HC06U

Hardware Design

Bluetooth Module Series

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating the module. Manufacturers of the cellular terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be paid to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
SOS	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergent help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or

metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2021-08-10	Elinor WANG/Lucas HUANG	Creation of the document
1.0	2020-08-10	Elinor WANG/Lucas HUANG	First official release

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1 Introduction

This document defines the HC06U module and describes its air interfaces and hardware interfaces which are connected with customers' application.

This document can help you quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. Associated with application notes and user guides, customers can use HC06U module to design and set up applications easily.

The module is limited to OEM installation ONLY. And the OEM integrator is responsible for ensuring the end-user has no manual instruction to remove or install module.

The module is limited to installation in mobile or fixed applications.

2 Product Overview

2.1. General Description

Quectel HC06U is a low power Bluetooth on-chip system (SoC) solution. It integrates high performance and low power RF transceiver and rich peripheral IO extension.

Mainly used in low-power data transmission, keyboard, mouse, remote control, sports and leisure equipment, mobile phone accessories and consumer electronics products. HC06U conforms to the *Bluetooth 5.0 Specification* and supports all *Bluetooth Standard 5.0* functions.

This module integrates 48 MHz high-performance MCU, GPIO, I2S, I2C, SPI and UART, supports 24 MHz external crystal oscillator, multi-purpose 12-bit ADC. The module Integrates with 256 KB ROM, 128 KB SRAM. It also supports user-defined IDE system SFLASH MCU development and JTAG software upgrade.

Radio frequency:
● Receiving sensitivity: -90 dBm
● Transmission power: max. 2 dBm

Peripherals:
● SPI × 1
● I2C × 1
● UART × 1
● GPIOs
● Battery test

Software:
● Supports Bluetooth 5.0 single mode protocol stack (BLE)
● Support air software upgrade and configuration
● ROM boot
● Support for debugging mode

Power management:
● Multiple power management modes, support for software shutdown and hardware wake up
● Wide voltage input: 2.0–3.6 V

CPU:

- ARM CM3, max. 48 MHz
- 128 KB SRAM
- 256 KB ROM, ROM Encryption
- 4 Mb SFLASH

Clocks:

- 24 MHz crystal oscillator clock, 24 MHz RC clock, 32.768 kHz crystal oscillator clock, 32.768 kHz RC clock

Link Controller:

- Bluetooth 5.0 LE physical layer, controller layer
- 2.4 GHz Private transport protocol

2.2. Key Features

The following table describes the key features of HC06U module.

Table 1: Key Features

Specification		HC06U
Bluetooth	Bluetooth specification	Bluetooth 5.0
	Bluetooth level	Class 2
	Distance	45 m (open area)
	Antenna	Built-in ceramic antenna or external antenna
	Output power	2 dBm (typical)
	Receive sensitivity	-90 dBm (typical)
	Support mode	Master-slave
	Profile	GATT
Hardware interface		UART, GPIO
Operating voltage		3.3 V
Operating temperature		-40 to +85 °C

Physical Characteristics	(16.5 ±0.2) mm × (13.3 ±0.2) mm × (2.3 ±0.2) mm

2.3. Antenna requirement

Type	Requirements
Frequency Range	2.400–2.500 GHz
VSWR	≤2
Gain (dBi)	≤1dBi
Input Impedance (Ω)	50
Polarization Type	Vertical
Description	50 mm × Φ 10 mm with reverse SMA Male Antenna

