For BC660K&BC950K Development and Application Process in Power-off and PSM Mode

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一、Foreword

Currently, the NB-IoT modules of Quectel are applied in wide industries, which involve multi-form and multi-style IoT applications. However, due to sensitiveness in power consumption, it is ncessary to take life duration of product and battery endurance into consideration in stage of application design. Based on common "power off" and "PSM" and targeted to the NB-IoT terminal application design, relevant design procedure is sorted out and arranged in this document for reference on develpment design and application.

二、Illustration

1. Related design procedure and utilization illustrated in this document is just for reference on application development. For actual application, pelase query and refer to corresponding AT document and manual.
2. The document will sort out based on common "Power off" and "PSM" application scenario, which will fous on main procedure design. For some solution on “interrupt”, please integrate with actual bussiness. Meanwhile, please note the deployment of PSM shall be merged with power off.
3. The "blue" mark in the document represents the relevant AT commands to be executed. Some important URC and AT response outputs are marked with "red"; At the same time pay attention to check the "notes";
4. The document contains multiple application protocols, which are marked with corresponding rule identifiers. The details are as follows:

Application Protocol	CODE	INDEX	Description
Other		x-y-z	x- the first digit indicates the corresponding application function y- the second digit indicates the debugging order of the corresponding function z- the third digit represents the implementation methods of different functions of the corresponding application protocol, for example, -1, -2, and -3 respectively represent three different implementation methods. The actual required method should be combined with the program processing and task invocation of mcu
LwM2M	**L**	L-x-y-z	
TCP	**T**	T-x-y-z	
UDP	**U**	U-x-y-z	
MQTT	**Q**	Q-x-y-z	
HTTP	**H**	H-x-y-z	
RAI	**R**	R-x-y-z	

三、Reference for Process of Developing Application

3.1 BC660K/BC950K

3.1.1 Access to CHN Telecom CTWING Platform(AEP)

3.1.1.1 in Power-off Mode

Application	The terminal is connected to AEP platform of CHN Telecom, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ **Reference for Process of Developing Application:**

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design

	>> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK	
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK	

	//Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 2 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the AEP platform		
L2-1	**//Set parameters and register AEP** >> **AT+QSCLK=0** //Disable the deepsleep function >> >> OK >> **AT+QLWCFG="auto_reg",0** //Disable the auto_registration function >> >> OK >> **AT+QLWCONFIG=0,"221.229.214.202",5683,"868543060025186",86400,3** //Set connection parameters of AEP platform >> >> OK >> **AT+QLWADDOBJ=19,0,1,0** //Add object19 and resource for upload channel >> >> OK >> >> +QLWADDOBJ: 0 >> **AT+QLWADDOBJ=19,1,1,0** //Add object19 and resource for download channel >> >> OK >>	The program or MCU needs to monitor the URC output of the registration status of the platform, and should reboot if the waiting window time of the program is exceeded

	>> +QLWADDOBJ: 0 >> **AT+QLWREG** //Initiate registration >> >> OK >> >> +QLWURC: "registering",102,0 >> >> +QLWREG: 0 >> >> +QLWURC: "observe",7191,0,19,0,0	
L2-2	>> **AT+QLWOBSRSP=7191,1,19,0,0,2,11,"68656c6c6f20776f726c64",0** //Response observe resource >> >> OK >> >> +QLWOBSRSP: 0	
L2-3	>> **AT+QLWSTATUS?** //Query the status of the current connection >> >> +QLWSTATUS: 2 //registered >> >> OK	The program or mcu can query the registration status of the platform by AT+QLWSTATUS. After the query returns +QLWSTATUS: 2,then the data can be sent normally

L2-4	**//Report/send data to AEP platform**
	>> **AT+QLWNOTIFY=19,0,0,2,11,"68656c6c6f20776f726c64",0,1**
	//It is recommended to report data of the CON type
	>>
	>> OK
	>>
	>> +QLWNOTIFY: 0
	>>
	>> +QLWURC: "report",60516
	>>
	>> +QLWURC: "report_ack",0,60516
	//the data is successfully reported and the ACK message is received from the platform.
		CON type is recommended for reporting or sending data. When "report_ack" is received, the data is successfully sent

L2-5	**//Set the receiving data mode - Direct Output mode (default)** >> >> +QLWURC: "write",40832,19,1,0,2,9,"636f6d706c65746564",0 >> **AT+QLWWRRSP=40832,2** //After receiving the data, respond platform >> >> OK >> >> +QLWWRRSP: 0	Currently, the BC660K/BC950K supports only direct output mode
L2-6	>> **AT+QLWDEREG** //Initiate de-registration >> >> OK >> >> +QLWDEREG: 0 // de-registered	If the application design does not require this step, you can skip the step
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function >> OK	If the terminal is designed for power-off mode and powered off

	//Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash
4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the AEP platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.1.2 in PSM Mode

Application	PSM function is enabled, and only the AEP platform of CHN telecom is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network

	>> AT+QSCLK=1 //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> AT+QRST=1 //Reboot >> OK	requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> AT+QBAND=0 //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> AT+QSCLK=0 //Disable the deepsleep >> OK >> AT+CPSMS=1,,,"01000010","00000000" //Enable th PSM >> OK >> AT+CEDRXS=0,5 //Disable the eDRX >> OK >> AT+QNBIOTEVENT=1,1 //Enable the URC of PSM >> OK >> AT+QCFG="dsevent",1 //Enable the URC of Deepsleep >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design By AT+CPSMS=1,, "<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network
1-2	**// Configure the APN based on the requirement of SIM card** >> AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>" >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> AT+CPIN? //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> ATI //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> AT+CGSN=1 //Query the IMEI >> +CGSN:<IMEI> >> >> OK	If the application design does not require this step, you can skip the step

	…… //Other queries	
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals ……	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 2 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain

		RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the AEP platform		
L2-1	**//Set parameters and register AEP** >> **AT+QLWCFG="auto_reg",0** //Disable the auto_registration function >> >> OK >> **AT+QLWCONFIG=0,"221.229.214.202",5683,"868543060025186",86400,3** //Set connection parameters of AEP platform >> >> OK >> **AT+QLWADDOBJ=19,0,1,0** //Add object19 and resource for upload channel >> >> OK >> >> +QLWADDOBJ: 0 >> **AT+QLWADDOBJ=19,1,1,0** //Add object19 and resource for download channel >> >> OK >> >> +QLWADDOBJ: 0 >> **AT+QLWREG** //Initiate registration >> >> OK >> >> +QLWURC: "registering",102,0 >> >> +QLWREG: 0 >> >> +QLWURC: "observe",7191,0,19,0,0	The program or MCU needs to monitor the URC output of the registration status of the platform, and should reboot if the waiting window time of the program is exceeded
L2-2	>> **AT+QLWOBSRSP=7191,1,19,0,0,2,11,"68656c6c6f20776f726c64",0** //Response observe resource >> >> OK >> >> +QLWOBSRSP: 0	
L2-3	>> **AT+QLWSTATUS?** //Query the status of the current connection >> >> +QLWSTATUS: 2 //registered >> >> OK	The program or mcu can query the registration status of the platform by AT+QLWSTATUS. After the query returns +QLWSTATUS: 2,then the data can be sent normally
L2-4	**//Report/send data to AEP platform** >> **AT+QLWNOTIFY=19,0,0,2,11,"68656c6c6f20776f726c64",0,1**	CON type is recommended for reporting or sending data.

	//It is recommended to report data of the CON type
	>>
	>> OK
	>>
	>> +QLWNOTIFY: 0
	>>
	>> +QLWURC: "report",60516
	>>
	>> +QLWURC: "report_ack",0,60516
	//the data is successfully reported and the ACK message is received from the platform.
		When "report_ack" is received, the data is successfully sent

L2-5	**//Set the receiving data mode - Direct Output mode (default)** >> >> +QLWURC: "write",40832,19,1,0,2,9,"636f6d706c65746564",0 >> **AT+QLWWRRSP=40832,2** //After receiving the data, respond platform >> >> OK >> >> +QLWWRRSP: 0	Currently, the BC660K/BC950K supports only direct output mode
3- Feature of RAI		
Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"221.229.214.202",4,1,32,1	
R3-1	>> **AT+QPING=0,"221.229.214.202",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,221.229.214.202,32,342,44 >> >> +QPING: 0,1,1,0,342,342,342 >> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value is very important, it will affect the module to quickly enter deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot and be saved; You need to make settings and reboot after the modem is initialized	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution
5- Exit status of Deepsleep and PSM		

L5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >>>>> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> **AT+QLWRECOVER** //Trigger to recovery of the Lwm2m protocol >>>> OK >>>> +QLWURC: "recovered",0,102,0 >> **AT+QLWNOTIFY=19,0,0,2,11,"68656c6c6f20776f726c64",0,1** //Send data of the CON type >>>> OK >>>> +QLWNOTIFY: 0 >>>> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >>>> +QLWURC: "report",26457 >>>> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >>>> +QLWURC: "report_ack",0,26457 //the data is successfully reported and the ACK message is received from the platform **Go to 6-2,or goto L3-3 for sending data,or goto L3-5 for receving data, and the subsequent process**	Method to trigger PSM wake-up
L5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >>>> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> **AT+QPING=0,"221.229.214.202",4,1** //Trigger to exit PSM by PING >>>> OK >>>> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >>>> +CSCON: 1 //It is recommended to obtain the signal reference after return the +CSCON:1 >>>> +QPING: 0,221.229.214.202,32,762,44 >>>> +QPING: 0,1,1,0,762,762,762 >> **AT+QENG=0** //Query signal reference >>>> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >>>> OK >> **AT+QLWRECOVER** //Trigger to recovery of the Lwm2m protocol >>>> OK	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process

