High-Speed 850-nm VCSELs Operating Error-Free Beyond 50 Gbit/s

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Introduction

The 850-nm vertical-cavity surface-emitting laser (VCSEL) is a key component in today's short reach (<100 m) optical interconnects due to low-cost fabrication, excellent high-speed properties at low drive currents, low power consumption, and the availability of high-speed multimode fiber (MMF) optimized for 850 nm.

Facebook's new data center in Luleå.

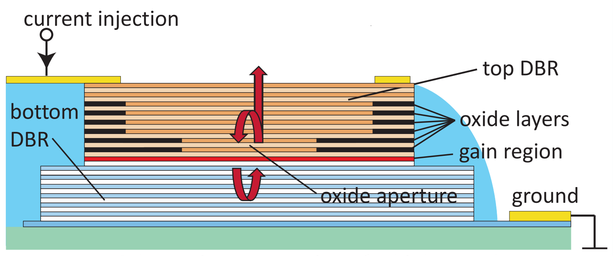
To meet the growing needs for capacity, near future datacom standards will require VCSELs operating well beyond the ~20 Gbit/s which today's commercially available VCSELs are capable of.

High-Speed VCSEL

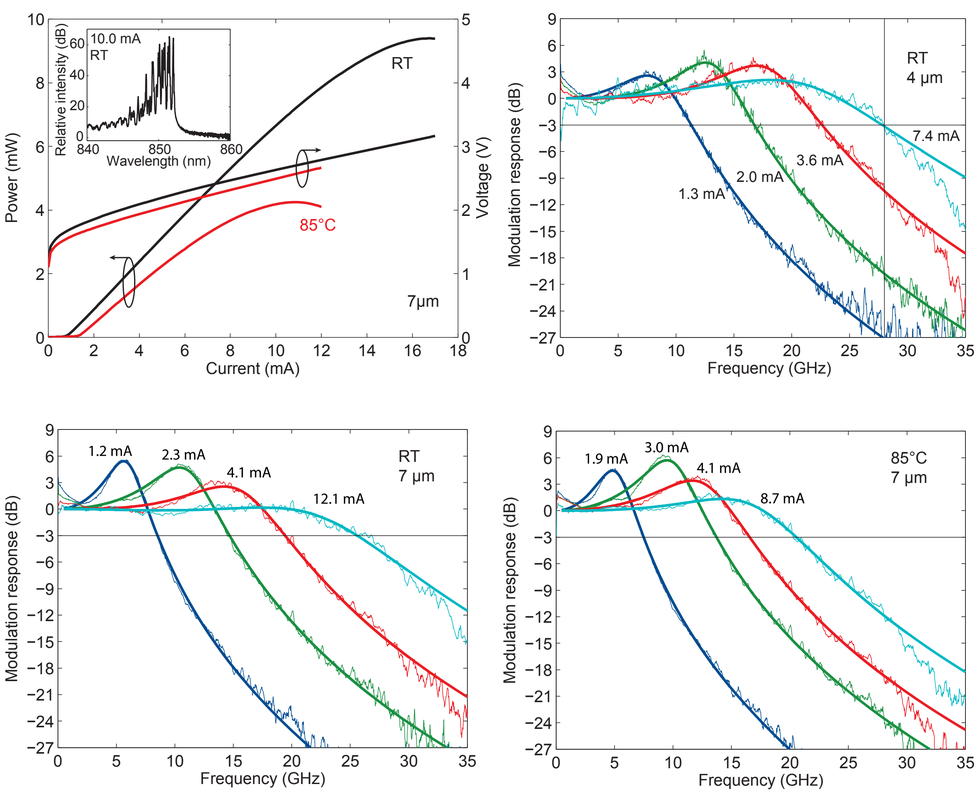
High-speed VCSELs were realized by:

- Reduction of the electrical parasitics
- Improvement of the optical confinement
- Optimization of the photon lifetime (trade-off between resonance frequency and damping)

→Record high modulation bandwidth of 28 GHz at room temperature and above 20 GHz at 85°C [1-2].

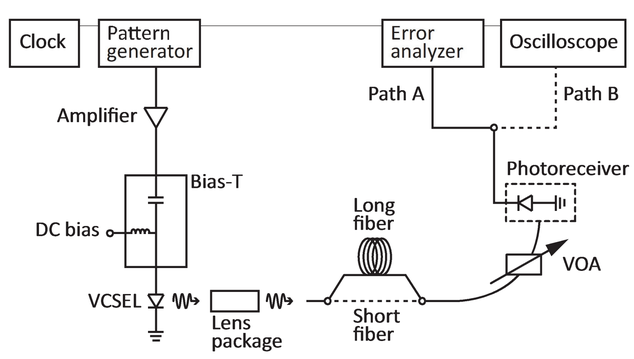


Schematic cross-section of a high-speed oxide-confined VCSEL.



Transmission Experiments

The VCSEL's ability to function as a high-speed data transmitter was tested through large signal modulation experiments. Error-free transmission is defined as bit-error-rate (BER) less than 10^{-12}.