Frequency (MHz)	2400	2500
VSWR	1.43	1.75

Frequency (MHz)	2400	2450	2500
Eff. (%)	56.14	53.9	49.06

Frequency (MHz)	2400	2450	2500
Gain (dBi)	0.78	0.88	0.25

The reference impedence simulation and PCB design is shown below:
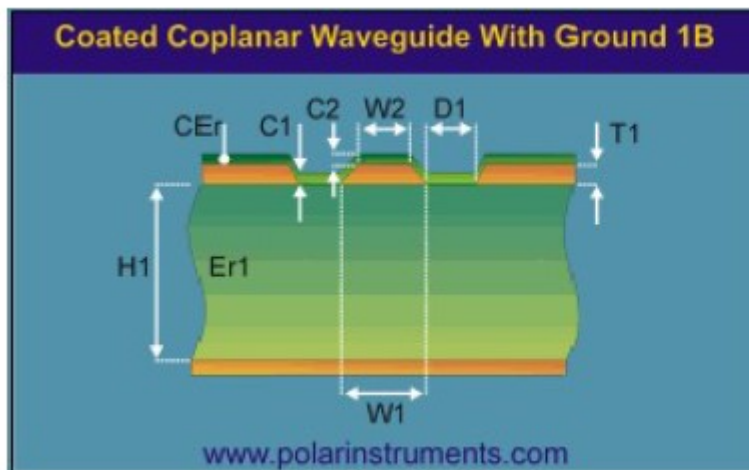
H1	57.66Mil
Er1	4.9
W1	34.6 Mil
W2	33.6 Mil
D1	8.25 Mil
T1	1.65 Mil
C1	0.5 Mil
C2	0.5 Mil
C3	0.5 Mil
CEr	3.4
Imp	50.09 Ω
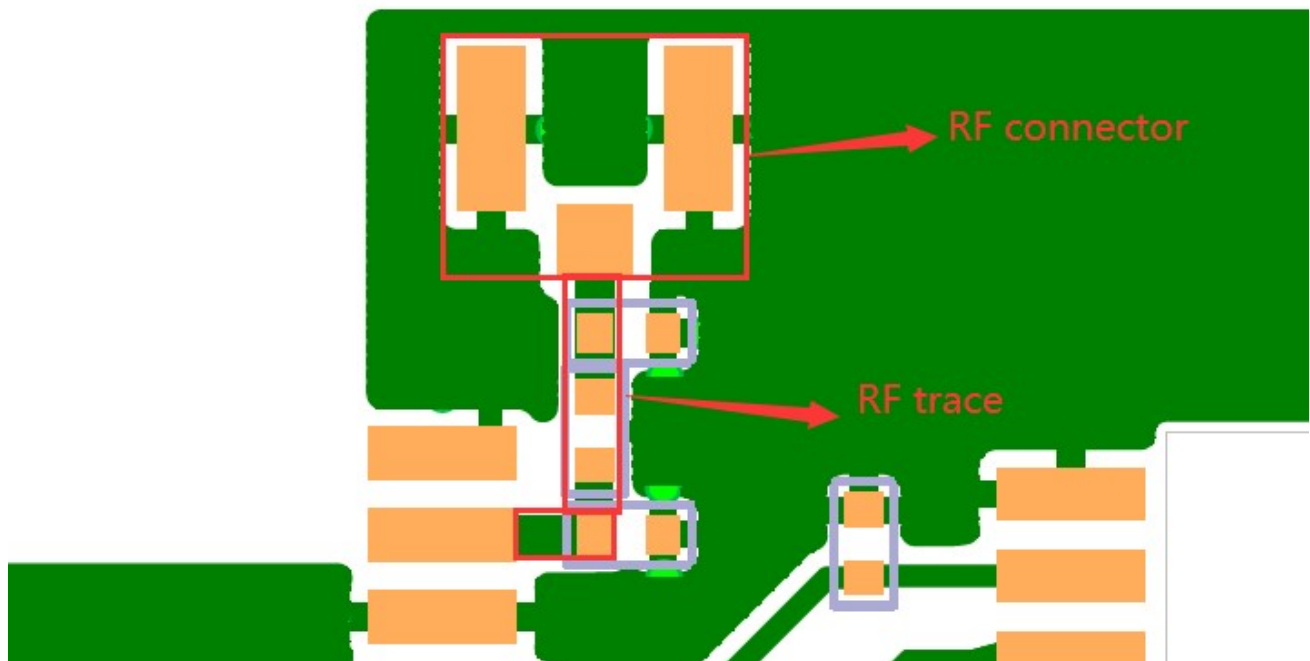
3 Application Interfaces

