Animated LED lighting, LLC

A18804
Music to LED Shield

Features and Benefits

Vin Range: 7.6Vdc to 12.5Vdc supply

Four independent MOSFET Drivers

Four independent PWM dimming inputs set by microcontroller

Additional LED dimming options using a Resistor divider or a PWM signal applied to the ADIM1 pin of the A80804

Combine multiple shields together in parallel to increase the number of LED strings using a 5-pin connector.

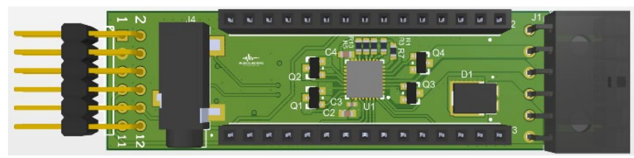
The A80804 LED driver provides extensive fault protections:
Drain short-to-ground protection
Drain short-to-VIN protection
Open LED detection
Thermal protection
Programmable input UVLO protection

Applications:

Drive RGBW LED strip lights synchronized to music or activated by various sensors

Drive individually addressable LED strip lights to music or sensors

Holiday lighting synced to music



Description:

The Music to LED Shield is designed around the Allegro MicroSystems A80804 linear LED driver and form fits the Arduino Nano family of microcontrollers.

The shield provides 12vdc power to the generic LED strip and uses Pulse Width Modulation (PWM) to regulate the current in the four independent output channels of the A80804 LED driver. The duty cycle of each PWM signal controls the brightness of each channel.

A 3.5mm headphone jack is used to connect the shield to an audio source. The audio signals are divided into 7 frequency bands using the MSI MSGEQ7 equalizer chip and the Arduino converts each band into PWM signals driving the inputs of each channel on the A80804.

A single shield can drive three simple RGBW 16.4ft LED strips connected in series for a total of 49.2ft of LED strips without the use of power injection. Multiple shields can be connected in

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parallel to increase the number of LED strips using a 5 pin connector located on the bottom of the board. The new P4804 Daisy Chain board was designed specifically for this purpose and through a 5-pin connector, multiple P4804 boards can be connected in parallel to the one A18804 music to LED shield. Connecting additional shields or daisy chain boards in parallel does not require additional Arduino Nano microcontrollers but does require additional power supply connections.

The shield is wired to utilize the remaining digital outputs of the Arduino for simultaneously driving four independent individually addressable LED light strips totaling 2000 individually addressable LEDs per Arduino. Connecting multiple Arduino/shield combinations is possible by using an audio splitter to drive the audio inputs of each shield combination separately or connecting the audio input of each shield combination to an antenna source such as an FM radio receiver.

Connecting individually addressable LED strips to the Arduino only requires one data wire for each strip, however, each strip requires separate power supply connections.
The number of individually addressable LEDs is limited by the internal memory of the Arduino and cannot be connected in parallel.

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Selection Guide

Part Number	Vsupply	# of RGBW LED strips	Ind. Addr. LEDs	# of Outputs	# of Sensor inputs	Comm.	Conn.
A18804	+12Vdc	3	2000	8	7	Rx/Tx	Plug

Absolute Maximum Ratings

Input Supply		Min	Typ	Max	Unit
Operating input voltage	Raw shield	7.6	12	14	V
Isupply	Raw shield	7.51	9.2	10.0	mA
Isupply	Complete shield	9	208	1000	mA

