73. Light Direction Sensor Experiments **DRAFT 1.2**

UFO Doctor, March 14th, 2014

1. Introduction

Sharp is the manufacturer of the Distance Measuring Sensor GP2Y0A710K0F.
It consists of a LED light source, a PSD (Position Sensing Device) as a receiver, an electronic circuit for synchronizing the LED with the PSD and optical lens.
The light is modulated by a burst (see Fig. 3); the wavelength is about 870nm and the optical lenses serve also as daylight filters.

This sensor shows a measuring distance range from 100 to 550cm and provides a non linear analog output signal of 0.5 to 1.85V F.S.

Sharp GP2Y0710K0F

Distance Sensor Sensor
100 to 550cm
Wavelength 870nm
5V, 30mA average

Fig. 1: Sensor

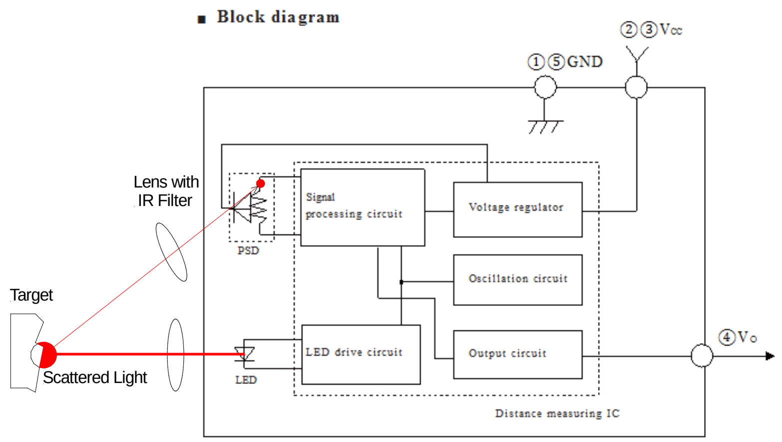


Fig. 2: Block Diagram

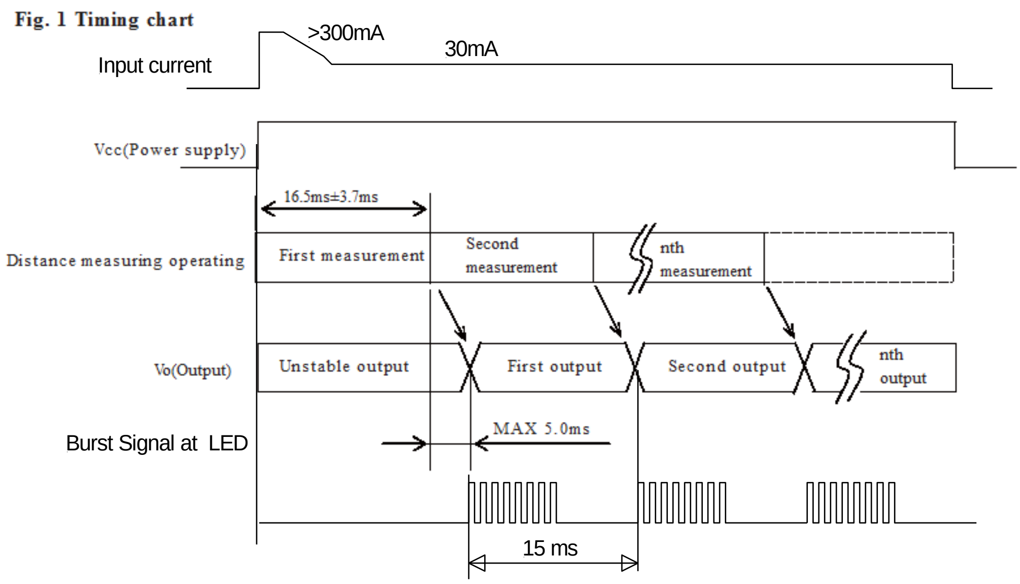


Fig. 3: Timing Chart

The signal processing is synchronized with the LED Driver by the Burst Signal. Only light reflections at the target generated by its own LED will be processed, ambient light is suppressed by the plastic lens with IR-Low Pass characteristics.
(See chapter 6 below)

