LT-1PA01

Proximity Ambient Light Sensor
LT Series

Features
- Proximity sensor and ambient light sensor in 1package
- Very small package size(L3.05 x W2.1 x H1.0 mm)
- Low Current consumption
  – 80mA typical at sleeping time 800ms
- I2C serial communication

<Proximity sensor>
- Extremely low current consumption
- Fully calibrated to 70 mm detection with gray card

<Ambient Light Sensing (ALS)>
- Illuminance sensing angle is +/-45 degrees at 50%
- Low lux Performance at 0.015 lux (High : 2k lux)

Applications
- Mobile devices: Smart phone, PDA, GPS
- Computing devices: Laptop PC, Tablet PC
- Consumer devices: LCD-TV, digital picture frame, digital camera
- Industrial and proximity sensing

Overview
Murata LT-1PA01 is a low power Ambient Light Sensor (ALS) and proximity (PROX) sensor. It has a built-in IR-Emitter driver for proximity function.
The ALS function measures amount of light (in the visible spectrum) incident on the LT-1PA01 device.
The ALS provides a 12-bit measurement. A passive optical filter removes unwanted wavelengths (IR or Ultraviolet) to ensure accurate ALS measurement.

The built-in current-driver pulses an internal infrared emitter at a programmed current for 96μs. The infrared light that is reflected and received by LT-1PA01 is digitized by an 8-bit ADC.
The proximity sensor also has a passive optical filter designed to pass IR and reject visible wavelengths.

The LT-1PA01 provides a hardware pad to indicate an interrupt event.
The interrupt pad saves power as the host microcontroller can 'wake-up' on an interrupt event and does not need to poll the device for an interrupt event.

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2. Specifications

2.1 Ratings and characteristics

2.1.1 Absolute Maximum Ratings (TA = +25°C)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage Range	V_{DD}	-40 to +85℃,V_{DD}	-0.5	-	4.0	V
Open-Drain Pin Voltage(SCL,SDA,INT)			-0.5	-	4.0	V
Open-Drain Pin Current(SCL,SDA,INT)			-	-	10	mA
Operating Temperature Range	T_{OP}		-30		85	℃
Storage Temperature Range	T_{ST}		-40		85	℃
ESD Rating		Human Body Model		2		kV
		Machine Model		200		V
		Charged-Device Model		2		kV
Solder Temperature	T_{SOL}		250	～	260	℃

2.1.2 Recommended Operating Conditions

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage	V_{DD}		2.7	3.0	3.6	V
Operating Temperature	T_{OP}		-30	25	85	℃

2.1.3 Electrical Specifications (VDD = 3.0V, TA = +25°C)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Current when Powered Down	I_{DD_OFF}	ALS_EN=0; PROX_EN=0		0.2	1.0	uA
Supply Current for ALS+Prox in Sleep Time	I_{DD_NORM}	ALS_EN=1; PROX_EN=1		75	100	uA
Supply Current for Prox in Sleep Time	$I_{DD\_PRX\_SLP}$	ALS_EN=0; PROX_EN=1		60		uA
Supply Current for ALS	I_{DD_ALS}	ALS_EN=1; PROX_EN=0		62		uA
12-bit ALS Integration/Conversion Time	t_{INTGR_ALS}			180		ms
8-bit Prox Integration/Conversion Time	t_{INTGR_PROX}			0.96		ms

Parameter	Symbol	Conditions	Min	Typ	Max	Units
ALS Result when Dark	$DATA_{ALS\_0}$	$E_{AMBIENT}$=0Lux, 2k Range		1		Counts
Full Scale ALS ADC Code	$DATA_{ALS\_F}$	$E_{AMBIENT}$>Selected Range Maximum Lux			4095	Counts
Output Count Variation Over Three Light Sources: Fluorescent, Incandescent and Sunlight	$\frac{\Delta DATA_1}{DATA}$	Ambient Light Sensing, No Cover Glass After Programmable Active IR Compensation		±10		%
Output Count Variation Over Three Light Sources: Fluorescent, Incandescent and Sunlight	$\frac{\Delta DATA_2}{DATA}$	Ambient Light Sensing, Under Cover Glass After Programmable Active IR Compensation (*1)		±10		%
Light Count Output with LSB of 0.0203 lux/count	$DATA_{ALS\_1}$	E=62Lux, ALS_RANGE=0		3037		Counts
Light CountOutput with LSB of 0.0404 lux/count	$DATA_{ALS\_2}$	E=62Lux, ALS_RANGE=1		1523		Counts
Light CountOutput with LSB of 0.3672 lux/count	$DATA_{ALS\_3}$	E=280Lux, ALS_RANGE=2		752		Counts
Light CountOutput with LSB of 0.7482 lux/count	$DATA_{ALS\_4}$	E=280Lux, ALS_RANGE=3		369		Counts
Prox Measurement w/o Object in Path	$DATA_{PROX\_}$			1		Counts
Full Scale Prox ADC Code	$DATA_{PROX\_}$				255	Counts
Washout bit activation level	ProxWASH			20k		Lux
Proximity Offset adjust Increment referenced to proximity ADC range	ProxOffsetInc			32		LSB
Rise time for IRDR (VCSEL) Sink Current	t_r	R_{LOAD}=15ΩatIRDR pin, 20% to 80%		25		ns
Fall time for IRDR (VCSEL) Sink Current	t_f	R_{LOAD}=15ΩatIRDR pin, 80% to 20%		15		ns
IRDR (VCSEL) Sink Current	I_{IRDR_0}	PROX_DR=0;		3.6		mA
IRDR (VCSEL) Sink Current	I_{IRDR_1}	PROX_DR=1;		7.2		mA
IRDR (VSCEL) Sink Current	I_{IRDR_2}	PROX_DR=2;		10.8		mA
IRDR (VCSEL) Sink Current	I_{IRDR_3}	PROX_DR=3;		14.4		mA
I_{IRDR} On Time Per PROX Conversion	t_{PULSE}			200		μs

