RAK5860 WisBlock NB-IoT Interface Module Datasheet

Overview

Description

The RAK5860 WisBlock Connect module is designed to be part of a production-ready IoT solution in a modular way and must be combined with a WisBlock Core and a Base module.

The RAK5860 is a module designed to work with the RAK5005-O baseboard and it provides wireless communication (LTE Cat M1, LTE Cat NB2) to the final application. This module supports the LTE-FDD network and supports half-duplex operation in the LTE network. It also provides optional GNSS functionality.

For debugging purposes, a Micro-USB connector is used for sending AT commands, data transmission, and receiving GNSS NMEA output. Once the module is integrated with the RAK5005-O baseboard, the internal UART port of the module is connected through the IO connector to a WisBlock Core module.

Features

- Quectel BG77 with LTE Cat M1, LTE cat NB2, and GNSS
- IPEX connectors for the LTE and GPS antenna
- Micro-USB connector
- Nano SIM and ESIM options
- Status Indication LEDs
- Power Supply: 2.6-4.2 V, typical supply voltage 3.3 V
- Module size: 25 mm x 35 mm

Specifications

Overview

The overview shows the realistic view of the RAK5860 module and its block diagram. It also covers the installation mechanism of the module into the baseboard.

Board Overview

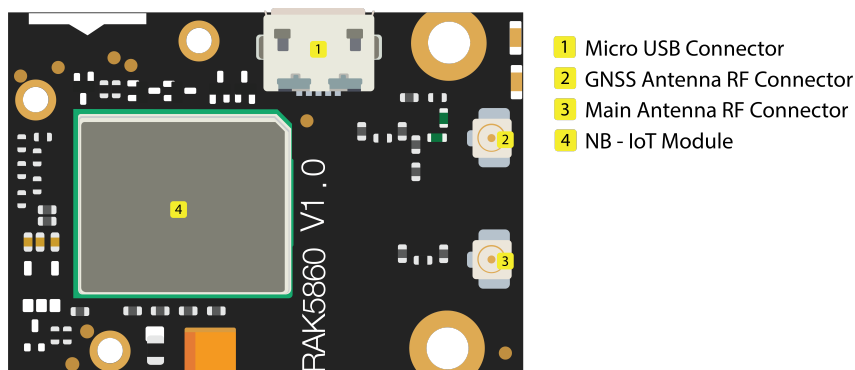Figures 1 and 2 shows a realistic view and main component description of the RAK5860 Module

1 Micro USB Connector
2 GNSS Antenna RF Connector
3 Main Antenna RF Connector
4 NB - IoT Module

Figure 1: RAK5860 Board Realistic View (Front)

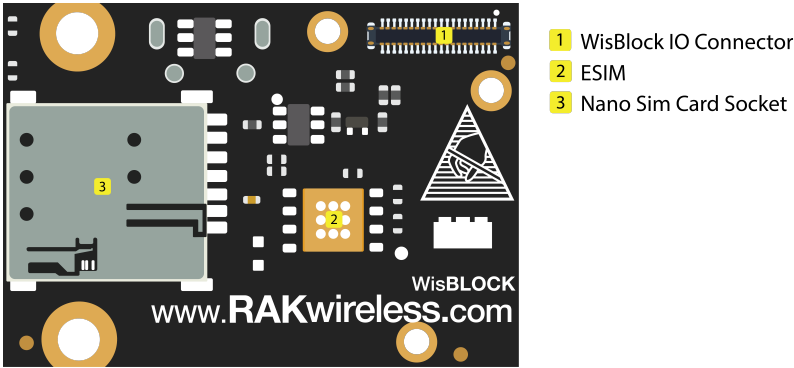1. WisBlock IO Connector
2. ESIM
3. Nano Sim Card Socket

Figure 2: RAK5860 Board Realistic View (Back)

Mounting Sketch

Figure 3 shows how RAK5860 module (a WisIO module) is integrated with the RAK5005 baseboard. The mounting sketch is shown.
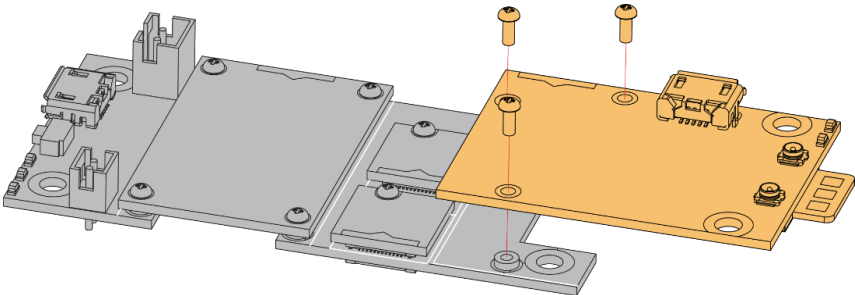

