

GP2AP01VT00F

Time-of-Flight ranging Sensor



Description

GP2AP01VT00F range sensor provides accurate and repeatable long range distance measurement for high-speed autofocus (AF). The innovative time-of-flight technology allows performance independent of object reflectance.

GP2AP01VT00F's time-of-flight sensing technology is realized by Sharp's original SPAD (Single Photon Avalanche Diodes) using low-cost standard CMOS process. It enables accurate ranging result, higher immunity to ambient light and better robustness to cover-glass optical cross-talk by special optical package design.

Features

- 940nm laser classified as class 1 under operation condition by IEC 60825-1:2014-3rd edition
- Small ceramic package (4.4 × 2.4 × 1.0mm)
- Long range absolute range measurement up to 1.5m within 5% accuracy at indoor
- Reported range is independent of the target reflectance
- Operates in high infrared ambient light levels
- Advanced optical cross-talk compensation
- High speed ranging MAX 30ms
- Standard solder reflow compatible
- No additional optics
- Single power supply
- I2C interface for device control and data transfer
- Lead-free, RoHS compliant

Applications

- High-speed AF
- Continuous AF for video
- User detection for Personal Computers/ Laptops/Tablets
- Robotics (obstacle detection)
- White goods (hand detection in automatic Faucets, refrigerator etc.)

1. These specification sheets include materials protected under copyright of Sharp Corporation ("Sharp").
Please handle with great cares and do not reproduce or cause anyone to reproduce them without Sharp's consent.
2. When using this Sharp product, please observe the absolute maximum ratings, other conditions and instructions for use described in the specification sheets, as well as the precautions mentioned below.
Sharp assumes no responsibility for any damages resulting from use of the product which does not comply with absolute maximum ratings, other conditions and instructions for use included in the specification sheets, and the precautions mentioned below.

(Precautions)

- (1) In making catalogue or instruction manual based on the specification sheets, please verify the validity of the catalogue or instruction manuals after assembling Sharp products in customer's products at the responsibility of customer.
- (2) This Sharp product is designed for use in the following application areas ;
 - Computers • OA equipment • Telecommunication equipment (Terminal) • Measuring equipment
 - Tooling machines • Audio visual equipment • Home appliances
 If the use of the Sharp product in the above application areas is for equipment listed in paragraphs (3) or (4), please be sure to observe the precautions given in those respective paragraphs.
- (3) Appropriate measures, such as fail-safe design and redundant design considering the safety design of the overall system and equipment, should be taken to ensure reliability and safety when Sharp product is used for equipment in responsibility of customer which demands high reliability and safety in function and precision, such as ;
 - Transportation control and safety equipment (aircraft, train, automobile etc.)
 - Traffic signals • Gas leakage sensor breakers • Rescue and security equipment
 - Other safety equipment
- (4) Sharp product is designed for consumer goods and controlled as consumer goods in production and quality.
Please do not use this product for equipment which require extremely high reliability and safety in function and precision, such as ;
 - Space equipment • Telecommunication equipment (for trunk lines)
 - Nuclear power control equipment • Medical equipment
- (5) Please contact and consult with a Sharp sales representative if there are any question regarding interpretation of the above four paragraphs.

3. Disclaimer

The warranty period for Sharp product is one (1) year after shipment.
During the period, if there are any products problem, Sharp will repair (if applicable), replace or refund.
Except the above, both parties will discuss to cope with the problems.

The failed Sharp product after the above one (1) year period will be coped with by Sharp, provided that both parties shall discuss and determine on sharing responsibility based on the analysis results thereof subject to the above scope of warranty.

The warranty described herein is only for Sharp product itself which are purchased by or delivered to customer.
Damages arising from Sharp product malfunction or failure shall be excepted.

Sharp will not be responsible for the Sharp product due to the malfunction or failures thereof which are caused by:

- (1) storage keep trouble during the inventory in the marketing channel.
 - (2) intentional act, negligence or wrong/poor handling.
 - (3) equipment which Sharp products are connected to or mounted in.
 - (4) disassembling, reforming or changing Sharp products.
 - (5) installation problem.
 - (6) act of God or other disaster (natural disaster, fire, flood, etc.)
 - (7) external factors (abnormal voltage, abnormal electromagnetic wave, fire, etc.)
 - (8) special environment (factory, coastal areas, hot spring area, etc.)
 - (9) phenomenon which cannot be foreseen based on the practical technologies at the time of shipment.
 - (10) the factors not included in the product specification sheet.
4. Please contact and consult with a Sharp sales representative for any questions about Sharp product.

1. Application

This technical sheets applies to the outline and characteristics of time of flight sensor

Model No. GP2AP01VT00F

1.1. Outline Refer to the drawing page 5.

1.2. Ratings and characteristics Refer to Page 6 to 7.

1.3. Supplement

1) This product is built-in SPAD (single photon avalanche diode).

