

## **Some Important Tips on LED Drivers – Part 1**

It is very important to have a good knowledge on LED drivers when working with LED lighting application such as Lighting manufactures, Lighting Designers, Consultants, Architects, Engineers and Electricians etc.

This document will provide some important tips on LED drivers.

A LED driver is used to drive LED fittings. Its main purpose is to rectify higher voltage, alternating current (AC) to low voltage direct current (DC). Mainly, there are two types of LED drivers named “Constant Current Driver” and “Constant Voltage Driver”.

### **Constant Current Drivers**

Constant current drivers (e.g. 350mA, 700mA or 1A) fix the current of the system and vary the voltage depending on the load of the LED. In this case LED lamps are connected in series with the driver.

### **Constant Voltage Drivers**

Constant voltage drivers (e.g. 10V, 12V or 24V) has a fixed voltage and the LED loads (lamps) are connected parallel across the output of the driver until maximum output currents are reached.

There are a few factors to be considered, when comparing constant current LED driver vs constant voltage driver. If your LED or array isn't specified to take a certain voltage, you will need to use a constant current driver. A constant current driver provides a more consistent brightness and overall more reliable performance. Generally LED fittings which used LED COB type (Chip On Board) are worked with “Constant Current LED Drivers”. If your lighting system does specify the voltage, you may be able to save money by using a constant voltage driver, especially in large-scale LED systems. Constant voltage technology also is more familiar and streamlined.

### **Dimmable LED Drivers**

If a dimmable LED driver is required, it is important to ascertain what type of controller will be used to dim the lights.

The most commonly used dimming drivers are:

- Trailing or leading-edge TRIAC dimming.
- 1-10V, or 0-10V dimming.
- DALI
- LED Drivers with PWM Output

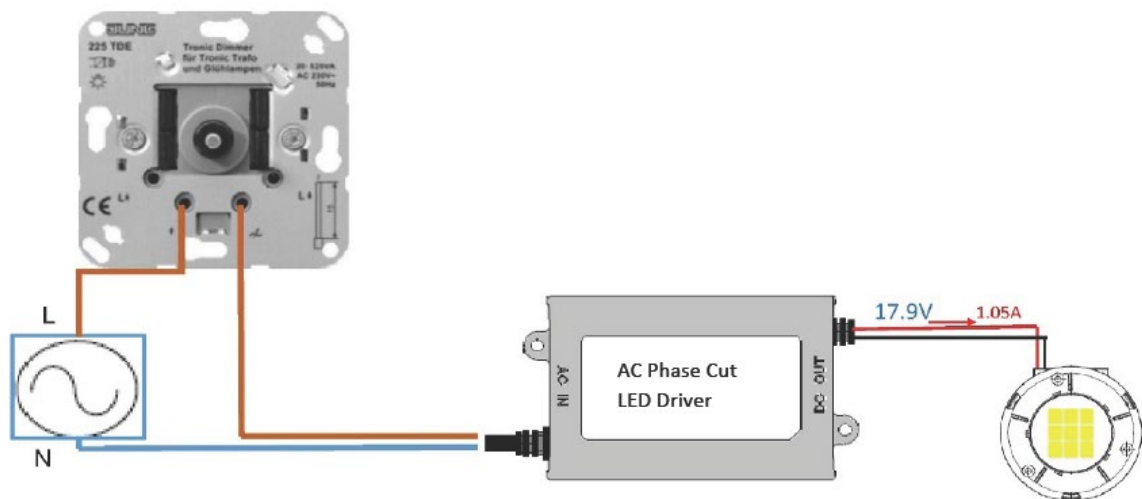
Dimmable drivers are available with “Constant Current” and “Constant Voltage” concepts. But Constant Current method is widely used.

## 1. Trailing or leading-edge TRIAC Dimming Driver

This is well known as “Phase Dimming”. These are installed across the AC input into the LED driver and work by ‘chopping’ the AC input. For these types of dimmers, a LED driver that has ‘AC Phase Cut’ dimming is required. The may also be referred to as a ‘TRIAC dimmable LED driver’.

When selecting an AC phase cut LED driver, it is preferable to check the compatibility of the LED driver with the dimmer switch that is being used. Generally, this Phase dimming use for Incandescent lamps, Halogen lamps. Even Some LED lamps can be driven by phase dimming drivers,

this phase dimming is not recommended for LED application due to poor performance and killing life time.



