TB3065

Enabling Intelligent Automation Using the MCP7941X I^{2}C^{TM} RTCC

Author:	Martin Bowman
	Microchip Technology Inc.

INTRODUCTION

This technical brief describes how the Microchip MCP7941X family of I^{2}C^{TM} Real-Time Clock/Calendar (RTCC) devices enable intelligent automation without additional component count. The MCP7941X family enables these enhancements by offering a unique set of features built onto the same silicon.

Microchip provides application notes and device drivers for many of the products available. Additional information on the RTCC devices can be found at www.microchip.com/rtcc.

> **Note:** It is recommended that the MCP7941X product data sheet (DS22266) is read along with the Best Practices document (DS01365) to avoid common pitfalls when designing with RTCC devices.

No source code is included with this technical brief, as it is intended as a general reference design that can be used as a starting point for a number of specific system designs.

RTCC FEATURES

The MCP7941X family is a new family of RTCC devices from Microchip that are designed with a unique set of features. The feature set was chosen to offer a selection of building blocks that are useful to an embedded system:

- Real-Time Clock/Calendar – battery-backed during power-fail
- On-chip digital trimming/calibration – can be used to trim crystal inaccuracies over temperature
- 64 bytes of separate SRAM – battery-backed during power-fail and separate from the RTCC registers
- 1 Kbit standard
- 64-bit unique ID that can be user factory-programmed with a unique value
- Power-fail time-stamp – records important power-fail events for later analysis
- Industry standard pinout and packages

The features listed above are commonly not available in an embedded MCU due to hardware and process limitations. By offering all the features in a single 8-pin device, Microchip has created a unique device that not only fills the missing blocks in a current system, but offers future expansion.
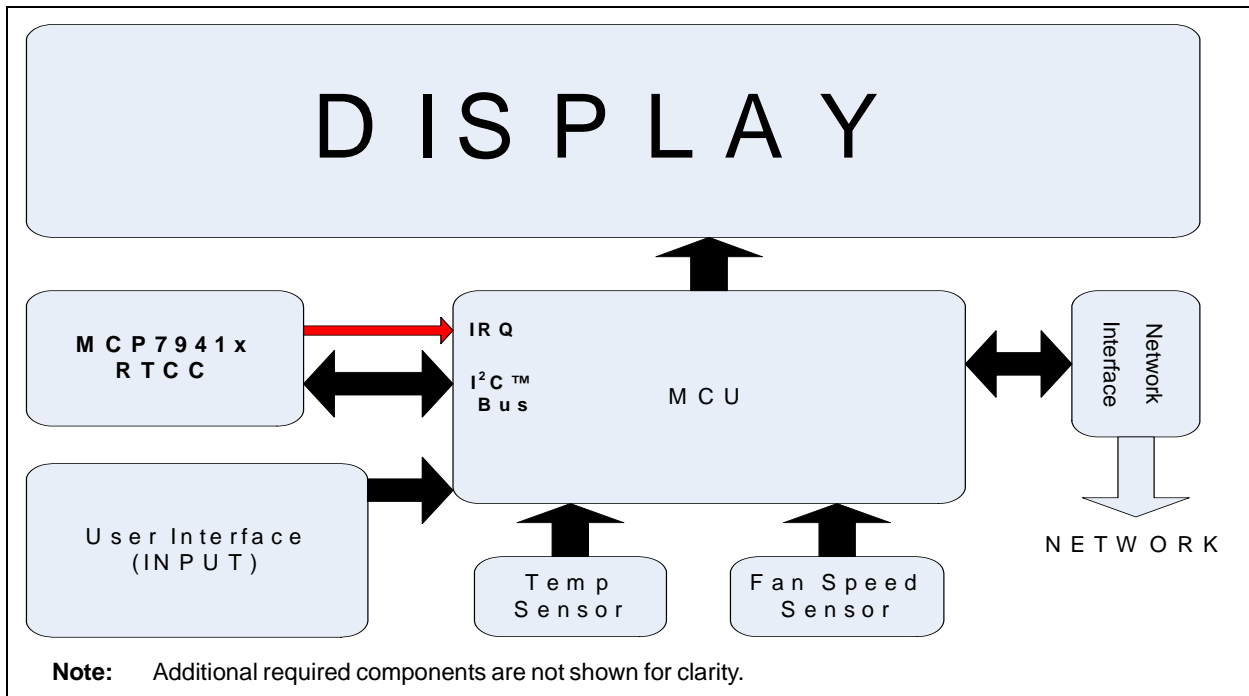
MCP7941X

