SY22306-S1

5 Range Ambient Light Sensor with Side View Package

General Description

The SY22306-S1 is an ambient light sensor (ALS) with SMBus-compatible I^2C interface. Communication to the device is accomplished through the fast I^2C interface (up to 750 kHz) for easy connection to a microcontroller or embedded controller.

The ambient light sensor (ALS) has five operating ranges for adapting to different applications and various optical arrangements. The ALS reading (output data) is proportional to the ambient light; no additional data manipulation is required. It also has a built-in circuit to reject the flicker noise caused by indoor light sources. The most important feature of the ALS is that the spectral response is almost the same as the human eye's photopic vision due to a well-engineered optical coating on the top of the photodiode; thus, a light source correction coefficient is unnecessary.

Features

- Wide Operating Voltage Range:
  - 1.7V to 3.6V Supply for I^2C Interface
  - 2.3V to 3.6V Sensor Power Supply
- Works Under All Light Sources, Including Sunlight
- Green Power:
  - Less than 130μA Supply Current
  - Less than 1μA Supply Current When Powered Down
- I^2C (SMBus Compatible) Interface
- Temperature Compensation
- Ambient Light Sensing:
  - Output Digital Counts Proportional to Lux
  - Indoor Light Source Flicker Noise Rejection and IR Rejection
  - Spectral Response Matching the Human Eye's Photopic Vision
  - Selectable 120/240/481/963/1927 Lux Range
- Side View Package:
  - Package Size: 2.95mm x 1.25mm x 1.5mm
  - Soldered on Both Top View and Side View

Applications

- TV Panel Control
- Accessories
- Industrial Control
- Lighting Control

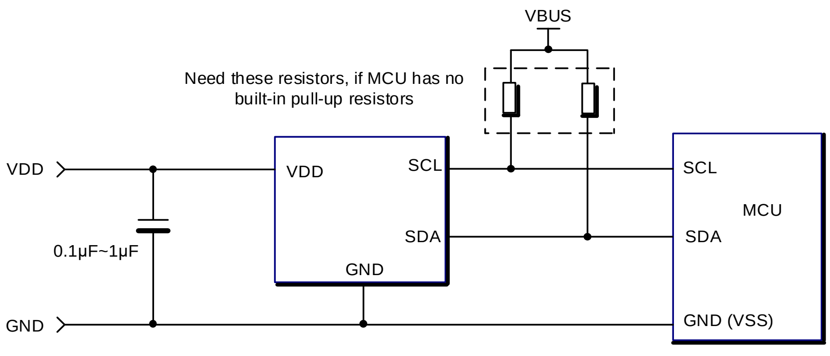


Figure 1. Typical Application Schematic Diagram

Note: Bypass capacitors should be placed as close as possible to the device to reduce noise.

Functional Block Diagram

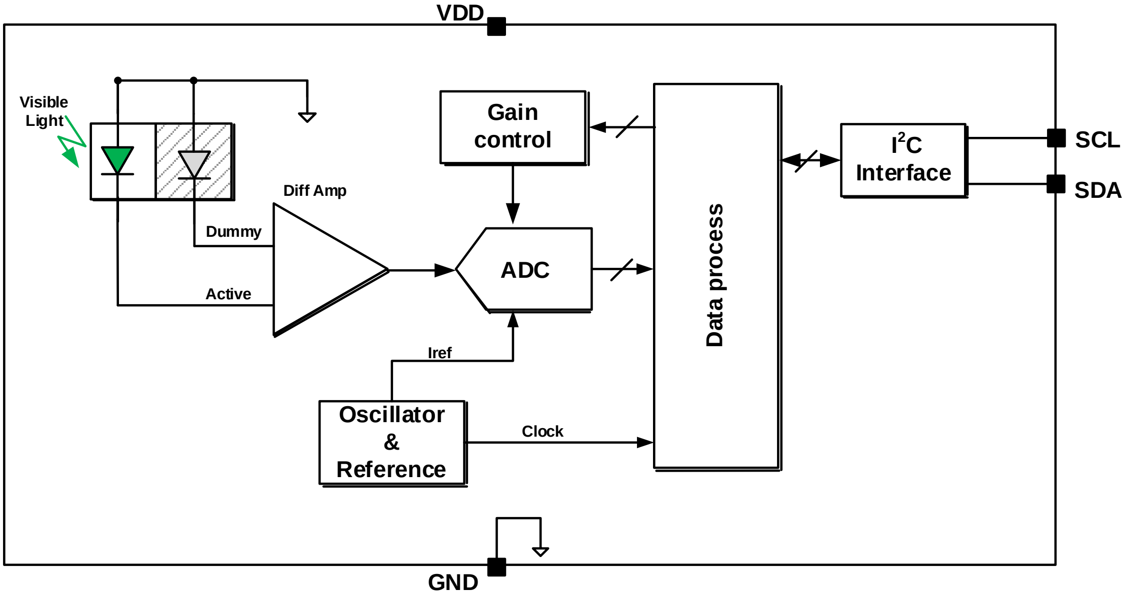
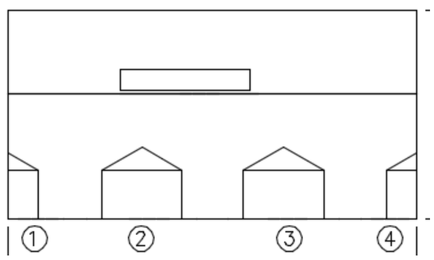


Figure 2. Block Diagram



Pin No	Pin Name	Pin Description
1	VDD	Positive supply: 2.3V to 3.6V.
2	GND	Ground pin.
3	SDA	I²C data line. The I²C bus lines can be pulled from 1.7V to above VDD, 3.6V max.
4	SCL	I²C clock line. The I²C bus lines can be pulled from 1.7V to above VDD, 3.6V max.

