

## POLARIZATION MAINTAINING FUSED FIBER COUPLERS / SPLITTERS

### Applications

- Optical amplifiers
- Fiber lasers
- Power monitoring
- Fiber gyroscopes
- Coherent communications

### Key Features

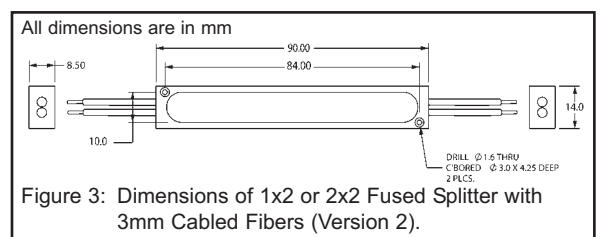
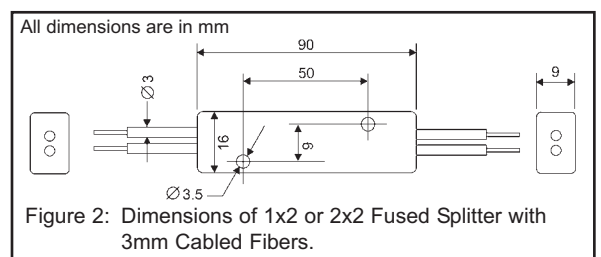
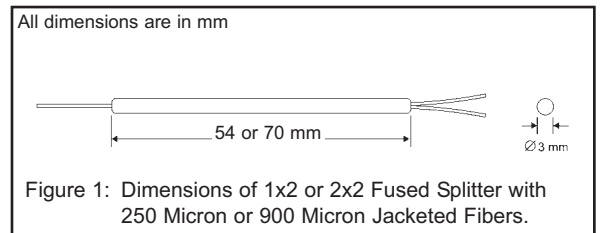
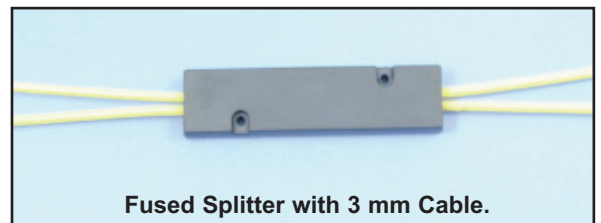
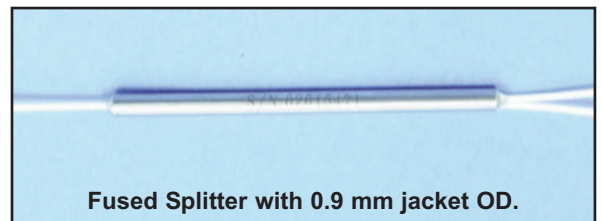
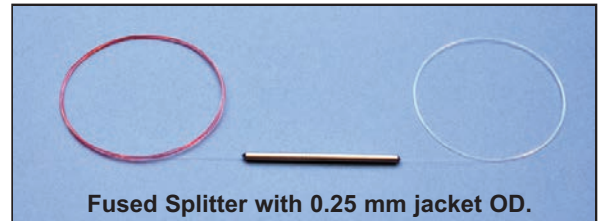
- Low loss and cost
- Broad bandwidth
- Good uniformity
- Small package
- High directivity
- Wide variety of wavelengths 780 nm–2005 nm

Fused couplers are used to split optical signals between two (or more) fibers or to combine optical signals from two (or more) fibers into one fiber. They are constructed by fusing and tapering the fibers together. This method creates a simple, rugged, compact method of splitting or combining optical signals. Typical excess losses are as low as 0.2 dB, while split ratio tolerances range from  $\pm 5\%$  to  $\pm 0.5\%$  at design wavelengths depending upon the splitting ratio. These devices are bidirectional and offer low backreflection and insertion losses.

OZ Optics' fused PM Splitters exhibit a broad operating wavelength range of up to  $\pm 20$  nm for 1550 nm region devices. For operation within the standard bandwidth of a splitter, it is best to order a standard center wavelength for lowest price and quickest delivery. Fused PM splitters are also available on smaller core fibers for 1064 nm, 980 nm and other wavelengths. (Nonstandard center wavelengths may require minimum order quantities or set up charges. Please contact OZ Optics for assistance).

