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FIXED ATTENUATORS AND ATTENUATING FIBER PATCHCORD
(PATENT: CANADA 2,494,133, USA 7095931, 7295731 AND CHINA 1672073)

Features:

- Low backreflection
- Wide wavelength range
- Polarization insensitive
- Compact and rugged housings
- Wide range of connectors/receptacles
- Hybrid style attenuator uses attenuating fiber
- Attenuating fiber patchcords utilize a new patented technique which is not based on **fusion splice.**
- Mode independent multimode loopback attenuators
- Designed to meet Telcordia requirements
- **Low cost**

Applications:

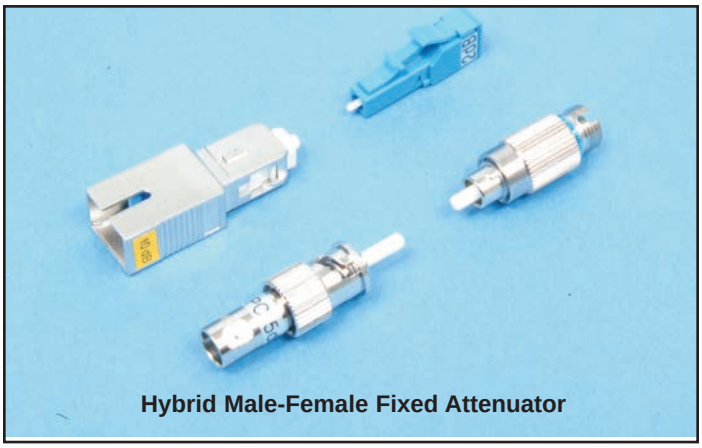
- Optical power equalization
- CATV, LAN, and telecommunications
- Test and measurement
- Channel balancing for WDM systems
- Receiver padding
- Optical transmission systems

Product Description:

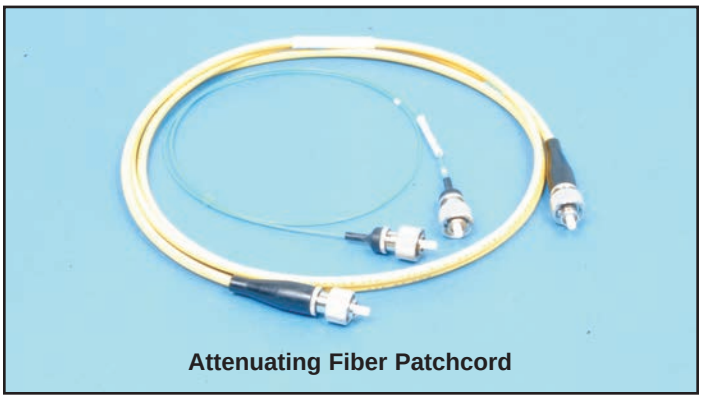
OZ Optics' line of low cost fixed attenuators are available in four different configurations (hybrid male to female, attenuating fiber patchcord, bulkhead receptacle and loopback) to best suit your particular application. Each configuration has its own strengths. The hybrid type is ideal for reducing the intensity of a signal just prior to going into a receiver. They are also available with different connector types on the input and output. The attenuating fiber patchcord is ideal for high power applications and can be easily installed into fiber splice enclosures. The receptacle style is ideal when two male connectors need to be mated with a fixed attenuator. Finally, the loopback style attenuator is intended for patch panel installations.

The Attenuating Fiber Advantage: OZ Optics has recently enhanced its fixed attenuator product line by developing a new technology to precisely attenuate signals in fibers. This patent pending, fully automatable technique allows one to create fixed attenuators within any standard fiber, with low polarization dependent loss (PDL) and high power handling. The resultant attenuating fiber is physically identical in appearance and behaviour to the original fiber, allowing it to be used to build patchcords or male-female hybrid attenuators. As the process used does not require the manufacture of special fiber, fixed attenuators can be constructed in small batch quantities economically. At the same time the automation aspect of the techniques allows large quantity orders to be manufactured at a cost as low as a dollar per unit.

