Quectel BG95

PSM Application Note

Confidentiality Level:(Tick the Box ■)		
Top Secret ☐	Confidential ☐	Public ☐

Document Control Record

Revision History			
Date	Revision	Revision Description	Author
2023-12-7	0	Initial	Kartigesan Chandran
2024-05-30	1	Optimized Some Illustrations	Kartigesan Chandran

Contents

Introduction

This document describes the Power Saving Mode (PSM) feature and explains how to utilize it on the Quectel BG95 modules.

The PSM feature enables IoT devices to stay inactive or powered down most of the time to save power. The PSM feature wakes up the device only during data transmission, which usually happens for a short period of time. The PSM feature is especially important for eMTC/NB-IoT devices and applications with following characteristics:

- The eMTC/NB-IoT devices and applications are frequently inactive
- The active communication is of short duration
- Data mainly is originated from eMTC/NB-IoT devices (although the eMTC/NB-IoT devices can also download data when they are active)
- There are power constraints (the devices are running on a battery)
- The eMTC/NB-IoT devices require long battery life

The PSM mode defined by 3GPP Release 13 is similar to power-off, but the UE (i.e., the BG770A-GL, BG950A-GL and BG951A-GL modules) remains registered to the network, so there is no need to re-attach or re-establish PDN connections. Therefore, the UE with PSM is not immediately available to mobile terminating services. The UE using PSM is available to mobile terminating services when it is in connected mode and during an Active Time that comes after the connected mode. The connected mode is caused by a mobile originated event like data transmission or signalling, e.g. after a periodic TAU procedure. The PSM is therefore suitable for UE that is expecting only infrequent mobile originating and terminating services, which can accept a corresponding latency in the mobile terminating communication.

NOTE

For a more detailed description of the PSM mode defined by 3GPP Release 13, see ***document 错误!未找到引用源。.***

1 Purpose

Power Saving Mode (PSM) is a crucial feature in cellular communication for optimizing energy consumption in Internet of Things (IoT) devices. PSM allows IoT devices to enter a low-power state during periods of inactivity, significantly extending battery life. This document is designed to assist MCU developers in efficiently implementing and leveraging the Power Saving Mode functionality provided by the specified module, ensuring effective power management in IoT projects. It aims to guiding developers in seamlessly integrating PSM into their applications, promoting energy efficiency and enhancing the overall performance of IoT devices.

In this document, it will mainly illustrate how to apply following PSM features in Quectel Demo.

2 Scope

This document applies to products with MCU mounted with BG95 module.

3 Term and Definition

Quectel: Quectel Wireless Solution Co., Ltd.
PSM: Power Saving Mode

4 API Design

One set of reference APIs is designed by we Quectel to implement PSM based on the relevant AT commands in BG95. See ***Table 1*** in detail.

Table 2：PSM API Reference Design

API	Implementation
QL_psm_setting()	Power Saving Mode Setting
QL_psm_ext_setting()	Extended Power Saving Mode Setting
QL_psm_cfg()	PSM Feature and Minimum Threshold Value Setting
QL_psm_ext_cfg()	Modem Optimization
QL_psm_timer()	Enable/Disable PSM Entering Indication

For specific design on API, please refer to appendix:

<Quectel_BG95&BG77&BG600L_Series_PSM_Application_Note_V1.0.pdf>

See following table for API usage and AT command.

Table 3: Mapping between API and AT command

API	AT Command
QL_psm_ setting()	AT+CPSMS
QL_psm_ ext_setting()	AT+QPSMS
QL_psm_cfg()	AT+QPSMCFG
QL_psm_ext_cfg()	AT+QPSMEXTCFG
QL_psm_timer()	AT+QCFG

4.1 PSM Setting API

The PSM Setting API provides commands for configuring the Power Saving Mode (PSM) parameters of a module in a mobile communication system. This API allows users to control whether the module should apply PSM, set the requested extended periodic TAU (Tracking Area Update) value in E-UTRAN, and define the requested Active Time value. Function named **QL_psm_setting()** will be used for setting PSM parameters.

