

# KOALA IR TRIANGULATION SENSOR USER MANUAL

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**Trademark Acknowledgements:**

GP2D02 : Sharp.  
Matlab: The Mathworks.  
LabView: National Instruments.  
Koala: K-Team S.A.

**NOTICE:**

- The contents of this manual are subject to change without notice.
- The information contained in this manual is, to the best of our knowledge, complete, accurate and up to date. However, K-Team can assume no responsibility or liability for any inaccuracies or omissions. Should any errors be detected please inform K-Team S.A.

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## 1. Introduction

Thanks for choosing the Infrared Triangulation Sensor extension for Koala! This extension for Koala greatly expands the obstacle detection capability of the Koala.

The package includes 4 Sharp GP2D02 compact, high sensitive distance measuring sensor. These sensors can detect obstacles over a wide range from 10cm to 80cm, and complement the Koala built-in infrared proximity sensors, which have a range from 5cm to 20cm. Koala can thus use the sonar sensors for exploring wide-open areas, while using the infrared sensors as a “virtual bumper” and for negotiating tight spaces.

### 1.1. Generalities

For the latest information on K-Team products, please visit <http://www.k-team.com>

#### *Safety Precautions*

- Check the operating voltage of all components before operation. It must correspond to your local power supply. The operating voltage is indicated on the nameplate of the power supply.
- Don't plug or unplug any connector when the system is switched ON.
- All connections (including adding or disconnecting extensions) must be made when the robot and the interface are switched OFF, otherwise damage can occur.
- Switch OFF the robot and any additional power supplies if you will not use them for more than a day.
- Do not open the robot unless explicitly directed to do so by K-Team technicians. Perform this operation by carefully following the instructions given in appendix C.
- Do not manually force any mechanical parts, such as pushing the robot and forcing its wheels.

If you have any questions or problems concerning the robot, please contact your Koala dealer.

#### *Recycling*

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Think about the end of life of your robot! Parts of the robot can be recycled and it is important to do so. It is for instance important to keep batteries out of the solid waste stream. When you throw away a battery, it eventually ends up in a landfill or municipal incinerator. These batteries can contribute to the toxicity levels of landfills or incinerator ash. By recycling the batteries through battery recycling programs, you can help to create a cleaner and safer environment for generations to come. For these reasons please take care to recycle your robot and robot accessories at the end of its life cycle, by for instance sending back the old equipment to the manufacturer or to your local dealer.

Thanks for your contribution to a cleaner environment!

## 2. Specifications

The Koala IR Triangulation package includes four GP2D02 (cf in attachment GP2D02 Specifications and GP2D02/05 Application Note). Two of them are on the right and left side of the Koala. The two others are in front of the Koala where they replace two Infrared Koala Sensors, leaving 14 Infrared Sensors on the Koala.

Technical Aspect	Details
Output	8-bit
Range	10cm to 80cm
Refresh Rate	1000Hz

## 3. Getting Started

Please use the following procedure to test the sensors:

1. Connect your PC to the Koala DCE serial port (item 4, p 4 of Silver Koala User Manual).
2. Check the active serial line jumper (item 8, p 5 of Silver Koala User Manual).
3. Connect to the Koala serial port using a terminal program set to 38400, 8bit, no flow control, no parity, 2 stop bits.
4. Ensure the Koala is in mode 3, and then turn on the robot. A startup message should appear on the terminal screen (see Koala documentation for more details).
5. Type **V** then return. You should see the following answer:

**v,side\_left,front\_left,side\_right,front\_left**

where side\_left, front\_left, side\_right and front\_left are 8bit output by IR sensors.

## 4. Using the Sonar Sensors

There are two ways you can read the IR triangulation sensors: via a serial line using the Koala SerCom protocol, or by writing a custom C program loaded into the robot's memory.

### 4.1. Using the Serial Port

The protocol command **V** allow to read the triangulation sensor. Simply connect to the Koala's serial port with a terminal program set to 38400 8 bit, no flow control, no parity, 2 stop bits. Make sure the Koala is in mode 3 and turn on the robot (see the Koala documentation for more details). After the startup message is displayed, you can read the 4 sensors directly using the command **V**.

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This simple serial protocol is very flexible, and lets you write control routines using any application that supports serial port communication (e.g. Matlab, LabView, etc.). You do, of course, need a serial cable connected to the robot at all times, or you may use a radio modem to transmit the commands to the host computer.

## 4.2. Using a Custom C Program

For the ultimate in speed and flexibility, you can write a custom C application compiled for the Koala and stored in its onboard flash memory. To read the analog inputs you must use the command `sens_get_sharp_value( input )` which returns a 8bit value delivered by the sensor.. Please see the example file `sonar.c` given in section 5 for more details.

For information on how to compile programs for Koala, please see the K-Team website ([www.k-team.com](http://www.k-team.com)) for more information.

## 5. Software Example

```
/*
; Test Sharp.
; =====

;-----
; Author:   Jaquet C.           30/07/2000
; Modifs:
;
; Project:  Koala
; Goal:    Test SHARP
;
; Jaquet@k-team.com
;
;-----
*/

#include <sys/kos.h>
#include <stdlib.h>
#include <stdio.h>
#include <string.h>

/*
* Process 0
* ^^^^^^^^^^
*
* This process changes the state of the LED 0
* every 500 ms.
*
*/

static void process_0 ()
{
    for (;;)
    {
        tim_suspend_task (5000);
        var_change_led (0);
    }
}

/*
* Process 1
* ^^^^^^^^^^

```

---

```

*
*
*
*/

void process_1()
{

    printf("Test SHARP proximity sensors\r\n");
    printf("-----\r\n\r\n");

    for (;;)
    {

        printf("Sharp value : %3.3li, %3.3li, %3.3li, %3.3li.\r\n"
            , sens_get_sharp_value(0), sens_get_sharp_value(1)
            , sens_get_sharp_value(2), sens_get_sharp_value(3));

        tim_suspend_task(200);
    }
    kill_task(tim_get_id());
}

/*
* MAIN
* ====
*
* - Initialise the used managers: tim & bios are initialised at the start-up.
* - Launch all the processes.
* - Kill the "main". At this moment only the launched processes are executed.
*
*/

void main(void)
{
    uint32      vIDProcess[3];
    int32 status;

    /*
    -----|-----|
    */

    static char prName_0[] = "User 0 process, EF-98
Rev. 1.00\r\n";
    static char prName_1[] = "User 1 process, EF-98
Rev. 1.00\r\n";

    com_reset();
    tim_reset();
    sens_reset();

    status = install_task(prName_0, 800, process_0);
    if (status == -1) exit(0);
    vIDProcess[0] = (uint32)status;

    status = install_task(prName_1, 800, process_1);
    if (status == -1) exit(0);
    vIDProcess[1] = (uint32)status;
}

```

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# **Appendix A :Specification of GP2D02 and Application Notes**

