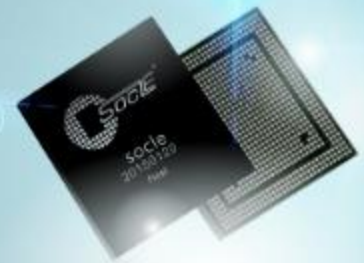
Sharp Microwave Sensor

Product Introduction

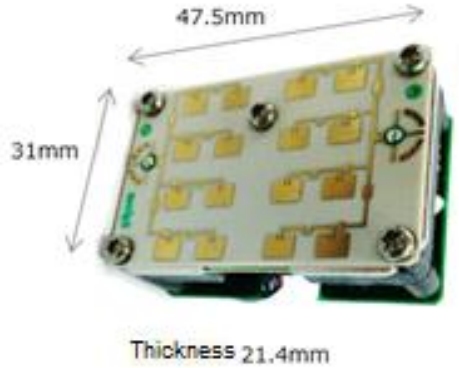


虹晶股份有限公司 Socle Technology Corp.

July 2018

Microwave Sensor (MWS) Key Features

- Human presence / absence detection
- Detect velocity and direction of human motion
- Detect body motion at a distance of 10m
- Wide angle detection area
- Detect a person approaching versus crossing an area
- Monitor heartbeat and respiration without contact (under development)
- Sensor module can be hidden within resin enclosure without any window needed
- Resists environmental impact of ambient light and temperature
- Alternative to PIR (Passive Infra-Red) / Pyroelectric sensors



Microwave Sensor Principles

- **Microwaves are a type of RF (Radio Frequency) wave - Sharp's MWS uses RF frequency of 24 GHz**

Low freq	Medium freq	High freq	Very high freq	Ultra high freq	Super High Freq	Extra high freq
30kHz ~ 300kHz	300kHz ~ 3MHz	3MHz ~ 30MHz	30MHz ~ 300MHz	300MHz ~ 3GHz	3GHz ~ 30GHz	30GHz ~ 300GHz
Radio clock	AM broadcast Aeronautical beacon Marine beacon	Short-wave broadcasting Aircraft radio Ship radio	Analog TV FM broadcast	Digital TV Mobile phone Wireless LAN	Satellite broadcast Wireless LAN	Rader

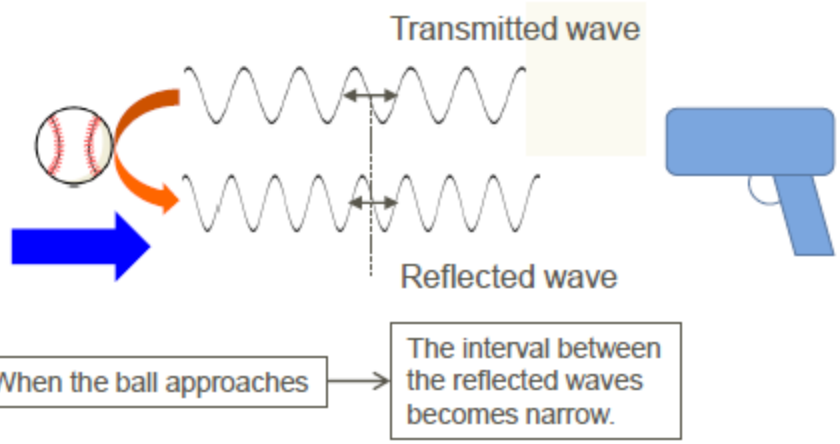
If frequency is low, it is easy to travel far away

If frequency is high, it is easy to be reflected by an object

Microwave Sensor Principles - The Doppler Effect

What is the Doppler effect?

Example) Measure the speed of the ball with a speed gun



①When the ball approaches, the interval between the reflected waves becomes narrower with respect to the transmitted wave.

②When the ball moves away, the interval between the reflected waves becomes wider with respect to the transmitted wave.

⇒ Application of this principle
[measuring approach and separation]

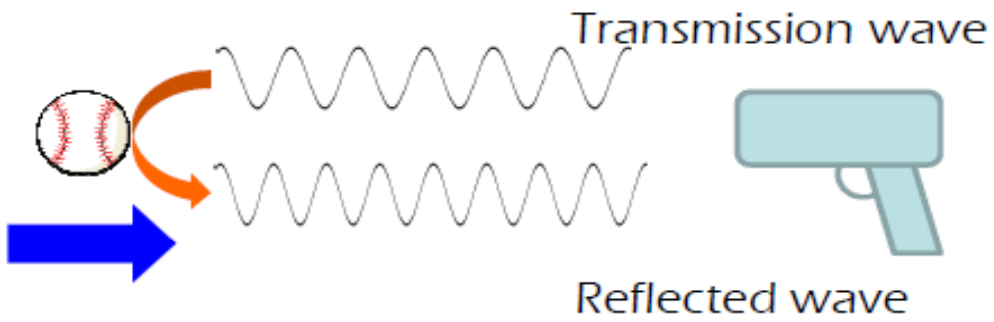
Microwave Sensor Principles - The Doppler Effect

1） an example of a sound wave （ambulance siren）

①For an approaching object
As the space pf the wave becomes small, the sound becomes high.

②For a receding object
As the space of the wave becomes wide, the sound becomes low.

