A76XX Series_Low Power Mode_Application Note

LTE Module

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Document Title:	A7600XX Series_Low Power Mode_Application Note
Version:	1.00
Date:	2023.06.15
Status:	

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About Document

Version History

Version	Date	Owner	What is new
V1.00	2023.06.15	Zemone Lee	First Release

Scope

This document applies to the following products: A76XX CAT1-bis series.

Contents

1 Introduction

1.1 Purpose of the document

Based on the AT Command Manual extension, this document introduces the three low power mode business processes of PSM, eDRX and sleep. By referring to this application document, developers can quickly understand and develop the related business processes.

1.2 Related documents

[1] A76XX Series AT Command Manual.docx

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

The A76XX CAT1-bis series supports three power saving modes: PSM (Power Saving Mode), DRX (Discontinuous Reception Mode) and eDRX (Extended DRX).
The A76XX CAT1-bis series supports PSM and eDRX. PSM mode eliminates the need for the terminal to receive paging to detect the availability of downlink services, while eDRX mode has a longer paging detection period compared to DRX, resulting in longer latency and affecting the real-time availability of data. In terms of capability, the network must not be configured for capabilities that are not supported by the terminal, while the configuration of the capabilities supported by the terminal can vary depending on the network.

2.1 PSM mode

PSM is a technology introduced in 3GPP Rel.12, which is based on the principle of allowing the module to switch off the transceiver and AS-related functions of the signal after a period of idle state (T3324), thus reducing the power consumption of the antenna, RF, signalling processing, etc. During PSM, the module does not receive any network paging, including searching for cell messages, cell reselection, etc. For the network side, the module is unreachable at this time and no more downlink data is received.
In PSM mode, the terminal is no longer listening for paging, but the terminal is still registered in the network; therefore, there is no need to reconnect or establish a PDN connection in order to send data. After the module Modem has entered PSM mode, it can still actively send uplink data to the platform. T3412 is the time for TAU and T3324 is the timer for entering 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

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.

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.

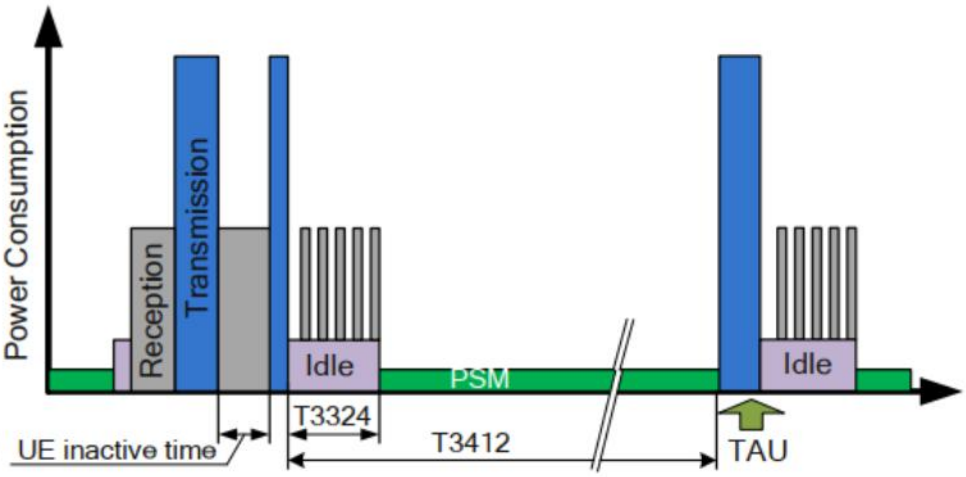

Figure 3.1 PSM mode

When the module is in the RRC Connect state, the module enters the Idle state when the end call is pressed, and the T3324 starts timing. In the T3324 time state, the module may be in the idle state, in the slow clock state, or even in the eDRX state with the slow clock (the module has the eDRX function turned on). When the T3324 time is over, the module enters the PSM state.
In the PSM state, it waits for the end of the T3412 timer, i.e. the end of the PSM phase. The module will enter the TAU state. tau is completed under RRC Connect, and at the end of that time it enters the RRC Release to idle state and starts the cycle again for the second cycle. If the module is under Instrument Connect and does not support TAU, it will enter an abnormal state at the end of one PSM. (TAU is a state only available at the normal end of the 3214), which is depicted in Figure 3.2.

