

NRC7292 Evaluation Kit User Guide (AT-command)

Ultra-low power & Long-range Wi-Fi

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NEWRACOM, Inc.

NRC7292 Evaluation Kit User Guide (AT-command) Ultra-low power & Long-range Wi-Fi

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1 Overview

This document introduces the NRC7292 AT-command. The NRC7292 AT-command allows users to apply fine controls over the NRC7292 modules such as: checking the modem status, scanning, connecting to an AP, opening sockets, and exchanging data.

2 Basic Setup

The AT-command package with a custom firmware binary to enable AT-command feature is required along with the firmware download tool. Users need to download the firmware binary onto the flash on the NRC7292 module to enable AT-command communication via UART or SPI.

2.1 Hardware connection

Figure 2.1 shows an NRC7292 evaluation board (EVB). The AT-command communication is achieved via the UART or SPI interface between an external host and the EVB.

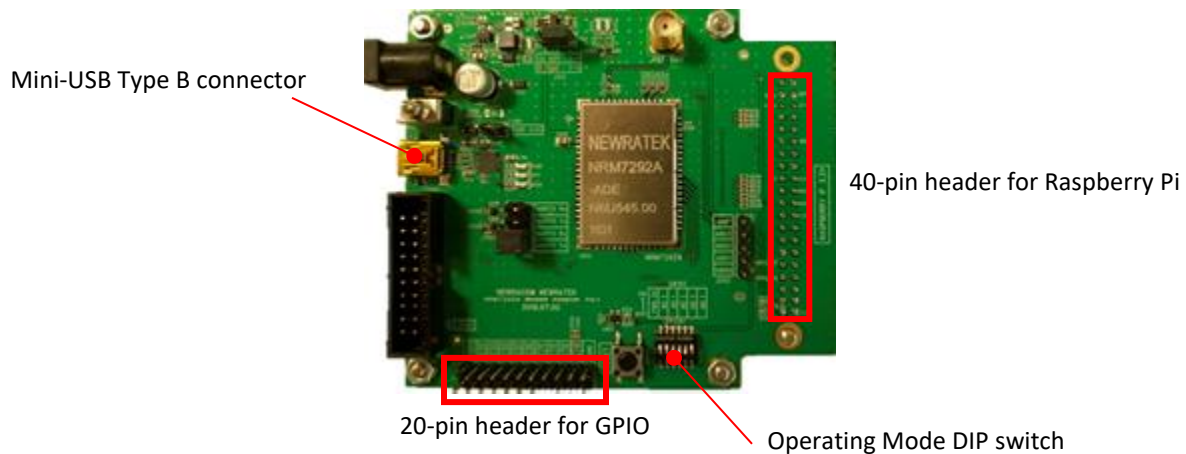
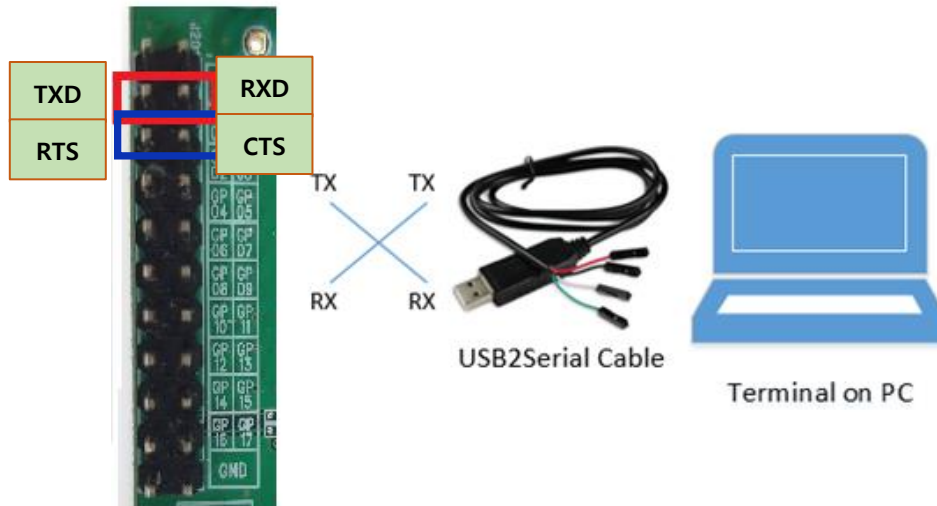


Figure 2.1 NRC7292 evaluation board

IMPORTANT: If the EVB is mounted on a Raspberry Pi host, detach the board from the Raspberry Pi host first before proceeding. The EVB must be used as a standalone for stable AT communication.

1) UART

The AT-command uses UART channel 2. The TX and RX of UART channel 2 are placed in a 20-pin header for GPIO.



**Module-to-Host Connection
(with flow control)**

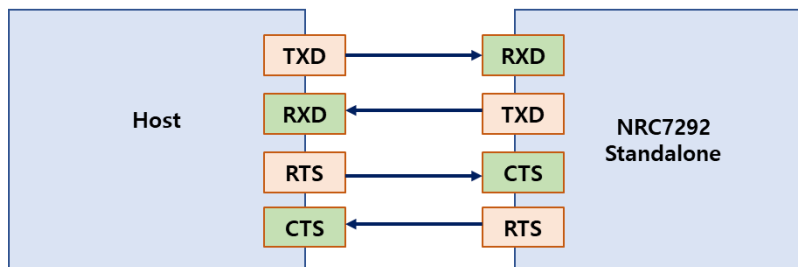


Figure 2.2 UART connection between EVK and external host

The GP00 and GP01 pins on the 20-pin header correspond to TX and RX of UART channel 2, respectively.

※ (Optional) GP02 and GP03 pins correspond to RTS and CTS of UART channel 2 for HW Flow Control

2) HSPI

The NRC7292 has a dedicated SPI slave controller for high speed. The SPI signals are placed in a 40-pin header for Raspberry Pi. The CLI application described in chapter 8 is available to perform AT-command communication via the SPI on Raspberry Pi.

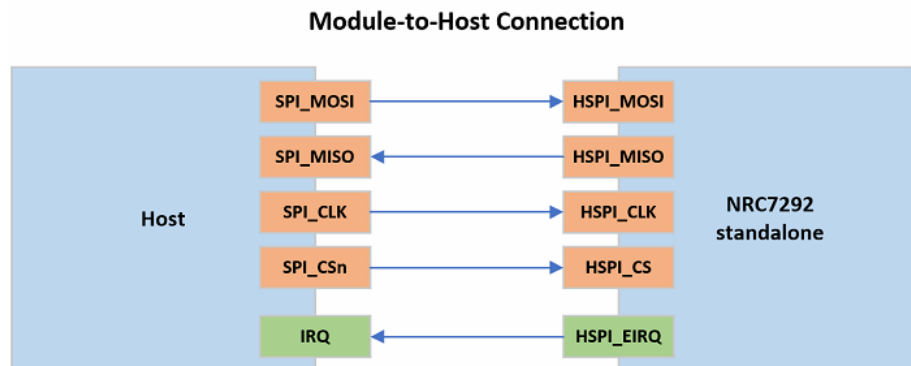
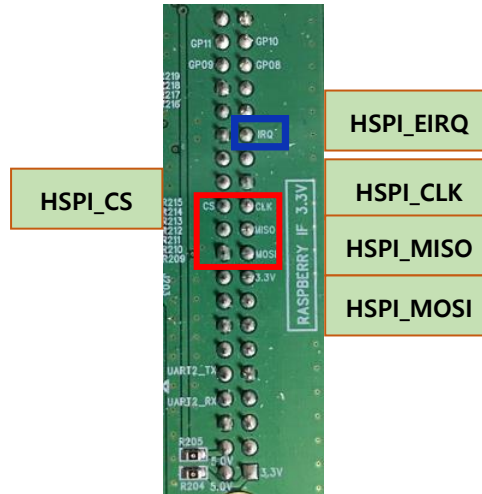


Figure 2.3 SPI connection between EVK and external host

To perform AT command communication through SPI on Raspberry Pi, spidev of Raspberry Pi3 must be enabled.

1. Modify /boot/config.txt and enable spi hardware interface configuration

```
# Uncomment some or all of these to enable the optional hardware interfaces
#dtparam=i2c_arm=on
#dtparam=i2c=on
dtparam=spi=on

# Uncomment this to enable the lirc-rpi module
#dtoverlay=lirc-rpi

# Additional overlays and parameters are documented /boot/overlays/README

# Enable audio (loads snd_bcm2835)
dtparam=audio=on
enable_uart=1
dtoverlay=pi3-disable-bt
dtoverlay=pi3-disable-wifi
#dtoverlay=pi3-disable-spidev
```

2. After rebooting the Raspberry Pi3, spidev0.0 and spidev0.1 could be accessible from the userspace.

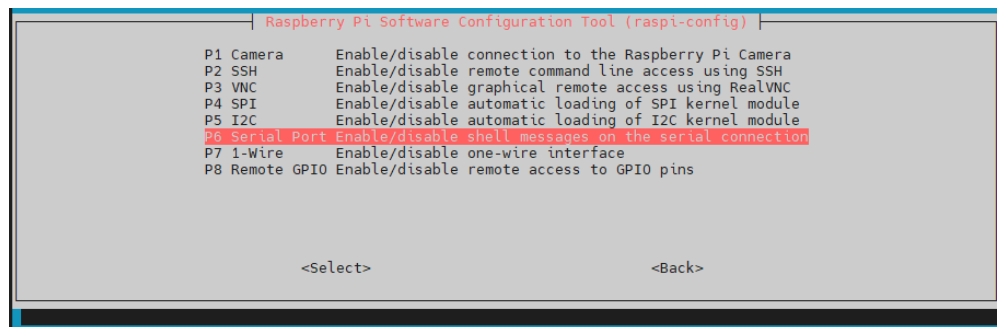
```
pi@raspberrypi:~$ ls /dev
autofs          gpiochip2      loop7          ram0           random         tty11          tty26          tty40          tty55          uhid           vcsa2
block           gpiomem       loop-control   ram1           raw            tty12          tty27          tty41          tty56          uinput        vcsa3
btrfs-control   hidraw0        mapper         ram10          rfkill         tty13          tty28          tty42          tty57          urandom       vcsa4
bus             hidraw1        mem           ram11          serial0        tty14          tty29          tty43          tty58          vchiq         vcsa5
cachefiles      hwrng         memory_bandwidth ram12          serial1        tty15          tty3           tty44          tty59          vcio          vcsa6
char            initctl       mmcblk0        ram13          shm            tty16          tty30          tty45          tty6           vc-mem        vcsa7
console         input         mmcblk0p1      ram14          sd             tty17          tty31          tty46          tty60          vcs           vcsm
cpu_dma_latency kmsg          mmcblk0p2      ram15          spidev0.0      tty18          tty32          tty47          tty61          vcs1          vhci
cuse            log           mqueue         ram2           spidev0.1      tty19          tty33          tty48          tty62          vcs2          watchdog
disk           loop0         net            ram3           stderr         tty2           tty34          tty49          tty63          vcs3          watchdog0
fb0            loop1        network_latency ram4           stdin          tty20          tty35          tty5           tty7           vcs4          zero
fd             loop2        network_throughput ram5           stdout         tty21          tty36          tty50          tty8           vcs5
full           loop3        null           ram6           tty            tty22          tty37          tty51          tty9           vcs6
fuse           loop4        ppp            ram7           tty0           tty23          tty38          tty52          ttyAMA0        vcs7
gpiochip0      loop5        ptmx           ram8           tty1           tty24          tty39          tty53          ttyprintk      vcsa
gpiochip1      loop6        pts           ram9           tty10          tty25          tty4           tty54          tty50          vcsa1
```

3. Enable SPI

The Raspberry Pi configuration tool can also be run from the command line.

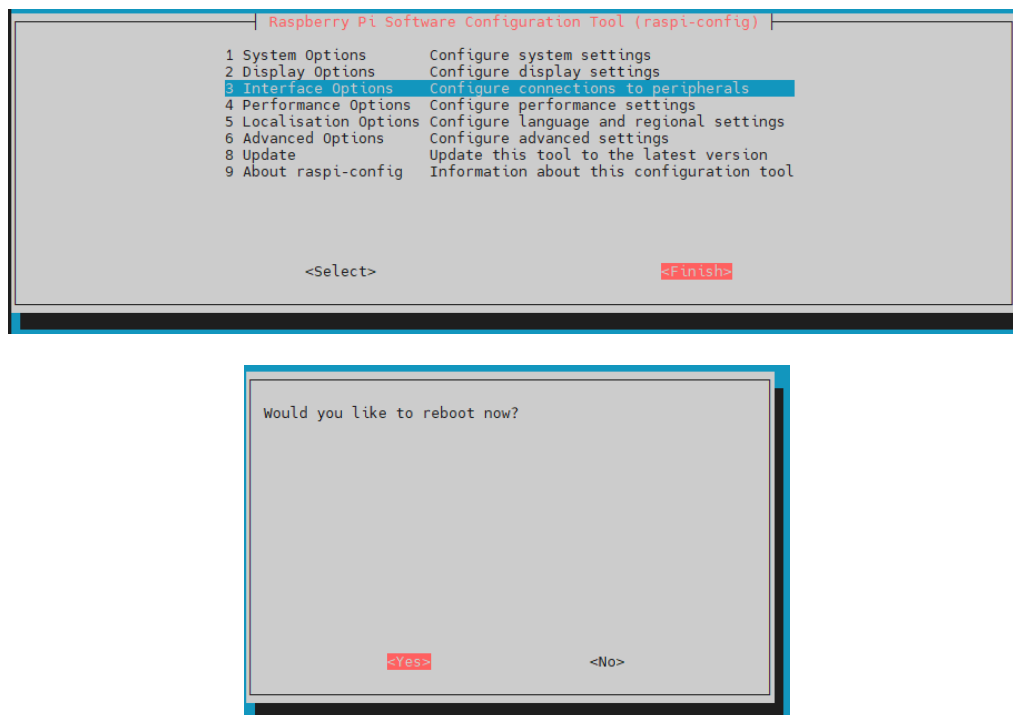
```
#sudo raspi-config
```

- Enable Serial Port





- Fininsh and reboot



2.2 Building the firmware

Refer to the user guide **UG-7292-004-Standalone SDK.pdf** for instructions on how to build the firmware binary. (2. Setup S/W build environment)

1. **HSPI mode:**
 - make select target=nrc7292.sdk.release APP_NAME=ATCMD_HSPI
2. **UART mode (without hardware flow control):**
 - make select target=nrc7292.sdk.release APP_NAME=ATCMD_UART
3. **UART mode (with hardware flow control):**
 - make select target=nrc7292.sdk.release APP_NAME=ATCMD_UART_HFC

2.3 Downloading the firmware and starting the module

Refer to the user guide **UG-7292-004-Standalone SDK.pdf** for instructions on how to download the firmware binary. (3.2 Download the unified binary)

3 AT Command Type

There are four types of AT-commands: HELP, GET, SET and RUN.

