Respiratory heart rate detection radar module HLK-LD6002

User Manual

2023.09
Shenzhen Hi-Link Electronic Co., Ltd

CONTENT

1.Product Introduction

HLK-LD6002 is a radar induction module developed based on ADT6101P chip, with a single-chip integrated 57-64GHz RF transceiver system, 2T2R PCB microstrip antenna, 1MB flash, radar signal processing unit, ARM ® Cortex ®- M3 kernel. This module is based on the FMCW radar mechanism, detecting radar echoes reflected from the surface of the human body. Combined with radar signal processing algorithms, it achieves real-time measurement of individual respiratory heart rate frequency.

2.Product characteristics

- Radar detection based on FMCW frequency modulated continuous wave signal
- Realize non-contact perception of human respiration and heart rate
- The maximum detection distance of human respiratory heart rate is 1.5m
- Universal UART interface, providing communication protocol
- Reserve multiple sets of IO ports and communication interfaces to support customer secondary development, suitable for multiple scenario applications
- Compact in size, only 25 * 31.5mm, supports two methods of pin insertion and patch connection
- Not affected by temperature, humidity, noise, airflow, dust, light and other environmental factors

3. Application Area

- Smart home applications
  Implementing home empowerment based on respiratory heart rate measurement
- Health management
  Real time monitoring of respiratory heart rate data
- Smart Health Care
  Elderly respiratory and heart rate monitoring, reporting any abnormalities immediately

4. Electrical characteristics and parameters

4.1 Function parameters

Parameters	Min	Typical	Max	Unit
Respiratory and heartbeat detection distance (chest)	0.4		1.5	m
Respiratory measurement accuracy		90		%
Respiratory measurement frequency range	9		48	bpm
Heartbeat measurement accuracy		90		%
Heartbeat measurement frequency range	60		150	bpm
Refresh time		50		ms
Setting test time		1		Min
Max testing No.		1		per

4.2 Electrical characteristics

Operation parameters	Min	Typical	Max	Unit

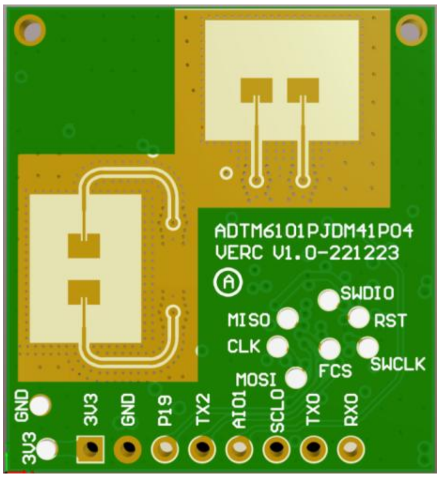
Operation voltage（VCC）	3.1	3.3	3.5	V
Operation current（ICC）			600	mA
Operation temperature（TOP）	-20		85	℃
Storage temperature（TST）	-40		85	℃

4.3 RF characteristics

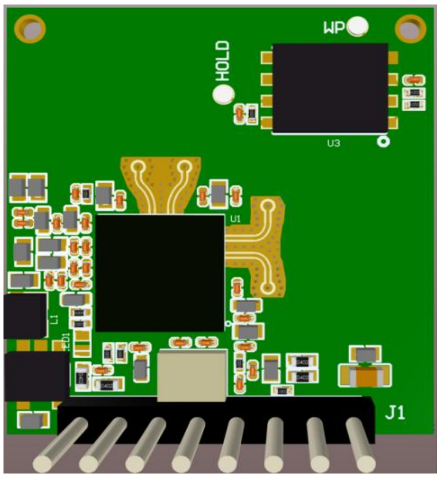
Operation parameters	Min	Typical	Max	Unit
Operating Frequency	58		62	GHZ
Transmission power（Pout）		12		dBm
Antenna gain		4		dBi
Horizontal beam（-3dB）	-60		+60	°
vertical beam（-3dB）	-60		+60	°

