SSA Fibre-Optic Extender 160
Fibre Installation Guidelines

Version 1.2

0.1 Introduction

This document provides information on the specification and installation of optical fibre networks to support SSA optical extender products.

1.0 Introduction

The SSA Fibre-Optic Extender 160 can operate with either singlemode or multimode optical fibres. When operated with multimode fibre, a mode conditioning patch cord (MCP) is required at each end of the link to ensure correct performance with the specified bit error rate on the link. The product specification for the SSA Fibre-Optic Extender 160 details the fibre types and parameters which are supported by the optical extender (OE) together with the maximum link distances supported. In general, singlemode fibre provides better technical performance in terms of attenuation and bandwidth for a given length than multimode fibre, allowing longer link distance. However, singlemode fibre is currently more expensive than multimode fibre and requires better alignment accuracy at interconnections which results in a higher connector cost. Consequently, multimode fibre can provide advantages for short operating distances with singlemode fibre being necessary past the maximum operating distance of multimode fibre.

It is possible to use singlemode fibre for short distances and this could be preferable if a singlemode fibre infrastructure already exists, or is preferred over a multimode solution. The improved performance of singlemode fibre would make it preferable to multimode fibres even at distances at which the product specification supports multimode. At distances greater than 2km, installation with singlemode fibre would probably be preferable to multimode if the choice exists. Although the performance of the optical extender will not change, the lower losses associated with singlemode fibre will make it easier to achieve the path loss specification. The network should also be more flexible in supporting future higher speed optical products operating with singlemode fibres.

1.1 Optical Fibre Specification

Irrespective of whether singlemode or multimode fibre is used, there are two parameters which define the operating limits for a fibre installation:

- **Path Loss**, which is the attenuation introduced on the optical signal by the fibre network. This insertion loss is the sum of the attenuation introduced by the optical fibre, any fibre splices in the path and all the connector losses along ths path.
- **Bandwidth or Dispersion** of the optical fibre, which defines the speed at which signals can be transmitted along the fibre. In the case of multimode fibres, this is normally specified in terms of a bandwidth/distance product, for example 500 MHz.km. Whereas in singlemode fibres, the dispersion of the fibre is normally specified, for example 5.0 ps/nm.km.

