$1xN^2$ Wavelength-Selective Switches with Tilted 2D Collimator Arrays for Inter-Channel-Response Suppression

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Abstract: A $1xN^2$ wavelength-selective switch (WSS) with a 2-axis analog micromirror array and a tilted 2D fiber collimator array has been successfully demonstrated to suppress inter-channel response. 8.2dB suppression is obtained at 20° tilting.

OCIS codes: (060.1810) Couplers, switches, and multiplexers
(060.4510) Optical communications

1. Introduction

MEMS-based wavelength-selective switches (WSS) are of great interest since they integrate wavelength demultiplexing, switching, and re-multiplexing functions in compact packages [1-3]. The maximum port count reported to date is N = 4. Previously, we demonstrated that the port count can be increased from N to N^2 by using a 2D collimator array in conjunction with two-axis beam-steering functions [4-6]. The two-axis beam steering is implemented by either two linear arrays of one-axis analog micromirrors with orthogonal scanning directions [4], or a monolithic two-axis analog micromirror array [6].

In our previous study of $1xN^2$ WSS, we observed a large inter-channel response when the signal is switched to an output port that is along the dispersion direction. This is due to coherent diffraction from the mirror edges [7]. The inter-channel response is undesirable for system applications. In this paper, we present a simple solution to suppress the inter-channel response in $1xN^2$ WSS. By tilting the collimator array such that no output ports are along the dispersion direction with the input port, coherent diffraction can be greatly reduced. Experimentally, 8.2dB suppression of inter-channel response has been achieved with 20° tilting.

2. Experimental Setup

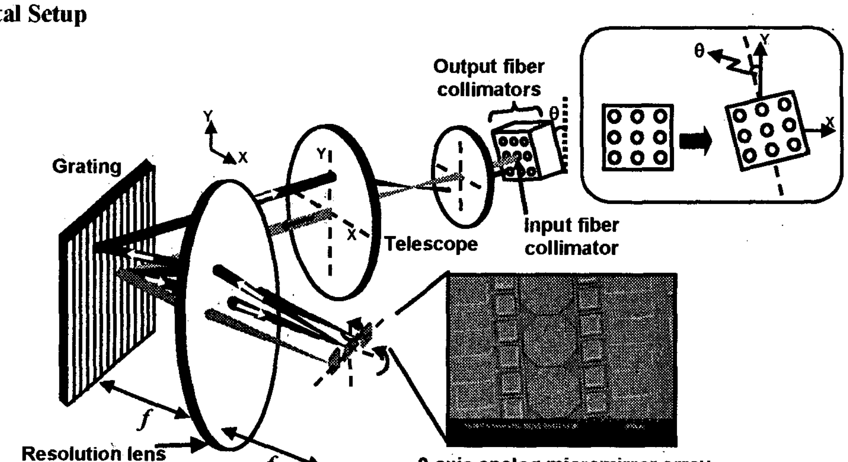
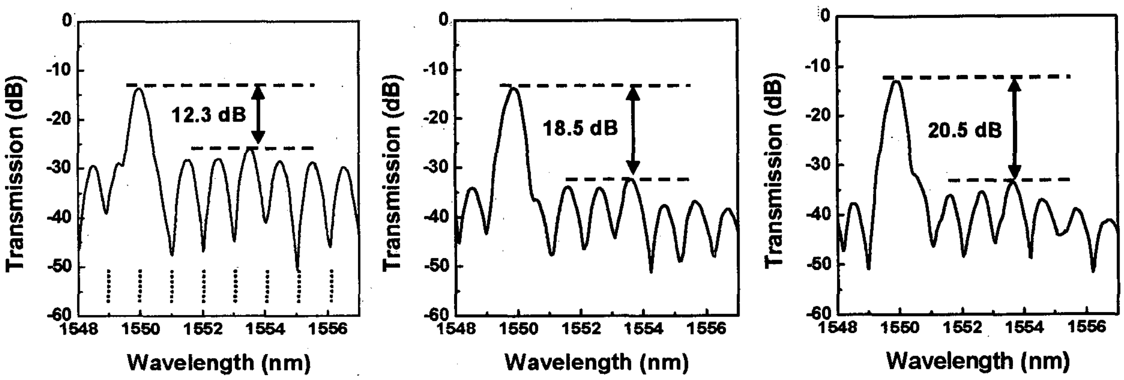


Figure 1. Schematic of the $1xN^2$ wavelength-selective switch with a tilted 2D collimator array. A two-axis analog micromirror array is used for 2D beam steering. The telescope expands the size of the optical beam.

