DMX 512 Overview

DMX is a lighting industry standard way of controlling lighting equipment. The whole idea behind DMX as a standard is that it allows equipment from one manufacturer to talk to that made by another. DMX-512 allows for one controller (like a lighting desk) to control many lights. DMX is limited to controlling 512 separate parameters, that's where the name DMX-512 comes from. DMX-512 is a protocol for controlling (at a basic level) the brightness of lights in a theatre (it is vary capable and can be used for controlling moving lights, smoke machines, strobe lights etc.) . It basically consists of one 8-bit (on or off) signal for each light which sets the brightness level (0-100%) of the light to one of 256 levels.

DMX-512 is the standard interface and protocol used in the theatre and entertainment industry. DMX-512 allows control systems to communicate with dimming systems, automated luminaires, colour scrollers and with other equipment. DMX-512 is connected using a daisy-chain methodology where the source connects to the input of the first device, the output of the first device connects to the input of the next device, and so on. The standard allows for up to 32 devices on a single DMX link. The DMX-512 communications protocol is very simple and robust. DMX-512 was created in 1986 by the United States Institute for Theatre Technology (USITT) as a standardized method for connecting lighting consoles. It was revised in 1990 to allow more flexibility (this is the version in use today). The Entertainment Services and Technology Association (ESTA) has assumed control over the DMX-512 standard. ESTA is making revisions to clarify and further extend the standard. Special care is being taken so that existing DMX-512 equipment will work under any new standard. Although the DMX-512 standard is being updated, existing equipment will still work the same under any new revision.

DMX-512 is designed to carry repetitive control data from a single controller to one or more receivers. This protocol is intended to be used to control dimmers, other lighting devices and related non-hazardous effects equipment. Since this Standard does not mandate error checking, DMX-512 is not an appropriate control protocol for hazardous applications. So do NOT use DMX-512 to control devices like moving platforms or pyrotechnics.

Officially DMX is carried on 5 pin connectors, which carry the data (RS485) on pins 2 & 3, screen (and common mode reference) on 1. There is a second data link on pins 4 & 5 the format of which has never been well defined and it is seldom used in practice. This means that at an electronics level, the signal is sent through 5-core cable (but only 3 are ever used) consisting of 0v, +ve and -ve signal wires. Cable for DMX-512 installations should be 110 ohm impedance shielded twisted pair cable. A normal microphone cable (shielded twisted pair) works OK for short runs, but can cause problems in long runs (so using it is not recommended).

In DMX-512 world there has been a long debate on 3-pin vs 5-pin connector. The official standard says 5-pin connector. Unfortunately some manufacturers use a cheaper 3-pin XLR connector instead of standard 5-pin. Cheaper/budget lighting kits (like many disco effects) are almost always 3 pin, probably because the plugs are cheaper! It seems that 3 pin is becoming the modern de-factor norm (although not conforming to the DMX-512 standard) and 5 pin is becoming more unusual. Current Martin kit uses 'pin 3 +ve' but older Martin stuff is the other way round. It's therefore worth carrying 'change-over' connectors as well as 3-to 5-pin adaptors if you are working with systems consisting of components from many different manufacturers.

Standard DMX-512 connector (5-pin XLR) wiring is:

- Pin 1 - Ground (shield)
- Pin 2 - Data complement (Data -)
- Pin 3 - Data true (Data +)
- Pin 4 - Optional Second Data Link Complement (Data 2 -)
- Pin 5 - Optional Second Data Link True (Data 2 +)

The pins 4 and 5 are reserved for spare data.

There are also some applications where 3-pin XLR-connector is used to carry DMX-512 data. Use of 3-pin connector is not defined in the DMX-512 standard, but the industry de-facto pinout for 3-pin XLR connector is the following:

- Pin 1 - Ground (shield)
- Pin 2 - Data complement (Data -)
- Pin 3 - Data true (Data +)

NOTE: There are some products using 3-pin XLR connectors with Data +/- reversed.

Which one of the connector you see on the equipment depends on the manufacturer and to what market those equipment are made for. In professional theatrical lighting applications the users and manufacturers prefer the standard 5-pin XLR connector. Practically all all the theatrical consoles, dimmer packs, PDU's, etc. use 5-pin connector. The new version of the DMX spec is very clear on connector issue - 5 pin only, anything else just makes life difficult for the end user. Go for 5-pin. Anything else will render your product non-compliant with the USITT DMX-512 standard.

