Low-Cost mTouch® Evaluation Kit User's Guide

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12-Sep-14
Date

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Preface

NOTICE TO CUSTOMERS

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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 online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the Low-Cost mTouch® Evaluation Kit. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- Recommended Reading
- The Microchip Website
- Development Systems Customer Change Notification Service
- Customer Support
- Revision History

DOCUMENT LAYOUT

This document describes how to use the Low-Cost mTouch Evaluation Kit as a development tool to evaluate mTouch 1D solution, as well as how to develop a capacitive sensing application based on this kit. The document is organized as follows:

- **Chapter 1. "Low-Cost mTouch Evaluation Kit Overview"** – Offers information on the hardware of the evaluation kit.
- **Chapter 2. "Communication and System Register"** – Introduces the I^2C communication protocol and registers for the mTouch system.
- **Chapter 3. "Work with mTouch Dawn GUI"** – Explains how to use Dawn GUI for this evaluation kit.
- **Appendix A. "Low-Cost mTouch Evaluation Board"** – Provides the schematic and layout for this evaluation kit.

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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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use the Low-Cost mTouch® Evaluation Kit. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

http://www.microchip.com

PIC16LF1554/1559 20-Pin Flash, 8-Bit Microcontroller Data Sheet (DS40001761)

This data sheet provides detailed information regarding the PIC16LF1559.

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- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB REAL ICE™ and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICkit™ 3 debug express.
- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART® Plus and PICkit 2 and 3.

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

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Technical support is available through the website at:

http://www.microchip.com/support.

REVISION HISTORY

Revision A (November 2015)

Initial release of this document.

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Chapter 1. Low-Cost mTouch® Evaluation Kit Overview

1.1 INTRODUCTION

The Low-Cost mTouch Evaluation Kit provides a simple and flexible platform for demonstrating and developing a variety of capacitive sensing applications. The controller board utilizes the dual high-speed ADCs with automated hardware CVD modules to scan one proximity and five button sensors. The firmware supplied with the controller board has been optimized for moisture resistance and noise immunity.

The kit also includes the MCP2221 breakout module, which allows the controller board to communicate with mTouch Dawn GUI. The Dawn GUI displays touch configuration and signals for real-time debugging.

1.1.1 Kit Contents

- Low-Cost Controller Board with detachable sensors
- MCP2221 Breakout Module
- Mini to USB B Cable

1.2 BOARD OVERVIEW

This kit includes the Low-Cost mTouch Controller Board and MCP2221 Breakout Module. They work in conjunction to provide real-time configuration and touch data to PC GUI.

