

Bidirectional Transmission over a single multimode optical fiber

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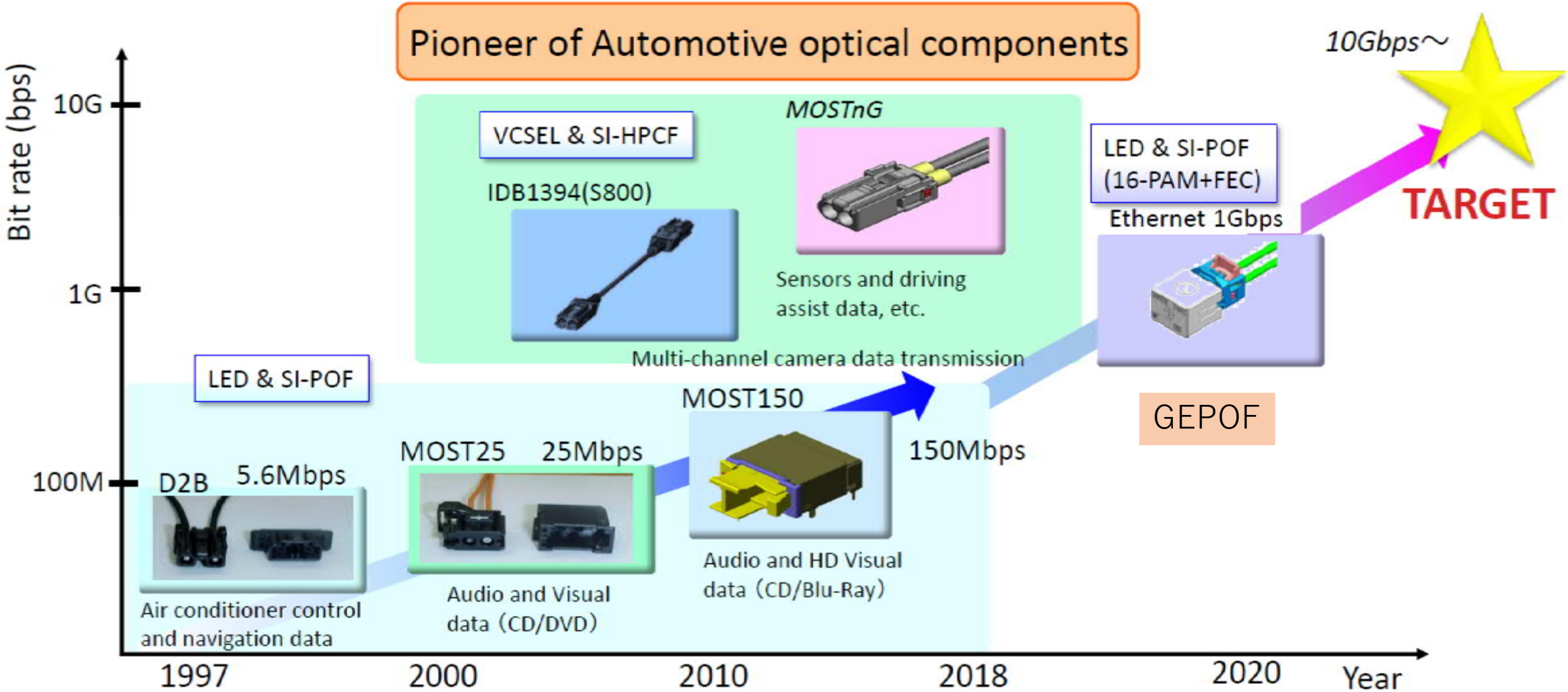
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Optical Components for Automotive Application



Background

Automotive Requirements

OMEGA Supporter (Volvo cars)

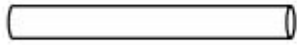
https://www.ieee802.org/3/OMEGA/public/jan_2020/eek_OMEGA_01_0120.pdf

• Speed grade

- Forced by configuration

- ✓ • Symmetric
- ✓ • Asymmetric (e.g. configurable speed of backchannel for control data for e.g. a camera.)

• Interesting harnesses

- ✓ • Single Optical (full duplex) 

