

**Optical Sensor**  
**Product Data Sheet**  
LTR-X1503

Spec No. :DS86-2021-0015  
Effective Date: 03/24/2023  
Revision: A

**LITE-ON DCC**

**RELEASE**

**BNS-OD-FC001/A4**

# OPTICAL SENSOR LTR-X1503

## Description

The LTR-X1503 is an integrated low voltage I2C ambient light sensor (ALS), and proximity sensor (PS), with built-in emitter in a single 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. Besides, with built-in proximity sensor, this sensor offers the feature to detect object at a user configurable distance.

The sensor has a PS programmable interrupt with hysteresis to response to events and that removes the need to poll the sensor for a reading which improves system efficiency. This 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
- Object detection in mobile, computing, and consumer devices.

## Ordering Information

Part Number	Packaging Type	Package	Quantity
LTR-X1503	Tape and Reel	8-pin chipled package	3,000pcs

## Features

- I<sup>2</sup>C interface (Standard mode @100kHz or Fast mode @400kHz)
- Ambient Light and Proximity Sensing in one
- ultra-small ChipLED package
- Very low power consumption with sleep mode capability
- Operating voltage ranges: 3.0V to 3.6V
- Operating temperature ranges: -40 to +85 °C
- Built-in temperature compensation circuit
- Programmable interrupt function for PS with upper and lower thresholds
- RoHS and Halogen free compliant

### ALS Features

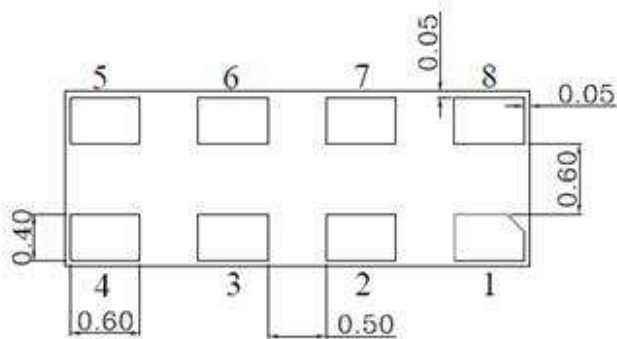
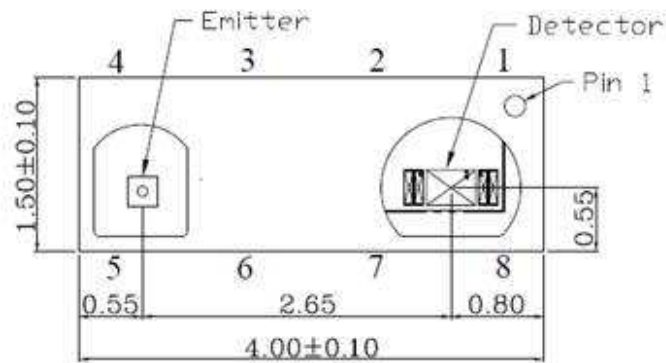
- 16 bits effective resolution
- Wide dynamic range with linear response
- Close to human eye spectral response
- Automatic rejection for 50Hz/60Hz lighting flicker

### PS Features

- Built-in LED driver
- High ambient light suppression
- 16-bit effective resolution
- Cancellation of crosstalk
- Programmable LED drive setting

## OPTICAL SENSOR LTR-X1503

### 1. Outline Dimensions and Pins Configuration



#### *Pin-Out Assignment:*

1. VDD	5. LDR
2. SCL	6. NC
3. GND	7. INT
4. LEDA	8. SDA

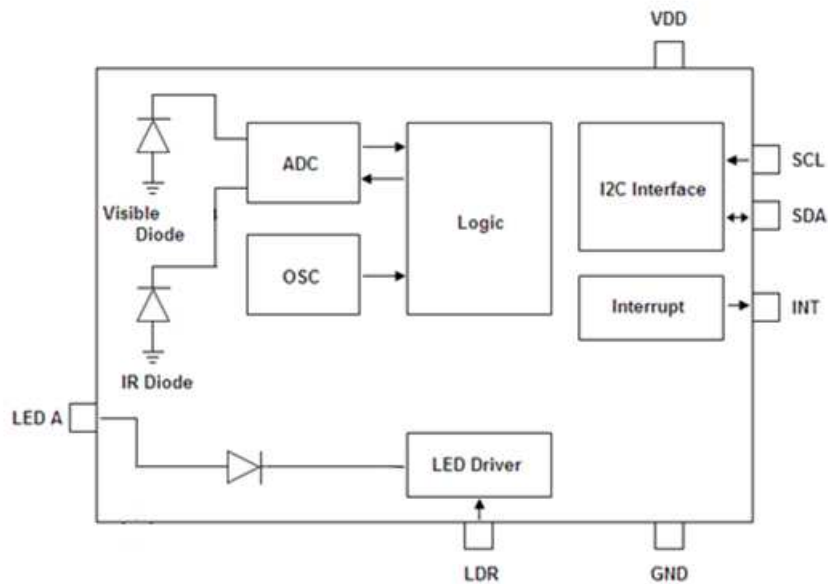
1. All dimensions in mm
2. Tolerances is  $\pm 0.2$  unless specify

Note: All dimension in millimeter

## OPTICAL SENSOR LTR-X1503

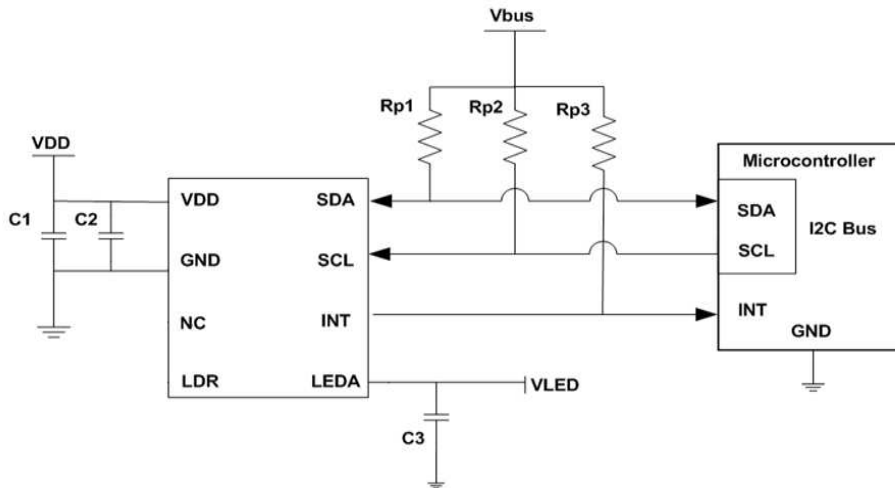
### 2. Functional Block Diagram

The LTR-X1503 contains 2 integrated photodiodes (1 for proximity diode, 1 diode for ambient diode) for respective photocurrent measurement. The photodiode currents are converted to digital values by ADCs. The sensor also included a LED driver, as well as some peripheral circuits such as an internal oscillator, a current course, voltage reference, and internal fuses to store trimming information.



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### 3. Application Circuit



In the powering off sequence, the VLED should be powered off first followed by the VDD.

In the powering on sequence, the VDD should be powered on first followed by the VLED.

#### I/O Pins Configuration Table

Pin	I/O Type	Symbol	Description
1		VDD	Supply Voltage
2	I	SCL	I <sup>2</sup> C serial clock
3		GND	GND
4		LEDA	LED Anode. To connect to LED Supply.
5		LDR	LED driver. Float
6		NC	No Connection on this pin
7	O	INT	Interrupt pin
8	I/O	SDA	I <sup>2</sup> C serial data

#### Recommended Application Circuit Components

Component	Recommended Value
Rp1, Rp2, Rp3 [1]	1 k $\Omega$ to 10 k $\Omega$
C1, C3	1 $\mu$ F $\pm$ 20%, X7R / X5R Ceramic
C2	0.1 $\mu$ F

[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 Ta = 25°C

Parameter	Symbol	Min.	Max	Unit
Supply Voltage	VDD		3.6	V
Digital Voltage Range	SCL, SDA, INT	-0.5	3.6	V
Max LED Voltage Range	V <sub>LED</sub>	-0.5	4.6	V
Max LDR Voltage Range	V <sub>LDR</sub>	-0.5	3.6	V
Storage Temperature	T <sub>stg</sub>	-40	100	°C
Electrostatic Discharge Protection (Human Body Model JESD22-A114)	V <sub>HBM</sub>		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	3.0		3.6	V
LED Supply Voltage	V <sub>LED</sub>	2.8		4.0	V
Interface signal input high	V <sub>I2Chigh</sub>	1.5		VDD	V
Interface signal input low	V <sub>I2Clow</sub>	0		0.4	V
Operating Temperature	T <sub>ope</sub>	-40		85	°C



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## Electrical & Optical Specifications

All specifications are at VDD = 1.8V, T<sub>ope</sub> = 25°C, unless otherwise noted.

Parameter	Min.	Typ.	Max.	Unit	Condition
Supply Current		160		uA	Both ALS and PS Active mode. MRR: ALS 100ms/ PS 100ms
ALS Active Supply Current		160		uA	Full load. MRR : 100ms
PS Active Supply Current		57		uA	MRR 100ms with 8 pulses, 100% duty, 32 us pulse width
Standby Current		1		uA	Shutdown Mode
Wakeup Time from Standby		0.25		ms	From Standby to Active mode where measurement can start

## Characteristics Ambient Light Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
ALS Resolution			16	Bit	Programmable for 13, 14, 15, 16 Bit
ALS Lux accuracy		10		%	White LED
Dark Level Count	0		5	Count	0 Lux, 16-bit resolution, gain 512x, integration time 100ms
Integration time	0.2		200	ms	--
50/60 Hz flicker noise error	-5		+5	%	Multiple of 50ms (Int Time)

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### Characteristics Proximity Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
PS Resolution			16	Bit	
Sensitivity Range		940		nm	
Detection Distance		20		cm	Pulse Number 32, Gain 4x, Current 186mA, Pulse Width 8us, Accumulated Data 8n
LED Pulse Current			186	mA	Configurable
LED Pulse width			64	us	Configurable for 8,16,32, 64 us
Number of LED Pulses	1		256	Pulses	
Ambient light suppression **			10	klux	Direct sunlight

\*\* Above 10 klux, internal fail-safe feature will force PS count to eight to prevent false trigger.

