Guangzhou HC Information Technology Co., Ltd.

Product Data Sheet

Module Data Sheet

Rev 1

1．0	**1.01**						
2010/5/15	2011/4/6						

DRAWN BY :	Ling Xin		**MODEL :** HC-05	
CHECKED BY :	Eric Huang		**Description:** BC04 has external 8M Flash and EDR mode HC-03 is industrial, and compatible with civil HC-05	
APPD. BY:	Simon Mok		**REV : 2.0**	**PAGES:**
Former version introduction	Linvaor is the former of Wavesen.			

www.wavesen.com Phone: 020-84083341 Fax: 020-84332079 QQ:1043073574
Address: Room 527, No.13, Jiangong Road, Tianhe software park, Tianhe district, Guangzhou Post: 510660
Technology consultant: support@wavesen.com Business consultant:sales@wavesen.com
Complaint and suggestion: sunbirdit@hotmail.com

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1.Product's picture

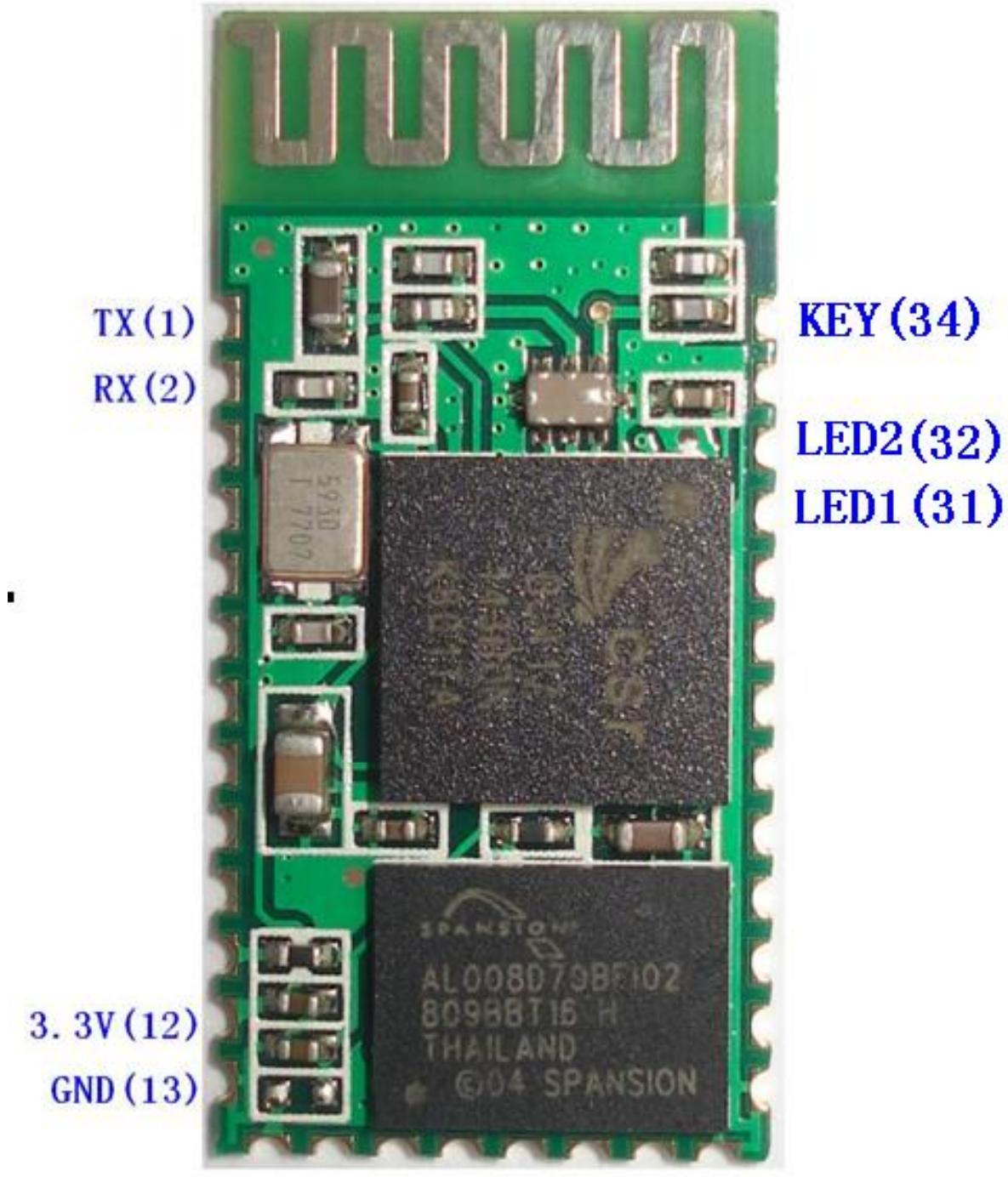

Figure 1. A Bluetooth module

Figure 2 50 pieces chips in an anti-static blister package

2. Feature

- Wireless transceiver
  - Sensitivity (Bit error rate) can reach -80dBm.
  - The change range of output's power: -4 - +6dBm.
- Function description (perfect Bluetooth solution)
  - Has an EDR module; and the change range of modulation depth: 2Mbps - 3Mbps.
  - Has a build-in 2.4GHz antenna; user needn't test antenna.

- Has the external 8Mbit FLASH
- Can work at the low voltage (3.1V~4.2V). The current in pairing is in the range of 30～40mA. The current in communication is 8mA.
- PIO control can be switched.
- Has the standard HCI Port (UART or USB)
- The USB protocol is Full Speed USB1.1, and compliant with 2.0.
- This module can be used in the SMD.
- It's made through RoHS process.
- The board PIN is half hole size.
- Has a 2.4GHz digital wireless transceiver.
- Bases at CSR BC04 Bluetooth technology.
- Has the function of adaptive frequency hopping.
- Small (27mm×13mm×2mm).
- Peripheral circuit is simple.
- It's at the Bluetooth class 2 power level.
- Storage temperature range: -40 ℃ - 85℃, operating temperature range: -25 ℃ - +75℃
- Any wave inter Interference: 2.4MHz， the power of emitting: 3 dBm.
- Bit error rate: 0. Only the signal decays at the transmission link, bit error may be produced. For example, when RS232 or TTL is being processed, some signals may decay.

- Low power consumption
- Has high-performance wireless transceiver system
- Low Cost
- Application fields:
  - Bluetooth Car Handsfree Device
  - Bluetooth GPS
  - Bluetooth PCMCIA , USB Dongle
  - Bluetooth Data Transfer
- Software
  - CSR

3. PINs description

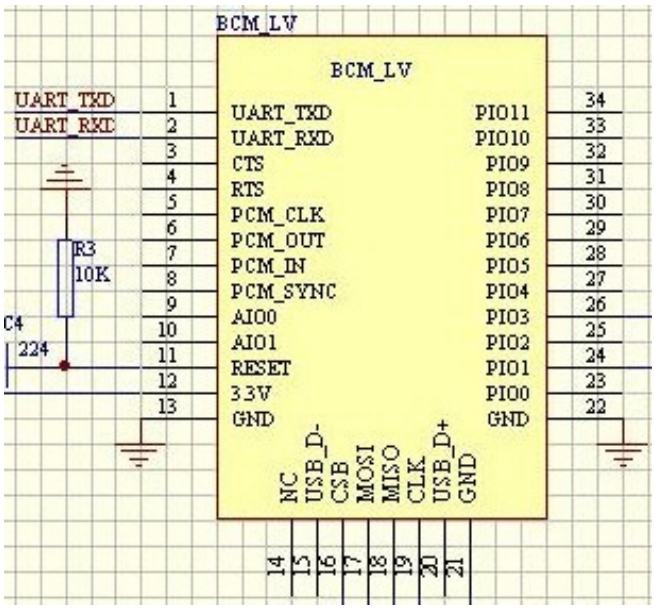

Figure 3 PIN configuration

The PINs at this block diagram is same as the physical one.

PIN Name	PIN #	Pad type	Description	Note
GND	13 21 22	VSS	Ground pot	
1V8	14	VDD	Integrated 1.8V (+) supply with On-chip linear regulator output within 1.7-1.9V	
VCC	12	3.3V		
AIO0	9	Bi-Directional	Programmable input/output line	
AIO1	10	Bi-Directional	Programmable input/output line	
PIO0	23	Bi-Directional RX EN	Programmable input/output line, control output for LNA(if fitted)	
PIO1	24	Bi-Directional TX EN	Programmable input/output line, control output for PA(if fitted)	
PIO2	25	Bi-Directional	Programmable	

			input/output line	
PIO3	26	Bi-Directional	Programmable input/output line	
PIO4	27	Bi-Directional	Programmable input/output line	
PIO5	28	Bi-Directional	Programmable input/output line	
PIO6	29	Bi-Directional	Programmable input/output line	CLK_REQ
PIO7	30	Bi-Directional	Programmable input/output line	CLK_OUT
PIO8	31	Bi-Directional	Programmable input/output line	
PIO9	32	Bi-Directional	Programmable input/output line	
PIO10	33	Bi-Directional	Programmable input/output line	
PIO11	34	Bi-Directional	Programmable input/output line	
RESETB	11	CMOS Input with weak intemal pull-down		
UART_RTS	4	CMOS output, tri-stable with weak internal pull-up	UART request to send, active low	
UART_CTS	3	CMOS input with weak internal pull-down	UART clear to send, active low	
UART_RX	2	CMOS input with weak internal pull-down	UART Data input	
UART_TX	1	CMOS output, Tri-stable with weak internal pull-up	UART Data output	
SPI_MOSI	17	CMOS input with weak internal pull-down	Serial peripheral interface data input	
SPI_CSB	16	CMOS input with weak internal pull-up	Chip select for serial peripheral interface, active low	
SPI_CLK	19	CMOS input with weak	Serial peripheral interface	

		internal pull-down	clock	
SPI_MISO	18	CMOS input with weak internal pull-down	Serial peripheral interface data Output	
USB_-	15	Bi-Directional		
USB_+	20	Bi-Directional		
1.8V	14		1.8V external power supply input	Default : 1.8V internal power supply.
PCM_CLK	5	Bi-Directional		
PCM_OUT	6	CMOS output		
PCM_IN	7	CMOS Input		
PCM_SYNC	8	Bi-Directional		

4. The parameters and mode of product

LINVOR BLUE T

www.linvor.com

Bluetooth Module

Bluetooth

CSR,BC417143B

V 2.0

2006/09/6

蓝牙 **RF** 模块

1. 采用 CSR BC4 +8M FLASH 方案
2. 具有 PIO0-PIO11、AIO0、AIO1、USB、PCM、UART 及 SPI 接口，模块内置 8MFLASH，功能强大，用户可定制软件,适用于各种蓝牙设备，内置 RF 天线,便于调试。

蓝牙协议版本	Bluetooth Specifcation V2.0 With EDR
USB 协议 USB Protocol	Full Speed USB V1.1 Compliant With USB V2.0
频率	2.4Ghz ISM band
调制方式	GFSK(Gaussian Frequency Shift Keying)
发射功率	-4 ->4 dBm, Class 2
灵敏度	≤-80dBm at 0.1% BER
通讯速率	Asynchronous:2Mbps(Max)
供电电源	3.3V
工作温度	-20~+55 Centigrade
封装尺寸	27mmX13mmX2mm

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If you want more information, please visit www.wavesen.com.

LINVOR BLUE T

LV-BC-2.0

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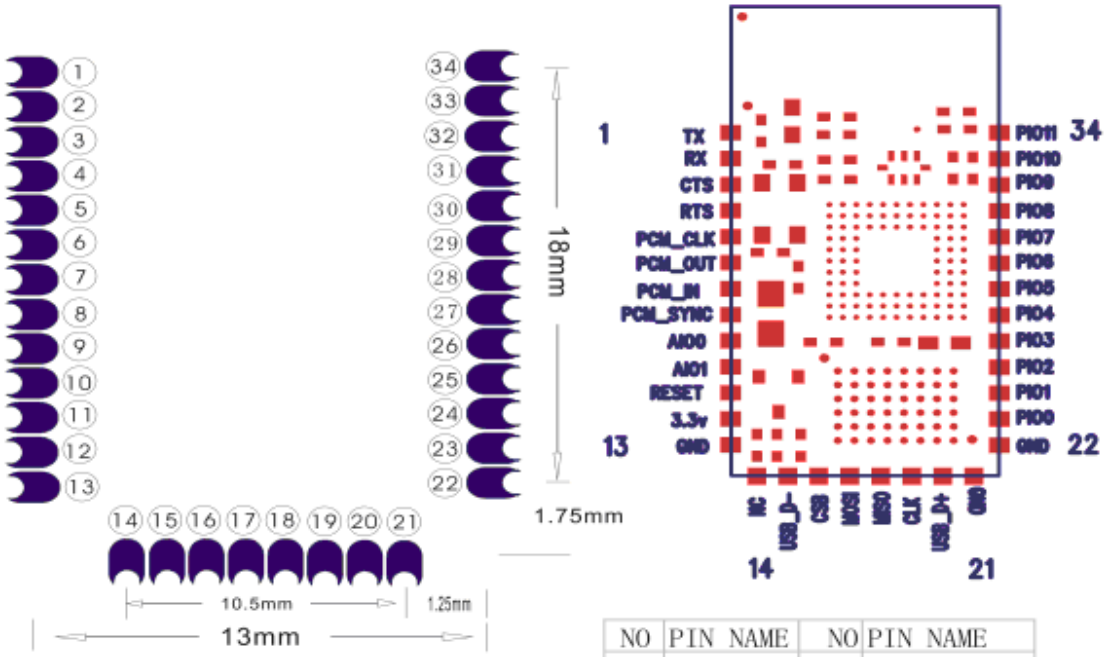
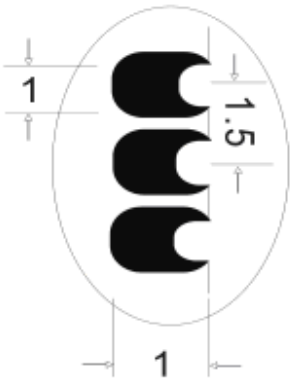
单位： mm





PCB Layout 请参考实物

NO	PIN NAME	NO	PIN NAME
1	TX	20	USB D+
2	RX	21	GND
3	CTS	22	GND
4	RTS	23	PIO0
5	PCM CLK	24	PIO1
6	PCM OUT	25	PIO2
7	PCM IN	26	PIO3
8	PCM SYNC	27	PIO4
9	AIO0	28	PIO5
10	AIO1	29	PIO6
11	RESET	30	PIO7
12	3.3V	31	PIO8
13	GND	32	PIO9
14	NC	33	PIO10
15	USB D-	34	PIO11
16	CSB		
17	MOSI		
18	MISO		
19	CLK		

5. Block diagram

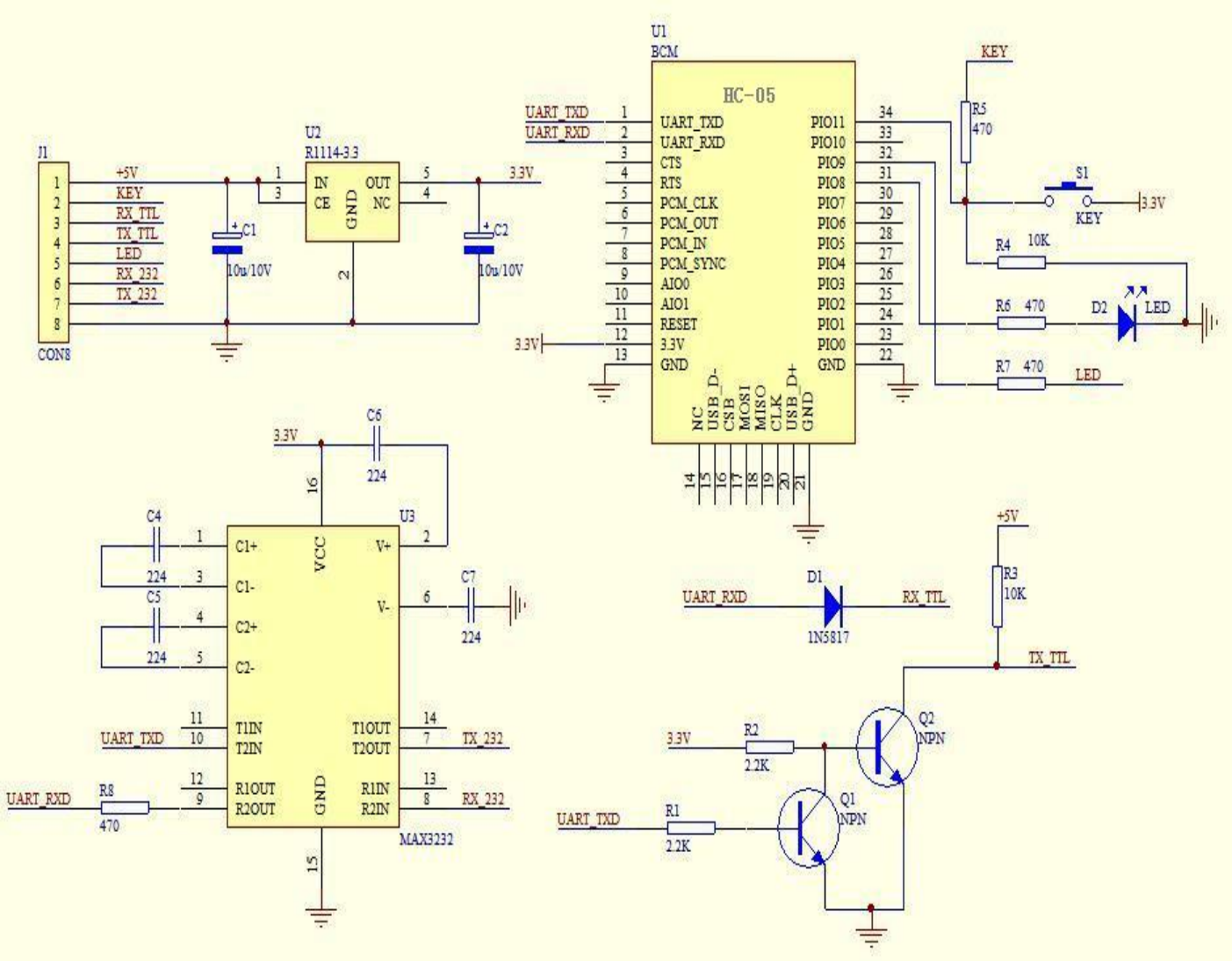


Figure 5 Block diagram

6. Debugging device

6.1 Device

PC, hardware, 3G，3G Frequency Counter (SP3386), 3.15V DC power supply, Shielding，Bluetooth Test box.

6.2 Software

7. Characteristic of test

Test Condition 25℃ RH 65%

		Min	Typ	Max	Unit
1.	Carrier Freq. (*ISM Band*)	2.4		2.4835	MHz
2.	RF O/P Power	-6	2	4	dBm
3.	Step size of Power control	2		8	dB
4.	Freq. Offset (*Typical Carrier freq.*)	-75		75	KHz
5.	Carrier Freq. drift (*Hopping on, drift rate/50uS*)	-20		20	KHz
	1 slot packet	-25		25	KHz
	3 slot packet	-40		-40	KHz
6.	Average Freq. Deviations (*Hopping off, modulation*)	140		175	KHz
	Freq. Deviation	115			KHz
	Ratio of Freq. Deviation	0.8			
7 .	Receive Sensitivity @< 0.1% BER*(Bit error rate)*	-83			dBm

8. Test diagram

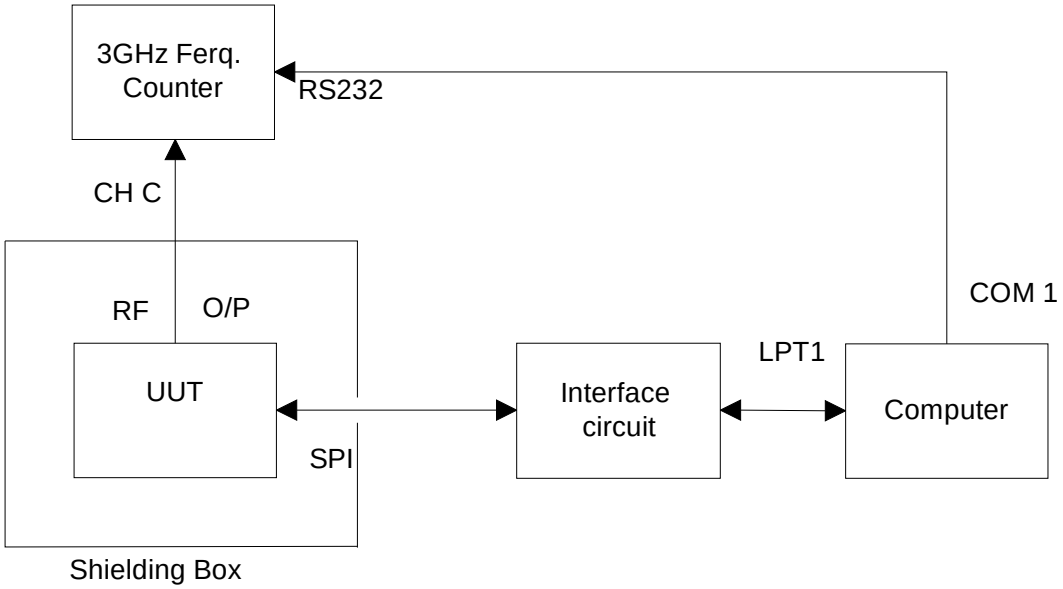


Fig 1. Programming and Freq. Alignment

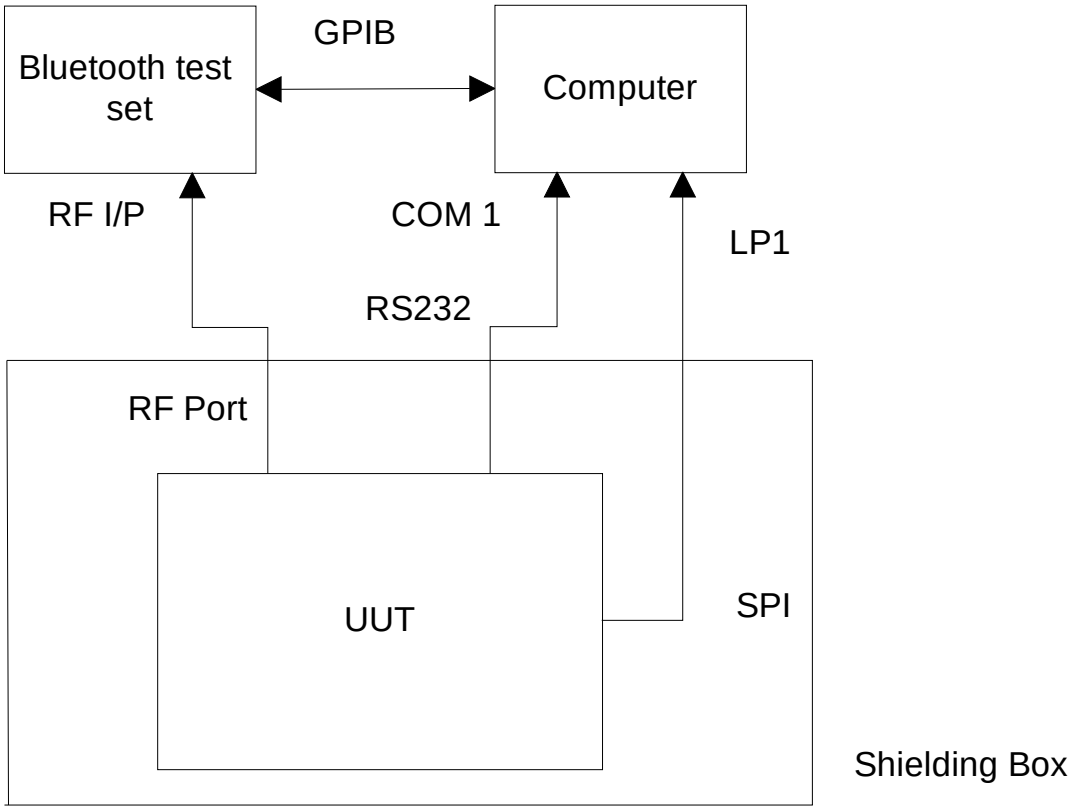


Fig 2 RF parameter Test Procedure

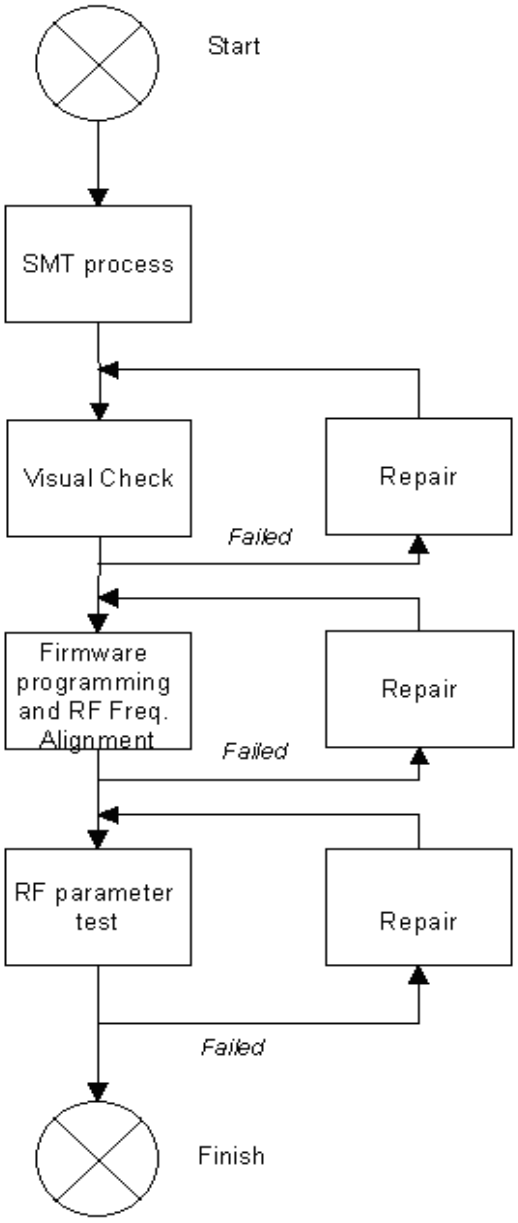


Fig 3 Assemble/Alignment/Testing Flow Chart

9. AT command set

More information about command set is provided at HC-05 master-salve bluetooth serial module command set.pdf. Please download it from our company website www.wavesen.com.

