

# RAK3172-SiP WisDuo LPWAN SiP Datasheet

## Overview

### Description

RAK3172-SiP (and the RAK3172LP-SiP variant) are low-power, long-range transceivers based on the STM32WLE5JC SoC in a system-in-package form factor. These two modules use different RF output paths to optimize current consumption depending on the application. RAK3172-SiP uses RFO\_HP, while RAK3172LP-SiP uses the RFO\_LP of the STM32WL SoC transceiver.

WisDuo SiP LoRa modules provide a small, easy-to-use, low-power solution for long-range wireless data applications. These modules comply with Classes A, B, and C of the LoRaWAN 1.0.3 specifications. They can easily connect to different LoRaWAN server platforms such as TheThingsNetwork (TTN), Helium, ChirpStack, and Actility. They also support LoRa point-to-point (P2P) communication mode, which facilitates the quick implementation of customized long-range LoRa networks.

You can configure the mode and operation of the RAK3172-SiP/RAK3172LP-SiP using AT commands via a UART interface or create custom firmware using the RUI3 API. The RAK3172-SiP/RAK3172LP-SiP are very small and offer low-power features suitable for battery-powered applications.

#### WARNING

The RAK3172-SiP does not have pre-flashed LoRaWAN credentials and you have to define and setup your own unique credentials for the SiP's.

## Features

- Based on **STM32WLE5JC**
- Two variants available
  - RAK3172-SiP (uses RFO\_HP)
  - RAK3172LP-SiP (uses RFO\_LP)
- System-in-Package form factor
- RUI3 API compatible
- **LoRaWAN 1.0.3** specification compliant
- **Supported bands:** IN865, EU868, AU915, US915, KR920, RU864, and AS923
- LoRaWAN Activation by OTAA/ABP
- LoRa Point-to-Point (P2P) communication
- Custom firmware using Arduino via RUI3 API
- Easy-to-use AT Command set via UART interface
- Long-range - up to 15 km with optimized antenna
- ARM Cortex-M4 32-bit
- 256 kbytes flash memory with ECC
- 64 kbytes RAM
- Ultra-low power consumption of 1.69 µA in sleep mode
- **Supply voltage:** 2.0 V ~ 3.6 V
- **Temperature range:** -40° C ~ 85° C
- **Size:** 12 mm x 12 mm x 1.22 mm
- **Package:** LGA73 type

## Specifications

This section covers the hardware and software specifications for the RAK3172-SiP. It also includes a block diagram and an updated firmware link for the RAK3172-SiP WisDuo Module.

## Overview

### Block Diagram

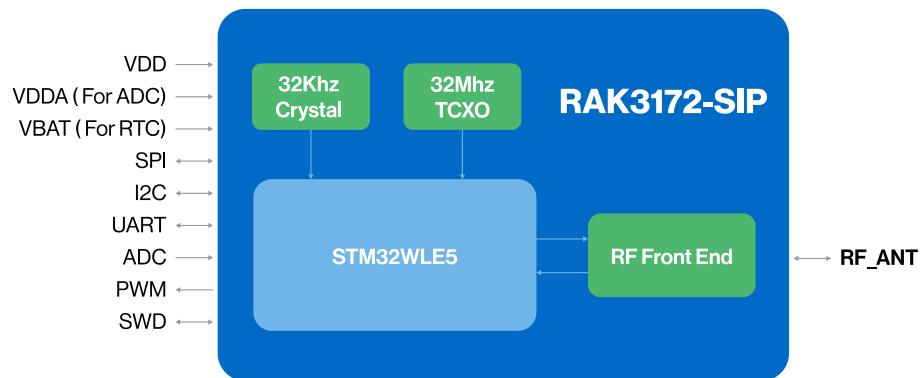


Figure 1: RAK3172-SiP system block diagram

## Hardware

The hardware specification is categorized into six parts. It discusses the interfacing, pinouts, and their corresponding functions and diagrams. It also covers the RF, electrical, mechanical, and environmental parameters, including tabular data of the functionalities and standard values of the RAK3172-SiP WisDuo LPWAN SiP module.

### NOTE

For the reference application schematic of RAK3172-SiP with minimum components requirements, refer to the [RAK3172-SiP Breakout Board Datasheet](#).

