SIM7020 Series_ Low Power Mode_Application Note

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About Document

Document Information

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Related Documents

[1] SIM7020 Series AT Command Manual V1.03

[2] SIM7020 Hardware Design_V1.02

[3] SIM7020G Hardware Design_V1.00

[4] SIM7020 Series_TCPIP_Application_Note_V1.02

This document applies to the following products:

Name	Type	Size (mm)	Comments
SIM7020C	NB1	17.6*15.7	Band 1/3/5/8
SIM7020E	NB1	17.6*15.7	Band 1/3/5/8/20/28
SIM7020G	NB2	17.6*15.7	Band 1/2/3/4/5/8/12/13/17/18/19/20/25/26/28/66/70/71/85
SIM7060G	NB2+GNSS	24*24	Band 1/2/3/4/5/8/12/13/17/18/19/20/25/26/28/66/70/71/85

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Contents

Figure and Table

1 Purpose of this document

Based on module AT command manual, this document will introduce module low power modes and relevant conditions.

Developers could understand and develop application quickly and efficiently based on this document.

2 Introduction

NB-IoT supports three power saving modes: PSM (Power Saving Mode), DRX (Discontinuous Reception Mode), and eDRX (Extended DRX).

PSM (power saving mode) and eDRX (extended Discontinuous Reception) are used in NB-IOT to save power. In PSM mode, the terminal does not need to receive paging to detect whether there is downlink service, and eDRX mode has a longer paging detection period than DRX, which may result in a longer time delay, which has an impact on the real-time performance of the data. Whether the PSM or the eDRX are used depends on the capabilities and configuration of the terminal and the network. In terms of capabilities, the capability network that the terminal does not support must not be configured, and the capabilities supported by the terminal may be different in different situations of the network.

2.1 PSM mode

In PSM mode, the terminal does not detect whether there is paging data in the downlink. As long as the TAU and uplink need to send data, the PSM state will be exited. T3412 is the time of TAU (Tracking Area Update), and T3324 is the timer that enters PSM in IDLE mode.

DRX
It can be considered that the downlink service can reach the terminal equipment at any time. In each DRX cycle (1.28s, 2.56s, 5.12s or 10.24s), the terminal will detect whether there is a downlink service arrival, which is applicable to services with high requirements for delay. Terminal equipment generally adopts a power supply method, such as a street light service.
● Since the DRX cycle is short (1.28s, 2.56s, 5.12s, or 10.24s, determined by the operator's network side setting), the downlink service can be considered to be reachable at any time with a small delay.
● Applicable to services with high latency requirements, but with relatively high power consumption. Terminal devices generally use power supply.

2.2   eDRX

eDRX has a longer paging cycle than DRX, which enables the terminal to save power and also causes longer downlink data delay (such as DRX value of 1.28s\2.56s, and eDRX value can be 20.48s, even 2.9h), so it is suitable for use in scenarios where time urgency is not very high.

2.3   The difference between three modes

DRX: Can find devices anytime, anywhere.
eDRX: It takes from few minutes to an hour or even longer time to find the device.
PSM: It may take a day or longer time to find the device.

3 PSM Mode

Power **S**aving **M**ode (**PSM**) will start after data connection terminates or periodic TAU completes. Data connection terminates, module will go to idle mode firstly, and then move to DRX (Discontinuous Reception) status. Once timer T3324 is expired, module will enter into PSM mode.

