LED Driver Application Guide 2017

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1. Selection Guide

Below is the basic selection block diagram of MORNSUN LED Drivers.

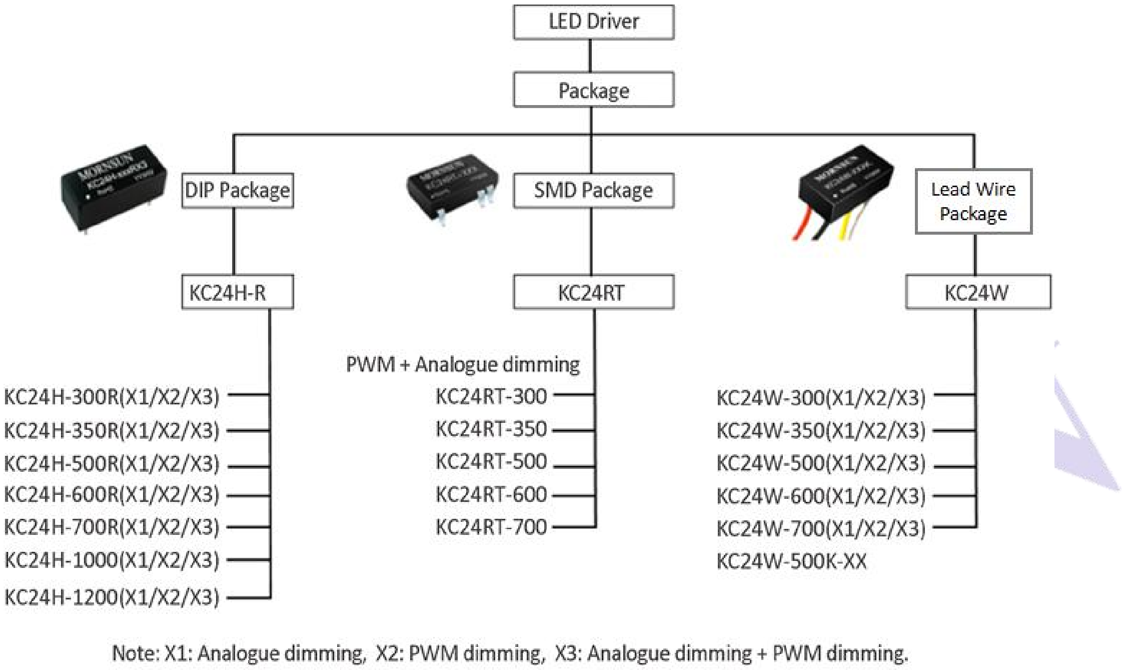

Diagram 1-1: Selection Block Diagram

LED driver selection is mainly based on the driven LED specification and the connection. If the brightness of the LED needs to be adjusted in the actual application, the driver should has PWM dimming or analog dimming as well as the appropriate package according to the actual design requirements. Steps are as follows,

Step 1, Package

Select the right package according to the actual requirements, such as DIP package (KC24H-R series), SMD package (KC24RT series), wiring package (KC24W series with waterproof function).

Step 2, Dimming Mode

Select the right LED driver according to the dimming mode needed in the actual application: 1) the part number without suffix means no dimming function, e.g. KC24H-300R; 2) the part number with suffix “X1” means this product has analog dimming function, e.g. KC24H-300X1; 3) the part number with suffix “X2” means this product has PWM dimming function; 4) the part number with suffix “X3” means this product has analog dimming function and PWM dimming function.

Step 3, Output Current

Select the constant current output LED driver (KC24 series) of 300mA, 350mA, 500mA, 600mA, 700mA, 1000mA, 1200mA based on the requirements of the LED specification.

Step 4, Voltage Requirements

Select the LED driver that can meet the minimum voltage-drop between the product input and the

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output according to the total voltage-drop of LED lights in the actual application.

2. LED Driver Test

2.1 Test Circuit and Method

LED driver test method as shown in Diagram 2-1, test condition: ambient temperature Ta =25 ℃ , humidity <75%.

