77GHz Respiration and Heartbeat Monitoring Radar Module Datesheet

R77BHM1

DALIAN IFLABEL CO.,LTD

Contents

IFLABEL

77GHz Respiration and Heartbeat Monitoring Radar Module (R77BHM1) Datesheet（V0.3）

Characteristics

77GHz radar sensor.

It has MIMO antennas, two for sending and four for receiving.

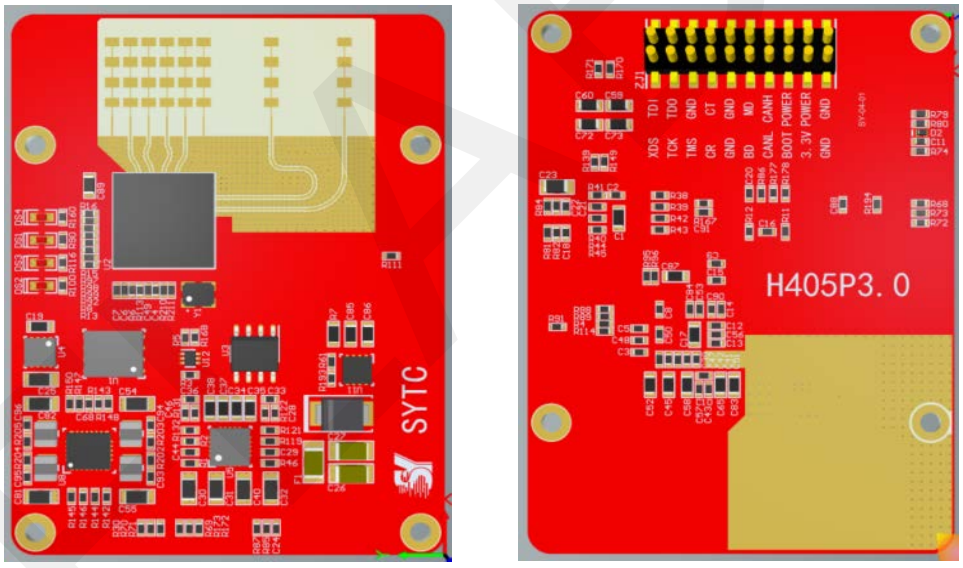
It realizes the radar detection based on FMCW signals.

This module realizes the synchronous perception function of frequency of respiration and heartbeat of human body.

Respiration and Heartbeat Detection Distance is 0.1-2m.

It's not affected by environmental factors like temperature, humidity, noise, airflow, dust, light and etc.

The output power is very small so that it poses no harm to human body.



a)Front View b)Rear View

Figure 1. Radar Module

Applications

- ✧ Human body Health Monitoring.
- ✧ Hospital Bed Monitoring.
- ✧ Elderly Care.
- ✧ Infant and Child Monitoring.
- ✧ Rehabilitation Monitoring .
- ✧ Physiological Monitoring of Priority.

Product Size

- Volume: ≤60mm*45mm*5mm

1. Overview

The respiration and heartbeat detection radar operates in the 77GHz millimeter wave band，It is a radar detection module to realize the real-time sensing measurement of human respiratory rate and heart rhythm.The module detects radar echoes reflected from human surfaces using the FMCW radar system. The ECG signal can be detected by calculating the distance of target point and the changes of body surface micromotion information in unit time.

This radar module has following characteristics：

- ✧ This module can observe the distance information from the human body to the radar.
- ✧ This module can detect the respiratory rate and heart rhythm of human body in real time.
- ✧ The output power is very small so that it poses no harm to human body
- ✧ It’ s not affected by environmental factors like temperature, humidity, noise, airflow, dust, light and etc.

