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Crosstalk Reduction using Cascade Connections of Multiplexer/Demultiplexer with different Channels (8&16) Spacing Based Array Waveguide Grating in Dense Wavelength Division Multiplexing

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Abstract

This paper introduced a cascaded connection of AWGs filters in multiplexer/demultiplexer with different channels spacing designs by using the WDM_ Phasar simulation which enhance the total channel accumulated crosstalk that allows for reasonable and high quality communication in DWDM systems. Obtaining a good performance of AWGs filters for cascading configurations that used different channels spacing of 8channels and 16channels design (100GHZ, 50GHZ, and 25GHZ). The most significant results of all input information are computed first. Running the simulation resulted in the graphical displays of the output power, and in tabulated summaries of the corresponding device performance.

Keywords: ***A****ccumulated crosstalk, dens wavelength division multiplexer, WDM_ Phasar, array waveguide grating, multiplexer / demultiplexer****.***

1. Introduction

Dense Wavelength Division Multiplexing (DWDM) system increases the available transmission capacity of an optical fiber through simultaneous transmission on several slightly different wavelengths each carrying a separate channel of information on the same optical fiber. The most popular optical structure used for multiplexing and demultiplexing is called the Array Waveguide Grating (AWG). A grating is an element used for combining and separating individual wavelengths in WDM systems. Grating is a periodic structure or variation in the material that has the property of reflecting or transmitting light in a certain direction depending on the wavelength [1]. However the number of channels a DWDM system handles is affected by the level of channel crosstalk in such a manner that the lower the level of the crosstalk the higher will the number be of provided system channels. AWGs method is better suited for a higher number of channels as all channels suffer a more or less equal and comparatively low loss [2]. Arrayed waveguide grating (AWG) multiplexer/demultiplexer is a very attractive planar device in wavelength division multiplexing (WDM) networks. It is capable of increasing transmission capacity of single optical fiber [3]. An AWG mux/demux device has lower loss, flatter passband, and easier to realize on an integrated optic substrate. An AWG has a reciprocal property that is: it can operate bi-directionally for either side input or output or both could take place at the same time. Array waveguide grating (AWG) is a passive wavelength-selective device, which provides basic multiplexing and demultiplexing WDM function [4]. Arrayed waveguide grating (AWG) is an optical filter that is constructed to make a large-scale wavelength multiplexer/demultiplexer [5].

A phasar arrays (PHASAR) WDM simulation package is used to speed up the design process, and reduce the fabrication runs and device costs. WDM-phasar is powerful advanced software for design and modeling Phased Array Grating devices. It provides a number of calculation tools to estimate the device performance before running advanced simulations and fabrication. It also automates index simulations, estimates quickly the bend loss and crosstalk level, and performs an advanced simulation of the whole device using the beam propagation method (BPM).

Additionally WDM_ phasar monitors easily and effectively crosstalk level, bend losses, phasar order, dispersion, free spectral range, channel nonuniformity, channel spacing,

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output channel bandwidth, and diffraction loss. But it also performs other huge variety of important tasks like effective index calculation, design of a WDM device using the Wizard tool, editing of the WDM device geometry, fast evaluation of the WDM device performance, performing a parameter scan, and run advanced calculations [6].

2. Running Advanced Simulations

The device which is designed has eight input ports and the same number of output ports. This step is used to analyze the device working in a demultiplexing regime, by changing the number of input ports to 1.
At the end of this step, a device with one input port and eight output ports is obtained as shown at figure (1).

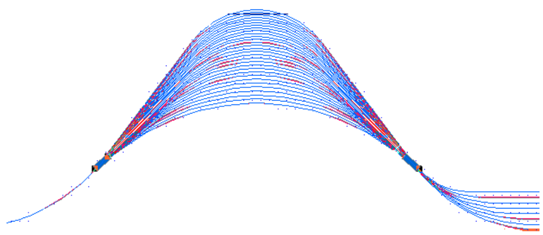


Figure 1: AWG device with one input port and eight output ports

At the end of an eight channels simulation, the output power vs the Scan Parameter is displayed graphically, figure (2) show that.

