
802.3ba Cu specifications

Chris Di Minico
MC Communications
cdiminico@ieee.org

Contributors

- **Galen Fromm, Jim McGrath - Molex**
- **Jens Aumann, Leoni High Speed Cables**
- **Vivek Telang, Broadcom**

Supporters

- **Dan Dove, ProCurve Networking by HP**
- **Shimon Muller, Sun Microsystems**

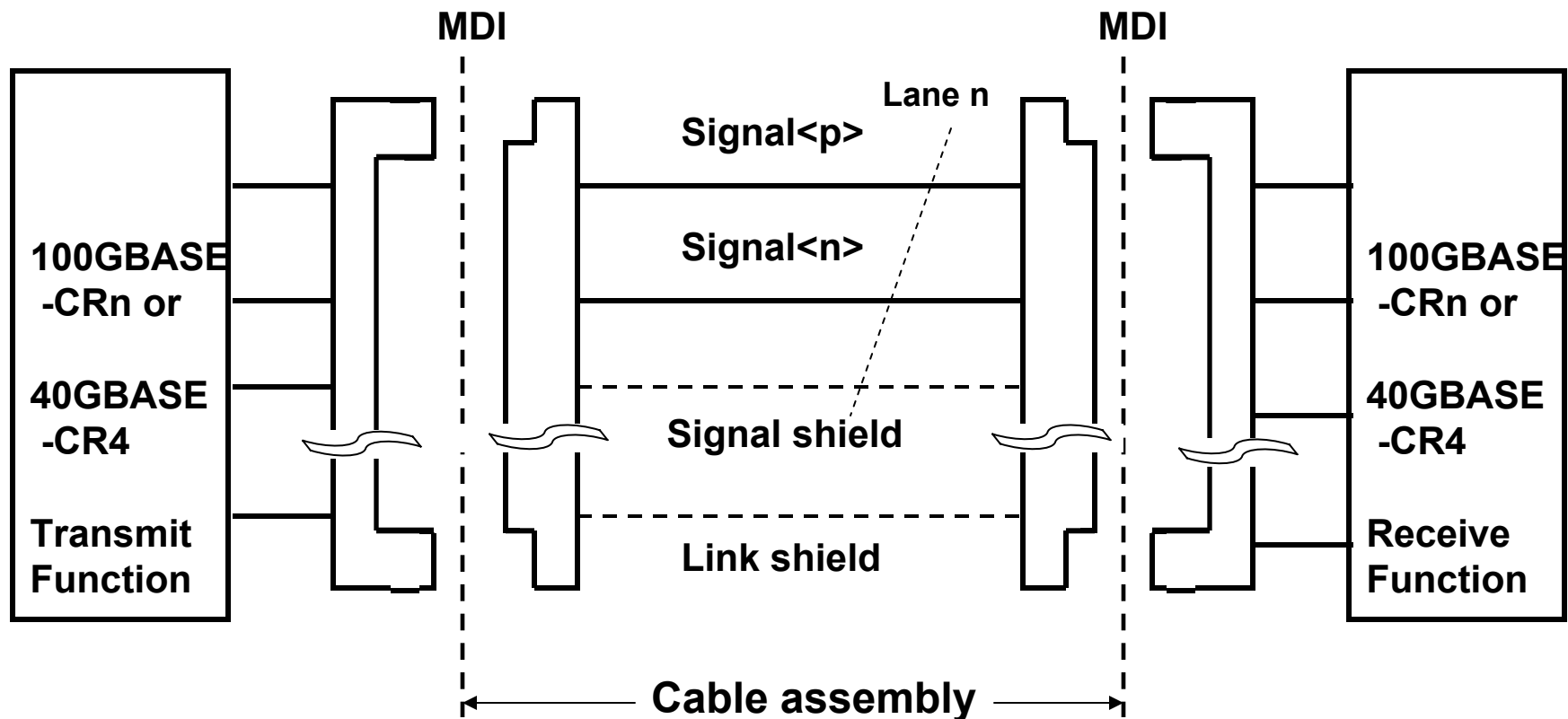
Presentation objectives

- **Considerations for 802.3ba Cu specifications for baseline proposal.**
- **Measurement models and simulation models in development to evaluate usage of 10GBASE-KR (Clause 72) for 10 Gb/s lane options for both 40GBASE-CR4 and 100GBASE-CR10 cable assemblies.**
- **QSFP cable connector and 10 meters of twinaxial cable considered for 40GBASE-CR4 cable assemblies.**

802.3ba objectives

- Support full-duplex operation only
 - Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
 - Preserve minimum and maximum FrameSize of current 802.3 standard
 - Support a BER better than or equal to 10^{-12} at the MAC/PLS service interface
 - Provide appropriate support for OTN
- **Support a MAC data rate of 40 Gb/s**
 - Provide Physical Layer specifications which support 40 Gb/s operation over:
 - at least 100m on OM3 MMF
 - **at least 10m over a copper cable assembly**
 - at least 1m over a backplane
 - **Support a MAC data rate of 100 Gb/s**
 - Provide Physical Layer specifications which support 100 Gb/s operation over:
 - at least 40km on SMF
 - at least 10km on SMF
 - at least 100m on OM3 MMF
 - **at least 10m over a copper cable assembly**

40GBASE-CR4 and 100GBASE-CRn link



Cu cable assembly baseline proposal

- Evaluate usage of 10GBASE-KR (Clause 72) and 10GBASE-CX4 to specify 40GBASE-CR4 and 100GBASE-CR10
 - For commonality with 40 Gb/s backplane proposal:
 - 64b/66b PCS
 - Signaling speed 10.3125 Gbd (per lane)
 - Optional FEC sublayer (TBD)
- Evaluate usage CX4 for commonality with twinaxial cable assembly usage and specifications (plug-and-play over all specified distances)
 - S-parameters (+ additional parameters i.e., group delay, etc..)
- QSFP MSA – 10 Gb/s lane operation demonstrated up to 10 meters of twinaxial cable
- Group delay differences between backplane and twinaxial cable assemblies (64b/66b spectra versus 8b/10b)

Copper cable assembly: PHY lane options discussed

- Support a MAC data rate of 100 Gb/s
- Provide Physical Layer specifications which support 100 Gb/s operation over:
 - at least 10m over a copper cable assembly
 - **10 x 10 Gb/s lane**
 - 4 x 25 Gb/s lane (TBD)
 - 5 x 20 Gb/s lane (TBD)
- Support a MAC data rate of 40 Gb/s
- Provide Physical Layer specifications which support 40 Gb/s operation over:
 - at least 10m over a copper cable assembly
 - **4 x 10 Gb/s lane**

S-parameter interconnect specifications

- S-parameters are sufficient to specify interconnect-induced signal impairments e.g.,

- Measured:

- Insertion loss

- Return loss

- Crosstalk

- NEXT

- FEXT

- Computed:

- PSNEXT

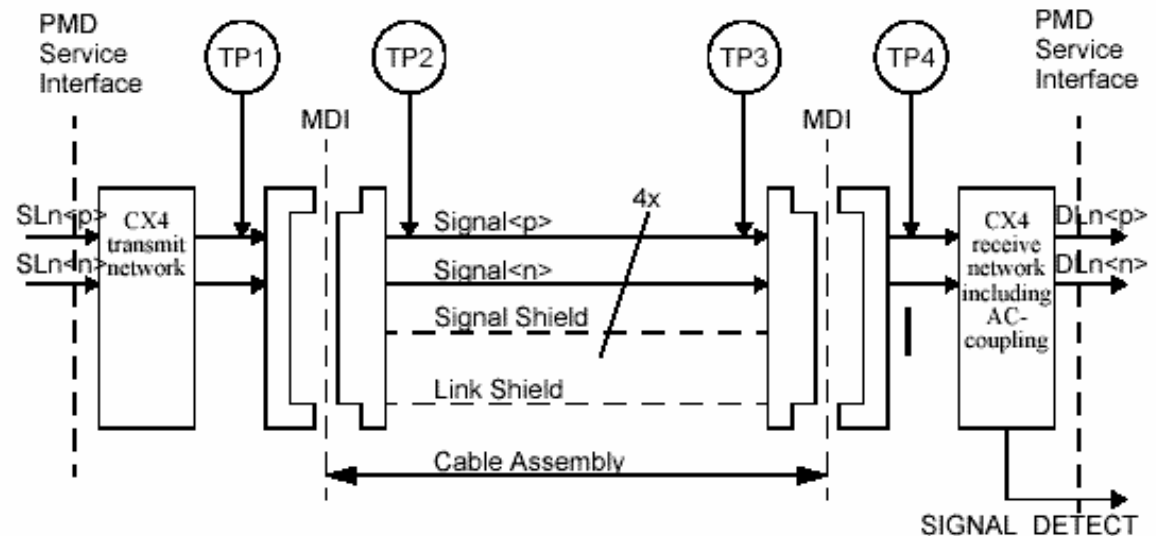
- PSELFEXT

- Limits:

- Measurement based

- InfiniBand

10GBASE-CX4 Cable assembly



For 10GBASE-CX4 - All cable assembly measurements are to be made between TP1 and TP4 as shown in the Figure illustrated above.