Terminal Diagrams

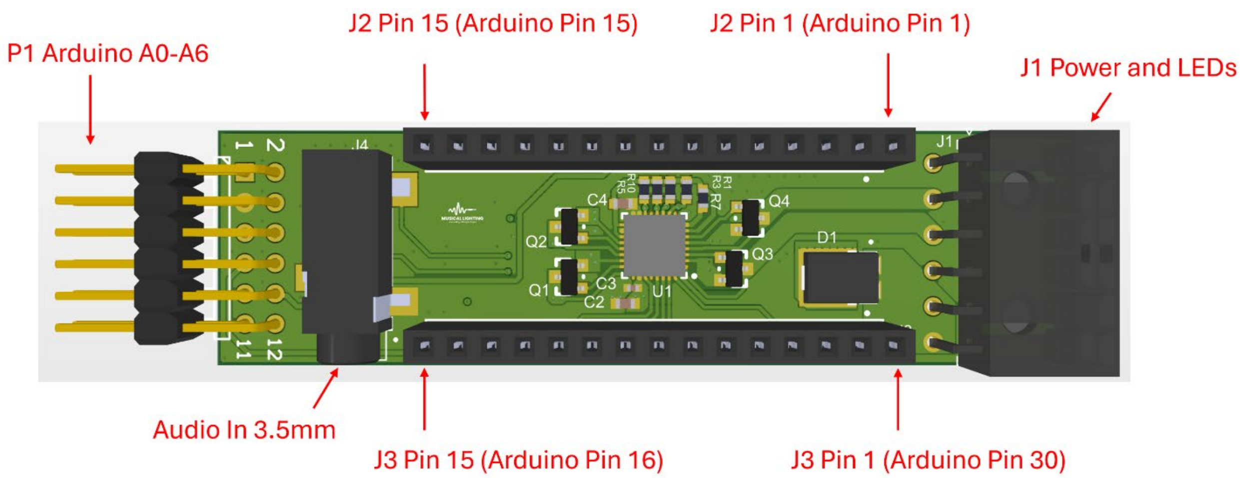

Figure 2, Connectors of the A18804 Shield

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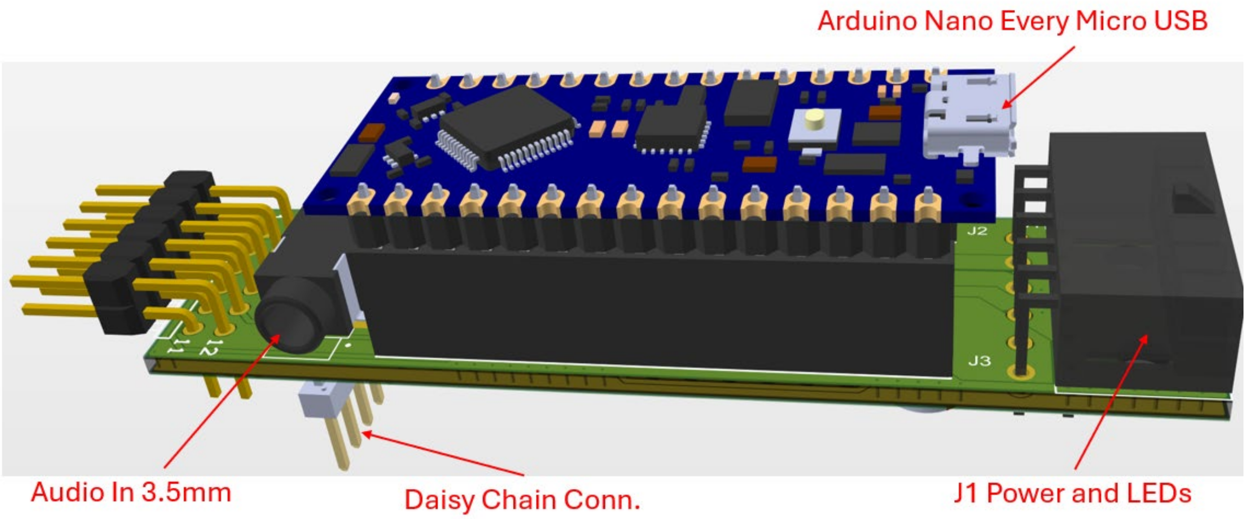

