Optical Sensor
LTR-556ALS-046

1. Description

The LTR-556ALS-046 is an integrated low voltage I^2C digital light sensor [ALS] and proximity sensor [PS] with built-in emitter, in a single miniature chipled lead-free surface mount package. This sensor 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 (emitter and detector), LTR-556ALS-046 offers the feature to detect object at a user configurable distance.

The sensor supports an interrupt feature that removes the need to poll the sensor for a reading which improves system efficiency. The sensor 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 sensor-to-sensor 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
  - 6 dynamic range from 0.01 lux to 64k 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

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3. Applications

To control display backlight in

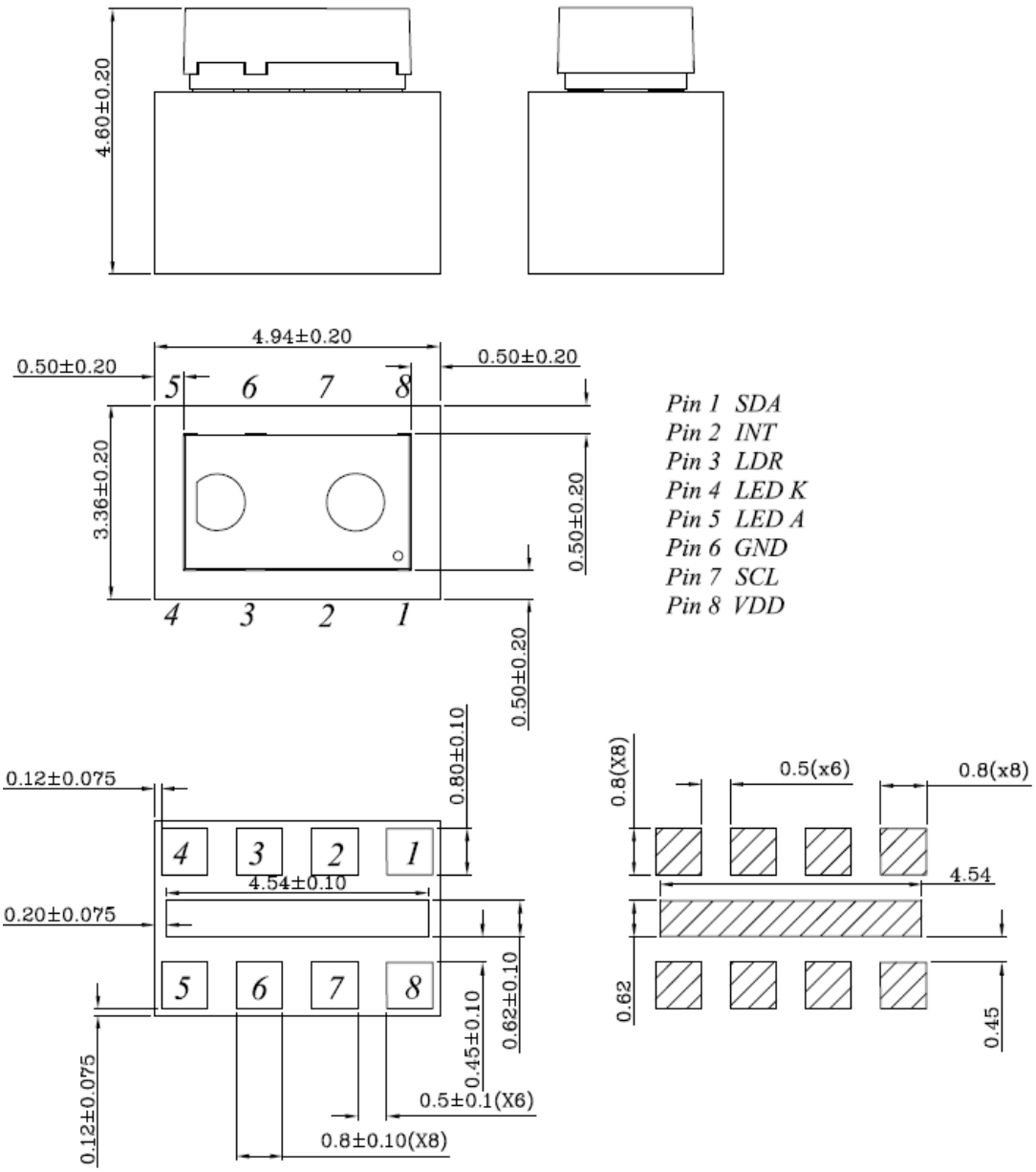
- Mobile Devices: Mobile phone, PDA
- Computing Devices: Notebook PC, Desktop Monitor
- Consumer Devices: LCD/PDP TV backlight systems, Cameras, Personal Navigation Device, Digital Photo Frame
- Dashboard

4. Ordering Information

Part Number	Packaging Type	Package	Quantity
LTR-556ALS-046	Tape and Reel	8-pin chipled package	8000

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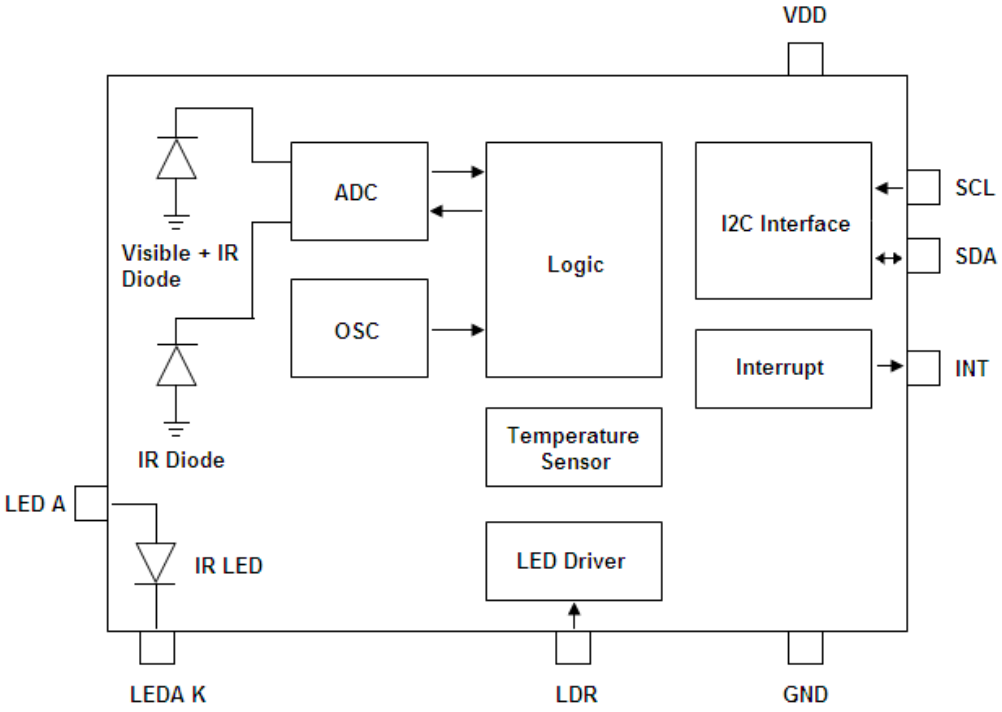
5. Outline Dimensions



