4 Channel Very Short Reach 10 GBE Optical Transceiver

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4 Channel Solution Update

- **Sampling of Prototypes**
  - Initial Prototypes shipped Q3'00
  - Multiple vendors to supply starting Q1'01
- **Completed 1st Comprehensive Test**
  - 300 meters up to 70C with ALL channels on
- **Working with SerDes Vendors**
  - Reference designs with multiple SerDes vendors in process
- **4 Channel gaining momentum at OIF, Fiber Channel, and Infiniband**

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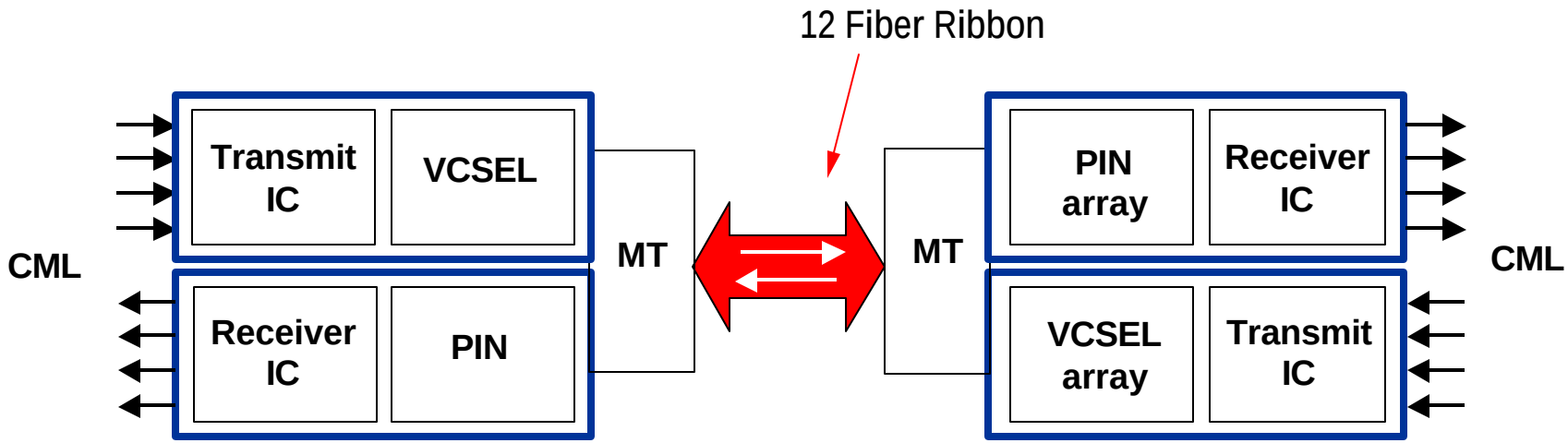
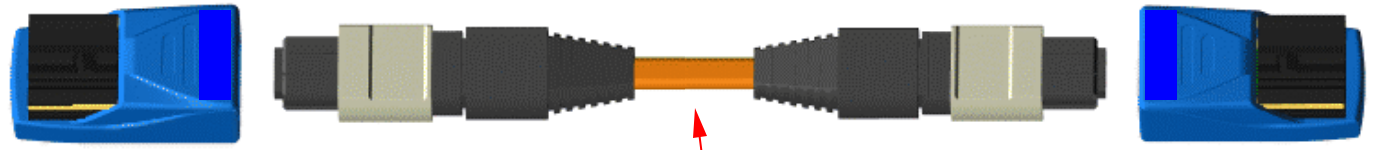
4 Channel Transceiver Implementation Diagram





Transceiver

12 Fiber Ribbon

(4 Tx; 4 Rx; 4 unused)

