WHITE PAPER

Extended Reach Fiber Applications

Leviton Link Loss Analysis
Theory, Design and Installation Considerations

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INTRODUCTION

Today's diverse and ever-changing technology applications require consistent review of the passive cabling infrastructures that support them. Thorough evaluation of current and future bandwidth requirements, active component costs, physical design constraints, and environmental factors drive a decision-making process that can be complex and subject to miscalculation. These factors can unfortunately lead to performance issues or an under-designed infrastructure that does not support future increased bandwidth needs.

Many organizations desire to maximize their existing cabling infrastructure or extend the network reach from that infrastructure. This can lead to the need for performance over distances that exceed industry standards, mating signals through multiple connection points, or a combination of both. These scenarios lead to concerns about the passive channel's bandwidth capabilities and attenuation loss in relation to the transceiver transmit power and receiver sensitivity.

This white paper addresses the background, factors, and steps to evaluate the physical layer's capability to support various Ethernet and Fibre Channel applications.

WHY IS EXTENDED REACH NECESSARY?

Extended reach refers to a cabling infrastructure that exceeds the maximum length for an application as defined by industry standards. It may also include a topology with many connections. If the sum of all individual connections exhibits the maximum allowed loss defined by standards, the total loss within the passive channel could approach or exceed the maximum channel loss allowed by the target Ethernet or Fibre Channel application.

Requirements for extended reach can be due to several factors:

Legacy Cabling Infrastructure

Network managers may choose to re-use an existing cabling infrastructure as a simple cost saving measure or due to a constraint in the ability to replace or upgrade due to downtime or pathway issues.

Technology Upgrades

Tech refreshes may occur where the new application has a shorter functional operational distance than the currently deployed application, per industry standards. For example, say a network manager has an OM3 trunk that is 250 meters long and mated to MTP® to LC modules, providing connection between two buildings as shown in Figure 1. 10GBASE-SR transceivers were previously used, having a standard-based operational length of 300 meters. If a migration to 25GBASE-SR is desired, the standard based length limit drops to 100 meters. The network manager would be seeking confirmation that 25GBASE-SR will be supported over the existing cabling infrastructure even though the length exceeds what is defined in industry standards.

Extended reach refers to a cabling infrastructure that exceeds the maximum length for an application as defined by standards. It may also include a topology with many connections.

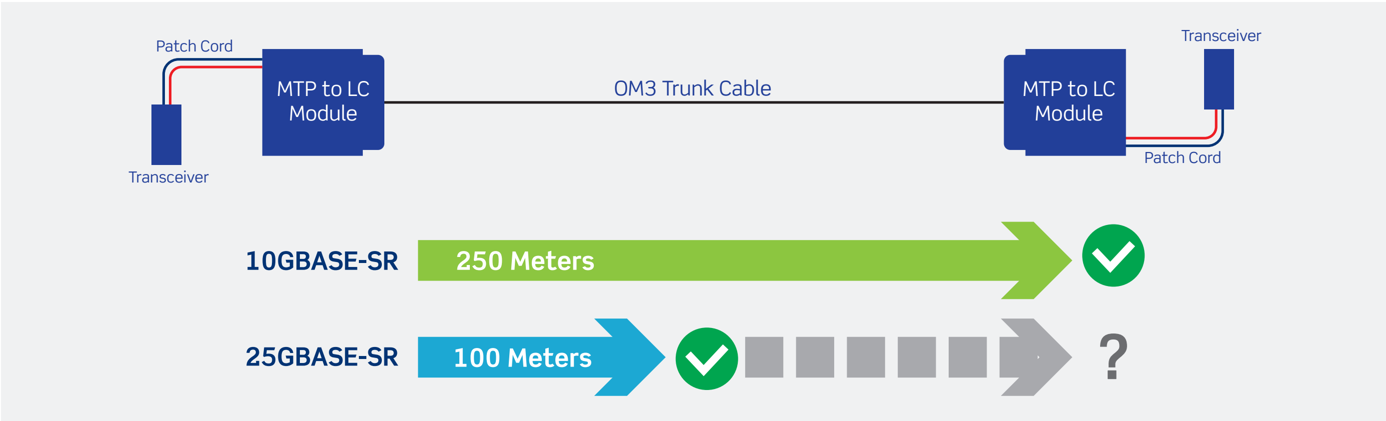

Figure 1. Upgrading to 25GBASE-SR over OM3 changes allowable length limits per industry standards

Some technology updates introduce additional fiber optic components, such as cassettes, harnesses, or adapter plates. These increase the number of physical matings within the channel. For example, a network has a 150-meter OM3 trunk mated to MTP® to LC modules, providing connection between two buildings (Figure 2). 10GBASE-SR transceivers are in use, with a standards-based operational length of 300 meters and a maximum allowable loss of 2.6 dB. The network manager wants to extend that same circuit to another building through another cassette/trunk/cassette channel of 200 meters. They want to confirm that 10GBASE-SR will still be supported over the existing cabling infrastructure, even though the length exceeds the standards length limit and the overall attenuation in the new channel is approaching the maximum allowable attenuation loss.