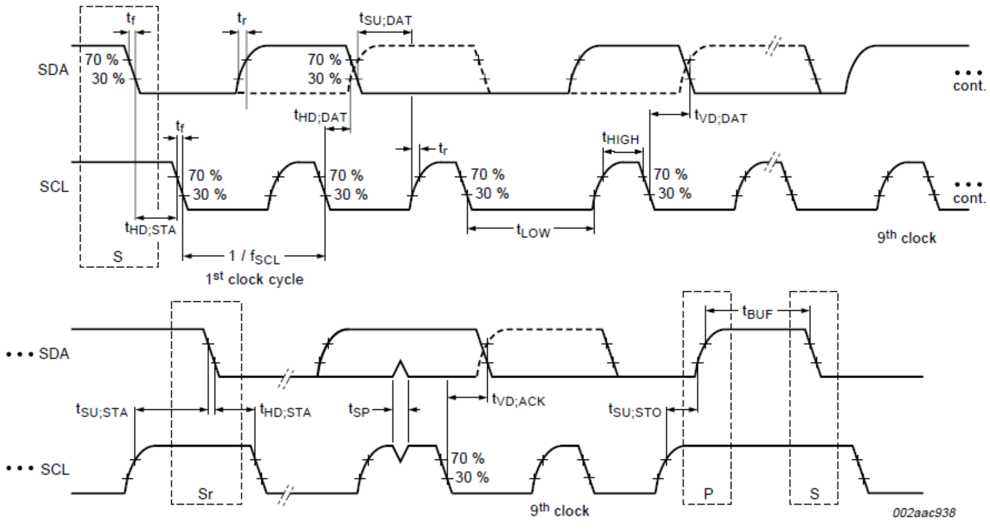
Typical value is a reference value, there is no gurantee.
*1：An LED is used in production test. The LED irradiance is calibrated to produce the same ALS count against a fluorescent light source of the same Lux level.

2.2 I2C Electrical specification (VDD = 3.0V, TA = +25° C)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage Range for I2C	V_{I2C}		1.7		3.6	V
SCL and SDA Input Low Voltage	V_{IL}				0.55	V
SCL and SDA Input High Voltage	V_{IH}		1.25			V
Hysteresis of Schmitt Trigger Input	Vhys		0.05 VDD			V
Low-level output voltage (open-drain) at 4mA sink current	V_{OL}				0.4	V
Input Leakage for each SDA, SCL	Ii		-10		10	μA
Pulse Width of Spikes that must be Suppressed by the Input Filter	t_{SP}				50	ns
SCL Falling Edge to SDA Output Data Valid	t_{AA}				900	ns
Capacitance for each SDA and	Ci				10	pF
Hold Time (Repeated) START Condition	$t_{HD:STA}$	After this period, the first clock pulse is	600			ns
LOW Period of the SCL clock	t_{LOW}	Measured at the 30% of VDD crossing	1300			ns
HIGH period of the SCL Clock	t_{HIGH}		600			ns
Set-up Time for a Repeated START Condition	$t_{SU:STA}$		600			ns
Data Hold Time	$t_{HD:DAT}$		30			ns
Data Set-up Time	$t_{SU:DAT}$		100			ns
Rise Time of both SDA and SCL Signals	t_R		20 +0.1xCb			ns
Fall Time of both SDA and SCL Signals	t_F		20 +0.1xCb			ns
Set-up Time for STOP Condition	$t_{SU:STO}$		600			ns
Bus Free Time Between a STOP and START Condition	t_{BUF}		1300			ns
Capacitive Load for Each Bus Line	C_b				400	pF
SDA and SCL System Bus Pull-up Resistor	$R_{pull\text{-}up}$	Maximum is determined by tR and	1			kΩ
Data Valid Time	$t_{VD;DAT}$				0.9	μs
Data Valid Acknowledge Time	$t_{VD:ACK}$				0.9	μs
Noise Margin at the LOW Level	V_{nL}		0.1VD			V
Noise Margin at the HIGH Level	V_{nH}		0.2VD			V