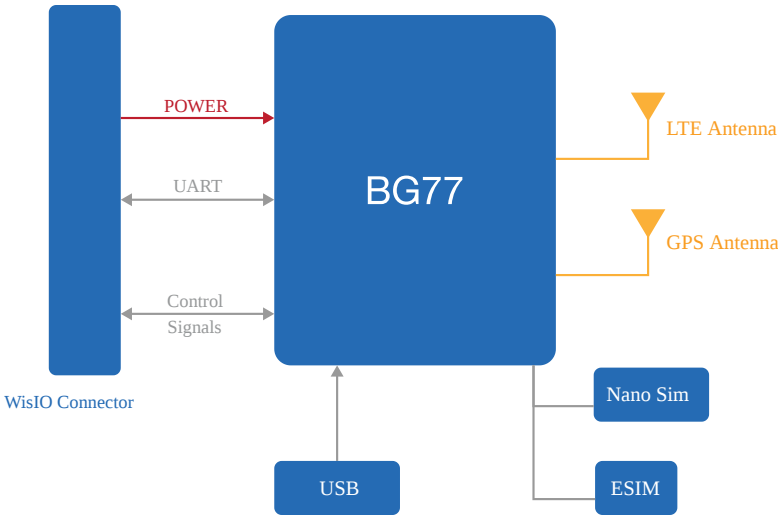**Figure 3:** Mounting Sketch

Block Diagram

Figure 4: RAK5860 Block Diagram

Hardware

The hardware specification of the RAK5860 is categorized into two. It covers the electrical standard ratings and the functionalities of the module. It also discusses the diagram of the module and its mechanism.

Electrical Characteristics

Absolute Maximum Ratings

Table below shows the absolute maximum ratings of the RAK5860 module.

Symbol	Description	Min.	Nom.	Max.	Unit
VBAT	Power Supply for the Module	-0.5		4.2	V
USB_VBUS	USB Connection Detection	1.3		1.8	V
Voltage at Digital Pins		-0.3		2.09	V

Recommended Operating Conditions

Table below shows the recommended operating conditions of the RAK5860 module.

Symbol	Description	Min.	Nom.	Max.	Unit
VBAT	Power Supply for the Module	2.6	3.3	4.2	V
USB_VBUS	USB Connection Detection	1.3		1.8	V
USBPHY_3P3	Power for USB PHY Circuit		3.3		V

Figure 5 shows the dimensions of the RAK5860 module.