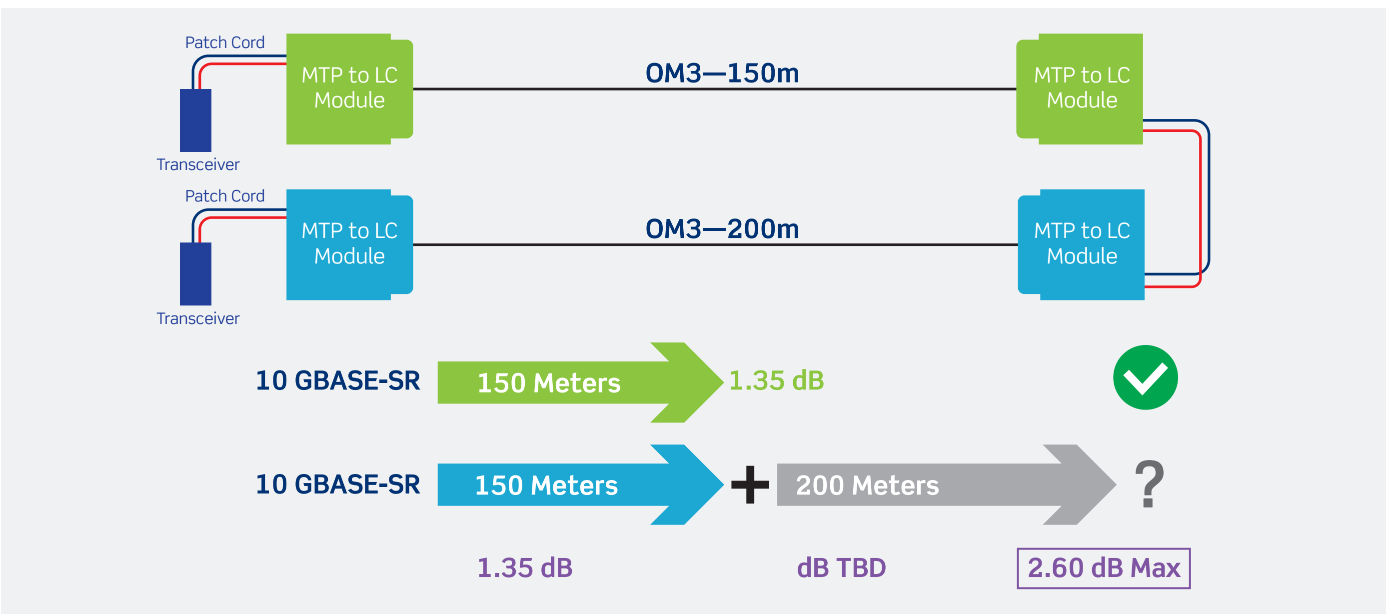

Figure 2. Adding components to a channel may exceed maximum industry standards for length limits and attenuation loss

Active hardware additions and associated changes

There are cases where the intended active hardware may result in requiring an additional Telecommunications Room or Telecommunications Enclosure in the facility design. Similarly, a different fiber grade may become necessary, such as OM4, OM5, or OS2. These changes could require additional patch points, resulting in loss in the channel or exceeding the standards-based maximum length.

Competitive product response

Sometimes, as part of their bidding or submittal process for award, a contractor or consultant may be asked to validate that their design will meet performance requirements to a specified distance, topology, or data rate that exceed industry standard specifications.

LIMITATION FACTORS

There are a range of factors that can limit extended reach. These include the maximum performance loss of components, the number of components or matings in the channel, fiber grade, transceiver choices, and the quality of the installation.

Maximum performance loss of components

Standards-based limits vs. engineered links

Standards-based links set limits on factors such as maximum allowable loss in the channel, individual components, and connector matings. Engineered links are designed to allow additional matings or components that are evaluated and configured to meet a target application.

Factory controlled product vs. field installation

Product that is manufactured in a controlled environment using commercial-grade assembly, termination and test equipment yields superior and repeatably performing product. In comparison, field termination typically results in lower performing components with a higher degree of variability.

Maximum vs. typical loss

Maximum loss is the standards-based loss limit for cables, connectors and mated pairs. Factory terminated components often have significantly lower loss values and historically traceable data that allows for proven repeatable values — known as typical loss — to be used when estimating link loss and extended reach capabilities.

Number of components/matings in the channel

With today's lower loss factory terminated products, the impact of each mating in a channel is greatly reduced. While additional loss is added with each additional mating, factory terminated components have a relatively small increase in total attenuation as additional components are added to a channel.

Fiber Grade

Multimode fiber has a much shorter transmission distance in comparison to single-mode fiber. Multimode fiber also produces greater attenuation loss over distance. The typical loss of ITU-T rated indoor, I/O and OSP rated multimode fiber is 3.0 dB/Km versus 0.5 dB/Km (ANSI/TIA) / 0.4 dB/Km (ISO 11801) for single-mode.

NOTE: OM1 and OM2 fiber grades are no longer recommended by ANSI/TIA.

Transceivers

Transceiver choice can be a factor in reach limitations, and transceiver output power and sensitivity ranges can vary from device to device. For Ethernet transceivers, there is a wide variety of maximum allowable attenuation by application. In general, the higher the data rate, the lower the allowable attenuation.

For Fibre Channel applications, options are available in both multimode and single-mode. Typically data rates are commonly seen at 8Gb and above in today's environment. The majority of multimode Fibre Channel applications are limited to less than 200 meters and a range of 1.6 to 2.9 dB in allowable loss.

Quality of the installed passive channel

The installation and quality of the components in the channel is important to the performance of all deployed passive infrastructure systems. When attempting to extend reach and/or add connections to a channel, it is mission critical that these systems be installed in an acceptable state for lowest possible loss. Any underperforming product goes against the overall operating budget already being impacted by extended reach requirements. Key contractor and end user technician practices include connector cleanliness through "Inspect before you connect" habits and standards-compliant installation practices.

LINK LOSS AND EXTENDED REACH CALCULATIONS

How is Link Loss and Extended Reach analysis performed?