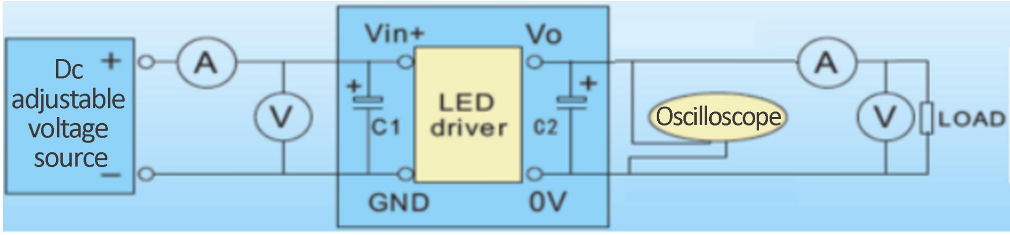

Diagram 2-1: LED Driver Test Method

Test Instruments: DC adjustable regulated power supply with large input voltage, ammeter A(0.001A accuracy), voltmeter V(0.001V accuracy)

Notes:

(1) Wire: The line loss should be small enough to avoid too high voltage-drop, and the multi-unit copper of 1mm diameter is the best recommendation. When the load current is large, the distance between output pin and each load should be shortened, and increase the cross-sectional area of the connecting wire to reduce the too high voltage-drop.

(2) Ensure the voltage-drop of above 4V between input voltage and output voltage in the test.

(3) Please refer to the product datasheet for the specific technical parameters.

Vin（min）	Vin（nom）	Vin（max）
1LED	5LEDs in series	10LEDs in series

Table 2-1: LED Driver Product Test Load Condition

In table 2-1, to meet the minimum voltage-drop requirements between input and output, the load should be varied with the input current or voltage. Because the output voltage of the LED driver is determined by the LED parameters and the number of LEDs.

2.2 Basic Performance Test

Connect the LED driver to do the performance test and determination, and confirm whether the performance parameters meet the requirements.

2.3 Output Current Accuracy

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Output nominal current is I_{nom}, the output current accuracy is measured under different input voltage points and corresponding load conditions.	Output Current Accuracy $= \frac{Iout - Inom}{Inom} \times 100\%$
Vin(min) input voltage, the output current I_{out1} is measured at 1LED load.	

For example KC24H-300RX1, the nominal output current $Inom = 300\ mA$, and the input voltage is 46V. When load is 10 LEDs, the measured output current

$Iout = 300.6mA$, output current accuracy $= \frac{300.6 - 300}{300} \times 100\% = 0.2\%$.

2.4 Output Current Stability

Nominal output current is I_{nom}	Output Current Stability $= \frac{Iout3 - Iout1}{Inom} \times 100\%$
Vin(min) input voltage, the output current I_{out1} is measured at 1LED load.	
Vin(max) input voltage, the output current I_{out3} is measured at 10LEDs load.	

For example KC24H-300RX1, the nominal output current $Inom = 300mA$, Vin(min) input voltage, the actual measured output current at 1 LED load $Iout = 300.4mA$; Vin(max) input voltage, the actual measured output current at 10 LEDs load $Iout3 = 301.2mA$, the output current stability

$= \frac{301.2 - 300.4}{300} \times 100\% = 0.27\%$

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2.5 Efficiency

Vin(nom) input voltage, the output current I_{out2} is measured at 5LEDs load; the actual measured output voltage V_{out2}; the actual measured input current Iin.	Efficiency $= \frac{Vout2 * Iout2}{Vin(nom) * Iin} \times 100\%$

For example KC24H-300RX1, the nominal input current is 24V. The actual measured output current at 5LEDs load is $Iout2 = 300.6mA$. The actual measured output voltage $Vout2 = 17.8V$, the actual measured input current $Iin = 232.4mA$. The conversion efficiency is : Efficiency= $= \frac{17.8 * 300.6}{24 * 232.4} \times 100\% = 95.93\%$.

2.6 Temperature Rise Test

Thermal imager or thermocouple can be used to test the temperature rise of case. Because the emissivity has an effect on the result of the infrared thermal imager which can result in a certain deviation

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in the test result, it is generally recommended to use thermal imager.

If the ambient temperature $T_a = 25℃$, and the case temperature of the converter tested by the thermal imager is $T_c = 60℃$, temperature rise of the converter is $\Delta T = T_c - T_a = 60 - 25 = 35℃$. (Tc = case temperature, Ta = ambient temperature, △T = temperature rise)

3. Application

3.1 LED used in series at the back-end

In the actual application, the driver needs to drive multiple LEDs at the same time, shown as following Diagram.

