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Abstract

GP2AP052A00F(GS part) is Gesture and Proximity sensor with function gesture sensing and proximity sensing by setting register.

Judgment result of object existence can be referred by reading register value(14bit) via I²C bus interface. INT terminal can be changed either interrupt output or sensing result output (detection/non-detection status) by setting register.

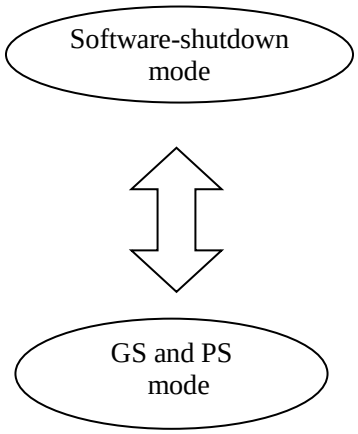


Fig.1 Operating mode of GP2AP052A00F(Gesture sensor(GS) and Proximity sensor(PS))

1.1. Features

- **Design**

  This product is composed of following three chips in one package, which is IC1 with the four built-in PD(photodiode) for Gesture sensors and proximity sensors, IC2 with a built-in PD(clear and infrared photodiode) for ambient light sensors(ALS), and infrared LED.

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

- **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.

- **INT terminal setting**

  INT terminal can be changed either interrupt output or sensing result output (detection/non-detection status) by setting register .

- **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, 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.

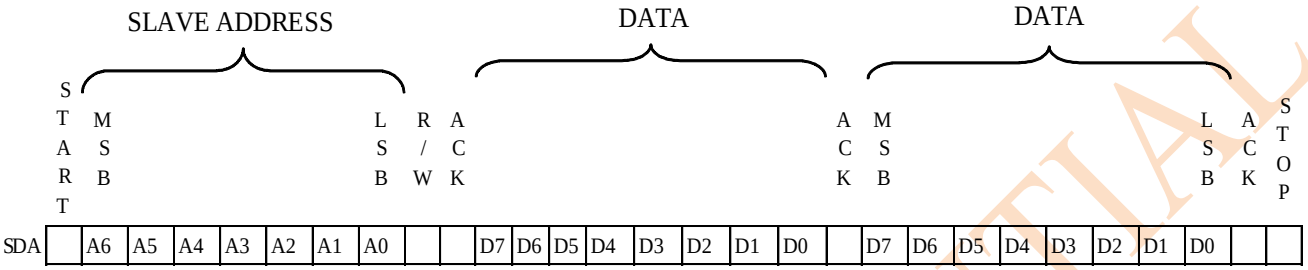


Fig.2 I²C Basic data format

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

Table 2. I²C slave address

ADDR terminal setting	A6	A5	A4	A3	A2	A1	A0	R/W
Slave address	1	0	0	0	1	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:00H　PROX, FLAG register in 00H are read only.

WordAddress:10H～19H D0[13:0], D1[13:0], D2[13:0] ,D3[13:0] and D4[15:0] registers from 10H to 19H are read only.

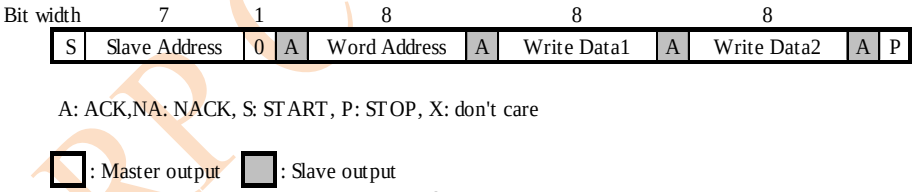


Fig.3 I²C write format

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.

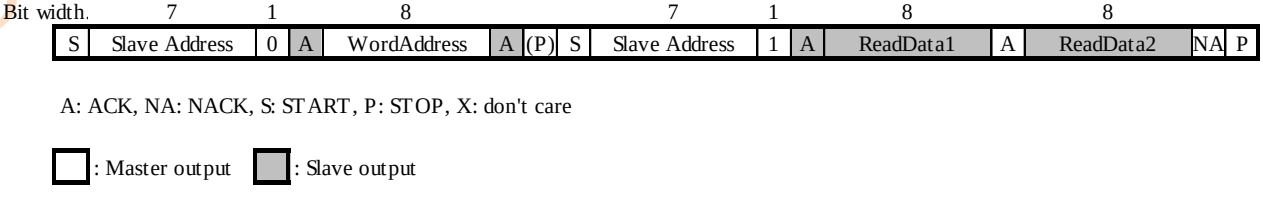


Fig.4 I²C read format

1.2.3. Others and Notes

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

2. Description of functions

2.1. Gesture sensing

Gesture sensing results can be read at D0[13:0],D1[13:0] ,D2[13:0],D3[13:0], and D4[15:0] register through I^2C bus interface.

The device outputs raw data of the four IR photodiodes sensitive to only infrared spectrum gesture sensing. It is necessary for device host (user side) to get detection results with calculation of gesture values for each channel data at D0[13:0] ,D1[13:0],D2[13:0],D3[13:0] and total value of each channel data at D4[15:0].

The device outputs interrupt signal to INT terminal in case that Data(D4[15:0]) exceed/fall below judgment threshold level(TH[15:0]/TL[15:0]) set before sensing operation.

Interrupt data source is selected by INTSEL[2:0] register.

2.2.Proximity sensing

Proximity sensing results can be read at D4[15:0] register through I^2C bus interface.

The device outputs interrupt signal or detection/non-detection status on INT terminal in which case D4[15:0] exceed/fall below judgment threshold level(TH[15:0]/TL[15:0]) set before sensing operation.

2.3. Software-shutdown mode

This product has shutdown function by which all circuits except I^2C go into shutdown mode and cease to draw supply current. In this case, I^2C communication is available. Current consumption ($ICC_{\_S\_GS}$) in shutdown mode is less than 5uA when I^2C bus interface is not used.

2.4. Hardware-shutdown

All the circuits can be completely stopped by stopping the power supply to the terminal Vcc, and the current consumption can completely be cut.

2.5. Auto-shutdown/ Continuous operating function

Select continuous operation or auto-shutdown after one time operation by setting OP[2] register.

2.6. Number of measurement cycles(Persistence)

Select number of measurement cycles by setting PRST[2:0] register(from 1time to 8times). Sensor outputs interrupt signal or judgment result of detection/non-detection state by detecting threshold setting cycles continuously. This function helps to decrease malfunction by noise such as flash of camera.

2.7. Resolution/Measuring time

Resolution and measuring time can be changed by setting RES[1:0] register.

2.8. Maximum measurable range

Maximum measurable range can be changed by setting RANGE[2:0] register.