802.3ap Channel Parameters

•Channel measurement reference: TP1 to TP4.

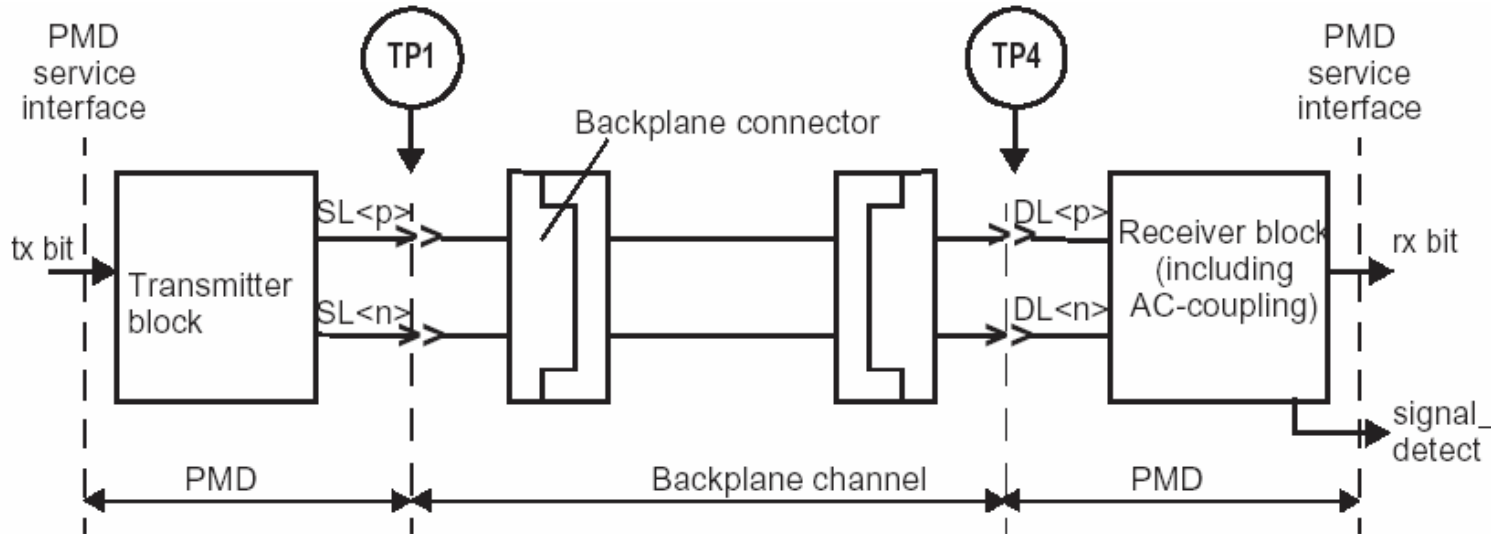


Figure 70-1—Link block diagram

•Measured

- Insertion Loss
- NEXT
- FEXT
- Return Loss

•Computed

- Insertion loss deviation
- Insertion loss to crosstalk ratio
- PSNEXT, PSFEXT, PSXT

•Limits

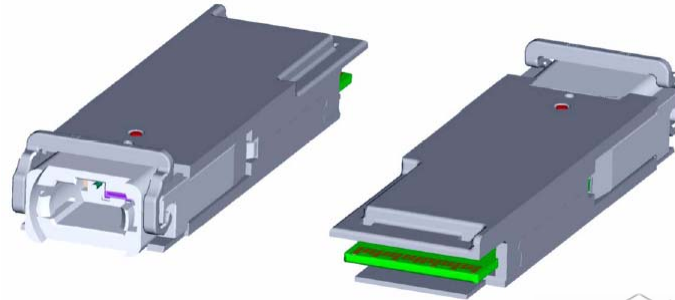
- To support existing platforms (ATCA)

Cable board connector – QSFP - 38 ckt

- Infiniband Copper

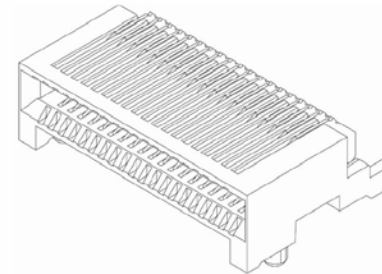
- Annex A5: Pluggable Interfaces: CATx, Copper and Optical
 - Pluggable QSFP FOR 4x, 8x and 12x
 - Multiple 4x QSFP pluggables used for 8x or 12x links

