

Debugging Stand-Alone Real-Time Clock/Calendar-Based Applications

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This application note describes how to debug an application using Microchip's MCP794XX and MCP795XX RTCC devices.

Several code examples are detailed and explained in [Table 1](#).

INTRODUCTION

An increasing number of applications require Real-Time Clock/Calendar (RTCC) devices.

Microchip's RTCCs (I²C and SPI) are feature-rich devices that incorporate EEPROM, Time/Date registers, Timestamp registers, alarm modules, SRAM, a Watchdog Timer, and event detect modules, making them useful in many timekeeping applications.

COMMON ISSUES

TABLE 1: COMMON ISSUES

Problem	Solution
The oscillator does not function	Take into account two main factors: hardware and firmware.
	Hardware
	<ul style="list-style-type: none"> Verify that you have the correct type and value of crystal. Every type of crystal has specific parameters such as: CLOAD (equivalent capacitance of the crystal); ESR (equivalent series resistor of the crystal, at the resonance frequency). Verify that you have the correct values of the capacitors, as stated in the crystal manufacturer's data sheet and/or in Microchip's documents. Make sure the board is clean. Some of the flux used in the Pb-free may be slightly conductive; leaving residue on the board will delay the oscillator from starting or prevent oscillation completely (a dirty board will create parasitic resistors and capacitors). Verify your layout for the oscillator. An example is described in AN1365 – "Recommended Usage of Microchip Serial RTCC Devices" (DS00001365). Ensure that the crystal was not overheated during soldering.
	Firmware
	<ul style="list-style-type: none"> Make sure the Start bit (ST) in register 00h is set; set ST = 1 to enable the oscillator. Check if the EXTOSC bit in the Control register (07h) is clear; EXTOSC = 0. This should be cleared when using an external crystal.
The oscillator occasionally starts and stops	If the oscillator starts and stops, it means that the Start bit is set. Take into account only the hardware issues described above (crystal, capacitors, board, layout). Additionally, moisture on the board can affect crystal operation, as can trying to measure the crystal using a standard (x1 or x10) oscilloscope probe.
The SRAM is losing data and the clock is resetting when VCC is removed	Make sure that you have enabled battery backup in the code, through the VBATEN bit in register 03h; VBATEN = 1. Measure the backup supply voltage to make sure it is within the specification given in the data sheet.

TABLE 1: COMMON ISSUES (CONTINUED)

Problem	Solution
Cannot communicate with the I ² C device (or does not acknowledge)	<ul style="list-style-type: none"> • Make sure that RTCC is powered and VCC > VTRIP. • Verify the I²C bus is pulled high when inactive/idle. • Ensure that you have the correct value pull-up resistors, refer to AN1028 – “Recommended Usage of Microchip I²C Serial EEPROM Devices” (DS01028). • Is the I²C bus address correct for the MCP794XX? <ul style="list-style-type: none"> - Nonvolatile (EEPROM): 0xAE (for writes), 0xAF (for reads). - Volatile (SRAM): 0xDE (for writes), 0xDF (for reads). • Is the address of the byte location correct? Entering an address past 0x5F for an SRAM operation will result in the MCP7941X not acknowledging the address. Addressing undefined EEPROM locations will result in the MCP7941X not acknowledging the address. • Have you installed the battery? If your application does not need a battery, the VBAT pin should be connected to ground.
MFP does not toggle (MCP7941X)	<p>Please consider two possible factors:</p> <p>Hardware</p> <p>MFP is an open-drain pin and needs a pull-up resistor. Verify that you have the correct resistor and the pin is high at power-up.</p> <p>Firmware</p> <p>MFP may be used as clockout (in timekeeping applications) or as interrupt (in alarm applications). The MFP pin can also be driven via the OUT bit. Ensure that this bit is not being modified by the code.</p> <p>In timekeeping applications (such as an electronic watch), MFP can output pulses to offer a time reference.</p> <p>An example of how to program the Control register (07h) for such an application is described in the code of AN1355 – “A Complete Electronic Watch Based on MCP79410 I²C RTCC” (DS00001355) (the code will toggle MFP at 1 Hz).</p> <pre>rtcc_wr(SQWEN + ALM_NO + MFP_01H, CONTROL),</pre> <p>where constants are defined as below:</p> <pre>#define CONTROL 0x07 // address of the control register #define SQWEN 0x40 // MFP = square wave #define ALM_NO 0x00 // no alarms activated #define MFP_01H 0x00 // MFP = square wave at 1 Hz</pre> <p>In alarm applications, the initialization code could be:</p> <pre>rtcc_wr(ALM_EN, CONTROL) ; // enable ALARM0, OUT=0, no SQWAVE rtcc_wr(ALMPOL+ALMxALL+MONDAY, ; // MFP=1 on ALARM, match on all vars, ALM0WKDAY) ; // (alarm) day of week for alarm = 1</pre> <p>Definitions of constants for this example are:</p> <pre>#define ALM0EN 0x10 // ALARM0 is activated (CONTROL register) #define ALMPOL 0x80 // polarity of MFP alarm (CONTROL register) #define ALMxALL 0x70 // ALARM compare on all param (ALM0WKDAY) #define ALM0WKDAY 0x0d // address of ALARM0 CONTROL register</pre>
Alarms do not trigger (MCP7941X)	<p>Same issues that may effect MFP apply:</p> <ul style="list-style-type: none"> • MFP is open-drain and needs a pull-up. • The initialization code for an alarm application includes the two above statements related to Control register (07h) and ALARM 0 Control register (0Dh).