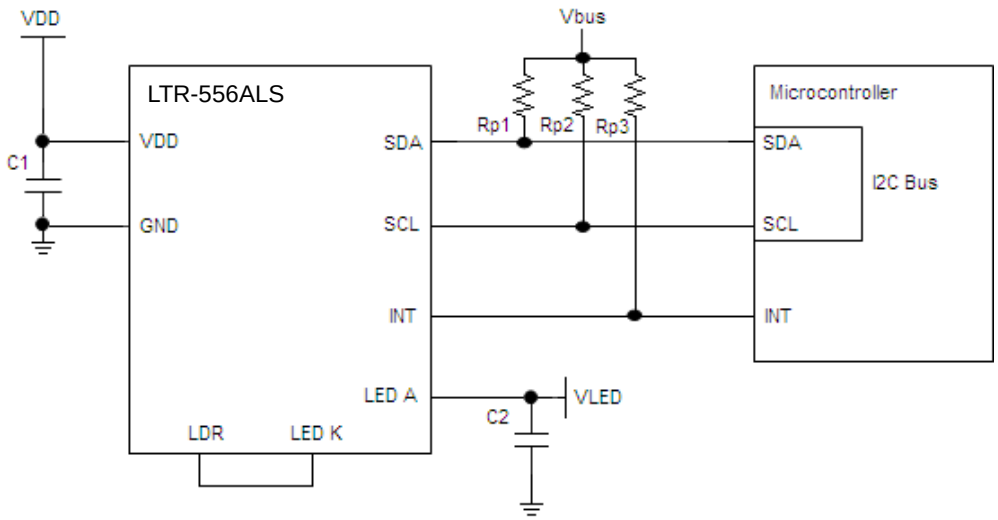
1. All dimensions are in millimeters

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6. Functional Block Diagram



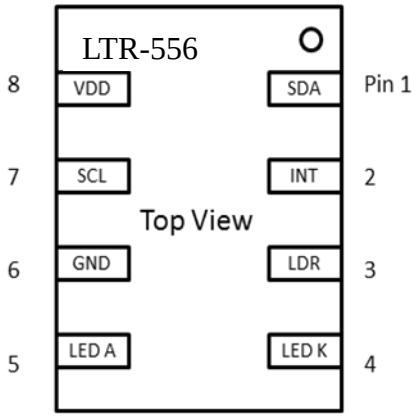
7. Application Circuit



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I/O Pins Configuration Table

Pin	I/O Type	Symbol	Description
1	I/O	SDA	I^2C serial data. This pin is an open drain input / output.
2	O	INT	Level Interrupt Pin. This pin is an open drain output.
3	I	LDR	LED Driver for proximity emitter. This pin is an open drain input.
4	O	LED K	LED Cathode. Connect to LDR pin if using internal LED driver circuit.
5	I	LED A	LED Anode. Connect to VDD or VBAT on PCB
6		GND	Ground
7	I	SCL	I^2C serial clock. This pin is an open drain input.
8		VDD	Power Supply Voltage



Recommended Application Circuit Components

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

[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

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8. Ratings and Specifications

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 100	°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
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			250	uA	Active Mode, T_{ope} = 25°C
Standby Current			5	uA	Standby / Sleep Mode
Initial Startup Time	60	100	1000	ms	(Note 1)
Wakeup Time from Standby			10	ms	(Note 1)

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Optical Sensor
LTR-556ALS-046

Light Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
Full Scale ADC Count			65535	count	
Dark ADC Count	0		6	count	Ch0, Lux = 0
	0		6	count	Ch1, Lux = 0
ADC Count (Gain=96)	3200	4900	6600	count	Ch0 White LED 200 Lux Integration Time : 50ms Measurement Time : 100ms
	1200	1800	2400	count	Ch1 White LED 200 Lux Integration Time : 50ms Measurement Time : 100ms
ALS Ratio	0.15	0.26	0.35		Ratio = Ch1/(Ch1 + Ch0) Lux = 200 (White LED)

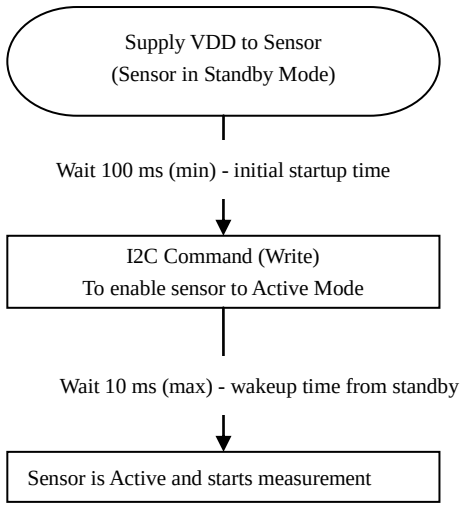
Proximity Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
Full Scale ADC Count			2047	count	
Peak Sensitivity	925	940	955	nm	
Detection Distance		30		mm	100mA, 8 pulses, 18% Gray card
Ambient Light Suppression			50k	Lux	Direct sunlight
LED Pulse Count	1		15	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

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	50	mA	LED Peak Current = 011
	100	mA	LED Peak Current = 1XX
Optical Rise / Fall Time	100	ns	

Note 1: Startup Sequence



LUX Formula

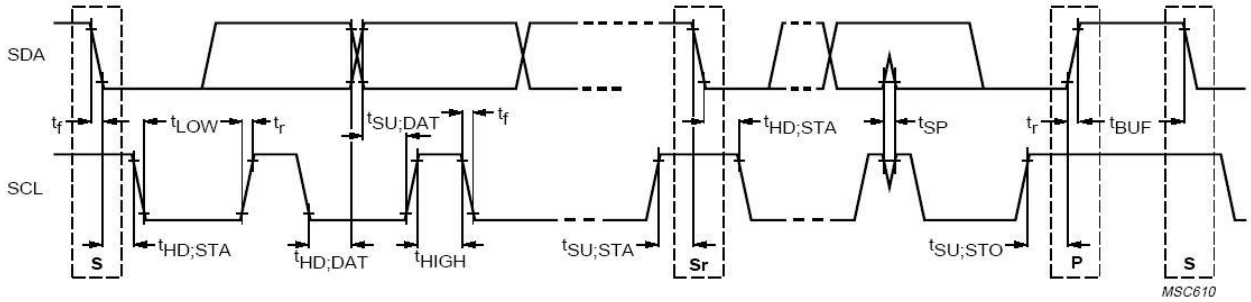
Refer to Appendix A for the lux formula

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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



