Sharp Distance Sensors (DMS and TOF)

Product Introduction

虹晶股份有限公司　Socle Technology Corp.

July 2018

Sharp Distance Sensors

- Multiple product lines related to distance sensing (DMS, ToF, Proximity)

- DMS = Distance Measuring Sensor (measure position of reflected light)

- ToF = Time-of-Flight Sensor (measure time it takes to receive reflected light)

- Most DMS and ToF sensors return absolute distance

- Some DMS and Proximity sensors are designed for object detection only

- Each type of sensor has an effective measuring range (or distance)

DMS - GP2Y0A41SK0F   **ToF - GP2AP0AVT10F**   **ToF Module - MTOF171000C0**   **Proximity - GP2AP070S00F**
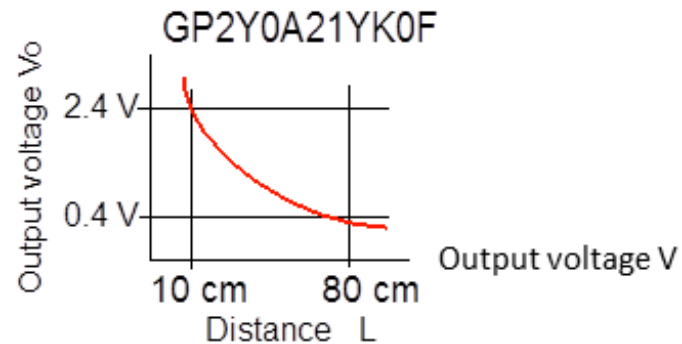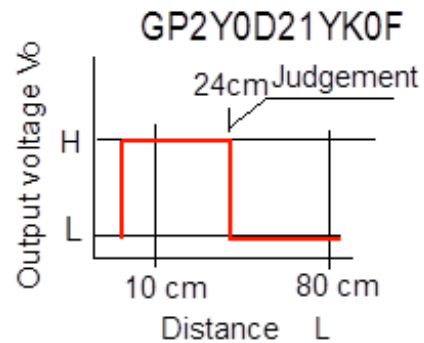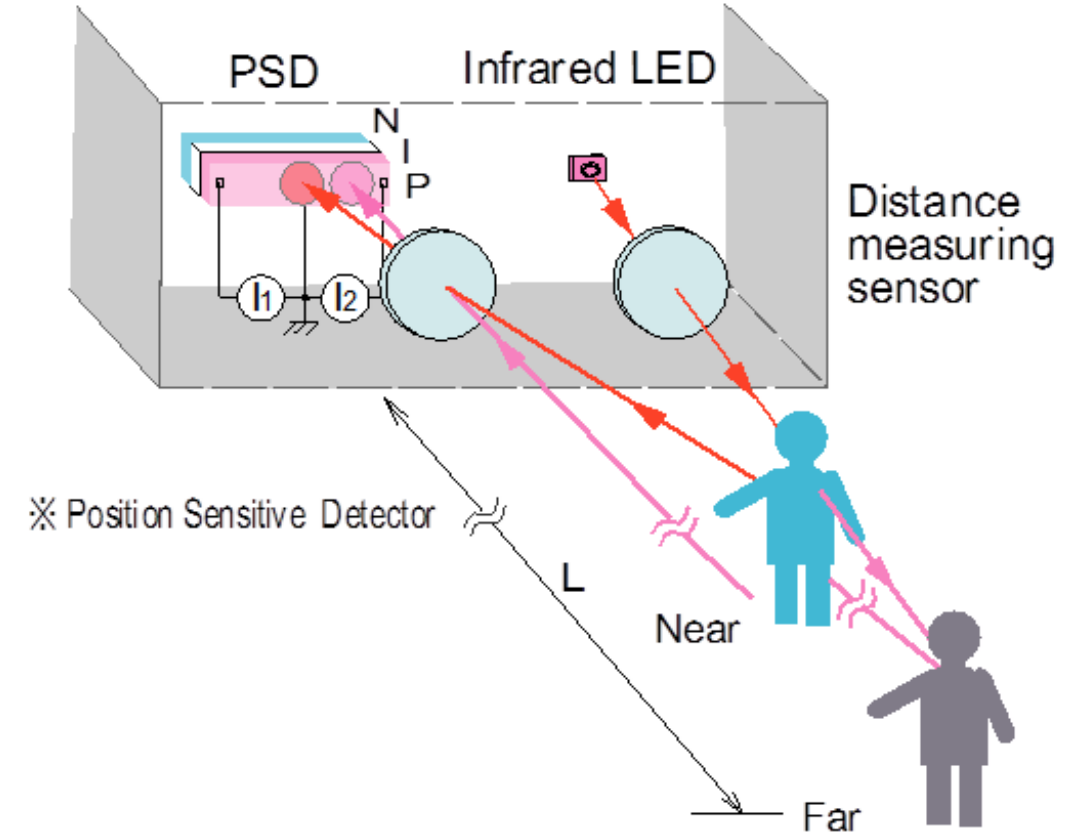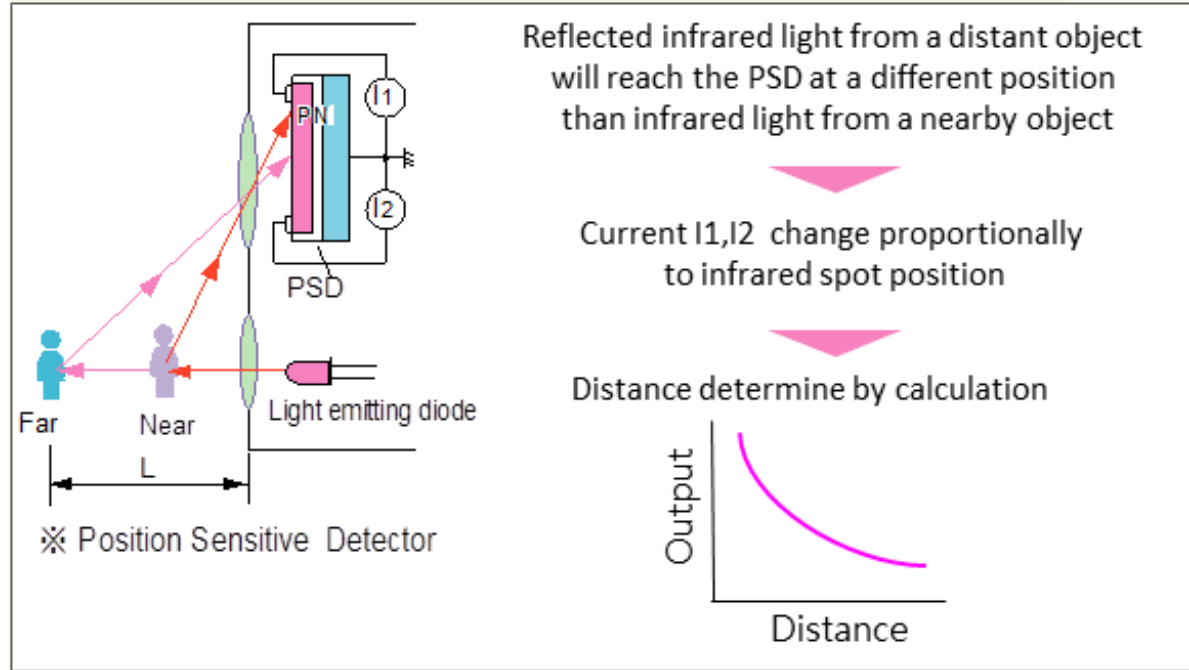
DMS

