

XL-2121RGBC-WS2812B**技术数据表** Technical Data Sheet**2121幻彩 贴片式发光二极管****特点 (Characteristics) :**

- * 外观尺寸 (L/W/H) :2.1*2.1*1.0mm
Outline Dimensions (L / w / h): 2.0 * 2.0* 1.0 mm
- * 发光颜色及胶体: 高亮度RGB/半透明雾状胶体
Luminous color and colloid: high brightness RGB / translucent foggy colloid
- * 环保工艺符合ROHS标准
Environmental protection products Complied With RoHS Directive
- * EIA规范标准包装
EIA standard packaging
- * 适用于SMT贴片自动化生产
Suitable for SMT automatic production
- * 适用于回流焊制程
Suitable for reflow soldering process

应用领域 (Product application) :

- * LED全彩发光字灯串, LED全彩模组
LED full-color luminous character string, LED full-color module
- * LED全彩软灯条硬灯条
LED full-color soft light strip hard light strip
- * 电器设备跑马灯
Electric equipment marquee
- * 智能音箱, 风扇
Smart speaker, fan
- * 显示屏, 像素屏, 点光源, LED异形屏
Display screen, pixel screen, point light source, LED special-shaped screen
- * 各种电子产品
Various electronic products



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产品概述: Product overview:

2121 内封 IC 灯珠是一款集成高质量单线级联恒流驱动 IC 和高质量 RGB LED 芯片的外控恒流 2121 集成灯珠。其中内置控制 IC 是三通道低压 LED 灯串驱动芯片。芯片内部包含数据锁存电路、数据整形处理电路、数据转发电路、双振荡器、PWM 调制电路，以及 R/G/B 三路 LED 驱动电路。采用单线归零码的通讯协议。芯片在上电复位后，DI 口接收从 MCU 传输过来的数据帧，并通过数据锁存电路将数据帧里的头 24bit 数据锁存下来，并送至 PWM 调制电路，以控制 R/G/B LED 驱动电路的工作。数据帧的头 24bit 数据被锁存下来后，剩余的数据经过内部数据整形处理电路进行整形后，通过数据转发电路及 DO 口转发至下一颗级联的 IC 芯片。如此数据帧每经过一颗灯珠的传输，数据便减少 24bit。

The 2121 IC is an integrated high-quality single-wire cascade constant-current driver IC and high-quality RGB LED chip external constant-current 2121 integrated lamp beads. ONE BUILT-IN CONTROL IC is a three-channel low-voltage LED lamp string driver chip. The chip contains a data latch circuit, a data shaping circuit, a data forwarding circuit, a dual oscillator, a PWM modulation circuit, and an R/g/b three-way LED driver circuit. Communication Protocol based on single-line zeroing. After the chip is reset, the DI interface receives the data frame from MCU, and the first 24bit data in the data frame is locked by the data latch circuit, and sent to the PWM modulation circuit to control the work of the R/G/B LED drive circuit. After the first 24 bit data of the data frame is locked down, the remaining data is processed by the internal data processing circuit, and then transmitted to the next cascaded IC chip through the data transmitting circuit and the DO port. Each time a data frame passes through a light bulb, the data is reduced by 24 bits.

功能特点/Functional characteristics:

1 电源电压 5V

Power Supply Voltage 5V

2 R/G/B 端口耐压最高达 13V

B port withstand voltage up to 13V

3 内置上电复位和掉电复位电路

Built-in power-on and power-off reset circuits

4 灰度调节电路 (256 级灰度可调) ;

Gray Level Adjustment Circuit (256 gray level adjustable).

5 内置数据整形电路，保证数据经过多级级联不会产生波形畸变累加

Built-in data shaping circuit to ensure that the data through the cascade will not generate wave distortion accumulation

6 数据传输频率可达 800Kbps

Data transmission frequency can reach 800Kbps

7 当刷新速率为 30 帧/秒时，芯片级联数可不小于 1024 点

At a refresh rate of 30 FPS, the number of cascades can be no less than 1024

功能说明/Description of functions:

2121 内封 IC 灯珠采用单线通讯方式，采用归零码的方式发送信号。芯片在上电复位以后，接收 DIN 端打来的数据，接收够 24bit 后，DO 端口开始转发数据，供下一个芯片提供输入数据。在转发之前，DO 口一直拉低。此时灯珠将不接收新的数据，内置 RGB 芯片根据接收到的 24bit 数据后产生的不同占空比信号，展现不同亮度。如果 DIN 端输入信号为 RESET 信号，芯片将接收到的数据送显示，芯片将在该信号结束后重新接收新的数据，在接收完开始的 24bit 数据后，通过 DO 口转发数据，灯珠在没有接收到 RESET 码前，RGB 亮度保持不变，当接收到 80us 以上低电平 RESET 码后，灯珠内部 RGB 芯片将根据刚才接收到的 24bit 数据后产生的不同占空比信号，展现不同亮度。

2121 IC lamp beads sealed in a single line of communication, the use of zero-return code to send signals. After the reset, the chip receives the data from Din. After receiving 24 bits, the DO begins to transmit the data for the next chip to provide the input data. The DO was pulled down until it was retweeted. At this point will not receive new data, BUILT-IN RGB chip according to the received 24 bit data generated by the duty cycle signal, display different brightness. If the DIN input signal is a RESET signal, the chip will send the received data to display, the chip will re-receive the new data after the end of the signal, after receiving the initial 24 bit data, the data will be transmitted through the DO port, before receiving the Reset Code, the RGB brightness remains the same. After receiving the low level RESET code above 80us, the RGB chip inside the lamp will display different brightness according to the different duty cycle signal produced after receiving the 24bit data just now.

