Seeed Technology Co.,Ltd.

# MR60BHA2

# Breathing and Heartbeat Module Technical Specification (Beta Version)

Made by Seeed Technology Co.,Ltd.

March 5, 2024

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# 1. Product Introduction

MR60BHA2 is a radar sensing module developed based on the ADT6101P chip. It monolithically integrates a 57~64GHz radio frequency transceiver system, 2T2R PCB microstrip antenna, 1MB flash, radar signal processing unit, and ARM® Cortex®-M3 core. This module is based on the FMCW radar mechanism, detects the radar echo reflected by the human body surface, and combines the radar signal processing algorithm to measure the respiratory heart rate frequency of people in specific situations.

# 2. Product Characteristics

- Radar detection based on FMCW frequency modulated continuous wave signal
- Realize contactless sensing of human breathing and heart rate
- The maximum detection distance of human respiratory heart rate is 1.5m
- Universal UART interface, providing communication protocol
- Multiple sets of IO ports and various communication interfaces are reserved to support secondary development by customers and are suitable for multiple scenarios.
- Small size, only 25*31.5mm, supports pin header connection and patch connection.
- Not affected by temperature, humidity, noise, airflow, dust, light and other environmental influences

# 3. Application Scenarios

- Smart home applications

  Realize home empowerment based on breathing and heart rate measurement

- health management

  Real-time monitoring of respiratory and heart rate data

# 4. Electrical Characteristics and Parameters

## 4.1 Function parameters

| parameter | minimum value | Typical value | maximum value | unit |
|---|---|---|---|---|
| Breathing and heartbeat detection distance (chest) | 0.4 | | 1.5 | m |
| Breath measurement accuracy | | 90 | | % |

| | | | | |
|---|---|---|---|---|
| Breath measurement range | | | | times/minute |
| Heartbeat measurement accuracy | | 90 | | % |
| Heartbeat measurement frequency range | | | | times/minute |
| refresh time | | | | |
| Establish detection time | | 1 | | Min |

### 4.2 Electrical characteristics

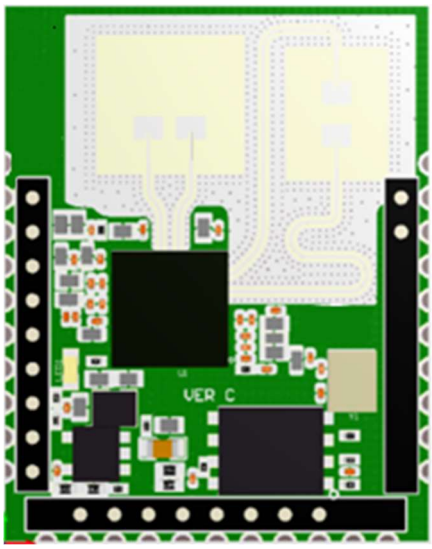
| Working parameters | minimum value | Typical value | maximum value | unit |
|---|---|---|---|---|
| Operating voltage (VCC) | 3.1 | 3.3 | 3.5 | V |
| Operating current (ICC) | | | 600 | mA |
| Operating temperature (TOP) | -20 | | 85 | ℃ |
| Storage temperature (TST) | -40 | | 85 | ℃ |

### 4.3 RF characteristics

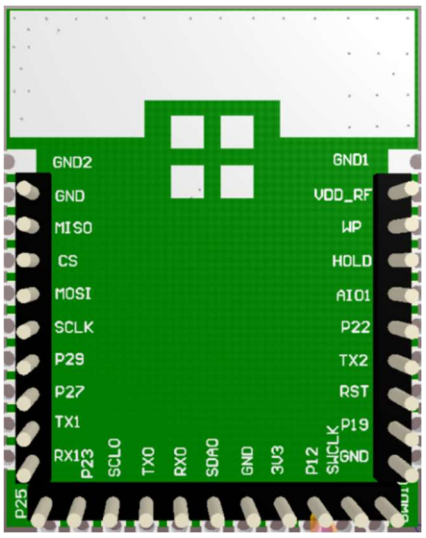
| Working parameters | minimum value | Typical value | maximum value | unit |
|---|---|---|---|---|
| working frequency | 58 | | 62 | GHZ |
| Transmit power (Pout) | | 12 | | dBm |
| Antenna gain | | 4 | | dBi |
| Horizontal beam (-3dB) | -60 | | +60 | ° |
| Vertical beam (-3dB) | -60 | | +60 | ° |

