SK9816

5.5x5.0x1.6mm Top SMD Type 0.3Watt Power Single line transmission And High grade grey level tegrated light source Intelligent control LED （5a）

Change History

Date	Rev. No.	Changes/Reason of changes	Signature
2015-07-08	01	Initial Document	KEVIN ZHU
2017-07-14	02	Modify the usage specification	KEVIN ZHU
2018-05-18	03	Fix internal data structure	KEVIN ZHU
2019-01-21	04	Revision of Specification Format	KEVIN ZHU

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1. Product Overview :

SK9816 is an intelligent external control LED light source that integrates a single-wire transmission three-channel (RGB) drive control circuit and a light emitting circuit. The product contains signal decoding module, data buffer, built-in constant current circuit and RC oscillator; internal integrated current gain control module, CMOS process, low voltage, low power consumption; default output of three-channel constant current driver is 19mA, single-wire output is adopted, The output actions of each chip in series are synchronized; the power-on default is no light. Unipolar NRZ data protocol of communication, the transmission-line LED driving control dedicated chip, while the chip built-in current gain adjustment function, setting the current 1.75mA ~ 19mA, a total of 16 current gain levels; refresh rate of the PWM signal is high 4KHz, displays become more smoother, dark streaks solve the shooting screen;

2. Main Application Field:

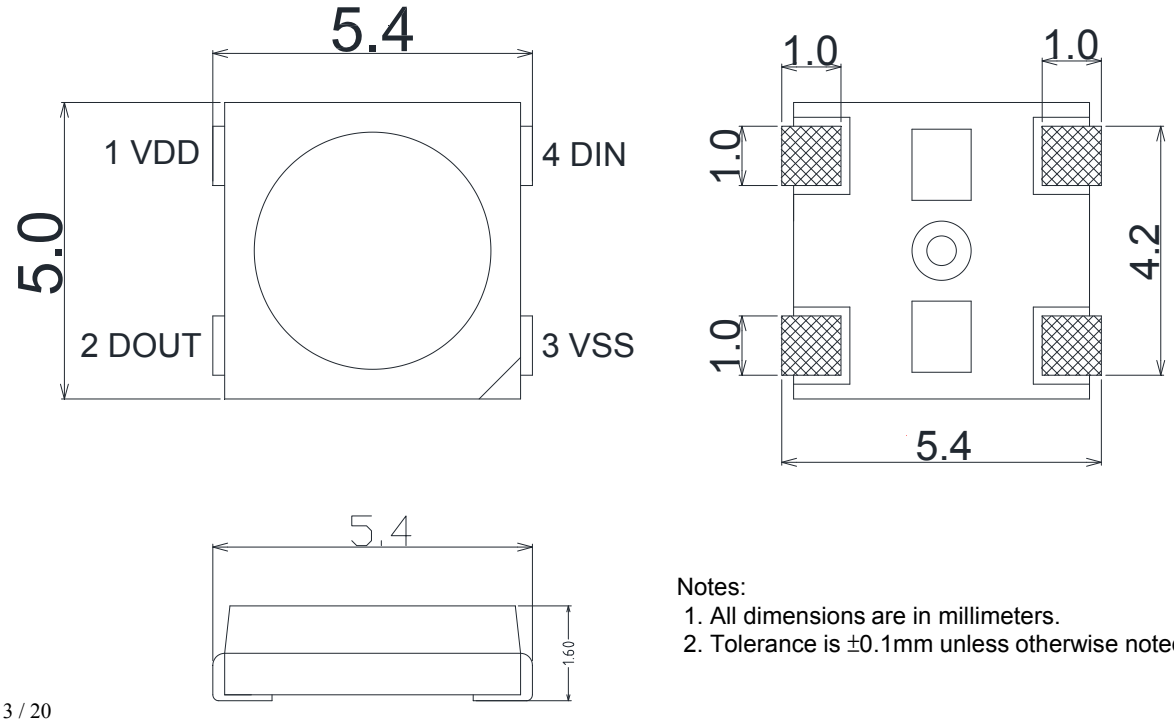
● Full color LED string light, LED full color module, LED super hard and soft lights, LED guardrail tube, LED appearance / scene lighting

● LED point light, LED pixel screen, LED shaped screen, a variety of electronic products, electrical equipment etc..

3. Description:

● Top SMD internal integrated high quality external control line serial cascade constant current IC; 5V application; default on electric lights;
● Control circuit and the RGB chip in SMD 5050 components, to form a complete control of pixel, color mixing uniformity and consistency;
● Single-wire synchronous control, built-in one-way transmission function, the concatenation shaped output; prevent attenuation data;
●OUTR/G/B each 4bits current gain adjustment bit, grayscale adjustment circuit ((gamma correction) 65536 gray scale adjustable);
● Current driver as high-accuracy and high stability oscillator, current error <± 5%.
● Built-in PWM patented technology, refresh rate up to 4KHz, signal transmission rate of 800Kbps.
● When sending current gain data, all need to send 16bits current gain adjustment bit. When sending RGB three-color current gain bits, the reserved 4bits gain data is also randomly input, but it can not be null; any data can be sent.

4. Mechanical Dimensions:

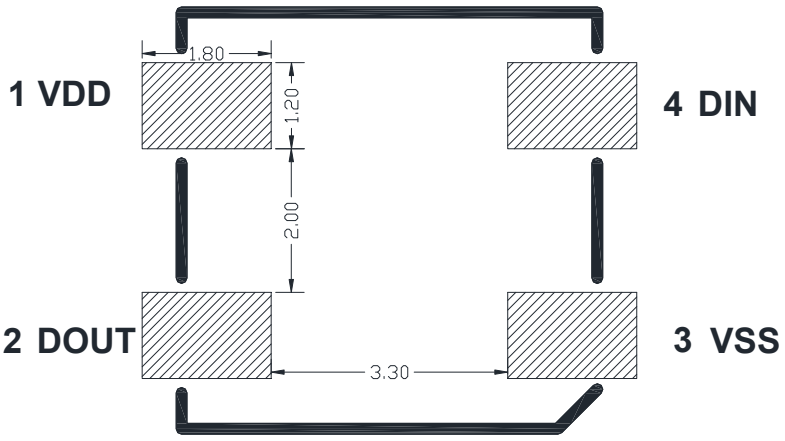


Notes:
1. All dimensions are in millimeters.
2. Tolerance is ±0.1mm unless otherwise noted

