LITEON®
OPTOELECTRONICS

Optical Sensor
Product Data Sheet
LTR-X130A-039

Spec No. :DS86-2020-0023
Effective Date: 11/26/2020
Revision: -

LITE-ON DCC

RELEASE

BNS-OD-FC001/A4

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Optical Sensor
LTR-X130A-039

1. Description

The LTR-X130A-039 is an integrated low voltage I2C ambient light sensor (ALS) which offers low power consumption, high ALS accuracy in a single miniature chipled lead-free surface mount package.

The ALS provides a linear response over a wide dynamic range, which is well suited to applications under very low or bright ambient brightness. It's close to human eye spectral response to provide excellent ambient light detection accuracy. A programmable interrupt with hysteresis to response to events is included in the sensor and it 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.

2. Features

- I^2C interface (Standard mode @100kHz or Fast mode @400kHz)
- Ambient Light in one ultra-small ChipLED package
- Very low power consumption with sleep mode capability suited for battery operated devices
- Operating voltage ranges: 1.7V to 3.6V
- Count stability across temperature range
- Operating temperature ranges: -40 to +85 ºC
- Built-in temperature compensation circuit
- Programmable interrupt function for ALS with upper and lower thresholds
- RoHS and Halogen free compliant
- Fast Response Time

ALS Features

- 16 to 20 bits effective resolution
- Wide dynamic range with linear response
- Close to human eye spectral response
- Automatic rejection for 50Hz/60Hz lighting flicker

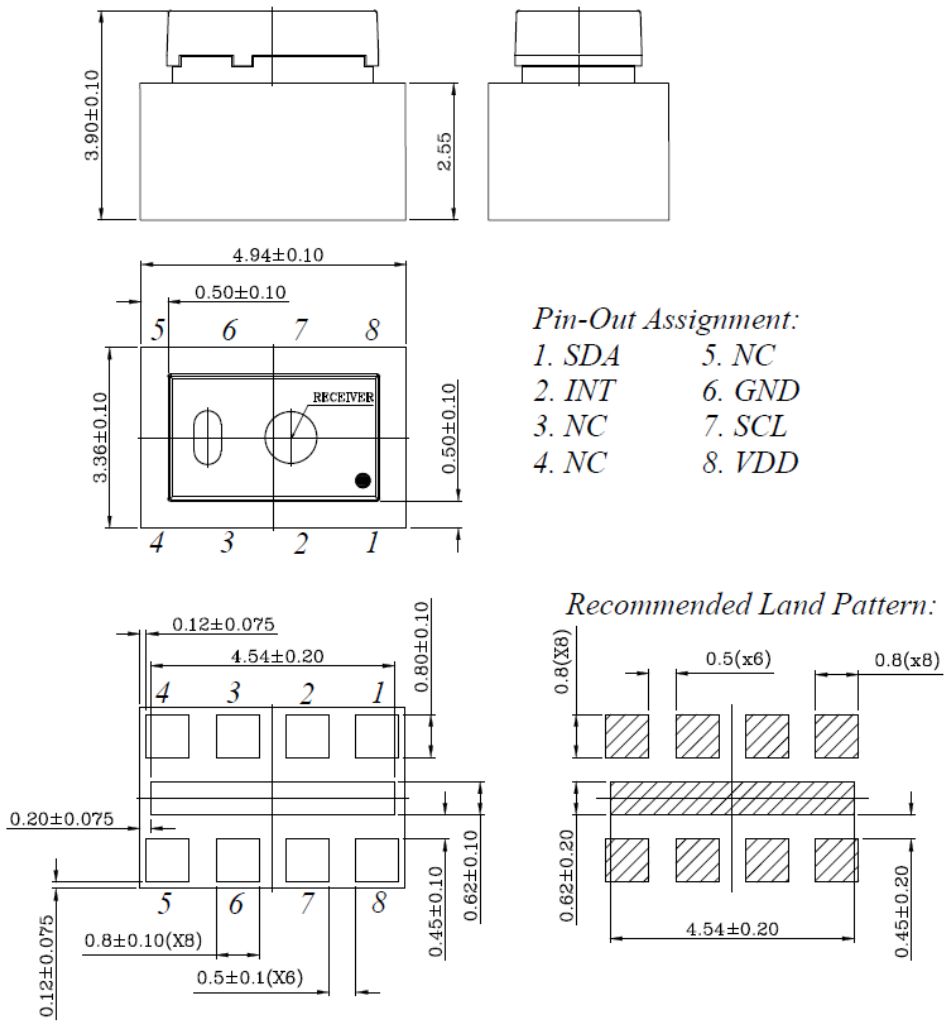
3. Applications

- Control brightness of display panel
- Object detection in mobile, computing, and consumer devices.

