



All numerical values are in metric units [with U.S. customary units in brackets]. Figures and illustrations are for identification only and are not drawn to scale.

**1. INTRODUCTION**

In a fiber optic system, buildout attenuators play an important role in controlling optical power levels in telecommunications and CATV applications. As such, they must offer consistent performance over a range of operating conditions so that attenuation levels remain constant and predictable.

A key feature of buildout attenuators (BOAs) is easy use. Configured as a connector with the plug or ferrule at one end and the receptacle at the other, they can be installed at a patch panel or receiver by simply unplugging the cable, plugging the attenuator into the bulkhead adapter, and plugging the cable into the receptacle end of the attenuator. BOAs are available in a range of fixed loss values typically up to 25 dB. Figure 1 shows examples of common BOAs.

When corresponding with TE Connectivity personnel, use the terminology provided in this specification to facilitate your inquiries for information. Basic terms and features of this product are provided in Figure 1.

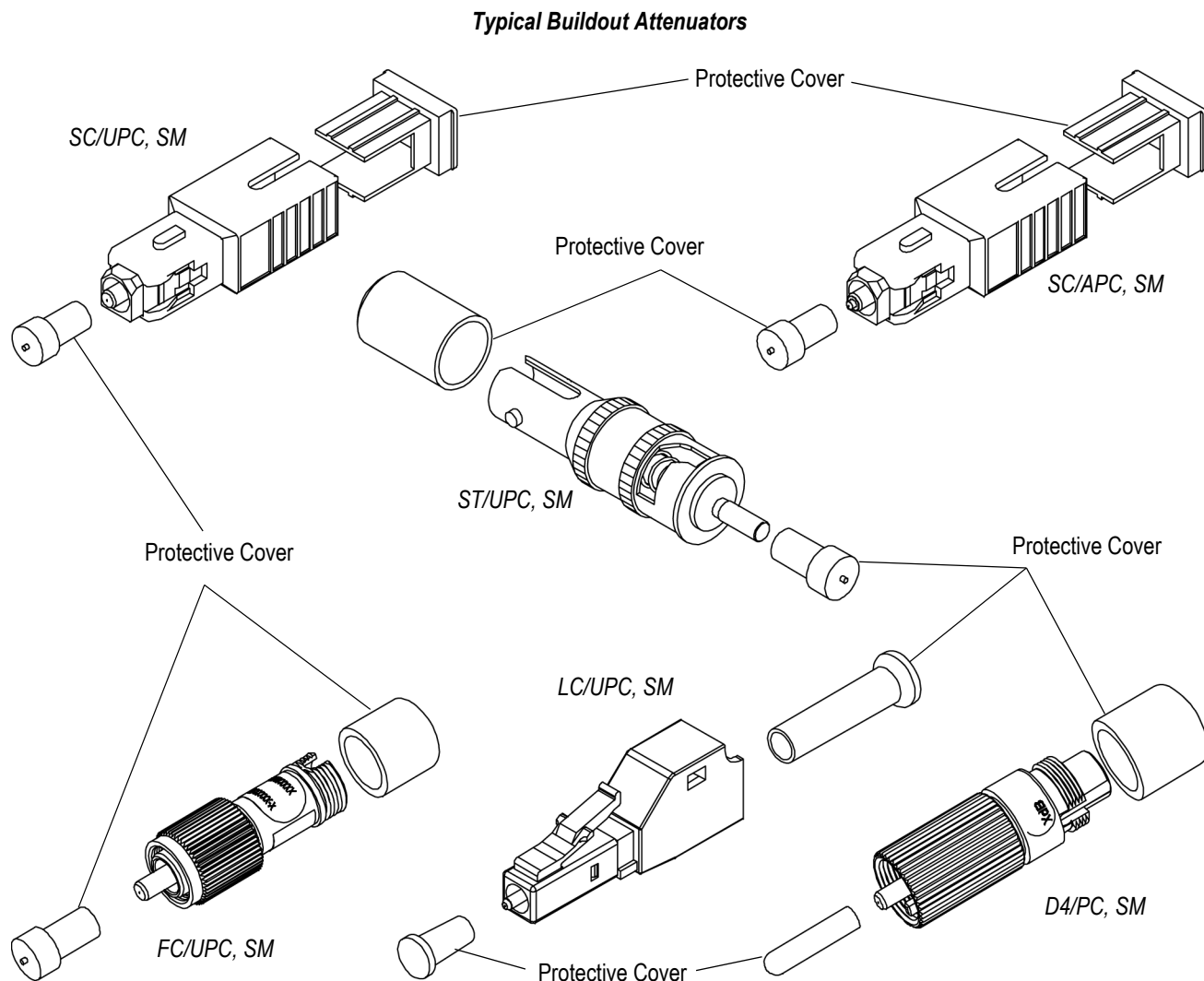


Figure 1

## 2. REFERENCE MATERIAL

### 2.1. Revision Summary

Revisions to this application specification include

- Updated document to corporate requirements

### 2.2. Customer Assistance

Reference Base Product Part Number 5209250 and Product Code G912 are representative of Singlemode Fixed Buildout Attenuators. Use of these numbers will identify the product line and expedite your inquiries through a service network established to help you obtain product and tooling information. Such information can be obtained through a local TE Representative or, after purchase, by calling the Product Information number at the bottom of page 1.

### 2.3. Drawings

Customer Drawings for product part numbers are available from the service network. If there is a conflict between the information contained in the Customer Drawings and this specification or with any other technical documentation supplied, call the Product Information number at the bottom of page 1.

### 2.4. Instructional Material

Instruction Sheet 408-8895 provides information for Attenuator Installation and Cleaning Instructions.

### 2.5. Specifications

Design Objective 108-2099 and Product Specification 108-2221, which are based on Telcordia GR-910, provides expected product performance and test information.

