

Optical Sensor
Product Data Sheet
LTR-X150P

Spec No. :DS86-2021-0040
Effective Date: 03/24/2023
Revision: A

LITE-ON DCC

RELEASE

BNS-OD-FC001/A4

OPTICAL SENSOR LTR-X150P

Description

The LTR-X150P is a standalone proximity sensor (PS), with built-in emitter in a single miniature chipled lead-free surface mount package.

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.

Features

- I²C interface (Standard mode @100kHz or Fast mode @400kHz)
- ultra-small ChipLED package
- Very low power consumption with sleep mode capability
- Operating voltage ranges: 1.7V 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

PS Features

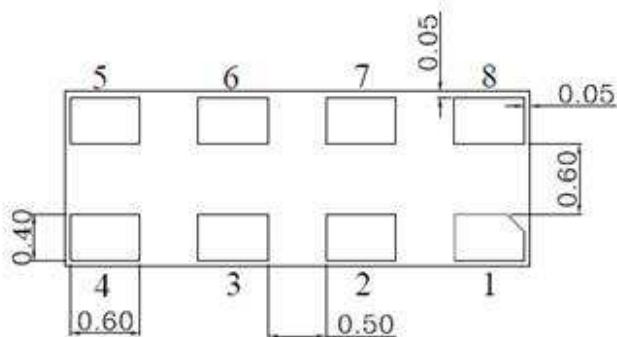
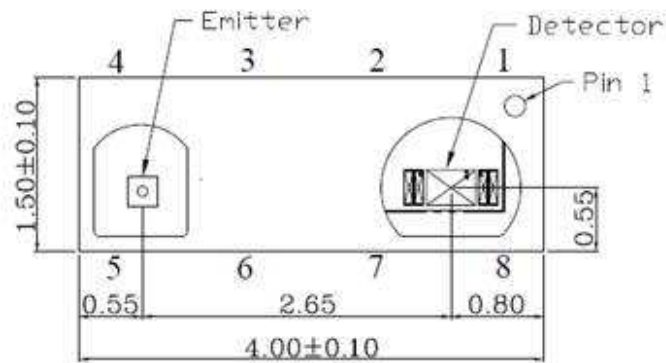
- Built-in LED driver
- High ambient light suppression
- 16-bit effective resolution
- Cancellation of crosstalk
- Programmable LED drive setting

Ordering Information

| Part Number | Packaging Type | Package | Quantity |
|-------------|----------------|-----------------------|----------|
| LTR-X150P | Tape and Reel | 8-pin chipled package | 3,000pcs |

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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 |

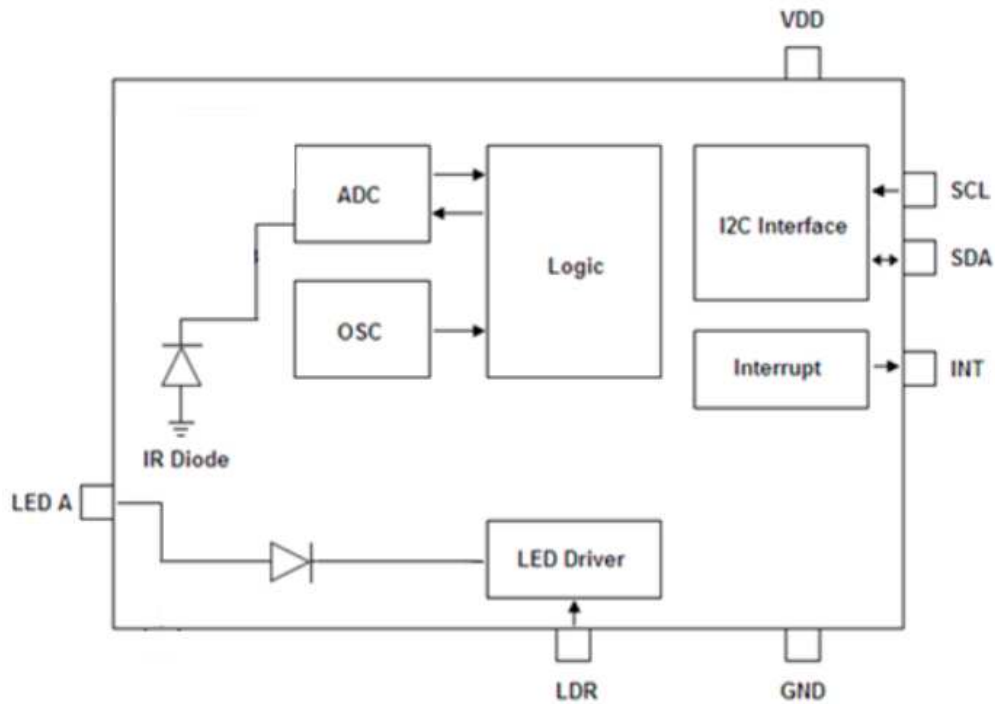
1. All dimensions in mm
2. Tolerances is ± 0.2 unless specify