1.2.1 Low-Cost Evaluation Board

FIGURE 1-1: LOW-COST EVALUATION BOARD

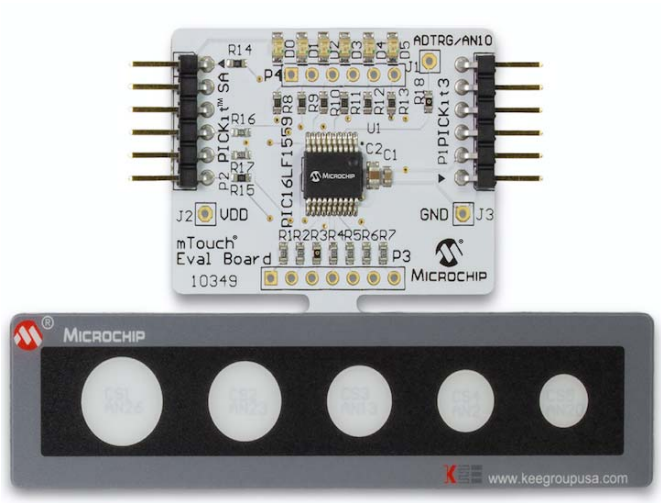


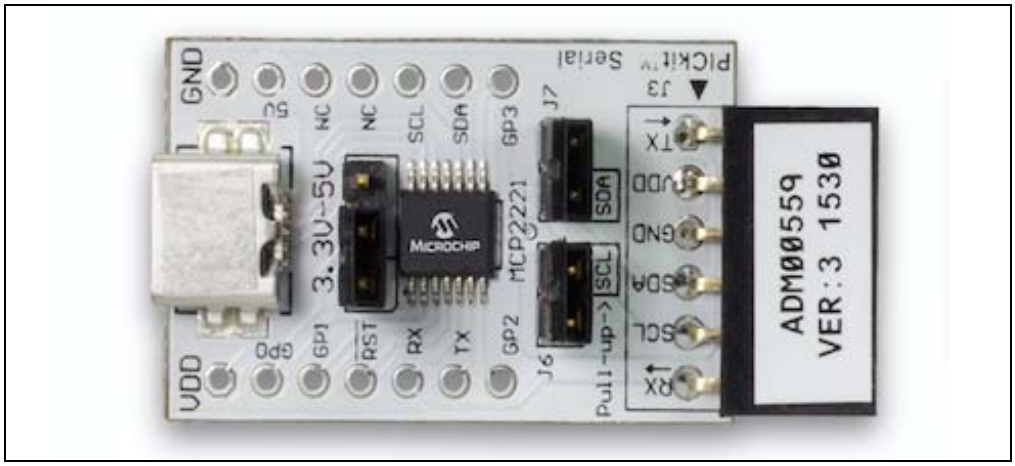
Figure 1-1 shows the Low-Cost mTouch Evaluation board. It includes a proximity loop sensor, five touch button sensors, six LEDs, an ICSP™ header and PICkit™ Serial interface.

The default firmware scans the proximity and touch buttons periodically, and uses the LEDs to indicate the proximity and button state. If a proximity or touch event is detected, the corresponding LED will be lit. An I^2C interface is also implemented to communicate with a host system through the header marked with "PICkit SA", which accommodates the PICkit Serial Analyzer pin-out. This feature allows the system not only to report its sensor data in real-time, but to be configured by a host device as well.

1.2.2 MCP2221 Breakout Module

The Evaluation Kit comes with the MCP2221 Breakout Module (ADM00559) as shown in Figure 1-2. This module works as an I^2C to USB bridge in this evaluation kit.

FIGURE 1-2: MCP2221 BREAKOUT MODULE



Refer to *MCP2221 Breakout Module User's Guide* for more information on this breakout module.

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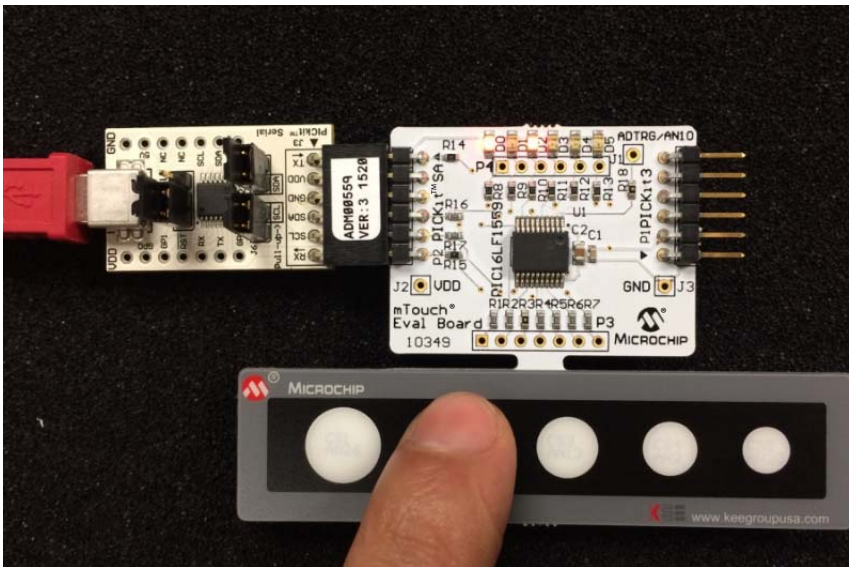
1.3 BOARD SETUP