2） an example of a radio wave （speed gun）

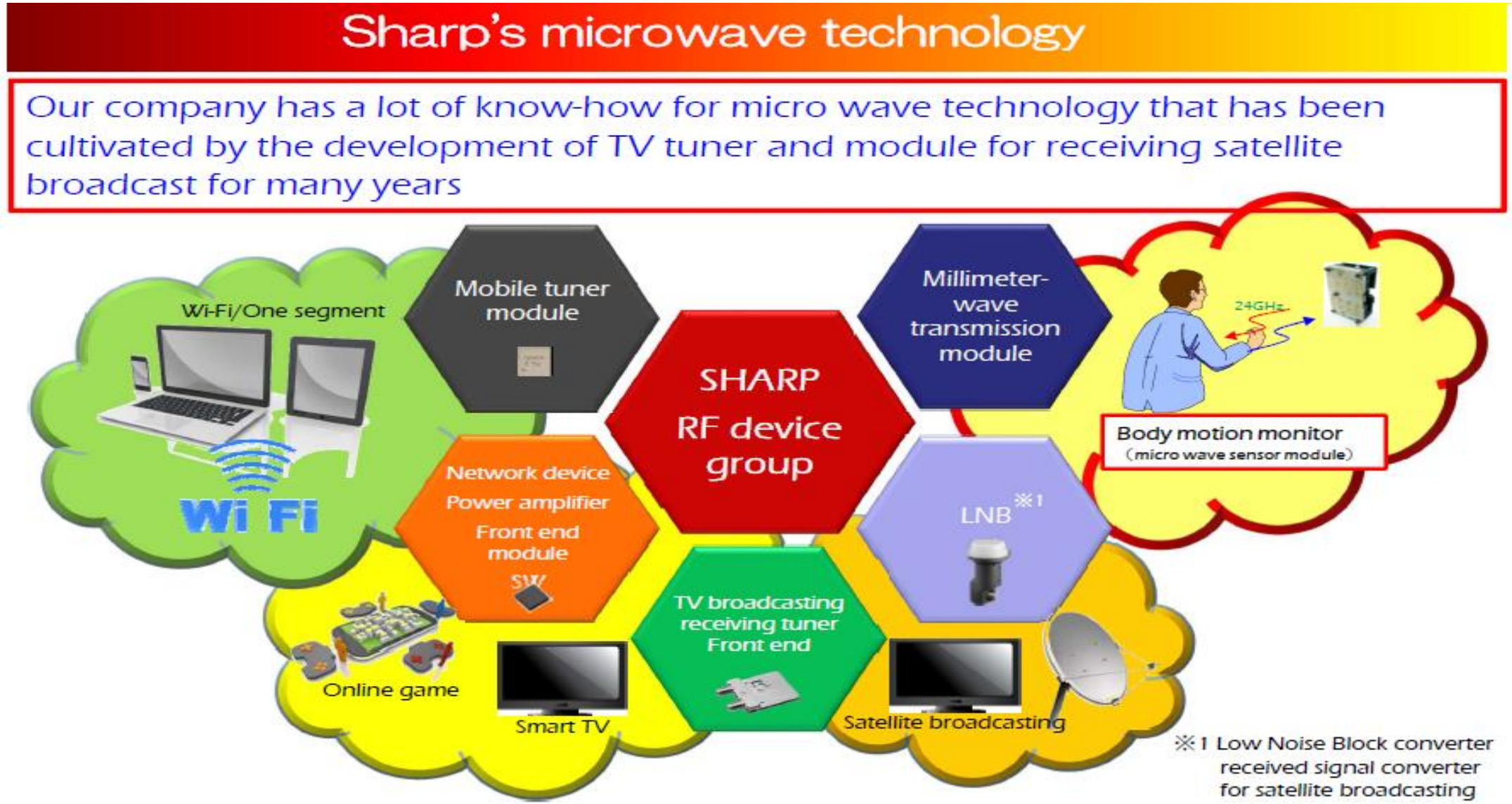


①For an approaching object
The space of a radio wave becomes small.

②For a receding object
The space pf a radio wave becomes large.

⇒ It can measure body motion based on this principle.

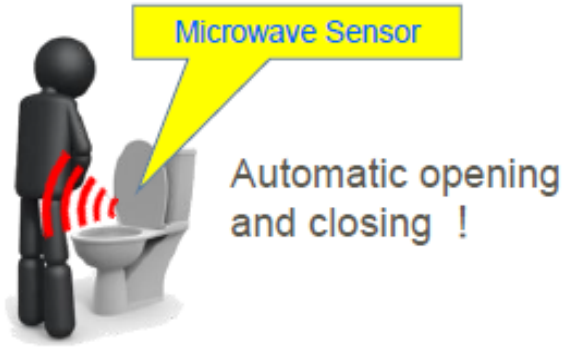
Microwave Technology Experience



Microwave Sensor Applications - Human motion sensing

■ Control opening and closing of the toilet lid

- The sensor can be installed invisible place (Built-in sensor on toilet lid and Chamber pot)
- Design improvement
- No sensor cover (Black-window) required



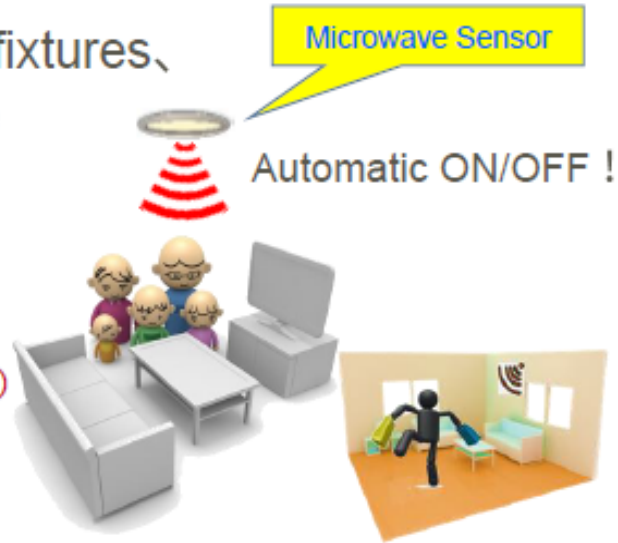
■ Improve detection accuracy

★Infrared sensor problem avoidance

- You can also detect people wearing clothes without exposure
- There is no influence of Temperature and humidity environment

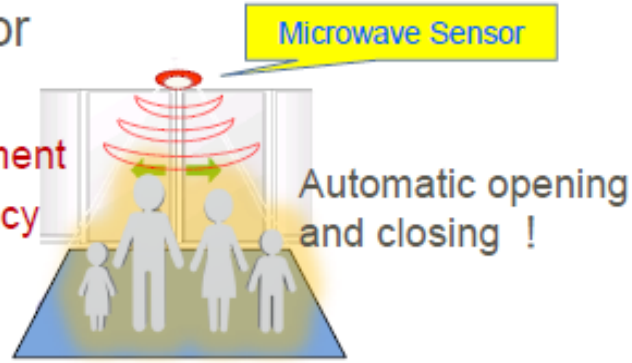
■ Can be built in lighting fixtures、Energy saving possible

- Can be installed in the cover （No design change required）
- Improve detection accuracy （Detection of slight movement）
- Use for security



■ Prevent erroneous opening and closing of the automatic door

- Detection of slight movement
- Improve detection accuracy



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Microwave Sensor Applications - Printer standby control

■ MFP(Multi Function Printer) standby control

- **When people are detected, standby mode cancellation.**
  → Standby is released at the approaching stage, and printing is possible immediately.
- **Transition to standby mode upon detecting absence**
  → Standby without waiting, so it realizes further low power consumption.

< Characteristic of microwave compact human detection sensor >

① **Hidden sensor** (Sensors can also be installed in invisible places in the resin enclosure. No window required.)	➡ Improving the design of the equipment
② **Compact and thin size** (It also carries parts on the antenna side, realizing a compact thin type module)	➡ Sensor installation space is easy to secure.
③ **Wide detection range**	➡ People approaching from the oblique direction (60 degrees) are also detected.
④ **Detect motion direction** (Detect approach / separation)	➡ It is also possible to set not to detect people away from the sensor or people crossing the sensor.
⑤ **Resistant to environmental impact**	➡ The following items need consideration with Pyroelectric Sensor do not affect the performance of the microwave sensor. ・ Ambient light ・ Temperature

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Sharp Microwave Sensor Module Lineup

Test Sample: July 2018 Mass Production: Oct 2018

Sharp P/N	Part Description	Features	Applications
DC6M4xN3xxx	**1. Body Motion Sensor Module (Digital UART output)**	Detection of body motion up to 10m. Monitor heartbeat / respiration up to 1m. 50 degree detection area. Built-in MCU.	Motion detector. Monitor vitals of a person at home (non-medical / non-hospital setting).
DC6S4xN30xx	**2. Human Motion Sensor Module (Analog output)**	Human presence / absence detection. Detect direction and velocity of motion. 110 degree detection area.	Automatic lighting control. Automatic door sensor. General purpose human sensor. Motion detector for security system.
DC6S4xN31xx	**3. Human Motion Sensor Module (Digital UART output)**	Human presence / absence detection. Detect direction and velocity of motion. 110 degree detection area. Integrated RF circuit, analog signal processing and MCU.	Automatic lighting control. Automatic door sensor. General purpose human sensor. Motion detector for security system.

