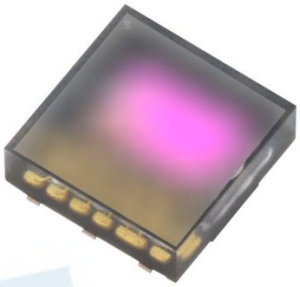
DATASHEET

Ambient Light Sensor with I²C Interface
ALS-DPDIC17-78C/L749/TR8



Features

- 10~16bit ADC resolution
- Specially coated photo diode with an optical response similar to human eyes
- High resolution (0.0033Lux/count)
- 50Hz/60Hz flicker noise and IR rejection
- Amplifier with adjustable gain (x1, x4, x8, x32, X96)
- Individual programmable low and high threshold for interrupt function
- Programmable integration time
- The product itself will remain within RoHS compliant version
- Compliance with EU REACH
- Compliance Halogen Free(Br < 900ppm, Cl < 900ppm, Br+Cl < 1500ppm)

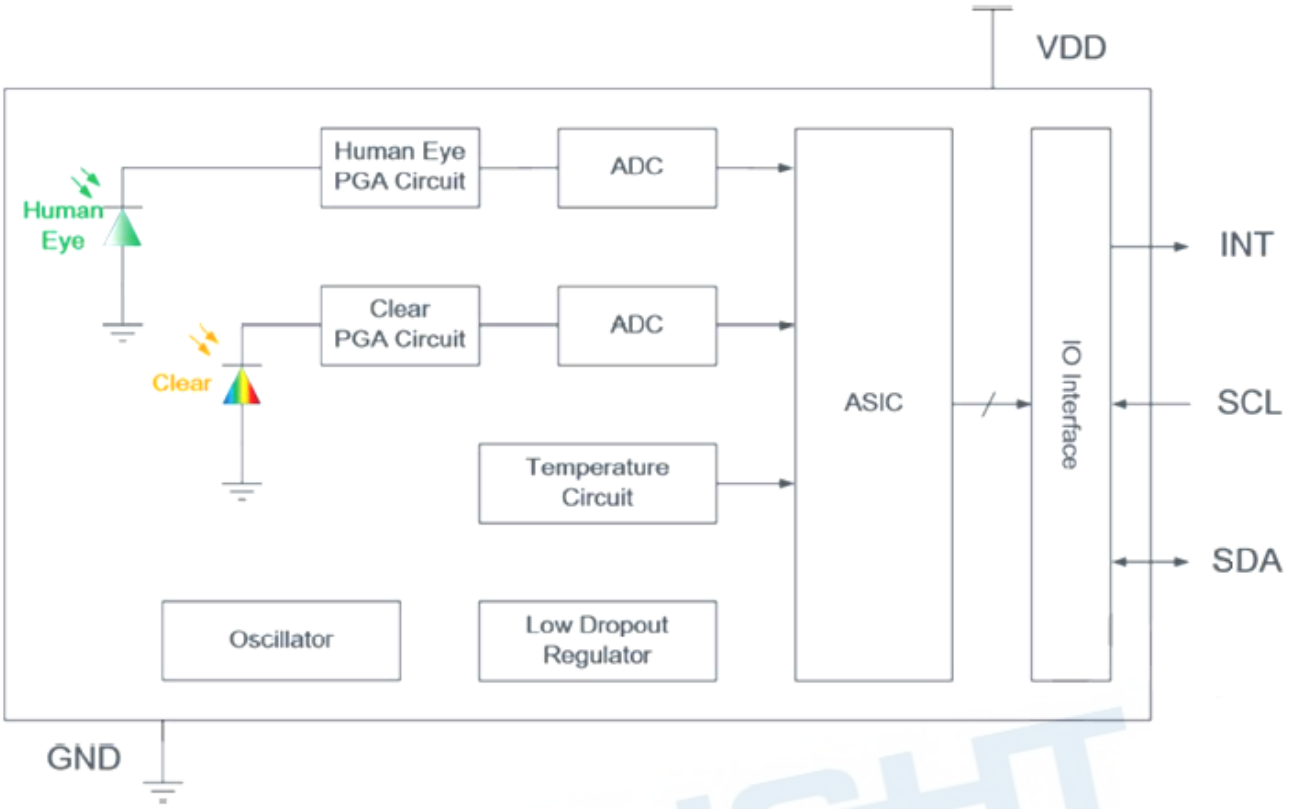
Description

The ALS-DPDIC17-78C/L749/TR8 is a digital output ambient light with I²C interface and interrupt. It has a flexible and wide operating range for the ambient light sensor with a maximum resolution of 0.0033Lux/count and a maximum detectable illumination of 83000Lux. The ALS-DPDIC17-78C/L749/TR8 built-in an optical filter for IR rejection, and providing a spectrum which is close to the human eye's response. Dual-channel output (human eye and clear), so it has excellent light ratio under different light conditions.

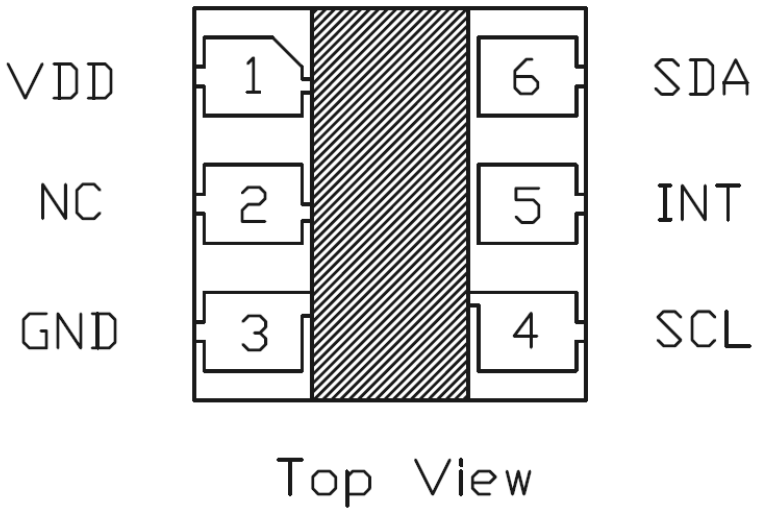
Applications

- Detection of ambient for controlling the backlight of TFT LCD display.
- Automatic residential and commercial lighting management.
- Automatic contrast enhancement for electronic signboard.
- Mobile phone, Smart phone, PDA, Tablet PC.

Block Diagram



I/O Pins Configuration



Top View

Pad Description

Pin	I/O Type	Pin Name	Description
1	PWR	VDD	Power supply
2	NC	NC	No connection
3	GND	GND	Ground
4	I	SCL	I²C serial clock line
5	O	INT	Interrupt pin
6	I/O	SDA	I²C serial data line

Direction denotation:

I/O Type	Dir.	I/O Type	Dir.
O	Output	GND	Ground
I	Input	I/O	Input / Output
PWR	Power	NC	Not Connect

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply Voltage	VDD	4.5	V
I²C Bus Pin Voltage	SCL, SDA, INT	-0.2 to 4.5	V
I²C Bus Pin Current	SCL, SDA, INT	10	mA
Operating Temperature	T_{ope}	-40 to +85	℃
Storage Temperature	T_{stg}	-45 ~ 100	℃
ESD Rating	Human Body Model	2	KV

Note:

Exceeding these ratings could cause damage to the device. All voltages are with respect to ground. Currents are positive into,

negative out of the specified terminal.

