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Opto Plus LED Corp
OPS-L0404F6
Top View Chip LED

● **EDIT HISTORY**

Version A : FEB. 17, 2025

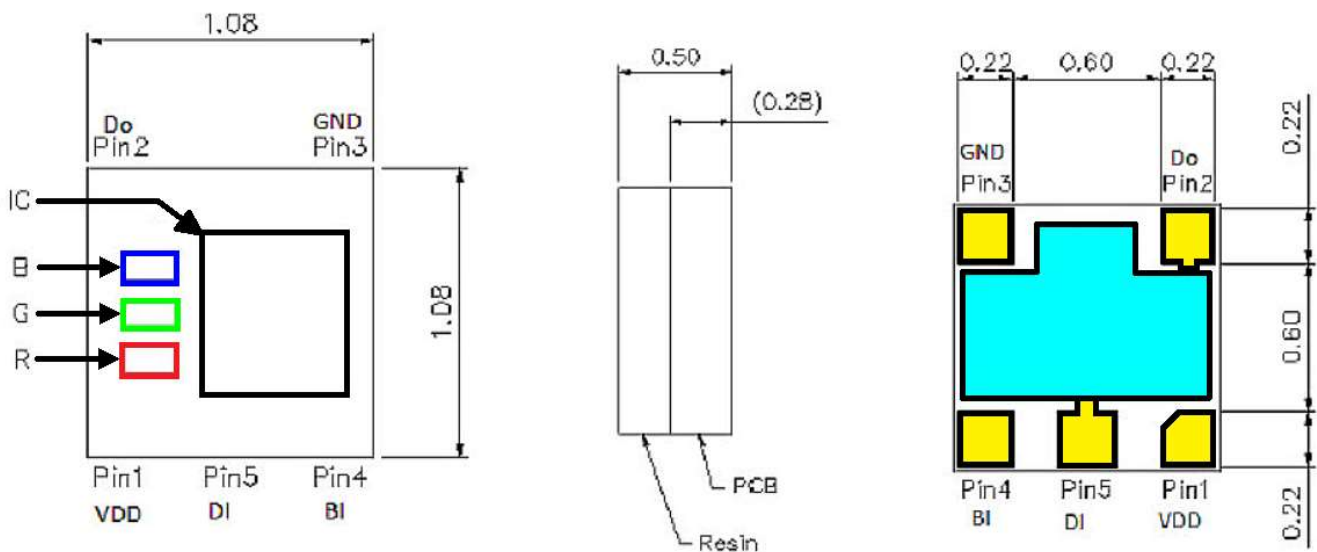
Preliminary Spec.

Confidential Document

● FEATURES

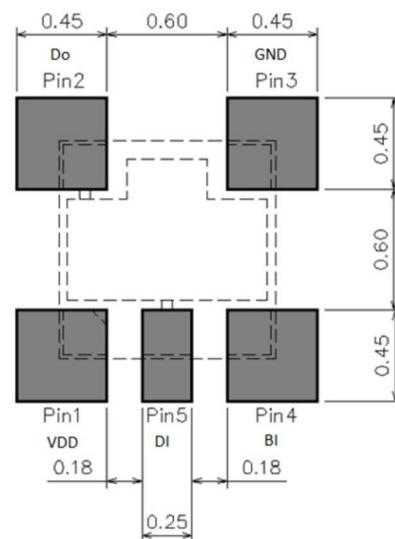
- 1.08mm x 1.08 mm x 0.50 mm. [0.04 inch x 0.04 inch x 0.02 inch]
- Top View Chip Programmable LED. [With Backup Data Signal Input]
- Low power consumption.
- RoHS compliant.

● PACKAGE DIMENSIONS



Unit:mm Tolerance: +/-0.1

SOLDERING PATTERN



VDD: Power Supply.

DO : Control Data Signal Output.

GND : Ground.

BI : Backup Data Signal Input. (Single Signal Wiring Diagram : BI is connected to GND.)

