Increasing the Delay-Bit Rate Product on Silicon Chip Using Star-16QAM Signal with High Spectral Efficiency

Liang Zhang(1), Tao Wang(1), Qi Liu(1), Xiaofeng Hu(1), Jing Wang(2),Min Qiu(2), Yikai Su(1)
(1) State Key Lab of Advanced Optical Communication Systems and Networks, Department of Electronic Engineering, Shanghai Jiao Tong University, 800 Dongchuan Rd, Shanghai 200240, China, yikaisu@sjtu.edu.cn
(2) Department of Microelectronics and Applied Physics, Royal Institute of Technology, Sweden

Abstract: *We experimentally demonstrate optical delay of a novel star-16QAM signal through a silicon microring resonator. Delay time of ~ 30ps is observed by comparing the eye diagram of the star-16QAM signal on-resonance with that off-resonance.*

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1. Introduction

Optical delay lines based on passive photonic structures are promising in future all-optical packet-switched networks [1] and optical interconnections in computer systems [2]. Continuous tuning of optical delay using silicon microring resonator has been experimentally demonstrated by virtue of the large linear dispersion on resonance [3]. However, the delay-bit rate product of a microring resonator is limited in nature, which critically constraints the buffering capacity of the resonator system. To overcome this limitation, M-ary quadrature amplitude modulation (M-QAM) is an attractive candidate, which can reduce the symbol rate and thus the bandwidth required for the microring resonator. As a result, spectral efficiency (SE) is highly improved and delay-bit rate product is increased. Recently, square-16QAM has been investigated and multiple schemes have been proposed and experimentally demonstrated [4][5]. However, compared with square-16QAM, star-16QAM has a better OSNR performance resulting from the larger minimum Euclidean distance when transmitted with the same power. In this paper, for the first time to the best of our knowledge, we experimentally demonstrate optical delay of a star-16QAM signal through a silicon microring resonator. The star-16QAM signal is generated with a novel scheme and demodulated with coherent detection and offline processing [6]. Compared with binary signals through the same silicon microring resonator, the delay-bit rate product for star-16QAM quadruples.

2. **Principles**

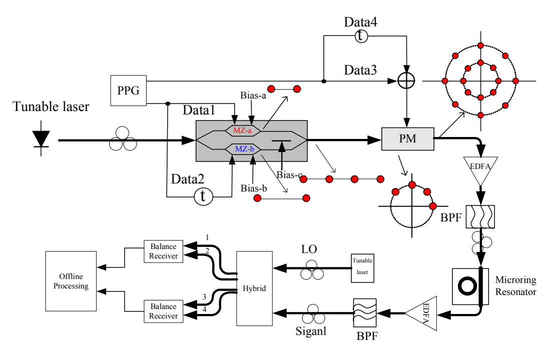

Fig.1. Experimental setup

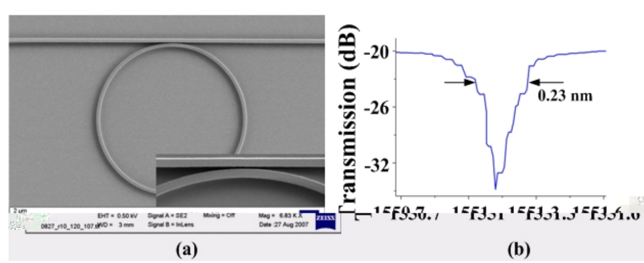

Fig. 2. The SEM photograph (a) and the measured spectrum in the through channel (b) of the mircroring resonator.

We perform an experiment to demonstrate optical delay of a star-16QAM signal with the setup shown in Fig. 1. A CW light from a tunable laser (TSL210-F) has a linewidth of less than 1 MHz. The star-16QAM generation consists of two stages. In the first stage, the two sub-modulators of a dual-parallel Mach-Zehnder modulator (DPMZM) are push-pull driven by 5-Gbit/s Data1 and Data2 with a word length of 2^7-1, respectively, to generate two BPSK signals with unequal amplitudes. The two BPSK signals are constructively added by adjusting Bias-c such that a 4APSK signal can be obtained, as depicted in Fig. 1. In the second stage, the generated 4APSK is further phase-modulated by a 4-level electrical signal, which is obtained by combining Data3 and Data4 at 5Gbit/s, to realize 4-PSK (0, $\pi/4$, $\pi/2$, $3\pi/4$) modulation. In that case, we obtain a 20-Gbit/s star-16QAM which has a tunable amplitude ratio and eight different phase states with symmetrical distribution on a circle. The achieved star-16QAM with high spectral efficiency is then amplified by an erbium-doped fibre amplifier (EDFA) and filtered by a tunable bandpass