

Lone Star Holidays Do It Yourself Workshop

The DMX and LOR Protocols

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The Layers...

Protocol

- LOR: LOR₁/LOR₂
- DMX: DMX_{512A}

Transport/Signaling

- LOR: RS-485
- DMX: RS-485

Physical Layer

- LOR: CAT₅ & Telephone Wire
- DMX: CAT₅, XLR, DMX Cables

RS-485 Physical Layer

- RS-485 defines the wire type and distances
- Twisted pair *should* be used per RS-485 spec (telephone and XLR MIC cables are not twisted pairs)
 - CAT5 cable does meet these requirements
- LOR allows standard telephone wire
- DMX512A requires “DMX Cable”, though microphone and CAT5 cable are often used

Transport Layer

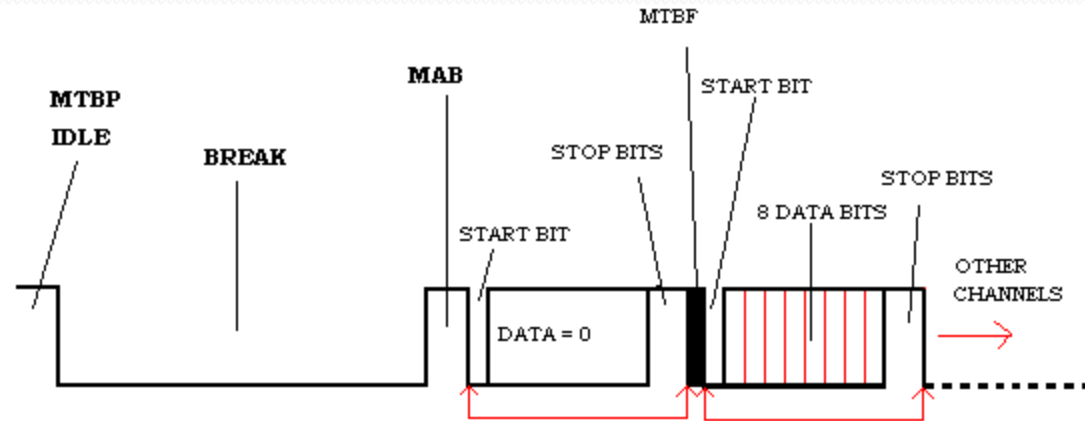
- Both DMX and LOR both use RS-485 to send data “over the wire”
- RS-485 is a standard introduced by TIA/EIA in the 1970's
- RS-485 is not a data protocol, instead it defines the electrical signaling, wiring, distances, network topology, etc
- DMX & LOR require only 2 wires (single duplex) but the RS485 spec requires four wires + ground
- Speeds up to 35 Mbit/s @ 30ft and 100 kbit/s @ 4,000 feet
- Designed originally for industrial use (usually running the MODBUS protocol) and thus is very robust in it's design
- Allows for daisy chain and star topology including repeaters
- Signaling: High = 1 = +5v / Low = 0 = -5v (differential)

DMX and LOR Protocol Differences

	DMX	LOR 1/d-Light
Standard	Open Standard DMX512A	Closed Protocol LOR and d-Light have slightly different versions
Transport/Network	RS-485	RS-485
Maximum Networks/Universes	Limited by host machine (technically unlimited)	4
Maximum Controllers / Channels Per Network	32 (16 Channels) 512 Channels Max	240 (16 Channels) 3,840 Channels Max (theoretical maximum)
Intelligence @	Host/PC – lighting devices simply turn on to indicated dimming level	Device – host sends commands (e.g. fade over .5 sec) to controller, controller then runs commands locally
Protocol Complexity	Simple	Complex
Topology	Daisy Chain & Star (using splitter)	Daisy Chain Star (LOR RS485REP)

The DMX512A Protocol

- 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 $\sim 12 \mu\text{s}$ 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) (actual lights start with channel 1)
- 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



The DMX512A Protocol cont...

- Example of timing:
 - $[(88)+(12)+(44)+(channels*44)+(channels*MTBF)+(MTBP)] \mu s$
 - $88+12+44+22528+0+50 = 22,722 \mu s$
 - $1,000,000\mu s$ (1 second) / $22,722\mu s = 44.01$ 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
 - Since DMX updates 44 times a second, if a device “missed” a command, within 1 second 43 more commands will have been sent so it’s not likely you would see “stuck on” or “stuck off” channels due to network issues

The LOR1 Protocol

- LOR runs at 19,200, 57,600 or 115,200 kb/s (distance+nodes limits speed)
- Byte = 8 bits (11111111)
- Sync/start Byte – Signals the start of the packet, always zero byte
- Unit/Controller Address Byte– 240 possible (01 to F0). FF is reserved for all units. F1 to FE are not used.
- Command Byte – First three bits are function (on, off, intensity, shimmer, twinkle, heartbeat, firmware update, etc) the remaining bits are which channels it should be applied to (single, lower 8 or upper 8 channels, all channels)
- Parameter/Channel(s) Byte – Which specific channels should the command byte be applied to or multiple commands such as ramps
- Stop Byte – Signals the end of the packet, always is zero byte
- Notes: Controller address, commands or parameters are never zero – only the stop/start byte can be zero

Sync Byte (always zero)	Controller Address	Command (Turn ON Channels 5 and 1/bank 1-8)		Parameter 1-5 Bytes	Stop Byte (always zero)
		Function	Parameter Format		
0	1	49		17 33	0

The Good and the Bad

	DMX Protocol	LOR Protocol
Stuck channels (excluding failed hardware)	Less to no issues	Possible to common
Efficiency of protocol	Poor – updates required every time, timing is based on the host	Good to very good – updates only required when a change is made and more than one channel per packet possible
Channel Density	Moderate 512 Channels All channels can be used	Very Good 3,840 Channels (240 x 16) May not be able to actually use all channels (LOR II offers 256 channels/controller)
Future changes	Easy – all changes at host, device/dimmer only needs timing and intensity	Harder – each revision to the protocol could require all devices to have firmware updated
Host load	Medium to Very High (dependant on DMX box)	Low to Medium

What does this mean for me?

- The LOR protocol only sends data when it's necessary which is more efficient but requires some optimization on the host sending the commands. The DMX protocol sends commands to all 512 channels 44 times per second, even if an update/change to that channel is not required.
- DMX is a “known” quantity of bandwidth – it is always sending 512 channels so it either works or does not work. LOR's bandwidth varies depending on the channels and current function in all the channels – there is no way to know if you have “used up” that bandwidth and could be losing commands to the controllers – mainly only an issue with high channel count networks.

Light-O-Rama iDMX-1000

- Uses a LOR protocol as input and outputs DMX
- Price: \$259.95
- Requires XLR to CAT5 for use with Lynx/LOR DMX controllers
- Only required when you don't have native DMX support in the software (LOR S2)
- 256 Channels of DMX (512 channels in beta as of Feb 2010)



References

- DMX
 - <http://www.dmx512-online.com/packt.html>
 - <http://www.dmx512-online.com/physl.html>
- General Lighting Controller Info
 - <http://www.epanorama.net/documents/lights/lightdimmer.html>
 - <http://computerchristmas.com/ForumBoard/read.php?f=4&i=1227&t=1171&v=f>
- RS-485
 - <http://www.maxim-ic.com/app-notes/index.mvp/id/763>