77GHz Radar Sensor for Respiration and Heartbeat Monitoring IR77BHM1

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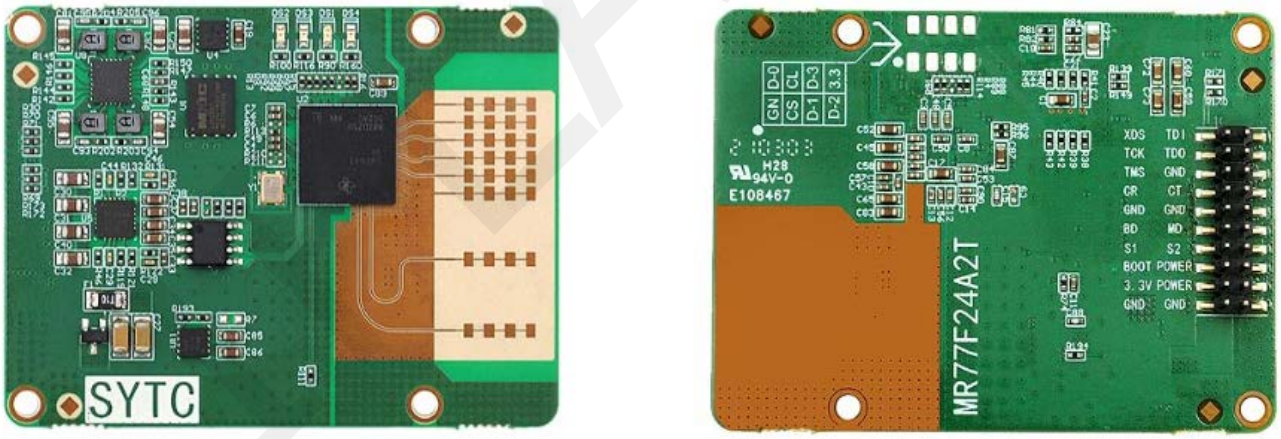
77GHz Radar Sensor for Respiration and Heartbeat Monitoring IR77BHM1 Datasheet V1.0

Features

- 77GHz Radar Sensor;
- MIMO antenna with 2 transmitters and 4 receivers
- Radar detection based on FMCW signal;
- Synchronous perception of human respiratory rate and heart rhythm; Respiration and heartbeat detection range 0.1-2m;
- Not affected by environmental factors like temperature, humidity, noise, airflow, dust, light and etc;
- Output power is low, which is harmless to human body;



a)Front View b)Rear View

Figure 1. 77GHz Radar Module for Respiration and Heartbeat Monitoring

Application

- ✧ Human body health monitoring;
- ✧ Elderly care;
- ✧ Hospital bed monitoring;
- ✧ Health care;
- ✧ Infant monitoring;
- ✧ Physiological monitoring of key/ high-level personnel;

Product Packaging

- Volume：≤60mm×45mm×5mm

Contents

1. Overview

The respiratory and heartbeat monitoring radar works in the 77GHz millimeter wave band, which is a radar detection module to realize the real-time perception and measurement of human respiratory frequency and heart rhythm. This module detects the radar echo reflected by human body surface through FMCW radar system, and realizes the detection of human ECG by calculating the change of target distance information and body surface micro motion information in unit time.

The radar module has the following working characteristics:

- ✧ This module can observe the distance information from human body to radar;
- ✧ This module can detect human respiratory rate (PR) and heart rhythm (RESP) in real time;
- ✧ Low output power, harmless to human body;
- ✧ Not affected by environmental factors like temperature, dust, light and etc with high sensitivity.

2. Main Parameters

Parameters	Minimum	Typ.	Max.	Unit
Operating Performance				
Detection Distance(Chest)	0.1		2	m
Detection Distance(Back)	0.05		0.5	m
Measurement Accuracy of Respiration		90		%
Measurement Accuracy of Heartbeat		90		%
Refresh Time	1		60	S
Observation Construction Time		20		S
Operating Parameters				
Operating Voltage（VCC）	4.6	5	6	V
Operating Current（ICC）		250	300	mA
Operating Temperature（TOP）	-20		60	℃
Storage Temperature（TST）	-40		80	℃
Parameters of Transmission				
Operating Frequency（fTX）		77	78	GHz
Transmitting Power（Pout）	8	10	12	dBm
Parameters of Antenna				
Antenna Gain（GANT）		12		dBi
Horizontal Beam（-3dB）	-40		40	°
Vertical Beam（-3dB）	-20		20	°

