



**Optical Sensor**  
**Product Data Sheet**  
LTR-311ALS-02

Spec No. :DS86-2023-0022  
Effective Date: 11/17/2023  
Revision: A

**LITE-ON DCC**

**RELEASE**

**BNS-OD-FC001/A4**



## Data Sheet

# OPTICAL SENSOR LTR-311ALS-02

### Description

The LTR-311ALS-02 is an integrated low voltage I2C ambient light sensor (ALS) in a single 2.40 x 2.0mm miniature ChipLED lead-free surface mount package.

The ALS provides a linear response over a wide dynamic range, which is well suited to applications under very low or bright ambient brightness.

The sensor CMOS design and factory-set one-time trimming capability ensure minimal sensor-to-sensor variations for ease of manufacturability to the end customers.

### Application

- Control brightness of display panel in mobile, computing, and consumer devices.

### Features

- I<sup>2</sup>C interface (Standard mode @100kHz or Fast mode @400kHz)
- Ambient Light in ultra-small ChipLED package
- Operating voltage ranges: 1.7V to 3.6V
- Operating temperature ranges: -30 to +85 °C
- Built-in temperature compensation circuit
- Programmable interrupt function for ALS with upper and lower thresholds
- RoHS and Halogen free compliant

### ALS Features

- 16 bits effective resolution
- Wide dynamic range with linear response
- Visible wavelength spectral response
- Automatic rejection for 50Hz/60Hz lighting flicker
- Short/Programmable integration time
- Sensitivity of 0.00012 lux/count [x512Gain, 100ms integration time, 3.0V, WLED]

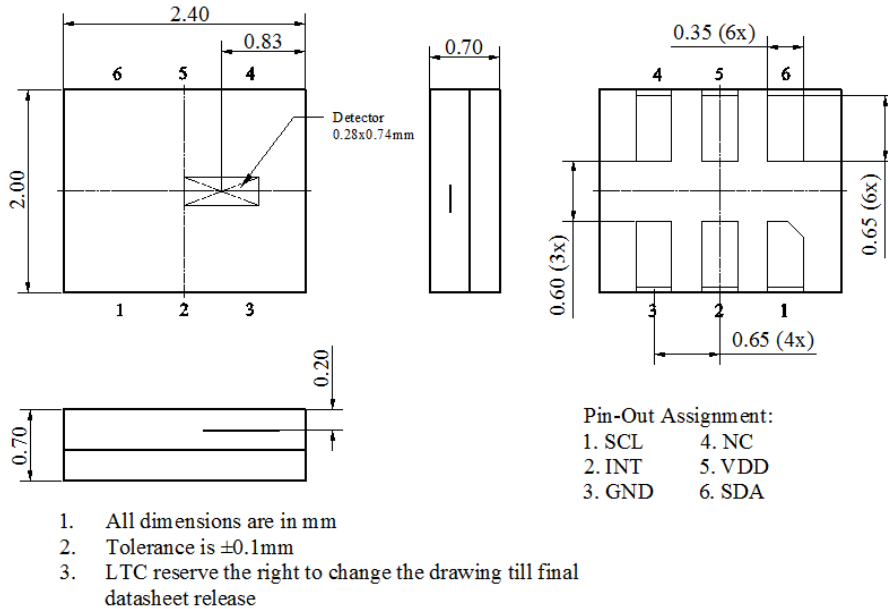
### Ordering Information

Part Number	Packaging Type	Package	Quantity
LTR-311ALS-02	Tape and Reel	6-pin ChipLED package	2500pcs

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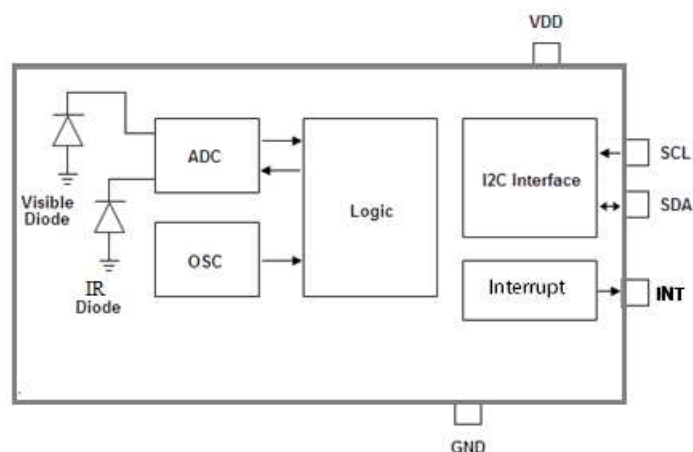
## OPTICAL SENSOR LTR-311ALS-02

### 1. Outline Dimensions and Pins Configuration



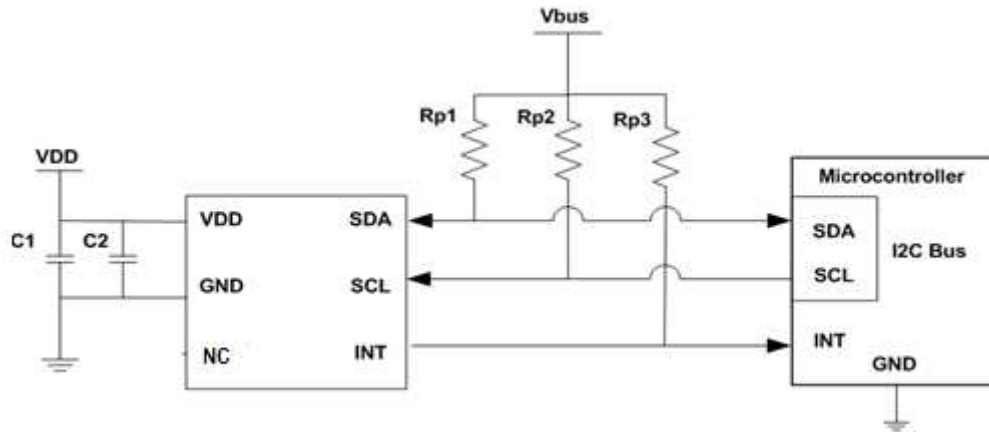
### 2. Functional Block Diagram

The LTR-311ALS-02 contains a photodiodes for ALS and IR measurement. The photodiode currents are converted to digital values by ADCs. The sensor also includes some peripheral circuits such as an internal oscillator, a current source, voltage reference, and internal fuses to store trimming information.