Type	Format	Description
HELP	AT+<CMD>=?	List the input argument format and description.
SET or RUN	AT+<CMD>	Run with no argument.
	OR AT+<CMD>=<X1,X2,...>	OR Set or run with the given arguments.
GET	AT+<CMD>?	Query the current values with no argument.
	OR AT+<CMD>?=<X1,X2,...>	OR Query the current values with the given arguments.

Table 3.1 AT-command type

- String input parameter values must be enclosed between double quotation marks (“”).
- Parameters enclosed between a pair of square brackets ‘[]’ indicate optional parameters.
- Optional parameters may be nested.
- All AT commands must be in upper-case letters and terminated by CR-LF.
- Default optional values in the parameter descriptions are indicated by the asterisk ‘*’ characters.

4 Return for Commands

Return Message	Description
OK	The operation for command completes successfully.
ERROR	The command is not supported.
+<CMD>:1 ERROR	The parameter for command is not valid.
+<CMD>:2 ERROR	The previous operation for command is in progress.
+<CMD>:3 ERROR	The operation for command failed with some error.
+<CMD>:4 ERROR	The operation for command is still in progress after the specified time.

5 Basic AT Commands

Commands	Description
AT	Check the AT serial interface status.
ATE	Enable or disable echo.
ATZ	Reset the hardware and restart the firmware.
AT+VER	Fetch the AT firmware version and software package version.
AT+UART	Configure the serial UART parameters.
AT+GPIOCONF	Configure the GPIO pin mode, direction and pull-up option.
AT+GPIOVAL	Read or write the output GPIO pin level.
AT+ADC	Fetch the ADC value at the selected ADC channel index.
AT+SLEEP	Configure deep sleep mode

5.1AT

Command	AT
Response	OK
Description	Check the AT serial interface status.
Example	AT OK

5.2ATE

Command	ATE0 or ATE1	
Response	OK	
Description	Enable (ATE1) or disable (ATE0) echo. (default: disable) NOTE: Echo should typically be enabled for manual communication via a terminal.	
Example	ATE1 OK	ATE0 OK

5.3ATZ

Command	ATZ
Response	
Description	Reset the hardware and restart the firmware. (restarting time : 3 secs)
Example	ATZ

5.4AT+VER

Command	<u>GET</u> AT+VER?
Response	<u>GET</u> +VER: <S/W package version>,<AT firmware version> OK
Description	Fetch the AT firmware version and software package version.

Example	AT+VER? +VER:"1.3.1","1.15.3" OK
----------------	----------------------------------------

5.5 AT+UART

Command	<u>SET</u> AT+UART=<baud rate>,<HFC> <u>GET</u> AT+UART?
Response	<u>SET</u> OK <u>GET</u> +UART:<baud rate>,<data bits>,<stop bits>,<parity>,<HFC> OK
Parameters	<p><baud rate> 19200, 38400, 57600, 115200*, 230400, 460800, 500000, 576000, 921600, 1000000, 1152000, 1500000 or 2000000</p> <p><data bits> Always 8 (8-bit)*</p> <p><stop bits> Always 1 (1-bit)*</p> <p><parity> Always 0 (None)*</p> <p><HFC> 0 (RTS/CTS disabled)* or 1 (RTS/CTS enabled)</p>
Description	Configure the baud rate and HFC for the UART.
Example	<div> <div> AT+UART=115200,1 OK </div> <div> AT+UART? +UART:115200,8,1,0,1 OK </div> </div>

5.6 AT+GPIOCONF

Command	<u>SET</u> AT+GPIOCONF=<index>,<direction>[,<pull-up>] <u>GET</u> AT+GPIOCONF? AT+GPIOCONF?=<index>
Response	<u>SET</u> OK <u>GET</u> +GPIOCONF=<index>,<direction>,<pull-up> OK
Parameters	<p><index> The GPIO pin index. (8, 9, 10, 11, 12, 13, 14, 15, 16, 17)</p> <p><direction> 0 (input)*, 1 (output)</p> <p><pull-up> (input pin only) 0 (floating)*, 1 (pull-up)</p>
Description	Configure the GPIO pin direction and pull-up option.
Example	<div> AT+GPIOCONF=8,1 OK </div> <div> AT+GPIOCONF=11,0,0 OK </div> <div> AT+GPIOCONF=17,0,1 OK </div> <div> AT+GPIOCONF? +GPIOCONF:8,1,0 : +GPIOCONF:11,0,0 : +GPIOCONF:17,0,1 OK AT+GPIOCONF?=13 +GPIOCONF:13,0,0 OK </div>

5.7 AT+GPIOVAL

Command	<u>SET</u> AT+GPIOVAL=<index>,<level> <u>GET</u> AT+GPIOVAL? AT+GPIOVAL?=<index>	
Response	<u>SET</u> OK <u>GET</u> +GPIOVAL:<index>,<level> OK	
Parameters	<GPIO pin index> The GPIO pin index. (8, 9, 10, 11, 12, 13, 14, 15, 16, 17) <GPIO pin level> 0 (low)*, 1 (high)	
Description	Read or write the output GPIO pin level.	
Example	AT+GPIOVAL=8,1 OK AT+GPIOVAL=13,1 OK AT+GPIOVAL=17,0 OK	AT+GPIOVAL? +GPIOVAL:8,1 : +GPIOVAL:17,0 OK AT+GPIOVAL?=13 +GPIOVAL:13,1 OK

5.8 AT+ADC

Command	<u>SET</u> AT+ADC=<ADC channel index>
Response	<u>SET</u> +ADC:<ADC channel index>,<ADC value> OK

Parameters	<ADC channel index> 1, 2, 3 <ADC value> 0 ~ 511
Description	Fetch the ADC value at the selected ADC channel index.
Example	AT+ADC=1 +ADC:1,23 OK

6 Wi-Fi AT Commands

Commands	Description
AT+WMACADDR	Read the MAC address.
AT+WOUNTRY	Configure the Wi-Fi country code
AT+WTXPOWER	Configure the transmission power level.
AT+WRXSIG	Fetch or monitor the RSSI (dBm) and SNR (dB) values.
AT+WRATECTRL	Toggle the MCS rate control option.
AT+WMCS	Set the MCS index applied when the rate control is disabled.
AT+WTXTIME	Set carrier sense time and pause time.
AT+WDUTYCYCLE	Configure duty cycle operation.
AT+WCCATHRESHOLD	Set CCA threshold.
AT+WTSF	Read the elapsed TSF timer duration.
AT+WIPADDR	Configure the IP address, netmask and gateway.
AT+WDHCP	Request dynamic IP allocation from the DHCP server.
AT+WSCAN	Perform Wi-Fi scanning.
AT+WCONN	Connect to a new AP.
AT+WDISCONN	Disconnect from the AP or abort an on-going connection process.
AT+WPING	Initiate a ping session.
AT+WROAM	Enable or disable Wi-Fi roaming.
AT+WFOTA	Enable or disable Firmware Over-the-Air (FOTA).
AT+WSLEEP	Configure sleep mode to save power.
AT+WSOFTAP	Run as the AP mode.
AT+WBSSMAXIDLE	Configure the BSS Max idle service for SoftAP.
AT+WSTAINFO	Get information of associated STAs on AP mode.
AT+WDHCPS	Run the DHCP sever in SoftAP mode.
AT+WTIMEOUT	Configure the response timeout for the specified command.

+WEVENT	Asynchronously raised Wi-Fi event logs.
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6.1 AT+WMACADDR

Command	<u>GET</u> AT+WMACADDR?
Response	<u>GET</u> +WMACADDR:"<MAC address>" OK
Parameters	<MAC address> The MAC address 'HH:HH:HH:HH:HH:HH' where H is a hexadecimal character.
Description	Read the MAC address.
Example	AT+ WMACADDR? +WMACADDR:"2F:33:4F:65:11:20" OK

6.2 AT+WCCOUNTRY

Command	<u>SET</u> AT+WCCOUNTRY="<country code>" <u>GET</u> AT+WCCOUNTRY?
Response	<u>SET</u> OK <u>GET</u> +WCCOUNTRY="<country code>" OK
Parameters	<country code> <ul style="list-style-type: none"> - AU : Australia - CN : China - EU : Europe - JP : Japan - NZ : New Zealand - TW : Taiwan - US : United States - KR : Korea
Description	Configure the Wi-Fi country code

Example	AT+WCOUNTRY="US" OK	AT+WCOUNTRY? +WCOUNTRY:"US" OK
----------------	------------------------	--------------------------------------

6.3 AT+WTXPOWER

Command	<u>SET</u> AT+WTXPOWER=<power in dBm> <u>GET</u> AT+WTXPOWER?	
Response	<u>SET</u> OK <u>GET</u> +WTXPOWER:<power in dBm >	
Parameters	<power in dBm> 8, 9, ... ,17*, 18	
Description	Configure the transmission power level.	
Example	AT+WTXPOWER=11 OK	AT+WTXPOWER? +WTXPOWER:11 OK

6.4 AT+WRXSIG

Command	<u>GET</u> AT+WRXSIG? <u>SET</u> AT+WRXSIG =<time>	
Response	<u>GET</u> +WRXSIG:<RSSI>,<SNR> OK <u>SET</u> +WRXSIG:<RSSI>,<SNR> ... +WRXSIG:<RSSI>,<SNR> OK	

Parameters	<time> Monitoring duration in seconds.	
Description	Fetch or monitor the RSSI (dBm) and SNR (dB) values.	
Example	AT+WRXSIG? +WRXSIG:-50,25 OK	AT+WRXSIG=2 +WRXSIG:-62,20 +WRXSIG:-82,9 OK

6.5 AT+WRATECTRL

Command	<u>SET</u> AT+WRATECTRL=<mode> <u>GET</u> AT+WRATECTRL?	
Response	<u>SET</u> OK <u>GET</u> +WRATECTRL=<mode> OK	
Parameters	<mode> 0 (disable), 1 (enable)*	
Description	Toggle the MCS rate control option.	
Example	AT+WRATECTRL =1 OK	AT+WRATECTRL? +WRATECTRL:1 OK

6.6 AT+WMCS

Command	<u>SET</u> AT+WMCS=<index> <u>GET</u> AT+WMCS?	
Response	<u>SET</u> OK <u>GET</u>	

	+WMCS=<index> OK	
Parameters	<index> Modulation Coding Scheme index (0, 1, 2, 3, 4, 5, 6, 7 and 10)	
Description	Set the MCS index applied when the rate control is disabled.	
Example	AT+WRATECTRL? +WRATECTRL:1 OK AT+WRATECTRL=0 OK AT+WRATECTRL? +WRATECTRL:0 OK	AT+WMCS? +WMCS:2 OK AT+WMCS=7 OK AT+WMCS? +WMCS:7 OK

6.7 AT+WTXTIME

Command	<u>SET</u> AT+WTXTIME=<cs_time>[,<pause_time>] <u>GET</u> AT+WTXTIME?	
Response	<u>SET</u> OK <u>GET</u> +WTXTIME:<cs_time>,<pause_time> OK	
Parameters	<cs_time> Carrier sensing time. Listen before talk (time unit: us) (0~12480) <pause_time> Tx pause time (time unit : us)	
Description	Set carrier sense time and pause time.	
Example	AT+WTXTIME? +WTXTIME:0,0	AT+WTXTIME=10480

	OK AT+WTXTIME=1000,100 OK AT+WTXTIME? +WTXTIME:988,100 OK	OK AT+WTXTIME? +WTXTIME:10452,100 OK
--	----------------------------------------------------------------------------------	---------------------------------------------------

6.8 AT+WDUTYCYCLE

Command	<u>SET</u> AT+WDUTYCYCLE=<window>[,<duration>[,<margin>]] <u>GET</u> AT+WDUTYCYCLE?	
Response	<u>SET</u> OK <u>GET</u> +WDUTYCYCLE=<window>,<duration>,<margin> OK	
Parameters	<window> Duty cycle window (time unit: us) <duration> Specify allowed TX duration within duty cycle window (time unit: us) <margin> Duty margin (time unit: us)	
Description	Configure duty cycle operation.	
Example	AT+WDUTYCYCLE? +WDUTYCYCLE:0,5000000,0 OK AT+WDUTYCYCLE=60000000 OK	AT+WDUTYCYCLE=120000000,6000000,5 OK AT+WDUTYCYCLE? +WDUTYCYCLE:120000000,6000000,5 OK

