# LTR-501ALS-WA

## 2-in-1 Digital Light Sensor and Proximity Sensor

## Technical Data Sheet

## (Preliminary Specification)



SPEC NO: _____

CREATED: 6th May 2011

REV. NO: 1.1

## Revision Table

| Version | Change Description | Issue Date |
|---|---|---|
| 1.0 | As created | 06/05/11 |
| 1.1 | Outline Dimensions | 13/06/11 |
| | Functional Block Diagram | |
| | Application Circuit: Change SEL pin to NC pin | |
| | IO Pins Configuration Table | |
| | Active Supply Current | |
| | Power Down Sequence for VDD | |
| | ALS_CONTR Register: ALS Gain | |
| | PS_CONTR Register: PS Gain | |
| | ALS Measurement Repeat Rate: Default setting change to 500ms | |
| | INTERRUPT Register: Output Mode | |
| | PS_THRES: Change in default value | |

# 1. Description

The LTR-501ALS-WA is an integrated I2C digital light sensor [ALS] and proximity sensor [PS] with built-in LED driver, in a miniature chipled lead-free surface mount package. This device converts light intensity to a digital output signal capable of direct $I^2C$ interface. It provides a linear response over a wide dynamic range from 0.01 lux to 64k lux and is well suited to applications under high ambient brightness. With built-in proximity sensor, LTR-501ALS-WA offers the feature to detect object at a user configurable distance up to 12cm.

The device supports an interrupt feature that removes the need to poll the sensor for a reading which improves system efficiency. The device also supports several features that help to minimize the occurrence of false triggering. This CMOS design and factory-set one time trimming capability ensure minimal device-to-device variations for ease of manufacturability to the end customers.

# 2. Features

- $I^2C$ interface (Fast Mode @ 400kbit/s)
- Ultra-small ChipLED package
- Built-in temperature compensation circuit
- Low active power consumption with standby mode
- Supply voltage range from 2.4V to 3.6V capable of 1.7V logic voltage
- Operating temperature range from -30°C to +70°C
- RoHS and Halogen free compliant
- Light Sensor
  - Close to human eye spectral response
  - Immunity to IR / UV Light Source
  - Automatically rejects 50 / 60 Hz lightings flicker
  - Full dynamic range from 2 lux to 64k lux
  - High resolution range from 0.01 lux to 320 lux
  - 16-bit effective resolution
- Proximity Sensor
  - Built-in LED driver, emitter and detector
  - Programmable LED drive settings
  - 11-bit effective resolution
  - High ambient light suppression

## 3. Applications

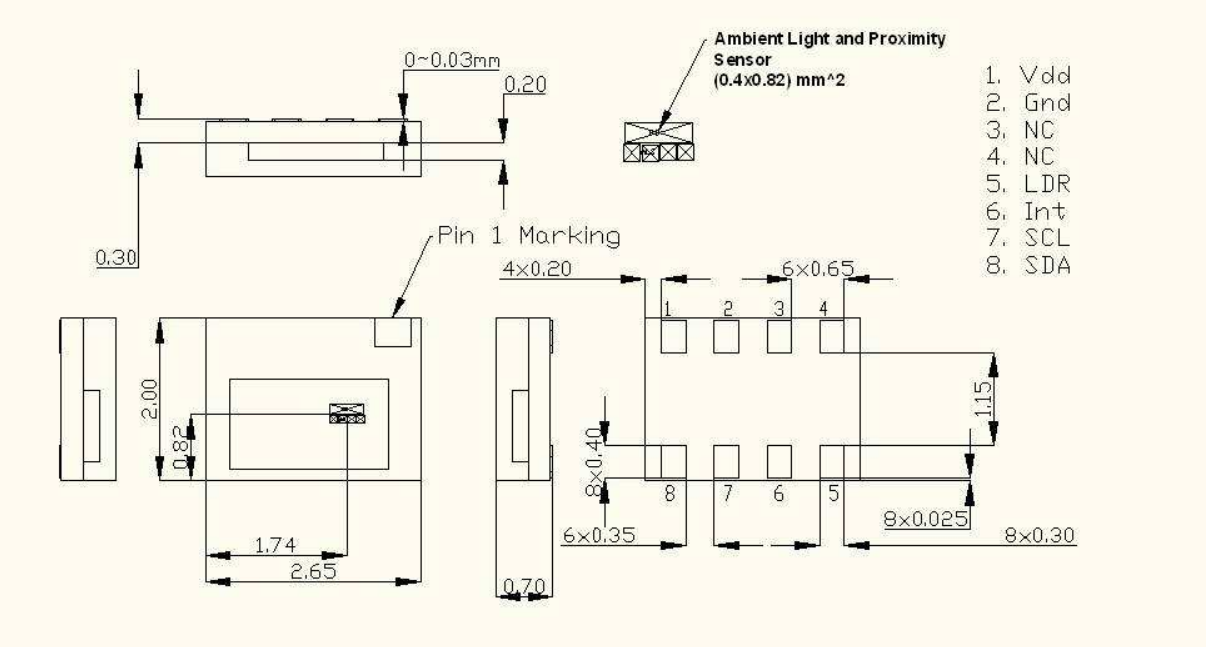
To control display backlight and/or object detection in

- Mobile Devices: Mobile phone, PDA
- Computing Devices: Notebook PC, Desktop Monitor
- Consumer Devices: LCD/PDP TV backlight systems, Cameras, Personal Navigation Device, Digital Photo Frame
- Dashboard

## 4. Ordering Information

| Part Number | Packaging Type | Package | Quantity |
|---|---|---|---|
| LTR-501ALS-WA | Tape and Reel | 8-pin chipled package | 2500 |

