

# Programmable System Wake Up Controller on Ultra-Low Power MSP430 MCU



## Introduction

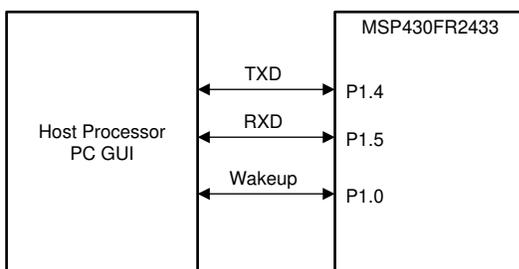
The programmable system wake-up controller function of the [MSP430FR2433](#) microcontroller (MCU) offers a simple way to add an external, real-time, and low power wake-up controller to an existing system. This type of system wake-up controller is useful to applications that need to stay in low-power modes for variable extended periods of time. To get started, download project files and a code example demonstrating this functionality.

### Note

This example can be used with any MSP430 LaunchPad Development Kit with the required MCU peripherals. For migrating pinouts and peripherals, see the device-specific data sheet.

## Implementation

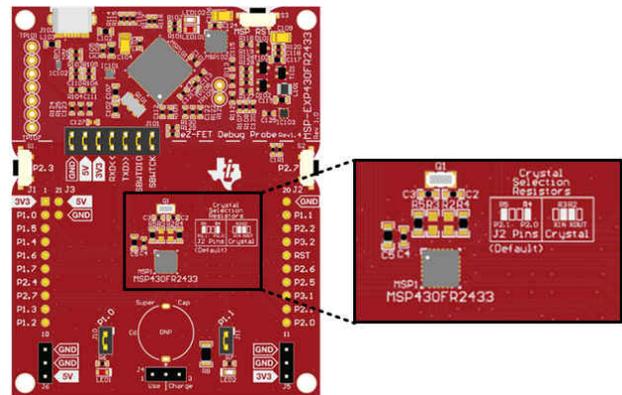
A low-frequency 32.768-kHz crystal is required for this application. The host MCU/PC GUI can send the wake-up time through universal asynchronous receiver/transmitter (UART) to MSP430FR2433. At this point, the host should go into a low-power or sleep mode as the real-time clock (RTC) starts immediately after reception of time data. When the wakeup timer counts down to zero, the MSP430FR2433 will toggle the P1.0 to wake up the host MCU and will send back a wakeup signal to the GUI (see [Figure 1](#)).



**Figure 1. Programmable System Wake-up Controller Block Diagram**

### Note

This example requires resistors R2/R3 to be populated and R4/R5 to be removed to use the LF XTAL for the MSP430FR2433 as shown in [Figure 2](#). For the exact specifications to enable the LF XTAL, check your LP documentation.



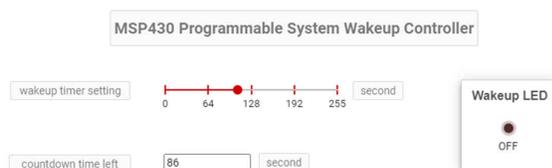
**Figure 2. MSP430FR2433 Resistor Selection for Onboard 32-kHz Crystal**

The wake-up time is a function of the RTC Counter peripheral and software scaling factors. The RTC Counter module in this application is clocked by XT1 at approximately 32.768 kHz. The largest pre-divider for the module is 1024. By using this divider value, every 32 counts of the RTC Counter is 1 second. The RTCMOD register holds a count value that gives an interrupt when the RTC Counter counts to it. The RTCMOD register of the RTC Counter is 16 bits wide so the maximum that time the RTC Counter can count before overflow is approximately 34 minutes. The RTCMOD is set as 31 and fixed in this example, which provides an interrupt every second. The wake-up time defines as an unsigned int8 format. It allows the customer to set the wakeup time from 1s to 255s in the example code. For example, if a host wanted to setup a wake-up time of 60 seconds, it would send a value of 0x3C over UART.

The programmable wake-up controller is design to stay in low-power mode 3 (LPM3) to conserve power. When the host controller sends the wake-up time data, the RTC starts counting to the time value sent to the device. The RTC interrupt manages the total wake-up time and sends a low-to-high pulse to the host controller after the time value has been reached. The MSP430 MCU also sends the countdown time left data to the GUI (see [Figure 3](#)). Host MCU and GUI can change the wakeup time by sending a new value to the MSP430 MCU at any time. The MSP430 MCU reconfigures the wake-up timer settings when it receives a new data.

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**Figure 3. Programmable System Wake-Up Controller GUI**

## Performance

The average power consumption of the programmable system wake-up controller is around 1.3  $\mu$ A. The average current of the application is dominated by the LPM3 current of the device and approaches this level as the wake-up time period is extended.

## To Get Started

1. Watch our training video [“Programmable Wake Up Controller with a Housekeeping MCU”](#), where we walk through how to use a GUI to wake up the MCU after an elapsed amount of time.
2. Order an [MSP430FR2433 LaunchPad kit](#) to evaluate the Programmable Wake Up Controller example code.
3. Download and test this example with the [Programmable Wake-Up Controller example GUI](#).
4. Evaluate the [Programmable Wake-Up Controller example code](#) for the MSP430FR2433 LaunchPad kit.

## Device Recommendations

Part Number	Key Features
MSP430FR2433	16KB FRAM, 4KB SRAM, 10-bit ADC, UART/SPI/I2C, Timer
MSP430FR2422	8KB FRAM, 2KB SRAM, 10-bit ADC, UART/SPI/I2C, Timer

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