

## VARIABLE FIBER OPTIC ATTENUATORS NEUTRAL DENSITY FILTER VERSION – PIGTAIL STYLE

### Features:

- Rugged and compact size
- Wide wavelength range
- Singlemode, polarization maintaining and multimode fiber versions
- Low Polarization Dependent Loss (PDL)
- Low wavelength dependence
- Mode insensitive attenuation
- Low backreflection
- Designed to meet Telcordia requirements
- Low cost

### Applications:

- Optical power equalization and power control for WDMs and multi-channel optically amplified networks
- Telecommunications
- CATV
- LAN
- Test and measurement
- Receiver padding
- Optical sensors

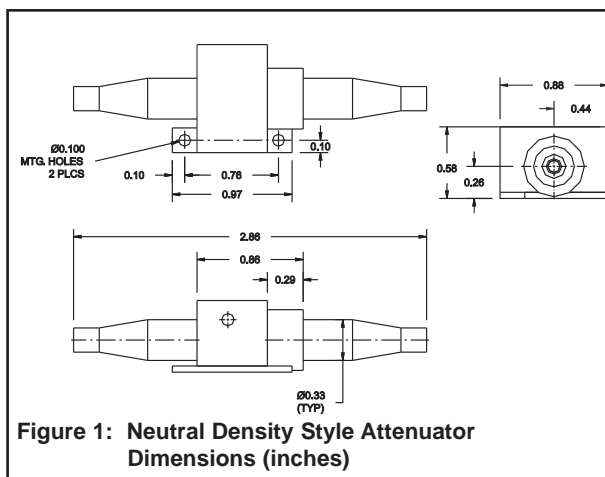
### Product Description:

OZ Optics offers a complete line of low cost, compact PC board mountable, pigtail style variable attenuators with low backreflection. These attenuators are designed to meet Telcordia requirements. These attenuators can be used for 1300nm and 1550nm, as well as for C (1520-1570nm), L (1570-1620nm) and S (1470-1520nm) bands, with minimal changes in the insertion loss. Mounting holes provide easy attachment to PC boards and patch panels. The mounting hole patterns and attenuator sizes can be modified to meet our customer requirements on OEM orders.

The attenuators consist of two baseplates. Each baseplate contains a fiber followed by a collimating lens. The attenuator is prealigned for optimum coupling efficiency using a patented tilt alignment technique. A variable neutral density filter is used to provide more uniform attenuation in multimode applications than the blocking screw technique. The attenuation is controlled by a turn screw on the side of the attenuator, which controls the position of the filter.

Variable attenuators based on the neutral density filter are ideal for multimode fiber applications where one may be concerned about modal noise. The term multimode means there is more than one path for light to travel inside a single fiber. These paths are known as modes. It does not mean the unit consists of multiple fibers in a bundle. When coherent laser light is coupled into multimode fiber, the output shows speckles. Bending the fiber causes the speckle pattern to change. If the losses in a system depend on which modes are excited, then changing the modes excited in the fiber changes the output power. This is known as modal noise. If the source being used is an LED, then one does not see speckles, and modal noise is not an issue. However, for laser sources, modal noise is an issue. When blocking style attenuators are used with multimode fiber, some modes are blocked, while others are transmitted. This can produce 1dB or greater modal noise fluctuations with coherent sources. A variable attenuator using a neutral density filter is not as strongly affected by modal noise. However, neutral density filter attenuators offer lower attenuation range (around 40dB) and can only handle about 50mW of power.

While generally used for multimode applications, OZ Optics can also produce singlemode and polarization maintaining versions. 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.