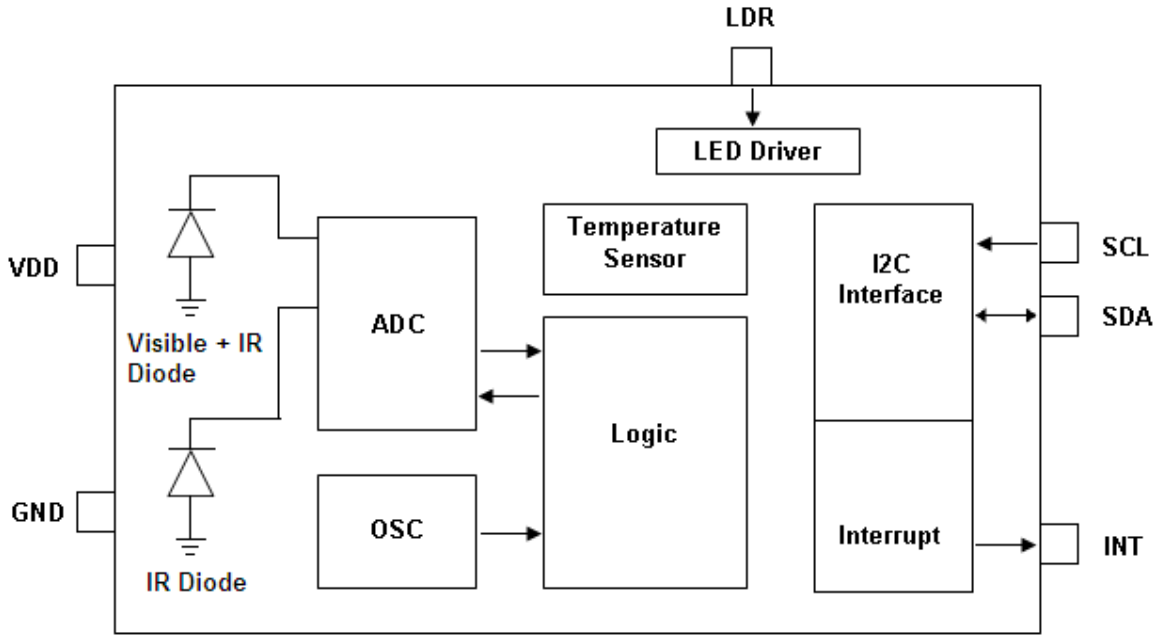
## 5. Outline Dimensions



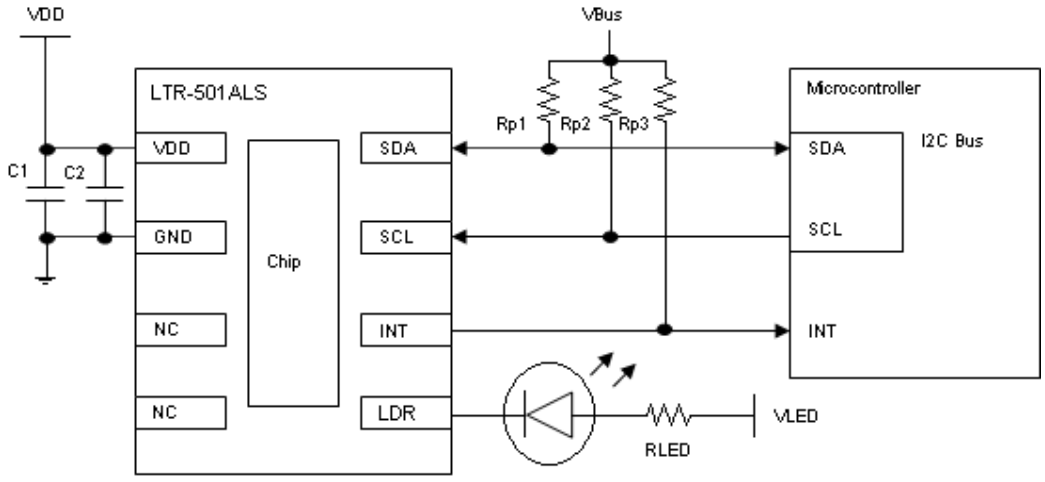

Notes:

1. All dimensions are in millimeters
2. Tolerances: ±0.2mm
3. LTC reserves the right to change the drawing till final datasheet release

## 6. Functional Block Diagram




## 7. Application Circuit



### I/O Pins Configuration Table

| Pin | I/O Type | Symbol | Description |
|---|---|---|---|
| 1 | | VDD | Supply Voltage |
| 2 | | GND | Ground |
| 3 | | NC | No Connect |
| 4 | | NC | No Connect |
| 5 | I | LDR | To connect to LED Cathode. |
| 6 | O | INT | Level Interrupt pin. Active LOW for interrupt. This pin is an open drain. |
| 7 | I | SCL | $I^2C$ serial clock |
| 8 | I/O | SDA | $I^2C$ serial data |

### Recommended Application Circuit Components

| Component | Recommended Value | Condition |
|---|---|---|
| Rp1, Rp2, Rp3 [1] | 1 kΩ to 10 kΩ | |
| RLED [2] | TBD | 2.5V ≤ VLED ≤ 4.35V |
| C1 | 0.1uF | |
| C2 | 4.7uF | |

[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

[2] IR LED = LTE-C216R-14 or LTE-C248

## 8. Rating and Specification

**Absolute Maximum Ratings at Ta = 25°C**

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Supply Voltage | VDD | 3.8 | V |
| Digital Voltage Range | SCL, SDA, INT | -0.5 to 3.8 | V |
| Digital Output Current | SCL, SDA, INT | -1 to 20 | mA |
| Storage Temperature | $T_{stg}$ | -40 to 85 | °C |

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 | Condition |
|---|---|---|---|---|---|---|
| Supply Voltage | VDD | 2.4 | | 3.6 | V | |
| LED Supply Voltage | VLED | 2.5 | | 4.35 | V | |
| Interface Bus Power Supply Voltage | $V_{IO}$ | 1.7 | | 3.6 | V | |
| Operating Temperature | $T_{ope}$ | -30 | | 70 | °C | |

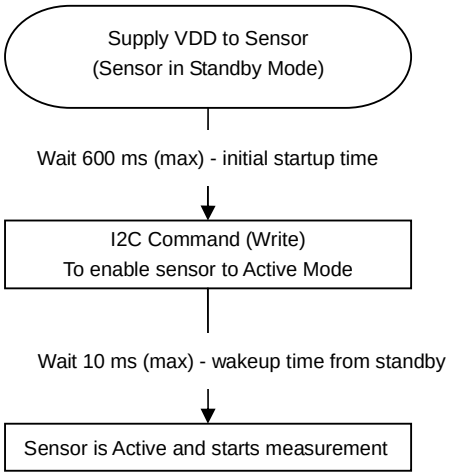
## Electrical & Optical Specifications

All specifications are at VDD = 3.0V, $T_{ope}$ = 25°C, unless otherwise noted.

