

BG96 PSM

Application Note

LTE Module Series

Rev. BG96_PSM_Application_Note_V1.0

Date: 2018-04-23

Status: Released



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About the Document

History

Revision	Date	Author	Description
1.0	2018-04-23	Walker HAN/ Elvis SUN/ Hyman DING/ Lyndon LIU	Initial

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1 Introduction

Power Saving Mode (PSM) is a key feature for eMTC/NB-IoT devices and applications with the following requirements:

- Infrequently active
- Short duration of active communication
- Data transmission is mainly originated by eMTC/NB-IoT devices, but also possible to engage in DL receive during the active duration
- Power constraint, running on battery
- Requires long battery life

The objective of PSM is to make an IoT device inactive or power-down most of time to save power and wake up the device only for a short time of data transmission.

This document mainly introduces PSM feature and also describes how to use PSM function of Quectel BG96 module.

2 General Overview of PSM

3GPP R12 defined PSM mode is similar to power-off, but the UE (BG96 module) remains registered with the network and there is no need to re-attach or re-establish PDN connections. Therefore, UE in PSM is not immediately reachable for mobile terminating services. The UE using PSM is available for mobile terminating services only during the time it is in connected mode and for the period of an Active Time that is after the connected mode. The connected mode is caused by a mobile originated event like data transfer or signalling, e.g. after a periodic TAU/RAU procedure. PSM is therefore intended for UE that is expecting only infrequent mobile originating and terminating services and that can accept a corresponding latency in the mobile terminating communication.

NOTE

For more detailed description of 3GPP R12 defined PSM mode, please refer to 3GPP TS 23.682 **clause 4.5.4 UE Power Saving Mode**.

3 PSM Setting

Customers can configure the PSM capability using the following commands.

3.1. AT+CPSMS Power Saving Mode Setting

The Write Command controls the setting of BG96's power saving mode (PSM) parameters. The command controls whether the module wants to apply PSM or not, as well as the requested extended periodic RAU value and the requested GPRS READY timer value in GERAN, the requested extended periodic TAU value in E-UTRAN and the requested Active Time value. See the unsolicited result codes provided by commands **AT+CGREG** for the Active Time value, the extended periodic RAU value and the GPRS READY timer value that are allocated to the module by the network in GERAN and **AT+CEREG** for the Active Time value and the extended periodic TAU value that are allocated to the module by the network in E-UTRAN.

A special form of the command can be given as **AT+CPSMS=** (with all parameters omitted). In this form, the parameter **<mode>** will be set to 0, the use of PSM will be disabled and data for all parameters in **AT+CPSMS** will be removed or, if available, set to default values.

The Read Command returns the current parameter values.

The Test Command returns the supported **<mode>**s and the value ranges for the requested extended periodic RAU value and the requested GPRS READY timer value in GERAN, the requested extended periodic TAU value in E-UTRAN and the requested Active Time value as compound values.

AT+CPSMS Power Saving Mode Setting

Test Command AT+CPSMS=?	Response +CPSMS: (list of supported <mode> s),(list of supported <Requested_Periodic-RAU> s),(list of supported <Requested_GPRS-READY-timer> s),(list of supported <Requested_Periodic-TAU> s),(list of supported <Requested_Active-Time> s) OK
Write Command AT+CPSMS=[<mode>],[<Requested_Periodic-RAU>],[<Requested_GPRS-RE	Response OK

ADY-timer>[,<Requested_Periodic-TAU>[,<Requested_Active-Time>]]]]	If there is any error, response: ERROR
Read Command AT+CPSMS?	Response +CPSMS: <mode>[,<Requested_Periodic-RAU>],[<Requested_GPRS-READY-timer>],[<Requested_Periodic-TAU>],[<Requested_Active-Time>] OK
Maximum Response Time	300ms
Reference 3GPP TS 27.007	