	AT+WDUTYCYCLE? +WDUTYCYCLE:60000000,5000000,0 OK AT+WDUTYCYCLE=0 OK AT+WDUTYCYCLE? +WDUTYCYCLE:0,5000000,0 OK	AT+WDUTYCYCLE=0 OK AT+WDUTYCYCLE? +WDUTYCYCLE:0,6000000,5 OK
--	--------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------

6.9 AT+WCCATHRESHOLD

Command	<u>SET</u> AT+WCCATHRESHOLD=<threshold> <u>GET</u> AT+WCCATHRESHOLD?	
Response	<u>SET</u> OK <u>GET</u> +WCCATHRESHOLD=<threshold> OK	
Parameters	<threshold> CCA threshold.(unit: dBm) (-100 ~ -70)	
Description	Set CCA threshold.	
Example	AT+WCCATHRESHOLD? +WCCATHRESHOLD:-1 OK AT+WCCATHRESHOLD=-80 OK AT+WCCATHRESHOLD? +WCCATHRESHOLD:-80 OK	

6.10 AT+WTSF

Command	<u>GET</u> AT+WTSF?
Response	<u>GET</u> +WTSF:<time> OK
Parameters	<time> Elapsed TSF timer duration in microseconds.
Description	Read the elapsed TSF timer duration.
Example	AT+WTSF? +WTSF:44142384 OK

6.11 AT+WDHCP

Command	<u>RUN</u> AT+WDHCP
Response	<u>RUN</u> +WDHCP:"<IP>","<netmask>","<gateway>" OK
Parameters	<IP>, <netmask> and <gateway> 'A.B.C.D' where A, B, C and D are between 0 and 255, inclusive.
Description	Request dynamic IP allocation from the DHCP server. NOTE: Wi-Fi connection must be established before using this command.
Example	AT+WDHCP +WDHCP:"192.168.200.20","255.255.255.0","192.168.200.1" OK

6.12 AT+WIPADDR

Command	<u>SET</u> AT+WIPADDR="<IP>","<netmask>","<gateway>" <u>GET</u>
----------------	-----------------------------------------------------------------------

	AT+WIPADDR?
Response	<u>SET</u> OK <u>GET</u> +WIPADDR="<IP>","<netmask>","<gateway>" OK
Parameters	<IP>,<netmask>,<gateway> 'A.B.C.D' where A, B, C and D are between 0 and 255, inclusive.
Description	Configure the IP address, netmask and gateway.
Example	AT+WIPADDR="192.168.200.20","255.255.255.0","192.168.200.1" OK AT+WIPADDR? +WIPADDR="192.168.200.20","255.255.255.0","192.168.200.1" OK

6.13 AT+WSCAN

Command	<u>RUN</u> AT+WSCAN <u>SET</u> AT+WSCAN=[{+ -}]<freq>[,<freq> ...] <u>GET</u> AT+WSCAN?
Response	<u>RUN</u> +WSCAN:<bssid>,<freq>,<sig_level>,<flags>,<ssid> : OK <u>SET</u> OK <u>GET</u> +WSCAN:<freq>[,<freq> ...] OK
Parameters	<bssid> The BSSID of the AP. <freq>

	<p>The center frequency of the channel. (MHz)</p> <p><sig_level> The RSSI (Received Signal Strength Indicator) in dBm.</p> <p><flags> Service set flags.</p> <p><ssid> The SSID of the AP.</p>
Description	<p><u>RUN</u> Perform Wi-Fi scanning.</p> <p><u>SET/GET</u> Set the frequencies of the channel to scan or get a list of them.</p> <p>In the SET command, if the first frequency value has a '+' or '-' prefix, a new frequency is added or a specific frequency is excluded.</p> <p>"AT+WSCAN=0" command resets the scan frequency list to scan all supported channels.</p> <p>NOTE: The SET command cannot be used while connected to the AP and responds with ERROR.</p> <p>After "AT+WCOUNTRY" and "AT+WDISCONN" commands, the scan frequency list is reset to scan all supported channels.</p>
Example	<p>AT+WCOUNTRY="US" OK</p> <p>AT+WSCAN? +WSCAN:902.5,903.0,903.5,904.5,905.0,905.5,906.0,906.5,907.0,907.5 +WSCAN:908.5,909.5,910.5,911.5,912.5,913.5,914.5,915.5,916.5,917.5 +WSCAN:918.5,919.5,920.5,921.5,922.5,923.5,924.5,909.0,911.0,913.0 +WSCAN:915.0,917.0,919.0,921.0,923.0,925.0,910.0,914.0,918.0,922.0 +WSCAN:925.5,926.5,927.5,927.0,926.0 OK AT+WSCAN +WSCAN:"02:00:eb:13:d3:4a",922.5,-39,"[ESS]","halow_open" +WSCAN:"68:27:eb:0e:07:27",922.5,-30,"[WPA2-PSK-CCMP][ESS]","halow_wpa2"</p>

```
+WSCAN:"8c:0f:fa:00:28:1f",906.0,-54,"[WPA3-SAE-CCMP][ESS]","halow_sae"  
+WSCAN:"8c:0f:fa:00:29:46",921.0,-75,"[WPA3-SAE-CCMP][ESS]","halow_sae2"  
OK  
  
AT+WSCAN=922.5  
OK  
AT+WSCAN?  
+WSCAN:922.5  
OK  
AT+WSCAN  
+WSCAN:"02:00:eb:13:d3:4a",922.5,-39,"[ESS]","halow_open"  
+WSCAN:"68:27:eb:0e:07:27",922.5,-30,"[WPA2-PSK-CCMP][ESS]","halow_wpa2"  
OK  
  
AT+WSCAN=+906,921  
OK  
AT+WSCAN?  
+WSCAN:906.0,921.0,922.5  
OK  
AT+WSCAN  
+WSCAN:"02:00:eb:13:d3:4a",922.5,-39,"[ESS]","halow_open"  
+WSCAN:"68:27:eb:0e:07:27",922.5,-30,"[WPA2-PSK-CCMP][ESS]","halow_wpa2"  
+WSCAN:"8c:0f:fa:00:28:1f",906.0,-54,"[WPA3-SAE-CCMP][ESS]","halow_sae"  
+WSCAN:"8c:0f:fa:00:29:46",921.0,-75,"[WPA3-SAE-CCMP][ESS]","halow_sae2"  
OK  
  
AT+WSCAN=-921,922.5  
OK  
AT+WSCAN?  
+WSCAN:906.0  
OK  
AT+WSCAN  
+WSCAN:"8c:0f:fa:00:28:1f",906.0,-54,"[WPA3-SAE-CCMP][ESS]","halow_sae"  
OK  
  
AT+WSCAN=0  
OK
```



```
AT+WSCAN?
+WSCAN:902.5,903.0,903.5,904.5,905.0,905.5,906.0,906.5,907.0,907.5
+WSCAN:908.5,909.5,910.5,911.5,912.5,913.5,914.5,915.5,916.5,917.5
+WSCAN:918.5,919.5,920.5,921.5,922.5,923.5,924.5,909.0,911.0,913.0
+WSCAN:915.0,917.0,919.0,921.0,923.0,925.0,910.0,914.0,918.0,922.0
+WSCAN:925.5,926.5,927.5,927.0,926.0
OK

AT+WSCAN=922.5
OK
AT+WSCAN
+WSCAN:"02:00:eb:13:d3:4a",922.5,-39,"[ESS]","halow_open"
+WSCAN:"68:27:eb:0e:07:27",922.5,-30,"[WPA2-PSK-CCMP][ESS]","halow_wpa2"
OK
AT+WCONN="halow_open"
OK
AT+WSCAN?
+WSCAN=922.5
OK
AT+WSCAN=+906,921
ERROR

AT+WDISCONN
OK
AT+WSCAN?
+WSCAN:902.5,903.0,903.5,904.5,905.0,905.5,906.0,906.5,907.0,907.5
+WSCAN:908.5,909.5,910.5,911.5,912.5,913.5,914.5,915.5,916.5,917.5
+WSCAN:918.5,919.5,920.5,921.5,922.5,923.5,924.5,909.0,911.0,913.0
+WSCAN:915.0,917.0,919.0,921.0,923.0,925.0,910.0,914.0,918.0,922.0
+WSCAN:925.5,926.5,927.5,927.0,926.0
OK

AT+WCCOUNTRY="EU"
OK
AT+WSCAN?
+WSCAN:863.5,864.5,865.5,866.5,867.5,864.0,866.0
OK
```

6.14 AT+WCONN

Command	<u>SET</u> AT+WCONN=" <ssid> <bssid> "[, " <security> "[, " <password> "]] <u>GET</u> AT+WCONN?
Response	<u>SET</u> OK <u>GET</u> +WCONN=" <ssid> ", " <bssid> ", " <security> ", " <password> ", " <state> " OK
Parameters	<ssid> The SSID of the AP. <bssid> The BSSID of the AP. <security> open*, wpa2-psk (or psk), wpa3-owe (or owe), wpa3-sae (or sae) <password> (wpa2/wpa3-sae security option only) The password when wpa2/wpa3-sae security option is used. (length : 8 ~ 63) <state> State indicator: "connecting", "connected", "disconnecting" or "disconnected"
Description	Connect to a new AP or retrieves information about the current AP. NOTE: Before attempting to connect to the specified AP, the "AT+WSCAN" command should be executed to scan the APs. If the specified AP is not in the scan result list, this command will return an error. If an "ERROR" is returned with the error number INPROGRESS(2) or TIMEOUT(4), the AT-STA needs to be disconnected from the AP with the "AT+WDISCONN" command before a connection is attempted again with "AT+WCONN".
Example	OPEN : AT+WSCAN +WSCAN:"8c:0f:fa:00:2b:a1",922.0,-13,"[ESS]","halow_ap" OK AT+WCONN="halow_ap"

```
OK
AT+WCONN?
+WCONN:"halow_ap","8C:0F:FA:00:2B:A1","open","","connected"
OK

WPA2-PSK :
AT+WSCAN
+WSCAN:"8c:0f:fa:00:2b:a1",922.0,-14,"[WPA2-PSK-CCMP][ESS]","halow_ap"
OK
AT+WCONN="halow_ap","wpa2-psk","12345678"
OK
AT+WCONN?
+WCONN:"halow_ap","8C:0F:FA:00:2B:A1","wpa2-psk","12345678","connected"
OK

WPA3-OWE :
AT+WSCAN
+WSCAN:"8c:0f:fa:00:2b:a1",922.0,-13,"[WPA2-OWE-CCMP][ESS]","halow_ap"
OK
AT+WCONN="halow_ap","wpa3-owe"
OK
AT+WCONN?
+WCONN:"halow_ap","8C:0F:FA:00:2B:A1","wpa3-owe","","connected"
OK

WPA3-SAE :
AT+WSCAN
+WSCAN:"8c:0f:fa:00:2b:a1",922.0,-14,"[WPA2-SAE-CCMP][ESS]","halow_ap"
OK
AT+WCONN="halow_ap","wpa3-sae","12345678"
OK
AT+WCONN?
+WCONN:"halow_ap","8C:0F:FA:00:2B:A1","wpa3-sae","12345678","connected"
OK
```

6.15 AT+WDISCONN

Command	<u>RUN</u> AT+WDISCONN
Response	<u>RUN</u> OK
Description	Disconnect from the AP or abort an on-going connection process.
Example	AT+WDISCONN OK

6.16 AT+WPING

Command	<u>SET</u> AT+WPING=" <remote IP> "[, <time>]
Response	<u>SET</u> +WPING:<size>,"<remote IP>",<sequence number>,<TTL>,<elapsed time> +WPING:<size>,"<remote IP>",<sequence number>,<TTL>,<elapsed time> OK
Parameters	<p><remote IP> The remote IP of the recipient.</p> <p><time> Monitoring duration in seconds. (Default: 5)</p> <p><sequence number> ICMP sequence number.</p> <p><TTL> Time to leave (TTL).</p> <p><elapsed time> Time since the start of the session in seconds.</p>
Description	Initiate a ping session.
Example	AT+ PING ="192.168.200.1",10

	+PING:64,"192.168.200.1",1,64,11 +PING:64,"192.168.200.1",10,64,12 OK
--	--------------------------------------------------------------------------------------

6.17 AT+WROAM

Command	<u>SET</u> AT+WROAM=<scan_delay>,<rssi_threshold>,<rssi_level> AT+WROAM=0 <u>GET</u> AT+WROAM?
Response	<u>SET</u> OK <u>GET</u> +WROAM=<scan_delay>,<rssi_threshold>,<rssi_level> OK
Parameters	<u><scan_delay></u> Delay time between scan cycles that is executed to search for nearby APs. (msec) <u><rssi_threshold></u> Current AP's minimum RSSI to move to a new AP. (dBm, -100 ~ 0) <u><rssi_level></u> The minimum signal strength of a new AP to leave the current AP. (dBm, 1 ~ 100)
Description	<p>Enable or disable Wi-Fi roaming.</p> <p>Wi-Fi roaming can be enabled after connecting to the AP with AT+WCONN command and disabled with AT+WROAM=0 command.</p> <p>All APs that is scanned and connected for Wi-Fi roaming have the same SSID and security settings.</p> <p>Conditions for leaving current AP and moving to new AP.</p> <ol style="list-style-type: none"> 1. Current AP's RSSI <= rssi_threshold 2. (New AP's RSSI - Current AP's RSSI) >= rssi_level <p>If it is disconnected from the current AP or the current AP is not scanned, it is connected to a new AP with the highest RSSI value among the scanned APs.</p> <p>When moving to a new AP during the roaming process, the following events occur sequentially.</p> <ol style="list-style-type: none"> 1. +WEVENT:"DISOCNNECT","<bssid>","<ssid>","<security>"

