

Understanding DMX

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What can DMX do?

- DMX is simple – it is designed to control devices, usually lights
- This may also mean just turning on and off a device
- Work with desperate devices and software applications



Where did “DMX” Come From?

- DMX was designed as a public standard to allow hardware and software vendors to all be able to design interoperation devices
- Designed in the early 90’s
- Developed by USITT – United States Institute for Theatre Technology
- Designed to be very reliable (but not guaranteed – no error checking)



What is DMX?

- DMX is a protocol
- DMX is a public standard
 - E1.11 (ANSI)
 - Just a set of rules
- DMX runs “over” other protocols or wiring systems



What DMX isn't

- DMX isn't a wiring standard
- DMX isn't a physical "thing"
- DMX isn't complicated
- DMX isn't the perfect protocol



RS485 and DMX

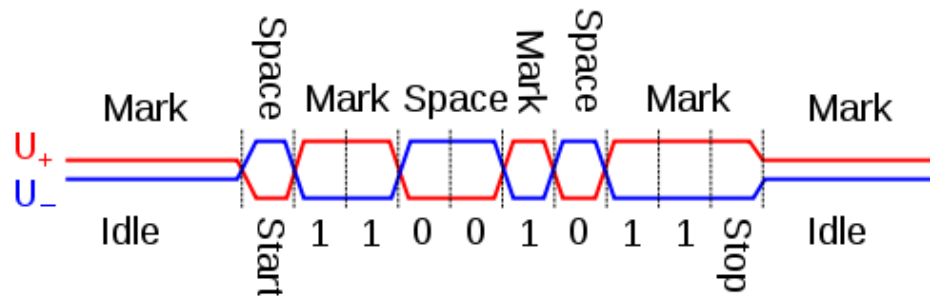
- It is important to understand that RS485 ISN'T DMX and vice-versa
- RS485 is the most common method of DMX transmission

CAT5 Cable	CAT5 Cable	CAT5 Cable	Freeway
RS-485	Ethernet	Ethernet	Roads Signs
DMX	TCP/IP	TCP/IP	Driving Laws
	DMX (E1.31)		



RS485

- RS485 is the “road” on which DMX runs
- Very robust – designed for industrial environments back in the 1970’s
- Differential signaling system (positive and negative voltages)



RS485

- Able to handle speeds up to 35 Mbit/s depending on cabling
- Cable lengths up to several thousand feet
- Two wires + ground (optional)
- Allows for a variety of wiring topologies
 - RS485 is the basis for DMX (E1.11) , LOR, Pixelnet and Renard protocols



RS485 Termination – Yes or no?

- **PRO:** Termination “dampens” the reflections of the signal in the cable
- **CON:** Termination “sucks up” power on the line, lowering the voltage and thus the distance
- The RS485 (DMX) specs call for termination (100-120 ohms) with standard DMX cable



Termination Cont.

- LOR Controllers don't use termination
- No one best answer – sometimes it is necessary...sometimes not
- A scope is the best tool for looking at the quality of the signal
- For video showing the effects of termination:

http://www.holidaycoro.com/kb_results.asp?ID=17



Splitting RS485

- Some controllers passively split the connection (LOR/LE Express) and some actively split and then repeat the signal (LE Express)
- Splitting DMX can be as simple as using 3-way splitters
- Keep “stubs” as short as possible



Connectors and Cable (E1.11)

- The E1.11 DMX standard says to use 5 PIN “XLR” plugs
- Many lighting industry devices use 3 PIN “microphone” cable with XLR plugs instead as it is more common
- The holiday lighting world uses CAT5 cable and connections almost exclusively – as they are cheap



RS485 Wiring

- Chart showing wiring interconnections:

CAT5 Pin # (T568B)	Wire Color (T568B)	Function	3/5 Pin XLR	LOR Wiring
1	White/Orange	DMX Data +	Pin 3	Blue
2	Orange	DMX Data -	Pin 2	White/Blue

- Ground wire often not connected in holiday lighting controllers



Controller Count per line

- Technical limit to the number of devices on a single DMX line is 32 but many more are possible depending on the line load per controller
- Controller counts can be increased with the use of repeaters



DMX over Ethernet (E1.31)

- No RS485 - DMX is instead sent over standard Ethernet/Wireless using TCP/IP
- Allows many universes over a single network connection
- Used when distances are far or channel counts are high
- EtherCongateway (J1SYS)