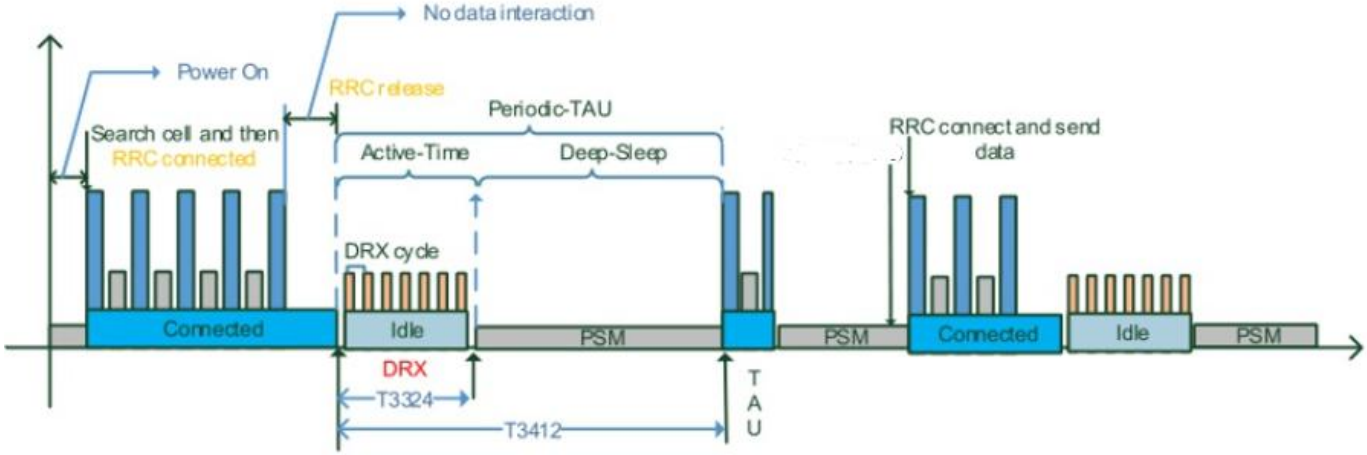

Figure 3.2 PSM process

PSM is activated after the data connection is terminated or the periodic TAU is completed. After the data connection is terminated, the terminal first enters idle mode and enters the discontinuous reception (DRX) state. When timer T3324 times out, the terminal enters PSM mode.
In PSM mode, the terminal is in hibernation mode, which is similar to a shutdown, and consumes 3.5 microamps of current, allowing significant power savings. The terminal wakes up after timer T3412 has timed out.

3.1 PSM Wake-up

Wake-up conditions: T3412 timer is expired

3.2 AT Commands Related to PSM Mode

AT Command	Description
AT+CPSMS	Power Saving Mode Setting

For the detail of these commands, refer to " A76XX Series AT Command Manual ".

3.3 Speciality

***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.

Table 3.1 <Requested_Periodic-TAU> of AT+CPSMS

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

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

Table 3.2 <Requested_Active-Time> of AT+CPSMS

Unit	Base	Min. in Second	Max. in Second
0	2sec	0	62

1	1min	120	1860
2	6min	2160	11160

3.4 Notice

1) 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.

2) 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+CPSMS command can be used to query the terminal configuration and the values of T3324 and T3412 delivered by the network.

3) The usage of AT+CPSMS 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+CPSMS.

4) 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.

5) 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.

4 eDRX Mode

4.1 eDRX introduction

eDRX has a longer paging period than DRX, which allows the terminal to save power better, but also leads to longer downlink data latency (e.g. drx takes the value 1.28s\2.56s, etc., while eDRX can take the value 20.48s, or even 2.9h), which is suitable for scenarios with low real-time requirements.

The eDRX can only be accessed with a slow clock if the module is already in the slow clock. eDRX requires attention to three parameters:

- DRX
- PTW (TPTW=N *Tdrx, N=number of BURSTs)
- CL (Cycle Lenth)

State Description: In the eDRX state, the module goes through a period of DRX time. The time from the beginning of DRX to the end plus one DRX is collectively called the PTW time, and the whole silent period + PTW is called CL, as shown in Figure 4.1.

