



Optical Sensor Product Data Sheet LTR-308ALS-01

Spec No.: DS86-2016-0027

Effective Date: 04/19/2016

Revision: -

LITE-ON DCC

RELEASE

BNS-OD-FC001/A4

OPTICAL SENSOR LTR-308ALS-01

Description

The LTR-308ALS-01 is an integrated low voltage I2C ambient light sensor (ALS) in a single 2x2mm miniature chip 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 has a 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 in mobile, computing, and consumer devices.

Features

- I²C interface (Standard mode @100kHz or Fast mode @400kHz)
- Ambient Light in ultra-small chip lead 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 ALS with upper and lower thresholds
- RoHS and Halogen free compliant

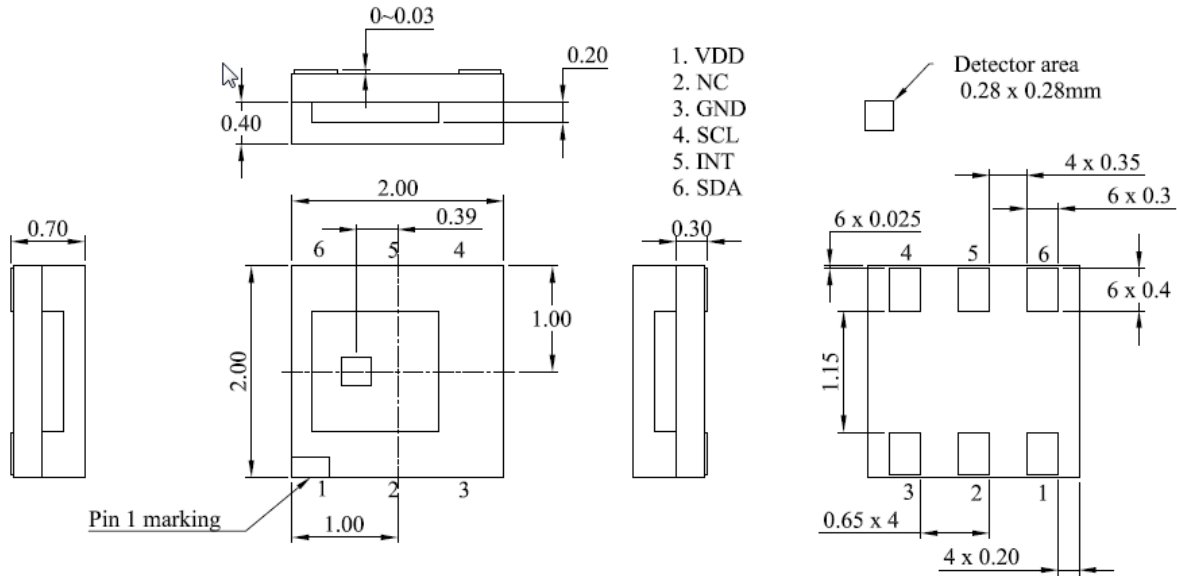
- **ALS Features**
 - 16 to 20 bits effective resolution
 - Wide dynamic range (0.01 to 157K lux) with linear response
 - Close to human eye spectral response
 - Automatic rejection for 50Hz/60Hz lighting flicker

Ordering Information

| Part Number | Packaging Type | Package | Quantity |
|---------------|----------------|-------------------------|----------|
| LTR-308ALS-01 | Tape and Reel | 6-pin chip lead package | 2500 |

OPTICAL SENSOR LTR-308ALS-01

1. Outline Dimensions

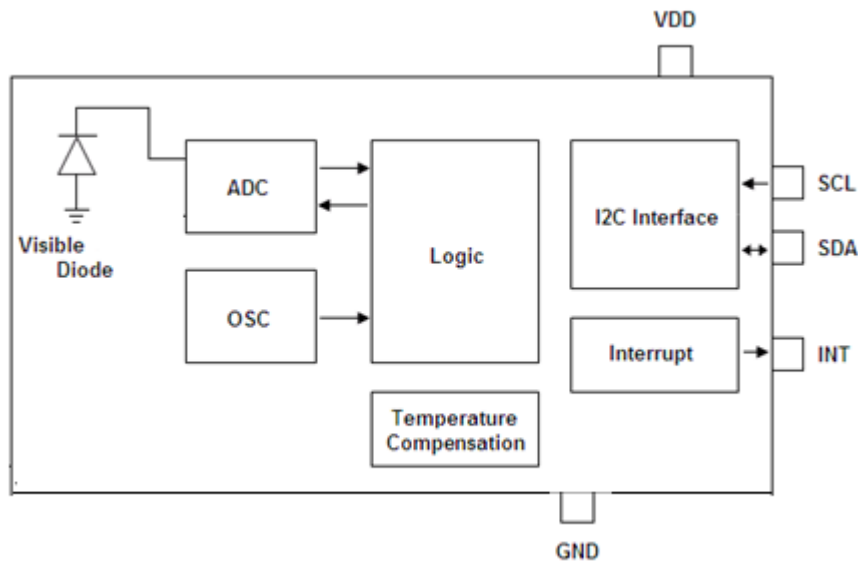


1. All dimensions in mm
2. Tolerances is +/-0.2
3. LTC reserve the right to to change the drawing till final datasheet release

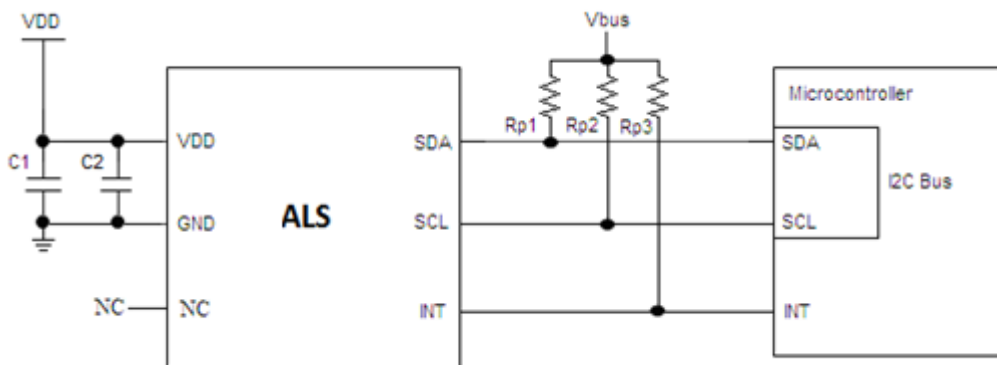
OPTICAL SENSOR LTR-308ALS-01

2. Functional Block Diagram

LTR-308ALS-01 contains photodiode for respective photocurrent 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 course, voltage reference, and internal fuses to store trimming information.



3. Application Circuit



OPTICAL SENSOR LTR-308ALS-01

I/O Pins Configuration Table

| Pin | I/O Type | Symbol | Description |
|-----|----------|--------|---|
| 1 | | VDD | Power Supply Voltage |
| 2 | | NC | No connection to this pin |
| 3 | | GND | Ground |
| 4 | I | SCL* | I ² C serial clock. This pin is an open drain input. |
| 5 | O | INT* | Level Interrupt Pin. This pin is an open drain output. |
| 6 | I/O | SDA* | I ² C serial data. This pin is an open drain input / output. |

* Note: For noisy environment, add 10pF capacitor from signal to GND for additional noise filtering.

