CM3218

High Sensitivity I²C Ambient Light Sensor

Rev: 0.82 Revised 2th-July-2012

Description

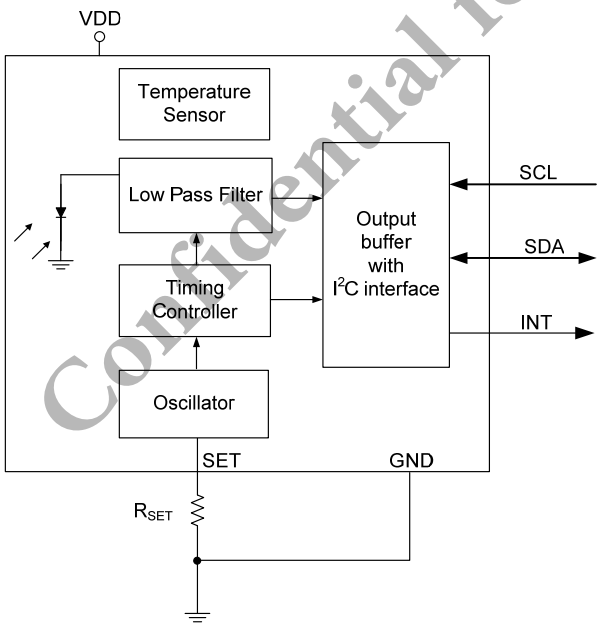
CM3218 is an advanced ambient light sensor with I²C protocol interface and designed by the CMOS process. It is easily operated via a simple I²C command. The active interruption feature within the threshold windows setting offers the benefit of eliminating loading of the controller monitor.

CM3218 incorporates a photodiode, amplifiers and analog circuits into a single chip. The best spectral sensitivity is used to closely capture real human eye responses. CM3218 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 1μA. CM3218's operating voltage ranges from 2.7V to 5V and can detect a wide range of ambient light power.. The maximum detective light strength is over 140K Lux.

Features

- Filtron™ technology adoption :
  excellent responsivity : close to real human eye responses
- High sensitivity:
  minimum detectable intensity 0.00089 Lux/Bit
  supports low transmittance(dark) lens design
- O-Trim™ technology adoption :
  ALS output tolerance: ± 10%
- Excellent temperature compensation: -40 to 85ºC
- 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
- Auto memorization of the last light data before shutdown
- Software shutdown mode control
- Operation voltage from 2.7V to 5V
- Ambient light strength detection range over 140K Lux
- Package: OPLGA (2.35 x 1.8 x 1.0 mm)
- Lead-free package (RoHS compliant)

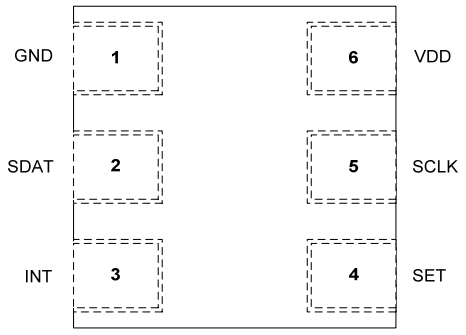
Block Diagram



Applications

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

Pin Definition



<Top View>

1	Ground	4	Rset
2	I²C Data	5	I²C Clock
3	Interrupt	6	Power

Ordering Information

PART NUMBER	PACKING	PACKAGE	PIN NO.	QUANTITY	LEAD FREE	REMARK
CM3218A3OP	Tape and Reel	2.35 x 1.8 x 1.0mm	6	2500	Compliant	Slave address 0x10 Interrupt Alert Response Address (ARA) 0x0C
CM3218A3OP-AD	Tape and Reel	2.35 x 1.8 x 1.0mm	6	2500	Compliant	Slave address 0x48 Interrupt Alert Response Address (ARA) 0x0C

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	5.5	V	

Recommended Operating Conditions

PARAMETER	SYMBOL	MIN	MAX	UNIT	CONDITION
Operating temperature	T_A	-40	+85	°C	
Supply voltage	V_{DD}	2.7	5	V	
I²C 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)	I²C digital serial data output to the host
3	INT	O (Open Drain)	Interrupt pin
4	SET		Light reading adjustment. Connect a resistor to GND.
5	SCLK	I	I²C 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^2C signal input	Logic High	V_{IH}	1.4		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			0.00089		LUX	R_{SET} = 2.4M, IT= 4T Note 1,2,3 (ALS_SM = "01")
	Maximum			149000			R_{SET} = 30K, IT = ½T, Note 1,2,3 (ALS_SM = "10")
Dark offset				3		STEP	R_{SET} = 604K, IT = ½T, Note 1,2,3
Supply operation voltage		V_{DD}	2.7	3.3	5	V	
Supply current		I_{DD}		130		μA	Note 1,2
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. Maximum detection range to ambient Light can be determined by the R_{SET} value.