	<p>2. +WEVENT:"CONNECT_SUCCESS", "<bssid>", "<ssid>", "<security>"</p> <p>At this time, the TCP connection may be disconnected and the TCP socket may be closed.</p>
Example	<pre> AT+WSCAN +WSCAN:"02:00:eb:3a:a3:b4",922.5,-43,"[WPA2-PSK-CCMP][ESS]","wifi_roaming" +WSCAN:"02:00:eb:ee:9a:87",918.5,-35,"[WPA2-PSK-CCMP][ESS]","wifi_roaming" +WSCAN:"02:00:48:32:58:42",920.5,-59,"[WPA2-PSK-CCMP][ESS]","wifi_roaming" OK AT+WCONN="wifi_roaming","wpa2-psk","12345678" OK AT+WCONN? +WCONN:"wifi_roaming","02:00:eb:ee:9a:87","wpa2-psk","12345678","connected" OK AT+WROAM=10000,-30,10 OK AT+WROAM? +WROAM:10000,-30,10 OK +WEVENT:"DISCONNECT","02:00:eb:ee:9a:87","wifi_roaming","wpa2-psk" +WEVENT:"CONNECT_SUCCESS","02:00:48:32:58:42","wifi_roaming","wpa2-psk" +WEVENT:"DISCONNECT","02:00:48:32:58:42","wifi_roaming","wpa2-psk" +WEVENT:"CONNECT_SUCCESS","02:00:eb:3a:a3:b4","wifi_roaming","wpa2-psk" AT+WROAM=0 OK </pre>

6.18 AT+WFOTA

Command	<p><u>SET</u> AT+WFOTA=<check_time>[,\"<server_url>\"[,\"<bin_name>\",<bin_crc32>]]</p> <p><u>GET</u> AT+WFOTA?</p> <p><u>RUN</u> AT+WFOTA</p>
----------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Response	<p><u>SET</u> OK</p> <p><u>GET</u> +WFOTA:<check_time>,"<server_url>","<bin_name>",<bin_crc32> OK</p> <p><u>RUN</u> OK</p>
Parameters	<p><check_time> Interval time in seconds to get new firmware information from the server. Set to 0 to stop the getting or get manually. Set to -1 to disable FOTA operation.</p> <p><server_url> HTTP or HTTPS Server URL</p> <p><bin_name> Firmware binary name with extension .bin.</p> <p><bin_crc32> 32bit CRC value to detect data corruption of downloaded firmware. A hexadecimal number prefixed with 0x.</p>
Description	<p>FOTA(Firmware Over-the-Air) is enabled with the SET command and disabled by AT+WFOTA=-1 command.</p> <p>When FOTA is enabled, the current firmware starts checking for new firmware on the server. The server check interval can be controlled through the <check_time> parameter.</p> <p>To check for new firmware, the current firmware downloads the fota.json file from the server. The server should have a fota.json file as well as firmware binary. The contents of the fota.json file are as follows.</p> <pre> 1 { 2 "AT_SDK_VER" : "10.10.10", 3 "AT_CMD_VER" : "10.10.10", 4 5 "AT_HSPI_BIN" : "nrc7292_standalone_xip_ATCMD_HSPI.bin", 6 "AT_HSPI_CRC" : "750243d8", 7 8 "AT_UART_BIN" : "nrc7292_standalone_xip_ATCMD_UART.bin", 9 "AT_UART_CRC" : "793066ec", 10 11 "AT_UART_HFC_BIN" : "nrc7292_standalone_xip_ATCMD_UART_HFC.bin", 12 "AT_UART_HFC_CRC" : "8f564369" 13 }</pre> <p>If new firmware has a higher version, the current firmware sends a FOTA_VERSION event to the terminal or host.</p> <p>+WEVENT:"FOTA_VERSION","<sdk_version>","<atcmd_version>"</p>

After receiving the FOTA_VERSION event, the terminal or host can use the RUN command to download new firmware from the server.

If there is no fota.json file on the server, the firmware information to be downloaded can be set with the bin_name and bin_crc32 parameters. And the terminal or host can use the RUN command without receiving the FOTA_VERSION event.

The terminal or host can check the download process through FOTA_BINARY and FOTA_DOWNLOAD events from the current firmware.

+WEVENT: "FOTA_BINARY", "<binary_name>"

+WEVENT: "FOTA_DOWNLOAD", "<total_size>,<download_size>"

When the download is complete and ready to update, the terminal or host will receive a FOTA_UPDATE event from the current firmware.

+WEVENT: "FOTA_UPDATE"

If an error occurs during the above process, the terminal or host will receive a FOTA_FAIL event from the current firmware.

+WEVENT: "FOTA_FAIL"

And FOTA will be automatically disabled.

If there are no errors, the current firmware will be replaced with the new firmware after a software reset. A software reset is possible with the ATZ command.

Firmware replacement will take about 10 seconds or more.

If an error occurs while accessing the flash memory for firmware replacement, the current firmware cannot be restored. If the error still occurs after a hardware reset, the firmware can only be restored through the download tool.

EVENT:

Name	Description
FOTA_VERSION	The version of new firmware on the server. - User SDK version - AT Command Set version
FOTA_BINARY	The binary name of new firmware to download from the server.
FOTA_DOWNLOAD	The binary size of new firmware being downloaded from the server. - Total size - Downloaded size
FOTA_UPDATE	The current firmware is ready to be replaced with the new firmware.
FOTA_FAIL	An error occurred during the FOTA process.

TEST:

The AT+WFOTA command can be tested using the python-http-server package in the SDK.

Path : sdk/apps/atcmd/host/python-http-server

This package has the shell and python scripts to run HTTP/HTTPS server.

```
python-http-server/
├── fota.json
├── nrc7292_standalone_xip_ATCMD_HSPI.bin
├── nrc7292_standalone_xip_ATCMD_UART.bin
├── nrc7292_standalone_xip_ATCMD_UART_HFC.bin
├── python
│   ├── crc.py
│   └── https-server.py
├── Run-server.sh
├── ssl-cert
│   ├── server.crt
│   ├── server.csr
│   ├── server.key
│   └── server.key.origin
└── Update-fota-info.sh
```

Shell Script	Description
Run-sever.sh	Run HTTP or HTTPS server. Usage: \$./Run-server.sh http \$./Run-server.sh https
Update-fota-info.sh	Calculate the CRC value of firmware binaries and update the fota.json file. Usage: \$./Update-fota-info.sh [options] Firmware version and binary name can be set by editing this file. <pre>6 SDK_VER="10.10.10" 7 CMD_VER="10.10.10" 8 9 HSPI_BIN="nrc7292_standalone_xip_ATCMD_HSPI.bin" 10 UART_BIN="nrc7292_standalone_xip_ATCMD_UART.bin" 11 UART_HFC_BIN="nrc7292_standalone_xip_ATCMD_UART_HFC.bin"</pre> Alternatively, it can be set as options when executing the script. Available options can be checked with the -h or --help option. Values set as options overwrite values set in the file. If a binary is replaced with a new one, the fota.json should be updated by Update-fota-info.sh.

Example

AT+WFOTA?
+WFOTA:0,"","","0x0

OK

< Get new firmware information from fota.json file >

AT+WFOTA=10,"https://192.168.200.1:4443"

AT+WFOTA=10,"https://192.168.200.1:4443"

OK

AT+WFOTA?

+WFOTA:10,"https://192.168.200.1:4443","",0x0

OK

+WEVENT:"FOTA_VERSION","10.10.10","10.10.10"

+WEVENT:"FOTA_VERSION","10.10.10","10.10.10"

+WEVENT:"FOTA_VERSION","10.10.10","10.10.10"

*Stop the getting to switch manually.

AT+WFOTA=0

OK

AT+WFOTA=0

OK

+WEVENT:"FOTA_VERSION","10.10.10","10.10.10"

< Set new firmware information without fota.json file >

AT+WFOTA=0,"https://192.168.200.1:4443","nrc7292_atcmd_hspi.bin",0x3e47cf92

OK

AT+WFOTA?

+WEVENT:0,"https://192.168.200.1:4443","nrc7292_atcmd_hspi.bin",0x3E47CF92

OK

< Download the firmware binary >

AT+WFOTA

OK

+WEVENT:"FOTA_BINARY","nrc7292_atcmd_hspi.bin"

+WEVENT:"FOTA_DOWNLOAD",897632,90112

+WEVENT:"FOTA_DOWNLOAD",897632,180224

+WEVENT:"FOTA_DOWNLOAD",897632,270336

:

+WEVENT:"FOTA_DOWNLOAD",897632,720896

+WEVENT:"FOTA_DOWNLOAD",897632,811008

	+WEVENT:"FOTA_DOWNLOAD",897632,897632 +WEVENT:"FOTA_UPDATE" < Reset and update > ATZ
--	----------------------------------------------------------------------------------------------------------------

6.19 AT+WSLEEP

Command	<u>SET</u> AT+WSLEEP=<mode>[,<timeout> <gpio> <timeout>[,<gpio>]] <u>GET</u> AT+WSLEEP? NOTE: GET command can only be used in active mode and modem sleep mode.
Response	<u>SET</u> OK <u>GET</u> +WSLEEP:<mode>,<timeout>
Parameters	<mode> 0 : active 1 : modem sleep 2 : deep sleep (TIM) 3 : deep sleep (Non-TIM) <timeout> Time in milliseconds. <gpio> GPIO number to use as external signal input. Available GPIO numbers are between 8 and 17.
Description	Configure sleep mode to save power. < Modem Sleep >

	<p>Modem sleep mode only powers off the modem.</p> <p>If there are frames to receive or send, power is applied to the modem until there are no frames. The maximum power time is set with the timeout parameter of the SET command. When this time expires, the modem powers off.</p> <p>Modem sleep mode can be disabled by setting the mode parameter of the SET command to 0. The GET command returns whether modem sleep mode is enabled and the maximum power time.</p> <p>< Deep Sleep ></p> <p>Deep sleep mode powers off most peripherals to use minimal power. The RTC and retention RAM are always powered. The CPU is powered only in TIM mode to run the uCode stored in the retention RAM. And the GPIO may be powered for external signal input.</p> <p>In TIM mode, the NRC7292 wakes up when there are frames to receive. However, in Non-TIM mode, it cannot be woken up until a timeout.</p> <p>If there are frames to send, the NRC7292 can only be woken up via the GPIO input. The GPIO input level should be low in active mode. If it is high in deep sleep mode, the NRC7292 wakes up.</p> <p>After waking up, the CPU resets and the firmware reboots. When the firmware reboot is finished, the host application or terminal program will receive a "DEEPSLEEP_WAKEUP" event message.</p>
Example	<p>< Modem Sleep ></p> <pre> AT+WCONN="halow_ap","wpa2-psk","12345678" OK AT+WDHCP +WDHCP:"192.168.200.18","255.255.255.0","192.168.200.1" OK AT+WSLEEP? +WSLEEP:0,0 OK AT+WSLEEP=1,3000 OK AT+WSLEEP? +WSLEEP:1,3000 OK AT+WPING="192.168.200.1",2 +WEVENT:"PING",64,"192.168.200.1",1,64,6 </pre>

```
+WEVENT:"PING",64,"192.168.200.1",2,64,4
OK
AT+WSLEEP=0
OK
AT+WSLEEP?
+WSLEEP:0,3000
OK

< Deep Sleep, TIM mode >
AT+WCONN="halow_ap","wpa2-psk","12345678"
OK
AT+WDHCP
+WDHCP:"192.168.200.18","255.255.255.0","192.168.200.1"
OK
AT+WSLEEP=2,11
OK

+WEVENT:"DEEPSLEEP_WAKEUP"

AT+WCONN="halow_ap","wpa2-psk","12345678"
OK
AT+WDHCP
+WDHCP:"192.168.200.18","255.255.255.0","192.168.200.1"
OK
AT+WPING="192.168.200.1",2
+WEVENT:"PING",64,"192.168.200.1",1,64,5
+WEVENT:"PING",64,"192.168.200.1",2,64,4
OK

< Modem Sleep, Non-TIM mode >
AT+WCONN="halow_ap","wpa2-psk","12345678"
OK
AT+WDHCP
+WDHCP:"192.168.200.18","255.255.255.0","192.168.200.1"
OK
AT+WSLEEP=3,5000,11
OK
```

	<pre> +WEVENT:"DEEPSLEEP_WAKEUP" AT+WCONN="halow_ap","wpa2-psk","12345678" OK AT+WDHCP +WDHCP:"192.168.200.18","255.255.255.0","192.168.200.1" OK AT+WPING="192.168.200.1",2 +WEVENT:"PING",64,"192.168.200.1",1,64,6 +WEVENT:"PING",64,"192.168.200.1",2,64,4 OK </pre>
--	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

6.20 AT+WSOFTAP

Command	<p><u>SET</u> AT+WSOFTAP=<frequency>,"<ssid>"[, "<security>"[, "<password>"]]</p> <p><u>GET</u> AT+WSOFTAP?</p>
Response	<p><u>SET</u> OK</p> <p><u>GET</u> +WSOFTAP=<frequency>,"<ssid>","<security>","<password>"[, "dhcp"] OK</p>
Parameters	<p><frequency> S1G channel frequency (MHz)</p> <p><ssid> The SSID of the AP.</p> <p><security> open*, wpa2-psk (or psk)</p> <p><password> (wpa2 security option only) The password when wpa2 security option is used. (length : 8 ~ 63)</p> <p><dhcp> Only included when the DHCP server is running.</p>