Transceiver

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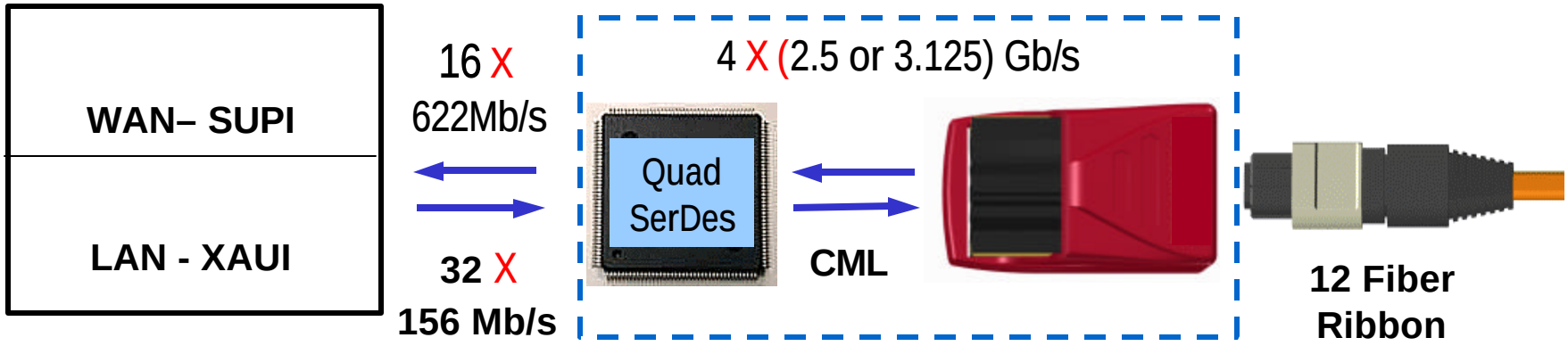
4 Channel VSR Architecture



- 4 channel transceiver @ 2.5 or 3.125 Gb/s
- 12 fiber ribbon (50um MMF bidirectional)
- WAN (SUPI) or LAN (XAUI) Interface
- Based on 850nm VCSEL, CMOS, BiCMOS
- Link length: 100m (LAN) or 300m (WAN)

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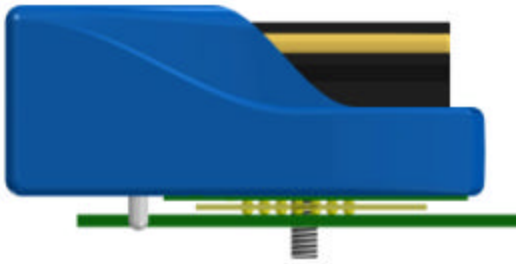
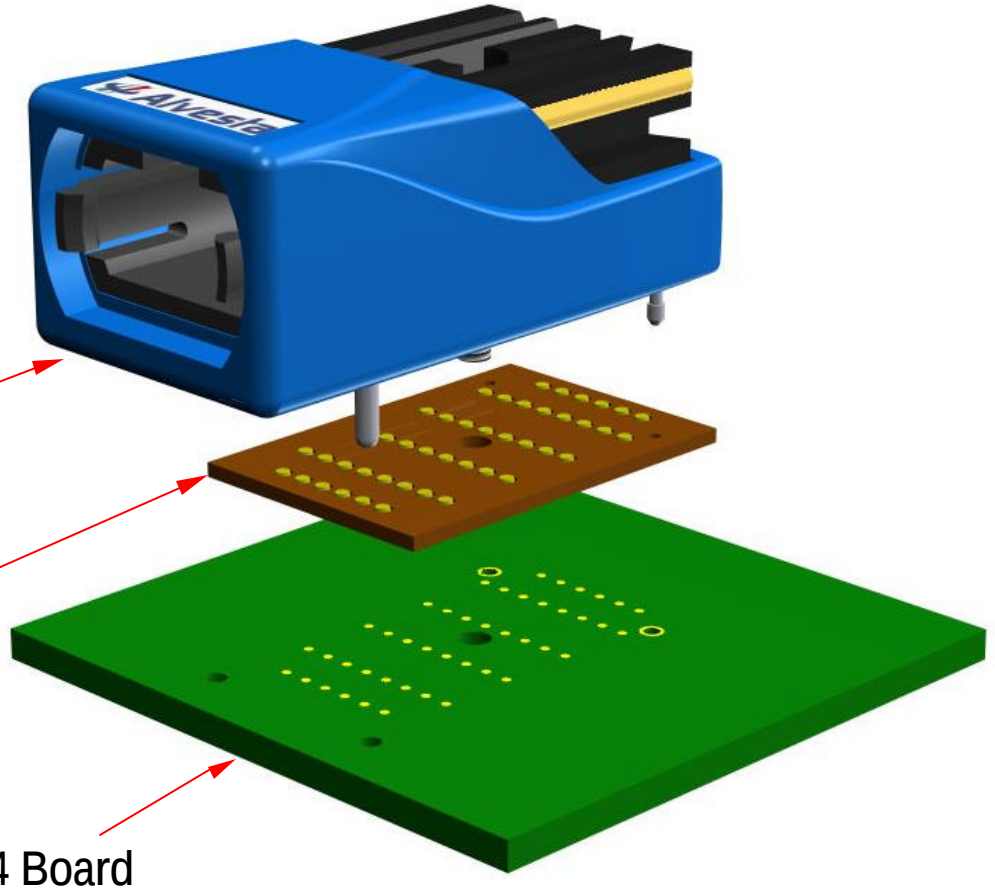
All Tests Performed using Elastomeric Contact

