

HAC-LBee
2.4G Low Power Data Radio Module
(Based on ZigBee protocol)
V3.1-2.2



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Catalogue

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I Features of HAC-LBee V3.1-2.2

HAC-LBee V3.1-2.2 is a kind of low power wireless module based on Zigbee protocol stack. The features are shown as follow:

1. Low power transmission with 100mW (20dBm) , and receiving sensitivity is -105dBm (BER=10⁻²) .
2. ISM frequency band with no require of applying frequency. The carrier frequency is 2.4GHz.
3. High anti-interference and Low BER (Bit error Rate)

Based on the Quadrature Phase Shift Keying (QPSK) modulation, the high-efficiency forward error correction channel encoding technology is used to enhance data's resistance to both transient interference and random interference. Narrowband interference of the same frequency can be suppressed by Direct Sequence Spread Spectrum. The 16 CRC verify bits can be used to check mistake.

4. The transmitting speed in the air can reach up to 250kbps.

5. Transmission Distance

Within the visible range, when the antenna is placed at 2m high, the reliable transmission distance is 1000m.

6. Multi-channels

HAC-LBee V3.1-2.2 offers 16 channels. It will select the suitable and reliable communication channel automatically according to the user's environment.

7. UART interface

HAC-LBee V3.1-2.2 provides a UART interface of TTL level. The default interface baud rate is 38400bps ex-factory, and the parity is no-parity (8N1).

8. Low power consumption

The receiving current is less than or equal to 50mA, and the transmitting current is less than or equal to 160mA.

9. Small size and light weight

10. By using monolithic radio-frequency integrated circuit and single-chip MCU, the transceivers have less peripheral circuits, higher reliability, and lower failure rate.

11. Offering many kinds of antenna connecting methods, such as PCB antenna, Chip antenna, IPX antenna connecting base and so on.

12. It can meet for the protocol of IEEE 802.25.4 for 2.4GHz and the application of ZigBee, it can make network automatically.



II. Applications of HAC-LBee V3.1-2.2

HAC-LBee V3.1-2.2 low power wireless module is suitable for:

- * Home appliances intelligent control.
- * Auto Meter Reading system.
- * Industry telemetry and automatic data collection system.
- * Security and alarm.
- * Wireless monitor for hotel and equipment of computer room, door's security, personnel orientation.
- * Traffic and the control for street lamp.
- * Logistics, active RFID, POS system and wireless handheld terminal.

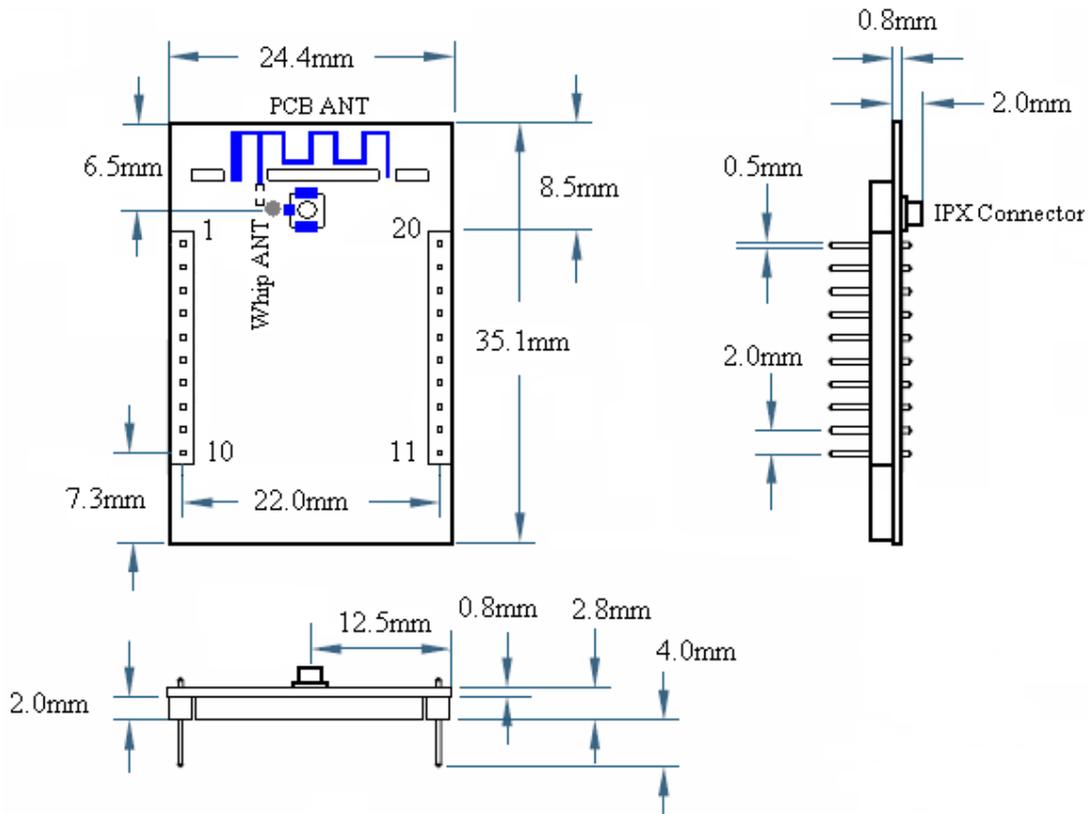
III. Technical Specs of HAC-LBee V3.1-2.2

3.1 Technical Parameter of HAC-LBee V3.1-2.2

Name	Parameter			Unit
	Minimum	Typical Value	Maximum	
Electric Performance (25°C)				
Power Supply	3.0	3.3	3.6	V
Interface Level	-0.3		$V_{CC} + 0.3 \leq 3.6$	V
Transmitting Current	140	150	160	mA
Receiving Current	29	30	31	mA
Sleeping Current		3		μA
Wireless Performance (25°C)				
Working Frequency	2.405		2.485	GHz
Transmitting Power	19.0	19.5	20.2	dBm
Receiving Sensitivity		-105		dBm
Transmitting Rate		250		Kbps
General Performance				
Interface baud rate	1200	38400	115200	bps
Working Temperature	-40		80	°C
Size	35.1 X 24.4 X 4			mm

Table 1 Technical Parameter of HAC-LBee V3.1-2.2

3.2 The Dimension of HAC-LBee V3.1-2.2 (35.1X24.4X4mm)



Picture 1 The Size of HAC-LBee V3.1-2.2

3.3 Pin Definition of HAC-LBee V3.1-2.2

Pin	Definition	Input/Output	Function Instruction
1	VCC	IN	Power Supply, +3.0~3.6V
2	TXD	OUT	Serial data output
3	RXD	IN	Serial data input
4	DIO1	IN/OUT	Data I/O1 /RS485 Enable
5	RESET	IN	Low level reset
6	DIO2	IN/OUT	Digital I/O2
7	DIO3	IN/OUT	Digital I/O3
8	DIO4/DD	IN/OUT	Digital I/O4 / Program data
9	DIO5/DC	IN/OUT	Digital I/O5 / Program clock/Sleep Enable

10	GND		Power supply (Negative),Ground
11	DIO6	IN/OUT	Digital I/O6
12	DIO7	IN/OUT	Digital I/O7
13	DIO8	IN/OUT	Digital I/O8
14	DIO9	IN/OUT	Digital I/O9
15	DIO10	IN/OUT	Digital I/O10
16	DIO11	IN/OUT	Digital I/O11
17	DIO12/ADC3	IN/OUT	Digital I/O12/Analog Input 3
18	DIO13/ADC2	IN/OUT	Digital I/O13/Analog Input 2
19	DIO14/ADC1	IN/OUT	Digital I/O14/Analog Input 1
20	DIO15/ADC0	IN/OUT	Digital I/O15/Analog Input 0

Table 2 Pin Definition of HAC-LBee V3.1-2.2

3.4 HAC-LBee V3.1-2.2 Optional fittings

1) Standard fittings

Standard LBee V3.1-2.2 always goes with PCB antenna, excluding IPX antenna base.



2) There is an optional Chip antenna called HAC-Antenna-CH2400 for customers.

When using Chip antenna, it needs to cut down the PCB antenna connection and connect with pad of Chip antenna. In such fittings, it doesn't include antenna base.



3) Using antenna cable to connect with external antenna

Such a connecting method is suitable for the products with the enclosure that has strong shield for wireless signal. The module has been soldered with IPX antenna base, at the same time, it needs to cut down the PCB antenna and lead the signal to IPX antenna base. If the IPX antenna base isn't needed, it can solder antenna cable directly. In this way, the connecting method is much firmer, but it is not suitable for transportation and assembly, because the pad for soldering antenna cable is easy to fall off if there is a force during the process of transportation and assembly.

A. Using antenna cable with two ends connector called KX-IPEX-10G1-SMA-F to connect with an 10cm external folding helical antenna called HAC-Antenna-LX2400-10-ZSMA-M.



HAC-KX-IPEX-10G1-SMA-F

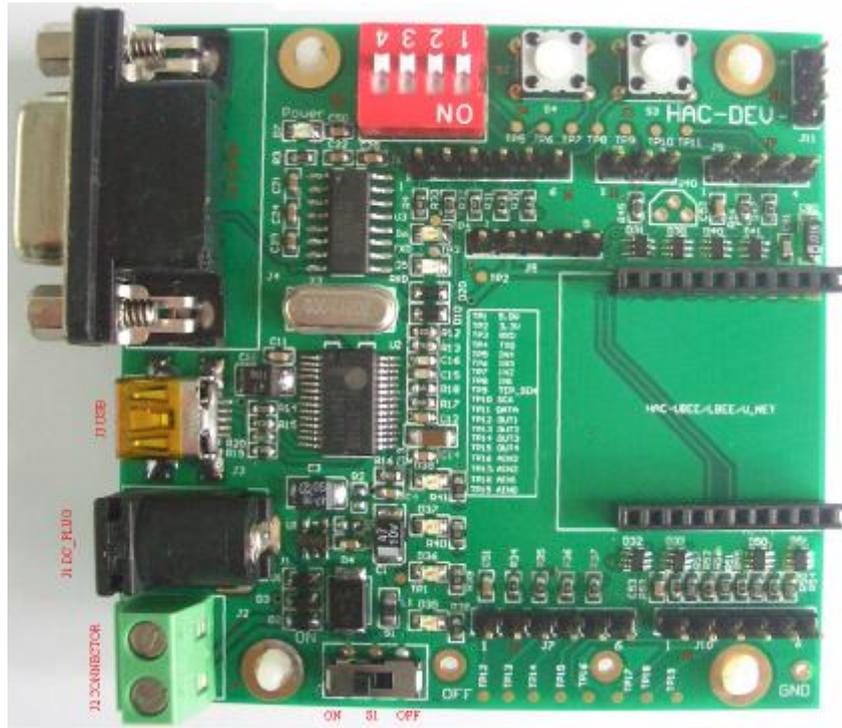
HAC-Antenna-LX2400-10-ZSMA-M

B Using antenna called LX2400Z-10-KX-10G1-IPEX to connect with the HAC-LBee V3.1-2.2 module directly.



IV. Development Kit for HAC-LBee V3.1-2.2 Wireless Module

4.1 General Information for HAC-DEV Development Kit



Picture 2 HAC-DEV

Connector Definition:

- a. J1 (DC_PLUG) 5V power supply input
- b. J2 (DC_CONNECTOR) 5V power supply input

Pin Name	Definition
Pin1	GND
Pin2	5V

- c. J3 (USB_PLUG) USB port, USB to Serial port. Please refer to the Appendix 2 for the installation for USB Driver.
- d. J4 (DB9/F) RS232 data port

Pin Name	Definition
Pin2	TXD
Pin3	RXD
Pin5	GND
Other pins	No Definition

- e. J5 (Programming) CC2530F256 Program Port

Pin Name	Definition
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Pin1	GND
Pin2	3.3V Input
Pin3	DD
Pin4	DC
Pin5	RESET

If there is an external power supply, don't connect the Pin2: 3.3V.