2.9. Intermittent operating function

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[1:0] 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.

2.10. LED drive peak current setting

Change drive peak current by setting IS[2:0] register. (LED drive peak current is 17.5mA, 35mA, 70mA ,140mA and 193mA)

2.11. INT terminal output type setting

INT terminal can be changed either interrupt output or sensing result output (detection/non-detection status) by setting PIN register.

2.12. LED pulse setting

LED pulse setting can be changed by setting SUM[2:0] register.

Number of LED pulses can be changed from 1time to 128times.

LED pulse width is 9usec.

Setting a lower number of LED pulses makes LED average consumption current lower.

2.13. Software reset

All registers can be initialized by writing 1 to RST register.

RST register value also becomes 0 automatically which is initial value.

2.14. Interrupt function

Interrupt function becomes available by setting TH[15:0] register and TL[15:0] register.

Interrupt signal or detecting/non-detecting judgment result is outputted to INT terminal in case that detection result (D4[15:0] value) is less than TL[15:0] setting value or more than TH[15:0] value.

Enable to change desirable threshold in detecting distance and hysteresis by setting TH[15:0] and TL[15:0] registers. However, detecting distance depends on LED output power as well. It can be changed by setting IS[2:0] register.

2.15. Offset function

Offset function becomes available by setting OS_D0[13:0],OS_D1[13:0],OS_D2[13:0] and OS_D3[13:0] register.

Offset function is the ability to reduce the cross talk count for gesture and proximity sensor.

If you set offset value OS_D0[13:0],detection result (D0[13:0] value) is gotten by subtraction of offset value (OS_D0[13:0]).

3. Basic operation

3.1. Gesture sensor(GS) and 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.

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[2:0] is 16times of LED pulses.)

[2]In Count period, this device convert from a signal charge to digital value. (Recommend setting for RES[1:0] is 14bit 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.

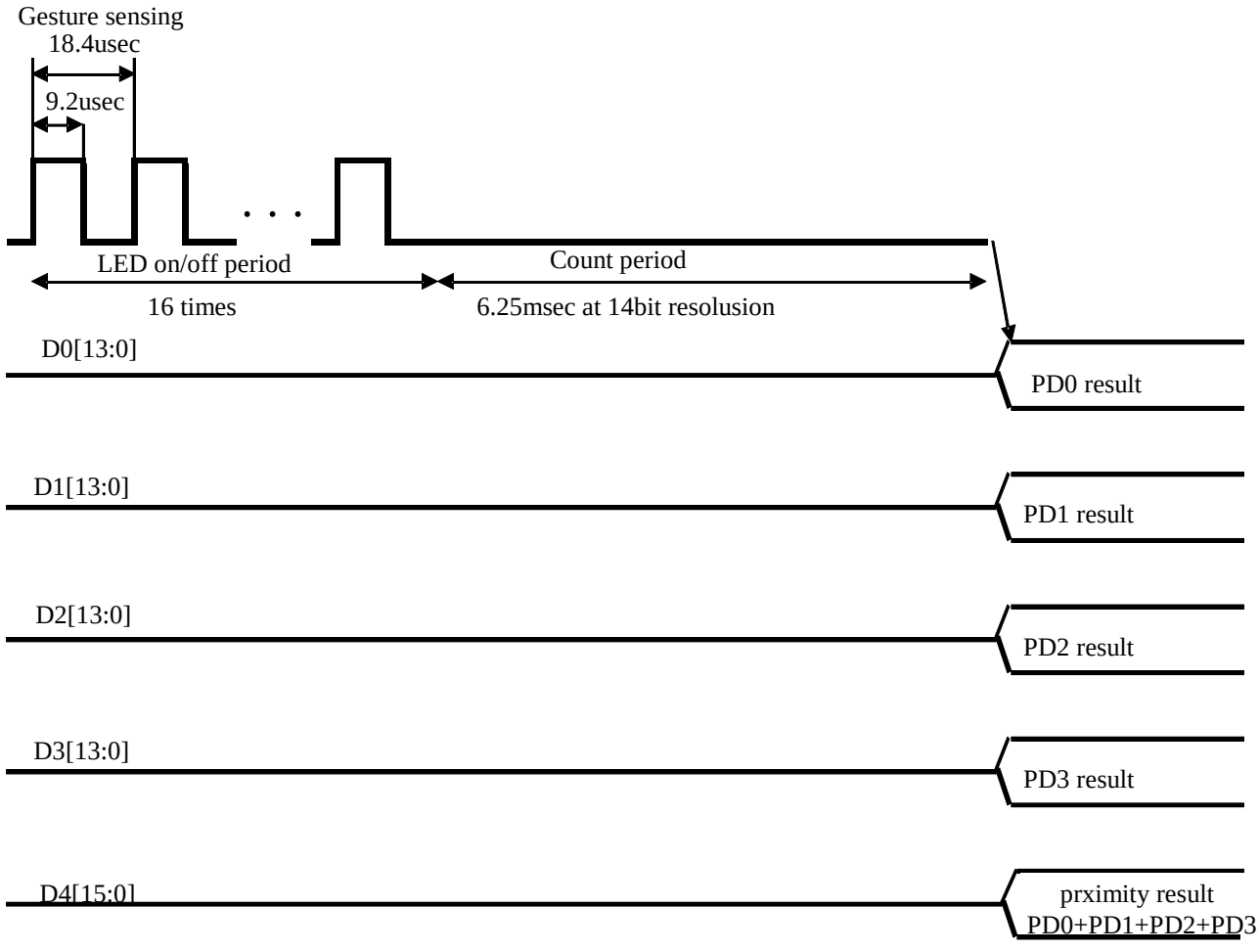


Fig.5 Output results for GS mode

4. Register Mapping

4.1. Register Mapping

When Vcc power is supplied, GP2AP052A00F starts up with initializing all registers.