# 5.Hardware description

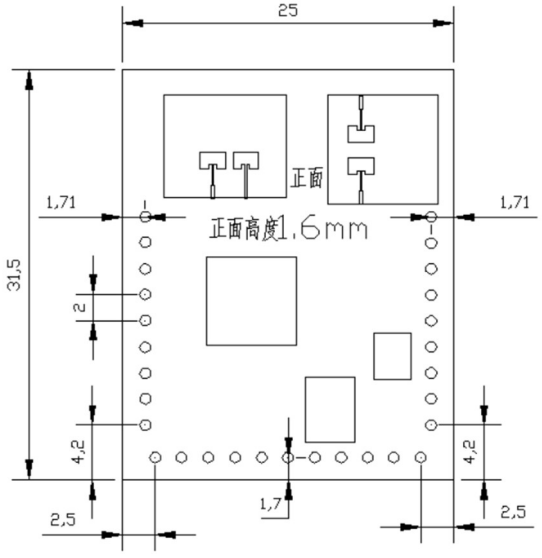
## 5.1 Dimensions

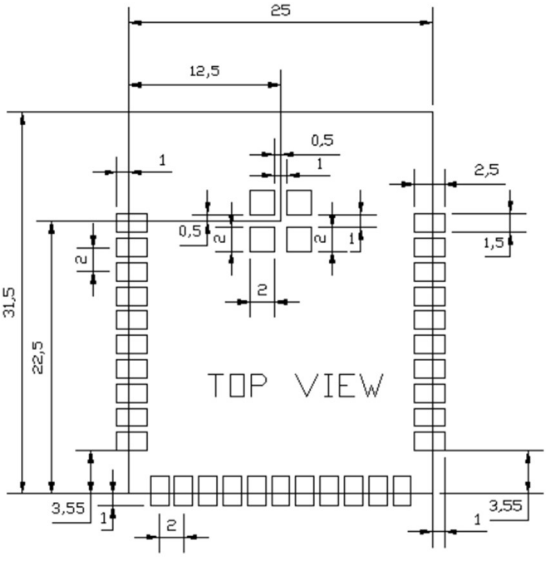


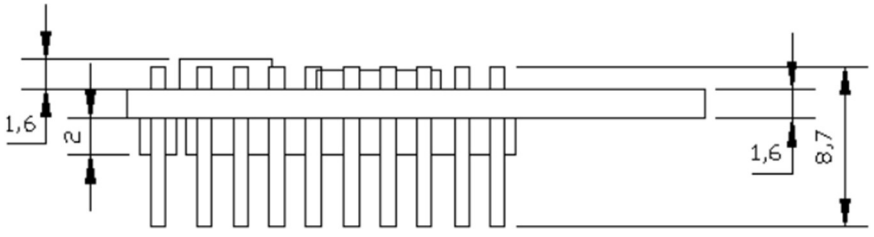

Module physical front view




Module physical rear view



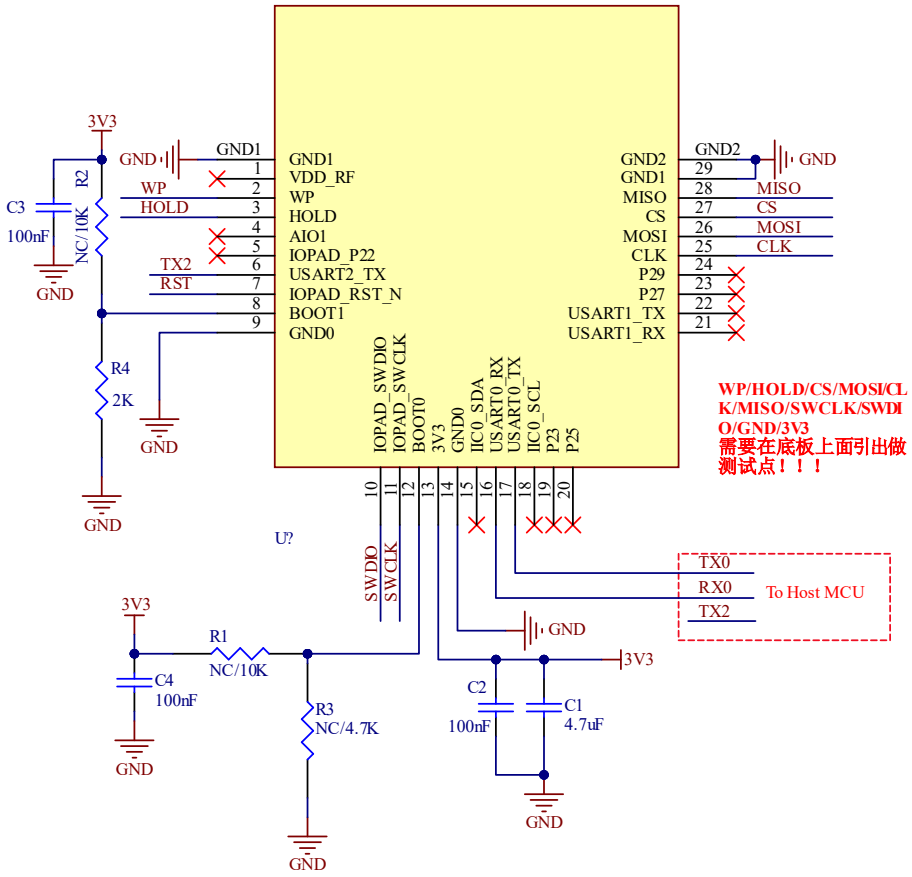



### 5.2 Pin definition

| Pin serial number | Pin name | describe | Remark |
|---|---|---|---|
| GND1 | GND | GND | Only supports patch packaging |
| 1 | VDDRF | External RF Power /1.35V | |
| 2 | WP | Write protection active low | Flash function pin |
| 3 | HOLD | To pause the device without deselecting the device | Flash function pin |
| 4 | AIO1 | Temperature index test interface | Can be used as analog input |
| 5 | P22 | interfaceGPIO_P22/LDO_EXT_EN_H | |
| 6 | TX2 | GPIO_P20/uart2 txd | Control output (such as relay, etc.) |
| 7 | RST | Reset Signal input | |
| 8 | P19 | GPIO_P19/boot1 | Boot |