In PSM mode, module will be in a kind of deep sleep mode, in extremely low power mode, the current of SIM7020 is about 3.5 μA.
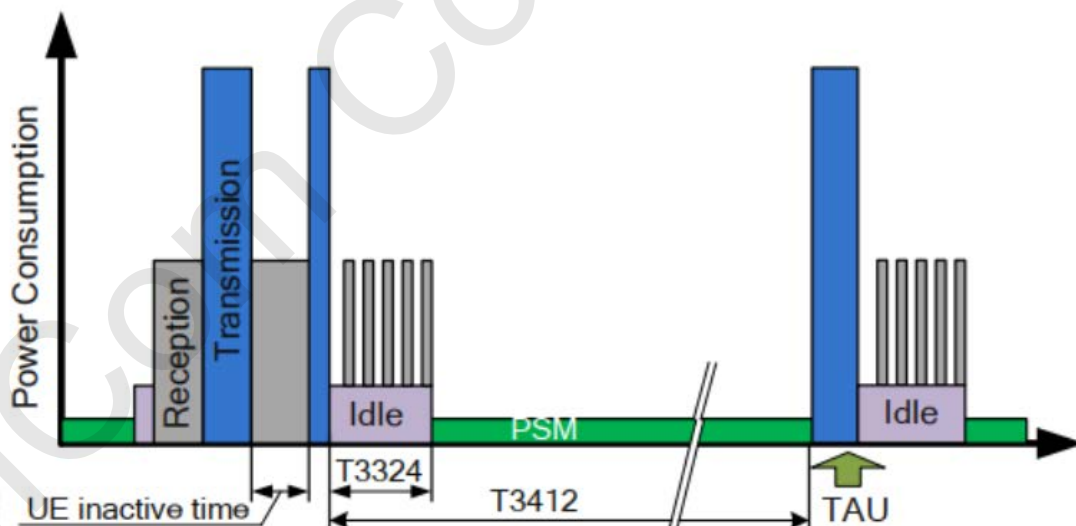
Figure 1   PSM mode

3.1   PSM Wake-up

Wake-up conditions:
1)   T3412 timer is expired

2) Pulling PWRKEY to low level (Typ. 800ms)

3) Pulling RTC_EINT to low level

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{on}	The time of active low level impulse of PWRKEY pin to power on module	215	800	-	ms

Figure 2   PWRKEY time

3.2   AT Commands Related to PSM Mode

AT Command	Description
AT+CPSMS	Power Saving Mode Setting
AT+CNBIOTRAI	NB-IOT Release Assistance Indication
AT+RETENTION	Retention of Socket Scence

For the detail of these commands, Please refer to "SIM7020 Series AT Command Manual".

NOTE：**Parameters for AT+CPSMS command**

+CPSMS:

<mode>,<Requested_Periodic-RAU>,<Requested_GPRS-Ready-timer>,<Requested_periodic-TAU>
,<Requested_Active-Time>

Here, parameters <Requested_Periodic-RAU> and<Requested_GPRS-Ready-timer> are not need to configure. <Requested_periodic-TAU> is T3412_ext, <Requested_Active-Time> is timer T3324.

Parameter includes unit (high 3 bits) and value (low 5 bits), below is the table.

<Requested_Periodic-TAU>

Unit	Base	Min. in Second	Max. in Second
0	10min	2400	18600
1	1h	21600	111600
2	10h	144000	1116000
3	2sec	0	62
4	30sec	90	930
5	1min	960	1860
6	320h	1152000	35712000

Table 1   <Requested_Periodic-TAU> of AT+CPSMS

For example, <TAU>=01000111 means, unit=2(010 hours) and value=7(00111), so total period is 7*10hours=70 hours.

<Requested_Active-Time>

Unit	Base	Min. in Second	Max. in Second

0	2sec	0	62
1	1min	120	1860
2	6min	2160	11160

Table 2   <Requested_Active-Time> of AT+CPSMS

For example, <Requested_Active-Time>=00001111
Parameter includes unit (high 3 bits) and value (low 5 bits)
T3324 is 000 (2s) x 01111 (15)=30s

3.3   Notice

1) After module wake up from PSM mode by PWRKEY or RTC_EINT, it will enter into PSM mode automatically after 5s timer (The module will not do the Random Access Channel (RACH) procedure to attach to the base station). There is a 5s timer for UART port (Refer to section 5.2.5). If MCU sends AT command every second, the module will not enter into PSM mode.