## Interfaces

Module	Interfaces
RAK3172-SiP	UART2 (Default for AT Command), UART1
RAK3172LP-SiP	UART2 (Default for AT Command), UART1

## Pin Definition

You can check the pin definitions on the table and illustration, as shown in **Figure 2**.

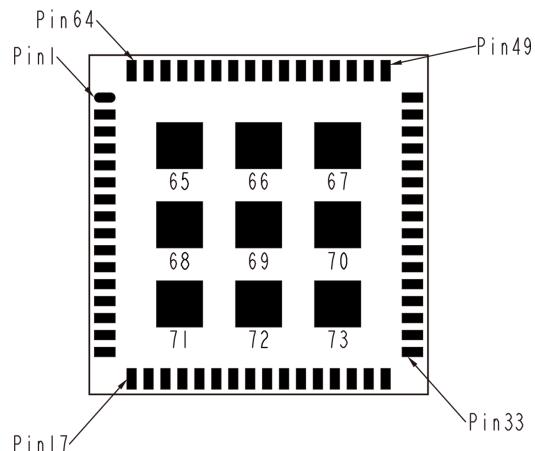


Figure 2: RAK3172-SiP top view pin diagram

**⚠ WARNING**

When using the **RF\_OUT** pin for an antenna and not the IPEX connector variant, design considerations are necessary to ensure optimum RF performance.

- The RF trace must be away from sources of interference (switching nodes of DC-DC supplies, high-current/high-voltage pulses from controllers of inductive loads like motors, signal generators, etc.).
- The RF trace must have 50-ohm impedance. Using impedance simulation software is advisable to achieve this.
- If using an external antenna connector, position it close to the **RF\_OUT** pin.
- Ground plane optimization is critical for certain antenna types, such as monopoles.
- The GND trace used for the RF return path must be directly connected to the GND plane and not treated as a thermal relief.
- It is recommended to route the RF trace in a curve, rather than with sharp 90-degree angles.

In addition, with a commitment to making IoT easy, RAK offers a dedicated service for [Antenna RF Design](#) which includes PCB design, tuning, matching, and RF testing.

Pin No.	Name	Type	Description
1	PA13	I	Reserved - SWD debug pin (SWDIO)
2	PA14	O	Reserved - SWD debug pin (SWCLK)
3	VDD		VDD
4	VBAT		VDD (For RTC)
5	PC13	I/O	GPIO
6	VREF+		Input reference voltage for ADC
7	VDDA		External power supply for the analog sections (ADC Converter)
8	PA15	I/O	GPIO or PIN_A4
9	PB15	I/O	GPIO
10	VFBMPS		DC-DC switching power feedback
11	VDDMPS		DC-DC switching power input
12	GND		Ground
13	VLXSMPS		DC-DC switching output
14	PB3	I/O	GPIO or PIN_A0
15	PB4	I/O	GPIO or PIN_A1
16	PB5	I/O	GPIO
17	PB6/UART1_TX	I/O	GPIO or UART1_TX
18	PB7/UART1_RX	I/O	GPIO or UART1_RX
19	PB8	I/O	GPIO
20	PB9	I/O	GPIO
21	PC0	I/O	GPIO

Pin No.	Name	Type	Description
22	PC1	I/O	GPIO
23	PC2	I/O	GPIO
24	PC3	I/O	GPIO
25	PC4	I/O	GPIO
26	PC5	I/O	GPIO
27	PC6	I/O	GPIO
28	GND		Ground
29	PA2/UART2_TX	O	Reserved - UART2/LPUART1 Interface (AT Commands and FW Update)
30	PA3/UART2_RX	I	Reserved - UART2/LPUART1 Interface (AT Commands and FW Update)
31	PA4	I/O	GPIO or SPI1 (SPI1_CS)
32	PA5	I/O	GPIO or SPI1 (SPI1_CLK)
33	PA6	I/O	GPIO or SPI1 (SPI1_MISO)
34	PA7	I/O	GPIO or SPI1 (SPI1_MOSI)
35	GND		Ground
36	GND		Ground
37	RF_OUT	O	RF Output
38	GND		Ground
39	GND		Ground
40	NC		Not connected
41	NC		Not connected
42	NC		Not connected
43	BOOT 0	I	Boot Mode Select pin (Activates STM32WL UART Bootloader when HIGH)
44	NRST	I	MCU Reset (NRST)
45	NC		Not connected
46	GND		Ground
47	GND		Ground
48	PB11	I/O	GPIO
49	PB10	I/O	GPIO
50	PA9	I/O	GPIO or I2C_SCL

