



CM32181

Low Power, High Sensitivity I²C Ambient Light Sensor

Rev: 1.1 Revised 11th-June-2013

Description

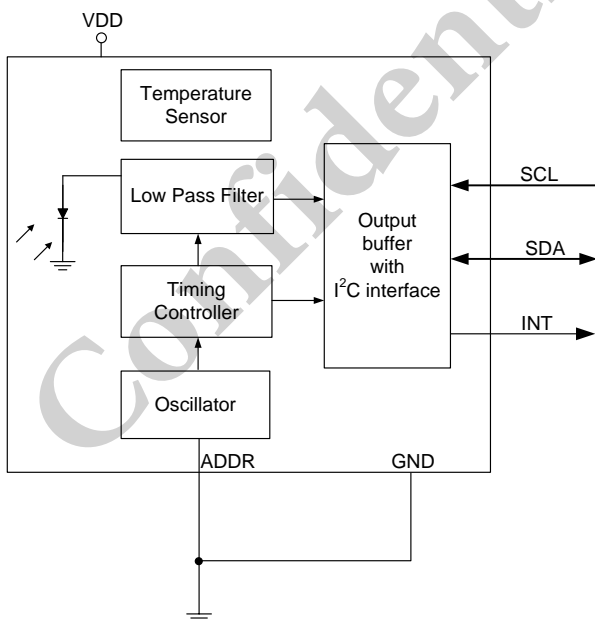
CM32181 is an advanced ambient light sensor with I²C protocol interface and designed by the CMOS process. It is easily operated via a simple I²C command. The active interruption feature within the threshold windows setting offers the benefit of eliminating loading of the controller monitor.

CM32181 incorporates a photodiode, amplifiers and analog circuits into a single chip. The best spectral sensitivity is used to closely capture real human eye responses. CM32181 has excellent temperature compensation. Its robust refresh rate setting does not need an external RC low pass filter. Software shutdown mode is provided which reduces power consumption to be less than 0.5µA. CM32181's operating voltage ranges from 2.5V to 3.6V and consumes only 1uA. The maximum detectable light strength is over 167K Lux.

Features

- Filtron™ technology adoption : excellent responsivity : close to real human eye responses
- High sensitivity: minimum detectable intensity 0.005 Lux/Bit supports low transmittance(dark) lens design
- O-Trim™ technology adoption : ALS output tolerance: ± 10%
- Support various Low power modes.
- Excellent temperature compensation: -40 to 85°C
- High dynamic detection resolution
- Standard I²C protocol interface
- Interruption feature (INT) support Programmable interrupt function with upper and lower thresholds. Adjustable persistence to prevent false triggers.
- Fluorescent light flicker immunity
- Software shutdown mode control
- Operation voltage from 2.5V to 3.6V
- Ambient light strength detection range over 100K Lux
- Package: OPLGA (2.35 x 1.8 x 1.0 mm)
- Lead-free package (RoHS compliant)

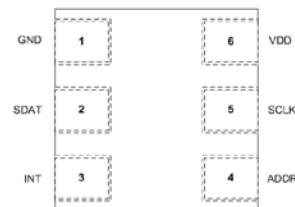
Block Diagram



Applications

- Notebook, Tablet, TV
- Mobile Phone, Smart-phone, PDA
- Automotive

Pin Definition



OPLGA
<Top View>

1	Ground	4	Address Select
2	I ² C Data	5	I ² C Clock
3	Interrupt	6	Power

Ordering Information

PART NUMBER	PACKING	PACKAGE	PIN NO.	QUANTITY	LEAD FREE	REMARK
CM32181A3OP	Tape and Reel	2.35 x 1.8 x 1.0mm	6	2500	Compliant	

Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN	MAX	UNIT	CONDITION
Storage temperature	T _S	-40	+100	°C	
Operating temperature	T _A	-40	+85	°C	
Supply voltage	V _{DD}	0	4	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 operating frequency	f _(I2CCLK)	10	400	kHz	

Pin Descriptions

PIN ASSIGNMENT	SYMBOL	TYPE	FUNCTION
1	GND	I	Power supply ground. All voltages are referenced to GND
2	SDAT	I/O (Open Drain)	I ² C digital serial data output to the host
3	INT	O (Open Drain)	Interrupt pin. (Active low).
4	ADDR		Address Select. Pull high to select address 0x48 or low to select address 0x10
5	SCLK	I	I ² C digital serial clock input from the host
6	VDD	I	Supply voltage

Electrical & Optical Specifications

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	CONDITION
Peak sensitivity wavelength	λ_P		550		nm	
I ² C signal input	Logic High	V_{IH}	1.2		V_{DD}	V Note1
	Logic Low	V_{IL}	—	0.4		
Output Low Voltage SDA		V_{OL}	0	0.4	V	3mA sink current
Detectable intensity	Minimum		0.005		LUX	Note 1,2 (ALS_SM = "01")
	Maximum		167000			Note 1,2 (ALS_SM = "10")
Dark offset			3		STEP	Note 1,2 (ALS_SM = "01")
Supply operation voltage		V_{DD}	2.5	3.3	3.6	V
Supply current			1			Note 1,2,3 (PSM=11,refresh time:4500ms)
		I_{DD}	6			Note 1,2,3 (PSM=00,refresh time:600ms)
			35			Note 1,2 (PSM_EN=0,refresh time:100ms)
Shutdown current		$I_{DD} (SD)$	0.5		uA	Light Condition = Dark, Note 1

