APPLICATION NOTE

LED Application Introduction

1. Introduction

LED (Light Emitting Diode) is a semiconductor electronic component that converts electricity to light. Compared to traditional light source from electricity to heat, then heat to light, LED has characteristics of high luminous efficiency, energy saving and long life time. As LED technology improve, beside traditional single chip and multi chips LED packages, products (RGB+IC) that build in driver IC and LEDs have also been developed.

2. LED specification introduction

This chapter introduces general characteristics of the LED specifications. Specifications of each LED are different. Please refer to the corresponding specifications when using it.

A. Absolute Maximum Ratings

Figure 1 shows maximum driving conditions that LED withstand at 25℃. Exceeding the driving conditions may cause product damage, performance and life time degradation. General specifications are as follows:

*Reverse Voltage(V_R)：The reverse voltage of LED. Product withstand maximum reverse voltage.

Forward Current(I_F)：The current flow through LED. Product withstand maximum current in DC driving mode. When temperature over 25℃, please refer to derating curve in Figure 2. For example, current cannot be over 20mA at 40℃.

Peak Forward Current(I_{FP})：Maximum current at PWM frequency = 1kHz; Duty = 10% is 100mA

*Note: LED circuit design should avoid reverse voltage.

Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Rating	Unit
Reverse Voltage	V_R	5	V
Forward Current	I_F	25	mA
Peak Forward Current (Duty 1/10 @1KHz)	I_{FP}	100	mA

Figure 1. LED absolute maximum ratings

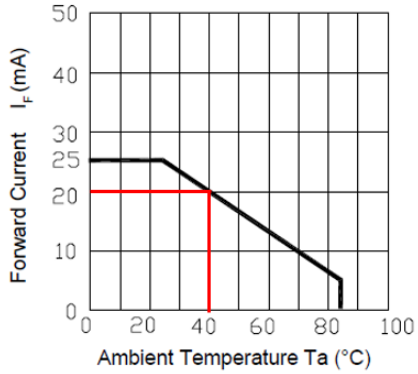

Figure 2. derating curve

B. Electro-Optical Characteristics

Each LED will be tested under condition current. Following figure shows the electro optical characteristics at 25℃.

Electro-Optical Characteristics (Ta=25℃)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Luminous Intensity	Iv	72.0	-----	180	mcd	I_F=5mA
Viewing Angle	$2\theta_{1/2}$	-----	130	-----	deg	
Forward Voltage	V_F	2.6	----	3.0	V	

Figure 3. Electro optical characteristics

Luminous Intensity(I_V)：Luminous Intensity range at condition current.

Viewing Angle($2\theta_{1/2}$)：The angle when luminous intensity reduced to 50%.

As shown in Figure 4, the dotted line indicates when intensity reduce to 50% viewing angle is ±65˚(130˚).

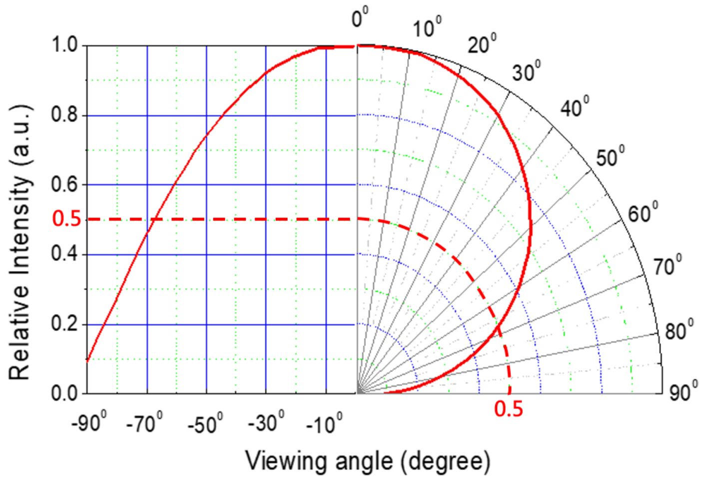

Figure 4. Viewing angle

Forward voltage (V_F): When current flows from LED anode to cathode. The voltage between anode and cathode is called forward voltage. Take figure 3, V_F range is 2.6V~3.0V at 5mA.

V_F is variable and proportional to I_F. In Figure 5, V_F=3.0V at 10mA; V_F=3.4V at 25mA.

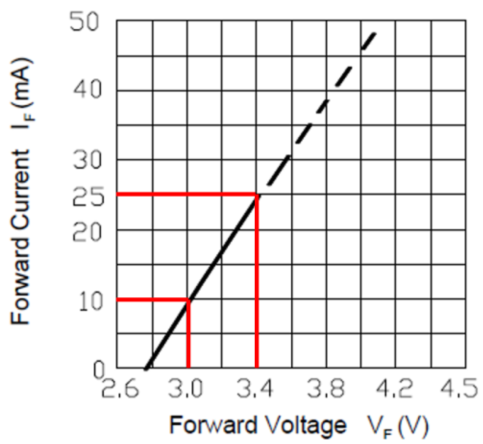

Figure 5. I_F vs V_F diagram

3. Introduction of LED driving mode

Traditional LED driving mode：

The characteristics of LEDs (such as I_V, V_F) vary with the driving current. LED has two driving modes: constant voltage and constant current. Constant voltage only needs a voltage source and a current-limiting resistor, so circuit is simple and cheap, but uncontrollable current leads to poor light consistency. Constant current generally requires a constant current driver IC, which has higher cost, but light consistency is better.

