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RAK3112 WisDuo LPWAN+BLE+Wi-Fi Module Datasheet

Overview

Description

The RAK3112 is a low-power, long-range LoRaWAN module based on the Espressif ESP32-S3 MCU with an integrated Semtech SX1262 LoRa transceiver. Supporting LoRa, BLE, and Wi-Fi, this module is ideal for various IoT applications such as home automation, sensor networks, building automation, and other IoT network applications.

NOTE

There are two variants available for the RAK3112 Module:

1. With MHF4 IPEX connector to connect external antennas.
2. No IPEX connector but with RF pinout to connect custom antenna.

Features

- Based on **Espressif ESP32-S3**
 - Xtensa® 32-bit LX7 dual-core microprocessor
 - 16 MB Flash
 - 512 kB SRAM
 - 512 kB RAM
 - 8 MB PSRAM
 - 16 kB RTC SRAM
- LoRa transceiver **Semtech SX1262**
 - LoRa and LoRaWAN support
 - Frequency support from 863 MHz to 928 MHz
- **LoRaWAN 1.0.2** specification compliant (LoRaWAN **BasicModem** support in preparation)

- **Supported bands:** IN865, EU868, AU915, US915, KR920, RU864, and AS923-1/2/3/4
- LoRaWAN Activation by OTAA/ABP
- LoRa Point-to-Point (P2P) communication
- BLE 5.0 support
- Wi-Fi support
- Custom firmware using Arduino
- I/O ports: UART/I2C/SPI/ADC/GPIO
- Long-range: greater than 10 km with optimized antenna
- **Supply Voltage:** 3.0 V ~ 3.6 V
- **Temperature range:** -40° C ~ 65° C

Specifications

Overview

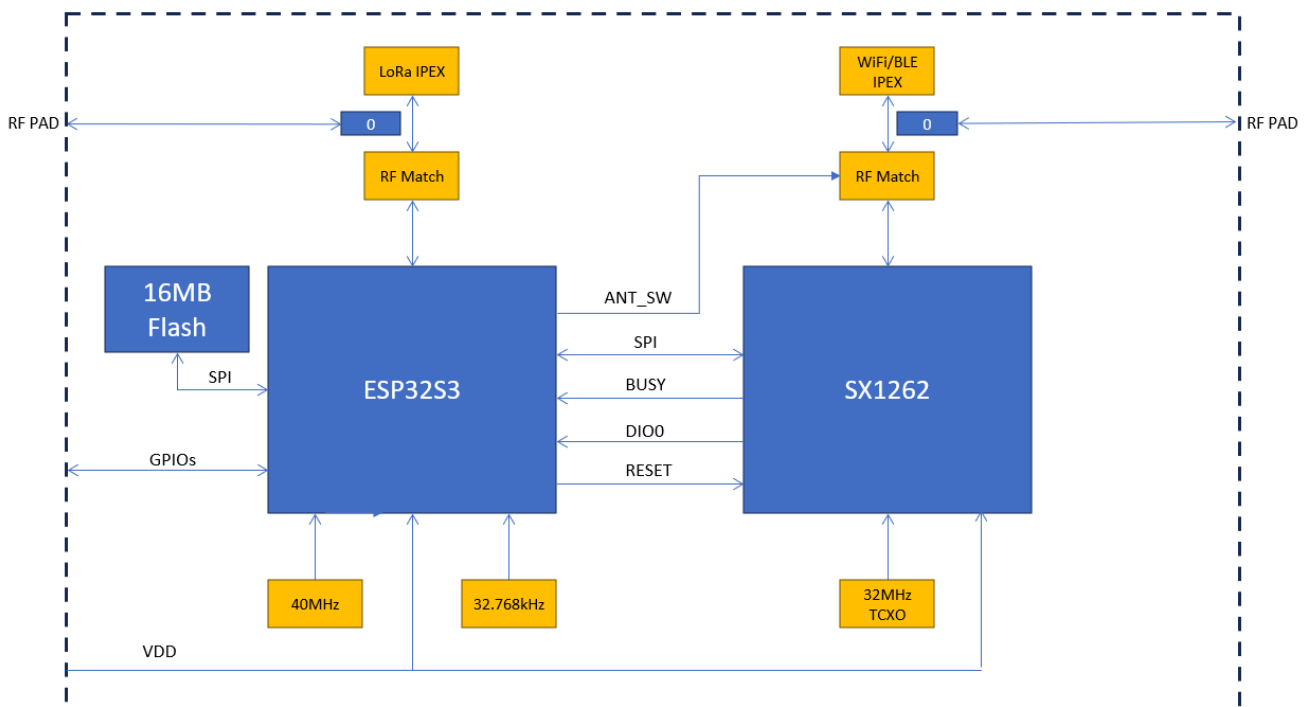


Figure 1: RAK3112 system block diagram

Hardware

The hardware specification is categorized into three parts: RF, electrical, and mechanical parameters. These include tabular data of the functionalities and standard values for the RAK3112 WisDuo LPWAN Module.