### Typical Device Parameter

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

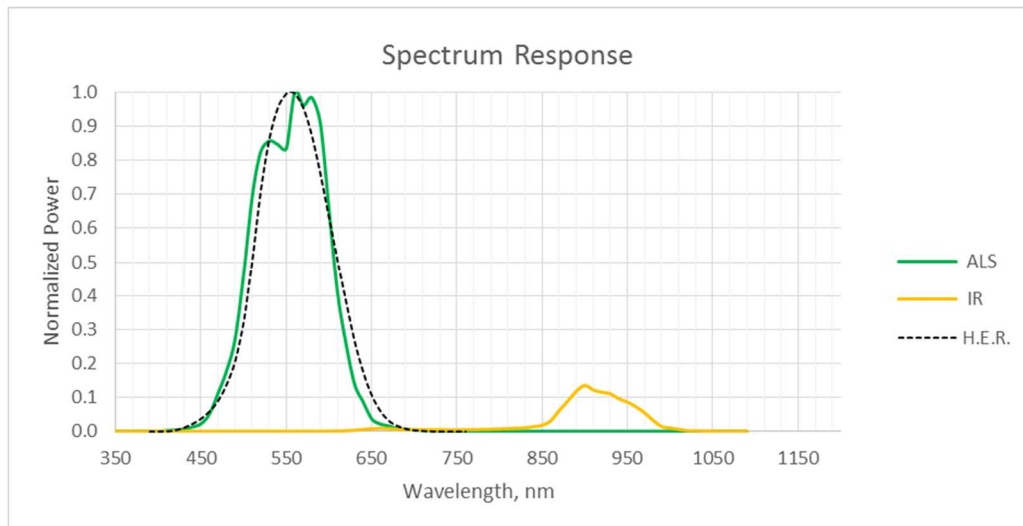


Figure 4.1 : ALS Spectral response



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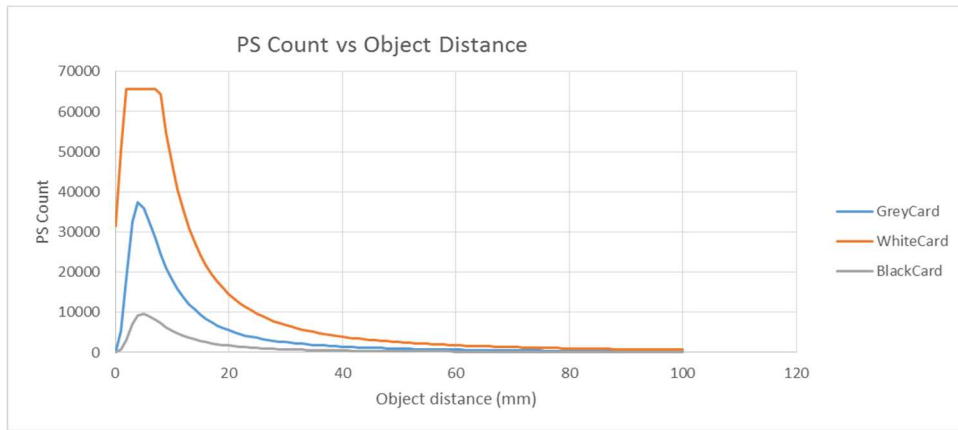


Figure 4.2: PS performance across distance VDD 1.8V, 104mA, 16pulses, with others in default settings.

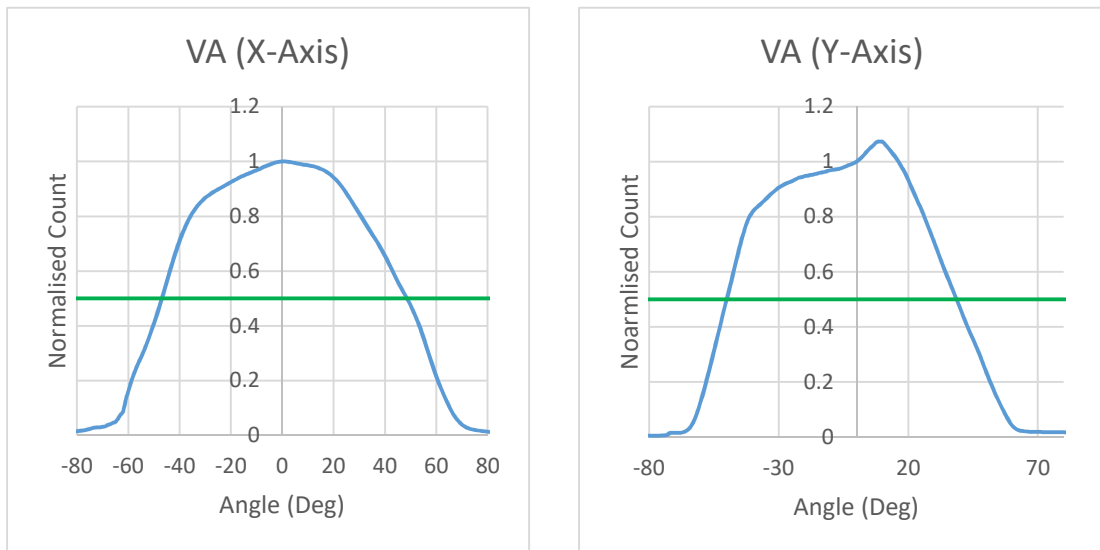


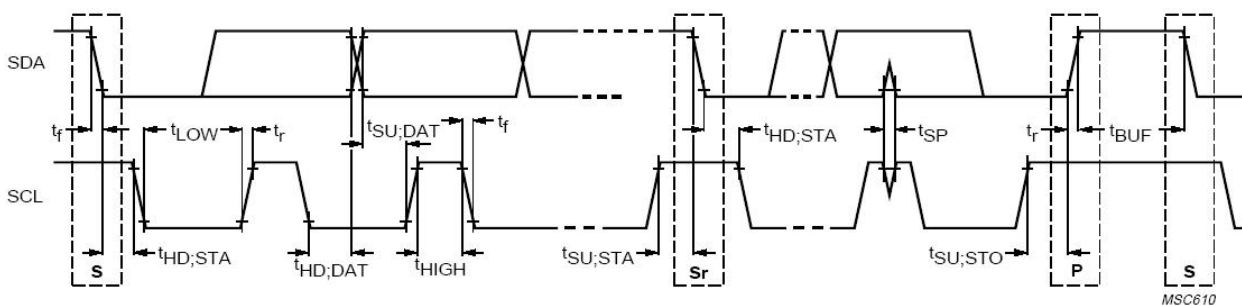
Figure 4.3: ALS viewing angle performance

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## Electrical Characteristics

All specifications are at  $V_{Bus} = 1.7V$ ,  $T_{op} = 25^{\circ}C$ , 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

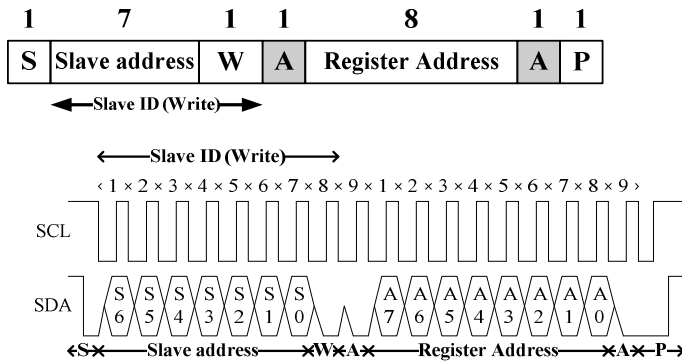


### Definition of timing for I<sup>2</sup>C bus

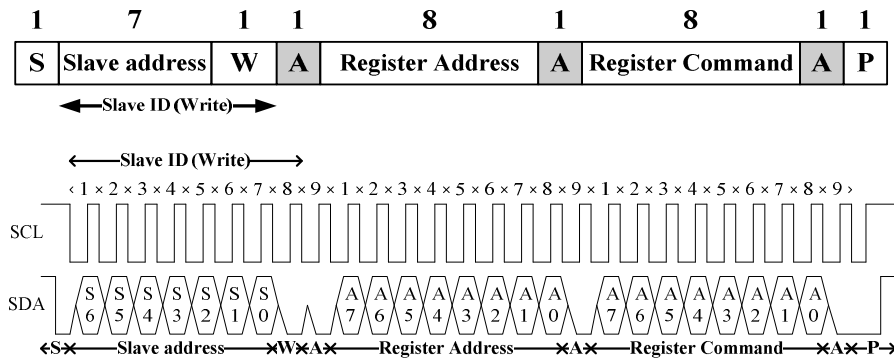
## 5. Principles of Operation

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

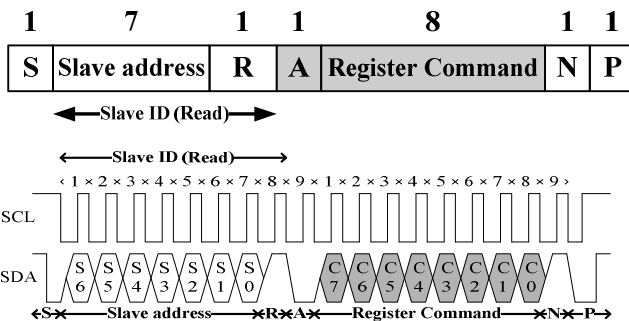
#### • I<sup>2</sup>C Write Protocol (type 1):