2. Conversion of the Sharp Sensor to a DIRECTION Sensor

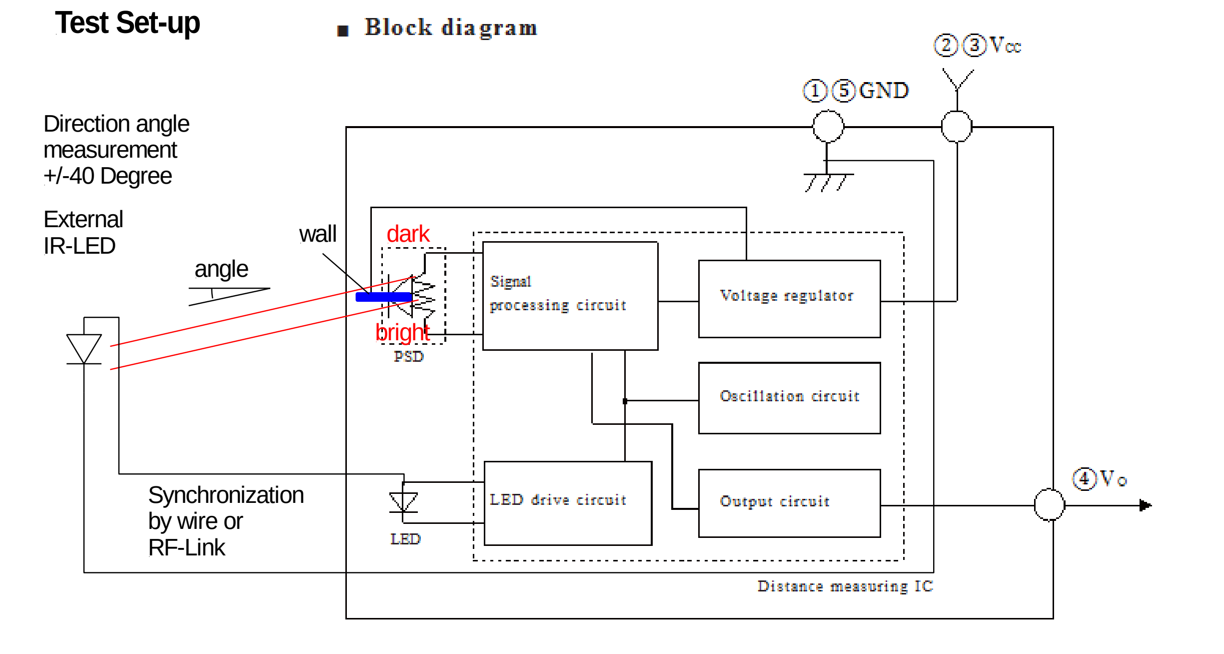


Fig. 4: Concept for light direction measurement with a modified Sharp sensor

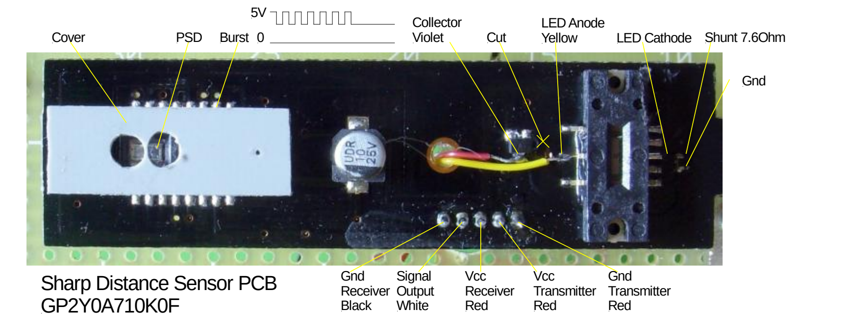


Fig. 5: Sharp Distance Sensor modified to a Direction Sensor. The cover (see drawing) distribute the incoming light to the left and right side of the PSD Sensor