Recommended Application Circuit Components

| Component | Recommended Value |
|-------------------|-------------------|
| Rp1, Rp2, Rp3 [1] | 1 kΩ to 10 kΩ |
| C1 | 0.1uF |
| C2 | 4.7uF |

Notes:

[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

OPTICAL SENSOR LTR-308ALS-01

4. Rating and Specification

4.1. Absolute Maximum Rating at Ta=25°C

| Parameter | Symbol | Min. | Max. | Unit |
|--|------------------|------|------|------|
| Supply Voltage | VDD | | 4.0 | V |
| Digital Voltage Range | SCL, SDA, INT | -0.5 | 4.0 | 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.

4.2. 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} | -40 | | 85 | °C |

4.3. Electrical Specifications (VDD = 1.8V, Ta=25°C, unless otherwise noted)

| Parameter | Min. | Typ. | Max. | Unit | Condition |
|--------------------------|------|------|------|------|------------------------------------|
| Active Supply Current | | 110 | | μA | Max. duty cycle, Vdd=1.8V, Gain 3x |
| Standby Current | | 1 | | μA | Shutdown Mode |
| Wakeup Time from Standby | | 5 | 10 | ms | From Standby to Active mode where |

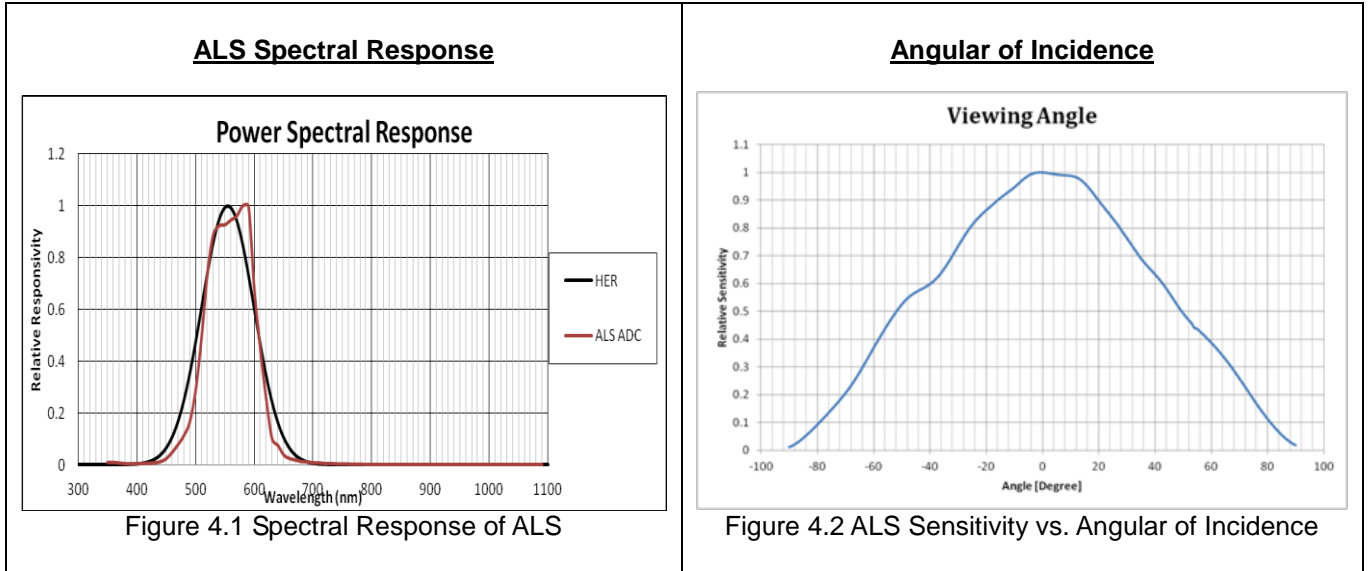
4.4. Characteristics Ambient Light

| Parameter | Min. | Typ. | Max. | Unit | Condition |
|------------------------------|------|------|------|-------|---|
| ALS Resolution | 16 | | 20 | Bit | Programmable for 16, 17, 18, 19, 20 Bit |
| ALS Lux accuracy | -10 | | 10 | % | White LED, 5000K, Ta = 25° |
| Dark Level Count | | 0 | 5 | Count | 0 Lux, 18-bit resolution |
| Integration time | 50 | | 400 | ms | With 50/60Hz Rejection |
| 50/60 Hz flicker noise error | -5 | | +5 | % | |

OPTICAL SENSOR LTR-308ALS-01

4.5. Typical Device Parameter

(VDD = 2.8V, Ta=25°C, Default power-up settings, unless otherwise noted)

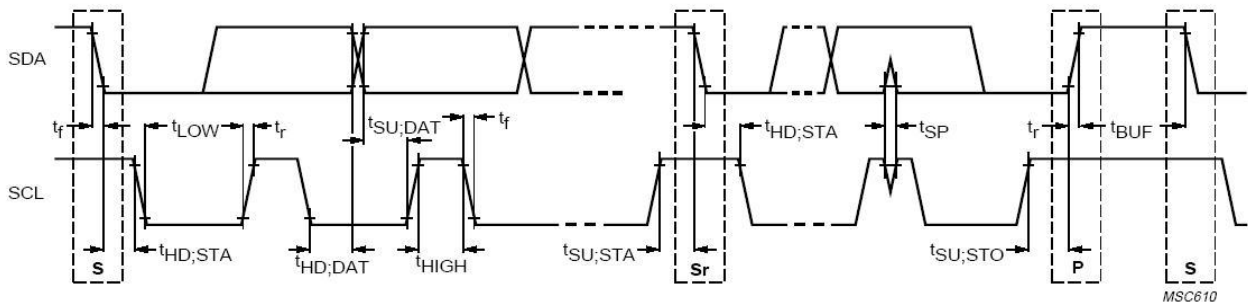


OPTICAL SENSOR LTR-308ALS-01

4.6 AC Electrical Characteristics

All specifications are at $V_{Bus} = 1.7V$, $T_{ope} = 25^{\circ}C$, unless otherwise noted.

| Parameter | Symbol | Min. | Max. | Unit |
|---|--------------|------|------|------|
| SCL clock frequency | f_{SCL} | 1 | 400 | kHz |
| Bus free time between a STOP and START condition | t_{BUF} | 1.3 | | us |
| Hold time (repeated) START condition. After this period, the first clock pulse is generated | $t_{HD;STA}$ | 0.6 | | us |
| LOW period of the SCL clock | t_{LOW} | 1.3 | | us |
| HIGH period of the SCL clock | t_{HIGH} | 0.6 | | us |
| Set-up time for a repeated START condition | $t_{SU;STA}$ | 0.6 | | us |
| Set-up time for STOP condition | $t_{SU;STO}$ | 0.6 | | us |
| Rise time of both SDA and SCL signals | t_r | 30 | 300 | ns |
| Fall time of both SDA and SCL signals | t_f | 30 | 300 | ns |
| Data hold time | $t_{HD;DAT}$ | 0.3 | 0.9 | us |
| Data setup time | $t_{SU;DAT}$ | 100 | | ns |
| Pulse width of spikes which must be suppressed by the input filter | t_{SP} | 0 | 50 | ns |