4. Ordering Information

Part Number	Packaging Type	Package	Quantity
LTR-X130A-039	Tape and Reel	8-pin chipled package	1500

5. Outline Dimensions

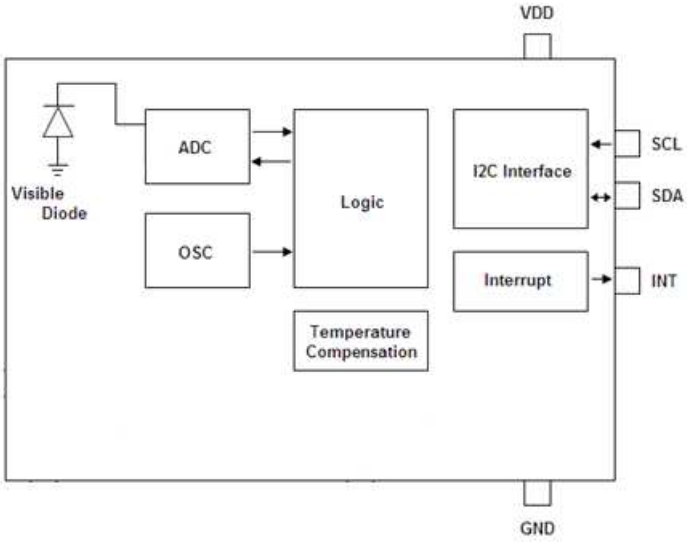


Note: 1. All dimension in millimeter.

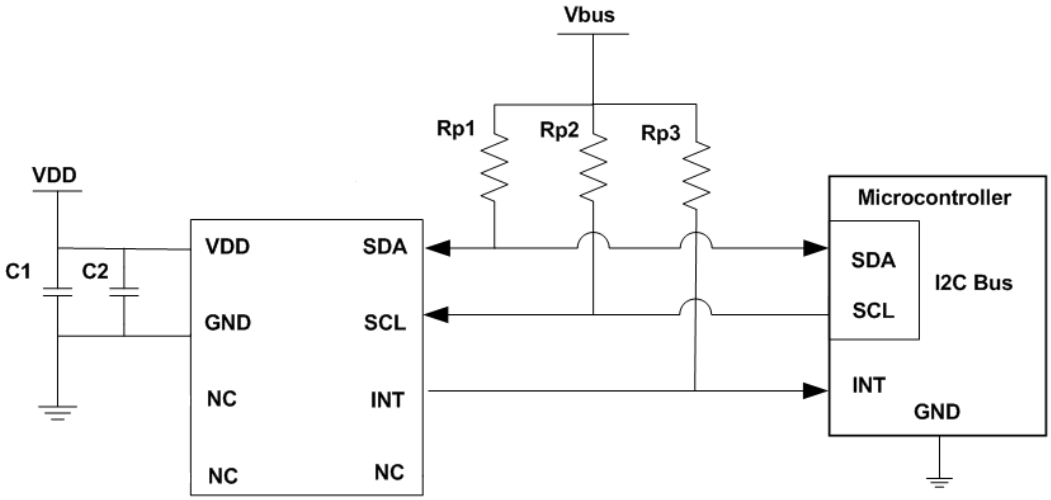
2. All dimension tolerance is 0.2mm unless specified.

6. Functional Block Diagram

LTR-X130A-039 contains photodiode (Visible) for photocurrent measurement. The photodiode currents are converted to digital values by ADCs. The sensor also included some peripheral circuits such as an internal oscillator, a current source, voltage reference, and internal fuses to store trimming information.



7. Application Circuit



I/O Pins Configuration Table

Pin	I/O Type	Symbol	Description
1	IN/OUT	SDA	I^2C serial data
2	OUT	INT	Interrupt
3	NC	NC	Not connected
4	NC	NC	Not connected
5	NC	NC	Not connected
6	Ground	GND	Ground
7	IN	SCL	I^2C serial clock
8	Supply	VDD	Power Supply Voltage

Recommended Application Circuit Components

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

[1] Selection of pull-up resistors value is dependent on bus capacitance values. For more details, please refer to I^2C Specifications: http://www.nxp.com/documents/user_manual/UM10204.pdf

8. Ratings and Specifications

Absolute Maximum Ratings 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.

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

Electrical & Optical Specifications

All specifications are at VDD = 2.8V, T_{ope} = 25°C, unless otherwise noted.

