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MINIATURE INLINE POLARIZATION MAINTAINING SPLITTERS/ TAPS/COMBINERS

Features:

- Rugged compact design
- Broad wavelength range
- Low insertion loss
- High extinction ratio
- Low return losses
- Low Polarization Dependent Loss (PDL)
- Low Wavelength Dependent Loss (WDL)

Applications:

- EDFA amplifiers
- Raman amplifier combiners
- Polarization mode dispersion compensation
- Polarization extinction ratio measurements
- Fiber optic sensors
- Coherent communication systems
- OCT systems

Product Description:

OZ Optics' miniature fiber optic beam splitters are used to split the light traveling through a fiber into two fibers, or to split or combine orthogonally polarized light into separate fibers. These splitters feature a rugged miniature housing to fit into compact spaces in equipment and systems. Light from a fiber is first collimated, then sent through a beamsplitting optic to divide it into two beams by either a fixed ratio or into two orthogonal polarizations. The resultant output beams are then coupled back into the output fibers. This flexible design allows one to manufacture splitters with different fiber types on the input and output ports.

Miniature inline splitters are sold in two different configurations - a polarization maintaining splitter, with a fixed splitting ratio, and a polarizing splitter, to split and combine orthogonal polarizations. Their operating principles are as follows:

Polarization Maintaining Splitters: Also known as optical taps, these splitters use a partially reflecting mirror to transmit a portion of the light from the input fiber to the main output fiber, and reflect the remainder of the light to the second output fiber. All ports made using polarization maintaining fiber are aligned so that polarized light aligned parallel to the stress rods on the input fiber emerge from the output fibers in the same manner, maintaining the polarization state to a high degree. The top drawing in Figure 2 shows the arrangement of the input and output ports.

Splitters that only split off a small portion of the input light are commonly known as taps. These splitters are often used for power monitoring applications. The small signal, typically between one and ten percent, is sent to a monitoring photodiode, while the majority of the signal goes on to the main destination. For a very low cost alternative configuration, combining the functions of a tap and monitor photodiode in a single unit, we invite you to review our data sheet *Directional Fiber Optic Power Monitors (Taps/Photodiodes)* http://www.ozoptics.com/ALLNEW_PDF/DTS0042.pdf

Polarizing Splitters: Polarizing Beam Splitters split incoming light into two orthogonal states. They can also be used to combine the light from two fibers into a single output fiber. When used as a beam combiner, each input signal will transmit along a different output polarization axis.
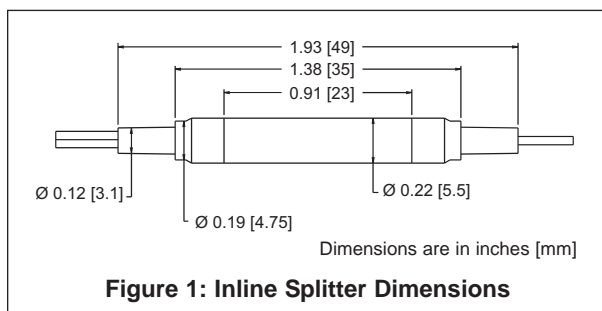

Miniature Inline Splitter

Dimensions are in inches [mm]

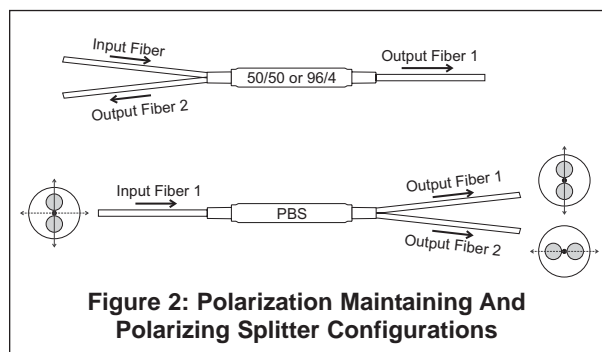**Figure 1: Inline Splitter Dimensions**

Figure 2: Polarization Maintaining And Polarizing Splitter Configurations

By default the output fibers on a polarizing splitter are aligned so that the output polarization from each fiber is in line with the stress rods of the fibers. If the input fiber is a polarization maintaining (PM) fiber, the input fiber is aligned such that light polarized parallel to the fiber's stress rods is transmitted to port 1 of the splitter, while light polarized perpendicular to the stress rods is transmitted to port 2 of the splitter. The bottom drawing in Figure 2 illustrates this. Because of OZ Optics' modular design, the PM fiber configuration can be changed to whatever suits your needs.

Splitters can be manufactured with different fibers on the input and output ports. For example, light from a singlemode fiber could be split into its two orthogonal states and then launched into two polarization maintaining fibers. Standard products for 1550 nm applications are readily available, while custom items can be made with rapid turnaround at low cost. Products for other wavelengths, such as 980 nm, 1300 nm, or 1480 nm are offered. Contact OZ Optics for details and a quotation.