2) Brominated flame retardants

Specific brominated flame retardants such as the PBB and PBDE are not used in this device at all.

3) This product shall not contain the following materials.

Also, the following materials shall not be used in the production process for this product.

Materials for ODS : CFCs, Halon, Carbon tetrachloride, 1,1,1-Trichloroethane (Methylchloroform)

4) Compliance with each regulation

4.1) The RoHS directive (2011/65/EU)

This product complies with the RoHS directive (2011/65/EU) .

Object substances: mercury, lead, cadmium, hexavalent chromium, polybrominated biphenyls (PBB)

and polybrominated diphenyl ethers (PBDE)

4.2) Content of six substances specified in Management Methods for Control of Pollution Caused by Electronic

Information Products Regulation (Chinese : 电子信息产品污染控制管理办法).

Marking Styles for the Names and Contents of the Hazardous Substances

Category	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent chromium (Cr ⁶⁺)	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
Proximity	○	○	○	○	○	○

This table is prepared in accordance with the provisions of SJ/T 11364.

○ : Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572

5) Country of origin : China

6) Product mass : Approx . 0.017g

7) The moisture absorption level of this product is MSL.3.

1.4. Notes

1) Notes concerning receiver surface

Please note enough that it is likely to malfunction when a receiver surface is dirty with garbage and dust, etc. Moreover, please do not touch a receiver surface.

2) For cleaning

Cleaning shall carry out as the below items to avoid keeping solvent, solder and flux on the device.

- Solvent cleaning : Solvent temperature 45°C or less, Immersion for 3 min or less
- Ultrasonic cleaning : Please don't carry out ultrasonic cleaning.
- The cleaning shall be carried out with solvent below.

Solvent: Ethyl alcohol, Methyl alcohol, Isopropyl alcohol

3) Please take proper methods to prevent ESD. The IC built in GP2AP01VT00F is ESD-sensitive because it is fabricated by sub-micron CMOS process. For example, in handling GP2AP01VT00F, human body and soldering iron etc. should be grounded.

4) Before the circuit design

In circuit designing, make allowance for the degradation of the light emitting laser output that results from long continuous operation.

5) Notes ambient light

Proximity mode when set to avoid malfunctions due to a strong disturbance light, such an arrangement to receive ambient light Directly on the detector, please be avoided. Also by placing this product in close proximity to other components, it may be a malfunction with the light reflected from their product, structural arrangement to reduce the amount of light receiving surface of the outer, please consider.

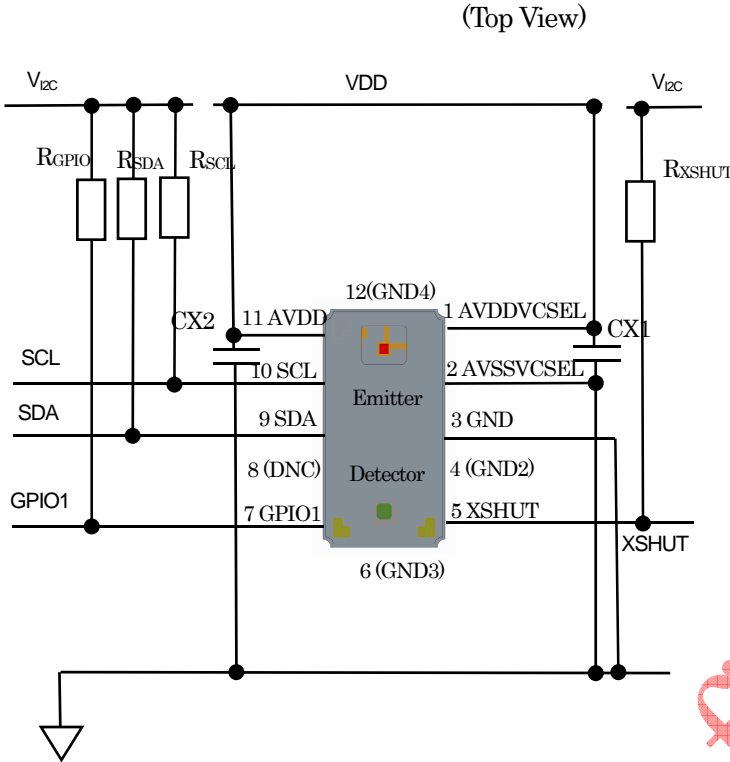
6) After being mounted and soldered, if GP2AP01VT00F is deformed by external force or impact, e.g. something falls onto the

device, it may result in defective implementation such as lift-off of the terminals. Careful handling should be taken.

7) For soldering

Refer to Page 10.