2) The module only makes network requests when it switches from CPSMS 0 to CPSMS 1, and gets the parameters issued by the operator. When the value of CPSMS is already 1, reconfiguring AT+CPSMS=1 will not do network requests.

3) The actual value of T3324 and T3412 is issued by the operator. The parameters of T3324 and T3412 manually configured by AT+CPSMS command can only take effect after they are accepted and issued by the operator. The actual value of T3324 and T3412 can be used according to the query through AT+CEREG command (Refer to section 5.2.1).

4) When USB interface of module is connected to the PC, the module can't enter into the PSM mode.

5) For TCP connection, it must close the socket after the data exchange, and then the module can enter into the PSM mode. Otherwise, the module can't enter into the PSM mode.

4 eDRX Mode

4.1   eDRX introduction

4.1.1 eDRX Mode

The eDRX mode is a new feature in the Rel-13. Its main purpose is to support longer-cycle paging monitoring to save power. The traditional 2.56-second paging interval consumes a large amount of power for the UE, and the downlink data transmission frequency is small. Through the

negotiation cooperation between the core network and the user terminal, the user terminal skips most of the paging monitoring, thereby achieving the purpose of power saving.

The power saving effect of the eDRX mode is worse than the PSM mode, but the accessibility of the downlink communication link is greatly improved relative to the PSM mode.

The eDRX cycle is shown in Figure 3. The user can check the eDRX cycle by consulting the relevant AT command (AT+CEDRXS).

4.1.2 PTW

During each eDRX cycle, there is a Paging Time Window (PTW). The UE can only listen to the paging channel according to the DRX cycle in the PTW to receive downlink traffic. The time outside the PTW is in a sleep state and does not monitor. The paging channel cannot receive downlink traffic.

The PTW cycle is shown in Figure 3. The user can perform the PTW cycle setting by consulting the relevant AT command (AT*MEDRXCFG).

Note: The user terminal and the core network negotiate the length of the eDRX through the attach and TAU procedures.
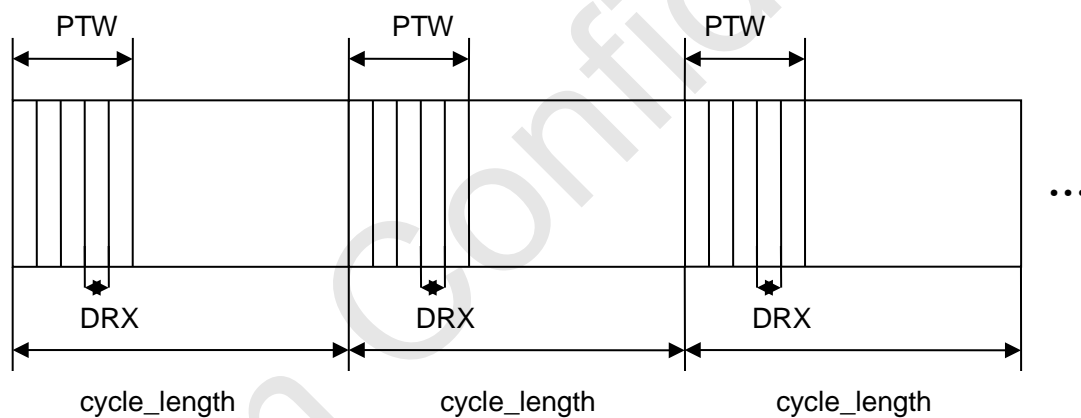
Figure 3   eDRX diagrammatic sketch

4.1.3 eDRX cycle length

Paging Time Window (PTW), octet 3 (bit 8 to 5)
The field contains a PTW value. The PTW value can be applied for NB-S1 mode as specified below.