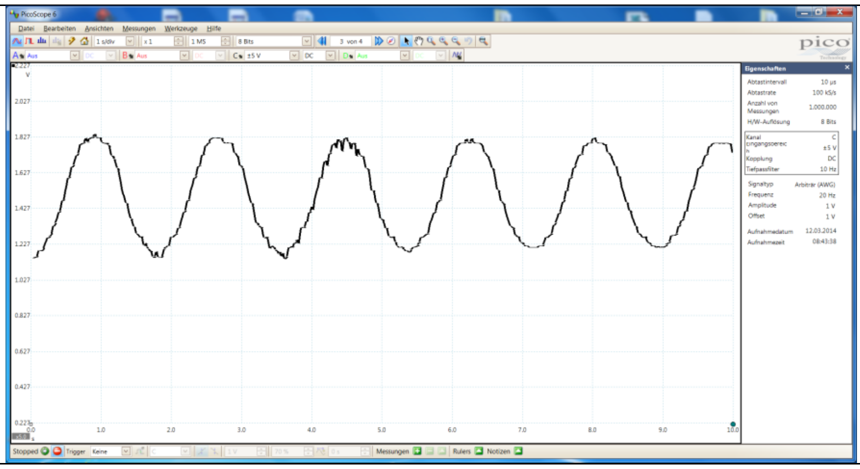


Fig. 6: First Experiment with a remote LED swinging to the left and right at an angle of max +/35 degree.

Time Scale: 1s/div
Output: 1.1 to 1.8V
Filtered by 10Hz

Comment:
- Large angle range, very good
- Frequency response: DC to about 20 Hz, ok for many applications

3. Multiplex Concept

In our application we have four Baby Ducks which should measure the direction angle to Mama Duck.

Each Baby Duck gets a PSD Module and an ASK-transmitter for 433 MHz, transferring the electrical Burst Signal to Mama Duck.
Mama Duck gets a ASK receiver and an IR-LED, radiating the optical burst signal.
You may look it at as an electromagnetic "Ping" from Baby to Mama and "Light Answer" by Mama.

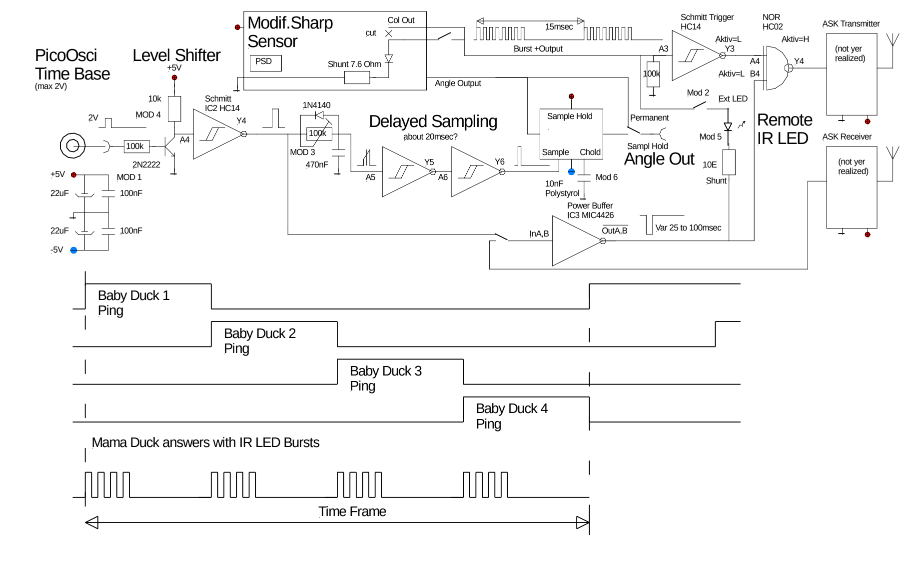


Fig. 7:
Circuit for multiplexing.

First experiments with remote IR-LED connected to Sharp Sensor by cable only

It is Important to investigate the “Delayed sampling” Since the PSD will lose the track by multiplexing!

