



CM3323

Color Sensor with
I²C Interface

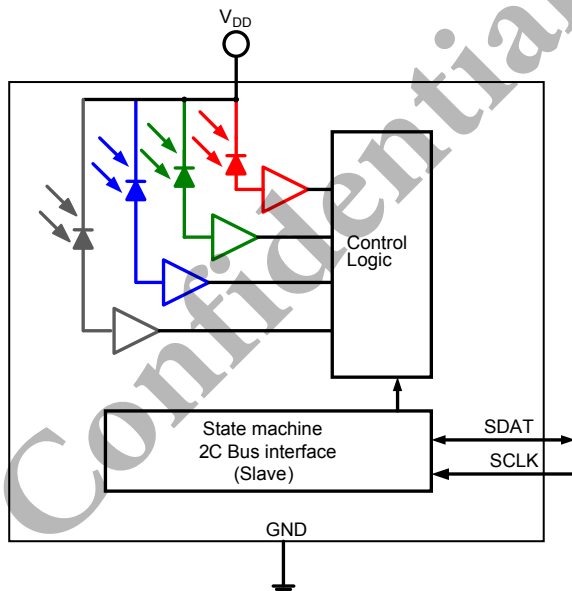
Rev: 0.9 Revised 29th-Oct-2012

Description

CM3323 Color Sensor senses Red, Green, Blue and White light and incorporates photodiode, amplifiers and analog/digital circuits into a single chip using CMOS process. The active programmable color sensor interruption features offer the best utilization on the microcontroller. With the color sensor applied, the brightness and color temperature of backlight can be adjusted base on ambient light source that makes panel looks more comfortable for end user's eyes. The adoption of Capella's patented Filtron™ technology achieves the closest ambient light spectral sensitivity to real human eye responses.

CM3323 provides excellent temperature compensation capability for keeping the output stable under changing temperature. CM3323's function are easily operated via the simple command format of I²C (SMBus compatible) interface protocol. CM3323's operating voltage ranges from 2.5 V to 3.6 V. CM3323 is packaged in a lead-free 4 pin OPLGA package which offers the best market-proven reliability.

Block Diagram



Features

- Filtron™ technology provides a spectrum matching real human eye responses
- Supports low transmittance (dark) lens design
- Fluorescent light flicker immunity
- Provides 16-bit resolution for each channel (R,G,B,W)
- Selectable maximum detection range (360\721\1442\2883\5767\11796) lux with highest sensitivity 0.022 lux/step

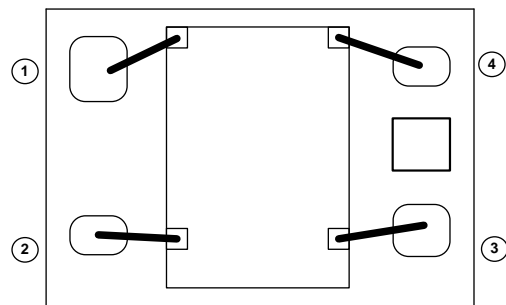
Additional Features

- Temperature compensation
- Low power consumption I²C (SMBus Compatible) Interface
- Operation voltage range of 2.5 V to 3.6 V
- Package: OPLGA (2.0 x 1.25 x 1.00 mm)
- Lead-free package (RoHS compliant)

Applications

- Handheld device
- Notebook
- Consumer device
- Industrial and medical application

Pin Definition



<Top View>

1	GND	3	SCLK
2	SDAT	4	VDD

Ordering Information

PART NUMBER	PACKING	PACKAGE	PIN NO.	QUANTITY	LEAD FREE	REMARK
CM3323 A3OG	Tape and Reel	2.0 x 1.25 x 1.0mm	4	2500	Compliant	

Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	CONDITION
Storage temperature	T _S	-40	+85	°C	
Operating temperature	T _A	-40	+85	°C	
Supply voltage	V _{DD}	2.5	3.6	V	

Recommended Operating Conditions

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	CONDITION
Operating temperature	T _A	-40	+85	°C	
Supply voltage	V _{DD}	2.5	3.6	V	
I ² C Bus operating frequency	f _(I2CCLK)	10	400	kHz	

Pin Descriptions

PIN ASSIGNMENT	SYMBOL	TYPE	FUNCTION
1	GND	I	Ground
2	SDAT	I/O (Open Drain)	I ² C data bus data in/output
3	SCLK	I	I ² C digital bus clock input
4	V _{DD}	I	Power supply input