Leviton has the capability to calculate the maximum distance that a specific application can be supported over a given channel topology. This capability is based on statistical analysis of typical component losses and industry accepted models to determine optical losses in a channel.

Standards-compliant link loss

The data points calculated are:

- Connector insertion loss of all channel components.
  - Manufacturers will use "typical" loss values for the products they make. These loss values are often below the maximum loss defined by standards organizations.
  - These values may be compiled using statistical means, applied confidence factors or other formulaic measures
- Attenuation over channel length by fiber type.
- Maximum allowable transceiver loss by the applicable IEEE 802.3xx standard or manufacturer-determined specifications in a non-standards-based product.

The calculation provides a compliance value against IEEE standards for loss and length. It provides validation that a specified Ethernet or Fibre Channel application can be supported by the product configuration. This extended reach calculation capability can help installers and network managers reinforce their design work. The highly accurate output calculated by Leviton Technical Support provides a 95% confidence estimation of the performance of any channel topology.

Using our previous example of an OM3 4-cassette channel shown in Figure 2, below is example output of the expected loss based on the products and channel topology provided at 300 meters (Table 1). The multimode table shows the applications supported at their standard-defined maximum length. Using standards-based maximums, several applications would not be supported at 301 meters. Since we know adding one meter of length will not make this channel inoperable, we know that there is an extended reach that can be supported by the installed infrastructure.

While the standards length limit for 10GBASE-SR is 300 meters, an evaluation of the channel reveals that an extended reach is achievable.

AT 300 METERS

Supported Multimode Ethernet Applications		Standards Length
10BASE-FL	Yes	2000.0
10BASE-SX	Yes	300.0
100BASE-SX	Yes	300.0
1000BASE-SX	Yes	550.0
1000BASE-LX	Yes	550.0
10BASE-SR	Yes	300.0
10GBASE-LRM	-	-
10GBASE-LX4	Yes	300.0
25GBASE-SR	-	-
40GBASE-SR4	-	-
40GBASE-SR-BD	-	-
40GBASE-XSR4	Yes	300.0
100GBASE-SR4	-	-
100GBASE-SR10	-	-
100GBASE-SR-BD	-	-
100GBASE-SWDM4	-	-
200GBASE-SR4	-	-

AT 301 METERS

Supported Multimode Ethernet Applications		Standards Length
10BASE-FL	Yes	2000.0
10BASE-SX	-	-
100BASE-SX	-	-
1000BASE-SX	Yes	550.0
1000BASE-LX	Yes	550.0
10BASE-SR	-	-
10GBASE-LRM	-	-
10GBASE-LX4	-	-
25GBASE-SR	-	-
40GBASE-SR4	-	-
40GBASE-SR-BD	-	-
40GBASE-XSR4	-	-
100GBASE-SR4	-	-
100GBASE-SR10	-	-
100GBASE-SR-BD	-	-
100GBASE-SWDM4	-	-
200GBASE-SR4	-	-

Table 1. Example output of 4-cassette channel over OM3. While no longer meeting standards length requirements at one meter longer than standard maximum, the channel will still achieve extended reach.

Extended Reach

Leviton has the capability to calculate extended reach, which is the estimated maximum length a desired signal can travel and remain operational. Calculations are generated based on the IEEE engineered link models that were originally developed to assist Ethernet and Fibre Channel committees to develop specifications and evaluate the impact of various link penalties.

The model includes assessment of:

- Penalties associated with transceivers based on each IEEE application.
- Transmitter characteristics: optical modulation amplitude (OMA), center wavelength, spectral width, rise/fall time, and jitter.
- Receiver characteristics: nominal sensitivity, and receiver bandwidth.
- Link characteristics: attenuation, modal bandwidth, and chromatic dispersion.

It also provides a compliance report for transmission applications and maximum operational distance.

- The channel is often evaluated at a distance longer than a standards limit.
- This length may also be reported with a value shorter (de-rating) than a standards limit depending on channel configuration.

NOTE: Fibre Channel modeling currently utilizes the 10 Gigabit Ethernet spreadsheet model as the basis for generating its 10 Gb/s specifications.

Using our previous example of an OM3 4-cassette channel at 350 meters (shown in Figure 2), below is the result of the extended reach evaluation (Table 2). The total estimated connector loss is 0.80 dB. The remainder of the loss is resulting from the distance of the provided measurement of 350 meters and the various applied power penalties specific to the target Ethernet Application. Based on these data inputs, the functional maximum limit is 370 meters.

Example of the output showing extended reach of a system:

- The target Ethernet Application of 10GBASE-SR
- Higher data transmission rates of 40G, 100G, 200G and Fibre Channel options are also evaluated for operational length enabling the user to forecast future migration strategies.

As the actual length of the channel (350 meters) is very near the estimated functional limit of 370 meters, risk assessment involving design considerations are critical in the decision-making process.