## 2. 1-10V and 0-10V Dimming Drivers

This is the most common dimming method use with LED light fittings. These dimmer switches are not wired across the LED driver’s AC input. Instead the dimmer switch, or controller’s output is wired to the dedicated terminals on the LED driver. It means dedicated control wire (Communication cable – Analogue Signal) should be used to loop dimming drivers together when more than one lamp (more one driver) and this communication signal is controlled by the controller. A LED driver must be selected that is compatible with either 0-10V dimmers, or 1-10V dimmers.

When using a 1-10V dimming driver LED driver will only dim down to a light level of 10%, even if the data sheet states that the LED driver can dim down to zero, or ‘off’.

When using this dimming method, it is important to check the current required to provide the analogue signal. For example, you may find that need a current of 0.1ma per LED power supply. Therefore, if you are controlling 3 LED drivers one dimming controller, you will need a current of 0.3ma on the voltage control line.

In this case all light fittings that have been looped by the dimming control cable will be dimmed all together as a group. Therefore, dimming groups should be created where need independent dimming each other. This has to be carefully done at the design stage.

### 3. DALI Dimmable LED Drivers

DALI (**D**igital **A**ddressable **L**ighting **I**nterface) is a digital addressable dimming solution that is becoming ever increasingly popular and use due to its beauty. Actually DALI is a protocol that is used in Lighting control system. Normally we used to call “DALI Dimming Drivers” to Drivers which are compatible to work with DALI solution. A LED driver with a DALI interface is required. Otherwise it may be possible to place a DALI converter between the output of the DALI controller and the LED drivers dimming input terminals.

The range of LED drivers with a built in DALI interface has grown noticeably over the past couple of

years, so it is getting easier to find a LED driver with the required specifications.

By using DALI solutions that each and every drivers and its cooperative fittings can be addressed individually. Then these drivers and its related fittings can be monitored and controlled (Dimming &

Switching) individually. Therefore, no need to consider or pay hard time for Dimming group to achieve dimming scenes like 1-10V or 0-10V dimming solutions.

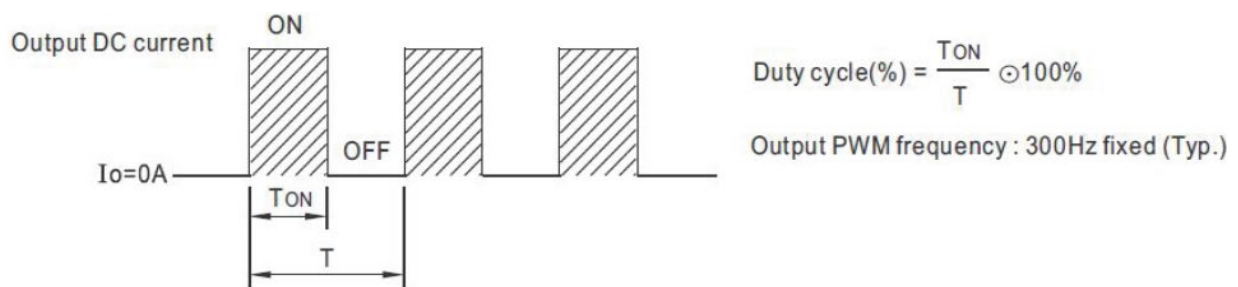
### 4. LED Drivers with PWM Output

Constant voltage LED drivers with a PWM output cycle the LEDs on and off at a fast rate.

The on/off

rate has to be high enough so that the flicker is undetectable by the human eye. A single on/off cycle

is called the ‘duty cycle’. The below diagram shows the duty cycle of a LED driver with PWM output.



When the “On” period equates to 50% of the duty cycle, as it does in the above diagram, the light level will be at 50% of maximum brightness. If the “On” period equates to 100% of the duty cycle the lights would be at maximum brightness. The LED driver will alter the duty cycle according to the output of the dimming controller. One advantage of this dimming method is that changes in the colour temperature are unnoticeable at different brightness levels. This makes it ideal for architectural lighting projects, where colour stability is a must. The other advantage is that the LED driver will dim smoothly, regardless of the load on the LED driver.

If a LED driver has a PWM output it does not necessarily mean it is compatible with a PWM dimming controller, although there are LED drivers available that are. There are also LED drivers with a PWM output available that can be dimmed via a DALI controller, an analogue voltage signal (0-10V, or 1-10V), or are compatible with leading and trailing-edge TRIAC dimmers.

## **The Loading of LED Drivers**

Typically for non-dimming power supplies recommends that the load on the LED driver does not exceed 80% of its maximum rated capacity. This is to allow some head room for unexpected spikes in the AC input.