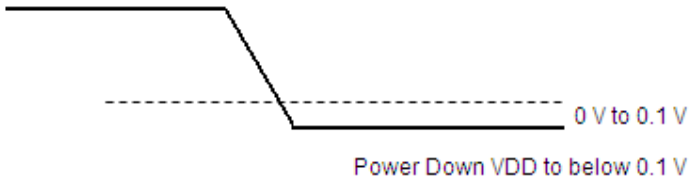
| Parameter | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|
| Active Supply Current | | 200 | 300 | uA | Active Mode, $T_{ope}$ = 25°C |
| Standby Current | | | 5 | uA | Standby / Sleep Mode |
| Initial Startup Time | | | 600 | ms | (Note 1) |
| Wakeup Time from Standby | | | 10 | ms | (Note 1) |
| **Light Sensor** | | | | | |
| **Parameter** | **Min.** | **Typ.** | **Max.** | **Unit** | **Condition** |
| Full Scale ADC Count | | | 65535 | count | |
| Dark ADC Count | 0 | | 5 | count | Ch0, Lux = 0 |
| | 0 | | 5 | count | Ch1, Lux = 0 |
| ADC Count | TBD | TBD | TBD | count | Ch0 |
| | TBD | TBD | TBD | count | Ch1 |
| Dynamic Range 1 | 0.01 | | 320 | lux | 0.005 lux / count |
| Dynamic Range 2 | 2 | | 64k | lux | 1 lux / count |
| **Proximity Sensor** | | | | | |
| **Parameter** | **Min.** | **Typ.** | **Max.** | **Unit** | **Condition** |
| Full Scale ADC Count | | | 2047 | count | |
| Peak Sensitivity | | 850 | | nm | |
| Detection Distance | | 120 | | mm | |
| Ambient Light Suppression | | | 50k | lux | Direct sunlight |
| LED Pulse Count | 1 | | 255 | pulses | |
| LED Pulse Frequency | 30k | | 100k | Hz | Increment of 10k Hz |
| LED Duty Cycle | 25 | | 100 | % | Increment of 25% |
| LED Peak Current | | 5 | | mA | LED Peak Current = 000 |
| | | 10 | | mA | LED Peak Current = 001 |
| | | 20 | | mA | LED Peak Current = 010 |
| | | 50 | | mA | LED Peak Current = 011 |
| | | 100 | | mA | LED Peak Current = 100/101/110/111 |
| Optical Rise / Fall Time | 100 | | | ns | |

Notes:

1. Startup Sequence



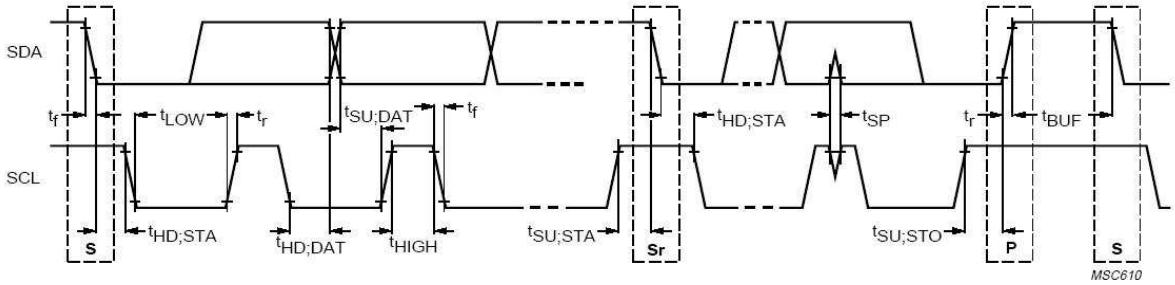

2. Power Down Sequence for VDD



## AC Electrical Characteristics

All specifications are at VBus = 1.8V, $T_{ope}$ = 25°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 |

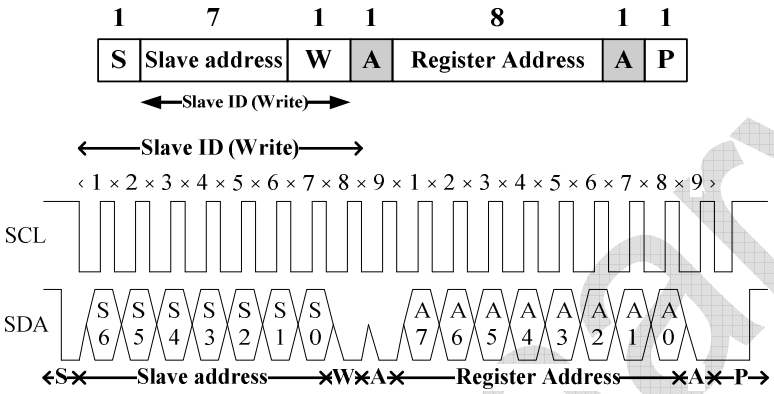



**Definition of timing for $I^2C$ bus**

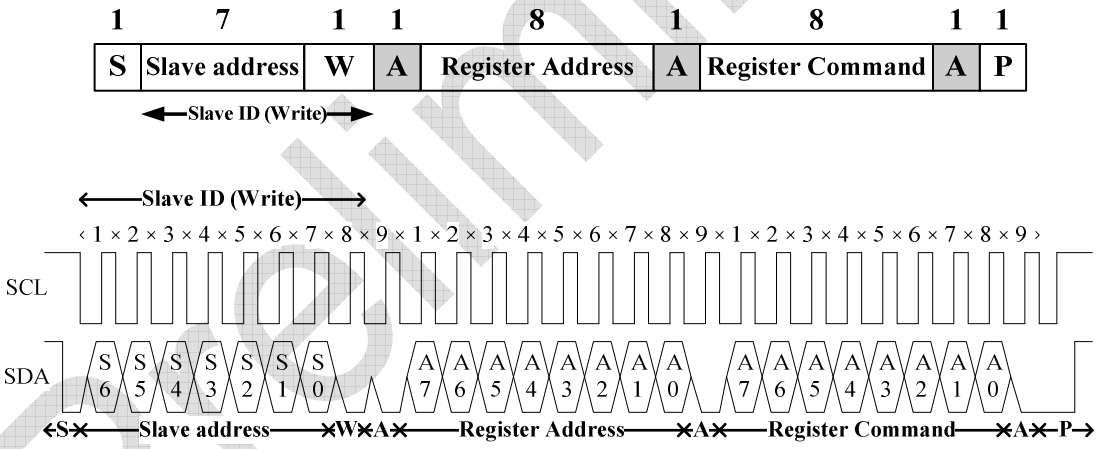
# 9. Principles of Operation

## I2C Protocols

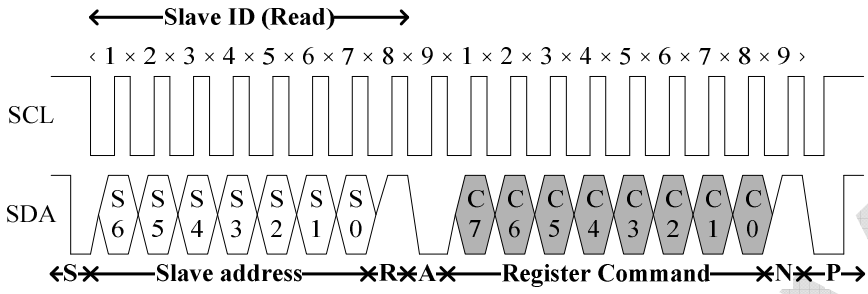
· I2C Write Protocol (type 1):