8) Recommended external circuit



Components	Recommended values
CX1	4.7 μ F
CX2	100nF
R _{GPIO}	47k Ω
R _{SDA}	10k Ω
R _{SCL}	10k Ω
R _{XSHUT}	47k Ω

There are cases to generate a noise because VCSEL driving current flows AVDDVCSEL terminal, and to distort a waveform of VCSEL driving current.

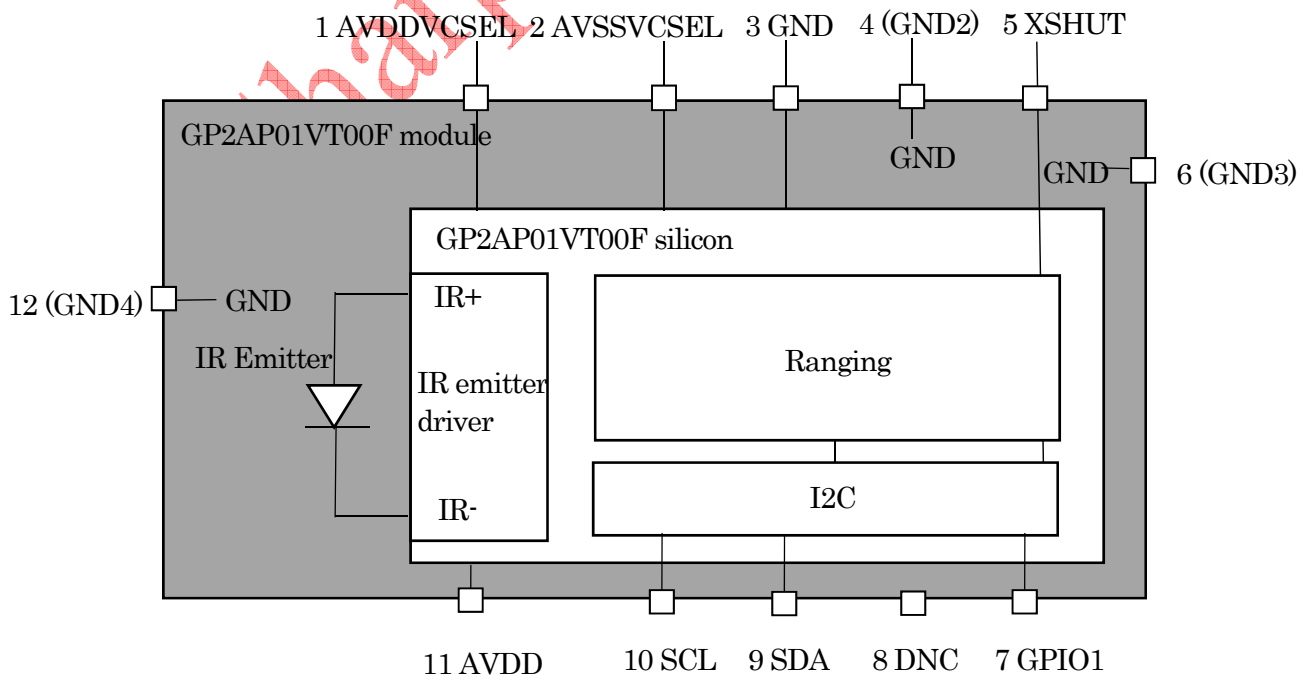
To reduce these influences, please arrange CX1 within 5mm from AVDDVCSEL terminal, and wire between VDDVCSEL terminal, CX1 and GND terminal as close as possible. Also, the wiring of AVDDVCSEL is separated from VDD and V_{I2C} terminals, and the power source of V_{VCSEL} is separated from VDD is recommended.

And in order to reduce the influence of the power supply noise, please arrange CX2 within 5mm from VDD terminal.

Please evaluate with the actual electrical implementation, and carefully make sure that there is no problem.

