



SIM7022 Series_Low Power Mode_Application Note

LPWA Module

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About Document

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V1.00	2022.5.31	Xinsheng.Wu Yanan.Sun	First Release
V1.01	2022.07.08	Yanan.Sun	Update some description

Scope

This document applies to the following products

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1 Introduction

1.1 Purpose of the document

Based on SIM7022 AT command manual, this document will introduce the low power mode on SIM7022. Developers could understand and develop application quickly and efficiently based on this document.

1.2 Related documents

[1] SIM7022 Series_AT Command Manual

2 Lower Power Mode Introduction

NB-IoT technology 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

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.

2.2 DRX

DRX 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.

2.3 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 application in scenarios where time urgency is not very high.

2.4 The difference between three modes

No.	Method	Description
1	PSM	It may take a day or longer time to find the device.
2	DRX	Can find devices anytime, anywhere.
3	eDRX	It takes from few minutes to an hour or even longer time to find the device.

PSM Mode

This section describes the PSM application features of SIM7022 series of module.

Power Saving Mode (**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 SIM7022 is about 0.8 μ A. After timer T3412 get expired, the terminal wakes up itself. The terminal can also be woken up by pulling the wake-up pin down.

The module needs to confirm its maximum allowed sleep depth before entering hibernation. The sleep depth level can be set with the AT command "AT+ECPMUCFG". With different sleep depth level, the system internal power off differs in amount, resulting in different module power consumption.

SIM7022 can enable the PSM function by sending the command "AT+CPSMS=1". When the conditions are met, the module automatically enters the PSM mode. The module has very low current consumption at PSM (typical: 800 nA). The main purpose of PSM is to reduce module power consumption and prolong battery power supply time.

The following figure shows the power consumption of the module in different modes.

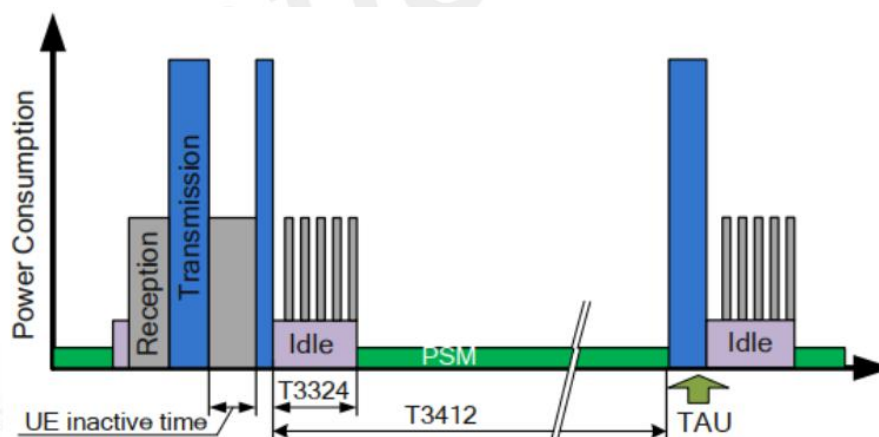


Figure1 PSM mode

3.1 Sleep Depth Level

The sleep depth is higher than SLEEP1 and only RTC Wake-up and Wake-up pin are supported. Any interruption of peripherals in IDLE state can wake up the system.

The hardware block diagram of PMU is as following

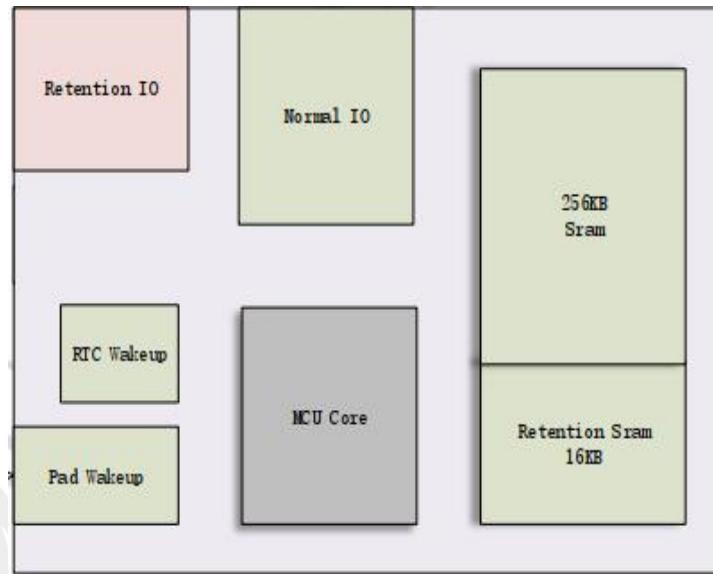


Figure1 Hardware

There are few sleep depth levels the module could enter in:

ACTIVE state: The module is in active mode, even if there is nothing to do, the internal MCU will still be in the cyclic waiting state with high power consumption.