Standard Product Specifications:

In general, OZ Optics uses polarization maintaining fibers based on the PANDA fiber structure when building polarization maintaining components and patchcords. However we can construct devices using other PM fiber structures. We do carry some alternative fiber types in stock, so please contact our sales department for availability. If necessary, we are willing to use customer supplied fibers to build devices.

Parameter	Condition	Value			
Tap Ratios		50/50, 96/4, standard			
		Polarizing beam splitter standard			
		Custom split ratios 50/50 to 98/2 available on request			
Tap Ratio Tolerance:	50/50 splitters	±3%			
	96/4 splitters	±1%			
Central Wavelength:		1550 nm Standard			
		Other wavelengths available on request			
Bandwidth:		±2.5% of the central wavelength			
Wavelength Dependent Loss (WDL):	1520-1570 nm	0.1 dB			
Polarization Extinction Ratios[1]:	Transmitted Channel	20 dB minimum, 23 dB typical			
	Reflected Channel	18 dB minimum, 20 dB typical			
Polarization Dependence Loss (PDL):		0.1 dB			
Directivity		>50 dB			
Return Losses[2]:		60 dB[4,6]	50 dB[4,6]	40 dB[5,6]	30 dB[7]
Insertion Losses[2,3] :	Typical	<0.5 dB	<0.9 dB	<0.9 dB	<0.9 dB
	Maximum	<0.6 dB	<1.0 dB	<1.0 dB	<1.0 dB
Power Handling[3]		>200 mW (+23 dBm)			
Operating Temperature Range:		+0°C to +70°C			
Storage Temperature Range:		-40°C to +85°C			

1 Higher extinction ratios available for custom orders.
2 Does not include connector losses and connector return losses.
3 For 1550 nm wavelengths with either singlemode or polarization maintaining fibers. Contact OZ Optics for other wavelengths or fiber types.
4 Standard for 1300/1550 nm wavelength bands.
5 Standard for non-telecom wavelength bands.
6 Non-telecom products with low return losses and insertion losses available on special order.
7 Standard for multimode fibers.

Ordering Information For Standard Parts:

The following items are all standard and usually in stock. For more standard parts, please see our Online Catalog
http://shop.ozoptics.com/ Connectors can be added to the splitters per customer specifications.

Bar Code	Part Number	Description
20406	FOBS-12N-111-8/125-PPP-1550-50/50-50-XXX-1-1	Miniature inline polarization maintaining splitter for 1550 nm, with a 50/50 splitting ratio, 50 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled PM fibers, with no connectors.
20413	FOBS-12N-111-8/125-PPP-1550-50/50-60-XXX-1-1	Miniature inline polarization maintaining splitter for 1550 nm, with a 50/50 splitting ratio, 60 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled PM fibers, with no connectors.
20407	FOBS-12N-111-8/125-PPP-1550-96/4-50-XXX-1-1	Miniature inline polarization maintaining splitter for 1550 nm, with a 96/4 splitting ratio, 50 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled PM fibers, with no connectors.
20408	FOBS-12N-111-8/125-PPP-1550-96/4-60-XXX-1-1	Miniature inline polarization maintaining splitter for 1550 nm, with a 96/4 splitting ratio, 60 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled PM fibers, with no connectors.
16584	FOBS-12N-111-9/125-SSS-1550-PBS-50-XXX-1-1	Miniature inline polarizing splitter/combiner for 1550 nm, with 50 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled Corning SMF-28 singlemode fibers, with no connectors.
20409	FOBS-12N-111-9/125-SSS-1550-PBS-60-XXX-1-1	Miniature inline polarizing splitter/combiner for 1550 nm, with 60 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled Corning SMF-28 singlemode fibers, with no connectors.
20411	FOBS-12N-111-9/125-SPP-1550-PBS-50-XXX-1-1	Miniature inline polarizing splitter/combiner for 1550 nm, with 50 dB return loss. The input fiber is Corning SMF-28 singlemode fiber while the two output fibers are PM fibers. The fibers on all ports are 1 meter long, 900 micron loose tube cabled, with no connectors.
20412	FOBS-12N-111-9/125-SPP-1550-PBS-60-XXX-1-1	Miniature inline polarizing splitter/combiner for 1550 nm, with 60 dB return loss. The input fiber is Corning SMF-28 singlemode fiber while the two output fibers are 1550 nm PM fibers. Fibers on all ports are 1 meter long, 900 micron loose tube cabled, with no connectors.

Ordering Information For Standard Parts:

A customer requires a polarization maintaining tap to monitor the output power from a 1550 nm DFB laser diode with a PM output. The tap ratio needs to be 5% or smaller. The coupler has to exhibit the lowest possible insertion losses and return losses. Connectors are not required.

