LiNbO3 Photonic Foundry of FOGPhotonics,inc

FOGPhotonics,inc

one Idealphotonics company

Products Guide

FOG Components

IMU Systems

FOG Devices

RLG Devices

FOG Instruments

Processes:

Annealing Proton Exchange

High Temperature Proton Exchange (Soft Proton Exchange)

Fiber pigtailing

High resolution Poling

X, Y and Z cuts of LiNbO3,

Dielectric and metal deposition

Photolithography

Devices:

Phase and intensity Electro −Optical modulators

Multifunctional integrated optical chips for gyros

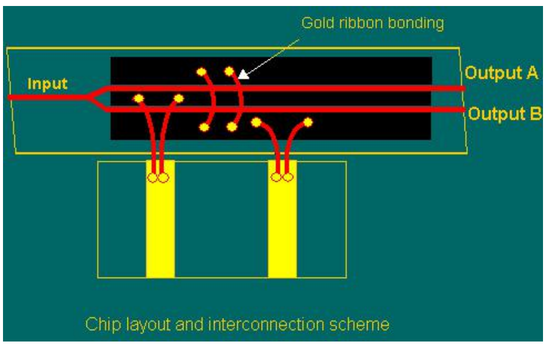
High speed polarisation insensitive switches

PPLN devices

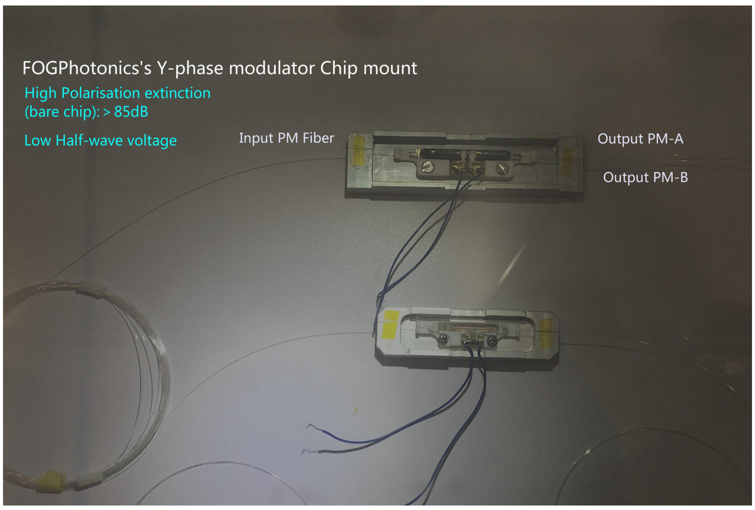
2016 NEW VERSION

Description

MIOC is a monoblock hermetic product. It includes a linear polarizer, Y-junction coupler and two pairs of electro-optic phase modulators



LiNbO3 X-cut FOG (Fiber Optic Gyro) chips



LiNbO3 Foundry Services

A foundry service is offered to Customers to exploit the FOGPHotonics Integrati technological know-how in LiNbO3 processing for integrated optical circuits.Customer uses the service to get processed wafer, polished and diced circuits as well as pigtailed and packaged devices.Custom integrated optical circuits are realised on the basis of the Customer's designs or starting from the requirements, exploiting the FOGPhotonics's design capabilities.

1310nm MIOC Provided by FOGPhotonics

Parameter	Unit	Values
Wavelength	nm	1310
Insertion Loss	dB	≤4.0
Half wave Voltage	V	≤4.0
Splitting Beam Ratio	-	47/53—53/47
Optical Return	dB	≥50
Polarization extinction ,chip	dB	≥55
Additional Intensity Modulating	-	≤0.2%
PM Pigtail Crosstalk	dB	≤-30
Electrode type	-	Push-pull modulating
Bandwidth	MHz	≥300
Pigtail type	-	PM
Work temperature	℃	-40～+70
Packaging dimensions	mm	30X8X5 or 35X10X5
Submount material		Stainless Steel
Optical chip length	mm	23
Optical chip width	mm	2.5
Output Channel Separation	um	400 ± 0.2
End-face angle (Z axis)	deg	80 ± 0.25
End-face angle (X axis)	deg	90 ± 0.25
End-face surface quality		< 3 λ(633 nm)

1550nm MIOC Provided by FOGPhotonics

Operation wavelength	nm	1550
Vπ(1/2λ differential phase shift)	v	4
Insertion loss	dB	≤4.0
Intensity modulation	%	< 0.1 (+/-Vpi v)
Optical Insertion Loss (chip output A+B) (*)	dB	2.5
Split Ratio (A/B)	%	52/48
Cross Polarisation Rejection (chip)	dB	< -55
Cross Polarisation Rejection (Fiber)	dB	<-25