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### 3. Application Circuit



I/O Pins Configuration Table

Pin	I/O Type	Symbol	Description
1	I	SCL	I <sup>2</sup> C serial clock
2	OUT	INT	Interrupt Pin
3	GND	GND	Ground
4	NC	NC	No connection to this pin
5	Supply	VDD	Power Supply Voltage
6	I/O	SDA	I <sup>2</sup> C serial data

#### Recommended Application Circuit Components

Component	Recommended Value
Rp1, Rp2, Rp3 [1]	1 kΩ to 10 kΩ
C1	0.1uF
C2	1.0uF

[1] Selection of pull-up resistors value is dependent on bus capacitance values. For more details, please refer to I<sup>2</sup>C Specifications: [http://www.nxp.com/documents/user\\_manual/UM10204.pdf](http://www.nxp.com/documents/user_manual/UM10204.pdf)



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## 4. Ratings and Specifications

Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$ 

Parameter	Symbol	Min.	Max	Unit
Supply Voltage	VDD		4.5	V
Digital Voltage Range	SCL, SDA, INT	-0.5	4.5	V
Storage Temperature	$T_{stg}$	-40	100	$^\circ\text{C}$
Electrostatic Discharge Protection (Human Body Model JESD22-A114)	$V_{HBM}$		2000	V

Note: Exceeding these ratings could cause damage to the sensor. All voltages are with respect to ground. Currents are positive into, negative out of the specified terminal.

## Recommended Operating Conditions

Description	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	1.7		3.6	V
Interface signal input high	$V_{I2Chigh}$	1.5		VDD	V
Interface signal input low	$V_{I2Clow}$	0		0.4	V
Operating Temperature	$T_{ope}$	-30		85	$^\circ\text{C}$

## Electrical &amp; Optical Specifications

All specifications are at  $V_{DD} = 1.8\text{V}$ ,  $T_{ope} = 25^\circ\text{C}$ , unless otherwise noted.

Parameter	Min.	Typ.	Max.	Unit	Condition
ALS Active Supply Current		266		$\mu\text{A}$	50ms INT, 50ms MRR @ 3.0V
Standby Current			5	$\mu\text{A}$	Shutdown Mode
Wakeup Time from Standby		5	10	ms	From Standby to Active mode where measurement can start



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## OPTICAL SENSOR LTR-311ALS-02

### Characteristics Ambient Light/Color Sensor

All specifications are at VDD = 3V, T<sub>opc</sub> = 25°C, unless otherwise noted.

Parameter	Min.	Typ.	Max.	Unit	Condition
ALS Resolution			16	Bit	Integration time > 50ms
ALS Lux accuracy		10		%	WLED, 500lux, 5414K CCT
Dark Level Count		2		Count	0 Lux, 16-bit resolution
Integration time	10		200	ms	
Measurement Rate			400	ms	0.78ms scale, 256 steps
50/60 Hz flicker noise error	-5		5	%	Multiple of 50ms



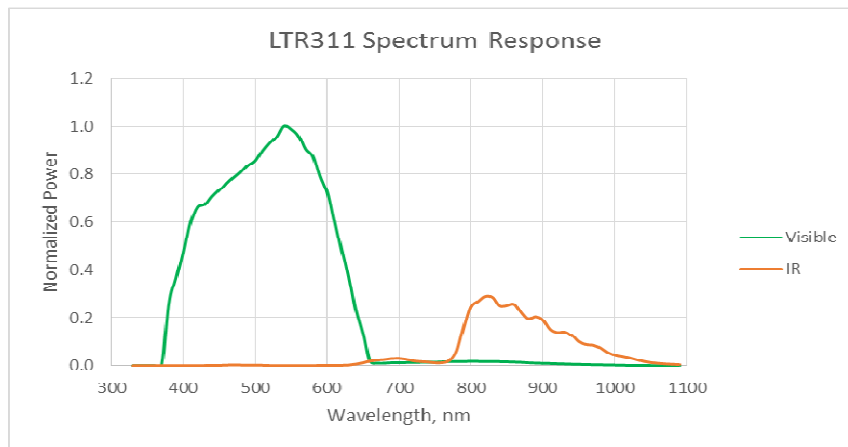
# Data Sheet

## OPTICAL SENSOR LTR-311ALS-02

### Typical Device Parameter

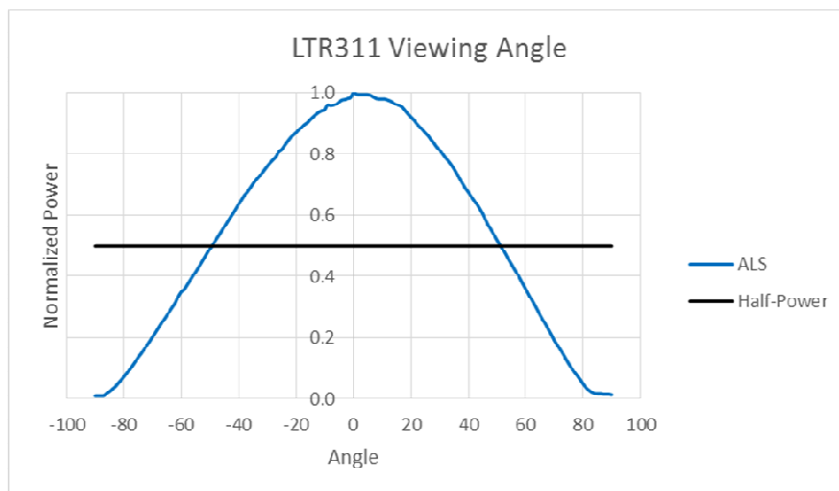
(VDD = 1.8V, Ta=25°C, Default power-up settings, un less otherwise noted)

#### ALS Spectral Response



Spectral Response of ALS

#### Angular of Incidence



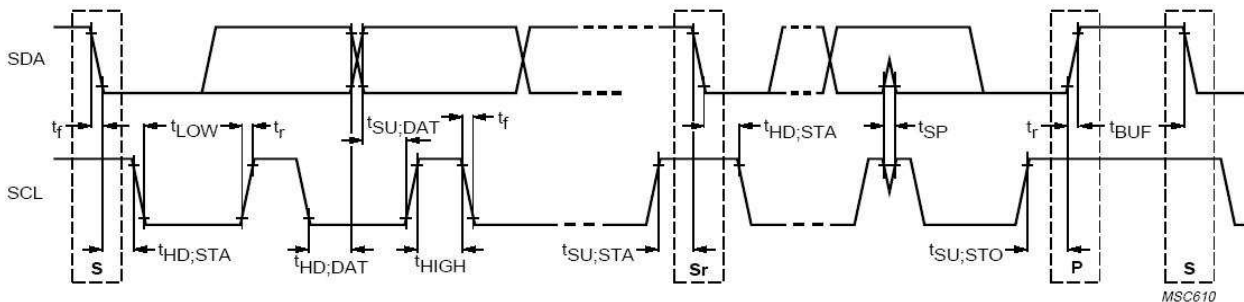
ALS Sensitivity vs. Angular of Incidence

## OPTICAL SENSOR LTR-311ALS-02

### AC Electrical Characteristics

All specifications are at VBus = 1.7V, T<sub>ope</sub> = 25°C, unless otherwise noted.