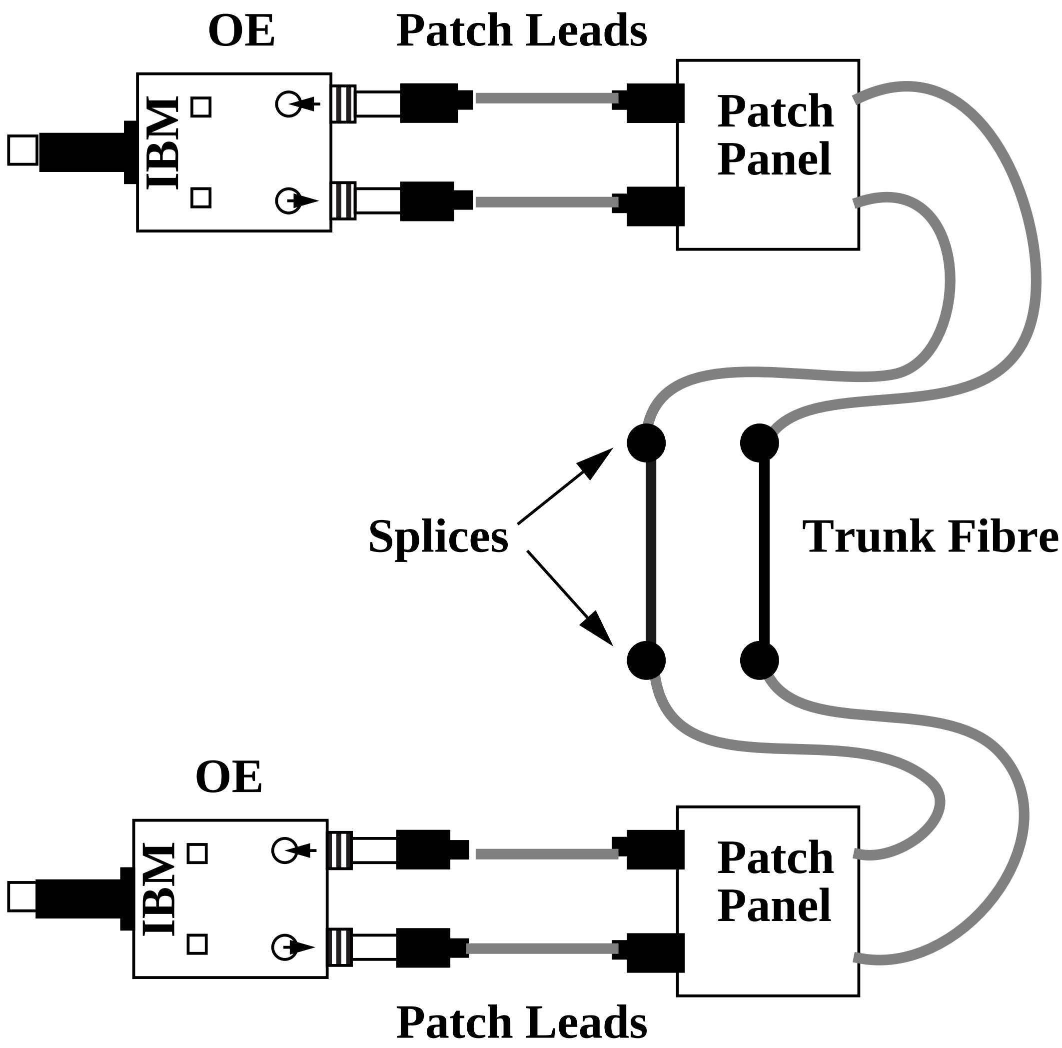
In specifying a fibre installation for the optical extender, the path loss needs to be calculated and measured to ensure that it is within the limits of the specification. The bandwidth or dispersion of the optical fibre is really a specification issue, in procuring the fibre for a network it is important to ensure that this parameter of the fibre meets the relevant specification. The bandwidth or dispersion is important for the main length of the fibre installation, for example the trunk fibre, over short lengths such as patch fibres it is possible to use lower bandwidth fibres without significant degradation.

The performance of the optical extender will decrease with increasing fibre distance as the maximum data bandwidth of the extender reduces with fibre length. The relationship between bandwidth and fibre length is detailed in the performance documentation for the optical extender.

In verifying a fibre installation, both the path loss and length can be measured with the appropriate equipment and the ways in which this may be done are described later in this document. The bandwidth or dispersion of optical fibre is more difficult to measure outside of a laboratory environment and since it is a basic physical property of the fibre itself, which does not vary with installation, it can just be checked through the manufacturer’s specification for the installed fibre.

2.0 Installing Optical Extenders

The Fibre-Optic Extender 160 requires a pair of optical fibres, one for the transmit channel and one for the receive channel. A typical link would consist of a main trunk fibre which would connect to a patch panel at each end of the fibre. Usually some form of connection, for example optical splices, would be made between the trunk fibre and the patch panel. The main length of the optical link would normally reside in the trunk cable which could connect between buildings. The patch panels provide a central location for the attachment of trunk fibres and patch leads, and may be mounted in a rack or wiring cupboard. The patch lead provides the local connection between the OE and the patch panel and although the end connecting to the OE must use ST connectors, it is possible to use alternative optical connectors at the patch panel provided that they are suitable for the fibre being used and provide an acceptable insertion loss. Of course, for short links a single set of patch leads could be used to interconnect the optical extenders.