Note: All dimension in millimeter

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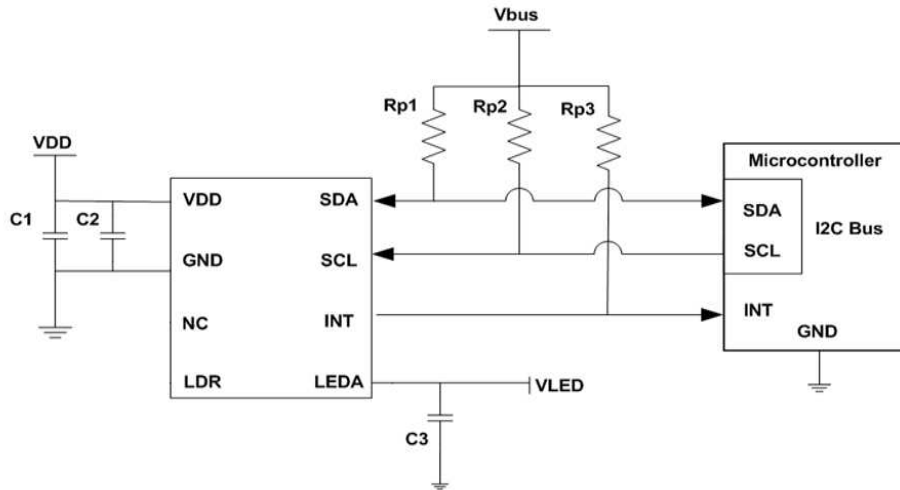
2. Functional Block Diagram

The LTR-X150P contains a photodiodes (1 for proximity diode) for 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



Note: It is a requirement to separate the VDD and VLED

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

I/O Pins Configuration Table

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

Recommended Application Circuit Components

| Component | Recommended Value |
|-------------------|-----------------------------|
| Rp1, Rp2, Rp3 [1] | 1 kΩ to 10 kΩ |
| C1, C3 | 1μF ±20%, X7R / X5R Ceramic |
| C2 | 0.1μF |

[1] Selection of pull-up resistors value is dependent on bus capacitance values. For more details, please refer to I²C Specifications: 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 |
| LED Voltage Range | LED | -0.5 | 4.6 | V |
| LDR Voltage Range | LDR | -0.5 | 3.6 | V |
| Storage Temperature | T _{stg} | -40 | 100 | °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 |
| LED Supply Voltage | V _{LED} | 2.8 | | 4 | 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 | °C |

Electrical & Optical Specifications

All specifications are at VDD = 1.8V, T_{ope} = 25°C, unless otherwise noted.

| Parameter | Min. | Typ. | Max. | Unit | Condition |
|--------------------------|------|------|------|------|--|
| 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 |



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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 Width 32us, 16 pulses, LED Current 104mA |
| 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 TBD 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)

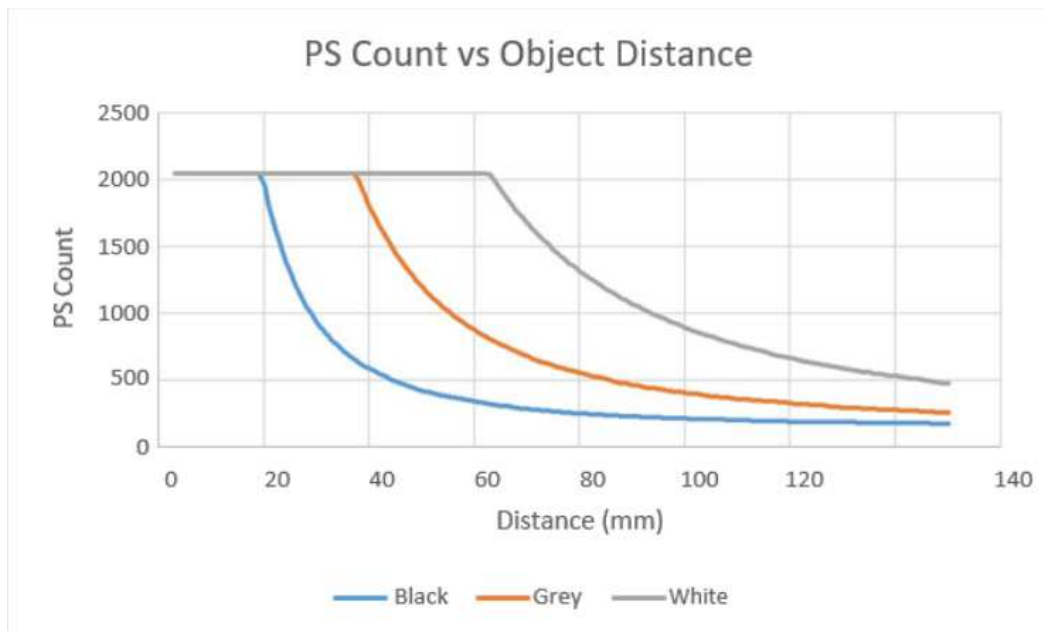


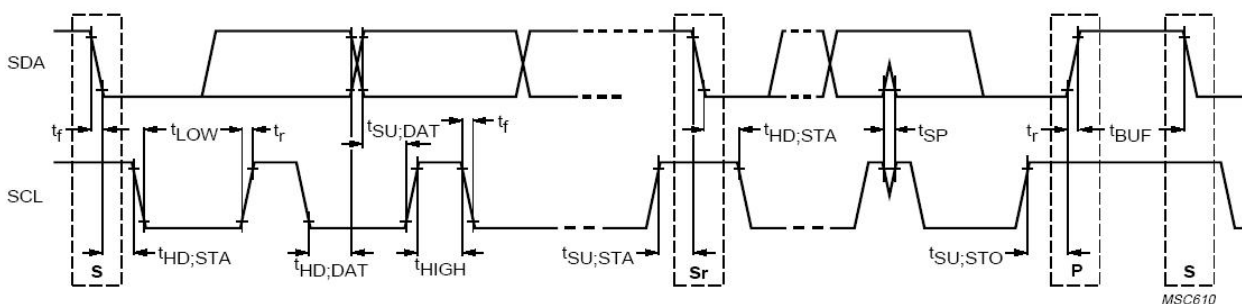
Figure 4.1: PS performance across distance VDD 1.8V, 104mA, 16pulses, with others in default settings.