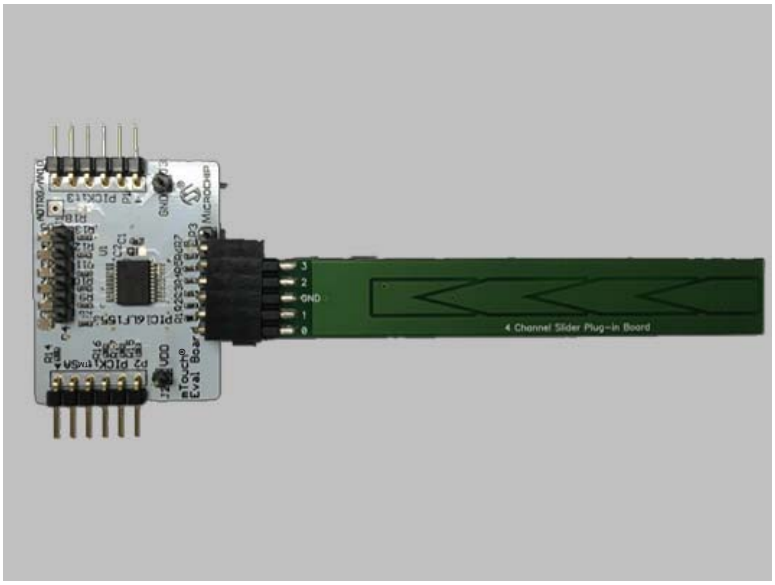
Before evaluating the kit, two boards in the kit need to be connected as shown in Figure 1-3, and then powered by the mini USB cable. After powering the kit, the proximity and touch functions will work out-of-box. The LEDs will reflect the state of proximity sensor and each touch button.

FIGURE 1-3: BOARD SETUP



The sensor portion of the low-cost board can be snapped off from the whole board, so that a different sensor can be connected to the controller through the P3 connector. This provides flexibility for quick prototyping and evaluating different sensor designs. In Figure 1-4, a four-channel slider is connected to the controller board through the P3 connector.

FIGURE 1-4: SLIDER SENSOR EXAMPLE



NOTES:

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Chapter 2. Communication and System Register

2.1 INTRODUCTION

The default firmware on the Low-cost Evaluation Board communicates with host system through a register-based I²C communication protocol.

2.1.1 mTouch I²C communication protocols

The default I²C slave address for this evaluation board is 0x28 (7-bit address). The evaluation board supports the following protocols: Read Byte, Write Byte, Read Block, and Write Block. Please note that the system register referred in this document is on the firmware level, not the PIC® microcontroller registers in the data sheet.

2.1.1.1 WRITE BYTE

The Write Byte protocol is used to write one byte of data to a specific register as shown in Table 2-1.

TABLE 2-1: WRITE BYTE PROTOCOL

Start	Slave address	W	ACK	Register Address	ACK	Register Data	ACK	Stop
1->0	0b101000	0	0	XXh	0	XXh	0	0->1

2.1.1.2 READ BYTE

The Read Byte protocol is used to read one byte of data from the register shown in Table 2-2.

TABLE 2-2: READ BYTE PROTOCOL

Start	Slave address	W	ACK	Register Address	ACK	Start	Slave address	R	ACK	Register Data	Nack	Stop
1->0	0b101000	0	0	XXh	0	1->0	0b101000	1	0	XXh	1	0->1

2.1.1.3 WRITE BLOCK

The Write Block protocol is used to write multiple bytes to a group of contiguous registers as shown in Table 2-3. The internal Address Pointer will be automatically incremented after every byte is received.

TABLE 2-3: WRITE BLOCK PROTOCOL

Start	Slave address	W	ACK	Register Address	ACK	Register Data	ACK	...	Register Data	ACK	Stop
1->0	0b101000	0	0	XXh	0	XXh	0	...	XXh	0	0->1
						data @ start address			data @ (start address + n)		

2.1.1.4 READ BLOCK

The Read Block protocol is used to read multiple data bytes from a group of contiguous registers as shown in Table 2-4. The internal Address Pointer will be automatically incremented after every byte is received.

TABLE 2-4: READ BLOCK PROTOCOL

Start	Slave address	W	ACK	Register Address	ACK	Start	Slave address	R	ACK	Register Data	ACK
1->0	0b101000	0	0	XXh	0	1->0	0b101000	1	0	XXh	0
...	Register Data n	Nack	Stop							data @ (start address + n)	
...	XXh	1	0->1								

data @ start address

2.1.2 System Register Description

The protocol packet that is described above only contains one byte for system register address, so the addressing range is from 0 to 255 locations for a single command. To extend the addressing range, the firmware has partitioned the system memory in "banks". Each bank has 256 locations and you can switch the active bank by writing the bank index to the bank register, which will be shown in the following tables.