- Full duplex 

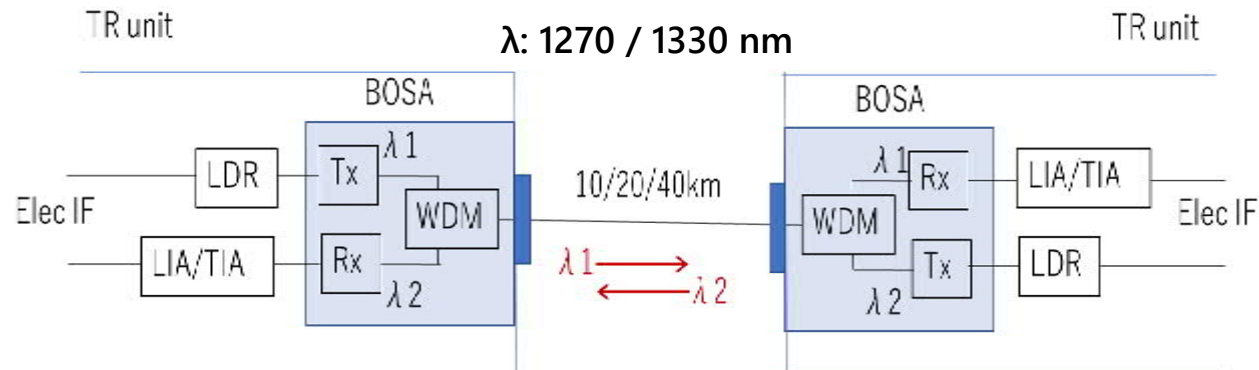
- Hybrid cable 

BiDi might support these configurations

IEEE P803.2cp

Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs

Current stage: D2.4



BOSA: Bidirectional Optical Sub Assembly, TIA: Trans Impedance amplifier, LIA: Limiting Amplifier

Features of Bidirectional (BiDi)

BiDi

Pros:

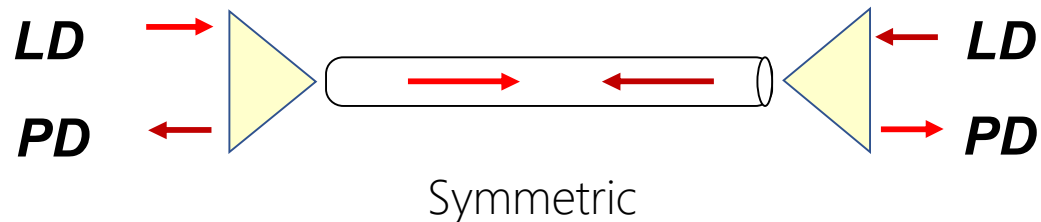
- Halve the number of optical fibers and connectors
- Small connector and Cable flexibility

Cons:

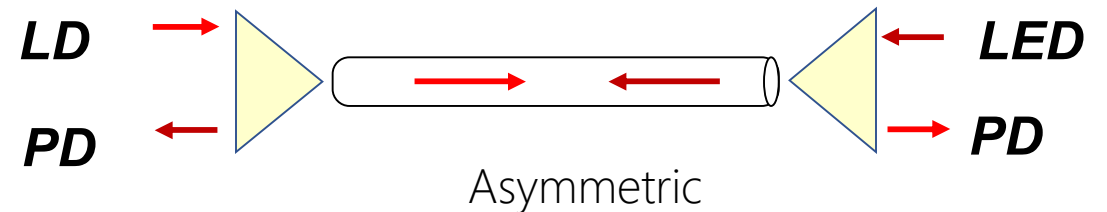
- Optical properties: Increased insertion loss and crosstalk
- Cost

Propose configuration

High speed LDs:
10~50 Gbps



Low speed LEDs :
10~1000 Mbps



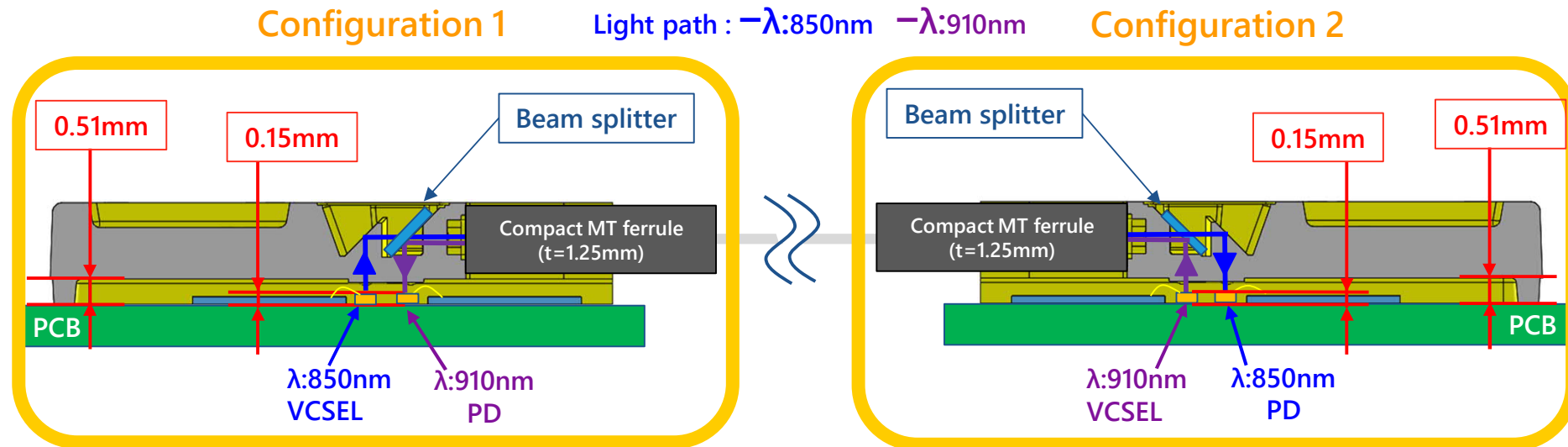
By replacing one of the light sources with LEDs, cost reduction and higher reliability can be achieved.