Distance Measuring Sensor Applications

- Robot vacuum cleaners
- Automatic faucets
- ATM, self-service kiosk
- Consumer/toy robotics
- Copier, vending machine, video game machine
- Automatic control of lighting
- Factory automation
- Sharp has 70% market share for DMS worldwide

Distance Measuring Sensor Principles - PSD (position sensitive detector)

Principle of DMS

PN
I1
I2
PSD

Far
Near
L
Light emitting diode

※ Position Sensitive Detector

Reflected infrared light from a distant object will reach the PSD at a different position than infrared light from a nearby object

Current I1, I2 change proportionally to infrared spot position

Distance determine by calculation

Output
Distance

PSD   Infrared LED
N
I
P
I1   I2

Distance measuring sensor

※ Position Sensitive Detector

L
Near
Far

GP2Y0D21YK0F

Output voltage Vo
24cm Judgement
H
L
10 cm   80 cm
Distance   L

GP2Y0A21YK0F

Output voltage Vo
2.4 V
0.4 V
10 cm   80 cm
Output voltage V
Distance   L

Distance Measuring Sensor Applications
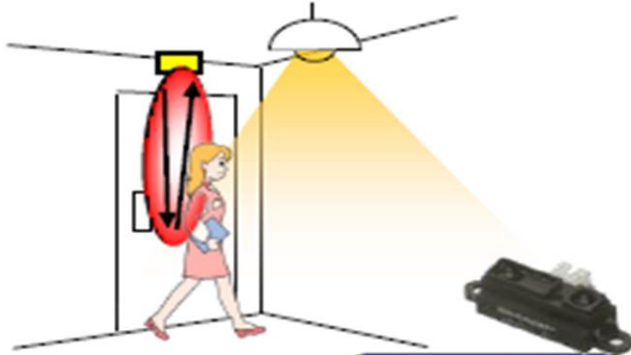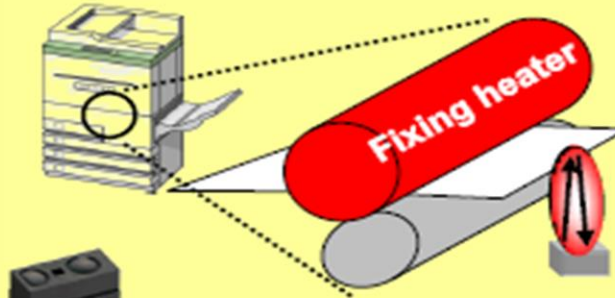
Distance Measuring Sensor Applications

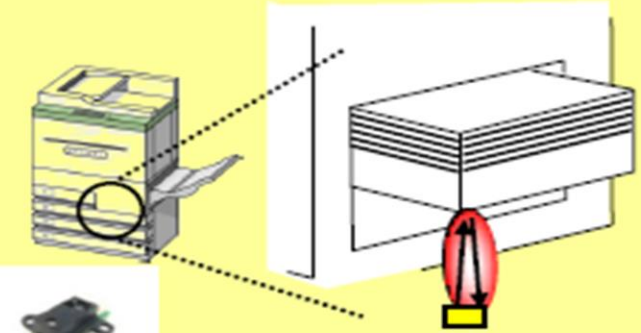**Auto ON/OFF control for illumination**
GP2Y0A02YK0F

Detecting paper through for copier
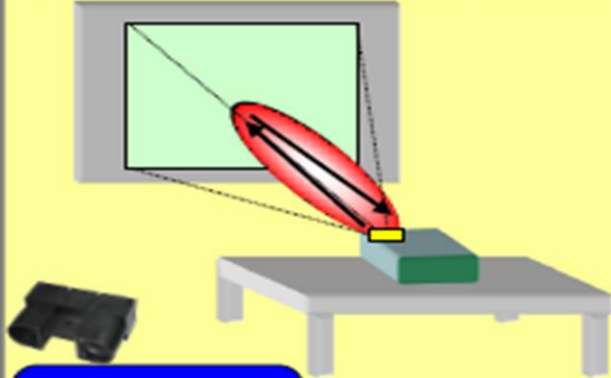Fixing heater
GP2Y0D810Z1F
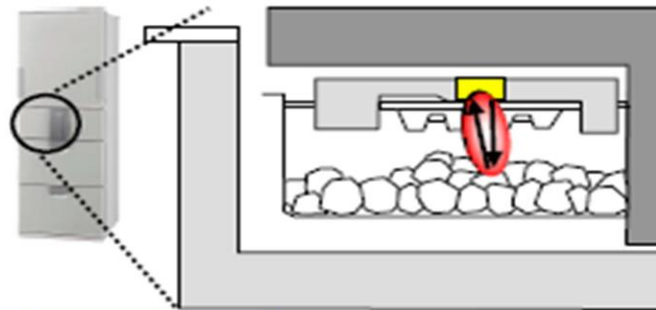
Detecting amount of paper for copier
GP2Y0AF30*

Measuring distance for Auto focus of projector
GP2Y0A710K0F

Sensing amount of ice for refrigerator
GP2Y0AF30*

Detecting hand for amusement equipment
Switch the view by touch-less operation
GP2Y0E**

SOcLE®

DMS #1 Application: Robot cleaner

【Features】**. Step detection sensor・・・ (Triangulation method) infrared sensor**
・In the dark, The infrared sensor that can detect a difference in level.
・Less influence of the floor color（Black or White）, accurately detect the floor!