NOTES:
・Cover glass assumes fixed infrared/visible ratio

Figure 1 I2C TIMING DIAGRAM

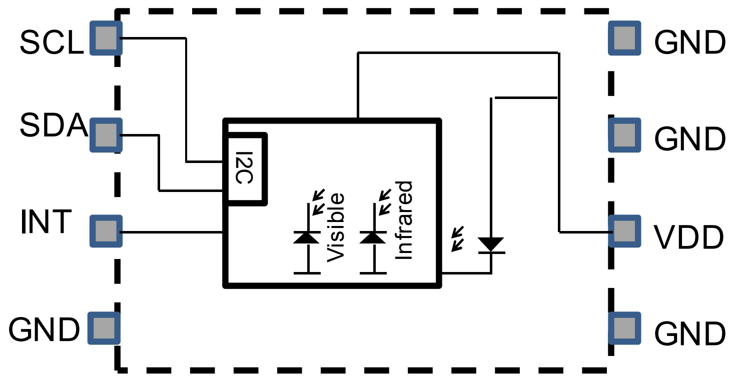


3. Measurement direction

3.1 Function block diagram and recommended external circuit

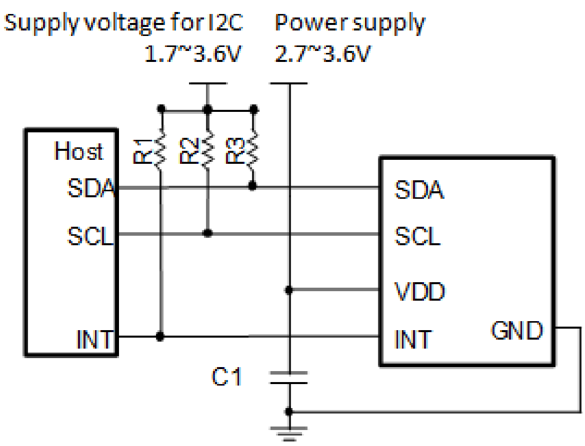
Function block diagram

Figure 2 Function block diagram



3.2 Recommended external circuit

Figure 3 Recommended external circuit

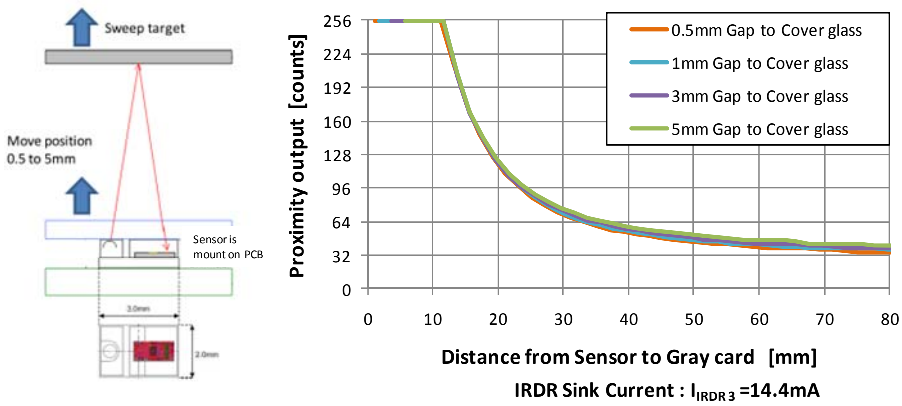


Components	Recommended Values
C1	0.1uF
R1	10kΩ
R2	10kΩ
R3	10kΩ

3.3 Typical Performance Curves (VDD = 3.0V, TA = +25° C)

PS Characteristics by Cover glass Gap

Figure 4 Proximity Sensitivity by cover

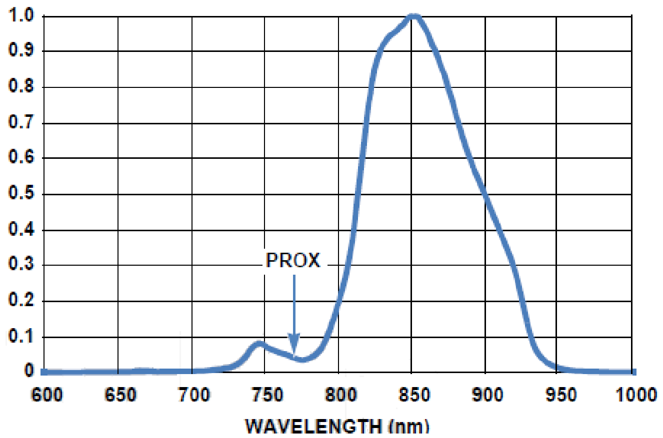


3.4 Proximity Sensing (PROX)

LT-1PA01 can reliably detect an object entering or exiting a specified proximity field by emitting infrared light (VCSEL) and measuring reflection from an object. It can also detect an object which is not moving or is moving very slowly. The drop in reflectance is as much as the fourth power of the distance. Measured value of proximity sensing is generated by subtracting infrared photodiode response when infrared light (VCSEL) is not emitted from the response when emitted.

For proximity sensor (PROX) data conversions, the built-in current-driver pulses an internal infrared Optical Device (OD) for 100μs. The reflected infrared light is measured and digitized by an 8-bit PROX ADC. The light-wavelength response of the PROX appears as shown in Figure 5.

Figure 5 Prox Sensitivity vs Wavelength

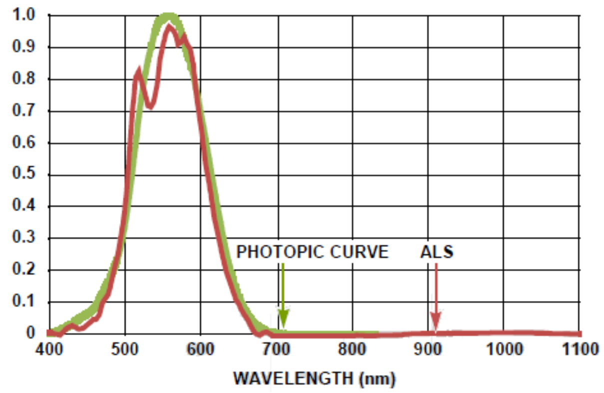


3. 5 Ambient Light Sensing (ALS)

LT-1PA01 has photodiodes capable of measuring both visible and infrared light. The light-wavelength response of the ALS appears as shown in Figure 6.

For ambient light sensor (ALS) data conversions, a 12-bit ADC converts photodiode current in 200ms per sample. The ADC rejects 50/60Hz from artificial light sources and has 4 selectable full scale ranges of 62.5, 125, 1000, and 2000 Lux.

Figure 6 ALS Sensitivity vs Wavelength



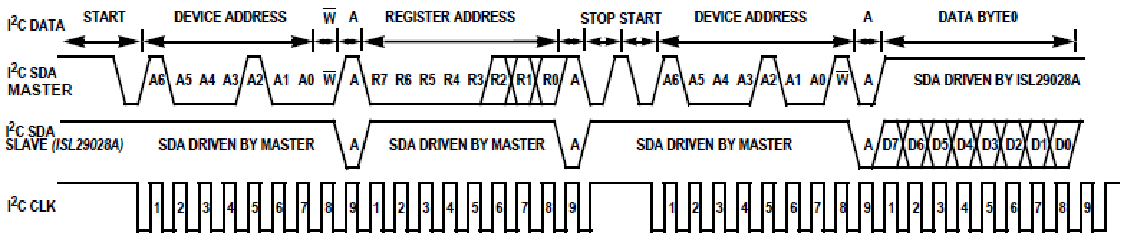
3. 6 Configuration and Control

3.6-1 I^{2}C Interface

LT-1PA01 configuration and control is performed using the I^{2}C or SMBus. LT-1PA01's I2C interface slave address is internally hardwired as 8'b1000100x, where x denotes the R/W bit.

Every I^{2}C transaction begins with the master asserting a start condition (SDA falling while SCL remains high). The first transmitted byte is initiated by the master and includes 7 address bits and a R/W bit. The slave is responsible for pulling SDA low during the ACK time after every transmitted byte. Figure 8 shows a sample one-byte read. The I^{2}C bus master always drives the SCL (clock) line, while either the master or the slave can drive the SDA (data) line. Each I2C transaction ends with the master asserting a stop condition (SDA rising while SCL remains high). For more information about the I^{2}C standard, consult the Philips™ I^{2}C specification documents. Timing specification are included in "I^{2}C Electrical Specifications" on page 9 The timing parameters are defined in Figure 7.