Electrical & Optical Specifications

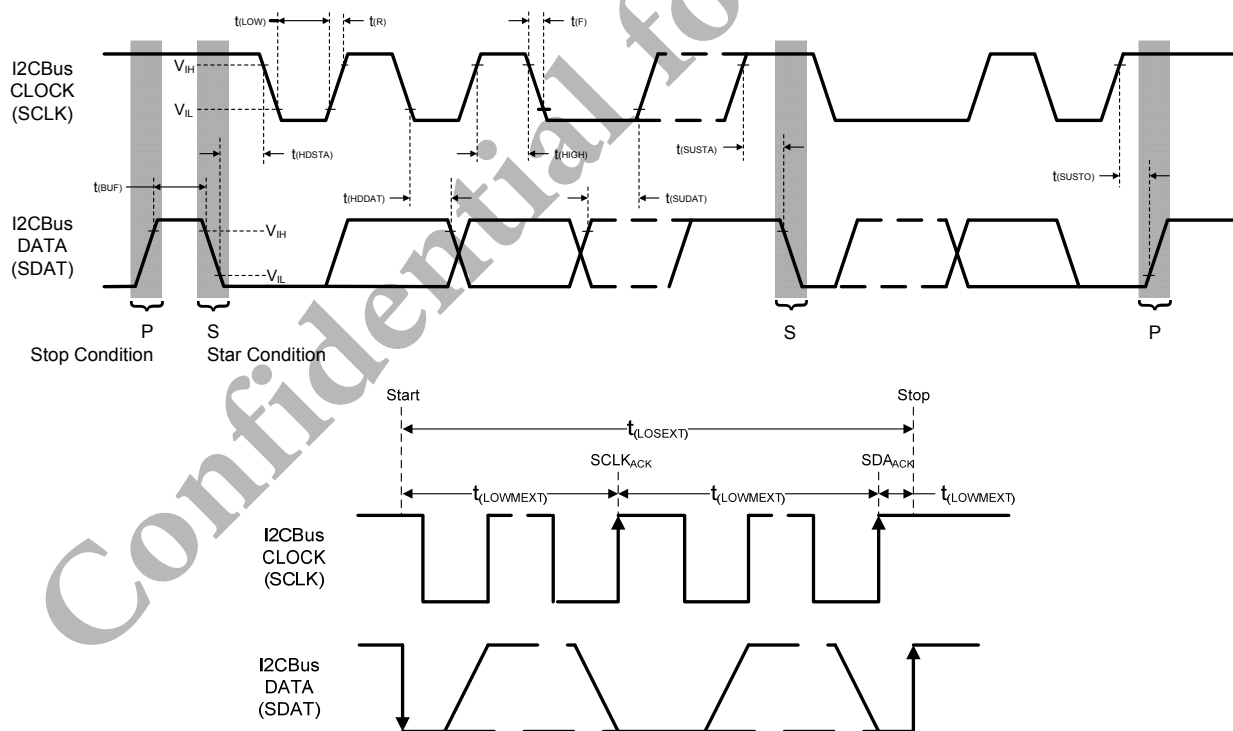
PARAMETER		SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Supply voltage		V _{DD}	2.5		3.6	V	
Supply current		I _{DD}		200		uA	
I ² C signal input	Logic High	V _{IH}	1.5			V	Note1, V _{DD} = 3.3V
	Logic Low	V _{IL}			0.8		Note1, V _{DD} = 3.3V
I ² C signal input	Logic High	V _{IH}	1.4			V	Note1, V _{DD} = 2.6V
	Logic Low	V _{IL}			0.6		Note1, V _{DD} = 2.6V
Peak sensitivity wavelength		λ _{PR}		650		nm	
		λ _{PG}		550			
		λ _{PB}		450			
Irradiance responsivity				180		LSB/(μW/cm ²)	λ _{pR} = 630nm
				144			λ _{pG} = 530nm
				52			λ _{pB} = 467nm
Detectable intensity	Minimum			0.0056		Lux	ALS(G channel), IT = 1280ms, Note1, 2
	Maximum			11796			ALS(G channel), IT = 40ms, Note1, 2
Operating temperature		T _A	-40		+85	°C	
Shutdown current		I _{DD} (SD)		800		nA	Light Condition = Dark; V _{DD} = 3.6 V, T _a = 25°C

Note:

1. Test condition: V_{DD} = 3.3 V, Temperature: 25°C.
2. Light source: White LED.

I²C Bus Timing Characteristics

PARAMETER	SYMBOL	STANDARD MODE		FAST MODE		UNIT
		MIN.	MAX.	MIN.	MAX.	
Clock frequency	$f_{(SMBCLK)}$	10	100	10	400	kHz
Bus free time between start and stop condition	$t_{(BUF)}$	4.7		1.3		us
Hold time after (repeated) start condition. After this period, the first clock is generated	$t_{(HDSTA)}$	4.0		0.6		us
Repeated start condition setup time	$t_{(SUSTA)}$	4.7		0.6		us
Stop condition setup time	$t_{(SUSTO)}$	4.0		0.6		us
Data hold time	$t_{(HDDAT)}$	300		90		ns
Data setup time	$t_{(SUDAT)}$	250		100		ns
I ² C clock (SCK) low period	$t_{(LOW)}$	4.7		1.3		us
I ² C clock (SCK) high period	$t_{(HIGH)}$	4.0		0.6		us
Detect clock/data low timeout	$t_{(TIMEOUT)}$	25	35	---	---	ms
Clock / Data fall time	$t_{(F)}$		300		300	ns
Clock / Data rise time	$t_{(R)}$		1000		300	ns

