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The 23rd Opto-Electronics and Communications Conference

OECC 2018

Conference Program & Abstracts

July 2 – 6, 2018

ICC Jeju, Korea

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  Optical Society of Korea (OSK)

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OECC 2018 Program

July 02 (Mon.)

		Samda Hall A (Room A)	Samda Hall B (Room B)	301 (Room C)	302 (Room D)	Halla Hall A (Room E)	303 (Room F)	Lobby(3F)
14:00-17:00	180'			Workshop Ⅰ	Workshop Ⅱ			Registration (12:00-18:00)
				Direct Detection vs. Coherent Detection for Short- and Intermediate-Haul Applications	Silicon Photonics			
17:00-18:00	60'	-						
18:00-20:00		**Get-Together Party (Ocean View, 5F)**						

July 03 (Tue.)

		Room A	Room B	Room C	Room D	Room E	Room F	Lobby(3F)
08:45-09:00	15'	Opening ceremony						Exhibition
09:00-09:45	45'	Plenary Talk Ⅰ - Roel Baets (Halla Hall, 3F)						
09:45-10:30	45'	Plenary Talk Ⅱ - Masatoshi Suzuki (Halla Hall, 3F)						
10:30-11:00	30'	Coffee Break						
11:00-11:45	45'	Plenary Talk Ⅲ - Sanghoon Lee (Halla Hall, 3F)						
11:45-12:30	45'	Plenary Talk Ⅳ - Chongjin Xie (Halla Hall, 3F)						
12:30-14:00	90'	Lunch						
14:00-15:30	90'	3A1	3B1	3C1	3D1	3E1	3F1 [Symposium Ⅰ]	
		Mode Division Multiplexing	Direct-Detection Systems	Optical Fiber Applications	Silicon Photonics	Passive Devices	10Giga Internet and Broadband Access	
15:30-16:00	30'	Coffee Break						
16:00-17:30	90'	3A2	3B2	3C2	3D2	3E2	3F2 [Symposium Ⅰ]	
		Photonic Signal Processing 1	Capacity-Approaching Techniques	Specialty Fibers	Optical Transmitter 1	Integrated Photonics 1	10Giga Internet and Broadband Access	

July 04 (Wed.)

		Room A	Room B	Room C	Room D	Room E	Room F	Lobby(3F)
08:30-10:00	90'	4A1	4B1	4C1	4D1	4E1	-	Exhibition
		Photonic Signal Processing 2	High Spectral Efficiency	Fiber Fabrication and Applications	Optical Transmitter 2	Integrated Photonics 2	-	
10:00-10:30	30'	Coffee Break						
10:30-12:00	90'	4A2	4B2	4C2	4D2	4E2	4F2 [Industrial Ⅰ]	
		Short Reach Networks	Light Propagation in Fiber	Fiber Amplifiers	Photonic Crystal	Silicon Photonics 1	High Power Fiber Lasers for Industrial Applications	
12:00-13:00	60'	Lunch						
13:00-14:00	60'	Poster Session Ⅰ (Lobby, 3F)						
14:00-15:30	90'	4A3	4B3	4C3	4D3	4E3	4F3 [Symposium Ⅱ]	
		Optical Access for 5G 1	Nonlinear Transmission	Fiber Amplifiers and Light Sources	Optical Transmitter 3	Silicon Photonics 2	Recent Advances in Photonic Packaging Technologies	
15:30-16:00	30'	Coffee Break						
16:00-17:30	90'	4A4	4B4	4C4	4D4	4E4	4F4 [Symposium Ⅱ]	
		Optical Wireless Access	SSB DD Systems	Fiber Lasers	Optical Receivers	Silicon Photonics 3	Recent Advances in Photonic Packaging Technologies	
17:30-18:30		-						-
18:30-20:30		**Banquet**						

July 05 (Thu.)