Parameter	Symbol	Standard mode		Fast mode		Unit
		Min.	Max.	Min.	Max.	
SCL clock frequency	$f_{SCL}$	100		400		kHz
Bus free time between a STOP and START condition	$t_{BUF}$	4.7	-	1.3	-	us
Hold time (repeated) START condition. After this period, the first clock pulse is generated	$t_{HD;STA}$	4.0	-	0.6	-	us
LOW period of the SCL clock	$t_{LOW}$	4.7	-	1.3	-	us
HIGH period of the SCL clock	$t_{HIGH}$	4.0	-	0.6	-	us
Set-up time for a repeated START condition	$t_{SU;STA}$	4.7	-	0.6	-	us
Set-up time for STOP condition	$t_{SU;STO}$	4.0	-	0.6	-	us
Rise time of both SDA and SCL signals	$t_r$	-	1000	-	300	ns
Fall time of both SDA and SCL signals	$t_f$	-	300	-	300	ns
Data hold time	$t_{HD;DAT}$	0	-	0	-	us
Data setup time	$t_{SU;DAT}$	250	-	100	-	ns







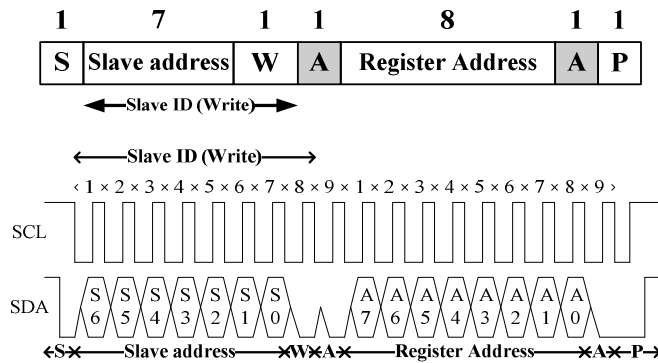
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Definition of timing for I<sup>2</sup>C bus

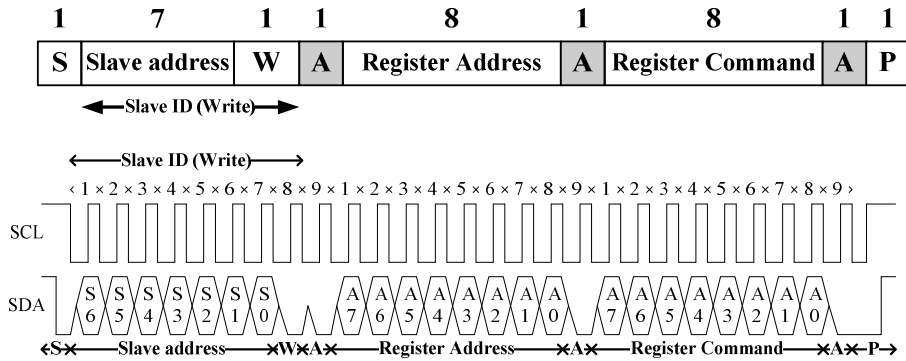
**7 Principles of Operation**

**I<sup>2</sup>C Protocols**

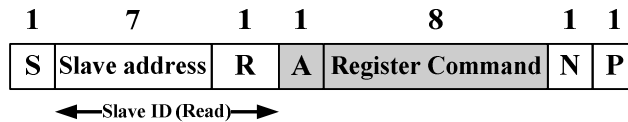
• I<sup>2</sup>C Write Protocol (type 1):



• I<sup>2</sup>C Write Protocol (type 2):



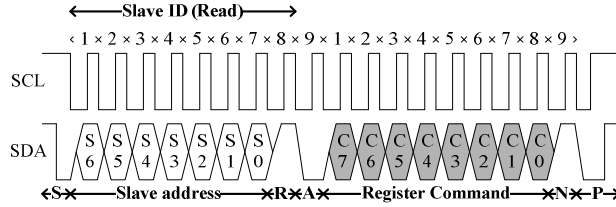
• I<sup>2</sup>C Read Protocol:



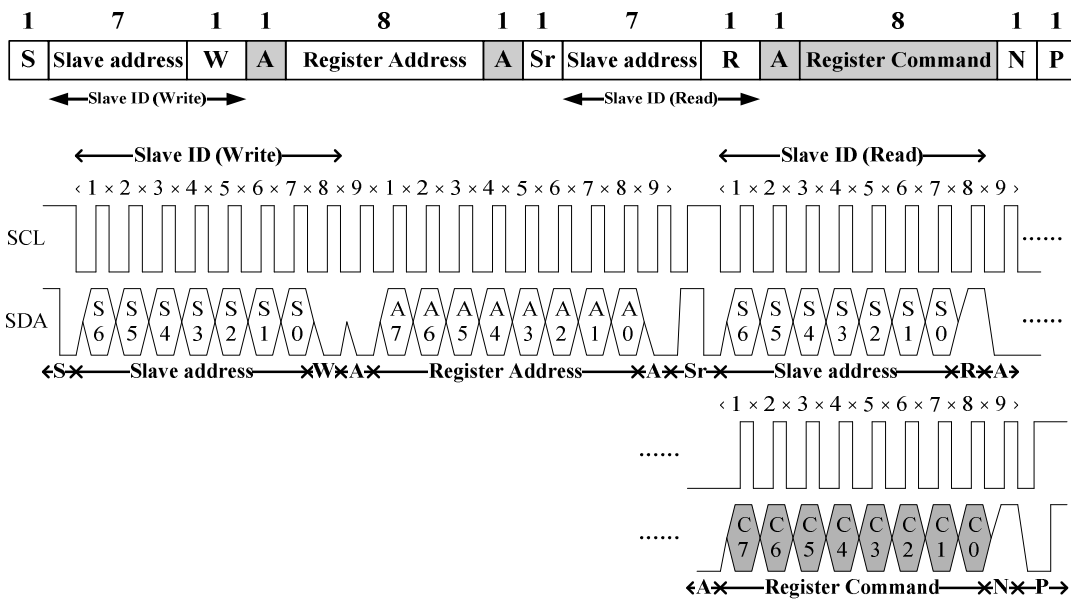


# Data Sheet

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**I<sup>2</sup>C Read (Combined format) Protocol:**



- A** Acknowledge (0 for an ACK)
- S** Start condition
- P** Stop condition
- W** Write (0 for writing)
- Slave-to-master
- N** Non-Acknowledge(1 for an NACK)
- Sr** Repeated Start condition
- R** Read (1 for read)
- Master-to-Slave

### I<sup>2</sup>C Slave Address

The 7 bits slave address for this sensor is 0x22H. A read/write bit should be appended to the slave address by the master device to properly communicate with the sensor.