# GP2D02

## Compact, High Sensitive Distance Measuring Sensor

### ■ Features

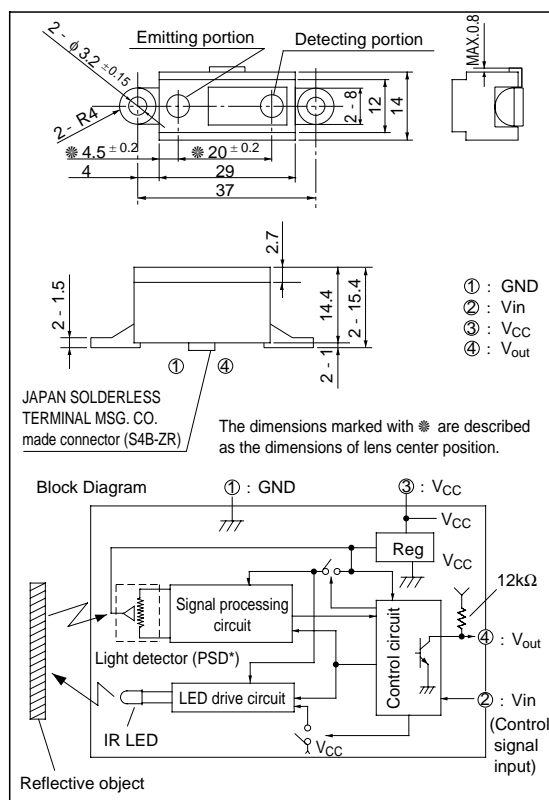
1. Impervious to color and reflectivity of reflective object
2. High precision distance measurement output for direct connection to microcomputer
3. Low dissipation current at OFF-state  
(dissipation current at OFF-state : TYP. 3  $\mu$ A)
4. Capable of changing of distance measuring range through change the optical portion (lens)

### ■ Applications

1. Sanitary sensors
  2. Human body sensors for consumer products such as electric fans and air conditioners
  3. Garage sensors
- \* PSD : Position Sensitive Detector

### ■ Outline Dimensions

(Unit : mm)



### ■ Absolute Maximum Ratings (Ta=25°C, V<sub>CC</sub>=5V)

Parameter	Symbol	Rating	Unit
Supply voltage	V <sub>CC</sub>	- 0.3 to + 10	V
*1 Input terminal voltage	V <sub>in</sub>	- 0.3 to + 3	V
Output terminal voltage	BV <sub>O</sub>	- 0.3 to + 10	V
Operating temperature	T <sub>opr</sub>	- 10 to + 60	°C
Storage temperature	T <sub>stg</sub>	- 40 to + 70	°C

\*1 Open drain operation input

### ■ Operating Supply Voltage

Symbol	Rating	Unit
V <sub>CC</sub>	4.4 to 7	V

\* In the absence of confirmation by device specification sheets, SHARP takes no responsibility for any defects that occur in equipment using any of SHARP's devices, shown in catalogs, data books, etc. Contact SHARP in order to obtain the latest version of the device specification sheets before using any SHARP's device.



■ Electro-optical Characteristics

(Ta=25°C, Vcc=5V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Distance measuring range	$\Delta L$	*1	10	-	80	cm
Output terminal voltage	$V_{OH}$	Output voltage at High L = 20cm	$V_{CC} - 0.3$	-	-	V
	$V_{OL}$	Output voltage at Low *1	-	-	0.3	V
Distance characteristics of output	D	L = 80cm, *1	-	75	-	DEC
	$\Delta D$	Output change at L=80 cm to 20 cm, *1	48	58	68	DEC
Dissipation current	at operating	$I_{CC}$ L = 20cm, *1, *2	-	22	35	mA
	at OFF-state	$I_{off}$ L = 20cm, *1	-	3	8	$\mu A$
Vin terminal current	$I_{vin}$	Vin = 0V	-	- 170	- 280	$\mu A$

Note) L : Distance to reflective object

DEC : Decimalized value of sensor output (8-bit serial)

\*1 Reflective object : White paper (reflectivity : 90%)

\*2 Average dissipation current value during distance measuring operation when detecting of input signal, Vin as shown in the timing chart

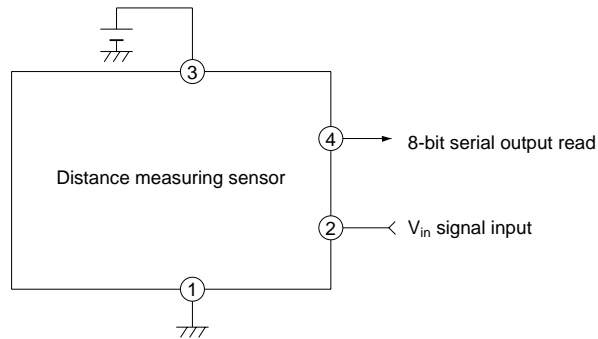
\*3 Vin terminal : Open drain drive input.

Conditions : Vin terminal current at Vin OFF-state : -1  $\mu A$

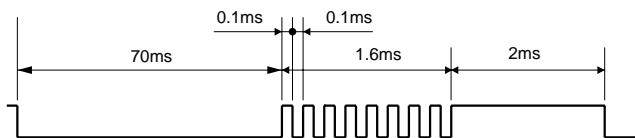
Vin terminal current at Vin ON-state : 0.3V

■ Test Circuit

1. Test circuit



2. Vin input signal for measurement



■ Timing Chart

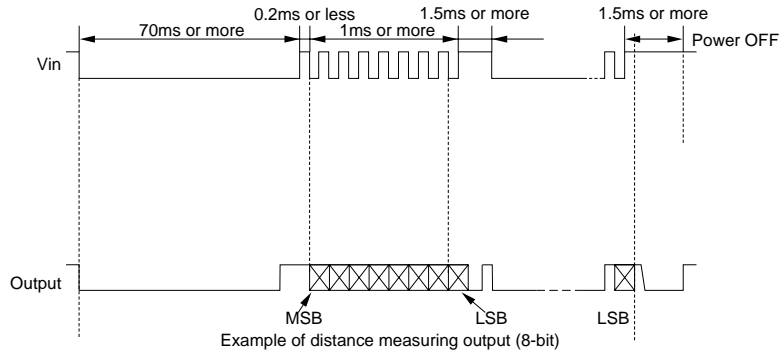


Fig. 1 Distance Measuring Output vs. Distance to Reflective Object

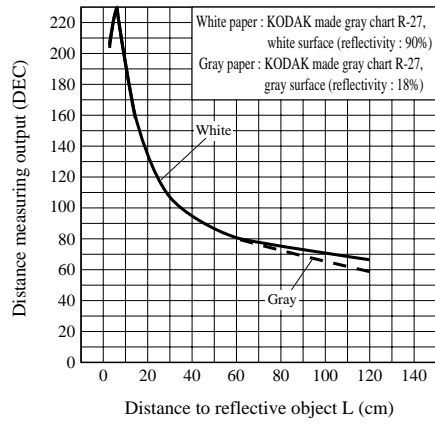
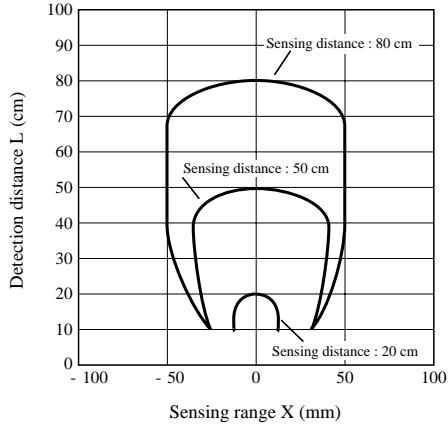


