Model 2405OE-HD

SMPTE 292M Re-Clocking
Fiber to Electrical Converter
Instruction Manual

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INFORMATION TO USERS IN EUROPE

NOTE

CISPR 22 CLASS A DIGITAL DEVICE OR PERIPHERAL

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to the European Union EMC directive. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

INFORMATION TO USERS IN THE U.S.A.

NOTE

FCC CLASS A DIGITAL DEVICE OR PERIPHERAL

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING

Changes or Modifications not expressly approved by Evertz Microsystems Ltd. could void the user's authority to operate the equipment.

Use of unshielded plugs or cables may cause radiation interference. Properly shielded interface cables with the shield connected to the chassis ground of the device must be used

REVISION HISTORY

REVISION	DESCRIPTION	DATE
1.0	Original Version	Apr 01
1.1	Changes to Input sensitivity specification, remove –L version	May 02
1.2	Fixed formatting	Jun 08

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1. OVERVIEW

The 2405OE-HD Fiber to Electrical converter provides an economical method of converting incoming optical distribution for SMPTE 292M (1.5 Gb/s) HDTV serial digital signals to in-plant coaxial distribution. The companion 2405EO-HD Electrical to Fiber converter facilitates conversion from coaxial distribution at the source. The converter features one optical input with two re-clocked serial digital outputs. The 2405OE-HD has been designed to be used primarily as a reclocking 1.5Gb/s distribution amplifier, however, it can also be used as a non-reclocking SMPTE 310M (19.4 Mb/s), DVB-ASI, or SMPTE 259M (143 to 540 Mb/s) distribution product.

Features:

- Reclocking mode for SMPTE 292M (1.5 Gb/s) signals
- Non-reclock mode for SMPTE 310M (19.4 Mb/s), SMPTE 259M (143 to 540 Mb/s) or DVB-ASI, or most other bit rates less than 1.5 Gb/s
- Independent isolated output drivers to ensure no cross channel loading effects and maintain polarity from input to output for DVB-ASI applications
- Operation with multi-mode or single-mode fiber
- SC/PC, ST/PC or FC/PC connector options
- Comprehensive signal, laser and modules status indicator LEDs
- Low power +12 VDC operation

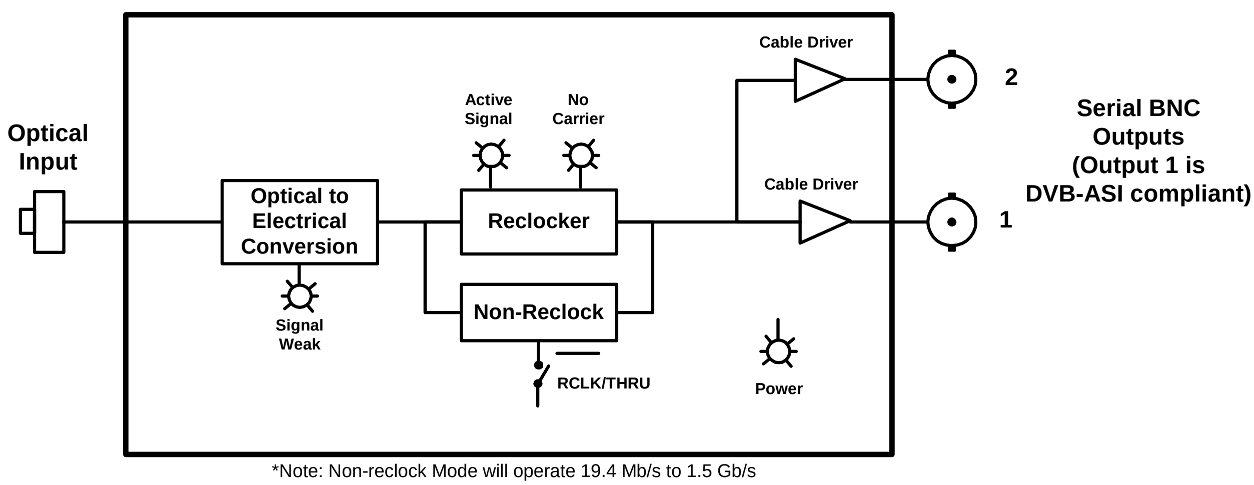


Figure 1-1: 2405OE-HD Block Diagram

2. INSTALLATION

The 2405EO-HD is a compact module that has two BNC connectors and one SC/PC (shown), ST/PC or FC/PC optical connector.

