SPECIFICATION

Product : Topview Smart RGB PKG

Part No. : IWS-L3138-WRGB-IC

Date : 2022. 09. 27 Ver. 4.0

Customer :

Checked By	Checked By	Checked By	Checked By	Approval

Manufacturer : CoAsia Corp.

Checked By	Checked By	Checked By	Checked By	Approval
Approved				

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1. Features

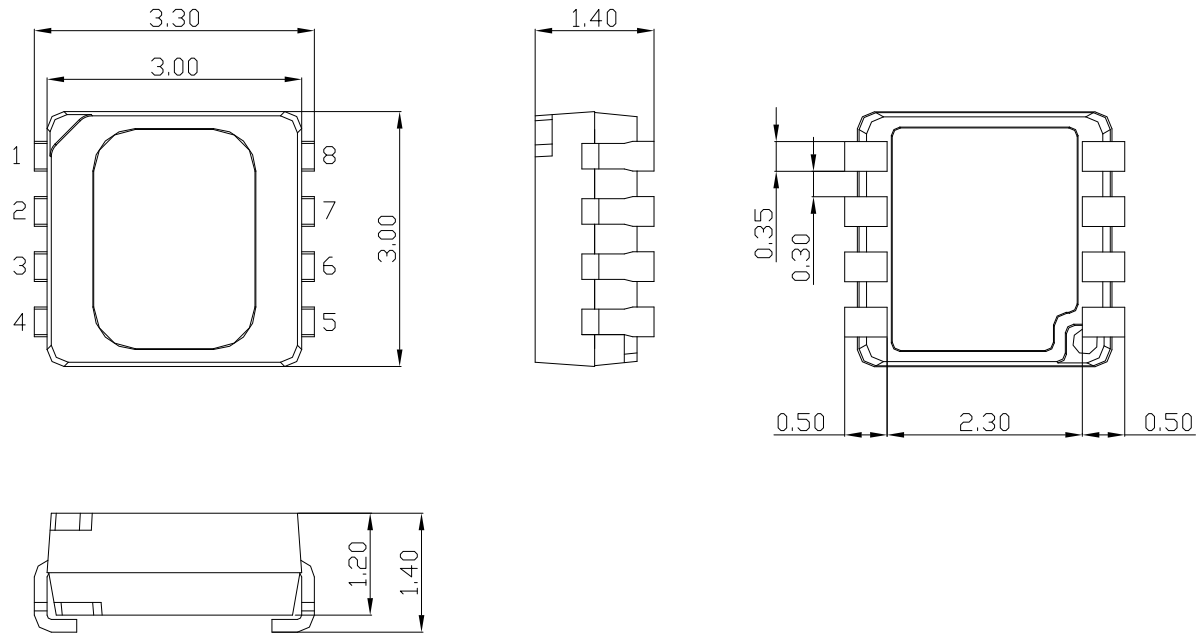
- IC Built in RGB PKG
- 3 Chip High-Brightness SMD LED
- 3.3 x 3.0 x 1.40 mm (L x W x H), Small Size Surface Mount Type
- 3 constant current mode LED drivers.
- Serial communication with ISELED compliance
- Bi directional, half-duplex, 2MBit/s, serial communication.
- White point calibration D65
- 8 bit brightness resolution for red, green, and blue LED.
- Build-in temperature sensor.
- Temperature compensation on red for constant brightness.
- Build-in diagnostic functions.
- Maximum of 4079 LED's in one chain.
- Qualified according to JEDEC MSL 2.
- Qualification : AEC-Q102 & AEC-Q100 Qualified

2. Applications

- Automotive: Backlight in Dashboard and Switch
- Automotive: Ambient lighting (Interior lighting)
- Functional lighting
- General lighting

3. Outline Drawing and Dimension

Unit : mm, Tolerance : ±0.1mm



Note

1. All dimensions are in millimeters
2. All dimensions without tolerances are for reference only

Pin Configuration

Pad	Name	Description
1	PRG	Ground (for LED manufacture)
2	SIO1_N	Serial Communication Master Side, Negative
3	SIO1_P	Serial Communication Master Side, Positive
4	GND	Ground
5	GND	Ground
6	SIO2_P	Serial Communication Slave Side, Positive
7	SIO2_N	Serial Communication Slave Side, Negative
8	Vcc_5V	IC Power Supply (5V)

4. Absolute Maximum Ratings(T_a = 25 ℃)

Parameter	Symbol	Value		Unit
		Min	Max	
Vcc Voltage	V_{CC}	-0.25	7.0	V
SIO1_P, SIO1_N SIO2_P, SIO2_N	Vsio1_P, Vsio1_N Vsio2_P, Vsio2_N	-0.48	7.0	V
Electrical Thermal Resistance※1	Rth $_{JS}$	-	120	K/W
Operating Temperature	T_{opr}	-40	110	℃
Storage Temperature	T_{stg}	-40	125	℃
Junction Temperature	T_j	-	125	℃
ESD Protection HBM	-	-	2	kV

※1 Using FR4 PCB (Cu 1oz, 25.4 x 25.4 x 1.6mm)

5. Recommended Operation Conditions

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
Vcc Voltage	V_{CC}	4.5	5.0	5.5	V
SIO1_P, SIO1_N	Vsio1_P, Vsio1_N	4.5	5.0	5.5	V

6. Electro-optical Characteristics(Ta = 25 ℃)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit.
Dominant Wavelength※1	W_d	Red	-	622	-	nm
		Green	-	533	-	nm
		Blue	-	465	-	nm
Luminous Intensity※2	I_V	Red	-	360	-	mcd
		Green	-	940	-	mcd
		Blue	-	85	-	mcd
		White※4	-	1400	-	mcd
View angle※3	$2\theta_{1/2}$	-	-	120	-	degree

※1 Dominant Wavelength has an accuracy of ±2nm
※2 Luminous Intensity is tested by a tester calibrated by CAS 140B(CIE LED_B) and has an accuracy of 10%
※3 Viewing Angle is the angle until 50% of brightness measured from the front part of LED.
※4 D65 (6500K), The above luminous intensity represent brightness at 100%.

7. Serial Interface

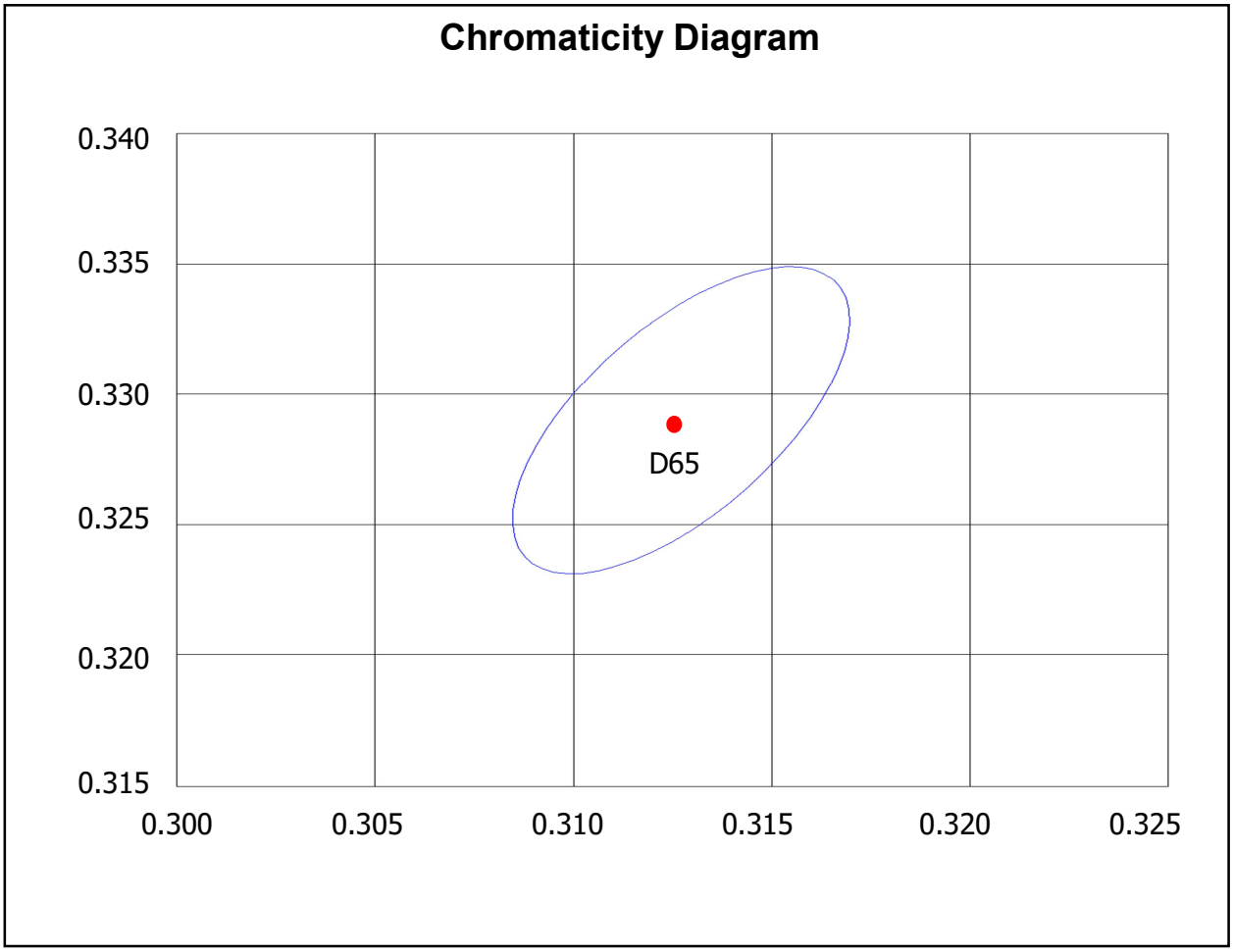
Parameter	Description	Value			Unit
		Min	Typ	Max	
$f_{SIO1\_P,single\ ended}$	Single ended data rate SIO1_P	1.40	2.00	2.60	MHz
$f_{SIO1\_N,single\ ended}$	Single ended data rate SIO1_N	2.80	4.00	5.20	MHz
$V_{IH,se}$	Single ended input high Voltage	1.20	-	-	V
V_{ILse}	Single ended input low Voltage	-	-	1.14	V
$V_{IAMP,diff}$	Differential input amplitude	150	250	325	mV
$V_{OAMP,diff}$	Differential output amplitude	175	250	325	mV

8. Current Consumption

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
Red	I_average	-	8.9	20.5	mA
Green	I_average	-	9.4	12.0	mA
Blue	I_average	-	6.3	7.0	mA
Driver	I_drv	0.9	1.2	1.5	mA

※ @ RGB set (255,255,255)

9. Color Coordinates Group

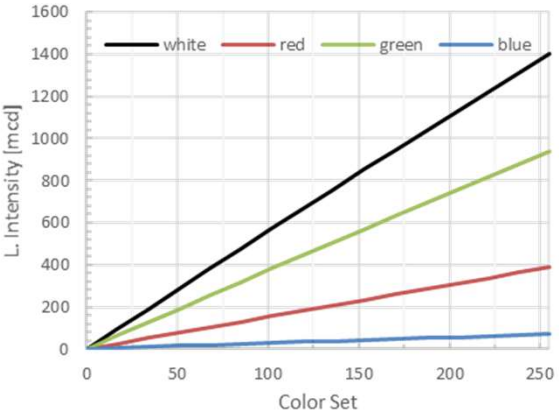


Rank	Description	x	y	a	b	theta
D65	Macadams 3steps	0.3127	0.3290	0.00669	0.00285	58.57

10. Typical Characteristics Curves

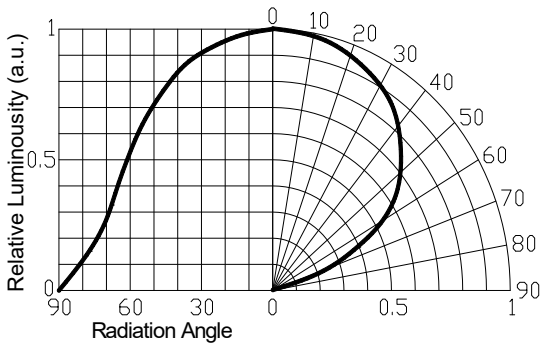
Relative Intensity vs. RGB set

Iv/Iv (25℃) : RGB Set = (255, 255, 255)



