Fiber Pigtailed Free Space Interferometer (MZI-001)

The MZI-001 is a fiber pigtailed compact Mach-Zehnder interferometer, based on free-space optics, for detecting changes in optical frequency. The device comes with two fast photodetectors for the balanced detection of the two complementary outputs of the interferometer. The free spectral range (FSR) or zero-cross spacing of the device is accurately defined to within 2%, a clear advantage over the all-fiber approach. In addition, the FSR can be selected from 10 GHz to as high as 100 GHz when ordering, making it flexible for system integration. Finally, the MZI-001's free-space optical design eliminates the polarization sensitivity commonly associated with all-fiber interferometers. The MZI-001 is ideal for applications in wavelength-swept light sources for determining their instantaneous frequencies, in OCT systems as a frequency clock for system triggering, in fiber sensors for detecting sensing signal spectral drift, and in coherent communication systems for detecting frequency drifts of the lasers.

Specifications:

Center Wavelengths[1]	1060, 1310, 1550 nm
Wavelength Range	±70 nm
FSR	10, 20, 30, 40, 50, 60, 70, 80, 90, 100 GHz, user selectable
FSR Tolerance	2%
Detector Responsivity	> 0.8 A/W
Overall Responsivity Per Channel	> 0.5 A/W
Detector Rise/Fall Time	0.3 ns with 50 Ω load
Detector Capacitance	0.7 pf
Return Loss	55 dB
Polarization Dependent Response	< 0.5 dB
Input Fiber	SMF-28 or Hi1060 fiber with 900 µm buffer
Optical Connectors	FC/APC or FC/PC, specify
Operating Temperature	-10 to 70 °C
Storage Temperature	-20 to 75 °C
Dimensions	2.11" (L) × 1.1" (W) × 0.37" (H)

Note:
1. Specifications in this table are given for 1550 nm operation. Performance at 1060 nm may be slightly different.

Features:

- Compact size
- Accurate free spectral range
- Temperature stable
- Polarization insensitive
- Fine optical frequency spacing
- Balanced photodetectors

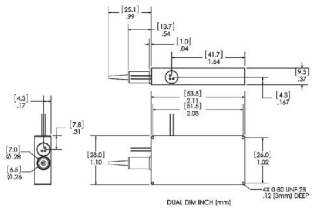
Applications:

- Wavelength swept light source
- Optical Coherence Tomography (OCT)
- Fiber optic sensor
- Test & measurement
- Spectrum analysis
- Coherent detection systems

Tech Info:

- Optical Coherence Tomography Technologies

Dimensions (in inches and mm):



Ordering Information:

MZI — 001 — □□ — □□ — □

Wavelength:
10 = 1060 nm
13 = 1310 nm
15 = 1550 nm

FSR:
See options above

Connector Type:
FC/PC, FC/APC or
NC = no connectors

PASSIVE COMPONENTS

NoTail™ Components (Summary Sheet)

General Photonics' NoTail™ components offer the advantages of short optical path delay and of eliminating the polarization fluctuations that accompany fiber pigtail movement. In addition, many of them include magnets for temporary mounting on optical tables. They are ideal accessories for use with various instruments.

Features:

- No pigtails
- Solid construction
- Easy to use and handle
- Easy to store and reuse

Applications:

- Laboratory
- Benchtop
- Prototypes
- Polarization maintaining applications
- Instrumentation

Tech Info:

- Optical Coherence Tomography Technologies

Available Components:

NoTail™ Circulator

NoTail™ PM Coupler

NoTail™ PBC/PBS

NoTail™ Drop-in Coupler

NoTail™ Faraday Mirror

NoTail™ PM/SM Isolator

NoTail™ In-Line Polarizer

NoTail™ Drop-in Coupler (NTC)

These connectorized couplers are free of fiber pigtails and ready to be inserted in optical systems without the headaches of tinkering with fragile and messy fiber pigtails. Another important feature of these devices is the short optical path delay (~30 cm) between the input and the output, desirable in many systems where the optical path balance is important, such as interferometric systems, ultra-short pulse systems, and fiber laser systems. Additionally, these devices have four strong magnets mounted on the back for temporary but secure placement on standard optical tables.