f. J6 (DA_IN) Digital Level Input

Pin Name	Definition
Pin1	3.3V input
Pin2	IN4 Digital Input 4th way
Pin3	IN3 Digital Input 3rd way
Pin4	IN2 Digital Input 2nd way
Pin5	IN1 Digital Input 1st way
Pin6	GND

g. J7 (DA_OUT) Digital Level Output

Pin Name	Definition
Pin1	3.3V Output
Pin2	OUT1 Digital Output 1st way
Pin3	OUT2 Digital Output 2nd way
Pin4	OUT3 Digital Output 3rd way
Pin5	OUT4 Digital Output 4th way
Pin6	GND

h. J8 (DS18B20) Temperature Sensor DS18B20 port

Pin Name	Definition
Pin1	GND
Pin2	TEP_SEN
Pin3	GND

i. J9 (SENSOR) 1²C port, connect with sensor

Pin Name	Definition
Pin1	3.3V
Pin2	SCK

Pin3	DATA
Pin4	GND

j. J10 (Analog Signals IN) 4~20mA current signal input

Pin Name	Definition
Pin1	3.3V Output
Pin2	AIN3 Current Signal Input 3rd way
Pin3	AIN2 Current Signal Input 2nd way
Pin4	AIN1 Current Signal Input 1st way
Pin5	AIN0 Current Signal Input 0 way
Pin6	GND

k. J11 (UART_TTL) Serial Port for TTL Level

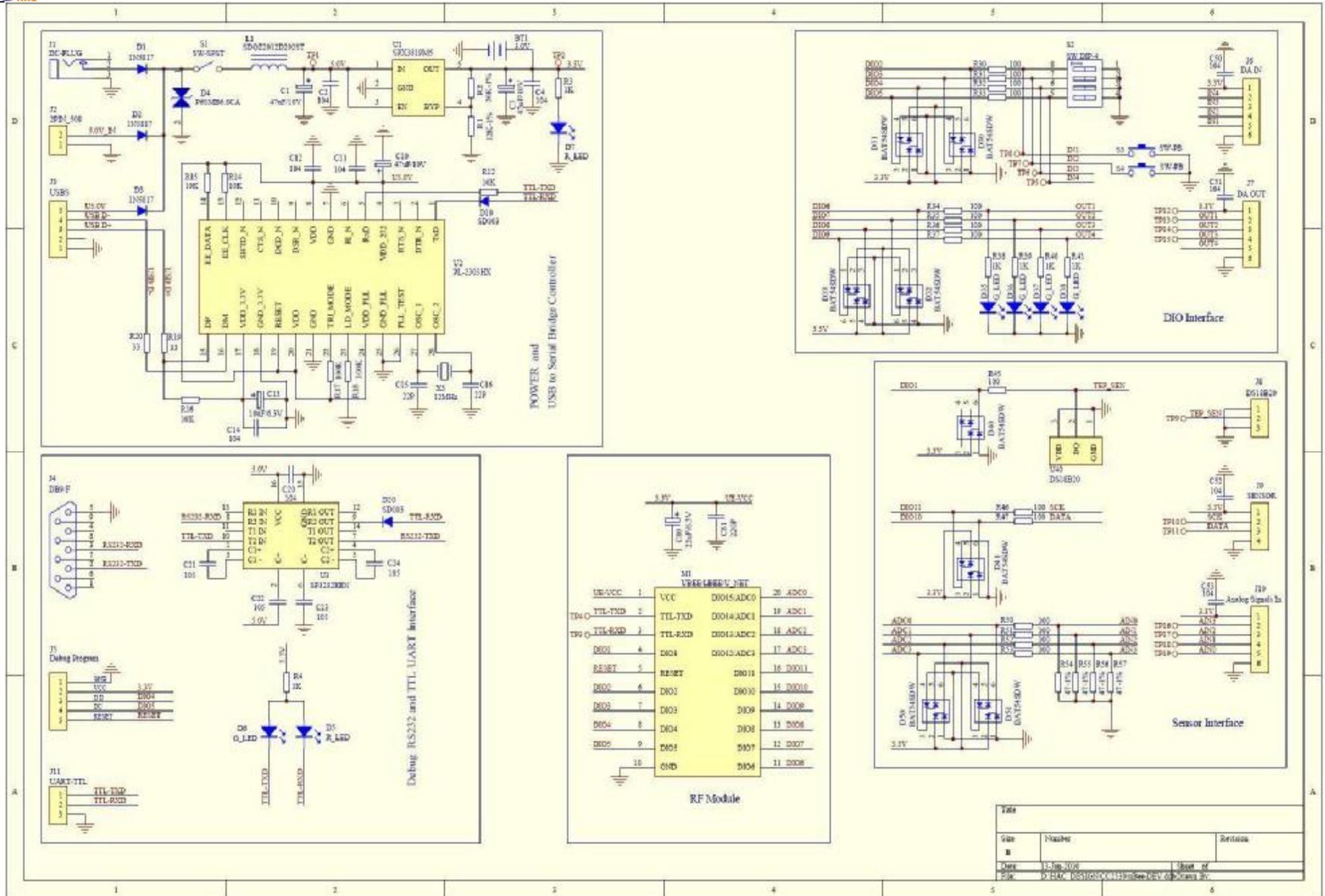
Pin Name	Definition
Pin1	TXD
Pin2	RXD
Pin3	GND

4.2 Connecting Methods between HAC-LBee V3.1-2.2 and HAC-DEV



Picture 3 Connecting Methods between HAC-LBee V3.1-2.2 and HAC-DEV

4.3 Schematic Diagram for HAC-DEV





V. Working Mode of HAC-LBee V3.1-2.2 Wireless Module

5.1. Working Mode of HAC-LBee V3.1-2.2 Wireless Module

There are three working modes for HAC-LBee V3.1-2.2. They are: Transparent Mode, API Mode, AT Command Mode.

5.1.1 Transparent Mode

By default, modules operate in Transparent Mode. When operating in this mode, the modules act as a serial line replacement - all UART data received through the RXD pin is queued up for RF transmission. When RF data is received, the data is sent out the TXD pin.

- I No serial characters are received for the amount of time determined.
- I The maximum number of characters that will fit in an RF packet (85) is received.

Serial-to-RF Packetization

Data is buffered in the RXD buffer until one of the following causes the data to be packetized and transmitted: If the module cannot immediately transmit (for instance, if it is already receiving RF data), the serial data is stored in the RXD Buffer. The data is packetized and sent at timeout or when 85 bytes (maximum packet size) are received.

The destination address for transparent transmission is used 16-bit destination address for transmission according to DS command.

5.1.2 API Mode

API (Application Programming Interface) Operation is an alternative to the default Transparent Operation. The frame-based API extends the level to which a host application can interact with the networking capabilities of the module.

When in API mode, all data entering and leaving the module is contained in frames that define operations or events within the module.

Transmit Data Frames (received through the RXD pin (pin 3)) include:

- RF Transmit Data Frame
- Command Frame (equivalent to AT commands)

Receive Data Frames (sent out the TXD pin (pin 2)) include:

- RF-received data frame
- Command response
- Event notifications such as reset, associate, disassociate, etc.

The API provides alternative means of configuring modules and routing data at the host application layer. A host application can send data frames to the module that contain address and payload information instead of using command mode to modify addresses. The module will send data frames to the application containing status packets; as well as source, RSSI and payload information

from received data packets. The API operation option facilitates many operations such as the examples cited below:

- Transmitting data to multiple destinations without entering Command Mode
- Receive success/failure status of each transmitted RF packet
- Identify the source address of each received packet

*** How to let the module work under the API mode after power up?**

User can use AT command to enter the API mode. The setup steps are shown as follow:

Enter the AT Command interface of upper machine software ‘HAC Studio For Zigbee’

Input the 3-character command sequence “+++” and wait for the reply “OK” from module.

Input “ATAP 1<CR>” command, the module will reply “OK”. It is used to set the module working under API mode.

Input “ATWR<CR>” command, the module will reply “OK”. It is used to save the setting. So the module will enter API mode automatically when restart the module next time.

Input “ATCN<CR>” command to exit from the AT Command mode. Now, the module works under the API mode. Even power up the module again, it still enters the API mode directly.

5.1.3 AT Command Mode

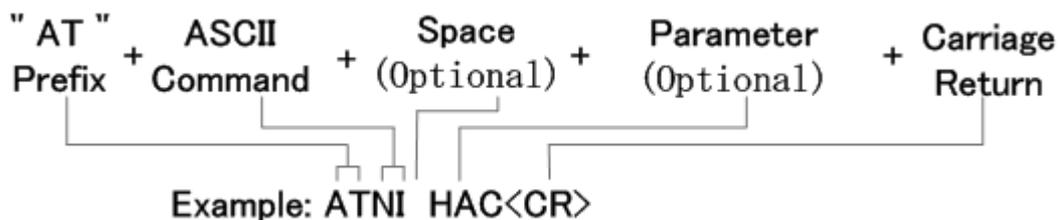
To modify or read RF Module parameters, the module must first enter into Command Mode - a state in which incoming characters are interpreted as commands. Two Command Mode options are supported: AT Command Mode [refer to section below] and API Command Mode

Send the 3-character command sequence “+++” and observe guard times before and after the command characters.

NOTE: Failure to enter AT Command Mode is most commonly due to baud rate mismatch. Ensure the ‘Baud’ setting on the “PC Settings” tab matches the interface data rate of the RF module. By default, the BD parameter = 5 (38400 bps), 8N1.

To read a parameter value stored in the RF module’s register, omit the parameter field.

System Response: When a command is sent to the module, the module will parse and execute the command. Upon successful execution of a command, the module returns an “OK” message. If execution of a command results in an error, the module returns an “ERROR” message.



The preceding example is shown how to change the module description for ‘HAC’.

NOTE: Some parameters will validate at once after setting, but some parameters will validate after

restart the module. So please read every AT command very carefully.

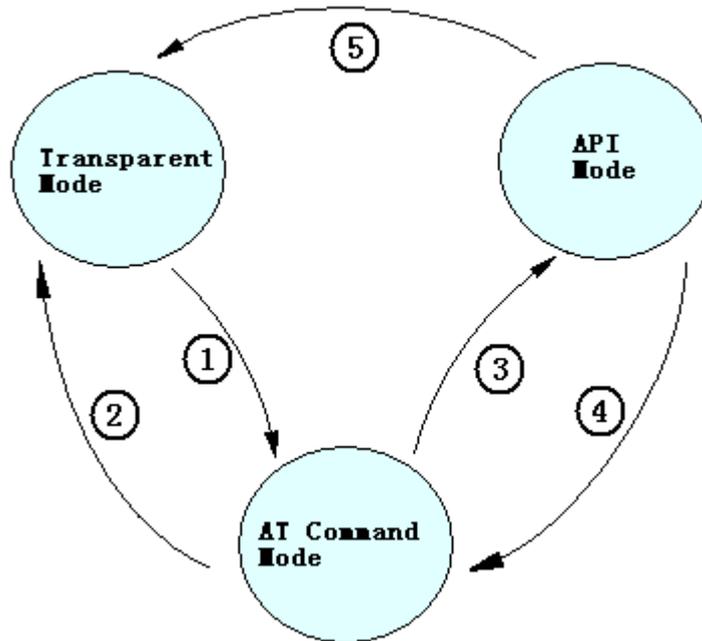
To Exit AT Command Mode:

Send the ATCN (Exit Command Mode) command (followed by a carriage return). [OR]

If no valid AT Commands are received within 10 seconds.

5.1.4 How to select the working mode

The default setting in the factory is transparent working mode.



1. Under the transparent mode, input 3-character command sequence “+++” from serial port, it will change for the AT Command mode.
2. When you select the transparent working mode (ATAP 0), inputting “ATCN” command can exit from the AT Command mode and enter the transparent mode. Or when you select the transparent working mode (ATAP 0), if there is no input in 10 seconds, the module will exit from the AT Command mode and enter the transparent mode.
3. When you select the API working mode (ATAP 1), inputting “ATCN” command can exit from the AT Command mode and enter the API mode. Or when you select the API working mode (ATAP 1), if there is no input in 10 seconds, the module will exit from the AT Command mode and enter the API mode.
4. Under the API mode, input 3-character command sequence “+++” will let the module switch to AT Command mode.
5. Under API mode, when using AT Command to setup transparent mode (ATAP 0), the module will switch to transparent mode.

5.2 AT Command



No.	AT Command	Command Category	Name and Description	Parameter Range	Default	Firmware Version
1	AI	Networking	Network state. query the network state of module, only effective for EndDevice.	0 - 1 0 = In the network 1 = No network	1	>=0x22
2	AP	Serial Interfacing	API Enable. Set/Read working mode of module.	0 - 1 0 = Transparent 1 = API	0	>=0x19
3	BD	Serial Interfacing	Baud rate. Set/Read baud rate of module.	0 - 7 0 = 1200 1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600 7 = 115200	5	>=0x19
4	CH	Networking	Channel. Read channel (uses 802.25.4 protocol channel numbers).	0x0B - 0x1A (Read Only)	-	>=0x19
5	CN	AT Command Mode Options	Exit AT command mode.	-	-	>=0x19
6	DS	Networking	16-bit destination address. Set/Read 16-bit destination address. When it is 0xFFFF, it is broadcasting.	0x00 - 0xFFFF	0xFFFF	>=0x19
7	FR	Special	Restart. Immediately execute a hardware reset and restart	-	-	>=0x19
8	HV	Diagnostics	Hardware version. Read the hardware version.	0x00 - 0xFFFF (Read only)	-	>=0x19
9	ID	Networking	PAN ID. Set/Read the value of PAN (Personal Area Network) ID.	0x00 - 0xFFFF	0x29AC	>=0x19
10	KY	Networking Secure	Set the Key for data encrypt. (Customize)	16 byte Hex (Setup only)	-	>=0x21
11	MP	Networking	Short address of father node. Read 16-bit short address of father node.	0x00 - 0xFFFFD (Read only)	-	>=0x21
12	MT	Networking	Module type. Read Zigbee module type.	0 - 2 (Read only) 0-Coordinator 1-Router 2-EndDevice	-	>=0x19
13	MY	Networking	16-bit source address. Read 16-bit source address	0x00-0xFFFFE (Read Only)	-	>=0x19
14	ND	Networking	Search node information. Read 16-bit address, 64-bit address, signal strength of receiving data and description string of online nodes.	0-20pcs ASCII	-	>=0x21
15	NI	Networking	Node description string setting. Set/Read description string.	0-20pcs ASCII	-	>=0x21
16	NO	Networking	Search node option. When searching, whether display the node information.	0-1 0-Not display 1-Display	0	>=0x21
17	NT	Networking	Time limit setting for node searching.	0x01 - 0xFC Unit: 100ms	0x19	>=0x21
18	PI	Networking	PAN ID. Read the PAN ID of module	0x00 - 0xFFFFE (Read only)	-	>=0x19
19	PL	RF Interfacing	Power level. Set/Read power level	0x00-0x04	0x04	>=0x19
20	PT	Diagnostics	Digital value. Set/Read the digital value of 6 th pin	0 - 1	1	>=0x22
21	RE	Special	Restore default setting. Let module parameter restore to factory default setting.	-	-	>=0x19
22	RN	Networking	Reset Network. Reset network, search the network again after restart the module. Note: after reset network and search network again, the 16-bit address and channel may change.	0 - 1 0 = Disabled 1 = Enabled	0	>=0x19
23	RR	Networking	Retry times setting when transmission	3 - 6	3	>=0x21



