

CD3023VGBMG01 Datasheet

IC LED Series (L* W*H): 3.0*2.3*0.9mm



Applications

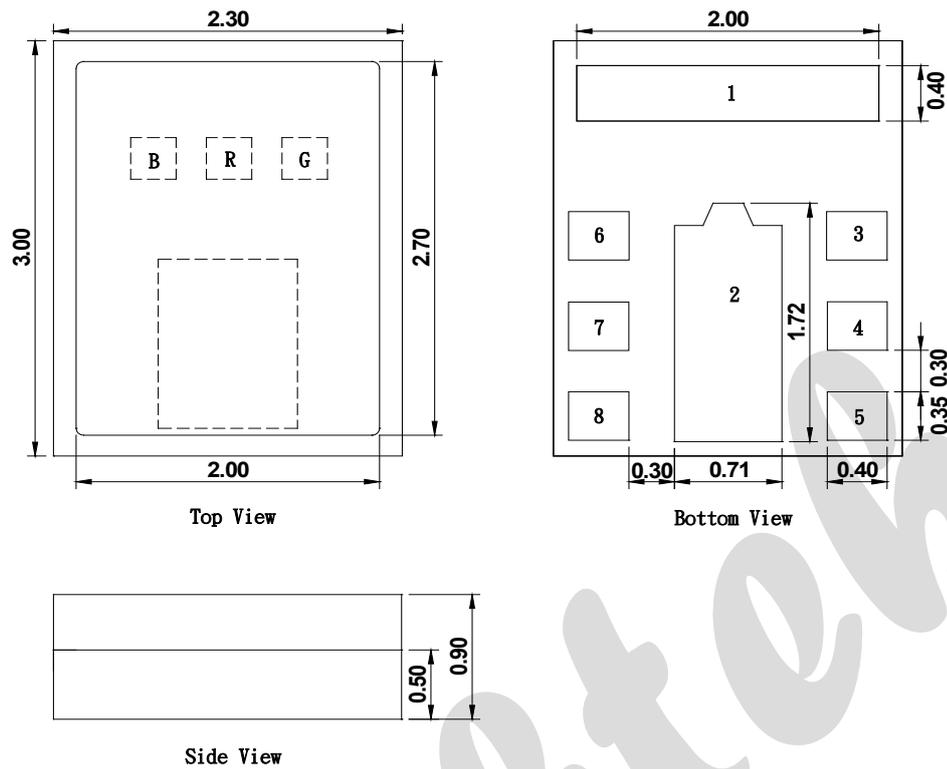
- Automotive interior & exterior lighting
- Ambient lighting
- Others applications

Features

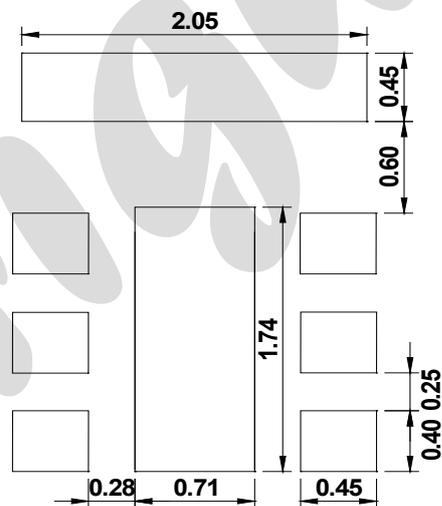
- RoHS2.0 Compliant;
- Low thermal resistance
- Serial communication with ISELED® compliance. 
- 488Hz PWM with 12 Bit resolution.
- Bi directional, half-duplex, 2MBit/s, serial communication
- Build-in temperature sensor
- Reliability Test: AEC Q-102 qualified
- Reliability Test :AEC Q-100 qualified
- 8 bit brightness resolution for red, green, and blue LED
- Build-in diagnostic functions
- Temperature compensation on red for constant brightness
- Calibration values for accurate white point of LED drivers
- Qualified according to JEDEC moisture sensitivity Level 2a
- ESD level 2kV(HBM)

Dimensional Drawing

CD3023VGBMG01



Recommend Pad layout



1. Dimensions are in millimeters.
2. General tolerance is ± 0.1 mm.

CD3023VGBMG01

Naming Rule

CD-3023-VGB-M-G-01

CD	3023	VGB	M	G	01
Type	Package Size	Color	Package Color	Current Code	Serial Number
CD: With IC series	3023: 3.0* 2.3mm	V: red G:green B:blue	M: white diffused	G:25mA	0: No Zener 1: Serial number

Maximum Ratings

T_A : 25 °C

Parameter	Symbol		Values	Unit
IC Power Supply voltage	VDD	max.	7.0	V
Operating junction temperature (LED)	T _{op}	max.	125	°C
Storage temperature	T _{stg}	max.	125	°C
Soldering temperature	T _{SD}	max.	260	°C
ESD	HBM	max.	2.5	KV
R _{th JS real} Color Set Point(255,255,255)		max	30	K/W

1. The IC Power Supply voltage is not allowed to exceed 7.0V.
2. The maximum of soldering time is 10 seconds in T_{SD}.

Recommend Operating Conditions

Parameter	Symbol		Values	Unit
IC Power Supply voltage	VDD	min. max.	4.5 5.5	V
Ambient temperature range	T _a	min. max.	-40 110	°C

Optical Characteristics

VDD : 5V | T_A : 25 °C

CD3023VGBMG01

Parameter	Symbol	Condition	Values	Unit
Calibrated White ¹	Cx/Cy	(255, 255, 255)	0.3127	
			0.3290	
Luminous Intensity	I _v	R (255, 0, 0)	typ. 390	mcd
		G (0, 255, 0)	typ. 910	mcd
		B (0, 0, 255)	typ. 100	mcd
		W (255, 255, 255)	typ. 1400	mcd
Dominant Wavelength	λ _d	R (255, 0, 0)	typ. 621	nm
		G (0, 255, 0)	typ. 526	nm
		B (0, 0, 255)	typ. 467	nm
View angle	2θ _{1/2}	(255, 255, 255)	typ. 120	°

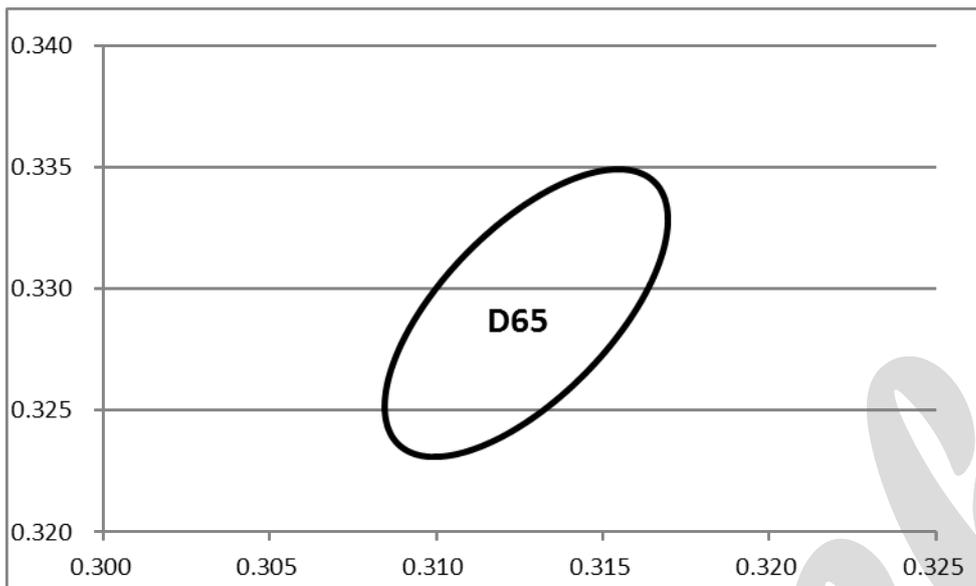
1. The above luminous intensity represent brightness at 100%, Color Set Point = (255, 255, 255).
2. Tolerance of Measure: Luminous Intensity: ±10%Im, Dominant Wavelength: ±1.0nm, Color Coordinate: ±0.005

CD3023VGBMG01

Bin groups

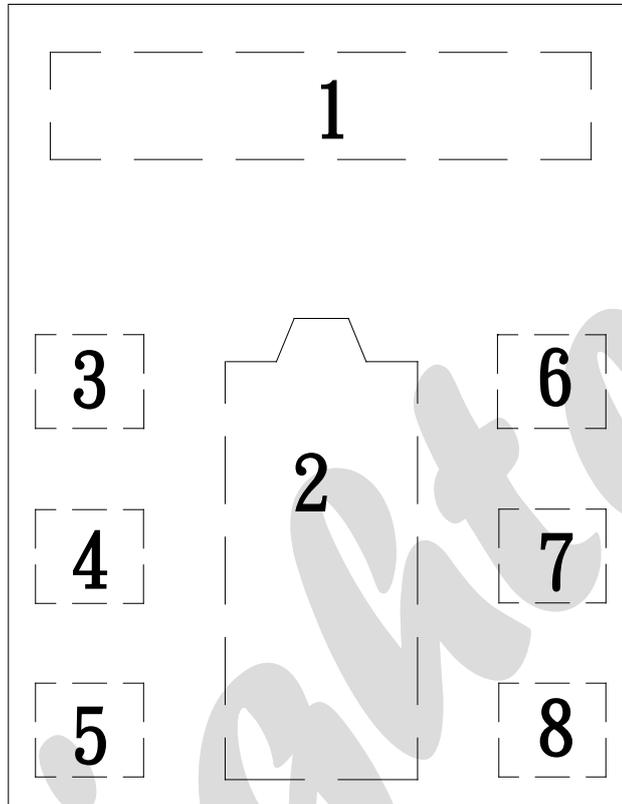
Chromaticity Coordinate Groups

Group					
BIN	Center		Radius		Angle(°)
	x	y	a	b	
D65	0.3127	0.3290	0.00669	0.00285	58.57



Brightek

PIN Configuration



No.	Symbol	Function description
1	VDD	Supply voltage for R/G/B
2	GND	Ground
3	SiO1_P	Serial Communication Interface Master Side, Positive Polarity
4	SiO1_N	Serial Communication Interface Master Side, Negative Polarity
5	PRG	Has to be Connected to GND for Proper Operation
6	SiO2_P	Serial Communication Interface Slave Side, Positive Polarity
7	SiO2_N	Serial Communication Interface Slave Side, Negative Polarity
8	VDD	Supply voltage

