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1. Abstract

GA1AUV100WP is ultraviolet sensor & ambient light s sensing by setting register.

Ultraviolet sensor (UV) mode: Detection result of ultraviolet can be referred by reading register value(16bit) via I^2C bus interface.

Ambient light sensor (ALS) mode: Detection result of ambient light can be referred by reading register value(16bit) via I^2C bus interface.

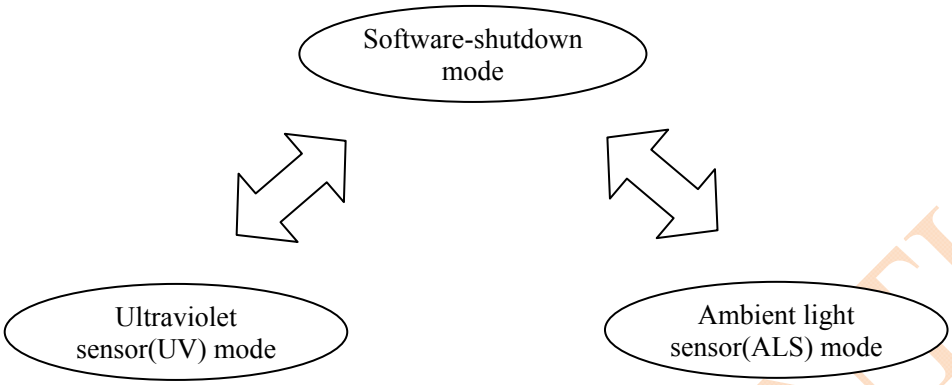

Fig.1 Operating mode of GA1AUV100WP

1.1. Features

- **Design**

  This product is composed of following a chip in a package, which is IC with the four built-in PD(photodiode) for ultraviolet sensors and ambient light sensors.

  Achieving Small package by transparent resin.

- **I^2C bus interface**

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

- **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 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.

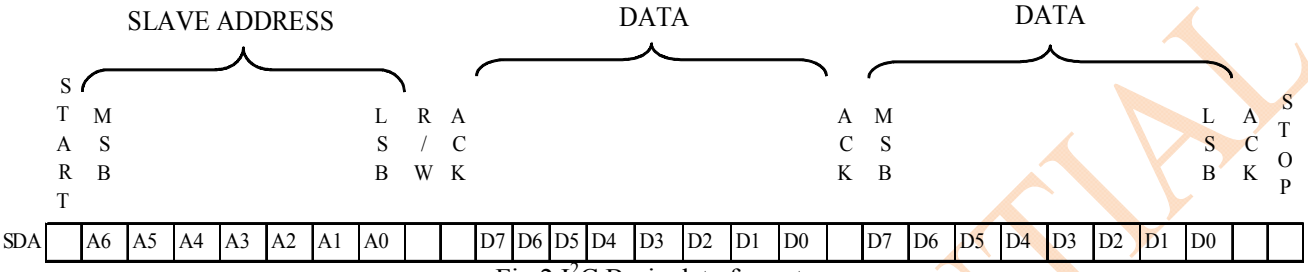

Fig.2 I²C Basic data format

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

Table 2. I²C slave address

A6	A5	A4	A3	A2	A1	A0	R/W
0	0	1	0	0	0	0	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 FLAG register in 00H are read only.
WordAddress:04H～07H D0[15:0] and D1[15:0] registers from 04H to 07H are read only.
WordAddress:08H ID[7:0] register in 08H are read only.

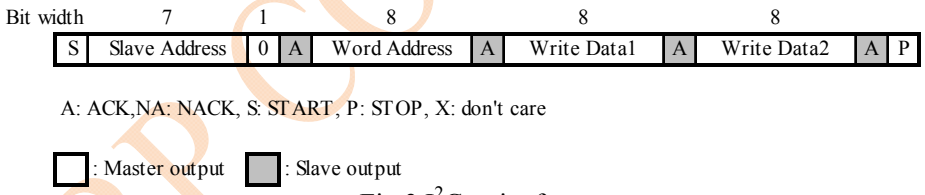

Fig.3 I²C write format

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.

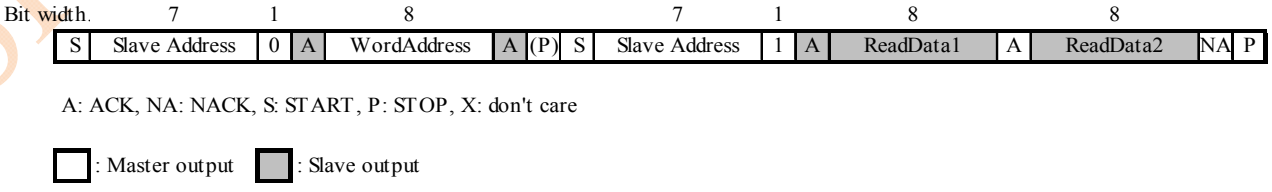

Fig.4 I²C read format

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 UV mode and ALS mode switch, please shutdown and switched again.