5. Hardware Description

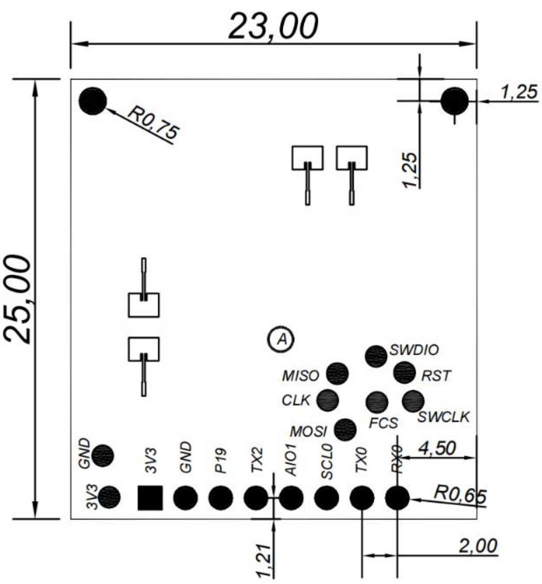
5.1External dimensions

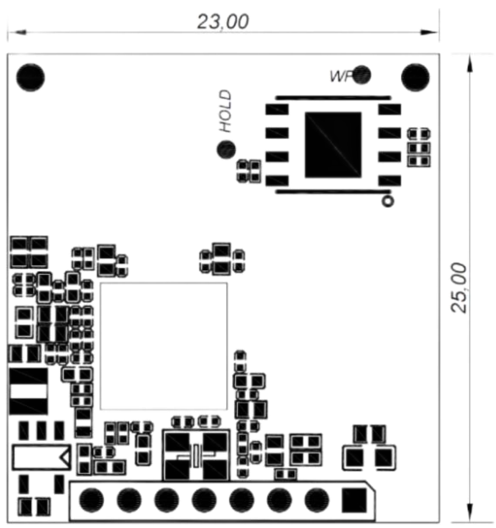


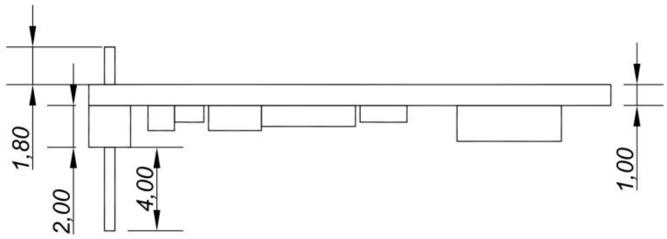
Front view of the module



Back view of the module



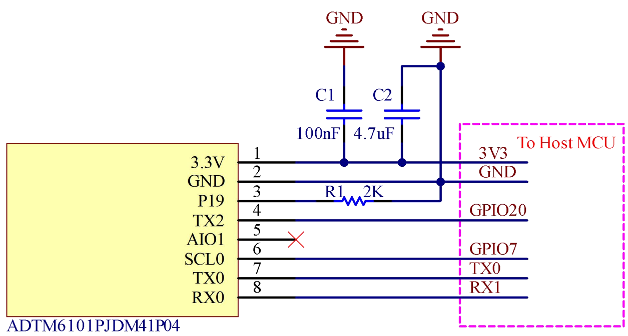




5.2 Pin Definition

Pin No.	Pin Name	Description	Note
1	3V3	POWER INPUT 3.3V	
2	GND	GND	
3	P19	GPIO19	Boot1
4	TX2	GPIO20	
5	AIO1	Analog IO	
6	SCL0	GPIO07	
7	TX0	Connected to external serial port TX	
8	RX0	Connected to external serial port RX	

5.3 Module peripheral reference design



5.4 Boot Configuration

	BOOT1	BOOT0	Note
Configure level	0	1	Flash startup within the module
Pin number	Pin8	Pin12	

* Both BOOT1 and BOOT0 modules are internally pull-up. Before starting the module, BOOT1 must be connected to a low level

6.Usage and Configuration

6.1 Typical application circuit

The typical application circuit LD6002 module can directly use UART0 to output detection results according to the specified protocol. The serial port data includes total phase, respiratory phase, heartbeat phase results, respiratory rate, and heartbeat rate results. Users can flexibly use it according to specific application scenarios.

The module is powered by 3.3V, and the input power supply capacity is required to be greater than 1A.

The output voltage of the module IO port is 3.3V. The default baud rate for the serial port is 1382400, with no parity check.

