SIM7070_SIM7080_SIM7090 Series_Low Power Mode_Application Note

LPWA Module
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About Document

Version History

<table>
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<th>Version</th>
<th>Date</th>
<th>Owner</th>
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Scope

This document applies to the following products

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1 Introduction

1.1 Purpose of the document

Based on module AT command manual, this document will introduce low power mode application process.

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

1.2 Related documents


1.3 Conventions and abbreviations

In this document, the GSM engines are referred to as following term:

- ME (Mobile Equipment);
- MS (Mobile Station);
- TA (Terminal Adapter);
- DCE (Data Communication Equipment) or facsimile DCE (FAX modem, FAX board);

In application, controlling device controls the GSM engine by sending AT Command via its serial interface. The controlling device at the other end of the serial line is referred to as following term:

- TE (Terminal Equipment);
- DTE (Data Terminal Equipment) or plainly "the application" which is running on an embedded system;
2 Lower Power Mode 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.

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 use in scenarios where time urgency is not very high.

2.4 The difference between three modes

<table>
<thead>
<tr>
<th>No</th>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PSM</td>
<td>It may take a day or longer time to find the device</td>
</tr>
<tr>
<td>2</td>
<td>DRX</td>
<td>Can find devices anytime, anywhere.</td>
</tr>
<tr>
<td>3</td>
<td>eDRX</td>
<td>It takes from few minutes to an hour or even longer time to find the device.</td>
</tr>
</tbody>
</table>
3 PSM Mode

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 SIM7080 is about 3.5 μA.

![Diagram of PSM mode](image)

**Figure1  PSM mode**

3.1 PSM Wake-up

Wake-up conditions:
1) T3412 timer is expired
2) Pulling PWRKEY to low level

3.2 AT Commands Related to PSM Mode
### AT Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CPSMS</td>
<td>Power Saving Mode Setting</td>
</tr>
<tr>
<td>AT+CPSMRDP</td>
<td>Read PSM Dynamic Parameters</td>
</tr>
<tr>
<td>AT+CPSMSTATUS</td>
<td>Enable Deep Sleep Wakeup Indication</td>
</tr>
<tr>
<td>AT+CPSMCFG</td>
<td>Configure PSM version and Minimum Threshold Value</td>
</tr>
<tr>
<td>AT+CPSMCFGEXT</td>
<td>Configure Modem Optimization of PSM</td>
</tr>
</tbody>
</table>

For the detail of these commands, Please refer to "SIM7070_SIM7080_SIM7090 Series AT Command Manual".

### 3.3 Speciality

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

+CPSMS:

\[\text{<mode>}, \text{<Requested_Periodic-RAU>}, \text{<Requested_GPRS-Ready-timer>}, \text{<Requested_periodic-TAU>}, \text{<Requested_Active-Time>}\]

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.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Base</th>
<th>Min. in Second</th>
<th>Max. in Second</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10min</td>
<td>2400</td>
<td>18600</td>
</tr>
<tr>
<td>1</td>
<td>1h</td>
<td>21600</td>
<td>111600</td>
</tr>
<tr>
<td>2</td>
<td>10h</td>
<td>144000</td>
<td>1116000</td>
</tr>
<tr>
<td>3</td>
<td>2sec</td>
<td>0</td>
<td>62</td>
</tr>
<tr>
<td>4</td>
<td>30sec</td>
<td>90</td>
<td>930</td>
</tr>
<tr>
<td>5</td>
<td>1min</td>
<td>960</td>
<td>1860</td>
</tr>
<tr>
<td>6</td>
<td>320h</td>
<td>1152000</td>
<td>35712000</td>
</tr>
</tbody>
</table>

**Table 1** <Requested_Periodic-TAU> of AT+CPSMS

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

\(<\text{Requested_Active-Time}>\)
### Notice

1) About the URC report of "+ CSMSTATUS: ENTER PSM" in the process of entering PSM, it means that the module is ready to enter PSM sleep mode. When the module exits from the PSM, it reports +CPSMSTATUS: "EXIT PSM". AT+CPSMSTATUS can control whether these URCs are reported.

2) The module enables and disables the PSM function through the AT+CPSMS command. This command can also configure the values of the terminal's T3324 and T3241. 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. Values configured with AT+CPSMS may in some cases be inconsistent with the values assigned by the network. The AT+CPSMRDP command can be used to query the terminal configuration and the values of T3324 and T3412 delivered by the network.