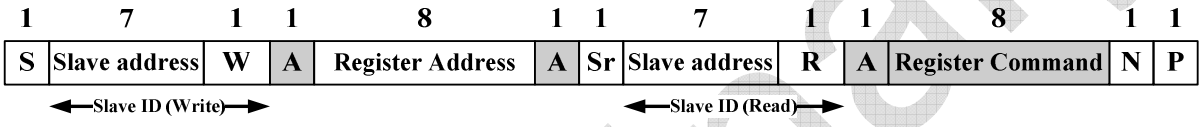

· I2C Write Protocol (type 2):

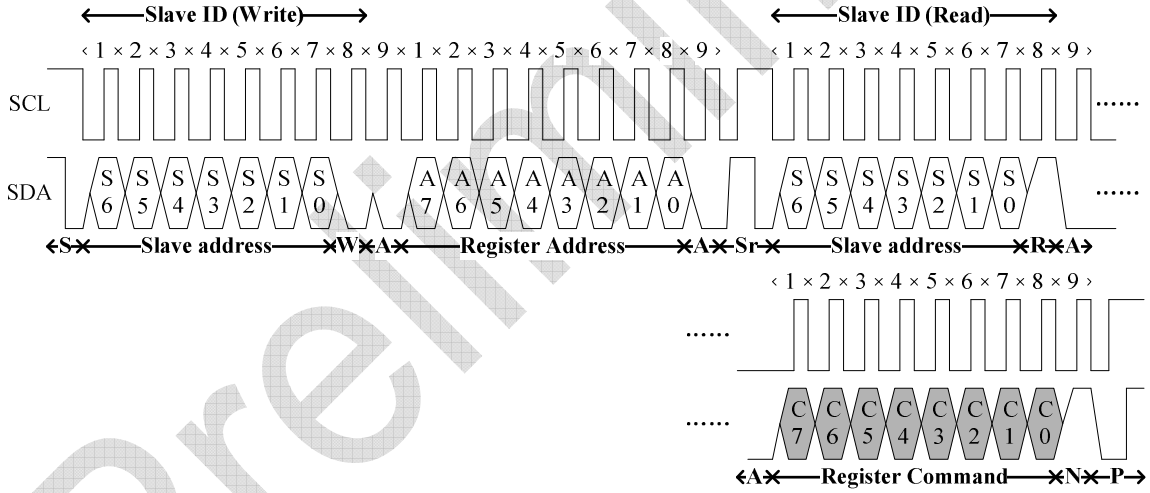



· I2C Read Protocol:




· I2C Read (Combined format) Protocol:




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

| I2C Slave Address | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Command Type | (0x23H) | | | | | | | W/R | value |
| | 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 |

**Register Set**

| Addr | R / W | Register Name | Description | Reset Value |
|---|---|---|---|---|
| 0x80 | R / W | ALS_CONTR | ALS operation mode control SW reset | 0x00 |
| 0x81 | R / W | PS_CONTR | PS operation mode control | 0x00 |
| 0x82 | R / W | PS_LED | PS LED setting | 0x6B |
| 0x83 | R / W | PS_N_PULSES | PS number of pulses | 0x08 |
| 0x84 | R / W | PS_MEAS_RATE | PS measurement rate in active mode | 0x02 |
| 0x85 | R / W | ALS_MEAS_RATE | ALS measurement rate in active mode | 0x03 |
| 0x86 | R | PART_ID | Part Number ID and Revision ID | 0x80 |
| 0x87 | R | MANUFAC_ID | Manufacturer ID | 0x05 |
| 0x88 | R | ALS_DATA_CH1_0 | ALS measurement CH1 data, lower byte | 0x00 |
| 0x89 | R | ALS_DATA_CH1_1 | ALS measurement CH1 data, upper byte | 0x00 |
| 0x8A | R | ALS_DATA_CH0_0 | ALS measurement CH0 data, lower byte | 0x00 |
| 0x8B | R | ALS_DATA_CH0_1 | ALS measurement CH0 data, upper byte | 0x00 |
| 0x8C | R | ALS_PS_STATUS | ALS and PS new data status | 0x00 |
| 0x8D | R | PS_DATA_0 | PS measurement data, lower byte | 0x00 |
| 0x8E | R | PS_DATA_1 | PS measurement data, upper byte | 0x00 |
| 0x8F | R / W | INTERRUPT | Interrupt settings | 0x08 |
| 0x90 | R / W | PS_THRES_UP_0 | PS interrupt upper threshold, lower byte | 0xFF |
| 0x91 | R / W | PS_THRES_UP_1 | PS interrupt upper threshold, upper byte | 0x07 |
| 0x92 | R / W | PS_THRES_LOW_0 | PS interrupt lower threshold, lower byte | 0x00 |
| 0x93 | R / W | PS_THRES_LOW_1 | PS interrupt lower threshold, upper byte | 0x00 |
| 0x97 | R / W | ALS_THRES_UP_0 | ALS interrupt upper threshold, lower byte | 0xFF |
| 0x98 | R / W | ALS_THRES_UP_1 | ALS interrupt upper threshold, upper byte | 0xFF |
| 0x99 | R / W | ALS_THRES_LOW_0 | ALS interrupt lower threshold, lower byte | 0x00 |
| 0x9A | R / W | ALS_THRES_LOW_1 | ALS interrupt lower threshold, upper byte | 0x00 |
| 0x9E | R / W | INTERRUPT PERSIST | ALS / PS Interrupt persist setting | 0x00 |

### ALS_CONTR Register (0x80)

The ALS_CONTR register controls the ALS operation modes and software (SW) reset for the sensor. The ALS sensor can be set to either standby mode or active mode. At either of these modes, the $I^2C$ circuitry is always active. The default mode after power up is standby mode. During standby mode, there is no ALS measurement performed but $I^2C$ communication is allowed to enable read/write to all the registers.

