

Source Wavelength for Low Cost Automotive Optical Links

Ramana Murty
Broadcom Inc.

Multi-Gigabit Optical Automotive Ethernet Task Force
TF Interim Teleconference
September 29, 2021

Supporters

Mabud Choudhury, OFS
David Lewis, Lumentum

Yuji Watanabe, AGC
Hidenari Hirase, AGC

Kazuya Takayama, Nitto
Tadashi Takahashi, Nitto

Takehiro Hayashi, HAT Lab
Hideki Goto, Toyota

Michizaki Aono, Yazaki
Naoshi Serizawa, Yazaki

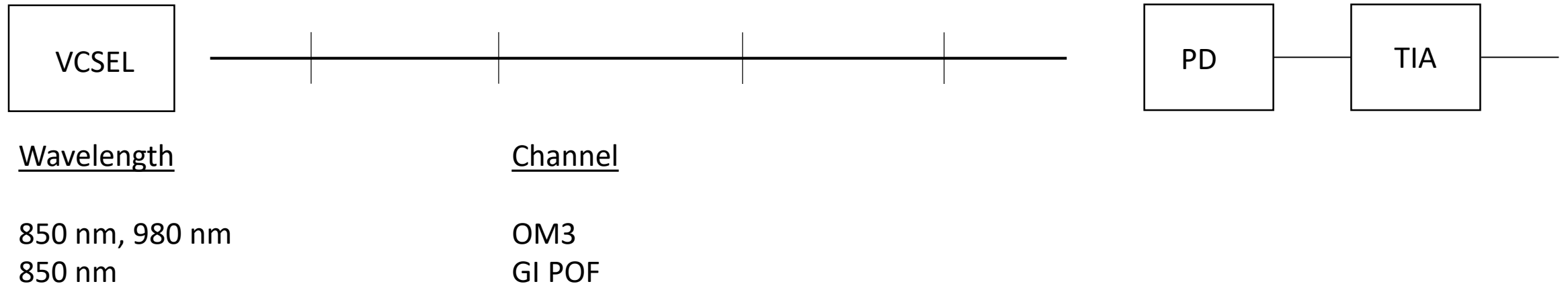
Tomohiro Kikuta, Adamant Namiki Precision Jewel
Satoshi Takahashi, POF promotion

