Using the Alarm Feature on the MCP79410 RTCC to Implement a Delayed Alarm

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INTRODUCTION

An increasing number of applications that involve time measurement are requiring a Real-Time Clock (RTC) device. The MCP79410 is a feature-rich Real-Time Clock and Calendar (RTCC) that incorporates EEPROM, SRAM, unique ID and time-stamp. This application note describes the use of the alarms that are available, in order to build a simple delayed alarm system.

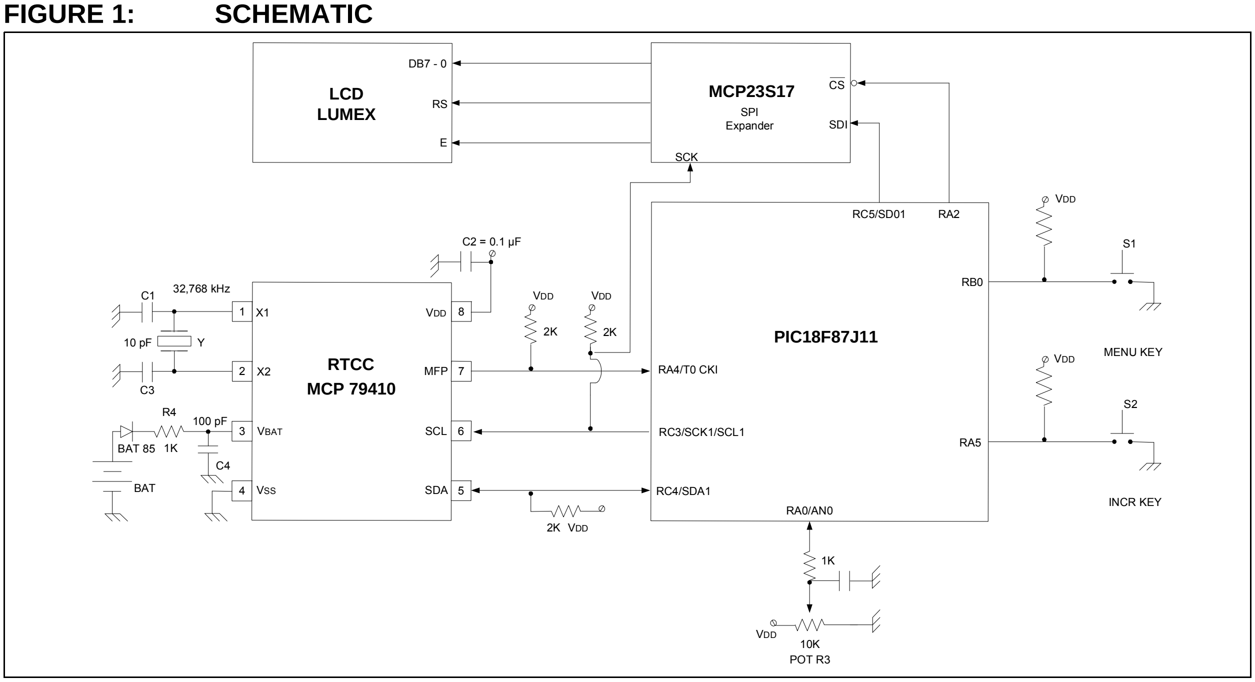
FEATURES OF THE RTCC STRUCTURE

- I^{2}C™ Bus Interface
- RTCC with Time/Date: Year, Month, Date, Day of Week, Hours, Minutes, Seconds
- Support for Leap Year
- Low-power CMOS Technology
- Input for External Battery Backup (maintains RTCC and SRAM contents)
- On-board 32,768 kHz Crystal Oscillator for the RTCC
- On-chip Digital Trimming/Calibration of the Oscillator
- Operates Down to 1.8V
- Backup Voltage Down to 1.3V
- Operating Temperature Range:
  - Industrial (I): -40°C to +85°C
- Multi-function Pin:
  - Open-drain configuration
  - Programmable clock frequency out
- Interrupt Capability (based on the 2 sets of alarm registers ALM0 and ALM1)
- Timesaver Function
- Time-stamp Registers for Holding the Time/Date of Crossing:
  - from VDD to VBAT
  - from VBAT to VDD

SCHEMATIC

The schematic includes a PIC18 Explorer demo board and the I^{2}C RTCC PICtail™ daughter board as shown in Figure 1.