Bar Code	Part Number	Description
20408	FOBS-12N-111-8/125-PPP-1550-96/4-60-XXX-1-1	Miniature inline polarization maintaining splitter for 1550 nm, with a 96/4 splitting ratio, 60 dB return loss. The fibers on all ports are 1 meter long, 900 micron loose tube cabled PM fibers, with no connectors.

Ordering Information For Custom Parts:

OZ Optics welcomes the opportunity to provide custom designed products to meet your application needs. As with most manufacturers, customized products do take additional effort so please expect some differences in the pricing compared to our standard parts list. In particular, we will need additional time to prepare a comprehensive quotation, and lead times will be longer than normal. In most cases non-recurring engineering (NRE) charges, lot charges, and minimum order will be necessary. These points will be carefully explained in your quotation, so your decision will be as well-informed as possible. We strongly recommend buying our standard products.

Questionnaire For Custom Parts:

1.   What is your operating wavelength?
2.   What is the intensity of your signal?
3.   What is the input fiber type?
4.   What is the first output fiber type?
5.   What is the second output fiber type?
6.   What splitting ratio do you desire? Do you require a fixed splitting ratio or a polarizing splitter?
7.   Do you intend to use the unit as a splitter or as a combiner?
8.   What are your insertion loss requirements?
9.   What are your return loss requirements?
10. How long should the fibers be on each port?
11. Do you require uncabled fibers, or fibers protected with a 900 micron diameter loose tube cable?
12. Do you need any connectors on the fibers? If so, what type?

Description   Part Number

Miniature Inline Splitter   **FOBS-12N-111-*a/b*-*ABC*-*W*-*S/R*-*LB*-*XYZ*-*JD*-*L***

_a/b_ =   Fiber core/cladding sizes in microns
9/125 for 1300/1550 nm singlemode fiber.
8/125 for 1550 nm PM fiber
7/125 for 1300 nm PM fiber
See tables 1 to 5 of the *Standard Tables*
http://www.ozoptics.com/ALLNEW_PDF/DTS0079.pdf
data sheet for other standard fiber sizes

ABC = Fiber Types on each port
(input, output 1, output 2)
M = Multimode
S = Singlemode
P = Polarization Maintaining

_W_ =   Wavelength: Specify in nanometers
(Example: 1550 for 1550 nm)

_S/R_ =   Splitting ratio: 50/50 to 98/2
50/50, 96/4 Standard
Use PBS for polarizing splitters

_L_ =   Fiber length, in meters

_JD_ =   Fiber jacket type
0.25 = 250 micron OD acrylate coating
1 = 900 micron OD hytrel jacket

XYZ =   Connector codes for each port
3S = Super NTT-FC/PC
3U = Ultra NTT-FC/PC
3A = Angled NTT-FC/PC
LC = LC
SC = SC
SCA = Angled SC
See Table 6 of the *Standard Tables*
http://www.ozoptics.com/ALLNEW_PDF/DTS0079.pdf
data sheet for other connectors

_LB_ =   Backreflection level:
30, 40, 50, or 60 dB
50, 60 dB are standard for 1300 nm to 1550 nm only
40 dB standard for other wavelengths
30 dB is standard for multimode

Ordering Examples for Custom Parts

A 980nm polarizing beamsplitter is needed to combine the signal from two polarization maintaining fibers into one singlemode fiber. The two polarization maintaining fibers are to be terminated with FC/APC connectors, while the singlemode fiber is left unterminated. Standard return losses, insertion losses and jacket materials are acceptable.

Part Number	Description
FOBS-12N-111-6/125-SPP-980-PBS-40-X3A3A-1-1	Miniature inline polarizing splitter/combiner for 980 nm, with 40 dB return loss. The input fiber is 980 nm singlemode fiber with no connector while the two output fibers are both 980 nm PM fibers with angled NTT-FC/PC connectors. The fibers on all ports are 1 meter long and 900 micron loose tube cabled.

Application Notes:

Polarization Extinction Ratio vs Power Extinction Ratio: For polarizing beamsplitters, the term Extinction Ratio (ER) is often applied to both polarization and power. The power extinction ratio is the ratio between the maximum signal intensity and the minimum signal intensity as the polarization is varied. It is essentially the same as polarization dependent loss, only that we now want this value to be as large as possible instead of as small as possible. In contrast the polarization extinction ratio is a measure of how well the output light from a polarization maintaining fiber is polarized.

Generally speaking the power extinction ratio will always be equal to or greater than the polarization extinction ratio. For example, there can be a splitter with a high power extinction ratio, but if the output PM fibers are not optimally aligned and attached, the output polarization extinction ratio from the fiber would be low. Please be sure to specify both of these values if your system has special requirements. Whenever an ER value is provided for a non-PM fiber system, it refers to the power extinction ratio. The output ratio for each port should also be specified if a lower value is acceptable as this provides for greater manufacturing tolerances and lower pricing.