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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 |

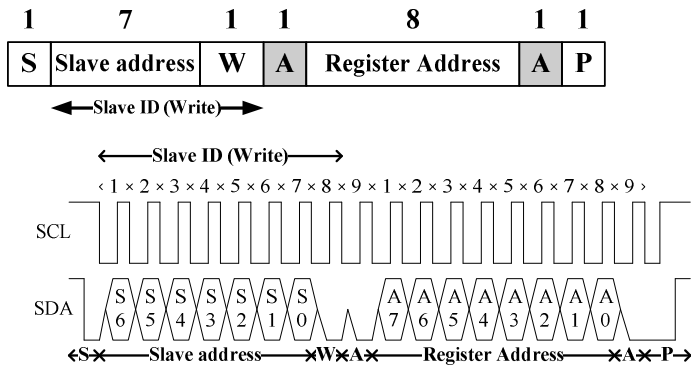


Definition of timing for I²C bus

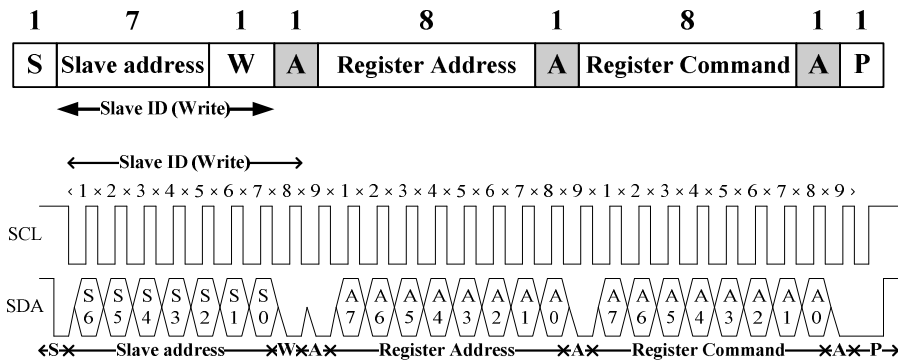
5. Principles of Operation

I²C Protocols

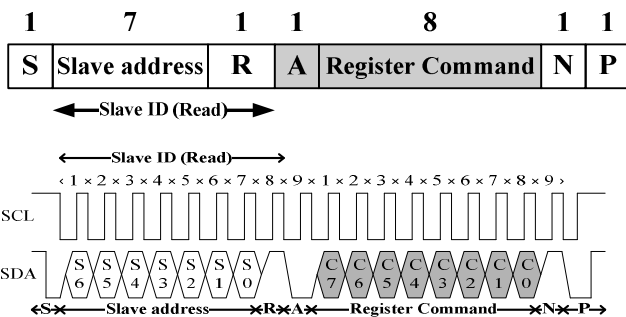
• I²C Write Protocol (type 1):



• I²C Write Protocol (type 2):

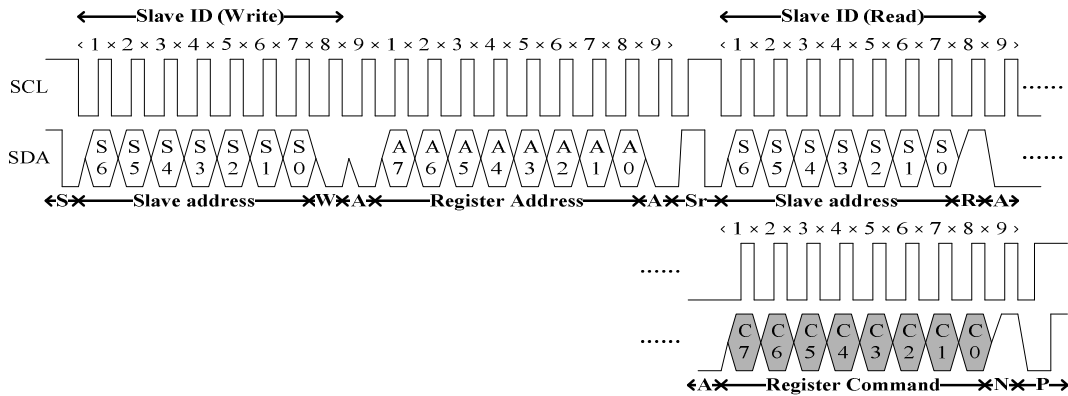
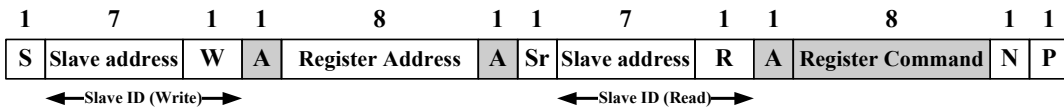


• I²C Read Protocol:



• I²C Read (Combined format) Protocol:

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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

I2C 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 ² 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 |
|---------|-------|--------------------|---|-------------|
| 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 |
| 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 |
| 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 |
| 0xA7 | RW | INTERRUPT | Interrupt settings | 0x40 |
| 0xA8 | RW | INTERRUPT_PERSIST | PS interrupt persist setting | 0x00 |
| 0xA9 | RW | PS_THRES_HIGH_LSB | PS interrupt upper threshold, LSB | 0xFF |
| 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 |
| 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 |
| 0xD8 | RW | PS_DIODE_SELECT | PS diode select | 0x0F |



