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Marine & Transit Dimming Guide

1.0 Introduction

Unlike traditional bulb technology, Light Emitting Diodes (LEDs) are low-voltage (i.e. 3V DC), current-driven solid-state devices. While LEDs offer the benefits of an extended operating life when compared to traditional bulb technology, their lifetime is contingent on their proper use within the LED lighting fixture in which they are installed. Critical factors including temperature and voltage/current (continuous and transient/surge) can reduce the lifetime, which is why i2Systems Marine and Transit Fixtures offer advanced thermal protection and integrated SmartDriver™ technology.

i2Systems integrated SmartDrivers regulate constant current to the LEDs within the fixture regardless of the input voltage to the fixture (provided that the voltage is within the specified operating voltage range of the fixture – i.e. 9-30V DC). By regulating the current to the LEDs, we are able to ensure consistent light output and constant power over the full input voltage range of the fixture. We are also able to ensure the LED is operated at or below its specified ratings, and thus offer an extended operating lifetime.

Therefore, because we have a SmartDriver integrated into our fixtures, by simply varying the voltage to the fixture, the fixture will not dim; rather the intensity will be the same brightness at 24V DC as it is at 12V DC using the above example. To provide dimming connectivity, i2Systems Marine and Transit LED fixtures include a Dimming Control Wire (typically yellow or white). This wire is provided in addition to our +V DC (typically red) and DC Common (typically black).

This technique has a number of advantages:

- Distributed Power. Lights may be connected to any local 12/24V DC source and zoned by tying together the Dimming Control Wire to fixtures in the same zone.
- Low Noise
- Precise dimming levels across all fixtures.
- Synchronized fixture on/off.
- Simple integration into 3rd party dimming systems without additional modules.

For our PRO Series fixtures (listed as PRO in the Product naming, i.e. Apeiron PRO™), additional advantages include:

- Digital communication embedded in the signal (i.e. to select colors on multi-color fixtures).
- Digital filtering integrated into each PRO Fixture to filter out noise.
- Dimming intensity curves integrated into each PRO Fixture optimize to your eye's response.
- 1%, flicker-free dimming.

This Dimming Guide will detail the following modes of dimming operation and assist in selecting the best means of dimming for your installation:

- Basic Standalone, Push-Button Dimming & Color Selection
- Integrating with 3rd Party 0-10V Dimming Systems
- Integrating with 3rd Party Marine/Transit Multiplex Systems, including NMEA 2000.

This document is for reference only and is subject to change. Should you have any questions prior to any installation, please contact us at +1.860.567.0708 or at support@i2systems.com.

2.0 Basic Standalone, Push-Button Dimming & Color Selection

The most common i2Systems Marine / Transit dimming solution is push-button dimming. Push-button dimming has a number of advantages compared to traditional dimming methods:

- A single switch controls on/off and dimming.
- Today's switches often fit 3 in a single-gang junction box, saving wall space.
- Any 3rd party Momentary Switch may be used, offering a wide range of styles and aesthetics.
- Push-button switches may be paralleled, allowing on/off and dimming control of a single lighting zone from multiple switches.
- Low-cost deployment.

A complete Push-Button Dimming Zone includes the following components:

- One or more i2Systems Dimmable LED Marine/Transit Fixtures
- i2Systems LightLink LL-101 Dimmer (models listed below)
- 3rd Party Normally Open Momentary Switch (NO, MOM)

i2Systems LightLink LL-101 dimmer is a small size Dimming Module that reads the Momentary Switch and provides a dimming signal to i2Systems Fixtures. Three models are available and are outlined as follows. A Manual for each model is located at our website at www.i2systems.com/marine-LED.

Model Comparison:

LL-101

- Dims up to 20 i2Systems LED Marine/Transit Dimmable Fixtures, including PRO Fixtures.
- Press & Hold 3rd Party Switch to Dim. Tap Switch for On/Off.
- Power cycle resets fixtures to a default 100% intensity.

