Application Engineering Note - Multimode Fiber Compatibility

Application Note

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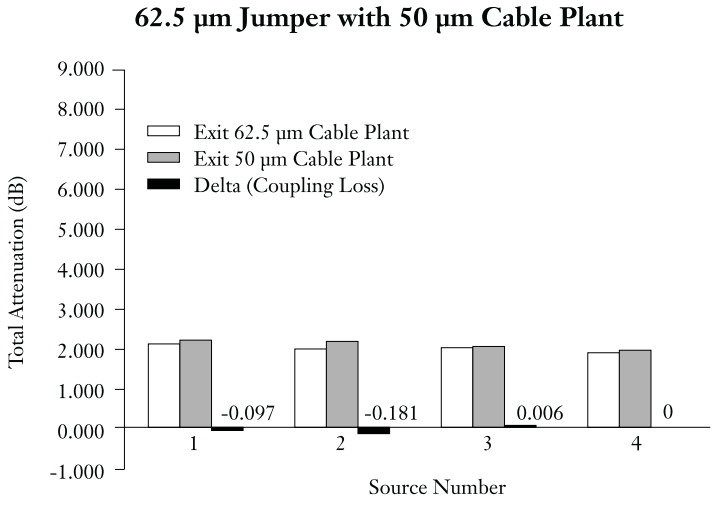
Fiber Compatibility – 50 µm and 62.5 µm Fibers

It is important to understand fiber compatibility, especially if different fiber types will be used in a given location. According to standards, multimode cable plants should maintain uniform fiber types in each link, including jumpers and patchcords. Corning recommends compliance with standards by maintaining consistent core sizes within a MMF cable plant. In situations where mixing core sizes are unavoidable, it is technically feasible to combine 50 µm and 62.5 µm fibers in a single link using either LED or laser sources. Single-mode fiber is not compatible with either 50 µm or 62.5 µm multimode fibers.

Corning performed extensive physical tests and computer simulations on combining 50 µm and 62.5 µm fiber. Initially, laser sources were tested for mixing fiber coupling losses (62.5 µm into 50 µm, and vice versa). Tests found no significant coupling losses, which indicate that 50 µm and 62.5 µm fibers are fully compatible with laser sources as shown in Figure 1. This result was no surprise since lasers have a relatively small spot size that launches light into the center of the fiber.

Laser Coupling Losses

Figure 1



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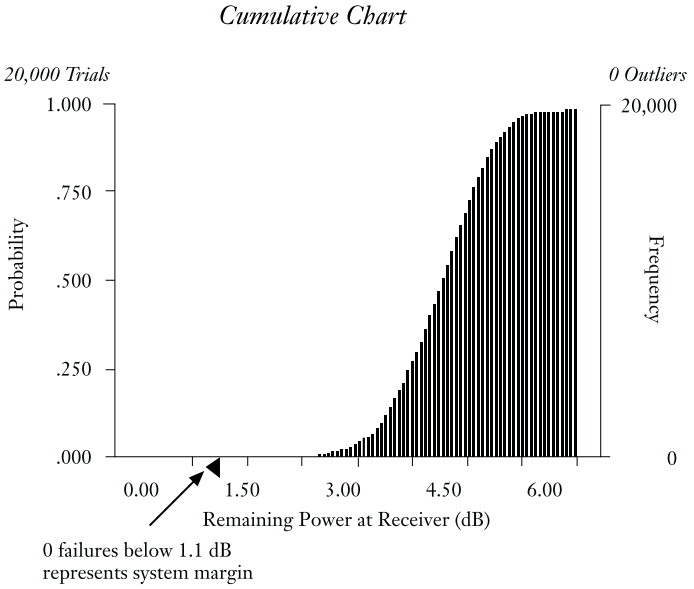
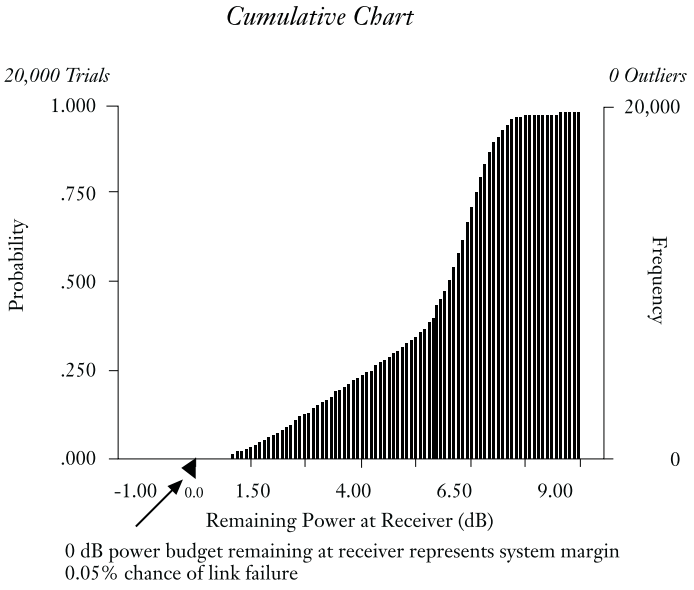
Next, LED sources were tested with 50 µm and 62.5 µm mixed media cable plants. As illustrated in Figure 2, no failures were found in 1300 nm LED systems after 20,000 trials were simulated.