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
I²C clock (SCK) low period	$t_{(LOW)}$	4.7		1.3		us
I²C 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

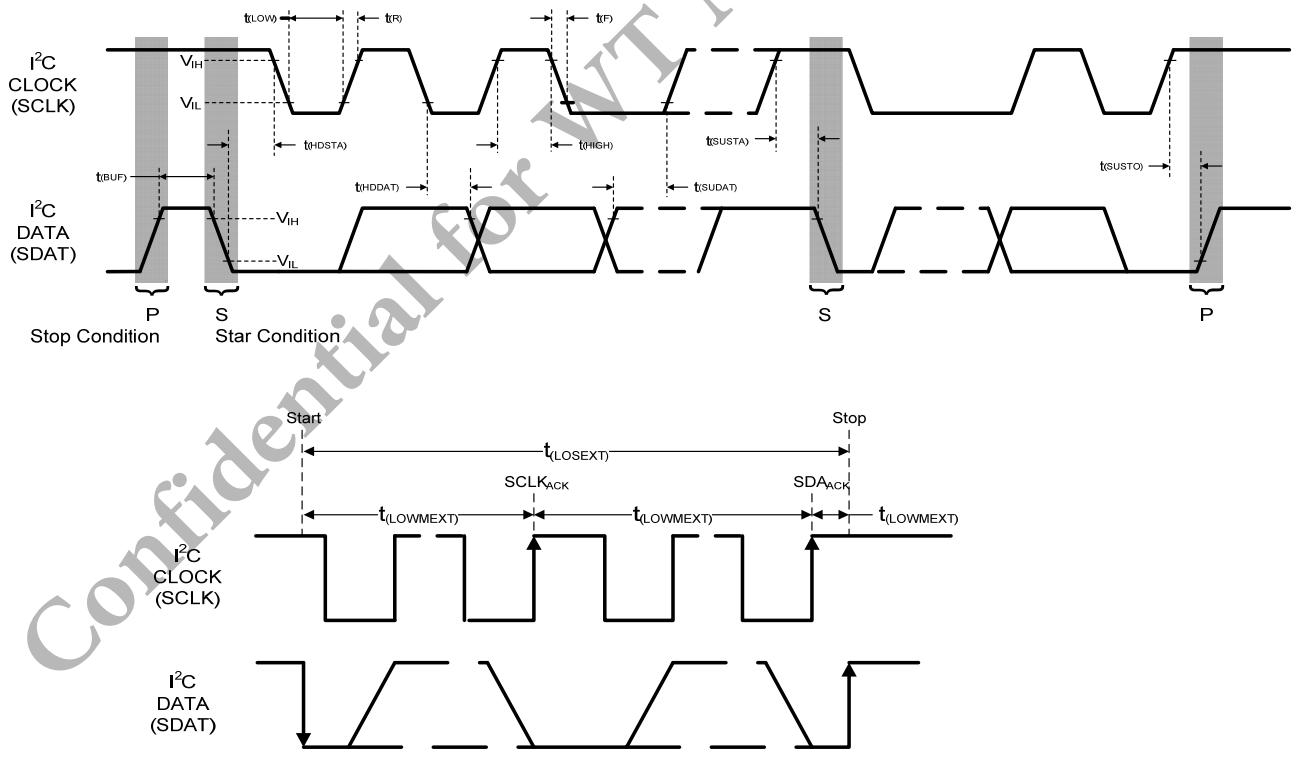


Figure 1. I²C Timing Diagram

Parameter Timing Information

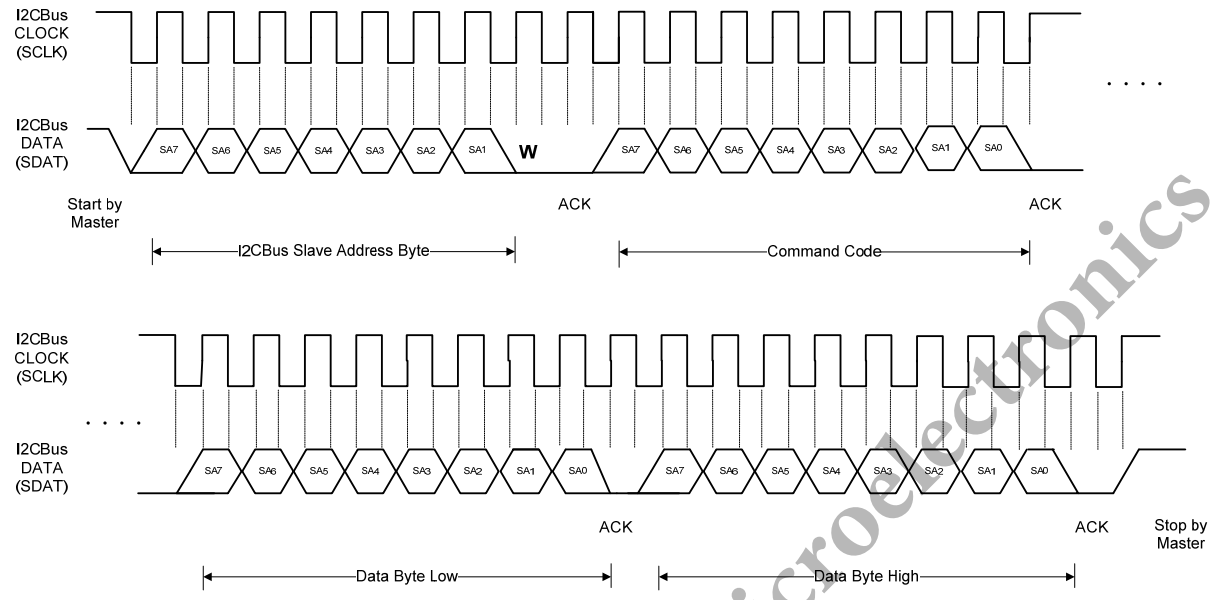


Figure 2-1. I²C Bus Timing for Sending Word Command Format