The registers shown in Table 2-5 are accessible from the communication protocol described above. Table 2-6 describes the details of each register.

TABLE 2-5: REGISTER MAP

Register Bank	Register Addresses	R/W	Register Name	Function	Default Values
0x00	0x01	R	Touch State Mask	Returns the touch state of proximity/touch sensor inputs	0x00
0x00	0x10	R	Proximity Signal Deviation	Stores the delta count for proximity sensor	0x00
0x00	0x11	R	Button 0 Signal Deviation	Stores the delta count for touch button 0	0x00
0x00	0x12	R	Button 1 Signal Deviation	Stores the delta count for touch button 1	0x00
0x00	0x13	R	Button 2 Signal Deviation	Stores the delta count for touch button 2	0x00
0x00	0x14	R	Button 3 Signal Deviation	Stores the delta count for touch button 3	0x00
0x00	0x15	R	Button 4 Signal Deviation	Stores the delta count for touch button 4	0x00
0x00	0x40	R/W	Proximity Threshold	Stores the delta count threshold for proximity sensor	0x64
0x00	0x41	R/W	Button 0 Threshold	Stores the delta count threshold for touch button 0	0x40
0x00	0x42	R/W	Button 1 Threshold	Stores the delta count threshold for touch button 1	0x40
0x00	0x43	R/W	Button 2 Threshold	Stores the delta count threshold for touch button 2	0x40
0x00	0x44	R/W	Button 3 Threshold	Stores the delta count threshold for touch button 3	0x40
0x00	0x45	R/W	Button4 Threshold	Stores the delta count threshold for touch button 4	0x40
0x00	0x70	R/W	Calibration State Mask	Return the calibration state of proximity/touch sensors inputs	0x00

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TABLE 2-5: REGISTER MAP

Register Bank	Register Addresses	R/W	Register Name	Function	Default Values
0x00	0x80	R/W	Proximity Scaling Factor	Stores the delta count scaling factor for proximity sensor	0x0A
0x00	0x81	R/W	Button 0 Scaling Factor	Stores the delta count scaling factor for button 0	0x0A
0x00	0x82	R/W	Button 1 Scaling Factor	Stores the delta count scaling factor for button 1	0x0A
0x00	0x83	R/W	Button 2 Scaling Factor	Stores the delta count scaling factor for button 2	0x0A
0x00	0x84	R/W	Button 3 Scaling Factor	Stores the delta count scaling factor for button 3	0x0A
0x00	0x85	R/W	Button 4 Scaling Factor	Stores the delta count scaling factor for button 4	0x0A
0x00	0xB0	R/W	Reading Gain	Store the reading gain for all sensor inputs	0x02
0x00	0xB1	R/W	Baseline Gain	Store the baseline gain for all sensor inputs	0x04
0x00	0xB2	R/W	Baseline Rate	Store the Baseline Rate fro all sensor inputs	0x10
0x00	0xC0	R/W	Negative Delta Count	Store the threshold of consecutive number of negative delta	0x10
0x00	0xC1	R/W	Press Timeout	Store the timeout count for pressed sensor inputs	0x0A
0x00	0xC2	R/W	Debounce	Store the debounce count for all sensor inputs	0x00
0x01	0x10	R	Proximity Reading	Store the unscaled proximity sensor readings	0x000000
0x01	0x11	R			
0x01	0x12	R			
0x01	0x13	R	Button 0 Reading	Store the unscaled button 0 readings	0x000000
0x01	0x14	R			
0x01	0x15	R			
0x01	0x16	R	Button 1 Reading	Store the unscaled button 1 readings	0x000000
0x01	0x17	R			
0x01	0x18	R			
0x01	0x19	R	Button 2 Reading	Store the unscaled button 2 readings	0x000000
0x01	0x20	R			
0x01	0x21	R			
0x01	0x22	R	Button 3 Reading	Store the unscaled button 3 readings	0x000000
0x01	0x23	R			
0x01	0x24	R			
0x01	0x25	R	Button 4 Reading	Store the unscaled button 4 readings	0x000000
0x01	0x26	R			
0x01	0x27	R			
0x02	0x10	R	Proximity Baseline	Store the unscaled proximity sensor baseline	0x000000
0x02	0x11	R			
0x02	0x12	R			

