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ANALYSIS OF OPTICAL-ADD-DROP MULTIPLEXER USING FIBER BRAGG GRATING AND THE OPTICAL CIRCULATOR

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Abstract
We have experimentally demonstrated analysis of optical add-drop multiplexer (OADM) using Light Runner and optical spectrum analyzer. The OADM experiment were carried out using two channels for 1530 nm and 1550 nm at 50 khz modulation speed. It is shown the power of dropping channel is depending on the reflectivity of FBG and isolation of circulator.

1.INTRODUCTION

Optical-add-drop multiplexer (OADM) is the crucial components for the optical wavelength-divisionmultiplexing (WDM) networks to add or dropvarious channels at the optical nodes [1].It permits single or many wavelengths to be added and/or dropped from atransport fiber without optical-to-electrical-to-optical domain translation. It is possible in various ways to implement OADMsuch as using ring resonators, arrayed waveguide gratings(AWGs), micro-electromechanical systems, and fiber Bragg gratings (FBGs) [2-6].Among all the methods the widely used method is the FBG based OADM because of its simplicity,high cascadability, and polarization insensitivity. The FBG based OADM includes a pair of 3-port optical circulators with one ormultiple FBGs.

The OADM selectively drops or adds the wavelength from a multiplicity of wavelengths in an optical fiber network, and thus form a traffic on the particular channel. It then adds in the samedirection of data flow the same wavelength, but with different data content. A schematic of OADMwhich can be generally employed to add and drop wavelengths has been exhibited in the Fig.1. As illustrated in the figure, it consists of FBG and the 3-port circulator. This OADM is designed to only add or drop optical signals with a particular wavelength (represented by the red light pulse below). Composite signal is broken into two components, drop and pass-through. The OADM drops only the red optical signal. The dropped signal stream is passed to the receiver of a client device. The remaining optical signals that pass through the OADM are multiplexed with a new add signal. The OADM adds a new red optical signal, which operates at the same wavelength as the dropped signal.The new optical signal is combined with the pass through signals and we get a composite signal.

In this paper, we have demonstrated an experimental analysis for the generations of a OADM and its architecture based on FBG. The experiment of OADM is performed on Light Runner fiber optica Setup.

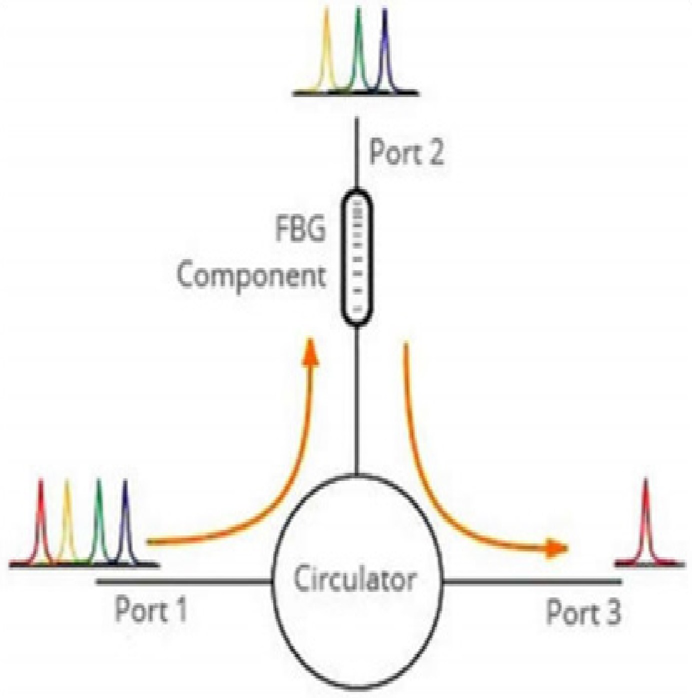


Fig. 1. Operation of the OADM using FBG and optical circulator.

Adding of the channels of WDM link

The schematic presentation of adding two channels of the wavelength of 1530 nm and 1550 nm is illustrated in Fig.2. The optical channel adding has been achieved by using a FBG and an optical circulator as shown in Fig.3. First of all, 1530 nm and 1550 nm laser sources have been connected to the optical spectrum analyzer by using the patch cords. The responses of these two laser sources have been illustrated in Fig.4 (a) and (b) respectively.

Now, the 1530 nm and 1550 nm laser sources have been connected to the photodetectors. The both photodetectors have been connected to channels of the DSO. The electrical response of 1530 nm (green color) and 1550 nm (yellow color) wavelength signal using the DSO have been illustrated in Fig. 5.