LL-101-01A

- Dims up to 20 i2Systems LED Marine/Transit Dimmable Fixtures, including PRO Fixtures.
- Press & Hold 3rd Party Switch to Dim. Tap Switch for On/Off.
- Memory Function recalls last Intensity state with Power Cycle.

LL-101-PRO

- Dims up to 50 i2Systems PRO LED Marine/Transit Fixtures.
- Press & Hold 3rd Party Switch to Dim. Tap Switch for On/Off.
- Changes PRO Fixture LED Color.*
- Memory Function recalls last Intensity and Color State* with Power Cycle.

*Pro Fixtures must be enabled with a 2nd or 2nd / 3rd Color when purchased. Specify when ordering.

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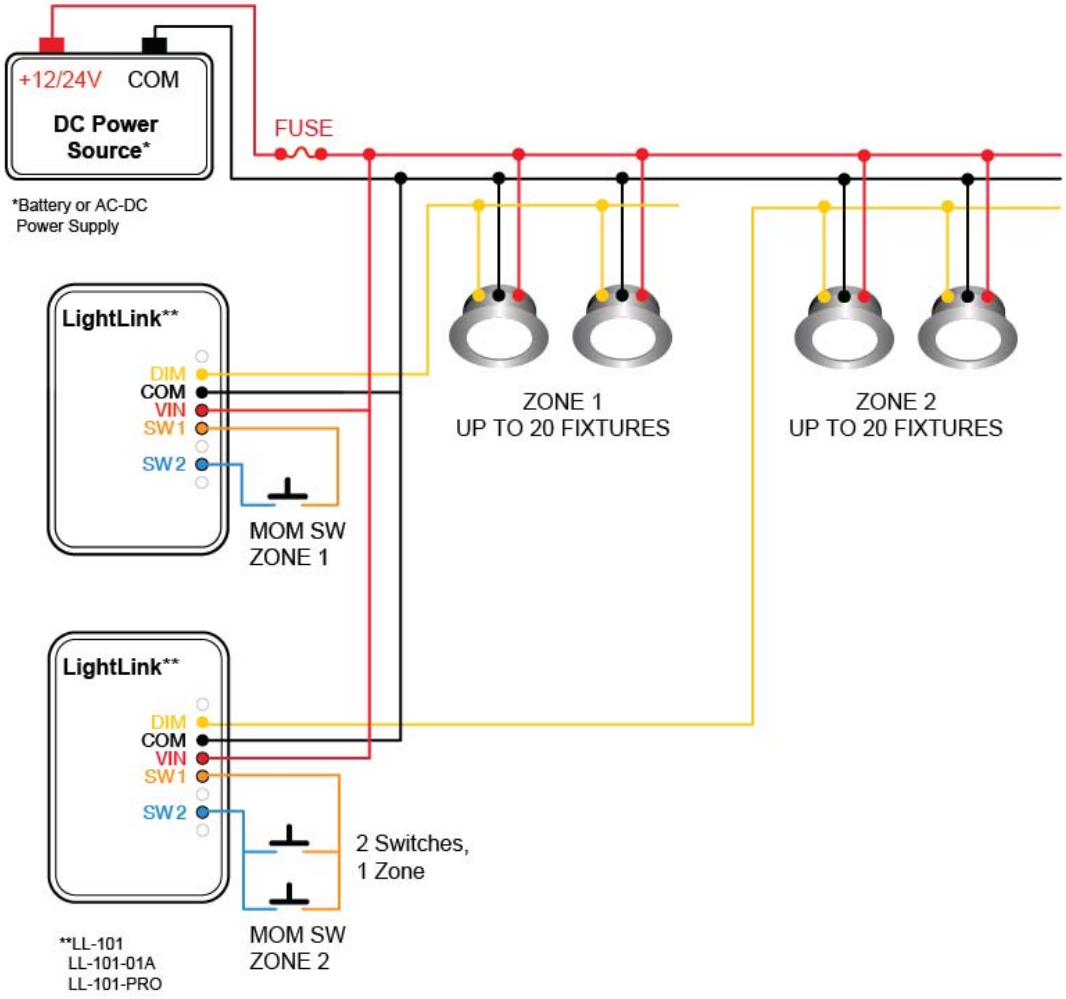
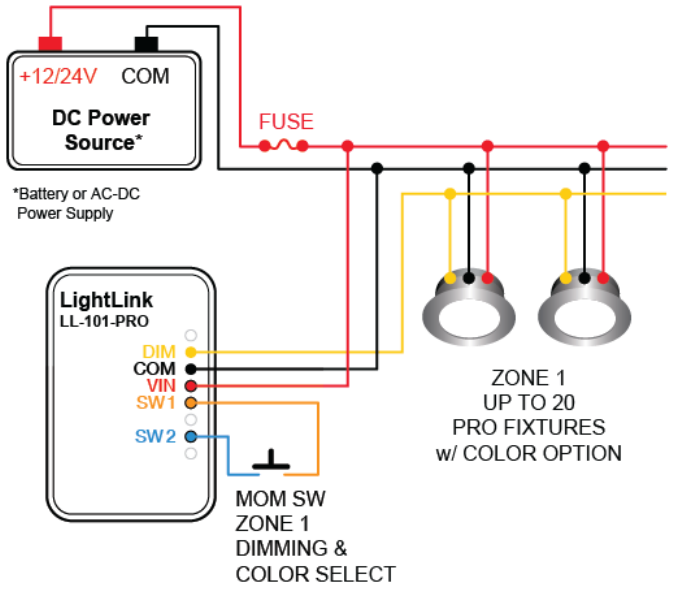
Wiring Example 1: Push-Button Switch Dimming in 2 Zones



