MCP9800 Temperature Data Logger Demo Board 2 User's Guide

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Table of Contents

NOTES:

MCP9800 TEMPERATURE DATA LOGGER DEMO BOARD 2 USER'S GUIDE

Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP9800 Temperature Data Logger Demo Board 2. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the MCP9800 Temperature Data Logger Demo Board 2. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP9800 Temperature Data Logger Demo Board 2.
- **Chapter 2. "Installation and Operation"** – Demonstrates what programs need to be installed and how to program the microcontroller on the PCB, as well as reading the data out and displaying the data in an Excel® spreadsheet.
- **Appendix A.** – "Schematic and Bill of Materials (BOM)"

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

The following Microchip documents are available and recommended as supplemental reference resources.

MCP9800 Data Sheet, “2-Wire High-Accuracy Temperature Sensor” (DS21909)

24LC16B Data Sheet, “16K I^2C™ Serial EEPROM” (DS21703)

PIC10F202 Data Sheet, “PIC10F200/202/204/206 Data Sheet” (DS41239)

MCP100/101 Data Sheet, “Microcontroller Supervisory Circuit with Push-Pull Output” (DS11187)

SEEVAL® 32 User’s Guide, “SEEVAL® 32 Quick Start Guide” (DS51338)

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- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user’s guides and hardware support documents, latest software releases and archived software
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- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (January 2007)

Initial Release of this Document.

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter contains an overview of the MCP9800 Temperature Data Logger Demo Board 2 and covers the following topics:

- What is the MCP9800 Temperature Data Logger Demo Board 2?
- What does the MCP9800 Temperature Data Logger Demo Board 2 include?

1.2 WHAT IS THE MCP9800 TEMPERATURE DATA LOGGER DEMO BOARD 2?

The MCP9800 Temperature Data Logger Demo Board 2 is a PCB assembly that uses a PIC10F202 to read temperature data using I^2C™ communication from a Microchip MCP9800 temperature sensor, and stores that data, also using I^2C communication, to a 24LC16B Serial EEPROM. The board can then be placed into a SEEVAL® 32 Serial EEPROM Evaluation tool and the content can be read and stored into a .hex file. We have also provided an Excel spreadsheet that can be used to import the .hex file so that the data may be graphed on your computer screen.

1.3 WHAT DOES THE MCP9800 TEMPERATURE DATA LOGGER DEMO BOARD 2 KIT INCLUDE?

This MCP9800 Temperature Data Logger Demo Board 2 Kit includes:

- Two MCP9800 Temperature Data Logger Demo Boards.

On the data CD provided:

- MCP9800 Temperature Data Logger Demo Board 2 User's Guide (DS22027)
- SEEVAL® 32 Quick Start User's Guide (DS51338)
- PIC10F202 Firmware (`SEEVALDM_DL.asm`)
- Excel Spreadsheet (Temperature Graph.xls)

NOTES:

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP9800 Temperature Data Logger Demo Board 2, once programmed, will log temperature measurements for a predetermined amount of time until the 24LC16B is fully programmed with temperature data (i.e., 2,048 temperature readings). Each sample uses one byte of memory. The intervals can be changed in the firmware we have provided by changing the *TIMEOUTVAL* variable. The firmware will take measurements for approximately 45 minutes (approx. 1 sample/sec).

