

The Corning logo consists of the word "CORNING" in white, uppercase, sans-serif font, centered within a solid blue square.

Corning Incorporated's 40 Gb/s Demonstration at the 2008 Interop New York Exposition White Paper

WP1179
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The need for speed

As bandwidth demand continues to increase, the need for higher speeds is also growing and the next generation standards are currently being developed. For Ethernet this means 40 Gb/s and 100 Gb/s. These next generation speeds currently include an objective for multimode fiber of "at least 100 m over OM3". OM3 is the only multimode fiber included in the 40/100G objectives. OM1 and OM2 (lower bandwidth fibers) are not considered.

The baseline proposal for the multimode objective includes parallel optics. In the case of 40 Gb/s this means 4 fibers x 10 Gb/s for transmit and 4 fibers x 10 Gb/s for receive. This configuration will require the use of one 12F ribbon. For 100 Gb/s it means 10 fibers for transmit and 10 fibers for receive or two 12F ribbons.

The transceiver specifications that have been accepted as the baseline proposal for the 40 Gb/s and 100 Gb/s multimode objectives are much less stringent than those currently specified for 10GBASE-SR Ethernet. As a result, they will not support the same link lengths that can currently be achieved using OM3 fiber for 10GBASE-SR.

In order to test the limits of the next generation speeds, Corning purchased commercially available 40 Gb/s 850nm transceivers (4 x 10 Gb/s VCSEL array) to demonstrate that with our commercially available Corning Cable Systems Pretium™ 300 solutions with Corning® InfiniCor® SX+ fiber, it is possible to extend the OM3 reach to at least 1.5x further than the 40 Gb/s and 100 Gb/s 100 m base line proposals.

Although the 40 Gb/s and 100 Gb/s objectives currently call for "at least 100 m over OM3", there is a multimode fiber extended reach adhoc group investigating the need to increase this distance. Corning is actively involved in this effort. We want to ensure that the lowest cost solution is available for premises networks with links longer than 100 m. This demonstration proves that longer distances are technically and commercially achievable. We are showing a link length of 150 m, which covers the majority of LAN and data center link length requirements.

Experimental layout

The experiment you see today is done with OM3 (InfiniCor SX+) fiber. The experimental layout is shown below. Signals from a differential pulse splitter drive one channel (labeled X) differentially while the other three channels are driven single-ended by a 1x3 splitter to present a crosstalk environment.

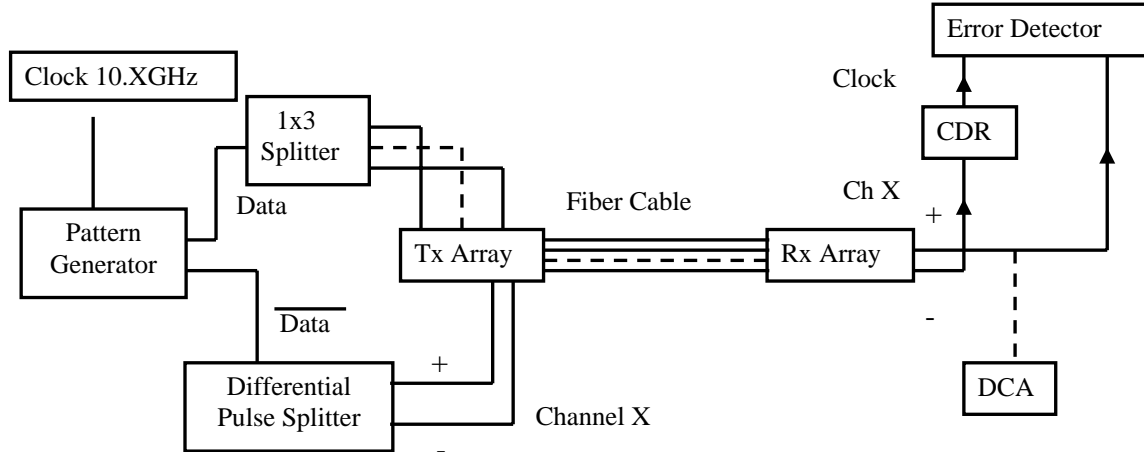


Figure 1 – Experimental layout

Transmitter characteristics

The 850 nm transmitters used for this demonstration are commercially available products that Corning purchased from Intexys Photonics. Measured output power levels of the transmitters are included in Table 1.

Table 1 – Transmitter power characteristics

Transceiver 1	Transmitter Power	Transceiver 2	Transmitter Power
Channel 1	-2.18 dBm	Channel 1	-2.73 dBm
Channel 2	-2.52 dBm	Channel 2	-2.00 dBm
Channel 3	-2.11 dBm	Channel 3	-2.68 dBm
Channel 4	-2.33 dBm	Channel 4	-2.99 dBm

According to the specification sheet, the typical value for transmitter power is -4 dBm so in this case both transceivers measured significantly better than the specification.

