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1. Abstract

GP2AP080C00F is RGB color sensor and proximity sensor with function ambient light sensing and proximity sensing by setting register.

Proximity sensor (PS) mode: Judgment result of object existence can be referred by reading register value(14bit) via I^{2}C bus interface.INT terminal can be changed either interrupt output or sensing result output (detection/non-detection status) by setting register in PS mode.

RGB color sensor (RGB) mode: Detection result of ambient light can be referred by reading register value(16bit) via I^{2}C bus interface. INT terminal can be changed interrupt output by setting register in RGB mode.

This product is possible to operate both PS and RGB modes alternately.

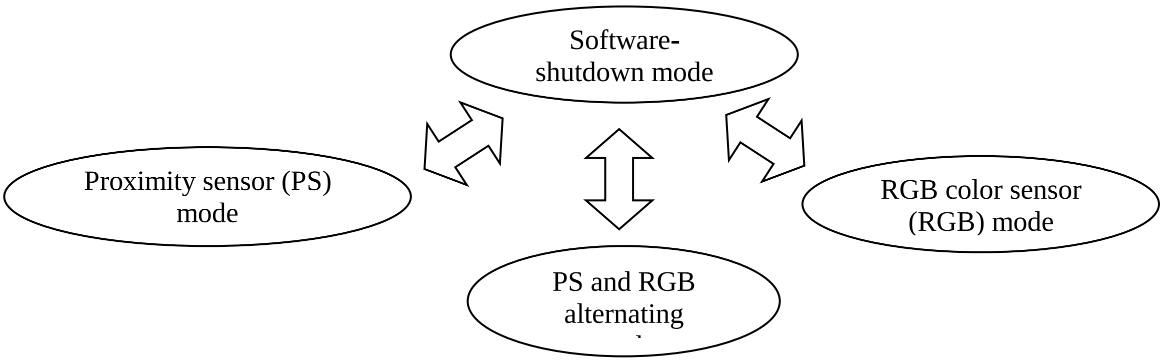


Fig.1 Operating mode of GP2AP080C00F

1.1. Features

- **Design**

  This product is composed of following two chips in one package, which is IC with a built-in photodiode (PD) (Clear (visible and infrared) photodiode and Infrared photodiode) for ambient light sensors and proximity sensors , and infrared LED.

  Achieving Small all-in-one package by Doubly-integrally-molded, transparent resin and light shield resin.

  Spectral sensitivity of the human eye without infrared light effects can be obtain by calculating RGB and Clear Photodiode.

- **I^{2}C bus interface**

  This product has 7bit slave address adherence to I^{2}C bus interface and can change register value for each function via I^{2}C bus.

- **INT terminal setting**

  INT terminal can be changed either interrupt output or sensing result output (detection/non-detection status) by setting register in PS mode. RGB mode has only interrupt output setting.

- **Power save mode**

  Software-shutdown /Hardware-shutdown

1.2. I²C bus interface

This product has 7bit slave address adherence to I²C bus interface and can change register value for each function via I²C bus. Besides, illuminance detection result and judgment result for detection/non-detection status can be read via I²C bus.

Table 1. Terminals for I2C bus interface are as follows.

Pin Name	Description
SCL	I²C Clock
SDA	I²C Data bus

Basic data format are as follows.

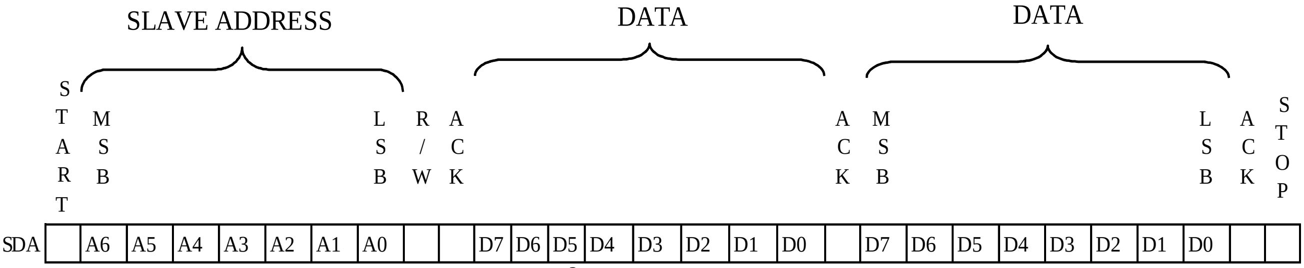


Fig.2 I²C Basic data format

DATA: Data which write into internal register/read from internal register.

SLAVE ADDRESS：

Table 2. I²C slave address

ADDRESS	A6	A5	A4	A3	A2	A1	A0	R/W
	0	1	1	1	0	0	1	X

R/W：Read:X=1, Write:X=0

1.2.1. Write Format

Write value in register and enable to write the next address sequentially after writing data. Data writing will be end with inputting stop-condition.

WordAddress:81H　PROX, FLAG_P and FLAG_A register in 81H are read only.

WordAddress:90H～99H　D0～D4 registers from 90H to 99H are read only.

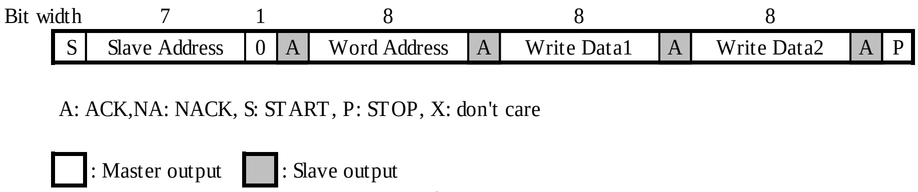


Fig.3 I²C write format

1.2.2. Read Format

Enable to read data in register. Following address can be read sequentially by inputting ACK after reading data. Reading data will be stopped by inputting NACK.

Stop-condition after setting Word address can be deleted since it corresponds to repeat-start-condition. Reading read data is done by not opening I²C bus interface.

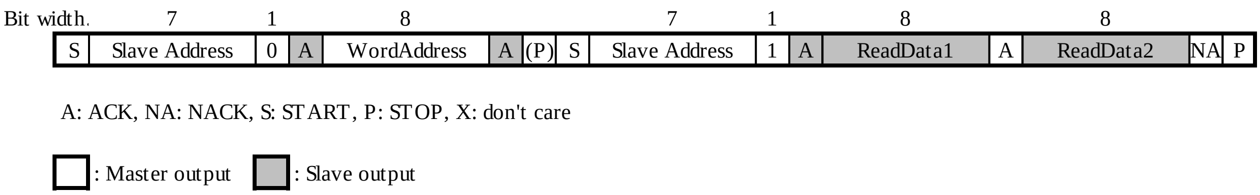


Fig.4 I²C read format

1.2.3. Others and Notes

This product doesn’t support Clock-stretch function and General-call-address function.

2. Recommended operating mode/Procedure of register setting

When the PS mode and RGB mode switch, please shut down and switched again.

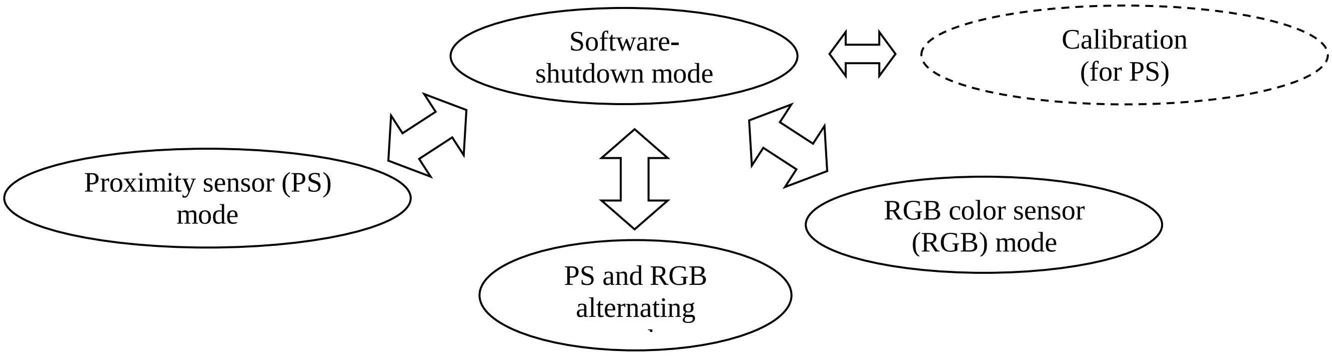


Fig.5 Recommended operating mode

2.1. Proximity sensor(PS) mode

The device can detect proximity objects by which integrates incident light in IR(infrared) photodiode during the time without emission of LED (LED off) and the time with emission of LED (LED on) in order to eliminate the influence of ambient light.