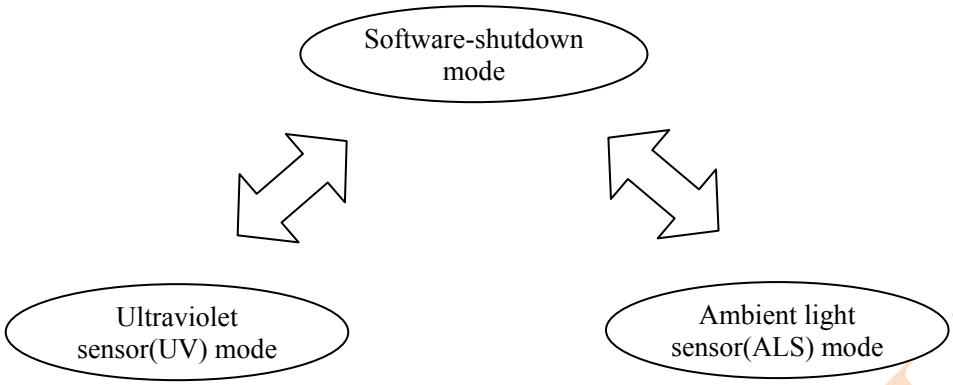

Fig5. Recommended operating mode

2.1. Ultraviolet sensor(UV) mode

The device can possible to operate both UV mode or ALS mode.
Below is an example of UV mode.

Table 3. Example of setting for UV mode

ADDR	Register value		Register Setting	Example	
	bite	Hex			
00h	1000_0000	80h	OP[3]=1b OP[0]=0b	Active UV mode	
01h	0000_0000	00h	PD0=0b	UV PD mode	
02h	0010_0101 ⇔ 0111_0101	25h ⇔ 75h	RANGE[2:0]=0010b⇔0111b RES[2:0]=101b	x4⇔x128 range Measurement time=25ms	Maximum detectable range(UV)*1
03h	0000_0000	00h	INTVAL=000b	Interval time=0.0msec	

*1 The range(×1 to ×256) is switched according to the D0 data.
Low_power_mode:×1⇔High_power_mode:×256

Ultraviolet sensing results can be read at D0[15 :0] and D1[15 :0] register through I^2C bus interface.
The device continues to execute integration operation until set measuring time(25msec, recommended) passes.
The device output raw data of UV phtodiode and UV photodiode with UV cut filter. It is necessary for device host (user side) to get UV intensity with calculation of both UV data at D0[15 :0] and UV cut data at D1[15 :0].

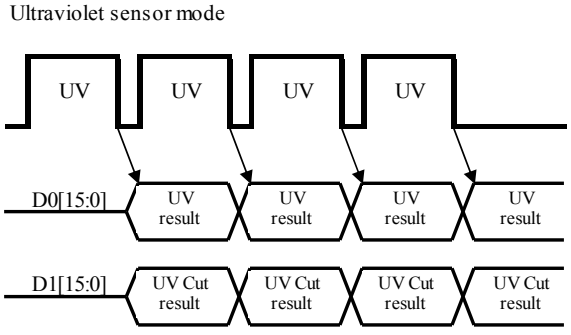

Fig.6 Output results for UV mode

2.2. Ambient light sensor(ALS) mode

The device can possible to operate both UV mode or ALS mode.
Below is an example of ALS mode.

Table 4. Example of setting for ALS mode

ADDR	Register value		Register Setting	Example	
	bite	Hex			
00h	1001_0000	90h	OP[3]=1b OP[0]=1b	Active ALS mode	
01h	0100_0000	40h	PD0=1b	ALS PD mode	
02h	0010_0101 ⇔ 1111_0101	25h ⇔ F5h	RANGE[3:0]=0010b⇔1111b RES[2:0]=101b	x4⇔x256 range Measurement time=25ms	Maximum detectable range(ALS)*2
03h	0000_0000	00h	INTVAL=000b	Interval time=0.0msec	

*2 The range(×1 to ×256) is switched according to the D0 data.
Low_lux_mode:×1⇔High_lux_mode:×256

Ambient light sensing results can be read at D0[15:0] and D1[15:0] register through I^2C bus interface.
The device continues to execute integration operation until set measuring time(25msec, recommended) passes.
The device outputs raw data of CLEAR photodiode sensitive to both visible and infrared spectrum and IR photodiode sensitive to only infrared spectrum during ambient light sensing. It is necessary for device host (user side) to get illuminance value with calculation of both CLEAR data at D0[15:0] and IR data at D1[15:0].

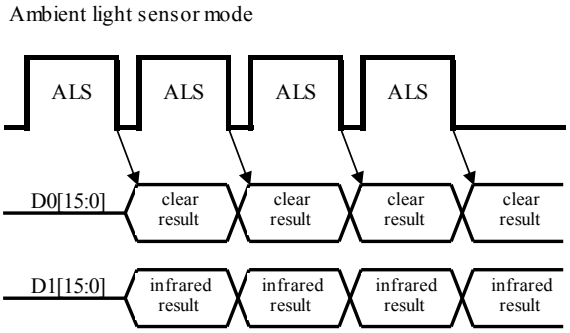

Fig.7 Output results for ALS mode

2.3. Shutdown mode

Control power supply to the circuit.
Below is an example of shutdown mode.(Average consumption current is typical 0.004mA)

Table 5. Example of setting for Shutdown mode

ADDR	Register value		Register Setting	Example	
	bite	Hex			
00h	0000_0000	00h	OP[3]=0b	Shutdown	

3. Register Mapping

3.1. Register Mapping

When Vcc power is supplied, GA1AUV100WP starts up with initializing all registers.