Interfaces

Interfaces
USB (Default for AT command and FW update)
2 x I2C
1 x UART
1 x SPI

Pin Definition

! INFO

- GPIO33 to GPIO37 are on the stamp modules pins, but with the 16 MB Flash chip, these GPIO's are not available.
- GPIO4 is used internally and not available.

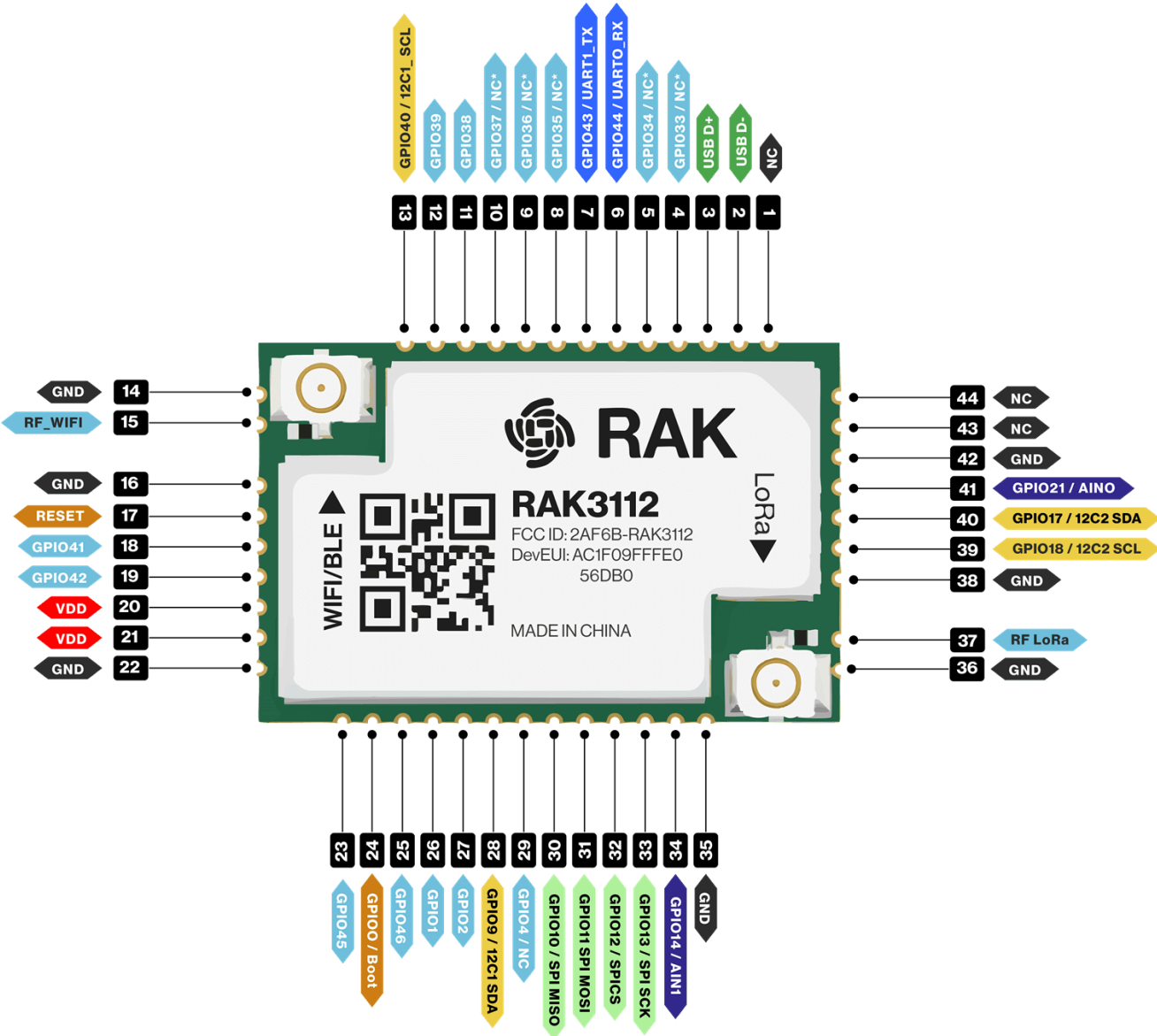


Figure 2: RAK3112 module pinout diagram

Pin No.	Name	Type	Description
1	NC	--	Not connected
2	USB_D-	USB	USB -
3	USB_D+	USB	USB +
4	GPIO33 / NC*	--	GPIO (not available with 16MB Flash)
5	GPIO34 / NC*	--	GPIO (not available with 16MB Flash)
6	GPIO44 / UART0_RX	I/O UART	GPIO / UART RX

Pin No.	Name	Type	Description
7	GPIO43 / UART1_TX	I/O UART	GPIO / UART TX
8	GPIO35 / NC*	--	GPIO (not available with 16MB Flash)
9	GPIO36 / NC*	--	GPIO (not available with 16MB Flash)
10	GPIO37 / NC*	--	GPIO (not available with 16MB Flash)
11	GPIO38	I/O	GPIO
12	GPIO39	I/O	GPIO
13	GPIO40 / I2C1_SCL	I/O I2C	GPIO / I2C SCL
14	GND	POWER	Ground connections
15	RF_WiFi	RF	Wi-Fi RF Port (only available on RAK3112 NO-IPEX connector variant)
16	GND	POWER	Ground connections
17	RESET	Reset	ESP32S3 Reset
18	GPIO41	I/O	GPIO
19	GPIO42	I/O	GPIO
20	VDD	POWER	VDD - Voltage Supply
21	VDD	POWER	VDD - Voltage Supply
22	GND	POWER	Ground connections
23	GPIO45	I/O	GPIO

Pin No.	Name	Type	Description
24	GPIO0 / Boot	I/O Boot	GPIO Bootloader force
25	GPIO46	I/O	GPIO
26	GPIO1	I/O	GPIO
27	GPIO2	I/O	GPIO
28	GPIO9 / I2C1_SDA	I/O I2C	GPIO / I2C SDA
29	GPIO4 / NC	I/O	GPIO (not available)
30	GPIO10 / SPI_MISO	I/O SPI	GPIO / SPI MISO
31	GPIO11 / SPI_MOSI	I/O SPI	GPIO / SPI MOSI
32	GPIO12 / SPI_CS	I/O SPI	GPIO / SPI CS