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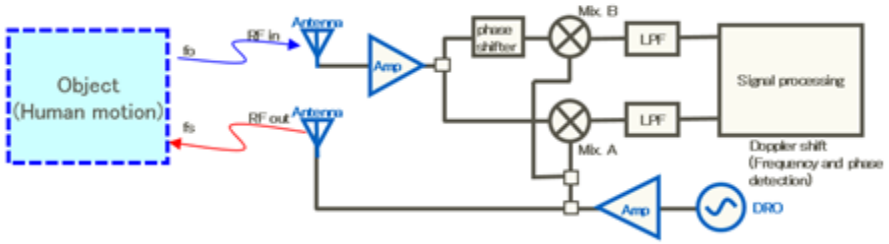
1. Body Motion Sensor Module - Specifications

Features

- Measure non-contact using Doppler effect
- Output frequency : 24.05 to 24.25 GHz
- Planar antenna with 8 patch Tx/Rx antenna elements
- Motion detection through resin casing (no sensor cover)
- Stable detection without being affected by temperature, direct sunlight, color of reflector
- Applicable operating speed: rest state
- Output signal : UART interface

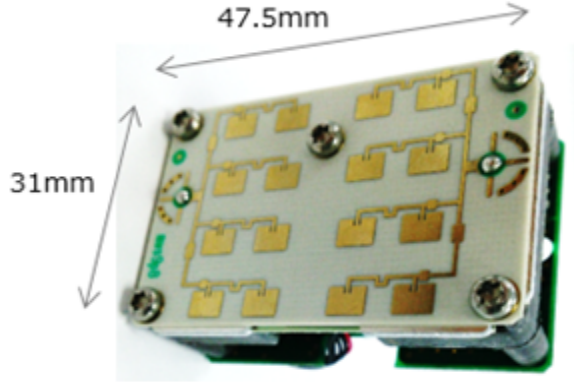
Block diagram



Specification

Parameter	Symbol	Characteristics	Unit
Output frequency	f	24.05 to 24.25	GHz
Output power	Pout	Max. 10	dBm
Antenna	Planar antenna with 8 patch Tx/Rx antenna elements		
Antenna angle (Azimuth)	H-plane	Typ. 25	deg
Antenna angle (Elevation)	E-plane	Typ. 20	deg
Detected distance	-	Max. 1	m
Output signal	UART interface		
Power supply voltage	Vin	3.2 to 3.6	V
Current consumption	I	80 to 130	mA
Operating temperature	Top	-20 to 50	℃
Product size	-	47.5x31x21.4	mm

Outline dimensions



Thickness 21.4mm

1. Body Motion Sensor Module - Applications

Remotely detect a heartbeat, breathing and body motion without direct body attachment.

Microwave Sensor Module

Monitoring and health care for humans and animals

※physical condition monitor in bedroom

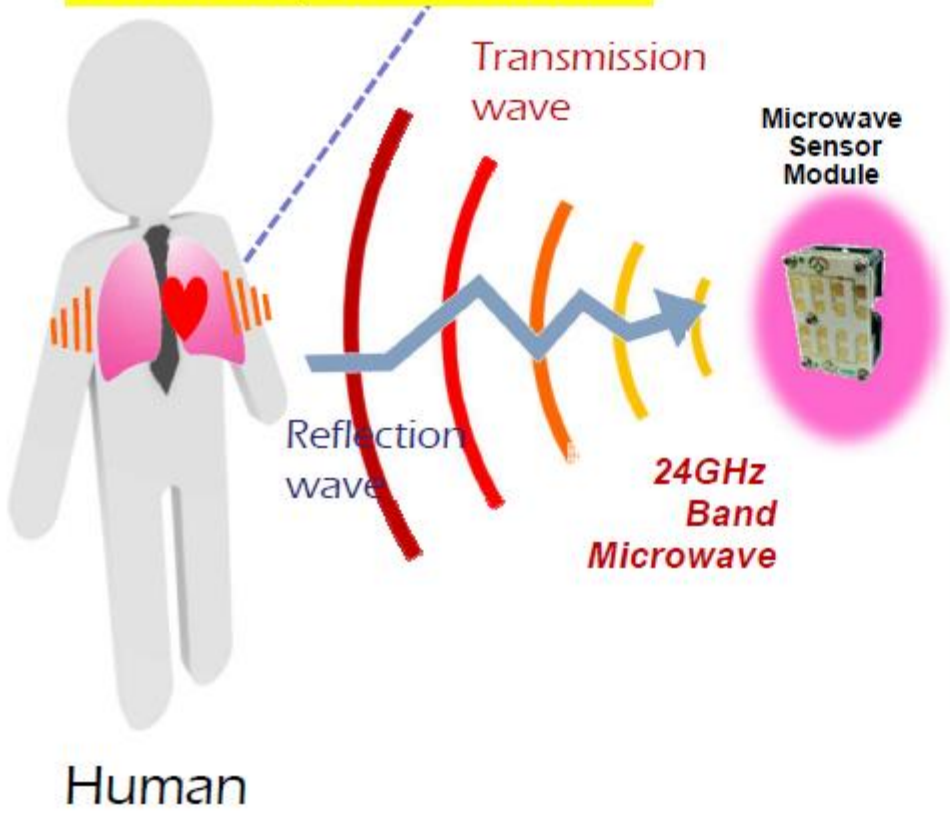
※daily management of physical condition

※Pet monitoring

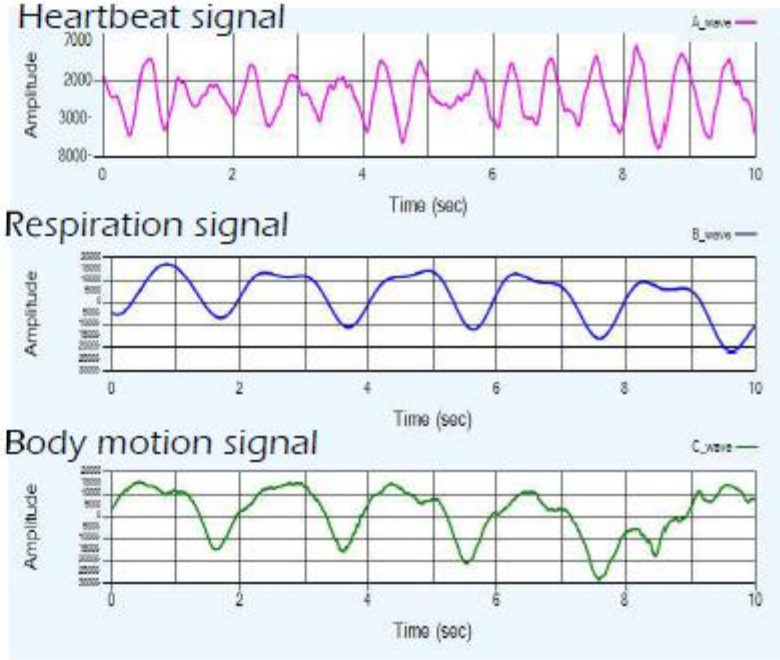
***** Heartbeat and respiration features currently under development *****

1. Body Motion Sensor Module - Heartbeat / respiration / body motion output

① Cardiopulmonary activity creates body surface motion.