DI : Control Data Signal Input

※ SUPPORT BI BACKUP INPUT DATA LINE

TO PREVENT DATA INPUT FAILURE FROM MALFUNCTION DI. ※

Unit:mm Tolerance: +/-0.1

Suggested pad dimension is just for reference only.

Please modify the pad dimension based on individual need.



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ABSOLUTE MAXIMUM RATING AT Ta=25°C

Parameter	Symbol	Maximum Rating	Unit
Supply Voltage	VDD	6.5	mW
Power Dissipation	PD	<400	mW
Maximum Output Current	I _{LED}	5	mA
Operating Temperature Range	T _{OPR}	-40~85	°C
Storage Temperature Range	T _{STO}	-65~120	°C
Soldering Temperature	T _{sol}	Reflow Soldering : 210 °C for 5 sec. Hand Soldering : 300 °C for 3 sec.	

ELECTRICAL - OPTICAL CHARACTERISTICS AT Ta=25°C

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Note.
Supply Voltage	VDD	3.3	5.0	5.5	V	
Operation Current (With IC)	I _{DD-1}		1		mA	R/G/B Without load @VDD=5V
Operation Current (With IC)	I _{DD-2}		0.6		mA	R/G/B Without load @VDD=3.3V
Sleep Mode Current	I _{sleep}		5		uA	
Input High "H" of DI、BI	V _{IH}	0.7*VDD		VDD+0.4	V	
Input Low "L" of DI、BI	V _{IL}	-0.4		0.2*VDD	V	
Output High "H" of DO	V _{OH}	4.5			V	I _{OH} =3mA
Output Low "L" of DO	V _{OL}			0.4	V	I _{OL} =3mA
R/G/B Sink Current	I _{Sink}	2.9	3.0	3.1	mA	Max. 3mA option
R/G/B Sink Current	I _{Sink}	4.8	5.0	5.2	mA	Max. 5mA option
R/G/B Current Gain	G _{level}		3/17		mA/level	Max. 3mA option
R/G/B Current Gain	G _{level}		5/17		mA/level	Max. 5mA option
DI / BI Input Leakage	I _{leak}			1	uA	V _{DI} =V _{BI} =VDD =5V
R/G/B off Leakage Current	I _{off}			1	uA	V _{R/G/B} =5V, PWM off
Propagation delay time	t _{PLZ}			80	ns	DI → DO, load=30pF
	t _{PZL}			80	ns	
Rising time	t _{THL}		15		ns	
Falling time	t _{TLH}		15		ns	
Rising time	t _R		50		ns	

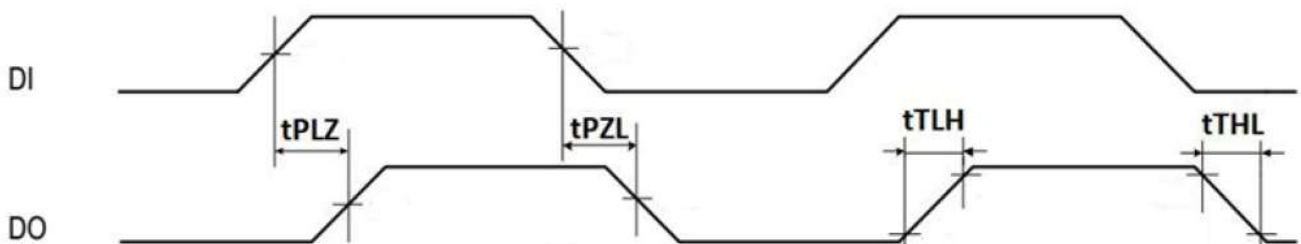
Falling time	t _F	50	ns	ISK(R/G/B) =3/5mA, load=30pF
Data rate	F _{data}	800	KHz	
Dominant Wavelength (Red)	λ_D	624	nm	I _{Sink} =5mA
Dominant Wavelength (Green)	λ_D	523	nm	I _{Sink} =5mA
Dominant Wavelength (Blue)	λ_D	470	nm	I _{Sink} =5mA
Luminous Intensity (Red)	I _V	65	mcd	I _{Sink} =5mA
Luminous Intensity (Green)	I _V	85	mcd	I _{Sink} =5mA
Luminous Intensity (Blue)	I _V	20	mcd	I _{Sink} =5mA
Spectrum Radiation Bandwidth (Red)	$\Delta\lambda$	18	nm	I _{Sink} =5mA
Spectrum Radiation Bandwidth (Green)	$\Delta\lambda$	35	nm	I _{Sink} =5mA
Spectrum Radiation Bandwidth (Blue)	$\Delta\lambda$	25	nm	I _{Sink} =5mA

