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DATA SHEET

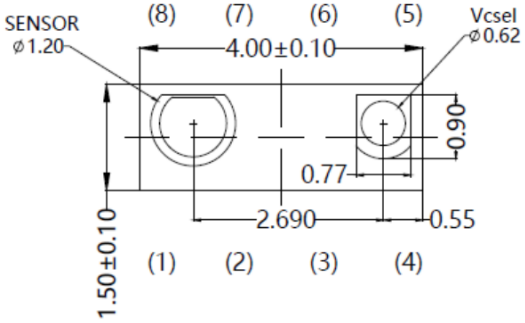
PART NO. : ZSMP4015-S20

REV: A / 0

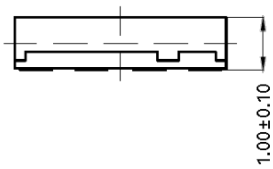
CUSTOMER'S APPROVAL : _____ DCC : _____

PACKAGE OUTLINE DIMENSIONS

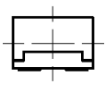
Top View



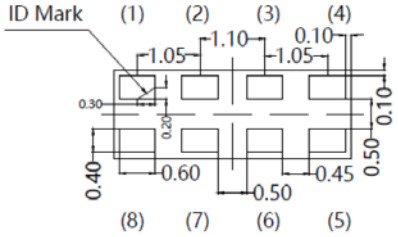
Front View



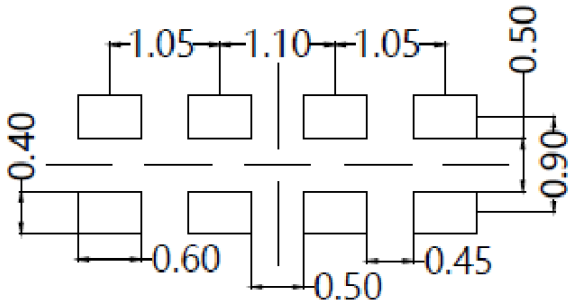
Right Side View



Bottom View



Pin-out	Name
(1)	VDD
(2)	SCL
(3)	GND
(4)	LEDA
(5)	LDR
(6)	NC
(7)	INT
(8)	SDA



Recommended pad size

Notes:

1. All dimensions are in millimeters.
2. Tolerance is ± 0.1mm (.004") unless otherwise noted.

Descriptions

The ZSMP4015-S20 provides both ambient light sensing (ALS) and proximity detection (PS) with IR VCSEL.
The ALS approximates human eye response to light intensity under a difference of lighting conditions and through a difference of attenuationmaterials.ZSMP4015G3 can detect the wide range illumination from the dark up to under direct sunlight. It also supports program hardware interrupt with interrupt with hysteresis to respond to events.
Proximity sensor part detects the human or object approach by reflection of IR VCSEL light.4015G3detection feature operates well from bright sunlight to dark rooms. The wide dynamic range also allows for operation in short distance detection behind dark glass such as a cell phone.

Features

1.1^2 C interface (Fast Speed Mode at400kHz/s)

2.Dedicated interrupt Pin

3.Supply Voltage Range from 1.7V to3.6V

4.Operating Temperature Range from -40°C to +85°C

5.Ambient Light Photo Sensor

1)Close to human eyes responsibility

2)Up to 16-bit Digital Output(0~65535)

3)Programmable Dynamic Range

4)Linear Output Code for DynamicRange Selection

5)Eliminate 50 /60 Hz Filter byProgrammable Integrated Time

6)Fluorescent light flicker immunity

6.Proximity Sensor

1)Selectable ADC Output, up to 16-bit

2)Auto calibration for sunlight

3)Programmable VCSEL DriverCurrent Output, up to 150mA

4)PS Integration Time Selection, PGAGain Selection and Pulse CountSelection

Applications

1.Cell Phone

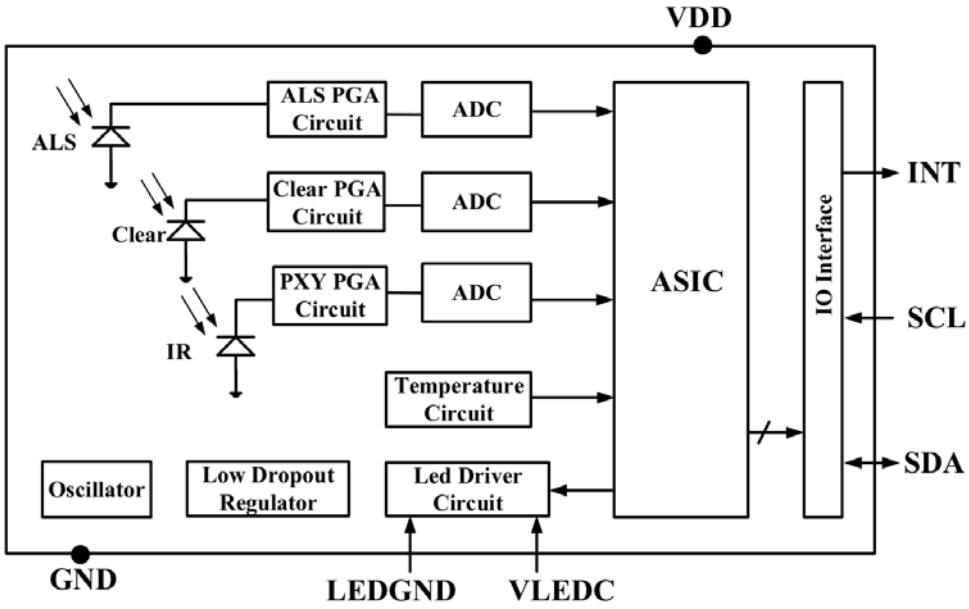
2.LCD display backlight control

3.Notebook/Monitor Security

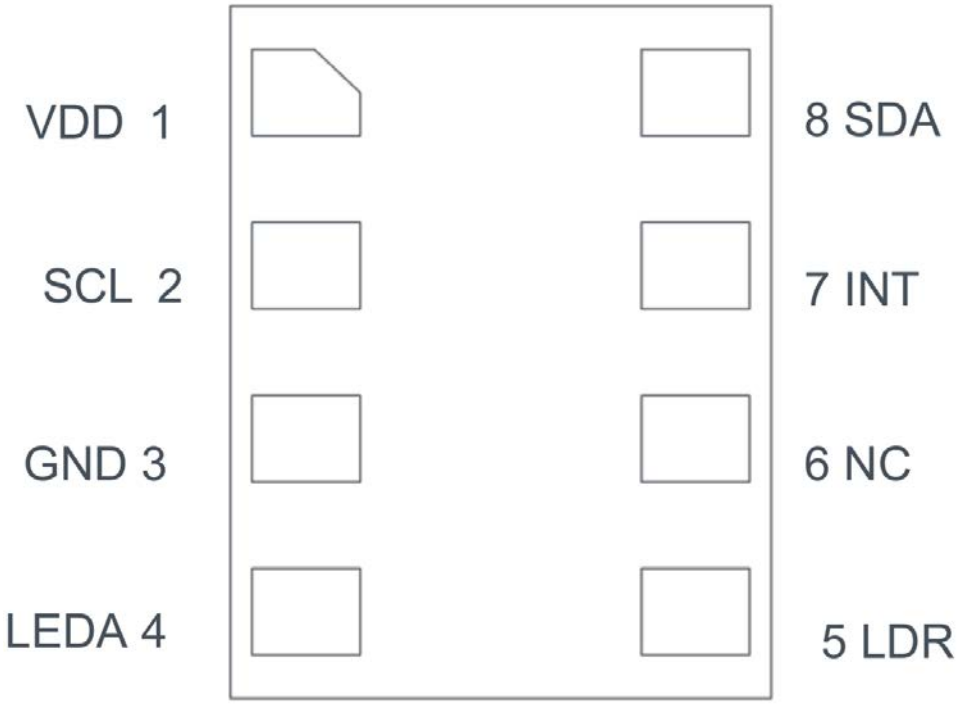
4.Automatic Menu Pop

5.Digital Camera light mete

- Block Diagram



- I/O Pins Configuration



Pin	1/O Type	Pin Name	Description
1	I	VDD	Power supply
2	I	SCL	1^2C serial clock line
3	P	GND	Ground
4	P	LEDA	Anode of the embedded lR LED, connect to power
5	P	LDR	IR LED driver pin connecting to the cathode of the internal lR LED
6		NC	No Connect
7	O	INT	Interrupt pin
8	I/O	SDA	1^2C serial data line

● Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply Voltage	VDD	4.5	V
1^2C Bus Pin Voltage	SCL,SDA ,INT	-0.2 to 4.5	V
1^2C Bus Pin Voltage	SCL,SDA ,INT	10	mA
LDR Pin Voltage	LEDA,LDR	-0.2V to VDD + 0.5V	V
Operating Temperature	Tope	-40 to +85	°C
Storage Temperature	Tstg	-45 to +100	°C
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 Operation Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage Note1	V_{DD}	1.7		3.6	V	
1^2C Bus Pin Voltage	V_{Bus}	1.62		VDD	V	$V_{Bus} \leq V_{DD}$
Operating Temperature	T_{ope}	-40		+85	°C	
1^2C Bus Input Low Voltage Note2	V_{IH_SCL}, V_{IH_SDA}	1.4			V	
1^2C Bus Input Low Voltage Note2	V_{IL_SCL}, V_{IL_SDA}			0.5	V	
SDA Output Low Voltage	V_{oL_SDA}	0		0.4	V	3mA sinking current
		0		0.6	V	6mA sinking current
INT Output Low Voltage	V_{OL_INT}	0		0.4	V	3mA sinking current

Notes.

1. The power supply needs to make sure the VDD slew rate at least 2V/ms. have power on reset function. When VDD drops below 1.2V under room temp, the IC will be reset automatically and enter the initial state. Then power back up at the requirement slew rate, and write registers to the desired values.
   A hardware reset method can be used. Set VDD=0 for 1 second or more. then power back up will same us power on status, and write registers to the desired values
2. The specs are defined under VDD=3.3V, T=25°C

● Electrical & Optical Specifications

Unless otherwise specified, the following specifications apply over the operating ambient temperature T=25°C, VDD = 3.3V, and measure the output current by white light LED.

Electrical Characteristics	Symbol	Min.	Typ.	Max.	Notes	Unit
Active Supply Current Note1	I_{DD}		140		EV=0, Note1 Default setting	μA
	I_{PD}		0.9		Sleep mode, Ev=0,12C inactive Note2	μA

Waiting Characteristics	Symbol	Min.	Typ.	Max.	Notes	Unit
Wait time unit	WUNIT		10			ms
Wait time number	WTIME	1		256		WUNIT

ALS Characteristics	Symbol	Min.	Typ.	Max.	Notes	Unit
Sensing Gain, relative to x1setting	PGA_ALS	4		400		
Unit of ADC integration time	INT_TIME	1		64	1T=1ms	T
Number of ADC integration time	ALSCONV	1		32		INT_TIME
Full Scale ADC counts		1023		65535		count
Dark ADC Count(White LED, EV=0)			1	3	PGA_ALS=200INT_ TIME=64TALSCONV=0	count
Sensitivity(White LED, EV=100 Lux)	Clear_CH	235	277	318	PGA _ALS=X100INT_ TIME=64TALSCONV=0	Count/LuX
	ALS_CH	28	33	38		Count/LuX

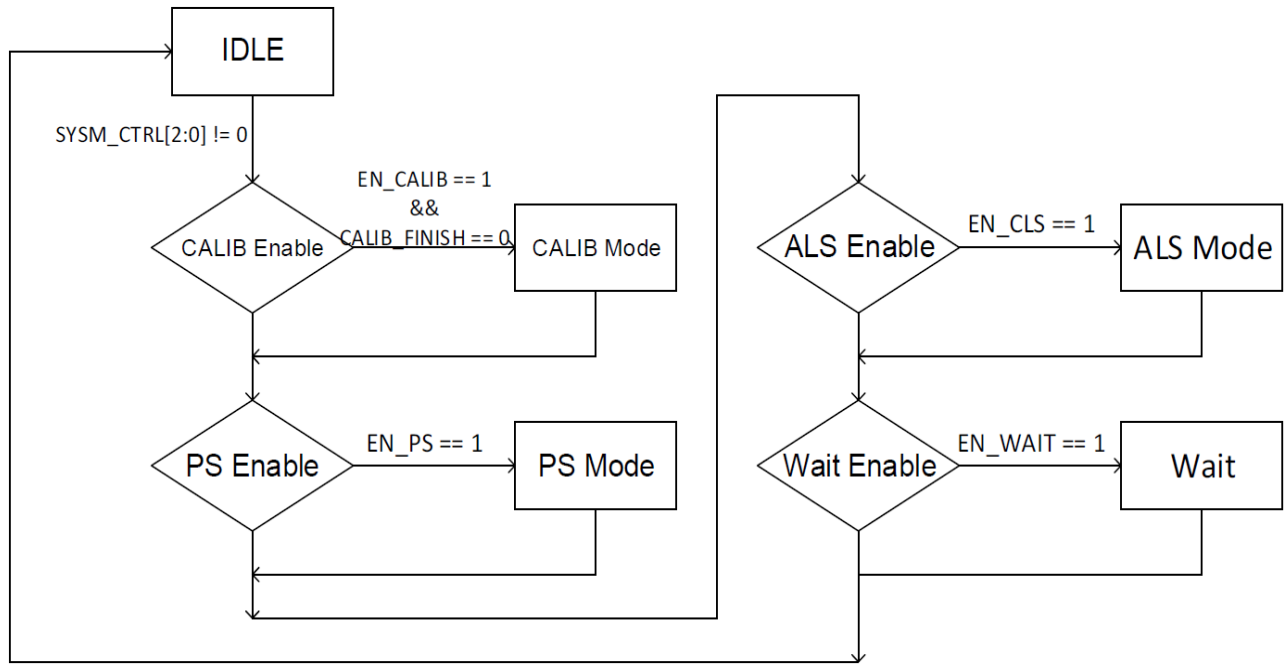
Notes1: The testing condition WTIME=12, INT_TIME=64T,ALSCONV=0.

PS Characteristics	Symbol	Min.	Typ.	Max.	Notes	Unit
Sensing Gain, relative to x1setting	PGA_PS	2		64		
Unit of ADC integration time	PSCONV		0.128			ms
Number of PSCONV		1		64		Unit
Full Scale ADC counts	FSC	255		65535		count
Sensitivity (10cm , gray card)			TBD			count
LED Driving Current	PLDR(TYPE SEL=0)	5.5		82	I step =5.5	mA
	PLDR(TYPE _ SEL=1)	14		146	I step=14	mA
IR Peak Wavelength			940			nm

Notes2: Brown Out Reset circuit disable.

State Machine

There are two operation mode ALS and PS. The state machine is shown below.



