

SIM7020E NB-IoT HAT

Introduction

NB-IoT HAT for Raspberry Pi, Based on SIM7020E

User Manual

Overview

This is an NB-IoT (NarrowBand-Internet of Things) HAT for Raspberry Pi, controlled via serial AT commands, supports communication protocols like LWM2M/COAP/MQTT, etc. Due to the advantages of low delay, low power, low cost, and wide coverage, it is the ideal choice for IoT applications such as intelligent instruments, asset tracking, remote monitoring, and so on.

Features

- Raspberry Pi connectivity, compatible with any revision
- Supports communication protocols such as LWM2M/COAP/MQTT/TCP/UDP/HTTP/HTTPS, etc.
- Onboard USB interface, for power supply OR debugging
- Breakout UART control pins, to connect with host boards like Arduino/STM32
- Onboard voltage translator, 3.3V by default, allows to be switched to 5V via onboard jumper
- SIM card slot, supports NB-IoT specific card
- 2x LED indicators, easy to monitor the working status
- Baudrate: 300bps~921600bps (115200bps by default)
- Control via AT commands (V.25TER, 3GPP TS 27.007, and SIMCOM AT Commands)
- Comes with development resources and manual (examples for Raspberry Pi/Arduino/STM32/Python)

Specification

Communication

- Band
 - FDD-LTE B1/B3/B5/B8/B20/B28
- Data rate
 - Uplink \leq 62.5Kbps
 - Downlink \leq 26.15Kbps

- SMS
 - Text mode and PDU mode (depends on the NB card)

General

- Power supply: 5V
- Logic level: 5V/3.3V (3.3V by default)
- Overall current (idle mode): ~18mA
 - Single module current (VBAT=3.3V):
 - Idle mode: 5.6mA
 - Sleep mode: 0.4mA
 - PSM mode: 5uA
 - eDRX mode: 70uA (eDRX=655.36s)
- Dimension: 30.5mm x 65.0mm

Interfaces

PIN	Description
5V	5V power input
GND	Ground
RX1	Data receive of Serial port 1
TX1	Data send of Serial port 1
DTR	Sleep Control, High: Sleep; Low: Wake up (need to be set with "AT+CSCLK=1")
RI	Interrupt PIN, High by default. It becomes Low (120ms) when message received or URC reported) (need to be set with "AT+CFGRI=1")
RX2	Data receive of Serial port 2

TX2	Data send of Serial port 2
PWR	Power control
RESET	Reset

Jumpers

Jumpers	Descriptions
VCCIO	Set the operating voltage to 3.3V or 5V
PWR	Set the power control, set to controllable by P4 (BCM) pin of Raspberry Pi by default

Indicators

LEDs	Descriptions
PWR	On: The module is powered on
NET	On(64ms)&OFF(800ms): Internet isn't registered On(64ms)&OFF(3000ms): Internet is registered On(64ms)&OFF(300ms): Data are transmitting OFF: Power off or PSM Sleep Mode

Working with Windows PC

Hardware connection

The external components required:

- A special sim card which supported NB-IoT
- A USB to TTL module (Recommend [CP2102 USB to UART Module](#))

Connection:

1. Insert sim card to the backside card slot, connect LTE antenna (The **LTE antenna must be rotated to the outside of the board**)
2. Connect CP2102 module to UART1 (or UART2) of SIM7020E NB-IoT HAT(SIM7020 hereafter), and connect to your PC by USB cable
3. Power on SIM7020. (PWR:On ; NET: OFF)
4. Press PWRKEY buttons for about 1s (NET: Blinking)
5. Download the serial assistance software and open it. Set it 115200 8N1, and check the newline options
6. Click Extend to get the pre-configure commands. Testing



Quick testing

Herein we list some common commands which can be used to quick test the SIM7020.

