HUAWEI MU509 Series HSDPA LGA Module

Power Management Design Guide

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About This Document

Revision History

Document Version	Date	Chapter	Description
01	2012-10-23		Creation
02	2013-09-13	3.4	Updated section 3.4 Module Wake-up
		3.5.3	Updated section 3.5.3 WAKEUP_OUT Waking Up the Host
		All	Updated the scope

Scope

- MU509-b
- MU509-c
- MU509-g
- HUAWEI MU509-1

Contents

1 Overview

As an embedded component in the host, the module also consumes power, which increases the power consumption of the integrated product. Therefore, the most important task of power management is to reduce the power consumption of the integrated product by enabling the module's sleep mode when necessary.

The host and the module need to wake up each other from sleep if communication is required. Therefore, another task of power management is to provide a wake-up control mechanism for the host and module.

Power management involves three parts: the host system software (including the USB driver/UART driver/GPIO driver/sleep mechanism functions), connection hardware between the host and module, and wake-up mechanism of the module's software.

This document mainly describes the wakeup mechanism of the module's software, including the USB-based automatically wakeup function of the module (priority use), compulsory sleep function (it is used only in the special circumstances), how the USB related events take effects on waking up the module and remotely wake up the module, and how the module remotely wakes up the host.

This document briefly describes the power management related connection hardware between the host and module.

This document is only applicable to the Windows XP/Android system; and is not applicable to the Windows 7/8/blue system and later systems released by Microsoft because of their feature (they defines their own sleep, wakeup and remote wakeup standards).

This document does not describe the host system software. For example, if the host runs on a Windows or Mac system, Huawei will provide a USB driver program corresponding to the module. If the host runs on an Android system, Huawei will provide *Guide to Kernel Driver Integration in Android for Huawei WCDMA & CDMA & LTE Modules* for users to configure the USB-based wakeup function of the module.

This document describes typical application scenarios of the module. A host can be designed based on the actual system features and the application scenarios of the module to reduce power consumption of both the module and integrated product.

For details about the module's performance indicators, refer to relevant description in *HUAWEI MU509 Series HSDPA LGA Module Hardware Guide*.

2 Hardware Interfaces

2.1 Hardware Interfaces

The interface of the module is LGA. The module communicates with the host mainly using USB or UART. For details about pins related to power management, see Table 2-1 .

Table 2-1 Power management related pins

Interface	Pin No.	Pin Name	Input/ Output	Description	Sequence Diagram	Reference design
LGA	71	WAKEUP_OUT	Output	WAKEUP_OUT pin outputs a high-level voltage by default. When a call or text message arrives, this pin outputs a low-level-voltage pulse lasting for 1s, during which if new calls or text messages arrive, the module will re-output a low-level-voltage pulse lasting for 1s. The sequence (see Figure 2-1) is designed based the hardware design (NPN circuit is added peripherally). If NPN circuit is not added, WAKEUP_OUT pin is detected to output low level by default. When a call or text message arrives, this pin outputs a high-level-voltage pulse lasting for 1s.	Figure 2-1	Please see *HUAWEI MU509 Series HSDPA LGA Module Hardware Guide*.

Interface	Pin No.	Pin Name	Input/ Output	Description	Sequence Diagram	Reference design
LGA	11	WAKEUP_IN	Input	If WAKEUP_IN pin is input low level during power-on or receives a falling edge after power-on, the module enters the compulsory sleep mode (see 3.6.1). If WAKEUP_IN pin receives a rising edge when module is in the compulsory sleep mode, the module will exit the compulsory sleep mode. Other level changes do not affect the module's operating status.	Figure 2-2	Please see *HUAWEI MU509 Series HSDPA LGA Module Hardware Guide*.