3.1. Pin Assignment
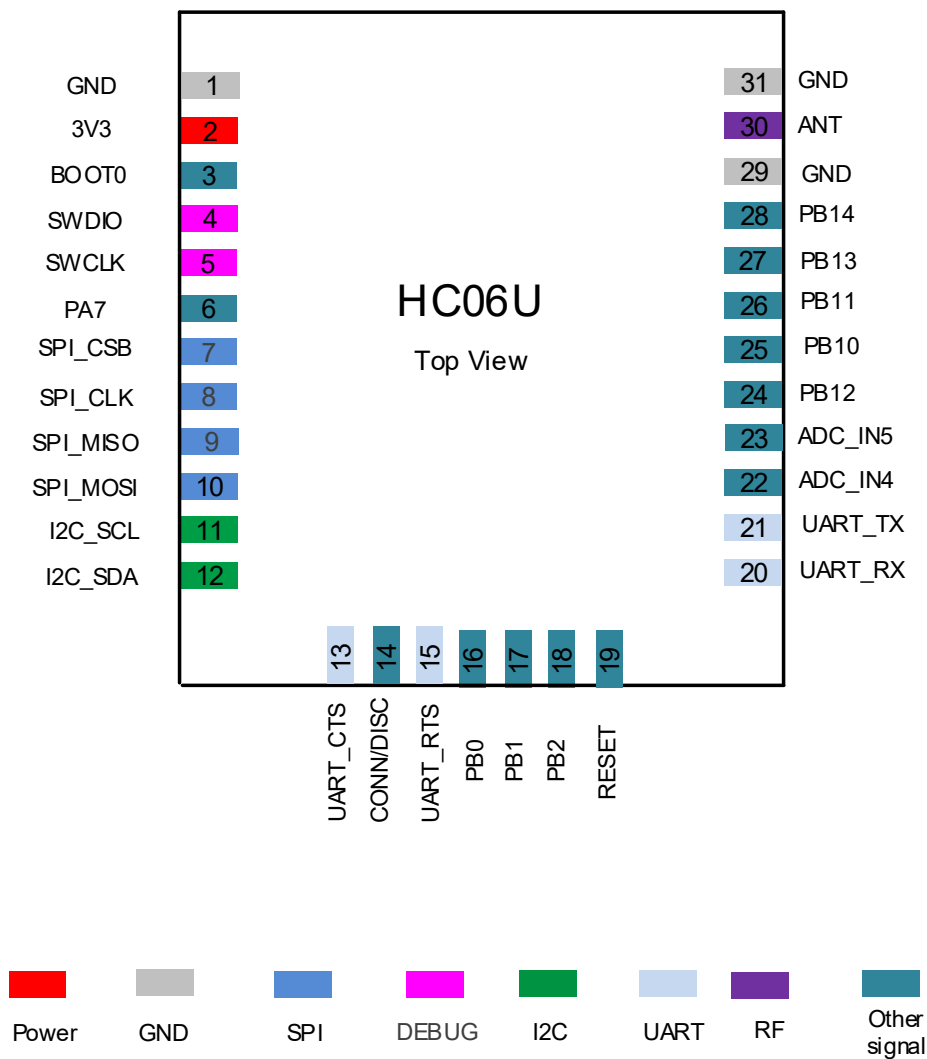
Figure 2: Pin Assignment

3.2. Pin Description

Table 2: Pin Description

Pin No.	Pin Description	Functions
1	GND	GND
2	3V3	+3.3 V power supply
3	BOOT0	Pull down into programming mode, hover or pull up into working mode
4	SWDIO	Debug port: SWDIO
5	SWCLK	Debug port: SWCLK
6	PA7	Pull up into sleep, pull down the wake device
7	SPI_CSB	SPI communication port
8	SPI_CLK	SPI communication port
9	SPI_MISO	SPI communication port
10	SPI_MOSI	SPI communication port
11	I2C_SCL	I2C communication port
12	I2C_SDA	I2C communication port
13	UART_CTS	Clear to Send (active low)
14	CONN/DISC	CONN/DISC
15	UART_RTS	Request to Send (active low)
16	PB0	Configurable GPIO
17	PB1	Configurable GPIO
18	PB2	Configurable GPIO
19	RESET	RESET (active low)
20	UART_RX	UART data receive
21	UART_TX	UART data transmission
22	ADC_IN4	Analog-digital conversion

23	ADC_IN5	Analog-digital conversion
24	PB12	Configurable GPIO
25	PB10	Configurable GPIO
25	PB11	Configurable GPIO
27	PB13	Configurable GPIO
28	PB14	Configurable GPIO
29	GND	Ground
30	ANT	RF Antenna (optional)
31	GND	Ground

NOTE

All digital IO ports can be configured as any function of GPIO.

3.3. Power Supply

Standard 3.3 V power supply.

3.4. UART Interfaces

The UART interface is used for serial communication with a peripheral, modem (data carrier equipment, DCE) or data set. Data is written from a master (CPU) over the APB bus to the UART interface and it is converted to serial form and transmitted to the destination device. Serial data is also received by the UART interface and stored for the master (CPU) to read back. The UART interface contains registers to control the character length, baud rate, parity generation/checking, and interrupt generation. Although there is only one interrupt output signal from the UART interface, there are several prioritized interrupt types that can be responsible for its assertion. Each of the interrupt types can be separately enabled or disabled by the control registers.

HC06U has 2 UARTs; the UART0 is a common 2 wire (TX/RX) controller, and the UART1 support low control (CTS/RTS). UART1 also supports ISO7816 protocols.