2.2 FEATURES

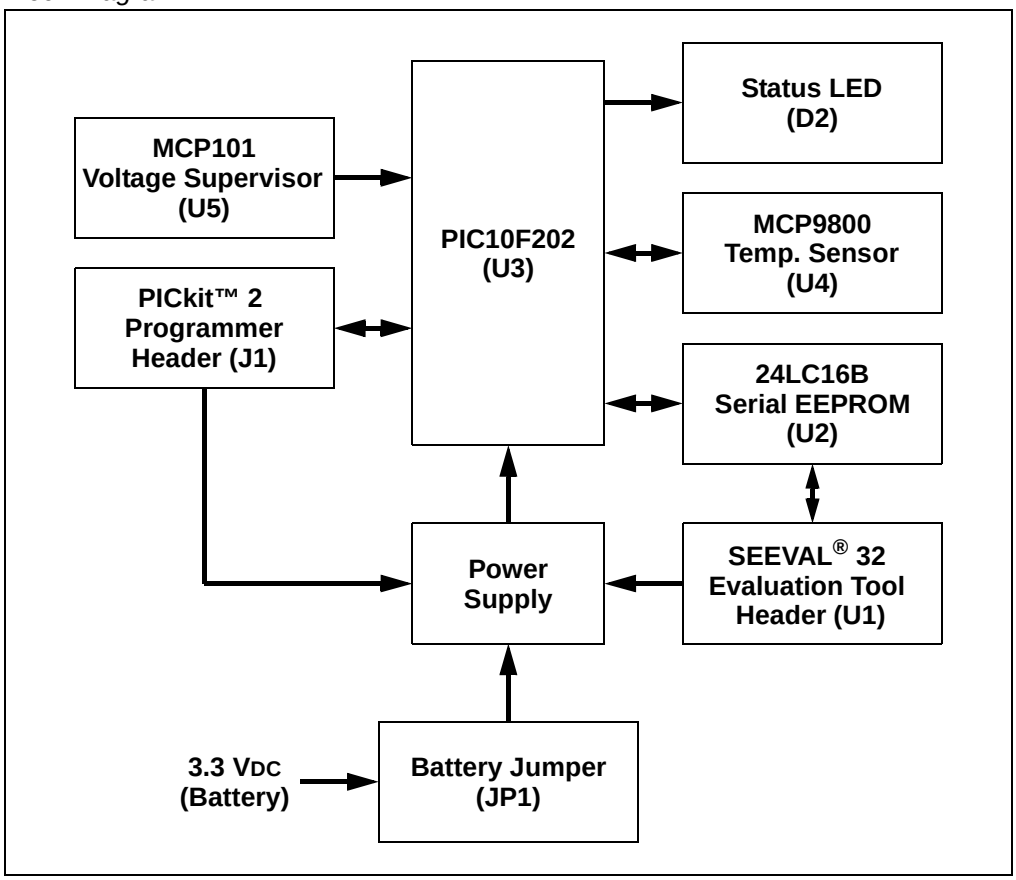
The MCP9800 Temperature Data Logger Demo Board 2 has the following features:

- Small PCB layout. Can be placed virtually anywhere you need to measure temperature.
- Standard ICSP™ pinout so the firmware can be modified using a PICkit™ 2 programmer or any of Microchip's programming tools using the ICSP programming adapter.
- Standard Two-Wire 8-pin pinout (inverted) for easy reading of the 24LC16B into the SEEVAL® 32 evaluation tool software.

2.3 GETTING STARTED

This section describes how to get your MCP9800 Temperature Data Logger Demo Board 2 programmed and ready to take temperature readings. The boards have been pre-programmed at the factory with the default settings, so it is not necessary to program them unless the firmware has been modified. It will also show how to read the logged data from the board into the SEEVAL® 32 evaluation tool software. Then it will show how to export that data from the SEEVAL 32 evaluation tool software and also how to import and display the data on an Excel spreadsheet.

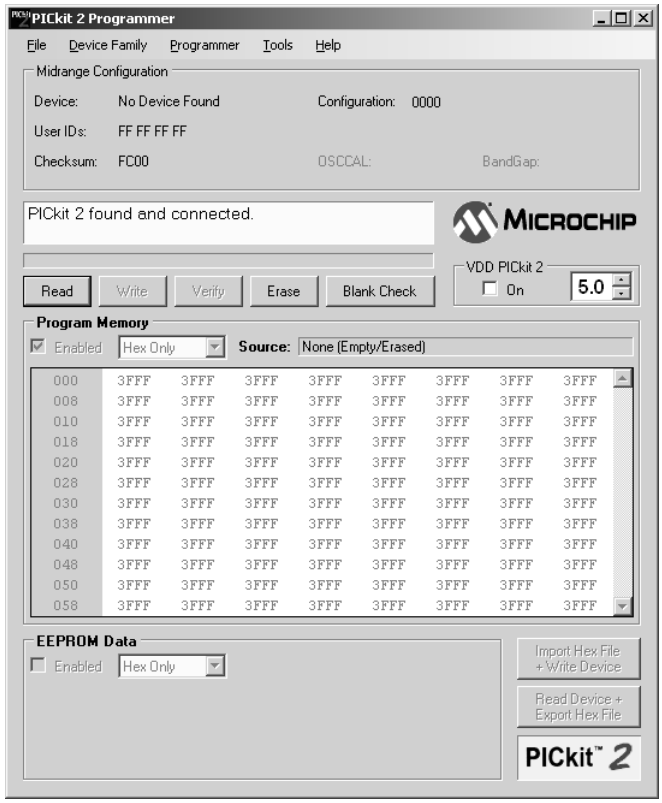
FIGURE 1-1: *MCP9800 Temperature Data Logger Demo Board 2 Functional Block Diagram*