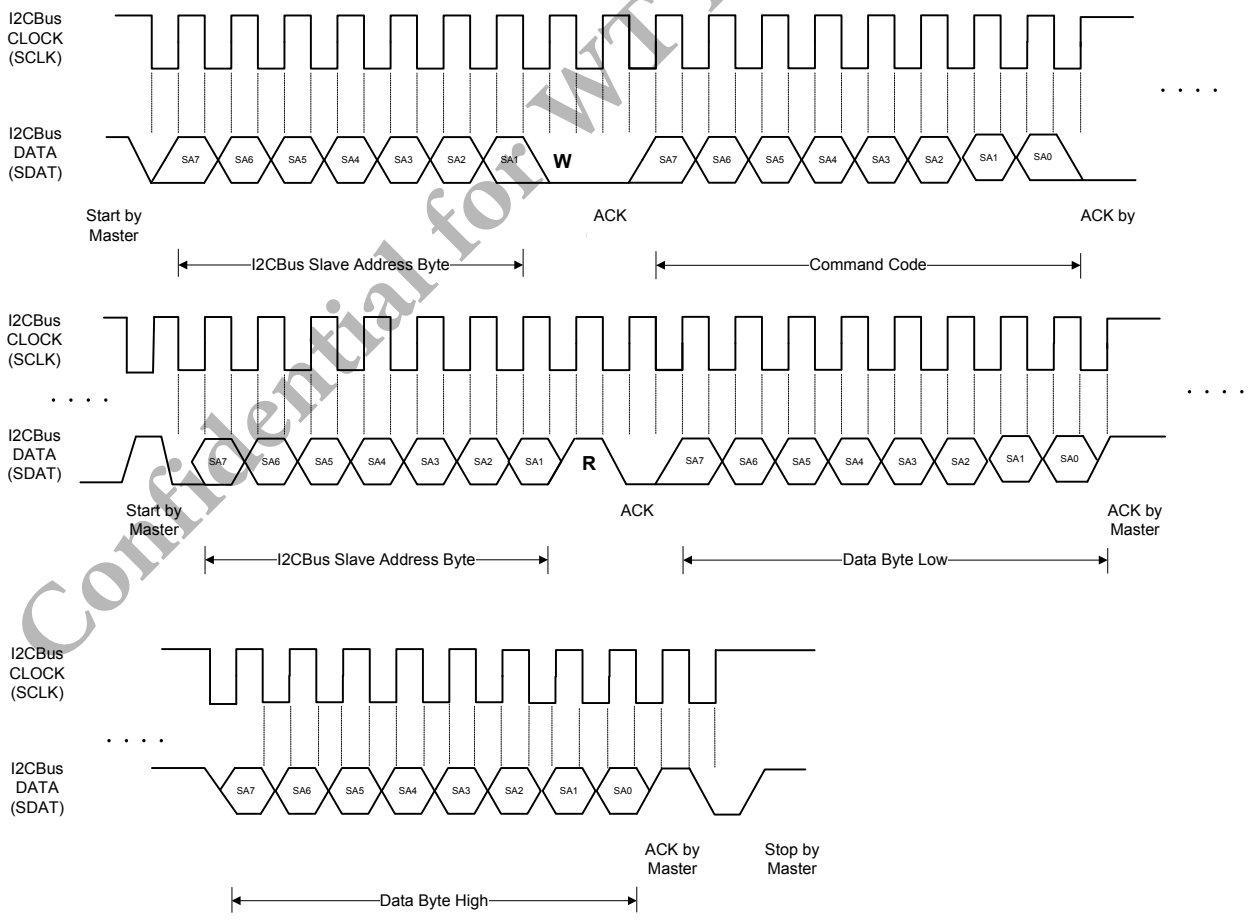


Figure 2-2. I²C Bus Timing for Receiving Word Command Format

Typical Performance Characteristics

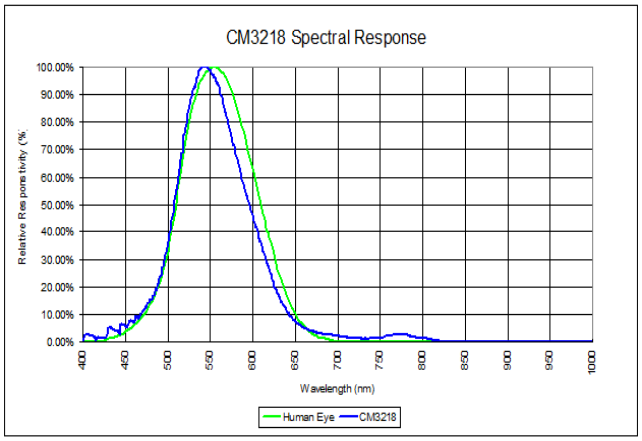


Figure 3. Normalized Spectral Response

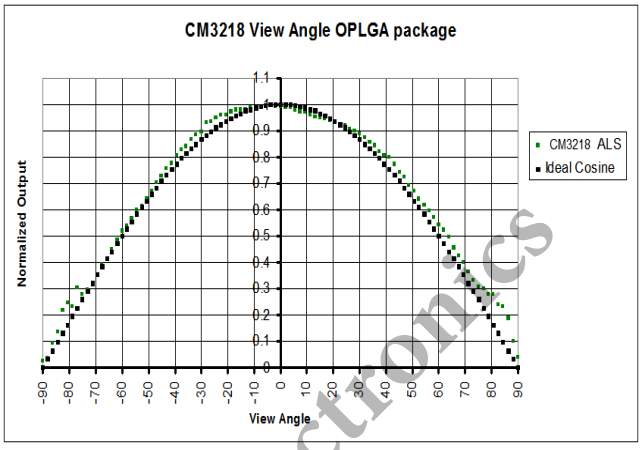


Figure 4. View Angle

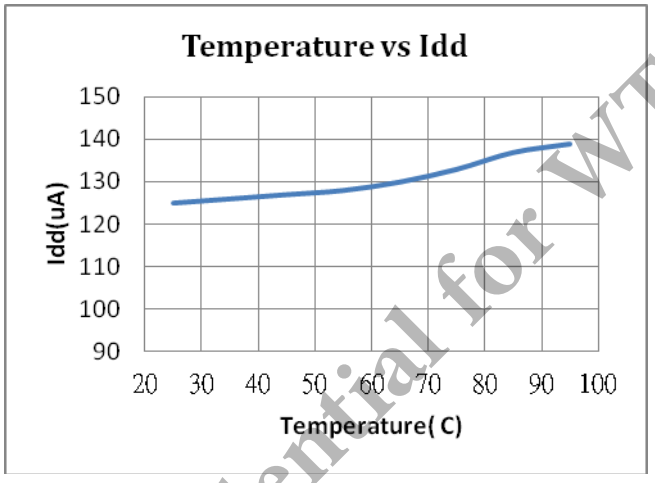