2.2 Sequence Diagram

Figure 2-1 WAKEUP_OUT (when a NPN triode is externally connected to the WAKEUP_OUT pin) output sequence

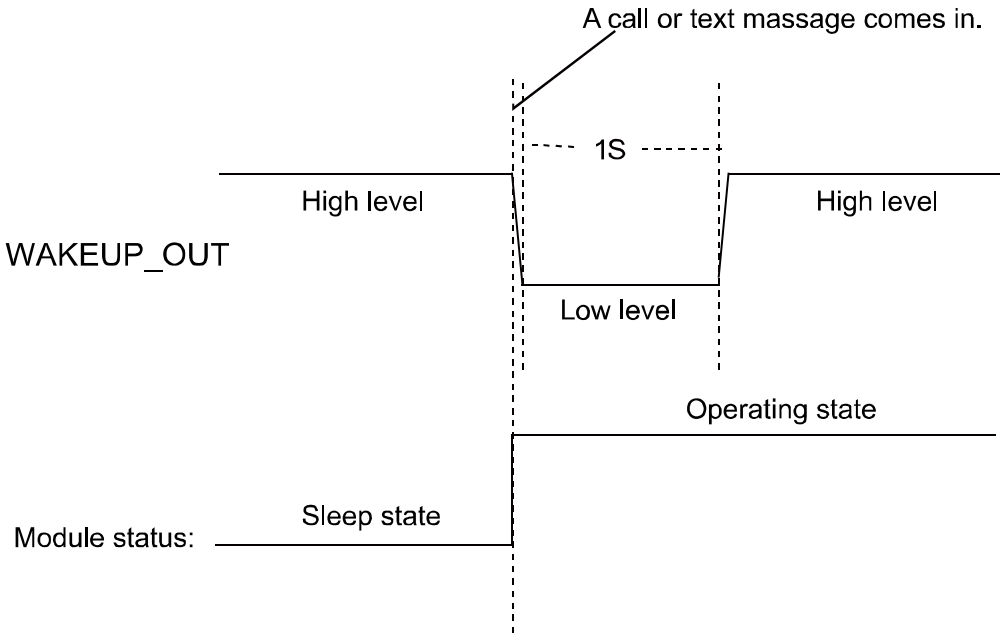
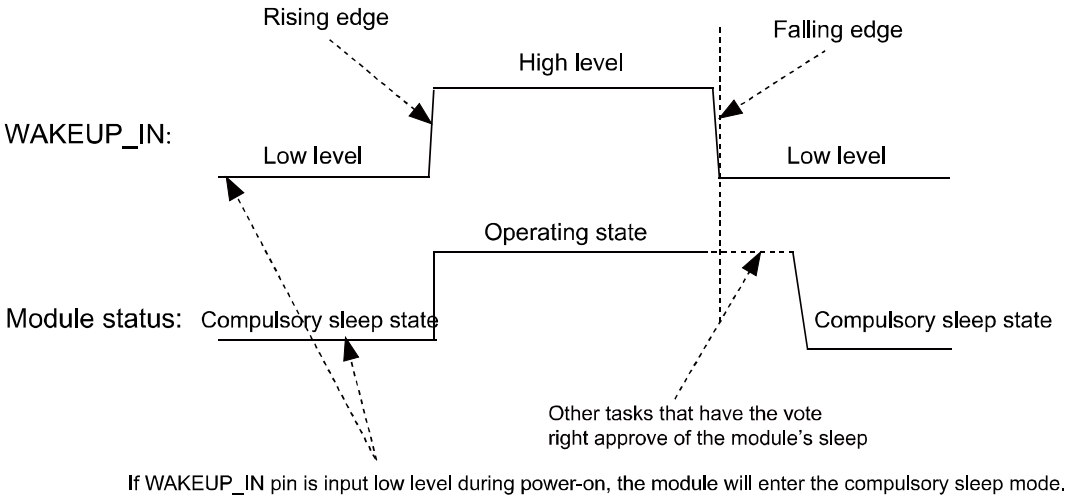


