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Benefits of Using Singlemode Ultra Low Loss Systems

Tech Brief

Reading Time: 5 minutes

Singlemode Ultra Low Loss Systems

As data center operators are adding new switches and servers into their spaces it's critical to have low loss optical fiber cabling to support current and next generation optics. To best support applications from 100G to 400G and upcoming 800G, singlemode cabling becomes the most cost effective and logical choice on new deployments. A major advantage of using singlemode fiber is the optical loss budgets are less stringent than multimode fiber which allows for more connection points. A structured cabling design introduces connection points into the fiber links to support different optic types that use either LC and MPO/MTP connectors or both and is optimal to best manage moves, adds and changes.

The use of a structured cabling design can make day to day device management easier on the data center operator by allowing them to connect new devices using short length jumpers and patch cords. Connection points are located near the spine, core or director switches on one end of the link and near the leaf, edge or Top of Rack switches or servers on the other end. Figure 1 shows a basic structured cabling channel using MTP-to-LC modules connected together via an MTP-to-MTP trunk using LC-to-LC jumpers from the front of the modules into the optics on each end.

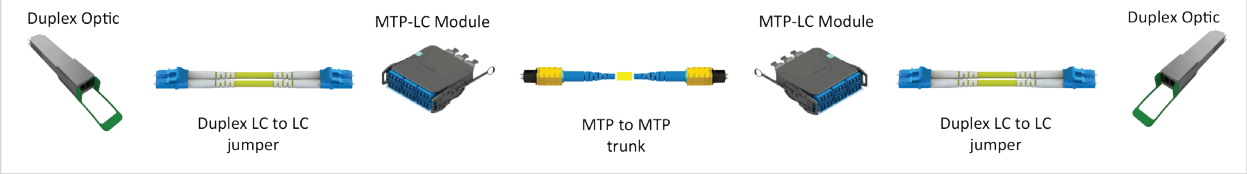

Figure 1 Basic structured cabling channel

Another common structured cabling implementation is to use a cross-connect design. This type of design is often used in medium to large enterprise data centers because it supports different generations of compute equipment and can connect different types of optics that require different connector types or breakouts. An advantage of the cross-connect design is that it provides the ability to take an active port and move it out onto the data center floor one port at a time. The cross-connect design also reduces unused active switch ports making the entire data center more efficient. The challenge with the cross-connect design is that it adds more connections or mated pairs of optical fiber connectors which increases optical loss. This is where the value of using ultra low loss optical fiber components provides the most tangible benefits. Figure 2 illustrates a cross-connect design to support duplex LC optics.

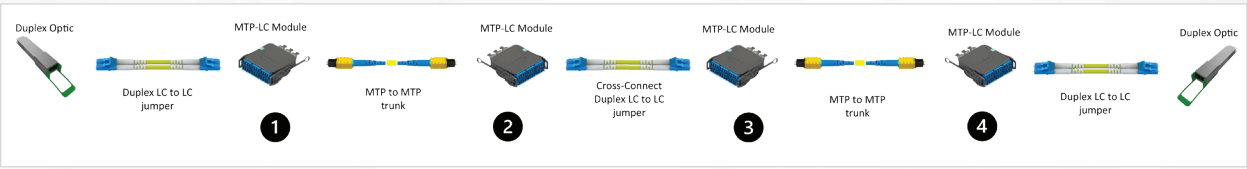

Figure 2 Example of a duplex LC cross-connect channel

The maximum or worst-case dB link loss or insertion loss performance will confirm if the overall link will function as required for the application's optics. Note that typical loss—which is another term often used in the industry to specify average performance—does not equate to maximum loss and is not to be used in optical loss calculations. When calculating a link loss value, one needs to start with the maximum connector dB loss by adding up all the connections in the link.

Figure 3 below shows the three main Siemon singlemode ULL components. The LC has a maximum loss of 0.20 dB and the MTP a maximum loss of 0.30 dB. The MTP-to-LC module has an MTP in the back and LC connection in the front. Add these two connector numbers together and you come up with 0.50 dB loss for each MTP-to-LC module. Note that the LC value assumes the use of a duplex LC jumper that also has a maximum loss of 0.2 dB or better. The dB loss of the fiber also then needs to be added into the overall loss calculation. The maximum loss of Siemon's pre-terminated singlemode MTP-to-MTP trunks is 0.4 dB/km. The connectors plugged into the optics on each end of the channel are not applicable in the link loss budget.