TABLE 2-5: REGISTER MAP

Register Bank	Register Addresses	R/W	Register Name	Function	Default Values
0x02	0x13	R	Button 0 Baseline	Store the unscaled button 0 baseline	0x000000
0x02	0x14	R			
0x02	0x15	R			
0x02	0x16	R	Button 1 Baseline	Store the unscaled button 1 baseline	0x000000
0x02	0x17	R			
0x02	0x18	R			
0x02	0x19	R	Button 2 Baseline	Store the unscaled button 2 baseline	0x000000
0x02	0x20	R			
0x02	0x21	R			
0x02	0x22	R	Button 3 Baseline	Store the unscaled button 3 baseline	0x000000
0x02	0x23	R			
0x02	0x24	R			
0x02	0x25	R	Button 4 Baseline	Store the unscaled button 4 baseline	0x000000
0x02	0x26	R			
0x02	0x27	R			
Available in all banks	0xF0	R/W	Active Bank	Store the current active bank value	0x00
	0xF1	R	Sensor Input Count	Return the count of sensor inputs	0x06
	0xF7	R	Product ID	Store a fixed value that identifies each product (Little Endian)	0x00000001
	0xF8	R			
	0xF9	R			
	0xFA	R			
	0xFB	R	Manufacture ID	Store a fixed value that identifies Microchip (Little Endian)	0x0001
	0xFC	R			
	0xFD	R	Build Number	Stores a fixed value that represents the build number	0x00
	0xFE	R	Minor Version	Stores a fixed value that represents the minor version number	0x00
	0xFF	R	Major Version	Stores a fixed value that represents the major version number	0x01

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TABLE 2-6: REGISTER DESCRIPTION

Register Name	Description
Touch State Mask	Bit 0 represents the touch state of proximity loop sensor, bit 1-5 represent the touch state of button 1-5, respectively. '0' means no touch, '1' means touch detected.
Proximity/Button Signal Deviation	This signal deviation register stores an 8-bit 2's compliment signed value to represent the sensor delta value, which then compares with threshold to determine if a touch has been detected.
Proximity/Button Threshold	The Proximity/Button Threshold registers store the signal deviation threshold that is used to determine if a touch has been detected.
Calibration State Mask	Bit 0 represents the calibration state of proximity loop sensor, bit1-5 represent the calibration state of touch button 1-5, respectively. '0' means calibration completed, '1' means calibration is in process. Write '1' to a bit in this register will force a calibration on the corresponding sensor.
Proximity/Button Scaling Factor	This register controls the sensitivity of proximity/touch detection. The smaller the value is, the more sensitivity the sensor gets. The range is from 0 to 15.
Reading Gain	This register controls the low pass filter gain for sensor reading. The range is from 0 to 3.
Baseline Gain	This register controls the low pass filter gain for sensor baseline. The range is from 0 to 3.
Reading Rate	This register value represents how many scan cycles before baseline update. The range is from 1 to 255.
Negative Delta Count	This register value determines how many consecutive negative signal deviation samples will trigger the baseline recalibration. The range is from 1 to 255.
Debounce	This register value determines how many consecutive signal deviation samples across the threshold will trigger the proximity/button touch event. The range is from 1 to 255.

Chapter 3. Work with mTouch® Dawn GUI

The mTouch Dawn GUI can be installed on a Windows-based computer with a USB port, in order to further evaluate the performance and features of the PIC16LF1559 touch solution. The MCP2221 board works as the I^2C host, polling data from the PIC16LF1559 evaluation board at a fixed time interval, communicating then with the Dawn GUI through USB communication.

3.1 DAWN GUI INSTALLATION

Download the "Dawn 1.0 setup.zip" file from Microchip website (http://www.microchip.com/DM160227/). Unzip the file and run Dawn 1.0 setup.exe program. Figure 3-1 shows the initial installation screen, which displays briefly as the setup program loads, and follows the GUI installation to finish the setup.