Command	Description	Return
AT	Check module status	OK
ATE	ATE1:Echo Mode On; ATE0: Echo Mode Off	OK
AT+CSQ	Check Internet Signals Quality	OK
AT+CGMR	Check Firmware Version	OK
AT+CGREG?	Check Internet register status	OK
AT+CGACT?	Check PDP status	OK

AT+COPS?	Check Internet Information	OK
AT+CGCONTRDP	Check Internet status	OK
AT+CFUN=0	Turn off RF	OK
AT*MCGDEFCONT	Set APN, e.g: AT*MCGDEFCONT="IP","3GNET"	OK
AT+CFUN=1	Turn On RF	OK

```
AT
OK
AT+CFUN?
+CFUN: READY

OK
AT+CSQ
+CSQ: 20,0

OK
AT+CGREG?
+CGREG: 0,2

OK
AT+CGREG?
+CGREG: 0,1

OK
AT+CGACT?
+CGACT: 1,1

OK
AT+COPS?
+COPS: 0,2,"46000",9

OK
AT+CGCONTRDP
+CGCONTRDP: 1,5,"3GNET","100.90.251.126.255.255.0"

OK
AT+CFUN=0
+CFUN: NOT READY

OK
AT+MCFGDEFCNT="IP","3GNET"
OK
AT+CFUN=1
OK

+CFUN: READY
AT+CGMR
1752B075IM7020C

OK
AT+CFUN?
+CFUN: READY

OK
AT+CSQ
+CSQ: 20,0

OK
AT+CGREG?
+CGREG: 0,2

OK
AT+CGREG?
+CGREG: 0,2

OK
AT+CGREG?
+CGREG: 0,1

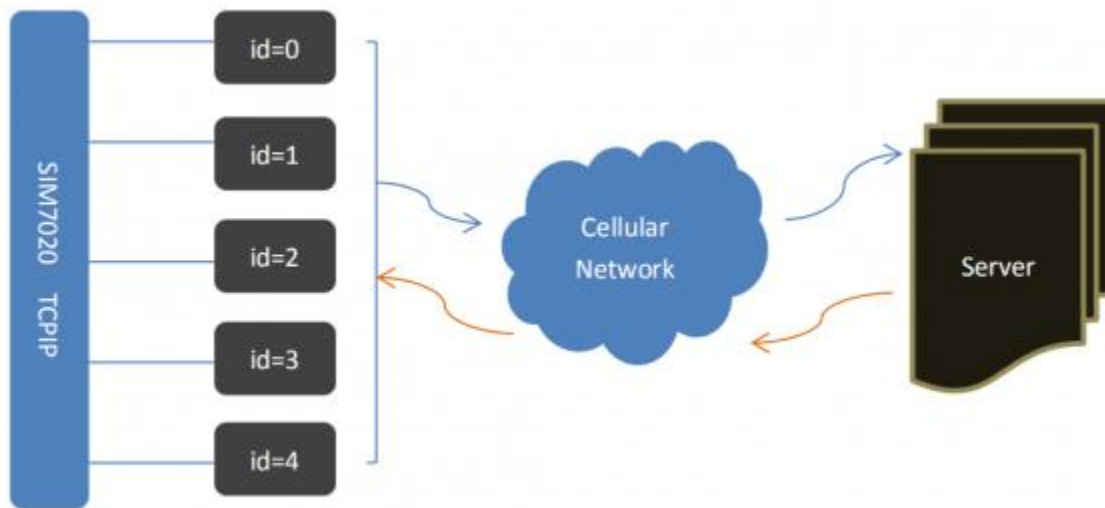
OK
AT+CGACT?
+CGACT: 1,1

OK
```

TCP/IP Communication

SIM7020 cannot support transparent and server mode.

TCP/IP of SIM7020 is multiple client structure, supports up to 5 sockets (like TCP or UDP)



Connect modules and test network connection by following instruction above before TCP/IP communicating.

For more information about TCP, UDP, DNS, etc. Please refer to SIM7020 Series_TCPIP_Application_Note

【TCP Client】

Commands	Description	Return
AT+CSOC=1,1,1	Create TCP socket, <socket_id>=0	OK
AT+CSOCON=0,2317,"118.190.93.84"	Connect to remote server	OK
AT+CSOSEND=0,0,"Hello World"	Send data	OK
AT+CSOCL=0	Close socket	OK
AT+CSOSENDFLAG	Enable Send ACK	OK
AT+CSORCVFLAG	Enable receive ACK	OK

