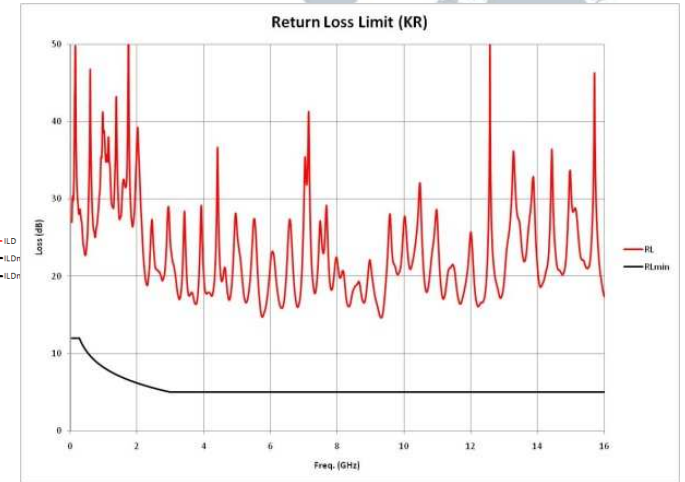
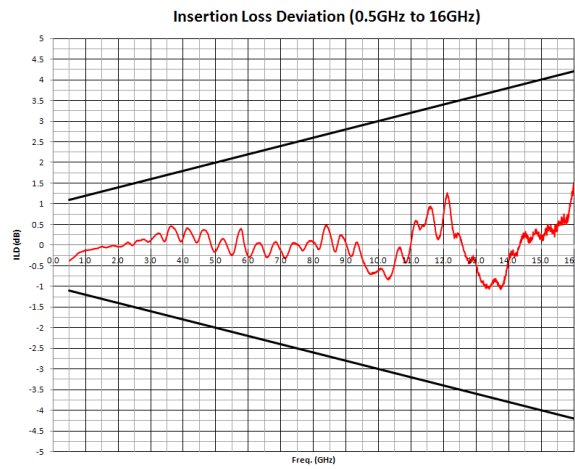
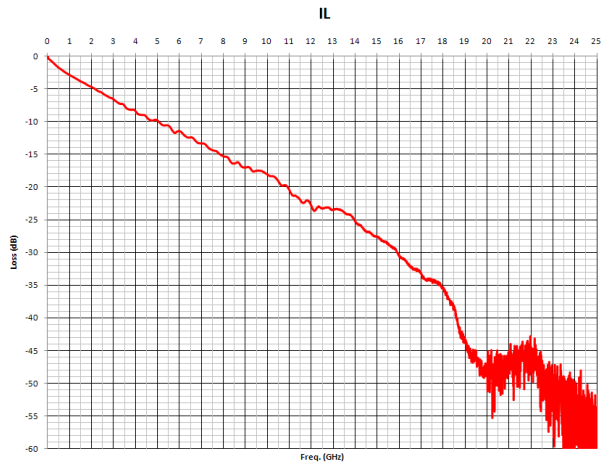
Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
1.0	29.1mV	19.3%	24.8mV	17.0%	-31.9	MEG6-MEG6-MEG6 8

0.77 m Channel (Megtron6->Megtron6->Megtron6):



Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.77	24.5mV	21.2%	23.9mV	18.9%	-26.4	MEG6-MEG6-MEG6 9

0.42 m Channel (FR408 -> FR408 -> FR408):



Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.42	23.5mV	24.4%	22.7mV	22.1%	-26.4	FR408-FR408-FR408 10

Eye Characteristics



Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
1.0	29.1mV	19.3%	24.8mV	17.0%	-31.9	MEG6-MEG6-MEG6
0.77	24.5mV	21.2%	23.9mV	18.9%	-26.4	MEG6-MEG6-MEG6
0.6	21.4mV	18.6%	20.5mV	16.2%	-23.9	MEG6-MEG6-MEG6
0.54	32.9mV	25.1%	32.3mV	22.9%	-22.0	MEG6-MEG6-MEG6
0.42	21.8mV	15.5%	20.9mV	13.1%	-18.7	MEG6-MEG6-MEG6
0.54	24.3mV	21.3%	23.5mV	19.0%	-26.8	FR408-MEG6-FR408
0.54	24.5mV	27.8%	23.6mV	25.5%	-27.0	MEG6-FR408-MEG6
0.42	23.5mV	24.4%	22.7mV	22.1%	-26.4	FR408-FR408-FR408