Fall!
Please stop !

Extensive experience

LG
dyson
Panasonic
SHARP
SAMSUNG
YUJIN ROBOT
VORWERK

・**Step detection sensor**
Type: GP2Y0A51SK0F
Detection distance range:2～15cm
（When there is no panel）

GP2Y0A51SK0F
SHARP
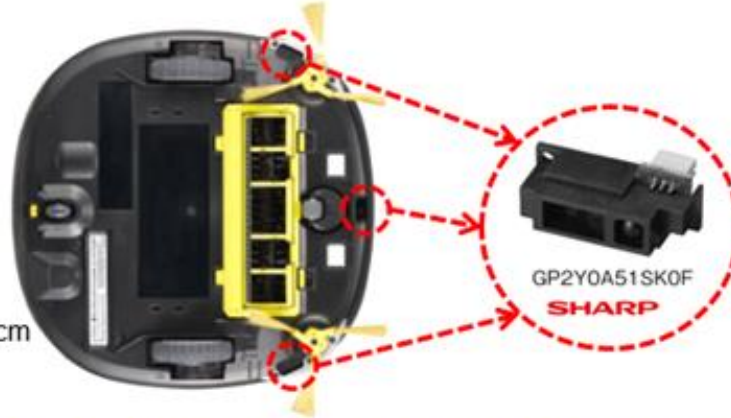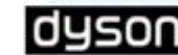
【Features】 Detecting a distance from the wall. Anti-collision sensor to the wall.
The CMOS sensor mounting distance measuring sensor.
・Detection distance range 4～50cm. Detection accuracy±10%.
・Communication specification ,Both Analog and I2Ctype, Analog output type, I2C output type.

Crash into a wall !
Slowly !

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・Wall detection
・Collision avoidance
GP2Y0E02A
Detection distance range
: 4～50cm
(When there is no panel)

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・Wall detection
・Collision avoidance
GP2Y0E02A
Detection distance range
: 4～50cm
(When there is no panel)

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DMS

Analog output type

- **Standard type**

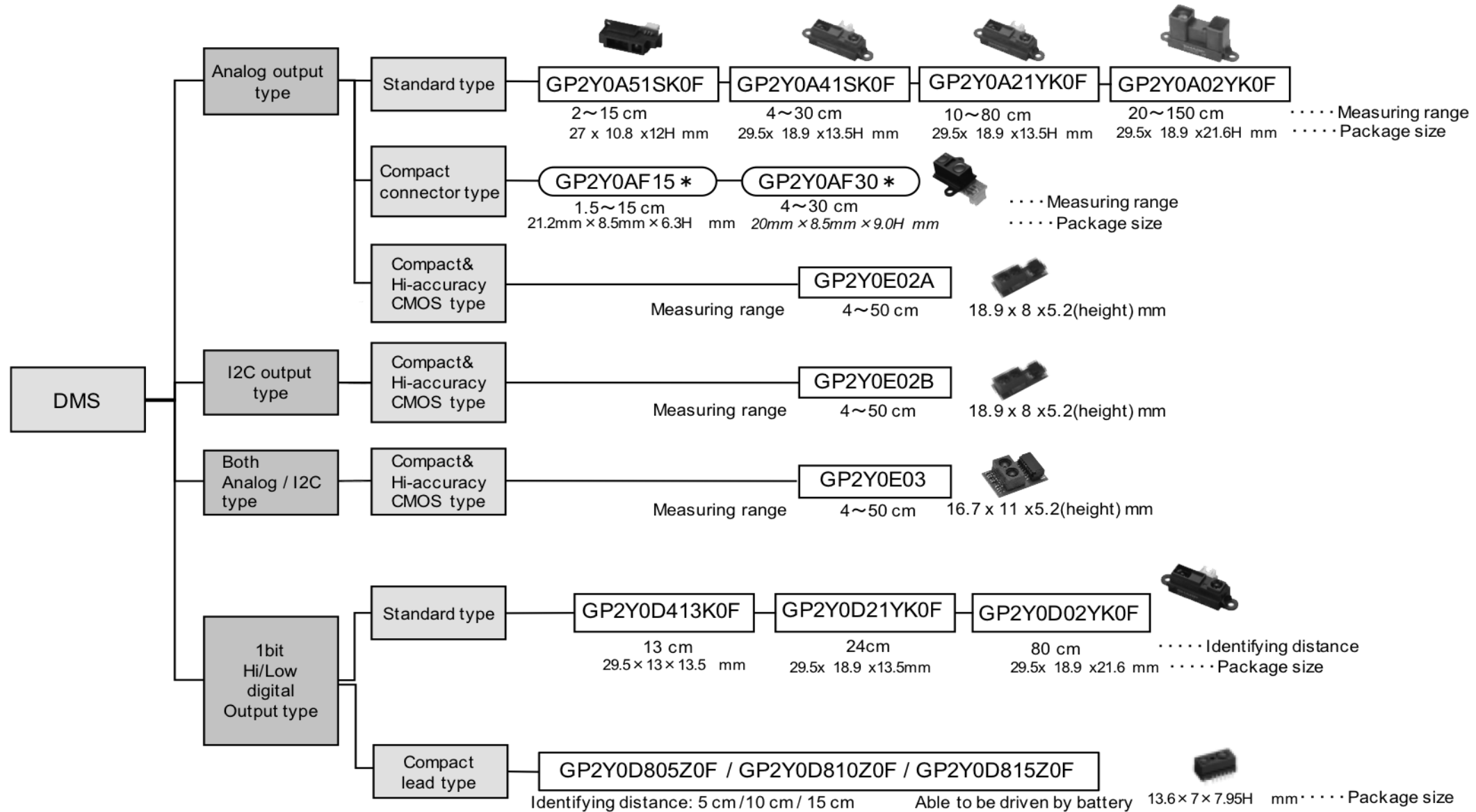 | GP2Y0A51SK0F | GP2Y0A41SK0F | GP2Y0A21YK0F | GP2Y0A02YK0F | |
  |---|---|---|---|---|
  | 2～15 cm | 4～30 cm | 10～80 cm | 20～150 cm | ·····Measuring range |
  | 27 x 10.8 x12H mm | 29.5x 18.9 x13.5H mm | 29.5x 18.9 x13.5H mm | 29.5x 18.9 x21.6H mm | ·····Package size |

