AWG-WDM application in Radar

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ABSTRACT *– In this paper a AWG-WDM has been introduced and a typical AWG-WDM has been simulated. 4 structures including in, out, full, flat has been simulated for 8*1 channels AWG-WDM. Two parameters including attenuation and length are important in Radar systems. The advantages of optical fiber have been addressed. The effect of A angle on zLi, zAai and zRi and consequently array length has been determined. The minimum value of A has been calculated. All of the models have been simulated in Rsoft software.*

Key words: array length, A angle, AWG-WDM, Radar

INTRODUCTION

New technologies in radar use from Active phased array antennas by low power transmitter/receiver. First of all Smith proposed the phased array antennas in 1988 [1]. In Conventional radar networks the coaxial cable is used which leads to more complex, massive and in-flexibility in system [1,2]. Optical link has good advantages: Reduction size (to their physical compactness), weight and loss, low attenuation, immunity to electro-magnetic interference (EMI), and high bandwidth capacity [3].

Menna et.al has been done an experiment to show the feasibility of using optical WDM link for distribution of different types of RF and digital signals. This condition leads to lighter system. In this experiment the CW, pulsed CW, waveforms have been used for experimental measurements. Delay and attenuation are deterministic parameters which can be compensated based on the application requirements. A finite attenuation has been observed due to various component losses incurred in the link. For a particular network losses can be compensated by using the amplifiers in the electrical or optical domain because the link loss is fixed. Also the experiment has been done for various fiber spools which lead to a delay proportional to the length of the fiber spool. [4]

So the length is an important parameter to reduce the loss and mass. In this paper the effect of A angle on the pass length has been described and evaluated.

Wavelength Division Multiplexing (WDM)

Wavelength Division Multiplexing (WDM) is the basic technology of optical networking. It is a technique for using a fiber to carry many separate and independent optical channels. WDM is the basic technology for full optical networking. The width of channel depends on many things such as the modulated line width of transmitter, its stability and the tolerance of the other components in the system. WDM function has the following stages: 1) transmitters (always are lasers those have line width and spectral width). 2) Combining the signals (channels) that do with Y-junctions and Grating and planar waveguide grating. Grating and planar waveguide grating are better because they have much lower loss and they don't depend on the number of channels. 3) Transmission and amplification (EFDA), 4) Separating the channels at the receiver with the following techniques: Reflective grating, waveguide grating routers, circulators with in-fiber Bragg gratings, splitters with individual Fabry-Perot filters. 4) Receiving the signals.[5]

Arrayed Waveguide Gratings (AWGs) are commonly used as optical multiplexers and de-multiplexers in WDM systems because they have low loss. [6]

These devices are capable of multiplexing a large number of wavelengths into a single optical fiber, thereby increasing the transmission capacity of optical networks considerably. They are used to multiplex channels of several wavelengths on to a single optical fiber at the transmission end and are also used to de-multiplex and retrieve individual channels of different wavelengths at the receiving end of an optical communication network. [7]

AWG-DWM works based on the phase difference in the arrayed waveguides and have an important role in high speed propagation applications [8]. In Metro-networks with many channels this device is more useful, because AWG-DWM is independent of number of channels. The other advantages of this device is capability of making a full optic device, flexibility of selecting channel number, flexibility of channel spacing [9] Further, WDM systems allow for more flexible network architectures, which can make use of wavelength routers and/or add-drop multiplexers (ADM) [6]

The Rsoft (Beam Propagation Method) software has been used to simulate the models in this paper. The other Imaging method [10] , Fourier Optic method and BPM[11] are the methods to evaluate the operation of AWG-DWM. The waveguides in figure 1 designes base on defrential length (ΔL) between two neighbour waveguide. ΔL should be an intijer multiple of central wavelenght of waveguide.

$$\Delta L = \frac{m\lambda_c}{n_a}$$

that m is an intijer , λ_c is the central wavelenght in free space and n_a is the cofficient in the waveguide[12]. The position of input and output of arrays is on Rowland Circles. This device is a device for focusing and dispersive planar component based on optical phased array and has a good optical charectristic in losses and bandwidth. [13]

One of the important part of full structure in AWG-WDM is " A " angle. This parameter has a linear relationship with the length of optic and losses of matterial i.e by the decreasing this angle, the length of the optic from input to output and the losses are decresed.