电性参数

Electrical Characteristics

光电参数 (Ta=25℃):

Electro-Optical Characteristics(Ta = 25 °C)

参数 Parameter	符号 Symbol	最小值 Min.	代表值 Typ.	最大值 Max.	单位 Unit
工作电流 Operating Current	IDD	-	0.7	-	mA
R/G/B 驱动电流 R/G/B drive current	ILED01	-	12	-	mA
DI 高电平输入 Di High level input	VIH	0.65VDD	-	-	V
DI 低电平输入 Di Low level input	VIL	-	-	0.3VDD	V

极限参数 (Ta=25℃)

Absolute Maximum Ratings (TA = 25 °C)

参数 Parameter	符号 Symbol	最大额定值 Maximum rating	单位 Units
供电电压 Supply Voltage	Vdd	-0.5~5.5	V
R/G/B输出端口耐压 R/g/b output port voltage withstand	Vout	13	V
逻辑输入电压 Logic input voltage	Vi	-0.5~Vdd+0.5	V
工作温度 Operating Temperature Range	Topt	-30~+70	°C
储存温度 Operating Temperature Range	Tstg	-20~+60	°C
湿气敏感等级 Moisture sensitive level	MSL	5a	-
ESD 耐压 (HBM) ESD WITHSTAND VOLTAGE (HBM)	VESD	2	KV

推荐工作范围 (如无特殊说明, $T_a=25^{\circ}\text{C}$, $V_{DD}=5\text{V}$)

Recommended scope of work($T_a = 25^{\circ}\text{C}$, $V_{DD} = 5\text{V}$ without special description):

参数 Parameter	符号 Symbol	最小 Min.	典型 Typ.	最大 Max.	单位 Units
供电电压 Supply Voltage	VDD	3.5	5	5.5	V
工作温度 Operating temperature	T_a	-30	-	70	$^{\circ}\text{C}$

内置LED参数

Built-in LED parameters:

发光颜色 Luminous color	主波长 (nm) Main wavelength (nm)	发光强度 (mcd) Luminous Intensity (mcd)	工作电流 (mA) Operating Current (mA)	测试条件 Test Condition
R	620-630	200-300	12	DC5V
G	515-525	550-750	12	DC5V
B	465-475	100-200	12	DC5V

亮度分档:

Brightness grading

颜色 Color	代码 Code	最小值 Min.	最大值 Max.	单位 Unit	测试条件 Test conditions
红Red	P01	200	300	mcd	IF=20mA
绿Green	U53	550	750		
蓝Blue	P00	100	200		

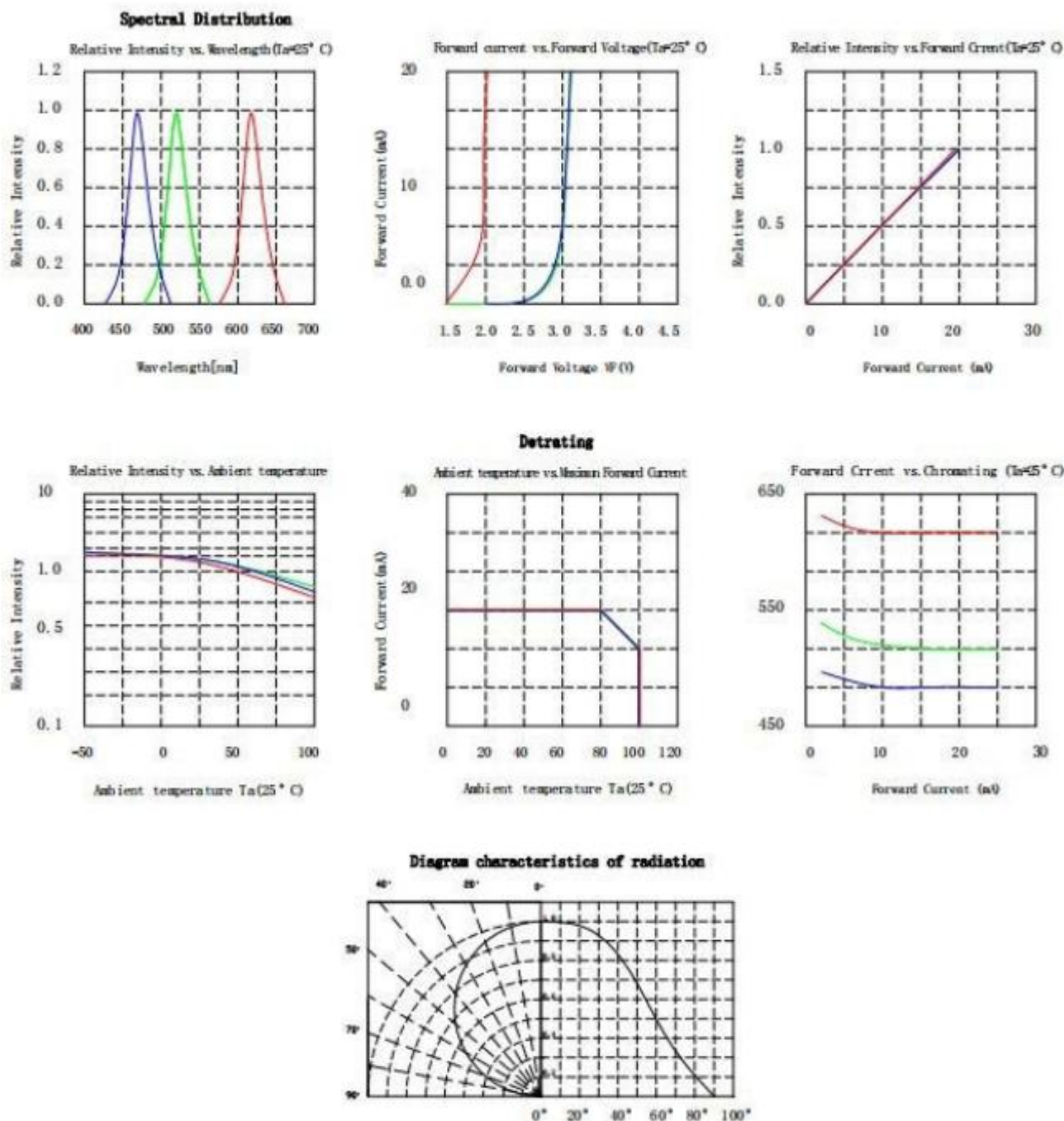
色温分档:

Color temperature grading

颜色 Color	代码 Code	最小值 Min.	最大值 Max.	单位 Unit	测试条件 Test conditions
红Red	HR55	620	630	nm	IF=20mA
绿Green	HG23	515	525		
蓝Blue	TB32	465	475		

典型特性曲线

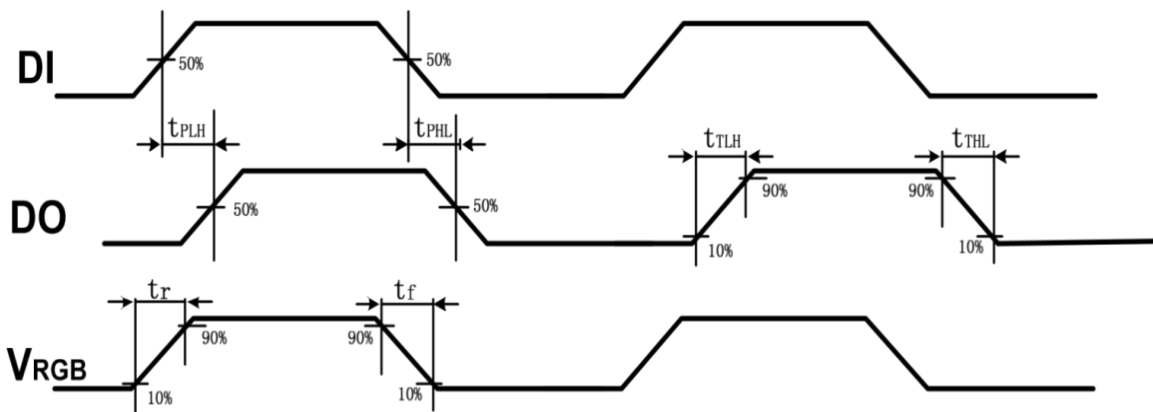
Typical Characteristics Curves



动态参数 (Ta=25°C)

Dynamic parameters (Ta=25 °C)

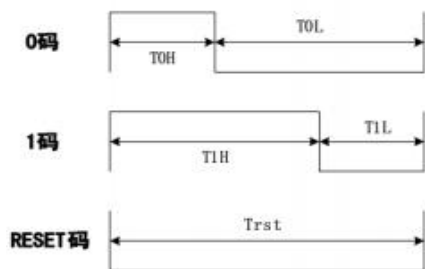
颜色 Color	符号 Symbol	最小值 Min.	典型值 Typical value	最大值 Max.	单位 Unit	测试条件 Test conditions
数据传输速度 Data transfer speed	fDATA	-	800	-	kHz	
R/G/B 口的 PWM 频率 PWM FREQUENCY OF R/G/B port	fPWM	-	1.5	-	kHz	
数据转发传输延迟 Data forward transmission delay		-	0.16	0.30	us	DI DO 信号延时



时序波形图 :Time sequence oscillogram

1. 输入码型:

Input code type:



2. 码型时间: Code type time

时序表名称 Timeline name	最小值 Min.	典型值 Typical value	最大值 Max.	单位 Unit
TDATA 码元周期 Code period	1.2	1.25	-	us
T0H 0 码高电平时间 Zero Yard high-level time	-	0.25	0.3	us
T0L 0 码低电平时间 Zero Yard low level time	-	1	-	us
T1H 1 码高电平时间 One Yard high level time	0.62	0.85	1	us
T1L 1 码低电平时 One Yard low level time	-	0.4	-	us
Tres Reset 码低电平时间 Reset Code Low level time	80	-	-	us

注:控制器发送数据 “0” 码高电平时间必须小于**0.3us**; 数据 “1” 码高电平时间必须大于**0.62u**

Note: Controller must send data “0” Code High Level Time is less than 0.3 US; data “1” Code high level time is more than 0.62 us.