I <sup>2</sup> C Slave Address		
Command	(0x22H)	(0x22H)



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Type								(0x22H)	
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
Write	0	1	0	0	0	1	0	0	0x44H
Read	0	1	0	0	0	1	0	1	0x45H

## 8 Register Set

Address	R / W	Register Name	Description	Reset Value
0x7F	RW	ALS_Averaging	ALS averaging control	0x07
0x80	RW	ALS_CONTR	ALS operation mode control	0x00
0x81	RW	RESET	IC Reset control	0x00
0x85	RW	ALS_TIME_SCALE	ALS integration time and measurement rate time scale	0x02
0x86	RW	ALS_INT_TIME_STEPS	ALS integration time steps	0x3F
0x87	RW	ALS_MRR_STEPS	ALS measurement rate time steps	0xFF
0x88	R	ALS_STATUS	ALS Status	0x00
0x8B	R	ALS_DATA_LSB	ALS measurement ALS data, LSB	0x00
0x8C	R	ALS_DATA_MSB	ALS measurement ALS data, MSB	0x00
0x8D	R	ALS_IR_DATA_LSB	ALS measurement IR data, LSB	0x00
0x8E	R	ALS_IR_DATA_MSB	ALS measurement IR data, MSB	0x00
0x95	RW	IR_ENABLE	Enable IR Channel	0x28
0xA0	RW	INTERRUPT	Interrupt settings	0x00
0xA1	RW	INTERRUPT_PERSIST	Interrupt persist setting	0x00
0xAA	RW	ALS_THRES_HIGH_LSB	ALS interrupt upper threshold, LSB	0xFF
0xAB	RW	ALS_THRES_HIGH_MSB	ALS interrupt upper threshold, MSB	0xFF
0xAC	RW	ALS_THRES_LOW_LSB	ALS interrupt lower threshold, LSB	0x00
0xAD	RW	ALS_THRES_LOW_MSB	ALS interrupt lower threshold, MSB	0x00
0xAE	R	PART_ID	Part ID	0x90
0xAF	R	MANUFAC_ID	Manufacture ID	0x06
0xB4	RW	INTERNAL_CONTR1	Internal IC Setting	0x60
0xBC	RW	INTERNAL_CONTR2	Internal IC Setting for ALS offset scaling	0x00
0xBE	RW	ALS_CONFIG1	Configuration 1	0x00



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0xC1	RW	ALS_CONFIG2	Configuration 2	0x00
0xC2	RW	ALS_CONFIG3	Configuration 3	0x00
0xC5	R	IR_OS_LASER_CODE	IR Offset Laser trim code readout	0x00
0xC7	R	ALS_OS_LASER_CODE	ALS Offset Laser trim code readout	0x00
0xD5	R	ALS_OS_EFUSE_CODE	ALS Offset Efuse trim code readout	0x00
0xD7	R	IR_OS_EFUSE_CODE	IR Offset Efuse trim code readout	0x00
0xE6	R	ALS_SIGN_READ Register	ALS & IR Channel count sign bit	0x00

### ALS\_AVERAGING (0x7F) (Read/Write)

The ALS\_AVERAGING register control the averaging intensity for ALS channels.

0x7F	ALS_AVERAGING (default = 0x07)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>ALS Averaging Factor</i>							

Field	Bits	Default	Description
<i>ALS Averaging Factor</i>	7:0	00000111	Higher factor give lesser averaging intensity. Writing 0 into this register will turn off the averaging function.



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### ALS\_CONTR Register (0x80) (Read/Write)

The ALS\_CONTR register controls the ALS operation modes for the sensor. The ALS sensor can be set to either standby mode or active mode. At either of these modes, the I2C circuitry is always active. The default mode after power up is standby mode. During standby mode, there is no ALS measurement performed but I2C communication is allowed to enable read/write to all the registers.

0x80	ALS_CONTR (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>		<i>ALS_Gain</i>				<i>Reserved</i>	<i>ALS Mode</i>

Field	Bits	Default	Description	
Reserved	7:6	00	Must Write 01	
ALS_GAIN	5:2	0000	0000	Gain 1X ( <b>default</b> )
			0001	Gain 2X
			0010	Gain 4X
			0011	Gain 8X
			0100	Gain 16X
			0101	Gain 32X
			0110	Gain 64X
			0111	Gain 128X
			1000	Gain 256X
			1001	Gain 512X
Reserved	1	0	Must Write 0 ( <b>default</b> )	
ALS MODE	0	0	0	Stand-by mode ( <b>default</b> )
			1	Active continuous mode



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### RESET Register (0x81) (Read/Write)

The RESET register controls the software reset.

0x81	RESET (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved							Reset

Field	Bits	Default	Description	
Reserved	7:1	0	Must write as 0000000	
SW RST	0	0	0	No Action <b>(default)</b>
			1	Reset registers to default values, with sensor into standby mode.

### ALS\_TIME\_SCALE Register (0x85) (Read/Write)

The ALS\_TIME\_SCALE register controls the scale of integration time and timing of the periodic measurement of the ALS in active mode. Register 0x86 & 0x87 setting will be based on scale setting in register 0x85.

0x85	ALS_TIME_SCALE (default = 0x02)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				ALS Integration Time Scale		ALS MRR Scale	

Field	Bits	Default	Description	
Reserved	7:4	000	Must write 1110	
ALS Integration	3:2	01	00	0.78ms per steps <b>(default)</b>

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Time Scale			01	0.39ms per steps
			1x	0.2ms per steps
ALS Measurement Rate Scale	1:0	10	00	0.2ms per steps
			01	0.39ms per steps
			10	0.78ms per steps ( <b>default</b> )
			11	1.56ms per steps

### ALS\_INT\_TIME\_STEP Register (0x86) (Read/Write)

The ALS\_INT\_TIME\_STEP register controls the integration time of the ALS in active mode. E.g. 100ms integration time = 0.78ms per steps \* 64 steps. Setting 0 in this register is equivalent to 1 step.

0x86	ALS_INT_TIME_STEP (default = 0x3F)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Integration Time Steps</i>							

Field	Bits	Default	Description
Integration Time Steps	7:0	00111111	Specifies ALS integration time number of steps. Refer 0x85 bit [3:2] for integration time scale per steps.

### ALS\_MEAS\_RATE\_STEP Register (0x87) (Read/Write)

The ALS\_MEAS\_RATE\_STEP register controls the integration time of the ALS in active mode. E.g. 200ms Measurement Rate = 0.78ms per steps \* 256 steps. Setting 0 in this register is equivalent to 1 step.