FIGURE 3-1: GUI INSTALLATION

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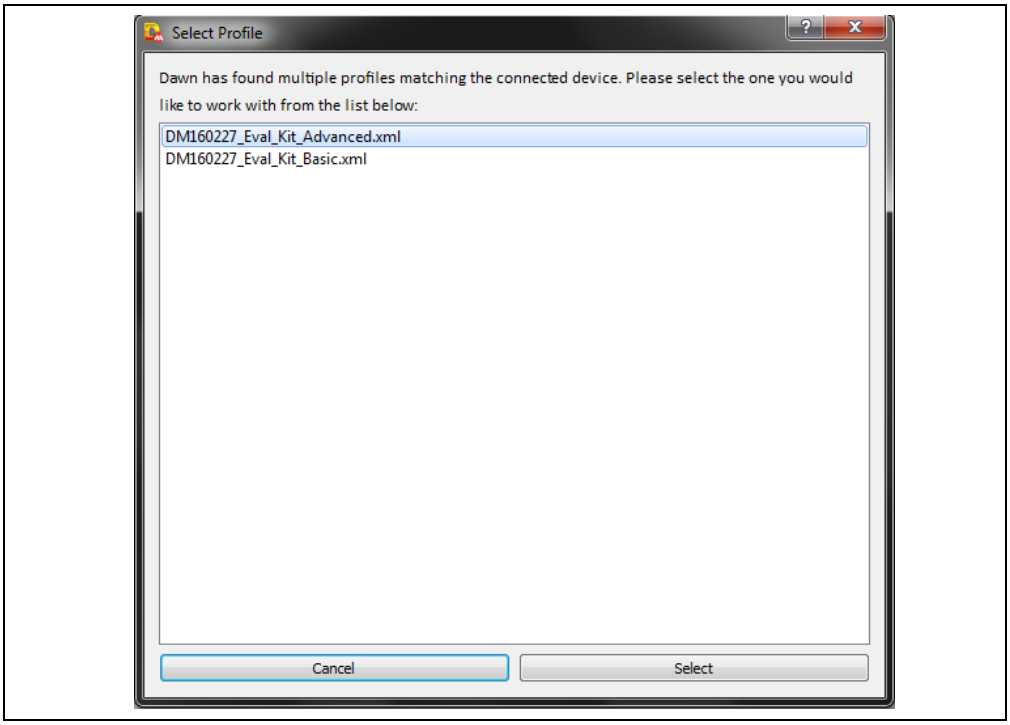
3.2 GUI OVERVIEW

Before opening the Dawn GUI, connect the evaluation kit to the PC via USB.

When the GUI is launched for the first time, a dialog window will show up to select the profile for this kit, as shown in Figure 3-2.

FIGURE 3-2: PROFILE SELECTION



There are two predefined profiles for this kit, which configures the registers that are displayed in the GUI. The “DM160227_Eval_Kit-Basic” configures the basic and mostly used registers, while the “DM160227_Eval_Kit_Advanced” displays all the mTouch registers.

The Dawn GUI contains five panels: Variable Control Panel, Signal Plotter Panel, Signal Level Panel, Signal Control Panel and Event Log Panel, as shown in Figure 3-3.

FIGURE 3-3: DAWN GUI

Variable Control Panel: Display system register value in text box at a fixed fresh rate, and also allow updating writable register values.

Signal Control Panel: Configure the register values that are displayed in Signal Plotter and Signal Level Panels.

Signal Plotter Panel: Display the register values configured in Signal Control Panel in the plot diagram fashion.

Signal Level Panel: Display the register values configured in Signal Control Panel in the bar diagram fashion.

Event Log Panel: Display the board, signals, and variables information.

More details on the GUI can be found in the mTouch Dawn GUI User's Guide.