Figure 1. I²C Bus Timing Diagram

Parameter Timing Information

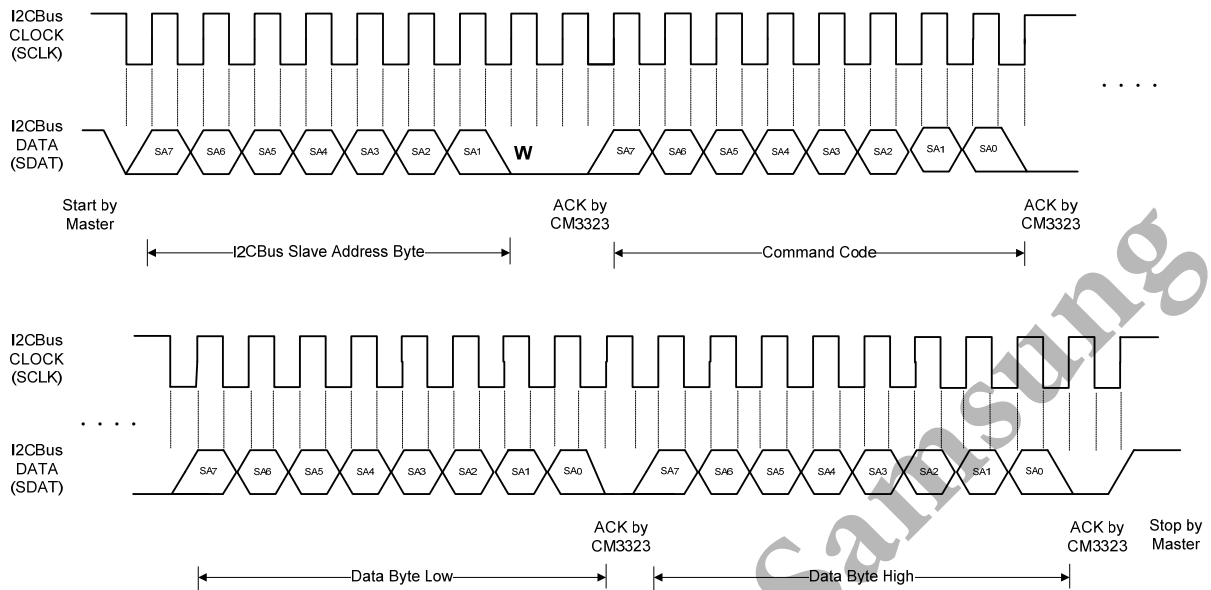


Figure 2. I²C Bus Timing for Sending Word Command Format

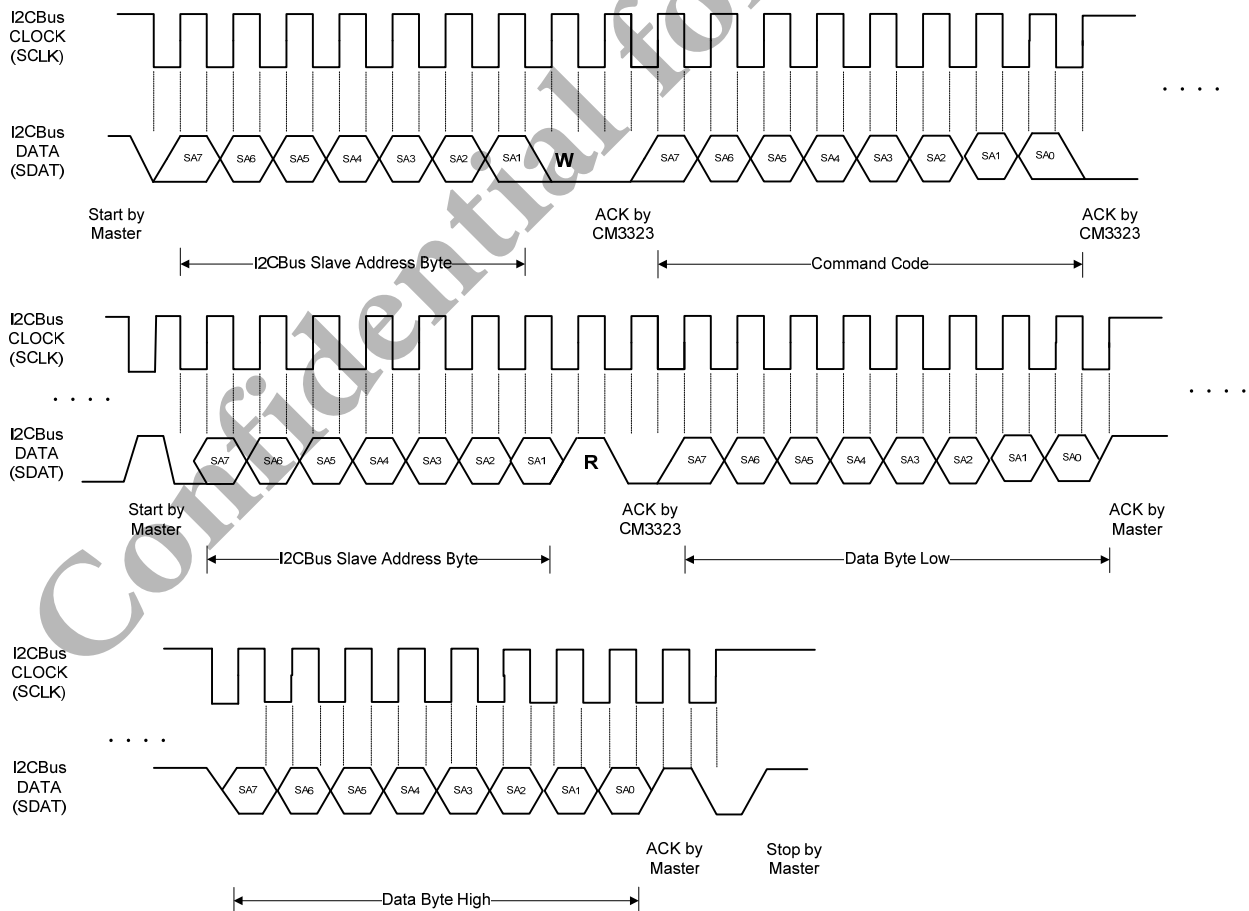


Figure 3. I²C Bus Timing for Receive Word Command Format

Typical Performance Characteristics

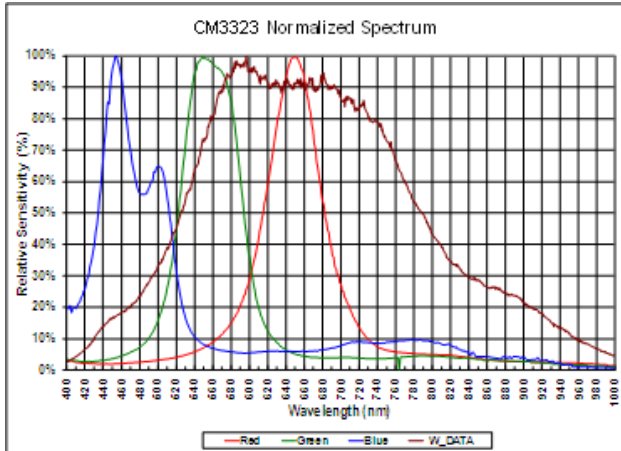


Figure 4. Normalized Spectral Response

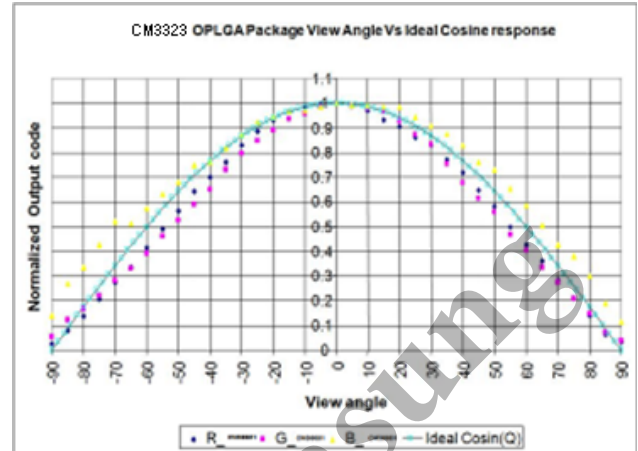


Figure 5. ALS Normalized Output vs. View Angle

Application Information