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

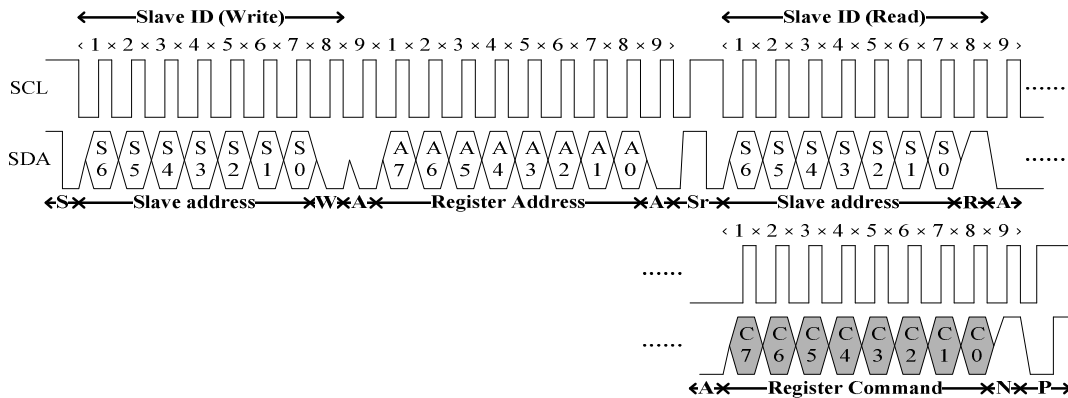
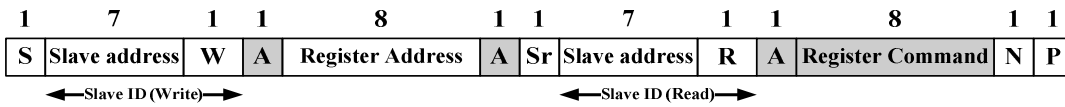


#### • I<sup>2</sup>C Read Protocol:



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

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

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

The 7 bits slave address for this sensor is 0x23H. 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 Type	(0x23H)							(0x23H)	(0x23H)
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
Write	0	1	0	0	0	1	1	0	0x46H
Read	0	1	0	0	0	1	1	1	0x47H



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### 6. Register Set

Address	R / W	Register Name	Description	Reset Value
0x80	RW	ALS_CONTR	ALS operation mode control	0x00
0x81	RW	PS_CONTR	PS operation mode control/SW Reset	0x00
0x82	RW	PS_LED_DUTY_PW	PS LED pulse duty cycle and pulse width setting	0x0E
0x83	RW	PS_LED_CURRENT	PS LED current	0x0F
0x84	RW	PS_N_PULSES	PS number of pulses	0x00
0x85	RW	ALS_SCALE_SET	ALS integration time and measurement rate scale settings	0x02
0x86	RW	ALS_INT_TIME	ALS integration time	0x3F
0x87	RW	ALS_MEAS_RATE	ALS measurement rate	0xFF
0x88	R	ALS_STATUS	ALS Status	0x00
0x8B	R	GREEN_DATA_LSB	GREEN Channel data, LSB	0x00
0x8C	R	GREEN_DATA_MSB	GREEN Channel data, MSB	0x00
0x8D	R	IR_DATA_LSB	IR channel data, LSB	0x00
0x8E	R	IR_DATA_MSB	IR channel data, MSB	0x00
0x93	RW	PS_GAIN	PS Gain setting	0x10
0x94	RW	PS_MEAS_RATE	PS average PS measurement rate	0xA9
0x95	RW	PS_LED_DUTY_PW_INV	Invert of 0x82	0x01
0x96	RW	PS_LED_CURRENT_INV	Invert of 0x83	0x10
0x97	RW	PS_N_PULSES_INV	Invert of 0x84	0xFF
0x98	RW	ALS_INTERRUPT	ALS Interrupt Register	0x0C
0x99	R	PS_STATUS	PS Status	0x00
0x9A	R	PS_DATA_LSB	PS measurement data, LSB	0x00
0x9B	R	PS_DATA_MSB	PS measurement data, MSB	0x00
0x9C	R	AMBIENT_IR_SATURATION	Ambient IR saturation register	0x00
0xA7	RW	INTERRUPT	Interrupt settings	0x40
0xA8	RW	INTERRUPT_PERSIST	PS and ALS interrupt persist setting	0x00
0xA9	RW	PS_THRES_HIGH_LSB	PS interrupt upper threshold, LSB	0xFF



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0xAA	RW	PS_THRES_HIGH_MSB	PS interrupt upper threshold, MSB	0xFF
0xAB	RW	PS_THRES_LOW_LSB	PS interrupt lower threshold, LSB	0x00
0xAC	RW	PS_THRES_LOW_MSB	PS interrupt lower threshold, MSB	0x00
0xAD	RW	PS_XTALK_LSB	Xtalk correction on PS, LSB	0x00
0xAE	RW	PS_XTALK_MSB	Xtalk correction on PS, MSB	0x00
0xAF	RW	ALS_THRES_HIGH_LSB	PS interrupt upper threshold, LSB	0xFF
0xB0	RW	ALS_THRES_HIGH_MSB	PS interrupt upper threshold, MSB	0xFF
0xB1	RW	ALS_THRES_LOW_LSB	PS interrupt lower threshold, LSB	0x00
0xB2	RW	ALS_THRES_LOW_MSB	PS interrupt lower threshold, MSB	0x00
0xB3	R	PART_ID	Part Number ID and revision IDs	0x9C
0xB4	R	MANUFAC_ID	Manufacturer ID	0x05
0xB6	RW	PS_CONFIG_1	PS configuration register 1	0xF5
0xDB	RW	PS_CONFIG_2	PS configuration register 2	0x14
0xE3	RW	PS_CONFIG_3	PS configuration register 3	0x67
0xF9	RW	PS_CONFIG_4	PS configuration register 4	0x8F
0xBC	RW	ALS_CONFIG_1	ALS configuration register 1	0xC0
0xBF	RW	ALS_CONFIG_2	ALS configuration register 2	0x40
0xC1	RW	ALS_CONFIG_3	ALS configuration register 3	0x80
0x7F	RW	ALS_CONFIG_4	ALS configuration register 4	0x50
0xD8	RW	PS_DIODE_SELECT	PS diode select	0x0F



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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
	IR_GAIN_SEL		ALS_GAIN				Reserved	ALS Mode

Field	Bits	Default	Description	
IR_GAIN_SEL	7:6	00	To have different IR gain by dividing ALS gain with a factor.	
			00	No division <b>(default)</b>
			01	Divide by 2
			10	Divide by 4
ALS_GAIN	5:2	0000	11	Divide by 8
			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
Reserved	1	0	<b>Must write 0</b>	
ALS MODE	0	0	0	Stand-by mode <b>(default)</b>
			1	Active continuous mode



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### PS\_CONTR Register (0x81) (Read/Write)

The PS\_CONTR register controls the PS operation modes and software reset for sensor. The PS 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 PS measurement performed but I2C communication is allowed to enable read/write to all the registers.

0x81	PS_CONTR (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Smart persist Enable	Reserved		PS_16 BITS_EN	PS_OS	FTN/NTF Enable	PS Mode	SW Reset

Field	Bits	Default	Description	
Smart persist EN	7	0	Enable fast PS threshold persistence check which can be done within 1 measurement time setting.	
			0	Disable <b>(default)</b>
			1	Enable
Reserved	6:5	00	<b>Must write as 00</b>	
PS_16BITS_EN	4	0	0	Output 11 bits with data cap at 11 bits only <b>(default)</b>
			1	Output 16 bits
PS_OS	3	0	PS offset cancellation. When enabled, PS DATA will be subtracted with PS OFFSET register data, 0xAD,0xAE	
			0	Disabled <b>(default)</b>
			1	Enabled
FTN/FTN_EN	2	0	0	Disable FTN/NTF Status reporting <b>(default)</b>
			1	Enable FTN/NTF Status reporting
PSMODE	1	0	0	Stand-by mode <b>(default)</b>
			1	Active mode
SW_RST	0	0	Reset registers to default values, with sensor into standby mode.	
			0	No action <b>(default)</b>
			1	Reset Registers to default values (including calibration values)





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### PS\_LED\_DUTY\_PW Register (0x82) (Read/Write)

PS LED duty cycle and pulse width settings. **Must be written in tandem with inverted register 0x95.**

0x82	PS_LED_DUTY_PW (default = 0x0E)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				PLED Pulse Duty		PLED Pulse Width	

Field	Bits	Default	Description	
Reserved	7:4	0000	<b>Must write 0000</b>	
PLED Pulse Duty	3:2	11	00	25%
			01	50%
			10	75%
			11	100% <b>(default)</b>
PLED Pulse Width	1:0	10	PS LED ON-time pulse width.	
			00	8us
			01	16us
			10	32us <b>(default)</b>
			11	64us

### PS\_LED\_CURRENT Register (0x83) (Read/Write)

PS LED Current settings. **Must be written in tandem with inverted register 0x96.**

0x83	PS_LED_Current (default = 0x0F)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				LED Current			

Field	Bits	Default	Description
Reserved	7:5	000	<b>Must write 000</b>



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LED Current	4:0	01111	LED current selection	
			00000	0 mA
			00001	7 mA
			00010	13 mA
			00011	20 mA
			00100	27 mA
			00101	33 mA
			00110	40 mA
			00111	47 mA
			01000	53 mA
			01001	60 mA
			01010	67 mA
			01011	73 mA
			01100	80 mA
			01101	87 mA
			01110	93 mA
			01111	100 mA ( <b>default</b> )
			10000	107 mA
			10001	113 mA
			10010	120 mA
			10011	127 mA
			10100	133 mA
			10101	140 mA
			10110	147 mA
			10111	153 mA
			11000	160 mA
			11001	167 mA
			11010	173 mA
11011	180 mA			
111xx	186 mA			



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### PS\_N\_PULSES Register (0x84) (Read/Write)

This register controls number of PS LED pulses. **Must be written in tandem with inverted register 0x97.**

0x84	PS_N_PULSES (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>PS Number of LED Pulses</i>							

Field	Bits	Default	Description
PS Number of LED Pulses	7:0	0x00	00000000 to 11111111 Specifies PS LED number of pulses. If PS number of pulse set to 0, the pulse count is 1. Maximum is 256 pulses

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

This register needs to work with register 0x86 & 0x87 to set the respective integration and measurement time.