Note:

1. Test condition: $V_{DD} = 3.3V$, Temperature: 25°C.
2. Light source: White LED.
3. Power saving mode enable

I²C 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 conditions	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

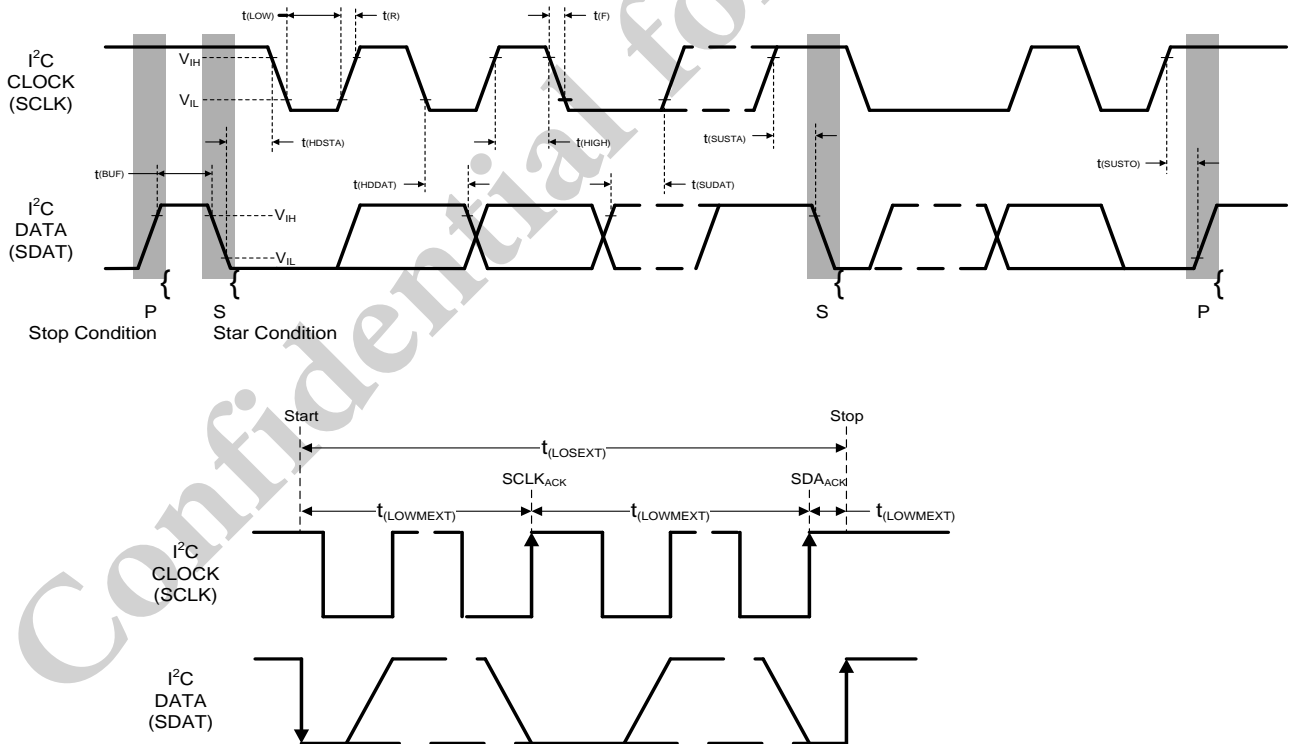


Figure 1. I²C Timing Diagram

Parameter Timing Information

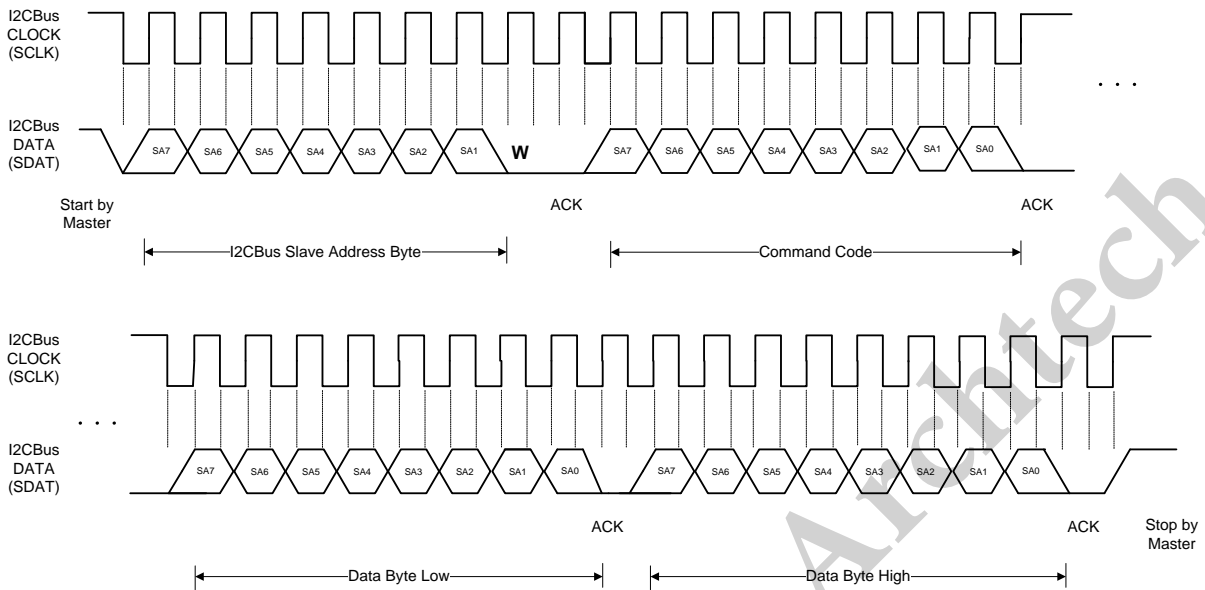


Figure 2-1. I²C Bus Timing for Sending Word Command Format

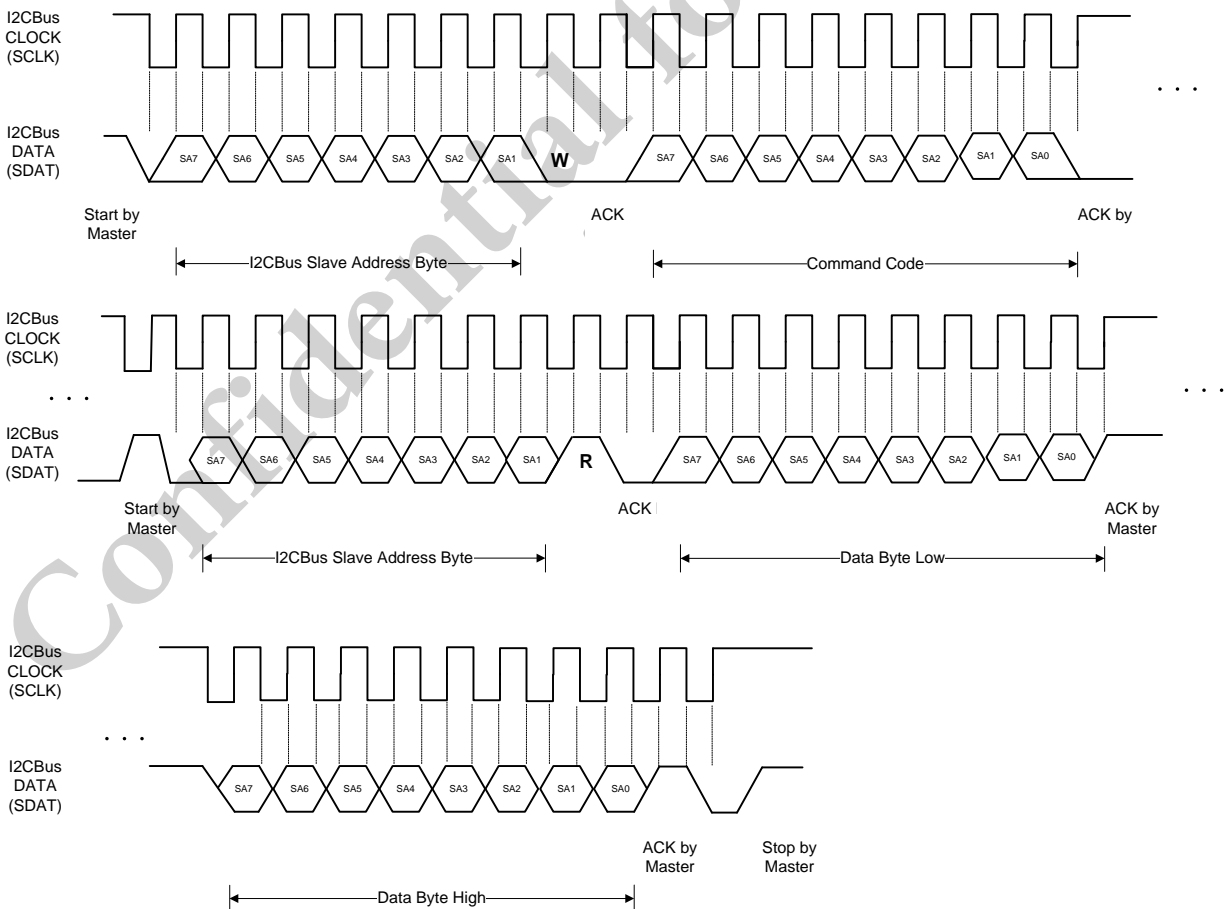


Figure 2-2. I²C Bus Timing for Receiving Word Command Format

