Using Fiber Optics for DMX-512A Long Distance, Interference Free Digital Signal Transmission

In 1986 the engineering commission of the US Institute for Theatre Technology developed a standard for the transmission of digital signals that could be used in that industry for applications such as stage lighting. After subsequent revision DMX-512A was released in 1990 and has been in common used since then. Initially DMX-512A was a one-way transmission scheme with a "head end" that generated signals and a number of remote "slave" units that received the signals and controlled the status of the various lights. Recently the one-way DMX-512A protocol has been upgraded to a two-way system called DMX-512A/RDM. The RDM stands for "remote data management". This allows units that are being controlled to send back status information when required. The primary goal of fiber optics as it relates to DMX-512A and DMX-512A/RDM signal transmission is to convey noise free signals that can be reproduced without significant degradation even over very long distances or electrically noisy environments such as might be found in applications not just related to the theater but in applications such as stadium arena lighting and even long distance highway systems.

The use of fiber optic data transmission technology is well known in telecommunications, local area networks, the closed circuit TV Security marketplace and in many Intelligent Transportation System (ITS) highway projects. 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 are important since 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/repeater system designed specifically for the transmission and distribution of traditional DMX-512A digital signals. In operation a transmitter (DMXT-7001) at the "head end" accepts electrical DMX-512A signals and converts them into modulated light which is then "launched" into an optical fiber. The other end of the fiber goes to a receiver/repeater (DMXP-7001) that coverts the modulated light back into an exact replica of the original electrical DMX signal, outputs the signal to a 5 pin XLR connector and also converts the electrical signal back into another modulated light source for transmission to additional receiver/repeaters. In this way the DMX signal can be sent from point to point to numerous locations. Since the carrier between all units is only by modulated light, all of the advantages of fiber optic cable is maintained.

Figure 2 is a photograph of the receiver portion of a commercially available low cost fiber optic DMX-512A transmitter. The receiver/repeater unit is similar. The individual fiber optic transmission modules can be mounted anywhere convenient or, when required, to a standard 19 inch rack-mountable panel. Power is usually derived directly from the AC line via small plug-in wall-type adapters and is in the vicinity of 12 volts AC or DC. Regulated voltages are not required since all units have internal regulators.

The above discussion describes a one-way system (from transmitter to receiver/repeaters) which is currently the most common. An upgraded version of this is the DMX-512A/RDM protocol which, as described above, is a two-way system so that the various receiving locations can report back to the main control location. Fiber optic equipment to accommodate this protocol is also available and is very similar in appearance. Figure 3 shows the details of a DMX-512A/RDM system. Note that the fiber optic path is a complete ring so that signals from any receiver/repeater can return to the "head end".

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 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 infrastructure itself.

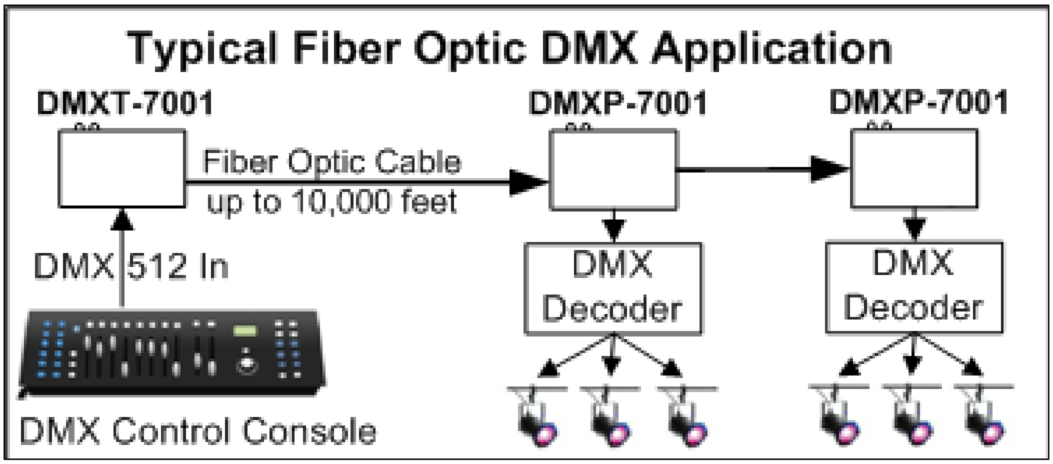

Figure 1, Typical DMX-512 fiber optic transmission system.

Figure 2, Transmitter portion of a complete Ready-to-operate DMX-512A fiber optic transmission system.

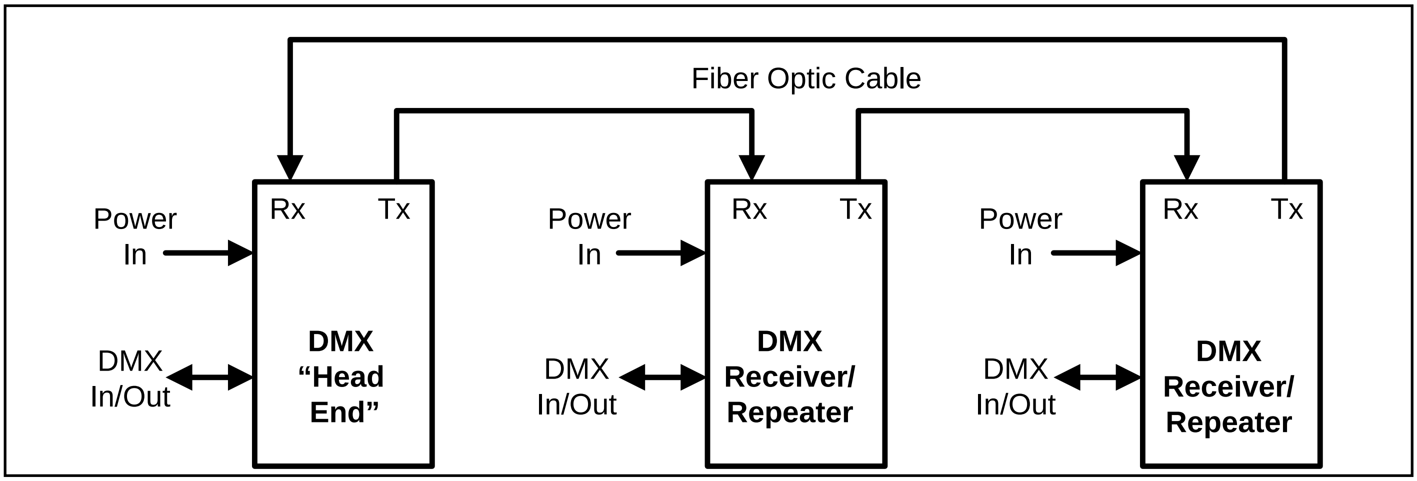

Figure 3, Typical DMX-512A/RDM fiber optic transmission system.