Market	US		
Fiber Grade	**OM3**		[ ] Override Fiber Grade
Attenuation	3.000	dB/km	[ ] Override Attenuation
Connector Loss	0.80	dB	[ ] Override Connector Loss

Transmission Standards	
Multimode	**Single Mode**
[ ] 1000BASE-SX	[ ] 1000BASE-LX
[x] 10GBASE-SR	[ ] 10GBASE-LR
[ ] 25GBASE-SR	[ ] 25GBASE-LR
[ ] 25GBASE-CSR	[ ] 25GBASE-ER
[x] 40GBASE-SR4	[ ] 40GBASE-LR4
[ ] 40GBASE-eSR4	[ ] 40GBASE-ER4
[ ] 40GBASE-CSR4	[ ] 40GBASE-FR
[ ] 40GBASE-SWDM4	[ ] 50GBASE-FR
[ ] 40GBASE-BiDi	[ ] 100GBASE-LR4
[ ] 50GBASE-SR	[ ] 100GBASE-ER4
[x] 100GBASE-SR4	[ ] 100GBASE-PSM4
[ ] 100GBASE-eSR4	[ ] 100GBASE-CWDM4
[ ] 100GBASE-SR10	[ ] 100GBASE-CWDM4 OPC
[ ] 100GBASE-SWDM4	[ ] 100GBASE-DR
[ ] 100GBASE-BiDi	[ ] 200GBASE-LR4
[ ] 100GBASE-SR2	[ ] 200GBASE-DR4
[x] 200GBASE-SR4	[ ] 200GBASE-FR4
[ ] 400GBASE-SR8	[ ] 400GBASE-LR8
[ ] 400GBASE-SR4.2	[ ] 400GBASE-DR4
[ ] 8GFC	[ ] 400GBASE-FR8
[x] 16GFC	[ ] 16GFC
[ ] 32GFC	[ ] 32GFC
[x] 64GFC	[ ] 64GFC
[ ] 128GFC	[ ] 128GFC PSM4
	[ ] 128GFC CWDM4

Multimode	
Standard	**Supported Distance (meters)**
1000BASE-SX	-
10GBASE-SR	370
25GBASE-SR	-
25GBASE-CSR	-
40GBASE-SR4	205
40GBASE-eSR4	-
40GBASE-CSR4	-
40GBASE-SWDM4	-
40GBASE-BiDi	-
50GBASE-SR	-
100GBASE-SR4	105
100GBASE-eSR4	-
100GBASE-SR10	-
100GBASE-SWDM4	-
100GBASE-BiDi	-
100GBASE-SR2	-
200GBASE-SR4	105
400GBASE-SR8	-
400GBASE-SR4.2	-
8G Fibre Channel	-
16G Fibre Channel	170
32G Fibre Channel	-
64G Fibre Channel	85
128G Fibre Channel	-

Table 2. Example output of extended reach evaluation for 4-cassette channel over OM3

Scalable and appropriate infrastructure design

Many network managers design for the ability to easily scale networks in environments such as data centers and multi-floor or campus facilities. With ever increasing bandwidths, minimizing the quantity of connector matings while still providing the ability to inter-connect or cross-connect is a common priority.

What to look out for

Approaching potential non-functional scenarios

The goal of any channel loss evaluation is to determine whether data transmission will function over a specific length or with a specific configuration of components. While there is always a variable degree of risk, system designers should work to avoid validating configurations that place the network at an unnecessary risk of downtime, inoperability, or failure.

In the assurance matrix below (Table 3), OM4 fiber is being evaluated for distance capabilities using conversion cassette MPO/MTP® multifiber matings for a 40GBASE-SR4 application.

- The ANSI/TIA standards length limit for 40GBASE-SR4 using OM4 components is 150 meters
- The number of fibers used for 40GBASE-SR4 is 8

40GBASE-SR4	**ANSI/TIA Standards limit - OM4 / 150 m**							
OM4	**Extended reach distance in meters**					**No. of Fibers used**		**8**
Connections	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**MTP Cassettes**
0	N/A	270	240	200	145	55	N/A	
1	280	250	215	170	100	N/A	N/A	
2	270	240	205	150	60	N/A	N/A	
3	260	230	185	125	N/A	N/A	N/A	
4	250	215	170	95	N/A	N/A	N/A	
5	240	205	150	60	N/A	N/A	N/A	
6	230	190	130	20	N/A	N/A	N/A	
MTP Matings								

LESS THAN MAXIMUM LENGTH BUT VERY NEAR MAXIMUM LOSS LIMIT

NEAR MAXIMUM LENGTH BUT WITH ATTENUATION HEADROOM

NOT SUPPORTED

Table 3. Assurance matrix evaluating supported loss over extended distance and added MTP matings

*NOTE: An MTP/MTP cassette has two MTP connections per device but is calculated as one total loss event.
An example of an MTP Mating is the mating of two trunks or array cords in a channel.

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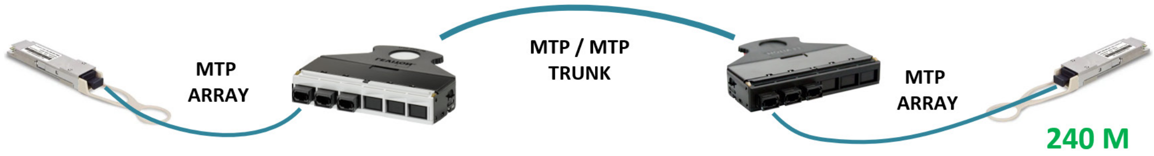
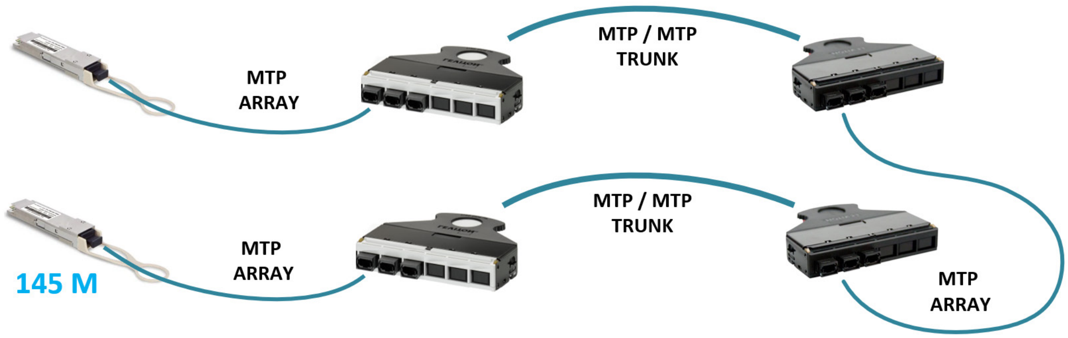
We can see from the assurance chart that a common configuration of two cassettes allows for a length of 240 meters, 90 meters beyond the 150 meter limit.