### Ordering Information For Standard Parts:

Bar Code	Part Number	Description
14050	BB-500-11-850-50/125-M-35-XX-3-1-ND	Pigtail style neutral density variable attenuator for 850nm with 1m long, 3mm OD jacketed unterminated 50/125 multimode fiber on both ends, 35dB return loss.
14051	BB-500-11-1300/1550-50/125-M-35-XX-3-1-ND	Pigtail style neutral density variable attenuator for 1300/1550nm with 1m long, 3mm OD jacketed unterminated 50/125 multimode fiber on both ends, 35dB return loss.
14052	BB-500-11-850-62.5/125-M-35-XX-3-1-ND	Pigtail style neutral density variable attenuator for 850nm with 1m long, 3mm OD jacketed unterminated 62.5/125 multimode fiber on both ends, 35dB return loss.
14053	BB-500-11-1300/1550-62.5/125-M-35-XX-3-1-ND	Pigtail style neutral density variable attenuator for 1300/1550nm with 1m long, 3mm OD jacketed unterminated 62.5/125 multimode fiber on both ends, 35dB return loss.
12459	BB-500-11-1300/1550-9/125-S-40-SCSC-3-1-ND	Pigtail style neutral density variable attenuator for 1300/1550nm with 1m long, 3mm OD jacketed single mode SC terminated fibers on both ends, 40dB return loss.

### Standard Product Specifications:

Model	BB-500-...ND	
Insertion loss:	Standard	< 1.5dB
	Low Loss Versions <sup>1</sup>	< 0.6dB <sup>2</sup>
Backreflection:	Singlemode or polarization maintaining	40, 50 or 60dB <sup>3</sup>
	Multimode	35dB
Power handling	Up to 50mW	
Attenuation range	Up to 40dB	
Wavelength dependence		
	From 1300nm to 1550nm:	< 0.3dB
	From 1520nm to 1620nm (C and L bands):	< 0.3dB
Available wavelengths	800 -1625nm	
Polarization sensitivity	±(0.1dB + 1% of the attenuation in dB)	
Extinction ratios <sup>4</sup>	< 20dB, < 25dB or < 30dB	

#### Notes:

<sup>1</sup> See Ordering Information for Custom Parts for details.

<sup>2</sup> For singlemode and PM fibers, with 60dB return losses only. For other fibers, wavelengths or backreflection, the loss is <1.0dB

<sup>3</sup> 60dB available only for singlemode or PM fibers and only for 1290 to 1625nm wavelengths.

<sup>4</sup> The standard extinction ratio is 20dB. For higher extinction ratios please refer to the section on ordering information for custom parts.

### Ordering Examples For Standard Parts:

A customer needs to buy a mode independent multimode attenuator at 1300/1550nm with 3mm OD cabled, 1m long on each side, 50/125 micron fiber with no connectors. He also also wants to get 35dB return loss from the unit.

Our standard part number will be:

Bar Code	Part Number	Description
14051	BB-500-11-1300/1550-50/125-M-35-XX-3-1-ND	Pigtail style neutral density variable attenuator for 1300/1550nm with 1m long, 3mm OD jacketed unterminated 50/125 multimodemode fiber on both ends, 35dB return loss.

## 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 10 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.

### Questionnaire For Customs Parts:

1. What is your operating wavelength?
2. What type of fiber do you wish to use?
3. What is the worst acceptable return loss?
4. What connectors, if any, do you need?
5. What should the fiber length and jacket diameter be?
6. How much power will be transmitted through the attenuator?
7. Would a beam blocking attenuator be better suited for your purposes?
8. Do you need a variable or fixed attenuation?
9. What environmental requirements do you need to meet?
10. Are there any special performance requirements that you need to meet?

### Neutral Density Style Attenuator: **BB-500-11-W-a/b-F-LB-XY-JD-L-ND**

**W** = Wavelength: Specify in nanometers:  
Example: 1300/1550 for 1300 and 1550nm wavelength ranges

**a/b** = Fiber core/cladding sizes, in microns  
9/125 for 1300/1550nm SM fiber.  
50/125, 62.5/125 are standard multimode sizes. See the OZ Standard Tables data sheet for other standard fiber sizes

**F** = Fiber type:  
S = Singlemode  
M = Multimode  
P = Polarization Maintaining (PM)

**LB** = Backreflection level:  
40, 50 or 60dB for singlemode and PM fibers, 35dB for multimode fibers

**Note 1:** For low loss attenuators add "LL" to the end of the part number.  
LL = 0.6dB with units that have 60dB return loss, LL = 1dB for rest of the attenuators.