3. 协议数据格式: Protocol Data Format

Trst+第一颗芯片 24bits 数据+第二颗芯片 24bits 数据+.....+第 N 颗芯片 24bits 数

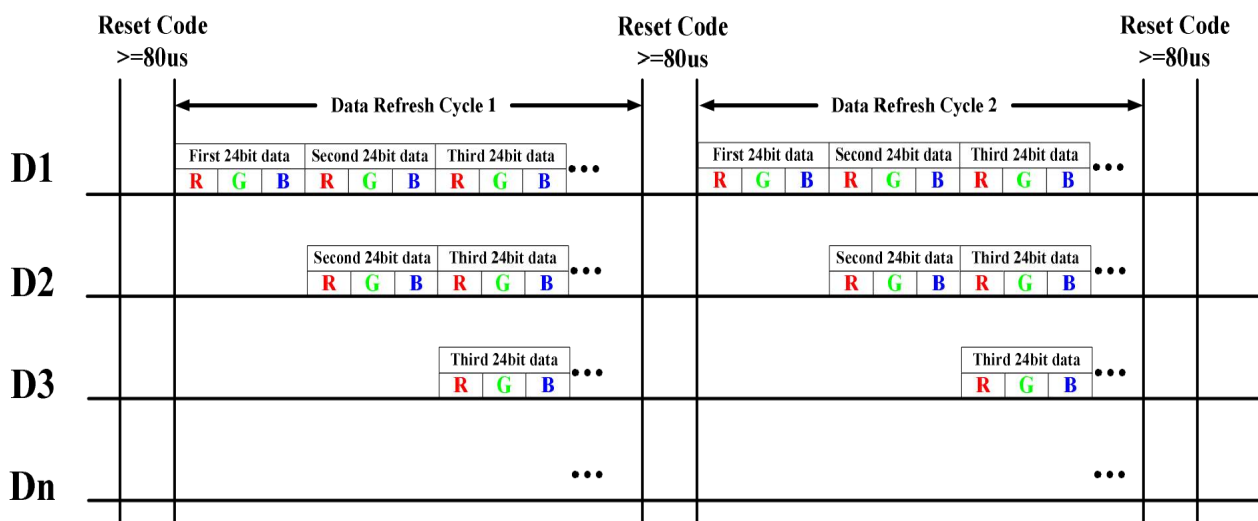
据

+Trst 24bit 灰度数据结构: 高位



数据传输方法

Data transmission method

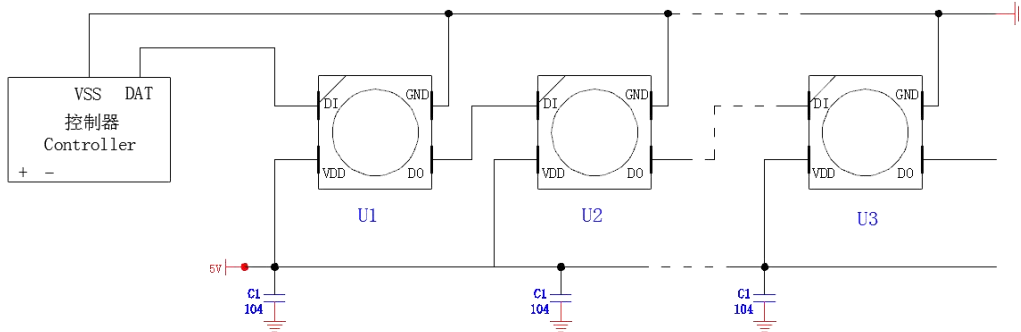


注: 其中 D1 为 MCU 端发送的数据, D2、D3、D4 为级联电路自动整形转发的数据。

Note: D1 is the data sent by MCU, D2, D3 and D4 are the data automatically shaped and forwarded by cascade circuit.

连接方式：

Connection mode:



注/Note：

1.在走线时，应避免电源线、地线走线过细；

In the line, should avoid the power cord, the ground wire too fine.

2.产品应用中驱控灯珠级联数量及控制器参数配置、驱动电源品质均有较大差异，故请在批量使用产品前，客户方务必自行验证产品兼容性，我司不承诺满足客户所有应用需求。

In the application of the product, there are big differences in the number of the cascade of the driving lights, the configuration of the controller parameters and the quality of the driving power, we are not committed to meeting all the application requirements of our customers.