Conclusion



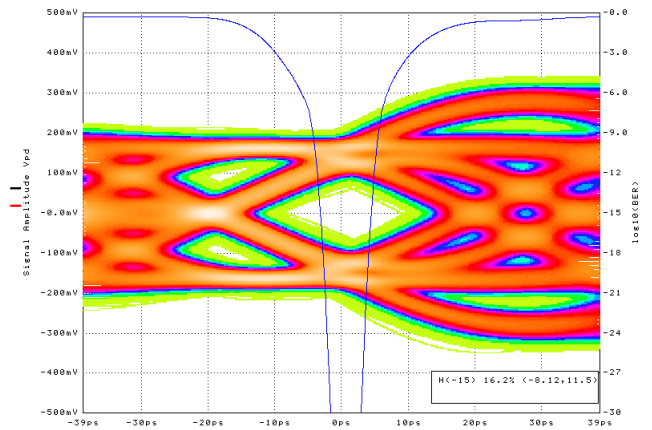
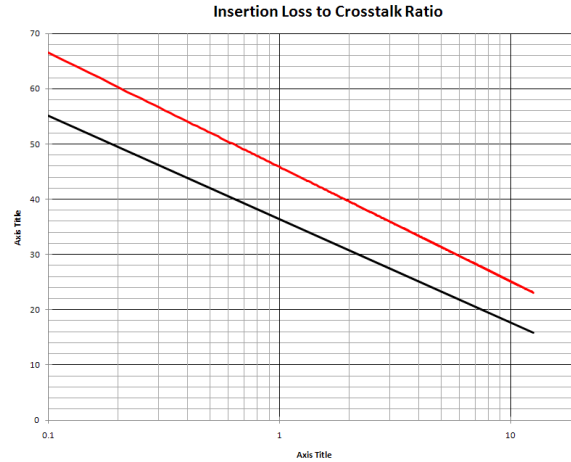
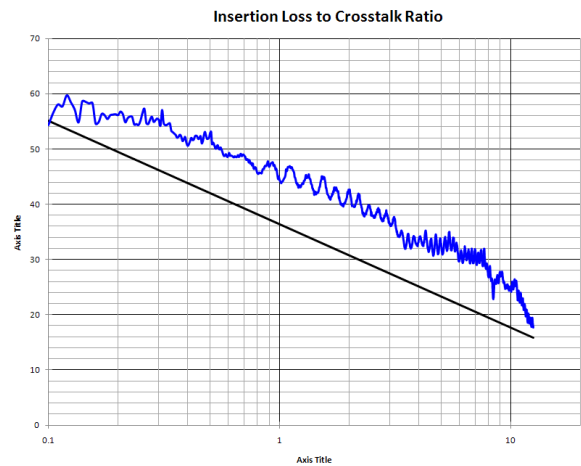
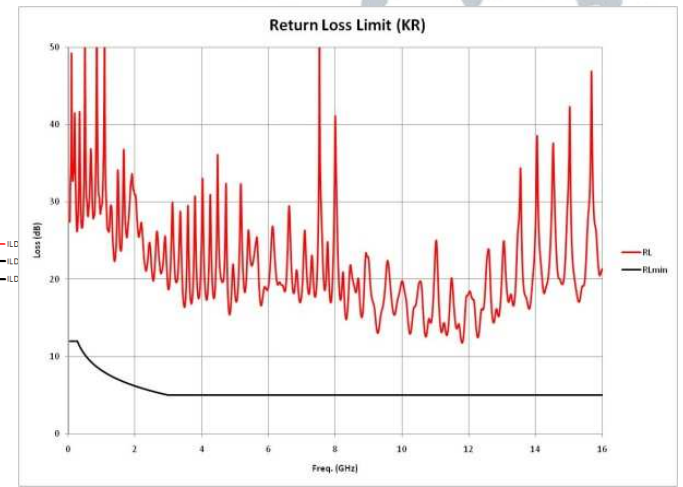
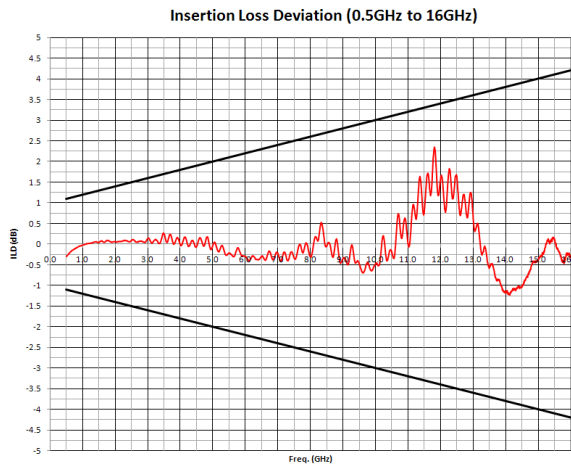
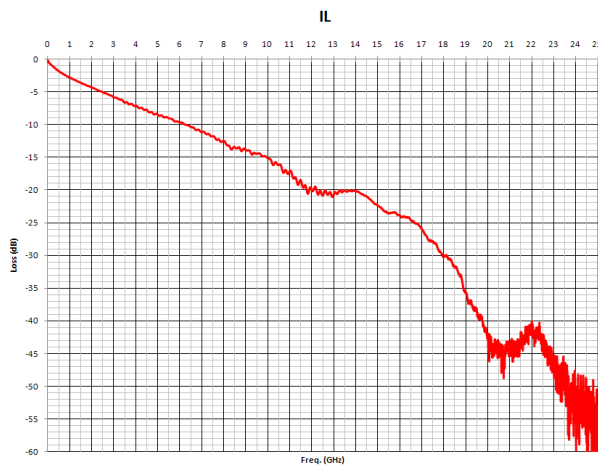
- **Channel loss ≤ 30 db loss can be constructed channel can be constructed and provide good Eye margins at BER better than $1e-12$ using NRZ**
- **Currently available connector, low loss materials, and board manufacturing technologies would support up to 0.77m for 25Gb/s, four lane 100Gb/s backplanes**