Pin No.	Name	Type	Description
51	PA8	I/O	GPIO
52	GND		Ground
53	VDDPA		RF PA power input
54	VDDRF		RF Segment power input
55	VDD		VDD
56	GND		Ground
57	PB1	I/O	GPIO
58	PB2	I/O	GPIO or PIN_A2
59	PB12	I/O	GPIO
60	PB13	I/O	GPIO
61	PB14	I/O	GPIO
62	PA10	I/O	GPIO or PIN_A3 or I2C_SDA
63	PA11	I/O	GPIO
64	PA12	I/O	GPIO
65-73	GND		Ground

#### RF Characteristics

The RAK3172-SiP supports the frequency of operation from 863 to 930 Mhz.

#### Operating Frequencies

Region	Frequency
Europe	EU868
North America	US915
Australia	AU915
Korea	KR920
Asia	AS923-1/2/3/4
India	IN865
Russia	RU864

#### Electrical Characteristics

#### Absolute Maximum Ratings

Parameter	Minimum	Typical	Maximum	Unit
VDD and GPIO	-0.3 V	-	3.9	Volts (V)

#### Operating Voltage

Parameter	Minimum	Typical	Maximum	Unit
VCC	1.8	-	3.6	Volts (V)
VDDA (ADC or COMP used)	1.71	-	3.6	Volts (V)
VDDA (VREFBUF used)	2.4	-	3.6	Volts (V)
VDDA (ADC, COMP, or VREFBUF not used)	0	-	3.6	Volts (V)
VBAT	1.55	-	3.6	Volts (V)
VDDSMPS	1.8	-	3.6	Volts (V)
VDDRF	1.8	-	3.6	Volts (V)
VDDPA	1.8	-	3.6	Volts (V)
VREF+	2.0	-	VDDA	Volts (V)
VREF+ (VDDA < 2 V)	VDDA	-	VDDA	Volts (V)

#### Operating Current

##### RAK3172-SiP (uses RFO\_HP RF output)

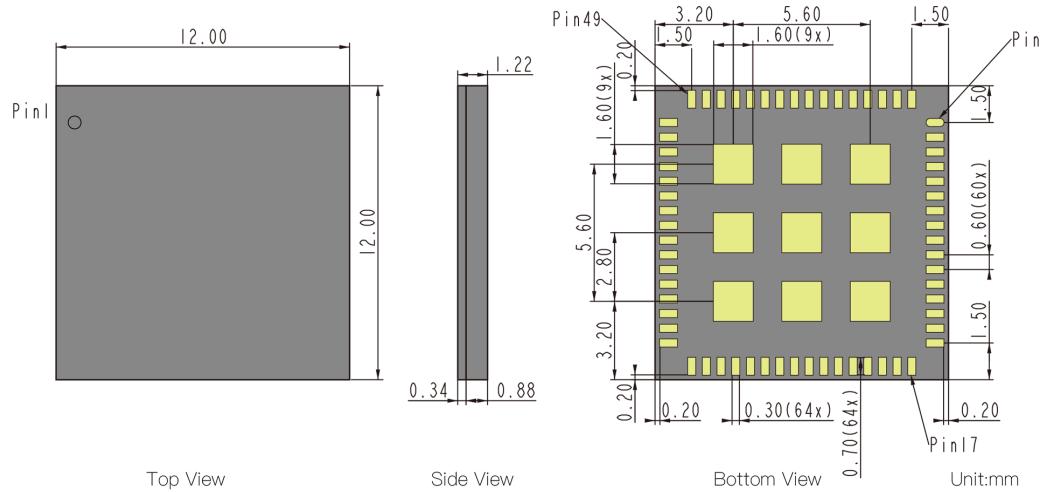
Parameter	Condition	Current Consumption (Typical)
TX mode	20 dBm	87 mA
RX mode	-	6.14 mA
Sleep mode	-	1.69 uA

##### RAK3172LP-SiP (uses RFO\_LP RF output)

Parameter	Condition	Current Consumption (Typical)
TX mode	14 dBm	39.1 mA
	12 dBm	33 mA
	10 dBm	28 mA
	8 dBm	25 mA
RX mode	-	9.69 mA
Sleep mode	-	2.1 uA