	>> >> +QLWURC: "recovered",0,102,0 >> **AT+QLWNOTIFY=19,0,0,2,11,"68656c6c6f20776f726c64",0,1** //Send data of the CON type >> >> OK >> >> +QLWNOTIFY: 0 >> >> +QLWURC: "report",8824 >> >> +QLWURC: "report_ack",0,8824 //the data is successfully reported and the ACK message is received from the platform **Go to 5-2,or goto L2-4 for sending data,or goto L2-5 for receving data, and the subsequent process**	
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to L2-4 for sending data,or goto L2-5 for receving data, and the subsequent process**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of AEP platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot; 4) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout. If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time exceeds, power off or reboot should can

		be operated

3.1.2 Access to Leshan Platform

3.1.2.1 **in Power-off Mode**

Application	The terminal is connected to Leshan platform, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >>\ >> RDY >>\ >> +CFUN: 1 >>\ >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >>\ >> RDY >>\ >> +CFUN: 1 >>\ >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design

1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Query the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2	If the query only returns +CEREG:0,0 or +CEREG:0,2 within

	>> >> OK		the search time (no less than 2 minutes); the program goes to 4-1
1-9	>> **AT+CEREG?** >> +CEREG:0,1 //+CEREG:0,5 (roaming) //the registered successfully >> >> OK	>> **AT+CEREG?** >> +CEREG:0,3 //the registration denied >> >> OK	If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card
1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK		
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK		CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK		Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the leshan platform			
L2-1	**//Set parameters and register leshan** >> **AT+QSCLK=0** //Disable the deepsleep function >> >> OK >> **AT+QIDNSCFG=0,"8.8.8.8","223.6.6.6"** //Configure the valid DNS >> OK >> **AT+QLWCFG="auto_reg",0** //Disable the auto_registration function >> >> OK >> **AT+QLWCONFIG=0,"leshan.eclipseprojects.io",5683,"urn:imei:866207055068526",86400,3** //Set connection parameters of leshan platform >> >> OK >> **AT+QLWADDOBJ=3311,0,3,5706,5701,5850** //Add object3311 and resources >> >> OK >> >> +QLWADDOBJ: 0 >> **AT+QLWREG** //Initiate registration >> >> OK >> >> +QLWURC: "registering",102,0		The program or MCU needs to monitor the URC output of the registration status of the platform, and should reboot if the waiting window time of the program is exceeded

	>> >> +QLWREG: 0	
L2-2	>> **AT+QLWSTATUS?** //Query the status of the current connection >> >> +QLWSTATUS: 2 //registered >> >> OK	The program or mcu can query the registration status of the platform by AT+QLWSTATUS. After the query returns +QLWSTATUS: 2,then the data can be sent normally
L2-3	>> >> +QLWURC: "observe",43605,0,3311,0,5706 >> **AT+QLWOBSRSP=43605,1,3311,0,5706,1,5,"white",0** //Response observe resource >> >> OK >> >> +QLWOBSRSP: 0	

L2-4	**//Report/send data to leshan platform**
	>> **AT+QLWNOTIFY=3311,0,5706,1,6,"orange",0,1**
	//It is recommended to report data of the CON type
	>>
	>> OK
	>>
	>> +QLWNOTIFY: 0
	>>
	>> +QLWURC: "report",60516
	>>
	>> +QLWURC: "report_ack",0,60516
	//the data is successfully reported and the ACK message is received from the platform.
		CON type is recommended for reporting or sending data. When "report_ack" is received, the data is successfully sent

L2-5	**//Set the receiving data mode - Direct Output mode (default)** >> >> +QLWURC: "write",38156,3311,0,5706,2,4,"626c7565",0 >> **AT+QLWWRRSP=38156,2** //After receiving the data, respond platform >> >> OK >> >> +QLWWRRSP: 0	Currently, the BC660K/BC950K supports only direct output mode
L2-6	>>**AT+QLWDELOBJ=3311** //Delete the subscribed object >> >>OK >> >>+QLWDELOBJ: 0 >> >>+QLWURC: "ping",0,102,0 >> **AT+QLWDEREG** //Initiate de-registration >> >> OK >> >> +QLWDEREG: 0 // de-registered	If the application design does not require this step, you can skip the step
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function	If the terminal is designed for

	>> OK //Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	power-off mode and powered off after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash
4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the leshan platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.2.2 in PSM Mode

Application	PSM function is enabled, and only the Leshan platform is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state	In the application design, when the module is powered on after the device is powered on, if the

	>> OK >> AT+QSCLK=1 //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> AT+QRST=1 //Reboot >> OK	terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> AT+QBAND=0 //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> AT+QSCLK=0 //Disable the deepsleep >> OK >> AT+CPSMS=1,,,"01000010","00000000" //Enable th PSM >> OK >> AT+CEDRXS=0,5 //Disable the eDRX >> OK >> AT+QNBIOTEVENT=1,1 //Enable the URC of PSM >> OK >> AT+QCFG="dsevent",1 //Enable the URC of Deepsleep >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design By AT+CPSMS=1,, "<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network
1-2	**// Configure the APN based on the requirement of SIM card** >> AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>" >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> AT+CPIN? //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> ATI //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> AT+CGSN=1 //Query the IMEI >> +CGSN:<IMEI> >>	If the application design does not require this step, you can skip the step

	>> OK ..... //Other queries	
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended

		to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the leshan platform		
L2-1	**//Set parameters and register leshan** >> **AT+QSCLK=0** //Disable the deepsleep function >> >> OK >> **AT+QIDNSCFG=0,"8.8.8.8","223.6.6.6"** //Configure the valid DNS >> OK >> **AT+QLWCFG="auto_reg",0** //Disable the auto_registration function >> >> OK >> **AT+QLWCONFIG=0,"leshan.eclipseprojects.io",5683,"urn:imei:866207055068526",86400,3** //Set connection parameters of leshan platform >> >> OK >> **AT+QLWADDOBJ=3311,0,3,5706,5701,5850** //Add object3311 and resources >> >> OK >> >> +QLWADDOBJ: 0 >> **AT+QLWREG** //Initiate registration >> >> OK >> >> +QLWURC: "registering",102,0 >> >> +QLWREG: 0	The program or MCU needs to monitor the URC output of the registration status of the platform, and should reboot if the waiting window time of the program is exceeded
L2-2	>> **AT+QLWSTATUS?** //Query the status of the current connection >> >> +QLWSTATUS: 2 //registered >> >> OK	The program or mcu can query the registration status of the platform by AT+QLWSTATUS. After the query returns +QLWSTATUS: 2,then the data can be sent normally
L2-3	>> >> +QLWURC: "observe",43605,0,3311,0,5706 >> **AT+QLWOBSRSP=43605,1,3311,0,5706,1,5,"white",0** //Response observe resource >> >> OK >> >> +QLWOBSRSP: 0	

L2-4	**//Report/send data to leshan platform**
	>> **AT+QLWNOTIFY=3311,0,5706,1,6,"orange",0,1**
	//It is recommended to report data of the CON type
	>>
	>> OK
	>>
	>> +QLWNOTIFY: 0
	>>
	>> +QLWURC: "report",60516
	>>
	>> +QLWURC: "report_ack",0,60516
	//the data is successfully reported and the ACK message is received from the platform.
		CON type is recommended for reporting or sending data. When "report_ack" is received, the data is successfully sent

L2-5	**//Set the receiving data mode - Direct Output mode (default)** >> >> +QLWURC: "write",38156,3311,0,5706,2,4,"626c7565",0 >> **AT+QLWWRRSP=38156,2** //After receiving the data, respond platform >> >> OK >> >> +QLWWRRSP: 0	Currently, the BC660K/BC950K supports only direct output mode
3- Feature of RAI		
Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"8.8.8.8",4,1,32,1	
R3-1	>> **AT+QPING=0,"8.8.8.8",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,8.8.8.8,32,275,51 >> >> +QPING: 0,1,1,0,275,275,275 >> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value is very important, it will affect the module to quickly enter deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot and be saved; You need to make settings and reboot after the modem is initialized	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution
5- Exit status of Deepsleep and PSM		

L5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >>>>> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> **AT+QLWRECOVER** //Trigger to recovery of the Lwm2m protocol >>>> OK >>>> +QLWURC: "recovered",0,102,0 >> **AT+QLWNOTIFY=3311,0,5706,1,3,"red",0,1** //Send data of the CON type >>>> OK >>>> +QLWNOTIFY: 0 >>>> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >>>> +QLWURC: "report",26457 >>>> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >>>> +QLWURC: "report_ack",0,26457 //the data is successfully reported and the ACK message is received from the platform **Go to 6-2,or goto L3-3 for sending data,or goto L3-5 for receving data, and the subsequent process**	Method to trigger PSM wake-up
L5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >>>> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> **AT+QPING=0,"8.8.8.8",4,1** //Trigger to exit PSM by PING >>>> OK >>>> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >>>> +CSCON: 1 //It is recommended to obtain the signal reference after return the +CSCON:1 >>>> +QPING: 0,8.8.8.8,32,275,51 >>>> +QPING: 0,1,1,0,275,275,275 >> **AT+QENG=0** //Query signal reference >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >>>> OK >> **AT+QLWRECOVER** //Trigger to recovery of the Lwm2m protocol >>>> OK	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process

	>> >> +QLWURC: "recovered",0,102,0 >> **AT+QLWNOTIFY=3311,0,5706,1,3,"red",0,1** //Send data of the CON type >> >> OK >> >> +QLWNOTIFY: 0 >> >> +QLWURC: "report",8824 >> >> +QLWURC: "report_ack",0,8824 //the data is successfully reported and the ACK message is received from the platform **Go to 5-2,or goto L2-4 for sending data,or goto L2-5 for receving data，and the subsequent process**	
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to L2-4 for sending data,or goto L2-5 for receving data，and the subsequent process**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of leshan platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot; 4) In the case of exceptions，when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK，then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout. If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time exceeds, power off or reboot should can

		be operated

3.1.3 TCP Application

3.1.3.1 in Power-off Mode

Application	The terminal is connected to the TCP server, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ **Reference for Process of Developing Application:**

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design

	>> OK	
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?**	If the query only returns

