ECE 469 Lab Report Lab 3
Lab Section: PRA 0104
Lab Time Slot : Tuesday, 12pm - 3pm
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By signing our name, We acknowledge that we: (a) have participated in the experimental session; (b) have contributed to and are accountable for the lab report of our team.

Nawabzada Maaz Farhat Khan Sherwani
Signature: **Maaz Farhat**

Fazal Shahid
Signature: **Fazal Shahid**

Introduction and Purpose

The Purpose of this lab is to understand and characterize the performance of basic passive optical components such as isolator, circulator, fiber bragg gratings and 4 channel Demux used in fiber optic communication systems.

Theory

The results of this this experiment were explained using the properties of different passive optical components.

Results and Discussion

From the experiment we observe that In isolator, light transmits only in one direction and does not transmit in the opposing direction. Circulator had 3 ports and light transmits only in one direction between two ports but not in the other direction. The reflection spectra was observed from port 2 and port 3 as there is a reflector at port 2. Demultiplexer separates the wavelengths of incoming light and output different wavelengths into different ports. The centre wavelengths were 1556 nm for port A, 1549 nm for port B, 1552 nm for port C and 1553 nm for port D. Each channel had 1 nm 3 dB bandwidth accounting for total of 4 nm 3 dB bandwidth for the whole system.Fiber bragg gratings did not transmit the light at 1543 nm and the light was reflected at this wavelength.There were insertion loss for each of the optical components. All the components behaved accordingly as expected.

Post-Lab Questions

1. The transmission and reflection spectra of each of the optical components are shown in Appendix A.

Isolator: As shown in Figure 2 in Appendix A, In one direction the isolator has similar spectrum as source(Figure 1) with -1.048 dB insertion loss.When the incident light is in the opposite direction, the transmission spectrum is attenuated to -60dBm as presented in Figure 3.

Circulator: Circulator has a reflective material at port 2 and hence the reflected light appears at port 3.The center wavelength and the 3dB bandwidth is same as the source with an insertion loss of -2.4 dB.

DEMUX The plots for each ports can be seen in Figure 5,6,7,8 of Appendix A. There is an insertion loss with the range -5.11dB to -2.74 dB for each of the ports. The reflection spectrum can be seen in Figure 9 of Appendix of A and the reflection is closer to zero.

Fiber Bragg Grating

In Figure 11 of Appendix A, the reflected wave contains particular center wavelength around 1543 nm. The insertion loss at the reflected spectrum is -7.88dB taking into account the loss contributed by the circulator in the system. The power level at the reflection spectrum at 1543 nm is -43.8dBm. We can see from the the transmission spectra Figure 10 in Appendix A that light does not transmit at wavelength 1543 nm.

2. The parameters of the respective spectrum for each device is shown in the graphs as seen in Appendix A.

Parameters of the spectrum of the source

Parameter	Value
Center Wavelength	1533 nm
3dB bandwidth	42 nm
Insertion Loss	0 dB

Parameters of the transmission spectrum of the isolator at Port 1

Parameter	Value
Center Wavelength	1533 nm
3dB bandwidth	42 nm
Insertion Loss	-1.048 dB

Parameters of the reflection spectrum of the circulator at Port 3

Parameter	Value
Center Wavelength	1533 nm
3dB bandwidth	42 nm
Insertion Loss	-2.4 dB

Parameters of the transmission spectrum of the DEMUX at Port A,B,C,D

Parameter	Port A	Port B	Port C	Port D
Center Wavelength	1556 nm	1549 nm	1552 nm	1553 nm
3dB bandwidth	1 nm	1 nm	1 nm	1 nm
Insertion Loss	-5.11 dB	-3.84 dB	-3.92 dB	-2.74 dB

Parameters of the reflection spectrum of the FBG

Parameter	Value
Center Wavelength	1543 nm
3dB bandwidth	0.5 nm
Insertion Loss	-7.88 dB

3. We can see from the Figure 12 in Appendix A that the transmission spectra light does not transmit at wavelength 1543 nm and in the reflection spectra light reflects at 1543 nm and when we combine the two plots the power level is around -43.8dB. Ignoring the insertion loss we can say that power is conserved.

4. Isolator
Isolator is like a diode which is an optical component that allows the transmission of light in only one direction. Furthermore, if the light is propagated in the opposite direction, the incoming light is blocked and thus blocking reflections back to the source.

Circulator
Optical circulators are non-reciprocal optics, which is a three port device that allows light entering from any port to exit from the next. For example, the light entering port 1 will output at port 2 and the light entering port 2 will result at port 3.

DEMUX
Demultiplexers separate the wavelengths of the incoming light and the signal with different wavelength to different output ports. Each output has a different center wavelength.

Fiber Bragg Grating
FBG is a type of a reflector which reflects certain wavelengths of light and transmit all others due to its periodic change in the refractive index of the optical fibre. It can be used to block certain wavelengths and act as an optical filter.

5. The isolator has -36.988dBm of transmission light, the reflection intensity is approximately -60 dBm, so total loss across isolator is about 24dB. This isolator is not sufficient to achieve the isolation of single-mode DFB laser. Isolation efficiency can be improved by adding more isolators in the communication channel. If each isolator isolates about 24dB of light, three isolators will meet the criteria of DFB laser.

