Theoretical Model of Spectral Response Efficiency of Arrayed Waveguide Grating Multi/demultiplexer*

Guo Fuyuan[1,2], Wang Minghua[1]

1 *Department of Information Science & Electronic Engineering, Zhejiang University, Hangzhou* 310027

2 *Fujian Provincal Key Laboratory of Photonic Technology, Institute of Laser & Optoelectronics Technology, Fujian Normal University, Fuzhou* 350007

Abstract Based on the eigen mode field distribution of single mode waveguide, the Rayleigh-Sommerfeld diffraction integral formula and the reciprocal theorem of antenna theory, the coupling characteristic between two non-contact single mode planar waveguides in the coupler are presented. As the optical field superposition theorem of multiple beam interference with equal optical path difference and unequal amplitudes is engaged, the original analytic function expression of spectral response efficiency of arrayed waveguide grating multi/demultiplexer is deduced. This expression affords the theoretical basis for analyzing the characteristics of arrayed waveguide grating multi/demultiplexer accurately and quickly. An example of computing the spectral responsivity and crosstalk of arrayed waveguide grating multi/demultiplexer is presented.

Keywords Guided optics; Arrayed waveguide grating; Interference; Spectral response efficiency; Crosstalk; Diffraction; Coupling

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0 Introduction

Since the idea of optical phased array was put forward by M. K. Smit[1], arrayed waveguide grating (AWG) multi/demultiplexer has turned into focus in the domain of wavelength division multiplexing[2~14]. The Gaussian approximation for the optical waveguide eigen mode field distribution and their diffraction field distribution[2~7], simplification or scalarization for coupling characteristic between the focal field of AWG and output waveguide[6~9], taper frame for the ends of arrayed waveguides[9~11], multimode interference (MMI) coupler or mode converter in the input region[12~14], the beam propagation method (BPM), complex numerical computation and simulation are adopted for designing AWG multi/demultiplexer at whiles. The propagation directions of the vector waves which take part in multiple beam interference in the focal field of AWG are neglected for analyzing the characteristics of AWG multi/demultiplexer in some cases.

As the basic structure of AWG multi/demultiplexer is composed of two star couplers, the coupling characteristic between two non-contact waveguides in star coupler is the theoretical basis of an AWG multi/demultiplexer. The classical theory of star coupler which based on the Fourier transform in finite region $(-1,1)$ and the Fresnel diffraction integral was presented by C. Dragone[15,16] and L. Qiu[17]. In this paper, the eigen mode field distribution of single mode waveguide is taken into account, the reciprocal theorem[17] between emissive and receiving waveguides is engaged, a perfect expression of the coupling characteristic between two non-contact single mode planar waveguides is presented.

As a result of propagation directions of the vector waves in AWG focal field is attached importance to, the receiving power of output waveguide which correlated with the direction of incident wave is considered, the brief and efficient expression of spectral response efficiency of AWG multi/demultiplexer which derived from the summation of the transfer function is given, this affords an valid and direct method for probing into the spectral responsivity and crosstalk of AWG multi/demultiplexer quickly.

1 Coupling characteristics between two non-contact waveguides

The basic structure of AWG multi/demultiplexer consists of a pair of slab waveguides, M pair of input and output rectangular waveguides, and N arrayed rectangular waveguides, all of them are restricted by the same pair of waveguide cladding layers, the geometrical relationship between two rectangular waveguides, such as waveguide$_1$ and waveguide$_2$ shown in Fig.

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Tel: 0571-87951706 Email: guofy@zju.edu.cn

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1, the coupling characteristic between this non-contact waveguides is deduced in the plane coordinate system in the following text.

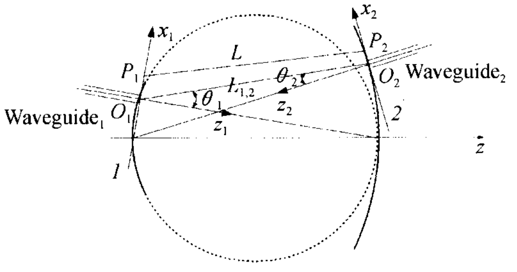

Fig. 1 Geometrical relationship between two non-contact waveguides

According to the Rayleigh-Sommerfeld diffraction theory[18], the diffraction field distribution $\Psi(P_2)$ is given by

