1.25GHz repetition rate operation of a SOA-DFB laser diode based all-optical flip-flop

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All-optical packet switches are gaining a lot of interest due to the need for networks that are transparent to different data formats. A key element in such an all-optical switch is an all-optical flip-flop [1]. Previously we reported on a novel concept for such an all-optical flip-flop [2]. Here we experimentally show the high-speed dynamic operation of this device.

The photonic integrated device consists of a semiconductor optical amplifier (SOA) and a DFB-laser diode that are connected through a coupler (in this case a 25% coupler). Due to optical feedback between the laser diode and the SOA the output power of the laser diode exhibits bistability over a certain range of input powers injected into the SOA as can be seen in Fig. 1(a). By applying a constant input power to the SOA (chosen inside the bistable domain) the output state of the DFB-laser diode can be changed by injecting appropriate optical set (injection from the DFB-side) and reset (injection from the SOA-side) pulses.

In the experiments, the SOA was driven at 83mA and the DFB-laser diode at 105.8mA. The wavelength of the CW input power and the pulses was 1550nm while the wavelength of the laser output was 1542nm. The CW input signal to the SOA used to operate the device inside the bistable domain was set at 4.5dBm. The pulses were generated at a 1.25GHz repetition rate, resulting in a pulse each 800ps, and then split along 2 different paths to form the set and reset pulses. The difference between the arrival of a set and reset pulse was determined by the different optical path length and was measured to be about 400ps. In Fig.1(c) a scheme of the measurement setup is shown.

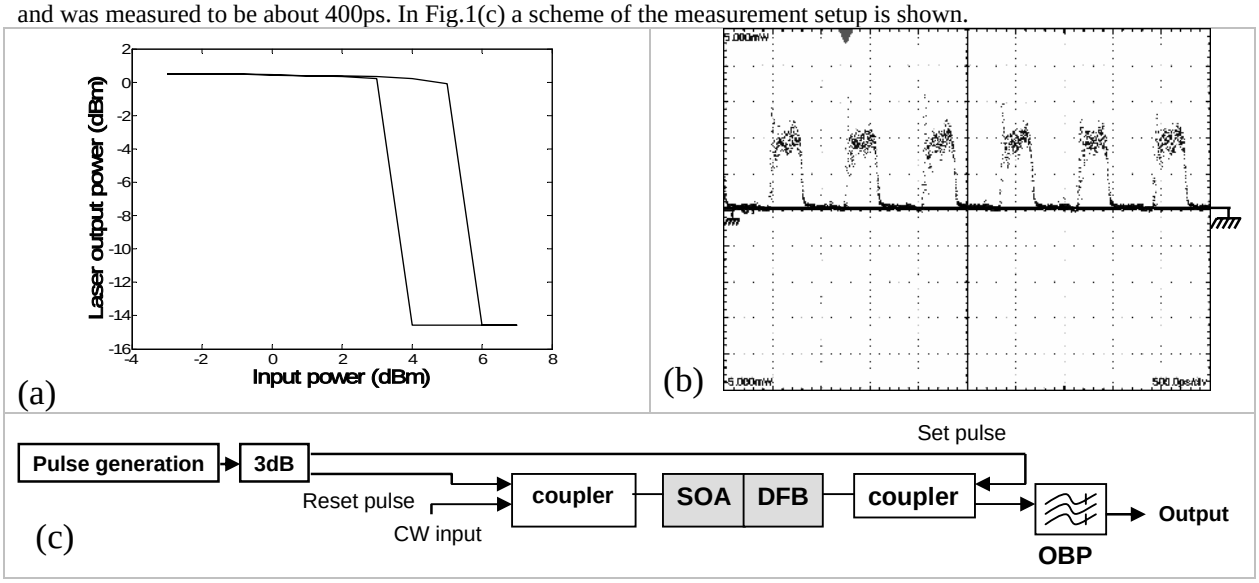

Fig. 1 (a) Static transfer function of the all-optical flip-flop, (b) Dynamic all-optical flip-flop operation using 50ps set and reset pulses (time base is 500ps/div), (c) Schematic representation of the measurement setup.

In Fig. 1(b) an experimental result showing the dynamic operation of the all-optical flip-flop is shown. The used set and reset pulses are about 50ps long and the minimal pulse energies required to obtain switching between the stable states are 1pJ and 1.3pJ for the set and reset pulses respectively. The on-off ratio of the flip-flop output is about 18dB. And the switch times between the 2 stable states are measured to be as low as 50ps.

By using set and reset pulses of 125ps long switching of the all-optical flip-flop, with an on-off ratio of over 25dB, has been obtained for switching energies as low as 900fJ and 700fJ for the set and reset pulses respectively.

References

1. F. Ramos, et al., "IST-LASAGNE: Towards All-Optical Label Swapping Employing Optical Logic Gates and Optical Flip-Flops", Journal of Lightwave Technology, 23(10), p.2993-746 (2005).
2. W. D'Oosterlinck, et al., "Optical Bistability in a Traveling-Wave SOA Connected to a DFB Laser Diode: Theory and Experiment,IEEE" Journal of Quantum Electronics, 42(8), p.739-746 (2006).