Output Channel Separation	µm	400 ± 0.2
End-face angle (Z axis)	deg	80 ± 0.25
End-face angle (X axis)	deg	90 ± 0.25
End-face surface quality	—	< 3 λ(633 nm)
Bandwidth	MHz	300
Maximum Optical input power	mW	100
Optical chip length	mm	25
Optical chip width	mm	2
Operational Temperature	°C	-45 - +75
Storage Temperature	°C	-40 - +90
Input fiber	—	8/125/250 or 6/80/165 Panda
Output fibers	—	8/125/250 or 6/80/165 Panda

Definition of parameters

The definition of V_π is the same as the V_π in an intensity modulator which interferometric configuration adopts the same push-pull electrodes (and optical waveguides) used in the gyro chip.

A test amplitude modulator is included in the wafer. Then we measured the V_π for this device. The V_π of an interferometric integrated optical amplitude modulator is defined as the voltage change requested to move the modulator from the minimum to the maximum optical transmission. It is a function of frequency f of the modulating signal V(f), and is defined in the modulator optical transmission function:

$$P_{out}^{opt} = \frac{\Gamma P_{in}^{opt}}{2}\left(1 - \sin\left(\pi \frac{V(f)}{V_\pi(f)}\right)\right)$$

1.1.1 Phase Modulators

The electro-optic effect is used to modulate the optical carrier fase. In this device a couple of electrodes are located on the sides of a single waveguide (figure 1) .

The modulator transfer function is simply given by:

$$\Delta\Phi = \pi \frac{V}{V_\pi}$$

Where $\Delta\phi$ is the relative phase delay, V is the voltage applied to the electrodes and V_π is the necessary voltage required to obtain a phase delay equal to π .

1.1.2 Coupling Electrodes

When the signal is time varying, the simple capacitive electrode configuration, in which they can be considered a capacitor C in parallel with the terminating resistor R, is frequency limited by the RC cut. The value of this cut is usually in the range of 1-2 GHz. In order to obtain modulators efficient enough for the microwave frequencies (20 GHz), coplanar transmission line configurations are adopted for the electrodes, allowing Travelling Wave (TW) coupling between the modulating signal and the optical carrier.

The higher frequency limit of the TW electrode configuration is possible due to:

the difference between the propagation speeds of the modulating signal (c/n_{RF}) and the optical carrier (c/n_{opt});
the resistive/dielectrical losses experimented by the modulating in the coupling electrodes.
The difference between the propagation speeds is the major limitation to the bandwidth in the case of conventional TW electrodes. The -3dB bandwidth (BW)is given in this case by the following expression:

$$BW \approx \frac{1.4 \cdot c}{\pi \cdot \Delta n \cdot L}$$

where L is the length of the coupling between the TW electrodes and the optical waveguide $\Delta n = n_{RF} - n_{opt}$ is the difference between the two propagation indexes (typically $\Delta n=2$). Because the efficiency of the modulator (V_π) decreases with L, wider bandwidths imply lower electro-optic efficiencies.

Alenia Marconi Systems has developed a new TW electrode configuration enabling us to overcome this limitation. In this new configuration, called "Velocity Matched" (VM) the propagation speed of the modulating signal is adapted to that of the optical carrier. The bandwidth of the modulator is now limited by resistive/dielectric losses only, which increase with frequency. Moreover, the electro-optic efficiency is practically bandwidth independent (figure 2) . This makes the VM increasingly advantageous, in terms of efficiency, over the conventional TW electrodes as the bandwidth increases. The electro-optic efficiency of the conventional TW still remains higher than that of the VM configuration for a bandwidth lower than a threshold value, typically in the range of 3、5 GHz. A further advantage of the VM configuration is the value of the characteristic impedance close to 50 Ohms, perfectly matched with the external signal line, in spite of the 25-35 Ohms of the conventional TW electrodes.

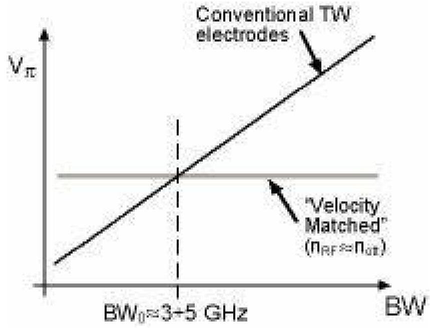


Figure 2: Electro-optic efficiency vs bandwidth

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