## 3. REQUIREMENTS



*Never look into the end of a fiber optic connector or attenuator when optical power or laser light inspection devices are attached to any of the connecting ends of the cable. Infrared light can not be seen but can severely damage the eye.*

### 3.1. Storage

Components are packaged and shipped in protective containers and should remain in them until ready for use to prevent physical damage. Components should be used on a first in, first out basis to avoid storage contamination. Storage temperatures should be within -40\_ to 70\_C [-40\_F to 158\_F].

### 3.2. Attenuator Installation

Refer to Instruction Sheet 408-8895 for Attenuator Installation and Cleaning Instructions.

### 3.3. System Design Considerations

There are three basic factors a system designer must consider in determining the appropriate buildout attenuator to use: attenuation level, attenuator housing type, attenuator interface type, and reflectance.

- **Attenuation level (1-30 dB)** -- This parameter is a function of the system budget and the receiver's dynamic range.
- **Attenuator housing type (ST, SC, FC, LC, or D4)** -- The attenuator housing type is a function of connectors and adapters used in the system.
- **Attenuator interface type and reflectance (UPC and APC)** -- The choice of the attenuator interface (UPC or APC) is driven by reflectance tolerance in a system. For instance, CATV systems are very sensitive to reflectance causing signal degradation and require APC finish (85 typically), which offers at least -65 dB reflectance. On the other hand, digital systems, which are less sensitive to reflectance, can use UPC finish, yielding -55dB reflectance.

### 3.4. Applications

Singlemode fixed buildout attenuators are very versatile in their physical application. They can be installed at a connector panel, inserted in line between two patch cords, or mounted directly at the receiver interface. The two main applications of buildout attenuators are power attenuation at the receiver and power balancing of multiple outputs.

Buildout attenuators enable the installer to adjust the optical power level without changing the other components, or cutting and splicing the fiber as in the case of the in line attenuator. The result is minimum downtime and maintenance of the overall system configuration.

