

XC800 Family

AP08098

Low Power Modes with Periodic/Real-time Clock Wake-up
in XC82x/XC83x

Application Note

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XC82x/XC83x

Revision History: V1.1 2010-08

Previous Version(s): V1.0

Page	Subjects (major changes since last revision)
Page 5	An overview of the power saving modes in XC83x has been added in Chapter 2.
Page 8	Added a description of the loss of external oscillation wake-up flag that are used in XC83x.
Page 9	Added a description on the considerations during waking up from all power down modes in XC82x and XC83x.
Page 9	Update Chapter 3.1 to include the usage of XC83x power down mode 1.
Page 10 Page 12	Added Chapter 3.2 and 3.3 on the usage of XC83x power down mode 2 and 3.
Page 13	Added a description of the XC83x power down mode 4 in Chapter 3.4. This mode has the same behaviors as XC82x power down mode 2.
Page 13	WDT must be disabled before entering XC82x power down mode 2 or XC83x power down mode 4 because a timer overflows in power down mode would prevent the microcontroller from waking up.
Page 15	Two C codes (XC82x_example and XC83x_example) have been added in Chapter 4. The assembly code found in the previous version (V1.0) has similar behaviors as the XC82x_example and it can also be used to illustrate the usage of XC82x power down mode 2.

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1 Introduction

Dynamically changing the microcontroller operating mode is one way to achieve the lowest average power consumption. For example, when the microcontroller needs to perform a computationally intensive task, the microcontroller can run as fast as possible for the shortest possible time. When there are no tasks to perform, a low current consumption power down mode can be entered, where as much of the microcontroller as possible is switched off.

Based on this approach, the XC82x/XC83x 8-bit microcontroller has additional built-in power saving modes, such as power down mode with periodic wake-up or real-time clock wake-up functions, to help achieve the lowest possible power consumption. These features provide flexibility for the user and offer ideal control for many applications especially sensor and fail safe applications.

This Application Note provides guidelines and information for the use and setup of the available power down modes. Two examples are also included. One example is used to illustrate the power down mode with periodic wake-up function in the XC82x, while a second example illustrates the power down with real-time clock wake-up function in the XC83x.

2 Overview: Power management

After reset, the active operating mode (normal operating mode) is entered in which the CPU is active and running in the system clock frequency of either 8 MHz or 24 MHz. From active mode, different power saving modes can be selected by software. They are:

- Idle mode (XC82x and XC83x)
- Power down mode 1 (XC82x and XC83x)
- Power down mode 2 (XC82x and XC83x)
- Power down mode 3 (XC83x)
- Power down mode 4 (XC83x)

Once the microcontroller wakes-up (exits) from these modes, it returns to active mode.

2.1 Idle Mode

The idle mode is used to reduce power consumption by stopping the CPU's clock. Oscillators and enabled peripherals remain functional. Refer to the User's Manual for more details of this mode.

2.2 Power Down Mode

In order to achieve different levels of operation that reduce power consumption, the XC82x has built-in two types of power down mode, while the XC83x has four power down modes.

In these modes, most of the modules are disabled and powered down while the contents of the on-chip memories are maintained. [Table 1](#) and [Table 2](#) show the modules that are still running during power down mode in XC82x and XC83x respectively. Modules which are not referenced in the table are not active in these modes.

Table 1 XC82x Module Behavior in Power Down Mode

Modules	Power Down Mode 1	Power Down Mode 2
Low Power Embedded Voltage Regulator	Running	Running
Real Time Clock	Shut down	Running in RTC Mode 1
75 kHz On-chip Oscillator	Shut down	Running

Table 2 XC83x Module Behavior in Power Down Mode

Modules	Power Down Mode 1	Power Down Mode 2	Power Down Mode 3	Power Down Mode 4
Low Power Embedded Voltage Regulator	Running	Running	Running	Running
Real Time Clock	Shut down	Running in RTC Mode 0	Running in RTC Mode 0	Running in RTC Mode 1
32.768 kHz Oscillator Pad	Shut down	Running	Running	Shut down
32.768 kHz Oscillator Watchdog	Shut down	Running	Shut down	Shut down
75 kHz On-chip Oscillator	Shut down	Running	Shut down	Running

The only current consumption in power down mode 1 is from the Low Power Embedded Voltage Regulator (LPEVR). The LPEVR is required to maintain memory contents and to facilitate a fast wake-up from power down to active mode.