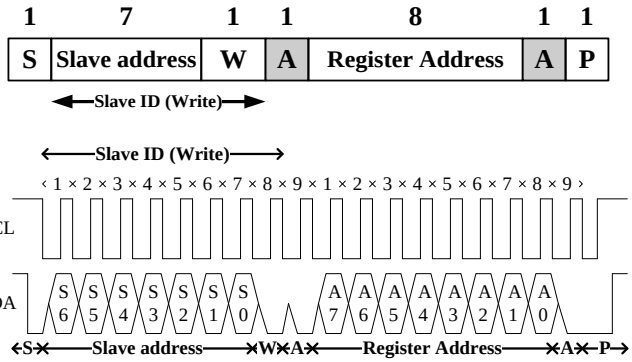
Definition of timing for I²C bus

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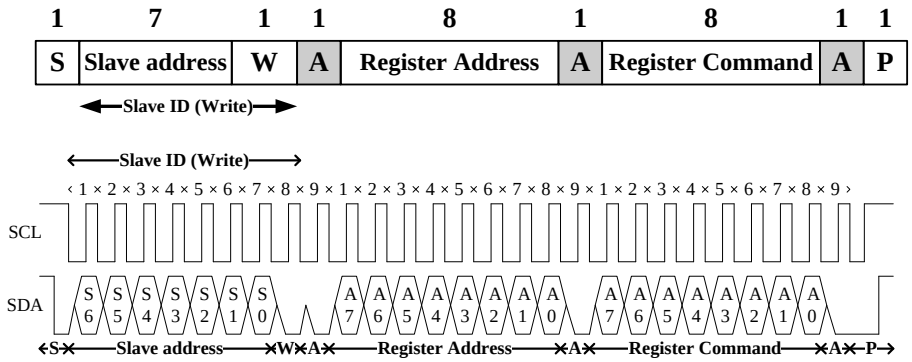
9. Principles of Operation

I²C Protocols

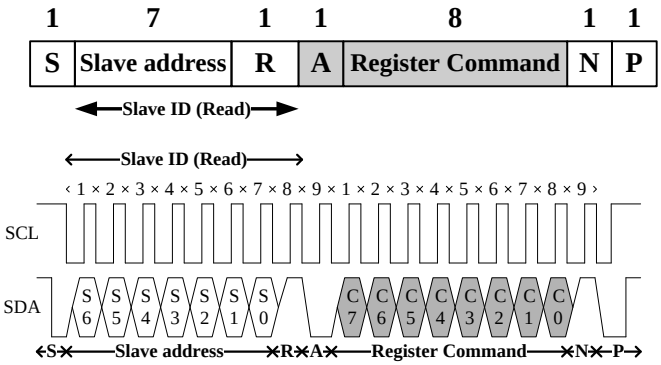
· I²C Write Protocol (type 1):



· I²C Write Protocol (type 2):

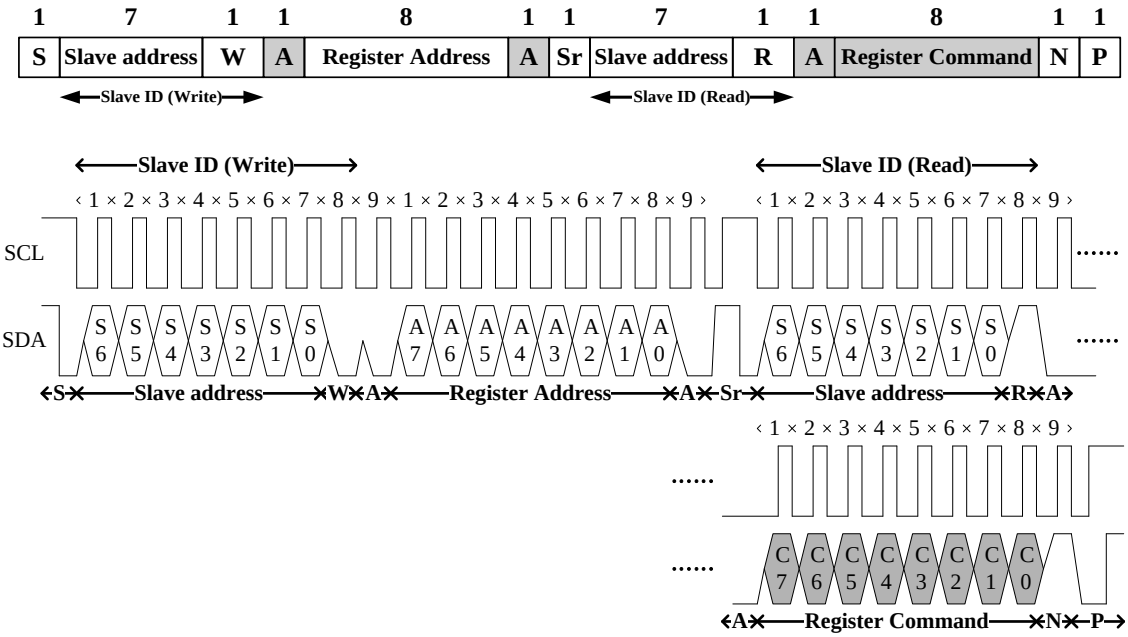


· I²C Read Protocol:



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· 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	(0x29H)							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

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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	0x7F
0x83	R/W	PS_N_PULSES	PS number of pulses	0x01
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	0x92
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	0x00
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
0x94	R/W	PS_OFFSET_1	PS offset, upper byte	0x00
0x95	R/W	PS_OFFSET_0	PS offset, lower 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

Notes:

1) *When reading ALS data registers, read sequence should always be from lower address to higher address (E.g. For ALS data, Ch1 data should be read first followed by Ch0 data. Read sequence should be 0x88, 0x89, 0x8A, 0x8B. When 0x8B is read, all four ALS data registers will be populated with new set of data).*

2) *When setting of INTERRUPT register (addr 0x8F) is necessary, it should be done before the device is in Active mode.*

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ALS_CONTR Register (0x80)

The ALS_CONTR register controls the ALS Gain setting, 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	Default	Type	Description	
Reserved	7:5	000	--	--	MUST write to 000 (default)
ALS Gain	4:2	000	RW	000	Gain 1X ➔ *1 lux to 64k lux* (default)
				001	Gain 2X ➔ *0.5 lux to 32k lux*
				010	Gain 4X ➔ *0.25 lux to 16k lux*
				011	Gain 8X ➔ *0.125 lux to 8k lux*
				100	Reserved
				101	Reserved
				110	Gain 48X ➔ *0.02 lux to 1.3k lux*
				111	Gain 96X ➔ *0.01 lux to 600 lux*
SW reset	1	0	RW	0	Initial start-up procedure is NOT started (default)
				1	Initial start-up procedure is started, bit has default value of 0 after start-up
ALS mode	0	0	RW	0	Stand-by mode (default)
				1	Active mode

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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.

PS Saturation Indicator Enable bit is used for enabling the saturation indicator in Bit 7 of PS_DATA register (0x8E).