33	GPIO13 / SPI_SCK	I/O SPI	GPIO / SPI SCK
34	GPIO14 / AIN1	I/O Analog In	GPIO / Analog In
35	GND	POWER	Ground connections
36	GND	POWER	Ground connections
37	RF_LoRa	RF	LoRa RF Port (only available on RAK3112 NO-IPEX connector variant)
38	GND	POWER	Ground connections

Pin No.	Name	Type	Description
39	GPIO18 / I2C2_SCL	I/O I2C	GPIO / I2C SCL
40	GPIO17 / I2C2_SDA	I/O I2C	GPIO / I2C SDA
41	GPIO21 / AIN0	I/O Analog In	GPIO / Analog In
42	GND	I/O	Ground connections
43	NC	--	Not connected
44	NC	--	Not connected

WARNING

When using `RF_LoRa`, `RF_WIFI` pins for antenna and not the IPEX connector variant, there are design considerations to make sure optimum RF performance.

- RF traces must be away from interference (switching nodes of DC-DC supplies, high-current/voltage pulses from controllers of inductive loads like motors, signal generators, etc.).
- RF traces must have 50 Ω impedance. It is advisable to use an impedance simulation software tool to achieve this requirement.
- If using an external antenna connector, place it close to the LoRa RF and BLE RF pins.
- Ground plane optimization is critical for certain antenna types like 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 that RF traces be routed in curves, not sharp 90 degree angles.

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

RF Characteristics

LoRa Transceiver

The RAK3112 module supports many LoRaWAN bands as shown in the table below.

Module	Region	Frequency
RAK3112 (H)	Europe	EU868
	North America	US915
	Australia	AU915
	Korea	KR920
	Asia	AS923-1/2/3/4
	India	IN865
	Russia	RU864

TX Power

Transmitter output power, programmable up to +22 dBm.

