Suppression of cross-gain modulation induced crosstalk in semiconductor optical amplifier using return-to-zero differential phase-shift-keying

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Abstract: We report experimental results that shows reduction of cross-gain modulation in semiconductor optical amplifier with differential-phase-shift-keyed DWDM input signals in comparison with on-off keyed signals operating at 12.5 Gb/s with 25 GHz channel spacing.

OCIS codes: (060.2330) Fiber optics communications; (250.5980) Semiconductor optical amplifiers; (060.5060) phase modulation

Conventional OOK is susceptible to cross-gain modulation (XGM) in SOAs. Reduction of XGM using DPSK in a single-channel experiment had been observed [1]. In this paper, we report results of suppression of XGM using nine 25-GHz spaced input RZ-DPSK channels at 12.5 Gb/s.

Fig. 1 shows the experimental setup. Nine 25-GHz spaced DFB lasers were combined and launched into a lithium niobate (LN) Mach-Zehnder modulator (MZM) driven by a 12.5 GHz sinusoidal wave producing RZ pulses. The pulses were encoded with DPSK (OOK) using a LN MZM biased at null (quadrature) driven by a 12.5 Gb/s NRZ data (PRBS: 2^{31}-1) with a $2V_\pi$ (V_π) swing voltage. A fiber with -340 ps/nm of dispersion (DCF) decorrelates the channels.

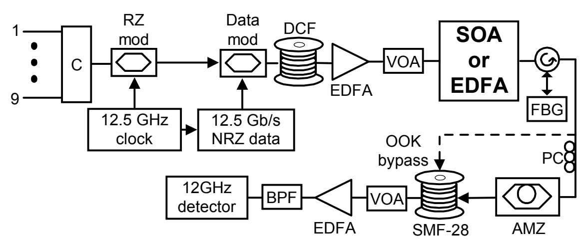

Fig. 1. Experimental setup. C: coupler. PC: polarization controller.

The nine channels were amplified followed by a VOA before launching to the SOA. The SOA fiber-to-fiber small-signal gain was 22 dB. Saturation input and output powers were -14 and +5 dBm. The SOA output was directed to a fiber Bragg grating (FBG) to select the center channel (1545.32 nm). 20 km of SMF-28 fiber (+340 ps/nm) was used to compensate the dispersion of the DCF followed by a VOA and a receiver consists of an EDFA, a 1.3-nm band-pass-filter (BPF), and a 12-GHz photoreceiver. A polarization-sensitive asymmetric Mach-Zehnder (AMZ) device after the FBG demodulates the RZ-DPSK signal. Due to the FBG dispersion, NRZ-like pulses were observed for RZ-OOK signal. For RZ-DPSK, the AMZ demodulator partially compensates the FBG dispersion [2]. To distinguish XGM from ASE noise degradation, measurements were repeated using an EDFA with similar output OSNR as the SOA.

Fig. 2 shows eye diagrams of the received center channel for RZ-DPSK and RZ-OOK. The composite power into the SOA was -17 dBm for both signals. XGM degradation on RZ-DPSK was minimal compared with RZ-OOK. Due to the FBG and AMZ, RZ-DPSK and RZ-OOK signals are different even with EDFA (Figs. 2(b) and 2(d)). Fig. 3 shows bit patterns of RZ-DPSK and RZ-OOK signals using SOA or EDFA. Severe XGM of RZ-OOK signal is evident. RZ-DPSK, however, suffers virtually no XGM for all three cases.

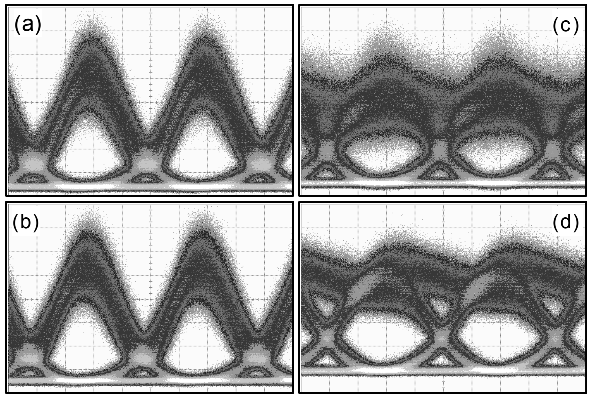

Fig. 2. Eye diagrams of the center channel for RZ-DPSK with (a) SOA, (b) EDFA, and for RZ-OOK with (c) SOA, (d) EDFA. PRBS length: 2^{31}-1. Horizontal scale: 20 ps/div.

