Best Practices for Dynamic 0-10VDC LED Lighting Control

Overview
In dynamic lighting control applications, “0-10” speaks to the use of an analog controller to adjust the voltage in a 2-wire (+10VDC and Common) bus connecting the controller to one or more LED drivers.

When To Use 0-10
The most common “0-10” application is intensity control for LED lighting fixtures fitted with a driver that has a 0-10VDC dimming input. It is uncommon (and often impractical) to use 0-10VDC in an application such as color changing lighting as that requires more than just an intensity signal.

How “0-10” Works
A dimmable LED driver includes a power supply circuit that produces approximately 10V for the signal wires and sources an amount of current in order to maintain that voltage. Accordingly, the driver is called the “source”. Typically, the dimming signal input to the driver will consist of a purple wire (+10VDC) and a gray wire (Signal Common). When the purple and gray wires are open (not touching each other or connected to anything else) the dimming signal will be 10V and output of the driver will be 100%. When the purple and gray wires are shorted together (touching each other) the dimming signal will be 0VDC and the output of the driver will either be set to the minimum dimming level or it will drop into “sleep mode” in which it will turn off the LEDs completely. When the signal wires of multiple 0-10VDC drivers are connected together, they all “see” the same voltage on their signal inputs and will set their outputs to the same level.

In simple terms, the controller (“dimmer”) connected to the 0-10V drivers works by pulling down, or “sinking” the 10V to a lower voltage which corresponds to the desired dim level. For example, if the user sets a level of 50%, then the dimmer would sink the signal voltage to 5V. The connected drivers would then read this lower voltage on their signal input and lower the output to their LEDs in response. To understand how the LEDs respond to different voltages, please consult the LED driver manufacturer for dimming curves.

Understanding 0-10VDC Drivers
There are many different types of 0-10VDC controlled drivers and it is extremely important to understand the specific properties of the driver to be controlled.

On driver data sheets, it is not unusual to see the term “Full Range Dimming”. Further it is easy to assume that the term “Full Range Dimming” means that the driver dims from 100% to 0%, but that is often not the case. This means that as control descends through 10%, the driver will stop supplying power to the LEDs. “Low End Cutoff” is an often used term that refers to the point where the driver ceases to supply power to the LEDs. Put another way, the luminaire cannot be dimmed from Full to Black as was customary with incandescent lighting fixtures. Further, the dimming curve in a LED driver can sometimes be logarithmic, not linear (actually Square Law on most quality incandescent dimmers) and will produce significantly more illumination (real and/or perceived) at 10% than was customary with incandescent dimmers.
Understanding 0-10VDC Drivers (cont.)
As different drivers can and do have different dimming performance characteristics, a functional mock-up of the proposed lighting fixtures and controls is highly recommended.

There are 0-10VDC controlled drivers that only dim from 100% to 20% and there are 0-10VDC controlled drivers that dim from 100% to <1% which, practically speaking, is black. These drivers are typically specified when low-end dimming is of particular importance in the space being illuminated. These spaces include, but are not limited to Auditorium, Houses of Worship, Ballrooms and Restaurants.

Isolation Of The 0-10VDC Dimming Input
Some drivers on the market do not have adequate isolation between either the line voltage input, the 0-10VDC dimming input or the driver output circuitry. This can cause unwanted voltage to ‘leak’ onto the signal wires. This leakage can then cause dimming performance issues, network communication issues, or equipment failure in the control system. Because of this, it is very important to make sure that the driver(s) being used have a fully isolated 0-10VDC dimming input.

Best Wiring Practice For Power And Analog Controls
Best practice is to limit the distance run for the analog control wiring from the controller to the last driver to 300’ 0”. This is based on 18ga wire. It is possible to extend the run to 400’ 0” by using 16ga wire, but that should be considered carefully as an exception to best design practice.

Whenever any part of the control circuit (the driver, dimer, or wire used) is designed for use in a Class 2 installation, it is critical that the entire control circuit be kept separate from Class 1 line voltage wiring per the requirement of National Electric Code section 725.136. The electrical drawings must be very clear that class 1 and class 2 wiring cannot be combined. There must be separation. Because: a) it is possible for higher voltage wiring to induce an AC voltage in to the low voltage signal wiring; and, b) cause undesirable visual artifacts in the dimmed lighting when the line and low voltage wiring is run together (especially for long distances); we do not recommend installing the low voltage signal wiring in the same conduit or raceway as line voltage wiring even when all elements of the control circuit are listed for Class 1 wiring methods.