FIGURE 1: SCHEMATIC



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The resources used on the demo board are:

- LCD
- 2 push buttons
- The on-board potentiometer related to RA0 input and internal 10 bits ADC.
- AC164140 RTCC PICtail daughter board

To access the LCD through a minimum of pins, the SPI on the MSSP1 module was used, in conjunction with a 16-bit I/O expander with SPI interface (MCP23S17). The two on-board push buttons are S1 and S2, connected to RB0, RA5 GPIOs. The I^2C RTCC is part of the PICtail evaluation board and is directly connected to the MSSP1 module of the MCU. Another necessary connection is between the MFP signal of the RTCC and the RA4 pin. The RTCC is programed to set the MFP at the end of the delay. All connections between the I^2C RTCC and the MCU (SDA, SCL, MFP) are open drain and use pull-up resistors. The RTCC PICtail daughter board has two other components:

- a 32,768 Hz crystal driving the internal clock of the RTCC
- a 3-volt battery sustaining the RTCC when V_{DD} is not present on the demo board.

DETAILS ABOUT IMPLEMENTATION

The application is designed around the PIC18 Explorer board, running on a PIC18F87J11 MCU. The code is written using the C18 compiler. The firmware implements a delayed alarm system, based on the internal alarm registers for ALARM0. The value of the delay is imposed using the on-board potentiometer (R3) measured through the internal ADC and is enabled by the S1 push button. The delay is then written to the ALARM0 registers. Once this sequence is finished, the firmware displays minutes and seconds (up to 17 minutes and 3 seconds). Once this time has been reached, an alarm message will be shown on the LCD. The application restarts automatically after two seconds.

FUNCTIONAL DESCRIPTION

MCP79410 is an I^2C slave device, working on the related bidirectional 2-wire bus. SDA is a bidirectional pin used to transfer addresses and data in and out of the device. It is an open-drain pin, therefore, the SDA bus requires a pull-up resistor to V_{CC} (typically 10kΩ for 100 kHz, 2kΩ for 400 kHz). For normal data transfers, SDA is allowed to change only during SCL low. Changes during SCL high are reserved for indicating the Start and Stop conditions. SCL input is used to synchronize the data transfer from and to the device. The related internal structures have the following device addresses/control bytes (the RTCC is included in the SRAM bank):

- RTCC + SRAM: 0xDE for writes, 0xDF for reads
- EEPROM: 0xAE for writes, 0xAF for reads

The chip can support speeds up to:

- 400 kHz 2.5 to 5V
- 100 kHz 1.8 to 2.5V

APPLICATION DESCRIPTION

This application performs a delayed alarm system. The firmware goes through three states:

- Setting the value of the delay through the on-board potentiometer. The LCD screen shows:

  ALM = aa min bb sec

  S1 = ENABLE ALARM

Once the value is enabled, it will be written in the related alarm registers and the RTCC will be initialized.

- Reading the current time count (minutes and seconds). The related LCD screen is:.

  ALM = aa min bb sec

  mm ss

- Reaching the end of the alarm delay. When a match occurs between the time count and the alarm registers, the MFP will be set. The pin is polled through firmware and the code stops displaying the time count. The LCD screen shows:

  END OF ALARM

The application will restart automatically after two seconds.

FIRMWARE DESCRIPTION

Drivers

The drivers are divided into 3 classes:

- LCD drivers
- RTCC registers access drivers
- ADC drivers

LCD Drivers

The application is implemented on the specific hardware PIC18 Explorer demo board. On this board it was important to reduce the number of GPIO pins used to access the LCD. Accessing the LCD is performed on a SPI bus (included in the MSSP1 module) through an auxiliary chip, the MCP23S17 SPI expander. Since the application handles only ‘minutes’ and ‘seconds’, there are only two high-level LCD drivers:

- `void sec_to_lcd(void)`
- `void min_to_lcd(void)`

Both of them are based on the basic LCD function:

- `void wrdata_lcd(unsigned char data_lcd)`

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Drivers to Access RTCC Registers

Since MCP79410 is an I^2C RTCC, it will use the I^2C bus of the MCU (included in the MSSP1 module). Accordingly, the related drivers will be divided into two categories: basic I^2C drivers and RTCC drivers. They use as a control method the SPP1IF bit (flag) in the PIR1 register (interrupt flag of the MSSP1 module), read through polling and not through interrupts. The method represents an alternative to the classical "`i2c.h`" library, included in the C18 compiler.

FIGURE 2: FLOWCHART FOR A TYPICAL WRITE OPERATION (FOR A RANDOM BYTE ACCESS):

