NLED 16-Bit RGBW Lamp Controller

The NLED 16-Bit RGBW Lamp Controller is designed for small LED based mood lamps and color washes. It features a rotary encoder(dial) with a button for user control, adjust the sequence, speed, intensity, and manually select colors. The device is compatible with the NLED Aurora Control software, which allows the user to connect the device to a computer over USB and design custom color sequences that can be uploaded to the controller, for it to run by itself, without a computer. This controller features 4 channels of 16-bit PWM, which can create trillions of unique colors with completetly smooth fade transistions. The multiple channels allow for 4 different groups of LEDs to be controlled, such as RGB, RGB+White/UltraViolet, or multiple single colors. It offers the ability to control the outputs over USB, serial from an Arduino or similar, and DMX-512(model B) with selectable 8-bit and 16-bit reception modes.

Features:

- Small Size 1.9” x 1.5” x 0.5”(tall)
- USB Connectivity for control from a computer(emulated serial) or for uploading user color Sequences.
- 4 Output Channels, current sinking, for RGB, RGB+W, or RGB+U.V. or single color setups.
- 16-Bit PWM Resolution(65,535 Brightness levels per channel) with full reception and Stand-Alone support.
- High Current Sinking Outputs(LED Configuration as Common Anode, see pg. 6)
- Dynamic stand-alone Sequences, in full 16-bit, user customizable via the software and an USB Cable.
- NLED Aurora Control Software compatibility, connection via Mini USB.
  Create and Upload(save) Custom Stand-Alone Color Sequences to the Controller From a Computer.
- Firmware Upgradable, all future firmware revisions and updates will be freely available and easy to apply to the device using an USB cable via the Bootloader(see page 4)
- Serial Reception at a user selected baud rate. With RS-485 or TTL reception and 8-bit or 16-bit options.
- Both models support DMX-512 with various reception modes(pg. 5), including 16-bit reception, but only model B has the DMX(RS-485) hardware populated, but is still capable of receiving, pg. 3 for details.
- DMX Master Transmission(model B, see pg. 3) of stand-alone sequences, in 8-bit or 16-bit mode.
- User Selectable PWM Frequency and Resolution, from 16-bit at 244Hz to 8-bit at 62.5Khz
- Serviceable Design, in case of any damage caused by accidents, including a Full Warranty and Guarantee

Specification:

Input Voltage	**5v to 12v**
Logic Current Draw	**< 100mA**
Output	**4 Channels, Sink**
Max Current Per Output	**6 Amp**
Max Current Total	**15 Amp**
PWM Frequency	**Selectable, 244Hz to 62.6Khz**
PWM Resolution	**Up to 16-Bit (65,535 levels)**
Connectors	**Screw Terminals, 0.2”(5.08mm)**
Connector Spacing	**0.1“(Headers) 0.2”(Terminal)**
Main PCB Dimension	**1.9” x 1.5”**

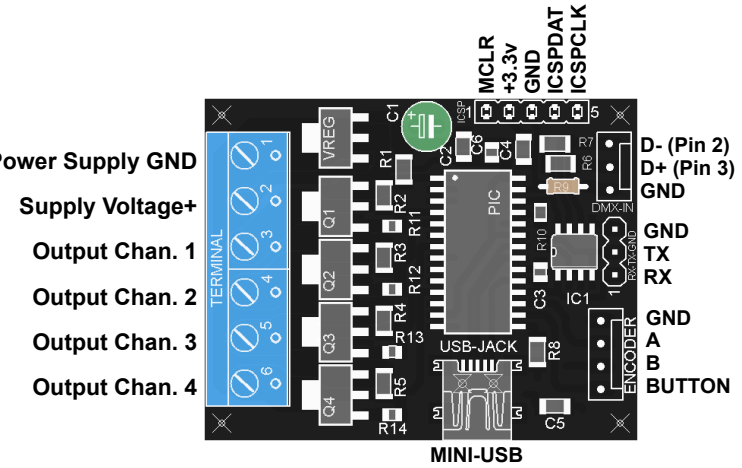


Fig. 1a

Rotary Encoder Usage

Action:	Description:
Short Press	Change Sequence Up
Press and Hold	Turn Off/Put to Sleep
Double Press	Enter Color Select Mode, See Description
Rotate CW	Adjust Overall Intensity Up
Rotate CCW	Adjust Overall Intensity Down
Rotate CW While Pressed	Adjust Sequence Speed Up, Not Saved
Rotate CCW While Pressed	Adjust Sequence Speed Down, Not Saved