Attenuating fiber can be made from either singlemode and polarization maintaining (PM) fiber. PM attenuating fiber

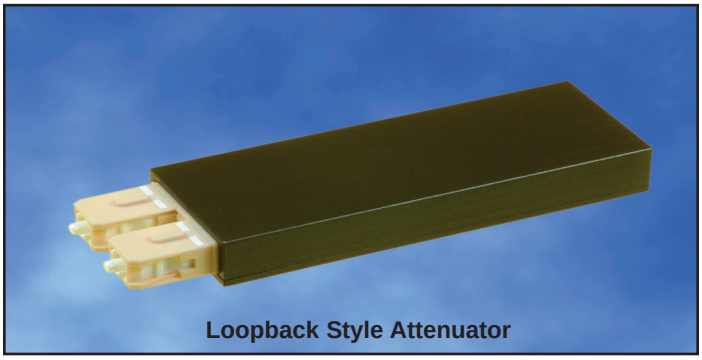


Hybrid Male-Female Fixed Attenuator



Attenuating Fiber Patchcord

Receptacle Style Attenuator



Loopback Style Attenuator

maintains polarization to better than 25dB. Multimode fiber attenuators can also be made this way, provided the light travelling through the fiber is incoherent and uniformly excites the fiber modes. Attenuating fiber is capable of handling up to 2 Watts of optical power at 1550nm. The attenuator creation technique can also be used to build attenuators directly onto fibers inside devices, allowing one to precisely trim the output signal strength from an optical device. The attenuating section is only a couple of millimetres to a couple of centimeters long, depending on the attenuation. The attenuator creation technique can be used to manufacture components with built in attenuators on the factory floor. OZ Optics offers to license our new technology to interested parties.

Some hybrid type attenuators on the market show light scattered into the cladding (cladding modes) in their output. These cladding modes can be picked up by many receivers when directly attached. If the attenuator is instead connected to a second fiber, these cladding modes will be absorbed with distance. Consequently the measured attenuation from these attenuators will depend on whether the attenuator will be connected to a receiver or another fiber. In contrast, the singlemode plug type attenuators offered by OZ Optics use attenuating fibers that are specially doped to reduce the intensity of the light. The fiber used in OZ attenuators also features a double cladding, with an absorbing dopant in the inner cladding layer. This double cladding structure effectively suppresses light scattering into the cladding. Thus the readings will not significantly depend on the application. This is a key advantage of the OZ Optics singlemode hybrid style fixed attenuator. (Note: Multimode plug style attenuators do show cladding modes.) These attenuators have been tested in accordance with Telcordia standards.

Hybrid male-female attenuators and attenuating patchcords are available with between 0.5 to 20 dB attenuation, in 0.1dB increments. Higher attenuation levels and higher resolution attenuation steps are possible. Attenuators can be made for operating wavelengths from 488nm to 1650nm. Prototype and custom designs can be made quickly and in small volumes economically.

Bulkhead receptacle style fixed attenuators also use attenuated doped fiber and are available in female to female configurations for FC, SC and ST types.

Finally, OZ Optics multimode loopback attenuators use a special attenuating filter inside. This provides uniform attenuation, regardless of the source being used. Many other loopback style fixed attenuators on the market use a high loss splice to attenuate the light. In multimode fibers this method is not recommended because the attenuation of the splice will greatly depend on the launch conditions from the source. Our loopback style attenuators avoid this problem.

Standard Product Specifications

Model	FA-300	FA-500	FA-400	PFA
Attenuation Method	Plug Type	Receptacle Type	Loopback	Patchcord
Attenuation Range	1dB to 25dB			0.5dB to 20dB
Attenuation Tolerance	1-5dB: ±0.5dB 6-10dB: ±0.7dB Over 10dB: ±1.0dB			
Polarization Dependent Loss (PDL)	±0.1dB		±1% of the specified attenuation, in dB	
Available Wavelengths	1240-1625 nm		440-1625 nm	
Return Losses	50dB (Ultra PC finish connectors) or 60dB (APC finish connectors) for SM & PM fibers			
Operating Temperature	-40°C to +75°C			
Power Handling	500 mW		50 mW (MM)	up to 2 Watts

Additional Product Specifications for Patchcord Style Attenuators

Specification	Value
Polarization Extinction Ratio	>25dB (> 30 dB versions available on request)
Return Loss[1]	> 50 dB
Standard Available wavelengths[2]	1310, 1480, 1550, 1625, 2050 nm
Wavelength dependence	±0.1 dB over a ±40 nm range
Polarization Dependent Loss (PDL)	< 0.2dB
Power handling	>1.5 Watts at 1550 nm
Operating Temperature	-10 to +80°C
Storage Temperature	-40 to +80°C
Relative Humidity	< 85% RH non condensing at 50°C

[1] Return losses do not include connector return losses.