	>> +CEREG:0,0 //+CEREG:0,2 >> >> OK		+CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1
1-9	>> **AT+CEREG?** >> +CEREG:0,1 //+CEREG:0,5 (roaming) //the registered successfully >> >> OK	>> **AT+CEREG?** >> +CEREG:0,3 //the registration denied >> >> OK	If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card
1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK		
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK		CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK		Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Connect to TCP server			
T2-1	**//Configure optional parameters** >> **AT+QICFG="dataformat",0,0** >> >> OK >> **AT+QICFG="showlength",1** >> >> OK >> **AT+QICFG="showRA",1** >> >> OK		In the actual development, please configure parameters according to your requirement
T2-2	**//Set the TCP server parameters and initiate the connection** >> **AT+QIOPEN=0,0,"TCP","220.180.239.212",8058,0,1** //Direct push mode >> >> OK >> >> +QIOPEN: 0,0 >> **AT+QISTATE=1,0** //Query TCP connection status >> >> +QISTATE: 0,"TCP","220.180.239.212",8058,0,2,0,1 >> >> OK		
T2-3-1	**//Send data in non-data mode** >> **AT+QISEND=0,19,"this is a test text"** //Send data		

	>> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
T2-3-2	**//Send data in data mode** >> **AT+QISEND=0** >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
T2-4	**//Switch receiving mode to Buffer access mode** **Or the parameter access_mode of AT+QIOPEN is set to 0** >> **AT+QISWTMD=0,0** //Switch the receive mode to Buffer access mode >> >> OK >> **AT+QISEND=0** //Send data in data mode >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058 //Receive the URC of data >> **AT+QIRD=0,1200** //Read the data in buffer >> >> +QIRD: 12,0,"220.180.239.212",8058,"hello world" >> >> OK	In actual development, if your requirement is buffer access mode, please configure access_mode to 0 in AT+QIOPEN
T2-5	>> **AT+QICLOSE=0** //Close TCP connection >> >> OK >> >> CLOSE OK	
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function >> OK //Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	If the terminal is designed for power-off mode and powered off after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash

4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the AEP platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.3.2 in PSM Mode

Application	PSM function is enabled, and only the TCP server is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run**	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode.

	>> AT+QRST=1 //Reboot >> OK	If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> AT+QBAND=0 //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> AT+QSCLK=0 //Disable the deepsleep >> OK >> AT+CPSMS=1,,,"01000010","00000000" //Enable th PSM >> OK >> AT+CEDRXS=0,5 //Disable the eDRX >> OK >> AT+QNBIOTEVENT=1,1 //Enable the URC of PSM >> OK >> AT+QCFG="dsevent",1 //Enable the URC of Deepsleep >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design By AT+CPSMS=1,,"<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network
1-2	**// Configure the APN based on the requirement of SIM card** >> AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>" >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> AT+CPIN? //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> ATI //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> AT+CGSN=1 //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> AT+CSCON=1 >> OK	If the application design does not require this step, you can

		skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32"	Time conversion: 24/01/16,08:55:19+32/4(h)=

	>> >> OK	2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the TCP server		
T2-1	**//Configure optional parameters** >> **AT+QICFG="dataformat",0,0** >> >> OK >> **AT+QICFG="showlength",1** >> >> OK >> **AT+QICFG="showRA",1** >> >> OK	In the actual development, please configure parameters according to your requirement
T2-2	**//Set the TCP server parameters and initiate the connection** >> **AT+QIOPEN=0,0,"TCP","220.180.239.212",8058,0,1** //Direct push mode >> >> OK >> >> +QIOPEN: 0,0 >> **AT+QISTATE=1,0** //Query TCP connection status >> >> +QISTATE: 0,"TCP","220.180.239.212",8058,0,2,0,1 >> >> OK	
T2-3-1	**//Send data in non-data mode** >> **AT+QISEND=0,19,"this is a test text"** //Send data >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
T2-3-2	**//Send data in data mode** >> **AT+QISEND=0** >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
T2-4	**//Switch receiving mode to Buffer access mode** **Or the parameter access_mode of AT+QIOPEN is set to 0** >> **AT+QISWTMD=0,0** //Switch the receive mode to Buffer access mode >>	In actual development, if your requirement is buffer access mode, please configure access_mode to 0 in

	>> OK >> **AT+QISEND=0** //Send data in data mode >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058 //Receive the URC of data >> **AT+QIRD=0,1200** //Read the data in buffer >> >> +QIRD: 12,0,"220.180.239.212",8058,"hello world" >> >> OK	AT+QIOPEN
3- Feature of RAI		
Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"8.8.8.8",4,1,32,1	
R3-1	>> **AT+QPING=0,"8.8.8.8",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,8.8.8.8,32,729,51 >> >> +QPING: 0,1,1,0,729,729,729 >> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value is very important, it will affect the module to quickly enter deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot and be saved; You need to make settings and reboot after the modem is initialized	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution
5- Exit status of Deepsleep and PSM		
T5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state	Method to trigger PSM wake-up

	>> **AT+QIOPEN=0,0,"TCP","220.180.239.212",8058,0,1** //Recreate the TCP connection >> >> OK >> >> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QIOPEN: 0,0 //The TCP connection was established successfully **Go to 5-2,or goto T2-3 for sending data,or goto T2-4 for receving data, and the subsequent process**	
T5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> **AT+QIOPEN=0,0,"TCP","220.180.239.212",8058,0,1** //Recreate the TCP connection >> >> OK >> >> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QIOPEN: 0,0 //The TCP connection was established successfully >> **AT+QENG=0** //Query signal reference >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK >> **AT+QISEND=0,51,"rsrp=-75,snr=14,cellid=05C4EF33,earfcn=3686,pci=121"** //Send current signal reference data >> >> OK >> >> SEND OK **Go to 5-2,or goto T2-3 for sending data or receving data, and the subsequent process**	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to T2-3 for sending data or receving data, and the subsequent process**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0	As described in 1-8, it is suggested that in the program design, after the first search

	>> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of leshan platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot; 4) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout. If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time exceeds, power off or reboot should can be operated

3.1.4 UDP Application

3.1.4.1 in Power-off Mode

Application	The terminal is connected to the UDP server, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform**	In the application design, when the module is powered on after the

	>> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the

		step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls

		query the time for multiple times
2- Connect to UDP server		
U2-1	**//Configure optional parameters** >> **AT+QICFG="dataformat",0,0** >> >> OK >> **AT+QICFG="showlength",1** >> >> OK >> **AT+QICFG="showRA",1** >> >> OK	In the actual development, please configure parameters according to your requirement
U2-2	**//Set the UDP server parameters and initiate the connection** >> **AT+QIOPEN=0,0,"UDP","220.180.239.212",8058,0,1** //Direct push mode >> >> OK >> >> +QIOPEN: 0,0 >> **AT+QISTATE=1,0** //Query TCP connection status >> >> +QISTATE: 0,"UDP","220.180.239.212",8058,0,2,0,1 >> >> OK	
T2-3-1	**//Send data in non-data mode** >> **AT+QISEND=0,19,"this is a test text"** //Send data >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
T2-3-2	**//Send data in data mode** >> **AT+QISEND=0** >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
T2-4	**//Switch receiving mode to Buffer access mode** **Or the parameter access_mode of AT+QIOPEN is set to 0** >> **AT+QISWTMD=0,0** //Switch the receive mode to Buffer access mode >> >> OK >> **AT+QISEND=0** //Send data in data mode >>	In actual development, if your requirement is buffer access mode, please configure access_mode to 0 in AT+QIOPEN

	>> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058 //Receive the URC of data >> **AT+QIRD=0,1200** //Read the data in buffer >> >> +QIRD: 12,0,"220.180.239.212",8058,"hello world" >> >> OK	
T2-5	>> **AT+QICLOSE=0** //Close UDP connection >> >> OK >> >> CLOSE OK	
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function >> OK //Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	If the terminal is designed for power-off mode and powered off after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash
4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the AEP platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.4.2 in PSM Mode

Application	PSM function is enabled, and only the UDP server is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** //Enable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK >> **AT+QNBIOTEVENT=1,1** //Enable the URC of PSM >> OK >> **AT+QCFG="dsevent",1** //Enable the URC of Deepsleep >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design By AT+CPSMS=1,, "<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network

1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	

1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK		If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 6-1
1-9	>> **AT+CEREG?** >> +CEREG:0,1 //+CEREG:0,5 (roaming) //the registered successfully >> >> OK	>> **AT+CEREG?** >> +CEREG:0,3 //the registration denied >> >> OK	If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card
1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK		
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK		CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK		Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the UDP server			
U2-1	**//Configure optional parameters** >> **AT+QICFG="dataformat",0,0** >> >> OK >> **AT+QICFG="showlength",1** >> >> OK >> **AT+QICFG="showRA",1** >> >> OK		In the actual development, please configure parameters according to your requirement
U2-2	**//Set the UDP server parameters and initiate the connection** >> **AT+QIOPEN=0,0,"UDP","220.180.239.212",8058,0,1** //Direct push mode >> >> OK >> >> +QIOPEN: 0,0 >> **AT+QISTATE=1,0** //Query TCP connection status >> >> +QISTATE: 0,"UDP","220.180.239.212",8058,0,2,0,1		

	>> >> OK	
U2-3-1	**//Send data in non-data mode** >> **AT+QISEND=0,19,"this is a test text"** //Send data >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
U2-3-2	**//Send data in data mode** >> **AT+QISEND=0** >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data	
U2-4	**//Switch receiving mode to Buffer access mode** **Or the parameter access_mode of AT+QIOPEN is set to 0** >> **AT+QISWTMD=0,0** //Switch the receive mode to Buffer access mode >> >> OK >> **AT+QISEND=0** //Send data in data mode >> >> > **this is a test text** //After ">" is responded, input the data and tap "Ctrl" + "Z" to send it >> >> OK >> >> SEND OK >> >> +QIURC: "recv",0,12,"220.180.239.212",8058 //Receive the URC of data >> **AT+QIRD=0,1200** //Read the data in buffer >> >> +QIRD: 12,0,"220.180.239.212",8058,"hello world" >> >> OK	In actual development, if your requirement is buffer access mode, please configure access_mode to 0 in AT+QIOPEN
3- Feature of RAI		
Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"8.8.8.8",4,1,32,1	
R3-1	>> **AT+QPING=0,"8.8.8.8",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,8.8.8.8,32,729,51	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value