Table 6. Register Mapping

ADDRESS	DATA								Initial Value	R/W
	D7	D6	D5	D4	D3	D2	D1	D0		
00h	OP3	0	0	OP0	0	0	FLAG	0	00h	R/W R +clear
01h	0	PD0	0	0	0	0	0	RST	00h	R/W
02h	RANGE3	RANGE2	RANGE1	RANGE0	0	RES2	RES1	RES0	00h	R/W
03h	0	0	0	0	0	INTVAL2	INTVAL1	INTVAL0	00h	R/W
04h	D0_7	D0_6	D0_5	D0_4	D0_3	D0_2	D0_1	D0_0	00h	R
05h	D0_15	D0_14	D0_13	D0_12	D0_11	D0_10	D0_9	D0_8	00h	R
06h	D1_7	D1_6	D1_5	D1_4	D1_3	D1_2	D1_1	D1_0	00h	R
07h	D1_15	D1_14	D1_13	D1_12	D1_11	D1_10	D1_9	D1_8	00h	R
08h	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0	81h	R

3.2. 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.
- 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 09H and the larger ones. (Test registers are assigned in those addresses.)

3.3. Register Functions

Functions and set contents of the registers are shown below.

Table 7. Description of the register function

ADDR	register	function	setting
00h	OP3	Software shutdown	0:shutdown, 1:operation
	OP0	UV mode, ALS mode selection	0:UV mode, 1:ALS mode
	FLAG	interrupt result	0:non-interrupt, 1:interrupt
01h	PD0	Photodiode selection	0:UV PD mode, 1:ALS PD mode
02h	RANGE[3:0]	UV, ALS:Maximum measurable range	0000:x1, 0001:x2, 0010:x4, 0011:x8, 0100:x16, 0101:x32, 0110:x64, 0111:x128, 1111:x256
	RES[2:0]	UV, ALS:Measurement time	000:800msec, 001:400msec, 010:200msec, 011:100msec, 100:50msec, 101:25msec, 110:12.5msec, 111:6.25msec
03h	INTVAL[2:0]	Intermittent operating	000:0msec, 001:12.5msec, 010:25msec, 011:50msec 100:100msec, 101:200msec, 110:400msec, 111:800msec
04h, 05h	D0[15:0]	UV mode result:UV	16bits output data from UV-PD
		ALS mode result:Clear	16bits output data from Clear PD
06h, 07h	D1[15:0]	UV mode result:UV+UV cut filter	16bits output data from UV-PD with UV Cut filter
		ALS mode result :IR	16bits output data from IR PD
08h	ID[7:0]	Device Identification Register	1000_0000:Device ID

4. Register settings for Basic operation

4.1. Software-shutdown: OP[3] （ADDRESS:00h）

Control power supply to the circuit. 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.

4.2. Operating mode selection: OP [0] (ADDRESS:00h）

Select UV mode or ALS mode.

OP [0] register (Address 00h)
0: UV mode
Detection result of UV photodiode is output to D0[15:0] register (Address 04h, 05h).
Detection result of UV photodiode with UV cut filter is output to D1[15:0] register (Address 06h, 07h).
1: ALS mode
Detection result of clear photodiode is output to D0[15:0] register (Address 04h, 05h).
Detection result of infrared photodiode is output to D1[15:0] register (Address 06h, 07h).

4.3. Software reset: PRST (ADDRESS:01H）

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

4.4. Maximum measureable range for UV mode and ALS mode: RANGE[3:0] (ADDRESS:02h）

Select maximum measurable range for UV mode and ALS mode by setting RANGE[3:0] register(Address 02h).

Detect with a set range in UV mode and ALS mode. Maximum count value is output in case of incident light exceeding maximum measureable range.

It is possible to have countermeasure for external light by setting a large count value at maximum measurable range.

It is necessary to set then considering the condition in the actual use and evaluating at your system.

Table8. Maximum measurable range for UV mode and ALS mode

RANGE[3:0]	Maximum measurable range	Remarks
0000	×1	
0001	×2	
0010	×4	
0011	×8	
0100	×16	
0101	×32	
0110	×64	
0111	×128	
1111	×256	

4.5. Resolution /Measuring time setting for UV mode and ALS mode: RES[2:0] (ADDRESS:02h）

Select measuring resolution and measuring time for UV mode and ALS mode by setting RES[2:0] register(Address 02h).

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

Table9. Resolution/Measuring time setting for UV mode and ALS mode

RES[2:0]	Resolution(bit)	Measuring time(msec)	Remarks
000	21	800	
001	20	400	
010	19	200	
011	18	100	
100	17	50	
101	16	25	recommended
110	15	12.5	
111	14	6.25	

4.6. Interval time setting for UV mode and ALS mode: INTVAL[2:0]（ADDRESS 03H）

Select interval time for UV mode and ALS mode by setting INTVAL [2:0] register (Address 03H).

Table10. Interval time setting for UV mode and ALS mode

INTVAL[2:0]	Interval time (msec)	Remarks
000	0.0	
001	12.5	
010	25	
011	50	
100	100	
101	200	
110	400	
111	800	

Intermittent operating will be done set interval time by INTVAL[2:0] register.

For UV mode and ALS mode, in case of RES[2:0]=101(Measuring time=25msec) and INTVAL[2:0]=100(Interval time=100msec), quiescent operation time will be 100msec.

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.