QSFP Module



SFF-8436

QSFP Connector: 38-contact,
right angle surface mount connector

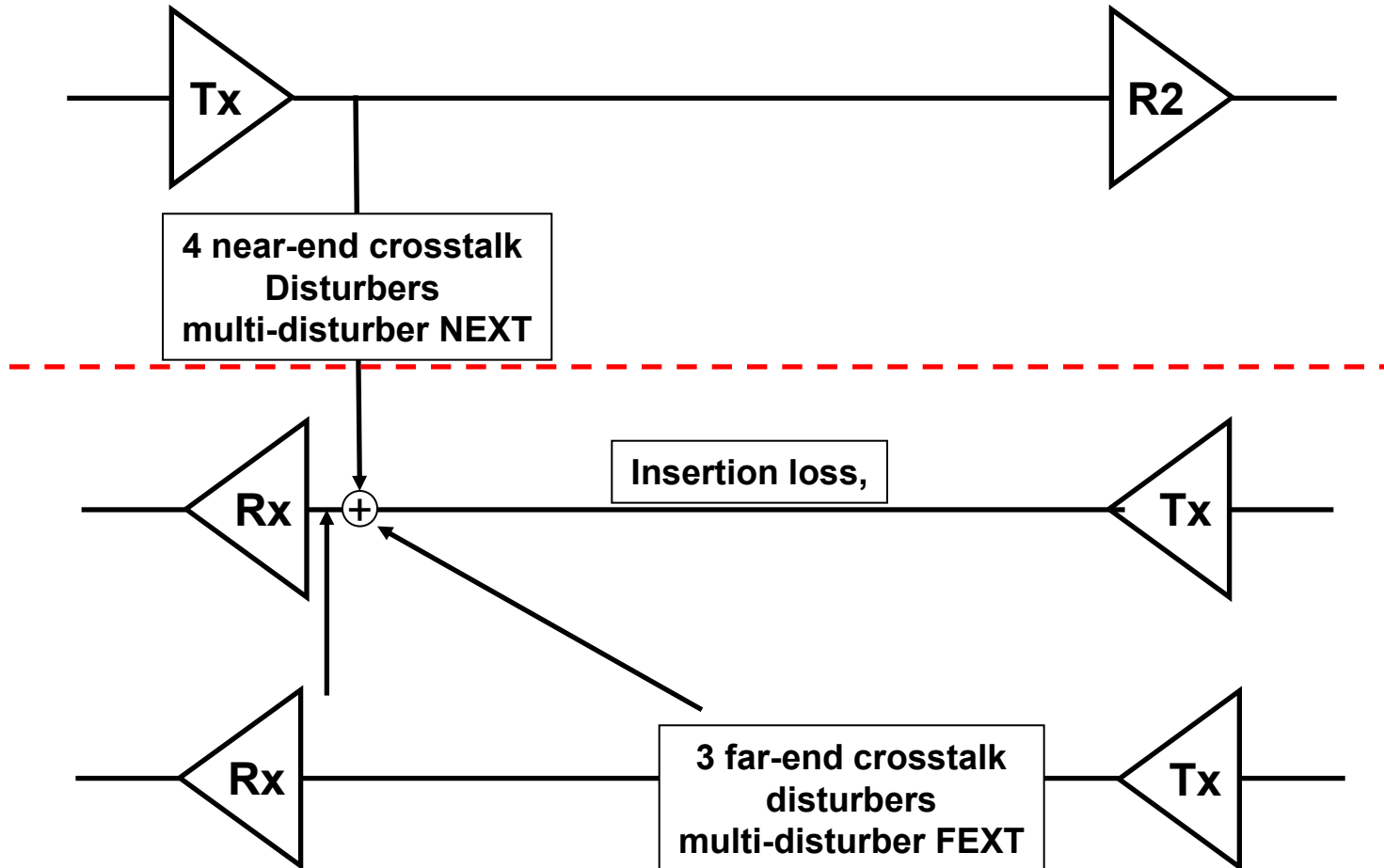


32 - QSFP Ports
1U rack space

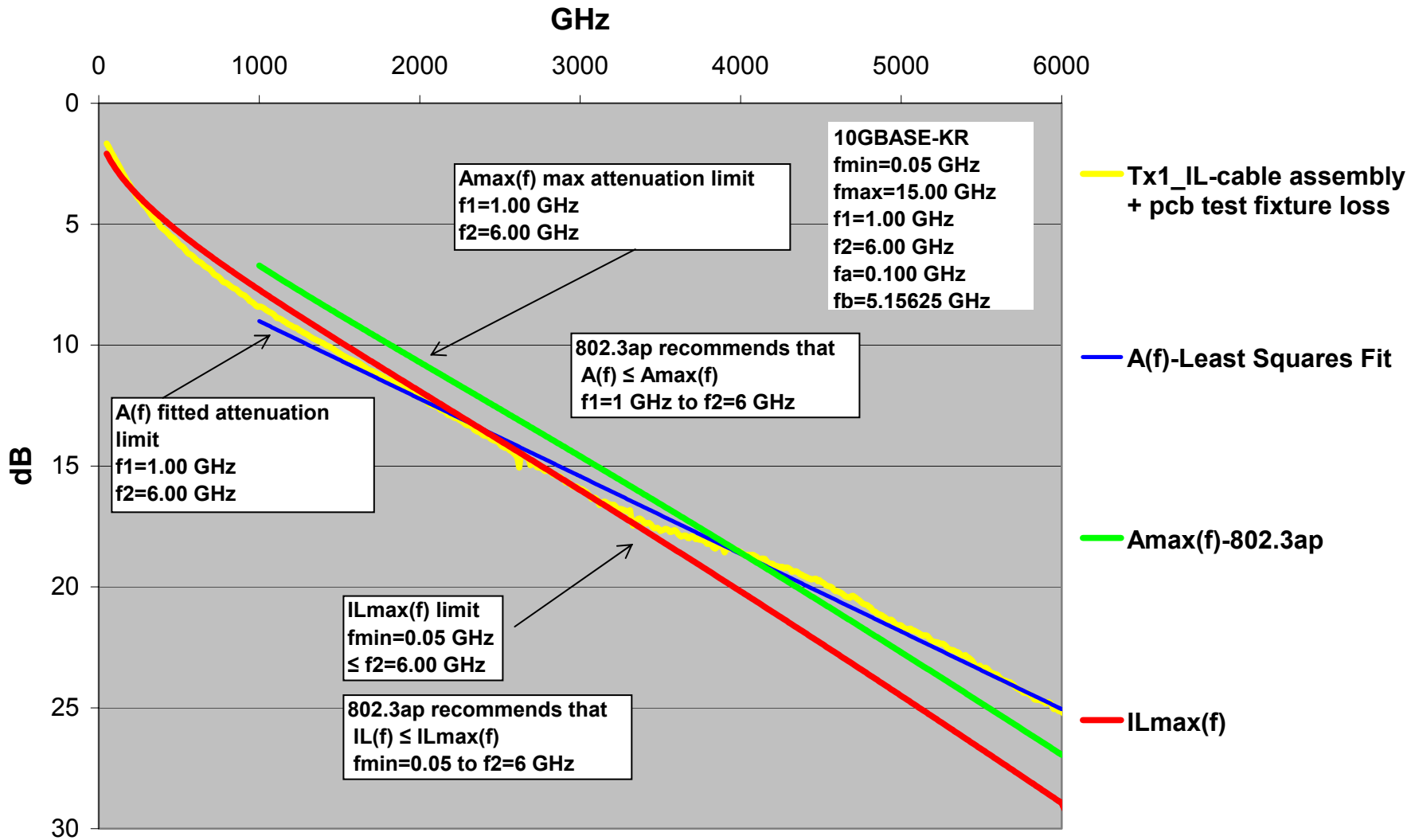
Source: Molex

802.3ap – channel parameter comparisons

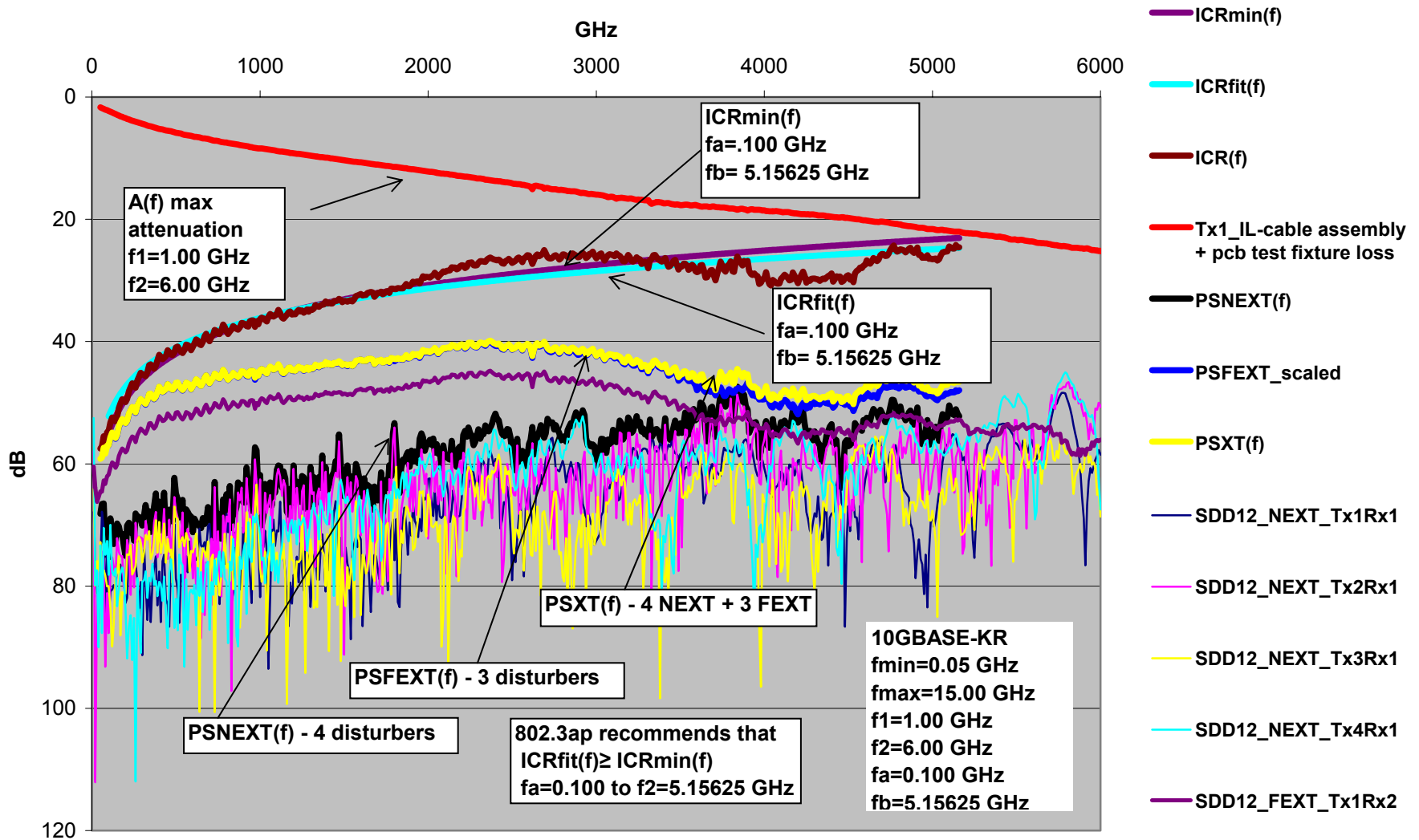
- Insertion loss to crosstalk ratio (ICR) computed from S-parameter measurements and models of QSFP 10 meter copper cable assembly (24 AWG).