| 0x80 | ALS_CONTR (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *Reserved* | | | | *ALS Gain* | *SW Reset* | *ALS Mode* | |

| Field | BITS | Description |
|---|---|---|
| Reserved | 7:4 | Must write as 0 |
| ALS Gain | 3 | 0: Dynamic Range 2 (2 lux to 64k lux) (default)<br>1: Dynamic Range 1 (0.01 lux to 320 lux) |
| SW Reset | 2 | 0: Software reset is NOT started (default)<br>1: Software reset is started, default value after reset is 0 |
| ALS Mode | 1:0 | 00 / 01: Standby Mode (default)<br>10 / 11: Active Mode |

### PS_CONTR Register (0x81)

The PS_CONTR register controls the PS operation modes. The PS sensor can be set to either standby mode or active mode. At either of these modes, the $I^2C$ circuitry is always active. The default mode after power up is standby mode. During standby mode, there is no PS measurement performed but $I^2C$ communication is allowed to enable read/write to all the registers.

| 0x81 | PS_CONTR (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *Reserved* | | | | *PS Gain* | | *PS Mode* | |

| Field | BITS | Description |
|---|---|---|
| Reserved | 7:4 | Must write as 0 |
| PS Gain | 3:2 | 00: x1 Gain (default)<br>01: x4 Gain<br>10: x8 Gain<br>11: x16 Gain |
| PS Mode | 1:0 | 00 / 01: Standby Mode (default)<br>10 / 11: Active Mode |

### PS_LED Register (0x82)

The PS_LED register controls the LED pulse modulation frequency, LED current duty cycle and LED peak current.

| 0x82 | PS_LED (default = 0x6B) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *LED Pulse Frequency* | | | *LED Duty Cycle* | | *LED Peak Current* | | |

| Field | BITS | Description |
|---|---|---|
| LED Pulse Frequency | 7:5 | 000: 30k Hz<br>001: 40k Hz<br>010: 50k Hz<br>011: 60k Hz (default)<br>100: 70k Hz<br>101: 80k Hz<br>110: 90k Hz<br>111: 100k Hz |
| LED Duty Cycle | 4:3 | 00: 25%<br>01: 50% (default)<br>10: 75%<br>11: 100% |
| LED Peak Current | 2:0 | 000: 5mA |

| | | |
|---|---|---|
| | | 001: 10mA<br>010: 20mA<br>011: 50mA (default)<br>Others: 100mA |

### PS_N_Pulses Register (0x83)

The PS_N_Pulses register controls the number of LED pulses to be emitted.

| 0x83 | PS_N_Pulses (default = 0x08) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *LED Pulse Count* | | | | | | | |

| Field | BITS | Description |
|---|---|---|
| LED Pulse Count | 7:0 | 0000 0000: Number of pulses = 0<br>0000 0001: Number of pulses = 1<br>0000 0010: Number of pulses = 2<br>…<br>0000 1000: Number of pulses = 8 (default)<br>…<br>1111 1110: Number of pulses = 254<br>1111 1111: Number of pulses = 255 |

### PS_MEAS_RATE Register (0x84)

The PS_MEAS_RATE register controls the timing of the periodic measurements of the PS in active mode. PS Measurement Repeat Rate is the interval between PS_DATA registers update.

| 0x84 | PS_MEAS_RATE (default = 0x02) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *Reserved* | | | | *PS Measurement Repeat Rate* | | | |

| Field | BITS | Description |
|---|---|---|
| Reserved | 7:4 | Must write as 0 |
| PS Measurement Repeat Rate | 3:0 | 0000: 50ms<br>0001: 70ms<br>0010: 100ms (default)<br>0011: 200ms<br>0100: 500ms<br>0101: 1000ms<br>0110 / 0111: 2000ms<br>1XXX: Reserved |

### ALS_MEAS_RATE Register (0x85)

The ALS_MEAS_RATE register controls the integration time and timing of the periodic measurement of the ALS in active mode. ALS Measurement Repeat Rate is the interval between ALS_DATA registers update. ALS Integration Time is the measurement time for each ALS cycle.

ALS Integration Time must be set to be equal or smaller than the ALS Measurement Repeat Rate. If ALS Integration Time is set to be bigger than ALS Measurement Repeat Rate, it will be automatically reset to be equal to ALS Measurement Repeat Rate by the IC internally.

| 0x85 | ALS_MEAS_RATE (default = 0x03) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | ***Reserved*** | | | ***ALS Integration Time*** | | ***ALS Measurement Repeat Rate*** | | |

| Field | BITS | Description |
|---|---|---|
| Reserved | 7:5 | Must write as 0 |
| ALS Integration Time | 4:3 | 00: 100ms (default)<br>01: 50ms (can only be used in Dynamic Range 2, effective resolution is 15-bit @ 2 lux / count)<br>10: 200ms (can only be used in Dynamic Range 1)<br>11: 400ms (can only be used in Dynamic Range 1) |

| | | |
|---|---|---|
| ALS Measurement Repeat Rate | 2:0 | 000: 50ms<br>001: 100ms<br>010: 200ms<br>011: 500ms (default)<br>100: 1000ms<br>101 / 110 / 111: 2000ms |

### PART_ID Register (0x86) (Read Only)

The PART_ID register defines the part number and revision identification of the sensor.

| 0x86 | PART_ID (default = 0x80) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | ***Part Number ID*** | | | | ***Revision ID*** | | | |

| Field | BITS | Description |
|---|---|---|
| Part Number ID | 7:4 | 0x08H |
| Revision ID | 3:0 | 0x00H |

### MANUFAC_ID Register (0x87) (Read Only)

The MANUFAC_ID register defines the manufacturer identification of the sensor.

| 0x87 | MANUFAC_ID (default = 0x05) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | ***Manufacturer ID*** | | | | | | | |

| Field | BITS | Description |
|---|---|---|
| Manufacturer ID | 7:0 | 0x05H |

### ALS_DATA_CH1 Register (0x88 / 0x89) (Read Only)

The ALS ADC channel 1 data are expressed as a 16-bit data spread over two registers. The ALS_DATA_CH1_0 and ALS_DATA_CH1_1 registers provide the lower and upper byte respectively. When the $I^2C$ read operation starts, both the registers are locked until the $I^2C$ read operation is completed. This will ensure that the data in the registers is from the same measurement even if an additional integration cycle ends during the read operation. New measurement data is stored into temporary registers and the ALS_DATA registers are updated as soon as there is no on-going $I^2C$ read operation.

| 0x88 | ALS_DATA_CH1_0 (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | ***ALS Data Ch1 Low*** | | | | | | | |

| 0x89 | ALS_DATA_CH1_1 (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | ***ALS Data Ch1 High*** | | | | | | | |

| Field | Addr | BITS | Description |
|---|---|---|---|
| ALS Data Ch1 Low | 0x88 | 7:0 | ALS ADC channel 1 lower byte data |
| ALS Data Ch1 High | 0x89 | 7:0 | ALS ADC channel 1 upper byte data |