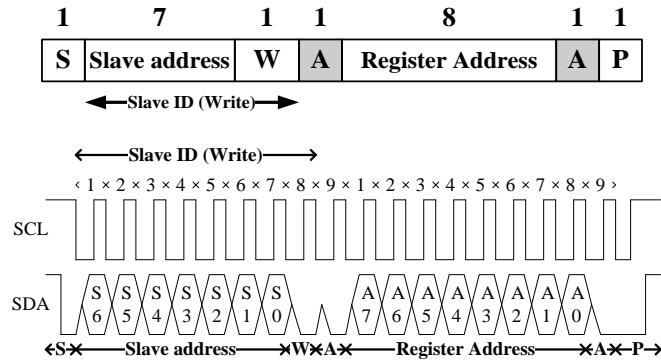
Definition of timing for I²C bus

OPTICAL SENSOR LTR-308ALS-01

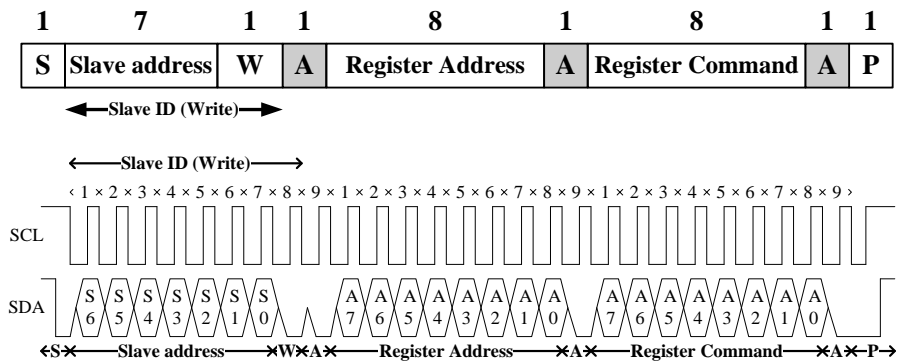
5. Principle of Operation

I²C Protocols

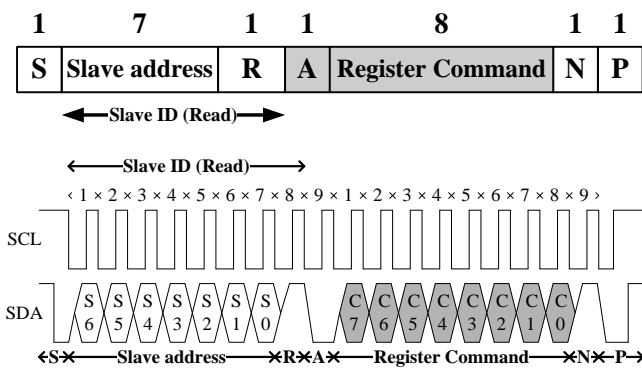
· I²C Write Protocol (type 1):



· I²C Write Protocol (type 2):

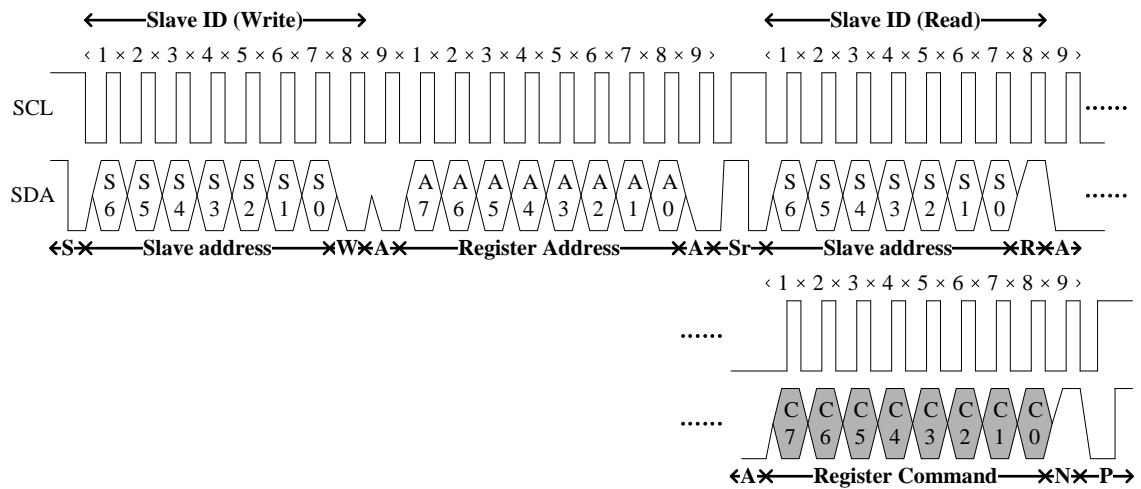
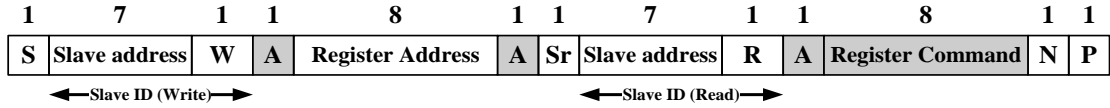


· I²C Read Protocol:



OPTICAL SENSOR LTR-308ALS-01

· I²C 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

I²C Slave Address

The device has a 7-bit slave address of 0x53. A read/write bit should be appended to the slave address by the master device to properly communicate with the device.

| I ² C Slave Address (Default) | | | | | | | | | |
|--|--------|-------|-------|-------|-------|-------|-------|-------|-------|
| Command Type | (0x53) | | | | | | | W/R | value |
| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
| Write | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0xA6H |
| Read | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0xA7H |

OPTICAL SENSOR LTR-308ALS-01

6. Register Set

| Addr | R/W | Register Name | Description | Reset Value |
|-----------|-----|-----------------|--|-------------|
| 0x00 | R/W | MAIN_CTRL | ALS operation mode control, SW reset | 0x00 |
| 0x01-0x03 | R | Reserved | -- | -- |
| 0x04 | R/W | ALS_MEAS_RATE | ALS measurement rate and resolution in Active Mode | 0x22 |
| 0x05 | R/W | ALS_GAIN | ALS analog Gain | 0x01 |
| 0x06 | R | PART_ID | Part number ID and revision ID | 0xB1 |
| 0x07 | R | MAIN_STATUS | Power-On status, Interrupt status, Data status | 0x20 |
| 0x08-0x0C | R | Reserved | -- | -- |
| 0x0D | R | ALS_DATA_0 | ALS ADC measurement data, LSB | 0x00 |
| 0x0E | R | ALS_DATA_1 | ALS ADC measurement data | 0x00 |
| 0x0F | R | ALS_DATA_2 | ALS ADC measurement data, MSB | 0x00 |
| 0x10-0x18 | R | Reserved | -- | 0x00 |
| 0x19 | R/W | INT_CFG | Interrupt configuration | 0x10 |
| 0x1A | R/W | INT_PST | Interrupt persist setting | 0x00 |
| 0x1B-0x20 | R | Reserved | -- | -- |
| 0x21 | R/W | ALS_THRES_UP_0 | ALS interrupt upper threshold, LSB | 0xFF |
| 0x22 | R/W | ALS_THRES_UP_1 | ALS interrupt upper threshold, intervening bits | 0xFF |
| 0x23 | R/W | ALS_THRES_UP_2 | ALS interrupt upper threshold, MSB | 0x0F |
| 0x24 | R/W | ALS_THRES_LOW_0 | ALS interrupt lower threshold, LSB | 0x00 |
| 0x25 | R/W | ALS_THRES_LOW_1 | ALS interrupt lower threshold, intervening bits | 0x00 |
| 0x26 | R/W | ALS_THRES_LOW_2 | ALS interrupt lower threshold, MSB | 0x00 |