Below is an example of PS mode (Average consumption current is typical 0.6mA.)

Table 3. Example of setting for PS mode

ADDR	Register value		Register Setting	Example	
	bite	Hex			
81h	-	-	-	-	
82h	0000_0000	00h	PIN[1:0]=00 INTTYPE=0	Prox mode Level interrupt	
83h	0000_0011	03h	INTVAL[2:0]=011	Interval time 30msec	
84h	-	-	-	-	
85h	0001_0011	13h	RES_P[1 :0]=01	12bit	
86h	0010_0100	24h	IS[2:0]=010 SUM[2]=1	IS=82mA LED Pulse x32	
87h	0010_0010	22h	PRST[2:0]=010	PRST 2cycle	
88h 89h	1010_0011 0000_0000	A3h 00h	PL[13 :0]=106	Loff=115mm	TBD
8Ah 8Bh	1101_0111 0000_0000	D7h 00h	PH[13 :0]=156	Lon=100mm	TBD
8Ch 8Dh	0000_0000 0000_0000	00h 00h	OS_D0[13 :0]=d 00		
B3h	0000_0001	01h	-		
80h	1010_0000	A0h	OP[3]=1 OP[2:0]=010	Active PS mode	

Please enter address 80h in the end after setting 81H to 8DH and B3h.

Proximity sensing result can be read at D0[13:0] register through I^2Cbus interface.

The device outputs interrupt signal or detection/non-detection status on INT terminal in which case D0[13:0] exceed/fall below judgment threshold level(PH[13:0]/PL[13:0]) set before sensing operation.

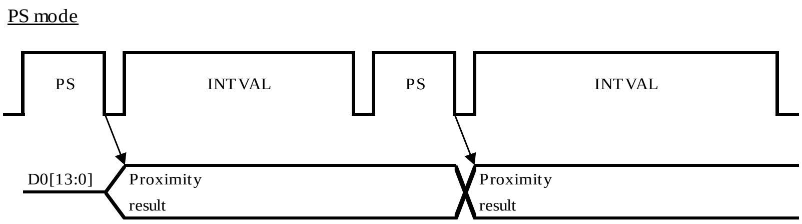


Fig.6 Output results for PS mode

2.2. RGB color sensor (RGB) mode

There are 4 photodiodes, CLEAR,Red,Green,Blue photodiodes in this sensor. Illuminance value can be obtained by calculation from RGB data.

Below is an example of RGB mode. (Average consumption current is typical 0.15mA.)

Table 4. Example of setting for RGB mode

ADDR	Register value		Register setting	Example	
	bite	Hex			
81h	-	-			
82h	-	-			
83h	0000_0000	00h	INTVAL[2 :0]=000	Interval time 0msec	
84h	0001_0001 0001_0101 0001_1110	11h 15h 1Eh	RES_A[1 :0]=01 GAIN_A[3 :0]= 0001⇔0101⇔1110	16bit x185⇔x16⇔x1 gain	Maximum detectable gain(RGB)*1
80h	1001_0000	90h	OP[3]=1 OP[2:0]=001	Active RGB mode	

*1 The gain (×185 or ×16 or ×1) is switched according to the D1 data.

Please enter address 80h in the end after setting 81H to 84H.

RGB color sensing results can be read at D1[15:0],D2[15:0],D3[15:0],andD4[15:0] register through I^2C bus interface.

The device continues to execute integration operation until set measuring time (30msec, recommended) passes, and then outputs the results of CLEAR photodiode at D1[15:0] register ,Red photodiode at D2[15:0] register ,Green photodiode at D3[15:0] register and Blue photodiode at D4[15:0] register.

Illuminance value can be obtained by some calculation using D1[15:0] and D4[15:0].

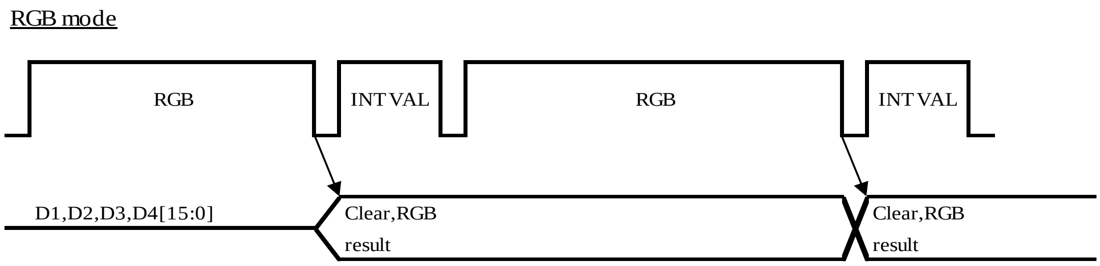


Fig.7 Output results for RGB mode

The results of illuminance(Ya) and color temperature(CCT) can be obtained by some calculation using D1[15:0], D2[15:0], D3[15:0] and D4[15:0].

$$Xa = \alpha\_x*D2[15:0] + \beta\_x*D3[15:0] + \gamma\_x *D4[15:0] + \delta\_x *D1[15:0]$$
$$Ya = \alpha\_y*D2[15 :0] + \beta\_y*D3[15 :0] + \gamma\_y *D4[15 :0] + \delta\_y *D1[15 :0]$$
$$Za = \alpha\_z*D2[15 :0] + \beta\_z*D3[15 :0] + \gamma\_z *D4[15 :0] + \delta\_z *D1[15 :0]$$
$$X = Xa / (Xa + Ya + Za)$$
$$Y = Ya / (Xa + Ya + Za)$$
$$n = (X - 0.332)/(0.1858 - Y)$$
$$CCT = 449*n*n*n + 3525*n*n + 6823.3*n + 5520.33$$
$$Ratio = (D2[15 :0] + D3[15 :0] + D4[15 :0]) / D1[15 :0]$$

α,β,γ and δ factor are decided by ratio.

These factors are shown below in the case of no panel.

These factors might be necessary to be adjusted according to the case panel in use.

Table 5. α , β , γ , δ factor for illuminance calculation (*TBD)

Ratio	α_x α_y α_z	β_x β_y β_z	γ_x γ_y γ_z	δ_x δ_y δ_z
Ratio ≦ 1.4	0.7983 -0.0311 -0.4981	-0.9976 0.0205 -0.4881	-1.1084 -0.7812 0.4881	1.3077 0.7918 0.4981
1.4 ＜ Ratio ≦ 2.8	0.7738 -0.0400 -0.4981	-0.9731 0.0293 -0.4881	-1.0839 -0.7723 0.4881	1.2832 0.7830 0.4981

2.3. Proximity sensor(PS) and RGB color sensor (RGB) alternating mode

This product is possible to operate both PS and RGB modes alternately.
Below is an example of PS mode and RGB alternating mode (Average consumption current is typical 0.6mA.)

Table 6. Example of setting for PS and RGB alternating mode

ADDR	Register value		Register setting	Example	
	bite	Hex			
81h	-	-			
82h	0000_0000	00h	PIN[1:0]=00 INTTYPE=0	Prox mode Level interrupt	
83h	0000_0000	00h	INTVAL[2 :0]=000	Interval time 0msec	
84h	0001_0001 0001_0101 0001_1110	11h 15h 1Eh	RES_A[1 :0]=01 GAIN_A[3 :0]= 0001⇔0101⇔1110	16bit x185⇔x16⇔x1 gain	Maximum detectable gain(RGB)*1
85h	0001_0011	13h	RES_P[1:0]=01	12bit	
86h	0010_0100	24h	IS[2:0]=010 SUM[2]=1	IS=82mA LED Pulse x32	
87h	0010_0010	22h	PRST[2:0]=010	PRST 2cycle	
88h 89h	1010_0011 0000_0000	A3h 00h	PL[13 :0]=106	Loff=115mm	TBD
8Ah 8Bh	1101_0111 0000_0000	D7h 00h	PH[13 :0]=156	Lon=100mm	TBD
8Ch 8Dh	0000_0000 0000_0000	00h 00h	OS_D0[13 :0]=d 00		
B3h	0000_0001	01h	-		
80h	1011_0000	B0h	OP[3]=1 OP[2:0]=011	Active PS and RGB mode	

*1 The gain(×185 or ×16 or ×1) is switched according to the D1 data.
Please enter address 80h in the end after setting 81h to 8Dh and B3h.