### ALS_DATA_CH0 Register (0x8A / 0x8B) (Read Only)

The ALS ADC channel data 0 are expressed as a 16-bit data spread over two registers. The ALS_DATA_CH0_0 and ALS_DATA_CH0_1 registers provide the lower and upper byte respectively. When the $I^2C$ read operation starts, both the registers are locked until the $I^2C$ read operation is completed. This will ensure that the data in the registers is from the same measurement even if an additional integration cycle ends during the read operation. New measurement data is stored into temporary registers and the ALS_DATA registers are updated as soon as there is no on-going $I^2C$ read operation.

| 0x8A | ALS_DATA_CH0_0 (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *ALS Data Ch0 Low* | | | | | | | |

| 0x8B | ALS_DATA_CH0_1 (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *ALS Data Ch0 High* | | | | | | | |

| Field | Addr | BITS | Description |
|---|---|---|---|
| ALS Data Ch0 Low | 0x8A | 7:0 | ALS ADC channel 0 lower byte data |
| ALS Data Ch0 High | 0x8B | 7:0 | ALS ADC channel 0 upper byte data |

### ALS_PS_STATUS Register (0x8C) (Read Only)

The ALS_PS_STATUS register stores the information about interrupt status and ALS and PS data status. New data means data has not been read yet. When the measurement is completed and data is written to the data register, the data status bit will be set to logic 1. When the data register is read, the data status bit will be set to logic 0.

Interrupt status determines if the ALS and PS interrupt criteria are met. It will check if the ALS or PS measurement data is outside of the range defined by the upper and lower threshold limits.

| 0x8C | ALS_PS_STATUS (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *Reserved* | | | *ALS Gain* | *ALS Interrupt Status* | *ALS Data Status* | *PS Interrupt Status* | *PS Data Status* |

| Field | BITS | Description |
|---|---|---|
| Reserved | 7:5 | Do not care |

| | | |
|---|---|---|
| ALS Gain | 4 | 0: ALS measurement data is in dynamic range 2 (2 to 64k lux)<br>1: ALS measurement data is in dynamic range 1 (0.01 to 320 lux) |
| ALS Interrupt Status | 3 | 0: ALS interrupt is clear or not yet triggered<br>1: ALS interrupt is triggered |
| ALS Data Status | 2 | 0: ALS measurement data is old data (Data has been read)<br>1: ALS measurement data is new data (Data has not been read) |
| PS Interrupt Status | 1 | 0: PS interrupt is clear or not yet triggered<br>1: PS interrupt is triggered |
| PS Data Status | 0 | 0: PS measurement data is old data (Data has been read)<br>1: PS measurement data is new data (Data has not been read) |

### PS_DATA_0 Register (0x8D / 0x8E) (Read Only)

The PS ADC channel data are expressed as a 11-bit data spread over two registers. The PS_DATA_0 and PS_DATA_1 registers provide the lower and upper byte respectively. When the $I^2C$ read operation starts, both the registers are locked until the $I^2C$ read operation is completed. This will ensure that the data in the registers is from the same measurement even if an additional integration cycle ends during the read operation. New measurement data is stored into temporary registers and the PS_DATA registers are updated as soon as there is no on-going $I^2C$ read operation.

| **0x8D** | **PS_DATA_0 (default = 0x00)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***PS Data Low*** | | | | | | | |

| **0x8E** | **PS_DATA_1 (default = 0x00)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***Reserved*** | | | | | ***PS Data High*** | | |

| Field | Addr | BITS | Description |
|---|---|---|---|
| PS Data Low | 0x8D | 7:0 | PS ADC lower byte data |

| | | | |
|---|---|---|---|
| Reserved | 0x8E | 7:3 | Do not care |
| PS Data High | 0x8E | 2:0 | PS ADC upper byte data |

### INTERRUPT Register (0x8F)

The INTERRUPT register controls the operation of the interrupt pin and functions. When the Interrupt Mode is set to 00, the INT output pin 2 is inactive / disabled and will not trigger any interrupt. However at this condition, the ALS_PS_STATUS register will still be updated.

| **0x8F** | **INTERRUPT (default = 0x08)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***Reserved*** | | | | ***Output Mode*** | ***Interrupt Polarity*** | ***Interrupt Mode*** | |

| **Field** | **BITS** | **Description** |
|---|---|---|
| Reserved | 7:4 | Must write as 0 |
| Output Mode | 3 | 0: INT output pin 2 is latched and keep in triggered state until INTERRUPT Register is read<br>1: INT output pin 2 is updated after every measurement (default) |
| Interrupt Polarity | 2 | 0: INT output pin 2 is considered active when it is a logic 0 (default)<br>1: INT output pin 2 is considered active when it is a logic 1 |
| Interrupt Mode | 1:0 | 00: INT output pin 2 is inactive / high impedance state (default)<br>01: Only PS measurement can trigger interrupt<br>10: Only ALS measurement can trigger interrupt<br>11: Both ALS and PS measurement can trigger interrupt |

### PS_THRES Register (0x90 / 0x91 / 0x92 / 0x93)

The PS_THRES_UP and PS_THRES_LOW registers determines the upper and lower limit of the interrupt threshold value respectively. These two values form a range and the interrupt function compares if the measurement value in PS_DATA registers is inside or outside the range. The interrupt function is active if the measurement data is outside the range defined by the upper and lower limits. The data format for PS_THRES must be the same as PS_DATA registers.

| 0x90 | PS_THRES_UP_0 (default = 0xFF) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *PS Upper Threshold Low* | | | | | | | |

| 0x91 | PS_THRES_UP_1 (default = 0x07) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *Reserved* | | | | | *PS Upper Threshold High* | | |

| 0x92 | PS_THRES_LOW _0 (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *PS Lower Threshold Low* | | | | | | | |

| 0x93 | PS_THRES_LOW_1 (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *Reserved* | | | | | *PS Lower Threshold High* | | |

| Field | Addr | BITS | Description |
|---|---|---|---|
| PS Upper Threshold Low | 0x90 | 7:0 | PS upper threshold lower byte |
| Reserved | 0x91 | 7:3 | Must write as 0 |
| PS Upper Threshold High | 0x91 | 2:0 | PS upper threshold upper byte |
| PS Lower Threshold Low | 0x92 | 7:0 | PS lower threshold lower byte |
| Reserved | 0x93 | 7:3 | Must write as 0 |

| | | | |
|---|---|---|---|
| PS Lower Threshold High | 0x93 | 2:0 | PS lower threshold upper byte |