In power down modes 2, 3 and 4, the Real-Time Clock (RTC) and RTC clock source will also be running in addition to the LPEVR. The RTC has 2 operating modes:

- RTC mode 0 uses the 32.768 kHz external oscillator via the oscillator pad
- RTC mode 1 uses the 75 kHz internal oscillator clock as the RTC clock input

Both RTC modes are available in the XC83x, but mode 0 is not available on the XC82x because it does not support the 32.768 kHz external oscillation.

The power down mode and RTC mode must be enabled and configured to the respective mode (see [Table 1](#) for XC82x and [Table 2](#) for XC83x) before entering power down mode. Note that in order to detect the failure of the 32.768 kHz external clock in the XC83x, an oscillator watchdog operating with a 75 kHz internal clock must be set up to run in the XC83x power-down mode 2.

Note: A failure in 32.768 kHz external oscillator is detected when it is running below 16 kHz (typical).

Wake-up Modes

In XC82x/XC83x, there are 2 types of wake-up from each power down mode:

- Wake-up with reset
- Wake-up without reset

When wake-up with reset is selected, the system will execute a reset sequence similar to the power-on reset sequence. The CPU starts running code from the beginning of the Flash code memory. This mode is useful when the user wants a defined state for all the registers and modules in the microcontroller after wake-up.

When wake-up without reset is selected, a fast wake-up sequence is implemented, which means that the CPU program counter will continue to run from the point at which it was stopped.

Wake-up Sources

To wake-up from power down mode, one or more sources are available for each power down mode as shown in [Table 3](#) for XC82x and [Table 4](#) for XC83x.

In power down mode 1, wake-up can only be triggered by toggling the external interrupt 0 pin. For the rest of the power down mode, RTC is running using either the 32.768 kHz external oscillator or the 75 kHz internal oscillator, so wake-up can also be triggered when the RTC counter reaches a predefined time. It allows the microcontroller to exit power down mode and enter active mode after a specific period of time. With this function, dynamically changing the operating mode of the microcontroller can be achieved with minimum software setup.

There are 2 types of wake-up sources generated from the RTC module:

- Periodic wake-up
- Real-time clock (RTC) wake-up

Both wake-up sources are available in XC83x, as shown in [Table 4](#).

The XC83x power down modes 2 and 3 support a real-time clock wake-up function with the RTC running in mode 0. The periodic wake-up function is available in the XC83x power down mode 4.

In XC82x, the real-time clock wake-up is not available (see [Table 3](#)). However, the periodic wake-up function is available in power down mode 2 with the RTC running in mode 1.

The XC82x power down mode 2 and the XC83x power down mode 4 have the same behavior.

Table 3 Available Wake-up Sources for Power Down Mode in XC82x

Wake-up Sources	Power Down Mode 1	Power Down Mode 2
Periodic wake-up	Not available	Available ¹⁾
EXINT0	Available	Available

1) This wake-up source will not be available if the RTC clock stops running.

Table 4 Available Wake-up Sources for Power Down Mode in XC83x

Wake-up Sources	Power Down Mode 1	Power Down Mode 2	Power Down Mode 3	Power Down Mode 4
Periodic wake-up	Not available	Not available	Not available	Available ¹⁾
Real-time Clock wake-up	Not available	Available ¹⁾	Available ¹⁾	Not available
32.678 kHz Clock failure	Not available	Available	Not available	Not Available
EXINT0	Available	Available	Available	Available

1) This wake-up source will not be available if the RTC clock stops running.

Besides the EXINT0 and RTC wake-up sources, XC83x power down mode 2 has an additional wake-up source as shown in [Table 4](#). A clock failure in the 32.768 kHz external clock will trigger the microcontroller to wake-up from power down mode 2. This can be seen as an advantage compared to the power down mode 3. If there is a clock failure in power down mode 3, the RTC wake-up source is not available and so the microcontroller can only be woken up by an external trigger EXINT0.