0x81	PS_CONTR (default = 0x00)							
	B7	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
	Reserved		***PS Saturation Indicator Enable***	***Reserved***			***PS Mode***	

Field	Bits	Default	Type	Description	
Reserved	7:6	00	--	--	MUST write to 00
PS Saturation Indicator Enable	5	0	RW	0	Saturation indicator disable
				1	Saturation indicator enable
Reserved	4:2	000	--	--	Must be 0
PS Mode	1:0	00	RW	00	Stand-by mode (default)
				01	
				10	Active mode
				11	

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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 = 0x7F)							
	B7	B6	B5	B4	B3	B2	B1	B0
	LED Pulse Frequency			*LED Duty Cycle*		*LED Peak Current*		

Field	Bits	Default	Type	Description	
LED Pulse Modulation Frequency	7:5	011	RW	000	LED pulse period = 30kHz
				001	LED pulse period = 40kHz
				010	LED pulse period = 50kHz
				011	LED pulse period = 60kHz (default)
				100	LED pulse period = 70kHz
				101	LED pulse period = 80kHz
				110	LED pulse period = 90kHz
				111	LED pulse period = 100kHz
LED Duty Cycle	4:3	11	RW	00	DUTY = 25%
				01	DUTY = 50%
				10	DUTY = 75%
				11	DUTY = 100% (default)
LED Current	2:0	111	RW	000	LED pulsed current level = 5mA
				001	LED pulsed current level = 10mA
				010	LED pulsed current level = 20mA
				011	LED pulsed current level = 50mA
				100	LED pulsed current level = 100mA (default)
				101	
				110	
				111	

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PS_N_Pulses Register (0x83)

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

0x83	PS_N_Pulses (default = 0x01)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Reserved				*LED Pulse Count*			

Field	Bits	Default	Type	Description	
Reserved	7:4	0000	--	--	0000 (default)
PS number of LED pulses	3:0	0001	RW	0000	RESERVED
				0001	Number of pulses = 1 (default)
				0010	Number of pulses = 2
				0011	Number of pulses = 3
				0100	Number of pulses = 4
				0101	Number of pulses = 5
				0110	Number of pulses = 6
				0111	Number of pulses = 7
				1000	Number of pulses = 8
				1001	Number of pulses = 9
				1010	Number of pulses = 10
				1011	Number of pulses = 11
				1100	Number of pulses = 12
				1101	Number of pulses = 13
				1110	Number of pulses = 14
				1111	Number of pulses = 15

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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	Default	Type	Description	
Reserved	7:4	0000	--	--	0000 (default)
PS measurement rate	3:0	0010	RW	0000	50ms
				0001	70ms
				0010	100ms (default)
				0011	200ms
				0100	500ms
				0101	1000ms
				0110	2000ms
				0111	
				1XXX	10ms

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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 Measurement Repeat Rate must be set to be equal or larger than the ALS Integration Time. If ALS Measurement Repeat Rate is set to be smaller than ALS Integration Time, it will automatically be reset to be equal to ALS Integration Time 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	Default	Type	Description	
Reserved	7:6	00	--	--	--
ALS integration time	5:3	000	RW	000	100ms (default)
				001	50ms
				010	200ms
				011	400ms
				100	150ms
				101	250ms
				110	300ms
				111	350ms
ALS measurement rate	2:0	011	RW	000	50ms
				001	100ms
				010	200ms
				011	500ms (default)
				100	1000ms
				101	2000ms
				110	
				111	

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PART_ID Register (0x86) (Read Only)

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

0x86	PART_ID (default = 0x92)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Part Number ID				*Revision ID*			

Field	Bits	Default	Type	Description
Part Number ID	7:4	1001	R	Part ID 0x09H
Revision ID	3:0	0010	R	Revision ID 0x02H

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	Default	Type	Description
Manufacturer ID	7:0	00000101	R	Manufacturer ID (0x05H)

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

The ALS_DATA registers should be read as a group, with the lower address read back first (i.e. read 0x88 first, then read 0x89). These two registers should also be read before reading channel-0 data (from registers 0x8A, 0x8B).

When the I^2C read operation starts, all four ALS data registers are locked until the I^2C read operation of register 0x8B 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.

The ALS ADC channel-1 data is 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.

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	Address	Bits	Default	Type	Description
ALS Data Ch1 Low	0x88	7:0	00000000	R	ALS ADC channel 1 lower byte data
ALS Data Ch1 High	0x89	7:0	00000000	R	ALS ADC channel 1 upper byte data

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

These two registers should be read after reading channel-1 data (from registers 0x88, 0x89). Lower address register should be read first (i.e. read 0x8A first, then read 0x8B). See ALS_DATA_CH1 register information above. The ALS ADC channel-0 data is 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.

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	Address	Bits	Default	Type	Description
ALS Data Ch0 Low	0x8A	7:0	00000000	R	ALS ADC channel 0 lower byte data
ALS Data Ch0 High	0x8B	7:0	00000000	R	ALS ADC channel 0 upper byte data

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ALS_ PS_STATUS Register (0x8C) (Read Only)

The ALS_PS_STATUS register stores the information about ALS 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 interrupt criteria are met. It will check if the ALS measurement data is outside of the range defined by the upper and lower threshold limits.

ALS Data Valid bit indicates the validity of the ALS data in Ch0 and Ch1.

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

Field	Bits	Default	Type	Description	
ALS Data Valid	7	0	R	0	ALS Data is Valid (default)
				1	ALS Data is Invalid
ALS Data Gain Range	6:4	000	R	000	ALS measured data in Gain 1X (default)
				001	ALS measured data in Gain 2X
				010	ALS measured data in Gain 4X
				011	ALS measured data in Gain 8X
				100	Invalid
				101	Invalid
				110	ALS measured data in Gain 48X
				111	ALS measured data in Gain 96X
ALS interrupt status	3	0	R	0	Interrupt signal INACTIVE (default)
					Interrupt signal ACTIVE
ALS data status	2	0	R	0	OLD data (data already read), (default)
				1	NEW data (first time data is being read)
PS Interrupt Status	1	0	R	0	Interrupt signal INACTIVE (default)
				1	Interrupt signal ACTIVE
PS Data Status	0	0	R	0	OLD data (data already read), (default)
				1	NEW data (first time data is being read)

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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.

PS Saturation Flag is used for monitoring the internal IC saturation. It will be flagged when the IC has reached saturation and not able to perform any further PS measurement. The PS Saturation Indicator Enable bit in PS_CONTR Register (0x81) has to be enabled in order to use this feature. If it is not enable, the flag will always be indicated as 0.

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
	PS Saturation Flag	*Reserved*				*PS Data High*		

Field	Address	Bits	Default	Type	Description	
PS Data, Low	0x8D	7:0	00000000	R	--	PS ADC lower byte data
PS Saturation Flag	0x8E	7	0	R	0	PS not saturated
					1	PS saturated
Reserved	0x8E	6:3	00000	--	--	--
PS Data, High	0x8E	2:0	000	R	--	PS ADC upper byte data

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INTERRUTP Register (0x8F) (Read Only)

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.

Note that when this register is to be set with values other than its default values, it should be set before device is in Active mode.

0x8F	INTERRUPT (default = 0x00)							
	B7	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
	Reserved					***Interrupt Polarity***	***Interrupt Mode***	

Field	Bits	Default	Type	Description	
RESERVED	7:3	00000	--	--	Must write as 00000
Interrupt Polarity	2	0	RW	0	INT pin is considered active when it is a logic 0 (default)
				1	INT pin is considered active when it is a logic 1
Interrupt Mode	1:0	0	RW	00	Interrupt pin is INACTIVE / high impedance state (default)
				01	Only PS measurement can trigger interrupt
				10	Only ALS measurement can trigger interrupt
				11	Both ALS and PS measurement can trigger interrupt

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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. These registers must be applied dynamically to have hysteresis interruption.