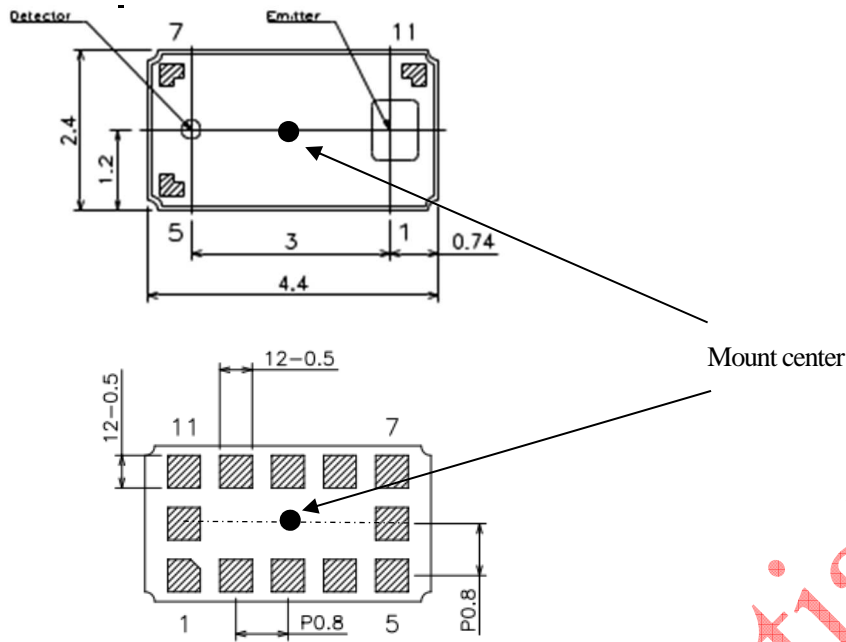
SDA terminal is NMOS open-drain output and digital input. XSHUT and SCL terminals are digital input. GPIO1 terminal is NMOS open-drain output.

9) Block diagram



10) Foot pattern of PCB

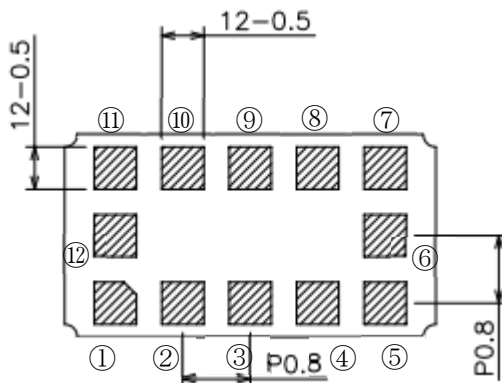
(1) Dimensions are shown for reference.



1. Dimension in parenthesis are shown for reference.
2. Unit : mm

Pin	Pin name	Symbol
①	Supply Voltage for VCSEL	AVDDVCSEL
②	Ground for VCSEL	AVSSVCSEL
③	Ground	GND
④	Ground	GND2
⑤	Digital I	XSHUT
⑥	Ground	GND3
⑦	Digital I/O	GPIO1
⑧	No connect	DNC
⑨	I2C Data Bus	SDA
⑩	I2C Clock	SCL
⑪	Supply Voltage	AVDD
⑫	Ground	GND4

(2) Recommendable size of solder creamed paste (Reference)

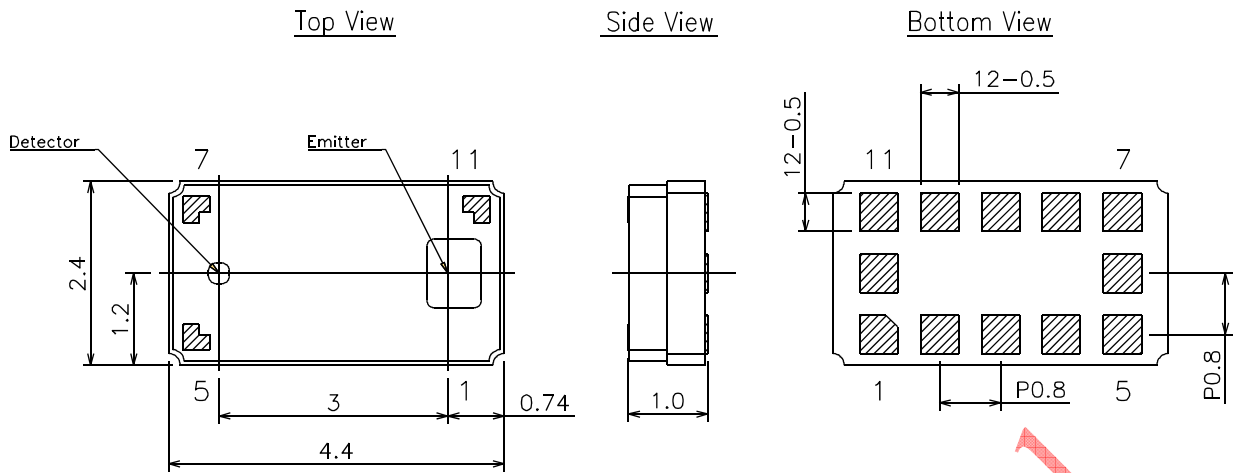


: Soldering paste area

* Dimensions in parenthesis are shown for reference.

Unit : mm

2. Outline Dimensions



Unit : mm

(Note)

- (1) area : Au plating
- (2) Unspecified tolerance shall be $\pm 0.1\text{mm}$.