Absolute Maximum Ratings [1] T_A = +25°C	Min	Max	Unit
VDD Supply Voltage	-0.3	4.0	V
I²C Bus Voltage (SCL, SDA)	-0.3	4.0	V
I²C Bus Current (SCL, SDA)		10	mA
ESD Human Body Model	±2000		V
ESD Charged Device Model	±500		V

Recommended Operation Conditions	Min	Max	Unit
Supply Voltage	2.3	3.6	V
Operating Temperature	-40	85	℃

Electrical Characteristics The general test conditions are V_{DD} = 3.0V, T_A = +25°C, unless otherwise specified						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Power Supply Range	V_{DD}		2.3	3.0	3.6	V
Supply Current when ALS disabled	I_{DD_OFF}	ALS_EN = 0			1	μA
Supply Current when ALS enabled	I_{DD_ALS}	ALS_EN = 1	90	110	130	μA
Full-Scale ADC Output	$DATA_{ADC\_FS}$				4095	counts
12-bit ALS Measurement Time	t_{ADC_ALS}			100		ms
Finest Resolution for ALS Channel	RES_{FINE}	White LED,Ev=100 Lux, ALS_RANGE=100	2550	3400	4080	counts
ALS Measurement when there is no Light	$DATA_{DARK}$	Ev = 0 Lux, Range 4			5	counts

I²C Electrical Specifications [2] Unless otherwise specified, V_{DD} = 3.0V, T_A = +25°C						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Supply Voltage Range for I²C Interface	V_{I^2C}		1.7		V_{DD}+0.3	V
SCL Clock Frequency	f_{SCL}				750	kHz
Low-Level Input Voltage of SCL and SDA	V_{IL}				0.55	V
High-Level Input Voltage of SCL and SDA	V_{IH}		1.25			V
Hysteresis of Schmitt Trigger Input	V_{hys}		0.05V_{DD}			V
Low-level Output Voltage (open-drain) at 4mA Sink Current	V_{OL}				0.4	V
Input Leakage for Each SDA, SCL	I_i		-10		10	μA
Pulse Width of Spikes Suppressed by the Input Filter	t_{SP}				50	ns
SCL Falling Edge to SDA Output Data Valid	t_{AA}				0.9	μs
Capacitance for Each SDA and SCL Pin	C_i				10	pF
Hold Time (repeated) START Condition	$t_{HD:STA}$		0.6			μs
Low Period of the SCL Clock	t_{LOW}		1.3			μs
High Period of the SCL Clock	t_{HIGH}		0.6			μs
Set-up Time for a Repeated START Condition	$t_{SU:STA}$		0.6			μs
Data Hold Time	$t_{HD:DAT}$		30			ns
Data Set-up Time	$t_{SU:DAT}$		100			ns
Rise Time of Both SDA and SCL	t_R	$R_{pull-up}$ = 10kΩ, C_b = 10pF		95		ns
Fall Time of SDA and SCL	t_F	$R_{pull-up}$ = 10kΩ, C_b = 10pF		25		ns
Set-up Time for STOP Condition	$t_{SU:STO}$		0.6			μs
Bus Free Time between a STOP and START Condition	t_{BUF}		1.3			μs
Capacitive Load for Each Bus Line	C_b				0.4	nF
SDA and SCL System Bus Pull-up Resistor	$R_{pull-up}$	Maximum is determined by t_R and t_F		10		kΩ
Data Valid Time	$t_{VD:DAT}$				0.9	μs
Data Valid to Acknowledge Time	$t_{VD:ACK}$				0.9	μs
Noise Margin at the LOW Level	V_{nL}		0.1VDD			V
Noise Margin at the HIGH Level	V_{nH}		0.2VDD			V

Note 1: Stresses beyond the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: The I²C bus protocol was developed by Philips (now NXP). For a complete description of the I²C protocol, please review the NXP I²C design specification at http://www.I²C−bus.org/references/.