3. External Dimension and Pin Definition

3.1. External Dimension

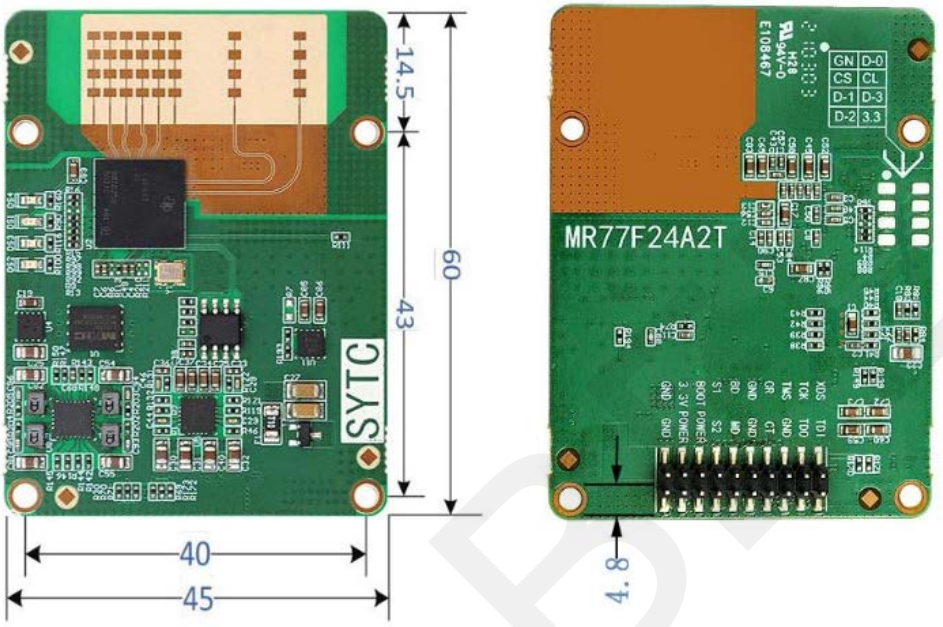
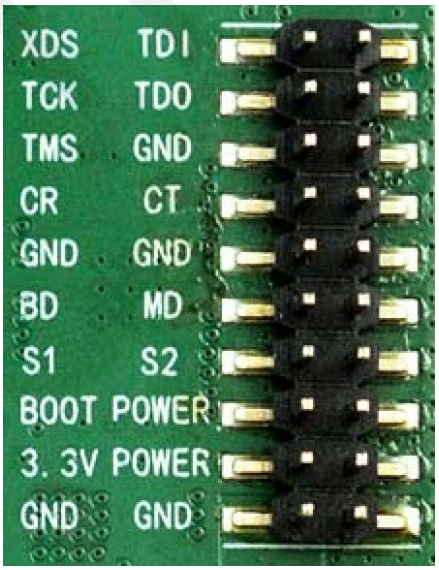


Figure 2 Dimension of 77GHz Radar for Respiration and Heartbeat Monitoring

3.2. Interface Description

The radar module is provided with a 20PIN interface. The interface pins are PH2.0mm and 2 * 10 pins. The interface diagram is shown in the figure below. Some interfaces are reserved ports for radar configuration 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 Schematic diagram

For this model of product, the interface definition of the product is shown in the table below:

	Pin	Description	Remarks
1	CRX	Configuration sending port	This port is the control port of the upper computer to the radar, which can be omitted. The radar works according to the default parameters.
2	CTX	Configuration receiving port	
3	MD	Data output port	Radar data output port
4	+5V	Input +5.0 Power supply	Radar power input terminal, radar working current ≥ 600mA
5	V33	Output +3.3V	External power supply port, current ≤ 150mA