Fig. 2 Detection Distance vs. Sensing Range



Test Method for Sensing Range Characteristics

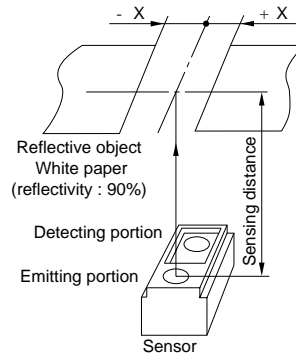
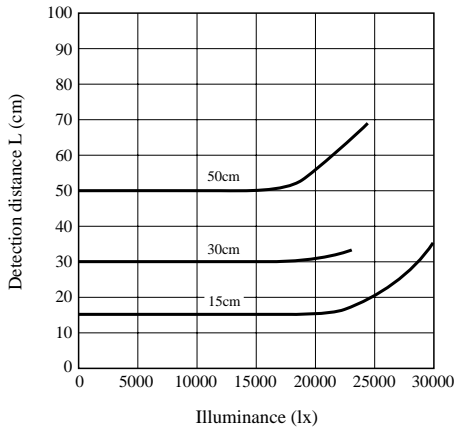
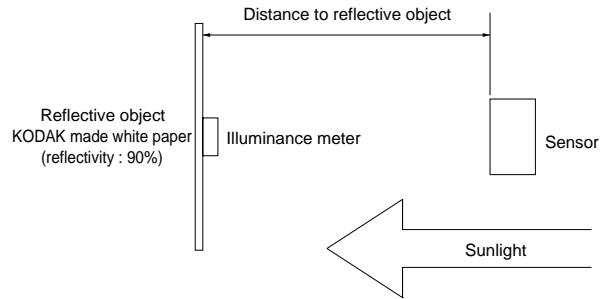


Fig. 3 Detection Distance vs. Illuminance



Test Method for Anti External Disturbing Light Characteristics



August 10, 1995

GP2D02/05 Application Note

Opto-System Project Team  
Opto-Electronic Devices Div.  
ELECOM Group  
SHARP CORPORATION

# GP2D02/ 05 Application Note

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## 1. General Description

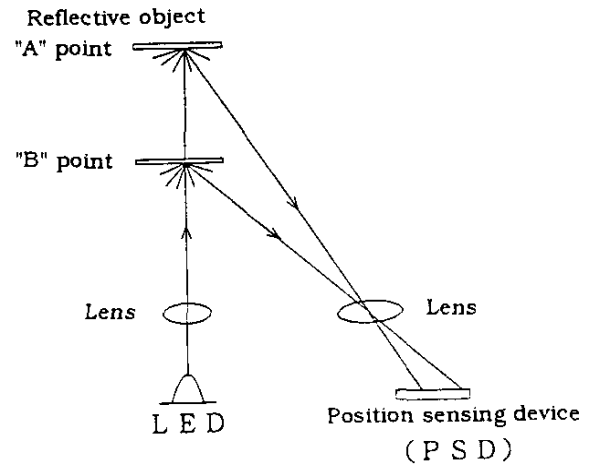
This GP2D02/05 application note has been completed by preparing several characteristic data for customers' convenient reference when the GP2D02/05 are used.

Please utilize this application note for customers' design. This application note should be for reference, however please make sure them in actual mounted condition before using.

## 2. Measuring principal and features of this sensor

### 2-1. Principal of triangulation

Optical spot position on PSD shall be changed when reflective object is at "A" point and at "B" point. By processing this optical spot position electrically, the position (distance) of the reflective object on straight line can be detected.



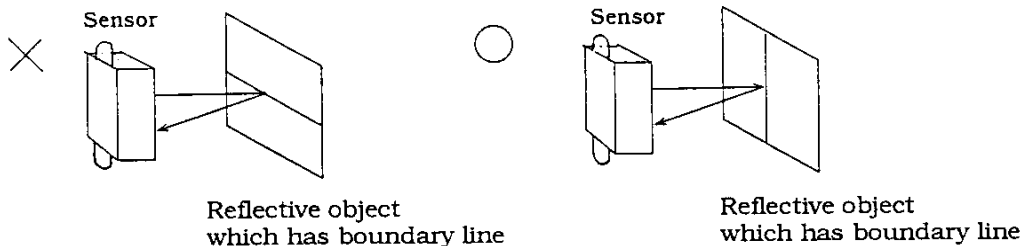
### 2-2. Features of the GP2D02/05

- ① Compact high performance distance measuring sensor with built-in PSD, Infrared LED and signal processing circuit
- ② Little influence by color and reflective ratio of the reflective object
- ③ High accuracy measuring by sequential position detection and mean processing data output
- ④ GP2D02 : 8 bit serial measured output which is possible to connect directly with micro computer
- ⑤ GP2D05 : 1 bit (High/Low) measured output  
The measuring range can be adjustable as threshold level at any distance by adjusting the built-in volume
- ⑥ Low current consumption at stand-by mode (Current consumption at stand-by mode : TYP 3  $\mu$ A)

3. Attended issues in use

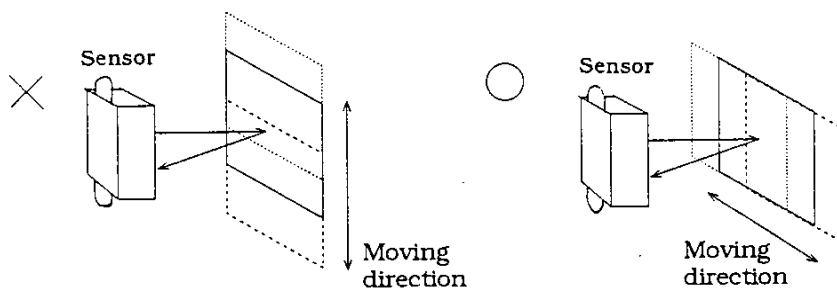
3-1. Direction of the reflective object

In case that reflective object has boundary line which material or color etc. are excessively different, in order to decrease deviation of measuring distance, it shall be recommended to set the sensor that the direction of boundary line and the line between emitter center and detector center are in parallel.