CW = Clockwise, CCW = Counter Clockwise

Fig. 2a

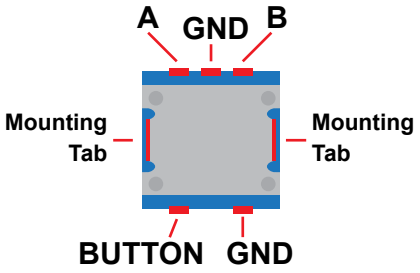


Fig. 2b - Encoder Viewed From Bottom

Note: Intensity adjustment is applied to the local output channels, it is not applied to DMX master transmission. After starting DMX reception(if enabled) the intensity value will be set to maximum, but after starting it can be used to adjust the intensity of the received DMX values.

Note: Double press timeout value is 600mS, not user adjustable, but can be by request, Contact for details.

Color Select Mode

Quickly pressing the button twice forces the device into Color Select mode. In Color Select mode the rotary encoder can be used to adjust the outputs to a chosen color. Upon entering the mode, rotating rotary encoder will alter the 1st channel(Red) value, pressing and releasing the button again will select the next color channel, and allow its value to altered using the encoder. Continue pressing to wrap back to chanel 1. Color Select mode and the selected values are saved to the device and will restore on power up if it was powered down in Color Select mode or the values will restore when the user re-enters Color Select mode.

Rotary encoder usage in Color Select Mode is as follows in Fig. 2c.

Action:	Description:
Short Press	Changes the selected channel to be altered.
Double Press	Exits Color Select Mode
Rotate CW	Alter the selected channel value upwards, Small.
Rotate CCW	Alter the selected channel value downwards, Small.
Rotate CW While Pressed	Alter the selected channel value upwards, Large.
Rotate CCW While Pressed	Alter the selected channel value downwards, Large.

CW = Clockwise, CCW = Counter Clockwise

Fig. 2c

User Settings and Configuration Saving

The device automatically saves any user settings adjusted using the encoder or button. When the device powers on it loads the previously saved settings so the device starts in the same state it was when it was turned off. After adjusting a setting, allow 3 seconds for the device to save before powering off or making more changes. Speed adjustments and Sleep mode do not get saved.

Serial Reception Usage

Serial reception can directly control the device's outputs using a common serial transmission device. Such as a standard COM port with level translation, an FTDI adapter, Arduino, PIC UART, wireless XBee, or similar. Data is recieved in packets of 4 bytes for 8-bit reception mode and 8 bytes, MSB first, for 16-bit mode. There is a maximum of 5mS between bytes and a minimum of 5mS between packets, to allow the data to latch. A delay between received data bytes of more than 5mS will reset the buffer pointer, framing the data. Partial packets will latch after the 5mS delay, or latching will occur immediately after receiving the last(4th or 8th) byte. 8-bit or 16-bit reception modes are selected through the configurations, which can be accessed through the software or through commands.

Serial reception can be enabled through the NLED Aurora Control Software. Upload an Index containing a Serial Reception icon, select it on the device via the button. Or on the Hardware Tab, select Auto-Detect Serial option to automatically enter Serial Reception when valid data is recieved, the device can take several packets to detect and validate the data before starting reception. The stock baud rate is 19,200, but the user can set the utilized baud rate using the software through the hardware Tab by selecting the desired baud rate from the drop down. The byte formatting is the standard 8-N-1(8-bits, no parity, 1 stop bit)

For Serial Reception on the model B devices, the RS-485 hardware must be configured. RS-485 is a differential transmission method, that DMX-512 utilizes. The user can select through the software to use the RS-485 hardware for Serial Reception(transmitting device must be RS-485 as well) on the DMXIN header or to disable usage and utilize the RX-TX-GND header for direct TTL (Low=0v, High=5v, 3.3v levels will work as well) control. Model A devices do not have the RS-485 hardware installed and will always use the RX-TX-GND header for serial reception.

