# RF-AL42UHB2 ASR6505 410 MHz ~ 525 MHz LoRa & LoRaWAN Module Hardware Specification

**Version 1.0**

Shenzhen RF-star Technology Co., Ltd.

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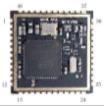
# RF-star LoRa Module List

| Chipset | Model | Antenna | Dimension (mm) | Package | Frequency (MHz) | TX Power (dBm) | Range (Km) | Photo |
|---|---|---|---|---|---|---|---|---|
| **ASR6501** | RF-AL42UH | Half-hole | 13.9 × 13.9 | Half-hole | 433 | 22 | 3 |  |
| **ASR6505** | RF-AL42UHB2 | Half-hole | 18.3 × 18.3 | Half-hole | 433 | 22 | 3 |  |
| **SX1278** | RF-42UH | Half-hole / IPEX | 16 × 26 | Half-hole | 433 | 18 | 3/4.5 |  |
| | RF-42UP | SMA | 21.1 × 36 | DIP | 433 | 18 | 3 |  |
| | RF-42SH | Half-hole | 16 × 16 | Half-hole | 433 | 18 | 3 |  |
| | RF-43UH | Half-hole / IPEX | 25 × 40.3 | Half-hole | 433 | 27 | 10 | Contact Me |
| | RF-43UP | SMA | 24 × 43 | Half-hole | 433 | 27 | 10 |  |
| | RF-43SH | Half-hole | 25 × 40 | DIP | 433 | 27 | 10 | Contact Me |
| **SX1276** | RF-82UH | Half-hole / IPEX | 16 × 26 | Half-hole | 868<br>915 | 18 | 3/4.5 |  |
| | RF-82UP | SMA | 21.1 × 36 | DIP | 868 | 18 | 3 |  |
| | RF-82SH | Half-hole | 16 × 16 | Half-hole | 915 | 18 | 3 |  |
| | RF-83UH | Half-hole / IPEX | 25 × 40.3 | Half-hole | 868 | 27 | 10 | Contact Me |
| | RF-83UP | SMA | 24 × 43 | DIP | 915 | 27 | 10 | Contact Me |
| | RF-83SH | Half-hole | 25 × 40 | Half-hole | 868 | 27 | 10 |  |

Note:

1. The communication distance is the longest distance obtained by testing the module's maximum transmission power in an open and interference-free environment in sunny weather.
2. Click the picture to jump to buy modules.

# 1 Device Overview

## 1.1 Description

The RF-AL42UHB2 is a general LoRa Wireless Communication Module, with integrated LoRa Radio Transceiver, LoRa Modem and an 8-Bit CISC MCU. The MCU uses an advanced STM 8-bit core, with 16 MHz operation frequency. The LoRa Radio Transceiver has continuous frequency coverage from 410 MHz to 525 MHz. The LoRa Modem supports LoRa modulation for LPWAN use cases and (G)FSK modulation for legacy use cases. The LoRa Wireless Communication module designed by ASR6505 provides ultra-long range and ultra-low power communication for LPWAN application.

The RF-AL42UHB2 can achieve a high sensitivity of over -140 dBm and the maximum transmit power is higher than +22 dBm. This makes it suitable to be used in long range LPWAN and have high efficiency. The total chip package is of very small size, with totally 48 pins.

## 1.2 Key Features

- Compact size: 18.3 mm x 18.3 mm
- SX1262 + STM8L152 integrated
- LoRa Radio and LoRa Modem
- Frequency Range: 410 MHz ~ 525 MHz
- Maximum Power +22 dBm constant RF output
- High sensitivity: down to -140 dBm
- Deepsleep mode current with RTC: 2 μA.
- TX mode current: 50 mA (@ 17 dBm), 40 mA (@ 14 dBm)
- RX mode current: 10 mA
- Programmable bit rate up to 62.5 kbps in LoRa modulation mode
- Programmable bit rate up to 300 kbps in (G)FSK modulation mode
- Preamble detection
- Embedded memories (up to 64 kbytes of Flash memory and 4 kbytes of SRAM, 2 kbytes of EEPROM)
- 30 x configurable GPIOs, 1 x $I^2C$, 2 x UART, 1 x SWIM, 1 x SPI, 3 x ADC
- LCD driver: 2 / 4 / 8 COM, Max 24 Segments
- 16-MHz Harvard architecture CPU
- 4-Channel DMA engine
- Embedded 12-bit 1 Mbps SAR ADC
- Embedded 2 x 12-bit DAC
- Embedded 2 x low power comparators
- 96-bit unique Chip ID
- Most complete EVK demo, with LCD, sensors, debug interfaces on board