0x85	ALS_SCALE_SET (default = 0x02)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>				<i>ALS Integration Time Scale</i>		<i>ALS Measurement Rate Scale</i>	

Field	Bits	Default	Description	
Reserved	7:4	0000	<b>Must write 1010</b>	
ALS Integration Time Scale	3:2	00	To select maximum ALS integration time and integration step resolution.	
			00	0.78ms/step <b>(default)</b>
			01	0.39ms/step
			10	0.2ms/step
			11	0.2ms/step



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ALS Measurement Rate Scale	1:0	10	To select maximum ALS measurement time and measurement time step resolution.	
			00	0.2ms/step
			01	0.39ms/step
			10	0.78ms/step ( <b>default</b> )
			11	1.56ms/step

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

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

Field	Bits	Default	Description
ALS Integration Time	7:0	00111111	Specifies number of integration time steps with the resolution selected in register 0x85 bit [3:2]. 50ms ( <b>default</b> )

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

0x87	ALS_MEAS_RATE (default = 0xFF)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>ALS Measurement Rate</i>							

Field	Bits	Default	Description
ALS Measurement Rate	7:0	11111111	Specifies number of measurement rate steps with the resolution selected in register 0x85 bit [1:0]. 200ms ( <b>default</b> )



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

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

Field	Bits	Default	Description	
Reserved	7	0	-	
ALS Data Valid	6	0	0	ALS Data is Valid <b>(Default)</b>
			1	ALS Data is Invalid
ALS Data 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	-	
ALS Data Status	0	0	0	OLD data (data already read) <b>(default)</b>
			1	NEW data (first time data is read)



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### ALS\_DATA Register (0x8B - 0x8E) (Read Only)

ALS measurement results are stored in ALS\_DATA registers.

Field	Register	Bits	Default	Description
GREEN LSB	0x8B	7:0	00000000	GREEN low byte data, bit 0 is LSB of the 16-bit data
GREEN MSB	0x8C	7:0	00000000	GREEN high byte data, bit 7 is MSB of the 16-bit data
IR LSB	0x8D	7:0	00000000	IR low byte data, bit 0 is LSB of the 16-bit data
IR MSB	0x8E	7:0	00000000	IR high byte data, bit 7 is MSB of the 16-bit data

### PS\_GAIN Register (0x93) (Read/Write)

0x93	PS_GAIN (default = 0x10)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>Reserved</i>						<i>PS Gain</i>	

Field	Bits	Default	Description	
Reserved	7:2	000100	<b>Must write 000100</b>	
PS Gain	1:0	00	00	1x (default)
			01	2x
			10	4x
			11	8x



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### PS\_MEAS\_RATE Register (0x94) (Read/Write)

The PS\_MEAS\_RATE register controls the timing of the periodic measurements of the PS in active mode.

Measurement Repeat Rate is the interval between DATA registers update.

0x94	PS_MEAS_RATE (default = 0xA9)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved	Average Accumulate EN	PS Average/ Accumulation		PS Measurement Time			

Field	Bits	Default	Description	
Reserved	7	1	<b>Must write 1</b>	
Average Accumulate EN	6	0	0	Output average data ( <b>default</b> )
			1	Output accumulated data
PS Average/ Accumulation	5:4	10	Number of PS data for averaging or accumulation	
			00	1x
			01	2x
			10	4x ( <b>default</b> )
PS Measurement Time	3:0	1001	0011	3.125ms
			0100	6.25ms
			0101	12.5ms
			0110	25ms
			0111	50ms
			1000	75ms
			1001	100ms ( <b>default</b> )
			1010	125ms
			1011	150ms
			1100	175ms
1101	200ms			



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### PS\_LED\_DUTY\_PW\_INV Register (0x95) (Read/Write)

Inverted PS\_LED\_DUTY\_PW settings. **Must be written in tandem with register 0x82.**

0x95	PS_LED_DUTY_PW_INV (default = 0x01)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				PLED Pulse Duty Inverse		PLED Pulse Width Inverse	

Field	Bits	Default	Description	
Reserved	7:4	0000	<b>Must write 0000</b>	
PLED Pulse Duty Inverse	3:2	00	PS LED pulse duty cycle.	
			11	25%
			10	50%
			01	75%
PLED Pulse Width Inverse	1:0	01	PS LED ON-time pulse width	
			11	8us
			10	16us
			01	32us <b>(default)</b>
00	64us			

### PS\_LED\_CURRENT\_INV Register (0x96) (Read/Write)

Inverted PS\_LED\_Current settings. **Must be written in tandem with inverted register 0x83.**

0x96	PS_LED_CURRENT_INV (default = 0x10)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				LED Current			





## Data Sheet

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Field	Bits	Default	Description
Reserved	7:5	000	<b>Must write 000</b>
LED Current	4:0	10000	LED current selection
			11111   0 mA
			11110   7 mA
			11101   13 mA
			11100   20 mA
			11011   27 mA
			11010   33 mA
			11001   40 mA
			11000   47 mA
			10111   53 mA
			10110   60 mA
			10101   67 mA
			10100   73 mA
			10011   80 mA
			10010   87 mA
			10001   93 mA
			10000   100 mA (default)
			01111   107 mA
			01110   113 mA
			01101   120 mA
			01100   127 mA
			01011   133 mA
			01010   140 mA
			01001   147 mA
01000   153 mA			
00111   160 mA			
00110   167 mA			
00101   173 mA			
00100   180 mA			



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			000xx	186 mA
--	--	--	-------	--------

### PS\_N\_PULSES\_INV Register (0x97) (Read/Write)

The PS\_N\_Pulses\_INV register activates the PS number of pulse function written in PS\_N\_Pulses Register (0x84).

The value written in PS\_LED\_INV is inverse value of PS\_N\_Pulses 0x84.

0x97	PS_N_PULSE_INV (default = 0xFF)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>PS Number of LED Pulses</i>							

Field	Bits	Default	Description	
PS Number of LED Pulses	7:0	0xFF	11111111 to 00000000	Specifies PS LED number of pulses. If PS number of pulse set to 11111111, the pulse count will be 1

### ALS\_Interrupt Register (0x98) (Read/Write)

0x98	ALS_Interrupt (default = 0x0C)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	<i>ALS Interrupt status</i>	<i>Reserved</i>						

Field	Bits	Default	Description	
ALS Interrupt status	7	0	0	Interrupt signal INACTIVE ( <b>default</b> )
			1	Interrupt signal ACTIVE
Reserved	6:0	00	<b>Must write 000000</b>	



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### PS\_STATUS Register (0x99) (Read Only)

0x99	PS_STATUS (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved		FTN	NTF	PS LED Setting Invalid Flag	PS_INT Greater RATE flag	PS_INT status	PS data status

Field	Bits	Default	Description	
Reserved	7:6	00	-	
FTN	5	0	0	No far to near object detected ( <b>default</b> )
			1	Far to near object detected
NTF	4	0	0	No near to far object detected ( <b>default</b> )
			1	Near to far object detected
PS LED Setting Invalid Flag	3	0	PS LED settings are invalid if the settings in registers 0x95, 0x96 and 0x97 are not inverse of registers 0x82, 0x83 and 0x84.	
			0	Valid ( <b>default</b> )
			1	Invalid
PS_INT Greater RATE Flag	2	0	This flag to check PS Integration time greater or less than measurement rate	
			0	Less than ( <b>default</b> )
			1	Greater than
PS Interrupt Status	1	0	0	Interrupt signal INACTIVE ( <b>default</b> )
			1	Interrupt signal ACTIVE
PS Data Status	0	0	0	OLD data (data already read) ( <b>default</b> )
			1	NEW data (first time data is read)

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### PS\_DATA Register (0x9A – 0x9B) (Read Only)

PS measurement results are stored in PS\_DATA registers. It is necessary to do a block read from registers 0x99 to 0x9C to ensure the data integrity.

Field	Register	Default	Description
PS Data LSB	0x9A	00000000	PS measurement data LSB
PS Data MSB	0x9B	00000000	PS measurement data MSB

### AMBIENT\_IR\_SATURATION Register (0x9C) (Read Only)

0x9C	AMBIENT_IR_SATURATION (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved	Ambient IR Saturation Flag	Reserved					

Field	Bits	Default	Description	
Reserved	7	0	-	
Ambient IR Saturation Flag	6	0	0	Ambient IR not saturate (default)
			1	Ambient IR saturate
Reserved	5:0	000000	-	

### INTERRUPT Register (0xA7) (Read/Write)

INTERRUPT register controls the operation of the interrupt pin and functions.

0xA7	INT (default = 0x40)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				Interrupt Polarity	Interrupt Mode		Reserved



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Field	Bits	Default	Description	
Reserved	7:4	0100	<b>Must write 0100</b>	
Interrupt Polarity	3	0	0	INT pin is active when it is a logic 0 ( <b>default</b> )
			1	INT pin is active when it is a logic 1
Interrupt Mode	2:1	00	00	Interrupt pin is INACTIVE / high impedance state ( <b>default</b> )
			01	Only PS measurement can trigger interrupt
			10	Only ALS measurement can trigger interrupt
			11	Both ALS and PS measurement can trigger interrupt
Reserved	0	0	<b>Must write 0</b>	

### INTERRUPT\_PERSIST Register (0xA8) (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.

0xA8	INT (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	PS_PERSIST				ALS_PERSIST			

Field	Bits	Default	Description	
PS_PERSIST	7:4	0000	0	Every PS value out of threshold range ( <b>default</b> )
			1	1 consecutive PS values out of threshold range
			.....	.....
			1111	15 consecutive PS values out of threshold range
ALS_PERSIST	3:0	0000	0	Every ALS value out of threshold range ( <b>default</b> )
			1	1 consecutive ALS values out of threshold range
			.....	.....
			1111	15 consecutive ALS values out of threshold range



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### PS\_THRESHOLD Register (0xA9 – 0xAC) (Read/Write)

PS\_THRESHOLD\_HIGH register is used to set the upper limit of the absolute interrupt threshold value. Interrupt functions compare the value in the PS\_THRESHOLD\_HIGH registers to measured data value in PS\_DATA registers. The data format for PS\_THRESHOLD\_HIGH must be the same as that of PS\_DATA registers.