Comparison between Power Down Modes

The XC83x current consumption in power down modes 2, 3 and 4, is approximately 2 uA - 3 uA (typically) higher than power down mode 1, because more built-in modes are running to support the real-time clock and periodic wake-up functions.

Similarly, the XC82x power down mode 2 is approximately 2 uA higher than power down mode 1.

While the current consumption of the XC83x power down modes 3 and 4 are quite similar, power down mode 2 has the highest current consumption in that microcontroller.

The main advantage of power down modes 2, 3 and 4 is that the length of time that the microcontroller stays in power down mode can be easily configured to achieve the required average power consumption.

A feature of the XC83x power down mode 2 is the additionally enabled oscillator watchdog that is used to wake-up the microcontroller when there is a 32.768 clock failure. If the application is able to take the additional 1 uA - 2 uA (typical) current, this is a preferred power down mode, as compared to the mode 3.

Refer to the Data Sheet and AP08101 for more information on power down current.

3 Using Power Down Mode

To enter power down mode, follow the steps listed here. Settings for the specific power down modes are given in [Section 3.1](#), [Section 3.2](#), [Section 3.3](#) and [Section 3.4](#).

- Configure wake-up source. Refer to [Section 3.1](#), [Section 3.2](#), [Section 3.3](#) and [Section 3.4](#).
- Select the type of power down mode.
- Select wake-up mode with reset or without reset.
- Enable power down mode.

General code execution sequence for power down mode entry:

```
MOV     SCU_PAGE, #0x01
ORL     PMCON0, #0x04      ;select PD mode 2
ORL     PMCON0, #0x10      ;wake-up with reset mode is selected
MOV     PASSWD, #0x98      ;open protection, PD bit is a protected bit
ORL     PMCON0, #0x02      ;Power Down Mode Enable.
MOV     PASSWD, #0xA8      ;close protection
```

Pin Status In Power Down Mode

In power down mode, pin handling is transparent to the user. All port pins are disabled, except for the external interrupt 0 pin if it is enabled as a wake-up source. Each port signal that goes into the microcontroller will be held at the last state when the power down mode was activated. If the user intends to maintain a level of “1” or “0” on the output pin during power down, the internal pull-up/pull-down device should be enabled before entering power down mode. Upon wake-up, the port pins will be enabled as per the SFR setting.

Flash Handling In Power Down Mode

Flash memory is shut down in power down mode regardless of the current flash activity; i.e program/erase operation. It is therefore recommended to ensure that all flash program or erase operations are completed before entering the power down mode. For a situation where power down mode must be entered immediately, it is recommended to repeat the previous flash operation after waking-up from power down mode.

Wake-up Flags

When a wake-up from power down mode without reset is selected, the status flag of the wake-up event can be used to indicate the wake-up source.

- wake-up by RTC, bit RTC_RTCON.CFRTC is set to 1
- wake-up by external interrupt 0, bit CFRTC is 0
- wake-up by loss of external 32.768kHz oscillation, OSC_CON.XTAL2 flag is set to 1

Note that interrupt servicing of the wake-up event is not supported.

Checking of the status bit is useful when an application needs to perform a different task for each source of wake-up.

The status wake-up indication bit RSTCON.WKRS, is used to indicate that the microcontroller has exited to active mode from the power down state. In addition, this bit can also be used to distinguish between a wake-up with reset from power down mode and other type of resets; i.e. power on reset (POR). In the wake-up with reset mode, all registers are reset to default values after wake-up except for this bit. Wake-up flags are listed in [Table 5](#).

Table 5 Wake-up Flags with Different Wake-up Sources

Wake-up sources	RST_RTCON.CFRTC	OSC_CON.XTAL2L	RSTCON.WKRS
EXINT0	0	0	1 (with or without reset)
RTC	1	0	1 (with or without reset)
Loss of External Oscillation	0	1	1 (with or without reset)

Considerations On Waking Up From Power Down Mode

On waking up from power down mode without reset, the CPU starts to run from the instruction following the one that sets the PD bit. User code must include two NOP instructions immediately after the instructions that sets the PD bit. This ensures that the first instruction (after the two NOP instructions) is executed correctly after wake-up from power down mode.