MAIN_CTRL Register (0x00) (Read/Write)

This register controls the operation modes of ALS, which can be set to either standby or active mode. When writing to this register, it will cause a stop to any ongoing measurements and start new measurement.

| 0x00 | MAIN_CTRL (default = 0x00) | | | | | | | |
|------|----------------------------|----|----|-----------------------|-----------------|----|-------------------|-----------------|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>Reserved</i> | | | <i>Software Reset</i> | <i>Reserved</i> | | <i>ALS Enable</i> | <i>Reserved</i> |

OPTICAL SENSOR LTR-308ALS-01

| Field | Bits | Default | Description | |
|------------|------|---------|-------------|---|
| Reserved | 7:5 | 000 | -- | Must write 000 |
| SW Reset | 4 | 0 | 0 | Software reset is NOT triggered (default) |
| | | | 1 | Software reset is triggered |
| Reserved | 2:3 | 00 | -- | Must Write 00 |
| ALS Enable | 1 | 0 | 0 | ALS standby(default) |
| | | | 1 | ALS active |
| Reserved | 0 | 0 | -- | Must write 0 |

ALS_MEAS_RATE Register (0x04) (Read/Write)

This register controls ALS measurement resolution, Gain setting and measurement rate. When the measurement rate is programmed to be faster than possible for the programmed ADC measurement, the rate will be lowered than programmed (maximum speed).

| 0x04 | ALS_MEAS_RATE (default = 0x22) | | | | | | | |
|------|--------------------------------|-----------------------------------|----|----|-----------------|-----------------------------|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>Reserved</i> | <i>ALS/C Resolution/Bit Width</i> | | | <i>Reserved</i> | <i>ALS Measurement Rate</i> | | |

| Field | Bits | Default | Description | |
|----------------------|------|---------|--------------|--|
| Reserved | 7 | 0 | Must write 0 | |
| ALS Resolution | 6:4 | 010 | 000 | 20 Bit, Conversion time = 400ms |
| | | | 001 | 19 Bit, Conversion time = 200ms |
| | | | 010 | 18 Bit, Conversion time = 100ms(default) |
| | | | 011 | 17 Bit, Conversion time = 50ms |
| | | | 100 | 16 Bit, Conversion time = 25ms |
| | | | 101/110/111 | Reserved |
| Reserved | 3 | 0 | -- | -- |
| ALS Measurement Rate | 2:0 | 010 | 000 | 25ms |
| | | | 001 | 50ms |
| | | | 010 | 100ms (default) |
| | | | 011 | 500ms |
| | | | 101 | 1000ms |
| | | | 110/111 | 2000ms |

OPTICAL SENSOR LTR-308ALS-01

ALS_GAIN Register (0x05) (Read/Write)

This register controls ALS measurement Gain Range.

| 0x05 | ALS_GAIN (default = 0x01) | | | | | | | |
|------|---------------------------|----|----|----|----|-----------------------|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>Reserved</i> | | | | | <i>ALS Gain Range</i> | | |

| Field | Bits | Default | Description | |
|----------------|------|---------|-------------|-------------------------|
| Reserved | 7:3 | 00000 | 00000 | Must write 00000 |
| ALS Gain Range | 2:0 | 001 | 000 | Gain Range: 1 |
| | | | 001 | Gain Range: 3 (default) |
| | | | 010 | Gain Range: 6 |
| | | | 011 | Gain Range: 9 |
| | | | 100 | Gain Range: 18 |

PART_ID Register (0x06) (Read Only)

This register defines the part number and revision identification of the sensor.

| 0x06 | PART_ID (default = 0xB1) | | | | | | | |
|------|--------------------------|----|----|----|--------------------|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>Part Number ID</i> | | | | <i>Revision ID</i> | | | |

OPTICAL SENSOR LTR-308ALS-01

| Field | Bits | Default | Description |
|----------------|------|---------|----------------|
| Part Number ID | 7:4 | 1011 | Part Number ID |
| Revision ID | 3:0 | 0001 | Revision ID |

MAIN_STATUS Register (0x07) (Read Only)

This register stores the information about the ALS interrupts and data status. The interrupt status in Bit 4 determines if the ALS interrupt criteria are met in Normal Interrupt Mode. It triggers when the ALS data is above the upper or below the lower threshold for a specified number of consecutive measurements in respective interrupt persist settings. For details interrupt behavior, refer to Section 10.

| 0x07 | MAIN_STATUS (default = 0x20) | | | | | | | |
|------|------------------------------|----|-----------------|----------------------|-----------------|----------|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | Reserved | | Power ON Status | ALS Interrupt Status | ALS Data Status | Reserved | | |

| Field | Bits | Default | Description |
|----------------------|------|---------|---|
| Reserved | 7:6 | 00 | 00 Must write 00 |
| Power On Status | 5 | 0 | Power on event and All interrupt threshold settings in the registers have been rest to power on default states (either due to part turned on or power supply voltage glitch). Flag is cleared after read. |
| ALS Interrupt Status | 4 | 0 | 0 Interrupt is NOT triggered (default) |
| | | | 1 Interrupt is triggered and will be cleared after read |
| ALS Data Status | 3 | 0 | 0 ALS data is old data (Data has been read) |
| | | | 1 ALS data is new data (Data has not been read and will be cleared after read) |
| Reserved | 2:0 | 000 | 000 Must write 000 |

OPTICAL SENSOR LTR-308ALS-01

ALS_DATA Register (0x0D / 0x0E / 0x0F) (Read Only)

The ALS Channel digital output data are expressed as a 16 to 20 bit unsigned integer data. When I2C read operation is active and points to any of the register address between 0x07 and 0x18, all 3 registers will be locked until the I2C read operation has been completed or the specified address range is left. This is to ensure that the data in the registers is from the same measurement even if an additional measurement cycle ends during the read operation. New measurement data is stored into temporary registers and the ALS_DATA registers will be updated as soon as there is no on-going I2C read operation to the address range 0x07 to 0x18.

| 0x0D | ALS_DATA_0 (default = 0x00) | | | | | | | |
|------|-----------------------------|----|----|----|----|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>ALS DATA, Low</i> | | | | | | | |

| 0x0E | ALS_DATA_1 (default = 0x00) | | | | | | | |
|------|-----------------------------|----|----|----|----|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>ALS DATA, Middle</i> | | | | | | | |

| 0x0F | ALS_DATA_2 (default = 0x00) | | | | | | | |
|------|-----------------------------|----|----|----|-----------------------|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>Reserved</i> | | | | <i>ALS DATA, High</i> | | | |

| Field | Address | Bits | Default | Description |
|------------------|---------|------|----------|---------------------------|
| ALS Data, Low | 0x0D | 7:0 | 00000000 | ALS Data lower byte data |
| ALS Data, Middle | 0x0E | 7:0 | 00000000 | ALS Data Middle byte data |
| ALS Data, High | 0x0F | 7:4 | 0000 | Reserved |
| | | 3:0 | 0000 | ALS Data Higher byte data |

OPTICAL SENSOR LTR-308ALS-01

INT_CFG Register (0x19) (Read/Write)

This register controls the operation of the interrupt pin and functions. ALS has independent interrupt signal and ALS interrupt is active low.