### 3.5. Typical Uses of Singlemode Fixed Buildout Attenuators

#### A. Power Equalization (Balancing) at Patch Distribution Panel or Receiver Panel

Patch panels are extensively used in the telephony and test (laboratory) environments to connect fiber optic lines to transmission equipment. Occasionally some lines may need to be attenuated at the distribution or receiver panel to closely match the power in other lines, and, thereby, achieve power uniformity. One way to achieve this is by inserting the buildout attenuator at the panel without having to disturb or cut lines. See Figure 2. Because of its compactness and design versatility, the buildout attenuator can be easily installed on any type of fiber optic panel.

Power equalization through attenuation eliminates the need to carry receivers with different dynamic ranges. This receiver standardization can reduce system costs and further simplify the designer's system budget. Some original equipment manufacturers (OEMs) incorporate buildout attenuators in fiber distribution frames and as components for optical transport systems, including WDM systems.

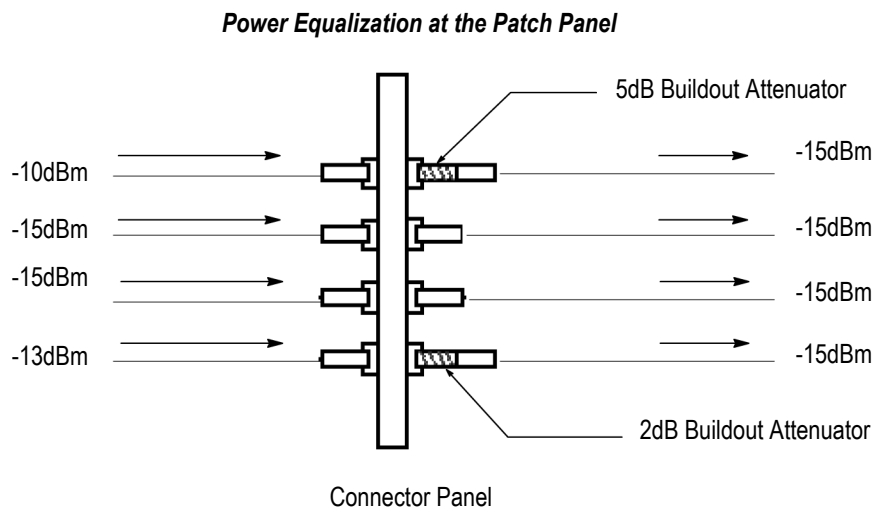


Figure 2

#### B. Signal Attenuation to Meet Receiver's Dynamic Range

If the output power at the receiver exceeds the upper limit of the receiver's dynamic range, signals may become distorted, leading to high noise in analog systems and errors in digital transmissions. See Figure 3.

This situation may arise when a system designer overestimates system losses due to fiber absorption, connections, splices, and components and chooses the incorrect receiver sensitivity.

To remedy this problem, an inexpensive buildout attenuator can be inserted between the connector (source) and receiver.

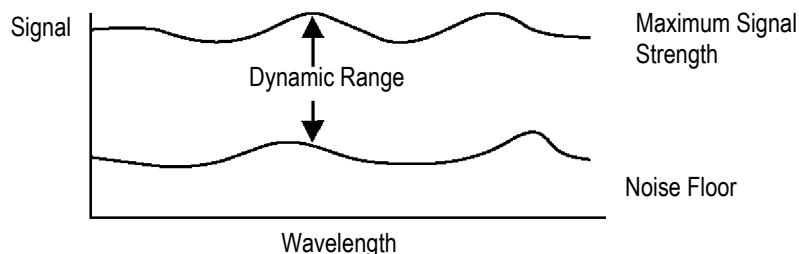


Figure 3

### C. Power Matching in SONET and ATM Systems

Buildout attenuators may be installed at the optical receiver or at the patch panel of SONET and ATM systems to equalize powers at the nodes. The distance between the host and the node can vary by several kilometers depending on the node.

Figure 4 shows an example of a SONET optical layer. A transmitter puts out -3 dBm at a wavelength range of 1260 to 1360 nm. The signal travelling over a singlemode fiber is divided into four equal outputs at the 1x4 splitter. There are four receivers that share the same dynamic range (-14 dBm to -31 dBm) to simplify the system's design. The optical link distances between a node and the distribution patch panel vary by several kilometers. The fiber is singlemode and the loss is 0.2dB/km.