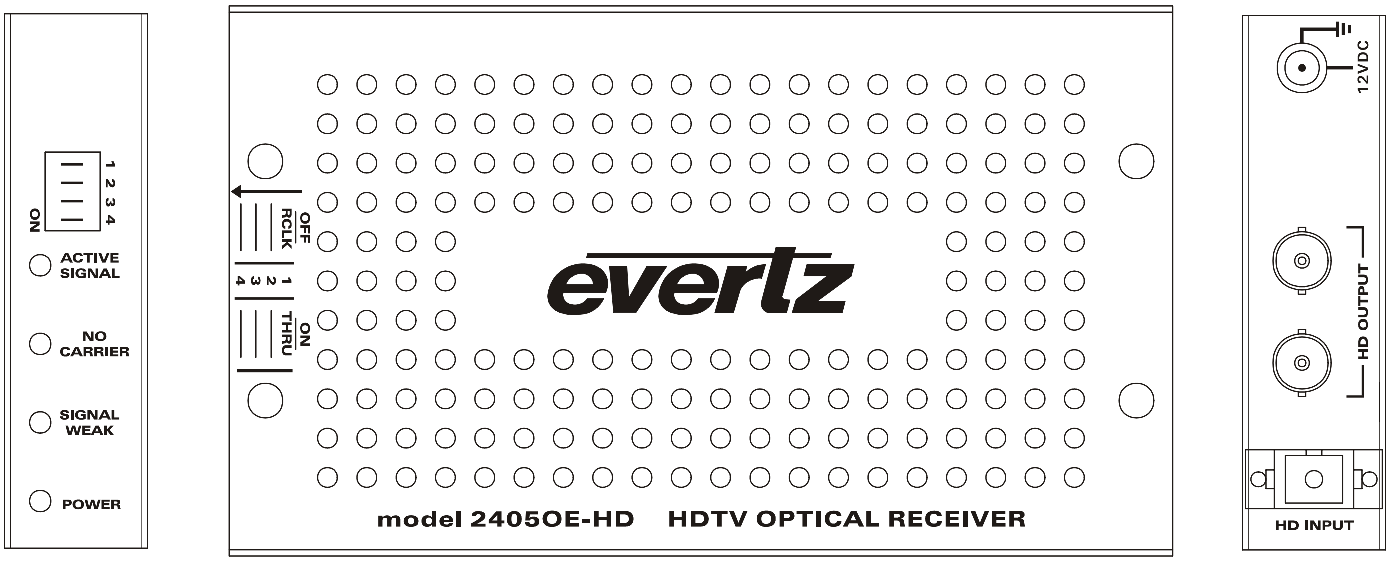


Figure 2-1: 2405EO-HD Module

HD INPUT: There is a SC/PC (shown), ST/PC or FC/PC female connector for optical 10-bit serial digital video signals compatible with the SMPTE 292M standard. The 2405OE-HD can also be used in non-reclock mode with SMPTE 310M (19.4 Mb/s), SMPTE 259M (143 to 540 Mb/s) or DVB-ASI, or any other signal with bit rate less than 1.5 Gb/s. See section 5.1 for information on operating the module in non-reclock mode.

HD OUTPUT: There are two BNC connectors with reclocked serial component video outputs, compatible with the SMPTE 292M standard. In non-reclock mode these outputs contain an equalized copy of the input signal.

The 2405OE-HD comes with an auto-ranging DC voltage adapter that automatically senses the input voltage. Power should be applied by connecting a 3-wire grounding type power supply cord to the power entry module on the DC voltage adapter. The power cord should be minimum 18 AWG wire size; type SST marked VW-1, maximum 2.5 m in length. The DC cable of the voltage adapter should be connected to the DC power jack on the rear panel. A green LED located beside the power connector will be illuminated when there is power applied to the 2430DAC-HD.