Figure 2-2 WAKEUP_IN input sequence



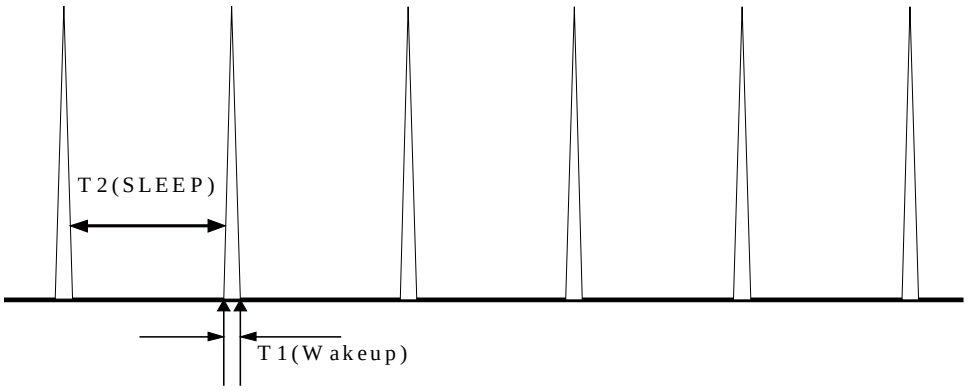
About the vote, see section 3.1 .

3 Software Interfaces

3.1 Principle

The module runs on a multi-task software system. The sleep task is granted with the lowest priority and assigned to detect whether the module can enter sleep mode. Other tasks (such as the RF, SIM card, USB, and UART) have a vote right. They vote to decide whether the module can enter sleep mode or not. When all other tasks are not running, the sleep task is executed. If the sleep task detects that all other tasks agree on the module's sleep, the module enters sleep mode, as shown in Figure 3-1 . At this time, the baseband chip reduces the work frequency, and the RF enters the Discontinuous Reception (DRX) mode.