Pin Connection with the Host

CM3323 integrates R, G, B and W Sensor together with I²C interface. It is very easy for the baseband (CPU) to access CM3323 output data via I²C interface without extra software algorithms. The hardware schematic is shown in the following diagram.

The 0.1uF capacitor near the V_{DD} pin is used for power supply noise rejection. The 2.2K ohm is suitable for the pull high resistor of I²C.

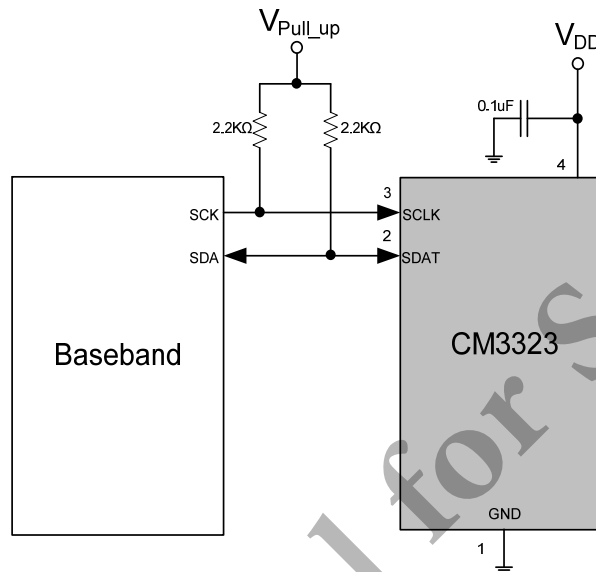
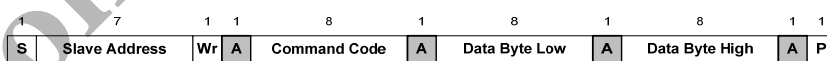