	>> >> +QPING: 0,1,1,0,729,729,729 >> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	is very important, it will affect the module to quickly enter deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot and be saved; You need to make settings and reboot after the modem is initialized	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution
5- Exit status of Deepsleep and PSM		
U5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> **AT+QISEND=0,10,"helloworld"** //After exit deepsleep, the program or mcu can directly send UDP data >> >> OK >> >> SEND OK >> >> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QIURC: "recv",0,12,"220.180.239.212",8058,"hello world" //Receive data **Go to 5-2,or goto U2-3 for sending data,or goto U2-4 for receving data, and the subsequent process**	Method to trigger PSM wake-up
U5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" >> **AT+QPING=0,"8.8.8.8",4,1** >> >> OK >>	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process

	>> +QNBIOTEVENT: "EXIT PSM" >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QPING: 0,8.8.8.8,32,699,51 >> >> +QPING: 0,1,1,0,699,699,699 >> **AT+QENG=0** //Query signal reference >> >> +QENG: 0,3686,11,121,"05C4EF33",-72,-2,-70,18,8,"4C10",0,0,3 >> >> OK >> **AT+QISEND=0,51,"rsrp=-72,snr=18,cellid=05C4EF33,earfcn=3686,pci=121"** //Send current signal reference data >> >> OK >> >> SEND OK **Go to 5-2,or goto U2-3 for sending data or receving data，and the subsequent process**	
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to U2-3 for sending data or receving data，and the subsequent process**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of leshan platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot;	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout.

	4) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time exceeds, power off or reboot should can be operated

3.1.5 MQTT-based AWS IoT Application

3.1.5.1 **in Power-off Mode**

Application	The terminal is connected to the MQTT of AWS IoT platform, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >>\ >> RDY >>\ >> +CFUN: 1 >>\ >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >>\ >> RDY >>\ >> +CFUN: 1 >>\ >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design

	>> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK	
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK …… //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status**	

	>> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals ……	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Connect to AWS IoT server		
Q2-1	**//Testing AWS IoT connectivity** >> **AT+QIDNSCFG=0,"8.8.8.8","8.8.4.4"** >> >> OK >> **AT+QPING=0,"a9ohm2zbim3d5-ats.iot.us-east-1.amazonaws.com",4,1** >> >> OK >> >> +QPING: 0,54.204.191.103,32,356,237 >> >> +QPING: 0,1,1,0,356,356,356	In the actual development, please configure parameters according to your requirement
Q2-2	**//Load the CA certificate and key files** >> **AT+QSSLCFG=0,0,"cacert"** // Upload the RootCA.pem to the FILE system >>	

	>> >
	>> -----BEGIN CERTIFICATE-----
	>> MIIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF
	>> .....
	>> rqXRfboQnoZsG4q5WTP468SQvvG5
	>> -----END CERTIFICATE-----
	>> +QSSLCFG: 0,0,"cacert",1187
	// The byte size of the indication must correspond to the byte size of the content of AmazonRootCA1.pem
	>>
	>> OK
	>> **AT+QSSLCFG=0,0,"clientcert"** // Upload the certificate.pem.crt to the FILE system
	>>
	>> >
	>> -----BEGIN CERTIFICATE-----
	>> MIIDWjCCAkKgAwIBAgIVAKp/znqyrMfoSWNqhC/Ln+qsPPI4MA0GCSqGSIb3DQEB
	>> .....
	>> ++kMnCN/oHJzDl2jzL65XktQm99MojobbN121jZm3v34nqOuYFT6351CaA64DQ==
	>> -----END CERTIFICATE-----
	>>
	>> +QSSLCFG: 0,0,"clientcert",1224
	// The byte size of the indication must correspond to the byte size of the content of xxx-certificate.pem.crt
	>>
	>> OK
	>> **AT+QSSLCFG=0,0,"clientkey"** // Upload the private.pem.key to the FILE system
	>>
	>> >
	>> -----BEGIN RSA PRIVATE KEY-----
	>> MIIEowIBAAKCAQEA3rCImNdAS6x43he0Zn0hq7BGHrdt3ttIjYmTsCVttkcdGX3+
	>> .....
	>> cnEBCR2U3DpU1qNrn0D8r8qCJjWbYJwzEbEoFaKi8zHuhLLVuuus
	>> -----END RSA PRIVATE KEY-----
	>>
	>> +QSSLCFG: 0,0,"clientkey",1675
	// The byte size of the indication must correspond to the byte size of the content of xxx-private.pem.key
	>>
	>> OK	

Q2-3	**//MQTT and SSL configuration** >> **AT+QSSLCFG=0,0,"seclevel",2** //SSL authorization mode:server authentication >> >> OK >> **AT+QMTCFG="ssl",0,1,0,0** //Enable SSL and configure SSL context/connect index >> >> OK >> **AT+QMTCFG="version",0,1** //Configure the MQTT version >>	

	>> OK >> **AT+QSSLCFG=0,0** //Query and validate the results of the current configuration >> >> +QSSLCFG: 0,0,"seclevel",2 >> +QSSLCFG: 0,0,"sslversion",4 >> +QSSLCFG: 0,0,"dataformat",0,0 >> +QSSLCFG: 0,0,"timeout",90 >> +QSSLCFG: 0,0,"debug",0 >> +QSSLCFG: 0,0,"cacert",1187 >> +QSSLCFG: 0,0,"clientcert",1224 >> +QSSLCFG: 0,0,"clientkey",1675 >> +QSSLCFG: 0,0,"dtls",0 >> +QSSLCFG: 0,0,"dtlsversion",2 >> >> OK	
Q2-4	**//MQTT of AWS IoT to connect and subscribe** >> **AT+QMTOPEN=0,"a9ohm2zbim3d5-ats.iot.us-east-1.amazonaws.com",8883** // Open the MQTT SSL connection >> >> OK >> >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"smartKit001"** // Initiate the MQTT server connection >> >> OK >> >> +QMTCONN: 0,0,0 >> **AT+QMTSUB=0,1,"toaws/smartKit001/update/message",1** // Subscribe to related topic >> >> OK >> >> +QMTSUB: 0,1,0,1	
Q2-5-1	**//MQTT publish** **Publish fixed-length messages in non-data mode** >> **AT+QMTPUB=0,1,1,0,"aws/meter001/data/report/message",23,"{"temp",22.5,"humi",68}"** // Publish messages to related topic >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"toaws/smartKit001/update/message","{ "message": "Hello from AWS IoT console"}"	
Q2-5-2	**//MQTT publish** **Publish fixed-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"aws/meter001/data/report/message",23** >> >	

	>> "{"temp",22.5,"humi",68}" // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"toaws/smartKit001/update/message","{ "message": "Hello from AWS IoT console"}"	
Q2-5-3	**//MQTT publish** **Publish variable-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"aws/meter001/data/report/message"** >> > >> **"{"temp",22.5,"humi",68}"** // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"toaws/smartKit001/update/message","{ "message": "Hello from AWS IoT console"}"	
Q2-6	>> **AT+QMTCLOSE=0** // Initiating MQTT connection disconnected >> >> OK >> >> +QMTCLOSE: 0,0	
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function >> OK //Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	If the terminal is designed for power-off mode and powered off after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash
4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.

5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the AEP platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions，when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK，then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.5.2 in PSM Mode

Application	PSM function is enabled, and only the MQTT of AWS IoT platform is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design By AT+CPSMS=1,, "<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly

	>> OK >> **AT+CPSMS=1,,,"01000010","00000000"** //Enable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK >> **AT+QNBIOTEVENT=1,1** //Enable the URC of PSM >> OK >> **AT+QCFG="dsevent",1** //Enable the URC of Deepsleep >> OK	which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >>\ >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >>\ >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >>\ >> OK …… //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>>\ >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >>\ >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >>\ >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.

	>> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals ……	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 6-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the AWS IoT server		
Q2-1	**//Testing AWS IoT connectivity** >> **AT+QIDNSCFG=0,"8.8.8.8","8.8.4.4"** >> >> OK >> **AT+QPING=0,"a9ohm2zbim3d5-ats.iot.us-east-1.amazonaws.com",4,1** >> >> OK >>	In the actual development, please configure parameters according to your requirement

	>> +QPING: 0,54.204.191.103,32,356,237 >> >> +QPING: 0,1,1,0,356,356,356	

Q2-2	**//Load the CA certificate and key files**
	>> **AT+QSSLCFG=0,0,"cacert"** // Upload the RootCA.pem to the FILE system
	>>
	>> >
	>> -----BEGIN CERTIFICATE-----
	>> MIIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF
	>> .....
	>> rqXRfboQnoZsG4q5WTP468SQvvG5
	>> -----END CERTIFICATE-----
	>> +QSSLCFG: 0,0,"cacert",1187
	// The byte size of the indication must correspond to the byte size of the content of AmazonRootCA1.pem
	>>
	>> OK
	>> **AT+QSSLCFG=0,0,"clientcert"** // Upload the certificate.pem.crt to the FILE system
	>>
	>> >
	>> -----BEGIN CERTIFICATE-----
	>> MIIDWjCCAkKgAwIBAgIVAKp/znqyrMfoSWNqhC/Ln+qsPPI4MA0GCSqGSIb3DQEB
	>> .....
	>> ++kMnCN/oHJzDl2jzL65XktQm99MojobbN121jZm3v34nqOuYFT6351CaA64DQ==
	>> -----END CERTIFICATE-----
	>>
	>> +QSSLCFG: 0,0,"clientcert",1224
	// The byte size of the indication must correspond to the byte size of the content of xxx-certificate.pem.crt
	>>
	>> OK
	>> **AT+QSSLCFG=0,0,"clientkey"** // Upload the private.pem.key to the FILE system
	>>
	>> >
	>> -----BEGIN RSA PRIVATE KEY-----
	>> MIIEowIBAAKCAQEA3rCImNdAS6x43he0Zn0hq7BGHrdt3ttIjYmTsCVttkcdGX3+
	>> .....
	>> cnEBCR2U3DpU1qNrn0D8r8qCJjWbYJwzEbEoFaKi8zHuhLLVuuus
	>> -----END RSA PRIVATE KEY-----
	>>
	>> +QSSLCFG: 0,0,"clientkey",1675
	// The byte size of the indication must correspond to the byte size of the content of xxx-private.pem.key
	>>
	>> OK	