But, for dimmable power supplies it is not always possible to follow this rule. However, for dimmable power supplies it is not always possible to follow this rule. If a dimmable LED driver has a PWM type output, then it is recommended you adhere to the 80% recommendation. This is because the dimming performance of this type of LED driver is not affected by the load on the driver. It is important to note that the term “PWM output” does not mean LED drivers that can be dimmed with PWM type dimming controllers. It means the LED driver itself has a PWM output on the secondary side.

Many dimmable LED drivers work by varying the amplitude of the output current. Constant voltage

LED drivers using this dimming method are prone to “Dead Travel” and the load on the LED driver

needs to be as close to its maximum rating as possible. It is generally recommending a load of 90%-95% of the maximum rated capacity. Constant current LED drivers do not suffer from “Dead Travel”.

## **The Meaning of “Dead Travel”**

If the load on the LED driver is only 50% of its maximum rated capacity the LEDs won't start to dim until the dimmer switch has been turned down past the 50% level. Once the dimmer switch has been turned past 50% the light level will suddenly drop to the minimum. The drop is that rapid that it is impossible for the user to adjust the light to the required level and they will presume the lights to be faulty. This is a very important tip.

Dead travel poses an additional challenge if more than one LED driver is being controlled via a single controller. All of the LED drivers need to be loaded to exactly the same level (as a percentage of the LED driver's maximum rated output) otherwise, they will not dim synchronously. For example, if a 150W LED driver and a 240W LED driver are being used, the load on

each of the LED drivers would need to be as follows:

150W driver: Actual load required is 142.5 Watts

240W driver: Actual load required is 228 Watts

The actual load values shown above are equal to 95% of the maximum capacity of the LED driver.

## **Power Factor Correction**

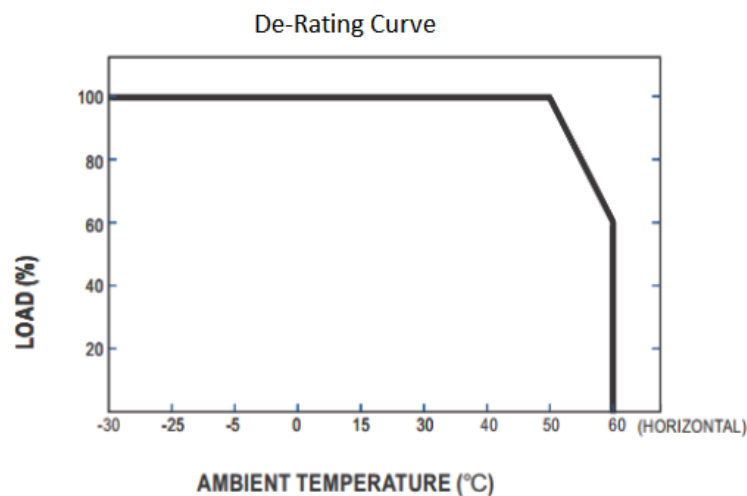
Power Factor is the ratio of the real power flowing to the load, to the apparent power in the circuit. Real power is the capacity of the circuit for performing work in a particular time.

Apparent power is the product of the current and voltage of the circuit. In an electric power system, a load with a low power factor draws more current than a load with a high-power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system. For this reason, many LED drivers have built in power factor correction to prevent this lost.

It is recommended that a LED driver with power factor correction which has high power factor is used where possible to improve the energy efficiency of the electrical circuit. In larger installations power factor correction will help reduce energy costs, due to the elimination of 'non-productive' power in a circuit.

## **De-rating a power supply in higher ambient temperatures**

Reputable manufacturers will publish a temperature de-rating curve in their data sheets, such as the one shown in the below example.



In this example the de-rating curve shows at 60 degrees Celsius the maximum load on the driver should be limited to 60% of its maximum rated capacity. It is important to check the de-rating curve, as it may be necessary to use a larger capacity LED driver than originally anticipated. Failure to take de-rating into account could potentially lead to a failure of the LED driver. Such failures are not covered by manufacturers' warranties.

## **Wiring LEDs to Constant Current LED Drivers**

LEDs should not be connected to a constant current LED driver in parallel. Constant current LED drivers are used to power LEDs that have no internal current regulation. Connecting multiple LEDs to a constant current LED driver in parallel, runs the risk of reducing the life span of your LEDs.

