

# 40G Extended Reach with Corning Cable Systems OM3/OM4 Connectivity with the Avago 40G QSFP+ eSR4 Transceiver

## 1. Introduction:

Corning Cable Systems performed a data center OM3/OM4 link length analysis for the 2009 to 2011 time period that showed 88 percent of installed links are  $\leq 100$  m (Figure 1). Longer lengths are expected in the near future as larger/mega data centers evolve in response to cloud computing, virtualization, data mining and other technology events. These trends facilitate a need for a low-cost 40G solution in the data center to serve distances beyond the 100 m distance using OM3 and the 150 m distance using OM4, as currently specified in the IEEE 802.3ba 40/100G Ethernet Standard.

### Data Center Multimode Cable Length Distribution

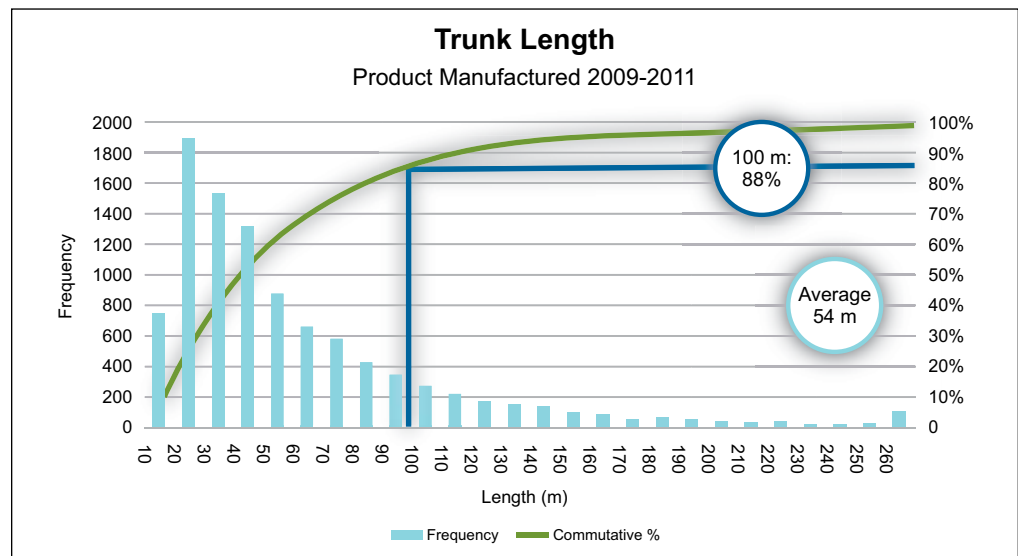


Figure 1: Trunk Length Distribution Obtained From 2009 to 2011 by Corning

Corning collaborated with Avago Technologies to develop a 40G Ethernet (OM3/OM4) extended-reach solution based on the Avago QSFP+ eSR4 transceiver. Corning's Pretium EDGE® Cables with Corning® ClearCurve® OM3/OM4 bend-insensitive multimode fibers were provided to Avago to assist with the transceiver development.

This paper reviews Corning's internal testing with a randomly selected Avago Technologies 40G QSFP+ eSR4 transceiver module. The test demonstrated a typical maximum 1250 m distance on Corning's Pretium EDGE cables with Corning ClearCurve OM4 multimode fiber that met a bit error rate (BER) of  $\leq 10^{-12}$ .

## Test Setup

Testing was conducted at Corning's Science and Technology Research Center at the 850 nm wavelength utilizing the Avago 40G QSFP+ eSR4 transceiver and 40G evaluation boards. A stringent pseudorandom binary bit sequence (PRBS) of  $2^{31-1}$  was used to ascertain a BER of  $\leq 10^{-12}$  compliance. Figure 2 shows a top view of an evaluation board with transceivers inserted and various cables connected. Figure 3 is a picture of the Avago 40G QSFP+ eSR4 transceiver.

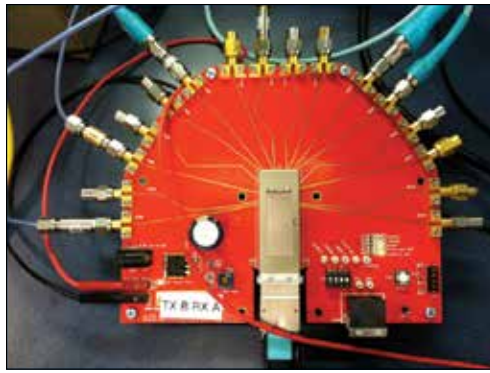


Figure 2: 40G Evaluation Board



Figure 3: Avago 40G QSFP+ eSR4 Transceiver

Figure 4 shows the schematic layout of the experimental configuration. One 10 Gb/s pattern generator and BER detector was integrated into one instrument. The pattern generator provides two streams of the PRBS signals with one to be an inverted signal of the other. One stream of the data is guided into a 1x16 splitter box, which splits the signal 16 ways with proper amplification. Seven of the split signals are used to drive the channels from the two 4x10G transceivers. One stream of the signal has passed a differential pulse splitter to provide a higher-quality signal to test the actual performance of a particular channel. All seven other channels (three from the same transceiver and four from the other transceiver with light propagating in the opposite direction) are driven from the signals coming out of the 1x16 splitter. The cable length for each signal has been chosen to be different, so the signals in each channel are independent. The presence of the seven channels results in a normal crosstalk environment from the transceiver for the testing to emulate a practical condition. The setup is switched so that each channel is provided a differential driving signal to test the actual BER performance.