(a) Constant voltage：

As shown in Figure 6, note each LED must has current-limiting resistor also VCC must be greater than V_F. Multiple LEDs are not recommend to share one current-limiting resistor.

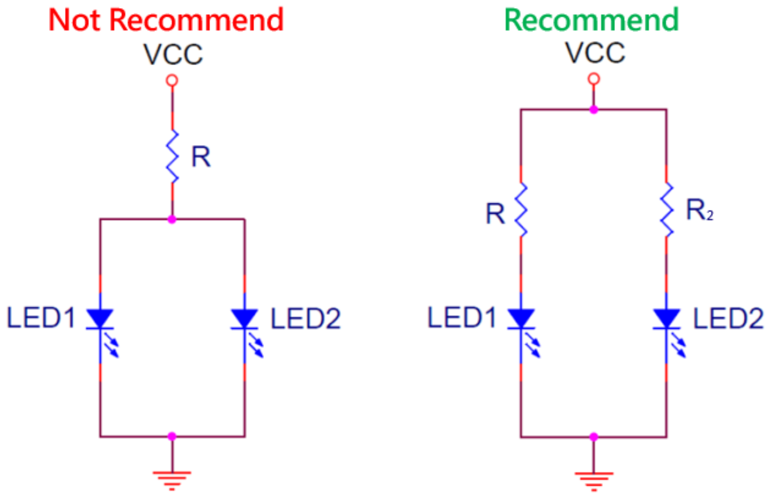

Figure 6. Constant voltage circuit

I_F can calculate by I=V/R.

Example: current limiting resistor R_1, R_2=500Ω；VCC = 5V

Let LED1 V_F = 2.6V, LED2 V_F = 3V.

LED1 I_F =4.8mA ($\frac{5V-2.6V}{500}$)；LED2 I_F =4mA ($\frac{5V-3V}{500}$)

LED V_F varies cause by production and I_F, because of V_F difference so even using same type of LED and same current-limiting resistor, I_F will be different. Different I_F will affect wavelength and I_V, therefore it is not recommend to use constant voltage for applications require high light consistency.

(b) Constant current

As shown in Figure 7, recommend one constant current source connect to one LED, which has better light consistency, so is not recommend to connected LEDs in parallel, since I_F is affected LED V_F.

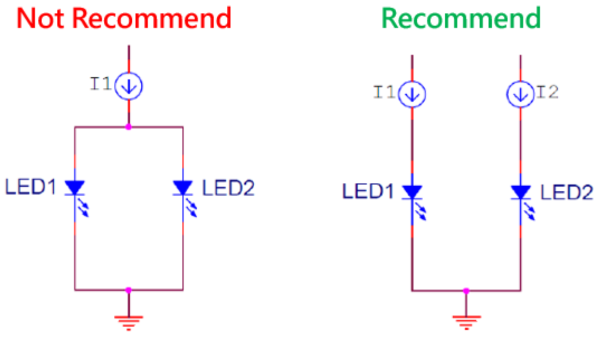

Figure 7. Constant current circuit

A. LED(build-in IC) driving mode

Different from traditional LEDs, each RGB+IC build-in a constant current driver IC, which does not require an external constant current source. RGB+IC has two control modes: single-wire (Data) and dual-wire (Data, Clock). Single wire product using one wire to transmit signal and connect multiple RGB LEDs in series with only two pins (DIN, DOUT) , the recommend circuit is shown in Figure 8. For more details, please refer to "Single-wire RGB+IC application note".

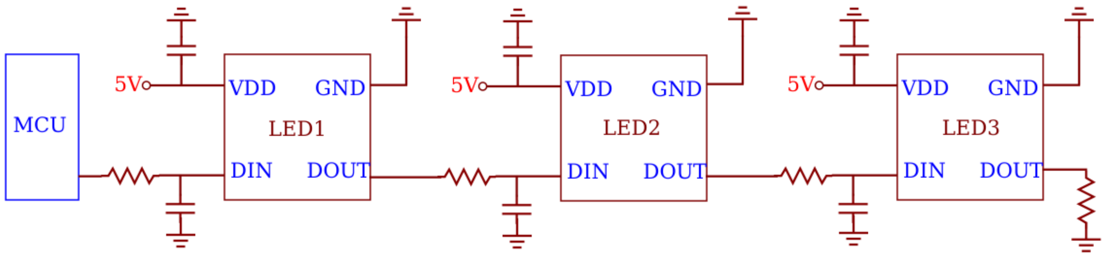

Figure 8. RGB+IC application circuit

4. Comparison of driving modes

Comparison table of driving modes are shown in Figure 9.

	Constant voltage	Constant current	RGB+IC
light consistency	Low	High	High
Circuit complexity	Middle	High	Low
Cost	Low	High	Middle
Power consumption	Low	Middle	High

Figure 9. Comparison table of different driving modes

This application manual provides customer design reference. If there are any problems in the design of the system, please contact Everlight for further technical support.