### ALS_THRES Register (0x97 / 0x98 / 0x99 / 0x9A)

The ALS_THRES_UP and ALS_THRES_LOW registers determines the upper and lower limit of the interrupt threshold value respectively. These two values form a range and the interrupt function compares if the measurement value in ALS_DATA registers is inside or outside the range. The interrupt function is active if the measurement data is outside the range defined by the upper and lower limits. The data format for ALS_THRES must be the same as ALS_DATA registers.

| **0x97** | **ALS_THRES_UP_0 (default = 0xFF)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***ALS Upper Threshold Low*** | | | | | | | |

| **0x98** | **ALS_THRES_UP_1 (default = 0xFF)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***ALS Upper Threshold High*** | | | | | | | |

| **0x99** | **ALS_THRES_LOW _0 (default = 0x00)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***ALS Lower Threshold Low*** | | | | | | | |

| **0x9A** | **ALS_THRES_LOW_1 (default = 0x00)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **B7** | **B6** | **B5** | **B4** | **B3** | **B2** | **B1** | **B0** |
| | ***ALS Lower Threshold High*** | | | | | | | |

| Field | Addr | BITS | Description |
|---|---|---|---|
| ALS Upper Threshold Low | 0x97 | 7:0 | ALS upper threshold lower byte |
| ALS Upper Threshold High | 0x98 | 7:0 | ALS upper threshold upper byte |
| ALS Lower Threshold Low | 0x99 | 7:0 | ALS lower threshold lower byte |
| ALS Lower Threshold High | 0x9A | 7:0 | ALS lower threshold upper byte |

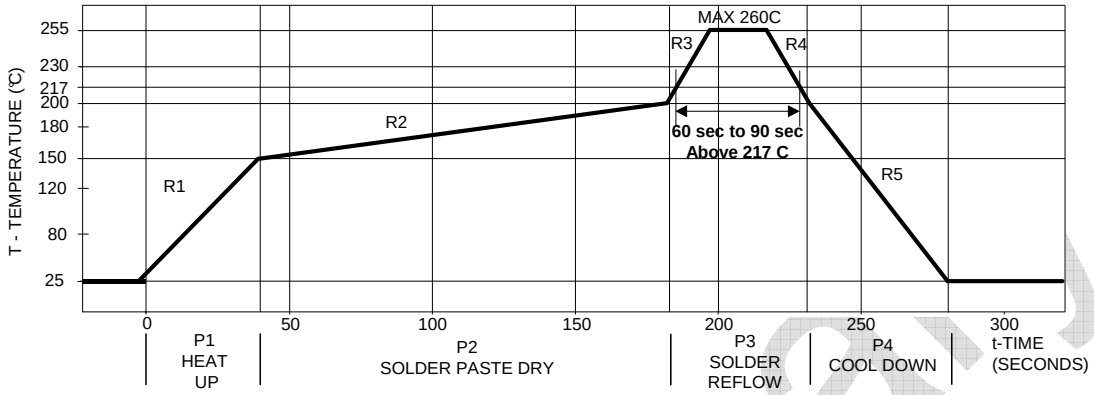
### INTERRUPT PERSIST Register (0x9E)

The INTERRUPT PERSIST 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 INT output pin 2.

| 0x9E | INTERRUPT PERSIST (default = 0x00) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | *PS Persist* | | | | *ALS Persist* | | | |

| Field | BITS | Description |
|---|---|---|
| PS Persist | 7:4 | 0000: Every PS measurement data will generate an interrupt (default)<br>0001: 1 consecutive PS measurement data outside the range<br>0010: 2 consecutive PS measurement data outside the range<br>…<br>1111: 15 consecutive PS measurement data outside the range |
| ALS Persist | 3:0 | 0000: Every ALS measurement data will generate an interrupt (default)<br>0001: 1 consecutive ALS measurement data outside the range<br>0010: 2 consecutive ALS measurement data outside the range<br>…<br>1111: 15 consecutive ALS measurement data outside the range |

## 10. Recommended Leadfree Reflow Profile




| Process Zone | Symbol | ΔT | Maximum ΔT/Δtime 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.

## 11. Moisture Proof Packaging

All LTR-501ALS-WA 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

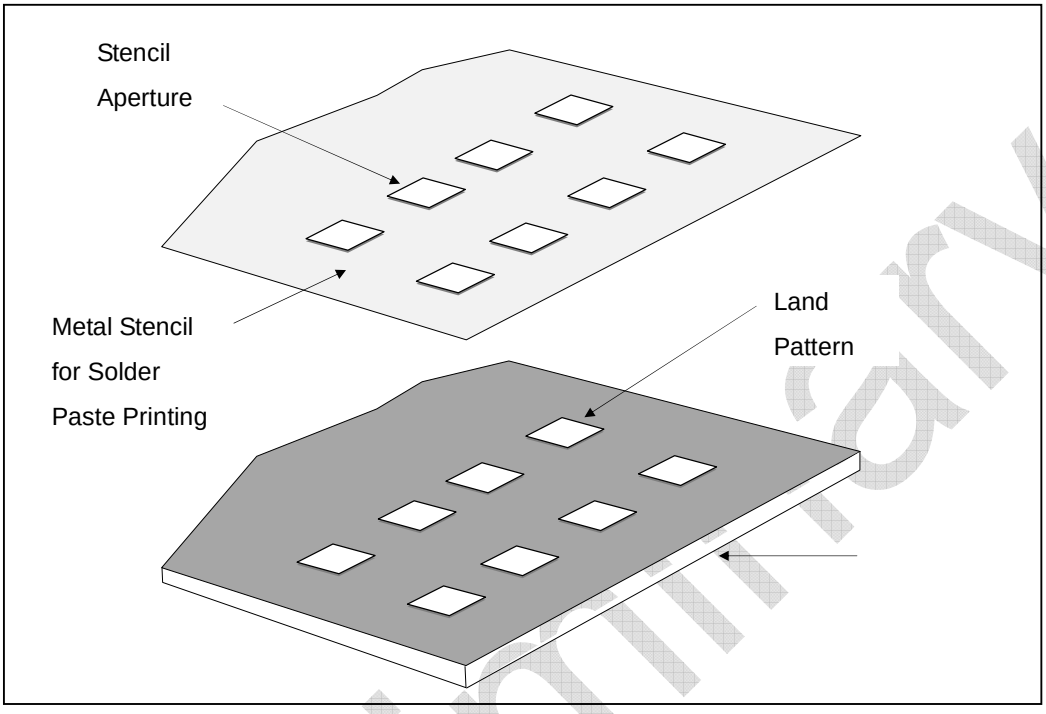
| | |
|---|---|
| **Storage Temperature** | 10°C to 30°C |
| **Relative Humidity** | Below 60% RH |