Parameters

1. **mode (Integer type):**
   - 0: Disable the use of PSM
   - 1: Enable the use of PSM
2. **Requested Periodic-TAU (String type):**
   - One byte in an 8-bit format.
   - Represents the requested extended periodic TAU value (T3412) to be assigned to the UE in E-UTRAN.
   - Example: "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:
     - 000: Value is incremented in multiples of 10 minutes
     - 001: Value is incremented in multiples of 1 hour
     - 010: Value is incremented in multiples of 10 hours
     - 011: Value is incremented in multiples of 2 seconds
     - 100: Value is incremented in multiples of 30 seconds
     - 101: Value is incremented in multiples of 1 minute
   - In the Write Command, when <mode> is 1 and <requested_periodicTAU> is omitted, the last configured value is used.

3. **Requested Active-Time (String type):**
    - **One byte in an 8-bit format.**
    - **Represents the requested Active Time value (T3324) to be allocated to UE.**
    - **Example: "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:**
        - **000: Value is incremented in multiples of 2 seconds**
        - **001: Value is incremented in multiples of 1 minute**
        - **010: Value is incremented in multiples of decihours**
        - **111: Value indicates that the timer is deactivated.**

4.1.1 Write PSM Settings

The Write Command configures the PSM parameters of a module. It allows users to:

- mode: Enable or disable PSM (0: disable; 1: enable)
- tau: Requested extended periodic TAU value in E-UTRAN
- atime: Requested Active Time value

4.1.2 Read PSM Settings

The Read Command retrieves the current parameter values of the PSM configuration.

- mode: Enable or disable PSM (0: disable; 1: enable)
- tau: Requested extended periodic TAU value in E-UTRAN
- atime: Requested Active Time value

4.2 PSM Extended Settings API

The **QL_psm_ext_setting()** is an extended AT command developed for configuring Power Saving Mode (PSM) parameters in a mobile communication system. This API provides a specialized form for setting PSM parameters. The command can be given in the format **QL_psm_ext_setting()**. In this form, the usage of PSM is controlled by the mode parameter, and data for all parameters in the command are removed when the mode is greater than or equal to 0.

Parameters

1. **mode (Integer type):**
    - **0: Disable PSM**
    - **1: Enable PSM**
    - **Values greater than or equal to 0 will remove data for all parameters in the command**
2. **Requested_Periodic-TAU (String type):**
    - **One byte in an 8-bit format.**

- **Represents the requested extended periodic TAU value (T3412) to be assigned to UE in E-UTRAN.**
- **Example: "00001010" equals to 100 minutes.**
- **Bits 5 to 1 represent the binary coded timer value.**
- **Bits 6 to 8 define the timer value unit.**

3. **Requested_Active-Time (String type):**
   - **One byte in an 8-bit format.**
   - **Represents the requested Active Time value (T3324) to be assigned to UE.**
   - **Example: "00001111" equals to 1 minute.**
   - **Bits 5 to 1 represent the binary coded timer value.**
   - **Bits 6 to 8 define the timer value unit.**
4. **Network_Periodic-TAU (Integer type):**
   - **Extended periodic TAU value (T3412) to be assigned to UE in E-UTRAN.**
   - **The value is specified by the network.**
5. **Network_Active-Time (Integer type):**
   - **Active timer value (T3324) to be assigned to UE in E-UTRAN.**
   - **The value is specified by the network.**

4.2.1 Write extended PSM Settings

The Write Command configures the PSM parameters of a module. It allows users to:

- mode: Enable or disable PSM (0: disable; 1: enable)
- tau: Requested extended periodic TAU value in E-UTRAN
- atime: Requested Active Time value

4.2.2 Read extended PSM Settings

The Read Command retrieves the current parameter values of the PSM configuration.

- mode: Enable or disable PSM (0 for disable, 1 for enable)
- tau: Requested extended periodic TAU value in E-UTRAN
- atime: Requested Active Time value

4.3 PSM Feature and Minimum Threshold Value Setting API

This function enables or disables the PSM feature and sets the minimum threshold value of the PSM cycle. The minimum threshold value determines the condition to enter PSM, with the condition being <threshold> less than the PSM cycle (= T3412 - T3324).

Parameters

1. **threshold (Integer type):**
   - **Minimum threshold value of the PSM cycle.**

- **Condition to enter PSM: <threshold> less than PSM cycle (= T3412 - T3324).**
- **Range: 20-4294967295 seconds.**

2. **PSM_version (Integer type):**
   - **Bitmask to indicate the PSM feature.**
   - **Each bit is configured independently.**
   - **Range: 0-2^15.**
   - **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**

4.2.1 Write extended PSM Settings

The Write Command configures the PSM parameters of a module. It allows users to:

- Threshold: Integer type. Minimum threshold value of the PSM cycle.
- PSM_version: Bitmask indicates the PSM feature.