| 9 | GND0 | GND | |
| 10 | SWDIO | SWD Debug Signal | |
| 11 | SWCLK | SWD Debug Clock | |
| 12 | P12 | GPIO_P12/boot0 | |
| 13 | 3.3V | POWER INPUT 3.3V | |
| 14 | GND | GND | |
| 15 | SDA | GPIO_P08/IIC0_SDA | |
| 16 | RX0 | GPIO_P01/uart0 _txd | |
| 17 | TX0 | GPIO_P00/uart0 _txd | |
| 18 | SCL | GPIO_P07/IIC0_SCL | |
| 19 | P23 | IOPAD_P23 | |
| 20 | P25 | IOPAD_P25 | |
| 21 | RX1 | GPIO_P11/uart1 rxd | |
| 22 | TX1 | GPIO_P10/uart1 txd | |
| 23 | P27 | IOPAD_P27 | |
| 24 | P29 | IOPAD_P29 | |
| 25 | SCLK | IOPAD_P03/SPI0_SCLK | Can be used as RF ADC signal acquisition output terminal |
| 26 | MOSI | IOPAD_P06/SPI0_MOSI | Can be used as RF ADC signal acquisition output terminal |
| 27 | CS | IOPAD_P04/SPI0_CS | Can be used as RF ADC signal acquisition output terminal |
| 28 | MISO | IOPAD_P05/SPI0_MISO | |
| 29 | GND1 | GND | |
| GND2 | GND2 | GND | Only supports patch packaging |