In PS and RGB alternating mode, the way of detection is as follows;

[1]In LED on/off period, this device store a signal charge which is subtracted LEDoff period charge from LEDon period charge automatically. (Recommend setting for SUM[2] is 32times of LED pulses.)

[2]In Count period, this device convert from a signal charge to digital value.
(Recommend setting for RES_P[1:0] is 12bit resolution.)

[3]Then, obtain detection result by subtracting the influence of ambient light. By using this value, proximity sensing judgment is done if reflective object is there or not.

[4] The device integrates incident light in CLEAR, Red, Green, Blue photodiode during a set period (recommended value:30msec), and then outputs the detection results to D1[15:0],D2[15:0],D3[15:0] and D4[15:0] respectively.

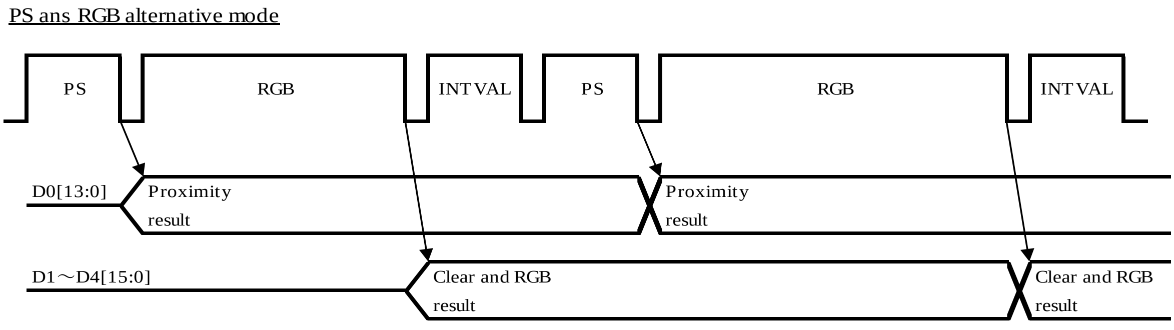


Fig.8 Output results for PS and RGB alternating mode

2.4. Shutdown mode

Control power supply to the circuit. LED drive circuit is always off in shutdown mode.
After power on, start with shutdown.
Below is an example of shutdown mode. (Average consumption current is typical 0.003mA.)
If you shut down, the INT terminal states are maintained. If the INT terminal is L level, due to the increased power consumption, it is recommended that you clear the interrupt. Please do not clear address 81H_0bit.

Table 7. Example of setting for Shutdown mode

ADDR	Register value		Register Setting	Example	
	bite	Hex			
80h	0000_0000	00h	OP[3:2]=00	Shutdown	
81h	0000_0000	00h		CLEAR	

2.5. Calibration

The device can use calibration function for PS mode to improve optical crosstalk.
The calibration function adjusts Proximity results closer to the target count.
Please set the calibration setting almost same way as the proximity setting(PS mode).

Below is an example of Calibration mode

Table 8. Example of setting for Calibration mode

ADDR	Register value		Register Setting	Example	
	bite	Hex			
81h	0000_0000	00h	Clear flag	-	
82h	0001_0000	00h	PIN[1:0]=01 INTTYPE=0	Flag_P mode Level interrupt	
83h	0001_0000	10h	INTVAL[2:0]=000	Interval time 0msec	
84h	-	-	-	-	
85h	0001_0011	13h	RES_P[1 :0]=01	12bit	
86h	0010_0100	24h	IS[2:0]=010 SUM[2]=1	IS=82mA LED Pulse x32	
87h	0111_0010	72h	PRST[2:0]=111	PRST 7cycle	
8Ch 8Dh	0000_0000 0000_0000	00h 00h	OS_D0[13 :0]=d 00		
8Eh	1000_1000	88h	PS_OFFSET[7 :0]	+128count	
B3h	0000_0001	01h	-		
C1h	0000_0001	01h	CALIB_EN=1		
C2h	0010_0001	21h	TARGET[2 :0]=010 SEARCH_EN=1	TARGET 63	
80h	1010_0000	A0h	OP[3]=1 OP[2:0]=010	Active PS mode	

Please enter address 80h in the end after setting 81H to 8EH and B3h,C1h,C2h.
Calibration result can be read at SEARCH[6:0] register through I^2Cbus interface.

Calibration

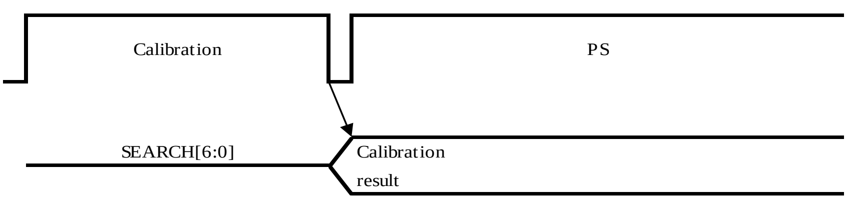


Fig.9 Output results for Calibration mode

3. INT terminal output mode

3.1. Detection result output mode for PS

INT terminal operates with sensing result output mode by setting PIN[2:0] register(Address 82H) 00:detection/non-detection sensing result output mode. Sensing result whether or not object is detected is able to be read out via I^2C bus interface and output from INT terminal with negative logic.

Table 9. INT terminal setting (Proximity detection mode)

PIN[2:0]	Setting	Output data
000	Interrupt output for PROX(detection/non-detection)	PROX

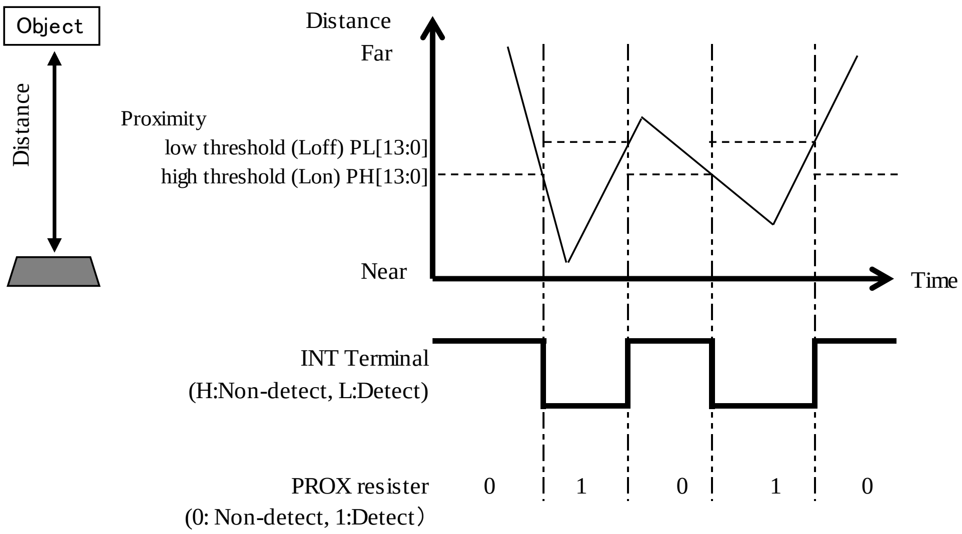


Fig.10 Detection result output mode

3.2. Interrupt output mode

Operates as interrupt output mode by setting PIN[2:0] register (Address 82H) 001,010,100: interrupt output mode.

Table 10. INT terminal setting(PIN[2:0] register)

PIN[2:0]	Setting	Output data
001	Interrupt output for PS only	FLAG_P
010	Interrupt output for RGB only	FLAG_A

There are two kinds of output mode(level interrupt & pulse interrupt) by setting INTTYPE register (Address 82H) 0 or 1. Below is a description of the level interrupt type.

Table 11. INT terminal setting (INTTYPE register)

INTTYPE	Setting
0	Level interrupt
1	Pulse interrupt

0: level interrupt type

In this case, transition from H to L in INT terminal become occurring interrupt signal and INT terminal will hold L level until interrupt is cleared.