HC Serial Bluetooth Products

User Instructional Manual

1 Introduction

HC serial Bluetooth products consist of Bluetooth serial interface module and Bluetooth adapter, such as:

(1) Bluetooth serial interface module:

Industrial level: HC-03, HC-04(HC-04-M, HC-04-S)

Civil level: HC-05, HC-06(HC-06-M, HC-06-S)

HC-05-D, HC-06-D (with baseboard, for test and evaluation)

(2) Bluetooth adapter:

HC-M4

HC-M6

This document mainly introduces Bluetooth serial module. Bluetooth serial module is used for converting serial port to Bluetooth. These modules have two modes: master and slaver device. The device named after even number is defined to be master or slaver when out of factory and can't be changed to the other mode. But for the device named after odd number, users can set the work mode (master or slaver) of the device by AT commands.

HC-04 specifically includes:

Master device: HC-04-M, M=master

Slave device: HC-04-S, S=slaver

The default situation of HC-04 is slave mode. If you need master mode, please state it clearly or place an order for HC-O4-M directly.The naming rule of HC-06 is same.

When HC-03 and HC-05 are out of factory, one part of parameters are set for activating the device. The work mode is not set, since user can set the mode of HC-03, HC-05 as they want.

The main function of Bluetooth serial module is replacing the serial port line, such as:

1. There are two MCUs want to communicate with each other. One connects to Bluetooth master device while the other one connects to slave device. Their connection can be built once the pair is made. This Bluetooth connection is equivalently liked to a serial port line connection including RXD, TXD

signals. And they can use the Bluetooth serial module to communicate with each other.

2. When MCU has Bluetooth salve module, it can communicate with Bluetooth adapter of computers and smart phones. Then there is a virtual communicable serial port line between MCU and computer or smart phone.

3. The Bluetooth devices in the market mostly are salve devices, such as Bluetooth printer, Bluetooth GPS. So, we can use master module to make pair and communicate with them.

Bluetooth Serial module's operation doesn't need drive, and can communicate with the other Bluetooth device who has the serial. But communication between two Bluetooth modules requires at least two conditions:

(1) The communication must be between master and slave.

(2) The password must be correct.

However, the two conditions are not sufficient conditions. There are also some other conditions basing on different device model. Detailed information is provided in the following chapters.

In the following chapters, we will repeatedly refer to Linvor's (Formerly known as Guangzhou HC Information Technology Co., Ltd.) material and photos.

2 Selection of the Module

The Bluetooth serial module named even number is compatible with each other; The salve module is also compatible with each other. In other word, the function of HC-04 and HC-06, HC-03 and HC-05 are mutually compatible with each other. HC-04 and HC-06 are former version that user can't reset the work mode (master or slave). And only a few AT commands and functions can be used, like reset the name of Bluetooth (only the slaver), reset the password, reset the baud rate and check the version number. The command set of HC-03 and HC-05 are more flexible than HC-04 and HC-06's. Generally, the Bluetooth of HC-03/HC-05 is recommended for the user.

Here are the main factory parameters of HC-05 and HC-06. Pay attention to the differences:

HC-05	HC-06
Master and slave mode can be switched	Master and slave mode can't be switched
Bluetooth name: HC-05	Bluetooth name: linvor
Password:1234	Password:1234

Master role: have no function to remember the last paired salve device. It can be made paired to any slave device. In other words, just set AT+CMODE=1 when out of factory. If you want HC-05 to remember the last paired slave device address like HC-06, you can set AT+CMODE=0 after paired with the other device. Please refer the command set of HC-05 for the details.	Master role: have paired memory to remember last slave device and only make pair with that device unless KEY (PIN26) is triggered by high level. The default connected PIN26 is low level.
Pairing: The master device can not only make pair with the specified Bluetooth address, like cell-phone, computer adapter, slave device, but also can search and make pair with the slave device automatically. Typical method: On some specific conditions, master device and slave device can make pair with each other automatically. (This is the default method.)	Pairing: Master device search and make pair with the slave device automatically. Typical method: On some specific conditions, master and slave device can make pair with each other automatically.
Multi-device communication: There is only point to point communication for modules, but the adapter can communicate with multi-modules.	Multi-device communication: There is only point to point communication for modules, but the adapter can communicate with multi-modules.
AT Mode 1: After power on, it can enter the AT mode by triggering PIN34 with high level. Then the baud rate for setting AT command is equal to the baud rate in communication, for example: 9600. AT mode 2: First set the PIN34 as high level, or while on powering the module set the PIN34 to be high level, the Baud rate used here is 38400 bps. Notice: All AT commands can be operated only	AT Mode: Before paired, it is at the AT mode. After paired it's at transparent communication.

when the PIN34 is at high level. Only part of the AT commands can be used if PIN34 doesn't keep the high level after entering to the AT mode. Through this kind of designing, set permissions for the module is left to the user's external control circuit, that makes the application of HC-05 is very flexible.	
During the process of communication, the module can enter to AT mode by setting PIN34 to be high level. By releasing PIN34, the module can go back to communication mode in which user can inquire some information dynamically. For example, to inquire the pairing is finished or not.	During the communication mode, the module can't enter to the AT mode.
Default communication baud rate: 9600, 4800-1.3M are settable.	Default communication baud rate: 9600, 1200-1.3M are settable.
KEY: PIN34, for entering to the AT mode.	KEY: PIN26, for master abandons memory.
LED1: PIN31, indicator of Bluetooth mode. Slow flicker (1Hz) represents entering to the AT mode2, while fast flicker(2Hz) represents entering to the AT mode1 or during the communication pairing. Double flicker per second represents pairing is finished, the module is communicable. LED2: PIN32, before pairing is at low level, after the pairing is at high level. The using method of master and slaver's indicator is the same. Notice: The PIN of LED1 and LED2 are connected with LED+.	LED: The flicker frequency of slave device is 102ms. If master device already has the memory of slave device, the flicker frequency during the pairing is 110ms/s. If not, or master has emptied the memory, then the flicker frequency is 750m/s. After pairing, no matter it's a master or slave device, the LED PIN is at high level. Notice: The LED PIN connects to LED+ PIN.
Consumption: During the pairing, the current is	Consumption: During the pairing, the current is

fluctuant in the range of 30-40mA. The mean current is about 25mA. After paring, no matter processing communication or not, the current is 8mA. There is no sleep mode. This parameter is same for all the Bluetooth modules.	fluctuant in the range of 30-40 m. The mean current is about 25mA. After paring, no matter processing communication or not, the current is 8mA. There is no sleep mode. This parameter is same for all the Bluetooth modules.
Reset: PIN11, active if it's input low level. It can be suspended in using.	Reset: PIN11, active if it's input low level. It can be suspended in using.
Level: Civil	Level: Civil

The table above that includes main parameters of two serial modules is a reference for user selection.

HC-03/HC-05 serial product is recommended.

3. Information of Package

The PIN definitions of HC-03, HC-04, HC-05 and HC-06 are kind of different, but the package size is the same: 28mm * 15mm * 2.35mm.

The following figure 1 is a picture of HC-06 and its main PINs. Figure 2 is a picture of HC-05 and its main PINs. Figure 3 is a comparative picture with one coin. Figure 4 is their package size information. When user designs the circuit, you can visit the website of Guangzhou HC Information Technology Co., Ltd. (www.wavesen.com) to download the package library of protle version.

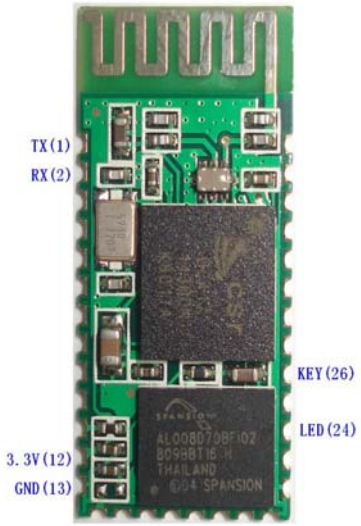


Figure 1 HC-06

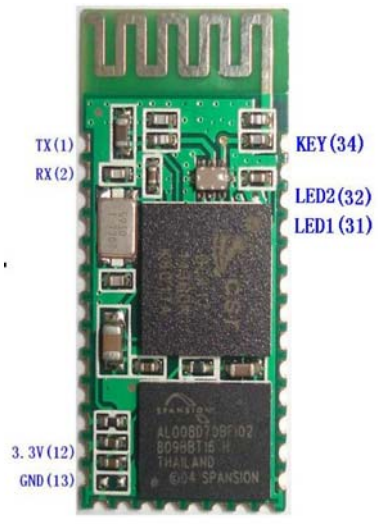


Figure 2 HC-05

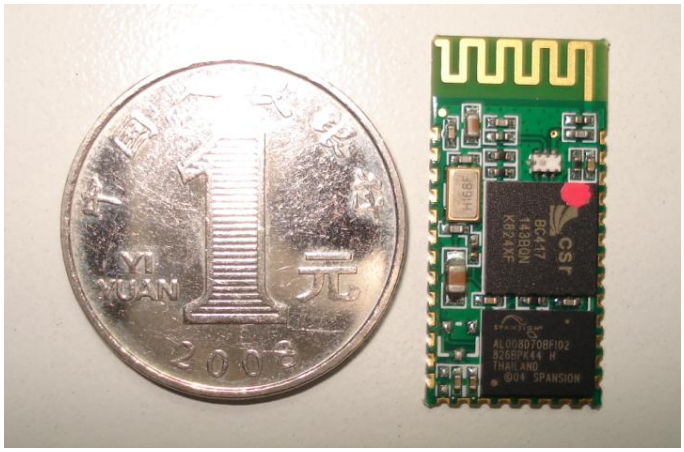
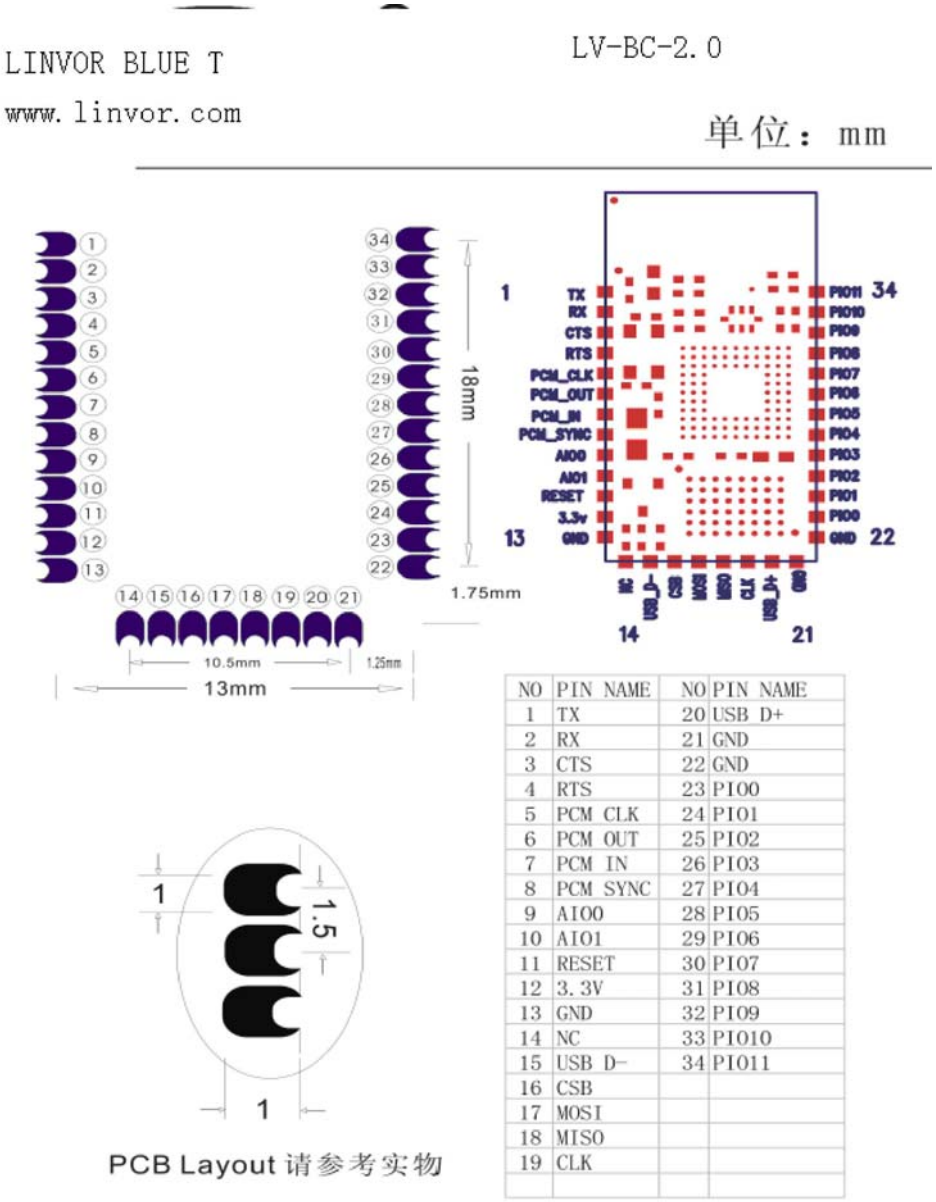


Figure 3 Comparative picture with one coin



NO	PIN NAME	NO	PIN NAME
1	TX	20	USB D+
2	RX	21	GND
3	CTS	22	GND
4	RTS	23	PIO0
5	PCM CLK	24	PIO1
6	PCM OUT	25	PIO2
7	PCM IN	26	PIO3
8	PCM SYNC	27	PIO4
9	AIO0	28	PIO5
10	AIO1	29	PIO6
11	RESET	30	PIO7
12	3.3V	31	PIO8
13	GND	32	PIO9
14	NC	33	PIO10
15	USB D-	34	PIO11
16	CSB		
17	MOSI		
18	MISO		
19	CLK		

Figure 4 Package size information

4. The Using and Testing Method of HC-06 for the First Time

This chapter will introduce the using method of HC-06 in detail. User can test the module according to this chapter when he or she uses the module at the first time.

PINs description:

PIN1	UART_TXD , TTL/CMOS level, UART Data output
PIN2	UART_RXD, TTL/COMS level, s UART Data input
PIN11	RESET, the reset PIN of module, inputting low level can reset the module, when the module is in using, this PIN can connect to air.
PIN12	VCC, voltage supply for logic, the standard voltage is 3.3V, and can work at 3.0-4.2V
PIN13	GND
PIN22	GND
PIN24	LED, working mode indicator Slave device: Before paired, this PIN outputs the period of 102ms square wave. After paired, this PIN outputs high level. Master device: On the condition of having no memory of pairing with a slave device, this PIN outputs the period of 110ms square wave. On the condition of having the memory of pairing with a slave device, this PIN outputs the period of 750ms square wave. After paired, this PIN outputs high level.
PIN26	For master device, this PIN is used for emptying information about pairing. After emptying, master device will search slaver randomly, then remember the address of the new got slave device. In the next power on, master device will only search this address.

(1) The circuit 1 (connect the module to 3.3V serial port of MCU) is showed by figure 5.

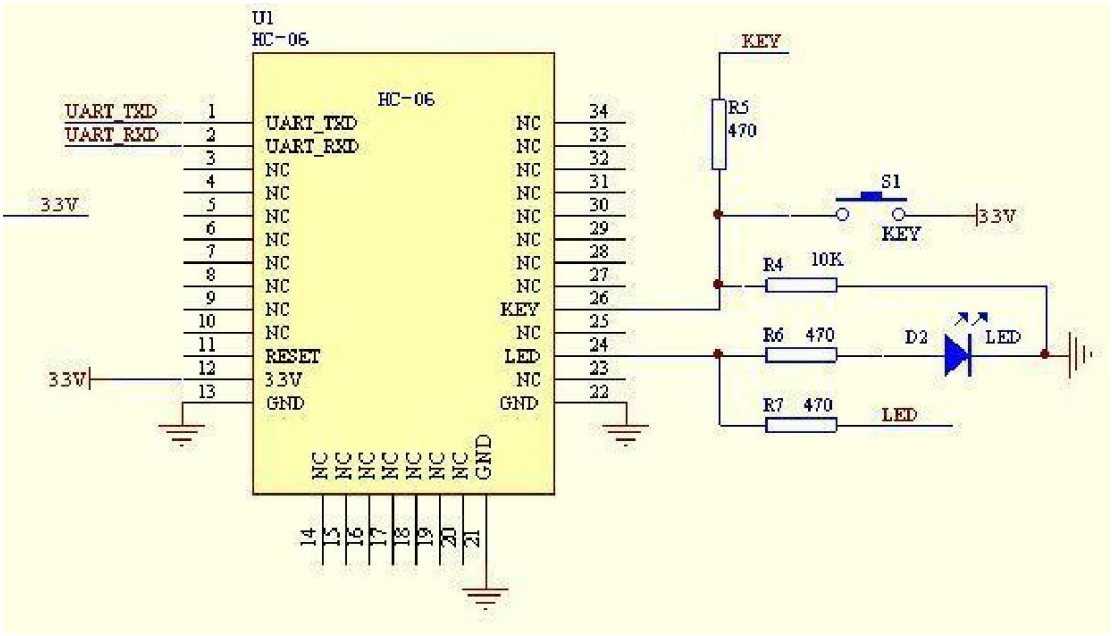


Figure 5 The circuit 1

In principle, HC-06 can work when UART_TXD, UART_RXD, VCC and GND are connected. However, for better testing results, connecting LED and KEY are recommended (when testing the master).

Where, the 3.3V TXD of MCU connects to HC-06's UART_RXD, the 3.3V RXD of MCU connects to HC-06's UART_TXD, and 3.3V power and GND should be connected. Then the minimum system is finished.

Note that, the PIN2:UART_RXD of Bluetooth module has no pull-up resistor. If the MCU TXD doesn't have pull-up function, then user should add a pull-up resistor to the UART_RXD. It may be easy to be ignored.

If there are two MCU which connect to master and slave device respectively, then before paired(LED will flicker) user can send AT commands by serial port when the system is power on. Please refer to HC-04 and HC-06's data sheet for detailed commands. In the last chapter, the command set will be introduced. Please pay attention to that the command of HC-04/HC-06 doesn't have terminator. For example, consider the call command, sending out AT is already enough, need not add the CRLF (carriage return line feed).

If the LED is constant lighting, it indicates the pairing is finished. The two MCUs can communicate with each other by serial port. User can think there is a serial port line between two MCUs.

(2) The circuit 2 (connect the module to 5V serial port of MCU) is showed by figure 6.

Figure 6 is the block diagram of Bluetooth baseboard. This kind of circuit can amplify Bluetooth module's operating voltage to 3.1-6.5V. In this diagram, the J1 port can not only be connected with MCU system of 3.3V and 5V, but also can be connected with computer serial port.

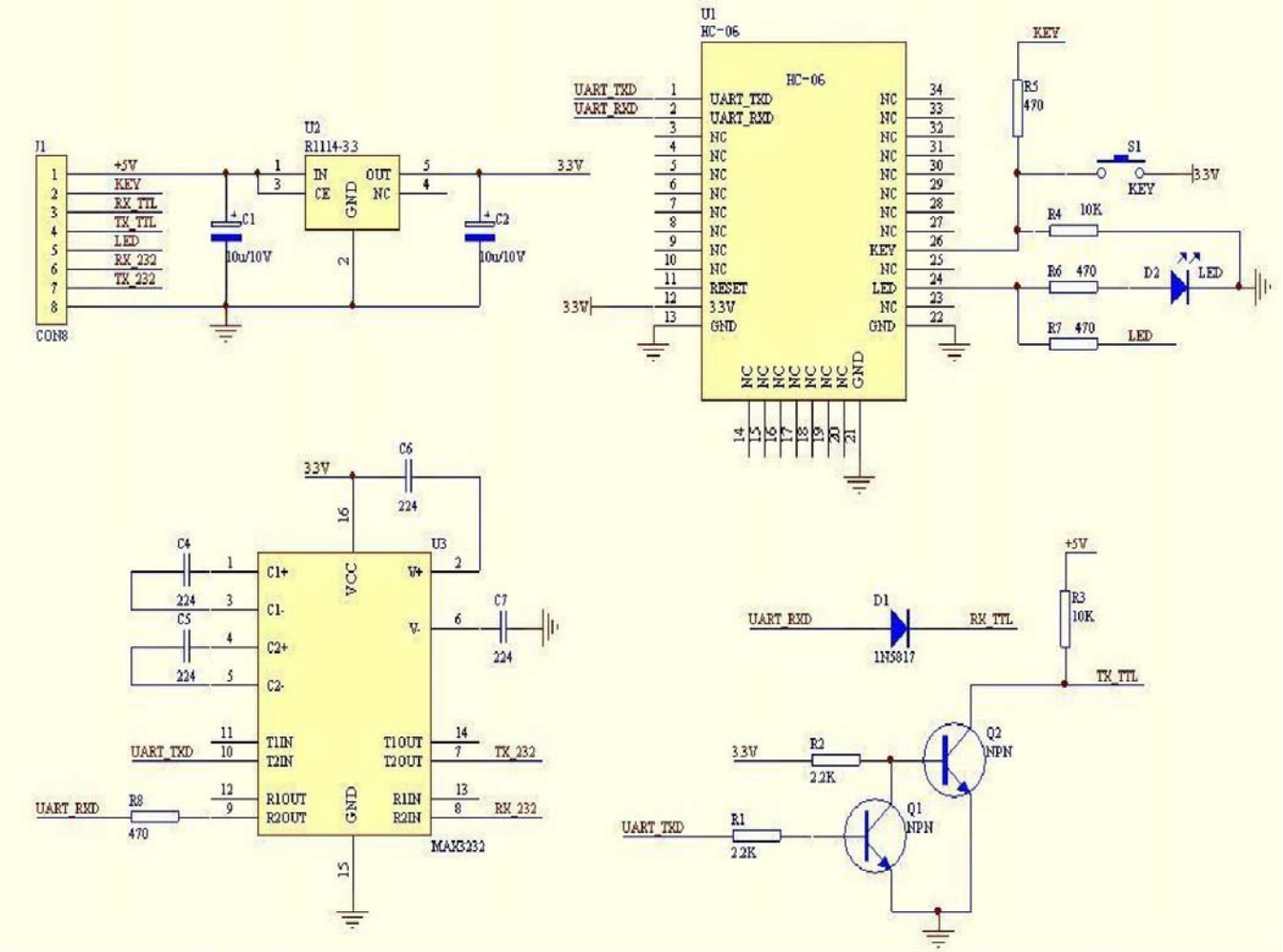


Figure 6 The circuit 2

(3) AT command test

Before paired, the mode of HC-04 and HC-06 are AT mode.

On the condition of 9600N81, OK will be received when user send the two letters AT. Please refer to the last chapter of datasheet for other commands of HC-06. Please pay attention to that sending out AT is already enough, need not add the CRLF (carriage return line feed).

The command set of Version V1.4 doesn't include parity. The version V1.5 and its later version have parity function. Moreover, there are three more commands of V1.5 than V1.4. They are:

No parity (default) AT+PN

Odd parity AT+PO

Even parity AT+PE

Do not let the sending frequency of AT command of HC-06 exceed 1Hz, because the command of HC-06 end or not is determined by the time interval.

(4) Pairing with adapter

User can refer to the download center of the company's website for "The Introduction of IVT" that introduces the Bluetooth module makes pair with computer adapter. That document taking HC-06-D for example introduces how the serial module makes pair with the adapter. That method is like to make pair with cell-phone. But the difference is that cell-phone need a third-party communication software to help. It's liked the kind of PC serial helper of and the hyper terminal. A software named "PDA serial helper" provided by our company is suitable for WM system. It has been proven that this serial module is supported by many smart phone systems' Bluetooth, such as, sybian, android, windows mobile and etc.

(5) Pairing introduction

HC-06 master device has no memory before the first use. If the password is correct, the mater device will make pair with the slave device automatically in the first use. In the following use, the master device will remember the Bluetooth address of the last paired device and search it. The searching won't stop until the device is found. If master device's PIN26 is input high level, the device will lose the memory. In that occasion, it'll search the proper slave device like the first use. Based on this function, the master device can be set to make pair with the specified address or any address by user.

(6) Reset new password introduction

User can set a new password for the HC-06 through AT+PINxxxx command. But the new password will become active after discharged all the energy of the module. If the module still has any energy, the old one is still active. In the test, for discharging all the system energy and activating the new password, we can connect the power supply PIN with GND about 20 seconds after the power is cut off. Generally, shutting down the device for 30 minutes also can discharge the energy, if there is no peripheral circuit helps discharge energy. User should make the proper way according to the specific situation.

(7) Name introduction

If the device has no name, it's better that user doesn't try to change the master device name. The name should be limited in 20 characters.

Summary: The character of HC-06: 1 not many command 2 easy for application 3 low price. It's good for some specific application. HC-04 is very similar with HC-06. Their only one difference is HC-04 is for industry, HC-06 is for civil. Except this, they don't have difference.

The following reference about HC-04 and HC-06 can be downloaded from company website www.wavesen.com:

HC-06 datasheet .pdf	(the command set introduction is included)
HC-04 datasheet .pdf	(the command set introduction is included)
IVT BlueSoleil-2.6	(IVT Bluetooth drive test version)
Bluetooth FAQ.pdf	
HC-04-D(HD-06-D)datasheet(English).pdf	
HC-06-AT command software (test version)	(some commands in V1.5 is not supported by V1.4)
PCB package of Bluetooth key modules	(PCB package lib in protel)
IVT software manual.pdf	(introduce how to operate the modern and make pair with Bluetooth module)
PDA serial test helper.exe	(serial helper used for WM system)

5 manual for the first use of HC-05

This chapter will introduce how to test and use the HC-05 if it's the first time for user to operate it.

(1) PINs description

PIN1	UART_TXD, Bluetooth serial signal sending PIN, can connect with MCU's RXD PIN
PIN2	UART_RXD, Bluetooth serial signal receiving PIN, can connect with the MCU's TXD PIN, there is no pull-up resistor in this PIN. But It needs to be added an eternal pull-up resistor.
PIN11	RESET, the reset PIN of module, inputting low level can reset the module, when the module is in using, this PIN can connect to air.
PIN12	VCC, voltage supply for logic, the standard voltage is 3.3V, and can work at 3.0-4.2V
PIN13	GND

PIN31	LED1, indicator of work mode. Has 3 modes: When the module is supplied power and PIN34 is input high level, PIN31 output 1Hz square wave to make the LED flicker slowly. It indicates that the module is at the AT mode, and the baud rate is 38400; When the module is supplied power and PIN34 is input low level, PIN31 output 2Hz square wave to make the LED flicker quickly. It indicates the module is at the pairable mode. If PIN34 is input high level, then the module will enter to AT mode, but the output of PIN31 is still 2Hz square wave. After the pairing, PIN31 output 2Hz square ware. Note: if PIN34 keep high level, all the commands in the AT command set can be in application. Otherwise, if just excite PIN34 with high level but not keep, only some command can be used. More information has provided at chapter 2.
PIN32	Output terminal. Before paired, it output low level. Once the pair is finished, it output high level.
PIN34	Mode switch input. If it is input low level, the module is at paired or communication mode. If it's input high level, the module will enter to AT mode. Even though the module is at communication, the module can enter to the AT mode if PIN34 is input high level. Then it will go back to the communication mode if PIN34 is input low level again.