4. Operating mode

4.1. Operating range

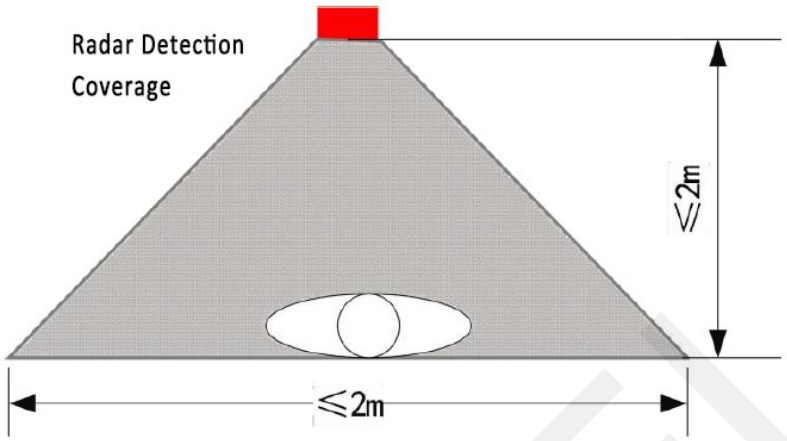


Figure.3 Detection Range of 77GHz Radar for Respiration and Heartbeat Monitoring

When the radar works, the working surface of the radar shall be facing the chest or back of the tested person as far as possible, and the distance from the human body to the radar surface shall be ≤ 2m.

4.2. Radar connection

The connection diagram between radar and peripheral host computer is shown in the figure below. There are three interfaces between radar and peripherals, namely data port, control port and mode selection port.

- **Data Port**
  This port is the radar detection data output port. Please refer to section 5-module interface protocol for specific parameter model. This port is a necessary port for radar.
- **Control Port**
  The upper computer can further operate the radar through the control port, such as querying the equipment ID and equipment status control, equipment working mode control, etc.
  Generally, the port is not connected, and the radar operates directly according to the default parameters. Please refer to the product protocol specification for the port data protocol.
- **Mode Selection Port**
  This port adopts a more direct radar control mode, that is, when CANL port is at high level, the radar works normally; When CANL port is at low level, the radar is in standby mode.

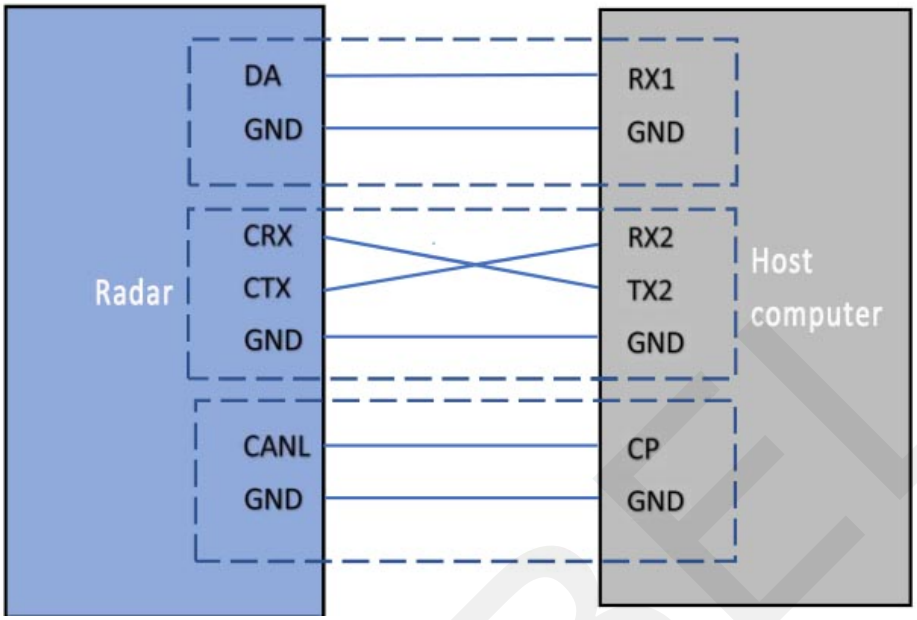


Figure 4 Connection between Radar and Host Computer

4.3. Radar Installation

Since the radar works mainly based on the fluctuation movement of the main body muscle surface caused by the respiratory rhythm, the fluctuation of the human chest and back will be more obvious. Therefore, the radar needs to be installed facing the chest or back of the human body to be tested.

Based on the radar action mode, the following installation modes are mainly considered for radar installation：

(1) Top-mounted

Corresponding to bedridden people or with sleep needs, the top mounting method is adopted (as shown in Figure 6). The radar beam is vertically downward and directly facing the human body, and the center position of the radar beam corresponds to the position of the human chest. In this installation, the distance requirement between radar and personnel should be ≤2m.