②The sensor measures the surface motion with non-contact microwave.



Measurement distance up to 1m

Measurement distance up to 1m

Measurement distance up to 10m

③Extract heartbeat and respiration signal using Sharp original algorithm.

*** Heartbeat and respiration features currently under development ***

1. Body Motion Sensor Module - Comparison with other solutions

Method	Micro wave sensor		Camera		Pyroelectric sensor (Far-infrared sensor)		Pressure sensor (Mat sensor)	
principle	Doppler effect of microwave		Video monitoring for a target person		Detect far-infrared rays from a target person		Detect the pressure change of a target person	
privacy	○	No problem	×	Having the risk of the intrusion of the privacy	○	No problem	○	No problem
Detection system	○	Contactless	○	Contactless	○	Contactless	×	Contact
Detectable Min action quantity	◎	Several millimeters	○	Several centimeters	×	Several centimeters	-	-
Environmental condition	○	none	△	brightness	△	Room temperature	○	none
Setting place	◎	Possible to be embedded and installed under a bed and a wall	×	No shield is allowed in front of the lens	×	No shield is allowed in front of the sensor	×	Under a mattress or on a floor
Additional function	◎	Heartbeat signal/ Respiration signal [TBD]	-	-	-	-	-	-

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1. Body Motion Sensor Module - Can be installed in ceilings and walls

Adoption of high gain and high efficiency antenna technology with high output transmission amplifier and low-noise amplifier technology cultivated through many years of broadcast satellite receiving devices

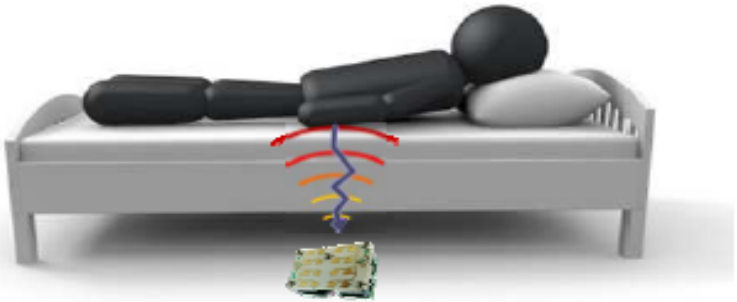
※If it is installed in the ceiling, please make sure you install the antenna of the sensor perpendicularly to the chest.
In this case, if you cannot acquire a heartrate, respiration rate by the distance, we recommend body motion detection.

- Few restrictions for installation locations
- Wide detection area

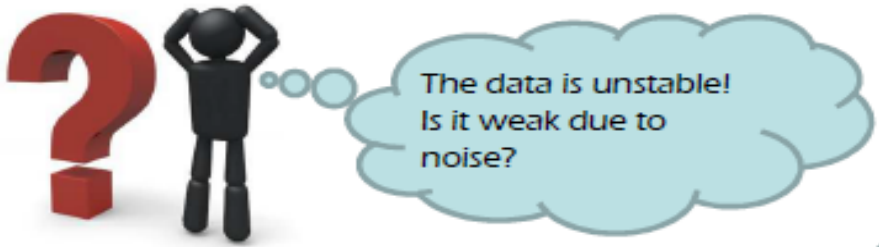
1. Body Motion Sensor Module - Accurate and stable output using DRO method

The accuracy of phase detection is improved by using a dielectric resonator type oscillator(DRO) with superior phase noise characteristics.

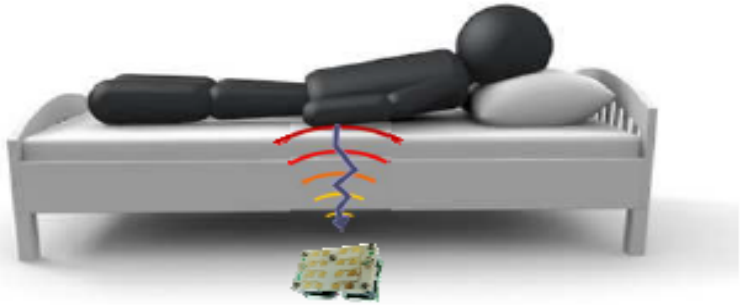
General oscillation method (Free run)



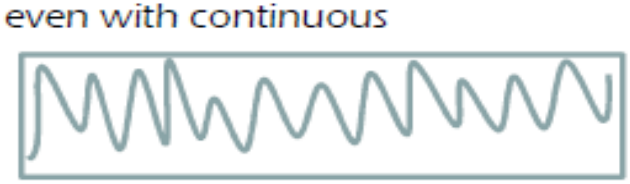
unstable oscillation time over from 5 to 10 second interval