(2) Application circuit 1 (connect to the 3.3V system)

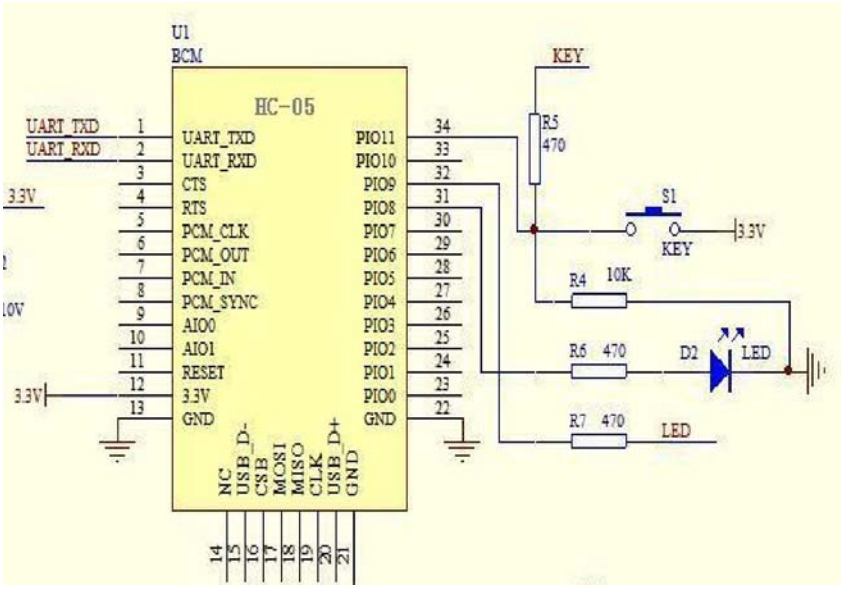


Figure 7 Application 1

(3) Application circuit 2 (connect to 5V serial system or PC serial)

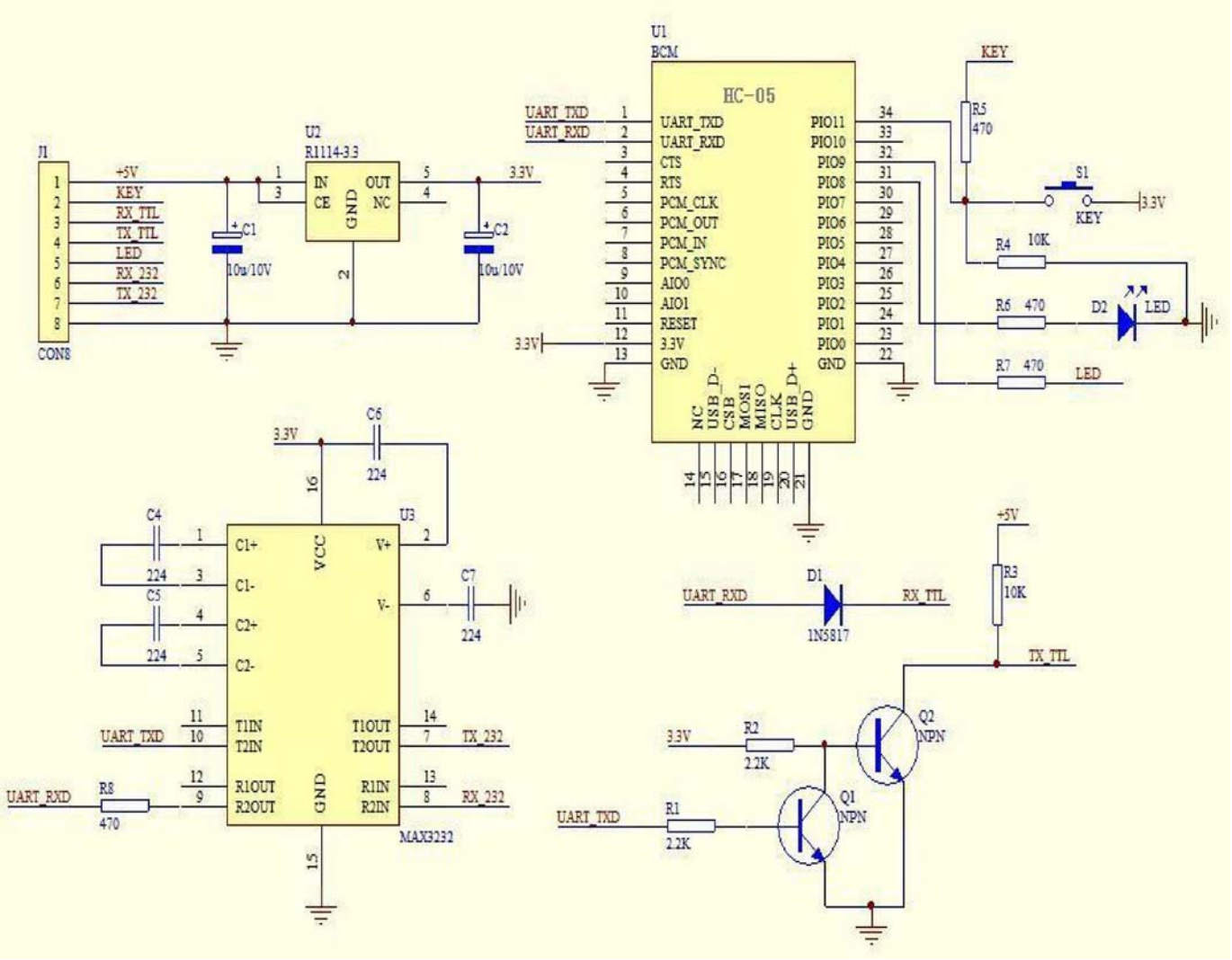


Figure 8 Application circuit 2

(4) AT command test

This chapter introduces some common commands in use. The detail introduction about HC-05 command is in HC-0305 AT command set.

Enter to AT mode:

Way1: Supply power to module and input high level to PIN34 at the same time, the module will enter to AT mode with the baud rate-38400.

Way2: In the first step, supply power to module; In the second step, input high level to PIN34. Then the module will enter to AT mode with the baud rate-9600. Way1 is recommended.

Command structure: all command should end up with “\r\n” (Hex: 0X0D X0A) as the terminator. If

the serial helper is installed, user just need enter “ENTER” key at the end of command.

Reset the master-slave role command:

AT+ROLE=0 ----Set the module to be salve mode. The default mode is salve.

AT+ROLE=1 ----Set the module to be master mode.

Set memory command:

AT+CMODE=1

Set the module to make pair with the other random Bluetooth module (Not specified address). The default is this mode.

AT+CMODE=1

Set the module to make pair with the other Bluetooth module (specified address). If set the module to make pair with random one first, then set the module to make pair with the Bluetooth module has specified address. Then the module will search the last paired module until the module is found.

Reset the password command

AT+PSWD=XXXX

Set the module pair password. The password must be 4-bits.

Reset the baud rate

AT+UART== <Param>,<Param2>,<Param3>.

More information is provided at HC-0305 command set

Example:

AT+UART=9600,0,0 ----set the baud rate to be 9600N81

Reset the Bluetooth name

AT+NAME=XXXXX

Summary:

HC-05 has many functions and covers all functions of HC-06. The above commands are the most common ones. Besides this, HC-05 leaves lots of space for user. So HC-05 is better than HC-06 and

recommended. HC-03 is similar with HC-05. The above introduction also suits HC-03

The following reference about HC-03 and HC-05 can be downloaded from company website www.wavesen.com:

HC-03 datasheet .pdf	(the command set introduction is included)
HC-05 datasheet .pdf	(the command set introduction is included)
IVT BlueSoleil-2.6	(IVT Bluetooth drive test version)
Bluetooth FAQ.pdf	
PCB package of Bluetooth key modules	(PCB package lib in protel)
IVT software manual.pdf	(introduce how to operate the modern and make pair with Bluetooth module)
PDA serial test helper.exe	(serial helper used for WM system)
HC-03/05 Bluetooth serial command set.pdf	

6. Ordering information

The website of Guangzhou HC Information Technology Co., Ltd is www.wavesen.com The contact information is provided at the company website.

Order Way: If you want our product, you can give order to the production center of our company directly or order it in Taobao. There is a link to Taobao in our company website.

Package: 50 pieces chips in an anti-static blister package. The weight of a module is about 0.9g. The weight of a package is about 50g.

Please provide the product’s model when you order:

HC-04-M HC-04 master module

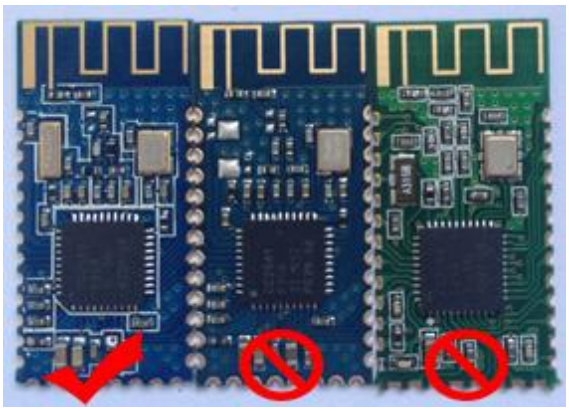
HC-04-S HC-04 slave module

HC-06-M HC-06 master module

HC-06-S HC-06 slave module

HC-03

HC-05 HC-03/05 can be preset to be master module or slave module.



Condemn the copycat company copied behavior on HM-10!!!!!!

If you buy a fake, please apply for a refund guarantee your legitimate rights and interests

JNHuaMao Technology Company

Bluetooth 4.0 BLE module

Datasheet

Professional bluetooth products suppliers.

Remote control module provider

data transmission module provider

PIO state acquisition module provider

Customizable bluetooth module and bluetooth solutions

Jinan high and new technology enterprise

SIG members

Address: D-4020, Qilu soft zone Jinan city,Shandong, China

Telephone: (86) 0531-85117999

WebSite: http://www.jnhuamao.cn

WebSite: http://www.huamaosoft.com

Mail: webmaster@jnhuamao.cn

The most complete, most convenient, the most stable of luetooth data transmission, remote control, PIO acquisition module

---- Master and slave role in one

---- Remote control without other MCU

---- The PIO data acquisition without other MCU

13. **Product parameters**

BT Version: Bluetooth Specification V4.0 BLE

Send and receive no bytes limit.

Working frequency: 2.4GHz ISM band

Modulation method: GFSK(Gaussian Frequency Shift Keying)

RF Power: -23dbm, -6dbm, 0dbm, 6dbm, can modify through AT Command AT+POWE.

Speed: Asynchronous: 6K Bytes

Synchronous: 6K Bytes

Security: Authentication and encryption

Service: Central & Peripheral UUID FFE0,FFE1

Power: +3.3VDC 50mA

Long range: Open space have 100 Meters with iphone4s

Power: In sleep mode 400uA~1.5mA, Active mode 8.5mA.

Working temperature:–5 ~ +65 Centigrade

Size: HM- 10 26.9mm x 13mm x 2.2 mm; HM-11 18*13.5*2.2mm

2. Product overview

Thanks for you choose our products. If you want to know more, www.jnhuamao.cn can help you (Videos, New version datasheet, Module work flow, project Codes, etc.)

HM Bluetooth module use CSR BlueCore or TI CC2540, Master and slave roles in one, transmission version and remote control version and PIO state acquisition functions in one, Support the AT command modify module parameters, Convenient and flexible.

Transmission version can be used to transmit data between two Bluetooth devices.

Remote Control version can be used to Control PIO ports output high or low level without any other MCU.

The PIO state acquisition version can be used to acquisition PIO ports state without any other MUC. (Only support Bluetooth V2.1)

HM-01, HM-02, HM-03, HM-04, HM-05, HM-06, HM-07, HM-08, HM-09 is Bluetooth V2.1 version. Use CSR Chip.

HM-10, HM-11, HM-12 is Bluetooth V4.0 BLE version. Use TI Chip.

HM-01, HM-02, HM-09, HM-10 have same size and same pins.

HM-05, HM-06, HM-07, HM-11 have same size and same pins.

3. Product model

Models	VDD	Size(mm)	Flash	Chip	BT Version
HM-01	3.3V	26.9*13*2.2	8M	BC417143	V2.1+EDR
HM-02	2.5-3.7V	26.9*13*2.2	6M	BC3/BC4	V2.1
HM-03	2.5-3.7V	27.4*12.5*4.3	6M	BC3/BC4	V2.1
HM-04	3.3V	Not for sale			
HM-05	2.5-3.7V	13.5*18.5*2.3	6M	BC3/BC4	V2.1
HM-06	2.5-3.7V	13.5*18.5*2.3	6M	BC3/BC4	V2.1
HM-07	2.5-3.7V	13.5*18.5*2.3	8M		V2.1+EDR
HM-08	3.3V	26.9*13*2.5	8M	Class 1	V2.1+EDR
HM-09	2.5-3.7V	26.9*13*2.2	8M		V2.1+EDR
HM-10	2-3.7V	26.9*13*2.2	256Kb	CC2540/1	V4.0 BLE
HM-11	2.5-3.7V	13.5*18.5*2.2	256Kb	CC2540/1	V4.0 BLE
HM-15	5V	65*32*16	256KB	CC2540	V4.0 BLE

4. Product certificate

CERTIFICATE OF CONFORMITY

CERTIFICATE

of Conformity

Reference No.: LCS120702006TS

Applicant	:	Jinan Huamao Technology Co., Ltd.
Address	:	Room 4020, South Area, Building #C, Environmental Science and Technology Park, No.554 Zhengfeng Road, High Tech Zone, Jinan, Shangdong, China
Product	:	Bluetooth Module
Model(s)	:	HM-XX（XX stand for 01-99）
Parameters	:	2.5-3.7V ⎓, 500mA

The submitted products have been tested by us with the listed standards and found in compliance with the following European Directives.

The LVD Directive 2006/95/EC

EN 60950-1: 2006+A11: 2009+A1: 2010+A12: 2011

The tests are performed in normal operation mode. The test results apply only to the particular sample tested and to the specific tests carried out. This certificate applies specifically to the sample investigated in our test reference number only.

The CE markings as shown below can be affixed on the product after preparation of necessary technical documentation.

Other relevant Directives have to be observed.

CE

Manager

July 04, 2012

Shenzhen LCS Compliance Testing Laboratory Ltd.
Xingyuan Industrial Park, Tongda Road, Bao'an Blvd., Bao'an District, Shenzhen, Guangdong, China
Tel: (86)755-82591330 Fax: (86)755-82591332
Http://www.LCS-cert.com Email: webmaster@LCS-cert.com

CERTIFICATE OF CONFORMITY

CERTIFICATE

of Conformity

Certificate No.: LCS-12070701

Applicant	:	Jinan Huamao Technology Co., Ltd
Address	:	Room 4020, South Area, Building #C, Environmental Science and Technology Park, No.554 Zhengfeng Road, High Tech Zone, Jinan, Shandong, China
Product	:	Bluetooth Module
Model(s)	:	HM-XX（XX stand for 01-99）
Trade Mark	:	N/A

The submitted products have been tested by us with the listed standards and found in compliance with the following European Directives:

The R&TTE Directive 1999/5/EC

Applied Standards	Report No.
Article 3.2: Effective Use of The Radio Spectrum ETSI EN 300 328 V1.7.1（2006-10）	LCS120702006TE
Article 3.1b): Electromagnetic Compatibility ETSI EN 301 489-17 V2.1.1（2009-05）	LCS120702007TE
Article 3.1a): Health and Safety EN 62479: 2010 EN 60950-1: 2006+A11: 2009+A1:2010+A12:2011	LCS120702006TH LCS120702006TS

The tests were performed in normal operation mode. The test results apply only to the particular sample tested and to the specific tests carried out. This certificate applies specifically to the sample investigated in our test reference number only.

The CE markings as shown below can be affixed on the product after preparation of necessary technical documentation.

Other relevent Directives have to be observed.

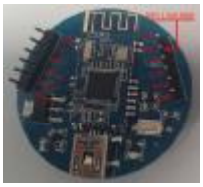
CE

Manager
July 07, 2012

Shenzhen LCS Compliance Testing Laboratory Ltd.
1F., Xingyuan Industrial Park, Tongda Road, Bao'an Blvd.,
Bao'an District, Shenzhen, Guangdong, China
Tel: (86)755-82591330
Http://www.LCS-cert.com

Fax: (86)755-82591332
Email: webmaster@lcs-cert.com

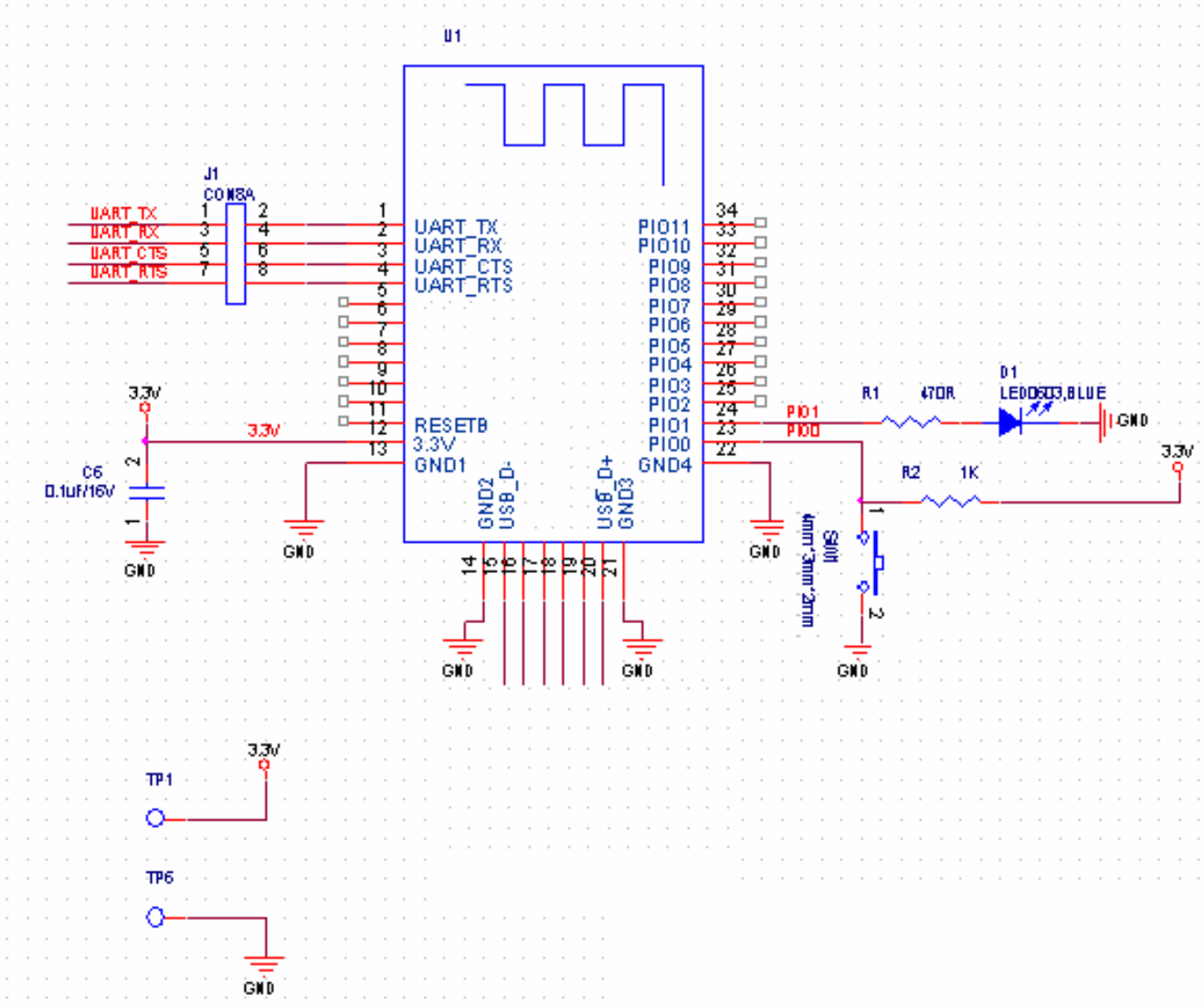
5. Product pictures

			**Not for sale**	
HM-01 **BT 2.1**	**HM-02** **BT 2.1**	**HM-03** **BT 2.1**	**HM-04** **BT 2.1**	**HM-05** **BT 2.1**
		**Class1** **Testing**		
HM-06 **BT 2.1**	**HM-07** **BT 2.1**	**HM-08** **BT 2.1**	**HM-09** **BT 2.1**	**HM-10** **BLE 4.0**
	**Dual mode** **Testing**			
HM-11 **BLE 4.0**	**HM-12** **HM-13**	**HM-15 BLE** **USB Dongle**	**HMSensor**	**iBeacon**

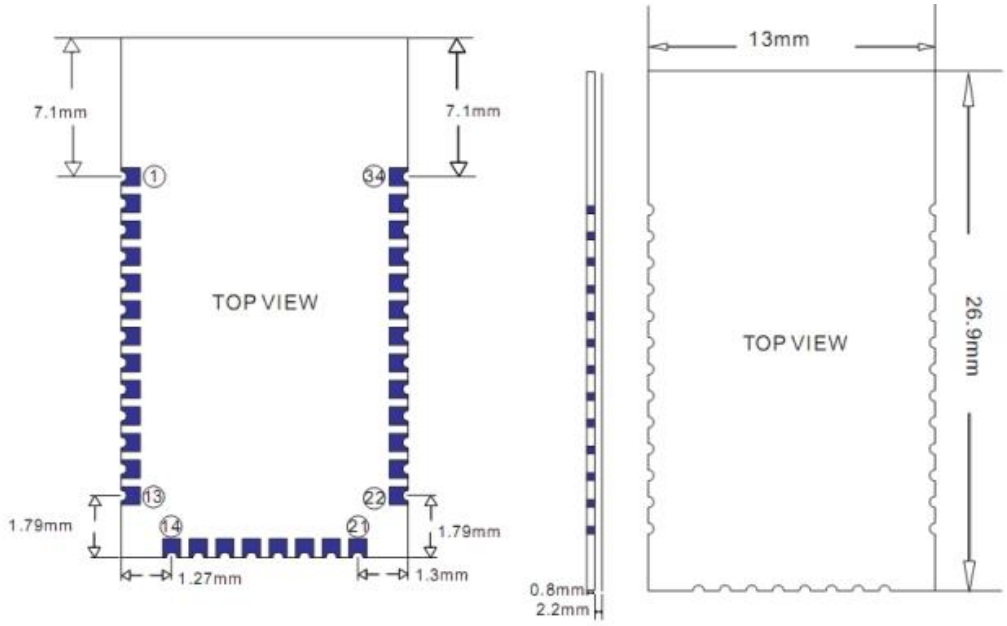
6. Product technical specifications

This document only include Bluetooth BLE 4.0 document, You can goto http://www.jnhuamao.cn/bluetooth_en.rar get Bluetooth V2.1 version datasheet. That document include: HM-01, HM-02, HM-03, HM-04, HM-05, HM-06, HM-07, HM-08, HM-09.