Table 3. Register Mapping

ADDRESS	REG NAME	DATA								Initial
		D7	D6	D5	D4	D3	D2	D1	D0	Value
00H	COMMAND I	OP3	OP2							H'00
						PROX	FLAG			
01H	COMMAND II	INTVAL1	INTVAL0	INTSEL2	INTSEL1	INTSEL0	PIN	INTTYPE	RST	H'00
02H	PS I	PRST2	PRST1	PRST0	RES1	RES0	RANGE2	RANGE1	RANGE0	H'00
03H	PS II	IS2	IS1	IS0	SUM2	SUM1	SUM0	PULSE1	PULSE0	H'00
04H	INT_LT_LSB	TL7	TL6	TL5	TL4	TL3	TL2	TL1	TL0	H'00
05H	INT_LT_MSB	TL15	TL14	TL13	TL12	TL11	TL10	TL9	TL8	H'00
06H	INT_HT_LSB	TH7	TH6	TH5	TH4	TH3	TH2	TH1	TH0	H'FF
07H	INT_HT_MSB	TH15	TH14	TH13	TH12	TH11	TH10	TH9	TH8	H'FF
08H	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
09H	OS_DATA0_MSB			OS_D0_13	OS_D0_12	OS_D0_11	OS_D0_10	OS_D0_9	OS_D0_8	H'00
0AH	OS_DATA1_LSB	OS_D1_7	OS_D1_6	OS_D1_5	OS_D1_4	OS_D1_3	OS_D1_2	OS_D1_1	OS_D1_0	H'00
0BH	OS_DATA1_MSB			OS_D1_13	OS_D1_12	OS_D1_11	OS_D1_10	OS_D1_9	OS_D1_8	H'00
0CH	OS_DATA2_LSB	OS_D2_7	OS_D2_6	OS_D2_5	OS_D2_4	OS_D2_3	OS_D2_2	OS_D2_1	OS_D2_0	H'00
0DH	OS_DATA2_MSB			OS_D2_13	OS_D2_12	OS_D2_11	OS_D2_10	OS_D2_9	OS_D2_8	H'00
0EH	OS_DATA3_LSB	OS_D3_7	OS_D3_6	OS_D3_5	OS_D3_4	OS_D3_3	OS_D3_2	OS_D3_1	OS_D3_0	H'00
0FH	OS_DATA3_MSB			OS_D3_13	OS_D3_12	OS_D3_11	OS_D3_10	OS_D3_9	OS_D3_8	H'00
10H	DATA0 LSB	D0_7	D0_6	D0_5	D0_4	D0_3	D0_2	D0_1	D0_0	H'00
11H	DATA0 MSB	SAT0		D0_13	D0_12	D0_11	D0_10	D0_9	D0_8	H'00
12H	DATA1 LSB	D1_7	D1_6	D1_5	D1_4	D1_3	D1_2	D1_1	D1_0	H'00
13H	DATA1 MSB	SAT1		D1_13	D1_12	D1_11	D1_10	D1_9	D1_8	H'00
14H	DATA2 LSB	D2_7	D2_6	D2_5	D2_4	D2_3	D2_2	D2_1	D2_0	H'00
15H	DATA2 MSB	SAT2		D2_13	D2_12	D2_11	D2_10	D2_9	D2_8	H'00
16H	DATA3 LSB	D3_7	D3_6	D3_5	D3_4	D3_3	D3_2	D3_1	D3_0	H'00
17H	DATA3 MSB	SAT3		D3_13	D3_12	D3_11	D3_10	D3_9	D3_8	H'00
18H	DATA4 LSB	D4_7	D4_6	D4_5	D4_4	D4_3	D4_2	D4_1	D4_0	H'00
19H	DATA4 MSB	D4_15	D4_14	D4_13	D4_12	D4_11	D4_10	D4_9	D4_8	H'00

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 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 address 19H and the larger ones. (Test registers are assigned in those addresses)

4.3. Register Functions

Functions and set contents of the registers are shown below.

Table 4. description of the register function

ADDR	register	function	setting
00H	OP3	Software shutdown	0:shutdown, 1:operation
	OP2	Auto shutdown/Continuous operation	0:auto shutdown, 1:continuous operating function
	PROX	detection/non-detection	0:non-detection, 1:detection
	FLAG	interrupt result	0:non-interrupt, 1:interrupt
01H	INTVAL[1:0]	Intermittent operating	00: 0msec, 01: 1.56msec, 10: 6.25msec, 11: 25msec
	INTSEL[2:0]	The interrupt data setting	000:D0[13:0], 001:D1[13:0], 010:D2[13:0], 011:D3[13:0], 100:D4[15:0], 101~111:not allowed
	PIN	INT terminal setting	0:FLAG, 1:PS(Detection/Non-detection)
	INTTYPE	Interrupt type setting	0:level, 1:pulse
	RST	Software Reset	0:not reset, 1:reset
02H	PRST[2:0]	Number of measurement cycles	000：once - 111：8cycles
	RES[1:0]	Resolution	00:14bits(6.25msec),01:12bits(1.56msec),10:10bits(0.39msec),11:8bits(0.1msec)
	RANGE[2:0]	Maximum measurable range	000:×1 - 111:×128
03H	IS[2:0]	LED drive peak current setting	000:17.5mA、001:35.0mA、010:70mA、011:140mA、111:193mA、
	SUM[2:0]	LED pulse setting	000:not allowed, 001:×2 to 111:×128
	PULSE[1:0]	LED pulse width setting	00:9.16us, 01:6.11us, 10:4.58us, 11:3.82us
04H.05H	TL	Low threshold setting(Loff)	16bits counts setting
06H,07H	TH	High threshold setting(Lon)	16bits counts setting
08H,09H	OS_DATA0	DATA0 offset count(Offset0)	14bits counts setting
0AH,0BH	OS_DATA1	DATA1 offset count(Offset1)	14bits counts setting
0CH,0DH	OS_DATA2	DATA2 offset count(Offset2)	14bits counts setting
0EH,0FH	OS_DATA3	DATA3 offset count(Offset3)	14bits counts setting
10H,11H	D0	DATA0 result	14bits output data of Photodiode0
12H,13H	D1	DATA1 result	14bits output data of Photodiode1
14H,15H	D2	DATA2 result	14bits output data of Photodiode2
16H,17H	D3	DATA3 result	14bits output data of Photodiode3
18H,19H	D4	DATA0-DATA3 sum	16bits output data of all Photodiode(D4=D0+D1+D2+D3)

4.4. Register settings for Basic operation

4.4.1. Software-shutdown: OP[3] （ADDRESS:00H）

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

OP [3] register (Address 00H)

0: shutdown mode

1: operating mode.

4.4.2. Auto-shutdown/Continuous operation: OP[2]（ADDRESS:00H）

Select auto-shutdown mode or continuous operating mode. After shutdown, OP[3] register will be automatically cleared.

OP [2] register (Address 00H)

0: auto shutdown mode

1: continuous operating mode.

4.4.3. Intermittent operating function: INTVAL[1:0]（ADDRESS 01H）

Enable to change intermittent operating periods by setting INTVAL [1:0] register (Address 01H).

00: 0msec, 01: 1.56msec, 10: 6.25msec, 11: 25msec

Intermittent operating will be done during period set by INTVAL [1:0] register.

For GS mode, in case of INTVAL[1:0]=10(6.25msec), quiescent operation time will be after GS 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.