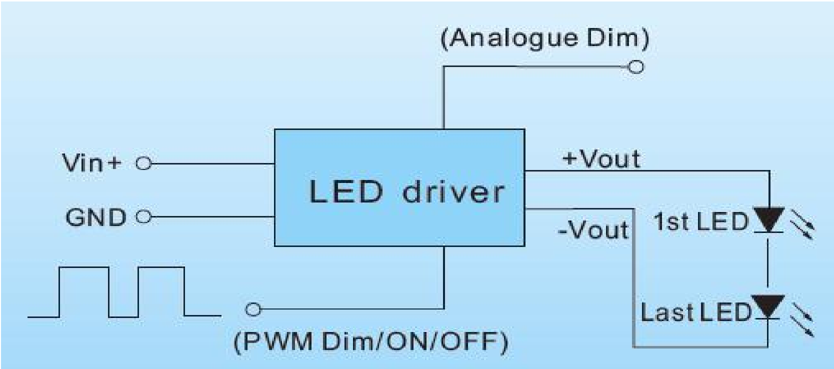

Diagram 3-1: LED used in series

In the application of above Diagram 3-1, the maximum driver current required by each LEDs should be over than the maximum output current of the driver when used in series. In addition, the sum of conducted voltage drop for all lamps should be no more than the maximum output voltage of the driver due to the output voltage range of the driver.

3.2 LED used in series and parallel at the back-end

In the actual application, LED not only need to connect in series, but also in both series and parallel in some special occasions. Diagram as below,

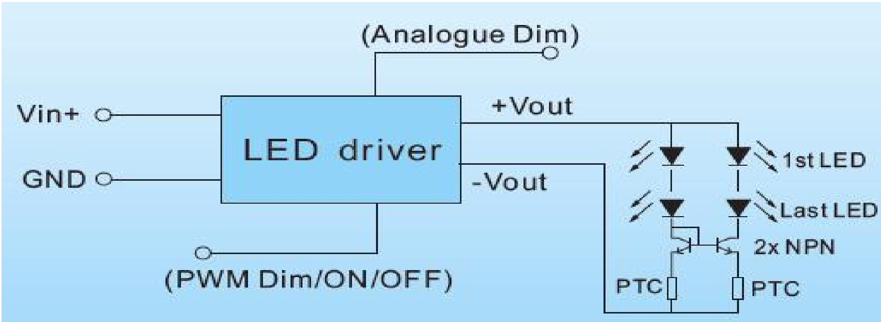

Diagram 3-2: LED Driver used in series and parallel

In Diagram 3-2, the followings should be noted:

(1) The sum of conducted voltage drop for a single branch LED should be no more than the maximum output voltage of the driver;

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(2) The sum of the driver current required by each branch LEDs should be no more than the maximum output current of the driver;

(3) In order to ensure that each branch current is relatively balanced and avoid the LED brightness difference, it is recommended to use PTC thermistor (0.5-1 Ω) for each branch as average-current to ensure all LED brightness consistent.