Figure 6. Hardware Pin Connection Diagram

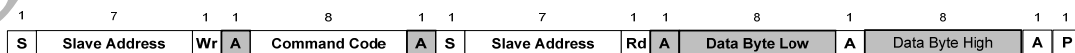
Digital Interface

CM3323 apply slave address 0x10 of 7 bit addressing protocol for I2C. CM3323 contains an 8-bit command register following each of slave address as shown in Figure 7. All operations can be controlled by the command register. The simple command structure helps users easily program the operation setting and latch the light data from CM3323. Following I²C command format is simple for Read and Write operations between CM3323 and the host as shown in Figure 7. The white sections indicate host activity and the gray sections indicate CM3323's acknowledgement of the host access activity. Based on Write Word protocol, 8-bit command codes can be written by the host under the same slave address. For data reading, CM3323 apply Read Word protocol.

Send Byte → Write Command to CM3323



Receive Byte → Read Data from CM3323



S = Start Condition

P = Stop Condition

A = Acknowledge

Shaded area = CM3323 acknowledge

Figure 7. Command Protocol Format

Slave Address and Function Description

CM3323 uses 0x10 slave address for 7-bit I2C addressing protocol. CM3323 has 16-bit resolution for each channel (R, G, B and W) that provides sensitivity up to 0.0056 Lux/step for ALS, which is advantageous under a low transmittance lens design (dark lens).

Slave Address 0x10										
Command Code	Register Name	R/W	BIT							
			7	6	5	4	3	2	1	0
00H_L	CONF	R/W	0	IT [2:0]			0	TRIG	AF	SD
00H_H	Reserve	R/W	Reserve							
01H~07H	Reserve	R/W	Reserve							
08H_L	R_Data_L	R	R_Data[7:0]							
08H_H	R_Data_M	R	R_Data[15:8]							
09H_L	ALS_Data_L	R	ALS_Data[7:0]							
09H_H	ALS_Data_M	R	ALS_Data[15:8]							
0AH_L	B_Data_L	R	B_Data[7:0]							
0AH_H	B_Data_M	R	B_Data[15:8]							
0BH_L	W_Data_L	R	W_Data[7:0]							
0BH_H	W_Data_M	R	W_Data[15:8]							
Slave Address 0x19 Reserved										

Note: Slave address is 7-bit addressing protocol

Table 1. Slave Address and Command Code Description

Command Register Format

CM3323 provides an 8-bit command register for controlling. The description of each command format is shown in the following tables. Color sensor is function compatible with Ambient Light sensor when apply Color sensor at Green channel.

Color Sensor Command

Slave Address:0x10; REGISTER NAME: CONF; Command Code:00H / Data Byte "Low"							
X	IT			X	TRIG	AF	SD
BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	IT2	IT1	IT0	0	TRIG	AF	SD
DESCRIPTION							
IT		Integration time setting					
TRIG		Proceed one detecting cycle at Manual force mode					
AF		Auto/Manual Force Mode					
SD		Chip shut down setting					

Table 2-1. Command code 00H Bits Description

BITS SETTING	DESCRIPTION	BITS SETTING	DESCRIPTION
BIT 7	Default=0	Bit 3	Default=0
IT [2:0]	(0 : 0 : 0) = 40ms	TRIG	0 = No trigger 1 = Trigger one time detect cycle
	(0 : 0 : 1) = 80ms	AF	0 = Auto mode 1 = Force mode
	(0 : 1 : 0) = 160ms		0 = Enable color sensor 1 = Disable color sensor
	(0 : 1 : 1) = 320ms	SD	
	(1 : 0 : 0) = 640ms		
	(1 : 0 : 1) = 1280ms		

Table 2-2. Command Code 00H Register Setting

Reserved		Command Code:00H / Data Byte "High"	
COMMAND	BIT	DESCRIPTION	
Reserved	7:0	Default = 00H	

Table 3-1. Reserve Command Code Description

Reserved		Command Code: 01-07H	
COMMAND	BIT	DESCRIPTION	
Reserved	7:0	Default = 00H	

Table 3-2. Reserve Command Code Description

COMMAND CODE	REGISTER	BIT	DESCRIPTION
08H_L (08H Data Byte Low)	R_Data_L	7:0	00H - FFH, R Channel LSB output data
08H_H (08H Data Byte High)	R_Data_M	7:0	00H - FFH, R Channel MSB output data
09H_L (09H Data Byte Low)	ALS_Data_L	7:0	00H - FFH, ALS LSB output data
09H_H (09H Data Byte High)	ALS_Data_M	7:0	00H - FFH, ALS MSB output data
0AH_L (0AH Data Byte Low)	B_Data_L	7:0	00H - FFH, B Channel LSB output data
0AH_H (0AH Data Byte High)	B_Data_M	7:0	00H - FFH, B Channel MSB output data
0BH_L (0BH Data Byte Low)	W_Data_L	7:0	00H - FFH, W Channel LSB output data
0BH_H (0BH Data Byte High)	W_Data_M	7:0	00H - FFH, W Channel MSB output data

Table 4. Read out Command Codes Description

Data Access

CM3323 has 16-bit high resolution sensitivity for each channel of color sensor(R,G,B and W). To represent the 16-bit data, it has to apply two bytes. One byte is for LSB and the other byte is for MSB. The host needs to follow the Read Word protocol as shown in Figure 9, page 7. The data format shows as below.