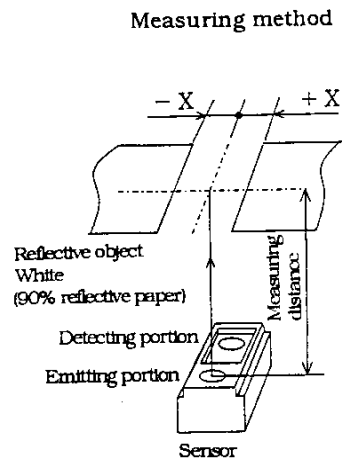
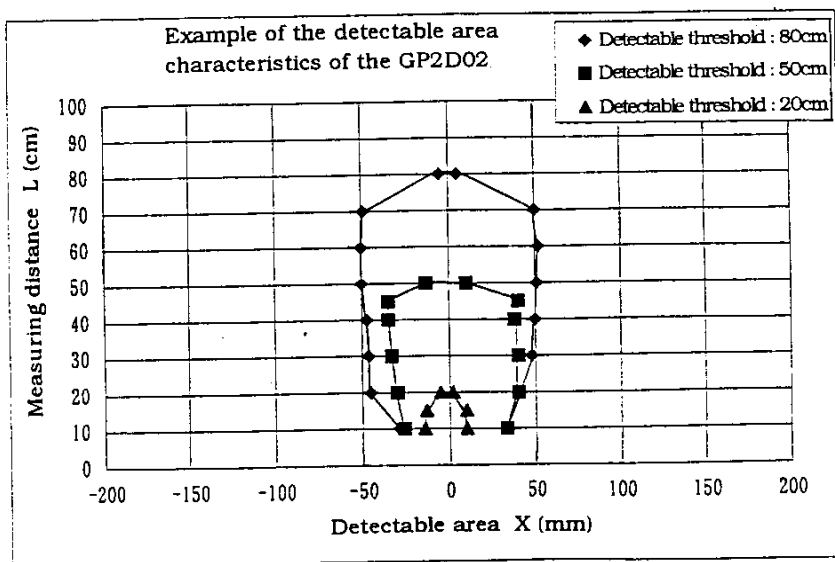


3-2. Moving direction of moving reflective object

In order to decrease deviation of measuring distance by moving direction of the reflective object, it shall be recommended to set the sensor that the moving direction of the object and the line between emitter center and detector center are vertical.



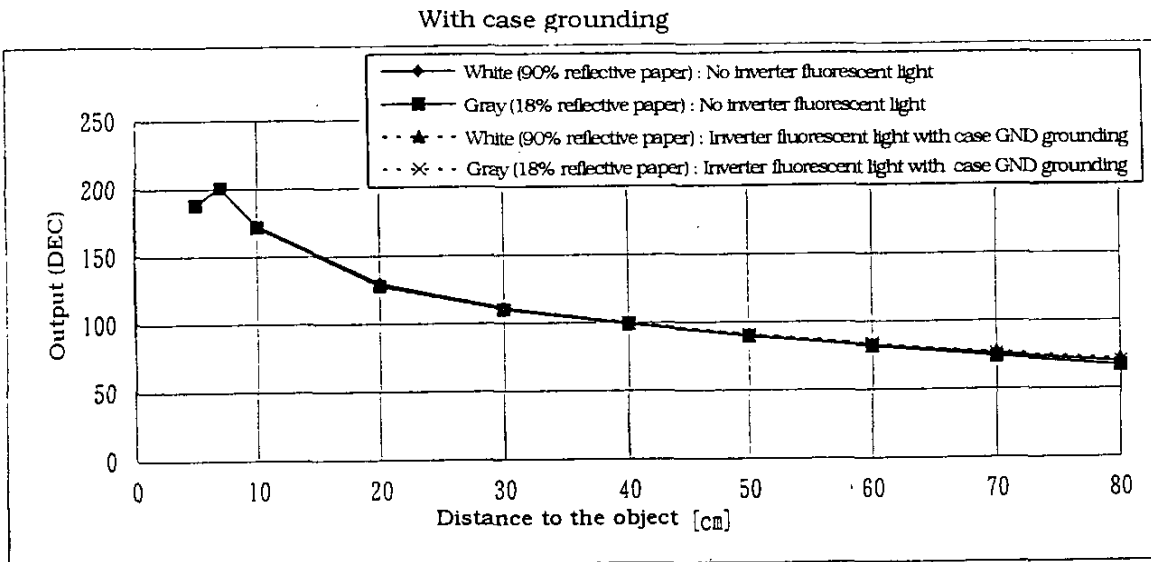
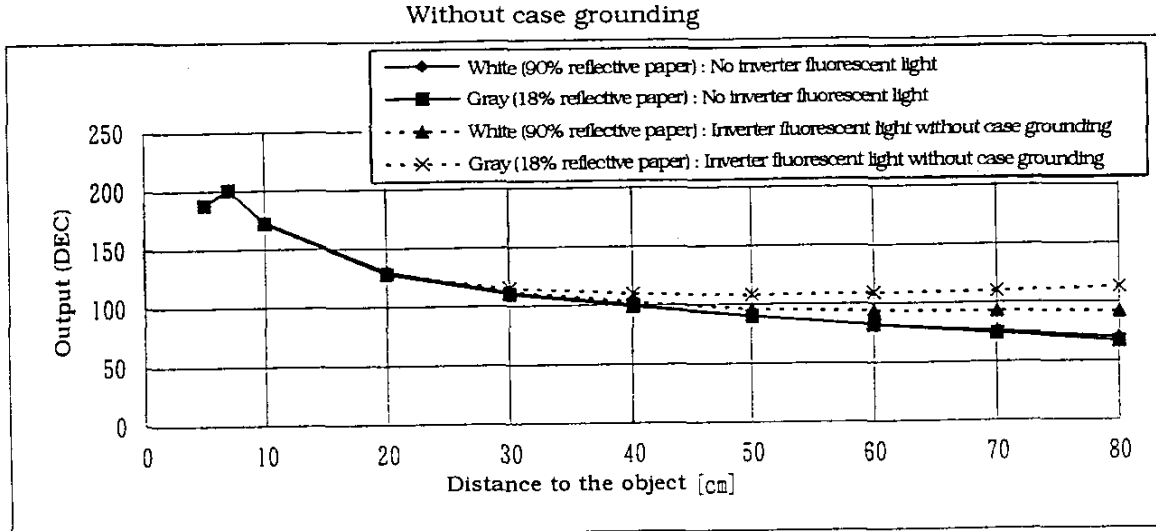
Detectable area vs. moving object example of characteristics are the following;



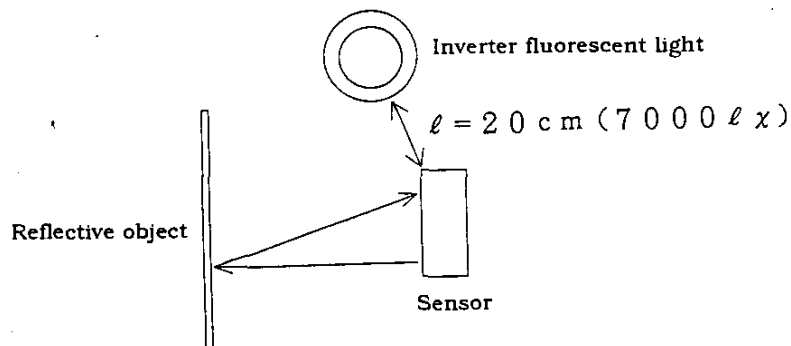
### 3-3. Noise resistance characteristics

Conductive resin is used as the case material. In order to avoid an influence of output signal by external disturbing noise, it shall be recommended that this case is grounded for use.