3.3 Analog Dimming

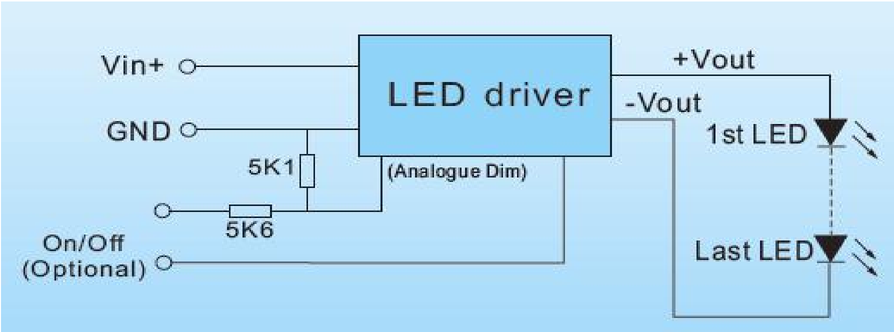

Diagram 3-3: Analog Dimming Application Circuit

The analog dimming mainly changes the output current sampling. Almost all DC/DC constant chips have an interface that detects current through a very small current sense resistor to form a certain voltage, and control the current constant by the detected voltage and the reference voltage across the chip. Analog dimming is to connect another branch to the detector side of the chip by adjusting the voltage of the detection side, so that the output current can be changed (he regulated voltage can be changed with the input voltage or divided by the potentiometer adjusting, etc.). In Diagram 3-3, set the pin voltage of the analog dimming at 0.2V through the resistance to the partial pressure, then start adjusting the driver output current. When the pin voltage of the analog dimming gradually rises, the output current decreases accordingly. The output current will drop to 0 when the voltage reaches 4.5V, and the driver has no output, shown as Diagram 3-4.

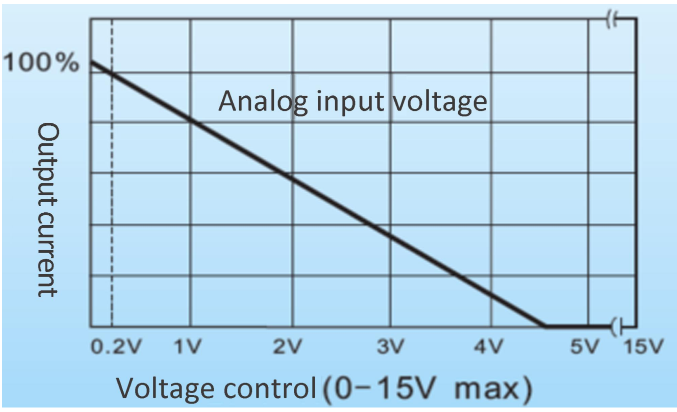

Diagram 3-4: Relationship of LED Driver between the regulation voltage and output current

The spectrum and color temperature are changed with the brightness which is also a problem to use

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the analog dimming method to adjust the brightness. Because current white LED has a cool color and a warm color, whose difference are blue or yellow in the spectrum. When the drive current is weak, it is possible to show the color more clearly.

3.4 PWM Dimming

Pulse width modulation (PWM) dimming is to change the size of average-current by adjusting the width of the pulse width. If the pulse cycle is T and the pulse width is ton, its duty cycle D is ton/T. Changing the duty cycle of the constant current source pulse can change the brightness of the LED. From the definition of PWM dimming, it changes the average current value, but not does the peak current. So the LED electrical stress is required to meet the specification.

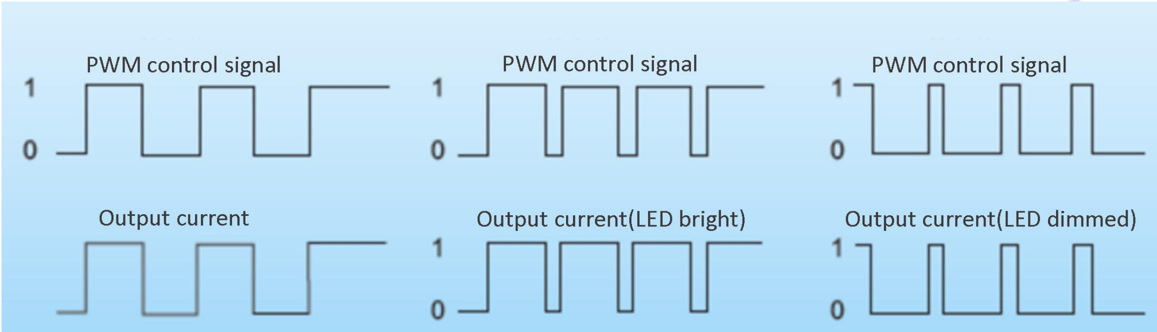

Diagram 3-5: PWM control signal and output current

In order to avoid the LED flicker due to turn on/off, the PWM dimming frequency is generally required to be higher than 100Hz. Different from analog dimming, PWM dimming can not only control the brightness of the LED but also ensure the stability of LED luminous chromaticity simultaneously.