- **Compact connector type**

GP2Y0AF15＊	GP2Y0AF30＊	
1.5～15 cm	4～30 cm	····Measuring range
21.2mm × 8.5mm × 6.3H mm	20mm × 8.5mm × 9.0H mm	·····Package size

- **Compact& Hi-accuracy CMOS type**

GP2Y0E02A	
Measuring range 4～50 cm	18.9 x 8 x5.2(height) mm

I2C output type

- **Compact& Hi-accuracy CMOS type**

GP2Y0E02B	
Measuring range 4～50 cm	18.9 x 8 x5.2(height) mm

Both Analog / I2C type

- **Compact& Hi-accuracy CMOS type**

GP2Y0E03	
Measuring range 4～50 cm	16.7 x 11 x5.2(height) mm

1bit Hi/Low digital Output type

- **Standard type**

GP2Y0D413K0F	GP2Y0D21YK0F	GP2Y0D02YK0F	
13 cm	24cm	80 cm	·····Identifying distance
29.5 × 13 × 13.5 mm	29.5x 18.9 x13.5mm	29.5x 18.9 x21.6 mm	·····Package size

- **Compact lead type**

GP2Y0D805Z0F / GP2Y0D810Z0F / GP2Y0D815Z0F	
Identifying distance: 5 cm /10 cm / 15 cm Able to be driven by battery	13.6 × 7 × 7.95H mm ·····Package size

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Distance Measuring Sensors - Analog Output

PART NUMBER	MEASURING RANGE	NOTE
ANALOG OUTPUT		
GP2Y0AF15Q	1.5 cm ~ 15 cm	Compact, connector type, other models GP2Y0AF15Y, GP2Y0AF15R
GP2Y0A51SK0F	2 cm ~ 15 cm	Standard type
GP2Y0A41SK0F	4 cm ~ 30 cm	Standard type
GP2Y0A21YK0F	10 cm ~ 80 cm	Standard type
GP2Y0A02YK0F	20 cm ~ 150 cm	Standard type
GP2Y0A60SZLF	10 cm ~ 150 cm	Compact, long distance type, no external control signal required
GP2Y0A710K0F	100 cm ~ 550 cm	Long distance type, no external control signal required
ANALOG OUTPUT - CMOS TYPE		
GP2Y0E02A	4 cm ~ 50 cm	Compact, high accuracy, CMOS type, Analog Output
GP2Y0E03	4 cm ~ 50 cm	Compact, high accuracy, CMOS type, Analog / I2C Output

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Distance Measuring Sensors - Digital Output

PART NUMBER	MEASURING RANGE	NOTE
DIGITAL OUTPUT - 1 BIT HIGH/LOW FOR OBJECT DETECTION		
GP2Y0D805Z0F	5 cm	Compact, lead type
GP2Y0D810Z0F	10 cm	Compact, lead type
GP2Y0D815Z0F	15 cm	Compact, lead type
GP2Y0D21YK0F	24 cm	Standard type
GP2Y0D02YK0F	80 cm	Standard type
DIGITAL OUTPUT - CMOS TYPE		
GP2Y0E02B	4 cm ~ 50 cm	Compact, high accuracy, CMOS type, I2C Output

TOF Sensor

Sharp ToF Sensor

- Time-of-Flight distance ranging sensor GP2AP01VT10F
- Operates using a Class 1 laser (940 nm)
- Measures absolute distance with high accuracy
- Effective distance range from 5 cm to 120 cm
- Small ceramic package (4.4 x 2.4 x 1.0mm)
- I2C interface for input and output
- High speed ranging - max 30 ms
- Applications:
    - High-speed autofocus (AF) for smartphone camera
    - Continuous AF for video
    - User detection for PCs, laptops, tablets
    - Robotics obstacle detection
    - White goods hand detection for automatic faucets

Sharp ToF Sensors Roadmap - Proximity ToF, long range ToF, multi-point ToF

2017   **2018**   **2019**

ToF (Time of flight)
⇒ SPAD （※） original circuit design technology
Differentiation, Low power consumption.

※Single Photon Avalanche Diode

Under planning   TS ：Sep.,2018

④Multipoint-ToF(128×128)
Measurement range:500cm

〔for VR/AR〕
- Ultra low power consumption
- Gesture recognition detection
- Assistance for 3D image sensor

Under planning   TS ：Apr.,2019

⑤Ultra long range, multipoint-ToF
Measurement range:10m

〔for FA/Robot/Smart Home〕
- Ultra long range for surveillance
- Super high resolution

Under development   TS ：Apr.,2018

②Small package 1D-ToF
Measurement range:70cm @ Grey

〔for Smartphone〕
- Size: 3.6×2.2×1.0mm
- Direct distance output without calculation
- Proximity function by absolute distance
- Low power consumption

NOW

MP ：Now

①GP2AP01VT10F 1D-ToF
Measurement range:120cm

〔for Smart home/PC
/Robot/Home electronics〕
- Camera AF assistance
- Human detection for PC
- Size: 4.4×2.2×1.0mm

Under planning   TS ：Dec.,2018

③Ultra Long range, 1D-ToF
Measurement range:10m

〔for Robot/FA〕
- Ultra Long range detection
- Tolerant of noises

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GP2AP01VT10F - Specification