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NOTES:

Appendix A. Low-Cost mTouch® Evaluation Board

FIGURE A-1: LOW-COST mTouch® EVALUATION BOARD SCHEMATIC

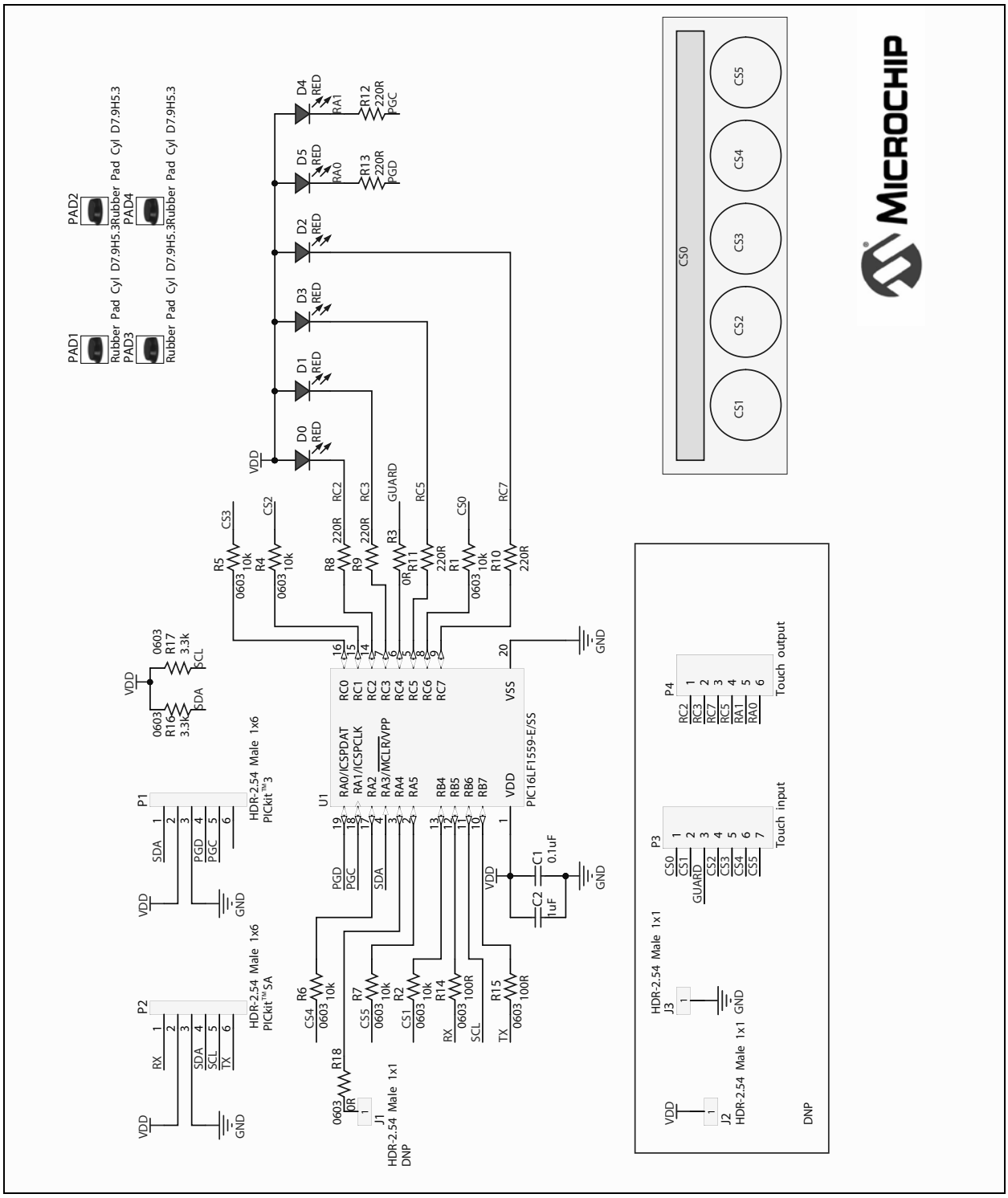

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FIGURE A-2: LOW-COST mTouch® EVALUATION BOARD LAYOUT (1 OF 2)