### 5.3 Module peripheral reference design




### 5.4 Startup configuration

| BOOT1 | BOOT0 | Start mode | Remark |
|---|---|---|---|
| 0 | 0 | UART1 | Serial port 1 starts |
| 0 | 1 | Flash | Flash startup in module |
| 1 | 0 | IIC0 | This module does not support this method |
| 1 | 1 | Debug | For software debugging |

# 6.Use and Configuration

### 6.1 Typical application circuit

The MR60BHA2 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 use it flexibly according to specific application scenarios.

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

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

### 6.2 GUI visualization tool application

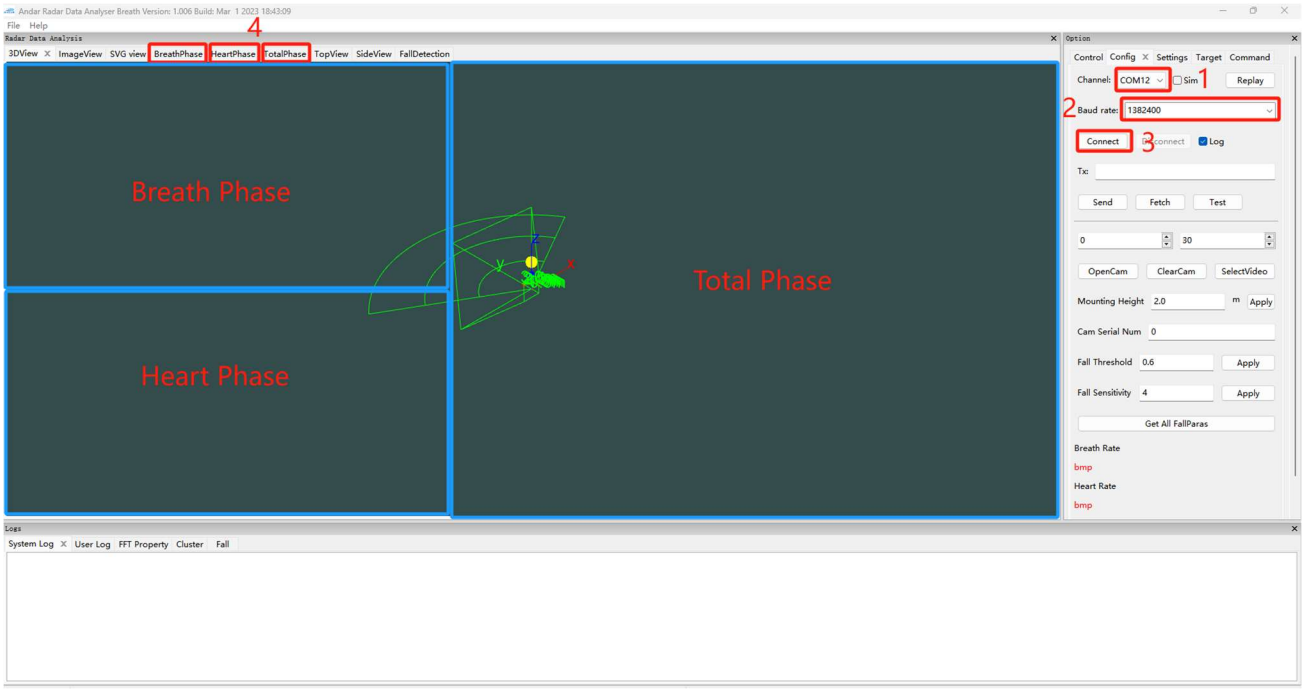
1. Device connection

1) Select the connected serial port in the Config interface in the Option bar on the upper right