Figure 7 I^{2}C DRIVER TIMING DIAGRAM FOR MASTER AND SLAVE CONNECTED TO COMMON BUS



3. 7 Register Descriptions

ADDRESS (HEX)	REGISTER NAME	POWER-ON	REGISTER ACCESS	BIT Fields	FUNCTION NAME/VALUE	FUNCTION
0x00	Device ID	b11001xxx	RO	[7:0]		Device Identification
				[7:3]	[11001]	IC ID Code
				[2:0]		Reserved
0x01	Config0	0x00	RW	[7:0]		Proximity Configuration
				[7:6]		Reserved
			RW	[5]	PROX_EN	Proximity Enable/Disable
					[1]	Enable
					[0]	Disable
			RW	[4:2]	PROX_SLP	Proximity Sleep Time Select
					[000]	800ms
					[001]	200ms
					[010]	100ms
			RW	[1:0]	IRDR_DRV	IRDR (VCSEL) Current
					[00]	3.6mA
					[01]	7.2mA
					[10]	10.8mA
					[11]	14.4mA
0x02	Config1	0x00	RW	[7:0]		Proximity/ALS Configuration
			RW	[7]	INT_ALG	Interrupt Algorithm
					[1]	Window Comparator
					[0]	Hysteresis Window
			RW	[6:3]	PROX_OFFSET	Proximity Offset Compensation
			RW	[2]	ALS_EN	Ambient Light Sensing Enable/Disable
					[1]	Enable
					[0]	Disable
			RW	[1:0]	ALS_RANGE	Ambient Light Sensor Range Select
					[00]	62.5 Lux
					[01]	125 Lux
					[10]	1000 Lux
					[11]	2000 Lux
0x03	Config2	0x00	RW	[7:0]	ALS_IR_COMP	Ambient Light Sensor IR Compensation
			RW	[7:5]		Reserved
			RW	[4:0]	ALSIRComp	ALS Infra Red Compensation (Unsigned Binary)
0x04	INTConfig	0x10	RW	[7:0]	INTConfig	Interrupt Configuration, Status & Control
			R0	[7]	PROX_INT_FLG	Proximity Interrupt Flag
					[1]	Proximity Interrupt Event
					[0]	No Proximity Interrupt Event
			RW	[6:5]	PROX_PRST	Proximity Interrupt Reporting Persistency
					[00]	INT after 1 Proximity Flag Event
					[01]	INT after 2 Consecutive Proximity Flag Event
					[10]	INT after 4 Consecutive Proximity Flag Event
					[11]	INT after 8 Consecutive Proximity Flag Event
			RO	[4]	PWR_FAIL	Power Failure (Brown-out) Alarm
					[1]	Brown Out Detected
					[0]	Normal Operation
			RO	[3]	ALS_INT_FLG	Ambient Light Sensor Interrupt Flag
					[1]	ALS Interrupt Flag Event
					[0]	No ALS Interrupt Flag Event
			RW	[2:1]	ALS_INT_PRST	ALS Interrupt Reporting Persistency
					[00]	INT after 1 ALS Flag Event
					[01]	INT after 2 Consecutive ALS Flag Event
					[10]	INT after 4 Consecutive ALS Flag Event
					[11]	INT after 8 Consecutive ALS Flag Event
			RW	[0]	INT_CFG	Interrupt Output (Pin) Configuration
					[1]	Interrupt if ALS and PROX Event
					[0]	Interrupt if ALS or PROX Event

ADDRESS (HEX)	REGISTER NAME	POWER-ON	REGISTER ACCESS	BIT Fields	FUNCTION NAME/VALUE	FUNCTION
0x05	PROX_INT_T	0x00	RW	[7:0]	PROX_INT_TL	Proximity Interrupt LOW threshold
0x06	PROX_INT_T	0xFF	RW	[7:0]	PROX_INT_TH	Proximity Interrupt HIGH threshold
0x07	ALS_INT_TL	0x00	RW	[7:0]	ALS_INT_TL1	ALS Interrupt LOW threshold bit[11:4]
0x08	ALS_INT_TLH	0x0F	RW	[7:0]	ALS Interrupt	LOW/HIGH threshold bits
				[7:4]	ALS_INT_TL0	ALS Interrupt LOW threshold bit[3:0]
				[3:0]	ALS_INT_TH1	ALS Interrupt HIGH threshold bit[11:8]
0x09	ALS_INT_TH	0xFF	RW	[7:0]	ALS_INT_TH0	ALS Interrupt HIGH threshold bit[7:0]
0x0A	PROX_DATA		RO	[7:0]	PROX_DATA	Proximity Data (Unsigned Binary)
0x0B	ALS_DATA_HB		RO	[7:0]	ALS_DATA_HB	ALS Data HIGH Byte
				[7:4]		Set to 0000
				[3:0]		ALS Data Bit[11:8]
0x0C	ALS_DATA_LB		RO	[7:0]	ALS_DATA_LB	ALS Data Bit[7:0]
0x0D	PROX_AMBIR		RO	[7:0]	PROX_AMBIR	Proximity Mode Ambient IR Measurement
				[7:1]		Proximity Mode Ambient IR Component
			RO	[0]	PROX_WASH	Proximity Washout Status
					[1]	Proximity Washout Detected
					[0]	Normal Proximity Operation
0x0E	Config3	0x00		[7:0]	Soft Reset	Software Reset
					0x38	Initiate Soft Reset
					0x00	Normal operation

Registers 0x01, 0x02 are used to configure the primary proximity and ALS parameters. Register 0x03 is used for optimizing IR compensation in ALS measurements. A procedure to optimize IR compensation is described in “ALS IR Compensation” on page 11. Register 0x04 is the Interrupt Configuration and Status Register, and is used primarily to indicate interrupt events from proximity

and ALS measurements. A PWR_FAIL bit to indicate a ‘Brown-Out’ event is available and is set in case of a power supply interruption. A ‘Brown-Out’ event does not generate a hardware interrupt.

The host micro-controller must clear this bit by writing a ‘0’ to Reg 0x04[4]. Register 0x04 is also used to configure ALS & Proximity interrupt persistency and the operation of the INT pin. Registers 0x05 and 0x06 are used to set the proximity ‘LOW’ and ‘HIGH’ threshold for proximity interrupt event generation. Registers 0x07, 0x08 and 0x09 are used to set the ALS ‘LOW’ and ‘HIGH’ threshold. Two 12 bit numbers span three address locations as shown in Table 1. Data registers 0x0A holds result of proximity conversion. The proximity result should be validated by ‘Washout’ bit in Reg 0x0D[0]. Registers 0x0B and 0x0C hold result of an ALS measurement. The ALS data is 12 bits wide. Least Significant Byte of the ALS data is available at address 0x0C and Most Significant Byte (MSB) of ALS data is available at address 0x0B. The MSB is right justified, i.e., the upper nibble is always zero and lower nibble contains four data bits. Register 0x0D contains ambient IR measurement in proximity

measurement phase. This measurement is for detecting ambient Washout condition, which is indicated by Reg 0x0D[0] being ‘HIGH’. Proximity ‘Washout’ is described in “Proximity Ambient

Washout Detection” on page 11. A software reset can be initiated by writing 0x38 to Reg 0x0E.

3. 8 LT-1PA01 Operation

3.8.1 Photodiodes and ADCs

LT-1PA01 contains two photodiode arrays which convert photons (light) into current. The ALS photodiodes are designed to mimic the human eye's wavelength response curve to visible light.