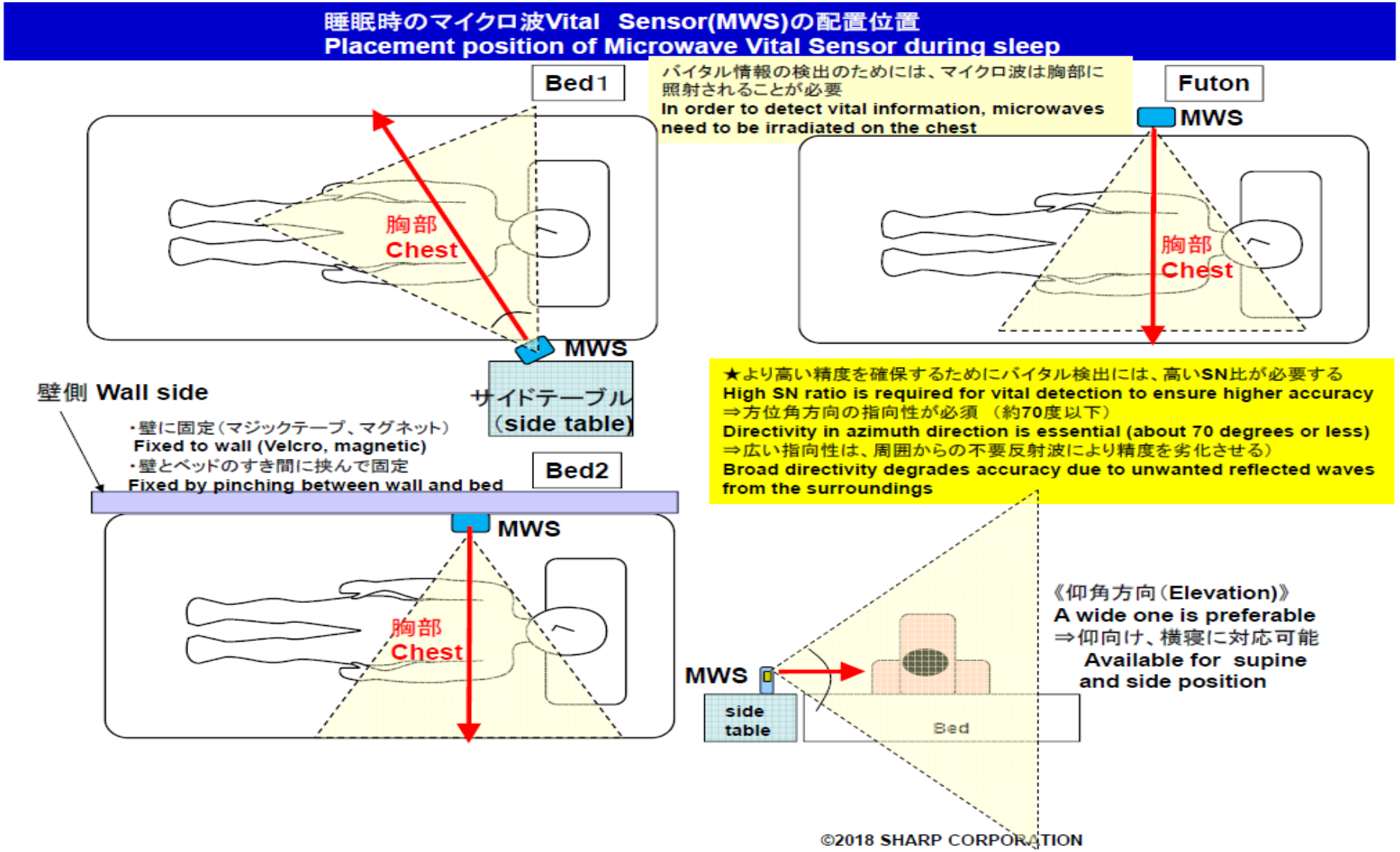
SHARP DRO method



Remains stable even with continuous measurement



1. Body Motion Sensor Module - Monitoring vitals during sleep



2. Human Motion Sensor Module (Analog) - Overview

●Features

Ultra-compact module that is easy to install in various equipment.

- **24.0 x 15.0 x 1.5 mm (Pin header not included)**
- Operating frequency 24.10GHz
- 4 elements Tx/Rx plane antenna
- Contributing to improving equipment design without requiring a window on the sensor (It can be hidden in the resin case)
- RoHS Compliance

●application

- Control opening and closing of the toilet lid Sensor
- Automatic lighting ON / OFF Sensor
- Automatic door Sensor
- General purpose human sensor
- Security system

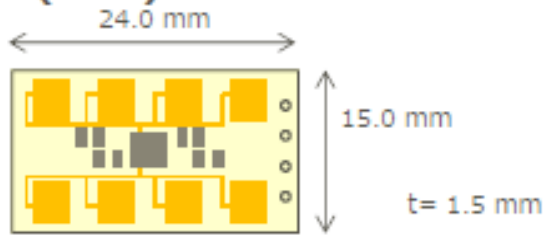
●Operating range

item	unit	Min.	Typ.	Max.
frequency	GHz	24.075	24.10	24.175
Operating temperature	℃	-25		+50

●specification (TBD)

item	unit	Min.	Typ.	Max.
Transmission power(EIRP)	dBm			20
Antenna pattern(Azimuth)	deg		40	
Antenna pattern(Elevation)	deg		110	
Temperature drift	MHz/℃		0.5	
Power-supply voltage	V	3.2	3.3	3.4
power consumption	mA		47	57

●External dimensions (TBD)



2. Human Motion Sensor Module (Analog) - Specifications

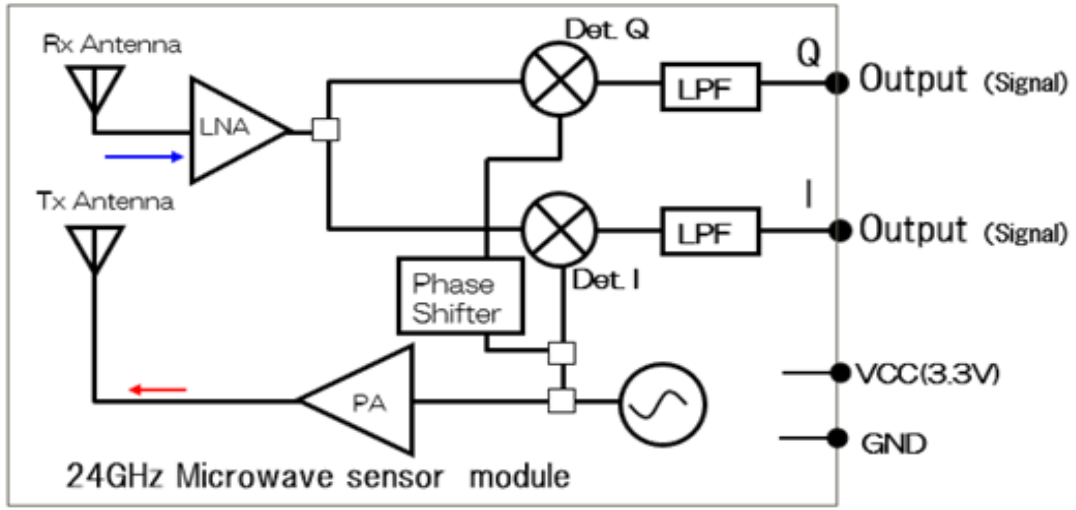
Features(TBD)

- Measure non-contact using Doppler effect
- Output frequency : 24.05 to 24.25 GHz
- Planar antenna with 4 patch Tx/Rx antenna elements
- Motion detection through resin casing (no sensor cover)
- Stable detection without being affected by temperature, direct sunlight, color of reflector
- Applicable operating speed: walking
- Output signal : I/Q signal (analog)

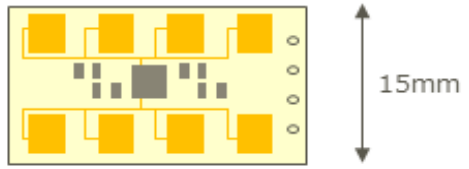
Specification(TBD)

Parameter	Symbol	Characteristics	Unit
Output frequency	f	24.05 to 24.25	GHz
Output power	Pout	Max. 20	dBm
Antenna	Planar antenna with 4 patch Tx/Rx antenna elements		
Antenna angle (Azimuth)	H-plane	Typ. 70	deg
Antenna angle (Elevation)	E-plane	Typ. 140	deg
Detected distance	-	Max. 10	m
Output signal	I/Q signal (analog)		
Power supply voltage	Vin	3.2 to 3.4	V
Current consumption	I	Typ. 47	mA
Operating temperature	Top	-20 to 60	℃
Product size	-	24x15x1.5	mm

Block diagram(TBD)



Outline dimensions(TBD)



Thickness : 1.5 mm

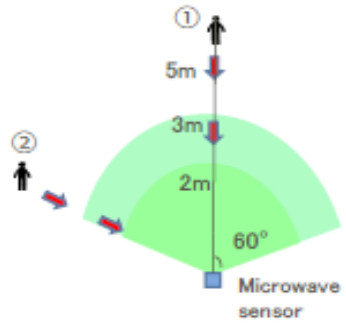
2. Human Motion Sensor Module (Analog) - Detect approach versus area crossing

Introduction of our experimental data

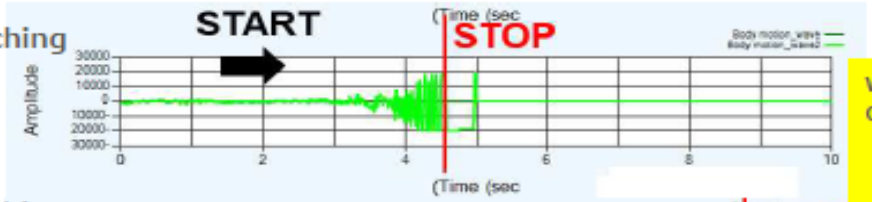
This data is for handling only I signal waveform.
It is also possible to perform judgment processing of approaching / separating by using IQ 2 signals.