5. PIN configuration

Item	Symbol	Pin Name	Function description
1	VDD	Power	power supply pin
2	DOUT	Data Input	Series data output and internal strong drive output
3	VSS	Ground	The signal and power supply and grounding
4	DIN	Data Input	control signal Input data

6. Recommended dimensions for PCB



7. General description of product naming.

SK 9816-X-X

① ② ③ ④

①	②	③	④
Series	IC series and current code	PPA Surface Color	Packaging glue color
The default is to integrate the RGB chip with the IC in the 5.4x5.0x1.6mm package outline	Refers to the 9816 series IC 2~19MA current version（Adjustable current）	B: Black faceW: White face, usually not marked.	D: Represents diffusion/grindingW: It means transparent, not labeled.

8. Electrical Parametres（Ta=25℃,VSS=0V）：

Parameter	Symbol	Range	Unit
Power supply voltage	VDD	+3.7～+5.5	V
Logic input voltage	V_{IN}	-0.4～VDD+0.4	V
Working temperature	Topt	-40~+85	℃
Storage temperature	Tstg	-50~+150	℃
ESD pressure(HBM)	V_{ESD}	>4K	V
ESD pressure(DM)	V_{ESD}	200	V

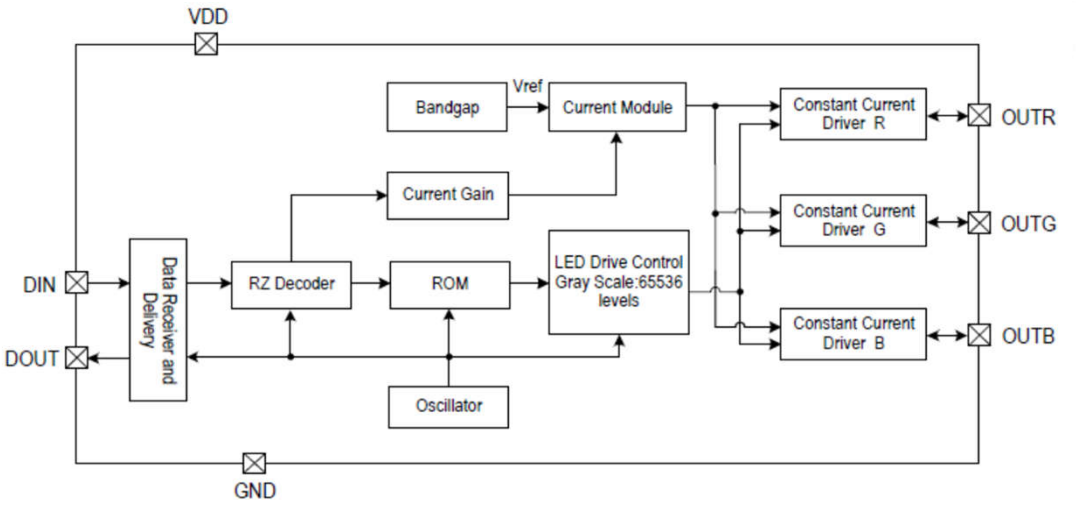
9. Electrical/Optical Characteristics:

Color	SK9816 2-19mA		
	Dominate Wavelength(nm)	Luminance(mcd)	luminous flux(lm)
Red	620-630	400-700	1.0-2.0
Green	520-535	1000-1500	3.0-4.0
Blue	460-475	200-400	0.5-1.0

10. The IC electrical parameters (unless otherwise specified, TA=-20 ~ +70 ℃, VDD=5.0V, VSS=0V):

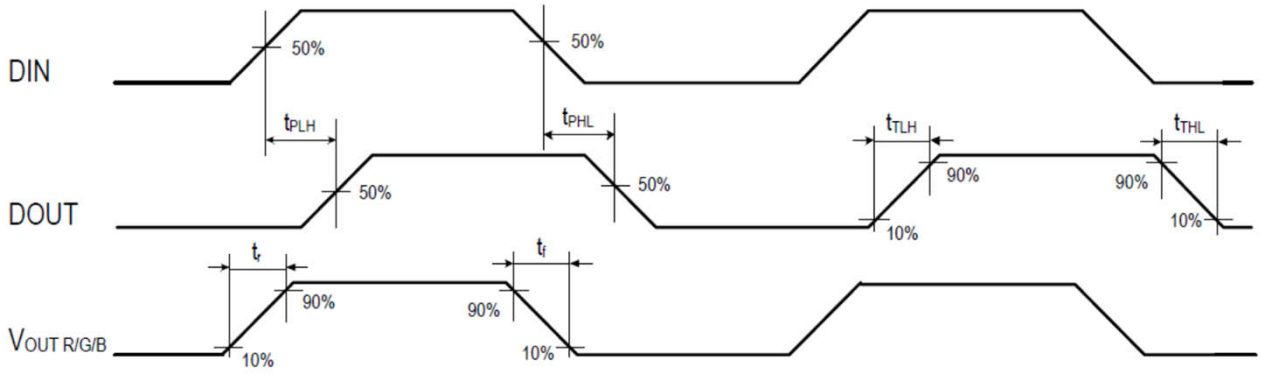
Parmeter	Symbol	Min	Typical	Max	Unit	Test conditions
The chip supply voltage	VDD	3.5	5.0	5.5	V	---
Static power consumption	I_{DD}	---	2.5	---	mA	VDD=4.5V,Iout"OFF"
The signal input flip threshold	VIH	0.7*VDD	---	---	V	VDD=5.0V
	VIL	---	---	0.3*VDD	V	
The biggest LED output current	I_{max}	1.75	---	19.0	mA	V_{DS} =2V, current gain setting 0000~1111
The frequency of PWM	FPWM	---	4.0	---	KHZ	---
OUT R/G/B leak current	I_{leak}	---	---	1	uA	V_{DS} =15V, Iout"OFF"
OUT R/G/B constant current knee point voitage	V_{DS-s}	---	0.5	---	V	I_{OUT} =5mA
		---	0.7	---	V	I_{OUT} =12mA
		---	0.7	---	V	I_{OUT} =19mA
OUTR / G / B port current variation	%VS.V_{DS}	---	1.0	---	%	V_{DS} =1~3V, I_{OUT} =19mA
	%VS.VDD	---	1.0	---	%	VDD =4.2~5.2V, I_{OUT} =19mA
	%VS . Temp.	---	---	6.0	%	I_{OUT} =19mA,Temp=-40~+85℃