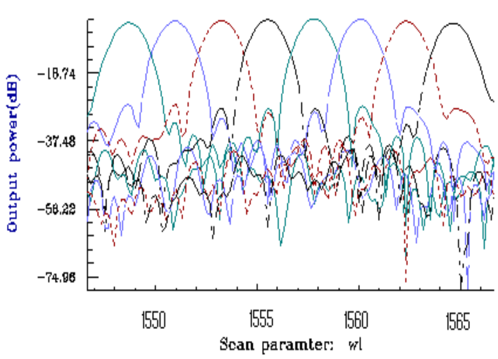


Figure 2: The Scan Parameter vs output power

The simulator also provides a list in table (1) form for the device performance and statistics as shown below where individual channel amplitude, width and crosstalk are displayed [7].

Table 1: Device performance

channel	*Amplitude In(dBs)*	*Channel spacing in(nm)*	Crosstalk in (dBs)
1	-4.973324	0.000700	-29.216834
2	-4.417054	0.000700	-28.921708
3	-3.956224	0.000650	-29.114058
4	-3.731089	0.000700	-29.391477
5	-3.946152	0.000700	-29.673149
6	-4.162486	0.000650	-29.538424
7	-4.366012	0.000700	-28.502909
8	-4.874898	-	-28.024551

3. WDM_Phasar Simulator-based AWG Units Design

Now that WDM_ Phasar simulator is used for designing an 8-channels unit and designing 16-channels unit as DWDM multiplexers/Demultiplexers with different channel spacing. The simulation is run for each unit to obtain the crosstalk of each channel. Then the simulation is run in cascading manner by activating the cascading tool for each unit, and after taking about twenty four hours the simulator provides the resulting crosstalk [8].

4. Design of eight channels with different spacing

The same design procedure and simulation is now repeated for 8 channels. The most significant results of all input information are computed first, and shown in table (2).

Table 2: Calculation results of input information for 8ch with different spacing

Central frequency (nm)	*Crosstalk level (dBs)*	*Channel spacing (nm)*	Output channel bandwidth (GHZ)
1550	-35.334416	1.6106315	271.66771
1550	-35.334416	0.40018507	67.499832
1550	-35.334416	0.20106688	33.91426

Running the simulation for eight channels with different channel spacing (100GHZ, 50GHZ, 25GHZ) resulted in the graphical displays of the output power, and in tabulated summaries of the corresponding device performance as shown in the figures (3, 4, 5) and tables

(3, 4, 5) below.

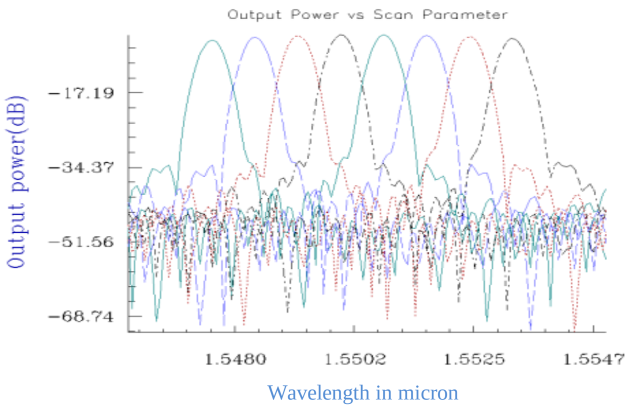


Figure 3: Output power vs wavelength in micron (scan parameter), of eight channels with 100GHZ spacing

Table 3: Eight channels with 100GHZ device performance summary.
Bandwidth level (dB) = -30.000000

Channel	***Channel spacing(nm)***	***Peak In(dBs)***	Crosstalk In(dBs)
1	0.125	-34.430225	-4.79365
2	0.001625	-4.681250	-33.691062
3	0.001625	-3.948772	-33.703823
4	0.001625	-3.662371	-33.048559
5	0.000000	-3.792596	-33.112339
6	0.001458	-4331944	-33.448572
7	0.000917	-5.326724	-34.671018
8		-23.830746	-13.86646