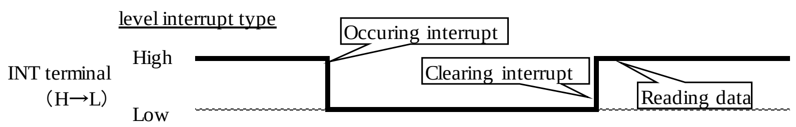


Fig.11 Interrupt output (level interrupt type)

1: pulse interrupt type

In this case, L pulse output in INT terminal become occurring interrupt signal and INT terminal will not hold L level. Therefore we need not to clear interrupt flag(FLAG_M,FLAG_P, FLAG_A). FLAG_M,FLAG_P and FLAG_A are cleared automatically in 1 clock (about 0.47us).

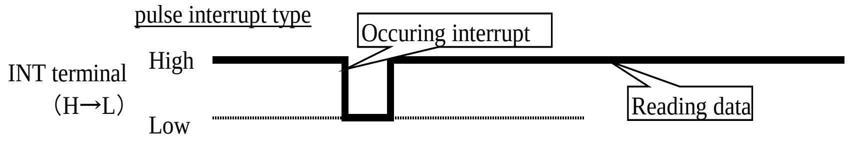


Fig.12 Interrupt output (pulse interrupt type)

The result of interrupt judgment is written into FLAG_x register (Address 81H), and is read out from I^2C bus interface. (0: Non-interrupt, 1: interrupt)

In this case, transition from H to L in INT terminal become occurring interrupt signal and INT terminal will be hold L level until interrupt is cleared. Interrupt will be cleared in writing 0 data in FLAG_x register.

Detecting operation will continue while INT terminal is L level. Update RGB detection result D1[15:0],D2[15:0],D3[15:0],D4[15:0] and sensing result of object detection/non-detection status. Therefore, host needs to read data after FLAG_A and FLAG_P register clear.

4. Register Mapping

4.1. Register Mapping

When Vcc power is supplied, GP2AP080C00F starts up with initializing all registers.

Table 12. Register Mapping

ADDRESS	REG NAME	DATA								Initial	Recommend setting			
		D7	D6	D5	D4	D3	D2	D1	D0	Value	PS	RGB	PS_RGB	Calib
80H	COMMAND I	OP3		OP1	OP0					H'00	H'A0	H'90	H'B0	H'A0
81H	COMMAND II					PROX	FLAG_P	FLAG_A		H'00	-	-	-	-
82H	COMMAND III			PIN1	PIN0			INTTYPE	RST	H'00	H'00	-	H'00	H'10
83H	COMMAND IV				1		INTVAL2	INTVAL1	INTVAL0	H'00	H'13	H'10	H'13	H'10
84H	RGB I			RES_A1	RES_A0	GAIN_A3	GAIN_A2	GAIN_A1	GAIN_A0	H'00	-	H'11/15/1E	H'11/15/1E	-
85H	PS I			RES_P1	RES_P0		0	1	1	H'00	H'13	-	H'13	H'13
86H	PS II		IS2	IS1	IS0		SUM2			H'00	H'24	-	H'24	H'24
87H	PS III		PRST2	PRST1	PRST0			1		H'00	H'22	-	H'22	H'72
88H	PS_LT_LSB	PL7	PL6	PL5	PL4	PL3	PL2	PL1	PL0	H'00	A3H	-	A3H	-
89H	PS_LT_MSB			PL13	PL12	PL11	PL10	PL9	PL8	H'00	00H	-	00H	-
8AH	PS_HT_LSB	PH7	PH6	PH5	PH4	PH3	PH2	PH1	PH0	H'FF	D7H	-	D7H	-
8BH	PS_HT_MSB			PH13	PH12	PH11	PH10	PH9	PH8	H'FF	00H	-	00H	-
8CH	OS_DATA0_LSB	OS_D0_7	OS_D0_6	OS_D0_5	OS_D0_4	OS_D0_3	OS_D0_2	OS_D0_1	OS_D0_0	H'00	H'00	-	H'00	H'00
8DH	OS_DATA0_MSB			OS_D0_13	OS_D0_12	OS_D0_11	OS_D0_10	OS_D0_9	OS_D0_8	H'00	H'00	-	H'00	H'00
8EH	PS_OFFSET	PS_OFFSET7	PS_OFFSET6	PS_OFFSET5	PS_OFFSET4	PS_OFFSET3	PS_OFFSET2	PS_OFFSET1	PS_OFFSET0	H'00	H'88		H'88	H'88
90H	DATA0 LSB	D0_7	D0_6	D0_5	D0_4	D0_3	D0_2	D0_1	D0_0	H'00				
91H	DATA0 MSB	SAT		D0_13	D0_12	D0_11	D0_10	D0_9	D0_8	H'00				
92H	DATA1 LSB	D1_7	D1_6	D1_5	D1_4	D1_3	D1_2	D1_1	D1_0	H'00				
93H	DATA1 MSB	D1_15	D1_14	D1_13	D1_12	D1_11	D1_10	D1_9	D1_8	H'00				
94H	DATA2 LSB	D2_7	D2_6	D2_5	D2_4	D2_3	D2_2	D2_1	D2_0	H'00				
95H	DATA2 MSB	D2_15	D3_14	D2_13	D2_12	D2_11	D2_10	D2_9	D2_8	H'00				
96H	DATA3 LSB	D3_7	D3_6	D3_5	D3_4	D3_3	D3_2	D3_1	D3_0	H'00				
97H	DATA3 MSB	D3_15	D3_14	D3_13	D3_12	D3_11	D3_10	D3_9	D3_8	H'00				
98H	DATA4 LSB	D4_7	D4_6	D4_5	D4_4	D4_3	D4_2	D4_1	D4_0	H'00				
99H	DATA4 MSB	D4_15	D4_14	D4_13	D4_12	D4_11	D4_10	D4_9	D4_8	H'00				
A0H	ID	1	1	0	0	0	0	0	0	H'C0				
B3H	RESERVED				0		0	0	1	H'00	H'01	-	H'01	H'01
C0H	CALIBRATION I		SEARCH6	SEARCH5	SEARCH4	SEARCH3	SEARCH2	SEARCH1	SEARCH0	H'00				
C1H	CALIBRATION II								CALIB_EN	H'00	-	-	-	H'01

4.2. Precautions for Register setting

- Please start setting registers after power-supply voltage becomes stable up to 90% or more set value.
  Please wait for some 1msec before setting registers from power-on.
- PROX, FLAG_P and FLAG_A registers are able to be cleared by writing 0 data in each register.
  (but these registers can’t be written 1 data.)
- Please don’t set the other address. (Test registers are assigned in those addresses)

4.3. Register Functions

Functions and set contents of the registers are shown below.

Table 13. description of the register function

ADDR	register	function	setting
80H	OP[3]	Software shutdown	0:shutdown, 1:operation
	OP[1:0]	operation	01:RGB, 10:PS, 11:PS & RGB
81H	PROX	detection/non-detection	0:non-detection, 1:detection
	FLAG_P	PS interrupt result	0:non-interrupt, 1:interrupt
	FLAG_A	RGB interrupt result	0:non-interrupt, 1:interrupt
82H	PIN[1:0]	INT terminal setting	00:PS(Detection/Non-detection),01:FLAG_P,10:FLAG_A
	INTTYPE	Interrupt type setting	0:level, 1:pulse
	RST	Software Reset	0:not reset, 1:reset
83H	INTVAL[2:0]	Intermittent operating	000:0msec, 001:1.9msec, 010:7.6msec, 011:30msec, 100:61msec, 101:122msec, 110:244msec, 111:488msec
84H	RES_A[1:0]	ALS Resolution	00:18bits(122msec),01:16bits(30msec),10:14bits(7.6msec),11:12bits(1.9msec)
	GAIN_A[3:0]	Maximum measurable gain	0001:×185, 0010:×113, 0011:×62, 0100:×32, 0101:×16, 0110:×8, 1100:×4, 1101:X2, 1110:X1
85H	RES_P[1:0]	PS Resolution	00:14bits(7.6msec),01:12bits(1.9msec),10:10bits(0.48msec),11:8bits(0.12msec)
86H	IS[2:0]	LED drive peak current setting	000:OFF、001:10mA、010:82mA、011:155mA、111:210mA
	SUM	LED pulse setting	0:×16, 1:×32
87H	PRST[2:0]	Number of measurement cycles	000：everytime, 001：1cycle - 111：7cycles
88H.89H	PL	Low threshold setting(Loff)	14bits counts setting
8AH,8BH	PH	High threshold setting(Lon)	14bits counts setting
8CH,8DH	OS_DATA0	DATA0 offset count(Offset0)	14bits counts setting
8EH	PS_OFFSET	PS offset setting	16count/LSB ×（±128LSB)
90H,91H	D0	DATA0 result	14bits output data of PS Photodiode0
92H,93H	D1	DATA1 result	16bits output data of CLR Photodiode
94H,95H	D2	DATA2 result	16bits output data of Red Photodiode
96H,97H	D3	DATA3 result	16bits output data of Green Photodiode
98H,99H	D4	DATA4 result	16bits output data of Blue Photodiode
A0H	ID[7:0]	Device ID	1100_0000
B3H	RESERVED	-	0000_0001
C0H	SEARCH	Calibration result	7bits output data of calibration result
C1H	CALIB_EN	Calibration setting	0:calibration OFF, 1:calibration ON
C2H	TARGET	search target	000:0, 001:31, 010:63, 011:127, 100:255, 101:511, 110:1023, 111:2047
	SERACH_EN	search result setting	0:serach result disable, 1:search result enable

5. Register settings for Basic operation

5.1. Operating mode selection: OP [3:0] (ADDRESS:80H)

Select Software shutdown or RGB or PS or alternating mode(PS + RGB).