		Room A	Room B	Room C	Room D	Room E	Room F	Lobby(3F)
08:30-10:00	90'	5A1	5B1	5C1	5D1	5E1	-	Exhibition
		Indoor Network	Polarization Issues & Monitoring	Optical Fiber Sensors	Secure & Free-Space Communications	Sensing Devices	-	
10:00-10:30	30'	Coffee Break						
10:30-12:00	90'	5A2	5B2	5C2	5D2	5E2	5F2 [Industrial Ⅱ]	
		High Speed PON	Space Division Multiplexing	Nonlinear Interaction of Light	Photonic Integrated Circuits	Fiber Devices	5G and Photonics	
12:00-13:00	60'	Lunch						
13:00-14:00	60'	Poster Session Ⅱ (Lobby, 3F)						
14:00-15:30	90'	5A3	5B3	5C3	5D3	5E3	5F3 [Symposium Ⅲ]	
		Signal Processing for Access Network	High Capacity Transmission	Optical Fibers for SDM	Quantum Communication Devices	Photonic Devices 1	State of the Art in Distributed Fiber Sensors	
15:30-16:00	30'	Coffee Break						
16:00-17:30	90'	5A4	5B4	5C4	5D4	5E4	5F4 [Symposium Ⅲ]	
		Optical Access for 5G 2	Transceiver Technologies	Specialty Fibers for High Power Lasers	Advanced Optical Devices 1	Photonic Devices 2	State of the Art in Distributed Fiber Sensors	
17:30-18:00		-						-
18:00-19:00	60'	PDP Session						

July 06 (Fri.)

		Room A	Room B	Room C	Room D	Room E	Room F	Lobby(3F)
08:30-10:00	90'	6A1	6B1	6C1	6D1	6E1	-	-
		Novel Algorithm for Optical Network	Performance Monitoring	Distributed Fiber Sensing	Advanced Optical Devices 2	Photonics Devices 3	-	
10:00-10:30	30'	Coffee Break						
10:30-12:00	90'	6A2	6B2	6C2	6D2	-	-	
		Visible Light Communication	Technologies for Datacenter Applications	Access Network Technologies	Digital Signal Processing			

Tuesday, July 3

Room D (302)

[3D2] 16:00-17:30
Optical Transmitter 1
Session Chair : Nicola Calabretta (TU/e)

3D2-1 16:00-16:30 (30') Invited
Modeling Depletion-Type Si Ring Modulators
Woo-Young Choi[1], Minkyu Kim[1], Myungjin Shin[1], Byung-Min Yu[1], Christian Mai[2], Stefan Lischke[2], and Lars Zimmermann[2].
[1]Yonsei Univ., Korea, [2]IHP, Germany
For achieving monolithic integration of Si electronics and photonics, accurate and convenient-to-use models for Si photonic devices are very important. We present such amodel for depletion-type Si ring modulators.

3D2-2 16:30-17:00 (30') Invited
Ultra-Low-Power Microring Modulators for PAM and WDM Links
Wei Shi and Yelong Xu
Université Laval, Canada
We review our recent results on low-power microring modulators for pulse-amplitude modulation and high-quality frequency comb generation. This single-laser WDM solution is promising for next-generation optical interconnects.

3D2-3 17:00-17:15 (15')
A Wavelength Stabilization Integrated Circuit for 25-Gb/s Si Micro-Ring Modulator
Min-Hyeong Kim[1], Lars Zimmermann[2], and Woo-Young Choi[1]
[1]Yonsei Univ., Korea, [2]IHP, Germany
We demonstrate wavelength stabilization of Si micro-ring modulator (MRM) with an integrated circuit custom-designed in 0.25-μm BiCMOS technology. Our circuit controls the MRM temperature so that it can have the maximum optical modulation amplitude with 25-Gb/s modulation.

3D2-4 17:15-17:30 (15')
An Actively Mode-Locked Laser based on a 5th Order Micro-Ring Resonator
Qihong Wu[1], Yuhua Li[2], Shaohao Wang[3], Qian Li[1], and Sai Tak Chu[2]
[1]Peking Univ., China, [2]City Univ. of Hong Kong, China, [3]Fuzhou Univ., China
We present a mode locked laser configuration with an integrated 5th order micro-ring resonator, where highly stable pulse trains with single and multiple pulses per period have been achieved.

Room E (Halla Hall A)

[3E2] 16:00-17:30
Integrated Photonics 1
Session Chair : Benjamin J. Eggleton (The Univ. of Sydney)

3E2-1 16:00-16:30 (30') Invited
Silicon Nitride (TriPleX™) based Photonic Integrated Circuits for a Broad Range of Application Modules
Arne Leinse
LioniX Int'l, Netherlands
An overview of recent developments of the SiN based TriPleX™ Photonic-Integrated-Circuit technology is given. The unique features of the technology are explained and application examples in avariety of wavelength ranges are shown.