### Baking Conditions

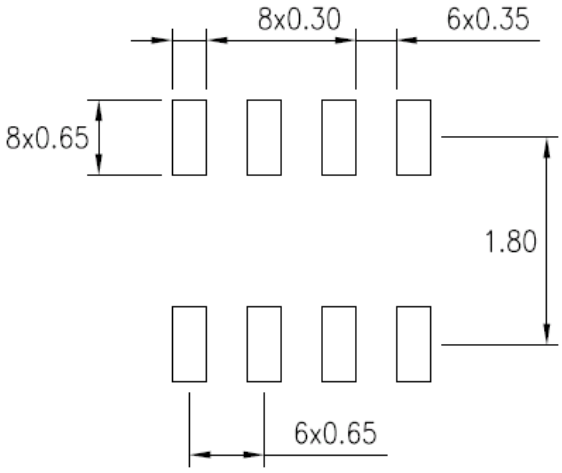
| **Package** | **Temperature** | **Time** |
|---|---|---|
| In Reels | 60°C | 48 hours |
| In Bulk | 100°C | 4 hours |

Baking should only be done once.

## 12. Recommended Land Pattern and Metal Stencil Aperture




**Recommended Land Pattern**



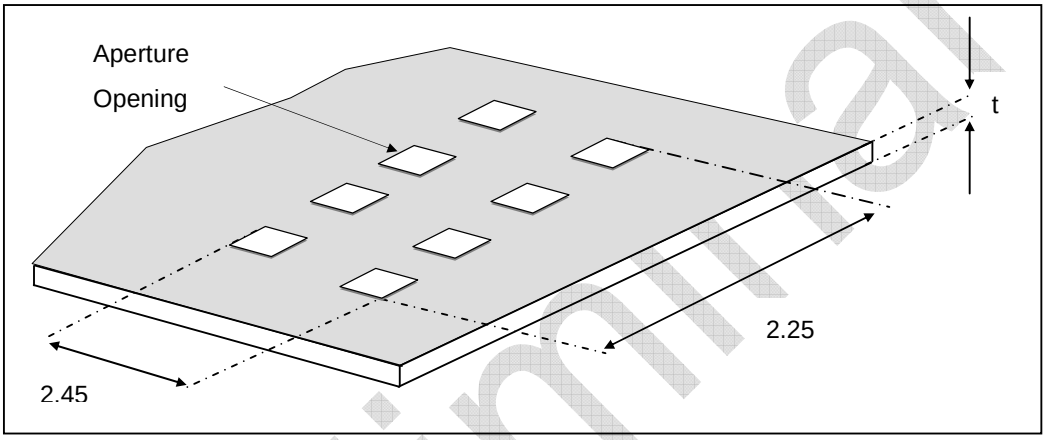

Note:

1. All dimensions are in millimeters

**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).

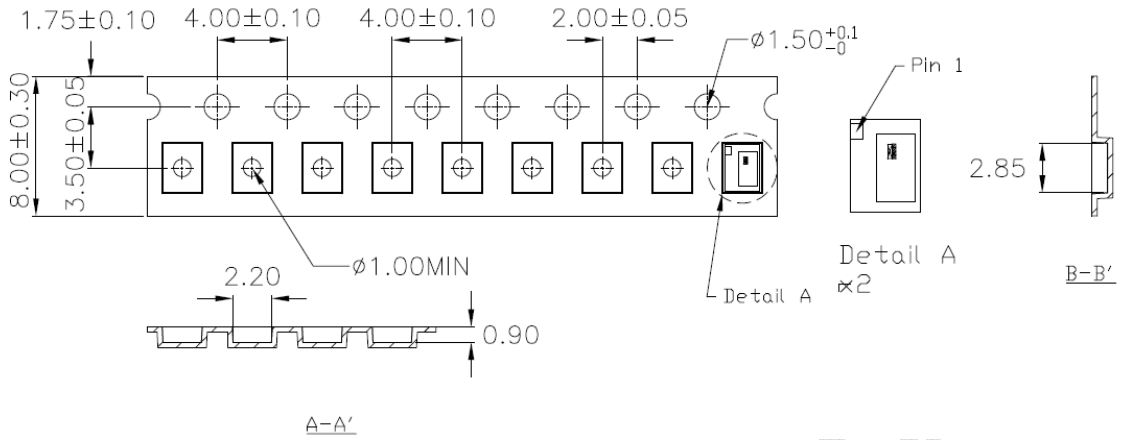
The stencil aperture opening is recommended to be 0.3mm x 0.65mm which has the same dimension as the land pattern. This is to ensure adequate printed solder paste volume and yet no shorting.




Note:

1. All dimensions are in millimeters

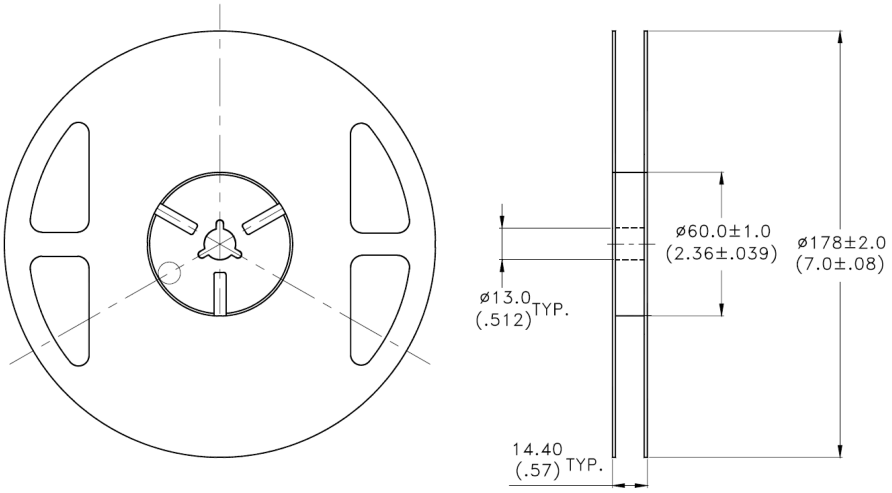
## 13. Package Dimension for Tape and Reel




Note:

1. All dimensions are in millimeters

**Package Dimension of Reel**




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