2. Main Parameters

Parameters	Min	Typ	Max	Unit
Performance				
Detection range（Chest）	0.1		2	m
Detection range（Back）	0.05		0.5	m
Accuracy of respiration		90		%
Accuracy of heartbeat		90		%
Update time	1		60	S
Observation establishment		20		S
Parameters				
Working Voltage（VCC）	4.6	5	6	V
Working Current（I_{CC}）		250	300	mA
Working Temperature（T_{OP}）	-20		60	℃
Storage Temperature（T_{ST}）	-40		80	℃
Parameters for Transmission				
Working Frequency（f_{TX}）		77	78	GHz
Transmission Power（P_{out}）	8	10	12	dBm
Parameters for Antenna				
Antenna Gain（G_{ANT}）		12		dBi
Horizontal Beam（-3dB）	-40		40	°
Vertical Beam（-3dB）	-20		20	°

3. Module Dimension and Pin Definition

3.1. Module Dimension

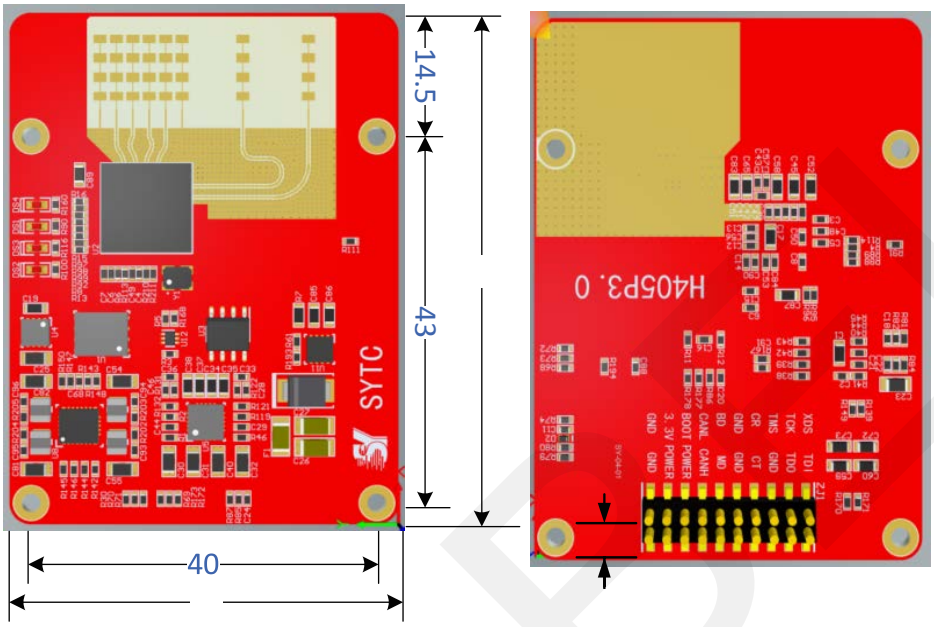
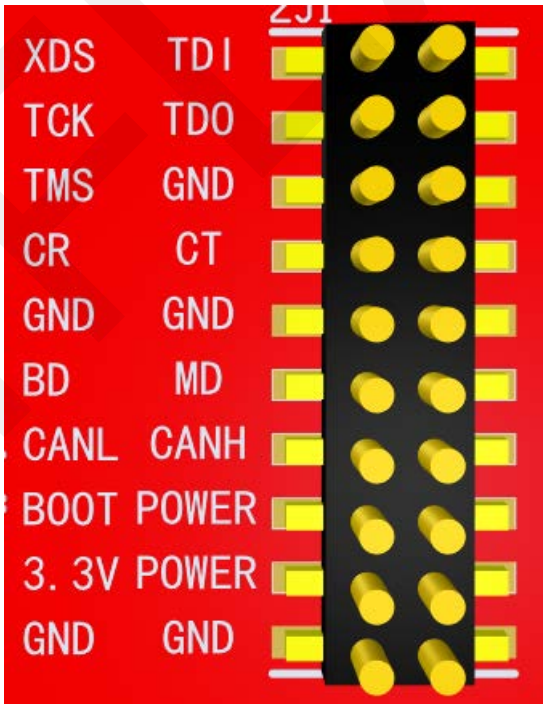


Figure 2. Radar Module Size

3.2. Interface Introduction

The radar module is externally set with a 20PIN interface, and the interface pin is PH2.0mm and 2*10 pin， Some pin are reserved for radar configurations or other products.