Side View





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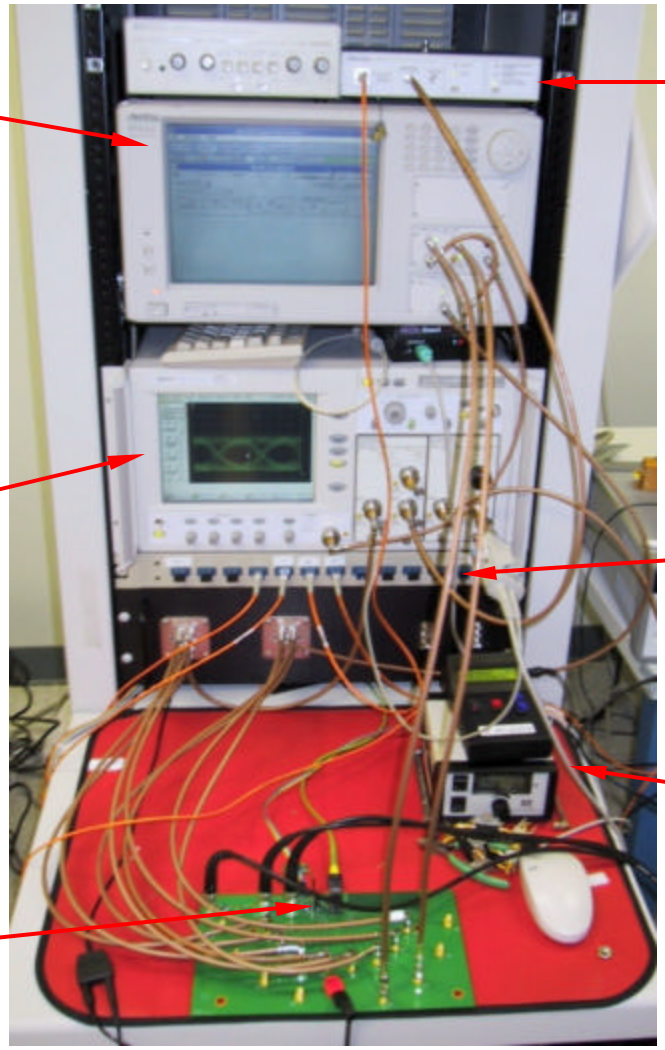
Module Test Setup