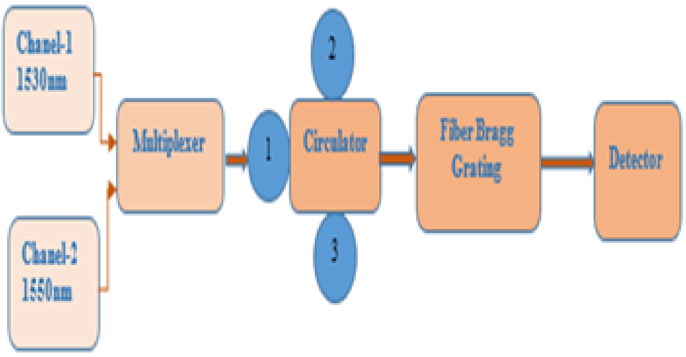


Fig. 2. Schematic of OADM to add two channels.

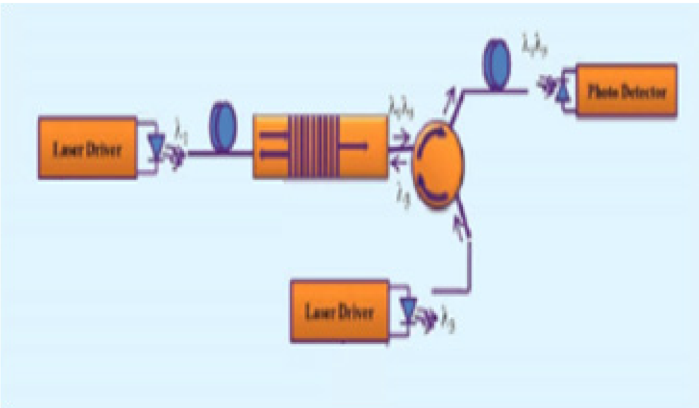
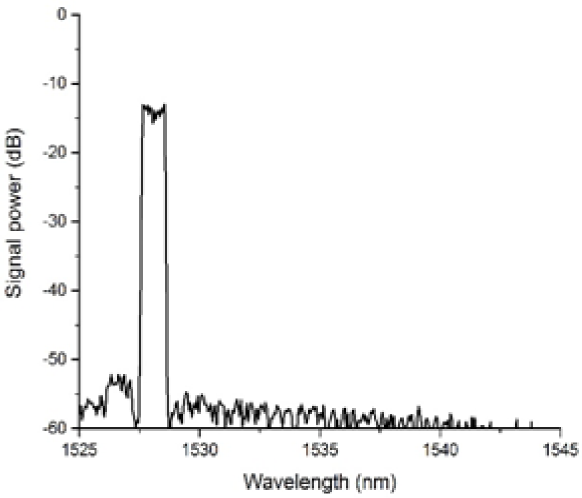
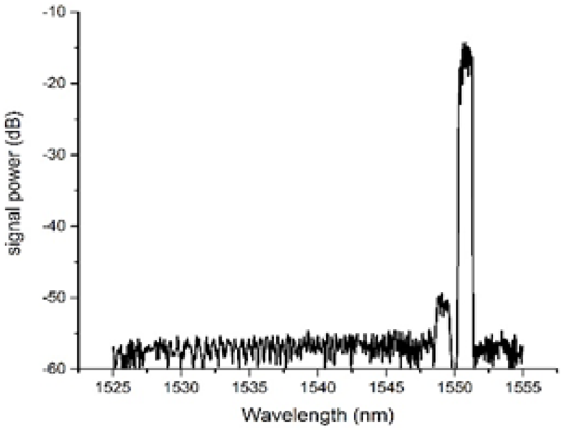


Fig. 3. Schematic of the experiment setup for adding of the optical channels.

The electrical response of the 1530nm laser with laser power of 1.4 Mw, frequency of 50 kHz, and duty cycle of 50% is shown in green color in Fig.5; and the electrical response of 1550nm with laser power 1.4mW, frequency of 50 kHz, and duty cycle of 20% is shown in the same figure in yellow color.



(a)



(b)

Fig. 4. Optical spectrum analyzer response of DFB Laser source of (a) 1330 nm; and (b) 1550 nm.