Noise resistance characteristics of the GP2D02 without/with grounding are the following;



(Measuring method for noise resistance characteristics)

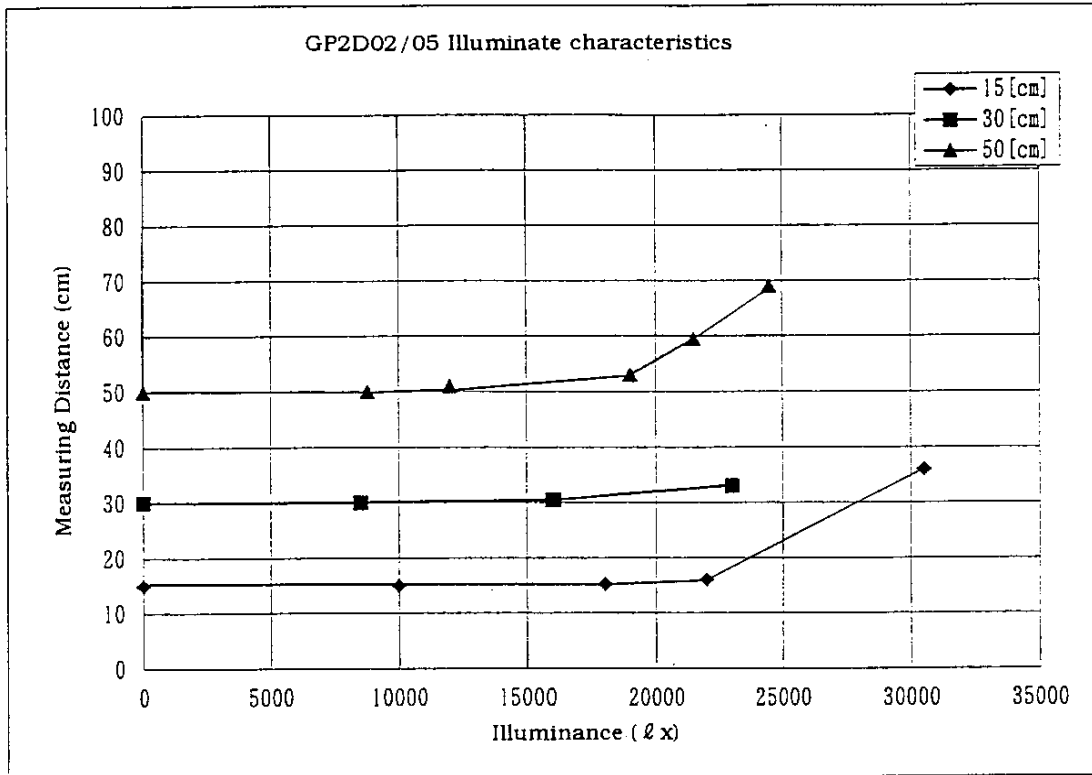




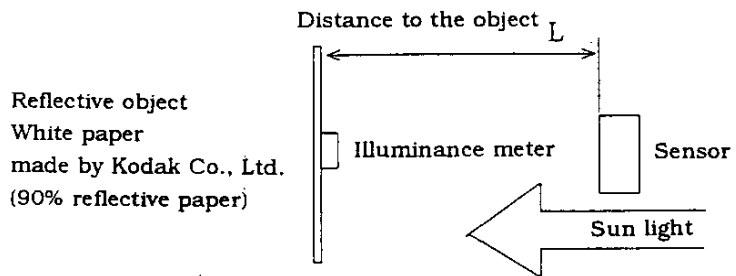
### 3-4. External disturbing light resistance characteristics

If the direct light from light source such as the sun, tungsten lamp etc. comes into the detector surface, there are cases that it can not measure exactly. Please consider the design that the direct light from such light source does not come into the detector surface.

External disturbing light resistance characteristics of the GP2D02/05 are the following:



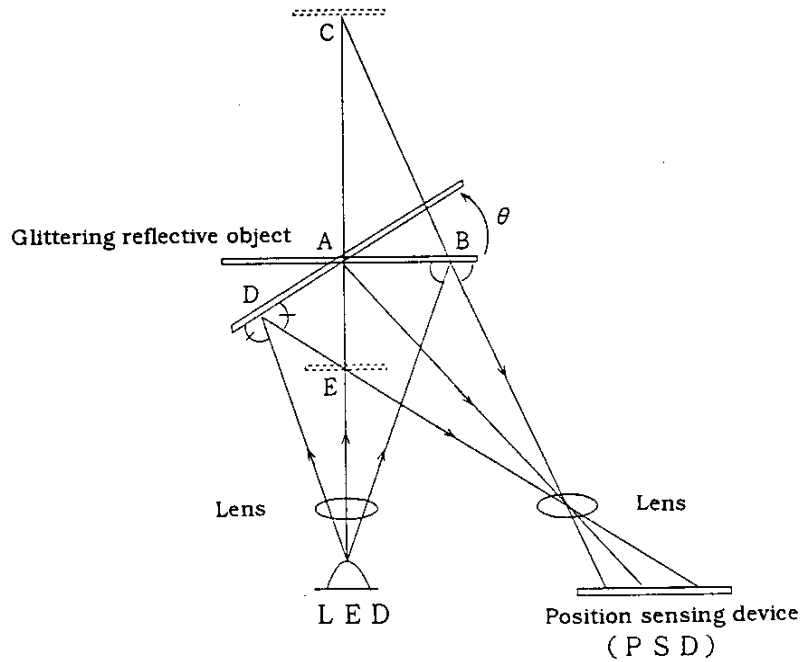
(Example of external disturbing light resistance characteristics measuring method)



### 3-5. Output at glittering reflective object

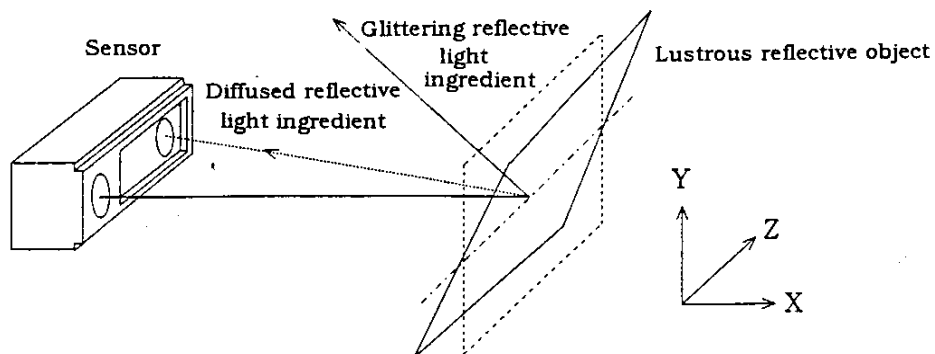
#### 3-5-1. In case of glittering reflective object with no diffused reflective light ingredient (Mirror, Glass etc.)