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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 (default) |
| | | | 1 | Enable |
| Reserved | 6:5 | 00 | Must write as 00 | |
| PS_16BITS_EN | 4 | 0 | 0 | Output 11 bits with data cap at 11 bits only (default) |
| | | | 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 (default) |
| | | | 1 | Enabled |
| FTN/FTN_EN | 2 | 0 | 0 | Disable FTN/NTF Status reporting (default) |
| | | | 1 | Enable FTN/NTF Status reporting |
| PSMODE | 1 | 0 | 0 | Stand-by mode (default) |
| | | | 1 | Active mode |
| SW_RST | 0 | 0 | Reset registers to default values, with sensor into standby mode. | |
| | | | 0 | No action (default) |
| | | | 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 | Must write 0000 | |
| PLED Pulse Duty | 3:2 | 11 | 00 | 25% |
| | | | 01 | 50% |
| | | | 10 | 75% |
| | | | 11 | 100% (default) |
| PLED Pulse Width | 1:0 | 10 | PS LED ON-time pulse width. | |
| | | | 00 | 8us |
| | | | 01 | 16us |
| | | | 10 | 32us (default) |
| | | | 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 |
|-------|------|---------|-------------|
|-------|------|---------|-------------|



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| Reserved | 7:5 | 000 | Must write 000 | |
|----------------|--------|---------------------------|-----------------------|-------|
| 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 (default) | | |
| | 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 |

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 | Must write 000100 | |
| 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 | Must write 1 | |
| Average Accumulate EN | 6 | 0 | 0 | Output average data (default) |
| | | | 1 | Output accumulated data |
| PS Average /Accumulation | 5:4 | 10 | Number of PS data for averaging | |
| | | | 00 | No average |
| | | | 01 | 2x average |
| | | | 10 | 4x average (default) |
| PS Measurement Time | 3:0 | 1001 | 0011 | 3.125ms |
| | | | 0100 | 6.25ms |
| | | | 0101 | 12.5ms |
| | | | 0110 | 25ms |
| | | | 0111 | 50ms |
| | | | 1000 | 75ms |
| | | | 1001 | 100ms (default) |
| | | | 1010 | 125ms |
| 1011 | 150ms | | | |



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| | | | | |
|--|--|--|------|-------|
| | | | 1100 | 175ms |
| | | | 1101 | 200ms |

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 | Must write 0000 | |
| 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 (default) |
| | | | 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 | | | |



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| Field | Bits | Default | Description |
|----------------|------|---------|--------------------------|
| Reserved | 7:5 | 000 | Must write 000 |
| 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 | | | |



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| | | | | |
|--|--|--|-------|--------|
| | | | 00110 | 167 mA |
| | | | 00101 | 173 mA |
| | | | 00100 | 180 mA |
| | | | 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 |

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 |
| | <i>Reserved</i> | | <i>FTN</i> | <i>NTF</i> | <i>PS LED Setting Invalid Flag</i> | <i>PS_INT Greater RATE flag</i> | <i>PS_INT status</i> | <i>PS data status</i> |

| Field | Bits | Default | Description |
|----------|------|---------|---|
| Reserved | 7:6 | 00 | - |
| FTN | 5 | 0 | 0 No far to near object detected (default) |



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| | | | | |
|--------------------------------|---|---|--|---|
| | | | 1 | Far to near object detected |
| NTF | 4 | 0 | 0 | No near to far object detected (default) |
| | | | 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 (default) |
| | | | 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 (default) |
| | | | 1 | Greater than |
| PS Interrupt Status | 1 | 0 | 0 | Interrupt signal INACTIVE (default) |
| | | | 1 | Interrupt signal ACTIVE |
| PS Data Status | 0 | 0 | 0 | OLD data (data already read) (default) |
| | | | 1 | NEW data (first time data is read) |

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 |
| | <i>Reserved</i> | <i>Ambient IR Saturation Flag</i> | <i>Reserved</i> | | | | | |



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| 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 | |

| Field | Bits | Default | Description |
|--------------------|------|---------|--|
| Reserved | 7:4 | 0100 | Must write 0100 |
| Interrupt Polarity | 3 | 0 | 0 INT pin is active when it is a logic 0 (default) |
| | | | 1 INT pin is active when it is a logic 1 |
| Interrupt Mode | 2:1 | 00 | 00 Interrupt pin is INACTIVE / high impedance state (default) |
| | | | 01 PS measurement can trigger interrupt |
| | | | -- -- |
| | | | -- -- |
| Reserved | 0 | 0 | Must write 0 |

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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 | | | | Reserved | | | |

| Field | Bits | Default | Description | |
|------------|------|---------|-------------|--|
| PS_PERSIST | 7:4 | 0000 | 0 | Every PS value out of threshold range (default) |
| | | | 1 | 1 consecutive PS values out of threshold range |
| | | | | |
| | | | 1111 | 15 consecutive PS values out of threshold range |
| Reserved | 3:0 | 0000 | -- | -- |

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 |



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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 |

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 | Must write as 11000101 |



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PS_CONFIG_2 Register (0xDB) (Read/Write)

| Field | Bits | Default | Description |
|----------|------|----------|---|
| Reserved | 7:0 | 00010100 | A different value may be recommended depending on application |

PS_CONFIG_3 Register (0xE3) (Read/Write)

| Field | Bits | Default | Description |
|----------|------|----------|---|
| Reserved | 7:0 | 01100111 | A different value may be recommended depending 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 |

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) |

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| | | | | |
|---------------|---|---|---|--------------|
| DIODE0 switch | 0 | 1 | 0 | OFF |
| | | | 1 | ON (default) |

7. Application Information

7.1 Operating Mode

Stand-by Mode

The device is by default in stand-by mode after power-up. No measurement activity will be done. 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

Measurement data is expected to be available within a known fixed time.