2.1. CARE AND HANDLING OF OPTICAL FIBER

2.1.1. Safety

Never look directly into an optical fiber. Non-reversible damage to the eye can occur in a matter of milliseconds.

The laser modules used in the Evertz fiber optic modules are Class I, with a maximum output power of 2mW, and wavelengths of either 1310 nm or 1470 to 1610 nm.

2.1.2. Handling And Connecting Fibers

Never touch the end face of an optical fiber.

The transmission characteristics of the fiber are dependent on the shape of the optical core and therefore care must be taken to prevent fiber damage due to heavy objects or abrupt fiber bending. Evertz recommends that you maintain a minimum bending radius of 3 cm to avoid fiber-bending loss that will decrease the maximum attainable distance of the fiber cable. The Evertz fiber optic modules come with cable lockout devices, to prevent the user from damaging the fiber by installing a module into a slot in the frame that does not have a suitable I/O module. For further information about care and handling of fiber optic cable see section 3 of this manual binder.

3. SPECIFICATIONS

3.1. OPTICAL INPUT

Standards:
Normal: SMPTE 292M
Non-Reclocked: SMPTE 310M (19.4 Mb/s) or
SMPTE 259M A, B, C, D, or
DVB-ASI or any other bit rate less than 1.5 Gb/s
Connector: SC/PC, ST/PC or FC/PC female housing
Maximum Input Power: -3dBm
Wavelength 1310 nm to 1610 nm
Optical Sensitivity: -18 dBm
Fiber Size: 62 μm core / 125 μm overall

3.2. SERIAL VIDEO OUTPUTS

Number of Outputs: 2 Reclocked.
Standards: same as input
Connectors: 2 BNC per IEC 169-8
Signal Level: 800mV nominal
DC Offset: 0V ±0.5V
Rise and Fall Time: 200ps nominal
Overshoot: <10% of amplitude
Return Loss: > 15 dB up to 1 Gb/s, > 12 dB up to 1.5 Gb/s
Wide Band Jitter: < 0.15 UI (reclocked)

3.3. ELECTRICAL

Voltage: + 12VDC
Power: 6 Watts.
EMI/RFI: Complies with FCC regulations for class A devices.
Complies with EU EMC directive.
DC Power Supply: 115/230 VAC 50/60 Hz, 30 VA

3.4. PHYSICAL

Dimensions: 6“ L x 3.5” W x 1” H
(152mm L x 89mm W x 25mm H)

With Mounting Flanges: 6“ L x 4” W x 1” H
(152mm L x 114mm W x 25mm H)

Weight: 0.5 lbs. (0.28 Kg)

4. STATUS LEDS

ACTIVE SIGNAL: This Green LED will be On when there is a valid signal present at the module input.

NO CARRIER: This Red LED will be On when there is no valid signal present at the module input.

SIGNAL WEAK: This Yellow LED will be On when the optical receiver detects that the received optical power is less than a preset threshold.

POWER This Green LED will be On when there is power to the unit.

5. USER CONTROLS

The 2405EO-HD is equipped with a 4 position DIP switch to allow the user to configure the module. The On position is down, or closest to the printed circuit board. Table 5-1 gives an overview of the DIP switch functions.

DIP Switch	Function
1	Reclock Mode Selection
2	*Future Use*
3	
4	

Table 5-1: DIP Switch Functions

5.1. SELECTING RECLOCK OR NON-RECLOCK MODE

DIP switch 1 determines whether the module will operate as a reclocking distribution amplifier with SMPTE 292M (1.5 Gb/s) video signals or as a non-reclocking distribution amplifier with other data rates as shown in Table 5-2.

DIP 1	FUNCTION	DESCRIPTION
Off	Reclock (default)	The 2405EO-HD will reclock 1.485 Gb/s video signals.
On	Non-reclock	The 2405EO-HD will act as a non-reclocking distribution amplifier for signals in the 19.4 Mb/s to 1.485 Gb/s frequency range.

Table 5-2: Reclock Mode Switch Setting

6. FIBER OPTICS SYSTEM DESIGN

Fiber optics is best known for its applications in the telephone industry, even though it is widely used in video and television systems. In television systems they typically send signals between two locations or distribute the same signal to many destinations.

