

## RAK410 Serial WIFI Module Data Sheet

# 1 Overview

## 1.1 Revision History

V0.4.4	Initial Draft	2012-9-26
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## 1.2 General Description

RAK410 module is an ultra-low power WIFI module that fully supports IEEE 802.11b/g/n wireless standards, with a small package and easy-to-use features. The module supports connecting to devices via UART and SPI interfaces, and is internally integrated TCP / IP protocol stack. Hence it facilitates rapid development. In order to adapt to a variety of application environments, RAK410 module is extended into four sub-types: RAK410A, RAK410B, RAK410-1A, and RAK410-1B.

RAK410A: Supports UART interface, with on-board antenna;

RAK410B: Supports UART interface, with U-FL connector to connect to an external antenna.

RAK410-1A: Supports SPI interface, with on-board antenna;

RAK410-1B: Supports SPI interface, with U-FL connector to connect to an external antenna.

## 1.3 Key Applications

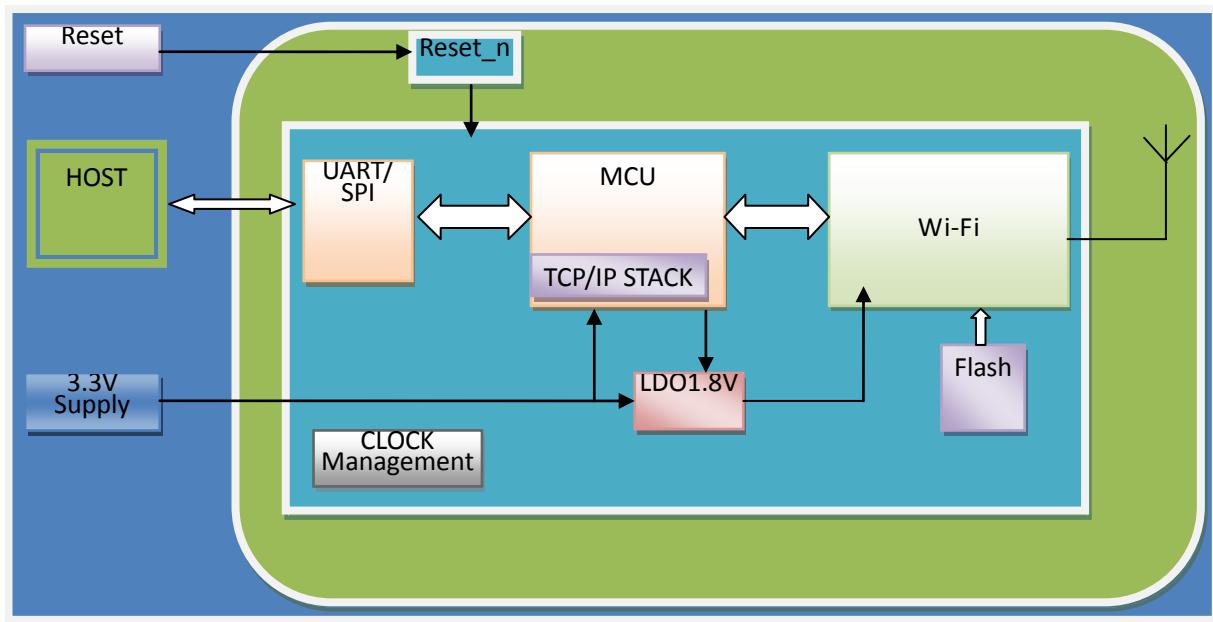
- Portable products
- Home appliances and electrical appliances
- Industrial sensors
- Sales terminals
- Buildings automation
- Logistics and freight management
- Home security and automation
- Medical applications, such as patient monitoring, medical diagnostics
- Metering (stop timing, measuring instruments, meters, etc.)

