ABSTRACT

The return-to-zero Differential Phase Shift Keying (RZ-DPSK) transmission format has attracted the interest of transmission experimentalist as an enabler for 40 Gbit/s systems because it provides 3 dB more system margin. Combined with Return-to-Zero (RZ) coding, it is also more resilient to non-linear distortions imposed by the transmission fiber. Here, a 40 Gbit/s Carrier-Suppressed RZ-DPSK transmission system with receiver sensitivity of -33.5 dBm is presented. Various new features such as demodulation of RZ-DPSK signals using a delay interferometer having delay of 4 symbol durations and lock-in stabilization of the delay interferometer phase are demonstrated. It is particularly shown that a signed online chromatic dispersion measurement scheme which synchronously detects arrival time variations in the clock recovery phase locked loop also works for this type of modulation formats.

Further more, the residual chromatic dispersion of a various fiber link lengths up to 263 km length is automatically compensated for NRZ-DPSK and CSRZ-DPSK modulation formats at 40 Gbit/s, using synchronous arrival time detection scheme and a fiber Bragg grating–based thermally tunable dispersion compensator in the range of -300 to -700 ps/nm. The total measured penalty of transmission and CD compensation is -1.2 dB ... $+1.2$ dB, for various link lengths and compensator CDs.

A simple alternative to double the existing transmission capacity without optical bandwidth increase is to use Differential Quadrature Phase Shift Keying (DQPSK). Combined with RZ coding its robustness against cross-phase modulation is also large because the intensity is not modulated by the data. In this work, 2×40 Gbit/s (40 Gbaud) RZ-DQPSK transmission over 263 km of fiber with manually thermally tunable chromatic dispersion compensator with a back-to-back Q factor > 20 dB (extrapolated BER $< 10^{-23}$) is reported. The receiver sensitivity is -27.5 dBm. Even after transmission the Q factor is 17.5 dB.

DQPSK and polarization division multiplex (PolDM) transmission each double fiber capacity by their increased spectral efficiency. Both techniques have been combined to transmit 4×40 Gbit/s per WDM channel. The fiber capacity is 1.6 bit/s/Hz, the value which has been previously reported or surpassed only at 10 Gbaud. A 1.6 bit/s/Hz transmission over 230 km of fiber is demonstrated with Q> 15.6 dB for one of the 8 WDM channels for which the thermally tunable dispersion compensator was operational.

A differential amplifier combined with travelling wave amplifier at 40 Gbit/s is designed and simulated in a pseudomorphic AlGaAs/InGaAs HEMT technology. The gain and 3 dB bandwidth are 17 dB and 46 GHz, respectively.

A version of the amplifier that will work at 10 Gbit/s is simulated, designed, and fabricated in low-cost $0.18\mu m$ CMOS technology. Amplifier makes use of striplines. The experiment demonstrates the 10 Gbit/s signal propagation over narrow CMOS striplines. For a single phase input, amplifier has a gain of 6 dB at 10 Gbit/s. The measured bandwidth is 6.2 GHz and common mode rejection ratio (CMRR) is 8 dB. This CMOS circuit using striplines exhibits a performance comparable performances with that of the state-of-the-art amplifiers designed in conventional technologies. This opens the possibility for using

striplines with its over all good shielding in complex analog systems. Such differential in differential out amplifiers can be used in balanced optical front ends to achieve the record sensitivity values.