HUAWEI Module

Power Management Design Guide

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About This Document

Revision History

Document Version	Date	Chapter	Description
01	2013-05-30		Creation

Scope

EM820W

MU609T

MU733

MU736

MU739

MU609

Later HUAWEI modules that support Windows XP/Android system.

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 (Universal Asynchronous Receiver/Transmitter))driver/GPIO (General Purpose Input/Output) 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 wake-up principle, 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 System for Huawei WCDMA or CDMA Module* 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 Hardware Guide.

2 Hardware Interfaces

2.1 Hardware Interfaces

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

The interfaces of the module include the mini-PCIE (Peripheral Component Interconnect Express), LGA (Land Grid Array), B2B (Board to Board), and so on. For corresponding interface numbers, reference design, see Hardware Guide for each product.

NOTE

- Some HUAWEI products may not support all pins listed in Table 2-1 . For example, some LGA modules only support WAKEUP_IN/WAKEUP_OUT pin and does not support SLEEP_STATUS pin. You can get the detailed information in the corresponding hardware guide.
- Modules with PCIE interface do not support UART, therefore, the descriptions related to UART in this document are not applicable to modules with PCIE interface.

Table 2-1 Power management related pins

Interface	Pin Name	Input/ Output	Description	Sequence Diagram
PCIE	WAKE#	Output	These pins output a high-level voltage by default. When a wake-up source (see section 3.5.1) arrives, these pins output a low-level-voltage pulse lasting for 1s during which if other wake-up sources arrive, the module will ignore the later wake-up requests. In other words, the module will not output a second pulse in this 1s.	Figure 2-1
LGA	WAKEUP_OUT			
B2B				
LGA	WAKEUP_IN	Input	When the pin carries a high-level voltage, the states of the module are as follows:	Figure 2-2

Interface	Pin Name	Input/ Output	Description	Sequence Diagram
B2B			The module will be prohibited to enter sleep mode if the module is awake. The module will be wakened up if the module is in sleep mode. When the pin carries a low-level voltage, the module is allowed to enter sleep mode. (By default, the pin is set to INPUT/PD, which is, the software detects a low-level voltage on the pin when the pin is not connected.)	
LGA B2B	SLEEP_STATUS	Output	Indicates the state of the module. When the pin carries a high-level voltage, the module is in working mode. When the pin carries a low-level voltage, the module is in sleep mode.	Figure 2-3