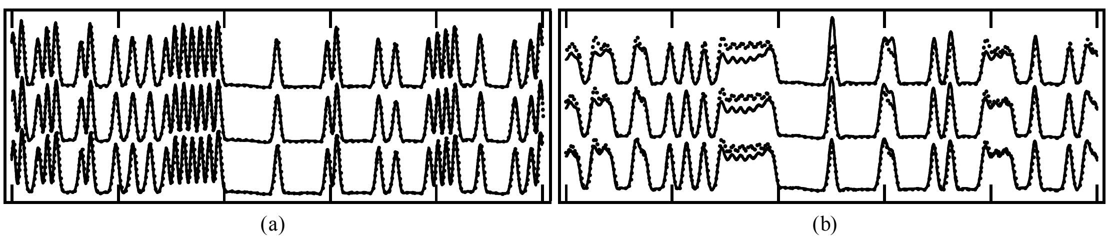

Fig. 3. Time-averaged bit patterns of (a) DPSK, and (b) OOK signals. Top, middle, and bottom traces depict composite input powers of -14, -17, and -20 dBm to the SOA. Solid and dotted lines represent SOA and EDFA. PRBS: 2^7-1. Horizontal scale: 1 ns/div.

Fig. 4 shows BER for RZ-DPSK and RZ-OOK amplified by SOA or EDFA for -14, -17, and -20 dBm input to the SOA. For EDFA, the input power was adjusted to produce similar OSNR as the SOA. The optimal input powers to SOA for RZ-OOK and RZ-DPSK were -20 and -17 dBm. Although there was no XGM for input powers up to -10 dBm, BER degradation was observed for RZ-DPSK. This is likely caused by four-wave-mixing and phase noise from signal and ASE noise beating [3].

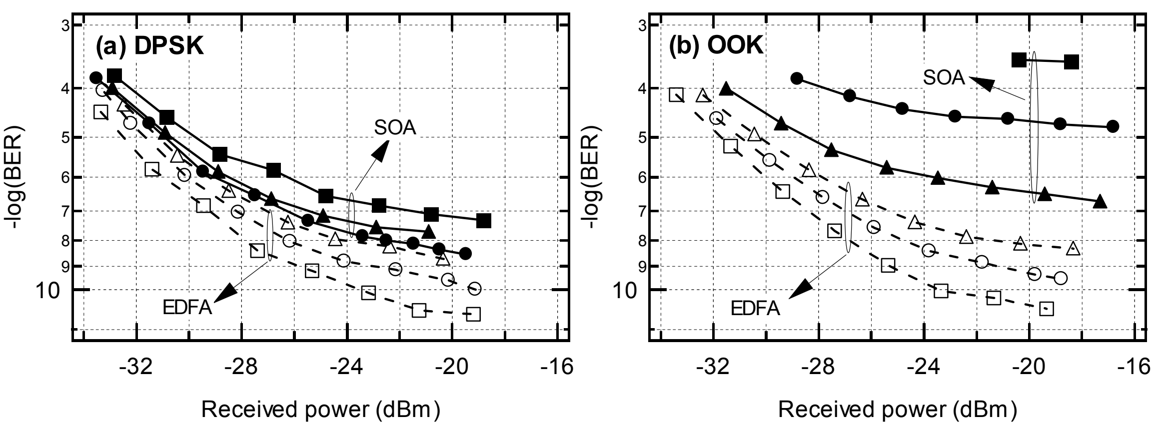

Fig. 4. BER of the center channel versus received power for (a) RZ-DPSK, and (b) RZ-OOK through SOA or EDFA. Square, circle, and triangle denote -14, -17, and -20 dBm input to the SOA. Solid and dashed lines represent SOA and EDFA. PRBS: 2^{31}-1.

References

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