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*			

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Field	Address	Bits	Default	Type	Description
PS Upper Threshold Low	0x90	7:0	11111111	RW	PS upper threshold lower byte data
Reserved	0x91	7:3	00000	--	Reserved
PS Upper Threshold High	0x91	2:0	111	RW	PS upper threshold upper byte data
PS lower threshold, Low	0x92	7:0	00000000	RW	PS lower threshold lower byte data
Reserved	0x93	7:3	00000	--	Reserved
PS lower threshold High	0x93	2:0	000	RW	PS lower threshold upper byte data

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PS_OFFSET Register (0x94 / 0x95)

The PS_OFFSET register defines the offset compensation value for proximity offsets caused by device variations, optical crosstalk and other environment factors. This value will be used and cancelled from the original PS raw data such that the data in PS_DATA register (0x8D and 0x8E) are the compensated value.

0x94	PS_OFFSET_1 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	Reserved						*PS Offset, High byte*	

0x95	PS_OFFSET_0 (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	PS Offset, Low byte							

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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							

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Field	Address	Bits	Default	Type	Description
ALS upper threshold Low	0x97	7:0	11111111	RW	ALS upper threshold lower byte data
ALS upper threshold High	0x98	7:0	11111111	RW	ALS upper threshold upper byte data
ALS lower threshold Low	0x99	7:0	00000000	RW	ALS lower threshold lower byte data
ALS lower threshold High	0x9A	7:0	00000000	RW	ALS lower threshold upper byte data

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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 interrupt.

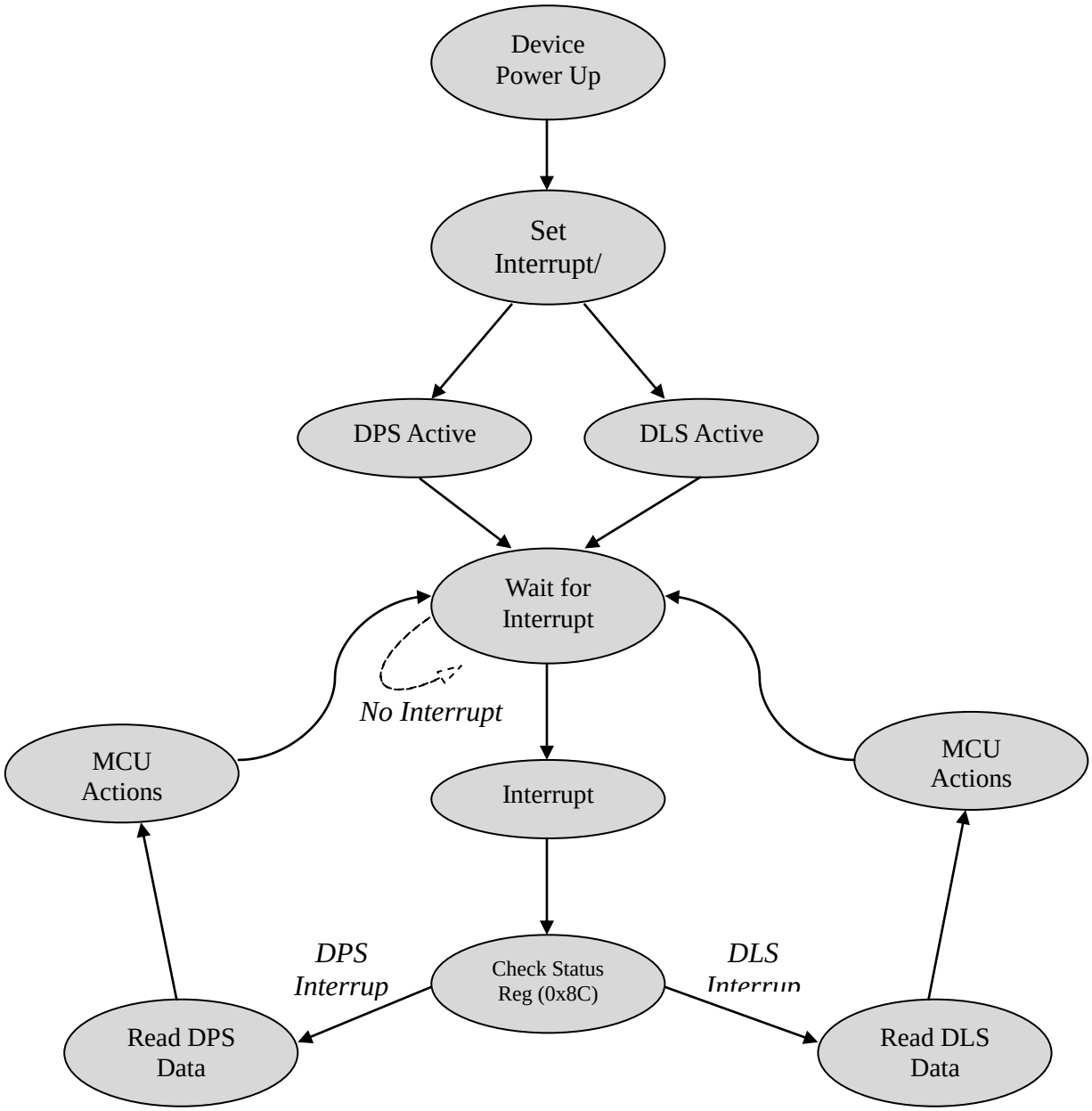
0x9E	INTERRUPT PERSIST (default = 0x00)							
	B7	B6	B5	B4	B3	B2	B1	B0
	PS Persist				***ALS Persist***			

Field	Bits	Default	Type	Description	
PS Persist	7:4	0000	RW	0000	Every PS value out of threshold range (default)
				0001	2 consecutive PS values out of threshold range
				….	….
				1111	16 consecutive PS values out of threshold range
ALS Persist	3:0	0000	RW	0000	Every ALS value out of threshold range (default)
				0001	2 consecutive ALS values out of threshold range
				---	---
				1111	16 consecutive ALS values out of threshold range

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10. Device Operation (using Interrupt)

Below flow diagram illustrates the LTR-556ALS operation involving the use of Thresholds and Interrupts.