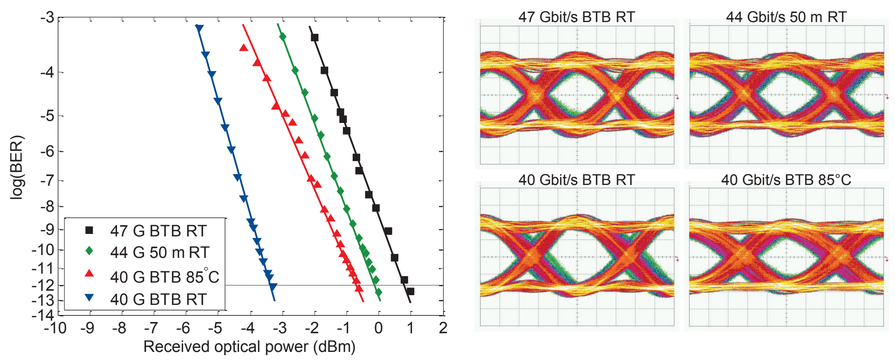


Experimental setup.

Results

A link employing a 7 µm oxide aperture VCSEL and a 30 GHz photoreceiver with an integrated *limiting* amplifier enabled error-free transmission up to [2]:

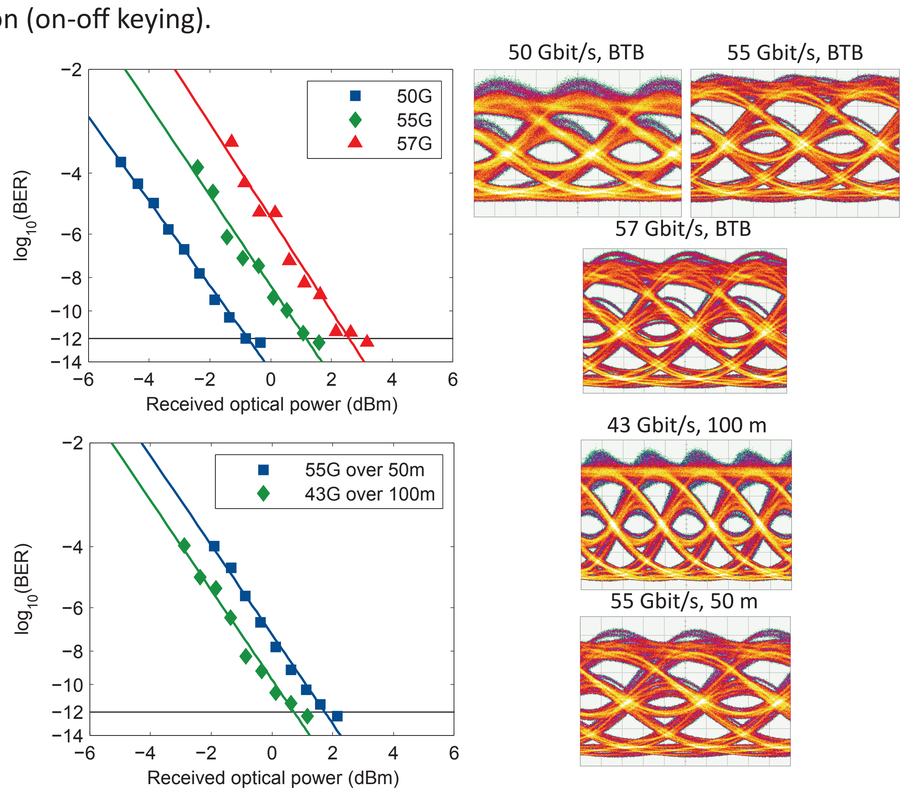
- 47 Gbit/s back-to-back (BTB) at room temperature (RT)
- 44 Gbit/s over 50 m OM4 fiber at room temperature
- 40 Gbit/s back-to-back at temperatures up to 85°C.



Another link employing an 8 µm oxide aperture VCSEL and a 22 GHz photoreceiver with an integrated *linear* amplifier enabled error-free transmission at room temperature up to [3]:

- 57 Gbit/s back-to-back
- 55 Gbit/s over 50 m OM4 fiber
- 43 Gbit/s over 100 m OM4 fiber.

These are the highest data rates reported for any directly modulated VCSEL using binary modulation (on-off keying).



Conclusion

We have demonstrated high-speed data transmission at record bit rates up to 57 Gbit/s back-to-back, 55 Gbit/s over 50 m OM4 fiber and 43 Gbit/s over 100 m OM4 fiber using 850-nm VCSELs. These results represent a significant progress of current state-of-the-art in VCSEL performance.

References

[1] P. Westbergh, et al., "High-speed 850 nm VCSELs with 28 GHz modulation bandwidth operating error-free up to 44 Gbit/s", Electron. Lett., vol. 48, no. 18, pp. 1145-1147, Aug. 2012.

[2] P. Westbergh, et al., "High-speed oxide confined 850 nm VCSELs operating error-free at 40 Gbit/s up to 85°C", IEEE Photon. Techn. Lett., vol. 25, no. 8, pp. 768-771, Apr. 2013.

[3] P. Westbergh, et al., "High-speed 850 nm VCSELs operating error free up to 57 Gbit/s", Electron Lett., vol. 49, no. 16, pp. 1021-1023, Aug. 2013.

Acknowledgement

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