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Phase Deviation in Switching of Optical QPSK Pulse Train by Collinear Acoustooptic Device

コリニア音響光学素子による光QPSKパルス列スイッチングに伴う位相変化の検討

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1. Introduction

In broadband photonic network nodes, wavelength-selective optical switching, routing and signal processing are expected to improve the processing speed with lower power consumption. Collinear acoustooptic (AO) devices using collinear interaction between guided optical pulses and guided surface acoustic waves (SAWs) provide wavelength-selective processing capability though the switching speed is limited to an order of micro seconds.[1,2)]

As the symbol rate of optical pulse packets becomes high, the spectrum of the pulses broadens and broader bandwidth is required in processing devices. The authors have investigated amplitude distortion of pulse trains of on-off keying (OOK) and binary phase-shift keying (BPSK) packets.[3)] In this report, we consider phase characteristics of quadrature PSK (QPSK) pulse trains with collinear AO devices. We consider a collinear AO device with weighted AO coupling along the interaction region.

2. Weighted AO device

A collinear AO device with a tapered SAW waveguide is shown in Fig.1, where sidelobe suppression is realized.[4)] Alternatives to achieve weighted AO interaction include employment of a tilted SAW waveguide[5)] and a SAW directional coupler[6)].

The AO coupling $g(z)$ for the tapered SAW waveguide is assumed to be given by

$$g(z)=g_0\left[1-\alpha\cos\left(2\pi z/l_{SW}\right)\right] \qquad (1)$$

where α is a parameter indicating the weighting strength, l_{SW} is the interaction length and is assumed to be 20mm. For complete switching, g_0 is set to be $g_0\ l_{SW}=\pi/2$. We assume α=0 for the conventional coupling and α=0.5 for a weighted one. It is noted that the sidelobe is decreased to -20dB for α=0.5.

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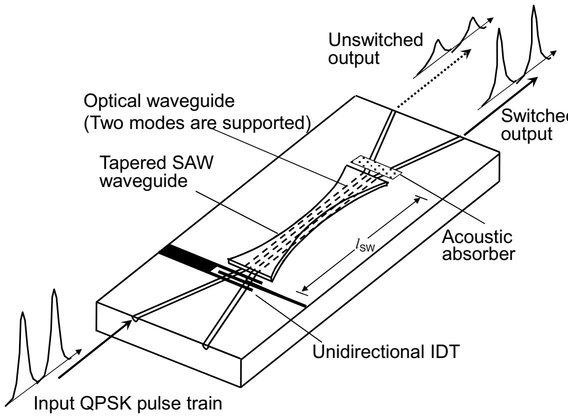

Fig.1 Pulse train processing along collinear AO device.

3. Switching characteristics of pulse trains

We consider QPSK optical pulse trains at 40 and 100Gsymbol/s. To conserve high-symbol-rate pulse trains through AO processing, the filtering bandwidth has to be enough wide to transmit all the frequency components.

First, we consider a single pulse having bandwidth of 75GHz and 150GHz, which correspond to pulse trains at 40 and 100Gsymbol/s, respectively. Switched output with the AO device is shown in Figs.2 and 3. The 150GHz pulse cannot be switched with high extinction ratio due to

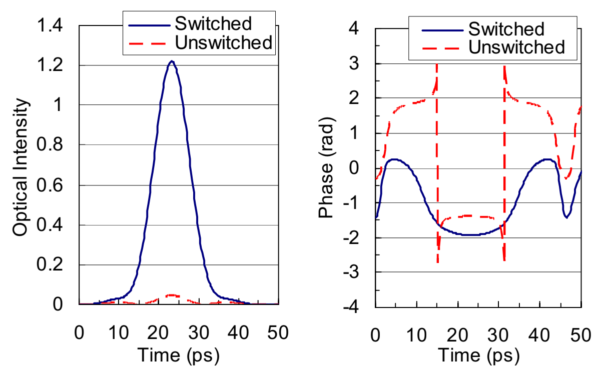

Fig.2 Switched and unswitched outputs for a 75GHz pulse.