Field	Register	Default	Description
PS_THRES_HIGH LSB	0xA9	11111111	PS upper interrupt threshold value, LSB
PS_THRES_HIGH MSB	0xAA	11111111	PS upper interrupt threshold value, MSB
PS_THRES_LOW LSB	0xAB	00000000	PS lower interrupt threshold value, LSB
PS_THRES_LOW MSB	0xAC	00000000	PS lower interrupt threshold value, MSB

### PS\_OFFSET Register (0xAD – 0xAE) (Read/Write)

PS\_OFFSET registers let user define PS crosstalk of the device. PS data will be subtracted by this OFFSET value if PS\_OS is enabled at register 0x81.

Field	Register	Default	Description
PS Offset LSB	0xAD	0	PS offset data lower byte
PS Offset MSB	0xAE	0	PS offset data higher byte

### ALS\_THRESHOLD Register (0xAF – 0xB2) (Read/Write)

Field	Register	Default	Description
ALS_THRES_HIGH LSB	0xAF	11111111	ALS upper interrupt threshold value, LSB
ALS_THRES_HIGH MSB	0xB0	11111111	ALS upper interrupt threshold value, MSB
ALS_THRES_LOW LSB	0xB1	00000000	ALS lower interrupt threshold value, LSB
ALS_THRES_LOW MSB	0xB2	00000000	ALS lower interrupt threshold value, MSB



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### PART\_ID Register (0xB3) (Read Only)

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

0xB3	PART_ID (default = 0x9C)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Part Number ID						Revision ID	

### MANUFAC\_ID Register (0xB4) (Read Only)

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

0xB4	MANUFAC_ID (default = 0x05)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Manufacturer ID							

### PS\_CONFIG\_1 Register (0xB6) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	11110101	<b>Must write as 11000101</b>

### PS\_CONFIG\_2 Register (0xDB) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	00010100	<b>A different value may be recommended depending on application</b>

### PS\_CONFIG\_3 Register (0xE3) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	01100111	<b>A different value may be recommended depending</b>



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			on application
--	--	--	----------------

### PS\_CONFIG\_4 Register (0xF9) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	10001111	A different value may be recommended depending on application

### ALS\_CONFIG\_1 Register (0xBC) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	11000000	Must write as 00000000

### ALS\_CONFIG\_2 Register (0xBF) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	01000000	Must write as 00000000

### ALS\_CONFIG\_3 Register (0xC1) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	10000000	Must write as 00000000

### ALS\_CONFIG\_4 Register (0x7F) (Read/Write)

Field	Bits	Default	Description
Reserved	7:0	01010000	A different value may be recommended depending on application





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### PS\_DIODE\_SELECT Register (0xD8) (Read/Write)

0xD8	PS_DIODE_SELECT (default = 0x0F)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				CH0_3	CH0_2	CH0_1	CH0_0

Field	Bits	Default	Description	
Reserved	7:4	0000	Must write 0000	
DIODE3 switch	3	1	0	OFF
			1	ON (default)
DIODE2 switch	2	1	0	OFF
			1	ON (default)
DIODE1 switch	1	1	0	OFF
			1	ON (default)
DIODE0 switch	0	1	0	OFF
			1	ON (default)



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### 7. Application Information

#### 7.1 ALS Lux Conversion formula

1. Lux formula for all Gains

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

$$Lux_{Converted} = \frac{0.174 * ALS\_count}{(Gain * INT)} * WFAC$$

Where :

2. 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.
3. The Gain factors & Integration time factors:

ALS Gain	GAIN
X1	<b>1</b>
X4	<b>4</b>
X16	<b>16</b>
X64	<b>64</b>
X128	<b>128</b>
X512	<b>512</b>

Integration Time (ms)	INT
50	<b>0.5</b>
100	<b>1</b>
200	<b>2</b>
-	-

## OPTICAL SENSOR LTR-X1503

### 7.2 Operating Mode

#### Stand-by Mode

The device is by default in stand-by mode after power-up. No measurement activity will be done in either ALS or PS. I2C protocol allows communication 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 when power-on reset is triggered.

#### Active Mode

The ALS and PS can be simultaneously 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 and PS specification).

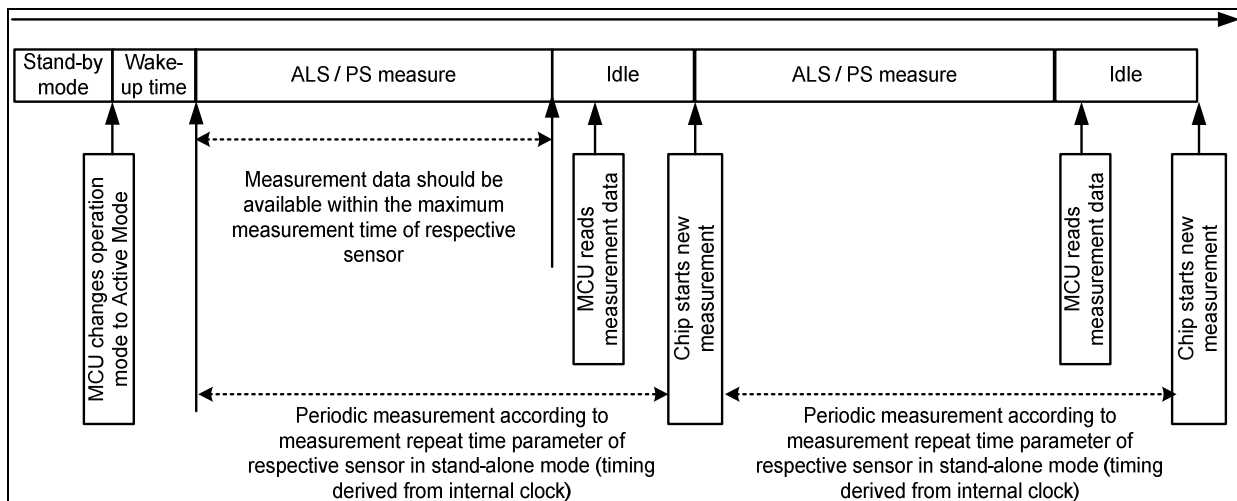


Figure 7.2.1 : ALS and PS measurement sequence

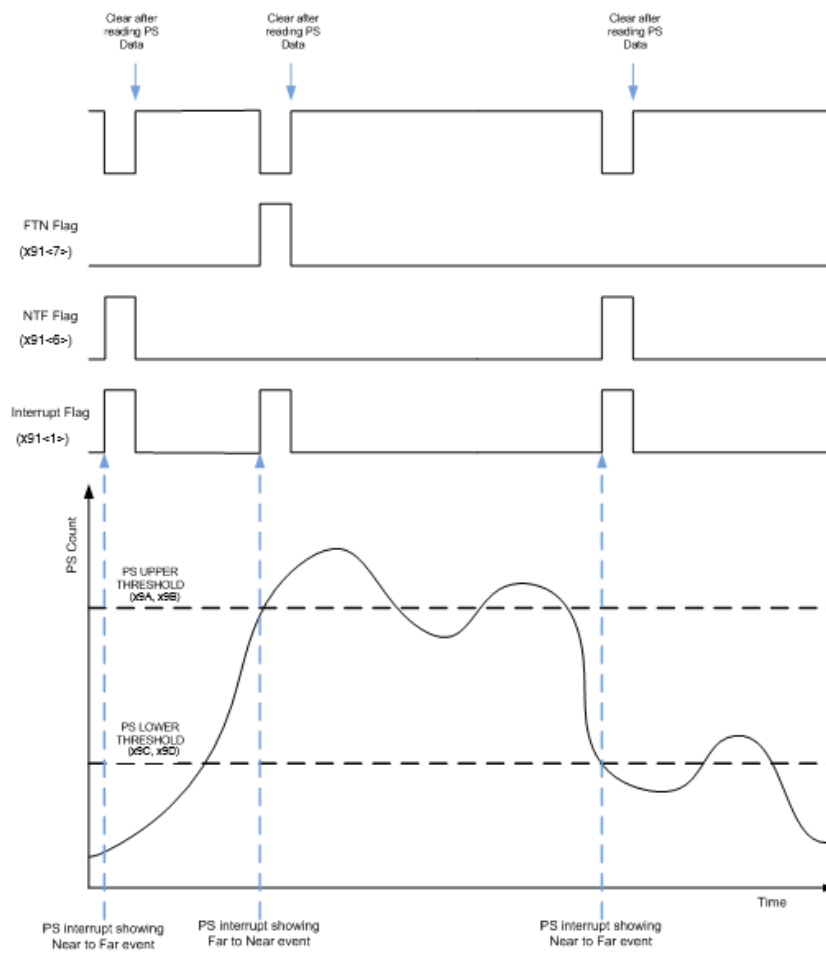
### 7.3 Interrupt Features

The interrupt function is active if PS measurements are outside of the upper and lower absolute threshold levels set in the appropriate threshold register. Only newly measured data is compared to the threshold levels set such that old data will not cause triggering of the INT pin if in case the threshold levels are changed in between measurements.

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The status of interrupt can be monitored directly through the interrupt (INT) pin or by checking contents of the interrupt register. Interrupt pin can either be enable or disabled. Possible to invert interrupt output of LOW or HIGH state. Interrupt pin IO requirements are exactly the same as those of the I2C bus pins SDA and SCL.

There are two user selectable type of interrupts, which are window interrupt type & logic interrupt type. Refer to Figure 7.3.1 and 7.3.2 for illustration.



