

# RAK411 SPI-WIFI Module

## Specification v1.5

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# 1. Overview

## 1.1 Module Overview

RAK411 module is a Wi-Fi module that fully compliant with IEEE 802.11b/g/n wireless standards, with internally integrated TCP / IP protocol stack, supporting numerous protocols such as ARP, IP, ICMP, TCP, UDP, DHCP CLIENT, DHCP SERVER, DNS and other etc. It supports AP mode, Station mode and Ad-hoc and mode. Users can easily and quickly use it to networking and data transmission. Through SPI interface, the module's maximum transmission rate is up to 2Mbps.

RAK411 supports storing parameters, and by the customer commands it determines whether to enable automatic networking to realize easy networking and reduce time for system to networking. The module has built-in WEB server, supporting wireless network parameters configuration, supporting wireless firmware upgrade. It also supports WPS and EasyConfig one-key networking, significantly reducing software development effort.

RAK411 has four power management modes, among which the minimum standby power consumption is 2uA, fully meet customer's requirement for low power design.

## 1.2 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.)

## 1.3 Device Features

- Support IEEE 802.11b/g/n wireless standards
- Support four-wire SPI interface
- Support SPI Clock up to Maximum 16Mhz
- Minimalist hardware peripheral circuit design
- Support Station, Ad-hoc and AP modes

- Support DHCP SERVER / DHCPCLIENT
- Support OPEN, WEP, WPA-PSK, WPA2-PSK and WPS encryption
- Support TCP, UDP protocols, with maximum 8 UDP/TCP connections
- Support webpage-based parameter configuration
- Support WPS and EasyConfig one-key to network connection
- Support parameter storage, customer orders loading after boot
- Support parameters store in Deep Sleep State, with connection time as fastest as 300ms
- Support wireless upgrade firmware
- On-board ceramic antenna or U.FL antenna connector
- Operating voltage: 3.3V
- 4 kinds power working modes, with minimum power consumption as 1~2uA
- FCC, RoHS and CE compliant

## 1.4 System Diagram

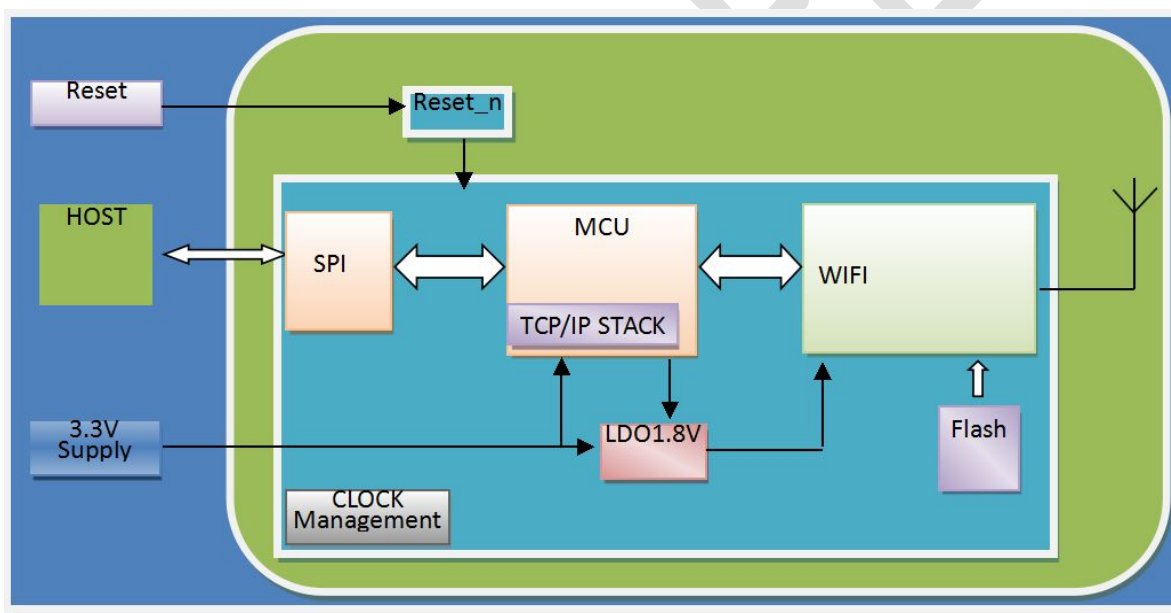


Figure 1-1 RAK411 System Diagram

## 2. Functional Description

### 2.1 HW Interface

- Support clock 16MHz Maximum
- Interface actual throughput up to 2Mbps
- Four-wire SPI interface, support SPI data interrupt pin

