

# Source Wavelength for Low Cost Automotive Optical Links

Ramana Murty  
Broadcom Inc.

Multi-Gigabit Optical Automotive Ethernet Task Force  
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# Supporters

Hidenari Hirase, AGC

Kazuya Takayama, Nitto

Mabud Choudhury, OFS

Tadashi Takahashi, Nitto

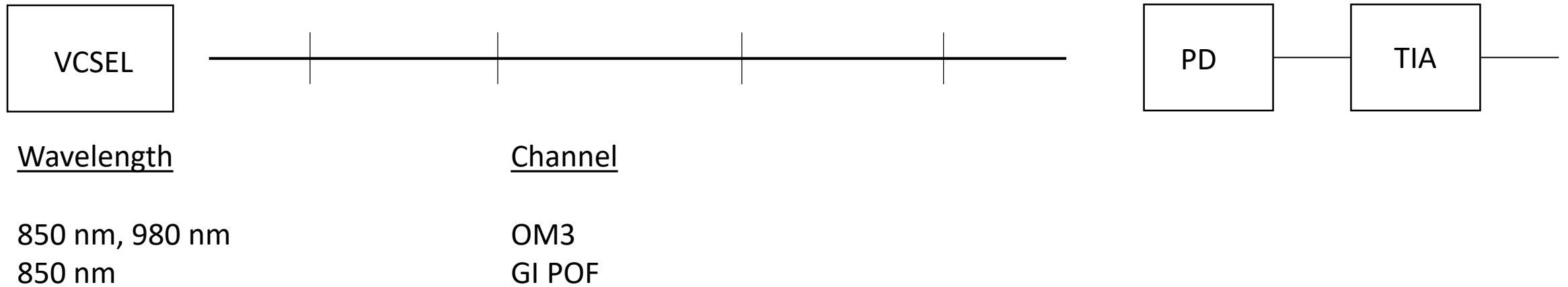
Yuji Watanabe, AGC

# 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

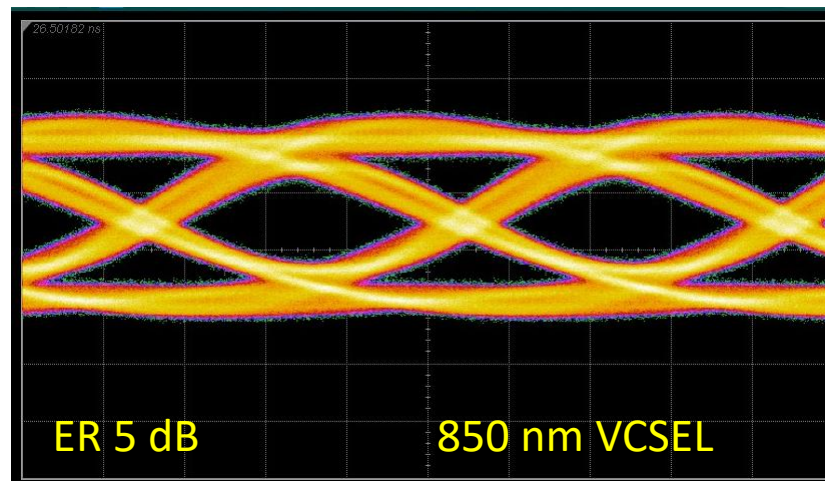


# 850 nm VCSEL: Operation at 5 mA

- 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.

125°C, 5 mA

26.88 Gb/s



No pre-emphasis  
Unequalized eye

# Channel

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

## OM3 Fiber<sup>1</sup>

Wavelength	Modal Dispersion BW	Chromatic Dispersion BW <sup>2</sup>	Effective BW at 40 m
844 nm	1896 MHz·km	2844 MHz·km	39.4 GHz
990 nm	$\approx 950$ MHz·km <sup>2</sup>	5557 MHz·km	23.4 GHz

$\gg 13.5$  GHz

## GI POF<sup>4</sup>

Wavelength	Modal Dispersion BW	Chromatic Dispersion BW <sup>2,4</sup>	Effective BW at 15 m
850 nm	350 MHz·km	1710 MHz·km	22.9 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](#).
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 <sup>1</sup>		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