Enhanced mTouch™ Capacitive Touch Evaluation Kit User's Guide

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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 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 you use an Enhanced mTouch™ Capacitive Touch Evaluation Kit. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use an Enhanced mTouch Capacitive Touch Evaluation Kit as a development and demonstrative tool for PIC16F, PIC18F, PIC24F, PIC24H and PIC32MX MCU device capabilities and features. The document layout is as follows:

- **Chapter 1. Introduction to the Evaluation Boards –** This chapter introduces the Enhanced mTouch Capacitive Touch Evaluation Kit and provides an overview of their features.
- **Chapter 2. Demonstration Application** – This chapter describes the preprogrammed capacitive touch sense demonstration application.
- **Chapter 3. Using the mTouch™ Sensing Solution** – This chapter describes the diagnostic software and how to use it with an Enhanced mTouch Capacitive Touch Evaluation Kit.
- **Chapter 4. "mTouch™ Sensing Solution GUI"** – This chapter describes how to setup and use the mTouch GUI with the PIC16F evaluation set.
- **Chapter 5. Evaluation Board Hardware** – This chapter provides a functional overview of the Enhanced mTouch Capacitive Touch Evaluation Kit and identifies the major hardware components.

- **Chapter 6. Troubleshooting** – This chapter provides troubleshooting tips for commonly encountered issues.
- **Appendix A. "Evaluation Board Schematics"** – This appendix provides detailed schematic diagrams of the evaluation boards.

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
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) { ... }`

WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles you to receive new product updates. Interim software releases are available at the Microchip web site.

RECOMMENDED READING

This user's guide describes how to use an Enhanced mTouch Capacitive Touch Evaluation Kit. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources. The latest documentation is available from the mTouch sensing solution web page (www.microchip.com/mtouch).

Readme Files

For the latest information on using other tools, read the tool-specific Readme files in the Readme subdirectory of the MPLAB® IDE installation directory. The Readme files contain update information and known issues that may not be included in this user's guide.

Family Reference Manual Sections

Family Reference Manual sections are available, which explain the operation of the PIC® microcontroller family architecture and peripheral modules. The specifics of each device family are discussed in the individual family's device data sheet.

Users are specifically directed to the **"Charge Time Measurement Unit (CTMU)"** Family Reference Manual sections for a detailed discussion of this module, which is at the heart of the capacitive touch sense demonstration. Please refer to the Microchip web site for the latest version of these documents.

Device Data Sheets and Flash Programming Specifications

Refer to the appropriate device data sheet for device-specific information and specifications. Also, refer to the appropriate device Flash Programming Specification for information on instruction sets and firmware development. These documents may be obtained from the Microchip web site or your local sales office.

16-bit MCU and DSC Programmer's Reference Manual (DS70157)

This manual is a software developer's reference for the 16-bit PIC24F and PIC24H MCU, and 16-bit dsPIC30F and dsPIC33F DSC families of devices. It describes the instruction set in detail and also provides general information to assist in developing software for these device families.

Note: Refer to *"MIPS32® Architecture for Programmers Volume II: The MIPS32® Instruction Set"* at www.mips.com for related information on PIC32 MCUs.

MPLAB® Assembler Linker and Utilities for PIC24 MCUs and dsPIC® DSCs User's Guide (DS51317)

This document details Microchip Technology's language tools for dsPIC® DSC devices based on GNU technology. The language tools discussed are:

- MPLAB Assembler PIC24 MCUs and dsPIC® DSCs
- MPLAB Linker PIC24 MCUs and dsPIC® DSCs
- MPLAB Archiver/Librarian PIC24 MCUs and dsPIC® DSCs
- Other Utilities

MPLAB® Assembler Linker and Utilities for PIC32 MCUs User's Guide (DS51833)

This document details Microchip Technology's language tools for PIC32 MCU devices based on GNU technology. The language tools discussed are:

- MPLAB Assembler PIC32 MCUs
- MPLAB Linker PIC32 MCUs
- MPLAB Archiver/Librarian PIC32 MCUs
- Other Utilities

HI-TECH C® for PIC10/12/16 User's Guide (DS51865)

This document details the use of Microchip's HI-TECH C Compiler for PIC10/12/16 MCUs, which is a free-standing, optimizing ANSI C compiler. It supports all PIC10, PIC12 and PIC16 series devices, as well as the PIC14000 device and the enhanced Mid-Range PIC® MCU architecture.

MPLAB® C Compiler for PIC18 MCUs User's Guide (DS51288)

This document details the use of Microchip's MPLAB C Compiler for PIC18 MCU devices to develop an application. The MPLAB C Compiler is a GNU-based language tool, based on source code from the Free Software Foundation (FSF). For more information about the FSF, see www.fsf.org.

MPLAB® C Compiler for PIC24 MCUs and dsPIC® DSCs User's Guide (DS51284)

This document details the use of Microchip's MPLAB C Compiler for PIC24 MCUs and dsPIC DSC devices to develop an application. The MPLAB C Compiler is a GNU-based language tool, based on source code from the Free Software Foundation (FSF). For more information about the FSF, see www.fsf.org.

MPLAB® C Compiler for PIC32 MCUs User's Guide (DS51686)

This document details the use of Microchip's MPLAB C Compiler for PIC32 MCU devices to develop an application. The MPLAB C Compiler is a GNU-based language tool, based on source code from the Free Software Foundation (FSF). For more information about the FSF, see www.fsf.org.

MPLAB® REAL ICE™ In-Circuit Emulator User's Guide (DS51616)

This document describes how to use the MPLAB REAL ICE in-circuit emulator as a development tool to emulate and debug firmware on a target board, as well as how to program devices.

MPLAB® IDE User's Guide (DS51519)

This document describes how to use the MPLAB IDE Integrated Development Environment, as well as the MPLAB project manager, MPLAB editor and MPLAB SIM simulator. Use these development tools to help you develop and debug application code.

Application Notes

There are several Application Notes available from Microchip that help in understanding capacitive touch applications. These include:

- AN1101 *"Introduction to Capacitive Sensing"*
- AN1102 *"Layout and Physical Design Guidelines for Capacitive Sensing"*
- AN1250 *"Microchip CTMU for Capacitive Touch Applications"*
- AN1298 *"Capacitive Touch Using Only an ADC ("CVD")"*
- AN1317 *"mTouch™ Conducted Noise Immunity Techniques for the CTMU"*
- AN1334 *"Techniques for Robust Touch Sensing Design"*

Microchip mTouch™ Sensing Solutions Webinars

Currently, there are three online Webinars available for mTouch Sensing Solutions:

- Introduction to mTouch™ Capacitive Touch Sensing
- Capacitive mTouch™ Sensing Solutions: Design Guidelines
- Overview of Charge Time Measurement Unit (CTMU)

THE MICROCHIP WEB SITE

Microchip provides online support through our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **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
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **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

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers and other language tools. These include the MPLAB C compiler; MPASM™ and MPLAB 16-bit assemblers; MPLINK™ and MPLAB 16-bit object linkers; and MPLIB™ and MPLAB 16-bit object librarians.
- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB ICE 2000, MPLAB ICE 4000, MPLAB REAL ICE.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 2, and MPLAB ICD 3.
- **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 SIM simulator, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the PICSTART® Plus and PICkit™ 1, 2 and 3 development programmers.

CUSTOMER SUPPORT

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 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 our web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (April 2009)

- Initial Release of this Document

Revision B (September 2009)

- Added reference to PIC18F MCU
- Added PIC18F CTMU Evaluation Board Schematic
- Added PIC18F Block Diagram for the CTMU Board
- Modified the Kit Contents list

Revision C (June 2010)

This version of the document includes the following updates:

- Added references to PIC24H and PIC32MX MCUs throughout the document
- Modified the Kit Contents list
- Added the PIC32 CVD Touch Evaluation Board
- Added block diagrams for the PIC24H CVD and PIC32 CVD Evaluation Boards
- Updated PIC16F CSM/CVD Evaluation Board schematic and layout

Revision D (August 2011)

- Removed references to CSM
- Added references to new CVD Eval Board
- Replaced "CVD/CSM schematic" with "CVD schematic"
- Updated all references to CVD/CSM, to CVD only
- Changed document's title from **mTouch™ Advanced Capacitive Evaluation Kits User's Guide** to **Enhanced mTouch™ Capacitive Touch Evaluation Kit**

NOTES:

Chapter 1. Introduction to the Evaluation Boards

Thank you for purchasing a Microchip Technology Enhanced mTouch Capacitive Touch Evaluation Kit. Depending on the kit purchased, up to four individual evaluation boards are provided. These evaluation boards are intended to introduce and demonstrate the possibilities for capacitive touch sense applications on the PIC16F, PIC18F, PIC24F and PIC32MX (DM183026-2 kit), PIC24H (AC243026 kit) microcontroller platforms.

Note: This Evaluation Kit is intended as a functional evaluation of Microchip's mTouch Capacitive Sensing Solutions. It has not been designed for use in noisy or production-level testing environments. Please refer to Microchip Application Notes for guidelines when attempting to design a product to be used or deployed in such environments.

This chapter introduces the evaluation kits and provides an overview of their features. Topics covered include:

- Overview
- Operational Requirements
- Initial Board Setup

1.1 OVERVIEW

The mTouch Capacitive Touch Evaluation Kits provide a simple platform for developing a variety of capacitive touch sense applications. Depending on the kit purchased, up to four evaluation boards are included with PIC16F, PIC18F, PIC24F, PIC24H and PIC32MX microcontrollers, with four sensor daughter boards, as shown in Figure 1-1 and Figure 1-2.

These evaluation kits are intended to be used to develop a capacitive touch sense application using Microchip's mTouch sensing solution technologies. A kit is used by first connecting a sensor board, and then supplying power to the board via USB, PICkit™ 3 or the PICkit Serial Analyzer. The connector, J3/J4, with numbers from 0 to 15, is the connector for sensing channels. The numbers; from 0 to 13 for PIC16F, from 0 to 12 for PIC18F, and from 0 to 15 for PIC24F/PIC24H/PIC32MX represent the microcontroller's sensing channels. The vertical 2-row header is for debugging, to give easy access to some of the microcontroller pins. Debugging may also be done by Microchip programmers and the I^2C™ or USB is used to communicate with the mTouch diagnostic tool.

When using an evaluation kit out of the box, the default function of the LEDs is to illuminate on a key press. All functionalities may be reprogrammed by using a Microchip programmer and reprogramming the firmware in the device. The firmware supplied with the evaluation kit is optimized to use with the four sensor boards supplied.

The USB connection supplies power to the board; no additional external power supply is needed. For independent operation, the evaluation board may be disconnected from the PC and powered at test points. For the PIC18F, PIC24F and PIC32MX Evaluation Boards, the USB also provides communications with the MPLAB mTouch Diagnostic Tool. The PIC16F and PIC24H Evaluation Boards use the PICkit™ Serial Analyzer to communicate via I^2C and ASYNC to the PC. The MPLAB mTouch application allows

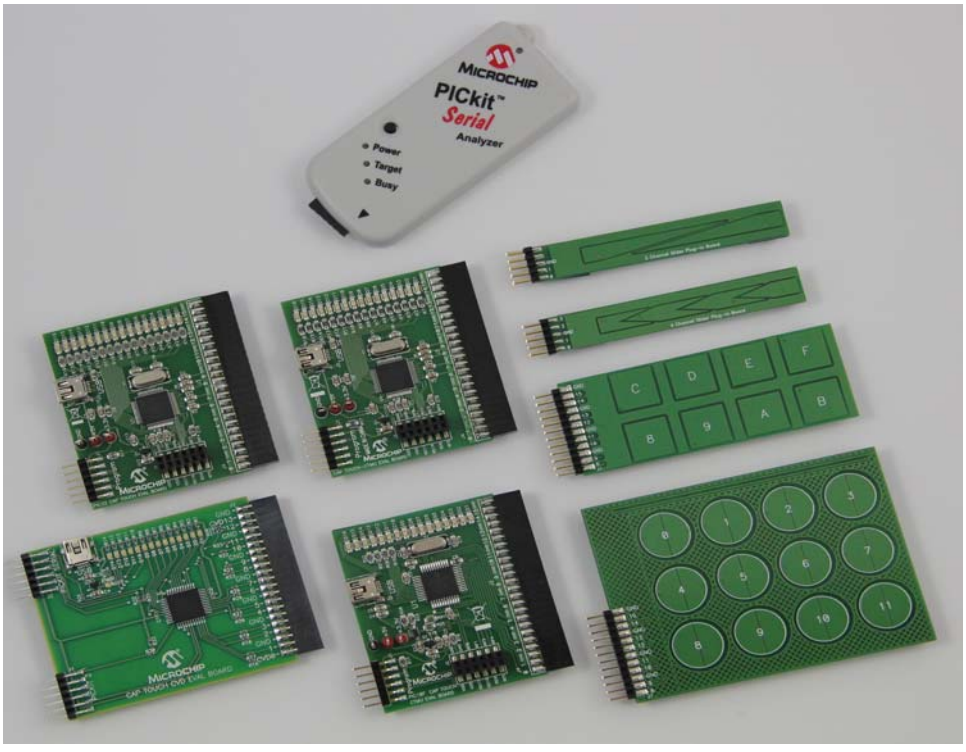
users to monitor the performance of the touch sensors and to optimize the sensor response. A separate, 6-wire programming interface allows users to replace the preprogrammed demonstration firmware with their own applications using Microchip's MPLAB® Integrated Development Environment (IDE) and In-Circuit Serial Programming™ (ICSP™). This allows the board to also be used as a test platform for capacitive touch sense applications.