Backup

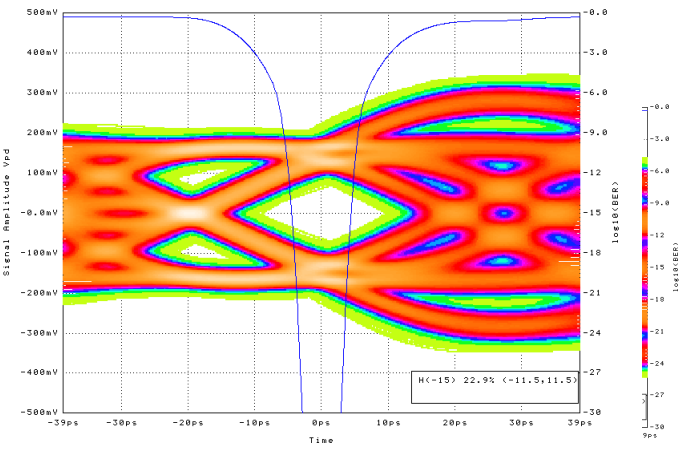
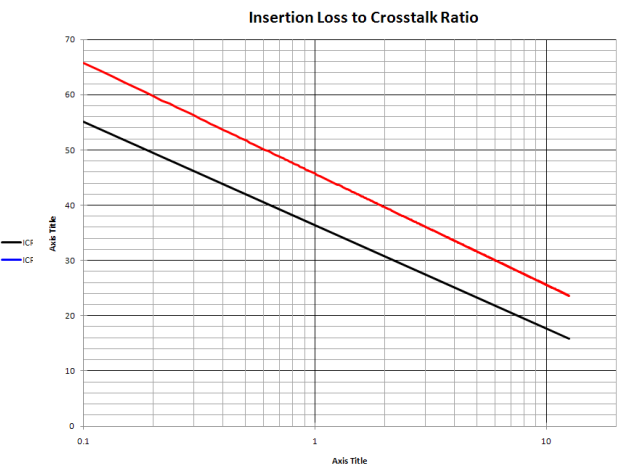
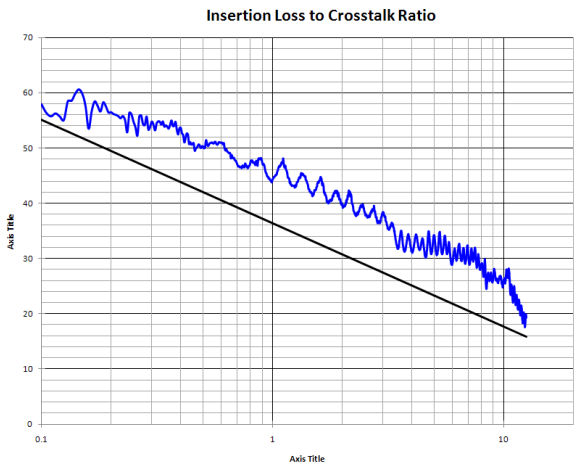
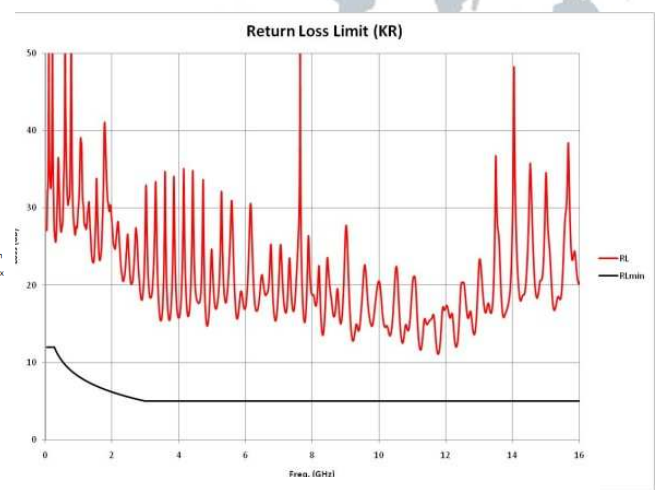
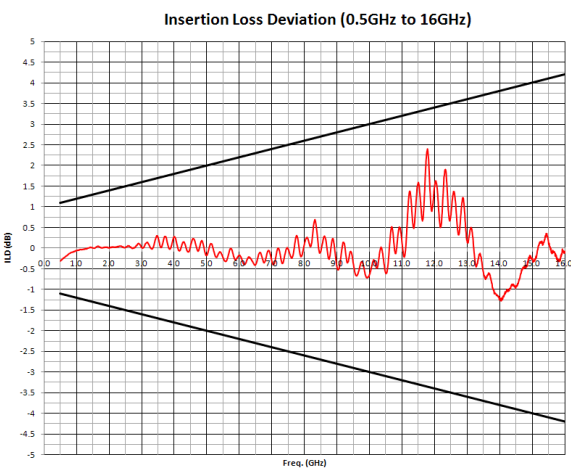
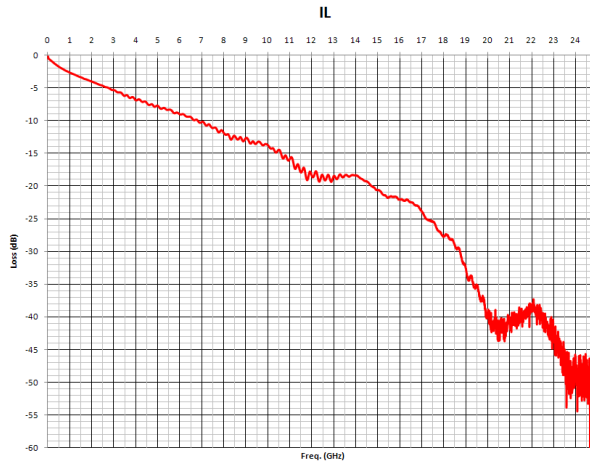


0.6 m Channel (Megtron6->Megtron6->Megtron6):