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11. Pseudo Codes Examples

Control Registers

// The Control Registers define the operating modes and gain settings of the ALS and PS of LTR-556.
// Default settings are 0x00 for both registers (both in Standby mode).

```
Slave_Addr = 0x23                       // Slave address of LTR-556 device

// Enable ALS
Register_Addr = 0x80                    // ALS_CONTR register
Command = 0x01                          // For Gain X1
                                        // For Gain X2, Command = 0x05
                                        // For Gain X4, Command = 0x09
                                        // For Gain X8, Command = 0x0D
                                        // For Gain X48, Command = 0x19
                                        // For Gain X96, Command = 0x1D
WriteByte(Slave_Addr, Register_Addr, Command)

// Enable PS
Register_Addr = 0x81                    // PS_CONTR register
Command = 0x03

WriteByte(Slave_Addr, Register_Addr, Command)
```

PS LED Registers

// The PS LED Registers define the LED pulse modulation frequency, duty cycle and peak current.
// Default setting is 0x7F (60kHz, 100%, 100mA).

```
Slave_Addr = 0x23                       // Slave address of LTR-556 device

// Set LED Pulse Freq 30kHz (duty cycle 100%, peak curr 100mA)
Register_Addr = 0x82                    // PS_LED register
Command = 0x1F                          // Pulse Freq = 30kHz, (duty cyc 100%, peak curr 100mA)
                                        // For Pulse Freq = 40kHz, (100%, 100mA), Command = 0x3F
                                        // For Pulse Freq = 50kHz, (100%, 100mA), Command = 0x5F
                                        // For Pulse Freq = 60kHz, (100%, 100mA), Command = 0x7F
                                        // For Pulse Freq = 70kHz, (100%, 100mA), Command = 0x9F
                                        // For Pulse Freq = 80kHz, (100%, 100mA), Command = 0xBF
                                        // For Pulse Freq = 90kHz, (100%, 100mA), Command = 0xDF
                                        // For Pulse Freq = 100kHz, (100%, 100mA), Command = 0xFF
WriteByte(Slave_Addr, Register_Addr, Command)

// Set LED Duty Cycle 25% (pulse freq 60kHz, peak curr 100mA)
Register_Addr = 0x82                    // PS_LED register
Command = 0x67                          // Duty Cycle = 25%, (pulse freq 60kHz, peak curr 100mA)
                                        // For Duty Cycle = 50%, (60kHz, 100mA), Command = 0x6F
                                        // For Duty Cycle = 75%, (60kHz, 100mA), Command = 0x77
                                        // For Duty Cycle = 100%, (60kHz, 100mA), Command = 0x7F
WriteByte(Slave_Addr, Register_Addr, Command)
```


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// Set LED Peak Current 5mA (pulse freq 60kHz, duty cycle 100%)
Register_Addr = 0x82 // PS_LED register
Command = 0x78 // Peak Current = 5mA, (pulse freq 60kHz, duty cyc 100%)
// For Peak Current = 10mA, (60kHz, 100%), Command = 0x79
// For Peak Current = 20mA, (60kHz, 100%), Command = 0x7A
// For Peak Current = 50mA, (60kHz, 100%), Command = 0x7B
WriteByte(Slave_Addr, Register_Addr, Command)

PS Measurement Rate

// The PS_MEAS_RATE register controls the PS measurement rate.
// Default setting of the register is 0x02 (repeat rate 100ms)

Slave_Addr = 0x23 // Slave address of LTR-556 device

// Set PS Repeat Rate 50ms
Register_Addr = 0x84 // PS_MEAS_RATE register
Command = 0x00 // Meas rate = 50ms
// For Meas rate = 500ms, Command = 0x04
WriteByte(Slave_Addr, Register_Addr, Command)

ALS Measurement Rate

// The ALS_MEAS_RATE register controls the ALS integration time and measurement rate.
// Default setting of the register is 0x03 (integration time 100ms, repeat rate 500ms)

Slave_Addr = 0x23 // Slave address of LTR-556 device

// Set ALS Integration Time 200ms, Repeat Rate 200ms
Register_Addr = 0x85 // ALS_MEAS_RATE register
Command = 0x12 // Int time = 200ms, Meas rate = 200ms
// For Int time = 400ms, Meas rate = 500ms, Command = 0x1B
WriteByte(Slave_Addr, Register_Addr, Command)

ALS Data Registers (Read Only)

// The ALS Data Registers contain the ADC output data for the respective channel.
// These registers should be read as a group, with the lower address being read first.

Slave_Addr = 0x23 // Slave address of LTR-556 device

// Read back ALS_DATA_CH1
Register_Addr = 0x88 // ALS_DATA_CH1 low byte address
ReadByte(Slave_Addr, Register_Addr, Data0)
Register_Addr = 0x89 // ALS_DATA_CH1 high byte address
ReadByte(Slave_Addr, Register_Addr, Data1)

// Read back ALS_DATA_CH0
Register_Addr = 0x8A // ALS_DATA_CH0 low byte address
ReadByte(Slave_Addr, Register_Addr, Data2)
Register_Addr = 0x8B // ALS_DATA_CH0 high byte address
ReadByte(Slave_Addr, Register_Addr, Data3)

ALS_CH1_ADC_Data = (Data1 << 8) | Data0 // Combining lower and upper bytes to give 16-bit Ch1 data
ALS_CH0_ADC_Data = (Data3 << 8) | Data2 // Combining lower and upper bytes to give 16-bit Ch0 data

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ALS / PS Status Register (Read only)

// The ALS_PS_STATUS Register contains the information on Interrupt, ALS and PS data availability status.
// This register is read only.

```
Slave_Addr = 0x23                    // Slave address of LTR-556 device

// Read back Register
Register_Addr = 0x8C                 // ALS_PS_STATUS register address
ReadByte(Slave_Addr, Register_Addr, Data)

Interrupt_Status = Data & 0x0A       // Interrupt_Status = 8(decimal) ➔ ALS Interrupt
                                     // Interrupt_Status = 2(decimal) ➔ PS Interrupt
                                     // Interrupt_Status = 10(decimal) ➔ Both Interrupt

NewData_Status = Data & 0x05         // NewData_Status = 4(decimal) ➔ ALS New Data
                                     // NewData_Status = 1(decimal) ➔ PS New Data
                                     // NewData_Status = 5(decimal) ➔ Both New Data

ALS_Data_Valid = Data & 0x80         // ALS_Data_Valid = 0x00 ➔ ALS New Data is valid (usable)
                                     // ALS_Data_Valid = 0x80 ➔ ALS New Data is invalid, discard and
                                     // wait for new ALS data
```

PS Data Registers (Read only)

// The PS Data Registers contain the ADC output data.
// These registers should be read as a group, with the lower address being read first.

```
Slave_Addr = 0x23                    // Slave address of LTR-556 device

// Read back PS_DATA registers
Register_Addr = 0x8D                 // PS_DATA low byte address
ReadByte(Slave_Addr, Register_Addr, Data0)
Register_Addr = 0x8E                 // PS_DATA high byte address
ReadByte(Slave_Addr, Register_Addr, Data1)

PS_ADC_Data = (Data1 << 8) | Data0   // Combining lower and upper bytes to give 16-bit PS data
```

Interrupt Registers

// The Interrupt register controls the operation of the interrupt pins and function.
// The default value for this register is 0x08 (Interrupt inactive)
// Note that when this register is to be set with values other than its default values,
// it should be set before device is in active mode.

```
Slave_Addr = 0x23                    // Slave address of LTR-556 device

// Set Interrupt Polarity for Active Low, both ALS and PS trigger
Register_Addr = 0x8F                 // Interrupt Register address
Command = 0x03                       // Interrupt is Active Low and both ALS and PS can trigger
                                     // For Active High Interrupt, both trigger, Command = 0x07
                                     // For Active High Interrupt, ONLY ALS trigger, Command = 0x06
                                     // For Active High Interrupt, ONLY PS trigger, Command = 0x05
WriteByte(Slave_Addr, Register_Addr, Command)
```