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage Note1	V_{DD}	2.4	-	3.6	V	-
I²C Bus Pin Voltage	V_{Bus}	1.62	1.8	V_{DD}	V	$V_{Bus} \leq V_{DD}$
Operating Temperature	T_{ope}	-40	-	+85	℃	-
I²C Bus Input High VoltageNote2	V_{IH_SCL}, V_{IH_SDA}	1.4	- -	- -	V	-
I²C Bus Input Low VoltageNote2	V_{IL_SCL}, V_{IL_SDA}	- -	- -	0.5	V	-
SDA Output Low Voltage	V_{OL_SDA}	0	-	0.4	V	3mA sinking current
INT Output Low Voltage	V_{OL_INT}	0	-	0.4	V	3mA sinking current

Notes:

1.The power supply need to make sure the V_{DD} slew rate at least 1.0V/ms. ALS-DPDIC17-78C/L749/TR8 have power on reset function. When V_{DD} drops below 2V under room temp, the IC will be reset automatically. Then power back up at the requirement slew rate, and write registers to the desired values.

2. The specs are defined under V_{DD}=3.3V, T_a=25°C

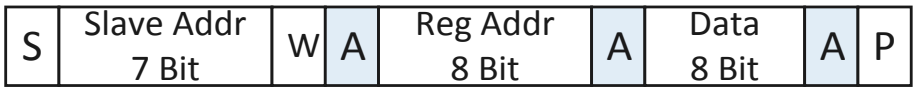
Electro-Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Active Supply Current	I_{DD}	-	160	300	μA	E_v=0 lx Note1
	I_{PD}	-	2.5	-	μA	Sleep mode E_v= 0 lx I^2C inactive
Ambient Light Sensor	-					
ALS A/DC resolution	-	10	-	16	bit	-
Number of ADC integration time	ATIME	1	-	256	step	-
ALS Dark Output	CH0 CH1	0 0	1 1	5 5	counts	Ev=0 lx, ALS gain=x96, Tint =674ms
ALS detection output	CH0 CH1	1610 2170	2300 3100	2990 4030	counts	E_v=100 lx, ALS gain=x32, Tint =170ms
ALS detection resolution	-	-	-	0.0033	lx/count	ALS gain=x96,Tint=674ms
ALS maximum detection	-	-	-	83K	Lux	ALS gain=x1,Tint=5.5ms
ALS sensitivity peak wavelength	λ_{PALS}	-	550	-	nm	For channel 0

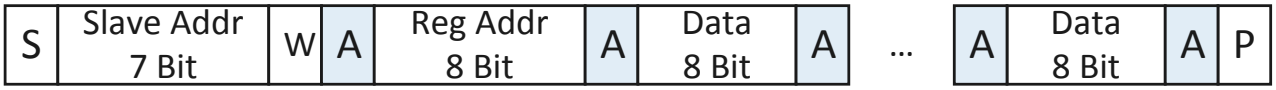
Note :

1. V_{DD} = 3.3 V, T_a = 25℃, **EN_ALS**=1, **ALSCONV**=0x3F, **PGA_ALS** =0x04, **WTIME**=0x07

I2C Write Format

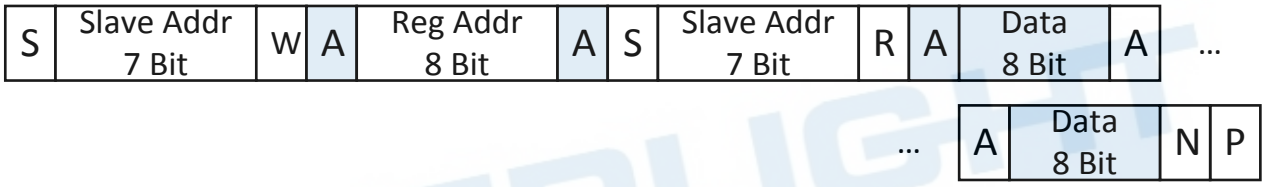


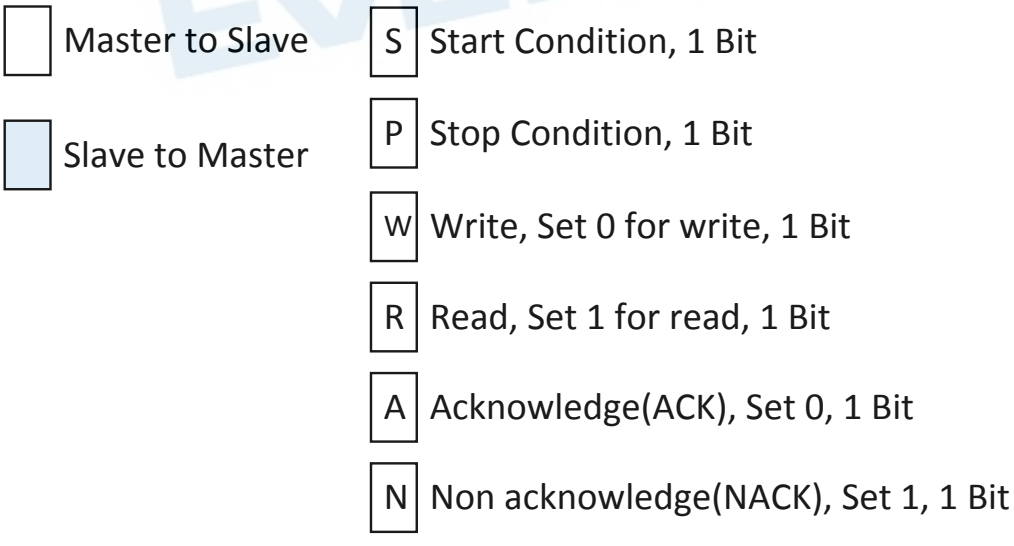
I2C Block Write Format



I2C Read Format

I2C Block Read Format





I2C Slave Address and R/W bit

This address is seven bits long followed by an eighth bit which is a data direction bit (R/W). A '0' indicates a transmission (WRITE), a '1' indicates a request for data (READ). The slave address of this device is 0x38.

Register Set

The ALS-DPDIC17-78C/L749/TR8 is operated over the I²C bus with registers that contain configuration, status, and result information. All registers are 8 bits long.

Address	Name	Type	Default value	Description
0x00	SYSM_CTRL	RW	0x00	ALS operation mode control, waiting mode control, SW reset
0x01	INT_CTRL	RW	0x03	Interrupt pin control, interrupt persist control
0x02	INT_FLAG	RW	0x00	Interrupt flag, error flag, power on reset(POR) flag
0x03	WAIT_TIME	RW	0x00	Waiting time setting
0x04	ALS_GAIN	RW	0x00	ALS analog gain setting
0x05	ALS_TIME	RW	0x00	ALS integrated time setting
0x0B	PERSISTENCE	RW	0x11	ALS persistence setting
0x0C	ALS_THRES_LL	RW	0x00	ALS lower interrupt threshold - LSB
0x0D	ALS_THRES_LH	RW	0x00	ALS lower interrupt threshold - MSB
0x0E	ALS_THRES_HL	RW	0xFF	ALS higher interrupt threshold - LSB
0x0F	ALS_THRES_HH	RW	0xFF	ALS higher interrupt threshold - MSB
0x16	INT_SOURCE	RW	0x00	ALS interrupt source
0x17	ERROR_FLAG	RW	0x00	Error flag
0x1C	CH0_DATA_L	R	0x00	Channel 0 output data - LSB
0x1D	CH0_DATA_H	R	0x00	Channel 0 output data - MSB
0x1E	CH1_DATA_L	R	0x00	Channel 1 output data - LSB
0x1F	CH1_DATA_H	R	0x00	Channel 1 output data - MSB
0xBC	PNO_LB	R	0x14	Product number, Low Byte
0xBD	PNO_HB	R	0x16	Product number, High Byte

SYSM_CTRL

0x00	SYSM_CTRL, System Control (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	SWRST	EN_WAIT	0	0	0	0	0	EN_ALS

SWRST：Software reset. Reset all register to default value.

