

Optical: Power and Calculating Loss on a Fiber Span

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Overview

- Optics have thresholds for how strong or weak of a light level they can receive before they'll theoretically fail
- The purpose of this page is to help estimate if a particular optic will work on a particular fiber span
- Other factors, such as optical signal-to-noise ratio, reflections, and dispersion, are important and impact your optical performance but are not discussed here

Terminology

- Power level
 - The power level from optics is measured in microwatts but converted to dBm for ease of reading by humans
 - dB is on a logarithmic scale
 - The higher the dBm the stronger your receive level
 - The lower the dBm the weaker your receive level

Milliwatts to dBm Conversion

- Milliwatts to dBm conversion table and some examples (rounding happening on some examples)
 - Note! Not shown: LR, ER, and ZR max receive levels are not shown here.

Power in milliwatts	Power in dBm	1310 and 1550 10G Optic Examples			
10	10				
	9				
	8				
	7				
4	6				
	5				
	4				
2	3				
	2				
	1	Transmit minimum for some 10G ZR optics (80km)			
1	0				
	-1	Transmit minimum for some 10G ER optics (40km)			
	-2				
	-3				
	-4				
	-5				
	-6				
	-7				
	-8	Transmit minimum for some 10G LR optics (10km)			

	-9				
0.1	-10		LR	ER	ZR
	-11		~6dB power budget	~11dB power budget	~23dB power budget
	-12				
	-13				
	-14	Receive minimum for some 10G LR optics (10km)			
	-15	Receive minimum for some 10G ER optics (40km)			
	-16				
	-17				
	-18				
	-19				
0.01	-20				
	-21				
	-22				
	-23	Receive minimum for some 10G ZR optics (80km)			
	-24				
	-25				
	-26				
	-27				
	-28				
	-29				
0.001	-30				

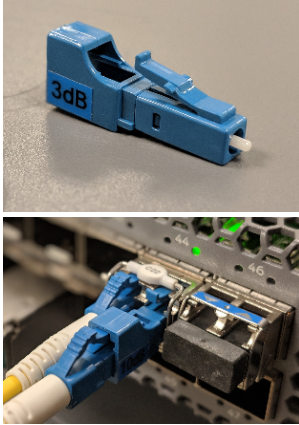
Estimates

- Ballpark estimates:
 - 0.25dB loss per kilometer for 1550nm
 - 0.5 dB loss per kilometer for 1310nm
 - 0.3 dB loss per connector

Tools & Resources

- **DOM**
 - See our knowledge base page [Optical: Digital Optical Monitoring \(DOM\)](#)
 - Command line tools to see reported RX and TX light levels of and optic inserted in a router or switch and current levels
- **Vendor Docs**
 - You should also be able to search your optical vendor's documents to find the rx and tx thresholds for each model optic
 - Example: <https://www.flexoptix.net/en/sfp-plus-zr-transceiver-10-gigabit-stm64-sm-1550nm-80km-23db-ddm-dom.html>
 - RECEIVE MIN. -23.00dBm
 - RECEIVE MAX. (RECEIVER OVERLOAD) -8.00dBm
 - TRANSMIT MIN. 0.00dBm
 - TRANSMIT MAX. 5.00dBm
 - POWERBUDGET (DB) 23 dB
- **OTDR**
 - See [Optical: Optical Time-Domain Reflectometer \(OTDR\)](#)
 - An OTDR is always preferred to accurately determine your path's loss
 - The calculations performed on this page are intended to help when you don't have an OTDR test to rely on
- **Power meter**
 - Tool used to report the current light levels (dBm) being received
- **Pads/Attenuators**
 - It's best to use the right fiber optic for your fiber span but you can use an attenuators to bring the receiving laser light within the specified receive range of your optic
 - You can damage optics when operating outside of the specified maximum receive spec! Never run an optic outside its manufacturer define receiver maximum.
 - Always pad optics on the the rx (receiver) ports of your optics
 - One pad on the rx port of the hub interface, one pad on the rx port of the cpe interface
 - The RX port on an optic should be the right-hand side if the lever is facing up

- Example images:



Calculating Loss

1. Record the TX power of your optic
 - a. Either by using DOM or a power meter
2. Subtract the OTDR results (loss in dB)
 - a. If you don't have OTDR test results, subtract the estimated loss based on the distance
3. Subtract the connector loss (number of patches)
4. Results
 - a. Is the result within your optic's receive min -> max?
 - i. If it's above the max RX add the appropriate pad
 - ii. If it's below the max RX you might need a different optic or

Example:

1. My optic is transmitting at **+1dBm**
2. I don't have an OTDR, but the fiber path distance is 27km
 - a. Subtract 0.25dB loss per kilometer for 1550nm at 37km, **subtract 9.25dB**
3. I'm using two patch cables, one on each side of my fiber span, **subtract 1dB**
4. Result: **9.25dBm**
5. My result of **-9.25dBm** is within the -8dBm to -23dBm receiver specifications for the optic
 - a. My optic should work, but as always I should check DOM post install to verify