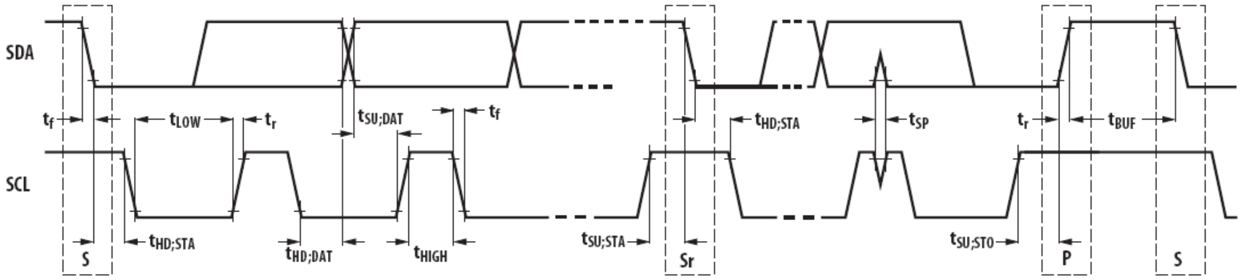
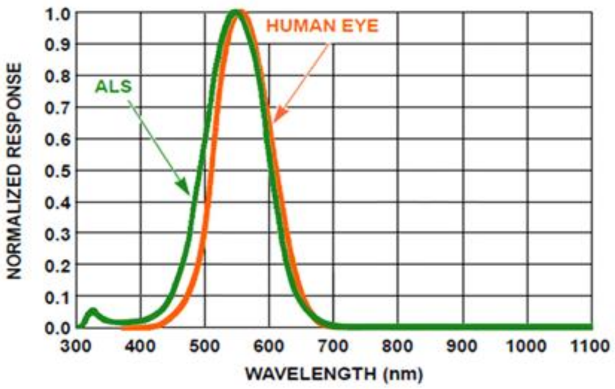


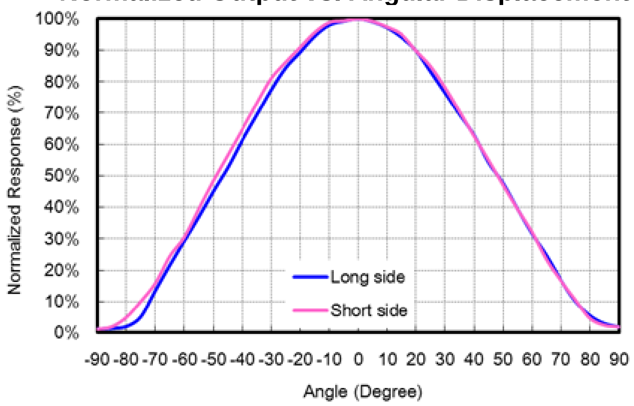
Figure 3. I²C Timing Diagram

Typical Performance Curves

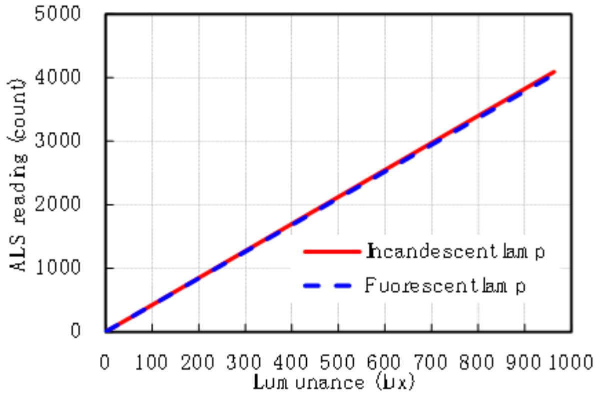
Spectral Response



Normalized Output vs. Angular Displacement



ADC Reading vs Illuminance (Range 1)



Detailed Description

Ambient Light Sensing

Figure 4 shows the spectral response of SY22306-S1, which is very similar to the human eye's photopic vision curve. Under the same luminance (lux), the ratio of the ALS reading of an incandescent light source (rich in IR radiation) to that of a fluorescent light source (no IR radiation) is around 1.0.

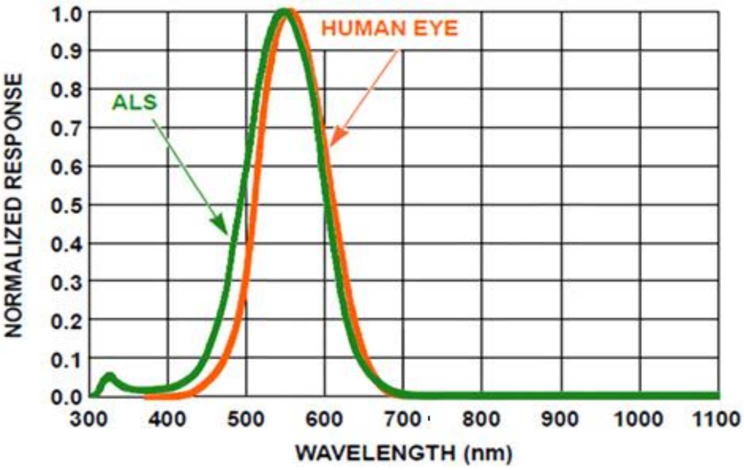


Figure 4. Relative Spectral Response

The power grids are using either 50Hz or 60Hz AC. The artificial light sources powered by the grid vary in intensity at the power grid frequencies. The varying light intensity is one of the noise sources for light sensors. To eliminate the noise caused by the power grid, set the integration time of the internal ADC as an integer multiple of the noise signal period. For example, for a 50Hz grid, light flicker noise can be eliminated by setting up the ADC integration time to n*20ms (n=1,2…ni).

The integration time for SY22306-J01 is 100ms, which will eliminate the power grid noise or indoor light source flicker noise.