## 1.3 Application

- Smart home
- Smart transportation
- Sensor network
- Automation industry
- Farming modernization
- Intelligent building
- Automatic collection system for water, electricity, gas and heating
- Street light control
- Grid monitoring

- Wind and solar complementary system transmission
- Industrial equipment data wireless

### 1.4 Functional Block Diagram

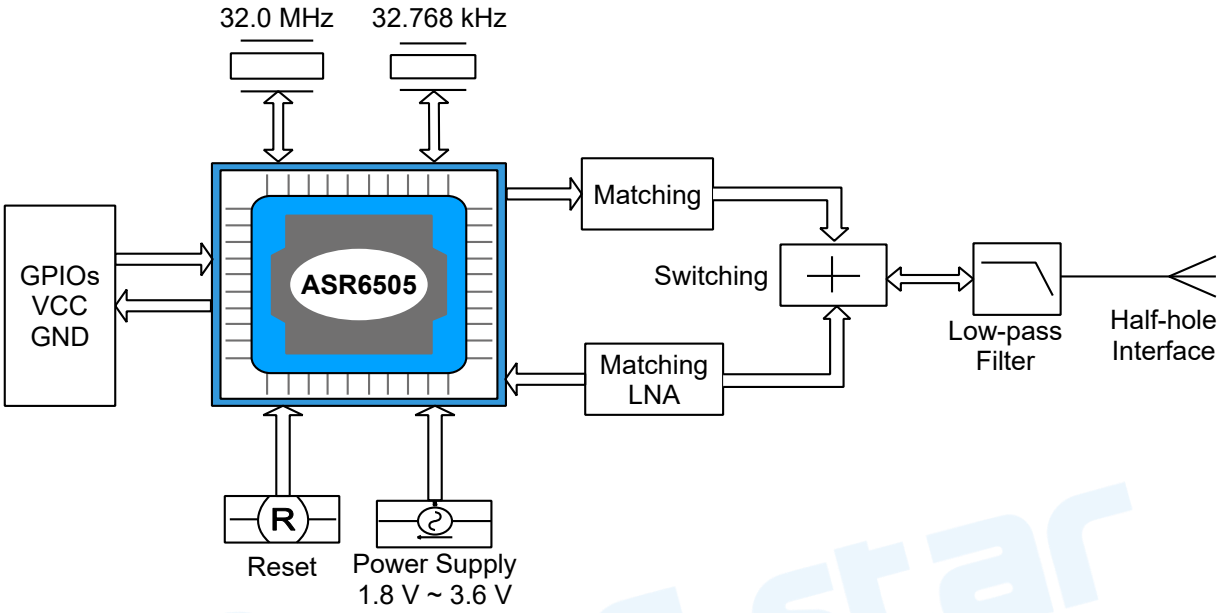



Figure 1. Block Diagram of RF-AL42UHB2

### 1.5 Part Number Conventions

The part numbers are of the form of RF-AL42UHB2 where the fields are defined as follows:

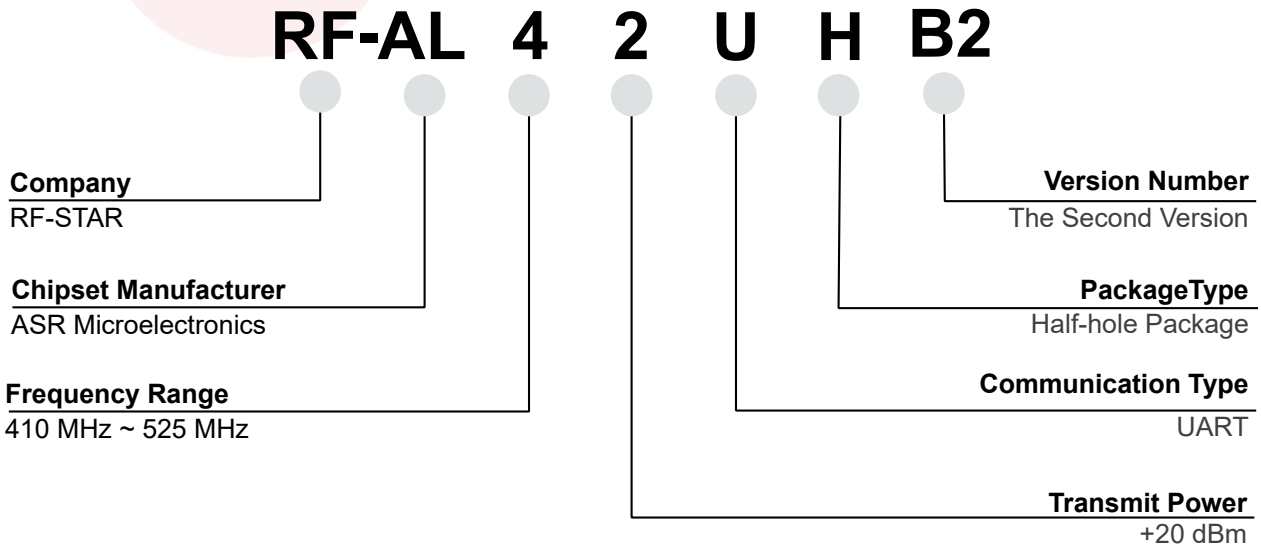



Figure 2. Part Number Conventions of RF-AL42UHB2

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# 2 Module Configuration and Functions

## 2.1 Module Parameters

Table 1. Parameters of RF-AL42UHB2

| | |
|---|---|
| Chipset | ASR6505 (STM8L152 + SX1262) |
| Supply Power Voltage | 1.8 V ~ 3.6 V, recommended to 3.3 V |
| Frequency | 410 MHz ~ 525 MHz |
| Maximum Transmit Power | +22 dBm |
| Receiving Sensitivity (125 kHz Bandwidth, SF = 12, rate = 0.3 Kbps) | -140 dBm |
| GPIO | 40 |
| Crystal | 32 MHz, 32.768 KHz |
| SRAM | 4 KB |
| Flash | 64 KB |
| EEPROM | 2 KB |
| Package | SMT Packaging |
| Interface | UART, $I^2C$, SPI, SD, ADC |
| Dimension | 18.3 mm x 18.3 mm |
| Type of Antenna | Half hole Interface |
| Operating Temperature | -40 ℃ ～ +85 ℃ |
| Storage Temperature | -55 ℃ ～ +125 ℃ |
| Operating Humidity | 5 ~ 95% (Non-Condensing) |
| Storage Humidity | 10 ~ 95% (Non-Condensing) |
| Power Consumption | Sleep mode: 2 μA (@ without RF Config Retention, without RTC)<br>TX Current: 50 mA (@ 17 dBm)<br>TX Current: 40 mA (@ 14 dBm)<br>RX Current: 10 mA |