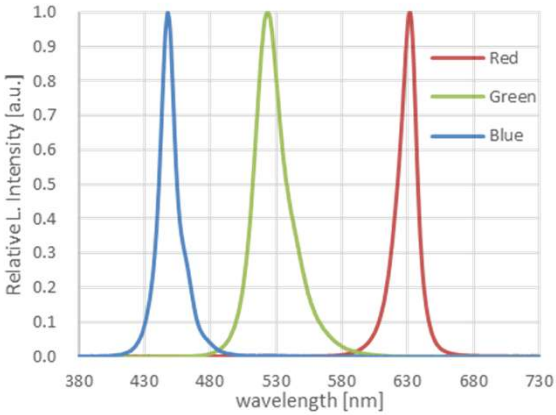
Radiation Diagram

Iv/Iv (25℃) : RGB Set = (255, 255, 255)



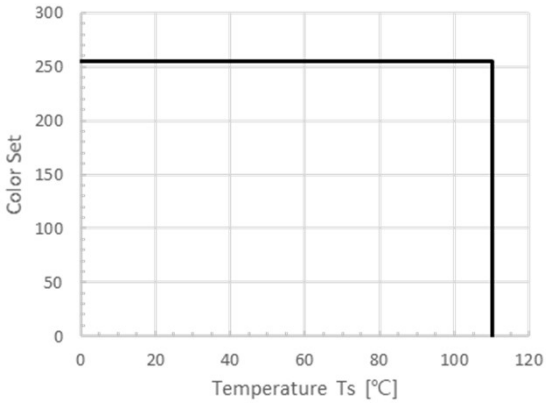
Relative Spectral Emission

Iv/Iv (25℃) : RGB Set = (255, 255, 255)



Maximum RGB Set vs. Temp

RGB Set = (255, 255, 255)

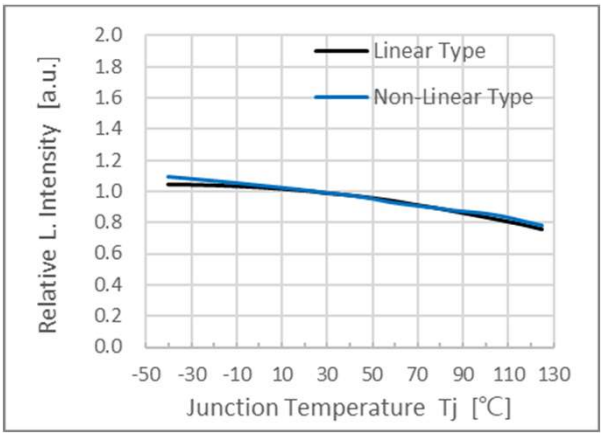


10. Typical Characteristics Curves

Relative L. Intensity vs. Junction Temperature

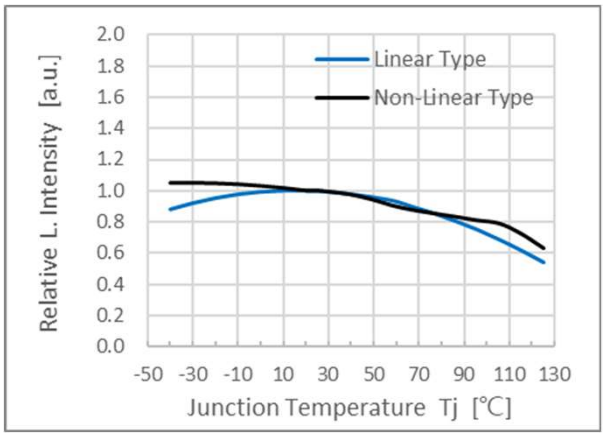
White

Iv/Iv (25℃) : RGB Set = (255, 255, 255)



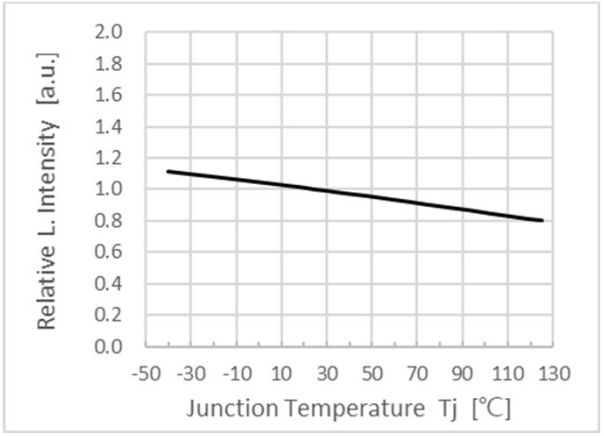
Red

Iv/Iv (25℃) : RGB Set = (255, 0, 0)



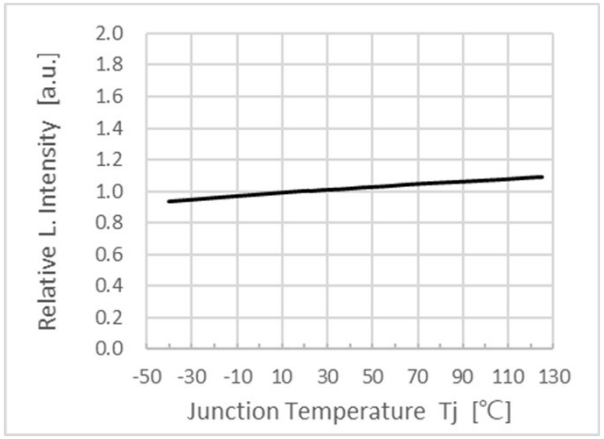
Green

Iv/Iv (25℃) : RGB Set = (0, 255, 0)



Blue

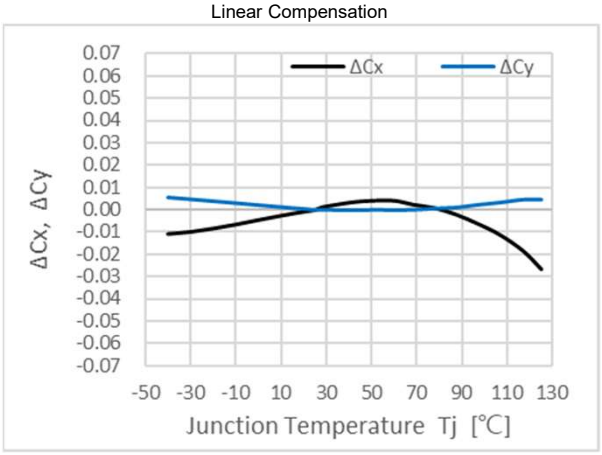
Iv/Iv (25℃) : RGB Set = (0, 0, 255)



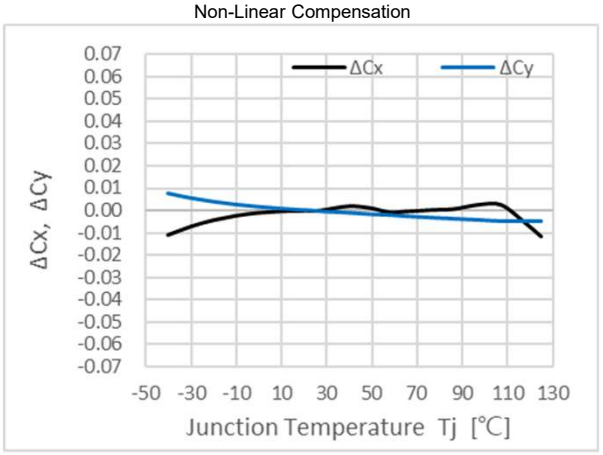
10. Typical Characteristics Curves

Color Coordinate Shift vs. Junction Temperature

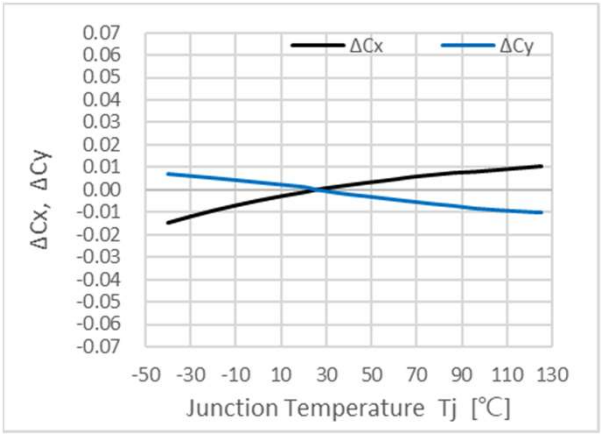
White
RGB Set = (255, 255, 255)
Linear Compensation



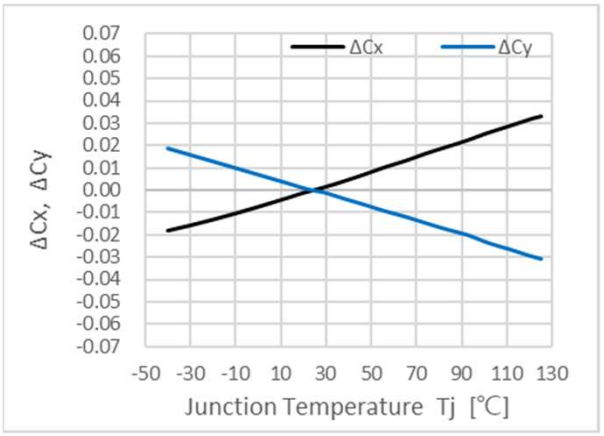
White
RGB Set = (255, 255, 255)
Non-Linear Compensation



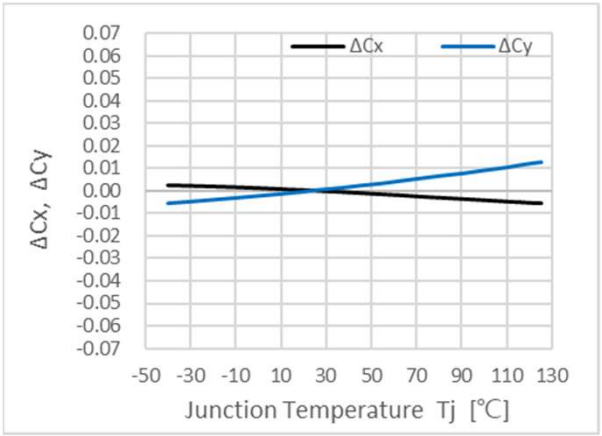
Red
RGB Set = (255, 0, 0)



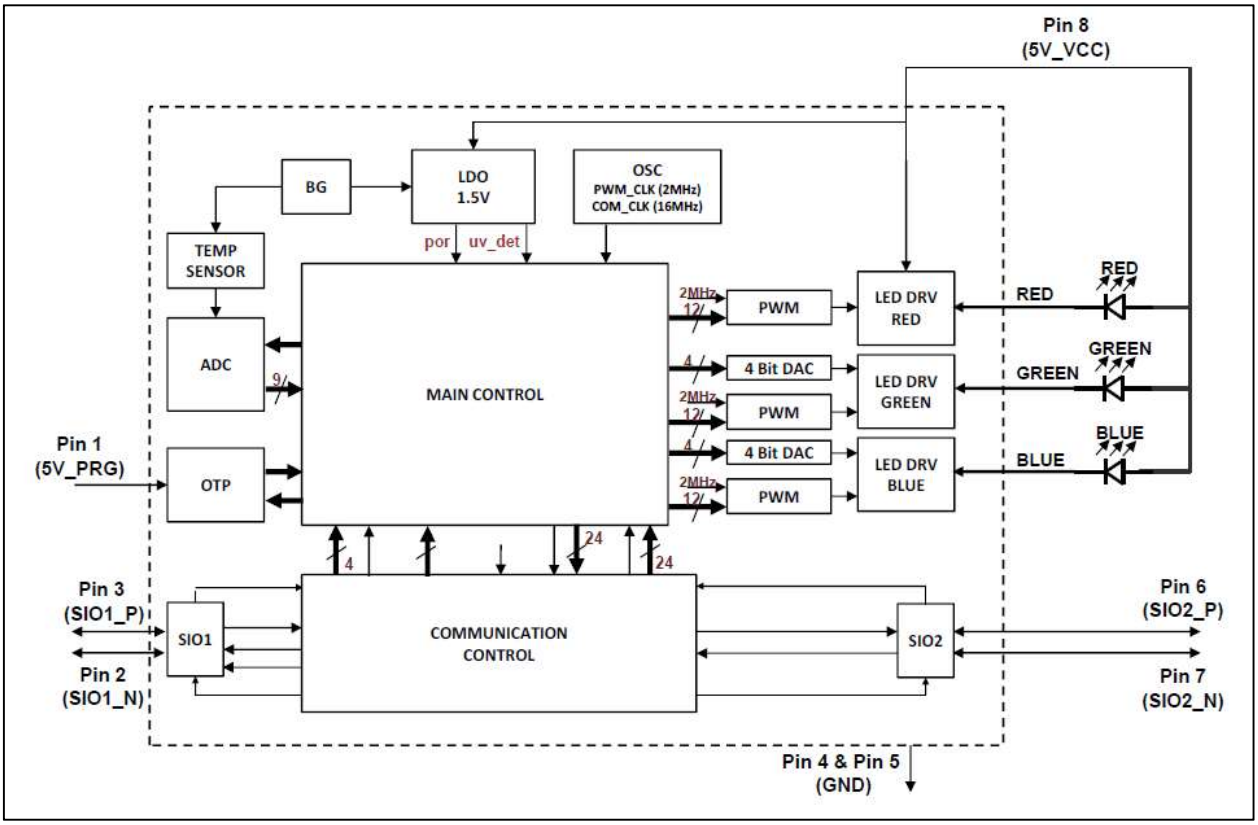
Green
RGB Set = (0, 255, 0)



Blue
RGB Set = (0, 0, 255)



11. Block Diagram



The device implements a communication for the reception of control commands and for providing device status and configuration data.