可靠性试验

Reliability Test Items And Conditions

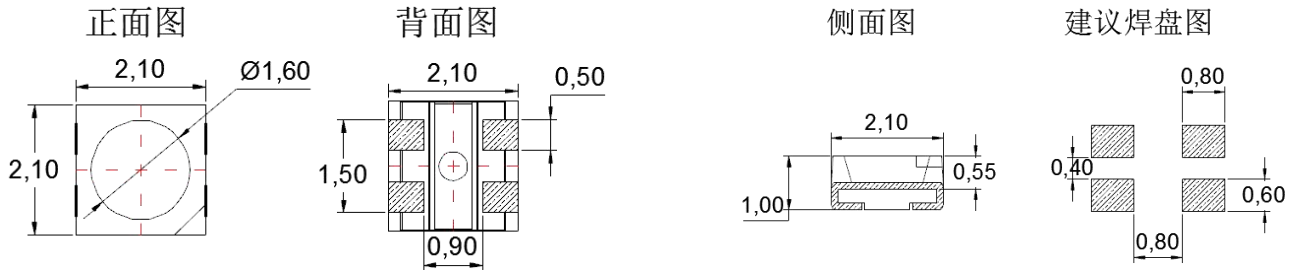
类型 Type	测试项目 Test items	参考标准 Reference standard	测试条件 Test conditions	注释 notes	失效 LED 数量 (PCS) Number of failed LEDs Quantity (PCS)
环境顺序 Environmental order	回流焊耐热测试 Reflow soldering heat resistance test	JESD22-B106	Tsld(回流焊温度)=260℃, 10sec	2次 2 times	0/22
	温度循环 Temperature cycle	JESD22-A104	-40℃ 30min ↑↓ 5min 100℃ 30min	100周期 100 cycles	0/22
	冷热冲击 Thermal Shock	JESD22-A106	-40℃ 15min ↑↓ 5min 100℃ 15min	100周期 100 cycles	0/22
	高温储存 High temperature storage	JESD22-A103	Ta=100℃	1000小时 1000 hours	0/22
	低温储存 Low temperature storage	JESD22-A119	Ta=-40℃	1000小时 1000 hours	0/22
	间断点亮测试 Intermittent lighting test	JESD22-A105	On 5min -40℃ > 15min ↑↓<15min Off 5min 100℃ > 15min	1000周期 1000 cycles	0/22
操作顺序 Operation sequence	老化寿命测试 Aging life test	JESD22-A108	Ta=25℃ IF=5V	1000小时 1000 hours	0/22
	高温高湿老化测试 High temperature and humidity aging test	JESD22-A101	60℃RH=90% IF=5V	1000小时 1000 hours	0/22

失效标准 Test criteria

项目 project	符号 Symbol	测试条件 Test conditions	失效标准 Failure criteria	
			最小 minimum	最大 maximum
发光强度 Luminous intensity	IV	DC=5V, 规格典型 电流 DC=5V, typical specification electric current	初始数据 X0.7 Initial data X0.7	---
耐焊接热 Resistance to welding heat	---	DC=5V, 规格典型 电流 DC=5V, typical specification electric current	无死灯或 明显损坏 No dead light or Obvious damage	---

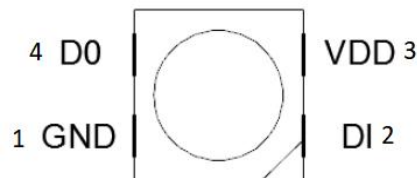
外形尺寸

Outline Dimension



LED引脚示意图:

LED pin diagram:



备注: 1.以上尺寸单位均为mm

Remarks: All dimensions are in millimeters.

2.未标注公差为: X.X ±0.10mm ,X.XX±0.05mm

Unmarked tolerances: X. X ± 0.10 mm, X. XX ± 0.05

LED引脚功能:

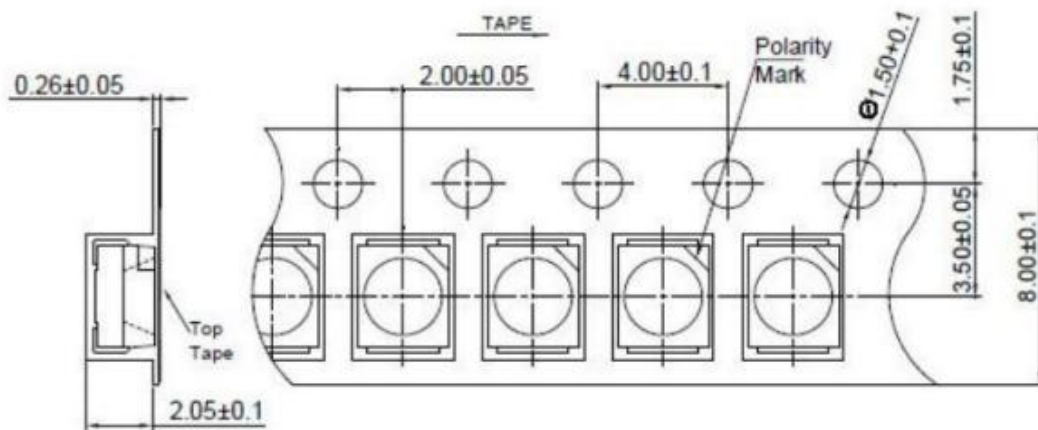
LED pin function:

引脚序号 Pin No	符号 Symbol	功能描述 Function description
1	GND/VSS	信号地及电源地 Signal ground and power supply ground
2	DI	显示数据输入 (800K) Display data input (800K)
3	VCC/VDD	内部IC电源正及RGB正极 INTERNAL IC power supply and RGB positive pole
4	DO	显示数据级联输出 (800K) Display data cascade output (800K)

包装 (1)

Packaging (1)