Outline

1. Optical Link
2. Operation at 5 mA
3. Channel
4. Interoperability
5. Proposal

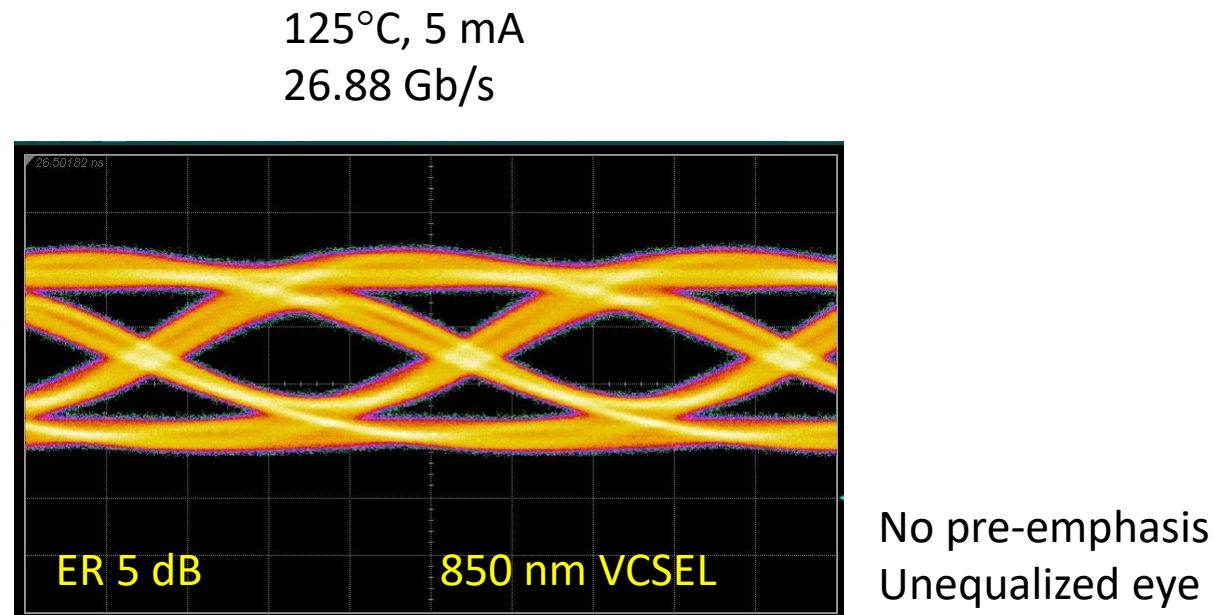
Automotive Optical Link

Proposed VCSEL-based links in 802.3cz



850 nm VCSEL: Operation at 5 mA

- Operation at 5 mA was suggested in [perezaranda_3cz_01_220621_vcsel_reliability_mission_profiles.pdf](#) as a requirement to meet lifetime for the automotive mission profile. This was based on an analysis of commercial 850 nm VCSELs.
- Lifetime analysis of the 850 nm VCSEL considered here was presented in [giovane_3cz_01a_061521.pdf](#).
- As the example below shows, 850 nm VCSEL has sufficient performance and low drive current leading to long lifetime for the automotive links.



Channel

Fiber bandwidth (BW) exceeds the receiver bandwidth (≈ 13.5 GHz, -3dBe) across 844 – 990 nm by a significant margin.
 \Rightarrow Fiber BW is not a limitation for the data link.

OM3 Fiber ^[1]

Wavelength	Modal Dispersion BW (-3 dBo)	Chromatic Dispersion BW ^[2] (-3 dBo)	Effective BW at 40 m	
			(-3 dBo)	(-3 dBe)
844 nm	1896 MHz·km	2844 MHz·km	39.4 GHz	28.8 GHz
990 nm	≈ 950 MHz·km ^[3]	5557 MHz·km	23.4 GHz	17.1 GHz

GI POF^[4]

Wavelength	Modal Dispersion BW (-3 dBo)	Chromatic Dispersion BW ^{[2],[4]} (-3 dBo)	Effective BW at 15 m	
			(-3 dBo)	(-3 dBe)
850 nm	350 MHz·km	1710 MHz·km	22.8 GHz	16.7 GHz

> 13.5 GHz

1. P. Kolesar, [kolesar 3cm 01 1118.pdf](#).
2. Calculated for RMS spectral width of 0.65 nm.
3. John Abbott, [abbott 3cz 02 0521 Laser Optimized Fiber.pdf](#) and Rick Pimpinella, [pimpinella 3cz 01 271020.pdf](#).
4. Y. Watanabe, [watanabe 3cz 02a 310821 baseline proposal with POF.pdf](#).

Interoperability

Optical link/network is self-contained in an automobile. Interoperability between source wavelengths is not necessary.

If interoperability is required,

1. Use InGaAs PIN
2. Maintain high responsivity of the photodiode (PD) using an anti-reflection (AR) coating to cover 840 – 990 nm
 - Not new to the market
InGaAs photodiodes with AR coating covering 840 – 920 nm (Bidi links) and 840 – 950 nm (SWDM links) have been used in data centers for over 6 years.
 - Every photodiode needs an anti-reflection (AR) coating because of the large refractive index difference between semiconductor and air.
 - Does not add cost
Wide band AR coating is a modification to one process step in one component. Furthermore, PD is often the lowest cost component in a link.

Source Wavelength

850 nm VCSEL

Long record of high volume use in data centers
Established low random failure rate of < 1 FIT in datacom
Adequate lifetime for automotive mission profile
Use GaAs (or InGaAs) PIN

980 nm VCSEL

Chiefly used in sensing and high power applications
Use InGaAs PIN
Adequate lifetime for automotive mission profile

850 - 980 nm VCSELs

More Suppliers ⇒ Lower Cost

Recent example

P802.3db

Short reach 100G links

850 – 940 nm source wavelength over OM3, OM4, and OM5 fibers.
multiple wavelengths multiple fibers

Proposal: Source + OM3

D1.1 does not have tables for transmit and receive characteristics.

Table 166 – x Transmit Characteristics

Description	BASE-AU		Unit
Fiber	OM3		—
Link	2.5 – 25G	50G	—
Nominal Wavelength	844 – 990		nm
Operating Distance	40	15	m

Table 166 – y Receive Characteristics

Description	BASE-AU		Unit
Link	2.5 – 25G	50G	—
Nominal Wavelength	844 – 990 ^[1]		nm

1 Centered around the source wavelength; interoperability not required.

Proposal: Source + GI-POF

D1.1 does not have tables for transmit and receive characteristics.

Table 166 – x Transmit Characteristics

Description	BASE-AUS	Unit
Fiber	GI POF	—
Link	2.5 – 25G	—
Nominal Wavelength	844 – 870	nm
Operating Distance	15	m

Table 166 – y Receive Characteristics

Description	BASE-AUS	Unit
Link	2.5 – 25G	—
Nominal Wavelength	844 – 870	nm