Adding two additional cassettes creates a calculated reduced functional length of 145 meters.



This evaluation of OM4 shows that the standards-based length limit can be exceeded for many of the connector configurations.

Options with Additional Matings

If the design requires additional matings, what is the solution? Using different components may provide the necessary additional matings while still meet the length requirements for the facility design. Using the same 40GBASE-SR4 application, the Table 4 assurance matrix below evaluates OM4 for distance capabilities using MTP trunks and array cords via adapter MPO/MTP® multifiber matings — as opposed to the cassette MTP matings as in Table 3.

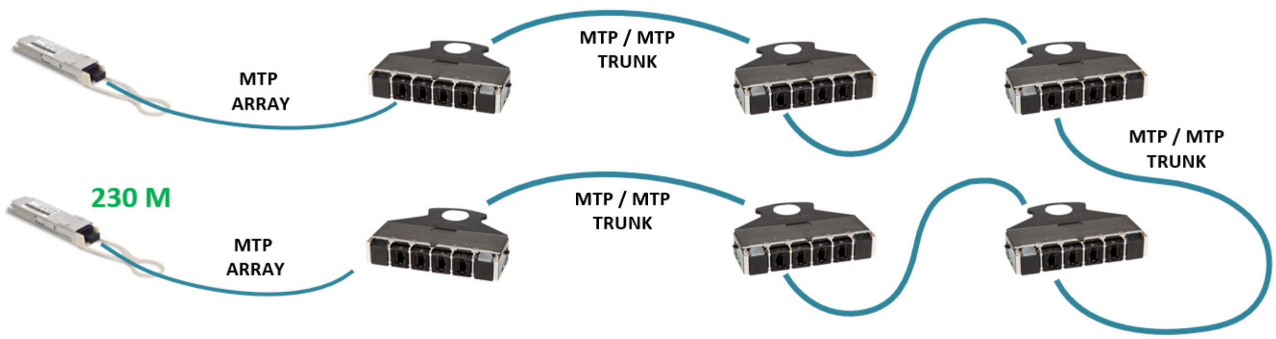
- The ANSI/TIA standards length limit for 40GBASE-SR4 using OM4 components is 150 meters
- The number of fibers used for 40GBASE-SR4 is 8

40GBASE-SR4		**ANSI/TIA Standards limit - OM4 / 150 m**						
OM4	**Extended reach distance in meters**					**No. of Fibers used**		**8**
Connections	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**MTP Matings**
0	**N/A**	**280**	**270**	**260**	**250**	**240**	**230**	
1	**280**	**265**	**255**	**245**	**235**	**225**	**215**	
2	**275**	**260**	**250**	**240**	**225**	**215**	**205**	
3	**270**	**250**	**240**	**230**	**215**	**205**	**195**	
4	**260**	**245**	**230**	**220**	**210**	**195**	**180**	
5	**255**	**235**	**225**	**210**	**195**	**180**	**165**	
6	**245**	**225**	**215**	**200**	**185**	**170**	**150**	
LC Matings								
(orange)	**NEAR MAXIMUM LENGTH BUT WITH ATTENUATION HEADROOM**							

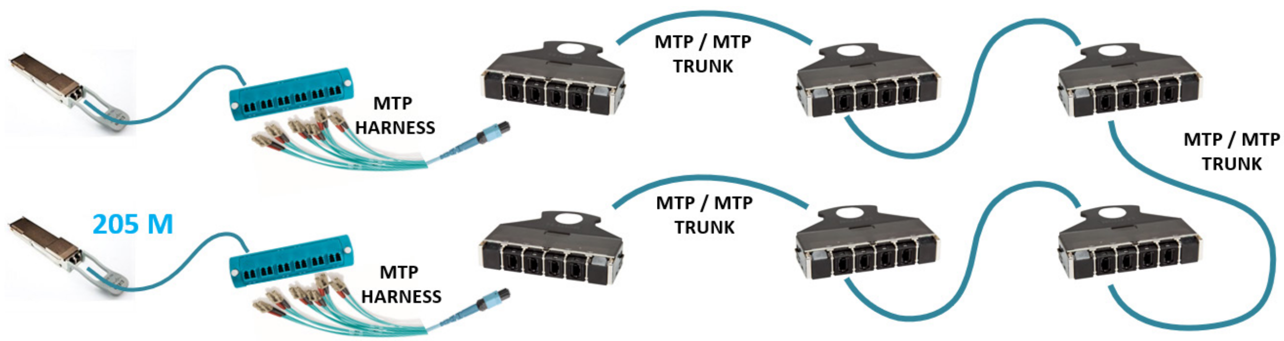
Table 4. Assurance matrix evaluating supported loss over extended distance and added MTP matings

*NOTE: An example of an MTP Mating is the mating of two trunks or array cords in a channel
An example of an LC Mating is the use of an MTP to LC Conversion harness to connect to active hardware

We can see from the assurance chart that a configuration of six MTP matings allows for a length of 230 meters, 80 meters beyond the 150-meter limit.