## 2.2 Module Pin Diagram

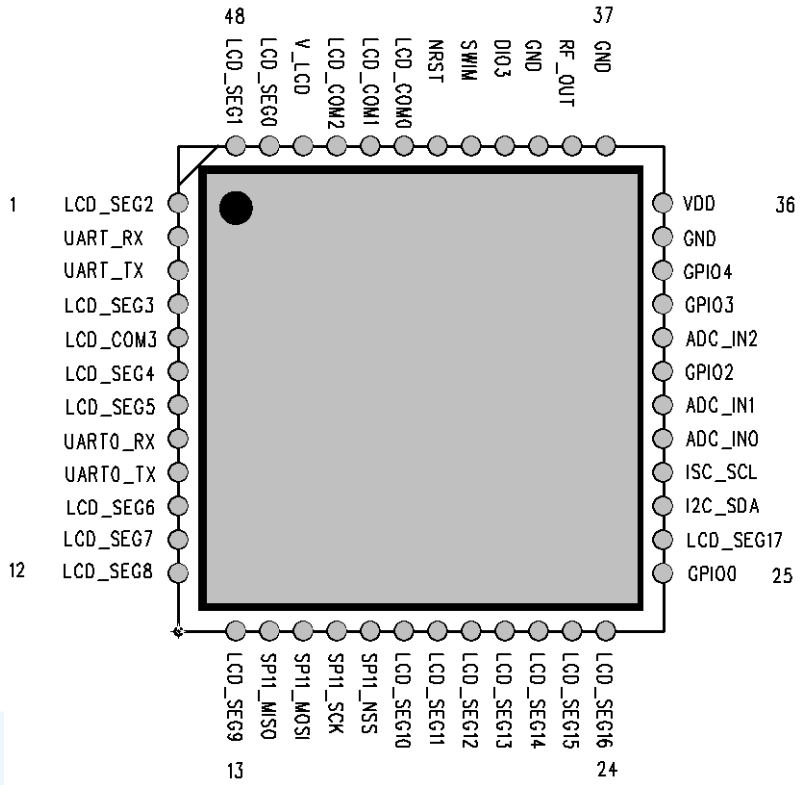


Figure 3. Pin Diagram of RF-AL42UHB2

## 2.3 Pin Functions

Table 2. Pin Diagram of RF-AL42UHB2

| Pin NO. | Pin Name | P/G/I/O | Description |
|---|---|---|---|
| 1 | LCD_SEG2 / GPIO | I/O | LCD Segment pin 2 |
| 2 | UART_RX / GPIO | I | UART RX pin, wake up UART |
| 3 | UART_TX / GPIO | O | UART TX pin, wake up UART. |
| 4 | LCD_SEG3 / GPIO | I/O | LCD Segment pin 3 |
| 5 | LCD_COM3 / GPIO | I/O | LCD Common pin 3 |
| 6 | LCD_SEG4 / GPIO | I/O | LCD Segment pin 4 |
| 7 | LCD_SEG5 / GPIO | I/O | LCD Segment pin 5 |
| 8 | UART0_RX / GPIO | I | UART0 RX pin, wake up UART |
| 9 | UART0_TX / GPIO | O | UART0 TX pin, wake up UART |
| 10 | LCD_SEG6 / GPIO | I/O | LCD Segment pin 6 |
| 11 | LCD_SEG7 / GPIO | I/O | LCD Segment pin 7 |

| | | | |
|---|---|---|---|
| 12 | LCD_SEG8 / GPIO | I/O | LCD Segment pin 8 |
| 13 | LCD_SEG9 / GPIO | I/O | LCD Segment pin 9 |
| 14 | SPI1_MISO / GPIO | O | SPI slave output, can be external SPI |
| 15 | SPI1_MOSI / GPIO | I | SPI slave input, can be external SPI |
| 16 | SPI1_SCK / GPIO | I | SPI clock, can be external SPI |
| 17 | SPI1_NSS / GPIO | O | SPI slave select, can be external SPI |
| 18 | LCD_SEG10 / GPIO | I/O | LCD Segment pin 10 |
| 19 | LCD_SEG11 / GPIO | I/O | LCD Segment pin 11 |
| 20 | LCD_SEG12 / GPIO | I/O | LCD Segment pin 12 |
| 21 | LCD_SEG13 / GPIO | I/O | LCD Segment pin 13 |
| 22 | LCD_SEG14 / GPIO | I/O | LCD Segment pin 14 |
| 23 | LCD_SEG15 / GPIO | I/O | LCD Segment pin 15 |
| 24 | LCD_SEG16 / GPIO | I/O | LCD Segment pin 16 |
| 25 | GPIO0 | I/O | MCU GPIO |
| 26 | LCD_SEG17 / GPIO | I/O | LCD Segment pin 17 |
| 27 | I2C_SDA / GPIO | I/O | I2C SDA pin |
| 28 | I2C_SCL / GPIO | O | I2C SCL pin |
| 29 | ADC_IN0 / GPIO | I | ADC input pin0 |
| 30 | ADC_IN1 / GPIO | I | ADC input pin1 |
| 31 | GPIO2 | I | MCU GPIO |
| 32 | ADC_IN2 / GPIO | I/O | ADC input pin2 |
| 33 | GPIO3 | I/O | MCU GPIO |
| 34 | GPIO4 | I/O | MCU GPIO |
| 35 | GND | G | Ground |
| 36 | VDD | P | Supply for the LoRa Radio (1.8 V ~ 3.6 V) |
| 37 | GND | G | Ground |
| 38 | RF_OUT | O | RF transmitter output |
| 39 | GND | G | Ground |
| 40 | DIO3 | I/O | Multipurpose digital I/O-external TCXO32M supply voltage |
| 41 | SWIM | I/O | SWIM download pin |
| 42 | NRST | I/O | External reset pin |
| 43 | LCD_COM0 / GPIO | I/O | LCD Common pin 0 |

| | | | |
|---|---|---|---|
| 44 | LCD_COM1 / GPIO | I/O | LCD Common pin 1 |
| 45 | LCD_COM2 / GPIO | I/O | LCD Common pin 2 |
| 46 | V_LCD | I | VLCD voltage input |
| 47 | LCD_SEG0 / GPIO | I/O | LCD Segment pin 0 |
| 48 | LCD_SEG1 / GPIO | I/O | LCD Segment pin 1 |