11. Internal functional framework



12. Switching characteristics (VCC = 5V ± 5%, Ta = 25 ° C):

Parameter	Symbol	Min	Typical	Max	Unit	Test conditions
The speed of data transmission	F_{PWM}	---	4.0	---	KHZ	I_{OUT} =19mA,OUT R/G/B connects 200Ω resistor to VDD
Signal transmission delay	T_{PLH}	---	65	---	ns	DOUT load capacitor to ground:30pF DIN to DOUT signal,transmission delay
	T_{PHL}	---	55	---	ns	
DOUT Transfer time	T_{TLH}	---	3.0	---	ns	DOUT load capacitor to ground:30pF
	T_{THL}	---	3.0	---	ns	
OUT R/G/B transfer time	T_r	---	55	---	ns	I_{OUT} =19mA,OUT R/G/B connects 200Ω resistor to VDD load capacitor to ground:15pF
	T_f	---	60	---	ns	



13. Data communication protocol:

(1) Code Description:

The protocol of the SK9816 adopts single polarity RZ code, LOW level must be contained in each code element. Each code element in the protocol initiates with HIGH level , and the width of the HIGH level time determines 0 code or 1 code.

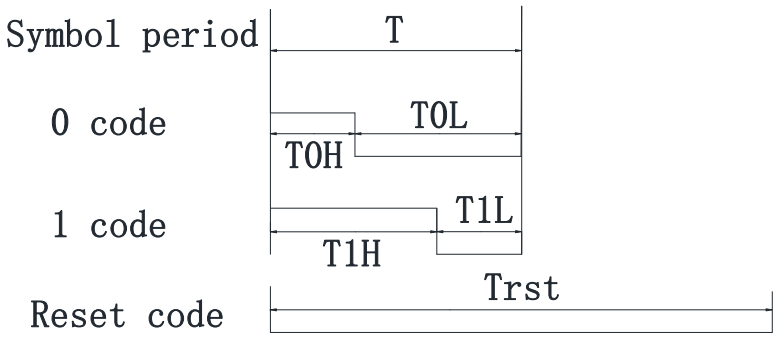
Symbol		Min.	Typ.	Max.	Unit
T	Code element period	1.20	--	--	μs
T0H	0 , HIGH level	0.2	0.3	0.4	μs
T0L	0 , LOW level	0.8	0.9	--	μs
T1H	1 , HIGH level	0.8	0.9	1.0	μs
T1L	1 , LOW level	0.2	0.3	--	μs
Trst	Reset，LOW level	>80	--	--	μs

When writing the program, the minimum code period is 1.2us.

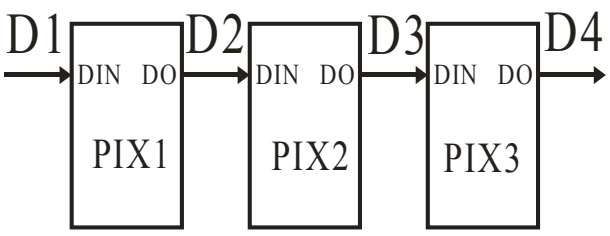
The high level time of 0 and 1 code should be in accordance with the specified scope of the above table, and the low level time of 0 yards and 1 yard is less than 20us.

14. Timing waveform:

Input code:



Connection mode:



(2) Protocol Data Format:

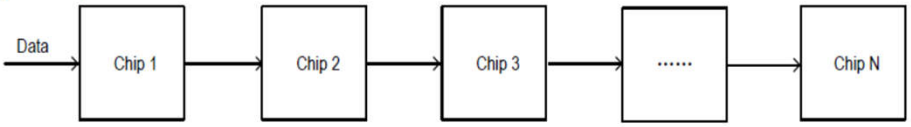
Trst+ First chip 24bits data +Second chip 24bits data +……+ The N chip 24bits data +16bits current gain +Trst

- 24bits gray scale data structure: High levels first, sent by the order of RGB

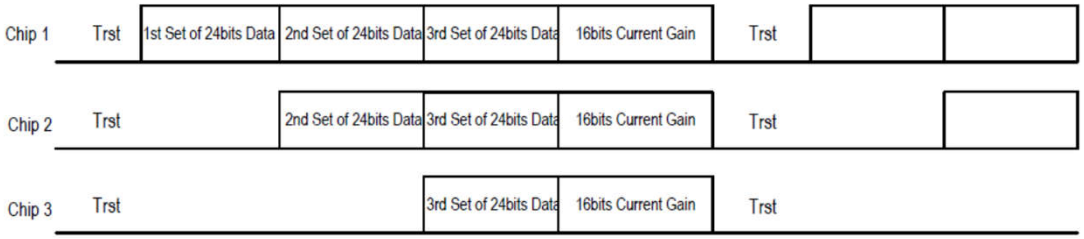
R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0

bit23……bit0

- System Topological Graph:



- Input Data Stream of every chip (3 chips as an example):



Total current gain data:16bits, with 4 reserved bits and 4 bits RGB current gain adjustment for each color, respectively Correspond 4bits(S3~S0). The system order is to send 4 bits of R first, then 4 bits G, 4bits of B, 4 bits of reserved. High Level S3 sent first , low level S0 at last.

Current gain parameter transmission format			
Red（R)	**Green（G)**	**Blue（B)**	**Reserved bit**
S3 , S2 , S1 , S0	**S3 , S2 , S1 , S0**	**S3 , S2 , S1 , S0**	**S3 , S2 , S1 , S0**

Note: Reserved bits data do not affect current gain adjustment.