Specifications:

Operating Center Wavelength	1310, 1550, or 1310/1550
Operating Bandwidth	±40 nm
Insertion Loss	See table below
Excess Loss	0.3 dB typical, 0.7 dB max.
Return Loss	FC/PC connectors: 50 dB, FC/APC connectors: 55 dB
PDL	0.1 dB typical
Thermal Stability	0.1 dB typical
Operating Temperature	0 to 70 °C
Storage Temperature	-40 to 85 °C
Fiber Type	SMF-28
Port Configuration	1 × 2 or 2 × 2
Dimensions	3.5" × 1.5" × 5/8" (L × W × H)

Note:
Values are referenced with connectors in table above.

Insertion Loss (IL) Table

Coupling Ratio	IL (Single Window)	IL (Dual Windows)
50/50	< 3.5/3.5	< 3.6/3.6
40/60	< 4.5/2.7	< 4.7/2.7
30/70	< 5.8/2.0	< 6.0/1.9
20/80	< 7.7/1.25	< 7.9/1.3
10/90	< 11.0/0.7	< 11.2/0.75
5/95	< 14.0/0.45	< 14.6/0.4
1/99	< 21.5/0.25	< 22.5/0.25

Note:
Values are referenced without connectors for IL table only.

Ordering Information:

NTC – □□ – □□ – □ – □

- **Wavelength:** 13 = 1310nm; 15 = 1550nm; 35 = 1310/1550nm
- **Configuration:** 12 = 1x2; 22 = 2x2
- **Coupling Ratio:** e.g. 10/90
- **Connector Type:** FC/PC, FC/APC, SC/PC, SC/APC

Features:

- Wide operating bandwidth
- Short optical path delay
- Compact and rugged design
- Easy to integrate into fiber optical systems
- Low excess loss
- High temperature stability

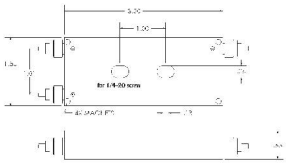
Applications:

- Power monitoring and sharing
- CATV
- Local area networks

Tech Info:

- Optical Coherence Tomography Technologies

Dimensions (in inches):



Polarization Maintaining Coupler (PMC & NPMC)

The polarization maintaining filter coupler can either split the light from an input PM fiber between 2 output PM fibers, or can combine light signals from 2 PM input fibers into a single PM output fiber. The device can be used to split high power linearly polarized light into multiple paths without perturbing the linear state of polarization (SOP). It can also be used as a power tap to monitor signal power in a PM fiber system without disturbing the linear SOP of the light propagating in the PM fiber. Applications include PM fiber interferometers, power sharing in polarization sensitive systems, and signal monitoring in PM fiber systems. The rugged stainless steel package is designed for high optical performance and stability. This compact device offers low excess insertion loss, low back reflection, and high extinction ratio. Split ratios from 1 to 50% are available.

Specifications:

Operating Center Wavelength	1550 nm, 1310 nm		1064 nm		
Operating Bandwidth	±40 nm		±20 nm		
Type	1 x 2	2 x 2	1 x 2	2 x 2	
Max. Excess Loss[1]	0.7 dB	1.0 dB	0.8 dB	1.2 dB	
Max. Uniformity	0.6 dB	0.8 dB	0.6 dB	0.8 dB	
Min. Extinction Ratio[2]	20 dB	18 dB	20 dB	18 dB	
Return Loss	50 dB		Split Ratio Tolerances:		
Split Ratio	1 ~ 50%		1 x 2	2 x 2	
Optical Power Handling	300 mW min.		99/1:	± 0.2%	± 0.2%
Operating Temperature	-5 to 70 °C		98/2:	± 0.4%	± 0.4%
Storage Temperature	-40 to 85 °C		95/5:	± 1%	± 1%
Fiber Type	PM fiber		90/10:	± 2%	± 2%
Dimensions	Pigtailed: Ø 5.5 × 35 mm		50/50:	± 7.5%[3]	± 10%
	NoTail: 3.5" (L) × 1.5" (W) × 5/8" (H)				

Notes:
Values in table are for filter couplers without connectors. Specs for fused fiber couplers may be different.