CD3023VGBMG01

Lookup Table for Red LED Non-Linear Temperature Compensation

LUT	Values
LUT_10	155
LUT_9	163
LUT_8	176
LUT_7	194
LUT_6	212
LUT_5	236
LUT_4	262
LUT_3	299
LUT_2	350
LUT_1	405
LUT_0	511

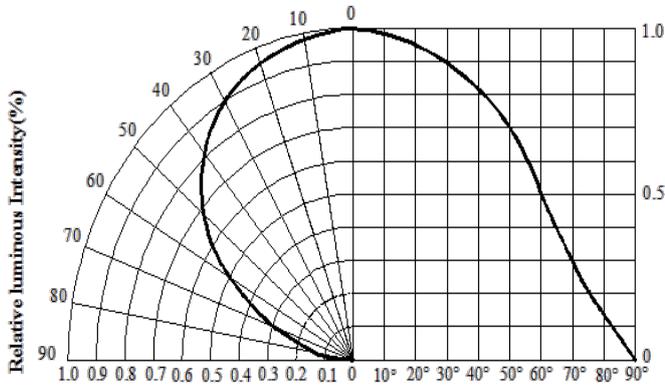
Brightek

CD3023VGBMG01

Typical Electrical Optical Characteristics Curves

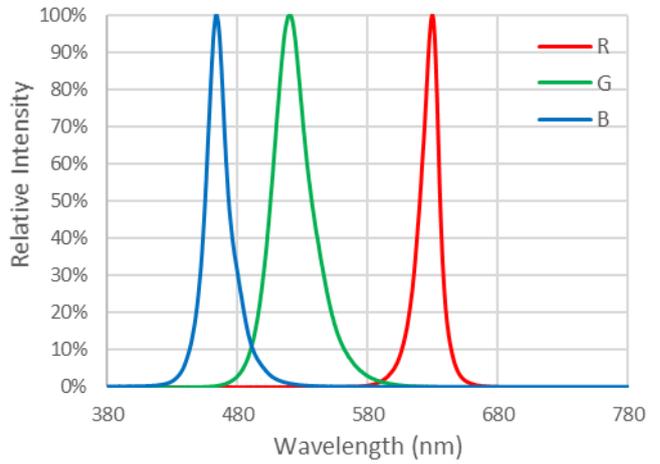
Radiation Characteristics

Color Set Point=(255,255,255)



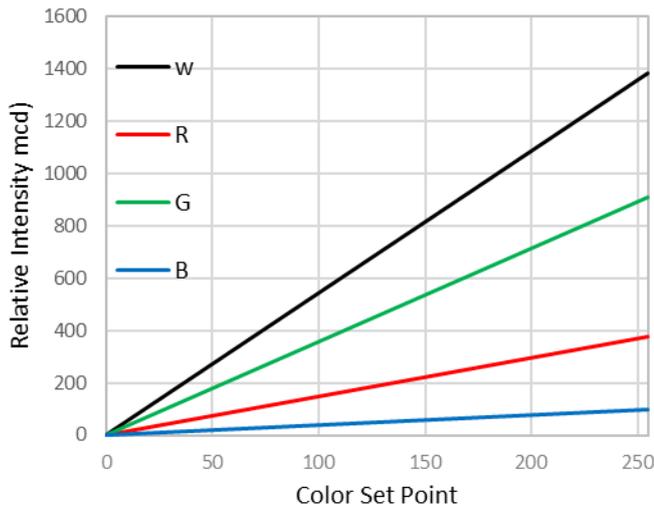
Relative Spectral Emission

T_J=25°C; Color Set Point=(255,255,255)



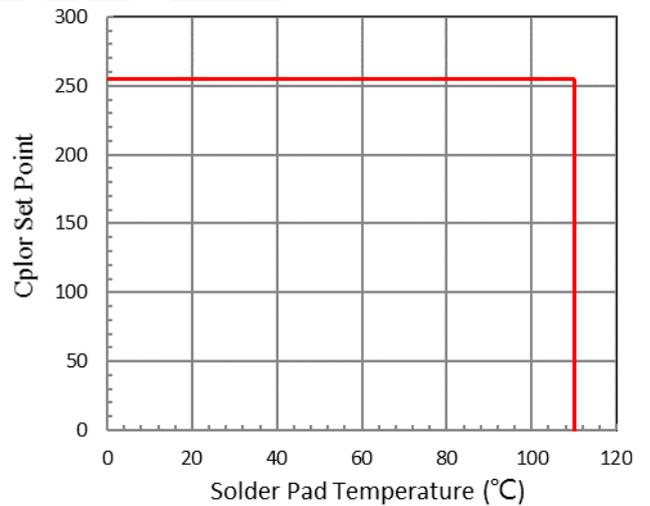
Relative Luminous Intensity

I_v=f(color set point); T_J=25°C; DIM0



Maximum Color Set Point vs Temperature

Color Set Point=f(T); Color Set Point=(255,255,255)



Relative Luminous Intensity vs Junction Temperature

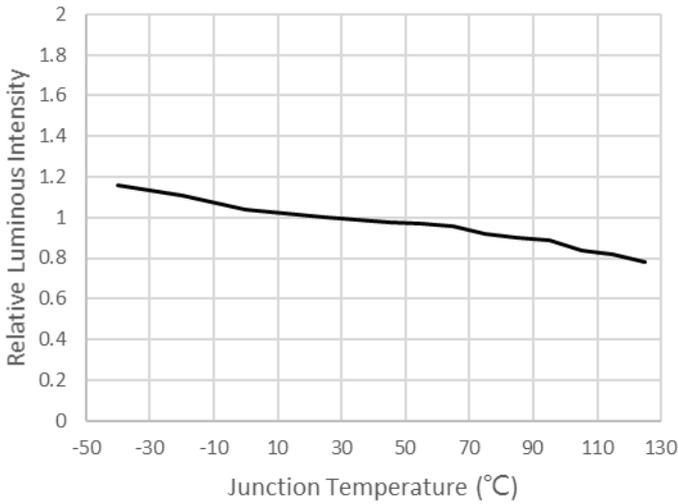
I_v/I_v(25°C)=f(T_J); Color Set Point=(255,255,255)

Relative Luminous Intensity vs Junction Temperature

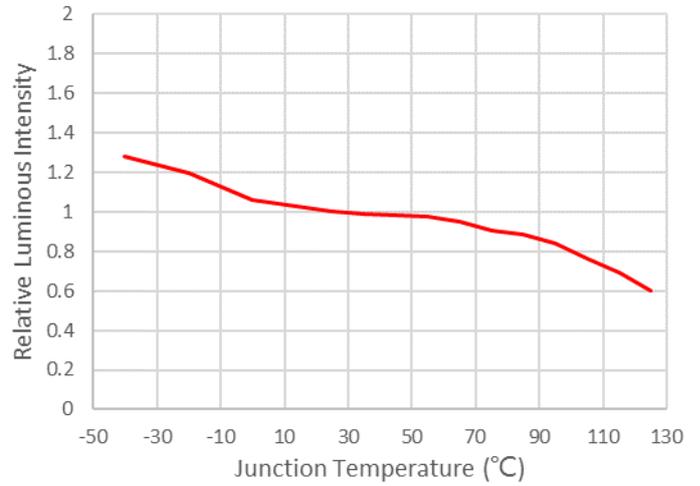
I_v/I_v(25°C)=f(T_J); Color Set Point=(255,0,0)

CD3023VGBMG01

White (Non-Linear Compensation)



Red (Non-Linear Compensation)



Relative Luminous Intensity vs Junction Temperature

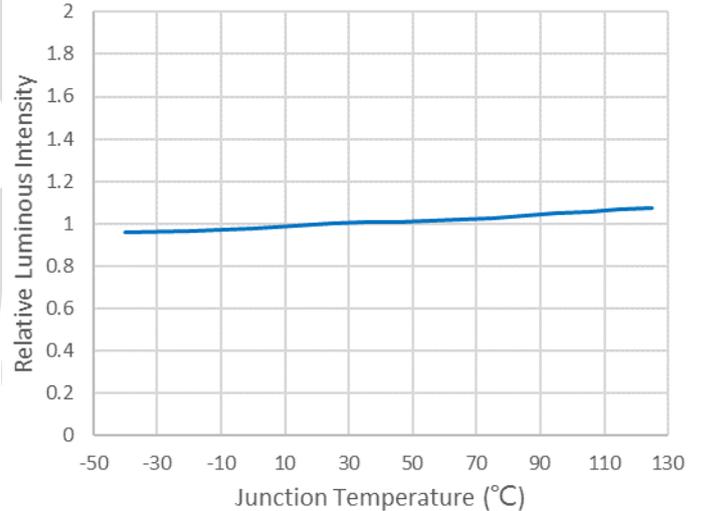
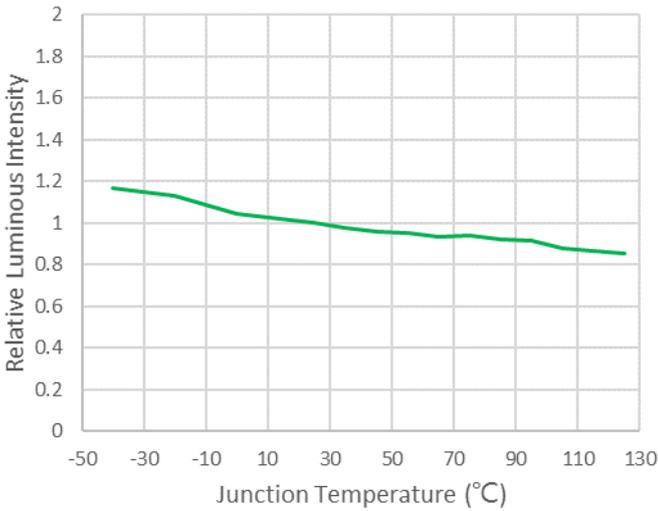
$I_v/I_v(25^\circ\text{C})=f(T_j)$; Color Set Point=(0,255,0)

Green

Relative Luminous Intensity vs Junction Temperature

$I_v/I_v(25^\circ\text{C})=f(T_j)$; Color Set Point=(0,0,255)

Blue



Chromaticity Coordinate Shift vs Junction Temperature

$\Delta C_x, \Delta C_y (25^\circ\text{C})=f(T_j)$; Color Set Point=(255,255,255)