1.1.1 mTouch Capacitive Touch Evaluation Kit Contents

The mTouch Capacitive Touch Evaluation Kit (DM183026-2) contains the following items:

- PIC16F CVD Evaluation Board
- PIC18F CTMU Evaluation Board
- PIC24F CTMU Evaluation Board
- PIC32MX CVD Evaluation Board
- 12-Key Matrix Sensor Daughter Board
- 4-Channel Slider Sensor Daughter Board
- 2-Channel Slider Sensor Daughter Board
- 8-Key Direct Sensor Daughter Board
- PICkit Serial Analyzer
- USB Cable

FIGURE 1-1: mTouch™ CAPACITIVE TOUCH EVALUATION KIT CONTENTS



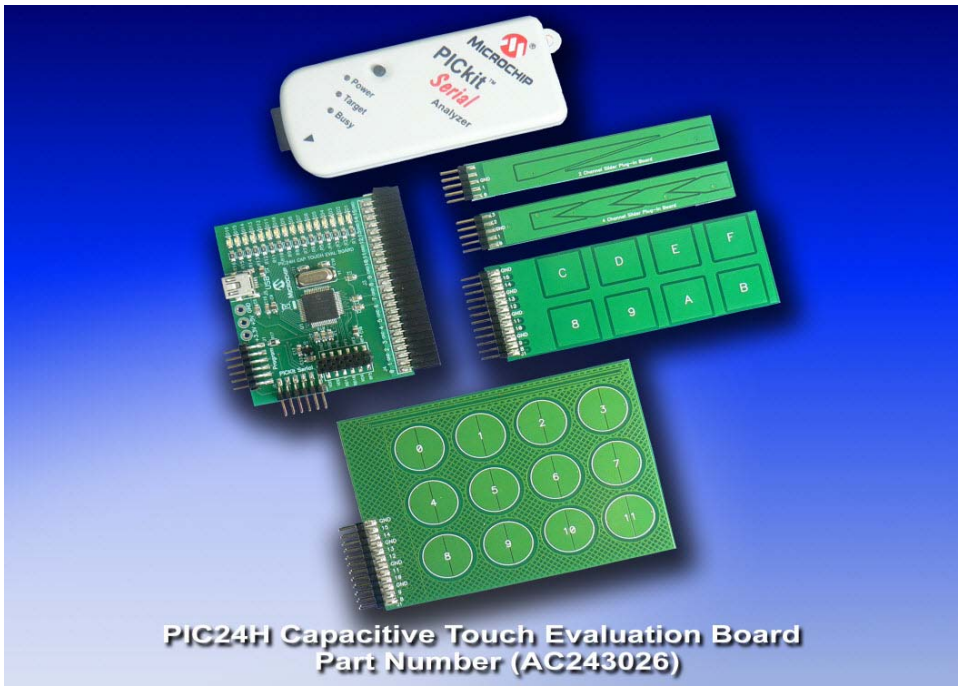
1.1.2 PIC24H Capacitive Touch Evaluation Kit Contents

The PIC24H Capacitive Touch Evaluation Kit (AC243026) contains the following items:

- PIC24H CVD Evaluation Board
- 8-Key Direct Sensor Board

- 12-Key Matrix Sensor Board
- 4-Channel Slider Sensor Board
- 2-Channel Slider Sensor Board
- PICkit Serial Analyzer
- USB Cable

FIGURE 1-2: PIC24H CAPACITIVE TOUCH EVALUATION KIT CONTENTS



1.2 OPERATIONAL REQUIREMENTS

To communicate with, and to program an evaluation board, the following hardware and software requirements must be met:

- PC-compatible system with a CD-ROM drive
- One available USB port on the PC or a powered USB hub
- Microsoft® Windows® XP SP2, Windows 7, or Windows Vista (32-bit)

1.3 INITIAL BOARD SETUP

With its pre-installed demonstration application, the evaluation board is designed to be used straight out of the box. Except for a single connection to a computer, no additional hardware or configuration is necessary.

1.3.1 Installing the Software

Before connecting the evaluation board to any computer for the first time, it is important to install the PC software found on the accompanying CD first. This ensures that the proper USB drivers for communicating with the evaluation board are installed and ready to recognize the board.

To install the software and driver, insert the evaluation kit CD into the CD-ROM drive. The installation process starts automatically. The process pauses for user responses to accept the Microchip software licenses, and to confirm the installation directories; you must accept the license to use the software.

1.3.2 Connecting the Hardware

Prior to connection, place the evaluation board on a flat surface near the computer. Check to make sure that there are no objects underneath the board. Once the evaluation kit software is installed, connect the provided USB cable (A to mini-B) to any available USB port on the PC or powered hub, and then to the board at the mini-B receptacle. The PC USB connection provides power to the board.

The PIC24F and PIC18F CTMU and PIC32MX Capacitive Voltage Divider (CVD) Evaluation Boards use the USB connection to power-up the boards and also to communicate with the mTouch diagnostic tool. The PIC16F and PIC24H (CVD) Evaluation Boards use the PICkit Serial Analyzer to communicate to the PC. Connect the USB cable to the PICkit Serial Analyzer, and connect it to the J2 connector on the board and the PC's USB port. The default code uses the 8-button board.

When connecting the PIC24F and PIC18F CTMU and PIC32MX CVD boards, a sequence of pop-up messages should appear in the system tray (lower right of the desktop), stating that (1) new hardware has been found, (2) drivers are being installed and (3) the new hardware is ready for use. If you do not see these messages and the evaluation board does not work, try unplugging and reconnecting the USB cable. If this does not work, see **Chapter 6. "Troubleshooting"**.

Chapter 2. Demonstration Application

This chapter describes the touch sense application that is preprogrammed on the PIC16F, PIC18F, PIC24F, PIC24H and PIC32MX microcontrollers, and its general principles of operation. Topics included in this chapter are:

- Introduction to the Touch Interface
- Individual Touch Sense Demonstrations

2.1 INTRODUCTION TO THE TOUCH INTERFACE

For PIC16F, PIC24H, and PIC32MX MCUs, touch sensing is achieved using a technique known as the Capacitive Voltage Divider (CVD), which makes use of the ADC module. This technique is based on successive charging/discharging cycles for sample and hold capacitance and conversely, sensor plus finger capacitance, which basically creates a voltage divider. For details, refer to application note, AN1298 *"Capacitive Touch Using Only an ADC ("CVD")."*

Control of the touch sense features is built on the PIC18F and PIC24F microcontrollers' on-chip Charge Time Measurement Unit (CTMU) module. The CTMU consists of a constant current source that charges each touch circuit to a voltage level. When any additional capacitance is added to the circuit (from the touch of a fingertip, for example), the fixed current source will now charge the circuit to a lower voltage. This change is how the microcontroller detects a touch event. For detailed information on the CTMU module, please refer to the related **"Charge Time Measurement Unit (CTMU)"** Family Reference Manual sections, which are available from the Microchip web site.

The microcontrollers use the CTMU or CVD to monitor its input channels, which are in turn, connected to capacitive touch pad sensors on the top layer of the circuit board.

The evaluation board has four different sensor demonstration boards:

- 8-Key Direct Plug-in Daughter Board
- 12-Key Matrix Plug-in Daughter Board
- 2-Channel Slider Plug-in Daughter Board
- 4-Channel Slider Plug-in Daughter Board

A more detailed description of evaluation board operation is provided in **Chapter 5. "Evaluation Board Hardware"**.

2.1.1 Touch Sensitivity

The response of the sensor to fingertip touch is influenced by many factors: touch areas, voltage and current levels, ambient humidity, static buildup, and so on. The capacitive touch sensing is done by a relative shift in the capacitance due to the addition of the finger capacitance to the touch sensor. The demonstration code supplied takes most of the typical environmental factors into consideration. The demonstration application is very flexible in the sense that it can be modified by the user.

The PC-side application accompanying the Enhanced mTouch Capacitive Touch Evaluation Kit can be used to change the sensitivity of the sensors by writing trip point information back to the board.

2.1.2 Sensor Persistence

By design, the demonstration application is designed to respond to a state change event on any sensor. More simply, they respond to a touch, and not to a touch and release. This behavior, along with the firmware's slow averaging algorithm that accounts for constant changes in the evaluation board's environment, causes a continuous touch on one or more sensors to yield an affirmative response for a few seconds, followed eventually by no response at all. Removing the touch stimulus from the sensor resets the algorithm and restores the sensor's responsiveness.

2.2 INDIVIDUAL TOUCH SENSE DEMONSTRATIONS

2.2.1 8-Key Direct Plug-in Daughter Board

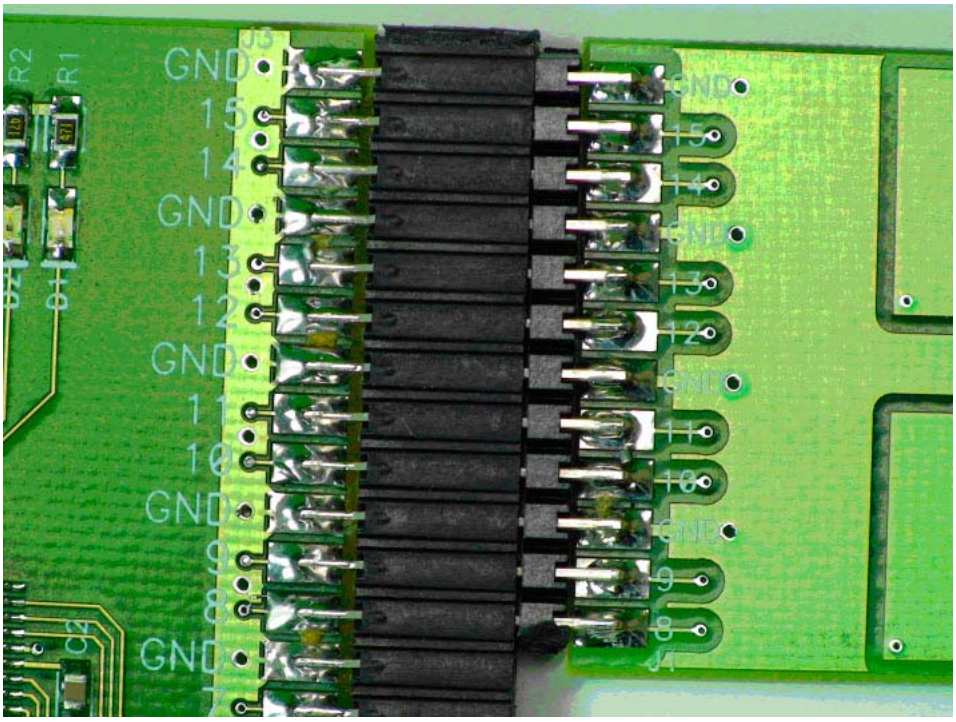
The Direct Key Plug-in daughter board is an 8-channel plug-in board with one key directly mapped to one channel. This can be interfaced with any of the 8 channels of the 16 channels provided in the mTouch Capacitive Evaluation Kit. Touching any one of the keys on the plug-in board will light up the corresponding LED in the evaluation board.

The LEDs, D8 to D15 of the evaluation board, correspond to the direct keys numbered from '8' to 'F', respectively, in the Direct Key Plug-in daughter board.

The default firmware loaded in the mTouch Capacitive Evaluation Kit is configured for channels 8 to 15 in the PIC24F CTMU, PIC24H CVD and PIC32MX CVD Evaluation Boards, and channels 0 to 7 in the PIC18F CTMU and PIC16F CVD Evaluation Boards.

When the key numbered '8' is pressed, the LED D8 will be lit. Similarly, when keys '9' through 'F' are pressed, the LEDs, D9 through D15, will be lit. Here, one LED will be lit for every press key on the plug-in board (see Figure 2-1).

FIGURE 2-1: DEFAULT PLUG-IN CHANNELS FOR 8-KEY PLUG-IN BOARD



2.2.2 12-Key Matrix Plug-in Daughter Board

The Matrix Key Plug-in daughter board is an array of 12 touch-sensitive keys arranged in a 4x3 matrix. Touching any one of the keys will light up one of the LEDs. Here, the Matrix Key Plug-in daughter board is numbered, 0 to 11, which corresponds to LEDs D1 to D12, respectively.

The default firmware loaded in the mTouch Capacitive Evaluation Kit for the Matrix Key Plug-in daughter board is configured for channels 8 to 14 in PIC24F CTMU, PIC24H CVD and PIC32MX CVD Evaluation Boards, channels 6 to 12 in PIC18F CTMU, and 0 to 7 in the PIC16F Evaluation Boards.

When the key numbered ‘0’ is pressed, the LED D1 will be lit. Similarly, when the keys numbered ‘1’ to ‘11’ are pressed, the LEDs D2 through D12 will be lit, respectively. Here, one LED will be lit for every press of the key on the plug-in board.

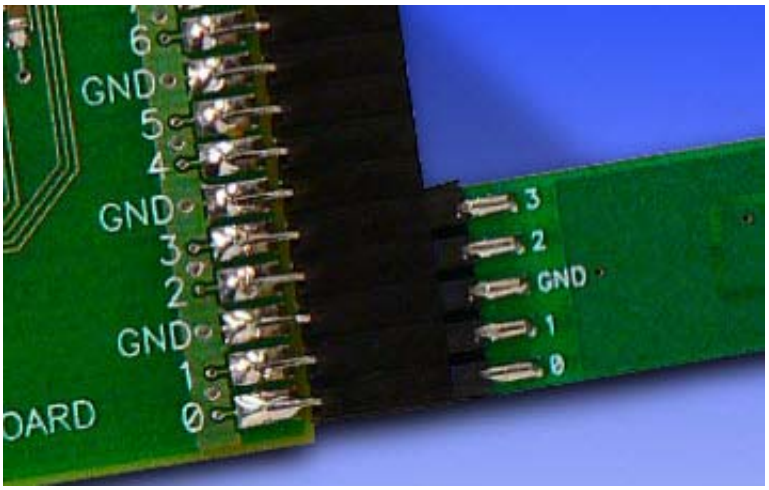
2.2.3 2-Channel and 4-Channel Slider Plug-in Daughter Board

Touching anywhere along the length of the slider causes all the LEDs to light up as a bar graph that is representative to the position of the touch. The LED bar graph follows the finger as it moves up and down along the length of the slider, and remains at the last position on the slider when the finger is removed.

The default firmware for the 2-Channel Slider Plug-in, loaded in the evaluation kit, is configured such that, channels 0 and 1 of connector J4/J3 in the evaluation kit are connected to the 2-Channel Slider Plug-in daughter board.

The default firmware for the 4-Channel Slider Plug-in, loaded in the evaluation kit, is configured such that, channels 0, 1, 2 and 3 of connector J4/J3 in the main evaluation board are connected to the 4 channels in the 4-Channel Slider Plug-in daughter board (see Figure 2-2).

FIGURE 2-2: DEFAULT PLUG-IN CHANNELS FOR 4-CHANNEL SLIDER PLUG-IN BOARD



Note 1:	The plug-in boards can be interfaced to any of the channels in the evaluation kit by changing the configuration settings. The details of the configuration settings are explained in the `Readme.txt` file, which is distributed in each demonstration.
2:	Plugging a sensor board in while an evaluation board is running, may require resetting the touch algorithm, most easily done by cycling power.

FIGURE 2-3: PLUG IN THE SENSORS BEFORE POWERING BOARD

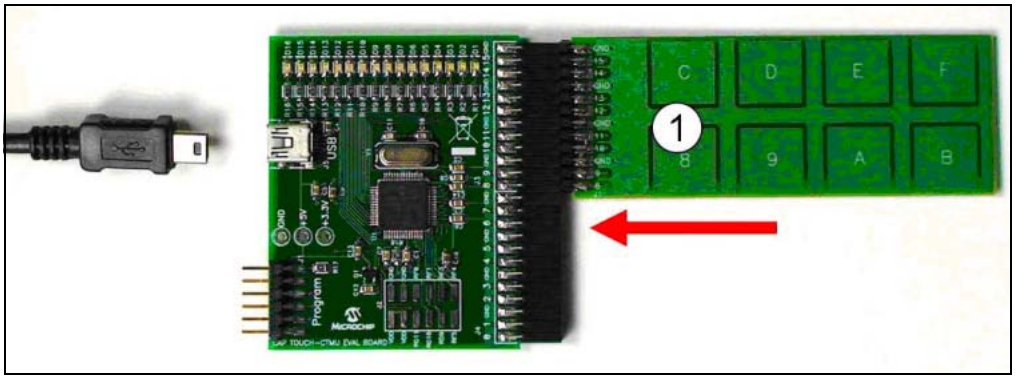
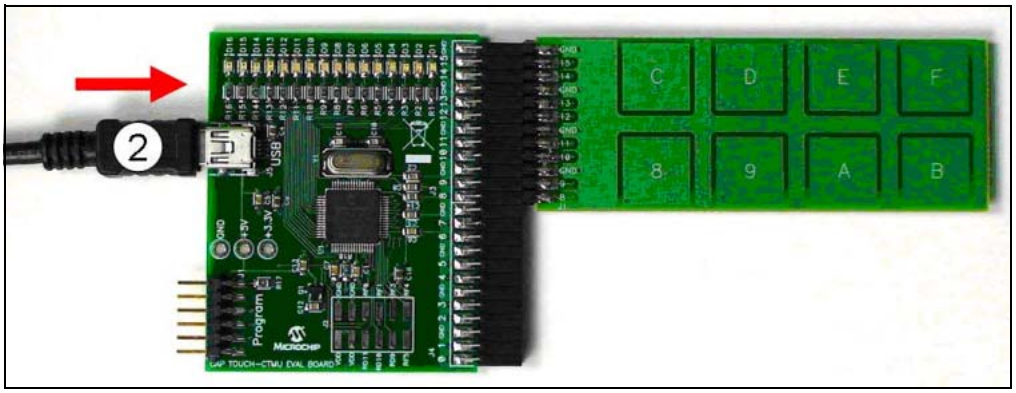


FIGURE 2-4: PLUG IN POWER AFTER SYSTEM IS CONFIGURED



Chapter 3. Using the mTouch™ Sensing Solution

This chapter describes the Graphical User Interface (GUI) diagnostic tool, mTouch™ sensing solution, that accompanies the evaluation boards in the mTouch Capacitive Evaluation Kits, and how it can be used in developing and troubleshooting touch sense applications. Topics include:

- About the mTouch Sensing Solution Diagnostic Tool
- MPLAB IDE integrated mTouch Diagnostic Tool GUI

3.1 ABOUT THE mTouch SENSING SOLUTION DIAGNOSTIC TOOL

The mTouch sensing solution is a multi-purpose application that has been designed for use with many of Microchip's touch sense demonstrations. The software provides a useful tool for viewing, adjusting and debugging various aspects of the demonstration software preloaded on the evaluation boards. The mTouch sensing solution can also be used for developing customized applications.