6. Spacing between DWDM channels:
A,B : 7 nm   A,C : 4 nm   A,D : 3 nm   B,C: 3 nm   B,D: 4 nm   C,D : 1 nm
Bandwidth: channel A : 1 nm   channel B: 1 nm   channel C: 1 nm   channel D: 1 nm.

The total bandwidth available through this DWDM system is 4nm

7. Approximate flatness:
Channel A: (-44.912-(-43.929)/(1555.44 - 1556.14) = 1.404 dB/nm
Channel B: (-42.235-(-42))/(1549.04 - 1549.62) = 0.405 dB/nm
Channel C: (-43.625 -(-42.889))/(1552.2 - 1552.84) = 1.15 dB/nm
Channel D: (-42.204 - (-43.41))/(1545.8 - 1546.44) = -1.88 dB/nm

It is important to have a flat transmission spectrum in the passband so that the transmission level is almost same for all the frequencies in this band.

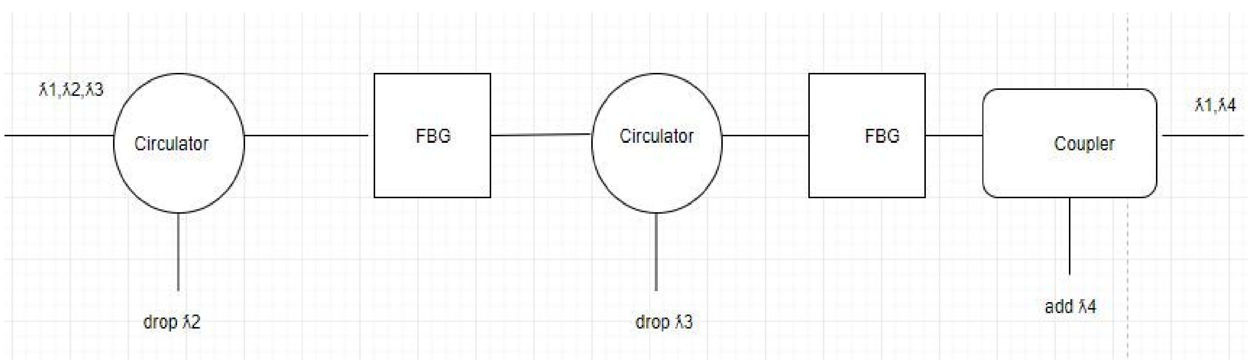
8. At -10 dB, these are the values at each channels.

<u>channel A:</u>	1552 nm	-51dB	1556.24 nm	-51dB
<u>channel B:</u>	1548.92 nm	-50.325dB	1549.72 nm	-48.652dB
<u>channel C:</u>	1552.12 nm	-49.321dB	1556.96 nm	-50.781dB
<u>channel D:</u>	1545.72 nm	-47.645dB	1546.50 nm	-48.50dB

Crosstalk bandwidth will only take place between channel A and channel C. The rest of the channels don't overlap as observed from the data we recorded so there will be no crosstalk at -10db. The operation bandwidth of the cross talk between channel A and channel C is (1556.24 - 1552.12) = 4.12nm.

9. If the signals are fed into channels A and B correspondingly the signals will have higher transmission and lower reflection. If they are fed into opposite channels they will have lower transmission and higher reflection.

10.



<u>**Conclusion:**</u> The results of this experiment were observed as expected. Isolator transmitted light only in one direction. Circulator transmitted light only in one direction between each ports. Demultiplexer separated wavelengths into different output ports. Fiber bragg gratings reflected light at certain wavelength.

Appendices:

Appendix A: Spectra of different passive optical components

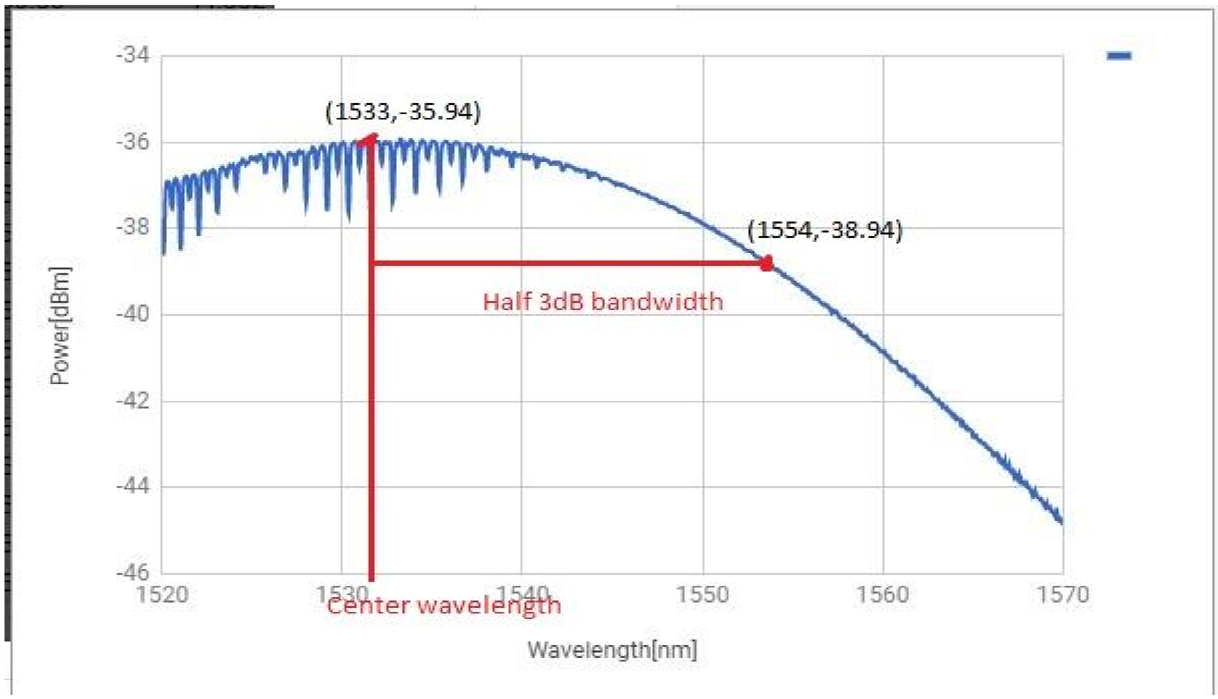


Figure 1: Spectrum of the source without optical components

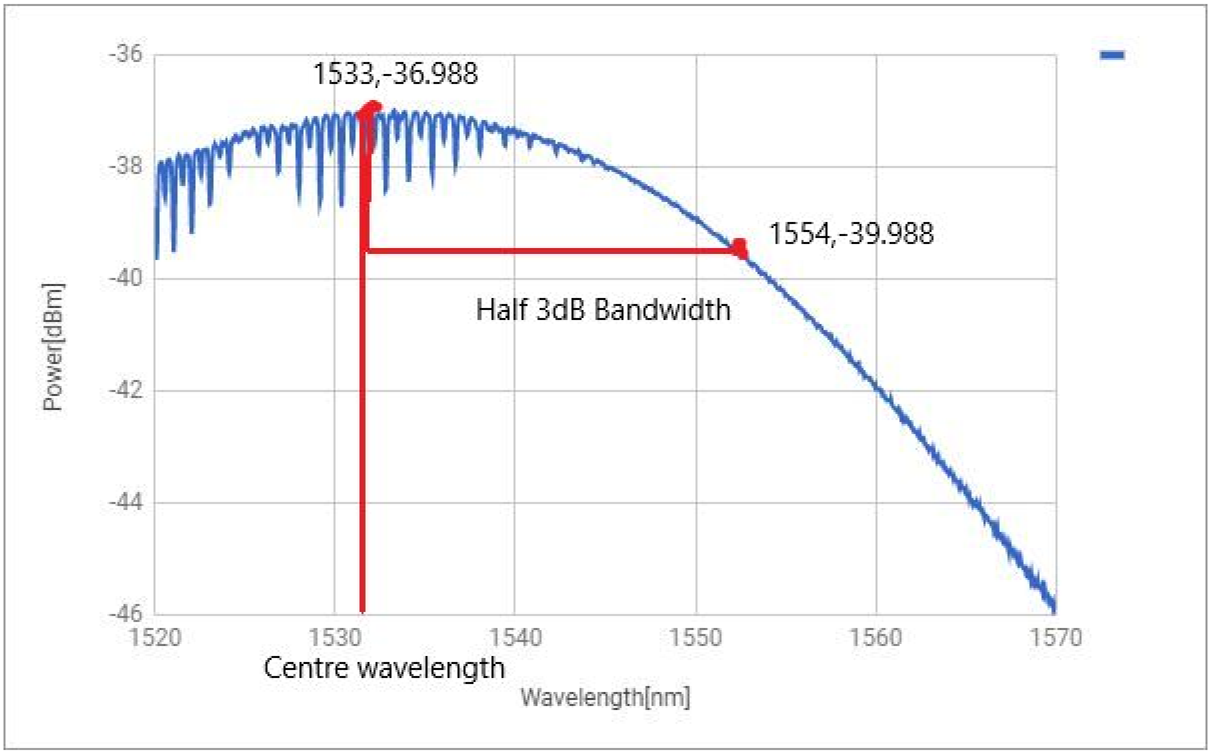