Traditional video distribution systems have used coaxial copper cabling. Fiber optic cable provides many advantages over traditional copper wire:

- Lower cable losses allow longer distances without distribution amplifiers
- Ability to carry higher data rate signals
- Improved signal quality
- Immunity from electro-magnetic radiation and Lightning
- Light Weight

The crucial difference between fiber optic distribution systems and coaxial cable systems is that signals are transmitted as light. The two key elements of optical fiber are its core and its cladding. The core is the inner part of the fiber, through which the light is guided. The cladding surrounds the core completely. The refractive property of the cladding is higher than that of the core, so light in the core that strikes the boundary with the cladding at a glancing angle, is totally reflected back into the core. The boundary of the core and cladding acts like a "cylindrical mirror", causing the core to act as a light pipe.

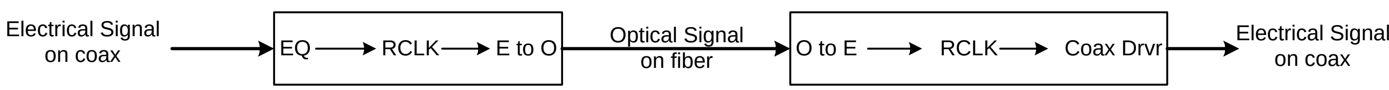


Figure 6-1: Components of a Fiber Optic Transmission System

The role of an optical transmitter is to convert an electrical data signal into an equivalent optical power waveform and couple it into an optical fiber. The role of the optical fiber is to convey the light from the source to the destination with the minimal amount of signal loss. The role of the optical receiver is to convert the optical power waveform back into an equivalent electrical data signal.

6.1. SYSTEM DESIGN PARAMETERS

6.1.1. Electrical to Optical Parameters

In optical output devices, the main design parameters that are important are the launched output power, the wavelength and the linewidth. Launch power and wavelength are always important in system designs. Line width is usually important only in high definition applications.

6.1.1.1. Transmitter Output Launch Power

The launched output power tells us the maximum power available at the optical transmitter. Table 6-1 indicates the launched output power available on current Evertz EO modules.

Module	Minimum Launch Power	Wavelength	Spectral width of Optical Signal
2405EO3F	-7.5 dBm	1310 nm	5 nm
2405EO3F-HD	-7.5 dBm	1310 nm	5 nm
2405EO3D-HD	0 dBm	1310 nm	0.8 nm
2405EO5D-S	0 dBm	1550 nm	0.8 nm
2405EO5D-HD	0 dBm	1550 nm	0.8 nm
2405EOxx	0 dBm	1470 to 1610 nm *	0.8 nm
2405EOxx-HD	0 dBm	1470 to 1610 nm *	0.8 nm

* xx= 47 (1470 nm), 49 (1490 nm), 51 (1510 nm), 53 (1530 nm), 55 (1550 nm), 57 (1570 nm), 59 (1590 nm), 61 (1610 nm)

Table 6-1: Launch Power

6.1.1.2. Wavelength

The wavelength of the optical signal determines the cable loss window within which the system will operate.

The Loss versus Wavelength graph in Figure 6-2 shows that at 1310nm the cable loss is 0.40dB/km and at 1550nm the loss is 0.30dB/km.