			fail			
24	S1	Diagnostics	Collect voltage level. Used for collecting the voltage level of 20 th pin of module	0x00 -0xFFFF (Read only)	-	>=0x22
25	S2	Diagnostics	Collect voltage level. Used for collecting the voltage level of 19 th pin of module	0x00 -0xFFFF (Read only)	-	>=0x22
26	S3	Diagnostics	Collect voltage level. Used for collecting the voltage level of 18 th pin of module	0x00 -0xFFFF (Read only)	-	>=0x22
27	S4	Diagnostics	Collect voltage level. Used for collecting the voltage level of 17 th pin of module	0x00 -0xFFFF (Read only)	-	>=0x22
28	SC	Networking	Search channel. Set/Read the search channel when enter the network.	0x01 - 0xFFFF	0x03	>=0x21
29	SH	Networking	High 32-bit of IEEE 64-bit address. Read high 32-bit of IEEE 64-bit address	0x00- 0xFFFFFFFF	-	>=0x19
30	SL	Networking	Low 32-bit of IEEE 64-bit address. Read low 32-bit of IEEE 64-bit address	0x00- 0xFFFFFFFF	-	>=0x19
31	SM	Sleep(Low Power)	Sleep state. Set/Read sleep mode of module. (only effective for EndDevice)	0-1 0 = Disabled 1 = Enabled	0	>=0x20
32	SP	Sleep(Low Power)	Time limits for data saving that Coordinator or Router do for EndDevice, or the period that EndDevice gets the data from its father node. (It is effective for Coordinator, Router and EndDevice)	0x01– 0xFFFF Unit: 10ms	0x12C	>=0x20
33	ST	Sleep(Low Power)	After wake up, the time for keep working. Note: it should be less than half of SP value. (only effective for EndDevice)	0x01– 0xFFFF Unit: ms	0x32	>=0x21
34	VR	Diagnostics	Software version. Read software version	0x00 - 0xFF (Read only)	-	>=0x19
35	WR	Special	Write parameter. Write the parameters to the nonvolatile memory, even if reset or re-power module, the parameter is still valid.	-	-	>=0x19

5.2.1 AI

AI is used query the network state of EndDevice, it is only effective for EndDevice. If the return value is '0', it means the EndDevice in the network, i.e. it can find its father node. If the return value is '1', it means no network, i.e. the EndDevice can not find its father node. The network searching of EndDevice needs within few seconds. User needs to use AI command several times to confirm its network state. In addition, the father node of EndDevice is dynamic, i.e. for every time entering network, the father node of EndDevice may be different.

Command	ATAI	
Parameter	Range	0 – 1 0 – In the network 1 – No network
	Default Value	1
Minimum Firmware Version Required: 0x22		



5.2.2 AP

The AP command is used to set or read the working mode. If it is '0', after the module exits AT command, it will enter transparent working mode. If it is '1', after the module exits AT command, it will enter API mode.

Command	ATAP (API Enable)	
Parameter	Range	0-1
	Default Value	0
	Value	0: Transparent mode 1: API mode
Effective Conditions	Validate at once after exit AT command mode	
Minimum Firmware Version Required: 0x19		

The examples for changing the working mode:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATAP command to setup the working mode you want, such as ATAP 0<CR> or ATAP 1<CR>.

If the setting is still needed to be validated after restart the module next time, using ATWR<CR> command to write the setting into Non-volatile memory.

Input “ATCN<CR>” command to exit from AT Command mode, the module will enter the setting working mode.

5.2.3 BD

The BD command is used to set and read the serial interface data rate used between the RF module and host. This parameter determines the rate at which serial data is sent to the module from the host. When parameters 0-7 are sent to the module, the respective interface data rates are used (as shown in the table on the below). The fixed RF data rate (250kbps) is not affected by the BD parameter. We recommend that users don't select too low interface data rate, or it will cause the serial port data communication overflow. It only offers AT command to change the baud rate, no command for changing baud rate under API mode.

Command	ATBD (Interface Data Rate)	
Parameter	Range	0-7
	Default Value	5



	Value	0 = 1200 1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600 7 = 115200
Effective Conditions	Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x19		

The examples for changing the serial port baud rate:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATBD command to setup the serial port baud rate you want, such as ATBD 6<CR>.

Using ATWR command to write the setting into Non-volatile memory

Input “ATFR<CR> command, the module will restart at once.

5.2.4 CH

The CH command is used to set/read the operating channel on which RF connections are made between RF modules. The total channels are 16 (0x0B-0x1A). In order for modules to communicate with each other, the modules must share the same channel number in the same Zigbee network. Different networks use different working channel can avoid interference. The module uses channel numbers of the 802.25.4 standard. Center Frequency = 2.405 + (CH - 11d) * 5 MHz (d = decimal)

Command	ATCH (Channel)	
Parameter	Range	0x0B - 0x1A
	Default Value	-
Minimum Firmware Version Required: 0x19		

The examples for reading the channel:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATCH command to read the channel, such as ATCH <CR>.

Input ATCN command to exit AT command mode.

5.2.5 CN

The CN command is used to explicitly exit the RF module from AT Command Mode.

Command	ATCN(Exit Command Mode)
Parameter	None



Effective Conditions	Validate at once
Minimum Firmware Version Required: 0x19	

5.2.6 DS

DS is used to set or read 16-bit destination address (short address). This setting is only effective under the transparent mode. If the 16-bit destination address is 0xFFFF, the module works on broadcasting mode under the transparent transmission

Command	ATDS (Short Destination Address/ 16-bit Destination Address)	
Parameter	Range	0x00 - 0xFFFF
	Default Value	0xFFFF
Effective	Validate at once	
Minimum Firmware Version Required: 0x19		

The examples for changing the 16-bit destination address:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATDS command to set the short address you want, such as ATDS FFFF<CR>.

Using ATWR command to write the setting into Non-volatile memory

Input ATCN command to exit AT command mode.

5.2.7 FR

FR is used to restart the module. When the module gets the FR command, the module will not feedback ‘OK’, just power off and restart immediately.

Command	ATFR (Short Reset)
Parameter	None
Effective	Validate at once
Minimum Firmware Version Required: 0x19	

The examples for restarting module:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATFR command to restart module, i.e. ATFR <CR>

5.2.8 HV

HV command is read the hardware version of module.

Command	ATHV(Hardware Version)
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Parameter	Range	0-0xFFFF[Read-only]
Minimum Firmware Version Required: 0x19		

5.2.9 ID

The ID command is used to set and read the PAN (Personal Area Network) ID of the RF module. Only modules with matching PAN IDs can communicate with each other. Unique PAN IDs enable control of which RF packets are received by a module.

To validate the setting PAN ID, when setting the PAN ID, at the same time, using the RN command to setup the module as that reset the network after restart next time, then write the settings to the non-volatile memory. In this way, the new PAN ID will be effective after restart the module next time.

Command	ATID (PAN ID)	
Parameter	Range	0x00 - 0xFFFF
	Default Value	0x29AC
Effective Conditions	RN=1, Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x19		

The PAN ID of all the modules in a network should be the same. If users want to assign PAN ID for a module, it can be set some values in 0x00-0xFFFFE range. If the PAN ID of module is 0xFFFF, and there will be different results according to different module types. If it is Coordinator, when power up, it will select one value from 0x00-0xFFFFE as its PAN ID in random. If it is Router or EndDevice, when power up, they will search the PAN ID of Zigbee network that is nearby, assign the same value for PAN ID and try to enter the Zigbee network. When there are some Zigbee networks around, they will select the network with best RSSI value.

When the PAN ID is 0xFFFF, the actual PAN ID value after enter the network can be read by ATPI command. When assign PAN ID value (0x00-0xFFFFE) for the module, the PAN ID value read by ATPI command is the same as the value read by ATID command.

The examples for changing the PAN ID of module:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATID command to setup the PAN ID you want, such as ATID 12AB<CR>.



Using ATRN command to setup the module reset the network after restart the module next time, i.e. ATRN 1<CR>.

Using ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATFR<CR>” command to restart the module at once.

5.2.10 KY

KY command is used set key value for data encrypt. This value only can be set, could not be read. It is 16-byte hex value (Note: data encrypt transmission means using AES encrypt arithmetic of IEEE standard for data transmission.). It is effective after reset network (ATRN=1). Even using ATRE command to restore factory setting of module, the key is still validated.

Command	ATKY	
Parameter	Range	16-byte hex value
Effective	ATRN=1, use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x21		

The examples for changing the key value:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATKY command to set the key value you want, such as ATKY 01234567890123456789012345678901<CR>.

Using ATRN 1 command to reset the network when start up next time, such as ATRN 1<CR>

Using ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input ATCN command to exit AT command mode.

5.2.11 MP

MP command is used to read the 16-bit address of father node.

Command	ATMP	
Parameter	Range	0x00 - 0xFFFFD[Read-only]
Minimum Firmware Version Required: 0x21		

5.2.12 MT

The MT command is used to read the type of RF modules. The type of RF module should be set in the factory, it couldn't be changed by the users.

Command	ATMT(Type)	
Parameter	Range	0-2



	Value	0 = Coordinator 1 = Router 2 = EndDevice
Minimum Firmware Version Required: 0x19		

5.2.13 MY

The MY command is used to read the own 16-bit source address of the RF module. The 16-bit source address is assigned by the Zigbee network when the module enters Zigbee network. If the 16-bit Source Address of module is 0xFFFFE, it means that the module doesn't enter any Zigbee networks. Whereas, if the 16-bit Source Address is less than 0xFFFFE, it means it has been in a Zigbee network.

Concerning the 16-bit address, please refer to the Appendix 'Zigbee Instruction' parts.

Command	ATMY (16-bit Source Address)	
Parameter	Range	0x00 - 0xFFFFE
Minimum Firmware Version Required: 0x19		

5.2.14 ND

ND command is used to search other online nodes' information. The information includes 16-bit address, high 32-bit of 64-bit address, low 32-bit of 64-bit address, RSSI and node description string.

If there is no parameter after ND command, it is used to search all the online nodes' information in the network.

If there is a parameter after ND command, the parameter is node description string. It is used to search the online node information that match the node description string completely.

Command	ATND(Node Discover)	
Parameter	Range	0-20 ASCII
Minimum Firmware Version Required: 0x21		

The examples for searching node information:

Input 3-character command sequence "+++" and switch to the AT Command mode.

Using ATND command to search appointed node, for example the node description string is 'Switch'.

Input ATND Switch<CR>

Input "ATCN<CR> command to exit AT command mode



5.2.15 NI

NI command is used to read or set module's description string. The description string should be displayed in ASCII character, and it can not start from 'space'. In additional, it should be no more than 20 characters. If it is more than 20 characters, and the first 20-character will be the effective value.

Command	ATNI (Node Identifier)	
Parameter	Range	0-20 ASCII
	Default Value	0
Effective	Validate at once	
Minimum Firmware Version Required: 0x21		

The examples for changing module description string:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATNI command to set the wanted description string, for example ATNI HAC LBee V3.1-2.2<CR>

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR> command to exit AT command mode

5.2.16 NO

NO command is used to read or set searching node options. When using ND command to search node, it will decide whether show its related information or not according to the value of ND command. If the NO value is '0', the module will not show its information. If the NO value is '1', the module will show its information.

Command	ATNO(Node Discover Options)	
Parameter	Range	0-1
	Default Value	0
	Value	0 = no display 1 = display
Effective	Validate at once	
Minimum Firmware Version Required: 0x21		

The examples for searching node options:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATNO command to set the wanted option, for example ATNO 0<CR> or ATNO 1<CR>



If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR> command to exit AT command mode

5.2.17 NT

NT command is used to read or set the time limits for searching network node, the unit is 100ms. When searching network node by using ND command, if it exceeds the setting time limits, other responses of nodes will be ignored.

Command	ATNT(Node Discover Time)	
Parameter	Range	0x01 - 0xFC [*100 msec]
	Default Value	0x19
Effective	Validate at once	
Minimum Firmware Version Required: 0x21		

The examples for changing time limits of node searching:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATNT command to set the wanted value, for example ATNT 1A<CR>

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR> command to exit AT command mode

5.2.18 PI

PI command is used to read the actual module PAN ID. Only when the setting value of PAN ID is 0xFFFF, the PAN ID after the module enters network will be different from the PAN ID read by using ‘ATID’ command. About this point, please refer to the ‘ATID’ command part.