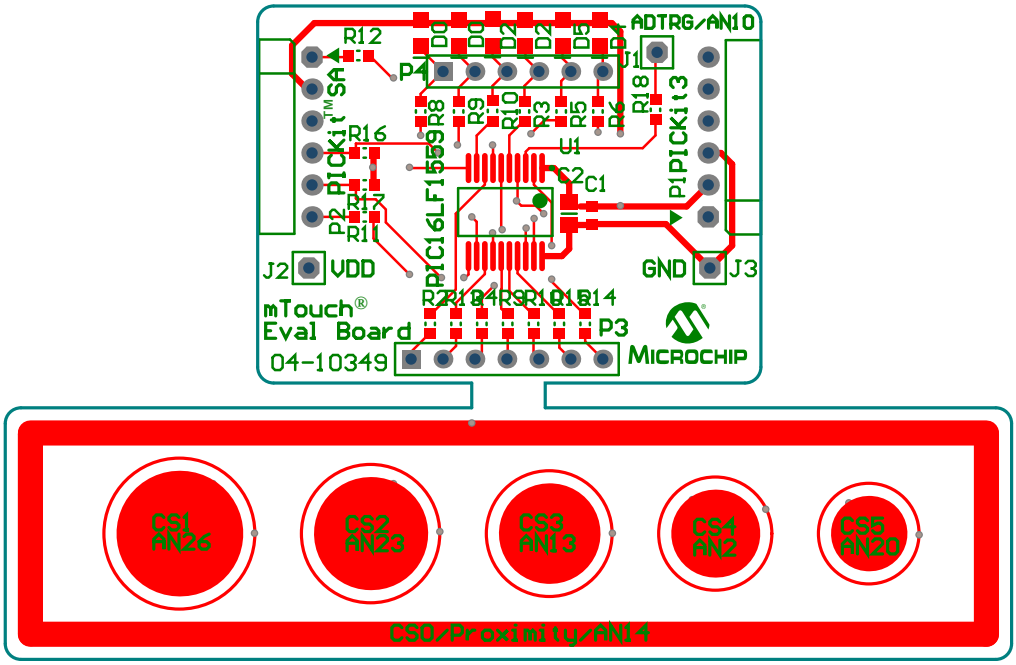
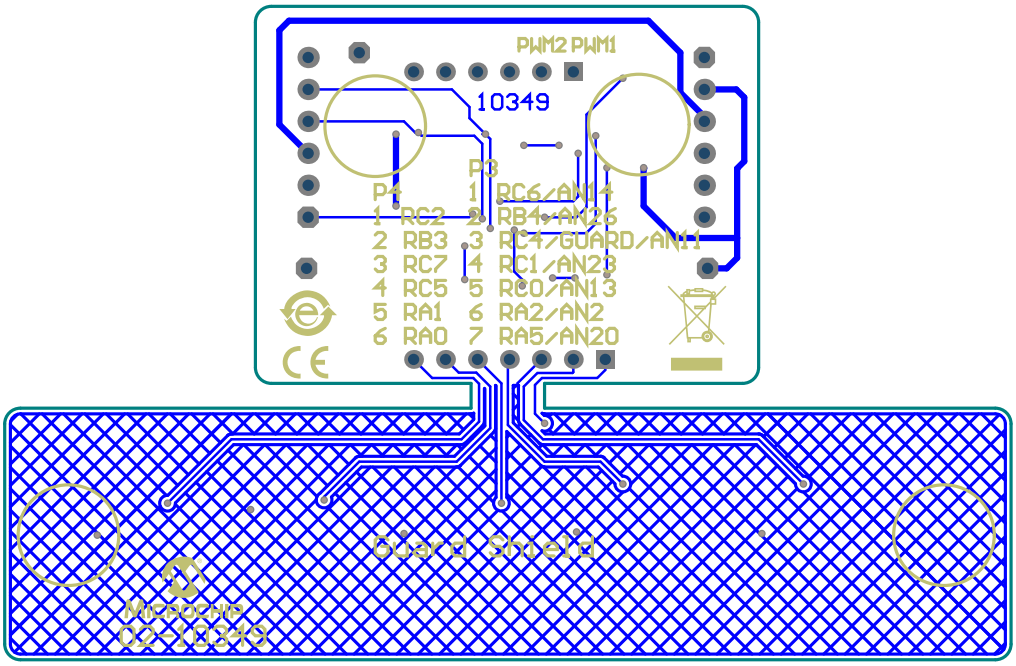


FIGURE A-3: LOW-COST mTouch® EVALUATION BOARD LAYOUT (2 OF 2)



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