Description	<p>Run as the AP mode or retrieves information about the current settings.</p> <p>NOTE:</p> <p>The system should be reset to exit the AP mode.</p> <p>Software Reset is possible with the ATZ command.</p>
Example	<pre>AT+WSOFTAP=918.5,"halow_softap","wpa2-psk","12345678" OK AT+WIPADDR="192.168.1.1","255.255.255.0","192.168.1.1" OK AT+WDHCPS +WDHCPS:"192.168.1.1","255.255.255.0","192.168.1.1" OK AT+WSOFTAP? +WSOFTAP:918.5,"halow_softap","wpa2-psk","12345678","dhcp" OK</pre>

6.21 AT+WBSSMAXIDLE

Command	<p><u>SET</u></p> <p>AT+WBSSMAXIDLE=<period>[,<retry>]</p> <p><u>GET</u></p> <p>AT+WBSSMAXIDLE?</p>
Response	<p><u>SET</u></p> <p>OK</p> <p><u>GET</u></p> <p>+WBSSMAXIDLE:<period>,<retry></p> <p>OK</p>
Parameters	<p><period></p> <p>BSS Max idle period (time unit: sec, default: 60)</p> <p><retry></p> <p>retry count for receiving keep alive packet from STA (1~100, default: 3)</p>
Description	Configure the BSS Max idle service for SoftAP.
Example	<pre>AT+WSOFTAP=918.5,"halow_softap_wpa2","wpa2-psk","12345678" OK</pre>

	AT+WDHCPS +WDHCPS:"192.168.50.1","255.255.255.0","192.168.50.1" OK AT+WBSSMAXIDLE? +WBSSMAXIDLE:60,3 OK AT+WBSSMAXIDLE=120,5 OK AT+WBSSMAXIDLE? +WBSSMAXIDLE:120,5 OK
--	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

6.22 AT+WSTAINFO

Command	<u>SET</u> AT+WSTAINFO=<aid> <u>GET</u> AT+WSTAINFO?
Response	+WSTAINFO=<aid>,"<mac_address>",<rssi>,<snr>,<mcs_index> OK
Parameters	<p><aid> Association ID</p> <p><mac_address> Hardware address of associated station</p> <p><rssi> Received Signal Strength indication</p> <p><snr> Signal to Noise Ratio</p> <p><mcs_index> Modulation Coding Scheme index</p>
Description	Get information of associated STAs <u>when the device is in AP mode.</u>

Example	<pre> AT+WSOFTAP=918.5,"halow_softap","wpa2-psk","12345678" OK AT+WIPADDR="192.168.1.1","255.255.255.0","192.168.1.1" OK AT+WDHCPS +WDHCPS:"192.168.1.1","255.255.255.0","192.168.1.1" OK Wait for one or more stations to be associated ... AT+WSTAINFO? +WSTAINFO:1,"8c:0f:fa:00:2b:a1",-34,31,7 +WSTAINFO:2,"8c:0f:fa:00:2b:a2",-45,34,7 +WSTAINFO:3,"8c:0f:fa:00:2b:a3",-16,21,7 OK AT+WSTAINFO=1 +WSTAINFO:1,"8c:0f:fa:00:2b:a1",-33,34,7 OK </pre>
----------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

6.23 AT+WDHCPS

Command	<u>RUN</u> AT+WDHCPS
Response	<u>RUN</u> +WDHCPS:"<IP>","netmask>","<gateway>" OK
Parameters	<IP>, <netmask> and <gateway> 'A.B.C.D' where A, B, C and D are between 0 and 255, inclusive.
Description	Run the DHCP sever in SoftAP mode. NOTE: SoftAP must be established before using this command. Refer to chapter 6.15. (AT+WSOFTAP)
Example	<pre> AT+WDHCPS +WDHCPS:"192.168.50.1","255.255.255.0","192.168.50.1" OK </pre>

6.24 AT+WTIMEOUT

Command	<u>SET</u> AT+WTIMEOUT="<command>",<timeout> <u>GET</u> AT+WTIMEOUT?	
Response	<u>SET</u> OK <u>GET</u> +WTIMEOUT:"<command>",<timeout> OK	
Parameters	<command> "WSCAN", "WCONN", "WDISCONN", "WDHCP" <timeout> Timeout in seconds. (0: no timeout, default: WDHCP=60, others=0)	
Description	Configure the response timeout for the specified command. A timeout event will trigger a Wi-Fi event notification "+WEVENT".	
Example	AT+WTIMEOUT="WCONN",30 OK	AT+WTIMEOUT? +WTIMEOUT:"WSCAN",0 +WTIMEOUT:"WCONN",30 +WTIMEOUT:"WDISCONN",0 OK

6.25 +WEVENT

Response	+WEVENT:<event>
Parameters	<event> "CONNECT_SUCCESS", "<bssid>",<ssid>",<security>" "CONNECT_FAIL", "<bssid>",<ssid>",<security>" "DISCONNECT", "<bssid>",<ssid>",<security>" "FOTA_VERSION", "<sdk_version>",<atcmd_version>" "FOTA_BINARY", "<binary_name>" "FOTA_DOWNLOAD", "total_size", "download_size" "FOTA_UPDATE" "FOTA_FAIL" "DEEPSLEEP_WAKEUP"

Description	Asynchronously raised Wi-Fi event logs.
Example	<pre>+WEVENT:"CONNECT_SUCCESS","8c:0f:fa:00:2b:a1","halow_sae","wpa3-sae" +WEVENT:"CONNECT_FAIL","8c:0f:fa:00:2b:a1","halow_sae","wpa3-sae" +WEVENT:"DISCONNECT","8c:0f:fa:00:2b:a1","halow_sae","wpa3-sae" +WEVENT:"FOTA_VERSION","10.10.10","10.10.10" +WEVENT:"FOTA_BINARY","nrc7292_atcmd_hspi.bin" +WEVENT:"FOTA_DOWNLOAD",897632,90112 +WEVENT:"FOTA_UPDATE" +WEVENT:"FOTA_FAIL" +WEVENT:"DEEPSLEEP_WAKEUP"</pre>

7 Socket AT Commands

Commands	Description
AT+SOPEN	Create a TCP/UDP socket.
AT+SCLOSE	Close an existing socket.
AT+SLIST	List all currently open sockets.
AT+SRXLOGLEVEL	Configure the received packet event log level for +RXD.
AT+SSEND	Send data through a socket.
AT+STIMEOUT	Configure the response timeout for the specified socket command.
+SEVENT	Asynchronously raised socket event logs.
+RXD	An event log for a received packet with payload.

7.1 AT+SOPEN

Command	<u>SET</u> AT+SOPEN="udp",<local_port> AT+SOPEN="tcp",<local_port> AT+SOPEN="tcp","<remote IP>",<remote port>
Response	<u>SET</u> +SOPEN=<socket ID> OK
Parameters	<local_port> (UDP) Optional argument to specify the outgoing local port. <local_port> (TCP Server) Local port to listen on. <remote IP>,<remote port> (TCP Client) The remote IP and remote port of the server.
Description	Create a TCP/UDP socket. For TCP, the server socket will listen on the given port in the background and asynchronously raise the event CONNECT to notify incoming connections.
Example	AT+ SOPEN ="TCP","192.168.100.109",8088 +SOPEN=0 OK AT+ SOPEN ="TCP",8088 +SOPEN=1 OK +SEVENT: "CONNECT",2 AT+ SOPEN ="UDP",8088 +SOPEN=3 OK

7.2 AT+SCLOSE

Command	<u>SET</u> AT+SCLOSE=<socket ID> <u>RUN</u> AT+SCLOSE
Response	<u>SET</u> +SCLOSE:<socket ID> OK <u>RUN</u> +SCLOSE:<socket ID> : +SCLOSE:<socket ID> OK
Parameters	<socket ID> The ID allocated to the socket.
Description	Close an existing socket. To close all existing sockets, run a command without the parameter <socket ID>. If a server socket is closed, all client sockets connected to the server socket will close automatically.
Example	AT+SCLOSE=1 +SCLOSE:1 OK AT+SCLOSE +SCLOSE:0 : +SCLOSE:3 OK

7.3 AT+SLIST

Command	<u>GET</u> AT+SLIST?
Response	<u>GET</u> +SLIST:<socket ID>,"<tcp-udp>","<remote IP>",<remote port>,<local port> : +SLIST:<socket ID>,"<tcp-udp>","<remote IP>",<remote port>,<local port> OK

Parameters	<p><socket ID> The ID allocated to the socket.</p> <p><tcp-udp> TCP, UDP</p> <p><remote IP>,<remote port>,<local port> The remote IP, remote port and local port associated with the socket.</p>
Description	List all currently open sockets.
Example	<p>AT+SLIST?</p> <p>+SLIST:1,"UDP","0.0.0.0",0,8088</p> <p>+SLIST:3,"TCP", "192.168.100.109",8089,6000</p> <p>OK</p>

7.4 AT+SRXLOGLEVEL

Command	<p><u>SET</u> AT+SRXLOGLEVEL=<mode></p> <p><u>GET</u> AT+SRXLOGLEVEL?</p>						
Response	<p><u>SET</u> +SRXLOGLEVEL:<mode></p> <p>OK</p> <p><u>GET</u> OK</p>						
Parameters	<p><mode> 0 (terse)*, 1 (verbose)</p>						
Description	Configure the received packet event log level for +RXD.						
Example	<table border="0"> <tr> <td>AT+SRXLOGLEVEL =1</td> <td>AT+SRXLOGLEVEL?</td> </tr> <tr> <td>OK</td> <td>+ SRXLOGLEVEL:1</td> </tr> <tr> <td></td> <td>OK</td> </tr> </table>	AT+SRXLOGLEVEL =1	AT+SRXLOGLEVEL?	OK	+ SRXLOGLEVEL:1		OK
AT+SRXLOGLEVEL =1	AT+SRXLOGLEVEL?						
OK	+ SRXLOGLEVEL:1						
	OK						

7.5 AT+SSEND

Command	<p><u>SET</u> AT+SSEND =<socket ID>[,<length>]</p>
----------------	---------------------------------------------------------------------------

	AT+SSEND =<socket ID>,"<remote IP>", <remote port>[,<length>]
Response	<u>SET</u> OK
Parameters	<p><socket ID> The ID allocated to the socket.</p> <p><remote IP>,<remote port> (UDP only) The IP and port of the remote UDP server.</p> <p><length> The (signed) number of raw bytes to send. (See the description)</p>
Description	<p>Send data through a socket.</p> <p>In synchronous send mode, the value of the <length> parameter must be positive, and its maximum value is 2048. The payload byte sequence of <length> bytes must be directly followed by "AT+SSEND=<socket ID>,<length>\r\n". The payload byte sequence does not have to be followed by "\r" or "\n" and the next payload byte sequence can be sent again after receiving the "OK\r\n" response code from the firmware.</p> <p>In normal passthrough send mode, the value of the <length> parameter must be 0, so that the command takes the form "AT+SSEND=<socket ID>,0\r\n". As soon as the firmware receives the command, the firmware enters the active passthrough state; all bytes fed into the AT stream is redirected to the associated socket stream. To exit the passthrough state, no byte should be fed into the AT stream for the duration of SSEND timeout duration in seconds (default: 1 second) to transition the active passthrough state to the idle passthrough state. The transition is notified by the +SEVENT:"SEND_IDLE" event. Upon receiving the idle event notification, the four magic bytes "AT\r\n" should be fed into the AT stream to exit the passthrough state. The magic bytes themselves will not be regarded as part of the payload as long as they are fed into the AT stream following the idle event notification, but if the characters following the idle event notification are different from the magic bytes, the fed bytes will indeed be regarded as part of the payload. The +SEVENT:"SEND_EXIT" event is raised upon exiting the passthrough mode.</p> <p>In buffered passthrough send mode, the value of the <length> parameter must be positive, and its maximum value is 2048. The command takes the form "AT+SSEND=<socket ID>,-<length>\r\n", with the "-" sign preceding the <length> parameter. The buffered passthrough mode operates similarly to the normal passthrough mode. However, unlike the normal passthrough mode, the firmware</p>

	<p>maintains an internal byte buffer of size <length> and transfers the buffered byte onto the send queue only when the byte buffer is full. However, using this mode still does not guarantee that the receiver will always receive the payload in <length> bytes without fragmentation, as other factors such as the MTU size limit and other implementation-dependent features may affect the payload transfer process differently.</p>
Example	<p>[Normal Mode] AT+SSEND=0,6 OK Hello!</p> <p>[Normal passthrough mode] AT+SSEND=0,0 Hello, World! Goodbye, World!</p> <p>[Wait for SSEND timeout duration to change the internal state to receive magic bytes and exit the continuous transmission state]</p> <p>+SEVENT:"SEND_IDLE",0,23,0,5 AT OK +SEVENT:"SEND_EXIT",0,28,0</p> <p>[Buffered passthrough Mode] AT+SSEND=0,-8 TEST0001 (<- Without \r\n) TEST0002 (<- Without \r\n) TEST0003 (<- Without \r\n)</p>

7.6 AT+STIMEOUT

Command	<p><u>SET</u> AT+STIMEOUT="<command>",<timeout></p> <p><u>GET</u> AT+STIMEOUT?</p>
Response	<p><u>SET</u> OK</p> <p><u>GET</u> +STIMEOUT:"<command>",<timeout></p>