Typical Characteristics Curves

Unless otherwise specified, the following specifications apply over the operating ambient temperature T=25°C,VDD=3.3V

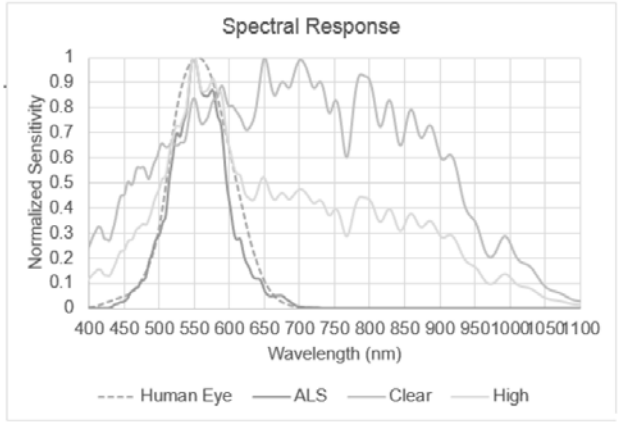


Fig. 1 ALS Spectral Response

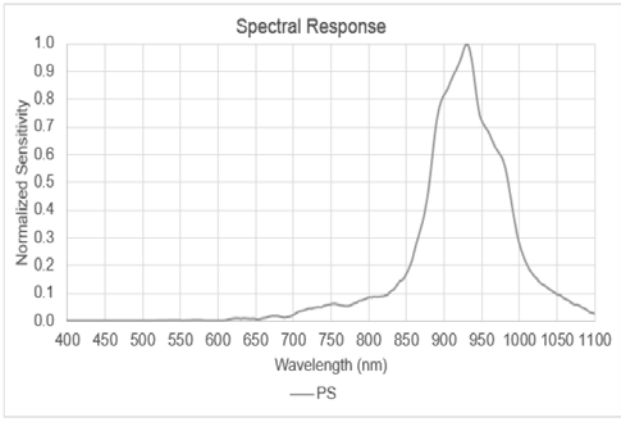


Fig. 2 PS Spectral Response

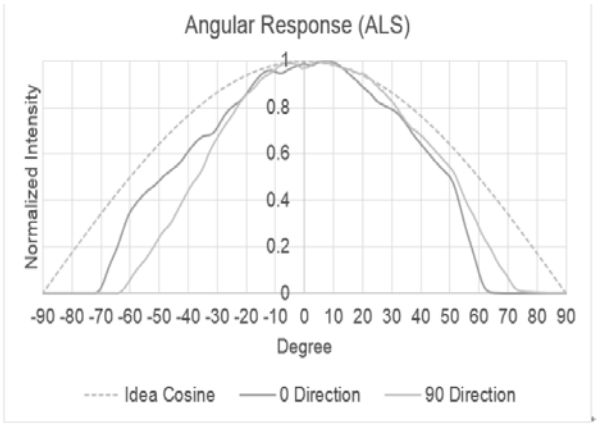


Fig. 3 ALS Angular Response

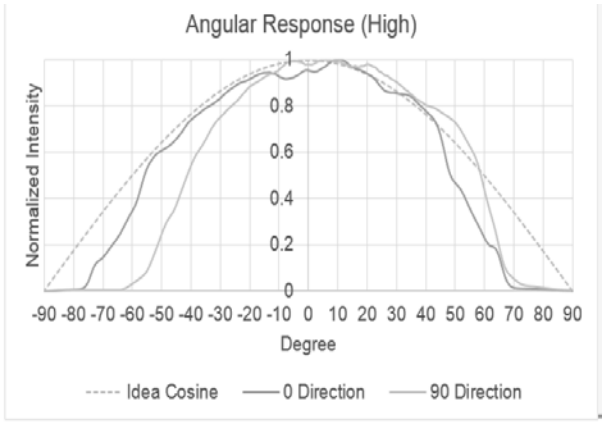


Fig. 4 High Sensitivity ALS Angular Response

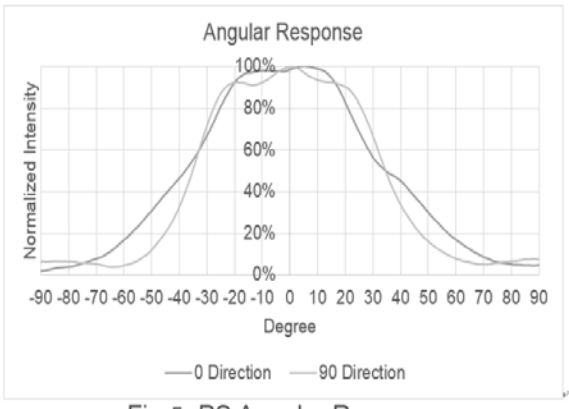


Fig.5 PS Angular Response

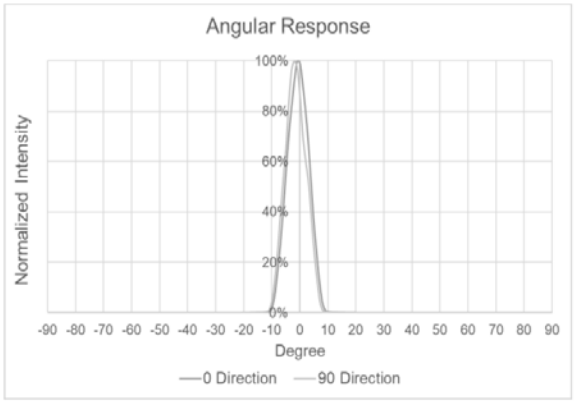


Fig. 6 IR VCSEL Angular Response

- 1²C Write Format

S	Slave Addr 7 Bit	W	A	Reg Addr 8 Bit	A	Data 8 Bit	A	P

- 1²C Block Write Forma

S	Slave Addr 7 Bit	W	A	Reg Addr 8 Bit	A	Data 8 Bit	A	…	A	Data 8 Bit	A	P

- 1²C Read Format

S	Slave Addr 7 Bit	W	A	Reg Addr 8 Bit	A	S	Slave Addr 7 Bit	R	A	Data 8 Bit	N	P

- 1²C Block Read Format

S	Slave Addr 7 Bit	W	A	Reg Addr 8 Bit	A	S	Slave Addr 7 Bit	R	A	Data 8 Bit	A	…	A	Data 8 Bit	N	P

Master to Slave	S Start Condition, 1 Bit
Slave to Master	P Stop Condition, 1 Bit
	W Write, Set 0 for write, 1 Bit
	R Read, Set 1 for read, 1 Bit
	A Acknowledge(ACK), Set 0, 1 Bit
	N Non acknowledge(NACK), Set 1, 1 Bit

1²C Slave Address and R/W bit

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

Register Set

The UCS148G3 is operated over the1²C 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	R/W	0X10	ALS/PS operation mode control, waiting mode control, SW reset
0X01	INT_CTRL	R/W	0X07	Interrupt pin control, interrupt persist control
0X02	INT_FLAG	R/W	0X80	Interrupt flag, error flag, power on reset(POR) flag
0X03	WAIT_TIME	R/W	0X00	Waiting time setting
0X04	ALS_CFG0	R/W	0X80	ALS analog gain setting
0X05	ALS_TIME	R/W	0X03	ALS integrated time setting
0X06	PS_GAIN	R/W	0X00	PS analog gain setting
0X07	LED_CTRL	R/W	0X01	LED setting
0X08	PS_CFG0	R/W	0XF0	PS PD select
0X09	PS_TIME	R/W	0X00	PS integrated time setting
0X0A	PS_FILTER	R/W	0XD0	PS Filter setting
0X0B	PERSISTENCE	R/W	0X11	ALS/PS persistence setting
0X0C	ALS_THRES_LL	R/W	0X00	ALS low interrupt threshold - LSB
0X0D	ALS_THRES_LH	R/W	0X00	ALS low interrupt threshold -MSB
0X0E	ALS_THRES_HL	R/W	0XFF	ALS high interrupt threshold -LSB
0X0F	ALS_THRES_HH	R/W	0XFF	ALS high interrupt threshold - MSB
0X10	PS_THRES_LL	R/W	0X00	PS low interrupt threshold - LSB
0X11	PS_THRES_LH	R/W	0X00	PS low interrupt threshold - MSB
0X12	PS_THRES_HL	R/W	0XFF	PS high interrupt threshold -LSB
0X13	PS_THRES_HH	R/W	0XFF	PS high interrupt threshold - MSB
0X14	PS_OFFSET_L	R/W	0X00	PS offset level -LSB
0X15	PS_OFFSET_H	R/W	0X00	PS offset level -MSB