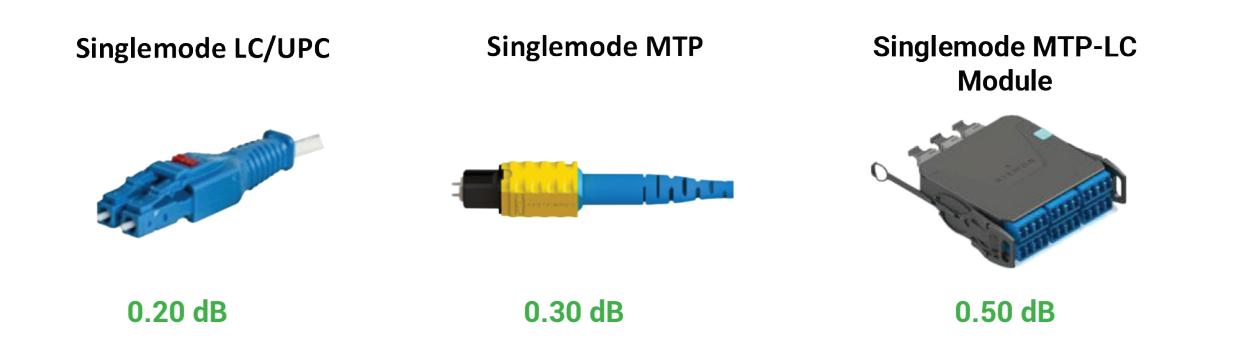

Figure 3 Siemon singlemode ULL components

The two most prominent applications for 400G used in the data center are 400GBASE-FR4 (IEEE 802.3cu) and 400GBASE-DR4 (IEEE 802.3bs). 400GBASE-FR4 uses a 2-fiber singlemode duplex LC connector and has an operating distance of 2 kilometers with an associated maximum channel insertion loss limit of 4.0 dB. Figure 2 shows the duplex cross-connect design with duplex optics on each end. There are four ULL MTP-to-LC modules in the link which equates to 4 x 0.50 = 2.0 dB. Adding in the loss of the fiber cable (0.4 dB/km x 2km = 0.8 dB) results in a maximum loss of 2.8 dB which provides 1.2 dB of headroom to the 4.0 dB application limit as shown in Figure 4.

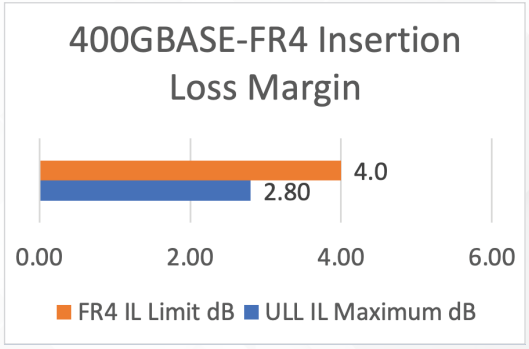

Figure 4 400GBASE-FR4 maximum channel insertion loss

400GBASE-DR4 uses 8-fibers of a 12-fiber singlemode MPO/MTP connector and has a maximum operating distance of 500m with an associated maximum insertion channel loss limit of 3.0 dB.

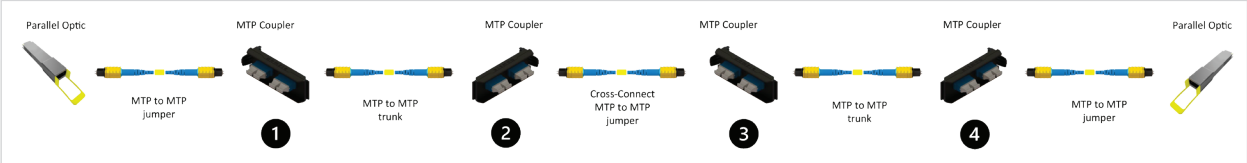

Figure 5 Example of a MPO/MTP cross-connect channel

While the operating distance of 400GBASE-DR4 is less than the 2 kilometers of 400GBASE-FR4, it can still accommodate many data center environments. Figure 5 shows a parallel cross-connect design with the 400GBASE-DR4 MPO/MTP optics on each end. There are 4 MPO/MTP adapters in the link which equates to 4 x 0.30 = 1.2 dB. Adding in the loss of the fiber cable (0.4 dB/km x 500m = 0.2 dB) results in a maximum loss budget of 1.4 dB. which provides 1.6 dB of headroom to the 400GBASE-DR4 application limit of 3.0 dB as shown in Figure 6.

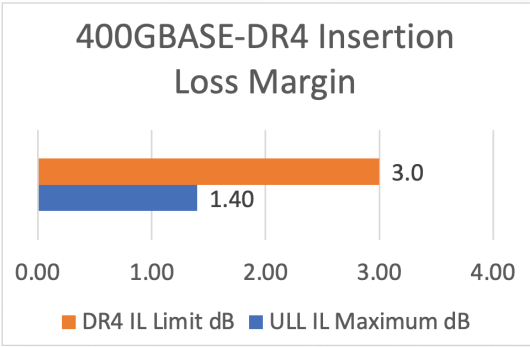

Figure 6 400GBASE-DR4 maximum channel insertion loss

Siemon's new ultra low loss (ULL) singlemode optical fiber components allow for the data center operator to confidently install a flexible structured cabling infrastructure to not only support today's 400G applications, but also provides a solid foundation for future 800G migration.

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Total Quality. Assured.

Siemon's Third-Party 400G Testing of Singlemode Ultra Loss System components were tested, witnessed & certified by Intertek Testing Services on January 14, 2022.

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Graphic 2: MTP Adapter Types

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