BiDi Optical Transceiver (Symmetric)



ex. QSFP regin lens module - (4-lane BiDi)

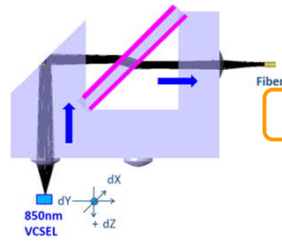
- ❑ 1 ~ 4 Lane optics
- ❑ WDM: 850nm & 910 nm
- ❑ Reduced back reflection design
- ❑ Chip on board & IC cover integrated
- ❑ GI-MMFs (OM3 / GI-POF)
- ❑ Chip On Board type
- ❑ Regin material: Ultem



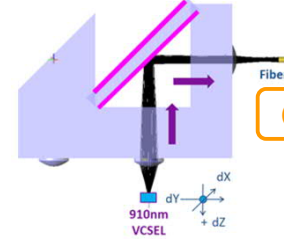
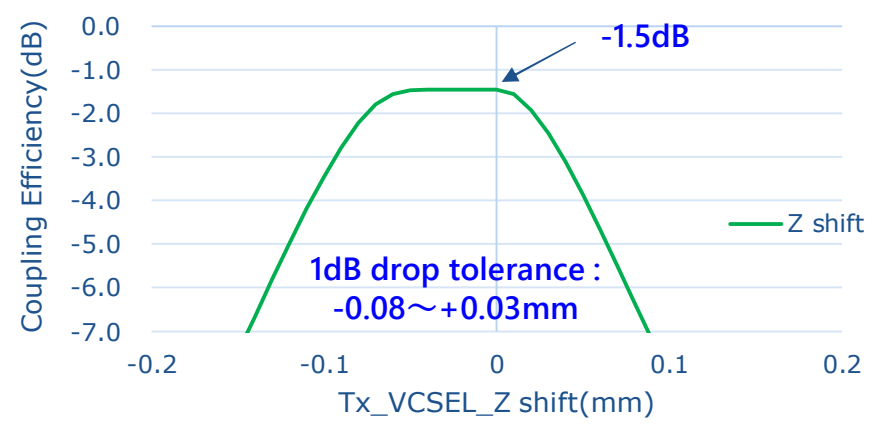
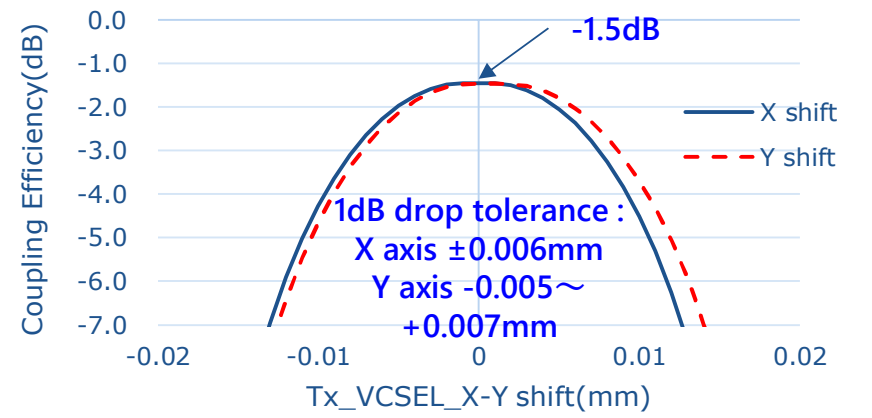
4-lane BiDi (Symmetric) coupling efficiency (1/2)

simulation condition VCSEL : NA0.28, ϕ 0.013mm, 25G VCSEL FFP is assumed
 Fiber : NA0.2, ϕ 0.05mm