Pad No.	Pad Name
1	AVDDVCSEL
2	AVSSVCSEL
3	GND
4	(GND2)
5	XSHUT
6	(GND3)
7	GPIO 1
8	(DNC)
9	SDA
10	SCL
11	AVDD
12	(GND4)

This laser marking means



: Model Number



: Year

* it repeats the cycle during 20 years except G, I, O, Q, Y

Year	Mark
2016	H
2017	J
2018	K
2019	L
...	
2031	B
2032	C

This laser marking means



: Month (1 to 9, X to Z)
* X to Z = 10 to Z



: Day (1 to 9, A to Y)
* A to Y = 10 to 31

Charts of the Days

10	11	12	13	14	15
A	B	C	D	E	F
16	17	18	19	20	21
G	H	J	K	L	M
22	23	24	25	26	27
N	P	Q	R	S	T
28	29	30	31		
V	W	X	Y		

SCALE	MATERIAL	FINISH	Name	TOF Sensor Outline dimension	
10/1	Terminal : Cu	Terminal : Ni, Au			
UNIT	Package : Ceramic				
1 = 1/1 mm			DRAWING No.		

3. Pin Description

Pad Name	Functional description	Equivalent Internal Circuit
AVDD	Power Supply	
AVDD_VCSEL	VCSEL Power Supply	
GND AVSS_VCSEL	Ground VCSEL Ground	
SDA	I2C serial data line The terminal is pulled-up to VI2C	
SCL	I2C serial clock line The terminal is pulled-up to VI2C	
GPI01	Interrupt pin The terminal is pulled-up to VI2C Open drain output terminal	
XSHUT	Active/Shutdown control pin	

*ESD protection device
 External circuit

4. Ratings and Characteristics

4.1 Absolute Maximum Ratings

Ta=25°C(unless otherwise specified)

Parameter	Symbol	Rating	Unit	Remarks
Power supply voltage	VDD	-0.5 to 3.6	V	
VCSEL voltage	V _{VCSEL}	-0.5 to 3.6	V	
I2C voltage	V _{I2C}	-0.5 to 3.6	V	
Operating temperature	T _{opr}	-20 to 70	°C	
Storage temperature	T _{stg}	-40 to 85	°C	
Soldering temperature	T _{sol}	250	°C	peak temperature duration:10s

4.2 Recommended Operating Conditions

Ta=25°C(unless otherwise specified)

Parameter	Symbol	Operating condition	Unit	Remarks
Power supply voltage	VDD	2.6 to 3.5	V	
VCSEL voltage	VLED	2.6 to 3.5	V	
I2C voltage	V _{I2C}	1.7 to 3.5	V	
Optimum operating temperature	T _{opt}	-20 to 70	°C	
Functional operating temperature	T _{func}	-20 to 70	°C	
SCL, SDA input low level	V _{IL}	-0.5 to 0.6	V	
SCL, SDA input high level	V _{IH}	1.12 to VDD+0.5	V	

4.3 Electrical and Optical Characteristics

Ta=25°C, AVDD=AVDDVCSEL=VI2C=3.3V

(unless otherwise specified. The external circuit constants follow the recommended external circuit of page 3.)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Current consumption (AVDD)	I _{CC_VDD}	9	13	18	mA	
Current consumption (VDDVCSEL)	I _{CC_VCSEL}	9	15	23	mA	Average consumption
Current consumption (Power Down)	I _{CC_S}	—	—	5	μA	
I2C clock frequency	f	1	—	400	kHz	
SDA output low level voltage	V _{OL_SDA}	0	—	0.4	V	I _{OL_SDA} =3mA
GPIO1 output low level voltage	V _{OL_GPIO1}	0	—	0.4	V	I _{OL_GPIO1} =3mA
XSHUT output low level voltage	V _{OL_XSHUT}	0	—	0.4	V	I _{OL_XSHUT} =3mA

Ta=25°C, AVDD=AVDDVCSEL=VI2C=3.3V

(unless otherwise specified. The external circuit constants follow the recommended external circuit of page 3.)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
VCSEL peak wavelength	λ _{P_PS}	—	940	—	nm	
VCSEL peak current	I _{vcsel}	—	59	—	mA	

4.4 Ranging Characteristics

Ta=25°C, AVDD=AVDDVCSEL=VI2C=3.3V

(unless otherwise specified. The external circuit constants follow the recommended external circuit of page 3.)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Range distance (White)	R _{white}	120	180 (1)	—	cm	White Card 88%、Indoor※ (1) without wrap around function
Range distance (Gray)	R _{gray}	70	80	—	cm	Gray Card 17%、Indoor※
Range accuracy	R _{acc}	—	—	4	%	Indoor White Card 88% at 120cm ※
Range accuracy	R _{accg}	—	—	7	%	Indoor Gray Card 17% at 70cm ※
Range distance (White)	R _{outwhite}	60	—	—	cm	White Card 88%、Outdoor※
Range distance (Gray)	R _{outgray}	40	—	—	cm	Gray Card 17%、Outdoor※
Range accuracy	R _{outacc}	—	—	7	%	Outdoor White Card 88% at 60cm ※
Range accuracy	R _{outaccg}	—	—	12	%	Outdoor Gray Card 17% at 40cm ※
Ranging speed	Trange	—	—	30	msec	