Maximum output current of OUT R/G/B is 19mA. Users can regulate other current value by changing current gain value. The current value refers to the sheet below：

Current regulation level	Current gain adjustment bit				Corresponding current value (mA)
	S3	S2	S1	S0	
1	0	0	0	0	1.75
2	0	0	0	1	2.90
3	0	0	1	0	4.05
4	0	0	1	1	5.20
5	0	1	0	0	6.35
6	0	1	0	1	7.50
7	0	1	1	0	8.65
8	0	1	1	1	9.80
9	1	0	0	0	10.95
10	1	0	0	1	12.10
11	1	0	1	0	13.25
12	1	0	1	1	14.40
13	1	1	0	0	15.55
14	1	1	0	1	16.70
15	1	1	1	0	17.85
16	1	1	1	1	19.00

15. Constant Current Characteristic:

When it gets to constant current knee point voltage, MW1863-DICE output current is not affected by V_{DS}.

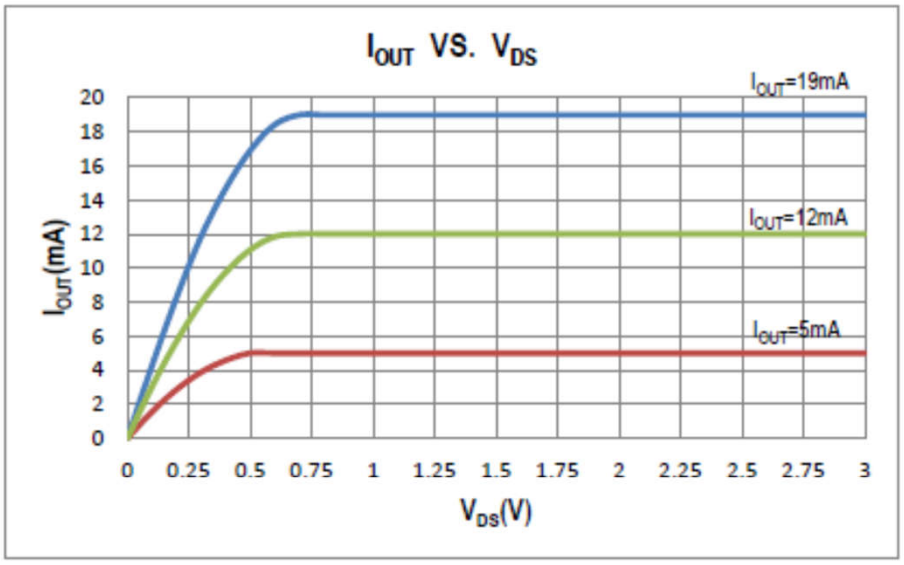


Fig. Relationship diagram between I_{OUT} and V_{DS}

Output Current Setting

Maximum OUT R/G/B output current is 19mA. When current gain is in 16-level, the maximum current value is 19mA.

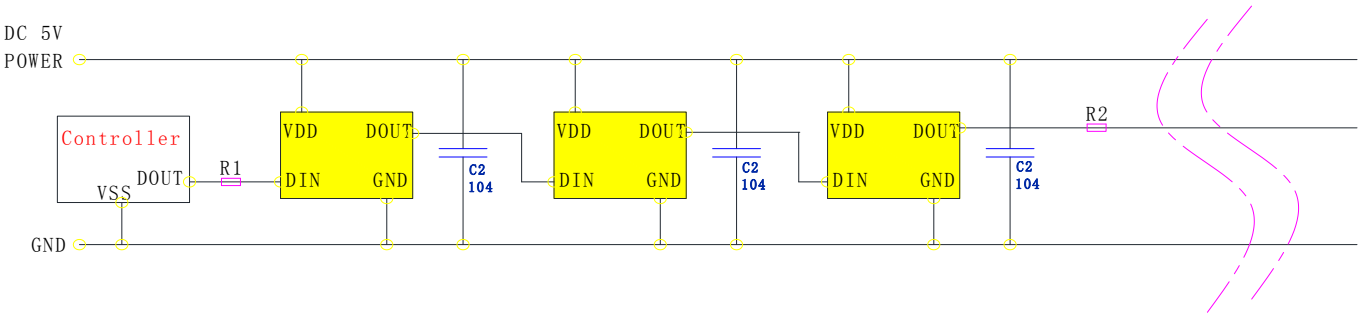
Current gain is in 1~16-level, output current value is set by the formula below:

$$I_{OUT}(mA) = 1.75 + 1.15 \times (G - 1)$$

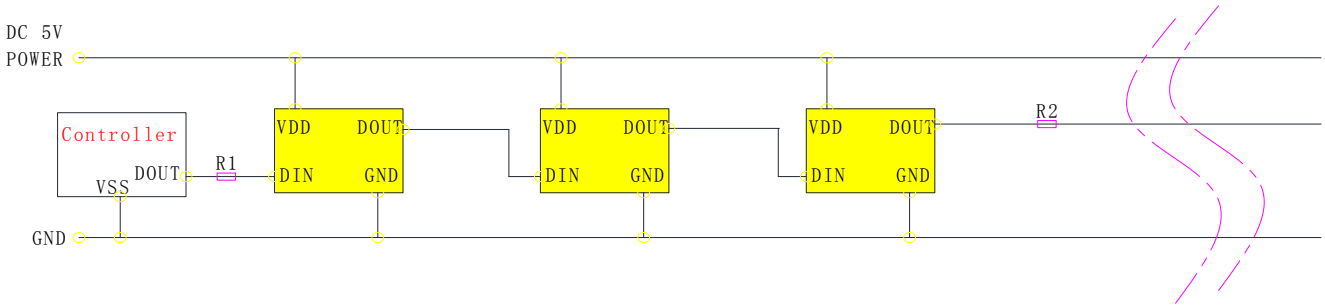
G is current gain (1~16-level). When G=1, I_{OUT}=1.75mA, when G=16, I_{OUT}=19mA.