Figure 2: Transmission Spectrum of the Isolator Port 1

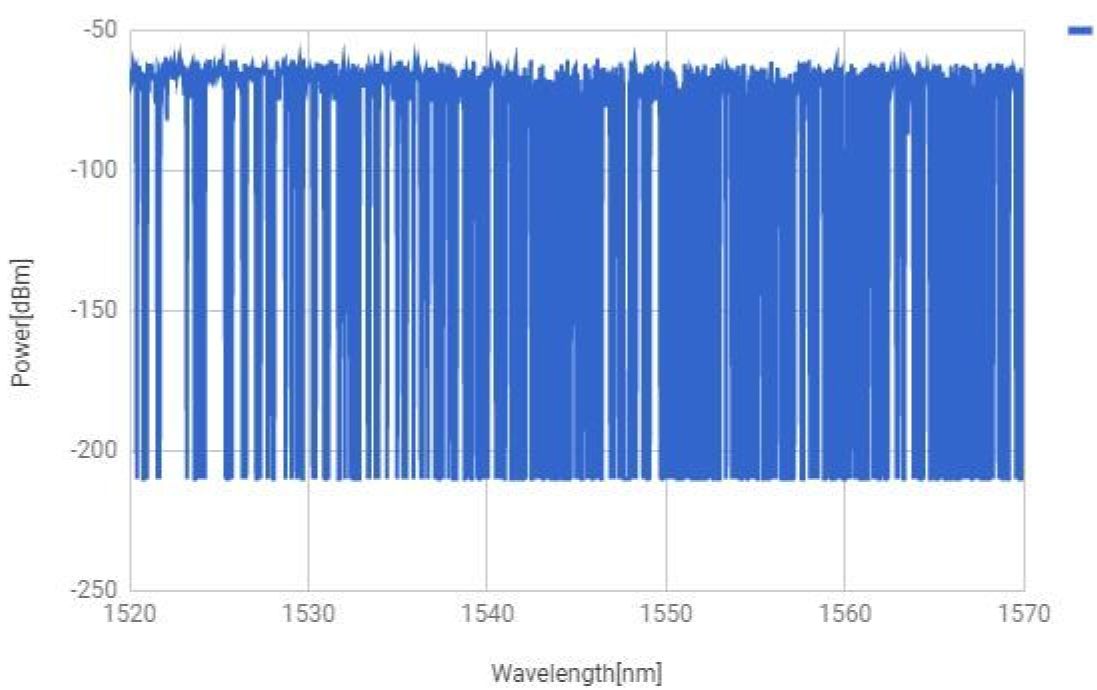


Figure 3: Transmission Spectrum of the Isolator Port 2

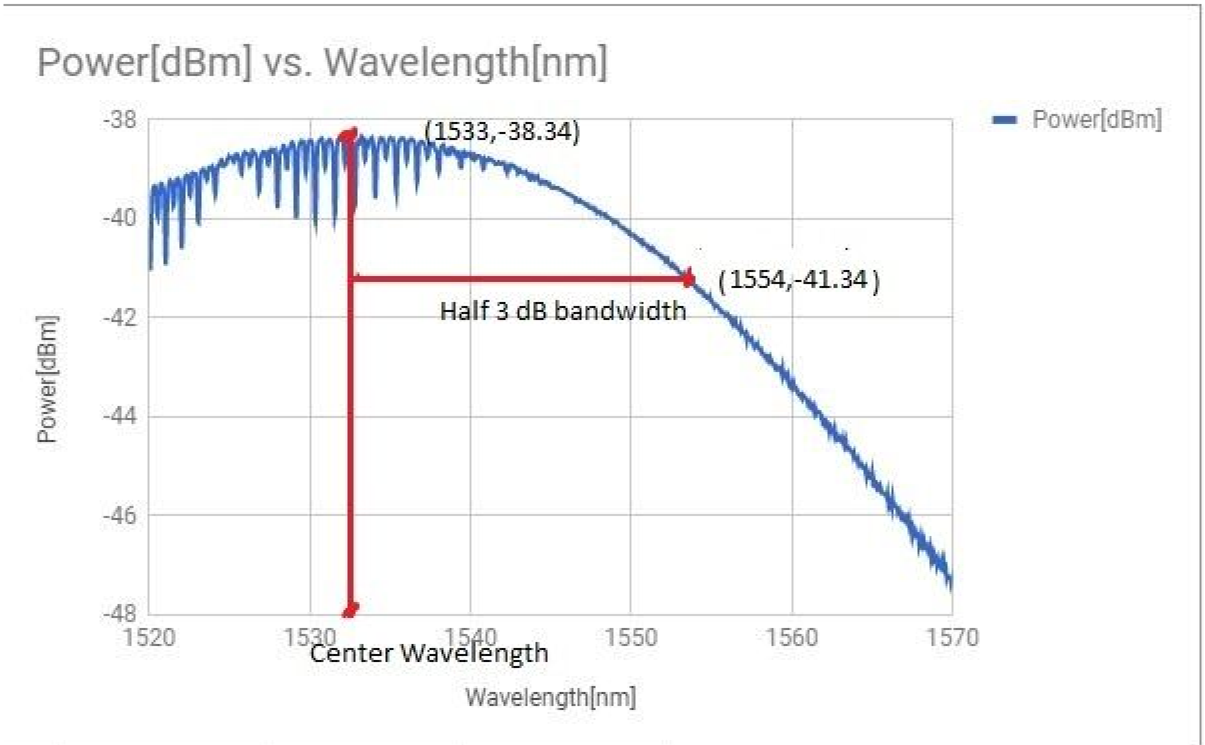