※EMITTED COLOR : RED & GREEN & BLUE

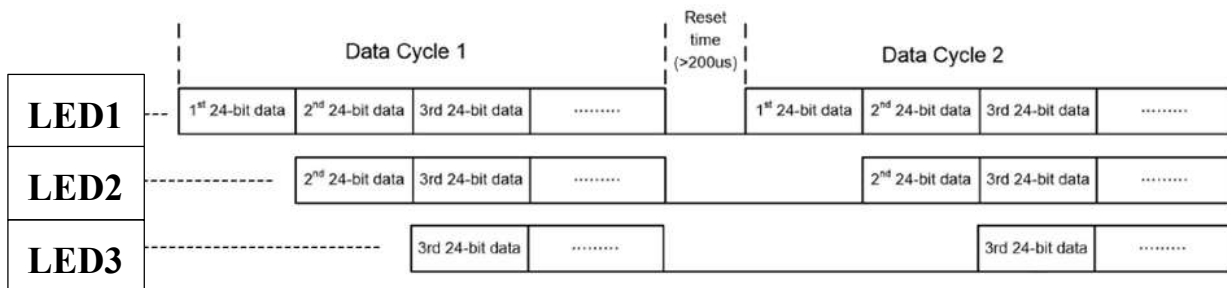
IN PRACTICAL CIRCUIT APPLICATIONS, IT IS CRUCIAL TO CONNECT THE SIGNAL INPUT AND OUTPUT PINS OF THE INTEGRATED CIRCUIT (IC) TO THEIR RESPECTIVE TERMINALS. ADDITIONALLY, FOR ENHANCED STABILITY OF THE IC CHIP, IT IS NECESSARY TO INCLUDE CAPACITANCE BETWEEN DISPLAYS.

FOR SHORT DISPLAY TRANSMISSION DISTANCES, IT IS RECOMMENDED TO CONNECT SERIES PROTECTION RESISTOR (APPROXIMATELY 470 OHMS) AT BOTH THE INPUT AND OUTPUT ENDS OF THE CLOCK LINE SIGNAL.

IN CASES WHERE THE DISPLAY TRANSMISSION DISTANCE IS LONGER, ESPECIALLY FOR MODULES OR SPECIALIZED PRODUCTS, VARIATIONS IN WIRE TYPE AND TRANSMISSION DISTANCE MAY OCCUR. AS A RESULT, SLIGHT DIFFERENCES IN GROUNDING PROTECTION RESISTANCE AT BOTH ENDS OF THE CLOCK LINE SIGNAL SHOULD BE ANTICIPATED AND ADDRESSED TO ENSURE CONSISTENT PERFORMANCE IN PRACTICAL USAGE.

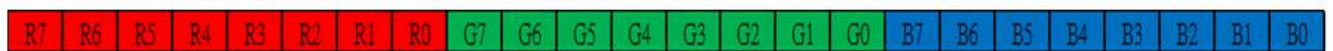


● Data Transfer Protocol



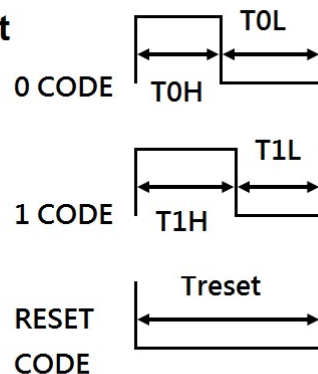
The single wire data transfer protocol supports 24-bit data for each LED RGB display data refresh.