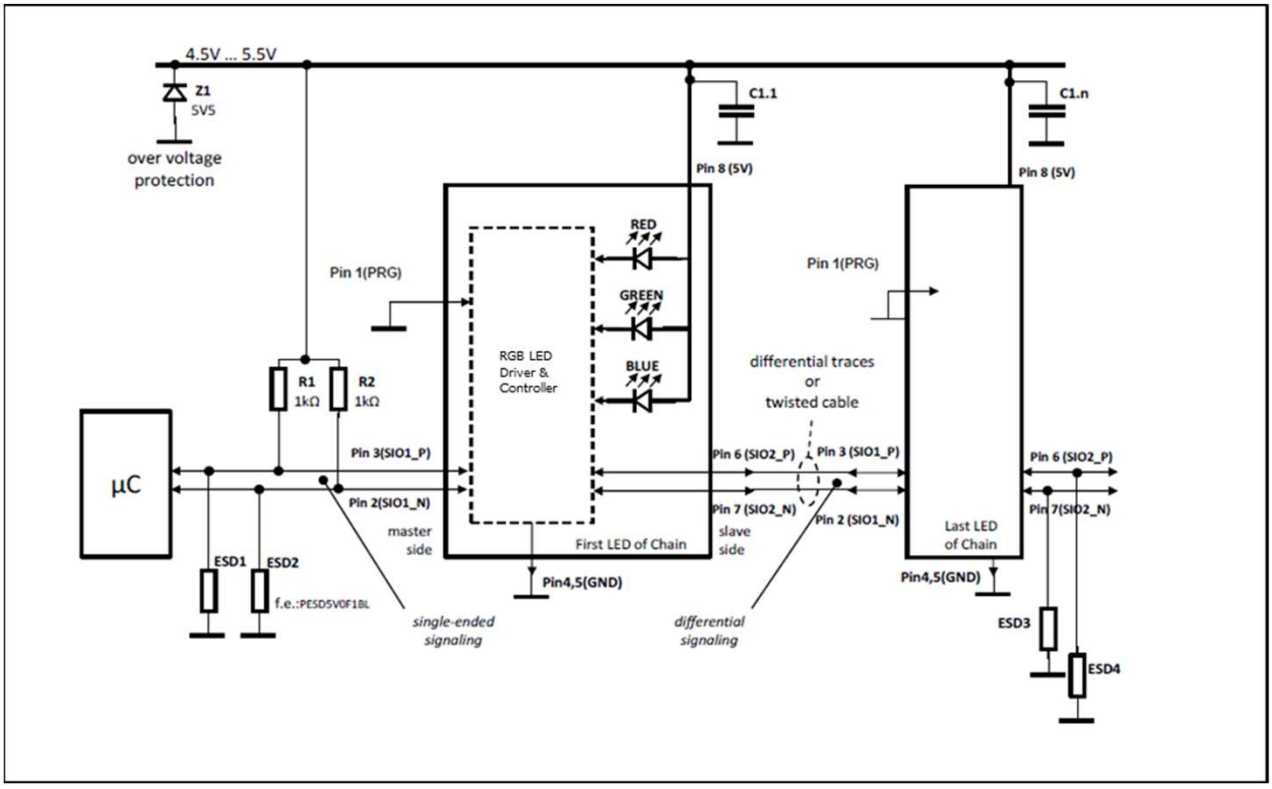
Low side, configurable constant current sinks are provided for controlling 3 LEDs (RGB).
The Main Unit computes the PWM duty cycles from the incoming commands and applies the corresponding control values to the three PWM units.

The main unit is also in charge of a periodic temperature measurement and an appropriate duty cycle adjustment for the red PWM channel.

The actual device temperature is obtained via an integrated analog-digital converter (ADC).
Besides the temperature the ADC can also measure various other analog values. These measurements are always triggered by a command from the host. The result of the corresponding A/D conversion is also retrieved by a host command. As each device is individually calibrated to compensate for production variations, the corresponding parameters can be stored in an on-die non-volatile memory.

This one-time-programmable memory (OTP) is read at hardware reset and the parameters are copied from the OTP to directly accessible registers.

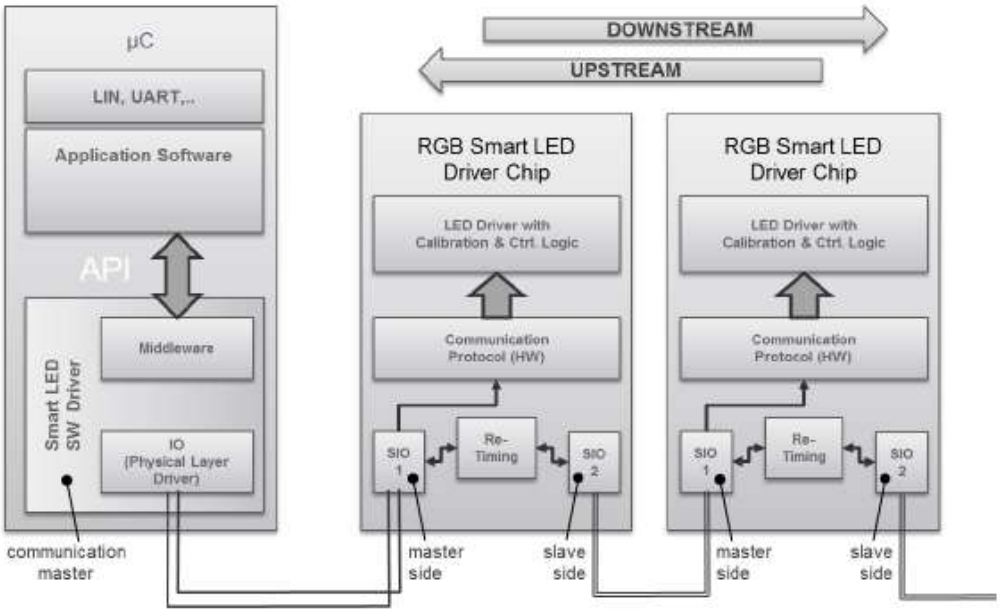
Typical Application Layout



In order to prevent voltage drops, it is recommended to mount the capacitors C1 closely to the Vcc pin. The dimensioning of the capacitors depends on the PCB layout and the supply concept.

12. Functional Description

Serial Communication



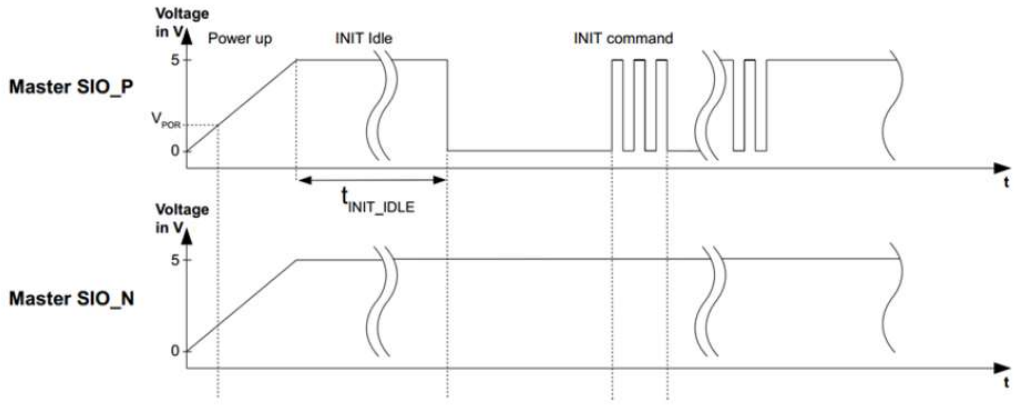
The attachment to the adjacent devices in the chain is made up by two bidirectional differential serial communication lines. The direction towards the controlling microcontroller device is referred to as the “upstream” connection. The opposite direction towards the end of the chain is the “downstream” link. Both links are controlled by the communication unit. Incoming command frames from upstream and responses from downstream are passed to the main unit which is responsible for command processing and overall device control. Commands always originate from the controlling microcontroller. The microcontroller is referred to as the “host” in this document.

The gross data rate on the serial line is 2Mbit/s, i.e. each bit has a nominal duration of 500 ns. As the on-die oscillator has a very limited accuracy, the actual bit time may vary significantly. The whole system is designed for a maximum oscillator variance of ±30%. With the nominal oscillator frequency being 16 MHz, the actual frequency range is 11.2-20.8MHz.

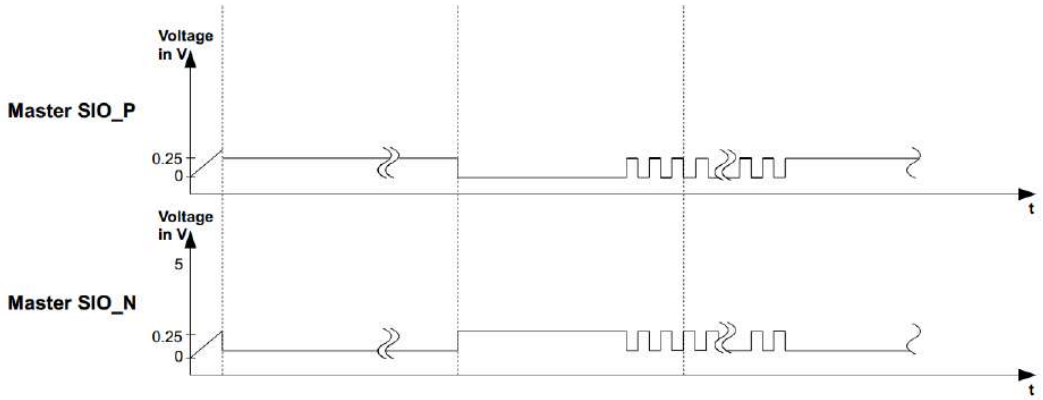
The device directly attached to the host does not use the differential line mode on the upstream side. Instead a single-ended line mode is used. The single-ended mode is intended to allow for an easy attachment to industry standard microcontrollers. Both single-ended lines require an external pull-up at the microcontroller to 5V.

Automatic Detection of the Serial Line Mode

During start-up, the devices automatically detect the mode of the upstream and the downstream link.
The upstream link may be either single-ended or differential. If a device detects the upstream to be single-ended, it is the first in the chain of LEDs.
The downstream link may be either differential or unconnected, i.e. the device is the last in the chain of LEDs.
After power-up, an idle of $t_{INIT\ Idle}$ = 150µs is recommended before the initialization.
If during the initialization, while receiving the enumeration command, the master SIO_N pin is single ended high (5V), the device is switched into single ended communication mode for this port.
The detected mode is stored and used for all following communications until a power cycle or a reset command.