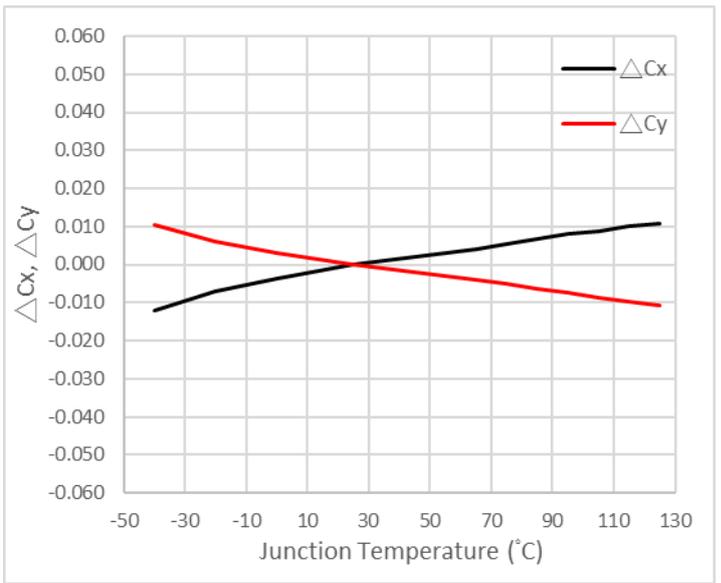
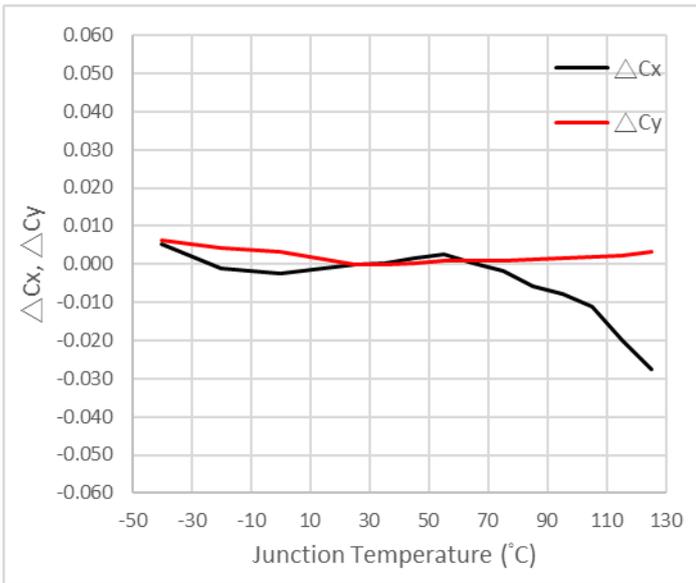
White (Non-Linear Compensation)

Relative Luminous Intensity vs Junction Temperature

$\Delta C_x, \Delta C_y (25^\circ\text{C})=f(T_j)$; Color Set Point=(255,0,0)

Red (Non-Linear Compensation)

CD3023VGBMG01



Relative Luminous Intensity vs Junction Temperature

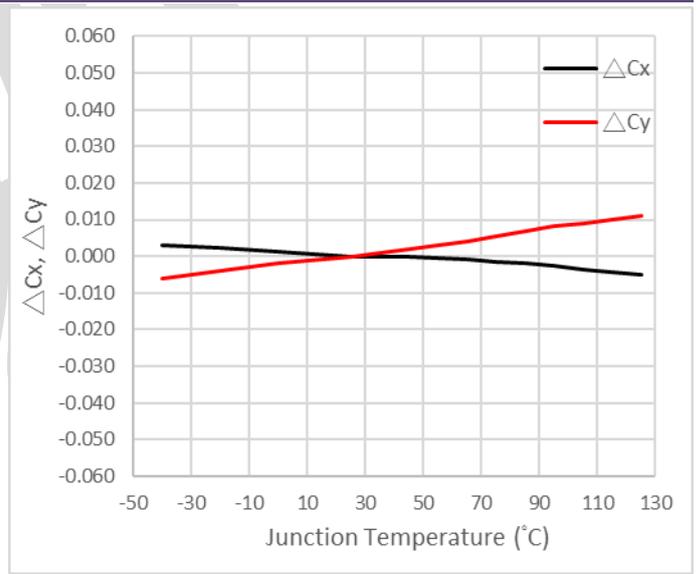
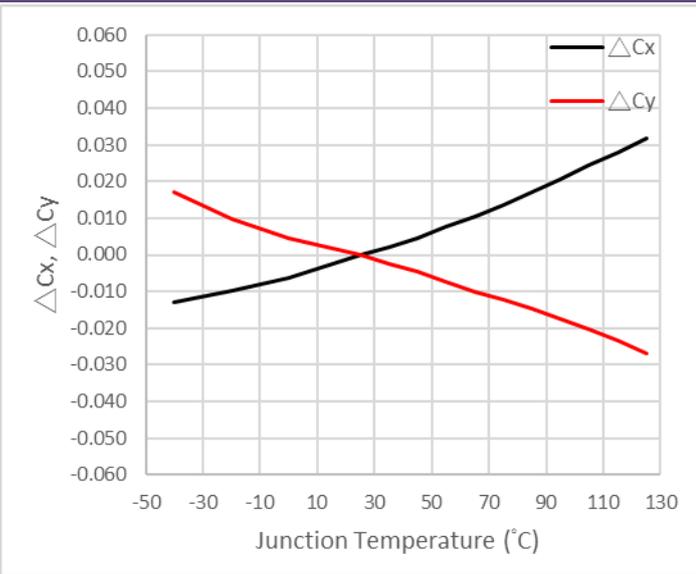
$\Delta C_x, \Delta C_y (25^\circ\text{C})=f(T_j)$; Color Set Point=(0,255,0)

Green

Relative Luminous Intensity vs Junction Temperature

$\Delta C_x, \Delta C_y (25^\circ\text{C})=f(T_j)$; Color Set Point=(0,0,255)

Blue



LED Driver Interface ($T_a=25^\circ\text{C}$)

Parameter	Symbol	Condition	Values	Unit
PWM Frequency	f_{PWM}	-	min.	122
			max.	488

CD3023VGBMG01

PWM Pulse Length	t_{PWM}	-	min.	2	us
			max.	2050	

Serial Interface (Ta=25°C)

Parameter	Symbol	Condition		Values	Unit
Input high voltage	V_{IH}	-	min.	1.08	V
			max.	VDD	
Input low voltage	V_{IL}	-	min.	0	V
			max.	1.04	
Minimal Differential Input Amplitude	V_{min}	-	typ.	60	mV
Maximal Differential Input Amplitude	V_{max}	-	typ.	250	mV
Differential Output High Voltage	V_{OH}	-	typ.	250	mV
Differential Output Low Voltage	V_{OL}	-	typ.	0	mV

Switching Characteristics (Ta=25°C)

Parameter	Symbol	Condition		Values	Unit
Power on Reset	VDD	-	min.	3.2	V
			max.	3.3	
Under voltage - lockout	V_{uvlo}	-	min.	3.1	V
			max.	3.2	

Current Consumptions (Ta=25°C)

Parameter	Symbol	Condition		Values	Unit
LED Green	$I_{average}$	-	min.	0*	mA
			typ.	12.8	
			max.	-	
	I_{peak}	-	min.	0*	mA

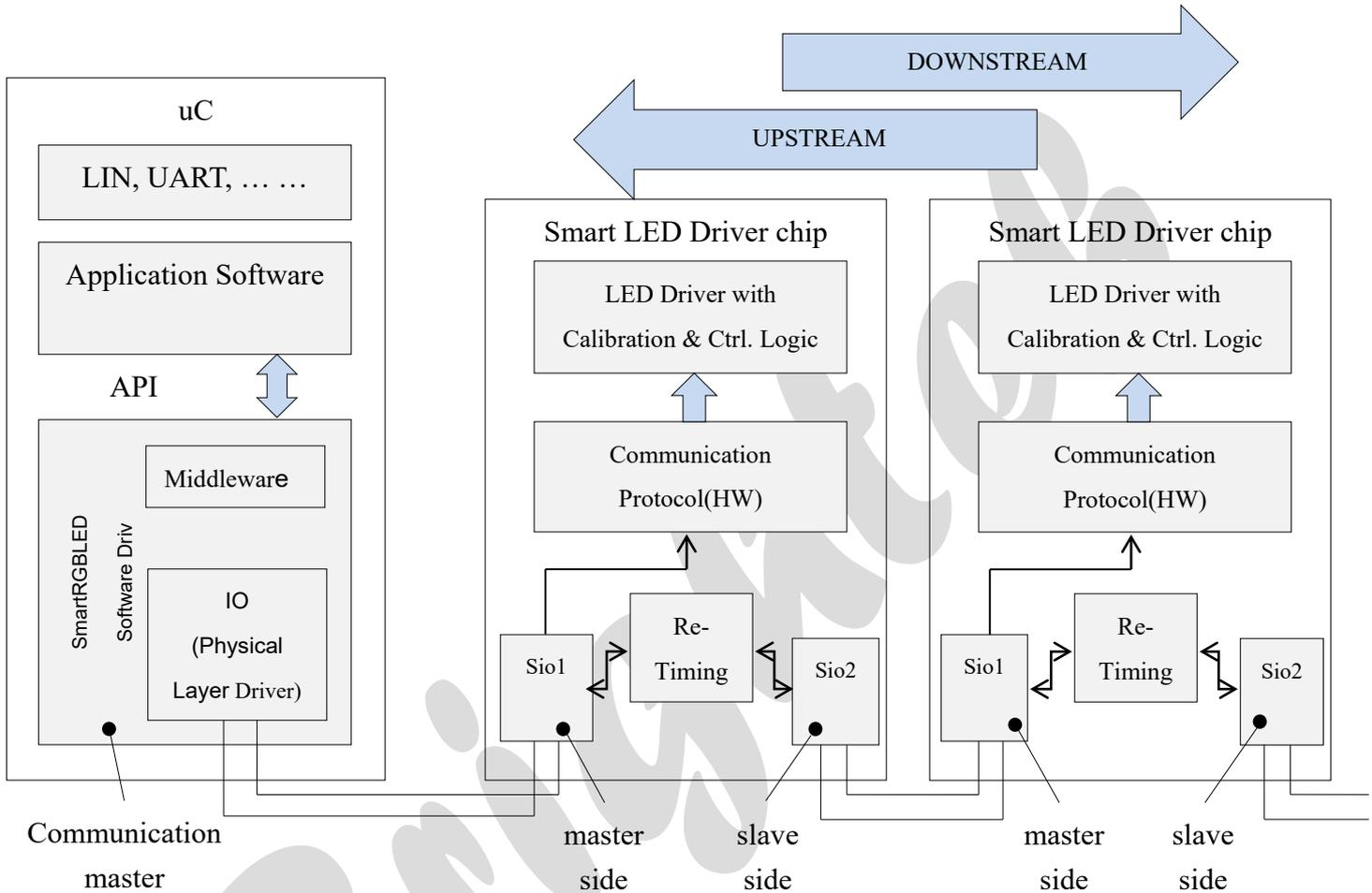
CD3023VGBMG01

			typ.	-	
			max.	80	
			min.	0*	
LED Blue	I_average	-	typ.	9.0	mA
			max.	-	
			min.	0*	
LED Blue	I_peak	-	typ.	-	mA
			max.	80	
			min.	0*	
LED Red	I_average	-	typ.	12.7	mA
			max.	-	
			min.	0*	
LED Red	I_peak	-	typ.	-	mA
			max.	25	
			min.	0.9	
Driver	I_VDD	-	typ.	1.0	mA
			max.	1.1	

* LED current set to zero by command

Bidirectional / Single Ended and Differential

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.