Initially, the diagnostic tool was developed as a stand-alone GUI and later was integrated into the MPLAB IDE. This version works for the PIC18F, PIC24F, PIC24H and PIC32 Evaluation Boards. The PIC16F CVD Evaluation Board uses a new stand-alone GUI configured for higher speed communications through the PICkit™ Serial Adaptor.

The following sections describes the MPLAB IDE integrated mTouch Diagnostic Tool GUI. These sections also list the embedded firmware that are successfully tested on this platform.

The last section described the new stand-alone GUI in use with the PIC16F Evaluation Board.

The operation of the mTouch sensing solution described here is specific to its use with the evaluation boards. For use with other Microchip applications, refer to the application-specific user's guide.

3.2 MPLAB IDE INTEGRATED mTouch DIAGNOSTIC TOOL GUI

This section describes the MPLAB IDE integrated mTouch Diagnostic Tool GUI features.

The following firmware items from the mTouch Capacitive Evaluation Kit (DM183026) were tested using this GUI:

- PIC16F CVD Evaluation Board
- PIC18F CTMU Evaluation Board
- PIC24F CTMU Evaluation Board
- PIC32MX CVD Evaluation Board

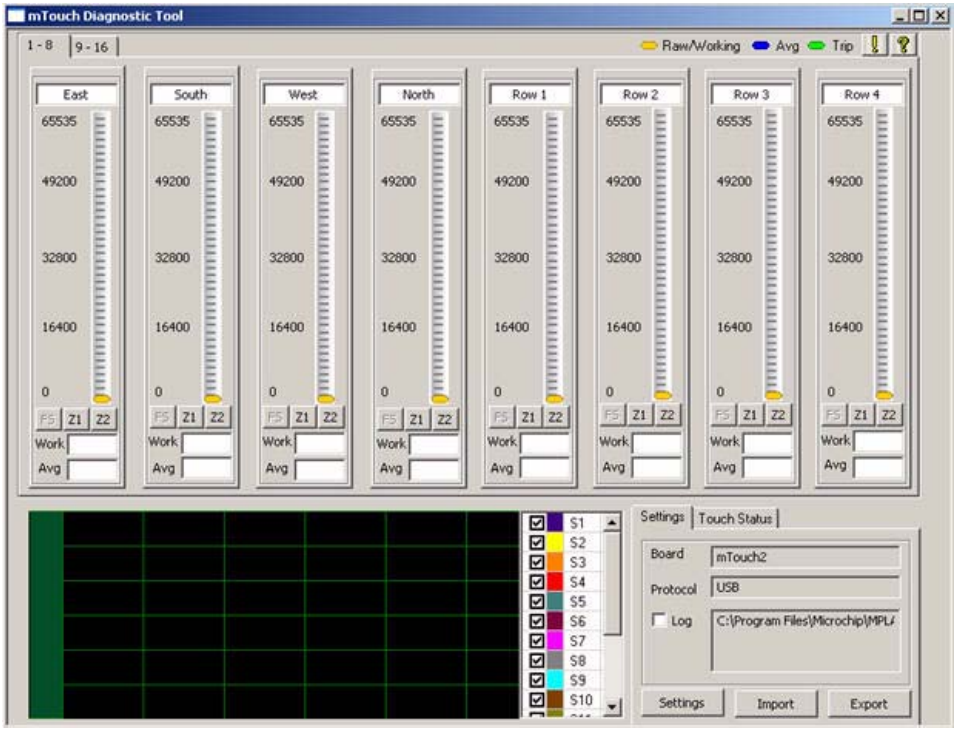
The firmware for the PIC24H CVD Evaluation Board was also tested using this GUI.

3.2.1 USING THE MPLAB IDE INTEGRATED mTouch DIAGNOSTIC TOOL GUI

Before starting the mTouch sensing solution diagnostic tool, ensure that the evaluation board is connected to a USB port on a personal computer (or a USB hub connected to the computer) and that the evaluation board is operating normally.

To start the mTouch Diagnostic Tool, select the homonymous item from *MPLAB>Tools*. The GUI child window launches, as shown in Figure 3-1.

FIGURE 3-1: THE mTouch™ SENSING SOLUTION AT START-UP (MPLAB® IDE)



At the bottom left of the mTouch Diagnostic Tool window is the histogram window, which is used to display the status of the individual sensors or channels selected for the hardware and subsystem. On the right side of this graph there are multiple sensor selection checkboxes. Select the appropriate sensor number so that unused ones are removed from the resulting histogram.

On the bottom right there is the status and settings sections of this GUI – which contains two tabs – **Settings** and **Touch Status**. The **Touch Status** tab enable visualization of the pressed button with the specific board shape as selected in the **Settings** tab.

Click the **Settings** button in the **Settings** tab to display the window, as shown in Figure 3-2.

FIGURE 3-2: THE mTouch™ DIAGNOSTIC TOOL – BOARD SETTINGS (MPLAB® IDE)

The Settings window contains the possible setup for the hardware and subsystem selected – contained in 3 tabs: **Board**, **Communication** and **Logging**.

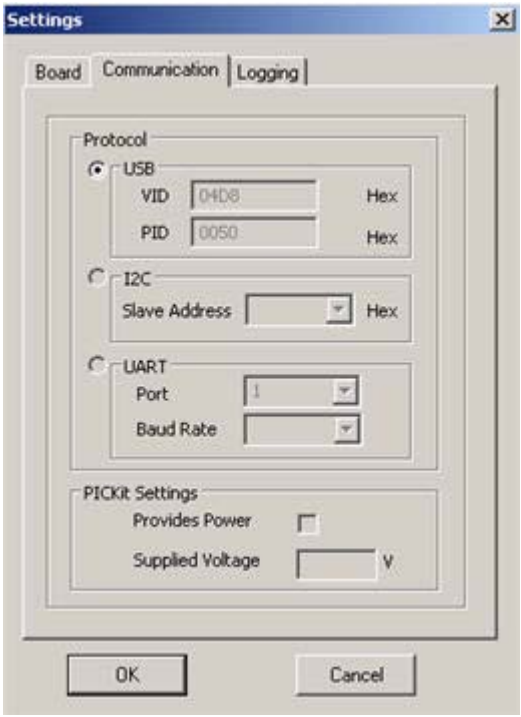
The **Board** tab contains:

- **Select Board drop-down box:** By default mTouch2 board is selected. Other options in the drop-down box includes mTouch 1 and 2 hardware, the mTouch Evaluation Kit hardware and the Custom board.
- **Area of the Board:** This contains the options for selecting the shape/type of the sensed buttons.
- **Custom board:** This selects the number of sensor disposed on board.
- **Trip section**: Select the ''GUI Value'', when values for trip level for each sensor are calibrated online from the host, or select ''Firmware Value'' if the value for trip is contained in firmware. Trip Firmware Value is provided by the evaluation board's firmware, using an algorithm that calculates the optimum trip values based on the average value. These values are sent to the mTouch Diagnose Tool through the USB/I2C/UART connection, and are constantly updated and displayed on the bar graphs; this is enabled by default. When selecting GUI Values, the trip levels are calibrated from the host and sent to the embedded firmware by USB/I2C/UART, which takes them into account for internal calculations.

The **Communication** tab as shown in Figure 3-3 contains:

- **Protocol selection section**: This contains settings for USB (VID and PID selection), I^2C (Slave Address) and UART (Port and Baud Rate). Choose one option only by selecting the appropriate radio button.
- **PICkit™ Serial Setting:** This contains the options – Provides Power and Supplied Voltage.

FIGURE 3-3: THE mTouch™ DIAGNOSTIC TOOL – COMMUNICATION SETTINGS (MPLAB® IDE)



The **Logging** tab, as shown in Figure 3-4, includes the settings typical for logging data such as data contained by the log, destination file and data delimiter.

FIGURE 3-4: THE mTouch™ DIAGNOSTIC TOOL -– LOGGING SETTINGS (MPLAB® IDE)

Click **OK** to close the Settings window and to display the setup in the **Settings** tab. To actually use the logging, check the Log checkbox in the **Settings** tab (the setup made previously will be used for logging).

The upper part of the mTouch Diagnostic Tool window contains the status display for each of the sensors in form of a bar graph. Above each bar graph display is an indicator; this lights up (changes to light green) when the software detects a touch event. The bar graph shows the sensor's current state in terms of the A/D conversion value of its channel. Values shown may be in the range of 0 to 65,535 and are dimensionless.

Each bar graph has the following information:

- A constantly moving orange vertical bar that indicates the instantaneous conversion value
- A blue horizontal indicator across the bar that indicates the moving average of the touch sensor
- A green horizontal indicator that shows the trip level that the touch channel must reach to become pressed or activated
- The average and raw conversion values, displayed numerically at the bottom of the bar graph

A color key for the indicators is provided at the top of the mTouch Diagnostic Tool window.

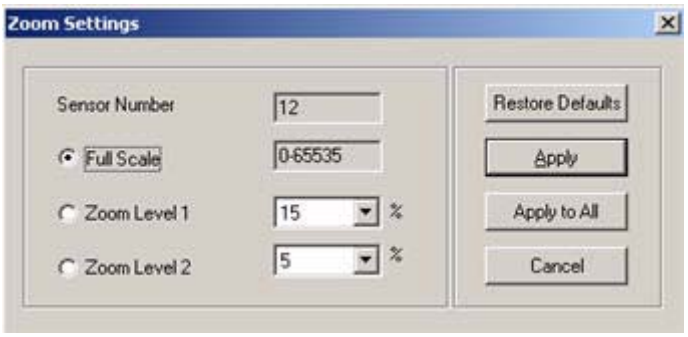
The A/D converter produces values of up to 4096 (12 bits). The evaluation board contains software algorithms that use scaled values of the raw A/D reading to improve averaging and overall performance of the hardware.

Right click on the bar graph for each sensor to display menu options: Display Data, Zoom Settings and Sensor Settings.

FIGURE 3-5: THE mTouch™ DIAGNOSTIC TOOL – DISPLAY DATA SETTINGS (MPLAB® IDE)

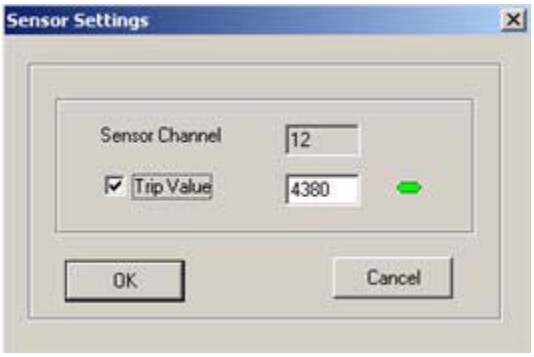
Selecting the Display Data option will display a Display Data dialog containing the settings for data visualization, as shown in Figure 3-5. The Data Type can be selected between ‘’Raw’’ and ‘’Working’’ where Raw data represents working data values divided by 16. The Display Data settings can be applied to the sensor selected or to all sensors.

FIGURE 3-6: THE mTouch™ DIAGNOSTIC TOOL – ZOOM SETTINGS (MPLAB® IDE)



Select the Zoom Settings option to display the Zoom Settings dialog, as shown in Figure 3-6. This enables settings for zooming in the bar graph. There are two available zoom levels, which once set can be easily accessed from the GUI main window by pressing the corresponding shortcut buttons situated at the bottom of each bar graph (Z1, Z2). As for Display Data settings, there is a possibility to set the setup zoom levels for the current sensor or for all sensors at once.

FIGURE 3-7: THE mTouch™ DIAGNOSTIC TOOL – SENSOR SETTINGS (MPLAB® IDE)



Select the Sensor Setting option to select the trip level from which a button can be indicated as pressed. The ''Trip Value'' can only be set if Trip GUI value is selected in the Settings window, if not, the error "*Trip Value Can't be Set!, Change Settings to GUI Trip*" is displayed.

Chapter 4. mTouch™ Sensing Solution GUI

4.1 OVERVIEW

The mTouch™ sensing solution GUI v1.0 is a Microsoft Windows application that collects information from an mTouch evaluation board, running the Microchip mTouch™ sensing solution CVD Framework for PIC16F v1.x, and then graphically displays it on a PC.

It can manage mTouch boards with up to 12 buttons (referred to as sensors in the PIC16F CVD framework). For each sensor, the application displays:

- Its status waveform allowing to graphically and continuously track any changes affecting a particular sensor, including transitions, noise, etc.
- Its state, using a graphic LED, allowing to show when a button is in the "Pressed" or "Released" state. The GUI window shows a set of 4 colored buttons per page, in order to track any change in the button states.
- The instantaneous raw value for each sensor as they are generated (calculated) by the mTouch board running the CVD framework.
- The minimum and maximum value for each sensor, since the application start (or the last Min/Max reset).

For debug purposes, the mTouch sensing solution GUI application also allows logging of all raw data it receives to a readable text file. Each sample is precisely dated before it is recorded. This feature builds a framework behavior history, allowing to precisely analyze what exactly happened over a long period of time.