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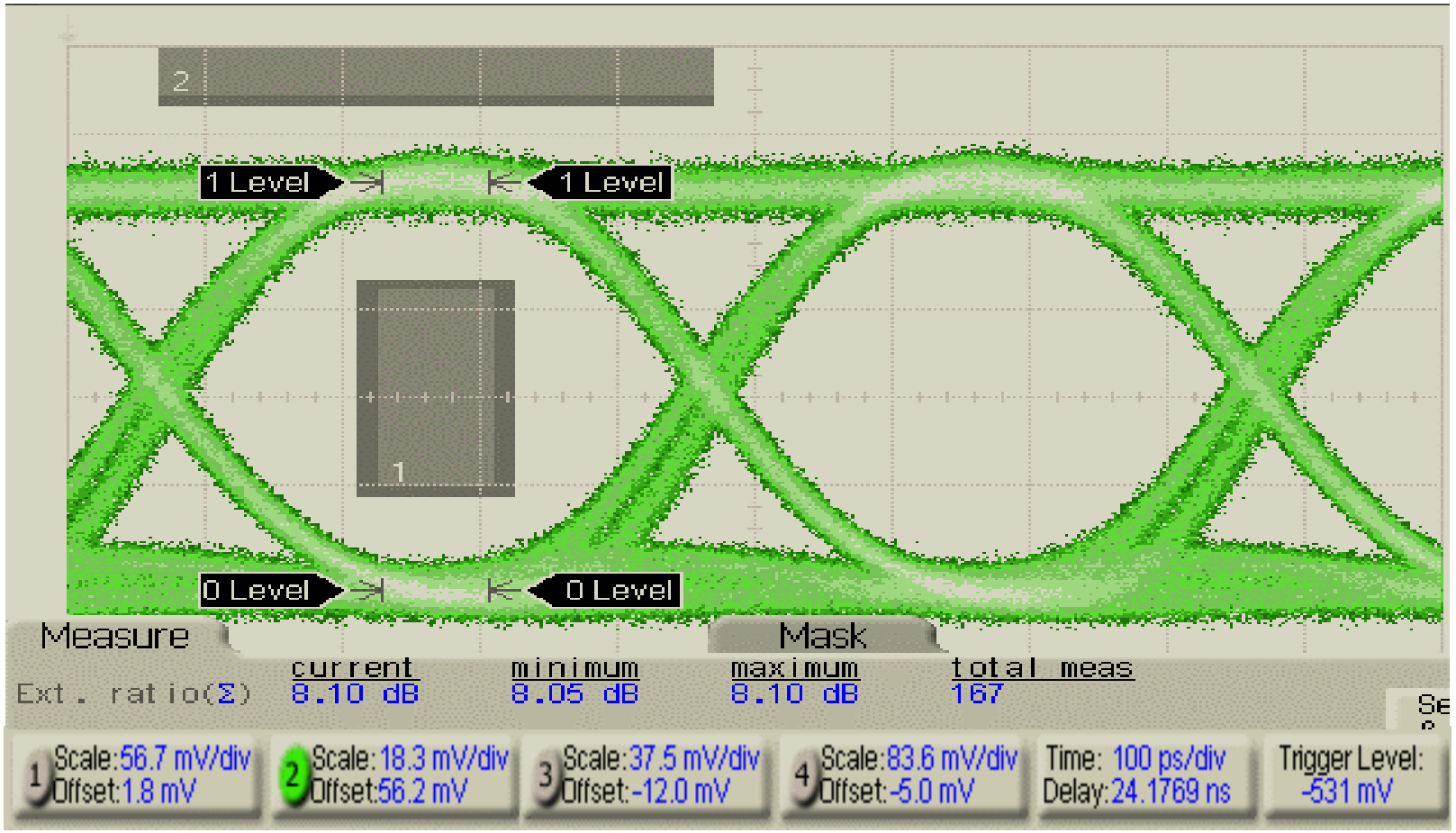
Tx Optical Eye at 2.5 Gb/s with Eye Mask