16. The typical application circuit:

Typical application circuit One:



Capacitance-free application circuit Two:
We must ensure that no product power spike noise and damage to the LED used; and the maximum number cascaded LED ≤30Pcs.



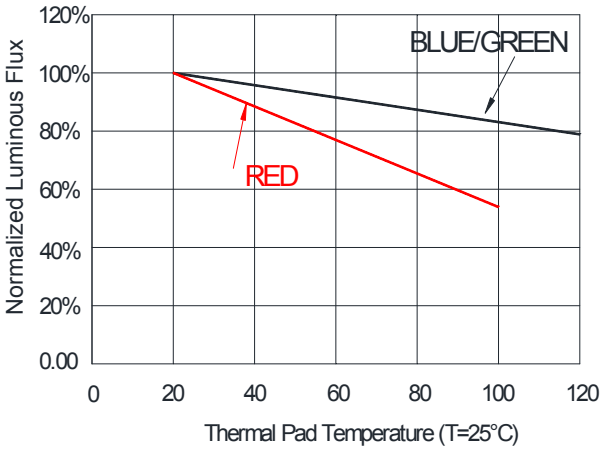
In the practical application circuit, in order to prevent the instantaneous high-voltage damage to the internal power supply and signal input and output pin of IC caused by the charged plug of the product during the test, the protective resistance should be connected in the signal input and output end. In addition, in order to make each IC chip work more stably, the decoupling capacitance between each lamp bead is essential.

1. The two ends of the product and decoupling capacitors are generally not recommended omitted; must be omitted, shall ensure compliance with the requirements of said application circuit using two power supply;

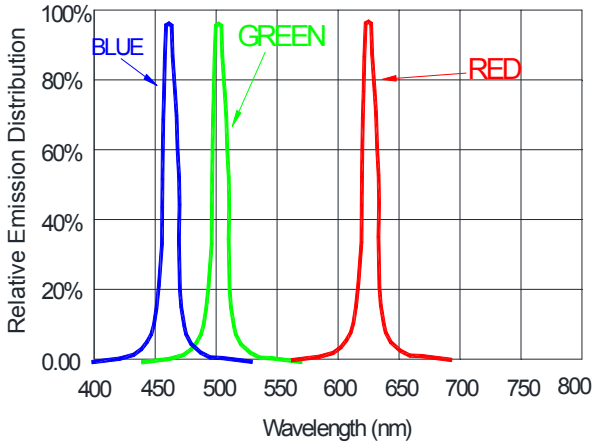
2. The signal input and output of the product must be connected in series with the protection resistors R1/R2. The size of R1/R2 depends on the number of cascaded lamp beads. The larger the number of cascades is, the smaller the R1/R2 is. Generally recommended at 200- Values between 2000 ohms are usually recommended around 500 ohms;

17. Standard LED Performance Graph:

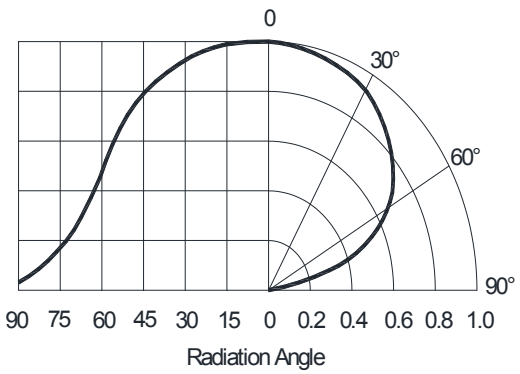
Thermal Pad Temperature vs. Relative Light Output