It is important to understand that all LEDs have a manufacturing tolerance. This means that even though several LEDs with exactly the same part number are being used, there can be slight variances in the voltage at which the LEDs start up. For example, consider a constant current LED driver with a 1A output powering 5 LEDs with an input current rating of 200mA. Due to the permissible manufacturing tolerance one of the LEDs will come on once the output voltage of the LED driver reaches 9V, another will come on at 9.3V, and the others at 9.5V, 9.6V and 9.7V. Because the first LED is ON before the others, it will draw a slightly higher current than it needs. The other LEDs will be slightly under powered. As the first LED is being over driven, there is a risk that its lifespan will be reduced, and it could fail prematurely. This failure has a "knock-on" effect. Because there are now only four LEDs connected to the LED driver, they will all be driven with a current of 250mA. This means all

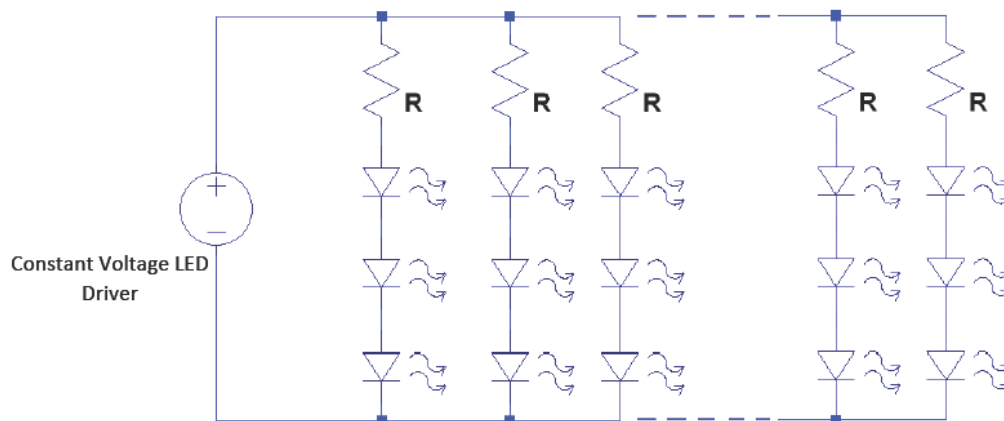
4 LEDs are now being overdriven. This will most likely result in another of the LEDs failing soon. Of course, the remaining 3 LEDs are now driven with 333mA, which means it won't be long before they too fail. Therefore, only connect multiple LEDs to a constant current LED driver in series. This way the power is cut should one of the LEDs fail, protecting the other LEDs from being over driven.

## Electronics Architectures of Drivers and LED Lamps

There are a number of different architectures. All have their advantages and disadvantages.

### 1. Simple Constant Voltage (CV)

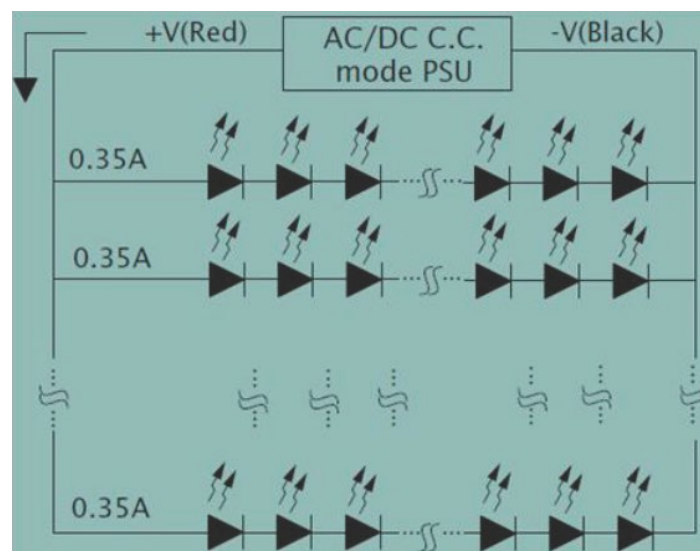
This architecture is commonly seen in low cost LED strips used for decorative lighting.



It has a low level of complexity and is a low-cost solution. However, it has poor current regulation and low efficiency.

