TB052

Multi-Zone Temperature Monitoring with the TCN75 Thermal Sensor

Author: *Ken Dietz*
Microchip Technology Inc.

INTRODUCTION

This Technical Brief presents an example of a simple, multi-zone thermal monitoring system using the Hardware mode of the Master Synchronous Serial Port (MSSP) module of a PICmicro® microcontroller. The design uses several TCN75 thermal sensors and the PIC16LF872 microcontroller.

Typical applications where this design may be implemented include power supplies, aquariums, personal computers, work stations, ovens, hot-swappable thermal sensing systems, office electronics, and electronic test equipment. This type of system design is also optimum for monitoring temperatures in the electronic systems of various home appliances, such as microwave ovens, blenders, toasters, refrigerators, washers, dryers, vacuum cleaners, and mixers.

SENSOR OVERVIEW

The TCN75 is a solid state, serially programmable digital temperature sensor. Environment temperature is output as a 9-bit, 2's complement serial digital signal. The device has an operating range of -55°C to +125°C (represented as 192h to 0FAh), with a typical resolution of 0.5°C.

The TCN75 has the ability to notify the host controller when a temperature measurement exceeds a user programmable set-point through its interrupt feature. It also incorporates a comparator function that can be used in place of the interrupt. These two functions are multiplexed through the same pin (INT/CPL) on the chip. Selectable addressing is implemented by pulling the three address pins to either V_{DD} (binary 1), or ground (binary 0), providing for a total of eight devices that can be addressed on the same two-wire serial bus.

The device is available in MSOP and SOIC packaging, which also makes it an ideal choice for low cost/low profile thermal management systems.

CIRCUIT OVERVIEW

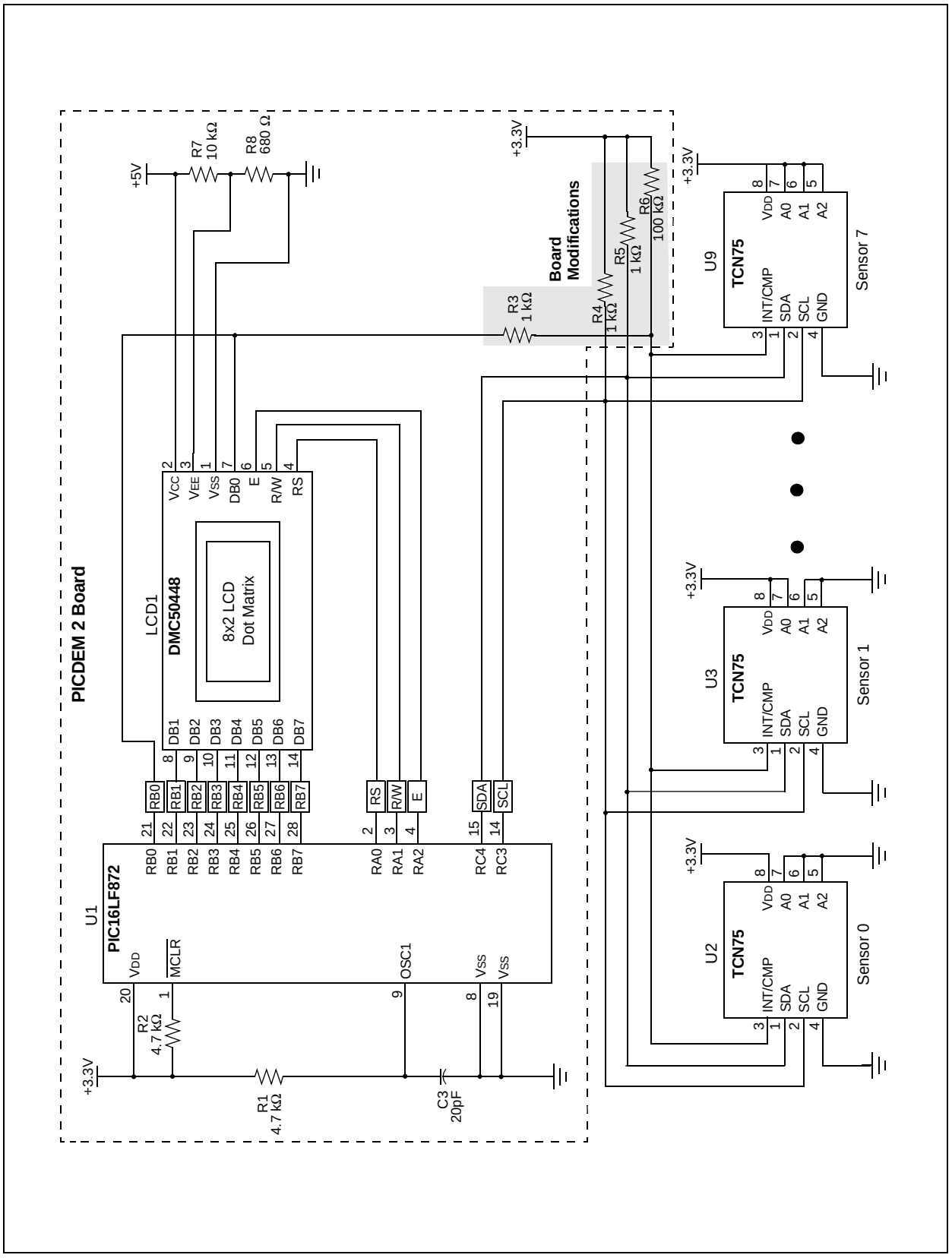
Figure 1 shows the overall design of the system. The circuit is divided into two sections: the remote sensors and the microprocessor board. The thermal sensing nodes are connected to the host processor through an I^2C™ interface. Only three TCN75 sensors are shown, to demonstrate the binary addressing scheme using pins A0 through A2.