Typical Performance Characteristics

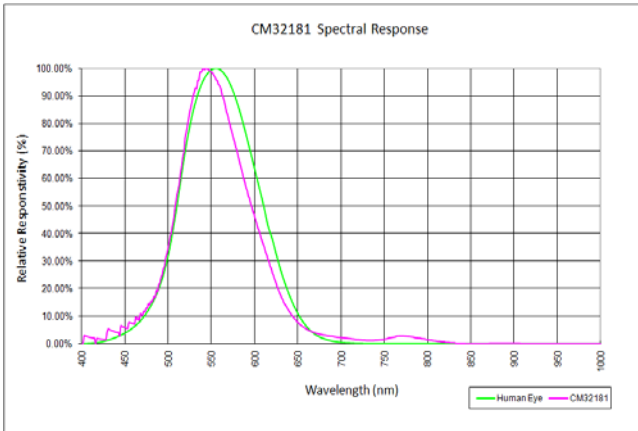


Figure 3. Normalized Spectral Response

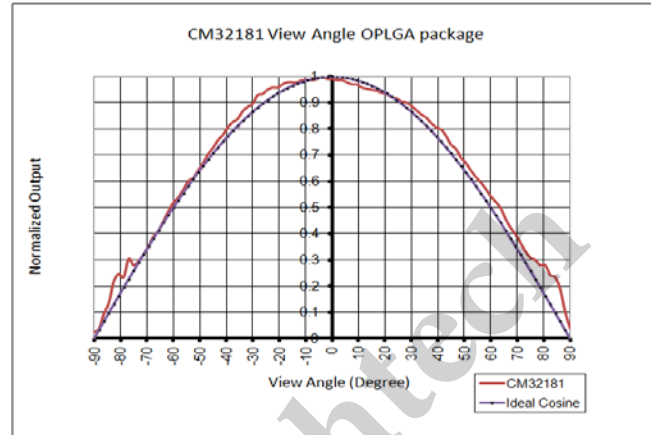


Figure 4. View Angle

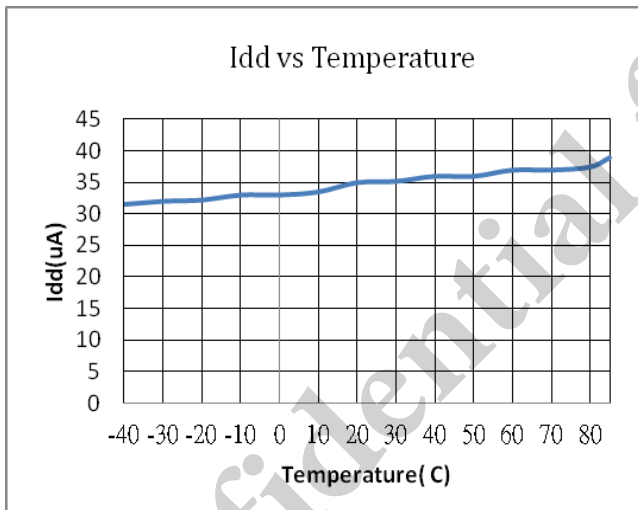


Figure 5. I_{DD} vs. Temperature Characteristics

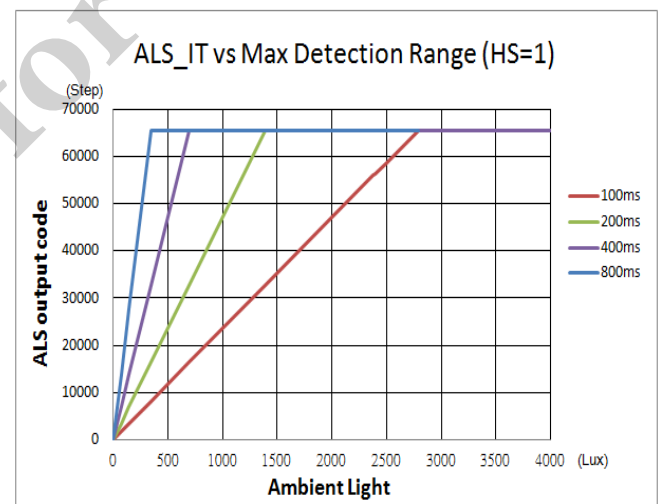


Figure 6. ALS_{IT} vs, Max Detection Range

Application Information

Pin Connection with the Host

CM32181 is a cost effective solution for an ambient light sensor with I²C interface. The standard serial digital interface easily accesses “light intensity” without using complex calculations and programming by an external controller.

The additional capacitor near the V_{DD} pin in the circuit is used for power supply noise rejection. The value is recommended at 0.1uF. The pull-high resistors for the I²C bus design are recommended to be 2.2KΩ. Pin ADDR is for address Select. Pull high to select address 0x48 or low to select address 0x10. An example of the circuit diagram is shown in Figure 7.