RX Sensitivity

- -124 dBm for LoRa (BW = 125 kHz, SF = 7)
- -121 dBm for LoRa (BW = 250 kHz, SF = 7)
- -137 dBm for LoRa (BW = 125 kHz, SF = 12)
- -134 dBm for LoRa (BW = 250 kHz, SF = 12)

Wi-Fi

Operating Frequencies

2412 ~ 2484 MHz

TX Power

Rate	Type (dBm)
802.11b, 1 Mbps	21.0
802.11b, 11 Mbps	21.0
802.11g, 6 Mbps	20.5
802.11g, 54 Mbps	19.0
802.11n, HT20, MCS0	19.5
802.11n, HT20, MCS7	19.0
802.11n, HT40, MCS0	19.5
802.11n, HT40, MCS7	18.0

RX Sensitivity

Rate	Type (dBm)
802.11b, 1 Mbps	-98.4
802.11b, 11 Mbps	-88.6
802.11g, 6 Mbps	-93.2
802.11g, 54 Mbps	-76.5
802.11n, HT20, MCS0	-92.6
802.11n, HT20, MCS7	-74.2
802.11n, HT40, MCS0	-90.0
802.11n, HT40, MCS7	-71.4

Bluetooth

Operating Frequencies

2402 ~ 2480 MHz

TX Power

Rate	Type (dBm)
BLE @1 Mbps	Programmable from -24 dBm to 20 dBm
BLE @2 Mbps	Programmable from -24 dBm to 20 dBm
BLE @125 Kbps	Programmable from -24 dBm to 20 dBm
BLE @500 Kbps	Programmable from -24 dBm to 20 dBm

RX Sensitivity

Rate	Type (dBm)
BLE @1 Mbps	-97.5
BLE @2 Mbps	-93.5
BLE @125 Kbps	-104.5
BLE @500 Kbps	-101

Electrical Characteristics

Operating Voltage

Feature	Minimum	Typical	Maximum	Unit
VDD	3.0	3.3	3.6	Volts (V)

Operating Current

The current consumption measurements are taken with a 3.3 V supply at 25° C of ambient temperature.

Work Mode	Condition	Peak current	Unit
Wi-Fi TX	802.11b, 1 Mbps, @21 dBm	340	mA
	802.11g, 54 Mbps, @19 dBm	291	mA
	802.11n, HT20, MCS7, @18.5 dBm	283	mA
	802.11n, HT40, MCS7, @18 dBm	286	mA
Wi-Fi RX	802.11b/g/n, HT20	88	mA
	802.11n, HT40	91	mA
Lora TX	+22 dBm@ 868 to 915Mhz	140	mA
	+20 dBm@ 868 to 915 Mhz	127.5	mA
	+17 dBm@ 868 to 915 Mhz	118	mA
	+14 dBm@ 868 to 915 Mhz	112	mA
Lora RX	LoRa 125 kHz	25.46	mA

Sleep Current

The current consumption measurements are taken with a 3.3 V supply at 25° C of ambient temperature.

Feature	Condition	Maximum	Unit
Light-sleep	VDD_SPI and Wi-Fi are powered down, and all GPIOs are high-impedance.	241	uA
Deep-sleep 1	RTC memory and RTC peripherals are powered up.	9	uA
Deep-sleep 2	RTC memory is powered up. RTC peripherals are powered down.	8	uA

Feature	Condition	Maximum	Unit
Power off	CHIP_PU is set to low level. The chip is shut down.	2	uA