Figure 4: Reflection Spectrum of the Circulator at Port 3

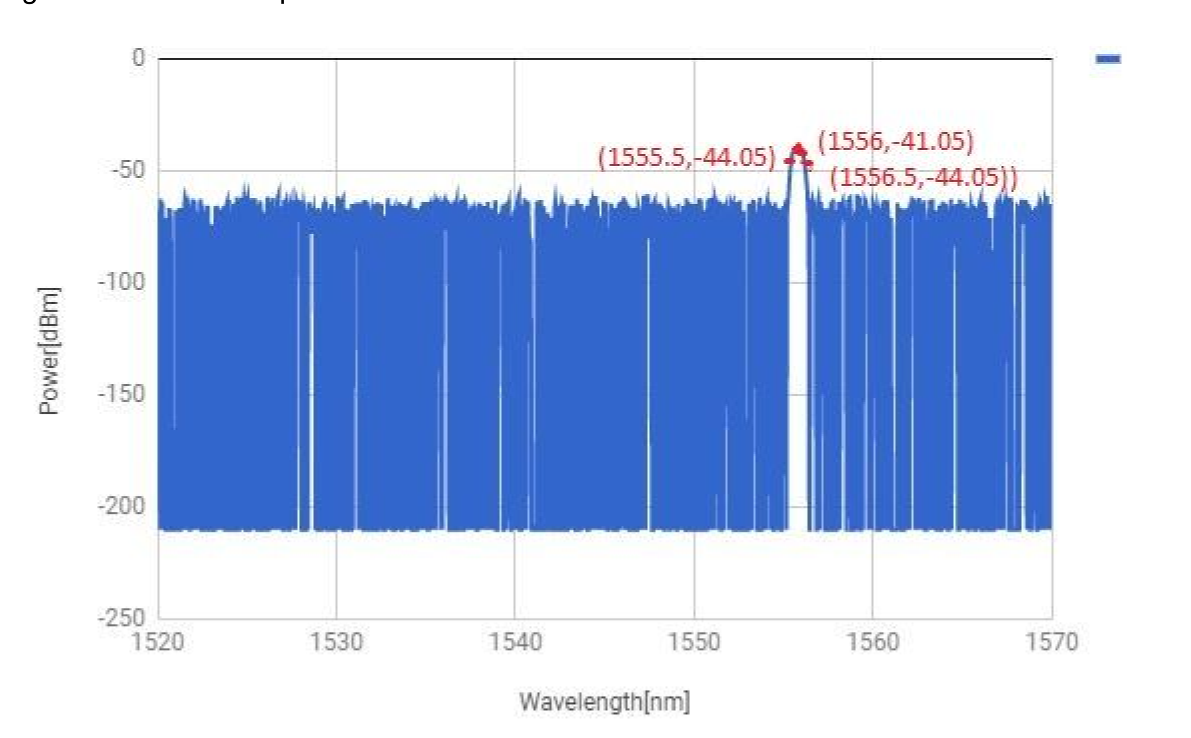


Figure 5: Transmission Spectrum of the DEMUX Port A

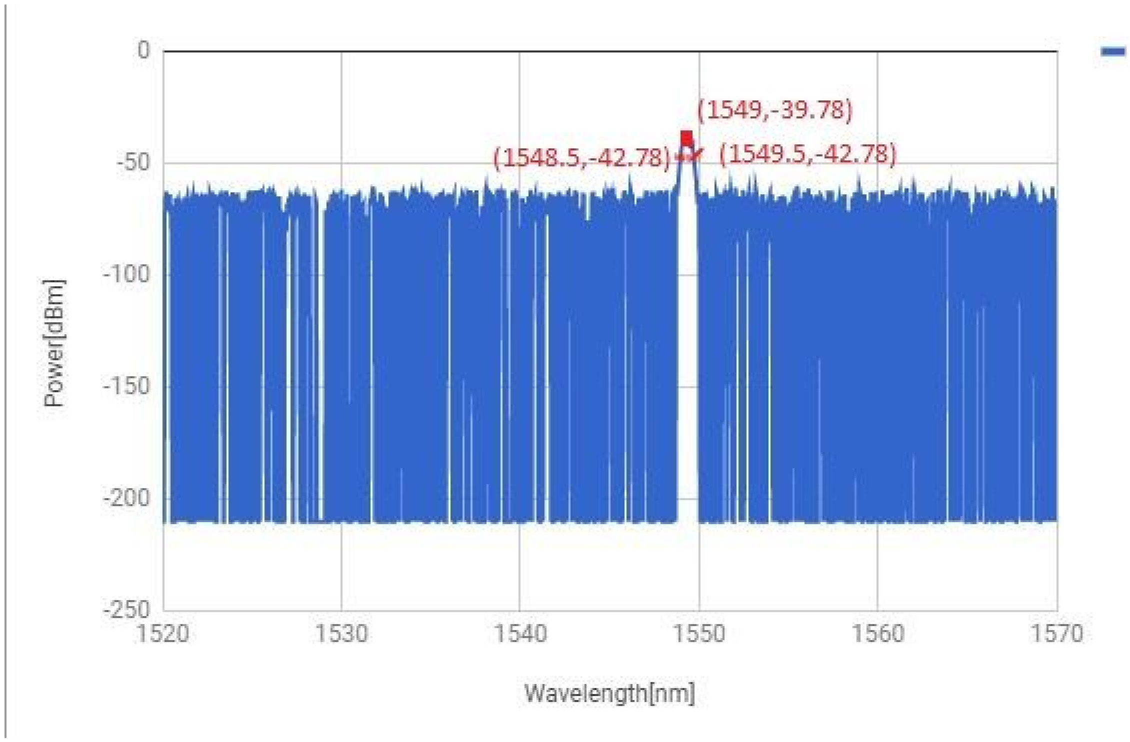