As a human sensor, "human absence detection" is the basic function, but by analysis of the waveform, it seems to be able to distinguish between "approach and crossing". Here are the data.

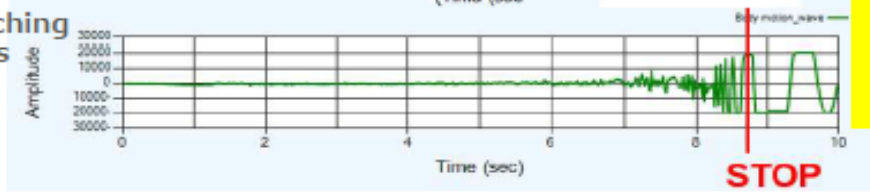
● In case of approaching



① When approaching from the front

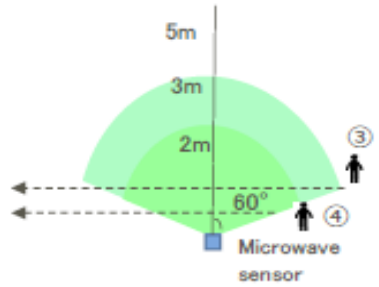


② When approaching from 60 degrees direction

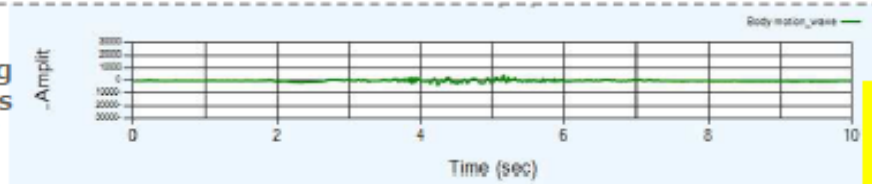


waveform characteristics in case of approaching
- The amplitude and frequency increase.
- The frequency component increases as it moves, and the frequency decreases when it stops.

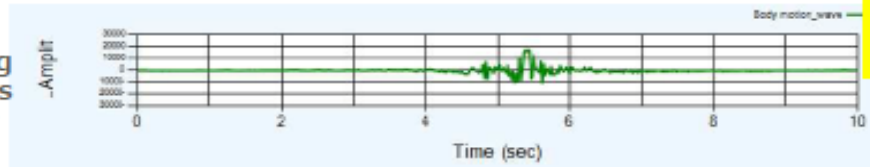
● In case of crossing



③ When crossing 3 m (60 degrees direction) away

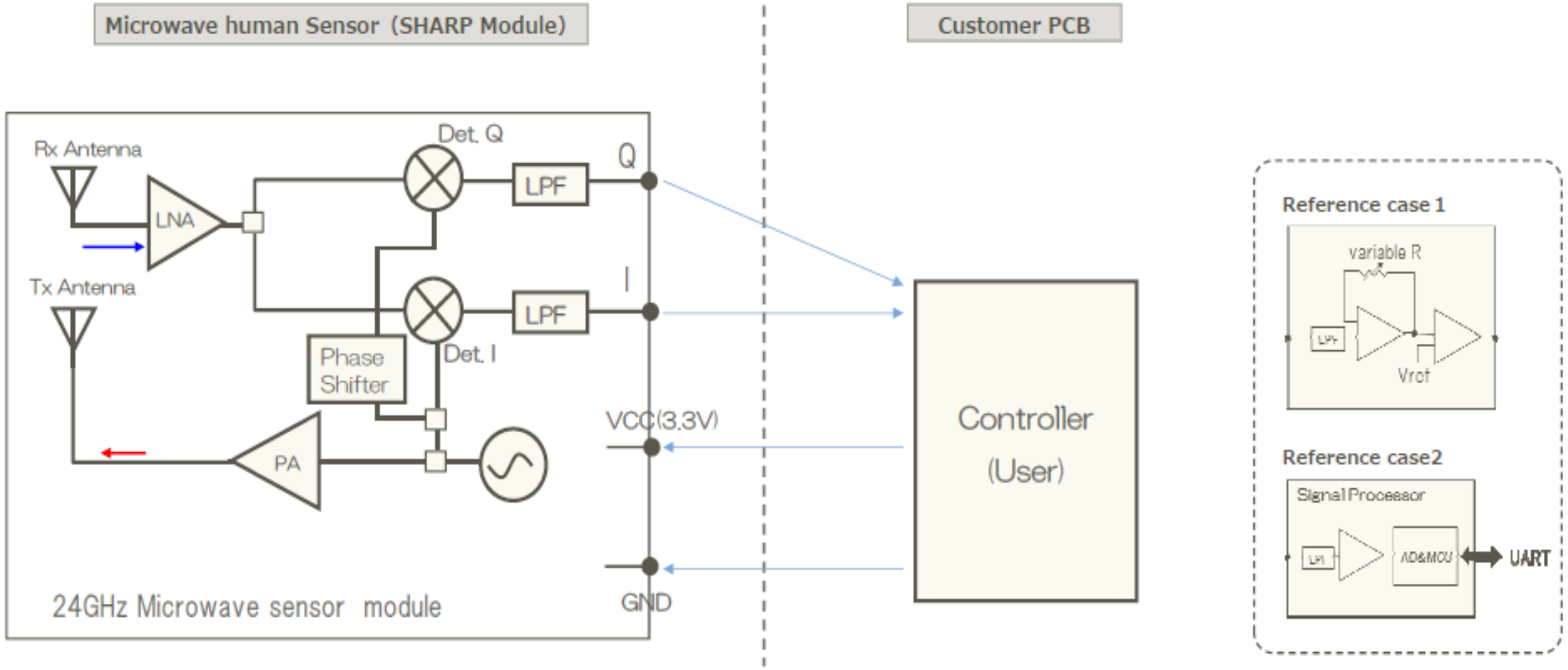


④ When crossing 1 m (60 degrees direction) away



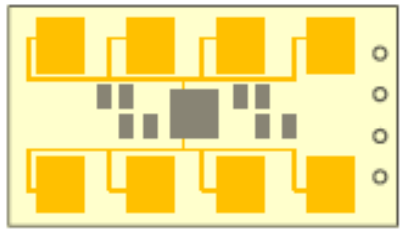
waveform characteristics in case of crossing
- There is no large increase in amplitude.
- Frequency component fluctuation can not be seen.

2. Human Motion Sensor Module (Analog) - Block diagram



⚠ ●The module itself outputs two signals I Q,For human sensor applications, it can only be used with the I signal.