Figure 3, Arduino Nano Every Micro USB Connector

Functional Block Diagram

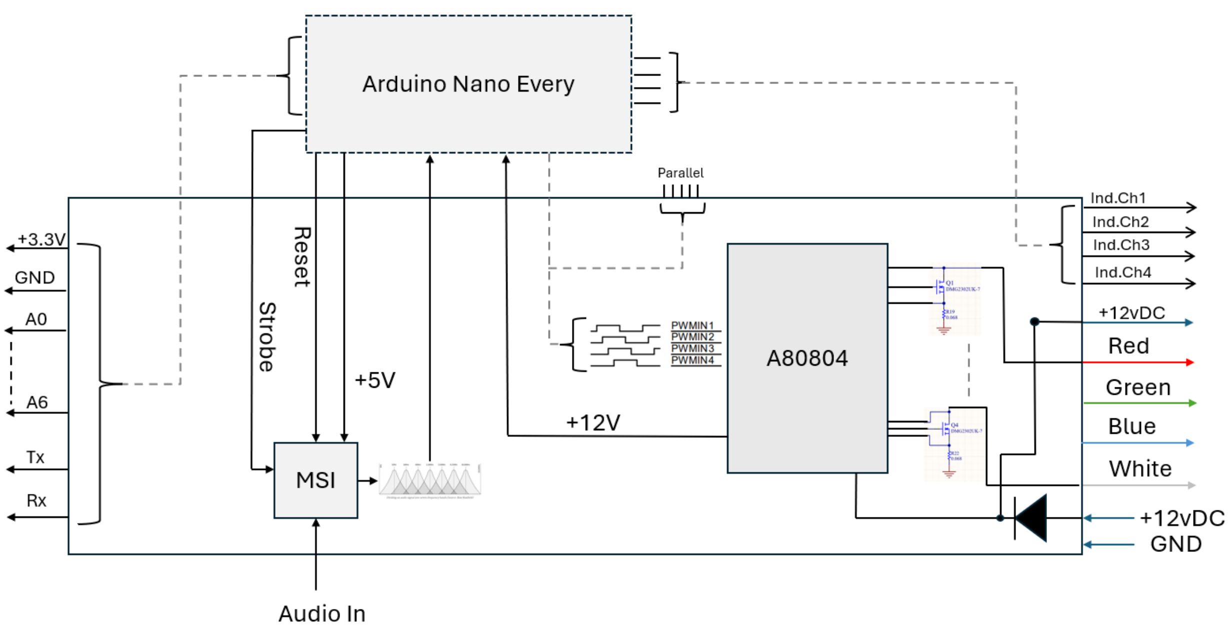

Figure 4, Functional Block Diagram

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Electrical Characteristics

Input Supply		Min	Typ	Max	Unit
Operating input voltage	(Voltage applied to pins 12 and 6 of J1)	8.5	12	12.5	V
Supply Current	Isupply A18804	7.5	8.2	8.5	mA
With Arduino	Full module (no LEDs)	8.9	9.5	9.6	mA
With RGBW(3)		9	500	1000	mA
Channel Current					
Vref	Rsense voltage per channel	196	200	206	mV
Ireg	Peak current per channel	2.62	2.97	3.06	A
PWMpins					
PWMrise/fall times	Between 10%-90%	-	20	-	us
PWMx	Vil	0.8	-	1.1	V
PWMx	ViH	1.5	-	2	V
Propagation delay	Tpde	-	2	-	Us
PWM Frequency	Freq.	200	-	1000	Hz
PWM duty cycle	Duty	5	-	100	%

Functional Description

The A18804 receives audio input through a 3.5mm headphone jack. The MSGEQ7 audio chip divides these audio signals into seven bands, 63Hz, 160Hz, 400Hz, 1kHz, 2.5kHz, 6.25kHz and 16kHz, see Figure 5.

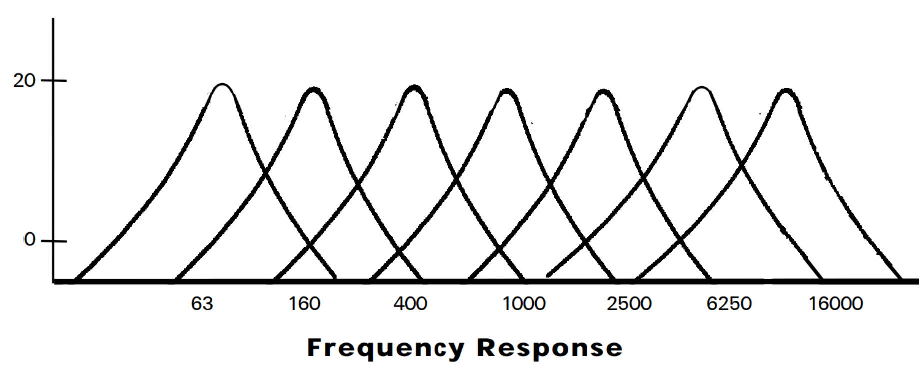

Figure 5, Frequency Bands of the MSGEQ7

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The seven frequencies are peak detected and multiplexed to the output providing a DC representation of the amplitude in each band. The multiplexor is controlled by the reset and strobe signals derived from the Arduino Nano Every microcontroller. The MSGEQ7 chip gets its power from the +5V pin on the Arduino Nano Every microcontroller.

The Arduino Nano Every measures the peak values detected by the MSI chip on pin A7 using a 10 bit digital to analog converter. The values range from 0 to 1023, with the lowest value of 0 and the max value of 1023. Through software, these values are then scaled to match the PWM scale of the Arduino which is 0 to 255, then stored in an array. The values in the array are then sent out to the Arduino Nano Every PWM pins as a clock pulse of 976Hz with a duty cycle equal to the value in the array. The duty cycle of the PWM outputs range from 0 to 255, where a value of 0 equals a 0% duty cycle and a 255 equals a 100% duty cycle. The PWM value corresponds to the amplitude in each of the seven bins detected by the MSI chip and therefore will vary in PWM value from 0% to 100% according to the peak value at the time of the reading in each frequency band.

The A80804 LED driver receives the PWM signals from the Arduino on four input channels and thereby controls the individual output channel brightness level based on the PWM value. A PWM value of 0% will completely turn off the subsequent channel and a value of 100% will turn on the channel at full brightness. Any values in between 0% and 100% will vary the brightness level of the particular channel. With four channels on the output of the A80804, the individual colors of red, green, blue and white can be manipulated to produce only the color desired or combined in varying intensity levels to create any color in the RGB color wheel.