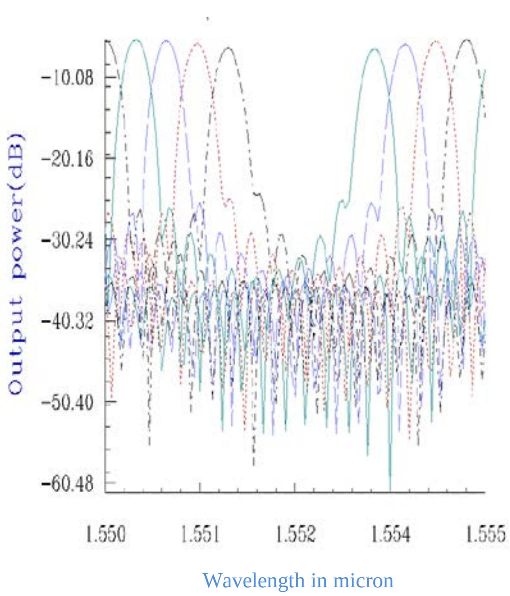
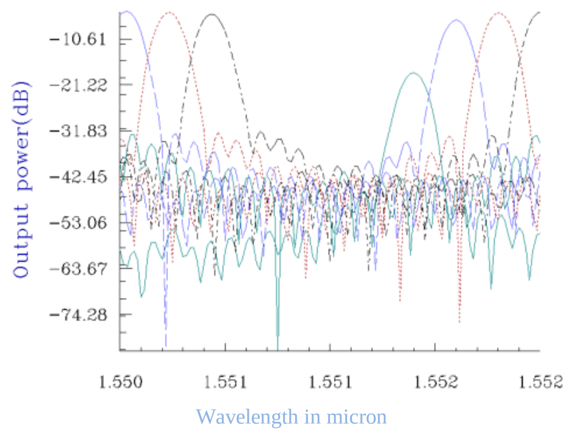


Figure 4: Output power vs wavelength (scan parameter) of eight channels with 50 GHZ spacing

Table 4: Eight channels with 50GHZ, device performance Summary

Channel	***Channel spacing (nm)***	***Peak In(dBs)***	Crosstalk In (dBs)
1	0.000417	-6.423919	-5.215691
2	0.000417	-5.870877	-6.389682
3	0.000375	-5.571413	-7.687522
4	0.004333	-5.399366	-7.433287
5	0.000417	-5.376695	-8.718746
6	0.000375	-5.601921	-7.137873
7	0.000417	-5.990570	-8.281994
8	-	-6.591463	-6.270646



Figures 5: Output power vs wavelength (scan parameter) of eight channels with 25GHZ spacing

Table 5: Summary of the device performance of eight channels with 25GHZ.Bandwidth level [dB] = -30.000000

Channel	***Channel spacing(nm)***	***Peak In (dBs)***	Crosstalk In (dBs)
1	0.000200	-5.012519	-39.057086
2	0.000200	-4.539263	-39.213751
3	0.000017	-4.282133	-35.423109
4	0.001950	-32.736311	-4.665291
5	0.000200	-4.268769	-34.798220
6	0.000200	-4.614697	-36.107457
7	0.000200	-6.284236	-38.399622
8	-	-18.535410	-42.118539

5. Design of 16 channel with different channel spacing

The same design procedure and simulation is now repeated for 16 channels. The most significant results of all input information are computed first, and shown in table (6).

