850 nm datacom VCSELs for higher-speed and longer-reach transmission

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Keywords: datacom, high-speed, quasi-single mode, bandwidth.

The 850 nm GaAs-based VCSEL is already the dominating technology for transmitters in optical interconnects up to 100 m in datacenters, thanks to low-cost fabrication, excellent high-speed properties at low currents and the existence of high-speed OM4 multimode fiber optimized for this particular wavelength. Future datacenters will require faster and more energy-efficient VCSELs to increase the overall bandwidth and reduce the power consumption of the datacenter network. In addition, longer-reach interconnects exceeding 1 km will also be required as datacenters grow into large multi-building complexes.

By optimizing the doping profiles of the DBRs to reduce resistance, using a short (½-λ) cavity to improve longitudinal optical confinement and optimizing the photon lifetime for optimal damping, we obtained a record-high small-signal modulation bandwidth of 28 GHz for a ~4 µm oxide aperture VCSEL. A 7 µm oxide aperture VCSEL (~27 GHz bandwidth) enabled error-free transmission (bit-error-rate < 10^{-12}) at 47 Gbit/s back-to-back (BTB) and 44 Gbit/s over 50 m of OM4 fiber, using a VI-systems R40-850 photoreceiver (30 GHz) with an integrated limiting transimpedance amplifier. The high bandwidth also allows for error-free transmission at 40 Gbit/s BTB at 85°C [1]. By instead using a New Focus 1484-A-50 photoreceiver (22 GHz) with a linear amplifier, 50 Gbit/s error-free transmission was achieved BTB at room temperature, see figure 1.

At longer transmission distances (> 300 m), the large spectral width of VCSELs leads to severe signal degradation by fiber dispersion. We have investigated two methods of fabricating low-spectral width quasi-single mode VCSELs to mitigate this problem. By using a small oxide aperture of ~3 µm, error-free transmission was achieved at 22 Gbit/s over 1.1 km of OM4 fiber [2]. An alternative approach is to use an integrated mode filter in the form of a shallow surface relief to reduce the spectral width of the VCSEL. The mode filter allows for the use of a larger oxide aperture and thereby enables a lower resistance and operation at a lower current density. A 5 µm oxide aperture VCSEL with a mode filter enabled error-free transmission at 25 Gbit/s over 500 m of OM4 fiber [3].

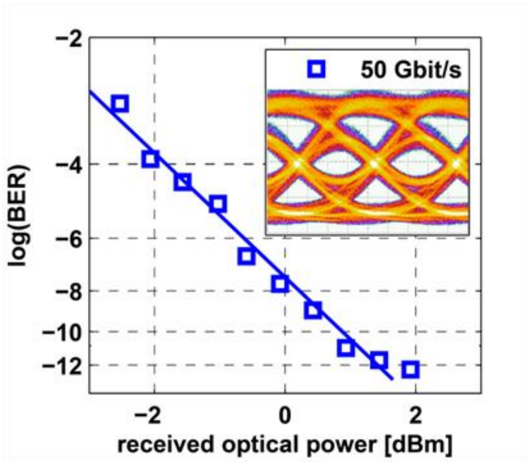

Figure 1. BER vs. received optical power at 50 Gbit/s BTB with eye diagram.

References

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