ALS interrupt is enabled by Bit 2. Under Normal Interrupt Mode, the edge-triggered interrupt signal output will be maintains at active level until MAIN_STATUS register is read.

| 0x19 | INT_CFG (default = 0x10) | | | | | | | |
|------|--------------------------|----|----------------|----|----------|--------------------|----------|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | Reserved | | ALS INT SELECT | | Reserved | ALS INT PIN ENABLE | Reserved | |

| Field | Bits | Default | Description | |
|--------------------------|------|---------|-------------|----------------------------------|
| Reserved | 7:6 | 00 | 00 | Must write 00 |
| ALS Interrupt Select | 4:5 | 01 | 00 | Reserved |
| | | | 01 | ALS Channel(Default) |
| Reserved | 3 | 0 | 0 | Must be 0 |
| ALS Interrupt Pin Enable | 2 | 0 | 0 | ALS interrupt disabled (default) |
| | | | 1 | ALS interrupt enabled |
| Reserved | 1:0 | 00 | 00 | Must write 00 |

INT_PST Register (0x1A) (Read/Write)

This register controls the N number of times the measurement data is outside the range defined by the upper and lower threshold limits before asserting the interrupt.

| 0x1A | INT_PST (default = 0x00) | | | | | | | |
|------|--------------------------|----|----|----|----------|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | ALS Persist | | | | Reserved | | | |

OPTICAL SENSOR LTR-308ALS-01

| Field | Bits | Default | Description | |
|-------------|------|---------|-----------------|---|
| ALS Persist | 7:4 | 0000 | 0000 | Every ALS value out of threshold range asserts an interrupt (default) |
| | | | 0001 | 2 consecutive ALS values out of threshold range assert an interrupt |
| | | | ... | ... |
| | | | 1111 | 16 consecutive ALS values out of threshold range assert an interrupt |
| Reserved | 3:0 | 0000 | Must write 0000 | |

ALS_THRES Register (0x21 / 0x22 / 0x23 / 0x24 / 0x25 / 0x26) (Read/Write)

The ALS_THRES_UP (up to 20-bits) and ALS_THRES_LOW (up to 20-bits) registers determines the upper and lower limit of the interrupt threshold value respectively. Interrupt will be triggered if measurement data in ALS_DATA is exceeding the upper and lower limits.

| 0x21 | ALS_THRES_UP_0 (default = 0xFF) | | | | | | | |
|------|---------------------------------|----|----|----|----|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>ALS Upper Threshold, Low</i> | | | | | | | |

| 0x22 | ALS_THRES_UP_1 (default = 0xFF) | | | | | | | |
|------|---------------------------------|----|----|----|----|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>ALS Upper Threshold, Mid</i> | | | | | | | |

| 0x23 | ALS_THRES_UP_2 (default = 0x0F) | | | | | | | |
|------|---------------------------------|----|----|----|----------------------------------|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | <i>Reserved</i> | | | | <i>ALS Upper Threshold, High</i> | | | |

| 0x24 | ALS_THRES_LOW_0 (default = 0x00) | | | | | | | |
|------|----------------------------------|----|----|----|----|----|----|----|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |

OPTICAL SENSOR LTR-308ALS-01

| | | | | | | | |
|---------------------------------|--|--|--|--|--|--|--|
| <i>ALS Lower Threshold, Low</i> | | | | | | | |
|---------------------------------|--|--|--|--|--|--|--|

| | | | | | | | | |
|---------------------------------|----------------------------------|----|----|----|----|----|----|----|
| 0x25 | ALS_THRES_LOW_1 (default = 0x00) | | | | | | | |
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| <i>ALS Lower Threshold, Mid</i> | | | | | | | | |

| | | | | | | | | |
|-----------------|----------------------------------|----|----|----------------------------------|----|----|----|----|
| 0x26 | ALS_THRES_LOW_2 (default = 0x00) | | | | | | | |
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| <i>Reserved</i> | | | | <i>ALS Lower Threshold, High</i> | | | | |

| Field | Address | Bits | Default | Description |
|---------------------------|---------|------|----------|--|
| ALS Upper Threshold, Low | 0x21 | 7:0 | 11111111 | ALS upper interrupt threshold, Low byte |
| ALS Upper Threshold, Mid | 0x22 | 7:0 | 11111111 | ALS upper interrupt threshold, Mid byte |
| ALS Upper Threshold, High | 0x23 | 7:4 | 0000 | Reserved |
| | | 3:0 | 1111 | ALS upper interrupt threshold, High byte |
| ALS Lower Threshold, Low | 0x24 | 7:0 | 00000000 | ALS lower interrupt threshold, Low byte |
| ALS Lower Threshold, Mid | 0x25 | 7:0 | 00000000 | ALS lower interrupt threshold, Mid byte |
| ALS Lower Threshold, High | 0x26 | 7:4 | 0000 | Reserved |
| | | 3:0 | 0000 | ALS lower interrupt threshold, High byte |

7. Application Information

7.1 Lux Formula

Lux_Calc is the calculated lux reading and ALS DATA is the digital representation (output ADC) of ambient light level stored in the registers (Address: 0x0D-0x0F) regardless of light sources.

OPTICAL SENSOR LTR-308ALS-01

For no window (Clear window)

$$Lux_{Calc} = \frac{0.6 \times ALS_{DATA}}{(GAIN \times INT)}$$

For device under window (eg: Tinted window)

Window Factor is needed when device under Window glass with coated tinted ink. This is to compensate the light loss due to the lower transmission rate of the window glass.

$$Lux_{Calc} = \frac{0.6 \times ALS_{DATA}}{(GAIN \times INT)} \times Window\ Factor$$

Where:

| ALS Gain | GAIN |
|----------|------|
| X1 | 1 |
| X3 | 3 |
| X6 | 6 |
| X9 | 9 |
| X18 | 18 |

| Resolution (bit) / Integration Time (ms) | INT |
|--|------|
| 16-bit, 25ms | 0.25 |
| 17-bit, 50ms | 0.5 |
| 18-bit, 100ms | 1 |
| 19-bit, 200ms | 2 |
| 20-bit, 400ms | 4 |

Note :