Parameter	Min.	Typ.	Max.	Unit	Condition
Supply Current		110		uA	Max. duty cycle, Vdd=2.8V, Gain3
Standby Current		1		uA	Shutdown Mode
Wakeup Time from Standby		5	10	ms	From Standby to Active mode where measurement can start

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	%	
Dark Level Count		0	5	Count	0 Lux, 18-bit resolution
Min. Integration time	50		400	ms	With 50/60Hz Rejection
50/60 Hz flicker noise error	-5		+5	%	
ALS Gain	1		18		Programmable to 1x,3x,6x,9x,18x
Sensitivity (White LED, CCT = 5000 K)		5.8		Count/lux	ALS Gain = 3x, Integration time = 100ms
Sensitivity (White LED, CCT = 5000 K)		35		Count/lux	ALS Gain = 18x, Integration time = 100ms
Sensitivity (White LED, CCT = 5000 K)		140		Count/lux	ALS Gain = 18x, Integration time = 400ms

Typical Device Parameter

VDD = 2.8V, Ta=25℃, Default power-up settings, unl ess otherwise noted)

ALS Spectral Response

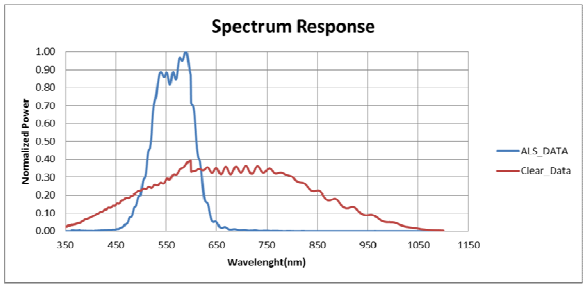


Figure 4.1 : Spectral response for ALS

Angular of Incidence

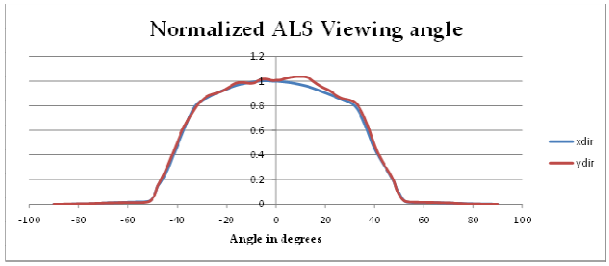


Figure 4.2 ALS Sensitivity vs. Angular of Incidence

Counts under Dark Environment

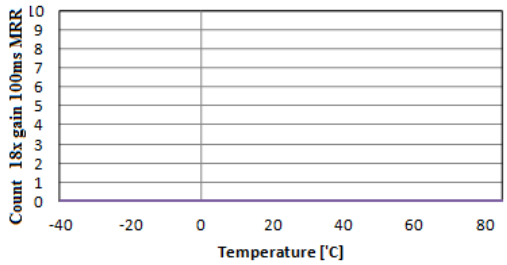


Figure 4.3 : Dark Count VS Temperature (Bench Test)

Standby Current Across Temperature

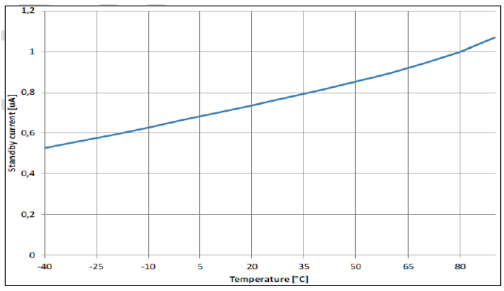
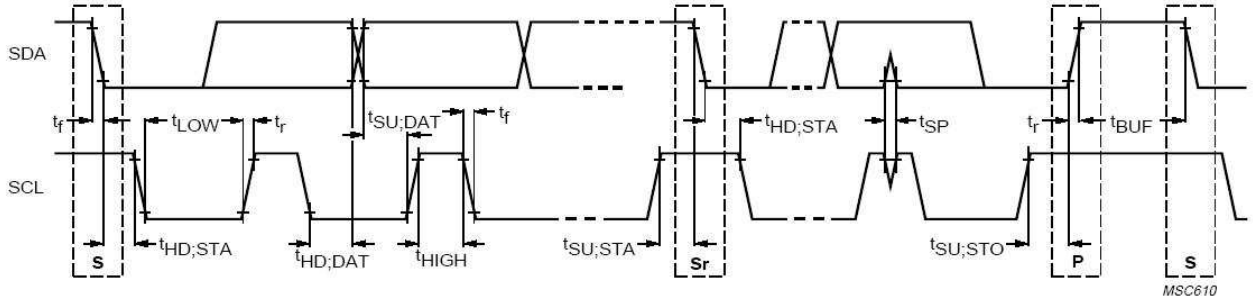


Figure 4.4 : Standby Current VS Temperature

AC Electrical Characteristic

All specifications are at VBus = 1.7V, 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	--	300	ns
Fall time of both SDA and SCL signals	t_f	--	300	ns
Data hold time	$t_{HD;DAT}$	0		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