Figure 1 shows the schematic of the $1xN^2$ WSS. The 2D collimator array is mounted on a rotary stage with rotation axis parallel to the optical beams. The center collimator serves as the input port. The WDM signals are spatially dispersed by the grating, and focused onto their corresponding mirrors by the resolution lens. The two-axis mirrors direct individual wavelengths to the desired output ports. The spectral response of the output ports are recorded for various tilting angles of the collimator array. The telescope beam expander reduces the optical spot size on the MEMS mirror.

3. Experimental Results

A 1x10 two-axis micromirror array with 200μm pitch and 98% fill factor was used in the experiment, as shown in the inset of Figure 1. The scan angles are ±2.63° (at 14.1V) and ±1.27° (at 21.1V) [5]. The MEMS devices are fabricated using the SUMMiT-V surface micromachining process provided by Sandia National Laboratory. A 600 grooves/mm grating is used. The focal length of the resolution lens is 30 cm. The channel spacing is 125 GHz. A commercial 6x6 collimator array with a 1mm pitch and a 125μm beam radius is employed in our system. A 16x telescope expands the optical beams. The collimator array is rotated by small angles (10°, 20°) to mitigate the undesired coherent coupling that resulted in large inter-channel response. Figure 2 shows the spectra from a specific output port at three different rotation angles (0°, 10°, 20°). At 0°, the input and output ports are aligned in the dispersion direction. The dotted lines in Fig. 2(a) indicate the position of wavelength channels for this WSS. The 1550nm wavelength is switched to this output port. Signals at other wavelength channels are below ~ -35dB. However, the response in between channel (between dotted lines) are very pronounced (-12.3dB below signal) due to coherent diffraction from mirror edges. The inter-channel response was reduced to -18.5dB at 10° (6.2dB suppression) and -20.5dB at 20° (8.2dB suppression). Though greatly reduced, the response at 20° is still larger than our 1D (1xN) systems, probably due to the octagon-shaped mirrors used in this experiment (there are four extra mirror edges). We expect to achieve higher suppression with rectangular mirror shapes. The temporal response of the WSS is shown in Fig. 3. The switching time is less than 2 msec.



(a) (b) (c)

Figure 2. Optical spectra from a horizontal output port when the collimator array is tilted by (a) 0°, (b)10°, and (c) 20°.The dotted lines in (a) indicate the position of the wavelength channels. The minor peaks between dotted lines are inter-channel responses due to coherent diffraction from mirror edges.

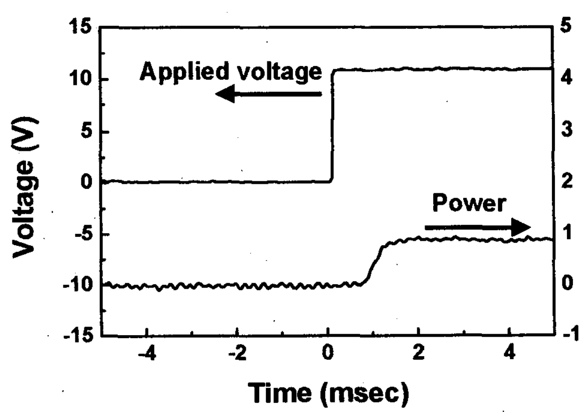


Figure 3. Temporal response of the WSS. The switching time is less than 2 msec.

4. Conclusion

The inter-channel response of a $1xN^2$ wavelength-selective switch with a 2-axis micromirror array has been successfully suppressed by tilting the 2D collimator array. The mirror needs to tilt in both axes to reach any output port. Experimentally, 8.2dB suppression is achieved at 20° tilting. Larger suppression is possible with rectangular mirrors. The switching time is less than 2 msec.

5. References

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