3.5. RESET

It supports hardware reset. The reset sequence is shown in the figure below, the T_{rst} > 50 ms.
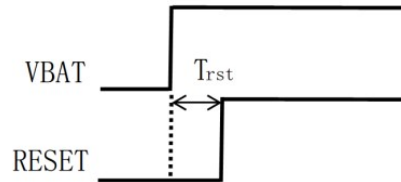

Figure 3: Power on Reset Timing

3.6. I2C Interface

The I2C interface is a master or slave interface. It supports 100 kHz, 400 kHz and 800 kHz clock rates for controlling EEPROM etc. The I2C interface provides several data formats and can fit various I2C peripherals. Sequential reading and writing are supported to improve throughputs. The I2C support DMA operation for extra MCU free data transfer. The I2C work as either master or slave, but cannot change the working mode after configuration.

3.7. SPI

The Serial Peripheral Interface (SPI) bus is a synchronous serial communication interface specification used for short distance communication, primarily in embedded systems. The HC06U integrates 2 SPIs, they can work in either master or slave mode and support DMA or software mode to transfer data.

The master or slave controller only supports point-to-point connection by hardware. Both the SPI has only one CS pin. The connection is shown below.
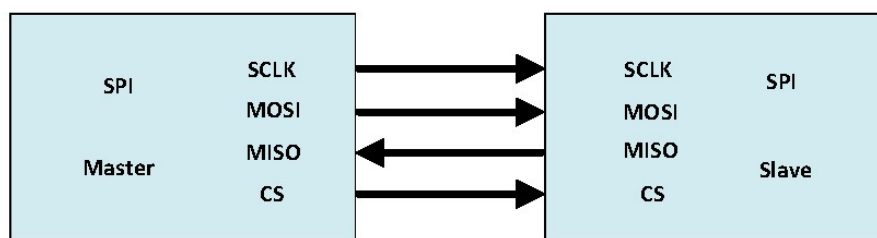

Figure 4: SPI Connection

SPI makes it suitable for most of SPI slave devices for its flexibility. SPI offers four modes due to the programmable ability of SCK's polarity and phase. The delay from CS to SCK, the delay from SCK to NCS and SCK period are also programmable. SPI timing diagram is shown in figure below:
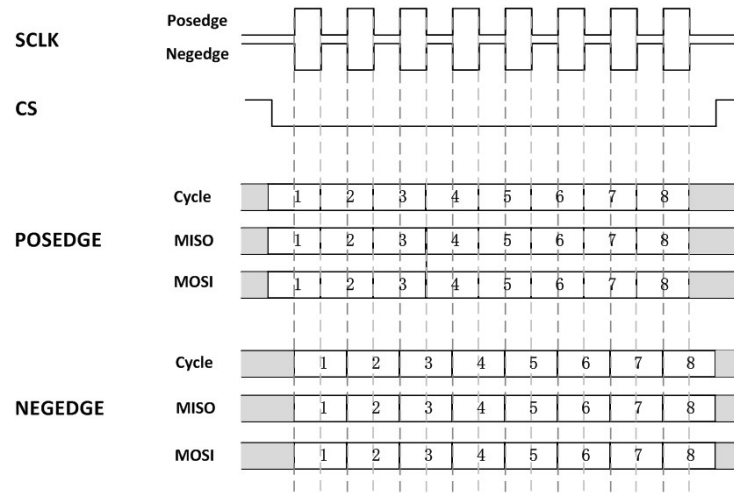

Figure 5: SPI Timing

3.8. GPIOs

● Programmable GPIOs;
● Each pin can choose either pull-up or pull-down resistors;
● Each pin remains the last state when the chipset enters sleep mode;
● Each pin interrupt can wake up chipset from sleep mode.

3.9. ADC Interfaces

HC06U integrates high speed and low power consumption 12-bit General Purpose Analog-to-Digital Converter (GPADC) for sampling an external signal. It can operate in unipolar (single-ended) mode as well as bipolar (differential) mode. The ADC has its own 1.2 V voltage regulator (LDO), which represents the full-scale reference voltage.

The features of ADC interfaces are as follows:

● 12-bit dynamic ADC with 65 ns conversion time
● Maximum sampling rate 3.3 M sample/s
● Ultra-low power (5 μA typical supply current at 100 k sample/s)

- Single-ended as well as differential input with two input scales
- Eight single-ended or four differential external input channels
- Battery monitor function
- Chopper function
- Offset and zero scale adjustment
- Common-mode input voltage adjustment

4 Electrical Characteristics

4.1. Absolute Maximum Ratings

Table 3: Absolute Maximum Ratings

Operating mode		Min.	Max.	Unit
Storage Temperature		-40	125	°C
ESD	Human Body Model	2000	-	V
	Machine Model	200	-	V
	Charge Device Mode	500	-	V

4.2. Recommended Operating Conditions

Table 4: Recommended Operating Conditions

Operating mode	Min.	Typ.	Max.	Unit
Operating temperature	-40	-	85	°C
I/O voltage	3.1	3.3	3.5	V
Supply voltage	2	3.3	3.6	V