2.3.1 Programming the PIC10F202

1. Download and Install the PICkit™ 2 programmer software onto your PC.
2. Copy the *SEEVALDM-DL.hex* file (supplied on the CD that came with this kit) onto your PC.
3. When the PICkit™ 2 programmer software is started the main window will be displayed on the PC, as indicated in Figure 1-2.
4. Be sure that the battery (BT1) is installed and the jumper for Power is connected (JP1).
5. Connect the MCP9800 Temperature Data Logger Demo Board 2 to the PICkit™ 2 programmer (both programmer and board should be face up when connecting).
6. PICkit™ 2 programmer should have a green led on the front indicating that no errors have occurred.

FIGURE 1-2: *PICkit™ 2 Programmer GUI Window on the PC*



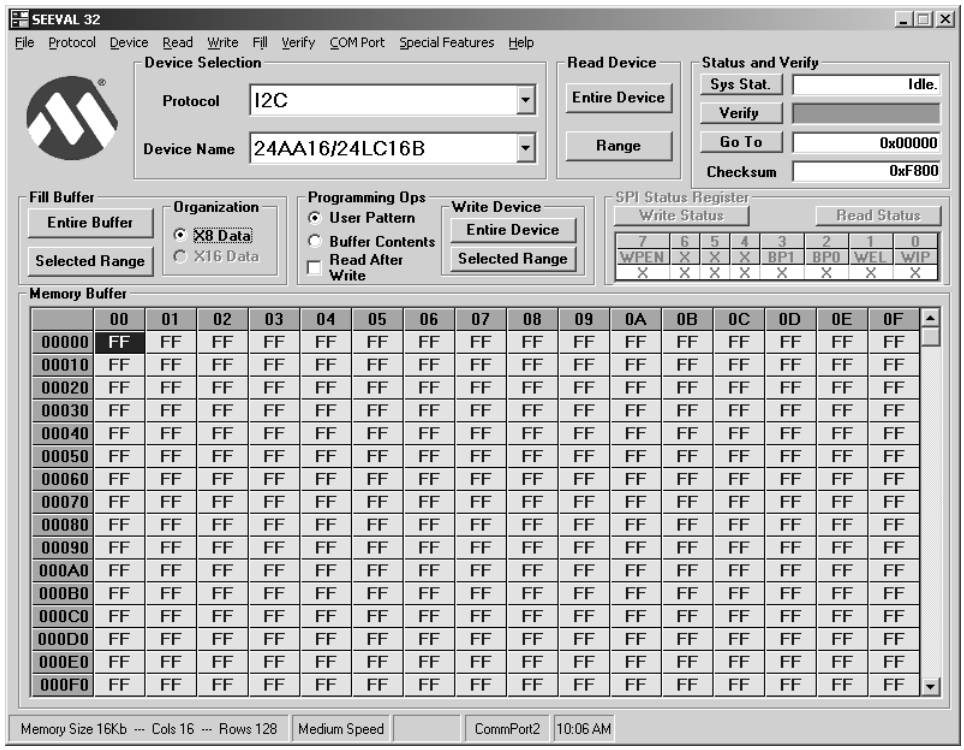
7. Select *Device Family>Baseline*.
8. Select **PIC10F202** from the Device pull-down menu.
9. Select *File>Import Hex* from the File pull-down menu. A file window will appear. Locate, select, and open *SEEVALDM-DL.hex* from your PC.
10. Click on the **Write Device** Button in the PICkit™ 2 Programmer window. The PIC10F202 will be written to with the *SEEVALDM-DL.hex* firmware. Once completed, the status bar in the middle of the window will indicate Write Successful.
11. Disconnect the MCP9800 Temperature Data Logger Demo Board 2 from the PICkit™ 2 programmer. Remove and replace the Power Header (JP1). Led should begin flashing indicating that the PIC10F202 is reading temperature from the MCP9800 and storing the data into the 24LC16B.
12. LED will flash indicating that measurements are being taken until the 24LC16B has reached its storage limit (2,048 bytes).