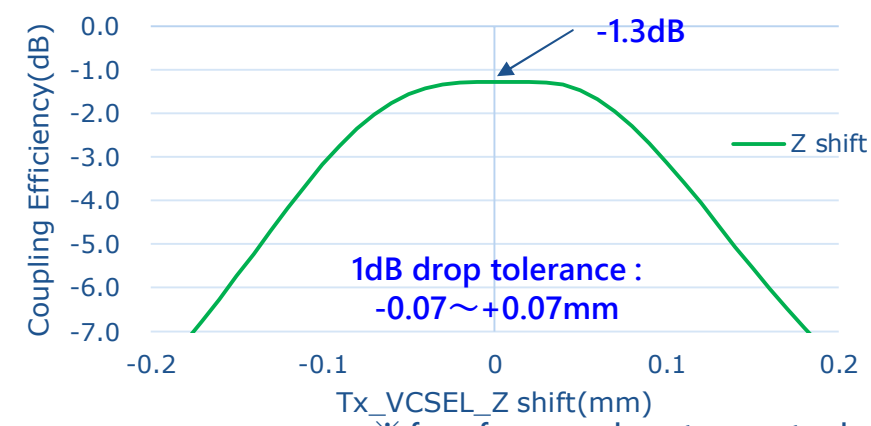
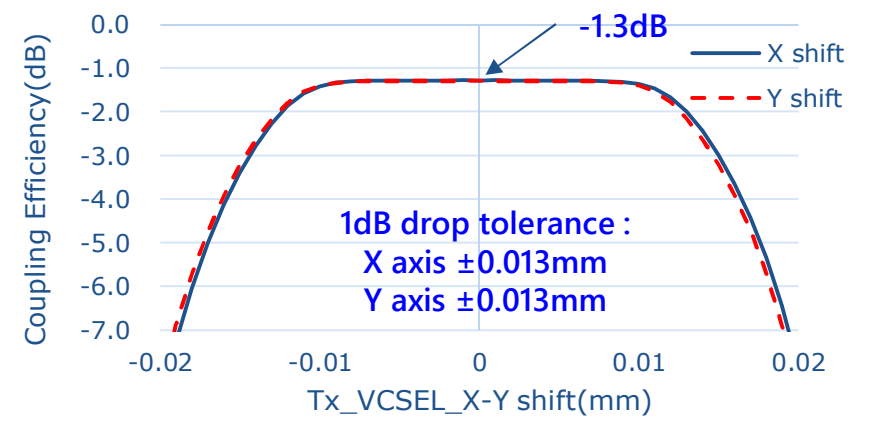
Reduced back reflection design



Configuration 1 λ :850nm, Tx side



Configuration 2 λ :910nm, Tx side

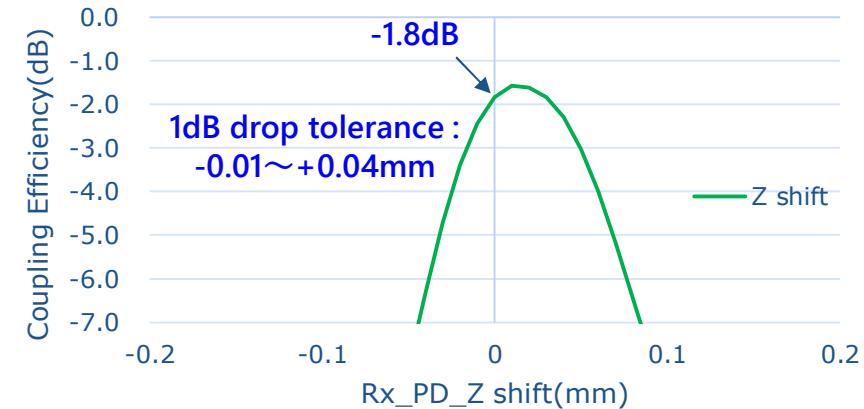
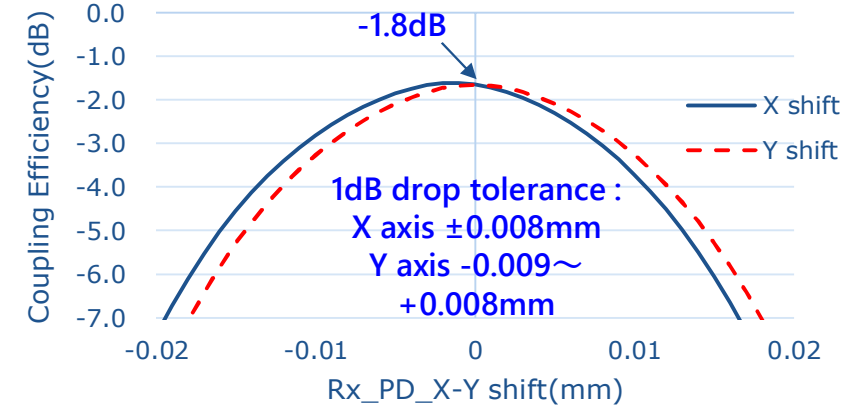
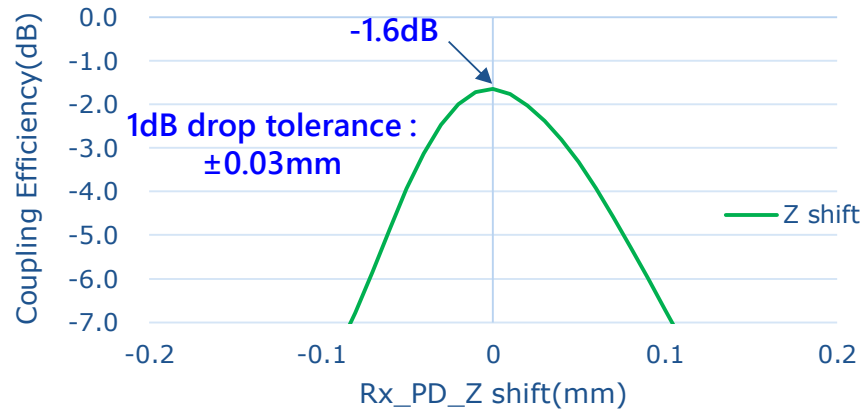
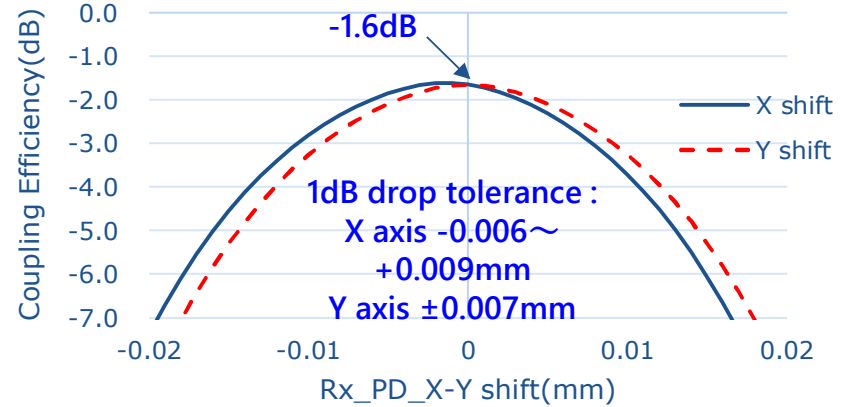