[2] Attenuation constant over a ±40 nm range at telecommunications wavelengths.

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Ordering Information For Standard Parts

Bar Code	Part Number	Description
4293	FA-300-3A3A-1300/1550-9/125-S-5-M1	Plug type, singlemode 5dB fixed attenuator at 1300/1550 nm with male to female FC/APC connectors.
4295	FA-300-3A3A-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female FC/APC connectors.
4296	FA-300-3A3A-1300/1550-9/125-S-15-M1	Plug type, singlemode 15dB fixed attenuator at 1300/1550 nm with male to female FC/APC connectors.
4311	FA-300-3U3U-1300/1550-9/125-S-5-M1	Plug type, singlemode 5dB fixed attenuator at 1300/1550 nm with male to female FC/Ultra PC connectors.
4125	FA-300-3U3U-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female FC/Ultra PC connectors.
4313	FA-300-3U3U-1300/1550-9/125-S-15-M1	Plug type, singlemode 15dB fixed attenuator at 1300/1550 nm with male to female FC/Ultra PC connectors.
4314	FA-300-SCASCA-1300/1550-9/125-S-5-M1	Plug type, singlemode 5dB fixed attenuator at 1300/1550 nm with male to female SC/APC connectors.
4315	FA-300-SCASCA-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female SC/APC connectors.
4316	FA-300-SCASCA-1300/1550-9/125-S-15-M1	Plug type, singlemode 15dB fixed attenuator at 1300/1550 nm with male to female SC/APC connectors.
4302	FA-300-SCUSCU-1300/1550-9/125-S-5-M1	Plug type, singlemode 5dB fixed attenuator at 1300/1550 nm with male to female SC/Ultra PC connectors.
4304	FA-300-SCUSCU-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female SC/Ultra PC connectors.
4305	FA-300-SCUSCU-1300/1550-9/125-S-15-M1	Plug type, singlemode 15dB fixed attenuator at 1300/1550 nm with male to female SC/Ultra PC connectors.
13529	FA-300-LCULCU-1300/1550-9/125-S-5-M1	Plug type, singlemode 5dB fixed attenuator at 1300/1550 nm with male to female LC/Ultra PC connectors.
13530	FA-300-LCULCU-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female LC/Ultra PC connectors.
13531	FA-300-LCULCU-1300/1550-9/125-S-15-M1	Plug type, singlemode 15dB fixed attenuator at 1300/1550 nm with male to female LC/Ultra PC connectors.
20167	FA-300-8U8U-1300/1550-9/125-S-5-M1	Plug type, singlemode 5dB fixed attenuator at 1300/1550 nm with male to female ST/Ultra PC connectors.
18422	FA-300-8U8U-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female ST/Ultra PC connectors.
20168	FA-300-8U8U-1300/1550-9/125-S-15-M1	Plug type, singlemode 15dB fixed attenuator at 1300/1550 nm with male to female ST/Ultra PC connectors.
11610	FA-400-SC-850-50/125-M-5	Loopback style 5dB fixed attenuator at 850 nm with 50/125micron multi mode fiber and SC/Super PC male connectors.
12845	FA-400-SC-850-62.5/125-M-3	Loopback style 3dB fixed attenuator at 850 nm with 62.5/125 micron multi mode fiber and SC/Super PC male connectors.
17771	PFA-3A3A-1550-8/125-3-0.5-P-5-HP	High power inline 5dB fixed attenuator at 1550 nm with 0.5 meter long, 3 mm OD cabled, 8/125 micron PM fiber with FC/Angle PC connectors on both ends.
17595	PFA-3A3A-1550-8/125-3-0.5-P-10-HP	High power inline 10dB fixed attenuator at 1550 nm with 0.5 meter long, 3 mm OD cabled, 8/125micron PM fiber with FC/Angle PC connectors on both ends.
21769	PFA-SCSC-1550-9/125-3-1-S-10-HP	High power inline 10dB fixed attenuator at 1550 nm with 1 meter long, 3 mm OD cabled, 9/125µ SM fiber with SC/Super PC connectors on both ends.
4100	PFA-XX-1300-9/125-3-1-S-5	Pigtail style 5dB fixed attenuator at 1300 nm with 1 meter long, 3 mm OD jacketed single mode unterminated fiber on both ends.
4074	PFA-XX-1300-9/125-3-1-S-10	Pigtail style 10dB fixed attenuator at 1300 nm with 1 meter long, 3 mm OD jacketed single mode unterminated fiber on both ends.
14209	PFA-XX-1300-9/125-3-1-S-15	Pigtail style 15dB fixed attenuator at 1300 nm with 1 meter long, 3 mm OD jacketed single mode unterminated fiber on both ends.