LED light beam has an expanse. (Half intensity angle for LED in GP2D02/05 :  $\Delta \theta = 1.5^\circ$  ). Therefore, in case that there is glittering reflective object at "A" point in the following drawing, the glittering reflected light comes into the detecting device from "B" point and it shall be the same output when there is the diffused lustrous reflective object at "C" point, so that accurate measuring is not possible.



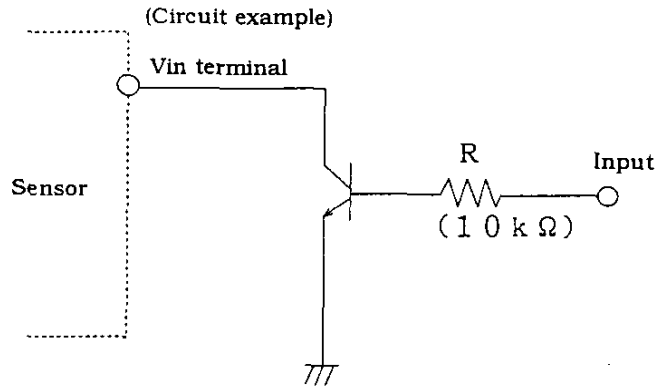
#### 3-5-2. In case of lustrous reflective object with diffused reflective light ingredient (painted metal, Colored vinyl etc.)

In case that lustrous reflective object with diffused reflective light ingredient shall be measured, accurate measuring for the distance between the sensor and the object is possible by tilting the lustrous reflective object like the following drawing since the glittering reflective light ingredient runs away to "Y" direction and the diffused reflective light ingredient comes into the detecting device (PSD).



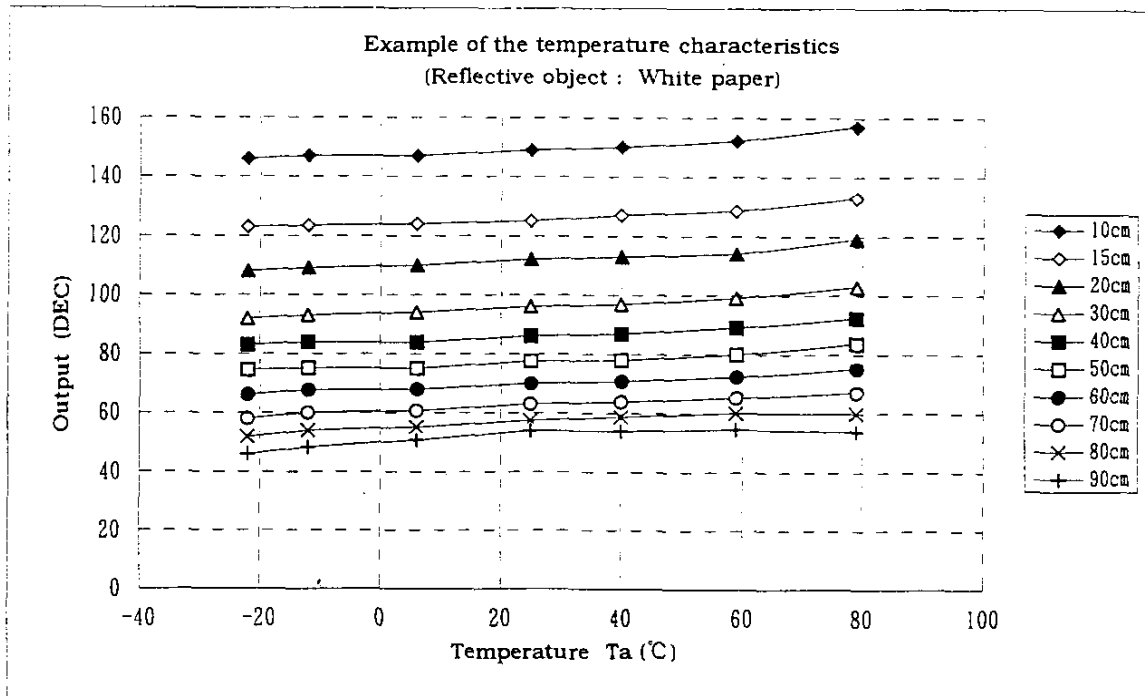
### 3-6. Input signal

Input should be current driving input in order to improve the measuring accuracy.



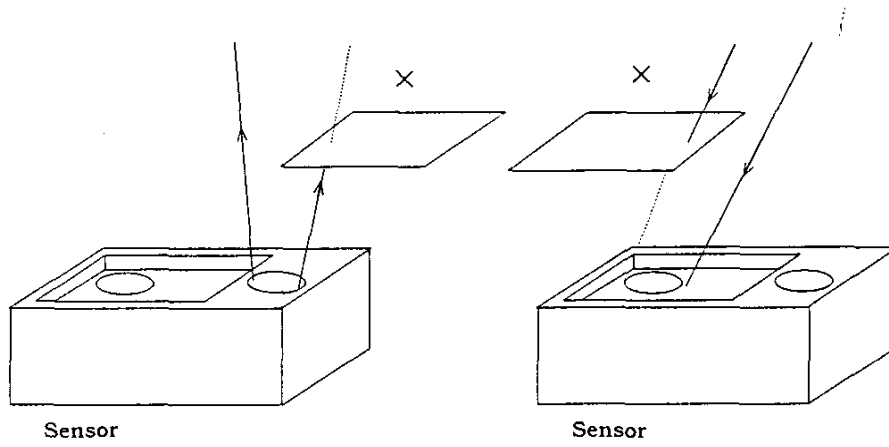
### 3-7. Ambient temperature

Example of ambient temperature characteristics of the GP2D02/05 are the following:

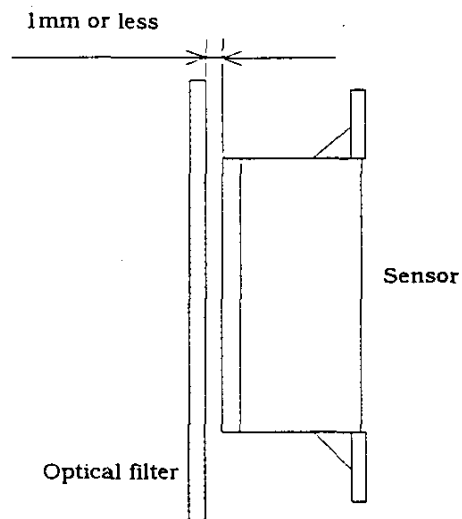


### 3-8. Optical conditions in front of the sensor

- ① Please consider that there is no object which interrupt the LED beam from sensor or no object which interrupt the reflective light from the reflective object to the detector portion.



- ② In case that an optical filter is set in front of the sensor, the filter must have high transmittance with emitted spectrum wavelength of LED ( $\lambda = 850\text{nm} \pm 70\text{nm}$ ) which is used in the sensor. Also, the clearance between the sensor and the optical filter should be set at 1mm or less.