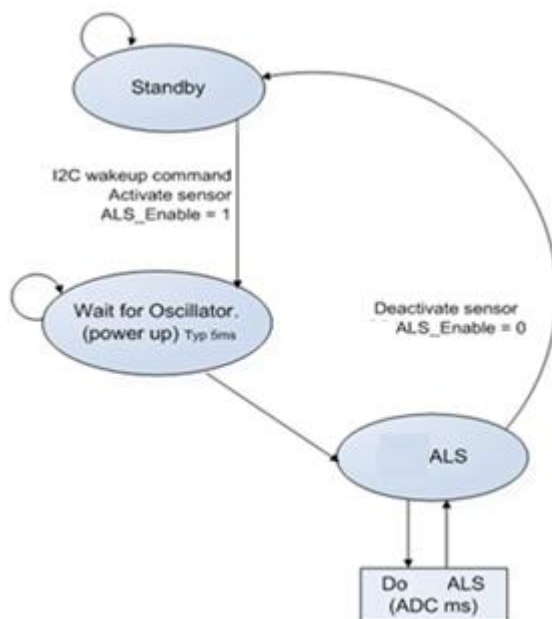
1. For low lux detection (0.01 lux to 10 000 lux , under bare die condition), it is recommended to use highest Gain (Gain x18) and highest resolution bit (20 bit).
2. For default setting Gain 3x, 18-bits, 100ms integration time, detectable lux 0.2 to 52K lux

7.2 Device Operation (State Machine and Interrupt Features)

State Machine

Below diagram is the main state machine of LTR-308ALS.

OPTICAL SENSOR LTR-308ALS-01



During the ALS Operation, ALS measurements can be activated by setting the ALS_Enable bit to 1. As soon as the ALS sensors become activated through an I2C command, the internal support blocks are powered on. Once the voltages and currents are settled (typically after 5ms), the state machine checks for trigger events from a measurement scheduler to start ALS conversions according to the selected measurement repeat rates. Once ALS_Enable is changed back to 0, a running conversion on the respective channel will be completed and the relevant ADCs and support blocks will move to power-down state.

Interrupt Features

This device generates independent ALS interrupt signal that can be multiplexed and output to the INT output pin. The interrupt conditions are always evaluated after completion of a new conversion of the ALS channels. ALS interrupts is active low at the INT pin.

ALS Interrupt

The ALS interrupt is enabled by Bit 2 (ALS INT Pin Enabled) of INT_CFG register (0x19). The source is selected by Bit 4 and 5 (ALS INT Select) of INT_CFG register.

OPTICAL SENSOR LTR-308ALS-01

The INT is set when the data of the selected interrupt source is above the upper or below the lower threshold for a specified number of consecutive measurements set in ALS Persist in INT_PST register (0x1A).

The Interrupt signal is also stored in MAIN_STATUS register (0x07) as flag bit in Bit 4 (ALS INT Status). This status flag bit is cleared by reading the MAIN_STATUS register. A cleared flag will also clear the interrupt signal on the INT pin.

OPTICAL SENSOR LTR-308ALS-01

8. Pseudo Codes Examples

Slave address

Slave_Addr = 0xA6

MAIN_CTRL Register

// This defines the operating modes of the ALS
// Default settings is 0x00 (ALS standby)

Register_Addr = 0x00
Command = 0x03

// MAIN_CTRL register
// ALS in Active Mode
// Command = 0x07, ALS in Active Mode,

WriteByte(Slave_Addr, Register_Addr, Command);

ALS_MEAS_RATE Register

// This controls the ALS measurement resolution and measurement rate.
// Default setting of the register is 0x22 (Resolution = 18 Bit, Measurement rate of 100ms)

Register_Addr = 0x04
Command = 0x41

// ALS_MEAS_RATE register
// Resolution = 16 bit, Meas Rate =50ms
// Command =0x25,Resolution = 18 bit, Meas Rate =1000ms
// Command =0x02, Resolution = 20 bit, Meas Rate =100ms

WriteByte(Slave_Addr, Register_Addr, Command)

ALS_GAIN Register

// This controls the ALS Gain Range.
// Default setting of the register is 0x01 (Gain Range = 3)

Register_Addr = 0x05
Command = 0x00

// ALS_GAIN register
// Gain = 1
// Command =0x04, Gain = 18

WriteByte(Slave_Addr, Register_Addr, Command)

MAIN_STATUS Register (Read Only)

// This Register contains the information on Interrupt, ALS data status.

Register_Addr = 0x07
Data = ReadByte(Slave_Addr, Register_Addr)

// MAIN_STATUS register address

Power_ON_Status = Data & 0x20

// If 0x20 Part went through power-up event
// If 0x00 Normal

ALS_Interrupt_Status = Data & 0x10

// If 0x10 Interrupt triggered
// If 0x00 Interrupt condition not fulfilled

ALS_Data_Status = Data & 0x08

// If 0x08 ALS data is new
// If 0x00 Old (previously read) Data

ALS_DATA Registers (Read Only)

// The register 0x0D contains ALS_ADC 0 lower byte data.
// The register 0x0E contains ALS_ADC 1 upper byte data.
// The register 0x0F contains ALS_ADC 2 (top) upper byte data.
// These registers should be read as a group, with the lower address being read first.

OPTICAL SENSOR LTR-308ALS-01

```

Register_Addr = 0x0D // ALS_DATA__0 low byte address
Data0=ReadByte(Slave_Addr, Register_Addr)
Register_Addr = 0x0E // ALS_DATA_1 middle byte address
Data1=ReadByte(Slave_Addr, Register_Addr)
Register_Addr = 0x0F // ALS_DATA_2 upper byte address
Data2=ReadByte(Slave_Addr, Register_Addr)
ALS_ADC_Data =(Data2<<16)| (Data1 << 8) | Data0
// Shift and combine all registers to get ALS_ADC Data

```

INT_CFG Register

//This register controls the operation of the interrupt pins and options to trigger interrupt for ALS.
//The default value for this INT_CFG register is 0x10 (Interrupts inactive for both ALS)

```

Register_Addr = 0x19 // INT_CFG Register address
Command = 0x14 // Interrupt CH = ALS, ALS Interrupt Enable, Normal Trigger Mode

```

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

INTERRUPT_PERSIST Register

// This register sets the ALS persist level.
// The default setting is 0x00. Interrupt at every ALS reading outside set thresholds.

```

Register_Addr = 0x1A // INT_PST register
Command = 0x00 // Interrupt for every ALS value outside threshold
// Command =0x10, Subsequent 2 ALS outside threshold range

```

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

ALS_THRES Registers

//The register 0x21 contains ALS Interrupt upper threshold lower byte data (ALS_THRES_UP_0)
//The register 0x22 contains ALS Interrupt upper threshold 1 upper byte data (ALS_THRES_UP_1)
//The register 0x23 contains ALS Interrupt upper threshold 2 upper byte data (ALS_THRES_UP_2)

//The register 0x24 contains ALS Interrupt lower threshold lower byte data (ALS_THRES_LOW_0)
//The register 0x25 contains ALS Interrupt lower threshold 1 upper byte data (ALS_THRES_LOW_1)
//The register 0x26 contains ALS Interrupt lower threshold 2 upper byte data (ALS_THRES_LOW_2)

```

// To set ALS Upper threshold for Interrupt
Upper_Threshold_Value=1000 // Example 1000
Data2 = Upper_Threshold_Value >> 16 // Shift right to extract the 2 upper byte
Data1 = Upper_Threshold_Value >> 8 // Shift right to extract the 1 upper byte
Data0 = Upper_Threshold_Value & 0xFF // Mask to extract lower byte.