Ordering Examples For Standard Parts

Example 1:

A customer needs to reduce the signal power from fiber by 10dB before the receiver. The fiber in the system has an FC/PC male connector. The signal wavelength is 1550 nm. The OZ Optics bar code number and description of the attenuator for this application is as follows:

Bar Code	Part Number	Description
4295	FA-300-3A3A-1300/1550-9/125-S-10-M1	Plug type, singlemode 10dB fixed attenuator at 1300/1550 nm with male to female FC/APC connectors.

Example 2:

A customer needs to reduce by 5dB the signal power from a polarization maintaining fiber that has an angle FC/PC connector before it enters a receiver, which also has an angle FC receptacle. The signal wavelength is 1550 nm, and the power is in excess of 1 Watt. The OZ Optics bar code number and description of the attenuator for this application is as follows:

Bar Code	Part Number	Description
17771	PFA-3A3A-1550-8/125-3-0.5-P-5-HP	High power inline 5dB fixed attenuator at 1550 nm with 0.5 meter long, 3 mm OD cabled, 8/125 micron PM fiber with FC/Angle PC connectors on both ends.

Questionnaire For Custom Parts:

1. What is your operating wavelength range?
2. Are you using polarization maintaining fiber? What type?
3. What level of attenuation do you require?
4. Do you need the ends of the fiber connectorized? What type of connector do you need?
5. How long should each end of the fiber be?
6. Do you need the fiber cabled? What cable size do you need?
7. What is the power level of your application?

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 a 25 piece 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.

Description **Part Number**

Hybrid Style Fixed Attenuator:

FA-300-*XY*-1300/1550-*a/b*-*F*-*N*-*M1*

X Y = Connector Code
(X for male, Y for female end):
3U = Ultra NTT-FC/PC
3A = Angled NTT-FC/PC
SCU = SC Ultra PC
SCA = Angled SC
LC = LC
8U = ST Ultra PC

a/b = Fiber core/cladding size in microns
singlemode: 9/125
multimode: 50/125, 62.5/125

N = Patchcord Attenuation:
1 for 1dB
2 for 2dB
...
20 for 20dB
25 for 25dB

F = Fiber type:
M=Multimode
S=Singlemode

Note: Hybrid style attenuators with angled finishes must have matching style connectors one each end (i.e. Angled NTT-FC/PC to Angled NTT-FC/PC, not Angled NTT-FC/PC to Angled SC or Angled NTT-FC/PC to Ultra NTT-FC/PC

Bulkhead Receptacle Style Fixed Attenuator:

FA-500-*X*-1300/1500-9/125-S-*N*

X = Receptacle Code:
3U = Ultra NTT-FC/PC
SCU = SC Ultra
8U = ST Ultra

N = Attenuation:
1 for 1dB
2 for 2dB
...
20 for 20dB
25 for 25dB

Loopback Plug Style Fixed Attenuator:

FA-400-*X*-*W*-*a/b*-*F*-*N*

X = Connector Code:
SCU = Ultra SC
SCA = Angle SC
3U = Ultra FC
3A = Angled FC
LC = Ultra