Q2-3	**//MQTT and SSL configuration** >> **AT+QSSLCFG=0,0,"seclevel",2** //SSL authorization mode:server authentication >>	

	>> OK >> **AT+QMTCFG="ssl",0,1,0,0** //Enable SSL and configure SSL context/connect index >>OK >> **AT+QMTCFG="version",0,1** //Configure the MQTT version >>OK >> **AT+QSSLCFG=0,0** //Query and validate the results of the current configuration >>+QSSLCFG: 0,0,"seclevel",2 >> +QSSLCFG: 0,0,"sslversion",4 >> +QSSLCFG: 0,0,"dataformat",0,0 >> +QSSLCFG: 0,0,"timeout",90 >> +QSSLCFG: 0,0,"debug",0 >> +QSSLCFG: 0,0,"cacert",1187 >> +QSSLCFG: 0,0,"clientcert",1224 >> +QSSLCFG: 0,0,"clientkey",1675 >> +QSSLCFG: 0,0,"dtls",0 >> +QSSLCFG: 0,0,"dtlsversion",2 >>OK	
Q2-4	**//MQTT of AWS IoT to connect and subscribe** >> **AT+QMTOPEN=0,"a9ohm2zbim3d5-ats.iot.us-east-1.amazonaws.com",8883** // Open the MQTT SSL connection >>OK >>+QMTOPEN: 0,0 >> **AT+QMTCONN=0,"smartKit001"** // Initiate the MQTT server connection >>OK >>+QMTCONN: 0,0,0 >> **AT+QMTSUB=0,1,"toaws/smartKit001/update/message",1** // Subscribe to related topic >>OK >>+QMTSUB: 0,1,0,1	
Q2-5-1	**//MQTT publish** **Publish fixed-length messages in non-data mode** >>**AT+QMTPUB=0,1,1,0,"aws/meter001/data/report/message",23,"{"temp",22.5,"humi",68}"** // Publish messages to related topic >>OK >>+QMTPUB: 0,1,0 >>	

	>> +QMTRECV: 0,0,"toaws/smartKit001/update/message","{ "message": "Hello from AWS IoT console"}"	
Q2-5-2	**//MQTT publish** **Publish fixed-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"aws/meter001/data/report/message",23** >> >> >> **"{"temp",22.5,"humi",68}"** // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"toaws/smartKit001/update/message","{ "message": "Hello from AWS IoT console"}"	
Q2-5-3	**//MQTT publish** **Publish variable-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"aws/meter001/data/report/message"** >> >> >> **"{"temp",22.5,"humi",68}"** // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"toaws/smartKit001/update/message","{ "message": "Hello from AWS IoT console"}"	
3- Feature of RAI		
Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"8.8.8.8",4,1,32,1	
R3-1	>> **AT+QPING=0,"8.8.8.8",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,8.8.8.8,32,729,51 >> >> +QPING: 0,1,1,0,729,729,729 >> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value is very important, it will affect the module to quickly enter deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution

	related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot and be saved; You need to make settings and reboot after the modem is initialized	
5- Exit status of Deepsleep and PSM		
Q5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >>\ >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state //Recreate the MQTT connection >> **AT+QSSLCFG=0,0,"seclevel",2** >>\ >> OK >> **AT+QMTCFG="ssl",0,1,0,0** >>\ >> OK >> **AT+QMTCFG="version",0,1** >>\ >> OK >> **AT+QMTOPEN=0,"a9ohm2zbim3d5-ats.iot.us-east-1.amazonaws.com",8883** >>\ >> OK >>\ >> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >>\ >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >>\ >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"meter001"** >>\ >> OK >>\ >> +QMTCONN: 0,0,0 //The MQTT connection was established successfully **Go to 6-2,or goto Q3-5 for sending data or receving data，and the subsequent process**	Method to trigger PSM wake-up
Q5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >>\ >> +QNBIOTEVENT: "EXIT DEEPSLEEP" >> **AT+QPING=0,"8.8.8.8",4,1** >>\ >> OK >>\ >> +QNBIOTEVENT: "EXIT PSM" >>\	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process

	>> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QPING: 0,8.8.8.8,32,699,51 >> >> +QPING: 0,1,1,0,699,699,699 >> **AT+QENG=0** //Query signal reference >> >> +QENG: 0,3686,11,121,"05C4EF33",-72,-2,-70,18,8,"4C10",0,0,3 >> >> OK //Recreate the MQTT connection >> **AT+QSSLCFG=0,0,"seclevel",2** >> >> OK >> **AT+QMTCFG="ssl",0,1,0,0** >> >> OK >> **AT+QMTCFG="version",0,1** >> >> OK >> **AT+QMTOPEN=0,"a9ohm2zbim3d5-ats.iot.us-east-1.amazonaws.com",8883** >> >> OK >> >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"meter001"** >> >> OK >> >> +QMTCONN: 0,0,0 //The MQTT connection was established successfully **Go to 5-2,or goto Q2-5 for sending data or receving data，and the subsequent process**	
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to Q2-5 for sending data or receving data，and the subsequent process**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time

	order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of leshan platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot; 4) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout. If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time exceeds, power off or reboot should can be operated

3.1.6 MQTT-based Alibaba Cloud Application

3.1.6.1 in Power-off Mode

Application	The terminal is connected to the MQTT of Alibaba cloud platform, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the

	>> OK	application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK …… //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute

	>> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals ……	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Connect to Alibaba Cloud server		
Q2-1	**//Configuring DNS** >> **AT+QIDNSCFG=0,"223.5.5.5","223.6.6.6"** >>	

	>> OK	
Q2-2	**//MQTT configuration** >> **AT+QMTCFG="version",0,1** //Configure the MQTT version >> OK >> **AT+QMTCFG="keepalive",0,1200** //Configure the keepalive >> OK >> **AT+QMTCFG="aliauth",0,"i2uq00ze3N3","device001","3af2ccf1273f1b8866effc4d64b85d07"** //Configure the device certificate for Ali Cloud:ProductKey,DeviceName,DeviceSecret >> >> OK	
Q2-3	**//MQTT of Alibaba Cloud to connect** >> **AT+QMTOPEN=0,"iot-06z00hxss3rggno.mqtt.iothub.aliyuncs.com",1883** // Open the MQTT connection >> >> OK >> >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"device001"** // Initiate the MQTT server connection >> >> OK >> >> +QMTCONN: 0,0,0	
Q2-4-1	**//MQTT publish** **Publish fixed-length messages in non-data mode** >> **AT+QMTPUB=0,1,1,0,"/sys/i2uq00ze3N3/device001/thing/event/property/post",99,"{"id":"null","params":{"temp":23.6,"humi":82},"version":"1.0","method":"thing.event.property.post"}"** >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"/sys/i2uq00ze3N3/device001/thing/event/property/post_reply","{"code":200,"data":{},"id":"null","message":"success","method":"thing.event.property.post","version":"1.0"}"	
Q2-4-2	**//MQTT publish** **Publish fixed-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"/sys/i2uq00ze3N3/device001/thing/event/property/post",99** >> >> > >> {"id":"null","params":{"temp":18.5,"humi":79},"version":"1.0","method":"thing.event.property.post"} // Publish data >> >> OK >> >> +QMTPUB: 0,1,0	

	>> >> +QMTRECV: 0,0,"/sys/i2uq00ze3N3/device001/thing/event/property /post_reply","{"code":200,"data":{},"id":"null","message":"success", "method":"thing.event.property.post","version":"1.0"}"	
Q2-4-3	**//MQTT publish** **Publish variable-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"/sys/i2uq00ze3N3/device001/thing /event/property/post"** >> >> > >> {"id":"null","params":{"temp":18.5,"humi":79}, "version":"1.0","method":"thing.event.property.post"} // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"/sys/i2uq00ze3N3/device001/thing/event/property /post_reply","{"code":200,"data":{},"id":"null","message":"success", "method":"thing.event.property.post","version":"1.0"}"	
Q2-5	**//MQTT server push** >> >> +QMTRECV: 0,0,"/i2uq00ze3N3/device001/user/reply","LED status:off"	
Q2-6	>> **AT+QMTCLOSE=0** // Initiating MQTT connection disconnected >> >> OK >> >> +QMTCLOSE: 0,0	
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function >> OK //Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	If the terminal is designed for power-off mode and powered off after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash
4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK	As described in 2-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and

	>> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	try again.
5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the AEP platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.6.2 in PSM Mode

Application	PSM function is enabled, and only the MQTT of Alibaba cloud platform is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >>	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design

	>> +CPIN: READY >> AT+QBAND=0 //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> AT+QSCLK=0 //Disable the deepsleep >> OK >> AT+CPSMS=1,,,"01000010","00000000" //Enable th PSM >> OK >> AT+CEDRXS=0,5 //Disable the eDRX >> OK >> AT+QNBIOTEVENT=1,1 //Enable the URC of PSM >> OK >> AT+QCFG="dsevent",1 //Enable the URC of Deepsleep >> OK	By AT+CPSMS=1,, "<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network
1-2	**// Configure the APN based on the requirement of SIM card** >> AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>" >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> AT+CPIN? //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> ATI //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> AT+CGSN=1 //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> AT+CSCON=1 >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> AT+CIMI //Query the IMSI >> 460113061353533 >> >> OK >> AT+NCCID //Query the CCID of SIM	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN

	>> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals ……	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 6-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the Alibaba Cloud server		
Q2-1	**//Configuring DNS** >> **AT+QIDNSCFG=0,"223.5.5.5","223.6.6.6"** >> >> OK	

Q2-2	**//MQTT configuration** >> **AT+QMTCFG="version",0,1** //Configure the MQTT version >> OK >> **AT+QMTCFG="keepalive",0,1200** //Configure the keepalive >> OK >> **AT+QMTCFG="aliauth",0,"i2uq00ze3N3","device001","3af2ccf1273f1b8866effc4d64b85d07"** //Configure the device certificate for Ali Cloud:ProductKey,DeviceName,DeviceSecret >> >> OK	
Q2-3	**//MQTT of Alibaba Cloud to connect** >> **AT+QMTOPEN=0,"iot-06z00hxss3rggno.mqtt.iothub.aliyuncs.com",1883** // Open the MQTT connection >> >> OK >> >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"device001"** // Initiate the MQTT server connection >> >> OK >> >> +QMTCONN: 0,0,0	
Q2-4-1	**//MQTT publish** **Publish fixed-length messages in non-data mode** >> **AT+QMTPUB=0,1,1,0,"/sys/i2uq00ze3N3/device001/thing/event /property/post",99,"{"id":"null","params":{"temp":23.6, "humi":82},"version":"1.0","method":"thing.event.property.post"}"** >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"/sys/i2uq00ze3N3/device001/thing/event/property /post_reply","{"code":200,"data":{},"id":"null","message":"success" ,"method":"thing.event.property.post","version":"1.0"}"	
Q2-4-2	**//MQTT publish** **Publish fixed-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"/sys/i2uq00ze3N3/device001/thing /event/property/post",99** >> >> > >> {"id":"null","params":{"temp":18.5,"humi":79}, "version":"1.0","method":"thing.event.property.post"} // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >>	

	>> +QMTRECV: 0,0,"/sys/i2uq00ze3N3/device001/thing/event/property /post_reply","{"code":200,"data":{},"id":"null","message":"success", "method":"thing.event.property.post","version":"1.0"}"	
Q2-4-3	**//MQTT publish** **Publish variable-length messages in data mode** >> **AT+QMTPUB=0,1,1,0,"/sys/i2uq00ze3N3/device001/thing /event/property/post"** >> >> > >> {"id":"null","params":{"temp":18.5,"humi":79}, "version":"1.0","method":"thing.event.property.post"} // Publish data >> >> OK >> >> +QMTPUB: 0,1,0 >> >> +QMTRECV: 0,0,"/sys/i2uq00ze3N3/device001/thing/event/property /post_reply","{"code":200,"data":{},"id":"null","message":"success", "method":"thing.event.property.post","version":"1.0"}"	
Q2-5	**//MQTT server push** >> >> +QMTRECV: 0,0,"/i2uq00ze3N3/device001/user/reply","LED status:off"	
3- Feature of RAI		
Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"8.8.8.8",4,1,32,1	
R3-1	>> **AT+QPING=0,"8.8.8.8",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,8.8.8.8,32,729,51 >> >> +QPING: 0,1,1,0,729,729,729 >> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value is very important, it will affect the module to quickly enter deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution

	and be saved; You need to make settings and reboot after the modem is initialized	
5- Exit status of Deepsleep and PSM		
Q5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state //Recreate the MQTT connection >> **AT+QMTCFG="aliauth",0,"i2uq00ze3N3","device001","3af2ccf1273f1b8866effc4d64b85d07"** >> OK >> **AT+QMTOPEN=0,"iot-06z00hxss3rggno.mqtt.iothub.aliyuncs.com",1883** >> >> OK >> >> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"device001"** >> >> OK >> >> +QMTCONN: 0,0,0 //The MQTT connection was established successfully **Go to 6-2,or goto Q3-4 for sending data or receving data，and the subsequent process**	Method to trigger PSM wake-up
Q5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" >> **AT+QPING=0,"8.8.8.8",4,1** >> >> OK >> >> +QNBIOTEVENT: "EXIT PSM" >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QPING: 0,8.8.8.8,32,699,51 >> >> +QPING: 0,1,1,0,699,699,699 >> **AT+QENG=0** //Query signal reference >> >> +QENG: 0,3686,11,121,"05C4EF33",-72,-2,-70,18,8,"4C10",0,0,3 >> >> OK //Recreate the MQTT connection	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process

	>> **AT+QMTCFG="aliauth",0,"i2uq00ze3N3","device001","3af2ccf1273f1b8866effc4d64b85d07"** >> OK >> **AT+QMTOPEN=0,"iot-06z00hxss3rggno.mqtt.iothub.aliyuncs.com",1883** >> >> OK >> >> +QMTOPEN: 0,0 >> **AT+QMTCONN=0,"device001"** >> >> OK >> >> +QMTCONN: 0,0,0 //The MQTT connection was established successfully **Go to 5-2,or goto Q2-4 for sending data or receving data，and the subsequent process**	
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to Q2-4 for sending data or receving data，and the subsequent process**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of leshan platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot; 4) In the case of exceptions，when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK，then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout. If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time

		exceeds, power off or reboot should can be operated

3.1.7 HTTP(s) Application

3.1.7.1 in Power-off Mode

Application	The terminal is connected to the HTTP(s) server, the interval of data reported/upload is relatively long, the application logic of mcu or program is relatively simple, and the PSM is not enabled

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >>\ >> RDY >>\ >> +CFUN: 1 >>\ >> +CPIN: READY	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK ..... **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >>\ >> RDY >>\ >> +CFUN: 1 >>\ >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 5-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=0** //Disable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design

	>> OK	
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx >> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	If the application design does not require this step, you can skip the step
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?**	If the query only returns

	>> +CEREG:0,0 //+CEREG:0,2 >> >> OK		+CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 4-1
1-9	>> **AT+CEREG?** >> +CEREG:0,1 //+CEREG:0,5 (roaming) //the registered successfully >> >> OK	>> **AT+CEREG?** >> +CEREG:0,3 //the registration denied >> >> OK	If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card
1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >> >> OK		
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK		CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK		Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Connect to HTTP(s) server			
H2-1	**//Configure the parameters for HTTP** >> **AT+QHTTPCFG="contextid",0** >> >> OK >> **AT+QHTTPCFG="requestheader",0** >> >> OK >> **AT+QHTTPCFG="ssl",0,0** >> >> OK >> **AT+QHTTPCFG="contenttype",1** >> >> OK		In the actual development, please configure parameters according to your requirement
H2-2	**//Set the SSL parameters for HTTPs** >> **AT+QSSLCFG=0,0,"sslversion",4** >> >> OK >> **AT+QSSLCFG=0,0,"dtls",1** >> >> OK >> **AT+QSSLCFG=0,0,"dtlsversion",2** >> >> OK		In the actual development, please configure parameters according to your requirement

	>> **AT+QSSLCFG=0,0,"ciphersuite",0xFFFF** >> >> OK >> **AT+QSSLCFG=0,0,"sni",1** >> >> OK	
H2-3	**//Connect to HTTPs and send a GET or POST service** >> **AT+QIDNSCFG=0,"223.5.5.5","8.8.8.8"** //Configure reliable DNS >> >> OK >> **AT+QHTTPURL=57,80** >> >> > >> https://ncu-receiver.fukuku.saico.dev/gas-meter/push/**** >> OK >> **AT+QHTTPGET=80** >> >> OK >> >> +QHTTPGET: 0,200,99 >> **AT+QHTTPPOST=146** >> >> > >> {"DATETIME":"20240528T143744Z","IMEI":"868020030003890","NCU_FW_VER":100, "GAS_METER":1265035,"CSQ":29,"MCU_TEMP":28,"BAT_VOL":3665,"METER_TYPE":7} >> OK >> >> +QHTTPPOST: 0,200,139 >> **AT+QHTTPREAD=139** >> >> +QHTTPREAD: 139,0 >> {"module":{"code":"700.101.1001","name":"GAS_METER_RECEIVER.PUSH_ MEASUREMENT","version":"1.1.3"},"data":{"messageId":"194083404774019072"}} >> >> OK	In the actual development, please configure parameters according to your application
H2-4	**// Custom POST request for requestheader/ responseheader** >> **AT+QIDNSCFG=0,"8.8.8.8","223.5.5.5"** // Configure reliable DNS >> >> OK >> **AT+QHTTPCFG="contextid",0** >> >> OK >> **AT+QHTTPCFG="responseheader",1** >> >> OK >> **AT+QHTTPCFG="requestheader",1** >> >> OK >> **AT+QSSLCFG=0,0,"seclevel",0**	In the actual development, please configure parameters according to your application

```
>>
>> OK
>> AT+QHTTPCFG="ssl",0,0
>>
>> OK
>> AT+QSSLCFG=0,0,"sni",1
>>
>> OK
>> AT+QHTTPURL=75,80
>>
>> >
https://spc-smoke-sniffer-function-app-dev.azurewebsites.net/api/devicelxxx
>>
>> OK
>> AT+QHTTPPOST=404,80,80
>>
>> >
POST /api/devicelogs HTTP/1.1
Host: spc-smoke-sniffer-function-app-dev.azurewebsites.net:443
Authorization: Basic MzUtMjA5OTAwLTE3NjE0OC03OjM=
User-Agent: Apifox/1.0.0 (https://apifox.com)
Content-Type: text/plain
Accept: */*
Connection: keep-alive
Content-Length: 125

[{"IMEI":"35-209900-176148-7","LogTypeId":"1","Value":"Normal"},
{"IMEI":"35-209900-176148-7","LogTypeId":"2","Value":"True"}]
>>
>> OK
>>
>> +QHTTPPOST: 0,200,205
>> AT+QHTTPREAD=1024
>>
>> +QHTTPREAD: 329,0
>> HTTP/1.1 200 OK
>> Content-Length: 205
>> Content-Type: application/json; charset=utf-8
>> Date: Tue, 12 Nov 2024 10:55:35 GMT
>>
>> [{"subDeviceId":0,"imei":"35-209900-176148-
7","logTypeId":1,"value":"Normal","dateLogged":"11/12/2024"},{"subDeviceId":0,
"imei":"35-209900-176148-7","logTypeId":2,"value":"True",
"dateLogged":"11/12/2024"}]
>>
>> OK
// Custom GET requests based on POST methods for requestheader/
responseheader
>> AT+QIDNSCFG=0,"8.8.8.8","223.5.5.5"          // Configure reliable DNS
```

```
>>
>> OK
>> AT+QHTTPCFG="responseheader",1
>>
>> OK
>> AT+QHTTPCFG="requestheader",1
>>
>> OK
>> AT+QSSLCFG=0,0,"seclevel",0
>>
>> OK
>> AT+QHTTPCFG="ssl",0,0
>>
>> OK
>> AT+QSSLCFG=0,0,"sni",1
>>
>> OK
>> AT+QHTTPURL=96,80
>>
>> >
https://spc-smoke-sniffer-function-app-dev.azurewebsites.net/api/commanxx
/35-209900-176148-7/102
>>
>> OK
>> AT+QHTTPPOST=248,80,80
>>
>> >
GET /api/commands/35-209900-176148-7/102 HTTP/1.1
Host: spc-smoke-sniffer-function-app-dev.azurewebsites.net
Authorization: Basic MzUtMjA5OTAwLTE3NjE0OC03OjM=
User-Agent: Apifox/1.0.0 (https://apifox.com)
Accept: */*
Connection: keep-alive


>>
>> OK
>>
>> +QHTTPPOST: 0,200,2
>> AT+QHTTPREAD=1024
>>
>> +QHTTPREAD: 192,0
>> HTTP/1.1 200 OK
>> Content-Length: 2
>> Content-Type: application/json; charset=utf-8
>> Date: Tue, 12 Nov 2024 11:00:33 GMT
>> Request-Context: appId=cid-v1:2b659d4a-595b-4cb4-9f04-b4177a338dda
>>
>> []
```