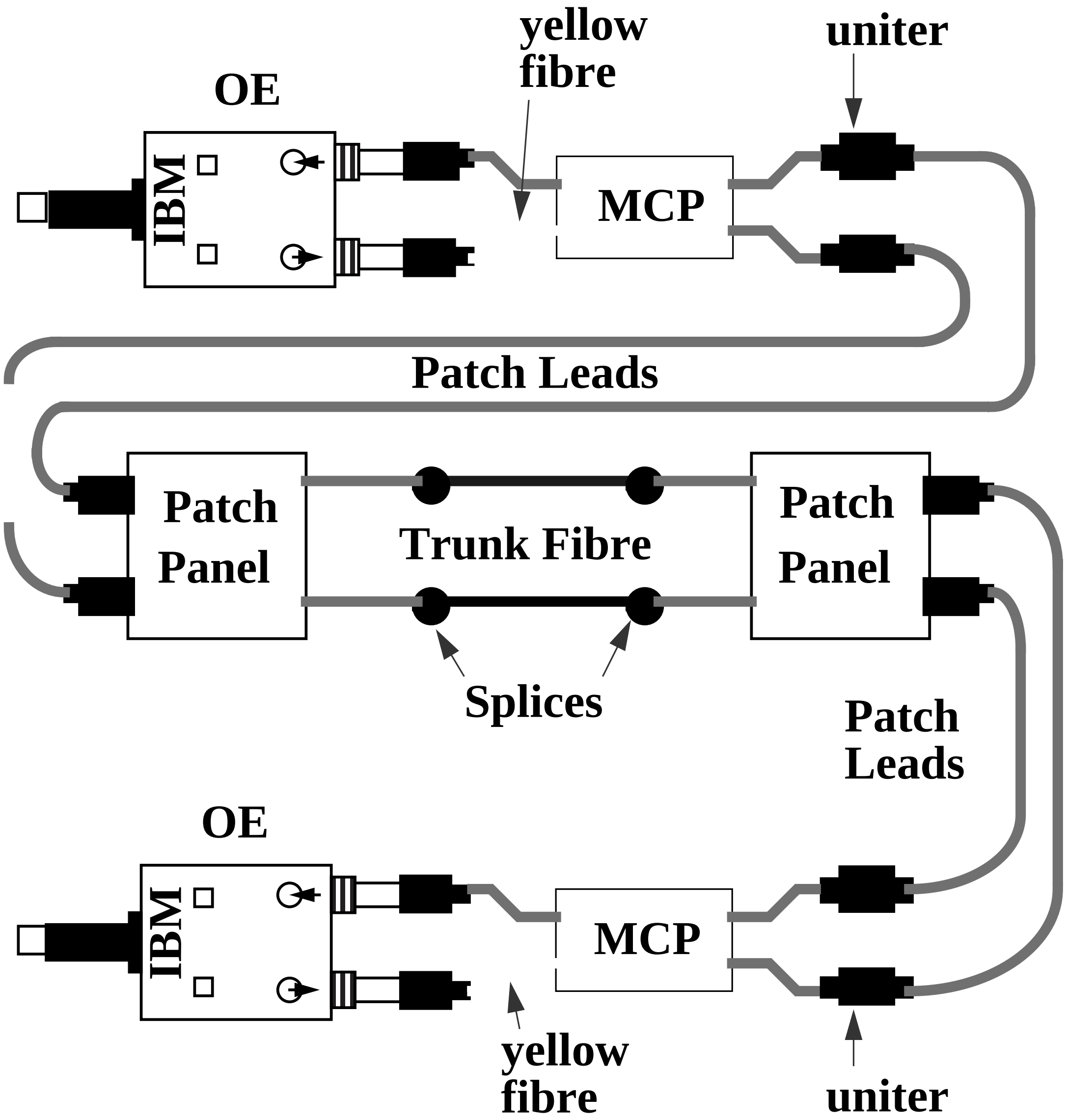
In singlemode applications, a fibre size of 9/125um is specified and this should be used on all fibres within the system. Also any couplers used within the system should be of singlemode standard, multimode couplers have a lower alignment tolerance and could produce an unacceptably high loss.

In multimode application, a fibre size of 50/125um or 62.5/125um can be used, however it is important that the same fibre size is used throughout the link since mixing of fibre sizes will cause an unacceptable loss in the system. Generally for a common optical media, 50/125um has a higher specification than its 62.5/125um counterpart, and so if a choice exists between the two fibre sizes it is preferable to choose the former.

It is necessary to use mode condition patch (MCP) cords within multimode systems to ensure proper mode filling of the fibre which is necessary to guarantee the bit error rate performance of the link. The MCP cord is available in two sizes, 50/125um and 62.5/125um, and needs to be selected according to the multimode fibre size used within the system.