3E2-2 16:30-17:00 (30') Invited
Integrated Polarization Diversity Devices
Kyong Hon Kim[1], Yudeuk Kim[1], Yoohan Kim[1], Dong Wook Kim[1], and Moon Hyoek Lee[2]
[1]Inha Univ., Korea, [2]Heinrich Hertz Inst., Germany
Integrated polarization diversity devices, such as polarization beam splitter, polarization rotator, and polarizer, are very important in silicon-based photonic integrated circuits. The integrated polarization diversity devices are introduced, and experimentally demonstrated results are reported.

3E2-3 17:00-17:15 (15')
Two- and Three-Dimensional Polymer Directional Coupler for High-Density Optical Interconnects at 1550 nm
Xiao Xu, Lin Ma, and Zuyuan He
Shanghai Jiaotong Univ., China
We demonstrate two- and three-dimensional single-mode polymer directional coupler directly inscribed using a micro-dispenser. We successfully fabricated two-core couplers with splitting ratios of 0.95 and 0.52 and three-dimensional couplers operating at 1550 nm.

3E2-4 17:15-17:30 (15')
Analytical Investigation of Generic Form Expressing Adaptive Dispersion of Optical Fractional Fourier Transform Circuit
Tomohiro Naganuma and Hiroyuki Uenohara
Tokyo Inst. of Tech., Japan
We clarified the regularity of the dispersion performance of an optical fractional Fourier transform circuit, realizing variable dispersion compensation in an optical OFDM system. The generic form of dispersion performance is presented.

Room F (303)

[3F2] 16:00-17:30 [Symposium 1]
10Giga Internet and Broadband Access
Session Chair : Xiang Liu (Huawei)
T. Nirmalathas (The Univ. of Melbourne)

3F2-1 16:00-16:30 (30') Invited
State of Broadband Access and High Speed PON
Hyung Jin Park
KT, Korea

3F2-2 16:30-17:00 (30') Invited
Broadband Access in Japan and Flexible Optical Access
Sangyeup Kim
NTT Corp., Japan

3F2-3 17:00-17:30 (30') Invited
Deployment of 10G Internet and Broadband Access: Korean Story
Sung-uk Rha
NIA, Korea

A Wavelength Stabilization Integrated Circuit for 25-Gb/s Si Micro-Ring Modulator

Min-Hyeong Kim*, Lars Zimmermann**, and Woo-Young Choi*
* Department of Electrical and Electronic Engineering, Yonsei University, Seoul, Korea;
** IHP, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany

Abstract

We demonstrate wavelength stabilization of Si micro-ring modulator (MRM) with an integrated circuit custom-designed in 0.25-μm BiCMOS technology. Our circuit controls the MRM temperature so that it can have the maximum optical modulation amplitude (OMA). It consists of trans-impedance amplifier, power detector, track-and-hold circuit, comparator, digital-to-analog converter, and synthesized digital controller. 25-Gb/s MRM modulation is achieved with the wavelength stabilization IC.

I. INTRODUCTION

As the demand for commercial data centers and mobile devices are rapidly increasing, the application of high-bandwidth photonic solutions is extending from medium-and-long distance communications to short reach interconnects. There is a great interest in Si micro-ring modulators (MRMs) for short-reach interconnect applications, as they provide high modulation speed and small size [1]. However, the Si MRM has a serious drawback in that its characteristics are very easily influenced by the temperature. Fig. 1 shows the Si MRM used in the present investigation, which was fabricated with IME foundry service. It also shows its measured transmission characteristics at various temperatures. With about 80-pm/°C change for its resonance wavelength is changed to about, a wavelength stabilization (λ-stabilization) circuit is indispensable for its practical use [2]. There are several previous reports on realization of the λ-stabilization circuit [3,4], but very few on its integrated circuit (IC) implementation [5,6], which is absolutely required for any practical application of Si MRMS. In this paper, we demonstrate a novel Si MRM wavelength stabilization circuit implemented in IHP's 0.25-μm BiCMOS technology, which directly measures Si MRM OMA and provides control voltages to the on-chip heater next to Si MRM for achieving optimal MRM operation.