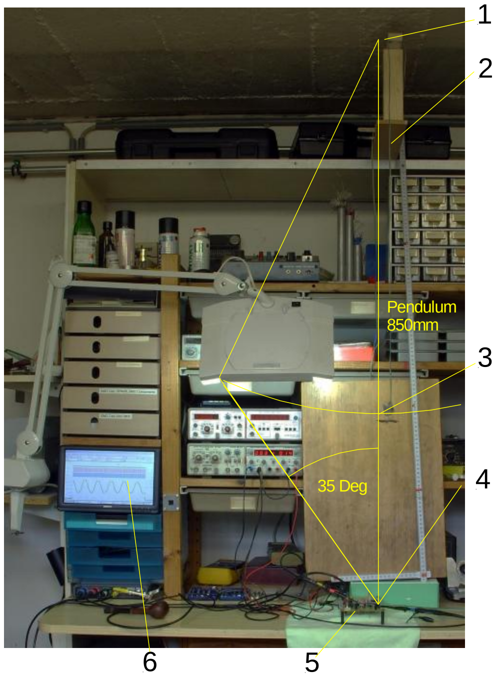


Fig. 8: Test Set-up
1: Joint; 2: Cable; 3: Remote IR-LED
4: PSD-Sensor, 5: Wire Wrap Board:
6: PicoScope Recording

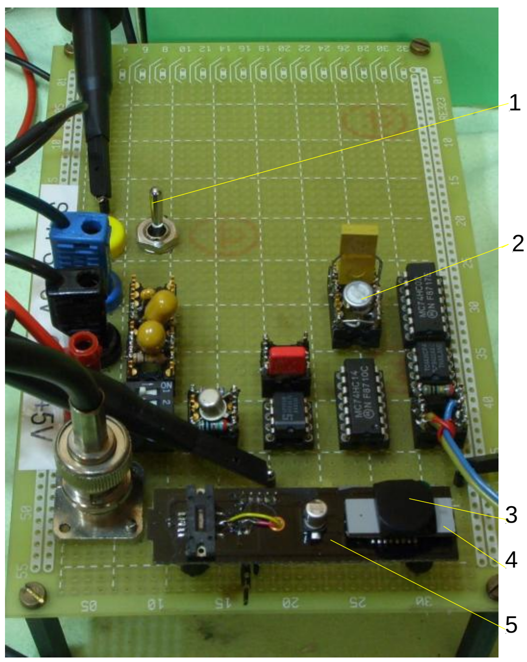


Fig. 9: Wire Wrap Test Board
1: Switch Sample-Hold/Original Signal;
2: Sample Delay, 3: IR-Filter, Sharp Lens milled flat to get a Day-Light Filter;
4: Cover with Light Wall; 5: Sharp PCB

3.1 Results Multiplex 2 Channels, 10 Hz, 50% Duty Cycle, Rectangular

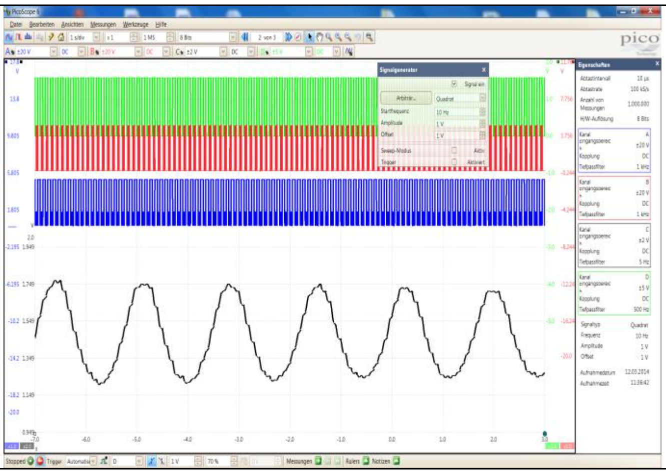
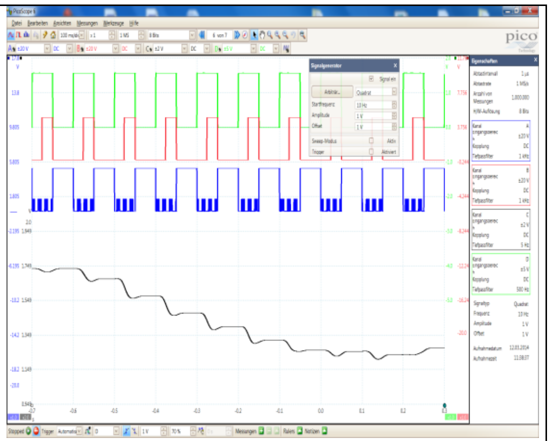
	