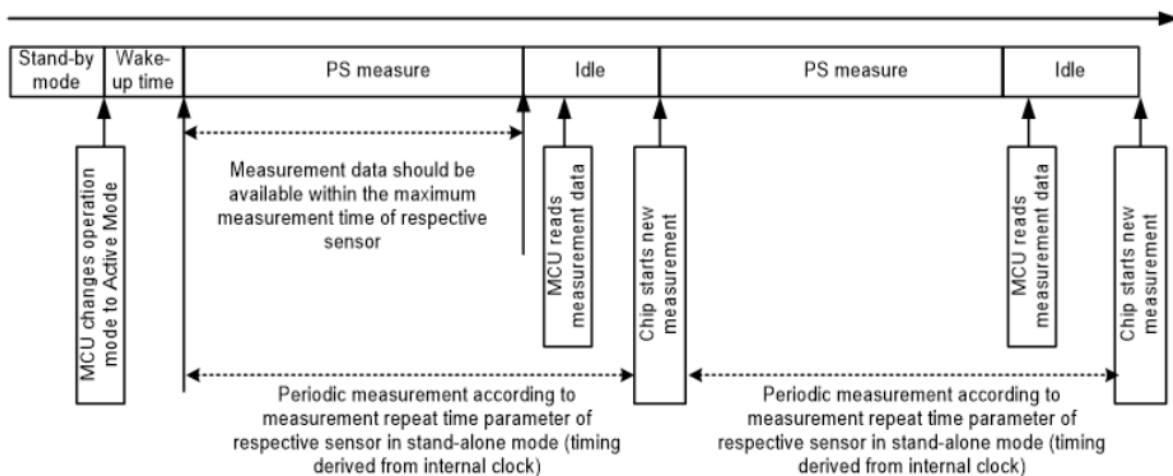


Figure 7.2.1 : PS measurement sequence

7.2 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

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that old data will not cause triggering of the INT pin if in case the threshold levels are changed in between measurements.

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.

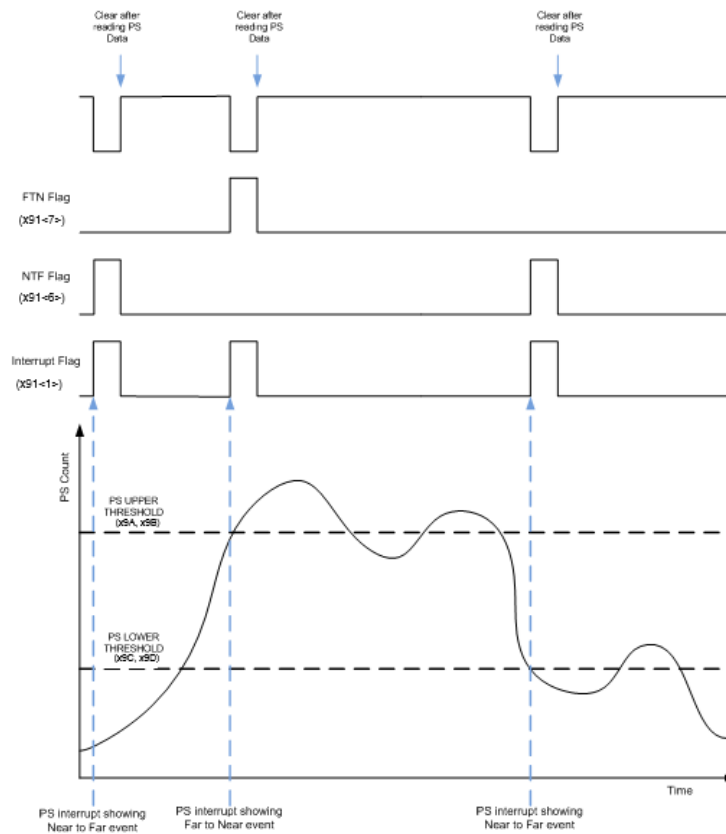


Figure 7.3.1 : Interrupt illustration on logic type (with NTF/FTN reporting)

(Logic Mode: activated by control register PS_CONTR (0x81<2>) and INTERRUPT (0xA7<1>))