**Figure 7.3.1 : Interrupt illustration on logic type (with NTF/FTN reporting)**

**(Logic Mode: activated by control register PS\_CONTR (0x81<2>) and INTERRUPT (0xA7<1>))**

# OPTICAL SENSOR LTR-X1503

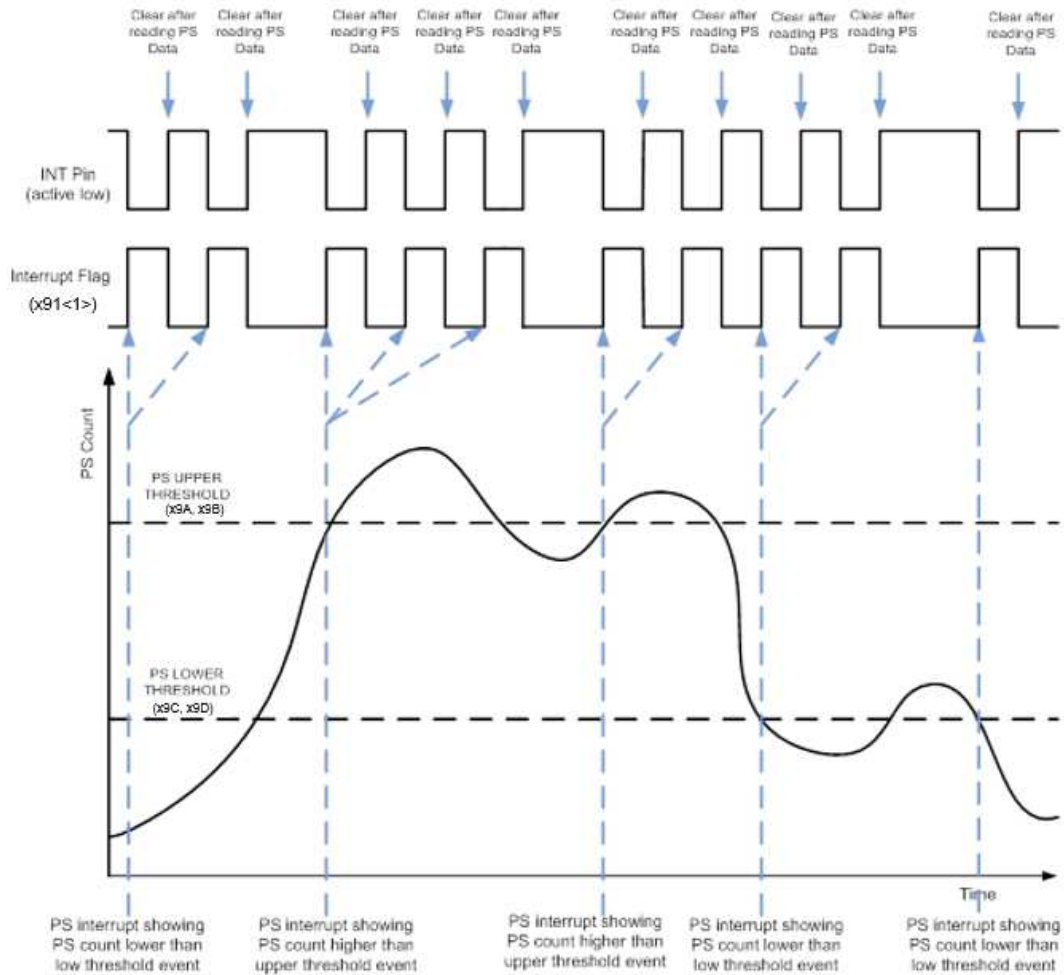
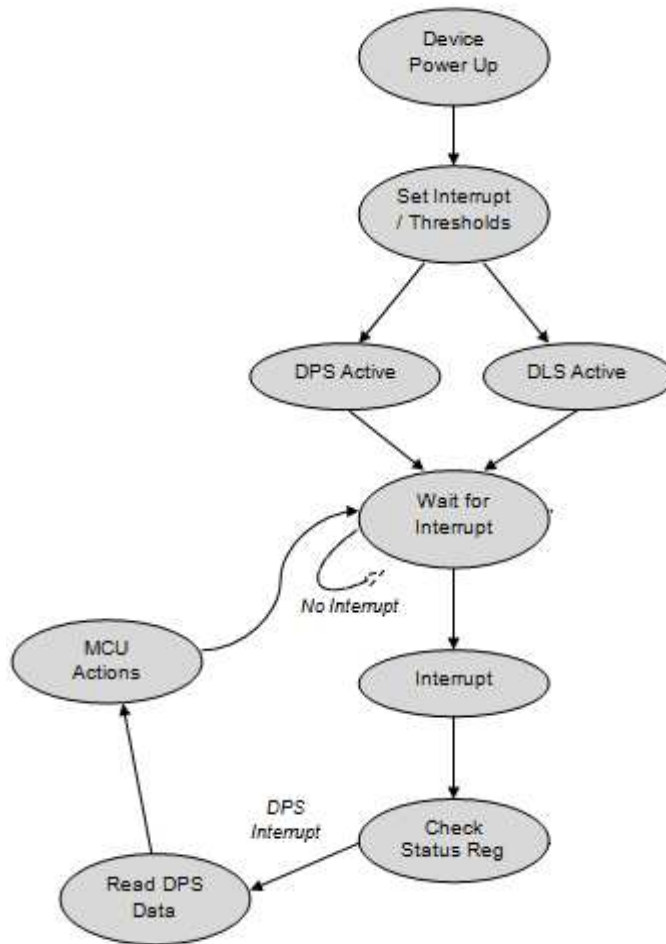


Figure 7.3.2 : Interrupt illustration on window type (by default, without NTF/FTN reporting)

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





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### 8. Pseudo Codes Examples

#### PS LED Registers

```
// The PS LED Registers define the LED duty, pulse width and peak current.
// Default setting is 0x7D (Pulse width 32us, 100mA).
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

#### // Set LED Pulse width 4us ( with 100mA LED current)

```
Register_Addr = 0x82 // PS_LED register
Command = 0x65 // For Pulse width=4us
// For Pulse width =8us, Command = 0x6D
// For Pulse width =16us, Command = 0x75
// For Pulse width = 32us, Command = 0x7D
```

```
WriteByte(Slave_Addr, Register_Addr, Command)
```

#### // Set LED Peak Current 0mA (with default pulse width 32us)

```
Register_Addr = 0x82 // PS_LED register
Command = 0x78 // For Peak Current = 0mA
// For Peak Current = 20mA, Command = 0x79
// For Peak Current = 40mA, Command = 0x7A
// For Peak Current = 60mA, Command = 0x7B
// For Peak Current = 80mA, Command = 0x7C
// For Peak Current = 100mA, Command = 0x7D
// For Peak Current = 120mA, Command = 0x7E
// For Peak Current = 140mA, Command = 0x7F
```

```
WriteByte(Slave_Addr, Register_Addr, Command)
```

#### PS\_N\_Pulses Register

```
// The PS_N_Pulses register controls the PS averaging factor and LED pulses to be emitted.
// Default setting is 0x00.
```

```
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

#### // Set PS averaging factor 0 (with default number of pulse 1)

```
Register_Addr = 0x83 // PS_N_Pulses register
Command = 0x00 // For PS averaging factor 0n,
// For PS averaging factor 2n, Command = 0x40,
// For PS averaging factor 4n, Command = 0x80,
// For PS averaging factor 8n, Command = 0xC0,
```

#### // Set LED Pulses to 2 Pulses (with default ps averaging factor 0)

```
Register_Addr = 0x83 // PS_N_Pulses register
Command = 0x00 // For PS pulses = 1
// For PS pulses = 2, Command = 0x01
// For PS pulses = 3, Command = 0x02
// For PS pulses = 4, Command = 0x03
// .....
// For PS pulses = 64, Command = 0x3F
```



## OPTICAL SENSOR LTR-X1503

WriteByte(Slave\_Addr, Register\_Addr, Command)

### PS Measurement Rate

// PS\_MEAS\_RATE register controls the PS measurement rate which define the interval between DATA update.  
// Default setting of the register is 0x04

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device

#### // Set PS Repeat Rate 6.125ms

Register\_Addr = 0x84 // PS\_MEAS\_RATE register  
Command = 0x00 // For Meas rate = 6.125ms  
// For Meas rate = 12.5ms, Command = 0x01  
// For Meas rate = 25ms, Command = 0x02  
// For Meas rate = 50ms, Command = 0x03  
// For Meas rate = 100ms, Command = 0x04  
// For Meas rate = 200ms, Command = 0x05  
// For Meas rate = 400ms, Command = 0x06  
// For Meas rate = 800ms, Command = 0x07

WriteByte(Slave\_Addr, Register\_Addr, Command)

### ALS Integration Time

// The ALS\_INT\_TIME register controls the ALS integration time and ALS measurement rate.  
// Default setting of the register is 0x06

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device

#### // Set ALS integration time 50msec (with default ALS measurement rate 400ms)

Register\_Addr = 0x85 // ALS\_INT\_TIME register  
Command = 0x02 // For Integration time = 50msec  
// For Integration time = 100msec, Command = 0x06  
// For Integration time = 200msec, Command = 0x0A  
// For Integration time = 400msec, Command = 0x0E

#### // Set ALS measurement rate 100msec (with default ALS integration time 100ms)

Register\_Addr = 0x85 // ALS\_INT\_TIME register  
Command = 0x04 // measurement rate = 100msec  
// measurement rate = 200msec, Command = 0x05  
// measurement rate = 400msec, Command = 0x06  
// measurement rate = 800msec, Command = 0x07

WriteByte(Slave\_Addr, Register\_Addr, Command)

### Interrupt Register

// The Interrupt register controls the operation of the interrupt pins and function.  
// The default value for this register is 0x08  
// The bit7 must write 1.

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device

#### // Set INT pin is considered active when it is a logic 1 ( with Interrupt pin is INACTIVE / high impedance state)

Register\_Addr = 0x98  
// INT pin is considered active when it is a logic 1=Command 0x0C  
// INT pin is considered active when it is a logic 0=Command 0x08





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**// Set Only PS measurement can trigger interrupt ( with INT pin is considered active when it is a logic 0)**

```
Register_Addr = 0x98 // Only PS measurement can trigger interrupt
// Only PS measurement can trigger interrupt =Command 0x09
// Interrupt pin is INACTIVE / high impedance state =Command 0x08
```

```
WriteByte(Slave_Addr, Register_Addr, Command)
```

### Interrupt Persist Register

// The Interrupt persist register controls the N number of times the measurement is out of the threshold range settings before asserting the INTERRUPT pin

// The default value for this register is 0x00

```
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

### // Set 1 consecutive PS values out of threshold range

```
Register_Addr = 0x99 // 1 consecutive PS values out of threshold range
Command = 0x10 // Every PS value out of threshold range =Command 0x00
// 1 consecutive PS values out of threshold range =Command 0x10
// 2 consecutive PS values out of threshold range =Command 0x20
// ....
// 15 consecutive PS values out of threshold range =Command 0xF0
```

```
WriteByte(Slave_Addr, Register_Addr, Command)
```

### PS Threshold Registers

// The PS\_THRES\_UP and PS\_THRES\_LOW registers determines the upper and lower limit of the interrupt threshold value.

// Following example illustrates the setting of the PS threshold window of decimal values of 200 (lower threshold) and // 1000 (upper threshold).