4.3. RF Characteristics

4.3.1. BLE Transmitter

Table 5: BLE Transmitter

Parameter	Min.	Typ.	Max.	BLE Specification	Unit
RF transmitted power	-	2	-	-6–4	dBm
Power control range	-18	-	2	-	dB
Frequency offset	-	4.02	-	-150–150	kHz
Frequency drift	-	-3.31	-	-50–50	kHz
Frequency drift rate	-	-3.13	-	-20–20	kHz/50 μs
Initial carrier drift	-	-2.25	-	-20–20	kHz
MOD Char Δf1avg	225	250	275	-	kHz
MOD Char Δf2max	-	220	-	> 185	kHz
MOD Char Δf2avg/Δf1avg	0.84	-	-	> 0.8	-

4.3.2. BLE Receiver

Table 6: BLE Receiver

Parameter		Min.	Typ.	Max.	BLE Standard	Unit
Sensitivity	-	-93	-90	-81	≤ -70	dBm
I/C co-channel	-	-	-	9	-21	dB
Adjacent channel selectivity	F = F0 + 1 MHz	-	-	1	-15	dB
	F = F0 - 1 MHz	-	-	-3	-15	dB
	F = F0 + 2 MHz	-	-	21	15	dB
	F = F0 - 2 MHz	-	-	23	15	dB
	F = F0 + 3 MHz	-	-	33	27	dB
	F = F0 - 3 MHz	-	-	34	27	dB

NOTE

Carrier signal strength -67 dBm, adjacent channel interference modulation signal, BER = 0.1 %.

4.3.3. Power Consumption

Table 7: Power Consumption

Operating Modes	Min.	Typ.	Max.	Unit	Note
Deep sleep	-	31.44	-	µA	Stop the broadcast function, the module enters the sleep state
Advertising	-	227	-	µA	ADV interval = 320 ms, the module enters the sleep state
Advertising	-	3.98	-	mA	ADV interval = 320 ms, the module exits the sleep state
Bluetooth receive	-	10.88	-	mA	Conn interval = 11.25 ms
Bluetooth transmit	-	8.42	-	mA	519 bytes transmit every 1 ms
BLE	-	4.7	-	mA	ADV interval = 320 ms, ACTIVE state after connecting the device

5 Module Function Description

5.1. RF Transmitter

The Radio Transceiver implements the RF part of the Bluetooth Low Energy protocol. Together with the Bluetooth 5.0 PHY layer, this provides a reliable wireless communication.

All RF blocks are supplied by on-chip low-drop out-regulators (LDO's). The Bluetooth LE radio comprises the receiver, transmitter, synthesizer, Rx/Tx combiner block, and biasing LDO's.

5.2. Bluetooth Baseband Unit

The BLE (Bluetooth Low Energy) core is a qualified Bluetooth 5.0 baseband controller compatible with Bluetooth Smart specification and it oversees packet encoding/decoding and frame scheduling.

Features:

- All device classes support (broadcaster, central, observer, peripheral)
- All packet types (advertising/data/control)
- Encryption (AES/CCM)
- Bit stream processing (CRC)
- Frequency Hopping calculation
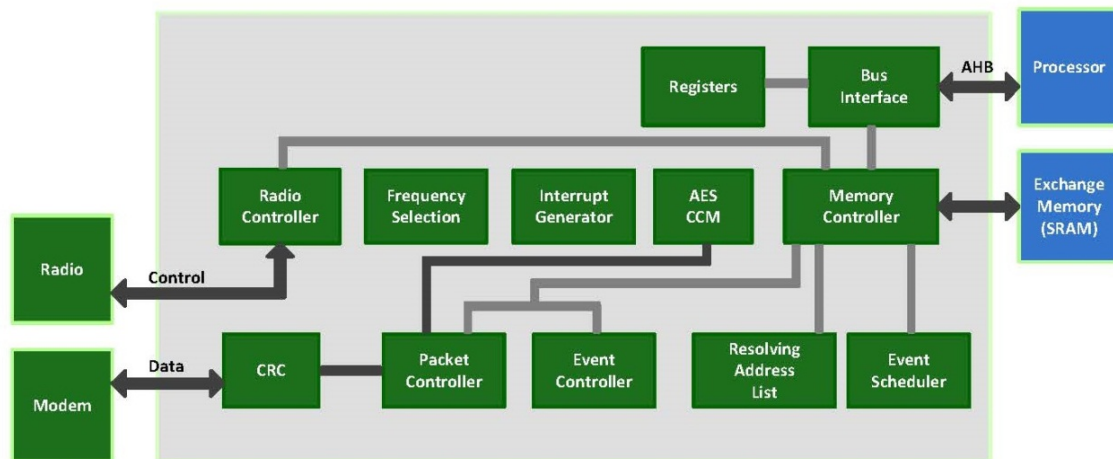- Low power modes supporting 32.768 kHz