Press and hold Momentary Switch to Dim. Single tap of the Momentary Switch turns lights on and off.

Note above the use of 2 Momentary Switches on Zone 2. This is optional and is shown to demonstrate wiring of 2 dimmer switches to control a single lighting zone.

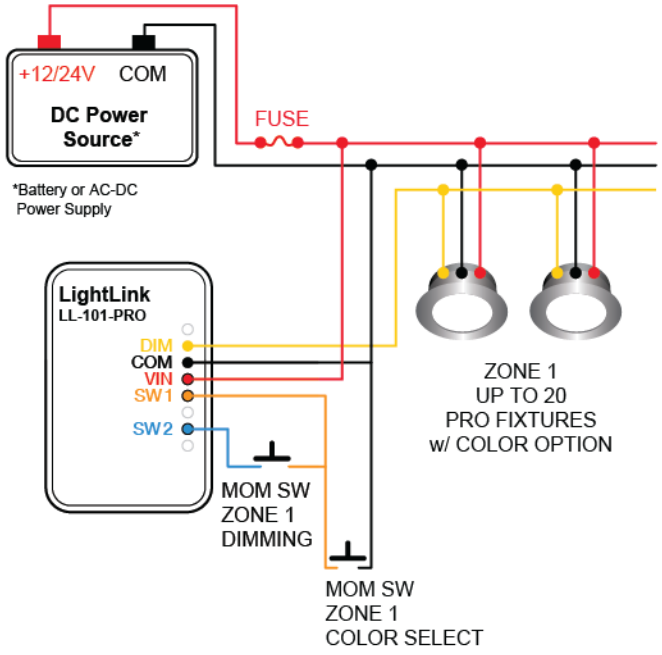
Wiring Example 2: Changing LED Color of PRO LED Marine/Transit Fixtures using 1 Switch.



Press and hold Momentary Switch to Dim. Single tap of the Momentary Switch turns lights on and off.

Double click the Dimming Switch to cycle through the colors; triple click to change to Red LED.

Wiring Example 3: Changing LED Color of PRO LED Marine/Transit Fixtures using 2 Switches



Press and hold Momentary Switch to Dim. Single tap of the Momentary Switch turns lights on and off.