Command	ATPI (PAN ID)	
Parameter	Range	0x00 - 0xFFFFE
Minimum Firmware Version Required: 0x19		

5.2.19 PL

The PL command is used to set or read the transmitting power level (0~4). If the parameter is ‘0’, the transmitting power is minimum power. If it is ‘4’, the transmitting power is maximum power.

If the parameter is not ‘4’ (maximum power), it will take effect to the module communication. So



we don't recommend the users to change this parameter.

Command	ATPL(Power Level)	
Parameter	Range	0-4
	Default Value	4
	Value	0 = Min Power 4 = Max Power
Effective Conditions	Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x19		

The following table shows the corresponding transmitting current under different transmitting power levels.

Power level	Transmitting power	Transmitting current
0	0 dBm	70mA
1	5 dBm	75mA
2	10 dBm	85mA
3	15 dBm	108mA
4	20 dBm	160mA

The examples for changing the power level:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATPL command to set the power level you want, such as ATPL 4<CR>.

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATFR<CR>” command to restart the module at once.

5.2.20 PT

PT command is used to set or read the digital value of 6th pin. When plug the module into the testing board HAC-DEV, the 6th pin of module is connected with J6-5 pin of HAC-DEV.

Command	ATPT	
Parameter	Range	0-1
	Default Value	1
Effective	Validate at once	
Minimum Firmware Version Required: 0x22		

The examples for changing the digital value of 6th pin:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATPT command to set the wanted value, such as ATPT 1<CR>

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR>” command to exit AT command mode.

5.2.21 RE

The RE command is used to restore all configurable parameters to their factory default settings. When the module receives RE command, it will restore all parameters to factory default setting, write these values to non-volatile (persistent) memory and force a software reset on the RF module. This command will make the module drop out of the network and may change some settings like PAN ID, 16-bit address and so on.

Command	ATRE (Restored defaults)
Parameter	None
Effective Conditions	Validate at once
Minimum Firmware Version Required: 0x19	

The examples for changing the power level:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATRE command to restore the factory default setting, ATRE<CR>

5.2.22 RN

The RN command is used to read and setup whether reset the network when restart the module next time. If yes, when restart the module next time, the module will search the Zigbee network again and try to enter. It means if the module has entered a Zigbee network, it will lose the network. After restart, the settings such as PAN ID, channel, 16-bit address and so on may change.

Command	ATRN (Reset network when restart the module next time)	
Parameter	Range	0-1
	Default Value	0
	Value	0 = Disable 1 = Enable
Effective Conditions	Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x19		

**The examples for changing whether reset the network when restart the module next time:**

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATRN command to setup whether reset the network when restart the module next time, such as ATRN 1<CR>.

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATFR<CR>” command to restart the module at once.

5.2.23 RR

RR command is used to set or read the retry times when there is a data fail

Command	ATRR(Retrie s)	
Parameter	Range	3-6
	Defaul t Value	3
Effective	Validate at once	
Minimum Firmware Version Required: 0x21		

The examples for changing the retry times:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATRR command to set wanted retry times, such as ATRR 4<CR>

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR>” command to exit from the AT Command mode.

5.2.24 S1

S1 command is used to collect the voltage value of 20th pin of module. The return voltage value is in Hex. The calculation formula is show as follow: ‘X’ / 8192 * 3.3, ‘X’ is the return value. For example: if the return value is 0x1FE8, its Decimal will be 8168, so the corresponding voltage value will be (8168/8192)*3.3, i.e. 3.29V. When plug the module into the testing board HAC-DEV, the 20th pin of module is connected with J10-5 pin of HAC-DEV.

Command	ATS1	
Parameter	Range	0x00 - 0xFFFF [Read-onl y]
Minimum Firmware Version Required: 0x22		

5.2.25 S2

S2 command is used to collect the voltage value of 19th pin of module. The return voltage value is in Hex. The calculation formula is shown as follow: 'X' / 8192 * 3.3, 'X' is the return value. When plug the module into the testing board HAC-DEV, the 19th pin of module is connected with J10-4 pin of HAC-DEV.

Command	ATS2	
Parameter	Range	0x00 - 0xFFFF [Read-only]
Minimum Firmware Version Required: 0x22		

5.2.26 S3

S3 command is used to collect the voltage value of 18th pin of module. The return voltage value is in Hex. The calculation formula is shown as follow: 'X' / 8192 * 3.3, 'X' is the return value. When plug the module into the testing board HAC-DEV, the 18th pin of module is connected with J10-3 pin of HAC-DEV.

Command	ATS3	
Parameter	Range	0x00 - 0xFFFF [Read-only]
Minimum Firmware Version Required: 0x22		

5.2.27 S4

S4 command is used to collect the voltage value of 17th pin of module. The return voltage value is in Hex. The calculation formula is shown as follow: 'X' / 8192 * 3.3, 'X' is the return value. When plug the module into the testing board HAC-DEV, the 17th pin of module is connected with J10-2 pin of HAC-DEV.

Command	ATS4	
Parameter	Range	0x00 - 0xFFFF [Read-only]
Minimum Firmware Version Required: 0x22		

5.2.28 SC

SC command is used to set or read the channel that the module needs to search. The module selects the working channel according to the value set by SC command. The SC parameter is 2-byte, if there is a bit is '1' in the 2-byte, it will search the corresponding channel of that bit (The corresponding channel is shown in the following table). If there are more than two '1' in the 2-byte, it will search the channel by using 'OR' method. For the Coordinator, it will select one of the set channels. For the Router and EndDevice, they will search these channels and try to enter the



network till they enter the network.

If users want the set value to be effective, the RN command should be used when set the searching channel to make the module reset the network after power on next time, then write the two settings to the Non-volatile memory. In this way, the module will select the new working channel according the set value after power on next time.

Command	ATSC(Scan Channels)				
Parameter	Range	0x01 – 0xFFFF			
	Default Value	0x03			
Value	bit0 – 0x0B	bit4 – 0x0F	bit8 – 0x13	bit12 – 0x17	
	bit1 – 0x0C	bit5 – 0x10	bit9 – 0x14	bit13 – 0x18	
	bit2 – 0x0D	bit6 – 0x11	bit10 – 0x15	bit14 – 0x19	
	bit3 – 0x0E	bit7 – 0x12	bit11 – 0x16	bit15 – 0x1A	
Effective	RN=1, use WR command to save setting, it will be effective after restart the module again.				
Minimum Firmware Version Required: 0x21					

The examples for changing module searching channel:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATSC command to set the wanted value, such as ATSC 2<CR>, (0x0C channel)

Using ATRN command to reset the network when restart module next time, i.e. ATRN 1<CR>.

Using ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATFR<CR>” command to restart the module at once.

5.2.29 SH

The SH command is used to set and read the high 32 bits of the RF module's unique IEEE 64-bit address.

Note: The 64-bit address has been set by the chip manufactory of the module in the factory. The chip manufacture ensures the unique 64-bit address for each chip. In a Zigbee network, the 64-bit address of each module is unique, otherwise, it will cause communication chaos. So we don't recommend users to change the 64-bit address (Serial Number).

If the high 32-bit and low 32-bit are set as 0xFFFFFFFF, it can make the 64-bit address (Serial Number) restore to the factory default setting.

To validate the 64-bit address, when setting the 64-bit address, at the same time, using the RN command to set the module as that reset the network after restart next time, then write the settings



to the non-volatile memory. In this way, the new 64-bit address will be effective after restart the module next time.

Command	ATSH(Serial Number High)	
Parameter	Range	0-0xFFFFFFFF
	Default Value	-
Effective Conditions	RN=1, Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x19		

5.2.30 SL

The SL command is used to set or read the low 32 bits of the RF module's unique IEEE 64-bit address.

Command	ATSL(Serial Number Low)	
Parameter	Range	0-0xFFFFFFFF
	Default Value	-
Effective Conditions	RN=1, Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x19		

5.2.31 SM

SM command is used to set or read the sleep mode. This setting is only effective for EndDevice. When the parameter is '0', disable the sleep function. When it is '1', enable the module enter the sleep state after enter the network.

When the module is not in the Zigbee network, it needs to search Zigbee network for entering continuously, so it doesn't enter the sleep state.

There are three preconditions for that EndDevice enters sleep state. First, the EndDevice should be in the Zigbee network. Second, SM parameter should be '1', i.e. sleep enable. Third, the 9th pin (sleep control pin) should be high level. The EndDevice ONLY could enter the sleep state after it meets all these requirements.

Command	ATSM(Sleep Mode)	
Parameter	Range	0-1
	Default Value	0
	Value	0 = Disable 1 = Enable
Effective	Validate at once	



Minimum Firmware Version Required: 0x20

The examples for changing sleep mode:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATSM command to set the sleep mode, such as ATSM 1<CR>

If users want the setting still validates next time, you can use ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR> command to exit from the AT Command mode.

5.2.32 SP

SP command is used to set or read time limits that Coordinator or Router saves data for its child-node EndDevice. This command is also used to set or read the period that EndDevice collects data from its father-node in a definite time. This command is effective for Coordinator, Router and EndDevice. In additional, the sleep period of EndDevice should be same as the value of its father-node (Coordinator or Router). Because EndDevice couldn't receive data from air in the sleep state, its father-node will save all the data that send to it. The time length of saving data is up to the value set by SP command. After waken, EndDevice will collect data from its father-node. But if EndDevice doesn't come to collect the data within time limit, its father-node will clear all the data. So the SP value of EndDevice and its father-node should be the same.

Command	ATSP (Cyclic Sleep Period)	
Parameter	Range	0x01 - 0xFFFF [*10 msec]
	Default Value	0x12C
Effective	Use WR command to save setting, it will be effective after restart the module again.	
Minimum Firmware Version Required: 0x20		

The examples for changing SP value:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATSP command to set the wanted value, such as ATSP 1F4<CR>

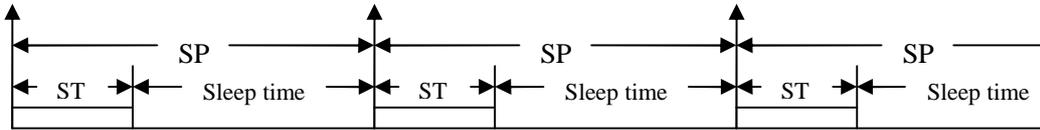
Using ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATFR<CR>” command to restart the module at once.

5.2.33 ST

ST command is used to set or read the working time after waken EndDevice. The ST value should be no more than half of SP value, or it will cause chaos for sleep period. This command is only effective for EndDevice. When the timing waken signal (set by SP command) is coming,

EndDevice will wake automatically and work in a definite time (set by ST command). Then it will enter sleep state again till the next waken signal is coming. So the actual sleep time is $(SP*10-ST)$, the unit is ms. Please refer to the following timing diagram:



Command	ATST (Time before Sleep)	
Parameter	Range	0x01 - 0xFFFF [*1msec]
	Default Value	0x32
Effective	Validate at once	
Minimum Firmware Version Required: 0x21		

The examples for changing working time after waken:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATST command to set the wanted value, such as ATST 64<CR>

Using ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR> command to exit from the AT Command mode.

5.2.34 VR

The VR command is used to read the firmware version. Some AT commands require different firmware versions.

Command	ATVR (Firmware Version)	
Parameter	Range	0x00 - 0xFF [Read-only]
Minimum Firmware Version Required: 0x19		

5.2.35 WR

The WR command is used to write all configurable parameters to the RF module's non-volatile memory. Parameter values remain in the module's memory until overwritten by subsequent use of the WR Command. If changes are made without writing them to non-volatile memory, the module reverts back to previously saved parameters the next time the module is powered-on.



Note: The effective conditions for every parameter may be different. Some of parameters even write it to no-volatile memory, they will not be effective after powered-on next time. So please pay attention to the effective conditions of every command.

Command	ATWR (Write)
Parameter	None
Minimum Firmware Version Required: 0x19	

5.3 API Operation

By default, RF Modules act as a serial line replacement (Transparent Operation) - all UART data received through the RXD pin is queued up for RF transmission. When the module receives an RF packet, the data is sent out the TXD pin with no additional information.

Inherent to Transparent Operation are the following behaviors:

- If module parameter registers are to be set or queried, a special operation is required for transitioning the module into Command Mode.
- In point-to-multipoint systems, the application must send extra information so that the receiving module(s) can distinguish between data coming from different remotes.

As an alternative to the default Transparent Operation, API (Application Programming Interface) Operations are available. API operation requires that communication with the module be done through a structured interface (data is communicated in frames in a defined order). The API specifies how commands, command responses and module status messages are sent and received from the module using a UART Data Frame.

5.3.1 API Frame Specifications

API mode can be enabled using the AP (API Enable) command. Use the following AP parameter values to configure the module to operate in a particular mode:

- AP = 0 (default): Transparent Operation (UART Serial line replacement) API modes are disabled.
- AP = 1: API Operation

Any data received prior to the start delimiter is silently discarded. If the frame is not received correctly or if the checksum fails, the data is silently discarded.

API Operation (AP parameter = 1)

When this API mode is enabled (AP = 1), the UART data frame structure is defined as follows:

Figure UART Data Frame Structure:



Every frame is composed of 4 fields, there are Start Delimiter, Length, frame data and Checksum.

Start Delimiter

Start Delimiter is the sign the head of frame, it is fixed as 0x7E.

Length

Length means effective data length. It is the length of Frame Data. MSB = Most Significant Byte, LSB = Least Significant Byte.

Frame Data

Frame Data is effective data field.