Single ended startup (first device in chain)



Differential startup (device in chain > 1)

Recommended INIT Idle

Parameter	Description	Min	Typ	Max	Unit
$t_{INIT\ Idle}$	INIT Idle directly after power up	150	-	-	µs

Half-Duplex Communication

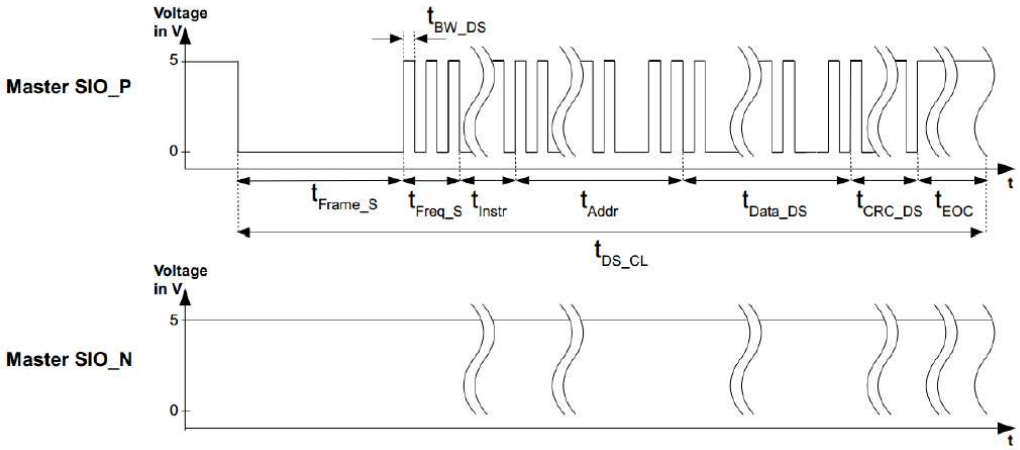
The communication operates in a strict master slave manner. I.e. the microcontroller as the master always initiates a communication. Depending on the type of command the LED devices may send a response (read access) or just silently execute the command (write access).
There are three basic types of commands which are described in the following.

Basic Frame Format

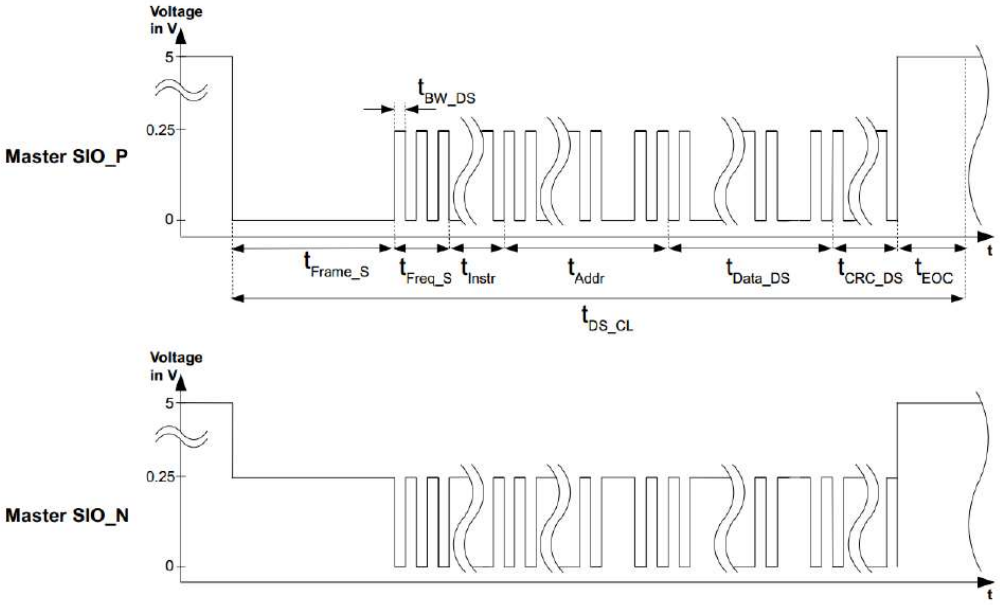
Commands and the response to commands are transmitted with serial frames. A serial frame always consists of a frame_sync section, followed by a frequency_sync section, followed by a run length coded command section and finally terminated with an optional CRC section. The command and the CRC sections differ in length between downstream and upstream frames.

The chosen bit encoding ensures a maximum number of adjacent zeros of 4 and a maximum number of adjacent ones of 5 on the serial line. Some of the bit patterns which cannot occur during regular data transmission are used for special purposes. A pattern of 6 or more 1-bits is considered as the bus-idle condition. The bus is idle, when no communication is currently ongoing. A pattern of 15 0-bits is recognized as the so-called frame synchronization. This is the sequence to begin a new frame. The pattern “10101” is the so-called frequency synchronization pattern. It is used after the frame synchronization to determine the transmitter’s gross data rate.

Downstream communication is defined as data inputs at SIO1 and outputs at SIO2. This is the data flow for write commands. Upstream respectively is defined as data inputs at SIO2 and outputs at SIO1.
This is the data flow for the read response.



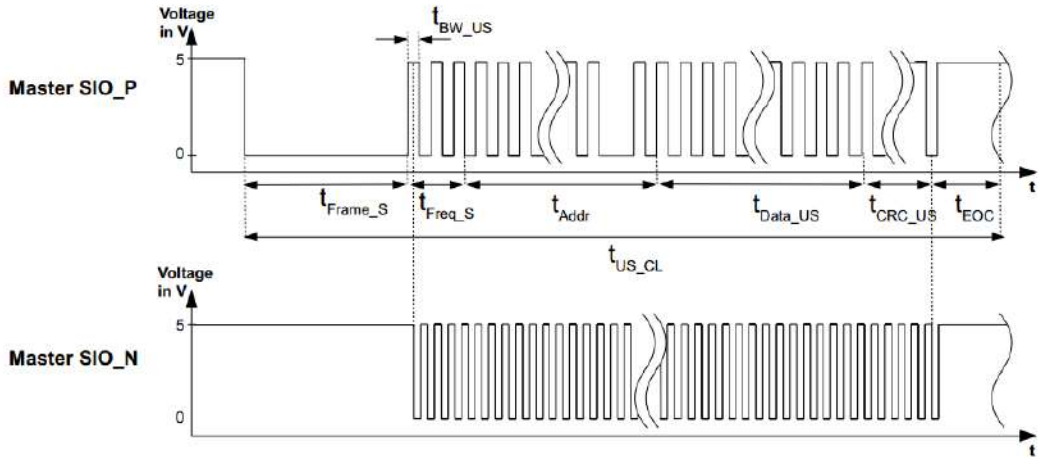
Single ended downstream command frame



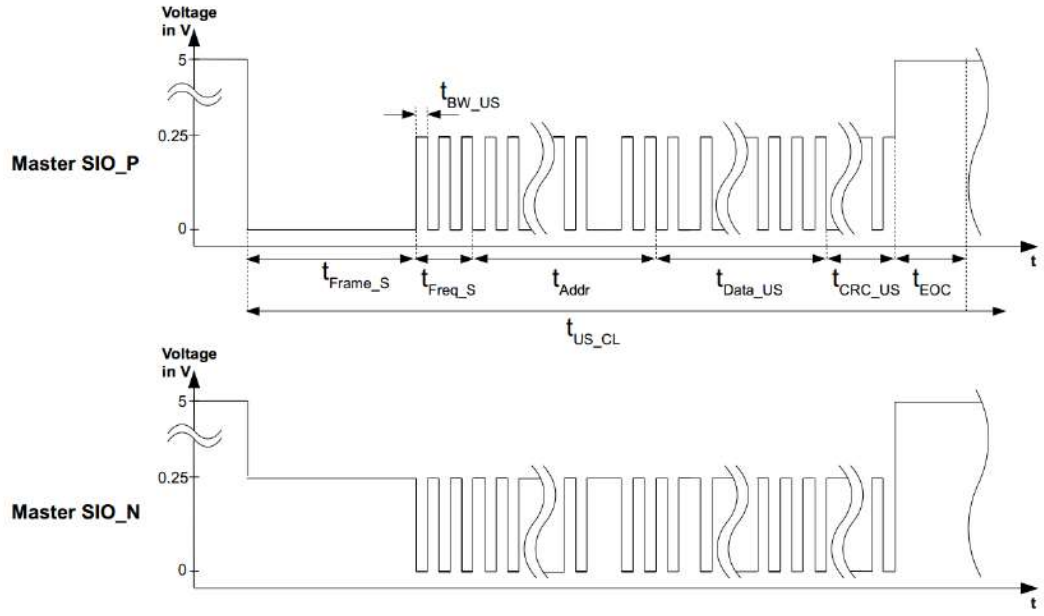
Differential downstream command frame

Downstream command frame parameters

Parameter	Description	Min	Typ	Max	Unit
t_{BW_DS}	Downstream bit width	384	500	714	ns
t_{DS_CL}	Downstream command length CRC enabled CRC disabled		 86 x t_{BW_DS} 76 x t_{BW_DS}		 ns ns
t_{Frame_S}	Frame sync		15 x t_{BW_DS}		ns
t_{Freq_S}	Frequency sync		5 x t_{BW_DS}		ns
T_{inst}	Instruction		5 x t_{BW_DS}		ns
t_{Addr}	Address		15 x t_{BW_DS}		ns
t_{Data_DS}	Downstream data		30 x t_{BW_DS}		ns
t_{CRC_DS}	CRC downstream		10 x t_{BW_DS}		ns
t_{EOC}	End of command idle		6 x t_{BW_DS}		ns



Single ended upstream response frame



Differential upstream response frame

Upstream command frame parameters

Parameter	Description	Min	Typ	Max	Unit
t_{BW_US}	Upstream bit width	384	500	714	ns
t_{US_CL}	Upstream command length CRC enabled CRC disabled		 61 x t_{BW_DS} 56 x t_{BW_DS}		 ns ns
t_{Frame_S}	Frame sync		15 x t_{BW_DS}		ns
t_{Freq_S}	Frequency sync		5 x t_{BW_DS}		ns
t_{Addr}	Address		15 x t_{BW_DS}		ns
t_{Data_US}	Upstream data		15 x t_{BW_DS}		ns
t_{CRC_US}	CRC downstream		5 x t_{BW_DS}		ns
t_{EOC}	End of command idle		6 x t_{BW_DS}		ns

Bit Retransmission

To ensure a correct bit-timing, the forwarded data is regenerated with the clock of the device.
The retransmission starts with its own frame-sync when it can be guaranteed that a valid frame-sync timing can be created. A new frequency synchronization is only created after the freq-sync on the reception side has been received (the first four bits). Therefore, the minimum propagation delay t_{pd} introduced by the retransmission is four bit widths t_{BW}.

Propagation delay

Parameter	Description	Min	Typ	Max	Unit
t_{pd}	Propagation delay	2.0	4.0	5.2	μs

To guarantee a correct bit-timing the device uses its own clock as reference and will never transmit faster than its own bit-timing defines, but if the received freq-sync was slower, this timing is used for the retransmission.

The retransmission uses a FIFO to compensate for speed differences between reception and transmission.

Due to the variance in the oscillator clocks of different devices, after each transmission a pause of 43% of the nominal transmission time has to be introduced. If the transmission is created by a chip with ±30% oscillator clock variation the time has to be increased to a total of 70% of the transmission duration.

Initialization

The digLED_Init_Strip command initializes a particular ISELED chain by issuing the command on an Associated ISELED communication channel.

This command is always the first command to be transmitted after power-up or reset.
The command initializes a chain of devices by assigning the address of the device and by en- or disabling the phaseshift, the CRC and temperature compensation functions. The digLED_Init_Strip command is always executed with a CRC checksum. This is true for both, the command and the response frame.
If any command is received by a device before initialization, the command is always considered as illegal and the error status bit for an undefined command is set. This may happen in the chain's first device only, as a non-initialized device does not forward received messages.

If the first device in the chain receives a digLED_Init_Strip command, it takes the received address as its own device address and afterwards transmits another digLED_Init_Strip frame to the next device in the chain. It increments the address before the transmission. As the adjacent devices proceed in the same manner, the devices in the chain get enumerated with ascending addresses. When the final device in the chain recognizes there is no receiving device at its downstream link, it transmits a response frame upstream. The response frame to a digLED_Init_Strip command carries the configuration word read from the OTP. It also transmits the own devices address just initialized.
All upstream devices wait for the responses to be received and forward them towards the microcontroller. If a frame with an address equal to the adjacent device address (own address plus one) is received, the own response to the digLED_Init_Strip command is transmitted thereafter. If the first device has transmitted its response frame, the chain is ready to process regular commands (non-Init frames).

