Channel Studies on 4 x 25 G Optical Module with CEI-25/CFBI Electrical Interface

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Outline

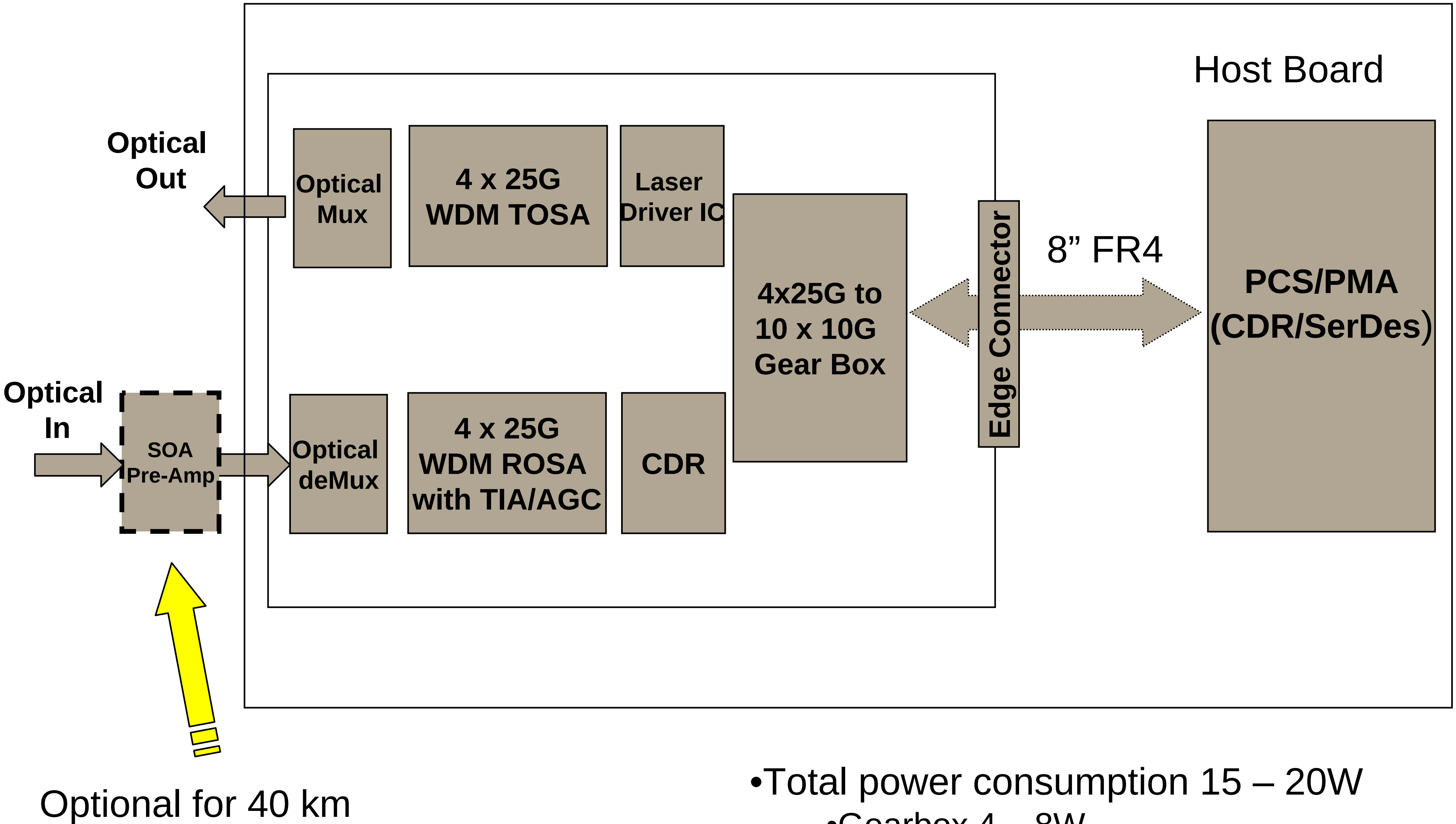
- Motivations for studying 25G CEI interface
- 25G electrical channels and their frequency responses
- Simulation results
- Conclusions

Background

- 100GE Module Gen-1 on CTBI (10x10G) Electrical Interface
  – Time to market by leveraging existing technology
- 100GE Module Gen-2 on CEI-25/CFBI (4 x 25G) Electrical Interface
  – Performances optimized through new technology development & innovations

4x25G Optical Module Block Diagram --- Gen-1

The Gear box required consumes 25 to 40% of the total power.



