HVW Technologies
Digital Infra-Red Ranging System (DIRRS™)

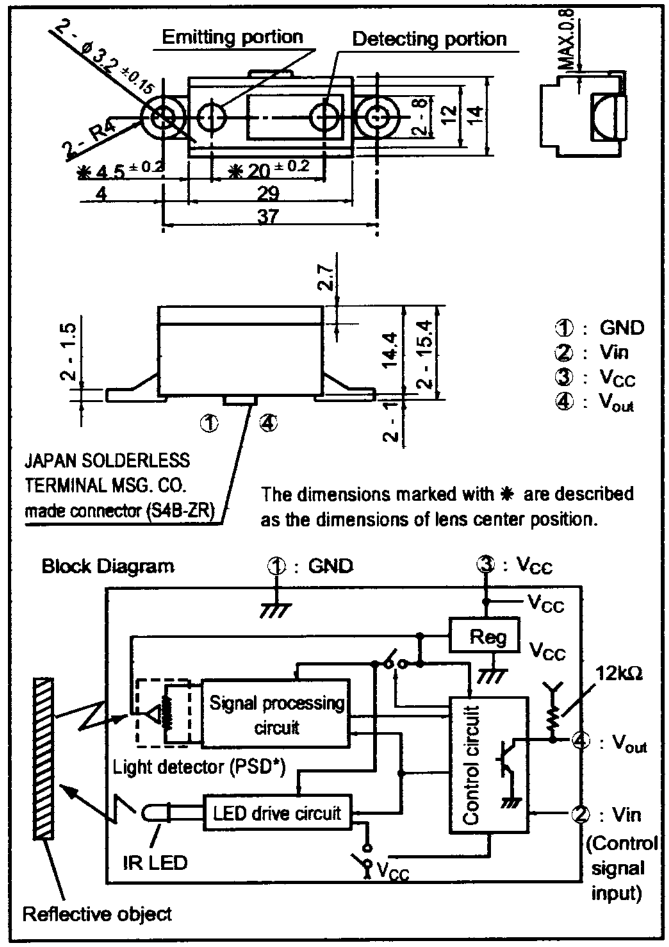
Overview

DIRRS™ is a low-cost, short-range Infra-Red (IR) alternative to ultrasonic range-finding systems. Usable detection range is 10 cm to 80 cm (approx. 4” to 31.5”).

The IR Object Detection System consists of the Sharp GP2D02 Distance Measuring Sensor and a custom cable assembly. The GP2D02 is a compact, self-contained IR ranging system incorporating an IR transmitter, receiver, optics, filter, detection, and amplification circuitry. The unit is highly resistant to ambient light and impervious to variations in the surface reflectivity of the detected object.

Unlike many IR systems, DIRRS™ has a fairly narrow field of view; making it easier to get the range of a specific target. The field of view changes with the threshold distance (see the graph at the end of this document), but is no wider than 10 cm (5 cm either side of centre) at maximum range.

■ Outline Dimensions (Unit : mm)



Specifications

ABSOLUTE MAXIMUM RATINGS (Ta=25 °C, Vcc= 5V)

Parameter	Symbol	Rating	Unit
Supply Voltage[1]	V_{cc}	-0.3 to + 10	V
Input Terminal Voltage[2]	V_{in}	-03. To + 3	V
Output Terminal Voltage	V_o	-0.3 to + 10	V
Operating Temperature	T_{opr}	-10 to + 60	°C
Storage Temperature	T_{stg}	-40 to + 70	°C

NOTES:

1. The *operating* voltage of the unit is 4.4 – 7 VDC and **should normally be run on 5 VDC**
2. The input terminals maximum voltage rating is **3 V**. Exceeding this level may cause **permanent damage**.