Additonal details and graphics can be found at:

http://www.nledshop.com/downloads/manuals/nled-serial-reception-manual.pdf

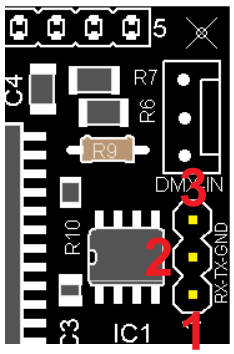


Fig. 3c

RX-TX-GND Header Connection

1 RX ⟵ TX
2 TX ⟶ RX
3 GND ⟷ GND

Fig. 3b

*Percentage of error is within usable limits. And won't affect usage.

ID#	Actual Device Baud	Closest Common Baud Rate	Error %
0	9,615	9,600	0.16%
1	19,230	19,200	0.16%
2	38,461	38,400	0.16%
3	57,142	57,600	0.64%
4	117,647	115,200	-0.79%
5	222,222	230,400	2.12%*
6	250,000		
7	444,444	460,800	-3.55%*
8	500,000		
9	1,000,000	921,600	8.51%

Fig. 3a

8-N-1

Firmware Updates Using The Bootloader

Visit www.NLEDshop.com/bootloader for downloads and additional documents.

This device includes a H.I.D. USB bootloader. It allows the firmware on the device to be updated usig a USB cable and a small computer program. To enter the device bootloader: with the device powered off, connect the device using a USB cable to a computer, start the supplied software that is compatible with your O.S., then hold the button down and then power up the device, continue to hold the button and the software will indicate that it is connected. Follow the instructions supplied with the software download to select the correct HEX file and upload it to the device. Once the new firmware is uploaded either hit the reset button in the software or power cycle the device. If it does not work, try again, if still doesn't work Contact Support.

Every microcontroller is sold with special code that prevents other devices from being programmed with the update firmware images. If a firmware image is loaded onto a microcontroller without the special protection code it will respond to commands and USB will work, but the Sequences will NOT run, but display static starting colors. Contact Us for help restoring your device to original condition if your microcontroller

The bootloader entry method is:
- With the device powered off, while holding down the button
- Power up the device.
- Wait a second or two.
- Open the bootloader software from www.NLEDshop.com/bootloader

Or the device can enter the bootloader mode via USB commands. Either from NLED Aurora Control, using the button on the upper right on the Hardware Tab. Or through USB commands.

Bootloader Compatibility Note

Devices sold before October 2017 are currently not compatible with the new version 2 firmware. The bootloader method has changed, and version 2 firmware can not be loaded onto those controllers.

How to Identify an Uncompatible Device:
1. The large IC on the controller says PIC24F32GB002
2. The controller PCB says v.1a
3. It was purchased before October 2017

How to Identify a Version 2 Compatible Device:
1. The large IC on the controller says PIC24F64GB002
2. The controller PCB says v.1b or higher
3. It was purchased after October 2017

It is an unforseen issue that older controllers are not compatible with the newer version 2 firmware. NLED is available to help you upgrade if you would like to use the new version 2 firmware on an uncompatible controller. Please contact Support@NLEDshop.com to get help upgrading your controller.

Model A & Model B

There is a model A and a model B of this device. The model A does not have the integrated circuits to transmit or recieve a standard RS-485 DMX signal. Although a DMX signal in TTL levels could be applied to the RX-TX-GND header. The model B does have all the DMX integerated circuits populated, and all DMX functions are fully usable. If you would like to upgrade your device to a model B, please contact us for details

Daisy Chaining Model A

Multiple model A devices can be chained together. They would function as if using DMX, but using TTL signal levels. All the RX pins on the RX-TX-GND header would be connected in parallel. One device on the chain would be setup up as the DMX Master(as normal) and that device's TX pin connected to the other device's RX pins(which are all in parallel)