0: (default)

1: Reset will be triggered.

EN_WAIT：Waiting time will be inserted between two measurements.

0: Disable waiting function.

1: Enable waiting function.

EN_ALS：Enables ALS function.

0: Disable ALS function (default)

1: Enable ALS function

INT_CTRL

0x01	Interrupt Pin Control (Default = 0x03)							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	0	ALS_ SYNC	0	0	0	EN_AINT

ALS_SYNC： Measurement is pended when ALS interrupt is triggered. Until clear the interrupt then start the next measurement.

0: Disable pending ALS function (default).

1: Enable pending ALS function.

EN_AINT：The ALS interrupt (INT_ALS) flag can trigger the INT pin to low.

0: Disable **INT_ALS** effect INT pin.

1: Enable **INT_ALS** effect INT pin (default)

INT_FLAG

0x02	INT_FLAG, System Control (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	INT_POR	DATA_FLAG	0	0	0	0	0	INT_ALS

INT_POR：Power-On-Reset Interrupt flag trigger the INT pin when the flag sets to one.

0: Write zero to clear the flag.
1: This bit will be set to one when it satisfy one of the following conditions:

- Power On
- VDD < 2.0V
- SWRST

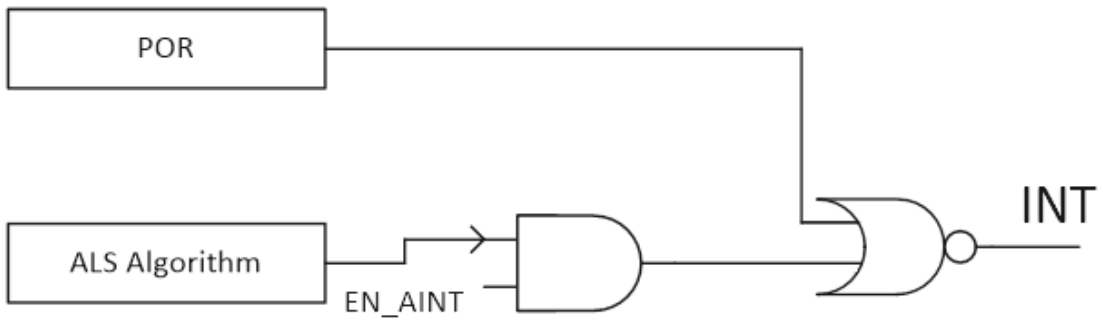
DATA_FLAG：It shows if any data is invalid after completion of each conversion cycle. This bit is read-only.

0: data valid
1: data invalid

INT_ALS：ALS Interrupt flag. It correlation with CH0/1 data and ALS high/low threshold. Write zero to clear the flag.

0: ALS Interrupt not trigger or be cleared.
1: ALS Interrupt triggered

Interrupt Behavior ：



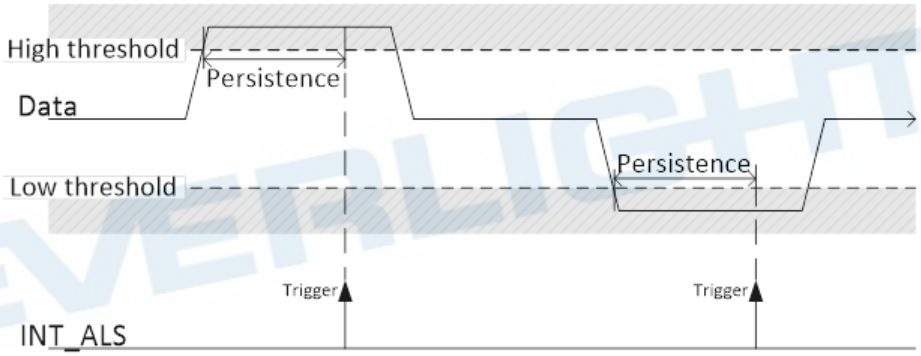
ALS Interrupt Algorithm

Correlative register:

The ALS Interrupt (**INT_ALS, register 0x02, bit0).**
The ALS Persistence (**PRS_ALS**, register 0x0B, bit0 to bit3),
The ALS Data (**CH0_DATA and CH1_DATA**, register 0x1C to 0x1F),
The ALS Low Threshold (**ALS_THRES_L**, register 0x0C to 0x0D),
The ALS High Threshold (**ALS_THRES_H**, register 0x0E to 0x0F).

INT_ALS triggered condition:

1. Rule of active interrupt: **DATA**>**ALS_THRES_H** or **DATA**<**ALS_THRES_L.**
2. If the **DATA** meets the rule, the **interrupt** count increases one.
   If the **DATA** fails in the rule, the interrupt count will be clear.
3. When the **interrupt** count equal to **PRS_ALS setting**, **INT_ALS** will be triggered and reset the interrupt counter.
4. If **PRS_ALS** is set to zero, **threshold** will be ignored and **DATA** will meets the active interrupt rule forcibly.



WAIT_TIME

0x03	WAIT_TIME, waiting time (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	WTIME							

WTIME : This register controls the time unit of waiting state which is inserted between any two measurements. It is 5ms per time unit.

0x00: 1 time unit.
0x01: 2 time units
……
0xFF: 256 time units

ALS_GAIN

0x04	ALS_GAIN, ALS analog gain (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	0	0	0	PGA_ALS		

PGA_ALS：ALS sensing gain.

0x0: x1 (default)
0x1: x4
0x2: x8
0x3: x32
0x4: x96
0x5, 0x6, 0x7: NA

ALS_TIME

0x05	ALS_TIME, ALS integrated time (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	ALSCONV							

ALSCONV：This register controls the integrated time of AD converter at ALS mode (T_{ALS}), and the resolution of output data (CH0_DATA, CH1_DATA).

0x00: The maximum count of **output data is** 1023, T_{ALS} = 5.513ms (default)
0x01: The maximum count of **output data is** 2047, T_{ALS} = 8.138ms
……
0xff: The maximum count of **output data is** 65535, T_{ALS} = 674.888ms

The maximum count of **output data is** minimum of [1024 x (**ALSCONV** + 1) – 1, 65535].

The conversion time of ALS function (T_{ALS}) is decided by **ALSCONV**.
T_{ALS}=2.888 + 2.625 x (**ALSCONV** + 1) (ms)

PERSISTENCE

0x0B	PERSISTENCE, ALS persistence setting (Default = 0x11)							
BIT	7	6	5	4	3	2	1	0
R/W	0			1	PRS_ALS			

PRS_ALS：This register sets the numbers of similar consecutive ALS interrupt events before the interrupt pin is triggered.

0x0: Every ALS conversion is done.
0x1: 1 ALS interrupt event is asserted.
……
0xf: 15 consecutive ALS interrupt events are asserted.

ALS_THRES_L

0x0C 0x0D	ALS_THRES_L, ALS low interrupt threshold (Default = 0x0000)							
BIT	7	6	5	4	3	2	1	0
R/W	ALS_THRE_LL							
R/W	ALS_THRE_LH							

This register sets the lower threshold value of ALS interrupt. The interrupt algorithm compares the selected ALS data and ALS threshold value.