2) Set the baud rate to 115200

3) Click the [Connect] button to start measurement

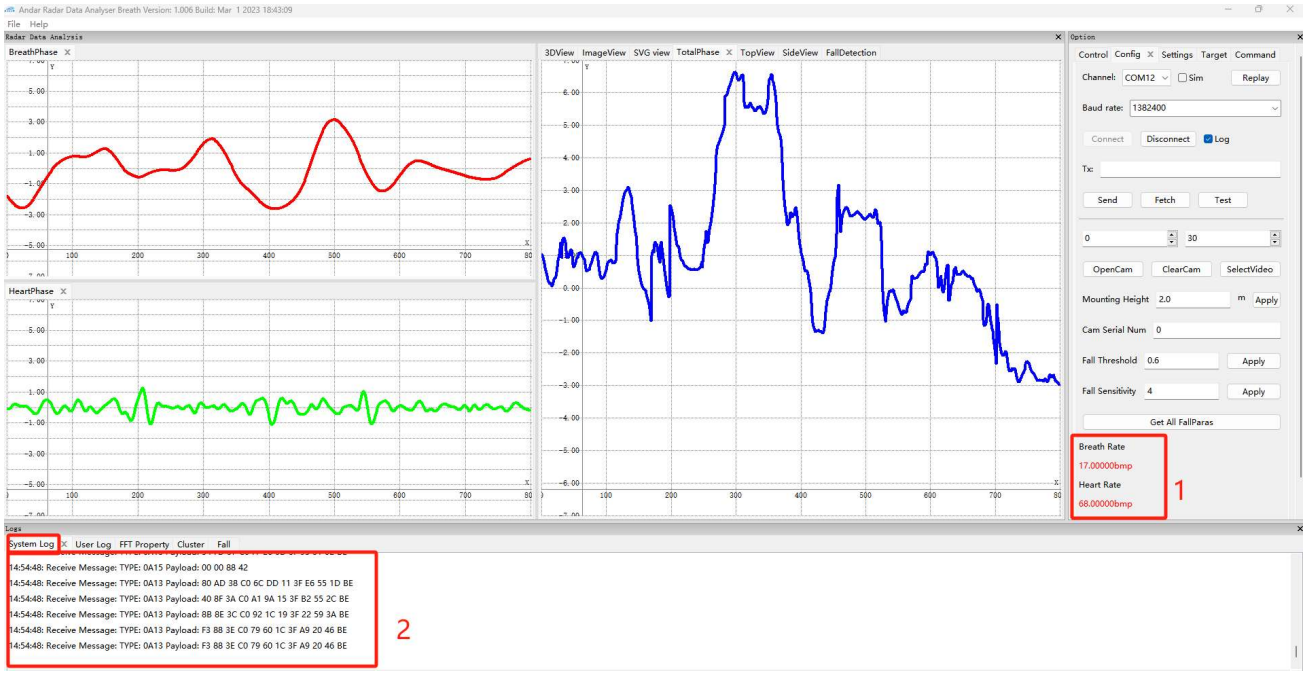
4) To facilitate viewing of data, you can drag and drop the Breath Phase, Heart Phase, and Total Phase windows into the following format




2. Data view

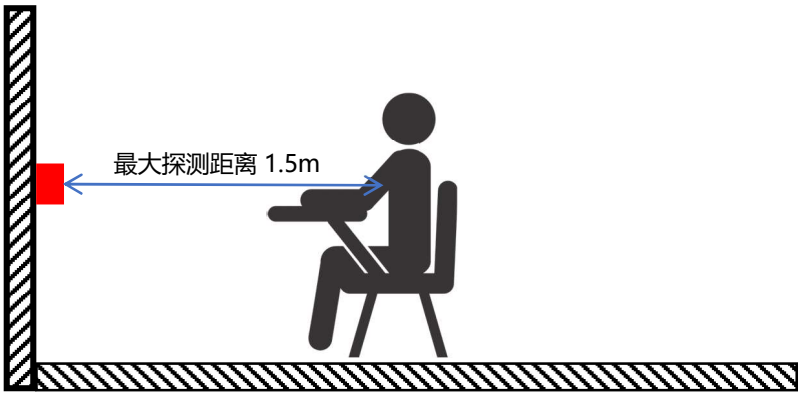
1) The lower right corner displays breathing and heart rate information.