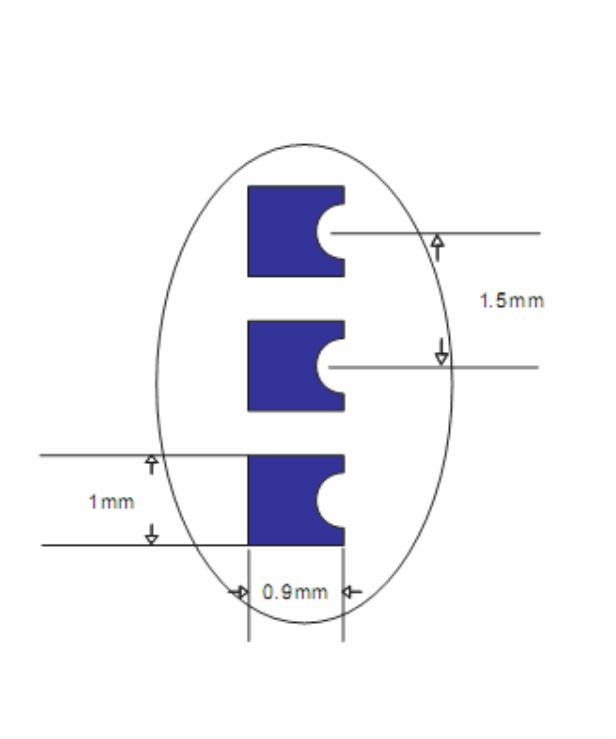
6.1 HM-10 Schematic



6.2 HM-10 Size



6.3 HM-10 package information



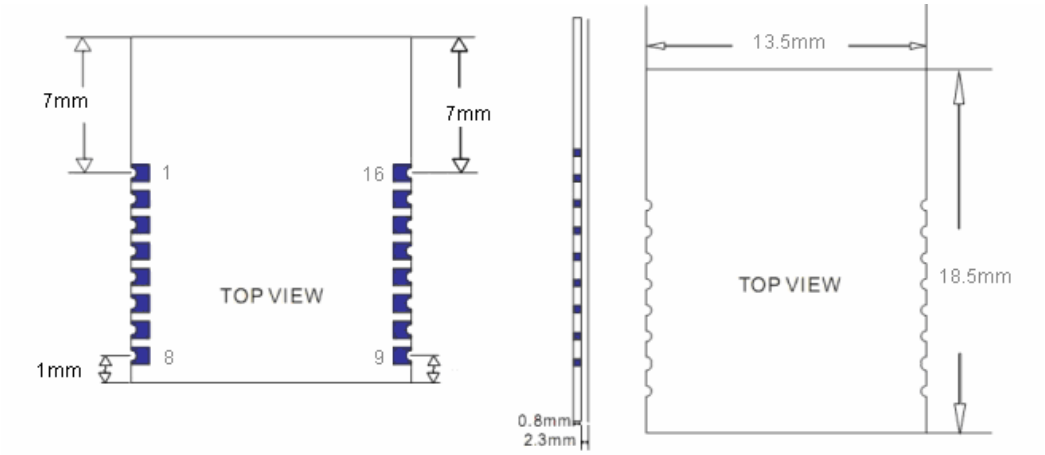
6.4 HM-10 Device Terminal Functions

No	Name	Description	CC254X
1	UART_TX	UART interface	P1_6
2	UART_RX	UART interface	P1_7
3	UART_CTS	UART interface	P1_4

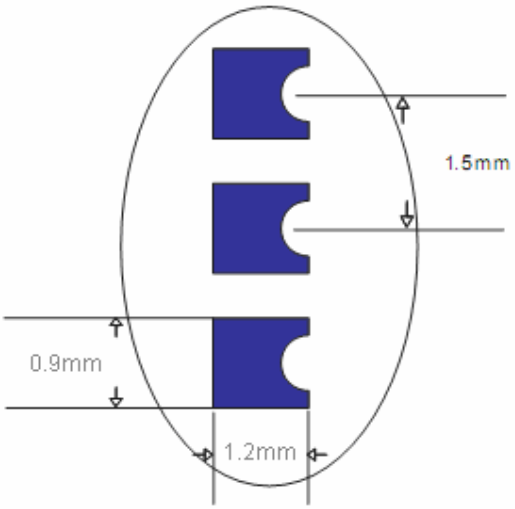
4	UART_RTS	UART interface	P1_5
5	NC	NC	
6	NC	NC	
7	NC	NC	P2_2
8	NC	NC	P2_1
9	NC	NC	P2_0
10	NC	NC	
11	RESETB	Reset if low >100ms.	RESET_N
12	VCC	3.3V	
13	GND	Ground	
14	GND	Ground	
15	USB_D-	USB interface	PIN3
16	NC	NC	
17	NC	NC	
18	NC	NC	
19	NC	NC	
20	UB_D+	USB interface	PIN2
21	GND	Ground	GND
22	GND	Ground	GND
23	PIO0	System Key	P1_3
24	PIO1	System LED	P1_2
25	PIO2	input/output pin	P1_1
26	PIO3	input/output pin	P1_0
27	PIO4	input/output pin	P0_7
28	PIO5	input/output pin	P0_6
29	PIO6	input/output pin	P0_5
30	PIO7	input/output pin	P0_4
31	PIO8	input/output pin	P0_3
32	PIO9	input/output pin	P0_2

33	PIO10	input/output pin	P0_1
34	PIO11	input/output pin	P0_0

6.5 HM-11 Size



6.6 HM-11 Package information



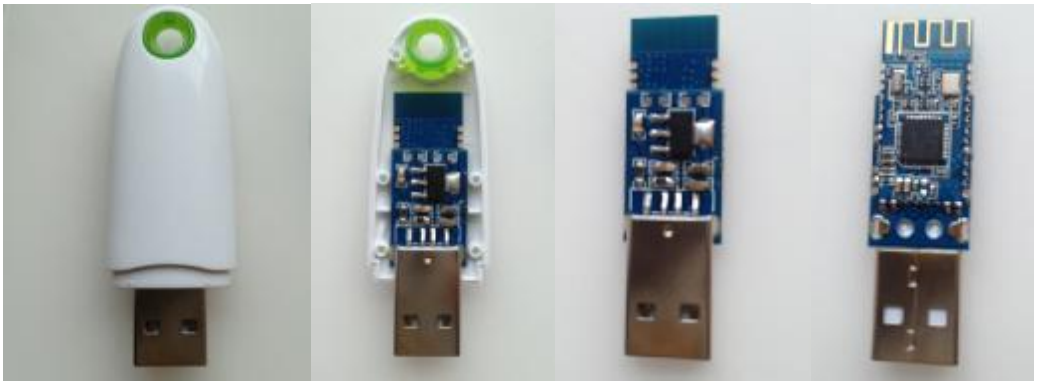
6.7 HM-11 Device Terminal Functions

No	Name	Description	CC254X
1	UART_RTS	UART interface	P1_5
2	UART_TX	UART interface	P1_6

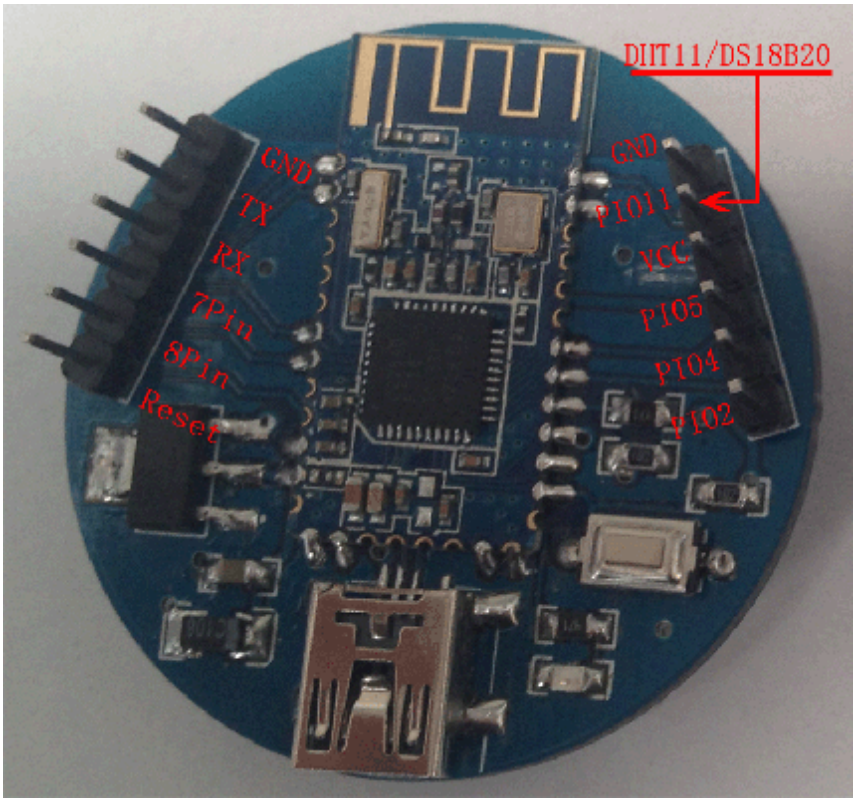
3	UART_CTS	UART interface	P1_4
4	UART_RX	UART interface	P1_7
5	NC	NC	P2_1
6	NC	NC	P2_2
7	NC	NC	PIN2
8	NC	NC	PIN3
9	VCC	V3.3	VCC
10	NC	NC or VCC	
11	RESETB	Reset if low <100ms	RESET_N
12	GND	Ground	GND
13	PIO3	input/output line	P1_1
14	PIO2	input/output line	P1_0
15	PIO1	System LED	P0_7
16	PIO0	System KEY	P0_6

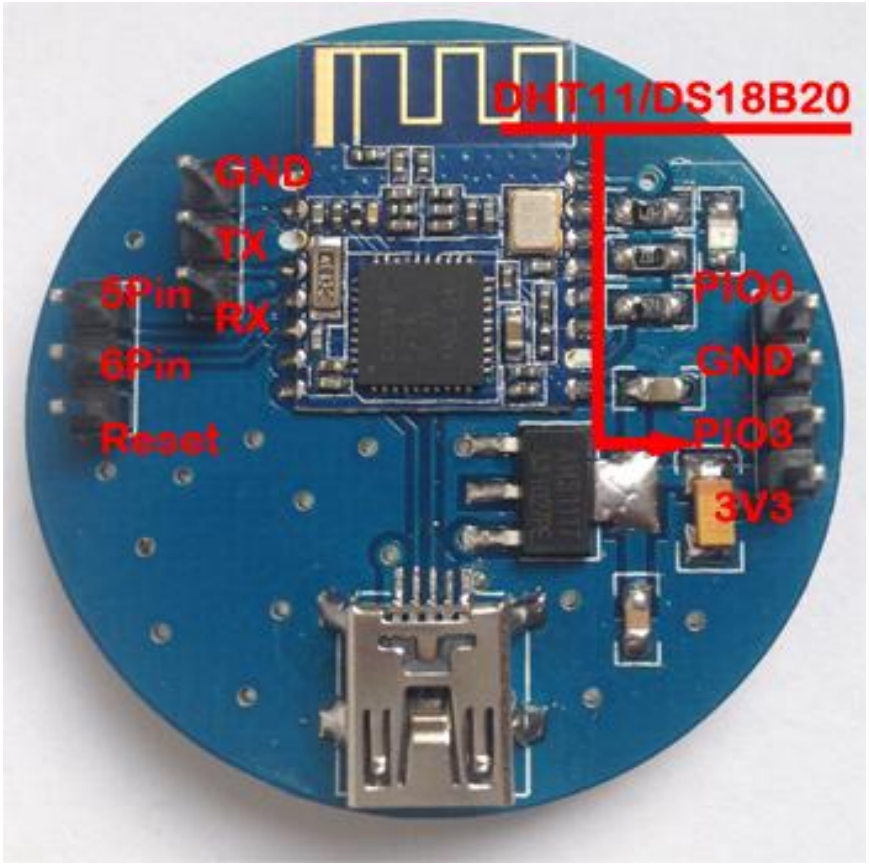
6.8 HM-15

HM-15 is based HM-10, a real USB interface.



6.9 HM-Sensor


DHT11/DS18B20
GND
TX
RX
7Pin
8Pin
Reset
GND
PIO11
VCC
PIO5
PIO4
PIO2


DHT11/DS18B20
GND
TX
5Pin
RX
6Pin
Reset
PIO0
GND
PIO3
3V3

7. System function

How to wake up module from sleep mode?

There are two ways to wake up module from sleep mode.

7.1 Send “I am iron man, I am iron man, I am iron man I am iron…..” string.

Yes, that is a joke, in sleep mode, you can send a long string (Length > 80 or more), that string can made module wake up, and you will receive “OK+WAKE” string through UART. That string can’t include any AT commands.

7.2 Long press system KEY >=1000 ms.

After wake up module, you can send and receive AT commands.

How to let module into sleep mode?

In discoverable mode, send “AT+SLEEP” string through UART, if all is okay, module will return “OK+SLEEP” string and into sleep mode.

System KEY function (PIO0)

Press if Low > 1000ms:

7.3.1 If Module is in sleep mode

Module will wake up immediately, if AT+NOTI value is “1”, module will send “OK+WAKE” string through UART.

7.3.2 If Module has already connected to remote device

Module will disconnect from remote device.

7.3.3 If Module is standby mode

Module will reset to default configuration. Then restart.

System LED function (PIO1)

In sleep mode, LED has turned off.

If AT+PIO10 is setup

Unconnected status: Output High 500 ms, Low 500 ms

Connected status: Output High

If AT+PIO11 is setup

Unconnected status: Output Low.

Connected status: Output High.

System work Mode

A) Mode 0(Transmission mode):

When not connected, through the AT command configuration module, connection, only for serial data transmission.

B) Mode 1(PIO acquisition mode):

When not connected, through the AT command configuration module, connection, a) serial data transmission. b) Control of the PIO2,3 output state(HM-11 has none). c) The acquisition of PIO4 ~ 11 input state(HM-11 only PIO2,3).

C) Mode 2(Remote control mode):

When not connected, through the AT command configuration module, connection, a) serial data transmission. b) Control of the PIO2~11 output state(HM-11 only PIO2,3).

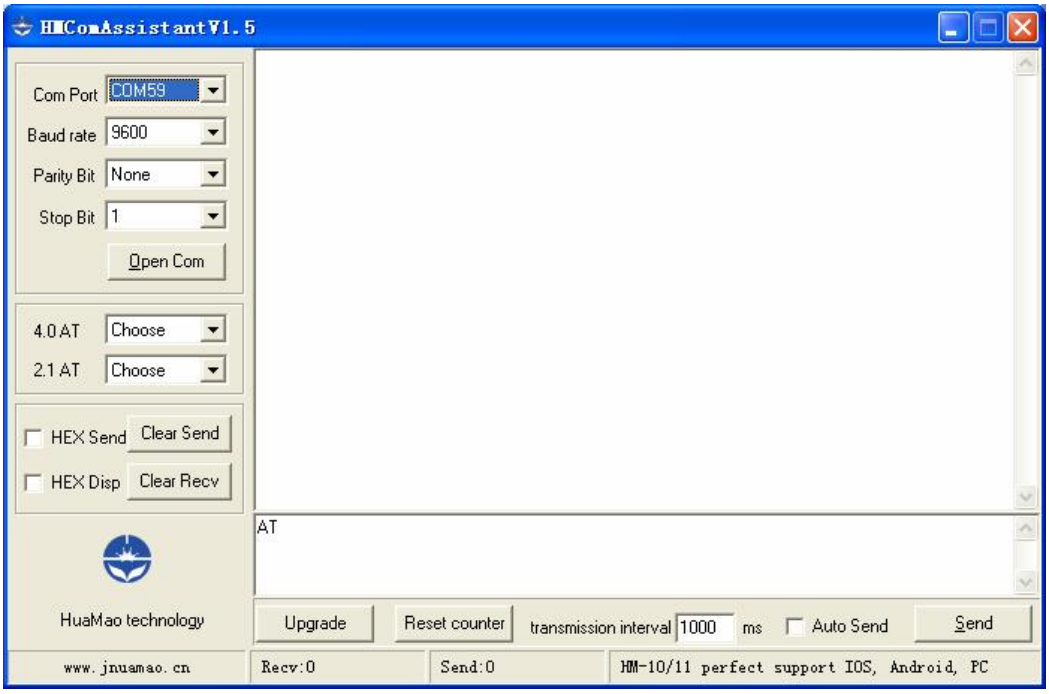
8 AT Commands

Factory default setting:

Name: HMSoft; Baud: 9600, N, 8, 1; Pin code: 000000; Peripheral Role; transmit mode.

AT Command format:

Uppercase AT command format. string format, without any other symbol. (e.g. \r or \n).



On Transmit version: Only accept AT Command from UART interface when Bluetooth device is not connected with remote device.

On Remote version: Can accept AT Command from UART interface when Bluetooth Device is not connected with remote device, Also can accept AT Command from remote Bluetooth device when connected that.

On PIO collection version: Only accept AT Command from UART interface when Bluetooth device is not connected with remote device.

Bluetooth V2.1 version Command is not here, please download datasheet from http://www.jnhuamao.cn/Bluetooth_en.rar

1. Test Command

Send	Receive	Parameter
AT	OK OK+LOST	None

If Module is not connected to remote device will receive: “OK”

If Module has connected, module will disconnected from remote device, if “AT + NOTI” is setup to 1, will receive: “OK+LOST”

2. Query module address

Send	Receive	Parameter
AT+ADDR?	OK+ADDR:MAC Address	None

3. Query/Set Advertising interval

Send	Receive	Parameter
AT+ADVI?	OK+ Get:[Para]	None
AT+ADVI[Para]	OK+ Set:[Para]	Para: 0 ~ F 0: 100ms 1: 152.5 ms 2: 211.25 ms 3: 318.75 ms 4: 417.5 ms 5: 546.25 ms 6: 760 ms 7: 852.5 ms 8: 1022.5 ms 9: 1285 ms A: 2000ms B: 3000ms C: 4000ms D: 5000ms E: 6000ms F: 7000ms Default: 9 HMSoft Default: 0 HMSensor Default: 9

The maximum 1285ms recommendations form the IOS system. That is to say, 1285ms is apple allowed, but in response to scan and connected all the time will be long.

This command is added since V517 version.

V522 allow max value F.

4. Query/Set Advertising Type

Send	Receive	Parameter
AT+ADTY?	OK+ Get:[Para]	None
AT+ADTY[Para]	OK+ Set:[Para]	Para: 0 ~ 3 0: Advertising ScanResponse, Connectable 1: Only allow last device connect in 1.28 seconds 2: Only allow Advertising and ScanResponse. 3: Only allow Advertising Default: 0

Added since V519

5. Query/Set ANCS switch

Send	Receive	Parameter
AT+ANCS?	OK+ Get:[Para]	None
AT+ANCS[Para]	OK+ Set:[Para]	Para: 0 ~ 1 0: Off 1: On Default: 0

Note1: This command added in V524.

Note2: Please send AT+RESET to restart module if you set value 1.

Note3: Must execute AT+TYPE3 first.

6. Query/Set whitelist switch

Send	Receive	Parameter
AT+ALLO?	OK+ Get:[Para]	None

AT+ALLO[Para]	OK+ Set:[Para]	Para: 0 ~ 1 0: Off 1: On Default: 0

Note1: This command added in V523.

Note2: Whitelist allow three mac address link to module. Please use AT+AD command set whitelist mac address.

7. Query/Set whitelist mac address

Send	Receive	Parameter
AT+AD[para1]??	OK+ Get:[Para2]	None
AT+ALLO[Para1][Para2]	OK+ Set:[Para2]	Para1: 1, 2, 3 Para2: MAC address Para1 default: 0

Note1: This command added in V523.

E.g.

Send AT+ID1001122334455

Recv OK+Set:001122334455

8. Query/Set battery monitor switch

Send	Receive	Parameter
AT+BATC?	OK+ Get:[Para]	None
AT+BATC[Para]	OK+ Set:[Para]	Para: 0 ~ 1 0: Off 1: On Default: 0

This command added in V520

9. Query battery information

Send	Receive	Parameter
AT+BATT?	OK+BATT:[Para]	Para: 000~100

There has three ways to get battery information:

a. Before establishing a connection, Send “AT+BATT?” through UART.
b. After established a connection, In Mode 1 or 2, remote side send “AT+BATT?”

Battery information has included in scan response data package, one hour update once. You can use Android or IOS discovery module, when module has been discovered, you can get it from scan result array.

Data format is 0x02, 0x16, 0x00, 0xB0, [reserved], [temperature], [humidity], [battery].

Android:

Included in OnLeScan function result array, you can see it direct.

```
private BluetoothAdapter.LeScanCallback mLeScanCallback = new BluetoothAdapter.LeScanCallback() {

    @Override

    public void onLeScan(final BluetoothDevice device, int rssi,

            byte[] scanRecord) {

        ......<Other code>......

        String sBatt = ""; //Battery

        String sTemp = ""; //Temperature

        String sHumi = ""; //Humidity

        for(int i = 0; i < scanRecord.length; i++)

        {

            if(i + 7 < scanRecord.length)

            {

                //Since V522

                if(scanRecord[i] == 0x07 && scanRecord[i + 1] == 0x16

                        && scanRecord[I + 2] == 0x00 && scanRecord[I + 3] == 0xB0)

                {

                    if(scanRecord[i + 7] > 0)

                        sBatt = String.valueOf(scanRecord[i + 7]);

                    if(scanRecord[i + 5] > 0)

                        sTemp = String.valueOf(scanRecord[i + 5]);
```

```
                    if(scanRecord[i + 6] > 0)
                        sHumi = String.valueOf(scanRecord[i + 6]);
                }

            }
        }
        ......<Other code>......

    }
};
```

iOS:

c. Included in LeScan function result NSDictionary struct, service id is 0xB000.

10. Set iBeacon into service mode(*)

Send	Receive	Parameter
AT+BUSHU	OK+BUSHU	

This command is added in V520, Removed in V521, Please use AT+DELO

This command set iBeacon into service mode until next power on.

In service mode, module not allow any link request.

BUSHU is Chinese spelling, meaning the deployment.

Note: Should to open iBeacon switch first (AT+IBEA).

11. Query/Set Bit format

Send	Receive	Parameter
AT+BIT7?	OK+Get:[para1]	Para1: bit7 switch. 0-----Not compatible 1-----Compatible Default: 0
AT+BIT7[para1]	OK+Set:[para1]	

This command is used only for compatible uses 7 data bits, 2 stop bit device.

12. Query/Set baud rate

Send	Receive	Parameter
AT+BAUD?	OK+Get:[para1]	Para1: Baud rate No. 0---------9600 1---------19200 2---------38400 3---------57600 4---------115200 5---------4800 6---------2400 7---------1200 8---------230400 Default: 0(9600)
AT+BAUD[para1]	OK+Set:[para1]	

e.g.

Query baud:

Send: AT+BAUD?

Receive: OK+Get:0

Setup baud:

Send: AT+BAUD1

Receive: OK+Set:1

Note: If setup to Value 7, After next power on, module will not support any AT Commands, until PIO0 is pressed, Module will change Baud to 9600.

13. Query/Set Characteristic

Send	Receive	Parameter
AT+CHAR?	OK+Get:[para1]	Para1: 0x0001~0xFFFE Default: 0xFFE1
AT+CHAR[para1]	OK+Set:[para1]	

e.g. change characteristic value to 0xAAA0

Send: AT+CHAR0xAAA0

Recv: OK+Set:0xAAA0

14. Clear Last Connected device address

Send	Receive	Parameter
AT+CLEAR	OK+CLEAR	None

Notice: Only Central role is used.

15. Try connect to last succeeded device

Send	Receive	Parameter
AT+CONNL	OK+CONN[Para1]	Para1: L, E, F, N L: Connecting E: Connect error F: Connect Fail N: No Address

Notice: Only Central role is used.

If remote device has already connected to other device or shut down, "OK+CONNF" will received after about 10 seconds.

16. Try connect an address

Send	Receive	Parameter
AT+CON[Para1]	OK+CONN[Para2]	Para1: Address Like: 0017EA090909 Para2: A, E, F A: Connecting E: Connect error F: Connect Fail

Notice: Only central role is used.

If remote device has already connected to other device or shut down, "OK+CONNF" will received after about 10 Seconds.

e.g.

Try to connect an device which MAC address is 00:17:EA:09:09:09

Send: AT+CON0017EA090909

May receive a reply:

OK+CONNA ========= Accept request, connecting

OK+CONNE ========= Connect error

OK+CONN ========= Connected, if AT+NOTI1 is setup

OK+CONNF ========= Connect Failed, After 10 seconds

17. Query PIO04~PIO11 input(output) state

Send	Receive	Parameter
AT+COL??	OK+ Col:[Para1]	Para1: 0x00~0xFF

Para1 is a byte, has 8 bits, bit 7 ~ bit 0 is map to the PIO4 ~ PIO11.

This command is added since V515 version.

18. Query/Set PIO collection rate

Send	Receive	Parameter
AT+CYC??	OK+ Get:[para1]	Para1: 00~99 Unit: seconds Default: 10
AT+CYC[para1]	OK+ Set:[para1]	

In mode 1, when PIO state is change, module will send OK+Col:[xx] to UART or remote side. This command is set send interval.

This command is added since V515 version.

19. Start a device discovery scan

Send	Receive	Parameter
AT+DISC?	OK+DISC[para1]	Para1: S, E, Address string S: Start discovery E: End discovery Address string: Discovered device address information max results is 6 devices

Please set AT+ROLE1 and AT+IMME1 first.

e.g.

Send: AT+DISC?

Recv: OK+DISCS

Recv: OK+DISC:123456789012 (discovered device address information)

If AT+SHOW1 is setup, you will receive then Name information as follow

Recv: OK+NAME: xxx

After send Name value, will send two extra “\r\n” value ASCII byte

Recv: OK+DISC:234567890123

Recv: OK+NAME: xxx

After send Name value, will send two extra “\r\n” value ASCII byte

…..(Max results is 6, use array 0~5)

Recv: OK+DISCE

Connect to a discovered device: AT+CONN0, AT+CONN1……AT+CONN5

20. Connect to an Discovery device

Send	Receive	Parameter
AT+CONN[para1]	OK+CONN[para2]	Para1: 0~5 Para2: E, F, 0~5 E: Link error F: Link failed 0~5: Try to connect

This command is use after execute AT+DISC?

This command will clear all discovery data.

21. Query/Set iBeacon deploy mode

Send	Receive	Parameter
AT+DELO[para1]	OK+DELO[para1]	Para1: 1, 2 1: Allowed to broadcast and scanning 2: Only allow broadcast

After receive OK+DELO[para1], module will reset after 500ms.

This command will let module into non-connectable status until next power on.

22. Query/Set filter of HM modules

Send	Receive	Parameter
AT+FILT?	OK+ Get:[para1]	Para1: 0, 1 0: Will find all BLE modules 1: Only find HM Modules Default: 1
AT+FILT[para1]	OK+ Set:[para1]	

23. Remove bond information

Send	Receive	Parameter
AT+ERASE	OK+ERASE	

Note1: Added in V524 version.

24. Query/Set flow control switch

Send	Receive	Parameter
AT+FIOW?	OK+ Get:[para1]	Para1: 0, 1 0: Off 1: On Default: 0
AT+FIOW[para1]	OK+ Set:[para1]	

25. System Help Information

Send	Receive	Parameter
AT+HELP?	Help Information	None

26. Query/Set Module work type

Send	Receive	Parameter
AT+IMME?	OK+ Get:[para1]	Para1: 0, 1 1: When module is powered on, only respond the AT Command, don't do anything. until AT + START is received, or can use AT+CON,AT+CONNL 0: When power on, work immediately
AT+IMME[para1]	OK+ Set:[para1]	

		Default: 0

This command is only used for Central role.

27. Query/Set Module iBeacon switch

Send	Receive	Parameter
AT+IBEA?	OK+Get:[para1]	Para1: 0, 1 0: Turn off iBeacon 1: Turn on iBeacon Default: 0
AT+IBEA[para1]	OK+Set:[para1]	

iBeacon UUID is: 74278BDA-B644-4520-8F0C-720EAF059935.

This command is added since V517 version.

28. Query/Set iBeacon UUID

Send	Receive	Parameter
AT+IBE0?	OK+Get:[para1]	Para1: 0x00000001~ 0xFFFFFFFE Default: 74278BDA
AT+IBE0[para1]	OK+Set:[para1]	

iBeacon UUID is: 74278BDA-B644-4520-8F0C-720EAF059935.

This command can change red color string in iBeacon UUID.

This command is added since V520 version.

e.g.: Send: AT+IBE012345678 change iBeacon UUID red color string to “12345678”

29. Query/Set iBeacon UUID

Send	Receive	Parameter
AT+IBE1?	OK+Get:[para1]	Para1: 0x00000001~ 0xFFFFFFFE Default: B6444520
AT+IBE1[para1]	OK+Set:[para1]	

iBeacon UUID is: 74278BDA-B644-4520-8F0C-720EAF059935.

This command can change red color string in iBeacon UUID.

This command is added since V520 version.

e.g.: Send: AT+IBE112345678 change iBeacon UUID red color string to

“12345678”

30. Query/Set iBeacon UUID

Send	Receive	Parameter
AT+IBE2?	OK+Get:[para1]	Para1: 0x00000001~ 0xFFFFFFFE Default: 8F0C720E
AT+IBE2[para1]	OK+Set:[para1]	

iBeacon UUID is: 74278BDA-B644-4520-8F0C-720EAF059935.

This command can change red color string in iBeacon UUID.

This command is added since V520 version.

e.g.: Send: AT+IBE112345678 change iBeacon UUID red color string to “12345678”

31. Query/Set iBeacon UUID

Send	Receive	Parameter
AT+IBE3?	OK+Get:[para1]	Para1: 0x00000001~ 0xFFFFFFFE Default: AF059935
AT+IBE3[para1]	OK+Set:[para1]	

iBeacon UUID is: 74278BDA-B644-4520-8F0C-720EAF059935.