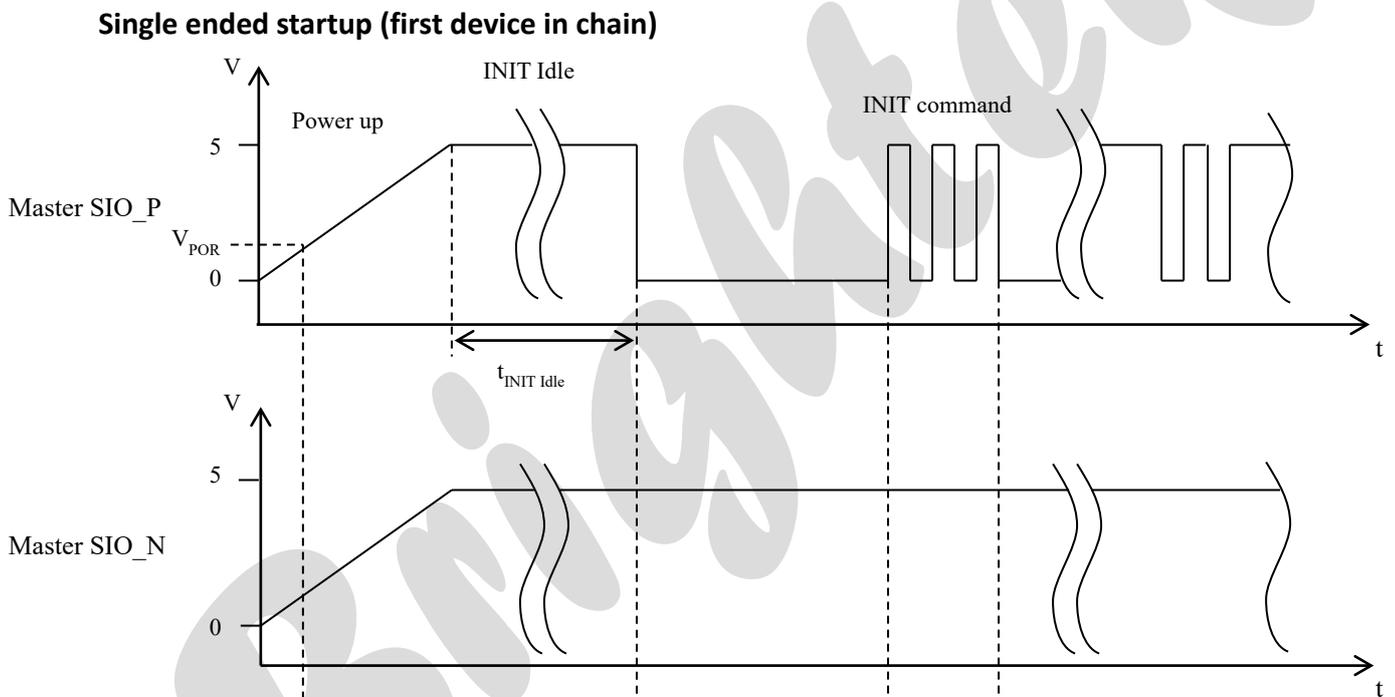
The gross data rate on the serial line is 2Mbit/s, i.e. each bit has a nominal duration of 500 ns. As the on-die oscillator has a very limited accuracy, the actual bit time may vary significantly. The whole system is designed for a maximum oscillator variance of $\pm 30\%$. With the nominal oscillator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

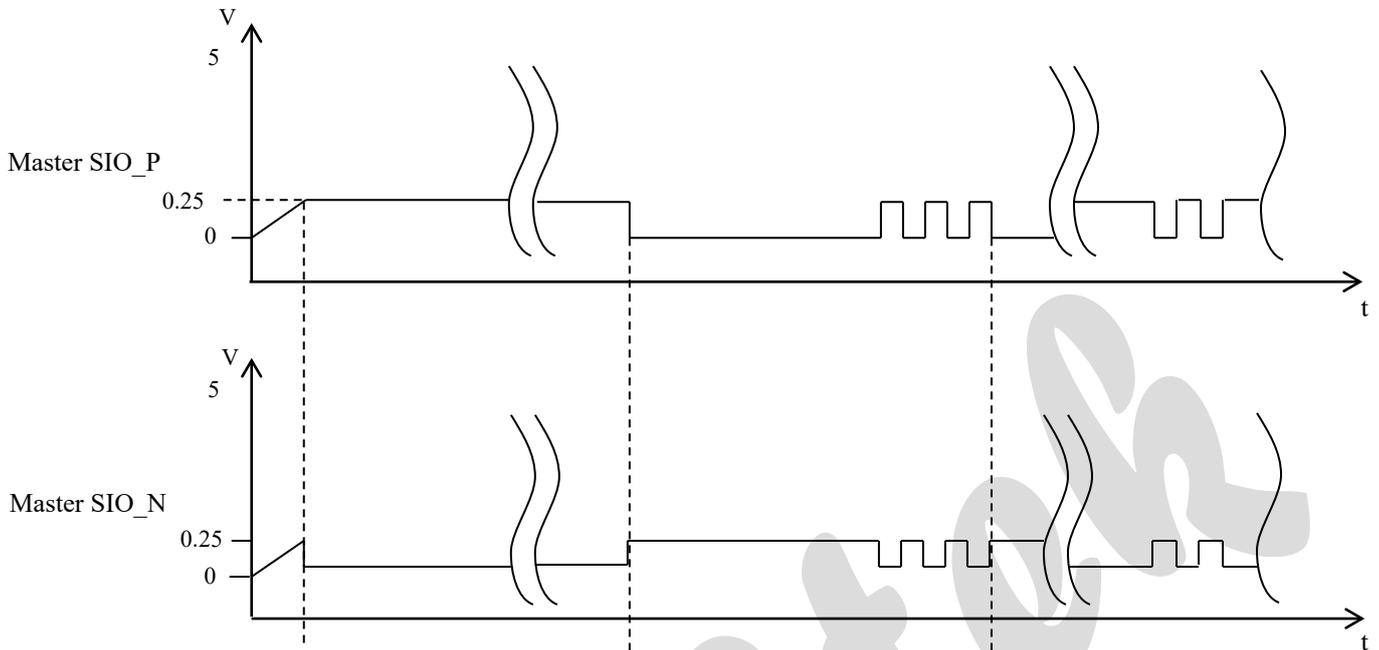
industry standard microcontrollers. Both single-ended lines require an external pull-up at the microcontroller to 5V.

(1) 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 $t_{\text{INIT Idle}} = 150\mu\text{s}$ 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.



Differential startup (devices in chain >1)



Recommended init idle

Parameter	Description	Values	Unit
$t_{INIT\ Idle}$	Init idle directly after power up	min. 150 max. -	us

(2) 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.

(3) Basic Frame Format

Commands and the response to commands are transmitted with serial frames. A serial frame always consist 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.

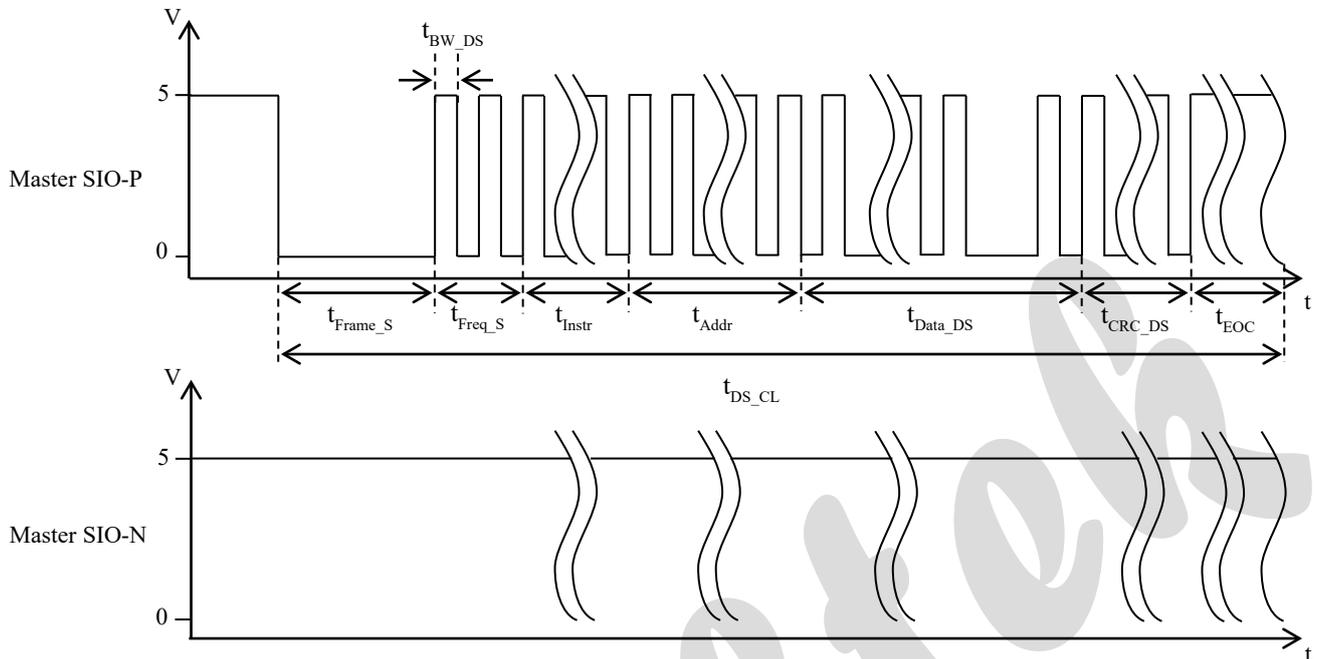
The chosen bit encoding ensures a maximum number of adjacent zeros of 4 and a maximum number of adjacent ones of 5 on the serial line. Some of the bit patterns which cannot occur during regular data transmission are used for special purposes. A pattern of 6 or more 1-bits is considered as the bus-idle 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