Figure 3-1 Current state when the module is in sleep mode

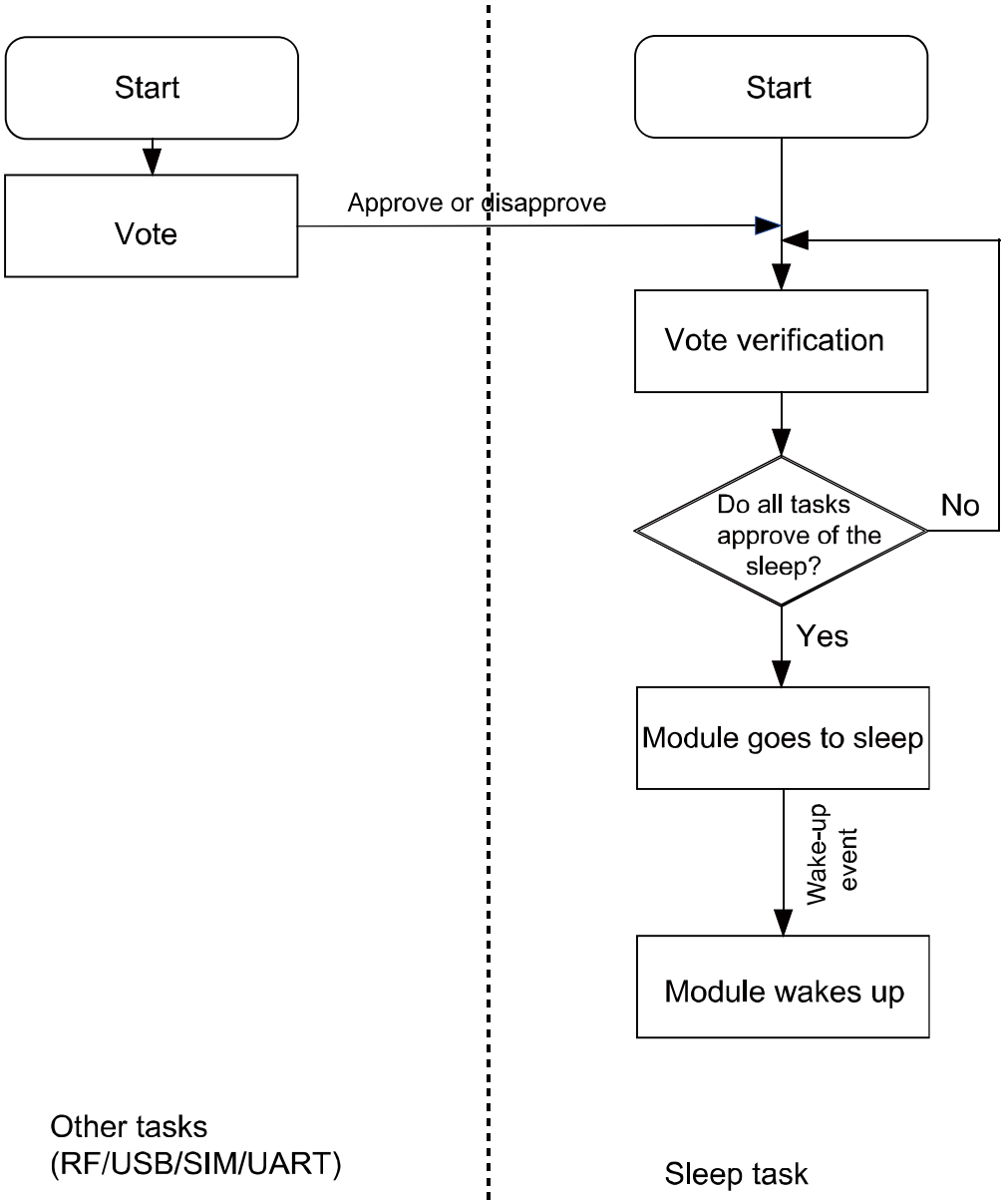


NOTE

- The module's sleep mode is different between various modes set using the **AT+CFUN** command. The RF will be turned off when **AT+CFUN** is set to 0 while the RF will enter DRX mode without being turned off when the module is in sleep mode. For more details, refer to the corresponding AT Command Interface Specification.
- The module enters sleep mode automatically when the sleep task detects that all other tasks agree on the module's sleep. The module may take several seconds to several minutes from awake to asleep. It depends on all other tasks whether agree on sleep or not.

About the sleep procedure of the module, see Figure 3-2 .

Figure 3-2 Sleep procedure



3.2 USB and Sleep

USB is an important communication channel between the module and the host. According to the USB protocol, normally a hub or a root hub periodically sends Start of Frame (SOF) data packages (one data package per ms using full-speed USB and one package per 125 µs using high-speed USB). At this time, USB always votes to stop the module from entering sleep mode.

When the USB driver provided by Huawei detects that the module and the host do not exchange data in 5 seconds, the USB driver will enable the port's suspend feature, stopping sending SOF data packages and suspending the USB controller. At this time, USB will vote to agree the module's sleep.

NOTE

If the USB driver used is developed by users or is integrated with external application, ensure that the USB driver supports the USB suspend features (including selective suspend and global suspend, which are defined in the USB standard.)

3.3 UART and Sleep

UART is an important communication channel between the module and the host. If the host uses UART (a TTL level Interface), the host can connect to the module's UART directly. If the host uses RS232, the host can connect to the module's UART through a conversion chip such as MAX232. Regardless of the connection modes, when there is no data transmitted on the UART, the host should set the RX pin of the module's UART to low level so that the module can enter sleep mode. Otherwise, UART always votes to stop the module from entering sleep mode.

NOTE

If the host uses RS232 and connects to the module's UART through a conversion chip such as MAX232, and the host requires the module’s sleep, the compulsory sleep mode can be taken (see 3.6).

3.4 Module Wake-up

RF periodically wakes up the module based on the DRX circle (depending on the actual configuration of the network system), as shown in Figure 3-1 .

Other aperiodic events include:

1. The host sends data using USB/UART when modules are not in the compulsory sleep mode.
2. The changes on the network, for example, an incoming call, an incoming text message, a signal change, a network working mode change, a network search, an IP data package (when a dial-up network connection is set up).
3. Software system events such as a timer
4. Abnormal events, for example, an antenna drops or a SIM card gets loosen.

3.5 The Host Being Wakened up by the Module

3.5.1 Wake-up Source

A wake-up source means a module event that can wake up the host, for example, an incoming voice call, a text message, data (PPP data, TCP/UDP data from the network), and unsolicited reports.

3.5.2 Remotely Waking up the Host by Using USB

When the USB controller is in suspended mode (for example, the host is in sleep mode), if the module needs to send data to the host (for example, a wake-up source has arrived), the module sends a remote wake-up signal that lasts 3 ms to inform the host to start USB resume (as shown in Figure 3-3). To complete the procedure, the following conditions must be met:

1. The USB controller on the host supports USB remote wake-up and can wake up the host.
2. The USB driver enables or disables remote wake-up by executing SET_FEATURE and CLEAR_FEATURE commands. Therefore, remote wake-up must be enabled on the USB driver before USB enters suspended mode.
3. When the host receives the remote wake-up signal from the module, the host needs to send a full speed K signal that lasts at least 20 ms. When the USB controller resumes, the host must send the SOF token within 3 ms from the startup of the idle state. Otherwise, the module enters suspended mode again, as shown in Figure 3-4 .