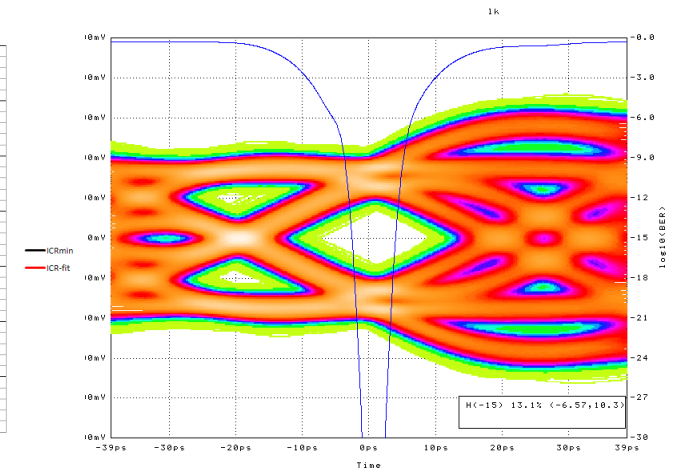
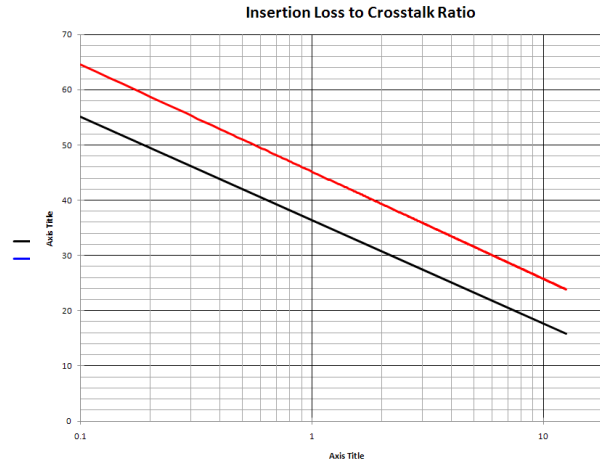
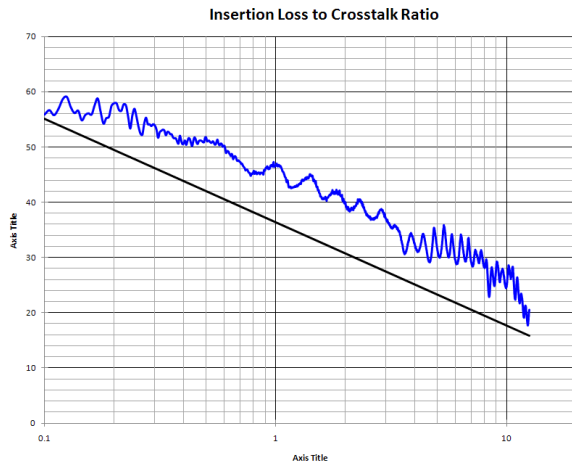
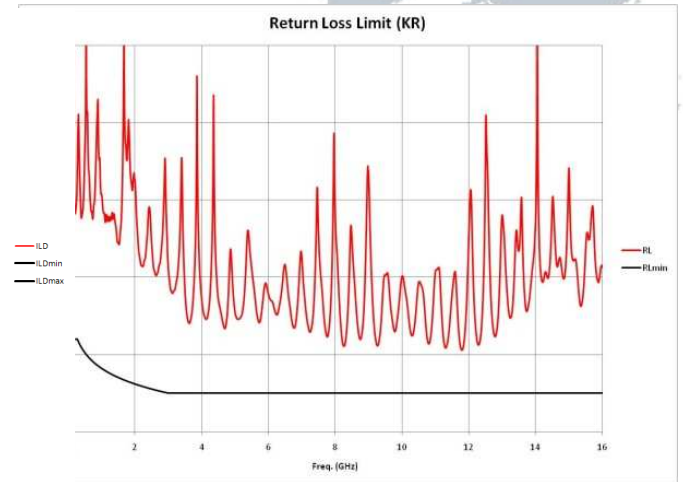
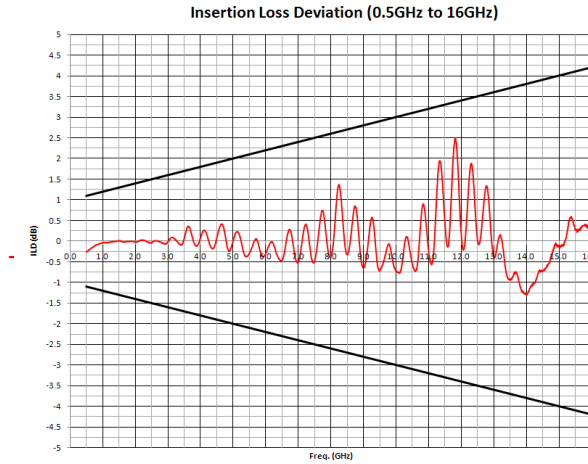
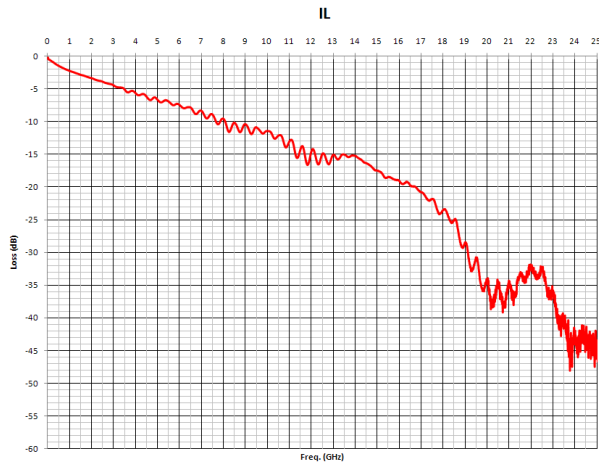
Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.6	21.4mV	18.6%	20.5mV	16.2%	-23.9	MEG6-MEG6-MEG6 ₁₄

