Induced Noise with RGB LEDs

If you are using a RGB LED controller or any external device that changes color **or** brightness, you may have a noise issue, depending on the way the controller changes the LED color or intensity.

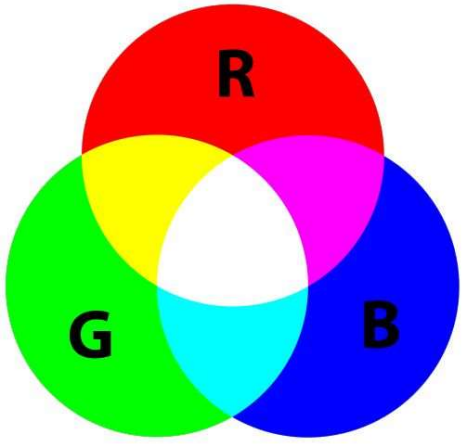
If you are wanting to use single color LED lights without any additional controller in your application, you should not have any noise issues; this is because you will be powering the LEDs with a constant DC voltage source, which does not create electromagnetic interference (EMI).

To understand why a controller is needed to change LED colors, we must know how LEDs produce colors…

The three most common colors of LEDs (red, green, and blue) can be used independently for a solid color, or they can be combined to produce almost any color desired.

Examples: red and green combined produce yellow, blue and red produce violet, yellow and blue produce green,

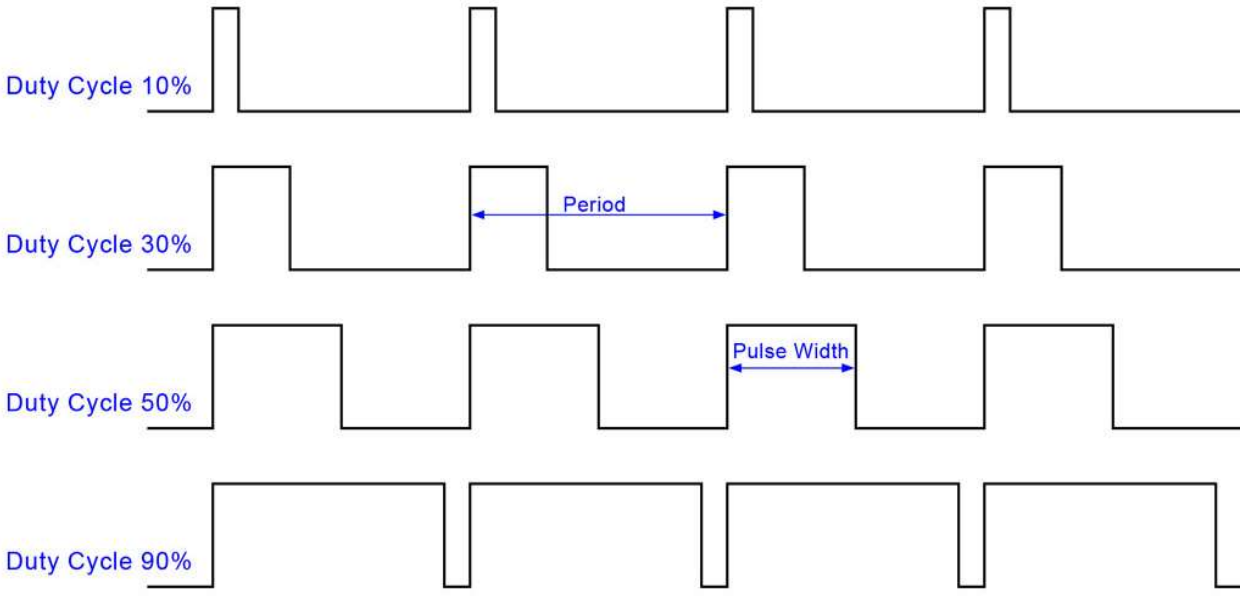
If you combine all three at equal brightness you will get white.



To obtain various colors of LED light (other than the 3 standard LED colors), you will need to combine 2 or 3 of the LED colors and/or vary the brightness of any of the three standard LED colors. With the 3 common standard LED colors you can produce a diverse spectrum of visible light.

There are two ways to change brightness of LEDs. One method to control the brightness of LEDs is to change the current supplied to the LEDs by changing the resistance. This is by far the simplest, but it has limitations. LEDs require a minimum voltage (1.7 to 3.3 volts) to illuminate and have a maximum current draw (typically 20mA) before failure. This will limit the range of colors and the brightness that can be achieved but will not induce noise into an audio system. DC current has almost no radiated magnetic fields that become noise, even when the LED wires are in close of proximity to signal wires.

The other method used to change brightness or color of RGB LEDs is by pulse width modulation (PWM). This "pulses" the LED on and off at variable durations at a constant voltage. Duty cycle refers to length of "on" pulse vs. the "off" period.



This pulse rate at which the LEDs are turned on and off is so fast that our eyes cannot detect the LEDs turning on and off. They will appear not to be as bright at lower duty cycles and brighter at higher duty cycles. By applying this technique to the three different primary color LEDs, you can achieve a huge range of colors and brightness for desired results. If the manufacturer does not indicate what method of changing LED colors is, you will have to use an oscilloscope to test the output to see if they are using PWM.

The bad news…switching DC voltage on and off causes a pulsing magnetic field around the wires that are carrying the voltage to the LED. When this pulsing magnetic field passes through nearby signal wires, it will induce a small amount of voltage into the wire. Car audio amplifiers can interpret that voltage as part of the incoming audio signal and amplify this unwanted pulsing voltage together with the musical signal from your source. We will hear it as "noise".

Solutions and precautions:

If you are using a RGB LED controller that changes colors using PWM, you will need to do the following:

1. Make sure your source unit is wired directly to the battery and not through the main harness of the vehicle.

2. Always use twisted pair RCA cables for the best possible noise rejection.

3. Use amplifiers (such as all Kicker amplifiers) that do not use single ended inputs, where the shield of the RCA is grounded to chassis ground.

4. Always use the highest signal voltage available (such as speaker level) when sending audio signals to an amplifier. Kicker amplifiers are equipped with **F.I.T. technology,** that allows a 10-to-40-volt signal input capability (see this link for more information).

5. Ensure the LED wires are run as far as possible from all audio signal wires.