UART SLEEP MODE

1.0 INTRODUCTION

This application note describes the general issues about sleep mode of UARTs. Sleep mode is for reducing power consumption when UARTs are not actively used.

2.0 ENTERING SLEEP MODE

When the UART is not actively used, the sleep mode can be enabled to minimize power consumption. In the sleep mode, the UART stops its clock oscillator to conserve power.

2.1 CONDITIONS TO ENTER THE SLEEP MODE

Generally, all the following conditions must be satisfied for the UART to enter the sleep mode:

- no interrupts pending (ISR bit-0 = 1)
- modem inputs are not toggling (MSR bits 0-3 = 0)
- RX input pin is idling HIGH
- divisor (the value in DLL register) is non-zero
- TX and RX FIFOs are empty

2.2 INITIALIZATION FOR ENABLING THE SLEEP MODE

If the sleep mode bit is located in IER bit-4, the documentation may refer to the following steps to enable the sleep mode.

- LCR = 0xBF
- EFR[4] = 1
- LCR[7] = 0
- IER[4] = 1

If the sleep mode bit is located in sleep mode register (such as in PCI UARTs), we may refer to the following steps to enable the sleep mode:

- Set SLEEP register to 0xFF (the maximum channel number is 8)

2.3 VERIFYING THE SLEEP MODE

The UART has entered the sleep mode when there is no clock on XTAL2 pin. If UART doesn't go to sleep, then one or more conditions have not been met. All the conditions in 2.1 need to be re-checked as well as make sure that sleep mode has been enabled.

In any case, the sleep mode will not be entered while an interrupt is pending from any channel. The UART will stay in the sleep mode of operation until it is disabled by setting sleep mode bit to a logic 0.

Also, it is recommended the RX pin is idling HIGH or "marking" condition during sleep mode. This may not occur when the external interface transceivers (RS-232, RS-485 or another type) are also put to sleep mode and cannot maintain the "marking" condition. To avoid this, the system design engineer can use a 47k ohm pull-up resistor on each of the RX input.

3.0 EXIT FROM SLEEP MODE

3.1 METHODS

3.1.1 The UART resumes normal operation by any of the following:

- a receive data start bit transition (HIGH to LOW)
- a data byte is loaded to the transmitter, THR or FIFO
- a change of logic state on any of the modem or general purpose serial inputs: CTS#, DSR#, CD#, RI#

If the UART is awakened by any one of the above conditions, it will return to the sleep mode automatically after all interrupting conditions have been serviced and cleared. If the UART is awakened by the modem inputs, a read to the MSR register is required to reset the modem input delta bits.