NRST	TDI
TCK	TDO
TMS	GND
CR	CT
GND	GND
BD	MD
CANL	CANH
BOOT	+5V
V33	+5V
GND	GND

Figure 3. Pin Definition of Radar Module

The following table describes the interfaces of this product model.

	Pin	Instruction	Remark
1	CRX	Send port	This port is the control port of the upper computer to the radar, which is not connected.The radar works according to the default parameters.
2	CTX	Receive port	
3	MD	Data output port	Radar output data port.
4	+5V	Input 5V	Radar power input terminal, radar operating current ≥600mA
5	V33	Output 3.3	External power supply port: current ≤150mA

4. Working Mode

4.1. Detection Coverage

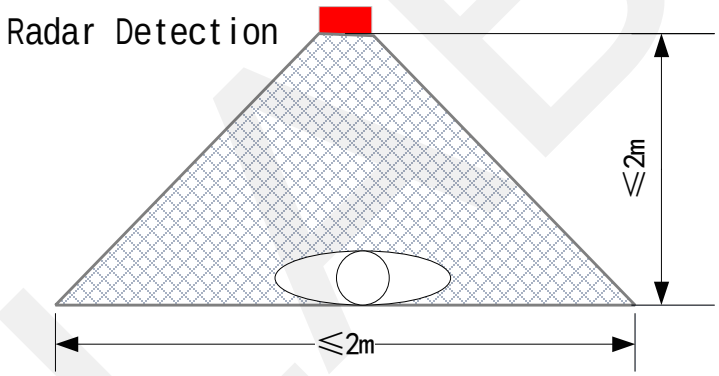


Figure 4. Detection Coverage

When working, the radar should be positioned as right in front of the chest or back of the person being observed as possible, with a distance no more than 2 meters.

4.2. Connection of Radar

The schematic diagram of the connection between the radar and the peripheral upper computer is shown in the figure below. There are three kinds of interfaces between radar and peripherals, that is, data interface, control interface and mode selection interface.

- **Data Interface**

  This interface is the output port of radar detection data. For the specific parameter model, see section 5 module interface Protocol. This interface is mandatory for radar.

- **Control Interface**

  Generally, the interface is not connected and the radar directly operates according to the default parameters.

  For details about the interface data protocol, see the product protocol specifications.

- **Mode Selection Interface**

  This port is controlled by a more direct radar mode.The radar is working normally when MISO is at high voltage and the radar is in standby mode when MISO is low power.

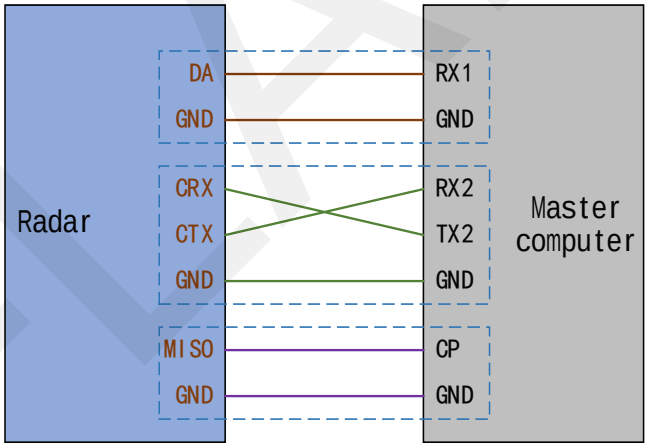


Figure 5. Connection of Radar with Master Computer

4.3 Installation of Radar

Because the radar works mainly based on the respiratory heart rate to cause the surface undulation of the major body, the fluctuation of the human chest and back will be obvious, so the radar installation needs to be measured in the position of the human chest or back.

The installation method of radar is as follows:

（1）Top Installation

In response to bedridden people or sleep needs, the roof installation method is adopted (as shown in Figure 5). The radar beam is vertically downward and directly facing the human body, and the center of the radar beam corresponds to the position of the human chest.

In this installation mode, the distance between the radar and the human body to be measured should be less than 2 meters.