Adding two additional MTP to LC Conversion harnesses creates a calculated reduced functional length of 205 meters, still well above the standards-based limit.



While not necessarily common configurations, the two examples above show that product selection can be adjusted to meet a specifically required cross-connect or interconnect design. Also, both scenarios show that while the standards-based maximum lengths may not always be achieved, configurations that require several matings can still function at a reduced length.

Validation Processes

To validate the statistical outputs of the link loss and extended reach applications, Leviton performed physical testing of representative cabling channels evaluating transmission beyond standard length limits through the comparison of expected and actual performance. Fiber links were constructed using Base-8 compliant cassettes, trunks and array cords for both OM3 and OM4 fiber grades. Fiber plant characteristics were measured, and optical components of transceivers were categorized to predict 40GBASE-SR4 transmission success. The results demonstrated that these extended length calculations are conservative.

Modal Delay

Differential Mode Delay (DMD) measures the delay between the first and last arriving pulse after they've propagated through their respective optical modes in a multimode fiber. Each waveform in the image below (Figure 3) represents an ultra-narrow light pulse that was launched from a given point on the fiber endface, propagated through its respective modes, and was detected by a receiver on the far end. This measurement contributes to the Effective Modal Bandwidth (EMB), which dictates the frequency and distance at which a signal can be transmitted through a given fiber.

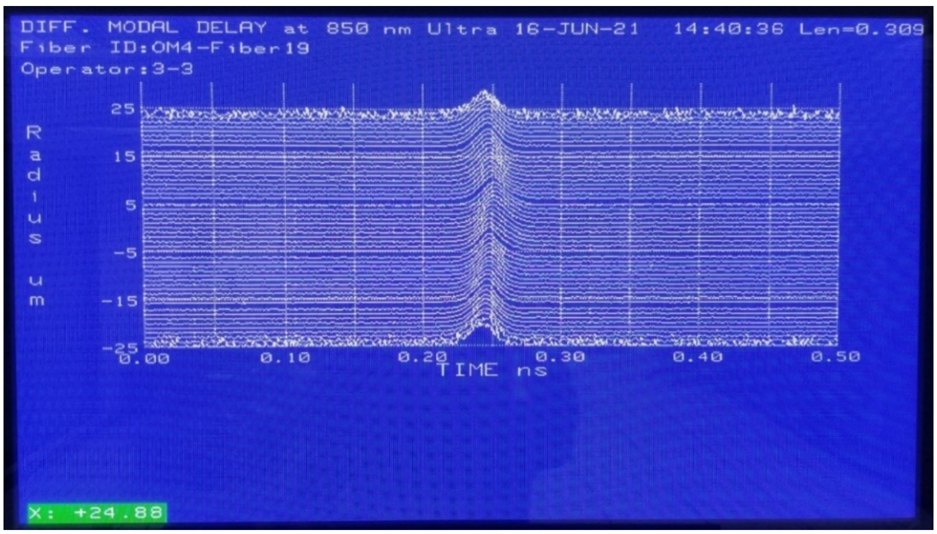


Figure 3. Measuring Differential Mode Delay understand frequency and distance

Eye Pattern

Transmitter eye patterns provide information on the quality of the optical signal being launched from a transceiver and into the fiber cable plant. They describe the timing and amplitude characteristics of the transmitted signal such that the entire end-to-end system can be better understood. The 10G pattern below (Figure 4) was generated by one of the transceivers used to test the operational length of OM3 and OM4 channels.

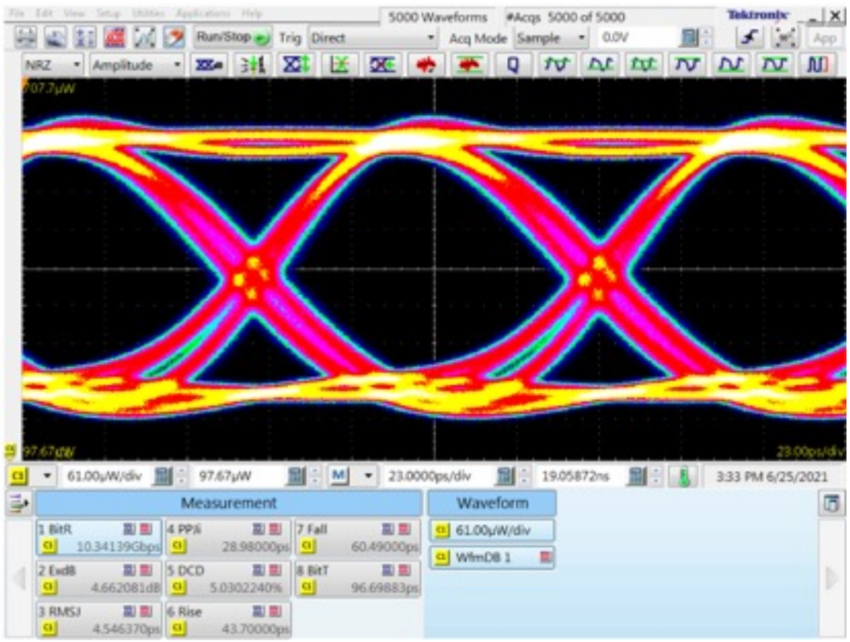


Figure 4. Measuring transmitter eye patterns to test operational length

Actual Operational Length vs. Predicted Operational Length

*NOTE: Per IEEE, the maximum allowable length for 40GBASE-SR4 is 100 meters over OM3 and 150 meters over OM4.