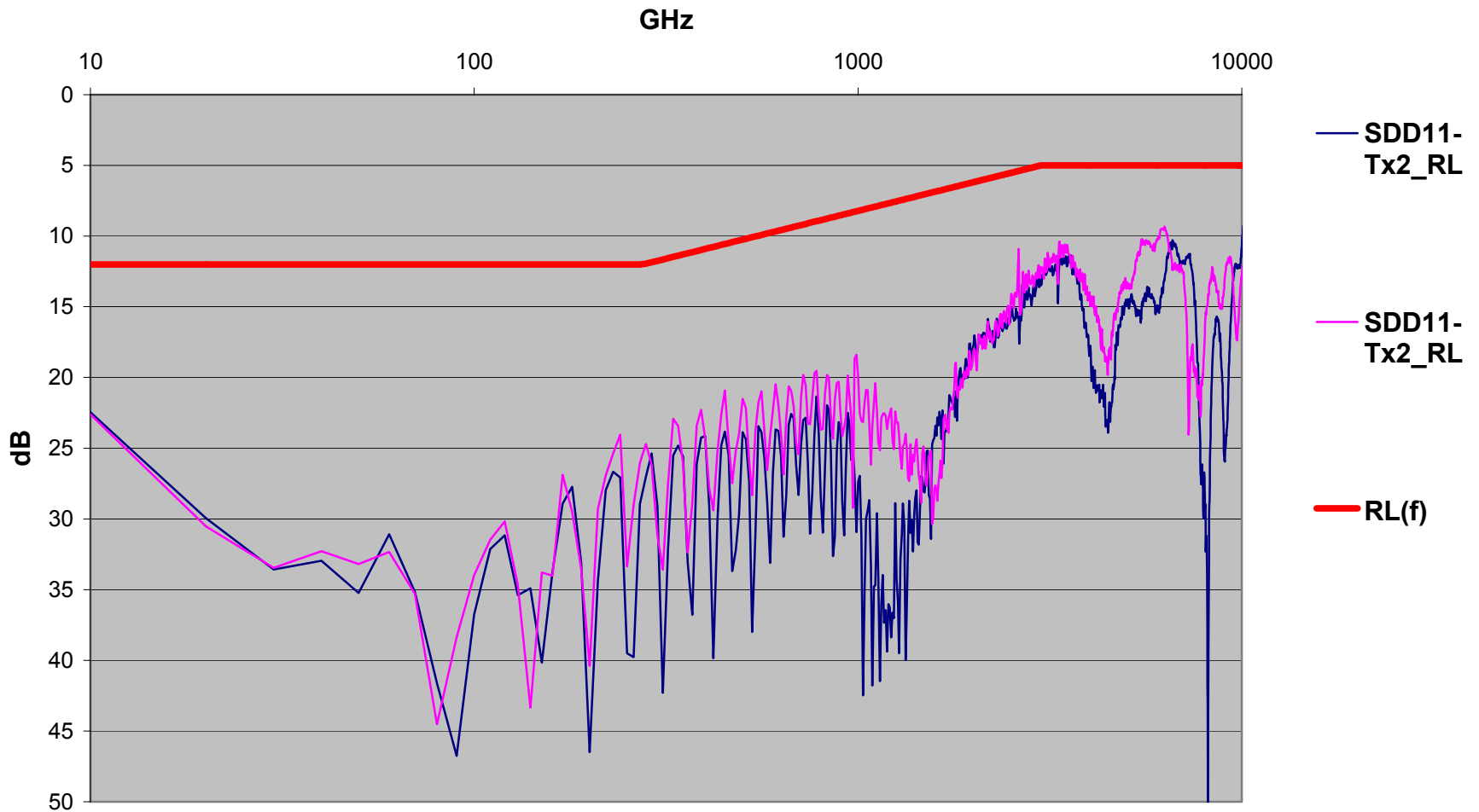
802.3ap IL limits vs 10 m QSFP cable assembly 24 AWG including test fixtures



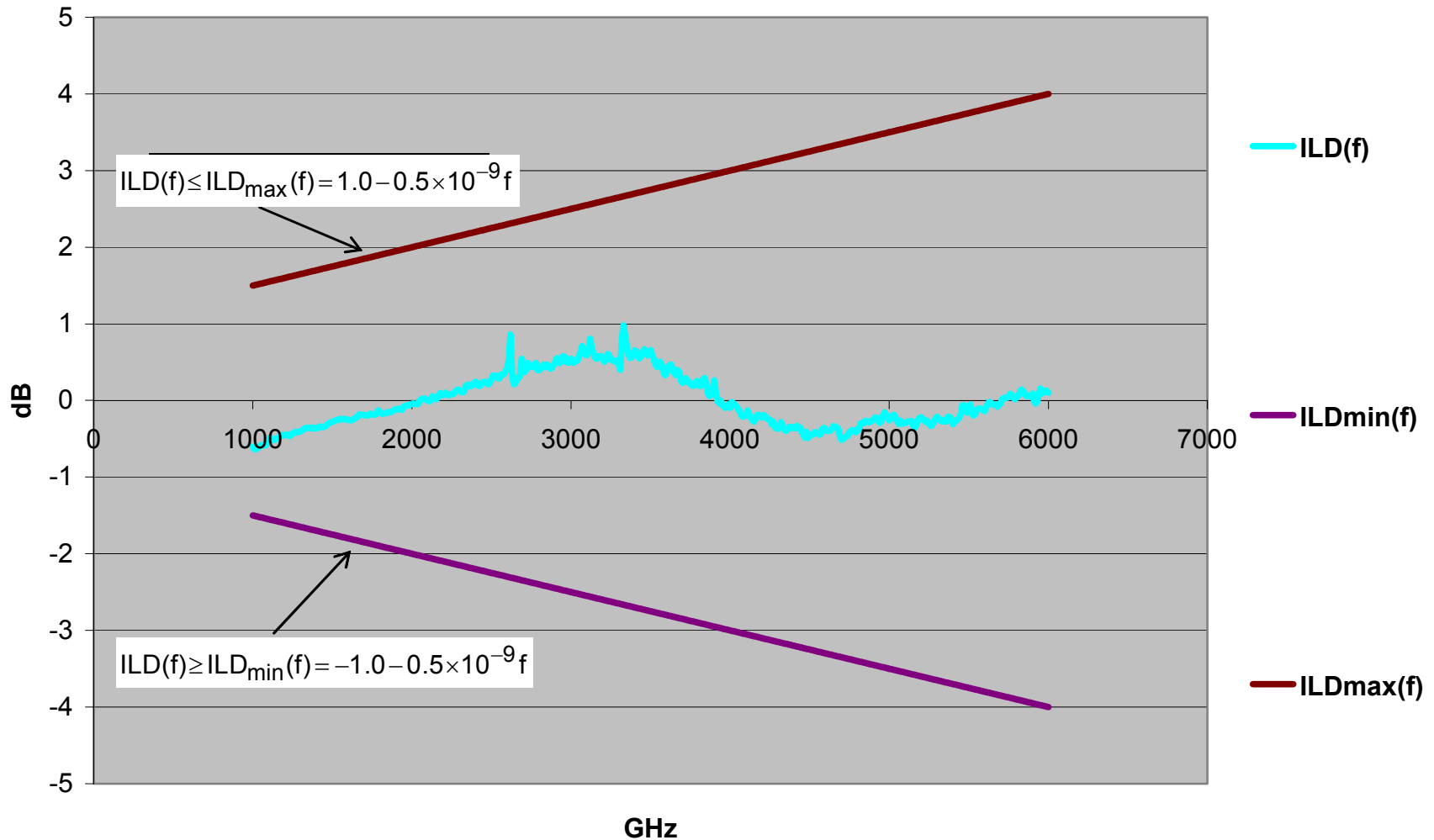
802.3ap ICR limits versus 10 m QSFP cable assembly 24 AWG including test fixture