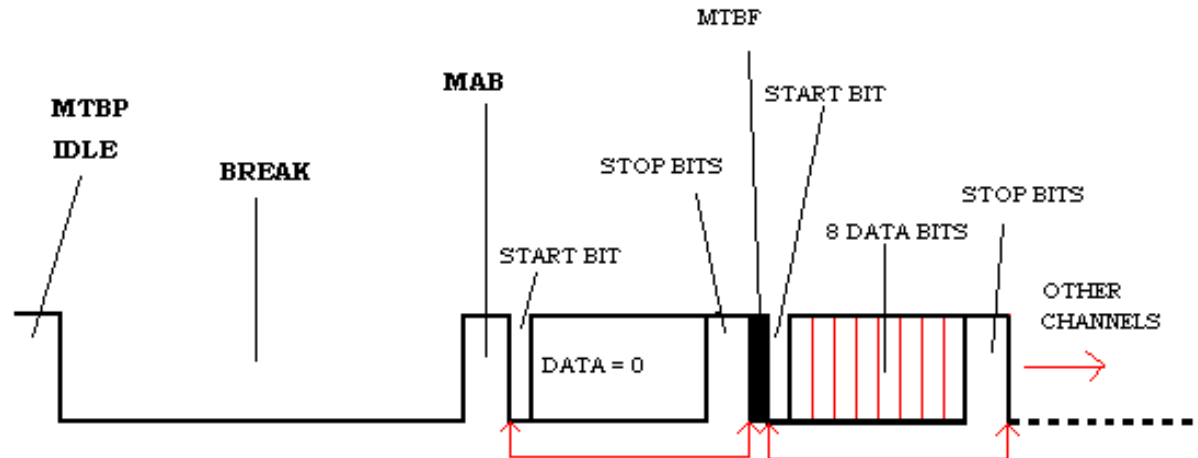
DMX Channels and universes

- There are 512 channels (9 bits) in a DMX universe
- One transmitter (RS485) per universe
- One transmitter (E1.31) for many universes
- Universes are effectively unlimited
- Universes are not “connected” to another universe



DMX Protocol Internals

- DMX runs at 250Khz or 4 micro seconds widths/"slices" of time
 - 1 Microsecond (μs) = .001 milliseconds (ms) / 1000 ms = 1 second
- MTBP – Mark Time Between Packets (idle)
- Break – Starts with 88 μs low/ 22 pulses (get ready...I'm about to send data)
- MAB – Mark After Break ~12 μs high / 2 pulses
- Channel Data - 44 μs / 11 pulses for each channel (**shown in red below**)
 - Start bit– 1 bit low
 - Data bits – 8 bits (0-255 that define the level of light intensity)
 - End bits – 2 bits high
- First channel zero, has the start code of binary 00000000 (zero)
- MTBF - Mark Time Between Frames 0-1 seconds high (the next channel is coming up)
- All 512 channels are sent one after another until the next MTBP and the process restarts



DMX Packet Timing

- Timing References
 - 1 Microsecond (μs) = .001 milliseconds (ms)
 - 1 Second = 1000ms
- $[(88)+(12)+(44)+(\text{channels} \times 44)+(\text{channels} \times \text{MTBF})+(\text{MTBP})] \mu\text{s}$
- $88+12+44+22528+0+50 = 22,722 \mu\text{s}$
- $1,000,000\mu\text{s}$ (1 second) / $22,722\mu\text{s} = 44.01 \text{ Hz}$ or 44(times per second)
- This means that as long as your sequences contain timing no smaller than 22ms or .022 seconds, the timing of the display will be as expected



Output Adapters / Dongles

- DMX must be generated by a device
- Devices can be “smart” or “Dumb”
 - **Smart** – Command is sent to device from the sequencing software (say...Channel 1 at 128 bits) once and the devices keeps repeating it 44 times/sec. This way the PC doesn't need to keep repeating it.
 - **Dumb** – Commands from the sequencing software have to be re-sent over and over 44 times/sec. This puts a larger load on the PC
- Adapters/Dongles
 - Smart – Enttec Pro, DIYLA Dongle
 - Dumb – Enttec Open, generic RS-485 Adapters



Levels of Fading

- Each channel in a universe carries 8 bits of data, allowing up to 256 (FF hex) levels of fading per channel.
- 0 = Off
- 128 = Half on
- 255 = Full on
- Fading “quality” can be affected by lighting curves, linear lighting output
 - <http://vimeo.com/19615787>
 - <http://vimeo.com/13703416>



DMX Effect Generation

- DMX Devices don't generate any local effects, unlike the LOR protocol which generates it's effects in the controller hardware
- Effects are generated in software
- This means that effects can be changed easily as they are created in the sequencing software



LOR Users – How get DMX

- LOR S2 Users – Upgrade to LOR S3
- Native in LOR S3 using Enttec Open/Pro (supported by LOR)
- Native in LOR S3 using Lynx Dongle
- iDMX-1000 – converts LOR protocol to DMX (not recommended)
- Play sequences in xLights – better output support and less moving parts



Misc

- LOR Controllers can listen to LOR and DMX allowing you to run all your controllers as DMX (DIY and LOR)
- There is “to spec” and there is “it works” – this is Christmas lights after all



Resources

- DMX Standards:
 - Recommended Practice for DMX512 from USITT – book, purchase only
 - BSR E1.11 Standard from USITT, book, purchase only
- RS-485
 - <http://www.maxim-ic.com/app-notes/index.mvp/id/763>
(wiring)



DEMO

- Capturing DMX signals using logic analyzer



Q&A