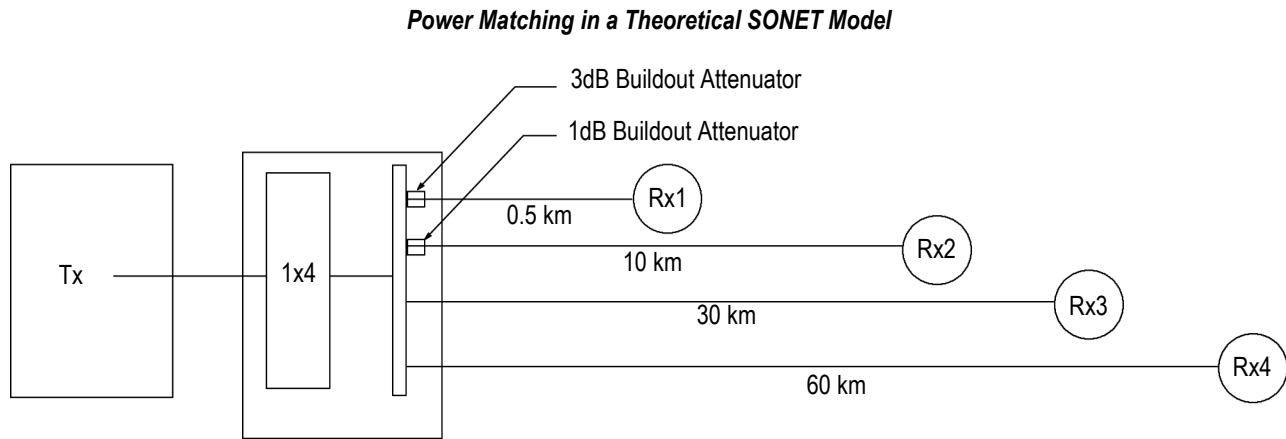


Figure 4

The table in Figure 5 shows power and loss levels in the SONET example. A system designer may be using a similar power budget scheme to determine the attenuation values to match the dynamic range of the receivers. Analysis shows that a 3 dB buildout attenuator is needed at the Receiver 1 line and a 1 dB BOA is needed at the Receiver 2 line to deliver power within the receiver dynamic range of -14 dBm to -31 dBm.

**ATTENUATION CALCULATION FOR THEORETICAL SONET MODEL**

RECEIVER	Rx1	Rx2	Rx3	Rx4
Source Tx Output @ 1260 - 1360 nm	-3 dBm	-3 dBm	-3 dBm	-3 dBm
Splice / Connector Losses	-1 dB	-1 dB	-1 dB	-1 dB
SM Fiber Loss (0.2 dB/km)	-0.5 dB	-2 dB	-6 dB	-12 dB
1x4 Splitter Loss	-7 dB	-7 dB	-7 dB	-7 dB
Output (O) at Receiver Rx	-11.5 dBm	-13 dBm	-17 dBm	-23 dBm
Rx Upper Dynamic Threshold (U)	-14 dBm	-14 dBm	-14 dBm	-14 dBm
= O-U	2.5 dB	-1 dB	-3 dB	-9 dB
Required BOA Attenuation Value	3 dB	1 dB	n/a	n/a

Figure 5

### D. CATV

Video applications demand more stringent reflectance and attenuation tolerance specifications. Reflections can degrade the system performance. The buildout attenuator, with an 8 or 9 degree polished end face (APC) meets the low reflectance ( $\leq 65$  dB) requirements. This system may call for attenuators either at the transceiver, or in line. Figure 6 shows an example of using buildout attenuators to maintain proper power levels at the splitter in a distribution node. Because distance between the node and the subscriber can vary, a buildout attenuator can be used to adjust the power levels in each branch.