$$\Psi(P_2)=\frac{1}{2\pi}\iint_{\Sigma}\Psi(P_1)\left(\frac{1}{L}-\mathrm{i}k\right)\cdot \cos(N,L)\frac{\exp(\mathrm{i}kL)}{L}\mathrm{d}s \qquad (1)$$

where $\Psi(P_1)$ is the field distribution of diffraction source, Σ is the area of diffraction source, L is the propagation distance between P_1 and P_2, $k=2\pi/\lambda$ is the wave number of wavelength λ, $\cos(N,L)$ is the inclination factor, N and L are the directions of z_1-axis and P_1P_2 respectively.

As the core layer dimension of single mode waveguide is micron order, and the field distribution of waveguide cladding layer is exponential decrease form, the effective range of Σ is small scale. If $L\gg\lambda$, then $x_1\ll L$ and $x_2\ll L$. Engaged the principle of coordinate transformation and used the Rayleigh criterion of no defect wave surface for reference, if the condition, $2x_1^2\ll L\lambda$, is satisfied, the error of approximate expression of L is non exceeding $\lambda/4$, then, the approximate expression of the distance L is, $L=L_{1,2}-x_1\sin\theta_1$. If the far field diffraction effect of the waveguide$_1$ is analyzed in paraxial approximation, $\cos(N,L)\approx 1$, From Eq. (1), the diffraction field distribution $\Psi(P_2)$ is expressed by[19]

$$\Psi(P_2)=\frac{\exp(\mathrm{i}kL_{1,2})}{\sqrt{\mathrm{i}\lambda L_{1,2}}}\int_{-\infty}^{\infty}\Psi_1(x_1)\cdot \exp(-\mathrm{i}kx_1\sin\theta_1)\mathrm{d}x_1 \qquad (2)$$

where $\Psi_1(x_1)$ is the eigen mode field distribution of single mode waveguide$_1$, $L_{1,2}$ is the distance between O_1 and O_2, θ_1 is the inclination angle between O_1O_2 and z_1-axis, x_1 and x_2 are the coordinate of point P_1 and P_2 in the plane coordinate systems $x_1O_1z_1$ and $x_2O_2z_2$ respectively.

If the mode field distribution $\Psi_1(x_1)$ is expressed by the normalized amplitude form, the reference[15] to[17] are used for reference, the emissive factor of waveguide$_1$ is defined by

$$T_e=\frac{\int_{-\infty}^{\infty}\Psi_1(x_1)\exp(-\mathrm{i}kx_1\sin\theta_1)\mathrm{d}x_1}{\int_{-\infty}^{\infty}\Psi_1^2(x_1)\mathrm{d}x_1} \qquad (3)$$

According to the reciprocal theorem of antenna theory[17], the expressions of the receiving factor of single mode waveguide$_2$ and the emissive factor and of waveguide$_1$ are in the same form, i. e. the receiving factor of waveguide$_2$ is defined by

$$T_r=\frac{\int_{-\infty}^{\infty}\Psi_2(x_2)\exp(-\mathrm{i}kx_2\sin\theta_2)\mathrm{d}x_2}{\int_{-\infty}^{\infty}\Psi_2^2(x_2)\mathrm{d}x_2} \qquad (4)$$

where $\Psi_2(x_2)$ is the eigen mode field distribution of simple mode waveguide$_2$ which expressed by the normalized amplitude form, θ_2 is the inclination angle between O_1O_2 and z_2-axis.

For the sake of simplified the computation expressions in this paper, the transmission losses of the waveguides are without consideration. From Eq. (2) to Eq. (4), the transfer function $T(1,2)$ between two non-contact waveguides is expressed by

$$T(1,2)=\frac{\exp(\mathrm{i}kL_{1,2})}{\sqrt{\mathrm{i}\lambda L_{1,2}}}\int_{-\infty}^{\infty}\Psi_1(x_1)\exp(-\mathrm{i}kx_1\cdot \sin\theta_1)\mathrm{d}x_1\,\frac{\int_{-\infty}^{\infty}\Psi_2(x_2)\exp(-\mathrm{i}kx_2\sin\theta_2)\mathrm{d}x_2}{\int_{-\infty}^{\infty}\Psi_2^2(x_2)\mathrm{d}x_2} \qquad (5)$$

The modulus of complex number $T(1,2)$ is the amplitude transfer coefficient between two non-contact waveguides, which is defined by the maximum amplitude ratio of receiving waveguide$_2$ to emissive waveguide$_1$. The argument of complex number $T(1,2)$ is phase delay, it is $kL_{1,2}-\pi/4$.