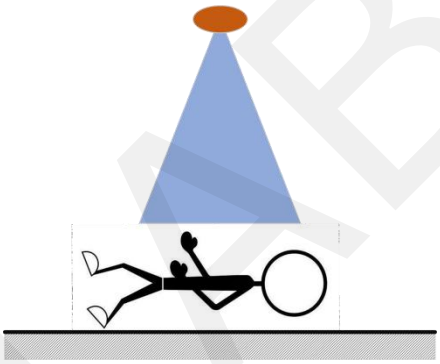


Figure 6 Top-mounted

(2) Inclined-mounted

The radar is installed obliquely and fixed on the wall or beside the bed(as shown in Figure 7). The radar beam irradiates the human body obliquely, and the center position of the radar beam corresponds to the position of the human chest. In this installation mode, the radial distance between the radar and the human body to be monitored is required to be ≤ 2m.

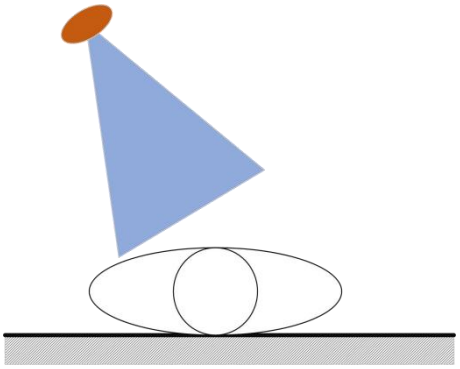


Figure 7 Inclined-mounted

(3) Horizontal-mounted

The radar is installed horizontally (as shown in Figure 8), fixed on the wall or placed on the desktop. The radar beam irradiates the human body in a positive direction, and the center position of the radar beam corresponds to the position of the human chest. In this installation mode, the radial distance between the radar and the human body to be monitored is required to be ≤ 2m.

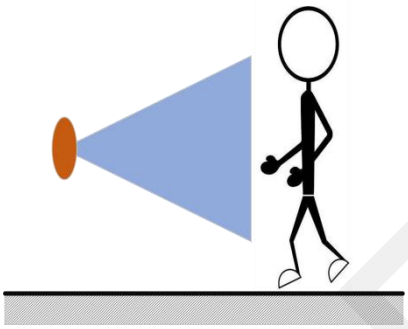


Figure 8 Horizontal-mounted

(4) Back-mounted

The radar is installed at corresponding positions such as seats and mattresses, and is separated from the human body by non-metallic media (as shown in Figure 9). In this installation mode, the radar mainly detects the surface movement of the back of the human body to realize respiration and heart rhythm monitoring. In this mode, the effective distance between the radar and the human body to be monitored is 5cm-50cm.

Figure 9 Back-mounted

5. Module Interface Protocol

5.1. Introduction of Interface

The radar module and the upper computer adopt the serial communication mode, and the serial communication is defined as follows:

- ✧ InterfaceLevel: CMOS
- ✧ Baud Rate: 115200bps
- ✧ Stop Bit: 1
- ✧ Data Bit: 8

The output data is output in small terminal mode.