Features

- All in one（ SPAD detector, IR-VCSEL emitter ）
- Small package : 4.4×2.4×1.0 mm
- ToF sensing using low-cost standard CMOS process
- Eye safe optimization by excellent light emission drive circuit
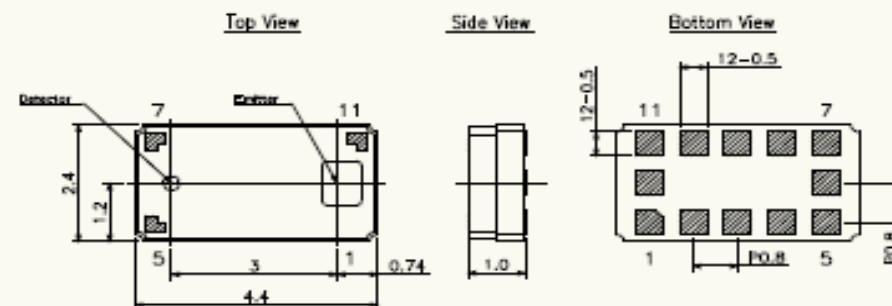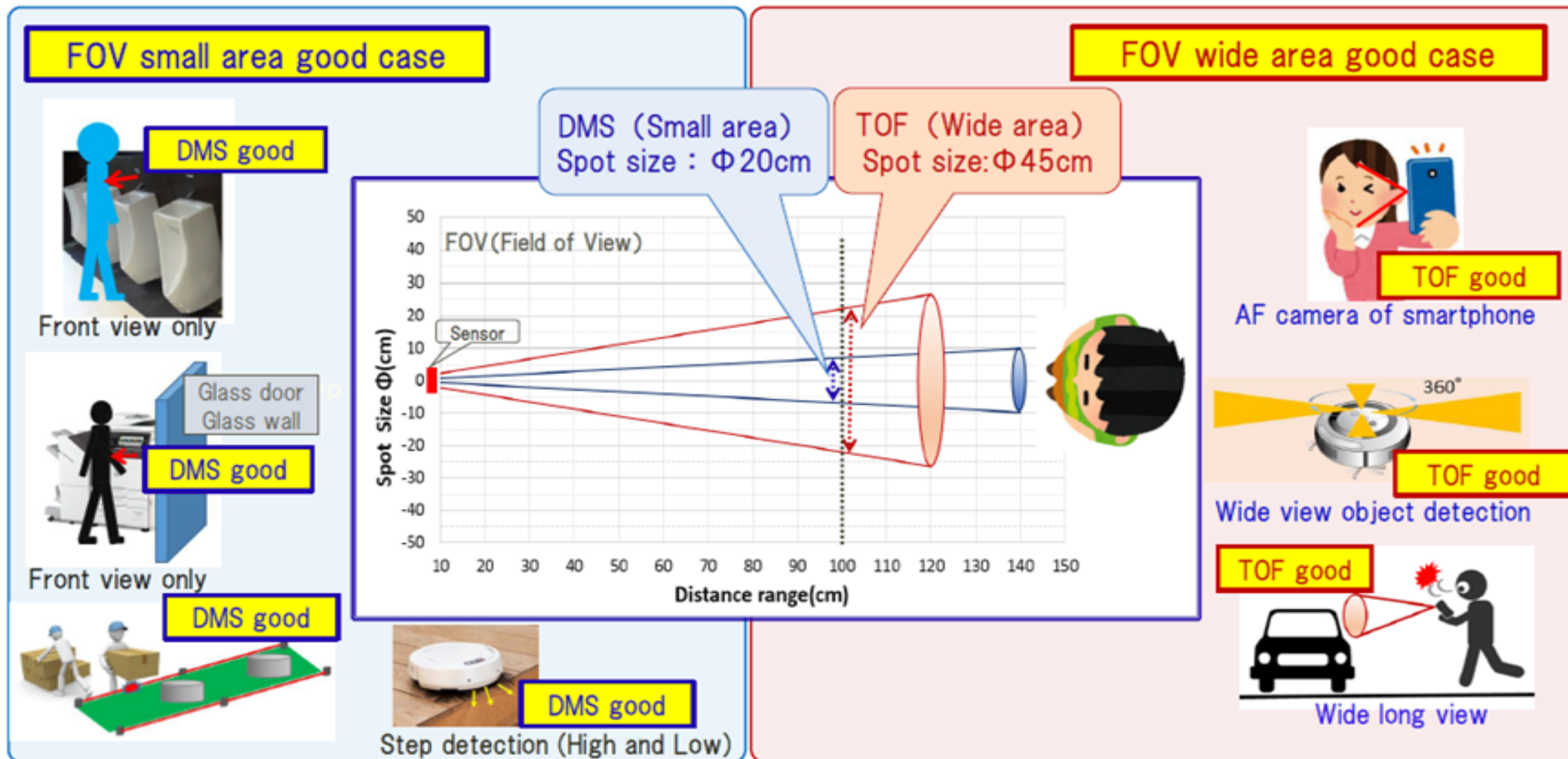- Realization of low crosstalk noise due to ceramic structure
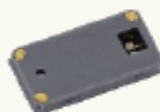
Block diagram
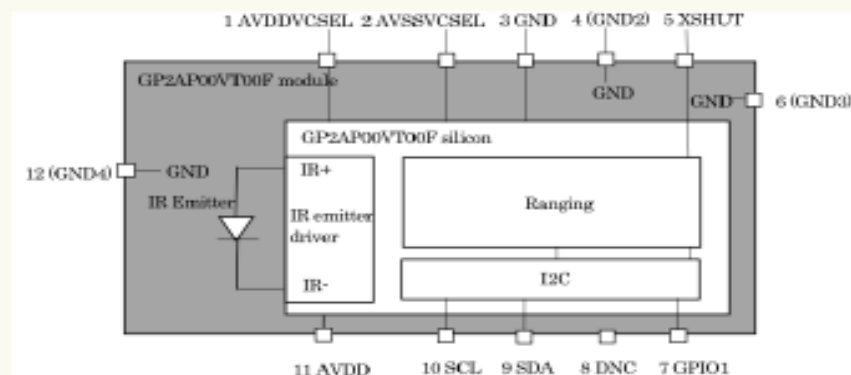
Specification

Parameter	Symbol	Value
Size		4.4×2.4×1.0mm
Output interface		I2C 0.4MHz
Operating supply voltage	V_{CC}	2.6~3.5V
Current consumption	I_{CC}	30mA
Ranging speed		33ms
Ranging distance		10cm ~ 120cm (white card)
Accuracy at 10cm	K	±20% (Black card)
Operating temp.	Topr	-20 to 70℃
Storage temp.	Tstg	-40 to 85 ℃

Outline dimensions

Compare DMS with TOF Sensors - Field of View (FOV)

FOV small area good case

DMS good
Front view only

Glass door / Glass wall
DMS good
Front view only

DMS good

DMS good
Step detection (High and Low)

DMS (Small area) Spot size : Φ20cm

TOF (Wide area) Spot size: Φ45cm

FOV (Field of View)
Sensor
Spot Size Φ(cm)
Distance range(cm)

FOV wide area good case

TOF good
AF camera of smartphone

360°
TOF good
Wide view object detection

TOF good
Wide long view

Compare DMS with TOF and Proximity Sensors - Panel Mounting

Please select sensor by panel mounting condition.