```

```

Register_Addr = 0x21 // ALS_THRES_UP_0 Register address
WriteByte(Slave_Addr, Register_Addr, Data0)
Register_Addr = 0x22 // ALS_THRES_UP_1 Register address
WriteByte(Slave_Addr, Register_Addr, Data1)
Register_Addr = 0x23 // ALS_THRES_UP_2 Register address
WriteByte(Slave_Addr, Register_Addr, Data2)

```

```

// To set ALS Lower threshold for Interrupt
Lower_Threshold_Value=100 // Example 100
Data2 = Lower_Threshold_Value >> 16 // Shift right to extract the 2 upper byte
Data1 = Lower_Threshold_Value >> 8 // Shift right to extract the 1 upper byte
Data0 = Lower_Threshold_Value & 0xFF // Mask to extract lower byte.

```

```
Register_Addr = 0x24 // ALS_THRES_LOW_0 Register address
```

OPTICAL SENSOR LTR-308ALS-01

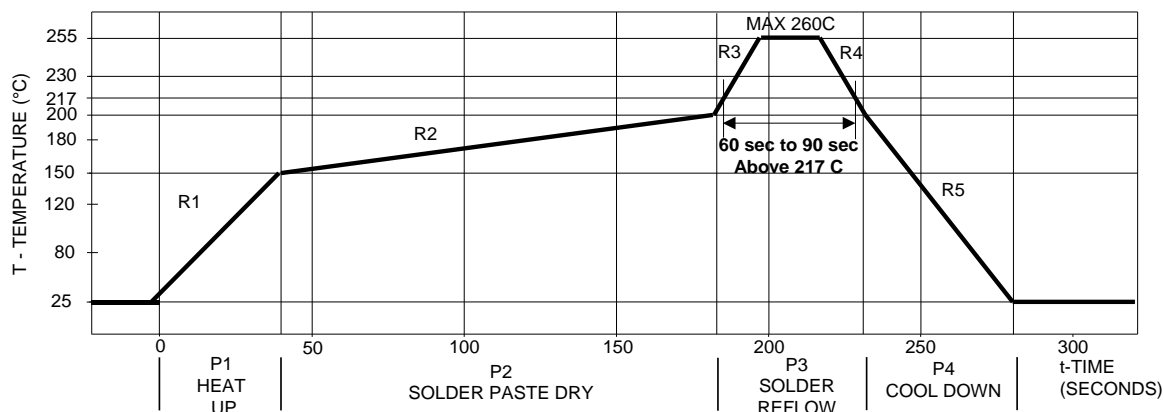
```
WriteByte(Slave_Addr, Register_Addr, Data0)  
Register_Addr = 0x25  
WriteByte(Slave_Addr, Register_Addr, Data1)  
Register_Addr = 0x26  
WriteByte(Slave_Addr, Register_Addr, Data2)
```

```
// ALS_THRES_LOW_1 Register address
```

```
// ALS_THRES_LOW_2 Register address
```


OPTICAL SENSOR LTR-308ALS-01

9. Recommended Leadfree Reflow Profile



| Process Zone | Symbol | ΔT | Maximum $\Delta T/\Delta t$ 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 liquid's 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.

OPTICAL SENSOR LTR-308ALS-01

10. Moisture Proof Packaging

All LTR-308ALS-01 are shipped in moisture proof package. Once opened, moisture absorption begins. This part is compliant to JEDEC J-STD-033A Level 3.

Time from Unsealing to Soldering

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

Recommended Storage Conditions

| | |
|---------------------|--------------|
| Storage Temperature | 10°C to 30°C |
| Relative Humidity | Below 60% RH |

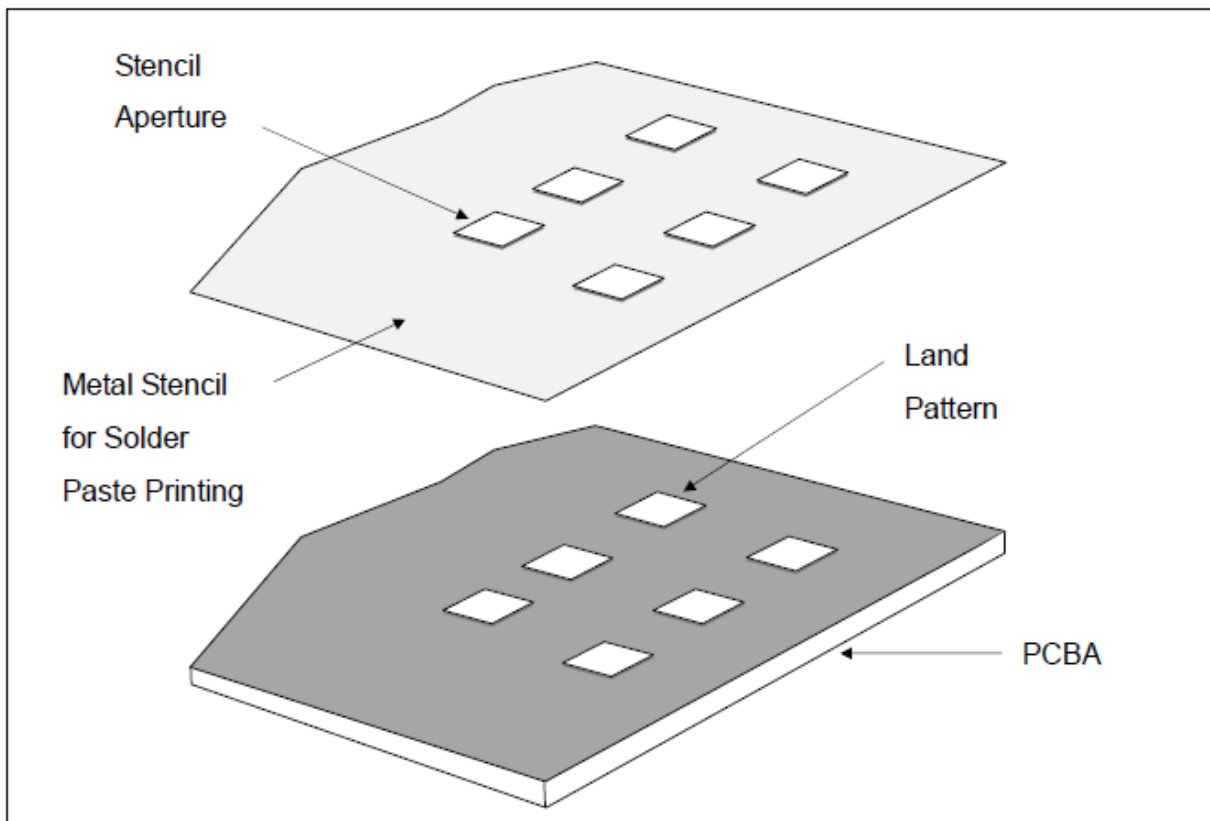
Baking Conditions

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

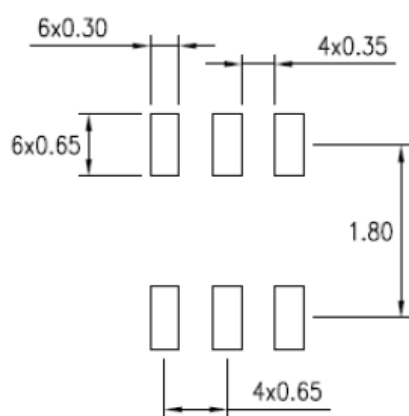
Baking should only be done once.