II. STABILIZATION CIRCUIT

The dotted box in fig. 2 shows the block diagram of the λ-stabilization circuit. TIA, power detector, T/H circuit, and comparator are used for monitoring the OMA and DAC and digital circuit (Counter) are used for controlling the heater voltage (V_{HEAT}), all of which are integrated monolithically.

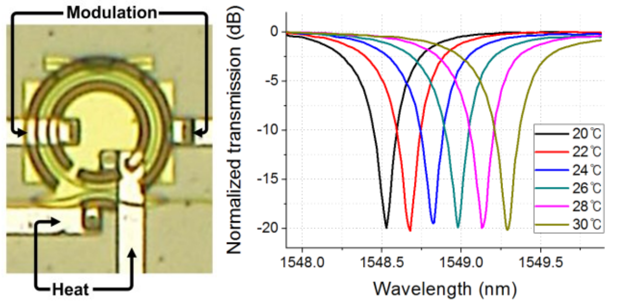

Figure 1. Microphotograph of Si MRM and its normalized transmission spectra at six different external temperatures

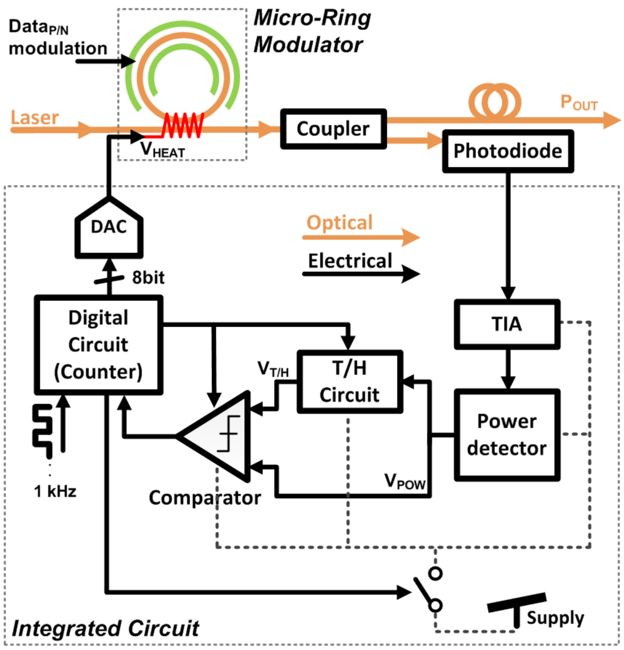

Figure 2. Block diagram of proposed wavelength stabilization circuit with optical setup

In our λ-stabilization circuit, the built-in controller scans V_{HEAT} while measuring OMA at each value of V_{HEAT}. The V_{HEAT} that produces that optimal OMA is determined and, then, the optimal V_{HEAT} can be automatically maintained continuously [7]. We also implement two-step approaches of 'coarse-scan and fine-control' steps for achieving a fast initial acquisition. In the first step, the full range of V_{HEAT} by the DAC is coarsely scanned with increasing N-bit step by step. Depending on the situation, a size of the N can be digitally adjustable. In the second step, detailed and continuous OMA optimization is performed through 1-bit DAC control. To save the power consumption, a low-

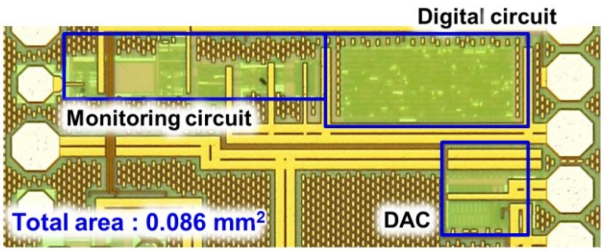

Figure 3. Microphotograph of the fabricated λ-stabilization circuit

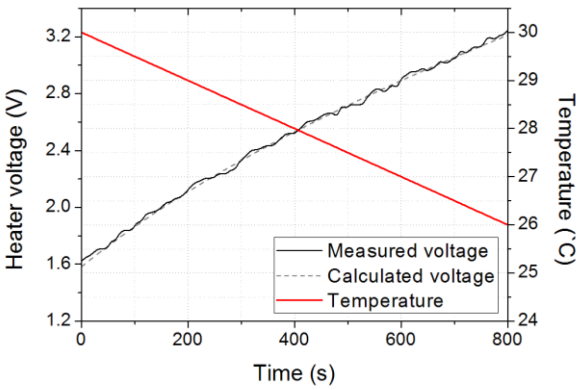

Figure 4. External temperature variations to MRM and measured heater voltages controlled by the λ-stabilization circuit