6.2 GUI visualization tool application

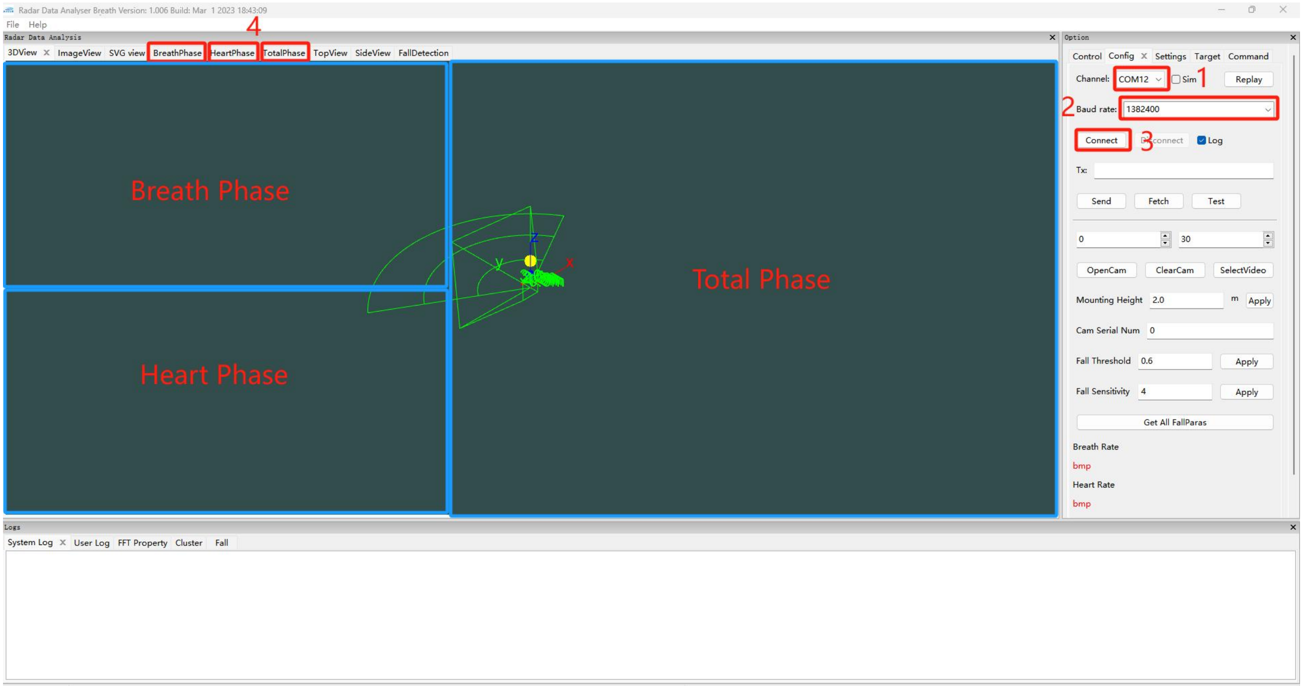
1) Equipment connection

2) Select the serial port to connect to in the Configuration interface of the Option bar in the upper right corner