Fig. 10a: 1sec/Div 1st: Pico Osci Output, 10Hz/50% 2nd: Delayed Sample Command 3rd: Remote LED Burst Signal 4th: Direction Signal, LP 5Hz	Fig. 10b: 100msec/Div Comment Reception of three bursts, ok Sample delay 40 msec, ok Good direction signals!

3.2. Results Multiplex 4 Channels, 10Hz, 25% Duty Cycle

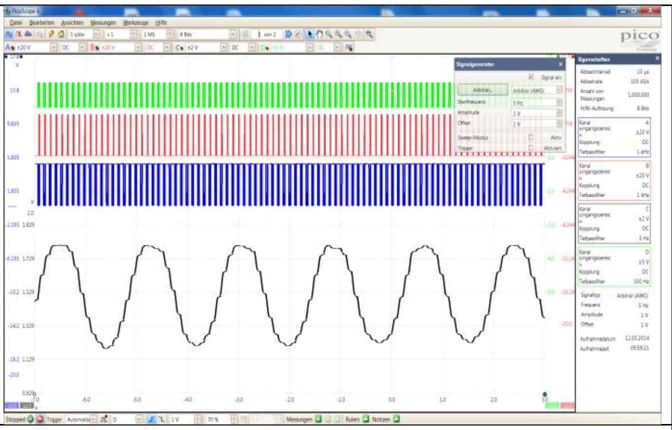
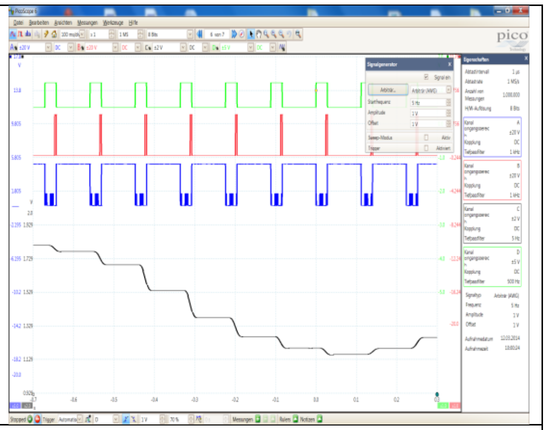
	

Fig. 11a: 1sec/Div 1st: Pico Osci Output, 10Hz/25% 2nd: Delayed Sample Command 3rd: Remote LED Burst Signal 4th: Direction Signal, LP 5Hz	Fig. 11b: 100msec/Div Comment Reception of two bursts, ok Sample delay 40 msec, ok Quite good direction signals!

Comment:
A 4 channel multiplexing with a repetition frame of 100msec is ok for our Duck Project. The master frame, given by RC from Papa Duck, is 6x 22msec. By counting the “aile” pulses each Baby Duck can activate its direction sensor in sequence.