Pulse Width Modulation(PWM) Modes

One of the main features of this device is the high resolution PWM outputs, that allow ultra smooth fading and color cycling. PWM isn't complicated. The PWM frequency is the number of times per second a PWM cycle occurs. Higher frequency produces less flicker and overall higher quality light. PWM cycle is a period of time where the output spends time being off and on, the on time vs the off time produces the light itensity levels. IE 100% on will make the LED as bright as possible, but 50/50 would produce light that is 50% the maximum brightness(simplified). PWM resolution is the amount of steps of on vs off time. A PWM resolution of 4-bits has 16 steps of light intensity including 0%/off. 8-bit resolution has 256 steps of 'intensity', and 16-bit has 65,535 steps of 'intensity'.

Available PWM Modes:
16 bit @ 244Hz
12 bit @ 3.9Khz
12 bit @ 478Hz
8 bit @ 62.5Khz
8 bit @ 976Hz

The PWM mode is a device configuration, see the later page for details.

Auto-Detect, DMX or Serial

One of the configuration options allows the device to detect valid serial data or DMX signal and automatically switch from stand-alone sequences to the selected data signal type. For DMX it will take a few packets of good data for the device to validate the signal and then switch over. Serial auto detection is similar, it must detect several packets of serial data at the correct baud rate for it to validate the signal and switchover from stand-alone sequneces. The configuration can be changed in NLED Aurora Control software or through NLED Aurora USB commands.

DMX Auto-Release

Another configuration option that indicates to the device to monitor the DMX packet timing. If a DMX packet is not received for 3 seconds the device will timeout and end DMX mode. It will then start playing stand-alone sequences, starting on the sequence that was last playing. If DMX was triggered through the index it will not leave DMX mode and will continue to wait. If this feature is disabled, once the device enters DMX mode, it will wait endlessly for packets. WIth it disabled the only way to end DMX mode is to manually change the color sequence using the buttons or commands.

Note: If using DMX Sequence Control mode, when the device releases DMX it will maintain the same sequence that it as playing, but will restore normal stand-alone usage.

DMX-512 Usage

The device supports multiple DMX-512 reception modes, a reception mode can be selected through the software and are detailed on pg. 5. It can also be a setup as a DMX Master device, which will broadcast a DMX universe when running stand-alone color sequences. The data transmitted will be the same the device is outputing to the *Output Channels*. So two or more devices could be daisy chanined together and would be synchronized.

DMX transmission from this device will not be fully compatible with the DMX-512 standard, due to voltage levels, so transmission may not be compatible with all devices. The DMX transceiver is 3.3v levels.

DMX Master Transmission Modes

When the device is running stand-alone color sequences it can be set to transmit its *Output Channel* value's over DMX. Which allows similar devices to recieve and synchronize with the transmitting device. The data sent varies depending on the sequence, but a Mono/Single sequence will transmit 4 values, RGB sequence will transmit 3 values, and RGBW sequence will transmit 4 values. If 16-bit master transmission is enabled each value would be 2 bytes MSB first, if its disabled, each value is a single byte.

Disabled No Master DMX Transmission, device receives normally. As Slave.

Full Transmits full DMX Universe when in Stand-Alone Mode, transmits the values, repeating, to all DMX channels. ex(1-3, 4-6, etc OR 1-4, 5-9, etc)

Partial Transmits a partial DMX Universe when in Stand-Alone mod. Repeats the values in order 16 times per DMX packet.

Through software 8-bit or 16-bit DMX master transmission can be selected. 16-bit mode transmits MSB first, then LSB. Not compatible with all DMX devices, check recieving device's specifications for details.

DMX Reception Modes

These are selectable through NLED Aurora Control software or through USB commands.

