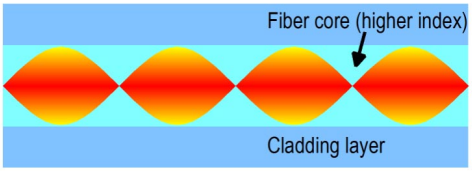
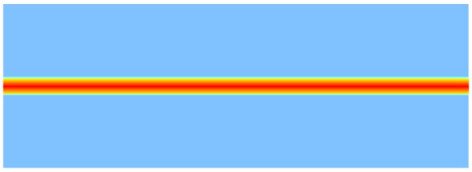
APPLICATION NOTE: 10 Gb/s ETHERNET OVER MULTIMODE FIBER

Ever-increasing bandwidth demand due to bandwidth-hungry high-performance applications has made more and more network managers request cost-efficient network solutions from their networking equipment suppliers for upgrading their enterprise LAN backbones to 10 Gb/s.



Multimode fiber (graded-index)



Single-mode fiber

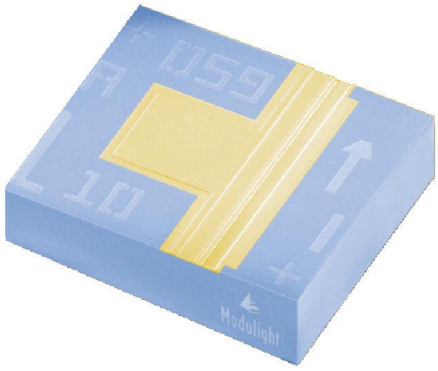
Modulight's 1310 nm 10 Gb/s Fabry-Pérot laser dies are used to overcome this problem.

A vast majority of the installed fiber connections in the enterprise data centers consists of very-short-reach legacy fiber cable connections, with 62.5 µm fiber core diameter. This multimode fiber, originally installed for Fiber Optic Distributed Data Interface (FDDI) applications, is capable of handling 1-2 Gb/s. It becomes a problem at 10 Gb/s, where differential mode dispersion leads into distorted signals, and unclear and incomplete data transmission. Replacing the fiber with single-mode fiber or higher-performance multimode fiber with 50 µm core diameter is generally not a favored solution, since it requires expensive fiber assembly work and may cause major changes in other network hardware, as well.

One solution for transmitting data at 10 Gb/s over multimode fiber is the LX4 optical interface, defined in the IEEE's original 10 Gb Ethernet standard. In this approach, four DFB laser diodes operate at different wavelengths with 3.125 Gb/s signalling speed each. Individual signal channels, separated by 24.8 nm, are coupled into the same transmission fiber using a optical multiplexer, and at the receiving end they are again separated using an optical demultiplexer before going to the four pin-TIA detectors.

LX4 approach, although existing for years, has not been widely adopted in the fiber optics industry. Main reason for this is the high module cost, inherent to the technology using 4 DFB lasers at different wavelengths, 4 laser drivers, 4 detectors, MUX and DeMUX/each link. Of course, the parallel operation at 3.125 Gb/s allows use of lower-performance electronics as a serial 10 Gb/s option, but the decreasing prices of 10 Gb/s electronics are reducing the significance of this initial advantage.

Despite recent developments for lower-cost LX4 modules, high module prices have increased pressure to set an IEEE optical interface standard for low-cost serial sources. IEEE 802.3aq study group has already published the first draft for the serial optical interface 10GBASE-LRM, which utilizes EDC to overcome the problems related to multimode fiber.



In this 10 Gb/s multimode application, Modulight's FP lasers can be used to obtain significant component cost reduction. A high-end solution for realizing the 10GBASE-LRM optical interface would is to use 10 Gb/s DFB laser at 1310 nm, as you would use for the single-mode interface 10GBASE-LR for 2-10 km links. A lower-cost solution is to use FP lasers. Not only is the laser die cost lower, but also assembly of the FP dies is significantly cheaper. Bonding-induced stress easily detoriates DFB mode behaviour, thus decreasing yield, and DFBs' sensitivity to back reflections makes use of an expensive optical isolator obligatory.

EDC is abbreviation for Electronic Dispersion Compensation, an advanced adaptive signal processing technology to compensate for the distortions in the optical transmission path. EDC chips use advanced and low-cost CMOS silicon technology. The EDC chip is built into the optical transceiver together with the high-speed transmitter optical subassembly (TOSA) containing the laser and monitor photodiode, laser driver, receiver optical subassembly (ROSA), transimpedance amplifier, and clock and data recovery circuitry. Latest EDC chips integrate EDC with clock and data recovery functions. Number of optical components is dropped significantly from that required for LX4 transceiver.

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