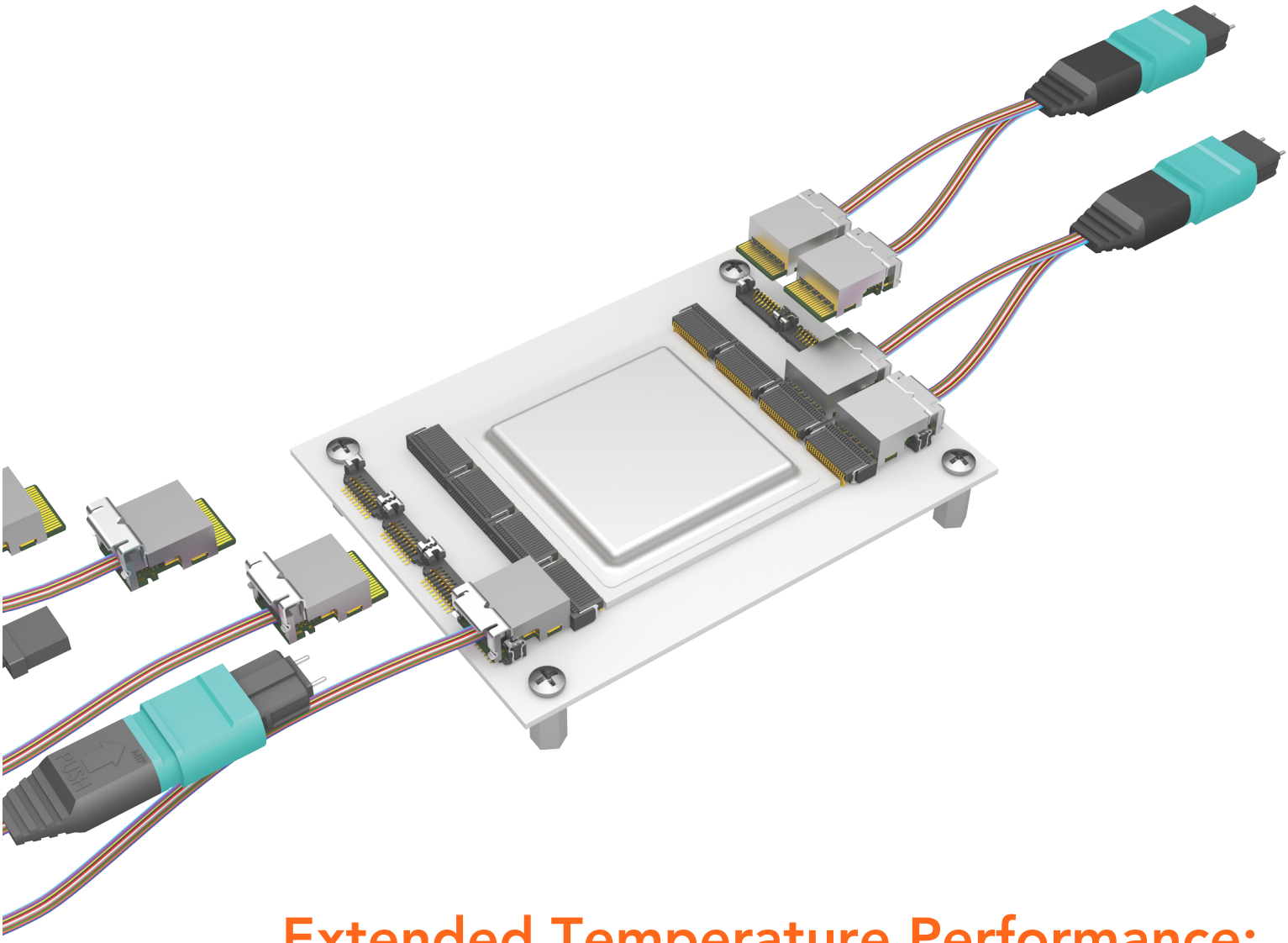

Extended Temperature Performance:

VCSEL Based Optical Transmitter

Presented at: The Avionics and Vehicle Fiber-Optics and Photonics Conference and International Topical Meeting on Microwave Photonics

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Introduction

Optical fiber has several benefits over copper cabling including reduced weight, immunity from electromagnetic interference, and increased bandwidth. However, difficulties in operating over temperature have impeded the use of vertical cavity surface emitting laser (VCSEL) based multimode optical transceivers outside datacenters. Higher bandwidth requirements in satellites and aircraft have led to proposals for optics-based solutions including SpaceFibre[1] and fly-by-light flight controller systems[2]. As a result, there have been increased efforts toward demonstrating VCSELs that operate across extended temperature ranges[3].

We demonstrate the operational performance of Samtec's FireFly™ 12 channel transmitter across the temperature range from -40 °C to 90 °C at 10.3125 Gbps. Reliability results from 2000 hours of high temperature operation are also included.

Performance

The VCSEL is the component in the FireFly™ that is most sensitive to changes in temperature; careful VCSEL selection is required to ensure the transceiver will operate with sufficient margin across temperature. Because both the slope efficiency and laser threshold vary with temperature, a temperature compensation algorithm is often implemented to adjust the laser drive current. The routine that was selected for the FireFly™ transmitter was determined to optimally balance performance and manufacturability.