The mode condition patch cords need to connect directly to the OE as shown in the following diagram with the yellow fibre connecting to the transmitter receptacle. The yellow fibre is fusion spliced to an output multimode fibre within the MCP and this connects through a uniter to the patch leads or trunk fibre. This path needs to connect to the receiver receptacle of the remote OE to complete the link, when power is applied to both OEs this should result in the receive light being illuminated. The other side of the MCP cord is a straight through multimode fibre patch lead which connects between the receiver receptacle of the OE and the uniter connecting to the patch leads or trunk fibre. The MCP cord is 2m long and could directly connect to the trunk cable without an intermediate patch lead if this length was sufficient. The MCP cords are supplied with the ST uniters needed to make the connection to the patch lead / trunk fibre within the installation.

Irrespective of which type of optical fibre is used to interconnect the OE units within the link, when they are correctly connected both lights on each OE should be illuminated. The receive light on the OE indicates that an optical connection exists between the remote OE transmitter and the local OE receiver, if this light is not illuminated then it indicates a fault somewhere along the optical fibre path. If the receive lights are off on both OE pairs it is possible that the OE units are misconnected and that the transmitters are not connected to the receivers within the OE pair.


yellow
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Patch Leads
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3.0 Calculating Path Loss

The path loss can be calculated in the same way for singlemode or multimode networks and is given by:

$$PathLoss = \sum SpliceLoss + \sum ConnectorLoss + \sum FibreLoss$$

Where

Splice Loss is the loss introduced by any splices introduced on the optical fibre network along its length

Connector Loss is the loss introduced by the connectors along the optical fibre network

Fibre Loss is the loss of the fibre itself which is given by:

$$FibreLoss = Length \times Attenuation(perUnitLength)$$

Example:

Consider the first network shown in Section 2.0 where:

Fibre Attenuation = 0.8dB/km on Trunk Fibre

= 1.0dB/km within Patch Panel

= 1.2dB/km on Patch Leads

Fibre Length = 1.5km on Trunk Fibre

= 2m within Patch Panel

= 50m on Patch Leads

$$\sum FibreLoss = (1.5 \times 0.8) + 2 \times (0.002 \times 1.0) + 2 \times (0.05 \times 1.2) = 1.324$$

If the Loss per Splice is 0.2dB

$$\sum SpliceLoss = 2 \times 0.2 = 0.4dB$$

If the Connector Loss is 0.5dB per connector

$$\sum ConnectorLoss = 4 \times 0.5 = 2.0dB$$

Hence the total loss of the network is given by:

$$PathLoss = 0.4 + 2.0 + 1.324 = 3.724dB$$

It is important to calculate the path loss of the optical fibre network used for connecting together optical extenders to ensure that it does not exceed the maximum path loss given for that fibre type given in the product specification.

When mode conditioning patch cords are included within the system then the loss through the patch cords needs to be included in the path loss calculation. The maximum loss for the IBM Fibre Optic Mode Conditioning Patch Cord is 0.5dB.

4.0 Measuring Path Loss

Path loss or attenuation can simply be measured using an optical light source and calibrated power meter, the output of the power source is first measured with the power meter. The network under test is then inserted between the source and power meter and the new power reading is recorded. The path or insertion loss of the network is the difference between these two readings.

It is essential that the measurement is made at the operating wavelength of the Fibre-Optic Extender 160 link which is 1310nm +-30nm. The attenuation of optical fibre is dependant upon the operating wavelength and care should be taken that the correct wavelength is used for both the source and power meter.

A commercial power source, such as the Rifocs 265A, can be used for this measurement. Alternatively it is also possible to use an optical extender as the source. In the latter case, the extender should be plugged into a SSA port and the power LED should be illuminated. Under these conditions, the laser driver of the optical extender will be active and the power meter should be first connected to this output to check the output power level.

Before measuring path loss, it is advisable to ensure that all of the connectors being used during the measurement are clean to avoid spurious results. It is generally good practice to wipe all these connectors with either tissues or cotton buds soaked in IPA[1] solution. Any contamination on the connector surfaces can lead to misalignment or attenuation of the optical signal which will introduce extra losses.