Checksum

Checksum is used to check the correctness of the whole frame.

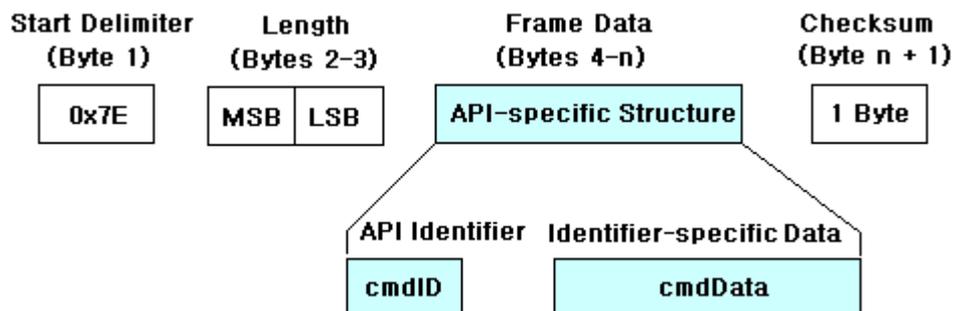
To calculate: Not including frame delimiters and length (1-3 bytes), add all bytes keeping only the lowest 8 bits of the result and subtract from 0xFF.

To verify: Not including frame delimiters and length (1-3 bytes), add all bytes keeping only the lowest 8 bits of the result, then plus the checksum. If the checksum is correct, the sum will equal 0xFF.

5.3.2 Frame Structure Definition

Frame structure under API mode & the definition of ‘Frame Data’ field is shown as follow:

Figure. UART Data Frame & API - Specific Structure:



The cmdID frame (API-identifier) indicates which API messages will be contained in the cmdData frame (Identifier-specific data). Refer to the sections that follow for more information regarding the supported API types. Note that multi-byte values are sent big endian.

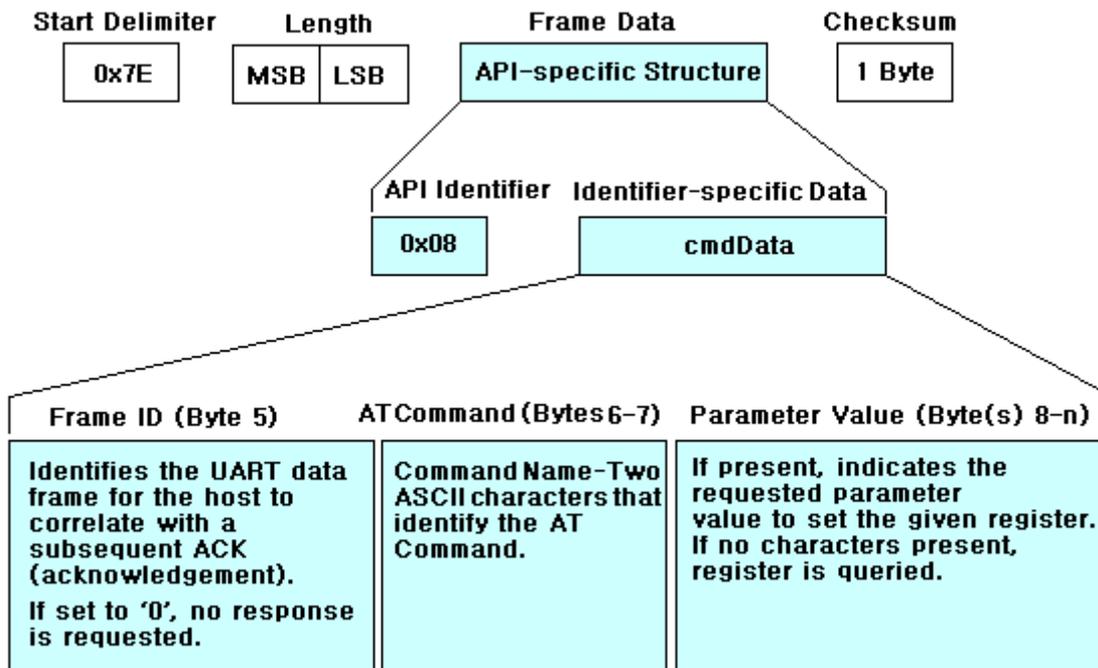
Local AT Command

Under API mode, the AT command could be executed. For example, use an AT command to read or set one parameter under API mode, it has the same result as the execution under AT command mode. Whether the new parameter values validate at once or restart next time, it is up to the different AT Commands. Register queries (reading parameter values) are returned immediately.

The API Identifier Value: 0x08

Figure. AT Command Frames

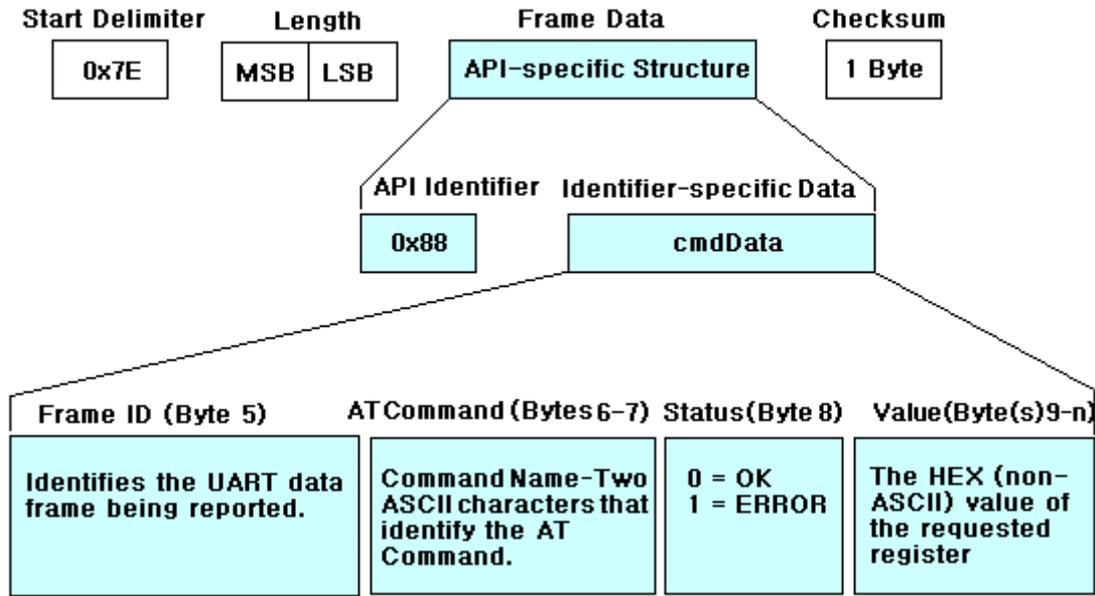
(Note that frames are identical to the “AT Command” API type except for the API identifier.)



AT Command Response

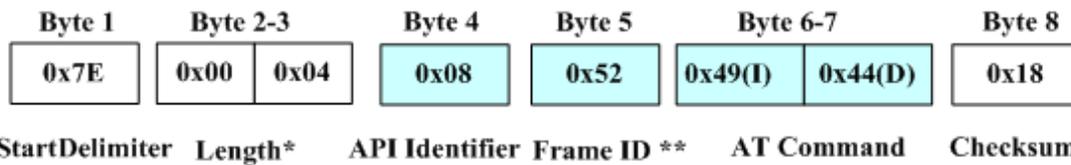
API Identifier Value: 0x88

Figure. AT Command Response Frames

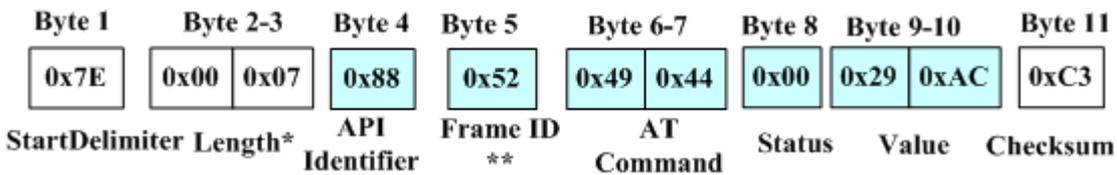


Example:

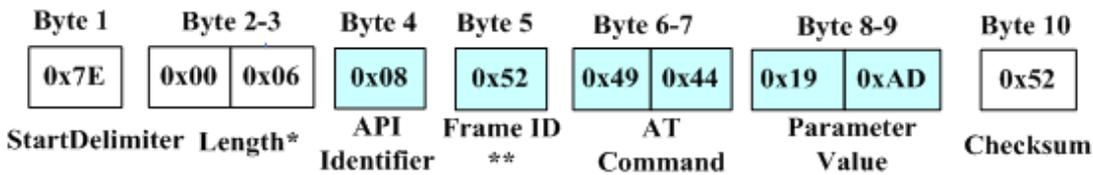
The required data frame for reading PAN ID is shown as follow:



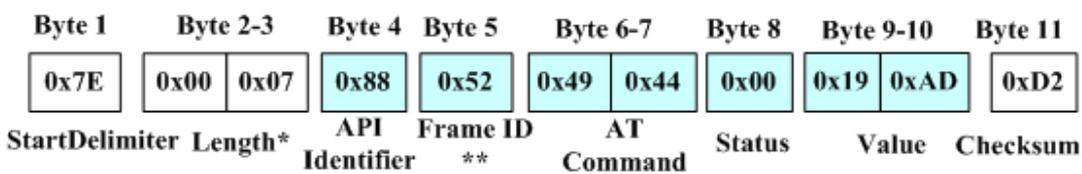
The return data frame for reading PAN ID is shown as follow:



Under API mode, use AT command to set the PAN ID as 0x19AD, the required data frame is shown as follow:



The return data frame for setting PAN ID is shown as follow:



Remote AT command (API mode)

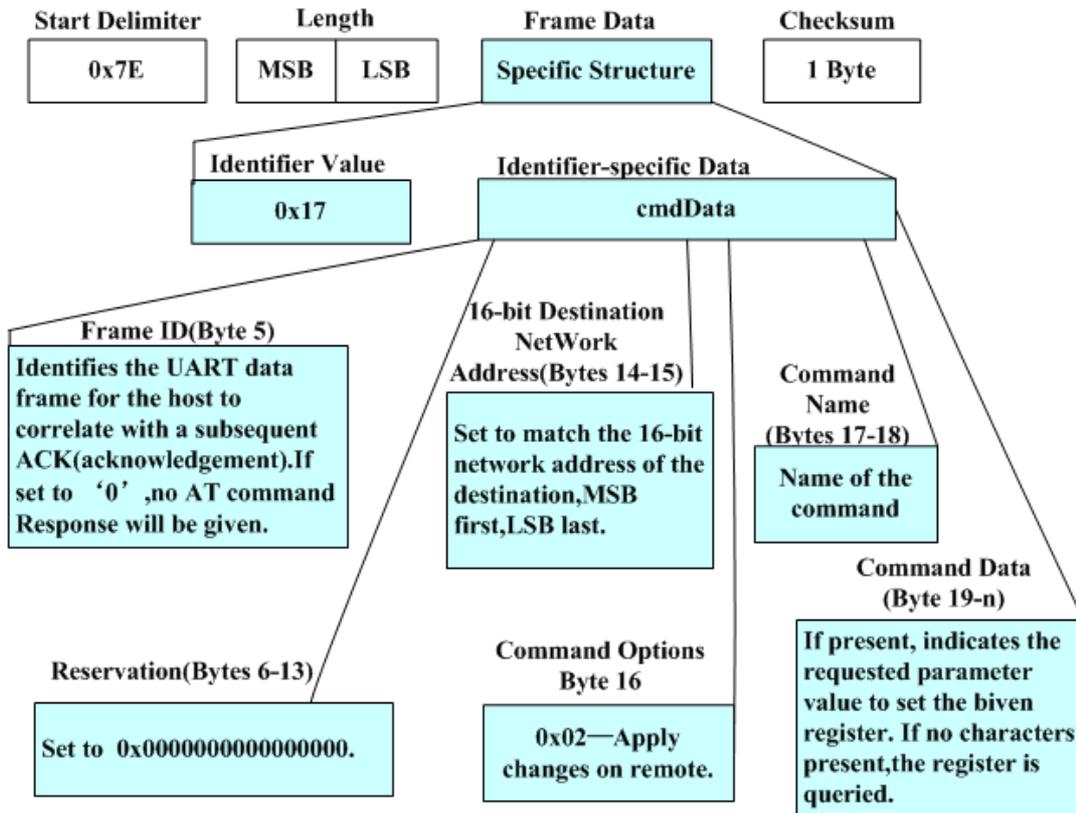
Remote AT command is used to read or set the parameters of the remote destination node in the

same Zigbee network.