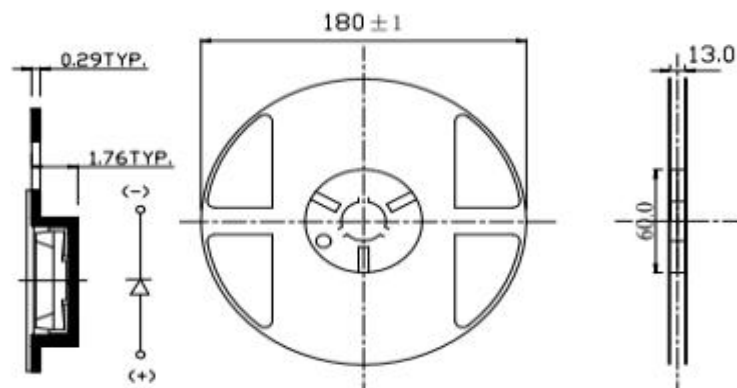
载带 Carrier Tape



单位: mm, 未注公差: ± 0.1 mm

All dimensions in mm, tolerances unless mentioned is ± 0.1 mm.

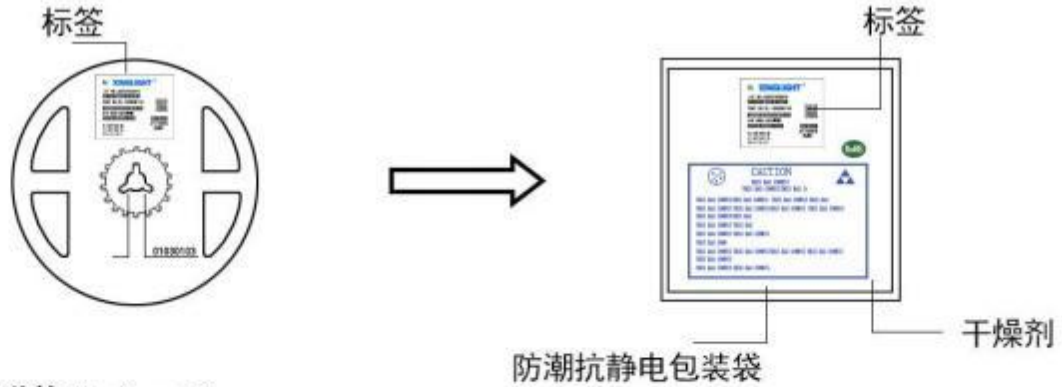
◇ 带盘 Reel Dimension



包装 (2)

Packaging (2)

◇ 防潮防静电包装 Moisture Proof and Anti-Electrostatic Foil Bag



◇ 外包装箱 Cardboard Box



Capacity 5 or 10 reels per box (内箱容量: 50或100卷)

◇ 标签说明: Label Explanation

- LOT NO: 批次信息
- PART NO: 产品型号
- BIN CODE: 产品名称
- WL: 波长范围
- IV: 光强范围
- VF: 电压范围



焊接指导（1）

Guideline for Soldering (1)

