Why 10GBASE-SR is not suitable for automotive

In-Vehicle Optical Multi-Gigabit Communications

10GBASE-SR is the current standard by IEEE that establishes a communications channel in optical fiber at 10 Gbps. Although well-established for industrial use, it is not suitable for automotive applications. Reasons are the temperatures and life ranges, among others, the industry demands. Consequently, a new automotive standard is urgently required.

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10 Gbps Communications for Automotive

The automotive industry is currently seeking technologies to enable 10 Gbps communications. This derives from the growing need for data interchange between sensors and electronic control units in the car. Infotainment, ADAS and growing levels of autonomy are the key trends that explain the exponential growth of data rates: 100 Mbps to 1 Gbps and to 10 Gbps. Some OEMs are even talking about 25 and 50 Gbps for the upcoming years.

Shortcomings of 10GBASE-SR

Ideally, an existing standard would work for automotive applications. However, 10GBASE-SR has not been designed to meet stringent automotive requirements. It was originally created to meet the demands of data centers where temperature, operating life, price, reliability and mechanical robustness are very controlled and modest.

Automotive Requirement: Temperature

Most automotive use cases require AEC-Q100 grade-2 qualification. This means that ambient operating temperatures range from -40 °C to 105 °C. 10GBASE-SR does not establish any temperature range. Consequently, available commercial products do not meet automotive temperature requirements.

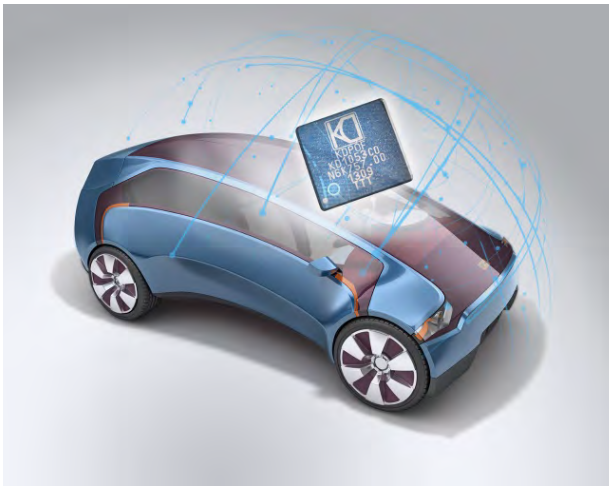
If 10GBASE-SR is used in an automotive environment in the high temperature range, there will be a negative impact on the maximum power that the light source (Vertical-Cavity Surface-Emitting Laser, VCSEL) can inject into the fiber. In other words, the light source will reduce its output light power at high temperatures. This translates to shorter link lengths and/or a smaller number of in-line connectors allowed.

Automotive Requirement: Reliability

Automotive applications require over 15 years of operation with close to 0 ppm failures. The current density is the main parameter affecting the VCSEL. The higher the current density, the lower the operating life of the device. Accordingly, the VCSEL's current density needs to be reduced to meet automotive requirements in terms of reliability and lifetime. Effects include a negative impact on the maximum power that the VCSEL can inject into the fiber. Shorter links and/or a smaller number of in-liners are the consequences. In addition, transmission bandwidth is reduced, resulting in slower transmission speeds. Furthermore, relative intensity noise will increase, with the effect of lower signal-to-noise ratio and a link budget reduction.

Automotive Requirement: Harsh Environment

For automotive, the number of in-line connections is larger than supported by 10 GBASE-SR. In addition, the insertion loss of in-line connections is going to be larger due to dust, aging, and cost restrictions.



Vibration
Currently available in-line connectors increase their insertion loss when vibrations are present. Thus, the number of allowable connectors will be reduced for a 10GBASE-SR link.

Aging
Present fiber and connectors age quickly when operated in a harsh automotive environment. This translates into a link power budget degradation (shorter lengths and/or fewer in-liners).

Dust
Modern connectors are not designed to withstand automotive dust specifications. As a result, they will get soiled and insertion losses will be increased (smaller number of in-liners and/or shorter link length allowed).

Dynamic Temperature Changes
Automotive applications require the communications system to adapt to quick temperature changes without any impact on the error rate or link performance. This means that the system needs to adapt its operation depending on the operating temperature. This is not possible with 10GBASE-SR: the system remains the same when temperatures change, and the impact on the performance translates into different parameter degradations such as link length, error rate, etc.

Further Automotive Requirements

There are also further automotive requirements that affect 10GBASE-SR and make it unsuitable for in-vehicle usage.

Harness Routing
Automotive environments involve a high number of in-line connectors (up to 4) in a single link. This is not the case for applications that 10GBASE-SR was designed for. Automotive routing practices are aggressive with tight bends, which 10GBASE-SR also does not support.

Low Power
In-vehicle applications require low power ports with less than 2 watts/port at 10 Gbps. This cannot be achieved by any 10GBASE-SR component available.

Low Cost
Automotive demands low link cost for 10 Gbps (< 2x of 1 Gbps link cost). Commercially existing components that comply with 10GBASE-SR are far beyond this cost target.

High Production Yield
In order to keep the cost low, components have to be manufactured in high-volume industrial processes. Thus, they can withstand large parametric variations as a result of manufacturing processes. This is not the case with currently available 10GBASE-SR components, as they are not produced in high-volume low-cost lines. Having a system able to automatically adapt and providing big margins is essential to deliver a production with high yield, low cost end of line test, and reduced cost in the component base technology.

Operations, Administration, Maintenance
A service channel is required for automotive's unique functionalities. This Operations, Administration, Maintenance (OAM) service channel is not provided by 10GBASE-SR.

New Automotive Standard Progress

When automotive requirements are applied, the link budget offered by 10GBASE-SR is too low to be acceptable. Several suppliers of fiber optics components propose OEMs solutions like sleeves

and ferrules, which are working concerning performance. But what is the cost, and what is the yield?

Due to all these reasons, and with power consumption and especially cost being key in automotive applications, only a new communications scheme can provide larger margins and adapt itself automatically to varying environmental conditions and manufacturing process variations.

The new standard should support production processes for its components that enable a high yield, low-cost market. By combining optimization in all areas of the new standard, the right balance in complexity and cost among all parts (CMOS IC, VCSEL, PD, ferrules, sleeves, cable, in-line connection technology, optics, and lenses, etc.) can be achieved in order to deliver the lowest cost solution to the automotive market.

Moreover, the new standard should be a scalable technology in order to enable even higher data rates such as 25, 50, and 100 Gbps in the future. The technology approach of 10GBASE-SR belongs to technology of more than 15 years. It is time to develop a future-ready solution for OEMs using more advanced techniques that will make an impact by providing the lowest cost, most reliable, and highly scalable solution.

Currently, a team of individuals affiliated with more than 15 key carmakers, such as PSA, Toyota, and Volvo, Tier1s, and components suppliers, including KDPOF, is working on defining this new standard. The team is specifying the needs and technologies to support a new standard for 10 Gbps in automotive that will complement the existing 10GBASE-SR. The working group is expected to kick off in the summer of 2019, with the first prototypes to be projected by the end of 2021.

About KDPOF
Fabless semiconductor supplier KDPOF provides innovative gigabit and long-reach communications over Plastic Optical Fiber (POF). Making gigabit communication over POF a reality, KDPOF technology supplies 1 Gbps POF links for automotive, industrial, and home networks. Founded in 2010 in Madrid, Spain, KDPOF offers their technology as either ASSP or IP (Intellectual Property) to be integrated in SoCs (System-on-Chips).
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