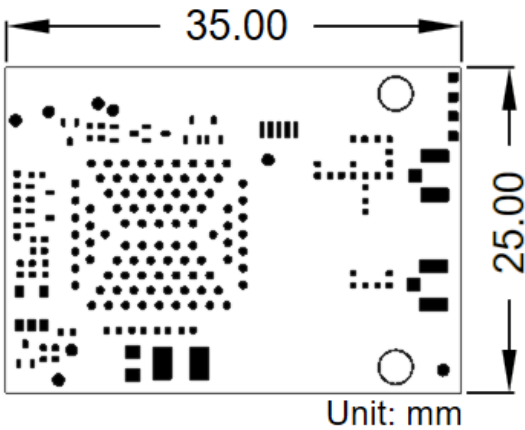# Mechanical Characteristics

Board Dimensions

Figure 5: Mechanical Dimensions
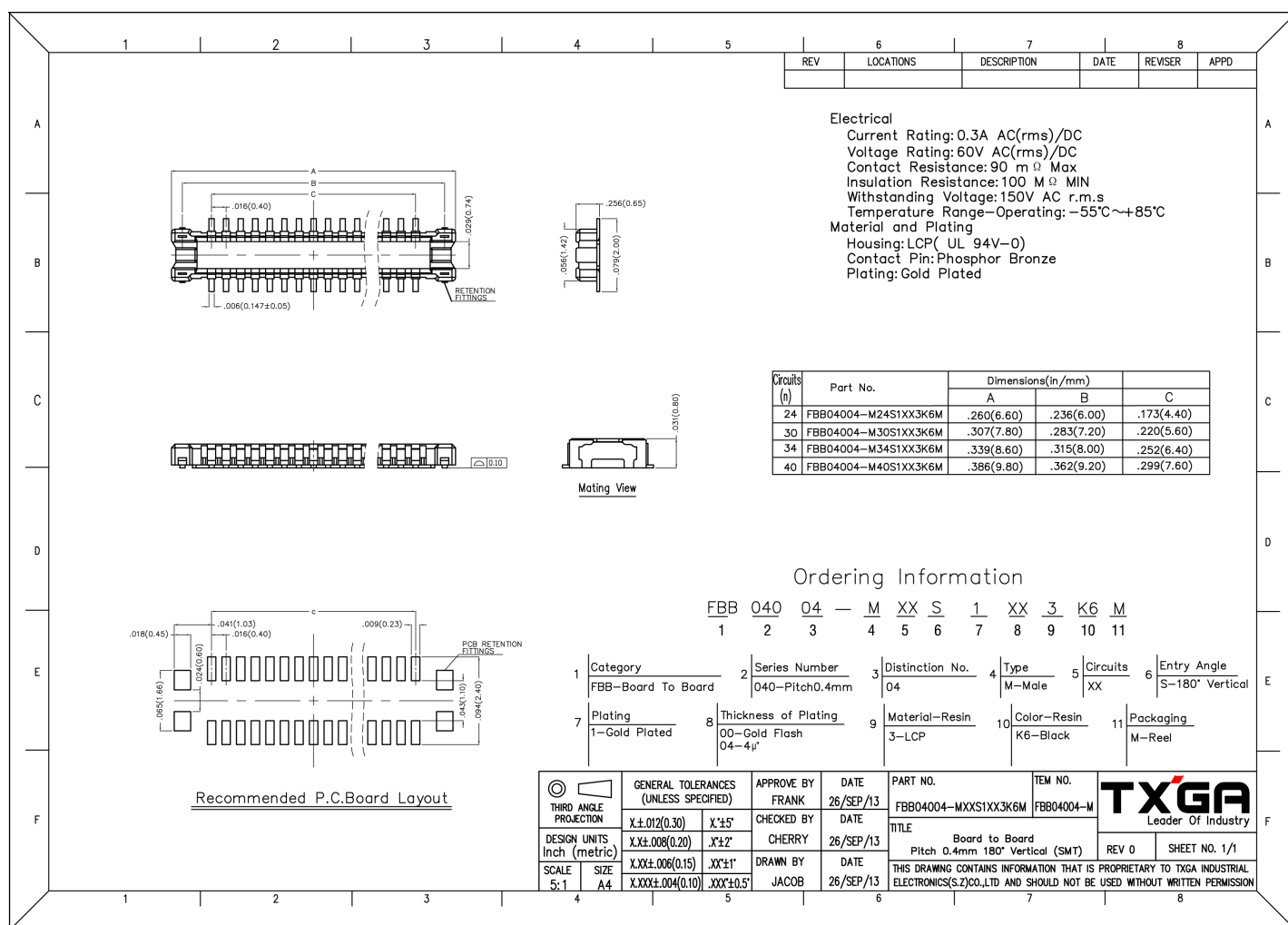
WisConnector PCB Layout

Figure 6: WisConnector PCB footprint and recommendations

Schematic Diagram

The following sections will describe the schematic of the RAK5860 module, which include:

- Turn on/off module
- IO Connector
- Voltage-level translator
- SIM card circuit
- USB Connector
- Status Indication LEDs
- Main Antenna
- GNSS Antenna

Turn On/Off Mechanism

Figure 7 shows a circuit to allow turn on or to turn off the module. By default, the internal Quectel BG77 module is in power off mode, it can be turned on by driving WIS_PWRKEY to high state (positive digital pulse) for a period of 500-1000 ms.

Driving WIS_PWRKEY high for 650-1500 ms, the module will execute power-down procedure after WIS_PWRKEY is released, then enter off mode.

Alternatively, you can send a command **AT+QPOWD** command turn off the internal Quectel BG77 module.

Figure 7: Turn On/Off Module Circuit

IO Connector

Figure 8 shows the definition of IO connector.