# 3 Electrical Characteristics

Electrical Characteristics include Absolute Maximum Ratings for the Chipset and Module, Recommended Operating Range and Power Consumption Characteristics. All the data are tested under demo board with fully matching and harmonic filtering networks.

## 3.1 Recommended Operating Range

Table 3. Table of Recommended Operating Range

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| VDD | Supply Voltage | 1.8 | 3.3 | 3.6 | V |
| Pin | RF Input Power | | | +10 | dBm |

## 3.2 Power Consumption Characteristics

Table 4. Table of Power Consumption Characteristics

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| IDD_SL | Supply current in Sleep mode | Without RF Config Retention, without RTC | 1 | | μA |
| | | Without RF Config Retention, with RTC | 1.6 | | μA |
| | | With RF Config Retention and RTC | 2 | | μA |
| IDD_RX | Supply current in Receiver mode | | 9 | | mA |
| IDD_RX | Supply current in Receiver mode | | 9 | | mA |
| IDD_TX | Supply current in Transmitter mode | Pout = +22 dBm | 108 | | mA |
| | | Pout = +22 dBm (TX OPT) | 85 | | mA |
| | | Pout = +21 dBm | 106 | | mA |
| | | Pout = +20 dBm | 98 | | mA |
| | | Pout = +17 dBm | 90 | | mA |
| | | Pout = +17 dBm (TX OPT) | 50 | | mA |
| | | Pout = +14 dBm | 78 | | mA |
| | | Pout = +14 dBm (TX OPT) | 40 | | mA |
| | | Pout = +10 dBm | 59 | | mA |
| | | Pout = +5 dBm | 47 | | mA |

## 3.3 RF Characteristics

The table 6,7 gives the electrical specifications for the LoRa RF transceiver operating with LoRa modulation. Following

conditions apply unless otherwise specified:

- Supply Voltage = 3.3 V
- Temperature = 25 ℃.
- Frequency bands: 470 MHz.
- Bandwidth (BW) = 125 kHz.
- Spreading Factor (SF) = 12.
- Coding Rate (CR) = 4/6.
- Package Error Rate (PER) = 1%.
- CRC on payload enabled.
- Payload length = 10 bytes.
- Preamble Length = 12 symbols.
- With matched impedances.

Table 5. Table of Transceiver RF Parameters

| Items | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Frequency Range | | 410 | 433 | 525 | MHz |
| Tx Power | RFO Pin | 18 | 21 | 22 | dBm |

Table 6. Table of Receiver RF Parameters

| Items | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Frequency Range | | 410 | 433 | 525 | MHz |
| Sensitivity | 125 kHz Bandwidth, SF=7 | | -126 | | dBm |
| | 125 kHz Bandwidth, SF=10 | | -135 | | dBm |
| | 125 kHz Bandwidth, SF=12 | | -140 | | dBm |
| $2^{nd}$ order harmonic | Tx Power = 20 dBm | | -41 | | dBm |

### 3.4 DC Characteristics (Reference chip)

Table 7. Table of DC Characteristics

| Symbol | Description | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| VIH | I/O input high level | | 0.7xVDD | | | V |
| VIL | I/O input low level | | | | 0.3xVDD | V |
| RPU | Weak pull up resistor | Vin=GND | 30 | 45 | 60 | KΩ |
| RPD | Weak pull down resistor | Vin=VDD | 30 | 45 | 60 | KΩ |