※ for reference only, not guaranteed spec

4-lane BiDi (Symmetric) coupling efficiency (2/2)

simulation condition Fiber : NA0.2, ϕ 0.05mm, Gaussian distribution is assumed
 PD : ϕ 0.03mm

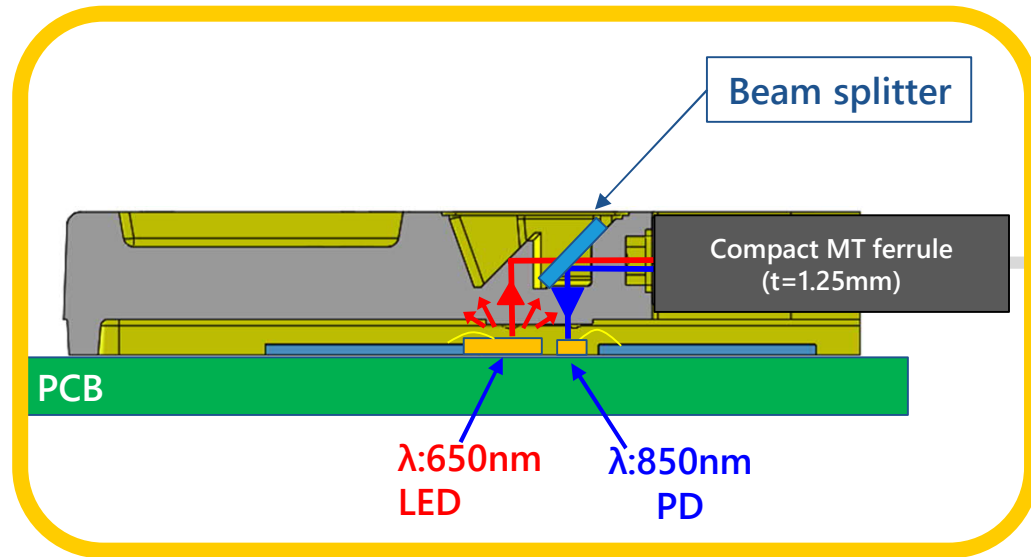
Reduced back reflection design



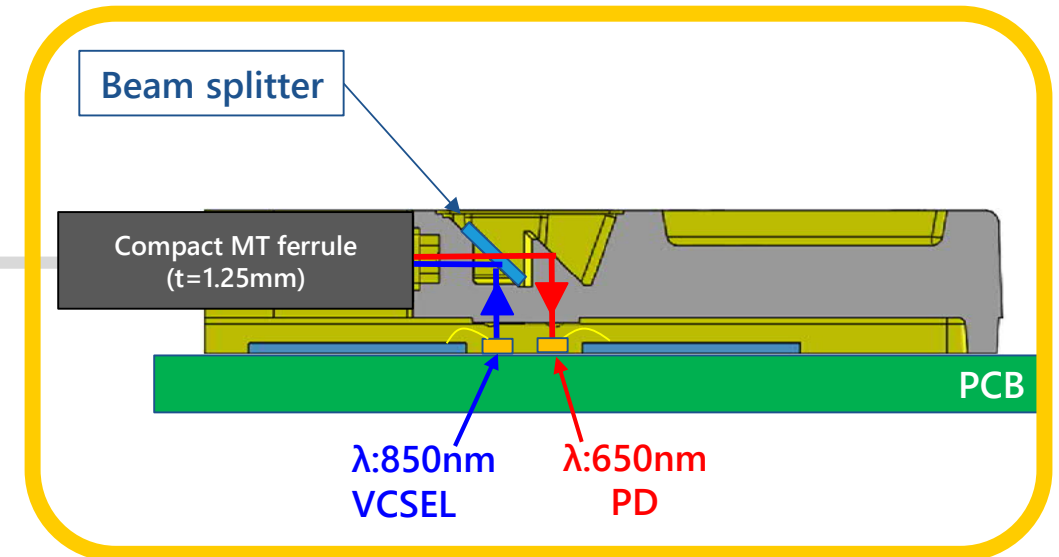
※ for reference only, not guaranteed spec

Asymmetric BiDi with VCSEL and LED

Configuration 1