802.3ap RL limits vs 10 m QSFP cable assembly 24 AWG including test fixture



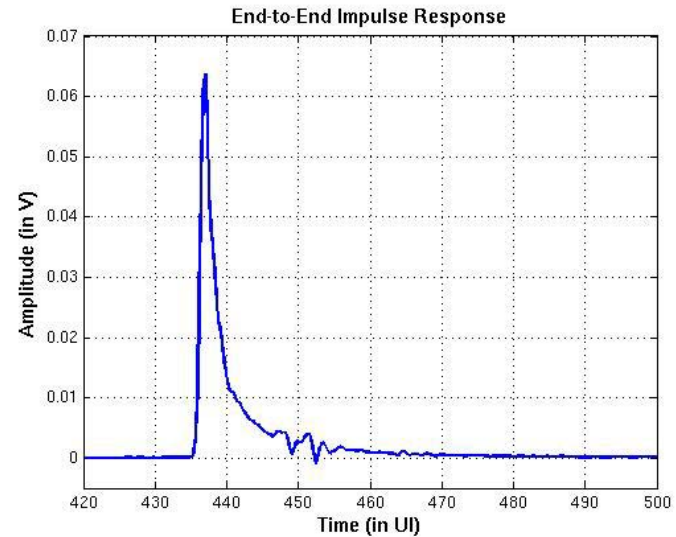
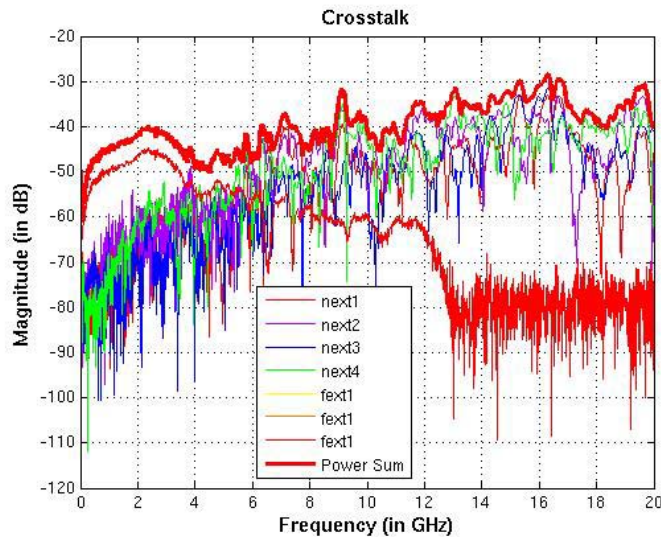
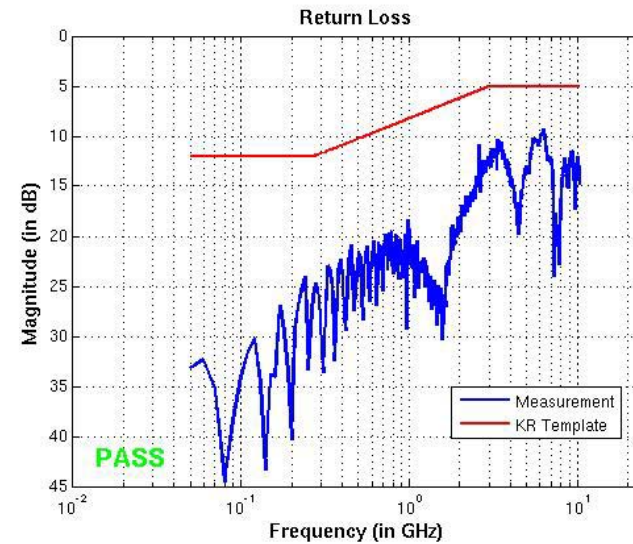
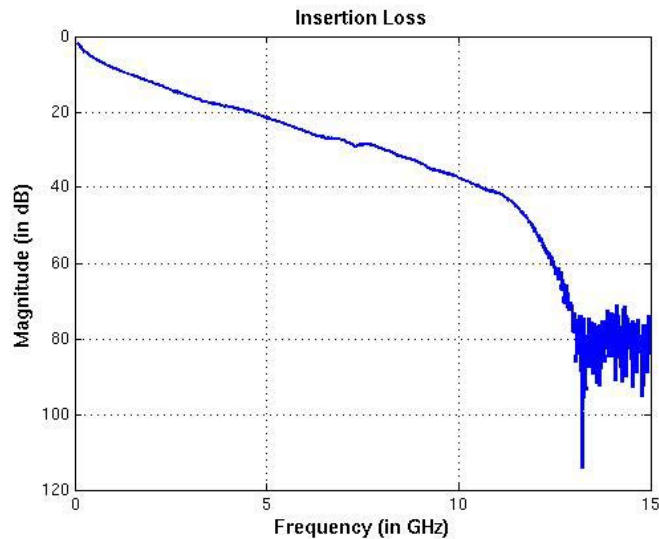
802.3ap ILD vs 10 m QSFP cable assembly 24 AWG including test fixtures



Simulation Setup

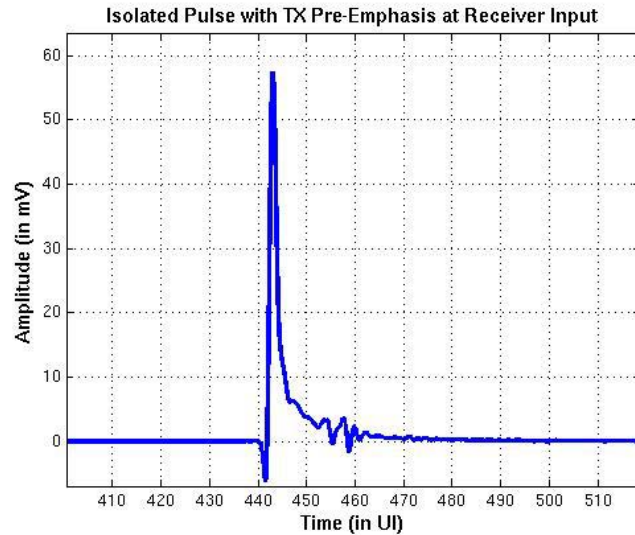
- **Insertion Loss, Return Loss, Crosstalk per data from Chris DiMinico**
- **Package models based on measured data**
- **Receiver architecture same as that used in KR group (802.3ap)**
- **MATLAB simulations**
 - **Pulse Response “Frequency-domain” Analysis, with MMSE optimization**
- **Performance evaluation based on detailed, worst-case error probabilities (not simple Gaussian assumption)**
- **On-chip impairments included**
 - **Clock jitter, Offsets, Front-end noise, Detailed analog circuit models, Detailed equalizer implementation penalties**
- **Worst-casing of ISI data patterns and crosstalk phase**