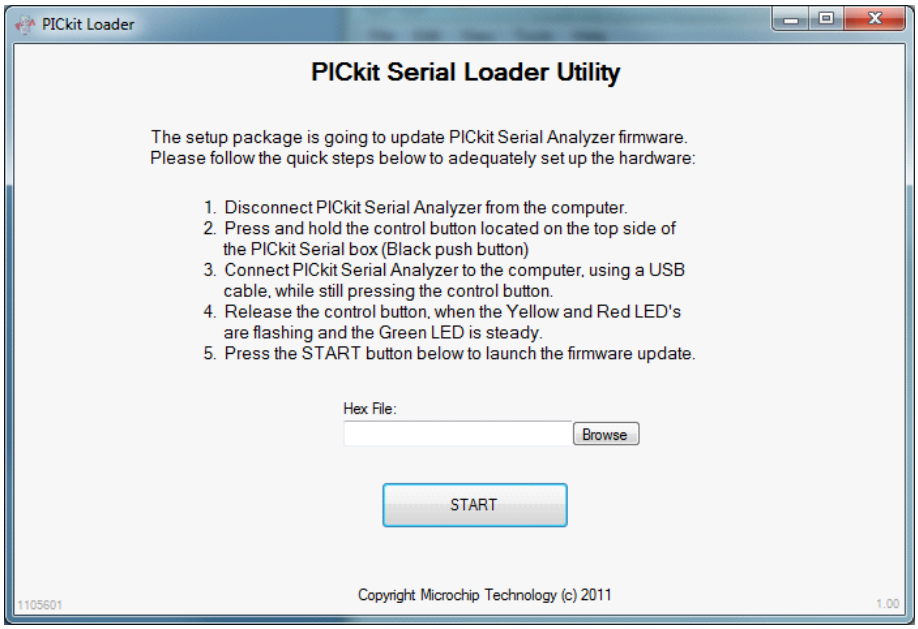
4.2 SETTING UP THE GUI FOR PROPER OPERATION:

4.2.1 Configuring the Hardware:

The Enhanced mTouch™ Capacitive Touch Evaluation Kit includes a PICkit Serial Analyzer unit, allowing to route USART communication in and out of the Capacitive Touch CVD Evaluation Board, from/to a PC through a USB connector. The mTouch™ sensing solution GUI uses standard COM-based communication. The PICkit Serial Analyzer unit comes pre-programmed with code performing native Windows USB communication (Human Interface Device mode). This unit needs to be re-programmed, so Windows uses it as a COM-Device (Communication Device Class mode).

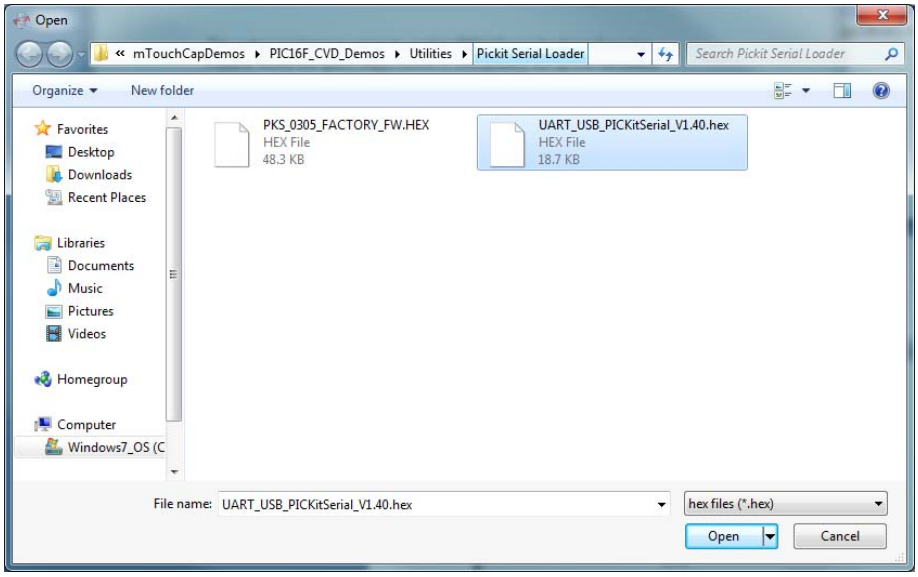
After installing the Microchip Application Libraries (http://www.microchip.com/MAL/), go to the Microchip Group in the Start Menu, then run *\mTouchCap Library vx.xx\PIC16F CVD Framework\Pickit Serial Loader Utility*. You should get the following window (Figure 4-1):

FIGURE 4-1: PICkit SERIAL LOADER UTILITY



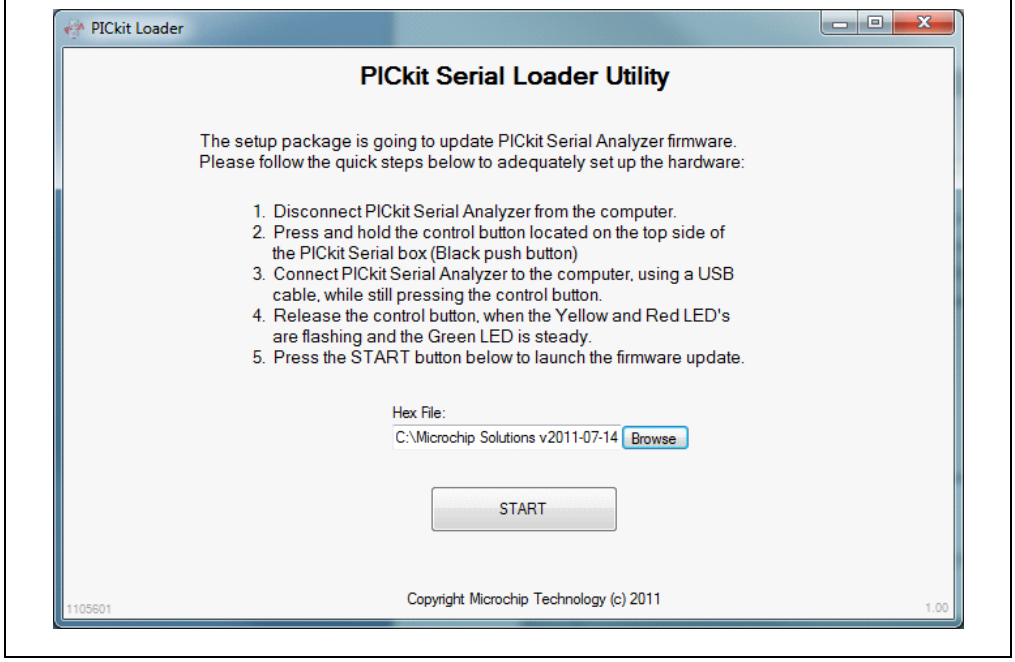
Follow the on-screen instructions to prepare the PICkit Serial Analyzer for programming, then click the Browse button and select the code file as shown below (Figure 4-2):

FIGURE 4-2: LOADING THE FIRMWARE



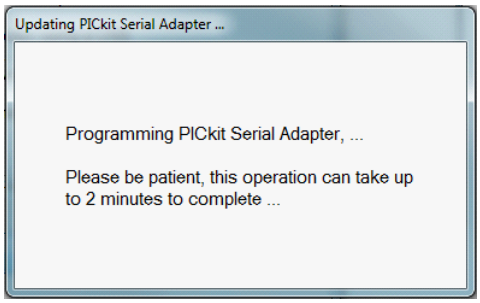
Click Open, the following window should be displayed (Figure 4-3). Click START:

FIGURE 4-3: STARTING PICkit SERIAL UPDATE



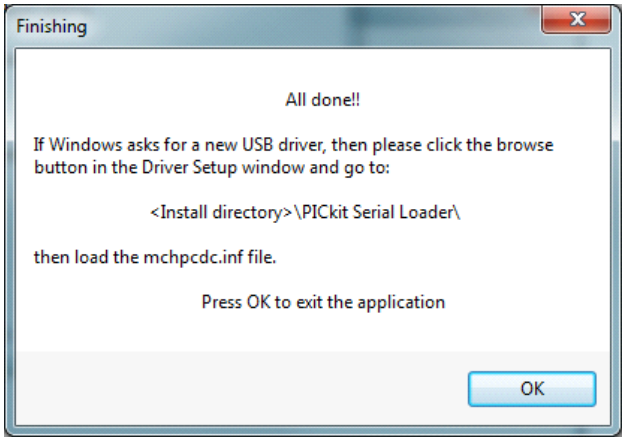
The following window will be displayed (Figure 4-4):

FIGURE 4-4: PROGRAMMING STATUS



Just be patient, until the following window is displayed (Figure 4-5):

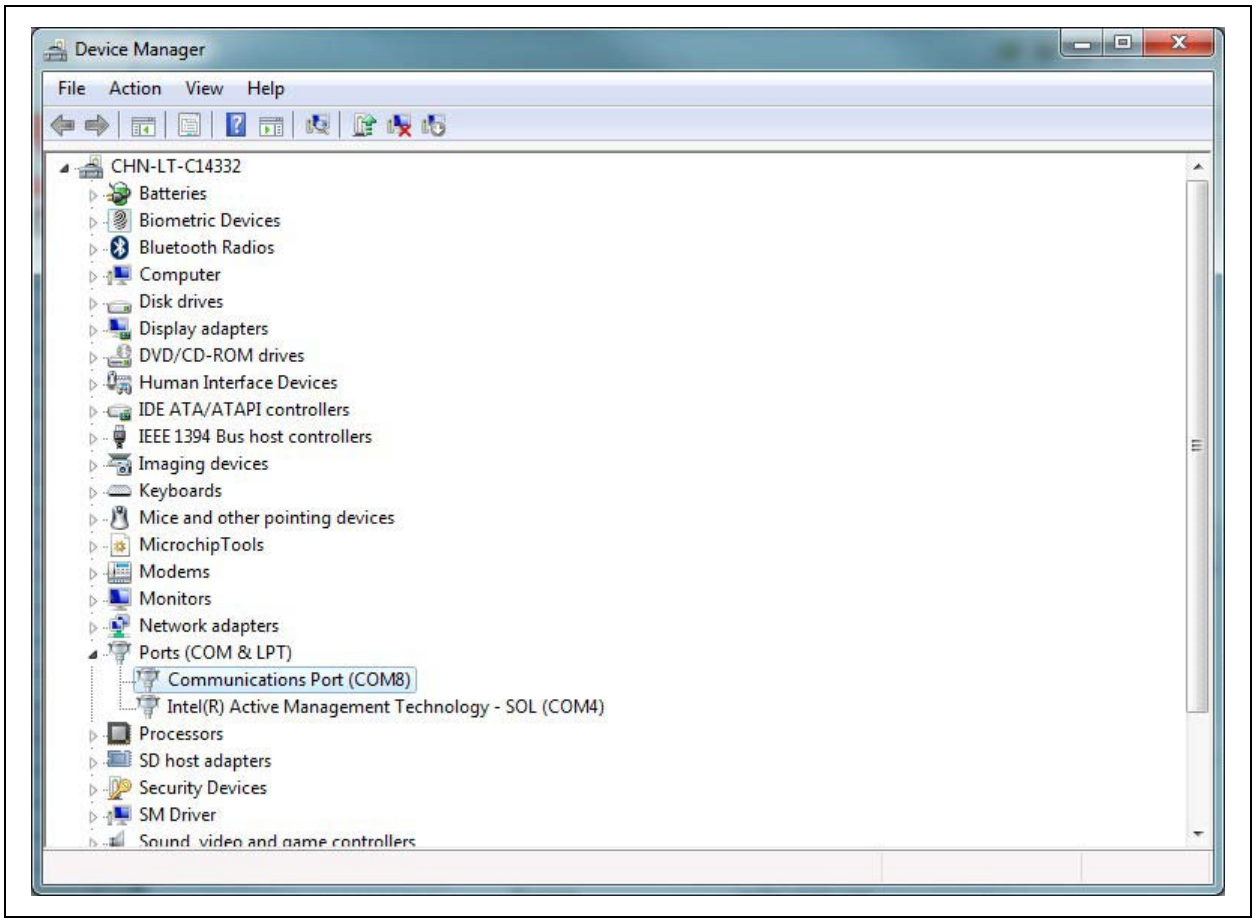
FIGURE 4-5: SUCCESSFUL PROGRAMMING NOTIFICATION



4.2.2 Configuring the Software

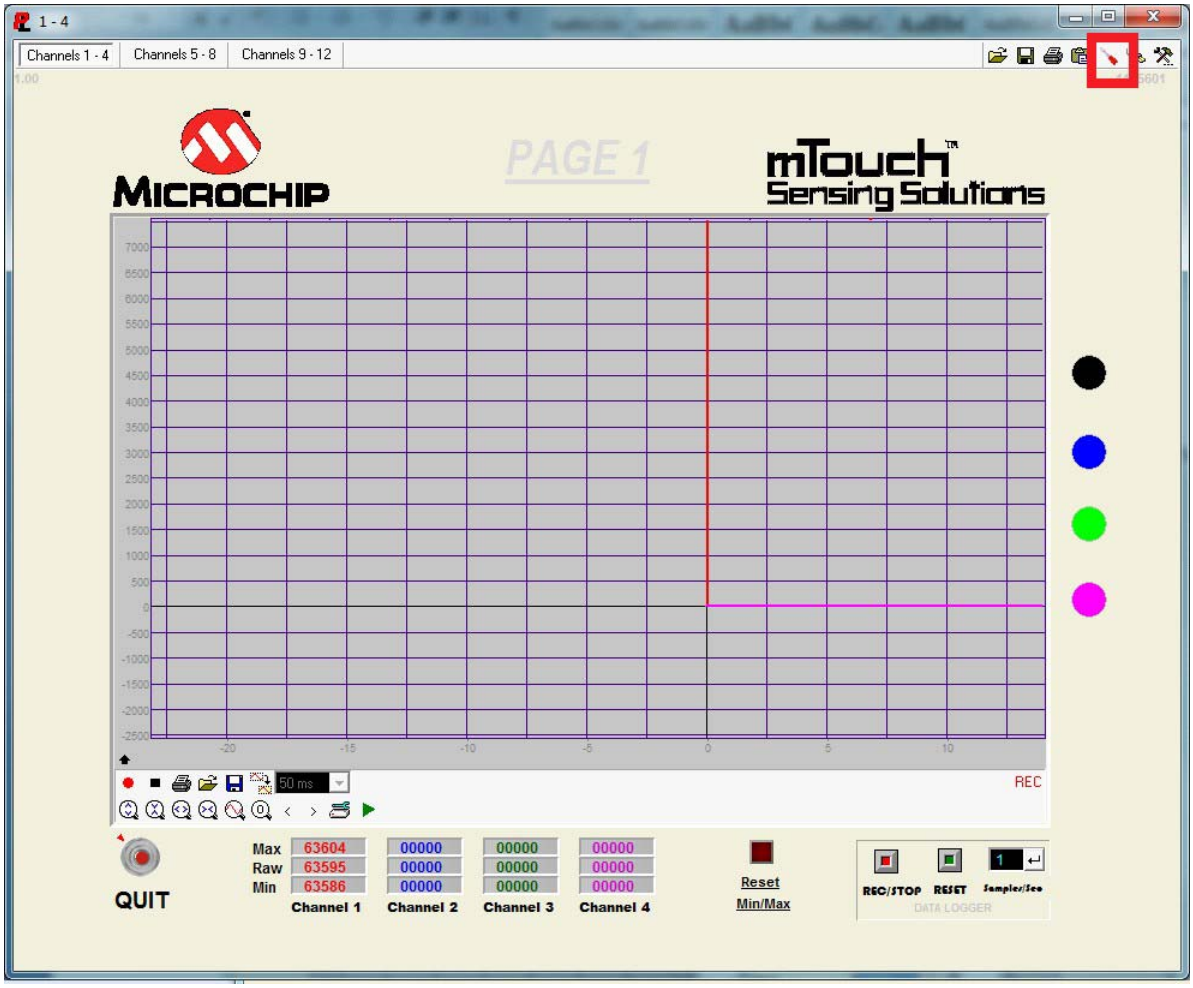
The mTouch sensing solution GUI uses standard asynchronous UART/USART communication. In the Windows environment, it uses a standard COM port. Knowing what COM port the serial communication is using is the first thing that needs to be determined. To do so, open up the Windows Device Manager, and then, in the "Ports (COM & LPT)" group, check what COM port number the communication is using (Figure 4-6):