Figure 3-3 USB resume time sequence

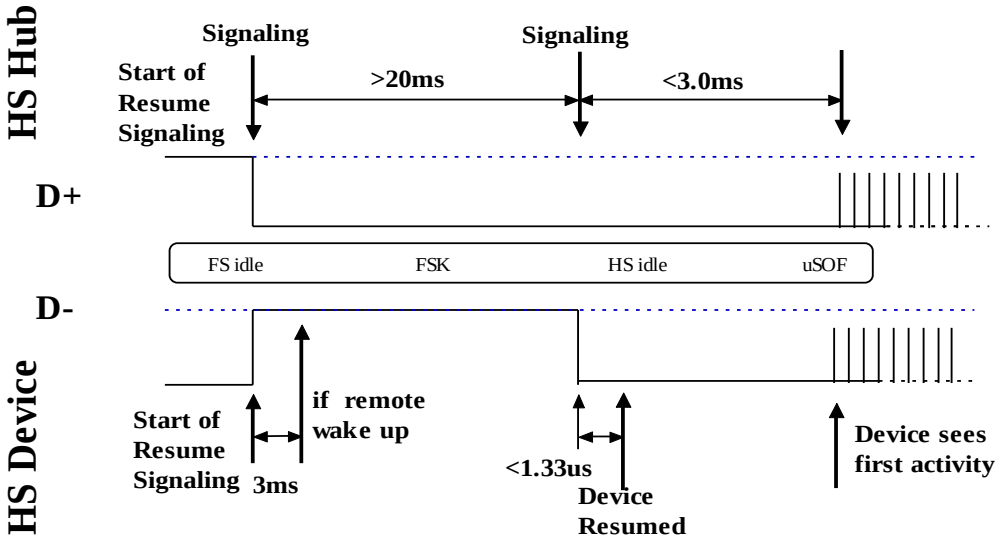
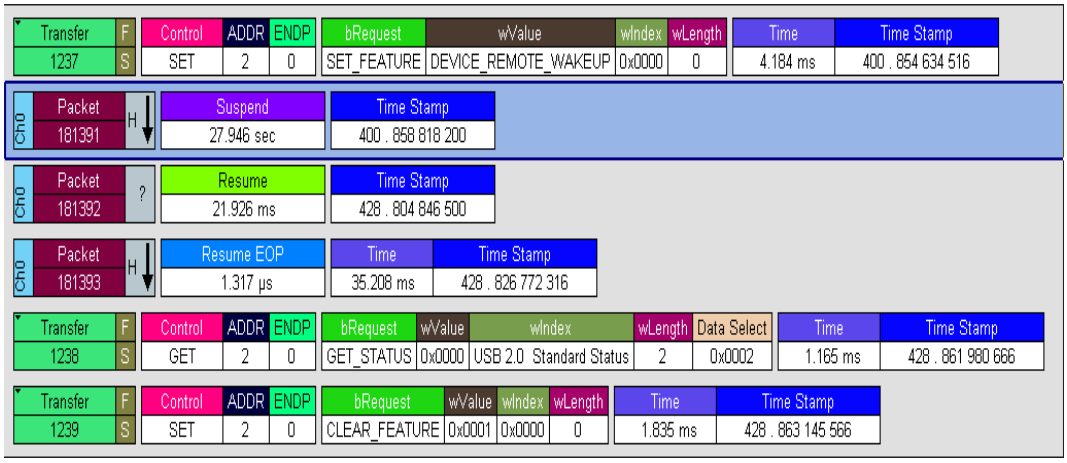


Figure 3-4 Successful procedure of remote wake-up



3.5.3 WAKEUP_OUT Waking Up the Host

The module will output a 1s level pulse using WAKEUP_OUT as shown in Figure 2-1 when an incoming voice call or a text message arrives. The host wakes up itself after detecting the level change.