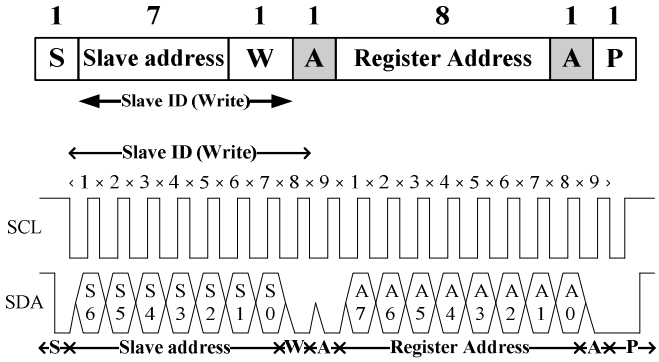


Definition of timing for I²C bus

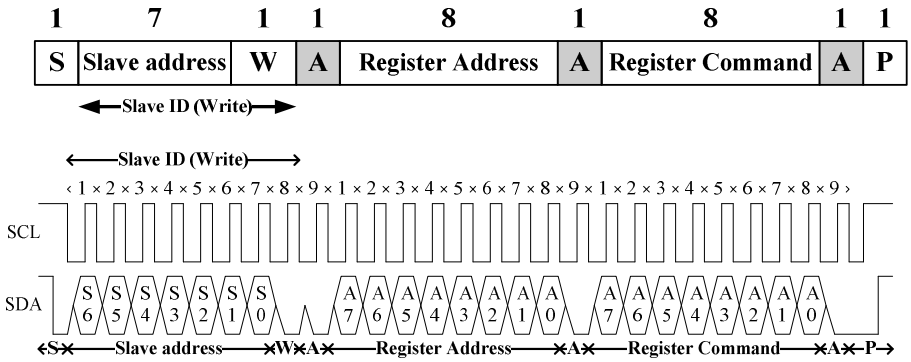
9. Principles of Operation

I²C Protocols

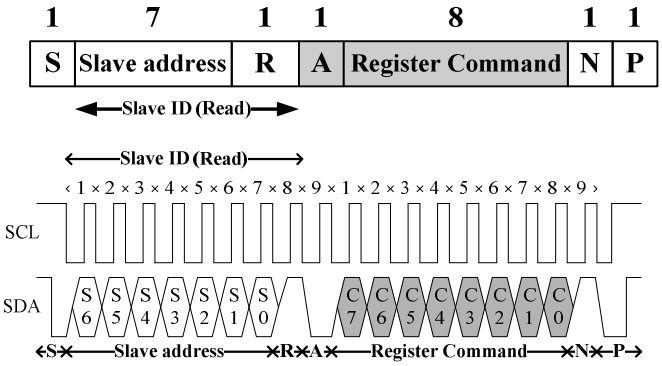
· I²C Write Protocol (type 1):



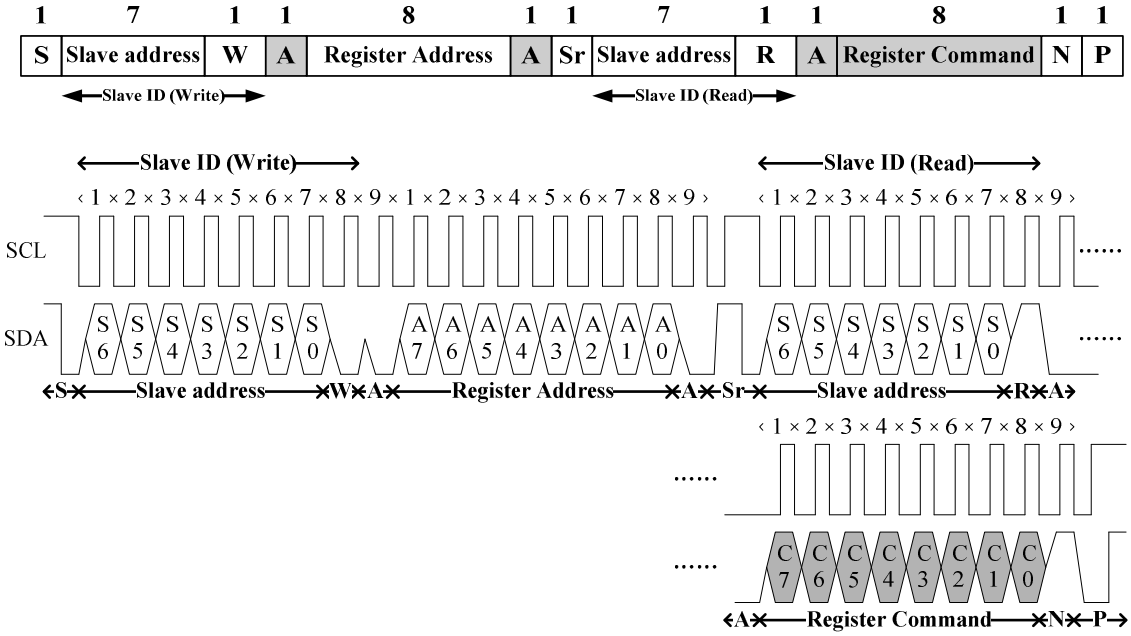
· I²C Write Protocol (type 2):



· I²C Read Protocol:



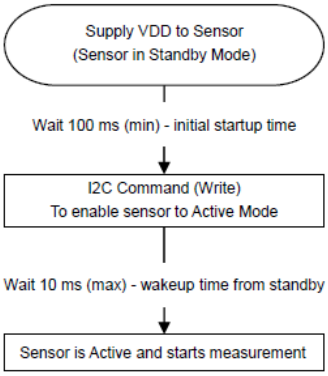
· I²C Read (Combined format) Protocol:



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

Notes:

1. Startup Sequence



I2C Slave Address

The 7 bits slave address for this sensor is 0x53H. 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	(0x53H)							W/R	value
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
Write	1	0	1	0	0	1	1	0	0xA6H
Read	1	0	1	0	0	1	1	1	0xA7H

Register Set

Addr	R / W	Register Name	Description	Reset Value
0x00	RW	MAIN_CTRL	ALS operation mode control, SW reset	0x00
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
0x0A	R	CLEAR_DATA_0	CLEAR ADC measurement data, LSB	0x00
0x0B	R	CLEAR_DATA_1	CLEAR ADC measurement data	0x00
0x0C	R	CLEAR_DATA_2	CLEAR ADC measurement data, MSB	0x00
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
0x19	R/W	INT_CFG	Interrupt configuration	0x10
0x1A	R/W	INT_PST	Interrupt persist setting	0x00
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 measurement and start new measurement.

0x00	MAIN_CTRL (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Reserved			*Software Reset*	*Reserved*	*Reserved*	*ALS Enable*	*Reserved*

Field	Bits	Default	Description	
Reserved	7:5	000	--	--
SW Reset	4	0	0	Software reset is NOT triggered (default)
			1	Software reset is triggered
Reserved	2:3	00	--	--
ALS Enable	1	0	0	ALS standby(default)
			1	ALS active
Reserved	0	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
	Reserved	*ALS/C Resolution/Bit Width*			*Reserved*	*ALS Measurement Rate*		

Field	Bits	Default	Description	
Reserved	7	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

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**
	Reserved					***ALS Gain Range***		

Field	Bits	Default	Description	
Reserved	7:3	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
	Part Number ID				*Revision ID*			

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 interrupt and data status. The interrupt status in Bit 4 and Bit 1 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*	*Reserved*	*Reserved*

Field	Bits	Default	Description	
Reserved	7:6	00	--	--
Power On Status	5	0	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	--	--
Reserved	1	0	--	--
Reserved	0	0	--	--

CLEAR_DATA Register (0x0A / 0x0B / 0x0C) (Read Only)

The Clear 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 CLEAR_DATA registers will be updated as soon as there is no on-going I2C read operation to the address range 0x07 to 0x18.

0x0A	CLEAR_DATA _0 (default = 0x00)							
	B7	***B6***	***B5***	***B4***	***B3***	***B2***	***B1***	***B0***
	CLEAR DATA, Low							

0x0B	CLEAR_DATA_ 1 (default = 0x00)							
	B7	***B6***	***B5***	***B4***	***B3***	***B2***	***B1***	***B0***
	CLEAR DATA, Middle							

0x0C	CLEAR_DATA_ 2 (default = 0x00)							
	B7	***B6***	***B5***	***B4***	***B3***	***B2***	***B1***	***B0***
	Reserved				***CLEAR DATA, High***			

Field	Address	Bits	Default	Description
Clear Data, Low	0x0A	7:0	00000000	Clear Data lower byte data
Clear Data, Middle	0x0B	7:0	00000000	Clear Data Middle byte data
Clear Data, High	0x0C	7:4	0000	Reserved
		3:0	0000	Clear Data Higher byte data

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**
	ALS DATA, Low							

0x0E	ALS DATA_ 1 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	ALS DATA, Middle							

0x0F	ALS_DATA_ 2 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Reserved				*ALS DATA, High*			

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

INT_CFG Register (0x19) (Read/Write)

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

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

Field	Bits	Default	Description	
Reserved	7:6	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	--	--
Reserved	0	0	--	--

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***			

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	--	--

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
	ALS Upper Threshold, Low							

0x22	ALS_THRES_UP_1 (default = 0xFF)							
	B7	B6	B5	B4	B3	B2	B1	B0
	ALS Upper Threshold, Mid							

0x23	ALS_THRES_UP_2 (default = 0x0F)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Reserved				*ALS Upper Threshold, High*			

0x24	ALS_THRES_LOW_0 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	ALS Lower Threshold, Low							

0x25	ALS_THRES_LOW_1 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	ALS Lower Threshold, Mid							

0x26	ALS_THRES_LOW_2 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Reserved				*ALS Lower Threshold, High*			

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

10. Application Information

10.1 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.