ALS_THRE_LL：ALS lower interrupt threshold value, LSB. (Reg. 0x0C)
ALS_THRE_LH：ALS lower interrupt threshold value, MSB. (Reg. 0x0D)

ALS_THRES_H

0x0E 0x0F	ALS_THRES_H, ALS high interrupt threshold (Default = 0xFFFF)							
BIT	7	6	5	4	3	2	1	0
R/W	ALS_THRE_HL							
R/W	ALS_THRE_HH							

This register sets the high threshold value of ALS interrupt. The interrupt algorithm compares the selected ALS data and ALS threshold value.

ALS_THRE_HL：ALS high interrupt threshold value, LSB. (Reg. 0x0E)
ALS_THRE_HH：ALS high interrupt threshold value, MSB. (Reg. 0x0F)

INT_SOURCE

0x16	INT_SOURCE, ALS interrupt source (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	0	0	0	0	0	INT_SRC

INT_SRC： This register sets to select the ALS data for the ALS Interrupt algorithm.

0x0: Select CH0_DATA.
0x1: Select CH1_DATA.

ERROR_FLAG

0x17	ERROR_FLAG, Error flag status							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	0	0	0	0	ERR_CH1	ERR_CH0

This register indicates the ALS data status. If the ALS data is outside of measurable range, the corresponding error flag (ERR_CH0, ERR_CH1) will set to one. That also means the data is invalid.

CH0_DATA

0x1C 0x1D	CH0_DATA, Channel 0 output data.							
BIT	7	6	5	4	3	2	1	0
R/W	CH0_DATA_L							
R/W	CH0_DATA_H							

The channel 0 result of ALS sensor is written into CH0_DATA when ALS conversion is done.
For insuring the data in the register comes the same measurement, the high byte data will be latched when the low byte data has been accessed until the high byte data has be read.

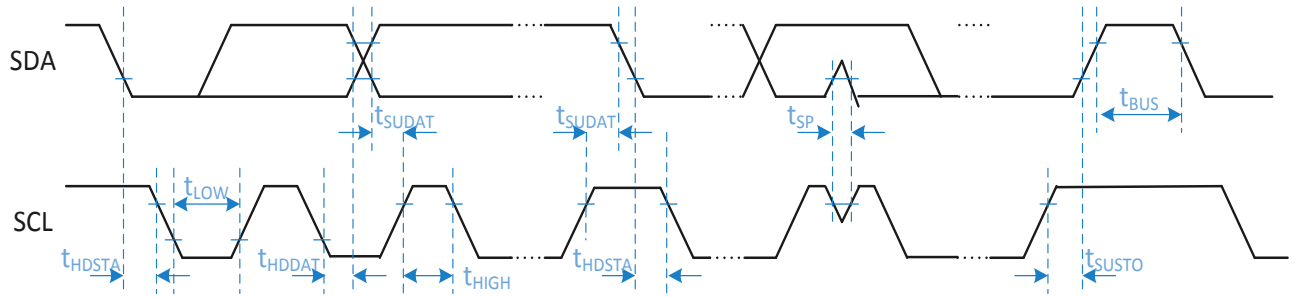
CH1_DATA

0x1E 0x1F	CH1_DATA, Channel 1 output data.							
BIT	7	6	5	4	3	2	1	0
R/W	CH1_DATA_L							
R/W	CH1_DATA_H							

The channel 1 result of ALS sensor is written into CH1_DATA when ALS conversion is done.
For insuring the data in the register comes the same measurement, the high byte data will be latched when the low byte data has been accessed until the high byte data has be read.

I²C Interface Timing Characteristics

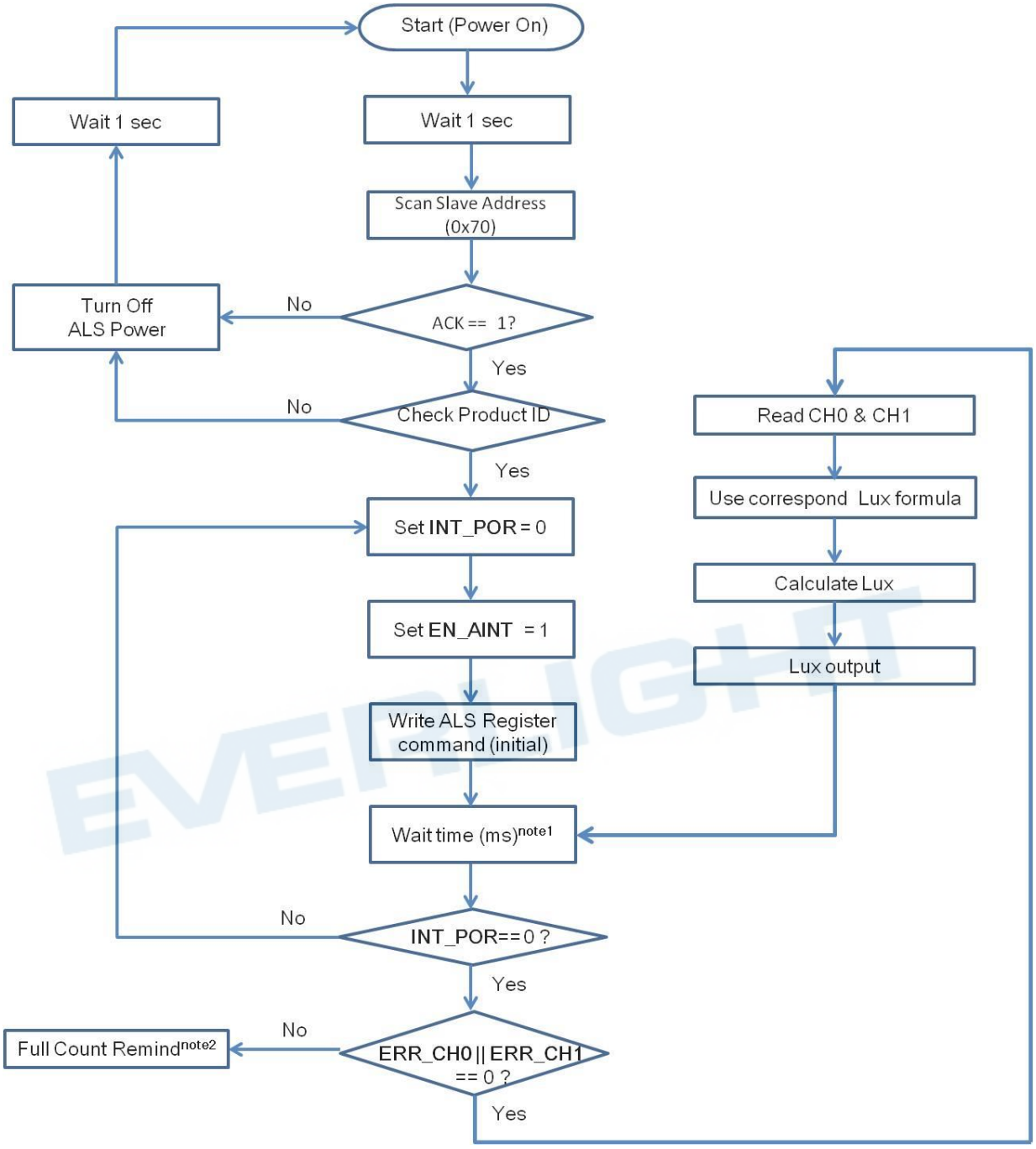
This section will describe the protocol of the I²C bus. For more details and timing diagrams please refer to the I²C specification.



