THE BASICS OF A DMX SYSTEM

DMX SERIES – ARTICLE 2

Adapted from a talk given by Thomas Ladd and Simon Hicks at LEDucation 2022

NB: This article is the second in a three-article series aimed at construction and electrical engineering professionals who work in lighting installation but have not worked with lighting fixtures controlled by the DMX protocol. It does not cover DMX distribution over Ethernet.

HOW A DMX CONTROLLER COMMUNICATES WITH DMX FIXTURES

Compared to other protocols, the streaming nature of DMX is what lends it to dynamic lighting control. The DMX controller streams out 512 channels of data, which it updates every 30 milliseconds; this is picked up by the DMX device, which is set to listen to a specific channel or set of channels.

Different fixtures will have different DMX needs. A white fixture might need a single channel to operate intensity, while an RGB fixture needs three – one for each colour. The control system will need to know the profile of each fixture type so it can send the correct data in the correct position of the stream to operate the fixture.

Below are some examples of common DMX profiles we see in lighting fixtures today.

DMX CONTROL PROFILES

Lighting fixtures and DMX devices can use one or more channels. We talk about a fixture's required channels as its device profile and the number of channels a fixture requires as its DMX footprint.

Single channel fixtures

- White intensity
- Single colour intensity
- Warm dimming

Multi-channel fixtures (8 and 16 bit)

- Ww Cw (2 ch)
- I/RGB/A/W/ (up to 6 ch)
- Int CCT (2 ch)
- Int CCT Hue Sat (4 ch)
- RGBW Pan Tilt (6 ch)

Note how the first and third multi-channel profiles both have a 2-channel footprint and are tuneable white but use their two channels of DMX in very different ways.

THE IMPORTANCE OF FIXTURE PROFILES

Some DMX fixtures can be set into different modes where their footprint and profile changes. Fixtures that have a 16-bit mode use twice the number of channels for control. So rather than a white fixture using one channel with 256 steps of dimming, using two channels gives you 256 steps of each of the 256 steps – 65,536 steps in total! That lets you harness a much finer dimming resolution or colour gamut, especially good for longer cross fades at low intensities.

Most of the time, this range of 0-255 or 0-65535 typically maps to a 0-100% range in the control system for a device's parameter.

DMX wiring must be a strict daisy chain when wiring lighting fixtures…

Fixture manufacturers are actually free to map the range any way they want, which is another reason why control systems have this concept of fixture profiles. As an example, entertainment automated fixtures will use half of the range to operate one feature and the other half for another, all on a single channel of DMX. It is again up to the control system to use the right profile when controlling a fixture like this.

### CHARACTERISTICS OF HEALTHY DMX WIRING

DMX is a streaming serial protocol based on RS485. It's a party line. One master controller (the source) can send DMX down a wire with many DMX devices, such as fixtures, listening.

DMX wiring must be a strict daisy chain when wiring lighting fixtures – you can't have T-junctions, splices or loops.

A healthy and properly wired segment of DMX has four key characteristics:

- A total length of less than about 1,000 ft

- A single source – fixtures are wired in a 'home run' back to a source, e.g. a controller

- Multiple listeners – typically fixtures (one daisy chain can have up to 32 listeners)