## 1.4 Devices Features

- Support IEEE 802.11b/g/n wireless standards
- Integrated TCP / IP protocol stack
- Support OPEN, WEP, WPA/WPA2-PSK Encryptions
- Support Station mode and Ad-Hoc mode
- Support TCP, UDP protocols
- Support DHCP SERVER / DHCP CLIENT
- Support AT commands and transparent transmission mode

- Support UART/SPI interfaces
- Support UART communication with a data flow control, maximum rate of 921600bps
- On-board ceramic antenna or U.FL antenna connector
- Operating voltage: 3.3V
- Support 3 kinds of power operating mode, with the lowest power consumption of 0.5uA
- Small package size: 23.14mm × 28.75mm
- FCC, RoHS and CE compliant

## 1.5 RAK410 System Diagram



## 2 Functional Description

### 2.1 Interface

- **UART**
  - Rate: 9600 ~ 921600bps
  - Support hardware flow control
- **SPI**
  - Work mode: slave mode
  - Maximum clock frequency: 4MHz
  - Configurable clock polarity and clock phase

## 2.2 Wi-Fi

- Comply with IEEE 802.11b/g/n standards
- Support WEP, WPA/WPA2-PSK encryptions
- Support QoS
- Support Infrastructure and Ad-hoc Modes