Figure 5. I_{DD} vs. Temperature Characteristics

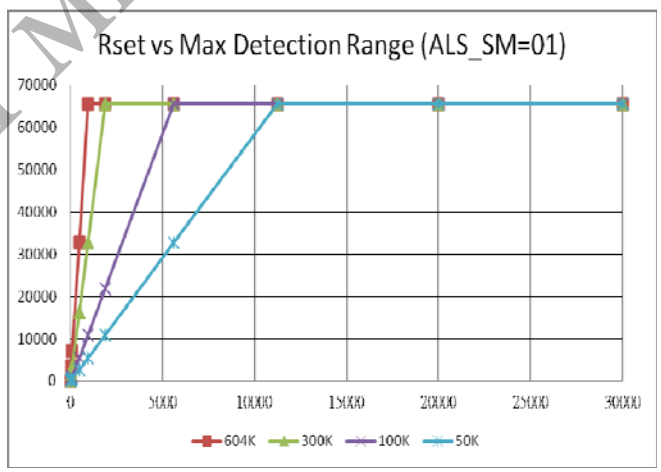


Figure 6. R_{SET} vs, Max Detection Range

Application Information

Pin Connection with the Host

CM3218 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. The R_{SET} is recommended to be 604KΩ . An example of the circuit diagram is shown in Figure 7.