4) The usage of AT+CPSMCFG indicates that if the terminal cannot enter the PSM in some cases, it can be checked whether the difference between T3412 and T3324 is less than the default minimum threshold. If it is less than, you can adjust this threshold by AT+CPSMCFG.

5) AT + CPSMCFGEXT is mainly used to configure PSM extended parameters, these parameters mainly include network search and other related content. If it is needed in the actual application, you can refer to the documentation of the command to set it up.

6) If the SIM card is opened with a PIN code and other related functions, it may not be able to enter the PSM. If you want to use the PSM function, please first confirm the related functions such as closing the SIM card PIN code.

7) If the module is not woken up when the time of the T3412 arrives, in this case, it needs to interact with the network to enter the PSM mode again. The interaction mode can be to send a packet of data.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Base</th>
<th>Min. in Second</th>
<th>Max. in Second</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2sec</td>
<td>0</td>
<td>62</td>
</tr>
<tr>
<td>1</td>
<td>1min</td>
<td>120</td>
<td>1860</td>
</tr>
<tr>
<td>2</td>
<td>6min</td>
<td>2160</td>
<td>11160</td>
</tr>
</tbody>
</table>

Table 2: <Requested_Active-Time> of AT+CPSMS
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+CEDRX).

NOTE

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

eDRX value, octet 3 (bit 4 to 1)
The octet contains the eDRX value field. The values are listed in table 3.

<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>eDRX cycle length duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5.12 seconds</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>10.24 seconds</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>20.48 seconds</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>40.96 seconds</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>61.44 seconds</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>81.92 seconds</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>102.4 seconds</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>122.88 seconds</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>143.36 seconds</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>163.84 seconds</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>327.68 seconds</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>655.36 seconds</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1310.72 seconds</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2621.44 seconds</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>5242.88 seconds</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10485.76 seconds</td>
</tr>
</tbody>
</table>

Table 3 eDRX cycle length
4.2 AT Commands Related to eDRX Mode

<table>
<thead>
<tr>
<th>AT Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CEDRXS</td>
<td>Entended-DRX Setting</td>
</tr>
<tr>
<td>AT+CEDRXRDP</td>
<td>eDRX Read Dynamic Parameters</td>
</tr>
<tr>
<td>AT+CEDRX</td>
<td>Configure EDRX parameters</td>
</tr>
<tr>
<td>AT+CEDRXS</td>
<td>Entended-DRX Setting</td>
</tr>
</tbody>
</table>

For the detail of these commands, Please refer to "SIM7070_SIM7080_SIM7090 Series AT Command Manual".

4.3 Notice

1) AT+CEDRXS can be used to enable and disable the EDRX function of the module. If it has been registered to the network, executing this command will initiate a TAU update process. If accepted by the network, these parameters will take effect immediately.

2) The AT+CEDRXRDP command can be used to query whether the request sent by the module to the network is accepted by the network. If the response "+CEDRXRDP: 0" indicates that the EDRX request is not accepted by the carrier's network.

3) The AT+CEDRX command can be used to configure the EPRX paging cycle and PTW parameters, but the configuration parameters need to be restarted. This command can be used for the need to modify the PTW parameters.
5 Sleep Mode

In sleep mode, the module will consume very low power, but still can receive paging.
6 Bearer Configuration

Usually module will register PS service automatically.

6.1 PDN Auto-activation

//Example of PDN Auto-activation.

AT+CPIN? //Check SIM card status
+CPIN:READY

OK

AT+CSQ //Check RF signal
+CSQ: 20,0

OK

AT+CGATT? //Check PS service. 1 indicates PS has attached.
+CGATT: 1

OK

AT+COPS? //Query Network information, operator and network.
+COPS: 0,0,"CHN-CT",9 //Mode 9 means NB-IOT network.

OK

AT+CGNAPN //Query the APN delivered by the network after the CAT-M or NB-IOT network is successfully registered.
+CGNAPN: 1,"ctnb" //"ctnb" is APN delivered by the CAT-M or NB-IOT network. APN is empty under the GSM network.

OK

AT+CNCFG=0,1,"ctnb" //Before activation please use AT+CNCFG to set APN\user name\password if needed.

OK

AT+CNACT=0,1 //Activate network, Activate 0th PDP.

OK
6.2 APN Manual Configuration

If not attached automatically, could configure correct APN setting.

//Example of APN Manual configuration.