**Buildout Attenuator (BOA) in CATV System**

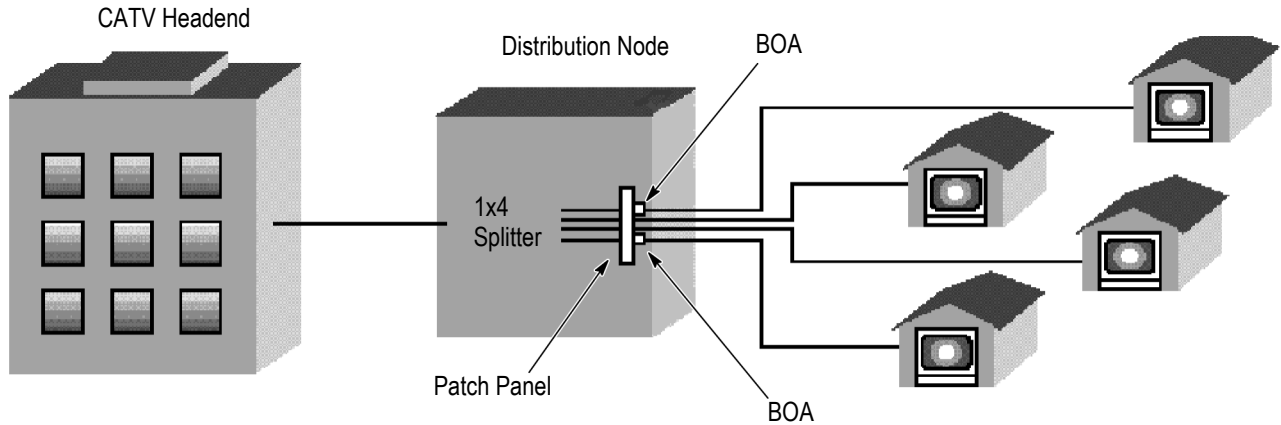


Figure 6

**E. DWDM Systems**

As the need to multiplex/demultiplex several narrowly spaced signals increases in DWDM systems, so does the need to match output powers with the receiver's dynamic range. The buildout attenuator is well suited for this application since it is wavelength independent. The designer has the option to insert an attenuator at the detector or patch panel to achieve the proper power level as shown in Figure 7.

**F. Test Systems**

Manufacturers of erbium-doped fiber amplifiers (EDFA) and other fiber optic equipment use attenuators in loop measurement setups to measure gain flatness of the EDFA over a certain bandwidth as a function of distance (for example, 3000, 6000, 10,000 km).

**Buildout Attenuator in a WDM System**

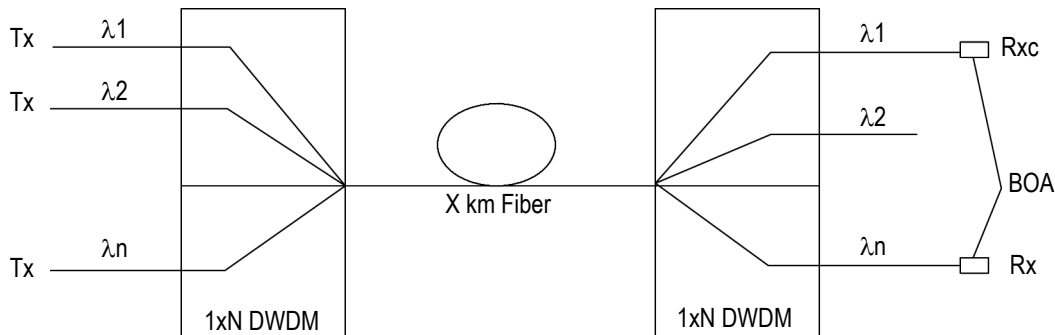


Figure 7

**4. QUALIFICATIONS/REPORTS**

1, 3, 5, and 10dB SC/UPC Fixed Buildout Attenuators have been tested to the requirements of Telcordia GR-910-CORE. See TE Engineering Reports 502-1197 (1dB), 502-1198 (3dB), 502-1199 (5dB), and 502-1200 (10dB) for results.

**5. TOOLING**

No tooling is required for the assembly of Singlemode Fixed Buildout Attenuators.