A novel All-Optical Wavelength Conversion scheme using a SOA and a 2nd Order Micro-ring Resonator ROADM

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Wavelength converters (WCs) are key components for the realization of large scale photonic routers. Despite the considerable photonic integration efforts, power consumption, thermal crosstalk and heat dissipation still remain key issues in developing larger and faster integrated WC devices [1]. Following this rationale, we present the RAWC (Ring Resonator-Assisted Wavelength Converter) an all-optical WC that employs a single SOA followed by a compact and integrated micro-ring resonator ROADM. The ROADM is fabricated using the TriPleX™ waveguide technology [2] and features two coupled and tunable micro-ring resonators that provide both a periodic spectral response and a filter profile suitable for high-speed chirp filtering. The RAWC employs a single active element and consumes electrical power as low as 1.5W and as such it is suitable for implementing scalable high-capacity photonic routers.

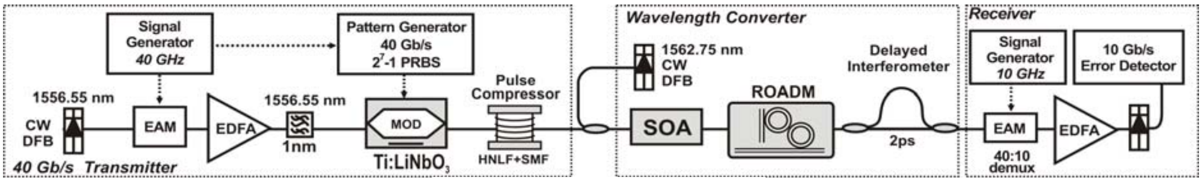

Figure 1: Experimental setup

Figure 1 shows the experimental setup. The data stream is RZ formatted with 3ps pulses at 1556.55 nm and is combined with a CW signal at 1562.75 nm at the input of the RAWC. The transmission peaks of the ROADM are detuned with respect to the CW wavelength, speeding up the effective system recovery time. In the case of the blue-shift filtering, an inverted signal at the output of the ROADM is obtained, so a Delay Interferometer (DI) with a suitable periodic response is required for polarity inversion. The DI was implemented using standard polarization maintaining fiber and provided a differential delay of 2 ps.

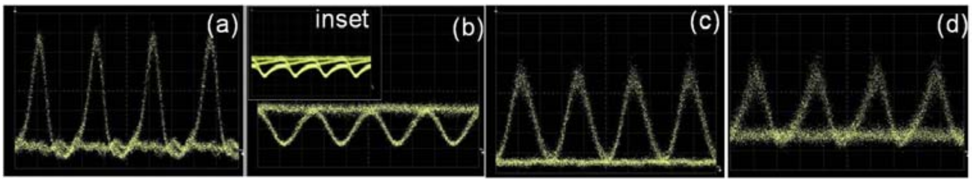

Figure 2 : Experimental results: a) input signal, b) inverted WC, inset inverted signal at the output of the SOA c) WC signal after DI and d) non-inverted WC. Time scale is 10 ps/div.

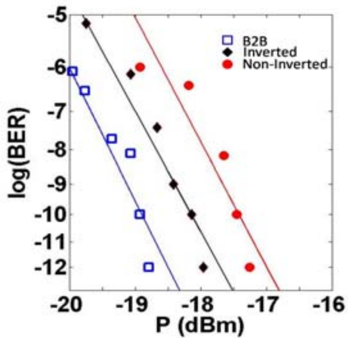

Figure 3: BER measurements

The eye diagram of the incoming data is depicted in Figure 2a). Firstly, the ROADM is detuned by 0.1nm for selecting the lower signal wavelength and the inverted signal of figure 2b) is obtained. The inset of figure 2b) shows the signal directly at SOA's output indicating the SOA slow recovery. The inverted signal at the output of the ROADM is launched in the PM DI and the pulse polarity is restored (fig. 2c). The same setup was also employed for non-inverted WC. By de-tuning the ROADM by 0.3 nm the non-inverted eye diagram of figure 2d) was obtained. Both eye diagrams verify the increase of the effective system operational speed. BER measurements were also obtained. The inverted WC signal exhibits a power penalty of 0.84 dB whereas a power penalty of 1.5 dB is measured for the non-inverted WC signal with respect to the input signal. The optical power requirements were 7 dBm for the CW and 3 dBm for the data signal. The RAWC requires approximately 1.5W of electrical power to operate, which includes the SOA bias and TEC as well as driving requirements for the micro-ring resonator heaters.

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[1] Y. Liu, et al.: "Error-free 320 Gbit/s SOA-based wavelength conversion using optical filtering" in Proc. OFC, Anaheim, CA, USA, 2006

[2] R. Heideman, et al., "Large-scale integrated optics using TriPleXTM waveguide technology: from UV to IR" (Invited), SPIE Photonics West, San Jose, California, 24–29 January 2009, p. 7221-26