4. PSD Sensitivity and IR-LED Power

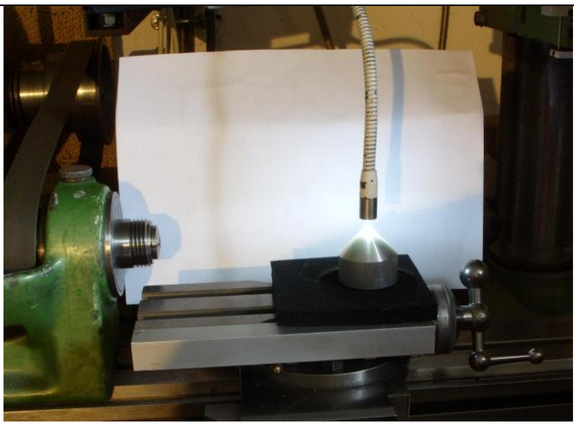
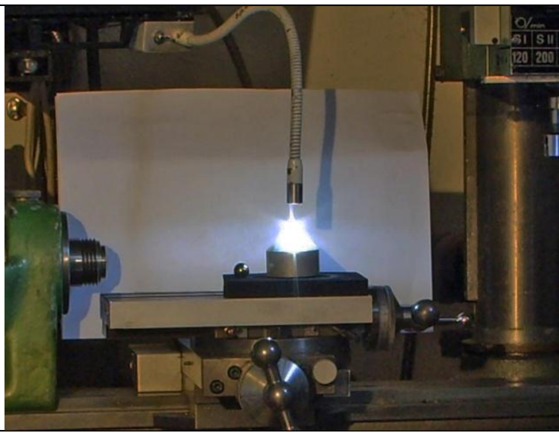
Both PSD and LED operate here without lens. Thus, the maximum distance for proper operation is limited to about 2 meters at present.

The IR-LED draws about 10mA average, multiplexed 50% at 10 Hz
Vishay offers the IR-LED VSYL5850 for 100mA continuous current!

5. Omnidirectional LED experiments, here with visible light for comparison

The light source driving the PSD should radiate omnidirectional into the horizontal plan. An arrangement with 8 LEDs each at 45 deg in the horizontal plane would be easiest and the best.

Since we want to investigate later the Time of Flight (TOF) method, we try here to create a Light Point Source with a diameter of 5 to 10 mm only.

<table>
<tr><td></td><td></td></tr>
<tr><td>Fig. 12: Optical Signal with an Alum-Cone: WITHOUT Mirror-bright spray: Not so bright!</td><td>Fig. 13: Optical Signal with an Alum-Cone: WITH Mirror-bright spray: Much brighter!</td></tr>
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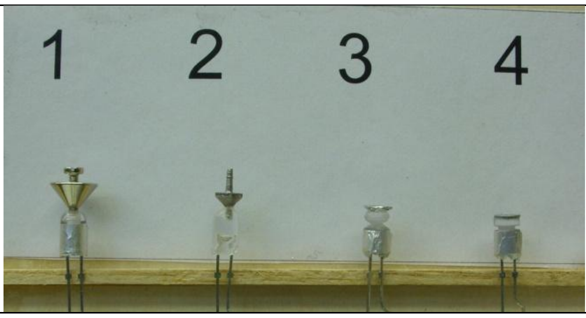
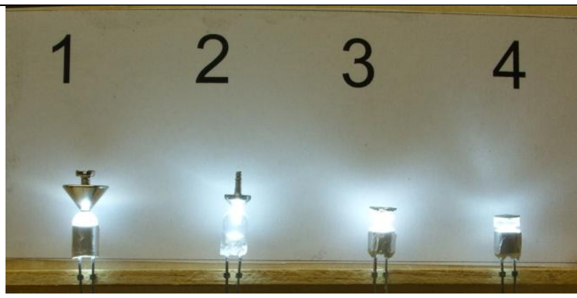
<tr><td>
</td><td>
</td></tr>
<tr><td>Fig. 14a: LEDs at day light</td><td>Fig. 14b: Light performance in the dark</td></tr>
<tr><td colspan="2">Nr.1: Large polished chrome cone mounted by a M2 screw into the LED.
Nr.2: Small polished INOX cone mounted by a M2 screw into the LED.
Nr.3: 90 Deg groove, at the top a 90 deg mirror cap of alum foil, mounted inside directed downwards. Alum foil around the shaft of the LED.
Nr.4: Rectangular groove, flat alum foil at the top of and around the LED.</td></tr>
</table>

Comment to Light Point Sources

The LED Nr 1 and Nr 3 look good for omnidirectional radiation into the horizontal plane.

- A mirror-bright 90 deg cone on the top of the LED would be the best; however this is difficult to manufacture and to hold firmly in place.
- Experiments with the transparent UHU-Plus epoxy glue (in order to keep the cone in place) were not successful, too much absorption!
- The Alum-foil around the shaft of the LED helps very much to guide the light to the upper cone!