The IC receives 24-bit data and passes the remaining data to next LED. The 24-bit data consist of red, green and blue data, each with 8-bit width, and are transferred with MSB first.



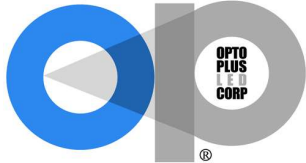
The transferred data are recognized based on the pulse widths received by the IC. A low bit 0 is represented by a 0.3us high pulse followed by a 0.9us low pulse. A high bit 1 is represented by a 0.9us high pulse followed by a 0.3us low pulse. A low pulse $\geq 200\mu s$ is used to issue a reset command to the IC to start a new cycle of serial commands.

Sequence Chart



(T0H:0.3us+0.15us, T0L:0.9us+0.15us)

(T1H:0.9us+0.15us, T1L:0.3us+0.15us)



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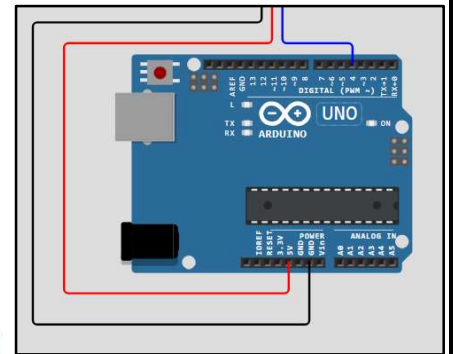
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● Sample CODE

// Please write using Arduino IDE.

// Make sure that the Adafruit_NeoPixel library has been installed.

```
#include <Adafruit_NeoPixel.h>
#define LED_PIN 4 // Signal pin for the LED Display.
#define LED_COUNT 10 // Number of LEDs in the LED Display.
Adafruit_NeoPixel strip(LED_COUNT, LED_PIN, NEO_RGB + NEO_KHZ800);
// Function used to create colorful effects
void setup() {
  strip.begin();
  strip.show();
  strip.setBrightness(127); //Set brightness to approximately 1/2 (maximum value = 255)
}
void loop() {
  strip.setPixelColor(0, 255, 0, 0); // Turn on D1-Red
  strip.setPixelColor(1, 255, 0, 0); // Turn on D3-Red
  strip.setPixelColor(8, 0, 0, 0); // Turn off
  strip.setPixelColor(9, 0, 0, 0); // Turn off
  strip.show(); // Update to display
  delay(500); // delay 0.5 seconds.
  strip.setPixelColor(0, 0, 0, 0); // Turn off
  strip.setPixelColor(1, 0, 0, 0); // Turn off
  strip.setPixelColor(8, 0, 0, 255); // Turn on D9-Green
  strip.setPixelColor(9, 0, 0, 255); // Turn on D10-Green
  strip.show(); // Update to display
  delay(500); // delay 0.5 seconds.
}
```

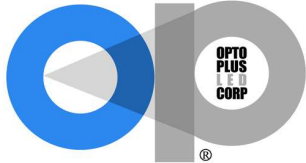


● Sleep and power saving mode

OPS-L0404F6 supports sleep/wake-up modes for power-saving purpose. When receiving 24-bit 0's RGB data, 8-bit 0x5A special data, and a reset command, OPS-L0404F6 will enter sleep mode. In sleep mode, the built-in oscillator and associated circuitry is disabled. The quiescent current of OPS-L0404F6 is less than 2uA (typ.) in sleep mode.

A sleeping OPS-L0404F6 wakes up from sleep mode when detecting an input rising edge on DI or BI pin. Normally a positive pulse on DI or BI pin can be used as a wake-up trigger. After waking up, all sleeping circuits in OPS-L0404F6 return to normal working mode within 1ms. To wake-up the next cascaded OPS-L0404F6, the received positive pulse on DI pin is passed to DO pin, which is connected to DI pin of the next OPS-L0404F6, and in turn wakes up the next OPS-L0404F6. Hence, all cascaded sleeping OPS-L0404F6s can wake up successively.