- Total power consumption 15 – 20W
  - Gearbox 4 – 8W

Market Expectation

- Lower cost
- Lower power
- Smaller form factor

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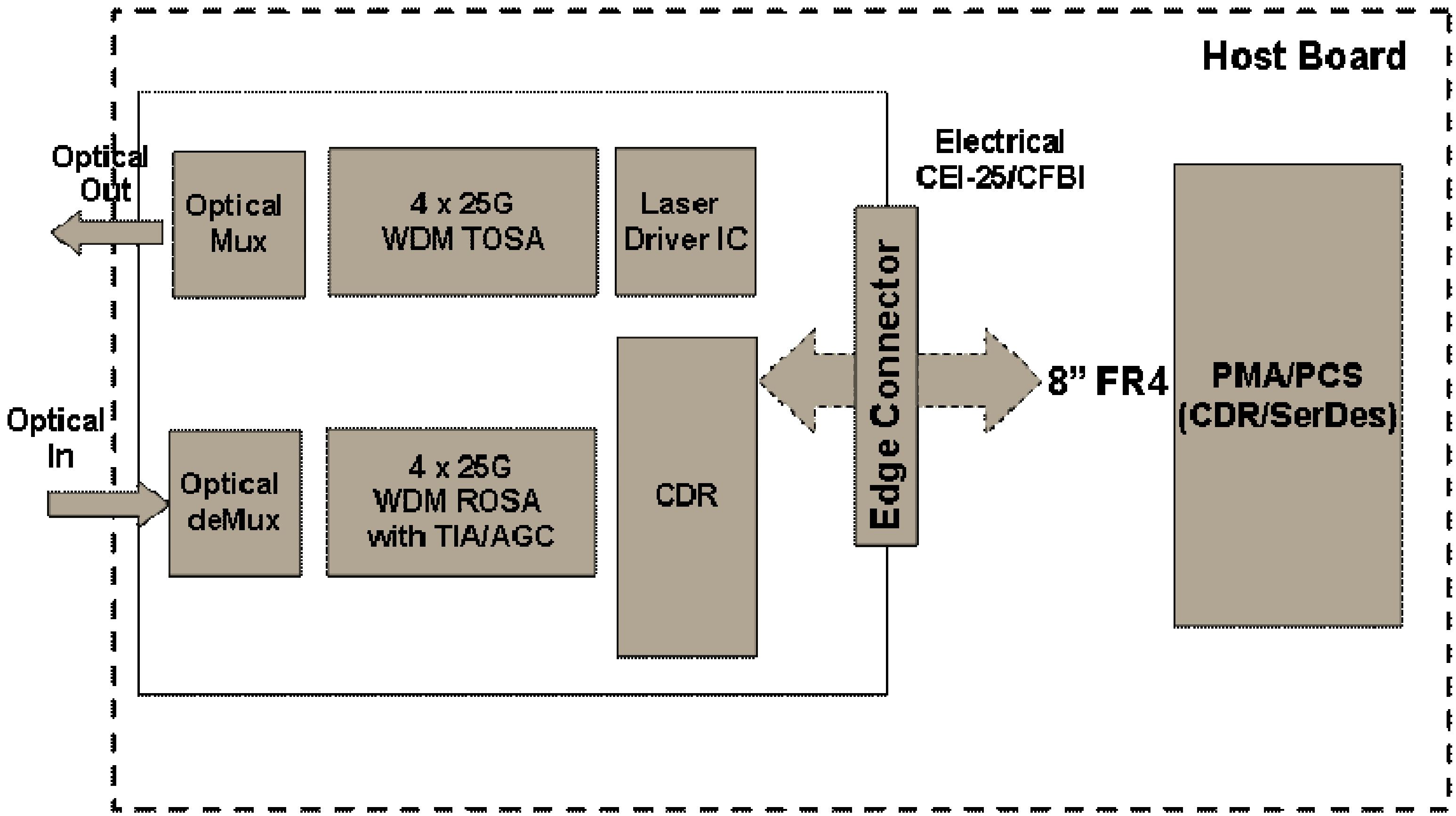
Gen-2 Module with CEI-25/CFBI Interface

4x25G Optical Module Block Diagram --- Gen-2

No gear box is required!