2.3.2 Reading Data from the MCP9800 Temperature Data Logger Demo Board 2 board

1. Download and install the SEEVAL® 32 evaluation tool software using the SEEVAL® 32 Quick Start User's Guide.
2. When the SEEVAL 32 evaluation tool software is started the main window will be displayed on the PC, as indicated in Figure 1-3.
3. Select **"I2C"** from the **Protocol** pull-down menu.
4. Select **"24AA16/24LC16B"** from the **Device Name** pull-down menu.

5. Insert the MCP9800 Temperature Data Logger Demo Board 2 into to SEEVAL® 32 evaluation board. To do this, flip the board upside down making sure the ICSP pins are facing the right side of the SEEVAL® 32 evaluation board. Place the 8 header pins in the rear (right side) of the ZIF socket. Close the socket.
6. Select *Read>Entire Device* to read the 24LC16B.
7. Your data (hexadecimal) will be displayed on the SEEVAL® 32 evaluation tool software GUI.

FIGURE 1-3: *SEEVAL® 32 Evaluation Tool GUI Window on the PC*



2.3.3 Storing your Data

Select *File>Export>Hex File* and store your data to your PC (`filename.hex`).

2.3.4 Displaying Temperature Data

1. Open file `Temperature Graph.xls` (Provided on the CD). Choose **enable macros** if prompted. (May need to adjust security settings here if you are unable to launch the file.)
2. Press the **Import Data** button.
3. Find your data file on your PC (`filename.hex`), Press **Open** Button.
4. Enter **"1"** for sample period when asked and press **OK**. If you have changed the sample period in the firmware you will need to adjust the sample period here, default is approximately 1 sample/sec.
5. Temperatures both positive and negative will be displayed on the graph. Tabs at the bottom of the graph will show either °F or °C.

2.4 FUNCTIONAL DESCRIPTION

2.4.1 The MCP9800 Temperature Data Logger Demo Board 2

This demo board was originally developed for the use in a class to teach people the basics of the I²C™ protocol. The code is formatted in such a manner that it is easy to read and modify should one need to. Table 1-1 and Table 1-2 show some of the basic subroutines and constant definitions used in the code. The *TIMEOUTVAL* variable may be modified to put longer delays between measurements. Any value between 1 (default) and 255 may be used to vary the sample rate. The higher the number, the slower the sample rate. The *TIMEOUTVAL* variable is approximately the number of seconds delay between measurements.

2.5 I²C™ SUBROUTINES

The following subroutines provide low-level I²C support:

TABLE 1-1: I²C™ SUBROUTINES

Subroutine	Description
BSTART	Generate an I²C™ bus *Start* condition.
BSTOP	Generate an I²C™ bus *Stop* condition.
SEND_ACK	Generate an I²C™ bus *Acknowledge* condition.
SEND_NACK	Generate an I²C™ bus *Not Acknowledge* condition.
BYTEOUT	Output an entire byte to the I²C™ bus.
BYTEIN	Input an entire byte from the I²C™ bus.

The following constants have been defined for communicating with the 24LC16B and MCP9800:

TABLE 1-2: CONSTANT DEFINITIONS

Constant	Value	Description
MEM_WRITE	b'10100000'	Control byte for EEPROM write operation
MEM_READ	b'10100001'	Control byte for EEPROM read operation
TEMP_WRITE	b'10010000'	Control byte for temp. sensor write operation
TEMP_READ	b'10010001'	Control byte for temp. sensor read operation
TEMP_REG	0x00	Temperature register address for temp. sensor
CONFIG_REG	0x01	Configuration register address for temp. sensor
SHUTDOWN	b'00000001'	Configuration value for Shutdown mode
ONESHOT	b'10000001'	Configuration value for One-Shot mode

Subroutine Descriptions

BSTART

Description: Generate an I²C bus *Start* condition.
Arguments: None.
Output: None.
Return Value: 0
Code Example:
```
call  BSTART      ; Generate Start
```

BSTOP

Description: Generate an I²C bus *Stop* condition.
Arguments: None.