Figure 6: Transmission Spectrum of the DEMUX Port B

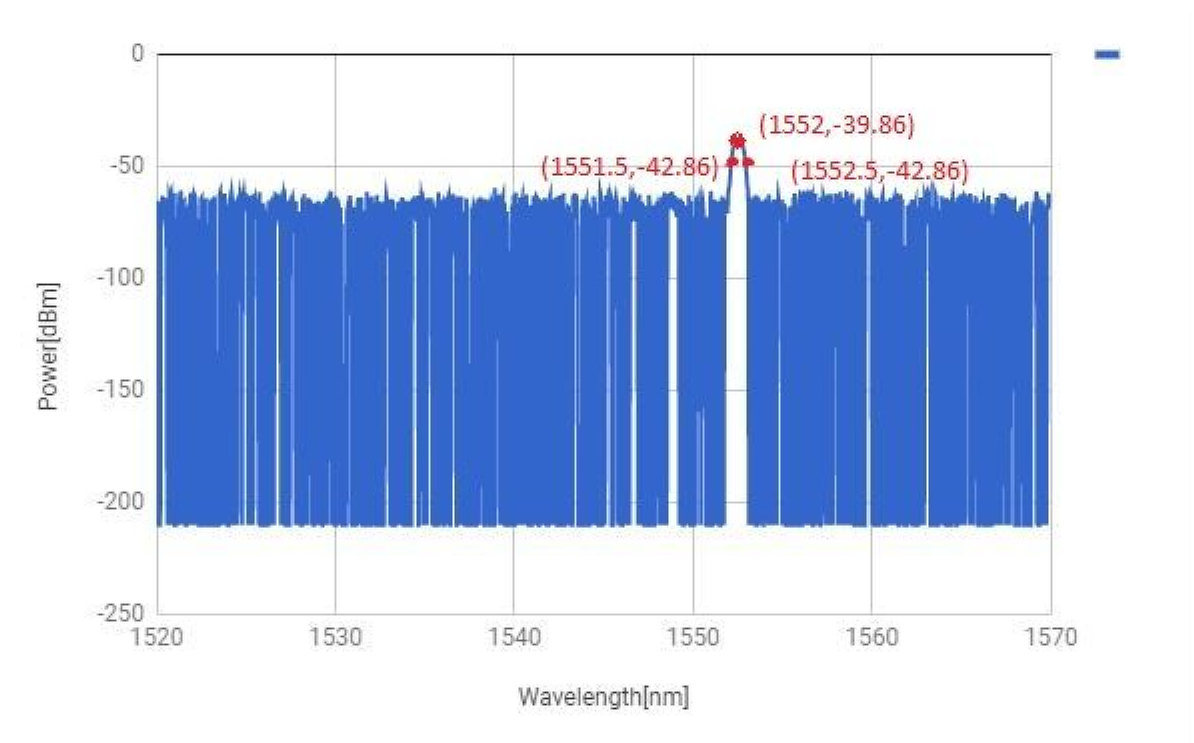


Figure 7: Transmission Spectrum of the DEMUX Port C

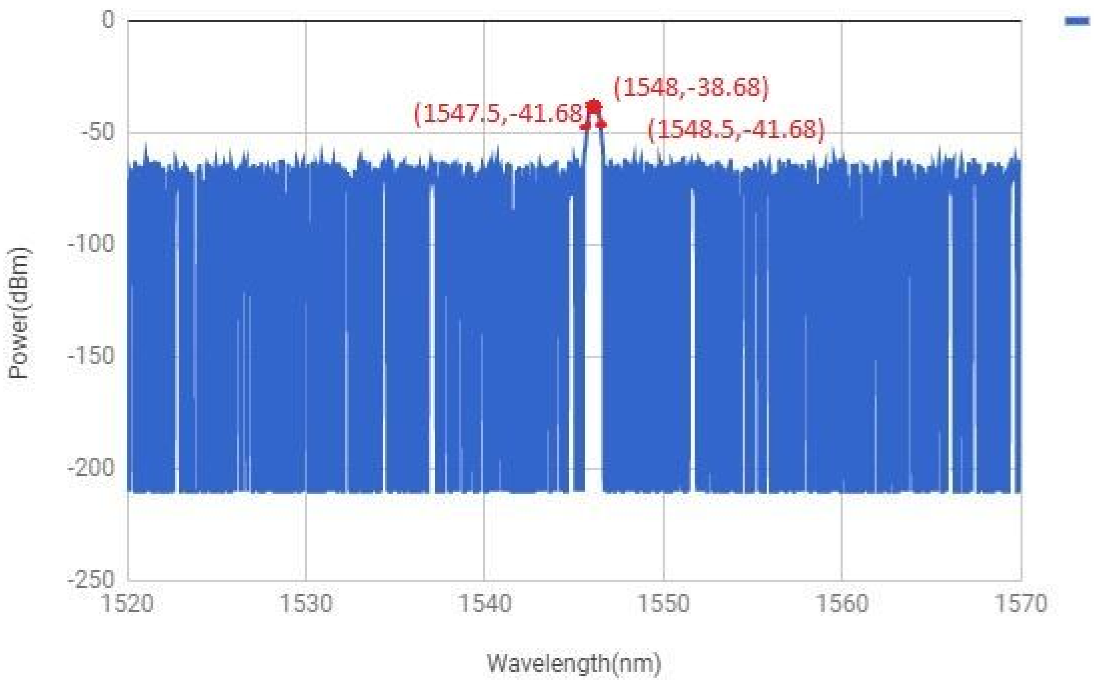