Figure 8: WisIO Connector Pin Definition

The RAK5860 only uses a subset of all the pins available in the IO connector. These are shown in the Table below:

Name	Description	Comment
VBAT	BG77 Power Supply	Max 4.2V
3v3_S	3.3V for GNSS Antenna	3V3_S is controlled by IO2 of WisBlock (P1.02 of NRF52840). This pin must be set HIGH in your code so that the active GPS antenna has power supply and will work.
3V3	3.3V For Voltage Level Transistor	
WIS_PWRKEY	Turn on/off BG77	Active High
WIS_TX	UART TXD	BG77 MAIN_RX, 1.8 V power domain
WIS_RX	UART RXD	BG77 MAIN_TX, 1.8 V power domain

IO Connector Pin Order

Figure 9 shows the IO connector's pin order. The connector is located in the bottom layer of the RAK5860 module.
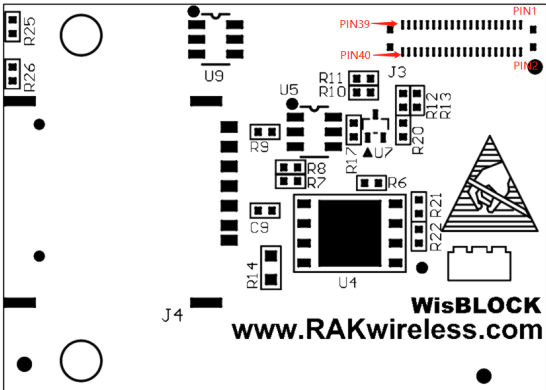
Figure 9: IO Connector Pin Order

Voltage-level Translator

Within the BG77, all interfaces are designed to work with 1.8 V level. RAK5860 features a voltage-level translator in order to down-convert the 3.3 V coming from the WisBlock Core module. Figure 10 shows the design of the internal voltage-level translator.
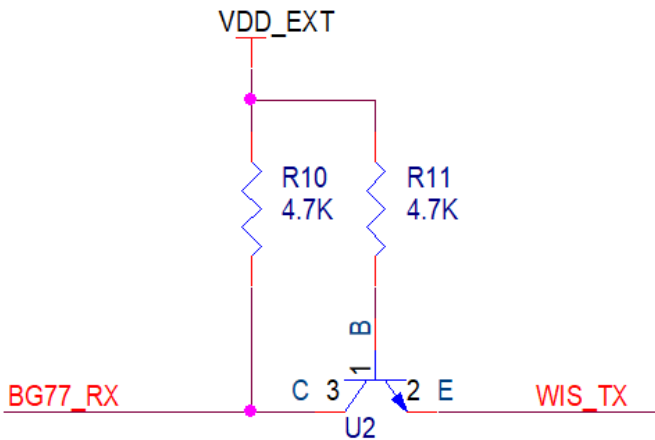

Figure 10: 3.3 V to 1.8 V voltage-level translator

- When WIS_TX is high (3.3 V), the NPN triode is turned off, BG77_RX is pulled high (1.8 V)

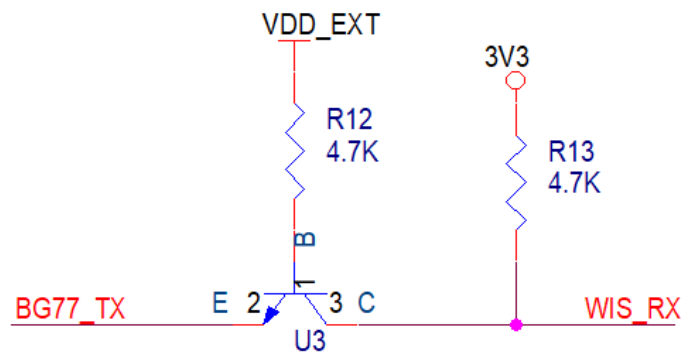- When WISTX is low (0 V), the NPN triode is turned on, BG77 RX is low (0 V).