Distance Measuring Sensor

[Panel mount condition]
Air Gap: 0 ~1.0mm

below1.0mm
(IR Transmittance:85%to95%)
Panel
Air Gap 0~1.0mm
Sensor

■Detection distance range

2~15cm	4~50cm	10~80cm	20~150cm
Model:GP2Y0A51SK0F	Model:GP2Y0E03	Model:GP2Y0A21YK0F	Model:GP2Y0A02YK0F

Connector
Stop !
Step detection sensor

Connector
Object Detection sensor

Connector
Human detection

Take forget prevention sensor

Easy mounting. With Connector and screw holes.

TOF Sensor/Proximity Sensor

[Panel mount condition]
Air Gap:Must 0~0.5mm
★Small spacing.

below0.8mm
(IR Transmittance:85%to95%)
Panel
Air Gap 0~0.5mm
Sensor

■Proximity Sensor   ■TOF Sensor

0~10cm	4~120cm	4~500cm Under planning
Low Price	Middle range	Long range / Multi Long range
Model:GP2AP008/070S	Model:GP2AP01VT10F	Next Model TS:03/2018
Distance accuracy:10cm±10mm	Distance accuracy:120cm±5mm	

Proximity sensor/Grip Sensor

AF Camera of smartphone

Safety sensor

AR/VR/Robotics

Compare DMS with TOF Sensors - Specification

item		Distance Measuring Sensor TYPE:PSD	Distance Measuring Sensor TYPE:C-MOS	Distance Measuring Sensor TYPE:TOF
Output Signal Type		Analog voltage output or 1bit digital output(High/Low) ◎	Analog voltage output (I2C output) *Slave address 8 item ○	I2C output *Slave address 1 item △
Panel design	From panel to sensor distance (Gap)	0 to1.0mm If a "plate" is inserted between receiving and emitting; 0 to 2.0mm ○	0 to1.0mm If a "plate" is inserted between receiving and emitting; 0 to 2.0mm ○	0 to 0.5mm △
	Panel thickness (IR Transmittance:85 to 95%)	below1.0mm ○	below1.0mm ○	below 0.8mm △
Package type		With board. Connector connection possible. ◎	With board. Connector connection possible. ◎	SMD Surface Mount Device ○
Package Size		Large Size	Small Size	Ultra-Small Size
FOV(Field Of Veiw)		±2~5° Spot Size 20cm (at100cm) ○	±2~5° Spot Size10cm (at 50cm) ○	±13° Spot Size 45cm (at 100cm) ○
Detection distance accuracy	Distance:5cm	5cm±1cm ◎	5cm±1cm ◎	5cm±4cm △
	Distance10cm	10cm±2cm ○	10cm±1cm ◎	10cm±2cm ○
	Distance120cm	120cm±20cm △	(MAX 50cm±5cm) –	120cm±5cm ◎

Compare DMS with TOF Sensors - Specification

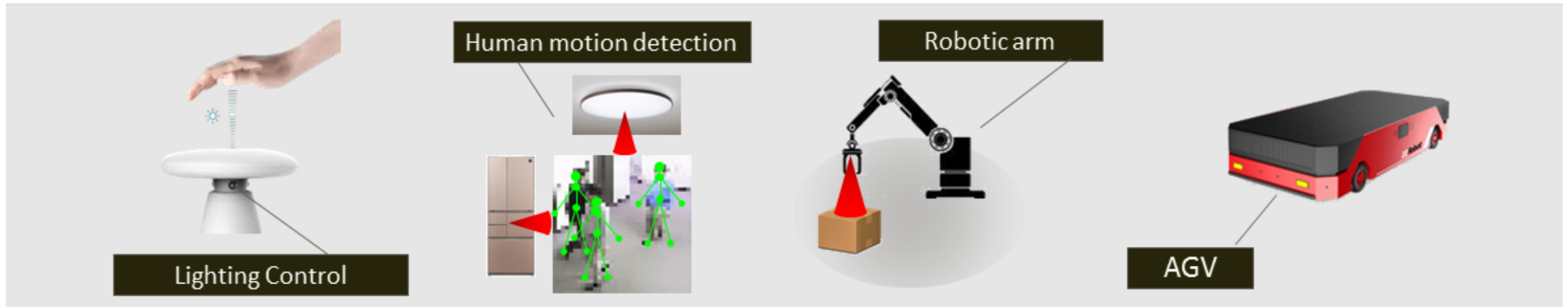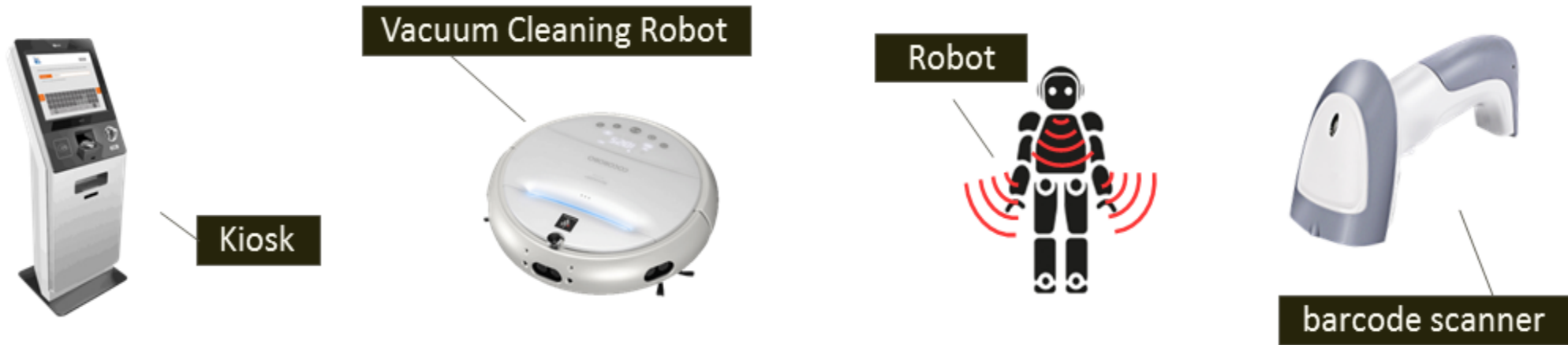| Item		DMS (PSD type)	Small PSD (CMOS type)	Lazar DMS (TOF)	NOTE
Output type		Analog output High / Low output	Analog output I2C output (Possible to set up 8 slave address)	I2C output (Fixed only one slave address)	CMOS type is suitable in case operating some number at Same timing.
Panel Design (degree of freedom in panel design)	Gap Distance (from Sensor to Panel)	Less than 1 mm (More than 1mm if shielding wall installs.)	Less than 1 mm (More than 1mm if shielding wall installs)	Less than 0.5 mm	For panel design, DMS is easier than ToF.
	Panel Thickness	unspecified Recommend less than 2.0 mm	unspecified Recommend less than 1.0 mm	Required less than 0.8 mm	
Package		Mounted on board with connector	Mounted on board with connector	SMD part	TOF: world smallest parts, but require to mount and need around some parts DMS: Easy to connect
Distance Measuring Accuracy	Short Range (5 cm)	○	◎	△	DMS has advantage
	Long Range (120 cm)	△	×	◎	TOF has advantage
Operating Temperature		-10℃ ~ 60℃	-10℃ ~ 60℃	-20℃ ~ 70℃	TOF has advantage
Detection the object has surface like mirror		Impossible	Impossible	Possible	TOF has advantage
Detection Time		Max: 52.9 ms	Max: 40 ms	28.6 ms (Default)	TOF has advantage
Operating Voltage		4.5V ~ 5.5V	2.7V ~ 5.5V	2.6V ~ 3.5V	CMOS type DMS has advantage