Figure 8: Transmission Spectrum of the DEMUX Port D

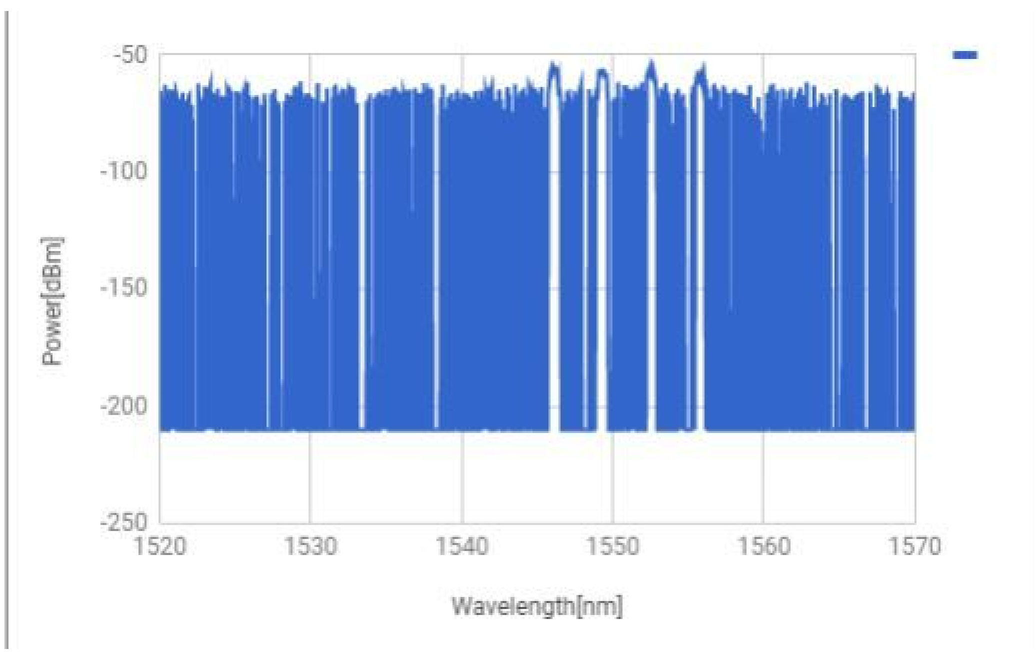


Figure 9: Reflection spectra of Demux

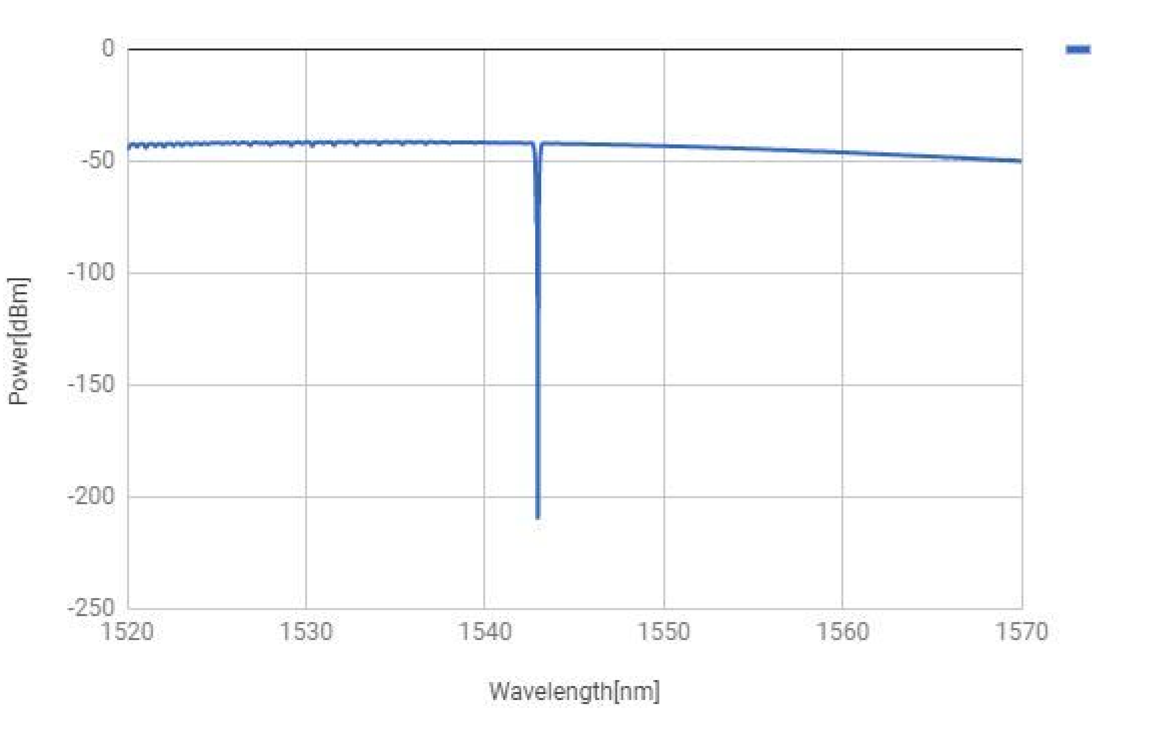


Figure 10: Transmission spectra of FBG