OP [3][1:0] register (Address 00H)

0xxx: Software shutdown

Control power supply to the circuit. LED drive circuit is always off in shutdown mode.
After power on, start with shutdown

1x01: RGB mode

Detection result of Clear photodiode is output to D1[15:0] register (Address 92H, 93H).
Detection result of Red photodiode is output to D2[15:0] register (Address 94H, 95H).
Detection result of Green photodiode is output to D3[15:0] register (Address 96H, 97H).
Detection result of Blue photodiode is output to D4[15:0] register (Address 98H, 99H).

1x10: PS mode and calibration mode

Sensing result of detection/non-detection is output to PROX register(Address 81H).
Detection result of distance is output to D0[13:0] register (Address 90H, 91H).

1x11: PS and RGB alternating

5.2. Proximity detection/non-detection: PROX （ADDRESS 81H）

Sensing result for detection/non-detection is output. There is a function which clears data by writing 0 in PROX register.

PROX register (Address 01H): 0: non-detection, 1: detection

5.3. Interrupt result: FLAG_P,FLAG_A（ADDRESS 81H）

FLAG_P register is output interrupt result for PS mode.
FLAG_A register is output interrupt result for RGB mode.
There is a function which clears by writing 0 in FLAG register.

FLAG register (Address 81H) : 0: non-interrupt, 1: interrupt

5.4. INT terminal setting: PIN[1:0]（ADDRESS 82H）

Select output mode in INT terminal by setting PIN register.
The outputs by PROX, FLAG_P,and FLAG_A can be selected.

Table 14. INT terminal setting

PIN[1:0]	Setting	Output data
00	Interrupt output for PROX(detection/non-detection)	PROX
01	Interrupt output for PS only	FLAG_P
10	Interrupt output for RGB only	FLAG_A

5.5. Interrupt type setting (for PS,RGB) : INTTYPE (ADDRESS:82H)

Select level interrupt type or pulse interrupt type by setting INTTYPE register.

Table 15. INT terminal setting (INTTYPE register)

INTTYPE	Setting
0	Level interrupt
1	Pulse interrupt

5.6. Software reset: RST（ADDRESS 82H）

Initialize all registers by writing 1 in RST register. RST register is also initialized automatically and becomes 0.

5.7. Intermittent operating function: INTVAL[2:0]（ADDRESS 83H）

This function is to reduce average consumption current by stopping part of circuit intermittently, and this is different from software shutdown function. Intermittent operating duration can be changed by setting INTVAL[2:0] register.
Setting a longer intermittent operating duration makes LED average consumption current lower. However, update period of the detection result becomes long. It will make response time of detecting longer.

Enable to change intermittent operating periods by setting INTVAL [2:0] register.

Table 16. Intermitting time setting

INTVAL[2:0]	Intermitting time setting	Remarks
000	0msec	Calibration
001	1.9msec	
010	7.6msec	
011	30msec	PS mode
100	61msec	
101	122msec	
110	244msec	
111	488msec	

For PS mode, quiescent operation will be after PS operation.
For RGB mode, quiescent operation will be after RGB operation.
For PS and RGB alternating mode, quiescent operation will be after RGB operation.
Although setting a longer intermittent operating period contributes to reduce average consumption current, it makes update period and response time for detection longer as a result. Need to set it considering your actual conditions in use.

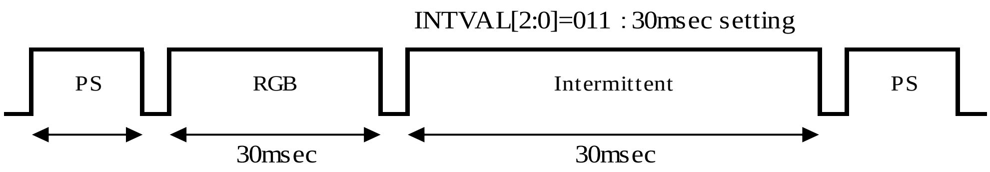


Fig.13 Intermittent operating

5.8. Device ID : ID[7:0]（ADDRESS A0H）

Device Identification Register is 1100_0000 (C0h).

6. Register settings for RGB

6.1. Resolution/Measuring duration setting for RGB mode: RES_A [1:0]（ADDRESS 84H）

Select measuring resolution and measuring duration for RGB mode by setting RES_A [1:0] register .If resolution is low, measuring tolerance becomes large. Please have an adjustment at your system.

Table 17. Resolution/Measuring duration setting for RGB mode

RES_A[1:0]	Resolution	Measuring time RGB mode	Remarks
00	18bit	122msec	recommended
01	16bit	30msec	recommended
10	14bit	7.6msec	
11	12bit	1.9msec	

＊Grayed-out portions is not recommended.

6.2. Maximum measurable gain for RGB mode: GAIN_A[3:0]（ADDRESS 84H）

Select maximum measurable gain for RGB mode by setting GAIN_A [3:0] register.

Detect with a set gain in RGB mode. Maximum count value is outputted in case of incident light exceeding maximum measurable gain. It is possible to have countermeasure for external light by setting a large count value at maximum measurable gain. It is necessary to set them considering the condition in the actual use and evaluating at your system.

Table 18. Maximum measurable gain for RGB mode

GAIN_A[3:0]	Maximum measurable range RGB mode	Remarks
0000	-	not allowed
0001	×185	
0010	×113	
0011	×62	
0100	×32	
0101	×16	
0110	×8	
1100	×4	
1101	×2	
1110	×1	

6.3. RGB Detection result: D1[15:0],D2[15:0],D3[15:0],D4[15:0]（ADDRESS 92H～99H）

Detection result of Clear photodiode is output to D1[15:0] register (Address 92H, 93H).
Detection result of Red photodiode is output to D2[15:0] register (Address 94H, 95H).
Detection result of Green photodiode is output to D3[15:0] register (Address 96H, 97H).
Detection result of Blue photodiode is output to D4[15:0] register (Address 98H, 99H).

The results of illuminance(Ya) and color temperature(CCT) can be obtained by some calculation using D1[15:0], D2[15:0], D3[15:0] and D4[15:0].

$$Xa = \alpha\_x * D2[15:0] + \beta\_x * D3[15:0] + \gamma\_x * D4[15:0] + \delta\_x * D1[15:0]$$

$$Ya = \alpha\_y * D2[15:0] + \beta\_y * D3[15:0] + \gamma\_y * D4[15:0] + \delta\_y * D1[15:0]$$

$$Za = \alpha\_z * D2[15:0] + \beta\_z * D3[15:0] + \gamma\_z * D4[15:0] + \delta\_z * D1[15:0]$$

$$X = Xa / (Xa + Ya + Za)$$

$$Y = Ya / (Xa + Ya + Za)$$

$$n = (X - 0.332)/(0.1858 - Y)$$

$$CCT = 449*n*n*n + 3525*n*n + 6823.3*n + 5520.33$$

$$Ratio = (D2[15:0] + D3[15:0] + D4[15:0]) / D1[15:0]$$

α,β,γ and δ factor are decided by ratio.

These factors are shown below in the case of no panel.
These factors might be necessary to be adjusted according to the case panel in use.

