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Published in:
CLEO 2000 Technical Digest

Link to article, DOI:
10.1109/CLEO.2000.907094

Publication date:
2000

Document Version
Publisher's PDF, also known as Version of record

coming can be remedied by using a NOLM or any intensity discriminator devices.

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CWK73

All-optical signal regeneration at 40 Gbit/s using a Mach-Zehnder interferometer based on semiconductor optical amplifiers

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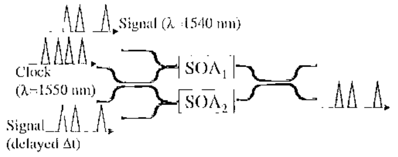
All-optical signal regeneration and processing are interesting for high bit-rate transmission systems. The Mach-Zehnder Interferometer (MZI) is a promising device for functionalities like all-optical add/drop and signal regeneration. Wavelength conversion up-to 20 Gbit/s,[1] demultiplexing of a 8 × 10 Gbit/s signal[2] and all-optical signal regeneration at 40 Gbit/s[3] have been experimentally demonstrated, showing the high speed processing potential.

Figure 1 shows a schematic diagram of the regeneration set-up. The original signal determines when a pulse from the "clock" pulse-train is switched to the output port. The signal pulses injected into the upper arm open a switching window, which is closed a few picoseconds later by the time-delayed control pulse injected into the other arm.

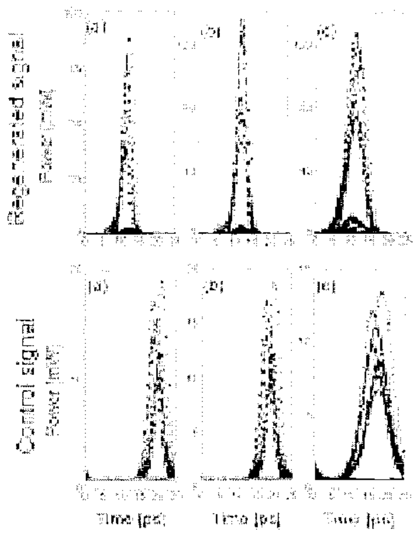
In the simulations we assume a 40 GHz clock signal, which in practice will be generated by a clock-recovery circuit. The SOA large signal model has successfully been used to assess the system performance of various four wave mixing schemes.[4]

Figure 2 shows 40 Gbit/s control and regenerated signal optical eye-diagrams. The Extinction Ratio (ER) for signal and clock was 10 and 16 dB, respectively. Fig. 2(a) shows the case of a time-delay of 5 ps and 3 ps signal and clock pulses, resulting in a strong reduction of timing jitter. The ER increases by 2 dB, while the amplitude jitter is basically unaffected. In Fig. 2(b) the time-delay is increased to 8 ps, improving the eye-opening.

The high amplitude jitter in the regenerated signals can be reduced by using higher power levels for the clock (Fig. 2c) or control signal.



CWK73 Fig. 1. Schematic of all-optical regeneration using a Mach-Zehnder interferometer based on semiconductor optical amplifiers (SOAs).



CWK73 Fig. 2. Regenerated signals (upper row) for input signals (lower row) distorted by amplitude and timing jitter as well as a finite noise background. Pulsewidths: 3ps (a, b) and 6 ps (c). Time-delays: 5ps (a), 8 ps (b), 10 ps (c).

However, higher power levels result in stronger saturation of the SOAs and thus a reduced ER. In Fig. 2c we used 6 ps pulses and a time-delay of 10 ps. The reduction in timing jitter is not as strong as for the 3 ps pulses showing the advantage of narrow clock pulses.

A drawback of the scheme is that timing jitter is converted to amplitude jitter and vice versa. Short clock pulses result in low timing jitter, while the amplitude jitter increases, since the switching window is not a flat transfer function in time. In the case of broad clock pulses, the switching window has a stronger pulse shaping effect, which gives a poorer performance with respect to timing jitter, but a better performance with respect to amplitude jitter. However, the main reason for the strong amplitude jitter in our case is patterning effects, since the SOAs are not fast enough for a full recovery within one bit period. These patterning effects can be somewhat reduced by operating closer to the bandgap, or by other means increasing the amplitude-phase coupling.

Finally we investigate regeneration of a 4 × 10 Gbit/s signal, with simultaneous clearing of one channel. The results are shown in Fig. 3 and indicate good clear functionality as long as the ER of the clock signal exceeds a critical value.

In conclusion we have theoretically investigated all-optical signal regeneration in a SOA-based MZI and identified some of the main limiting factors and optimization issues.

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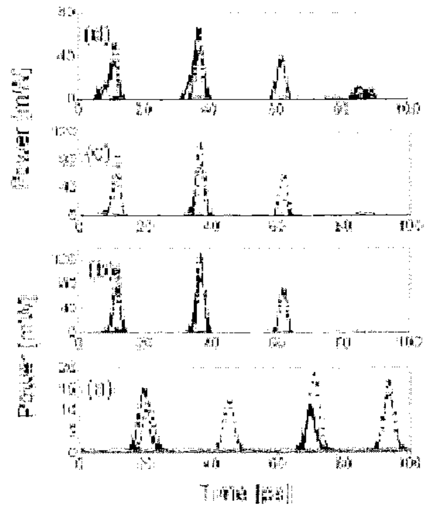

CWK73 Fig. 3. Simultaneous regeneration and clearing for the input signal given in (a) and clock ER's of 22 dB (b), 16 dB (c) and 10 dB (d).

CWL 2:30 pm–4:15 pm
Room 100

Quantum-Dot Lasers 1

Yasuhiko Arakawa, *Univ. of Tokyo, Japan, Presider*

CWL1 2:30 pm

High characteristic temperature of near-1.3-μm InGaAs/GaAs quantum-dot lasers

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Quantum-dot lasers are expected to attain remarkable reduction in threshold current and temperature-insensitive operation, however, high characteristic temperature of threshold current (T_0) has not yet been achieved except lasers which required huge current injection. For example, the dot lasers with low threshold