BSTOP

Output: None.

Return Value: 0

Code Example:
```
call  BSTOP       ; Generate Stop
```

SEND_ACK

Description: Generate an I^2C bus *Acknowledge* condition.

Arguments: None.

Output: None.

Return Value: 0

Code Example:
```
call  SEND_ACK    ; Send ACK to continue reading
```

SEND_NACK

Description: Generate an I^2C bus *Not Acknowledge* condition.

Arguments: None.

Output: None.

Return Value: 0

Code Example:
```
call  SEND_NACK   ; Send NACK to end operation
```

BYTEOUT

Description: Output an entire byte to the I^2C bus.

Arguments: *WREG*
Data byte to be transmitted to the I^2C bus.
pollflag<0>
Flag indicating whether or not currently polling (1 if polling, 0 otherwise).

Output: None.

Return Value: 0 if an Acknowledge was received.
-1 if an Acknowledge was not received and *pollflag<0>* is set.

Remarks: If an Acknowledge was not received and *pollflag<0>* is cleared, this sub-routine sets the current state to ERR1_STATE and goes to sleep. This state is used to indicate that an Acknowledge error occurred.

Code Example:
```
movlw 0x7F        ; Load 0x7F into WREG
call  BYTEOUT     ; Output byte
```

BYTEIN

Description: Input an entire byte from the I^2C bus.

Arguments: None.

Output: *buffer*
Data byte read from the I^2C bus.

Return Value: 0

Code Example:
```
call  BYTEIN      ; Input byte
call  SEND_NACK   ; Send NACK to end operation
movfw buffer      ; Copy data to WREG
```

2.5.1 The MCP9800

The MCP9800 comes with user-programmable registers that provide flexibility for temperature-sensing applications. The register settings allow user-selectable 9-bit to 12-bit temperature measurement resolution, configuration of the power-saving Shutdown and One-Shot (single conversion on command while in Shutdown) modes and the specification of both temperature alert output and hysteresis limits. When the temperature changes beyond the specified limits, the MCP9800 outputs an alert signal. The user has the option of setting the alert output signal polarity as an active-low or active-high comparator output for thermostat operation, or as a temperature event interrupt output for microprocessor-based systems.

This device has I^2C/SMBus-compatible serial interface (refer to the MCP9800 data sheet (DS21909) for further details).

2.5.2 The 24LC16B

The 24LC16B is a 16 Kbit Electrically Erasable PROM. This device has I^2C/SMBus-compatible serial interface. Low-voltage design permits operation down to 1.8V with standby and active currents of only 1µa and 1mA, respectively. The device also has a page write capability for up to 16 bytes of data.

2.5.3 The MCP101

The MCP101 is a voltage supervisory device designed to keep a microcontroller in Reset until the system voltage has reached the proper level and stabilized. It also operates as protection from brown-out conditions when the supply voltage drops below a safe operating level.

NOTES:

Appendix A. Schematic and Bill of Materials (BOM)

