locked source (>10 GHz), these devices could lead to continuous very-high repetition rate output trains (>500 GHz).

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CTuM46 **1:00 pm**

Fast all optical flip-flop using coupled Mach-Zehnder interferometers

Martin T. Hill, H. de Waardt, H.J.S. Dorren,
Department of Electrical Engineering, EH 12.33, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands; Email: m.t.hill@ele.tue.nl

Recently all optical high speed gates employing interferometers containing semiconductor optical amplifiers (SOA),[1] have been used in optical TDM networks. We outline a fast all optical flip-flop which will be useful to threshold and store the output of these gates. The flip-flop also has similar high performance and integration potential.

The work reported here is an extension of concepts developed for optical flip-flops constructed from coupled lasers.[2]

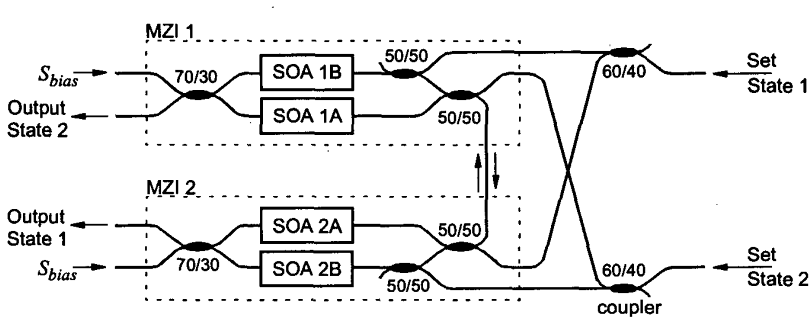
The flip-flop consists of two coupled MZIs as shown in Fig. 1. Each MZI has a continuous wave (CW) bias light input S_{bias}. When light flows out of MZI 1 into MZI 2, the device is in state 1. The MZI parameters are chosen such that when light flows out of MZI 1 into MZI 2, the two arms of MZI 2 are balanced and no light flows from MZI 2 back into MZI 1. The system is symmetric, so the reverse can occur, with MZI 2 suppressing output of MZI 1, in which case the device is in state 2.

To change the flip-flop from state 2 to say state 1, a short light pulse is injected at the input 'Set State 1' Fig. 1. Part of the pulse is injected into SOA 1B and unbalances MZI 1 so that it now outputs light into MZI 2. The rest of the pulse is injected into MZI 2 and causes MZI 2 to become balanced, and stops it injecting light into MZI 1. Changing from state 1 to 2 is similar, but using input 'Set State 2'.

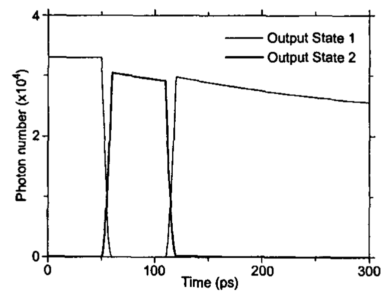
The change in phase in the MZI arms required to take the MZI from the balanced to the unbalanced states and visa versa is chosen to be $\ll\pi$. This choice means that little energy is required in the set pulse to balance and unbalance the MZIs. Furthermore the gain in the SOAs is not greatly changed from the steady state gain.

The set pulses reduce the carrier numbers in the SOAs. These carrier numbers slowly recover to steady state values on the slow time scale of the carrier lifetime. However, the amount of light output by a MZI, and thus the flip-flop state, changes little as the carrier numbers recover to their steady state values. Furthermore, the flip-flop operates correctly with consecutive set state 1 and set state 2 pulses occurring before the carrier numbers have fully recovered. However, the carrier numbers must not have been driven too far from their steady state values. This high speed operation, relatively independant of the carrier lifetime, is shown in a simulation of the flip-flop, Fig. 2, Fig. 3, where 4 mW peak power, 10 ps pulses switch the flip-flop.

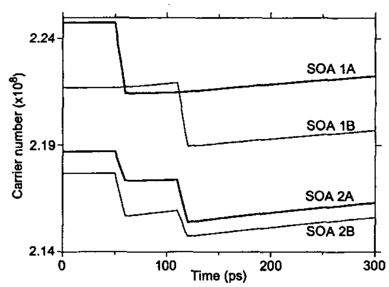
The switching speed of the implementation given in Fig. 1 will be limited to the order of several picoseconds, because the set pulses and the flip-flop output counter propagate in the MZI.[1] However, with slight changes, the set pulses and flip-flop output can co-propagate, allowing higher speeds.[1]



CTuM46 Fig. 1. Structure of Mach-Zehnder Interferometer (MZI) based optical flip-flop. SOA: semiconductor optical amplifier.



CTuM46 Fig. 2. Optical outputs of flip-flop showing high speed switching.



CTuM46 Fig. 3. Carrier numbers in the SOAs. Note the slow recovery of the carrier number does not affect the high speed operation greatly.

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CTuM47 **1:00 pm**

Space-Variant Polarization State Manipulation Using Subwavelength Metal Grating

Ze'ev Bomzon, Vladimir Kleiner, Erez Hasman,
Optical Engineering Laboratory, Faculty of Mechanical Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel

Subwavelength metal stripe gratings are usually used as homogenous space-variant polarizers. Sometimes, however, a different polarization state is required at each location. Such nonuniform space-variant polarization state is useful for polarization coding of data in optical communication, optical computers and neural networks, optical encryption, tight focusing, imaging polarimetry and for particle trapping and acceleration. Here, we demonstrate a novel method for designing, analyzing and realizing computer gen-