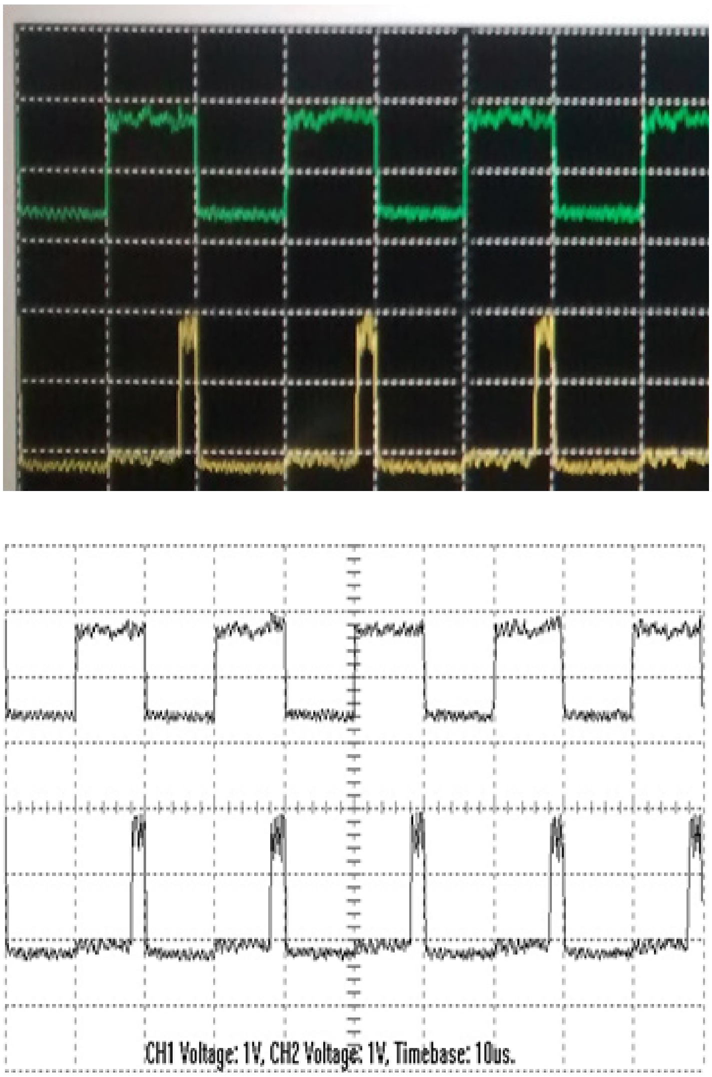


Fig.5. Electrical response of 1530nm (green color) and1550 nm (yellow color) wavelength signal using DSO.

Further these signals fed into the multiplexer and we get the combined signal at the output of the multiplexer which contain both 1530nm and 1550nm wavelengths. The response is shown in the Fig. 6 (OSA) &Fig.7 (DSO). We identify the signal in DSO with help of their duty cycle.

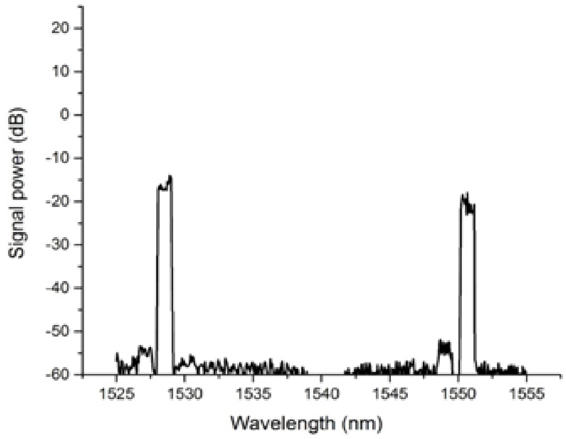


Fig. 6. Adding response of the optical channels in OSA

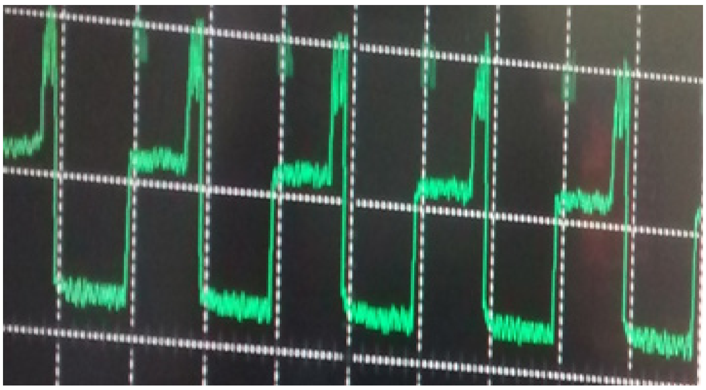


Fig. 7. Electrical response of adding 1530nm and 1550nm

Dropping of the channels of WDM link

As demonstrated in Fig.8, the multiplexed signal fed into the circulator at the port-1. The port-2 of the circulator is connected to the port-1 of the FBG. The FBG used in this experiment having center wavelength of 1550 nm. So 1550 nm wavelength reflected back into the circulator at port-2 and collected at the port-3 of the circulator. The 1530 nm wavelength passes through the grating. In this way we dropped the 1550 nm wavelength using the appropriate grating. Figure-9 (a & b) shows the adding response of the optical channels at the circulator and the FBG respectively. As shown in Fig.9 (a) the intensity of the 1530 nm laser is less in comparison to that of the 1550 nm. This is because of the cross coupling effect arises in the circulator. The cross coupling between the port-1 and port-3 of circulator occurs when there is no 100% isolation. As illustrated in Fig.9(b), at the output of the FBG the intensity of the 1550 nm is undesirable. It comes because of the Bragg wavelength of FBG is not exactly at 1550 nm. Therefore, we have analyzed the FBG using OSA and found that the exact Bragg wavelength is 1547.8 nm with 10 nm FWHM.