According to Marcatili theory[20], the orthogonal representation is engaged for expressing the eigen field distribution of step index rectangular waveguide, the normalized field distributions of rectangular waveguide of E_{00}^x mode and E_{00}^y mode are similar to the normalized field distributions of planar waveguide of TE_0 mode and TM_0 mode in the orthogonal directions.

For the weakly guiding optical waveguide, the difference of refractive indexes between the core and cladding layers of step index waveguide is small, the difference of eigen mode field distributions between TE_0 mode and TM_0 mode is quite small, the difference of diffraction field distributions between TE_0 mode and TM_0 mode is quite small too, so that, only TE_0 mode is studied in this paper.

As the eigen mode field distributions of the core and cladding layer of step index TE_0 mode planar waveguide are expressed by the normalized amplitude form[19,21]

$$\Psi(x)=\cos(U\rho) \qquad (|\rho|\leqslant 1)(6)$$

$$\Psi(x)=\cos(U)\exp[-W(|\rho|-1)] \quad (|\rho|>1) \tag{7}$$

where $\rho=x/a$ is the normalized dimension, a is half width of waveguide core layer, U and W are the normalized standing wave parameter and evanescent wave parameter, $W=U\tan U$.

From Eq. (5) to Eq. (7), the transfer function $T(1,2)$ become

$$T(1,2)=\frac{a_1 W_2 V_1^2 V_2^2}{\sqrt{\lambda L_{1,2}}(1+W_2)(F_1^2+W_1^2)(F_2^2+W_2^2)}\cdot \left[\frac{\sin(F_1-U_1)}{F_1-U_1}+\frac{\sin(F_1+U_1)}{F_1+U_1}\right]\cdot \left[\frac{\sin(F_2-U_2)}{F_2-U_2}+\frac{\sin(F_2+U_2)}{F_2+U_2}\right]\cdot \exp\left[i(kL_{1,2}-\frac{\pi}{4})\right] \tag{8}$$

where $F_g = ka_g\sin\theta_g$ is normalized spatial frequency[19] of the diffraction field of label g waveguide, $V_g = U_g/\cos U_g$ is normalized frequency of label g waveguide, the subscripts $g=1$ and $g=2$ label the parameters of waveguide$_1$ and waveguide$_2$ in Fig. 1.

2 Spectral response efficiency of AWG multi/demultiplexer

Fig. 2 shows the half of AWG multi/demultiplexer, input coupler for example.

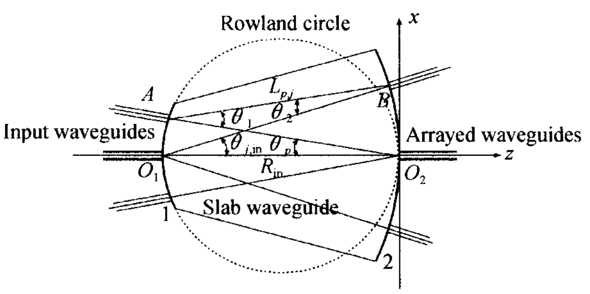

Fig. 2 Schematic diagram of input coupler of an AWG multi/demultiplexer

In the Fig. 2, the ends of arrayed waveguides locate at the circular arc 2 of radius R_{in}, their end face normal directions point to the center input waveguide end face O_1, the ends of input waveguides locate at the Rowland circle 1 of diameter R_{in}, their end face normal directions point to the center arrayed waveguide end face O_2.

$L_{p,j}$ is the distance between A and B, used the Rayleigh criterion of no defect wave surface for reference, if the condition, $(jh_{in})^4\sin\theta_p\tan\theta_p \ll 2R_{in}^3\lambda$, is satisfied, the error of expression of $L_{p,j}$ is non exceeding $\lambda/4$, then, the distance $L_{p,j}$ is given[19]

$$L_{p,j}=R_{in}\cos\theta_p - jh_{in}\sin\theta_p \tag{9}$$

where θ_p is the inclination angle between AO_2 and z-axis, j and p are the labels of arrayed waveguide and input waveguide respectively, h_{in} is grating constant, i. e. the space length between adjacent arrayed waveguides end face centers projected to x axis.