When an optical filter is used, please use it after confirming the operation in actual application.

#### 4. Concrete application example of the GP2D02/05

##### 4.1 Concrete application example of the GP2D02

- Output conversion

The relation between the output of the GP2D02 : "D" and the distance to the reflective object : "L" can be shown in the following;

$$D = b / (L + a) + C \quad (*1)$$

However, actual deviation shall deviate mainly shifting the following output curve (Distance characteristics) toward up and down direction.

This is caused by the positioning tolerance between the detecting device (PSD) and the front lens in assembly.

This deviation will be appeared as "C" in (\*1). Since "a" and "b" can be assumed as almost constant value, actual relation between "D" and "L" shall be shown in the following;

$$D = 1560 / (L + 0.5) + C \quad (*2)$$

- Output conversion method

① As shown in (\*2), the output of the GP2D02 : "D" is in proportion to  $1 / (L + 0.5)$  (at  $L = 10$  to  $80$ cm). The relation graph between output "D" of the sample which has output characteristics shown in Fig.1 and  $1 / (L + 0.5)$  is shown in Fig.2.

② By getting "C" for each sample using (\*2), the distance to the reflective object : "L" can be calculated by output value "D".

(Example) Sample shown in Fig.1 : at  $L = 60$ cm  $D = 80$  (DEC)

$$\text{Using (*2)} \quad 80 = 1560 / (60 + 0.5) + C \quad \text{Therefore, } C = 54.2$$

So the relation between "D" and "L" of that sample shall be shown in the following;

$$D = 1560 / (L + 0.5) + 54.2$$

Then, the sample output at  $D = 202$  (DEC) is

$$202 = 1560 / (L + 0.5) + 54.2 \quad \text{Therefore, } L = 10.1 \text{cm}$$

As mentioned above, for example, by measuring the output at  $L = 60$ cm before, "C" for each sample can be got, then the distance to the reflective object : "L" can be detected by sensor output "D".

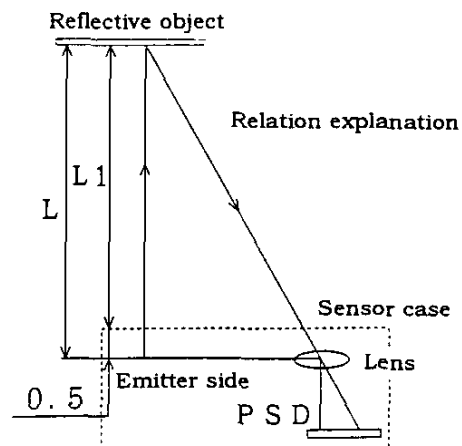
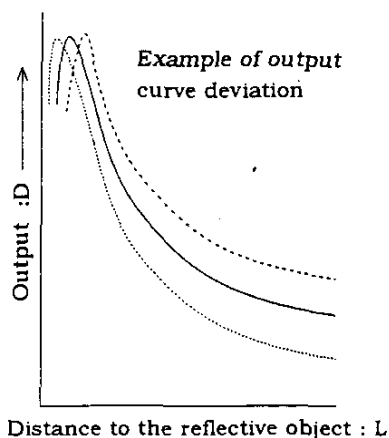