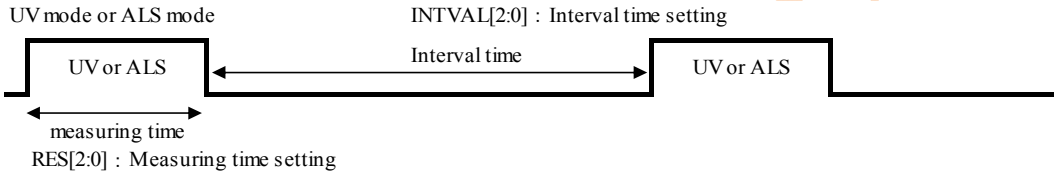

Fig.8 intermittent operating for each mode

4.7. UV detection and ALS detection result: D0[15:0], D1[15:0]（ADDRESS 04h,05h,06h,07h）

4.7.1. Detection result at UV mode (OP[0]=0b)

Detection result of UV photodiode is output to D0[15:0] register (Address 04h, 05h).

Detection result of UV photodiode with UV cut filter is output to D1[15:0] register (Address 06h, 07h).

The result of UV light intensity can be obtained by calculation using D0[15:0] and D1[15:0].

The result of UV light intensity =α*D0[15:0] – β*D1[15:0]

α and β factor are decided by ratio of D1 [15:0]/D0 [15:0].

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

4.7.2. Detection result at ALS mode (OP[0]=1b)

Detection result of clear photodiode is output to D0[15:0] register (Address 04h, 05h).

Detection result of infrared photodiode is output to D1[15:0] register (Address 06h, 07h).

The result of without infrared light can be obtained by calculation using D0[15:0] and D1[15:0].

The result of without infrared light = α*D0[15:0] – β*D1[15:0]

α and β factor are decided by ratio of D1 [15:0]/D0 [15:0].

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

4.8. Device ID : ID[7:0]（ADDRESS 08h）

Device Identification Register is 1000_0000b (81h).

5. Example of setting sequence

5.1. From Power-On to operating condition

The internal register of GA1AUV100WP are all initialized after powering on.(Power-On-Reset)
Insert a wait for at least 1ms until the Power-On-Reset state stabilizes.