1300 nm LED Systems – Remaining Power in a Mixed 50/62.5 µm System
Figure 2



In addition, 20,000 trials of 850 nm LEDs showed similar results, as illustrated in Figure 3.

850 nm LED Systems – Remaining Power in a Mixed 50/62.5 µm System
Figure 3



Intuitively this is less obvious, since the theoretical mismatch of core size and numerical aperture between the fiber types should lead to approximately a 4 dB coupling loss. However, a one-time attenuation loss of approximately 2 dB is experienced when coupling 62.5 µm fiber into 50 µm fiber with LEDs, because the mode power distribution of LEDs is not always uniformly overfilled. In simulations this smaller loss was covered by the excess power budget of the system, and was independent of the number of connectors and fiber type changes that occur in a cable run.

Fiber Compatibility – Fibers of Same Core Size with Different Bandwidths

According to standards, multimode cable plants should maintain uniform fiber types in each link, including jumpers and patchcords. Corning recommends compliance with standards by maintaining uniform bandwidth types in a single link. Again, in those applications where mixing fiber bandwidth types are unavoidable, it is technically feasible to do so.

In this case, since the fiber geometries are identical, the primary consideration will be modal bandwidth. Corning evaluated the impact of modal bandwidth combinations by modeling inter-symbol-interference differences, differential mode delay differences, and comparing standards-defined link length capabilities. The following "rules of thumb" are offered:

50 µm fiber

- InfiniCor® 600 fiber (510 MHz.km at 850 nm) counts as **4.5 meters** in a system with InfiniCor® SX+ fiber (2000 MHz.km at 850 nm)
- InfiniCor® SXi fiber (850 MHz.km at 850 nm) counts as **2 meters** in a system with InfiniCor SX+ fiber (2000 MHz.km at 850 nm)

62.5 µm fiber

- InfiniCor® 300 fiber (220 MHz.km at 850 nm) counts as **1.7 meters** in a system with InfiniCor® CL-1000 fiber (385 MHz.km at 850 nm)

For example, consider a standards-compliant InfiniCor SX+ fiber system with a 298 meter backbone and two each 1 meter patchcords, for a total link length of 300 meters at 10 Gb/s. If two meters of InfiniCor 600 fiber patchcords are instead used (1 meter at each end), they will behave like 2 x 4.5 = 9 meters of InfiniCor SX+ fiber. The total link length capability then becomes 300 – 9 = 291 meters, where the backbone length is 291 – 2 = 289 meters.

Fiber Compatibility – Fibers from Different Manufacturers

Standards-compliant fibers are fully compatible in standard-compliant links, regardless of manufacturer.

With the InfiniCor family of laser-optimized fibers, Corning is able to offer engineered link capabilities that are greater than those outlined in applications standards. These extra-standards link lengths are enabled by the superior laser bandwidth measurement techniques unique to Corning Incorporated. Therefore, InfiniCor link lengths are achievable only with InfiniCor fibers. Table 1 outlines the link lengths enabled by Corning InfiniCor fibers.

Link Lengths with InfiniCor Fibers

Table 1

		InfiniCor® Fiber Link Length (m)				
	Core Size	50 µm			62.5 µm	
	Wavelength	850 nm			850 nm	
	Fiber	InfiniCor® 600	InfiniCor® SX*i*	InfiniCor® SX+	InfiniCor® 300	InfiniCor® CL-1000
	EMB (MHz•km)	510 (a)	850 (b)	2000 (b)	220 (a)	385 (a)
Application Standard	Nominal Speed (Mb/sec)					
IEEE 802.3 series Ethernet (d)						
100BASE-SX	1,000	600	750	1000	300	500
10GBASE-SR	10,000	82	150	300	33	33
ANSI-INCITS Fibre Channel						
100-M5/6-SN-1	1,000	600	750	1000	300	500
200-M5/6-SN-1	2,000	320	428	526	170	260
400-M5/6-SN-1	4,000	162	228	291	80	130
1200-M5/6E-SNS	10,000	82	150	300	33	33
ITU/T - Asynchronous Transfer Mode (ATM)	1,000	600	750	1000	300	500
ITU/T - SONET/SDH IOIF VSR (p)						
OC-192 VSR4-01	10,000	650	750	1000	300	500
OC-192 VSR4-03	10,000	306	375	620	-	-
OC-192 VSR4-04	10,000	82	150	300	33	33
OC-768 VSR5-001	40,000	100	150	300	-	-

a. As predicted by RML BW, per TIA/EIA 455-204 and IEC 60793-1-41, for intermediate-performance laser-based systems (< 850 MHz.km)

b. As predicted by minEMBc, per TIA/EIA 455-220 and IEC 60793-1-49 Ed. 2.0, for high-performance laser-based systems (≥ 850 MHz.km)

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