Since it takes 1ms for a sleeping OPS-L0404F6 returning to normal functioning mode, it is recommended for MCU to wait for 1ms to send display data and commands after issuing a



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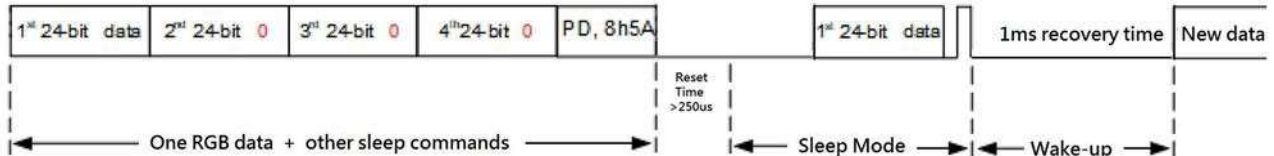
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wake-up pulse. In case a mal-functioned OPS-L0404F6 exists in an LED strip, the one next to the mal-functioned OPS-L0404F6 determines the sleep/wake-up mode through BI pin, instead of DI pin.

In an LED strip, it is possible to set certain OPS-L0404F6s active, while the others in sleep mode. As an example, the following commands are for two leading active OPS-L0404F6s and other sleeping OPS-L0404F6s.

RGB 24'h100FFF	RGB 24'h235678	RGB 24'h000000	RGB 24'h000000		PD 8'h5A	+ Reset code >250 us
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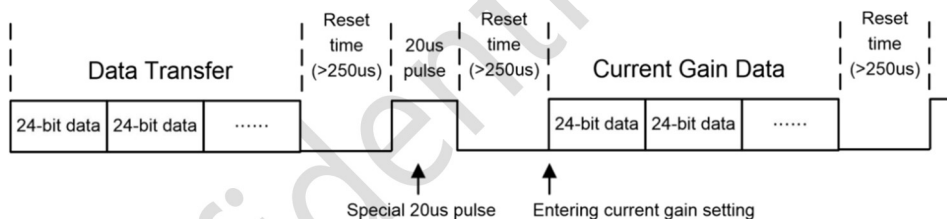
As an example of sleep/wake-up commands shown below, the first OPS-L0404F6 is kept active and the remaining OPS-L0404F6s enter sleep mode by 24-bit 0's and an ending 0x5A byte. Later on, a positive pulse wakes up all sleeping OPS-L0404F6s.



● Dimming Control

OPS-L0404F6 supports an 16-level current gain control to adjust sink current of R/G/B channels. This feature enables dimming control of LED lighting. Each of the red, green and blue channels can be controlled individually, which in turn not only to save power consumption, but also to fine-tune the color temperature of R/G/B LEDs.

To set the current gain of OPS-L0404F6's R/G/B channels, a special pulse must be issued by MCU before setting the current gain levels, as shown below.



After a reset pulse following normal data transfer, if a 20us positive pulse is issued with another reset pulse, OPS-L0404F6 is forced into a special mode to interpret following 24-bit data as current gain setting data. Each of the 24-bit data comprises 4-bit gain values of R/G/B channels, as shown below.

S23	S22	S21	S20	S19	S18	S17	S16	S15	S14	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	S0
0	0	0	0	R[3]	R[2]	R[1]	R[0]	0	0	0	0	G[3]	G[2]	G[1]	G[0]	0	0	0	0	B[3]	B[2]	B[1]	B[0]

The maximum output current of each R/G/B channels is then determined as below (ISK=3mA or 5mA).

$R_{sink} = ISK * (R[3]*10/17 + R[2]*4/17 + R[1]*2/17 + R[0]*1/17)$
 $G_{sink} = ISK * (G[3]*10/17 + G[2]*4/17 + G[1]*2/17 + G[0]*1/17)$
 $B_{sink} = ISK * (B[3]*10/17 + B[2]*4/17 + B[1]*2/17 + B[0]*1/17)$
 By default, $R[3:0] = G[3:0] = B[3:0] = 0x0F$.