0.54 m Channel (Megtron6->Megtron6->Megtron6):



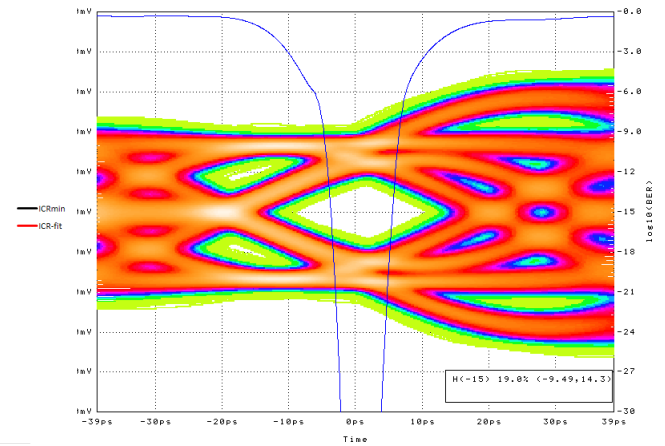
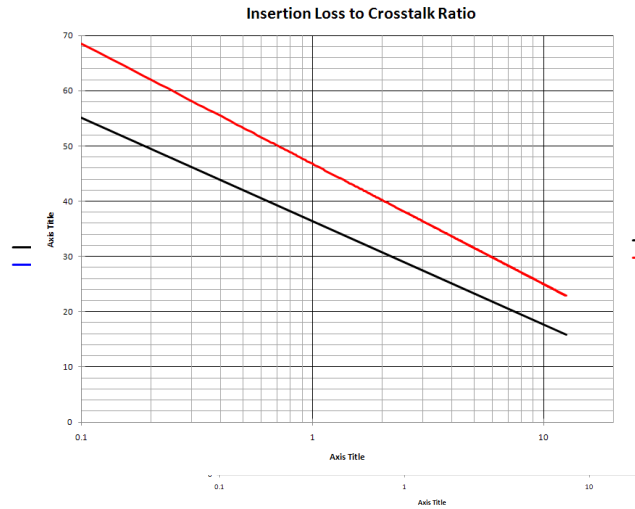
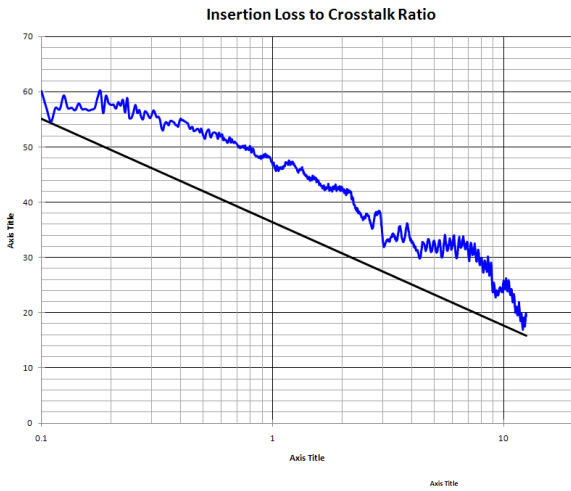
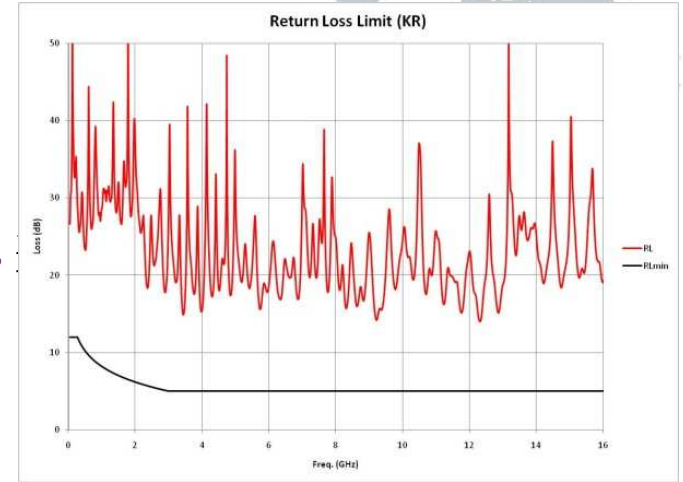