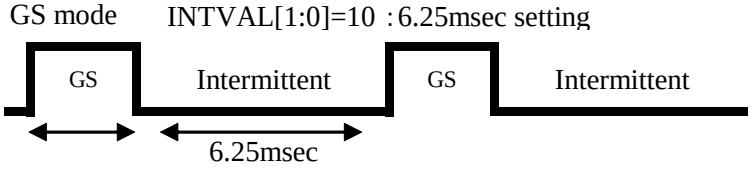


Fig.6 Intermittent operating

4.4.4. Interrupt data setting: INTSEL[2:0]（ADDRESS 01H）

Select interrupt data souce by setting INTSEL[2:0] register (Address 01H).

Table 5. Number of measurement cycles setting

INTSEL[2:0]	The interrupt data	Remarks
000	D0[13:0]	
001	D1[13:0]	
010	D2[13:0]	
011	D3[13:0]	
100	D4[15:0]	recommended(proximity)
101	NA	
110	NA	
111	NA	

＊Grayed-out portions is not recommended.

4.4.5. INT terminal setting: PIN（ADDRESS 01H）

Select output mode in INT terminal by setting PIN register (Address 01H).
The outputs by FLAG, PROX can be selected.

Table 6. INT terminal setting

PIN	Setting	Output data
0	Interrupt output	FLAG
1	Detection/Non-detection judgment output	PROX

4.4.6. Interrupt type setting: INTTYPE (ADDRESS:01H)

Select level interrupt type or pulse interrupt type.
INTTYPE register (Address 01H)

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.

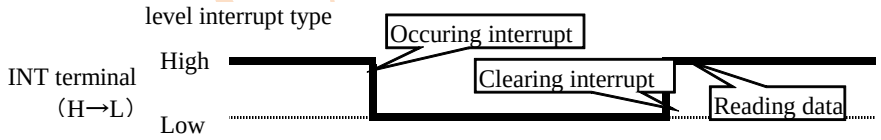


Fig.7 Interrupt output (level interrupt type)

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). FLAG are cleared automatically in 1 clock (about 0.39us).

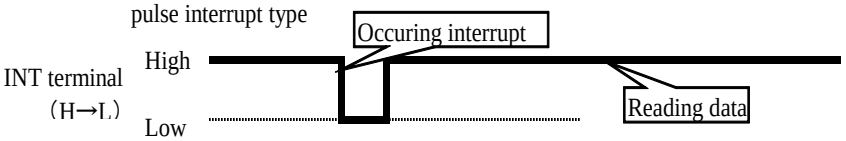


Fig.8 Interrupt output (pulse interrupt type)

4.4.7. Software reset: RST（ADDRESS 01H）

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

5. Register settings for GS and PS

5.1. Output value of sensing result for detection/non-detection: PROX （ADDRESS 00H）

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

PROX register(Address 00H): 0: non-detection, 1: detection

5.2. Output value of interrupt result: FLAG（ADDRESS 00H）

FLAG register is output interrupt result.

There is a function which clears by writing 0 in d FLAG register.

FLAG register (Address 00H) : 0: non-interrupt, 1: interrupt

5.3. Number of measurement cycles setting: PRST[2:0] (ADDRESS:02H）

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 (D4[15:0]).

Table 7. Number of measurement cycles setting

PRST[2:0]	Persistance Cycle	Remarks
000	1cycle	recommended(gesture)
001	2cycles	
010	3cycles	
011	4cycles	
100	5cycles	
101	6cycles	
110	7cycles	
111	8cycles	

・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

5.4. Resolution/Measuring duration setting: RES [1:0]（ADDRESS 02H）

Select measuring resolution and measuring duration by setting RES[1:0] register (Address 02H).

If resolution is low, measuring tolerance becomes large. Please have an adjustment at your system.

Table 8. Resolution/Measuring duration setting

RES[1:0]	Resolution	Measuring duration	Remarks
00	14bit	6.25msec	recommended
01	12bit	1.56msec	
10	10bit	0.39msec	
11	8bit	0.098msec	

＊Grayed-out portions is not recommended.

5.5. Maximum measurable range: RANGE[2:0]（ADDRESS 02H）

Select maximum measurable range by setting RANGE [2:0] register (Address 02H).

Detect with a set range. Maximum count value is outputted in case of incident light exceeding maximum measurable range.

Changing maximum measurable range, detection result count is also change. In case of considering 000: ×1 setting as ×1 time, count would be 1/2 times at 001: ×2 setting, 1/4 times at 010: ×4 setting. Adjusting detecting distance by proximity low threshold TL[15:0] and TH[15:0]. It is necessary to set them considering the condition in the actual use and evaluating at your system.

Table 9. Maximum measurable range

RANGE[2:0]	Maximum measurable range	Remarks
000	×1	
001	×2	recommended
010	×4	
011	×8	
100	×16	
101	×32	
110	×64	
111	×128	

＊Grayed-out portions is not recommended.

5.6. LED drive peak current setting IS[2:0]（ADDRESS 03H）

Enable to select LED drive peak current by setting IS[2:0] register (Address 03H).

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 TL[15:0] and proximity high threshold TH[15:0].

LED drive peak current will depend on Vcc voltage. (Refer to 12.1. LED drive peak current data)

Table 10. LED drive peak current

IS[2:0]	LED drive peak current	Remarks
000	17.5 mA	
001	35 mA	
010	70 mA	
011	140 mA	recommended
111	193 mA	

＊Grayed-out portions is not recommended.

5.7. LED pulse setting: SUM[2:0] （ADDRESS 03H）

Select LED pulse setting by setting SUM[2:0] register (Address 03H).

If LED pulse setting is low, measuring tolerance becomes large. Please have an adjustment at your system.

Number of LED pulses can be changed from 2times to 128times.

Table 11. LED pulse setting

SUM[2:0]	LED pulse setting	Remarks
000	NA	
001	×2 times	
010	×4 times	
011	×8 times	
100	×16 times	recommended
101	×32 times	
110	×64 times	
111	×128 times	

＊Grayed-out portions is not recommended.

5.8. LED pulse setting: PULSE[1:0] （ADDRESS 03H）

Select LED pulse width setting by setting PULSE[1:0] register (Address 03H).

Table 12. LED pulse width setting

PULSE[1:0]	LED pulse width(usec)	Remarks
00	9.16	recommended
01	6.11	
10	4.58	
11	3.82	

＊Grayed-out portions is not recommended.

5.9. Gesture and Proximity low threshold (Loff):TL[15:0]（ADDRESS 04H、05H）

Sets proximity low threshold in TL[15:0] register at PS mode.
Please set it with confirming at optical mounting condition in the actual use.