Another consideration is to give at least 500 usec between the time that bit PMCON0.PD is set, to the triggering of the wake-up. A shorter time will not result in any saving in power consumption because this is the amount of time needed to shut down all the unused modules.

3.1 Using Power Down Mode 1 In XC82x/XC83x

To enter power down mode 1, the following sequence is recommended:

- Disable the WDT module (optional).
- Disable the RTC module (optional).
- Configure wake-up source external interrupt 0, including the selection of external interrupt 0 input pin and external interrupt 0 trigger select.
- Select power down mode 1 where all modules are powered down including the 48 MHz and 75 kHz oscillators.

Considerations When Entering Power Down Mode 1 In XC82x/XC83x

In power down mode 1, the shutting down of the 75 kHz oscillator causes the RTC and Watchdog Timer (WDT) module which uses this oscillator to clock their respective counter/timer to stop running. If the user intends to use these 2 modules after the microcontroller wakes-up without a reset, it is recommended to disable the RTC and WDT module by software before entering power down mode and only to enable them again after exiting from power down mode. This is to avoid any inaccurate counting because the 75 kHz oscillator usually starts to run with an inaccurate frequency on waking up.

Considerations On Waking up from Power Down Mode 1 In XC82x/XC83x

After wake-up from power down mode without reset, ensure that the 48 MHz and 75 kHz oscillators are stable after power up by checking the status of the OSC_CON.INTOSC_ST status flag. It is recommended to enable the WDT and RTC module only after this bit is set to 1_B. In addition, the oscillator watchdog which monitors the behavior of these 2 oscillators can also be re-enabled by setting bit OSC_CON.RCOWDRST.

Demonstration Code

Example for power down mode 1 entry and exit:

```
;Disable WDT
    MOV     SCU_PAGE, #0x01
    MOV     PASSWD, #0x98 ;open protection, WDTEN is a protected bit
    ANL     WDTCON, #0xFB
    MOV     PASSWD, #0xA8 ;close protection
;Disable RTC
    ANL     RTC_RTCON, #0xFE
;Configure external interrupt 0 as wake-up event
;P0.5 pin is the default external interrupt 0
    MOV     SCU_PAGE, #0x01 ;enable external interrupt 0 wake-up resource
    ANL     PMCON0, #0xFE
    ORL     PMCON0, #0x01 ;set bit EWS to 1
    MOV     SCU_PAGE, #0x00
    ANL     EXICON0, #0xFC
    ORL     EXICON0, #0x01 ;set rising edge to trigger external interrupt 0
;Select power down mode 1
```

```

MOV     SCU_PAGE, #0x01
ANL     PMCON0, #0xFB           ;select PD mode 1
;Enable power down mode
MOV     PASSWD, #0x98           ;open protection, PD bit is a protected bit
ORL     PMCON0, #0x02           ;Power Down Mode Enable.
NOP     ;2 NOPs are required after setting PD 1 when wake-up without reset
NOP
MOV     PASSWD, #0xA8           ;close protection

```

3.2 Using Power Down Mode 2 In XC83x

The sequence to enter power down mode 2 is:

- Power up the 32.768 kHz oscillator pad.
- Wait for 2 seconds for the oscillation to be stable.
- Ensure that the 75 kHz oscillator is stabilized before enabling the 32.768 kHz OWD.
- Restart the 32.768 kHz OWD.
- When bit XTAL2L is 0, select the RTC Mode 0.
- Configure and enable the RTC.
- Disable the WDT module.
- Select power down mode 2.
- Enter power down mode.

Considerations When Entering Power Down Mode 2 In XC83x

The RTC, 75 kHz oscillator and 32.768 kHz oscillator pad are not shut down in power down mode 2. The Watchdog Timer(WDT), which is clocked by the 75 kHz oscillator, will also be running if it was enabled before entering this mode. Because the microcontroller will not be able to wake-up and return to active mode when the Watchdog Timer overflows in power down mode, it is mandatory to disable the WDT before the entry to power down mode 2. The RTC must be programmed to run in Mode 0; i.e. it must be in time keeping mode before the entry to power down mode 2. In this RTC mode the real-time clock operates with the 32.768 kHz oscillator input and the real-time count is maintained. The RTC is not reset and continues to run when the RTC triggers a wake-up from power down mode 2.