4 Channel Mode: Standard RGBW Usage(od1)

DMX Channel	Function	Value	Description
Channel 1	Red	0 - 255	Red Value, 0 is Off, 255 is Maximum
Channel 2	Green	0 - 255	Green Value, 0 is Off, 255 is Maximum
Channel 3	Blue	0 - 255	Blue Value, 0 is Off, 255 is Maximum
Channel 4	White/UV	0 - 255	Fourth Value, 0 is Off, 255 is Maximum

8 Channel, 16-bit Mode: 16-Bit RGBW(od2)

DMX Channel	Function	Value	Description
Channel 1	Red MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 1st value
Channel 2	Red LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 1st value
Channel 3	Green MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 2nd value
Channel 4	Green LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 2nd value
Channel 5	Blue MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 3rd value
Channel 6	Blue LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 3rd value
Channel 7	White/UV MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 4th value
Channel 8	White/UV LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 4th value

5 Channel Mode: RGBW Control with Intensity - RGBWA(od3)

DMX Channel	Function	Value	Description
Channel 1	Red	0 - 255	Red Value, 0 is Off, 255 is Maximum
Channel 2	Green	0 - 255	Green Value, 0 is Off, 255 is Maximum
Channel 3	Blue	0 - 255	Blue Value, 0 is Off, 255 is Maximum
Channel 4	White/UV	0 - 255	Fourth Value, 0 is Off, 255 is Maximum
Channel 5	Intensity/Alpha	0 - 255	Scales other channel's Intensity, 0 is 0%, 255 is 100%

10 Channel, 16-bit Mode: 16-Bit RGBW Control with Intensity(od4)

DMX Channel	Function	Value	Description
Channel 1	Red MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 1st value
Channel 2	Red LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 1st value
Channel 3	Green MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 2nd value
Channel 4	Green LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 2nd value
Channel 5	Blue MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 3rd value
Channel 6	Blue LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 3rd value
Channel 7	White/UV MSB	0 - 255	Most-Signifcant-Bits of the 16-bit 4th value
Channel 8	White/UV LSB	0 - 255	Least-Signifcant-Bits of the 16-bit 4th value

Need something different? Custom? Contact Support@NLEDshop.com for Help

3 Channel Mode: Basic Sequence Control(od5)

Channel	Function	Value	Description
1	Sequence #	0 - 32	0 Blanks the All Outputs, 1-32 maps to indexed sequences
2	Speed	0 - 255	0 is Pause, 1 - 255 is the speed used for sequence
3	Position/Fade	0 - 255	If Speed is greater than 1, usage is ignored. See Note 1.

7 Channel Mode: Sequence Control with 4 Channel 8-bit Control(od6)

Channel	Function	Value	Description
1	Sequence #	0 - 32	0 control using channels 4 - 33, 1-32 maps to sequences
2	Speed	0 - 255	0 is Pause, 1 - 255 is the speed used for sequence
3	Position/Fade	0 - 255	If Speed is greater than 1, usage is ignored. See Note 1.
4	Chan. 1	0 - 255	Output Channel 1
5	Chan. 2	0 - 255	Output Channel 2
6	Chan. 3	0 - 255	Output Channel 3
7	Chan. 4	0 - 255	Output Channel 4

11 Channel Mode: Sequence Control with 4 Channel 16-bit Control(od7)

Channel	Function	Value	Description
1	Sequence #	0 - 32	0 control using channels 4 - 33, 1-32 maps to sequences
2	Speed	0 - 255	0 is Pause, 1 - 255 is the speed used for sequence
3	Position/Fade	0 - 255	If Speed is greater than 1, usage is ignored. See Note 1.
4	Chan. 1 MSB	0 - 255	Output Channel 1 MSB
5	Chan. 1 LSB	0 - 255	Output Channel 1 LSB
6	Chan. 2 MSB	0 - 255	Output Channel 2 MSB
7	Chan. 2 LSB	0 - 255	Output Channel 2 LSB
8	Chan. 3 MSB	0 - 255	Output Channel 3 MSB
9	Chan. 3 LSB	0 - 255	Output Channel 3 LSB
10	Chan. 4 MSB	0 - 255	Output Channel 4 MSB
11	Chan. 4 LSB	0 - 255	Output Channel 4 LSB

Note 1: Position/Fade Control: If the Speed is 0, it allows the position of Instant Sequences to be set by the Positon value. As calculated: (Position / 255) x Amount of Data Frames. For Fade and Gradient Sequences, it allows the Sequence to run normally for Position value amount of times, which for 8-bit sequences, a value of 255 will run all output channels 1 frame. For Fades and Gradient sequences, the Positon value used is the difference between the previous Position value and the current Position value.