The expressions of transfer function $T(p,j)$ between label p input waveguide and label j arrayed waveguide is the same as Eq. (5), where $L_{p,j}$ substitutes for $L_{1,2}$.

Output coupler is similar to input coupler, the schematic diagram of output coupler is a left and right inversion of Fig. 2, where output waveguide substitutes for input waveguide, label 3 and label 4 substitute for label 2 and label 1, subscripts out and q substitute for subscripts in and p respectively. The expression of distance $L_{q,j}$ is the same as $L_{p,j}$, it is

$$L_{j,q}=R_{out}\cos\theta_q - jh_{out}\sin\theta_q \tag{10}$$

The expression of transfer function $T(j,q)$ between label j arrayed waveguide and label q output waveguide is the same as $T(p,j)$, where subscripts' substitute rule is as what mentioned above.

In an AWG multi/demultiplexer, the lengths of arrayed waveguides are arithmetic series, $L_j = L_0 - j\Delta L$, where L_0 is the length of label 0 arrayed waveguide, and ΔL is the length difference of adjacent arrayed waveguides. If the bent losses of arrayed waveguides are constant, these losses are ignored for the sake of simplified the expressions, assumed the transmission efficiency of arrayed waveguides is unit, $\eta(j)=1$, the transfer function between input and output end face of the label j arrayed waveguide is

$$T(j)=\left[\frac{\int_{-\infty}^{\infty}\Psi_2^2(x_2)\,dx_2}{\int_{-\infty}^{\infty}\Psi_3^2(x_3)\,dx_3}\right]^{1/2}\exp[ik(L_0-j\Delta L)] \tag{11}$$

So the transfer function $T(p,j,q)$ between label p input waveguide and label q output waveguide, which wave transmit through a given label j arrayed waveguide, is given by

$$T(p,j,q)=T(p,j)T(j)T(j,q) \tag{12}$$

As the optical field characteristic of output waveguide of AWG multi/demultiplexer is complies with multiple beam interference effect. The total optical field of output waveguide is the summation of the optical field what caused by any one of the arrayed waveguides, the transfer function $T(p,q,\varphi)$ between label p input waveguide and label q output waveguide are the summation of $T(p,j,q)$ for all of N arrayed waveguides, so the spectral response efficiency of AWG multi/demultiplexer $\eta(p,q,\varphi)$, which is defined by the power ratio of label q output waveguide to label p input waveguide, is expressed by

$$\eta(p,q,\varphi)=\int_{-\infty}^{\infty}\Psi_2(x_2)\exp(-ik_s x_2\sin\theta_2)\,dx_2]^2\cdot \frac{[\int_{-\infty}^{\infty}\Psi_3(x_3)\exp(-ik_s x_3\sin\theta_3)\,dx_3]^2}{\lambda^2\int_{-\infty}^{\infty}\Psi_1^2(x_1)dx_1\int_{-\infty}^{\infty}\Psi_2^2(x_2)dx_2\int_{-\infty}^{\infty}\Psi_3^2(x_3)dx_3\int_{-\infty}^{\infty}\Psi_4^2(x_4)dx_4}\cdot$$

$$|\sum_{j=-A}^{A}\int_{-\infty}^{\infty}\Psi_1(x_1)\exp(-ik_s x_1\sin\theta_1)dx_1\cdot \frac{\int_{-\infty}^{\infty}\Psi_4(x_4)\exp(-ik_s x_4\sin\theta_4)dx_4}{\sqrt{L_{p,j}L_{j,q}}}\exp(-ij\varphi)|^2 \quad (13)$$

where | | is complex modulus operation, Σ is summation operation, A is maximal label of arrayed waveguide, arrayed waveguide number $N=2A+1$, $\lambda=C/(n_s f)$, $k_s=2\pi n_s f/C$, f and $C=299792$ km/s are the frequency and velocity of optical wave in vacuum, n_s and n_a are the effective indexes of slab waveguides and arrayed waveguides respectively, $\theta_1\approx\theta_{j,\mathrm{in}}=\arcsin(jh_{\mathrm{in}}/R_{\mathrm{in}})$, $\theta_2\approx\theta_p\approx\arcsin(pb_{\mathrm{in}}/R_{\mathrm{in}})$, $\theta_3\approx\theta_q\approx\arcsin(qb_{\mathrm{out}}/R_{\mathrm{out}})$, $\theta_4\approx\theta_{j,\mathrm{out}}=\arcsin(jh_{\mathrm{out}}/R_{\mathrm{out}})$, b_{in} or b_{out} are the space length between adjacent input or output waveguides end face centers. φ is the phase delay difference caused by the adjacent arrayed waveguides, it is