	>> >> OK	
3- Power off after sending and receiving data		
3-1	>> **AT+CFUN=0** //Set minimum function >> OK //Wait for the return OK, then mcu control to power off; If not return OK after running AT+CFUN=0 for a long period of time (for example, 20s), you can power off directly.	If the terminal is designed for power-off mode and powered off after data interaction is complete, you need to run AT+CFUN=0, then power off the terminal after return OK to avoid damage to the flash
4- Erase the historical frequency		
4-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
5- Exception handling or interruption		
5-1	1) The program or mcu needs to add the interrupt method of time-out or failure to register the AEP platform, such as re-registration or reboot. 2) The program or mcu needs to add the interrupt method of timeout or failure for sending or receiving data, such as reboot. 3) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout

3.1.7.2 in PSM Mode

Application	PSM function is enabled, and only the HTTP(s) server is connected. The data is reported/upload frequently, and the application logic of mcu or program is relatively complex

■ Reference for Process of Developing Application:

Index	Process of AT Command	Notes
0- Initial		
0-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >>	Boot log output, mcu can also determine whether it is normal boot; If the terminal needs to connect to the network immediately after power on, start from 1-1

	>> +CPIN: READY	
0-2	**//After powering on, if the terminal (mcu) does not need to connect to the network, or prioritize other tasks, you need to perform** >> **AT+CFUN=0** //Enter the deepsleep state >> OK >> **AT+QSCLK=1** //The deepsleep is enabled by default >> OK …… **//If the terminal needs to connect to the network later, you can run** >> **AT+QRST=1** //Reboot >> OK	In the application design, when the module is powered on after the device is powered on, if the terminal has no network requirements temporarily or mcu gives priority to other tasks, cfun0 can be executed to enter the low power mode. If this requirement is not in the application design, skip this step to 1-1
1- Search and register network		
1-1	**//Power on,initial** >> >> RDY >> >> +CFUN: 1 >> >> +CPIN: READY >> **AT+QBAND=0** //*If you did not execute the lock BAND in 7-1, skip the command >> OK >> **AT+QSCLK=0** //Disable the deepsleep >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** //Enable th PSM >> OK >> **AT+CEDRXS=0,5** //Disable the eDRX >> OK >> **AT+QNBIOTEVENT=1,1** //Enable the URC of PSM >> OK >> **AT+QCFG="dsevent",1** //Enable the URC of Deepsleep >> OK	+CPIN: NOT READY indicates that the module fails to check the sim card.so you need to check the SIM card itself or the pin connection and hardware design By AT+CPSMS=1,, "<T3412/TAU>","<T3324>", you can configure the T3412 and T3324 timers properly which you need.at the same time, after the completion of the registration network, by AT+CEREG=5; +CEREG? or AT+QPSMS?, You need to query the real value of T3324,T3412/TAU provided by the network
1-2	**// Configure the APN based on the requirement of SIM card** >> **AT+QCGDEFCONT="IPV4V6","<APN>", "<username>", "<password>"** >> OK	If APN needs to be configured for the SIM card, please perform the command, others can be ignored
1-3	>> **AT+CPIN?** //check the SIM status >> +CPIN: READY >> >> OK	If return NO READY,indicates the check of SIM card is failed. You need to check the SIM card and hardware. So the program can be directly powered off, or go to the above 0-2, into the low power state
1-4	**//Check the attribute values of the module** >> **ATI** //Query module identification >> Quectel_Ltd >> xxxxxxx >> Revision: xxxxxxx	If the application design does not require this step, you can skip the step

	>> >> OK >> **AT+CGSN=1** //Query the IMEI >> +CGSN:<IMEI> >> >> OK ..... //Other queries	
1-5	>> **AT+CSCON=1** >> OK	If the application design does not require this step, you can skip the step
1-6	>> >> +CSCON:1 //Indicates that the RRC connection is complete **//To query the following parameters, it is recommended to query after return +CSCON:1, or query after the registration network is completed** >> **AT+CIMI** //Query the IMSI >> 460113061353533 >> >> OK >> **AT+NCCID** //Query the CCID of SIM >> +NCCID:89861122223000411769 >> >> OK >> **AT+QENG=0** //Query the information about the current camp on the cell >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK	If the application design does not require this step, you can skip the step In the application design of the terminal, you can execute AT+QENG=0 to obtain the relevant network and signal reference, and to encode RSRP, SNR, CELLID, EARFCN and PCI and upload the data to the server. It will helps for troubleshoot problems.
1-7	**// Query the network registration status** >> **AT+CEREG?** //Query the network registration status >> +CEREG:0,2 >> >> OK //Periodic queries, such as 500ms intervals	
1-8	>> **AT+CEREG?** >> +CEREG:0,0 //+CEREG:0,2 >> >> OK	If the query only returns +CEREG:0,0 or +CEREG:0,2 within the search time (no less than 2 minutes); the program goes to 6-1

1-9	>> **AT+CEREG?**
	>> +CEREG:0,1 //+CEREG:0,5 (roaming)
	//the registered successfully
	>>
	>> OK
	
	>> **AT+CEREG?**
	>> +CEREG:0,3
	//the registration denied
	>>
	>> OK
		If the program finally returns +CEREG:0,3 within the search time (e.g. 5 minutes); Restart or try again in the next cycle. If +CEREG:0,3 is still returned after multiple attempts, it is recommended to check the SIM card

1-10	>> **AT+CGPADDR** //Query the IP address obtained >> +CGPADDR: 0,"10.21.53.152","2409:8d30:0114:0242:17ab:01f8:98b0:032e" >>	

	>> OK	
1-11	>> **AT+CSQ** //Query the CSQ >> +CSQ:xx,99 >> >> OK	CSQ=(RSSI+113)/2 CSQ corresponds to signal reference RSSI. In actual applications, it is recommended to run AT+QENG=0 to obtain RSRP and SNR
1-12	>> **AT+CCLK?** //Query the current date and time >> +CCLK: "24/01/16,08:55:19+32" >> >> OK	Time conversion: 24/01/16,08:55:19+32/4(h)= 2024/01/16,16:55:19 If the default time is returned, pls query the time for multiple times
2- Access the HTTP(s) server		
H2-1	**//Configure the parameters for HTTP** >> **AT+QHTTPCFG="contextid",0** >> >> OK >> **AT+QHTTPCFG="requestheader",0** >> >> OK >> **AT+QHTTPCFG="ssl",0,0** >> >> OK >> **AT+QHTTPCFG="contenttype",1** >> >> OK	In the actual development, please configure parameters according to your requirement
H2-2	**//Set the SSL parameters for HTTPs** >> **AT+QSSLCFG=0,0,"sslversion",4** >> >> OK >> **AT+QSSLCFG=0,0,"dtls",1** >> >> OK >> **AT+QSSLCFG=0,0,"dtlsversion",2** >> >> OK >> **AT+QSSLCFG=0,0,"ciphersuite",0xFFFF** >> >> OK >> **AT+QSSLCFG=0,0,"sni",1** >> >> OK	In the actual development, please configure parameters according to your requirement
H2-3	**//Connect to HTTPs and send a GET or POST service** >> **AT+QIDNSCFG=0,"223.5.5.5","8.8.8.8"** //Configure reliable DNS >> >> OK >> **AT+QHTTPURL=57,80** >>	In the actual development, please configure parameters according to your application