Eye Mask: STM-16/OC-48



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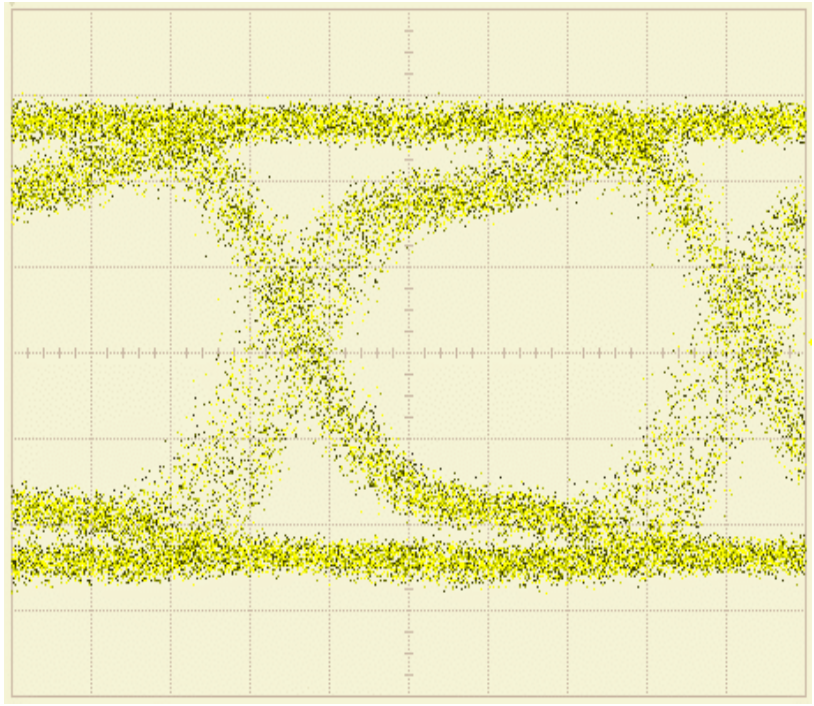
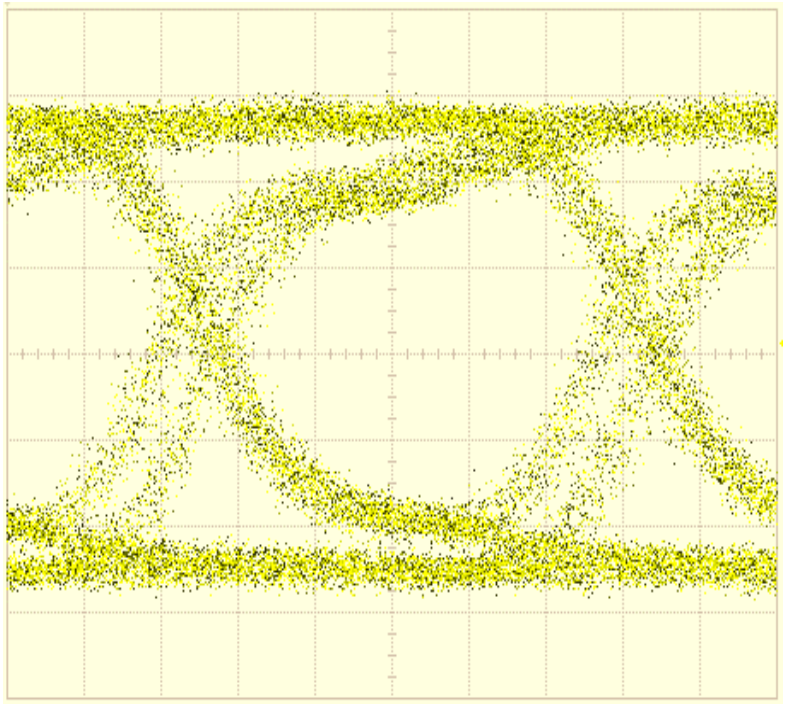
Worst Case Rx Eye over 300m @ 2.5 Gb/s