2.2 Sequence Diagram

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

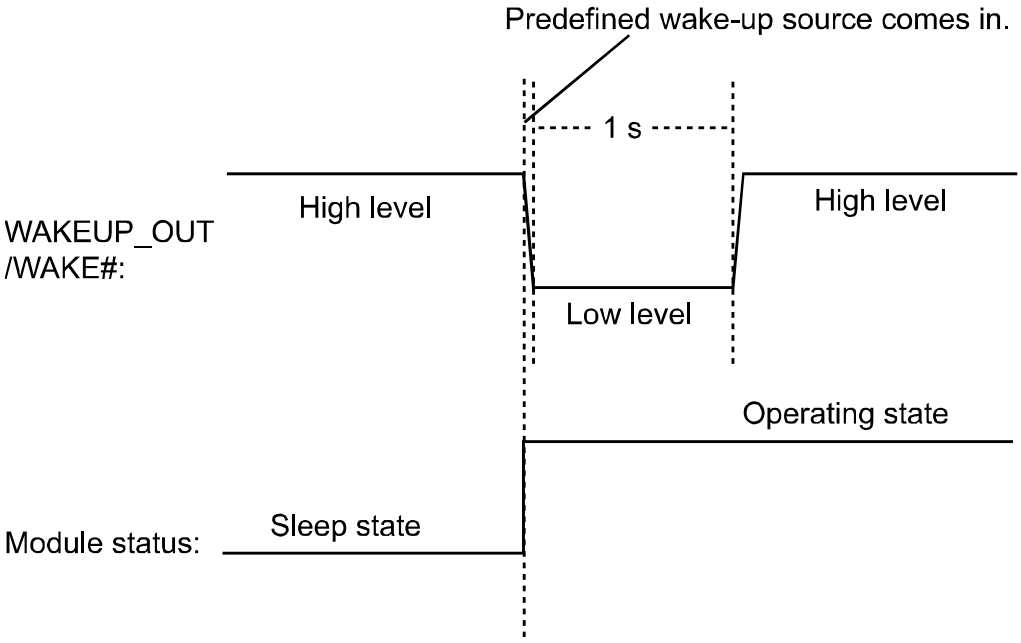
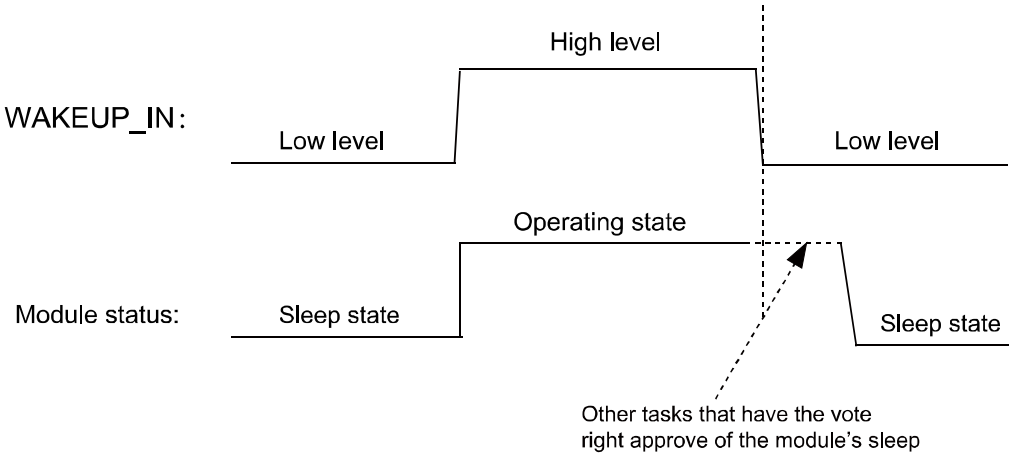
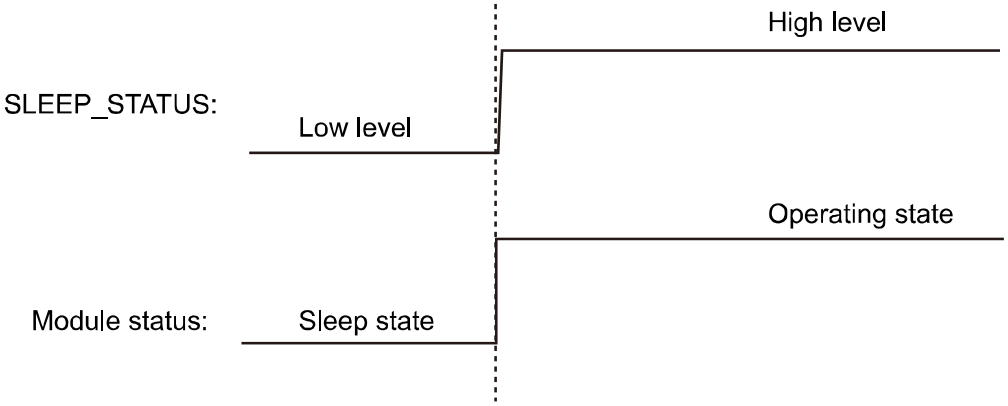


Figure 2-2 WAKEUP_IN input sequence



About the vote, see section 3.1 .

Figure 2-3 SLEEP_STATUS output sequence

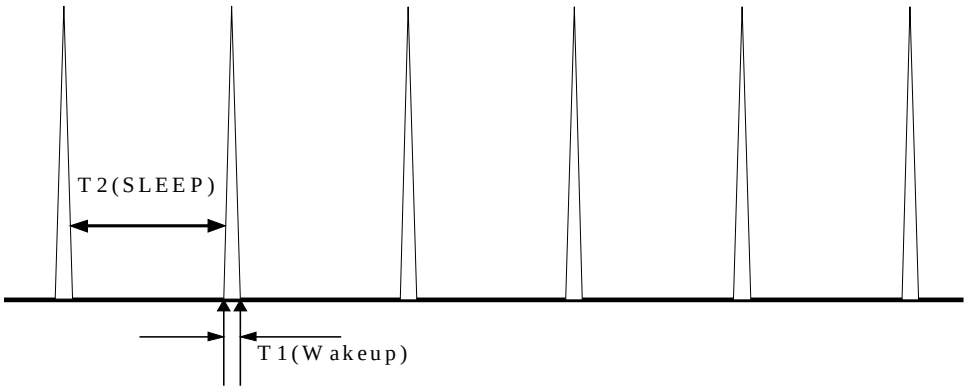


3 Software Interfaces

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 votes to decide whether the module can enter sleep mode. 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.