AT+CSOCON?	Check communication port and type	OK
Commands	Descriptions	Return
AT+CSOC=1,2,1	Create UDP socket, <socket_id>=0	OK
AT+CSOCON=4,524,"116.247.119.165"	Connect remote server	
AT+CSOSEND=4,0,"Waveshare"	Send data	OK
AT+CSOCL=0	Close socket	OK
AT+CSOSENDFLAG	Enable send ACK	OK
AT+CSORCVFLAG	Enable receive ACK	OK
AT+CSOCON?	Check communication port and types	OK

【Multiple Sockets】

The image below shows you how to create five sockets communication at the same time using one SIM7020. Please refer to Commands of **【TCP Client】** **【UDP Client】**

The screenshot shows a serial terminal window with the following content:

```

AT+CSOC=1,1,1
+CSOC: 0
OK
AT+CSOCON=0,2317,"118.190.93.84"
OK
AT+CSOSEND=0,0,"Waveshare Send to Socket id 0"
OK
SEND: 0,29
+CSOIMMI: 0,29,Waveshare Send to Socket id 0
AT+CSOC=1,1,1
+CSOC: 1
OK
AT+CSOCON=1,2317,"118.190.93.84"
OK
AT+CSOSEND=1,0,"Waveshare Send to Socket id 1"
OK
SEND: 1,29
+CSOIMMI: 1,29,Waveshare Send to Socket id 1
AT+CSOC=1,1,1
+CSOC: 2
OK
AT+CSOCON=2,2317,"118.190.93.84"
OK
AT+CSOSEND=2,0,"Waveshare Send to Socket id 2"
OK
SEND: 2,29
+CSOIMMI: 2,29,Waveshare Send to Socket id 2
AT+CSOC=1,2,1
+CSOC: 3
OK
AT+CSOCON=3,2317,"118.190.93.84"
OK
AT+CSOSEND=3,0,"Waveshare Send to Socket id 3 using UDP"
OK
+CSOIMMI: 3,39,Waveshare Send to Socket id 3 using UDP
AT+CSOC=1,2,1
+CSOC: 4
OK
AT+CSOCON=4,2317,"118.190.93.84"
OK
AT+CSOSEND=4,0,"Waveshare Send to Socket id 4 using UDP"
OK
+CSOIMMI: 4,39,Waveshare Send to Socket id 4 using UDP
AT+CSOCL=0
OK
AT+CSOCL=1
OK
AT+CSOCL=2
OK
AT+CSOCL=3
OK
AT+CSOCL=4
OK
  
```

On the right side, there is a list of commands and their descriptions:

Command	Description	Count
—TCP Client—	—TCP Client—	0 1000
AT+CSOC=1,1,1	创建TCP socket	0 1000
AT+CSOCON=2,2317,"118.190.93.84"	连接远端 TCP server	0 1000
AT+CSOSEND=2,0,"Waveshare Send to Socket id 2"	发送TCP数据	0 1000
AT+CSOCL=4	关闭TCP socket	0 1000
AT+CSOSENDFLAG=1	传输TCP 发送ACK回执	0 1000
AT+CSORCVFLAG=1	传输TCP 接收ACK回执	0 1000
—UDP Client—	—UDP Client—	0 1000
AT+CSOC=1,2,1	创建UDP socket	0 1000
AT+CSOCON=4,2317,"118.190.93.84"	连接远端UDP peer	0 1000
AT+CSOSEND=4,0,"Waveshare Send to Socket id 4 using UDP"	发送UDP数据	0 1000
AT+CSOCL=0	关闭 socket	0 1000
AT+CSOCON?	检查端口和通信类型	0 1000
—HTTP POST—	—HTTP POST—	0 1000
AT+CHTTPCREATE="http://139.217.9.49:8080/"	创建 HTTP 服务器端	0 1000
AT+CHTTPCON=0	连接 server	0 1000
2736174656e6e697465223a2235222c22766f6c74616765223a22342e32227d	发送 http 请求	0 1000
AT+CHTTPDISCON=0	断开连接	0 1000
AT+CHTTPDESTROY=0	销毁HTTP实例	0 1000
—HTTP GET—	—HTTP GET—	0 1000
AT+CHTTPCREATE="https://www.waveshare.com/"	创建HTTP Host实例	0 1000
AT+CHTTPCON=0	连接 server	0 1000
AT+CHTTPSEND=0,0,"/index.html"	发送 http 请求	0 1000
AT+CHTTPDISCON=0	断开连接	0 1000
AT+CHTTPDESTROY=0	释放销毁 HTTP 实例	0 1000
AT+CHTTPCREATE?	44无注释	0 1000
—LWMM2M—	—LWMM2M—	0 1000
AT+CLMCONF="182.150.27.21","5683","1222","sim7020test","IPV4",10	创建 LWMM2M 连接	0 1000
AT+CLMADDR=0,5,2,8,0,1,2,3,4,5,6,7	创建对象	0 1000
AT+CLMDELOBJ=0,5	删除对象	0 1000
AT+CLMREAD=0,5,2,1,1,"S",5,"abcde"	读取	0 1000
AT+CLMWWRITE=0,0	写操作	0 1000
AT+CLMEXECUTE=0,0	执行	0 1000
AT+CLMNOTIFY=0,5,2,3	通知配置	0 1000
AT+CLMDEL=0	断开并删除实例	0 1000
—MQTT—	—MQTT—	0 1000
AT+CMQNEW="198.41.30.241","1883",12000,100	创建 MQTT 连接	0 1000
AT+CMQCON=0,3,"myclient",600,0,0	发送 MQTT 请求	0 1000
AT+CMQSUB=0,"mytopic",1	订阅主题	0 1000
AT+CMQPUB=0,"mytopic",1,0,0,8,"31323334"	发布主题和消息	0 1000
AT+CMQUNSUB=0,"mytopic"	取消订阅主题	0 1000