Figure 6: Bluetooth Baseband

6 Mechanical Information

This chapter describes the mechanical dimensions of HC06U module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified
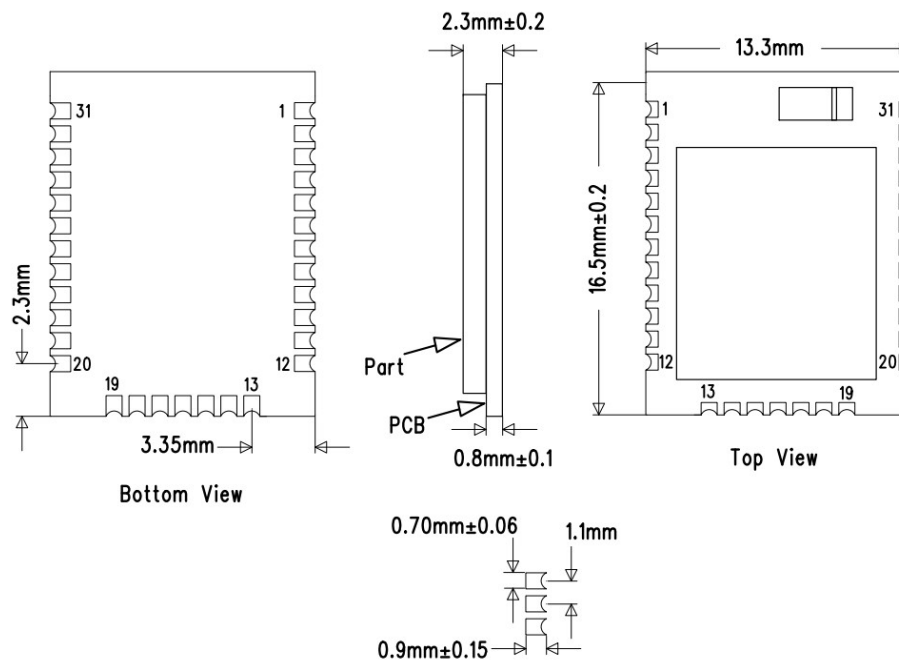
6.1. Mechanical Dimensions

Figure 7: Top and Side Dimensions (Top and Side View)

The detailed size information of HC06U is as follows:

Table 8: Mechanical Dimensions (Top View)

PCB Package	Mechanical Size	Process Type
Stamp holes	(16.5 ±0.2) mm × (13.3 ±0.2) mm × (2.3 ±0.2) mm	SMD