Parameter (*)	Symbol	I2C Standard Mode		I2C Fast Mode		Unit
		Min.	Max.	Min.	Max.	
SCL clock frequency	f_{SCL}	0	100	0	400	kHz
Bus free time between STOP condition and START condition	t_{BUS}	4.7	--	1.3	--	μs
LOW period of the SCL clock	t_{LOW}	4.7	--	1.3	--	μs
HIGH period of the SCL clock	t_{HIGH}	4	--	0.6	--	μs
Hold time (repeated) START condition	t_{HDSTA}	4	--	0.6	--	μs
Set-up time (repeated) START condition	t_{SUSTA}	4.7	--	0.6	--	μs
Set-up time for STOP condition	t_{SUSTO}	4	--	0.6	--	μs
Data hold time	t_{HDDAT}	0	3.45	0	0.9	μs
Data set-up time	t_{SUDAT}	250	--	100	--	μs
Rise time of both SDA and SCL signals	$t_{(r)}$	--	300	--	300	μs
Fall time of both SDA and SCL signals	$t_{(f)}$	--	1000	--	300	μs

(*) All specifications are at V_{Bus} = 3.3V, T_{ope}=25°C, unless otherwise noted. Specified by design and characterization; not production tested.

Basic Operation Flow Chart



Notes:

1. The wait time need to be longer than WAIT_TIME + ALS_TIME (ms).
2. ERR_CH0 || ERR_CH1 ==1 means ALS data is outside of measurable range.

   Next steps can be decided by costumer, such as:

   ●Ignore the reminder and continue reading CH0 & CH1.

   ●Send an error message to MCU and wait for next command.

   ●Other error handling actions.

Lux Calculating

User could calculate lux value by using the following equation (for white LED)

- **If *CH0/CH1* < 0.42, Lux= (*CH0*/ PGA_ALS)*[64/(ALSCONV +1)]*K1**
- **If 0.42 < *CH0/CH1* < 0.61, Lux= (*CH0*/ PGA_ALS)*[64/(ALSCONV +1)]*K2**
- **If *CH0/CH1* > 0.61, Lux= (*CH0*/ PGA_ALS)*[64/(ALSCONV +1)]*K3**

Ex:

Register setting：**ALSCONV** = 0x3F, **PGA_ALS** = 0x03, ***CH0/CH1***=0.83

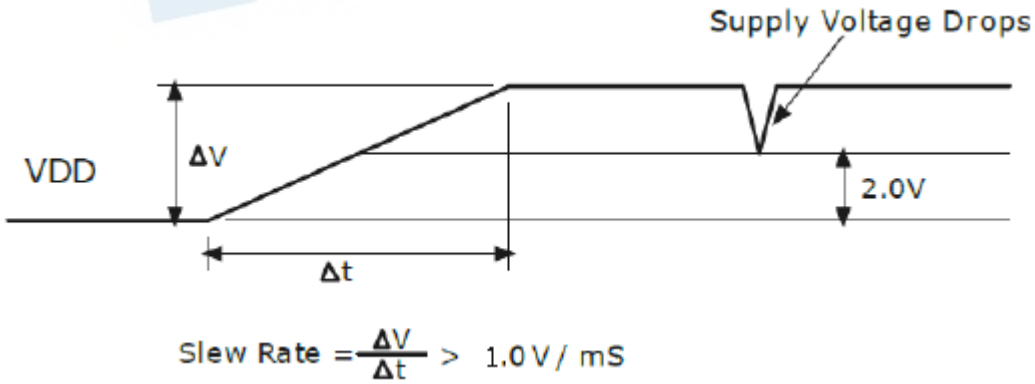
Lux=(*CH0* / 32)*[64 / (63+1)]*1.58

Note:

1. Recommend calibrate value：**K1 = 0.41, K2=0.57, K3 =1.58**
2. The values for **K1**, **K2** and **K3** shown above are only valid for the sensor component. If the sensor is placed behind an optical system (e.g. lens, cover panel etc.) the values above might not be suitable for a lux calculation. In such case the values for **K1**, **K2** and **K3** must be determined in the application by using a luxmeter and the sensor readings.

Supply Voltage Drops

Upon power-up, please ensure the slew rate of VDD greater than 1.0 V/mS. After power-up , the supply voltage shall NOT drop below 2.0V. Once it happens, please switch off the power, wait more than 1 second, and then power on the device again.



Note:

I²CBus Clear

In the unlikely event where the clock (SCL) is stuck LOW, the preferential procedure is to reset the bus using the HW reset signal if your I2C devices have HW reset inputs. If theI2C devices do not have HW reset inputs, cycle power to the devices to activate the mandatory Internal Power-On Reset (POR) circuit.

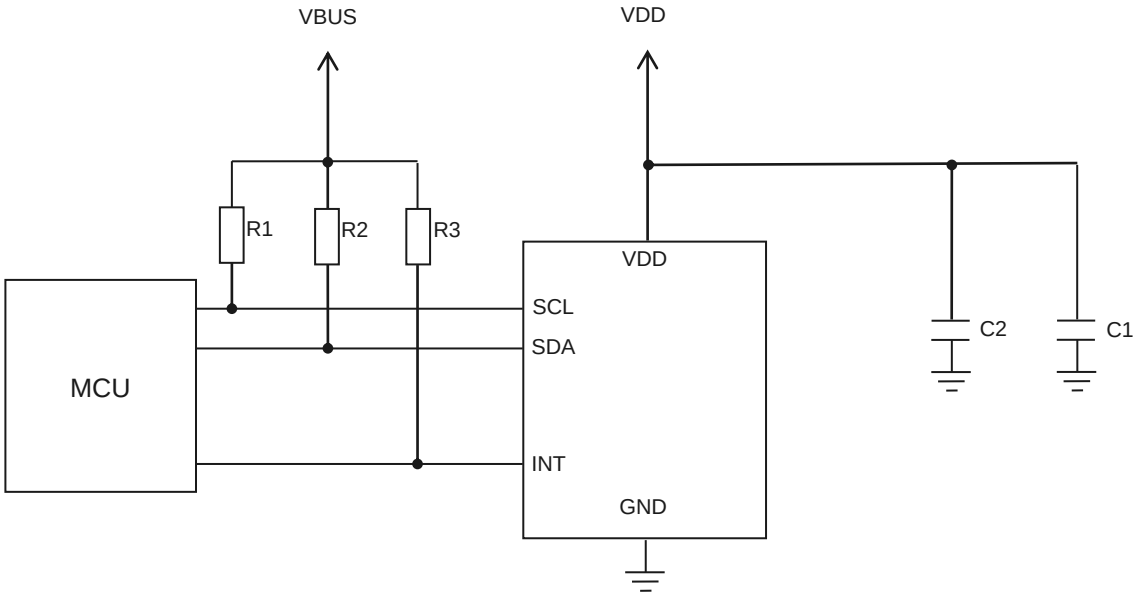
If the data line (SDA) is stuck LOW, the master should send nine clock pulses. The device that held the bus LOW should release it sometime within those nine clocks.

I²C General Call Software Reset

Following a General Call, (0000 0000), sending 0000 0110 (06h) as the second byte causes software reset. This feature is optional and not all devices will respond to this command. On receiving this 2-byte sequence, all devices designed to respond to the general call address will reset and take in the programmable part of their address.

Precautions have to be taken to ensure that a device is not pulling down the SDA or SCL line after applying the supply voltage, since these low levels would block the bus.

