A 1x2 fast fiber-optic switch based on electro-optic beam scanning

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Abstract: We report a packaged 1x2 fiber-optic switch based on electro-optic beam scanning. The resulting optical switch exhibits an insertion loss of less than 4 dB and a rise time of 187 nsec at 1310nm.

OSICS codes: (060.1810) Couplers, switches and multiplexers; (060.2340) Fiber optic components; (120.5800) Scanners; (230.2090) Electro-optical devices.

We have built a packaged 1x2 fast optical switch based on electro-optic (EO) beam scanning in $LiTaO_3$. The beam scanner device consists of a lithographically defined set of domain-inverted prisms on a 500μm z-cut $LiTaO_3$ single crystal. Electric field poling was used to invert the spontaneous polarization of the prism shaped domains creating voltage controlled regions with differing refractive indices. When an external electric field is applied to the device, index changes of opposite sign occur between adjacent domain regions, causing an optical beam to refract at the interface of each prism. The domain boundaries extend through the thickness of the wafer, offering low coupling and propagation losses compared to waveguide beam deflectors [1]. Once poled, electrodes are evaporated onto both faces of the wafer, the device is diced, and the optical facets are polished.

The scanner is mounted on an acrylic package and aligned to polarization maintaining (PM) fiber collimators, which are cemented to the package with UV epoxy. A knife edge prism is used to further separate the two beams at the output and electrical power is provided to the device through a connection to an external high voltage source. A schematic of the packaged switch is shown in figure 1.

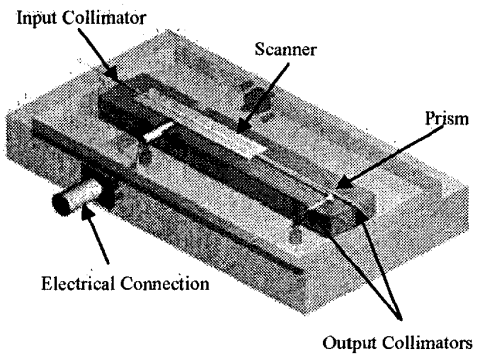

Figure 1. Switch Schematic

To test the switch a 1310nm, linearly polarized, fiber coupled laser source is used. The largest deflection and highest beam quality are achieved when the beam incident on the scanner is extraordinarily polarized (aligned to the z-axis of the $LiTaO_3$ crystal). The aligned PM fiber input collimator was measured to have a misalignment of 2.2° and a polarization extinction ratio of 26 dB. Insertion loss of the packaged switch includes the losses resulting from the fiber collimators, coupling loss into the crystal and the scanner loss. The facets of the scanner were not AR coated, and this source of loss was calculated and removed from the results. Deflection and power measurements for our packaged switch are shown in table 1.

Table 1. Switch Deflection and Power measurements

Applied voltage (V)	Deflection (deg)	Insertion Loss (dB)	Crosstalk (dB)
0	0.00	2.37	-39.24
1200	1.22	3.61	-37.31

Since we are switching more than 1000V, the speed of operation is limited by the drive electronics. With a high voltage pulse generator, pulse rise and fall times (10% to 90%) of 187 nsec and 82 nsec were measured respectively. Future work will investigate reducing the voltage requirements, increasing the switch port count, reducing the insertion loss, and the construction of a switch fabric.

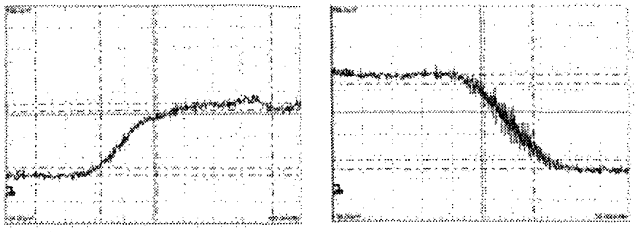

Figure 2. Rise and fall time plots

References

[1]Li J., Cheng C., Kawas M.J., Lambeth D.N., Schlesinger T.E., Stancil D.D., "Electrooptic wafer beam deflector in $LiTaO_3$." IEEE Photonics Technol. Lett. **8**, 1486 (1996).