7. Register settings for PS and Calibration

7.1. Number of measurement cycles setting: PRST[2:0] (ADDRESS:87H)

Select number of measurement cycles by setting PRST[2:0] register. Judgment result for detection/non-detection is over threshold continuously more than the set cycles in PRST[2:0] register. This judgment result is done in using the detection result of distance (D0[13:0]).

Table 19. Number of measurement cycles setting

PRST[2:0]	Persistance Cycle	Remarks
000	everytime	
001	1cycles	
010	2cycles	recommended
011	3cycles	
100	4cycles	
101	5cycles	
110	6cycles	
111	7cycles	

・Algorithm for detecting object in PS is as follows.

<Judge the change from non-detecting status to detecting status>

Detection result is over high threshold (Lon) N times continuously : Detection

Other : Non-detection

<Judge the change from detecting status to non-detecting status>

Detection result is over low threshold (Loff) N times continuously : Non-Detection

Other : Detection

7.2. Resolution/Measuring duration setting: RES_P [1:0]（ADDRESS 85H）

Select measuring resolution and measuring dursation by setting RES_P[1:0] register.
If resolution is low, measuring tolerance becomes large. Please have an adjustment at your system.

Table 20. Resolution/Measuring duration setting

RES_P[1:0]	Resolution	Measuring duration	Remarks
00	14bit	7.6msec	
01	12bit	1.9msec	recommended
10	10bit	0.48msec	
11	8bit	0.12msec	

＊Grayed-out portions is not recommended.

7.3. LED drive peak current setting IS[2:0]（ADDRESS 86H）

Enable to select LED drive peak current by setting IS[2:0] register.
In case of changing this setting, the count will change correspond to the set LED drive peak current.
Please adjust detecting distance with proximity low threshold PL[13:0] and proximity high threshold PH[13:0].
LED drive peak current will depend on Vcc and VLED voltage. (Refer to 12.1. LED drive peak current data)

Table 21. LED drive peak current

IS[2:0]	LED drive peak current	Remarks
000	OFF	
001	10 mA	
010	82 mA	recommended
011	155 mA	
111	210 mA	

7.4. LED pulse setting: SUM （ADDRESS 86H）

Select LED pulse setting by setting SUM register.
If LED pulse setting is low, measuring tolerance becomes large. Please have an adjustment at your system.
Number of LED pulses can be changed at 16times or 32times.

Table 22. LED pulse setting

SUM	LED pulse setting	Remarks
0	×16 times	
1	×32 times	recommended

7.5. Proximity low threshold (Loff):PL[13:0]（ADDRESS 88H,89H）

Sets proximity low threshold in PL[13:0] register at PS mode.
Please set it with confirming at optical mounting condition in the actual use.

7.6. Proximity high threshold (Lon):PH[13:0]（ADDRESS 8AH,8BH）

Sets proximity high threshold in PH[13:0] register at PS mode.
Please set it with confirming at optical mounting condition in the actual use.

7.7. Proximity offset:OS_D0[13:0]（ADDRESS 8CH,8DH）

Sets proximity offset in OS[13:0] register at PS mode.
If there is Panel crosstalk, you will be able to subtract the Panel crosstalk count by using proximity offset.
Please set it with confirming at optical mounting condition in the actual use.

7.8. Proximity offset:PS_OFFSET[7:0]（ADDRESS 8EH）

Sets proximity offset in PS_OFFSET[7:0] register at PS mode.
Using proximity offset(PSoffset) will be able to add or subtract PS count by .
Please set it with confirming at optical mounting condition in the actual use.

Offset count = 16 count / LSB × (±0～127)

PS_OFFSET[7] is sign bit.(0= －,1= +)

PS_OFFSET[6:0] is magnitude bit. (0～127)

7.9. PS Detection result: D0[13:0]（ADDRESS 90H,91H）

Detection result of proximity sensing is output to D0[13:0] register.
Detection result is defined as follows,

Detection result (D0[13:0]) = Raw count(D0[13:0], include panel crosstalk) – Offset(OS_D0[13:0])

Proximity detection:

If the detected object is closed, D0[13:0] > PH[13:0].
If the detected object is not closed, D0[13:0] < PL[13:0].

7.10. Saturation Detection result of the integrator: SAT（ADDRESS 91H）

Saturation detection result of the integrator is output to SAT register.
If the integrator is saturated, SAT register is set to 1.

7.11. Calibration result: SEARCH[6:0]（ADDRESS C0H）

Calibration detection result is output to SEARCH[6:0] register.

7.12. Calibration enable: CALIB_EN（ADDRESS C1H）

Enable to select calibration function by setting CALIB_EN register.

7.13. Search target: TARGET[2:0]（ADDRESS C2H）

Select number of search target counts by setting TARGET[2:0] register.

Table 23. Number of search target setting

TARGET[2:0]	Search Target	Remarks
000	0counts	
001	31counts	
010	63counts	recommended
011	127counts	
100	255counts	
101	511counts	
110	1023counts	
111	2047counts	

7.14. Search enable: SEARCH_EN（ADDRESS C2H）

Enable to select search results by setting SEARCH_EN register.

8. Average consumption current

Average consumption current in operation is the sum of the average current consumption value with Vcc terminal and LED consumption. The LED driven current flows from LEDA terminal to GND terminal.

8.1. Average consumption current with Vcc terminal

Average consumption current at PS mode is typical 0.19mA.
Average consumption current at RGB mode is typical 0.15mA.
Average consumption current at interval period is typical 0.025mA.
Average consumption current at Shutdown mode is typical 0.003mA.

8.2. Average consumption current with VLED terminal

In case of continuous operation, average consumption current in LED is estimated as below.

[LED average consumption current]
= LED drive peak current× (LED pulse setting× 6.5usec)/ (measuring time + Intermittence time)

[LED drive peak current]: IS[2:0] register.
001：10mA,　010：82mA,　011：155mA,　111：210mA

[LED pulse setting]: SUM register.
0：x16,　1：x32

[measuring time]：Enable to set with RES_P[1:0] register.
00：7.6msec(14bit),　01：1.9msec(12bit),　10：0.48msec(10bit),　11：0.12msec(8bit)

[Intermittence operating time]：Enable to set with INTVAL[2:0] register.
000：0msec,　001：1.9msec,　010：7.6msec,　011：30msec
100：61msec,　101：122msec,　110：244msec,　111：488msec

For example,

[LED drive peak current]	: 82mA	IS[2:0]=010
[LED pulse setting]	: x32	SUM=1
[measuring time]	: 1.9msec(12bit)	RES_P[1:0]=01
[Intermittence operating time]	: 30msec	INTVAL_P[2:0]=011

In the above case,

[LED averaging consumption current] ＝ 82mA × 32 × 6.5usec ／（1.43msec + 1.9msec + 30msec）
＝ 0.51mA

[Vcc averaging consumption current] ＝ ((1.43msec+1.9msec)×0.19mA+30msec×0.025mA)
／1.43msec+1.9msec+30msec）
＝ 0.041mA

Also, using auto-shut down function, it will be automatically shutdown after one operation. Utilizing it with adjusting your system, it contributes to reduce averaging consumption current in LED.

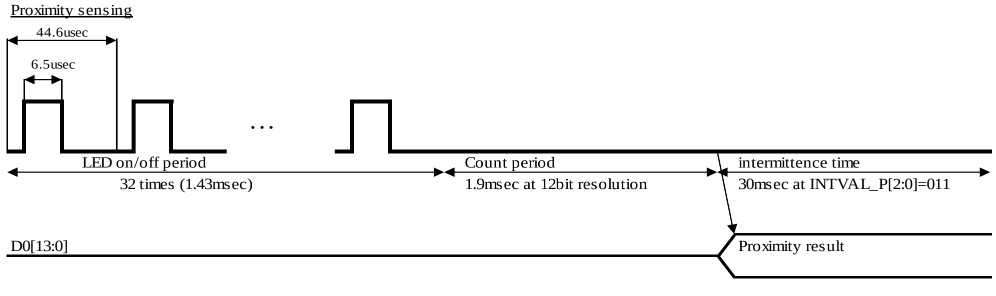


Fig.14 Proximity operating

9. Example of setting sequence

9.1. From Power-On to operating condition

The internal register of GP2AP080C00F are all initialized after powering on.(Power-On-Reset)
Insert a wait for at least 1ms until the Power-On-Reset state stabilizes.