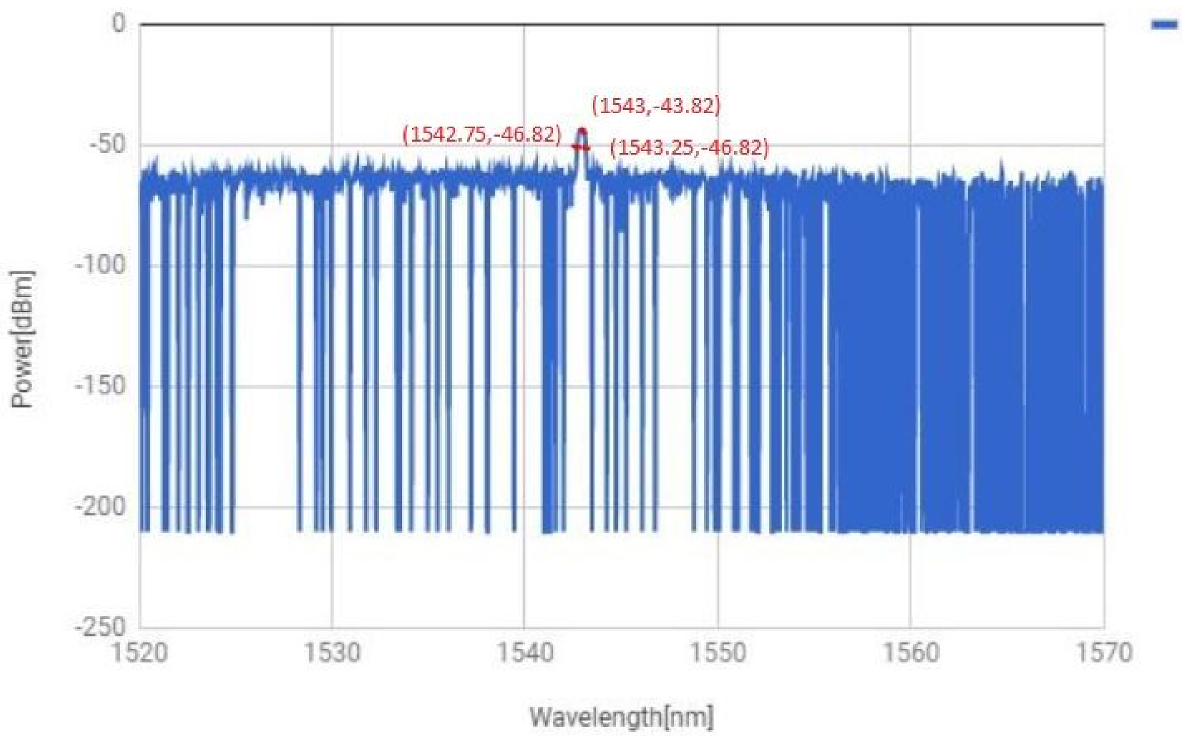


Figure 11: Reflection spectra of FBG

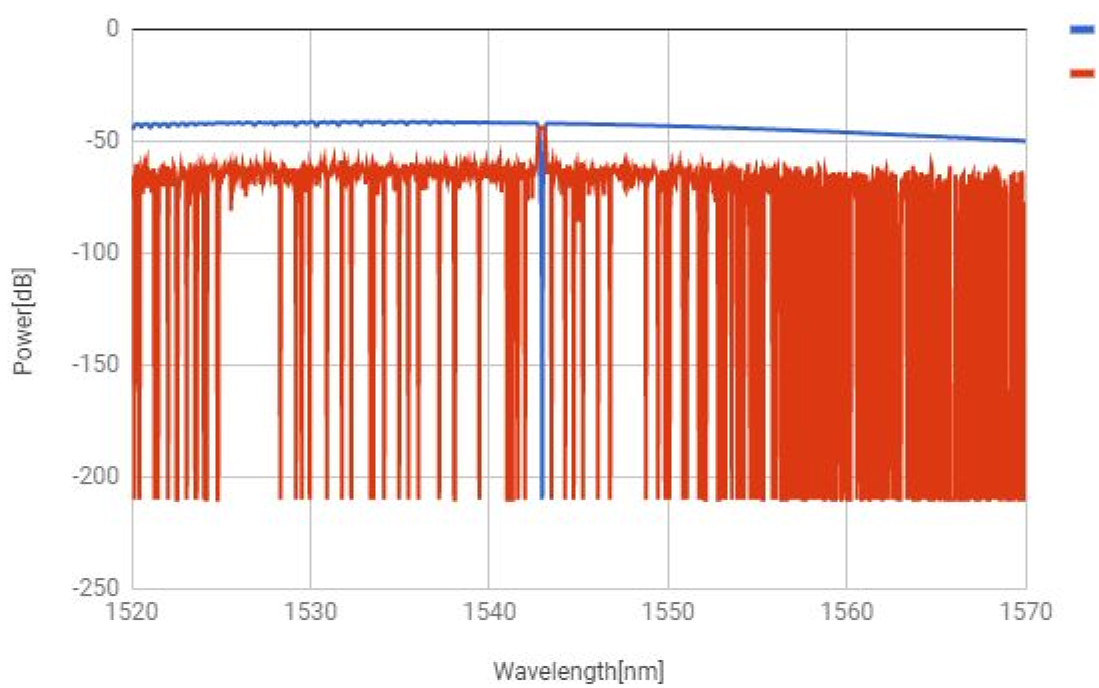


Figure 12 : Combined graph of transmission and reflection spectra of FBG