NB-S1 mode
The field contains the PTW value in seconds for NB-S1 mode. The PTW value is used as specified in 3GPP TS 23.682 [133a].The PTW value is derived as follows:

Bit

8	7	6	5	Paging Time Window length
0	0	0	0	2,56 seconds
0	0	0	1	5,12 seconds
0	0	1	0	7,68 seconds
0	0	1	1	10,24 seconds
0	1	0	0	12,8 seconds
0	1	0	1	15,36 seconds
0	1	1	0	17,92 seconds
0	1	1	1	20,48 seconds
1	0	0	0	23,04 seconds
1	0	0	1	25,6 seconds
1	0	1	0	28,16 seconds
1	0	1	1	30,72 seconds
1	1	0	0	33,28 seconds
1	1	0	1	35,84 seconds
1	1	1	0	38,4 seconds
1	1	1	1	40,96 seconds

Table 3   PTW value

eDRX value, octet 3 (bit 4 to 1)
The octet contains the eDRX value field. The parameter values are applied for A/Gb mode, Iu mode or S1 mode according to the tables below.

S1 mode
The field contains the eDRX value for S1 mode. The E-UTRAN eDRX cycle length duration value and the eDRX cycle parameter 'TeDRX' as defined in 3GPP TS 36.304 [121] are derived from the eDRX value as follows:

Bit

4	3	2	1	E-UTRAN eDRX cycle length duration	eDRX cycle parameter 'T_{eDRX}'
0	0	0	0	5,12 seconds (NOTE 2)	NOTE 1
0	0	0	1	10,24 seconds (NOTE 2)	2^0
0	0	1	0	20,48 seconds	2^1
0	0	1	1	40,96 seconds	2^2
0	1	0	0	61,44 seconds (NOTE 3)	6
0	1	0	1	81,92 seconds	2^3
0	1	1	0	102,4 seconds (NOTE 3)	10
0	1	1	1	122,88 seconds (NOTE 3)	12
1	0	0	0	143,36 seconds (NOTE 3)	14
1	0	0	1	163,84 seconds	2^4
1	0	1	0	327,68 seconds	2^5
1	0	1	1	655,36 seconds	2^6
1	1	0	0	1310,72 seconds	2^7
1	1	0	1	2621,44 seconds	2^8
1	1	1	0	5242,88 seconds (NOTE 4)	2^9
1	1	1	1	10485,76 seconds (NOTE 4)	2^{10}

Table 4   eDRX cycle length

All other values shall be interpreted as 0000 by this version of the protocol.

NOTE 1: For E-UTRAN eDRX cycle length duration of 5,12 seconds the eDRX cycle parameter 'TeDRX' is not used as a different algorithm compared to the other values is applied. See 3GPP TS 36.304 [121] for details.

NOTE 2: The value is applicable only in WB-S1 mode. If received in NB-S1 mode it is interpreted as if the Extended DRX parameters IE were not included in the message by this version of the protocol.

NOTE 3: The value is applicable only in WB-S1 mode. If received in NB-S1 mode it is interpreted as 0010 by this version of the protocol.

NOTE 4: The value is applicable only in NB-S1 mode. If received in WB-S1 mode it is interpreted as 1101 by this version of the protocol.

4.2   AT Commands Related to eDRX Mode

AT Command	Description
AT+CEDRXS	eDRX Setting
AT+CEDRXRDP	eDRX Read Dynamic Parameters
AT*MEDRXCFG	eDRX Configuaration

For the detail of these commands, Please refer to "SIM7020 Series AT Command Manual".

4.3　Power consumption

The power consumption under different eDRX parameters is shown in Table 6. This is the test result of enabling eDRX and entering into the sleep mode.

Item	Condition AT+CNETLIGHT=0; AT+CEDRXS=1	Consumption (μA)
1	PTW=10.24s; eDRX cycle length=20.48s; DRX cycle length =2.56s	454
2	PTW=20.48s; eDRX cycle length =81.92s; DRX cycle length =2.56s	377

Table 5　Power consumption under different eDRX parameters

5 Sleep Mode

In sleep mode, module will consume very low power, but still can receive paging.
When DRX is 2.56s, the current is about 0.46 mA, for the detail, please refer to "SIM7020 Hardware Design".