AT+CFUN=0 //Disable RF
+CPIN: NOT READY
OK
AT+CGDCONT=1,"IP","ctnb" //Set the APN manually. Some operators need to set APN first when registering the network.
OK
AT+CFUN=1 //Enable RF
OK
+CPIN: READY
AT+CGATT? //Check PS service. 1 indicates PS has attached.
+CGATT: 1
OK
AT+CGNAPN //Query the APN delivered by the network after the CAT-M or NB-IOT network is successfully registered.
+CGNAPN: 1,"ctnb" //"ctnb" is APN delivered by the CAT-M or NB-IOT network. APN is empty under the GSM network.
OK
AT+CNCFG=0,1,"ctnb" //Before activation please use AT+CNCFG to set APN\user name\password if needed.
OK
AT+CNACT=0,1 //Activate network, Activate 0th PDP.
OK
+APP PDP: 0,ACTIVE
AT+CNACT? //Get local IP
+CNACT: 0,1,"10.94.36.44"
+CNACT: 1,0,"0.0.0.0"
+CNACT: 2,0,"0.0.0.0"
+CNACT: 3,0,"0.0.0.0"
OK
7 Lower Power Mode Examples

7.1 PSM Mode Examples

7.1.1 Enable/Disable PSM mode

//Example of Enable or Disable PSM mode.

```
AT+CPSMSTATUS=1
OK
AT+IPR=115200
OK
AT+CEREG=4
OK
AT+CEREG?
+CEREG: 4,1,"5B57","195071B",9,,"00000000","01100000"
OK
AT+CPSMS=1,,"01011111","00000001"
OK
+CEREG: 1,"5B57","195071B",9,,"00000000","01101111"
+CEREG: 1,"5B57","195071B",9,,"00000000","01011111"
+CPSMSTATUS: "ENTER PSM"
AT+CEREG?
+CEREG: 4,1,"5B57","195071B",9,,"00000000","01011111"
OK
```

//Enable PSM Event report
//Fix baud rate
//Inquiry timers configured by network.
//Enable PSM mode and set the specific T3412_ext and T3324
//Inquiry timers configured by network.
7.2 eDRX Mode Examples

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

7.2.1 Enable eDRX

//Example of Enable eDRX

```
AT+COPS?
//Check operator information
+COPS: 0,0,"CHINA MOBILE CMCC",9
OK

AT+CEDRXS=1,5,"0000"
//Enable eDRX function.
OK

AT+CEDRXS?
+CEDRXS: 4,"0001"
+CEDRXS: 5,"0000"
OK

AT+CEDRXRDP
//If eDRX supported, 
"0000" Requested cycle length
"0010" Cycle length from network
"0100" PTW

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

OK

AT+CEDRXRDP
//If eDRX not supported, return with 0.
```
7.2.2 Set eDRX cycle length 20.48s

//Example of Set eDRX cycle length 20.48s

AT+CEDRXS?
+CEDRXS: 4,"0001"
+CEDRXS: 5,"0000"
OK
AT+CEDRXS=1,5,"0010"
OK
AT+CEDRXRDP
+CEDRXRDP: 5,"0010","0010","0100"
OK

7.2.3 Set eDRX cycle length 20.48s and PTW 10.24s

//Example of Set eDRX cycle length 20.48s and PTW 10.24s.

AT+CEDRXS?
+CEDRXS: 5,"0000"
OK
AT+CEDRX=2,1,3,2
OK
AT+CEDRXRDP
+CEDRXRDP: 5,"0010","0010","0011"
OK
7.2.4 Disable eDRX mode

//Example of Disable eDRX Mode.

<table>
<thead>
<tr>
<th>AT+CEDRXS=0</th>
<th>//Disable eDRX function</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>AT+CEDRXRDP</td>
<td>//If eDRX not supported, return with 0.</td>
</tr>
<tr>
<td>+CEDRXRDP: 0</td>
<td></td>
</tr>
<tr>
<td>OK</td>
<td></td>
</tr>
</tbody>
</table>

7.3 Sleep Mode Examples

//Example of Sleep Mode.

<table>
<thead>
<tr>
<th>AT+CSCLK=1</th>
<th>//Enable sleep mode 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>//Pulling up DTR pin, module will go to normal sleep mode</td>
</tr>
<tr>
<td></td>
<td>//Pulling down DTR pin will wake module up from sleep mode.</td>
</tr>
</tbody>
</table>