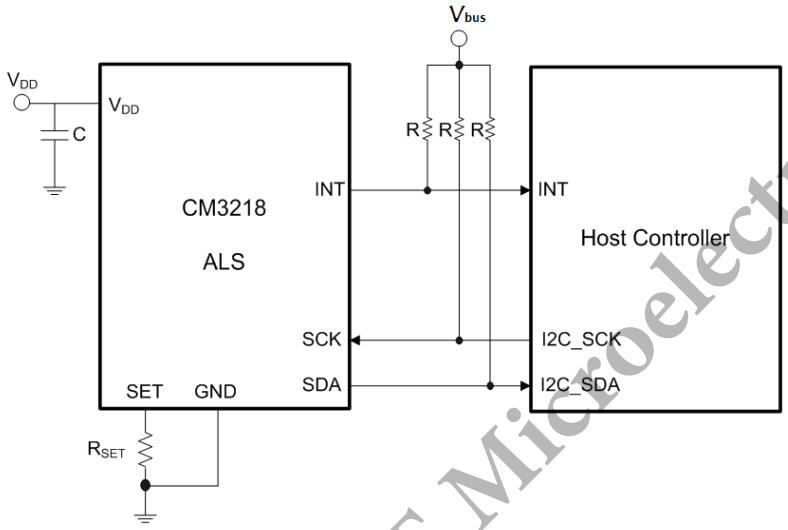
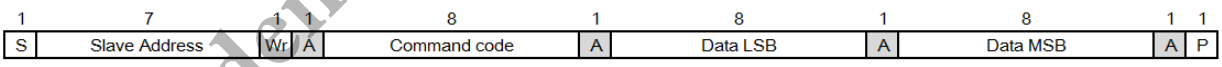


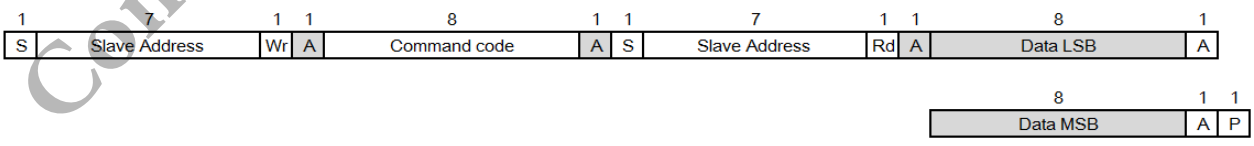
Figure 7. Hardware Pin Connection Diagram

Digital Interface

CM3218 I²C interface slave address is internally hardwired as CM3218A3OP: 0x10 and CM3218A3OP-AD: 0x48. CM3218 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 CM3218. CM3218's I²C command format description for Read and Write operations between CM3218 and the host is shown in Figure 8. The white areas indicate the host activity and the gray areas indicate CM3218's acknowledgement of the host access activity.



Write Protocol -> Write Command to CM3218



Read Protocol -> Read data from CM3218

S = Start Condition
P = Stop Condition
A = Acknowledge

Figure 8. CM3218 Command Protocol

Command Register Format

There are 5 command codes provided by CM3218. 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	Default:000	W
	ALS_SM	12:11	ALS sensitivity mode selection 00 = ALS Sensitivity *1 01 = ALS Sensitivity *2 10 = ALS Sensitivity *0.5	W
	Reserved	10:8	Default:000	W
	ALS_IT	7:6	ALS integration time setting (0 : 0) = 0.5T (0 : 1) = 1T (1 : 0) = 2T (1 : 1) = 4T (The unit "T" is determined by the external resistor)	W
	ALS_PERS	5:4	ALS Persistence protect number setting (0 : 0) = 1 (0 : 1) = 2 (1 : 0) = 4 (1 : 1) = 8	W
	Reserved	3:2	Default:01	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	15:0	Default:0x00	W
04	ALS	15:8	MSB 8bits data of whole ALS 16bits	R
	ALS	7:0	LSB 8bits data of whole ALS 16bits	R

Command code 00(HEX)

1. Bit 12:11 defines ALS sensitivity mode.

Bit 12:11	Function
00	ALS Sensitivity X 1
01	ALS Sensitivity X 2
10	ALS Sensitivity X 0.5

2. Bit 7:6 defines ALS integration time setting which represents how long ALS can update the readout value.

Bit 7:6	Function
00	0.5T
01	1T
10	2T
11	4T

(The unit "T" is determined by the external resistor)

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

(The unit "T" is determined by the external resistor)

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)

Reserved.

Bit	Function
15:8	Default 0x00
7:0	Default 0x00

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

Interruption (INT)

CM3218 has an ALS interrupt feature operated by a single pin "INT". The purpose of the interrupt feature is to actively inform the host once the data is outside of threshold window. With the interrupt function applied, the host doesn't need constantly pulling data from the sensor, but can just read data from the sensor while receiving interrupt request from the sensor.

As long as the host implements the INT function, it read data and acknowledges Alert Response Address (ARA), 0x0C to disengage INT pin when INT is asserted. A command format for responding to an ARA is shown in Figure 9. If the data is 0x20 (CM3218-AD 0x90), then the INT is asserted by CM3218.

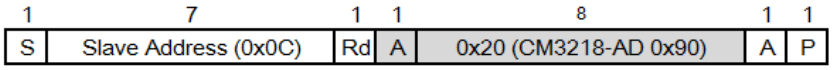


Figure 9. Command format for Responds to an ARA

Resolution to Ambient Light and Maximum Detection Range

CM3218 ambient light sensitivity can be tuned by an external resistor. To operate with the integration time (IT) setting, the light resolution (Lux/Step) is more precise and flexible.