1. Excess loss for NoTail™ version is < 0.1 dB higher than for the corresponding pigtailed version, excluding connectors.
2. Extinction ratio can be higher for fast-axis blocked version.
3. ± 8% for 1064 nm version.

Features:

- Compact size
- Low insertion loss
- Low back reflection
- Rugged design

Applications:

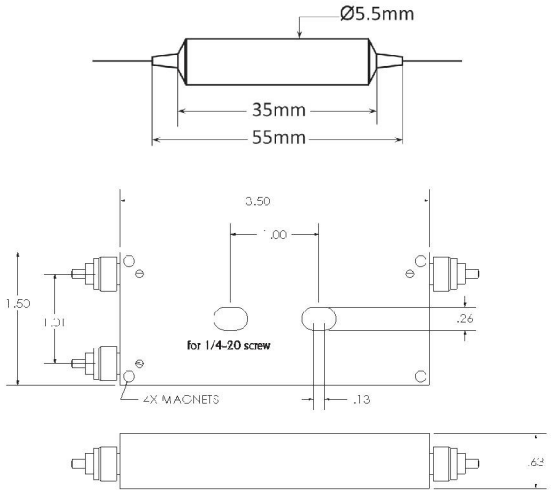
- Power sharing in PM systems
- Power monitoring in PM systems
- PM fiber interferometers
- R&D laboratories

Tech Info:

- Optical Coherence Tomography Technologies

Polarization Maintaining Coupler (PMC & NPMC)

Dimensions:



Ordering Information:

PMC — (Pigtailed) – □□ – □ – □□ – ▭ – □□ – ▭

- **Wavelength:** 10 = 1064, 13 = 1310nm, 15 = 1550nm
- **Type:** T = Filter, C = Crystal, F = Fused Fiber
- **Configuration:** 12 = 1 x 2, 22 = 2 x 2
- **Coupling Ratio:** xx/yy, e.g. 10/90
- **Pigtail Type:** 25 = 250 µm*, 90 = 900 µm
- **Connector Type:** FC/PC, FC/APC, SC/PC,SC/APC, NC

Note:
* Connectors not recommended with bare fiber pigtails.

NPMC — (NoTail) – □□ – □ – □□ – ▭ – ▭

- **Wavelength:** 10 = 1064, 13 = 1310nm, 15 = 1550nm
- **Type:** T = Filter, C = Crystal, F = Fused Fiber
- **Configuration:** 12 = 1 x 2, 22 = 2 x 2
- **Coupling Ratio:** xx/yy, e.g. 10/90
- **Connector Type:** FC/PC, FC/APC, SC/PC,SC/APC

Polarization Beam Combiner/Splitter (PB & NPB)

This device can be used either as a polarization beam combiner to combine light beams from two PM input fibers into a single output fiber, or as a polarization beamsplitter to split light from an input fiber into two output fibers of orthogonal polarization states. An important application of this device is polarization division multiplexing or demultiplexing in optical systems to increase their transmission capacity. In addition, as a pump combiner in optical amplifiers, the device efficiently combines the output from two pump lasers into a single fiber to increase the optical amplifier's saturation power and to reduce its polarization sensitivity. The wide operation bandwidth and high power handling capability make the device very attractive for next-generation amplifier systems. Finally, with a rugged stainless steel package designed for high optical performance and stability, this compact device offers low excess insertion loss, low back reflection, and high extinction ratio that equal or surpass others on the market.

Specifications:

Center Wavelength	1310, 1480, 1550 nm	1064 nm
Common Port Fiber Option	SMF-28 or PM Panda	HI 1060 or PM Panda
Operating Bandwidth	±40 nm	±20 nm
Insertion Loss[1]	0.4 dB typical 0.6 dB max.	0.6 dB typical 0.8 dB max.
Extinction Ratio (ER) (PBS Only)	22 dB	22 dB
Return Loss	50 dB	
Optical Power Handling[2]	500 mW	
Operating Temperature	-5 to 70 °C	
Storage Temperature	-40 to 85 °C	
Fiber type (Single Polarization Ports)	PM Panda Fiber	
Dimensions Pigtailed	Ø 5.5 × 35 mm	
Dimensions NoTail	3.5" (L) × 1.5" (W) × 5/8" (H)	

Notes:
Values are referenced without connectors.
1. Insertion loss for NoTail version is <0.1 dB higher than corresponding pigtailed device, excluding connectors.
2. Higher power handling available by special request.