	>> > >> https://ncu-receiver.fukuku.saico.dev/gas-meter/push/**** >> OK >> **AT+QHTTPGET=80** >> >> OK >> >> +QHTTPGET: 0,200,99 >> **AT+QHTTPPOST=146** >> >> > >> {"DATETIME":"20240528T143744Z","IMEI":"868020030003890","NCU_FW_VER":100, "GAS_METER":1265035,"CSQ":29,"MCU_TEMP":28,"BAT_VOL":3665,"METER_TYPE":7} >> OK >> >> +QHTTPPOST: 0,200,139 >> **AT+QHTTPREAD=139** >> >> +QHTTPREAD: 139,0 >> {"module":{"code":"700.101.1001","name":"GAS_METER_RECEIVER.PUSH_ MEASUREMENT","version":"1.1.3"},"data":{"messageId":"194083404774019072"}} >> >> OK	
H2-4	**// Custom POST request for requestheader/ responseheader** >> **AT+QIDNSCFG=0,"8.8.8.8","223.5.5.5"** // Configure reliable DNS >> >> OK >> **AT+QHTTPCFG="contextid",0** >> >> OK >> **AT+QHTTPCFG="responseheader",1** >> >> OK >> **AT+QHTTPCFG="requestheader",1** >> >> OK >> **AT+QSSLCFG=0,0,"seclevel",0** >> >> OK >> **AT+QHTTPCFG="ssl",0,0** >> >> OK >> **AT+QSSLCFG=0,0,"sni",1** >> >> OK >> **AT+QHTTPURL=75,80** >> >> > https://spc-smoke-sniffer-function-app-dev.azurewebsites.net/api/devicelxxx	In the actual development, please configure parameters according to your application

```
>>
>> OK
>> AT+QHTTPPOST=404,80,80
>>
>> >
POST /api/devicelogs HTTP/1.1
Host: spc-smoke-sniffer-function-app-dev.azurewebsites.net:443
Authorization: Basic MzUtMjA5OTAwLTE3NjE0OC03OjM=
User-Agent: Apifox/1.0.0 (https://apifox.com)
Content-Type: text/plain
Accept: */*
Connection: keep-alive
Content-Length: 125

[{"IMEI":"35-209900-176148-7","LogTypeId":"1","Value":"Normal"},
{"IMEI":"35-209900-176148-7","LogTypeId":"2","Value":"True"}]
>>
>> OK
>>
>> +QHTTPPOST: 0,200,205
>> AT+QHTTPREAD=1024
>>
>> +QHTTPREAD: 329,0
>> HTTP/1.1 200 OK
>> Content-Length: 205
>> Content-Type: application/json; charset=utf-8
>> Date: Tue, 12 Nov 2024 10:55:35 GMT
>>
>> [{"subDeviceId":0,"imei":"35-209900-176148-
7","logTypeId":1,"value":"Normal","dateLogged":"11/12/2024"},{"subDeviceId":0,
"imei":"35-209900-176148-7","logTypeId":2,"value":"True",
"dateLogged":"11/12/2024"}]
>>
>> OK
// Custom GET requests based on POST methods for requestheader/
responseheader
>> AT+QIDNSCFG=0,"8.8.8.8","223.5.5.5"          // Configure reliable DNS
>>
>> OK
>> AT+QHTTPCFG="responseheader",1
>>
>> OK
>> AT+QHTTPCFG="requestheader",1
>>
>> OK
>> AT+QSSLCFG=0,0,"seclevel",0
>>
>> OK
>> AT+QHTTPCFG="ssl",0,0
```

	>> >> OK >> **AT+QSSLCFG=0,0,"sni",1** >> >> OK >> **AT+QHTTPURL=96,80** >> >> > https://spc-smoke-sniffer-function-app-dev.azurewebsites.net/api/commanxx /35-209900-176148-7/102 >> >> OK >> **AT+QHTTPPOST=248,80,80** >> >> > GET /api/commands/35-209900-176148-7/102 HTTP/1.1 Host: spc-smoke-sniffer-function-app-dev.azurewebsites.net Authorization: Basic MzUtMjA5OTAwLTE3NjE0OC03OjM= User-Agent: Apifox/1.0.0 (https://apifox.com) Accept: */* Connection: keep-alive >> >> OK >> >> +QHTTPPOST: 0,200,2 >> **AT+QHTTPREAD=1024** >> >> +QHTTPREAD: 192,0 >> HTTP/1.1 200 OK >> Content-Length: 2 >> Content-Type: application/json; charset=utf-8 >> Date: Tue, 12 Nov 2024 11:00:33 GMT >> Request-Context: appId=cid-v1:2b659d4a-595b-4cb4-9f04-b4177a338dda >> >> [] >> >> OK	

3- Feature of RAI

Feature of RAI	1) After the data interaction is completed, you can run AT+QPING=0,"8.8.8.8",4,1,32,1	
R3-1	>> **AT+QPING=0,"8.8.8.8",4,1,32,1** //QPING method with RAI Flag >> OK >> >> +QPING: 0,8.8.8.8,32,729,51 >> >> +QPING: 0,1,1,0,729,729,729	RAI implementation method AT+QCFG="slplocktimes", <value> ; to configure the AT sleep lock to a value, this value is very important, it will affect the module to quickly enter

	>> >> +CSCON:0 //If +CSCON:0 is returned within 0-2s, RAI is effective >> **AT+QSCLK=1** //Enable deepsleep mode >> OK	deepsleep, it is recommended that you contact QUECTEL engineers to provide the solution
4- Enter status PSM and Deepsleep		
4-1	>> >> +QNBIOTEVENT: "ENTER PSM" //Enter the PSM state >> >> +QNBIOTEVENT: "ENTER DEEPSLEEP" //Enter the deepsleep state //The mcu or program needs to monitor the URC of PSM and deepsleep state for a certain window time to determine whether it has successfully entered the deepsleep state. If Deepsleep fails to enter within the window time, The program maybe to go to 0-2; If URC outputs "ENTER PSM" but does not immediately output "ENTER DEEPSLEEP", it is usually related to slplocktimes, which defaults to 10 seconds. It indicates that the interval from the last AT to deepsleep (the modem has entered sleep mode) is 10 seconds. If you have enabled RAI and T3324 is extremely short, for the timer you need to re-set a smaller slplocktimes. Note that execute AT+QCFG="slplocktimes",<value> to set other value, which will take effect after a reboot and be saved; You need to make settings and reboot after the modem is initialized.	Note If the URC +ENTER PSM output,but does not +ENTER DEEPSLEEP immediately, it is mainly due to the AT sleep lock. Contact QUECTEL' s Technical support for a solution
5- Exit status of Deepsleep and PSM		
H5-1-1	**//BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state **//Recreate the HTTP connection** H3-1,H3-2,H3-3 >> >> +QNBIOTEVENT: "EXIT PSM" //Exit the PSM state >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QHTTPPOST: 0,200,139 //The POST was established successfully **Go to 5-2,or goto H2-3 for sending data,or goto other, and the subsequent process**	Method to trigger PSM wake-up
H5-1-2	**//If you want to obtain the accurate signal reference in the current scene immediately after the PSM is woked up, please refer to //BC660K&BC950K support to wake up deepsleep by executing AT command or pulling down PSM_EINT pin** >> >> +QNBIOTEVENT: "EXIT DEEPSLEEP" //Exit the deepsleep state >> AT+QPING=0,"8.8.8.8",4,1,32 //Trigger PSM wake-up >> >> OK >> >> +QNBIOTEVENT: "EXIT PSM" >> >> +CSCON: 1 //Indicates that the RRC connection is established after the PSM is wakeup >> >> +QPING: 0,8.8.8.8,32,1284,51 >>	If the program or mcu needs to deal with other tasks, such as collecting the base station cell signal after wake-up; It is recommended to refer to this method to trigger PSM wake-up and obtain the network signal after wake-up. If no such requirement in the program, ignore the process

	>> +QPING: 0,1,1,0,1284,1284,1284 >> **AT+QENG=0** //Query signal reference >> +QENG: 0,3686,11,121,"05C4EF33",-75,-8,-65,14,8,"4C10",0,9,3 >> >> OK **//Recreate the HTTP connection** H3-1,H3-2,H3-3 **//It is recommended to report the data of relevant signal reference over HTTP** **"rsrp=-75,snr=14,cellid=05C4EF33,earfcn=3686,pci=121"** **Go to 5-2,or goto R4-1 or other HTTPS**	
5-2	**//Manual TAU update** >> **AT+CPSMS=0** >> OK >> **AT+CPSMS=1,,,"01000010","00000000"** >> OK **Go to R4-1 or other HTTPS**	TAU update manually can avoid automatic update of TAU cycle over time, so,non-service power consumption can be reduced; If no requirement in the application, ignore this step
6- Erase the historical frequency		
6-1	**//If 1-8 the registration network is not successful within the set search time(such as 2min), go to** >> **AT+CFUN=0** //Erase the historical frequency based on CFUN0 >> OK >> **AT+QCSEARFCN** //Erase the historical frequency >> OK >> **AT+QBAND=1,28** //*Lock a specific frequency band. Note that it is not recommended for non-specific situations, Unless you already know the BANDs in the area where the device is located and in order to speed up your search for a radio network. >> OK >> **AT+QRST=1** //Reboot, and re-search >> OK **Follow 1-7 above**	As described in 1-8, it is suggested that in the program design, after the first search fails to time out, the frequency clearing program must be executed. After run, follow the 1-7 to check the search status again; If the research fails to time out, you are advised to reboot without clearing the frequency again. Or wait for the next service cycle and try again.
7- Exception handling or interruption		
7-1	1) The program or mcu shall add the interrupt method of timeout or failure of leshan platform registration, such as re-registration or reboot; 2) The program or mcu shall add the interrupt method of sending or receiving data timeout or failure, such as reboot; 3) The program or mcu should add interrupt methods that cannot enter PSM normally or cannot wake up PSM, such as reboot; 4) In the case of exceptions, when the program or mcu performs hardware reset or power-off directly, you need to execute AT+CFUN=0 first, and return OK, then control hardware reset or power-off; But software reset or reboot does not run AT+CFUN=0.	If the terminal has strict requirements on power consumption, it is recommended that the program reasonably control timeout. If unable to enter PSM or wake up from PSM, it is recommended to compare the normal time to enter PSM or exit PSM. If the time exceeds, power off or reboot should can be operated