CASE STUDY – INDUSTRIAL REFRIGERATION

In this case study we will look at a typical industrial refrigeration control and how the MCP7941X can enable advanced features without adding additional component count and current consumption. Let's assume that the existing system includes an MCU, EEPROM for parameter storage, and some type of display. The upgraded system needs to support the following upgrades:

• Reduce the current consumption
• Enable the unit for network connectivity
• Support additional Defrost/Cool modes at set times
• Monitor the main supply and analyze the outage time
• Maintain the state machine of the MCU in nonvolatile memory for system recovery

A block diagram of the system is shown in Figure 1, with additional sensors that may be used in a typical system.

FIGURE 1: **BLOCK DIAGRAM**

Note: Additional required components are not shown for clarity.

By using the MCP7941X the user can enable the requirements listed above by using the following features of the RTCC:

- **Reduce the current consumption:** By using the available MFP pin on the RTCC, the main MCU can be placed into a deep Power-down mode. The RTCC can be configured to generate an IRQ either periodically or on an alarm condition. Additional hardware can be implemented to physically switch the main power bus off. In that case, the RTCC will continue to operate from the backup battery and can restore the main power when an alarm is generated.

- **Enable the unit for network connectivity:** The MCP7941X features an additional 64 bits (8 bytes) of unique ID implemented as EEPROM. The ID can be programmed from the factory with either a globally unique IEEE EUI-48^{TM} or EUI-64^{TM} serial number. In addition, custom programing is also available. These factory-programmed, globally unique ID codes, mean that the MCU does not need to be serialized. This is often a problem with MCUs that do not have on-board EEPROM. To ensure reliable operation, the unique ID is protected by an unlock sequence to prevent accidental erasure by errant code.

- **Support additional Defrost/Cool modes at set times:** With the programmable alarms that are available on the RTCC, two separate alarm conditions can be set. The alarm can match on every minute through to a single match at any time in the future. Separate interrupt flags are available to quickly determine which alarm caused the interrupt.

- **Monitor the main supply and analyze the outage time:** With the on-board V_{CC} to V_{BAT} switchover, the MCP7941X offers power-fail time-stamp registers that record the time when the power fails and also the time that power is restored. By using these separate time-stamps, the system can determine the time the refrigeration unit was not operating and flag the user or send a network message alerting to that fact.

- **Maintain the state machine of the MCU in nonvolatile memory for system recovery:** The RTCC also implements 64 bytes of separate SRAM that is not shared with the RTCC registers. This memory is also retained provided the backup battery supply is available. As this is a SRAM, there are no write cycle times and an unlimited number of writes are possible. This is ideal to store the state machine of the MCU and can be updated as often as necessary. Upon restarting the MCU, the state machine can be read and operation continued.

CONCLUSION

This document describes some of the unique features of the MCP7941X family of RTCC devices and shows how they can be used to implement an enhanced embedded system. The MCP7941X is an ideal companion to low-power MCUs and offers a way to add additional features without increasing the component count.

NOTES:

Note the following details of the code protection feature on Microchip devices:

• Microchip products meet the specification contained in their particular Microchip Data Sheet.

• Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.

• There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.

• Microchip is willing to work with the customer who is concerned about the integrity of their code.

• Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC^{32} logo, rfPIC and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MXDEV, MXLAB, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Omniscient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICtail, REAL ICE, rfLAB, Select Mode, Total Endurance, TSHARC, UniWinDriver, WiperLock and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2010, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

Printed on recycled paper.

ISBN: 978-1-60932-602-9

Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═══ ISO/TS 16949:2002 ═══

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://support.microchip.com
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

Santa Clara
Santa Clara, CA
Tel: 408-961-6444
Fax: 408-961-6445

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

Japan - Yokohama
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-6578-300
Fax: 886-3-6578-370

Taiwan - Kaohsiung
Tel: 886-7-213-7830
Fax: 886-7-330-9305

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham
Tel: 44-118-921-5869
Fax: 44-118-921-5820

08/04/10