As soon as a device is initialized, it unconditionally forwards incoming correct frames (Frame-Sync, Freq-Sync and the RLC coding as well as the frame length are checked) to the adjacent node in the chain.

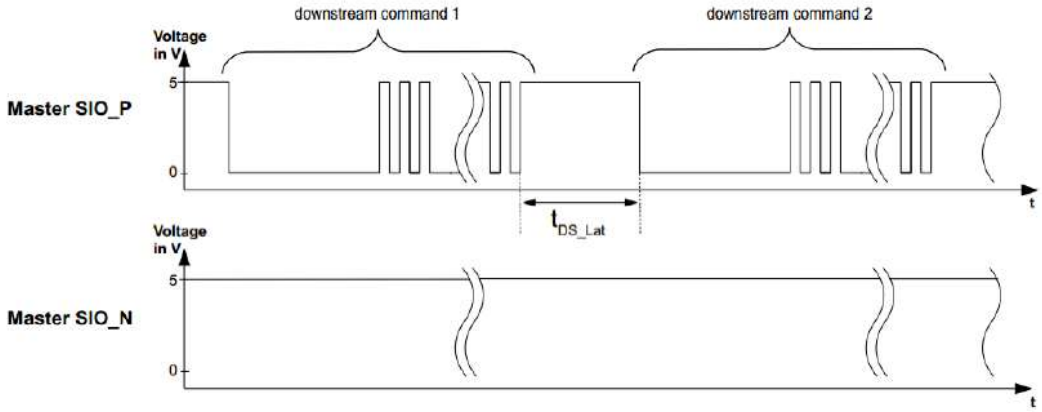
Frames received from upstream are forwarded downstream and vice versa. If an error is detected, the forwarding is stopped for this frame.

Initialization duration

Parameter	Description	Equation
t_{INIT}	Initialization duration	$n \times (t_{DS\_CL} + t_{US\_CL} + 2 \times t_{PD})$

Write Access

Most commands of the LED Controller are write-only commands. I.e. the devices receive a command frame and execute the appropriate actions without any further communication. A write access command may be directed to a single device (unicast), to all devices (broadcast), or to a defined group of devices (multicast). As every command frame is forwarded downstream irrespective of its destination address, all stations always receive all commands. Only its execution depends on the command's destination address. To avoid communication issues, it is recommended to wait 30% of the command length between two consecutive commands.



Multiple single ended downstream commands

Recommended latency between downstream commands

Parameter	Description	Min.
t_{DS_Lat}	Latency between two downstream commands	0.3 x t_{DS_CL}

Read Access

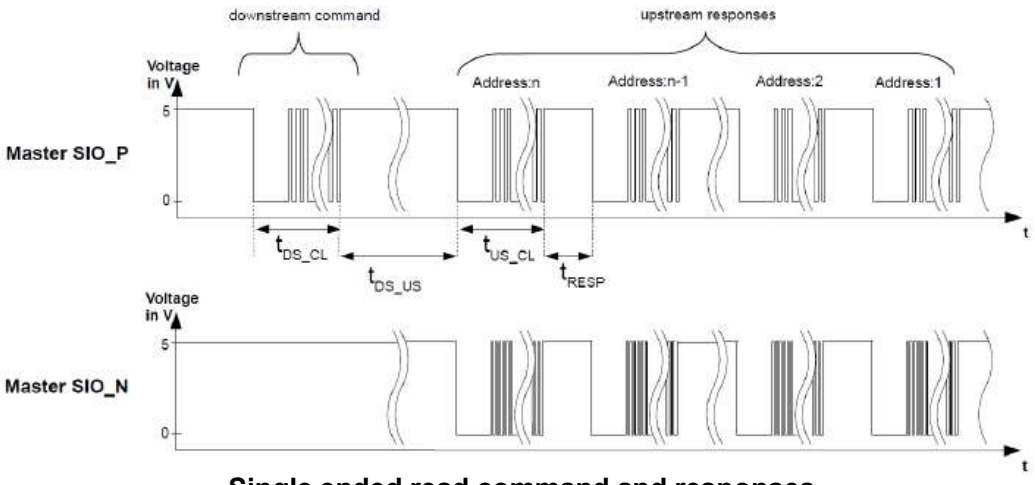
A read access consists of two phases, the command and the response phase. The command phase uses downstream communication and the response phase uses upstream communication. Commands for read access do not use the command address, i.e. these commands may not be directed to a device based on the device address.

There are two commands for read access, digLED_Read and digLED_Ping. The digLED_Read commands retrieve a status information from all devices and the digLED_Ping command is used to check the device chain's integrity. Only the final node in the chain responds to a PING command.

A digLED_Read command is first received by all devices via the frame in downstream direction.

The last node in the chain then immediately transmits its response frame upstream. The response frame's data field depends on the actual digLED_Read command. The response frame's address field is set according to the own device's address. All the nodes upstream forward all received response frames until a frame with the address of their adjacent node is received. Then the respective node transmits its own response frame. This procedure lasts until the chain's first node has transmitted its response frame.

A digLED_Ping command is similar to a digLED_Read command, but only the last device in the chain responds to a digLED_Ping. Thus, the digLED_Ping command is executed much faster than a regular digLED_Read command.



Single ended read command and responses

Down- and upstream delay, delay between responses

Parameter	Description	Min.
t_{DS_US}	Delay between down- and upstream	$t_{DS\_CL} + t_{US\_CL} + 2 \times n \times t_{PD}$
t_{RESP}	Delay between responses Oscillator variation of adjacent devices < ±30% Oscillator variation of adjacent devices > ±30%	 $0.43 \times t_{US\_CL}$ $0.7 \times t_{US\_CL}$

Timeouts

The digLED_Init_Strip, all the digLED_Read, and the digLED_Ping commands initiate upstream data transmission. With the digLED_Init_Strip and the read commands all nodes are expected to send a response to the host. The digLED_Ping requires only the last node in the LED chain to respond. However, in all cases each node needs to await all responses originating from the nodes downstream. Thereafter either the node's own response is transmitted or new commands are accepted. Only the last node in the LED chain may immediately transmit its response.

In case there is an error with the chain downstream, not all expected responses may arrive. Thus, each of the commands expecting a response waits for a certain time only and then returns to its previous state without having transmitted the node's response data.

The lengths of the timeouts depend on the respective command. They are calculated to account for the worst-case oscillator frequency tolerance. I.e. the waiting node has a high-speed clock and all the nodes waited for have a low speed clock. The hardware implementation uses an internally divided clock for the timeout counter:

$$f_{[timeout]} = f_{[osc]} / 2^{14}$$

With the nominal clock frequency of 16MHz the counter's resolution results to 1.024ms.

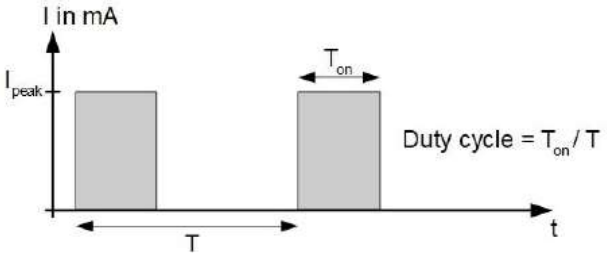
Timeouts

Command	Max. Counter value	timeout			Unit
		Min	Nom.	Max	
digLED_Init_Strip	992	780.6	1015.3	1451.2	ms
digLED_Read_*	427	335.6	436.7	624.6	ms
digLED_Ping	62	48.0	63.0	90.7	ms

PWM Units

Basic Mode of Operation

The LED controller device incorporates three independent PWM channels, one for each LED.



PWM Signal

The resolution is 12 bit. The supported duty cycles are 0/4095 to 4095/4095. The nominal PWM output frequency is 16MHz／215 = 488.3Hz. The frequency is reduced to the half or the quarter of this frequency with low duty cycles. This ensures a minimum on-time of 2μs for the LEDs. The minimum output frequency is 122Hz. The output frequency is not derived from the actual PWM duty cycle but from the RGB value received from the host. As the DIM command also has impact to the LED intensity, it is accounted for as well.
The actual relationship is given in the following table.

DIM parameter relationships between RGB parameters and PWM frequencies

DIM Parameter	RGB Parameter	PWM Frequency in Hz
0	8…255	488
	4…7	244
	0…3	122
1	16…255	488
	8…15	244
	0…7	122
2	32…255	488
	16…31	244
	0…15	122
3	64…255	488
	32…63	244
	0…31	122

The output frequency is determined independently for each of the PWM channels.

Update

When a new PWM duty cycle has to be applied, this is always done at the end of a PWM cycle. I.e. the PWM always completes an output cycle using the previously active duty cycle and starts the next output cycle using the updated duty cycle.

Phase Shift

In order to spread the current consumption of the LEDs over time, a phase shift can be set between the three PWM channels. This optional function can be enabled/disabled during device initialization.
If the phase shift is deactivated, the red channel controls all three outputs and thus provides the temperature compensation function for all three channels.
If the phase shift is enabled, it retains even if the output frequency of the channels is different. If a channel is operating at a lower frequency, it may be considered to leave out one or three full PWM cycles. When leaving power save mode, the channels are restarted appropriately to again obtain the correct phase shift.
The fixed phase shift is defined in the following table. Please note the absolute phase shift times are nominal values. I.e. they are subject to vary with the internal oscillator's frequency.

Phase Shift

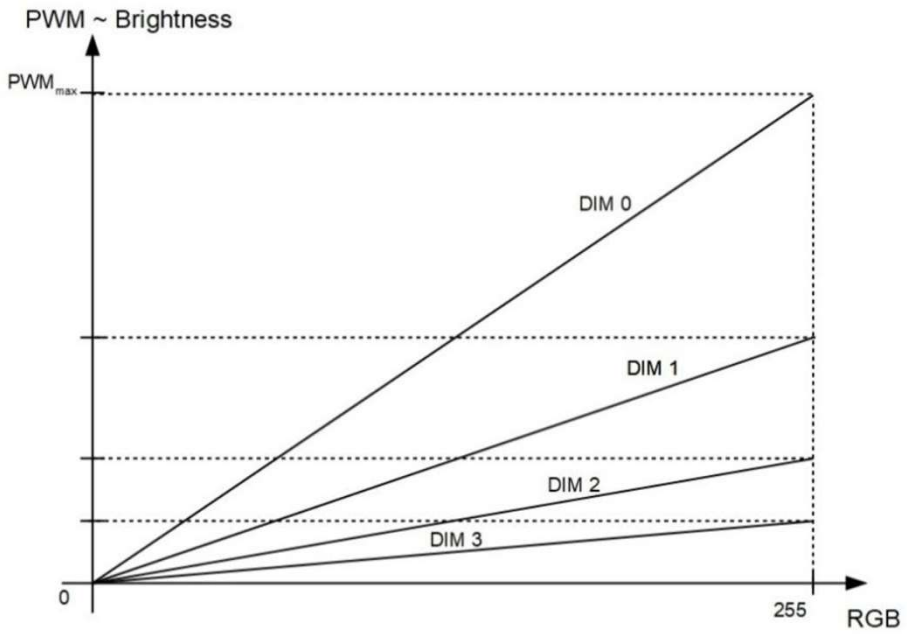
PWM channel	Rel. Phase Shift
Green	0%
Red	25%
Blue	75%

Power Save Mode

When all LED channels are set to an intensity of 0, the device enters a power save mode for the current sources driving the LEDs. I.e. the digLED_Set_RGB command must be issued with an RGB value of 0x000000 to enter the power save mode.
Recovering from this mode does not require any particular measures. I.e. the host just needs to issue a digLED_Set_RGB command with the data field different from 0x000000 and the current sources are restarted again. There is a delay of approx. 1µs before the restart of the green PWM channel (no phase shift applies to the green channel).
This is due to an internal ramp-up required by the analog circuitry. The same procedure is applied after device power-up or a hardware reset, as the initial RGB value is 0x000000. I.e. the LEDs are all turned off after power-up or a hardware reset.

DIM Function for Accurate Low Light Colors

To extend the SET_RGB command's resolution for accurate low light colors, the CoAsia-LED provides the DIM command. The command divides the PWM duty cycles computed from the RGB setting. There are four divisors available. Details are shown in Figure and table.