Fig.1

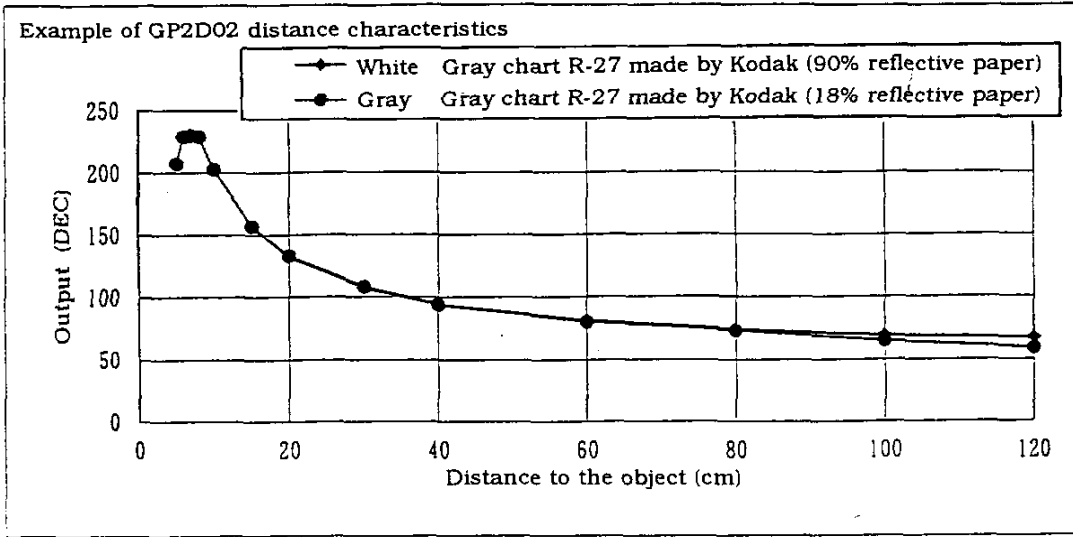
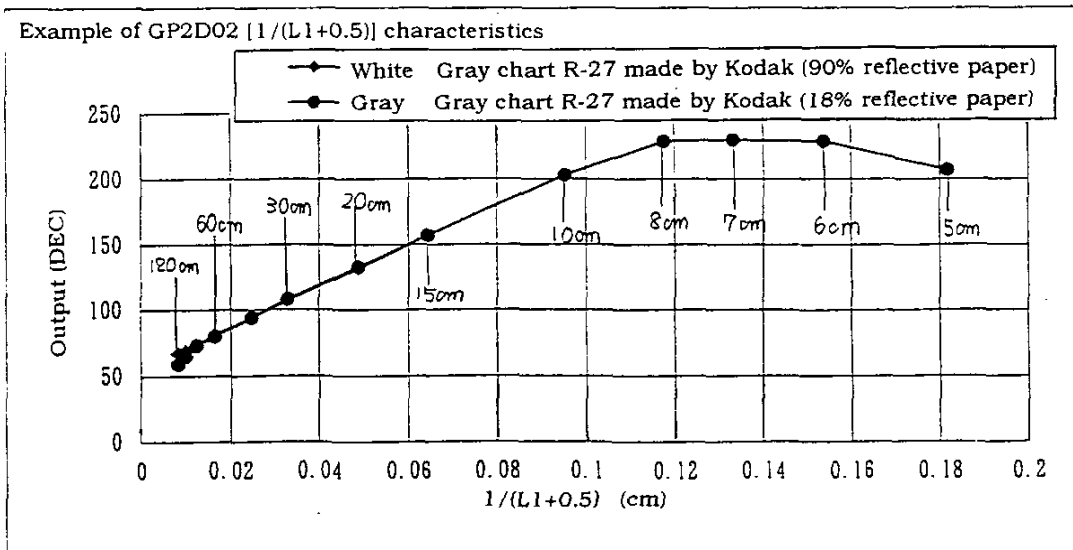
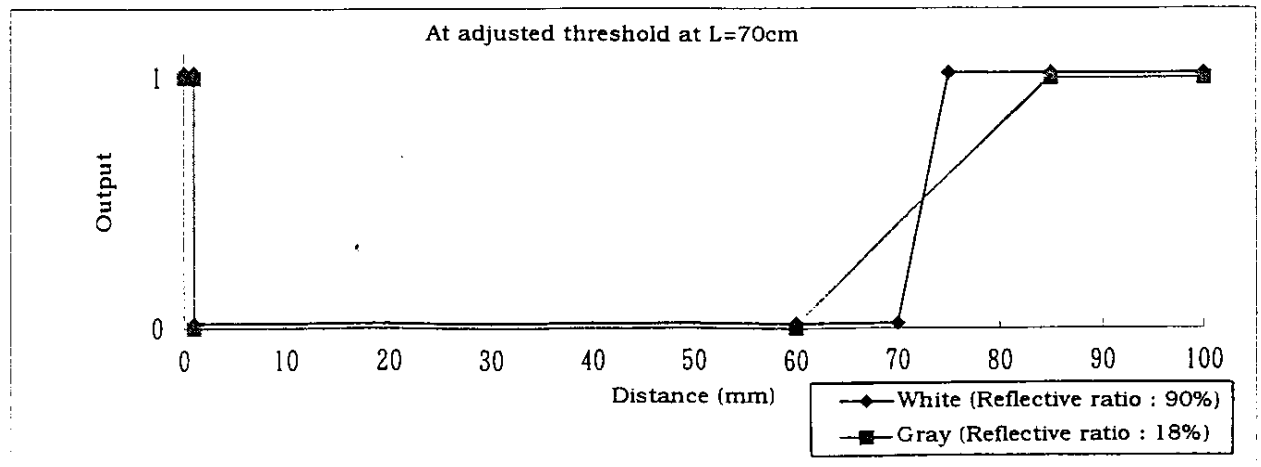
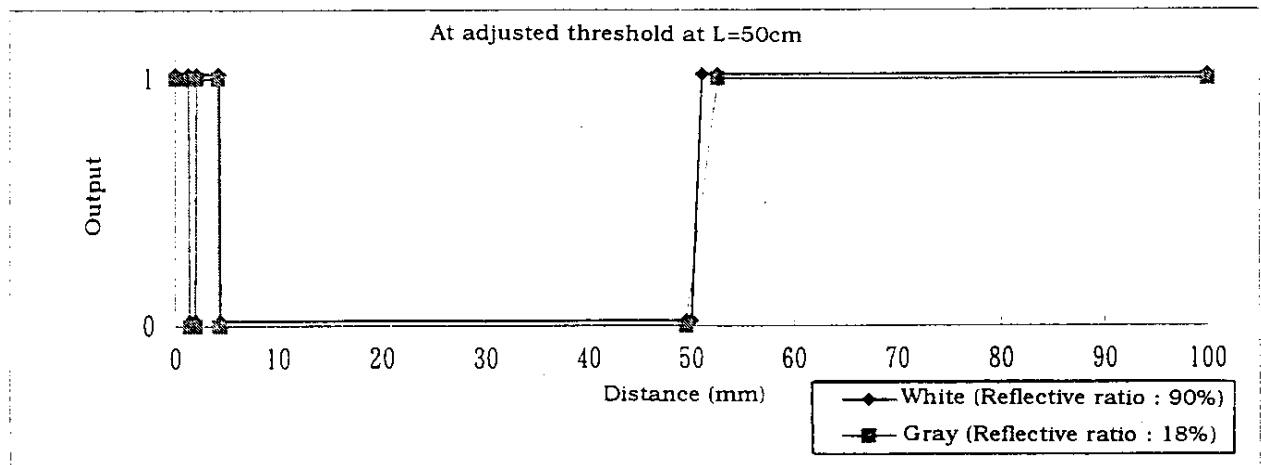
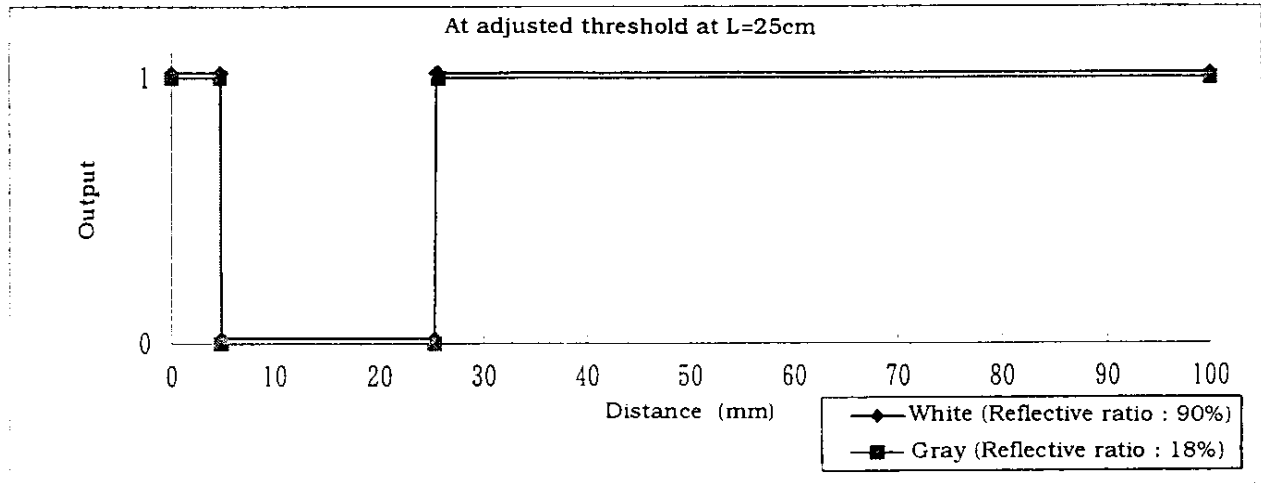


Fig.2



#### 4-2. Concrete application example of the GP2D05

- Since the GP2D05 is not adjusted the detecting threshold distance at shipping from Sharp, please adjust the built-in volume to get the detecting threshold distance by customer.
- If the detecting threshold distance shall be adjusted at around L=80cm, there are cases that the detecting accuracy is deteriorated remarkably. Then consult Sharp.



## 5. Supplement

### Modification of the measuring range

The following expression shall be realized by geometrical relation among the distance to the reflective object : "L", Base line length : "A", Focal distance of the lens : "f" and Optical spot position on PSD : "X".

$$X=(A \times f) / L$$

For example, when possible measuring range would like to be changed without any change of PSD detector size, it can be realized by changing the base line length : "A" or the focal distance of the lens : "f". Current distance measuring sensors GP2SD02/05 have the measuring range : 10 to 80cm. Modified measuring range type which is confirmed the operation by test samples by Sharp shall be the following;

- 4 to 30cm
- 50 to 400cm