A wide variety of options are available for fused PM splitters. Standard configurations are 1x2, 2x2, 1x3 (monolithic) and 1x4 (compact cascaded). A monolithic structure means that all fibers are fused together, while a cascaded device combines several 2x2 splitters to create a greater split count. **NOTE** – OZ Optics may substitute a 2x2 in place of an ordered 1x2 based on availability. If a 1x2 is required, please inform your sales contact when placing your request for quote or order. OZ Optics can design and construct larger split counts or different split ratios upon request.

OZ Optics has the capability to connectorize the fibers of fused splitters with all standard connectors such as FC, SC, ST, LC etc. and finishes (Super PC, Ultra PC, Angled PC [APC] etc.). As a component integrator, OZ Optics can construct additional components directly onto the coupler fibers. Examples include tunable filters, variable attenuators, or collimators. By building these devices directly onto the coupler fibers, OZ Optics saves the customer the added cost and insertion loss of intermediate connectors and adapters, or the time and cost of fusion splicing. Directly built devices are also the best way to maintain the highest possible Polarization Extinction Ratios.



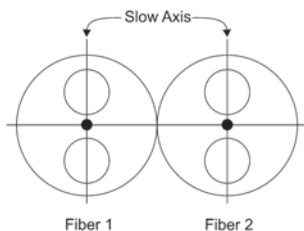


Figure 4: PM Splitter Fiber Geometry

As with any device, there are drawbacks to using PM fused splitters as opposed to other methods. OZ Optics offers other splitter options to cover all customer requirements. For example, the bandwidth of fused splitters is not as broad as that of a bulk optics device (using plates or cubes), so if a splitter is required to cover 50 nm or wider, then a bulk optics or a planar light circuit splitter (PLCS) device might be preferred. As another example, fused splitters are designed to be used along only one fiber polarization axis (Slow axis is standard). Bulk optics devices can be used for both axes. A uniform split ratio on both slow and fast axes can be offered as a custom order.

Some customers request a high split ratio (90/10, 95/5) in order to tap off a small amount of light for power monitoring. OZ Optics offers a revolutionary technology where we can tap a small percentage (1% to 3% typically) of the light in the fiber and directly couple it into a photodiode. This method has minimal loss, high extinction ratio and is very inexpensive (see the Optical Power Monitors / Taps data sheet). Fused splitters have an extinction ratio specification of 17-20 dB for the main through port. OZ Optics inline miniature splitters (FOBS-12N) offer 20 dB, and the larger package (FOBS-12P) offers values as high as 30 dB. Fused devices are lower cost and lower loss, however. An OZ Optics sales associate can review these differences as compared to your application requirements and recommend the best options.

In general OZ Optics uses polarization maintaining fibers based on the PANDA fiber structure when building polarization maintaining components and patchcords. However OZ Optics 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.

## STANDARD SPECIFICATIONS<sup>1</sup>

Parameter	Condition	Value
Split Ratio <sup>2</sup>		50/50, 90/10, 95/5 %
Split Ratio Tolerance	95/5	±1.5 %
	90/10	±2.2 %
	50/50	±5 %
Center wavelength		780, 850, 1064, 1310, 1480, 1550, 2005 nm <sup>2</sup>
Bandwidth		±1.25 % of center wavelength, ±20 nm <sup>3</sup>
Polarization Extinction Ratio	Through port	23 dB typical, 20 dB minimum <sup>4</sup>
	Tap port	17 dB typical, 15 dB minimum <sup>4</sup>
Return Loss		<50 dB
Directivity		<55 dB
Excess Loss	Typical	0.2 dB <sup>5</sup>
	Maximum	<0.4 dB <sup>5</sup>
Operating Temperature		0°C to 70°C
Storage Temperature		-40°C to 85°C

<sup>1</sup> For 780, 850, 1064, 1310, 1480, 1550, 2005 nm devices, 1x2 splitters.