5.10. Gesture and Proximity high threshold (Lon):TH[15:0]（ADDRESS 06H、07H）

Sets proximity high threshold in TH[15:0] register at PS mode.
Please set it with confirming at optical mounting condition in the actual use.

5.11. Gesture offset (Offset):OS_D0[13:0],OS_D1[13:0],OS_D2[13:0],OS_D3[13:0]（ADDRESS 08H~0FH）

Sets proximity offset in PO[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.

5.12. GS Detection result: D0[13:0], D1[13:0], D2[13:0], D3[13:0], D4 [15:0]（ADDRESS 10H~19H）

Detection result of gesture sensing is output to D0[13:0], D1[13:0], D2[13:0], D3[13:0] and D4[15:0] register (Address 10H~19H).

Detection result is defined as follows,

Detection result(D0[13:0]) = Raw count(D0[13:0], include panel crosstalk) – Offset(OS_D0[13:0])
Detection result(D1[13:0]) = Raw count(D1[13:0], include panel crosstalk) – Offset(OS_D1[13:0])
Detection result(D2[13:0]) = Raw count(D2[13:0], include panel crosstalk) – Offset(OS_D2[13:0])
Detection result(D3[13:0]) = Raw count(D3[13:0], include panel crosstalk) – Offset(OS_D3[13:0])

Gesture detection:

If the detected object on the right, D0[13:0]+D3[13:0] > D1[13:0]+D2[13:0].
If the detected object on the left, D0[13:0] +D3[13:0] < D1[13:0]+D2[13:0].
If the detected object on the top, D0[13:0]+D1[13:0] > D2[13:0]+D3[13:0].
If the detected object on the bottom, D0[13:0]+D1[13:0] < D2[13:0]+D3[13:0].

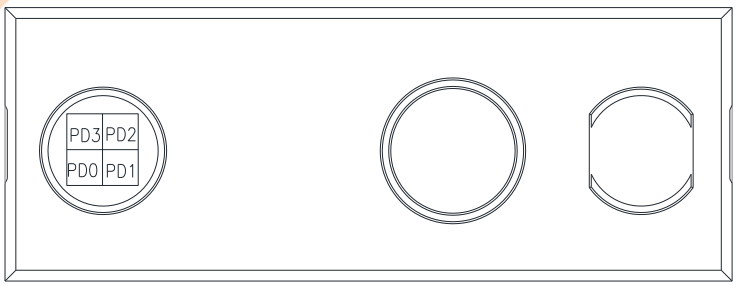


Fig.9 The built-in Photodiodes position(PD0, PD1, PD2, PD3).

Photodiode0(PD0) count value is stored to the raw count of D0[13:0].
Photodiode1(PD1) count value is stored to the raw count of D1[13:0].
Photodiode2(PD2) count value is stored to the raw count of D2[13:0].
Photodiode3(PD3) count value is stored to the raw count of D3[13:0].

5.13. Saturation Detection result of the integrator: SAT0, SAT1, SAT2, SAT3（ADDRESS 11H, 13H, 15H, 17H）

Saturation detection result of the integrator is output to SAT0, SAT1, SAT2, SAT3 register (Address 11H, 13H, 15H, 17H).

If the integrator(PD0) is saturated, SAT0 register is set to 1.
If the integrator(PD1) is saturated, SAT1 register is set to 1.
If the integrator(PD2) is saturated, SAT2 register is set to 1.
If the integrator(PD3) is saturated, SAT3 register is set to 1.

6. INT terminal output mode

6.1. Proximity detection/non-detection sensing result output mode

INT terminal operates with sensing result output mode by setting PIN register(Address 01H) 11: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.

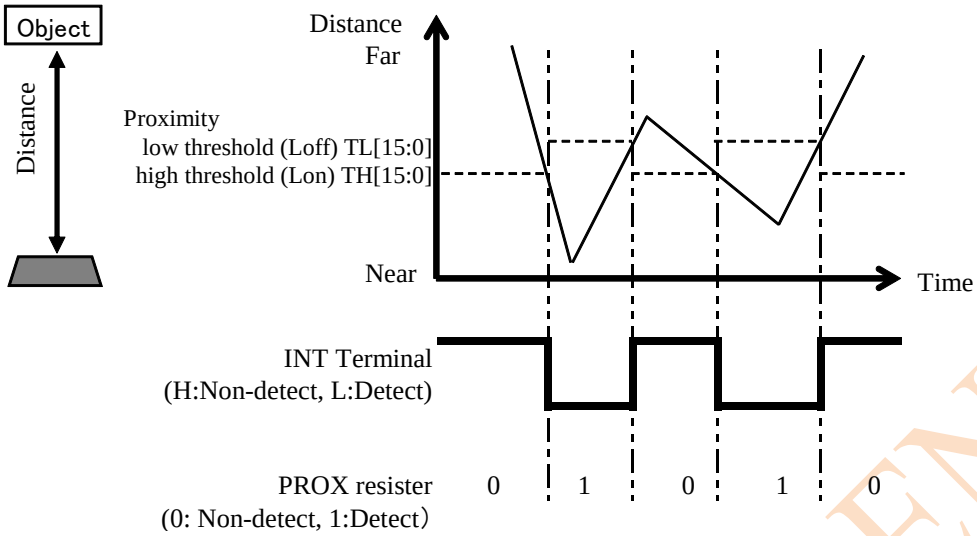


Fig.10 Detection result output mode

6.2. Interrupt output mode

Operates as interrupt output mode by setting PIN register (Address 01H) 0,1: interrupt output mode.

There are two kinds of output mode(level interrupt & pulse interrupt, see **4.4.5. Interrupt type setting**). Below is a description of the level interrupt type.

The result of interrupt judgment is written into FLAG register (Address 00H), 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 register.

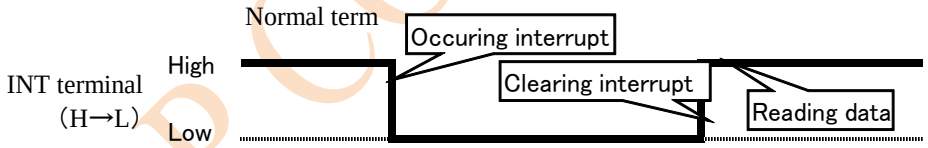


Fig.11 Interrupt output (level interrupt type)

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

For example, as shown in below diagram,
Interrupt occurs with FLAG=1: interrupt
Actual object moves “Detection” to “Non-detection” to “Detection” while interrupt is cleared.

In this case, while INT terminal (FLAG register) is hold, PROX value will be updated with result of judgment for detection/non-detection of object.