The A18804 is designed as an Arduino Nano Every shield, with complete pin to pin compatibility through 15 pin headers J2 and J3. The shield is pin to pin compatible with all the Arduino Nano family. **NOTE: Not all Arduino Nano products can handle +12Vdc. Confirm the input voltage maximum specifications match before plugging in a Nano.**

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Other microcontrollers can be used by using jumper wires from that microcontroller to correct pins of J2 and J3. The MSGEQ7 chip gets power from the +5v output pin of the Arduino and will need a separate power source if the Arduino is not inserted into J2 and J3.

The shield is designed around the Allegro MicroSystems A80804 LED driver with four channel linear current regulators for LED applications. Please see the Allegro MicroSystems A80804 datasheet for more detailed information on this product.

LED Current Sense Resistor

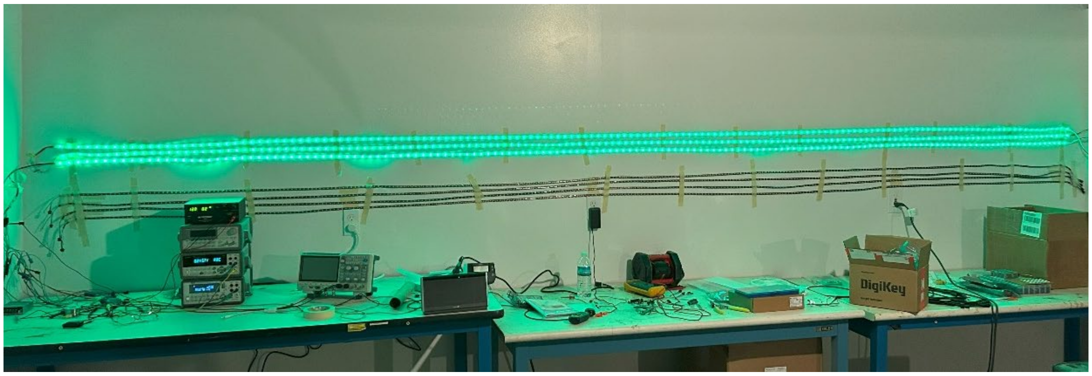
Sense resistors on each channel set the LED peak current and have been set to a value of 68mohms. Using the equation in the A80804 datasheet, Iledpk is equal to Vsense/Rsense.

Equation 1:

$$I_{LEDpeak} = V_{SENSE} / R_{SENSE}$$

The value of Vsense is set at 200mv and therefore divided by 68mohms, the current is set at a max peak value of 2.94 amps. **Do NOT exceed this limit or it may cause a fire. Observe all manufacturers' specifications for your particular model of LED strips.**

The average current in each individual channel is much less than the peak current in each channel. With a PWM signal, the ON time of each channel compared to the OFF time results in an average current during each cycle of the PWM frequency (976Hz). The average current for each channel as measured through an ammeter is shown in the graphs below. Using a PWM signal results in less power needed to run LED lighting, and making the LED light strip more energy efficient. The A18804 can successfully run 49.4 feet of generic LED RGBW strips without the need for power injection.