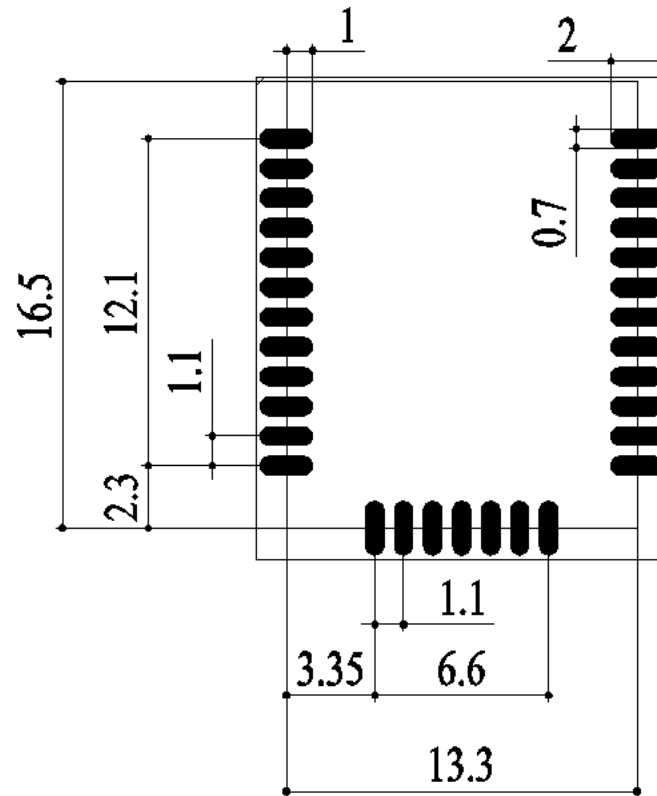## 6.2. Recommended Footprint

Figure 8: PCB Package Dimensions
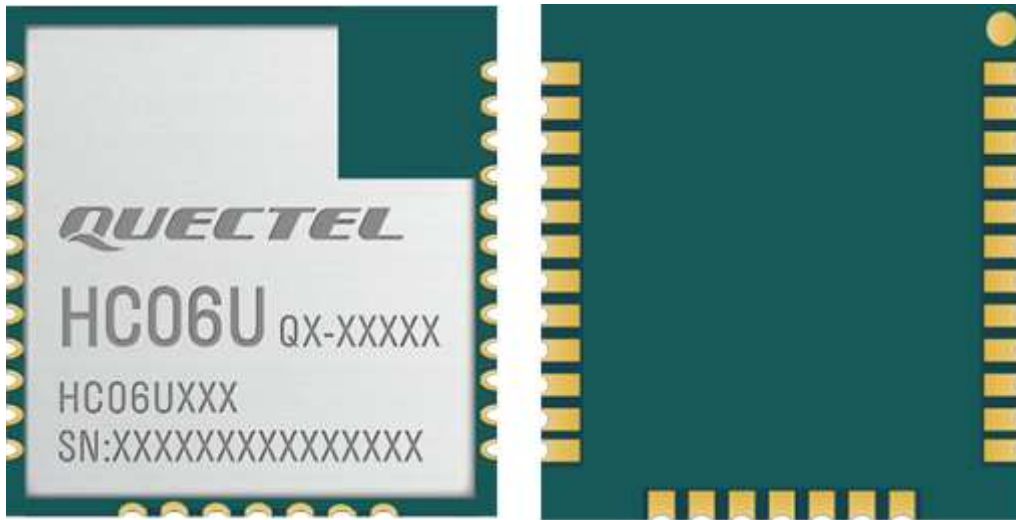
6.3. Top and Bottom Views

Figure 9: Top and Bottom Views

7 Storage, Manufacturing and Packaging

7.1. Storage Condition

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: The temperature should be 23 ±5 °C and the relative humidity should be 35 % to 60 %.

2. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.

3. The floor life of the module is 168 hours [1] in a plant where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g. a drying cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

    ● The module is not stored in Recommended Storage Condition;
    ● Violation of the third requirement above occurs;
    ● Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
    ● Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

    ● The module should be baked for 8 hours at 120 ±5 °C;
    ● All modules must be soldered to PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in a drying oven.

---

[1] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not remove the packages of tremendous modules if they are not ready for soldering.

> **NOTE**
>
> 1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
> 2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
> 3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see **document [1]**.

The peak reflow temperature should be 235–246 ℃, with 246 ℃ as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted only after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.
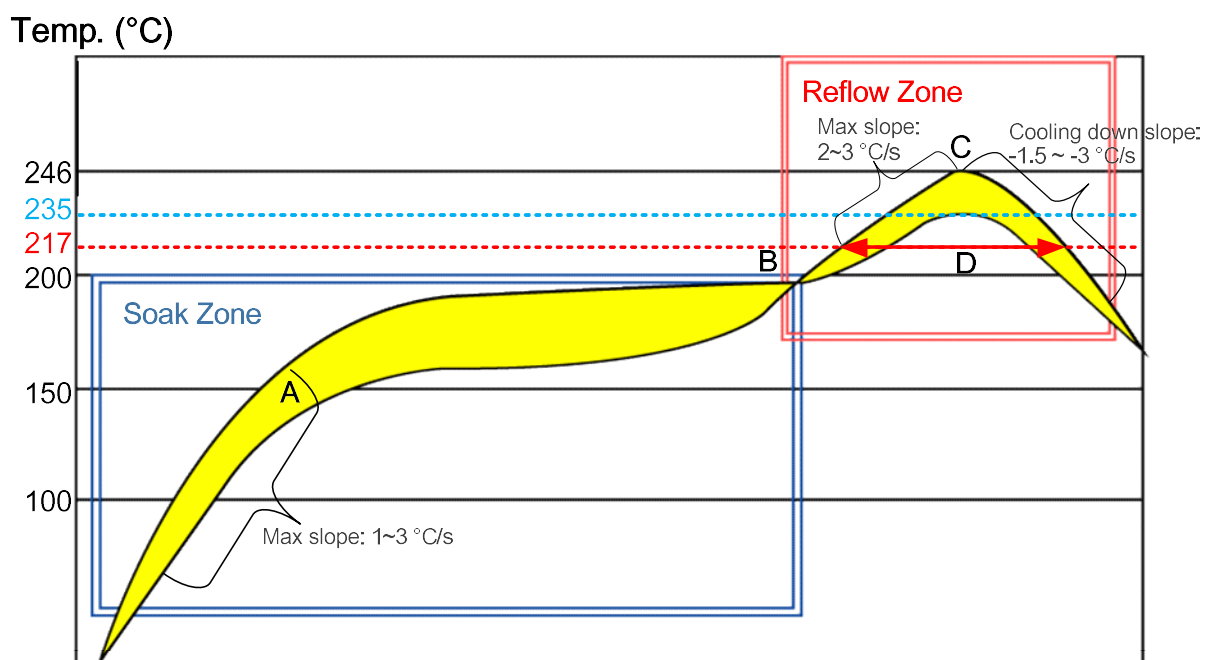