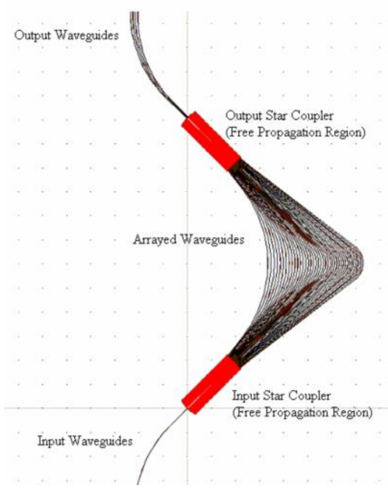

Figure1- the AWG-DWM structure

DISCUSSION

In this part an AWG-WDM has been simulated in Rsoft software. This software make 4 file for AWG-WDM: in, out,flat and full but full structure is used in this paper to consider the length of pass.The total pass length based on the figures 2 and 3 is(Defult value in Rsoft for Lo and Li is equal to 1000 and also Lin= Lout =100 μm):

As it can be seen the second part of pass length depend on A and change by it, but the first part is constant.

Total pass lengh =
*Lin+Li+Lstar+Lo+2(zLi+(zAai*zRi))+Lo+Lstar+Li*
*+Lout = 2(Lin+2Li+Lstar)+2(zLi+(zAai*zRi)* 2

(Lstar=2680 μm)

In this paper Number of waveguide channels (Nchan) is 8, Index of the free space region (Nslab) is 1.4532, Number of waveguides in array (M) 39, Redius of inner rouland circle and Redius of outer rouland circle (Ri=Ro) is 2777.29μm.

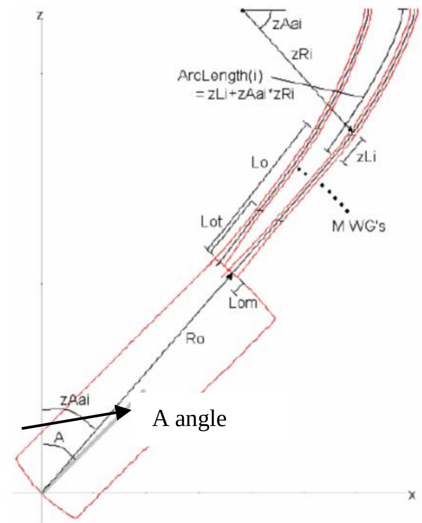

Figure 2- array design for Full layout

Figure 4 shows the initial simulated model with A=75 as a default. Rsoft software create 4 files including in, out, flat and full for AWG-WDM.

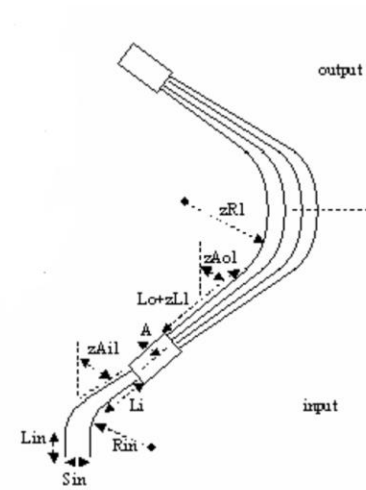

Figure 3- the full structure

To reduce the pass length and losses the A parameter has been reduced. zLi, zAai and zRi in equation 3 depend on A and vary with it. The values of these three papameter has been calculated by Rsoft software and used to calculate the pass length.

RESULTS OF SIMULATIONS

This effect of changing in A has been calculated for middle (i=20) waveguile. The results has been shown in Table 1.

Table1- the computed values for various "A"

A degree	zL20(μm)	zR20 (μm)	L(mm)
75	392.85	5154.33	455.580
70	639.80	4963.21	439.560
65	953.72	4683.68	416.040
60	1358.88	4270.42	381.160
55	1891.39	3649.35	328.580
50	2606.77	2694.52	247.480
45	3593.73	1181.72	118.824
43.19	4044.07	424.29	54.298

How mach can reduce the A? by the test it has been seen that the permissive is A= 43.19 and after that the reduction in A leads to inserference and the normal form of waveguides will be deformed. It can be seen in figure 4. The A has been reduced to 42 but it can be seen that the interference has been taken happen. With the trial and error method we receive to the minimum value of A= 43.19. More reduction of A leads to figure 5 and 6.