	CM3323 16-BIT DATA FORMAT																			
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0				
Data Byte Low																				
Data Byte High																				
Note																				
	S	Slave Address		Wr	A	Command Code		A	S	Slave Address		Rd	A	Data Byte Low		A	Data Byte High		A	P
<div>1. Data byte low represents LSB and data byte high represents MSB.</div> <div>2. To read CS data, for example, R channel, it has to be written in 0x10-08H-0x10 and then host read out 16 bit R channel data. Command code for R,G,B and W channel data is 08H, 09H, 0AH and 0BH individually.</div>																				

Table 5. 16-BIT ALS DATA FORMAT

The ALS (G Channel) resolutions that help define the threshold window are shown in Table 6.

IT setting		ALS Sensitivity
IT[2:0]	Integration time	
(0 : 0 : 0)	40ms	0.18
(0 : 0 : 1)	80ms	0.09
(0 : 1 : 0)	160ms	0.045
(0 : 1 : 1)	320ms	0.0225
(1 : 0 : 0)	640ms	0.01125
(1 : 0 : 1)	1280ms	0.005625
ALS Integration time= 40 ms		11796 Lux

Table 6. ALS (G Channel) Resolution and Maximum Detection Range

Data Auto-Memorization

CM3323 can memorize the last ambient light data before shutting down and keeps this data before waking up again. When CM3323 is in shutdown mode, the host can freely read this data directly via Read command. When CM3323 wakes up, the data is refreshed by a newly acquired detection.