To change LED colors, install as shown a 2nd Momentary Switch to cycle through colors via a single click. Colors cycle Color 1, 2, 3, 1, 2, 3, etc. The last used intensity level of each color is saved in the LightLink's memory, allowing intensity levels to be selected and saved for next use of a specific color.

3.0 Integrating with 3rd Party 0-10V Dimming Systems

Large Yachts often use Audio/Video (AV) systems and/or Dimming Systems such as those manufactured by Lutron, Crestron, Leviton, and Vantage, frequently found in residential and commercial installations. These systems offer the advantage of scene programming and control of additional peripherals, such as window shades. While each system is unique, most all companies in this field support 0-10 Volt (V) dimming control. 0-10V dimming as defined by IEC standard 60929 is widely used in commercial lighting.

A reference control voltage, 0-10V is simple to use and understand: ≥9V sets Fixture Intensity to 100%, ≤1V sets Fixture intensity to its lowest level (or in the case of our products ≤1V sets the Fixture off). Any voltage in-between sets an intensity level.

To use 0-10V with i2Systems Fixtures, use one of the following LightLink Controllers per dimming zone. An Installation Manual for each model is located at our website at www.i2systems.com/marine-LED

Model Comparison:

LL-105-R

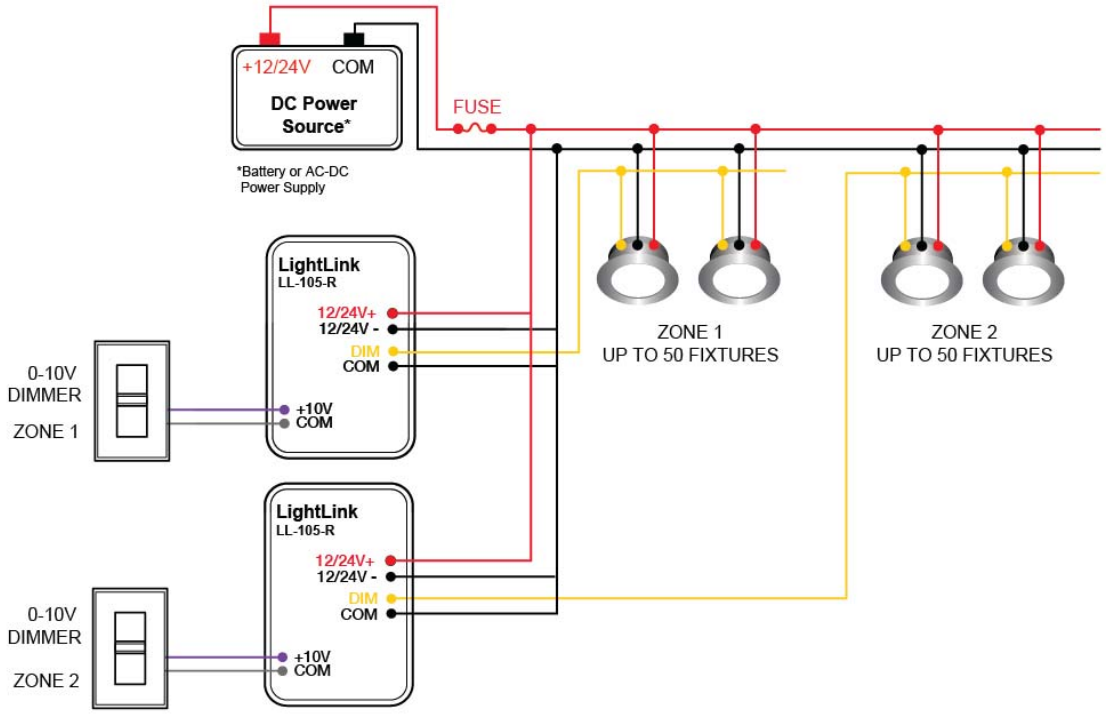
- Dims up to 50 i2Systems LED Marine/Transit Dimmable Fixtures, including PRO Fixtures.
- 12/24V DC input.