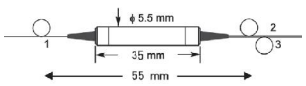
Features:

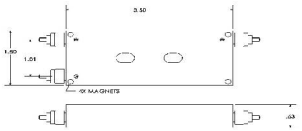
- Compact size
- Low insertion loss
- High power handling
- Rugged design

Applications:

- Polarization division Mux/DeMux
- EDFA and Raman amplifiers
- Fiber Laser Systems
- Fiber Sensor Systems
- Instruments
- R&D Laboratories

Dimensions:





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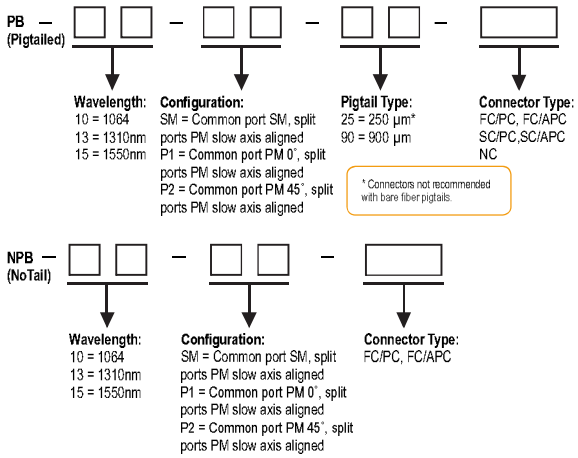


Faraday Rotator Mirror (FRM & NFRM)

The Faraday rotator mirror is a fiber optic polarization rotation mirror designed for fiber optic networks and measurement applications. The state of polarization (SOP) of the reflected light is rotated 90 degrees from that of the input light. A unique property of Faraday rotator mirrors is that at any point along the fiber, the SOPs of the forward going and reflected light are always orthogonal to each other, regardless of the birefringence of the fiber. Therefore, when properly used, the device can help to eliminate polarization sensitivity in optical fiber systems. Applications include eliminating polarization-induced fluctuations in fiber interferometers, Brillouin amplifier systems, fiber laser systems, and fiber optic antenna remoting systems. The FRM's optical path is epoxy free and thus offers low insertion loss and high temperature stability. We also offer the NoTail™ version, which eliminates unwanted optical path delay and pigtail handling problems.

Specifications:

Operating Wavelength	1550 nm, 1310 nm	1064 nm
Operating Bandwidth	±50 nm	±5 nm
Insertion Loss	0.4 dB typical 0.6 dB max.	3.0 dB max.
Faraday Rotation Angle (single pass)	45 degrees	45 degrees
Rotation Angle Tolerance (Center Wavelength at 23 °C)	±2 degrees	±6 degrees
Rotation Angle Wavelength Dependence	-0.14 deg/nm (1550nm) -0.17 deg/nm (1310nm)	-0.26 deg/nm
Rotation Angle Temperature Dependence	-0.13 deg/°C (1550nm) -0.08 deg/°C (1310nm)	-0.14 deg/°C
PDL	0.1 dB	0.1 dB
PMD	0.05 ps	0.05 ps
Optical Power Handling	300 mW min.	150 mW
Operating Temperature	0 to 70 °C	-5 to 50 °C
Storage Temperature	-40 to 85 °C	-40 to 85 °C
Fiber Type	SMF-28	HI 1060 Fiber
Dimensions	Ø 3.8 x 22mm (pigtailed) Ø 9.5 × 50 mm (NoTail™)	Ø 3.8 x 22mm (pigtailed)

Note:
Values are referenced without connectors

Features:

- Compact size
- Low insertion loss
- High stability
- Rugged design
- NoTail™ model available

Applications:

- Polarization sensitivity elimination in:
- Fiber interferometers & sensors
- Fiber laser systems
- Brillouin amplifiers
- Fiber optic antenna remoting systems
- Fiber optic modules

Tech Info:

- Optical Coherence Tomography Technologies
- Faraday Rotator Mirror Application Note

Faraday Rotator Mirror (FRM & NFRM)

Typical Performance Data:

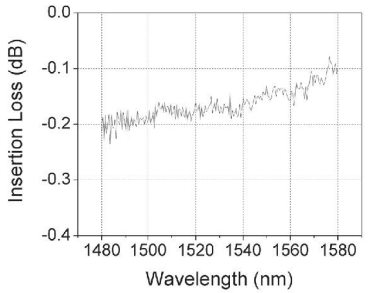
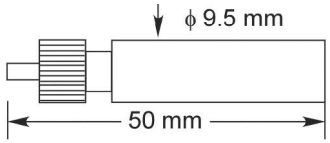


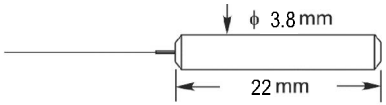
Figure 1. Insertion loss vs. wavelength

Dimensions:

NoTail:



Pigtailed:



Ordering Information:

FRM – (Pigtailed) – – –

- Wavelength: 10 = 1064, 13 = 1310nm, 15 = 1550nm
- Pigtail Type: 25 = 250 µm*, 90 = 900 µm
- Connector Type: FC/PC, FC/APC, SC/PC,SC/APC, NC

NFRM – (NoTail) – –

- Wavelength: 13 = 1310nm, 15 = 1550nm
- Connector Type: FC/PC, FC/APC

Note:
* Connectors not recommended with bare fiber pigtails.

In-line Polarizer (POL & NPOL)

This in-line polarizer is designed for fiber optic networks and measurement applications. Applications include polarization analysis, polarization monitoring and control, SNR monitoring, PMD monitoring, spectrum filtering and control, polarization extinction ratio improvement, fiber laser mode-locking, and polarization interferometry. When combined with a polarization controller, the polarizer can function as a variable optical attenuator to adjust the optical power in the fiber. It integrates a high-ER micro-polarizer in a rugged stainless steel package for high optical performance and stability. This compact device offers low insertion loss, low back reflection, and high extinction ratio. Both pigtailed and NoTail™ versions are available. The unique NoTail™ package has the advantage of eliminating polarization disturbances caused by fiber pigtails.

Specifications:

Operating Wavelength		1550, 1310 nm	1064 nm
Operating Bandwidth		±50 nm	±30 nm
Insertion Loss[1]		0.3 dB typical 0.5 dB max.	0.4 dB typical 0.6 dB max.
Return Loss		50 dB	50 dB
Extinction Ratio	SM Output	40 dB typical, 30 dB min.	30 dB typical, 28 dB min
	PM Output	30 dB typical, 28 dB min.	
Optical Power Handling		300 mW min.	
Operating Temperature		0 to 70 °C	
Storage Temperature		-40 to 85 °C	
Fiber Type		SM: SMF-28 or HI 1060	
		PM: PM Panda fiber	
Dimensions		Ø 5.5 × 35 mm (pigtailed) Ø 9.5 × 65 mm (NoTail™)	

Note:
Values are referenced without connectors.
1. Insertion loss for NoTail™ version can be up to 0.1 dB higher, excluding connector loss.

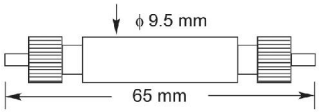
Features:

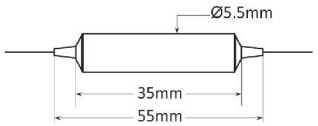
- Compact size
- Low insertion loss
- High extinction ratio
- Low back reflection
- Rugged design
- NoTail™ model available

Applications:

- Eliminating unwanted polarization state
- PMD monitoring
- Polarization interferometer

Dimensions:





Ordering Information:

POL – (Pigtailed) – – – –

- Wavelength: 10 = 1064, 13 = 1310nm, 15 = 1550nm
- Fiber Type: SS = SM to SM, SP = SM to PM, PP = PM to PM
- Pigtail Type: 25 = 250 µm*, 90 = 900 µm
- Connector Type: FC/PC, FC/APC, SC/PC,SC/APC, NC

NPOL (NoTail) – – – –

- Wavelength: 13 = 1310nm, 15 = 1550nm
- Fiber Type: SS = SM to SM, SP = SM to PM, PP = PM to PM
- Connector Type: FC/PC, FC/APC

Note:
* Connectors not recommended with bare fiber pigtails.