Parameter

<mode>	Integer type. Disable or enable the use of PSM in the UE. 0 Disable the use of PSM 1 Enable the use of PSM
<Requested_Periodic-RAU>	String type. One byte in an 8 bit format. Requested extended periodic RAU value (T3312) to be allocated to the UE in GERAN. (e.g. "01000111" equals to 70 hours) Bits 5 to 1 represent the binary coded timer value. Bits 6 to 8 define the timer value unit as follows: Bits 8 7 6 0 0 0 value is incremented in multiples of 10 minutes 0 0 1 value is incremented in multiples of 1 hour 0 1 0 value is incremented in multiples of 10 hours 0 1 1 value is incremented in multiples of 2 seconds 1 0 0 value is incremented in multiples of 30 seconds 1 0 1 value is incremented in multiples of 1 minute
<Requested_GPRS-READY-timer>	String type. One byte in an 8 bit format. Requested GPRS READY timer value (T3314) to be allocated to the UE in GERAN. (e.g. "01001010" equals to 1 hours) Bits 5 to 1 represent the binary coded timer value. Bits 6 to 8 define the timer value unit as follows: Bits 8 7 6 0 0 0 value is incremented in multiples of 2 seconds 0 0 1 value is incremented in multiples of 1 minute 0 1 0 value is incremented in multiples of decihours 1 1 1 value indicates that the timer is deactivated
<Requested_Periodic-TAU>	String type. One byte in an 8 bit format. Requested extended periodic TAU value (T3412) to be allocated to the UE in E-UTRAN. (e.g. "00001010" equals to 100 minutes) Bits 5 to 1 represent the binary coded timer value.

Bits 6 to 8 define the timer value unit as follows:

Bits 8 7 6

- 0 0 0 value is incremented in multiples of 10 minutes
- 0 0 1 value is incremented in multiples of 1 hour
- 0 1 0 value is incremented in multiples of 10 hours
- 0 1 1 value is incremented in multiples of 2 seconds
- 1 0 0 value is incremented in multiples of 30 seconds
- 1 0 1 value is incremented in multiples of 1 minute

<Requested_Active-Time>

String type. One byte in an 8 bit format. Requested Active Time value (T3324) to be allocated to the UE. (e.g. "00001111" equals to 1 minute)

Bits 5 to 1 represent the binary coded timer value.

Bits 6 to 8 define the timer value unit as follows:

Bits 8 7 6

- 0 0 0 value is incremented in multiples of 2 seconds
- 0 0 1 value is incremented in multiples of 1 minute
- 0 1 0 value is incremented in multiples of decihours
- 1 1 1 value indicates that the timer is deactivated.

Example

```
AT+CPSMS=1,,"0000100","00001111" //Set the requested T3412 value to 40 minutes, and set the
OK requested T3324 value to 60 seconds.
```

3.2. AT+QPSMS Extended Power Saving Mode Setting

Quectel extended AT command for PSM setting. The Write Command controls the setting of BG96's power saving mode (PSM) parameters. It is similar with **AT+CPSMS**.

AT+QPSMS Extended Power Saving Mode Setting

Test Command AT+QPSMS=?	Response +QPSMS: (list of supported <mode>s),(list of supported <Requested_Periodic-RAU>s),(list of supported <Requested_GPRS-READY-timer>s),(list of supported <Requested_Periodic-TAU>s),(list of supported <Requested_Active-Time>s) OK
Write Command AT+QPSMS=[<mode>],[<Requested_Periodic-RAU>],[<Requested_GPRS-READY-timer>],[<Requested_Periodic-TAU>]	Response OK If there is any error, response:

U>[,<Requested_Active-Time>]]]]]	ERROR
Read Command AT+QPSMS?	Response +QPSMS: <mode>,[<Network_Periodic-RAU>],[<Network_GPRS-READY-timer>],[<Network_Periodic-TAU>],[<Network_Active-Time>]
	OK
Maximum Response Time	300ms
Reference 3GPP TS 27.007	

Parameter

<mode>	Integer type. Disable or enable the use of PSM in the UE. <u>0</u> Disable the use of PSM 1 Enable the use of PSM
<Requested_Periodic-RAU>	String type. One byte in an 8 bit format. Requested extended periodic RAU value (T3312) to be allocated to the UE in GERAN. (e.g. "01000111" equals to 70 hours) Bits 5 to 1 represent the binary coded timer value. Bits 6 to 8 define the timer value unit as follows: Bits 8 7 6 0 0 0 value is incremented in multiples of 10 minutes 0 0 1 value is incremented in multiples of 1 hour 0 1 0 value is incremented in multiples of 10 hours 0 1 1 value is incremented in multiples of 2 seconds 1 0 0 value is incremented in multiples of 30 seconds 1 0 1 value is incremented in multiples of 1 minute
<Requested_GPRS-READY-timer>	String type. One byte in an 8 bit format. Requested GPRS READY timer value (T3314) to be allocated to the UE in GERAN. (e.g. "01001010" equals to 1 hours) Bits 5 to 1 represent the binary coded timer value. Bits 6 to 8 define the timer value unit as follows: Bits 8 7 6 0 0 0 value is incremented in multiples of 2 seconds 0 0 1 value is incremented in multiples of 1 minute 0 1 0 value is incremented in multiples of decihours 1 1 1 value indicates that the timer is deactivated.
<Requested_Periodic-TAU>	String type. One byte in an 8 bit format. Requested extended periodic TAU value (T3412) to be allocated to the UE in E-UTRAN. (e.g. "00001010" equals to 100 minutes) Bits 5 to 1 represent the binary coded timer value. Bits 6 to 8 define the timer value unit as follows:

	<p>Bits 8 7 6</p> <p>0 0 0 value is incremented in multiples of 10 minutes</p> <p>0 0 1 value is incremented in multiples of 1 hour</p> <p>0 1 0 value is incremented in multiples of 10 hours</p> <p>0 1 1 value is incremented in multiples of 2 seconds</p> <p>1 0 0 value is incremented in multiples of 30 seconds</p> <p>1 0 1 value is incremented in multiples of 1 minute</p>
<Requested_Active-Time>	<p>String type. One byte in an 8 bit format. Requested Active Time value (T3324) to be allocated to the UE. (e.g. "00001111" equals to 1 minute)</p> <p>Bits 5 to 1 represent the binary coded timer value.</p> <p>Bits 6 to 8 define the timer value unit as follows:</p> <p>Bits 8 7 6</p> <p>0 0 0 value is incremented in multiples of 2 seconds</p> <p>0 0 1 value is incremented in multiples of 1 minute</p> <p>0 1 0 value is incremented in multiples of decihours</p> <p>1 1 1 value indicates that the timer is deactivated.</p>
<Network_Periodic-RAU>	<p>Integer type. Extended periodic RAU value (T3312) to be allocated to the UE in GERAN, and the value is specified by network.</p>
<Network_GPRS-READY-timer>	<p>Integer type. GPRS READY timer value (T3314) to be allocated to the UE in GERAN, and the value is specified by network.</p>
<Network_Periodic-TAU>	<p>Integer type. Extended periodic TAU value (T3412) to be allocated to the UE in E-UTRAN, and the value is specified by network.</p>
<Network_Active-Time>	<p>Integer type. Active timer value (T3324) to be allocated to the UE in E-UTRAN, and the value is specified by network.</p>

Example

```

AT+QPSMS=1,,"0000100","00001111" //Set the requested T3412 value to 40 minutes, and set the
                                requested T3324 value to 30 seconds.
OK
AT+QPSMS?                        //Query the PSM mode and the timer from network.
+QPSMS:1,,"86400","2"
OK

```

3.3. AT+QPSMCFG PSM Feature and Minimum Threshold Value Setting

Quectel extended AT command for PSM setting. Customers can use this AT command to enable or disable PSM function and set the minimum threshold value to enter PSM.

AT+QPSMCFG PSM Feature and Minimum Threshold Value Setting

Test Command AT+QPSMCFG=?	Response +QPSMCFG: (list of supported <threshold>s),(list of supported <psm_version>s) OK
Write Command AT+QPSMCFG=[<threshold>[,<psm_version>]]	Response OK If there is any error, response: ERROR
Read Command AT+QPSMCFG?	Response +QPSMCFG: <threshold>,<psm_version> OK

Parameter

<threshold>	Minimum threshold value to enter PSM. Range: <u>60</u> -4294967295. Unit: second.
<psm_version>	Bitmask to indicate PSM modes (1 – Enable/0 – Disable). Each bit is configured independently. Range: 0- <u>4</u> -15. Bit 0 – PSM without network coordination Bit 1 – Rel 12 PSM without context retention Bit 2 – Rel 12 PSM with context retention Bit 3 – PSM in between eDRX cycles

Example

```

AT+QPSMCFG=100 //Set the threshold to 100 seconds.

OK
AT+QPSMCFG? //Query the threshold value and PSM mode.
+QPSMCFG: 100,5

OK

```

3.4. AT+QPSMEXTCFG Modem Optimization

Quectel extended AT command for PSM setting. This command is used to set extended parameters for modem optimizations.