	OK	
Parameters	<command> "SOPEN", "SSEND" <timeout> Timeout in seconds. (default: [SOPEN=30, SSEND=1], disable: 0)	
Description	Configure the response timeout for the specified socket command. A timeout event will trigger a socket event notification "+SEVENT".	
Example	AT+STIMEOUT="SOPEN",60 OK	AT+STIMEOUT? +STIMEOUT:"SOPEN",60 +STIMEOUT:"SSEND",1 OK

7.7 +SEVENT

Response	+SEVENT:<event>,<socket ID>[,<parameter 1>,...,<parameter N>]
Parameters	<event> "CONNECT",<socket ID> "CLOSE",<socket ID> "SEND_IDLE",<socket ID>,<done>,<drop>,<wait> "SEND_DROP",<socket ID>,<drop> "SEND_EXIT",<socket ID>,<done>,<drop> "SEND_ERROR",<socket ID>,<error> "RECV_ERROR",<socket ID>,<error> <socket ID> Socket ID <done> The length of the sent payload. <drop> The length of the dropped payload. <wait> The length of the buffered payload. <error>

	POSIX error code.		
	If the SEND_ERROR and RECV_ERROR events occur due to the following errors, the corresponding socket is closed by the firmware.		
	Event Name	Error Value	Description
	SEND_ERROR	-107	Transport endpoint is not connected. (ENOTCONN)
		-104	Connection reset by peer. (ECONNRESET)
	RECV_ERROR	-107	Transport endpoint is not connected. (ENOTCONN)
		-111	Connection refused. (ECONNREFUSED)
Description	Asynchronously raised socket event logs.		
Example	+SEVENT:"CONNECT",1 +SEVENT:"CLOSE",1 +SEVENT:"SEND_IDLE",1,1500,152,200 +SEVENT:"SEND_DROP",1,152 +SEVENT:"SEND_EXIT",1,1700,152 +SEVENT:"SEND_ERROR",1,-103 +SEVENT:"RECV_ERROR",1,-107		

7.8+RXD

Response	<u>RX mode (Terse)</u> +RXD:<socket ID>,<actual read length>,<raw bytes> <u>RX mode (Verbose)</u> +RXD:<socket ID>,<actual read length>,"<remote IP>",<remote port>,<raw bytes>
Parameters	<socket ID> The ID allocated to the socket. <max read length> The maximum number of bytes to read. (Max: 2048) <actual read length> Actual number of bytes read. <remote IP>,<remote port> The remote IP and port.

	<raw bytes> The received raw bytes (0x00~0xFF) payload.
Description	An event log for a received packet with payload. Upon receiving packets, +RXD event logs will automatically appear on the terminal output. Note that there will be no 'OK' message following the event log.
Example	<u>RX mode (Terse)</u> +RXD=0,15,ABCDE12345,.?+=+ <u>RX mode (Verbose)</u> +RXD=0,12,"192.168.200.1",5025,HELLO,WORLD!

8 Test Application

8.1 Command Line Interface (raspi-atcmd-cli)

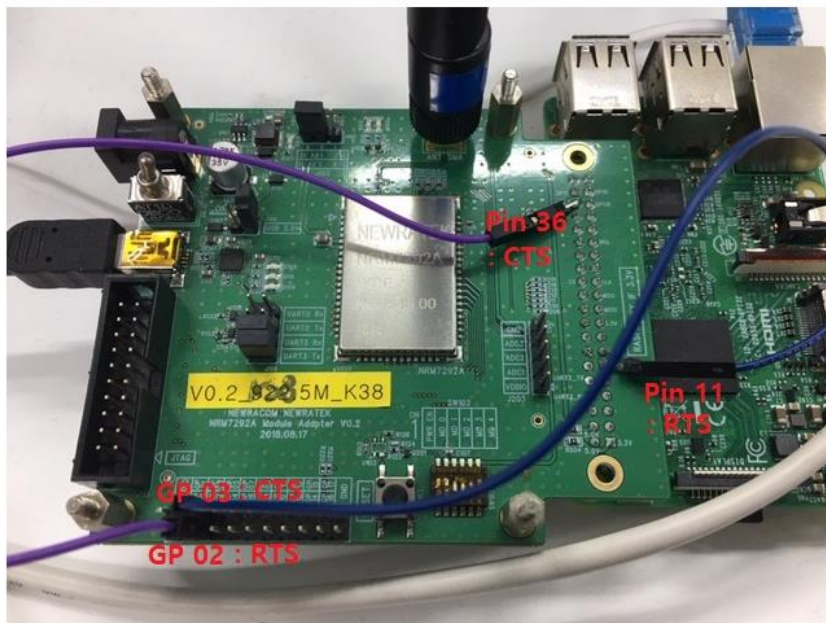
CLI application is a Linux program running on Raspberry Pi for AT-command communication via UART or SPI. In the CLI application, as in terminal program via UART, the user can enter the AT command and check the response to the command.

The NRM7292 EVB can use the Raspberry Pi as a host. The Raspberry Pi board is connected to the NRM7292 EVB through a 40-pin header. The 40-pin header has signals for UART and SPI.



Figure 8.1 Pin map of 40-pin header for Raspberry Pi

The NRM7292 EVB and Raspberry Pi board is connected as shown in the Figure 8.2. Both PIN11_UART0_RTS and PIN36_UART0_CTS used for hardware flow control on the UART needs to be directly connected to a 20-pin header in the NRM7292 EVB by a jumper wire.



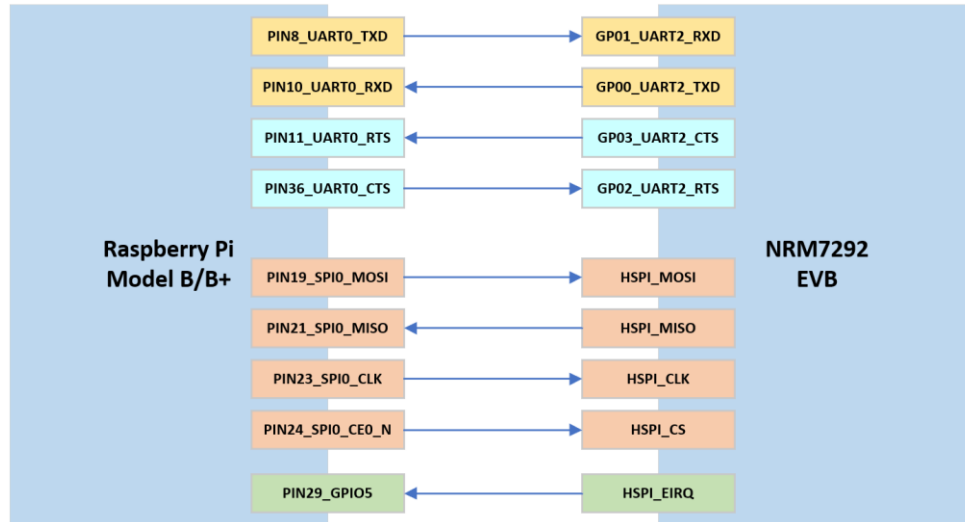


Figure 8.2 Connection between NRM7292 EVB and Raspberry Pi

1) Source files

```

├── common.h
├── main.c
├── Makefile
├── nrc-atcmd.c
├── nrc-atcmd.h
├── nrc-hspi.c
├── nrc-hspi.h
├── nrc-iperf.c
├── nrc-iperf.h
├── raspi-hif.c
├── raspi-hif.h
├── raspi-spi.c
├── raspi-uart.c
├── scripts
│   ├── examples
│   └── test-case

```

File	Description
common.h	Common header file
main.c	CLI related functions.
Makefile	Make file for building.
nrc-atcmd.c nrc-atcmd.h	AT command handler
nrc-hspi.c	Protocol driver for HSPI.

nrc-hspi.h	*Refer to this file to communicate with the ATCMD firmware via SPI from the host.
nrc-iperf.c nrc-iperf.h	lperf server/client
raspi-hif.c raspi-hif.h	Wrapper for user mode driver.
raspi-spi.c	User mode driver for SPI.
raspi-uart.c	User mode driver for UART.
scripts/	Script files

Table 8.1 raspi-atcmd-cli source files

2) Build

Copy all source files from standalone/sdk/apps/atcmd/host to the Raspberry Pi's home directory. And build the CLI application with the make command.

```
$ cd $HOME
$ cd host/raspi-atcmd-cli
$ make [clean]
```

```
pi@raspberrypi:~/raspi-atcmd-cli $ make clean
removed 'raspi-atcmd-cli'
pi@raspberrypi:~/raspi-atcmd-cli $ make
cc -g -o raspi-atcmd-cli raspi-spi.c raspi-uart.c raspi-hif.c nrc-hspi.c nrc-atcmd.c
nrc-iperf.c main.c -pthread -Wall -Wno-unused-function -lpthread
```

3) Run

A. It needs be executed on Raspberry Pi3 or Host which can use AT command through UART or SPI

Run the CLI application using a raspi-atcmd-cli file. And enter the AT command as in Terminal program.

● Help

```
$ ./raspi-atcmd-cli [-h|--help]
```

```
pi@raspberrypi:~/raspi-atcmd-cli $ ./raspi-atcmd-cli -h
raspi-atcmd-cli version 1.2.0
Copyright (c) 2019-2020 <NEWRACOM LTD>

Usage:
$ ./raspi-atcmd-cli -U [-H] [-D <device>] [-b <baudrate>] [-d] [-f] [-s <script>]
$ ./raspi-atcmd-cli -S [-H] [-D <device>] [-c <clock>] [-s <script>]

UART/SPI:
-D, --device #      specify the device. (default: /dev/ttyAMA0, /dev/spidev0.0)
-s, --script #      specify the script file.

UART:
-U --uart           use the UART to communicate with the target.
-b, --baudrate #    specify the baudrate for the UART. (default: 38,400 bps)
-f --flowctrl       enable RTS/CTS signals for the hardware flow control on the UART. (default: disable)

SPI:
-S --spi           use the SPI to communicate with the target.
-c, --clock #       specify the clock frequency for the SPI. (default: 16,000,000 Hz)

Miscellaneous:
-v, --version       print version information and quit.
-h, --help          print this message and quit.
```


- **SPI**

A clock of the SPI master is up to 20MHz. The clock default setting is 16 MHz.

\$ sudo ./raspi-atcmd-cli -S [-c <clock>]

```
pi@raspberrypi:~/raspi-atcmd-cli $ sudo ./raspi-atcmd-cli -S -c 16000000
[ SPI ]
- device: /dev/spidev0.0
- clock: 16000000 Hz
#
```

- **UART**

A default setting for baud rate is 115200bps without the hardware flow control.

\$ sudo ./raspi-atcmd-cli -U [-b <baudrate>]

```
pi@raspberrypi:~/raspi-atcmd-cli $ sudo ./raspi-atcmd-cli -U -b 115200
[ UART ]
- device: /dev/ttyAMA0
- baudrate : 115200
#
```

If the baud rate setting is more than 115200bps, the hardware flow control needs to be enabled on the UART.

\$ sudo ./raspi-atcmd-cli -U -f [-b <baudrate>]

```
pi@raspberrypi:~/raspi-atcmd-cli $ sudo ./raspi-atcmd-cli -U -f -b 2000000
[ UART_HFC ]
- device: /dev/ttyAMA0
- baudrate : 2000000
#
```

- Log

Getting the informations.

```
pi@raspberrypi:~/raspi-atcmd-cli $ sudo ./raspi-atcmd-cli -S

[ SPI ]
- device: /dev/spidev0.0
- clock: 16000000 Hz

# AT
SEND: AT
RECV: OK

# AT+VER?
SEND: AT+VER?
RECV: +VER:"1.3.2","1.18.3"
RECV: OK

# AT+WCCOUNTRY?
SEND: AT+WCCOUNTRY?
RECV: +WCCOUNTRY:"US"
RECV: OK

# AT+WTPXPOWER?
SEND: AT+WTPXPOWER?
RECV: +WTPXPOWER:17
RECV: OK

# AT+WMACADDR?
SEND: AT+WMACADDR?
RECV: +WMACADDR:"8c:0f:fa:00:2b:73"
RECV: OK

# AT+WIPADDR?
SEND: AT+WIPADDR?
RECV: +WIPADDR:"0.0.0.0","0.0.0.0","0.0.0.0"
RECV: OK

# AT+WCONN?
SEND: AT+WCONN?
RECV: +WCONN:"halow","00:00:00:00:00:00","open","","disconnected"
RECV: OK

# █
```

Connecting to an AP.

```
# AT+WSCAN
SEND: AT+WSCAN
RECV: +WSCAN:"8c:0f:fa:00:2b:a1",918.0,-16,"[ESS]","halow_atcmd_open"
RECV: OK

# AT+WCONN="halow_atcmd_open"
SEND: AT+WCONN="halow_atcmd_open"
RECV: OK

# AT+WDHCP
SEND: AT+WDHCP
RECV: +WDHCP:"192.168.200.23","255.255.255.0","192.168.200.1"
RECV: OK

# AT+WIPADDR?
SEND: AT+WIPADDR?
RECV: +WIPADDR:"192.168.200.23","255.255.255.0","192.168.200.1"
RECV: OK

# AT+WPING
SEND: AT+WPING
RECV: +WPING:64,"192.168.200.1",1,64,6
RECV: +WPING:64,"192.168.200.1",2,64,6
RECV: +WPING:64,"192.168.200.1",3,64,18
RECV: +WPING:64,"192.168.200.1",4,64,3
RECV: +WPING:64,"192.168.200.1",5,64,5
RECV: OK
```