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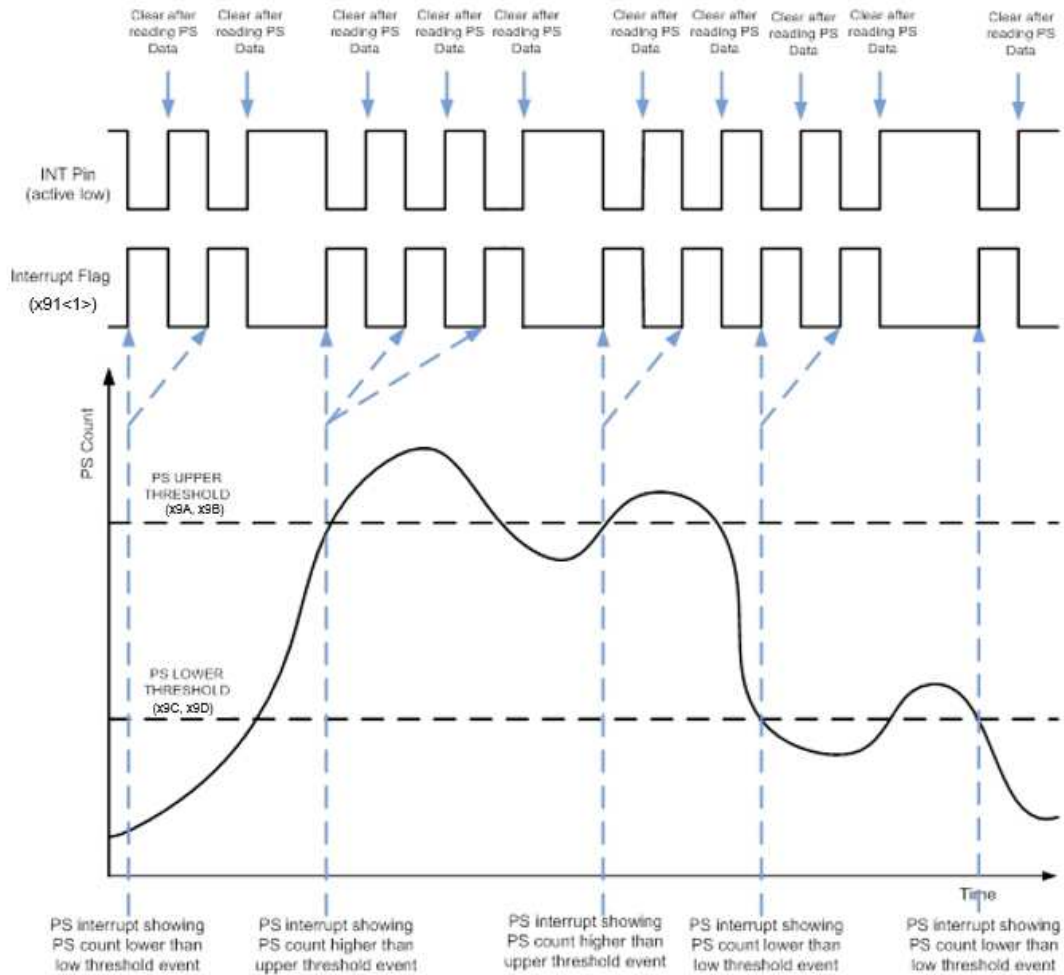
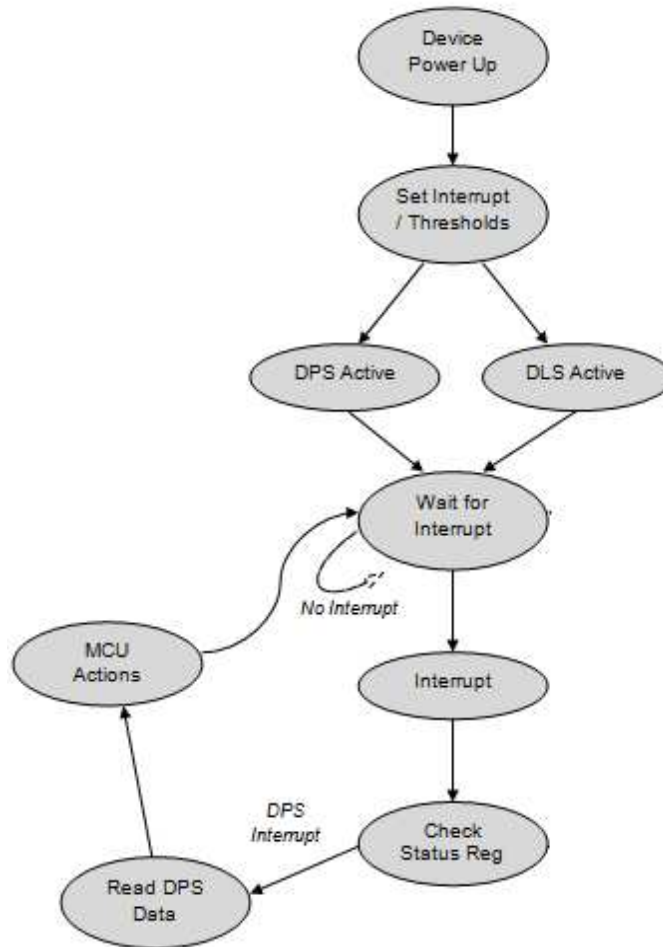


Figure 7.3.2 : Interrupt illustration on window type (by default, without NTF/FTN reporting)