For no window (Clear window)

$$Lux_{Calc} = \frac{0.51 * ALS_{DATA}}{GAIN * INT}$$

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.

$$Lux_{Calc} = \frac{0.51 * ALS_{DATA}}{GAIN * INT} * WindowFactor$$

Where:

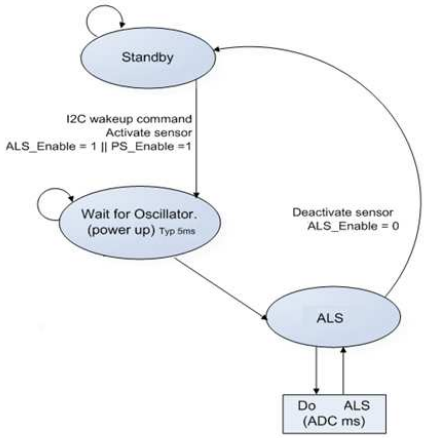
ALS Gain	GAIN
X1	**1**
X3	**3**
X6	**6**
X9	**9**
X18	**18**

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**

10.2 Device Operation (State Machine and Interrupt Features)

State Machine

Below diagram is the main state machine of LTR-X130A.



During the ALS, ALS measurements can be activated by setting the ALS_Enable bit to 1. As soon as the ALS sensor becomes 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

ALS Interrupt

The ALS interrupt is enabled by Bit 2 (ALS INT Pin Enabled) of INT_CFG register (0x19). The ALS interrupt source is ALS channel. 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.

11. 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                    // MAIN_CTRL register
Command = 0x03                          // 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                    // ALS_MEAS_RATE register
Command = 0x41                          //                  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                    // ALS_GAIN register
Command = 0x00                          //                  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                    // MAIN_STATUS register address
Data = ReadByte(Slave_Addr, Register_Addr)

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
```

CLEAR_DATA Registers (Read Only)

```
//The register 0x0A contains CLEAR_DATA   ADC 0 lower byte data.
//The register 0x0B contains CLEAR_DATA   ADC 1 middle byte data.
//The register 0x0C contains CLEAR_DATA   ADC 2 upper byte data.
//These registers should be read as a group, with the lower address being read first.

Register_Addr = 0x0A                    // CLEAR_DATA_0 low byte address
Data0=ReadByte(Slave_Addr, Register_Addr)
Register_Addr = 0x0B                    // CLEAR_DATA_1 middle byte address
Data1=ReadByte(Slave_Addr, Register_Addr)
Register_Addr = 0x0C                    // CLEAR_DATA_2 upper byte address
Data2=ReadByte(Slave_Addr, Register_Addr)
CLEAR_Data =(Data2<<16)| (Data1 << 8) | Data0
                                        // Shift and combine all register data to get CLEAR ADC Data
```

ALS_DATA Registers (Read Only)

```
// The register 0x0D contains ALS ADC lower byte data.
// The register 0x0E contains ALS ADC 1 middle byte data.
// The register 0x0F contains ALS ADC 2 upper byte data.
// These registers should be read as a group, with the lower address being read first.

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 register data 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 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)
```

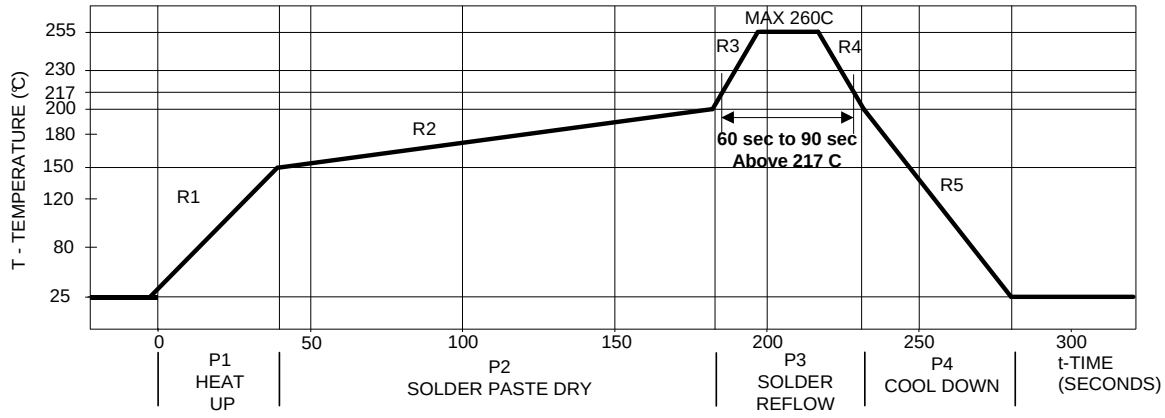
INTERRUPT_PERSIST Register