Mechanical Characteristics

Module Dimensions

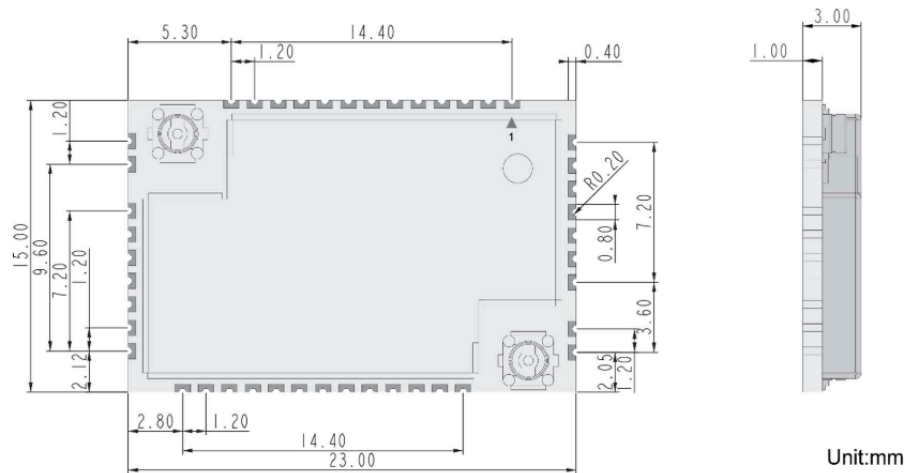


Figure 3: RAK3112 board dimension

Layout Recommendation

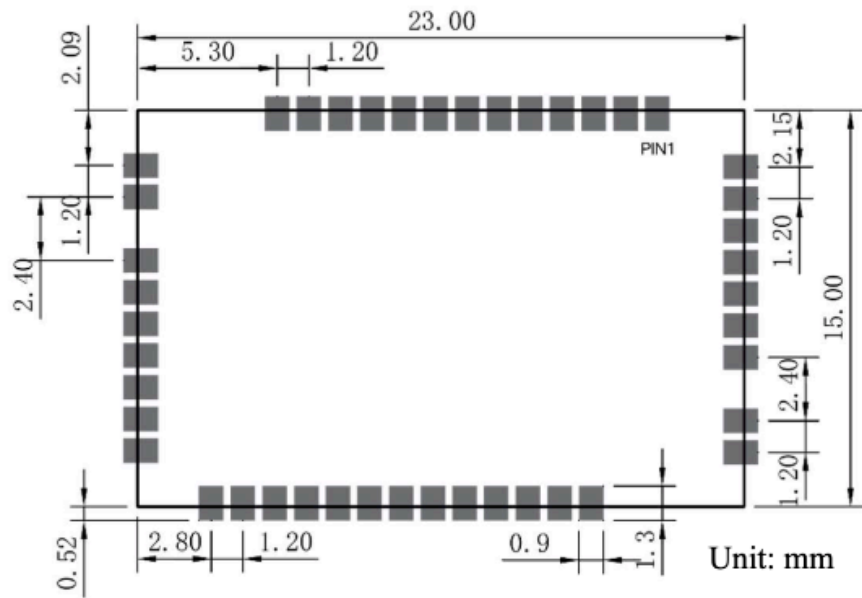


Figure 4: RAK3112 PCB footprint and recommendations

Environmental Characteristics

Operating Temperature

Feature	Minimum	Typical	Maximum	Unit
Operating Temperature	-40	25	65	° C

Storage Temperature

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

Recommended Reflow Profile

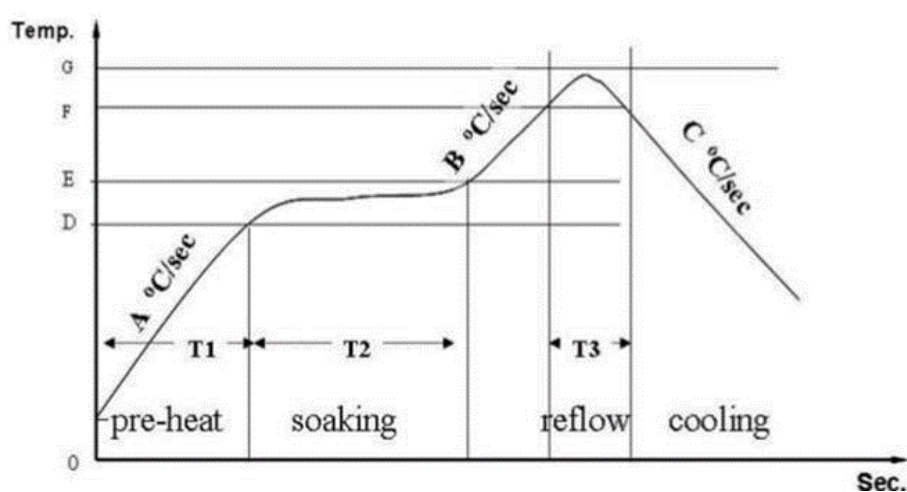


Figure 5: Reflow Profile for RAK3112

Standard conditions for reflow soldering:

- Pre-heating Ramp (A) (Initial temperature: 150° C): **1 ~ 2.5° C/sec**
- Soaking Time (T2) (150 ~ 180° C): **60 ~ 100 sec**
- Peak Temperature (G): **230 ~ 250° C**
- Reflow Time (T3) (> 220° C): **30 ~ 60 sec**
- Ramp-up Rate (B): **0 ~ 2.5° C/sec**
- Ramp-down Rate (C): **1 ~ 3° C/sec**