LL-205-10V

- Dims up to 50 i2Systems PRO LED Marine/Transit Fixtures.
- 120-277V AC input.
- Typically used on large yachts with 120-277V AC lighting circuits.

Both LightLink controllers listed above are engineered for 0-10V Sink or Source, in which case they are compatible with any IEC compliant 0-10V dimming. Keep in mind that color selection of PRO fixtures is not possible in this mode of operation; rather a LightLink LL-101-PRO Dimming Module is required as detailed in Section 2.0.

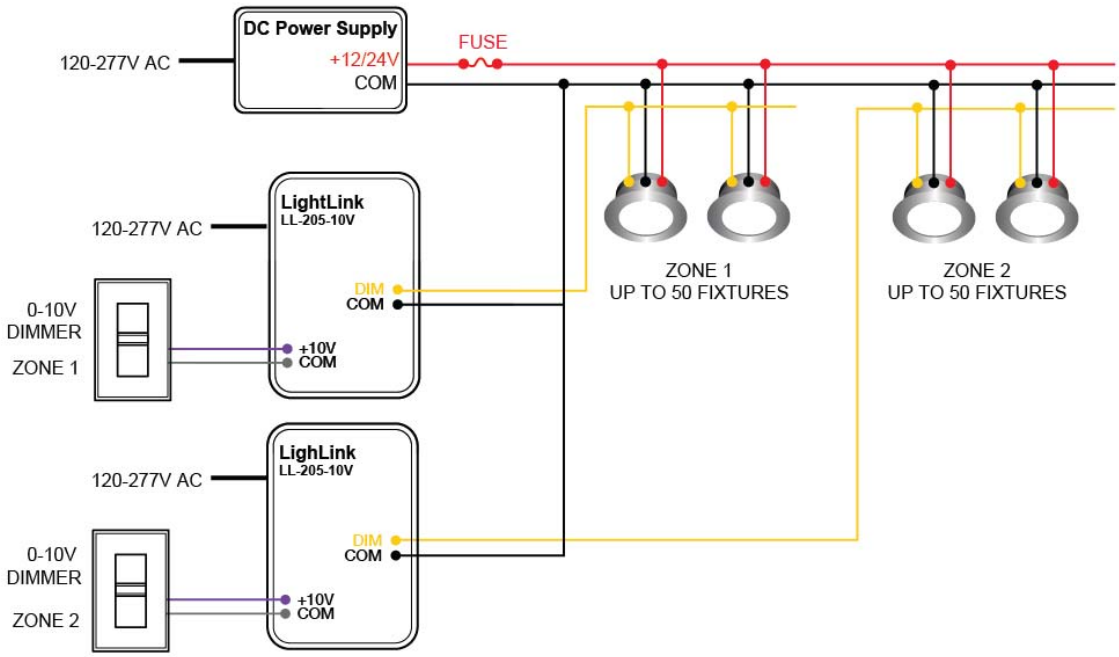
Wiring Example 4: 0-10V Dimming in 2 Zones,12/24V DC System



As shown above, a 3rd party dimmer / lighting panel provides 2 zones of lighting control to 2 LightLink LL-105-R Controllers.

Note that the LL-105-R controller offers multiple dimming inputs, including Momentary Switch dimming. Refer to the LightLink manual located at www.i2systems.com/marine-LED for additional information and wiring details.

Wiring Example 5: 0-10V Dimming in 2 Zones, 120-277V AC System



The above configuration is common for large yachts where all lighting circuits are powered via a 120/240/277V AC power source. i2Systems offers a wide range of DC Power Supplies that convert high voltage AC to 24V DC. Note in the above diagram how the LightLink LL-205-10V operates directly via 120-277V AC.

Refer to the LightLink manual located at www.i2systems.com/marine-LED for additional information and wiring details.

4.0 Integrating with 3rd Party Marine/Transit Multiplex Systems, including NMEA 2000

i2Systems LED Fixtures directly integrate with a 3rd Party Marine/Transit Multiplex System. These systems commonly use pulse-width modulation (PWM). PWM has been in use in the Marine/Transit industries for quite some time, initially being deployed for dimming incandescent and halogen fixtures. The concept is to pulse the 12/24V DC power to the fixture on and off at a rate outside of your eye's detection (i.e. 100 Hz) so that incandescent and halogen fixtures could be efficiently dimmed.