The RF performance of a 12 channel FireFly™ transmitter was characterized in a temperature chamber by adjusting the chamber temperature such that the heatsink temperature of the FireFly™ varied between -40 °C and 90 °C. Representative eye diagrams taken 10.3125 Gbps are provided in Figure 1; the eye mask defined in the 802.3ba specification is overlaid for reference.

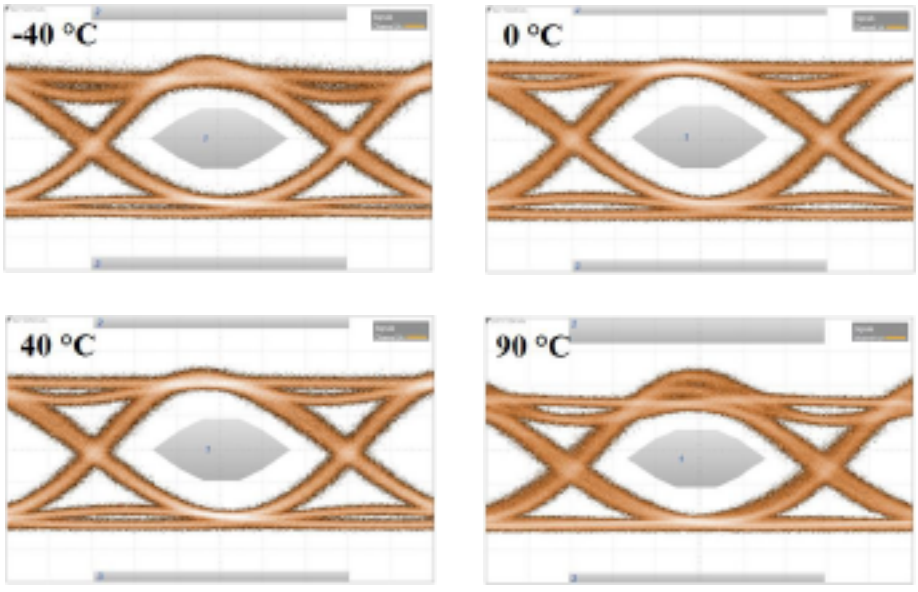

Figure 1: Representative eye diagrams for a FireFly™ module operating between -40 and 90 °C

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Laser Reliability

In addition to demonstrating that the VCSEL operates at extended temperatures, it must also be confirmed that it does so reliably. Increasing the operating temperature of the VCSEL reduces the length of time that it will function properly. For example, a 7 °C increase in temperature roughly halves the lifetime of the chip, assuming an industry standard activation energy for wearout of 0.7 eV. In order to determine the operating lifetime, eleven FireFly™ were placed in a temperature chamber and operated continuously for 2000 hours at 85 °C. The change in optical power over time is provided in Figure 2. It was found that for all channels on all parts, there was less than a 0.5 dB change in optical power after 2000 hours of operation.

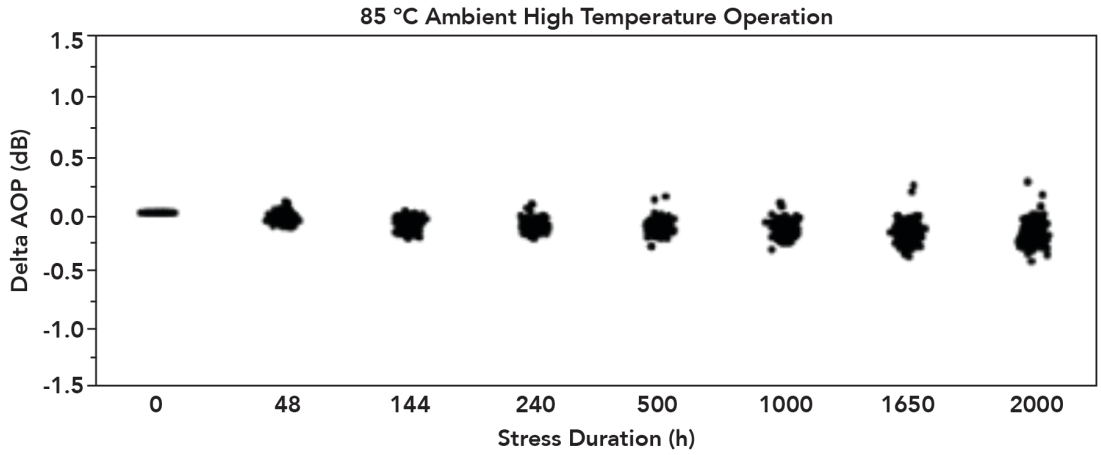

Figure 2: Change in average power during continuous operation at 85 °C ambient

Conclusion

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In this paper we demonstrate the extended temperature performance of Samtec's 12 channel margin FireFly™ optical transmitter at 10.3125 Gbps. The results indicate that the transmitter has more than 25% mask when operating between -40 °C and 90 °C. Reliability results for 11 different transmitters operating at 85 °C indicate that the output power of the laser changes by less than 0.5 dB after 2000 hours of continuous operation.

References

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