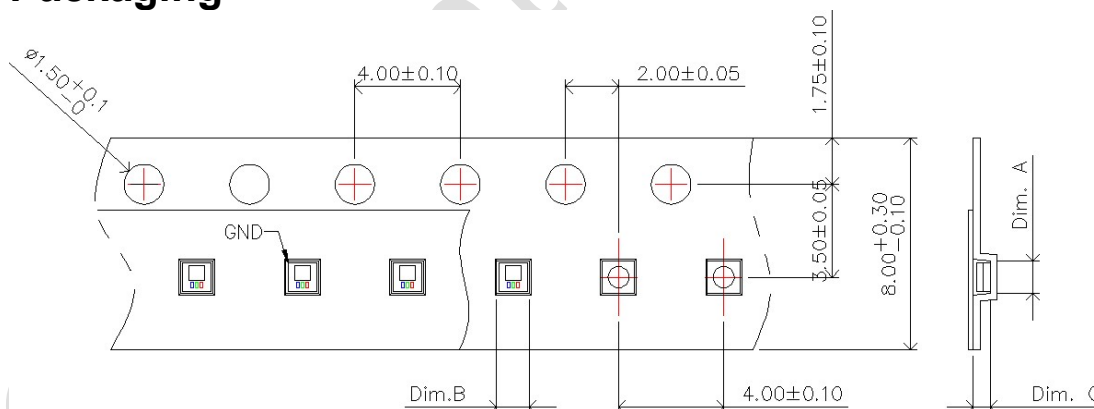
Recommended programming flow:

After system power-on, MCU should send data 0 first (dark mode) for all LEDs in the strip, then MCU can deliver normal display data or execute current gain (dimming) command to LEDs.

Notes

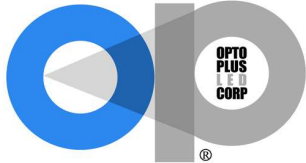
1. The chips should not be used directly in any type of fluid such as water, oil, organic solvent, etc.
2. When the LEDs are illuminating, the maximum ambient temperature should be first considered before operation.
3. LEDs must be stored in a clean environment. A sealed container with a nitrogen atmosphere is necessary if the storage period is over 3 months after shipping.
4. The LEDs must be used within 72hours after unpacked. Unused products must be repacked in an anti-electrostatic package, folded to close any opening and then stored in a dry and cool space.
5. The appearance and specifications of the products may be modified for improvement without further notice.
6. The LEDs are sensitive to the static electricity and surge. It is strongly recommended to use a grounded wrist band and anti-electrostatic glove when handling the LEDs. If a voltage over the absolute maximum rating is applied to LEDs, it will damage LEDs. Damaged LEDs will show some abnormal characteristics such as remarkable increase of leak current, lower turn-on voltage and getting unlit at low current.