## 2.3 Network Protocols

- TCP
- UDP
- ARP
- ICMP
- DHCP Client
- DHCP Server

# 3 Hardware Introduction

## 3.1 Top View

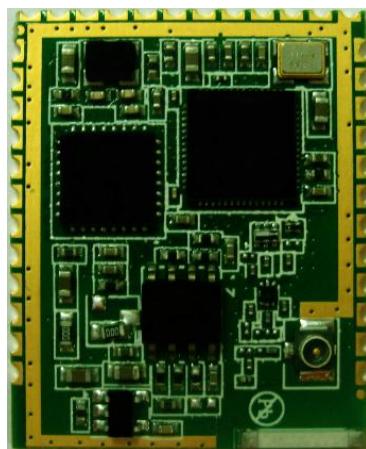


Figure 1: Module Top View

### 3.2 Bottom View

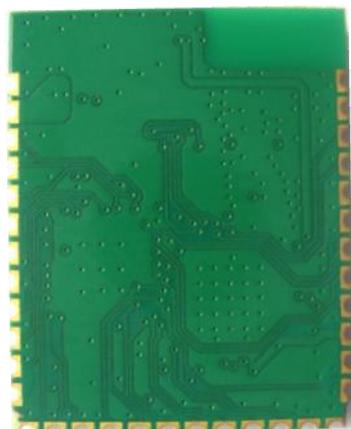


Figure 2: Module Bottom View

### 3.3 PCB Mechanical Size

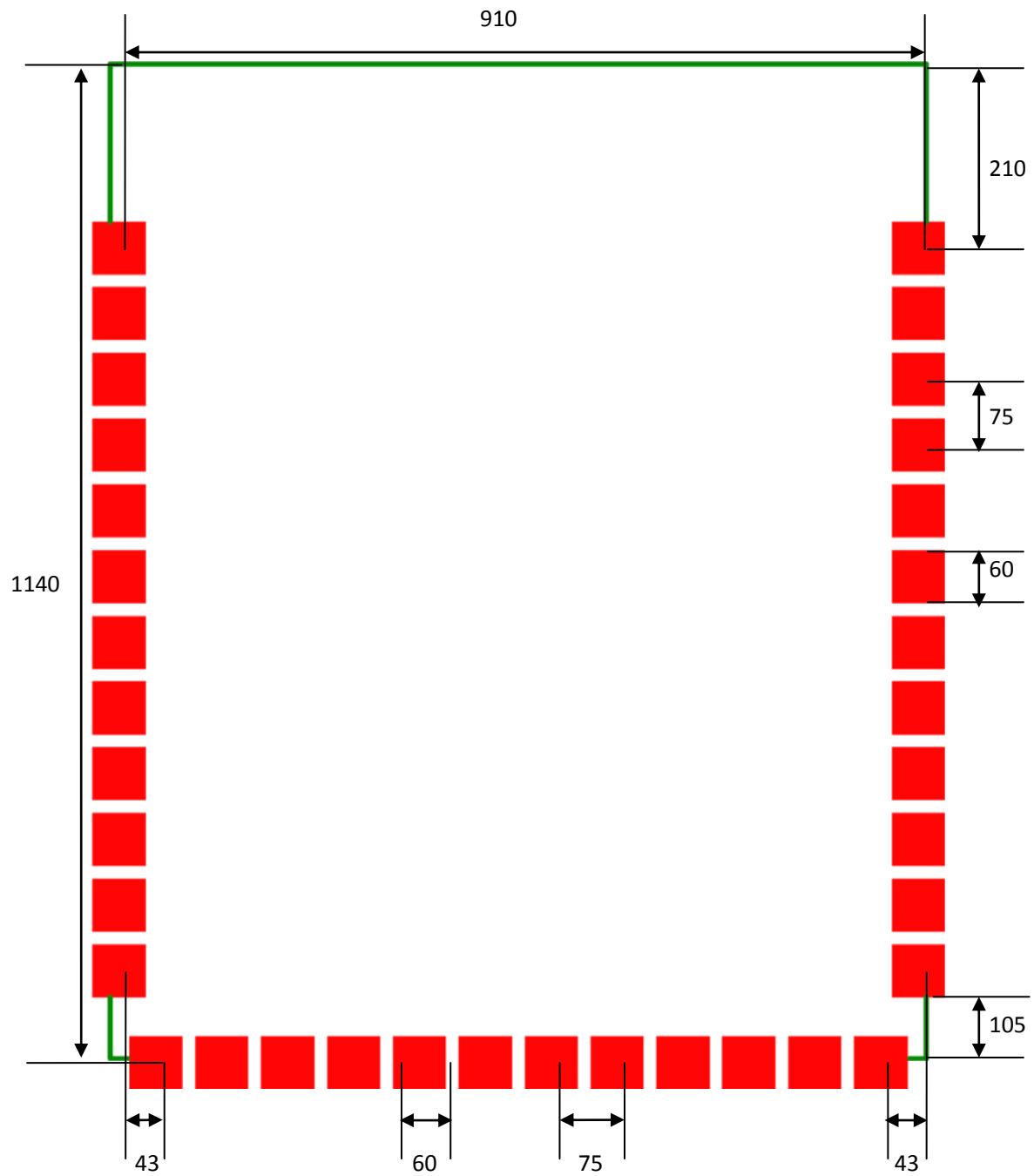


Figure 4: PCB Pins Size (Bottom View)  
(Unit : mil)