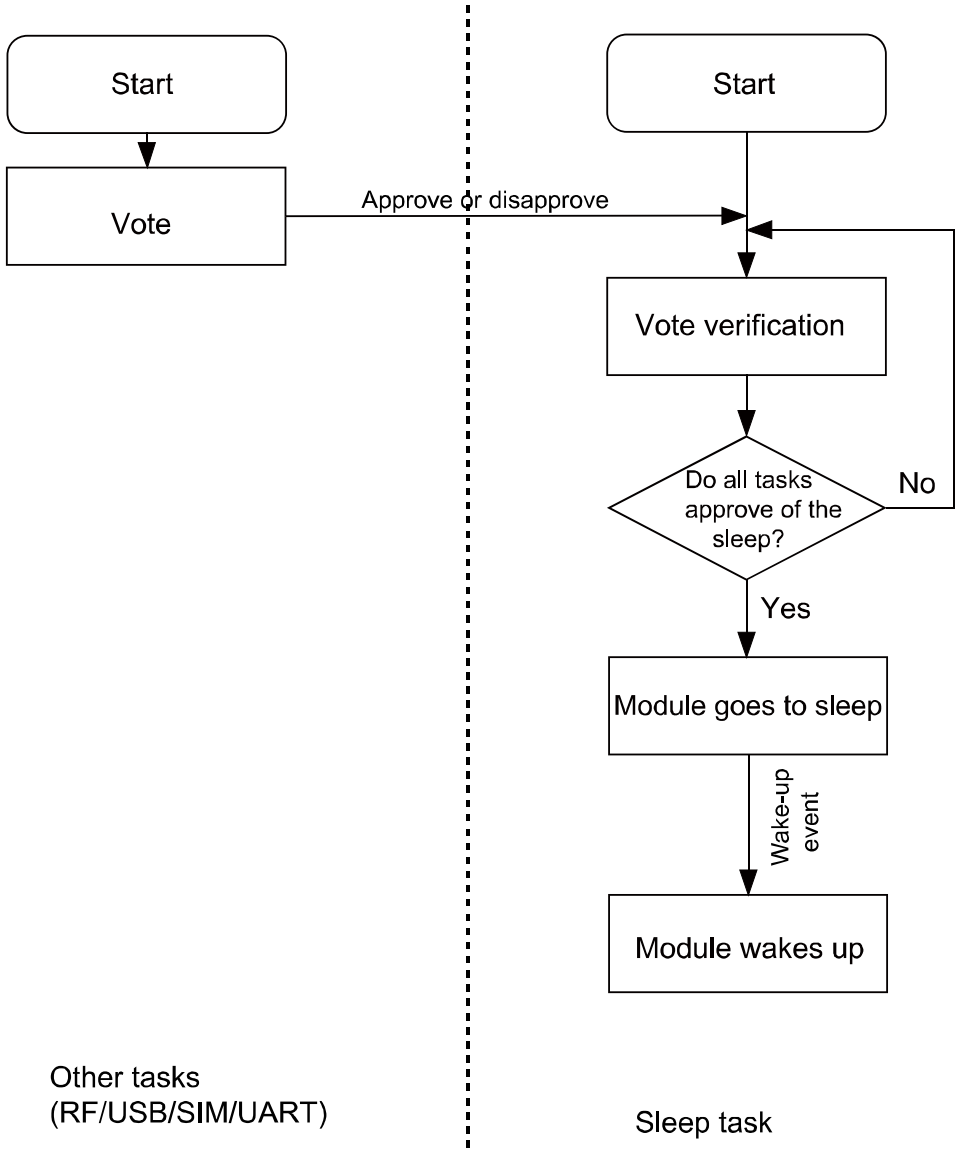
Figure 3-1 Currency state when the module is in sleep mode



NOTE

- The module's sleep mode is different from working mode or flight mode set using the AT+CFUN command. The RF will be turned off when the module enters LPM mode using the command AT+CFUN=0 while the RF will enter DRX mode without being turned off when the module is in sleep mode. For more details, refer to relevant description in 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 sleep period of the module depends on the current working state and circumstance. The period may last for several seconds to several minutes.