ELECTRO-OPTICAL CHARACTERISTICS (Ta=25 °C, Vcc=5V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Distance Measuring Range	ΔL	-	10	-	80	cm
Output Terminal Voltage	V_{OH}	Note 1	Vcc-0.3	-	-	V
	V_{OL}	Note 2	-	-	0.3	
Change in Distance	ΔD	Note 3	48	58	68	
Average Supply Current	I_{cc}	Note 4	-	22	35	mA
Standby Supply Current	I_{ccoff}	Note 5	-	3	8	μA
Vin Terminal Current	I_{vin}	Vin=0V	-	-170	-280	μA

Notes:
1) Output HIGH, L=20 cm
2) Output LOW, L=20 cm
3) Output change from L-80 cm to L=20 cm
4) Average current during measurement period (56 ms MAX.), L=20cm
5) Current consumption when Vin terminal is HIGH, L=20cm

Mounting the Sensor

The sensor unit may be mounted using the included piece of double-sided foam, or 2 appropriately-sized screws.

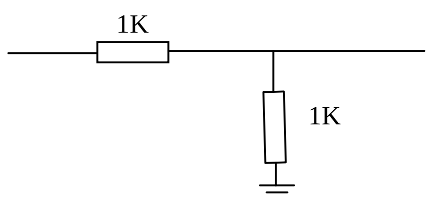
Connecting to the Sensor

A custom cable assembly is included with the DIRRS™ kit. The miniature connector is keyed so that it may only be inserted one way. The following table shows the necessary connections:

Pin	Symbol	Wire Colour	Connect To
1	GND	Black	Ground
2	V_{in}	Green	Voltage divider going to microcontroller pin (**MAX. 3.0 Volts !**)*
3	V_{cc}	Red	+ 5 V DC
4	V_{out}	Blue	Input pin of microcontroller

*The maximum voltage the input can tolerate is 3 V. Use two 1K resistors (included) to make a voltage divider (fig. 1)

To Microcontroller Pin



To V_{in} (Green wire) of GP2D02

Fig. 1.

Calibration

The decimal values representing distance will vary slightly from unit to unit. Some experimentation will be necessary to determine precisely how the numeric output corresponds to distance. Generally though, the GP2D02 will output a value of around 65 with the object 80 cm away, and of about 200 when there is an object at 10 cm. While Sharp claims that the GP2D02 is immune to variations in reflectivity (i.e. colour) of an object, there are some small variations in measurements from one extreme (white paper) to another (matte black paper). Here are the results of some tests we ran:

	5 cm*	**7 cm***	**10 cm**	**20 cm**	**30 cm**	**40 cm**	**50 cm**	**60 cm**	**70 cm**	**80 cm**	**85 cm***
White Paper	200	236	195	127	103	90	82	77	72	68	68
Brown Paper	210	236	194	126	102	90	82	77	72	69	68
Matte Black Paper	182	238	201	125	100	84	74	66	64	62	61

*These distances are outside the units' specified limits and are included for illustration only. Readings at these distances tended to be erratic.

Notice that the relationship between the sensor's numeric output and distance is not linear. The table above shows that for a piece of white paper, the difference in output between 10 cm and 20 cm (a change of 10 cm) is: 195-127 = 68, while the difference between 70 cm and 80 cm is just: 72-68=4. See the graph of Output vs. Distance and the end of this document for more details.