These isolators are the smallest in size but the highest in quality in the market. They are ruggedly built to function reliably in a wide variety of environments. Small size, low loss, and low back reflection combine to make these isolators ideal for integration in many fiber optic systems. We also offer the NoTail™ version to eliminate the problems that pigtails can cause. The short optical path (~ 7cm) of the NoTail™ isolator is desirable for ultra-short pulse and interferometric applications.

Specifications:

Operating Center Wavelength		1550 nm, 1310 nm		1064 nm	
Type		Single Stage	Double Stage	Single Stage	Double Stage
Operating Bandwidth		±20 nm	±20 nm	±5 nm	±5 nm
Peak Isolation		> 40 dB	> 52 dB	40 dB (SM)	55 dB (SM)
				38 dB (PM)	55 dB (PM)
Min. Isolation at 23°C		> 30 dB	> 45 dB	30 dB (SM)	45 dB (SM)
				35 dB (PM)	45 dB (PM)
Insertion Loss[1]	Typ	0.4 dB	0.5 dB	1.5 dB	2.4 dB
	Max	0.6 dB	0.7 dB	2.0 dB	3.4 dB
Return Loss (Input/Output)	SM	> 60/55 dB	> 60/55 dB	> 55/50 dB	> 55/50 dB
	PM	> 55/50 dB	> 55/50 dB		
PMD (SM)		< 0.2 ps	< 0.05 ps		
PDL (SM) at 23°C		< 0.05 dB	< 0.05 dB	0.15 dB	0.15 dB
Extinction Ratio (PM)		>20dB both axes open >25dB fast axis blocked	>20dB both axes open >25dB fast axis blocked	>20dB both axes open >23dB fast axis blocked	>20dB both axes open >23dB fast axis blocked
Optical Power Handling		300 mW		300 mW	
Operating Temperature		0 to 70 °C		-5 to 50 °C	
Storage Temperature		-40 to 85 °C		-40 to 85 °C	
Fiber Type		SM: SMF-28		SM: HI 1060	
		PM: PM Panda		PM: PM Panda	
Dimensions		Ø5.5 × 35 mm (pigtailed)		Ø5.5 × 35 mm (pigtailed)	
		Ø9.5 × 65 mm (NoTail™)		NA	

Notes:
Values are referenced without connectors.
1. Insertion loss for NoTail™ version can be up to 0.1 dB higher, excluding connector loss.

In-line Isolator (ISO & NISO)

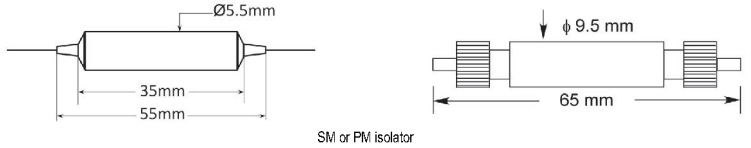
Features:

- Polarization insensitive or polarization maintaining
- NoTail™ model available
- Low loss and low reflection
- Compact size
- Environmentally stable
- High quality

Applications:

- Fiber optic amplifier
- WDM systems
- Transmitters and fiber lasers
- R&D laboratories

Dimensions:



SM or PM isolator

Ordering Information:

ISO (Pigtailed) – □ – □□ – □ – □□ – □

- **Stages:** S = Single, D = Double
- **Wavelength:** 10 = 1064, 13 = 1310nm, 15 = 1550nm
- **Fiber Type:** SS = SM to SM, PP1 = PM, both axes open, PP2 = PM, fast axis blocked
- **Pigtail Type:** 25 = 250 µm*, 90 = 900 µm
- **Connector Type:** FC/PC, FC/APC, SC/PC, SC/APC, NC

Note:
* Connectors not recommended with bare fiber pigtails.