Calculating ALS Lux

Table 1 lists the resolution of each ALS range. The luminance (lux) can be obtained simply by multiplying ALS data (ALS_DATA) by its corresponding resolution.

Table 1: ALS Resolution at Different Ranges

ALS_RANGE	Resolution (lux/count)	Luminance (lux)
0	0.471	ALS_ DATA x 0.471
1	0.235	ALS_ DATA x 0.235
2	0.118	ALS_ DATA x 0.118
3	0.059	ALS_ DATA x 0.059
4~7	0.029	ALS_ DATA x 0.029

In a typical application, the ambient light sensor is packaged or placed behind a window, as shown in Figure 6. The transmittance of the sensor window ranges from 80% to 5% or less. To obtain the actual illuminance, the window transmittance must be considered for accurate estimation:

ALS_DATA = (Ambient Light in lux) * (Transmittance of Window)/Resolution

Example 1

The illuminance where the ambient light sensor is placed is 100 lux, the transmittance of the sensor window is 50%, and the resolution of the ambient light sensor is set at 0.059 lux/counts. The output count of the ambient light sensor is calculated as:

ALS_DATA = Illuminance * Transmittance/Resolution = 100 lux * 50 %/(0.059lux/counts) ≈ 847 counts

This translates to an overall device sensitivity of 8.47 counts/lux.

Example 2

The illuminance where the ambient light sensor is placed is 100 lux, the transmittance of sensor window is 20%, and the resolution of the ambient light sensor is set at 0.059lux/counts. Under these conditions, the output count of the ambient light sensor is:

ALS_DATA = Illuminance * Transmittance/Resolution = 100 lux * 20 %/(0.059lux/counts) ≈ 339 counts.

This translates to an overall device sensitivity of 3.39 counts/lux.

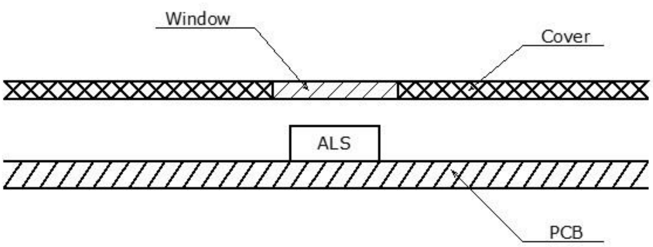


Figure 5. Ambient Light Sensor Mounted Inside an Apparatus

The light attenuation due to the air gap between the window's bottom surface and the top surface of the sensor was omitted for the above calculations. In actual applications, light attenuation can be induced by window transmittance, air gap, device placement tolerances, and more. A thorough validation using actual use case parameters is recommended to confirm the operation and evaluate the device performance and accuracy across all operating conditions.

VDD Power-Up and Power Supply Considerations

Upon power-up, ensure that the slew rate of VDD is greater than 0.5V/ms. After power-up, the supply voltage must not drop below 2.0V. If this happens, switch off the power, wait at least one second to discharge the power supply rail, and then power on the device again.

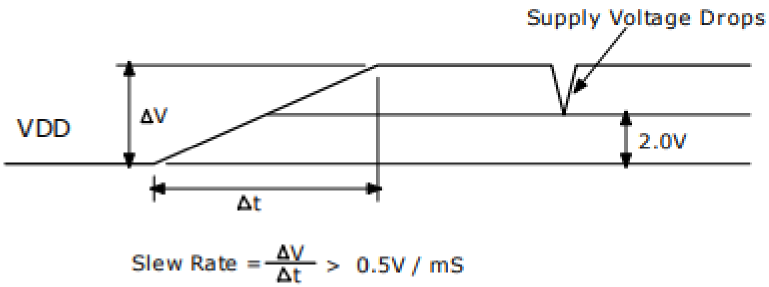


Figure 6. Waveform of Supply Voltage VDD

Layout Considerations

The SY22306-S1 is designed to reduce the influences of the PCB layout. To ensure optimal performance, route the supply and I²C traces as far as possible from all noise sources. Place a 0.1μF to 1μF decoupling capacitor close to the device.

I²C Read / Write Register Data

The SY22306-S1's I²C slave address is 0x45(0b'1000101). Figures 7 and 8 detail the protocol of writing or reading the sensor register data.

A : Acknowledge (0)

NA : Not Acknowledged (1)
P : Stop Condition
R : Read (1)
W : Write (0)
S : Start Condition
Sr : Repeat Start
... : Continuation of Protocol
: Master to Slave
: Slave to Master