All Tx & Rx On, Min. Launch Power (-8dBm), 1.5 dB Connector Loss, 300m



300m at 25°C

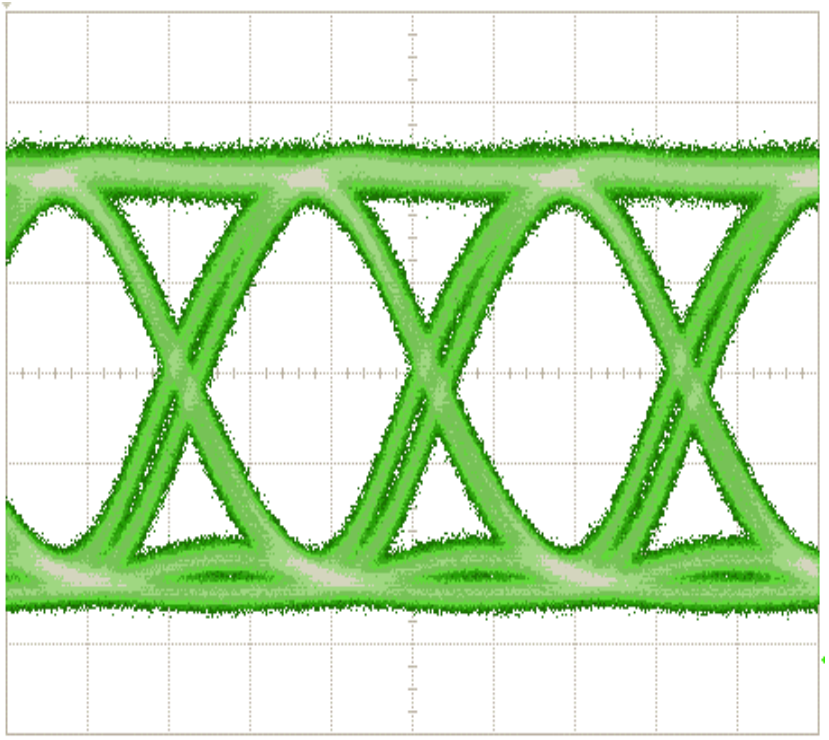


300m at 70°C

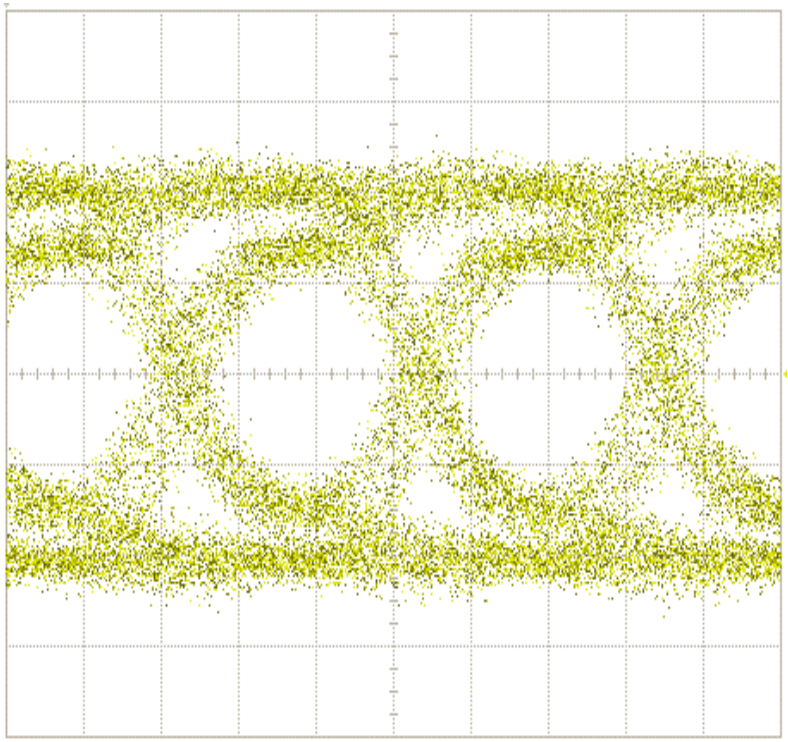
1 Scale:50.0 mV/div Offset:-6.2 mV	2 Scale:18.5 mV/div Offset:50.4 mV	3 Scale:84.9 mV/div Offset:-6.7 mV	4 Scale:83.6 mV/div Offset:-5.0 mV	Time: 70.0 ps/div Delay:24.0957 ns	Trigger Level: -531 mV

*Optical & Electrical Eye @ 3.125 Gb/s **

Tx Optical Eye



Rx Electrical Eye



* measured with 2.5 Gb/s filter (3.125 Gb/s unavailable a.t.o.t.)

