Multi-Function Reset Controller With Low-Memory MSP430™ MCUs

Introduction

Reset controllers are widely used in complex systems in which the processor is prone to lock-up. The lock-up or error state can be caused by anything from a software bug to electromagnetic interference. Using an external reset controller to do hard or soft reset to the processor can get the system back to proper state.

The MSP430FR2000 microcontroller (MCU) can be used as a low-cost solution for reset controller by making use of the internal Watchdog Timer, interrupt IO, and Timer_B modules. In this reset controller implementation, a button is used to initiate a manual reset. A single button or dual buttons can be detected by an MSP430 MCU in low-power standby mode. By using the watchdog timer in interval mode, short and long button presses can be detected. Timer_B using the internal reference oscillator (REFO) as the clock source can be used to generate an accurate time delay for the reset pulse. Button debounce is also implemented in the firmware to avoid false triggers.

This solution uses the MSP430™ MCU's low-power mode 4 (LPM4) when not executing a reset operation to save power. To get started, download project files and a code example demonstrating this functionality.

Implementation

The solution uses an MSP430FR2000 MCU with a single button to implement a reset controller for the host processor. If the button is pressed for less than 0.5 second, the MSP430FR2000 device outputs a reset pulse to the host processor's interrupt pin signaling the processor to initiate a soft reset through firmware. If the button is pressed for longer than 1 second, the MSP430FR2000 MCU outputs a reset pulse to the host processor's reset pin, triggering a hard reset. As shown in Figure 1, GPIO P1.1 is connected to the button, P1.0 outputs the soft reset pulse, and P1.2 outputs the hard reset pulse. Both of these pulses last 61 ms. The button press time and reset pulse time are defined by a macro that can be easily modified based on different application requirements.

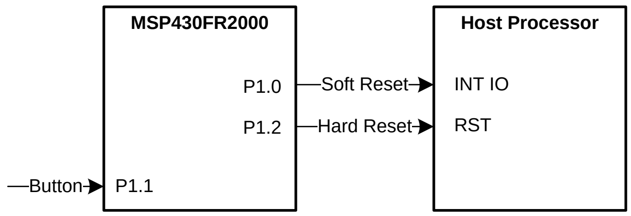

Figure 1. Reset Controller Block Diagram

The MSP430FR2000 device supports internal pullup and pulldown resistors, so no external resistor is required for the button. P1.1 is internally pulled up and is set up to trigger an interrupt with a high-to-low transition. When the button is pressed, the input of P1.1 will be low, and the port interrupt service routine will be entered.

In this solution, button debounce is implemented in software. Timer_B with the auxiliary clock (ACLK) as the clock source is used to generate the accurate debounce delay time. Internal REFO is selected as ACLK clock source. In this solution, after the 10-ms debounce delay, the button input voltage level is checked to avoid false trigger. Button interrupt edge is also checked to detect button press and button release.

The MSP430FR2000 MCU goes into LPM4 to wait for an IO interrupt. When the button is pressed, the MCU wakes up and starts the watchdog timer to detect the button hold time. Then the P1.1 interrupt edge setting is changed from high-to-low to low-to-high to detect the button release. The watchdog timer is set to interval timer mode, causing a watchdog interrupt to be triggered every 250 ms. The watchdog clock source is also ACLK so that the watchdog can operate in LPM3 to save power. In the watchdog interrupt service routine, counter WDT_cnt is used to count how many times the interrupt is triggered. Based on the WDT_cnt value, the button press time can be obtained. When the button is released, if WDT_cnt is smaller than the short time threshold, a soft reset pulse is generated. If WDT_cnt is larger than the long time threshold, a hard reset is triggered. After generating a reset pulse, the MCU enters LPM4 to wait for next button press. Figure 2 shows the soft reset pulse where the button is pressed for less than 0.5 second, and Figure 3 shows the hard reset pulse where the button is pressed for longer than 1 second.

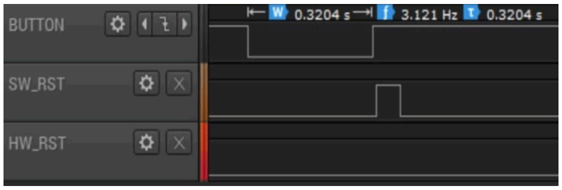

Figure 2. Soft Reset Pulse (SW_RST)

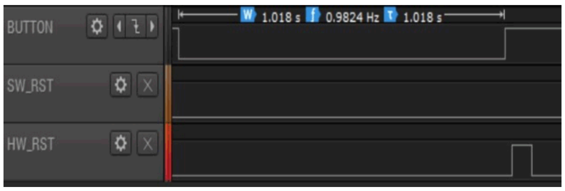

Figure 3. Hard Reset Pulse (HW_RST)

Performance

The MSP430FR2000 MCU was used with the MSP-TS430PW20 target development board to implement this reset controller solution. The firmware operates in LPM4 when there is no reset initiated. A standby current consumption of 0.6 µA was measured using the target development board. The MCU transitions from standby to active mode, which only lasts approximately 10 ms, when the button is pressed. During a long button press, the MCU operates in LPM3 with approximately 15-µA current consumption.

The reset pulse time is calculated based on REFO clock with ±3.5% absolute calibrated tolerance. The minimal adjustment step size for reset pulse time is one REFO clock cycle (30.5 µs). If higher pulse time accuracy is required, using the FLL to lock the DCO at high frequency with an external crystal can achieve higher accuracy with small time adjustment step size. More performance specifications can be found in the clock specifications section of the MSP430FR2100 MCU data sheet.

Device Recommendations

The device used in this example is part of the MSP430 Value Line Sensing portfolio of low-cost MCUs, designed for sensing and measurement applications. This example can be used with the devices shown in Table 1 with minimal code changes. For more information on the entire Value Line Sensing MCU portfolio, visit www.ti.com/MSP430ValueLine.

Table 1. Device Recommendations

Part Number	Key Features
MSP430FR2000	0.5KB FRAM, 0.5KB RAM, eComp
MSP430FR2100	1KB FRAM, 0.5KB RAM, 10-bit ADC, eComp
MSP430FR2110	2KB FRAM, 1KB RAM, 10-bit ADC, eComp
MSP430FR2111	3.75KB FRAM, 1KB RAM, 10-bit ADC, eComp

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