Figure 11: 1.8 V to 3.3 V voltage-level translator

- When BG77_TX is low (0 V), the NPN triode is turned on, WIS_RX is low (0 V)

- When BG77TX is high (1.8 V), the NPN triode is turned off, WIS RX is pulled high (3.3 V)

> 📝 **NOTE:**
>
> VDD_EXT is 1.8 V, from BG77 internal regulator, BG77 pin 21

SIM Card Circuit

The RAK5860 module only supports the 1.8 V ESIM/SIM card, the following Figure 12 shows SIM interface circuit. By default, Nano SIM card is used, and eSIM is no mounting. In order to offer good ESD protection, a TVS diode array is added in the SIM card circuitry.
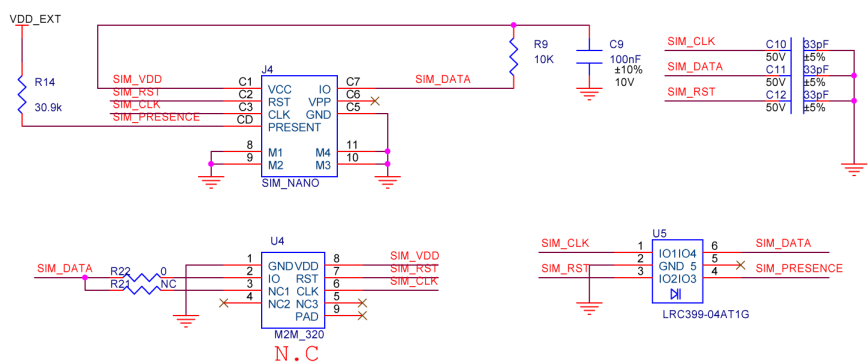

Figure 12: SIM Card Circuit

USB Connector

The RAK5860 module provides a Micro-USB connector for connection with a host device. The USB data lines USB+ and USB- are connected directly to the BG77. The VBUS line can be used for USB connection detection.

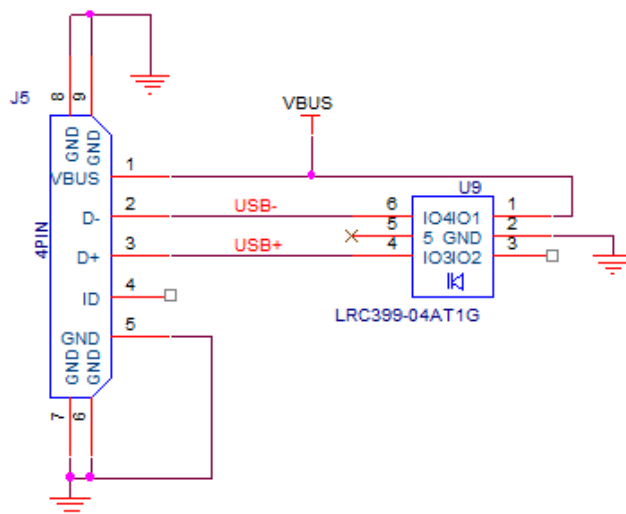To offer good ESD protection, a TVS diode array is added in the USB connector circuit.

Figure 13: USB Connector

The USB connection detection pin input voltage range is 1.3~1.8 V. Figure 14 shows the USB connection detection pin power supply.
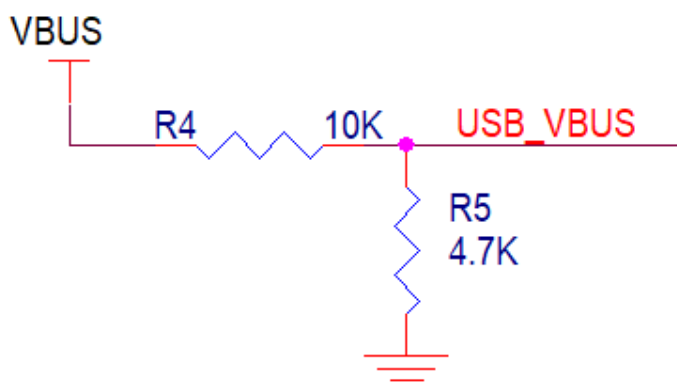

Figure 14: USB connection detection pin power supply

Power Supply for USB PHY Circuit
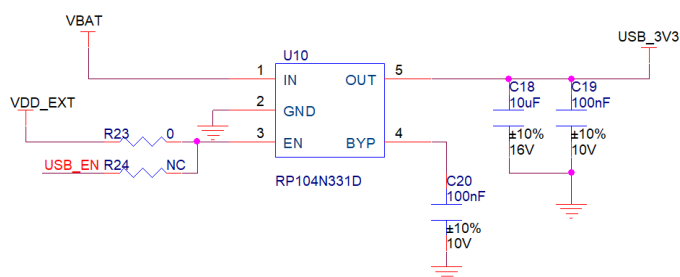
Figure 15 shows the power supply for USB PHY circuit.