FIGURE 1-1: *MCP9800 Temp Sensor SEEVAL® 32 Data Logger Schematic*

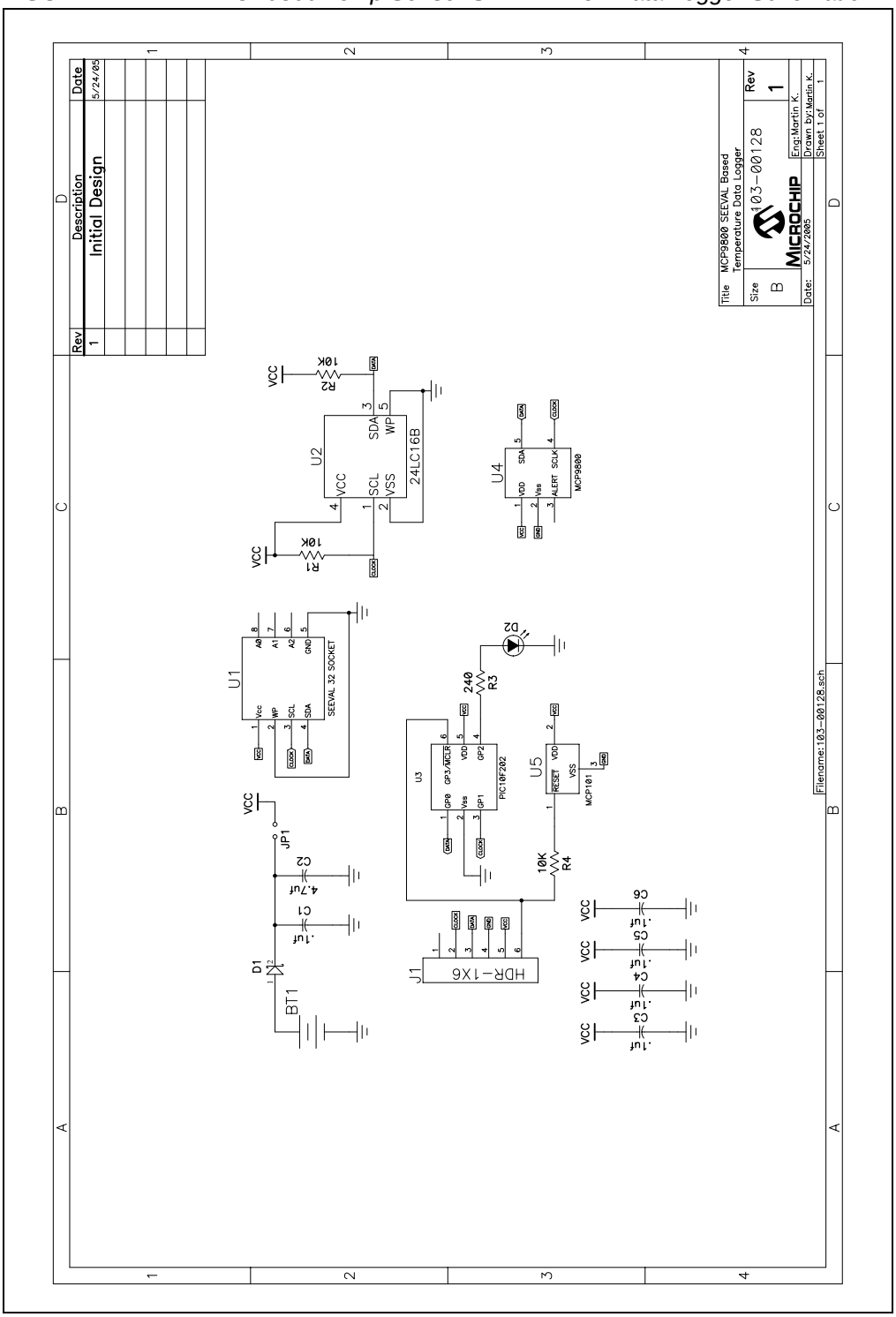


FIGURE 1-2: *MCP9800 Temp Sensor SEEVAL® 32 Data Logger BOM*

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Chandler, AZ 85224-6199

KEY	
CR: Cross	)rawing
CS: Consign	BOM
PL: Pack List	: Part
RoHS: Lead Free	: Label