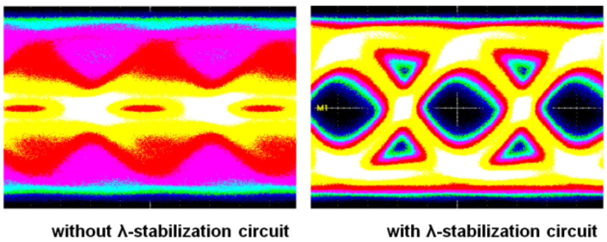

Figure 5. Measured 25-Gb/s PRBS7 eye diagrams accumulated for 13.3 min (a) without and (b) with the λ-stabilization circuit while external temperature variations are supplied as shown in Figure 4.

power strategy is employed in which the monitoring circuits are turned on periodically only for a short amount of time.

III. Measurement Results

Fig. 2 shows the measurement setup. A depletion-type Si MRM is modulated by 25-Gb/s PRBS-7 data and its output is coupled into a commercial photodiode for monitoring OMA. 1-kHz pulse signal is externally introduced as the clock signal for the digital circuit. Fig. 3 shows the photograph of our λ-stabilization IC. Its area is approximately 0.086-mm^2. The total power consumption is 6.26-mW.

In order to demonstrate the operation of our λ-stabilization IC, the temperature of MRM is intentionally ramped from 30ºC to 26ºC with the ramping speed of 5-mºC/sec. Fig. 4 shows the measured V_{HEAT} provided by our stabilization circuit during this ramp. The measured 25Gbps eye during this temperature is shown in Fig. 5(a). The degradation in eye quality is due to the shift of MRM resonance wavelength. With our λ-stabilization IC on, however, the eye can be maintained open as shown in Fig. 5(b).

IV. Conclusions

In this paper, we demonstrated a new fully-integrated wavelength stabilization circuit based on OMA monitoring for Si MRM. A prototype chip realized in IHP's 0.25-µm BiCMOS technology is successfully demonstrated. With the IHP's Si Photonic BiCMOS technology, which integrates 0.25-µm BiCMOS electronics with high performance Si photonic devices, our λ-stabilization IC can be monolithically integrated with Si MRM along with a monitor Ge photodetector, resulting in a complete integrated solution for Si MRM transmitters.

Acknowledgment

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References

[1] J. F. Buckwalter, et al., "A Monolithic 25-Gb/s Transceiver With Photonic Ring Modulators and Ge Detectors in a 130-nm CMOS SOI Process," in IEEE Journal of Solid-State Circuits, vol. 47, no. 6, pp. 1309-1322, June 2012.
[2] Bogaerts W., et al., "Silicon microring resonators," in *Laser Photon. Rev.*, 6 (1) (2012), pp. 47-73.
[3] K. Padmaraju, et al., "Wavelength Locking of a WDM Silicon Microring Demultiplexer using Dithering Signals," in Optical Fiber Communication Conference, paper Tu2E.4.
[4] S. Agarwal, et al, "Wavelength Locking of a Si Ring Modulator Using an Integrated Drop-Port OMA Monitoring Circuit," in IEEE Journal of Solid-State Circuits, vol. 51, no. 10, pp. 2328-2344, Oct. 2016.
[5] H. Li et al., "A 25 Gb/s, 4.4 V-Swing, AC-Coupled Ring Modulator-Based WDM Transmitter with Wavelength Stabilization in 65 nm CMOS," in IEEE Journal of Solid-State Circuits, vol. 50, no. 12, pp. 3145-3159, Dec. 2015.
[6] C. Sun et al., "A 45 nm CMOS-SOI Monolithic Photonics Platform With Bit-Statistics-Based Resonant Microring Thermal Tuning," in IEEE Journal of Solid-State Circuits, vol. 51, no. 4, pp. 893-907, April 2016.
[7] M. H. Kim, et al., "An integrated Mach-Zehnder modulator bias controller based on eye-amplitude monitoring," Proc. SPIE 9751, Smart Photonic and Optoelectronic Integrated Circuits XVIII, 97510X (March 3, 2016).