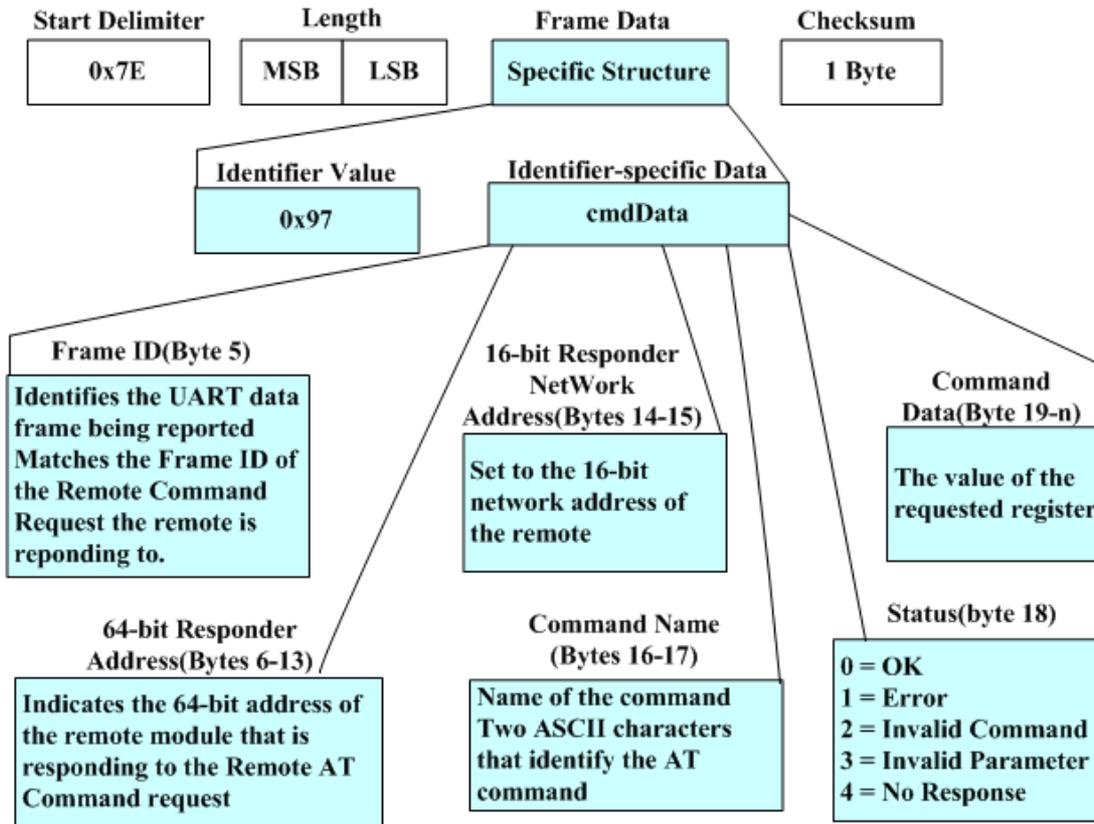
Remote AT command should be worked under the API mode, i.e. the communication data should be accord to the API frame structure. And whether the new parameter values validate at once or restart next time, it is up to the different remote AT Commands.

To read or change the setting of remote node, the short-address of destination node should be known, and the node must be online. When reading the parameter by using remote AT command, the parameter will be returned immediately. Note that when only reading parameter, don't need to enter the parameter of AT command.

Request command code for remote AT command: 0x17, and the frame structure is shown as follow:



Return command code for remote AT command: 0x97, and the frame structure is shown as follow:



Remote AT Command

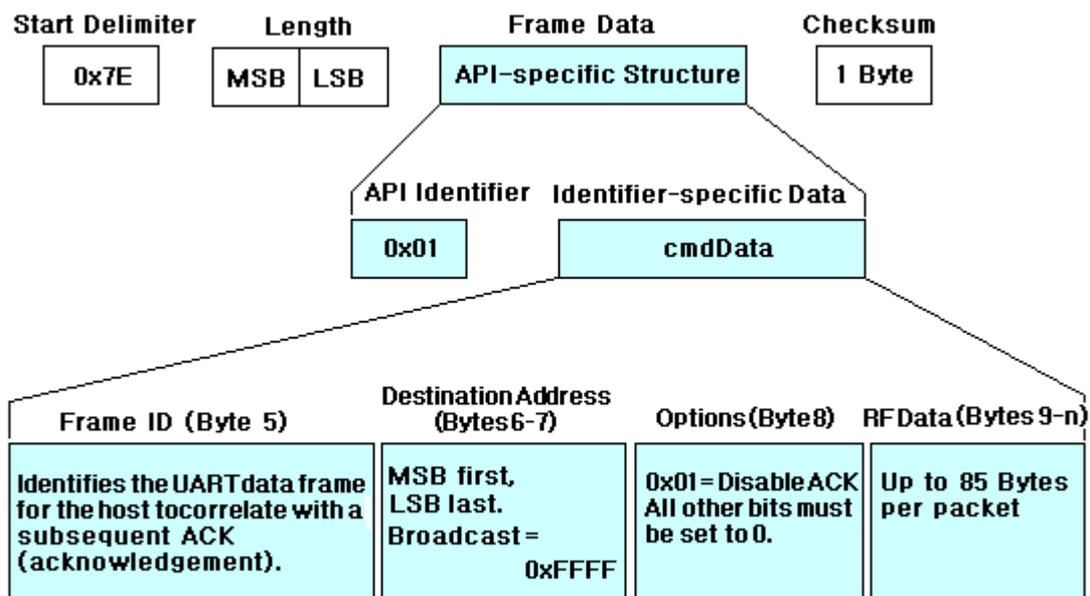
No.	AT command	Command Description	Remarks
1	AP	Working mode of remote node	inquire, set
2	BD	Baud rate of remote node	inquire, set
3	CH	Working channel of remote node	inquire
4	DS	16-bit destination address of remote node	inquire, set
5	FR	Remote node system restarts.	execute
6	HV	Hardware version of remote node	inquire
7	ID	PAN ID of remote node	inquire, set
8	MP	16-bit address of remote node' s father node	Inquire
9	MT	Type of remote node	inquire
10	MY	16-bit source address of remote node	inquire
11	NI	Description string for remote node	inquire, set
12	PI	Actual PAN ID of remote node	inquire
13	PL	Power level of remote node	inquire, set
14	PT	6 th pin digital value for remote node	inquire, set
15	RE	Remote node restores to the factory setting.	execute
16	RN	Remote node resets network when power on next time.	inquire, set
17	RR	Retry times setting when remote node' s transmission fails.	inquire, set
18	S1	20 th pin voltage value of remote node	inquire
19	S2	19 th pin voltage value of remote node	inquire

20	S3	18 th pin voltage value of remote node	inquire
21	S4	17 th pin voltage value of remote node	inquire
22	SC	Search channel for remote node	inquire, set
23	SH	High 32-bit of remote node IEEE 64-bit address.	inquire
24	SL	Low 32-bit of remote node IEEE 64-bit address.	inquire
25	SM	Remote node's sleep mode (only validate for EndDevice)	inquire, set
26	SP	Save and collect data period of remote node (only validate for EndDevice)	inquire, set
27	ST	Working time after remote node was waken	inquire, set
28	VR	Firmware version of remote node	inquire
29	WR	Write setting for remote node	execute

Send & Receive data through 16-bit address (under API mode)

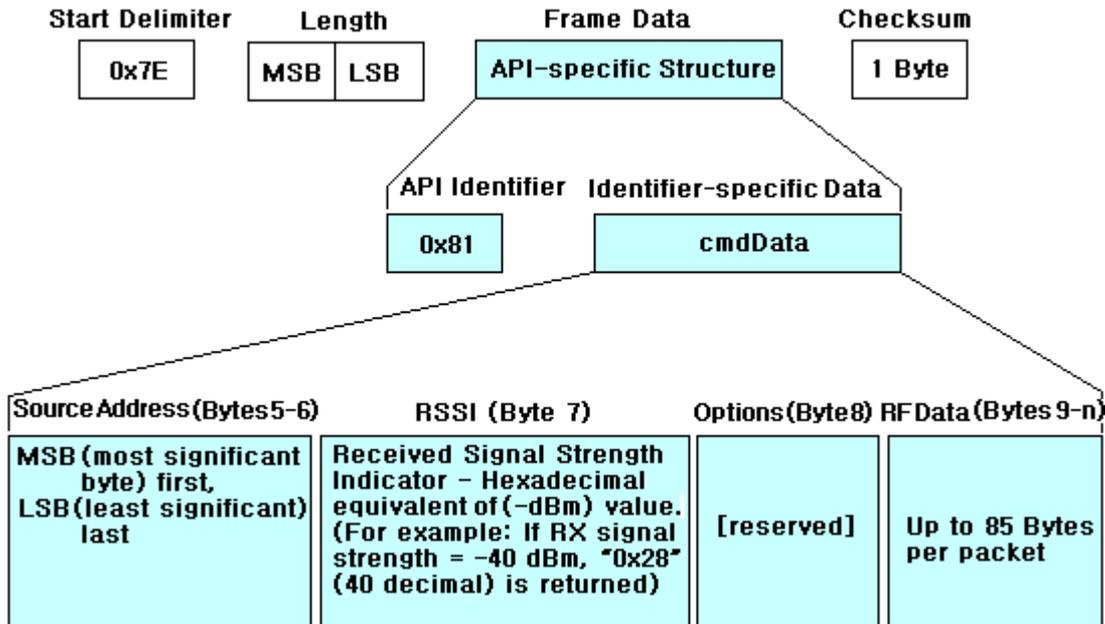
After receiving the data sending requested frame (command word: 0x01), the module will send the content of 'RF Data' field to the assigned 16-bit destination address.

Command word for sending data through 16-bit address is 0x01, the frame structure is shown as follow:



After receiving the air data, the module will pack the data according to the following frame structure definition and send to the serial port.

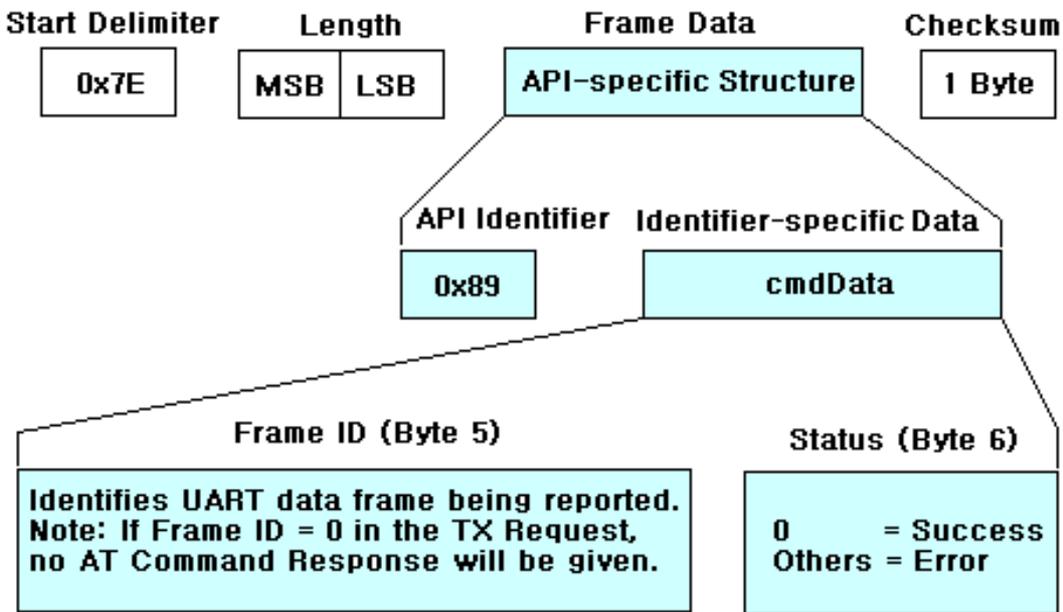
Command word for receiving data through 16-bit address is 0x81, the frame structure is shown as follow:



TX (Transmit) Status (under API mode)

When the module finishes sending a TX Request (command word 0x01), if there is no forbidden ACK, no matter whether it is successful, the module will return a TX status frame.

TX Status command word: 0x89, the frame structure is shown as follow:



5.4 Frequently Asked Questions.

5.4.1 How to use broadcast transmission?

When a module sends data through broadcasting, the other modules (work on the same channel) with same PAN ID could receive the broadcasting data.

Broadcast under transparent mode

Under the transparent mode, set 16-bit Dest Address as 0xFFFF by using ATDS command. In this

way, all the data input from serial port will be sent through broadcasting.

Broadcast under the API mode

Under the API mode, users only need to set the 16-bit Dest Address as 0xFFFF. In this way, the data will be sent through broadcasting under API mode.

5.4.2 How to send data to an assigned module under transparent mode?

Under transparent mode, except broadcasting mode, the data also could be sent to an assigned module. The method is shown as follow:

Input 3-character command sequence “+++” and switch to the AT Command mode.

Using ATAP command to make the module work on transparent mode, i.e. ATAP 0<CR>

Using ATDS command to set the wanted destination short address, for example ATDS 1A93<CR>

Using ATWR command to write the setting into Non-volatile memory, i.e. ATWR<CR>

Input “ATCN<CR>” command to exit AT command mode.

5.4.3 How to know whether the module enters the network?

Read the short address or 16-bit address (AT Command is ATMY.) can confirm the module whether it is in the network. If its short address is 0xFFFFE, it means it is not in the network. If its short address is less than 0xFFFFE, it means it is in the network.

Need to know that the Coordinator is always in the network. For one module, if the module has been in a network, it will always be in the network, even the module has been restarted again, and the short address can not be changed. Only when using the ATRN command to initialize the network, the module will lose the network.

5.4.4 How to make the module work under the API mode after power up?

Users can use AT command to make the module enter API mode:

Enter the AT Command page of HAC Studio.