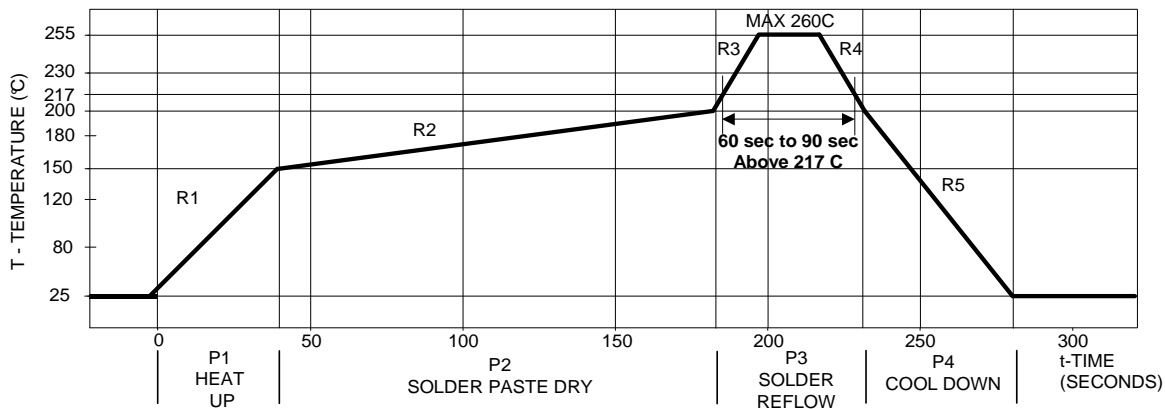
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Flow diagram below illustrates the operation flow, and involving the use of Thresholds and interrupt.



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8. Recommended Leadfree Reflow Profile



| Process Zone | Symbol | ΔT | 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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9. Moisture Proof Packaging

All LTR-X150P 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.

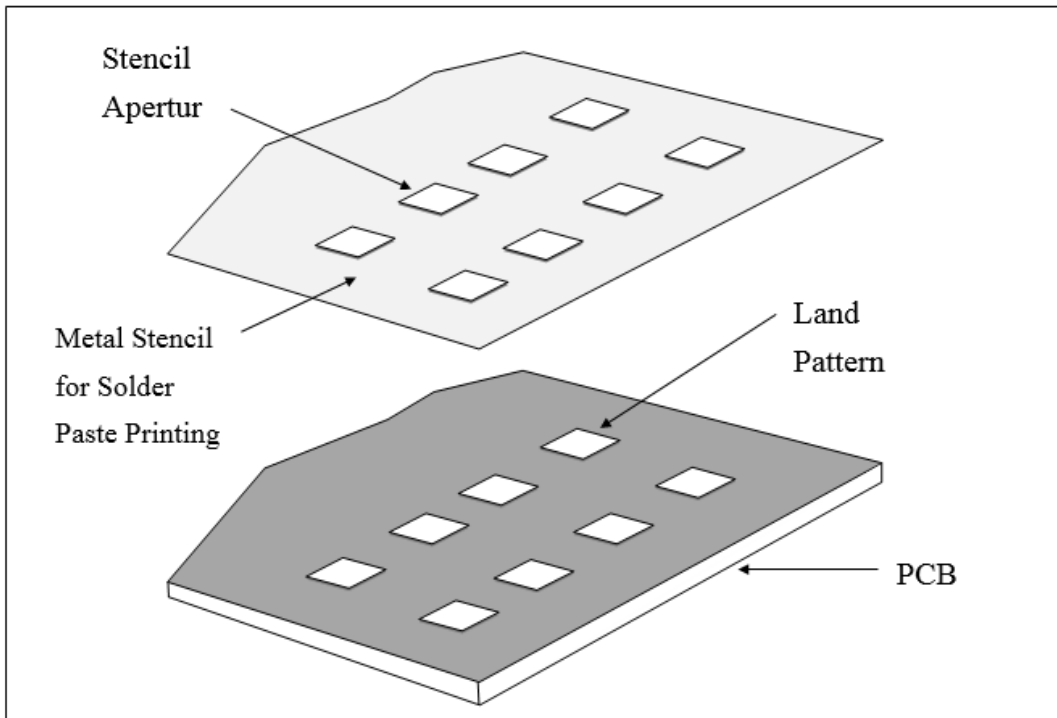
Baking Conditions

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

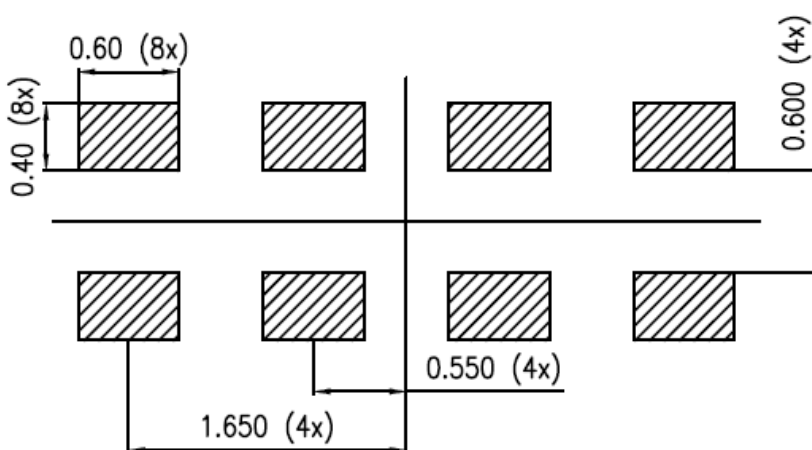
Baking should only be done once.