2. Human Motion Sensor Module (Analog) - Connection to customer board



【 Physical and electrical connections 】
In order to reduce the module size,
only the hole for pin header mounting is opened
in the SHARP microwave sensor module.

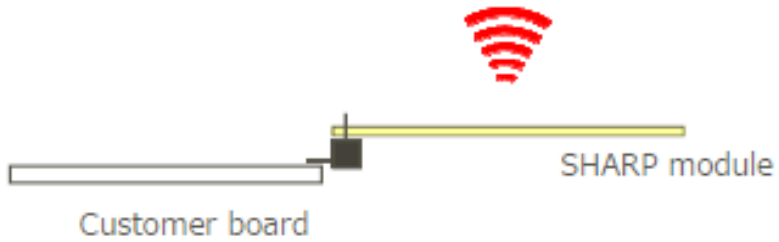
Please prepare a pin header suitable for your installation
and install it in this hole.

⚠ We also plan to ship a straight pin header (Example 1) with SHARP.

Mounting image on customer's board

Example 1

Example 2



3. Human Motion Sensor Module (Digital) - Overview

●Features

Small single board module with microcomputer

It can be used immediately as a radio wave type human sensor.

Built-in detection start distance adjustment function

- 50.0 x 15.0 x 3.8 mm (Module Size)
- Operating frequency 24.10GHz
- 4 elements Tx/Rx plane antenna
- Contributing to improving equipment design without requiring a window on the sensor (It can be hidden in the resin case)
- RoHS Compliance

●application

- Control opening and closing of the toilet lid Sensor
- Automatic lighting ON / OFF Sensor
- Automatic door Sensor
- General purpose human sensor
- Security system

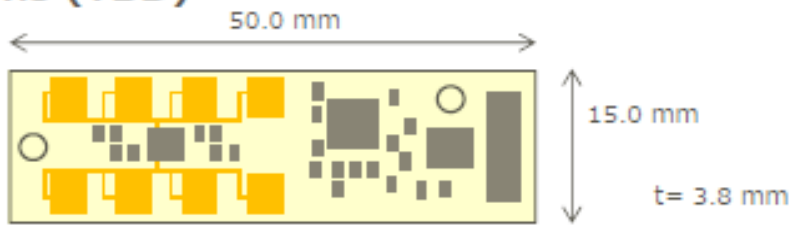
●Operating range

item	unit	Min.	Typ.	Max.
frequency	GHz	24.075	24.10	24.175
Operating temperature	℃	-25		+50

●specification (TBD)

item	unit	Min.	Typ.	Max.
Transmission power(EIRP)	dBm			20
Antenna pattern(Azimuth)	deg		40	
Antenna pattern(Elevation)	deg		110	
Temperature drift	MHz/℃		0.5	
Power-supply voltage	V	3.2	3.3	3.4
power consumption	mA		TBD	TBD

●External dimensions (TBD)



3. Human Motion Sensor Module (Digital) - Specifications

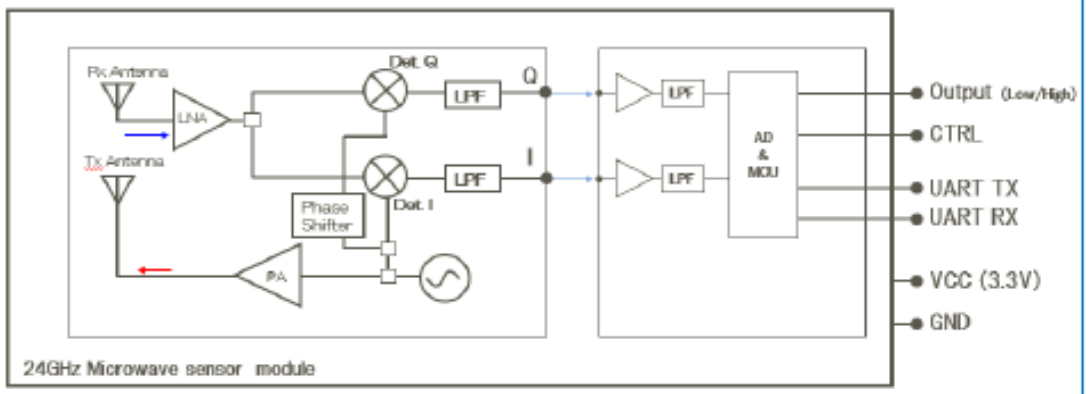
Features(TBD)

- Measure non-contact using Doppler effect
- Output frequency : 24.075 to 24.175 GHz
- Planar antenna with 4 patch Tx/Rx antenna elements
- Motion detection through resin casing (no sensor cover)
- Stable detection without being affected by temperature, direct sunlight, color of reflector
- Applicable operating speed: walking
- Output signal : UART interface, Low/High (digital)

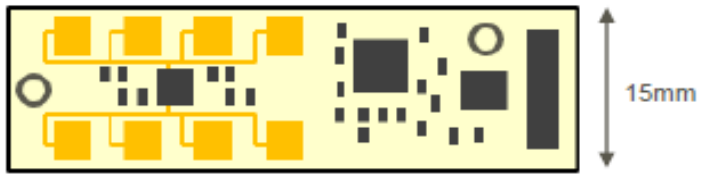
Specification(TBD)

Parameter	Symbol	Characteristics	Unit
Output frequency	f	24.075 to 24.175	GHz
Output power	Pout	Max. 20	dBm
Antenna	Planar antenna with 4 patch Tx/Rx antenna elements		
Antenna angle (Azimuth)	H-plane	Typ. 40	deg
Antenna angle (Elevation)	E-plane	Typ. 110	deg
Detected distance	-	Max. 10	m
Output signal	UART interface, Low/High (digital)		
Power supply voltage	Vin	3.2 to 3.4	V
Current consumption	I	TBD	mA
Operating temperature	Top	-20 to 50	℃
Product size	-	50x15x3.8	mm

Block diagram(TBD)

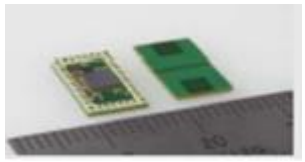


Outline dimensions(TBD)