### 3.4 Design Reference

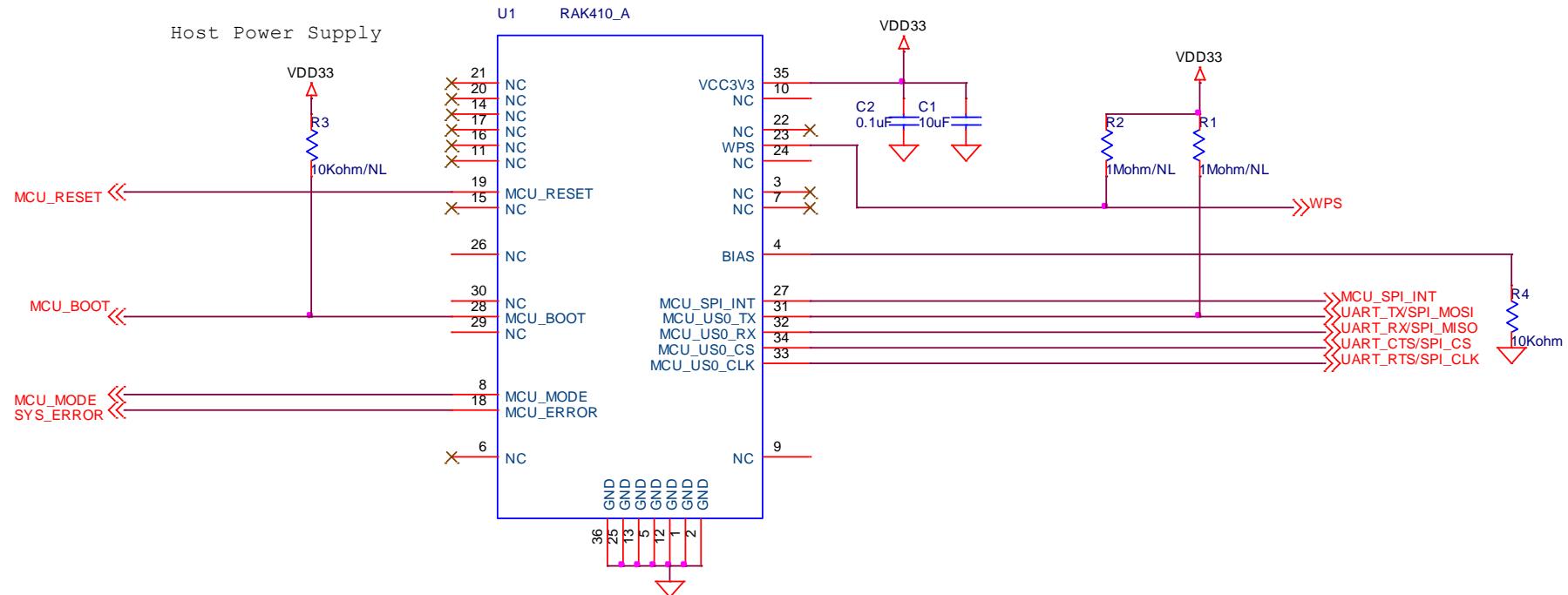


Figure 5 : RAK410 Module Peripheral Design Reference

**Note:** R1, R2, R3 are 10kΩ; C1 is 10μF; C2 is 0.1μF.

### 3.6 Reflow Soldering Temperature Graph

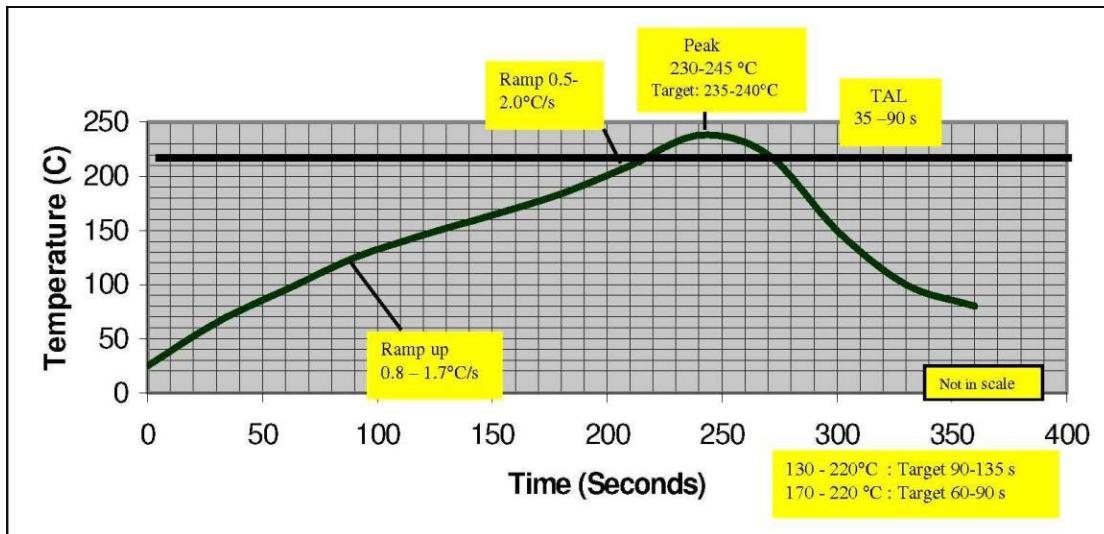


Figure 6: Temperature Graph

**Note: as shown in Figure 6, it is based on the SAC305 lead-free tin paste (3% silver, 0.5% copper). Alpha OM-338 lead-free cleaning-free flux is recommended. The Figure 6 is mainly used for guidance. The entire process time is subject to thermal pad number of assembly board and device Intensity.**

### 3.7 Baking Instructions

The RAK410 module is very sensitive to water. Be cautious to baking the device. At ambient conditions, it is required that within 168 hours removed from the vacuum packaging, the module should be processed with the circuit board assembly by reflow soldering; Or stored in the environment with a relative humidity below 10%. If the condition is not satisfied, the RAK410 must be processed with a 9-hour baking in the environment of 125 °C before the reflow soldering.