Figure 15: Power supply for USB PHY circuit

Status Indication LEDs

Figure 17 shows the operation status and network activity status led circuit, when BG77 is powered on, blue led is lit, different activity network status, the green led is lit or not is different.
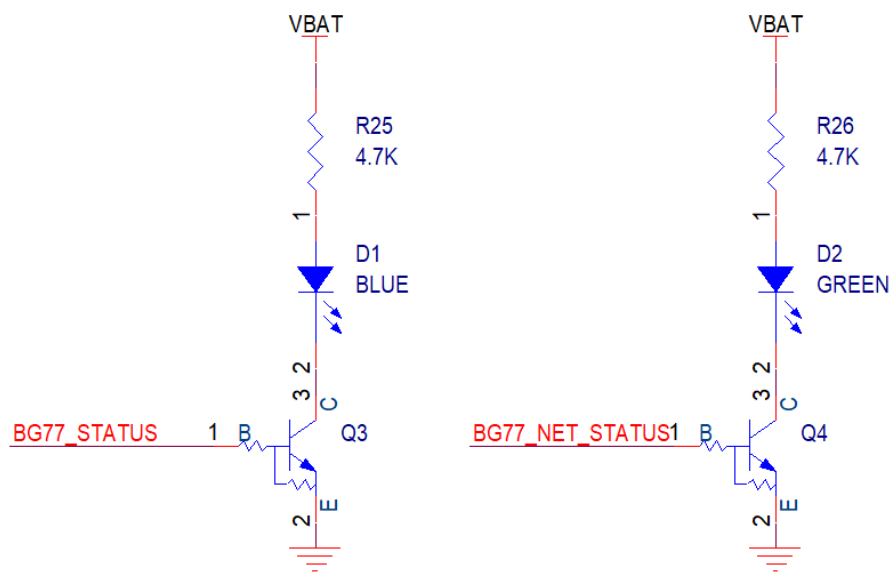
Figure 16: Status indication LED circuit

Main Antenna

The RAK5860 module's main antenna has a reserve π-type matching circuit for better RF performance, and a U.FL connector is used for main antenna.
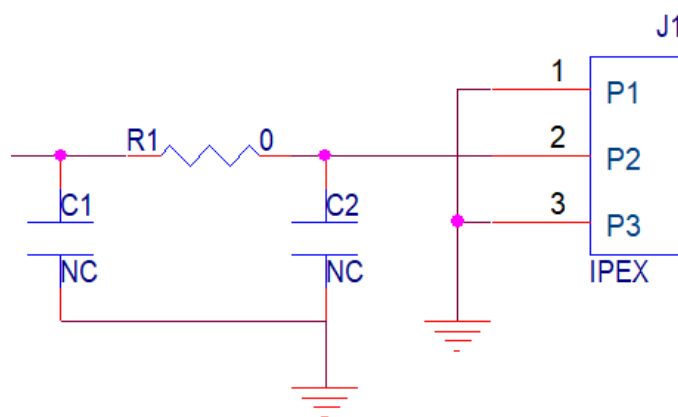

Figure 17: Main Antenna Circuit

GNNS Antenna

The RAK5860 module is designed with an active antenna. The 3V3_S is from WisIO connector, and a U.FL connector is used for the GNSS antenna. Figure 18 shows the GNSS antenna circuit.

> 📝 **NOTE:**
>
> 3V3_S is controlled by IO2 of WisBlock (P1.02 of NRF52840). For the active GPS antenna to work, set the pin to HIGH in your code.
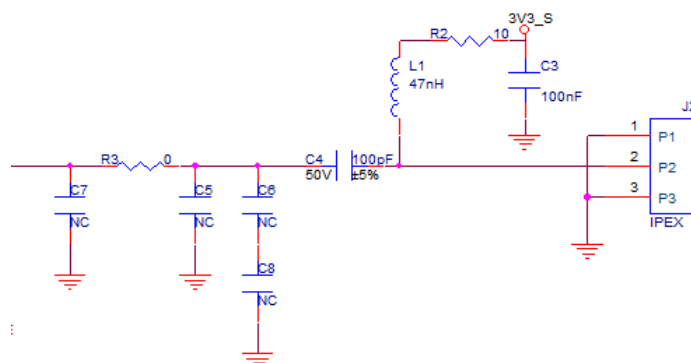

Figure 18: GNSS Antenna circuit

Certification

CE FCC