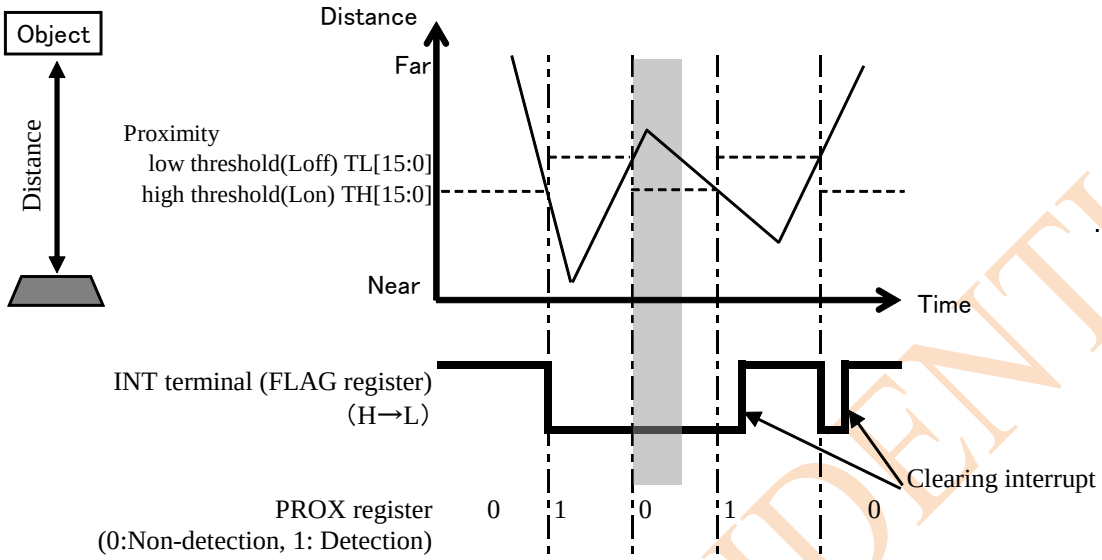


Fig.12 Interrupt output mode (level interrupt type)

7. Average consumption current in operation

7.1. Average consumption current in operation

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.

7.2. Average consumption current at gesture sensor (GS) and proximity sensor(PS) mode

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× 9.2usec)/ (measuring time + Intermittence time)
[LED drive peak current]: IS[2:0] register.
000：17.5mA, 001：35.0mA, 010：70mA, 011：140mA, 111：193mA
[LED pulse setting]: SUM[2:0] register.
000：NA, 001：x2, 010：x4, 011：x8, 100：x16, 101：x32, 110：x64, 111：x128
[measuring time]：Enable to set with RES[1:0] register.
00：6.25msec(14bit), 01：1.56msec(12bit), 10：0.39msec(10bit), 11：0.098msec(8bit)
[Intermittence operating time]：Enable to set with INTVAL[1:0] register.
00：0msec, 01：1.56msec, 10：6.25msec, 11：25msec

For example,

[LED drive peak current]	：140mA	IS[2:0]=011
[LED pulse setting]	：x16	SUM[2:0]=100
[LED pulse width setting]	：9.2usec	PULSE[1:0]=00
[measuring time]	：6.25msec(14bit)	RES[1:0]=00
[Intermittence operating time]	：0msec	INTVAL[1:0]=00

In the above case,
[LED averaging consumption current] ＝ 140mA × 16 × 9.2usec ／（6.25msec + 0msec） ＝ 3.3mA

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.

8. Countermeasure against external light noise

8.1 Countermeasure against external light noise

This product makes judgment of detection/non-detection by integrating light amount in PD for setting duration.
This device store a signal charge which is subtracted LED-off period charge from LED-on period charge automatically.

9. Recommended operating mode/Procedure of register setting

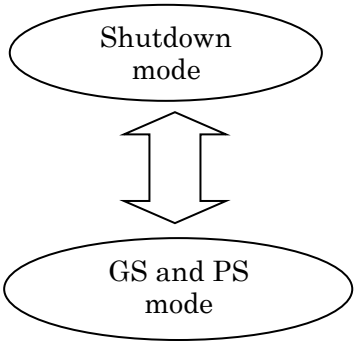


Fig.13 Recommended operating mode

9.1. Shutdown mode

Below is an example of shutdown mode.
If you shut down, the INT terminal states are maintained. The power consumption will increase as the INT terminal keeps low level. It is recommended that you clear the interrupt.

Table 12. example of setting for Shutdown mode

Setting	Example	Register
Operation mode	Shutdown	OP[3]=b'0
Detection/non-detection sensing result	Clear	PROX=b'0
Detecting interrupt result	Clear	FLAG=b'0

Table 13. example of register setting table for Shutdown mode

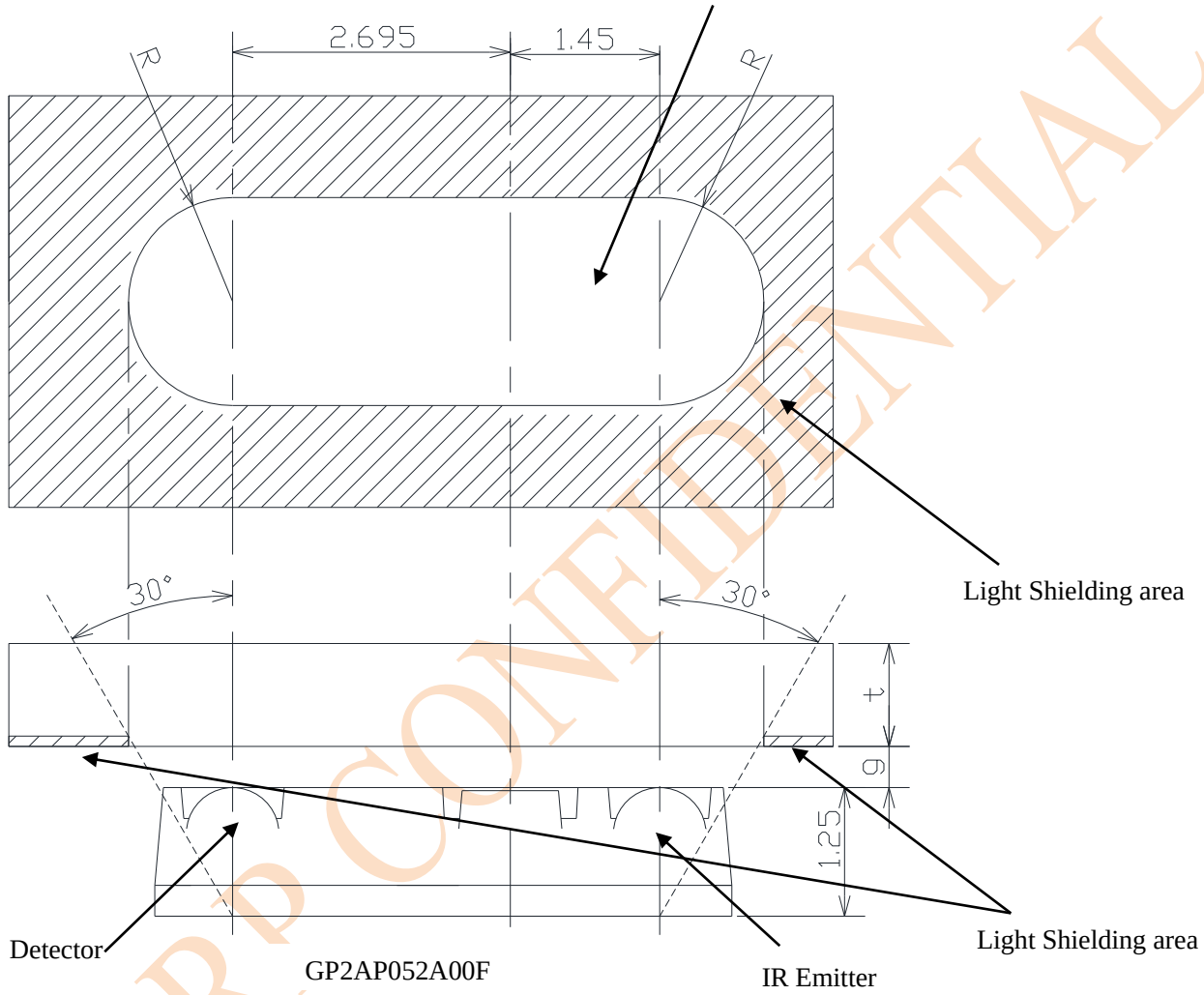
Register ADDRESS	Register SYMBOL	Register value		Remarks
		Bite	Hex	
00H	COMMAND I	b'0000_0000	h'00	