## 4 Pins Definition

### 4.1 Module Pins (Top View)

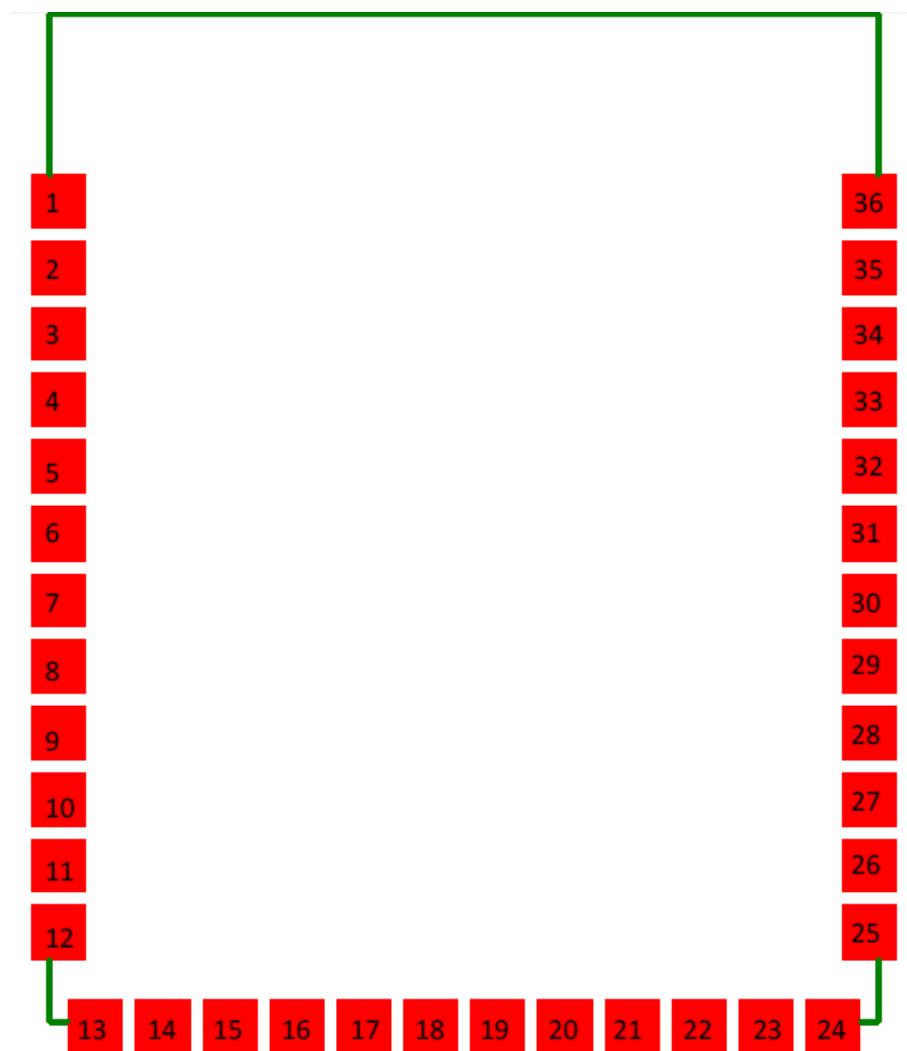


Figure 7: Module Pins Map

### 4.2 Pin Definition

Pin Serial No.	Name	Description	Type
1	GND	Ground	P
2	GND	Ground	P
3	NC	No connect (Reserved)	-
4	BIAS	Bias pin, 10K resistor to the ground	I
5	GND	Ground	P

6	NC	No connect (Reserved)	-
7	NC	No connect (Reserved)	-
8	MCU_MODE	If parameters saving is enabled, MCU_MODE=1, enter into transparent transmission mode MCU_MODE=0, enter into Command line mode	I
9	NC	No connect (Reserved)	-
10	NC	No connect (Reserved)	-
11	NC	No connect (Reserved)	-
12	GND	Ground	P
13	GND	Ground	P
14	NC	No connect (Reserved)	-
15	NC	No connect (Reserved)	-
16	NC	No connect (Reserved)	-
17	NC	No connect (Reserved)	-
18	MCU_ERROR	In Transparent Transmission mode, it is used to indicate the module when running error, high storage is valid.	O
19	MCU_RESET	Reset module, low storage is valid.	I
20	NC	No connect (Reserved)	-
21	NC	No connect (Reserved)	-
22	NC	No connect (Reserved)	-
23	NC	No connect (Reserved)	-
24	NC	No connect (Reserved)	-
25	GND	Ground	-
26	NC	No connect (Reserved)	-
27	NC	No connect (Reserved)	-
28	MCU_BOOT	It is used to enter the boot program, high storage is valid.	I
29	NC	No connect (Reserved)	-
30	NC	No connect (Reserved)	-
31	MCU_UART_TX	UART data transmit	O
	MCU_SPI_MOSI	SPI data receive	I
32	MCU_UART_RX	UART data receive	I
	MCU_SPI_MISO	SPI data transmit	O
33	MCU_UART_RTS	UART transmit request	O
	MCU_SPI_CS	SPI chip select input	I
34	MCU_UART_CTS	UART transmit clear	I
	MCU_SPI_CLK	SPI clock input	I
35	VCC3V3	Operating voltage input (3.3V)	P
36	GND	Ground	P