Figure 6. Top Installation

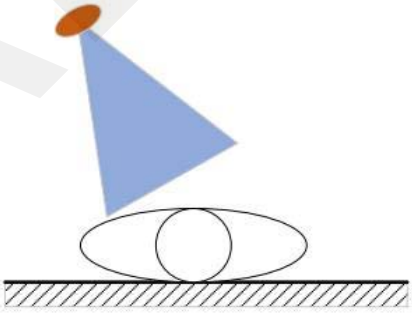


Figure 7. Inclined Installation

（2）Inclined Installation

The radar is fixed on the wall or beside the bed and mounted at an incline (as shown in Figure 7). The radar beam is tilted to illuminate the human body, and the center of the radar beam corresponds to the position of the human chest.

In this installation mode, the distance between the radar and the human body to be measured should be less than 2 meters.

（3）Horizontal Installation

The radar is placed horizontally (as shown in Figure 8). The radar is fixed on the wall or on the table. The radar beam is irradiating the

human body, and the center of the radar beam corresponds to the position of the human chest.

In this installation mode, the distance between the radar and the human body to be measured should be less than 2 meters.

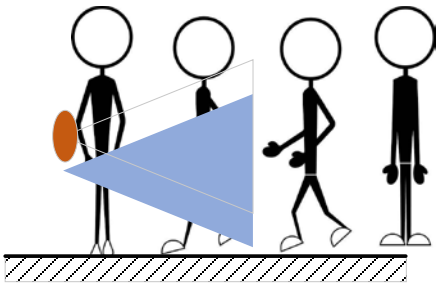


Figure 8. Horizontal Installation

Figure 9. Back Installation

（4）Back Installation

The radar is installed in the seat, mattress and other corresponding positions, and is separated from the human body by non-metallic media (as shown in Figure 9).

In this installation mode, the radar can measure respiration and heart rate mainly by detecting the surface movement of the human back.

In this mode, the effective measurement distance between the radar and the human body to be measured is 5cm-50cm.

5. Interface Protocol

5.1. Interface Instruction

The serial port communication mode is adopted between the radar module and the upper computer, which is defined as follows：

- ✧ Interface level：CMOS
- ✧ Baud rate：115200bps
- ✧ Stopbits：1
- ✧ Databits：8

The output data is output in small endian mode.

5.2 Output data frame definition

Data frame refers to the data frame transmitted by radar to the application end, and its frame structure is shown in Figure 10.

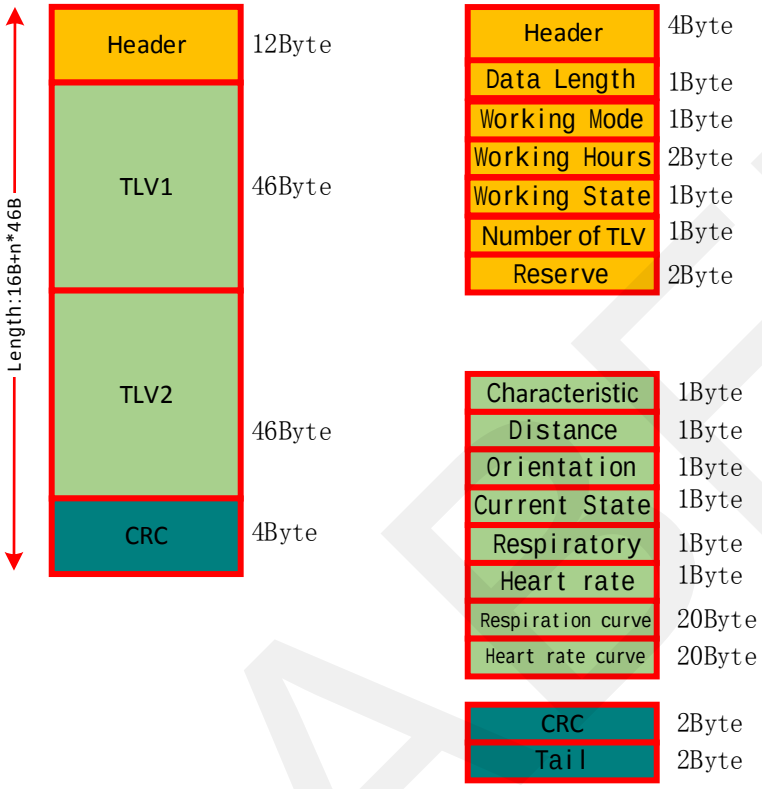


Figure 10. Data structure

The uplink frame consists of three parts, namely, frame header, parameter field and checksum field. The three frame data are defined below:

A. Header **Length**：12Byte

	Symbol	Definition	Length (B)	Instruction	Remark
1	SYNC	leading character	4	Fixed: “0x53 0x59 0x54 0x43”	Set to SYTC
2	Length	Data Length	1	The entire data frame length	Byte
3	Mode	Working Mode	1	0x00-Standby mode; 0x01-Forward wide detection mode; 0x02-Back detection mode; 0x03-Forward narrow domain mode; 0x04-Forward tracking mode; 0x06-Two-person monitoring mode;	
4	Time	Working Hours	2	Starting time of radar equipment	“Minutes”
5	NumTLV	Number of TLV	1	The number of people detected by radar	
6	WorkCon	Working State	1	Current operating status of radar	

				1-The normal work 2-Standby 3-Abnormal	
7	Reserve	Reserve	2	Reserve	

B. **Parameter field** **Length**：46Byte

	Symbol	Definition	Length (B)	Remark
1		TLV Characteristic	1	TLV subframe identifier: "0x01", "0x02" indicates the first position and the second position respectively
2		Distance	1	Int, 0.1m accuracy, 0-25.6m
3		Orientation	1	Int, 1° accuracy, -127° ～128°
4		Current State	1	0x01-The normal state; 0x02-Target abnormal state;
5		Respiratory	1	
6		Heart rate	1	Int
7		Respiration curve	20	8bit Int
8		Heart rate curve	20	8bit Int

Remark：When there are multiple targets, the target parameters are arranged in order of distance.

C. **CRC**

	Symbol	Definition	Length	Remark
1	CRC	CRC	2B	CRC16
2	ZW	Tail frame	2B	“0xEE 0xEE”

6. Precautions

6.1. Start Time

When the module starts to work when it is initially powered on, it is necessary to completely reset the internal circuit of the module and fully evaluate the environmental noise to ensure thenormal operation of the module. Therefore, when the module is initially powered on, it needs a start up stabilit time of ≥30s to ensure the validity of subsequent output parameters.

6.2. Limit on Heartbeat Monitoring

As this module is a breathing and heartbeat detection radar, the detection distance should not be too far, and the appropriate distance is 0.1m-2m.

When there are objects around the measured target with stronger reflectivity than the measured target, the radar may track the strongly reflected target when working. In this case, the radar detection parameters are abnormal, and the radar position needs to be adjusted.

At present, the radar module can only measure a single target, but cannot measure multiple targets temporarily. Therefore, when multiple people are located in the radar detection area, the detection parameters are chaotic , which needs to be paid attention to.

6.3. Radar biological detection performance

Because human biological characteristics belong to ultra-low frequency and weak reflection characteristic signals, radar processing requires a relatively long cumulative processing. During the cumulative process,so occasional detection failure is normal.

6.4. Power Supply

The radar module requires higher power quality than conventional low frequency circuits.

When powering the module, it is required that the power supply has no threshold glitchesor ripples and that it effectively shields the power supply noise caused by accessory equipment.

The radar module needs to be well grounded. Due to the ground noise brought by other circuits, the performance of the radar module may even be reduced or even work abnormally; the most common cause is a shorter detection distance or an increased false alarm rate.

In order to ensure the normal operation of the VCO circuitinside the module, the power supply requirement for this module is + 5V- + 9V power supply.

In particular, the power supply voltage cannot be lower than 5V. The external power supply must provide sufficient current output capability and transient response capability.

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9. Contact information

Dalian iFlabel Technology Co., Ltd.
Email address: info@iflabel.com
TEL: 0411-84619565
Address: Zhongnan Building, No.18, Zhonghua West ST,DST,Dalian,CHINA