Configuration 2



Since the relationship is as shown on the right, simply replacing the VCSEL with an LED has extremely poor coupling efficiency.

LED light emitting area \gg core area ($\Phi 50\mu\text{m}$)
Emitting NA of LED \gg receiving NA of OM3

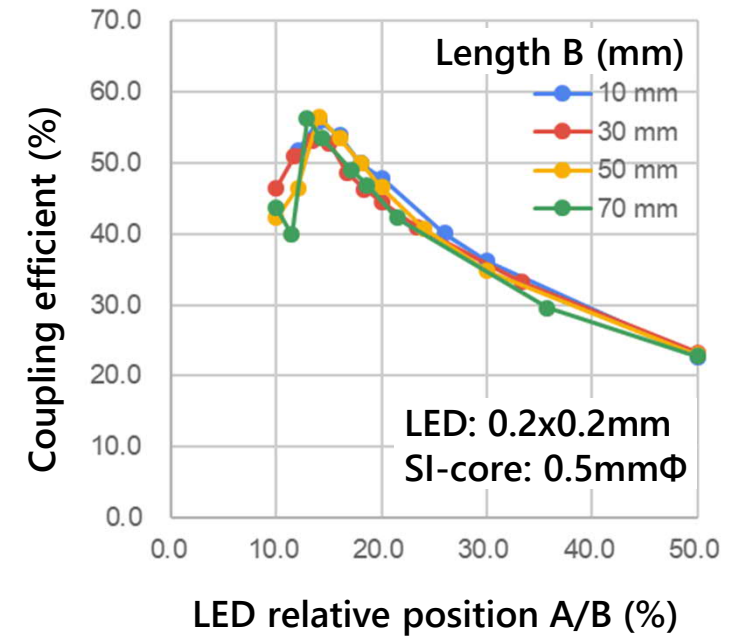


Need more efficient coupling structure

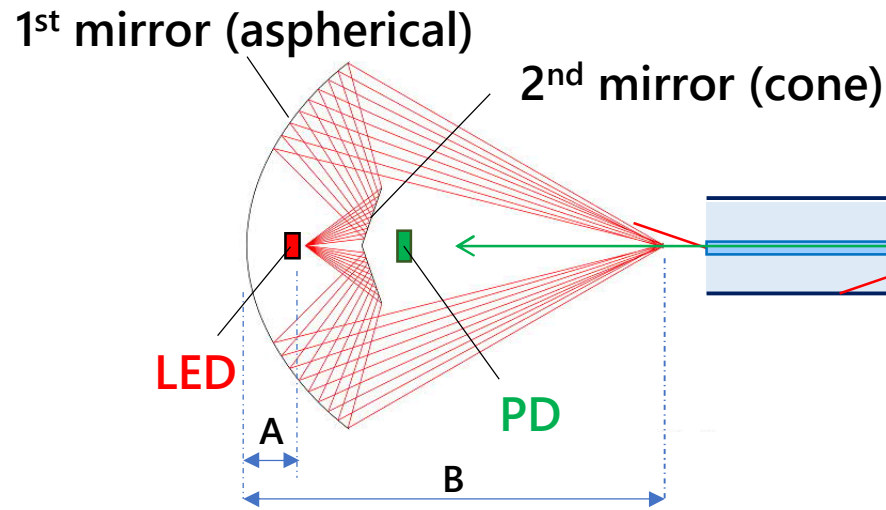
Asymmetric BiDi proposal

Key technologies:

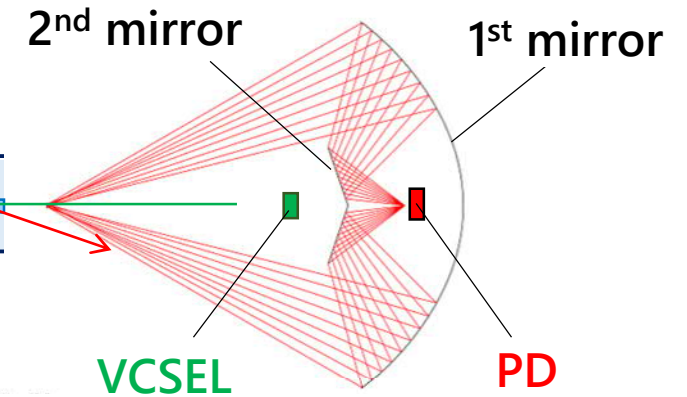
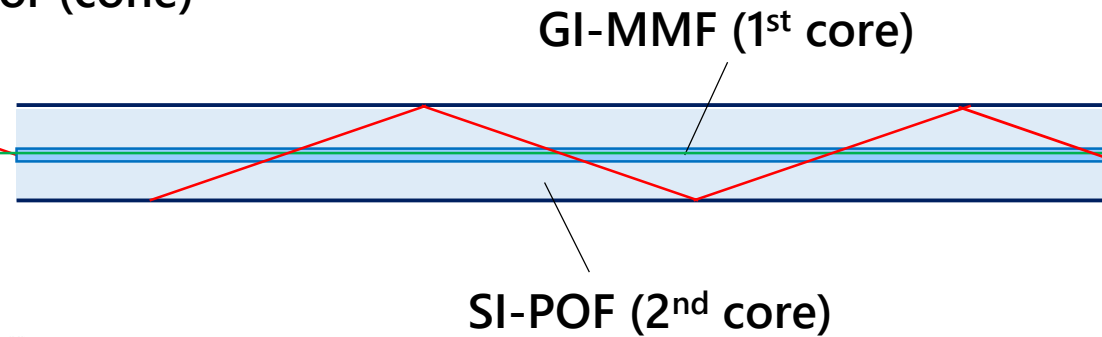
- GI/SI hybrid POF (GI-POF embedded in SI-POF)
- WDM/SDM transceiver module



Basic A-BiDi optics



GI/SI hybrid POF

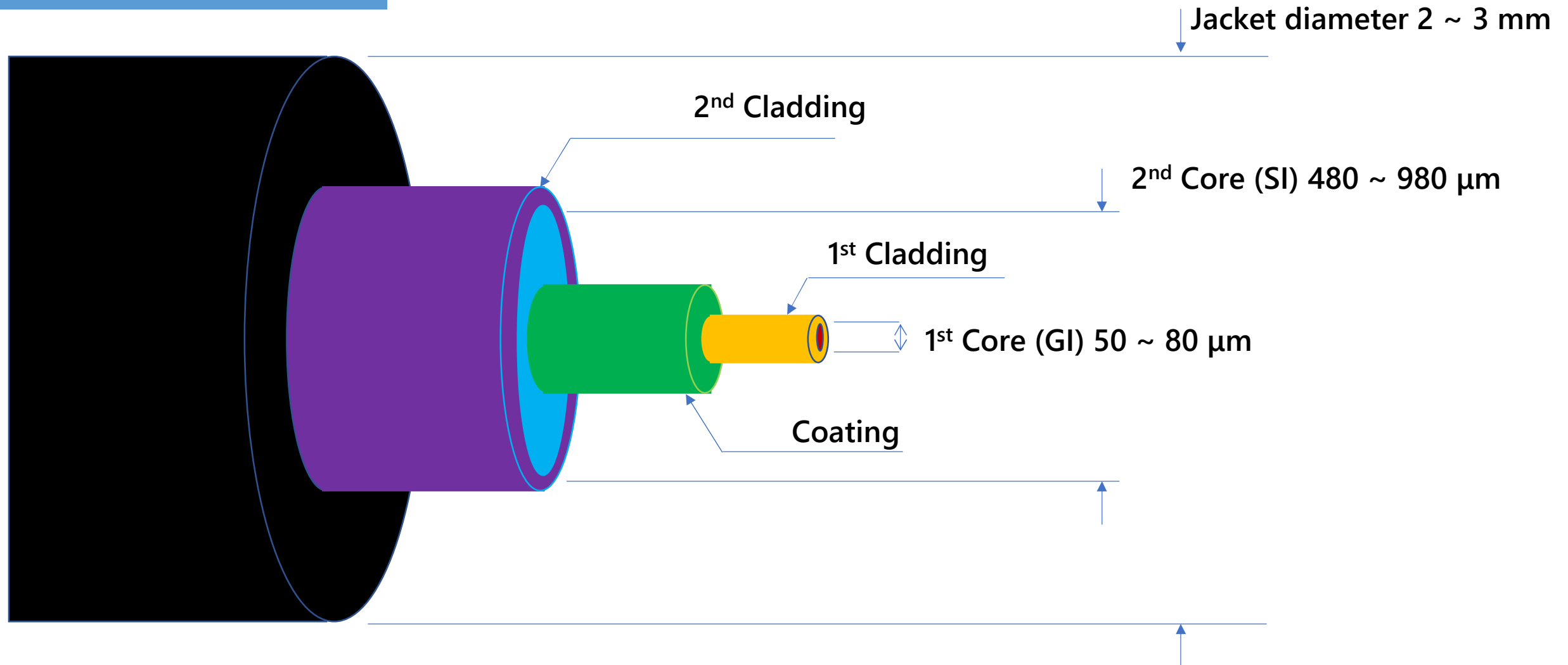


High-speed LD transmission optics: Butt coupling because of tight budget

Low-speed LED transmission optics: Budget becomes larger as the modulation speed becomes slower.