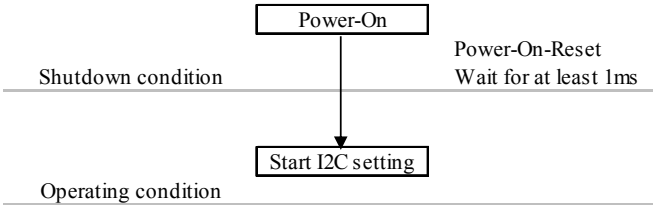

Fig.9 From Power-On to operating condition

5.2. From operating condition to Power-Off

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

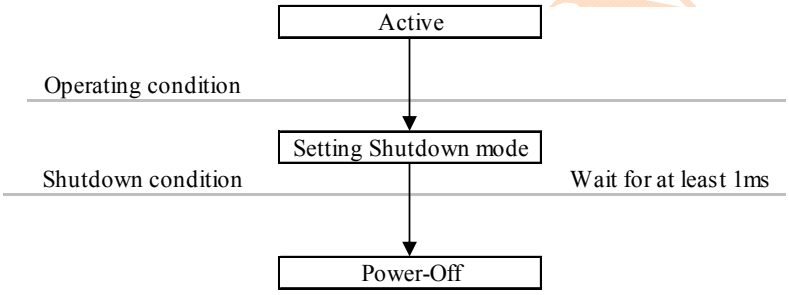

Fig.10 From operating condition to Power-Off

5.3. Power-On and Power-Off

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

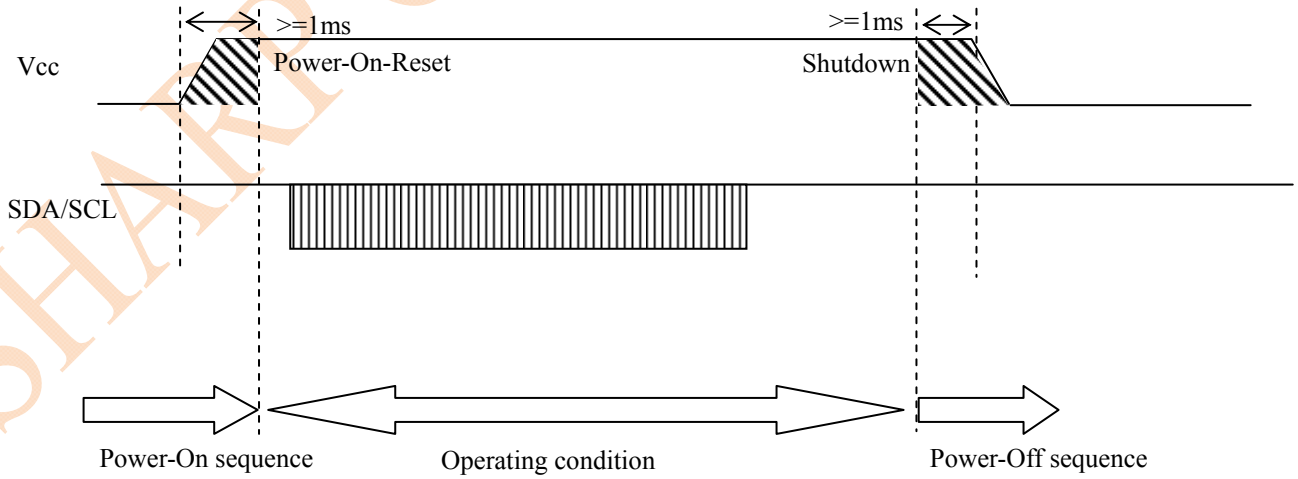

Fig.11 Power-On and Power-Off

6. Device Driver

6.1. Device Driver

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

7. Recommended Window Size (Reference)

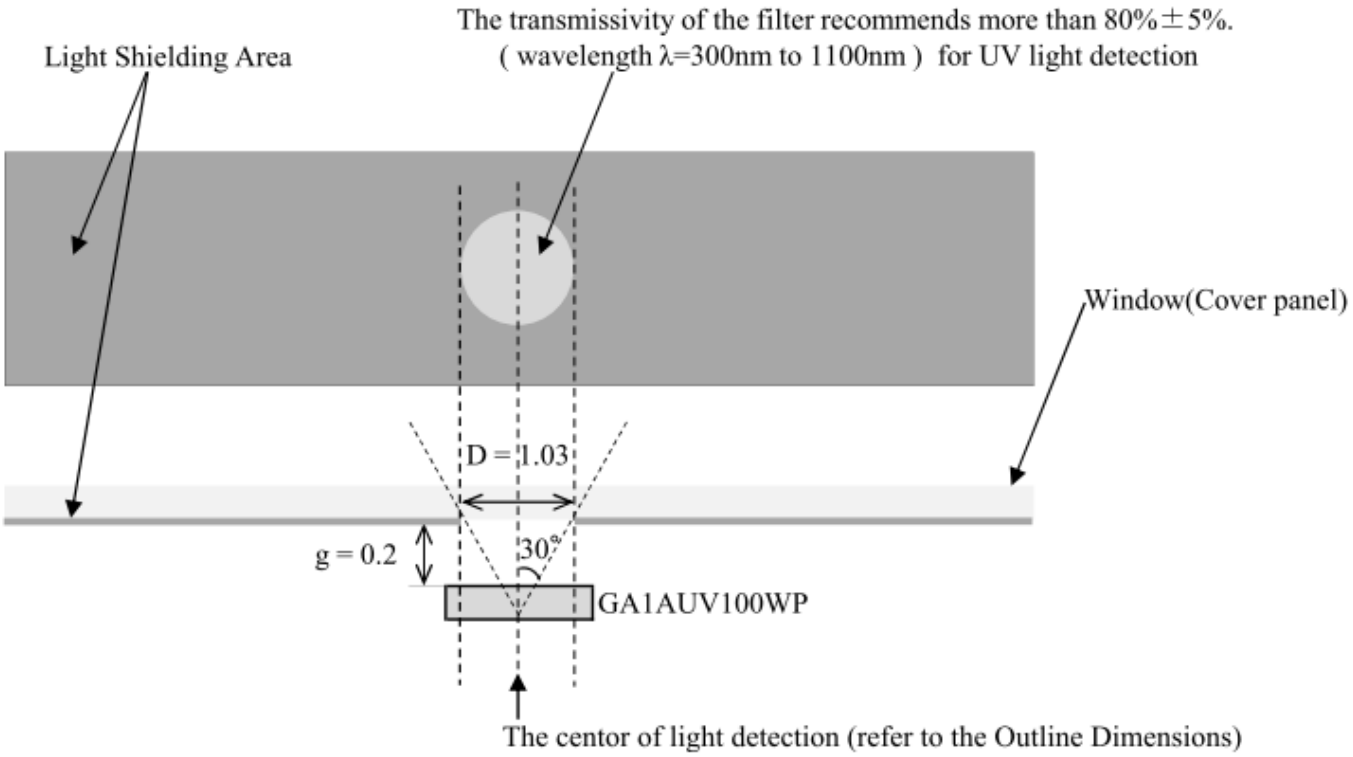

Fig12. Recommended Window Size (With Light Shield)

(Example)
In the case of "g=0.2mm"

D1 = (h+g)*(tan30°) * 2
= (0.6 + 0.2) * 0.58 *2
= 0.93 [mm]

Considering the tolerance of package
D = D1 + t
= 0.93 + 0.1
= 1.03 [mm]

D : Diameter of window (without Light Shielding Area)
g : gap from the sensor to window
h : hight of the sensor
t : tolerance of the sensor size (width or length of package)

(Note)
In addition, it is necessary to consider the error of mounting position.
Please confirm that there is no problem with an actual machine in consideration of the implementation gap, the misalignment of the windows and output variation.