0X16	INT_SOURCE	R/W	0X05	ALS/PS interrupt source
0X17	ERROR_FLAG	R/W	0X00	Error flag
0X1A	PS_DATA_L	R	0X00	PS output data - LSB
0X1B	PS_DATA_H	R	0X00	PS output data -MSB
0X1C	ALS_DATA_L	R	0X00	ALS channel output data -LSB
0X1D	ALS_DATA_L	R	0X00	ALS channel output data - MSB
0X1E	CLR_DATA_L	R	0X00	Clear channel output data - LSB
0X1F	CLR_DATA_H	R	0X00	Clear channel output data - MSB
0X20	HIGH_DATA_L	R	0X00	High sensitive channel output data -LSB
0X21	HIGH_DATA_H	R	0X00	High sensitive channel output data - MSB
0X25	CALIB_STAT	R	0X00	PS calibration status
0X27	CALIB_TARG	R/W	0X80	PS Sunlight calibration target
0X29	CALIB_CTRL	R/W	0X00	PS calibration control
0X2B	AUTO_CDAT	R	0X00	Automatic Sunlight calibration data
0X2C	MANU_CRDAT	R/W	0X00	Manual CR calibration data
0X2D	AUTO_CRDAT	R	0X00	Automatic CR calibration data
0X2E	PS_FILTER_THRES	R/W	0X10	PS FILTER Threshold
0XBC	PROD_ID_L	R	0X11	Product ID-LSB
0XBD	PROD_ID_H	R	0X45	Product ID-MSB

- SYSM_CTRL

0X00	SYSM_CTRL, System Control (Default = 0x10)							
BIT	7	6	5	4	3	2	1	0
R/W	SWRST	EN_WAIT	EN_FRST	EN_SUNALG	0	EN_CRCLIB	EN_PS	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.(Default)

1: Enable waiting function.

EN_FRST

0:Enable (Brown out Reset circuit enable). (Default)

1: Disable (Brown out Reset circuit disable)

EN_SUNALG

0:Disable photo diode compensation when sensor saturation.

1: Enable photo diode compensation when sensor saturation.(Default)

EN_CRCLIB:Enables CRCLlB function.

0:Disable crosstalk calibration function. (Default)

1:Enable crosstalk calibration function.

EN PS :Enables PS function.

0: Disable PS function.(Default)

1: Enable PS function.

EN_ALS :Enables ALS function.

0:Disable ALS function.(Default)

1: Enable ALS function

● INT_CTRL

0X01	Interrupt Pin Control (Default = 0x07)							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	PS_SYNC	ALS_SYNC	0	EN_CINT	EN_PINT	EN_AINT

PS_SYNC : Measurement is pended when PS interrupt is triggered. Until clear the interrupt thenstart the next measurement.

0:Disable pending PS function.(Default)

1: Enable pending PS function.

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_CINT : The CRCLlB interrupt (INT CRCLlB) flag can trigger the lNT pin to low.

0: Disable INT CRCLlB effect INT pin.

1: Enable INT CRCLlB effect lNT pin.(Default)

EN_PINT : The PS interrupt (INT PS) flag can trigger the lNT pin to low.
0: Disable lNT PS effect lNT pin.
1: Enable lNT PS effect INT pin. (Default)
EN_AINT : The ALS interrupt (lNT ALS) flag can trigger the INT pin to low.
0: Disable INT ALS effect lNT pin.
1:Enable INT ALS effect INT pin.(Default)

● INT_FLAG

0X02	INT_FLAG, System Control (Default = 0x80)							
BIT	7	6	5	4	3	2	1	0
R/W	INT_POR	DATA_FLAG	OBJ	0	0	INT_CRCLIB	INT_PS	INN_ALS

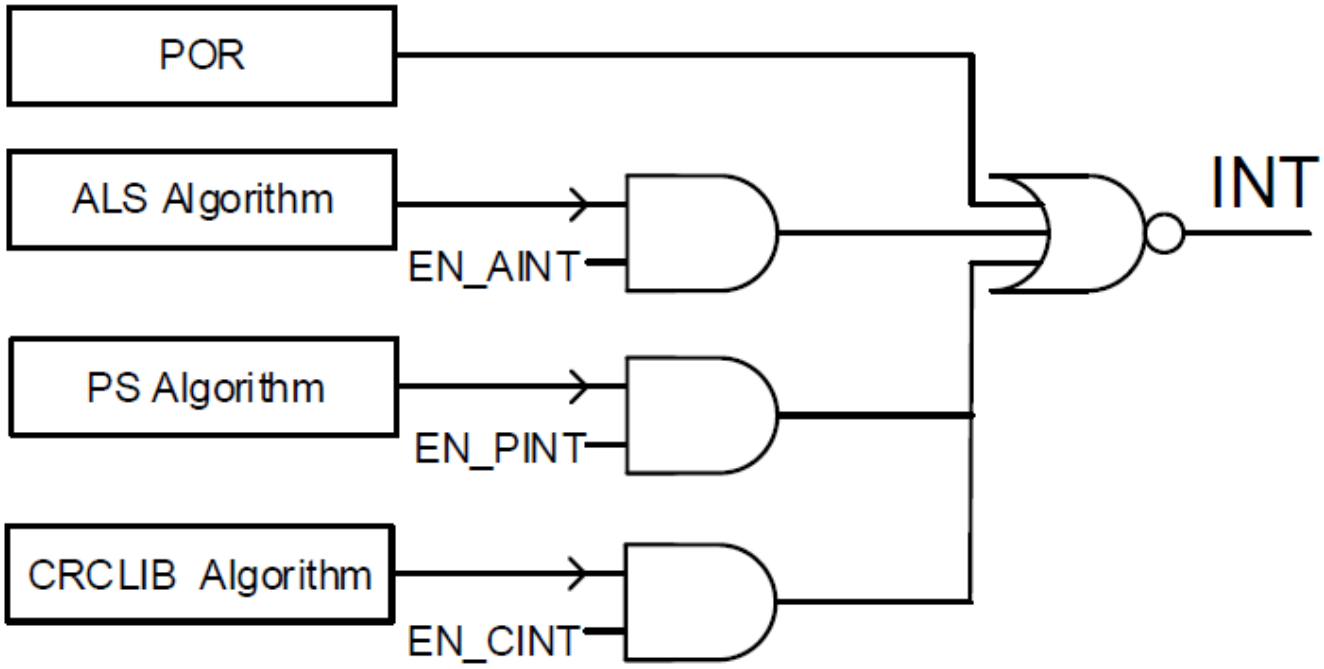
INT_POR : Power-On-Reset interrupt flag trigger the lNT pin when the flag sets to one. Write zero to clear the flag.
0:
1: This bit will be set to one when it satisfy one of the following conditions.
1)Power On
2)VDD < 1.4V
3)SWRST
DATA_FLAG : lt shows if any data is invalid after completion of each conversion cycle. This bit is read-only
0: Data valid.
1: Data invalid.
OBJ : Object Detection Bit. lt shows the position of the object. This bit is read only.
0:Object disappear.
1: Object appear.
INT_CRCLIB : CRCLlB Interrupt flag. When the crosstalk calibration function is done.
This flag will set to one. Write zero to clear the flag.
0: CRCLlB Interrupt not triggered or be cleared.
1: CRCLlB Interrupt triggered.
INT_PS : PS Interrupt flag. lt correlation with PS INT MODE, PS DATA and PS high/low threshold.
Writezero to clear the flag.
0:PS Interrupt not triggered or be cleared
1: PS Interrupt triggered.