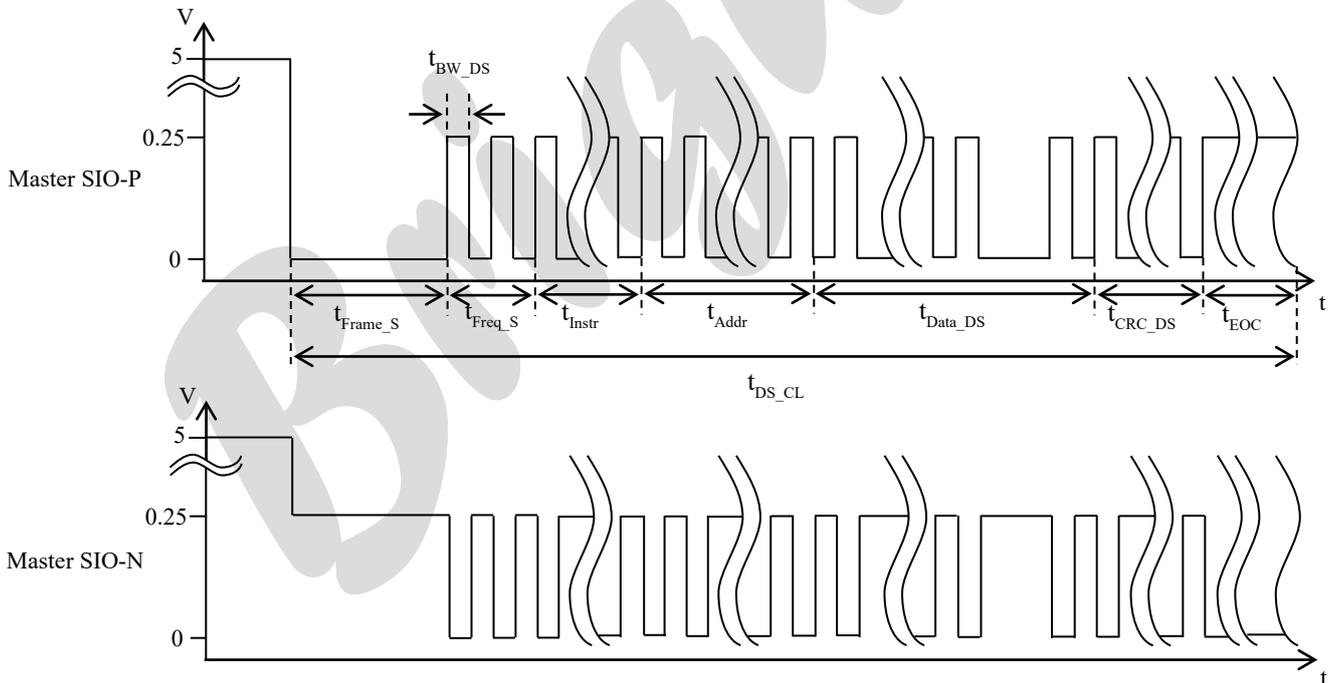
CD3023VGBMG01

flow for the read response.

Single ended downstream command frame



Differential downstream command frame



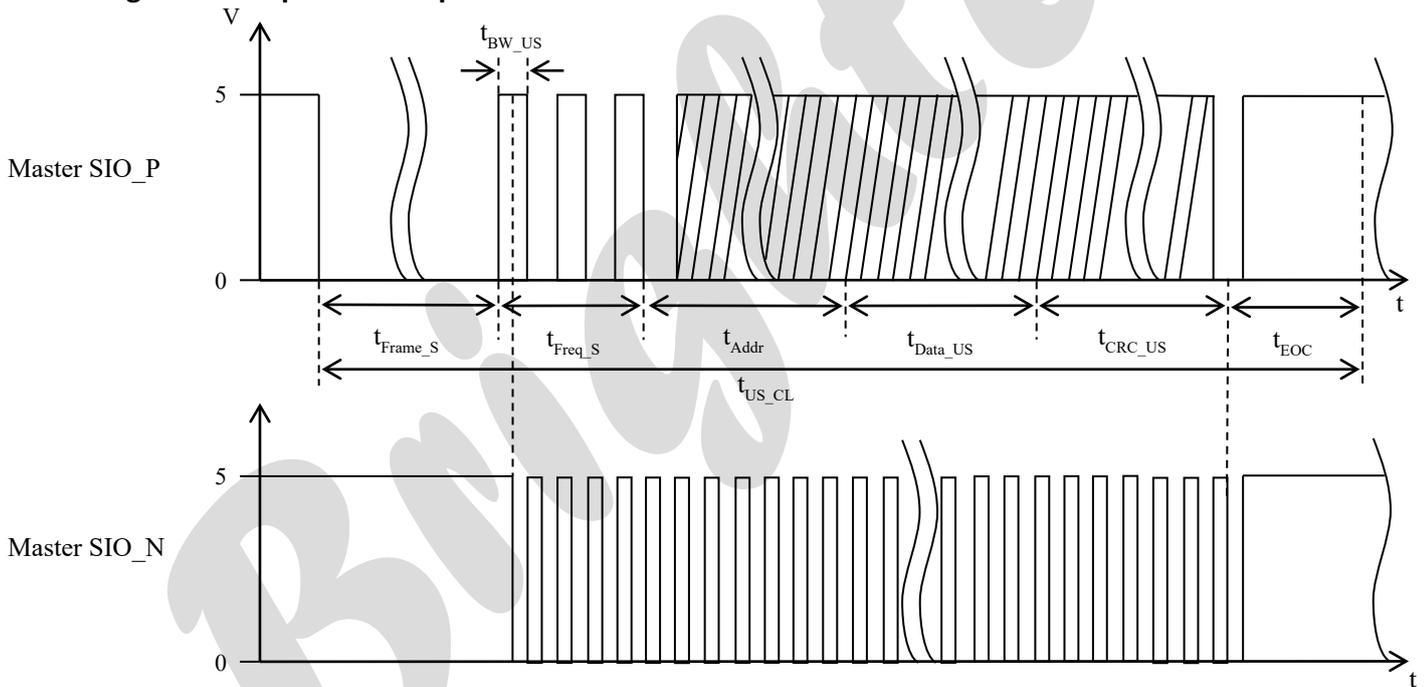
Downstream command frame parameters

Parameter	Description	Values	Unit
t_{BW_DS}	Downstream bit width	min. 350 typ. 500	ns

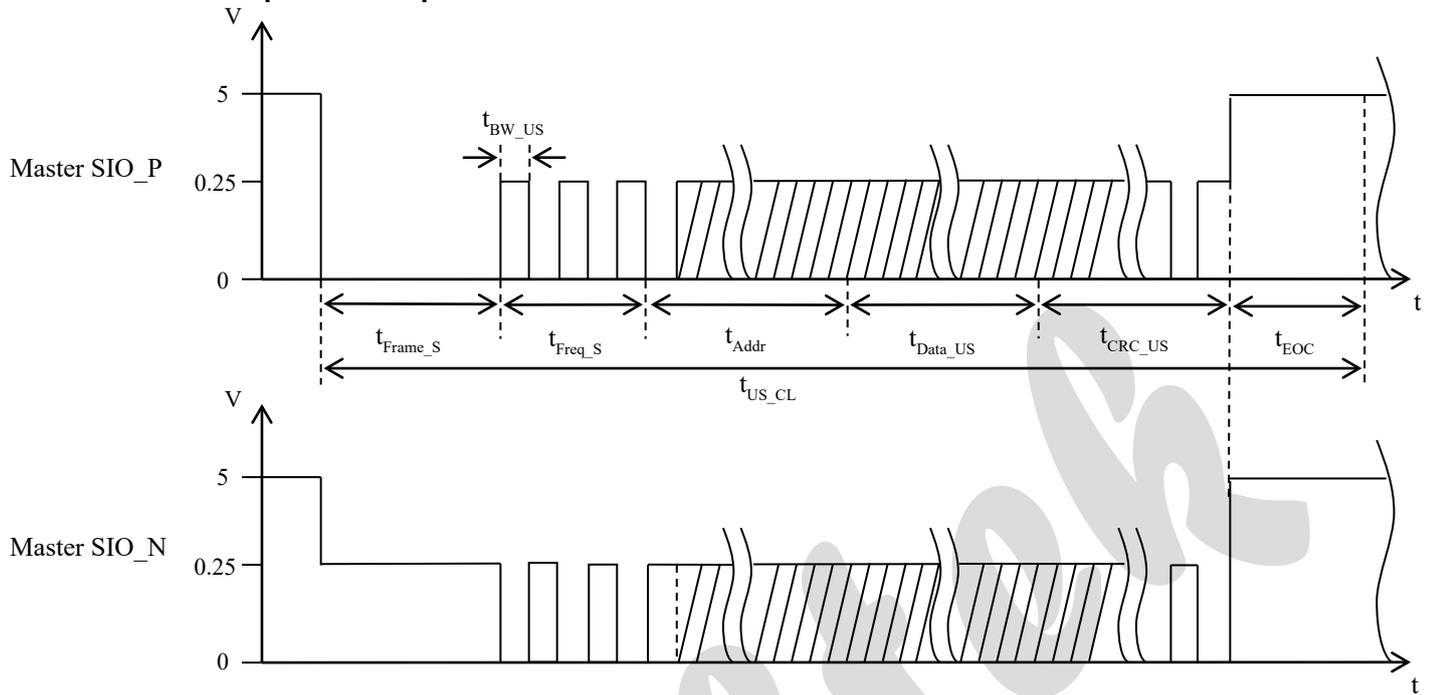
CD3023VGBMG01

		max.	650	
	Downstream command length	-	-	-
t_{DS_CL}	CRC enabled	typ.	$86 \times t_{BW_DS}$	ns
	CRC disabled	typ.	$76 \times t_{BW_DS}$	ns
t_{Frame_S}	Frame sync	typ.	$15 \times t_{BW_DS}$	ns
t_{Freq_S}	Frequency sync	typ.	$5 \times t_{BW_DS}$	ns
t_{Inst}	Instruction	typ.	$5 \times t_{BW_DS}$	ns
t_{Addr}	Address	typ.	$15 \times t_{BW_DS}$	ns
t_{Data_DS}	Downstream Data	typ.	$30 \times t_{BW_DS}$	ns
t_{CRC_DS}	CRC downstream	typ.	$10 \times t_{BW_DS}$	ns
t_{EOC}	End of command Idle	typ.	$6 \times t_{BW_DS}$	ns