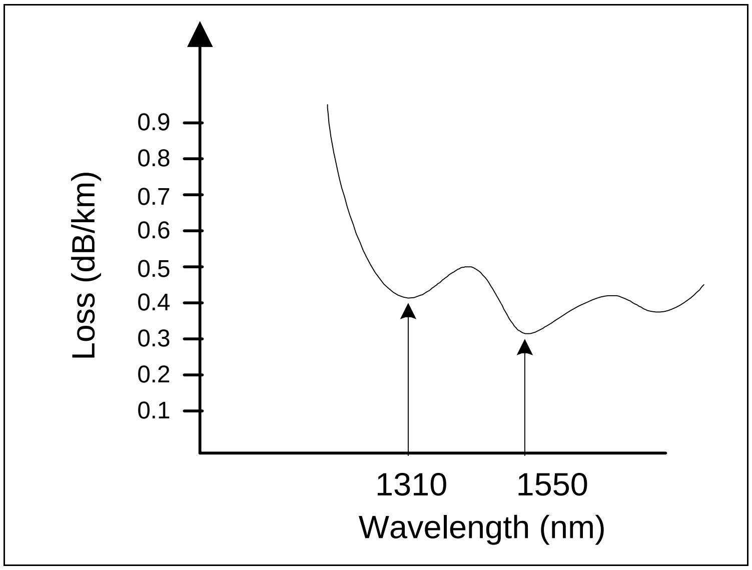


Figure 6-2: Cables Losses at Various Wavelengths

6.1.1.3. Linewidth

The linewidth is a measure of the laser's spectral purity, and determines the jitter penalty (how much jitter gets added to the signal). Linewidth is important in HD applications because the additional jitter penalty is significant compared to the bit period. In standard definition video applications linewidth is usually not a problem because the signal will lose too much power before it can go far enough for jitter to be a problem.

At 1310nm the jitter penalty is approximately 2.5psec/km of fiber /nm of linewidth. At 1550nm the jitter penalty is approximately 17ps/km of fiber/nm of linewidth.

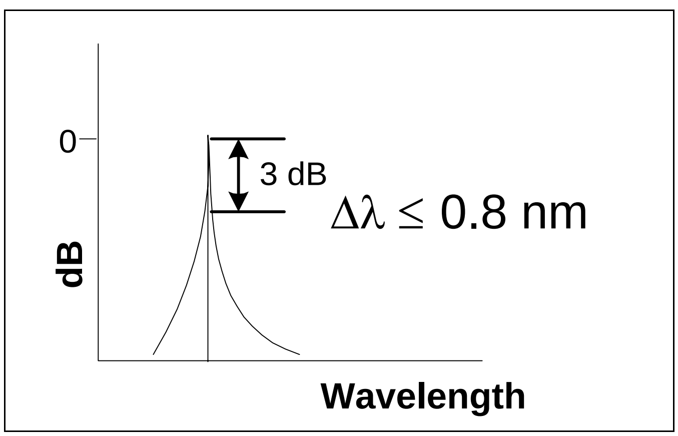


Figure 6-3: Spectrum of DFB Laser used in EO3D-HD, EO5D-HD and EOxx-HD

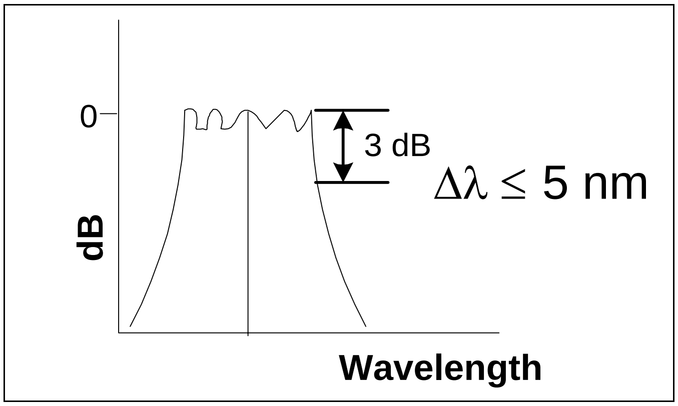


Figure 6-4: Spectrum of FP Laser used in EO3F and EO3F-HD

6.1.2. Optical to Electrical Parameters

In Optical input devices, the main design parameters that are important are the maximum power before overload and the minimum power before errors (Sensitivity). Table 6-2 indicates the maximum power and sensitivity on current Evertz OE modules.

Module	Maximum Input Power	Sensitivity
2405OE	0 dBm	-30 dBm
2405OE-HD	-3 dBm	-17 dBm

Table 6-2: Optical Receiver Power Parameters

6.1.3. Passive Optical Module Parameters

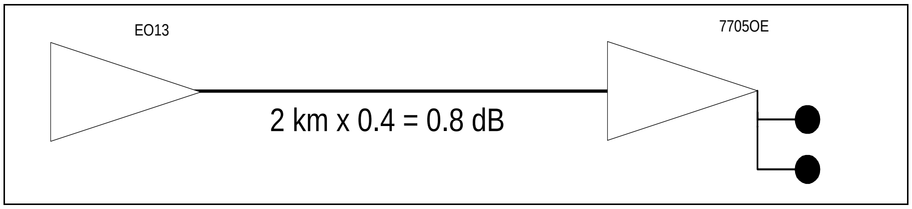
In passive optical modules, the main design parameter that is important is the loss through the passive device. Table 6-3 indicates the power loss on current Evertz 7705 series passive fiber modules.