FIGURE 4-6: CHECKING THE COM PORT NUMBER



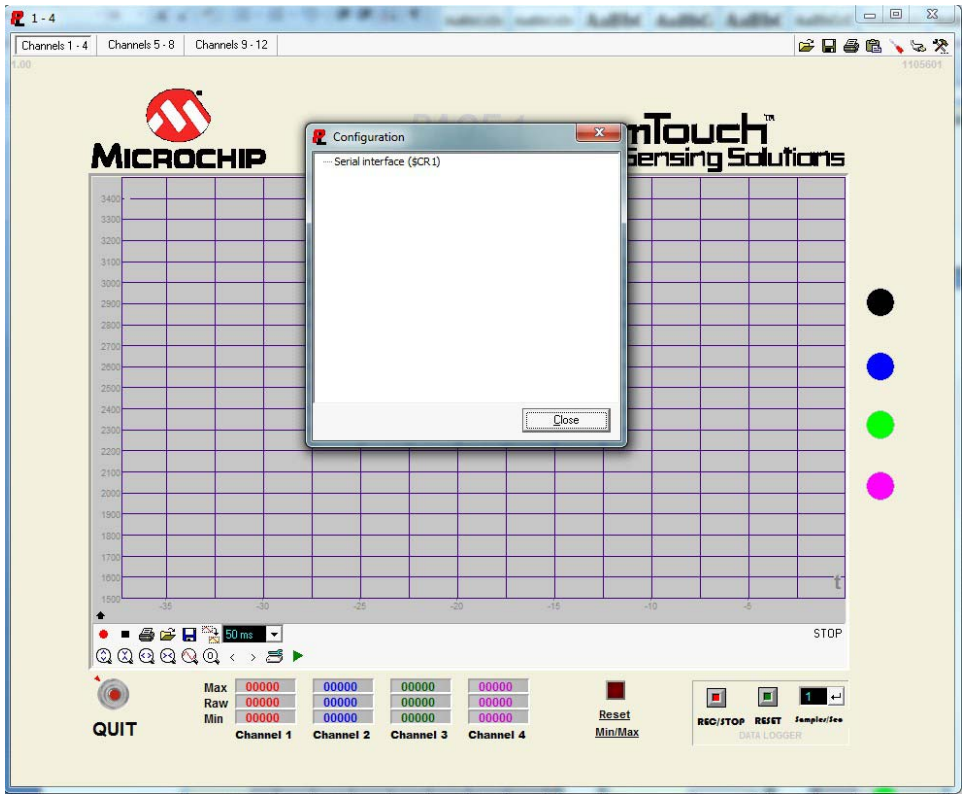
Once the COM port number is known, go to the GUI and click the red and white screwdriver icon at the top right hand corner of the Main window (Figure 4-7).

FIGURE 4-7: OPENING THE COM PORT CONFIGURATION WINDOW



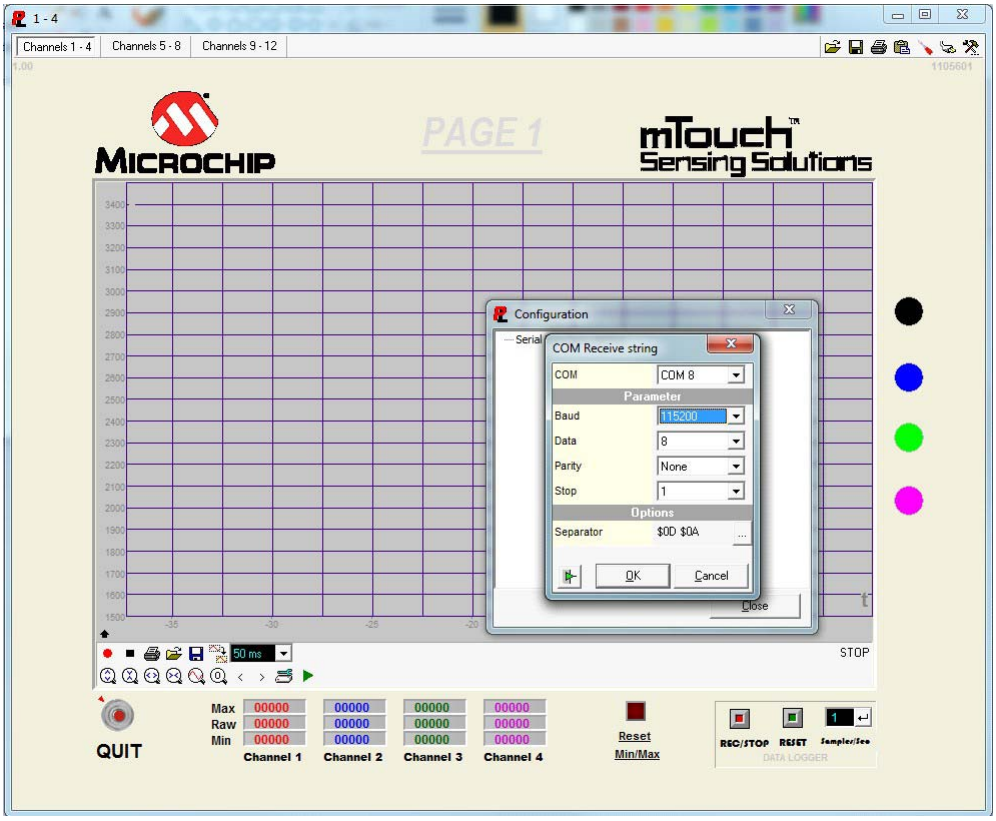
This will open up a small window with the following configuration options (Figure 4-8):

FIGURE 4-8: SELECTING THE SERIAL COM PORT



Double-click the "Serial Interface ($CR1)" option and the following windows will be displayed (Figure 4-9):

FIGURE 4-9: SETTING UP THE COMMUNICATION PARAMETERS

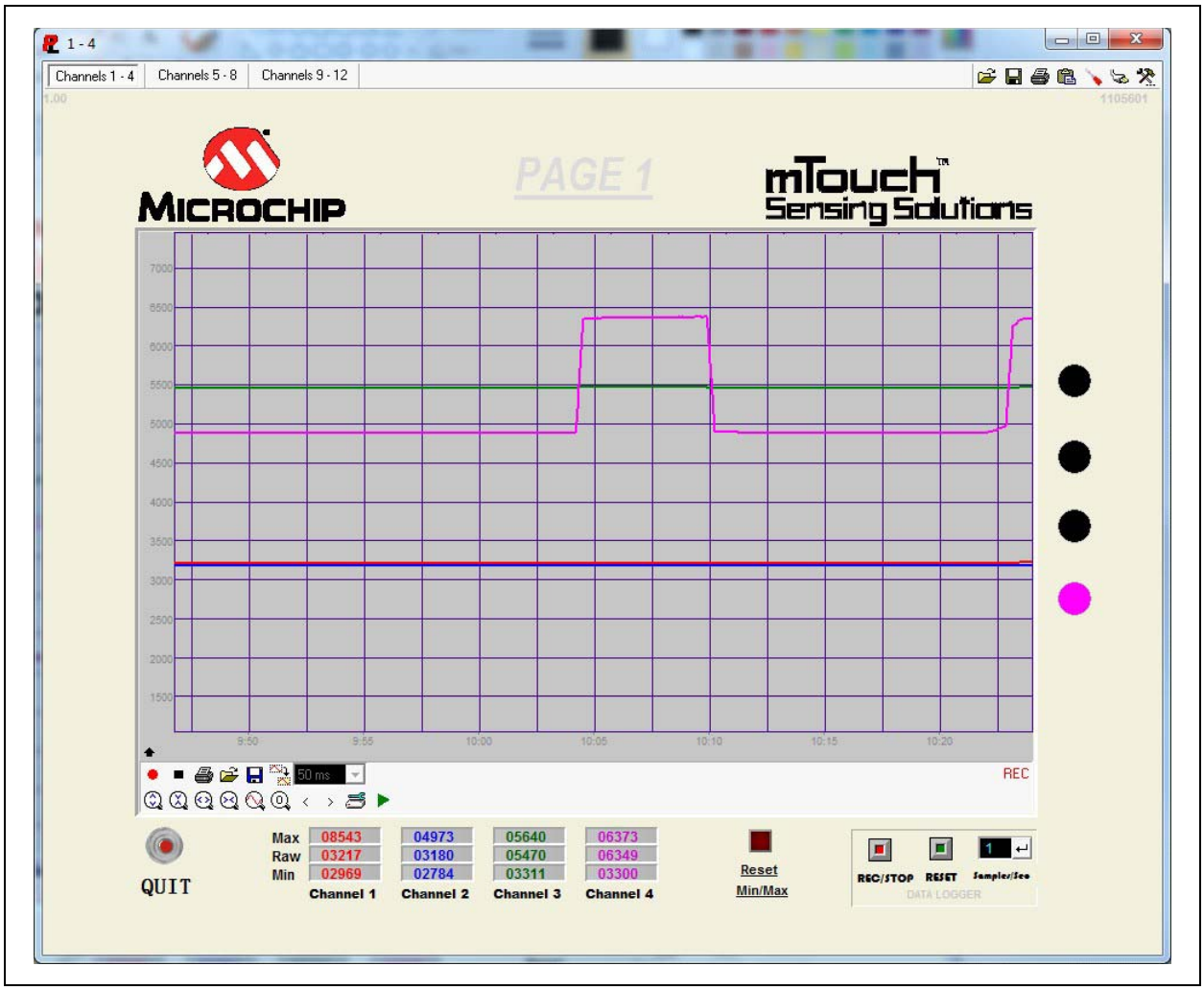


In the COM combo box, select the port number already found in the Windows Device Manager. Set all other options as shown, and click OK and Close.

If the mTouch™ application is already running and properly connected, you should start getting the button readings, which will immediately update the graphs on the plotter in the Main window, as well as the raw readings, and Min and Max for each channel or sensor.

If you start touching the buttons, you should easily find the ones mapped to Buttons 1 to 4 and immediately see the corresponding LEDs on the display, reflecting any change to each button state. The graphs on the plotter should also reflect any change made to the corresponding 4 buttons, as shown in the picture below (Figure 4-10):

FIGURE 4-10: CHECKING THAT THE COM PORT IS FUNCTIONAL



4.3 SETTING UP THE GRAPH PLOTTER:

In the center of the GUI Main window, a graph plotter allows to track in real time all the changes affecting the mTouch™ sensors, including displaying noise levels on these individual sensors.

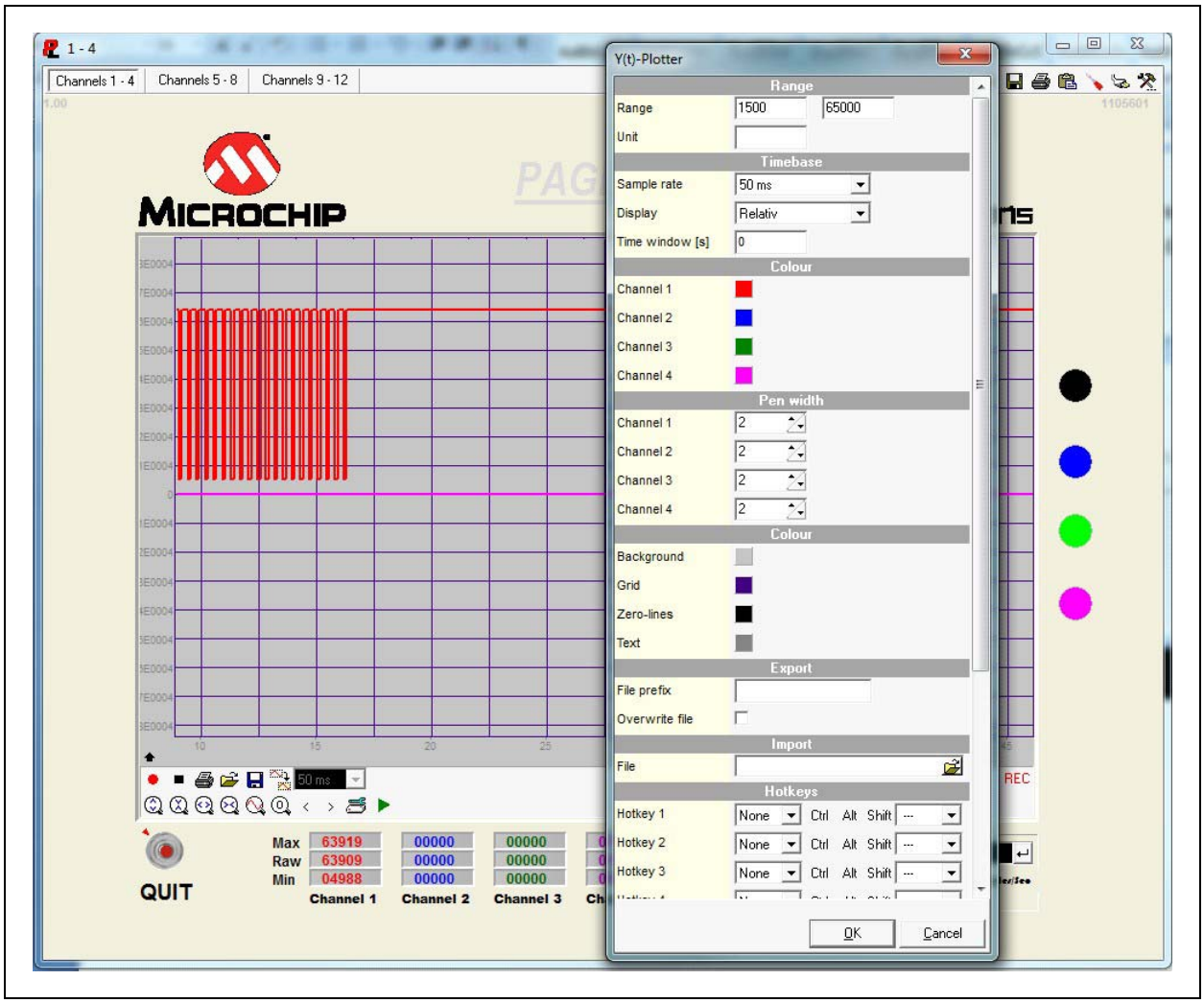
Showing the graphs requires two conditions:

- Scale the plotter to the correct range of values the CVD application sends to the GUI
- Set the correct reference on the plotter to the minimum value of the reading (scroll up or down the plotter window to have the minimum value at the bottom of the window).

One last parameter that can be adjusted is how fast the samples are plotted. The immediate effect of the display rate modification will be a faster or slower horizontal scroll of the graphs.