We have successfully integrated with the Systems below. They are directly compatible without the need of a LightLink Dimmer/Controller:

- Octoplex
- Spyder Controls
- E-Plex
- Capi2
- EmpirBus
- Vantage

This list is by no means exhaustive and the smart/flexible nature of our dimming technique allows integration to most any 3rd party PWM dimmer.

For operation, directly connect the Dimming Control Wire of any i2Systems Dimmable Marine/Transit LED Fixture listed as *Multiplex Compatible* to the 3rd party PWM Controller. Often these 3rd Party Controllers are engineered for dimming halogen lights at many Amps of current. While our typical installation requires ≤ 40 milliamps of current (being a logic-level signal and approx. 2mA per light), such dimmers work very well and we expect over time to see more logic level controllers coming available in the Marine/Transit industry as a means of further reducing the total cost of deployment.

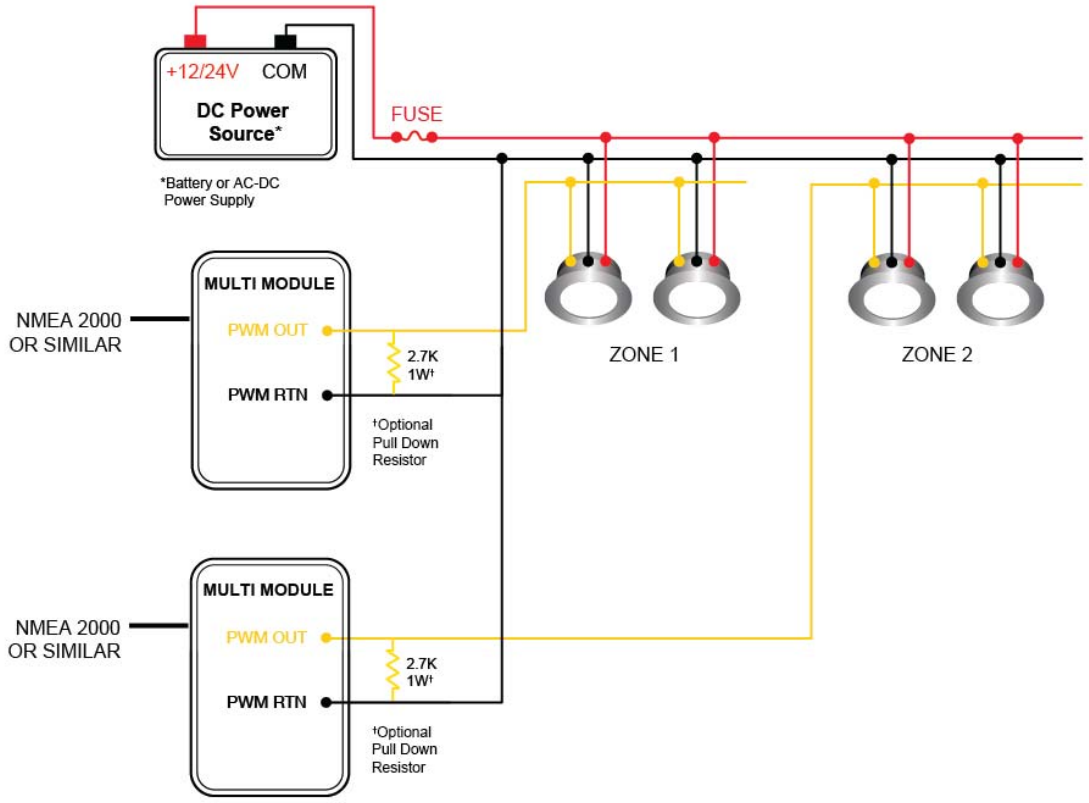
Multiplex Compatible Fixtures:

At the time of writing this document, i2Systems *Multiplex Compatible* products include:

- Apeiron PRO LED Down Lights (All Models)
- Apeiron A1110 LED Down Light
- Apeiron A2162 LED Down Light
- Apeiron A2163 LED Down Light
- Ember E1150/E2150 LED Step & Courtesy Light
- S-Line S1200 LED Linear Light
- V-Line V3280 Performance LED Linear Light
- V-Line V4290 Miniature LED Linear Light

If the i2Systems product you are interested in is not listed here, please contact us at +1.860.567.0708 or at support@i2systems.com. Chances are we will be able to provide a patch that will allow direct integration with your system.

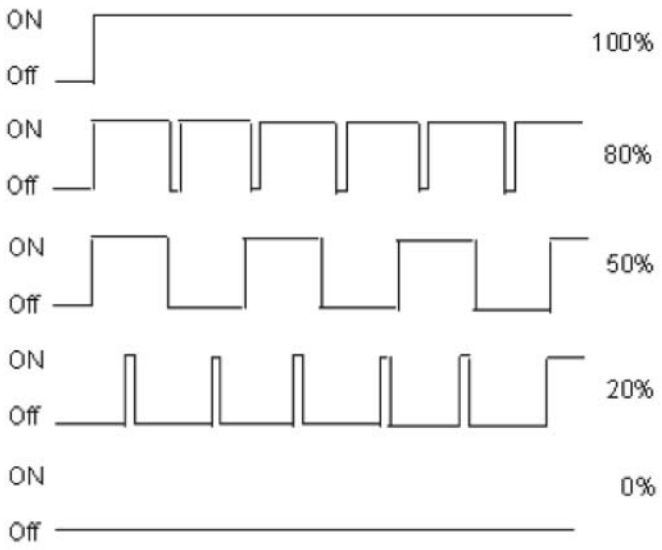
Wiring Example 6: 3rd Party Marine Multiplex System w/ NMEA 2000 Connection in 2 Zones



Two zones of dimming are shown above coming from a single 12/24V Power Source. Looking at Zone 1, the NMEA 2000 signal sets the lighting intensity level of the Multi Module (which in this case is a generic 3rd party controller for illustration). In turn, the Multi Module drives the PWM Output, adjusting duty cycle to change intensity. As many Multiplex type systems were originally designed for halogen lamps and do not drive the PWM Output Low (rather only High and Float), in this example we have added a Pull-Down Resistor. When the PWM Output is not driving the Dimming Control Wire, the Pull-Down Resistor pulls the Dimming Control Wire to Ground.

When the PWM Output drives the Dimming Control Wire High to DC Positive (i.e. 12/24V DC) or by allowing the Dimming Control Wire to Float (no connection), the LED Fixtures in Zone 1 turn ON to 100% intensity. When the PWM Output drives the Dimming Control Wire Low to DC Common (PWM Return), the LED Fixtures in Zone 1 turn OFF. The PWM signal must be a Square Wave at a fixed frequency and a maximum voltage of 30V DC. The Frequency range may range between 100 Hz and 300 Hz, with PRO models capable of 100 Hz to 1 kHz. For Duty Cycle examples, view Figure 1.

Figure 1: Square Wave Duty Cycle



It should be noted that the above figure is for reference only as a means of better understanding what duty cycle is and how our *Multiplex Compatible* LED Fixtures are able to interpret a 3rd party PWM signal from the 3rd party Multiplex controller. How our Fixtures interpret the PWM signal is not discussed in this document.

5.0 Additional Resources:

For additional information, visit our website at www.i2systems.com/marine-LED for:

- A complete Product listing
- Detailed Fixture spec sheets (with wiring diagrams)
- Manuals for all LightLink Dimmers/Controllers referenced in this Document
- Certified LM-79 Photometric / Lumen data

In addition, should you have any questions or would like a product demonstration, please feel free to use our Rep Finder online to locate your nearest Marine Representative or Reseller. Or contact us directly at:

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