$$\varphi=\frac{2\pi(n_a\Delta L+n_s h_{\mathrm{in}}\sin\theta_p+n_s h_{\mathrm{out}}\sin\theta_q)f}{C}. \quad (14)$$

While $\varphi=2m\pi$, where m is the interference order, the amplitude of output waveguide is maximum, Eq. (13) is the spectral responsivity $\eta(p, q, f)$ of AWG multi/demultiplexer for the channel center frequency f, Eq. (14) become the grating equation of AWG multi/demultiplexer[8,9], and differential operating on the grating equation, the angular (or linear) dispersion equation[10], and the expression of free spectral range[2] (FSR) would be gotten.

If the input frequency deviated the grating equation, $f_0+\delta f$ for example, spectral response efficiency $\eta(p,q,f_0+\delta f)$ is computed by Eq. (13) for $\lambda=C/(n_{s0}f_0+n_{s,g}\delta f)$, $k_s=2\pi(n_{s0}f_0+n_{s,g}\delta f)/C$, n_{s0} and $n_{s,g}=n_{s0}+f_0(dn_s/df)$ are the effective index of slab waveguide for signal frequency f_0 and the group index of slab waveguide respectively, and the phase delay difference caused by adjacent arrayed waveguides become

$$\varphi=2m\pi+\frac{2\pi(\delta f+p\Delta f+q\Delta f)}{\mathrm{FSR}} \quad (15)$$

where Δf is frequency interval between adjacent channels of AWG multi/demultiplexer, $\mathrm{FSR}=C/(n_{a,g}\Delta L)$ is free spectral range of center input and output channel ($p=0$ and $q=0$) with center frequency f_0, $n_{a,g}=n_{a0}+f_0(dn_a/df)$ is the group index of arrayed waveguide, n_{a0} is the effective index of slab waveguide for signal frequency f_0.

The normalized spectral response efficiency of AWG multi/demultiplexer is

$$\eta_0(p,q,\delta f)=\frac{\eta(p,q,f_0+\delta f)}{\eta(p,q,f_0)} \quad (16)$$

Assumed the frequency bandwidth of input optical signal is ignored, Eq. (16) is effective expression of computing crosstalk between any channels. Let $\delta f=t\Delta f$, where t is the difference of signal channel labels, the crosstalk between adjacent channels is computed by Eq. (16) with $t=1$, the crosstalk caused by all channels is computed by the summation of Eq. (16) with all given non zero integer t.

From Eq. (13), if and only if input waveguide and output waveguide are same in the structures, $\Psi_4(x_4)=\Psi_1(x_1)$, the spectral responsibility $\eta(p, q, f)$ of AWG multi/demultiplexer attains the maximum. If $\Psi_4(x_4)\neq\Psi_1(x_1)$, the MMI coupler or mode converter[12~14] is employed in input waveguide region for example, its spectral responsibility is less than the corresponding value of the structure of $\Psi_4(x_4)=\Psi_1(x_1)$. So that, same input and output waveguide structures is adopted for effective designing of AWG multi/demultiplexer.

In general, symmetrical structure is chosen for designing AWG multi/demultiplexer, input coupler and output coupler are identical in the structures, i. e. $a_4=a_1$, $a_3=a_2$, $h_{\mathrm{out}}=h_{\mathrm{in}}=h$, $b_{\mathrm{out}}=b_{\mathrm{in}}=b$, $R_{\mathrm{out}}=R_{\mathrm{in}}=R$, $\Psi_4(x_4)=\Psi_1(x_1)$ and $\Psi_3(x_3)=\Psi_2(x_2)$. Then $\theta_1\approx\theta_4=\arcsin(jh/R)$, $\theta_2\approx\arcsin(pb/R)$, $\theta_3\approx\arcsin(qb/R)$, $F_1\approx F_4=jka_1h/R$, $F_2\approx pka_2b/R$ and $F_3\approx qka_3b/R$.

