# 장주기 격자를 이용한 홀로그래픽 역다중화기의 편광의존손실 개선

# Enhancement of the polarization dependence loss in holographic demultiplexer using long-period grating

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We describe the results of a holographic demultiplexer with low polarization dependence loss using long period volumetric diffraction grating. A 0.8nm−spaced 21 channels holographic DMUX with the polarization dependence loss of less than −0.38dB, the channel uniformity of 0.495dB, and the channel crosstalk of −13dB has been demonstrated.

The dramatic increase in the volume of worldwide data traffic has placed an increasing demand for communication networks providing large bandwidth. To satisfy this requirement, fiber−optic communication systems using wavelength division multiplexing(WDM) have been developed. In WDM networks, WDM multiplexer/demultiplexer(MUX/DMUX) play a central role. Free space diffraction gratings[1]−[3] show many advantages including the simplicity and cost−attractive. However, it suffers from the large polarization dependence loss(PDL), while the PDL is required to be smaller than −0.5dB in case of commercialized components. In this paper, the experimental demonstration of a holographic DMUX with low PDL using long period holographic grating inside the Dupont's photopolymer has been described. Free space diffraction grating has been recorded under small angles such that the DMUX has low PDL but still satisfy the volumetric grating conditions to eliminate the multi−order diffractions. From the Kogelnik's coupled wave theory, the diffraction efficiency according to the input polarization states could be expressed by

$$\eta_P = \sin^2\left(\frac{\pi \Delta n d}{\lambda_R(\cos\theta_{ri}\cos\theta_{si})^{1/2}}\right), \qquad \eta_S = \sin^2\left(\frac{\pi \Delta n d}{\lambda_R(\cos\theta_{ri}\cos\theta_{si})^{1/2}}\right)\cos(\theta_{si}-\theta_{ri}) \qquad (1)$$

where, the $\Delta n$ is the refractive index modulation amplitude, $\theta_{ri}$ and $\theta_{si}$ are the reconstruction and signal beam angles inside the material, the $d$ is thickness of material, the $\eta_P$ is the diffraction efficiency for the p−polarization and the $\eta_S$ is the efficiency for the s−polarization. From above relationships, $\theta_{ri}$ must have the values less than 13.5° to achieve PDL less than −0.5dB. Therefore the maximum recording angle $\theta_{wi}$ is 4.59° if the recording wavelength is 532nm and the readout center−wavelength is 1550nm, respectively. Using above polarization dependence, we can expect the PDL of the holographic DMUX using free space diffraction grating as shown in figure 1. From the figure, we can see that the PDL is increased by a small grating spacing and large reconstruction wavelengths; also we have to use a diffraction grating with over the value of 2.214 $\mu m$. From the experimental results, the PDL of our scheme has maximum value of −0.243dB and −0.369dB, respectively, for each grating. Also, it shows that the PDL is increased according to the large center wavelength and small grating period as expected in the figure 1. Figure 2 shows the spectral response with 0.8nm channel spacing 21 channels using our demultiplexing scheme. In case of 3.813um period grating, the uniformity of 0.29 dB, the 3dB passband of 0.55nm and the crosstalk of −12.5dB are achieved, meanwhile the 2.544um period grating has 0.495dB uniformity, 0.36nm passband and −14.5dB crosstalk. Using long period grating, the properties of crosstalk, passband, spatial separation between the channelsare relatively worse than small period grating. However, it could dramatically enhance the PDL, the channel uniformity and insertion loss asshown in the theoretical and experimental results. Furthermore, our demonstrations should more effective when we use a large diameter of incident beam because the crosstalk level and passband could be enhanced.

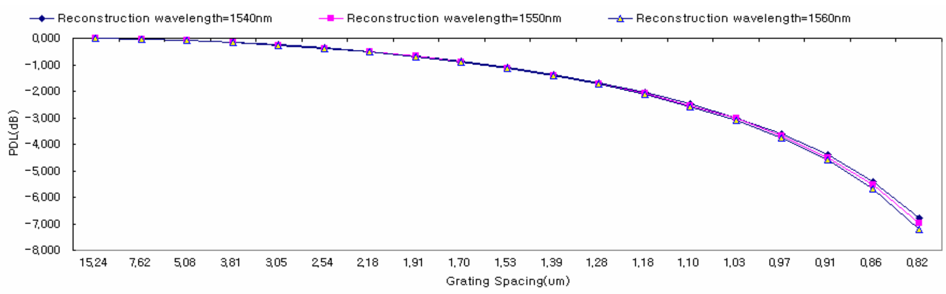
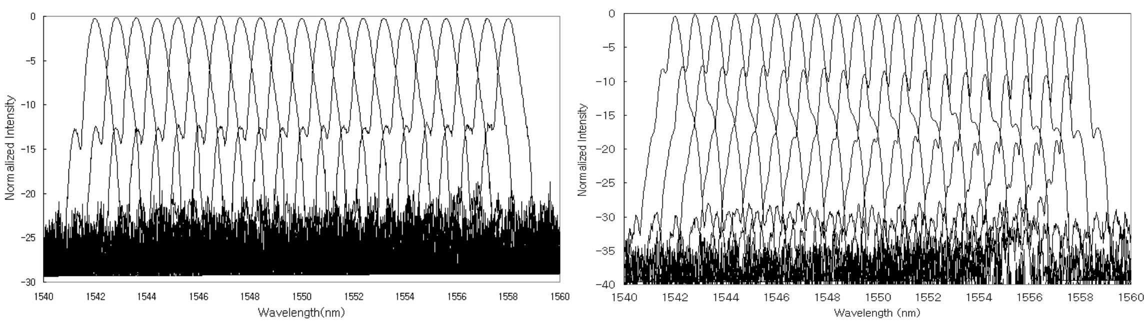



Figure 1. PDL according to the grating spacing and reconstruction wavelength




(a) by 3.813um grating spacing (b) by 2.544um grating spacing

Figure 2. Spectral response of the low PDL DMUX

**Acknowledgement**

This work was supported by the Regional Research Centers Program of the Ministry of Education & Human Resources Development in Korea and by the Ministry of Information & Communications, Korea, under the Information Technology Research Center Support Program.

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