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 the same 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.

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:

- The host sends data using USB/UART or pulls up WAKEUP_IN.
- 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).
- Software system events such as a timer
- 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, an text message, data (PPP data, TCP/UDP data from the network), and unsolicited messages.

3.5.2 Remotely Waking up the Host Using USB

When the host is in sleep mode and the USB controller is in suspended 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 3-3 .

Figure 3-3 USB resume time sequence

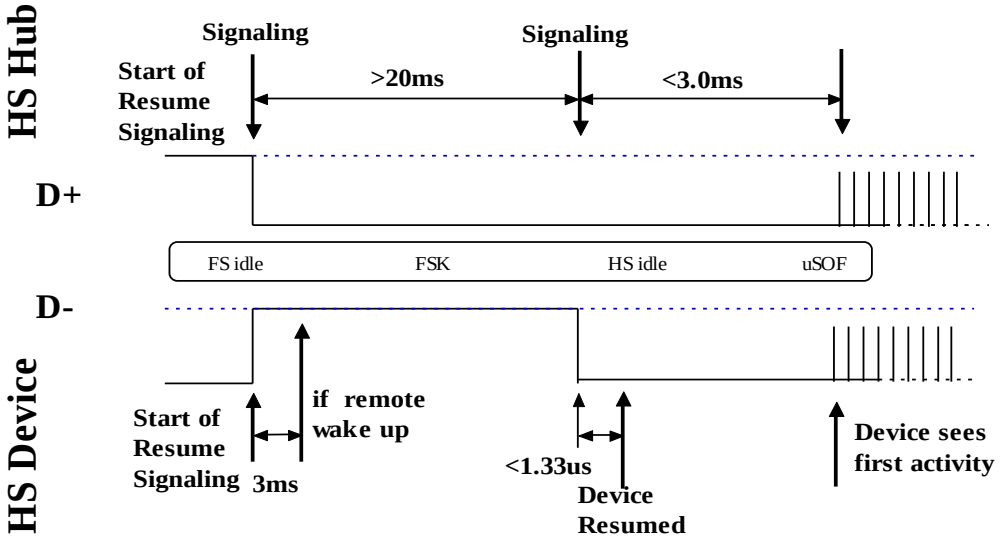
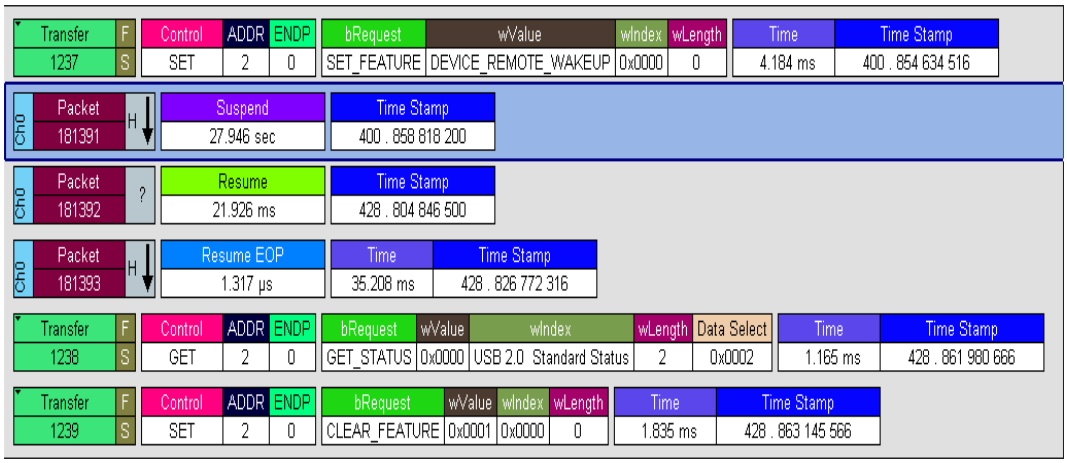


Figure 3-4 Successful procedure of remote wake-up



3.5.3 WAKEUP_OUT/WAKE# Waking Up the Host

The module will output a 1s level pulse using WAKEUP_OUT/WAKE# as shown in Figure 2-1 when a wake-up source arrives. The host wakes up itself after detecting the level change.