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ALS Threshold Registers

// The ALS_THRES_UP and ALS_THRES_LOW registers determines the upper and lower limit of the interrupt threshold value.
// Following example illustrates the setting of the ALS threshold window of decimal values of 200 (lower threshold)
// and 1000 (upper threshold)

Slave_Addr = 0x23 // Slave address of LTR-556 device

// Upper Threshold Setting (decimal 1000)
ALS_Upp_Threshold_Reg_0 = 0x97 // ALS Upper Threshold Low Byte Register address
ALS_Upp_Threshold_Reg_1 = 0x98 // ALS Upper Threshold High Byte Register address
Data1 = 1000 >> 8 // To convert decimal 1000 into two eight bytes register values
Data0 = 1000 & 0xFF
WriteByte(Slave_Addr, ALS_Upp_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, ALS_Upp_Threshold_Reg_1, Data1)

// Lower Threshold Setting (decimal 200)
ALS_Low_Threshold_Reg_0 = 0x99 // ALS Lower Threshold Low Byte Register address
ALS_Low_Threshold_Reg_1 = 0x9A // ALS Lower Threshold High Byte Register address
Data1 = 200 >> 8 // To convert decimal 200 into two eight bytes register values
Data0 = 200 & 0xFF
WriteByte(Slave_Addr, ALS_Low_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, ALS_Low_Threshold_Reg_1, Data1)

PS Threshold Registers

// The PS_THRES_UP and PS_THRES_LOW registers determines the upper and lower limit of the interrupt threshold value.
// Following example illustrates the setting of the PS dynamic threshold with hysteresis interruption for
// decimal value 1000 (for NEAR detection) and 500 (for FAR detection)

Slave_Addr = 0x23 // Slave address of LTR-556 device

//For NEAR detection (decimal 1000)
PS_Upp_Threshold_Reg_0 = 0x90 // PS Upper Threshold Low Byte Register address
PS_Upp_Threshold_Reg_1 = 0x91 // PS Upper Threshold High Byte Register address
Data1 = 1000 >> 8 // To convert decimal 1000 into two eight bytes register values
Data0 = 1000 & 0xFF
WriteByte(Slave_Addr, PS_Upp_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, PS_Upp_Threshold_Reg_1, Data1)

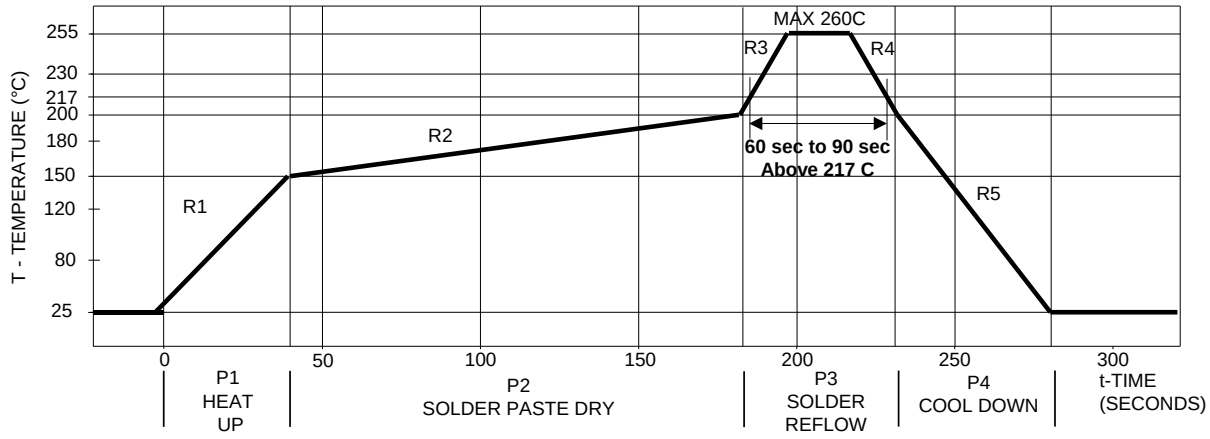
PS_Low_Threshold_Reg_0 = 0x92 // PS Lower Threshold Low Byte Register address
PS_Low_Threshold_Reg_1 = 0x93 // PS Lower Threshold High Byte Register address
Data1 = 0 >> 8 // To convert decimal 0 into two eight bytes register values
Data0 = 0 & 0xFF
WriteByte(Slave_Addr, PS_Low_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, PS_Low_Threshold_Reg_1, Data1)

//For FAR detection (decimal 500)
PS_Upp_Threshold_Reg_0 = 0x90 // PS Upper Threshold Low Byte Register address
PS_Upp_Threshold_Reg_1 = 0x91 // PS Upper Threshold High Byte Register address
Data1 = 2047 >> 8 // To convert decimal 2047 into two eight bytes register values
Data0 = 2047 & 0xFF
WriteByte(Slave_Addr, PS_Upp_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, PS_Upp_Threshold_Reg_1, Data1)

PS_Low_Threshold_Reg_0 = 0x92 // PS Lower Threshold Low Byte Register address
PS_Low_Threshold_Reg_1 = 0x93 // PS Lower Threshold High Byte Register address
Data1 = 500 >> 8 // To convert decimal 500 into two eight bytes register values
Data0 = 500 & 0xFF
WriteByte(Slave_Addr, PS_Low_Threshold_Reg_0, Data0)
WriteByte(Slave_Addr, PS_Low_Threshold_Reg_1, Data1)

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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.

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13. Moisture Proof Packaging

All LTR-556ALS-046 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

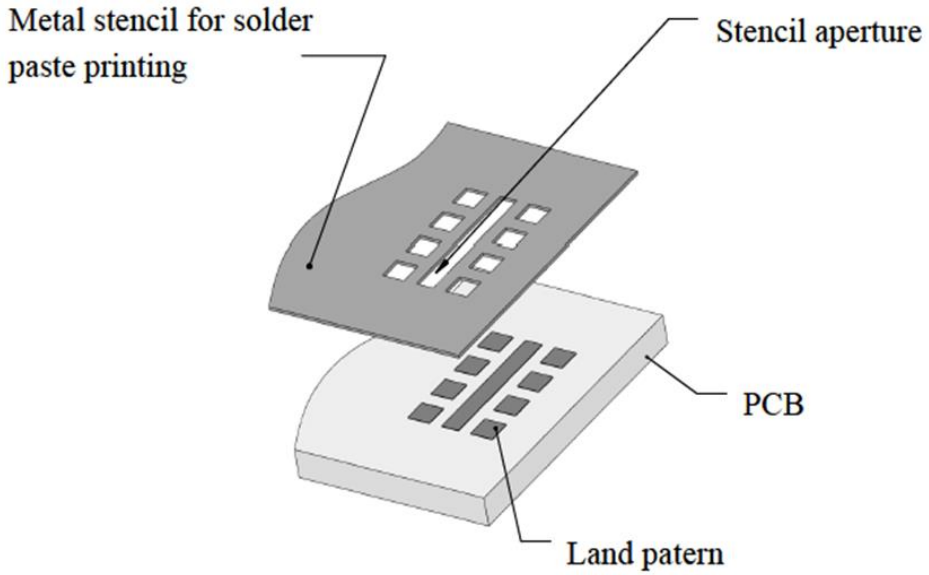
Baking Conditions

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

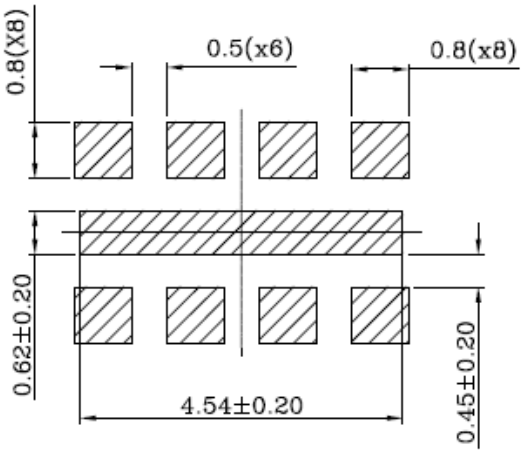
Baking should only be done once.