IDLE state: When MCU has no task, the core working clock will be turned off. Any interruption will wake up the system and restart the core clock.

SLEEP1 state: All peripherals are powered off on the IDLE basis. If the peripherals are interrupted, the system cannot be waked up.

In SLEEP2 state, 256KB Memory is closed based on SLEEP1, and only 16KB Memory is reserved.

HIBERNATE state: 16KB Retention Memory is turned off based on SLEEP2. This mode could get the lowest consumption.

SIM7022 is based on a multi-task system, which determines sleep depth equally. The final sleep depth is affected by many factors, and eventually SIM7022 will enter the deepest sleep mode possible.

Maximum sleep depth	AT Command	Minimum power consumption (typical value)
HIBERNATE	AT+ECPMUCFG=1,4	800nA
SLEEP2	AT+ECPMUCFG=1,3	8uA
SLEEP1	AT+ECPMUCFG=1,2	22uA
IDLE	AT+ECPMUCFG=1,1	>2.8mA

Disable PSM	AT+ECPMUCFG=0	>8mA
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3.2 PSM wake-up

After SIM7022 enters into PSM mode, the network connection is terminated and SIM7022 cannot respond to user requests.

If you need to send commands to the module through the serial port, need to wake up the module first and then send corresponding AT commands.

SIM7022 could exit from PSM mode with one of the following ways:

- After the network timer T3412 expired the module automatically exits from the PSM mode.
- Pull the WAKEUP pin low then module will wake up.

When the module detects that WAKEUP has a falling edge, the module will be awakened. At this time, relevant AT instructions need to be sent to the module within 10ms.

- Pull down the RESET pin to wake up the module.

At this time, the module is equivalent to a restart, the module will re-register, find the network, All the previous module settings will be lost.

3.3 PSM AT Commands

Command	Description
AT+CPSMS	Power Saving Mode Setting
AT+QCPSMR	Report power saving mode status
AT+QCPMUCFG	Set PMU mode
AT+QCSTATUS	Current reporting setting in the MT

For details, please see SIM7022 Series_AT Command Manual.

3.4 PSM Setting

AT+CPSMS could be used to set PSM parameters.

The <requested_periodic-rau> and <requested_gPRs-ready-timer> parameters do not need to be configured.

<Requested_Periodic-TAU> indicates T3412_ext, and <Requested_active-timer> indicates T3324.

Parameter values are expressed as 8-bit binary numbers, with the third digit as unit and the lower five digit as value. The conversion method is as follows.

<Requested_Periodic-TAU>

Unit	Cardinal number	The minimum seconds	The maximum seconds
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
7	Timer outage	-	-

The default value is 20 hours.

So 01000111 represents the value unit=2(010), value=7(00111), the time is 70h(10h * 7).

<Requested_Active-Time>

Unit	Cardinal number	The minimum seconds	The maximum seconds
0	2sec	0	62
1	1min	120	1860
2	6min	2160	11160
7	Timer outage	-	-

The default value is 5 Minutes.

NOTE

1. +QCPSMR: 1 indicates that the module is ready to enter in the PSM sleep mode.
+QCPSMR:0 indicates when module exits from the PSM.
AT+QCPSMR controls whether or not these URCs are reported.
2. AT+CPSMS will only do TAU request to network when a different setting to the switch on or off PSM mode. For example if you already enable PSM mode by this AT command, then next AT command with different parameter to enable PSM mode will not take effect.
3. The actual value of T3324 and T3412 is issued by the operator, the value manually configured by AT+CPSMS can only take effect after they are accepted and issued by the operator. The actual value could be queried through AT+CEREG? command.

DRX Mode

This chapter describes the eDRX application features of SIM7022.

4.1 eDRX introduction

4.1.1 eDRX mode

The eDRX mode is a new feature in the 3GPP 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+CEDRX).

NOTE

The user terminal and the core network negotiate the length of the eDRX through the attach and TAU procedures.