Single ended upstream response frame



Differential upstream response frame



Upstream command frame parameters

Parameter	Description	Values	Unit
t_{BW_US}	Upstream bit width	min. 350	ns
		typ. 500	
		max. 650	
t_{US_CL}	Upstream command length	-	-
	CRC enabled	typ. $61 \times t_{BW_DS}$	ns
t_{Frame_S}	CRC disabled	typ. $56 \times t_{BW_DS}$	ns
	Frame sync	typ. $15 \times t_{BW_DS}$	ns
t_{Freq_S}	Frequency sync	typ. $5 \times t_{BW_DS}$	ns
t_{Addr}	Address	typ. $15 \times t_{BW_DS}$	ns
t_{Data_US}	Upstream Data	typ. $15 \times t_{BW_DS}$	ns
t_{CRC_US}	CRC upstream	typ. $5 \times t_{BW_DS}$	ns
t_{EOC}	End of command Idle	typ. $6 \times t_{BW_DS}$	ns

(4) 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	Values	Unit
t_{pd}	Propagation delay	min.	2
		typ.	4
		max.	5.2

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 $\pm 30\%$ oscillator clock variation the time has to be increased to a total of 70% of the transmission duration.

(5) Initialization

The INIT command is always the first command to be transmitted after power-up or reset. 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 an INIT command, it takes the received address as its own device address and afterwards transmits another INIT 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 an INIT 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 INIT 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.

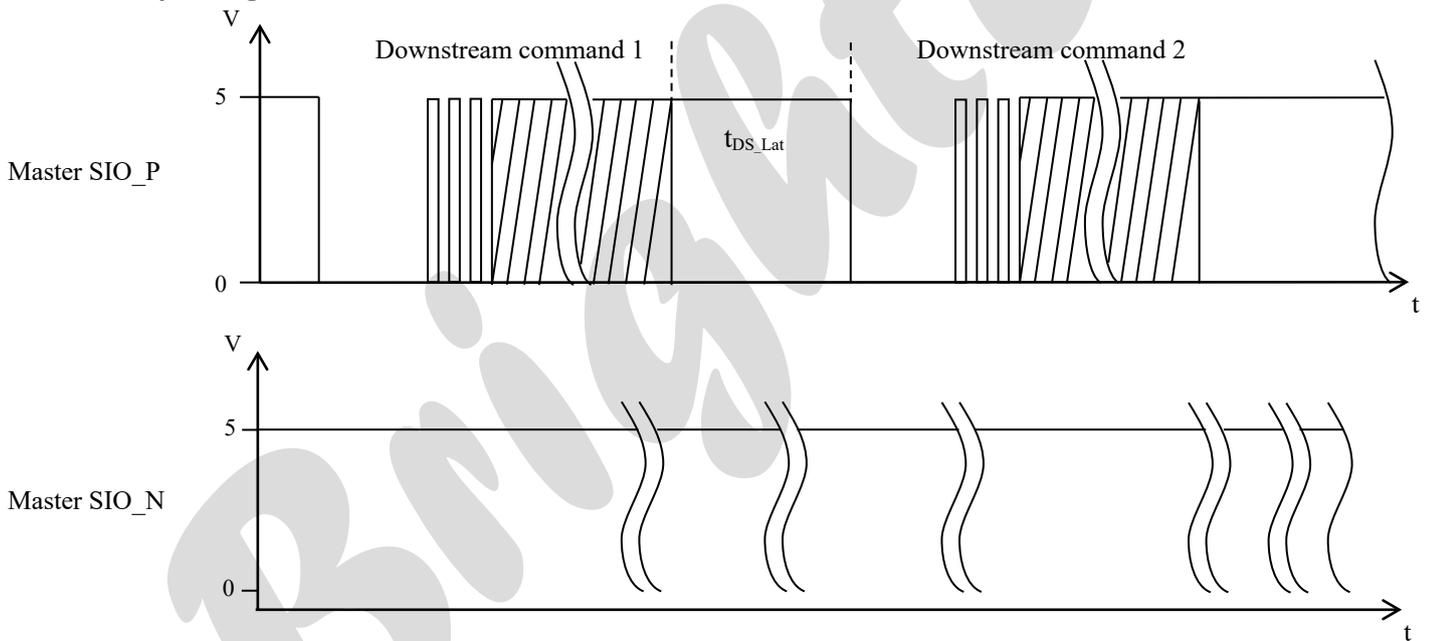
Frames received from upstream are forwarded downstream and vice versa. If an error is detected the forwarding is stopped for this frame.

Parameter	Description	Values	Unit
T_{INIT}	Initialization duration	min. $n \times (t_{DS_CL} + t_{US_CL} + 2 \times t_{PD})$	ns

(6) 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 commands 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	Values	Unit
t_{DS_lat}	Latency between two downstream commands	min. $0.3 \times t_{DS_CL}$	ns

(7) 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

CD3023VGBMG01

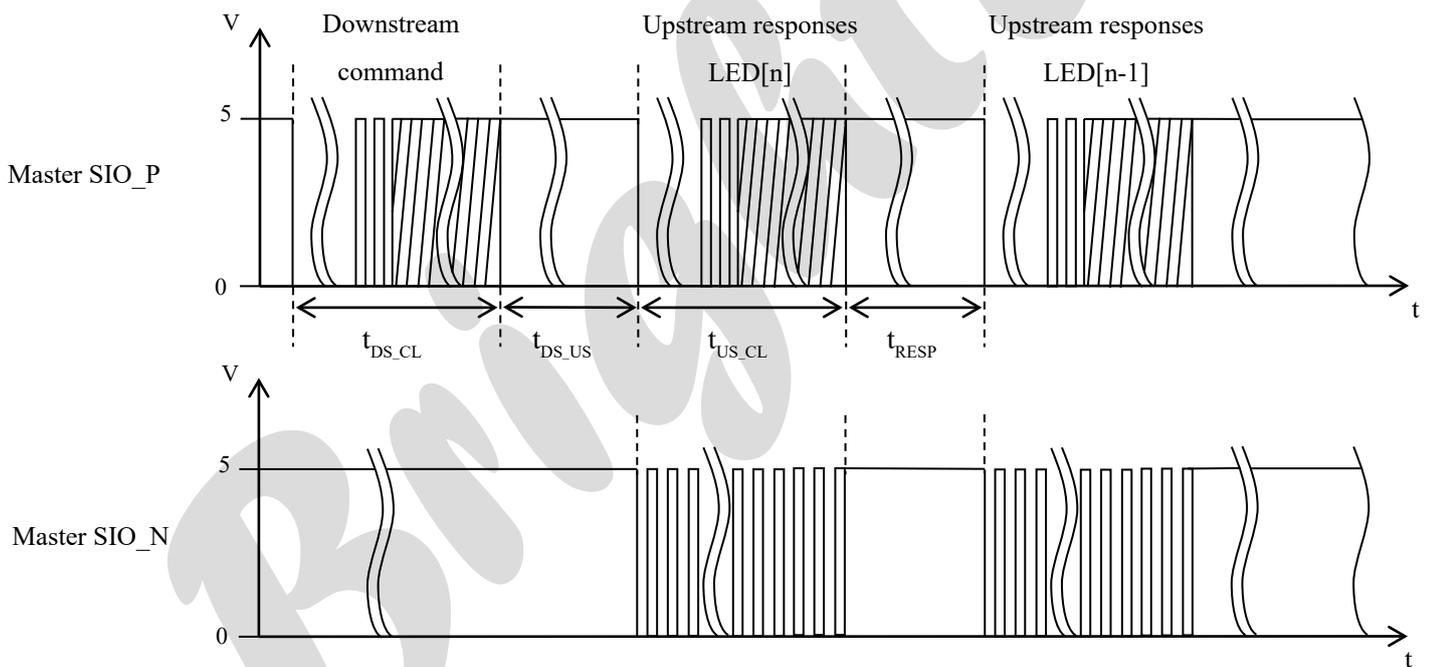
do not use the command address, i.e. these commands may not be directed to a device based on the device address.

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

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

Single ended read command & responses



Down- and upstream delay, delay between responses

Parameter	Description	Formula	Unit
t_{DS_US}	Delay between down- and upstream	$t_{DS_CL} + t_{US_CL} + 2 \times n \times t_{PD}$	ns
t_{RESP}	Delay between responses Oscillator variation of adjacent devices < $\pm 30\%$	- $0.43 \times t_{US_CL}$	- ns

CD3023VGBMG01

Oscillator variation of adjacent devices > ±30%

$0.7 \times t_{US_CL}$

ns

(8) Timeouts

The INIT, all the READ_*, and the PING command initiate upstream data transmission. With the INIT and the read commands all nodes are expected to send a response to the host. The 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:

$$F[\text{timeout}] = F[\text{osc}] / 2^{14}$$

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

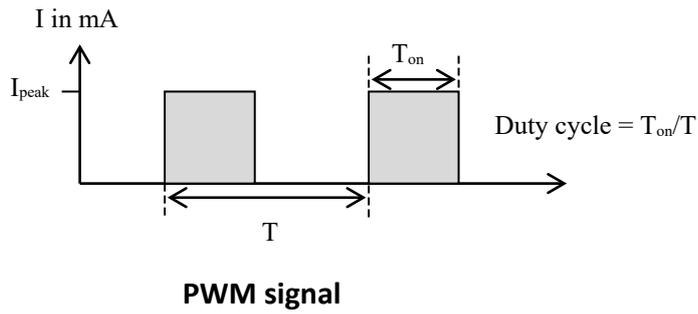
Timeouts

Command	Max. counter value	Min. timeout	Mom. timeout	Max. timeout	Unit
INIT	992	780.6	1015.3	1451.2	ms
READ_*	427	335.6	436.7	624.6	ms
PING	62	48.0	63.0	90.7	ms

PWM Units

(1) Basic Mode of Operation

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



The resolution is 12 bit. The supported duty cycles are 0/4095 to 4095/4095. The nominal PWM output frequency is $16\text{MHz} / 2^{15} = 488.3\text{Hz}$. The frequency is reduced to the half or the quarter of this frequency with low duty cycles. This ensures a minimum on-time of $2\mu\text{s}$ 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

(2) 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.