Sending and receiving the data with a socket for TCP client.

```
# AT+SOPEN="tcp","192.168.200.1",50000
SEND: AT+SOPEN="tcp","192.168.200.1",50000
RECV: +SOPEN:0
RECV: OK

# AT+SLIST?
SEND: AT+SLIST?
RECV: +SLIST:0,"TCP","192.168.200.1",50000,0
RECV: OK

# AT+SSEND=0,10
SEND: AT+SSEND=0,10
RECV: OK

# ABCDEFGHIJKLMNOPQRSTUVWXYZ
SEND: DATA 10

# RECV: +RXD:0,10

# AT
SEND: AT
RECV: OK

# AT+SSEND=0
SEND: AT+SSEND=0
RECV: OK

# ABCDEFGHIJKLMNOPQRSTUVWXYZ
SEND: DATA 26

# RECV: +RXD:0,26
RECV: +SEVENT:"SEND_IDLE",0,26

# DKAJFDKLAJFEKJAKEJA'A'D'AFLMEKFJAIDJFAKJEAFJDFJADKJFAEKJFADKJFADF
SEND: DATA 65

# RECV: +RXD:0,65
RECV: +SEVENT:"SEND_IDLE",0,91

# AT
SEND: AT
RECV: OK

# RECV: +SEVENT:"SEND_EXIT",0,91

# █
```

Sending and receiving the data with a socket for UDP client.

```
# AT+SOPEN="udp",60000
SEND: AT+SOPEN="udp",60000
RECV: +SOPEN:1
RECV: OK

# AT+SLIST?
SEND: AT+SLIST?
RECV: +SLIST:0,"TCP","192.168.200.1",50000,0
RECV: +SLIST:1,"UDP","0.0.0.0",0,60000
RECV: OK

# AT+SSEND=1,"192.168.200.1",55000,10
SEND: AT+SSEND=1,"192.168.200.1",55000,10
RECV: OK

# ABCDEFGHIJKLMNOPQRSTUVWXYZ
SEND: DATA 10

# RECV: +RXD:1,10

# AT
SEND: AT
RECV: OK

# AT+SSEND=1,"192.168.200.1",55000
SEND: AT+SSEND=1,"192.168.200.1",55000
RECV: OK

# ABCDEFGHIJKLMNOPQRSTUVWXYZ
SEND: DATA 26

# RECV: +RXD:1,26
RECV: +SEVENT:"SEND_IDLE",1,26

# AKDJFA0IEJFAI3EJFKALDJFAGJADFKGJA90E9RFA398RU4EYAGFAKJEJADKGJ3
SEND: DATA 62

# RECV: +RXD:1,62
RECV: +SEVENT:"SEND_IDLE",1,88

# AT
SEND: AT
RECV: OK

# RECV: +SEVENT:"SEND_EXIT",1,88

#
```

Closing all sockets.

```
# AT+SLIST?
SEND: AT+SLIST?
RECV: +SLIST:0,"TCP","192.168.200.1",50000,0
RECV: +SLIST:1,"UDP","192.168.200.1",55000,60000
RECV: OK

# AT+SCLCLOSE
SEND: AT+SCLCLOSE
RECV: +SCLCLOSE:0
RECV: +SCLCLOSE:1
RECV: OK

# EXIT
```

4) Run with script file

CLI application provides the option to run the script files. (-s/--script)

```
UART/SPI:
-D, --device #      specify the device. (default: /dev/ttyAMA0, /dev/spidev0.0)
-s, --script #      specify the script file.
```

The script file can be created using the AT command and the following script command.

Command	Description	Example
ECHO "<message>"	Print a message.	ECHO "AT Command"
DATA <length>	Send payload with random value.	DATA 1024
WAIT <time>{s m u}	Wait for the specified time. s: sec m: msec u: usec	WAIT 1s WAIT 1000m WAIT 100u
CALL <script_file>	Run the specified script file.	CALL wifi_connect CALL wifi/connect
LOOP <line> <count>	Repeat next lines. <line>: number of lines to repeat <count>: number of repetitions.	LOOP 2 5 AT+SSEND=0,1024 DATA 1024
HOLD	Pause until there is keyboard input.	ECHO "Run an AP in open mode" HOLD

***) Users can refer to the script files under the scripts directory.**

```
scripts/
├── examples
│   ├── socket-send-passthrough-exit
│   ├── socket-send-tcp-client
│   ├── socket-send-tcp-client-passthrough
│   ├── wifi-connect-open-dhcp
│   ├── wifi-connect-wpa2-dhcp
│   ├── wifi-softap-open-dhcps
│   └── wifi-softap-wpa2-dhcps
└── test-case
    ├── ATCMD_Test_Cases.xlsx
    ├── AT-TC-ALL
    ├── AT-TC-BASIC
    ├── AT-TC-BASIC-01
    ├── AT-TC-BASIC-02
    ├── AT-TC-BASIC-03
    ├── AT-TC-SOCKET
    ├── AT-TC-SOCKET-01
    ├── AT-TC-SOCKET-02
    ├── AT-TC-SOCKET-03
    ├── AT-TC-SOCKET-04
    ├── AT-TC-WIFI
    ├── AT-TC-WIFI-01
    ├── AT-TC-WIFI-02-01
    ├── AT-TC-WIFI-02-02
    ├── AT-TC-WIFI-03-01
    ├── AT-TC-WIFI-03-02
    ├── AT-TC-WIFI-04
    ├── AT-TC-WIFI-AP
    ├── AT-TC-WIFI-STA
    └── kr-mic
```

- **SPI**

\$ sudo ./raspi-atcmd-cli -S [-c <clock>] -s <script_file>

(Example) \$sudo ./raspi-atcmd-cli -S -s scripts/test-case/AT-TC-ALL

- **UART**

\$ sudo ./raspi-atcmd-cli -U [-b <baudrate>] -s <script_file>

(Example) \$sudo ./raspi-atcmd-cli -U -s scripts/test-case/AT-TC-ALL

- **UART with H/W flow control**

\$ sudo ./raspi-atcmd-cli -U [-b <baudrate>] -f -s <script_file>

(Example) \$sudo ./raspi-atcmd-cli -U -s scripts/test-case/AT-TC-ALL

5) Iperf

The CLI application supports the iperf2 command used for network performance measurement. However, the available options are limited as follows:

```
# iperf {-h|--help}
```

```
# iperf -h

Usage: iperf <-s|-c host> [options]

Client/Server:
  -i, --interval #      seconds between periodic bandwidth reports (default: 1 sec)
  -p, --port #          server port to listen on/connect to (default: 5001)
  -u, --udp              use UDP rather than TCP

Server specific:
  -s, --server           run in server mode

Client specific:
  -c, --client <host>   run in client mode, connecting to <host>
  -t, --time #           time in seconds to transmit for (default: 10 sec)
  -P, --passthrough      transmit in passthrough mode
  -N, --negative         use negative length in passthrough mode (always negative in UDP)

Miscellaneous:
  -h, --help             print this message and quit
```

The iperf command can be run after completing the Wi-Fi connection and IP setup. Wi-Fi connection and IP setup can be done in one of two ways:

- Enter the following AT commands in the CLI application.

```
# AT
SEND: AT
RECV: OK

# AT+WSCAN
SEND: AT+WSCAN
RECV: +WSCAN:"8c:0f:fa:00:30:73",921.5,-10,"[WPA2-PSK-CCMP][ESS]","halow_atcmd_wpa2"
RECV: OK

# AT+WCONN="halow_atcmd_wpa2","wpa2","12345678"
SEND: AT+WCONN="halow_atcmd_wpa2","wpa2","12345678"
RECV: OK

# AT+WDHCP
SEND: AT+WDHCP
RECV: +WDHCP:"192.168.200.31","255.255.255.0","192.168.200.1"
RECV: OK
```

- Specify a script file containing the AT commands above with the -s option when running the CLI application.

```
$ sudo ./raspi-atcmd-cli -S -s scripts/example/wifi-connect-wpa2-dhcp
```



```
[ SPI ]
- device: /dev/spidev0.0
- clock: 16000000 Hz

CALL: scripts/examples/wifi-connect-wpa2-dhcp

SEND: AT+WDISCONN
RECV: OK

ECHO: Run an AP in wpa2 mode.
ECHO: - SSID : hallow_atcmd_wpa2
ECHO: - Password : 12345678
ECHO: - IP : 192.168.200.1
ECHO: - DHCP Server
HOLD: Press ENTER to continue.

SEND: AT+WSCAN
RECV: +WSCAN:"8c:0f:fa:00:30:73",921.5,-10,"[WPA2-PSK-CCMP][ESS]","hallow_atcmd_wpa2"
RECV: +WSCAN:"00:10:40:39:81:13",920.0,-73,"[WPA2-PSK-CCMP][ESS]","hallow_tcp_test"
RECV: OK
SEND: AT+WDISCONN
RECV: OK
SEND: AT+WCONN="hallow_atcmd_wpa2","wpa2","12345678"
RECV: OK
SEND: AT+WDHCP
RECV: +WDHCP:"192.168.200.31","255.255.255.0","192.168.200.1"
RECV: OK

DONE: scripts/examples/wifi-connect-wpa2-dhcp
```

● Iperf TCP Client

iperf -c <server_ip> [-t <time>] [-P]

```
# iperf -c 192.168.200.1 -t 5 -P

[ IPERF OPTION ]
- role: client
- protocol: tcp
- server_port: 5001
- server_ip: 192.168.200.1
- send_time: 5
- send_passthrough: on
- report_interval: 1

SEND: AT+SRXLOGLEVEL=1
RECV: OK
SEND: AT+SOPEN="tcp","192.168.200.1",5001
RECV: +SOPEN:0
RECV: OK

[ IPERF TCP client ]
Sending 1470 byte datagram ...
Interval      Transfer      Bandwidth
0.0 ~ 1.0 sec  212.46 KBytes  1.74 Mbits/sec
1.0 ~ 2.0 sec  206.72 KBytes  1.69 Mbits/sec
2.0 ~ 3.0 sec  199.54 KBytes  1.63 Mbits/sec
3.0 ~ 4.0 sec  208.15 KBytes  1.70 Mbits/sec
4.0 ~ 5.0 sec  205.28 KBytes  1.67 Mbits/sec
0.0 ~ 5.0 sec  1.01 MBytes   1.69 Mbits/sec
Sent 719 datagrams
Done

SEND: AT
RECV: OK
SEND: AT+SCLCLOSE
RECV: +SEVENT:"SEND_EXIT",0,1056930
RECV: +SCLCLOSE:0
RECV: OK
SEND: AT+SRXLOGLEVEL=0
RECV: OK
```

NOTE: When sending data in passthrough mode with the -P option, the socket can only be closed after receiving the SEND_IDLE event. It takes more than 1 second after sending the last data. So, the iperf tcp server stops after 1 second.

```
pi@raspberrypi:~ $ iperf -s -i 1
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.200.1 port 5001 connected with 192.168.200.31 port 52436
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 1.0 sec    203 KBytes  1.66 Mbits/sec
[ 4] 1.0- 2.0 sec    204 KBytes  1.67 Mbits/sec
[ 4] 2.0- 3.0 sec    205 KBytes  1.68 Mbits/sec
[ 4] 3.0- 4.0 sec    206 KBytes  1.69 Mbits/sec
[ 4] 4.0- 5.0 sec    205 KBytes  1.68 Mbits/sec
[ 4] 5.0- 6.0 sec    8.17 KBytes  66.9 Kbits/sec
[ 4] 6.0- 7.0 sec    0.00 Bytes  0.00 bits/sec
[ 4] 0.0- 7.0 sec   1.01 MBytes  1.20 Mbits/sec
```

● Iperf UDP Client

iperf -u -c <server_ip> [-t <time>] [-P]

```
# iperf -u -c 192.168.200.1 -t 5 -P

[ IPERF OPTION ]
- role: client
- protocol: udp
- server_port: 5001
- server_ip: 192.168.200.1
- send_time: 5
- send_passthrough: on
- datagram_size: 1470
- report_interval: 1

SEND: AT+SRXLOGLEVEL=1
RECV: OK
SEND: AT+SOPEN="udp",50000
RECV: +SOPEN:0
RECV: OK

[ IPERF UDP Client ]
Sending 1470 byte datagrams ...
Interval      Transfer    Bandwidth
0.0 ~ 1.0 sec  235.43 KBytes  1.91 Mbits/sec
1.0 ~ 2.0 sec  235.43 KBytes  1.93 Mbits/sec
2.0 ~ 3.0 sec  236.87 KBytes  1.94 Mbits/sec
3.0 ~ 4.0 sec  241.17 KBytes  1.95 Mbits/sec
0.0 ~ 5.0 sec  1.15 MBytes   1.92 Mbits/sec
Sent 818 datagrams
Server Report:
0.0 ~ 5.0 sec  1.15 MBytes   1.92 Mbits/sec  4.883 ms  0/818 (0%)
Done

RECV: +SEVENT:"SEND_IDLE",0,0
SEND: AT
RECV: OK
SEND: AT+SCLSE
RECV: +SEVENT:"SEND_EXIT",0,0
RECV: +SCLSE:0
RECV: OK
SEND: AT+SRXLOGLEVEL=0
RECV: OK
```