However, 3 pin DMX exists and will no doubt continue to be widely used even in new products. 3-pin XLR connector is typically found on DJ/club type lighting instruments- One of the big reasons 3-pin XLR has become so popular is because manufacturers of intelligent lights targeted DJ's, clubs, etc. who already had 3-pin XLR's for their audio gear. 3 Pin XLR do not conform with the USITT DMX-512(1990) standard. The DMX-512 standard has always been clear about it being a 5-pin XLR. The reason many of the companies were using 3-pin is because they had their own native protocols that predated DMX and DMX was just an additional feature. The problem with using 3-pin XLR connectors is that you can easily confuse the DMX-512 cables with microphone cables that do not meet the needs of DMX-512 data cable. If you just use "any microphone cable" for DXM-512 connections, you might be able to get it to work with few instruments on short distances, but when distances get longer and number of instruments increase, things do not run smoothly anymore. The only rationalization for continuing to build any new product using 3-pin is to allow the inappropriate use of low-grade mic cables. Not a good reason in my book. The new version of the DMX-512 standard in the works by ESTA specifically disallows the 3-pin XLR (not that it was ever allowed to begin with). If you don't comply you can't mark your product as complying to the new standard.

Because there are this two connector model situation, many people working on this field need to use 3-to-5 and 5-to-3 pin adapters quite often.

DMX-512 uses EIA-485-A (commonly referred to as RS485) which is a balanced system. Normative references for electrical specifications at ANSI/TIA/EIA-485-A-1998 Electrical Characteristics of Generators & Receivers for Use in Balanced Digital Multipoint Systems. The electrical specifications of DMX-512-A standard are those of EIA-485-A with some minor exceptions.

The DMX-512 interface is electrically RS-485 bus where there is one transmitter all the time transmitting and multiple receives along the bus. There is always one transmitter (usually lighting desk or signal repeater) and there can be up to 32 receivers in a single bus. The signal voltage is is between the 2 data lines (pin 2 & 3). The difference between the pin 2 and 3 voltages is what is important: data high (digital 1) is if pin 3 is at a higher voltage than pin 2, data low (digital 0) is if pin 2 is at a higher voltage than pin 3. Typicaly the pin 2 and 3 are at either +5 or -5 Volts, but the RS485 limits are +12 and -7 Volts. In other words, the data is carried over a twisted pair (connected to pin 2 & 3). The transmitting device has a RS485 driver (transmitter) connected to pins 2 & 3, and transmits uses +5 and 0 volt levels with respect to the transmitting device’s ground. In receiver side pins 2 & 3 need to be within a few volts with respect to the receivers 0V reference (pin 1). There must be a difference of at least 200mV between pins 2 and 3 for the logic state to be reliably detected.

The main advantage of using a twisted pair is the ability accept a certain amount of common mode voltage (external noise/interference) and still get the data through. However there are limits to much common mode voltage it can accept, and the cable screen is used to help limit how much gets onto the

data lines. The DMX-512 standard that is not clear is exactly how pin 1 (shield ground) should be used. There are guidelines to manufacturers on how to implement electrical isolation between devices. There is an ideal situation discussed, and alternatives, but unfortunately not every manufacturer has implemented the ideal. Ideally, the shell of the connectors should be connected to the chassis of the device its plugged into. The cable screen should be connected to pin 1 at both ends, with the transmitting device provide a connection to ground. The receiving device provides no connection to avoid problems with devices having different ground references.

The wiring for what DMX-512 is designed to is 120 ohm shielded twisted pair wiring. DMX-512 is designed to use 5-pin XLR connectors, but some implementations use 3-pin XLR connectors. A DMX network is restricted to 32 devices in a daisy chain (including source), and the far end of the network should be terminated with a 120 ohm resistor between pins 2 & 3. If more than 32 devices needs to be connected, suitable active signal repeaters and/or splitters need to be used to split the wiring to parts with less than 32 devices in each part.

For reliable operation of DMX-512 system use the right kind of cable. DMX may, or may not, work with microphone cable. This depends on the cable and on the run lengths. So microphone cable is not recommended. DMX-512/1990 suggests Belden 9841/2 and Alpha 5271/2 cables, depending on if you want one or two pairs. There are many other cables around which work well with DMX-512 system. You need a shielded cable approved for EIA-485 use. Conductors connected to connector pins 2/3 and 4/5 should be twisted together. At 250K bits per second the max cable length is about 1000 ft for DMX-512 in good conditions.