1. 使用烙铁人手焊接

Hand Soldering

推荐使用功率低于 20W 的烙铁，焊接时烙铁的温度必须保持在 300℃ 以下，且每个电极只能进行一次焊接，每次焊接的持续时间不得超过 3 秒。

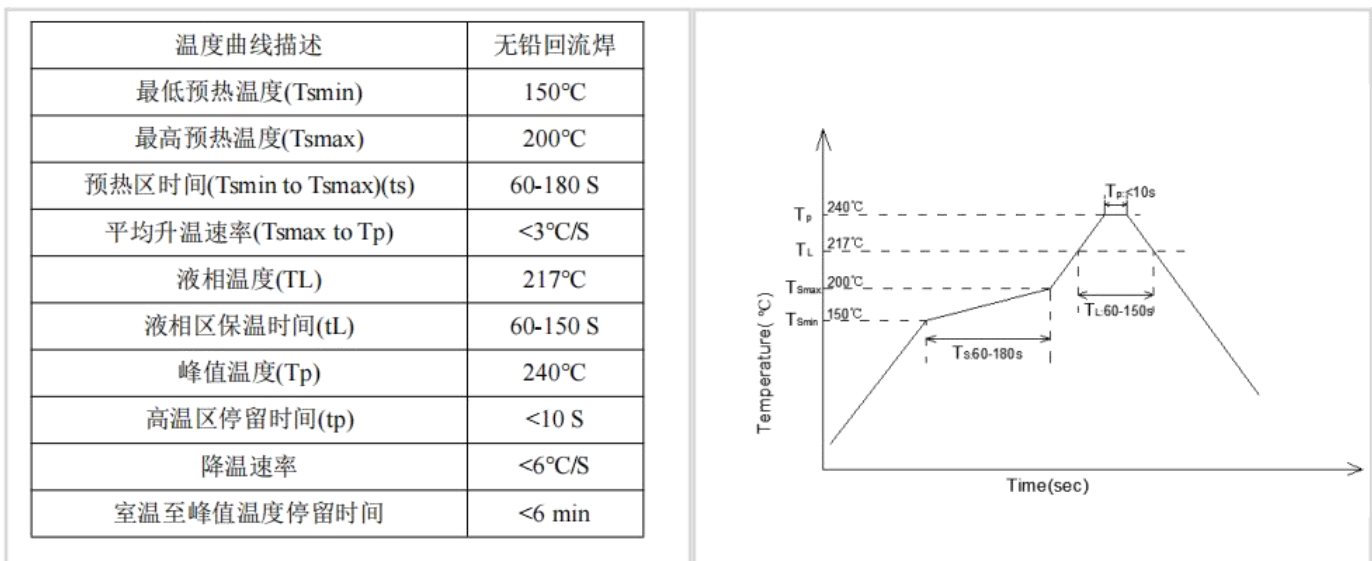
人手焊接过程中的不慎操作易引起 LED 产品的损坏，应当小心谨慎。

A soldering iron of less than 20W is recommended to be used in Hand Soldering. Please keep the temperature of the soldering iron under 300℃ while soldering. Each terminal of the LED is to go for less than 3 second and for one time only.

Be careful because the damage of the product is often started at the time of the hand soldering.

2. 回流焊接： 推荐使用以下无铅回流焊接温度图进行。

Reflow Soldering: Use the conditions shown in the under Figure of Pb-Free Reflow Soldering.



- 回流焊接最多只能进行两次。

Reflow soldering should not be done more than two times.

- 在回流焊接升温过程中，请不要对 LED 施加任何压力。

Stress on the LEDs should be avoided during heating in soldering process.

- 在焊接完成后，待产品温度下降到室温之后，再进行其他处理。

After soldering, do not deal with the product before its temperature drop down to room temperature.

焊接指导 (2)

Guideline for Soldering (2)

3. 清洗:

Cleaning

在焊接后推荐使用酒精进行清洗，在温度不高于 30°C 的条件下持续 3 分钟，不高于 50°C 的条件下持续 30 秒。使用其他类似溶剂清洗前，请先确认使用的溶剂不会对 LED 的封装和环氧树脂部分造成损伤。

超声波清洗也是有效的方法，一般最大功率不应超过 300W，否则可能对 LED 造成损伤。请根据具体的情况预先测试清洗条件是否会对 LED 造成损伤。

It is recommended that alcohol be used as a solvent for cleaning after soldering. Cleaning is to go under 30°C for 3 minutes or 50°C for 30 seconds. When using other solvents, it should be confirmed beforehand whether the solvents will dissolve the package and the resin or not.

Ultrasonic cleaning is also an effective way for cleaning. But the influence of Ultrasonic cleaning on LED depends on factors such as ultrasonic power. Generally, the ultrasonic power should not be higher than 300W. Before cleaning, a pretest should be done to confirm whether any damage to LEDs will occur.

4. 焊锡丝及锡膏的选择:

Selection of solder wire and solder paste:

不用含硫化物或溴化物的焊锡丝及锡膏，因为硫化物或溴化物会与支架表面电镀的银层进行化学反应，导致银层变黑，led 灯珠衰减就变大。

Selection of solder wire and solder paste: do not use solder wire and solder paste containing sulfide or bromide, because sulfide or bromide will chemically react with the silver layer plated on the surface of the support, causing the silver layer to become black, and the attenuation of led lamp beads will become larger.

*** 注意:** 此一般指导原则并不适用于所有 PCB 设计和焊接设备的配置。具体工艺受到诸多因素的影响，请根据特定的 PCB 设计和焊接设备来确定焊接方案。

*** Note:** This general guideline may not apply to all PCB designs and configurations of all soldering equipment. The technics in practise is influenced by many factors, it should be specialized base on the PCB designs and configurations of the soldering equipment..

使用注意事项（1）

Precautions (1)

1. 贮存：

Storage

- 本产品使用密封防潮抗静电袋包装，并附有干燥剂，未开封的产品有一年的保存时间。

Moisture proof and anti-electrostatic package with moisture absorbent material is used, to keep moisture to a minimum.

- 开封前，产品须存放在温度不高于 30℃，湿度不高于 60%RH 的环境中。

Before opening the package, the product should be kept at 30℃ or less and humidity less than 60% RH, and be used within a year.

- 开封后，产品须存放在温度不高于 30℃，湿度不高于 10%RH 的环境中，且应该在 168 小时（7 天）内使用完。建议工作环境为温度不高于 30℃，湿度不高于 60%RH。

After opening the package, the product should be stored at 30℃ or less and humidity less than 10%RH, and be soldered within 168 hours (7 days). It is recommended that the product be operated at the workshop condition of 30℃ or less and humidity less than 60%RH.

- 对于尚未焊接的 LED，如果吸湿剂或包装失效，或者产品没有符合以上有效存储条件，烘焙可以起到一定的性能恢复效果。烘焙条件：(60±5)℃，持续 24 小时。

If the moisture absorbent material has fade away or the LEDs have exceeded the storage time, baking treatment should be performed based on the following condition: (60±5)℃ for 24 hours.

2. 静电：

Static Electricity

静电和电涌会导致产品特性发生改变，例如正向电压降低等，如果情况严重甚至会损毁产品。所以在使用时必须采取有效的防静电措施。

所有相关的设备和机器都应该正确接地，同时必须采取其他防止静电和电涌的措施。

使用防静电手环，防静电垫子，防静电工作服、工作鞋、手套，防静电容器，都是有效的防止静电和电涌的措施。

Static electricity or surge voltage damages the LEDs. Damaged LEDs will show some unusual characteristic such as the forward voltage becomes lower, or the LEDs do not light at the low current. even not light.