AT+QPSMEXTCFG Modem Optimization	
Test Command AT+QPSMEXTCFG=?	Response +QPSMEXTCFG: (list of supported <psm_opt_mask>s),(list of supported <max_oos_full_scans>s),(list of supported <psm_duration_due_to_oos>s),(list of supported <psm_randomization_window>s),(list of supported <max_oos_time>s),(list of supported <early_wake_up_time>s) OK
Write Command AT+QPSMEXTCFG=[<psm_opt_mask>[,<max_oos_full_scans>[,<psm_duration_due_to_oos>[,<psm_randomization_window>[,<max_oos_time>[,<early_wake_up_time>]]]]]]	Response OK If there is any error, response: ERROR
Read Command AT+QPSMEXTCFG?	Response +QPSMEXTCFG: <psm_opt_mask>,<max_oos_full_scans>,<psm_duration_due_to_oos>,<psm_randomization_window>,<max_oos_time>,<early_wake_up_time> OK

Parameter

<psm_opt_mask>	Numeric type. Range: 0-14-15. 1 st bit of the parameter is used to enable/disable PSM ENTER request without sending PSM_READY_REQ to NAS. This is a quick PSM operation. 2 nd bit of the parameter is used to enable/disable Out of Service (OoS) status indication from Modem to AP. 3 rd bit of the parameter is used to enable/disable limited service status indication from Modem to AP. 4 th bit the parameter is used to enable/disable deep-sleep mode if PSM duration is less than the threshold value. If enabled, it puts the device in deep-sleep mode, if PSM is not entered due to not meeting threshold value.
<max_oos_full_scans>	Maximum number of full scans to wait before modem declares

<psm_duration_due_to_oos>	SYS_PSM_STATUS_OOS to clients. Range: 1-2-100. PSM duration used by PSM daemon upon OOS/Limited Service indication, due to service outage. Range: <u>120</u> -4294967295. Unit: second.
<psm_randomization_window>	PSM wakeup randomization window to avoid network congestion due to all the PSM devices waking up at the same time. Range: 1- <u>5</u> -1000. Unit: second.
<max_oos_time>	Maximum time in seconds to wait before declaring SYS_PSM_STATUS_OOS to clients. Range: 1- <u>120</u> -65535. Unit: second.
<early_wakeup_time>	Device wakes up early to account for boot-up and acquisition delay. While programming PMIC, PSM daemon reduces PSM duration by this duration. Range: 1- <u>3</u> -1000. Unit: second.

Example

```
AT+QPSMEXTCFG=14,2,120
OK
AT+QPSMEXTCFG?
+QPSMEXTCFG: 14,2,120,5,120,15
OK
```

3.5. AT+QCFG="psm/urc" Enable/Disable PSM Entering Indication

Quectel extended AT command to indicate PSM entered. When PSM function is enabled and RRC connection release is received, the active timer (T3324) will be started, and the indication URC will be reported.

AT+QCFG="psm/urc" Enable/Disable PSM Entering Indication	
Write Command AT+QCFG="psm/urc",<mode>	Response OK If there is any error, response: ERROR
Read Command AT+QCFG="psm/urc"	Response +QCFG="psm/urc",<mode> OK

Parameter

<mode>	Numeric type.
0	Disable QPSMTIMER URC report
1	Enable QPSMTIMER URC report

3.6. “+QPSMTIMER:” URC to Indicate the TAU Duration and Active Time Duration

The URC is used to indicate the TAU duration and Active time duration for the module’s PSM. The URC is disabled by default, and can be enabled by **AT+QCFG="psm/urc",1**.

“+QPSMTIMER:” URC to Indicate the TAU Duration and Active Time Duration

URC Format: +QPSMTIMER: <TAU_duration>,<Active_duration>	Indicate the TAU duration and Active time duration of UE’s PSM.
--	---

Parameter

<TAU_duration>	TAU duration of PSM. Unit: second.
<Active_duration>	Active time duration of PSM. Unit: second.

Example

```

AT+QCFG="psm/urc"
+QCFG: "psm/urc",0

OK
AT+QCFG="psm/urc",1
OK

+QPSMTIMER: 86400,2 //TAU Timer and Active Timer value.

POWER DOWN
    
```

4 Wake up from PSM

Either of the following methods will wake up the module from PSM:

- Drive PWRKEY pin to low level will wake up the module.
- When the T3412 timer expires, the module will be automatically woken up.