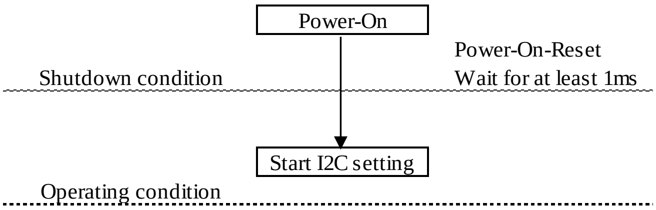


Fig.15 From Power-On to operating condition

9.2. From operating condition to Power-Off

Insert a wait for at least 1ms until shutdown state stabilizes.

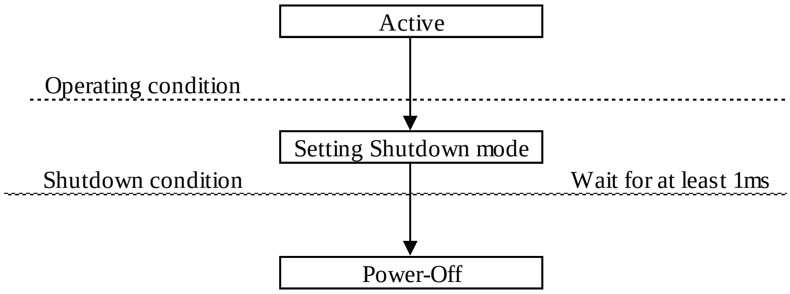


Fig.16 From operating condition to Power-Off

9.3. Power-On and Power-Off

The following figure shows configuration sequence at Power-On and Power-Off

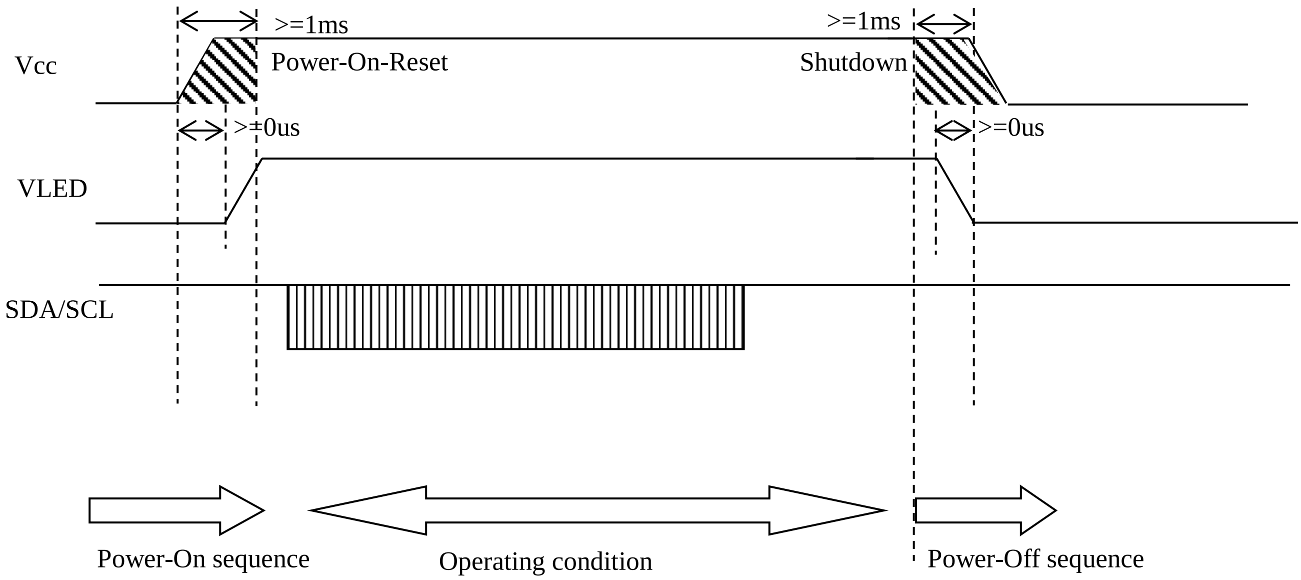


Fig.17 Power-On and Power-Off

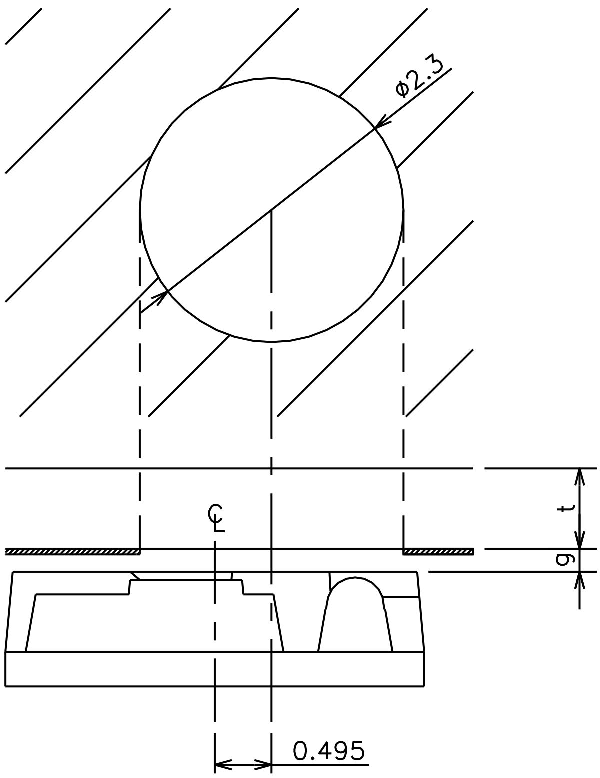
10. Device Driver

10.1. Device Driver

We can provide a device driver for this product.
If you need support for the software, please contact me feel free.

11. Recommended Window Size (Reference)

11.1. Without rubber cap light shield



g≦0.4mm（recommended） g : distance between sensor and panel
t≦0.73mm（recommended） t : thickness of panel

Fig.18 Recommended window size (Without light shield)

1. Please print or tape up not to transmit infrared.
2. Even recommended window size may cause malfunction depending on the reflection from the panel.
3. Please confirm that there is no problem with an actual machine in consideration of the implementation gap, the misalignment of the windows and voltage variation.
4. The example transmissivity 940nm of the window is 85%±5%.
5. The example transmissivity 555nm of the window is 90%±5%.
   Visible light cut printing on the top panel is unnecessary and cost reduction of the cost panel is possible.
   The internal chip structure of the sensor can not be seen due to adoption of visible light cutting resin.