- An end-of-line terminator – a 120 Ohm resistor

DMX WIRING – STRICT DAISY CHAIN
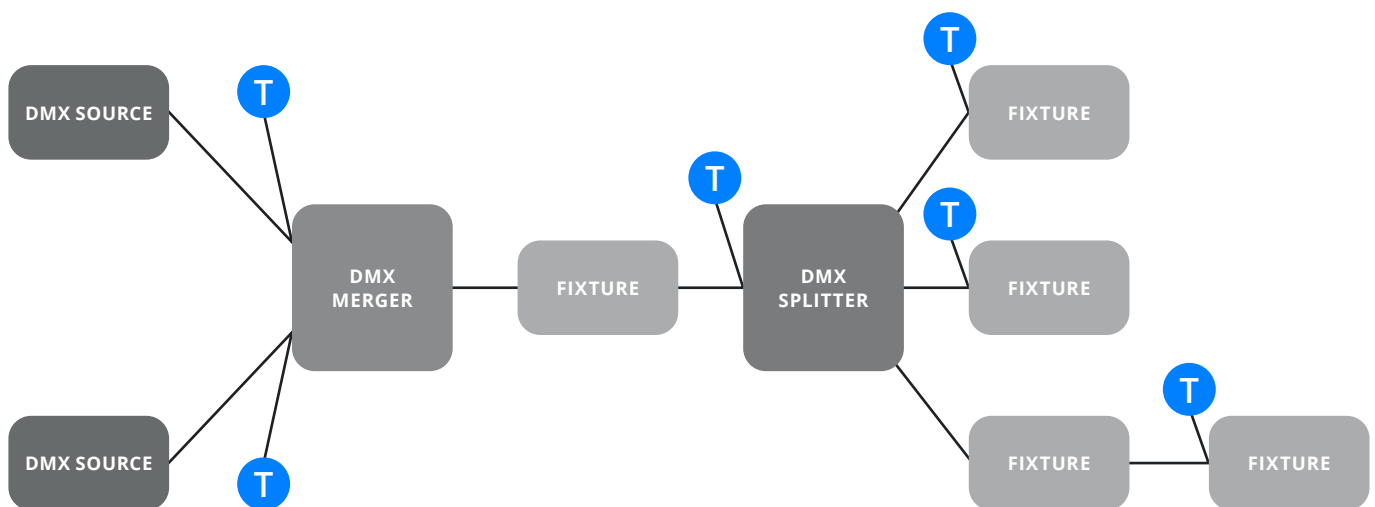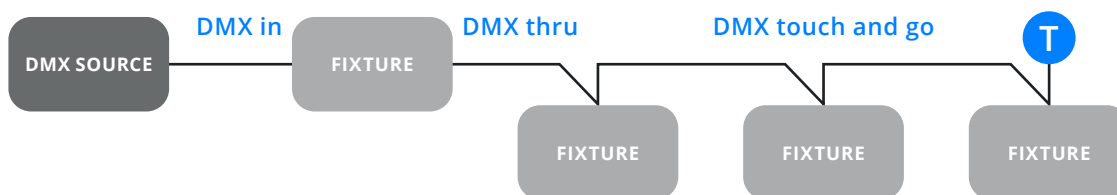
The top example shows a single DMX segment from source to end-of-line (EOL) termination. We have one source, several listeners and the end-of-line terminator.

In the bottom example, we see 6 properly run DMX segments that also satisfy our 4 characteristics of healthy wiring. Two new DMX devices are introduced: a DMX merger and splitter. These act as more than just a simple device listening for data on the line – they are active tools for manipulating DMX and, therefore, when they send out their DMX they are acting as a new source.
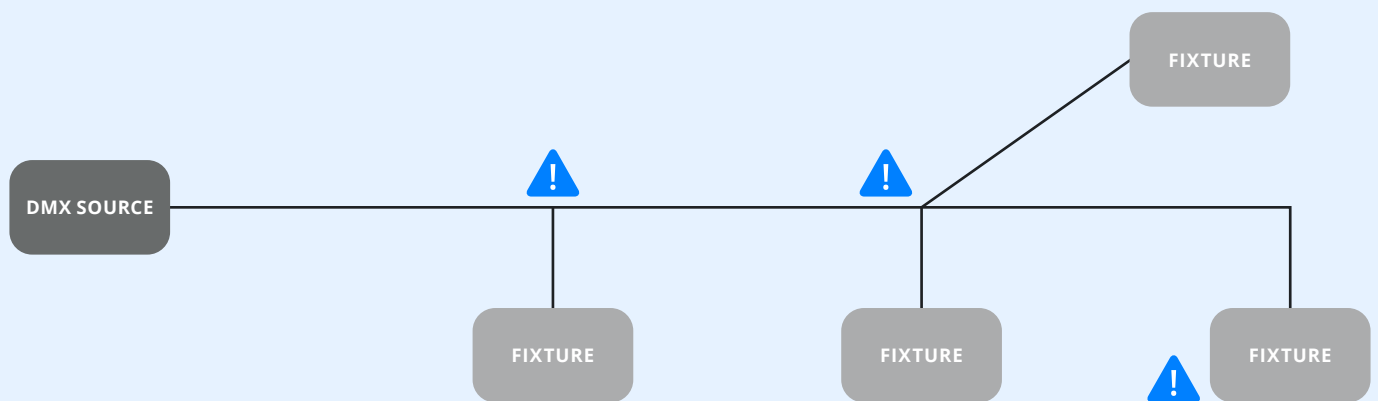
WHEN THINGS GO WRONG