At the bottom, there are control buttons and settings for the serial terminal, including '清除窗口', '打开文件', '发送文件', '停止', '请发送区', '最前', 'English', '保存参数', '隐藏', '端口号', 'COM7 Silicon Labs CP210x U', 'HEX显示', '保存数据', '接收数据到文件', 'HEX发送', '定时发送: 8000 ms/次', '加回车换行', '关闭串口', '更多串口设置', '加时间戳和分包显示', '超时时间: 20 ms', '第1字节至末尾', '加校验: None', 'RTS', 'DTR', '波特率: 115200', 'AT', and '发送'.

【DNS and Ping】

Functions of DNS and Ping are only available when network is accessible

Commands	Description	Return
AT+CIPPING	Ping commands. e.g. AT+CIPPING="61.135.169.121"	OK
AT+CDNSGIP	DNS, e.g. AT+CDNSGIP="www.baidu.com"	OK

```
AT+CIPPING="61.135.169.121"  
OK  
+CIPPING: 1,61.135.169.121,13,53  
+CIPPING: 2,61.135.169.121,11,53  
+CIPPING: 3,61.135.169.121,10,53  
+CIPPING: 4,61.135.169.121,13,53
```

```
AT+CDNSGIP="www.baidu.com"  
OK  
+CDNSGIP: 1,"www.baidu.com","111.13.100.91"
```

HTTP

SIM7020 supports two types of HTTP communicating, HTTP GET and HTTP POST

For more information about AT commands of HTTP communication, please refer to SIM7020 Series_HTTP_Application_Note

【HTTP GET】

Commands	Description	Return
AT+CHTTPCREATE=" https://www.waveshare.com/ "	Create HTTP Host example	OK
AT+CHTTPCON=0	Connect to server	OK
AT+CHTTPSEND=0,0,"/index.html"	Send HTTP Request	OK
AT+CHTTPDISCON=0	Disconnect	OK
AT+CHTTPDESTROY=0	Release and clear HTTP example	OK
AT+CHTTPCREATE?	Check HTTP connecting status	OK

Note: Request time is a little long because of NB-IoT network when testing HTTP commands, please be patient.



MQTT

For more information about MQTT, please refer to SIM7020 Series MQTT_Application_Note

【Subscribe and send message】

Herein show you how to use MQTT by using MQTT test tool which is found online

Command	Description	Description	Return
AT+CMQNEW="198.41.30.241","1883",12000,100	Create MQTT connection	OK	
AT+CMQCON=0,3,"myclient",600,0,0	Send MQTT request	OK	

AT+CMQSUB=0,"mytopic",1	Subscribe	OK	
AT+CMQPUB=0,"mytopic",1,0,0,8,"31323334"	Publish theme and message	OK	
AT+CMQUNSUB=0,"mytopic"	Unsubscribe	OK	
AT+CMQDISCON=0	Disconnect MQTT	OK	

Note: Request time is a little long because of NB-IoT network when testing HTTP commands, please be patient.