To wake-up from power down mode without reset using the RTC wake-up event, register RTCCR_x must be setup before entering power down mode. If the RTC is required to wake-up the microcontroller from power down mode 2, the following RTC configuration should be executed before setting the microcontroller to that mode:

- Set RTC to mode 0.
- Set RTC starting value.
- Set compare/capture register RTCCR0 - RTCCR3 value to define the time period after which the microcontroller should be woken-up from power down mode 2.
- Enable RTC.

It is possible to monitor the status of the external oscillation in power down mode 2, as the 32.768 kHz Oscillator Watchdog (OWD) is enabled in power down mode 2.

Although the 75 kHz oscillator is also running in power down mode 2, it is not possible to monitor the oscillation because its Watchdog is powered down.

Considerations On Waking up from Power Down Mode 2 In XC83x

To exit power down mode 2, besides the real-time clock wake up event, it is also possible to exit on receipt of an external wake-up signal via EXINT0 pin if EWS bit is set to 1_B in PMCON0 register. In the event of the loss of external 32.768kHz oscillation, power down mode 2 will be exited when the OSC_CON.XTAL2L flag is set to 1.

In addition, after wake-up from power down mode without reset, the WDT module and oscillator watchdog can be re-enabled if necessary as explained in [Considerations On Waking up from Power Down Mode 1 In XC82x/XC83x](#).

Demonstration Code

Example for XC83x power down mode 2 entry and exit:

```
;enable 32.768kHz oscillator and OWD
    MOV     SCU_PAGE, #0x01
    ANL     OSC_CON, #0xDF
WAIT_75_STABLE:
    MOV     A, OSC_CON
    JNB     ACC.6, WAIT_75_STABLE
    ORL     OSC_CON, #0x08
WAIT_32_STABLE:
    MOV     A, OSC_CON
    JB      ACC.4, WAIT_32_STABLE
;RTC configuration
    ANL     RTC_RTCON, #0xF9 ;select RTC mode 0
;configure RTC count clock register CNT0~3,
    MOV     SCU_PAGE, #0x01
    MOV     PASSWD, #0x98 ;Register RTC_CNTx are protected, open protection
    MOV     RTC_CNT0, #0x00 ;set the RTC start value
    MOV     RTC_CNT1, #0x00
    MOV     RTC_CNT2, #0x00
    MOV     RTC_CNT3, #0x00
    MOV     PASSWD, #0xA8 ;close protection
;configure RTC compare/capture register value
    MOV     RTC_RTCCR0, #0x00
    MOV     RTC_RTCCR1, #0x06
    MOV     RTC_RTCCR2, #0x00
    MOV     RTC_RTCCR3, #0x00
;enable RTC
    ORL     RTC_RTCON, #0x01 ;start RTC operation

;disable WDT
    MOV     SCU_PAGE, #0x01
    MOV     PASSWD, #0x98 ;open protection
    ANL     WDTCON, #0xFB
    MOV     PASSWD, #0xA8 ;close protection
;set microcontroller to PD mode 2
    MOV     SCU_PAGE, #0x01
    ANL     PMCON0, #0xF3
    ORL     PMCON0, #0x04 ;select PD2
    MOV     PASSWD, #0x98 ;open protection
    ORL     PMCON0, #0x02 ;Power Down Mode Enable.
    NOP     ;2 NOPs are required after setting PD 2 when wake-up without reset
    NOP
    MOV     PASSWD, #0xA8 ;close protection
```

3.3 Using Power Down Mode 3 In XC83x

The sequence to enter power down mode 3 is:

- Power up the 32.768 kHz oscillator pad.
- Wait for 2 seconds for the oscillation to be stable.
- Select the RTC Mode 0.
- Configure and enable the RTC.
- Disable the WDT module (optional).
- Select power down mode 3.
- Enter power down mode.