Combining Different Fibers: Inline splitters can be designed to couple light from one fiber into an identical fiber or into one with a larger mode field diameter (MFD) and/or numerical aperture (NA). However inline splitters cannot be made to transmit light from an input fiber into a fiber with a smaller MFD or NA without high losses. The basic loss estimation is as the square of the mismatch, so if the receiving fiber has a MFD of only ½ of what is should be, then only ¼ of the light will ideally be coupled. If instead the output fiber is larger, then coupling will be efficient. Therefore, systems cannot be designed to couple light from multimode fiber (for example 50 um MFD, 0.22 NA) into singlemode or PM fibers (9 um MFD 0.11 NA) with any reasonable efficiency. The most efficient way to circumvent this is to electronically detect the signal and use a second source pigtailed with the desired fiber.

Using Splitters as Combiners: A common question we receive is whether a 50/50 beamsplitter can be used in reverse, to combine the signals from two sources, thereby combining their output powers. Unfortunately beamsplitters are reciprocal in nature, meaning that they perform the same operation in both directions. Since the light from the input port on a polarization maintaining splitter will be split 50/50 into the two output ports, light sent back along either one of those ports will also be split 50/50. In a one by two splitter the other 50 percent is simply lost inside the coupler housing. In order to combine signals with low losses the two input signals must somehow be different: for instance light of two different wavelengths or light of two different polarizations can be efficiently combined.

Frequently Asked Questions (FAQs)

Q: Are the in line splitters offered in a 2x2 configuration? What about 1 by N?

A: While sample prototypes of 2x2 configurations have been put together, the second input port exhibits significant losses. We therefore decided not to offer it with this release of the data sheet. As an alternative, consider our standard pigtail and receptacle style splitters and combiners. Refer to our data sheet *Beam Splitters/Combiners* http://www.ozoptics.com/ALLNEW_PDF/DTS0095.pdf for additional information.

Q: Are any epoxies present within the optical path of the device?

A: Our polarization maintaining splitters and taps are epoxy free along the optical path, ensuring maximum power handling performance.

Q: Can I combine two polarizations into one fiber along the same axis?

A: If you use a 50/50 splitter, you will lose half of each input signal. A polarizing beamsplitter would allow you to combine the beams with low loss, but they would be launched down different polarization axes of a PM fiber. If the output fiber is singlemode, then both polarizations will be scrambled together. If the two sources have different wavelengths, then a polarization maintaining wave division multiplexer (WDM) may be used. OZ Optics offers this device for a variety of common and special wavelength pairs.

Q: How can I combine sources with two different wavelengths into the same fiber, and then split them again into two different fibers?

A: Usually, a device known as a wave division multiplexer is used. This device employs a dichroic filter (it reflects one wavelength and passes another) to combine or separate signals at different wavelengths. This can be done for multimode, singlemode, or PM fibers. Alternatively, if the two signals are carried along PM fiber, then they can be combined using a polarizing beamsplitter. However this idea cannot be used to later separate the two signals.

Q: What advantages do these splitters have over fused splitters (also called biconical taper couplers or taps)?

A: Fused splitters are often a good alternative for beamsplitting applications. For singlemode and multimode fiber applications, they offer lower insertion losses, lower return losses, are smaller and are less expensive. Having said that, the polarization maintaining fused splitters currently available on the market have a narrower operating bandwidth and often demonstrate mediocre polarization extinction ratio performance, particularly on the tapped port. The technique used by OZ Optics is also inherently more flexible. Different fiber types can be used on each port of the splitter, and the alignment of the polarization transmission axes on each port can be tailored to customer requirements. Systems for unusual wavelengths can also be rapidly developed.

As another note, the splitting ratio of multimode fused splitters is dependent how the light is initially launched into the input fiber. Standard multimode fused splitters rely on the input being a low coherence source, like an LED, to mask this behavior. In contrast, the OZ Optics miniature splitter splitting ratio is mode independent, thus ensuring correct behavior.

If you are still interested in a fused splitter, please see our data sheet *Fused Couplers - Fiber Optic* http://www.ozoptics.com/ALLNEW_PDF/DTS0033.pdf for our product offerings.

Q: What is directivity?

A: Directivity is a measure of how much unwanted light can be reflected from one output port on a splitter to the other output port. For example, light from the input port of a 50/50 splitter is normally sent evenly into the two output ports. The directivity is the measure of how much light can be transmitted from one output port to the other output port instead.

Q: I want a polarization combiner and you quoted me a splitter, why?

A: They are the same device used in opposite directions. All splitters are quoted as one fiber to two fibers. As long as your request is clear, your device will work fine.