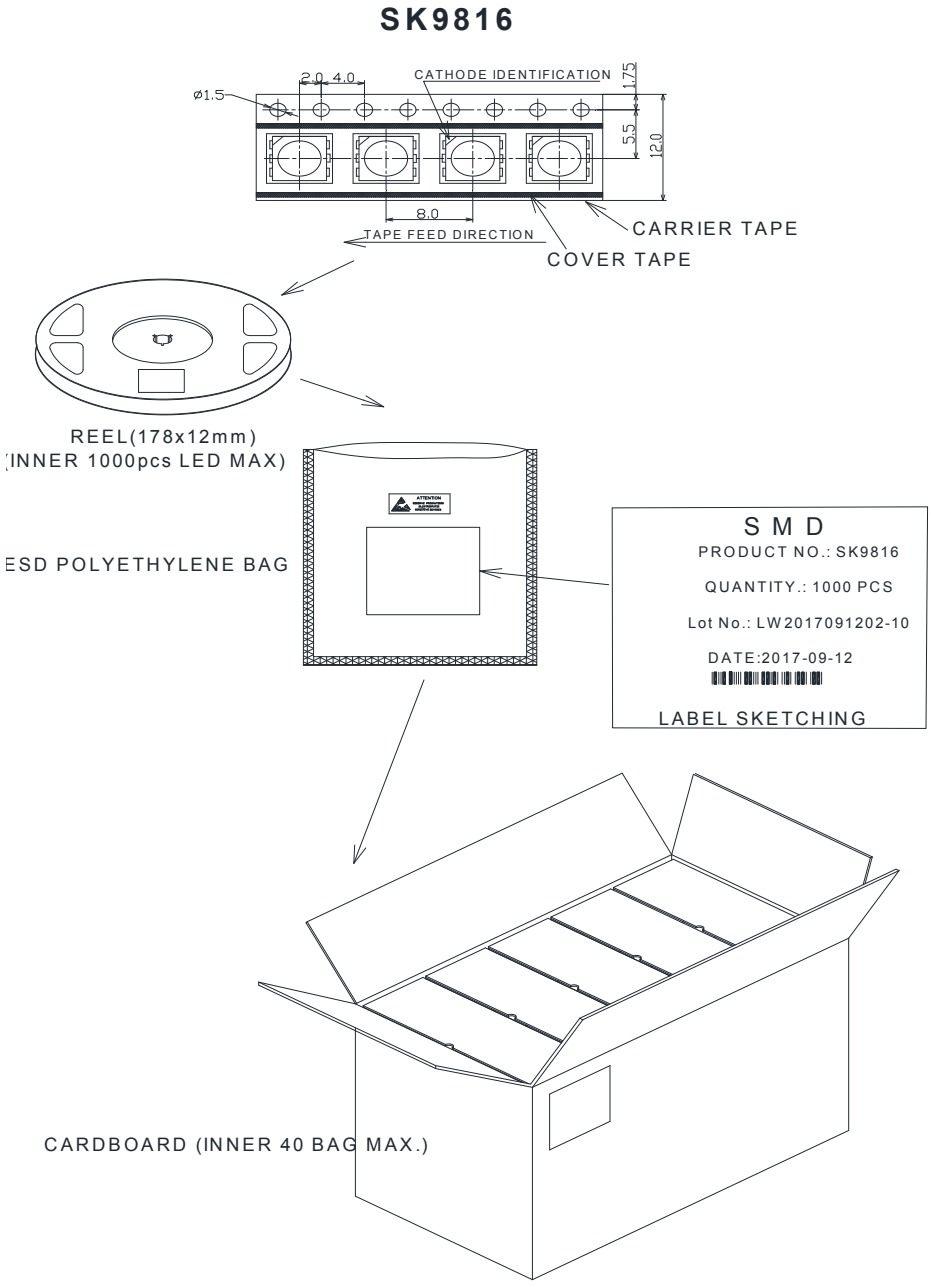
Wavelength Characteristics



Typical Radiation Pattern 120°



18. Packaging Standard:



The reel pack is applied in SMD LED. The LEDs are packed in cardboard boxes after packaging in normal or anti-electrostatic bags. cardboard boxes will be used to protect the LEDs from mechanical shocks during transportation. The boxes are not water resistant and therefore must be kept away from water and moisture.

19. Reliability Test :

NO.	Test item	Test Conditions	Reference	Criterion
1	Thermal Shock	100 ± 5° C ~ -40° C ± 5° C 30min~30min 300 cycles	MIL-STD-202G	0/22
2	High Temperature Storage	Ta= +100°C 1000hrs	JEITA ED-4701 200 201	0/22
3	Low Temperature Storage	Ta= -40°C 1000hrs	JEITA ED-4701 200 202	0/22
4	High Temperature High Humidity Storage	Ta=60°C RH=90% 1000hrs	JEITA ED-4701 100 103	0/22
5	Temperature Cycle	-55°C~25°C~100°C~25°C 30min~5min~30min~5min 100 cycles	JEITA ED-4701 100 105	0/22
6	Resistance to Soldering Heat	Tsld = 260° C, 10sec. 3 times	JEITA ED-4701 300 301	0/22
7	Room temp Life Test	25° C, IF: Typical current , 1000hrs	JESD22-A 108D	0/22

Criteria for Judging the Damage:

Item	Symbol	Test Condition	Limit	
			Min	Max
Luminous Intensity	IV	DC=5V, Typical current	Init. Value*0.7	---
Resistance to Soldering Heat	---	DC=5V, Typical current	No dead lights or obvious damage	

APPENDIX 1.TOP SMD LED Application Notes

1. Features

The Purposes of making NORMAND's customers and users to have a clear understanding on the ways how to use the LED.

2. Description

Generally. The LED can be used the same way as other general purposed semiconductors. When using NORMAND's TOP SMD LED, the following precautions must be taken to protect the LED.

3. Cautions

3.1. Dust & Cleaning

This emitter has a silicone surface, There are many benefits to the silicone surface in terms of optical properties and improved reliability. However, silicone is a softer material and prone to attract dust. While a minimal amount of dust and debris on the LED will not cause significant reduction in illumination, steps should be taken to keep the emitter free of dust.

These include keeping the LEDs in the manufacturer's package prior to assembly and storing assemblies in an enclosed area after installing the emitters.

Surface condition of this device may change when organic solvents such as trichloroethylene or acetone were applied.

Avoid using organic solvent, it is recommended that isopropyl be used as a solvent for cleaning the LEDs. When using other solvents, it should be confirmed beforehand whether the solvents will dissolve the package and the resin of not.

Do not clean the LEDs by the ultrasonic. When it is absolutely necessary, the influence as ultrasonic cleaning on the LEDs depends on factors such as ultrasonic power. Baking time and assembled condition. Before cleaning, a pre-test should be done to confirm whether any damage to the LEDs will occur.

3.2. Shipment and storage

TOP SMD LED is a humidity sensor, the LED packaging in the aluminum bag is to avoid the LED in the transport and storage of moisture absorption, in the bag with a desiccant to absorb the moisture inside the bag. If the LED absorbs water vapor, then in the LED over reflow, in the high temperature state, into which the rapid expansion of gas vaporization and produce a greater internal stress, so that the material crack, layered or damaged bonding wire , Resulting in product failure.

TOP SMD LED with a moisture-proof anti-static aluminum foil bag packaging, handling should avoid the process of squeezing, piercing the case of bags, and do the necessary anti-static protective measures; promise products on the line before the leak or broken, Please stop the use of direct use of the product; , Resulting in product failure;

Such as before the material has been found to prevent moisture-proof aluminum foil bags have been opened, damaged, perforated can be returned to the original re-dehumidification, must not be on-line use;

The humidity level of this product is LEVEL6.