12. Data (Reference)

12.1. ALS Angular Characteristic

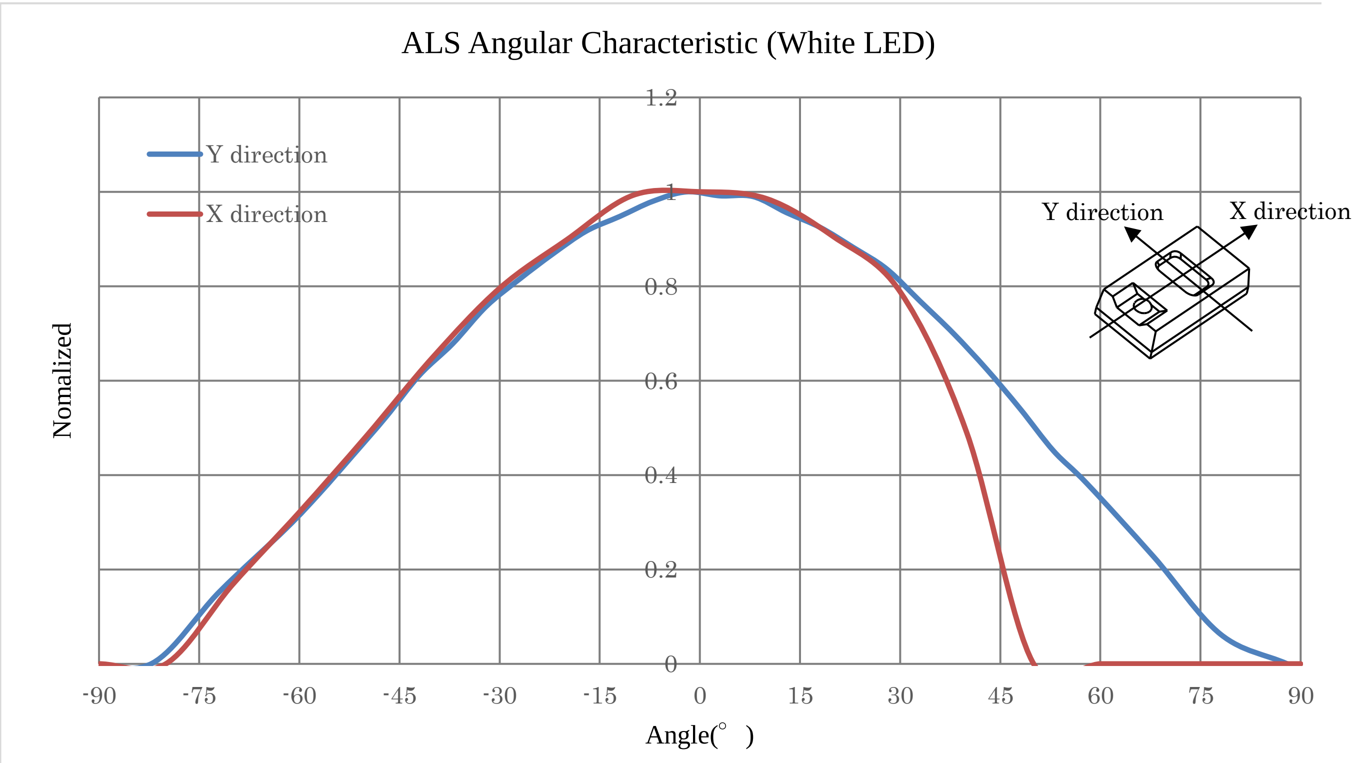


Fig.19 ALS Angular Characteristic

12.2. LED drive peak current

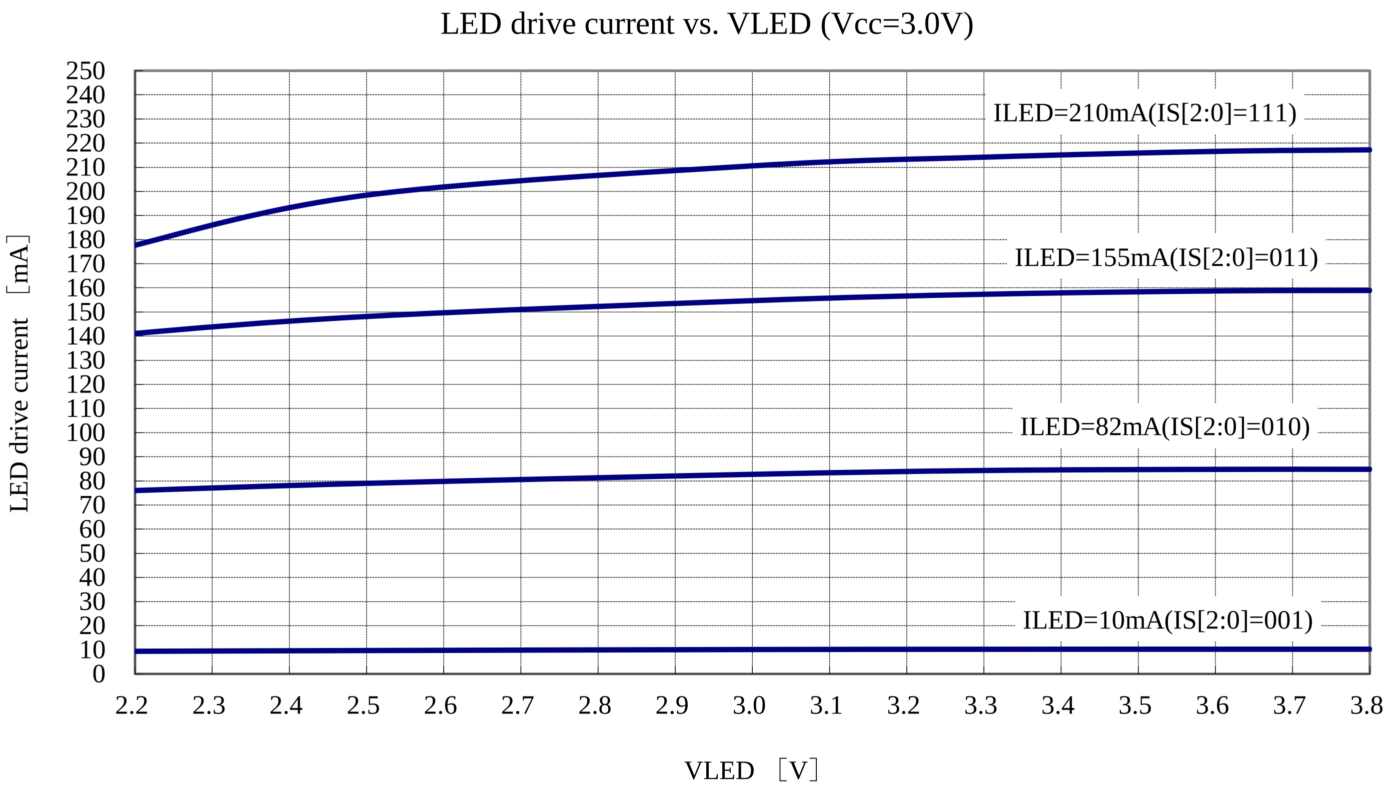


Fig.20 LED drive peak current vs. VLED

12.3. Spectral Responsivity

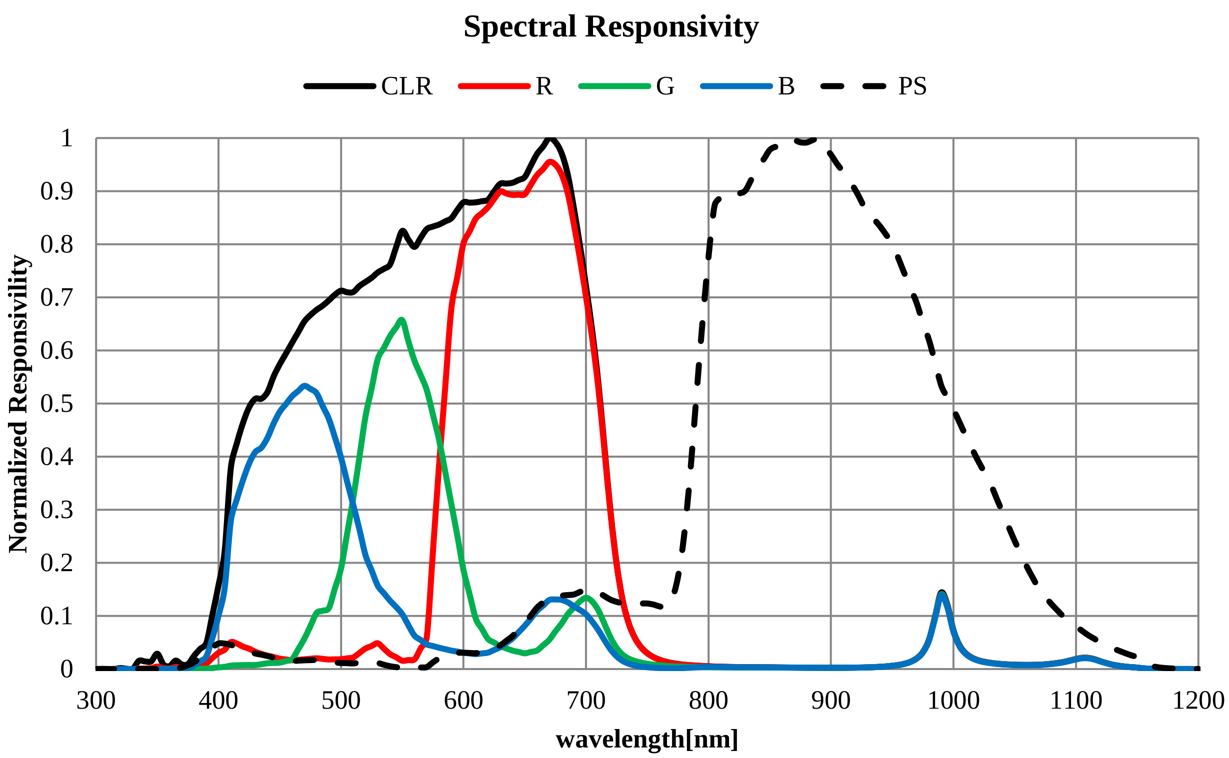


Fig.21 Spectral Responsivity