Module	Port	Insertion Loss
7705WDM		< 2 dB
7705WDM	1310nm	< 2 dB
	1550nm	< 3 dB
7705CWDM-M4		< 3 dB
7705CWDM-D4		< 3 dB
7705CWDM-M8		< 6 dB
7705CWDM-M8		< 6 dB
7705DS		< 4 dB
7705DS-8		< 11 dB
7705MS	80 %	< 2 dB
	20 %	< 9 dB

Table 6-3: Passive Module Insertion Loss

6.2. DESIGN EXAMPLES

6.2.1. Standard Definition 2 km Link



Using the 2405EO3F as the transmitter.

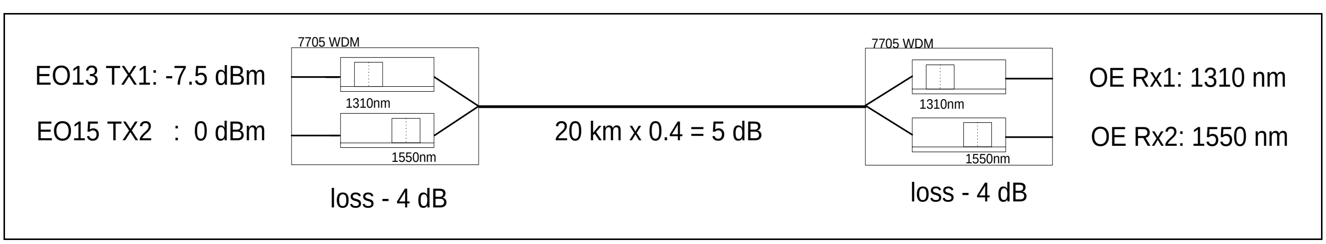
Launch Power =	-7.5 dBm
Connector Loss = 2 x 1	-2.0 dB
Fiber Loss = 2 x 0.4	-0.8 dB
Safety Margin =	-2.0 dB
Power at receiver	–12.3 dBm

The 2405OE has a listed sensitivity of –30 dBm, which is lower than –12.3 dBm so we can implement the system with no problems, at least with respect to power availability.

Next we need to check the jitter penalty. The system jitter-penalty = 2.5 ps/ x 2 km x 5 nm = 25 ps. So by going through 2km of fiber, we add 25ps of jitter under the worst conditions (under the best conditions we would add 2ps total). The standard definition video bit period is 3.7 ns; so if the maximum jitter penalty is 20% or 740 ps., then the added jitter for this system is insignificant.

When would jitter-penalty be a problem? For 1310 nm wavelengths, the cable length where the jitter penalty becomes significant is calculated as: 740 ps divided by 2.5 ps/km/nm divided by 5 nm = 60 Km (worst case), or 600 Km (normal condition). At 60 Km cable length the cable loss is 60 x 0.4 = 24 dB. So the power into the receiver would be: – 6 dBm – 24 dB = – 30 dBm. This is equal to the published specification of -30 dBm but leaves no margin for connector or other losses. The jitter penalty at 1550 nm for standard definition video is calculated as: 740 divided by 17 divided by 0.8 = 54 Km (worst case). At 54 Km cable length the cable loss is 54 x 0.3 = 16.2 dB. So the power into the receiver would be: - 0 dBm – 16.2 dB = - 16.2 dBm. This is above the published specification of -30 dBm, so added jitter may become significant on cable lengths approaching 54 Km at 1550 nm.