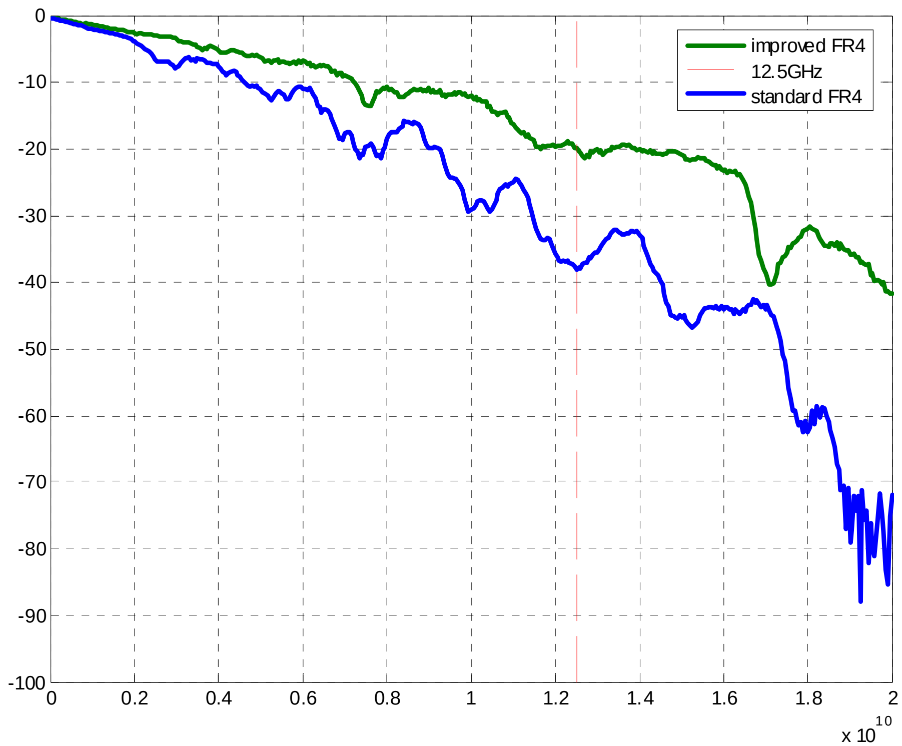


Target power < 10W

25G Electrical Channels Studied

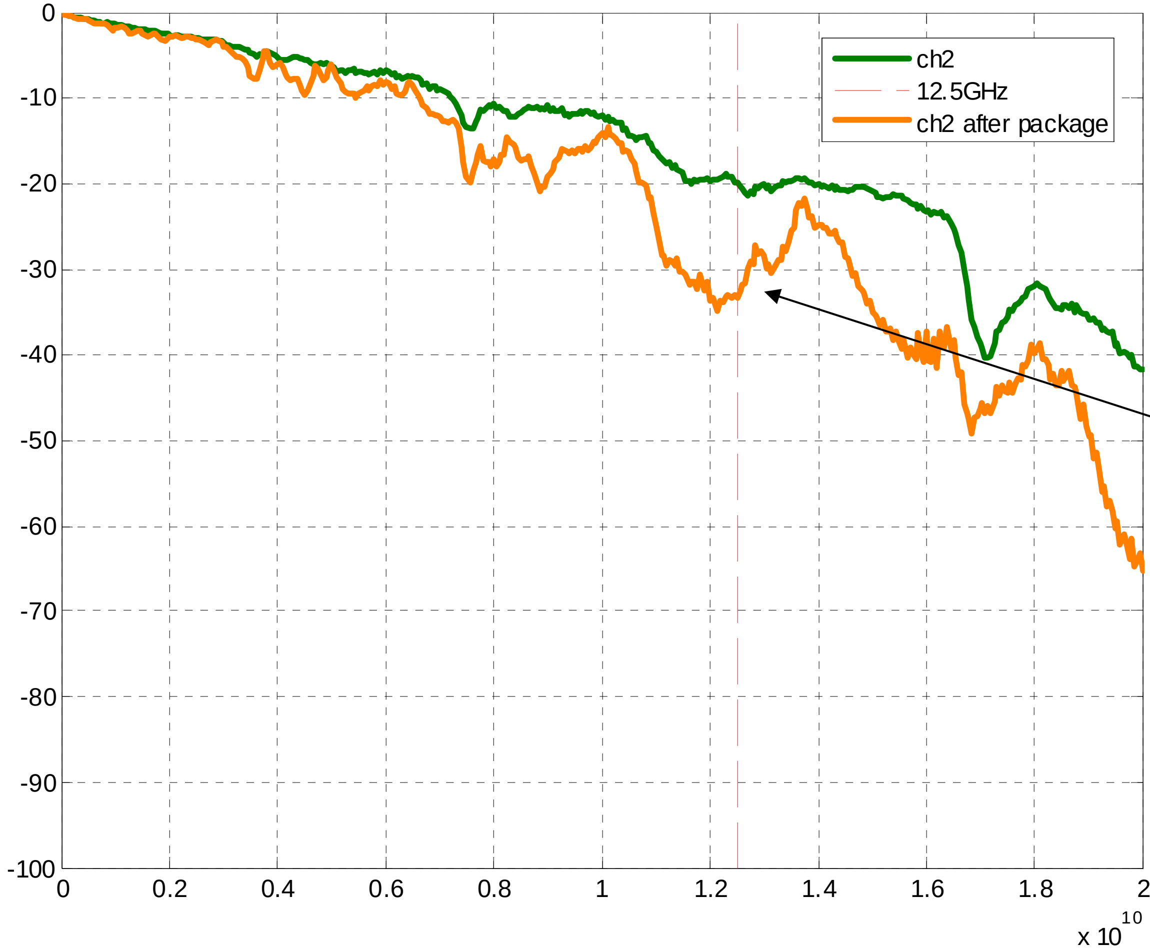
- Channel-1
  - 8” standard FR-4 + 1 electrical connector
- Channel-2
  - 8” improved FR4 + 1 electrical connector