As the R_{SET} value changes, the light resolution and the maximum detecting range also change. The correlation between R_{SET} and the resolution (Lux/Step) is shown below:

$$R_{SET1} * Resolution\_1 = R_{SET2} * Resolution\_2$$

Refresh Time Determination

CM3218's refresh time can be determined by the R_{SET} value. Cooperating with the command register setting, the designer has a flexible method in defining the timing for light data collection. The default refresh time is 1T, ALS_IT = (0 : 1). If the R_{SET} value is changed, the default timing changes and other parts in the register table also change relative to the default timing. An example of two R_{SET} resistors that show the timing table in which the system designer can determine the desired refresh time flexibly is shown in Table 2.

REGISTER	SETTING	REFRESH TIME TABLE
		R_{SET} = 604KΩ
ALS_IT	(0 : 0) = ½T	125ms
	(0 : 1) = 1T	250ms
	(1 : 0) = 2T	500ms
	(1 : 1) = 4T	1000ms

Table 2. Example of Refresh Time and R_{SET} Value Relation Table

If CM3218's refresh time is required to be at 500ms, the calculation of the refresh time becomes:

1). If R_{SET} = 604KΩ, "IT" register value should set to (1:0), 2T.
2). If R_{SET} = 300KΩ, "IT" register value should set to (1:1), 4T.

The parameter is independent from other command register settings. The designer can obtain the refresh timing range of the system operation requirement first, choose an appropriate R_{SET} value for the timing range setting and then write the correct value for the system application via I²C protocol.

Auto-Memorization

CM3218 can memorize the last ambient light data before shutdown and keep this data before waking up. When CM3218 is in shutdown mode, the host can freely read this data via Read command directly. When CM3218 wakes up, the data will be refreshed by the new detection.