**BERT Setup Schematic**

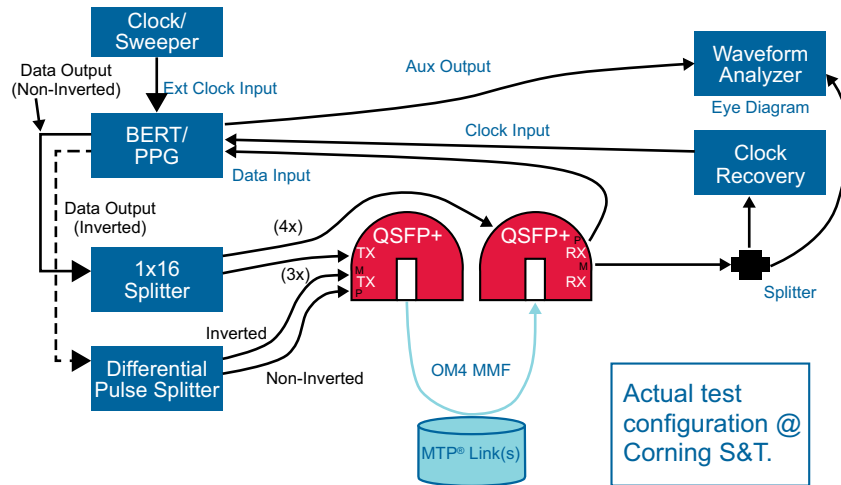


Figure 4: Schematic Layout of the Experimental Setup With all Transmitters in Each Direction Driven

Multiple Corning Pretium EDGE® Cables were interconnected using four MPO Connector pairs to provide a 1250 m distance.

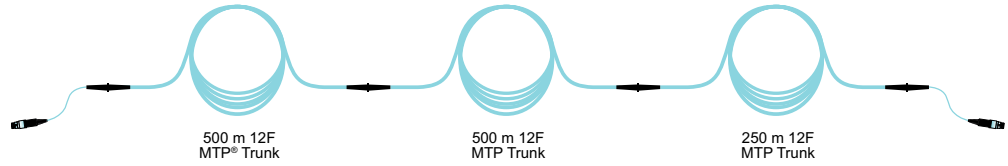


Figure 5: Cable Configuration Used in Experimental Testing

### Test Results

Compliant  $\leq 10^{-12}$  BER was measured for the 1250 m distance. Eye diagrams are provided that illustrate signal quality.

CORNING  
LANscape®  
Pretium® Solutions

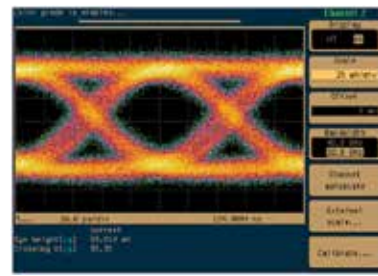
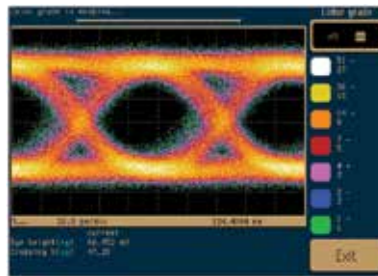
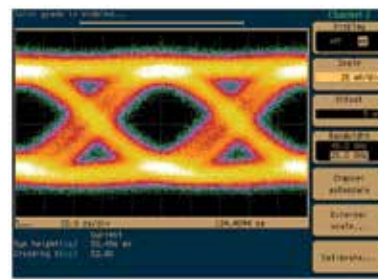
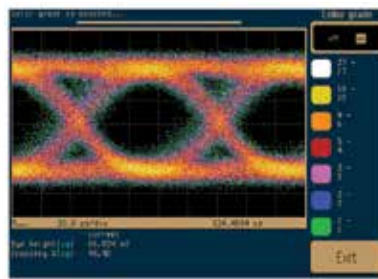


Figure 6: Eye Diagrams at 1250 m

Corning demonstrated a typical 40G Ethernet 1250 m distance capability over OM4 fiber with a randomly selected Avago 40G QSFP+ eSR4 transceiver. Corning's Pretium EDGE® Solution specifies 330 m at OM3 and 550 m at OM4 distances, which is inclusive to the Avago Technologies 40G QSFP+ eSR4 transceiver module.

### Summary

OM3/OM4 multimode fibers continue to be the dominant connectivity solution in the data center to support 10/40/100G and future higher data rates. Expectations are that data center link lengths ( $\Rightarrow$  100 m) will increase in the near future to require a low-cost, extended-reach 40G OM3/OM4 solution. Corning has collaborated with Avago Technologies to develop a 40G Ethernet (OM3/OM4) extended-reach solution based on the Avago QSFP+ eSR4 transceiver module. Corning's internal testing with a randomly selected Avago Technologies 40G QSFP+ eSR4 transceiver module demonstrated a typical maximum 1250 m distance on Corning's Pretium EDGE® Cables with Corning® ClearCurve® OM4 multimode fiber that met a BER  $\leq 10^{-12}$ . Corning's Pretium EDGE connectivity solutions support 330 m OM3 and 550 m OM4, which are inclusive to the Avago Technologies 40G QSFP+ eSR4 transceiver module.