Input 3-character command sequence “+++” and wait the module returns “OK”

Input “ATAP 1<CR>” command, the module returns “OK”, it is used to set the module work under the API mode.

Input “ATWR <CR>” command, the module returns “OK”, it is used to save the setting to keep the working mode as API mode after restart the module.

Input “ATCN <CR>” to exit from the AT Command mode. Now, the module is working on the API mode. Even restart the module, it also enters the API mode directly.

5.4.5 How to change the baud rate?

Using AT command ‘ATBD’ could change the baud rate, the parameter value is 0-7. The following example is for changing baud rate to 38400bps (the corresponding value is 5):

Enter the AT Command page of HAC Studio.

Input 3-character command sequence “+++” and wait the module returns “OK”

Input “ATBD 5<CR>” command, the module returns “OK”, it is used to set the baud rate as 38400bps.

Input “ATWR <CR>” command, the module returns “OK”, it is used to save the setting to keep the working mode as API mode after restart the module.

Input “ATCN <CR>” to exit from the AT Command mode. Now, the module is working on the API mode. Even restart the module, it also enters the API mode directly.

Note: The baud rate setting of upper machine software HAC Studio should be same as the baud rate of module to achieve normal communication. After changing the baud rate of the module, please update the baud rate setting of HAC Studio.

5.4.6 The sleep control for EndDevice

Before the EndDevice enters the sleep state, it should meet three requirements. First, EndDevice should be in the Zigbee network already. Second, the SM parameter should be set to ‘1’, i.e. sleep enable. Third, the sleep control pin should be in the sleep enable state, i.e. 9th pin should be high level. When all three requirements are satisfied, the EndDevice will enter the sleep state.

When the module enters sleep state, it can not receive the data from air or from serial port. The sleep time is related to the SP (sleep period) setting. The default SP value is 0x12C, unit:10ms. So the EndDevice wakes every 3000ms. After waken, it will collect the data sent by other nodes from its father node. Even the EndDevice doesn’t sleep, it also collect the data from its father node according SP value.

If want to wake module in irregular time and send data to the module through serial port, it is impossible. Because when send the data to the module, it may be in the sleep state. So the reliable waking method is waking the module by using the sleep control pin (9th pin). If the 9th pin keeps low level, EndDevice will keep on the working state and will not enter sleep state. When plugging the EndDevice into the testing board, the 9th pin of EndDevice is connected with 4th pin of switch on the testing board. So when the 4th pin of switch is ‘OFF’, enable sleep function, when it is in the ‘ON’ state, disable sleep function.

Note: After the power on the EndDevice, it needs to always be in the Zigbee network to achieve the power-saving purpose. Because if it is not in the Zigbee network, it needs to search the Zigbee network for entering continuously and will not enter the sleep state, so no power-saving.



5.4.7 The Net Load

The net load for sending data is up to the reasons like the current working state, system allocated resources and so on. But it is at least more than 80 bytes. If the air data transmission is in the no-encrypt mode, the net load is more than 80 bytes. (Note: module with encrypt mode should be customize.)

VI. Assistant Software

We offer a upper software called HAC Studio to help users to test, evaluate and setup the HAC-LBee V3.1-2.2 module. There are 5 parts in total.

"COM Setup" page is used to setup the computer's serial port. Only when the settings of serial port are correct, the software can communicate with the module normally.

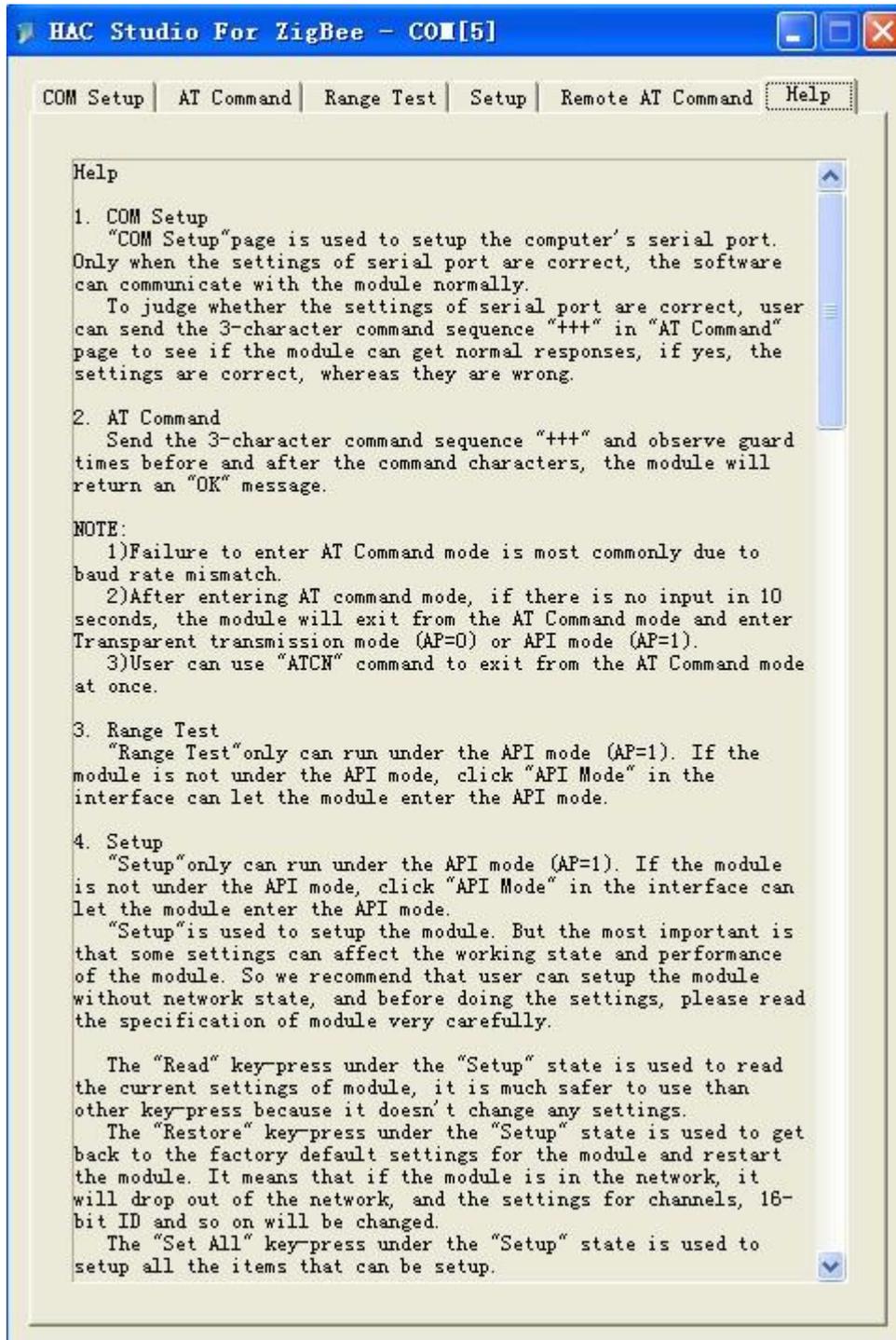
"AT Command" page is used to input and output AT Command.

"Range Test" is used for the communication test of module, it only can run under the API mode (AP=1).

"Setup" is used to setup the module. But the most important is that some settings can affect the working state and performance of the module. "Setup" only can run under the API mode (AP=1).

"Remote AT Command" is used to operate the remote AT command, it only can run under the API mode (AP=1).

"Help" is the help for software. Before using the software, please read the "Help" at first.



VII. Appendix

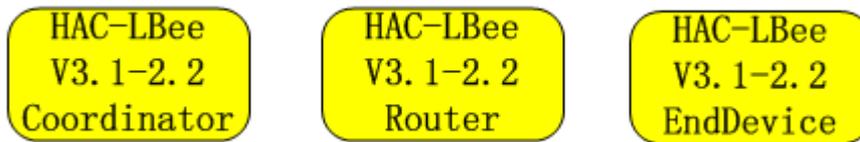
Appendix 1:

1. What is Zigbee?

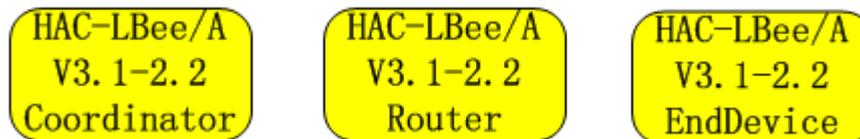
The ZigBee Alliance based on an open global standard is an association of companies working together to enable reliable, cost-effective and low-power Wireless communications solutions. ZigBee launched by ZigBee Alliance is a short-distance, low-power and low-cost wireless communication technology. Some International well-known companies are members of ZigBee Alliance, such as TI, Motorola, Siemens, Philips.

2. The sort of Zigbee module

Our ZigBee module is based on ZigBee protocol stack of TI company. According to different functions in the network, module can be divided into three types, one is Coordinator, another one is Router, the rest one is end device. The appearance and interface of three types are the same. Users can distinguish them by label or by the upper machine software.



Picture 1 No-Encrypt Module Label



Picture 2 Encrypt Module Label

3. Zigbee Network

One Zigbee network only have one Coordinator, it is used for the establishment of the network. Only after Coordinator has been electrified for a few seconds, the network can be startup. Coordinator is the first node in the network. Then Router can connect with Coordinator and enter into the network. At the same time, Router in the network allows the other Router enter the network by connecting with it. Any two nodes in the network can do point-to-point communication. At the same time, any node can broadcast to the other nodes.

Whether a module can enter the network depends on whether it has node that has enter network in



its communication distance. If the distance between the module and its nearest node in the network is more than its communication distance (seen in the module specification), and the node will not communicate with any nodes in the network.

The establishment of ZigBee network can finish automatically after the module has been electrified, User doesn't need to operate. The order for the module's power doesn't seem particularly important. After Coordinator has been electrified, ZigBee network can be built. Once a Router has entered the network, even if the Coordinator's power is off, the network can also work normally.

The networking for Coordinator needs to search the suitable channel. And Router enter the network also need to search channel and network and connect. It needs some time to deal with these processes. For Coordinator and Router, once the module enters the network, except initializing the network, or the module will still in the network.

All modules in one network should have the same PAN ID and channel.

4. The 64-bit address and 16-bit address of module

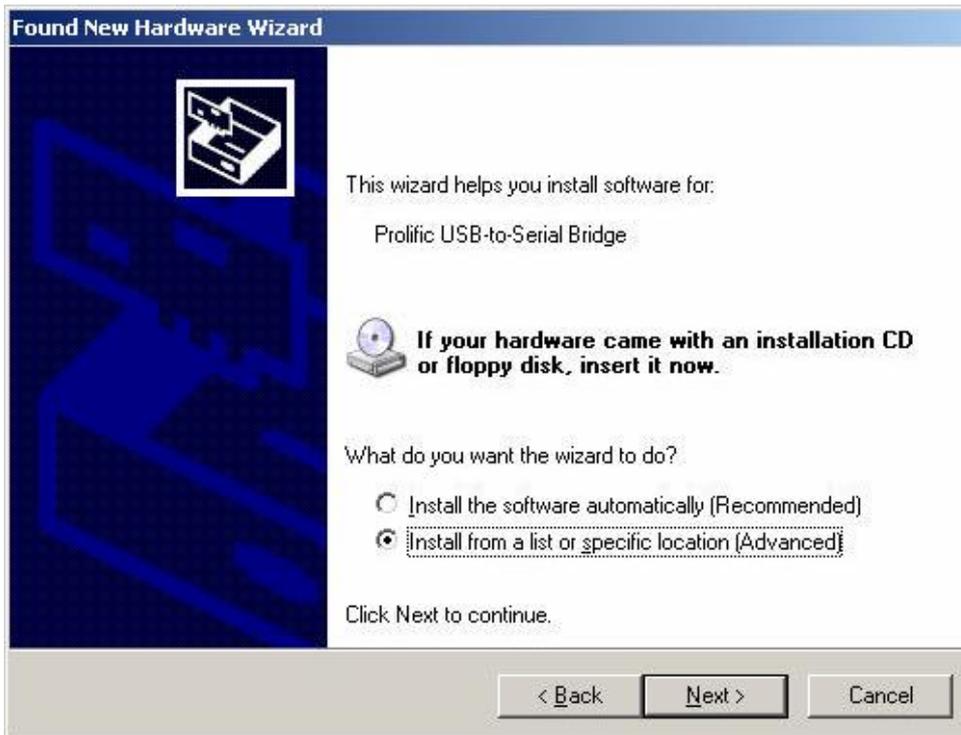
The 64-bit address is also called IEEE address, 64-bit ID or Serial Number. It has been set by the chip manufactory of the module in the factory. The chip manufacture ensures the unique 64-bit address for each chip. 16-bit address is also called short address or 16-bit ID, it is got after entering the Zigbee network. Before entering one Zigbee network, its 16-bit address is 0xFFFFE, it is unmeaning. Once the module enters the Zigbee network, it will get a 16-bit address that is less than 0xFFFFE. In this network, the 16-bit address is unique, except reset the network, or 16-bit address will always belong to this module. The 16-bit address of Coordinator in the network is fixed, it is always 0x0000.