4.2.2 Read extended PSM Settings

The Read Command retrieves the current parameter values of the PSM configuration.

- Threshold: Integer type. Minimum threshold value of the PSM cycle.
- PSM_version: Bitmask indicates the PSM feature.

5 Wake up from PSM

Waking up a communication module from Power Saving Mode (PSM) involves employing various methods to transfer the device from a low-power state to an active and communicative state. In this section, we explore three distinct methods:

1. **Rising Edge on PON_TRIG:**
   - Recommended method.
   - Give the PON_TRIG pin a rising edge to wake up the module.
   - Provides a controlled and efficient means of transferring from PSM to an active state.
2. **Driving PWRKEY Low:**
   - Alternative method.
   - Drive the PWRKEY pin low to wake up the module.
   - Offers an additional approach for waking up the module, providing flexibility in design.
3. **T3412 Timer Expiration:**
   - Automatic wake-up mechanism.
   - When the T3412 timer expires, the module is automatically woken up.
   - Allows for a hands-free approach, relying on a predetermined timer to manage the transition from PSM to an active state.

Understanding these methods is crucial for developers and engineers who seek to optimize power consumption while ensuring the timely and efficient resumption of communication activities in wireless modules.

5.1 Wake up from PSM with PON_TRIG

The **PON_TRIG** pin plays a pivotal role in waking up the module from PSM. By holding the PON_TRIG pin high, the module receives a signal that prompts it transferring from the low-power state of PSM to an active state, ready to engage in communication with the network. To initiate the wake-up process, holding the PON_TRIG pin high shall be done priorly. This action serves as a trigger for the module to exit PSM and transition to an active state. It's crucial to ensure that the PON_TRIG pin is held high for a sufficient duration to allow the module to complete the wake-up sequence.

After holding the **PON_TRIG** pin high, it is essential to verify whether the module has successfully woken up from PSM. This step ensures that the module is ready to resume communication with the network. Depending on the module's specifications, there may be status indicators or communication interfaces that provide feedback on the wake-up status. Once the module has successfully woken up from PSM, the next step is to build active UL and/or DL communication with the network, including initializing communication protocols, connecting to base stations, and negotiating network parameters. Thus, the module is now fully operational and ready to send and receive data as required.