The DMX-512 communications protocol is very simple and robust. The protocol used in DMX-512 bus is similar to normal serial communications (like RS-232 with 8 data bits + 1 stop bit) and operates at 250 kbps speed. Transmitting DMX-512 data involves transmitting a reset condition (indicating the start of a new "packet"), a start code, and up to 512 bytes of data. Data packets are transmitted continuously. As soon as one packet is finished, another can begin with no delay if desired (usually another follows within 1 ms). If nothing is changing (i.e. no lamp levels change) the same data will be sent out over and over again. Not all 512 channels need to be output per packet, and in fact, it is very uncommon to find all 512 used. For example, most simple lighting consoles only output 16 channels or less. The fewer channels are used, the higher the "refresh" rate. DMX needs to transmit all Channels up to the highest Channel-number used. So in theory if you leave gaps in your DMX numbering it cause any problems but it will lower your Refresh rate (More channels to transmit, so at fixed speed the transmissions take more time and thus you get less repeats per time interval.) In practice you don't have this amount of choice because on nearly all lighting control desks the number of dmx channels is fixed and the refresh rate is fixed. On expensive control desks you can go into the setup and alter the maximum DMX channel transmitted and therefore increase the refresh rate.

DMX is a very accurately timed stream of repeating data that loops continuously. To create this continual stream of data at 250,000 bits per second takes a lot of processing power and finely tuned software, and as such most commercial PC to DMX modules use on board memory and a processor to churn the data out continuously leaving the PC free to work on levels and update the module as required. The receivers for DMX-512 needs to be carefully designed, because a DMX-512 receiver MUST properly decode ANY possible DMX-512 transmitter. If the standard does not say that a transmitter can't make use of certain commands, then someone is sure to design a transmitter (console) that uses them!

The SIGNALLING in DMX is a "real" standard - virtually anything can coexist with virtually anything else and DMX will control it all and each device will stay out of each other's way nicely. On the other hand, the cabling isn't standardized since two devices that use the spare pair differently (pins 4 and 5) might object to being on the same daisy-chain.

DMX 512 STANDARD

DMX is a standard protocol developed in 1986 for lighting control to use equipment from different manufacturers in one system. The DMX 512 standard (Actually USITT DMX 512 - 1990) is published by the USITT.

It is a multiplexed protocol transmitted via the industry standard interface EIA485 (RS485) and provides up to 512 control "channels" per data link. It allows these 512 channels of information to be transmitted. For more than 512 channels, multiple DMX links are used. The DMX protocol does not have any form of error correction.

RS-485 defines that the signal voltage between the two wires should be at least 200 millivolts.

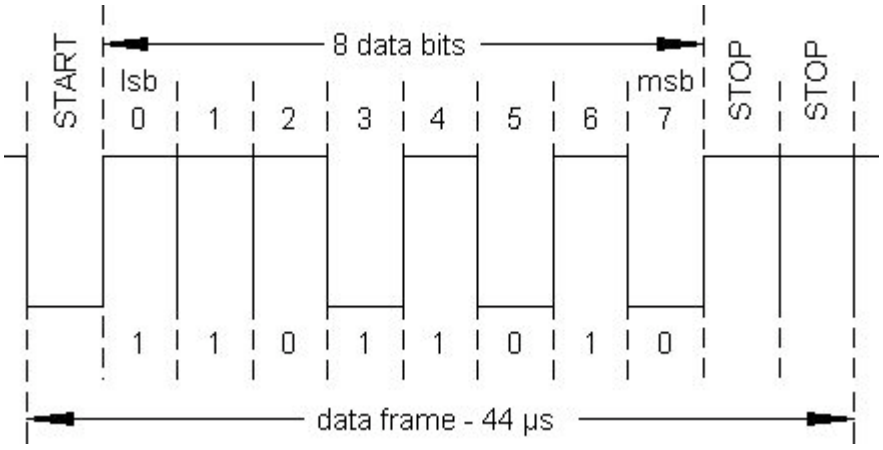
Higher voltage on the "+" pin and lower voltage on the "-" pin results in a digital "1". Higher voltage on the "-" pin and lower voltage on the "+" pin results in a digital "0".