0x87	ALS_MEAS_RATE_STEP (default = 0xFF)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Integration Time Steps</i>							

Field	Bits	Default	Description
Integration Time Steps	7:0	11111111	Specifies ALS measurement rate number of steps. Refer 0x85 bit [1:0] for measurement rate scale per steps.

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### ALS\_STATUS Register (0x88) (Read Only)

The ALS\_STATUS register stores information about ALS data status. New data means data has not been read before. Every time measurement is done and data is written to the data register, data status bit will be set to logic 1. Every time the data register is read, data status bit should be set to logic 0.

0x88	ALS_STATUS (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	IR Data Valid	ALS Data Valid	ALS_Gain				ALS Interrupt Status	ALS Data Status

Field	Bits	Default	Description	
Reserved	7	0	Reserved	
ALS Data Valid	6	0	0	ALS Data is Valid ( <b>default</b> )
			1	ALS Data is Invalid
ALS Data Gain Range	5:2	0000	0000	Gain 1X ( <b>default</b> )
			0001	Gain 2X
			0010	Gain 4X
			0011	Gain 8X
			0100	Gain 16x
			0101	Gain 32x
			0110	Gain 64x
			0111	Gain 128x
			1000	Gain 256x
			1001	Gain 512x
ALS Interrupt Status	1	0	0	Interrupt signal inactive ( <b>default</b> )





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			1	Interrupt active
ALS data status	0	0	0	OLD data (data already read) <b>(default)</b>
			1	NEW data (first time data is read)

### ALS\_DATA Register (0x8B,0x8C) (Read Only)

ALS measurement results are stored in ALS\_DATA registers. Data read until register 0x8E is required when IR channel is enabled. IR channel is on by default and can be disabled by setting 0 to register 0x95<bit3>.

Field	Bits	Default	Description
ALS_DATA_LSB	0x8B	0	ALS low byte data, bit 0 is LSB of the 16-bit data
ALS_DATA_MSB	0x8C	0	ALS high byte data, bit 7 is MSB of the 16-bit data

### ALS\_IR\_DATA Register (0x8D,0x8E) (Read Only)

IR measurement results are stored in ALS\_IR\_DATA registers.

Field	Bits	Default	Description
IR_LSB	0x8D	0	IR low byte data, bit 0 is LSB of the 16-bit data
IR_MSB	0x8E	0	IR high byte data, bit 7 is MSB of the 16-bit data

### IR\_ENABLE Register (0x95) (Read/Write)

The IR\_ENABLE register select IR channel to be active individually.

0x95	IR_ENABLE (default = 0x28)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				IR Enable	Reserved		



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Field	Bits	Default	Description	
Reserved	7:4	00	Must write as 0000	
IR Enable	3	0	0	Disabled
			1	Enabled ( <b>default</b> )
Reserved	2:0	000	Must Write as 000	

**INTERRUPT Register (0xA0) (Read/Write)**

INTERRUPT register controls the operation of the interrupt pin and functions. The ALS\_STATUS register is updated even if interrupt pin is INACTIVE / high-impedance state.

0xA0	INTERRUPT (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved			Interrupt Polarity	Interrupt Mode	Reserved		

Field	Bits	Default	Description	
Reserved	7:4	0000	Must write as 0000	
Interrupt Polarity	3	0	0	INT pin is active low ( <b>default</b> )
			1	INT pin is active high
Interrupt Mode	2	0	0	Interrupt pin is INACTIVE / high impedance state ( <b>default</b> )
			1	ALS measurement can trigger interrupt
Reserved	1:0	00	Must write as 00	

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### INTERRUPT PERSIST Register (0xA1) (Read/Write)

INTERRUPT PERSIST register sets the N number of times the measurement is out of the threshold range settings before asserting the INTERRUPT pin.

0xA1	INTERRUPT PERSIST (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				ALS_PERSIST			

Field	Bits	Default	Description	
Reserved	7:4	0000	Must write 0000	
ALS_PERSIST	3:0	0000	0	Every ALS value out of threshold range (default)
			1	1 consecutive ALS values out of threshold range
			.....	.....
			1111	15 consecutive ALS values out of threshold range

### ALS\_THRESHOLD Register (0xAA -0xAD) (Read/Write)

ALS\_THRESHOLD\_HIGH register is used to set the upper limit of the absolute interrupt threshold value. Interrupt functions compare the value in the ALS\_THRESHOLD\_HIGH registers to measured data value in ALS\_DATA registers.

Field	Bits	Default	Description	
ATH_HIGH LSB	0xAA	11111111	--	ALS upper interrupt threshold value, LSB
ATH_HIGH MSB	0xAB	11111111	--	ALS upper interrupt threshold value, MSB
ATH_LOW LSB	0xAC	00000000	--	ALS lower interrupt threshold value, LSB
ATH_LOW MSB	0xAD	00000000	--	ALS lower interrupt threshold value, MSB

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### PART\_ID Register (0xAE) (Read Only)

The PART\_ID register defines the part number and revision identification of the sensor.

0xAE	PART_ID (default = 0x90)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Part Number ID				Revision ID			

### MANUFAC\_ID Register (0xAF) (Read Only)

The MANUFAC\_ID register defines the manufacturer identification of the sensor.

0xAF	MANUFAC_ID (default = 0x05)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Manufacturer ID							

### INTERNAL\_CTR1 Register (0xB4) (Read/Write)

The INTERNAL\_CTR1 Register controls the test mode for IC. Write 1 to bit 4 to enable negative ALS count reading.

Upon enabled, sign bit of ALS count can be found in 0xE6 Bit<4>.

0xB4	INTERNAL_CTR1 (default = 0x60)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved		ALS Negative Reading		Reserved			

Field	Bits	Default	Description
Reserved	7:5	0000	Must write as 0000



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<i>ALS Negative Reading</i>	4	0	0	Disable ( <b>default</b> )
			1	Enable
Reserved	3:0	00	Must write as 00	

### INTERNAL\_CTR2 Register (0xBC) (Read/Write)

The INTERNAL\_CTR2 Register controls the offset scaling trimming function. Enable Bit<6> or Bit<5> will make the offset trim value scale according to integration time.

0xBC	INTERNAL_CTR2 (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>	<i>Dark Int Scale</i>	<i>CH Int Scale</i>	<i>Reserved</i>				

Field	Bits	Default	Description	
Reserved	7	0	Must write as 0	
<i>Dark Int Scale</i>	6	0	0	Dark Diode Offset not scale to Integration Time ( <b>default</b> )
			1	Dark Diode Offset scale to Integration Time
<i>CH Int Scale</i>	5	00	0	ALS/IR Diode Offset not scale to Integration Time ( <b>default</b> )
			1	ALS/IR Diode Offset scale to Integration Time
Reserved	4:0	00000	Must write as 00000	

### ALS\_CONFIG1 Register (0xBE) (Read/Write)

The ALS\_CONFIG1 register must write as 01100000.