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

a/b = Fiber core/cladding size in microns
singlemode: 9/125
multimode: 50/125, 62.5/125, or 100/140

N = Attenuation:
1 for 1dB
2 for 2dB
...
20 for 20dB
25 for 25dB

F = Fiber type:
M=Multimode
S=Singlemode

Ordering Information For Custom Parts - continued

Description **Part Number**

Fiber Patchcord Inline Fixed Attenuator:

PFA-*XY*-*W*-*a/b*-*JD*-*L*-*F*-*N*

Connector Code: 3S = Super NTT-FC/PC
3U = Ultra NTT-FC/PC
3A = Angled NTT-FC/PC
8 = AT&T-ST
SC = SC
SCA = Angled SC
See Table 6 of the Standard Tables data sheet for other connectors

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

Fiber Core/Cladding size, in microns:
9/125 for 1300/1550nm SMF
See tables 1 to 5 of the Standard Tables for other standard fiber sizes

Fiber Jacket Type: 1 = 900 micron OD hytrel jacket
3 = 3 mm OD Kevlar reinforced PVC cable
See Table 7 of the Standard Tables data sheet for other jacket sizes

Patchcord Attenuation: 1 for 1dB
2 for 2dB
...
20 for 20dB
25 for 25dB

Fiber type: M = Multimode
S = Singlemode

Fiber length, in meters, on each side of the device.
Example: To order 1 meter of fiber at the input and 7 meters at the output, replace " L" with 1,7

Note: Add **-**(HP) to the end of the part number for attenuated high power patchcord style.

Ordering Examples for Custom Parts

1. A customer needs a mode independent Loopback 10dB attenuator at 1300 nm for a multimode application. Core/cladding size should be 50/125: and requires SC connectors. OZ part number will be: **FA-400-1300-50/125-M-10**
2. A 20dB inline fixed attenuator is required for 9/125 singlemode fiber, with an operating wavelength of 1300 nm. The input connector is to be a male angled FC connector, while the output connector is a male SC connector. Fiber length 2 meters on each side. OZ part number will be: **PFA-3ASC-1300-9/125-3-2-S-20**
3. A customer needs 12dB attenuation between the patchcord and the receiver. This patchcord has an LC male connected while the receiver has a female LC receptacle. Working wavelength is C band. Then customer should order: **PFA-300-LCLC-1300/1550-9/125-12-S-M1**

Frequently Asked Questions (FAQs)

Q: Is the patchcord style attenuator a good choice for multimode applications?
A: The plug type or loopback type are better choices. The patchcord style uses a high loss splice. It will attenuate high order modes more than low order modes. Therefore the attenuation will depend on the launch conditions.

Q: Will I see the same attenuation with the patchcord attenuators at both 1300 nm and 1550 nm?
A: No. Because the mode field diameter is different for the different wavelengths, there is over 10% variation in the attenuation in dB with the change in wavelength.

Application Notes:

Example 1: Power Equalization in Optical Networks: A network installer often has to lower system powers in a complex network so that each receiver sees the optimum signal strength without being overloaded. To do this properly, the optical power from each fiber should be measured just before entering the corresponding receiver. The required attenuation can then be calculated for each channel, and the corresponding attenuator can be selected and installed. For instance, if each receiver is designed to work with between 0.5 mW (-3dBm) and 1 mW (0dBm) of optical power, and fiber one emits 20 mW (+13dBm), while fiber two emits 50 mW (+17dBm), then a 15dB attenuator can be used on fiber one, while a 20dB attenuator can be used for fiber two. The installer simply installs the matching plug style attenuator before each receiver.

Example 2: Patch Panel Attenuator Arrays: Patch panels are ideal locations for installing attenuation fiber patchcords. Quite often one needs to attenuate the incoming signals from many fibers entering a hub, in order to equalize the signals. Attenuating fiber patchcords provide a convenient means of introducing a fixed attenuation level in a fiber line, neatly arranged in a patch panel enclosure. In contrast, using hybrid male-to-female fixed attenuators requires using an additional fiber patchcord as well, adding complexity to the system, and potentialy increasing the chances of failure at a node.