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Best Practices for Dynamic 0-10VDC LED Lighting Control

OVERVIEW

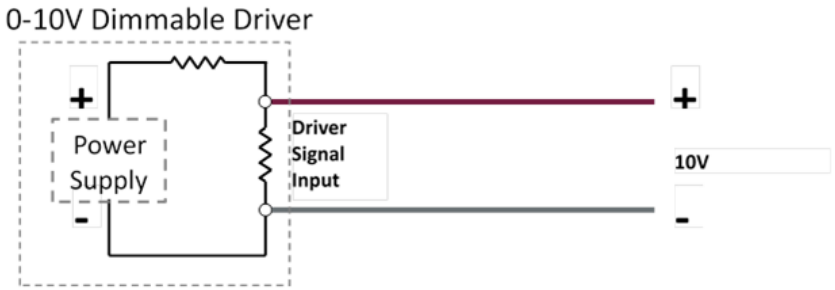
In dynamic lighting control applications, “0-10” describes the use of an analog controller to adjust the voltage in a 2-wire (+10VDC and Common) bus connecting the controller to one or more LED drivers equipped with a 0-10VDC dimming input. Pathway Connectivity manufactures two such controllers: the eDIN 1004 module; and the SNAP lighting control panel. Both controllers convert sixteen DMX512 slots to sixteen analog outputs. The SNAP panel also includes high voltage relays to control mains power to the drivers. Each analog control output is considered to be a “dimmer”.

WHEN TO USE “0-10”

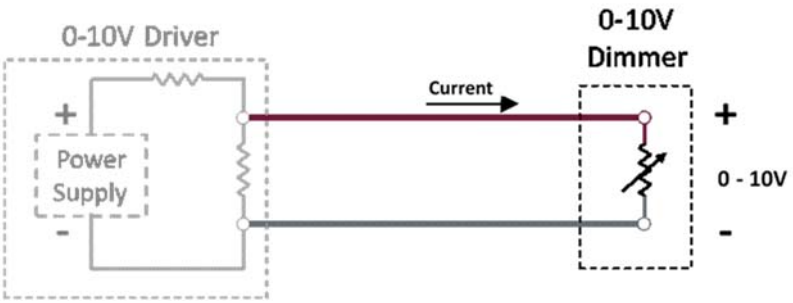
The most common application is intensity control for LED architectural lighting fixtures fitted with a driver that has a 0-10VDC dimming input. These practices are also recommended to dim fluorescent fixtures fitted with ballasts that have a 0-10VDC dimming input.

HOW “0-10” WORKS

A 0-10 dimmable LED driver includes a power supply circuit that produces approximately 10VDC 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 grey wire (Signal Common). When the purple and grey wires are open (not touching each other or connected to anything else) the dimming signal will be 10VDC and the output of the driver will be 100%. When the purple and grey wires are shorted together (touching each other) the dimming signal will be 0VDC the output of the driver will be set to the minimum dimming level or the driver will drop in to “sleep mode” and turn off the LEDs completely. When the signal wires of multiple 0-10VDC drivers are connected together – with proper polarity maintained – they all “see” the same voltage on their dimming signal inputs and set their outputs to the same level.



In very simple terms, the function of the controller / driver combination is to have an argument over the amount of voltage in the 2-wire control bus. Think of the Pathway Connectivity 1004 or SNAP controller as a water valve that precisely controls how much water is flowing through a pipe. The controller ("dimmer") connected to the 0-10VDC driver works by pulling down – or, "sinking" – the 10VDC to a lower voltage which corresponds to the desired dimmed intensity. For example, if the DMX512 controller is set to 50%, the dimmer sinks the signal voltage to 5VDC. The connected drivers read this lower voltage on their signal input and lower output to their LEDs in response. Typically – but not always so we recommend verification – LED drivers are designed so that the fixture light output will increase linearly with the signal voltage so, for example, a 10% increase in signal voltage will produce a 10% increase in intensity.



UNDERSTANDING "0-10" DRIVERS AND FIXTURE PERFORMANCE

Often the LED fixture and its driver have already been paired by the fixture manufacturer, and this pairing dictates the performance of the fixture, regardless of the 0-10V controller. On jobs where the systems integrator must match a driver to a third party fixture, understanding of the many different types of 0-10VDC dimmable drivers and their specific properties is critical.