0xBE	ALS_CONFIG1 (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>							

Field	Bits	Default	Description
Reserved	7:0	0000000	Must write as 01100000



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### ALS\_CONFIG2 (0xC1) (Read/Write)

The ALS\_CONFIG2 register control the IC calibrated ALS & IR Offset, must write as 01000000. IC calibration will use offset step of 15.

0xC1	ALS_CONFIG2 (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>							

Field	Bits	Default	Description
Reserved	7:0	0000000	Must write as 01000000

### ALS\_CONFIG3 (0xC2) (Read/Write)

The ALS\_CONFIG3 register control the factory calibrated ALS & IR Offset, must write as 00000000. factory calibration will use offset step of 5.

0xC2	ALS_CONFIG3 (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>							

Field	Bits	Default	Description
Reserved	7:0	0000000	Must write as 00000000

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### IR\_OS\_LASER\_CODE (0xC5) (Read/Write)

The IR\_OS\_LASER\_CODE register store the IR Offset Laser Trim Code.

0xC5	IR_OS_LASER_CODE (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved			IR Offset Laser Code				

Field	Bits	Default	Description
Reserved	7:5	000	Reserved
IR Offset Laser Code	4:0	00000	IC Calibrated IR Offset Laser Trim Code

### ALS\_OS\_LASER\_CODE (0xC7) (Read/Write)

The ALS\_OS\_LASER\_CODE register store the ALS Offset Laser Trim Code.

0xC7	ALS_OS_LASER_CODE (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved			ALS Offset Laser Code				

Field	Bits	Default	Description
Reserved	7:5	000	Reserved
ALS Offset Laser Code	4:0	00000	IC Calibrated ALS Offset Laser Trim Code



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### ALS\_OS\_EFUSE\_CODE (0xD5) (Read/Write)

The ALS\_OS\_EFUSE\_CODE register store the ALS Offset Efuse Trim Code from factory calibration.

0xD5	ALS_EFUSE_LASER_CODE (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved			ALS Offset Efuse Code				

Field	Bits	Default	Description
Reserved	7:5	000	Reserved
ALS Offset Efuse Code	4:0	00000	Factory Calibrated ALS Offset Efuse Trim Code

### IR\_OS\_EFUSE\_CODE (0xD7) (Read/Write)

The IR\_OS\_EFUSE\_CODE register store the IR Offset Efuse Trim Code from factory calibration.

0xD7	IR_EFUSE_LASER_CODE (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved			IR Offset Efuse Code				

Field	Bits	Default	Description
Reserved	7:5	000	Reserved
IR Offset Efuse Code	4:0	00000	Factory Calibrated IR Offset Efuse Trim Code





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### ALS\_SIGN\_READ Register (0xE6) (Read)

The ALS\_SIGN\_READ Register read out the sign bit for ambient light channel. To enable negative sign bit readout, register 0xB4 Bit<4> must be set to 1.

0xE6	ALS_SIGN_READ (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved			ALS Sign Bit	IR Sign Bit	Reserved		

Field	Bits	Default	Description	
Reserved	7:5	000	Must write as 000	
ALS Sign Bit	4	0	0	Positive ( <b>default</b> )
			1	Negative
IR Sign Bit	3	0	0	Positive ( <b>default</b> )
			1	Negative
Reserved	2:0	000	Must write as 000	



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### 9 Application Information

#### 9.1 Lux Formula

Lux\_Cal is the calculated lux reading based on the output ADC from ALS DATA regardless of light sources.

$$Lux_{Cal} = \frac{[0.0612 * ALS_{Data}] - [0.0068 * IR_{Data} * lightRatio]}{Gain_{Fac} * Int_{Fac}} * W_{Fac}$$

$$LightRatio = \frac{IR_{Data}}{ALS_{Data}}$$

$$Int\ Fac = \frac{INT_{Scale} * (INT_{Steps} + 1)}{100}$$

INT Scale = 0x85 bit<3:2>

INT Steps = 0x86 bit<7:0>

Where :

1. For device under tinted window with coated-ink of flat transmission rate at 400-600nm wavelength, window factor is to compensate light loss due to the lower transmission rate from the coated-ink.
  - a. WFAC = 1 for NO window / clear window glass.
  - b. WFAC >1 device under tinted window glass. Calibrate under white LED.
2. The Gain factors:

ALS Gain	X1	X2	X4	X8	X16	X32	X64	X128	X256	X512
Gain <sub>Fac</sub>	1	2	4	8	16	32	64	128	256	512

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### 9.2 Operating Mode

#### Stand-by Mode

The device is by default in stand-by mode after power-up. No measurement activity done in device. I2C communication is allowed to be able to read/write to the registers. The device can be reset from MCU by setting appropriate register control (SW reset). Start-up sequence is exactly the same as that when power-on reset is triggered.

#### Active Mode

The ALS can be set in active mode (see Fig 1). Measurement data is expected to be available within a known fixed time (refer to measurement time parameter from ALS specification/registers).