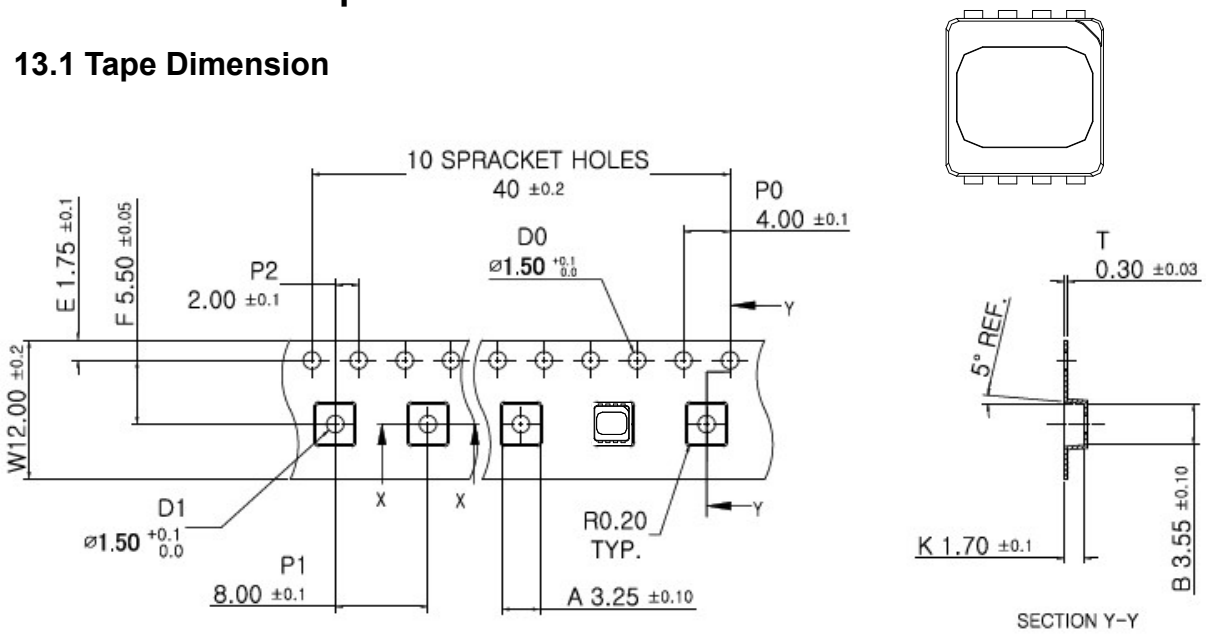


DIM Function

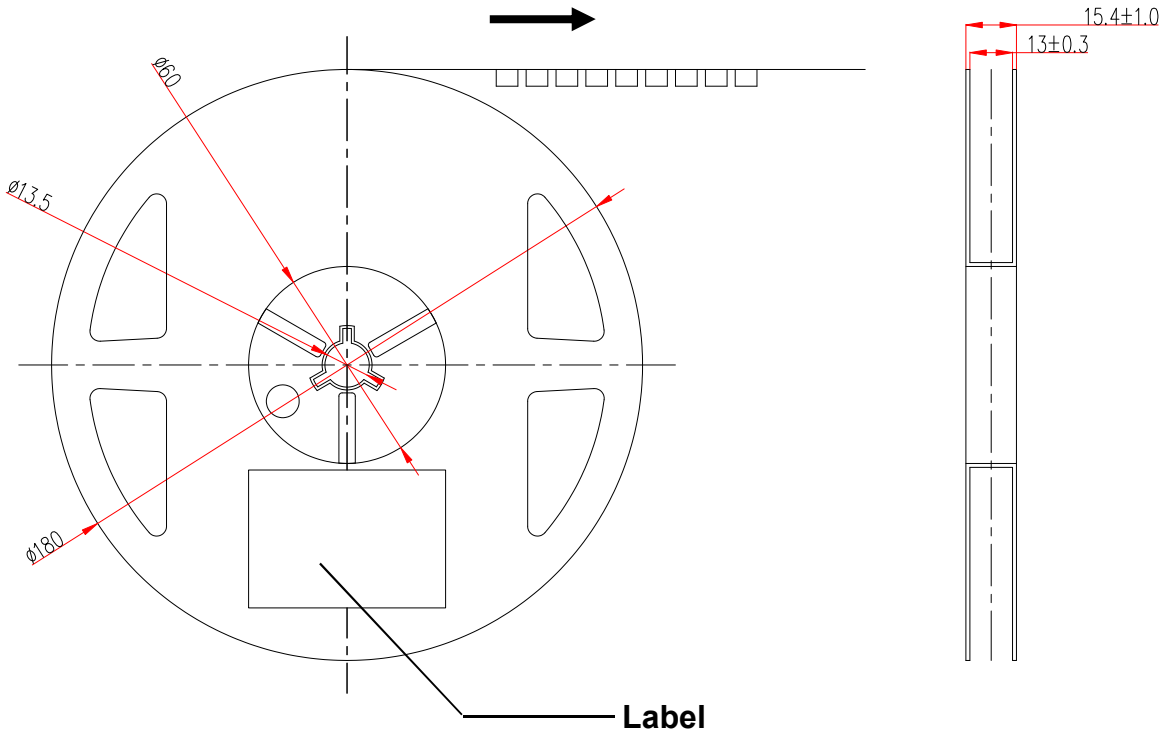
DIM	Relative PWM Ratio
0	1
1	1/2
2	1/4
3	1/8

13. Dimension of Tape / Reel

13.1 Tape Dimension



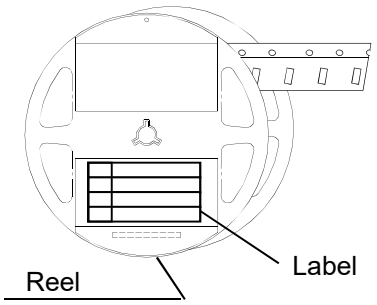
13.2 Reel Dimension



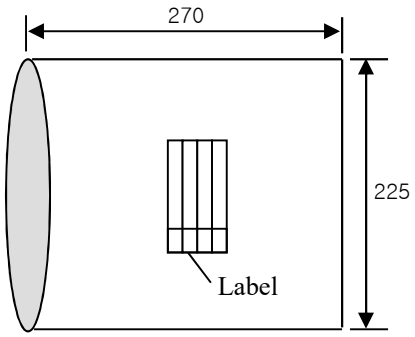
14. Packing Dimension

Unit :mm

Reel

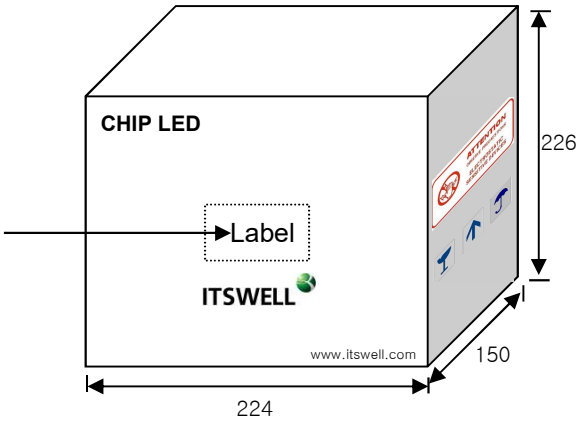


Aluminum Shield Bag

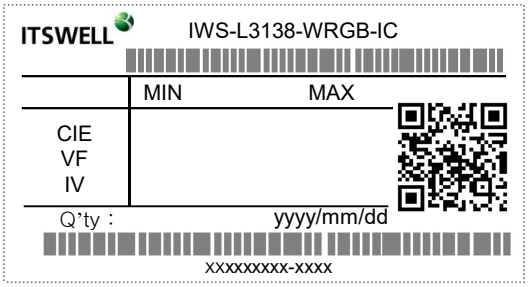


Including Silica gel in a bag

Card Board Box



Al Pack Label, Reel Label (70 × 37)



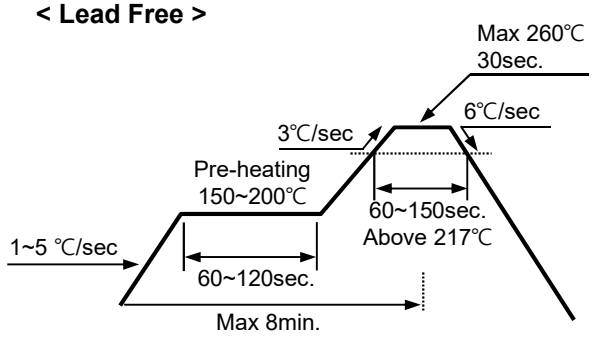
	Dimensions (mm)	Reel / Box	Q'ty / Box(pcs)
Reel	Φ180mm, 15mm Width	–	~ 1,000 Max
Al Shield Bag	270x225	–	~ 1,000 Max
Card board Box	224 x 150 x 226	8 Max	8,000 Max

15. Precaution in use

15.1 Soldering Conditions

- When soldering Power SMD, Heat may affect the electrical and optical characteristics of the LEDs.
  Power SMD를 납땜할 때, 발생되는 열은 LED의 전기 및 광학적 특성에 영향을 줄 수 있음.
- In soldering, do not stress the lead frame and the resin part under the high temperature.
  납땜할 때, 리드프레임 및 수지 영역에 높은 온도 가하는 것을 금함.
- The silicone part should be protected from mechanical stress or vibration until the Power SMD return to room temperature after soldering.
  납땜 후, Power SMD가 상온 상태가 될 때까지 실리콘 영역은 기계적 부하 및 진동으로부터 보호되야함.
- Preliminary heating to be at 150~200 ℃ max. for 120 Seconds max.
  예열은 최대 120초 동안 최대 150 ~ 200 ℃ 에서 권장함.
- Soldering heat to be at 260 ℃ max. for 30 sec. Max.
  납땜 열은 최대 30초 동안 260 ℃ 에서 권장함.
- Manual Soldering is Not more than 3 sec @MAX 350 ℃, under soldering iron.
  수납은 인두기 최대 350 ℃ 에서 3초보다 길게 하는 것을 금함.
- Do not assemble at atmosphere containing of humidity, condensation, chlorine and Volatile Organic Compounds.
  습기, 결로, 염소 및 휘발성 유기 화합물이 포함된 대기에서 조립을 금함.
- Recommend assembling the LEDs in last order to prevent delamination when implementing surface mounting technology.
  SMT 시, 박리를 방지하기 위해 LED는 제일 마지막에 조립하는 것을 권장함.
- When bifacially implementing surface mounting technology, LEDs assembling should be completed within 12 hours.
  양면으로 SMT 시, LED 조립은 12시간 이내에 완료 되어야함.
- When the LEDs containing moisture may vaporize and expand during soldering, it may cause delamination and optical degradation of the LEDs.
  습기를 함유하고 있는 LED가 납땜하는 동안에 증발하거나 팽창이 되어 박리 및 광학 특성 저하 시킬 수 있음.

