Increased sensitivity of delay-interferometer receiver for 10G DPSK for SOI platform

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Differential-phase-shift-keyed (DPSK) format exhibits several advantageous qualities [1]. It enables 3-dB improved receiver sensitivity with balanced detection, and has higher tolerance to nonlinear degradation if compared with OOK. The detection of the phase at the receiver can either be implemented using coherent or differential (non-coherent) detection. A coherent receiver uses carrier tracking by phase-locked loops to estimate the absolute phase, while in differential encoded PSK the information is in the phase transition and can be demodulated using a passive delay-interferometer. The simplicity of the differential detection and the elimination of a local oscillator (LO) and digital signal processor (DSP) makes differential detection advantageous for low cost links. However this comes with a loss, the differential detection has an intrinsic lower sensitivity of approximately 2dB [2]. Moreover, if the receiver isn't well balanced further losses in sensitivity could be produced.

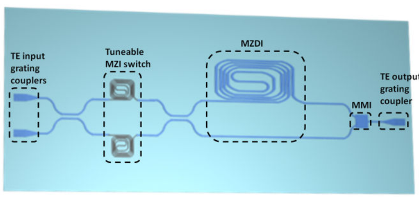

Figure 1: Schematic of the proposed DPSK demodulator. From left to right in the figure: Two input TE grating couplers with waveguide tapers, 2x2 unbalanced MZI switch, MZDI with a 10GHz delay-line, a 2x1 MMI, taper, and an output grating coupler.

As a technological platform, SOI presents a low-cost and compact solution for mass-production of highly integrated photonic devices and has shown good potential for implementing various formats of DPSK demodulation [3-9]. The small bending radius of about 5 microns, alongside the monolithic integration of Ge photo detectors by using CMOS compatible process makes this technology very attractive for low-cost differential receivers. Specifically in access networks at lower data speeds, such as 5Gbps or 10Gbps. Also, by implementing a polarization diversity scheme [3], the TE and TM polarization can be completely separated and processed individually in order to deal with problems such as polarization dependent loss.

Mainly two designs of the SOI receiver have been addressed in the literature, either using more standard MZDI [3-5] or by using micro ring-resonators [6-9]. There are mainly two advantages of using a ring resonator in the demodulation circuit; the size and the tolerance in bit-rate deviation. However, the optimal performance is reached for an optimized Q-factor and at the same time maximized extinction ratio, which usually requires adding some tuning mechanism as in [10] and therefore increases power consumption and complexity. MZDI still seems to be the most used implementation in more complete system such as presented in [4,5].

In this paper we demonstrate a simple approach to enhance the sensitivity of a MZDI while at the same time minimizing the power consumption by using wavelength tuning. The standard implementation of the MZDI suffers from unbalanced performance due to the propagation losses in the delay line. We here achieve optimized performance by modifying the input to a SOI 10Gbps DPSK differential receiver. We also show how the footprint can drastically be reduced by using compact spirals and so minimize the size of the receiver to just a few times larger than a ring resonator based implementation.

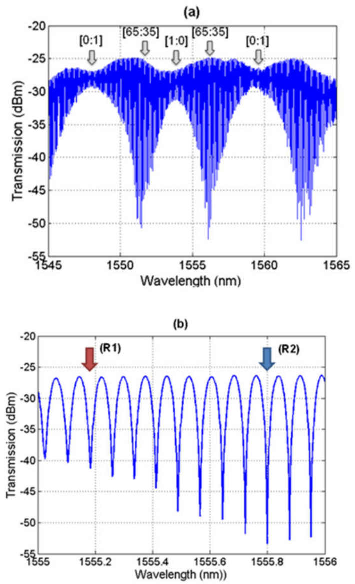

Figure 2: Measured spectral response at the DPSK demodulator. (a) Transmission spectrum of the full experimental wavelength band. The arrows mark the different states of the MZI switch at the input of the MZDI. (b) A zoom with 1pm resolution on the wavelength range where resonances have higher ER ratio. Two resonances are marked in the figure R1 for 16dB ER and R2 with optimized 28dB ER.

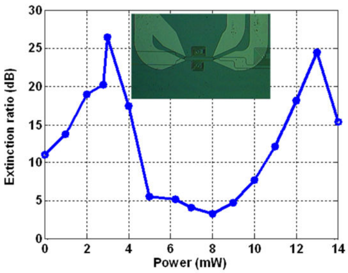

Figure 3: ER variation for different powers applied to the micro-heater on the MZI switch. The inset shows an optical image of the microheaters on top of the MZI switch

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