Chart 1:Definition of material’ s MSL prescribed by IPC/JEDECJ-STD-020

Moisture proof	Workshop lifespan after open the packaging	
	Time	condition
LEVEL1	unlimited	≦30℃/85 % RH
LEVEL2	1 year	≦30℃/60 % RH
LEVEL2a	4 Weeks	≦30℃/60 % RH
LEVEL3	168 Hours	≦30℃/60 % RH
LEVEL4	72 Hours	≦30℃/60 % RH
LEVEL5	48 Hours	≦30℃/60 % RH
LEVEL5a	24 Hours	≦30℃/60 % RH
LEVEL6	Take off and use immediately	≦30℃/60 % RH

3.3. Storage before unsealing

In order to avoid the moisture barrier caused by the reliability of the failure problem, need to do LED products SMT pre-storage and moisture-proof measures;

If the moisture-proof bag is not open, the TOP SMD element will be stored for less than 2 months at <30 ˚ C / 60% RH; (Note: The label date is the same and the packing is not leaked. Discoloration under the premise of use; for different moisture-proof grade materials or packaging to save the time there is a certain difference, the specific preservation time to the specification book or packaging tips prevail); recommended in the unassembled do not open the moisture before the bag;

3.4. Control after the packing bag is opened

After opening the moisture-proof bag, please read the moisture-proof bag inside the humidity indicator card in the moisture-proof beads into pink to confirm moisture in the moisture bag is too much, according to the color of the ball to determine whether the bag material on-line operation; And the material after opening the package should be strictly controlled in the table 1 as specified by the maximum temperature and humidity and operating time allowed, as long as the material exposed in the environment described in Table 1, the need to accumulate its use in the workshop time. Open the bag and paste the material on the PCB board, should be completed within 0.5H welding work, do not recommend the material attached to the PCB, a long time stay in the workshop does not carry out SMT work; Caused by adverse water within the lead;

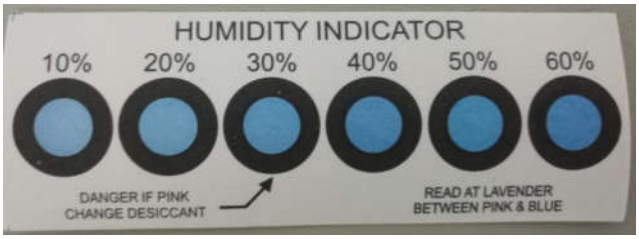
3.5. Definition of humidity card

Open the package after the TOP SMD LED bag inside the humidity card color instructions are as follows:

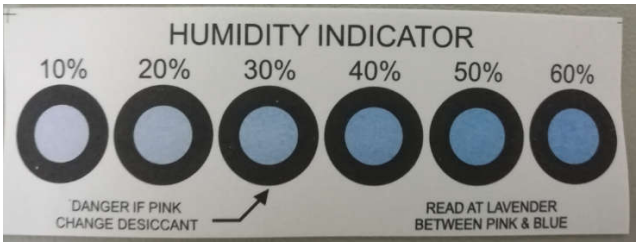
A. If the moisture card 10% of the moisture-proof beads into pink, other files for the blue, this situation, LED can be used directly;

B. If the humidity card moisture-proof beads 10%, 20% at all become pink, in fact, the file is blue, this situation, the need for low-temperature components dehumidification;

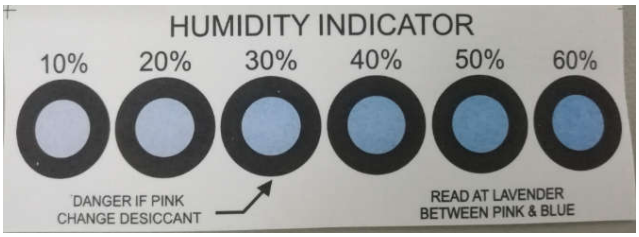
C. If the humidity card moisture-proof beads 10%, 20%, 30% more than three are turned pink, in this case, the customer needs to return the material to our company for high humidity dehumidification, re-packaging before use;



Humidity indicator DO not change color



Humidity indicator tums pink in 10% 20%



Humidity indicator tums pink in 10% 20% 30%

3.6. Unwanted material moisture-proof storage and moisture-proof control of finished material

If a roll of SMDs is not used at once and the plant temperature and humidity are within the defined conditions (<30 ˚ C / 60% RH), the exposure time of the element in the air does not exceed 2H, the remaining material should be carried out together with the desiccant Vacuum sealed, otherwise, the material must be low-wet baking dehumidification; dehumidified material can be re-packaged to re-start the calculation time;

Perform moisture control on SMDs components that have been assembled

A. After the components have been assembled to the PCB board no longer need to go through the high temperature process or reflow process, it will not be special treatment;

B. Do not need to do the necessary dehumidification work before making the appropriate protection process, bake in 70 ℃ ± 5 ℃ oven baking for less than 12 hours, To remove the product in the detection and aging process exposed to moisture in the air to avoid the product in the protective treatment, the package in the material surface of the moisture will slowly invade the product, will cause product failure;

C. For products that require secondary SMT process or high temperature, they should be subjected to the necessary moisture treatment before secondary welding, after exposure to (<30 ˚ C / 60% RH) , The maximum length of not more than 2H, Connaught second high temperature process separated by a long time, then a welding material must be necessary dehumidification work (70 ℃ ± 5 ℃ oven baking no less than 12 hours), and then pumping Vacuum storage; or the first product stored in the oven or with a desiccant container, the second high-temperature process before doing dehumidification work (70 ℃ ± 5 ℃ in the oven baking no less than 12 hours) , To ensure that products in the high temperature before the process is not damp;