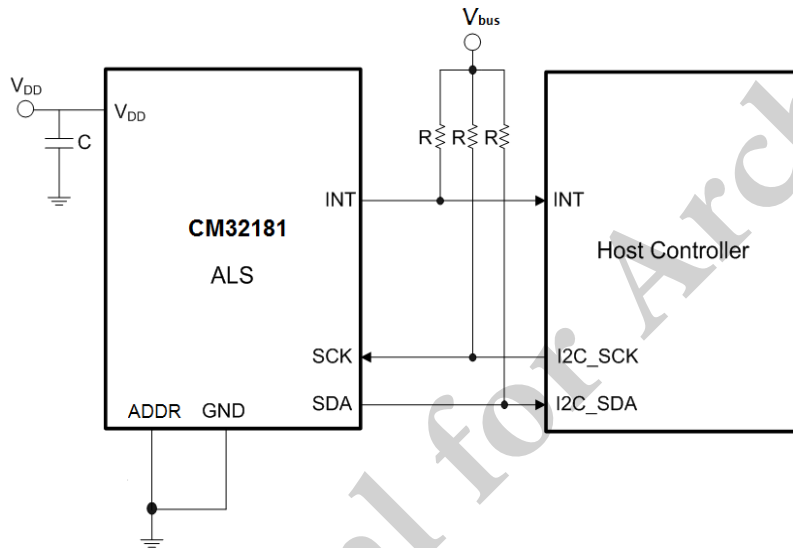
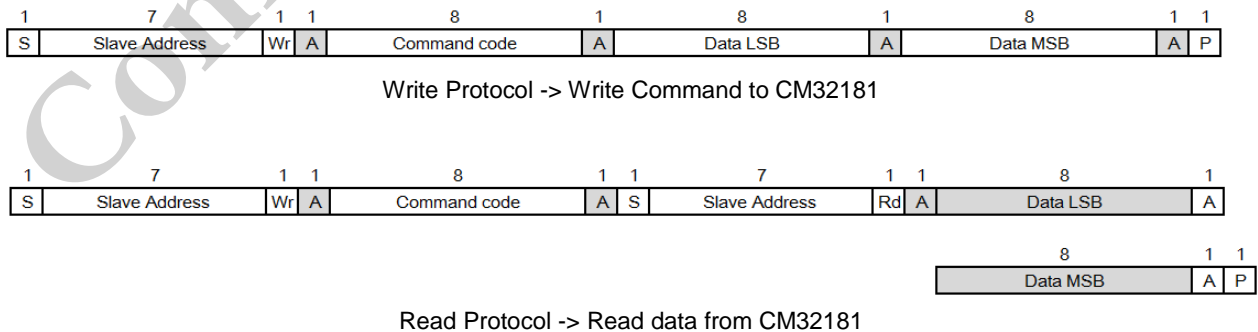


Figure 7. Hardware Pin Connection Diagram

Digital Interface

CM32181 contains a command register written via the I²C bus. All operations can be controlled by the command register. The simple command structure allows the user to easily program the operation setting and latch the light data from CM32181. CM32181's I²C command format description for Read and Write operations between CM32181 and the host is shown in Figure 8. The white areas indicate the host activity and the gray areas indicate CM32181's acknowledgement of the host access activity.



S = Start Condition
 P = Stop Condition
 A = Acknowledge

Figure 8. CM32181 Command Protocol

Command Register Format

There are 6 command codes provided by CM32181. Formats of these command code and registers' definition explanations are shown in below Table 1.

Command code	Register Name	Bit	Function/Description	R/W
00	Reserved	15:13	Set 000b	W
	ALS_SM	12:11	Sensitivity mode selection 00 = ALS Sensitivity x 1 01 = ALS Sensitivity x 2 10 = ALS Sensitivity x (1/8) 11 = ALS Sensitivity x (1/4)	W
	Reserved	10	Set 0b	W
	ALS_IT	9:6	ALS integration time setting 1100 = 25ms 1000 = 50ms 0000 = 100ms 0001 = 200ms 0010 = 400ms 0011 = 800ms	W
	ALS_PERS	5:4	ALS Persistence protect number setting 00 = 1 01 = 2 10 = 4 11 = 8	W
	Reserved	3:2	Set 00b	W
	ALS_INT_EN	1	ALS Interrupt enable setting 0 = ALS INT Disable 1 = ALS INT Enable	W
	ALS_SD	0	ALS shut down setting 0 = ALS Power On 1 = ALS Shut down	W
01	ALS_WH	15:8	ALS High Threshold Window setting(MSB)	W
	ALS_WH	7:0	ALS High Threshold Window setting(LSB)	W
02	ALS_WL	15:8	ALS Low Threshold Window setting(MSB)	W
	ALS_WL	7:0	ALS Low Threshold Window setting(LSB)	W
03	Reserved	15:3	Set 0000 0000 0000 0b	W
	PSM	2:1	Power Saving Mode 00 = Mode1 01 = Mode2	W

			10 = Mode3 11 = Mode4 Please refer to Table 2	
	PSM_EN	0	Power Saving Mode enable setting 0 = Disable 1 = Enable	W
04	ALS	15:8	MSB 8bits data of whole ALS 16bits	R
	ALS	7:0	LSB 8bits data of whole ALS 16bits	R
05	Reserved	15:0		R
06	ALS_IF_L	15	ALS crossing Low threshold INT trigger event	R
	ALS_IF_H	14	ALS crossing High threshold INT trigger event	R
07	Reserved	13:0		R

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Command code 00(HEX)

1. Bit 12:11 defines ALS sensitivity mode.

Bit 12	Function
00	ALS Sensitivity x 1
01	ALS Sensitivity x 2
10	ALS Sensitivity x (1/8)
11	ALS Sensitivity x (1/4)

2. Bit 9:6 defines ALS integration time setting which represents how long ALS can update the readout value.

Bit 9:6	Function
1100	25ms
1000	50ms
0000	100ms
0001	200ms
0010	400ms
0011	800ms

3. Bit 5:4 defines ALS interrupt persistence setting. The interrupt pin is triggered while sensor reading is out of threshold windows after consecutive number of measurement cycle.