Considerations When Entering Power Down Mode 3 In XC83x

As with power down mode 1, shutting down the 75 kHz oscillator causes the Watchdog Timer (WDT) module to stop running in power down mode 3. Considerations for WDT during power down mode are described in [Considerations When Entering Power Down Mode 1 In XC82x/XC83x](#).

In power down mode 3, the RTC and 32.768 kHz oscillator pad are not powered down. However, no monitoring of the status of the external oscillation is possible in this mode. In the event of the loss of the external OSC, the RTC will not be able to wake up the microcontroller from power down mode 3. It is therefore recommended to enable the external interrupt wake-up resource before entering power down mode 3.

As for the RTC, it must be programmed to run in RTC Mode 0. [Considerations When Entering Power Down Mode 2 In XC83x](#) describes the setup of RTC for power down mode 3.

Considerations On Waking up from Power Down Mode 3

To exit power down mode 3, the real-time clock wake-up event can be used if the external oscillation is stable. It can also be woken when it receives an external wake-up signal via the EXINT0 pin, by setting the EWS bit to 1_B in the PMCON0 register.

The use of WDT after wake up without reset from power down mode 3 is described in [Considerations On Waking up from Power Down Mode 1 In XC82x/XC83x](#).

Demonstration Code

Example for XC83x power down mode 3 entry and exit:

```
;enable 32.768kHz oscillator
    MOV    SCU_PAGE, #0x01
    ANL    OSC_CON, #0xDF
WAIT_32_STABLE:
    MOV    A, OSC_CON
    JB     ACC.4, WAIT_32_STABLE
;RTC configuration
    ANL    RTC_RTCON, #0xF9 ;select RTC mode 0
;configure RTC count clock register CNT0~3,
    MOV    SCU_PAGE, #0x01
    MOV    PASSWD, #0x98 ;Register RTC_CNTx are protected, open protection
    MOV    RTC_CNT0, #0x00 ;set the RTC start value
    MOV    RTC_CNT1, #0x00
    MOV    RTC_CNT2, #0x00
    MOV    RTC_CNT3, #0x00
    MOV    PASSWD, #0xA8 ;close protection
;configure RTC compare/capture register value
    MOV    RTC_RTCCR0, #0x00
    MOV    RTC_RTCCR1, #0x06
```

```

MOV    RTC_RTCCR2, #0x00
MOV    RTC_RTCCR3, #0x00
;enable RTC
ORL     RTC_RTCON, #0x01 ;start RTC operation

;disable WDT
MOV     SCU_PAGE, #0x01
MOV     PASSWD, #0x98 ;open protection
ANL     WDTCON, #0xFB
MOV     PASSWD, #0xA8 ;close protection
;set microcontroller to PD mode 3
MOV     SCU_PAGE, #0x01
ANL     PMCON0, #0xF3
ORL     PMCON0, #0x08 ;select PD3
MOV     PASSWD, #0x98 ;open protection
ORL     PMCON0, #0x02 ;Power Down Mode Enable.
NOP     ;2 NOPs are required after setting PD 3 when wake-up without reset
NOP
MOV     PASSWD, #0xA8 ;close protection

```

3.4 Using Power Down Mode 4 In XC83x and Power Down Mode 2 In XC82x

The sequence to enter XC83x power down mode 4 or XC82x power down mode 2 is:

- Configure and enable RTC.
- Disable the WDT module.
- Select XC83x power down mode 4 or XC82x power down mode 2.
- Enable power down mode.

Considerations When Entering Power Down Mode 4 In XC83x or Power Down Mode 2 In XC82x

In both modes, the RTC and 75 kHz oscillator are not powered down. The Watchdog Timer(WDT), clocked by the 75 kHz oscillator, will also be running if it was enabled before entering this mode. As the microcontroller will not be able to wake-up and return to active mode when the watchdog timer overflows, it is mandatory to disable the WDT before entering these two power down modes. As for the RTC, it must be programmed to run in RTC Mode 1: Periodic Wake-up Mode, before the entry to power down. In this RTC mode, the real-time clock operates with the 75 kHz oscillator running in the periodic wake-up mode and the real-time count is maintained. The RTC counter is reset and the count starts from zero every time the RTC triggers a wake-up from power down mode.