8. Data (Reference)

8.1. Spectral Responsivity at UV mode

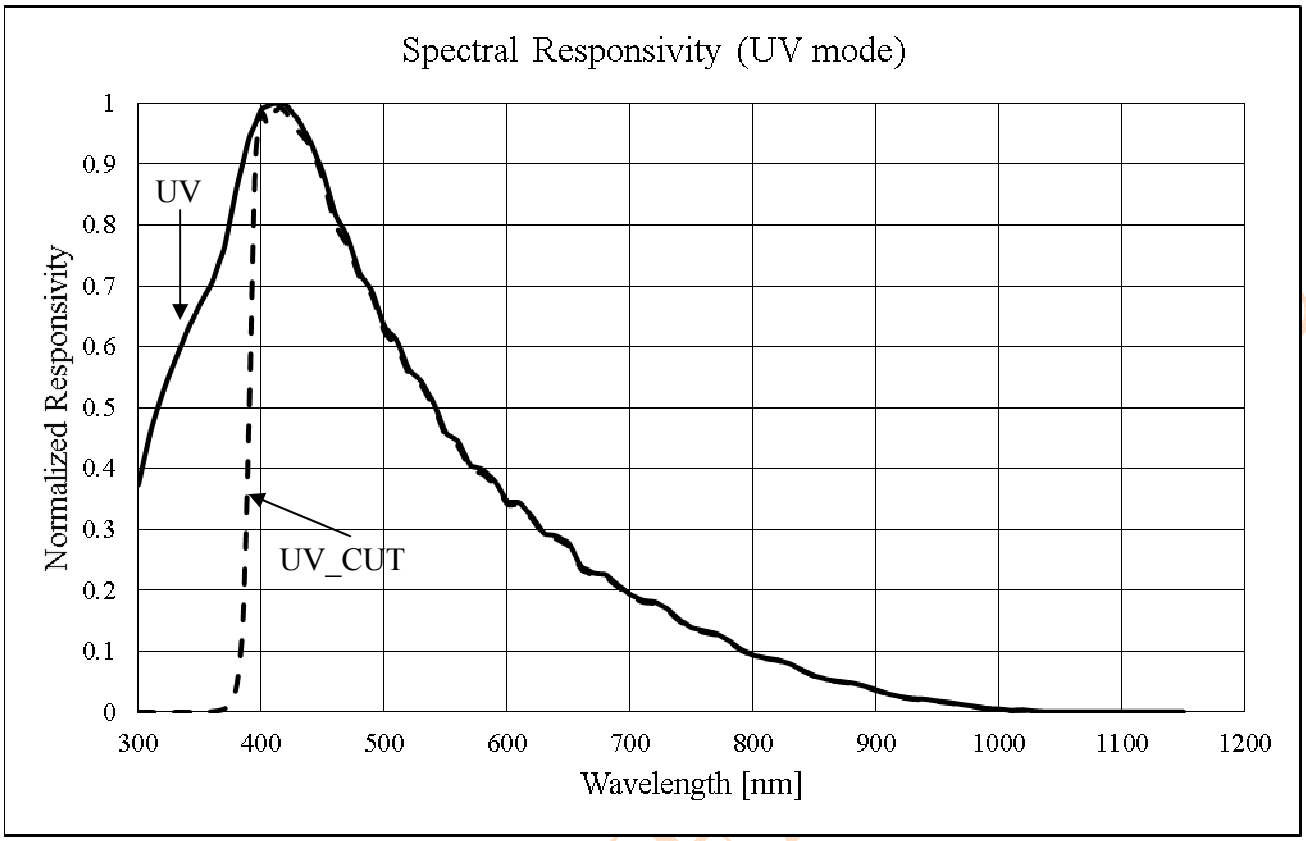

Fig.13 Spectral Responsivity (UV mode)

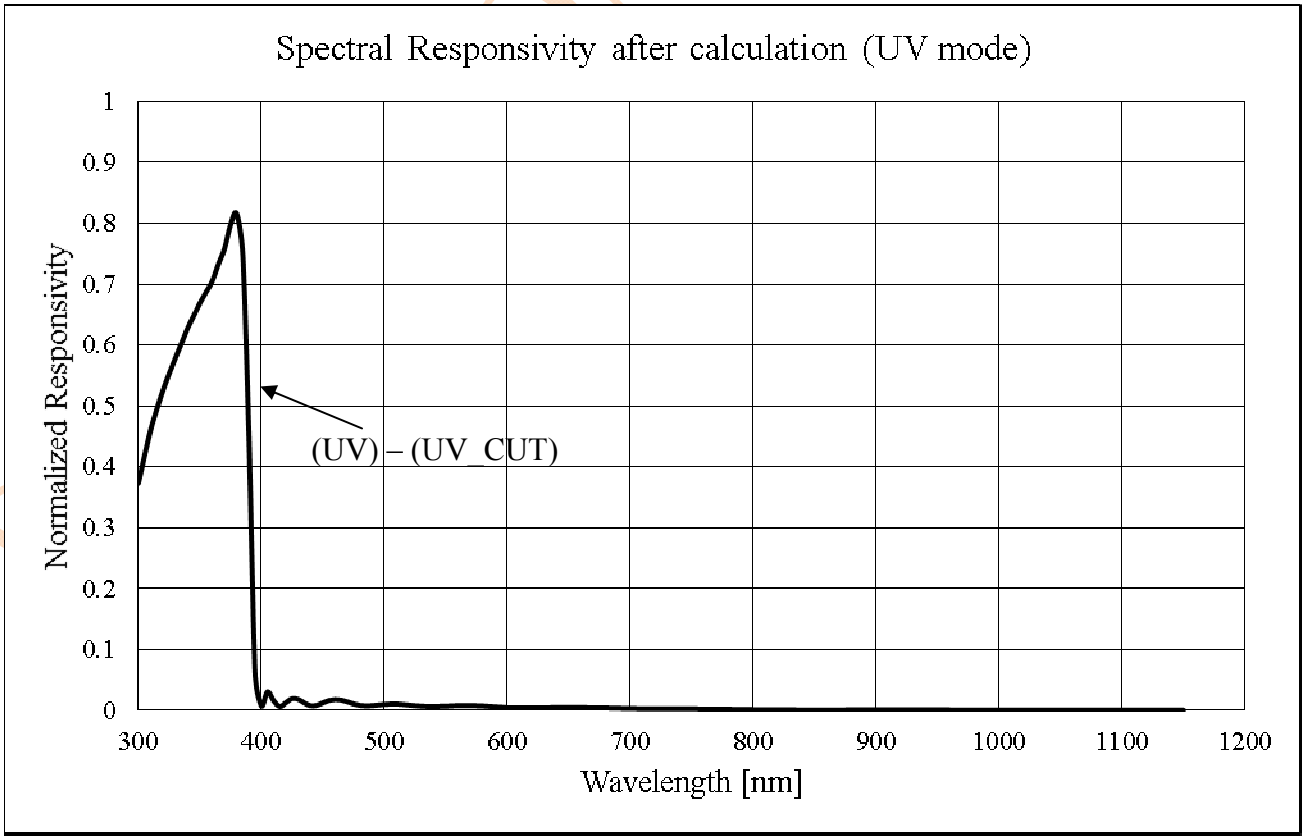

Fig.14 Spectral Responsivity after calculation (UV mode)