Ranging Distance Offset	Roffset			3	%	White 88% 120cm, Indoor※ Gray 17% 70cm, Indoor※ White 88% 60cm, Outdoor※ Gray 17% 40cm, Outdoor※
Voltage drift	Vdrift		10	15	mm	absolute data
Temperature drift	Tdrift		10	30	mm	absolute data

※Indoor : no infrared

Outdoor : equivalent to 5kLux daylight

4.5 ESD

Parameter	Specification	Conditions
Human Body Model	JS-001-2012	+/- 2kV, 1500 Ohms, 100pF
Charged Device Model	JZSD22-C101	+/- 500V

5. Cover Glass Selection Guide

In order to obtain the best performances, the following rules should be taken into account for the Cover Glass.

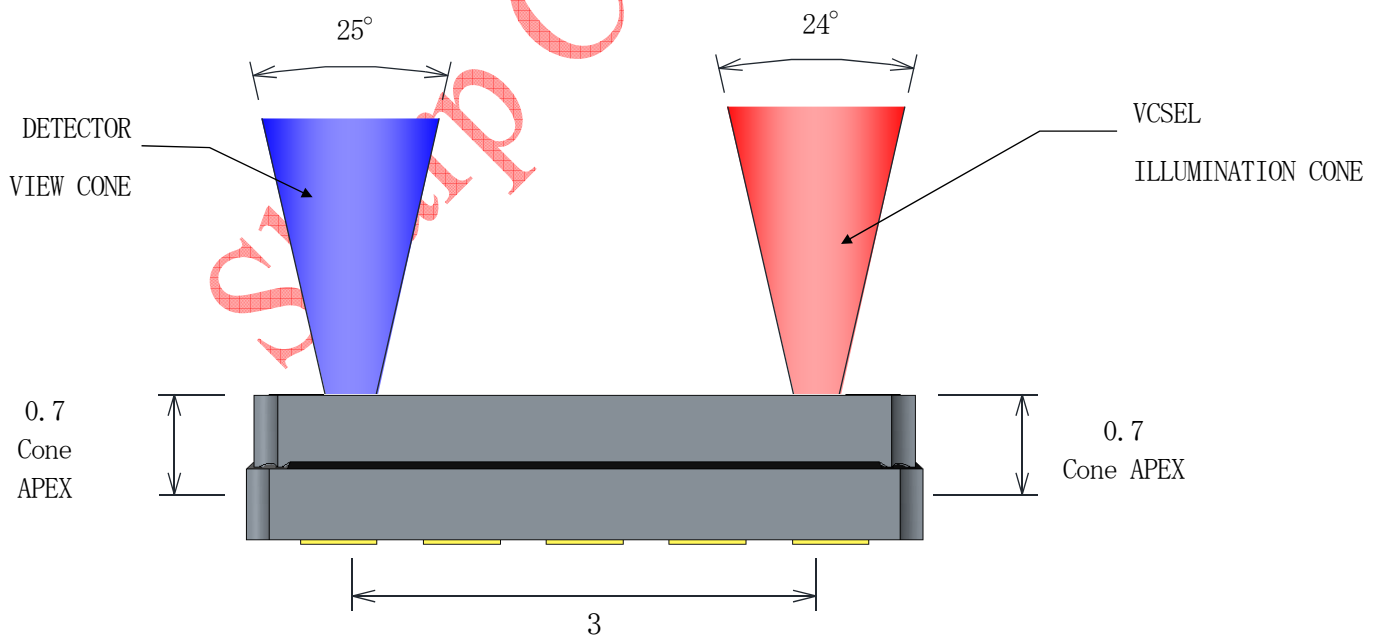
Material : PMMA / Gorilla glass

Spectral transmittance : $T > 90\%$ for $\lambda > 900\text{nm}$ (Gorilla Glass and AR coat is the better)

Air gap : $< 0.5\text{mm}$

Thickness : $< 0.8\text{mm}$, the thinner is the better

Dimensions : bigger than $2 \times 4\text{mm}$



6. Outgoing inspection

(1) Inspection lot

Inspection shall be carried out per each delivery lot.

(2) Inspection method

A single sampling plan, normal inspection level II based on ISO 2859 shall be adopted.