Package Information

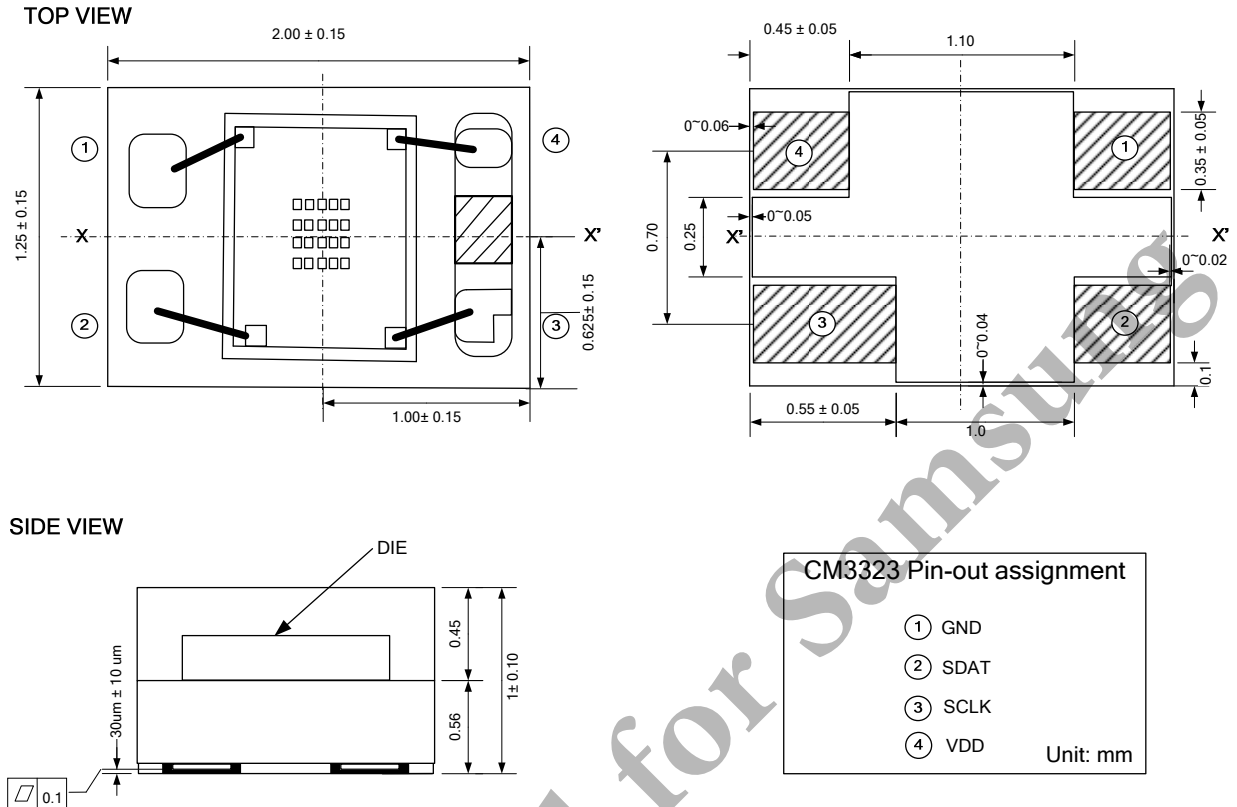


Figure 8. CM3323 A3OP Package Dimensions

Layout Notice and Reference Circuit

Pad and Circuit Layout Reference

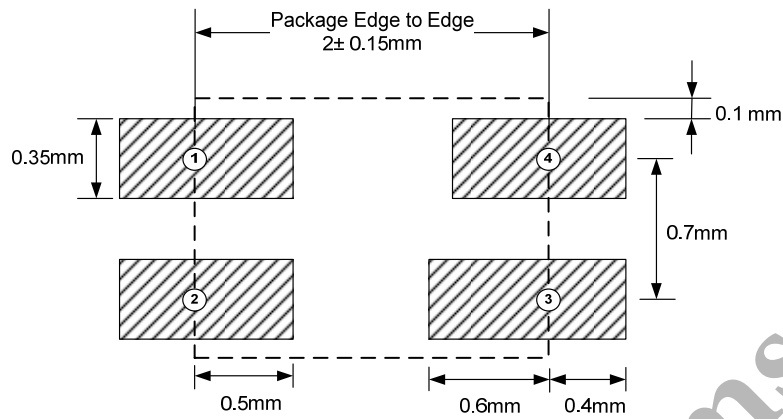


Figure 9. CM3323 PCB Layout Footprint

Application Circuit Block Reference

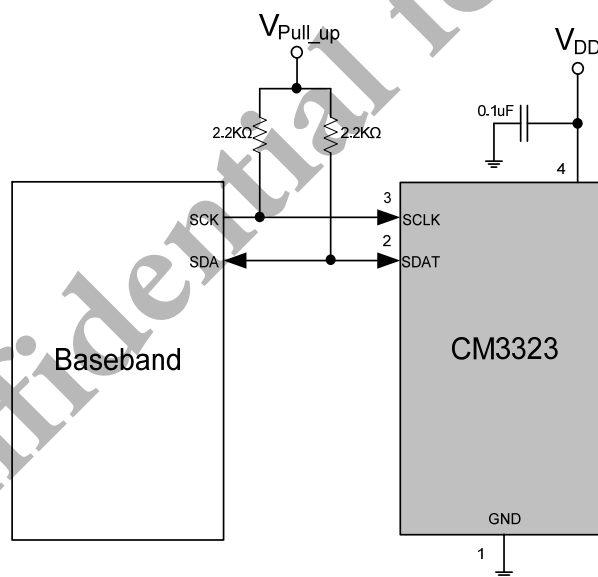


Figure 10. CM3323 Application Circuit

Recommended Storage and Rebaking Conditions

PARAMETER	MIN.	MAX.	UNITS	CONDITION
Storage temperature	5	50	°C	
Relative humidity		60	%	
Open time		168	hrs	
Total time	12 months from the date code on the aluminized envelope (unopened)			
Rebaking	1. Tape and Reel: 60°C, 22 hours 2. Tube: 60°C, 22 hours			

Recommended Infrared Reflow

Soldering conditions which are based on J-STD-020 C

1. IR reflow profile condition

PARAMETER	TEMPERATURE	TIME	CONDITION
Peak temperature	255+0/-5 °C (max.: 260°C)	10 seconds	
Preheat temperature range and timing	150 ~ 200°C	60 ~ 180 seconds	
Timing within 5°C to peak temperature		10 ~ 30 seconds	
Timing maintained above temperature / time	217°C	60 ~ 150 seconds	
Timing from 25°C to peak temperature		8 minutes (max.)	
Ramp-up rate	3°C/seconds (max.)		
Ramp-down rate	6°C/seconds (max.)		