Channel models

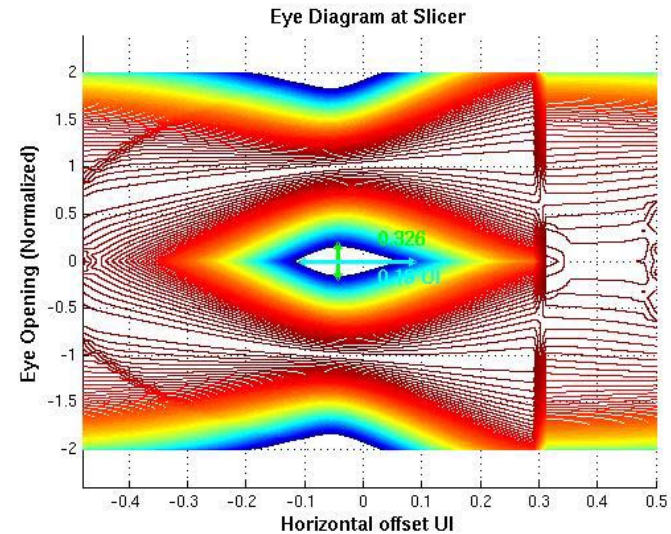
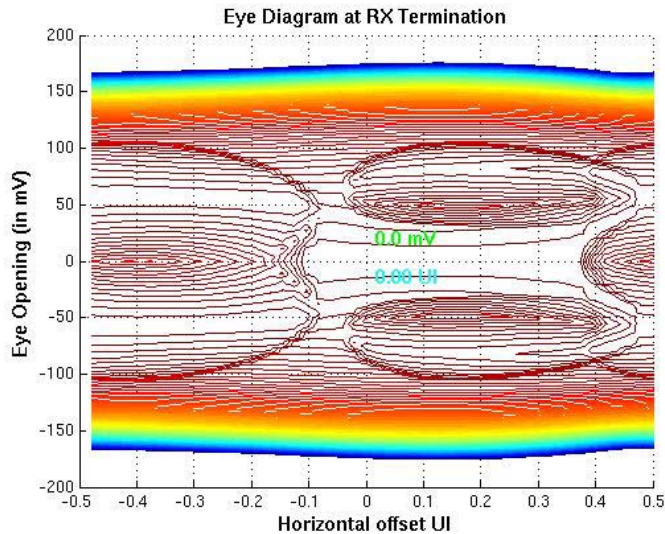


Source: Vivek Telang, Broadcom

Simulation results



Slicer SNR & BER	
SNR (dB)	BER
18.5	1.4×10^{-17}



Source: Vivek Telang, Broadcom

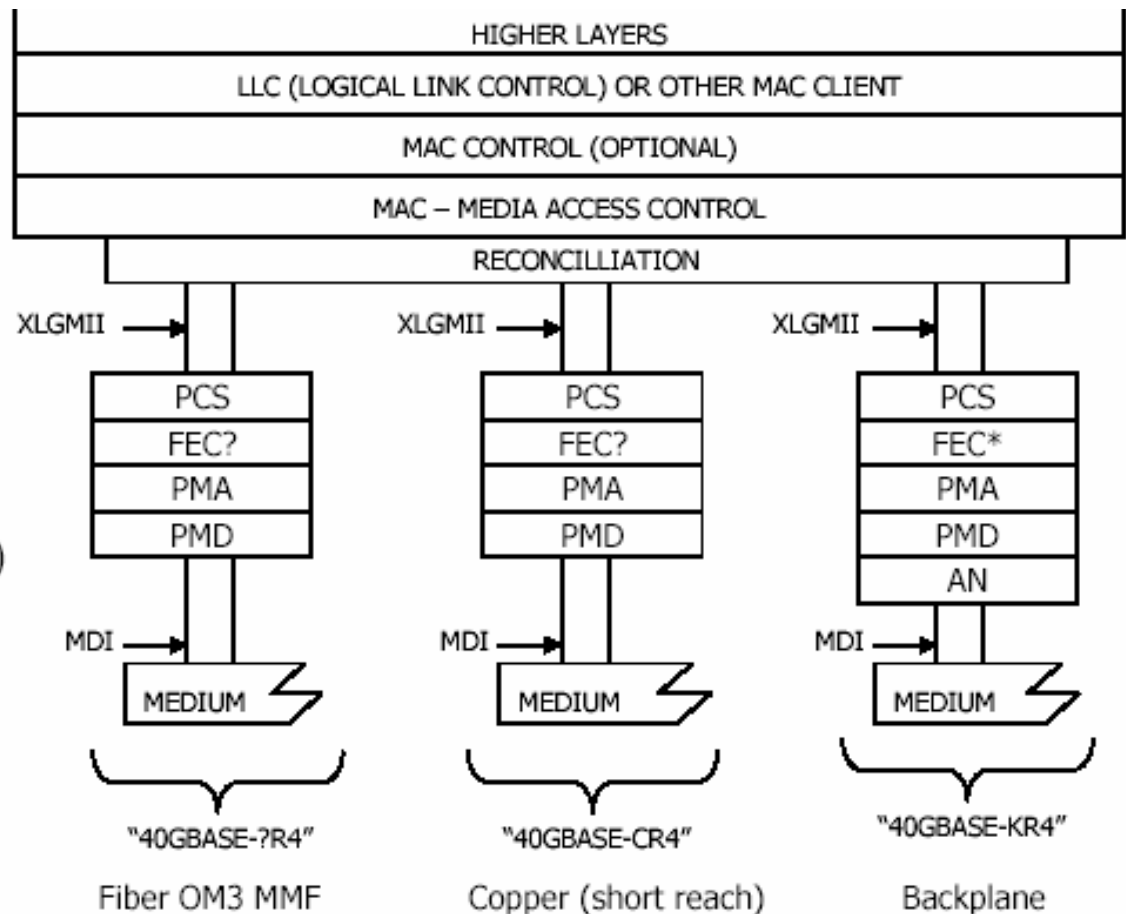
40GBASE-CR4 and 100GBASE-CR10 cable assembly

•Cable assembly differential parameters

Description	Value	Unit
$Insertion\ Loss(f) \leq TBD \sqrt{f} + TBD \times f + \frac{TBD}{\sqrt{f}}$	TBD	dB
$NextLoss(f) \geq TBD - TBD \times \log\left(\frac{f}{TBD}\right)$	TBD	dB
$ReturnLoss(f) \geq TBD$	TBD	dB
$MDNextLoss(f) \geq TBD - TBD \times \log\left(\frac{f}{TBD}\right)$	TBD	dB
$ELFEXT(f) \geq TBD - TBD \times \log\left(\frac{f}{TBD}\right)$	TBD	dB
$MDELFT(f) \geq TBD - TBD \times \log\left(\frac{f}{TBD}\right)$	TBD	dB

Possible 40 Gb/s Layer Diagram

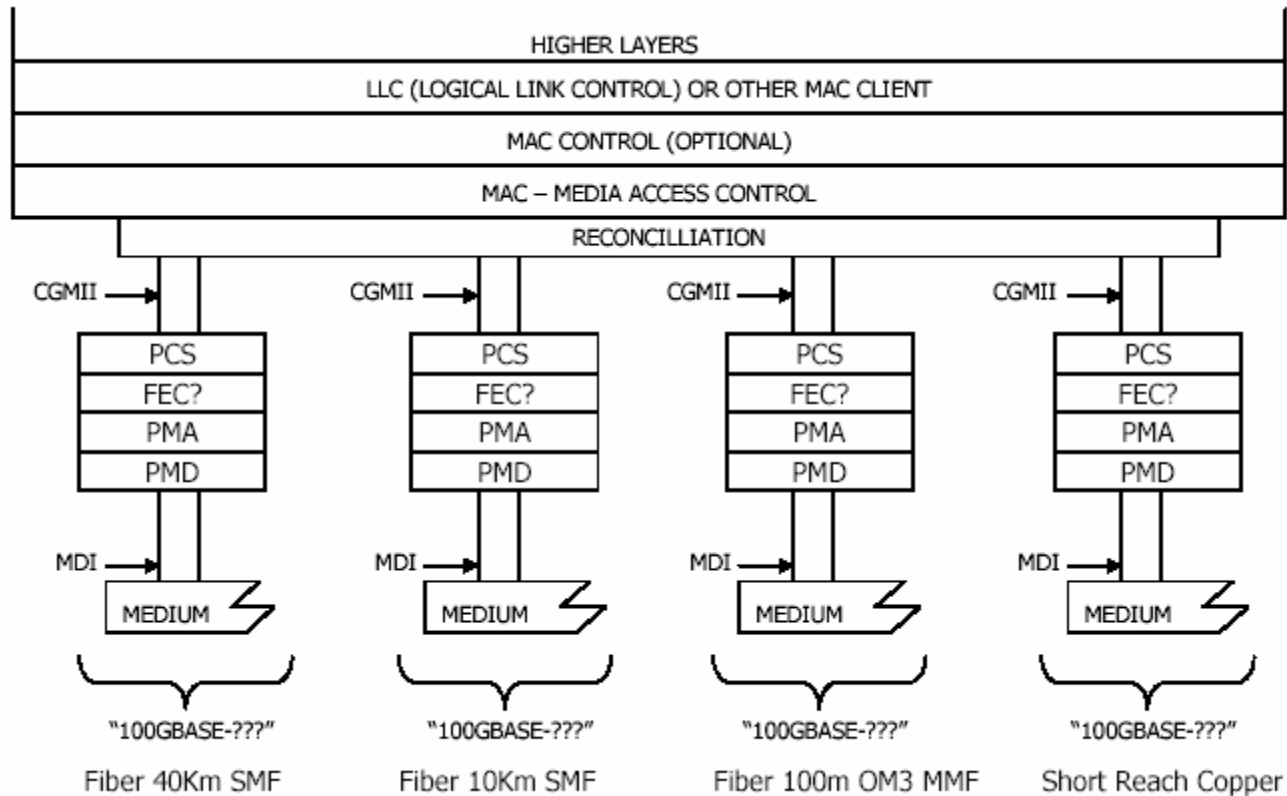
- Possible layer diagram based on discussions in HSSG
- Assumptions
 - 4 lanes of 10G
 - R PCS (64b/66b coding)



