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Characterization of Semiconductor Lasers for Radiation Hard High Speed Transceivers

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In the context of the versatile link project, a set of semiconductor lasers were studied and modeled aiming at the optimization of the laser driver circuit. High frequency measurements of the laser diode devices in terms of reflected and transmission characteristics were made and used to support the development of a model that can be applied to study their input impedance characteristics and light modulation properties. Furthermore the interaction between the laser driver, interconnect network and the laser device itself can be studied using this model. Simulation results will be compared to measured data to validate the model and methodology.

Summary

Keywords: Laser, VCSEL, model, Verilog-A, transceiver, radiation hard.

SUMMARY

The versatile transceiver under development for the Super Large Hadron Collider (SLHC) experiment will have to endure severe radiation conditions while providing multiple gigabit per second data transmission capability to cover the experiments requirements [1, 2]. For this, characterization and modeling of the electro-optic components (in particular the semiconductor laser), are of upmost importance as they will enable the correct design and optimization of the transceiver [3]. They will also enable to evaluate the link performance when the physical characteristics of the device change due to the environmental circumstances.

A measurement methodology will be presented whose results lead to the implementation of a model with broad validity. This model accommodates several different laser types (Fabry-Perot, Distributed Feedback, Vertical Emission) [4-7]. The laser model is implemented in Verilog-A for ease of use by integrated circuit designers, and it aims at easing the design of robust systems capable of complying with the demanding requirements of high energy physics experiments.

Since the impedance mismatch between the driver and the laser should be kept as low as possible to decrease inter-symbol interference, jitter and power loss, a very accurate model of the laser chip input and parasitic network was developed. It will be shown that the theoretical model is in good agreement with experimental data and that it enables correct design of the transmitter circuitry of the laser driver. The results of the study of an impedance matching network and signal pre-emphasis will be shown.

Current work is focusing on the use of the model to predict the performance degradation with environmental conditions and analyses of the system sensitivity to manufacturing parameter deviations [8].

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