```
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

### // Upper Threshold Setting (decimal 1000)

```
PS_THRES_UP_0 = 0x9A // PS Upper Threshold Low Byte Register address
PS_THRES_UP_1 = 0x9B // PS Upper Threshold High Byte Register address
Data1 = 1000 >> 8 // To convert decimal 1000 into two eight bytes register values
Data0 = 1000 & 0xFF
WriteByte(Slave_Addr, PS_Upp_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, PS_Upp_Threshold_Reg_1, Data1)
```

### // Lower Threshold Setting (decimal 200)

```
PS_THRES_LOW_0 = 0x9C // PS Lower Threshold Low Byte Register address
PS_THRES_LOW_1 = 0x9D // PS Lower Threshold High Byte Register address
Data1 = 200 >> 8 // To convert decimal 200 into two eight bytes register values
Data0 = 200 & 0xFF
WriteByte(Slave_Addr, PS_Low_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, PS_Low_Threshold_Reg_1, Data1)
```



## OPTICAL SENSOR LTR-X1503

### PS OFFSET Registers

// PS OFFSET registers let user define PS crosstalk of the device. All PS data will be subtracted by this OFFSET registers.  
// Following example illustrates the setting of the PS OFFSET of decimal values of 200

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device

#### // PS OFFSET Setting (decimal 200)

PS\_OFFSET\_0 = 0x9E // PS\_OFFSET Low Byte Register address  
PS\_OFFSET\_1 = 0x9F // PS\_OFFSET High Byte Register address  
Data1 = 200 >> 8 // To convert decimal 200 into two eight bytes register values  
Data0 = 200 & 0xFF  
WriteByte(Slave\_Addr, PS\_OFFSET\_0, Data0)  
WriteByte(Slave\_Addr, PS\_OFFSET\_1, Data1)

### PS CONFIG1 Register

// This register need to be written as 0x07. Default value is 0x01

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device  
PS\_CONFIG1=0xB6 // PS configuration register  
Command = 0x07

WriteByte(Slave\_Addr, PS\_CONFIG1, Command)

### Control Registers

// The Control Registers define the operating modes and gain settings of the ALS and PS of LTR-X1503.  
// It is recommended that Control Register for ALS (0x80) and PS (0x81) to be set at the end of the sequence.  
// This is to ensure all register settings are the same for all started measurement.  
// Default settings are 0x20 for ALS register and 0x10 for PS register (both in Standby mode after power up).

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device

#### // Enable ALS

Register\_Addr = 0x80 // ALS\_CONTR register  
Command = 0x21 // For Dynamic Range x1  
// For Dynamic Range x4 , Command = 0x25  
// For Dynamic Range x16 , Command = 0x29  
// For Dynamic Range x64 , Command = 0x2D  
// For Dynamic Range x128 , Command = 0x31  
// For Dynamic Range x512, Command = 0x35

WriteByte(Slave\_Addr, Register\_Addr, Command)

#### // Enable PS

Register\_Addr = 0x81 // PS\_CONTR register  
Command = 0x12 // For PS active

#### // Enable PS OFFSET



## OPTICAL SENSOR LTR-X1503

```
Register_Addr = 0x81 // PS_CONTR register
Command = 0x1A // For PS active & enable PS OFFSET
```

### // Enable FTN/NTF

```
Register_Addr = 0x81 // PS_CONTR register
Command = 0x1E // For PS active & enable PS OFFSET & enable FTN/NTF
```

```
WriteByte(Slave_Addr, Register_Addr, Command)
```

### Data Registers (Read Only)

```
// The ALS and PS Data Registers contain the ADC output data.
// These registers should be read as a group, with the lower address being read first.
```

```
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

### // Read ALS\_DATA

```
Register_Addr = 0x8B // ALS ADC low byte address
ReadByte(Slave_Addr, Register_Addr, Data0)
Register_Addr = 0x8C // ALS ADC high byte address
ReadByte(Slave_Addr, Register_Addr, Data1)
```

```
ALS_ADC_Data = ((Data1 << 8) | Data0) // Combining lower and upper bytes to give 16-bit ALS ADC data
```

```
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

### // Read PS\_DATA

```
Register_Addr = 0x92 // PS_DATA low byte address
ReadByte(Slave_Addr, Register_Addr, Data0)
Register_Addr = 0x93 // PS_DATA high byte address
ReadByte(Slave_Addr, Register_Addr, Data1)
```

```
PS_ADC_Data = ((Data1 << 8) | Data0) // Combining lower and upper bytes to give 16-bit PS data
```

### ALS Status Register (Read Only)

```
// The ALS_STATUS Register contains the information on Interrupt, ALS data gain, validity and status.
```

```
Slave_Addr = 0x23 // Slave address of LTR-X1503 device
```

```
Register_Addr = 0x88 // ALS_STATUS register address
ReadByte(Slave_Addr, Register_Addr, Data)
```

```
ALS valid = Data & 0x40 // ALS data valid = 0x40 → ALS data is invalid
// ALS data valid = 0x00 → ALS data is valid
```

```
ALS Gain Range= Data & 0x38 // Gain Range = 0x00 → Gain x1
// Gain Range = 0x08 → Gain x4
// Gain Range = 0x10 → Gain x16
// Gain Range = 0x18 → Gain x64
// Gain Range = 0x20 → Gain x128
// Gain Range = 0x28 → Gain x512
```



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ALS Data\_Status = Data & 0x01 // NewData\_Status = 0x00 → OLD data  
 // NewData\_Status = 0x01 → NEW data

### PS Status Register (Read Only)

// The PS\_STATUS Register contains the information on Interrupt, NTF/FTN information, ambient saturation and PS status.

Slave\_Addr = 0x23 // Slave address of LTR-X1503 device

Register\_Addr = 0x99 // PS\_STATUS register address  
 ReadByte(Slave\_Addr, Register\_Addr, Data)

FTN = Data & 0x20 // FTN = 0x20 → FTN detected  
 // FTN = 0x00 → No FTN detected  
 NTF = Data & 0x10 // NTF = 0x10 → NTF detected  
 // NTF = 0x00 → No NTF detected

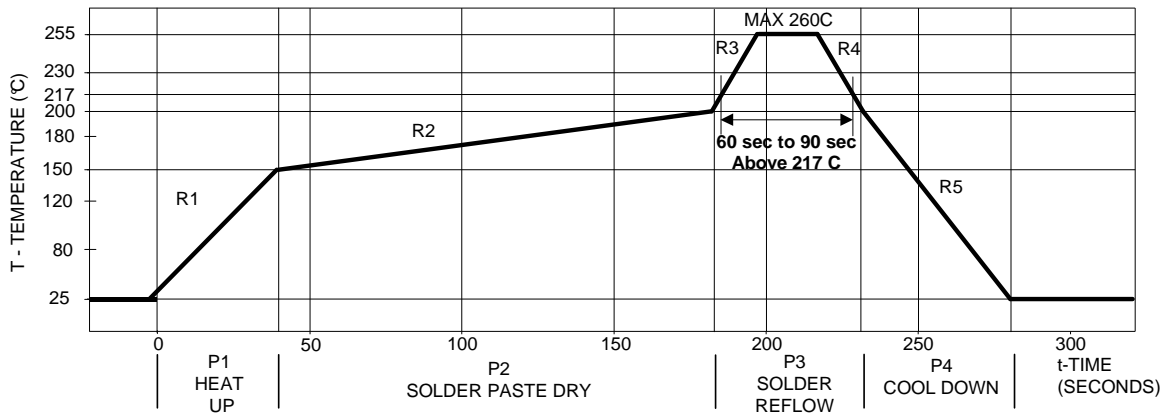
Ambient Saturation= Data & 0x04 // Ambient Saturation = 0x04 → Ambient Saturation happens  
 // Ambient Saturation = 0x00 → No ambient Saturation

PS\_Interrupt\_Status = Data & 0x02 // Interrupt\_Status = 0x02 → PS interrupt is triggered  
 // Interrupt\_Status = 0x00 → PS interrupt is not triggered

PS Data\_Status = Data & 0x01 // NewData\_Status = 0x00 → OLD data  
 // NewData\_Status = 0x01 → NEW data

## OPTICAL SENSOR LTR-X1503

### 9. Recommended Leadfree Reflow Profile



Process Zone	Symbol	$\Delta T$	Maximum $\Delta T/\Delta \text{time}$ or Duration
Heat Up	P1, R1	25°C to 150°C	3°C/s
Solder Paste Dry	P2, R2	150°C to 200°C	100s to 180s
Solder Reflow	P3, R3	200°C to 260°C	3°C/s
	P3, R4	260°C to 200°C	-6°C/s
Cool Down	P4, R5	200°C to 25°C	-6°C/s
Time maintained above liquidus point, 217°C		> 217°C	60s to 90s
Peak Temperature		260°C	-
Time within 5°C of actual Peak Temperature		> 255°C	20s
Time 25°C to Peak Temperature		25°C to 260°C	8mins

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



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### 10. Moisture Proof Packaging

All LTR-X1503 are shipped in moisture proof package. Once opened, moisture absorption begins. This part is compliant to JEDEC J-STD-033A Level 3.