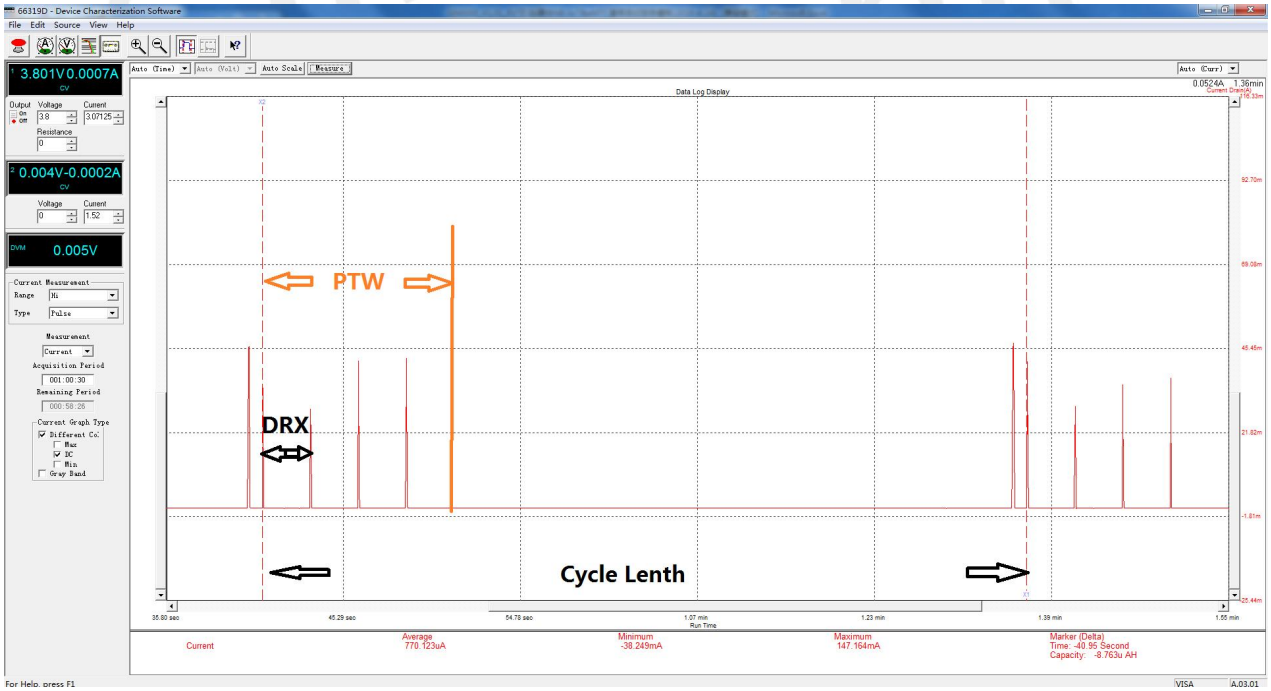

Figure 4.1 eDRX

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.

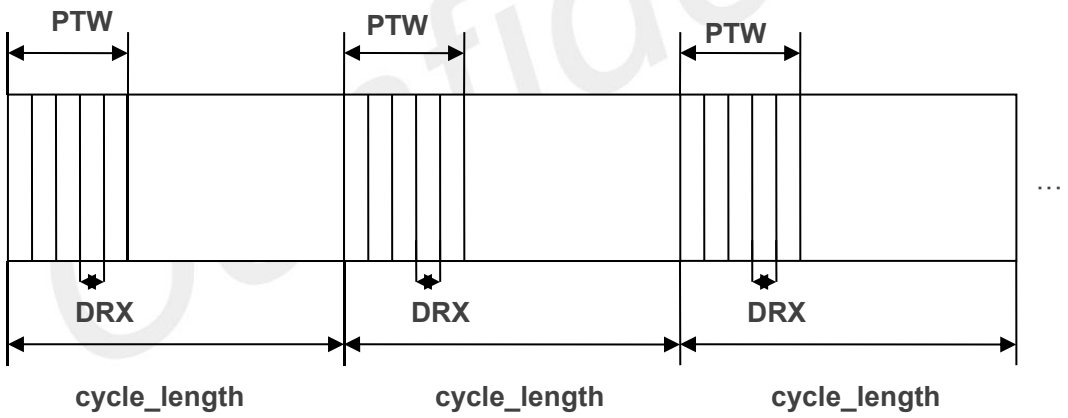

Figure 4.1 eDRX diagrammatic sketch

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 4.1.