# 4 Application, Implementation, and Layout

## 4.1 Module Photos

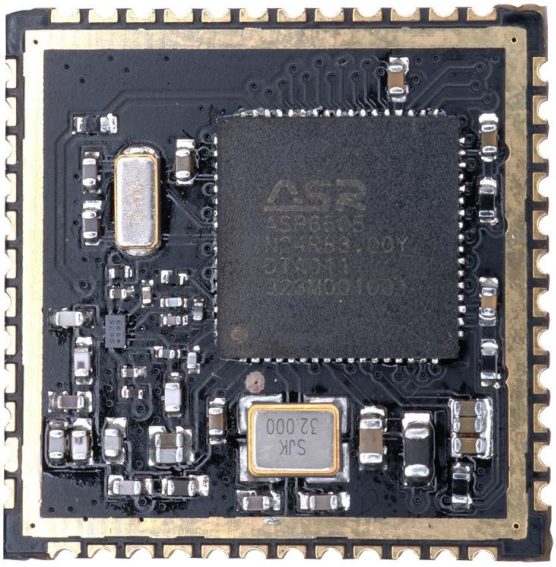

Figure 4. Photos of RF-AL42UHB2

## 4.2 Recommended PCB Footprint

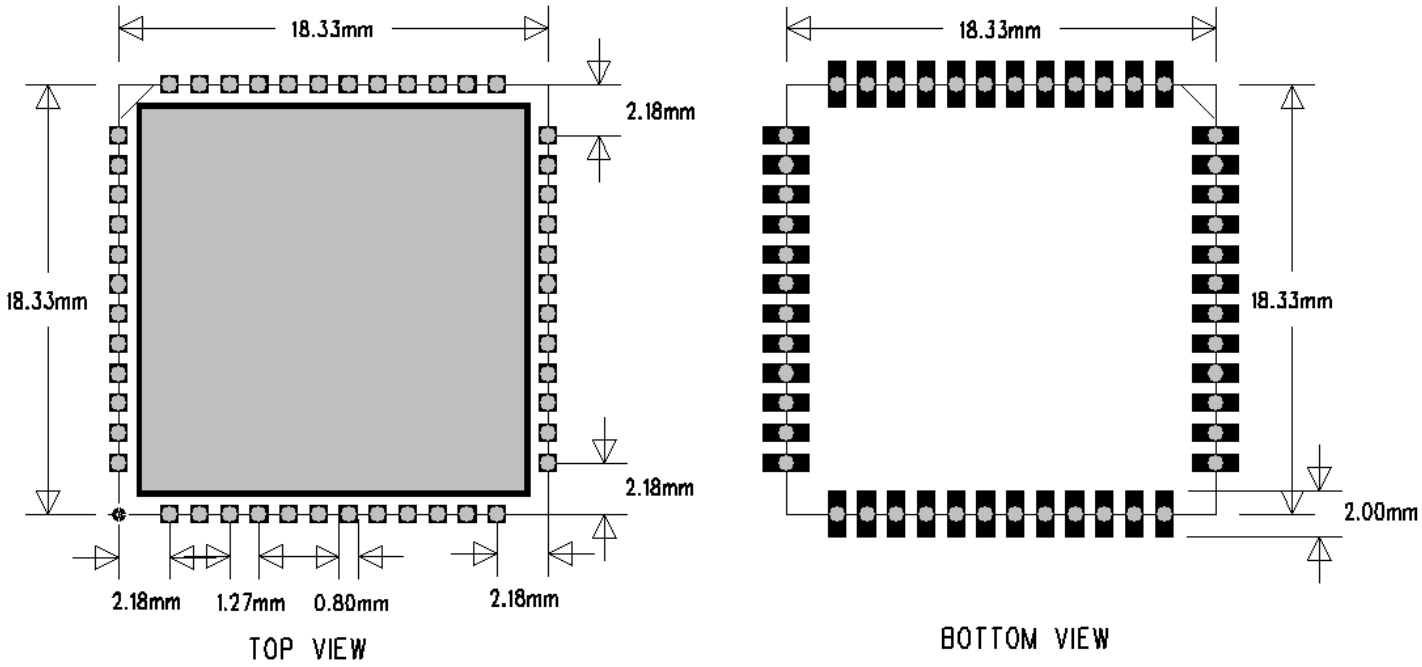


Figure 5. Recommended PCB Footprint of RF-AL42UHB2 (mm)