Output spectral power from one of the transceivers was also measured, as shown in Figure 2. The calculated spectral widths are shown in Table 2.

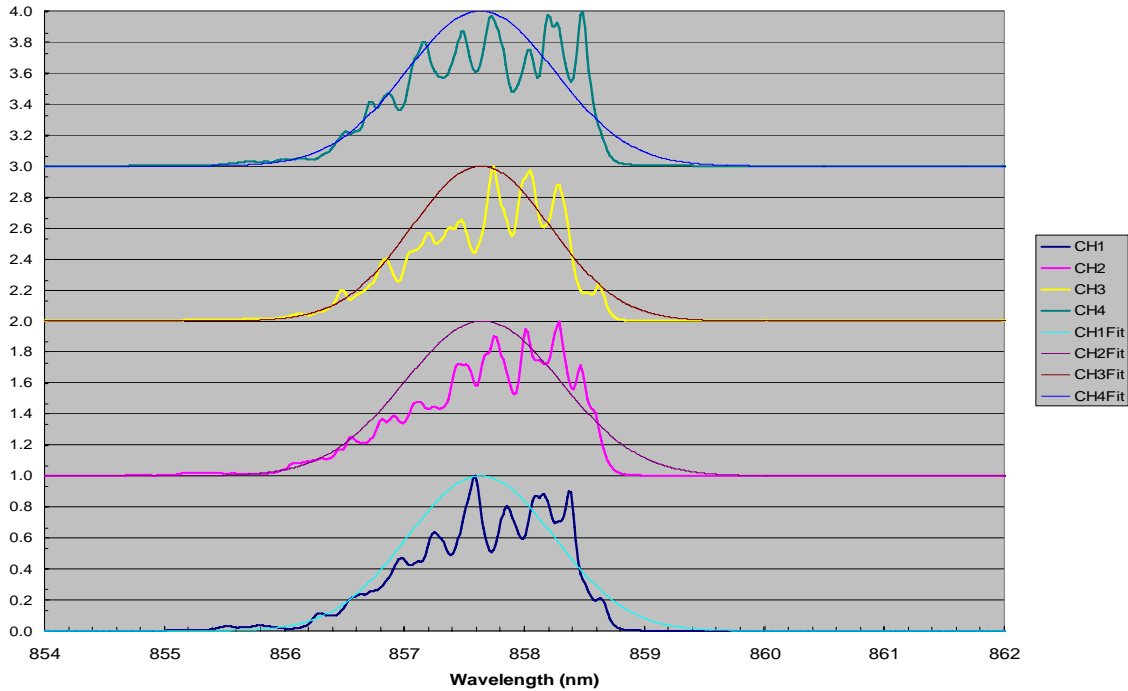


Figure 2 – Transmitter spectral power

Table 2 – Transmitter spectrum RMS width

	CH1	CH2	CH3	CH4
Center Wavelength (nm)	857.6	857.7	857.6	857.6
RMS Spectral Width (nm)	0.61	0.65	0.58	0.62

As expected, the spectral width of the array transceiver is much higher than that of a single channel XFP 10GBASE-SR transceiver (typically 0.25nm – 0.45nm) which yields a difference in the length that will have better than 10^{-12} bit error rate (BER) performance (error limit defined by the IEEE standard). These spectral width values are in line with the 40 Gb/s and 100 Gb/s baseline proposals that specify a spectral width of 0.65nm.

We also measured the encircled flux values for these transceivers and they were all in compliance with the values specified in the 10GBASE-SR transceiver multi-source agreement.

Although we are showing 150 m here today, we have also shown in a lab environment that it is possible, under ideal conditions, to achieve 250 m over InfiniCor SX+ (OM3) fiber with a BER better than 10^{-12} .

Performance with higher bandwidth fiber (i.e. OM3+ or OM4)

Various standards organizations are now discussing standardizing a higher bandwidth multimode fiber (i.e. OM4). Current OM4 proposals require an effective laser bandwidth equal to that which is currently being sold as Corning® InfiniCor® eSX+ fiber (OM3+). This higher bandwidth fiber (4700 MHz-km) could be used for higher serial bit rates, longer link lengths or increased margin for more connectivity.

We did some testing with this higher bandwidth fiber and achieved 350 m using Corning® InfiniCor® eSX+ fiber (OM3+) in our network simulations with a BER of less than 10^{-12} .

Plan for the future

OM3 connectivity solutions and electronics exist today that support duplex fiber transmission and also provide an easy migration to parallel optics, the solution of the future. Corning's minEMBc bandwidth measurement is the best way to ensure that the OM3 fibers you purchase will perform as advertised. Corning measures every reel of 50 µm InfiniCor® fiber and we have never had a field return for multimode bandwidth failure, ever.

Corning products are well positioned to provide an easy upgrade path to 40 Gb/s and 100 Gb/s. This is due in part to the quality, consistency and reliability of our fiber, cable and hardware products.

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