There are several manufacturers of optical power meters which are suitable for this type of measurement, an example would be the Rifocs 555B instrument. When using a power meter which can operate at several wavelengths, ensure that the 1300nm range is selected. The power meter itself should have valid calibration test results, especially if the measurements are being made with an optical extender as a source rather than a commercial power source which should have its own calibration test results. The following issues relate to singlemode and multimode power loss measurements:

4.1 Singlemode

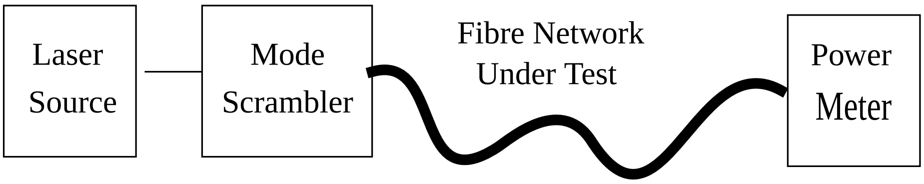
When making measurements on singlemode fibre networks, particular care should be taken to ensure that all connections are clean to prevent adverse losses due to misalignment which is more critical for singlemode applications.

4.2 Multimode

To accurately measure loss on multimode fibre networks it is necessary to ensure that there is adequate filling of the various propagation modes on the fibre. In the case of laser power sources which have a small numerical aperture, it is possible for the major-

1. Iso Propyl Alcohol

ity of the optical power to propagate down the centre of the fibre rather than filling the fibre which can result in lower losses than would be seen in practice. This problem can be overcome by using a **mode scrambler**[1] on the output of the laser source which ensures mode filling of an optical fibre before the signal reaches the network under test. In this situation, the following test arrangement can be used:



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Since the mode scrambler itself will have some insertion loss, the power meter is first used to measure the output power from the mode scrambler. The fibre network to be tested is then inserted between the mode scrambler and the power meter and the difference between these two reading provides the insertion loss of the network.

The laser transmitters used on the optical extender products have low numerical apertures and will tend not to fill short lengths of fibre. In such cases, the loss measurements made with a mode scrambler will be somewhat higher than those seen in normal operation of the optical extender.

It is also possible to use the optical extender itself as the power source for the measurement. If this is done then a mode scrambler is not required since the launch conditions of the source into the fibre will be the same during this measurement as during normal operation of the optical extender.

4.3 Measuring Path Length

The path length of a fibre optic network can be accurately measured using an OTDR[2], such as the Tektronix TFS3031 Tekranger, these instruments drive an optical pulse onto the fibre under test and measure the subsequent reflected optical signals. This instrument will measure the distances at which discontinuities in power loss occur along the fibre, which includes intermediate connections and splices, as well as the far end of the fibre. A high accuracy can be achieved with such an instrument for both distance and loss measurements.

1. A suitable mode scrambler (P/N 01605) can be obtained from Point Source, Unit 6, Leylands Farm, Nob’s Crook, Colden Common, Winchester, Hampshire, SO21 1TH, England (Tel 44-1962-601470 Fax: 44-1962-602470)
2. Optical Time Domain Reflectometer

Although an OTDR can also be used to measure loss, extra care needs to be taken with the use of the instrument for making these types of measurements. In particular, the launch conditions of the laser driver within the OTDR needs to be appropriate for the measurement, especially in the case of multimode fibres, otherwise inaccurate results may be obtained from this type of measurement. Generally in field applications, a power meter is used to measure loss with the OTDR being used just to check length if it is not known from the installation.

5.0 References

- Fibre-Optic Extender 160 Application Guide
- ITU-T Recommendation G651, Characteristics of a 50/125um Multimode Graded Index Optical Fibre Cable - International Telecommunication Union
- EIA/TIA-492AAAA, Detail Specification for 62.5um Core Diameter / 125um Cladding Diameter Class 1a Multimode Graded Index Optical Waveguide Fibres - Electronic Industries Association
- EIA/TIA-455-54A, Mode Scrambler Requirements for Overfilled Launching Conditions to Multimode Fibers - Electronic Industries Association
- BS7718: 1994 Installation of Fibre Optic Cabling
- SSA Optical Extender Performance Documentation
- Instructions for IBM Fibre Optic Mode Conditioning Patch Cord (IBM part number 09L5592)
- Fibre-Optic Extender 160 Cleaning Guide (IBM part number 09L2085)