**OPTICAL SENSOR
LTR-308ALS-01**

11. Recommended Land Pattern



Recommended Land Pattern for LTR-308ALS-01



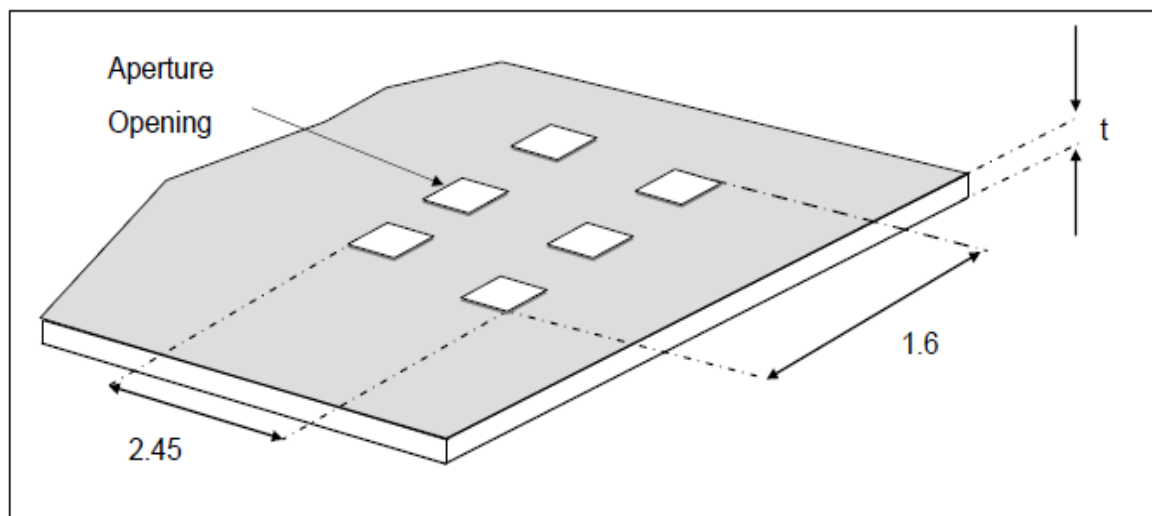
Note: All dimensions are in millimeters

OPTICAL SENSOR LTR-308ALS-01

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 0.3mm 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.

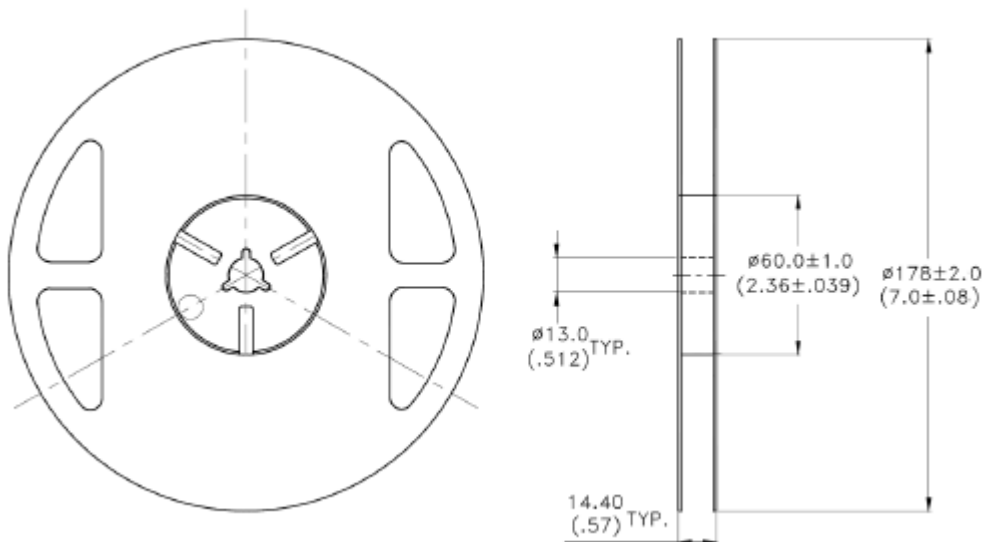
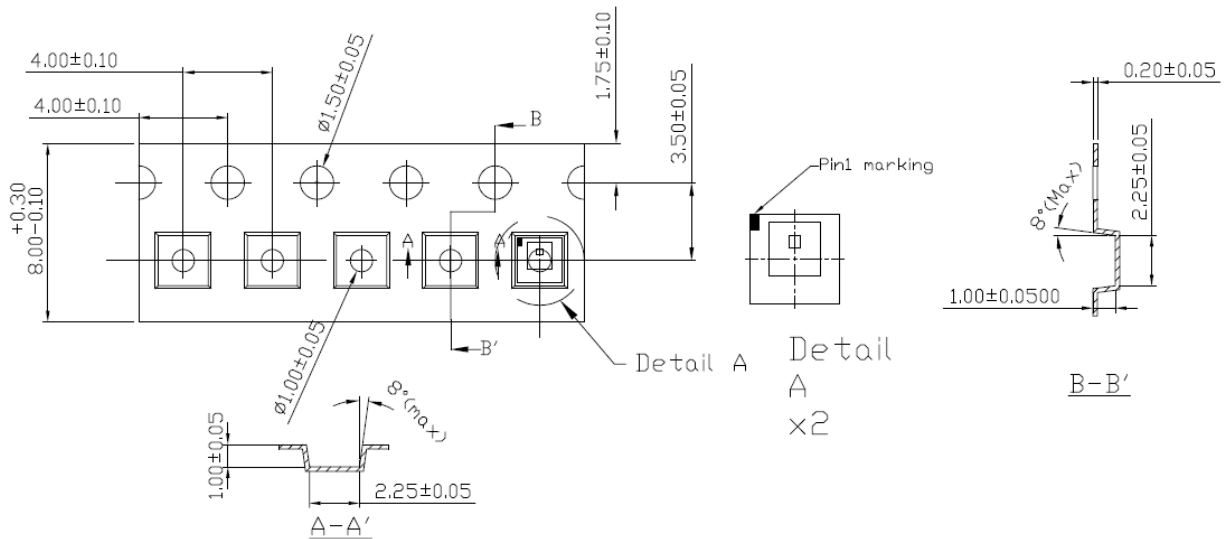


Note:

1. All dimensions are in millimeters

**OPTICAL SENSOR
LTR-308ALS-01**

13. Tape and Reel Dimensions



Notes:

1. All dimensions are in millimeters (inches)
2. Empty component pockets sealed with top cover tape
3. 7 inch reel - 2500 pieces per reel
4. In accordance with ANSI/EIA 481-1-A-1994 specifications

**OPTICAL SENSOR
LTR-308ALS-01**

Revision Table:

| Version | Update | Page | Date |
|---------|----------------------------------|----------|-----------|
| 1.0 | Final Datasheet as created | Total 29 | 22-Mar-16 |
| 1.1 | Update Part ID from 0xB2 to 0xB1 | 10 | 29-Mar-16 |