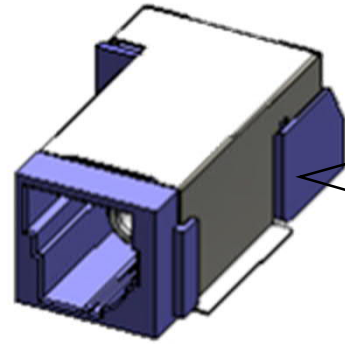
GI/SI Hybrid POF

Cable Structure



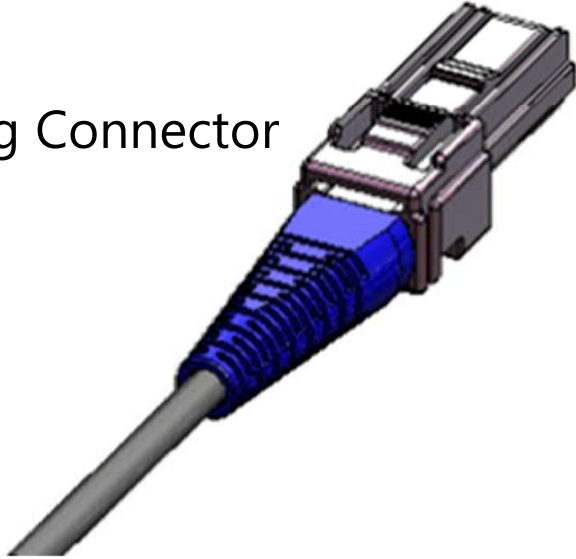
Connector Design Concept

BiDi Connector

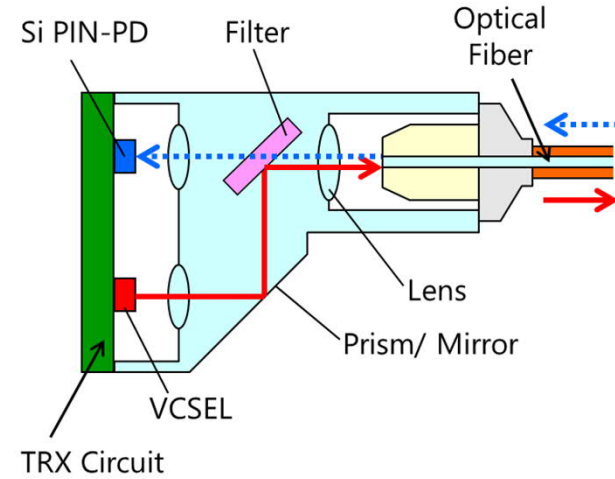


Socket Connector

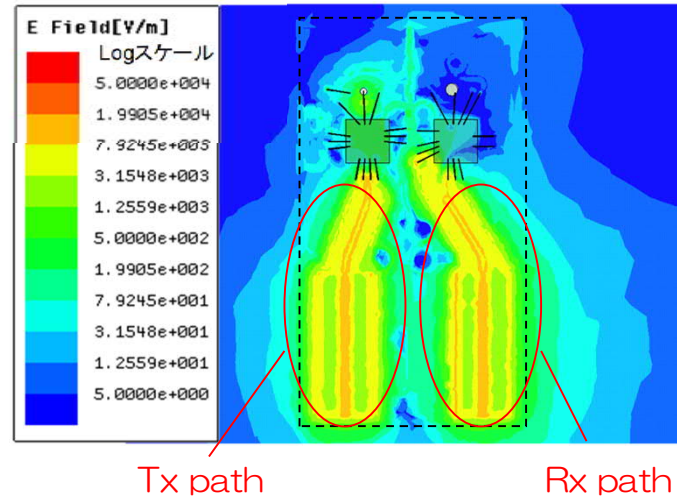
Plug Connector



Schematic diagram of FOT



X-talk analysis



Summary

- BiDi has the advantages of smaller connectors and lighter harnesses
- It is expected with communication speeds of 10~50 Gbps to become widespread in the market targeted by IEEE802.3cp and reduce costs
- Asymmetric BiDi can contribute to cost reduction and high reliability of camera links, etc

We propose to target the symmetric and asymmetrical structures by BiDi for OMEGA

Thank you for your attention

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