#### 10.1 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%

#### 10.2 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%

#### 10.3 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.

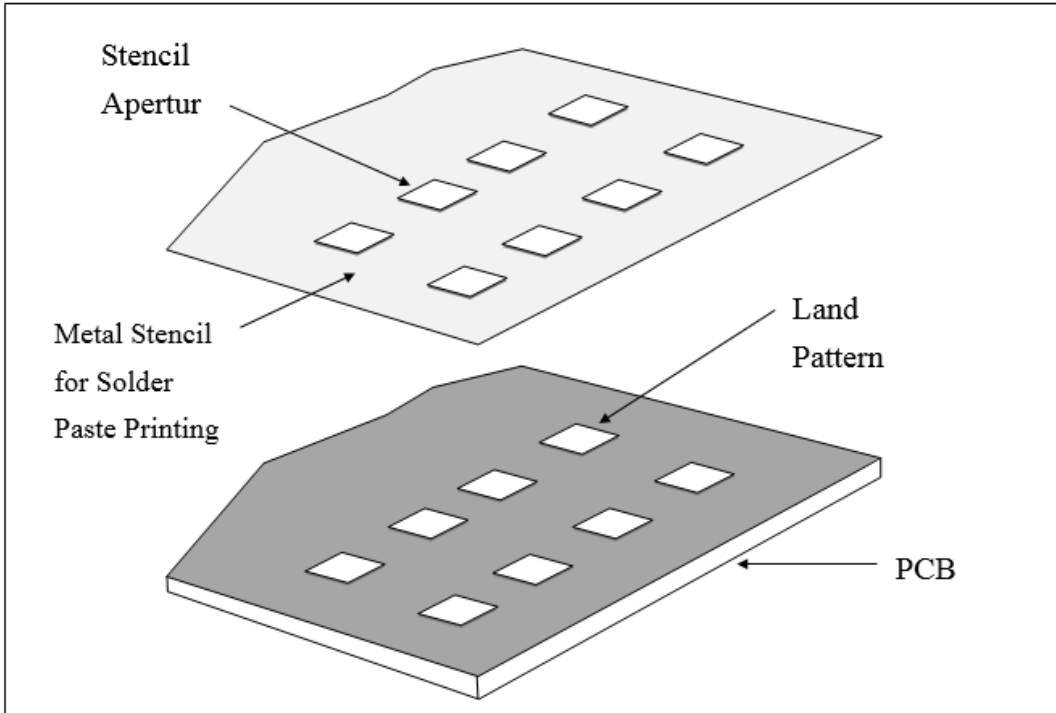
#### Baking Conditions

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

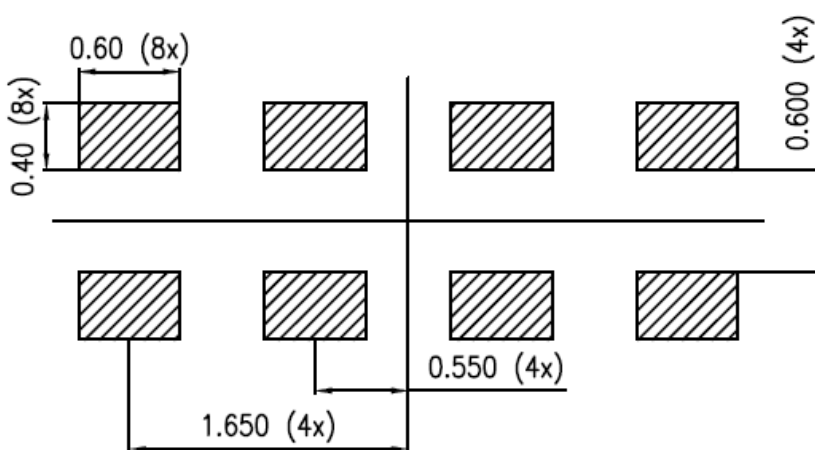
Baking should only be done once.

## OPTICAL SENSOR LTR-X1503

### 11. Recommended Land Pattern and Metal Stencil Aperture



#### Recommended Land Pattern



Note: All dimensions are in millimeters

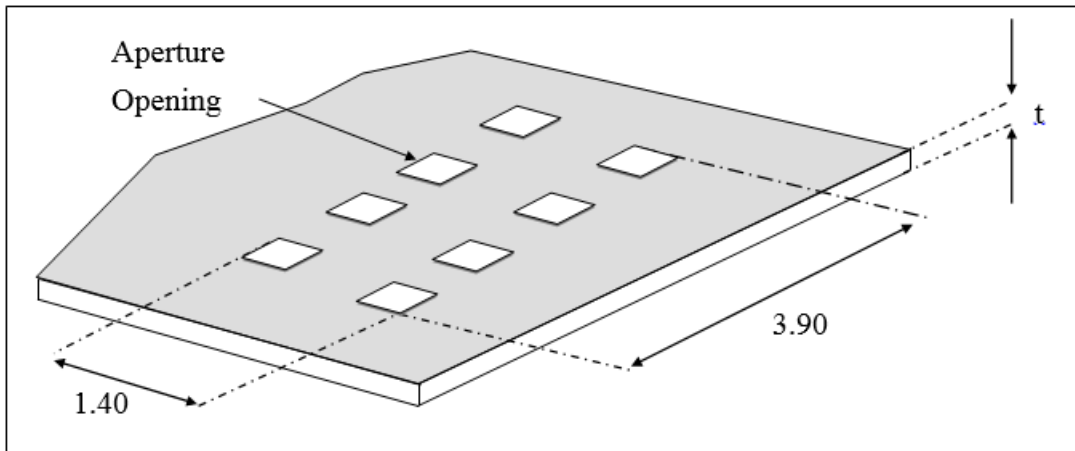


## OPTICAL SENSOR LTR-X1503

### Recommended 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).

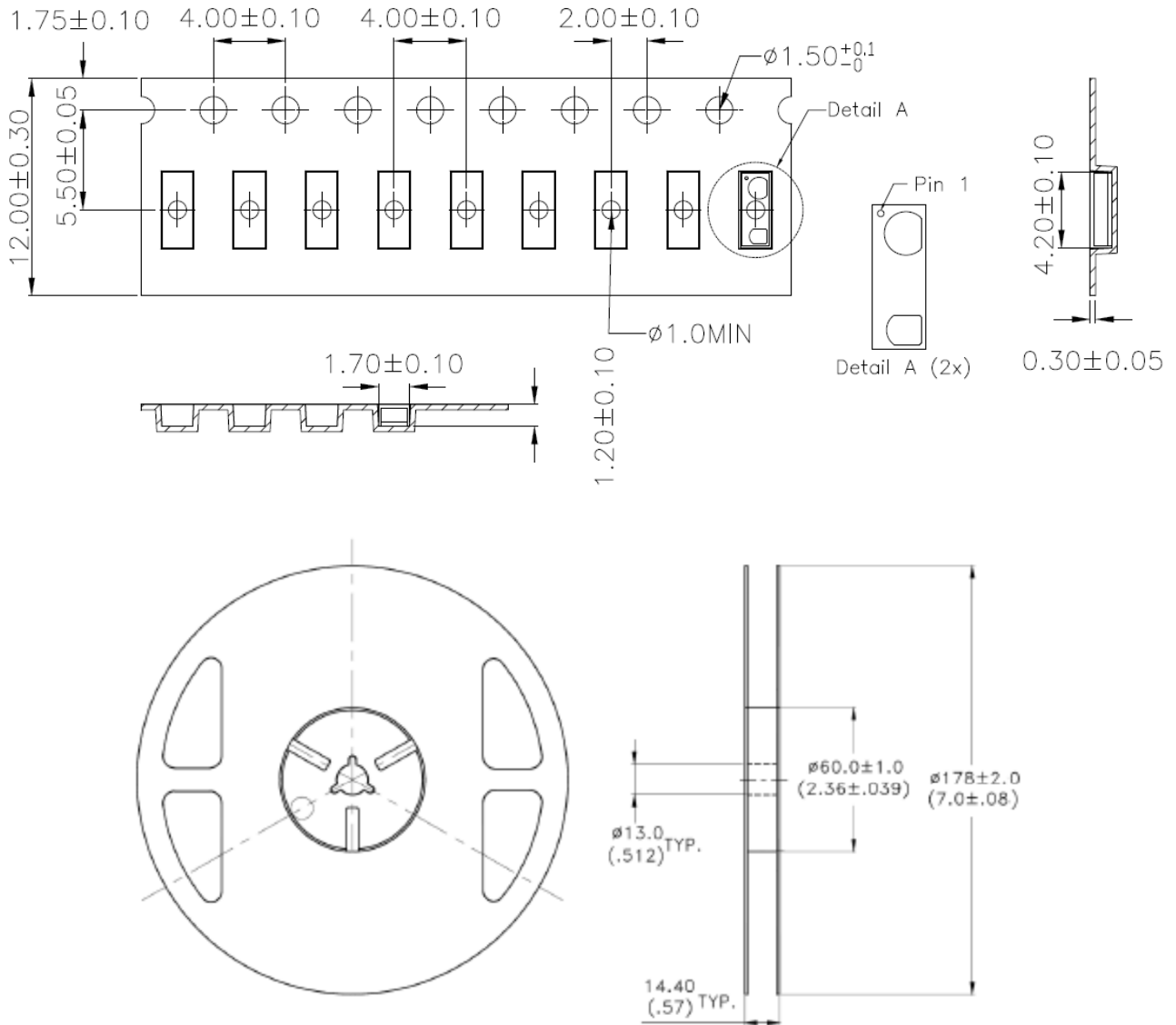
The stencil aperture opening is recommended to be 0.40mm x 0.60mm which has the same dimension as the land pattern. This is to ensure adequate printed solder paste volume and yet no shorting.





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### 12. Package Dimension for Tape and Reel



#### Notes:

1. All dimensions are in millimeters
2. Empty component pockets sealed with top cover tape
3. 7 inch reel – 3,000 pieces per reel
4. In accordance with ANSI/EIA 481-1-A-1994 specifications



## Data Sheet

**OPTICAL SENSOR  
LTR-X1503**
**Revision Table:**

Version	Update	Page	Date
1.0	Final datasheet as created	Total 49	14-Jan-2021
1.1	Updated Electrical Spec	Total 49	14-Feb-2021
1.2	Update Pin 1 chamfer orientation	Total 49	12-May-2021
1.3	Updated ALS FOV	Total 49	12-Jul-2021