Note: * optional

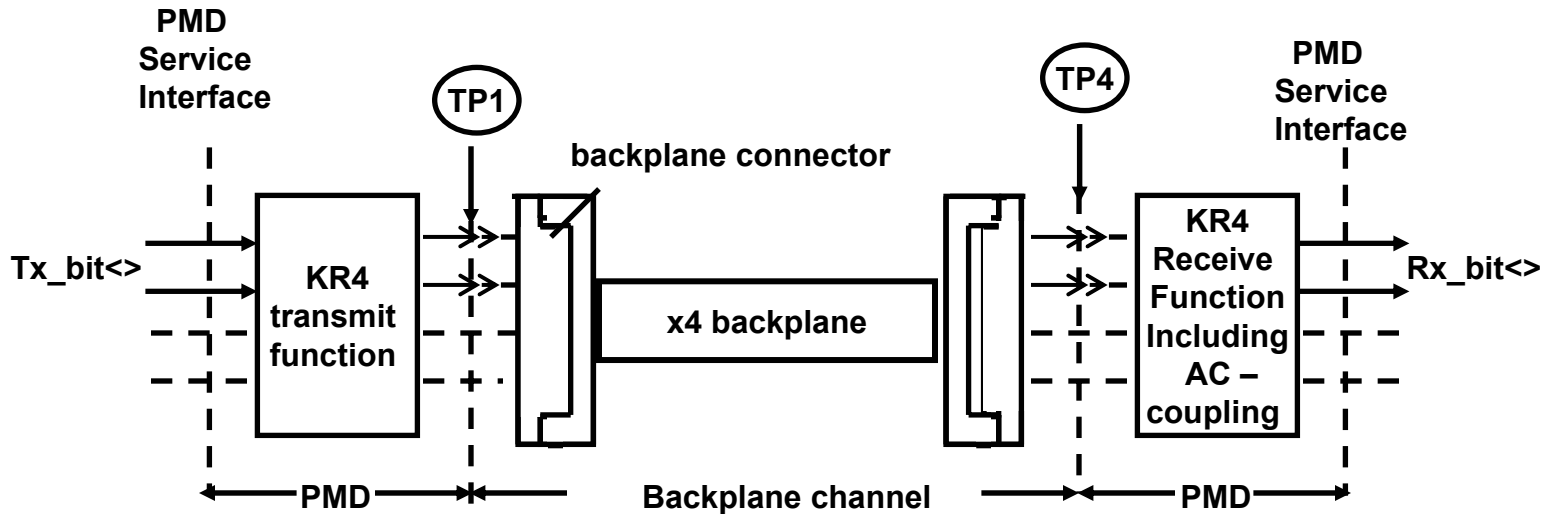
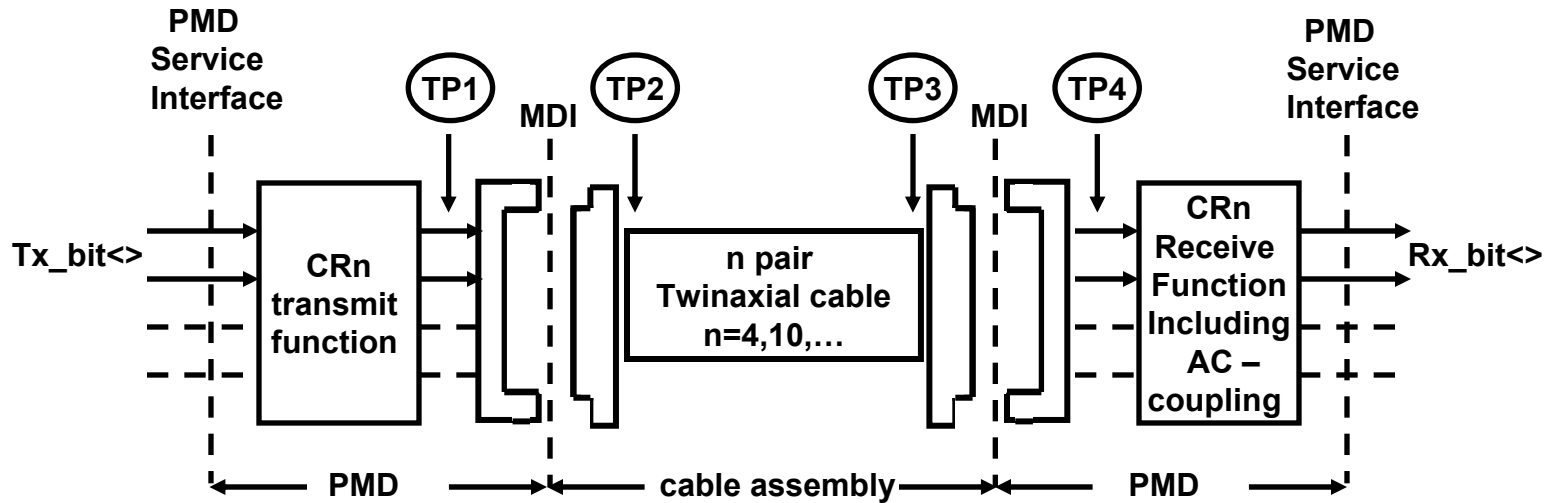
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Possible 100 Gb/s Layer Diagram