TABLE 1: COMMON ISSUES (CONTINUED)

Problem	Solution
An alarm cannot be retriggered	<p>The alarm interrupt flag, ALMxIF (bit 3 in the Alarm Control registers), is set automatically by the hardware but must be cleared in firmware in order to retrigger the alarm.</p> <p>The previous examples of code show the correct procedure, too. After every alarm match, re-initialize the alarm module; this is done by clearing the Alarm Interrupt Flag (ALMxIF).</p>
Cannot read the SPI device (MCP7952X)	<p>A read from an SPI device needs the master to produce the SPI clock. The clock generator is started only when writing a byte in the SPI data buffer. Accordingly, before reading the SPI device, write a byte in the SPI data buffer of the master. A generic example of code for a PIC18 application (including the SPI RTCC) could be:</p> <pre> unsigned char spi_rdtype (void) { // read a byte from the SPI RTCC unsigned char aux ; // auxiliary variable SSP1BUF = 0x55 ; // start ck generator, writing a dummy byte ; // you may write any value in the range ; // 00h - FFh while (!PIR1bits.SSP1IF) ; // polling the SPI interrupt flag aux=SSP1BUF ; // temporary variable to store the received ; // value PIR1bits.SSP1IF = 0 ; // clear the interrupt flag after end of ; // reception return aux ; // return the SPI received value </pre>
Time is not accurate	<p>This is the most common issue in timekeeping applications.</p> <p>Inaccurate timekeeping can be caused by three factors: the 32,768 Hz crystal, the two external capacitors and the thermal drift of the crystal. There are two methods to solve the problem:</p> <ul style="list-style-type: none"> • A good choice/match of the two capacitors (which can solve the problem of the offset of the frequency). Take into account the crystal tolerance. • The Calibration register of the RTCC, which can compensate the two deviations of the frequency: offset and thermal drift. <p>The order of operations should be:</p> <ul style="list-style-type: none"> • Match the capacitors to the chosen crystal; • Only after completing this, compensate the remaining offset through the Calibration register; • The best tool to measure the frequency is an (expensive) high-precision counter/frequency-meter. Due to the low-power operation of the oscillator, this cannot be tested with an oscilloscope probe without affecting the operation. The 32.768 kHz clock can also be observed as a square wave by enabling the CLKOUT. • Tolerance of crystals. • Crystal frequency varies with frequency. The system should be tested across all temperature and environmental conditions. • If the crystal is replaced with a device having equivalent parameters, the system should be re-qualified.

Common Crystal Issues

Please refer to AN1365 – “Recommended Usage of Microchip Serial RTCC Devices” (DS00001365).

CONCLUSION

A number of application notes are available to assist in developing with the RTCC. These are available on the Microchip website at www.microchip.com/rtcc.

For additional information, please refer to the following documents:

- AN1365 – *“Recommended Usage of Microchip Serial RTCC Devices”* (DS00001365)
- AN1364 – *“Using the Alarm Feature on the MCP79410 RTCC to Implement a Delayed Alarm”* (DS01364)
- AN1355 – *“A Complete Electronic Watch Based on MCP79410 I²C RTCC”* (DS00001355)
- AN1413 – *“Temperature Compensation of a Tuning Fork Crystal Based on MCP7941X”* (DS00001413)
- TB3065 – *“Enabling Intelligent Automation Using the MCP7941X I²C RTCC”* (DS93065)
- AN1379 – *“Stopwatch Based on MCP79410 I²C RTCC”* (DS01379)
- AN1412 – *“How to Calculate UNIX[®] Time Using a PIC18 Microcontroller and the MCP795W20 SPI RTCC”* (DS01412)

APPENDIX A: REVISION HISTORY

Revision A (02/2013)

Initial release of this document.

Revision B (12/2016)

Updated bit and register names to match new data sheet format.

NOTES:

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