Table 1: Pin Definition

## 5 Electrical Characteristics

### 5.1 Absolute Maximum

The following table shows the absolute maximum. Note that the module device may be damaged when exceeds the maximum. To avoid damages to the module and the device, please operate under specified conditions.

Parameters	Symbols	Value	Unit
External supply voltage	VCC3V3	-0.3~4.0	V
Maximum RF Input (Reference: 50Ω )	RF <sub>in</sub>	+10	dBm
When voltage is 3.3V, IO Max voltage	3V3V <sub>in</sub> IOMax	VCC+0.3	V
When voltage is 3.3V, IO Min voltage	3V3V <sub>in</sub> IOMin	-0.3	V
Storage ambient temperature	T <sub>store</sub>	-65~+135	°C
ESD resistance	ESD <sub>HBM</sub>	2000	V

Table 2: Parameters and Value Range

### 5.2 Recommended Operating Parameters

Parameters	Symbols	Min Value	Typical Value	Max Value	Unit
External voltage	V <sub>cc</sub>	3.14	3.3	3.46	V
Ambient temperature	T <sub>ambient</sub>	-20	--	TBD	°C

Table 3: Recommended Operating Parameter Range

### 5.3 RF Electrical Characteristics

- RF Receiver Specifications

Parameters		Test conditions	Typical Value	Unit
Receiver sensitivity	11b,1Mbps		-97	dBm
	11b,2Mbps		-92	dBm
	11b,5.5Mbps		-90	dBm
	11b,11Mbps		-88	dBm
	11g,9Mbps		-91	dBm
	11g,18Mbps		-87	dBm
	11g,36Mbps		-81	dBm
	11g,54Mbps		-75	dBm
	11n,MCS1,13Mbps		-89	dBm
	11n,MCS3,26Mbps		-82	dBm
	11n,MCS5,52Mbps		-75	dBm
Maximum input signal	CH7	11g,54Mbps	10	dBm

Adjacent channel suppression	6Mbps		37	dBc
	54Mbps		21	dBc
	MCS0		38	dBc
	MCS7		20	dBc

Table 4: Partial RF Receiver Specifications

- RF Transmit Specifications

Symbol	Parameters	Requirements	Typical Value	Unit
$F_{tx}$	Frequency range	--	2.4	GHz
	Output power	--	--	--
	802.11b	1Mbps	17	dBm
	802.11g	6Mbps	17	dBm
	802.11n,HT20	MCS0	17	dBm
	802.11g,EVM	54Mbps	14	dBm
	802.11n,HT20EVM	MCS7	10	dBm

Table 5: Partial RF Transmit Specifications

## 5.4 MCU Reset

Figure 8 shows the MCU reset timing diagram and reset pulse length.

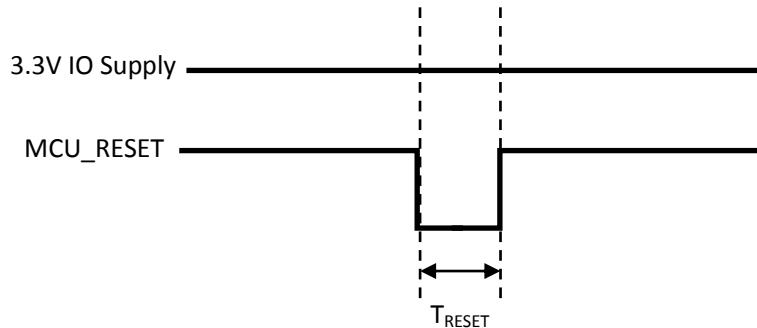


Figure 8: MCU Reset Timing

Table 6 shows the description of MCU reset parameters.