Engaged Eq. (6) and Eq. (7), the spectral response efficiency $\eta(p,q,f)$ become

$$\eta(p,q,\varphi)=\frac{a_1^2a_2^2W_1^2}{\lambda^2(1+W_1)^2(1+W_2)^2(F_2^2+W_2^2)^2}\cdot\frac{W_2^2V_1^8V_2^8}{(F_3^2+W_3^2)^2}\left[\frac{\sin(F_2-U_2)}{F_2-U_2}+\frac{\sin(F_2+U_2)}{F_2+U_2}\right]^2\cdot\left[\frac{\sin(F_3-U_3)}{F_3-U_3}+\frac{\sin(F_3+U_3)}{F_3+U_3}\right]^2|\sum_{j=-A}^{A}\frac{1}{(F_1^2+W_1^2)^2}\cdot\frac{1}{\sqrt{L_{p,j}L_{q,j}}}\left[\frac{\sin(F_1-U_1)}{F_1-U_1}+\frac{\sin(F_1+U_1)}{F_1+U_1}\right]^2\cdot\exp\left(-ij\,\frac{2\pi(\delta f+p\Delta f+q\Delta f)}{\mathrm{FSR}}\right)|^2 \quad (17)$$

As an AWG multi/demultiplexer is studied, avoiding the spectral lines overlap of different interference order m is considered firstly, the interference order should satisfied the condition, $m<f_0/(M\Delta f)-1/2$, where M is the signal channel number, and the computing expressions of other basic parameters are as follows, $\Delta L=mC/n_{s0}f_0$, $bh/R=n_{a,g}\Delta L\Delta f/(n_{s0}f_0)$.

As the field distribution of the taper frame of the ends of arrayed waveguides[9~11] is difficult to describe by a simple function, the taper frame is without consideration for the sake of simplified the expressions in this paper, let $a_4=a_3=a_2=a_1=a$.

3 An example of AWG multi/demultiplexer

As a example, the typical silica based SiO_2 and GeO_2 buried waveguides which would be fabricated by the photoetching technique is chosen, the basic parameters of an AWG multi/demultiplexer example are as follows, $n_1=1.4513$, $n_2=1.4440$, $a=2.5539\ \mu m$, $U=0.9149$, $W=1.1887$, $V=1.5$, $n_{s0}=1.4486$, $n_{s,g}=1.4701$, $n_{a0}=1.4459$, $n_{a,g}=1.4730$, $h=b=25\ \mu m$, $R=5526.85\ \mu m$, $\delta L=53.6871\ \mu m$, $f_0=193.1$ THz, $\Delta f=400$GHz, $m=50$, $M=9$, $N=45$, FSR=3790.9 GHz.

From Eq. (17), the spectral responsivity of an AWG multi/demultiplexer for center input and output waveguide ($p=0$ and $q=0$) and center channel frequency is $\eta(f_0)=-7.76$ dB, and as a explanation, this value is as a result of that only the couple losses between arrayed waveguides, input waveguide and output waveguide are considered. From Eq. (17), the spectral response efficiency characteristic for center input and output waveguides in a free spectral range is shown as solid line in Fig. 3. The full width at half maximum (FWHM) of spectral response efficiency,

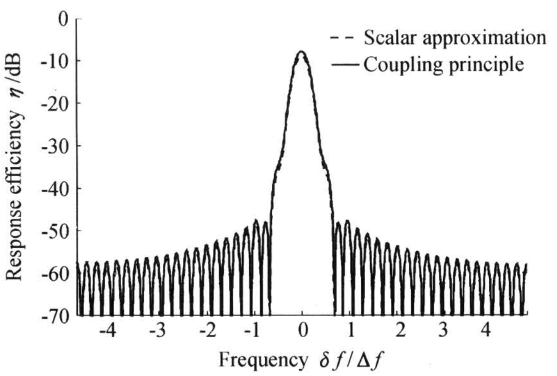

Fig. 3 Characteristic of the spectral response efficiency of center input and output channel

i. e. the full width at -3.01 dB maximal intensity, is 113.46 GHz, the crosstalk between adjacent signal channels is -41.55 dB, the crosstalk caused by other 8 signal channel is -36.81 dB.