2. Recommend normal solder reflow is: 235 ~ 255°C.

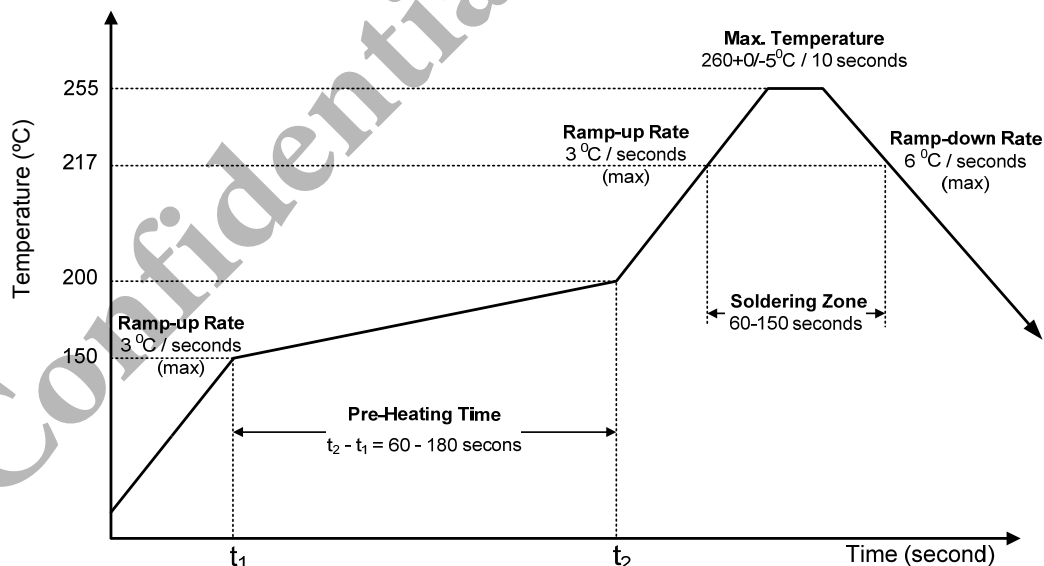


Figure 11. CM3323 OPLGA Solder Reflow Profile Chart

Recommended Iron Tip Soldering Condition and Warning Handling

- 1 Solder the device with the following conditions:
 - 1.1 Soldering temperature: 400°C (max.)
 - 1.2 Soldering time: 3 seconds (max.)
- 2 If the temperature of the method portion rises in addition to the residual stress between the leads, the possibility that an open or short circuit occurs due to the deformation or destruction of the resin increases.
- 3 The following methods: VPS and wave soldering, have not been suggested for the component assembly.
- 4 Cleaning method conditions:
 - 4.1 Solvent: Methyl Alcohol, Ethyl Alcohol, Isopropyl Alcohol
 - 4.2 Solvent temperature < 45°C (max.)
 - 4.3 Time: 3 minutes (min.)

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DIMENSION OF CARRIER TAPE

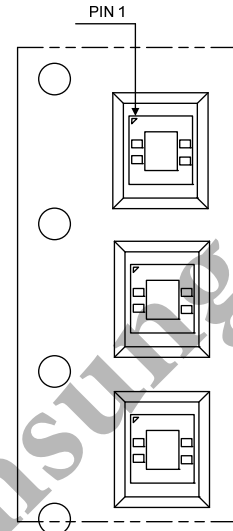


Figure 12. CM3323 A3OP Package Carrier Tape

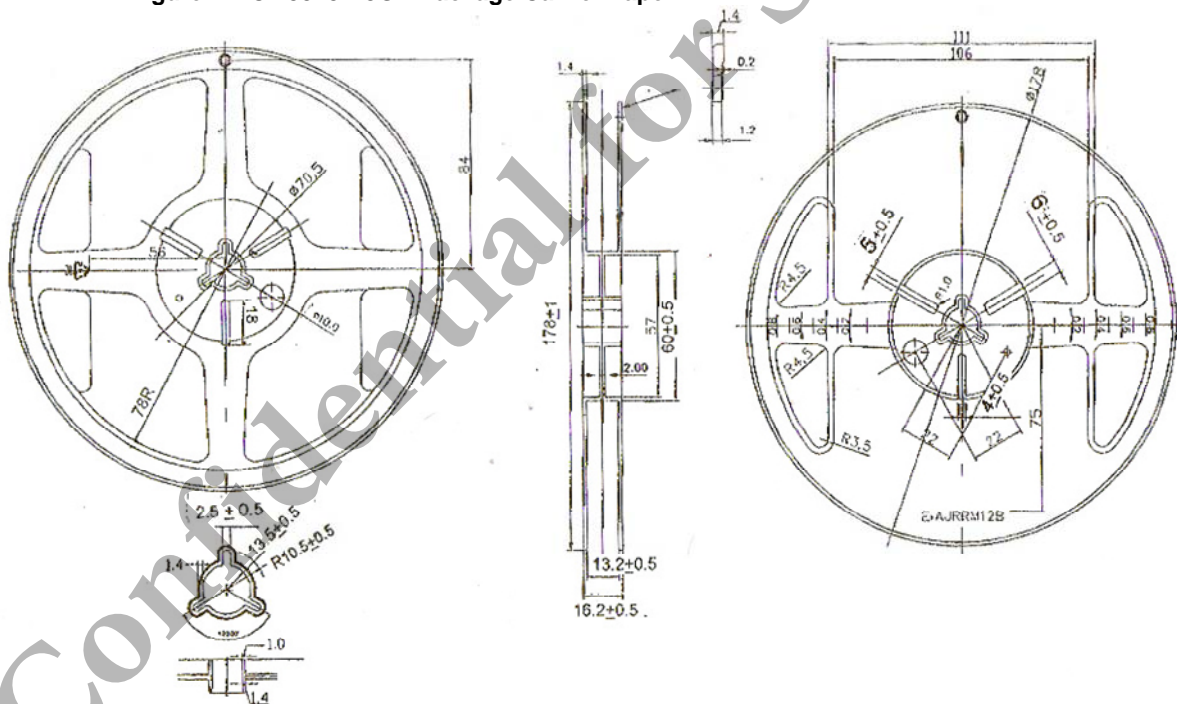


Figure 14. Reel Dimension

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