Voltage on both pins measured to ground should be between +12 volts and -7 volts.

Data is transmitted in serial format asynchronously with a transmission speed of 250 Kbps. All data for the individual 512 DMX channels is sent one after each other, beginning with channel 1. Not all 512 channels need to be output per packet, and in fact, it is very uncommon to find all 512 used. As soon as one packet is finished, another can begin. If nothing has changing the same data will be sent out over and over again. The fewer channels are used, the higher is the "refresh" rate of information.

DMX Tables for most DMX controlled devices

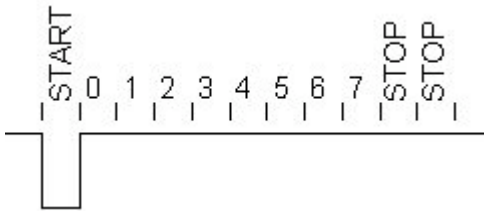
Each DMX channel contains a level represented by an 8-bit word. The 8-bit word allows 256 individual levels for each dimmer to be transmitted ("0" = channel off, "255" = channel full on). Many moving lights for instance use 2 channels to provide a 16-bit resolution.



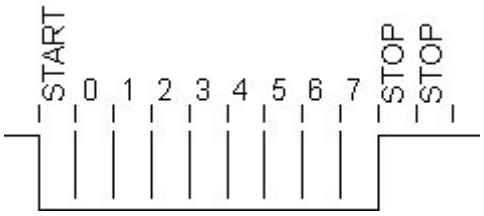
Data packets

Data transmission is based on the 8-bit asynchronous serial protocol with 1 start bit (low), 2 stop bits (high) and no parity. This gives a data "frame" of 11 bits. Since each bit is 4µs wide it takes 44µs to send a frame.

Without sending data, the line represents a logic "high" or "1". To send data, first a start bit is sent. The start and stop bits are used to synchronize the receiver with the transmitter. The start bit is followed by the data bytes. Receiving the start bit on the proper channel 'wakes' the device up. Now the next 8 bits are scanned and decoded. The following two stop bits indicate the end of the channel data; the process will be started all over again.



Channel full on, "255"



Channel off, "0"

Each channel is separated by a logic "high" or "mark" partition between the 8-bit data byte.

Any number of channels between one and 512 could be used. Only these data will be transmitted. The data of all used channels is sent again and again until it will be changed. This gives a so-called "refresh rate". This is the number of repeats of the channel data in one second. The refresh rate is measured in Hz. By sending fewer channels' data, the refresh rate is higher.

A DMX512 transmitter has the capacity to drive up to 32 units. DMX512 is connected using a daisy-chain methodology where the source connects serially to the input of the first device, the output of the first device connects to the input of the next device, and so on. To drive more than 32 units a DMX splitter is required.

Each receiving device typically has a rotary switch, which sets the starting channel number that it will respond to (for example, if two 12-channel dimmer packs are used, the first dimmer pack might be set to start channel 1 and the next dimmer pack would be set to start channel 13).

All "open ends" must be terminated. Terminating plugs contain a 120 ohm, 0.5W, resistor across pins 2 & 3. The terminator functions by absorbing signal power, which would otherwise be reflected back up the cable and degrade the data. DMX lines cannot be split passively. Always an active splitter must be used.

The ground wire is only a reference point and used for shielding.

Pin assignment / 5-pin XLR	
PIN 1	Signal Common (Shield)
PIN 2	Dimmer Drive Complement (Data 1 -)
PIN 3	Dimmer Drive True (Data 1 +)
PIN 4	Optional Second Data Link Complement (Data 2 -)
PIN 5	Optional Second Data Link True (Data 2 +)

The standard connector is a 5pin XLR connector. A DMX output connector is always FEMALE and a DMX input connector is always MALE.

Because DMX is a RS-485 interface, don't use standard microphone cables. The standard wiring is a twisted-pair, shielded, low-capacitance data cable designed for RS-485. Recommended cables are BELDEN 8227, BELDEN 9156, and BELDEN 43906. Use DMX cable with only the first three pins connected. DMX cable with all five pins connected should only be used when the user manual for the product states that it is necessary (for example if the dimmers return status data to the console).

Source: www.proav.de