4.1. Manually Wake up from PSM

The following steps can be used to wake up the module from PSM and then realize communication between the module and the network.

Step 1: Drive PWRKEY pin to low level, and then check the power on status of BG96.

Step 2: Active communication (UL and/or DL).

The following figure shows the procedure of manually waking up the module from PSM.

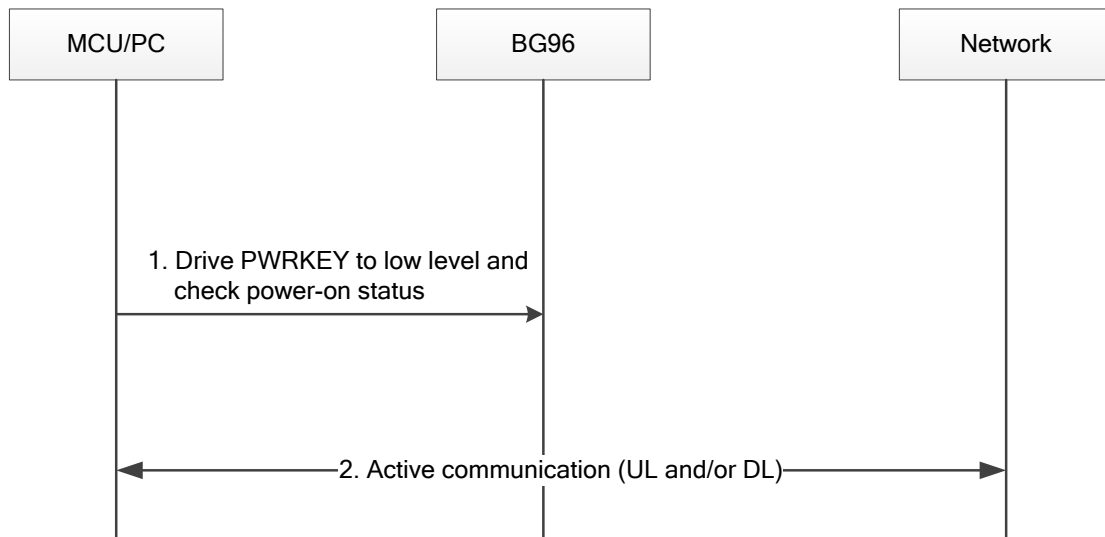


Figure 1: Manually Wake up Module from PSM

4.2. Automatically Wake up from PSM

When the T3412 (Extended TAU timer) expires, the module will be automatically woken up.

The following figure illustrates the automatic procedure of waking up module from PSM.