### 2.2 Wireless Driver

- Compliant with IEEE 802.11b/g/n standards
- Support AP、STA 、AD-HOC Mode
- Support WEP, WPA/WPA2-PSK encryption
- Fast networking, allowing module to be added to network within 1 sec after power up
- Support WPS and EasyConfig one-key to network connection
- Support wireless configuration and firmware upgrade

### 2.3 TCP/IP

- DHCP Client and Server features
- DNS Client and Server functions
- TCP Client, TCP Server, UDP Client, UDP Server and Multicast functions
- 8-way socket applications

### 2.4 Power Consumption

The module supports three power consumption modes:

- Full speed working mode, with approx 80mA average power consumption, peak current less than 200mA
- Power-saving mode, with approx 10ma average power consumption, peak current <200mA, DTIM = 100ms
- Deep sleep mode, with approx 5mA average power consumption, peak current <200mA, DTIM = 100ms
- Standby mode, with power consumption <2uA

## 3. Hardware Introduction

### 3.1 Top View

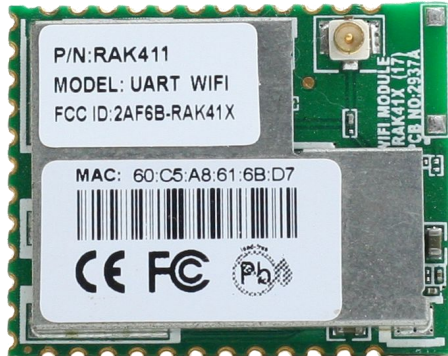


Figure 3-1 RAK411BS Top View

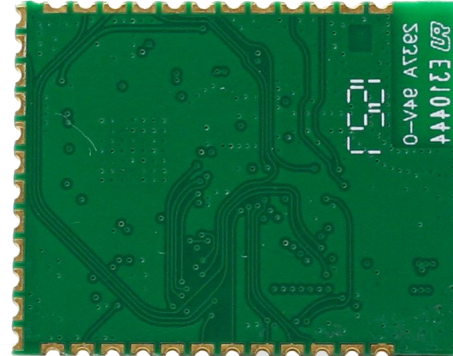


Figure 3-2 RAK411 Bottom View

### 3.2 Pin Definition

Table 3-1: Pin Definition

Pin No.	Name	Type	Description
1,2,5,12,13,25,36	GND	Ground	connected to ground pad or the copper
35	VCC3V3	Power	3.3V power supply
18	LINK	O, PU	"0" - STA connected in AP mode, Connected to router in STA mode "1" - disconnected Remain disconnected when no use
19	RESET	I, PU	Module reset pin, low effective
27	SPI_INT	O	SPI mode interrupt pin "0"——idle level "1"——has data sent to host
31	SPI_MISO	O	SPI slave: data of SPI Master Input, Slave Output
32	SPI_MOSI	I	SPI slave: data of SPI Master Output, Slave Input
33	SPI_CLK	O	SPI slave: SPI clock input
34	SPI_CS	I	SPI slave: SPI chip select input
Others	NC	NC	Remain disconnected when no use