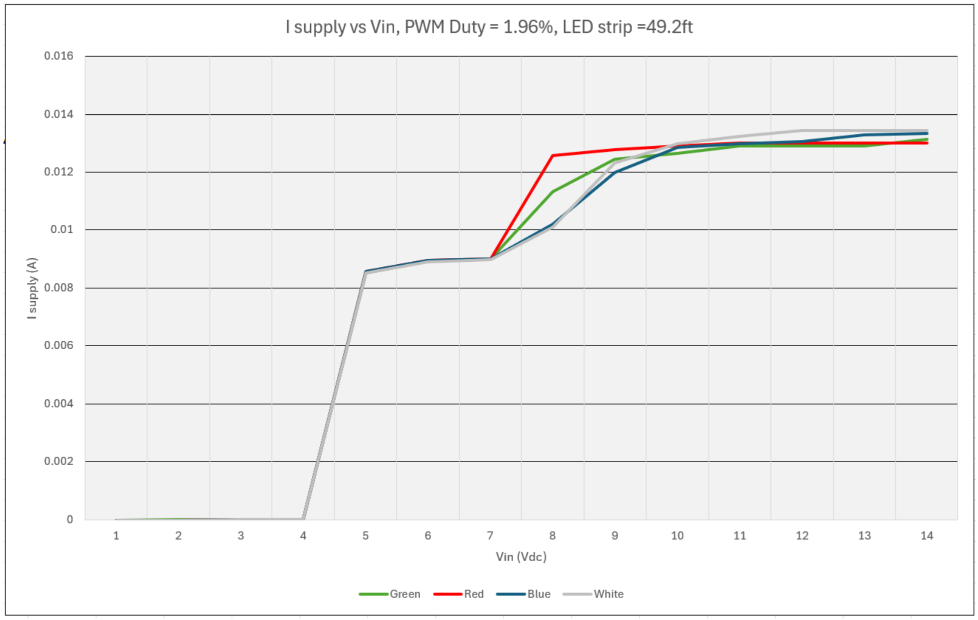


Figure 6, Total supply current when running only RGBW LED strips per channel

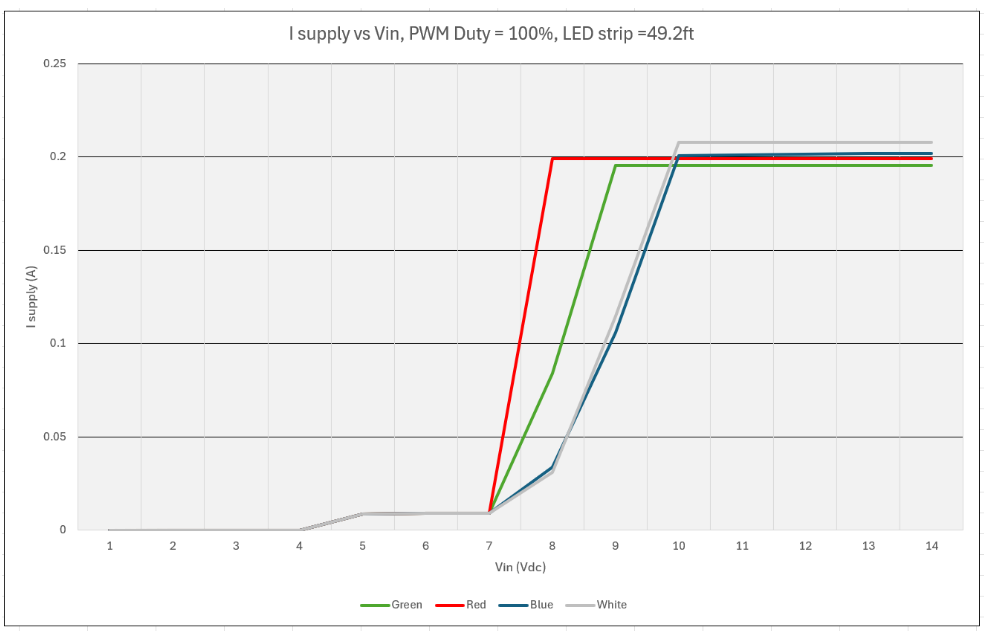


Figure 7, Total supply current when running only RGBW LED strips per channel

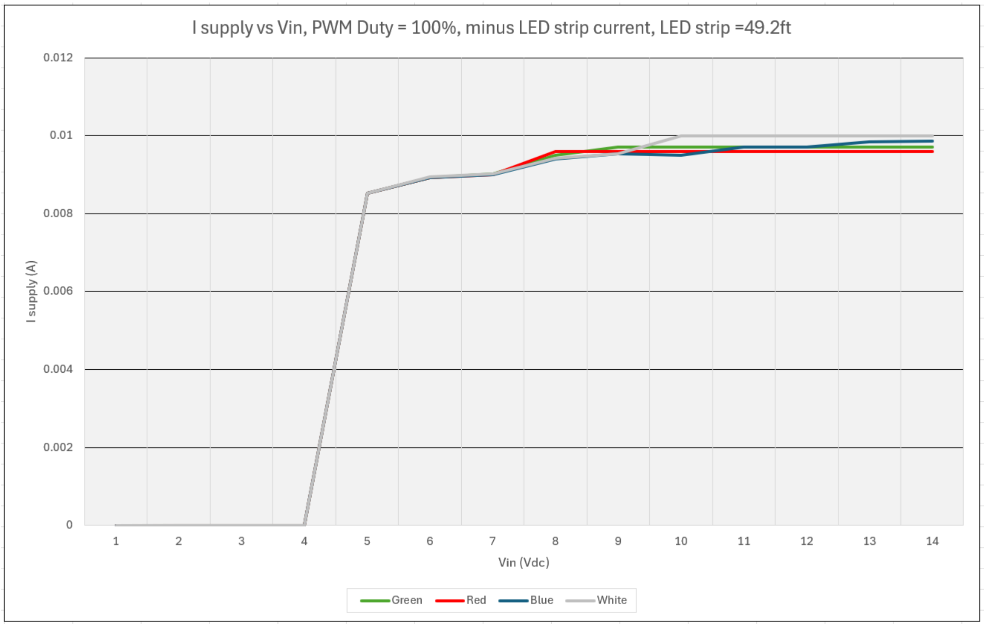


Figure 8, Total supply current of a fully assemble shield, minus LED Strips

PWM Pins

The PWM pins on the A80804 are logic-level pins and a logic high will turn on the output MOSFET to allow current to flow in each channel.