(3) 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.

CD3023VGBMG01

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	PWM Frequency in Hz	Unit
Green	0%	0	μs
Red	25%	512	μs
Blue	75%	1536	μs

(4) Power Save Mode

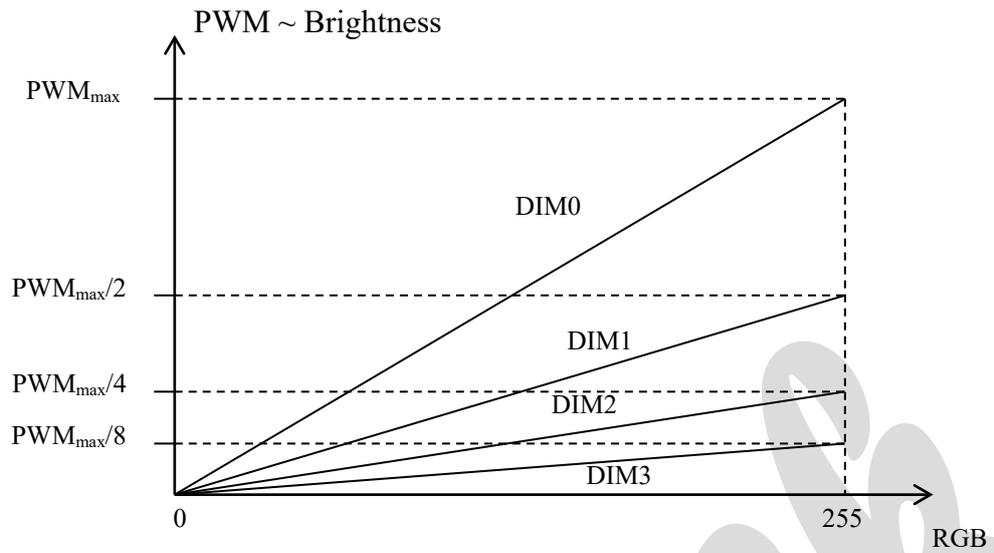
When all LED channels are set to an intensity of 0, the device enters a power save mode for the current sources driving the LEDs. I.e. the Set_RGB command must be issued with an RGB value of 0x000000 to enter the power save mode.

Recovering from this mode does not require any particular measures. I.e. the host just needs to issue a 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 INLC100Q16 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 Below Figure and Table.



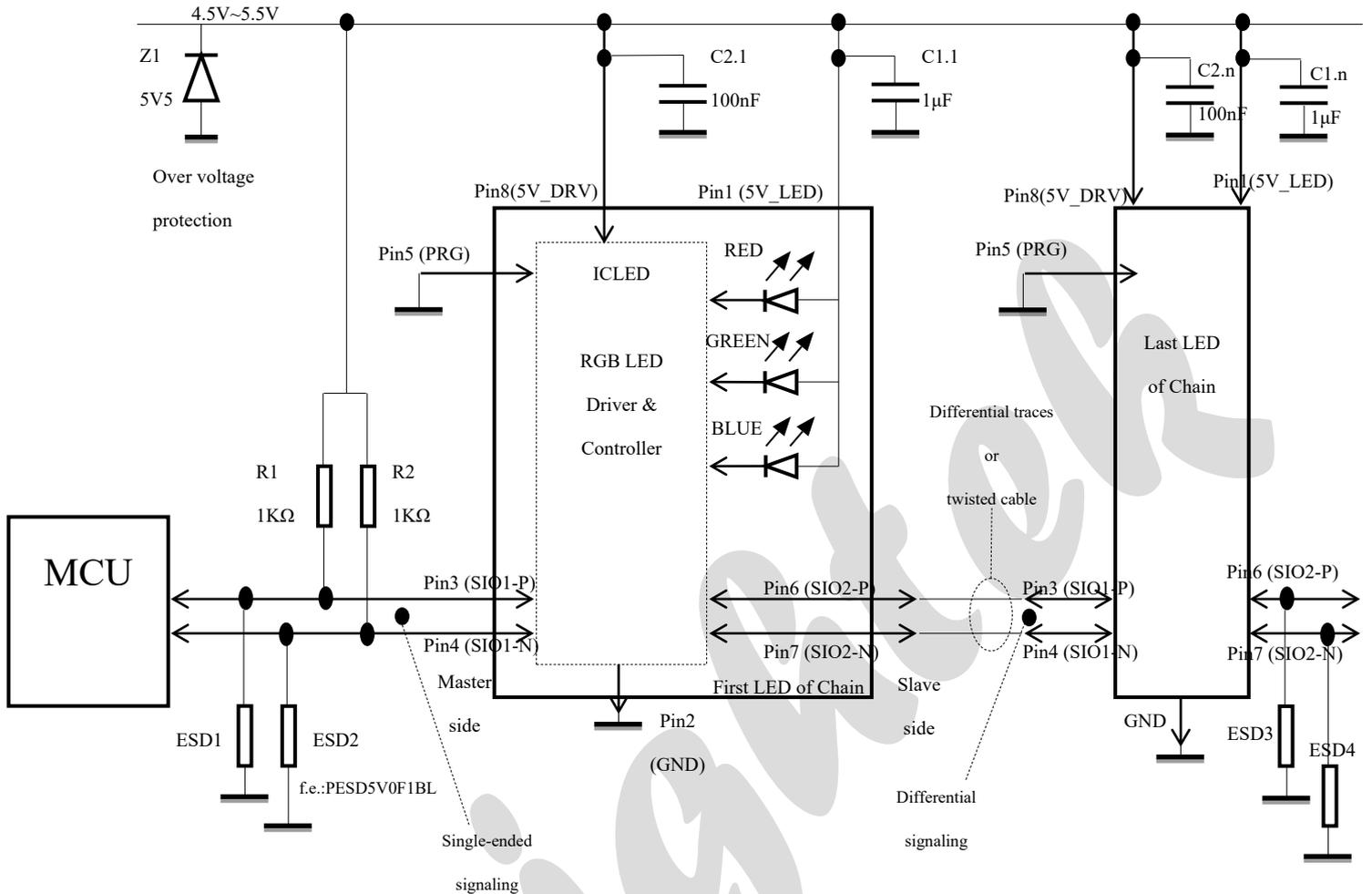
DIM Function

DIM	Relative PWM Range	Virtual Resolution = $\log_2 256 / \text{Relative PWM Range}$
0	1	8bit
1	1/2	9 bit
2	1/4	10 bit
3	1/8	11 bit

Application Circuit

CD3023VGBMG01

(1) Typical application circuitry

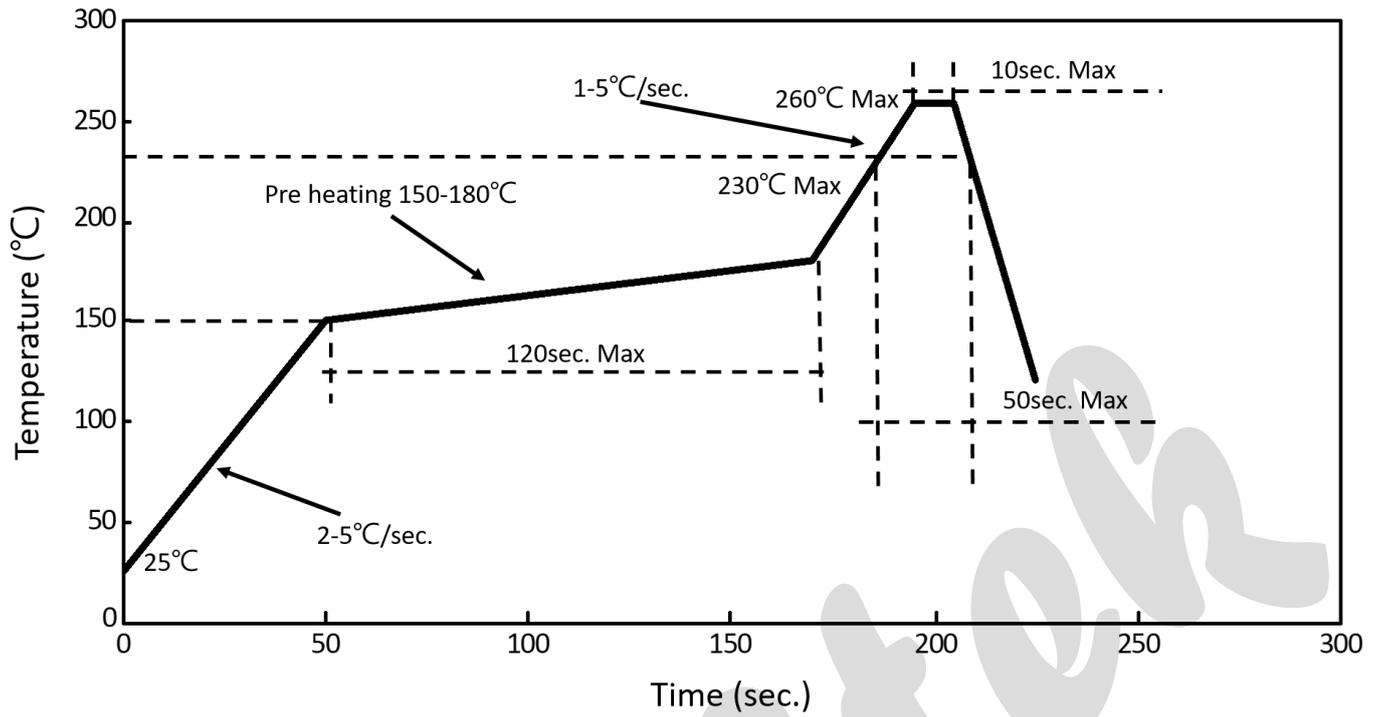


Note:

1. The signal pin of each LED shall be connected with an ESD tube in parallel with GND to avoid external static electricity damage to the LED.
2. In addition, the signal input pin of the first LED needs a 1K ohm resistor in parallel with VDD. The purpose is to reduce the damage caused by the MCU output signal. Please refer to the applied circuit diagram for the resistance signal.
3. The power supply pin of each LED needs a bypass capacitor in parallel with GND to reduce the damage caused by power supply. Please refer to the applied circuit diagram for the type of capacitor.
4. SIO2-P and SIO2-N should connect with ESD tube, it's to avoid the air static inside the car damaging the last LED.