6.2.2. 20 Km Link With 2 Standard Definition Signals On 1 Fiber



For Tx1 < Rx1:

Launch Power =	-7.5 dBm
Connector Loss = 4 x 1	-4.0 dB
Fiber Loss = 20 x 0.4	-8.0 dB
Safety Margin =	-2.0 dB

WDM Loss = 2 x 4	-8.0 dB
Power at receiver	–29.5 dBm

For the 1310 nm path the power available at the receiver is very close to the receiver input sensitivity of -30 dBm. This calculation assumes the worst case connector losses, and a safety margin of 2 dB. In practice, the actual system may be viable, but we should assemble the system including the connectors and actually measure the available power at the receiver to determine the viability. For the 1550 nm path the transmitter launch power is greater and the cable loss is less, so the resulting system design is OK for power loss.

6.3. CALCULATING THE OPTICAL SYSTEM POWER BUDGET

Given a specific optical transmitter and receiver pair, the most important question concerning a system designer or integrator is the maximum possible link length. Here is a worksheet that simplifies this calculation. The specific receiver/transmitter parameters used in the worksheet vary depending on the specific module being used. Consult the specifications in the respective chapters for the modules to get the correct values for the worksheet.

Transmitter Launch Power.. _______ dBm

Receiver Sensitivity.. - _______ dBm

Maximum Allowable Loss: .... = ________ dB

Fiber Loss: † ____km X Attenuation: _______dB/km .... ________ dB

Connector Loss: ‡ _____Connectors X Loss/Connector _______ dB ..... + ________ dB

Passive Device Attenuation .... + ________ dB

Safety Margin.. + ________ dB

Total System Loss:.. = ________ dB

If the Total System Loss < Maximum Allowable loss, then the system is viable. A conservative industry standard for the safety margin is 2dB, and 1 dB per connector. However, these may vary and are usually determined by the system integrator/system engineer.

† Attenuation over Corning SMF 28 Single Mode Fiber: 0.3 dB/km @ 1550 nm, 0.4 dB/km @ 1310 nm

‡ If 62.5μm multimode fiber is used then 2dB must be added to the connector loss to account for receiver and cable fiber diameter mismatch.

6.4. CARE AND HANDLING OF OPTICAL FIBER

6.4.1. Safety

Never look directly into an optical fiber. Non-reversible damage to the eye can occur in a matter of milliseconds. The laser modules used in Evertz fiber optic products are all CLASS I, with a maximum output power of 2mW, and wavelengths of either 1310 nm or 14750 nm to 1610 nm.

6.4.2. Handling And Connecting Fibers

Never touch the end face of an optical fiber.

The transmission characteristics of the fiber are dependent on the shape of the optical core and therefore care must be taken to prevent fiber damage due to heavy objects or abrupt fiber bending. Evertz recommends that you maintain a minimum bending radius of 3 cm to avoid fiber bending loss that will decrease the maximum attainable distance of the fiber cable. Evertz fiber modules come with cable lockout devices, to prevent the user from damaging the fiber by installing a module into a slot in the frame that does not have a suitable I/O module.

Dust particles on the ends of the optical fiber greatly increase the signal loss at interconnections, and large dust particles can even obscure light transmission altogether. To minimize the effects of dust contamination at the interconnections, the fiber should be cleaned each time it is mated or unmated. When using interconnection housings to mate two optical fibers it is good practice to remove dust particles from the housing assembly with a blast of dry air. Whenever a fiber is unmated it must be covered immediately. Most fiber manufacturers provide a plastic boot that fits over the ferrule body for this purpose.

Fiber interconnections must be made securely. The Evertz fiber optical transmitters and receivers come with SC interconnection housings built into the module. With this style of connector, the fiber assembly and the housing assembly can only be connected in one way and with very good repeatability. The rear fiber interconnect panel that is provided with each module can be ordered with optional SC/PC, ST/PC or FC/PC connectors. The customer is required to provide the optical fiber with the correct connectors to connect the modules together. SC/PC, ST/PC and FC/PC interconnection housing and connectors as well as adapters are industry standards with many available sources.

6.4.3. Making Sure The Optical Fibers Are Clean

It is very important to ensure that optical fibers are clean before mating and after unmating. You should have received a pre-moistened tissue with the optical module. Remove this tissue from its package and wipe the end of the fiber connector before mating it to the module.

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