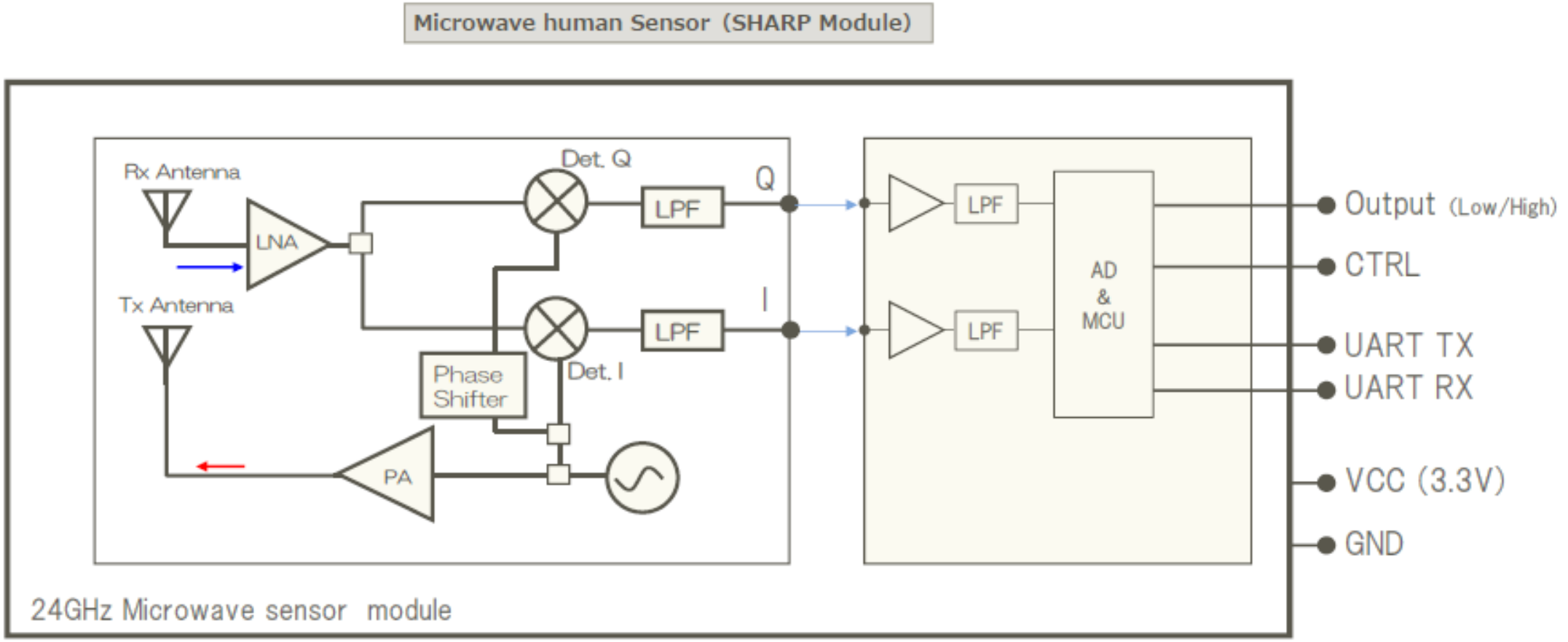
Thickness : 3.8 mm

3. Human Motion Sensor Module (Digital) - Comparison with competitor

Brand	SHARP	Socionext
Model	DC6S4xN31xx	SC1211AU2
Frequency	24.075 ~ 24.175 GHz	24.15 ± 0.1 GHz
Output Power	20 dBm	5 dBm
Antenna Pattern (10bB-BW)	70 deg (Azimuth)	160 deg (Azimuth)
Antenna Pattern (10bB-BW)	140 deg (Elevation)	160 deg (Elevation)
Antenna	4 elements transmitting / receiving, plane	1 element transmitting / receiving, plane
Distance	0.5 ~ 10m	8m
Power Suply	3.3V (3.2 ~ 3.4V)	2.5V
Consumption Current	49 ~ 62 mA	200 mA
Output Signal	UART, Threshold control & Low/High Level (Built-in Microcomputer)	SPI, AD conversion data (without Microcomputer)
Operating Temp.	-20 ~ +50 deg C	-20 ~ +80 deg C
Size	15 mm(L) x 50mm(W) x 3.8mm(T)	12mm x 7.0mm x 1.0mm
Figure		

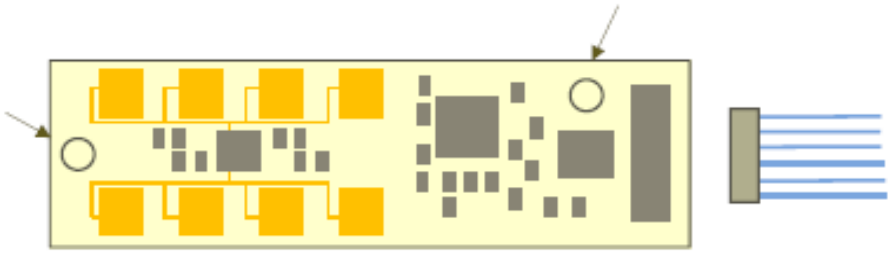
SHARP advantage: Built-in MCU, high sensitivity, free from signal processing, and space-saving design.

3. Human Motion Sensor Module (Digital) - Block diagram



- Digital output (Low / High) of the human detection result from the distance corresponding to the voltage applied to the CTRL terminal.
- It receives adjustment commands via the UART terminal, outputs human detection results, waveform data, etc. (This function is under design planning)

3. Human Motion Sensor Module (Digital) - Connection to customer board



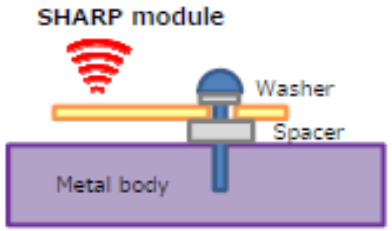
【 Physical connections 】
Since two screw holes are provided, please screw to the customer's cabinet and board with reference to the figure below.

【 Electrical connections 】
To facilitate handling, the SHARP microwave sensor module has a 6-pin connector. Please have CABLE ready.

※The connector is scheduled for "11002W90-6P-S-5A-HF" made by JCTC.
For housing use "11002H00-6P-HF" made by JCTC is recommended.
http://jctc.com.cn/

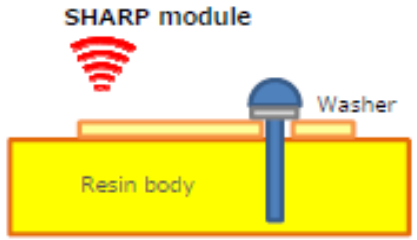
- Since the hole of Φ 2.1 is opened in the module, please use screw of M2.
- Resin screws are recommended. Although metal screws can also be used, please be aware that it may be affected by radio wave radiation pattern.
  Resin screw example : Hirosugi-Keiki Co.,Ltd. http://hirosugi.co.jp/products/RY/RY-0000.html
- There is wiring on the back of the module. Therefore, when attaching a module to a metal object etc., please use a resin spacer.

Installation example 1



Mounting on Customer Body (Metal)
Some spacers are necessary to prevent contact of the module backside pattern.

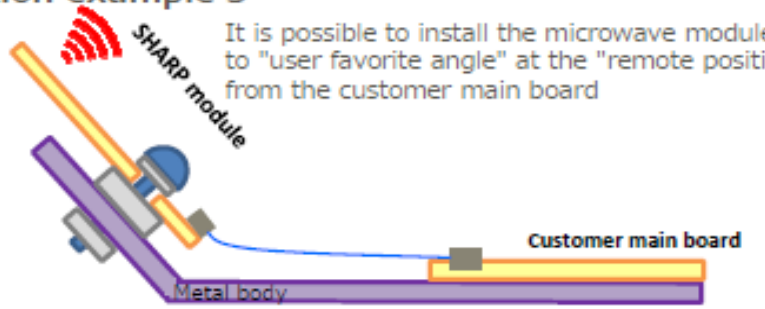
Installation example 2



Mounting on Customer Body (Resin)
Spacers are not required for insulators.

Installation example 3

It is possible to install the microwave module to "user favorite angle" at the "remote position" from the customer main board



Mounting on Customer Body (Sheet metal)

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

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