6 AT Test Example

6.1　Bearer Configuration

Usually module will register PS service automatically.

6.1.1 PDN Auto-activation

AT Command	Response	Description
AT+CPIN?	+CPIN:READY OK	Check SIM card status
AT+CSQ	+CSQ: 20,0	Check RF signal

AT Command	Response	Description
	OK	
AT+CGREG?	+CGREG: 0,1	Check PS service
	OK	
AT+CGACT?	+CGACT: 1,1	Activated automatically
	OK	
AT+COPS?	+COPS: 0,2,"46000",9	Check operator information
		46000 is Numeric <oper>
	OK	9 is NB-IOT network
AT+CGCONTRDP	+CGCONTRDP:	Attached PS domain and got IP
	1,5,"cmnbiot","100.80.73.123.255.255.255.0"	address automatically
	OK	

6.1.2 APN Manual configuration

If not attached automatically, could configure correct APN setting.

AT Command	Response	Description
AT+CFUN=0	+CPIN: NOT READY	Disable RF
	OK	
AT*MCGDEFCONT="IP","cmnbiot"	OK	Set the APN manually
AT+CFUN=1	OK	Enable RF
	+CPIN: READY	
AT+CGREG?	+CGREG: 0,1	Inquiry PS service
	OK	
AT+CGCONTRDP	+CGCONTRDP:	Attached PS domain and got IP
	1,5,"cmnbiot","100.80.73.123.255.255.255.0"	address automatically
	OK	

6.2 PSM Mode Demo

6.2.1 Enable/Disable PSM mode

AT Command	Response	Description
AT+CPSMSTATUS=1	OK	Enable PSM Event report

AT+IPR=115200	OK	Fix baud rate
AT+CEREG=4	OK	
AT+CEREG?	+CEREG: 4,1,"5B57","01A50B1A",9,"00",,,"111000 00","11100000" OK	
AT+CPSMS=1,,,"01011111","00000001"	OK +CEREG: 1,"5B57","01A50B1A",9,"00",,,"11100000","11100000" +CEREG: 1,"5B57","01A50B1A",9,"00",,,"00000001","11100000" +CPSMSTATUS: "ENTER PSM"	Enable PSM mode and set the specific T3412_ext and T3324
AT+CEREG?	+CEREG: 4,1,"5B57","01A50B1A",9,"00",,,"00000001","11100000" OK	Inquiry timers configured by network.
AT+CEREG=0	OK	Disable network registration unsolicited result code
AT+CPSMS=0	OK	Disable PSM

6.2.2 PSM and UDP test case

AT Command	Response	Description
AT+CPSMSTATUS=1	OK	Enable PSM Event report
AT+IPR=115200	OK	Fix baud rate
AT+CPSMS=1,,,"01011111","00000001"	OK +CPSMSTATUS: "ENTER PSM"	Enable PSM mode and set the specific T3412_ext and T3324
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from PSM mode
AT+CSOC=1,2,1	+CSOC: 0	Set up UDP connection

AT Command	Response	Description
	OK	
AT+CSOCON=0,8309,"117.131.85.139"	OK	
AT+CSOSEND=0,0,"Hello Light"	OK	Send data to UDP server
	+CSONMI: 0,28,68656C6C6F2053494D3730323045	Receive the data from the UDP server
	+CPSMSTATUS: "ENTER PSM"	The module will enter into PSM mode automatically after data exchange