3.5.4 Configure for Unsolicited Report

The ^CURC command can enable and disable part of Huawei proprietary unsolicited report commands. About the details, please refer to the description in AT command specification.

3.6 Compulsory Sleep

3.6.1 Overview

When the module is in the compulsory sleep mode, USB and UART will be disconnected (no data can be sent or received). If there are voice calls, the voice calls will be hung up; if there is data services connection, the current data services will be disconnected. If there are IP packets not been sent, the IP packet transmission will be disabled. The relative software tasks will be forced to vote to agree that the module fast enters sleep mode (please see 3.1). After that, module will enter the automatic sleep mode.

3.6.2 Enter the Compulsory Sleep Mode

If WAKEUP_IN pin is input low level during power-on or WAKEUP_IN pin is from high level to low level after power-on, the module enters the compulsory sleep mode.

3.6.3 Exit the Compulsory Sleep Mode

If a call or text message arrives or WAKEUP_IN pin is from low level to high level when module is in the compulsory sleep mode, the module will exit the compulsory sleep mode (other events cannot make module exit the compulsory sleep mode).

Afterwards, when all software tasks vote to agree that the module's sleep, the module will enter the automatic sleep mode.

3.6.4 Recommended Design for the Compulsory Sleep

The compulsory sleep mode is the complement of the automatic sleep mode. It is recommended to use the automatic sleep mode rather than the compulsory sleep mode.

NOTE

It is recommended to use the compulsory sleep only when the host connects to the module's UART through a conversion chip such as MAX232 and the host requires the module's sleep.

4 Application Scenarios

4.1 System with USB Connection

4.1.1 Overview

A tablet PC runs Android, with support for USB remote resume.

4.1.2 Hardware Connection

The host connects to the module using USB.

4.1.3 Software Procedure

About the host system, please refer to *Guide to Kernel Driver Integration in Android for Huawei WCDMA & CDMA & LTE Modules*. And USB driver must support USB Selective Suspend and USB Global Suspend.

When the host's screen is on, set **AT^CURC**=1 (the default value is 0). Module reports Huawei proprietary unsolicited report commands such as **^RSSI** and **^MODE** to the host so that the host can updates the module's state timely.

****

Run: AT^CURC=1

Response: OK

****

When the host's screen is off, set **AT^CURC**=0 to avoid that the host is frequently woken up by unsolicited report and to optimize the power consumption.

****

Run: AT^CURC=0

Response: OK

****

The location service will enable **+CREG**/**+CGREG** to cause that the host is frequently woken up. Therefore, it is recommended that disable the location service by default to optimize the power consumption.

The host system should avoid that the dashboard lines frequently access to the internet in order to optimize the power consumption.

4.2 System with USB and WAKEUP_OUT

4.2.1 Overview

A tablet PC runs Android, and does not support for USB remote resume.

4.2.2 Hardware Connection

The host must connect to the module using USB and WAKEUP_OUT pins.

4.2.3 Software Procedure

Please see 4.1.3 .

A balance design should be adopted between availability and power consumption because USB remote resume is not supported.

When the host is not in sleep mode and there are not data transmitted on the USB controller, USB controller will enter Selective Suspend status. Since USB remote resume is not supported, signal and mode changes cannot unsolicitedly report to the host. Therefore, the host system should query signal and mode changes so that the display status on the UI of the host can be updated timely

After the host detects that there are level changes on the WAKEUP_OUT pin, the host will be woken up. At this time, the host should query whether a text message arrives or not.

4.3 System with UART

4.3.1 Overview

A host is constructed based on a single-chip microcomputer and connects to the module's UART through a conversion chip such as MAX232. The host supports UART only.

4.3.2 Hardware Connection

The host must connect to the module using the UART, WAKEUP_OUT pins and WAKEUP_IN pins respectively.

