

## FIXED NEUTRAL DENSITY ATTENUATORS EXPANDED BEAM STYLE

### Features:

- Mode Independent Attenuation Level
- Rugged and Compact Size
- Pigtail and Receptacle Styles
- Removable Filter Versions
- Wide Wavelength Range
- Singlemode, Polarization Maintaining, and Multimode Fiber Versions
- Expanded Beam Technology for flexible design
- Low Cost

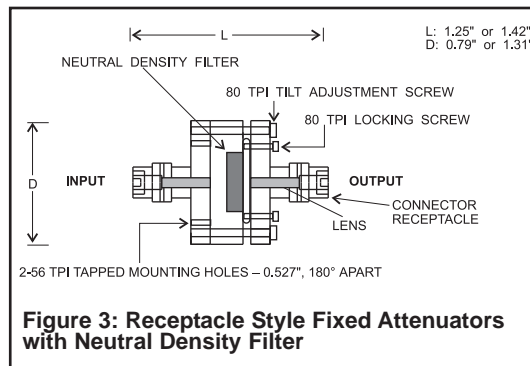
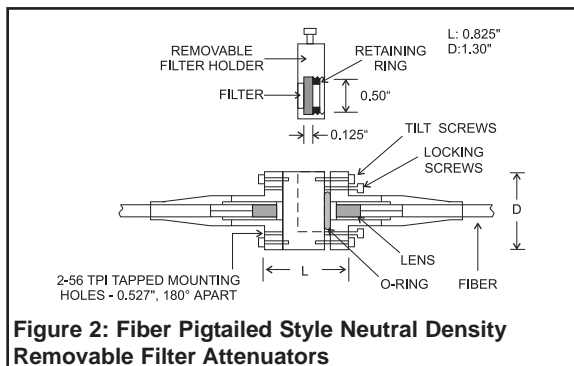
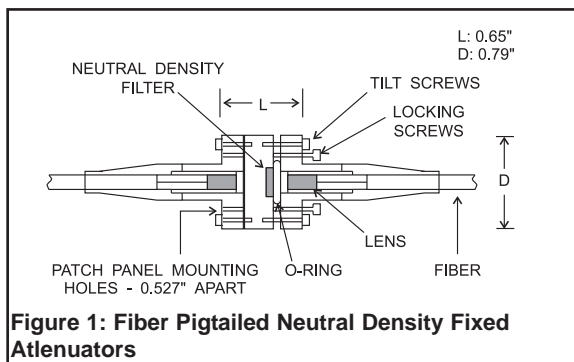
### Applications:

- CATV, LAN and Telecommunications use
- Receiver Padding
- Test and Measurement
- Optical Power Equalization
- Research & Design

### Product Description:

OZ Optics line of expanded beam style neutral density fixed attenuators are ideal for multimode applications and for applications where attenuating fibers are not available or usable. These attenuators provide mode independent fixed attenuation when used with multimode fibers. The insertion losses will not depend on how the light is launched into the fiber. This is a significant advantage over other attenuator designs.

The attenuators consist of a set of collimating and focusing optics and a central baseplate containing the filter. They can be ordered in receptacle or pigtail styles. The expanded beam design permits higher power handling than plug style attenuators. The filters themselves can be either permanent or removable. This provides great flexibility for experimentation.



## Standard Product Specifications:

| Version                            | Pigtail Style  |                               | Receptacle Style               |                               |
|------------------------------------|--|-------------------------------|--------------------------------|-------------------------------|
|                                    | Fixed Filter   | Removable Filter              | Fixed Filter                   | Removable Filter              |
| Attenuation                        | 5 dB to 30 dB, 5 dB increments                         |                               |                                |                               |
| Return Loss                        | 40 dB for Singlemode or PM Fibers, 35 dB for multimode |                               | 14 dB (Multimode offered only) |                               |
| Available Wavelengths <sup>1</sup> | 440-1625 nm  |                               |                                |                               |
| Attenuator Diameter                | 0.79" (20 mm)  | 1.31 "(33 mm)                 | 0.79" (20 mm)                  | 1.31 "(33 mm)                 |
| Filter size for removable filters  | N/A  | 12.7 mm diameter x 3 mm thick | N/A                            | 12.7 mm diameter x 3 mm thick |

## Questionnaire:

1. What is the power level of your application?
2. What is the operating wavelength?
3. Do you need a removable filter?
4. What fiber size are you using?