NISO (NoTail) – □ – □□ – □ – □

- **Stages:** S = Single, D = Double
- **Wavelength:** 13 = 1310nm, 15 = 1550nm
- **Fiber Type:** SS = SM to SM, PP1 = PM, both axes open, PP2 = PM, fast axis blocked
- **Connector Type:** FC/PC, FC/APC

General Photonics' fiber optic circulators are compact, high-performance light-wave components that separate signals traveling in opposite directions along fibers by transmitting signals from port 1 to port 2 and port 2 to port 3, while blocking signals traveling in the opposite directions. They offer excellent performance characteristics, including low insertion loss and high isolation. They are ideal components for add/drop filters, EDFAs, dispersion compensation, bi-directional communication and other applications.

Specifications[1]:

Center Wavelength	1310, 1550 nm		1064 nm	
Fiber Type	SM	PM[4]	SM	PM
Bandwidth	±20 nm	±30 nm	±5 nm	±5 nm
Insertion Loss[2]	0.6 dB typical 0.8 dB max.	0.7 dB typical 0.9 dB max.	1.8 dB typical 2.2 dB max.	1.8 dB typical 2.1 dB max.
Return Loss	50 dB	55 dB	50 dB	50 dB
PDL at 23°C	0.1 dB	N/A	0.2 dB	N/A
PMD	0.1 ps	N/A	0.1 ps	N/A
Extinction Ratio	N/A	22 dB min.	N/A	20 dB min.
Isolation (2 → 1 or 3 → 2, 23 °C)	50 dB typical 40 dB min.		25 dB typical 20 dB min.	30 dB typical 25 dB min
Cross Talk	50 dB		45 dB	50 dB
Optical Power Handling	300 mW			
Operating Temperature	0 to 70 °C		0 to 50 °C	
Storage Temperature	-40 to 85 °C			
Dimensions	Ø 5.5 x 50 mm (SM pigtailed, 1310 or 1550 nm) 34 x 8.4 x 8.4 mm (L x W x H) (SM 1064 nm) Ø 5.5 x 35 mm (PM pigtailed) 3.5" (L) x 1.5" (W) x 5/8" (H) (NoTail™)[3]			

Notes:
1. Values are referenced without connectors
2. Insertion loss for NoTail™ version can be 0.1 dB + connector loss higher.
3. 1064 nm SM version not available in NoTail configuration.
4. Standard configuration for PM circulators is fast axis blocked. Versions with both axes open may be available, but with different package size and specs.

Features:

- High quality and attractively priced
- Compact
- Exceptional environmental stability
- Low excess loss
- NoTail™ model available

Applications:

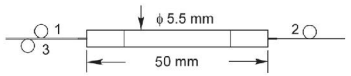
- Add-drop filter
- Digital, hybrid and AM-video system
- Dispersion compensator
- Fiber sensors
- Bi-directional communication

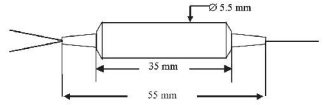
Tech Info:

- Optical Coherence Tomography Technologies

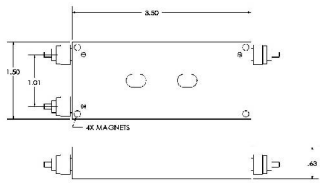
3-Port Fiber Optic Circulator (CIR & NCIR)

Dimensions:





PM package



NoTail™ package

Ordering Information:

CIR – (Pigtailed) – □□ – □□ – □□ – □

Wavelength	Configuration	Pigtail Type	Connector Type
10 = 1064nm 13 = 1310nm 15 = 1550nm	SM = SM in/out P1 = PM w. both axes open P2 = PM w. fast axis blocked	25 = 250 µm* 90 = 900 µm	FC/PC, FC/APC SC/PC,SC/APC NC

Note:
* Connectors not recommended with bare fiber pigtails.

NCIR – (NoTail) – □□ – □□ – □

Wavelength	Configuration	Connector Type
13 = 1310nm 15 = 1550nm	SM = SM in/out P2 = PM w. fast axis blocked	FC/PC, FC/APC

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