Bit 5:4	Measurement cycle
00	1
01	2
10	4
11	8

4. Bit 1 defines whether to enable interrupt function or not.

Bit 1	Function
0	INT Disable
1	INT Enable

5. Bit 0 defines how to power on and shut down sensor setting.

Bit 0	Function
0	Power on
1	Shutdown

Command code 01(HEX)

Once enable INT function and use High/Low windows threshold, Bit 15:0 provides 16 bit register for High bound threshold window setting.

Bit	Function
15:8	High Threshold Window setting(MSB)
7:0	High Threshold Window setting(LSB)

Command code 02(HEX)

Once enable INT function and use High/Low windows threshold, Bit 15:0 provides 16 bit register for Low bound threshold window setting.

Bit	Function
15:8	Low Threshold Window setting(MSB)
7:0	Low Threshold Window setting(LSB)

Command code 03(HEX)

1. Bit 2:1 defines Power Saving mode which provides various power consumption, sensitivity, and refresh time combinations. Please refer to Table2.

Bit 2:1	Function
00	Mode1
01	Mode2
10	Mode3
11	Mode4

2. Bit 0 defines whether to enable power saving mode or not.

Bit 0	Function
0	Disable
1	Enable

Command code 04(HEX)

To access 16-bit high resolution ALS output data, it's suitable to follow read protocol to read from Command code 04 16 bits register.

Bit	Function
15:8	MSB 8bits data of whole 16bits
7:0	LSB 8bits data of whole 16bits

Command code 06(HEX)

1. Bit 15 defines interrupt flag while trigger occurred due to data crossing low threshold windows.

Bit 15	Function
0	Interrupt not triggered
1	Interrupt occurred

2. Bit 14 defines interrupt flag while trigger occurred due to data crossing high threshold windows.

Bit 14	Function
0	Interrupt not triggered
1	Interrupt occurred

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Refresh Time Determination of PSM

CM32181's refresh time can be determined by PSM and ALS_IT setting in Power Saving Mode(PSM). Cooperating with the command register setting, the designer has a flexible method in defining the timing, power consumption and sensitivity for light data collection.

ALS_SM	PSM	ALS_IT	Refresh time(ms)	Idd(uA)	sensitivity(Lux/bit)
01	00	0000	600	6	0.042
01	01	0000	1100	3.5	0.042
01	10	0000	2100	2	0.042
01	11	0000	4100	1	0.042
01	00	0001	700	10	0.021
01	01	0001	1200	6	0.021
01	10	0001	2200	3.5	0.021
01	11	0001	4200	2	0.021
01	00	0010	900	15	0.01
01	01	0010	1400	10	0.01
01	10	0010	2400	6	0.01
01	11	0010	4400	3.5	0.01
01	00	0011	1300	21	0.005
01	01	0011	1800	15	0.005
01	10	0011	2800	10	0.005
01	11	0011	4800	6	0.005

Table 2. Refresh Time, Idd and sensitivity Relation Table

Auto-Memorization

CM32181 can memorize the last ambient light data before shutdown and keep this data before waking up. When CM32181 is in shutdown mode, the host can freely read this data via Read command directly. When CM32181 wakes up, the data will be refreshed by the new detection.

Package Information (OPLGA)