The ALS photodiodes' current output is digitized by a 12-bit ADC.The ALS ADC output is accessed by reading from Reg 0x0B and 0x0C when the ADC conversion is completed. The ALS ADC converter uses a charge-balancing architecture. Charge-balancing is best suited for converting small current signals in the presence of periodic AC noise. Integration over 200ms rejects both 50Hz and 60Hz light flicker by picking the lowest integer number of cycles for both 50Hz/60Hz frequencies. The proximity sensor uses an 8-bit ADC which operates in a similar fashion. The IRDR drives (pulses) an infrared emitter (VCSEL), the emitted IR reflects off an object back into the LT-1PA01, and the photo diodes convert the reflected IR to a current signal in 0.96ms (Figure 2). The ADC subtracts the IR reading before and after the IR emitter is driven to remove ambient IR contribution. The ALS runs continuously with new data available every 200ms. The proximity sensor runs continuously with a time between conversions controlled by PROX_SLP (Reg 0x01[6:4]).

3.8.2 Ambient Light Sensing

LT-1PA01 is set for ambient light sensing when Register bit ALS_EN = 1. Four measurement ranges from 62.5 Lux to 2000 Lux are available. The ALS measurement range is configured via Reg 0x02[1:0].

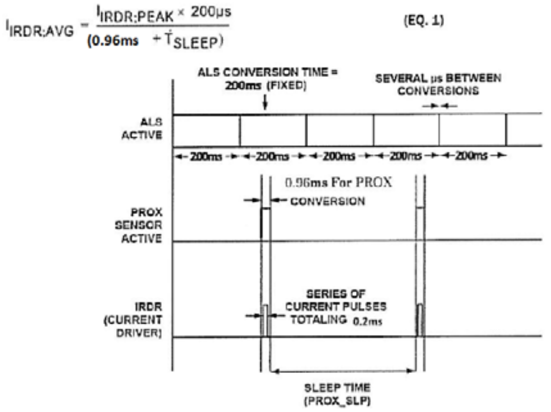
3.8.3 Proximity Sensing

When proximity sensing is enabled (PROX_EN = 1), the IR emitter (VCSEL) is driven for 200μs by the built-in driver through the IRDR . The IR emitter current depends on PROX_DRV (Reg 0x01[1:0]).

Drive current settings are as shown in Table 1. IR emitter drive is in high impedance state when not active. When the emitted IR reaches an object and gets reflected back to the LT-1PA01, the reflected light is converted into a current. This current is converted to digital data using an 8 bit ADC.

The proximity measurement takes 0.96ms for one conversion including the 0.2ms IR emitter drive time. The period between proximity measurements is determined by PROX_SLP (sleep time) in Reg 0x01[4:2]. Average IR emitter driving current consumption is given by Equation 1.

Figure 8 TIMING DIAGRAM FOR PROX/ALS EVENTS NOT TO SCALE



3. 9 Total Current Consumption

Total current consumption is the sum of IDD and IIRDR. The IRDR pin sinks current and the average IRDR current is calculated using Equation 1. IDD depends on voltage and the mode-ofoperation.

For simplicity Equation 1 ignores proximity ADC conversion time since it is much smaller than the sleep time.

3. 10 ALS IR Compensation

LT-1PA01 is designed for operation under dark glass cover. Glass or plastic covers can significantly attenuate visible light and pass the Infrared light without much attenuation. Consequently the LT-1PA01 under a glass cover experiences an (undesirable) IR rich environment. The on-chip ALS passive optical filter on LT-1PA01 is designed to block most of the IR incident on the ALS photo

diodes. In addition, LT-1PA01 provides a programmable active IR compensation that subtracts residual IR still reaching the sensor. The ALS_IR_COMP register (Reg 0x03[4:0]) allows fine tuning of

the residual infrared component from the ALS output. The recommended procedure for determining ALS IR compensation is as follows:

- Illuminate LT-1PA01 based product with a light source without IR, such as a white LED. Record the ALS measurement and the Lux level.
- Illuminate the device with an IR LED and the White LED. Take an ALS measurement and Lux level measurement.
- Adjust the ALS_IR_COMP register (Reg 0x03, bits 4:0) to compensate for the IR contribution.
- Repeat steps above until the IR light source contribution to the ALS measurement is under 10 percent assuming no change in Lux level due to IR light source.

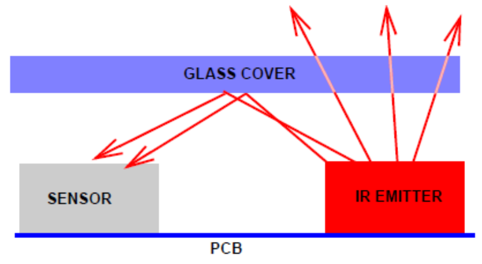
3. 11 Proximity Offset

Systems built with a protective glass cover over LT-1PA01 can provide light 'leakage' or 'crosstalk' from the IR emitter by reflection from the glass saturating the proximity sensor measurement system (Figure 9). Saturation can occur when the reflection from the glass with no object in the proximity detection space exceeds the full scale of the measurement system. LT-1PA01 proximity system

provides a user programmable proximity offset correction to compensate for this reflection.

The PROX_IR_COMP register (Reg 0x02[6:3]) applies a corrective offset to the received signal prior to ADC conversion, which allows the signal to be brought within the usable range of the proximity measurement system.

Figure 9 PROXIMITY SET-UP HIGHLIGHTING CROSSTALK REFLECTED FROM COVER GLASS



Attention:

3.12 Proximity Ambient Washout Detection

The optical proximity sensor can be saturated when illuminated with excessive ambient light. The LT-1PA01 provides a warning flag when the proximity measurement may be erroneous due to excessive ambient light. The PROX_WASH register (Reg 0x0D[0]) reports this condition.

3.13 Interrupts Events

LT-1PA01 interrupts are designed to minimize host micro-controller overhead of continuous polling. LT-1PA01 can generate interrupts on the results of an ALS measurement or proximity measurement. The ALS interrupt event ALS_FLAG (Reg 0x04[3]) is governed by Reg 0x07 through 0x09. Two 12 bit high and low threshold values are written to these registers. LT-1PA01 will set the ALS interrupt flag if the ADC conversion count in Registers 0x0B and 0x0C are outside the programmed thresholds. The ALS_FLAG is cleared by writing a '0' to Reg 0x04[3]. A proximity interrupt event (PROX_FLAG) is governed by the high and low thresholds in Reg 0x05 and 0x06 (PROX_LT and PROX_HT) and is indicated by Reg 0x04[7]. PROX_FLAG is set when the measured proximity data is more than the higher threshold. The proximity interrupt flag is cleared when the prox data is lower than the low proximity threshold or by writing a '0' to Reg 0x04[7].