Appendix 2:**Installation instruction for USB driver
MU series (USB to RS232)**

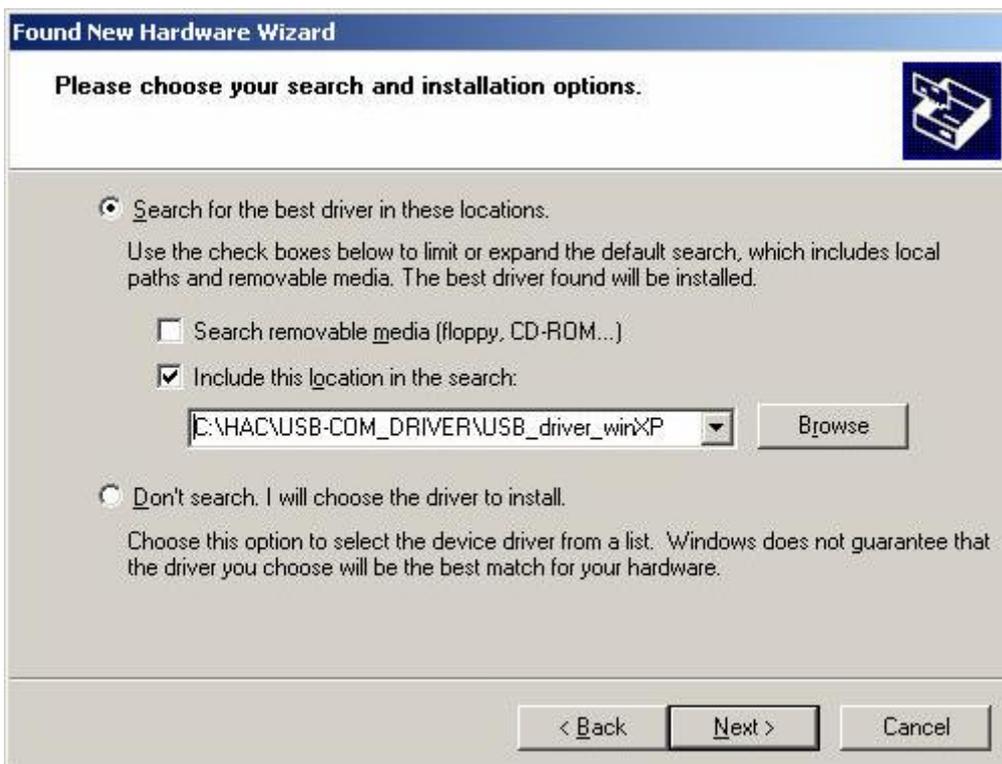
1. Connect MU USB port to the USB port of your computer. A dialog box pops up as follow. Select 'No, not this time' and click 'Next'.



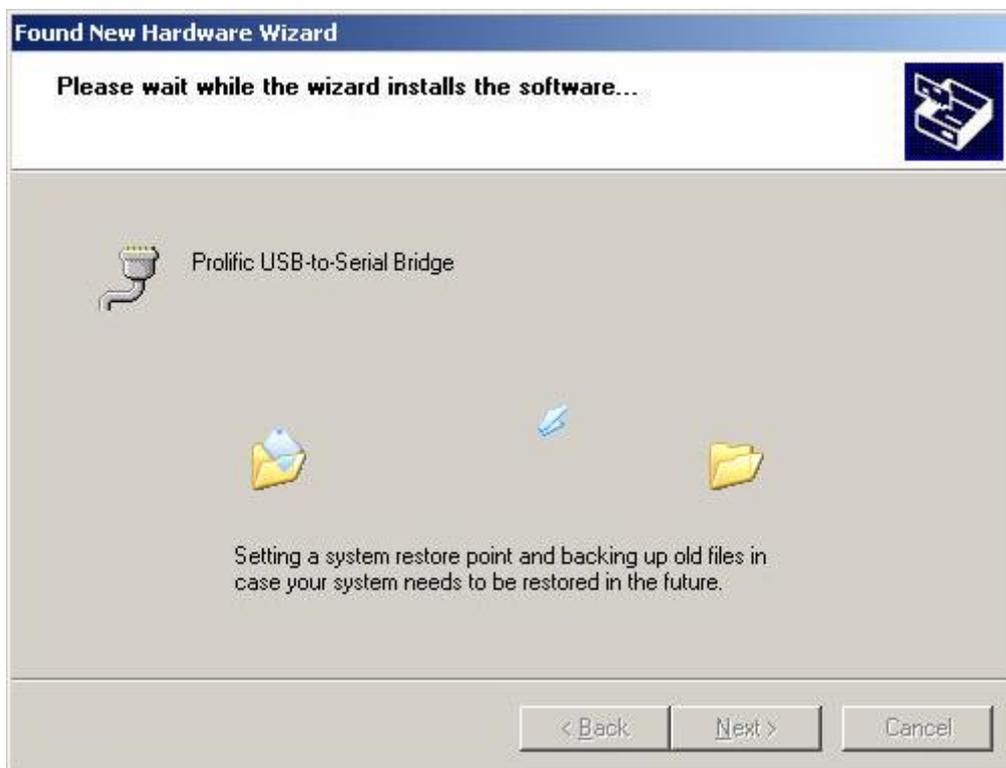
2. The next wizard box will show as below. Select 'Advanced' installation and click on 'Next' button.



3. In the next dialog box, please specify the path where your Windows XP driver located, and click next after the correct path is selected.



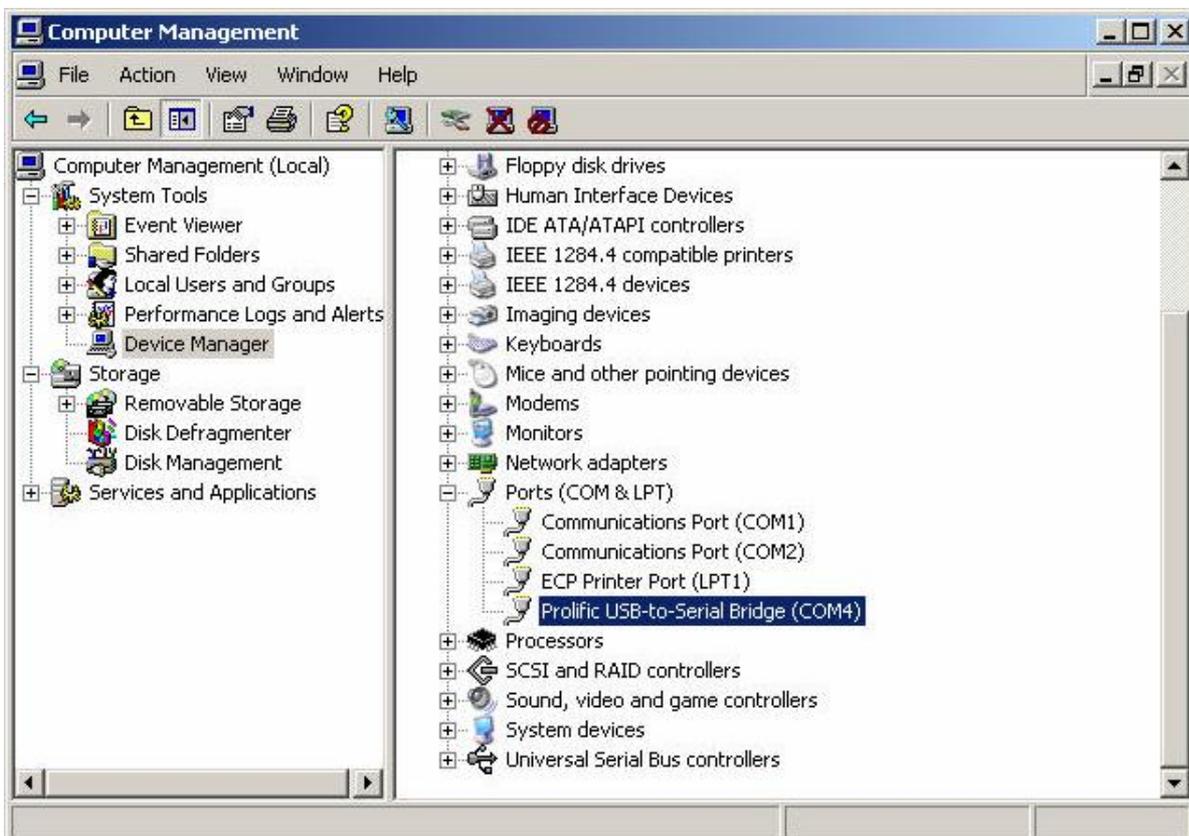
4. A warning message dialog box will appeared as below. Click 'Continue Anyway' button to start the installation.



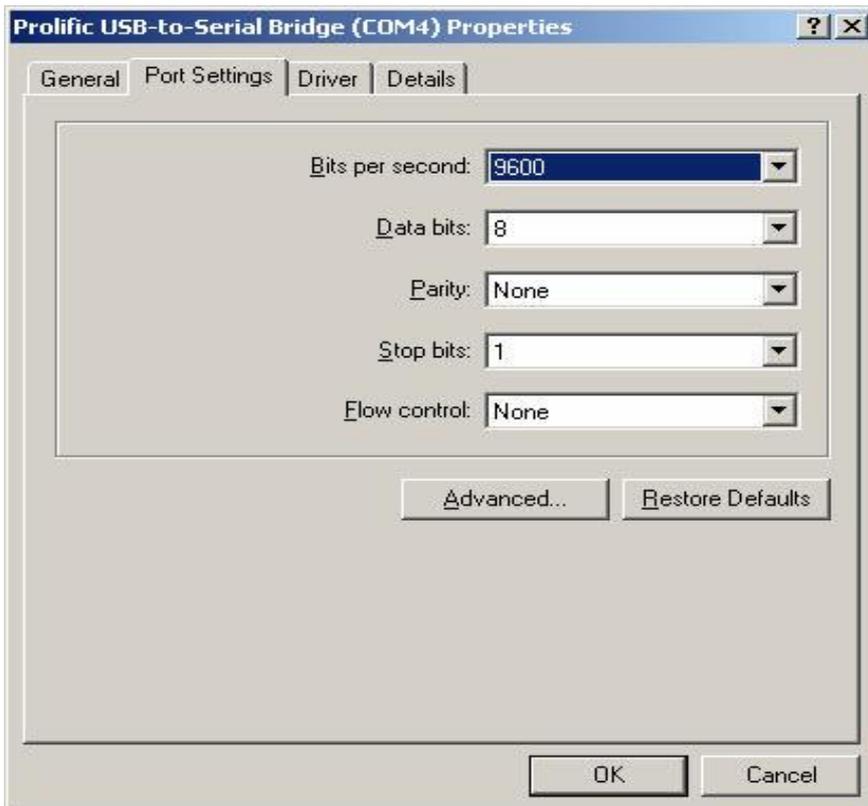
- After the installation is completed, the following dialog box will appear. Click on the 'Finish' button to complete the installation.



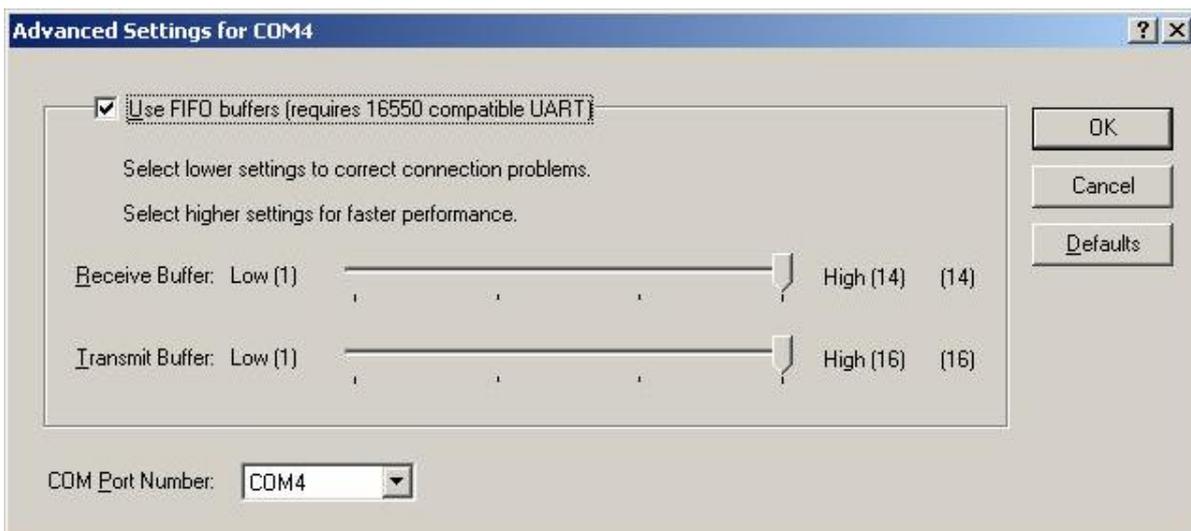
6. To verify and set the parameters of the serial port, open the Computer Manager window and select on Device Manager on the left window. Open the COM port field in the right window.



- Right click on 'Prolific USB-to-Serial Bridge (COMx)' and select on Properties. Make sure that the parameters of the properties dialog box has all the fields set as below.



- Open additional setting by click on 'Advanced' button on the properties dialog box. Double check and make sure that the advanced setting for selected COM ports has the following settings. Click OK when it's done.



Now, the configuration of the serial port has been done. You may use the COM4 or whatever the COM port you have installed to transmit data. One last thing for using the radio modem is that, remember to check the baud rate and parity bit of COM port must be the same as the Smart device.