Schematic Diagram (Minimal)

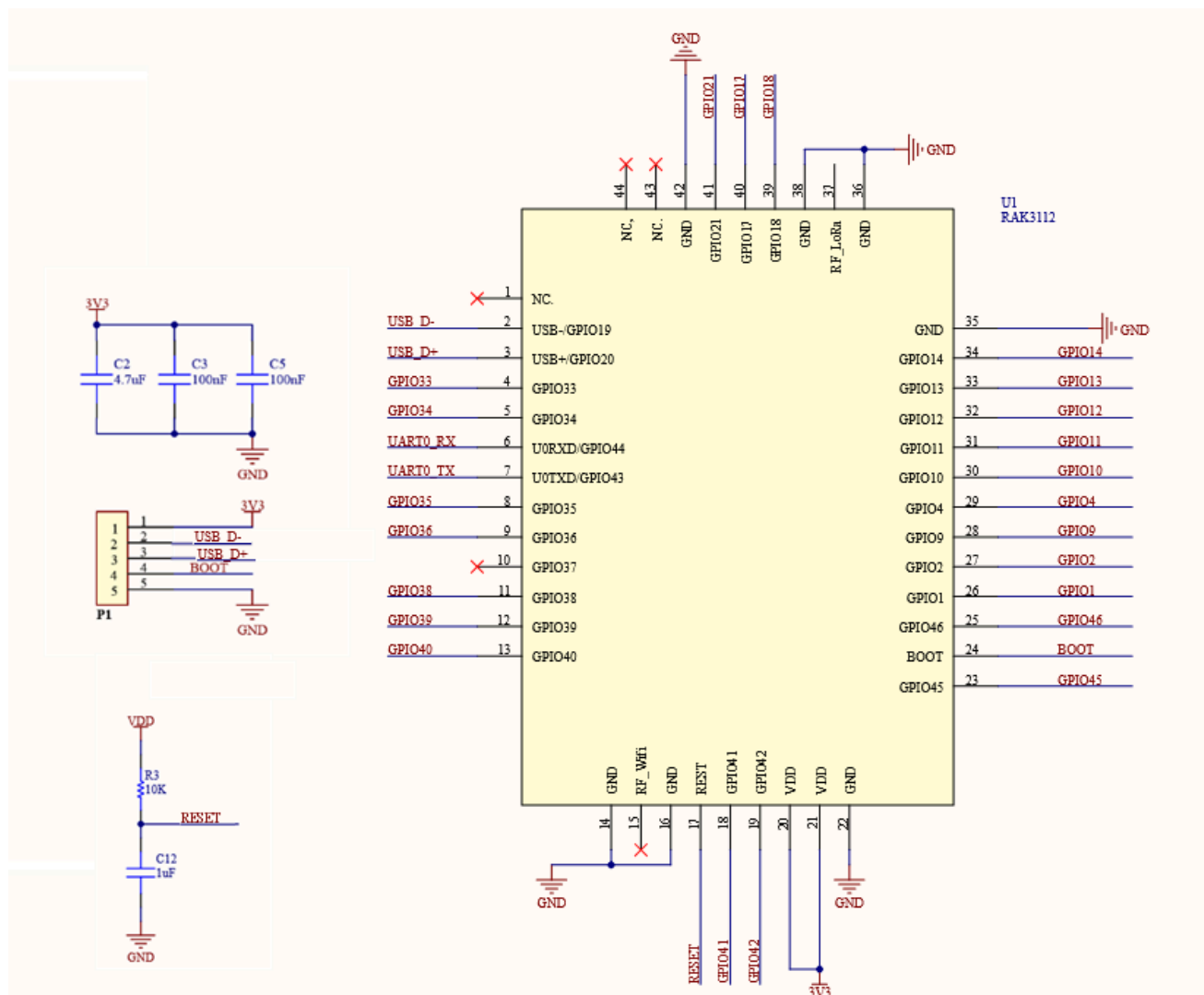


Figure 6: RAK3112 minimal schematic

Firmware

The RAK3112 does not come with default firmware. You have to develop your application based on the Arduino IDE, using the Espressif BSP. Examples of how to use LoRa, LoRaWAN, BLE, and WiFi are available in the [GitHub repo](#). A guide for firmware development can be found in the [RAK3112 Quick Start Guide](#).

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[Home](#)

[« Previous](#)



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