Since the original design was prototyped using Microchip's PICDEM™ 2 Demonstration Board, some minor changes to the board were required to accommodate the 3.3V power supply and the additional resistors (noted in the shaded areas of Figure 1). When RB0 is communicating with the LCD, the pin needs to be isolated from the sensors, regardless of the state of INT/CMP. For this reason, R3 was designed into the circuit as an isolation resistor. R4 and R5 are typical pull-up resistors for the I^2C bus, while R6 is a weak pull-up when RB0 is configured as an input waiting for INT/CMP to change state. The circuitry for implementing over-temperature conditions is shown using R3 through R6 (this feature is not included in the firmware, however). Users who also wish to use the demonstration board as a basis for their designs are advised to review the overall schematic, which may be downloaded from the Microchip corporate website.

To create a more economical design, the PIC16LF872 oscillator is configured for RC mode. Because I^2C bus timing is critical, and to accommodate minimum and maximum clock rate specifications that may be compromised due to running the processor in RC mode, the I^2C clock rate was derated to 49 kHz. (This is compared to the maximum 100 kHz clock rate for the controller port running in this I^2C mode.)

After powering up and completing its initialization sequence, the microcontroller enters the main software routine where I^2C addresses are continuously polled based on a timer interrupt and a counter. Detecting the sensors at various addresses is accomplished by sending address bytes to slave addresses, then testing the Acknowledge status bit in the MSSP module. When a slave acknowledges, the system identifies the device at the address as a TCN75 and interrogates it for temperature data. Once collected, the data is processed and displayed on the LCD. Each sensor is polled for data, approximately every 1 to 2 seconds; if the sensor acknowledges the master, its data is sequentially displayed on the LCD. Polling and display frequencies are controlled by a delay loop in the firmware.

FIGURE 1: CIRCUIT DIAGRAM FOR THE TEMPERATURE SENSOR



APPENDIX A: SOFTWARE DISCUSSED IN THIS TECHNICAL BRIEF

The source code for the design discussed in this Technical Brief is not provided here. The firmware for this design is available as a single WinZip archive file. The archive may be downloaded from the Microchip corporate Web site at

www.microchip.com

NOTES:

Note the following details of the code protection feature on PICmicro® MCUs.

- The PICmicro family meets the specifications contained in the Microchip Data Sheet.
- Microchip believes that its family of PICmicro microcontrollers is one of the most secure products 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 PICmicro microcontroller in a manner outside the operating specifications contained in the data sheet. The person doing so may be 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 product.

If you have any further questions about this matter, please contact the local sales office nearest to you.

DNV Certification, Inc. USA — ANSI-RAB QMS ACCREDITED — DNV MSC The Netherlands Accredited by the RvA — DNV — ISO 9001 / QS-9000 REGISTERED FIRM

Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999. The Company’s quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs and microperipheral products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001 certified.

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: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Dayton
Two Prestige Place, Suite 130
Miamisburg, OH 45342
Tel: 937-291-1654 Fax: 937-291-9175

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo
2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

New York
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

Australia
Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing
Microchip Technology Consulting (Shanghai) Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu
Microchip Technology Consulting (Shanghai) Co., Ltd., Chengdu Liaison Office
Rm. 2401, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou
Microchip Technology Consulting (Shanghai) Co., Ltd., Fuzhou Liaison Office
Rm. 531, North Building
Fujian Foreign Trade Center Hotel
73 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7557563 Fax: 86-591-7557572

China - Shanghai
Microchip Technology Consulting (Shanghai) Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen
Microchip Technology Consulting (Shanghai) Co., Ltd., Shenzhen Liaison Office
Rm. 1315, 13/F, Shenzhen Kerry Centre,
Renminnan Lu
Shenzhen 518001, China
Tel: 86-755-2350361 Fax: 86-755-2366086

Hong Kong
Microchip Technology Hongkong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India
Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-334-8870 Fax: 65-334-8850

Taiwan
Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Denmark
Microchip Technology Nordic ApS
Regus Business Centre
Lautrup hoj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy
Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

10/01/01