<sup>2</sup> Other split ratios available upon request. Other wavelengths available upon request.

<sup>3</sup> Bandwidth may differ for custom wavelengths.

<sup>4</sup> Not including connectors.

<sup>5</sup> Not including connector losses.

## Ordering Information For Standard Parts

Bar Code	Part Number	Description
22264	FUSED-12-1310-7/125-50/50-XXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1310 nm 7/125 PM fiber pigtails and 1x2 50/50 split ratio, with no connectors
22265	FUSED-12-1550-8/125-50/50-XXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1550 nm 8/125 PM fiber pigtails and 1x2 50/50 split ratio, with no connectors
22266	FUSED-22-1310-7/125-50/50-XXXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1310 nm 7/125 PM fiber pigtails and 2x2 50/50 split ratio, with no connectors
22309	FUSED-22-1550-8/125-50/50-XXXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1550 nm 8/125 PM fiber pigtails and 2x2 50/50 split ratio, with no connectors
22267	FUSED-12-1310-7/125-90/10-XXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1310 nm 7/125 PM fiber pigtails and 1x2 90/10 split ratio, with no connectors
22268	FUSED-12-1550-8/125-90/10-XXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1550 nm 8/125 PM fiber pigtails and 1x2 90/10 split ratio, with no connectors
22269	FUSED-22-1310-7/125-90/10-XXXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1310 nm 7/125 PM fiber pigtails and 2x2 90/10 split ratio, with no connectors
22310	FUSED-22-1550-8/125-90/10-XXXX-1-1-PM	Fused PM Splitter with 1 meter long 900 micron OD jacketed 1550 nm 8/125 PM fiber pigtails and 2x2 90/10 split ratio, with no connectors

## Ordering Example for Standard Parts:

A researcher is building an interferometer that works at 1540nm, and wants to use PM fiber in his system. For his work he needs to split the light into two equal parts, and monitor the reflected signals back along a second input arm. As his operating wavelength is within the bandwidth of a standard splitter, he elects to use parts designed for 1550nm wavelengths.

Bar Code	Part Number	Description
22309	FUSED-22-1550-8/125-50/50-XXXX-1-1-PM	Fused PM splitter with 1 meter long 900 micron OD jacketed 1550 nm 8/125 PM fiber pigtailed and 2x2 50/50 split ratio, with no connectors.

## Ordering Information For Custom Parts

OZ Optics welcomes the opportunity to provide custom designed and manufactured components to its valued customers. As with most manufacturers, customized products do take additional effort so please expect some differences in pricing compared to our standard parts. In particular, we may need additional detailed specifications or a drawing from the customer and extra time to prepare a comprehensive quotation. Lead times may also be longer for delivery. In most cases non-recurring engineering (NRE) or setup charges, lot charges and/or a minimum order quantity may be necessary. These points will be carefully explained in your quotation so your decision will be as well-informed as possible. Please contact OZ immediately if any part of your quote needs explanation. We strongly recommend you purchase our standard parts.

## Questionnaire For Custom Parts

1. What is your center wavelength and operating bandwidth?
2. What is the desired port configuration (i.e., 2x2, 1x3)
3. What split ratio is required? Are other ratios acceptable for initial trial?
4. What, if any, connectors are required for each port?
5. What fiber length is required?
6. Are there package size restrictions (important for 1x4 splitters)
7. Do you need additional components mounted to the input or output fiber ends?
8. What are your extinction ratio requirements on the through and tap ports?

## Description

## Part Number

One-by-Two Fused Splitter/Coupler **FUSED-12-W-a/b-S/R-XYZ-JD-L-PM-SF** **Add:** SF to the end of the part number to indicate uniform split ratio for both slow and fast axis launch conditions.