8.2. Spectral Responsivity at ALS mode

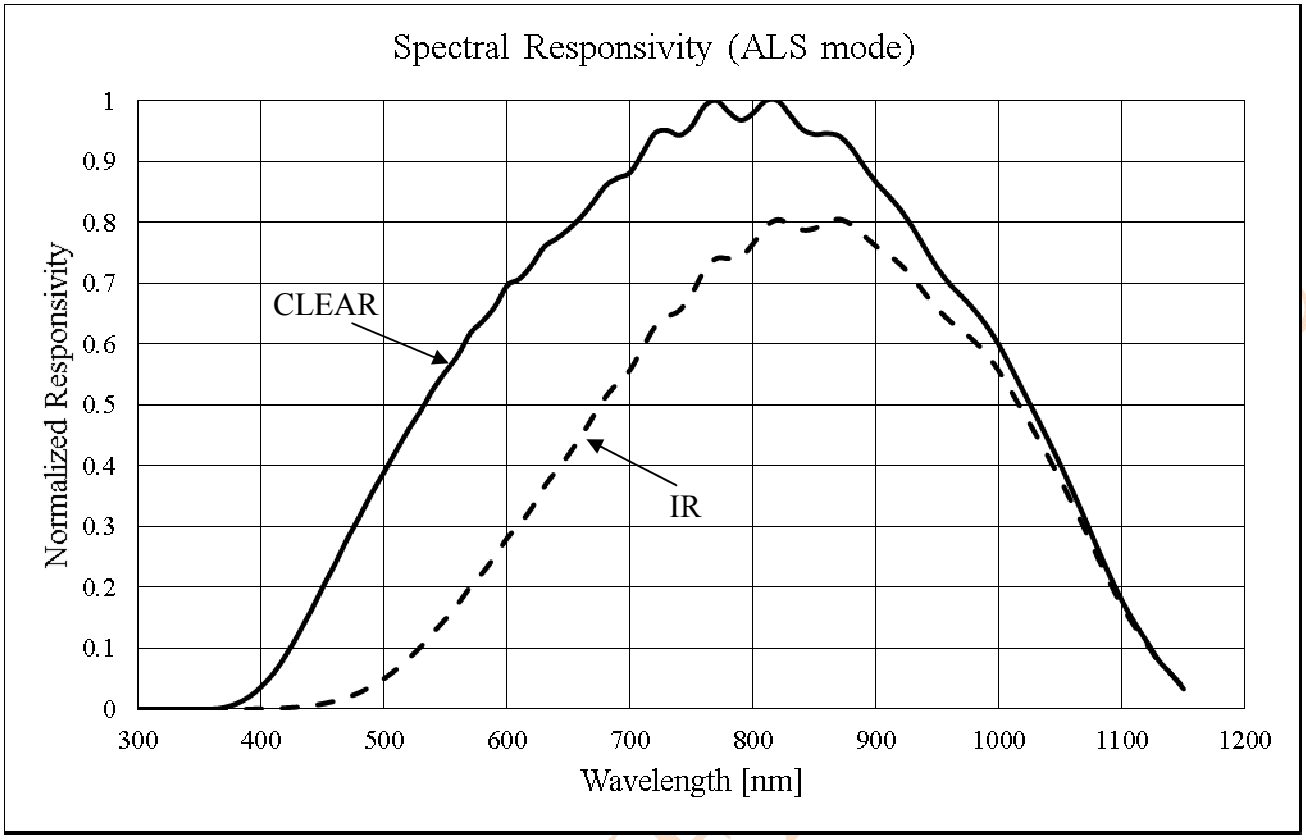

Fig.15 Spectral Responsivity (ALS mode)