#### Note:

1. I - input O - output PU – pulling up PD - pulling down NC - not connected
2. Pin in NC, remain disconnected

### 3.3 Design Reference

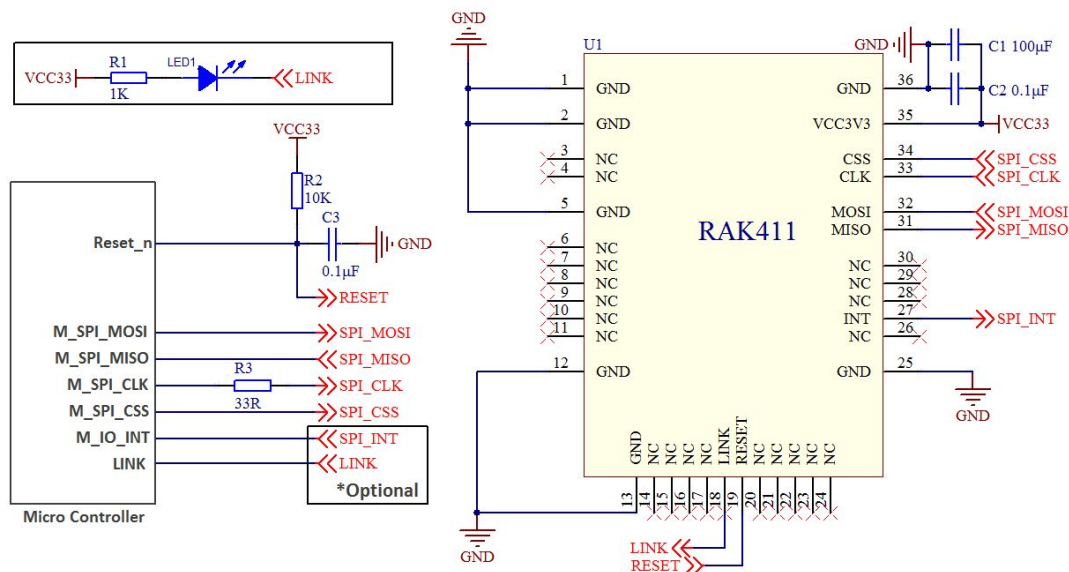


Figure 3-3 Module Typical Design Reference

#### Tips:

Upon SPI interface, the value of R3 depends on output resistance of host and PCB trace resistance, the default value is 33 ohm.



### 3.4 PCB package

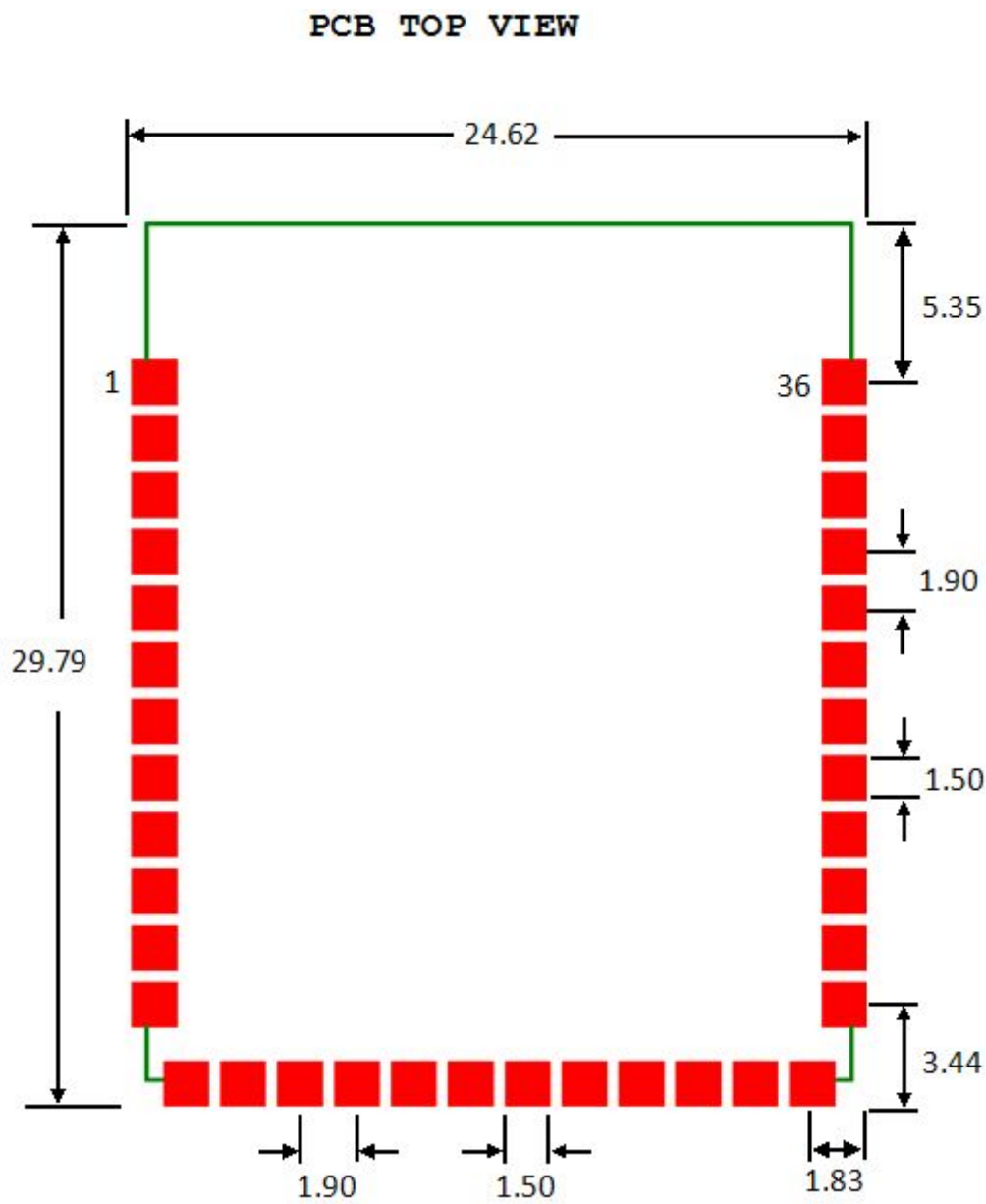


Figure3-4:PCB package (unit : mm)