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



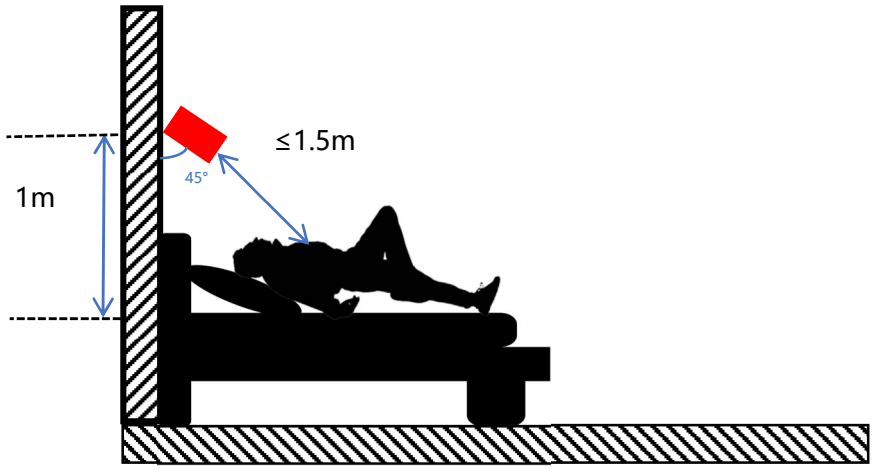

### 6.3 Installation method and sensing range

1. Side-mounted, it is recommended that the radar installation height be consistent with the chest height of the person being measured, and the module position and chest position ≤ 1.5m




**Side mounting diagram**

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




**Tilt installation diagram**

## 7. Precautions

1. The detection range of the radar module is closely related to the target RCS and environmental factors. The effective detection range may change as the environment and target change. Therefore, it is normal for the effective detection range 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 supply ripple ≤50mV, and current ≥1A. If a DCDC power supply is used, the switching frequency is required to be no less than 2MHZ.

3. Since respiratory and heart rate are weak reflection signals, radar signal processing requires a period of data accumulation. During the accumulation process, there are many factors that affect the radar processing results, so sporadic detection failures are normal.

4. Currently, respiratory and heart rate measurement only supports one person. Please make sure there is only one person in the detection area.

5. Measurement is required in a resting state, and measurement will be stopped if large movements are detected.

## 8.Radar radome design

Radomes are used to protect radar antennas from external environmental influences such as rain, sunlight, wind, etc. However, it has the following effects on the radar antenna: the dielectric loss and reflection loss caused by the radome will reduce the effective power of the radar; it will cause the antenna beam to be distorted, causing the radar's area of action to change; the reflection of electromagnetic waves by the shell will cause the radar transmitting and receiving antenna to The isolation becomes worse and may cause receiver saturation; the phase of electromagnetic waves changes when they pass through the radar radome, affecting the angle measurement. Therefore, it is

necessary to design the radar radome to reduce the impact of the shell and improve the radar performance.

**Design requirements:**

1. When selecting the material of the radome, under the premise of ensuring the sturdiness and low cost, materials with smaller dielectric constant and loss tangent should be selected to reduce the impact of the radome on radar performance.

The dielectric constant and dissipation factor of commonly used materials are as follows:

| Material | Dielectric constant ( $\varepsilon_r$ ) | 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. The radar radome is required to have a smooth surface and uniform thickness.

3. Radar radome thickness design requirements

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

**T:** radome thickness

**c:** speed of light , $3\times10^8$ m/s;

**f:** center frequency

$\varepsilon_r$ **:** Material dielectric constant, DK

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

$$d = N \bullet \frac{c}{2f} \text{ N=1, 2, 3 ...}$$

**c:** speed of light , $3\times10^8$ m/s;

**f:** center frequency

f=60GHz

c/2f=2.5mm

## Revision History

| Revison | Release Date | Description |
|---|---|---|
| V1.0 | 2024/03/05 | Initial version |
| | | |
| | | |