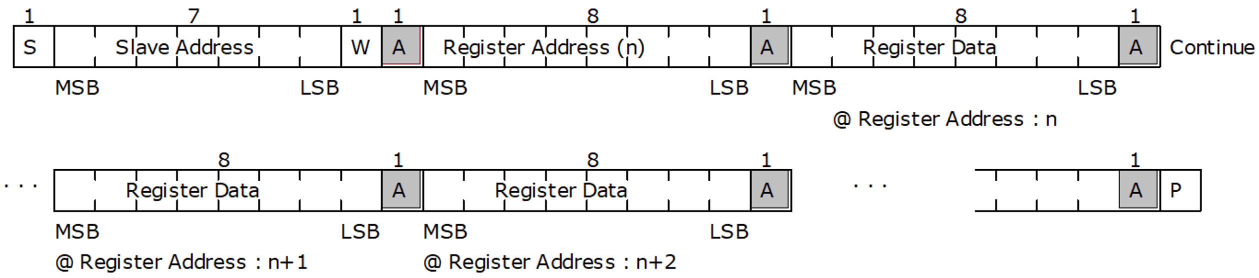


Figure 7. I²C Write-Register-Data Protocol

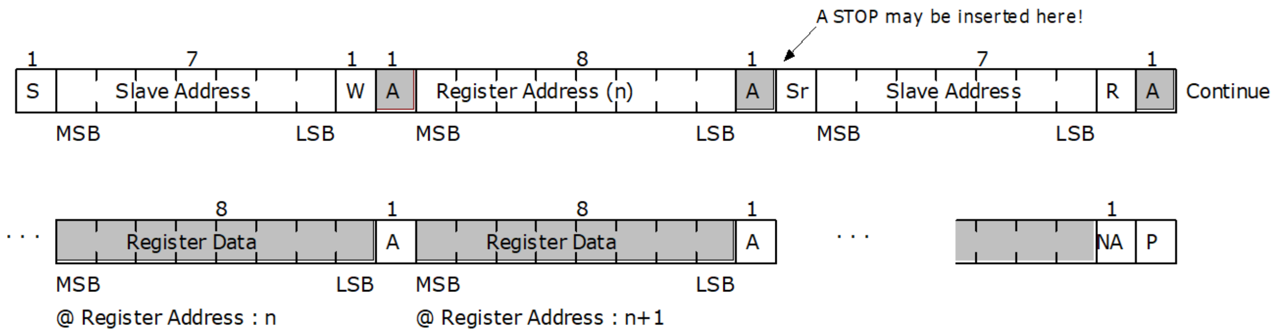


Figure 8. I²C Read-Register-Data Procotol

Register Map

There are eight 8-bit registers accessible via the I²C. Register 0x00 has a fixed value of 0x21 for communication test. Register 0x01 defines the operation mode of the device. Registers 0x02 through 0x05 are reserved for internal use. Registers 0x06 and 0x07 store the results of ALS ADC conversions.

Registers and Register Bits

REG Address	REG Name	BIT								
		7	6	5	4	3	2	1	0	Default
0x00	COM_TEST	Chip ID								0x21
0x01	CONFIGURE	Write 0	ALS_RANGE[2..0]			Write 0		ALS_EN	Write 0	0x00
0x06	ALS_DATAL	ALS_DATA[7:0]								0x00
0x07	ALS_DATAH	Unused				ALS_DATA[11:8]				0x00

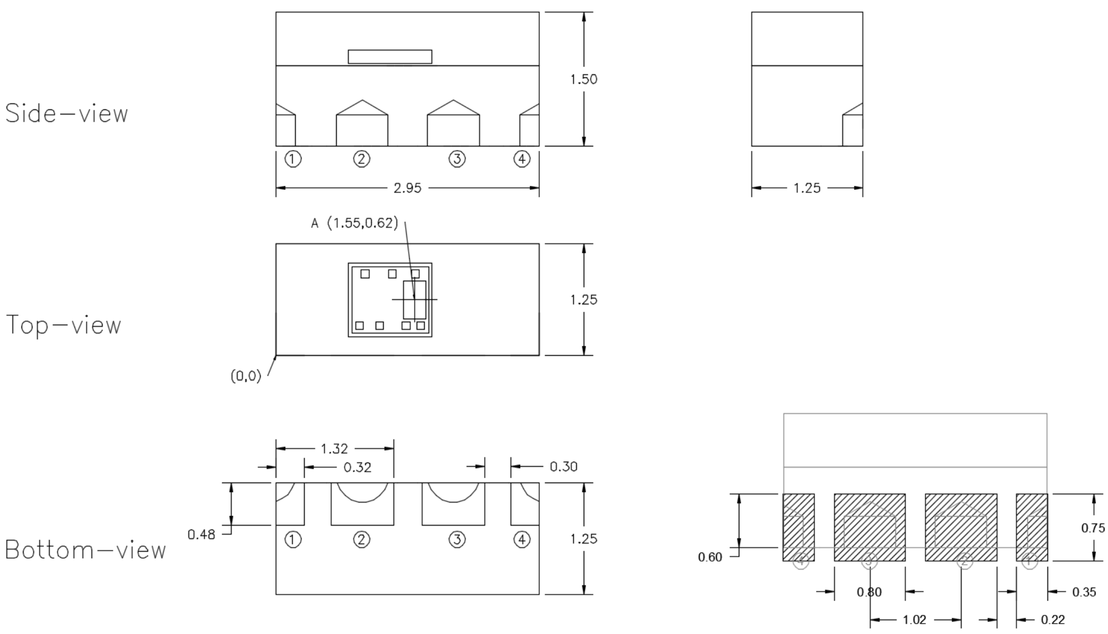
Register 0x00 (COM_TEST) –Communication Test Register				
Bit	Access	Default	Name	Description
7:0	RO	0x21	Chip_ID	Read this register through the I²C interface to identify the device with chip ID 0x21. It can also help to test whether the communication link is established or not.