### 3.5 Reflow Soldering Temperature Graph

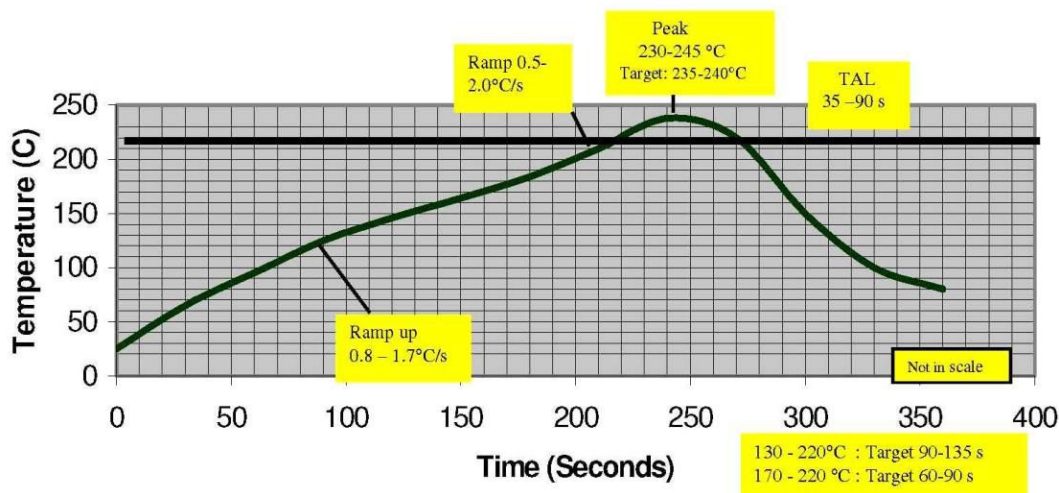


Figure 3-5: Temperature Graph

#### Note:

As shown in Figure, 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.

### 3.6 Baking Instructions

The RAK411 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 RAK411 must be processed with a 9-hour baking in the environment of 125 °C before the reflow soldering.

## 4. Electrical Characteristics

### 4.1 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.

Table 4-1: Parameters and Value Range

Parameters	Symbols	Value	Unit
External supply voltage	VCC3V3	-0.3~4.0	V
Maximum RF Input (Reference: 50Ω)	RFin	+10	dBm
When voltage is 3.3V, IO Max voltage	3V3VinIOMax	VCC+0.3	V
When voltage is 3.3V, IO Min voltage	3V3VinIOMin	-0.3	V
Storage ambient temperature	Tstore	-65~+135	°C
ESD resistance	ESDHBM	2000	V

### 4.2 Recommended Operating Parameters

Table 4-2: Recommended Operating Parameter Range

Parameters	Symbols	Min Value	Typical Value	Max Value	Unit
External voltage	Vcc	3.14	3.3	3.46	V
Ambient temperature	Tambient	-40	--	+85	°C

### 4.3 RF Electrical Characteristics

- **RF Transmit Specifications**

Table 4-3: Partial RF Transmit Specifications

Symbol	Parameter	Conditions	Typical Value	Unit
Ftx	Frequency range	--	2.4	GHz
Pout	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

- RF Receiver Specifications

Table 4-4: Partial Receiver Specifications

Parameter	conditions	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
	11n,MCS7,65Mbps		-72	dBm
Maximum input signal	CH7	11g,54Mbps	10	dBm
Adjacent channel suppression	6Mbps		37	dBc
	54Mbps		21	dBc
	MCS0		38	dBc
	MCS7		20	dBc

#### 4.4 MCU Reset

Figure 4-1 shows the MCU reset timing diagram and reset pulse length. When power on the module or an exception occurs, the module needs to be reset. RESET pin is internally pulled up, low input is effective.