Considerations When Entering Power Down Mode 2 In XC83x describes the RTC setup, except the RTC must be set to mode 1 instead of mode 0 before entering these two modes.

The calculation for periodic wake-up time setup is:

(1)

$$t_{\text{wake-up}} = \frac{(CCVAL - CNTVAL) \times 512}{75000}$$

where

- CNTVAL : Counter values in CNTx registers
- CCVAL : Compare values in RTCCRx registers

Although the 75 kHz oscillator is running in these two power down modes, it is not possible to monitor the status of the 75 kHz oscillation because the oscillator watchdog is powered down.

Considerations On Waking up from Power Down Mode 4 In XC83x or Power Down Mode 2 In XC82x

Besides the real-time clock wake up event, the microcontroller can also be woken on receipt of external wake-up signal via the EXINT0 pin, by setting the EWS bit to 1_B in the PMCON0 register.

After wake-up from power down mode without reset, the WDT module and Oscillator Watchdog(WDT) can be re-enabled if necessary, as explained in [Considerations On Waking up from Power Down Mode 1 In XC82x/XC83x](#). For subsequent entry to the XC82x power down mode 2, or the XC83x power down mode 4, the RTC does not require setup again if the time planned to stay in power down and active mode remains the same.

Demonstration Code

Example for XC82x power down mode 2 entry and exit:

```
;RTC configuration
    ORL     RTC_RTCON, #0x04 ;select RTC mode 1
;configure RTC count clock register CNT0~3,
    MOV     SCU_PAGE, #0x01
    MOV     PASSWD, #0x98 ;Register RTC_CNTx are protected, open protection
    MOV     RTC_CNT0, #0x00 ;set the RTC start value
    MOV     RTC_CNT1, #0x00
    MOV     RTC_CNT2, #0x00
    MOV     RTC_CNT3, #0x00
    MOV     PASSWD, #0xA8 ;close protection
;configure RTC compare/capture register value
    MOV     RTC_RTCCR0, #0x00
    MOV     RTC_RTCCR1, #0x06
    MOV     RTC_RTCCR2, #0x00
    MOV     RTC_RTCCR3, #0x00
;enable RTC
    ORL     RTC_RTCON, #0x01 ;start RTC operation
;disable WDT
    MOV     SCU_PAGE, #0x01
    MOV     PASSWD, #0x98 ;open protection
    ANL     WDTCON, #0xFB
    MOV     PASSWD, #0xA8 ;close protection
;set microcontroller to PD mode 2
    MOV     SCU_PAGE, #0x01
    ANL     PMCON0, #0xF3
    ORL     PMCON0, #0x04 ;select PD2
    MOV     PASSWD, #0x98 ;open protection
    ORL     PMCON0, #0x02 ;Power Down Mode Enable.
    NOP     ;2 NOPs are required after setting PD 2 when wake-up without reset
    NOP
    MOV     PASSWD, #0xA8 ;close protection
```

For XC83x power down mode 4, the example code above can be reused. The only difference is to set PMCON0.PDMODE to 11_B.

4 Demonstration Software: Wake-up from Power Down Mode 2

Two sets of example code are provided with this application note. The XC82x_example self-extracting EXE file demonstrates waking the microcontroller from power down mode 2 using the periodic wake-up function.

The XC83x_example.exe demonstrates waking the microcontroller from power down mode 2 using the real-time clock wake-up function. A 32.768 kHz clock failure event or external interrupt event will also wake-up the microcontroller.

The application examples are implemented and verified using the following hardware and software components:

- XC82x/XC83x easy kit boards.
- Infineon DAVE tool for code generation.
- DAVE-Bench for code compilation
- Infineon XC800_FLOAD for code downloading.

In XC82x_example, output “1” of P1.2 indicates that the microcontroller is in active mode. The microcontroller wakes up every 10 seconds using the periodic wake-up function, and enters power down mode again after 500 us.

In XC83x_example, output “1” of P1.5 indicates that the microcontroller is in active mode. The microcontroller wakes up every 4 seconds using the real-time clock wake-up function, and enters power down mode again after 500 us. The microcontroller is also configured to wake up by a rising edge on P0.5, or by a failure in the 32.768 kHz external oscillator.

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