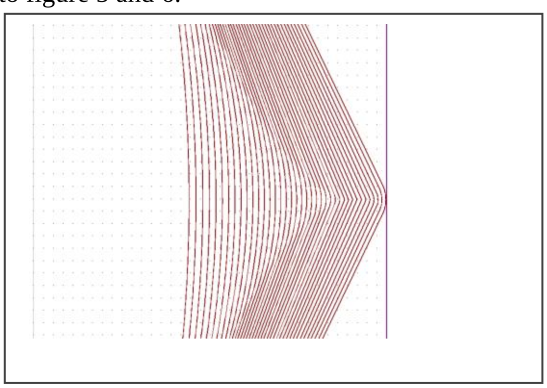

Figure 4- "A= 43.19"

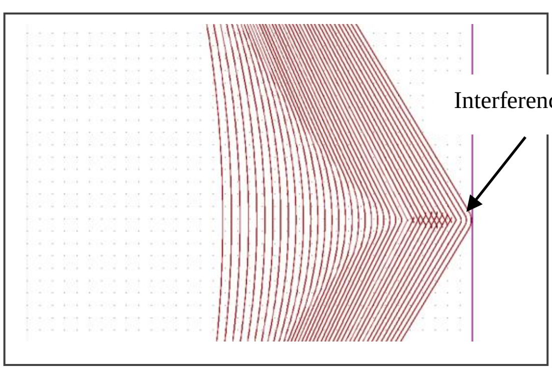

Figure 5- "A= 43"

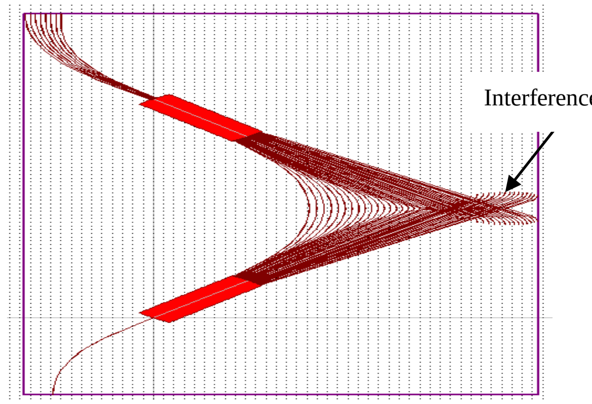

Figure 6- "A= 42"

CONCLUSION

The results show that in a special A angle the length of array would be minimum. In this paper minimum A is 43.19 and the limitation in this reduction is the interference because of adjacent arrays. By reduction in length the loss reduces too. Figure 7 shows the L(mm) values versus A angle. As it can be seen by decreasing of A the length is decreasing too.

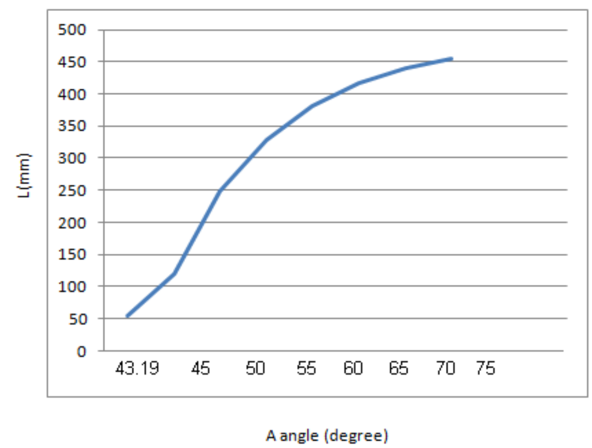

Fig7..L (mm) values versus A angle.

So if the optical links have been used in systems like Radar, they can use from these advantages: lower weight and loss, low attenuation, immunity to electro-magnetic interference (EMI), and high bandwidth capacity. These characteristics are very good for all electronic and electromagnetic systems like Radar.

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