Device Configurations Settings

Since this device is not compatible with an external LED display or other method of user input the only way the configurations can be changed is through the software NLED Aurora Control. The configurations affect how the controller functions, what pixel chipset it expects, notification LED options and more. After connecting the device to the software these options can be found on the Hardware Config tab.

Serial Baud Rate: Sets the expected baud rate used for serial reception and serial communication. The controllers baud must match the baud rate of the transmitting device.

DMX Address: The starting address for DMX reception.

DMX Reception Mode: Options for DMX Reception modes(see pg. 3)

DMX Master Mode: Enables the controller to output a DMX-512 universe as a master transmitter. This allows the current stand-alone color sequence to be sent to other controllers, to either duplicate/mirror multiple of the same controller, even ones of different makes and models. 8-bit or 16-bit options available.

Auto-Detect Options: Options allow the device to detect and automatically switch from stand-alone to the selected control method(DMX or Serial)

Dual Mode Communication: Allows a TTL serial device, such as a FTDI, X-Bee, Arduino, or ESP8266 to interface and command the controller over the RX/TX/GND serial connection. Serial control reception, DMX reception, and DMX transmission are disabled. USB remains enabled, both modes can run concurrently.

Gamma Correction: Enables or disables the use of the internal gamma correction formula. User can not edit the formula, but special formulas can be implented by request. Contact for details.

Serial RS-485: For use with serial reception, DMX usage ignores. If enabled it will use the RS-485 transceiver and the data terminals D-, D+, & GND to collect standard 8-N-1 serial data at the user selected baud rate. If disabled the TTL(0v, 5v) serial header(RX,TX,GND) can be used for serial reception normally.

PWM Profile Resolution & Frequency: Selects what PWM resolution and frequency profile to use. There are 8-bit(256), 12-bit(4096), and 16-bit(65,535) options, the higher the resolution the smoother the transitions. All modes lower than 16-bit are down converted to achieve higher PWM frequency. Regardless of whether the color data is 8-bit or 16-bit color data(via stand-alone, DMX, or live control). Higher PWM frequency creates a higher quality light that is easier to photograph/record. Higher PWM frequencies may not be supported for long wire runs, certain LED configurations, and may create more EMI radation.

DMX Timeout Release: Sets the option to detect loss of DMX signal and returns to playing stand-alone color sequences. Option allows either to restore the color sequence it had been playing. Or to start plaing the Idle sequence once DMX signal is lost. Timer is set to 3 seconds, if a valid DMX packet is not received within that period, the controller will start playing color sequences.

Enable I.R. Remote Control(Addon Card): Enables the device to be able to interface with the NEC Infrared Decoder and Encoder Board. The addon board converts infrared remote signals into serial commands that are received by the controller. The addon boards are hardware set to either use 19200 baud or 250,000 baud. To enable usage you must select the correct baud value for your addon card.

Default Configurations: DMX Reception mode 1, Auto-detect DMX enable

LEDs Configuration Examples

The controller outputs are current sinking, meaing the cathode of the LED(s) or LED string is connected to the controller *Output Channels* and the anode(s) are connected directly to the positive supply voltage. Either using the *Supply Voltage+* terminal position or directly to the power supply.

Many configurations of LEDs can be controlled. Such as standard 12 volt LED strip or 12 volt RGB(W) LED strip(common anode), series/parallel or single high wattage LEDs (1w, 3w, 5w, 10w, 20w, +more up to max specification) or series/parallel or single 10mm, 5mm LEDs with a current limiting resistors. And multi color LEDs with common anodes.

A few configuration examples are shown below.