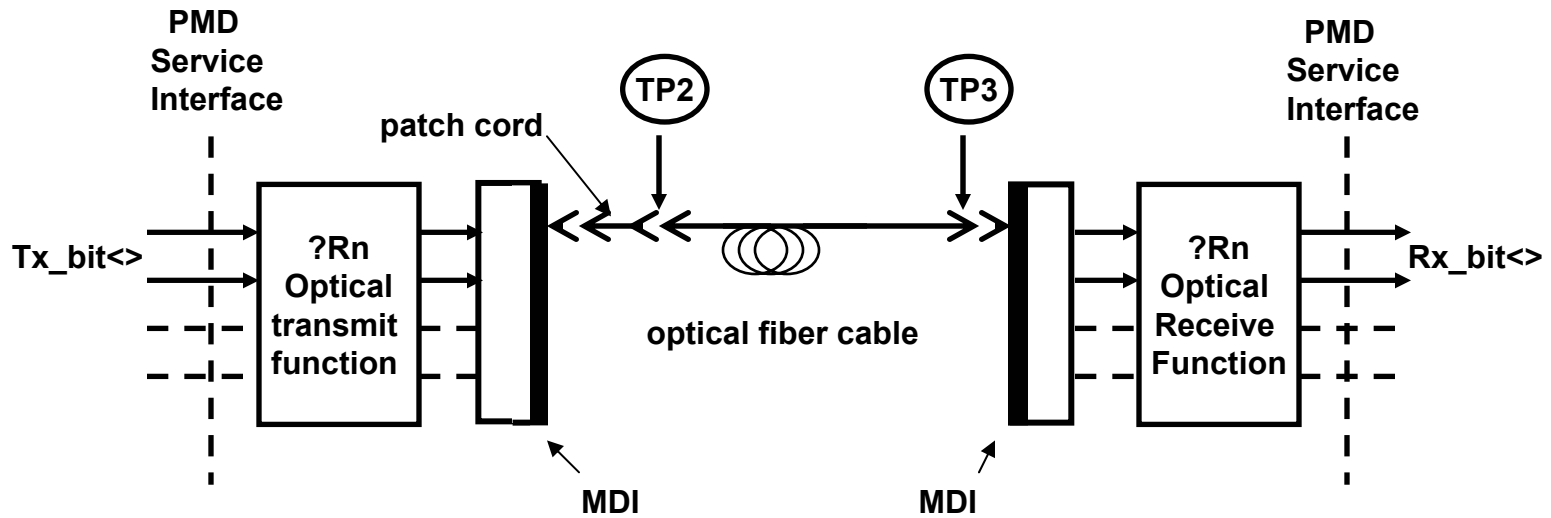


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Cu link diagrams



40GBASE-?Rn optical link diagram – OM3 Fiber

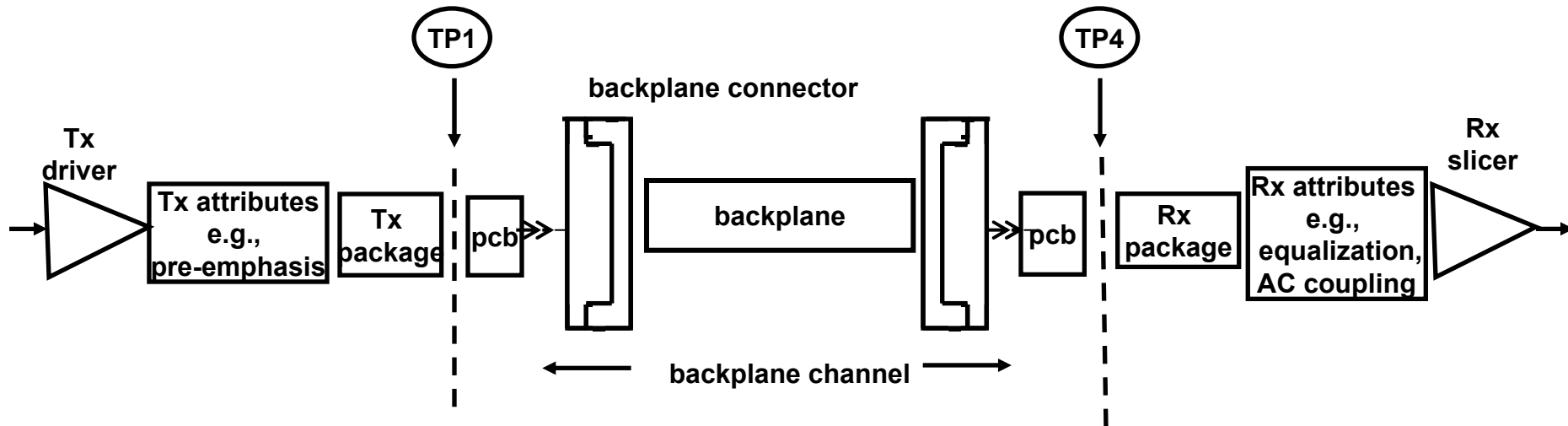
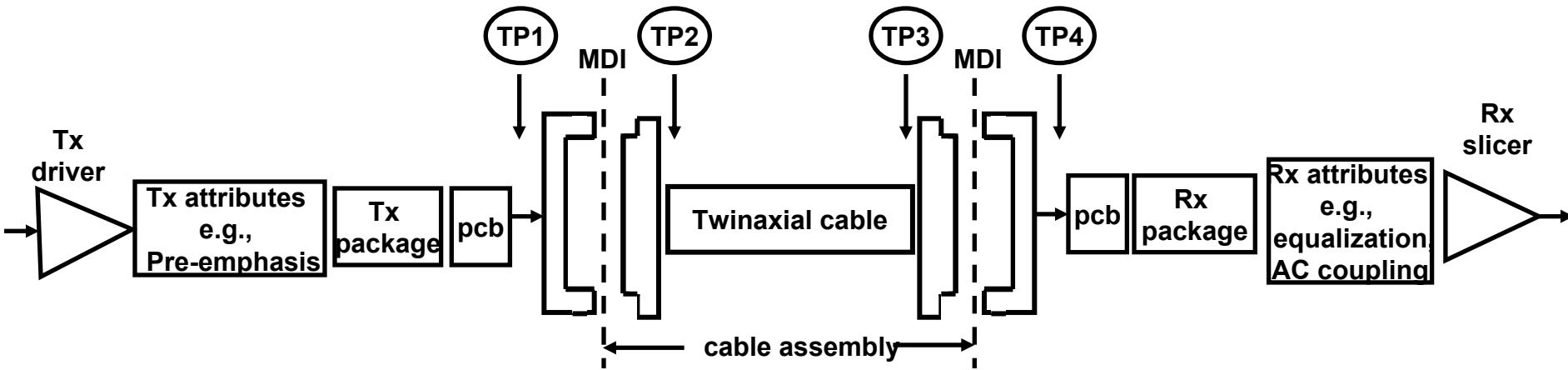


Conclusions

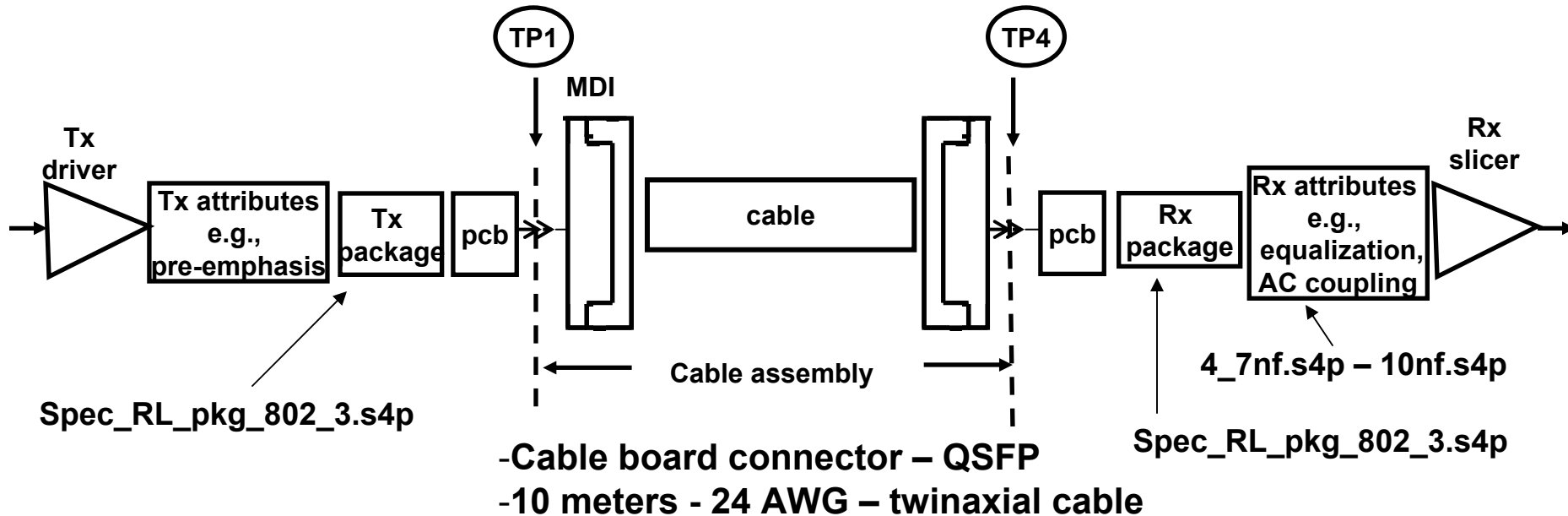
- **Measurements of 10 meter QSFP cable assembly compared to 10GBASE-KR (Clause 72) channel parameter limits used to validate 10 Gb/s lane operation over 10 meter QSFP cable assembly for 40GBASE-CR4.**
- **CX4 twinaxial cable assembly differential parameters proposed as basis for 40GBASE-CR4 and 100GBASE-CR10 link specification (i.e., S-parameters).**

Backup

Test points



Cu cable assembly channel model



http://www.ieee802.org/3/ap/public/channel_model/index.html#Package%20Models

Worst-case Package Model (*.zip) Richard Mellitz Spec_RL_pkg_802_3.s4p

Cable – 24 AWG twinaxial

Insertion Loss-10 m-24 AWG