To zoom in or out of the displayed graphs, right-click on any area of the plotter window, and choose Settings in the floating menu. Then select a new range by entering two values (Min and Max) in Edit window labeled Range, as shown (Figure 4-11):

FIGURE 4-11: CONFIGURING THE GRAPH PLOTTER

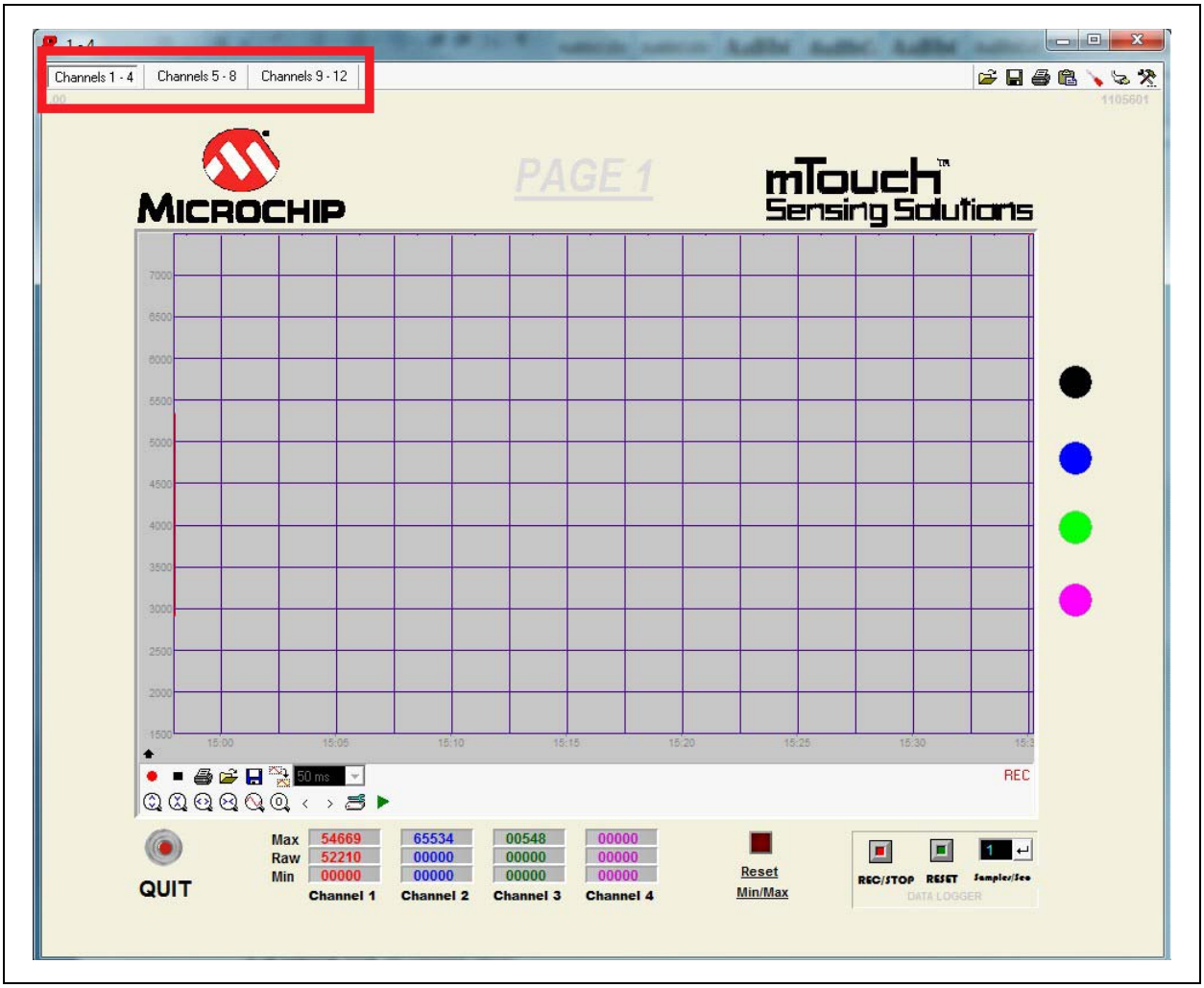


4.4 USING THE mTouch GUI:

4.4.1 Navigating Through all the Sensors:

The mTouch™ sensing solution GUI can manage up to 12 sensors simultaneously, but only 4 sensor data is displayed at a time. Displaying the data for sensor 5 and above requires moving to new pages. This is done by clicking the different tab buttons, located at the top-left corner of the GUI window, as shown below (Figure 4-12):

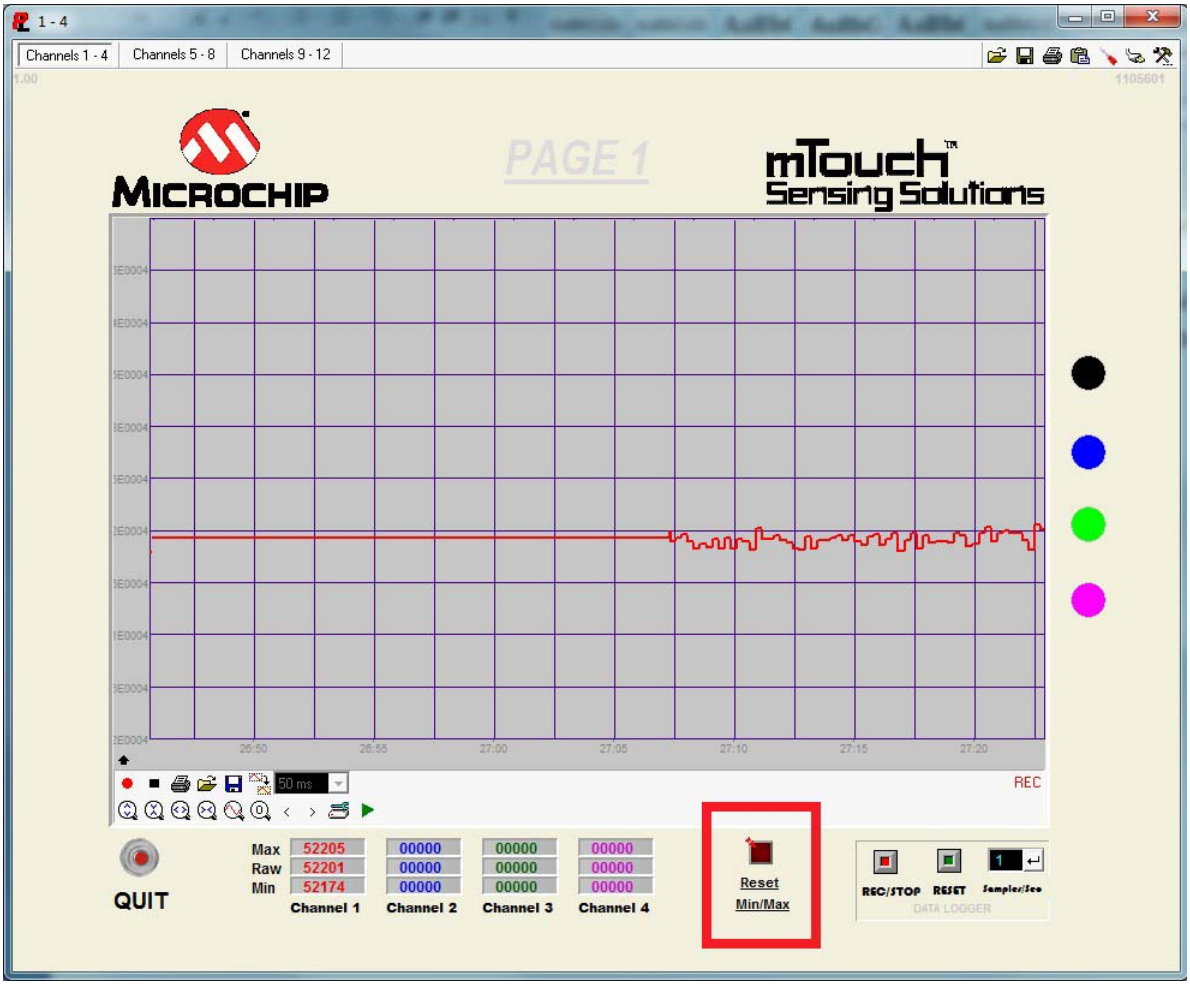
FIGURE 4-12: SELECTING A NEW PLOTTER PAGE



4.4.2 Minimum and Maximum Values of Readings

The mTouch™ sensing solution GUI monitors all the samples for each sensor. It keeps track of the smallest and greatest values per channel. The user can reset these values at any time, forcing the application to memorize new values. These parameters are specially useful when scaling the view, so the graphs fall between these two values. To reset the Min and Max for all sensors, just click the highlighted button shown below (Figure 4-13):

FIGURE 4-13: RESETTING MIN AND MAX VALUES



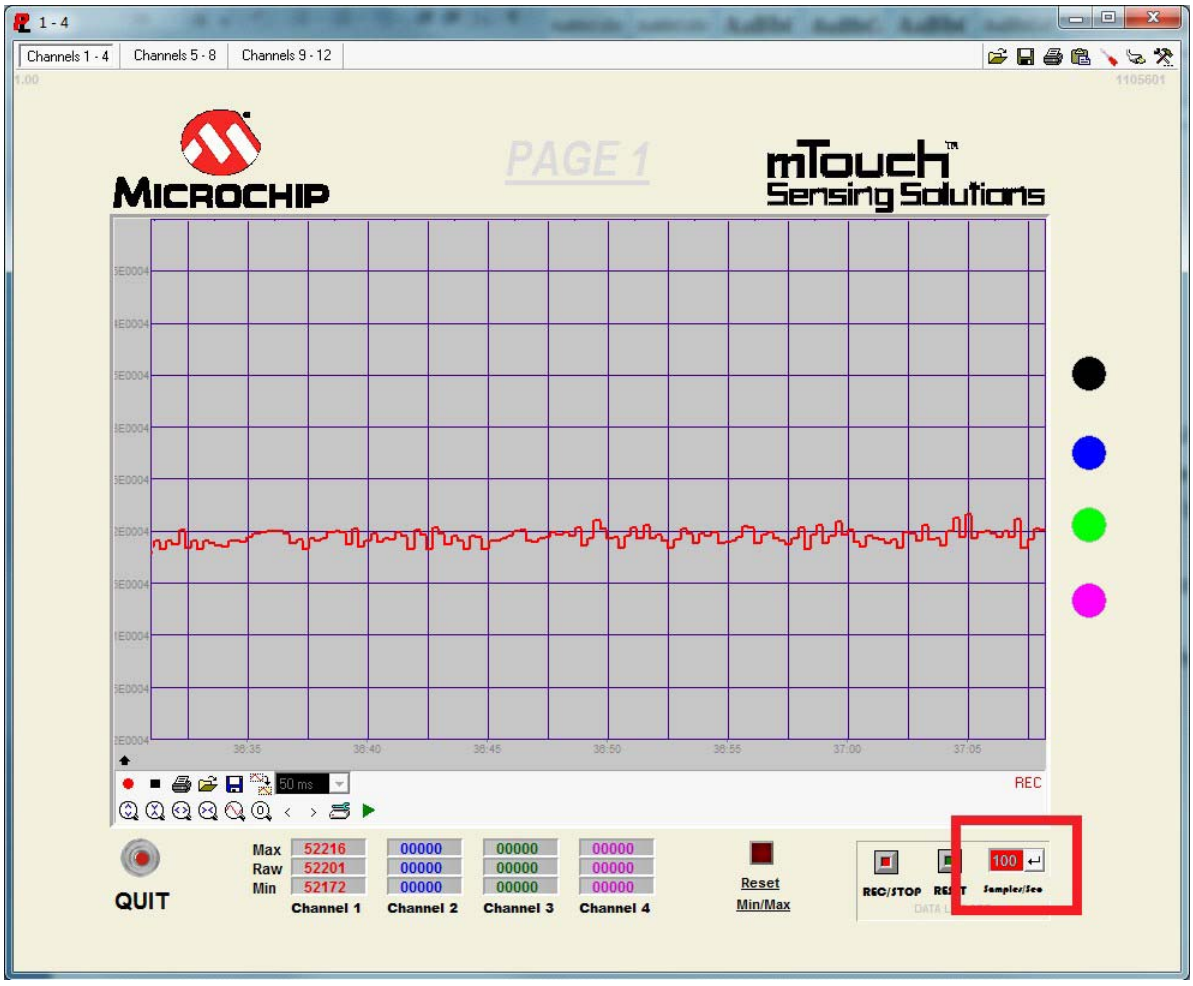
4.4.3 Logging All Received Readings to the Hard Drive

For debug purposes, over long periods of time, the mTouch™ sensing solution GUI allows the user to store all the readings into a text file, using a CSV format. This file can be read by the user in any text editor, like Windows NotePad, or can be directly imported into Microsoft® Excel, allowing the user to plot a graph and browse through the log period.

To start logging the data, go to the Data Logger window located at the bottom right area of the GUI window and:

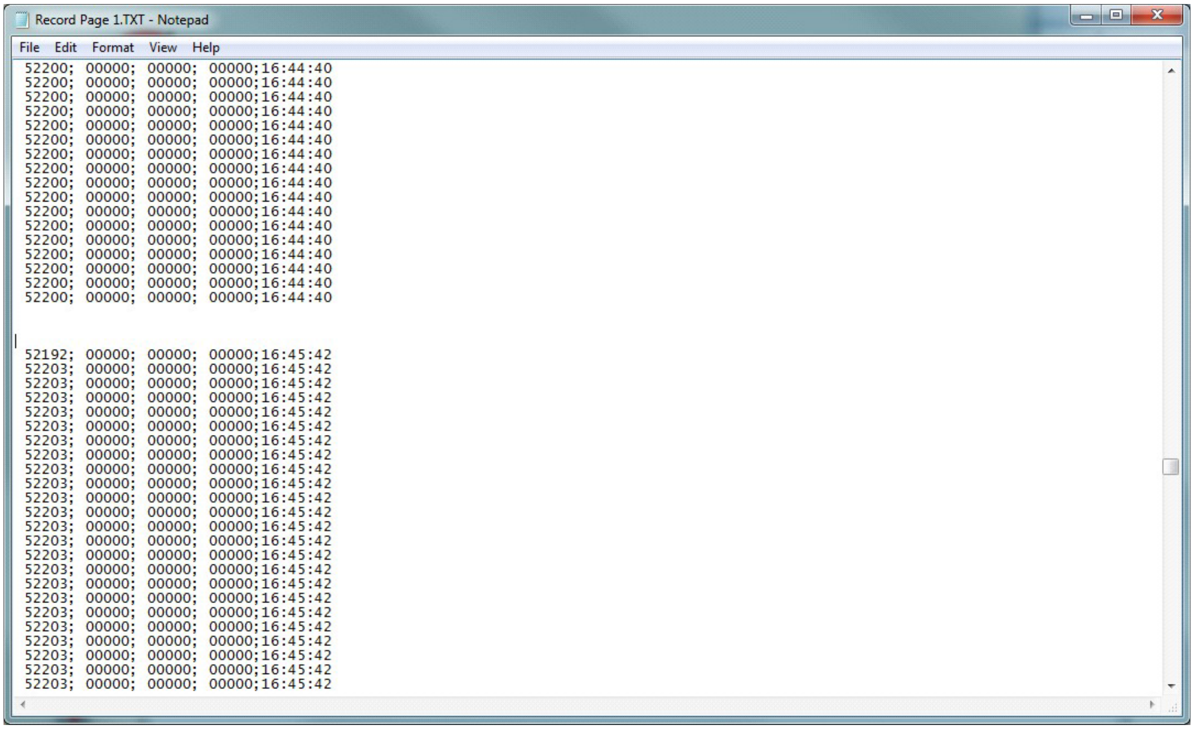
1. Adjust the number of samples per second to a value of your choice, by typing in the new value in the Edit window as shown (Figure 4-14):

FIGURE 4-14: ADJUSTING THE DATA RATE



2. Then click the REC/STOP button to start or stop the sample recording. A text file named Record Page *n.TXT* will be created in the “Data” sub-directory, at the location where the mTouch™ sensing solution GUI was installed. “*n*” represents the GUI page number you started logging the data for. Clicking the REC/STOP button again pauses the recording process. By clicking the same button again, it will append the new incoming data to the previous content of the file. The file text file below (Figure 4-15), shows recorded data, after pausing for about a minute:

FIGURE 4-15: DISPLAYING THE LOGGED DATA

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52203; 00000; 00000; 00000;16:45:42
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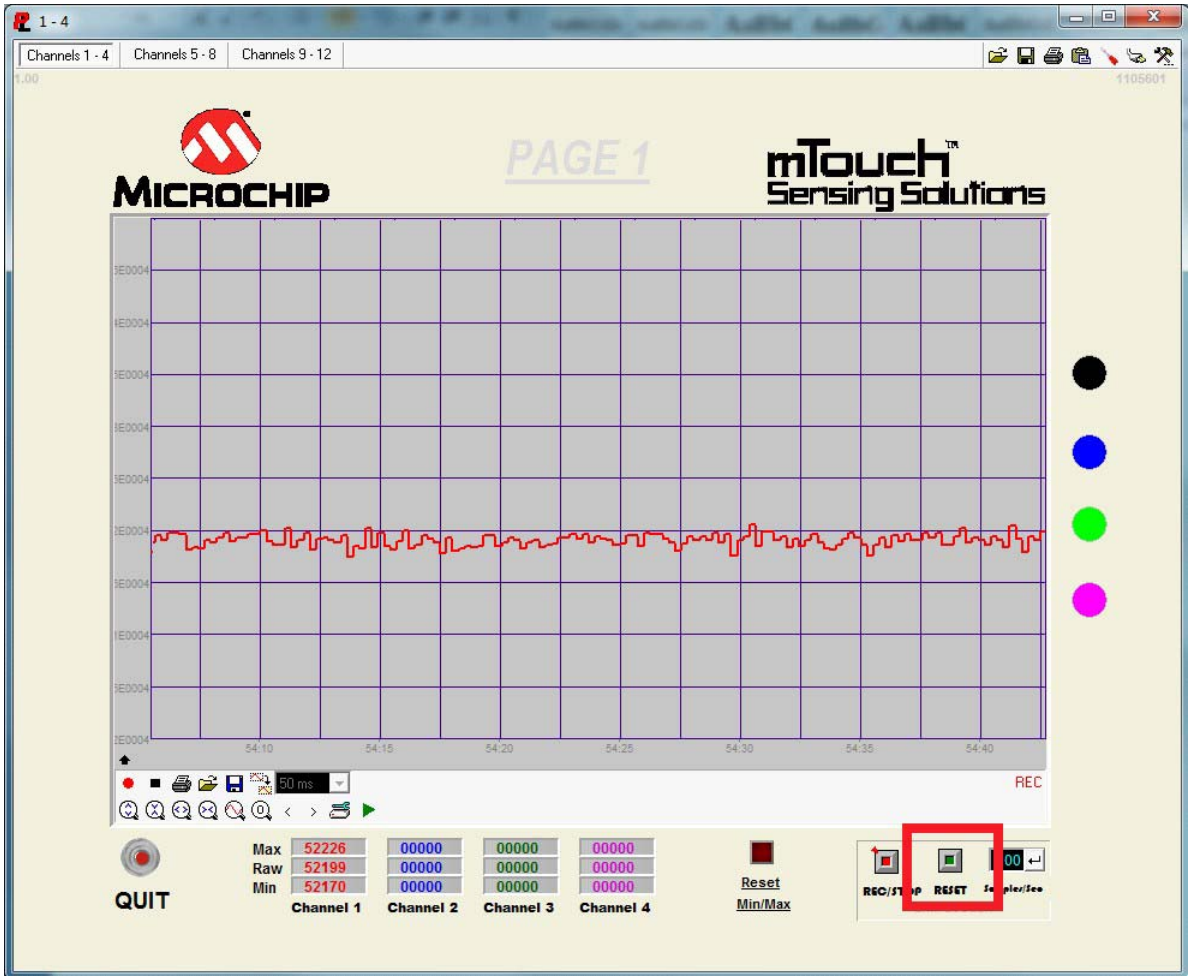
3. Finally, the Reset button allows the user to discard the content of the file for the current page. When the user starts recording again using the REC/STOP button, a new file is started and new data is stored (Figure 4-16).

FIGURE 4-16: RESETTING THE DATA LOGGER



NOTES:

Chapter 5. Evaluation Board Hardware

This chapter provides a functional overview of the evaluation boards and identifies the major hardware components. Topics covered include:

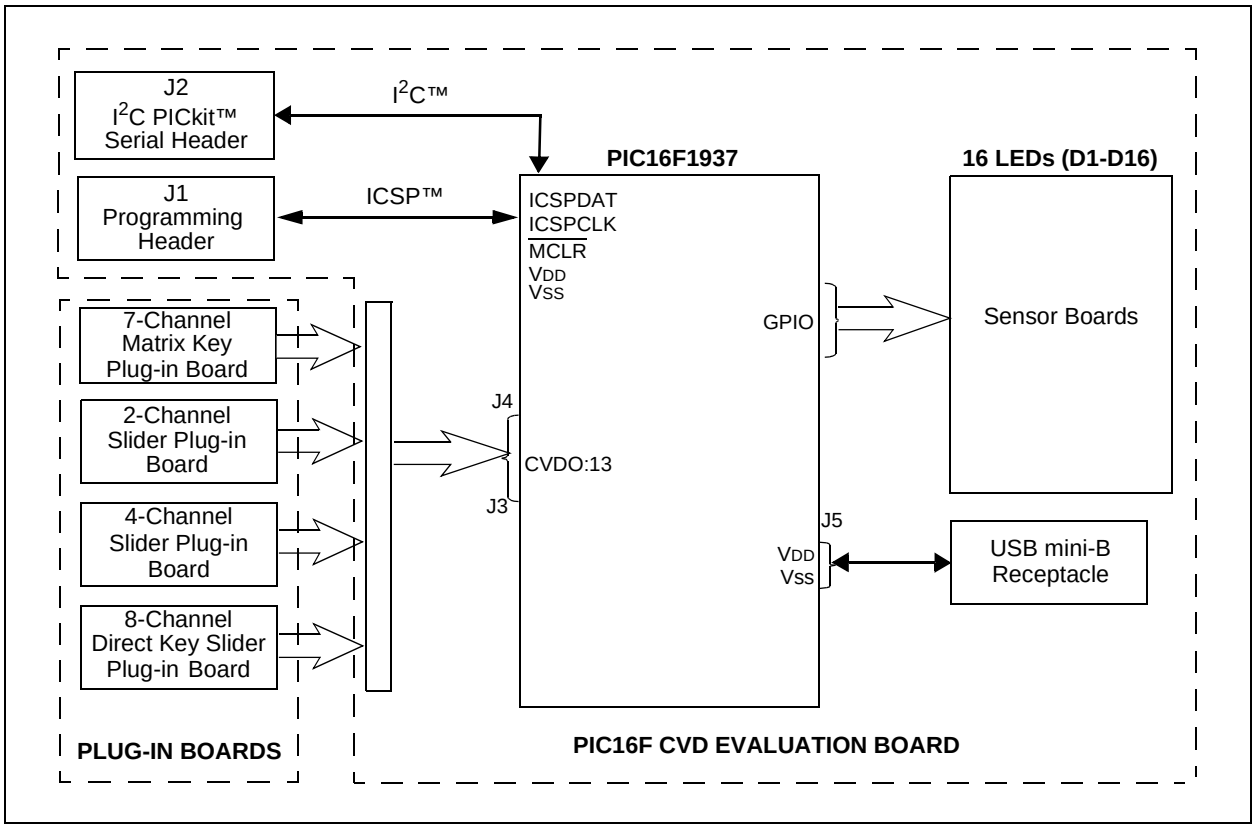
- Application Functional Overview
- Board Components

5.1 APPLICATION FUNCTIONAL OVERVIEW

5.1.1 PIC16F CVD Evaluation Board

For the PIC16F CVD board, ICSP lines are provided via a PICkit 2 header. A mini USB adaptor is available for power. The PICkit Serial Analyzer may be used to communicate with the mTouch sensing solution GUI through ASYNC. For this board, do not use both USB and PICkit tools to power the board. The USB connection has a 3.3V regulator afterwards to regulate the USB power and PICkit tools have their own regulator straight to the device. ICSPCLK and ICSPDAT share pins with active-low LEDs (D6 and D7) which can cause problems when debugging. To use in-circuit serial debugging, remove jumper J4 to disconnect these two LEDs.

FIGURE 5-1: PIC16F CVD EVALUATION BOARD APPLICATION-SIDE BLOCK DIAGRAM



5.1.2 PIC18F CTMU Evaluation Board

The PIC18F CTMU Evaluation Board (see Figure 5-2) is similar to the PIC24F CTMU Evaluation Board except for the change in the number of ADC channels. The PIC18F46J50 microcontroller on the PIC18F CTMU Evaluation Board has 13 ADC channels, which are used by the touch sense application as the sensing channels.

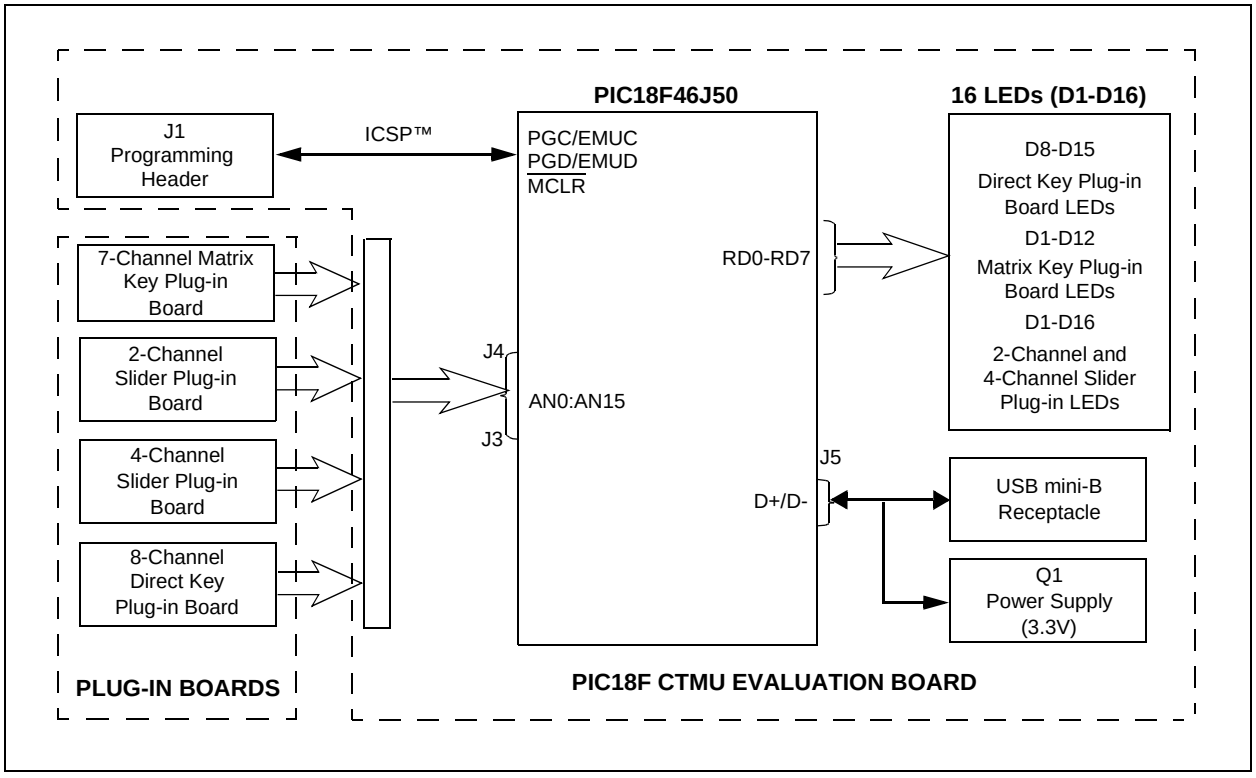
Note: PIC18F CTMU Evaluation Board firmware uses only 13 channels for touch sense applications and Channels 13 to 15 are unused in the PIC18F CTMU board.

The microcontroller uses its on-chip USB engine and transceiver to communicate to the PC side interface application, using the USB mini-B receptacle. The evaluation board also uses the USB receptacle for application power as a bus-powered device.

Microcontroller and LED power are provided from the V_{BUS} by Q1, an MCP1702 voltage regulator. Provisions on the board allow for the user to add components and create an externally powered application.

Note: Unlike the PIC24F CTMU Evaluation Board, the ICD interface (PGC and PGD) on the PIC18F Evaluation Board does not share with any of the CTMU channels.

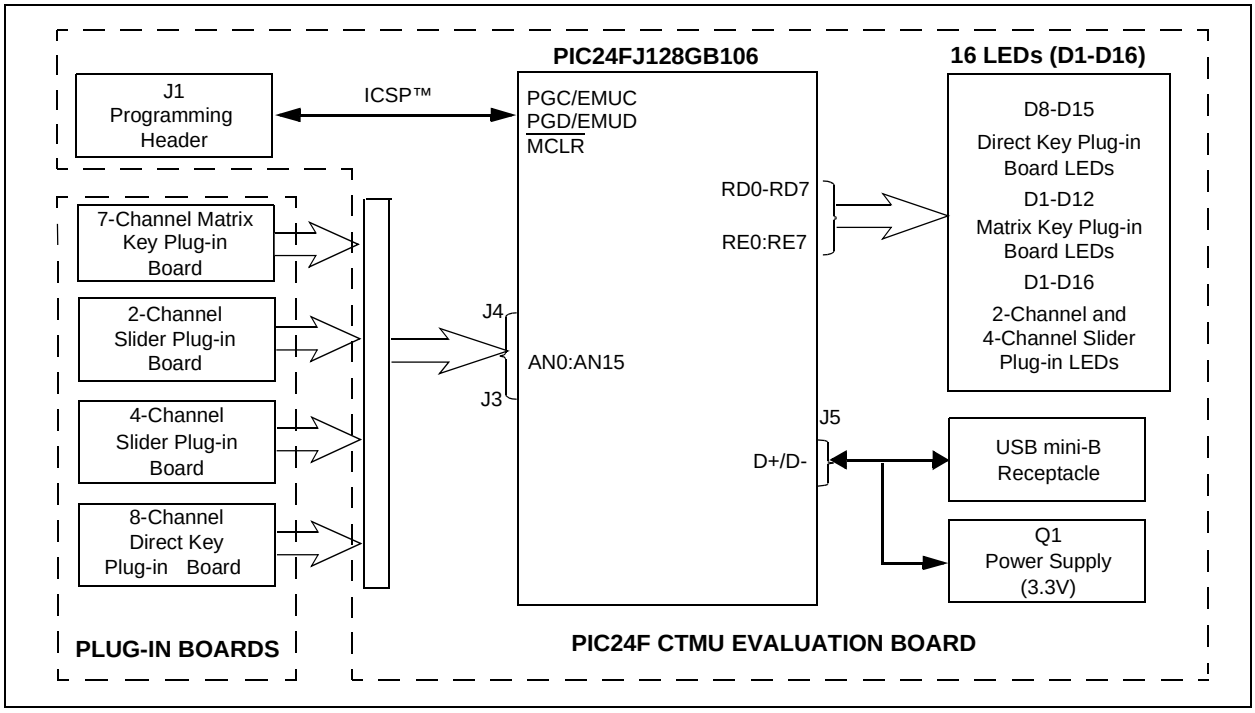
FIGURE 5-2: PIC18F CTMU EVALUATION BOARD APPLICATION-SIDE BLOCK DIAGRAM



5.1.3 PIC24F CTMU Evaluation Board

The operation of the PIC24F CTMU Evaluation Board (see Figure 5-3) is managed by the PIC24F microcontroller, which requires very little additional hardware to perform its tasks. In addition to the touch sense demonstration application code, the preloaded demonstration uses substantial parts of the Microchip USB Stack Library to provide a hardware interface to the PC-based mTouch sensing solution diagnostic tool.