For a certain frequency of PWM dimming, the range of dimming depends on the rise rate of the LED current which can be calculated by the time required from turn off to output value. For example, the required time of LED current from turn off to output value is 10 μS. The calculations of dimming range for a PWM dimming signal with a frequency of 200Hz is: Tpwm=1/200S, and ton=10 μS, then the minimum dimming range of the PWM dimming is (ton/Tpwm) × 100%=0.2%. Because the LED driver has a delay time of about 0.7mS, however the recommended dimming range is 20%-100% at 200Hz dimming frequency. The LED current is proportional to the duty cycle of PWM dimming signal of which the latter, can be calculated by the ratio of set LED current value and its nominal one, to adjust the LED brightness.

4. Precautions

4.1 Input Filter

If the output ripple of the input power supply is relatively large or the lead wire is long, it needs to connect a filter capacitor. There are some uncertain interference signal into input under different environmental conditions in actual applications which might affect the normal operation of the driver. So it is requested to connect the filter capacitor in the input of the driver (recommended value is 47 μF). If

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the output load is relatively heavy, the value of input capacitor can be increased appropriately.

4.2 Output Filter

A 2.2 μF-22 μF capacitor can be connected at the input of the driver in parallel, but its withstanding voltage should be over 1.5 times as much as the input voltage. The smaller ESR, the better. It makes the current flowing through the LED more smooth and LED luminous performance better.

4.3 Hot-plug

LED driver can not be used as a hot-plug power supply. The hot-plug operation should be avoided during test or use, otherwise the driver will be damaged.

4.4 EMI design

If there was mutual interference in the case of multiple drivers used together, an EMI filter can be connected to the input of each driver to ensure each driver work stably.

4.5 Derating Design

The maximum operating temperature of the LED driver series is +71℃ or +85℃. If the actual ambient temperature keeps high for a long time, the number of LED lights should be used for derating to reduce the output power of the driver in the applications for the consideration of LED lifetime.

4.6 Connection

LED has been widely used in lighting and decorative lights products. LED driver and LED as a load in series or parallel should be considered in the design of LED lights, only reasonable design can ensure the LED work normally.

(1) LED in series

The output voltage of the driver in series is relatively high, so it is required to ensure that the difference between the input voltage and output voltage should meet the requirements of specifications. Otherwise, the output of driver will be abnormal. When the consistency difference is large, though the distribution of different voltage across the LED is different, the current through each LED and the brightness of them is same. LED driver use the constant current drive, when a LED light short circuit due to poor quality, the output current of the driver remains the same and the remaining LED can work normally. When a LED light turns off due to poor quality, all LED lights in series will be off. A solution is to connect a Zener in parallel at both terminals of each LED. The conduction voltage of the Zener should be higher than the LED's. Otherwise, the LED is not bright.

(2) LED in parallel

LED driver in parallel is required to have a larger output current and a lower load voltage. The voltage

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distributed at both terminals are the same. When the consistency difference of LED is great, the current across each LED is inconsistent and the LED brightness is different. It is suggested to select LED with better consistency to suit to low voltage power products (such as solar or battery powered). When using a constant current driver and a LED is broken due to poor quality, the current distributed for the remaining LED will increase a lot and all LED has the risk of damage because the output current of driver stays the same. A solution is to connect LED in parallel as many as possible. When a LED is broken, the current distributed for the remaining LED is relatively less and the remaining LED can work normally. So the constant current driver is not suggested for Power LED as parallel load. When a LED shorts circuit due to poor quality, all LED will not be bright. However, if there are many LEDs connected in parallel, the current across the shorted circuit. LED will be large enough to burn it. Above analysis shows it is very important to connect the driver and load LED in series or parallel. The drive power LED with constant current is not suitable for parallel load. In addition, multi-group LED drivers in parallel should consider the low-voltage start-up issue in case of resulting in large inrush current and insufficient front-power supply and triggering the protection mode.

4.7 PWM Dimming

When PWM dimming or ON/OFF control, the control signal must be at the unblocked level of 2.8V<Vc<6V and the turn off level lower than 0.6V. Beside, and that the voltage drop of input and output should meet the requirements of specifications when the product does not dim. If the lead wire of the control source is longer than this pin, it is suggested to connect a capacitor of about 100pF near the pin to filter the interference signal.

4.8 Grounding Requirements

To avoid damage to the product, the output negative can not be connected to the ground during product testing and application, because the constant current control is achieved by collecting the difference between the output negative and the input ground.

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