Two-Dimensional Optoelectronic Digital Halftoning Processor

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ABSTRACT:

A two-dimensional (2-D) multi-channel 8x8 optical interconnect system was developed and investigated in optoelectronic processing architectures as a digital halftoning image processor. The system was designed and fabricated using complementary metal-oxide-semiconductor (CMOS) driven 850-nm vertical-cavity surface-emitting laser (VCSEL) arrays and the p-i-n photodetector (PD) arrays with corresponding wavelengths. The configurations of these 2-D VCSEL and PD arrays are in an 8x8 geometry with a 125-μm device pitch, which yield an interconnect density of 64 interconnects/mm^2. Individual VCSELs have been found to have 3-dB bandwidth as high as 6 Gb/s. The interconnect was integrated by flip-chip hybridization of VCSEL and PD chips onto silicon-on-sapphire (SOS) CMOS for the operational wavelength of 850-nm.

We constructed the entire system under a free-space configured 2-D optical interconnects driven by silicon-on-sapphire (SOS) circuits and carried out characterization of the system on data transmission using pseudo-random bit stream (PRBS) data sequence. Eye diagrams from single channels were obtained and analyzed using a pattern generator and a digital oscilloscope at data rates from 155 Mb/s to 1.5 Gb/s. BERs of 10^{-12} to 10^{-2} were measured within such bandwidths. Using a statistical model of Gaussian distribution for the random noise in the transmission, we used a method to compute the BER instantaneously in synchronous with the digital eye-diagrams. Direct measurements on this interconnects were also taken on a standard BER tester for verification. We found that the results of the two methods were in the same order and within 50% accuracy. The integrated interconnects are being investigated in optoelectronic processing architectures such as digital halftoning image processor. Error diffusion networks implemented by the inherently parallel nature of photonics promise to provide high quality digital halftoned images. Error diffusion networks implemented by the inherently parallel nature of photonics promise to provide high quality digital halftoned images.

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KEY WORDS: VCSEL, photodetector, digital halftoning, optical interconnect, pseudo-random bit stream (PRBS), bit-error-rate (BER)

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