**Note 2:** Add "-ER=25" or "-ER=30" for extinction ratios of 25 or 30dB respectively. If not specified, the extinction ratio for PM versions will be > 20dB.

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

**JD** = Fiber jacket type:  
1 = 900 micron OD hytrel jacket  
3 = 3mm OD Kevlar reinforced PVC cable. See the OZ Standard Tables data sheet for other jacket sizes

**X,Y** = Input & output connector codes:  
X = No connector  
3S = Super NTT-FC/PC  
3U = Ultra NTT-FC/PC  
3A = Angled NTT-FC/PC  
8 = AT & T-ST  
SC = SC  
SCA = Angled SC  
LC = LC/PC  
See the OZ Standard Tables data sheet for other connectors

### Ordering Examples for Custom Parts:

**Example 1:** A customer wants to order a multimode attenuator with a neutral density filter at 1300nm, with 2m long and 900 microns cabled, 50/125 micron fiber with FC/Super PC polished connectors on both ends and 35dB back reflection with low loss. The fiber is to be a total length of 4 meters, 900 microns cabled, and with the attenuators in the middle (ie. 2 meters on each end)  
The part number should be: **BB-500-11-1300/1550-50/125-M-35-3S3S-1-2-ND-LL**

**Example 2:** A customer wants to order a pigtailed variable attenuator at 850nm in a rectangular housing with 62.5/125 multimode fiber, 3m long at input, 2m long at output, 3mm OD cabled with neutral density filter, with no connectors and 35dB back reflection.  
The part number should be: **BB-500-11-850-62.5/125-M-35-XX-3-3,2-ND**

## Frequently Asked Questions (FAQs):

**Q:** What advantages or disadvantages does the neutral density version have over the beam blocking versions?

**A:** The neutral density version shows less mode dependence or modal noise in multimode applications. The beam blocking technique is naturally suited for high power applications, and can achieve greater attenuation levels.

**Q:** What do you mean by mode dependence and modal noise?

**A:** The term multimode means there is more than one path for light to travel inside a single fiber. These paths are known as modes. It does not mean the unit consists of multiple fibers in a bundle. When coherent laser light is coupled into multimode fiber, the output shows speckles. Bending the fiber causes the speckle pattern to change. If the losses in a system depend on which modes are excited, then changing the modes excited in the fiber changes the output power. This is known as modal noise. If the source being used is an LED, then one does not see speckles, and modal noise is not an issue. However, for laser sources, modal noise is an issue.

When blocking style attenuators are used with multimode fiber, some modes are blocked, while others are transmitted. This can produce 1dB or greater modal noise fluctuations with coherent sources. A variable attenuator using a neutral density filter is not as strongly affected by modal noise. However, neutral density filter attenuators offer lower attenuation range (around 40dB) and can only handle about 50mW of power.

**Q:** What are the standard numerical apertures (NA) for the fibers used in your attenuators? Should I specify the NA of the fiber when I'm ordering a pigtail style attenuator?

**A:** Please see our standard tables for detailed information on our fibers. If you want to use fiber that hasn't been specified in the standard tables then you should specify it when ordering.

**Q:** I ordered an attenuator with 60dB return loss but when I measured it my return losses are higher. Why?

**A:** If you ordered an attenuator with 60dB return loss with connectors, the back reflection will depend on what grade of connector you selected for your fibers. Typically only angle polished (APC) style connectors will give the desired return losses. The device itself has 60dB return loss (i.e. if you cut off the connectors and measured the return loss you will see it above 60dB) but if you picked only ultra PC finish connectors you may only see from 50 to 55dB return losses.

**Q:** Do 1300/1550nm attenuators work at other wavelengths?

**A:** Yes, they do. They can also be used for the S (1470-1520nm), C (1250-1570nm) and L (1570-1620nm) bands, with little variation in performance.