INT_ALS : ALS Interrupt flag. It correlation with CH0/1 data and ALS high/low threshold. Write zero to clearthe 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 (ALS data, register 0x1E 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

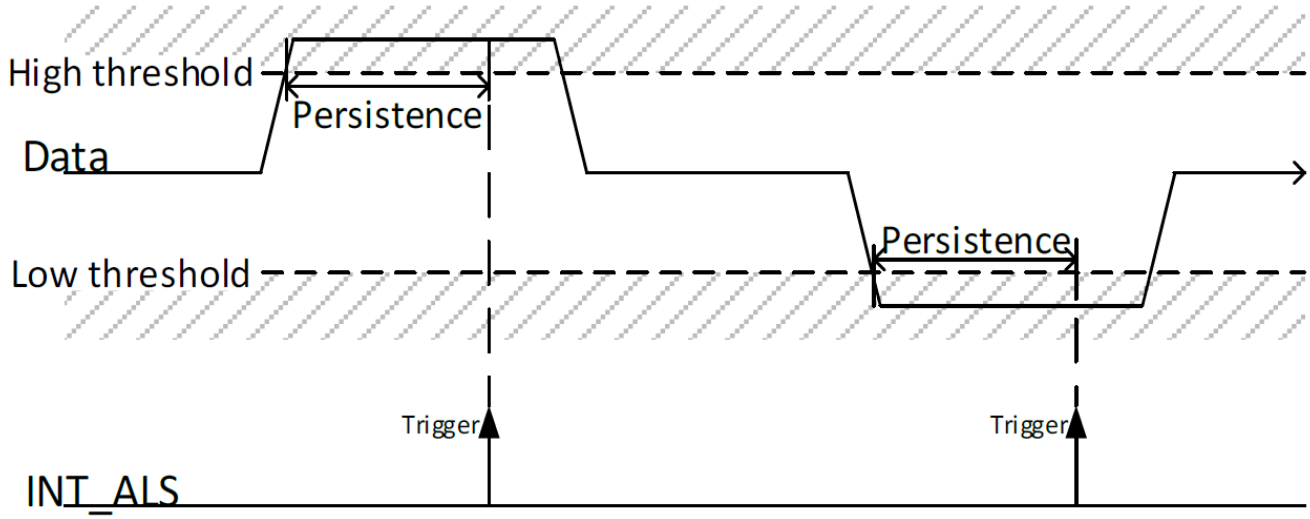
1.Rule of active interrupt: DATA>ALS THRES H or DATA < ALS THRES2.

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 reset3the interrupt counter.

4.If PRS ALS is set to zero, threshold will be ignored and DATA will meets the activeAinterrupt rule forcibly.



PS Interrupt Algorithm

Correlative register.

The Ps Interrupt (NT PS, register 0x02, bit1),

The PS Persistence (PRS PS, register 0x0B, bit4 to bit7),

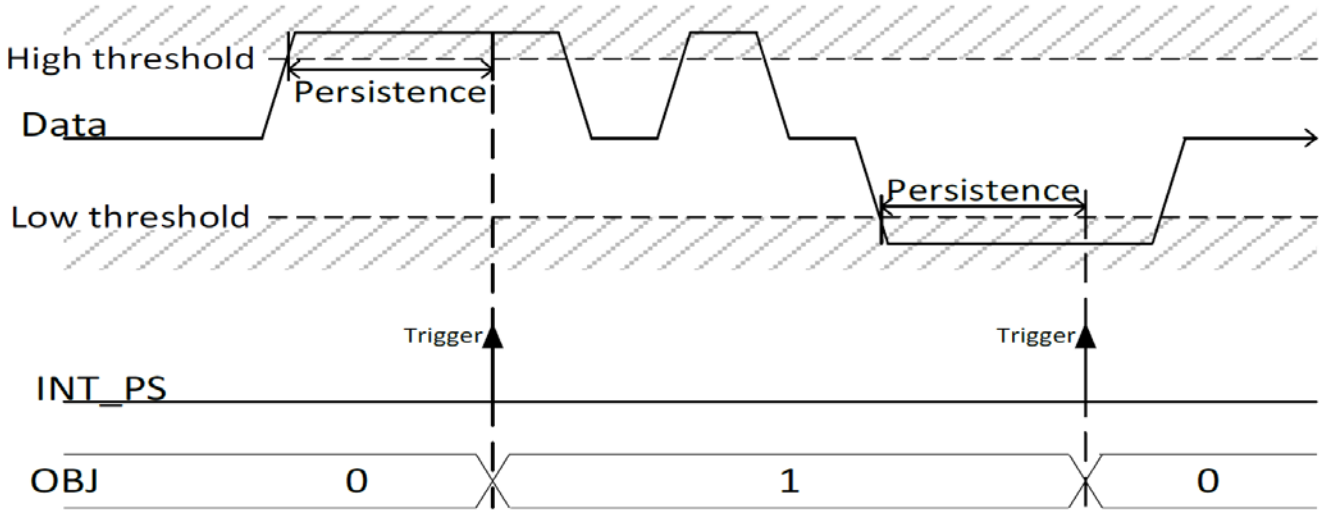
The PS Data (PS DATA, register 0x1A to 0x1B),

The PS Low Threshold (PS THRES L, register 0x10 to 0x11),

The PS High Threshold (PS THRES H, register 0x12 to 0x13)

●INT_PS triggered condition

1. Rule of active interrupt:
i. When OBJ is zero, PS_DATA > PS_THRES_H.
ii. When OBJ is one, PS_DATA < PS_THRES_L.
2. If PS_DATA meets the rule, the interrupt counter increases one.
If PS_DATA fails in the rule, the interrupt counter will be cleared.
3. When the counter value equal to PRS_PS, the OBJ flag will be inverted, INT_PS will be triggered, and clear interrupt counter.
4. If PRS_PS is set to zero, the threshold setting 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 10ms per time unit.
0x00:1 time unit.
0x01: 2 time units
……..
0xFF: 256 time units

● ALS_GAIN

0X04	ALS_GAIN, ALS analog gain (Default = 0x80)							
BIT	7	6	5	4	3	2	1	0
R/W	1	0	0	PGA_ALS				

PGA_ALS : ALS sensing gain
0x00:x1(Default)
0x01:x4
0x02:x20
0x04:x100
0x08:x200
0x10:x400

●ALS_TIME

0X05	ALS_TIME, ALS integrated time (Default = 0x03)							
BIT	7	6	5	4	3	2	1	0
R/W	ALSCONV					0	INT_TIME	

ALSCONV : This register controls the conversion time of AD converter at ALS mode (TALS), and theresolution of output data.
0x00:TALS =1 INT TIME(Default)
0x01:TALS =2 INT TIME
……
0x1f: TALS = 32 INT_TIME
INT_TIME：This register controls the integrated time.
0x0: 1 INT_TIME (T) = 1ms, the maximum count of output data is 1023.
0x1: 1 INT_TIME (4T) = 4ms, the maximum count of output data is 4095.
0x2: 1 INT_TIME (16T) = 16ms, the maximum count of output data is 16383.
0x3: 1 INT_TIME (64T) = 64ms, the maximum count of output data is 65535. (Default)
The conversion time of ALS function (TALS) is decided by ALSCONV and INT_TIME.

TALS= 1.782 + [4 ^ INT_TIME x (ALSCONV + 1)] x 1 (ms)

E.g.

Setting INT_TIME= 0x01 (4T UNIT) and ALSCONV = 0x01

The maximum count of output data is minimum of

[1024 x [4 ^ INT_TIME * (ALSCONV+1)] - 1 , 65535]

= [1024 x [4 * (1+1)] - 1, 65535].

●PS_GAIN

0X06	PS_GAIN, PS analog gain (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	PGAE_PS		PGA_PS					

PGAE_PS: Extra: PS sensing gain.

0x0: x1 (Default)

0x1: x2

0x2: x4

PGA_PS: PS sensing gain.

0x00: x1 (Default)

0x01: x2

0x02: x4

0x04: x8

0x08: x16

0x10: x32

0x20: x64.

●LED_CTRL

0X07	LED_CTRL, LED control(Default = 0x01)							
BIT	7	6	5	4	3	2	1	0
R/W	Range_SEL	0			IRDR-SEL			

TYPE_SEL： Driver Range select.

0x0: SEL1 (Default)

0x1: SEL2

IRDR_SEL： It configures the peak current of the internal LED driver.