The Arduino Nano provides Pulse Width Modulation (PWM) signals to the four PWMx pins of the A80804 to individually control each color strand of the generic RGBW LED strips. The PWM signals control the current passing through each string by increasing or decreasing the duty cycle. The duty cycle range is from 0-100% and controlled through software with a digital range setting of 0 to 255. The A80804 uses four external MOSFETs to handle power dissipation in each of the RGBW strings for the LED strip lights. The current in each channel is then regulated by sensing the voltage across the current sense resistors R19-R22. The maximum current per channel is set by the value of the sense resistor and can be changed for each individual channel. The sense resistor was set for the current limits of the recommended LED strips used during testing. The recommended LED strip part numbers are located at the end of this document. Other LED strips can be used but at the time of this publication, none have been tested. It is advised to read all of the manufacture's specifications for each particular LED strip and ensure safe operation by staying within the maximum limits per channel.

Analog Dimming with ADIM1

Further dimming of the LED strip can be achieved by applying a voltage on the ADIM1 pin to derate the peak LED current. This may be done for binning or other application requirements. In the A18804, a resistor divider created by R10 and R11 set the dimming at 64%. This value can be changed by changing the resistor divider R10 & R11, see the A80804 datasheet for further information.

Protection Faults

The A80804 asserts a fault by pulling the nFAULT pin low when a fault has been detected for three consecutive PWM cycles. The device returns to normal operation immediately after the fault is removed.

Any faulted LED string will operate at a 5% duty cycle during the PWM on-time to minimize power dissipation in the MOSFETs.

When a fault occurs on one channel, the remaining channels will continue to operate normally. Only the faulted string will reduce the duty cycle to 5% until the fault has been cleared.

Typical fault conditions detected by the A80804 are Open LED, Drain short to ground and Drain short to Vin.

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Stand Alone Application

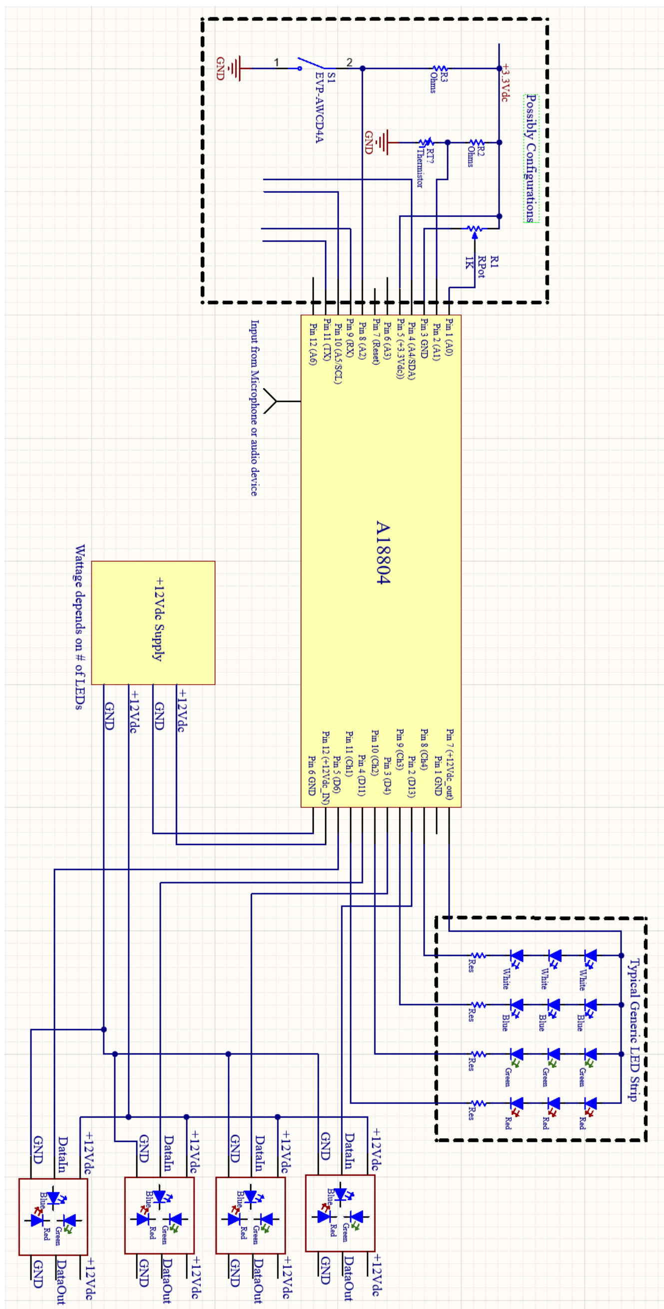

Figure 9, Typical applications

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Typical applications for generic LED strips consist of 3 LEDs in series with a current limiting resistor. The remainder of the strip is duplications of this configuration in parallel across the entire length of the strip.