6. Comparison of optical Band Pass-Filter with Plastic Daylight Filter

Fig. 15: Optical spectrometer,
equipment of optoLab, BFH (Ch. Meier)

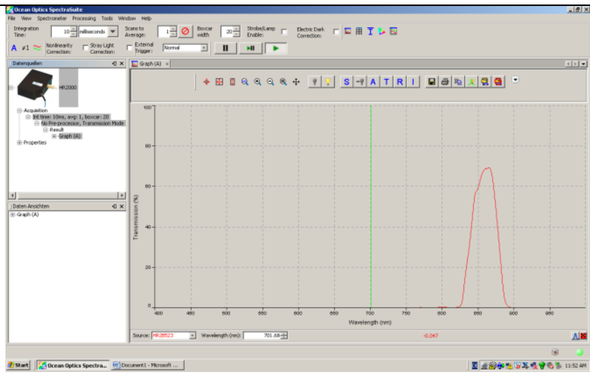


Fig.16: Filter THORLABS FB850-40
> 65 % transmission at 870nm,
<<1% at daylight, perfect!

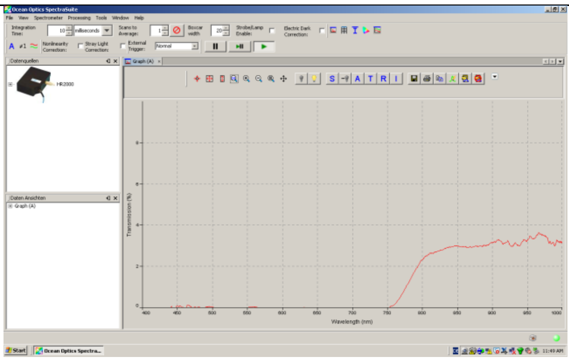


Fig.17: Filter Sharp Distance Sensor
GP2Y0710KOF:
Plastic lens milled flat to 2mm thickness
and polished (not perfect!)
Vertical scale: 0 to 10 % transmission
Comment:
Good daylight filtering <750nm

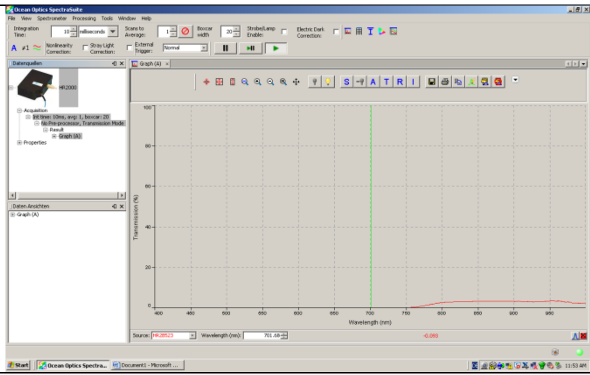


Fig. 18: Filter Sharp Distance Sensor,
Vertical scale: 0 to 100 % transmission
as in Fig. 16 above.