This command can change red color string in iBeacon UUID.

This command is added since V520 version.

e.g.: Send: AT+IBE112345678 change iBeacon UUID red color string to “12345678”

32. Query/Set Module iBeacon Marjor version

Send	Receive	Parameter
AT+MARJ?	OK+Get:[para1]	Para1: 0x0001, 0xFFFE Default: 0xFFE0
AT+MARJ[para1]	OK+Set:[para1]	

E.g. Change marjor version to 0x0102

Send: AT+MARJ0x0102, if all is okay, module will send back OK+Set: 0x0102

This command is added since V517 version.

33. Query/Set Module iBeacon minor

Send	Receive	Parameter
AT+MINO?	OK+Get:[para1]	Para1: 0x0001, 0xFFFE Default: 0xFFE1
AT+MINO[para1]	OK+Set:[para1]	

This command is added since V517 version.

34. Query/Set Module iBeacon Measured power

Send	Receive	Parameter
AT+MEAS?	OK+Get:[para1]	Para1: 0x0001, 0xFFFE Default: 0xFFE1
AT+MEAS[para1]	OK+Set:[para1]	

This command is added since V519 version.

35. Query/Set Module Work Mode

Send	Receive	Parameter
AT+MODE?	OK+Get:[para1]	Para1: 0, 1, 2 0: Transmission Mode 1: PIO collection Mode + Mode 0 2: Remote Control Mode + Mode 0 Default: 0
AT+MODE[para1]	OK+Set:[para1]	

Mode 0:

Before establishing a connection, you can use the AT command configuration module through UART.

After established a connection, you can send data to remote side from each other.

Mode 1:

Before establishing a connection, you can use the AT command configuration module through UART.

After established a connection, you can send data to remote side. Remote side can do fellows:

Send AT command configuration module.

Collect PIO04 to the PIO11 pins input state of HM-10.

Collect PIO03 pins input state of HM-11.

Remote control PIO2, PIO3 pins output state of HM-10.

Remote control PIO2 pin output state of HM-11.

Send data to module UART port (not include any AT command and per package must less than 20 bytes).

Mode 2:

Before establishing a connection, you can use the AT command configuration module through UART.

After established a connection, you can send data to remote side. Remote side can do fellows:

Send AT command configuration module.

Remote control PIO2 to PIO11 pins output state of HM-10.

Remote control PIO2, PIO3 pins output state of HM-11.

Send data to module UART port (not include any AT command and per package must less than 20 bytes).

36. Query/Set Notify information

Send	Receive	Parameter
AT+NOTI?	OK+Get:[para1]	Para1: 0, 1 0: Don't Notify 1: Notify Default: 0
AT+NOTI[para1]	OK+Set:[para1]	

If this value is set to 1, when link ESTABLISHED or LOSTED module will send OK+CONN or OK+LOST string through UART.

37. Query/Set Module name

Send	Receive	Parameter
AT+NAME ?	OK+NAME[para1]	Para1: module name, Max length is 12.
AT+NAME[para1]	OK+Set[para1]	

		Default: HMSoft

e.g.

change module name to bill_gates

Send: AT+NAMEbill_gates

Receive: OK+SetName:bill_gates

38. Query/Set Parity bit

Send	Receive	Parameter
Query: AT+PARI?	OK+Get:[para1]	None
Set: AT+PARI[para1]	OK+Set:[para1]	Para1: 0,1,2 0:None 1:EVEN 2:ODD Default: 0 (None)

39. Query/Set PIO1 output status (System LED)

Send	Receive	Parameter
AT+PIO1?	OK+Get:[para1]	Para1: 0, 1 0: Unconnected Output 500ms High 500ms Low, Connected output High. 1: Unconnected output Low, Connected output High. Default: 0
AT+ PIO1 [para1]	OK+Set:[para1]	

40. Query/Set PIO pins output high or low (Only this time, when module next power on, this value is not be used)

Send	Receive	Parameter
AT+PIO[para1]?	OK+PIO:[para1][para2]	Para1: 2~B Para2: 0, 1 HM-11 only has 4 pins.
AT+PIO[para1][para2]	OK+PIO:[para1][para2]	

		Para1 is which PIO pin you want to Query/Set Value: 2,3,4,5,6,7,8,9,A,B. Para2 is Query or setup value. 0 is low and 1 is high

e.g.

Query PIO2

Send: AT+PIO2?

Setup PIO2 output high

Send: AT+PIO21

Receive: OK+PIO21

41. Query/Set Pin Code

Send	Receive	Parameter
AT+PASS?	OK+Get:[para1]	Para1 is Pin Code, 000000~999999 Default: 000000
AT+PIN[para1]	OK+Set:[para1]	

e.g.

Query Pin Code

Send: AT+PIN?

Receive: OK+PIN:000000

Setup Pin Code 008888

Send: AT+PIN008888

Receive: OK+Set:008888

42. Query/Set Module Power

Send	Receive	Parameter
AT+POWE?	OK+Get:[para1]	None
AT+ POWE [para1]	OK+Set:[para1]	Para: 0 ~ 3

		0: -23dbm 1: -6dbm 2: 0dbm 3: 6dbm Default: 2

43. Query/Set Module sleep type

Send	Receive	Parameter
AT+PWRM?	OK+Get:[para1]	None
AT+PWRM[para1]	OK+Set:[para1]	Para1: 0~1 0:Auto sleep 1:don't auto sleep Default: 1

Only support peripheral role.

44. Restore all setup value to factory setup

Send	Receive	Parameter
AT+RENEW	OK+RENEW	None

45. Restart module

Send	Receive	Parameter
AT+RESET	OK+RESET	None

46. Query/Set Master and Slaver Role

Send	Receive	Parameter
AT+ROLE?	OK+Get:[para1]	Para1: 0, 1 0: Peripheral 1: Central Default: 0
AT+ROLE[para1]	OK+Set:[para1]	

47. Query RSSI Value

Send	Receive	Parameter
AT+RSSI?	OK+RSSI:[para1]	None

Require: AT+MODE value > 0

This command only used by Remote device query when connected.

48. Query Last Connected Device Address

Send	Receive	Parameter
AT+RADD?	OK+RADD:MAC Address	None

49. Query/Set Module Sensor work interval

Send	Receive	Parameter
AT+RAT??	OK+Get:[para1]	Para1: 00~99 0:Save when connected 1:Don't Save Default: 0 Unit: minute
AT+RAT[para1]	OK+Set:[para1]	

Note: This command is only use for HMSensor

50. Query/Set Stop bit

Send	Receive	Parameter
AT+STOP?	OK+Get:[para1]	None
AT+STOP[para1]	OK+Set:[para1]	Para1:0, 1 0: One stop bit 1: Two stop bit Default: 0 (One stop bit)

51. Work immediately

Send	Receive	Parameter
AT+START	OK+START	None

This command is only used when AT+IMME1 is setup.

52. Query Module into sleep mode

Send	Receive	Parameter
AT+SLEEP	OK+SLEEP	None

Only support Peripheral role.

53. Query/Set Module save connected address parameter

Send	Receive	Parameter

AT+SAVE?	OK+Get:[para1]	None
AT+SAVE[para1]	OK+Set:[para1]	Para1: 0~1 0:Save when connected 1:Don't Save Default: 0

54. Query/Set sensor type on module PIO11(HM-11 is PIO3)

Send	Receive	Parameter
AT+SENS?	OK+Get:[para1]	Para1: 0, 1, 2 0: None 1: DHT11 2: DS18B20 Default: 0
AT+SENS[para1]	OK+Set:[para1]	

Note: This command is use for HMSensor.

55. Query/Set discovery parameter

Send	Receive	Parameter
AT+SHOW?	OK+Get:[para1]	None
AT+SHOW[para1]	OK+Set:[para1]	Para1: 0~1 0:Don't show name 1:Show name Default: 0

Please execute AT+FILT0 first.

If AT+SHOW1 is setup, AT+DISC? Command will show you name information included into scan result package.

56. Query/Set Module Sensor Temperature and humidity(if has a sensor)

Send	Receive	Parameter
AT+TEHU?	OK+Get:[para1][para2]	Para1: 000~120 Para2: 000~100

Note: This command is use for HMSensor.

This value is added into scan response data package.

Data format is 0x02, 0x16, 0x00, 0xB0, [reserved], [temperature], [humidity], [battery].

Android:

Included in OnLeScan function result array, you can see it direct.

iOS:

Included in LeScan function result NSDictionary struct, service id is 0xB000.

57. Query DS18B20 Sensor temperature

Send	Receive	Parameter
AT+TEMP?	OK+Get:[para1]	Para1: 000.000~255.000

Note1: This command is use for HMSensor.

Note2: Added in V523 version.

58. Query/Set module connect remote device timeout value

Send	Receive	Parameter
AT+TCON?	OK+TCON:[para1]	None
AT+TCON[para1]	OK+Set:[para1]	Para1 is timeout value. when time is up module will not connect this address anymore, then enter search mode. Para1 allowed value: 000000~999999 Unit is ms. Default: 000000 Connect forever

This value is only used for Central Role, when module has Last Connected address.

59. Query/Set Module Bond Mode

Send	Receive	Parameter
AT+TYPE?	OK+Get:[para1]	None
AT+TYPE[para1]	OK+Set:[para1]	Para1: 0~2 0:Not need PIN Code 1:Auth not need PIN 2:Auth with PIN 3:Auth and bond Default: 0

Important: If your module version is less than V515, please don't use this command. Under android 4.3 AT+TYPE1 is same to AT+TYPE2.

Note1: Value 3 is added in V524.

60. Query/Set service UUID

Send	Receive	Parameter
AT+UUID?	OK+Get:[para1]	Para1: 0x0001~0xFFFE Default: 0xFFE0
AT+UUID[para1]	OK+Set:[para1]	

e.g. Change UUID value to 0xAAA0

Send: AT+UUID0xAAA0

Recv: OK+Set:0xAAA0

61. Query/Set UART sleep type

Send	Receive	Parameter
AT+UART?	OK+Get:[para1]	Para1: 0~1 0: When module into sleep mode, you can wake up module through UART. 1: When module into sleep mode, shutdown UART too. Default: 0xFFE0
AT+UART[para1]	OK+Set:[para1]	

Note: This command is only use for HMSensor.

62. Query Software Version

Send	Receive	Parameter
AT+VERR? AT+VERS?	Version Information	None

Resource:

Bluetooth Module 2.1 datasheet:

http://www.jnhuamao.cn/Bluetooth_en.zip

Bluetooth Module 4.0 datasheet:

http://www.jnhuamao.cn/Bluetooth40_en.zip

Bluetooth Module 4.0 USB Dongle

http://www.jnhuamao.cn/HMDongle40_en.zip

Bluetooth 2.1 Com Assistant for android:

http://www.jnhuamao.cn/HMComAssistant.rar

Bluetooth 4.0 Com Assistant for android 4.3:

http://www.jnhuamao.cn/HMBLEComAssistant.rar

Bluetooth 4.0 IOS Code:

http://www.jnhuamao.cn/HMSoft_iso7.zip

http://www.jnhuamao.cn/HMSoft_iso7.zip

2.4-GHz *Bluetooth*™ low energy and Proprietary System-on-Chip

Check for Samples: CC2541

FEATURES

- **RF**
  - **2.4-GHz *Bluetooth* low energy Compliant and Proprietary RF System-on-Chip**
  - **Supports 250-kbps, 500-kbps, 1-Mbps, 2-Mbps Data Rates**
  - **Excellent Link Budget, Enabling Long-Range Applications Without External Front End**
  - **Programmable Output Power up to 0 dBm**
  - **Excellent Receiver Sensitivity (–94 dBm at 1 Mbps), Selectivity, and Blocking Performance**
  - **Suitable for Systems Targeting Compliance With Worldwide Radio Frequency Regulations: ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan)**
- **Layout**
  - **Few External Components**
  - **Reference Design Provided**
  - **6-mm × 6-mm QFN-40 Package**
  - **Pin-Compatible With CC2540 (When Not Using USB or I^2C)**
- **Low Power**
  - **Active-Mode RX Down to: 17.9 mA**
  - **Active-Mode TX (0 dBm): 18.2 mA**
  - **Power Mode 1 (4-µs Wake-Up): 270 µA**
  - **Power Mode 2 (Sleep Timer On): 1 µA**
  - **Power Mode 3 (External Interrupts): 0.5 µA**
  - **Wide Supply-Voltage Range (2 V–3.6 V)**
- **TPS62730 Compatible Low Power in Active Mode**
  - **RX Down to: 14.7 mA (3-V supply)**
  - **TX (0 dBm): 14.3 mA (3-V supply)**
- **Microcontroller**
  - **High-Performance and Low-Power 8051 Microcontroller Core With Code Prefetch**
  - **In-System-Programmable Flash, 128- or 256-KB**
  - **8-KB RAM With Retention in All Power Modes**
  - **Hardware Debug Support**
  - **Extensive Baseband Automation, Including Auto-Acknowledgment and Address Decoding**
  - **Retention of All Relevant Registers in All Power Modes**
- **Peripherals**
  - **Powerful Five-Channel DMA**
  - **General-Purpose Timers (One 16-Bit, Two 8-Bit)**
  - **IR Generation Circuitry**
  - **32-kHz Sleep Timer With Capture**
  - **Accurate Digital RSSI Support**
  - **Battery Monitor and Temperature Sensor**
  - **12-Bit ADC With Eight Channels and Configurable Resolution**
  - **AES Security Coprocessor**
  - **Two Powerful USARTs With Support for Several Serial Protocols**
  - **23 General-Purpose I/O Pins (21 × 4 mA, 2 × 20 mA)**
  - **I^2C interface**
  - **2 I/O Pins Have LED Driving Capabilities**
  - **Watchdog Timer**
  - **Integrated High-Performance Comparator**
- **Development Tools**
  - **CC2541 Evaluation Module Kit (CC2541EMK)**
  - **CC2541 Mini Development Kit (CC2541DK-MINI)**
  - **SmartRF™ Software**
  - **IAR Embedded Workbench™ Available**

SOFTWARE FEATURES

- ***Bluetooth*** **v4.0 Compliant Protocol Stack for Single-Mode BLE Solution**
  - **Complete Power-Optimized Stack, Including Controller and Host**
    - **GAP – Central, Peripheral, Observer, or Broadcaster (Including Combination Roles)**
    - **ATT / GATT – Client and Server**
    - **SMP – AES-128 Encryption and Decryption**
    - **L2CAP**
  - **Sample Applications and Profiles**
    - **Generic Applications for GAP Central and Peripheral Roles**
    - **Proximity, Accelerometer, Simple Keys, and Battery GATT Services**
    - **More Applications Supported in BLE Software Stack**
  - **Multiple Configuration Options**
    - **Single-Chip Configuration, Allowing Applications to Run on CC2541**
    - **Network Processor Interface for Applications Running on an External Microcontroller**
  - **BTool – Windows PC Application for Evaluation, Development, and Test**

APPLICATIONS

- **2.4-GHz** ***Bluetooth*** **low energy Systems**
- **Proprietary 2.4-GHz Systems**
- **Human-Interface Devices (Keyboard, Mouse, Remote Control)**
- **Sports and Leisure Equipment**
- **Mobile Phone Accessories**
- **Consumer Electronics**

CC2541 WITH TPS62730

- **TPS62730 is a 2-MHz Step-Down Converter With Bypass Mode**
- **Extends Battery Lifetime by up to 20%**
- **Reduced Current in All Active Modes**
- **30-nA Bypass Mode Current to Support Low-Power Modes**
- **RF Performance Unchanged**
- **Small Package Allows for Small Solution Size**
- **CC2541 Controllable**

DESCRIPTION

The CC2541 is a power-optimized true system-on-chip (SoC) solution for both *Bluetooth* low energy and proprietary 2.4-GHz applications. It enables robust network nodes to be built with low total bill-of-material costs. The CC2541 combines the excellent performance of a leading RF transceiver with an industry-standard enhanced 8051 MCU, in-system programmable flash memory, 8-KB RAM, and many other powerful supporting features and peripherals. The CC2541 is highly suited for systems where ultralow power consumption is required. This is specified by various operating modes. Short transition times between operating modes further enable low power consumption.

The CC2541 is pin-compatible with the CC2540 in the 6-mm × 6-mm QFN40 package, if the USB is not used on the CC2540 and the I^2C/extra I/O is not used on the CC2541. Compared to the CC2540, the CC2541 provides lower RF current consumption. The CC2541 does not have the USB interface of the CC2540, and provides lower maximum output power in TX mode. The CC2541 also adds a HW I^2C interface.

The CC2541 is pin-compatible with the CC2533 RF4CE-optimized IEEE 802.15.4 SoC.

The CC2541 comes in two different versions: CC2541F128/F256, with 128 KB and 256 KB of flash memory, respectively.

For the CC2541 block diagram, see Figure 1.

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

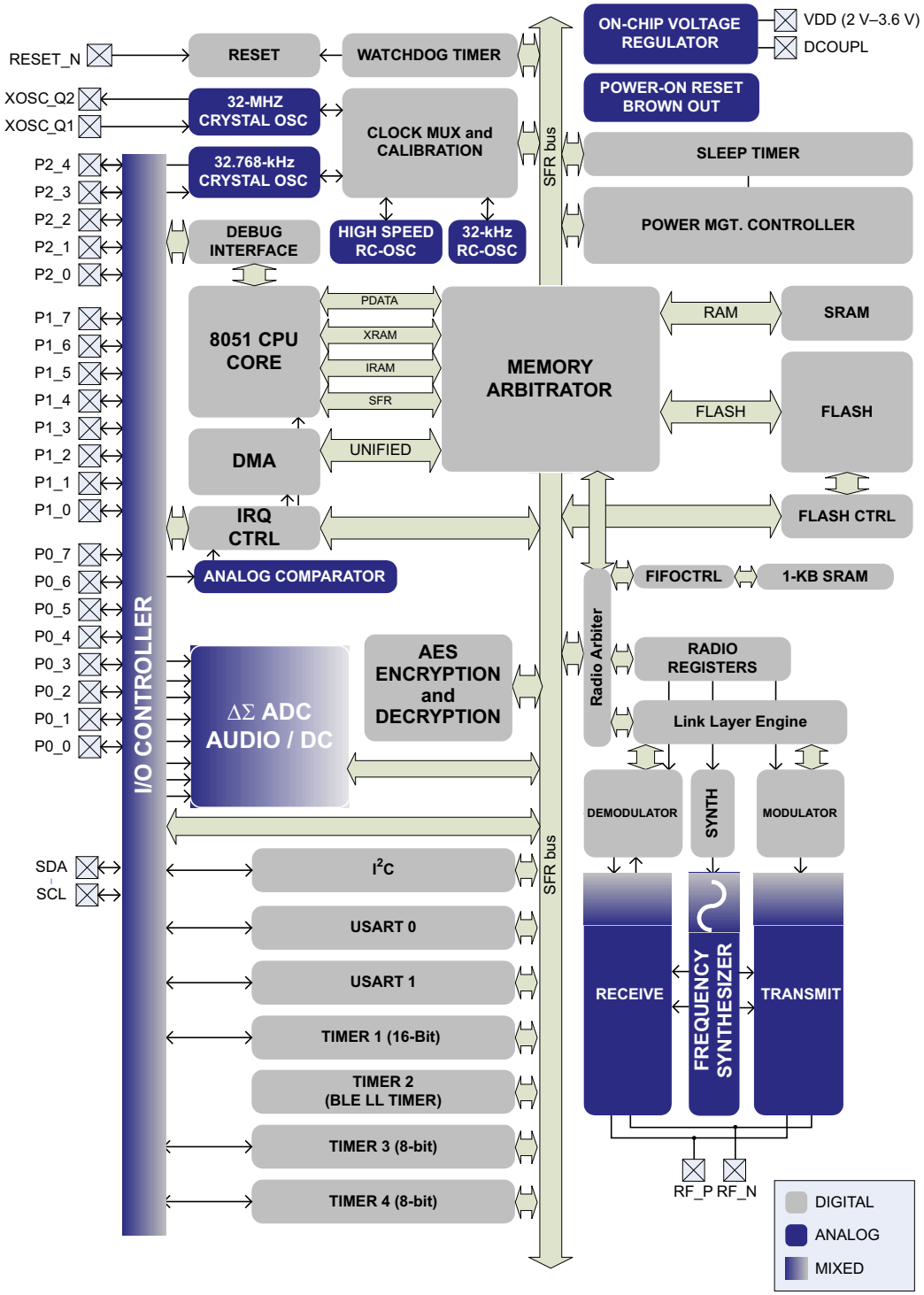


Figure 1. Block Diagram

ABSOLUTE MAXIMUM RATINGS(1)

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
Supply voltage	All supply pins must have the same voltage	–0.3	3.9	V
Voltage on any digital pin		–0.3	VDD + 0.3 ≤ 3.9	V
Input RF level			10	dBm
Storage temperature range		–40	125	°C
ESD(2)	All pins, excluding pins 25 and 26, according to human-body model, JEDEC STD 22, method A114		2	kV
	All pins, according to human-body model, JEDEC STD 22, method A114		1	kV
	According to charged-device model, JEDEC STD 22, method C101		500	V

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) **CAUTION:** ESD sesnsitive device. Precautions should be used when handling the device in order to prevent permanent damage.

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

	MIN	NOM	MAX	UNIT
Operating ambient temperature range, T_A	–40		85	°C
Operating supply voltage	2		3.6	V

ELECTRICAL CHARACTERISTICS

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V,
1 Mbps, GFSK, 250-kHz deviation, *Bluetooth* low energy mode, and 0.1% BER

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{core}	Core current consumption	RX mode, standard mode, no peripherals active, low MCU activity		17.9		mA
		RX mode, high-gain mode, no peripherals active, low MCU activity		20.2		
		TX mode, –20 dBm output power, no peripherals active, low MCU activity		16.8		
		TX mode, 0 dBm output power, no peripherals active, low MCU activity		18.2		
		Power mode 1. Digital regulator on; 16-MHz RCOSC and 32-MHz crystal oscillator off; 32.768-kHz XOSC, POR, BOD and sleep timer active; RAM and register retention		270		µA
		Power mode 2. Digital regulator off; 16-MHz RCOSC and 32-MHz crystal oscillator off; 32.768-kHz XOSC, POR, and sleep timer active; RAM and register retention		1		
		Power mode 3. Digital regulator off; no clocks; POR active; RAM and register retention		0.5		
		Low MCU activity: 32-MHz XOSC running. No radio or peripherals. Limited flash access, no RAM access.		6.7		mA
I_{peri}	Peripheral current consumption (Adds to core current I_{core} for each peripheral unit activated)	Timer 1. Timer running, 32-MHz XOSC used		90		µA
		Timer 2. Timer running, 32-MHz XOSC used		90		
		Timer 3. Timer running, 32-MHz XOSC used		60		
		Timer 4. Timer running, 32-MHz XOSC used		70		
		Sleep timer, including 32.753-kHz RCOSC		0.6		
		ADC, when converting		1.2		mA

GENERAL CHARACTERISTICS

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
WAKE-UP AND TIMING					
Power mode 1 → Active	Digital regulator on, 16-MHz RCOSC and 32-MHz crystal oscillator off. Start-up of 16-MHz RCOSC		4		µs
Power mode 2 or 3 → Active	Digital regulator off, 16-MHz RCOSC and 32-MHz crystal oscillator off. Start-up of regulator and 16-MHz RCOSC		120		µs
Active → TX or RX	Crystal ESR = 16 Ω. Initially running on 16-MHz RCOSC, with 32-MHz XOSC OFF		500		µs
	With 32-MHz XOSC initially on		180		µs
RX/TX turnaround	Proprietary auto mode		130		µs
	BLE mode		150		
RADIO PART					
RF frequency range	Programmable in 1-MHz steps	2379		2496	MHz
Data rate and modulation format	2 Mbps, GFSK, 500-kHz deviation 2 Mbps, GFSK, 320-kHz deviation 1 Mbps, GFSK, 250-kHz deviation 1 Mbps, GFSK, 160-kHz deviation 500 kbps, MSK 250 kbps, GFSK, 160-kHz deviation 250 kbps, MSK				

RF RECEIVE SECTION

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V, f_c = 2440 MHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
2 Mbps, GFSK, 500-kHz Deviation, 0.1% BER					
Receiver sensitivity			–90		dBm
Saturation	BER < 0.1%		–1		dBm
Co-channel rejection	Wanted signal at –67 dBm		–9		dB
In-band blocking rejection	±2 MHz offset, 0.1% BER, wanted signal –67 dBm		–2		dB
	±4 MHz offset, 0.1% BER, wanted signal –67 dBm		36		
	±6 MHz or greater offset, 0.1% BER, wanted signal –67 dBm		41		
Frequency error tolerance(1)	Including both initial tolerance and drift. Sensitivity better than –67dBm, 250 byte payload. BER 0.1%	–300		300	kHz
Symbol rate error tolerance(2)	Maximum packet length. Sensitivity better than–67dBm, 250 byte payload. BER 0.1%	–120		120	ppm
2 Mbps, GFSK, 320-kHz Deviation, 0.1% BER					
Receiver sensitivity			–86		dBm
Saturation	BER < 0.1%		–7		dBm
Co-channel rejection	Wanted signal at –67 dBm		–12		dB
In-band blocking rejection	±2 MHz offset, 0.1% BER, wanted signal –67 dBm		–1		dB
	±4 MHz offset, 0.1% BER, wanted signal –67 dBm		34		
	±6 MHz or greater offset, 0.1% BER, wanted signal –67 dBm		39		
Frequency error tolerance(1)	Including both initial tolerance and drift. Sensitivity better than –67 dBm, 250 byte payload. BER 0.1%	–300		300	kHz
Symbol rate error tolerance(2)	Maximum packet length. Sensitivity better than –67 dBm, 250 byte payload. BER 0.1%	–120		120	ppm

(1) Difference between center frequency of the received RF signal and local oscillator frequency
(2) Difference between incoming symbol rate and the internally generated symbol rate

RF RECEIVE SECTION (continued)

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V, f_c = 2440 MHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
1 Mbps, GFSK, 250-kHz Deviation, *Bluetooth* low energy Mode, 0.1% BER					
Receiver sensitivity(3)(4)	High-gain mode		–94		dBm
	Standard mode		–88		
Saturation(4)	BER < 0.1%		5		dBm
Co-channel rejection(4)	Wanted signal –67 dBm		–6		dB
In-band blocking rejection(4)	±1 MHz offset, 0.1% BER, wanted signal –67 dBm		–2		dB
	±2 MHz offset, 0.1% BER, wanted signal –67 dBm		26		
	±3 MHz offset, 0.1% BER, wanted signal –67 dBm		34		
	>6 MHz offset, 0.1% BER, wanted signal –67 dBm		33		
Out-of-band blocking rejection(4)	Minimum interferer level < 2 GHz (Wanted signal –67 dBm)		–21		dBm
	Minimum interferer level [2 GHz, 3 GHz] (Wanted signal –67 dBm)		–25		
	Minimum interferer level > 3 GHz (Wanted signal –67 dBm)		–7		
Intermodulation(4)	Minimum interferer level		–36		dBm
Frequency error tolerance(5)	Including both initial tolerance and drift. Sensitivity better than -67dBm, 250 byte payload. BER 0.1%	–250		250	kHz
Symbol rate error tolerance(6)	Maximum packet length. Sensitivity better than –67 dBm, 250 byte payload. BER 0.1%	–80		80	ppm
1 Mbps, GFSK, 160-kHz Deviation, 0.1% BER					
Receiver sensitivity(7)			–91		dBm
Saturation	BER < 0.1%		0		dBm
Co-channel rejection	Wanted signal 10 dB above sensitivity level		–9		dB
In-band blocking rejection	±1-MHz offset, 0.1% BER, wanted signal –67 dBm		2		dB
	±2-MHz offset, 0.1% BER, wanted signal –67 dBm		24		
	±3-MHz offset, 0.1% BER, wanted signal -–67 dBm		27		
	>6-MHz offset, 0.1% BER, wanted signal –67 dBm		32		
Frequency error tolerance(5)	Including both initial tolerance and drift. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–200		200	kHz
Symbol rate error tolerance(6)	Maximum packet length. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–80		80	ppm
500 kbps, MSK, 0.1% BER					
Receiver sensitivity(7)			–99		dBm
Saturation	BER < 0.1%		0		dBm
Co-channel rejection	Wanted signal –67 dBm		–5		dB
In-band blocking rejection	±1-MHz offset, 0.1% BER, wanted signal –67 dBm		20		dB
	±2-MHz offset, 0.1% BER, wanted signal –67 dBm		27		
	>2-MHz offset, 0.1% BER, wanted signal –67 dBm		28		
Frequency error tolerance	Including both initial tolerance and drift. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–150		150	kHz
Symbol rate error tolerance	Maximum packet length. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–80		80	ppm

(3) The receiver sensitivity setting is programmable using a TI BLE stack vendor-specific API command. The default value is standard mode.
(4) Results based on standard-gain mode.
(5) Difference between center frequency of the received RF signal and local oscillator frequency
(6) Difference between incoming symbol rate and the internally generated symbol rate
(7) Results based on high-gain mode.