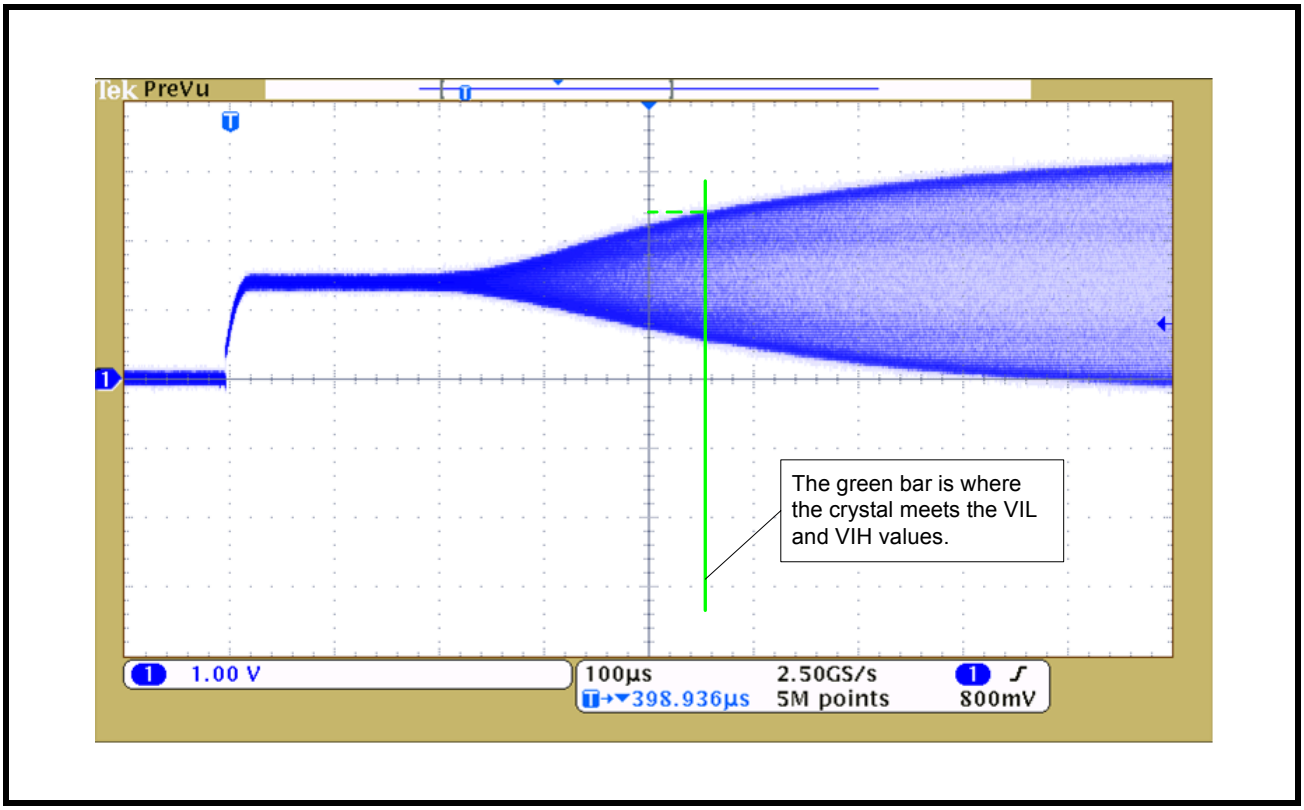
3.1.2 Disable sleep mode

Set the IER bit-4 to 0 or Sleep mode register to 0 to disable sleep mode fully.

3.2 CRYSTAL WAKE-UP TIME

When UART wakes up from sleep mode, it takes some time for crystal to oscillate fully. Different crystals have different parameters. Figure 1 shows an example of clock response when UART wakes up. In this example, it takes approximately 450 us before the UART is ready to transmit or receive data.

