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Performance Evaluation of Zero- Biased VCSEL for High Speed Data Transmission

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In an optical transceiver, the power consumption related to the operation of the laser device takes a significant parcel of the total consumed power. The reduction of it is an important issue when a large number of transceiver devices are interconnected in an optical network, such as the one that supports the data transmission in particle physics experiments. An analysis and simulation results will be presented regarding the operation of a bias-free VCSEL device based on a previously developed model. The impact on BER of the increased turn-on jitter due to the bit-pattern and spontaneous emission will be considered.

Summary

The upgrade to the existing Large Hadron Collider in CERN (European Organization for Nuclear Research) will require a boost of speed from the digital transceivers (4.8 Gbits/s) to allow for the increase of data output from the particle detectors. Low power consumption and low mass will be determinant for the performance of the detector.
By operating the laser device with no bias-current (0 current at the logic 0 stage) significant power saving can be made (in the order of 25 to 50%) regarding its operation with an optimum bias current. Nevertheless there will be a penalty in the eye diagram shape and therefore in the BER (Bit Error Rate). This is because of the turn-on delay increased jitter (about 50 pico seconds in the obtained simulation results) due to bit-pattern dependent effects and spontaneous emission.
Since the laser will only output optical power during the logic 1 stage, no clutter noise due to the residual optical output power at the logic 0 stage will be present in the network, possibly simplifying a passive optical network receiver architecture.
By using a laser model ([1]), the bellow threshold and bias-free operation of a VCSEL (Vertical Cavity Emitting Laser) device can be determined, the BER penalty estimated and the trade off correctly considered ([2],[3]). The data transmission speed limit can also be determined and its operation optimized by changing the Ioff / Ithreshold and Ion / Ithreshold ratios.
Operating a laser device in a bias-free mode can save power, lower transceiver complexity, mass and increase system reliability ([4]).
References
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