Packaging



Unit:mm Tolerance: +/-0.1

Dim. A	Dim. B	Dim. C	Q'ty/Reel
1.24 ± 0.05	1.28 ± 0.05	0.80 ± 0.05	4K

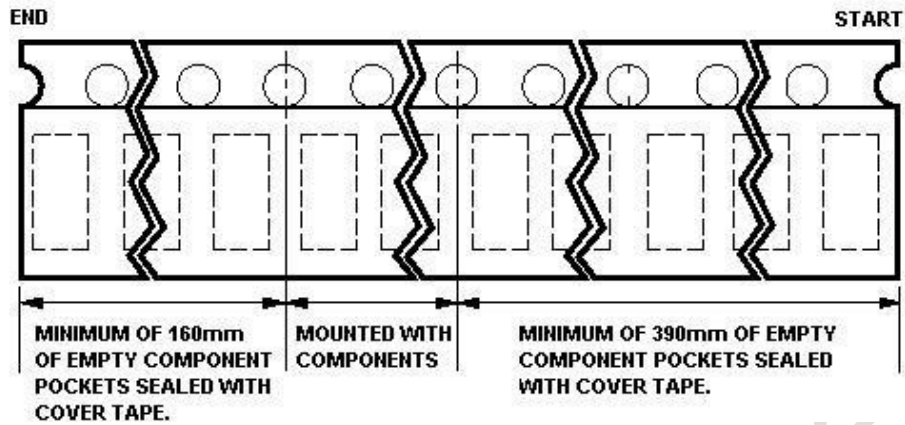


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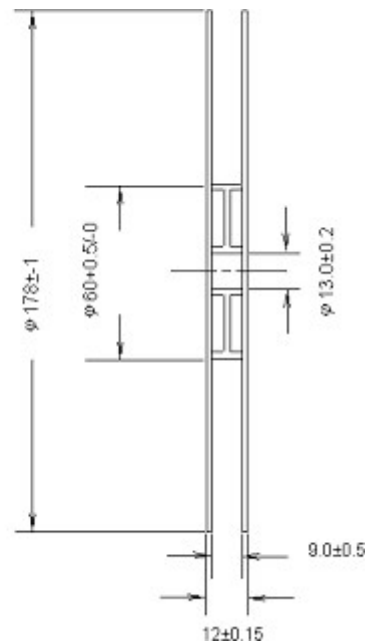
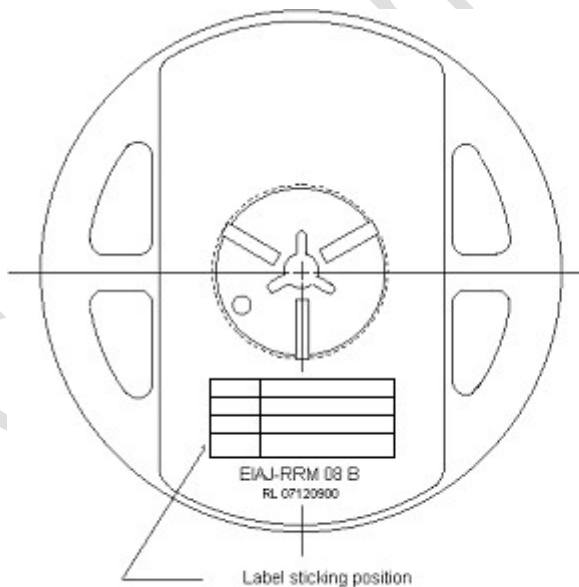
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● Reel Dimension

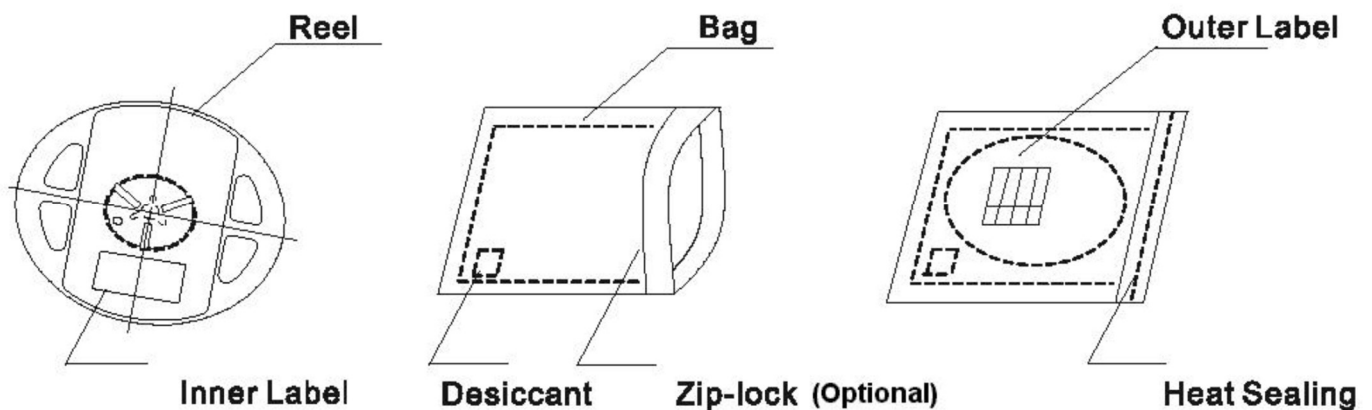


● Dry Pack

All SMD optical devices are **MOISTURE SENSITIVE**. Avoid exposure to moisture at all times during transportation or storage. Every reel is packaged in a moisture protected anti-static bag. Each bag is properly sealed prior to shipment.