Register 0x01 (CONFIGURE) - ALS Configuration				
Bit	Access	Default	Name	Description
7	RW	0x00	Reserved	Unused register bit- write 0
6:4	RW	0x00	ALS_RANGE	For bits 6:4 = (see the following) 000: ALS is in the 1927 lux range 001: ALS is in the 963 lux range 010: ALS is in the 481 lux range 011: ALS is in the 240 lux range 100~ 111: ALS is in the 120 lux range
3:2	RW	0x00	Reserved	Unused register bit- write 0
1	RW	0x00	ALS_EN	When = 0, ALS sensing is disabled When = 1, continuous ALS sensing is enabled with new data ready every integration cycle.
0	RW	0x00	Reserved	Unused register bit- write 0

Register 0x06 (ALS_DATAL) – ALS Reading (Lower 8 bits)				
Bit	Access	Default	Name	Description
7:0	RO	0x00	ALS_DATA	Lower 8 bits (of 12 bits) of ALS reading

Register 0x07 (ALS_DATAH) - ALS Reading (Upper 4 bits)				
Bit	Access	Default	Name	Description
7:4	RO	0x00	Unused	Unused bits
3:0	RO	0x00	ALS_DATA	Upper 4 bits (of 12 bits) of ALS reading

Package Outline Dimensions



Recommended Land Pattern

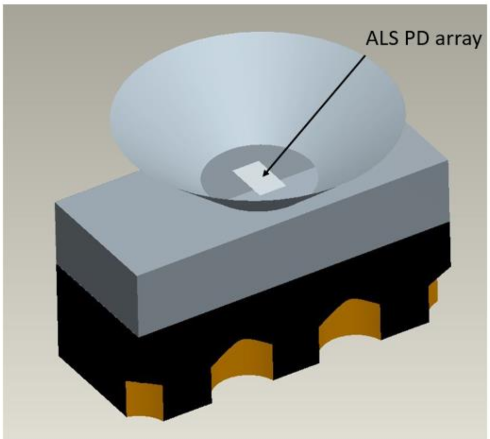
Pin Number	Pin Name
1	VDD
2	GND
3	SDA
4	SCL

Note 1: All tolerances are ±0.1mm unless otherwise specified.
Note 2: Sensing center coordinates at point A (x,y) = (1.55, 0.62).
Note 3: Sensitive area: 0.42mm x 0.25mm.
Note 4: Units are in mm.

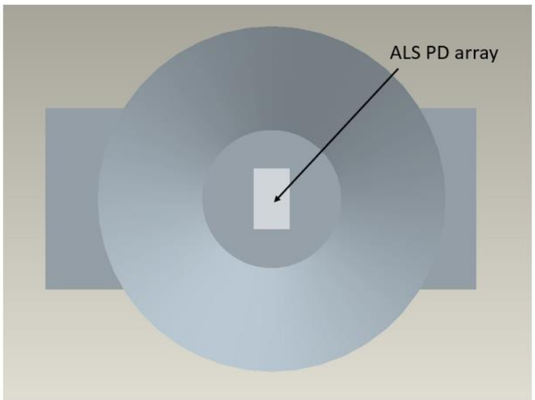
3D Product Drawing

Refer to the 3D drawing of SY22306-S1 ALS PD (photodiode) and FOV (field of view) below:

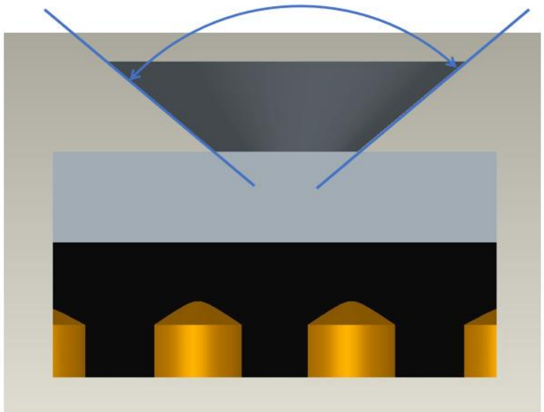
3D Drawing



Top-View

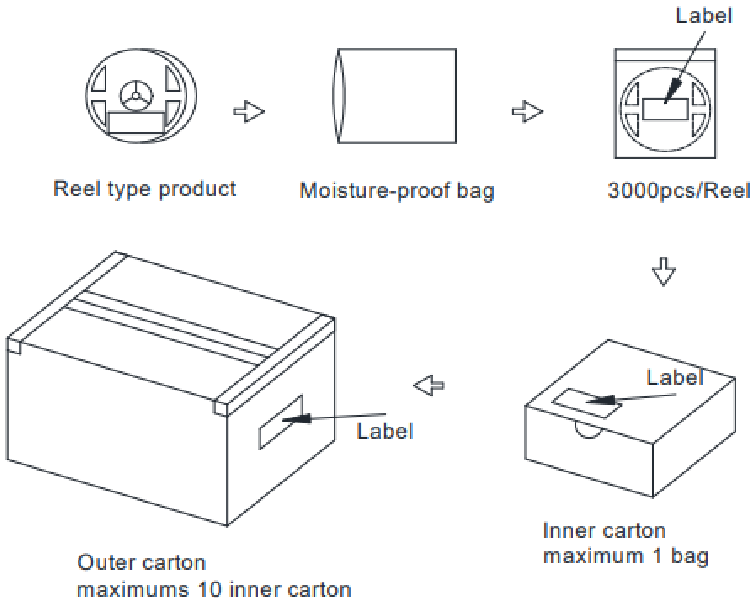


Side-View

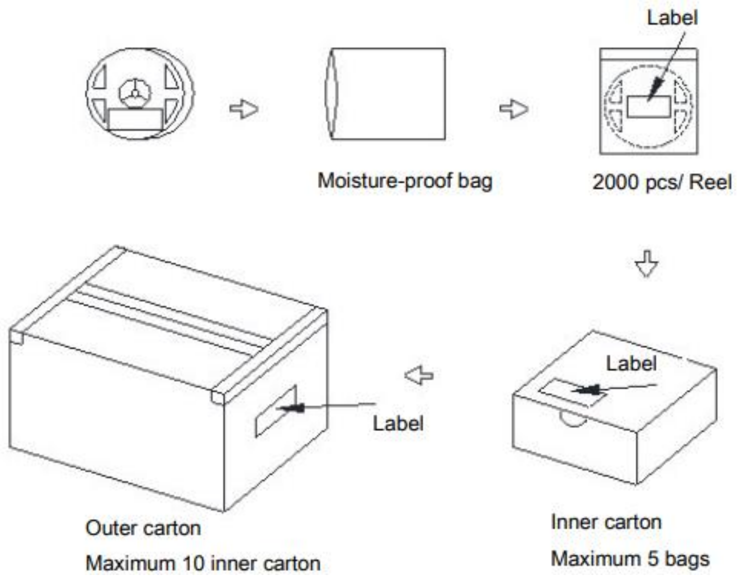


Packaging Specifications

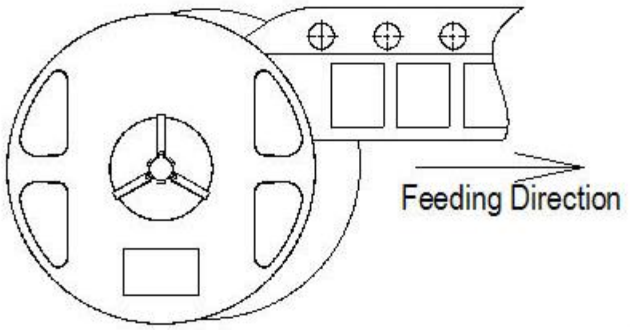
Option A:



Option B:

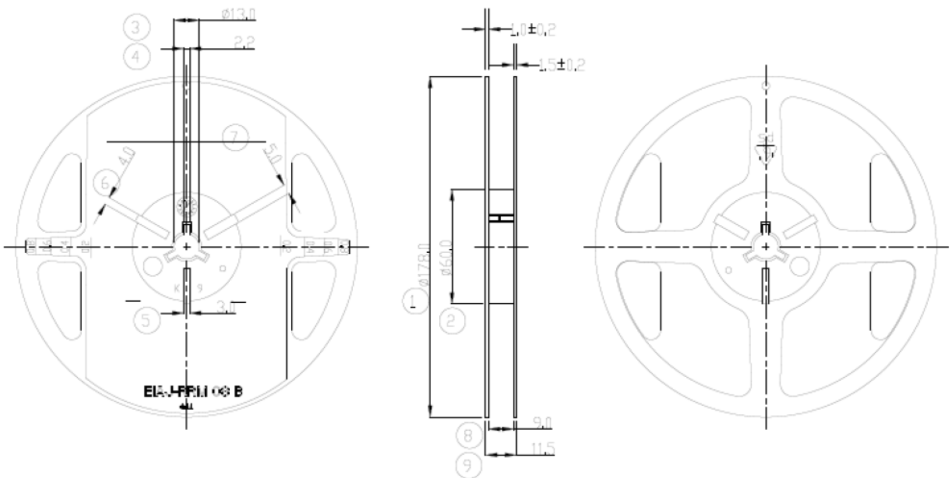


Feeding Direction:
(Applicable for both Option A and Option B)

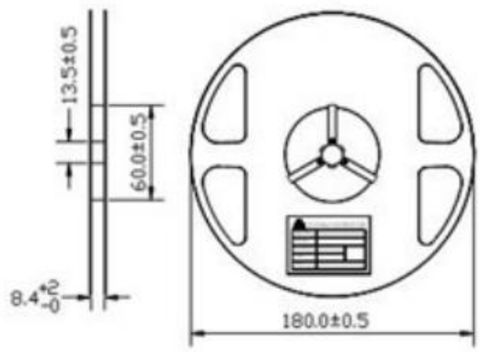


Dimensions of Reel

Option A:

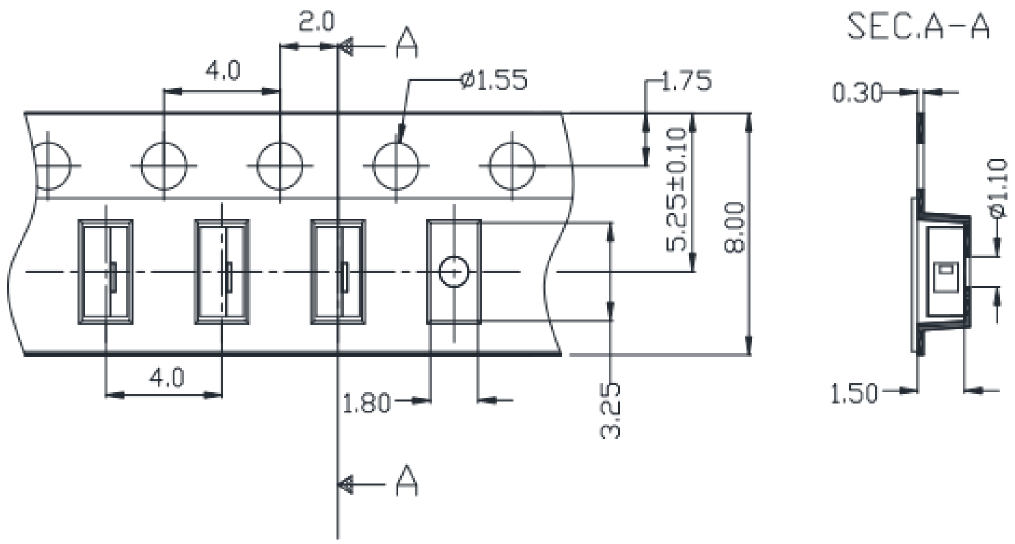


Option B:



Dimensions of Tape

(Applicable for both Option A and Option B.)



Note: All dimensions are in millimeters and exclude mold flash and metal burr.

Recommended Storage Method

Proper storage measures are recommended as soon as the bag is opened to prevent moisture absorption. The following conditions should be observed if bags are not available:

- Storage temperature: 10°C to 30°C
- Storage humidity: ≦60%RH max
- Storage Time: ≦168hr max

Moisture-Proof Package

To avoid moisture absorption by the resin, the product should be stored under the following conditions:

- Temperature: 23 ± 5°C
- Relative humidity: 60% (max)
- Baking is required if the devices have been stored unopened for more than 24 months and the HIC card is not discolored.

ESD Precaution

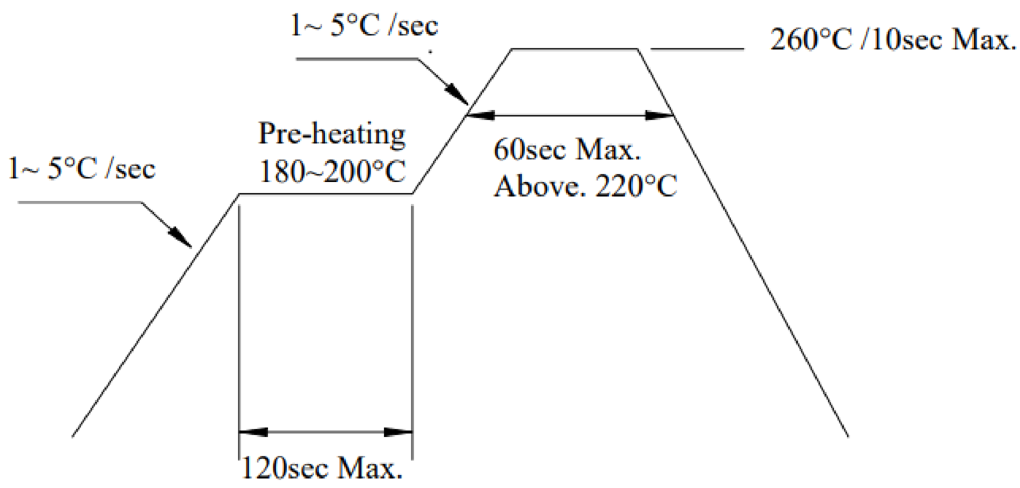
Proper storage and handling procedures should be followed to prevent ESD damage to the devices, especially when removed from the anti-static bag. Warning labels for electro-static sensitive devices are on the packaging.

Manual Soldering Corrections

Make any necessary soldering corrections manually.

Temperature shall be no more than 350°C (25W for soldering iron) within 3 seconds. Do not do this more than once for any given pin.

Recommended Solder Profile:



Note 1: Reflow soldering should not be done more than twice.

Note 2: Do not put stress on the ALS devices during the heating stage while soldering.

Note 3: Do not wrap the circuit board after soldering.

Revision History

The revision history provided is for informational purpose only and is believed to be accurate, however, not warrantied. Please make sure that you have the latest revision.

Revision Number	Revision Date	Description	Pages changed
0.9	Mar 6, 2018	Initial Release	
0.9A	Oct 8, 2018	1. Change COUNT_$_{ALS_4}$ condition from "Fluorescent Lamp" to "White LED" 2. Delete COUNT_$_{ALS_0}$, COUNT_$_{ALS_1}$, COUNT_$_{ALS_2}$ and COUNT_$_{ALS_3}$ 3. Delete Figs"Stability of ALS output over Temperature" 4. Update "Recommended Land pattern	
0.9B	Sept 1, 2021	Update Package and taping information	
0.9C	May 5, 2023	Update Package Outline Drawings	
1.0	Jun 27,2023	Production Release	

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