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TOF Module

MTOF17001's time-of-flight sensing technology is realized by Sharp's original SPAD (Single Photon AvalancheDiodes) using low-cost standard CMOS process. It enables accurate ranging result, higher immunity to ambient light and better robustness to work by special optical package design.
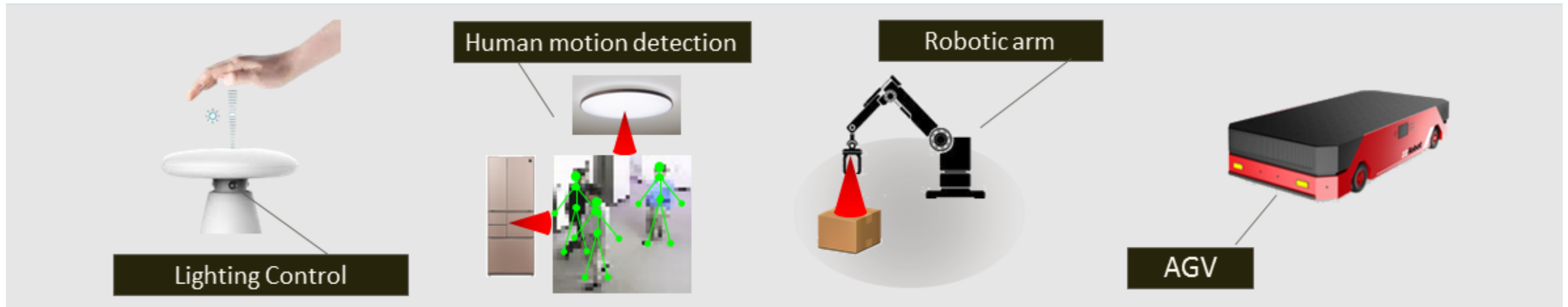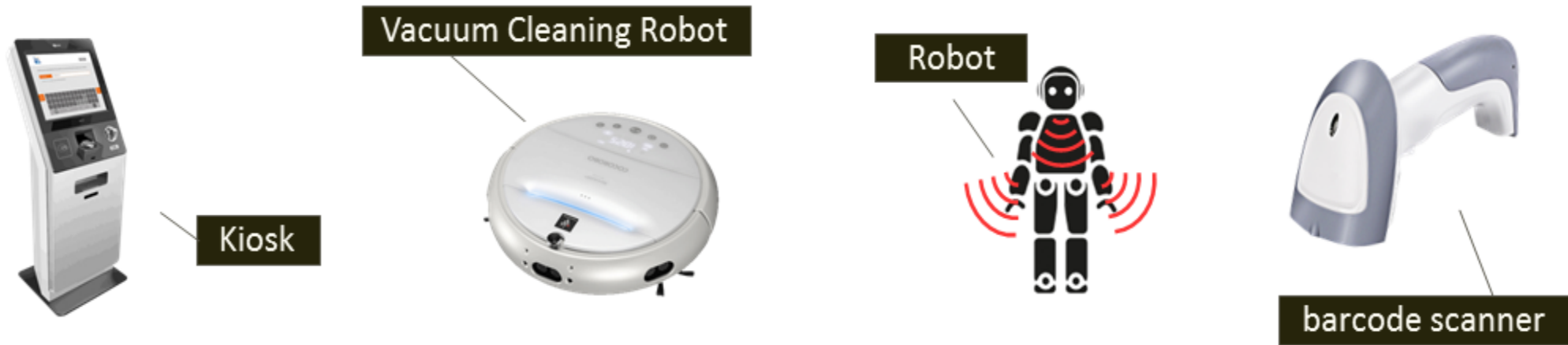
TOF Applications

Socle's high performance MTOF17001 is a cost-effective ToF (time-of-flight) Module system. Best-in-class distance measurement performance for a wide range of applications, including robot vacuum cleaners, tablets, drones, and smart home applications.