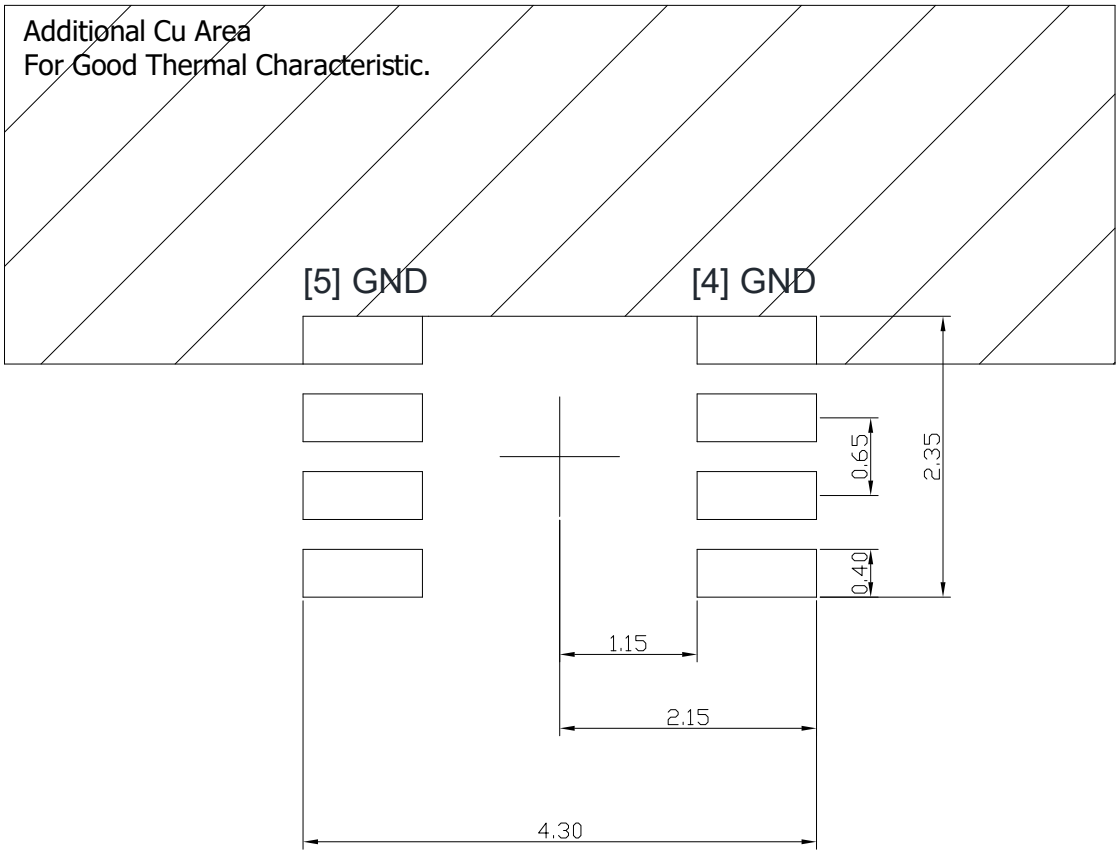
< Lead Free >



15.2 Soldering Conditions

- The use of flux in soldering material may make the LEDs discolored by thermal and lighting acceleration factor. so, recommend to clean a residual flux with Isopropyl Alcohol after soldering.
  납땜 소재에서 Flux의 사용은 열과 빛의 촉진 인자에 의해 LED의 변색이 될 수 있으므로 납땜 후에 이소프로필알코올을 사용하여 잔여 Flux 세정을 권장함.

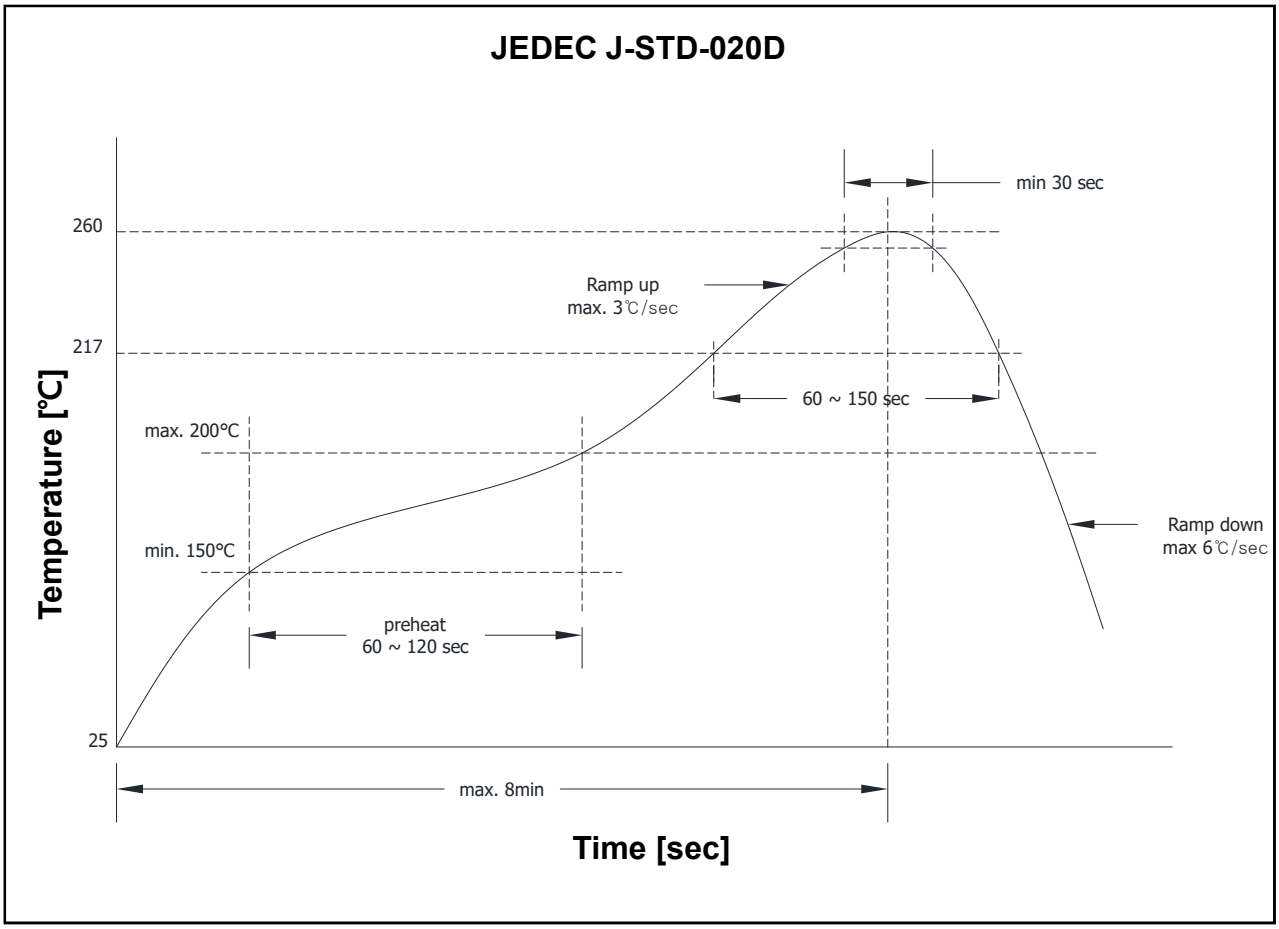
15.3 Recommended Solder pattern



Note

1. Additional cupper area is not open
   be covered with PSR (Photo Imageable Solder Resist).

15.4 Recommended Reflow soldering profile



15.5 Cleaning

- If user needs cleaning of the LEDs, use of Isopropyl Alcohol or Ethylene Alcohol is recommended in 5 minutes at room temperature. and dry at room temperature for 15 minutes before use the LEDs. If user uses other than Isopropyl Alcohol or Ethylene Alcohol as cleaning material, it should be not dissolve the LEDs.
  LED의 세정이 필요하면, 사용 전에 상온에서는 5분 이내에 건조한 상온에서는 15분동안 이소프로필 알코올 또는 에틸렌알코올으로 세정 권장함. 만약 세정 물질로 이소프로필알코올 또는 에틸렌알코올 이 외의 것을 사용하면, LED가 파손될 수 있음.

- Freon solvents should not be used to clean the LEDs because of worldwide regulations.
  국제 규정으로 LED의 세정에 프레온 용제를 사용을 금함.

15.6 Heat Generation

- When the LEDs are illuminating, operating current should be decided after being considering the ambient maximum temperature.
  LED를 구동 시킬 때, 구동 전류는 주변 최대 온도를 고려한 후에 결정 되어야 함.

- Please consider the heat generation of the LED when it is designed the PCB.
  PCB를 디자인 할 때, LED 열 발생을 고려하여 설계하는 것을 권장함.

15.7 Storage

- The LEDs must be stored in a clean environment.
  LED는 깨끗한 환경에 보관 해야함.

- Do not expose the LEDs to direct sunlight.
  직사광선에 LED를 노출시키는 것을 금함.

- Before opening the package, the LEDs should be kept at 30℃ or less and 60%RH or less.
  포장을 개봉 전에, LED는 30 ℃ 미만 또는 상대습도 60% 미만에 보관 해야함.

- The LEDs should be used within 672 hours (4 weeks) after opening the package.
  LED는 포장 개봉 후에 672시간(4주) 이내에 사용 해야함.

- The LEDs should be used within a year.
  LED는 1년 안에 사용 해야함.

15.7 Storage

- In case of the LEDs is used 3 months later since user received the LEDs, the LEDs is recommended to be stored in the nitrogen chamber. and user should inspect discolored appearance before using the LEDs.
  LED를 수령한지 3개월이 지난 후에 사용할 경우, LED는 질소실에 보관하고 사용 이전에 변색을 확인 해야함.

- After opening the package, the LEDs should be kept at 30℃ or less and 20%RH or less.
  포장 개봉 후에, LED는 30℃ 미만 또는 상대습도 20% 미만에 보관 해야함.

- If the moisture absorbent material (silica gel) has faded away or the LED have exceeded the storage time, baking treatment should be performed using the following conditions.
  - Baking treatment: 60℃±5 for 48 hours.
  만약 수분 흡수 물질(방습제)이 사라지거나 LED의 보관 시간이 경과하면, 다음과 같은 조건으로 Baking 해야함.
  - Baking 처리 : 60℃±5에서 48시간 동안.

- When restoring unused the LEDs with anti-electrostatic bag, seal off the anti-electrostatic bag so that no gas and humidity can get it.
  제전봉투에 사용되지 않은 LED를 보관할 때, 기체 및 습기가 침투하지 못하게 제전봉투를 밀봉 해야함.

- When storage the LEDs in the corrugated cardboard, it may make the LEDs discolored because of minute sulfur gas from the corrugated cardboard.
  골판지 상자에 LED를 보관할 때, 골판지 상자에서 나오는 미세한 황 기체로 인한 LED의 변색 될 수 있음.

- Do not use over 10 days in case of using corrugated cardboard.
  골판지 상자를 사용하는 경우에 10일을 경과하면 안됨.

- Recommend corrugated cardboard containing sulfur less than 850ppm when It is Inevitable use of corrugated cardboard.
  골판지 상자의 사용이 불가피한 경우에 황의 농도가 850ppm 보다 적게 함유된 골판지 상자의 사용을 권고함.

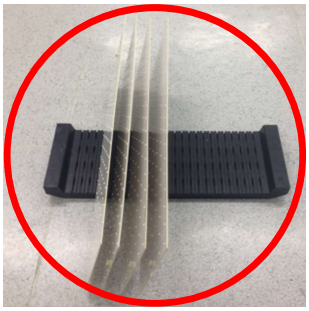
- Recommend using material type of PP or PET tray to storage the PCBs or assemblies containing the LEDs. and Insert the silica gel into each of tray.
  LED를 포함하는 PCB 또는 조립품은 폴리프로필렌 또는 폴리에틸렌테레프탈레이트 재질의 상자 사용을 권고함.

- Use the anti-electrostatic box with anti-electrostatic cover to prevent Volatile Organic Compounds, sulfur gas and humidity when storing the bundle of the PCBs or assemblies containing the LEDs.
  LED를 포함하고 있는 PCB 및 조립품의 묶음을 보관할 때, 유기화합물, 황 기체 및 습기 침투의 방지를 위해 제전덥개가 있는 제전박스를 사용 권장함.

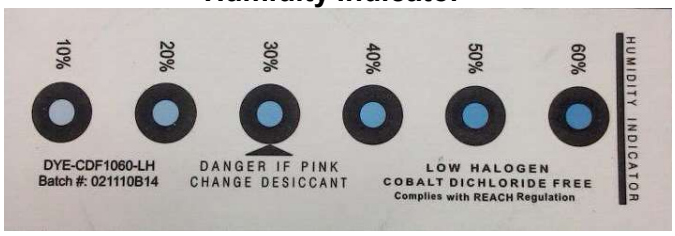
- Do not stack the PCBs or assemblies containing LEDs at shorter distance than 2 centimeters.
  LED를 포함하고 있는 PCB 및 조립품을 2센치미터 간격보다 좁게 적재는 것을 금함.

15.7 Storage

- Do not use bubble wrap directly on top of LEDs. It may cause damage the LEDs.
  LED가 손상될 수 있으므로, LED의 상단에 바로 포장 에어캡을 닿게 하는 것을 금함.
- Do not use rubber band.
  고무줄 사용을 금함.



<Humidity Indicator>



<Bulk Packing>

<Taping Packing>

15.8 Static Electricity

- Static electricity or surge voltage damages the Power SMD . It is recommended that a wrist band or an anti-electrostatic glove be used when handling the LEDs.
  정전기 또는 서지전압은 Power SMD에 손상을 줄 있음. LED를 다룰 때 손목 밴드 또는 제전 장갑 사용을 권장함.

15.8 Static Electricity

- A tip soldering iron is requested to be grounded. An ionizer should also be installed where risk of static.
  인두기는 접지시키고 이온화 장치는 위험 요소가 정적인 곳에 설치 해야함.