The Proximity interrupt generation can be selected between 'out-of-window' threshold and hysteresis schemes. When the PROX_INT_ALG register (Reg 0x02, Bit 7) is set to 0, proximity uses a window comparator scheme; when set to 1, proximity uses a hysteresis scheme. In hysteresis mode, the interrupt event is generated if the proximity ADC count is higher than the PROX_HT threshold and

the interrupt event is cleared when the proximity ADC count is less than the PROX_LT threshold. The interrupt event flag can also be cleared by writing a '0' to Reg 0x04[7].

3.14 Interrupt Persistence

To minimize interrupt events due to 'transient' conditions an interrupt persistency option is available for both ALS and proximity measurements. Persistency requires 'X-consecutive' interrupt flags before the INT pin is driven low. Both ALS and PROX have their own independent interrupt persistency options. ALS_PRST and PROX_PRST configuration is controlled from Reg 0x04.

should be periodically monitored to detect post power-up power supply interruption.

3.15 Power-Up and 'Brown-Out' Reset

LT-1PA01 has an enhanced power-on-reset system. A 'Brown-Out' detector flag in Reg 0x04[4] informs the system that the device has powered-up properly. This flag should be reset as part of initialization sequence. A 'Brown-out' condition is defined as an operating condition when the power supply voltage is not within the specified limits. During the brown-out period at power-up, the I2C interface and the IR emitter driver are inactive. Following brown-out, the I2C interface is re-initialized and the configuration registers are set to power-up default values. After power-up and during device
initialization host should examine that the PWR_FAIL flag (Reg 0x04[4]) is set and then clear the flag by writing '0' to Reg 0x04[4]. Following power-up, a 'Brown-Out' condition, if detected, is reported by PWR_FAIL flag by Reg 0x04[4]. Device configuration registers are not set to their power-up default after 'Brown-Out'. PWR_FAIL flag should be periodically monitored to detect post power-up power supply interruption.

3.16 Power-Down

Setting ALS_EN (Reg 0x02[2]) and PROX_EN (Reg 0x01[5]) to '0' puts the LT-1PA01 into a power-down state with power supplycurrent dropping to less than 1μA. All configuration register are maintained in power-down mode.

3.17 Soft Reset

A software reset to LT-1PA01 can be initiated by writing 0x38 to Reg 0x0E. Following reset, all configuration registers are set to their default power-up state. LT-1PA01 after soft reset defaults
to the power-down configuration.

3.18 ALS Data Count Read Out

A 2 byte I2C read from ALS_DATA_HB outputs MSB 1st data on SDA. This data is LSB justified with a zero fill for unused bits. Note that the MSB byte address precedes the LSB byte address. The
ALS count is 256*(ALS_DATA_HB) + ALS_DATA_LB.

3.19 Proximity Detection of Various Objects

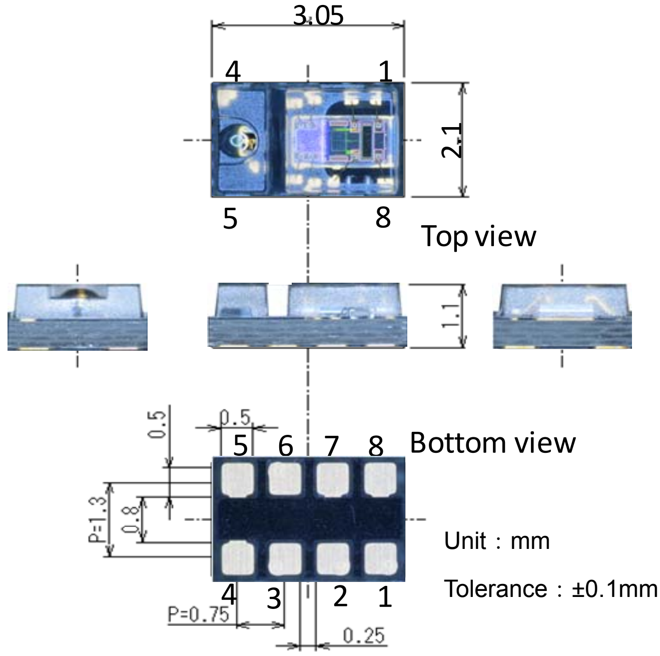
Proximity sensing relies on the amount of IR reflected back from objects. A perfect black object would absorb all incident light and reflect no photons. The LT-1PA01 is sensitive enough to detect black ESD foam which reflects only 1% of IR. Blonde hair typically reflects more than brown hair and skin tissue is more reflective than human hair. IR penetrates into the skin and is reflected from within. As a result, the proximity count generally peaks at contact and monotonically decreases as skin moves away. The reflective characteristics of skin are very different from that of an inanimate object such as paper.

4. Dimension, Land Pattern

4.1 Outline and Pin assign

Figure 10 Outline Dimensions

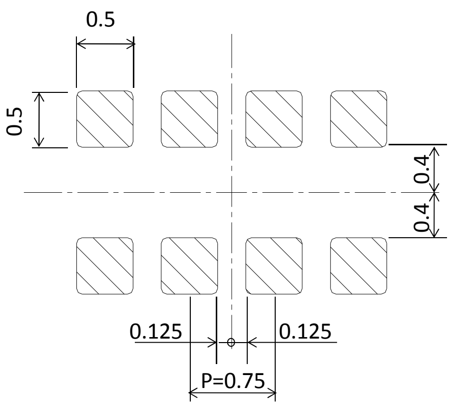
PIN	FUNCTION	NOTE
1	SCL	I2C clock
2	SDA	I2C data
3	INT	Interrupt output
4	GND	
5	GND	
6	VDD	3.0V
7	GND	
8	GND	



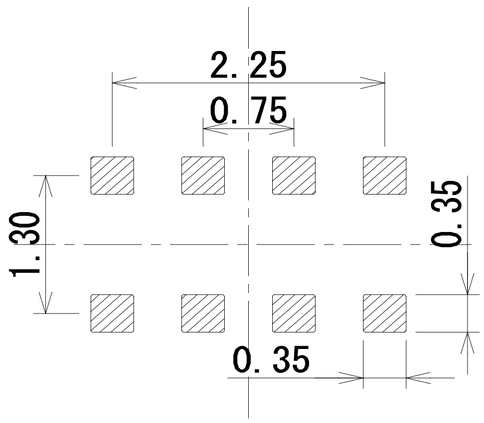
4.2 Recommended Land and Metal Mask pattern