Reflow Soldering Profile

CD3023VGBMG01



1. We recommend the reflow temperature 240°C ($\pm 5^\circ\text{C}$).the maximum soldering temperature should be limited to 260°C.
2. Do not stress the silicone resin while it is exposed to high temperature.
3. The reflow process should not exceed 3 times.

Handling Precautions

1. Handling precautions

1.1 Storage

- ① It is recommended to store the products in the following conditions:
 - Humidity: 60% R.H. Max.
 - Temperature : 5°C~30°C (41°F~86°F)
- ② Shelf life in sealed bag: 12 month at <5°C~30°C and <60% R.H. after the package is Opened, the products should be used within 1 weeks or they should be keeping to storage at $\leq 20\%$ R.H. with zip-lock sealed.

1.2 Baking

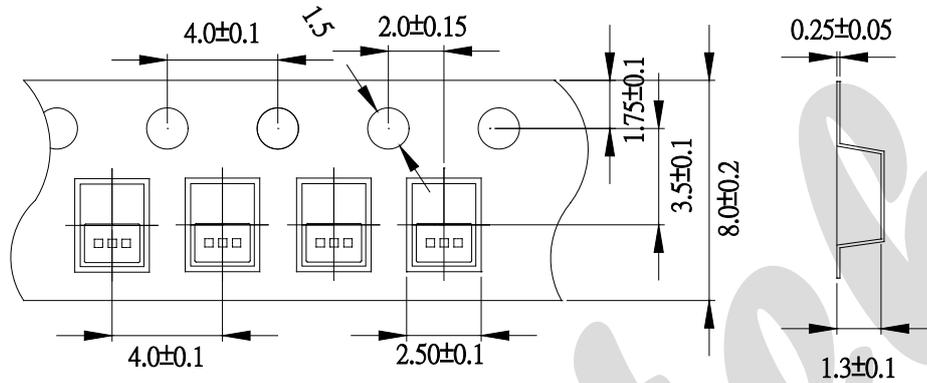
Suggest packing open after 1 weeks, before use baking products, conditions as follows:

- ① 60±3°C X 6hrs and <5%RH, for reel
- ② 125±3°C X 2hrs, for single LED

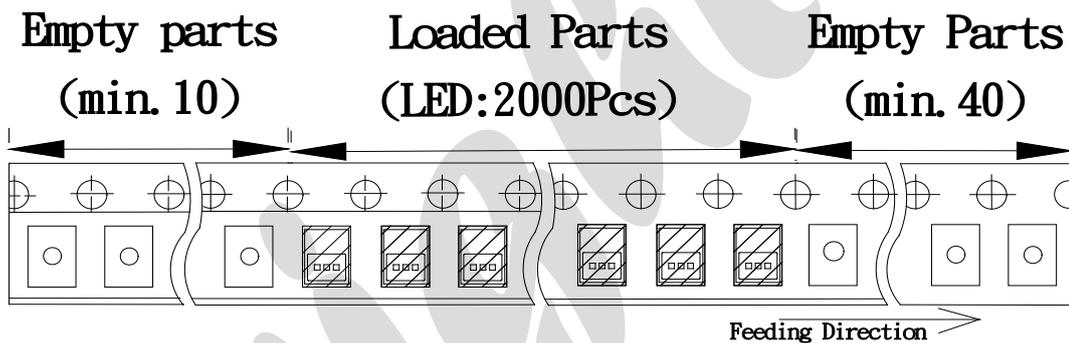
It shall be normal to see slight color fading of carrier (light yellow) after baking in process.

Tapping

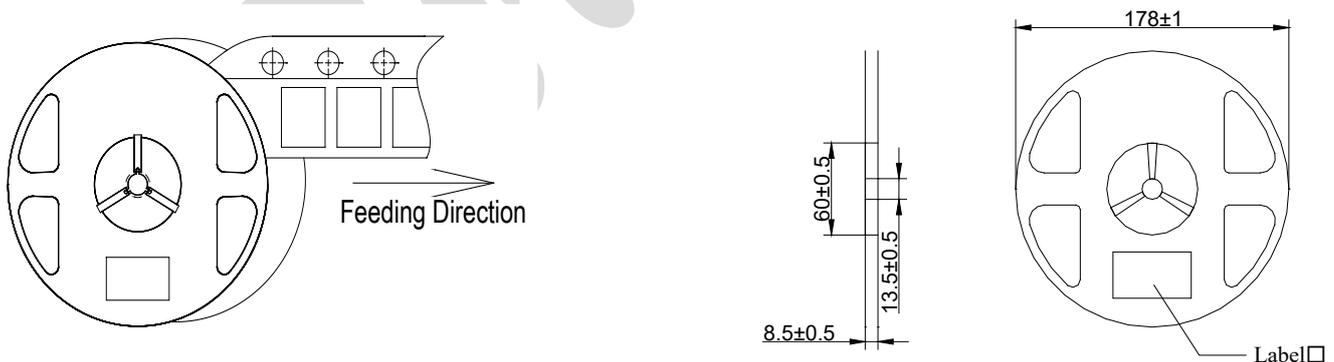
1. Dimensions of Tape (Unit: mm)



2. Arrangement of Tape



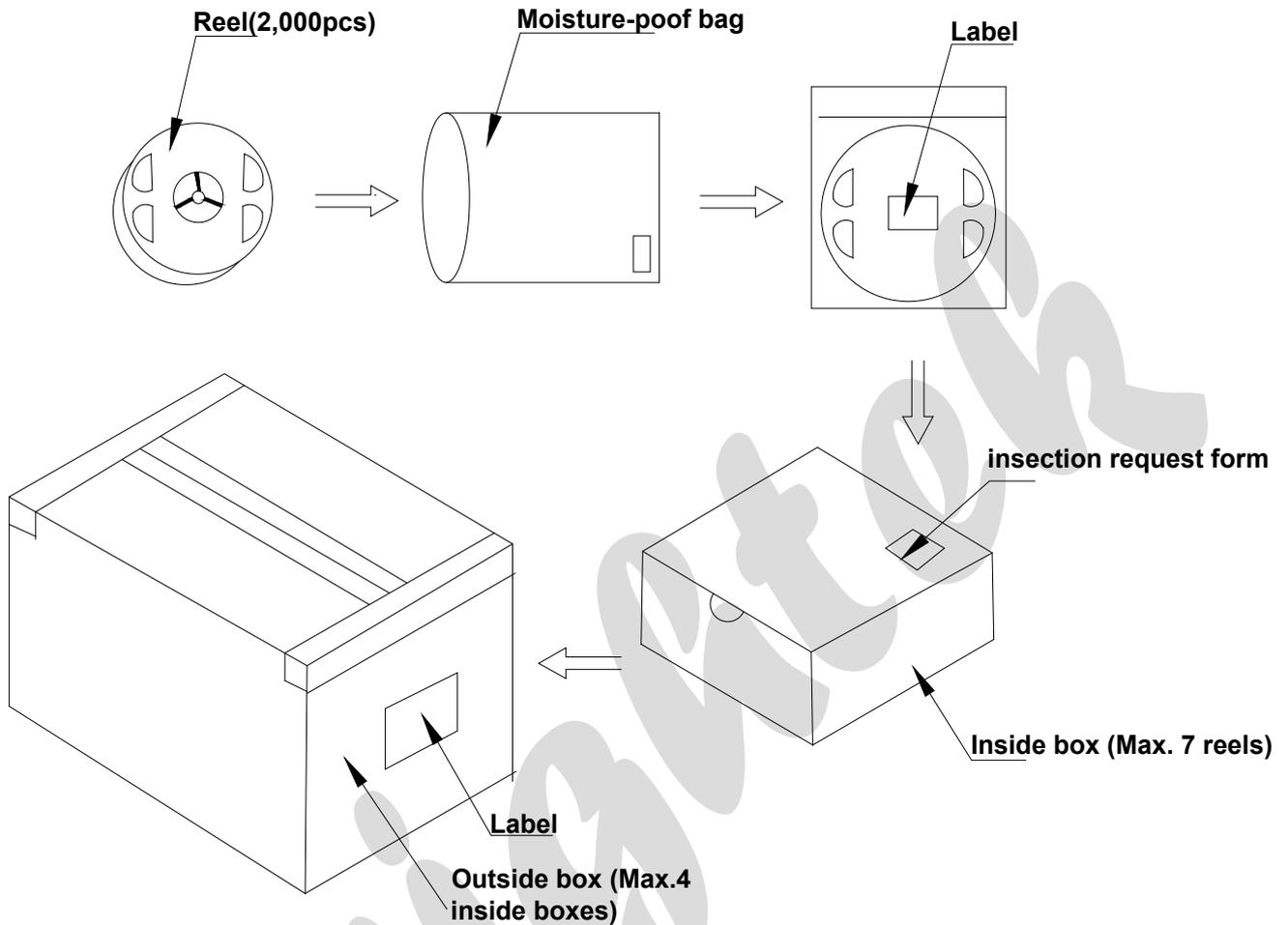
3. Dimensions of Reel (Unit: mm)



- Notes:
1. Empty component pockets are sealed with top cover tape
 2. The cathode is oriented towards the tape sprocket hole in accordance with ANSI/EIA RS-481 specifications;
 3. 2,000pcs per reel;
 4. The remainder packing in multiples of 500pcs.

Packing

4. Dimensions of Tape (Unit: mm)



Reeled product (max.2,000) is packed in a sealed moisture-proof bag. Seven bags are packed in an inner box (size: about 260 X 230 X 100 mm) and four inner boxes are in an outer box (size: about 480 X 275 X 215 mm). On the label of moisture-proof bag, there should be the information of Part No., Lot No. and quantity number; also the total quantity number should be on inspection request form on outer box.