On driver data sheets, it is not unusual to see the term "Full Range Dimming" and to assume that means the driver dims from 100% to 0% but that is often not the case. The most common 0-10VDC controlled drivers dim from 100% to 10% apparent output. What this means is – in DMX512 terms – the driver will not begin varying power to the LEDs, and hence apparent intensity until DMX512 control rises through 10%. It also means that as control descends through 10%, the driver will stop varying power to the LEDs. "Low End Cutoff" is an often used term that refers to the point where the driver ceases to dim the LEDs. Put another way, the luminaire has a minimum lumen output and cannot be dimmed from Full to Black as was customary with incandescent lighting fixtures.

Another consideration is how we perceive the LEDs change in intensity. 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. 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. Again, this behavior is inherent in the fixture driver, and not the 0-10V controller.

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.

For drivers that do not dim to black, it is customary that the DMX512 slot controlling the intensity also controls a relay that will open as DMX512 descends through the low-end cutoff point and will close as DMX512 ascends through the low-end cutoff point. This insures that the luminaires will uniformly transition to black as they dim down through the low-end cutoff point. Note that this transition will be abrupt and may not be desirable if low end dimming performance is a concern. Also, it is important that the DMX512 value at which the relay opens is properly coordinated with the 0-10 dimmer so that the relay does not open at a value too high or too low in the dimming range. A further consideration is that drivers will have on board processors and firmware that must boot and calibrate when power is applied and this can cause “lamp on/fade up” performance to be erratic.

ISOLATION OF THE 0-10VDC DIMMING INPUT

Some drivers on the market do not have adequate electrical isolation between either the line voltage input, the 0-10VDC dimming input or the driver output circuitry to the LEDs. This can cause unwanted voltage to leak on to the signal wires which 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 Class 2 or 3, fully isolated 0-10VDC dimming input. Many controls manufacturers – Pathway Connectivity included – do not warrant their 0-10VDC controllers against damage caused by the use of drivers without adequate isolation of the 0-10VDC dimming input.

GANGING MULTIPLE “0-10” DRIVERS ON A SINGLE CONTROLLER CHANNEL

A single analog channel on a 1004 Module has the capacity to sink 30mA of current and a single analog channel on the 4850-X controller has the capacity to sink 100mA of current. It is extremely important to verify the amount of current each driver sources when multiple drivers are controlled by a single output channel or “dimmer”. Source current is additive meaning that a circuit of two drivers will typically have twice the source current than a circuit of one driver. Generally speaking, a high quality driver will source 0.5mA of current. There are drivers on the market with considerably higher amounts of source current. While this seems to suggest that it is acceptable to connect up to 60 drivers to a single 1004 analog control channel (30mA / 0.5mA = 60) or 200 drivers to a single 4850-X control channel (100mA / 0.5mA = 200), best practice is to limit this to 30 drivers so as to contain: a) the length of the analog control wiring loop; and, b) the number of physical wiring terminations. Note that the operative word here is “drivers” because there are fixtures on the market fitted with multiple drivers.

BEST WIRING PRACTICE FOR MAINS POWER AND ANALOG CONTROL

Best practice is to limit the distance run for the analog control wiring from the controller to the last driver to 300’ 0” 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, dimmer 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 requirements of National Electric Code section 725.136. The electrical drawings must clearly separate Class 1 and Class 2 wiring. Separation is required because high voltage wiring may induce AC voltages on the low voltage control wiring causing unpredictable and undesirable artifacts in the dimmed fixtures. Never run line voltage and low voltage wiring in the same conduit and provide sufficient separation in raceway

installations. The 1004 and SNAP controllers should not be used where Class 1 wiring methods are required as they are not compatible with Class 1 drivers.

All 0-10VDC wiring should be done with shielded pair wiring with the shield grounded to earth at the controller. The pair does not need to be twisted. We particularly recommend this when low end dimming performance is of high importance. Unshielded analog control wiring runs can act like antennae. Radiated emissions (from transformers, radio transmitters, motors, etc.) can be collected by the unshielded analog control wiring and then interpreted by the driver as changes in the control voltage which will result in a flicker effect. When the number of drivers on a particular control channel is small, the effect can be pronounced because there is less current in the control loop than there would be with a larger number of drivers.

ADDITIONAL CONSIDERATIONS

Contract and construction documents for all “0-10VDC” control systems should include a complete system single line drawing to be confirmed in the installing contractor’s submittal.

APPLICATIONS SUPPORT

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