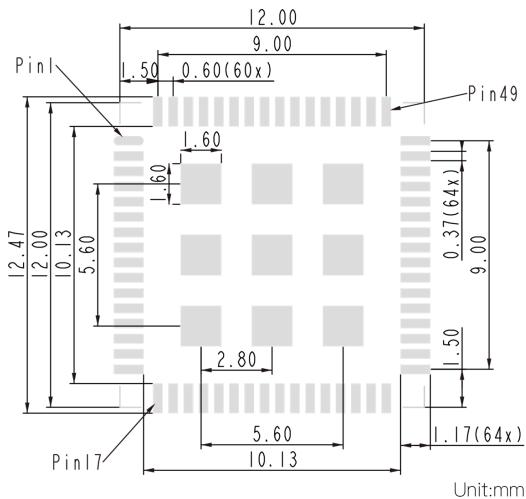
## Mechanical Characteristics

## Module Dimensions



**Figure 3:** RAK3172-SiP mechanical dimension

## Layout Recommendation



**Figure 4:** RAK3172-SiP layout

## **Environmental Characteristics**

## Operating Temperature

Feature	Minimum	Typical	Maximum	Unit
Operating Temperature	-40	25	85	°C

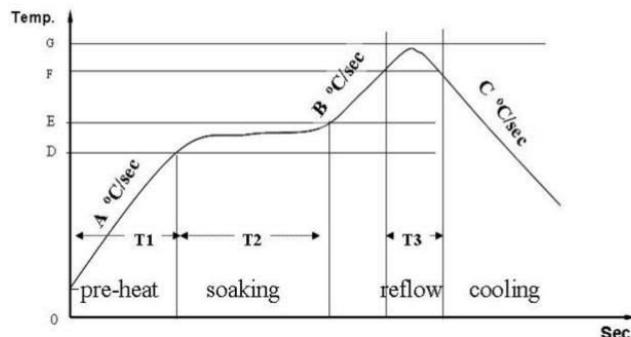
### **Storage Temperature**

Feature	Minimum	Typical	Maximum	Unit
Storage Temperature	-40	-	85	°C

## Recommended Reflow Profile

**⚠ WARNING**

- On SMT reflow process, follow MSL3 (Moisture Sensitivity Level 3) guidance for PCBA assembly.
- Before SMT reflow, it is recommended to bake at 125°C for 12 hours first to reduce the risk of soldering issues and abnormalities.



**Figure 5:** Reflow profile for RAK3172-SiP

Standard conditions for reflow soldering:

- Pre-heating Ramp (A) (Initial temperature: 150°C): **1~2.5° C/sec**
- Soaking Time (T2) (110~190°C): **90~120 sec**
- Peak Temperature (G): **240~245° C**
- Reflow Time (T3) (240~245°C): **50~70 sec**
- Ramp-up Rate (B): **1~3° C/sec**
- Ramp-down Rate (C): **1~5° C/sec**

## Software

Download the latest RAK3172-SiP WisDuo LPWAN SiP firmware provided below.

- The **bin file** contains the application code only and you need the RAK DFU Tool to upload this file to RAK3172-SiP via UART.
- The **hex file** contains both the bootloader and the application code. You need to [use STM32CubeProgrammer to upload](#) this.

RAK3172-SiP uses UART2 serial pins to upload the latest firmware.

## Firmware/OS

Download the latest RAK3172-SiP and RAK3172LP-SiP firmware provided below.

Model	Version	Source
RAK3172-SiP (.bin)	RUI3 (App only)	<a href="#">Download</a>
RAK3172-SiP (.hex)	RUI3 (Bootloader and App)	<a href="#">Download</a>
RAK3172LP-SiP (.bin)	RUI3 (App only)	<a href="#">Download</a>
RAK3172LP-SiP (.hex)	RUI3 (Bootloader and App)	<a href="#">Download</a>

## Models and Bundles

### Ordering Information

P/N	Model	Frequency	SKU
RAK3172-SIP-8-SM-NI	RAK3172-SiP	8XX MHz for RU864/IN865/EU868	305041
RAK3172-SIP-9-SM-NI	RAK3172-SiP	9XX MHz for US915/AU915/KR920/AS923	306039

## Certification



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### NOTE

For CE and FCC certifications we provide an AT command guide.

You can find it in our [RUI3 documentation](#) or get it from our [Download Center](#).