RF RECEIVE SECTION (continued)

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V, f_c = 2440 MHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
250 kbps, GFSK, 160 kHz Deviation, 0.1% BER					
Receiver sensitivity (8)			–98		dBm
Saturation	BER < 0.1%		0		dBm
Co-channel rejection	Wanted signal -67 dBm		–3		dB
In-band blocking rejection	±1-MHz offset, 0.1% BER, wanted signal –67 dBm		23		dB
	±2-MHz offset, 0.1% BER, wanted signal –67 dBm		28		
	>2-MHz offset, 0.1% BER, wanted signal –67 dBm		29		
Frequency error tolerance (9)	Including both initial tolerance and drift. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–150		150	kHz
Symbol rate error tolerance (10)	Maximum packet length. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–80		80	ppm
250 kbps, MSK, 0.1% BER					
Receiver sensitivity (11)			–99		dBm
Saturation	BER < 0.1%		0		dBm
Co-channel rejection	Wanted signal -67 dBm		–5		dB
In-band blocking rejection	±1-MHz offset, 0.1% BER, wanted signal –67 dBm		20		dB
	±2-MHz offset, 0.1% BER, wanted signal –67 dBm		29		
	>2-MHz offset, 0.1% BER, wanted signal –67 dBm		30		
Frequency error tolerance	Including both initial tolerance and drift. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–150		150	kHz
Symbol rate error tolerance	Maximum packet length. Sensitivity better than –67 dBm, 250-byte payload. BER 0.1%	–80		80	ppm
ALL RATES/FORMATS					
Spurious emission in RX. Conducted measurement	f < 1 GHz		–67		dBm
Spurious emission in RX. Conducted measurement	f > 1 GHz		–57		dBm

(8) Results based on standard-gain mode.
(9) Difference between center frequency of the received RF signal and local oscillator frequency
(10) Difference between incoming symbol rate and the internally generated symbol rate
(11) Results based on high-gain mode.

RF TRANSMIT SECTION

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V and f_c = 2440 MHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output power	Delivered to a single-ended 50-Ω load through a balun using maximum recommended output power setting		0		dBm
	Delivered to a single-ended 50-Ω load through a balun using minimum recommended output power setting		–23		
Programmable output power range	Delivered to a single-ended 50-Ω load through a balun using minimum recommended output power setting		23		dB
Spurious emission conducted measurement	f < 1 GHz		–52		dBm
	f > 1 GHz		–48		dBm
	Suitable for systems targeting compliance with worldwide radio-frequency regulations ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan)				
Optimum load impedance	Differential impedance as seen from the RF port (RF_P and RF_N) toward the antenna		70 +j30		Ω

Designs with antenna connectors that require conducted ETSI compliance at 64 MHz should insert an LC resonator in front of the antenna connector. Use a 1.6-nH inductor in parallel with a 1.8-pF capacitor. Connect both from the signal trace to a good RF ground.

CURRENT CONSUMPTION WITH TPS62730

Measured on Texas Instruments CC2541 TPA62730 EM reference design with T_A = 25°C, VDD = 3 V and f_c = 2440 MHz,
1 Mbsp, GFSK, 250-kHz deviation, Bluetooth™ low energy Mode, 1% BER(1)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Current consumption	RX mode, standard mode, no peripherals active, low MCU activity, MCU at 1 MHz		14.7		mA
	RX mode, high-gain mode, no peripherals active, low MCU activity, MCU at 1 MHz		16.7		
	TX mode, –20 dBm output power, no peripherals active, low MCU activity, MCU at 1 MHz		13.1		
	TX mode, 0 dBm output power, no peripherals active, low MCU activity, MCU at 1 MHz		14.3		

(1) 0.1% BER maps to 30.8% PER

32-MHz CRYSTAL OSCILLATOR

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Crystal frequency			32		MHz
	Crystal frequency accuracy requirement(1)		–40		40	ppm
ESR	Equivalent series resistance		6		60	Ω
C_0	Crystal shunt capacitance		1		7	pF
C_L	Crystal load capacitance		10		16	pF
	Start-up time			0.25		ms
	Power-down guard time	The crystal oscillator must be in power down for a guard time before it is used again. This requirement is valid for all modes of operation. The need for power-down guard time can vary with crystal type and load.	3			ms

(1) Including aging and temperature dependency, as specified by [1]

32.768-kHz CRYSTAL OSCILLATOR

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Crystal frequency			32.768		kHz
	Crystal frequency accuracy requirement(1)		–40		40	ppm
ESR	Equivalent series resistance			40	130	kΩ
C_0	Crystal shunt capacitance			0.9	2	pF
C_L	Crystal load capacitance			12	16	pF
	Start-up time			0.4		s

(1) Including aging and temperature dependency, as specified by [1]

32-kHz RC OSCILLATOR

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Calibrated frequency(1)			32.753		kHz
Frequency accuracy after calibration			±0.2%		
Temperature coefficient(2)			0.4		%/°C
Supply-voltage coefficient(3)			3		%/V
Calibration time(4)			2		ms

(1) The calibrated 32-kHz RC oscillator frequency is the 32-MHz XTAL frequency divided by 977.
(2) Frequency drift when temperature changes after calibration
(3) Frequency drift when supply voltage changes after calibration
(4) When the 32-kHz RC oscillator is enabled, it is calibrated when a switch from the 16-MHz RC oscillator to the 32-MHz crystal oscillator is performed while SLEEPCMD.OSC32K_CALDIS is set to 0.

16-MHz RC OSCILLATOR

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Frequency(1)			16		MHz
Uncalibrated frequency accuracy			±18%		
Calibrated frequency accuracy			±0.6%		
Start-up time			10		µs
Initial calibration time(2)			50		µs

(1) The calibrated 16-MHz RC oscillator frequency is the 32-MHz XTAL frequency divided by 2.
(2) When the 16-MHz RC oscillator is enabled, it is calibrated when a switch from the 16-MHz RC oscillator to the 32-MHz crystal oscillator is performed while SLEEPCMD.OSC_PD is set to 0.

RSSI CHARACTERISTICS

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
2 Mbps, GFSK, 320-kHz Deviation, 0.1% BER and 2 Mbps, GFSK, 500-kHz Deviation, 0.1% BER					
Useful RSSI range(1)	Reduced gain by AGC algorithm		64		dB
	High gain by AGC algorithm		64		
RSSI offset(1)	Reduced gain by AGC algorithm		79		dBm
	High gain by AGC algorithm		99		
Absolute uncalibrated accuracy(1)			±6		dB
Step size (LSB value)			1		dB
All Other Rates/Formats					
Useful RSSI range(1)	Standard mode		64		dB
	High-gain mode		64		
RSSI offset(1)	Standard mode		98		dBm
	High-gain mode		107		
Absolute uncalibrated accuracy(1)			±3		dB
Step size (LSB value)			1		dB

(1) Assuming CC2541 EM reference design. Other RF designs give an offset from the reported value.

FREQUENCY SYNTHESIZER CHARACTERISTICS

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V and f_c = 2440 MHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Phase noise, unmodulated carrier	At ±1-MHz offset from carrier		–109		dBc/Hz
	At ±3-MHz offset from carrier		–112		
	At ±5-MHz offset from carrier		–119		

ANALOG TEMPERATURE SENSOR

Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C and VDD = 3 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output	Measured using integrated ADC, internal band-gap voltage reference, and maximum resolution		1480		12-bit
Temperature coefficient			4.5		/ 1°C
Voltage coefficient			1		0.1 V
Initial accuracy without calibration			±10		°C
Accuracy using 1-point calibration			±5		°C
Current consumption when enabled			0.5		mA

COMPARATOR CHARACTERISTICS

T_A = 25°C, VDD = 3 V. All measurement results are obtained using the CC2541 reference designs, post-calibration.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Common-mode maximum voltage			VDD		V
Common-mode minimum voltage			–0.3		
Input offset voltage			1		mV
Offset vs temperature			16		µV/°C
Offset vs operating voltage			4		mV/V
Supply current			230		nA
Hysteresis			0.15		mV

ADC CHARACTERISTICS

T_A = 25°C and VDD = 3 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Input voltage	VDD is voltage on AVDD5 pin	0		VDD	V
	External reference voltage	VDD is voltage on AVDD5 pin	0		VDD	V
	External reference voltage differential	VDD is voltage on AVDD5 pin	0		VDD	V
	Input resistance, signal	Simulated using 4-MHz clock speed		197		kΩ
	Full-scale signal(1)	Peak-to-peak, defines 0 dBFS		2.97		V
ENOB(1)	Effective number of bits	Single-ended input, 7-bit setting		5.7		bits
		Single-ended input, 9-bit setting		7.5		
		Single-ended input, 10-bit setting		9.3		
		Single-ended input, 12-bit setting		10.3		
		Differential input, 7-bit setting		6.5		
		Differential input, 9-bit setting		8.3		
		Differential input, 10-bit setting		10		
		Differential input, 12-bit setting		11.5		
		10-bit setting, clocked by RCOSC		9.7		
		12-bit setting, clocked by RCOSC		10.9		
	Useful power bandwidth	7-bit setting, both single and differential		0–20		kHz
THD	Total harmonic distortion	Single ended input, 12-bit setting, –6 dBFS(1)		–75.2		dB
		Differential input, 12-bit setting, –6 dBFS(1)		–86.6		
	Signal to nonharmonic ratio	Single-ended input, 12-bit setting(1)		70.2		dB
		Differential input, 12-bit setting(1)		79.3		
		Single-ended input, 12-bit setting, –6 dBFS(1)		78.8		
		Differential input, 12-bit setting, –6 dBFS(1)		88.9		
CMRR	Common-mode rejection ratio	Differential input, 12-bit setting, 1-kHz sine (0 dBFS), limited by ADC resolution		>84		dB
	Crosstalk	Single ended input, 12-bit setting, 1-kHz sine (0 dBFS), limited by ADC resolution		>84		dB
	Offset	Midscale		–3		mV
	Gain error			0.68%		
DNL	Differential nonlinearity	12-bit setting, mean(1)		0.05		LSB
		12-bit setting, maximum(1)		0.9		
INL	Integral nonlinearity	12-bit setting, mean(1)		4.6		LSB
		12-bit setting, maximum(1)		13.3		
		12-bit setting, mean, clocked by RCOSC		10		
		12-bit setting, max, clocked by RCOSC		29		
SINAD (–THD+N)	Signal-to-noise-and-distortion	Single ended input, 7-bit setting(1)		35.4		dB
		Single ended input, 9-bit setting(1)		46.8		
		Single ended input, 10-bit setting(1)		57.5		
		Single ended input, 12-bit setting(1)		66.6		
		Differential input, 7-bit setting(1)		40.7		
		Differential input, 9-bit setting(1)		51.6		
		Differential input, 10-bit setting(1)		61.8		
		Differential input, 12-bit setting(1)		70.8		
	Conversion time	7-bit setting		20		µs
		9-bit setting		36		
		10-bit setting		68		
		12-bit setting		132		

(1) Measured with 300-Hz sine-wave input and VDD as reference.

ADC CHARACTERISTICS (continued)

T_A = 25°C and VDD = 3 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Power consumption			1.2		mA
Internal reference VDD coefficient			4		mV/V
Internal reference temperature coefficient			0.4		mV/10°C
Internal reference voltage			1.24		V

CONTROL INPUT AC CHARACTERISTICS

T_A = –40°C to 85°C, VDD = 2 V to 3.6 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
System clock, f_{SYSCLK} $t_{SYSCLK} = 1/ f_{SYSCLK}$	The undivided system clock is 32 MHz when crystal oscillator is used. The undivided system clock is 16 MHz when calibrated 16-MHz RC oscillator is used.	16		32	MHz
RESET_N low duration	See item 1, Figure 2. This is the shortest pulse that is recognized as a complete reset pin request. Note that shorter pulses may be recognized but do not lead to complete reset of all modules within the chip.	1			µs
Interrupt pulse duration	See item 2, Figure 2.This is the shortest pulse that is recognized as an interrupt request.	20			ns

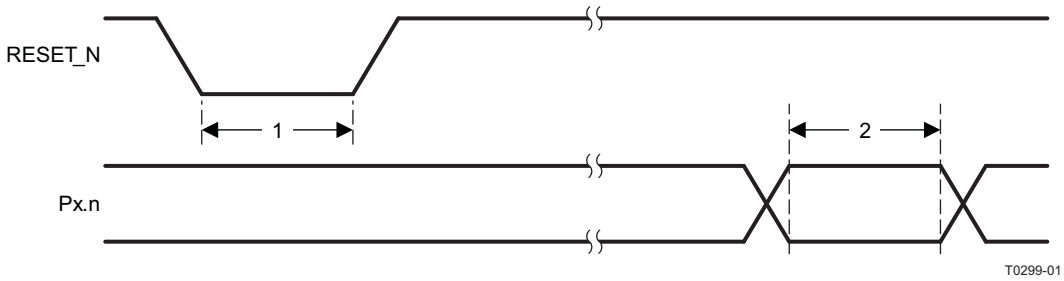


Figure 2. Control Input AC Characteristics

SPI AC CHARACTERISTICS

T_A = –40°C to 85°C, VDD = 2 V to 3.6 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_1	SCK period	Master, RX and TX	250			ns
		Slave, RX and TX	250			
	SCK duty cycle	Master		50%		
t_2	SSN low to SCK	Master	63			ns
		Slave	63			
t_3	SCK to SSN high	Master	63			ns
		Slave	63			
t_4	MOSI early out	Master, load = 10 pF			7	ns
t_5	MOSI late out	Master, load = 10 pF			10	ns
t_6	MISO setup	Master	90			ns
t_7	MISO hold	Master	10			ns
	SCK duty cycle	Slave		50%		ns
t_{10}	MOSI setup	Slave	35			ns
t_{11}	MOSI hold	Slave	10			ns
t_9	MISO late out	Slave, load = 10 pF			95	ns
	Operating frequency	Master, TX only			8	MHz
		Master, RX and TX			4	
		Slave, RX only			8	
		Slave, RX and TX			4	

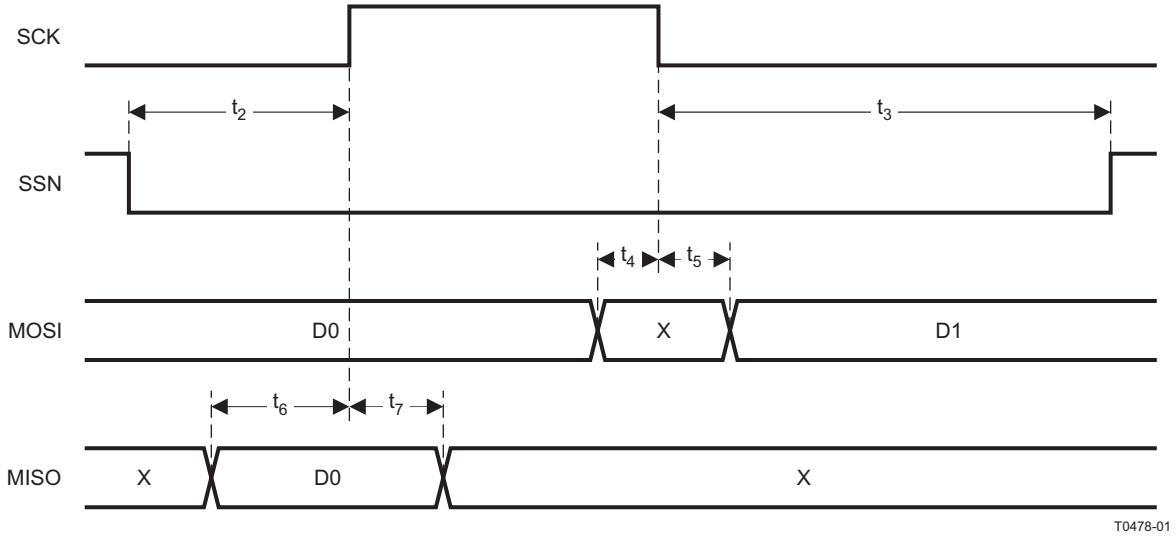


Figure 3. SPI Master AC Characteristics

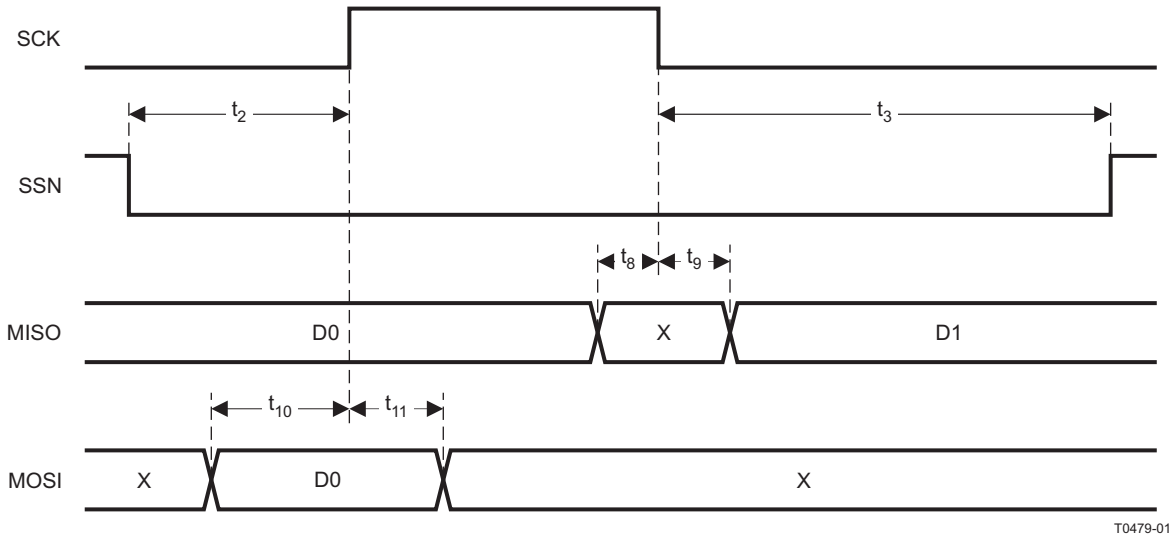


Figure 4. SPI Slave AC Characteristics

DEBUG INTERFACE AC CHARACTERISTICS

T_A = –40°C to 85°C, VDD = 2 V to 3.6 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{clk_dbg}	Debug clock frequency (see Figure 5)				12	MHz
t_1	Allowed high pulse on clock (see Figure 5)		35			ns
t_2	Allowed low pulse on clock (see Figure 5)		35			ns
t_3	EXT_RESET_N low to first falling edge on debug clock (see Figure 7)		167			ns
t_4	Falling edge on clock to EXT_RESET_N high (see Figure 7)		83			ns
t_5	EXT_RESET_N high to first debug command (see Figure 7)		83			ns
t_6	Debug data setup (see Figure 6)		2			ns
t_7	Debug data hold (see Figure 6)		4			ns
t_8	Clock-to-data delay (see Figure 6)	Load = 10 pF			30	ns

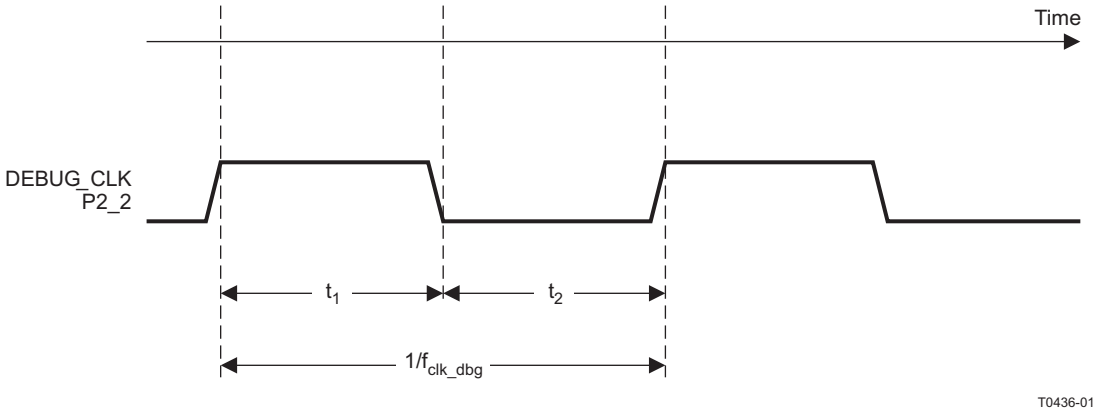


Figure 5. Debug Clock – Basic Timing

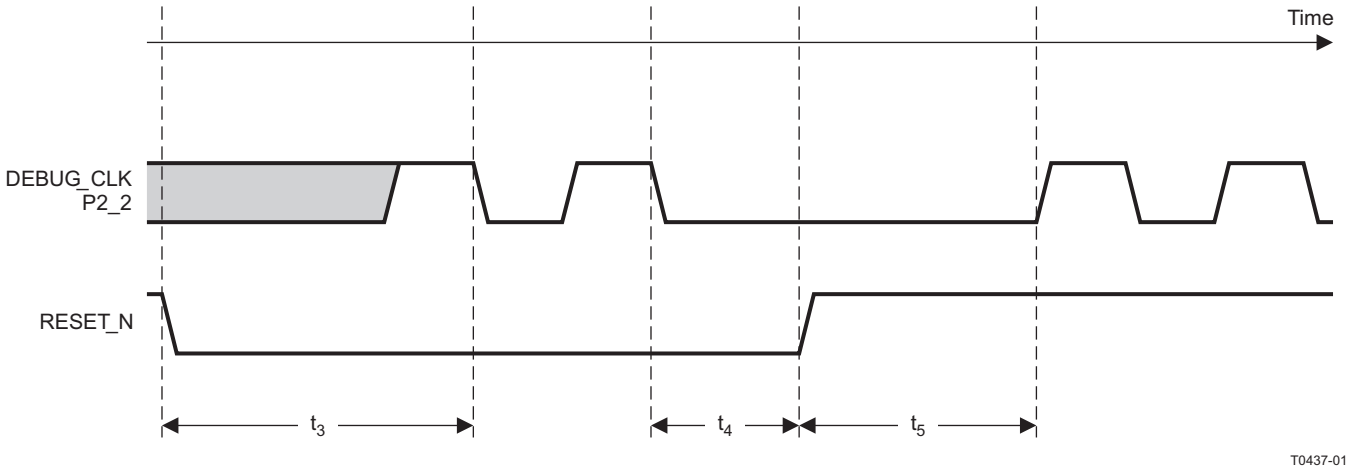


Figure 6. Debug Enable Timing

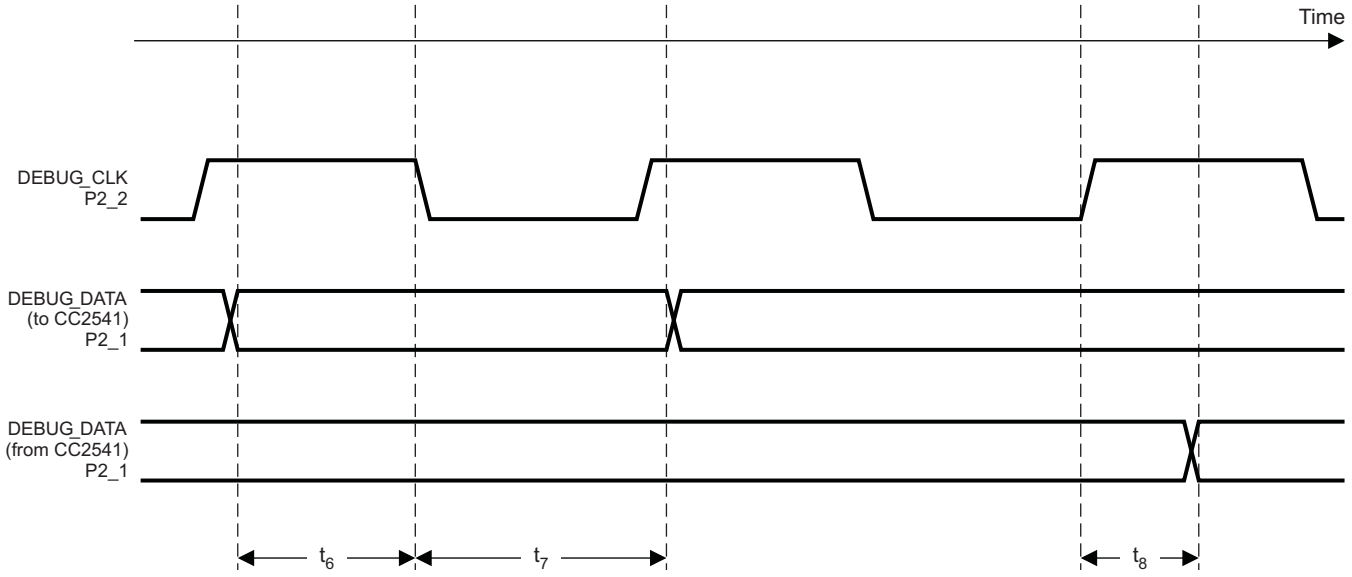


Figure 7. Data Setup and Hold Timing

TIMER INPUTS AC CHARACTERISTICS

T_A = –40°C to 85°C, VDD = 2 V to 3.6 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input capture pulse duration	Synchronizers determine the shortest input pulse that can be recognized. The synchronizers operate at the current system clock rate (16 MHz or 32 MHz).	1.5			t_{SYSCLK}

DC CHARACTERISTICS

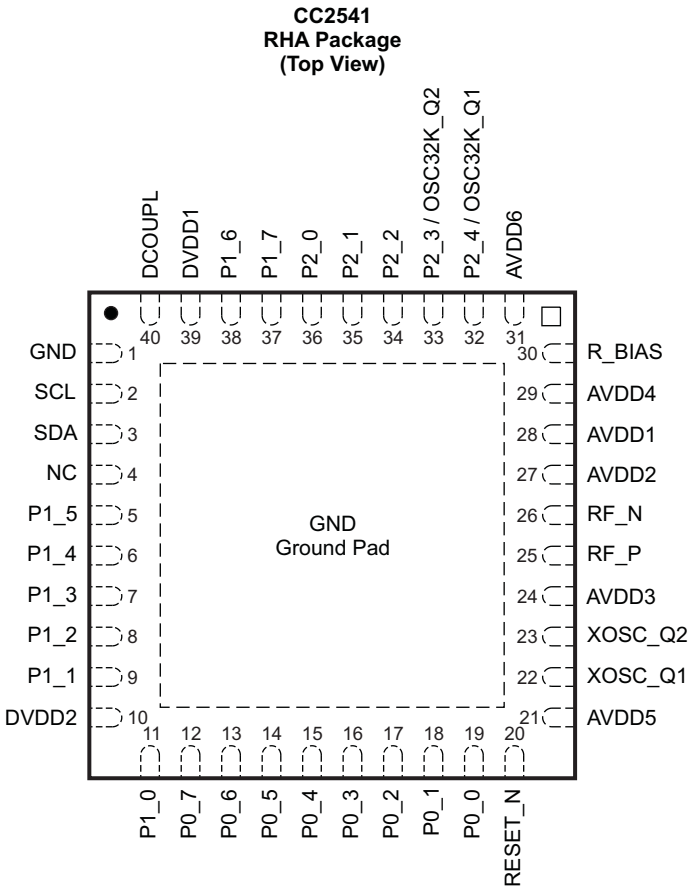
T_A = 25°C, VDD = 3 V

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Logic-0 input voltage				0.5	V
Logic-1 input voltage		2.4			V
Logic-0 input current	Input equals 0 V	–50		50	nA
Logic-1 input current	Input equals VDD	–50		50	nA
I/O-pin pullup and pulldown resistors			20		kΩ
Logic-0 output voltage, 4- mA pins	Output load 4 mA			0.5	V
Logic-1 output voltage, 4-mA pins	Output load 4 mA	2.5			V
Logic-0 output voltage, 20- mA pins	Output load 20 mA			0.5	V
Logic-1 output voltage, 20-mA pins	Output load 20 mA	2.5			V

DEVICE INFORMATION

PIN DESCRIPTIONS

The CC2541 pinout is shown in Figure 8 and a short description of the pins follows.