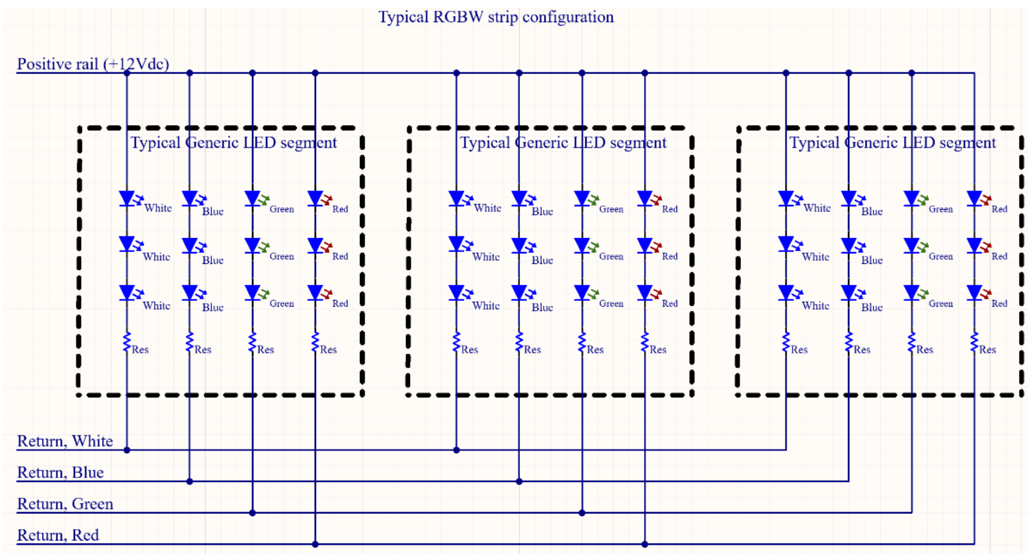

Figure 10, Typical RGBW LED Strip Manufacturing Schematic

Typical configurations of individually addressable LEDs consist of all LEDs connected in parallel to the power and ground pins, the data lines are connected in series from one LED to another across the entire length of the strip. NOTE: Data only flows in one direction, manufacturers place an identifying mark on the strip indicating which direction data will flow. Pay attention to these markings when connecting multiple strips together and when connecting to the A18804. The recommended product used for our testing is the: WS2815 DC12V LED Pixels Strip Light Dual-Signal 5M 60LEDs/M, IP65 Waterproof, White PCB

Part Number**: STW-E40K80-A6C-12B5M-12V**

These products are available from SuperbrightLEDs.com

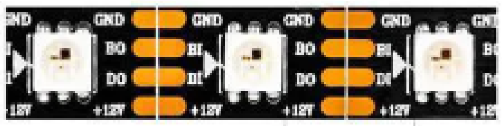

Figure 11, Typical Individually Addressable LED Strip Manufacturing Connections

A +12V DC power supply is needed to power the A18804 and can power the generic LED light strips directly through the A18804 shield.

The individually addressable LEDs require more power than is allowed to pass through the A18804 PCB, as a result, the power connections for the individually addressable LEDs should be connect directly to the power supply through an inline fuse for safety. Calculate the inline fuse value based on the manufacturers data sheet for maximum current specifications. *(At the time of this publication, a new product is in design to handle the additional current carrying capacity of the individually addressable LED strips)*

At the time of this publication, we have not identified a particular manufacturer's power supply we can recommend. The initial power supply used for testing has been discontinued. This publication will be updated when a new power supply has been confirmed. A typical supply to run the A18804 and the generic RGBW LED strips would require a +12Vdc output and a current capability of at least 4 amps (48W).

Daisy Chain Application

In the possible configuration section of Figure 6, the additional analog inputs to the Arduino Nano Every have been broken out to a header for easy access. This allows for the possibility of user inputs connected directly to the Arduino for enhanced user interaction with the A18804. Some possibilities are potentiometers for brightness or scaling factors to be controlled on the fly. Other possibilities are thermistors for temperature controls. Switches can be added for possible configuration settings. The possibilities are endless with the analog inputs A0 through A6 connected directly to the header of J5. Additionally, the +3Vdc power and ground terminals are located in the header J5, as well as the TX/RX pins for serial communications. For I2C communications, A4 and A5 can be configured in the software.