6.2.3 PSM and TCP test case

AT Command	Response	Description
AT+CPSMSTATUS=1	OK	Enable PSM Event report
AT+IPR=115200	OK	Fix baud rate
AT+CPSMS=1,,,"01011111","00000001"	OK	Enable PSM mode and set the specific T3412_ext and T3324
	+CPSMSTATUS: "ENTER PSM"	
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from PSM mode
AT+CSOC=1,1,1	+CSOC: 0	Set up TCP connection
	OK	
AT+CSOCON=0,8409,"117.131.85.139"	OK	
AT+CSOSEND=0,0,"Hello Light"	OK	Send data to TCP server
	+CSONMI: 0,28,68656C6C6F2053494D3730323045	Receive the data from the TCP server
AT+CSOCL=0	OK	For TCP connection, must close the socket, otherwise the module can't enter into PSM mode
	+CPSMSTATUS: "ENTER PSM"	

6.2.4 PSM and UDP test case with AT+RETENTION=1

AT Command	Response	Description

AT Command	Response	Description
AT+CPSMSTATUS=1	OK	Enable PSM Event report
AT+IPR=115200	OK	Fix baud rate
AT+CPSMS=1,,,"01011111","00000001"	OK	Enable PSM mode and set the specific T3412_ext and T3324
	+CPSMSTATUS: "ENTER PSM"	
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from PSM mode
AT+RETENTION=1	OK	Recover scene when module exited PSM mode (Default value is 0)
AT+CSOC=1,2,1	+CSOC: 0 OK	Set up UDP connection
AT+CSOCON=0,8309,"117.131.85.139"	OK	
AT+CSOSEND=0,0,"Hello Light"	OK	Send data to UDP server
	+CSONMI: 0,28,68656C6C6F2053494D3730323045	Receive the data from the UDP server
	+CPSMSTATUS: "ENTER PSM"	The module will enter into PSM mode automatically after data exchange
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from PSM mode
AT+CSOSEND=0,0,"Hello Light"	OK	Send data to the previous UDP server directly
	+CPSMSTATUS: "ENTER PSM"	The module will enter into PSM mode automatically after data exchange

6.2.5 PSM and UDP test case with AT+CNBIOTRAI mode 0 & 1

AT Command	Response	Description
AT+CPSMSTATUS=1	OK	Enable PSM Event report
AT+IPR=115200	OK	Fix baud rate

AT+CPSMS=1,,,"01011111","00000001"	OK	Enable PSM mode and set the specific T3412_ext and T3324
	+CPSMSTATUS: "ENTER PSM"	
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from PSM mode
AT+CNBIOTRAI?	+CNBIOTRAI: 0	
	OK	
AT+CSOC=1,2,1	+CSOC: 0	Set up UDP connection
	OK	
AT+CSOCON=0,8309,"117.131.85.139"	OK	
2019-04-17 15:44:31 AT+CSOSEND=0,0,"Hello Light"	OK	The module will enter into PSM mode automatically after data exchange
	2019-04-17 15:44:51 +CPSMSTATUS: "ENTER PSM"	It takes about 20s with T3324=2s setting to enter into the PSM mode
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from PSM mode
AT+CNBIOTRAI=1	OK	Enable Release Assistance Indication
AT+CSOC=1,2,1	+CSOC: 0	Set up UDP connection
	OK	
AT+CSOCON=0,8309,"117.131.85.139"	OK	
2019-04-17 15:56:37 AT+CSOSEND=0,0,"Hello Light"	OK	The module will enter into PSM mode automatically after data exchange
	2019-04-17 15:56:41 +CPSMSTATUS: "ENTER PSM"	It takes ONLY about 4s with T3324=2s setting to enter into the PSM mode
	+CPIN: READY	Pull PWRKEY to low level to wake up module from PSM mode
	+CPSMSTATUS: "EXIT PSM"	URC reports for waking up from

		PSM mode
2019-04-17 16:00:15 AT+CNBIOTRAI?	+CNBIOTRAI: 0 OK	After PSM cycle test, it will return back to the default value 0
	2019-04-17 16:00:20 +CPSMSTATUS: "ENTER PSM"	SIM7020 will enter into PSM mode automatically after 5s timer

6.3   eDRX Mode Demo

NOTE:

1) After eDRX enabled, you need to let module enter into sleep mode. To disable eDRX, you need to exit sleep mode firstly. In order to achieve real power saving.