Symbol	Description	typical ( $\mu$ S)
$T_{RESET}$	MCU reset pulse length	100

Table 6: MCU Reset Parameters

## 6 Software Overview

### 6.1 Functional Description

By sending AT commands via UART / SPI, RAK410 completes module configurations, which include wireless network scan, password entering and network connection, establishment of TCP / UDP connection and data transmit.

### 6.2 Software Features

- ◆ Support TCP, UDP protocols
- ◆ Support PING command
- ◆ Support DHCP SERVER / DHCP CLIENT
- ◆ Support command transmission mode and transparent transmission mode when send data
- ◆ Support configuration parameters saving; through pin control, the module can enter directly into the transparent transmission mode after powered
- ◆ Support disconnected TCP automatically reconnection, disconnected wireless automatically reconnection in transparent transmission mode,

## 6 Power Management

### 6.1 Functional Description

As the following figure shows, RAK410 supports three kinds of power operating mode:

Operating Mode	Work State	Power Consumption	
		Disconnecting to AP, no data is sent	Connecting to AP (beacon=100ms), no data is sent
Power Mode 0	Normal	80.4mA	80.4mA
Power Mode1	Standby	2.4mA	5.8mA
	Deep sleep	2mA	2mA
Power Mode2	Standby	0.4mA	2.9mA
	Deep sleep	0.5uA	0.5uA

Figure 6: Operating Mode and the Corresponding Power Consumption

### 6.1.1 Power Mode 0

In power Mode 0, RAK410 module operates at the best performance, and the wireless part and control part completely open.

### 6.1.1 Power Mode 1

The Power Mode 1 has two states: Standby and Deep sleep.

In Standby state, the wireless part will enter into a low-power status, where it reduces power consumption by accepting Beacon signals at a fixed time interval, the longer the time interval, the lower the power consumption is, but the delay of the wireless part of the reaction will be longer; In Standby state, the control part will enter into a low-power status as well, and the host can quickly wake this part by command and sending and receiving data.

In Deep sleep state, the module will turn off the power of the wireless part. Therefore, in this state the wireless part has the lowest power consumption. The host can restore the task status control from what was before the closure by specific commands, but the wake-up time will be longer; In Deep sleep state, the control part will enter into a low-power consumption status too, and the host can quickly wake this part by command and sending and receiving data.

### 6.1.2 Power Mode 2

The Power Mode 2 has two states: Standby and Deep sleep.

In Standby state, the wireless part will enter into a low-power status, where it reduces power consumption by accepting Beacon signals at a fixed time interval, the longer the time interval, the lower the power consumption is, but the delay of the wireless part of the reaction will be longer; In Standby state, the host can make the control part to enter into a deep sleep status by commands, the host can only wake this part via UART\_CTS pin or via sending data through wireless to the module.

In Deep sleep state, the module will turn off the power of the wireless part. Therefore, in this state the wireless part has the lowest power consumption. The host can restore the task status control from what was before the closure by specific commands, but the wake-up time will be longer; In Standby state, the host can make the control part to enter into a deep sleep status by commands, the host can only wake this part via UART\_CTS pin or via sending data through wireless to the module.

- Product Information

Product Models:

RAK410A (UART interface module, internal antenna)

RAK410B (UART interface module, external antenna)

RAK410-1A (SPI interface module, internal antenna)

RAK410-1B (SPI interface module, internal antenna)

Packaging: pallet packing

**Antenna Selection**

In order to maintain compliance with FCC regulations, an antenna with no more than 0 dBi gain must be used. This module has been tested with the following antennas:

Part Number	Antenna Type	Antenna Gain	DTS mode
7598-r4	CHIP	0dBi	Approved
7598-r7	male/female/SMT connector	0dBi	Approved

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device and its antenna(s) can not be installed and operating in conjunction with any other antenna or transmitter.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body

**The module must not be modified in any way. Coupling of external circuitry must not bypass the provided connectors.**

**End product must be externally labeled with “Contains FCC ID: RGLRAKE410”**

**The integrator must not provide any information to the end-user on how to install or remove the module from the end-product.**