Typical Application Circuit



ALS-DPDIC17-78C/L749/TR8

The capacitors (C1, C2) are required for sensor power supply. The capacitors should be placed as close as possible to the device. The high frequency AC noises can be shunted to the ground by the capacitors. The transient current caused by digital circuit switching also can be handled by the capacitors. A typical value 0.1 / 1 μF can be used.

The pull-up resistors (R1, R2) are required for I²C communication. At fast speed mode (400kHz/s) and VBUS = 3V, 1.0kΩ resistors can be used. The pull-up resistor (R3) is also required for the interrupt, a typical value between 10 kΩ and 100 kΩ can be used.

Electrical and Optical Characteristics (T_a=25℃)

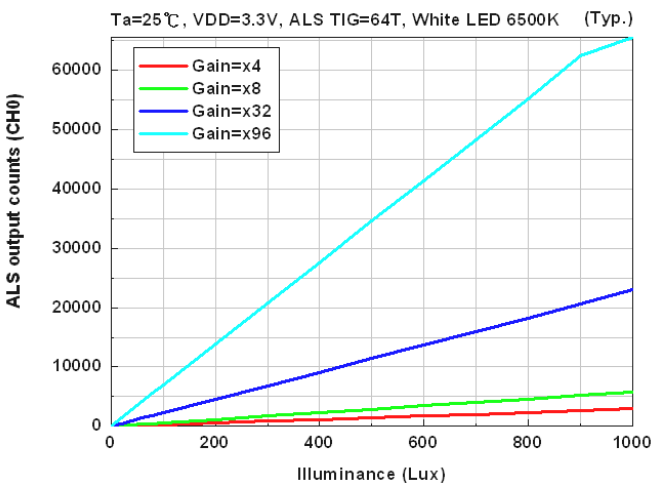


Fig.1 ALS output data vs. ALS Gain (for CH0)

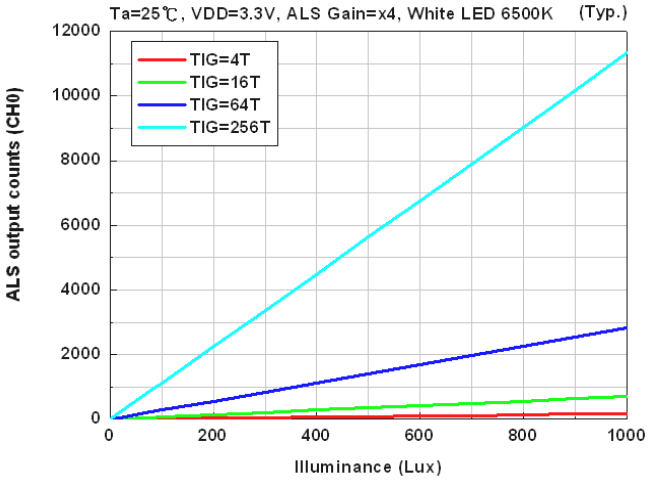


Fig.2 ALS output data vs. ADC TIG (for CH0)

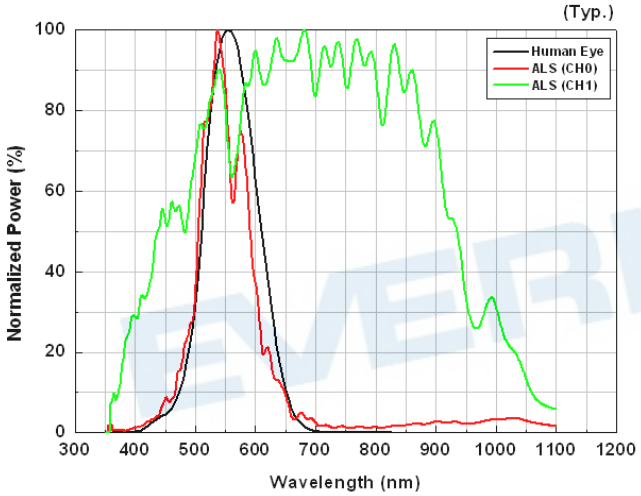


Fig.3 Spectral vs. Wavelength

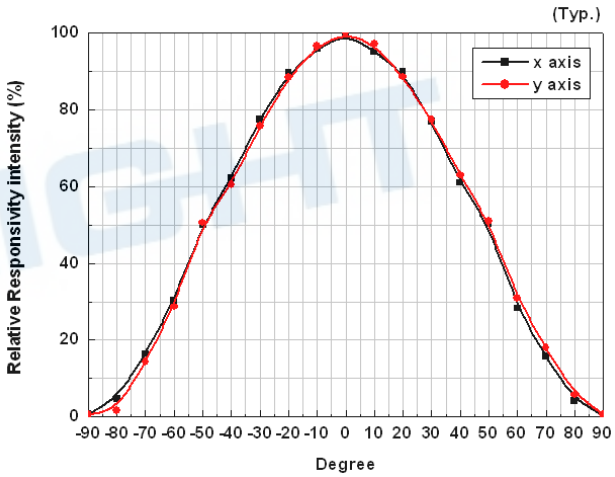
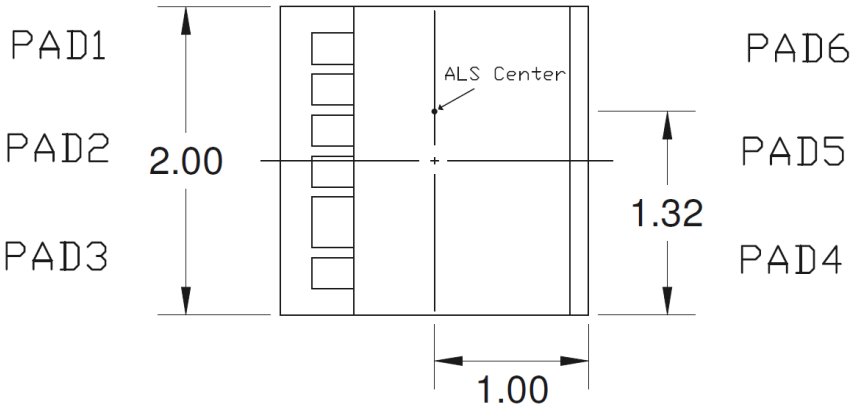


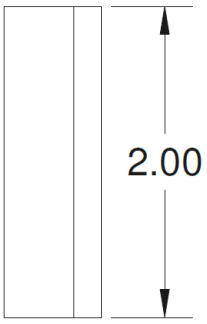
Fig.4 ALS view angle (for CH0)