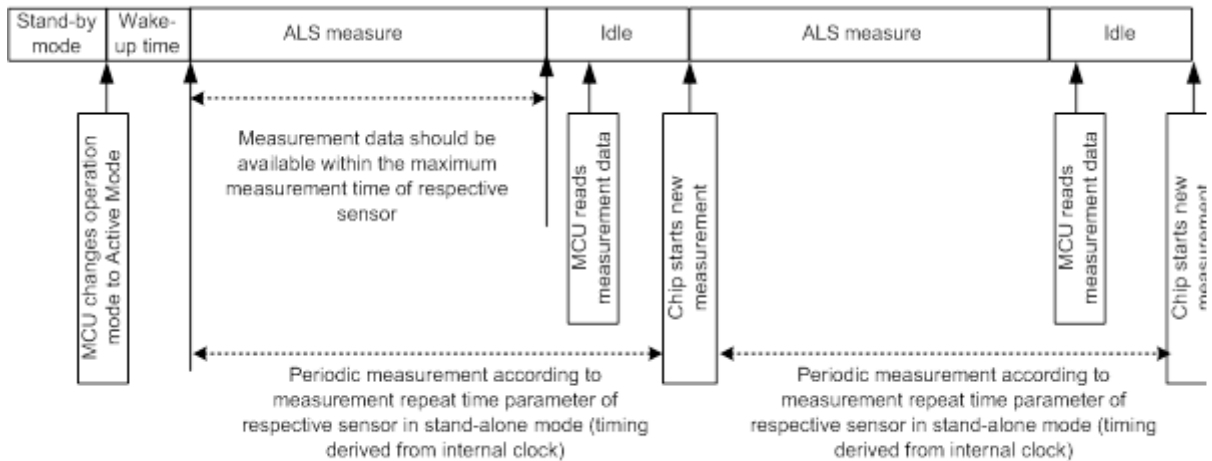
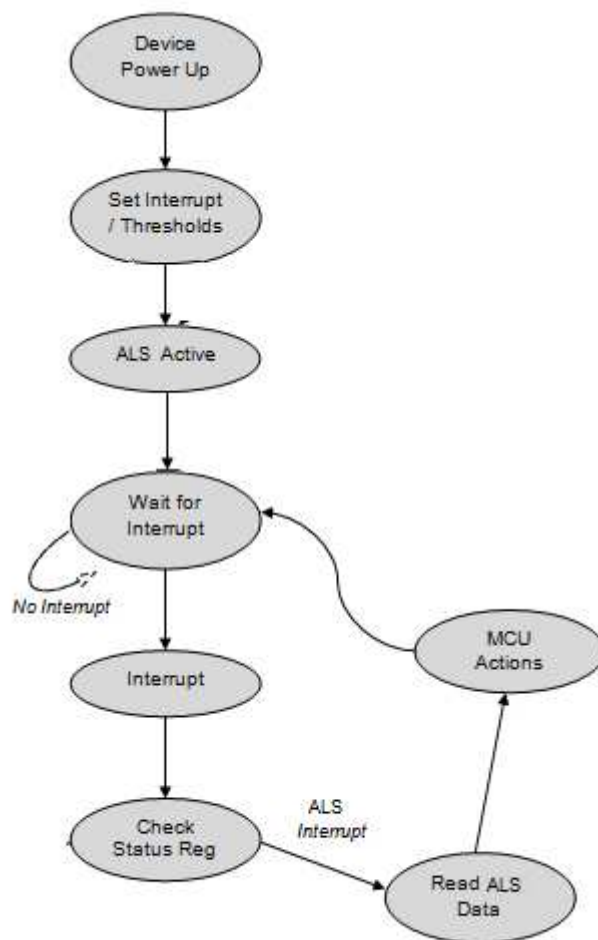


Figure 7.2.1 : ALS measurement sequence

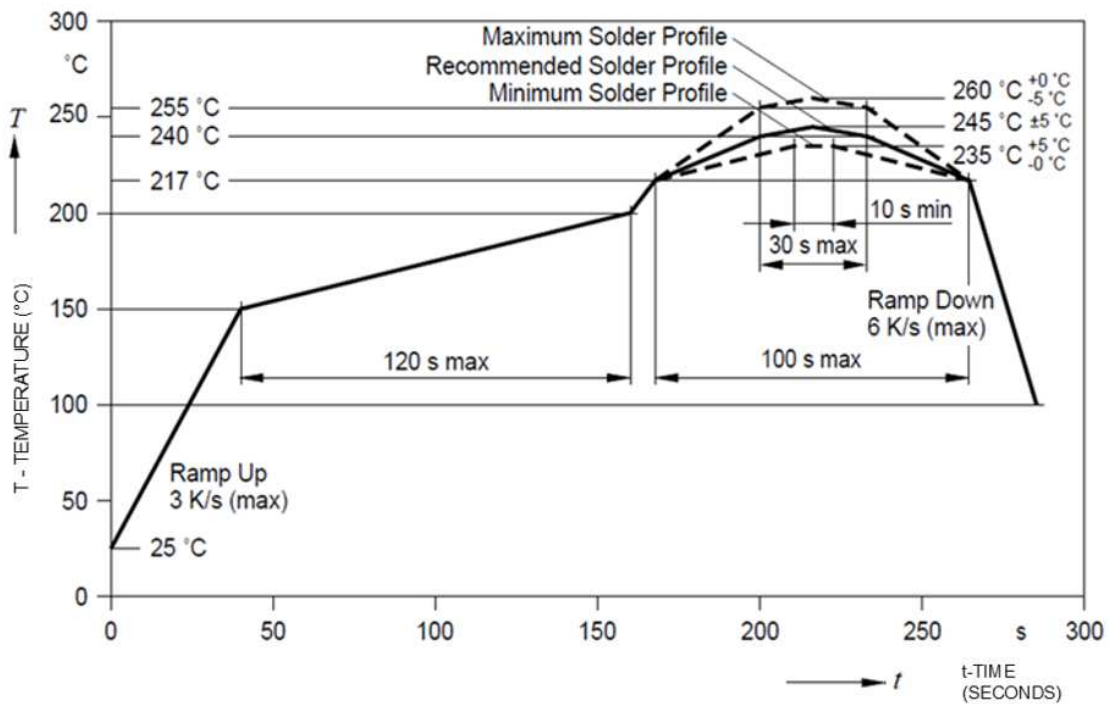
### 9.3 Interrupt Features

Flow diagram below illustrates the operation flow, and involving the use of Thresholds and interrupt.



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### 10 Recommended Leadfree Reflow Profile



Process Zone	$\Delta T$	Maximum $\Delta T/\Delta t$ or Duration
Heat Up	25°C to 150°C	3°C/s
Solder Paste Dry	150°C to 200°C	120s max
Solder Reflow	200°C to 245°C 245°C to 217°C	3°C/s -6°C/s
Cool Down	217°C to 100°C	-6°C/s
Time maintained above liquidus point , 217°C	> 217°C	100s max
Peak Temperature	245°C	±5°C
Time within 5°C of actual Peak Temperature	> 240°C	10 ~ 20s
Time 25°C to Peak Temperature	25°C to 245°C	8mins max

## Notes:

The reflow profile shown in Figure can be a typical range for the customer peak reflow temperature ( $T_p$ ) of 235°C ~ 250°C to be used.



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The peak reflow temperature (Tp) has to be lower than maximum peak reflow temperature (Tp) 260°C shown in Figure. The reflow profile and peak temperature should conform to the solder paste manufacturer recommendation.

It is recommended to perform reflow soldering no more than twice.

### 11 Moisture Proof Packaging

All are shipped in moisture proof package. Once opened, moisture absorption begins. This part is compliant to JEDEC J-STD-033A Level 3.

#### 11.1 Shelf Life

Device has the shelf life of 12 months if stored in an unopened moisture proof package. It is recommended to store in following condition.

- Shelf Life : 12 months
- Ambient Temperature : <40°C
- Relative Humidity: <90%

#### 11.2 Floor Life

After removal from the moisture barrier bag, the parts should be stored at the recommended storage conditions and soldered within seven days.

- Floor Life : 168 hours
- Ambient Temperature : <30°C
- Relative Humidity: <60%

#### 11.3 Rebaking information

When the moisture barrier bag is opened and the parts are exposed to the recommended storage conditions for more than seven days, the parts must be baked before reflow to prevent damage to the parts.

