In 1957, as a senior in high school, I was given the lead role in the Drama Club senior play. My drama teacher should probably have realized that, as a nerd before my time, my interests in that event related more to the operation of the curtain, set changes, and lighting, than to the process of learning my lines. As a result, I probably received more whispered prompts during our several performances than all the other actors in our cast.

Lighting in those days consisted of a few manually operated spotlights with gel filters for color change, and stage lighting powered by a couple of manually operated variable transformer (Variac) dimmers.

Today, theater lighting is controlled digitally. Color, spotlight positioning, brightness, and various special effects can be changed by digital data sent on a daisy chain serial bus network using either three or five wires in a thin cable coming from a master control panel. An XLR five-pin connector is preferred. The industry standard for such communication is known today as DMX512-A. It’s a special variation of the RS485 differential serial bus used in industrial applications.

Each light or effect has switch settings to allow it to recognize its data out of a string of up to 512 packets or frames, each 44 µs long, sent in a repeating pattern of less than 30 milliseconds total duration. With 11 bits in each frame, and with a bit duration of 4 µs, tracing the action of a single bit for a given light feature in the string is like looking for a needle in a haystack.

I immediately noted a long low period (defined as a BREAK in the standard) before each burst of 512 frames. I decided to use the Trigger Option… Pulse width on A… mode to get a reliable and repeatable trigger reference point. As you can see at the bottom of the screen, I selected a negative pulse width of 25 ms (slightly less than the duration of the BREAK), with a condition of >t to establish the desired trigger point. You can see the trigger level indicator now positioned at the beginning of the data set of interest.
I then increased the sweep speed to 20 µs per division so that I could resolve a 4 µs bit, and, after setting the lighting panel slider control to about 25 % green, I then began to look for a non-zero frame using the <MOVE> control on the ScopeMeter® tool. I scrolled to the right until I found the screen shown in Figure 2. You can see the trigger level indicator now has a “<<” notation indicating that the actual trigger is off-screen to the left. The value 1.680 ms at the bottom of the screen indicates our position within the data burst, and you can see the non-zero green control data with its 4 µs bits in the leftmost frame. That equals 4 usec, since there are four tic marks (defining five 4 us spaces) between the 20 usec/div display.

I then set the green slider to zero, and advanced the red slider to about 50 %, producing the screen in Figure 3a. Figure 3b shows green at 50 %, red at 0, and blue at 75 %.

By now I hope you get the idea—by setting the trigger options and conditions on our oscilloscope we can zero in on any portion of a repetitive waveform and zoom in to any desired resolution we choose.

I mentioned above that the DMX standard prefers the use of a cable using five-pin XLR connectors. The preference for the five-pin connector is to eliminate confusion with the popular three-pin version XLR that is used for audio connections. Here are the definitions for the connection of the five leads:

- Signal Common
- Data 1- (Primary Data Link)
- Data 1+ (Primary Data Link)
- Data 2- (Optional Secondary Data Link)
- Data 2+ (Optional Secondary Data Link)

As you can see, the data 2 lines are optional, but with a recently announced four-channel Fluke 190 Series II ScopeMeter, you could track the behavior of all four active lines with respect to ground.

Oh yeah! I had to return the lights and controller to the show group I borrowed them from—the show had to go on.

**Additional resources**

Go here for a diagram showing how differential voltages define marks and spaces of a digital byte

Read about the history and the current status of DMX512-A http://en.wikipedia.org/wiki/DMX512-A#Electrical

See illustrations and examples of the DMX412-A standard’s operation
http://www.dmx512-online.com/index.html