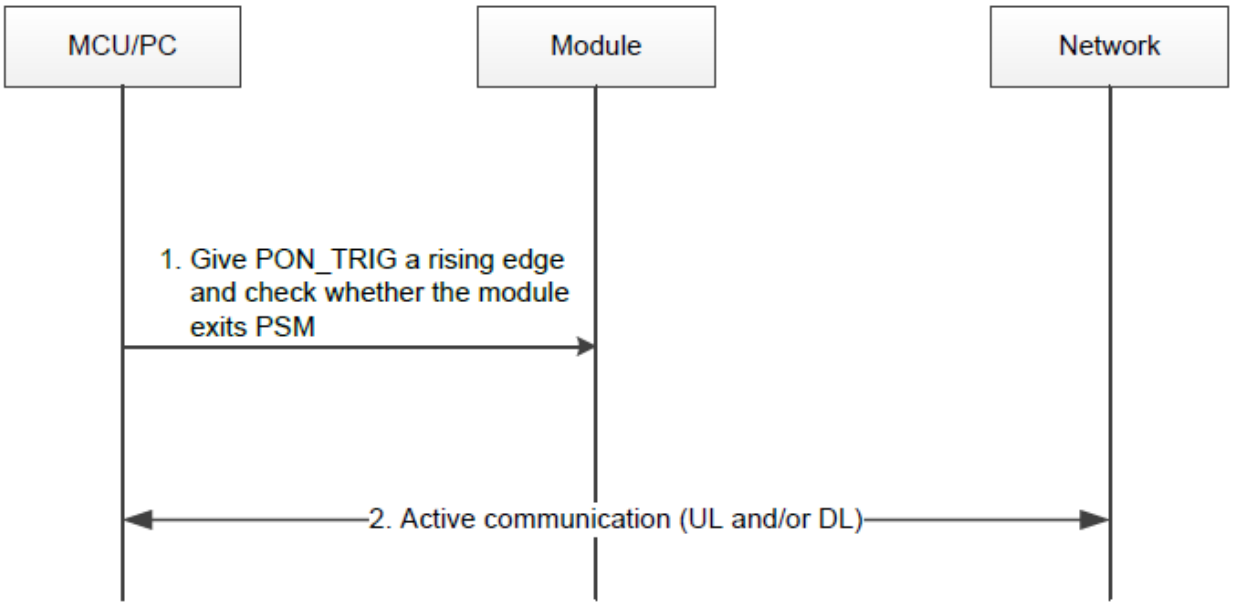

Figure 1: Wake up Module from PSM with PON_TRIG

5.2 Wake up from PSM with PWRKEY

Similar to the **PON_TRIG** solution, waking up the module from Power Saving Mode (PSM) via PWRKEY follows a set of steps to facilitate communication between the module and the network.

To initiate the wake-up process, the first step is to drive the PWRKEY pin low. This action serves as the trigger for the module to exit PSM and transition to an active state. By driving the PWRKEY pin low, the module receives a signal to awake from its low-power state and get ready to communicate with the network. It is imperative to ensure that the PWRKEY pin is held low for a sufficient duration, allowing the module to complete the wake-up sequence. Monitoring the module's status indicators or relevant interfaces can provide feedback on the successful transition from PSM to the active state.

Following the successful wake-up from PSM, the next step is to perform uplink (UL) and/or downlink (DL) communication, including initializing communication protocols, establishing connections with base stations, and negotiating network parameters. Thus, the module is in an operational state and ready to send and receive data as required.

By leveraging the PWRKEY method, developers can achieve a controlled and efficient means of waking up the module from PSM, balancing power efficiency with the need for responsive network communication.

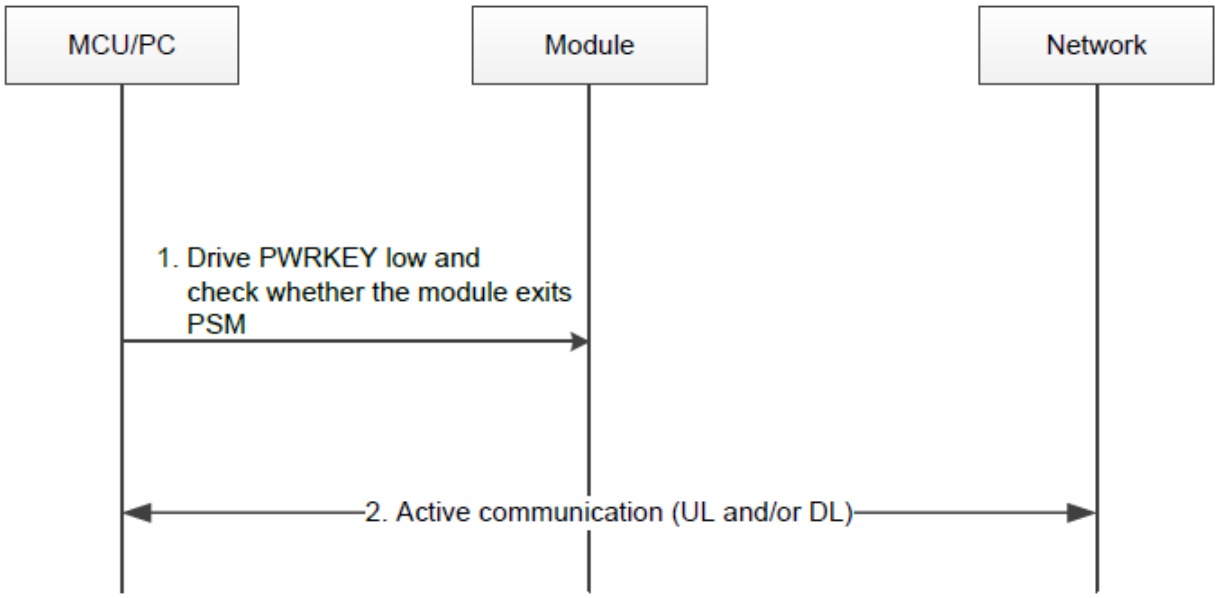

Figure 2: Wake up Module from PSM with PWRKEY

5.3 Wake up from PSM When T3412 Timer Expires

The wake-up process from Power Saving Mode (PSM) can be handled automatically through the expiration of the T3412 timer, also known as the extended Tracking Area Update (TAU) timer. This method provides a hands-free approach to transfer the module from a low-power state to an active state without manual intervention.