### 2. Direct Drive Constant Current (CC)

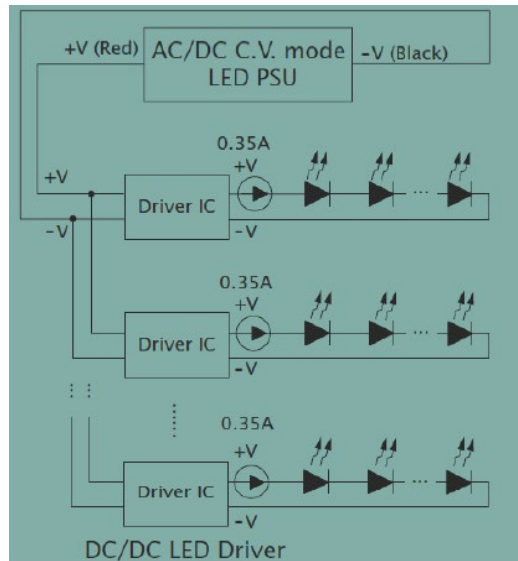
This architecture will require a high level of engineering knowledge, due to current imbalance.



Again it has a low level of complexity, but a high level of efficiency. It is also a low-cost solution. As previously mentioned, it is prone to current imbalance. For example, if you have one LED drawing more current it could result in a voltage drop on that string, altering the brightness of the LEDs. This architecture is also vulnerable should a single LED fail.

### 3. Constant Voltage & Constant Current

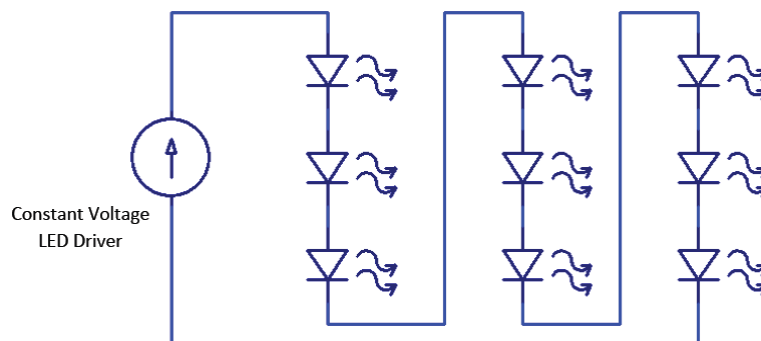
This architecture in good quality LED strips and is one option suggest to consider.



Each string of LEDs is driven by a driver giving a constant current output. These drivers are supplied from a constant voltage power supply. It gives more accurate control over each string and single LED failure can be easily controlled. It offers flexible design particularly with multi strips. This does mean it is a more complex architecture, with a higher cost.

### “Series” Connection Vs “Parallel” Connection

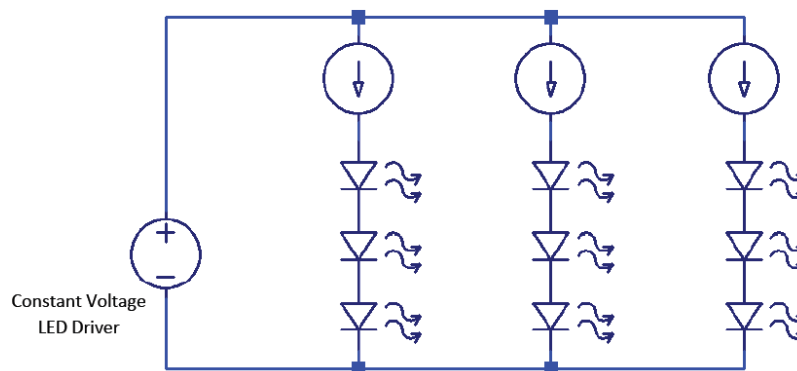
Configuring LEDs in series will result in a single current path, as well as a relatively simple design. However, it does have its drawbacks.





Firstly, for very long strings the brightness of the LEDs gets dimmer the further down the string they are. This is because each LED adds a little resistance to the circuit. Under normal circumstances it is not enough to affect the performance of the LEDs. But the aggregate resistance in a long string can cause a voltage drop to make enough of a difference to effect the function of an LED. Using a series topology also mean that your design will not offer SELV (safety extra low voltage), which is usually required on applications that maintenance electricians may later be working on.

Configuring your LEDs in parallel will give you much more flexibility in design and avoids the need to use a high-powered LED driver.



## **The Leakage current of Drivers**

Generally, an electronic Driver can create leakage current of 0.3mA to 0.5mA depending on the ballast's specification. This is directly engaged with RCD (Residual Current Device) tripping. It is noted, when Engineers do calculation for numbers of electronic Driver in a circuit that they consider only MCB loading. But due to this leakage current, when calculating number of driver for a circuit that RCD's rating also to be checked. For this reason, the maximum number of lights with ballasts per 30 mA RCD would be 60 theoretically with consideration of 0.5mA. But practically it is not good practice to go with its max. capacity 60 and it is recommending to keep within 30 to 40 due to few reasons.