## Application Notes:

One of the important applications of attenuators is channel balancing in WDMs. Attenuators can be adjusted to different attenuation levels so that at the receiver end all signals produce similar power levels. Each channel may have different output levels. By using the attenuators to adjust the power level of each channel, one can balance the power.

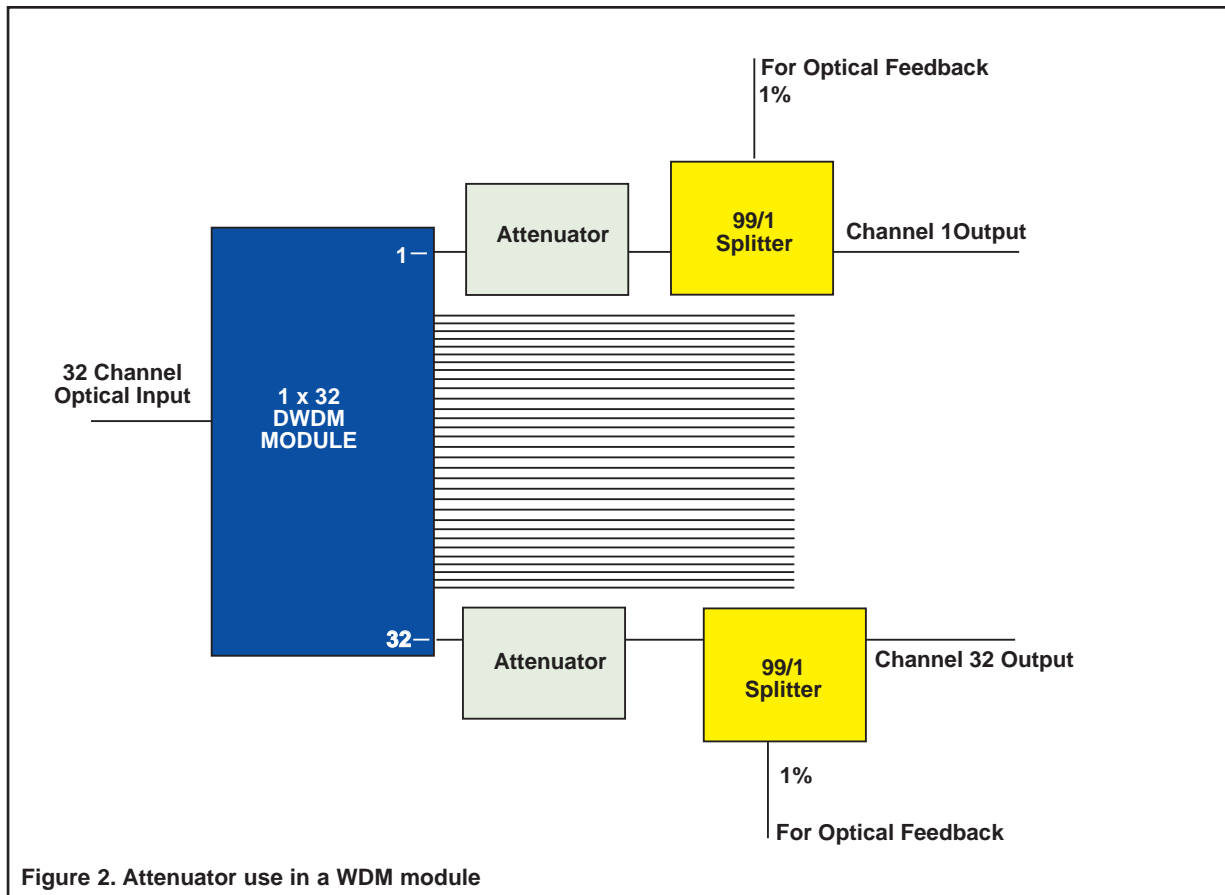


Figure 2. Attenuator use in a WDM module