DMX512

Its History & How To Split It

Back in the mid eighties, several lighting control companies around the world were either working on, or were already controlling dimmers via a digital control protocol rather than an analog signal. However, none of these protocols were compatible.

DMX512 started life in 1986 essentially from a meeting held at a USITT trade show in Oakland, California. At this meeting, a collection of manufacturers based mainly from the United States got together to propose a standard digital protocol for control of lighting equipment. This in essence, applied only to dimmers as the colour scroller was not yet in wide use and the intelligent light was restricted to companies such as Vari-Lite. These facts are very significant in what DMX512 can and can not offer us as a control standard for today.

After this meeting, consisting of around 12 people, the draft DMX512 standard was formulated based essentially on the Colortran D192 digital protocol. Later in 1986, revisions were made to this draft and the *DMX512 standard* was born.

The uptake of DMX512 around the world was reasonably slow. Here in Australia, although LSC had two DMX512 products on the market by late 1986, it was still well into 1988 before DMX512 started to gain acceptance. In some parts of the world analog systems are still sold although DMX512 systems do dominate the lighting world today without exception.

DMX512 in its original concept provided for multiple transmitters (as provided for by the RS485 standard), a mechanism to address different devices (the start code) and the possibility for the dimmers, or other controlled devices, to return information to the controller (the spare pair). All of these features have, apart from a few exceptions, not been delivered. Why? The answer to this is difficult since there are several factors that have prevented these features from being realised. It is not my intention to go into this here save to say that the original dozen people had no idea that DMX512 would be so successful and that their somewhat hasty decisions would have such a large impact on the industry.

After a few years when the standard had started to take hold it then became increasingly difficult to change it. This was because the dozen or so original people had increased to a multitude of people all wanting to change the standard for one reason or another. Whilst the majority of these changes were valid and worthwhile it was virtually impossible to get agreement within the group and also any changes needed to be backward compatible to ensure compatibility with the large amount of DMX equipment that was already out there. Thus as a result, except for some cosmetic changes in 1990, the DMX512 standard has remained virtually unchanged.

DMX512 was originally conceived to connect lighting controllers and dimmers and in general this would have been for no more than 512 dimmers or channels. The advent of DMX512 controlled intelligent fixtures and the general increase in the size of lighting systems over the last decade has pushed the limits of DMX512. It is now common to find venues with triple DMX runs to support 1536 channels of control. Regardless of the number of channels, multiple outlet points for DMX signals within the venue can be found in even the smaller halls or venues. In addition DMX512 inlet points distributed throughout the venue to feed signals from control desks back to the control room are commonplace. These type of systems, without careful design, can be plagued with problems. What are these problems?

The basics for good DMX512 data transmission have been covered before in an earlier article in this magazine but basically these can be summarised very simply as (1) Use good quality data cables; (2) Don't use Y split cables; (3) Use one terminator at the end of the cable (4) Use no more than 32 receivers per DMX line.
What other factors need to be considered? There are perhaps three potential problem areas that need to be dealt with. These are "Earth Loops", "Common Mode Voltage" and how to prevent one bad DMX device affecting any other device on the network.

Splitters

The last of the above issues is the easiest to deal with and most users of DMX512 systems these days have encountered Data Splitters. The simplest DMX system would consist of a single controller driving a single dimmer or moving light. This structure is however limited to very small systems and a typical system will want to control several devices. It is possible and acceptable to connect these onto one DMX cable and such a system will work just fine. However consider the situation where we want one group of dimmers on the fly floor and a second set of dimmers backstage. Since "Y splitting" of DMX cables is not permitted we would have to loop a single DMX cable to both locations. There are plenty of situations where this may not be convenient and a Splitter is used to overcome this problem.

A Splitter takes a single DMX input signal and electronically splits it into several new signals. Each of these outputs is a separate copy of the incoming DMX signal and can be used to drive a separate DMX line. Thus we can now do an electronic "Y Split" without fear of causing problems.

The second benefit of using a Splitter in this situation is that a problem on one DMX line from the Splitter will not cause any problems on any other output line because the two are driven by separate circuits.

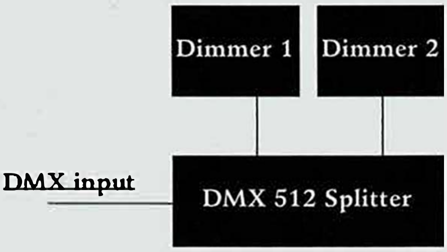

Figure 1 - Connecting a DMX512 splitter

A Splitter overcomes potential problems with:
a) line lengths;
b) Faulty devices;
c) Y split;

Earth Loops

Earth loops arise when the earth potential at one end of a DMX cable is different from the earth potential at the other end of the cable. This problem gets worse generally the further apart the ends of the cable are since it is then likely that the equipment on the respective ends are connected to different supplies. In this scenario large currents can flow along the shield of the cable and induce interference into the data signals thus creating errors. In the audio world this is often heard as a 50Hz buzz in the system. Note that this problem can exist between any two pieces of connected equipment, i.e. not just between controller and a controlled device.