Package Information

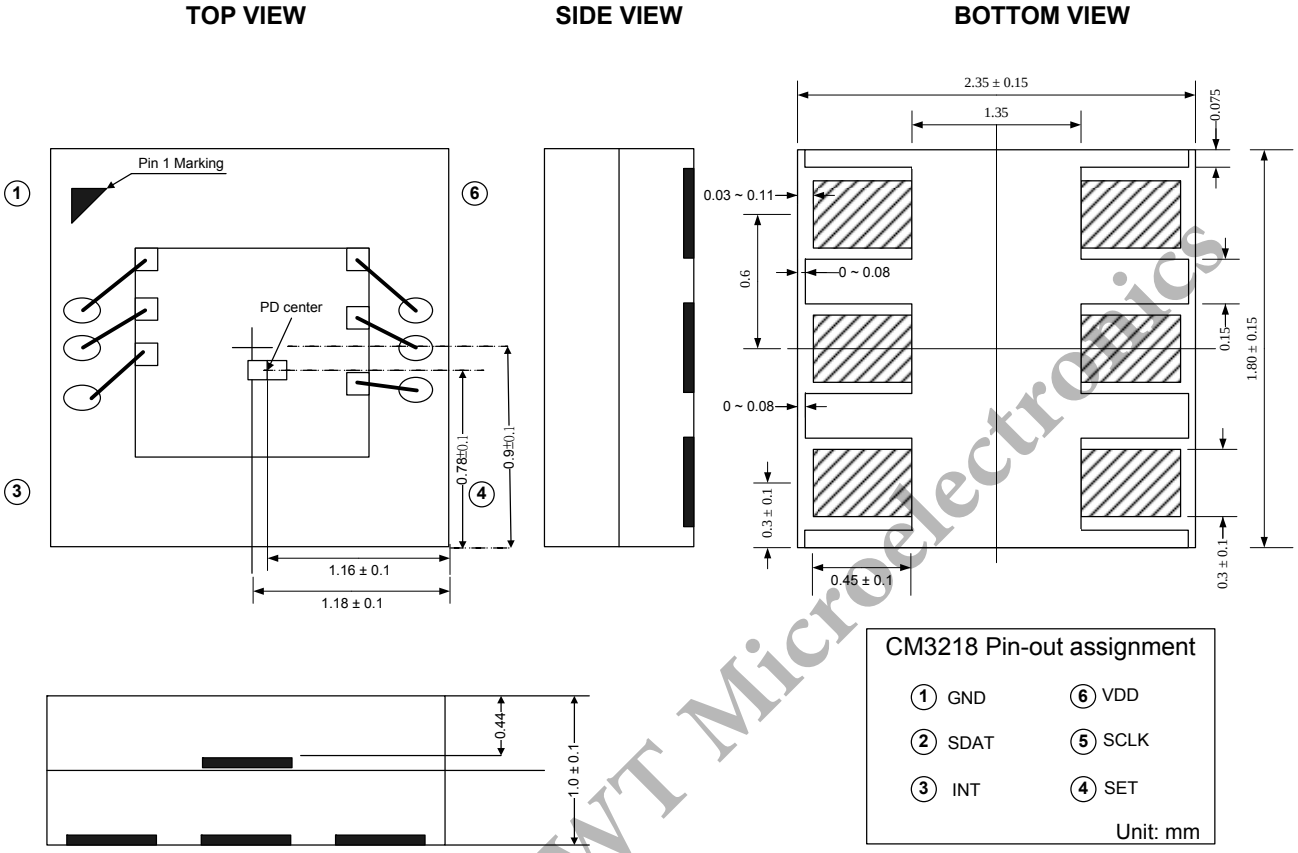


Figure 10. CM3218 A3OP Package Dimensions

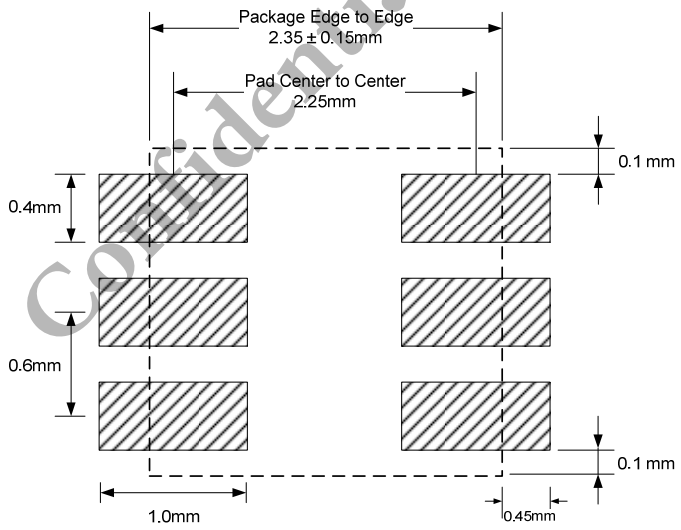


Figure 11. CM3218 OPLGA PCB Layout Footprint

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 ºC , 22 hours 2. Tube: 60 ºC , 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 ºC (Max: 260 ºC)	10 seconds	
Preheat temperature range and timing	150 ~ 200 ºC	60 ~ 180 seconds	
Timing within 5 ºC to peak temperature		10 ~ 30 seconds	
Timing maintained above temperature / time	217 ºC	60 ~ 150 seconds	
Timing from 25 ºC to peak temperature		8 minutes (Max)	
Ramp-up rate	3 ºC / seconds (Max)		
Ramp-down rate	6 ºC / seconds (Max)		