Frequency Responses



- Standard 8" FR4 channels have 30 to 40 dB loss at 12.5GHz
- Improved 8" FR4 channels have much lower loss (20 to 25dB) and are necessary for CEI-25/CFBI.

Impact of Chip Termination and Package



13dB loss @ 12.5GHz

Mellitz package model (Spec_RL_pkg_802_3)

Simulation - Analytic Model

- Analytic model is used to get slicer SNR at optimal sampling point.
  - Includes
    - Intersymbol Interference (channel and package)
    - Random Jitter
    - Electronics (White) Noise
    - Crosstalk (NEXT and FEXT)
    - Duty Cycle Distortion
  - Does Not Include
    - Receiver Sensitivity
    - Other Sources of DJ

Reference: J.Caroselli and C. Liu, "An Analytic System Model for High Speed Interconnects and its Application to the Specification of Signaling and Equalization Architectures for 10Gbps Backplane Communication", DesignCon 06.

How to Interpret SNR Results?

- SNR is the inverse of the equalizer mean square error (not to be confused with the signal to electronic noise ratio)

$$SNR = \frac{d_{\min}^2}{\sigma^2}$$

- SNR can be related to the BER if all the remaining noise sources have Gaussian distributions.
- Approximately 24dB is required for an error rate of 10-15 and 23dB for 10-12.

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$$\Pr_{err} \approx \frac{1}{2} erfc\left(\frac{\sqrt{SNR}}{2\sqrt{2}} \right)$$

Simulation Setup

- Data rate of 25Gbps
- Random data
- BER = 10E-15
- Tx DCDp-p=0.035UI
- Signal to electronic noise ratio: 40dB
- Tx RJ =0.0107UI sigma or 0.1693 UIpp@ 10E-15 BER
- Package = Spec_RL_pkg_802_3
- Mellitz package model

Simulation Results

3-tap FIR, 8-tap DFE, no Xtlk, NRZ signaling

Channel	SNR (dB) w/o pkg	SNR (dB) w/pkg
Standard FR4	18.9	18.2
Improved FR4	27.6	20.6

Better package design and termination are required.

Results for other short reach and medium reach channels are available and are similar to what are presented (need permission from contributors of the channel models to publish those results).

Conclusions

- Standard FR4 is too lossy and challenging to support Gen-2 optical module's CEI/CFBI electrical interface.
- Improved FR4 material is required for the host board to interface with Gen-2 optical modules with CEI/CFBI (4x25G) electrical interface.
- Chip termination and package have significant impact on the system performance and must be improved for the Gen-2 modules.
- More studies will be performed to study channel crosstalk, alternative signaling formats, etc.