3) Set the baud rate to 1382400

4) Click the 【 Connect 】 button to start measuring

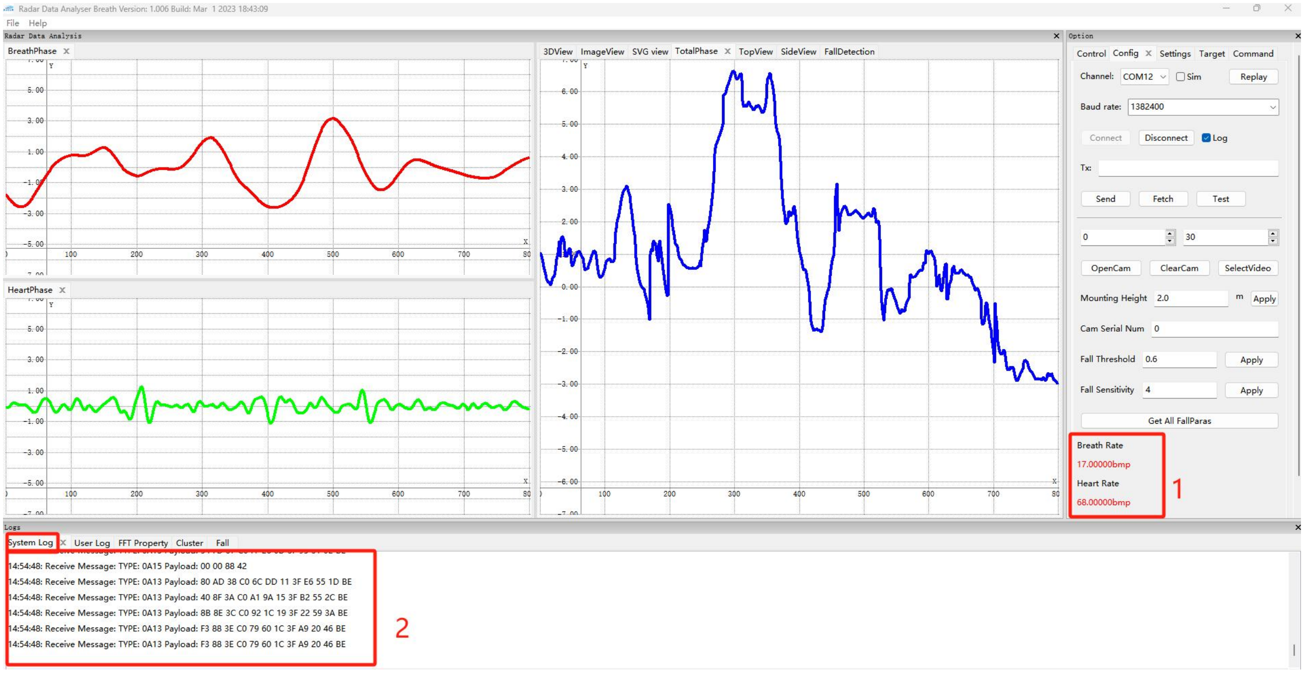
5) For the convenience of viewing data, the Breath Phase, Heart Phase, and Total Phase windows can be dragged and arranged in the following format



1. Data viewing

1) The lower right corner displays information on breathing and heart rate.

2) The System Log window in the bottom left corner displays message information, which includes total phase data, heartbeat phase, respiratory phase, respiratory rate, and heartbeat rate information.

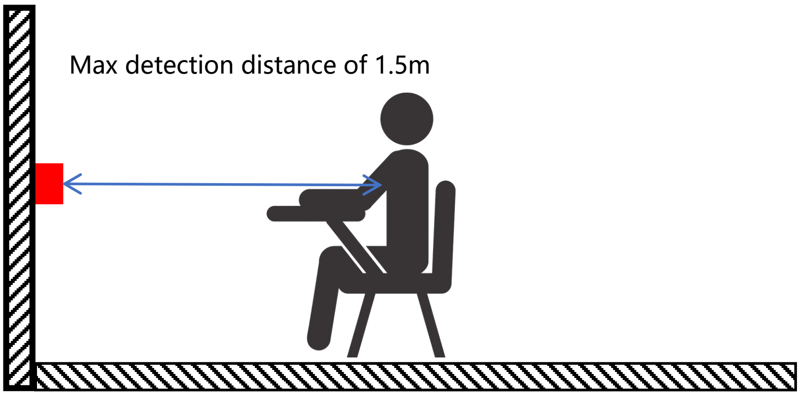


6.3 OTA Upgrade

Please refer to the document "OTA Upgrade Tool User Manual V1.0"

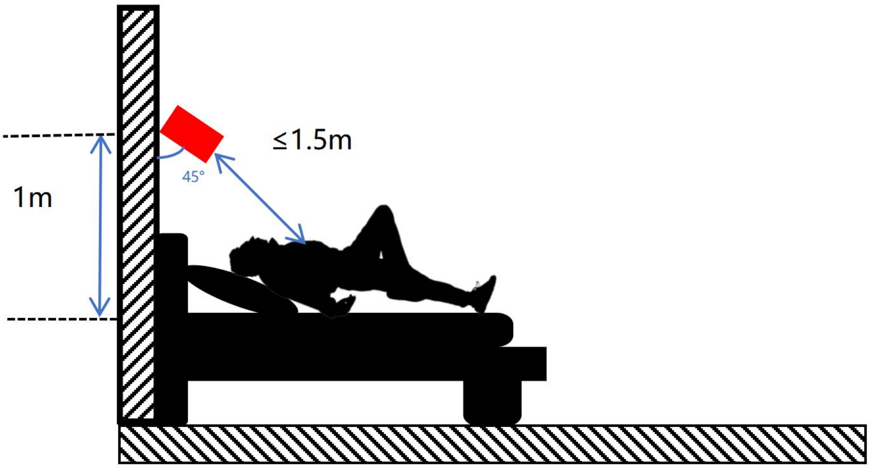
6.4 Installation method and sensing range