DMX WIRING – NON-COMPLIANT WIRING SCHEMES
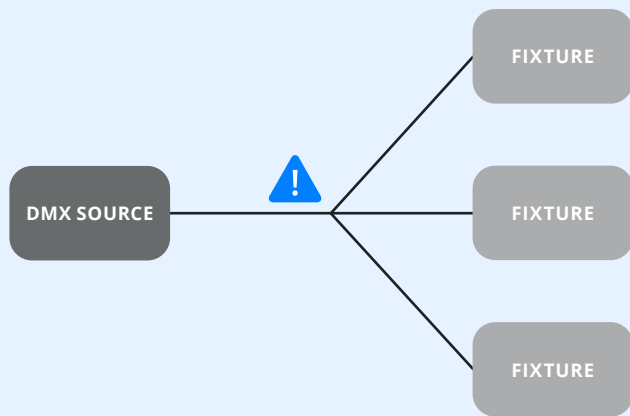
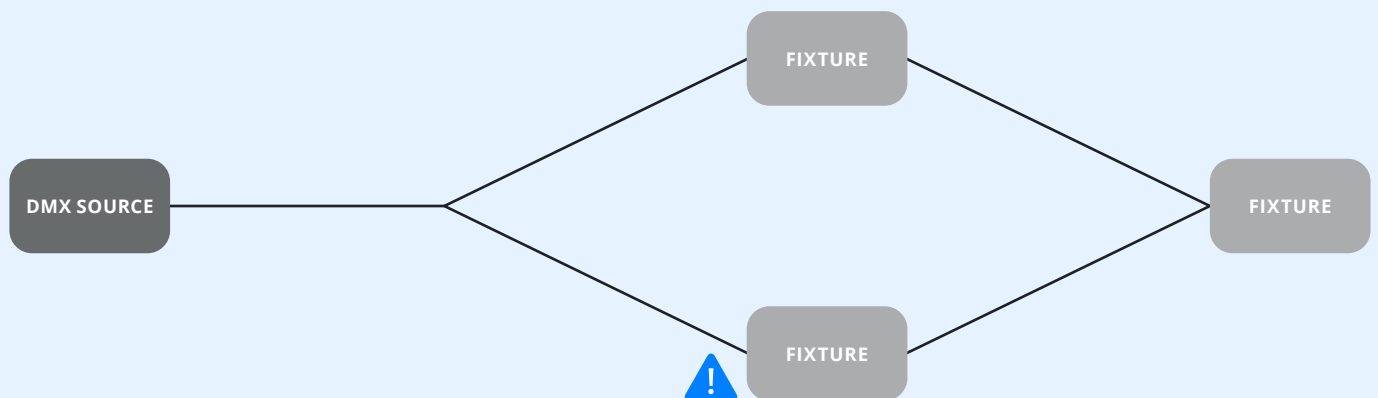**STAR TOPOLOGY –** Requires DMX splitter.
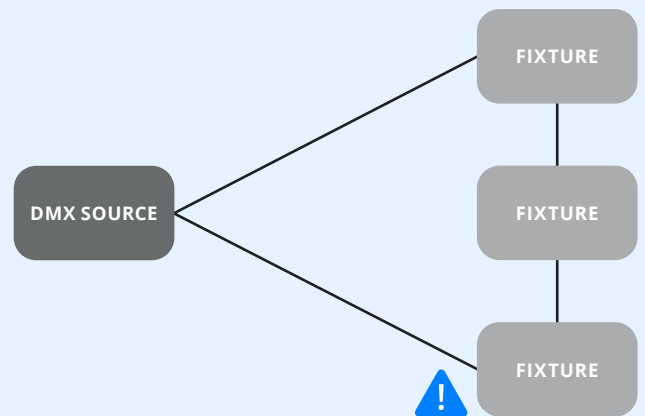
LOOP – Remove wiring back to source and terminate.

Y-SPLIT – Touch-and-go or daisy-chain to next device.
STAR TOPOLOGY – Requires DMX splitter or daisy-chain, terminate.

Y-SPLIT AND LOOP – Remove wiring from last device and terminate.

Flickering, which occurs with improperly wired DMX, is a sign of reflection either from lack of a daisy chain, missing EOL termination, a bad fixture or more than one source on the line. In these situations, that nice, orderly streaming package of 512 values will head down alternate routes, but the electrical signal will start being degraded by reflections. From the fixture's perspective, the DMX stream gets polluted and the fixture's ability to determine which values are relevant is severely impaired. Fixtures then read the wrong data points and set their parameters to the wrong values, and they do this at a rate of 33 times a second. Fortunately, flickering is avoidable and fairly easy to troubleshoot when you know the characteristics of a properly wired DMX segment.

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A RECIPE FOR DMX SUCCESS

What are the ingredients that make up a successful DMX project? We take you through the essentials and share the ultimate ingredient.

ARTICLE 3

THE BALLROOM PROJECT: A DMX CASE STUDY

We take a slow waltz through the various stages of a lighting project for a ballroom. Learn the steps along the way, including how to wire up fixtures, how to control them, and the tasks involved in the installation and commissioning process.

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