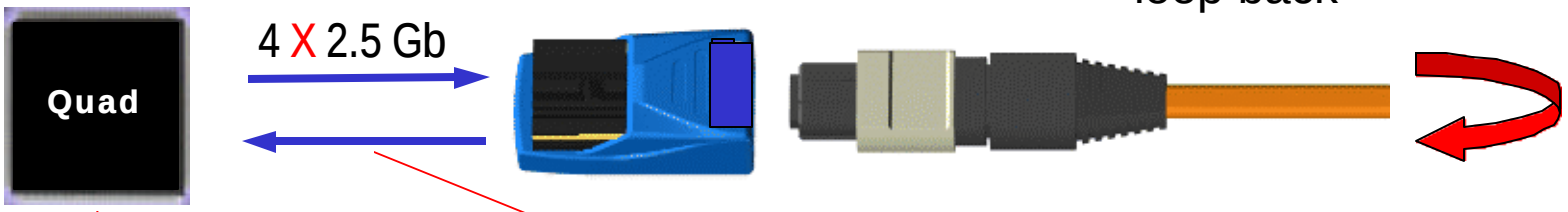
1	2	3	4		
Scale:59.5 mV/div Offset:1.4 mV	Scale:18.9 mV/div Offset:60.3 mV	Scale:16.5 mV/div Offset:-1.5 mV	Scale:83.6 mV/div Offset:-5.0 mV	Time: 100 ps/div Delay:24.0295 ns	Trigger Level: -543 mV

Working Demo. Thru Quad SerDes (8/10/00)