All devices, equipment and machinery must be properly grounded. At the same time, it is recommended that wrist bands or anti-electrostatic gloves, anti-electrostatic containers be used when dealing with the LEDs.

使用注意事项 (2)

Precautions (2)

3. 设计建议:

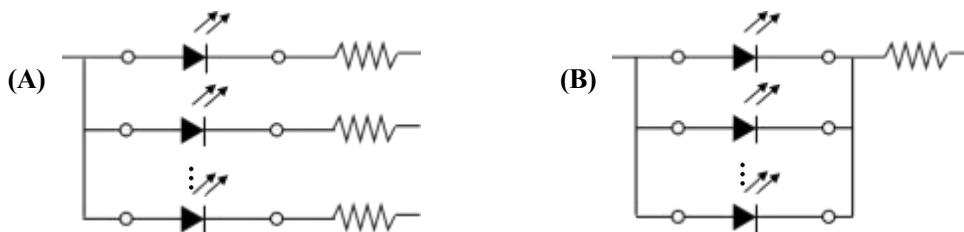
Design Consideration

设计电路时，通过 LED 的电流不能超过规定的最大值，同时，还需使用保护电阻，否则，微小的电压变化将会引起较大的电流变化，可能导致产品损毁。

建议使用以下 (A) 电路，该电路能够很好的调节通过每个 LED 的电流；不推荐使用 (B) 电路，该电路在持续的电压驱动下，LED 的正向电压 (V_F) 发生变化，电流会随之而发生变化，可能使某些 LED 承受高于规定的电流值。

In designing a circuit, the current through each LED must not exceed the absolute maximum rating specified for each LED. In the meanwhile, resistors for protection should be applied, otherwise slight voltage shift will cause big current change, burn out may happen.

It is recommended to use Circuit A which regulates the current flowing through each LED rather than Circuit B. When driving LEDs with a constant voltage in Circuit B, the current through the LEDs may vary due to the variation in Forward Voltage (V_F) of the LEDs. In the worst case, some LED may be subjected to stresses in excess of the Absolute Maximum Rating.



LED 的特性容易因为自身的发热和环境的温度的改变而发生改变。温度的升高会降低 LED 的发光效率、影响发光颜色等，所以在设计时应充分考虑散热的问题。

Thermal Design is paramount importance because heat generation may result in the Characteristics decline, such as brightness decreased, Color changed and so on. Please consider the heat generation of the LEDs when making the system design.

使用注意事项 (3)

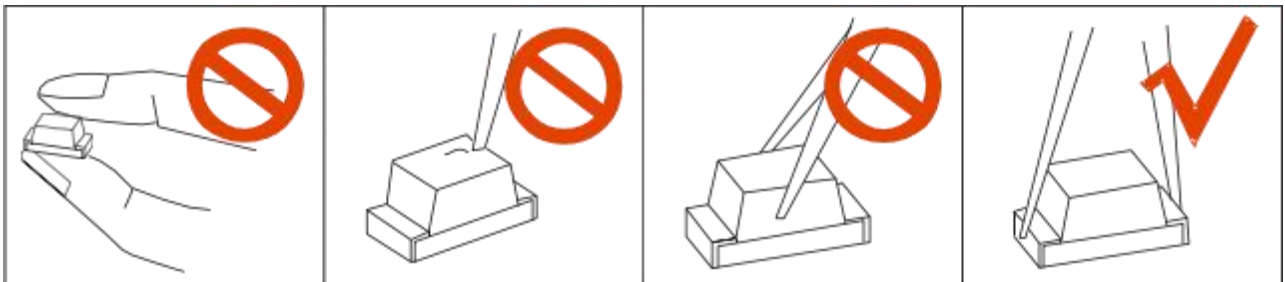
Precautions (3)

4. 其他事项:

Others

直接用手拿取产品不但会污染封装树脂表面，也可能由于静电等因素导致产品性能的改变。过度的压力也可能直接影响封装内部的管芯和金线，因此请勿对产品施加过度压力，特别当产品处于高温状态下，例如在回流焊接过程中。

When handling the product, touching the encapsulant with bare hands will not only contaminate its surface, but also affect on its optical characteristics. Excessive force to the encapsulant might result in catastrophic failure of the LEDs due to die breakage or wire deformation. For this reason, please do not put excessive stress on LEDs, especially when the LEDs are heated such as during Reflow Soldering.



LED 的环氧树脂封装部分相当脆弱，请勿用坚硬、尖锐的物体刮、擦封装树脂部分。在用镊子夹取的时候也应当小心注意。

The epoxy resin of encapsulant is fragile, so please avoid scratch or friction over the epoxy resin surface. While handling the product with tweezers, do not hold by the epoxy resin, be careful.

5. 眼睛保护忠告:

Safety Advice For Human Eyes

LED 发光时，请勿直视发光光源，特别是对于一些光强较高的 LED，强光可能伤害你的眼睛。

Viewing direct to the light emitting center of the LEDs, especially those of great Luminous Intensity, will cause great hazard to human eyes. Please be careful.

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