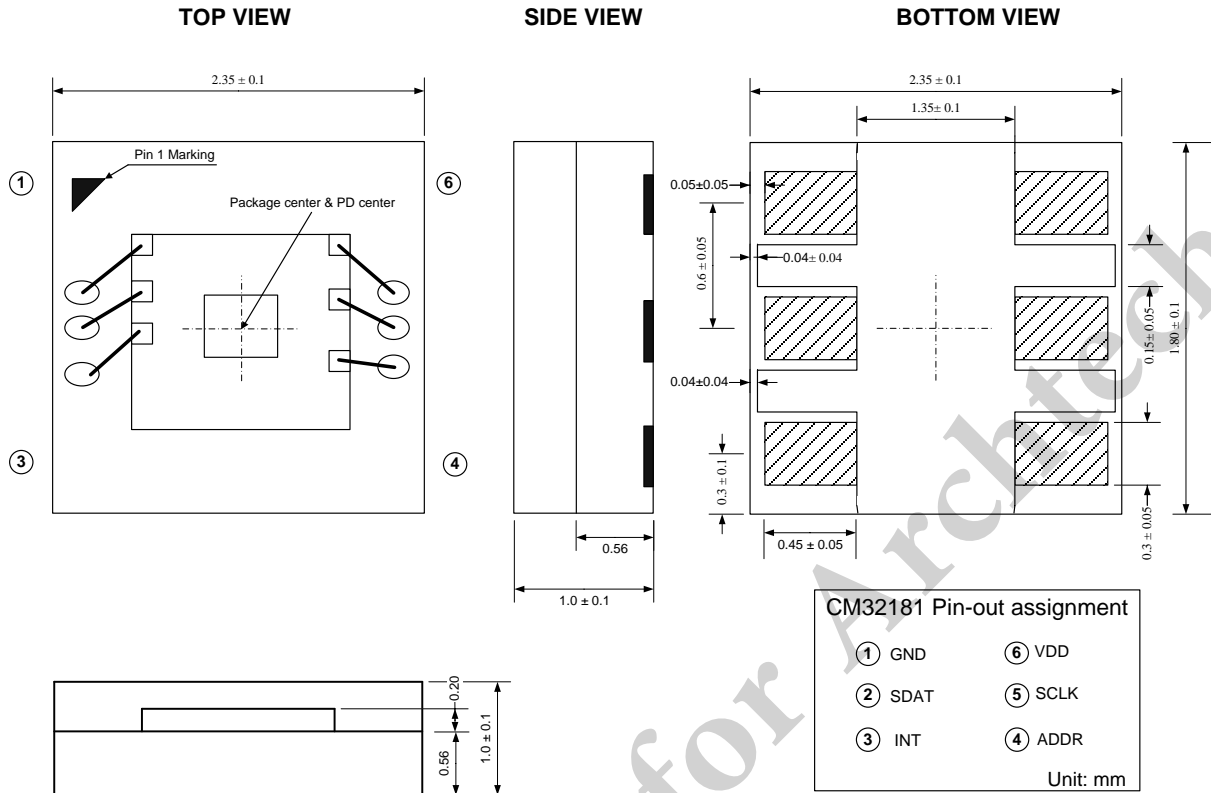


Figure 10. CM32181 A3OP Package Dimensions

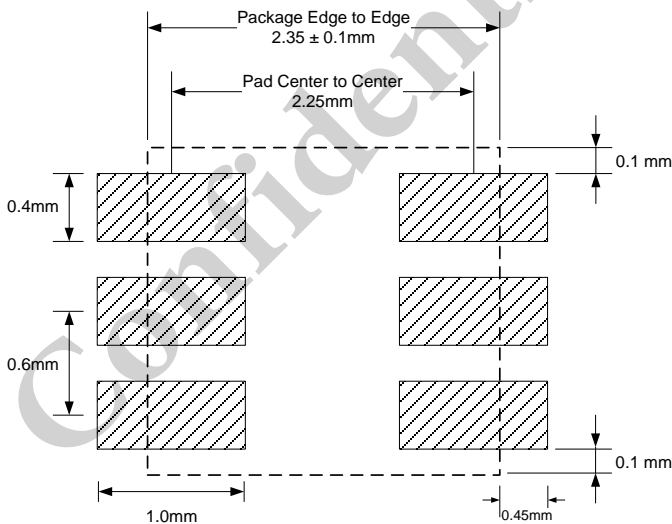


Figure 11. CM32181 OPLGA PCB Layout Footprint

Recommended Storage and Rebaking Conditions

PARAMETER	MIN	MAX	UNITS	CONDITION
Storage temperature	5	50	°C	
Relative humidity		60	%	
Open time		168	hrs	
Total time	6 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 are based on J-STD-020 C definition.

1. IR reflow profile conditions

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. Recommended normal solder reflow is: 235 ~ 255 °C.

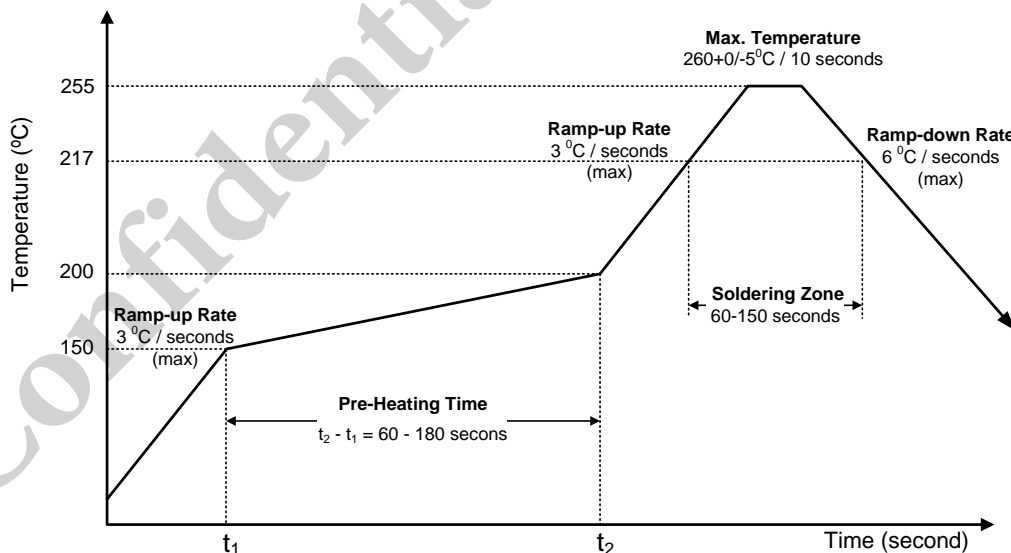


Figure 12. CM32181 Solder Reflow Profile Chart

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 open or short circuit occurs due to the deformation or destruction of the resin increases.
- 3 The following methods: VPS, and wave soldering are not suggested for the component assembly.
- 4 Cleaning method condition:
 - 4.1 Solvent: Methyl Alcohol, Ethyl Alcohol, and Isopropyl Alcohol.
 - 4.2 Solvent temperature < 45 °C (Max.);
 - 4.3 Time: 3 minutes (Min.)