Two-by-Two Fused Splitter/Coupler **FUSED-22-W-a/b-S/R-TXYZ-JD-L-PM-SF**

**W** = Wavelength in nm  
(Standard 780, 850, 980, 1064, 1310, 1480, 1550 and 2005nm)

**a/b** = Fiber core/cladding diameters  
8/125 for 1480 and 1550nm  
7/125 for 1310nm  
6/125 for 980 and 1064nm  
5/125 for 780 and 830nm

**S/R** = Split Ratio in % (50/50, 90/10, 95/5 and 99/1 are standard)

**L** = Fiber length in meters on all ports  
(standard is 1 meter)

**JD** = Fiber Jacket outside diameter in mm  
0.25 for 0.25 mm OD coated fibers  
1 for 0.9 mm OD loose tube jacket  
3 mm for 3 mm OD loose tube kevlar reinforced PVC cable.

**TXYZ** = Input and Output Male Connectors  
(T,X are inputs,Y,Z are outputs)

- X = No connector
- 3S = Super NTT-FC/PC
- 3U = Ultra NTT-FC/PC
- 3A = Angled NTT-FC/PC
- SC = SC
- SCA = Angled SC
- LC = LC/PC
- LCA = Angled LC

See table 6 of the OZ *Standard Tables* data sheet for other connectors.

## Ordering Example For Custom Parts

A customer wants a 1x2 fused coupler for 1480nm, with a 95/5 split ratio, to use as a tap to monitor the signal intensity through his system. He requires angled FC/APC connectors on the input port and the main output port, while on the 5% port he does not want a connector. He wants 0.5 meter long leads on all three ports, with 900 micron cabling.

Part Number	Description
FUSED-12-1480-8/125-95/5-3A3AX-1-0.5-PM	Fused PM splitter with 0.5 meter long 900 micron OD jacketed 1480 nm 8/125 PM fiber pigtails and 1x2 95/5 split ratio, with Angled NTT-FC/PC connectors on the input and through ports, and no connector on the tap port.

### Application Notes:

**Using a splitter as a combiner:** A common question we receive is whether a 50/50 beamsplitter can be used in reverse, to combine the signals from two sources to combine their powers. Unfortunately beamsplitters are reciprocal in nature, meaning that they perform the same operation in both directions. Since the light from the input port of a fused PM splitter will be split 50/50 into the two output ports, light sent back along either of the output ports will also be split 50/50. In a one-by-two splitter, the other 50 percent is simply lost inside the coupler housing. For high power applications, it is recommended that a 2x2 coupler always be used and the excess light from the unwanted fiber end be dumped into a beam block or similar device. In order to efficiently combine signals with low losses the two input signals must be different somehow, such as different wavelengths or polarizations. Please refer to OZ Optics' data sheets on wave division multiplexors and on fiber optic beam splitters/combiners for details.

**Extinction Ratio of Cascaded Components:** When combining several devices with PM fiber, it is important to be aware of the potential for degradation of the polarization extinction ratio after each segment. The rule-of-thumb, or quickest estimate is to reduce the Polarization Extinction Ratio (PER) by 3 dB for each additional fiber. For example, if the customer has a fused splitter with 20 dB PER and we build an attenuator with 20 dB PER directly onto the fiber, then the final output PER will be approximately  $20 - 3 = 17$  dB. If connectors were used between the two devices, then this value could be even lower depending on the tolerance of the orientation of the PM axes of the fiber.

### Frequently Asked Questions

**Q:** I asked for a PM fiber combiner and you quoted me a splitter, why?

**A:** They are the same device used in opposite directions. All splitters can be used as combiners as long as you understand the split will occur in both directions as explained in the application notes.

**Q:** What is directivity?

**A:** Directivity is a measure of how much unwanted light can be reflected or directed from one output port of a splitter into 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:** How many fibers or ports can I get?

**A:** Standard configurations are 1x2, 2x2 and 1x3. By using these base splitters as "building blocks" we can create higher input and output port counts. The final device will be in a box or case to protect the individual splitters.

**Q:** Will the split ratio remain uniform for both the slow and fast axis launch for standard unit?

**A:** No. For the standard (off shelf) PM splitter unit the split ratio is optimized for only slow axis propagation. For uniform split ratio on both slow and fast axis this can be done as a custom order.