RANGE SEL / IRDR SEL	SEL1	SEL2
0	0	0
1	5.5	14.3
2	11	29.7
3	16.5	44
4	22	59
5	27.5	74
6	33	88
7	38.5	102
8	44	117
9	50	132
10	55	146
11	60.5	No using
12	66	No using
13	72	No using
14	77	No using
15	82.5	No using

PS_CFG0

0X08	PS configure 0, PS PD select and Ps pulse count control(Default = 0xF0)							
BIT	7	6	5	4	3	2	1	0
R/W	EN_PD4	EN_PD3	EN_PD2	EN_PD1	0			

EN PD4, EN PD3, EN PD2, EN PD1 : It controls the sensing PD enable each.

0x0:Disable the sensing PD.

0x1:Enable the sensing PD. (Defult)

PS_TIME

0X09	PS_TIME,PS integrated time(Default =0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	0		PSCONV					

PSCONV : This register controls the conversion time of AD converter at PS mode (TPS), and the resolution of output data (PS DATA).

0x00:1 time unit (default).

0x01:2 time units.

……..

0x3F: 64 time unit.

The maximum count of output data is correlation with PGA PS and PSCONV setting. The minimum value of 65535 and [(256 x(2xPGA_PS)x(PSCONV+1))-1].

The conversion time of PS function (TPS) is decided by PSCONV

TPS=0.2+[2.5+0.256x(PSCONV+1)](ms)

PS_FILTER

0X0A	PS_FILTER, PS integrated time (Default = 0xD0)							
BIT	7	6	5	4	3	2	1	0
R/W	PS_PIPF_EN	PS_PIPF_NUM			0			

PS_PIPE_EN : This register sets pipeline filter function enable or not.

0x0: Disable pipeline filter function.

0x1: Enable pipeline filter function. (Default)

PS_PIPE_NUM : This register sets pipeline filter level.

0x0:2

0x1: 4

0x2: 8

……

0x5: 64 (Default)

PERSISTENCE

0X0B	PERSISTENCE,ALS, and PS persistence setting (Default = 0x11)							
BIT	7	6	5	4	3	2	1	0
R/W	PRS_PS				PRS_ALS			

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

0x0: Every PS conversion is done.

0x1:1 PS interrupt event is asserted.

……

0xF:15 consecutive PS interrupt events are asserted

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 theselected ALS data and ALS threshold value.
ALS _THRE_HL : ALS high interrupt threshold value, LSB. (Reg. 0xOE)
ALS_THRE_HH : ALS high interrupt threshold value, MSB. (Reg. OxOF)

● PS_THRES_L

0X10 0X11	PS_THRES_L, PS low interrupt threshold (Default =0x0000)							
BIT	7	6	5	4	3	2	1	0
R/W	PS_THRE_LL							
R/W	PS_THRE_LH							

This register sets the lower threshold value of PS interrupt. The interrupt algorithm compares theselected PS data and PS threshold value.

PS_THRE_LL :PS lower interrupt threshold value, LSB. (Reg. 0x10)

PS_THRE_LH :PS lower interrupt threshold value, MSB.(Reg. 0x11)

● PS_THRES_H

0X12 0X13	PS_THRES_H, PS high interrupt threshold (Default = 0xFFFF)							
BIT	7	6	5	4	3	2	1	0
R/W	PS_THRE_HL							
R/W	PS_THRE_HH							

This register sets the high threshold value of PS interrupt. The interrupt algorithm compares theselected PS data and PS threshold value.

PS_THRE_HL :PS high interrupt threshold value,LSB. (Reg. 0x12)

PS_THRE_HH :PS high interrupt threshold value, MSB. (Reg. 0x13)

PS_OFFSET

0X14 0X15	PS_OFFSET, PS offset level (Default =0x0000)							
BIT	7	6	5	4	3	2	1	0
R/W	PS_OFFSET_L							
R/W	PS_OFFSET_H							

This register used to calibrate the device's cross talk. The PS_DATA should be closed to zero with noobject, The PS_OFFSE is subtracted from the measured data before it output to PS_ DATA.

PS_OFFSET_L:PS calibrate offset value, LSB.(Reg. 0x14)

PS_OFFSET_H:PS calibrate offset value, MSB.(Reg. 0x15)

INT_SOURCE

0X16	INT_SOURCE,ALS interrupt source (Default = 0x05)							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	0	0	0	PINT_SRC	AINT_SRC	

PINT_SRC : This register sets to select the PS data for the PS Interrupt algorithm.

0x0: Select IR_DATA.

0x1: Select PS_DATA. (Default)

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

0x0: Select ALS_DATA.

0x1: Select CLR_DATA. (Default)

0x2:Select high sensitive data

●ERROR_FLAG

0X017	ERROR_FLAG, Error flag status							
BIT	7	6	5	4	3	2	1	0
R	PS_REDY	ALS_REDY	ERR_PS	0	0	ERR_HIGH	ERR_CLR	ERR_ALS

This register indicates the ALS/PS data status. If the ALS/PS data is outside of measurable range, the corresponding error flag will set to one. That also means the data is invalid.
Every ALS/PS conversion is done, the ALS/PS REDY flag will set to 1. it notifies the user that the sensor data is updated

●PS_DATA

0X1A 0X1B	PS_DATA, PS output data.							
BIT	7	6	5	4	3	2	1	0
R/W	PS_DATA_L							
R/W	PS_DATA_H							

The PS conversion result is written into PS_DATA
For insuring the data in the register comes the same measurement, the high byte data will be latched when the low byte data has being accessed until the high byte data has be read

●PS_DATA

0X1C 0X1D	ALS_DATA, ALS output data.							
BIT	7	6	5	4	3	2	1	0
R/W	ALS_DATA_L							
R/W	ALS_DATA_H							

The result of ALS sensor is written into ALS_DATA when ALS conversion is done.
For insuring the data in the register comes the same measurement, the high byte data wil be latchedwhen the low byte data has being accessed until the high byte data has be read.

- CLR_DATA

0X1E 0X1F	CLR_DATA, Clear channel output data.							
BIT	7	6	5	4	3	2	1	0
R/W	CLR_DATA_L							
R/W	CLR_DATA_H							

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

- HIGH_DATA

0X20 0X21	HIGH_DATA, High sensitive data.							
BIT	7	6	5	4	3	2	1	0
R/W	HIGH_DATA_L							
R/W	HIGH_DATA_H							

The high sensitive channel result is written into HGH_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 being accessed until the high byte data has be read.

● CALIB_STAT

0X25	CALIB_STAT,PS calibration status(Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	0	0	SAT_CRCLIB	SAT_CALIB	0	0	CRCLIB_FIN	CALIB_FIN

SAT_CRCLIB :It shows if crosstalk calibration bin-search result equal to 0xF

SAT_CALIB :It shows if PS calibration bin-search result equal to OxFF

CRCLIB_FIN : It shows if crosstalk calibration function is done. Write zero to clear the flag, and it will do crosstalk calibration function again at next conversion.

CALIB_FIN : It shows if PS calibration function is done. Write zero to clear the flag, and it will do PS calibration function again at next conversion

● CALIB_TARG

0X27	CALIB_TARG, PS Sunlight calibration target (Default = 0x80)							
BIT	7	6	5	4	3	2	1	0
R/W	CALIB_TARG							

This register sets calibration result target value. Let result data between 0 and setting

● CALIB_CTRL

0X29	CALIB_CTRL,PS calibration control (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	0				CACLIB_BIN_SEL	0	0	0

CRCLIB_BIN_SEL:It select crosstalk calibration bin-search data source

0x0: Automatic calibration (Default)

0x1: Manual

- AUTO_CDAT

0X2B	CALIB_TARG, PS Sunlight calibration target (Default = 0x80)							
BIT	7	6	5	4	3	2	1	0
R/W	AUTO_CDAT							

The automatic calibration data is setting by chip to do sunlight calibration. When calibration function isfinished, the calibration bin-search data will show on this register.