Bill of Materials

ASSEMBLY NUMBER: 102-00128 REV: 1 Part No: MCP9800DM-DL2

ASSEMBLY NAME: MCP9800 SEEVAL Based Temperature Data Logger

	Qty	Reference	Description	Mfgr.	Part Number	Distributor	Vendor/Part Number	RoHS	Rev	CR	CS	PL	Type
1	1	-	PCB ASSY DWG, MCP9800 SEEVAL Based Temperature Data Logger	-	102-00128-D	-	-		1	N	N	N	D
2	1	-	SCHEMATIC, MCP9800 SEEVAL Based Temperature Data Logger	-	103-00128	-	-		1	N	N	N	D
3	1	-	PCB FABRICATION DRAWING, MCP9800 SEEVAL Based Temperature Data Logger	-	104-00128-D	-	-		1	N	N	N	D
4	1	-	Gerber Files, 105-00128R1.ZIP MCP9800 SEEVAL Based Temperature Data Logger	-	105-00128	-	-		1	N	N	N	D
5	1	-	MCP9800 SEEVAL Based Temperature Data Logger Test Procedure	-	113-00128	-	-		1	N	N	N	D
6	1	-	Label, AIPD Assembly and Serial Numbers, Very Small	-	108-00004	-	-		2	N	N	N	LBL
7	1	PCB	RoHS Compliant Bare PCB, MCP9800 SEEVAL Based Temperature Data Logger	-	104-00128	-	-		1	Y	N	N	P
8	5	C1,C3,C4,C5,C6	CAP .10UF 16V CERAMIC X7R 0603	Kemet	C0603C104K4RACTU	Digi-Key	399-1096-1-ND	Y	1	Y	N	N	P
9	1	C2	CAP 4.7UF 6.3V CERAMIC X5R 0603	Panasonic - ECG	ECJ-1VBFJ475K	Digi-Key	PCC13495CT-ND	Y	1	Y	N	N	P
10	1	D1	DIODE SCHOTTKY 60V 800MA MINI-2P	Panasonic - SSG	MA2YD2600L	Digi-Key	MA2YD2600LCT-ND	Y	1	Y	N	N	P
11	1	D2	LED RED CLEAR 0805 SMD	Lite-On Trading USA	LTST-C170CKT	Digi-Key	160-1176-1-ND	Y	1	Y	N	N	P
12	3	R1,R2,R4	RES 10.0K OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1002V	Digi-Key	P10.0KHCT-ND	Y	1	Y	N	N	P
13	1	R3	RES 243 OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF2430V	Digi-Key	P243HCT-ND	Y	1	Y	N	N	P
14	1	BT1	HOLDER BATTERY COIN 20MM 1-CELL	Keystone Electr	103	Digi-Key	103K-ND	Y	1	Y	N	N	P
15	1	J1	HEADER,.1"ST MALE,1RW,6PIN,	JAMECO VALUEPRO	JS1109-6-R	Jameco	153700	Y	1	Y	N	N	P
16	1	JP1	HEADER,.1",2PIN,GOLDTAIL	JAMECO VALUEPRO	7000-1X2SG-R	Jameco	108338	Y	1	Y	N	N	P
17	2	U1	HEADER,.1"MALE,4PIN, GOLDTAIL	JAMECO VALUEPRO	JS-1109-4-R	Jameco	117560	Y	1	Y	N	N	P
18	1	BT1	BATTERY LITHIUM COIN 3V 20MM	Panasonic - BSG	CR2032	Digi-Key	P189-ND	Y	1	Y	N	N	P

Appendix A. Schematic and Bill of Materials (BOM)

FIGURE 1-3: *MCP9800 Temp Sensor SEEVAL® 32 Data Logger BOM (Continued)*

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KEY	
CR: Cross	Drawing
CS: Consign	BOM
PL: Pack List	: Part
RoHS: Lead Free	: Label

Bill of Materials

ASSEMBLY NUMBER: 102-00128 **REV:** 1 **Part No:** MCP9800DM-DL2

ASSEMBLY NAME: MCP9800 SEEVAL Based Temperature Data Logger

	Qty	Reference	Description	Mfgr.	Part Number	Distributor	Vendor/Part Number	RoHS	Rev	CR	CS	PL	Type
19	1	U2	16K I2C™ Serial EEPROM	Microchip	24LC16BT-I/OT	Microchip	24LC16BT-I/OT	Y	1	N	Y	N	P
20	1	U3	6-Pin, 8-Bit Flash Microcontrollers	Microchip	PIC10F202T-E/OT	Microchip	PIC10F202T-E/OT	Y	1	N	Y	N	P
21	1	U4	2-Wire High-Accuracy Temperature Sensor	Microchip	MCP9800A0T-M/OTG	Microchip	MCP9800A0T-M/OTG	Y	1	N	Y	N	P
22	1	U5	Microcontroller Supervisory Circuit with Push-Pull Output	Microchip	MCP101T-450I/TT	Microchip	MCP101T-450I/TT	Y	1	N	Y	N	P

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Malaysia - Penang
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