- Iperf TCP Server

iperf -s

```
# iperf -s

[ IPERF OPTION ]
- role: server
- protocol: tcp
- server_port: 5001
- report_interval: 1

SEND: AT+SRXLOGLEVEL=1
RCV: OK
SEND: AT+SOPEN="tcp",5001
RCV: +SOPEN:0
RCV: OK

[ IPERF TCP Server ]
Connected with client: id=1
Interval      Transfer      Bandwidth
0.0 ~ 1.0 sec  196.00 KBytes  1.60 Mbits/sec
1.0 ~ 2.0 sec  184.74 KBytes  1.51 Mbits/sec
2.0 ~ 3.0 sec  183.38 KBytes  1.50 Mbits/sec
3.0 ~ 4.0 sec  188.00 KBytes  1.54 Mbits/sec
4.0 ~ 5.2 sec  225.48 KBytes  1.59 Mbits/sec
0.0 ~ 5.2 sec  977.60 KBytes  1.55 Mbits/sec
Done

SEND: AT+SCLOSE
RCV: +SCLOSE:0
RCV: OK
SEND: AT+SRXLOGLEVEL=0
RCV: OK
```

- Iperf UDP Server

iperf -u -s

```
# iperf -u -s

[ IPERF OPTION ]
- role: server
- protocol: udp
- server_port: 5001
- report_interval: 1

SEND: AT+SRXLOGLEVEL=1
RCV: OK
SEND: AT+SOPEN="udp",5001
RCV: +SOPEN:0
RCV: OK

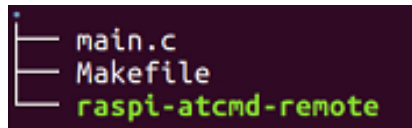
[ IPERF UDP Server ]
Connected with client: 192.168.200.1 port 43056
Interval      Transfer      Bandwidth      Jitter      Lost/Total Datagrams
0.0 ~ 1.0 sec  235.43 KBytes  1.93 Mbits/sec  2.399 ms    0/ 164 (0%)
1.0 ~ 2.0 sec  245.48 KBytes  2.01 Mbits/sec  1.527 ms    0/ 171 (0%)
2.0 ~ 3.0 sec  241.17 KBytes  1.97 Mbits/sec  0.735 ms    1/ 169 (0.59%)
3.0 ~ 4.0 sec  241.17 KBytes  1.97 Mbits/sec  1.365 ms    1/ 169 (0.59%)
4.0 ~ 5.0 sec  252.66 KBytes  2.01 Mbits/sec  2.942 ms    2/ 178 (1.1%)
0.0 ~ 5.0 sec  1.19 MBytes   1.98 Mbits/sec  2.942 ms    4/ 851 (0.47%)
Done

SEND: AT+SCLOSE
RCV: +SCLOSE:0
RCV: OK
RCV: +SEVENT:"RCV_ERROR",0,-9
SEND: AT+SRXLOGLEVEL=0
RCV: OK
```

8.2 Remote Server/Client (raspi-atcmd-remote)

A remote server/client application run one server or client at a time. This application is a Linux application that can be executed on Raspberry Pi. After running the AP, rasp-atcmd-remote must be run on the host running the AP. That is, the AP must run UDP or TCP server / client, and a user can send and receive data using socket-related AT commands through the CLI application(rasp-atcmd-cli).

1) Source files



File	Description
main.c	UDP/TCP server/client related functions
Makefile	Make file for building

Table 8.2 raspi-atcmd-remote source files

2) Build

```
$ cd $HOME
$ cd host/raspi-atcmd-remote
$ make [clean]
```

```
pi@raspberrypi:~/host/raspi-atcmd-remote $ make clean
removed 'raspi-atcmd-remote'
pi@raspberrypi:~/host/raspi-atcmd-remote $ make
cc -g -o raspi-atcmd-remote main.c -Wall -Wno-unused-function
```

3) Run

A. It needs be executed on Raspberry Pi3 running as a Host mode AP.

\$./raspi-atcmd-remote [-h|--help]

```
pi@raspberrypi:~/host/raspi-atcmd-remote $ ./raspi-atcmd-remote
raspi-atcmd-remote version 1.0.0
Copyright (c) 2019-2020 <NEWRACOM LTD>

Usage:
$ ./raspi-atcmd-remote -u [-p <bind_port>] [-e]
$ ./raspi-atcmd-remote -t -s [-p <listen_port>] [-e]
$ ./raspi-atcmd-remote -t -c <server_ip> [-p <server_port>] [-e]

UDP:
-u, --udp          use UDP.

TCP:
-t, --tcp          use TCP
-s, --server       run in server mode
-c, --client #     run in client mode

UDP/TCP:
-p, --port #       set port number (default: 50000)
-e, --echo         enable echo for received packets (default: disable)

-v, --version      print version information and quit.
-h, --help         print this message and quit.
```

Examples:

Mode	Command
UDP Server or Client	\$./raspi-atcmd-remote -u -p 50000 [-e]
TCP Server	\$./raspi-atcmd-remote -t -s -p 50000 [-e]
TCP Client	\$./raspi-atcmd-remote -t -c 192.168.200.39 -p 60000 [-e]

4) Log

UDP Server or Client (\$./raspi-atcmd-remote -u -p 50000 -e)

```
[ UDP ]
- bind_port : 50000
- echo : on
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
```

TCP Server (\$./raspi-atcmd-remote -t -s -p 50000 -e)

```
[ TCP_SERVER ]
- listen_port : 50000
- echo : on
LISTEN ...
CONNECT: addr=192.168.200.39 port=52433

RECV: addr=192.168.200.39 port=52433 len=16
SEND: addr=192.168.200.39 port=52433 len=16
RECV: addr=192.168.200.39 port=52433 len=16
SEND: addr=192.168.200.39 port=52433 len=16
RECV: addr=192.168.200.39 port=52433 len=16
SEND: addr=192.168.200.39 port=52433 len=16
RECV: addr=192.168.200.39 port=52433 len=16
SEND: addr=192.168.200.39 port=52433 len=16
RECV: addr=192.168.200.39 port=52433 len=16
SEND: addr=192.168.200.39 port=52433 len=16
```

TCP Client (\$./raspi-atcmd-remote -t -c 192.168.200.39 -p 60000 -e)

```
[ TCP_CLIENT ]
- server_ip : 192.168.200.39
- server_port : 60000
- echo : on
CONNECT: addr=192.168.200.39 port=60000

RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
RECV: addr=192.168.200.39 port=60000 len=16
SEND: addr=192.168.200.39 port=60000 len=16
```

9 Examples

9.1 Connect to 11ah AP and Send UDP Data to UDP Server

Configuration

- 11ah AP (IP: 192.168.200.1, SSID: halow_demo, Security: Open, DHCP Server: O)
- UDP Server (Port 8800, IP 192.168.200.10, DHCP Server)
- UDP Client (Port 1000, DHCP Client)

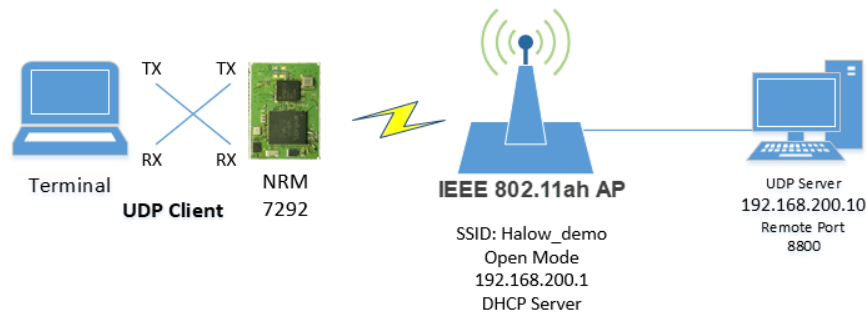


Figure 9.1 Configuration of Example1

[AT Command used for example1]

- 1) Find AP
➔ AT+WSCAN
- 2) Try to connection Wi-Fi AP (SSID: halow_demo, Open Mode)
➔ AT+WCONN="halow_demo"
- 3) Try to DHCP
➔ AT+WDHCP
- 4) Check IP address after connection
➔ AT+WIPADDR?
- 5) Check Connection to AP using PING
➔ AT+WPING="192.168.200.1"
- 6) Create UDP Client Socket to Server (Server Port 8800, Server IP 192.168.200.10)
➔ AT+SOPEN="UDP",1000
- 7) Check UDP Socket

➔ AT+SLIST?

8) Send Data to UDP Server

➔ AT+SSEND=0,"192.168.200.10",8800,10
"0123456789"

9) Close UDP Socket

➔ AT+SCLOSE=0

10) Check UDP Socket

➔ AT+SLIST?

9.2 Connect to 11ah AP and Send TCP Data to TCP Server

Configuration

- 11ah AP (IP: 192.168.200.1, SSID: halow_demo, Security: WPA2, PW:12345678, NO DHCP)
- TCP Server (Port 8098, IP 192.168.200.10)
- TCP Client (IP 192.168.200.20)

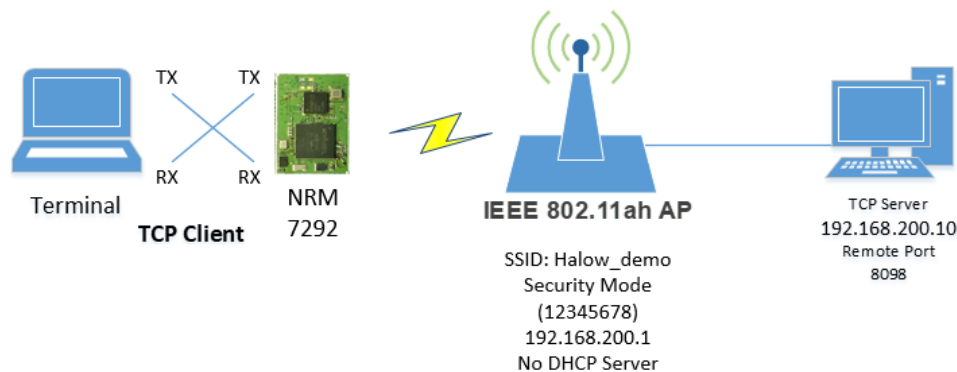


Figure 9.2 Configuration of Example2

[AT Command used for example2]

- 1) Find AP
➔ AT+WSCAN
- 2) Set Static IP
➔ AT+WIPADDR="192.168.200.20","255.255.255.0","192.168.200.1"
- 3) Try to connection Wi-Fi AP (SSID: halow_demo, Security Mode, Static IP)
➔ AT+WCONN="halow_demo","wpa2-psk","12345678"
- 4) Check IP address after connection
➔ AT+WIPADDR?
- 5) Check Connection to AP using PING
➔ AT+WPING="192.168.200.1"
- 6) Create TCP Client Socket to Server (Server Port 8800, Server IP 192.168.200.10)
➔ AT+SOPEN="TCP","192.168.200.10",8098
- 7) Check UDP Socket
➔ AT+SLIST?

8) Send Data to TCP Server

➔ AT+SSEND=0,10
"0123456789"

9) Close TCP Socket

➔ AT+SCLOSE=0

10) Check TCP Socket

➔ AT+SLIST?

10 Revision History

Revision No	Date	Comments
1.0	03/28/2019	Initial version for customer release created
1.1	07/02/2019	Sample Applications updated
1.2	08/01/2019	HW Flow Control added
1.3	09/17/2019	Additional AT-commands added
1.4	11/18/2019	Download binary update & remove description wpa security
1.5	02/14/2020	Improved command descriptions
1.6	03/25/2020	SPI connection and CLI application added
1.7	03/31/2020	AT+STXMODE, AT+SRXMODE, AT+SRXAVAIL and AT+SRECV commands removed
1.8	04/07/2020	Socket related events removed and added CLI application updated
1.9	05/15/2020	Ping size parameter removed Test Application added
1.10	05/22/2020	AT+WDHCPS, AT+WSOFTAP commands added
1.11	06/03/2020	AT+SLEEP command added
1.12	07/15/2020	"Chapter 2.2 Building the firmware" added
1.13	08/04/2020	UART default baudrate changed (38400 -> 115200) "4) Run with script file" in chapter 8.1 added
1.14	08/13/2020	BSSID in AT+WCONN command added
1.15	08/24/2020	AT+WROAM command added ROAMING event added
1.16	09/02/2020	AT+WFOTA command added FOTA event added
1.17	10/08/2020	In raspi-atcmd-cli application, lperf command supported
1.18	11/24/2020	FOTA updated <ul style="list-style-type: none"> - New events added - Get-bin-crc.sh removed - Update-fota-info.sh added
1.19	06/15/2021	AT+WSTAINFO command added
1.20	06/25/2021	WPA3-OWE/SAE security added
1.21	07/12/2021	AT+WMCS command removed
1.21.1	07/29/2021	Some examples fixed
1.22.0	10/21/2021	AT+SLEEP command removed AT+WSLEEP command added DEEPSLEEP_WAKEUP event added
1.22.1	11/12/2021	Country code added (AU, NZ)
1.22.2	12/16/2021	AT+WFOTA command updated <ul style="list-style-type: none"> - fota.json file in JSON format that describes new firmware

		<ul style="list-style-type: none">- bin_name and bin_crc32 parameters to set new firmware- description and example
1.22.3	02/03/2022	Added setting form enable serial port Change event name from TCP CONNECT to CONNECT
1.22.4	02/25/2022	SCAN_DONE event removed ROAMING event removed CONNECT_SUCCESS event changed CONNECT_FAIL event changed DISCONNECT event changed
1.22.5	03/08/2022	SEND_IDLE event changed SEND_DROP event changed SEND_EXIT event changed SEND_ERROR event changed
1.22.6	03/16/2022	AT+WMCS command added AT+WXTIME command added AT+WDUTYCYCLE command added AT+WCCATHRESHOLD command added AT+WBSSMAXIDLE command added
1.22.7	03/28/2022	AT+WSCAN SET/GET command added