Kiosk

Vacuum Cleaning Robot

Robot

barcode scanner

Lighting Control

Human motion detection

Robotic arm

AGV

SHARP

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Product Benefits - MTOF171000C0

- Compact module package
- 940nm Class 1 laser IEC 60825-1:2014-3rd ed
- Measure absolute distance up to 1.2 m
- Shorter working distances may be added later
- High speed distance measurement response
- Advanced optical cross-talk compensation
- Easy to set
- No additional optical calibration requirement
- Single power supply
- Lead-free, RoHS compliant
- Initial version with UART interface only
- I2C may be added if there is sufficient demand
- Demo kit available with module, cable, Arduino code and application manual
- Product brochure

Fundamental function

Paramaeter	Characteristics
MCU	8051
ToF Sensor	GP2AP01VT10F
F/W version	MTOF17001_D1801_1U
Operating temperature	-20 ~ 70°C
Power supply voltage	2.6V ~ 3.5V
Current consumption	30mA (at 2.8V)
Working Cycle time	33msec
Working Distance	10cm ~ typ120cm (White card) 10cm ~ typ70cm (Gray card)
Measurement Accuracy	±4% at 120cm (White card) ±7% at 70cm (Gray card)
Control Interface	Uart / I2C Selectable
Sensor board Package	6pin / 10×12×3.5mm

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TOF Module versus Sensor

- The TOF sensor GP2AP01VT10F is typically not used just by itself
- Usually it requires PCBA consideration, a cover glass, and calibration
- ToF applications involve optical + mechanical + electrical system
- This requires some expertise with optical design and calibration
- Many customers do not have ability to tune or modify the TOF firmware
- Some customers also only know how to use UART or GPIO interface
- So the **TOF Module** has been developed for ease of customer use
- First version of TOF Module will have UART interface only, I2C will follow if demand
- Shorter working distance range may also be supported
- Applications include smart home, robot cleaners, lighting control
- Some customers may require changes to PCBA layout or the cover lens
  - ➢ Order MOQ will be higher in these cases requiring customization
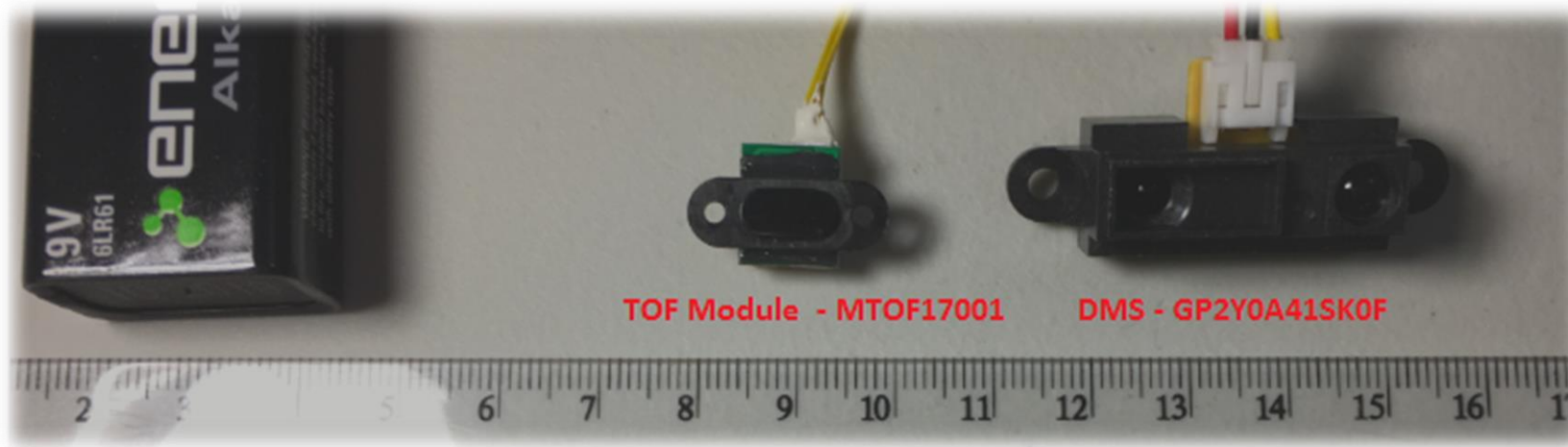
TOF Module Outline
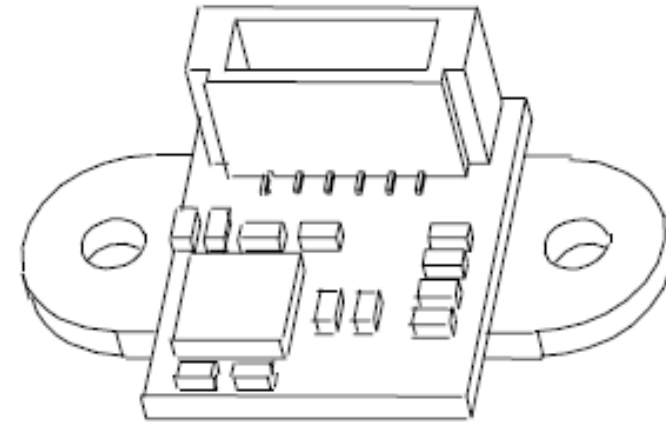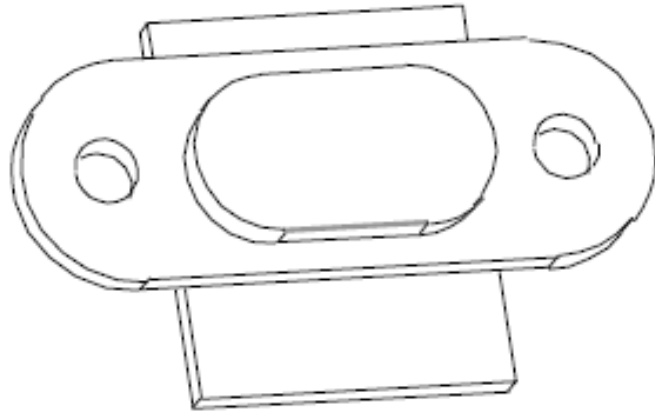
TOF Module Views

Top / Angle View

Bottom / Angle View

TOF Module - MTOF17001   DMS - GP2Y0A41SK0F

About Socle Technology Corp.

- Founded in 2001, Socle Technology Corp is a leading semiconductor design firm headquarted in Taiwan
- Socle provides SoC (System-on-Chip) design services for IoT, server, automotive, multimedia, and peripheral market segments
- 100% owned by Foxconn Technology Group (Hon Hai Precision Industry Co., Ltd.)
- Sales and marketing for Sharp Optoelectronics components and sensors in North America and China since 2017
- Parts are still designed and manufactured by Sharp, no change in production or packaging or branding
- Authorized distributors: WPG Americas, Future Electronics, Mouser, Digi-Key, WPI Group

For more information, contact: Socle_Sales_NA@socle-tech.com

http://www.socle-tech.com/