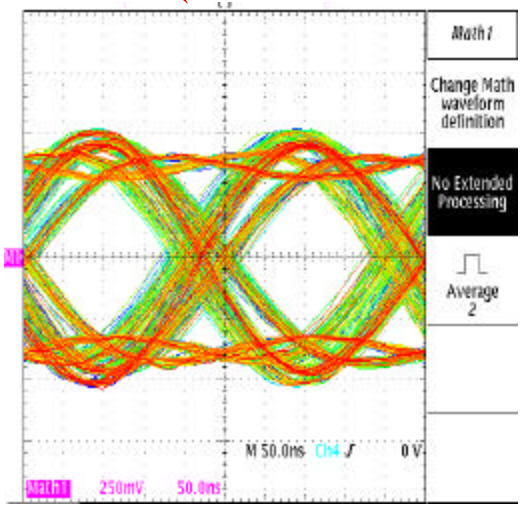
Quad SerDes

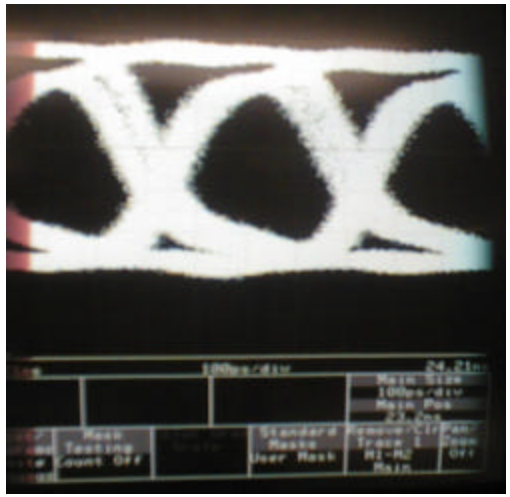
4 Channel Transceiver

200 meter optical loop back



Non Optimized Test





SerDes Rx Signal after 200m

Transceiver Rx after 200m

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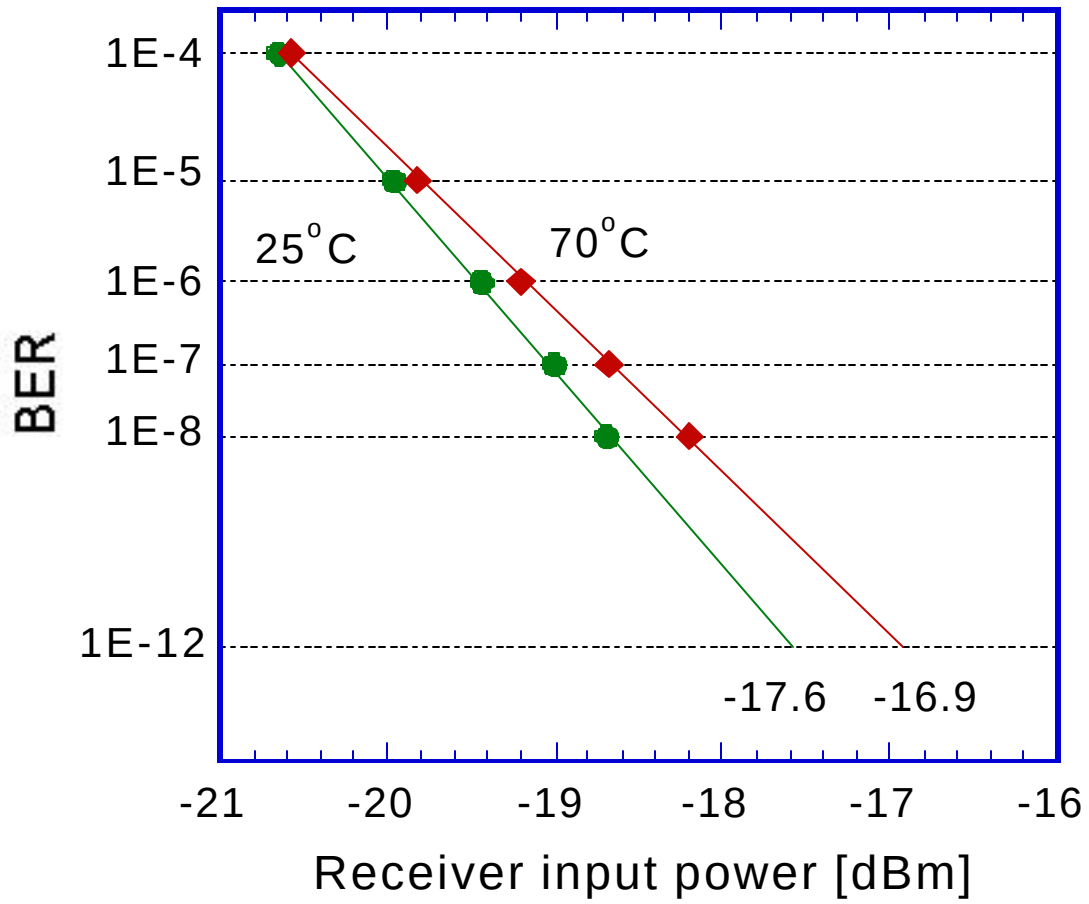
Receiver sensitivity vs. temperature



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Crosstalk Measurements at BER 10^{-12}

- Ch-to-Ch Crosstalk Penalty: -1.9 dB
- Rx-to-Tx Crosstalk Penalty: -0.1 dB

Worst case	Sensitivity* (dBm)	CrossTalk Penalty (dB)
1 Rx Channel On PRBS 2^{23}-1	-17.0	
4 Rx Channels On PRBS 2^{23}-1	-15.1	-1.9
4 Rx and Tx Channels On PRBS 2^{23}-1	-15.0	-2.0

* Includes 2.2 dB ER penalty

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Proposed link parameters for 4X2.5Gb/s

Parameter	MIN	TYP	MAX	UNIT
Transmitter				
Optical power out	-8		-3	dBm
Center wavelength	830		860	nm
Extinction ratio	6			dB
T_{rise}/T_{fall} (20%/80%)			140	ps
RIN			-116	dB/Hz
Total jitter		135		ps
Receiver				
Optical power in	-16		-3	dBm
Center wavelength	830		860	nm
Return loss	12			dB

(OIF 2000.076)

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4 Channel Transceiver Summary

Broad Market Potential

- 66% of 10GBE Interconnects (< 50m - Jumper)
- Multiple Vendors to source PMDs & Quad SerDes
- Prototypes shipped Q3'00, Production Q1'01

Technical Feasibility: 4 Channel works TODAY!

- Testing over temp. at 300m
- Excellent EMI design
- Evolutionary Approach (Least Technical Risk)

Economic Feasibility

- Lowest cost solution with a Quad SerDes
- Low Power Consumption (est. 1.5W)
- Small profile: (1/2) the size of a SMFF LC

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