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10. Recommended Land Pattern and Metal Stencil Aperture



Recommended Land Pattern



Note: All dimensions are in millimeters

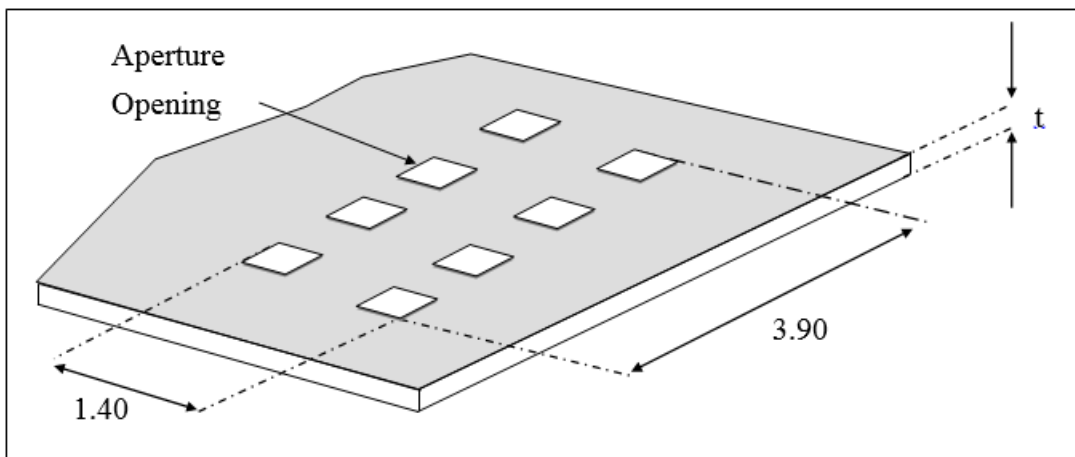


Data Sheet

**OPTICAL SENSOR
LTR-X150P****Recommended Metal Stencil Aperture**

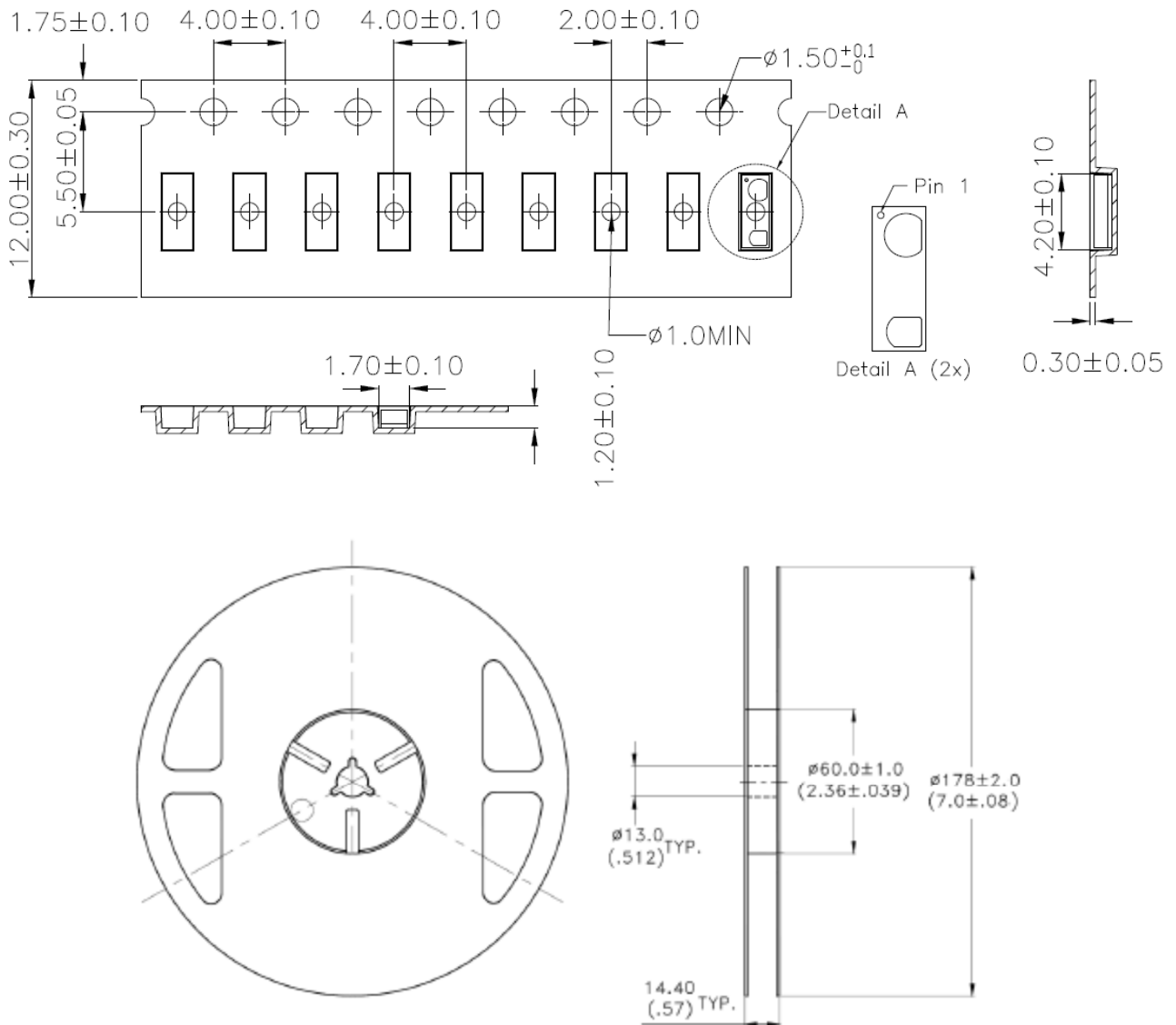
It is recommended that the metal stencil used for solder paste printing has a thickness (t) of 0.11mm (0.004 inches / 4 mils) or 0.127mm (0.005 inches / 5 mils).

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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11. 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 specification