2) If not enter into sleep mode, Enable eDRX mode is used to enter eDRX in standby mode.

AT Command	Response	Description
AT+COPS?	+COPS: 0,2,"46000",9 OK	Check operator info "46000" is operator's name 9 is NB-IOT network
AT+CEDRXS=?	+CEDRXS: (0-3),(5),("0000"-"1111") OK	Query eDRX parameters range
AT+CEDRXS?	+CEDRXS: 5,"0000" OK	Query eDRX current status
AT+CEDRXS=1	OK	Enable eDRX function. This configuration will be saved after reboot.
AT+CEDRXRDP	+CEDRXRDP: 5,"0010","0010","0011" OK	If eDRX supported, "0010" Requested cycle length "0010" Cycle length from network "0011" PTW
AT+CEDRXRDP	+CEDRXRDP: 0 OK	If eDRX not supported, return with 0.

6.3.1 Set eDRX with cycle length 20.48s

AT Command	Response	Description
AT+CEDRXS?	+CEDRXS: 5,"0000" OK	Query eDRX current status
AT+CEDRXS=1,5, "0010"	OK	Set eDRX cycle length with "0010",which is

		20.48 s.
AT+CEDRXRDP	+CEDRXRDP: 5,"0010","0010","0001"	"0010" Requested cycle length
		"0010" Cycle length from network
		"0001" PTW from network
	OK	

6.3.2 Set eDRX with cycle length 20.48s and PTW 10.24s

AT Command	Response	Description
AT+CEDRXS?	+CEDRXS: 5,"0000"	Query eDRX current status
	OK	
AT*MEDRXCFG=1,5,"0010","0011"	OK	Set eDRX cycle length with "0010"(20.48 s). PTW with "0011"(10.24s).
AT+CEDRXRDP	+CEDRXRDP: 5,"0010","0010","0011"	"0010" Requested cycle length
		"0010" Cycle length from network
		"0011" PTW from network
	OK	

6.3.3 Set eDRX with cycle length 163.84s to enter into the deep sleep mode

AT Command	Response	Description
AT+CEDRXS?	+CEDRXS: 5,"0000"	Query eDRX current status
	OK	
AT+CEDRXS=1,5, "1001"	OK	Set eDRX cycle length with "1001",which is 163.84 s.
AT+CEDRXRDP	+CEDRXRDP: 5,"1001","1001","0001"	"1001" Requested cycle length
		"1001" Cycle length from network
		"0001" PTW from network
	OK	

NOTE：

If the cycle length is greater than or equal to 163.84 s, the module will enter into deep sleep.
The wake up requires the following conditions:

1） ***Cycle length timer is expired***
2） ***Pulling PWRKEY to low level (Typ. 800ms)***
3） ***Pulling RTC_EINT to low level***

6.3.4 Disable eDRX mode

AT Command	Response	Description
AT+CEDRXS=0	OK	Disable eDRX function
AT+CEDRXRDP	+CEDRXRDP: 0	
	OK	

6.4 Sleep Mode Demo

6.4.1 Hardware Method

AT Command	Response	Description
AT+CSCLK=1	OK	Enable sleep mode 1.
		Pulling up DTR pin, module will go to normal sleep mode
		Pulling down DTR pin will wake module up from sleep mode.

6.4.2 Software Method

AT Command	Response	Description
AT+CSCLK=2	OK	After mode 2 configured, module will go to sleep mode automatically, if there is no data exchanged via UART.
		Sending twice (any) AT command will wake up module from the sleep mode.

NOTE:
For the detail about the sleep mode, please refer to "SIM7020 Hardware Design".

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