Figure 10: Reflow Soldering Thermal Profile

Table 9: Recommended Thermal Profile Parameters

Factor	Recommendation	
Soak Zone		
Max slope	1–3 °C/s	
Soak time (between A and B: 150 °C and 200 °C)	70–120 s	
Reflow Zone		
Max slope	2–3 °C/s	
Reflow time (D: over 217 °C)	40–70 s	
Max temperature	235 °C to 246 °C	
Cooling down slope	-1.5 to -3 °C/s	
Reflow Cycle		
Max reflow cycle	1	

7.3. Packaging Specification

The module is packaged in a vacuum-sealed bag which is ESD protected. The bag should not be opened until the devices are ready to be soldered onto the application. The following figures show the packaging details, measured in mm.
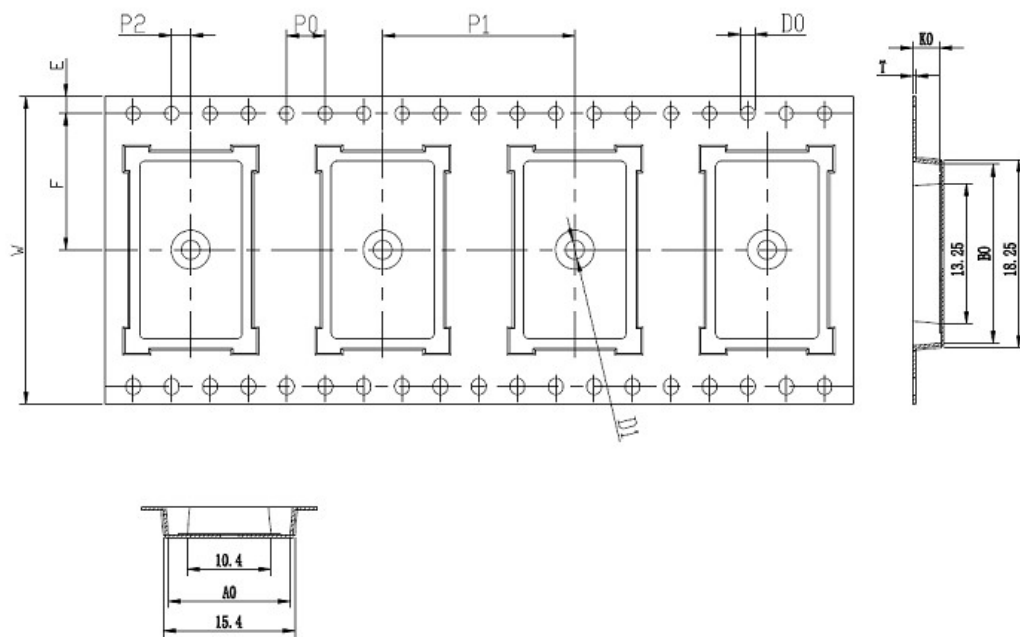
Figure 11: Tape Specifications

8 Appendix Reference

Table 10: Related Document

Document Name
[1] Quectel_Module_Secondary_SMT_Application_Note

Federal Communications Commission (FCC) Declaration of Conformity 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 un-desired operation. 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 equip-ment 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. Radiation Exposure Statement This equipment complies with FCC radiation exposure limits set forth for an uncontrolled rolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. Important Note：This radio module must not installed to co-locate and operating simultaneously with other radios in host system except in accordance with FCC multi-transmitter product procedures. Additional testing and equipment authorization may be required to operating simultaneously with other ra-dio. The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination. The firmware setting is not accessible by the end user. The host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the mod-ular

transmitter installed. The end user manual shall include all required regulatory information/warning as shown in this manual, including: This product must be in-stalled and operated with a minimum distance of 20 cm between the radiator and user body. This device have got a FCC ID: XMR202107HC06U.The final end product must be labeled in a visible area with the following: "Contains Transmitter Mod-ule FCC ID: XMR202107HC06U" This device is intended only for OEM integrators under the following conditions: 1) The antenna must be installed such that 20cm is main-tained between the antenna and users, and 2) The transmitter module may not be co-located with any other transmitter or antenna. As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance require-ments required with this module installed.