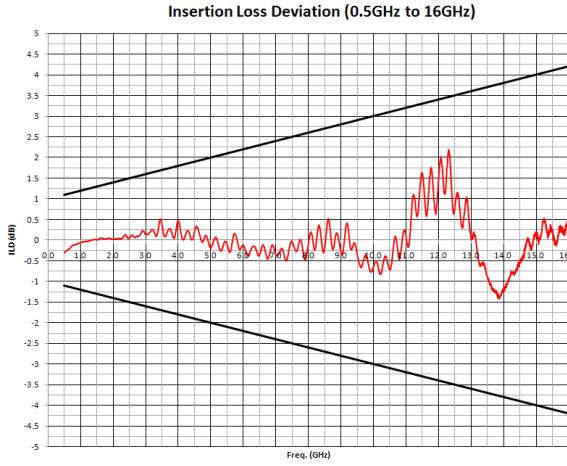
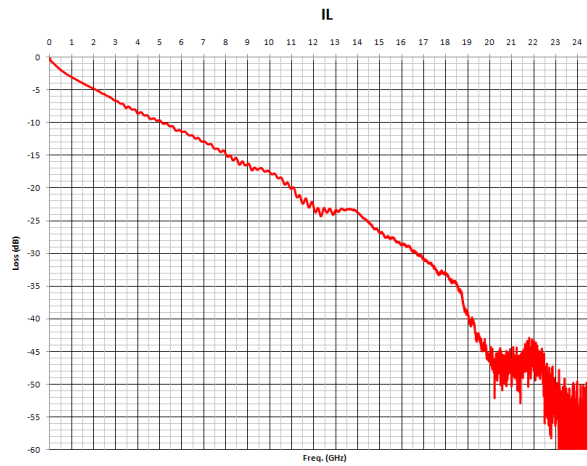
Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.54	24.3mV	21.3%	23.5mV	19.0%	-26.8	FR408-MEG6-FR408 15