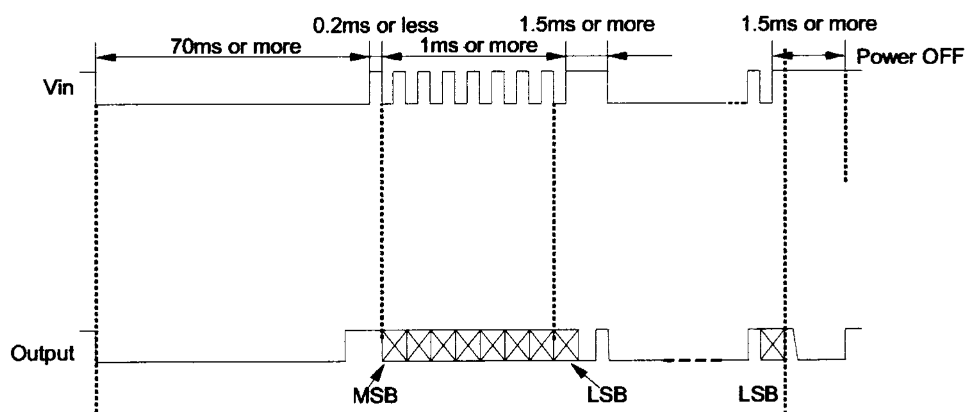
Operation

The GP2D02 makes repeated measurements before it returns the distance to an object. The time it takes to make these measurements varies slightly from unit to unit and can be as long as 70 ms (our tests show the average to be between 40 and 50 ms). The following 3 steps illustrate a measurement cycle:

1. The V_{in} line is normally held HIGH (+3V). To begin a measurement sequence, pull this line LOW (0V).
2. Wait for V_{out} to go HIGH.
3. You can now begin clocking-in the distance data (8 bits).

To transfer the data, you must generate a series of 8 pulses (maximum pulse width 200 µs) on the V_{in} line and read the V_{out} line in between each pulse. The pulses must not be more than 200 µs long. The entire process is done painlessly with the BASIC Stamp 2's SHIFTIN command, as demonstrated in the following example:

■ Timing Chart



Example of distance measuring output (8-bit)

Example

```
'Measurement Routine for DIRRS™ using a BASIC Stamp II
'==================================================================
'This program demonstrates how to implement a measurement cycle. It repeatedly checks to see if the conversion
'(measurement sequence) is done and displays the time it took to complete, along with the distance to to an object. For
'simplicity, you might like to find the average measurement time, add a 'fudge factor' of say, 5 ms, and put a plain PAUSE
'of that value in your program rather than constantly checking the output of the sensor.
'==================================================================
'P0 is connected to the voltage divider, which in turn goes to Vin (green wire). The clock pulses go out on this line.
'P1 is connected to Vout (blue wire). Data comes in on this line.
'==================================================================
T       VAR     BYTE
DIST    VAR     BYTE

START:  High 0                                          'Make sure that Vin sees a high-low transition
        Pause 3                                         'Wait for it to be seen
        Low 0                                           'Begin measurement sequence
        For T= 1 to 70                                  'Begin 70 ms wait
        Pause 1
        If IN1=1 Then JUMP                              'If Vout is HIGH, measurement is complete -jump
        Next                                            'Measurement not complete, wait another 1 ms
JUMP:   Debug "Measurement Time", dec T, " ms",cr       'Display measurement time for this cycle in debug window
        Shiftin 1,0,2,[DIST\8]                          'Shift 8 bits into DIST via pin P1, clocking with P0, MSB first
        Debug "Distance= ", dec DIST,cr                 'Display distance (in decimal form) in debug window
        Pause 500                                       'Pause briefly so you can read the debug window
        Goto START                                      'Start over
        END
```

The program runs through a loop to show the amount of time this particular unit takes to complete a measurement cycle. You can use this information t replace the FOR-NEXT loop and IF-THEN statements with a PAUSE of sufficient length.

Some Observations on the Effect of Different Kinds of Light

Ambient Light

Tests have shown the GP2D02 to be highly immune to ambient light levels. Incandescent, fluorescent, and natural light don't appear to bother it. The only instance where we were able to get it to falsely measure was when a flashlight was pointed *directly* into the sensor's receiver; even a few degrees off-centre is enough for the sensor to ignore it.

IR Light

The GP2D02 uses a modulated IR beam to guard against false triggering from the IR component of incandescent, fluorescent, and natural light. Tests with several kinds of IR remote controls have shown that even with 2 or 3 remotes pointed at the GP2D02, the unit still functions normally.

Laser Light

Tests with a laser pointer had results similar to the flashlight; only a beam aimed straight into the sensor's receiver would cause a false reading. If the beam comes from even a few degrees off-center, it has no effect.

How Does it Work ?

Figure 2 shows how the GP2D02 uses an array of photodiodes (called a Position Sensitive Detector, or PSD) and some simple optics to detect distance. An infra-red diode emits a modulated beam; the beam hits an object and a portion of the light is reflected back through the receiver optics and strikes the PSD. Object A is closer and therefore the reflected light from it enters the receiver's lens at a greater angle than does light from object B.