NOTE: The exposed ground pad must be connected to a solid ground plane, as this is the ground connection for the chip.

Figure 8. Pinout Top View

PIN DESCRIPTIONS

PIN NAME	PIN	PIN TYPE	DESCRIPTION
AVDD1	28	Power (analog)	2-V–3.6-V analog power-supply connection
AVDD2	27	Power (analog)	2-V–3.6-V analog power-supply connection
AVDD3	24	Power (analog)	2-V–3.6-V analog power-supply connection
AVDD4	29	Power (analog)	2-V–3.6-V analog power-supply connection
AVDD5	21	Power (analog)	2-V–3.6-V analog power-supply connection
AVDD6	31	Power (analog)	2-V–3.6-V analog power-supply connection
DCOUPL	40	Power (digital)	1.8-V digital power-supply decoupling. Do not use for supplying external circuits.
DVDD1	39	Power (digital)	2-V–3.6-V digital power-supply connection
DVDD2	10	Power (digital)	2-V–3.6-V digital power-supply connection
GND	1	Ground pin	Connect to GND
GND	—	Ground	The ground pad must be connected to a solid ground plane.
NC	4	Unused pins	Not connected
P0_0	19	Digital I/O	Port 0.0
P0_1	18	Digital I/O	Port 0.1
P0_2	17	Digital I/O	Port 0.2
P0_3	16	Digital I/O	Port 0.3
P0_4	15	Digital I/O	Port 0.4
P0_5	14	Digital I/O	Port 0.5
P0_6	13	Digital I/O	Port 0.6
P0_7	12	Digital I/O	Port 0.7
P1_0	11	Digital I/O	Port 1.0 – 20-mA drive capability
P1_1	9	Digital I/O	Port 1.1 – 20-mA drive capability
P1_2	8	Digital I/O	Port 1.2
P1_3	7	Digital I/O	Port 1.3
P1_4	6	Digital I/O	Port 1.4
P1_5	5	Digital I/O	Port 1.5
P1_6	38	Digital I/O	Port 1.6
P1_7	37	Digital I/O	Port 1.7
P2_0	36	Digital I/O	Port 2.0
P2_1/DD	35	Digital I/O	Port 2.1 / debug data
P2_2/DC	34	Digital I/O	Port 2.2 / debug clock
P2_3/ OSC32K_Q2	33	Digital I/O, Analog I/O	Port 2.3/32.768 kHz XOSC
P2_4/ OSC32K_Q1	32	Digital I/O, Analog I/O	Port 2.4/32.768 kHz XOSC
RBIAS	30	Analog I/O	External precision bias resistor for reference current
RESET_N	20	Digital input	Reset, active-low
RF_N	26	RF I/O	Negative RF input signal to LNA during RX Negative RF output signal from PA during TX
RF_P	25	RF I/O	Positive RF input signal to LNA during RX Positive RF output signal from PA during TX
SCL	2	I^2C clock or digital I/O	Can be used as I^2C clock pin or digital I/O. Leave floating if not used. If grounded disable pull up
SDA	3	I^2C clock or digital I/O	Can be used as I^2C data pin or digital I/O. Leave floating if not used. If grounded disable pull up
XOSC_Q1	22	Analog I/O	32-MHz crystal oscillator pin 1 or external clock input
XOSC_Q2	23	Analog I/O	32-MHz crystal oscillator pin 2

BLOCK DIAGRAM

A block diagram of the CC2541 is shown in Figure 9. The modules can be roughly divided into one of three categories: CPU-related modules; modules related to power, test, and clock distribution; and radio-related modules. In the following subsections, a short description of each module is given.

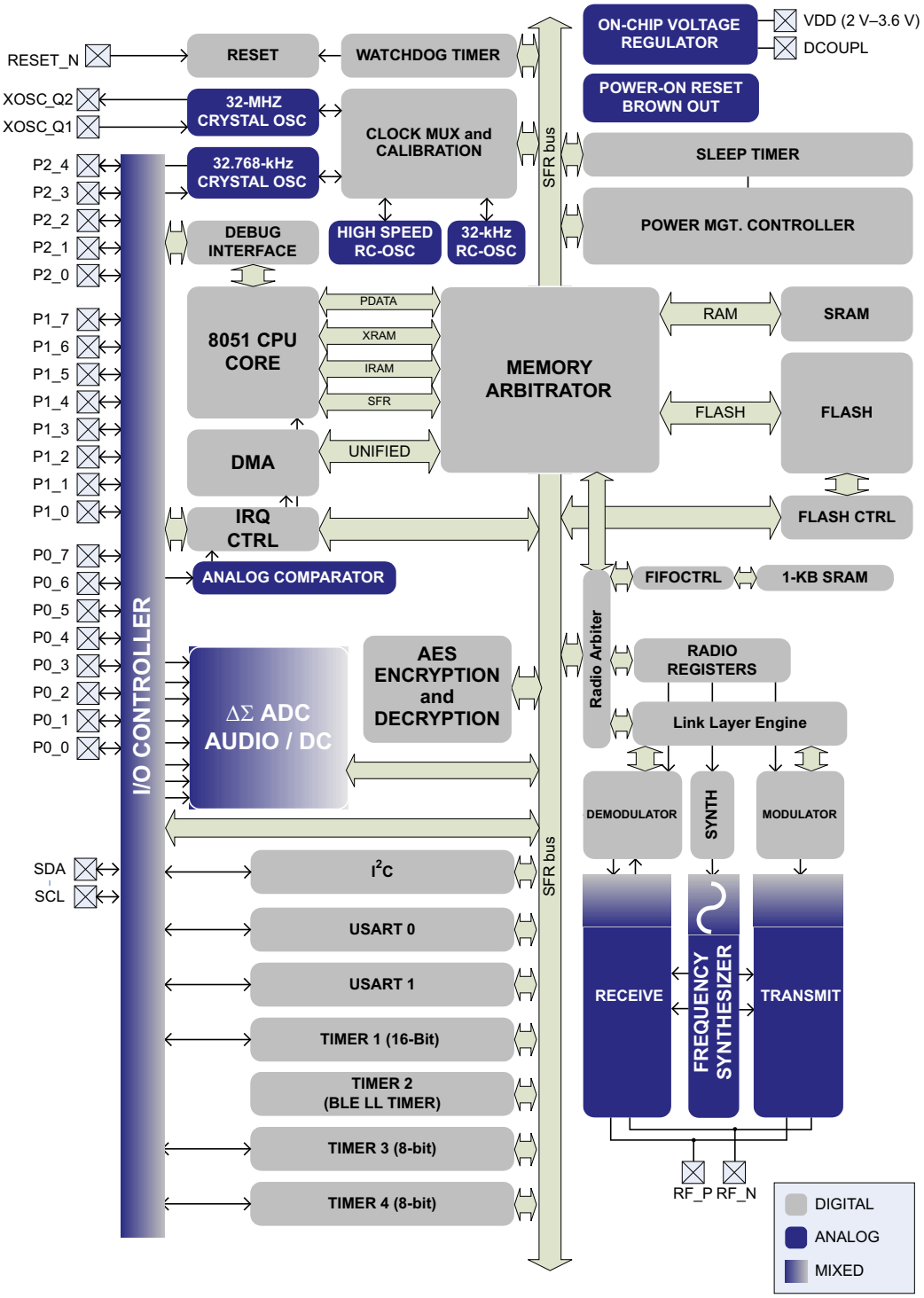


Figure 9. CC2541 Block Diagram

BLOCK DESCRIPTIONS

A block diagram of the CC2541 is shown in Figure 9. The modules can be roughly divided into one of three categories: CPU-related modules; modules related to power, test, and clock distribution; and radio-related modules. In the following subsections, a short description of each module is given.

CPU and Memory

The **8051 CPU core** is a single-cycle 8051-compatible core. It has three different memory access busses (SFR, DATA, and CODE/XDATA), a debug interface, and an 18-input extended interrupt unit.

The **memory arbiter** is at the heart of the system, as it connects the CPU and DMA controller with the physical memories and all peripherals through the SFR bus. The memory arbiter has four memory-access points, access of which can map to one of three physical memories: an SRAM, flash memory, and XREG/SFR registers. It is responsible for performing arbitration and sequencing between simultaneous memory accesses to the same physical memory.

The **SFR bus** is drawn conceptually in Figure 9 as a common bus that connects all hardware peripherals to the memory arbiter. The SFR bus in the block diagram also provides access to the radio registers in the radio register bank, even though these are indeed mapped into XDATA memory space.

The **8-KB SRAM** maps to the DATA memory space and to parts of the XDATA memory spaces. The SRAM is an ultralow-power SRAM that retains its contents even when the digital part is powered off (power mode 2 and mode 3).

The **128/256 KB flash block** provides in-circuit programmable non-volatile program memory for the device, and maps into the CODE and XDATA memory spaces.

Peripherals

Writing to the flash block is performed through a **flash controller** that allows page-wise erasure and 4-bytewise programming. See User Guide for details on the flash controller.

A versatile five-channel **DMA controller** is available in the system, accesses memory using the XDATA memory space, and thus has access to all physical memories. Each channel (trigger, priority, transfer mode, addressing mode, source and destination pointers, and transfer count) is configured with DMA descriptors that can be located anywhere in memory. Many of the hardware peripherals (AES core, flash controller, USARTs, timers, ADC interface, etc.) can be used with the DMA controller for efficient operation by performing data transfers between a single SFR or XREG address and flash/SRAM.

Each CC2541 contains a unique 48-bit IEEE address that can be used as the public device address for a *Bluetooth* device. Designers are free to use this address, or provide their own, as described in the *Bluetooth* specfication.

The **interrupt controller** services a total of 18 interrupt sources, divided into six interrupt groups, each of which is associated with one of four interrupt priorities. I/O and sleep timer interrupt requests are serviced even if the device is in a sleep mode (power modes 1 and 2) by bringing the CC2541 back to the active mode.

The **debug interface** implements a proprietary two-wire serial interface that is used for in-circuit debugging. Through this debug interface, it is possible to erase or program the entire flash memory, control which oscillators are enabled, stop and start execution of the user program, execute instructions on the 8051 core, set code breakpoints, and single-step through instructions in the code. Using these techniques, it is possible to perform in-circuit debugging and external flash programming elegantly.

The **I/O controller** is responsible for all general-purpose I/O pins. The CPU can configure whether peripheral modules control certain pins or whether they are under software control, and if so, whether each pin is configured as an input or output and if a pullup or pulldown resistor in the pad is connected. Each peripheral that connects to the I/O pins can choose between two different I/O pin locations to ensure flexibility in various applications.

The **sleep timer** is an ultralow-power timer that can either use an external 32.768-kHz crystal oscillator or an internal 32.753-kHz RC oscillator. The sleep timer runs continuously in all operating modes except power mode 3. Typical applications of this timer are as a real-time counter or as a wake-up timer to get out of power mode 1 or mode 2.

A built-in **watchdog timer** allows the CC2541 to reset itself if the firmware hangs. When enabled by software, the watchdog timer must be cleared periodically; otherwise, it resets the device when it times out.

Timer 1 is a 16-bit timer with timer/counter/PWM functionality. It has a programmable prescaler, a 16-bit period value, and five individually programmable counter/capture channels, each with a 16-bit compare value. Each of the counter/capture channels can be used as a PWM output or to capture the timing of edges on input signals. It can also be configured in IR generation mode, where it counts timer 3 periods and the output is ANDed with the output of timer 3 to generate modulated consumer IR signals with minimal CPU interaction.

Timer 2 is a 40-bit timer. It has a 16-bit counter with a configurable timer period and a 24-bit overflow counter that can be used to keep track of the number of periods that have transpired. A 40-bit capture register is also used to record the exact time at which a start-of-frame delimiter is received/transmitted or the exact time at which transmission ends. There are two 16-bit output compare registers and two 24-bit overflow compare registers that can be used to give exact timing for start of RX or TX to the radio or general interrupts.

Timer 3 and timer 4 are 8-bit timers with timer/counter/PWM functionality. They have a programmable prescaler, an 8-bit period value, and one programmable counter channel with an 8-bit compare value. Each of the counter channels can be used as PWM output.

USART 0 and USART 1 are each configurable as either an SPI master/slave or a UART. They provide double buffering on both RX and TX and hardware flow control and are thus well suited to high-throughput full-duplex applications. Each USART has its own high-precision baud-rate generator, thus leaving the ordinary timers free for other uses. When configured as SPI slaves, the USARTs sample the input signal using SCK directly instead of using some oversampling scheme, and are thus well-suited for high data rates.

The **AES encryption/decryption core** allows the user to encrypt and decrypt data using the AES algorithm with 128-bit keys. The AES core also supports ECB, CBC, CFB, OFB, CTR, and CBC-MAC, as well as hardware support for CCM.

The **ADC** supports 7 to 12 bits of resolution with a corresponding range of bandwidths from 30-kHz to 4-kHz, respectively. DC and audio conversions with up to eight input channels (I/O controller pins) are possible. The inputs can be selected as single-ended or differential. The reference voltage can be internal, AVDD, or a single-ended or differential external signal. The ADC also has a temperature-sensor input channel. The ADC can automate the process of periodic sampling or conversion over a sequence of channels.

The **I^2C** module provides a digital peripheral connection with two pins and supports both master and slave operation. I^2C support is compliant with the NXP I^2C specification version 2.1 and supports standard mode (up to 100 kbps) and fast mode (up to 400 kbps). In addition, 7-bit device addressing modes are supported, as well as master and slave modes.

The ultralow-power **analog comparator** enables applications to wake up from PM2 or PM3 based on an analog signal. Both inputs are brought out to pins; the reference voltage must be provided externally. The comparator output is connected to the I/O controller interrupt detector and can be treated by the MCU as a regular I/O pin interrupt.

TYPICAL CHARACTERISTICS

RX CURRENT vs TEMPERATURE

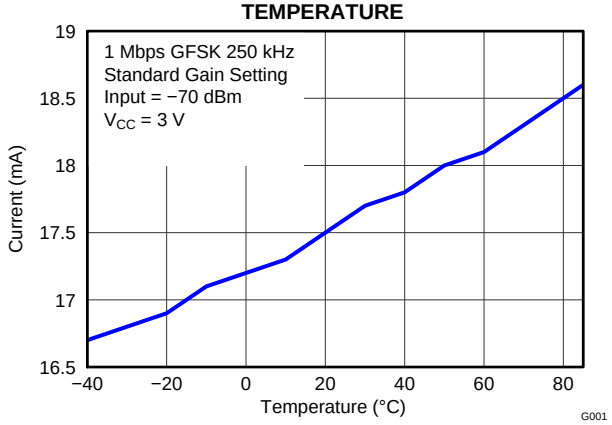


Figure 10.

TX CURRENT vs TEMPERATURE

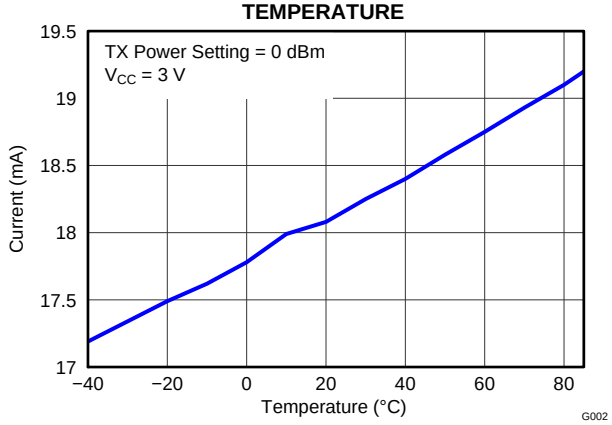


Figure 11.

RX SENSITIVITY vs TEMPERATURE

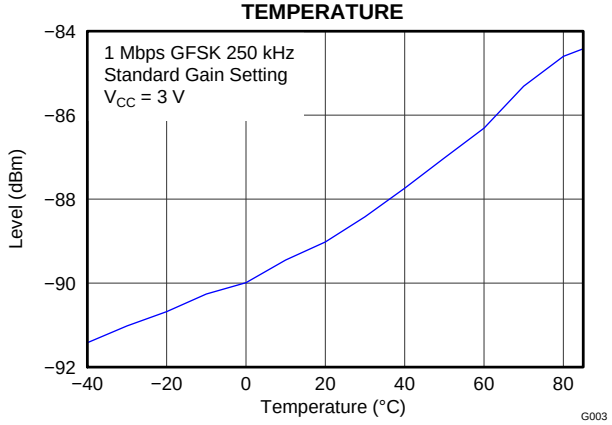


Figure 12.

TX POWER vs TEMPERATURE

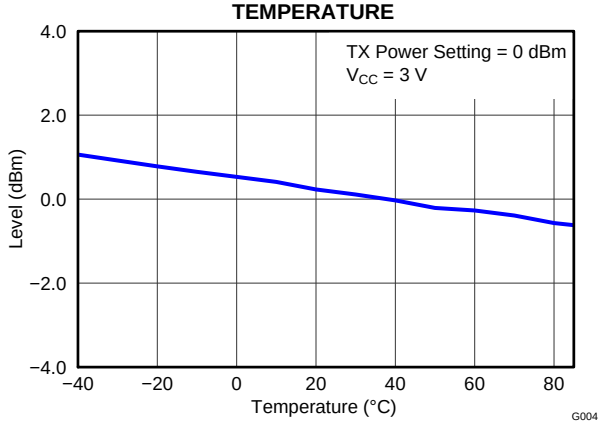


Figure 13.

RX CURRENT vs SUPPLY VOLTAGE

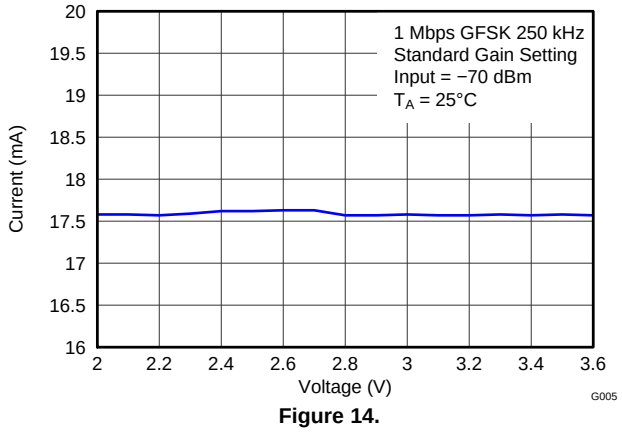


Figure 14.

TX CURRENT vs SUPPLY VOLTAGE

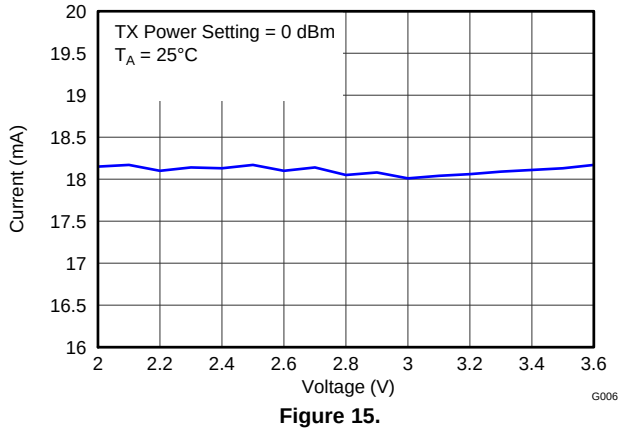


Figure 15.

TYPICAL CHARACTERISTICS (continued)

RX SENSITIVITY VS SUPPLY VOLTAGE

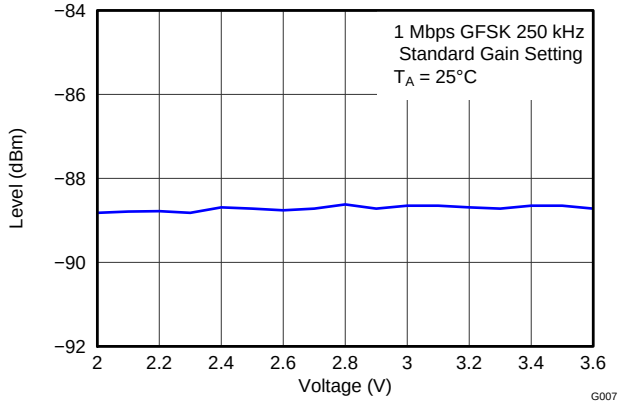


Figure 16.

TX POWER VS SUPPLY VOLTAGE

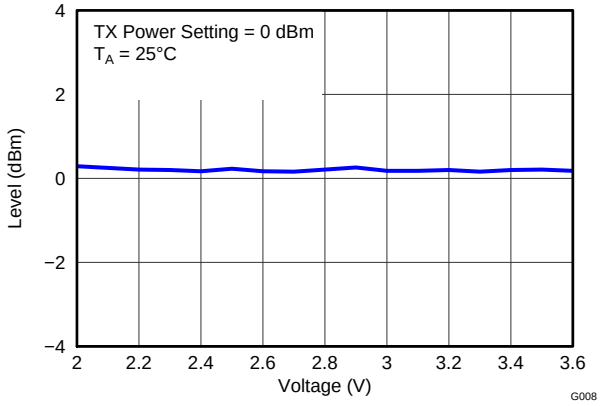


Figure 17.

RX SENSITIVITY VS FREQUENCY

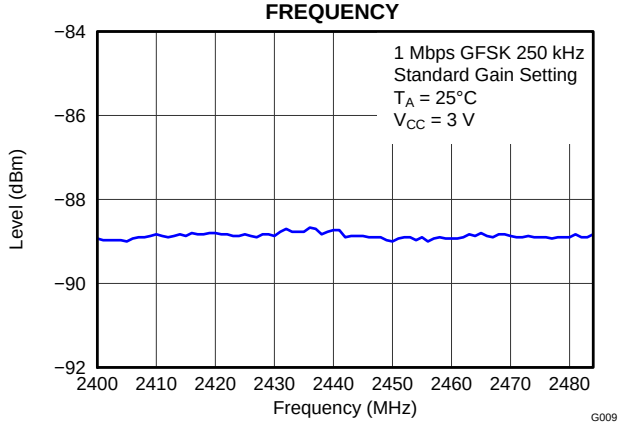


Figure 18.

TX POWER VS FREQUENCY

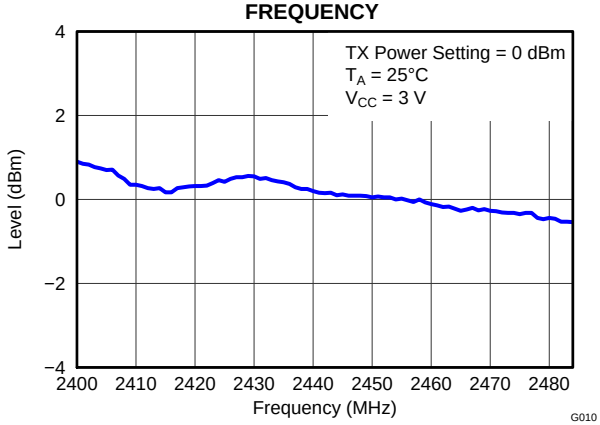


Figure 19.