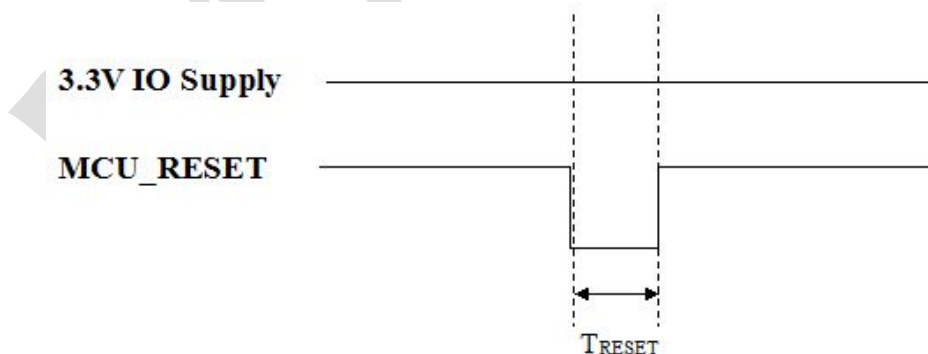


Figure 4-1: MCU Reset Timing

Symbol	Description	typical ( mS )
TRESET	MCU reset pulse length	>10

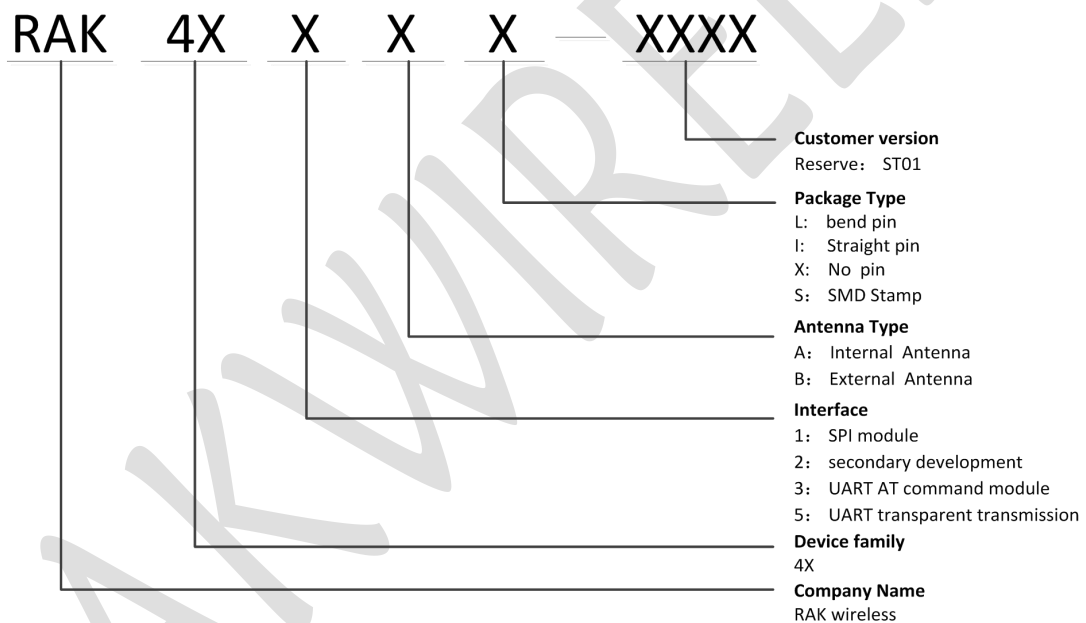
## 5. Order Information

### 5.1 Products

Table 5-1: Product Models

Product	Description	Single Tray Packing	Minimum Package	Development board corresponding model
RAK411AS-XXXX	SPI interface module, with on-board antenna	32pcs/tray	320pcs	RAK411AS_EVB
RAK411BS-XXXX	SPI interface module, with external antenna	32pcs/tray	320pcs	RAK411BS_EVB

### 5.2 Description



### 5.3 Size

Packaging: Hard plastic pallets

Weight:  $\leq 3.00\text{g/pcs}$

Table 5-2: Module Size

Module	Length and width	Thickness (Height)	Note
RAK411 Module	28.75mm×23.14mm	2.85±0.05mm	Without shield holder
		2.95±0.05mm	With shield holder
		3.30±0.15mm	With shield

Note: In considering height design of the product, please consider your motherboard thickness error and product fit gap (recommended 0.10-0.15mm).

RAK WIRELESS

## 6. Contact information

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## 7. Revision History

Version	Author	Modification	Date
V1.0		Initial Draft	2014-02-08
V1.1		Optimized power consumption to 1-2uA	2014-02-17
V1.2		Update the contact way,Update the document format	2014-08-22
V1.3		Update the Schematic and packaging(35 interface), Update the Order Information	2014-09-05
V1.4		Replace back to the original 36 interface schematics and packaging	2014-10-09
V1.5	Lampo	Update the contact way,Update the document format. Modification module size table,Update Module Image.	2016-03-02