If the propagation directions of the vector waves which take part in multiple beam interference in the focal field of AWG multi/demultiplexer are neglected, the focal field distribution of AWG multi/demultiplexer would be deduced. Based on this scalar approximation, and engaged coupling characteristic between the focal field of AWG multi/demultiplexer and output waveguide[6], the spectral response efficiency of AWG multi/demultiplexer would be presented. If the basic parameters of an AWG multi/demultiplexer are what mentioned above, the spectral responsivity of an AWG multi/demultiplexer for center input and output waveguide and center channel frequency is $\eta(f_0)=-8.79$ dB, the spectral response efficiency characteristic for center input and output waveguides in a free spectral range is shown as dotted line in Fig. 3, The FWHM of spectral response efficiency is 113.50 GHz, the crosstalk between adjacent signal channels is -41.58 dB, the crosstalk caused by other 8 signal channel is -36.88 dB.

The weakly difference is presented in the spectral response characteristics of an AWG multi/demultiplexer between above two computing method except the spectral responsivity for center input and output waveguide and center channel frequency.

From Eq. (17), the spectral response efficiencies of an AWG multi/demultiplexer for center input waveguide and 9 output waveguides are shown in Fig. 4, and as a result of the influence of diffraction effect of arrayed waveguide output

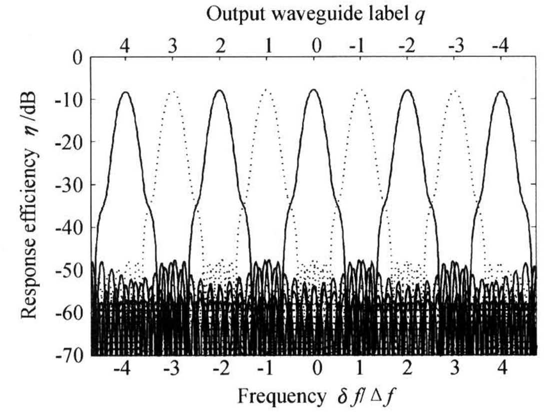

Fig. 4 Characteristic of the spectral response efficiency of nine channels

end faces, the spectral responsivity of center output waveguide is greater than the corresponding value of the others, $q=4$ for example, the difference between the spectral responsivity of $q=0$ and $q=4$ output waveguide is 0.53 dB.

4 Conclusions

In conclusion, some original and valid expressions of the coupling characteristic between two non-contact waveguides and the spectral response characteristics of AWG multi/demultiplexer are deduced. These expressions offer some useful foundation and novel method for analyzing the spectral responsivity and crosstalk of AWG multi/demultiplexer quickly. An example of computing the characteristics of AWG multi/demultiplexer is given to show the use of the expression of the spectral response efficiency.

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阵列波导光栅波分复用/解复用器光谱响应效率的理论模型

郭福源[1,2]　王明华[1]

(1 浙江大学信息与电子工程学系，杭州 310027)

(2 光子技术福建省重点实验室，福建师范大学激光与光电子技术研究所，福州 350007)

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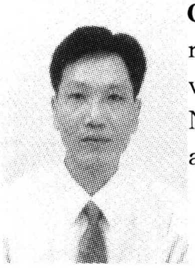
摘　要　基于单模光波导的本征模场分布，瑞利—索末菲衍射积分公式和天线原理的互易定理，给出耦合器中两个非接触平面光波导耦合特性的描述．基此，根据等光程差不等振幅多光束干涉的光场叠加原理，推导出新颖的阵列波导光栅波分复用/解复用器的光谱响应效率的解析函数表达式，这些表达式可为快速精确分析阵列波导光栅波分复用/解复用器的特性提供理论基础．同时，介绍了一个计算阵列波导光栅波分复用/解复用器特性的例子，给出其光谱响应度和信号通道串扰．

关键词　导波光学；阵列波导光栅；干涉；光谱响应效率；串扰；衍射；耦合



Guo Fuyuan　was bron in Fujian. He graduated from Zhejiang University in 1985, and received his doctor degree of optical engineering from Zhejian University in 2003. Now, he works as a postdoctoral fellow of Zhejiang University and an associate professor of Fujian Normal University. His research interests include the propagation theory of Gaussian beam and optical waveguide theory.