3.5.4 Remote Wake-up Configuration

The power consumption of the host increases if it is frequently waken up. The host can configure the module's wake-up sources using ^WAKEUPCFG and ^CURC command so as to reduce the power consumption.

The ^WAKEUPCFG command can be used to choose wake-up sources and the wake-up channel (USB or WAKEUP_OUT/WAKE#). The ^CURC command can choose unsolicited messages. For more details, refer to AT Command Interface Specification.

NOTE

Some HUAWEI products may only support ^WAKEUPCFG or ^CURC. You can get the detailed information in the corresponding product AT Command Interface Specification..

4 Application Scenarios

4.1 System with USB Connection only

4.1.1 Overview

A tablet PC runs Android, with support for USB suspend, USB remote resume, voice calling, and text messages.

4.1.2 Hardware Connection

The host connects to the module using USB.

4.1.3 Software Procedure

Perform the following software procedure when initiating the host.

****

Query the parameter range of WAKEUPCFG.

****

Run: AT^WAKEUPCFG=?

Response: ^WAKEUPCFG: (0–1),(0–3),(0–15)

OK

****

Configure the module to make sure that incoming calls, text messages, data, and unsolicited messages can remotely wake up the host using USB.

****

Run: AT^WAKEUPCFG=1,2,15

Response: OK

****

Query the parameter range of CURC.

****

Run: AT^CURC=?

Response: ^CURC: (0–2)

OK

****

The host wakes up from sleep if any of the following occurs: The SIM card state changes such as the SIM card is removed (^SIMST); the number of text messages exceeds the limit (^SMMEMFULL); a call ends (^CEND). Other unsolicited messages are saved in the cache when the host is in sleep mode, and reported to the host when it wakes up.

When the host is awake, unsolicited messages are reported to the host.

****

Run: AT^CURC=2,800820,1FFFFFFFFFFFFFFF

Response: OK

4.1.4 Advantages

With software configuration, while the system requirements (calling and text messages) are met, the number of times the host is waken up by unsolicited messages, and consequently the power consumption, are reduced.

4.2 System with USB and WAKE#

4.2.1 Overview

A tablet PC runs Android, with support for text messages, but not USB remote resume or voice calling.

4.2.2 Hardware Connection

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

4.2.3 Software Procedure

Perform the following software procedure when initiating the host.

****

Query the parameter range of WAKEUPCFG.

****

Run: AT^WAKEUPCFG=?

Response: ^WAKEUPCFG: (0–1),(0–3),(0–15)

OK

****

Configure the module to make sure that text messages, data, and unsolicited messages can remotely wake up the host using the WAKE# pin.

****

Run: AT^WAKEUPCFG=1,1,14

Response: OK

****

Query the parameter range of CURC.

****

Run: AT^CURC=?

Response: ^CURC: (0–2)

OK

****

The host wakes up from sleep if either of the following occurs: The SIM card state changes, such as the SIM card is removed (^SIMST); the number of text messages exceeds the limit (^SMMEMFULL). Other unsolicited messages are saved in the cache when the host is in sleep mode, and reported to the host when it wakes up.

When the host is awake, unsolicited messages are reported to the host.

****

Run: AT^CURC=2,820,1FFFFFFFFFFFFFF

Response: OK

4.2.4 Advantages

A solution is provided for the system not supporting USB remote resume.

With software configuration, while the system requirements (calling and text messages) are met, the number of times the host is waken up by unsolicited messages, and consequently the power consumption, are reduced.

4.3 System with UART and WAKEUP_OUT

4.3.1 Overview

A host is constructed based on a single-chip microcomputer. There is no user interface. The host supports UART and text messages. After receiving a text message, the host decodes it and takes corresponding actions.

4.3.2 Hardware Connection

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

4.3.3 Software Procedure

Perform the following software procedure when initiating the host.

****

Query the parameter range of WAKEUPCFG.

****

Run: AT^WAKEUPCFG=?

Response: ^WAKEUPCFG: (0–1),(0–3),(0–15)

OK

****

Configure the module to make sure that text messages can remotely wake up the host by WAKEUP_OUT.