```
// 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
WriteByte(Slave_Addr, Register_Addr, Data0)
Register_Addr = 0x25                        // ALS_THRES_LOW_1 Register address
WriteByte(Slave_Addr, Register_Addr, Data1)
Register_Addr = 0x26                        // ALS_THRES_LOW_2 Register address
WriteByte(Slave_Addr, Register_Addr, Data2)
```

12. 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 P3, R4	200°C to 260°C 260°C to 200°C	3°C/s -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.

13. Moisture Proof Packaging

All LTR-X130A-039 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

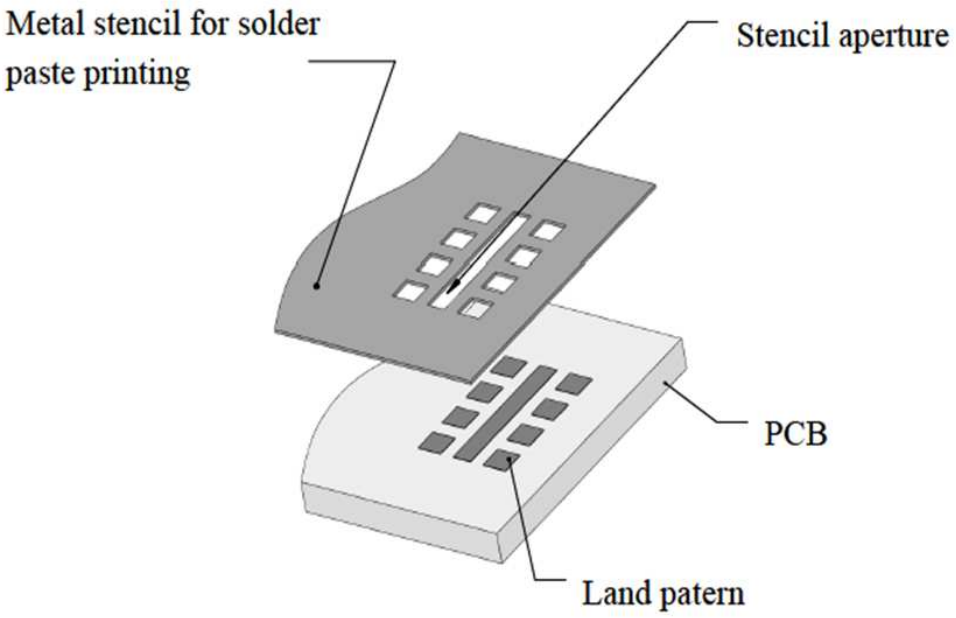
Storage Temperature	10°C to 30°C
Relative Humidity	Below 60% RH

Baking Conditions

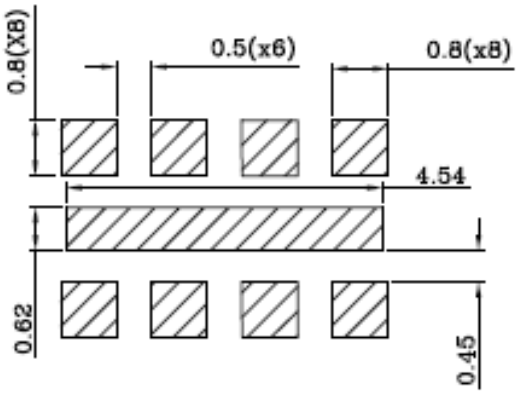
Package	Temperature	Time
In Reels	60°C	48 hours
In Bulk	100°C	4 hours

Baking should only be done once.

14. Recommended Land Pattern and Metal Stencil Aperture



Recommended Land Pattern