Table 5 below shows the predicted distance at which three OM3 channels and three OM4 channels could support 40GBASE-SR4 data transmission. In some instances, the actual supported length far exceeded the predicted. While many of the transceiver and fiber characteristics could be measured before data transmission testing, others could not. Because these unmeasured characteristics were required for robust modeling, they were generally assumed to be worst case, which produced conservative length estimates.

Channel Under Test	Maximum Connector Loss (dB)	40GBASE-SR4 Supported Length (meters)	
		Actual	Predicted
OM3 Channel #1	2.71	309+	350
OM3 Channel #2	2.64	309+	290
OM3 Channel #3	3.51	309+	165
OM4 Channel #1	2.33	309+	415
OM4 Channel #2	1.99	309+	430
OM4 Channel #3	1.84	309+	410

Table 5. Example actual operational length vs predicted operational length

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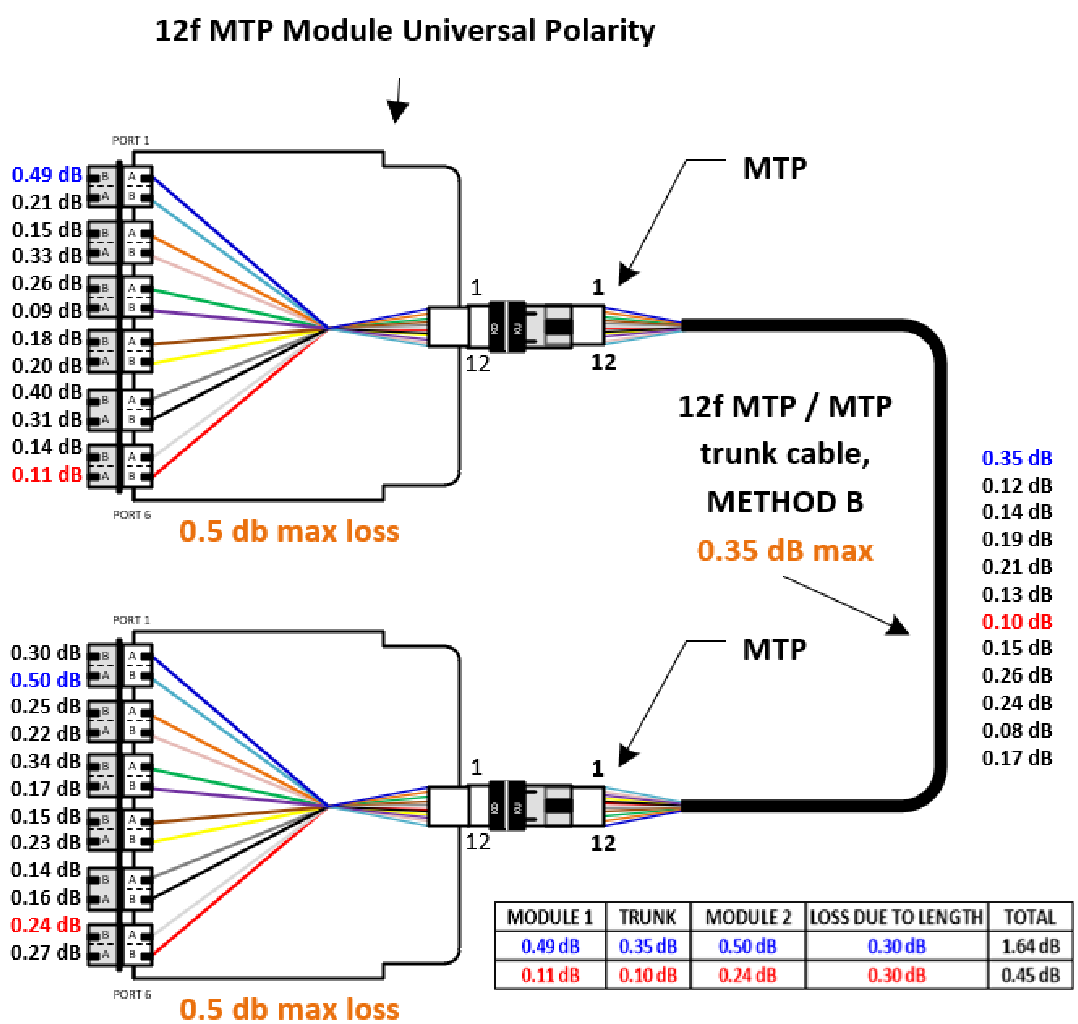
Risk needs to be assessed in the configurations that indicate potential intermittent or non-functioning scenarios. This could result in design changes reducing the number of matings, considering a different fiber grade (OM4 or OS2), evaluating optional cabling paths to reduce length, or a combination of all three.

Compounding connector loss and the "perfect storm" scenario

In any multi-fiber/multi-mating configuration, there is a grouping of fibers that all have a unique termination profile. Each connector has a different end face polish, different connector loss (IL) and different return loss (RL). As the fibers are mated through a series of components, each simplex channel results in a different performance value. While each connector is factory terminated and tested to no more than a manufacturers maximum allowable limit, it is feasible that a series of matings can result in a simplex channel where connector matings and imperfect performance from contamination or other field related issues causes a "perfect storm" of insertion loss that is higher than expected for that fiber link. While this scenario may not impact a lower data rate channel, higher data rate applications with longer length or additional connector matings accountable to a lower allowable channel loss could be affected.

The example shown below in Figure 5 provides a 100-meter channel with 0.3 dB loss for length. The first duplexed fiber link in blue has a total single fiber channel loss of 1.64 dB. The last duplexed fiber link in red has a total simplex fiber loss of 0.45 dB. While the blue simplex fiber link is most likely field correctible with inspection and cleaning, it is significantly higher than the other fiber links in this channel.