FIGURE 1. AN EXAMPLE OF CRYSTAL START-UP DELAY WHEN UART WAKES UP FROM SLEEP MODE

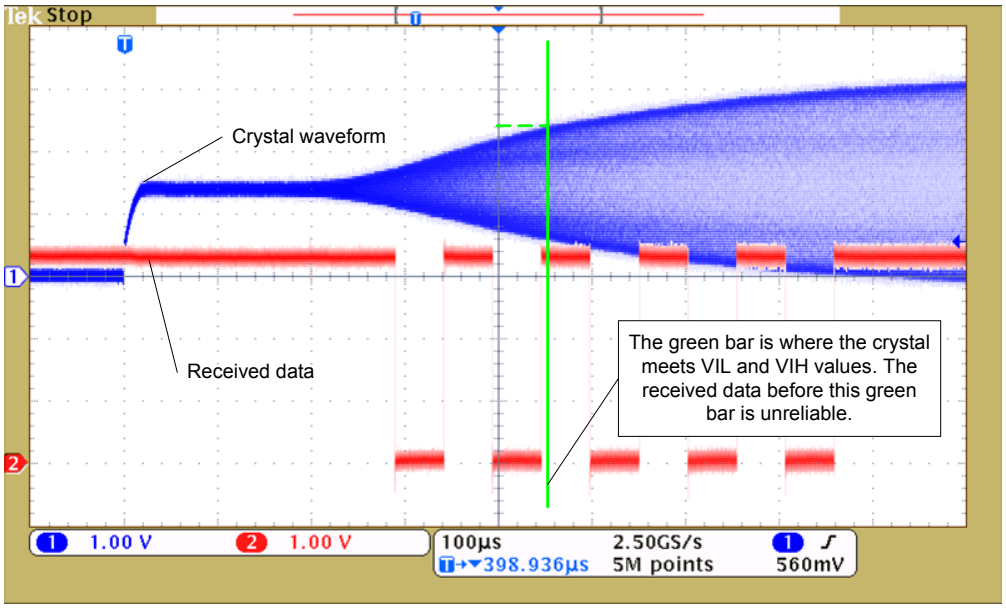


NOTE: *The conditions for the figure 1 are as following: XR68M752IM48 powered at 3.3V; Crystal frequency 14.7456MHz.*

3.3 RECEIVE BEFORE CRYSTAL WAKES UP

Due to the starting up delay of the crystal oscillator, the first few receive characters may be lost (shown in Figure 2). In this example, when UART wakes up from the sleep mode, the first few bits (in the left side of the green line in Figure 2) are lost. Thus, the first byte is unreliable.

FIGURE 2. AN EXAMPLE OF DATA RECEIVED BEFORE CLOCK FULLY OSCILLATE



NOTE: *The conditions for the figure 2 are as following: XR68M752IM48 powered at 3.3V; Crystal frequency 14.7456MHz; baud rate 19.2 Kbps.*

4.0 FAQ

4.1 HOW CAN I ENABLE THE SLEEP MODE?

First, make sure all the conditions in **section 2.1** are satisfied. Second, follow the steps listed in **section 2.2**. For different UARTs, there might be slight difference. Be sure to read datasheets before writing to any registers.

4.2 I ENABLE THE SLEEP MODE, HOWEVER, THE UART DOESN'T GO TO SLEEP. WHAT AM I MISSING?

Please check that all the conditions in **section 2.1** are satisfied first. Be sure sleep mode bit has been set to 1. If there are multiple UART channels, the sleep conditions must be true for all channels.

4.3 CAN I READ AND WRITE REGISTERS WHEN UART IS IN SLEEP MODE?

Yes. Note: some devices do have powersave mode. If UART goes into powersave mode, then the registers are not accessible.

4.4 HOW CAN I WAKE UP THE UART?

Receiving a data in RHR or writing data to THR or logic state change on any modem inputs will wake up UART. Also, setting sleep mode bit to 0 wakes up UART and permanently disables sleep mode.

4.5 I WRITE A BYTE DATA TO UART, HOWEVER, IT DOESN'T WAKE UP THE UART. WHAT IS THE REASON?

Read LSR register to check whether the UART receives the data or not.

- If LSR value is 0x60, it means that either UART receiver FIFO doesn't receive the data or the data in receiver FIFO has been read out before the read of LSR.
- If LSR value is 0x00, it means data is still in the THR (clock doesn't oscillate to transmit data).
- If LSR value is 0xFF, it means either UART is in powersave mode or UART is powered off.

For those devices with powersave mode, be sure that UARTS are not in powersave mode.

4.6 AFTER UART WAKES UP, IT CAN NOT TRANSMIT AND RECEIVE DATA. WHAT SHOULD I CHECK?

- Check whether the register set can be accessed.
- Check whether the crystal is oscillating fully.
- Check whether the data can be transmitted in internal loopback mode.

5.0 SUMMARY

Sleep mode provides a way to save power for application. It is useful in battery powered applications as it can extend the battery life.

6.0 SUPPORT

For any questions, please send an email to uarttechsupport@exar.com.

Datasheet June 2010.

Send your UART technical inquiry with technical details to hotline: uarttechsupport@exar.com.