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Packing Information

DIMENSION OF CARRIER TAPE

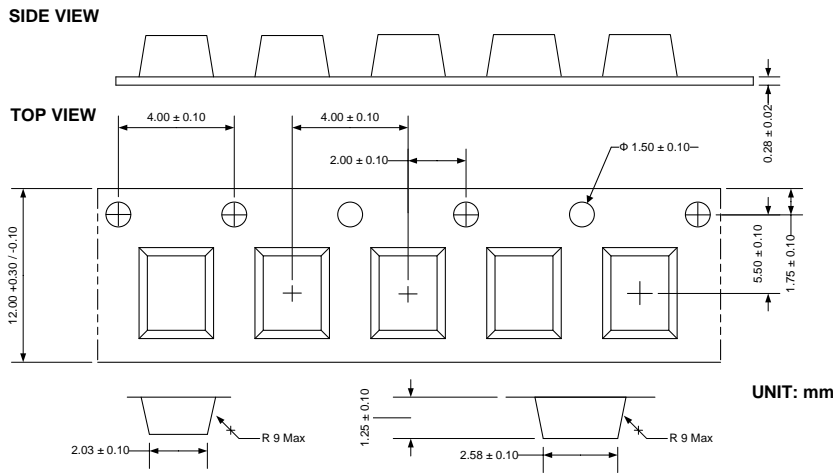


Figure 13. CM32181 A3OP Package Carrier Tape

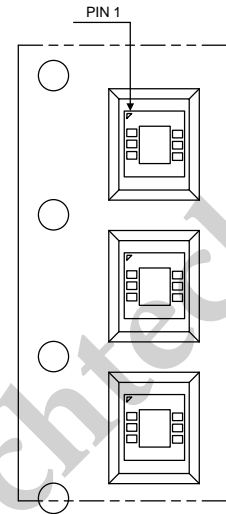


Figure 14. Taping Direction

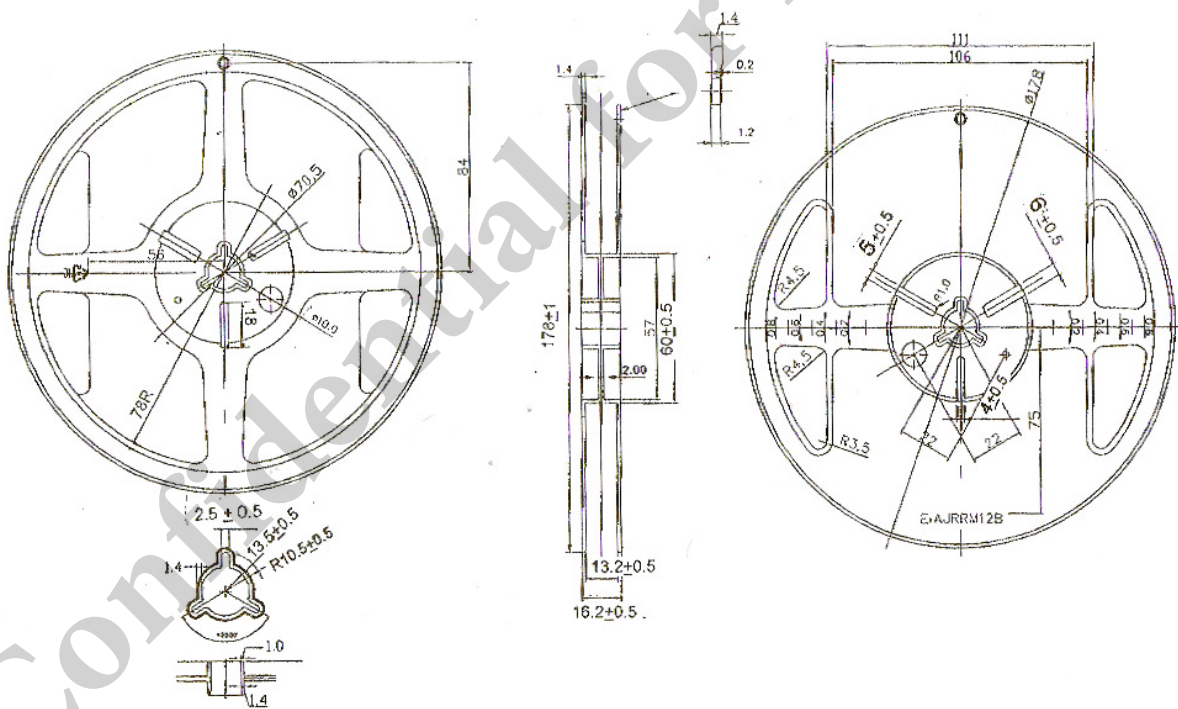


Figure 15. Reel Dimension

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