0.42 m Channel (Megtron6->Megtron6->Megtron6):



Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.42	21.8mV	15.5%	20.9mV	13.1%	-18.7	MEG6-MEG6-MEG6 16

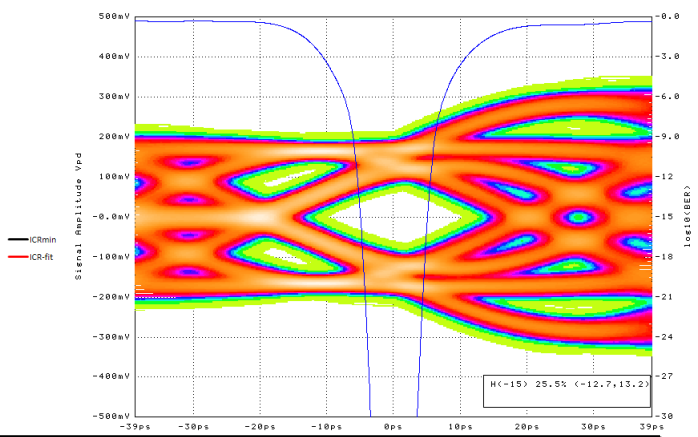
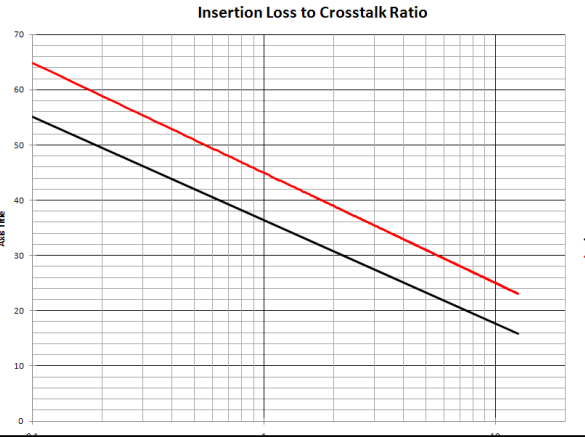
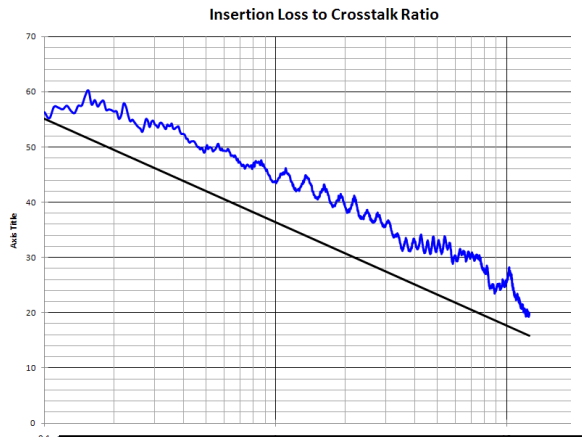
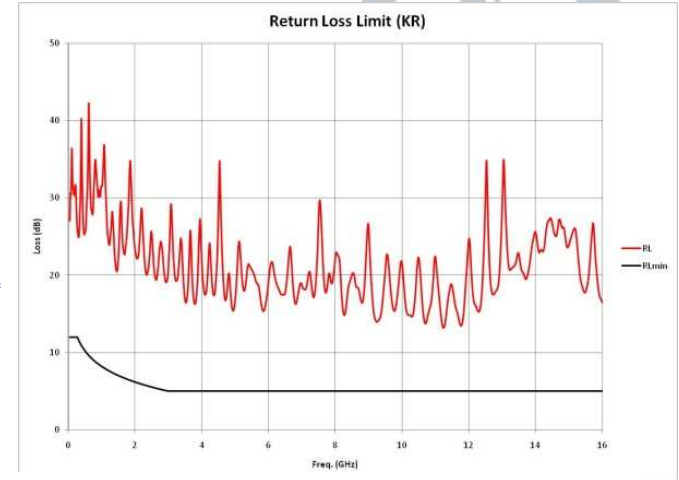
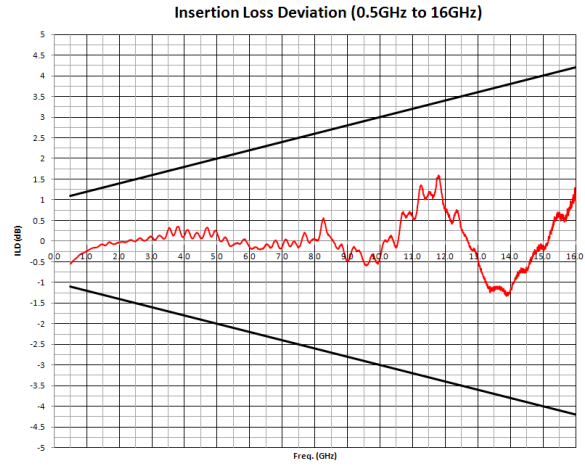
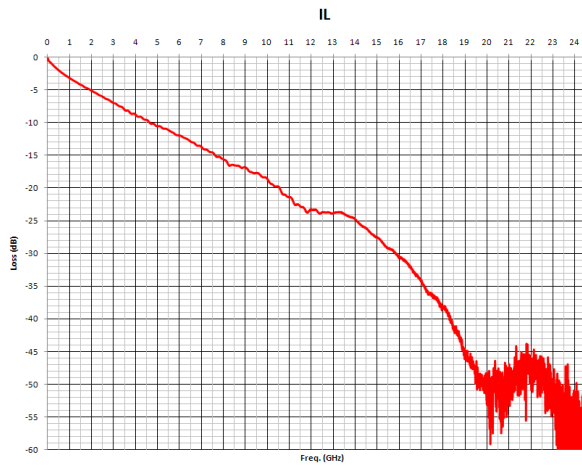
0.54 m Channel (FR408->Megtron6->FR408):



Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.54	24.3mV	21.3%	23.5mV	19.0%	-26.8	FR408-MEG6-FR408



0.54 m Channel (Megtron6-> FR408 ->Megtron6):



Channel Length (meter)	VEYE (1E-12)	HEYE (1E-12)	VEYE (1E-15)	HEYE (1E-15)	Channel Loss, dB (Including Package)	configuration
0.54	24.5mV	27.8%	23.6mV	25.5%	-27.0	MEG6-FR408-MEG6