Using Fiber Optics for AES/EBU Long Distance, Interference Free Digital Audio Transmission

Since the mid 1980s audio signals (sometimes with embedded timing signals) have been digitized for transmission between professional audio equipment. The goal has been to convey noise free signals that can be recorded, reproduced without significant degradation and manipulated to enable all sorts of effects for finished products. These digital audio signals have been regulated by a standard developed by the Audio Engineering Society (AES) in the United States and by the European Broadcast Union (EBU) abroad and is commonly referred to as “AES/EBU Digital Audio”.

The transmission of these signals is normally by means of XLR connectors (for balanced signals) and RCA type phono connectors and conventional BNC connectors (for unbalanced signals). A consumer version using plastic fiber optic cable is also available on the market but not normally used for professional applications as its transmission range is limited to only a few feet. There is a method of transmitting AES/EBU digital audio over distances of several miles or more however by means of conventional fiber optic data transmission techniques.

The use of fiber optic data transmission technology is well known in telecommunications, local area networks and the Closed Circuit TV Security marketplace and in many Intelligent Transportation System (ITS) highway projects. Even CATV (cable) distribution to various local feed points within a residential community is now routinely accomplished over fiber. Two of the most important attributes of fiber optic cable that make it a good candidate for digital signal transmission are its inherent immunity to electrical noise and the extremely wide available bandwidth as compared to copper wire (including coax). Both of these features will be of growing importance as higher speed digital audio technology develops. To attempt to achieve even a measure of fiber’s long distance error free transmission features using copper wire requires extensive shielding and careful manufacturing techniques to assure uniform characteristics at high frequencies commensurate with low losses. With totally non-metallic fiber optic cable and signals that consist only of modulated light however, even run-of-the-mill optical fiber performance (for these parameters) is far superior to copper.

In the case of noise immunity, when installing fiber optic cable the contractor does not have to be particularly concerned with the exact route the cable will take but rather can install it via the most convenient existing path. Running a fiber cable in close proximity (or even tie-wrapped where electrical codes permit) to a power line will not result in any induced 60 Hz “hum” or other AC line interference nor create any situation where the integrity of the power line is compromised. Having a fiber cable immersed in a pool of water after a heavy rainstorm or water leak will not result in any short circuits or “grounds” or, for that matter, even interfere with existing signals traveling through the fiber in most cases. In addition, although a broken fiber optic cable will result in a loss of signal it will never create any electrical safety or potential fire hazard both for humans or connected equipment. The copper wire route on the other hand requires a separate path as far from power lines as possible. Even when this is done the cable is still susceptible to water problems, short circuits, crosstalk and hum pickup, can create an electrical safety hazard when broken and requires extensive equalization in the form of special drivers and receivers when increased bandwidth or long distance transmissions are required.

To convert electrical signals to and from light for transmission in a fiber optic system requires an optical transmitter and receiver. These devices are similar to external computer modems in size, function and complexity and currently typically range in cost from a couple of hundred dollars for a simple single channel device to several thousand dollars for a multiplexed multi-signal multi-directional device. Figure 1 shows a block diagram of a typical fiber optic transmitter and receiver designed specifically for the transmission of AES/EBU digital signals. These units have both XLR and RCA type connectors allowing both balanced and unbalanced connections to be accommodated as per the AES/EBU specifications. The AES/EBU electrical signals are processed and converted to pulsed light by an LED or laser diode. The light signal is then “launched” onto the fiber optic conductor and transported to the receiver. The received light signal is then detected and converted back into a replica of the original signal. Since the carrier between units is only by modulated light, balanced or unbalanced signals can be used at either end even allowing conversion from one to another if required.

Figure 2 is a photograph of the receiver portion of a commercially available low cost fiber optic AES/EBU transmission system. The transmitter portion is similar. The individual fiber optic transmission modules can be mounted anywhere convenient or, when required, in standard 19 inch rack-mountable panels. Power is usually derived directly from the AC line via small plug-in wall-type adapters and is usually in the vicinity of 12 volts AC or DC. In a professional audio distribution system within a recording studio for example, a “head-end” might consist of a group of receivers at one central “recording location”, each being driven by separate transmitters in each studio where audio was being generated. Such a system would eliminate any extraneous noise pickup from peripheral equipment in and around the studio and would result in “perfect” noise-free ultra high "textbook quality" digital audio signals.

It is important to realize that even though installing a fiber optic system using currently available transmission modules is somewhat more expensive than installing a copper wire infrastructure, as technology progresses, the electronic fiber optic transmitters and receivers can always be easily changed or upgraded. The fiber optic cable in the walls however cannot be changed as easily since major construction is often involved with the resulting inconvenience to the end user. Since the fiber optic cable is capable of operating up into the GHz range if necessary there is little risk of it becoming obsolete and in most cases it will probably last as long as the physical studio itself.

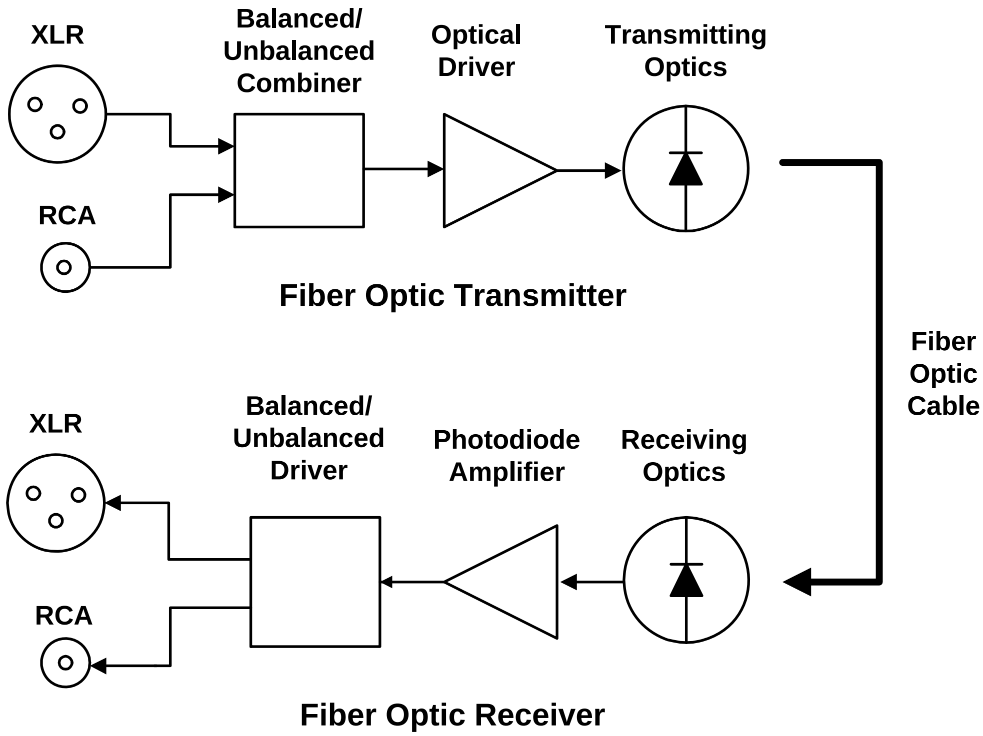

Figure 1, Typical AES/EBU Fiber Optic Transmission System.

Figure 2, Receiver Portion of a Complete Ready-to operate AES/EBU Fiber Optic Transmission System.

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