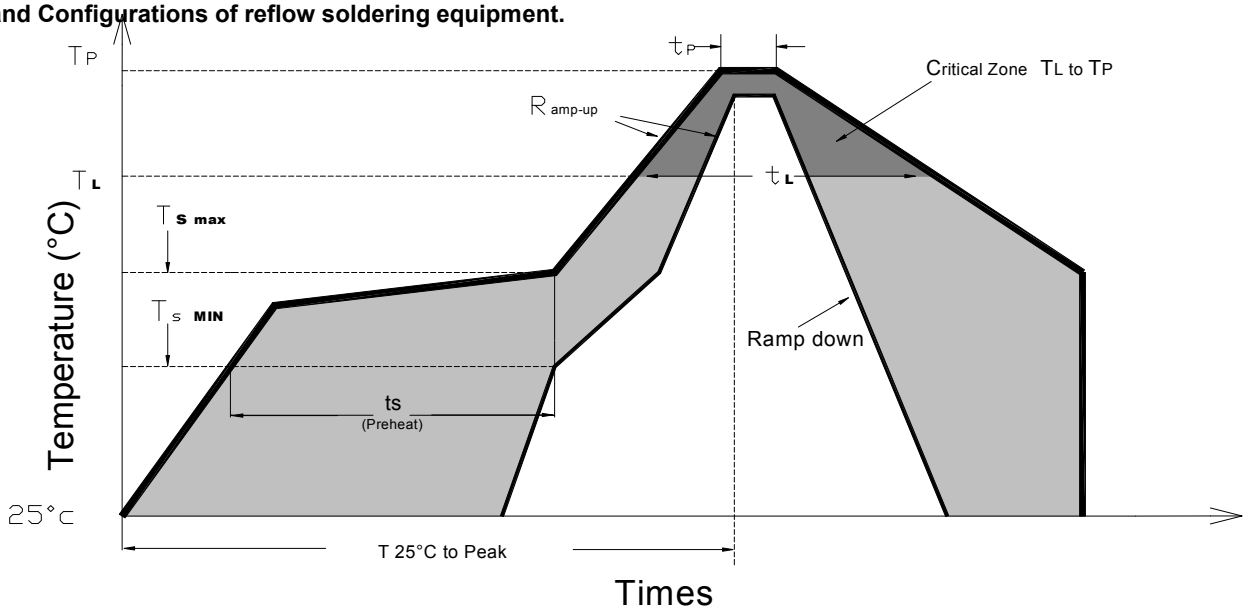
Low-temperature baking conditions: 70 ˚ C ± 5 ˚ C baking not less than 12 hours high temperature baking conditions: 130 ˚ C ± 5 ˚ C baking not less than 6 hours (lamp beads must be split into particles)

3.7. Reflow Soldering Characteristics

In testing, NORMAND has found S50 LEDs to be compatible with JEDEC J-STD-020E,using the parameters listed below. As a general guideline NORMAND recommends that users follow the recommended soldering profile provided

by the manufacturer of solder paste used.

Note that this general guideline is offered as a starting point and may require adjustment for certain PCB designs and Configurations of reflow soldering equipment.

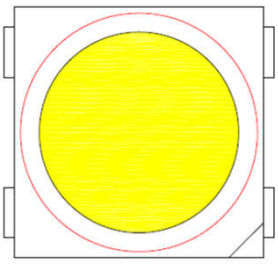


Profile Feature	Lead-Based Solder	Lead-Free Solder
Average Ramp-Up Rate (Ts_{max} to Tp)	3℃/second max.	3℃/second max.
Preheat: Temperature Min (Ts_{min})	100℃	150℃
Preheat: Temperature Min (Ts_{max})	150℃	200℃
Preheat: Time ($ts_{min\ to}$ ts_{max})	60-120 seconds	60-180 seconds
Time Maintained Above: Temperature (T_L)	183 ℃	217 ℃
Time Maintained Above: Time (t_L)	60-150 seconds	60-150 seconds
Peak/Classification Temperature (T_P)	215 ℃	240 ℃
Time Within 5℃ of Actual Peak Temperature (tp)	<10 seconds	<10 seconds
Ramp-Down Rate	6℃/second max.	6℃/second max.
Time 25 ℃ to Peak Temperature	<6 minutes max.	<6 minutes max.

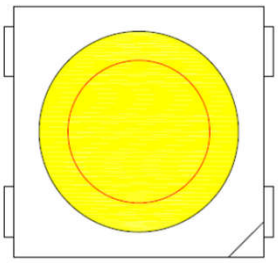
Note: All temperatures refer to topside of the package, measured on the package body surface.

3.8 General design requirements :

. SMT nozzle requirements: (red circle refers to the nozzle diameter)



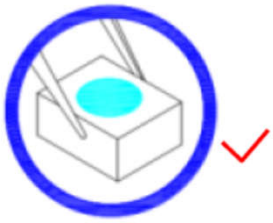
OK (nozzle diameter is greater than the light bulb area



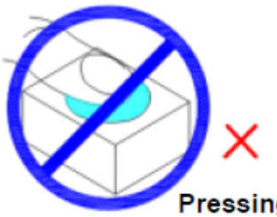
NG (nozzle diameter is less than the light beads light area)

. Material to take way: with tweezers folder material, can not press the colloid or sharp objects to touch the colloid, the material can not be stacked;

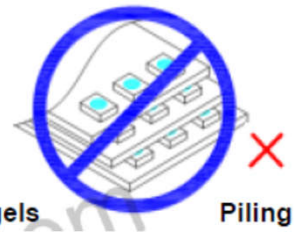
a.Correct handling



b.Wrong handling and wrong display after assembling



Pressing gels



Piling up material

. Products in the PCB layout design, for the soft sheet, and 0.5T below the plate, the pad direction should be perpendicular to the direction of PCB extension to reduce the PCB board bending stress generated in the LED pin, resulting in LED products Due to stress acting tensile failure;

3.9 Heat Generation:

Thermal design of the end product is of paramount importance. Please consider the heat generation of the LED when making the system design. The coefficient of temperature increase per input electric power is affected by the thermal resistance of the circuit board and density of LED placement on the board, as well as components. It is necessary to avoid in tense heat generation and operate within the maximum rating given in this specification. The operating current should be decided after considering the ambient maximum temperature of LEDs

The maximum working temperature of the product is not easy to exceed 40 ˚ C (≤ 40 ˚ C, refers to the product pin at the operating temperature)

4.0 Electrostatic Discharge & Surge Current :

Electrostatic discharge (ESD) or surge current (EOS) may damage LED.

Precautions such as ESD wrist strap, ESD shoe strap or antistatic gloves must be worn whenever handling of LED.

IC device signal input and output ports must be connected in series protection resistor to prevent surge or static shock port caused by product failure;

All devices, equipment and machinery must be properly grounded.

It is recommended to perform electrical test to screen out ESD failures at final inspection.

It is important to eliminate the possibility of surge current during circuitry design.

4.1 Moisture Proof Package

Cannot take any responsibility for any trouble that are caused by using the LEDs at conditions exceeding our specifications.

The LED light output is strong enough to injure human eyes. Precautions must be taken to prevent looking directly at the LEDs with unaided eyes for more than a few seconds.

The formal specification must be exchanged and signed by both parties before large volume purchase begins.

The appearance and specifications of the product may be modified for improvement without notice.