Package Dimensions and recommended solder pad layout

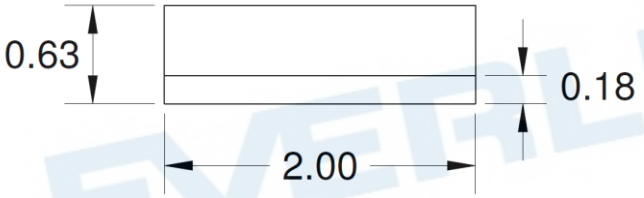
Top View



Side View

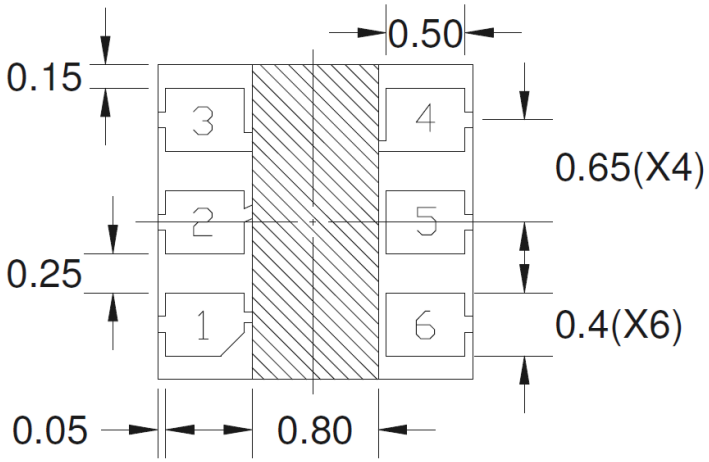


Side View

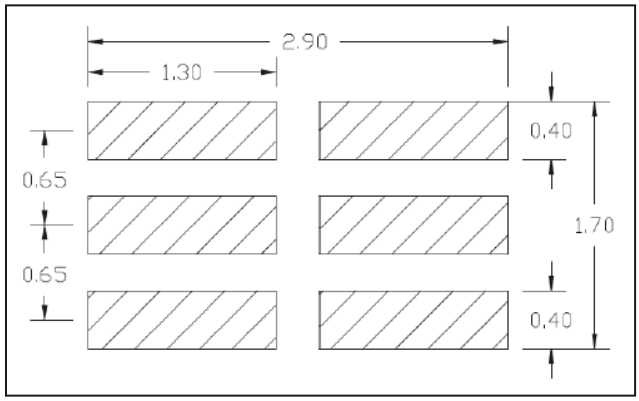


Pad Number	Pad Name
1	VDD
2	NC
3	GND
4	SCL
5	INT
6	SDA

Bottom View



Recommend soldering pad

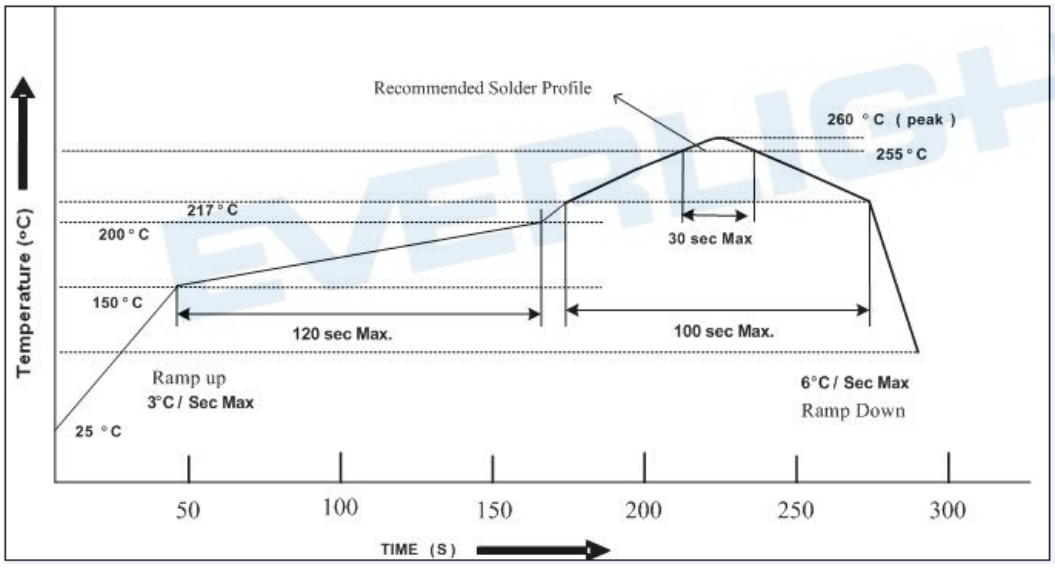


Unit: mm
Tolerances: ± 0.2mm

Recommended method of storage

1. Do not open moisture proof bag before devices are ready to use.
2. Shelf life in sealed bag from the bag seal date: 18 months at 10°C~30°C and < 90% RH.
3. After opening the package, the devices must be stored at 10°C~30°C and ≤ 60%RH, and used within 168 hours (floor life).
4. If the moisture absorbent material (desiccant material) has faded or unopened bag has exceeded the shelf life or devices (out of bag) have exceeded the floor life, baking treatment is required.
5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure or recommend the following conditions:
   192 hours at 40°C +5/–0°C and < 5 % RH (reeled/tubed/loose units) or
   96 hours at 60°C ± 5°C and < 5 % RH (reeled/tubed/loose units) or
   24 hours at 125°C ± 5°C, not suitable for reel or tubes.

Recommended Solder Profile



Notice:

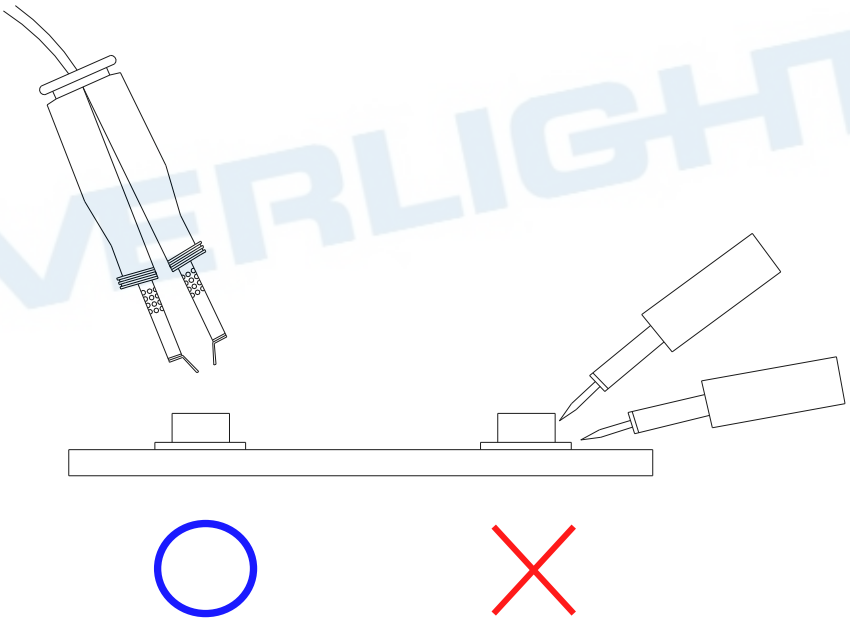
1. Reflow soldering should not be done more than two times.
2. When soldering, do not put stress on the devices during heating.
3. After soldering, do not warp the circuit board.
4. Reference: IPC/JEDEC J-STD-020D

Soldering Iron

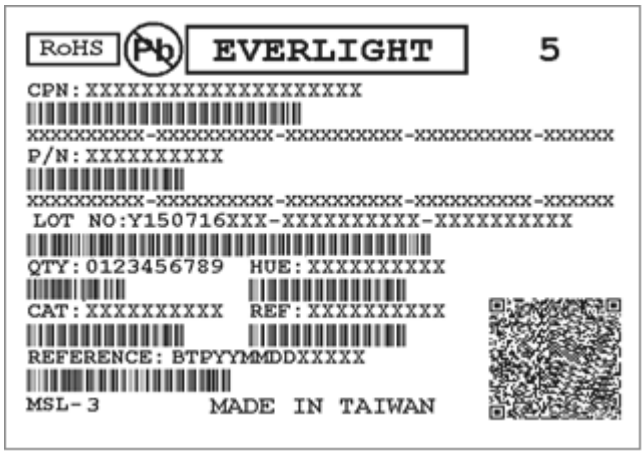
Each terminal is to go to the tip of soldering iron temperature less than 350°C for 3 seconds within once in less than the soldering iron capacity 25W. Leave two seconds and more intervals, and do soldering of each terminal. Be careful because the damage of the product is often started at the time of the hand solder.

