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A 4 x 8 Gbps VCSEL Array Driver ASIC and Integration with A Custom Array Transmitter Module for the LHC Front-end Transmission

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VCSEL-based parallel optical data links have recently seen rapid and wide-spread deployment in high performance computing labs, data centers and Ethernet networks. The benefits include highly aggregated bandwidth, compact footprint and low power consumption. To apply the parallel optics in high energy physics, for example, in the LHC upgrades as well as other collider detector developments, the devices also have to meet rigid environmental demands of radiation, electro-magnetic field and temperature. Two critical developments, the array driver ASIC and the precision optical interface assembly, are indispensable towards a dedicated array optical transmitter for on-detector deployment.

In this paper, we present the design and test results of the LOCld2014 ASIC, a 4 x 8-Gbps VCSEL array driver fabricated in a commercial 0.25- μm Silicon-on-Sapphire(SOS) CMOS technology. This is the first VSCEL array driver ever fabricated at this aggregated bandwidth targeting the high-energy physics experiments. The LOCld2014 receives a low-swing CML signal (differential p-p 200 mV), outputs a 7.5 mA modulation current with a 6.25 mA bias current. Programmable active-shunt-peaking technique is used to extend the bandwidth in pre-driving stages. A novel structure of the output stage removes the ordinary extra bias-circuit, and delivers both bias and modulation current with balanced branches to effectively minimize the switching signals on the power supply and crosstalk.

After integrated within a custom array optical transmitter (ATx), the LOCld2014 is able to be fully tested. The ATx module, while utilizing generic mechanical optical interface (MOI) and optical turn fiber ribbon, is assembled via a custom active alignment procedure. The optical eye diagram of each channel at 8Gbps has been measured, and passed the eye mask test with adjacent channels working simultaneously. The BER < 1E-12 is achieved at each channel working at 8 Gbps with adjacent channels working simultaneously. The full data link performance and crosstalk evaluation of the LOCld2014 will be presented in the paper. The X-ray irradiation tests of the whole module including the LOCld2014 will be conducted, and the results will be reported.

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