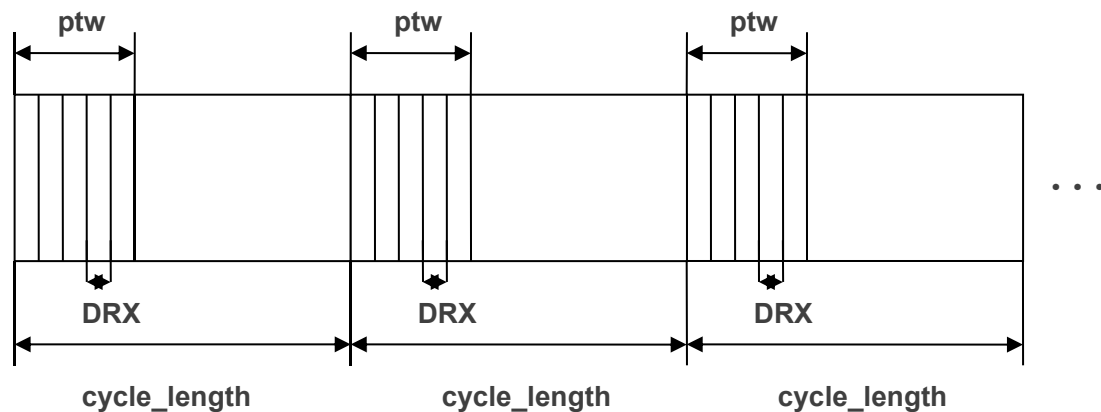


Figure 3 eDRX diagrammatic sketch

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:

4	3	2	1	eDRX cycle length duration
0	0	0	0	5.12 seconds
0	0	0	1	10.24 seconds
0	0	1	0	20.48 seconds
0	0	1	1	40.96 seconds
0	1	0	0	61.44 seconds
0	1	0	1	81.92 seconds
0	1	1	0	102.4 seconds
0	1	1	1	122.88 seconds
1	0	0	0	143.36 seconds
1	0	0	1	163.84 seconds
1	0	1	0	327.68 seconds
1	0	1	1	655.36 seconds
1	1	0	0	1310.72 seconds
1	1	0	1	2621.44 seconds
1	1	1	0	5242.88 seconds
1	1	1	1	10485.76 seconds

4.2 eDRX Setting

Commands	Description
AT+CEDRXS	Extended-DRX Setting
AT+CEDRXRDP	Read eDRX Dynamic Parameters

For details about the AT Command, see "SIM7022 Series AT Command Manual".

NOTE

AT+CEDRXRDP command can be used to query whether the request sent from a module to the network is accepted. If "+CEDRXRDP: 0" is answered, the EDRX request is not accepted by the carrier's network.

Examples

5.1 PSM Mode

//Enable\Disable PSM Mode Example.

AT+QCPMUCFG=1,4

//Set PMU Deep sleep mode

OK

AT+QCPSMR=1

//Open PSM reporting URC

OK

AT+CEREG?

+CEREG: 0,1

OK

AT+CPSMS=1,,,"01011111","00000001"

//Enable PSM Mode, Set T3412_ext and T3324

OK

+QCPSMR: 1

AT+CEREG?

//Query network status

+CEREG: 0,1

OK

AT+CPSMS=0

//Disable PSM mode

OK

5.2 eDRX Mode

Note

- 1) After enabling the eDRX, you need to enter the sleep Mode. To disable the eDRX, you need to exit the sleep Mode. In this way, we can really save electricity.
- 2) After eDRX is turned on, do not enter sleep mode, this is to enter eDRX in standby state.

5.2.1 Enable eDRX Mode

//Enable eDRX Mode Example

AT+COPS?

// Query network information, carriers, and network standards

+COPS: 0,0,"CHINA MOBILE CMCC",9

//9 means NB-IOT Network

OK

AT+CEDRXS=1,5,"0010"

//Enable eDRX

OK

AT+CEDRXS?

//Query eDRX status

+CEDRXS: 5,"0010"

OK

AT+CEDRXRDP

+CEDRXRDP: 5,"0000","0010","0100"

//If eDRX is supported

//First "0000", Query cycle length

//Second "0010" Network download Cycle length

//Third "0100" Network download PTW

OK

AT+CEDRXRDP

+CEDRXRDP: 0

//If eDRX is not support, return 0.

OK

5.2.2 Disable eDRX mode

AT+CEDRXS=0

//Close eDRX

OK

AT+CEDRXRDP

+CEDRXRDP: 0

OK