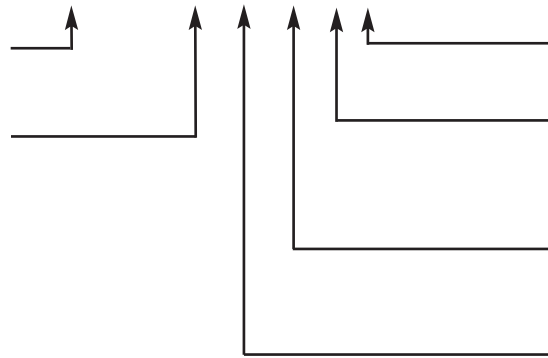
## Ordering Information Custom Parts:

### Receptacle Style

Body Type: ND for non-removable filters  
RND for removable filters

Connector Code: 3 = Flat, Super or Ultra  
FC/PC  
3A = Angled NTT-FC/PC  
8 = AT&T-ST  
SC = SC  
SCA = Angled SC  
See Table 6 of the OZ Standard Tables for other connectors

### ND-200-XY-W-a/b-F-N



Attenuation: 5 for 5 dB  
10 for 10 dB  
15 for 15 dB  
20 for 20 dB  
25 for 25 dB

Fiber type: M = Multimode

Fiber core/cladding sizes, in microns  
9/125 for 1300/1550 nm SMF  
See Tables 1 to 5 of the OZ Standard Tables for other standard fiber sizes

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

### Pigtail Style:

Body Type: ND for non-removable filters  
RND for removable filters

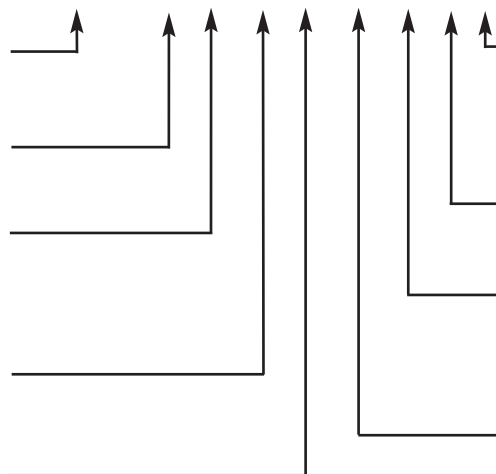
Wavelength: Specify in nanometers  
(Example: 1550 for 1550 nm)

Fiber core/cladding sizes, in microns  
9/125 for 1300/1550 nm SMF  
See Tables 1 to 5 of the OZ Standard Tables for other standard fiber sizes

Fiber type: M = Multimode  
S = Singlemode  
P = Polarization maintaining

Backreflection level (Return Loss):  
40 dB for Singlemode and PM  
35 dB for multimode

### ND-11-W-a/b-F-LB-XY-JD-L-N



Attenuation: 5 for 5 dB  
10 for 10 dB  
15 for 15 dB  
20 for 20 dB  
25 for 25 dB

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

Fiber jacket type: 1 = 900 Micron OD hytrel jacket  
3 = 3 mm OD Kevlar reinforced PVC cable  
See Table 7 of the OZ Standard Tables for other jacket sizes

Fiber Connectors 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  
MU = MU

See Table 6 of the OZ Standard Tables for other Connectors

## Ordering Examples For Custom Parts:

1. A customer needs a pigtail style 20 dB expanded beam neutral density fixed attenuator at 1300 nm with 50/125 micron, 3 mm OD cabled, 1 m long multimode fiber and FC/Super PC connectors on both sides. Required return loss is 35 dB. The OZ Optics part number should be: **ND-11-1300-50/125-M-35-3S3S-3-1-20**.
2. A customer needs a mode independent 10 dB attenuation for his system. He wants a receptacle style attenuator with ST connectors. The system wavelength is 850 and fiber size is 100/140. The OZ Optics part number will be: **ND-200-88-850-100/140-M-10**

## Frequently Asked Questions:

**Q:** What are the advantages and disadvantages of the neutral density fixed attenuators versus the butt joint style attenuators?

**A:** The butt joint style attenuators are primarily design for telecommunication applications. They are offered for 1300 nm and 1550 nm wavelengths only, and for only 9/125, 50/125, and 62.5/125 fiber sizes. In contrast the expanded beam technique can be manufactured for non-standard wavelengths and fiber sizes. The expanded beam method can also operate at higher power levels than the butt joint style attenuators. Finally the removable filter designs allow the use of different filters with the same housing. However butt joint style attenuators are much less expensive.

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

**A:** The neutral density filter method 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.

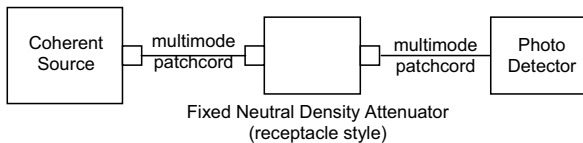
When blocking style attenuators are used with multimode fiber, some modes are blocked, while others are transmitted. This can produce 1 dB or greater modal noise fluctuations with coherent sources. A fixed attenuator using a neutral density filter is not as strongly affected by modal noise. However,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

**Q:** I want to use your removable filter design to mount my own filters. Can I do this?

**A:** Yes. The removable filter design allows one to install their own filters easily. The standard holder is designed to carry filters 12.7 mm in diameter, and up to 3 mm in thickness. Smaller filters can always be mounted in some sort of retainer prior to insertion. Custom designs can be made to accommodate larger filters.

## Application Notes:

You can use fixed neutral density attenuators where mode independent attenuation is required. For example, if you have a coherent source and your application has to be mode independent, you can use these attenuators.



In this setup, all the modes will be attenuated evenly in the output fiber, even if you bend the input fiber.

Your attenuation may vary according to your wavelength. Please see attenuation curve versus wavelengths for ND filters.

