Transmission Distance vs. dB Loss in Fiber Optic Cable

A common question that often arises when designing a fiber optic transmission system is “What is the distance I can cover with a particular set of transmitters and receivers?” The following is presented to help one understand the proper answer to this question.

The distance a signal can be transmitted by a fiber optic transmission system depends on the amount of light that can be recovered at the end of the fiber. This level is a function of three parameters. The first is amount of light entering the fiber. The second is the attenuation (or loss) of the light as it travels through the fiber and the third, the sensitivity of the receiver at the far end.

The first and third parameters are given for all ***Litelink***® and ***Luxlink***® transmission systems in terms of the published “optical loss budget”. This assures that a particular system will operate properly as long as the attenuation of the light between the transmitter and receiver does not exceed this value. The second parameter is a function of the fiber optic cable actually used to connect the transmitter and receiver.

The chart below shows the typical attenuation of light at the most common wavelengths used in fiber optic technology for standard multimode or single-mode fiber optic cable.

Wavelength	Typical Optical Attenuation
850nm	3.5 to 4 dB per Km
1310nm	1.0 to 1.5 dB per Km
1550nm	0.15 to 0.2 dB per Km

With this information in mind let us take a particular system and determine how far it will transmit. The ***Litelink***® CT/CR-7008 has a published optical loss budget of 0 to 10 dB. If this system is used with optical fiber at a wavelength of 850nm (the -1 option), the maximum transmission distance will be 2.5 to 2.8 Km. If the optical elements are now changed so that the operating wavelength is 1310nm (the -3 or -7 option), the maximum transmission distance will increase to 6.6 to 10 Km. Finally, if a wavelength of 1550nm is used (the -9 option) the maximum transmission distance will now increase to 50 to 66 Km.

For any other fiber length the formula for transmission distance will be:

Distance (Km) = Optical loss budget in dB / attenuation of the length of the actual fiber used in dB.

It is also good practice to always allow a safety margin of 2 to 3 dB in any system to compensate for miscellaneous losses such as connectors, splices etc.

Note that the -1 option is for multimode fiber at a wavelength of 850nm. The -3 option is also for multimode fiber but at a wavelength of 1310nm. The -7 option is for single-mode fiber at a wavelength of 1310nm and the -9 option is for single-mode fiber at a wavelength of 1550nm. All transmitters and receivers in any particular link must use the same option numbers. Multimode units will not work properly with single-mode units nor will 850nm devices work properly with 1310nm devices.