Comment:
Less than 4 % transmission >850nm
A thinner filter could be better

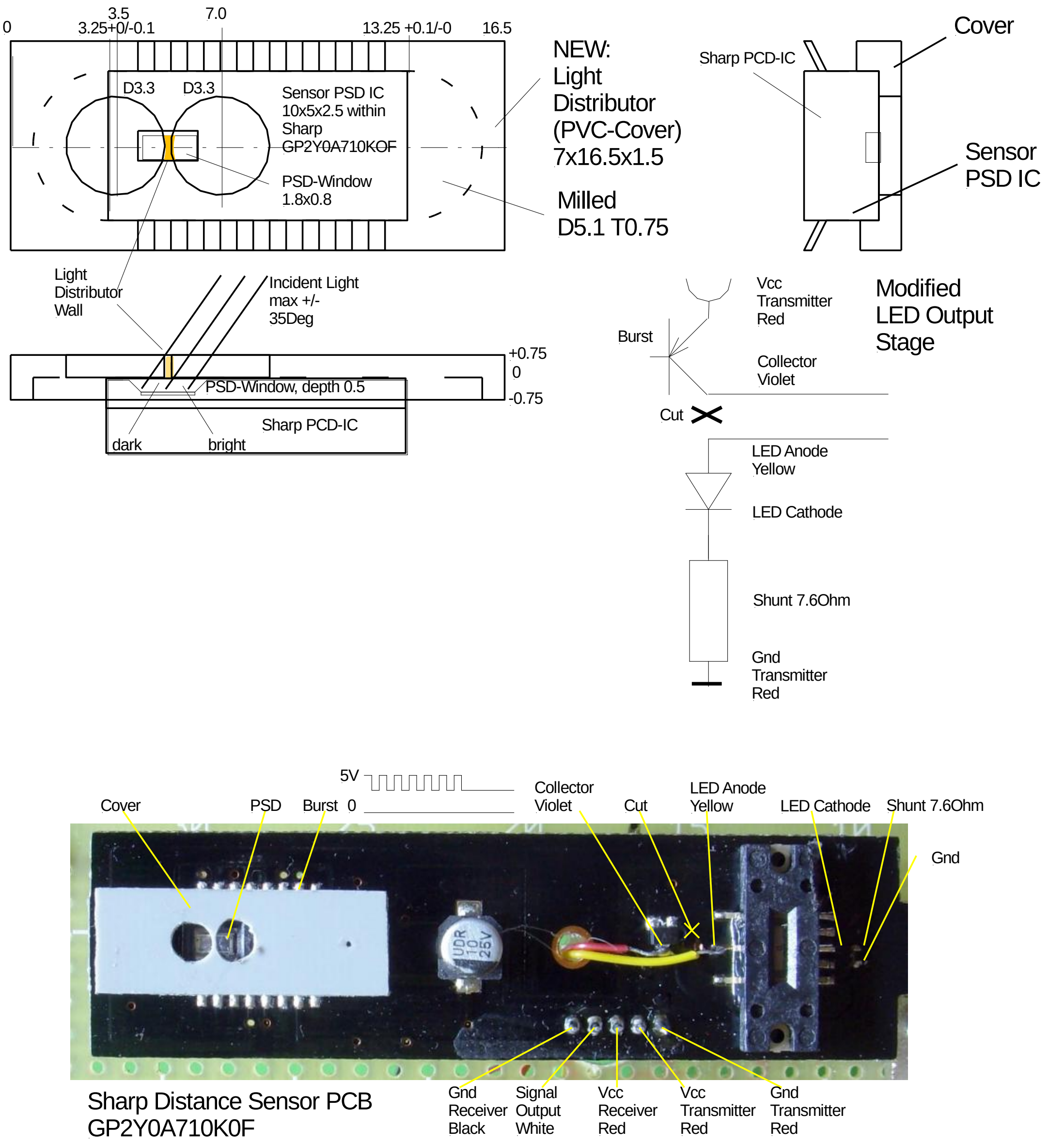
Preliminary Conclusion

An epoxy material (as used to manufacture the lens of the Sharp sensor) is fine to manufacture a low-cost day-light filter.

However, such a thick epoxy filter material attenuates the IR-signal very much, too.

CLAREX Nitto Jushi Kogyo CO. LTD offers thin plastic sheets:
Daylight filtering <600nm , IR transmission >70%
Distrelec: Art.Nr. 650945 Typ RH10NG N1 NIR79 200X91X05

7. Drawing of the modified Sharp Sensor



Sharp Distance Sensor PCB
GP2Y0A710K0F

(Verwendungsbereich)			(Zul. Abw.)	(Oberfl.)	Maßstab 1:1	(Gewicht)
					(Werkstoff, Halbzeug) (Rohteil-Nr) (Modell- oder Gesenk-Nr)	
				Datum	Name	PSD Sensor V3
			Bearb.	03.08.14	PAN	
			Gepr.	00.00.00	PAN	
			Norm			
					D 1	Blatt
						Blätter
Zust.	Änderung	Datum	Name	Ursprung	Ersatz für:	Ersatz durch:

8. Sample Hold Circuit with Wire Wrap Board