4.3.3 Software Procedure

Set **AT^CURC**=1 (the default value is 0). Module reports Huawei proprietary unsolicited report commands such as **^RSSI** and **^MODE** to the host

****

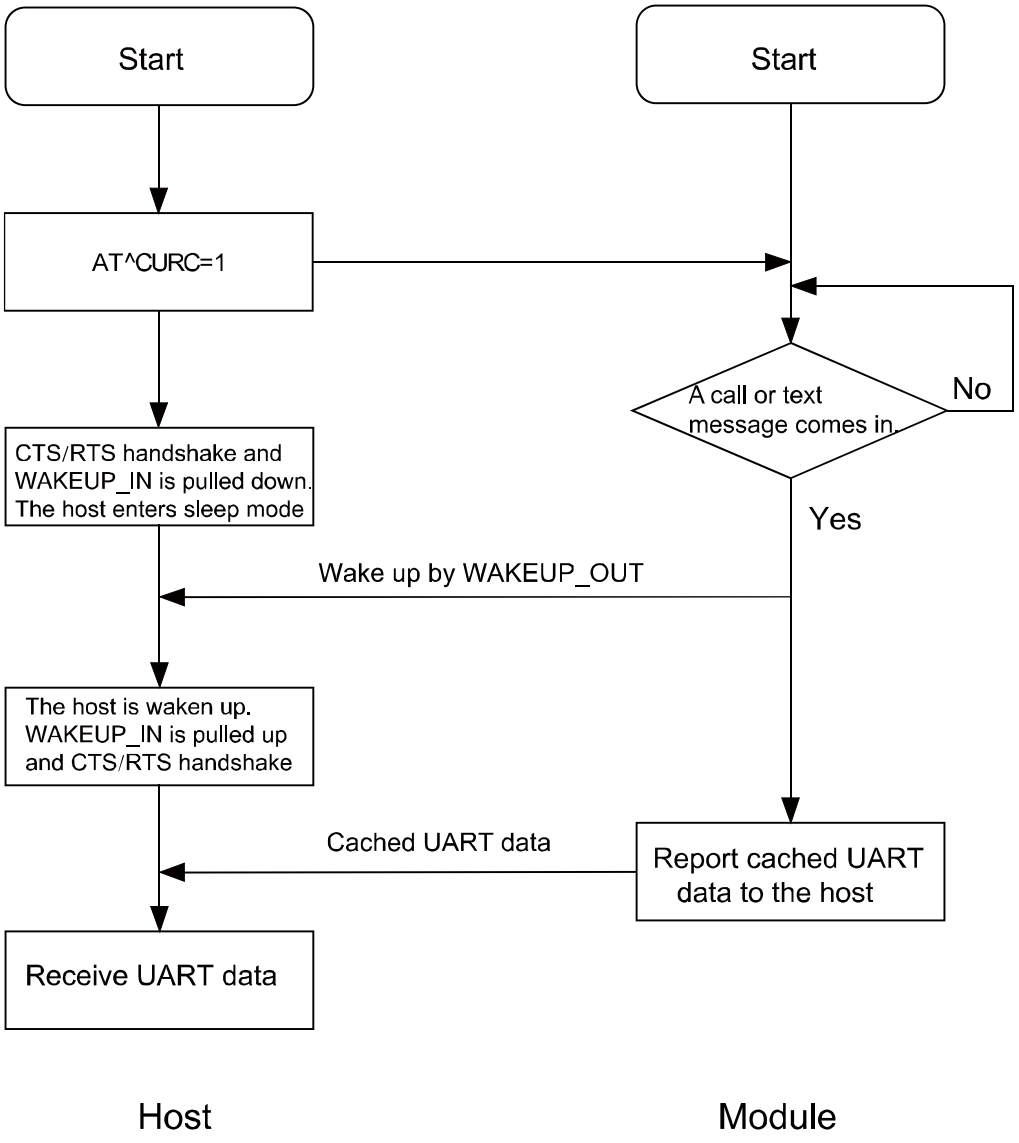
Run: AT^CURC=1

Response: OK

****

The host and the module must take a handshake to prevent data loss when the module wakes up the host.

Figure 4-1 Wake-up and hand-shaking using UART and WAKEUP_OUT pins



NOTE

If the host connects to the module using the TXD or RXD pin only, handshake is not implemented and consequently data on the UART may get lost when the host is in sleep mode.

4.4 System with Other Connection Methods

If the host can connect to the module using USB/UART/WAKEUP_IN/WAKEUP_OUT and can support USB remote wake-up and WAKEUP_OUT remote wake-up, prioritize USB remote wake-up.

For details about the software procedure, refer to the earlier sections while considering the host system feature.