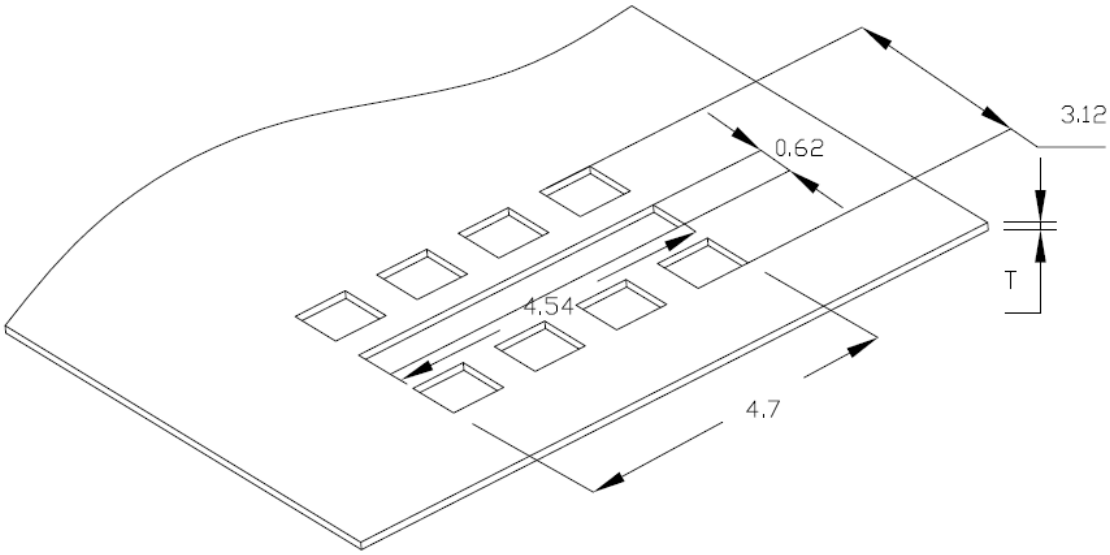


Note: All dimensions are in millimeters

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).

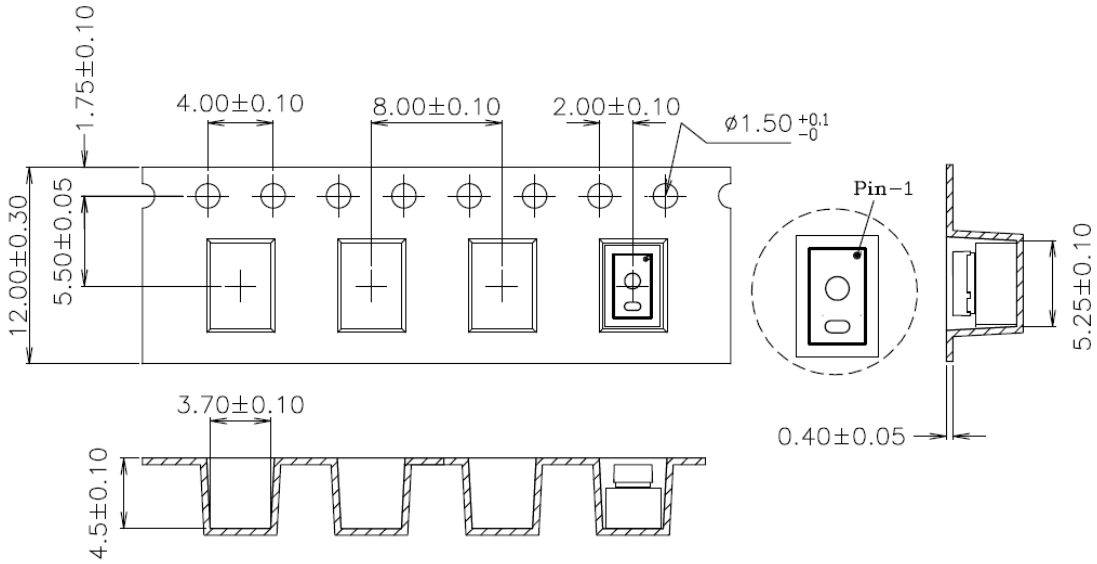
The stencil aperture opening for LTR-X130A-039 pads is recommended to be 0.80mm x 0.80mm which has the same dimension as the land patterns. For the center pad stencil aperture opening will be 4.54 mm x 0.62 mm. This is to ensure adequate printed solder paste volume and yet no shorting.

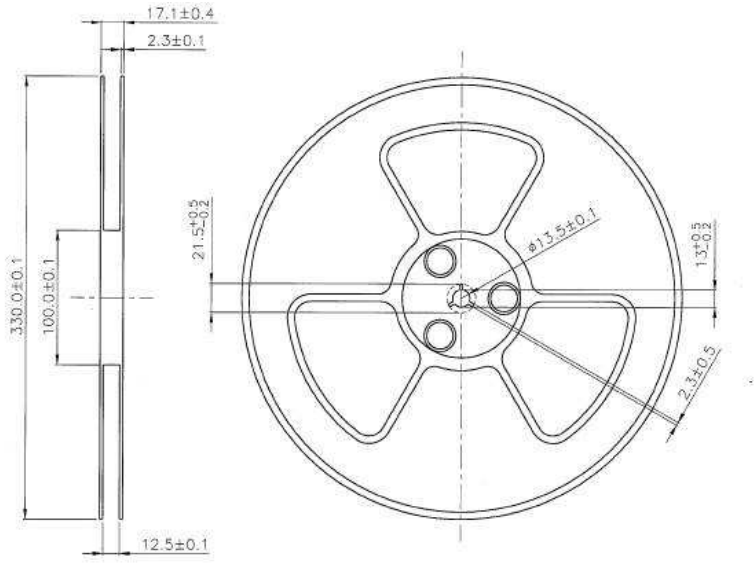


Note:

1. All dimensions are in millimeters

15. Package Dimension for Tape and Reel





Notes:
1. All dimensions are in millimeters
2. Empty component pockets sealed with top cover tape
3. 13 inch reel - 1500 pieces per reel
4. In accordance with ANSI/EIA 481-1-A-1994 specifications

Revision Table:

Version	Update	Page	Date
1.0	Datasheet as created	Total 29	19-Feb-2020
1.1	ALS Spec Update	Total 29	02-Mar-2020
1.2	ALS Formula Update	Total29	20-Mar-2020
1.3	ALS Formula Update	Total31	12-Jun-2020