SSCOM V5.13.1 串口/网络数据调试器,作者:大虾丁丁,2618058@qq.com, QQ群: 52502449(最新版本)

通讯端口 串口设置 显示 发送 多字符串 小工具 帮助 ▲PCB打样降至每款30元顺丰包邮! 【独立创官网】

```

AT+CMQKEY="198.41.30.241","1883",12000,100
+CMQKEY: 0
OK
AT+CMQCOFH=0,3,"myclient",600,0,0
OK
AT+CMQSUB=0,"mytopic",1
OK
AT+CMQFUB=0,"mytopic",1,0,0,8,"31323334"
OK
+CMQFUB: 0,"mytopic",1,0,0,8,"31323334"
+CMQFUB: 0,"mytopic",0,0,0,8,"AABBCCDD"

```

MQTT	56无注释	0	1000
AT+CMQKEY="198.41.30.241","1883",12000,100	创建 MQTT 连接	0	1000
AT+CMQCOFH=0,3,"myclient",600,0,0	发送 MQTT 请求	0	1000
AT+CMQSUB=0,"mytopic",1	订阅主题	0	1000
AT+CMQFUB=0,"mytopic",1,0,0,8,"31323334"	发布主题和消息	0	1000
AT+CMQUNSUB=0,"mytopic"	取消订阅主题	0	1000
AT+CMQDISCOFH=0	断开 MQTT 连接	0	1000
	63无注释	0	1000
	保持	0	1000
	NVRAM 中	0	1000
	NVRAM 中	0	1000
	AT+CMQKEY	0	1000
	主题	0	1000
	主题	0	1000
	主题数据	0	1000
	题	0	1000
	P服务器	0	1000
	目	0	1000
	持续时间	0	1000
	题	0	1000
	信息	0	1000
	t 基础	0	1000
	et3303	0	1000
	et3306	0	1000
	et3306	0	1000
	册	0	1000
	** 命令	0	1000
	re 命令	0	1000
	ver 命	0	1000
	上报	0	1000
	消	0	1000

MQTT测试工具 QQ:2081677739

broker
 addr: 198.41.30.241 port: 1883 id: user: pwd: disconnect

subscribe
 topic: mytopic QoS 0 unsubscribe
 mytopic
 31 32 33 34
 mytopic
 AA BB CC DD

publish
 topic: mytopic
 aa bb cc dd

Retained hex string
 QoS 0 string clear send

端口号 COM4 Silicon Labs CP210x U 关闭串口 更多串口设置 115200 波特率

HEX显示 保存数据 接收数据到文件 HEX发送 定时发送: 1000 ms/次 加回车换行

加时间戳和分包显示 超时时间 20 ms 第1字节至末尾 加校验 None

发送

【升级到SSCOM5.13.1】★PCB打样降至每款30元顺丰包邮! SMT贴片工程费60元,每焊盘1分钱! ★RT-Thread来自中国的开源免费商用物联网操作系统 ★新一代Wi-Fi芯片兼容8266支持RT-Thread

www.daxia.com S:145 R:265 COM4 已打开 115200bps,8,1,None,None CTS=0 DSR=0 RLSD=0

RXD	TXD (BCM:P14)
TXD	RXD(BCM: P15)
PWR	P7 (BCM: P4)

Software Setting

- Download demo code, copy SIM7020x folder to /home/pi/ of your Raspberry Pi
- Open Terminal, and execute:

```
chmod 777 sim7020_nbiot_hat_init
```

- Set script auto-executing:

- Modify rc.local file:

```
sudo nano /etc/rc.local
```

- Add the line in front of exit 1 as below

```
sh /home/pi/SIM7020X/sim7020_nbiot_hat_init
```

Serial Setting

To work with Raspberry Pi, you need to enable hardware serial and disable serial login shell function.

