

Transmission Speeds and their Maximum Channel Lengths

When designing a fiber topology the most important questions to ask are:

1. What is the highest transmission speed desired?
2. What is the longest channel length?
3. How many connections and splices are in the channel?

With this information, link budget models designed by the Institute of Electrical and Electronic Engineers (IEEE) or the Fibre Channel Industry Association (FCIA) can be utilized to theoretically qualify the channel before it is installed. Using these models requires extensive expertise in fiber optic cable technology and transceiver characteristics.

Panduit has utilized the models from IEEE and FCIA standards to produce multimode reach charts which can assist with the channel design and ensure standards compliancy. These charts are shown in Figures 1, 2 and 3.

For example:

1. Utilizing OM3 fiber with 2.5dB of connector insertion loss, what is the maximum allowable length of the channel for an 8G FC?

Answer: The maximum allowable length is 115m.

2. The longest channel in a datacenter is 150m. If there is 2.0dB of connector insertion loss, what transmission speeds can be run over this channel and with what fiber types?

Answer: OM3: 10GBASE-SR, Avago eSR-4, and 4G FC

OM4: 10GBASE-SR, Avago eSR-4, 4G FC and 8G FC

SC: 10GBASE-SR, Avago eSR-4, 4G FC, 8G FC and 16G FC

To further assist with the theoretical calculations of the link budgets, Panduit has categorized multimode fiber connectivity into three categories: Standard, Optimized and Ultra Low Loss. Typical values for the categories are as follows:

1. Standard Loss: 0.5dB-MPO, 0.25dB-LC, 0.75dB MPO to LC Cassette
2. Optimized Loss: 0.35dB-MPO, 0.15dB-LC, 0.50dB MPO to LC Cassette
3. Ultra Low Loss: 0.25dB-MPO, 0.10dB-LC, 0.35dB MPO to LC Cassette
(Available with Signature Core cabling only)

By knowing what transmission speed or speeds are being deployed in the link along with what type of connectivity and the theoretical insertion loss associated with that connectivity, a maximum reach value can be estimated by using the tables.

Example: Design a link that will be able to support 10GBASE-SR and 8G FC; there will be four optimized MPO to LC cassettes in the link. What is the longest channel length that can be deployed to support these two transmission speeds. Note: By selecting the optimized connector performance, only OM3 and OM4 cabling options are available.

Total connector insertion loss: 0.50dB per MPO to LC cassette
 0.50dB *4 = 2.0dB

By using the OM3 and OM4 charts, at 2.0dB the maximum channel length values are:

OM3: 10GBASE-SR: 285m

8G FC: 125m

OM4: 10GBASE-SR: 380m

8G FC: 160m

From this data, the maximum channel length is limited by 8G FC. If there are separate networks, then it is possible to extend the 10G channel out to its maximum length, but if both transmissions are running under the same sheath, the channel is limited to 125m over OM3 or 160m over OM4.

OM3 Maximum Channel Length (meters)						
Transmission Speed	Total Connector Insertion Loss (dB)					
	3.0	2.5	2.0	1.5	1.0	0.5
10GBASE-SR	255	270	285	300	310	320
40/100GBASE-SR4/10	NA	35	70	100	125	150
Avago eSR-4	290	300	305	310	315	320
4G FC	150	295	320	380	400	455
8G FC	35	115	125	150	180	200
16G FC	NA	45	75	100	120	140

Figure 1. Maximum Channel Length for OM3 cable given the transmission speed and connector insertion loss

OM4 Maximum Channel Length (meters)						
Transmission Speed	Total Connector Insertion Loss (dB)					
	3.0	2.5	2.0	1.5	1.0	0.5
10GBASE-SR	355	360	380	400	420	440
40/100GBASE-SR4/10	15	60	95	125	150	175
Avago eSR-4	400	420	440	455	470	480
4G FC	200	305	370	400	450	495
8G FC	50	125	160	190	220	240
16G FC	NA	55	100	125	150	170

Figure 2. Maximum Channel Length for OM4 cable given the transmission speed and connector insertion loss

*Signature Core™ Maximum Channel Length (meters)						
Transmission Speed	Total Connector Insertion Loss (dB)					
	3.0	2.5	2.0	1.5	1.0	0.5
10GBASE-SR	440	480	515	550	580	605
40/100GBASE-SR4/10	25	80	125	165	200	230
Avago eSR-4	540	570	595	615	630	640
4G FC	210	320	415	500	565	615
8G FC	100	165	215	250	280	300
16G FC	90	140	175	200	215	225

Figure 3. Maximum Channel Length for Signature Core cable given the transmission speed and connector insertion loss

***Note: Sig Core is not recognized within the standards, but has been laboratory tested to meet stated reach specifications.**

Summary

When designing a channel, following the IEEE and FCIA standards for each transmission speed is the proper way to ensure your channel will perform to expectations. Using the Panduit reach charts provides an easy way to assist with these calculations and ensure standards compliancy.