- All devices, equipment and machinery must be properly grounded (via 1MΩ). It is recommended that measures be taken against surge voltage to the equipment that mounts the Power SMD.
  모든 장치, 장비 및 기계는 1MΩ의 저항을 통해서 반드시 적절히 접지 되야함. Power SMD를 탑재한 장비는 서지전압을 감안하여 측정 권고함.

- If the LEDs is applied at voltage over maximum value, it may cause damage or destruction of the LEDs.
  LED가 전압 최대치를 넘게 적용되면, LED의 손상이나 파괴를 일으킬 수 있음.

- The LEDs damaged or destructed by anything may cause an increase in leak current, lowered turn on forward voltage, or the LEDs at low forward current.
  어떤 요인에 의해 손상 받거나 파괴된 LED는 누설전류, 낮아진 구동 전압 또는 낮은 구동 전류를 야기할 수 있음.

- It is important to eliminate the possibility of surge current when user designs circuit.
  회로를 설계할 때, 서지전류의 가능성을 제거하는 것을 권고함.

15.9 Exposure to Specific Material

- When the LEDs are exposed to specific material such as oxidizing material, rubber, paper, solder cream, sulfur, chlorine or other halogen compound, LEDs surface in silver-plating part of Lead Frame can be discolored.
  LED가 산화물질, 고무, 종이, 솔더크림, 황, 염소 및 다른 할로겐 화합물과 같은 특정 물질에 노출되면 리드프레임의 은도금 부분에서 변색이 일어날 수 있음.

- If LEDs surface in silver-plating part of Lead Frame are discolored, it can cause intensity degradation, change of color coordinates and open circuit.
  리드프레임의 은도금 부분에서 LED의 표면이 변색 되면, 빛의 강도 감쇄, 표색계 변화 및 개방회로를 야기할 수 있음.

- Recommend user to use adhesive type of silicone in minimum quantity. It is because that epoxy used as adhesive(sealing) material easily makes the LEDs discolored by gas than silicone material.
  접착(밀봉) 물질로서 에폭시가 실리콘 물질 보다 기체에 의한 LED의 변색이 쉽게 되므로, 최소한의 양으로 실리콘 물질의 접착제의 사용을 권고함.

- When user designs the LEDs assembly, consider about free air ventilation to avoid discoloration and outgas Volatile Organic Compounds easily.
  변색을 방지하고 유기화합물을 쉽게 빠지게 하기 위해 공기의 원활한 환기를 고려하여 LED 조립품을 설계 해야함.

- When user designs products containing the LEDs, do not use oxidizing raw and subsidiary materials such as sulfur, chlorine, other halides, gaseous or corrosive materials or substances. Because the LEDs contain silver-plating part that may discolor over time when exposed to these materials. It may cause corroded or contaminated silver-plating of the LEDs may cause an open circuit.
  LED를 포함하고 있는 제품을 설계할 때, 황, 염소, 여러 할로겐화물, 기체 또는 부식성 재료 및 성분과 같은 산화 원부자재 사용을 금함. 이러한 물질에 노출될 때 시간이 경과하면서 LED의 은도금 부분이 변색 될 수 있음. 이로인한 LED의 은도금 부분의 부식이나 오염은 개방 회로를 야기할 수 있음.

15.10 Handling LED

- User's working and testing environment can be a important factor to discolor. because unclean testing chamber or working place with wet floor may cause discolor of the LEDs.
  젖은 바닥과 청결하지 않은 실험 공간 또는 작업 장소는 LED의 변색을 일으키므로 사용자의 작업 및 실험 환경을 고려해야함.

- When handling the LED with tools like tweezers or nipper, do not apply Mechanical Forces directly on LED's Surface.
  집게 및 니퍼와 같은 공구로 LED를 다룰 때, LED의 표면에 직접적으로 기계적인 힘을 가하는 것을 금함.

- Do not directly touch LED's surface with hand . It may contaminate the surface and affect on optical characteristics.
  LED의 표면을 직접적으로 손으로 만지면 표면 오염으로 광학 특성에 영향을 미치므로 이것을 금함.

- The LEDs should be handled from side because LED's molding material may be damaged with scratching on surface, piercing molding material and broking wire.
  LED의 몰딩 물질은 LED의 표면의 스크래치, 몰딩부 뚫림 및 와이어 깨짐으로 손상의 영향이 있어 LED는 측면으로 다뤄야 함.

- When doing surface mounting technology, If the encapsulation material of the LEDs is silicone, do not any stress or pressure that may cause that emitting surface area of the LEDs resin can be cut, chipped, delaminate or deformed, causing wire bonding breaks and destruction of the LEDs.
  SMT 시, LED의 봉지재가 실리콘이면 LED의 와이어 파손 및 파괴를 야기하는 LED수지의 발광 표면의 잘림, 부서짐, 갈라짐, 형태 변형을 일으킬 수 있는 어떠한 스트레스 또는 압력을 가하면 안됨.

- Recommended that the picking up nozzle optimize wider than emitting surface area of the LEDs and setting so that it does not damage the silicone resin.
  실리콘 수지에 손상을 피하기 위해 픽업 노즐 사용 조건을 설정하고 픽업 노즐은 LED의 발광 표면 부분보다 크게 설계 권고함.

- Maintain cleanness of picking up nozzle.
  픽업 노즐의 청결함을 유지 해야함.

- Dropping the LEDs may cause damage.
  LED를 떨어뜨리는 것은 손상을 야기 할 수 있음.

- Do not contaminate emitting surface area of the LEDs.
  LED의 발광 표면 부분 오염을 금함.

16. Aluminum Zipper Bag

This bag contains
MOISTURE and E.S.D SENSITIVE DEVICE

1. Before opening the package, the LEDs should be kept at 5℃~30℃ and less 70% RH or less.

2. After opening please check if RH indicator does something wrong.
   If its color is not Pink at RH 10% or Blue at 20%, LEDs should be backed for min. (Baking 48hrs at 60℃)

3. Please keep the remained LEDS to your desiccators on condition of under 10% RH.

   1) Best method is to desiccate LEDs as Reel condition with RH indicator after baking min. 48hrs at 60℃ and store them up in Al bag.

   2) Always use LEDS after checking RH indicator when you reuse them. (Please use them after baking if RH indicator is not Pink at RH 10% or Blue at 20%)

4. Please work LED mounting last during SMT.

5. Advise that LEDs are used within 12hrs after opening. (Please use them ASAP during extremely humid condition such as rainy season.)

본 알루미늄 백은
습기와 E.S.D에 민감한 소자를 담고 있습니다.

1. 미 개봉 보관 시 온도 5℃~30℃, 습도 70% RH이하에서 보관하세요.

2. 개봉시 습도지시카드의 변색 유/무를 확인 후 사용하세요.
   습도 지시카드 10%에서 Pink 이거나 20%에서 Blue가 아닐 경우 Baking후 사용. (Baking 조건 : 60℃ , 48 hr ↑)

3. 사용 후 남은 잔량은 제습 보관함(데시케이터)에 10% RH 이하로 보관하세요.

   1) Reel 상태로 60℃, 48 hr ↑ Baking 실시 후 습도지시카드와 같이 Al Bag에 넣어 밀봉 보관하는 것이 가장 좋은 방법임.

   2) 재 사용시 습도지시카드 변색 유/무를 확인 후 사용. (10%에서 Pink 이거나 20%에서 Blue가 아닐 경우 Baking후 사용)

4. SMT 작업 시 LED 실장은 맨 마지막에 작업하세요.

5. 개봉한 제품은 12시간 이내에 실장 권고합니다.
   (특히 습기가 많은 우기 시 최단 시간에 사용 바랍니다.)

■ Important
This Al Zipper bag is designed to protect the enclosed products from moisture and ESD. Once opened, the products should be soldered onto the printed circuit board immediately. When not in use, please do not leave the products unprotected by the Al Zipper Bag. To repack unused products, please ensure the zip-lock is completely sealed with the dry pack left inside.

■ 주의사항
본 알루미늄 지퍼백은 습기와 정진기로부터 제품을 보호하기 위하여 제작되었습니다. 본 알루미늄 지퍼백을 개봉 후에 즉시 솔더 작업을 실시하여야 합니다. 습기와 정전기로부터 제품을 보호하기 위해서 개봉 후 사용하지 않는 제품은 반드시 본 백에 넣어서 보관하여야 합니다. 사용하지 않는 제품을 본 백에 넣을 때는 반드시 동봉된 제습제와 함께 넣고 지퍼부분을 완전히 닫아 밀봉하여야 합니다.

16.1 Aluminum Zipper Bag and Humidity Indicator

17. Reliability

17.1 Reliability Test Item

■ **AEC-Q102**

Test Items	Reference	Test Condition	Notes
High Temperature Operating Life	JESD22-A108	-. Ts = 110°C / Tj = 125°C -. @D65 (255, 255, 255) White / VCC @5.5V	0 /26*3
Wet High Temperature Operating Life 1	JESD22-A101	-. Ta = 85°C / 85% RH -. @D65(255, 255, 255) White, VCC@5.5V -. 30min on / 30min off	0 / 26*3
Wet High Temperature Operating Life 2	JESD22-A101	-. Ta = 85°C / 85% RH -. @D65 (5, 5, 5) White, VCC@5.5V	0 / 26*3
Temperature Cycling	JESD22-A104	-. Ts = -40℃ to 125℃ -. soak & dwell time 15min	0 / 26*3
Power Temperature Cycling	JESD22-A105	-. Ts = -40℃ to 105℃(dwell time Min 10min~) -. @D65(255, 255, 255) White, VCC@5.5V -. 5 min on / 5 min of	0 / 26*3
HBM	JEDEC JS-001	-. 1.5kΩ, 100pF -. ±1kV, ±1.5kV, ±2kV, ±2.5kV	0 / 10*3
CDM	AEC-Q101-005	-. ±1000V	0 / 10*3

■ **AEC-Q/100**

Test Items	Reference	Test Condition	Notes
High Temperature Storage Life	JESD22-A103	+125ºC Ta for 1000 hours	0 / 45*1
Temperature Cycling	JESD22-A104	-55ºC to +125ºC for 1000 cycles	0 / 77*3
Latch-up	AEC Q100-004	± 100mA, 5.5V	0 / 6*1

17.2 Criteria for Judging the Damage

Parameter	Acceptance criteria
Luminous flux or Intensity	± 20%
Color coordinates Cx & Cy	± 0.01

18. Part Name Description

□ □ □ – □ □ □ □ □ – □ □ – □ □

Information of Manufacturer

Color
UV : Violet
UB : Blue
UC : Cyan
UG : Green
UY : Yellow
UO : Orange
UR : Red
DR : Deep Red
EI : IR 850nm
NI : IR 950nm
BGR : Blue, Green, Red

BW : 0.26이하
CW : 0.26<x<0.3
PW : 5000~8000K
NW : 3600~5000K
WW : 2600~3600K

Number of leads
2 : 2 leads
4 : 4 leads
6 : 6 leads

Package Dimension
351 : 3.5x2.8
313 : 3.3x3.0
353 : 3.2x3.0
302 : 3.0x2.0
505 : 5.4x5.0
525 : 5.4x5.0 (2Pad/0.2W)
555 : 5.4x5.0 (0.5W)
5A5 : 5.4x5.0 (1W)
523 : 5.6x3.0 (0.2W)
533 : 5.6x3.0 (0.3W)
553 : 5.6x3.0 (0.5W)

Frame type
E : EMC
L : PLCC
C : Ceramic
S : Slug type

S : SMD type LED package

IW : ITSWELL Co., Ltd. (Company Name)

19. Rank Description

Forward Voltage Rank(RGB)

Dominant Wavelength Rank(RGB)

Luminous Intensity Rank(RGB)

20. Attention : Electric Static Discharge (ESD) Protection

The symbol shown on the page herein to introduce 'Electro-Optical Characteristics'. ESD protection for GaP and AlGaAs is based chips is still Necessary even though they are safe in low static-electric discharge. Material in AlInGaP, GaP, or/and InGaN based chips are STATIC SENSITIVE devices. ESD protection has to considered and taken in the initial design stage. If manual work/process is needed, please ensure the device is well protective From ESD during all the process.

21. Spec. Review History

Review Ver.	Date	Correction List	Etc.
Ver 1.0	2022.05.27	Established	
Ver 2.0	2022.06.07	Solder pattern correction	
Ver 3.0	2022.07.13	Current consumption correction	
Ver 4.0	2022.09.27	Changed Card Board Box Q'ty	