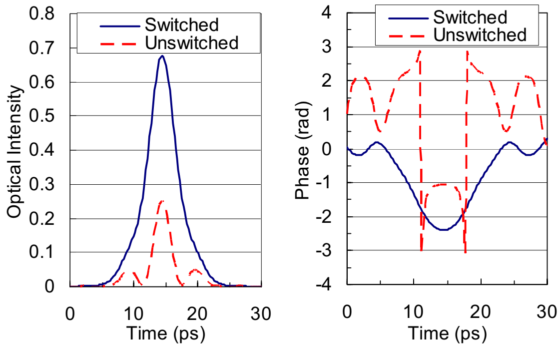

Fig.3 Switched and unswitched outputs for a 150GHz pulse.

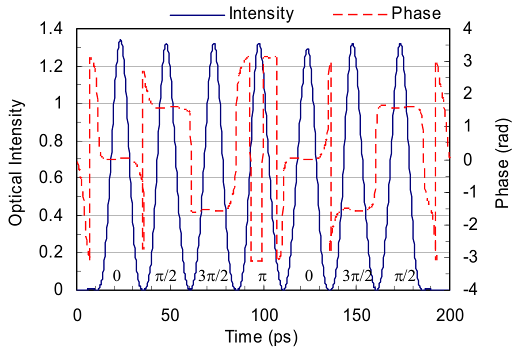

Fig.4 QPSK pulse train at 40Gsymbol/s.

filtering bandwidth of the AO device. It is noted that the full-width at half maximum (FWHM) of the AO device is 185GHz. Even for the 75GHz pulse, unswitched residual intensity is about 3.75%. It is found that the phase around the pulse skirt shifts from the value at the pulse peak.

Next, we consider QPSK pulse train at 40Gsymbol/s as shown in Fig.4. The phases of the pulses are assumed to be "0, π/2, 3π/2, π, 0, 3π/2, π/2". The output pulse trains at 40 and 100 Gsymbol/s are shown in Figs.5 and 6, respectively.

4. Conclusion

Switching characteristics for high-bit-rate QPSK pulse train with collinear AO devices were theoretically discussed. Phase deviation of QPSK pulses was analyzed. Bit error rate analysis for QPSK pulse processing will be investigated. Wavelength-selective processing with integrated AO devices for use in photonic routers will also be investigated in future.

Acknowledgment

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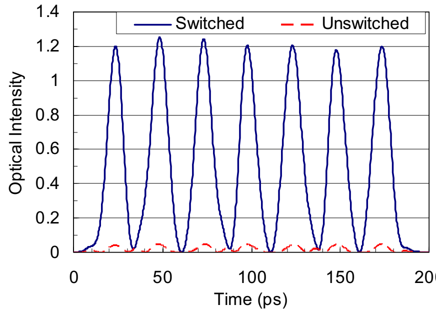
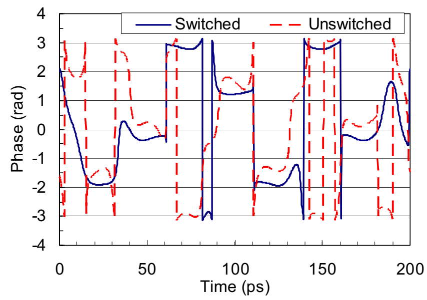
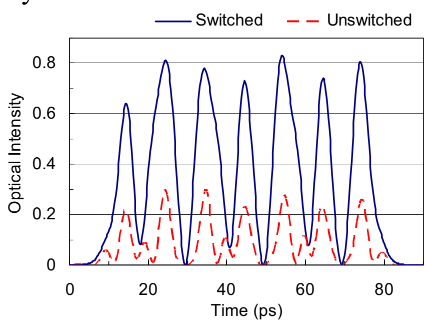


(a) Intensity

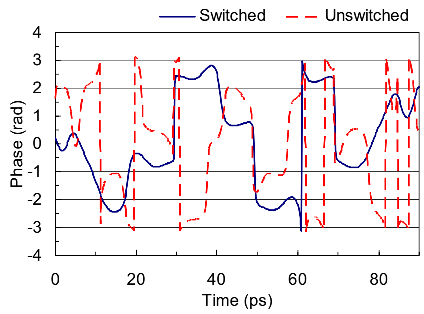


(b) Phase

Fig.5 Switched and unswitched outputs at 40Gsymbol/s.



(a) Intensity



(b) Phase

Fig.6 Switched and unswitched outputs at 100Gsvmbol/s.

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