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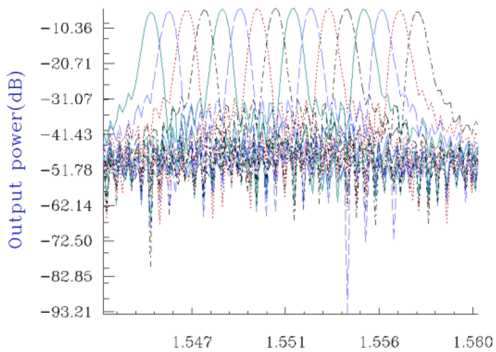
Table 6: Calculation results of 16ch with different spacing

Central frequency (nm)	***Crosstalk level (dB)***	Channel spacing (nm)
1543		0.79745526
1550	-35.334416	0.39852881
1550	-35.334416	0.20034874
1550	-35.334416	1.6021165

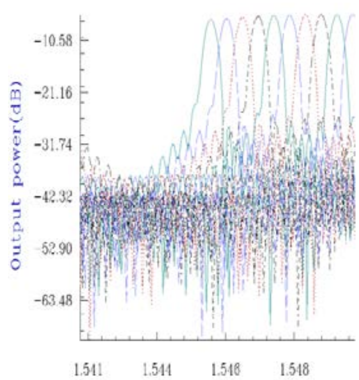
Running the simulation for the16 channels with different channel spacing (100GHZ, 50GHZ, 25GHZ) gave the graphical displays of the output power, and summaries of the corresponding device performance, shown in the figures (7, 8, 9) and tables (7, 8, 9,) below.



Wavelengt h in micron

Figure 7: Output power vs wavelength (scan parameter) of 16 channels with 100GHZ spacing

Table 7: Summary of the device performance of selected of the 16 channels design with 100GHZ.



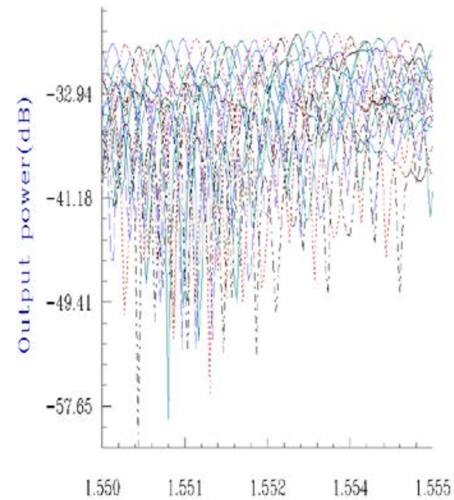
Wavelength in micron

Figure 8: Output power vs wavelength (scan parameter) of 16 channels with 50GHZ spacing

Channel	***Channel spacing (nm)***	***Peak In (dBs)***	Crosstalk In (dBs)
2	0.000850	-.183330	-0.288214
3	0.000850	-.973208	-9.589746
7	0.000708	-.663852	-2.241647
14	0.000850	-.347257	-0.881022
15	0.000850	-.414250	-2.365502
16		-.706495	-2.529537

Table 8: Summary of the device performance of selected of the 16 channels design with 50GHZ.

Channel	***Channel spacing in (nm)***	***Peak In (dBs)***	Crosstalk In (dBs)
2	0.417	-6.214623	-24.290659
4	0.417	-5.676817	-25.000050
11	0.417	-5.352705	-26.513337
12	0.417	-5.520055	-25.598293
13	0.333	-5.748207	-25.044807
15	0.417	-6.112078	-24.562771



Wavelength in micron

Figure 9: Output power vs wavelength (scan parameter) of 16 channels with 25GHZ spacing.

Table 9: Summary of the device performance of selected of the 16 channels design with 25GHZ.

Channel	***Channel spacing (nm)***	***Peak In (dBs)***	Crosstalk In (dBs)
8	0.208	-8.686253	-2.857551
9	0.208	-8.355847	-1.816779
10	0.208	-8.161337	-1.128289
13	0.208	-8.226542	-0.196989
14	0.208	-28.44930	-0.327088
15	0.208	-9.093623	-0.489447

6. Conclusions

AWG cascade connection that used in optical DWDM multiplexes/demultiplexers systems is a possible solution to the problem of crosstalk accumulated in large-scale arrayed-wave-guide grating. Simulation design of 8channels unit and 16channels unit with different channel spacing was done, resulting in a reasonable reduction of accumulated crosstalk that applicable for hall-communications.

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