Pulse Width Modulation (PWM) vs. Analog Dimming of LEDs

With the phenomenal growth of the LED lighting market, there has been a natural growth in demand for highly efficient and controlled LED drivers. Applications from 'smart' street lights, flashlights, digital signage and many others require not only highly regulated currents, but in many cases dimming capability in order to sustain the energy efficient scheme and end use flexibility behind LED design.

As there are several ways to achieve dimming of an LED, we describe here the main methods that are used to provide dimming for LED's from a switch mode LED driver.

PWM Dimming

PWM or **P**ulse **W**idth **M**odulation dimming is actually turning on and off the LED current for short periods of time. The on/off frequency has to be faster than what the eye can perceive so as not to cause a flickering effect (typically over 100Hz). PWM dimming can be achieved a number of ways:

- driving Vadj (adjust voltage) directly by a PWM signal
- via open collector transistor
- by a microcontroller as detailed in our product datasheets.

The average current to the LED is the product of the total nominal current and the duty cycle of the dimming function. A designer must also take into consideration the delays in shutdown and start-up of the converter's output which leads to limitations on the PWM dimming frequency and range of duty cycles.

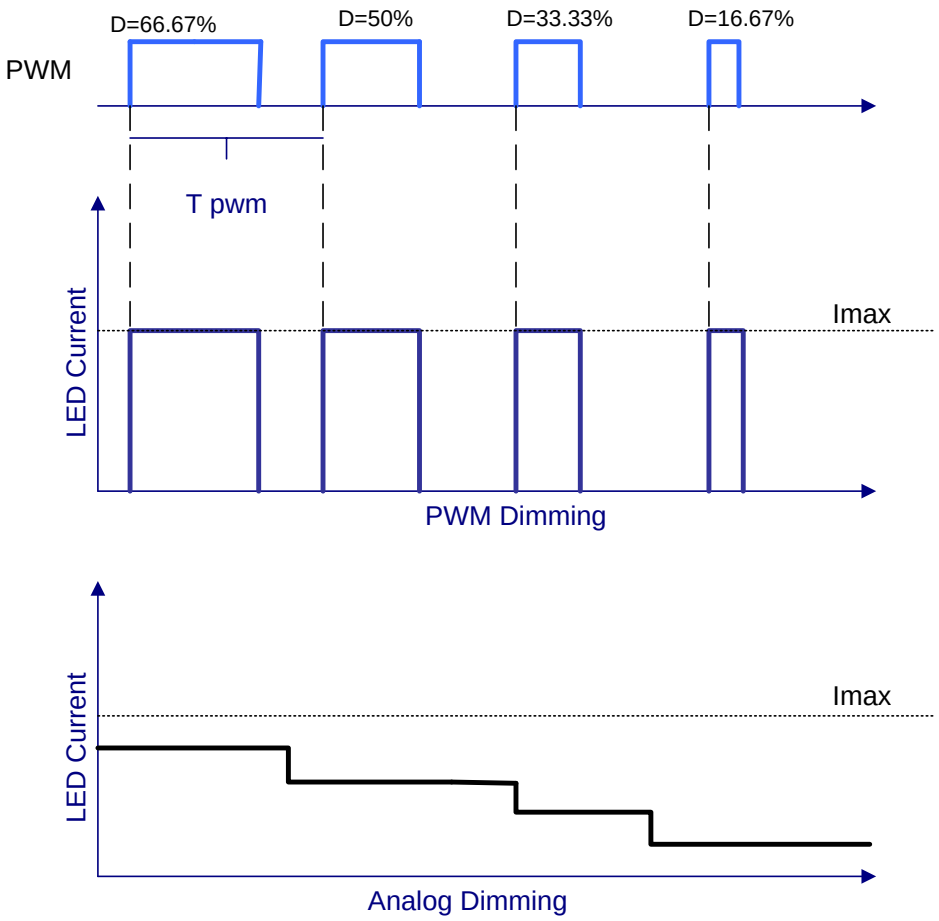
Analog Dimming

Analog dimming of the LEDs is the adjustment of the LED current level. This can be by resistive dimming or external DC control voltage. Since there is current level adjustment in analog dimming, inherently there is a disadvantage where color temperature variation can occur. The use of analog dimming is not recommended in applications where color of the LED is critical.

Comparison Table:

PWM Dimming	Analog Dimming
Brightness adjusted by modulating the peak current in the driver	Brightness adjusted by changing the DC current going to the LED
No Color Shift	Possible Color Shift as LED current changes
Possible current inrush problems	No inrush current to device
Frequency limitations & possible frequency concerns	No frequency concerns
Very linear change in brightness	Brightness linearity not as good
Lower Optical to electrical efficiency	Higher optical to electrical efficiency(>lumens per watt consumed)

LED current behavior vs dimming option:



Choosing the right dimming technique depends on your application and the performance metrics of that application. PWM dimming can be more complex and cost more but it has many advantages, as outlined above. However, a lower efficiency level is achieved while maintaining light chromaticity integrity.

Alternatively, resistive dimming can be very effective and simple to perform and could be the better choice if the design can tolerate the possibility of color shift. Another positive aspect of resistive dimming is that there are no frequency issues associated with the design.

Aimtec AC/DC LED drivers.

Aimtec's AC/DC LED Drivers are high performing IP67 products with extended input range, active PFC, -40°C to +85°C operating temperature range and no load power requirement. They also allow for full dimming control using resistive (analog) dimming and thus can target all output current points. With output power up to 150W, they provide comprehensive solutions to target many applications from low to medium to high power applications. Aimtec's AC/DC LED drivers offer several safety features that to make them one of the best in class in the market.

Aimtec DC/DC LED drivers

Aimtec's DC/DC LED drivers (through hole and SMD package) have ultra wide input range and support PWM, as well analog dimming control. With the choice for dimming options, Aimtec's LED drivers offer designers the dimming control options to optimize their application.

Whether a designer is looking for steady color output dimming for color shift associated dimming, Aimtec's DC/DC LED drivers allow designers to achieve their performance goals. With certain models having a unique pin for on/off control, these LED drives are designed to meet most application requirements in the market.