A humidity indicator will be included in the moisture protected anti-static bag prior to shipment.

The packaging sequence is as follows:



● Baking

Baking before soldering is recommended when the package has been unsealed for 4 weeks.

The conditions are as followings:

1. $60 \pm 3^{\circ}\text{C} \times (12 \sim 24\text{hrs})$ and $< 5\% \text{RH}$, taped reel type.
2. $100 \pm 3^{\circ}\text{C} \times (45\text{min} \sim 1\text{hr})$, bulk type.
3. $130 \pm 3^{\circ}\text{C} \times (15\text{min} \sim 30\text{min})$, bulk type.

● Precautions

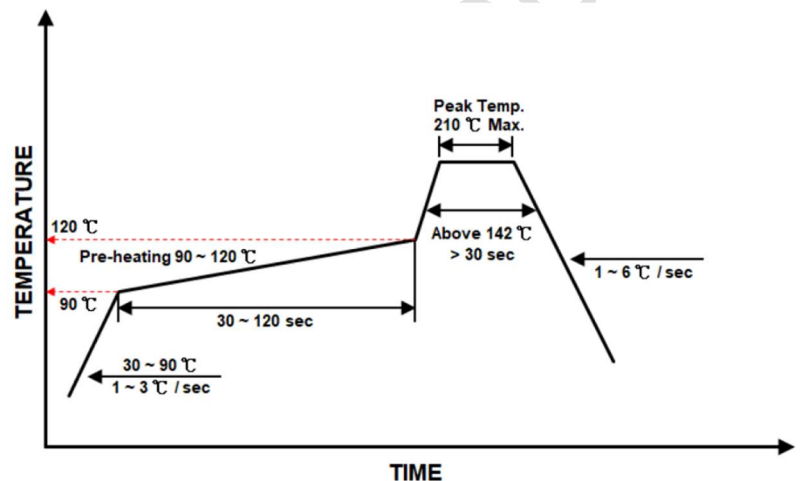
1. Avoid exposure to moisture at all times during transportation or storage.
2. Anti-Static precaution must be taken when handling GaN, InGaN, and AlInGaP products.
3. It is suggested to connect the unit with a current limiting resistor of the proper size. Avoid applying a reverse voltage beyond the specified limit.
4. Avoid operation beyond the limits as specified by the absolute maximum ratings.
5. Avoid direct contact with the surface through which the LED emits light.
6. If possible, assemble the unit in a clean room or dust-free environment.

● Reflow Soldering

Recommend soldering paste specifications:

1. Operating temp.: Above 142°C , >30sec
2. Peak temp.: 210°C Max., 5sec Max.
3. Never take next process until the component is cooled down to room temperature after reflow.
4. The recommended reflow soldering profile (measuring on the surface of the LED terminal) is following: Lead free Solder Profile
5. Reflow soldering should not be done more than two times

● Lead-free Solder Profile



● Reworking

- Rework should be completed within 3 seconds under 300°C.
- The iron tip must not come in contact with the copper foil.
- Twin-head type is preferred.

● Cleaning

Following are cleaning procedures after soldering:

- An alcohol-based solvent such as isopropyl alcohol (IPA) is recommended.
- Temperature x Time should be 50°C x 30sec. or <30°C x 3min
- Ultrasonic cleaning: < 15W/ bath; bath volume ≤ 1liter
- Curing: 100°C max, <3min

● Cautions of Pick and Place

- Avoid stress on the resin at elevated temperature.
- Avoid rubbing or scraping the resin by any object.
- Electric-static may cause damage to the component.

Please ensure that the equipment is properly grounded. Use of an ionizer fan is recommended.