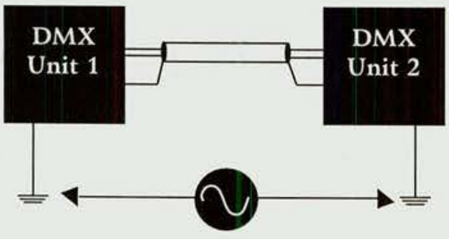

Figure 2 - An Earth Loop

There are two initial ways to cure or prevent this problem. One solution is to operate all the lighting equipment from the same mains point to ensure that there cannot be any difference in the earth potential. This is sometimes not possible, often not convenient and potentially costly.

The second option is to break the shield connection of the data cable and thus eliminate the earth loop circuit. This solves the problem but the break in the shield exposes the signal wires to interference. Thus neither of these solutions is desirable. Consider also the common mode voltage problem it introduces.

Common Mode Voltage.
For the moment assume that we have solved the problem of the earth loop and the two devices are no longer electrically connected. The voltage difference between the earths will still be there and this voltage now will appear as though it is part of the data signal. DMX512 works on being able to detect the voltage difference between the two wires of the data cable. As shown below, assume that the voltage on the data lines at the transmitter is 3 Volts and 1 Volt respectively. The difference of these two voltages is easy to detect. However assuming the earth voltage difference is 50 Volts, then the voltages at the receiving DMX device are 51 Volts and 53 Volts. It is not as easy electronically to detect the difference in these two voltages. It is a bit like trying to listen to a whisper as a train is going past. Without the train there would be no problem. With the train it is much more difficult and in fact may be impossible.

The voltage that appears between the two devices is called a common mode voltage as it appears on both inputs to the receiving device. *The common mode voltage limitation for DMX512 is -7 and +12 Volts.*

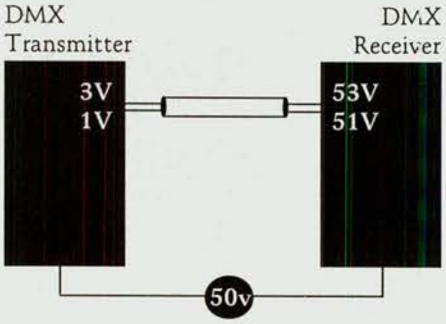

Figure 3 - Common Mode Voltage

The solution to this problem is obviously to connect the shields together again however this creates our earth loop problem once more so we are stuck between a rock and a hard place. What is the solution? Isolation!

Isolation
Isolation is used to remove the reference of the DMX512 signals to the ground connection. It is also known as providing a floating input or output. This is achieved by providing a separate isolated power supply for the DMX512 portion of the product's circuitry and using an optical device (generally an opto-coupler) to connect the data signal without using any physical electrical connection.

With this arrangement we can now connect various pieces of DMX512 equipment together and since the DMX512 signal lines no longer provide an electrical connection for earth between the devices, we have eliminated both the Earth Loop and the Common Mode Voltage problems. This can be seen in Figure 4. Note that here only one of the pieces of equipment needs to provide isolation to solve the problem. Many manufacturers however will design isolation into most or all their products to ensure that no matter what other equipment is connected to it, isolation will exist.

Most modern DMX data splitters provide isolated outputs but be careful as in some products there is only isolation between the input and all the outputs. There is not necessarily isolation between each of the outputs. These types of splitters are generally cheaper as isolation is expensive. Nevertheless they play a role in situations where we want to split the DMX signal to several devices located in close proximity. Here we often only need to provide isolation between these devices and the controller.

For more complex or professional environments a fully isolated splitter is a much better choice since with each input and/or output fully isolated from all others, the problems described above will not occur.

An added bonus of isolation is that it affords a level of safety. Assume that two separate devices are being fed from a splitter with fully isolated outputs as shown in Figure 1. If one of these devices fails and places high voltages on the DMX data lines, the isolation in the splitter will block this voltage from going any further. This will thus protect the second device on the other splitter output but more importantly, will prevent these voltages from reaching the control console and hence the operator.

In a later article we will discuss the pros and cons of using a central splitting system against using a distributed data splitting system as well as some of the more recent techniques in DMX distribution.

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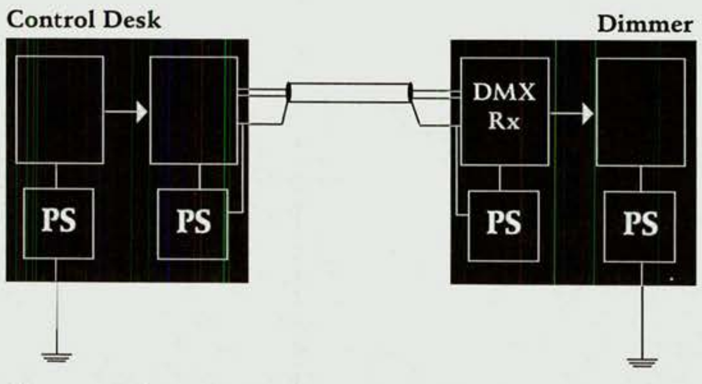

Figure 4 - Isolation of DMX Transmitter and Receiver avoids Earth Loop and Common Mode Voltage problems.