5.2. Output Data Frame Definition

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

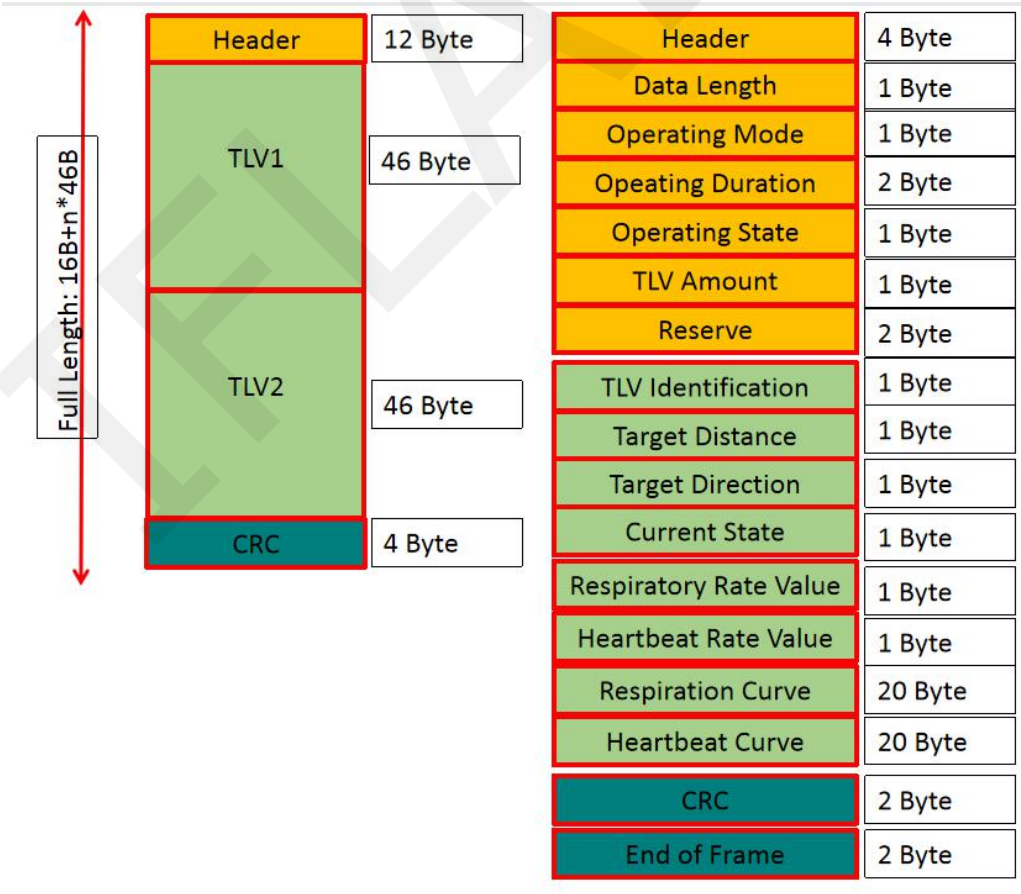


Figure 10 Uplink frame data structure

The uplink frame consists of three parts: frame header, parameter field and check field.

The three frame data are defined as follows:

A. Header **Full Length： 12Byte**

	Symbol	Definition	Length（B）	Description	Remarks
1	SYNC	Leader	4	Default as"0x53 0x59 0x54 0x43"	Default as SYTC
2	Length	Data length	1	Full data frame length indication;	Count by Byte
3	Mode	Operating mode	1	0x00-Stand-by mode; 0x01-Forward wide range detection mode; 0x02-Back detection mode; 0x03-Forward narrow domain mode; 0x04-Forward tracking mode; 0x06-Two-person monitoring mode ;	
4	Time	Working duration	2	Startup working time of radar,"min"	
5	NumTLV	TLV Amount	1	Number that radar detects from respiration and heartbeat rate	
6	WorkCon	Operating state	1	Current operating state 1-Normal 2-Stand-by 3-Abnormal	
7	Reserve	Reserve	2	Reserve fields	

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

	Symbol	Definition	Length(B)	Description
1		TLV Identification	1	TLV Subframe identification： "0x01"， "0x02" stand for the 1st and 2nd place respectively.
2		Target distance	1	Integer，0.1 m accuracy，0-25.6 m
3		Target direction	1	Integer，1°m，-127°～128°
4		Current state	1	0x01-Normal; 0x02-Target abnormal;
5		Respiratory Rate Value	1	Integer
6		Heartbeat Rate Value	1	Integer
7		Respiration Curve	20	8bit Integer
8		Heartbeat Curve	20	8bit Integer

Note: when there are multiple targets, the target parameters are arranged in the order of distance.

C. Check Field

	Symbol	Definition	Length	Descrpition
1	CRC	CRC	2B	CRC16
2	ZW	End of frame identification	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 the normal operation of the module. Therefore, when the module is initially powered on, it needs a startup stability time of ≥30s to ensure the validity of subsequent output parameters.

6.2. Limitations on Heartbeat Monitoring

Since this module is a respiratory and heartbeat detection radar, the detection distance should not be too far, and the appropriate distance is 0.1m-2m. When there are objects with stronger reflectivity than the measured target around the measured target, the radar may track the strongly reflected target during operation. At this time, 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, and multi-target measurement is temporarily unavailable. Therefore, when multiple people are located in the radar detection area, the detection parameters are disordered, which needs attention.

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, many factors may affect the radar parameters, so occasional detection failure is normal.

6.4. Power

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 glitches or 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 circuit inside the module, the power supply requirement for this module is + 5V- + 9V power supply, voltage of power supply no less than 5V. The external power supply must provide sufficient current output capability and transient response capability.

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