8.3. Angular dependence

Normalized Responsivity vs. Angular Dependence

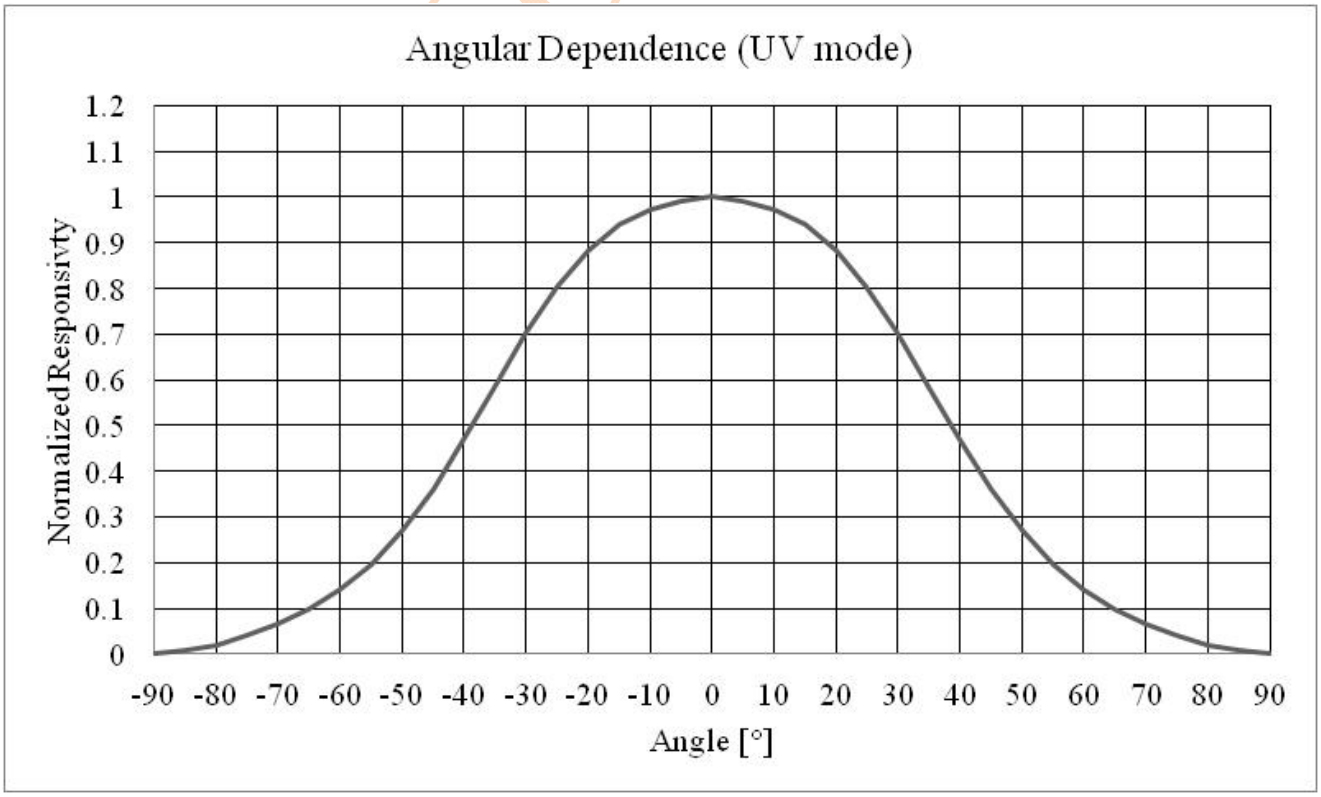

Fig.16 Angular Dependence (UV mode)

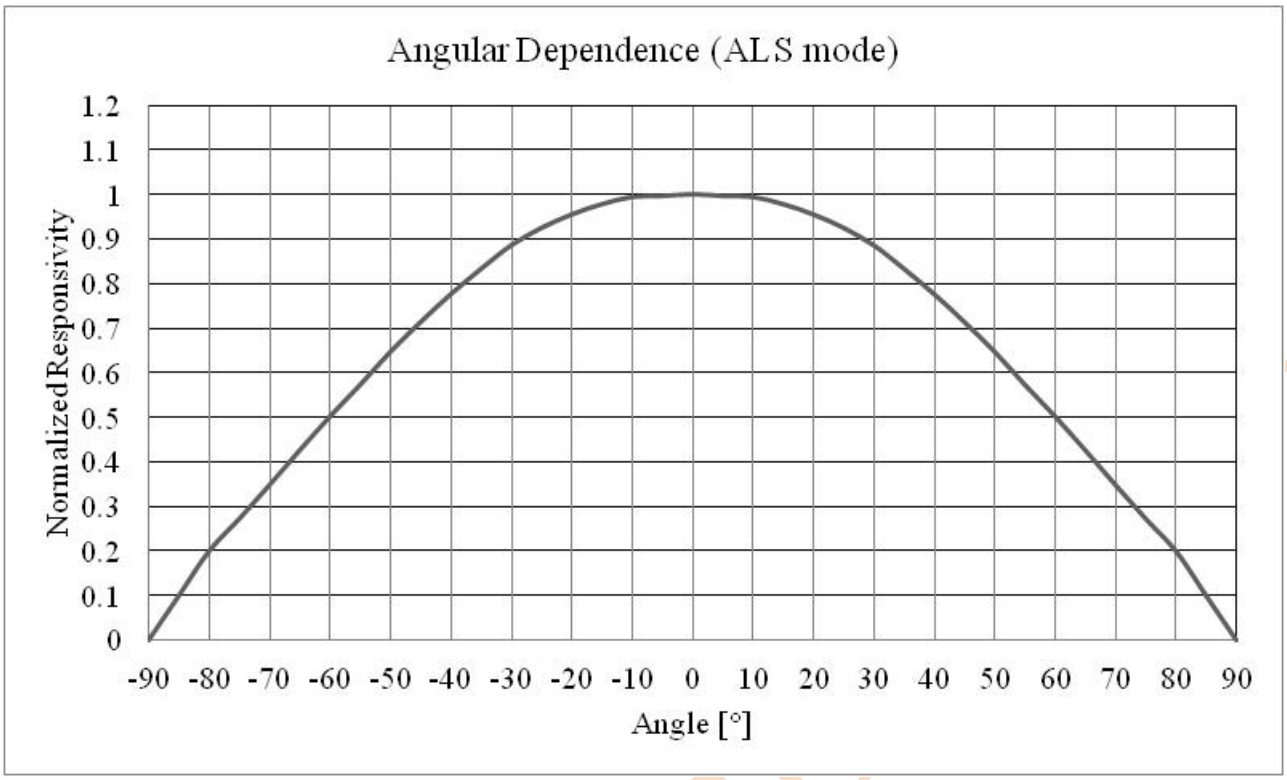

Fig.17 Angular Dependence (ALS mode)