Figure 11 Recommended Land and Metal Mask pattern

[Land Pattern]



[Metal Mask Pattern]



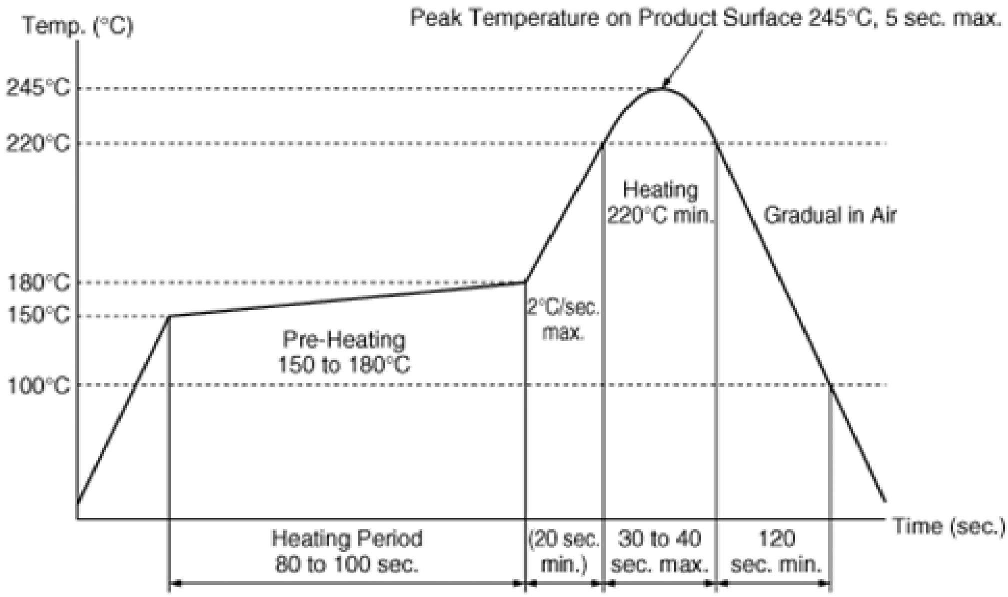
Thickness of Metal Mask : 0.12mm

(Insect eyeview from sensor's upper side)

Attention:

4.3 Recommended profit of solder reflow

Figure 12 Recommended profile of solder reflow



Other Precautions:

An infrared lamp used to heat up for soldering may cause a localized temperature risen the resin. Also avoid immersing the resin part in the soldering. Even if within the temperature profile above, there is the possibility that the gold wire in package is broken in case that the deformation of PCB gives the affection to lead pins. Please use after confirmation the conditions fully actual solder reflow machine and avoid the rework.

5. Packing

5.1 Packaging and Indication.

5.1.1 1 Tape structures and Dimensions and Product insertion

Symbol	D	E	P_0	t	F	D_1	P_2	W	P
Dimensions	1.5	1.75	4	0.3	5.5	1	2	12	4
Tolerance	+0.1/-0	±0.1	±0.1	±0.05	±0.05	±0.05	±0.05	±0.1	±0.1

Symbol	A_0	B_0	K_0	P_0 x 20
Dimensions	2.25	3.25	1.25	80
Tolerance	±0.0	±0.1	±0.1	±0.15

Unit [mm]

Figure 13 Tape dimensions and Product insertion

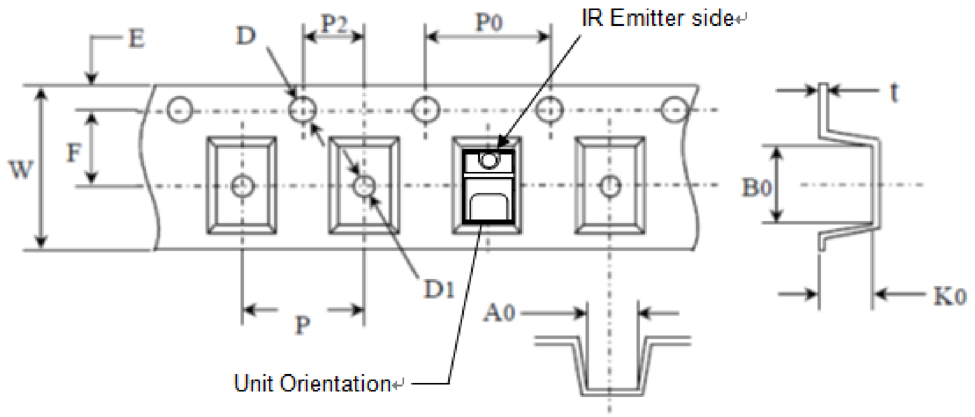
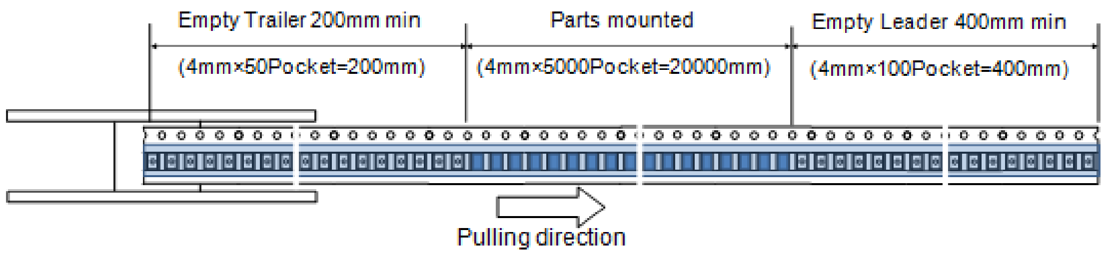


Figure 14 Pulling direction and Trailer/Leader



・All of the tape is adhesive with cover tape and the tape is clockwise twining.

・The runover of the cover tape is less than 1/3 of the tape forwarding hole.

・A cover film and the carrier tape do not have a joint.

・Attach 200mm or more of blank tape to the trailer and 400mm or more blank tape to the leader and fix the both ends with adhesive tape.