##### Baking Conditions

Package	Temperature	Time
In Reels	60°C	48 hours
In Bulk	100°C	4 hours

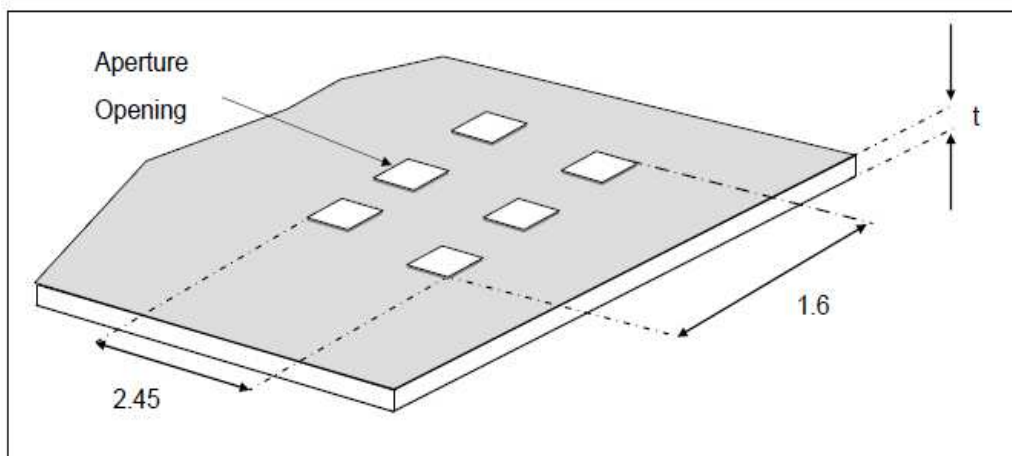
Baking should only be done once.

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### 12 Metal Stencil Aperture

It is recommended that the metal stencil used for solder paste printing has a thickness ( $t$ ) of 0.11mm (0.004 inches / 4 mils) or 0.127mm (0.005 inches / 5 mils).

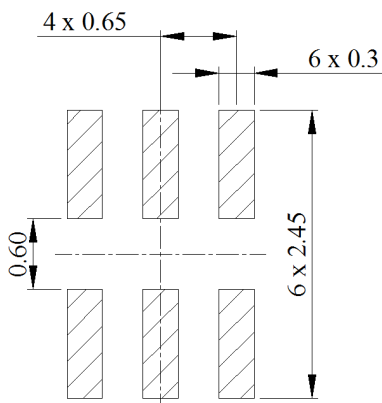
The stencil aperture opening is recommended to be 0.30 x 0.65mm which has the same dimension as the land pattern. This is to ensure adequate printed solder paste volume and yet no shorting.



Note:

1. All dimensions are in millimeters

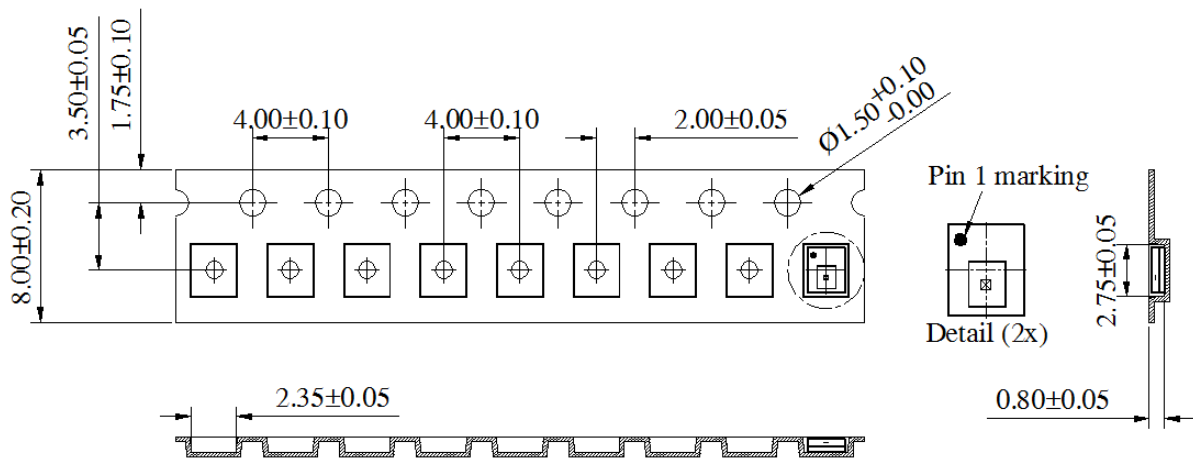
### 13 Recommended Land Pattern



Note: All dimensions are in millimeters

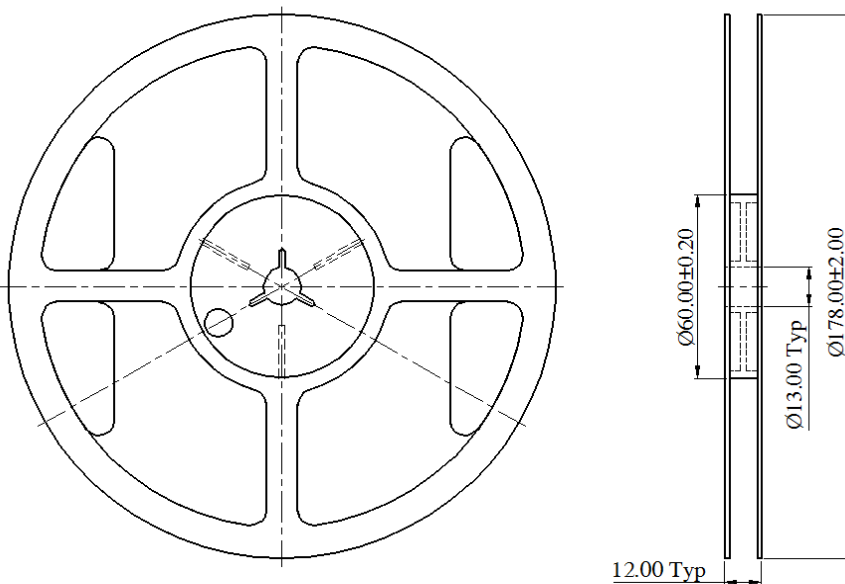
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### 14 Package Dimension for Tape and Reel



Note:

1. All dimensions are in millimeters



Note:

1. All dimensions are in millimeters
2. Empty component pockets sealed with top cover tape
3. 7-inch reel--2500 pieces per reel
4. In accordance with ANSI/EIA481-1-A-1994 specification





## Data Sheet

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### Revision Table:

Version	Update	Page	Date
1.0	Final Datasheet as created	Total 32	02-Feb-2021
1.1	Update Reflow profile	Page 28	07-Nov-2023