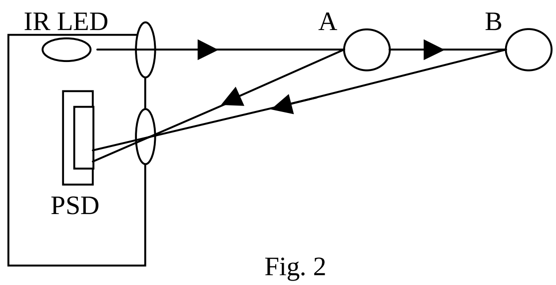
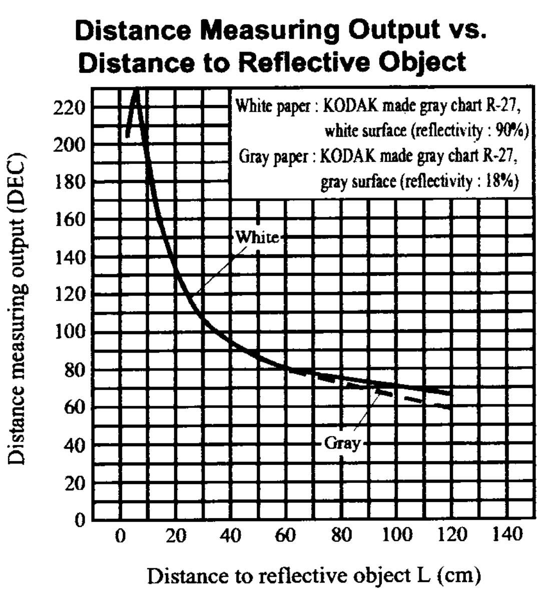


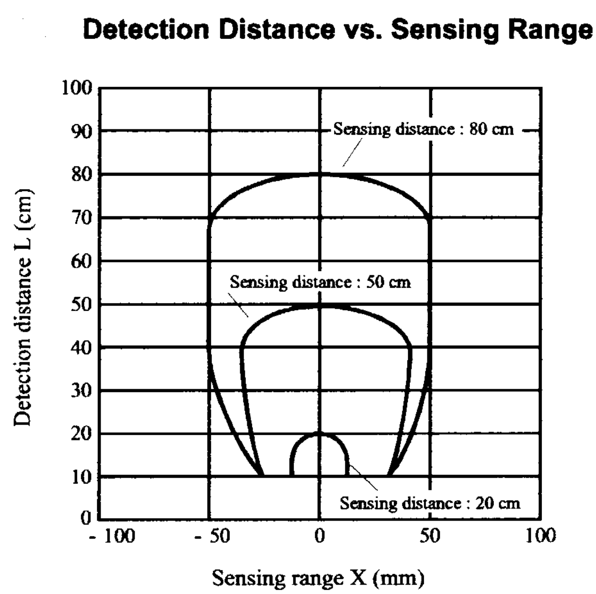
Fig. 2

Here, Object A is at the limit of the PSD's range (about 10 cm away). Notice how that if it were any closer, the light would not hit the PSD at all. Similarly, if B were moved farther away, its' light would eventually go past the 'top' of the PSD and would not be seen either (at about 80 cm). This explains why DIRRS$_{TM}$ has these limits

Think of the PSD as a resistor with a large number of taps (wires coming out at various points along the resistor). When light hits the PSD, it hits one of the 'taps' and causes current to flow out each end of the resistor, forming a voltage divider similar to that of figure 1. As an object moves closer or farther from the sensor, incoming light hits a different 'tap' causing the current coming out each end of the resistor to change. These currents are compared and a voltage proportional to the position of the 'tap' (and therefore the distance of the object) is generated. This voltage is digitized and is sent to the host serially.

CAUTION: The GP2D02 is a precision device. **DO NOT** attempt to open the unit. Doing so will ruin the delicate alignment of the optics.





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