Table 1. Output Power[1][2]

TXPOWER Setting	Typical Output Power (dBm)
0xE1	0
0xD1	–2
0xC1	–4
0xB1	–6
0xA1	–8
0x91	–10
0x81	–12
0x71	–14
0x61	–16
0x51	–18
0x41	–20
0x31	–23

(1) Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V and f_c = 2440 MHz. See SWRU191 for recommended register settings.
(2) 1 Mbsp, GFSK, 250-kHz deviation, Bluetooth™ low energy mode, 1% BER

Table 2. Output Power and Current Consumption

Typical Output Power (dBm)	Typical Current Consumption (mA)(1)	Typical Current Consumption With TPS62730 (mA)(2)
0	18.2	14.3
–20	16.8	13.1

(1) Measured on Texas Instruments CC2541 EM reference design with T_A = 25°C, VDD = 3 V and f_c = 2440 MHz. See SWRU191 for recommended register settings.
(2) Measured on Texas Instruments CC2541 TPS62730 EM reference design with T_A = 25°C, VDD = 3 V and f_c = 2440 MHz. See SWRU191 for recommended register settings.

TYPICAL CURRENT SAVINGS WHEN USING TPS62730

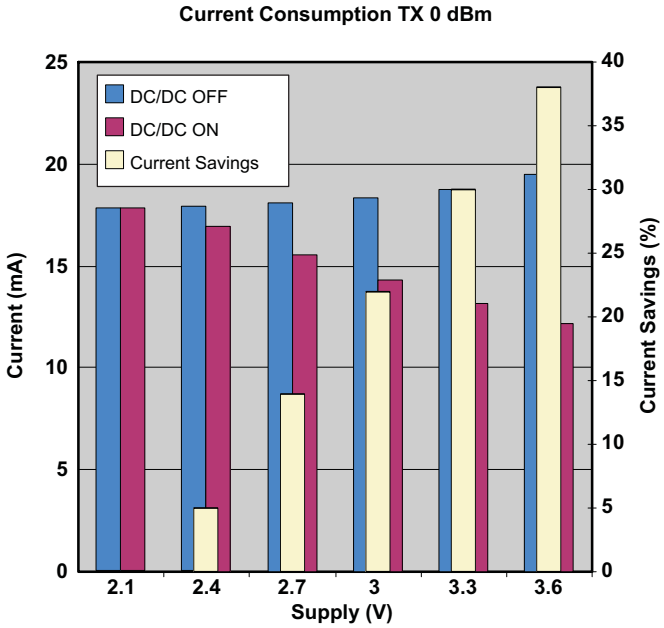


Figure 20. Current Savings in TX at Room Temperature

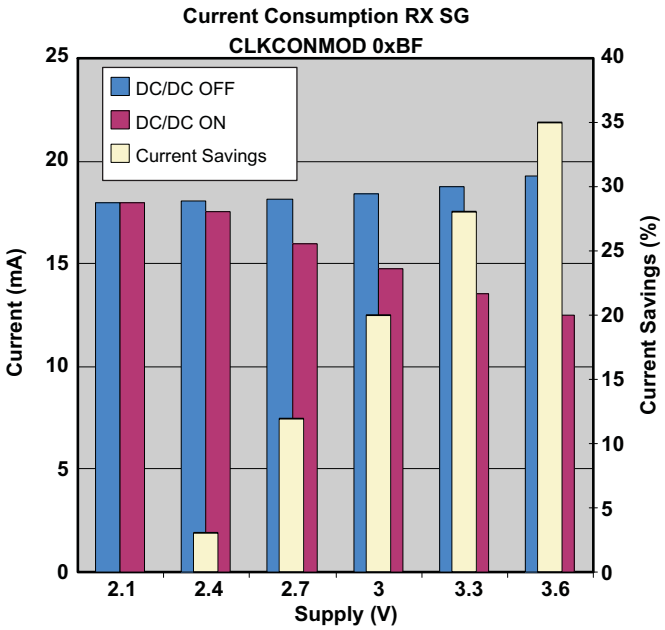
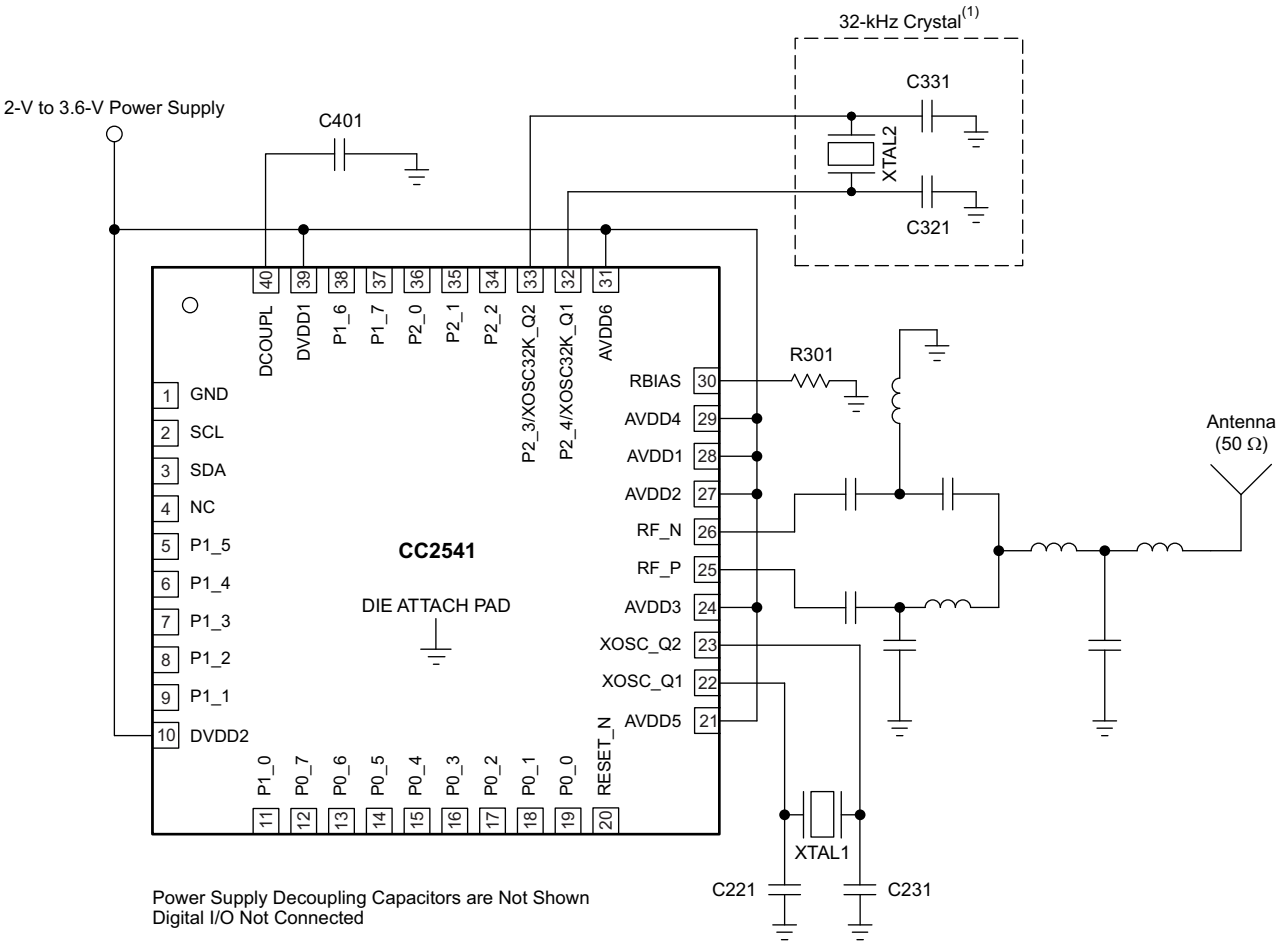


Figure 21. Current Savings in RX at Room Temperature

The application note (SWRA365) has information regarding the CC2541 and TPS62730 combo board and the current savings that can be achieved using the combo board.

APPLICATION INFORMATION

Few external components are required for the operation of the CC2541. A typical application circuit is shown in Figure 22.



(1) 32-kHz crystal is mandatory when running the BLE protocol stack in low-power modes, except if the link layer is in the standby state (Vol. 6 Part B Section 1.1 in [1]).

NOTE: Different antenna alternatives will be provided as reference designs.

Figure 22. CC2541 Application Circuit

Table 3. Overview of External Components (Excluding Supply Decoupling Capacitors)

Component	Description	Value
C401	Decoupling capacitor for the internal 1.8-V digital voltage regulator	1 µF
R301	Precision resistor ±1%, used for internal biasing	56 kΩ

Input/Output Matching

When using an unbalanced antenna such as a monopole, a balun should be used to optimize performance. The balun can be implemented using low-cost discrete inductors and capacitors. See reference design, CC2541EM, for recommended balun.

Crystal

An external 32-MHz crystal, XTAL1, with two loading capacitors (C221 and C231) is used for the 32-MHz crystal oscillator. See 32-MHz CRYSTAL OSCILLATOR for details. The load capacitance seen by the 32-MHz crystal is given by:

$$C_L = \frac{1}{\frac{1}{C_{221}} + \frac{1}{C_{231}}} + C_{parasitic} \quad (1)$$

XTAL2 is an optional 32.768-kHz crystal, with two loading capacitors (C321 and C331) used for the 32.768-kHz crystal oscillator. The 32.768-kHz crystal oscillator is used in applications where both very low sleep-current consumption and accurate wake-up times are needed. The load capacitance seen by the 32.768-kHz crystal is given by:

$$C_L = \frac{1}{\frac{1}{C_{321}} + \frac{1}{C_{331}}} + C_{parasitic} \quad (2)$$

A series resistor may be used to comply with the ESR requirement.

On-Chip 1.8-V Voltage Regulator Decoupling

The 1.8-V on-chip voltage regulator supplies the 1.8-V digital logic. This regulator requires a decoupling capacitor (C401) for stable operation.

Power-Supply Decoupling and Filtering

Proper power-supply decoupling must be used for optimum performance. The placement and size of the decoupling capacitors and the power supply filtering are very important to achieve the best performance in an application. TI provides a compact reference design that should be followed very closely.

References

1. *Bluetooth*® Core Technical Specification document, version 4.0
   http://www.bluetooth.com/SiteCollectionDocuments/Core_V40.zip
2. CC253x System-on-Chip Solution for 2.4-GHz IEEE 802.15.4 and ZigBee® Applications/CC2541 System-on-Chip Solution for 2.4-GHz *Bluetooth* low energy Applications (SWRU191)
3. Current Savings in CC254x Using the TPS62730 (SWRA365).

Additional Information

Texas Instruments offers a wide selection of cost-effective, low-power RF solutions for proprietary and standard-based wireless applications for use in industrial and consumer applications. Our selection includes RF transceivers, RF transmitters, RF front ends, and System-on-Chips as well as various software solutions for the sub-1- and 2.4-GHz frequency bands.

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- RF design help
- E2E interaction

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- Low-power RF and ZigBee module solutions and development tools
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REVISION HISTORY

Changes from Original (January 2012) to Revision A	Page
• Changed data sheet status from Product Preview to Production Data	1

Changes from Revision A (February 2012) to Revision B	Page
• Changed the Temperature coefficient Unit value From: mV/°C To: / 0.1°C	10
• Changed Figure 22 text From: Optional 32-kHz Crystal To: 32-kHz Crystal	24

Changes from Revision B (August 2012) to Revision C	Page
• Changed the "Internal reference voltage" TYP value From 1.15 V To: 1.24 V	12
• Changed pin XOSC_Q1 Pin Type From Analog O To: Analog I/O, and changed the Pin Description	17
• Changed pin XOSC_Q2 Pin Type From Analog O To: Analog I/O	17

Changes from Revision C (November 2012) to Revision D	Page
• Changed the RF TRANSMIT SECTION, Output power TYP value From: –20 To: –23	8
• Changed the RF TRANSMIT SECTION, Programmable output power range TYP value From: 20 To: 23	8
• Added row 0x31 to Table 1	22

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CC2541F128RHAR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU | CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC2541 F128	Samples
CC2541F128RHAT	ACTIVE	VQFN	RHA	40	250	Green (RoHS & no Sb/Br)	CU NIPDAU | CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC2541 F128	Samples
CC2541F256RHAR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU | CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC2541 F256	Samples
CC2541F256RHAT	ACTIVE	VQFN	RHA	40	250	Green (RoHS & no Sb/Br)	CU NIPDAU | CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC2541 F256	Samples
HPA01215RHAR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2541 F128	Samples
HPA01216RHAR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2541 F256	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

OTHER QUALIFIED VERSIONS OF CC2541 :

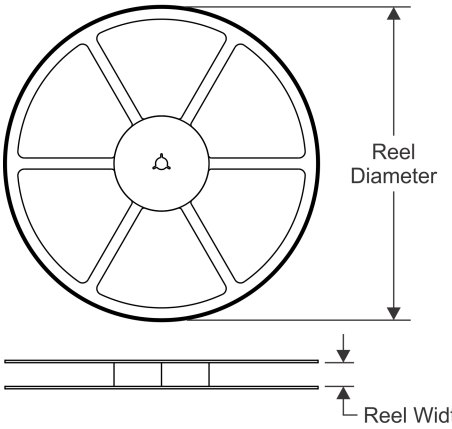
- Automotive: CC2541-Q1

NOTE: Qualified Version Definitions:

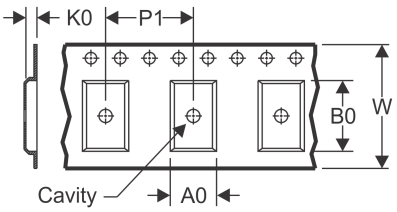
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

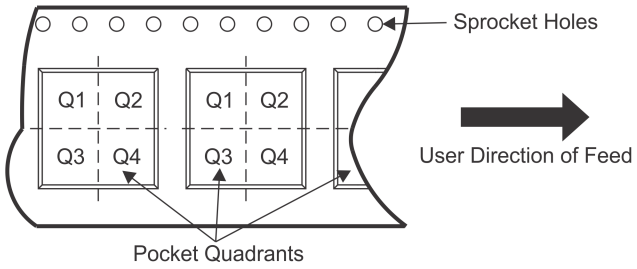


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

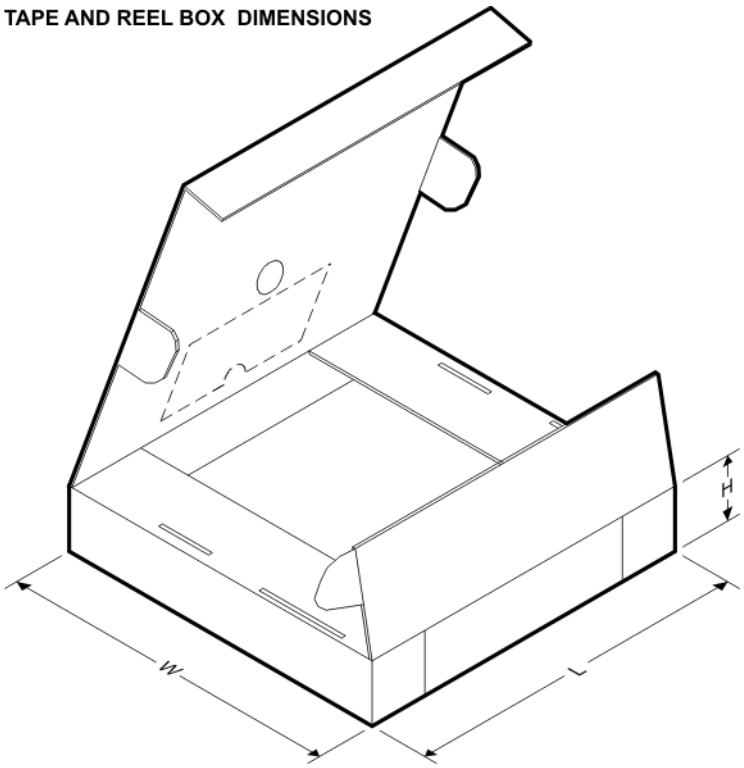
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CC2541F128RHAR	VQFN	RHA	40	2500	330.0	16.4	6.3	6.3	1.5	12.0	16.0	Q2
CC2541F128RHAT	VQFN	RHA	40	250	180.0	16.4	6.3	6.3	1.5	12.0	16.0	Q2
CC2541F256RHAR	VQFN	RHA	40	2500	330.0	16.4	6.3	6.3	1.5	12.0	16.0	Q2
CC2541F256RHAT	VQFN	RHA	40	250	180.0	16.4	6.3	6.3	1.5	12.0	16.0	Q2

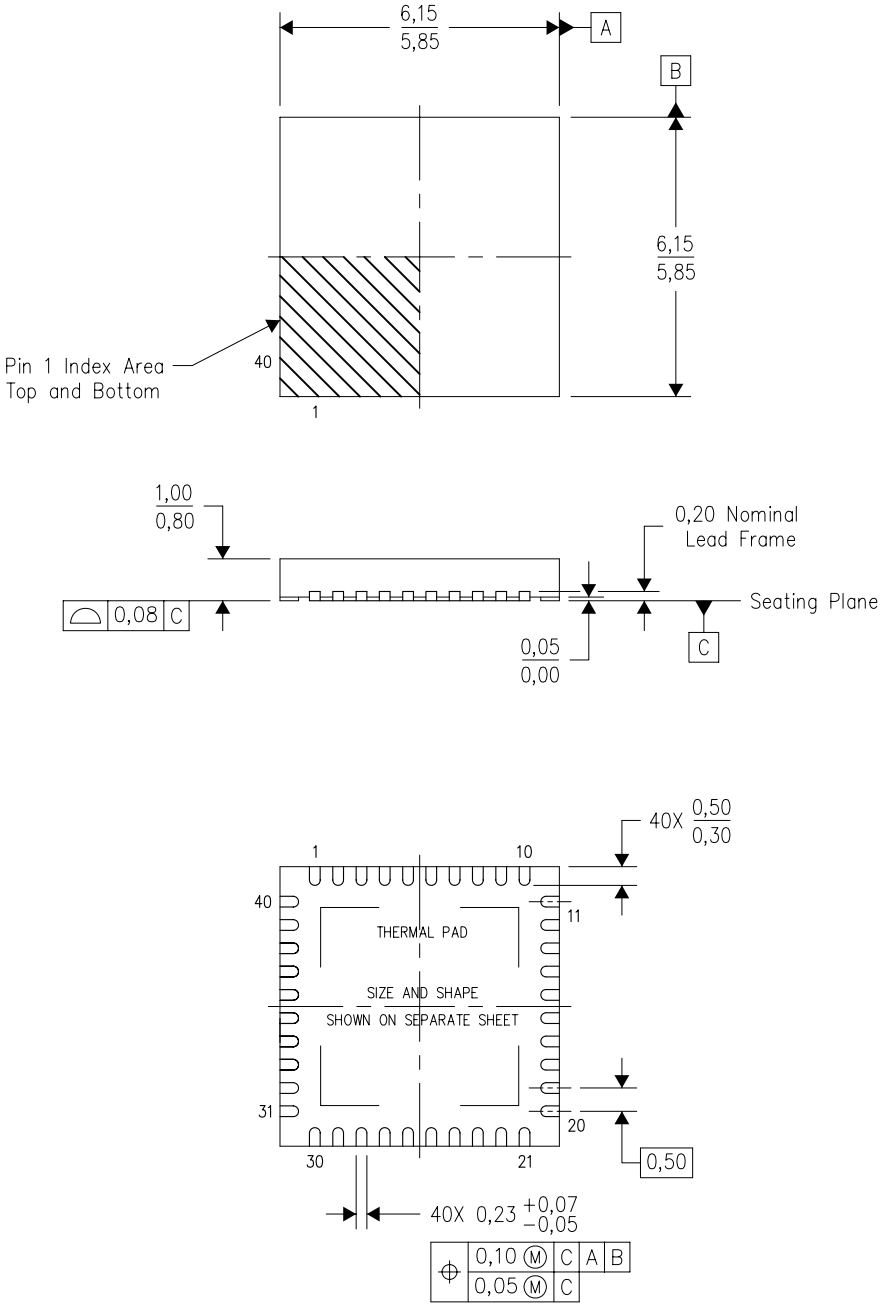
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CC2541F128RHAR	VQFN	RHA	40	2500	336.6	336.6	28.6
CC2541F128RHAT	VQFN	RHA	40	250	213.0	191.0	55.0
CC2541F256RHAR	VQFN	RHA	40	2500	336.6	336.6	28.6
CC2541F256RHAT	VQFN	RHA	40	250	213.0	191.0	55.0

RHA (S–PVQFN–N40) PLASTIC QUAD FLATPACK NO–LEAD



Bottom View

4204276/E 06/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) Package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
F. Package complies to JEDEC MO–220 variation VJJD–2.

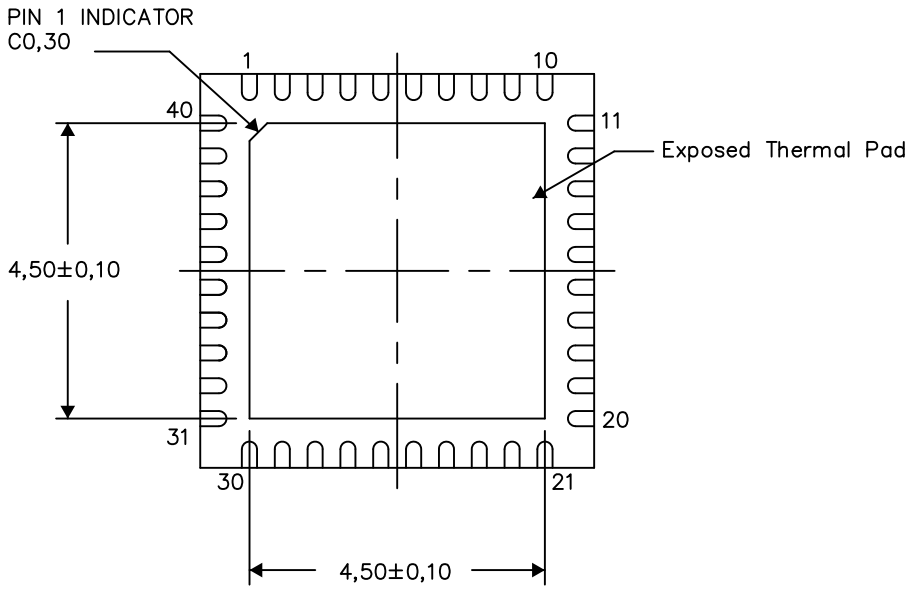
RHA (S–PVQFN–N40) PLASTIC QUAD FLATPACK NO–LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



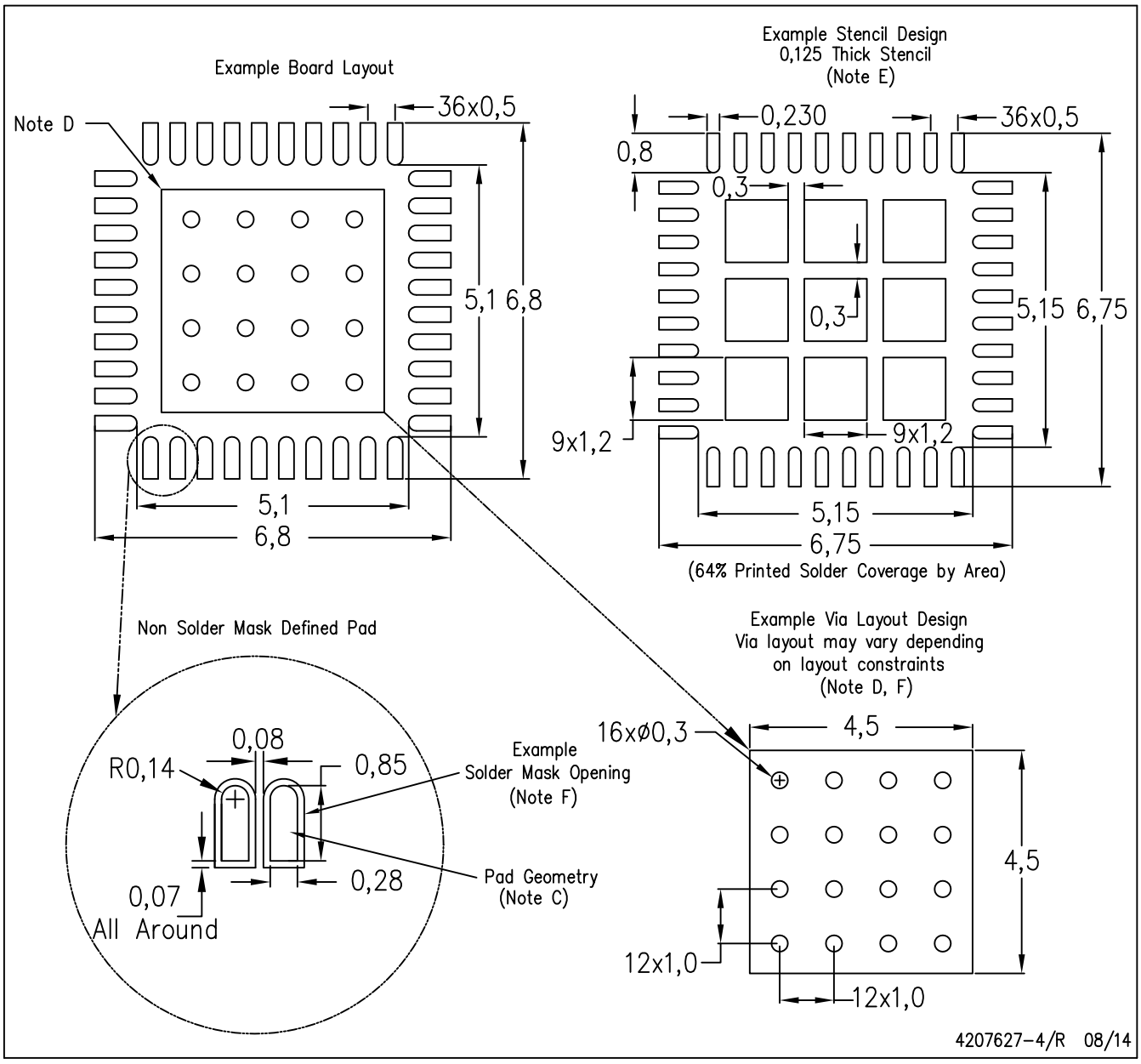
Bottom View

Exposed Thermal Pad Dimensions

4206355–4/X 08/14

NOTES: A. All linear dimensions are in millimeters

RHA (S–PVQFN–N40) PLASTIC QUAD FLATPACK NO–LEAD



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat–Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

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