Repairing

Repair should not be done after the device have been soldered. When repairing is unavoidable, a double-head soldering iron should be used (as below figure). It should be confirmed beforehand whether the characteristics of the device will or will not be damaged by repairing.



Label Explanation

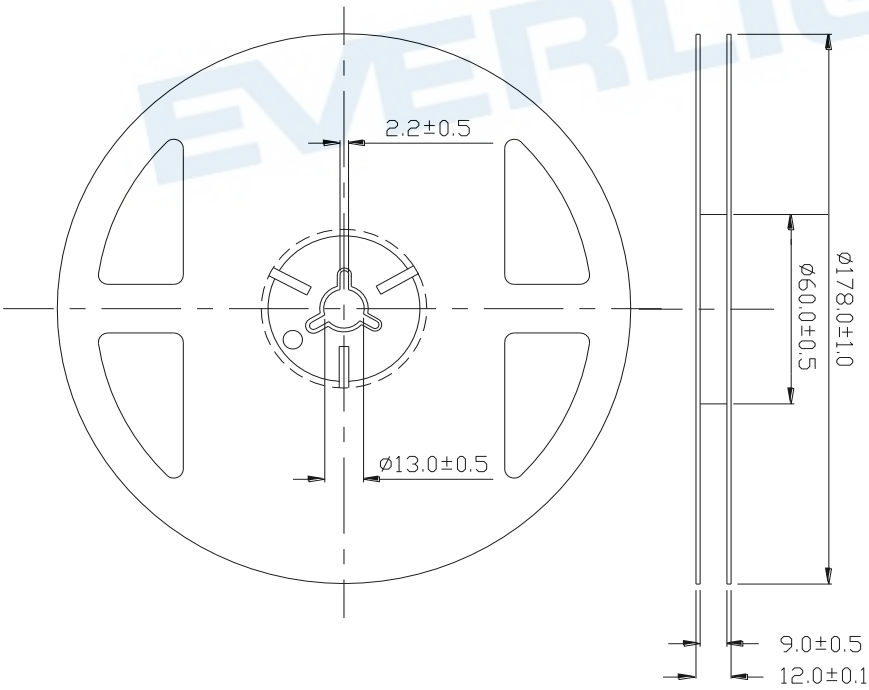


- CPN: Customer's Product Number
- P/N: Product Number
- QTY: Packing Quantity
- CAT: Luminous Intensity Rank
- HUE: Dom. Wavelength Rank
- REF: Forward Voltage Rank
- LOT No: Lot Number

Packing Quantity Specification

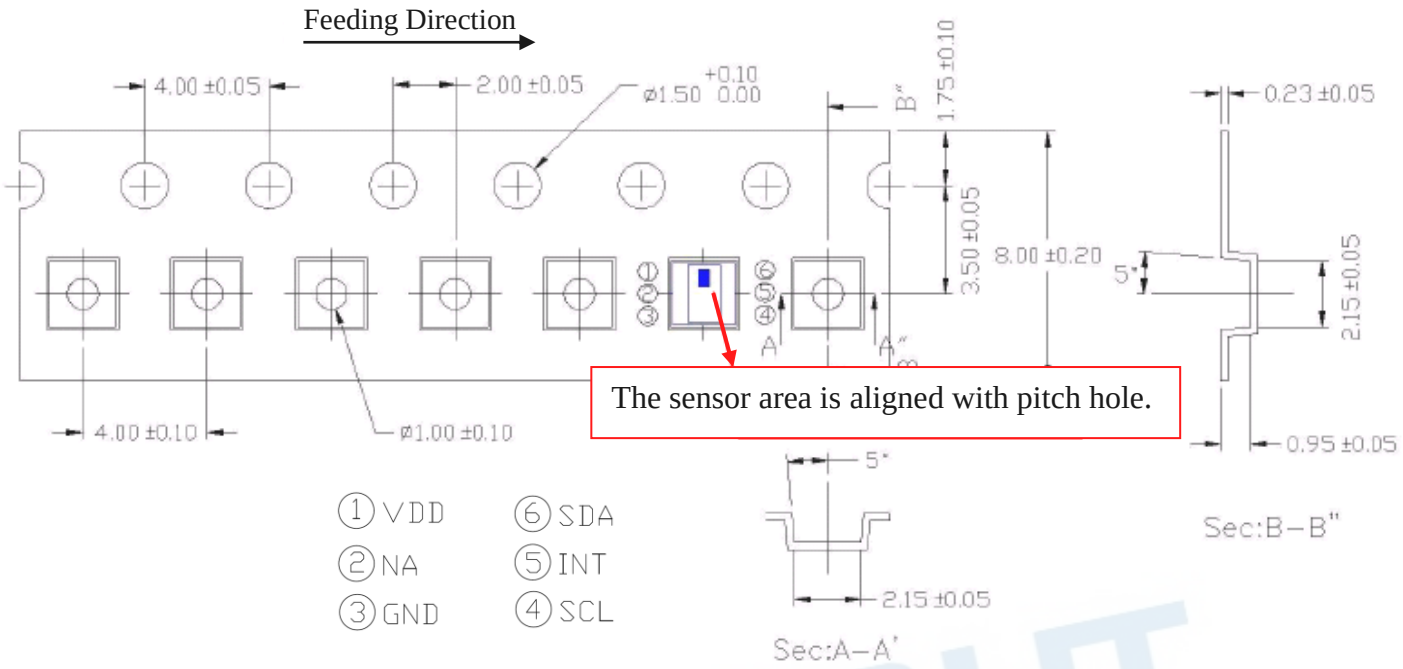
2000 PCS/ 1 Reel

Reel Dimensions



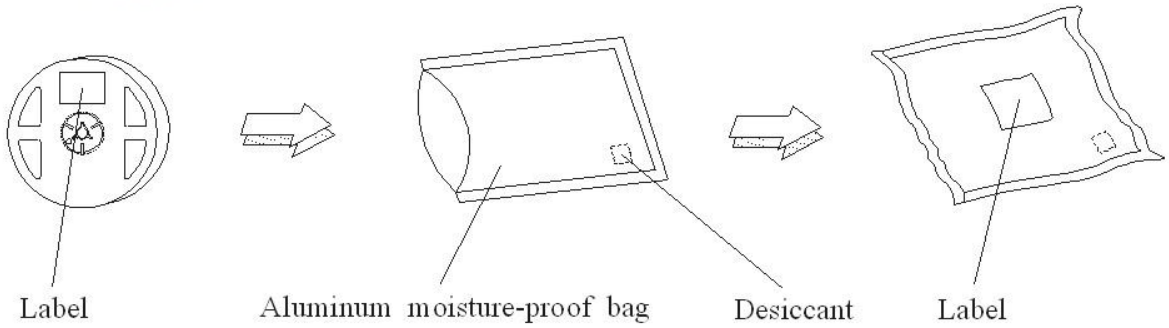
Unit: mm

Tape Dimensions



Unit: mm

Moisture Resistant Packing Process



DISCLAIMER

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2. The product meets EVERLIGHT published specification for a period of twelve (12) months from date of shipment.
3. The graphs shown in this datasheet are representing typical data only and do not show guaranteed values.
4. When using this product, please observe the absolute maximum ratings and the instructions for using outlined in these specification sheets. EVERLIGHT assumes no responsibility for any damage resulting from the use of the product which does not comply with the absolute maximum ratings and the instructions included in these specification sheets.
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