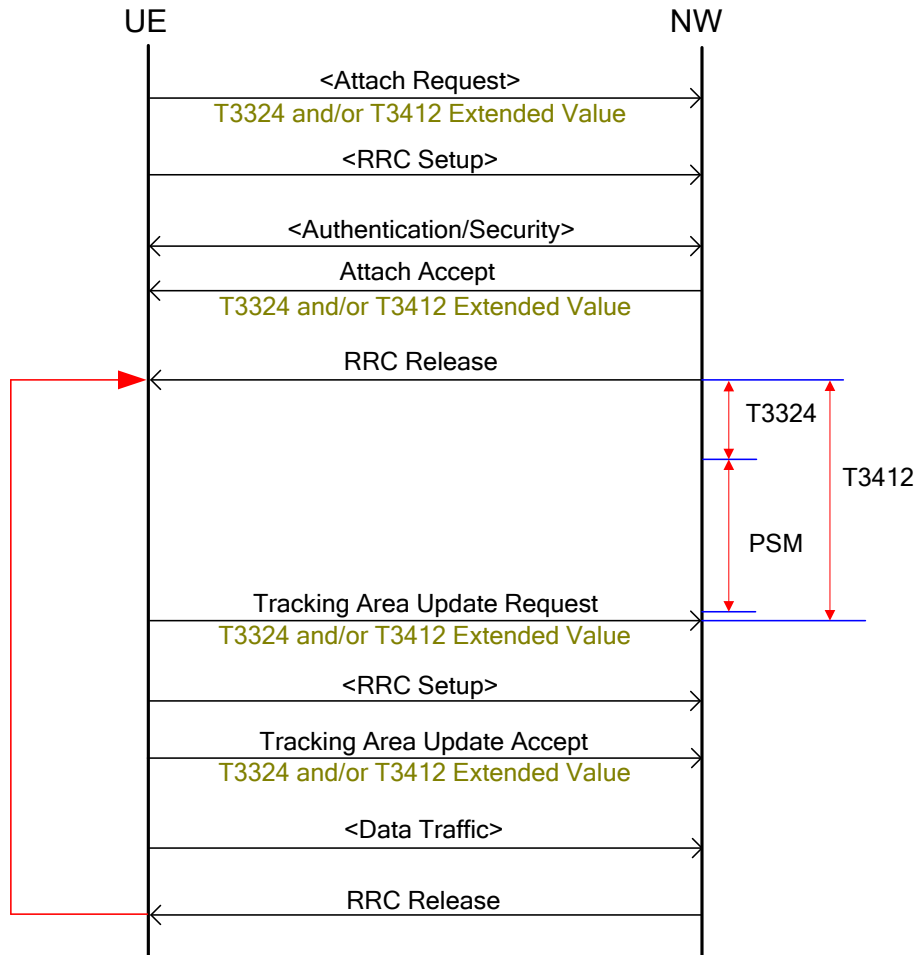


Figure 2: Automatically Wake up Module from PSM

5 Typical Power Consumption Cycle

The following figure shows the typical power consumption cycle of BG96 module.

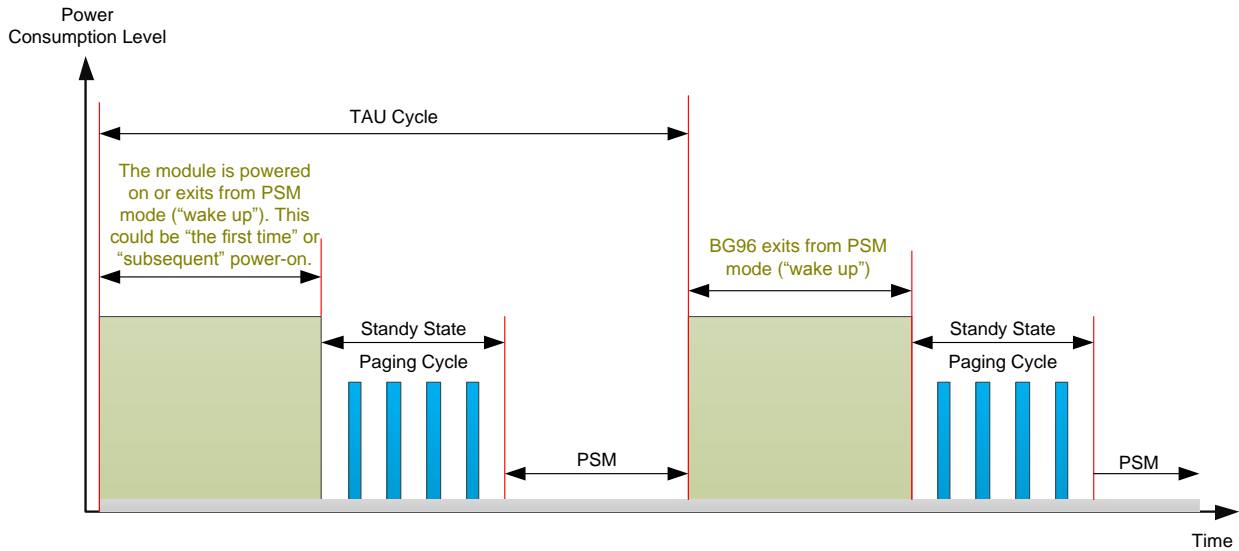


Figure 3: Automatically Wake up Module from PSM

6 Appendix A References

Table 1: Related Documents

SN	Document Name	Remark
[1]	Quectel_BG96_AT_Commands_Manual	BG96 AT Commands Manual
[2]	3GPP TS 23.401	3GPP Specification
[3]	3GPP TS 23.682	3GPP Specification

Table 2: Terms and Abbreviations

Abbreviation	Description
DRX	Discontinuous Reception
eDRX	Extended Discontinuous Reception
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
GERAN	GSM EDGE Radio Access Network
GPRS	General Packet Radio Service
PDN	Packet Data Network Gateway
PSM	Power Saving Mode
RAU	Routing Area Update
RRC	Radio Resource Control
TAU	Tracking Area Update
UE	User Equipment (typically the module)