- MANU_CRDAT

0X2C	MANU_CRDAT,Manual crosstalk calibration data							
BIT	7	6	5	4	3	2	1	0
R/W	MANU_CRDAT							

The manual crosstalk calibration data is setting by user to do crosstalk calibration.

- AUTO_CARAT

0X2D	AUTO_CRDAT,Automatic crosstalk calibration data.							
BIT	7	6	5	4	3	2	1	0
R/W	AUTO_CRDAT							

The automatic calibration data is setting by chip to do crosstalk calibration. When calibration functionis finished, the calibration data will show on this register.

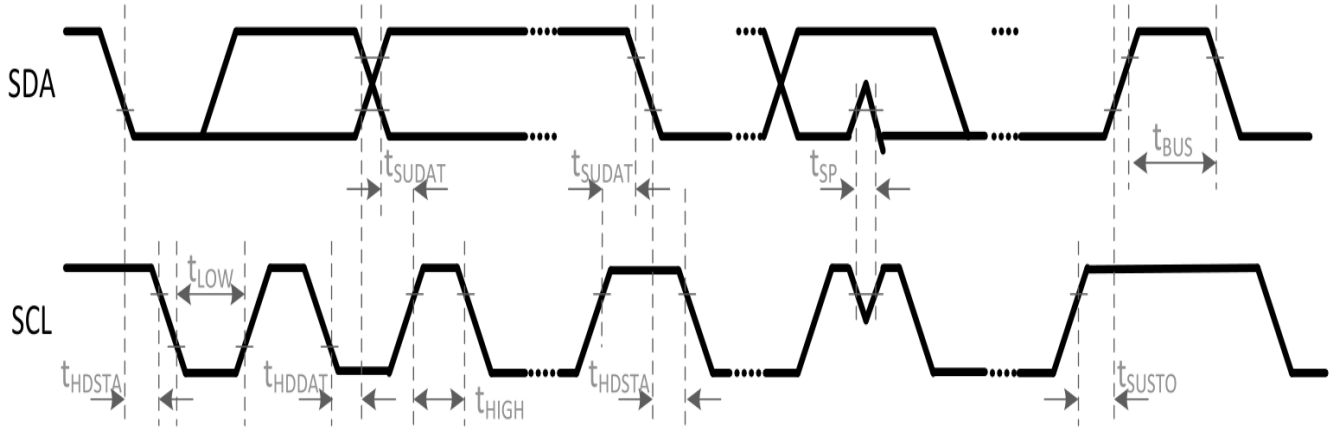
PS_FILTER_THRE

0X2E	PS_FILTER_YHRE,PS filter threshold (Default = 0x10)							
BIT	7	6	5	4	3	2	1	0
R/W	PS_PIPE_THRE							

This register sets the filter threshold that controls the slew rate of the filter When the PS data is large or less than before data over threshold, the filter will update to the new PS data

1²C Interface Timing Characteristics

This section wil describe the protocol of the 1²C bus. For more details and timing diagramsplease refer to the l2C specification.

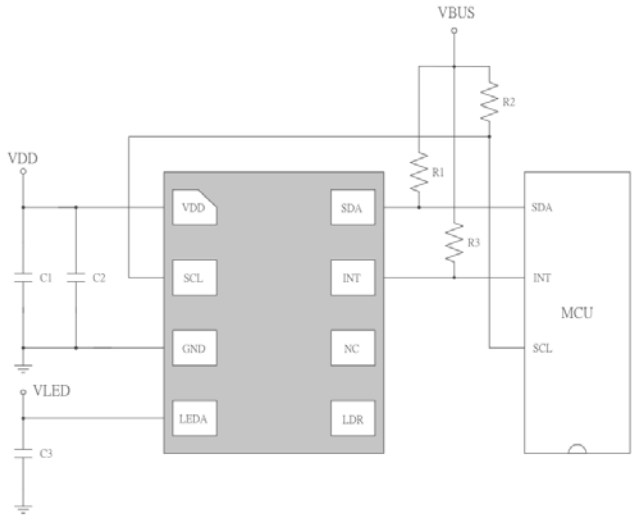


Parameter (*)	Symbol	Fast mode		Unit
		Min	Max	
SCL clock frequency	f_{SCL}	100	400	kHz
Bus free time between STOP conditionand START condition	t_{BUS}	1.3	--	μs
LOW period of the SCL clock	t_{Low}	1.3	--	μs
HIGH period of the SCL clock	t_{HIGH}	0.6	--	μs
Hold time (repeated) START condition	t_{HDSTA}	0.6	--	μs
Set-up time (repeated) START condition	t_{SUSTA}	0.6	--	μs
Set-up time for STOP condition	t_{susTO}	0.6	--	μs
Data hold time	T_{HDDAT}	50	--	ns
Data set-up time	t_{sSUDAT}	100	--	ns
Pulse width of spikes which must besuppressed by the input filter		0	50	ns
Rise time of both SDA and SCL signals		20xVDD/5.5	300	ns
Fall time of both SDA and SCL signals		20xVDD/5.5	300	ns

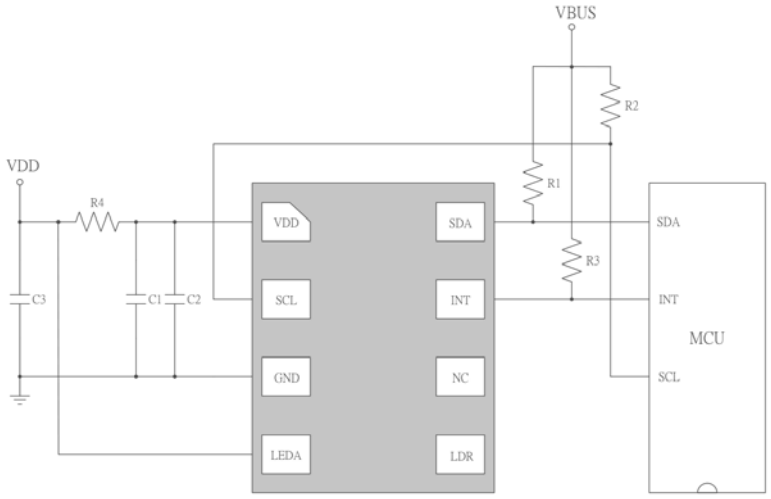
Specified by design and characterization; not production tested.

All specifications are at V_{Bus} = 3.3V, T_{ope}=25°C, unless otherwise noted.

●Application Circuit Separate Power Supplies



●Single Power Supply

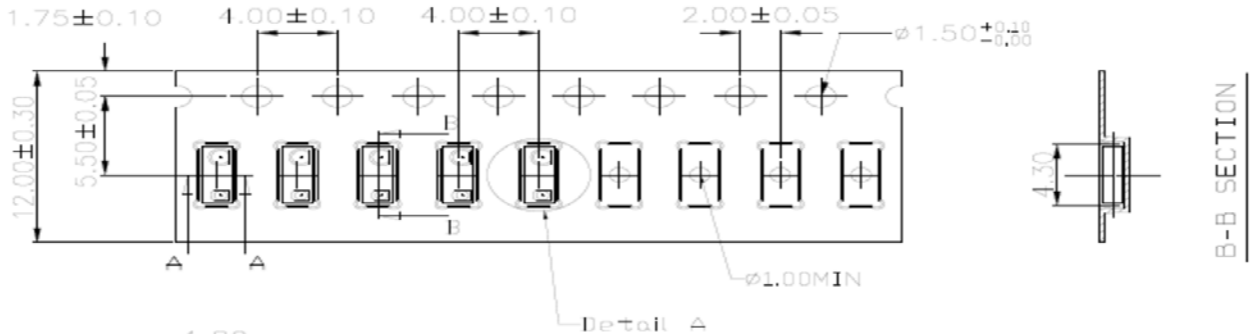


The capacitors (C1, C2) are required for sensor power supply. The capacitors should be placed as close as possible to the device. The high frequency AC noises can be shunted to the ground by the capacitors. The transient current caused by digital circuit switching also can be handled by the capacitors.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