Parameter	Inspection items and test method		AQL(%)
Major defect	1. Disconnection, short		0.1
	2. Electrical characteristics defect in parameter 3.3		
Minor defect	1. Appearance defect		0.25
	Parameter	Judgment criteria	
	Split, Chip. Scratch Stain, Blur	One which affects the characteristics of Parameter 3.3 shall be defect.	

7. Eye Safety Considerations

GP2AP01VT00F contains a laser emitter and corresponding drive circuitry. The laser output is Class 1 laser safety under all reasonably foreseeable including single faults in compliance with IEC 60825-1:2014. The laser output will remain within Class 1 limits as long as the Sharp recommended device settings are used and the operating conditions specified in this datasheet are respected. The laser output power must not be increased by any means and no optics should be used with the intention of focusing the laser beam.



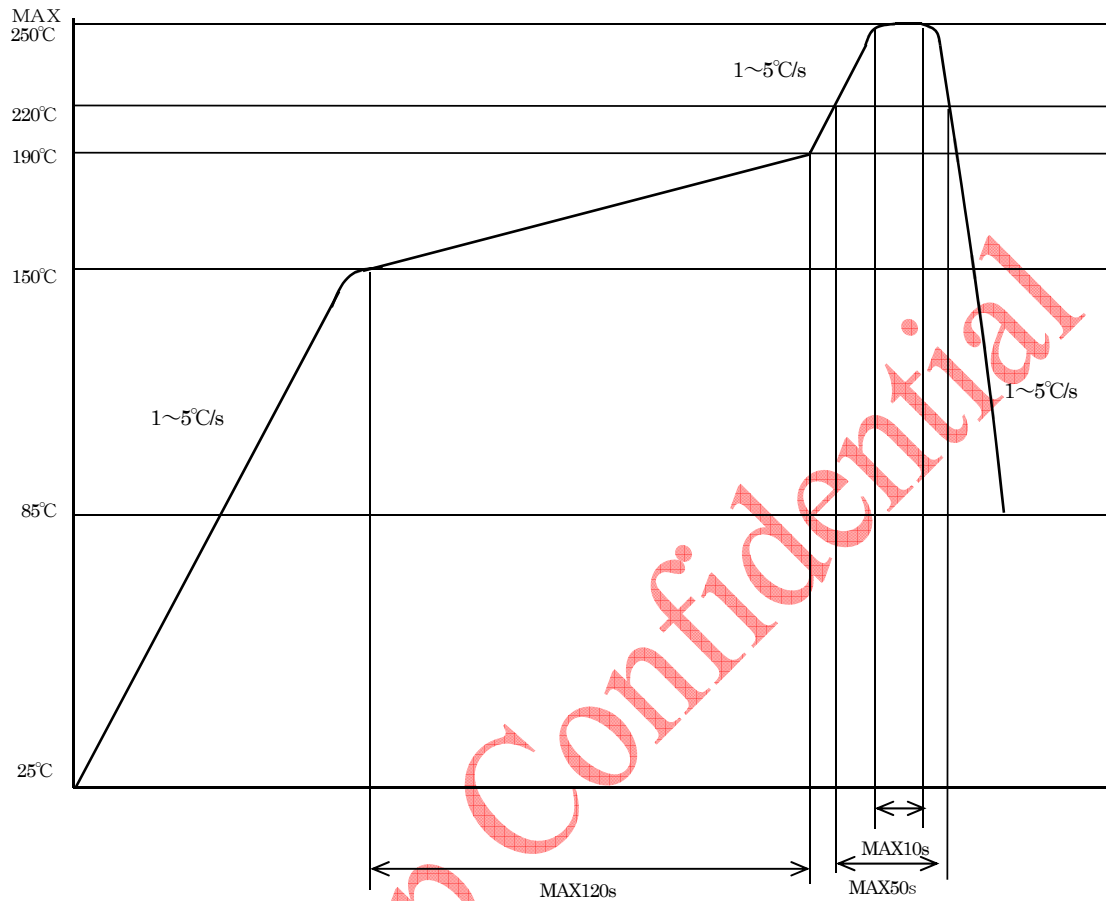
8. Precautions for Soldering

(1) In case of solder reflow

Reflow is allowed only three at the temperature and the time within the temperature profile as shown in the figure below.

This Profile temperature is the sensor surface package temperature.

Reflow interval shall be within 7 days under conditions, 10 to 30°C, 70%RH or less.



(2) Other precautions

An infrared lamp used to heat up for soldering may cause a localized temperature rise in the resin.