Need Help or Have Questions? Contact Support@NLEDshop.com For Help

Standard Loose LEDs

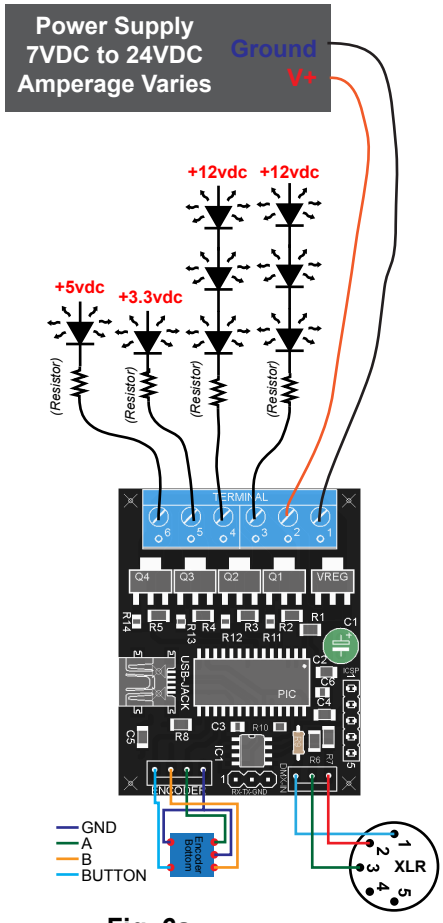


Fig. 6a

Common Anode RGB

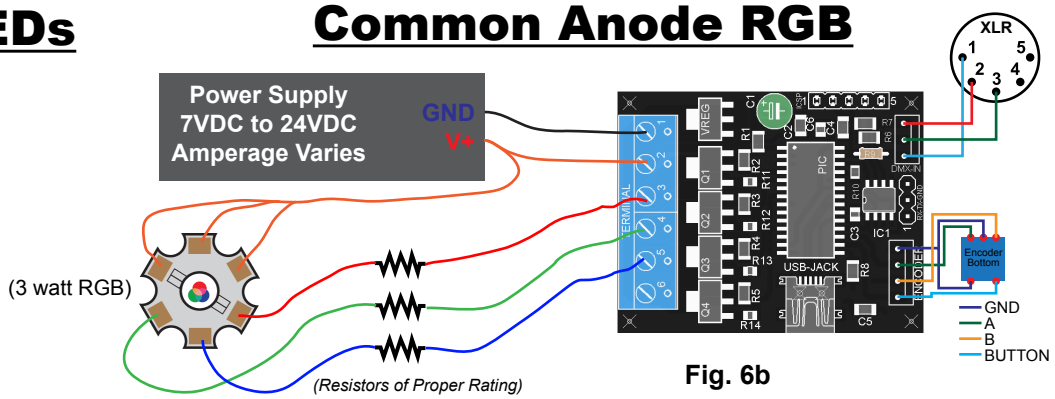


Fig. 6b

Strip LEDs Configuration

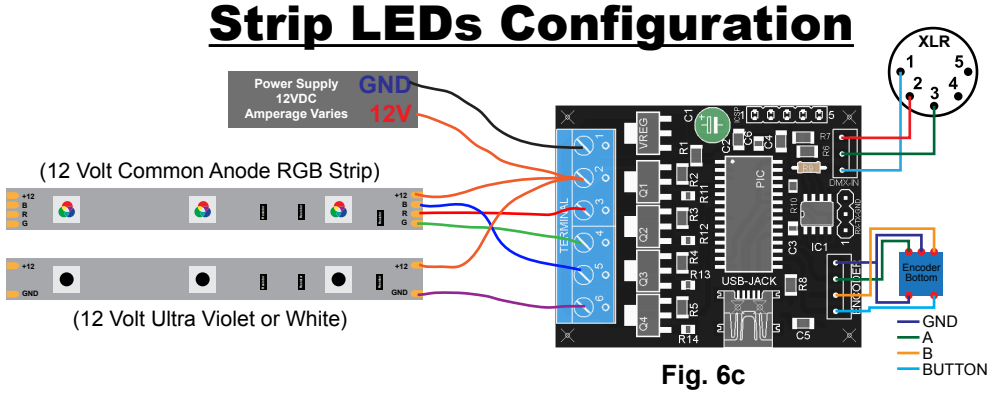


Fig. 6c

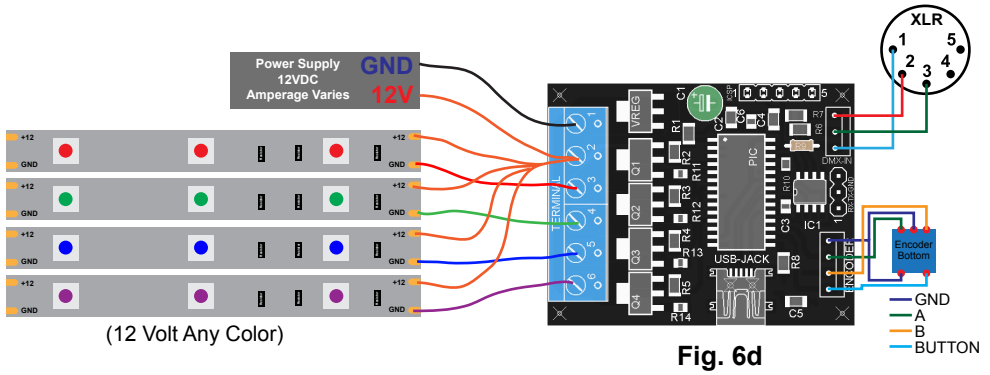
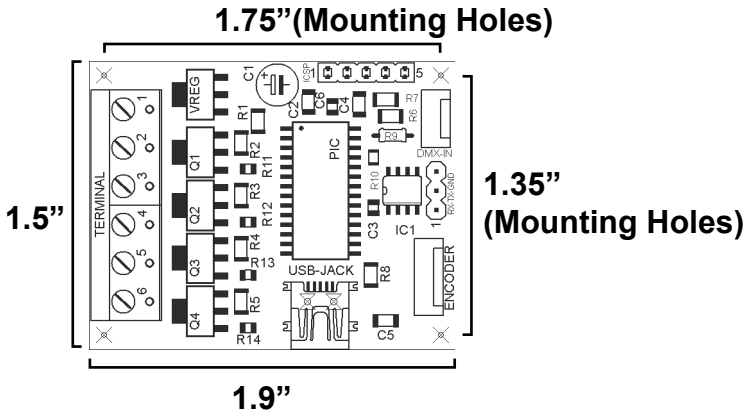
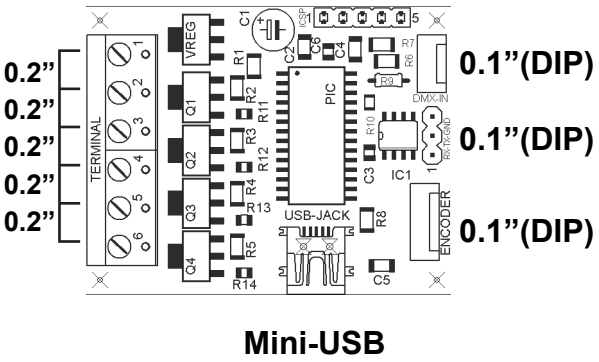


Fig. 6d

Dimensions





Common Issues and Troubleshooting

Please Contact Support@NLEDshop.com with any Questions, Comments, or Bug Reports.

Most issues can be resolved by power off the device, waiting a few seconds, and powering it back up.

Problem: Device with connected LEDs does not produce any light.
First ensure the LEDs are properly powered and wired to the controller and power source. Second ensure the intensity is set to maximum by rotating the encoder.

Problem: DMX-512 control is not working
Ensure you have the model B device that has the DMX circutiry installed. Model A devices do not have those installed and will not work, without some tweaks. Contact for details.

Problem: Device is not as bright as it should be.
Adjust the intensity value using the encoder, see page 2 for details.

Problem: Device appears to be “bricked”, unresponsive to user inputs and/or communication(USB etc)
Attempt to upload a new firmware image via the Bootloader, see page 4 for details.

Problem: USB connection is not being established.
Check to make sure the USB cable is plugged and seated correctly, then power up the device. Check for connection via NLED Control or your operating systems device manager, it should be listed as a COM port. All major operating systems should not require a driver. So the device should plug and play.