All-Passive Optical Signal Distribution

In a previous article we discussed optical switching and some of the associated applications. This article will discuss a close cousin to switching, namely optical signal distribution. Optical fiber systems can be so much more than just a simple replacement for copper cables. Once in the optical domain, they can be easily distributed, routed, and switched without any signal degradation or the need to be concerned about impedance matching, ground loops, reflections, etc that are common issues with copper systems.

1x2 Splitters – The most common and simplest type of optical distribution system is the 1x2 optical splitter. These devices have one input and two outputs where the signal is split into two optical paths for transmission to different locations. The most common 1x2 splitter is the 50/50 type. This device will split the optical input signal into two equal strength outputs. Every time the signal is split in half, the signal strength is cut in half or is decreased 3dB from its original level. For example, if the input power to the 1x2, 50/50 splitter is 1mW (0dBm), each leg will have a theoretical output level of 0.5mW or -3dBm. Almost any split ratio can be obtained. Some of the more common types include: 50x50, 80x20 and 90x10. The required split ratio is determined by the application and the optical loss in each leg of the fiber system. In multi-drop applications, different split ratios are typically used to match the received optical power as the optical signal traverses from one drop location to the next.

For example, in the digital signage application shown in Figure 1, the signal (video/audio) is sent to a number of different locations using only one fiber.

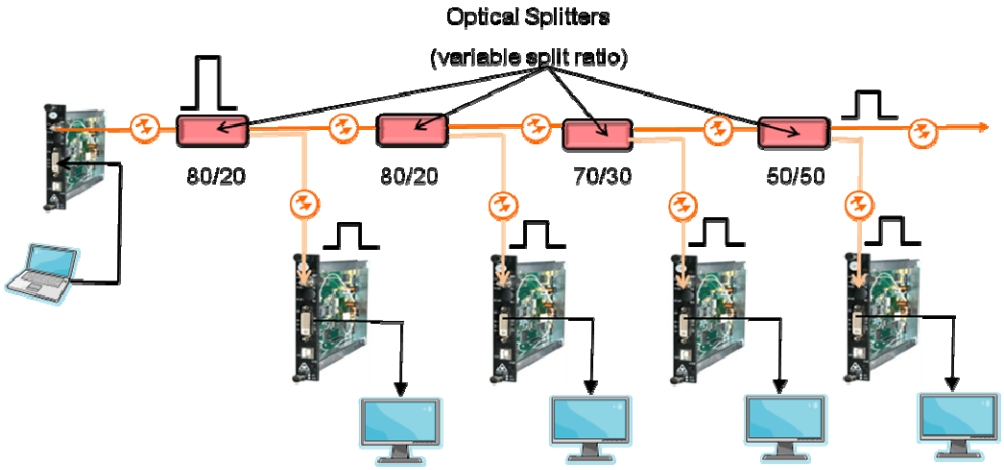

Figure 1
Optical Multi-Drop

The in-line optical splitters have various split ratios so that each of the receiver units has approximately the same received optical power while maximizing the throughput signal strength for additional drops down the fiber.

These 1x2 splitters have many applications in fiber optics including wavelength-selective devices for transmitting bi-directional signals on one fiber. These devices and applications will be covered in later articles.

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1x4 & 1x8 Splitters – These splitters are common devices that split the optical signal into equal parts, either 4, 8 or 16. Unlike the 1x2 splitters where different split ratios are available, these splitters are only available in equal split ratios. The optical loss of each of the legs in the splitter is determined by the number of outputs in the device. Every time the signal is split or divided in two, each output or leg has a 3dB attenuation or loss. The table below shows the attenuation or loss in each leg of the splitters: The 1x4 divides the optical signal into 4 equal parts – each having a loss of 6dB while each output port of a 1x8 splitter has a loss of 9dB.

Splitter Type	Port Attenuation
1x4	6dB
1x8	9dB
1x16	12dB

In addition to these 'split' losses there is also an overall device loss or attenuation do to the inefficiencies of the device. This loss is called the 'Insertion loss' and is typically around 1 to 2dB, depending on the quality of the splitter and the number of output ports on the device.

The figures below illustrate a typical schematic diagram for the 1x4 & 1x8 splitters.

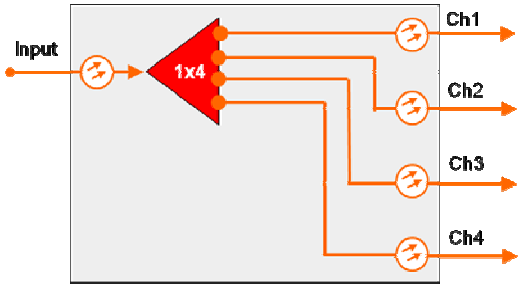

Figure 2
1x4 All-Optical Distribution Switch

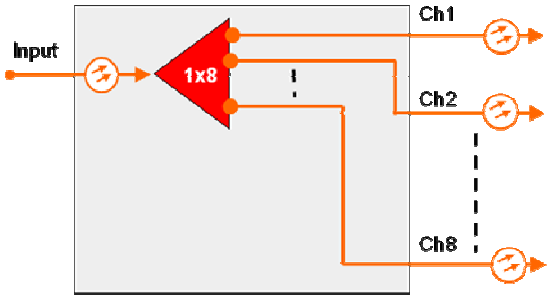

Figure 3
1x8 All-Optical Distribution Switch

Note that the symbol  is the international symbol for an optical fiber. Anytime this symbol appears on a drawing, it represents optical fiber connectivity.

Because these passive splitters attenuate the signal in each output port or leg, you must take this additional attenuation into account when calculating your overall link or system loss budget. A link loss budget for a typical HDSDI fiber link is around 15dB. This loss budget includes all fiber-related losses such as connectors, the fiber itself and any splitters that may be in the link. In this example, since an 8 channel splitter will introduce a per port attenuation of about 10dB (splitter plus insertion losses), only 5dB is available for all other optical losses – reducing the overall maximum transmission distance.

Optical splitters, available for both multimode and singlemode systems, play an important role in fiber transmission systems. Knowing their capabilities and specifications allows you to implement them in unique, efficient and effective transport systems for your various applications.

A future article will deal with wavelength selective optical splitters and couplers used in wavelength multiplexing systems for even more unique and inventive ways to incorporate fiber in your AV system designs.

If you have any questions or if you have any particular topic on fiber optics you would like to know more about, please send an email to me at emiskovic@meridian-tech.com.

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