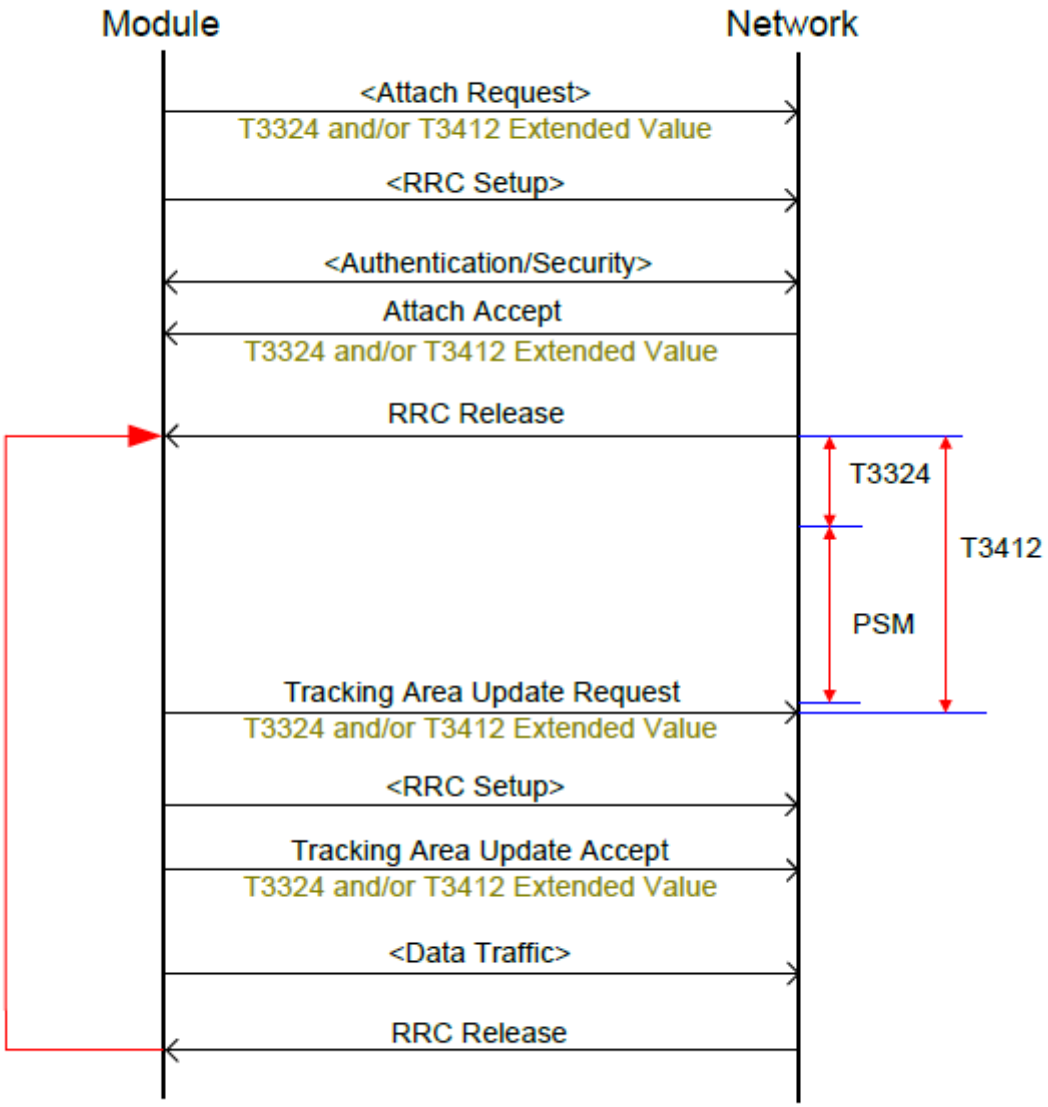

Figure 3: Automatically Wake up Module from PSM When T3412 Expires

6 Appendix

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