### 4.3 Basic Operation of Hardware Design

1. It is recommended to offer the module with a DC stabilized power supply, a tiny power supply ripple coefficient and the reliable ground. Please pay attention to the correct connection between the positive and negative poles of the power supply. Otherwise, the reverse connection may cause permanent damage to the module;
2. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure the stable power supply and no frequently fluctµAted voltage.
3. When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the margin, which is beneficial to the long-term stable operation of the whole machine. The module should be far away from the power electromagnetic, transformer, high-frequency wiring and other parts with large electromagnetic interference.
4. The bottom of module should avoid high-frequency digital routing, high-frequency analog routing and power routing. If it has to route the wire on the bottom of module, for example, it is assumed that the module is soldered to the Top Layer, the copper must be spread on the connection part of the top layer and the module, and be close to the digital part of module and routed in the Bottom Layer (all copper is well grounded).
5. Assuming that the module is soldered or placed in the Top Layer, it is also wrong to randomly route the Bottom Layer or other layers, which will affect the spurs and receiving sensitivity of the module to some degrees;
6. Assuming that there are devices with large electromagnetic interference around the module, which will greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
7. Assuming that there are routings of large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power routings), which will also greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
8. It is recommended to stay away from the devices whose TTL protocol is the same 433 MHz physical layer, for example: USB 3.0;
9. The antenna installation structure has a great influence on the module performance. It is necessary to ensure the antenna is exposed and preferably vertically upward. When the module is installed inside of the case, a high-quality antenna extension wire can be used to extend the antenna to the outside of the case.
10. The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.

### 4.4 Trouble Shooting

#### 4.4.1 Unsatisfactory Transmission Distance

1. When there is a linear communication obstacle, the communication distance will be correspondingly weakened. Temperature, humidity, and co-channel interference will lead to an increase in communication packet loss rate. The performances of ground absorption and reflection of radio waves will be poor, when the module is tested close to the ground.

2. Seawater has a strong ability to absorb radio waves, so the test results by seaside are poor.
3. The signal attenuation will be very obvious, if there is a metal near the antenna or the module is placed inside of the metal shell.
4. The incorrect power register set or the high data rate in an open air may shorten the communication distance. The higher the data rate, the closer the distance.
5. The low voltage of the power supply is lower than the recommended value at ambient temperature, and the lower the voltage, the smaller the power is.
6. The unmatchable antennas and module or the poor quality of antenna will affect the communication distance.

### 4.4.2 Vulnerable Module

1. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure the stable power supply and no frequently fluctuated voltage.
2. Please ensure the anti-static installation and the electrostatic sensitivity of high-frequency devices.
3. Due to some humidity sensitive components, please ensure the suitable humidity during installation and application. If there is no special demand, it is not recommended to use at too high or too low temperature.

### 4.4.3 High Bit Error Rate

1. There are co-channel signal interferences nearby. It is recommended to be away from the interference sources or modify the frequency and channel to avoid interferences.
2. The clock waveform on SPI is not standard. Check whether there is interference on the SPI line. The SPI bus line should not be too long.
3. The unsatisfactory power supply may also cause garbled. It is necessary to ensure the power supply reliability.
4. If the extension wire or feeder wire is of poor quality or too long, the bit error rate will be high.

## 4.5 Electrostatics Discharge Warnings

The module will be damaged for the discharge of static. RF-star suggest that all modules should follow the 3 precautions below:

1. According to the anti-static measures, bare hands are not allowed to touch modules.
2. Modules must be placed in anti- static areas.
3. Take the anti-static circuitry (when inputting HV or VHF) into consideration in product design.
   Static may result in the degradation in performance of module, even causing the failure.

## 4.6 Soldering and Reflow Condition

1. Heating method: Conventional Convection or IR/convection.
2. Solder paste composition: Sn96.5 / Ag3.0 / Cu0.5

3. Allowable reflow soldering times: 2 times based on the following reflow soldering profile.
4. Temperature profile: Reflow soldering shall be done according to the following temperature profile.
5. Peak temperature: 245 ℃.

Table 8. Temperature Table of Soldering and Reflow

| Profile Feature | Sn-Pb Assembly | Pb-Free Assembly |
|---|---|---|
| **Solder Paste** | Sn63 / Pb37 | Sn96.5 / Ag3.0 / Cu0.5 |
| **Min. Preheating Temperature ($T_{min}$)** | 100 ℃ | 150 ℃ |
| **Max. Preheating Temperature ($T_{max}$)** | 150 ℃ | 200 ℃ |
| **Preheating Time ($T_{min}$ to $T_{max}$) ($t_1$)** | 60 s ~ 120 s | 60 s ~ 120 s |
| **Average Ascend Rate ($T_{max}$ to $T_P$)** | Max. 3 ℃/s | Max. 3 ℃/s |
| **Liquid Temperature ($T_L$)** | 183 ℃ | 217 ℃ |
| **Time above Liquidus ($t_L$)** | 60 s ~ 90 s | 30 s ~ 90 s |
| **Peak Temperature ($T_P$)** | 220 ℃ ~ 235 ℃ | 230 ℃ ~ 250 ℃ |
| **Average Descend Rate ($T_P$ to $T_{max}$)** | Max. 6 ℃/s | Max. 6 ℃/s |
| **Time from 25 ℃ to Peak Temperature ($t_2$)** | Max. 6 minutes | Max. 8 minutes |
| **Time of Soldering Zone ($t_P$)** | 20±10 s | 20±10 s |