10. Sample programs

For the source code, if desired, and we submit.

11. Recommended Window Size (Reference)

The transmissivity of the filter recommends more than 20%±5%.
(wavelength λ=400nm to 700nm)
The transmissivity of the filter recommends more than 80% ±5%.
(wavelength λ=940nm)



R = (1.25 + g)×tan30°
g≦1.0mm（recommended） g : distance between sensor and panel
t≦0.8mm（recommended） t : thickness of panel

Fig.14 Recommended window size (Without light shield)

1. Please print not to transmit infrared.
2. Even recommended window size may cause malfunction depending on the reflection from the panel.
   In this case, it is effective to be extended the printing area between windows, but affects detection distance and ALS output.
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.

12. Data (Reference)

12.1. LED drive peak current

12.1.1. LED drive peak current vs. VLED (Vcc=VLED)

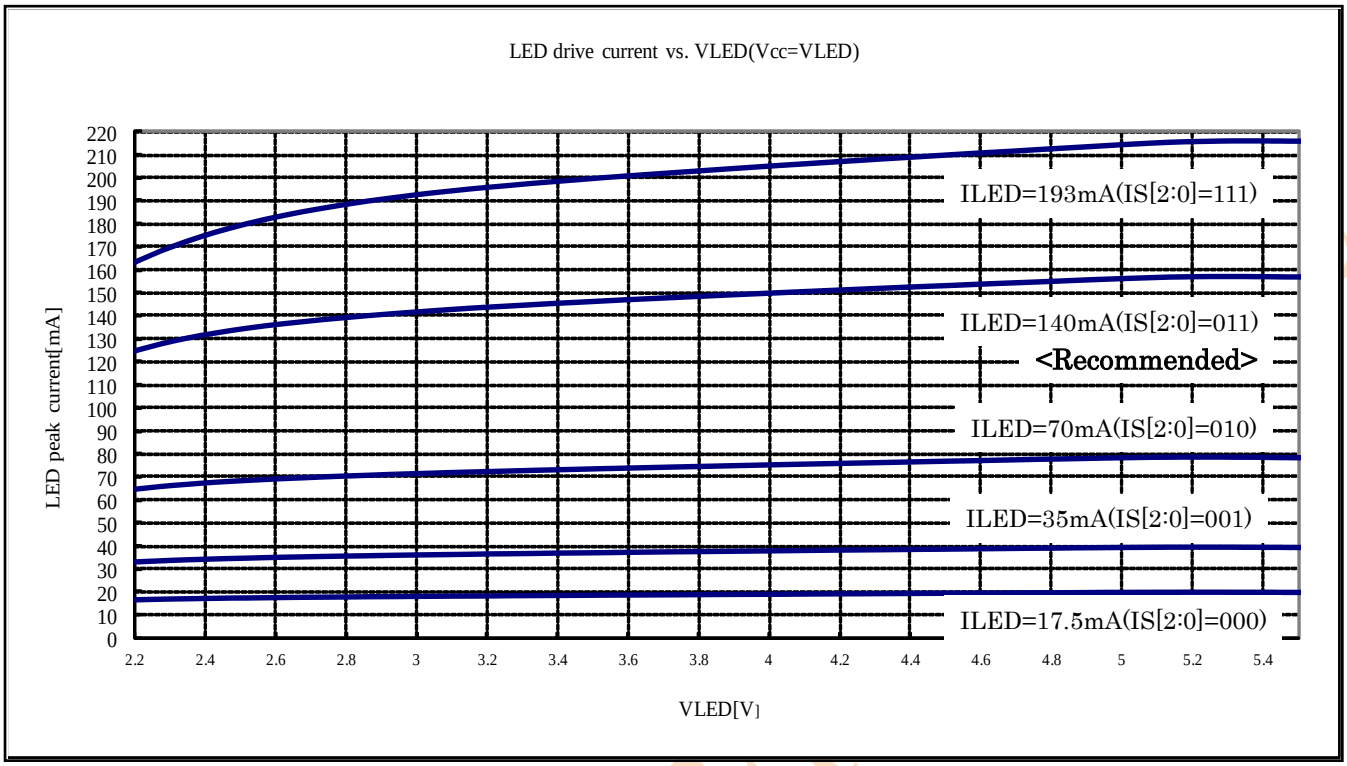


Fig.15 LED drive peak current vs. VLED

12.1.2. LED drive peak current vs. Vcc (VLED=3V)

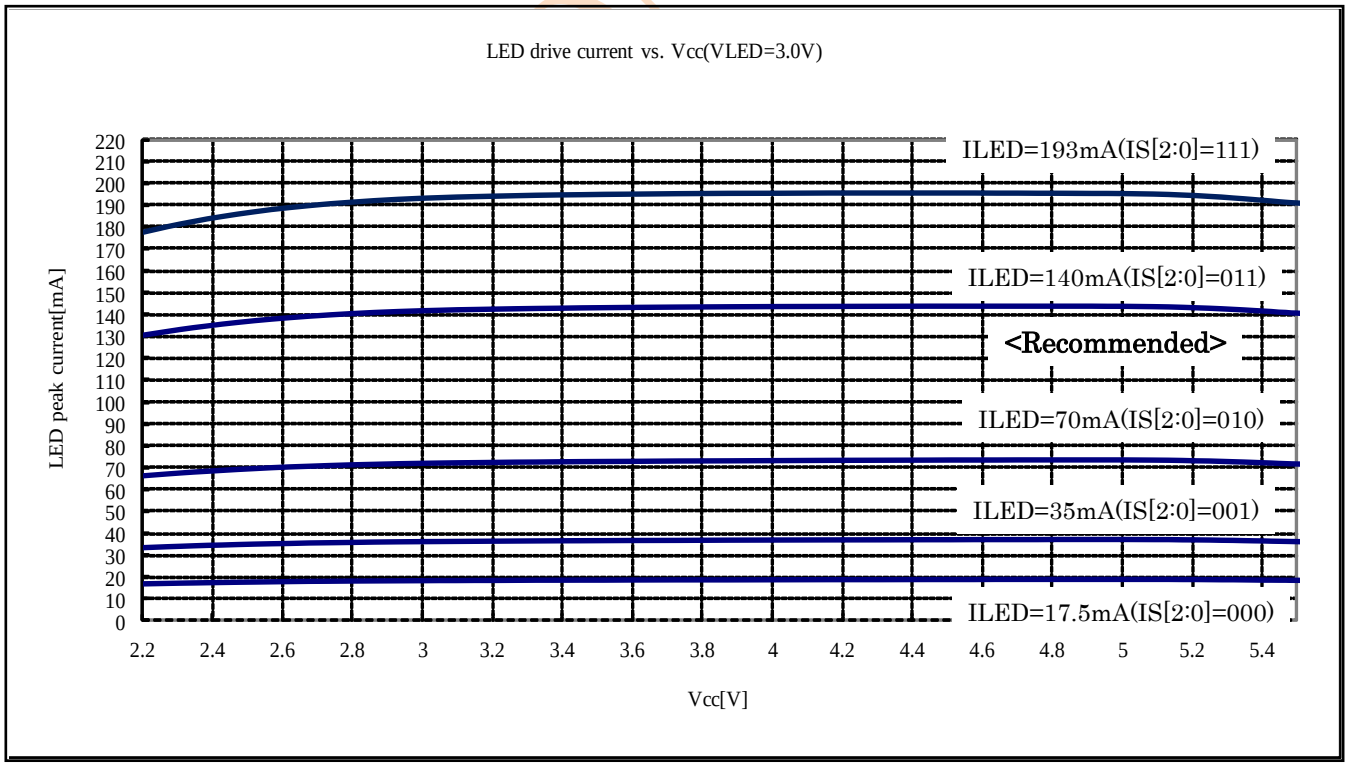


Fig.16 LED drive peak current vs. Vcc

12.1.3. Proximity sensor

Sensor output counts(D4) vs. distance

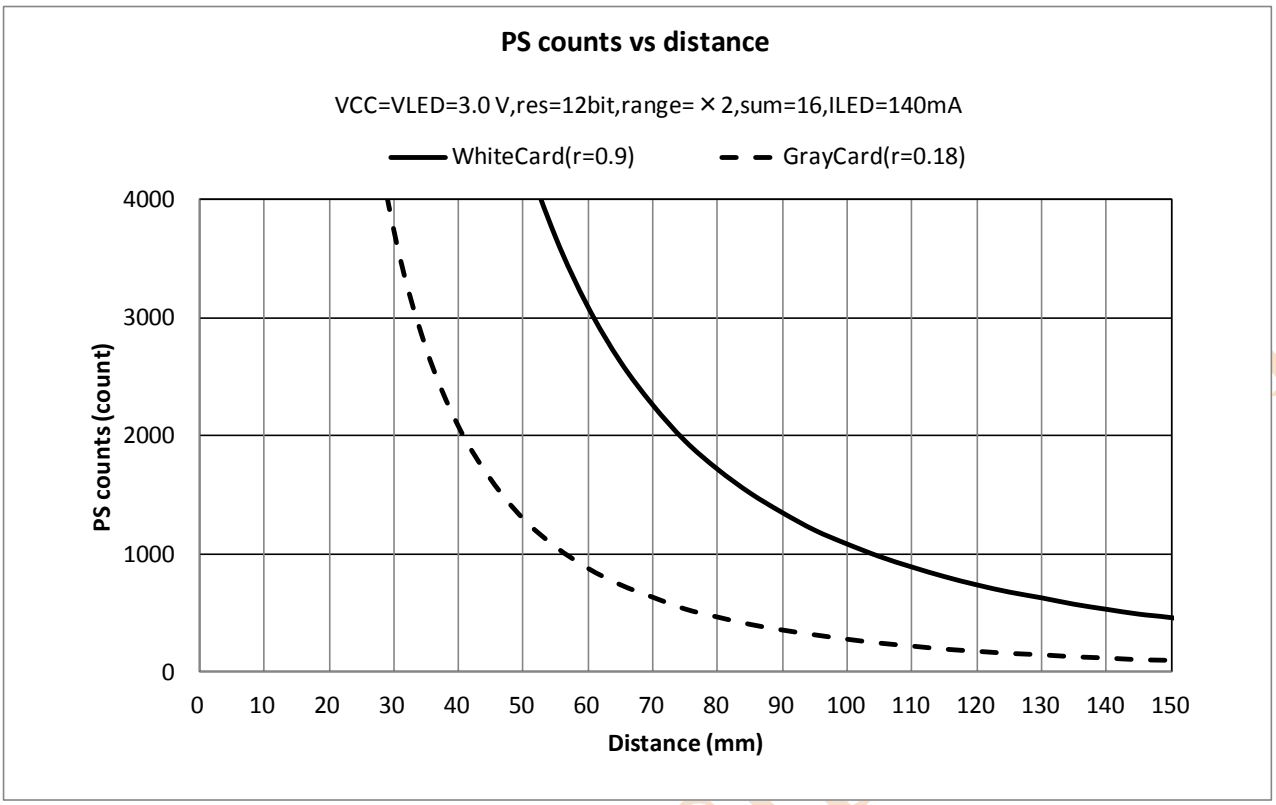


Fig.17 Sensor output counts vs. distance