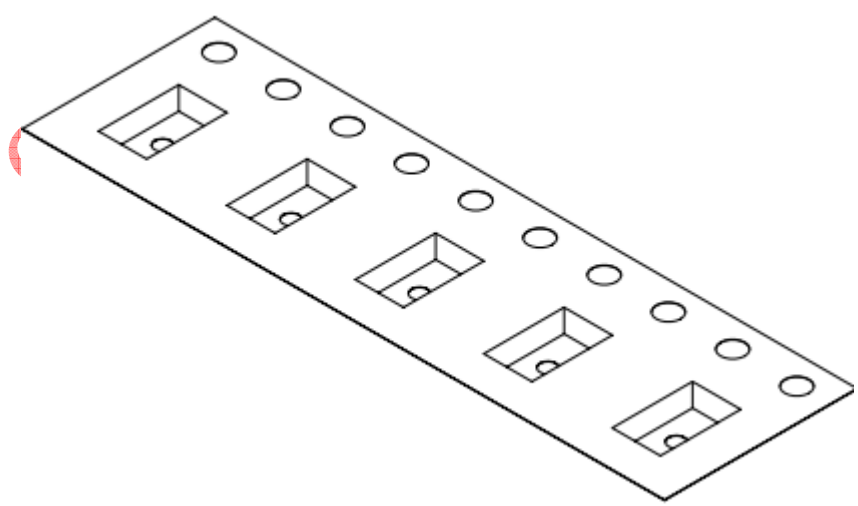
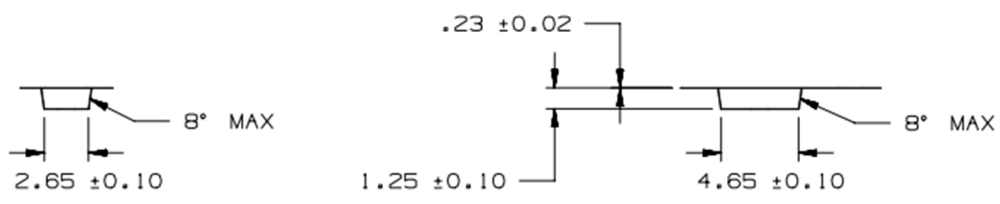
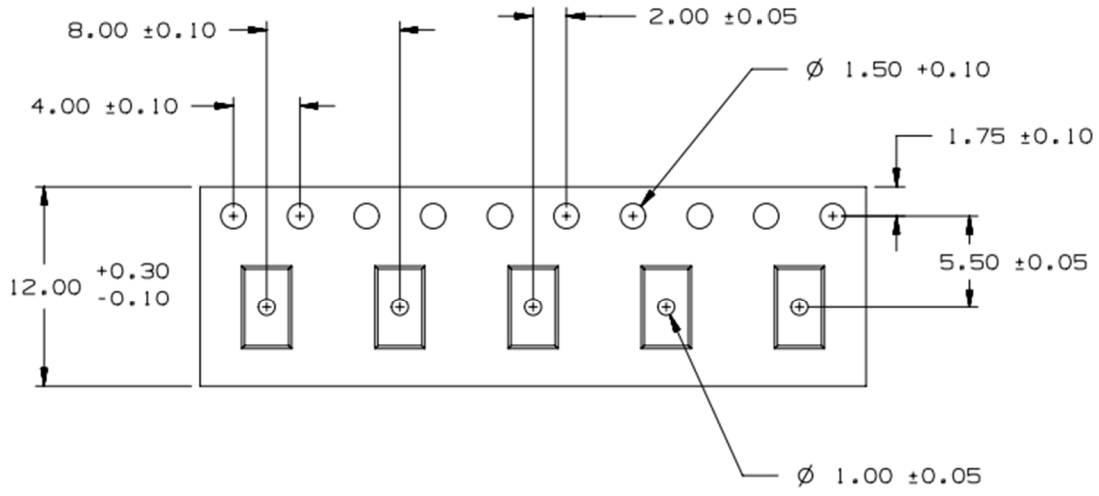
Also avoid immersing the resin part in the soldering.

Even if within the temperature profile above, there is the possibility that the gold wire in package is broken in case that the deformation of PCB gives the affection to lead pins.

Please use after confirmation the conditions fully actual solder reflow machine.

9. Packing

Tape outline drawing



Revision History

Revision	Description	Date
0.0	Preliminary release	31-Aug-2016
0.1	Fov update	23-Sep-2016
0.2	Outline Dimensions update Pin description added	11-Oct-2016
0.3	Operating Condition I2C clock frequency VCSEL peak current Range Characteristic	20-Oct-2016
0.4	Front page I2C clock frequency Ranging Distance Offset condition ESD(CDM) Air gap Packing	29-Nov-2016
0.5	4.3 Icc_vdd, Icc_vcsl add "8. Precautions for Soldering"	26-Dec-2016
0.6	4.2 I2C_voltage 4.3 Current 4.4 Range Distance	13-March-2017

Sharp Confidential