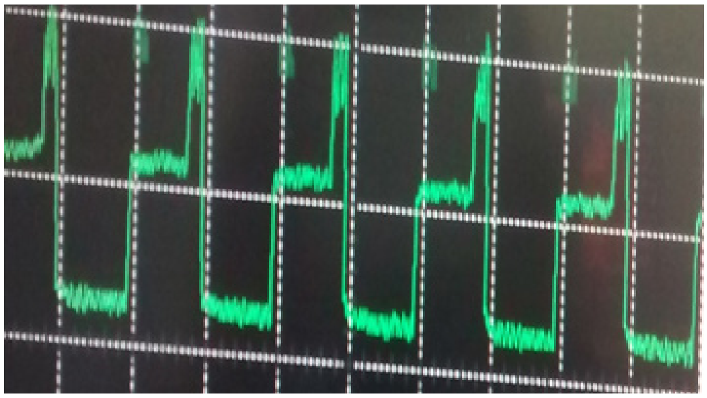
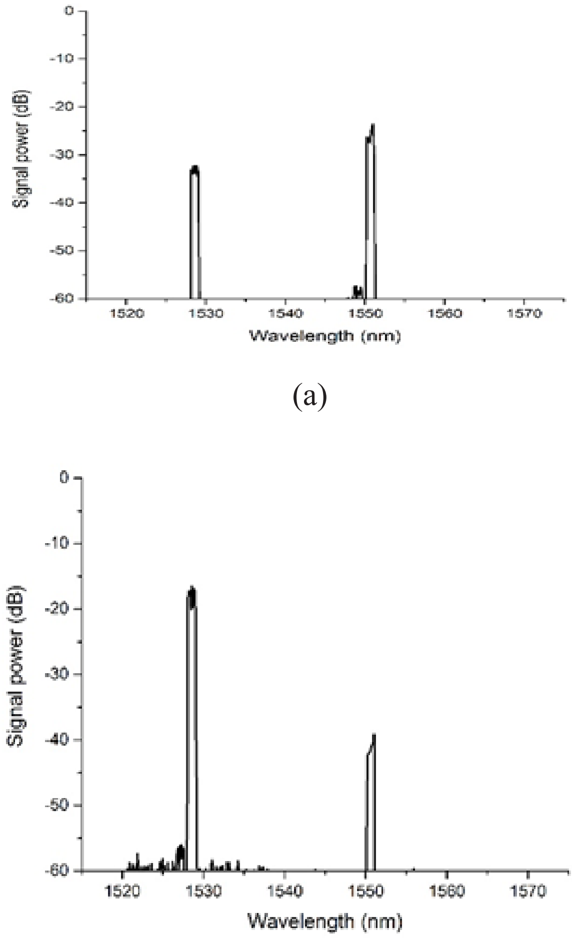


Fig. 8. Schematic of Experiment Setup for dropping of Channel in an OADM



(b)

Fig. 9. Adding rsponse of the optical channelsat the (a) circulator, and (b) FBG.

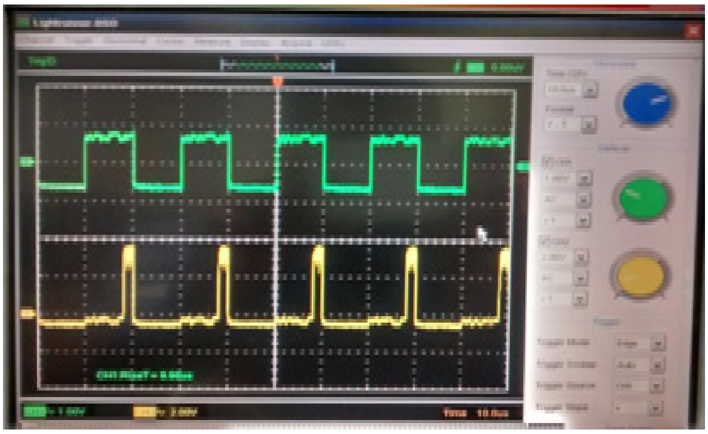


Fig. 10. Electrical response of the 1530nm and 1550nm lasers after dropping

Conclusion

With the help of result we conclude that the undesirable signal at the output of the FBG and the circulator is due to that the FBG is not 100% reflected and FWHM is too large. The port-1 and port-3 of the circulator are not properly isolated which causes the cross coupling and cross talk between the two channels. The photonic network is enable the construction of high capacity and flexible optical communication systems for the future data-centric era. Optical-add-drop multiplexers along with already well established DWDM systems are the key technologies for the photonic networks. The OADM can be used more efficiently in local nodes of the opticalnetworks.

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