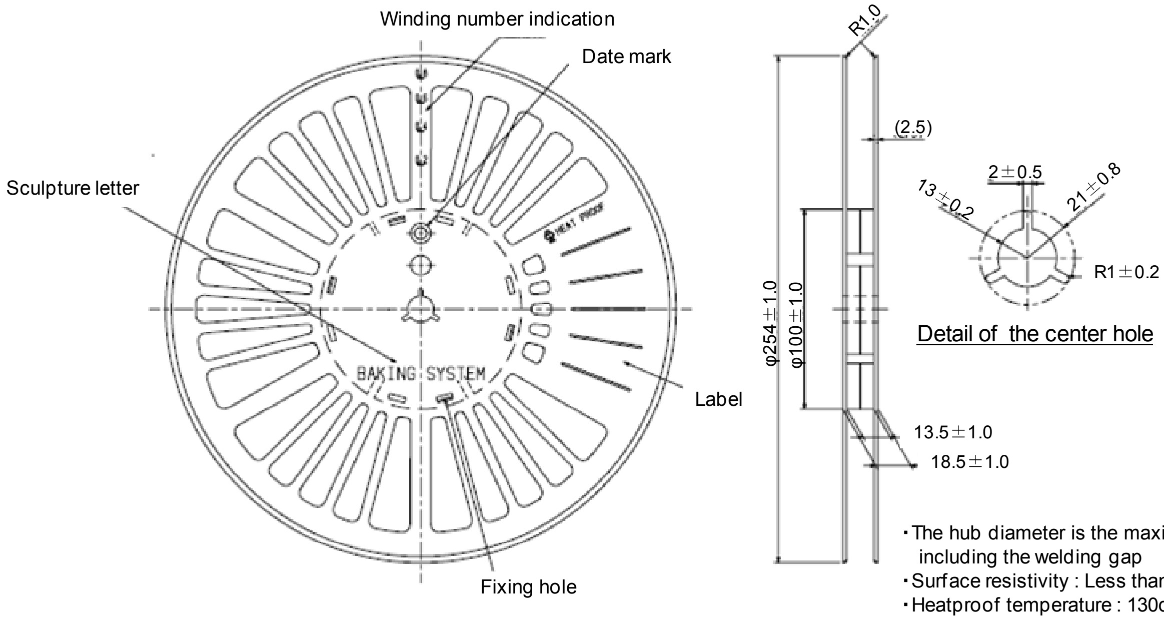
・One tape shall contain 5000pcs.

・Except a leader part, the non-adhesion part of the cover tape is less than 2mm.

・The exfoliation force between carrier and cover tape shall be 0.69N max. for 170 degree.

5.2 Reel structures and Dimensions

Figure 15 Reel structure and Dimensions



- The hub diameter is the maximum including the welding gap
- Surface resistivity : Less than 1x10⁹
- Heatproof temperature : 130degC max.

6. Other

6.1 ⚠ Cautions

Limitation of application

The product is designed and manufactured for consumer application only and is not available for any application listed below which requires especially high reliability for the prevention of such defect as may directly cause damage to the third party's life, body or property.

- Aircraft equipment.
- Aerospace equipment
- Undersea equipment.
- Power plant control equipment
- Medical equipment.
- Transportation equipment (vehicles, trains, ships, etc.).
- Traffic signal equipment.
- Disaster prevention / crime prevention equipment.
- Application of similar complexity and/ or reliability requirements to the applications listed in the above.

6.2 Fail-safe

Be sure to provide an appropriate fail-safe function on your product to prevent a second damage that may be caused by the abnormal function or the failure of our product.

6.3 Precautions for use

Notice in design

1) In the case of outdoor use, suitable optical filter and water and humidity proof structure should be applied.
2) To prevent failure or malfunction, please use a stabilized power supply.
3) Please avoid using the sensor in the following conditions because it may cause failure or malfunction ;

   a) In such a fluid as water, alcohol etc. corrosive gas (S02, Cl2, NOX etc.) or
   sea breeze.

   b) In high humidity.

   c) In a place exposed directly to sunlight or headlight of automobile.

   d) In a place exposed to rapid ambient temperature change.

   e) In a place exposed directly to blow from air-conditioner or heater.

   f) In a place exposed to strong vibration.

   g) In a place exposed to strong electromagnetic field.

   h) In such a place where infrared ray is shaded.

   i) In any other place similar to the above (a) through (h).

6.4 Notice in handling and storage

1) Optical lens and light receiving area of sensor should not be scratched or soiled.
2) Strong shock should be avoided.
3) Electrostatics and strong electromagnetic field should be avoided.
4) High temperature, high humidity, fluid as water or alcohol etc., corrosive gas (S02, Cl2, NOX etc.) and sea breeze should be avoided.
5) The delivered product should be stored with the conditions as follows and in dry box or N2 atmosphere, and the warranty term for the shipped product shall be for 6 months after shipping to the designated place by the order customer.

Storage temperature : 15 to 35□、Humidity : below 70%RH

6) Regarding treatment after unsealed, devices should be mounted under the temperature condition of 5 to30□, at the humidity condition of below 60%RH, within 168 hours and in case that long term storage is needed, devices should either be stored in dry box or resealed to moist-proof bag with siccative and leave them in the environment where the temperature is 15 to 30□, at humidity condition of below 70%RH, and devices must be mounted within 1 weeks.

7) Regarding baking before mounting, in the event that the devices are not maintained in the storage conditions described above, baking must be applied before devices are not mounted. The case that LT-1PA01 was not mounted under the temperature condition of 15 to 30□, at humidity condition of below 70%RH within 168 hours after 1st time reflow, baking process must be applied before 2nd time reflow. And also please note that baking should only be applied twice.

Recommended condition of the devices baking and reel baking : 100□, 4 hours

**To complete the baking properly, devices should be placed to the metal tray.
And also in the case of reel baking, hung the reel in the oven by passing the shaft in the center hole of reel and please avoid laying the reel.

6.5 ⚠ Notice (soldering and mounting)

1. Please follow soldering conditions described in the specification. This product can permanently stop operating if the optical characteristic is decreased due to excessive heating.
2. Cleaning after reflow soldering should not be applied. Optical lens and light receiving area of sensor should not be soiled because it may cause failure or malfunction.
3. As electrostatic field or discharge may degrade this product, please take methods such as wearing wrist strap, grounding working desk or equipment to avoid this damage.

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   The LT-1PA01 is designed and tested to enable manufacturers to achieve eye safety certification with minimal effort. This sensor complies with the Class 1 emission requirements of FDA 21CFR Part 1040.10 and IEC60825-1.
   When installed and operated in accordance with all requirements in this sheet, the LT-1PA01 satisfies FDA 21CFR Part 1040.10 and IEC60825-1 Class1.
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