- Enter raspi-configure

```
sudo raspi-config
```

- Choose Interfacing Options->Serial->no->yes
- Open /boot/config.txt file, check if the line was added:

```
enable_uart=1
```


- Reboot

Testing with minicom

Connect SIM7020 to Raspberry Pi, install minicom to your Raspberry Pi:

```
sudo apt-get install minicom
```

Execute `minicom -D /dev/ttyS0` to enter the minicom (ttyS0: Pi 3B/3B+, ttyAMA0: Zero/2B)

Demo codes

Download demo codes. Rename bcm2835 folder to SIM7020X and copy it to /home/pi of Raspberry Pi

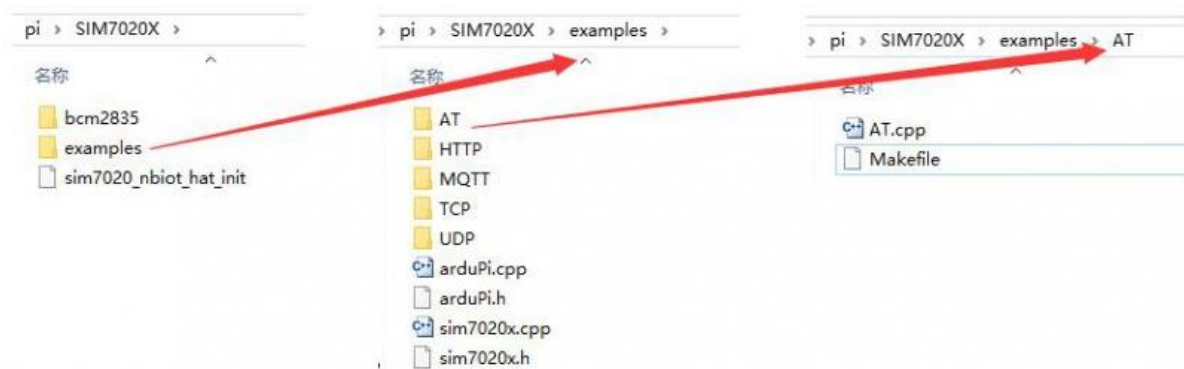
【Install BCM2835 libraries】

Enter SIM7020X/bcm2835 directory, install the libraries with commands:

```
./configure & make & sudo make check & sudo make install
```

【Compile and run】

The files tree:



```
cd /home/pi/SIM7020X/examples/AT  
sudo make clean && sudo make && sudo ./main
```

Working with STM32

SIM7020X NB-IoT HAT is compatible with STM32 MCU. The used pins are as below (Waveshare Open103V STM32F103V) :

SIM7020X NB-IoT HAT	STM32F103V
5V	5V
GND	GND
RXD	PA2 (对应USART2的TX)
TXD	PA3 (对应USART2的RX)

Coming soon...

Resources

- [Schematic](#)
- [Source code](#)

Tools

- [sscom \(with SIM7020 AT commands\)](#)
- [MQTT test tool](#)

SIM7020 Datasheets

- [SIM7020_SPEC_EN](#)
- [SIM7020 Series_AT Command Manual_V1.02](#)
- [SIM7020 Hardware Design_V1.02](#)
- [SIM7020 SIM7020 Series MQTT Application Note](#)
- [SIM7020 Series_MQTT\(S\)_Application Note_V1.03](#)
- [SIM7020 Series_CoAP_Application_Note_V1.0](#)
- [SIM7020 Series_CoAP_Application Note_V1.02](#)
- [SIM7020 Series_FOTA_Application_Note_V1.01](#)
- [SIM7020 Series_HTTP_Application_Note_V1.1](#)

- [SIM7020 Series_HTTP_Application Note_V1.02](#)
- [SIM7020 Series_Low Power Mode_Application Note_V1.02](#)
- [SIM7020 Series_Low Power Mode_Application Note_V1.03](#)
- [SIM7020 Series_LWM2M_Application Note_V1.02](#)
- [SIM7020 Series_TCPIP_Application_Note_V1.02](#)
- [More...](#)

Firmware upgrade

- [1752B07SIM7020E Firmware](#)
- [1752B10SIM7020E Firmware](#)
- [1752B11SIM7020E Firmware](#)
- [1752B12SIM7020E Firmware](#)
- [1752B13SIM7020E Firmware](#)
- [Upgrade tool](#)
- [Upgrade Video](#)