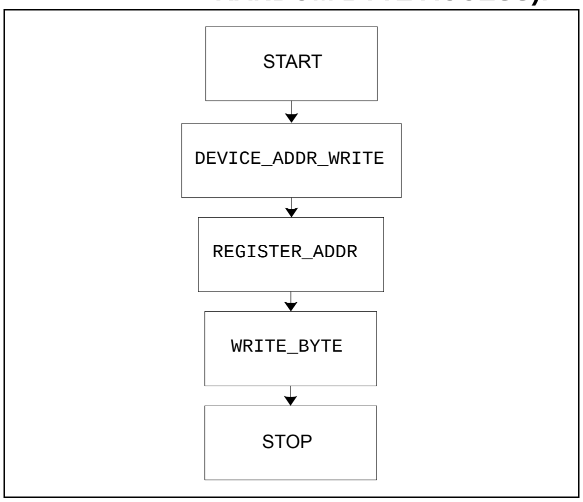
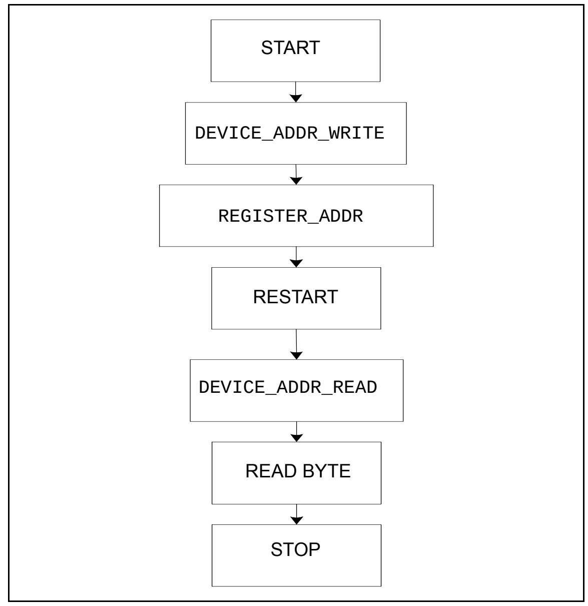


FIGURE 3: FLOWCHART FOR A TYPICAL READ OPERATION



The two related functions are: `void rtcc_wr (unsigned char time_var, unsigned char rtcc_reg); unsigned char rtcc_rd (unsigned char rtcc_reg);`

ADC Drivers

EXAMPLE 1: ADC FUNCTIONS:

```
void ini_adc (void)    ; //    ADC initalization (handling ADCON0, ADCON1 registers)
void adc_conv (void)  ;  //    ADC conversion (handles the ADCON0bits.GO bit)
```

The internal 10-bit ADC and the on-board potentiometer are used to set the value of the delay, which will be written to the alarm registers of the RTCC.

ACCESSING THE RTCC REGISTERS

There are two basic functions for accessing the RTCC: one for writes and one for reads. They can be defined as: `void rtcc_wr (unsigned char time_var, unsigned char rtcc_reg)`, `unsigned char rtcc_rd (unsigned char rtcc_reg)`. Each of these two functions include error messages displayed on LEDs, which could signal when an operation is not acknowledged by the slave (RTCC).

EXAMPLE 2: FLOWCHART FOR WRITES TO THE RTCC

```
i2c_start()           ; //   start I2C communication: SDA goes down while SCL remains high
i2c_wr(ADDR_RTCC_WRITE); //   send the RTCC's address for write = 0xde
i2c_wr(rtcc_reg)      ; //   send the register's address
i2c_wr(time_var)      ; //   send data byte to the RTCC
i2c_stop()            ; //   stop I2C communication: SDA goes high while SCL remains high
```

EXAMPLE 3: FLOWCHART FOR READS FROM THE RTCC

```
i2c_start()           ; //   start I2C communication: SDA goes down while SCL remains high
i2c_wr(ADDR_RTCC_WRITE); //   send the RTCC's address for write = 0xde
i2c_wr(rtcc_reg)      ; //   send the register's address
i2c_restart()         ; //   switch to reads
i2c_wr(ADDR_RTCC_READ) ; //   send the RTCC's address for read = 0xdf
i2c_rd()              ; //   read the byte from the RTCC (register's content)
i2c_nack              ; //   NoACK from MCU to the RTCC (no more bytes to read)
i2c_stop()            ; //   stop I2C communication: SDA goes high while SCL remains high
```

Only two time variables are used in this application: seconds and minutes. As described in the data sheet, the addresses of these registers are shown below:

Seconds = 00h (START OSCILLATOR BIT is located in Bit 7)

Minutes = 01h

In addition, two control registers are used to initialize properly the RTCC for this application (`void ini_rtcc (void)`):

- Control register located at address 07h. The constant written into it will enable ALARM0, initialize OUT (MFP = 0), with no square wave on MFP.
- The ALARM0 Control register located at address 0Dh. The constant written into it will set the MFP pin when all alarm variables match.

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CONCLUSION

This application note presents how to use the alarm registers of Microchip's I^2C RTCC, MCP79410. It shows how to build a delayed alarm system (a microwave batch automation on which the delay is controlled through an I^2C RTCC and a potentiometer related to an ADC). The project is designed around PIC18 Explorer demo board. Many of the on-board hardware resources are used and the code is written using the C18 compiler for portability.

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