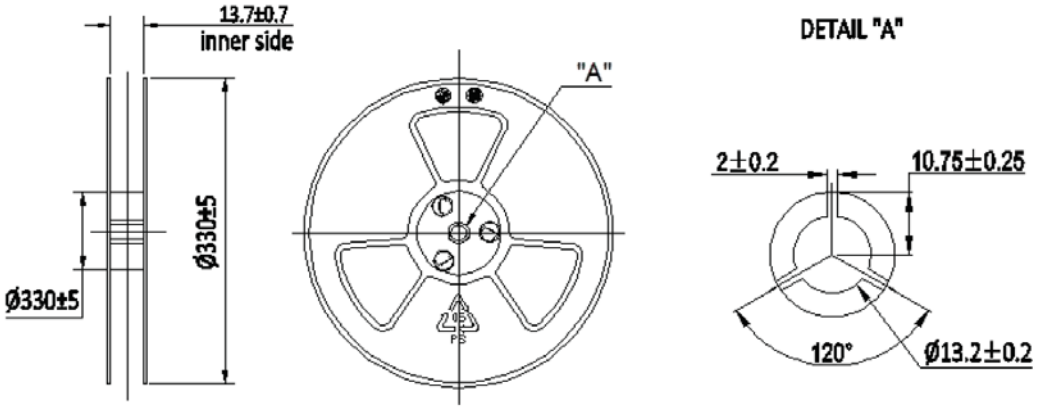
The capacitors (C3) is required for LED power supply. A typical value 2.2uF is used. The extra resistor (R4) is required when using single power supply. A typical value 22Ω is used.

The pull-up resistors (R1, R2) are reguired for 1²C communication. At fast speed mode (400kHz/s) and VBUS = 3V, 1.5k0 resistors can be used. The pull-up resistor (R3) is also required for the interrupt, atypical value between 10 kΩ and 100 kΩ can be used.

- Packaging

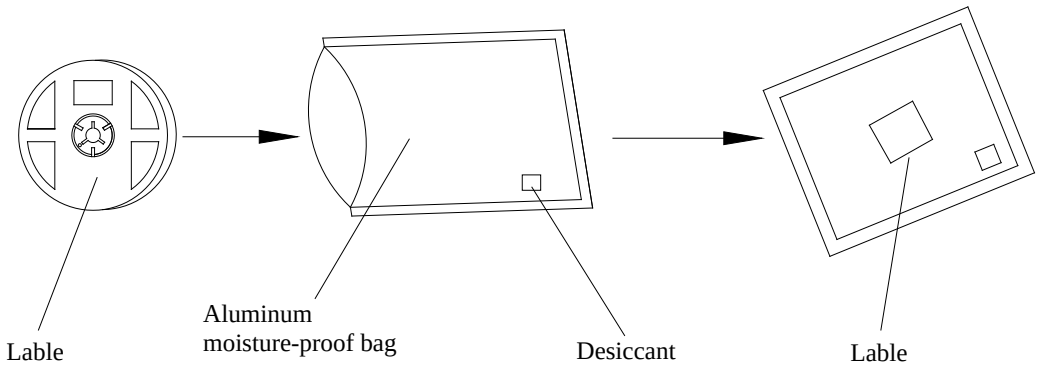


Note: Tolerance unless mentioned is ±0.1mm; Unit = mm

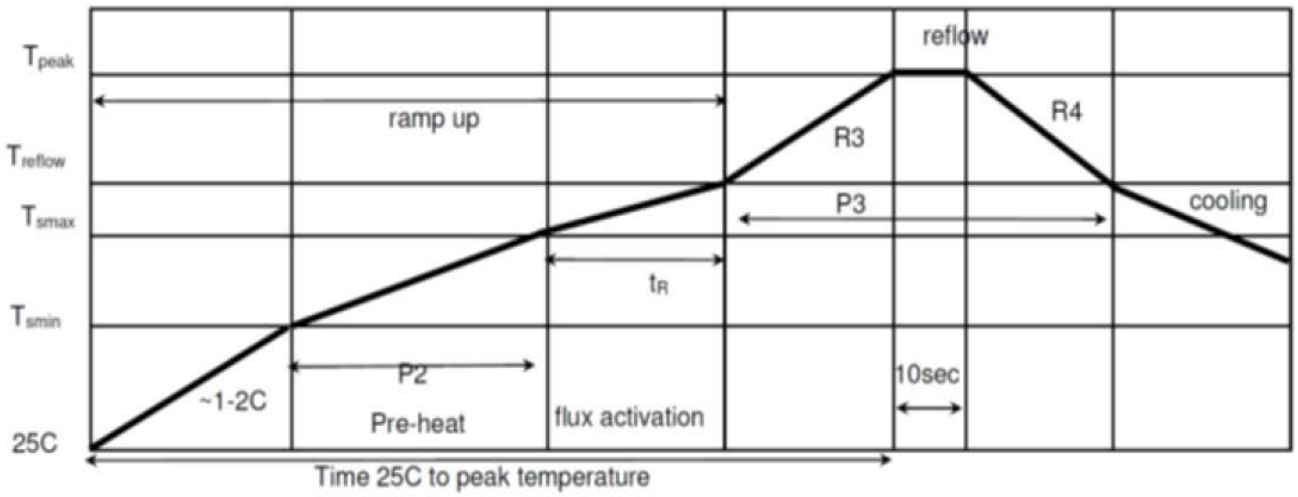


Carrier Tape Dimensions: Loaded Quantity 3000 pcs Per Reel.

- Moisture Resistant Packaging



- Welding requirements



	Peak temperature (Tpeak)	255-260C(max); 10s0C
Pre-Heat	Temperature min (Tsmin) Temperature max (Tsmax) P2: (Ts min to Ts max)	150C 2C/sec 150C-217C 100s to 180s 90-110s
Time maintain above	Temperature (Tresow) Time (P3) R3 slope (from 217C -> peak) R4 slope (from peak ·> 217C)	217C 60-90sec 2C/sec [typ] -> 2.5C/sec (max).1.5C/sec typ]-> .4C/sec (max)
	Time to peak temperature	480s max
	Cooling down slope (peak to 217C)	2.4C/ sec

storage instructions

ZSMP4015-S20 is supplied in the form of sealed moisture-proof bags. The humidity sensitivity level of the device is3(MSL3).Its storage should follow the followinginstructions:
Humidity Sensitivity During the welding process, the moisture absorbed by the device during packaging will adverselyaffect the optical characteristics of the device after being released and evaporated. In order to ensure that thehumidity in the package is as low as possible, each device should be baked before drying and packaging, Dry packagingadopts sealed aluminized molsture-proor bags to protect devices from enyronmental humidity during transportatiorand

storage Shelf life

When the sealed moisture-proof bag is not opened, the shelf life of the device under the following storage conditions is 12months (calculated from the date marked on the bag)
1.Shelf life: 12 months
2.Ambient temperature: < 40°C
3.Relative humidity:<90%
If the shelf life exceeds 12 months, or the storage condition of the humidityindicator card display device hasexceeded the allowable humidity range, it is necessary to bake the device

again.Workshop life

ZSMP4015-S20 has a humidity sensitivity level of MsL3, so the workshop life of the device after it is taken out of themoisture-proof bag is 168 hours from the opening of the moisture-proof bag, provided that it is stored under the followingconditions:
1.Workshop life: 168 hours
2.Ambient temperature: < 30°C
3.Relative humidity: < 60% If it exceeds the service life ofthe workshop or the abovetemperature/humidity conditions, the parts must be baked again before reflow soldering or dry packaging.

Baking standard

1.Bake at 125±5°C for 8 hours

2.Products cannot be baked directlyin the carrier tape;

3. Avoid excessive vibration or impact, and prevent serious deformation or damage of packaging materials.