****

Run: AT^WAKEUPCFG=1,1,2

Response: OK

****

Query the parameter range of CURC.

****

Run: AT^CURC=?

Response: ^CURC: (0–2)

OK

****

When the host wakes up from sleep if the number of text messages exceeds the limit.

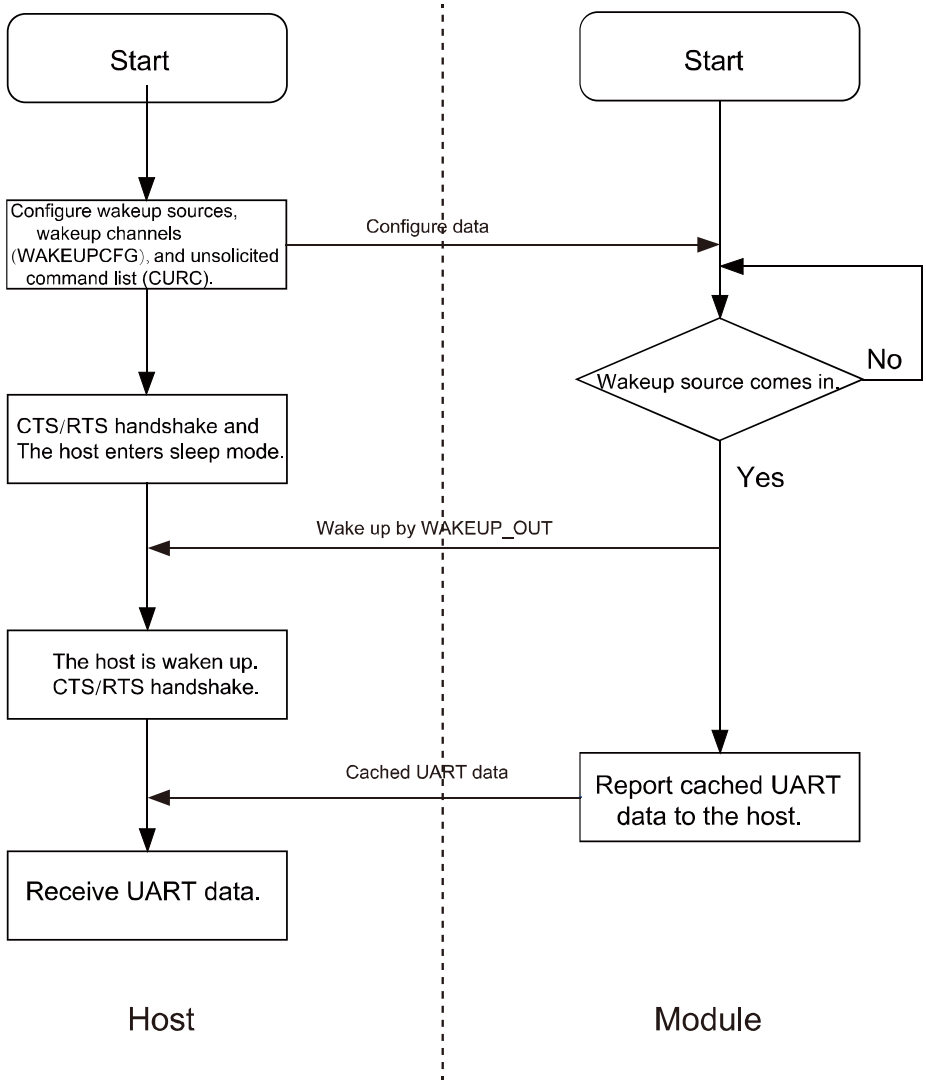
****

Run: AT^CURC=2,800,1FFFFFFFFFFFFFF

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(CTS/RTS) 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.

4.3.4 Advantages

This solution enables handshake between UART and WAKEUP_OUT.

With software configuration, the host can go to sleep with no data lost.

4.4 System with Other Connection Methods

If the host can be connected to the module only using UART, refer to the *HUAWEI Module UART Serial Port Design Guide.* If the host can connect to the module using USB/UART/WAKEUP_OUT and can support USB remote wake-up and UART remote wake-up, prioritize USB remote wake-up over WAKEUP_OUT remote wake-up. For details about the software procedure, refer to the earlier sections while considering the host system feature.