A 3.5mm audio headphone jack is located on the side of the A18804 for audio input. Typical Christmas light displays use an FM transmitter so families can hear the music in their car on the FM radio. Connecting one end of a headphone extension cable into an FM radio and the other into the A18804 is one way of getting audio into your display. This is fine for Christmas/Holiday lights, but if you're doing a Halloween display, you may want your sound to be heard as guests walk up to your home. In this case, an additional "Y" or splitter cable to another speaker may be necessary, or a the use of an additional FM radio will work. (The Arduino Nano Family of boards has a Bluetooth model which has not yet been tested at the time of this documents printing. We will be looking into this option soon.

Subscribe to our youtube channel for future videos.

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Package Outline Drawing

Package dimensions are for reference only, slight variations in size may occur.

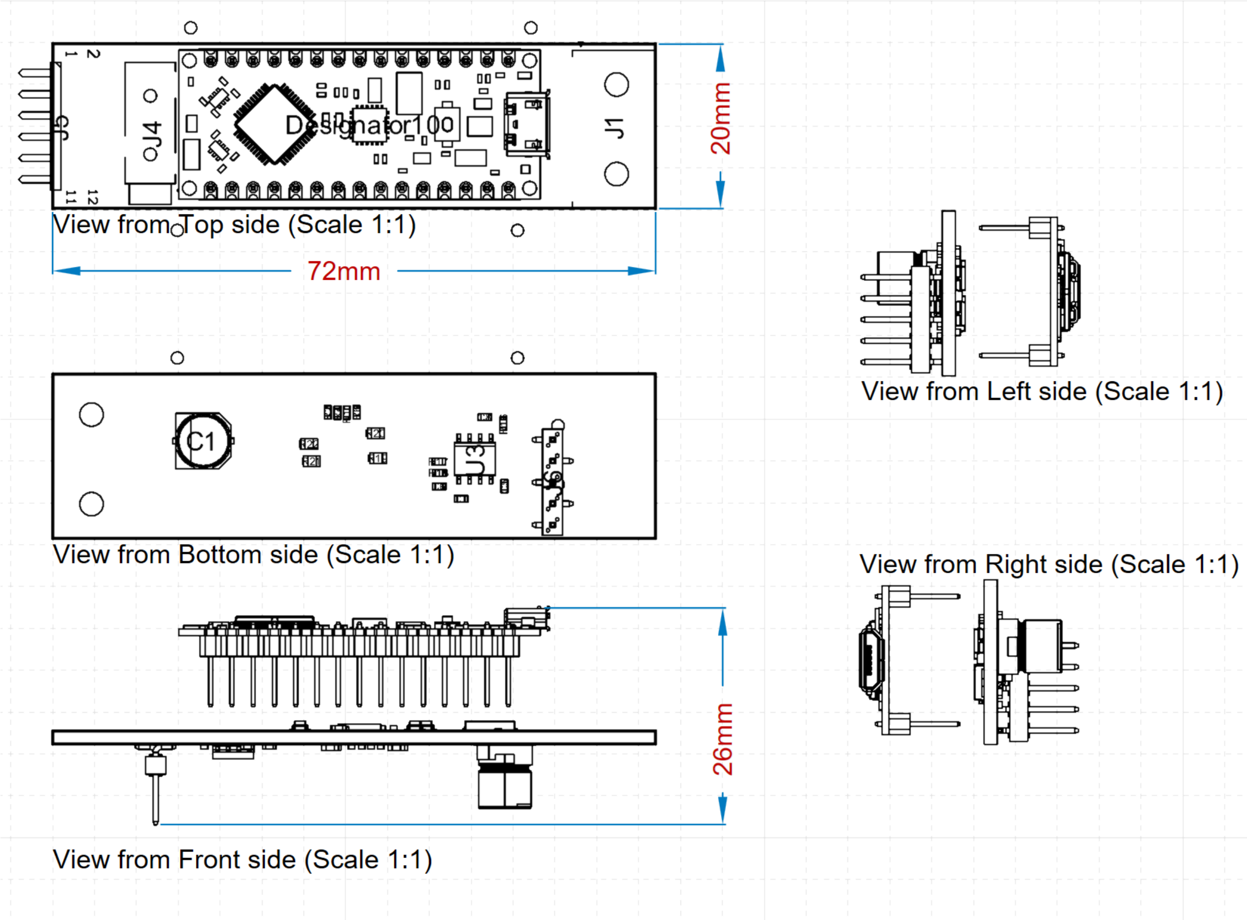

Figure 12, Package outline and Mechanical Views with Arduino installed

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Revision History

Number	Date	Description
0	May 31, 2024	Initial Release