1. Slide mounted, it is recommended that the radar installation height be consistent with the height of the tested person's chest cavity, and the module position should be ≤ 1.5m from the chest cavity position



Slide installation diagram

2. Oblique installation: For the needs of sleep breathing and heart rate detection, a tilted installation method can be used. The radar is required to be installed at a height of 1m directly above the head of the bed, with a downward tilt of 45 ° towards the middle of the bed. The distance between the radar and the chest cavity is controlled within a range of 1.5m, and the normal direction of the radar is aligned with the main detection position to ensure that the radar can detect breathing and heart rate data.



Oblique installation diagram

7. Notes

1. The detection distance of the radar module is closely related to the target RCS and environmental factors, and the effective detection distance may vary with changes in the environment and target. Therefore, it is normal for the effective detection distance to fluctuate within a certain range.

2. The radar module has extremely high power requirements, requiring an input voltage of 3.2-3.4V, power ripple ≤ 50mV, and current ≥ 1A. If using a DCDC power supply, the switching frequency is required to be no less than 2MHz.

3. Due to the fact that respiratory heart rate is a weak reflex signal, radar signal processing requires a period of time for data accumulation. During the accumulation process, there are many factors that affect the radar processing results. Therefore, occasional detection failures are a normal phenomenon.

4. Currently, respiratory heart rate measurement only supports single individuals. Please ensure that there is only one person in the detection area.

5. It is required to measure in a resting state, and if a large movement is detected, the measurement will stop.

8.Design of radar antenna cover

The radar antenna cover is used to protect the radar antenna from external environmental influences such as rain, sunlight, and wind. But it has the following effects on radar antennas: the dielectric loss and reflection loss caused by the antenna cover will reduce the effective power of the radar; Causing distortion of antenna beams, resulting in changes in the radar's operating area; The reflection of electromagnetic waves by the shell reduces the isolation of the radar transmitting and receiving antenna, and may lead to receiver saturation; The phase of electromagnetic waves passing through radar radomes changes, affecting the measurement of angles. Therefore, it is necessary to design radar radomes to reduce the impact of the casing and improve radar performance.

Design requirements:：

1. When selecting materials for radar radomes, while ensuring durability and low cost, materials with smaller dielectric constant and loss tangent should be selected to reduce the impact of radar radomes on radar performance.

The dielectric constant and dissipation factor of commonly used materials are shown in the table below:

Materials	**Dielectric constant（ε_r）**	**Dissipation factor（tan δ）**
polycarbonate	2.9	0.012
ABS	2.0-3.5	0.0050-0.019
PEEK	3.2	0.0048
PTFE（Teflon®）	2	<0.0002
Plexiglass®	2.6	0.009
Glass	5.75	0.003
Ceramics	9.8	0.0005
PE	2.3	0.0003
PBT	2.9-4.0	0.002

2. It is required that the surface of the radar antenna cover is smooth and the thickness is uniform and consistent

3. Design requirements for thickness of radar antenna cover

$$T = N \bullet \frac{c}{2f\sqrt{\varepsilon_r}}, \quad N=1，2，3\ldots$$

T： thickness of radar antenna cover

c： speed light，3×10^8 m/s；

f： Center frequency

ε_r**：** Material dielectric constant，DK

4. Design requirements for the height of radar antenna from the inner surface of the shell

$$d = N \bullet \frac{c}{2f} \quad N=1，2，3\ldots$$

c： speed light，3×10^8 m/s；

f： Center frequency

f=60GHz

c/2f=2.5mm

Shenzhen Hi-Link Electronic Co.,Ltd

Address: 1705, 17/F, Building E, XingheWORLD, Minle Community, Minzhi Street, Longhua District, Shenzhen

Tel： 0755-23152658/83575155

Email: sales@hlktech.com

Website: https://www.hlktech.net/