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14. Recommended Land Pattern and Metal Stencil Aperture



Recommended Land Pattern:



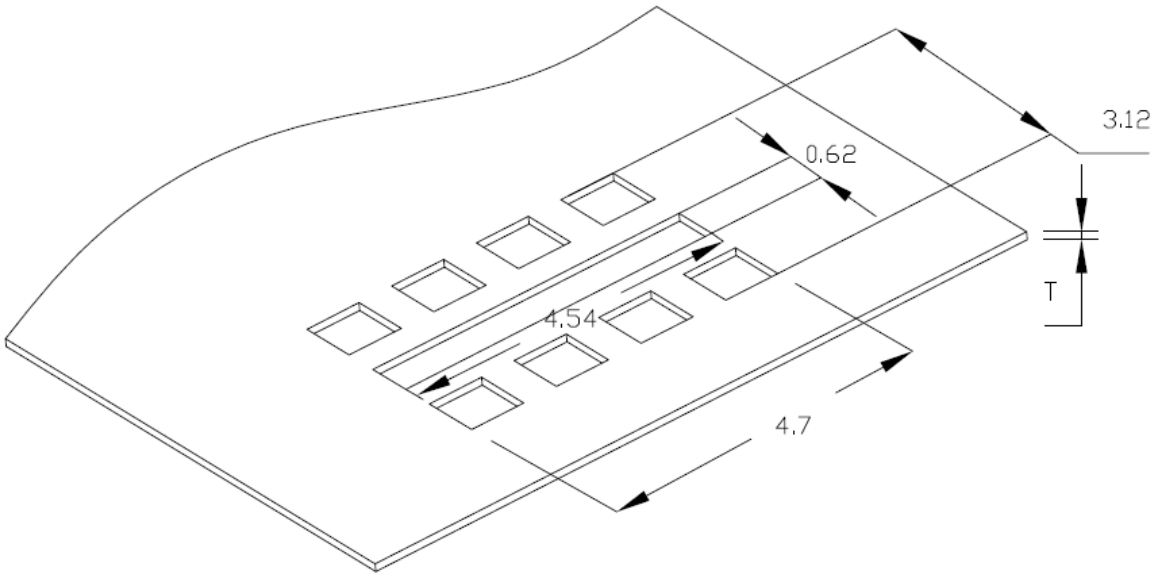
Note: All dimensions are in millimeters

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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-556ALS-046 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.



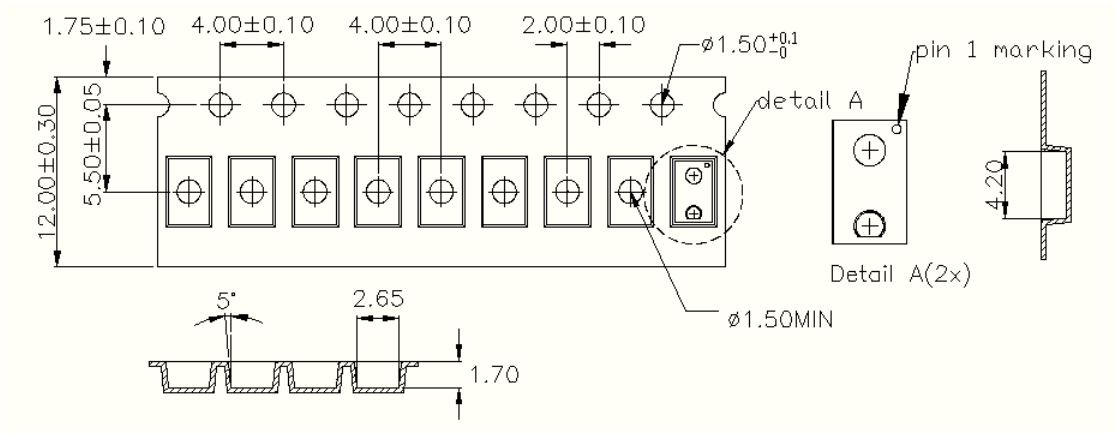
Note:

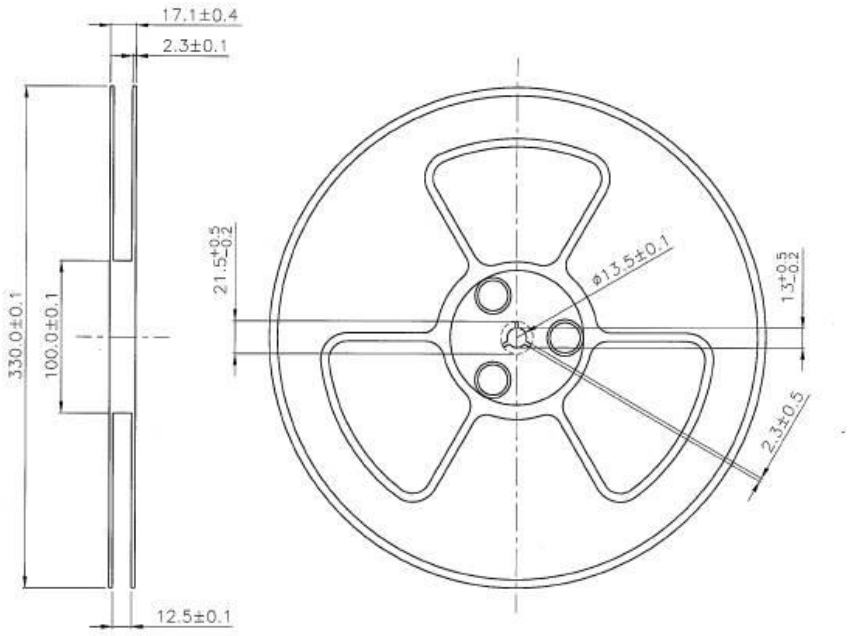
1. All dimensions are in millimeters

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15. Package Dimension for Tape and Reel

Final Tape & Reel information is TBD.





Notes:

1. All dimensions are in millimeters (inches)
2. Empty component pockets sealed with top cover tape
3. 13 inch reel - 8000 pieces per reel
4. In accordance with ANSI/EIA 481-1-A-1994 specifications

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Optical Sensor
LTR-556ALS-046

Revision Table:

Version	Update	Page	Date
1.0	Preliminary DS as created TBD info on Tape & Reel	Total 41	19-August-15

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