MODULE 1	TRUNK	MODULE 2	LOSS DUE TO LENGTH	TOTAL
0.49 dB	0.35 dB	0.50 dB	0.30 dB	1.64 dB
0.11 dB	0.10 dB	0.24 dB	0.30 dB	0.45 dB

Figure 5. Example multifiber matings with "perfect storm" insertion loss

Anticipating migration to higher bandwidths

As addressed previously, existing cabling infrastructure should be evaluated when higher data rate applications are intended to be deployed. Strong consideration should be given to transceiver types and single-mode fiber grades that are better suited to handle either extended distances, higher data rates or both.

Installation and environmental variables

The quality of the physical installation is critical to a functional and adaptable network infrastructure. Installers should ensure quality field terminations, proper pathway support, and the right environmental factors:

Quality field terminations

When evaluating the functional capability with either added length, connector matings or both, signal loss due to connector quality becomes extremely important. Installers must inspect the quality of connector end faces for cleanliness.

Proper pathway support

Correct bend radius, pathway and routing should be followed, including:

- Proper pull tension and bend radius control
- Proper aerial support
- Proper vertical/riser support
- Underground duct banks and conduits
- Resistance to water ingress

Environmental factors

Environmental factors can degrade passive components over time. Installers should recognize the appropriate operational climate, factoring in temperature, humidity, and direct sun/UV.

TESTING

Tier 1 Testing

Tier 1 testing is required per ANSI/TIA and IEC standards. It is achieved by performing a visual inspection of the end face of all connectors, documenting the length via cable markings or testing apparatus, verifying polarity (if applicable), and using an optical power source and optical meter. The optical meter measures the end-to-end loss (attenuation in dB) of the link.

The recommended method is ANSI/TIA 526-7 method A.1, One Reference Jumper method. Testing needs to be performed bi-directionally at the appropriate wavelengths by fiber type. The length shall be calculated and documented either automatically by the test device or by physical calculation.

Tier 2 Testing

Tier 2 testing is achieved by using an Optical Time Domain Reflectometer (OTDR). An OTDR sends pulses of light into an optical fiber and measures the strength of the power returned to the instrument as a function of time. The OTDR creates a graphical output (trace/picture) depicting the fiber link under test. The OTDR has the capability to measure the length of the fiber and estimate the loss between any two points along the fiber link.

Tier 2 testing is not required by ANSI/TIA standards and is not a substitute for Tier 1 certification. Tier 2 may be requested by the end user to provide added test detail and a historical benchmark for each individual link performance. OTDR testing is also valuable in determining cable attenuation and fault points during troubleshooting.

INFRASTRUCTURE ASSISTANCE

Balancing budgetary considerations, operational costs, migration strategy and system performance can be a complex process. Understanding the limitations of a networks functional capability is critical in assessing risk. Leviton recommends having a full understanding of current and future data applications, target application transceiver specifications, and a careful analysis of the performance capabilities of the passive cabling infrastructure.

The Leviton Optical Link Verification Tool reinforces design work by adding a high level of confidence in the channel performance and application support. In addition, Leviton Opt-X® Unity and Enterprise DC end-to-end fiber solutions exceed industry standard requirements, offering superior channel performance. The Optical Link Verification Tool calculations provide a snapshot of how any given topology using Unity and Enterprise DC connectivity will outperform the standard.

Contact Leviton Data Center Designers and Applications Engineers for a detailed evaluation of current and future infrastructure at:

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appeng@leviton.com (US, Canada, Caribbean, the Americas)
appeng.eu@leviton.com (Europe, Middle East, Africa)

REFERENCES

Standards

Industry Standards drive requirements in product selection and installation practices They also determine the electronic transmission and performance specifications in transceivers. Applicable standards include but are not limited to:

- ANSI/TIA-568.0, Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568.1, Commercial Building Telecommunications Cabling Standard
- ANSI/TIA 568.3-D Optical Fiber Cabling Standard
- ANSI/TIA 569-E Commercial Building Standard for Telecommunications Pathways and Spaces
- ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard
- ANSI/TIA-862, Building Automation Systems Cabling Standard
- ANSI/TIA-942, Telecommunications Infrastructure Standard for Data Centers
- ANSI/TIA-1005, Telecommunications Infrastructure Standard for Industrial Premises
- ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standard
- ANSI/TIA-4966, Telecommunications Infrastructure for Educational Facilities
- ANSI/TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
- ANSI/TIA-526-14 Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
- ISO/IEC 11801-1, Information Technology – Generic Cabling for Customer Premises
- ISO/IEC 11801-3, Information Technology – Generic Cabling for Customer Premises – Part 3 Industrial Premises
- ISO/IEC 11801-5, Information Technology – Generic Cabling Systems for Customer Premises – Part 5: Data Centres
- IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures
- IEC 61300-3-35 Fibre Optic Interconnecting Devices And Passive Components – Basic Test And Measurement Procedures – Part 3-35: Examinations And Measurements – Fibre Optic Connector Endface Visual And Automated Inspection
- IEEE 802.3xx addresses multiple Ethernet Applications
- INCITS/T11, Fibre Channel Interfaces

Today's networks must be fast and reliable, with the flexibility to handle ever-increasing data demands. Leviton can help expand your network possibilities and prepare you for the future. Our end-to-end cabling systems feature robust construction that reduces downtime, and performance that exceeds standards. We offer quick-ship make-to-order solutions from our US and UK factories. We even invent new products for customers when the product they need is not available. All of this adds up to the **highest return** on **infrastructure investment**.

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