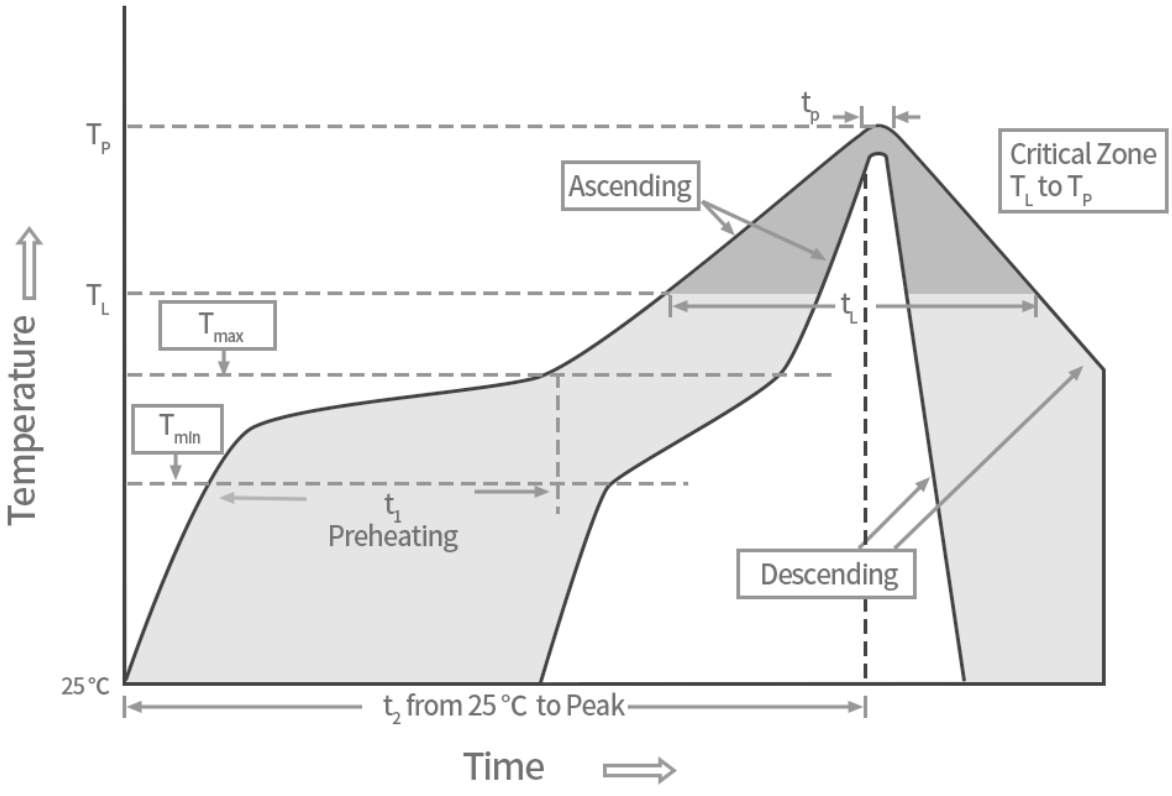


Figure 6. Recommended Reflow for Lead Free Solder

### 4.7 Optional Packaging


Figure 7. Optional Packaging Mode

Note: Default tray packaging.

## 5 Revision History

| Date | Version No. | Description | Author |
|---|---|---|---|
| **2019.09.03** | V1.0 | The initial version is released. | Aroo Wang |
| **2020.01.19** | V1.0 | Add LoRa module list. | Sunny Li |

Note:

1. The document will be optimized and updated from time to time. Before using this document, please make sure it is the latest version.
2. To obtain the latest document, please download it from the official website: www.szrfstar.com.

## 6 Contact Us

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