2. Recommended normal solder reflow is: 235 ~ 255 ºC.

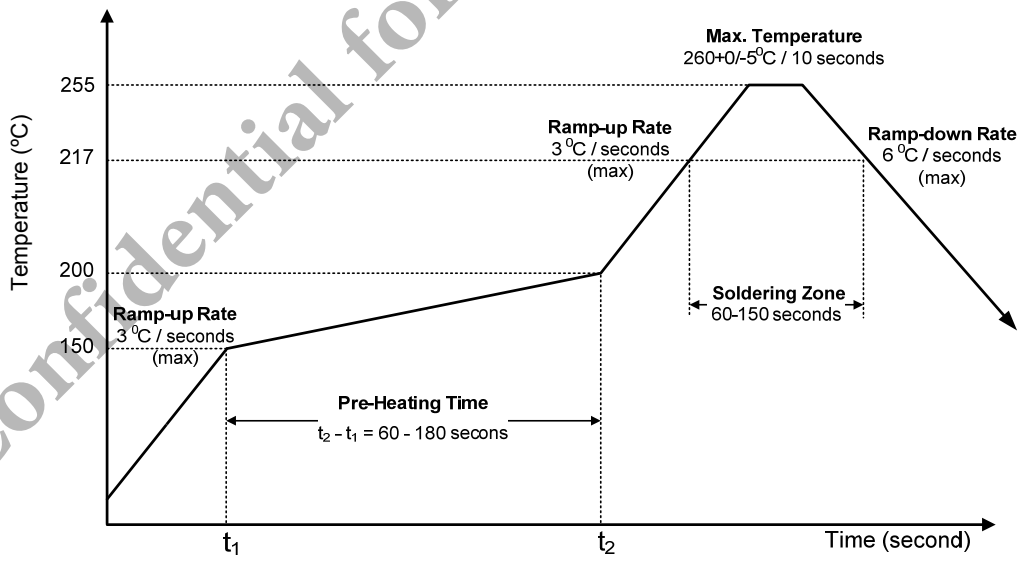


Figure 12. CM3218 Solder Reflow Profile Chart

Recommended Iron Tip Soldering Condition and Warning Handling

1 Solder the device with the following conditions:

1.1 Soldering temperature: 400 ℃ (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 ℃ (Max.);

4.3 Time: 3 minutes (Min.)

Packing Information

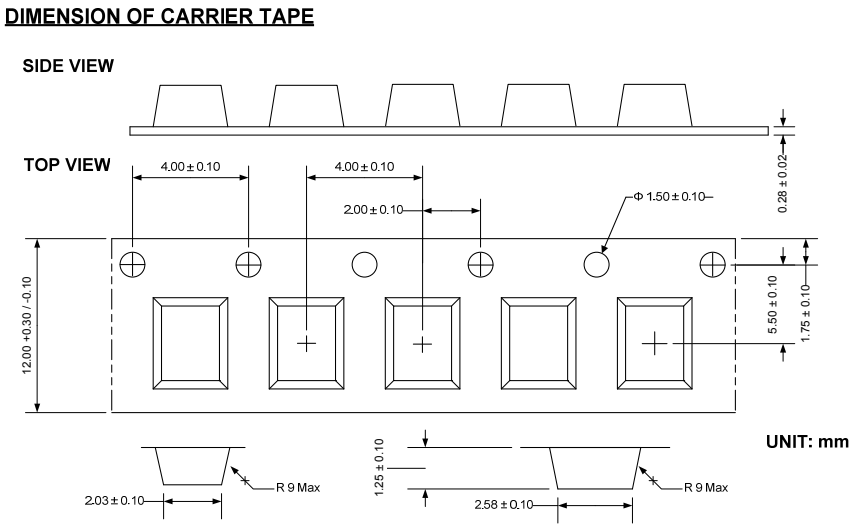


Figure 13. CM3218 A3OP Package Carrier Tape

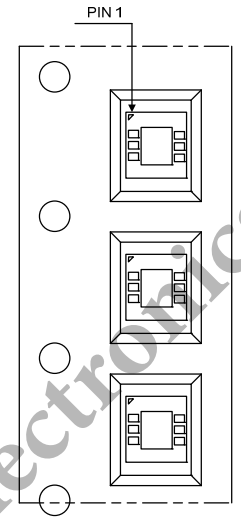


Figure 14. Taping Direction

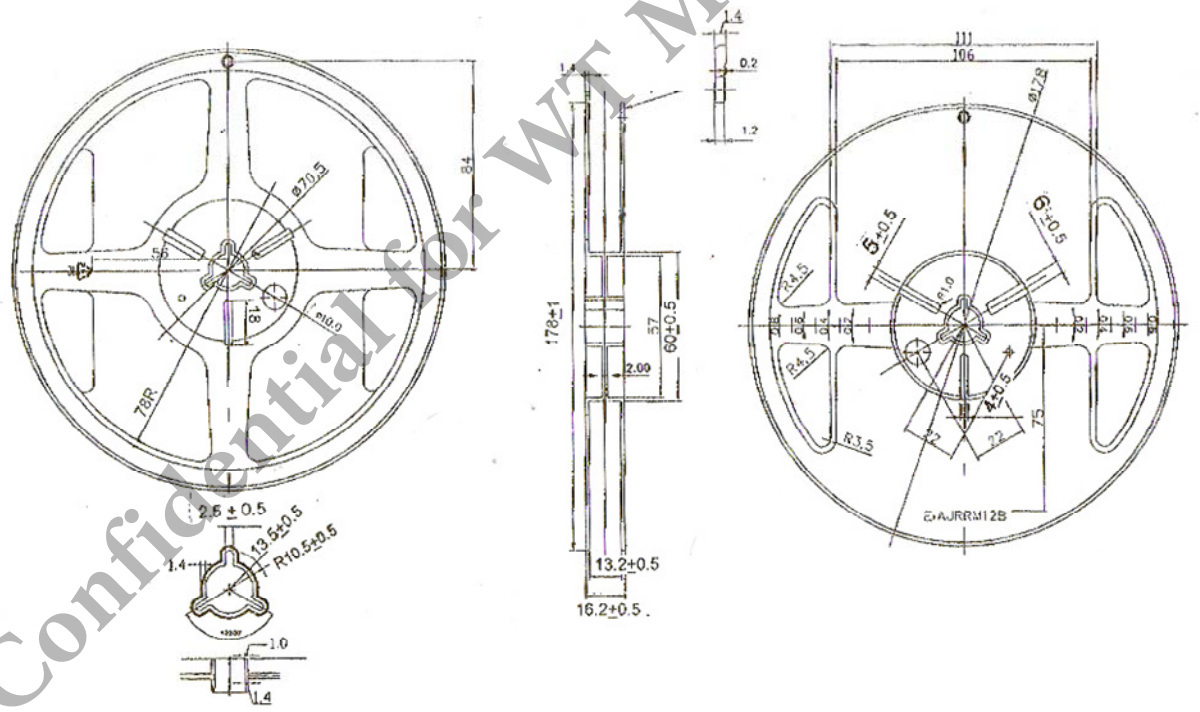


Figure 15. Reel Dimension