Table 4.1 eDRX cycle length

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 AT Commands Related to eDRX Mode

AT Command	Description
AT+CEDRXS	Entended-DRX Setting
AT+CEDRXRDP	eDRX Read Dynamic Parameters

For the detail of these commands, Please refer to" A76XX 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, module will consume very low power, but still can receive paging.

5.1 sleep introduction

In sleep mode, the module's current consumption is minimised, but the module is still able to receive paging messages and SMS.

5.2 sleep AT Commands Related to eDRX Mode

AT Command	Description
AT+CSCLK	Control UART Sleep

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: 28,99

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

OK
AT+CGACT?                                   //PDN actived success
+CGACT: 1,1

OK
AT+COPS?                                    //Query Network information, operator and network.
+COPS: 0,2,"46000",7

OK
AT+CGDCONT?
+CGDCONT: 1,"IP","cmnet ","100.24.28.188",0,0,,,,   //Query the APN delivered by the network after the
                                                    LTE network is successfully registered.
OK
AT+CGPADDR                                  //Get local IP

+CGPADDR: 1,100.24.28.188

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","cmnet"	//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+CGDCONT?	//Query the APN delivered by the network
+CGDCONT: 1,"IP","cmnet "	
OK	
AT+CGAUTH=1,1,"password","user"	//Before activation please use AT+CGAUTH to set user name\password if needed.
OK	
AT+CGACT=1,1	//Activate network, Activate 1th PDP.
OK	
AT+CGPADDR	//Get local IP
+CGPADDR: 1,100.24.28.188	
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*COMCFG=1,,,,,254                          //Enable 1 bis
OK
AT+CFUN=0                                    //Close RF

OK
AT+CPSMS=1,,,"01011111","00000001"           //Enable PSM mode and set the specific T3412_ext and
                                             T3324
AT+MEDCR=0,103,1                             //Start hardware PSM

OK
AT+MEDCR=0,71,2                              // Set wake-up time 2min
OK
AT+CFUN=1                                    Open RF

OK
AT+CPSMS=0                                   //Disable PSM
OK
```

7.2 eDRX Mode Examples

7.2.1 Enable eDRX

```
//Example of Enable eDRX

AT+COPS?                                     //Check operator information

+COPS: 0,2,"46000",7
```

```
OK
AT*COMCFG=1,,,,,254                    //Enable 1 bis

OK
AT+CEDRXS=1,5,”0000”                   //Enable eDRX function.
OK
AT+CEDRXS?                             //Query eDRX current status
+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.
+CEDRXRDP: 0

OK
```

NOTE

- 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.

7.2.2 Set eDRX cycle length 20.48s

```
//Example of Set eDRX cycle length 20.48s

AT+CEDRXS?                             //Query eDRX current status
+CEDRXS: 4,"0001"
+CEDRXS: 5,"0000"

OK
AT+CEDRXS=1,5,"0010"                   //Set eDRX cycle length with "0010",which is 20.48 s.
OK
AT+CEDRXRDP                            //“0010” Requested cycle length
                                       “0010” Cycle length from network
                                       “0100” PTW from network
```

```
+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?                          //Query eDRX current status
+CEDRXS: 5,"0000"

OK
AT+CEDRX=2,1,3,2                    //Set PTW with 3(10.24s).This configuration will be
                                    saved after reboot.
OK
AT+CEDRXRDP                         //"0010" Requested cycle length
                                    "0010" Cycle length from network
                                    "0011" PTW from network
+CEDRXRDP: 5,"0010","0010","0011"

OK
```

7.2.4 Disable eDRX mode

```
//Example of Disable eDRX Mode.

AT+CEDRXS=0                         //Disable eDRX function
OK
AT+CEDRXRDP                         //If eDRX not supported, return with 0.
+CEDRXRDP: 0

OK
```

7.3 Sleep Mode Examples

```
//Example of Sleep Mode.

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

sleep mode.