FIGURE 5-3: PIC24F CTMU EVALUATION BOARD APPLICATION-SIDE BLOCK DIAGRAM



The touch sense application uses the PIC24F microcontroller's CTMU and all 16 of the microcontroller's A/D input channels to monitor the touch interfaces. The CTMU functions by sensing small changes in capacitance on its inputs, such as those occurring when a person touches the copper pad electrodes. By continuously monitoring for these changes, the CTMU can determine when a touch event occurs. The sensors on the evaluation board comprise carefully placed circuit traces and capacitive touch pads.

The evaluation board comprises 16 A/D channels of the PIC24F microcontroller connected to connector, J4/J3. This connector is used to interface the plug-in boards to the evaluation board.

The plug-in boards can be connected to any of the 16 channels of the connector (14) by changing the configuration settings, which is explained in the `Readme.txt` file.

A total of 16 LEDs are provided in the evaluation board. These LEDs are driven directly by the microcontroller through pins on PORTD and PORTE. When an event occurs, the application firmware also provides feedback by activating one or more LEDs at that location. The sequence for the activation of the LEDs depends on the type of touch pads that is interfaced to the evaluation board.

The microcontroller uses its on-chip USB engine and transceiver to communicate to the PC side interface application, using the USB mini-B receptacle. The evaluation board also uses the USB receptacle for application power as a bus-powered device. Microcontroller and LED power are provided from the V_{BUS} by Q1, an MCP1702 voltage regulator. Provisions on the board allow for users to add components and create an externally powered application.

For users interested in using the evaluation board as an experimental platform, the microcontroller can be reprogrammed using the ICSP connector. A 6-pin header is provided for connecting the evaluation board to any MPLAB ICD 2 compatible programmer. Since the ICD interface (PGD and PGC) shares some input channels of the connector, J4/J3 (channel 6 and 7), necessary care should be taken when the debugger is enabled.

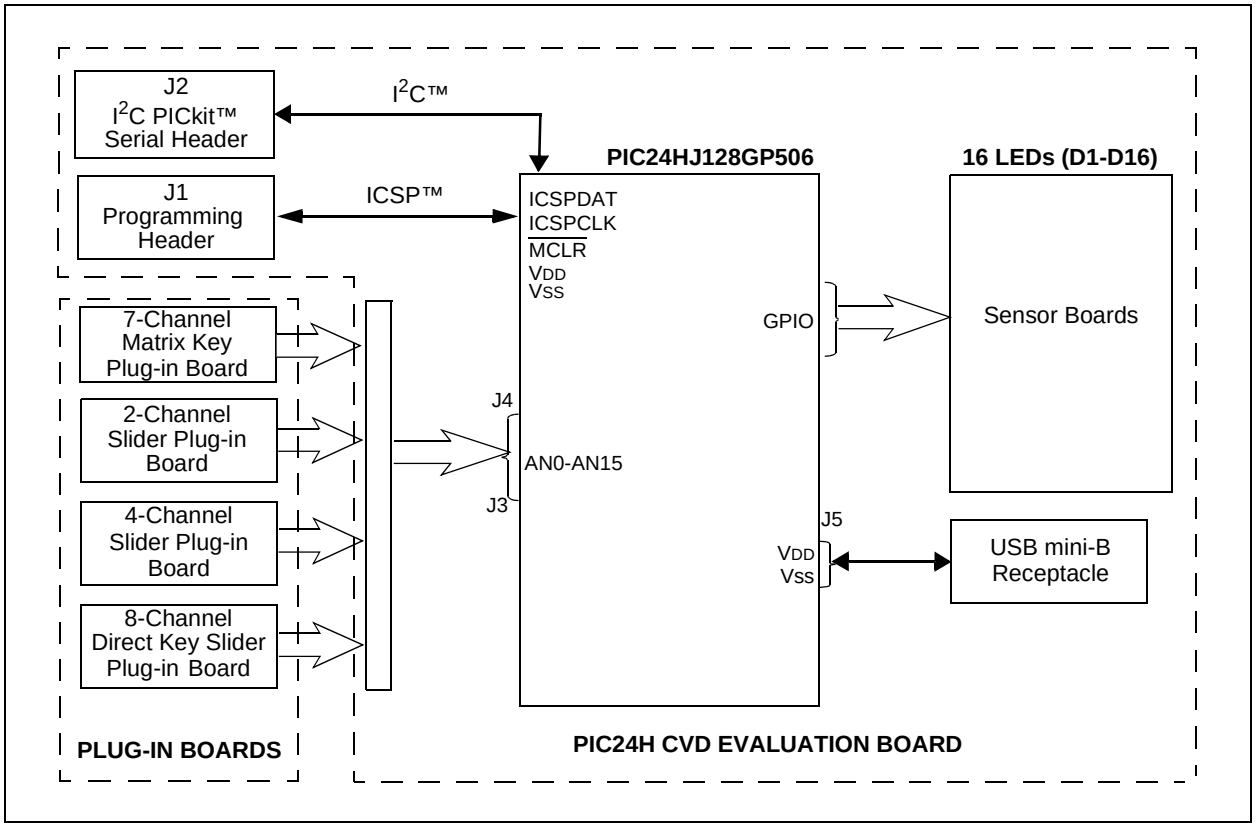
The firmware in the evaluation board will have the default plug-in board channel configurations, which is explained in the `Readme.txt` file. The user can reconfigure the channels based on his application by referring to the `Readme.txt` file.

5.1.4 PIC24H CVD Evaluation Board

The PIC24H CVD Evaluation Board (see Figure 5-4) is based on the same layout as the PIC24F CTMU and PIC32MX CVD Evaluation Boards and has similar functional characteristics as the PIC16F CVD Evaluation Board (I^2C interface with host).

This board does not use USB and a PICkit to power the board. The USB has a 3.3V regulator to regulate the USB power and the PICkit tools have their own regulator straight to the device V_{DD}; so, choose one or the other.

FIGURE 5-4: PIC24H CVD EVALUATION BOARD APPLICATION-SIDE BLOCK DIAGRAM

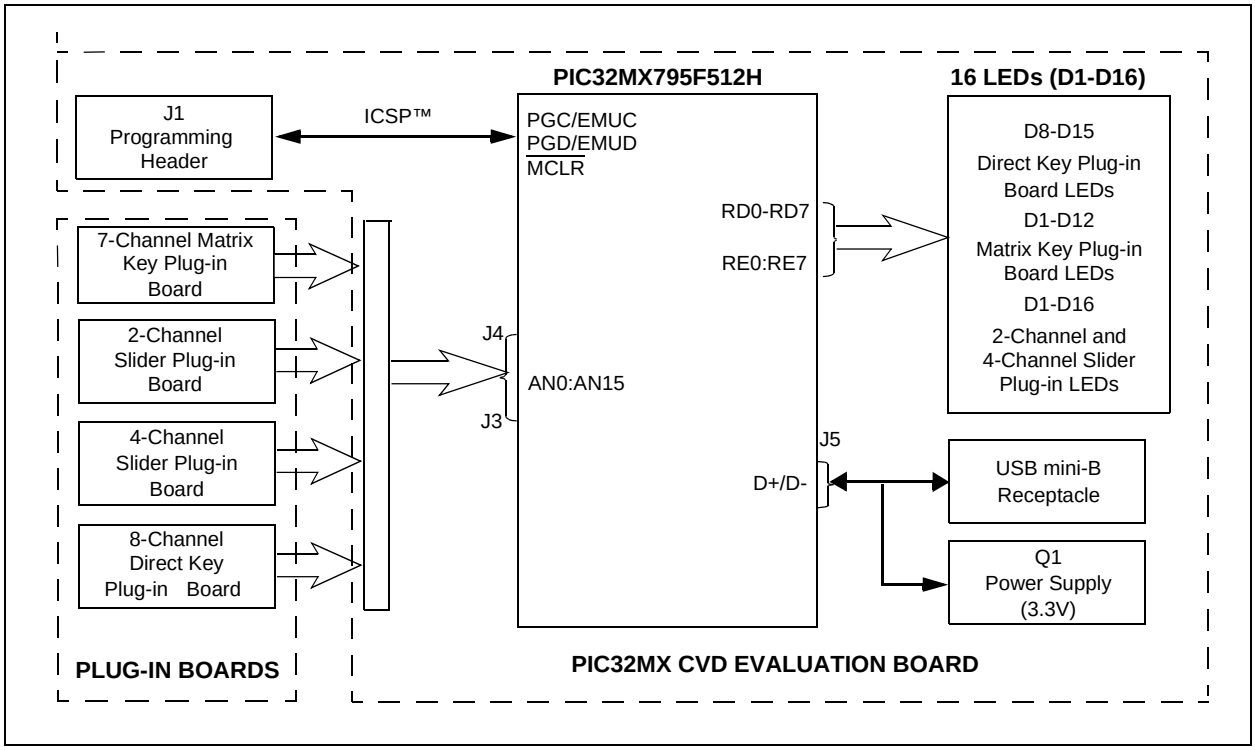


5.1.5 PIC32MX CVD Evaluation Board

The PIC32MX CVD Evaluation Board (see Figure 5-5) is similar to the PIC24F CTMU Evaluation Board. The user interface look and feel do not differ, while the evaluation board layout is almost identical due to the fact that the PIC32MX795F512H and PIC24FJ128GB106 are pin-to-pin compatible. The four daughter boards are connected to the J3/J4 connectors in the same manner. As for functionality, the PIC32MX CVD evaluation board has 15 LEDs to indicate touch sensing while the USB interface is used for communicating with the host application for visualization and diagnostic.

A major difference between the PIC24F CTMU and the PIC32MX CVD Evaluation Boards is the PIC32MX CVD uses the ADC module for capacitive touch sensing, while the PIC24F CTMU uses the dedicated CTMU module.

FIGURE 5-5: PIC32MX CVD EVALUATION BOARD APPLICATION-SIDE BLOCK DIAGRAM



5.2 BOARD COMPONENTS

5.2.1 PIC16F CVD Evaluation Board

Figure 5-6 identifies the key hardware components that are common for the PIC16F CVD Evaluation Board. There is one evaluation board and four plug-in daughter boards. The four plug-in daughter boards are identified as direct keys, matrix keys, 2-channel slider and 4-channel slider.

FIGURE 5-6: PIC16F CVD EVALUATION BOARD COMPONENT LAYOUT (TOP SIDE)

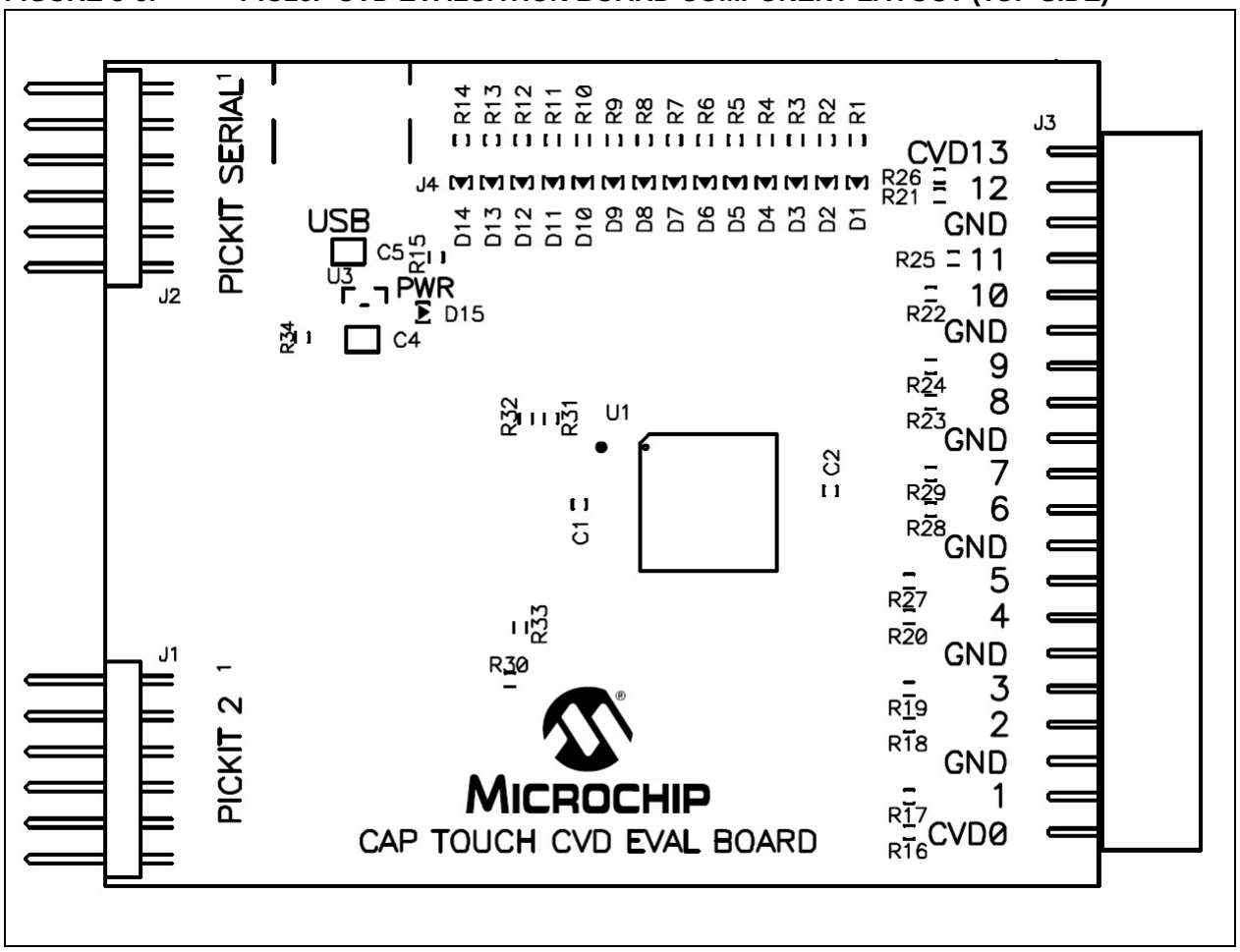


TABLE 5-1: BOARD COMPONENTS

Reference	Component
1	PIC16F1937 Microcontroller (U1) for PIC16F CVD Board
2	USB mini-B Receptacle (J5)
3	ICSP™ Programming Header (J1)
4	Power Supply (U2) to provide the V_{DD} to the Evaluation Board
5	Plug-in Sensor LEDs (D1-D16)
6	Plug-in Interface Connector (J4/J3)
7	PICkit™ Serial Analyzer Connector

5.2.1.1 COMPONENT DESCRIPTIONS

The components listed here (in order of their reference tags in Figure 5-6) are the key components of the application side of the PIC16F CVD Evaluation Board:

1. **PIC16F1937 Microcontroller (U1):** This provides the processing power for the touch sense applications in the PIC16F Evaluation Board.
2. **USB mini-B Receptacle (J5):** This provides power to the board via USB.
3. **ICSP™ Programming Header (J1):** This provides a standard Microchip ICD interface for programming and debugging applications on an evaluation board. It is designed to connect directly with Microchip's PICkit 3. Pin 1 is located on the right side of the interface, as viewed from the front of the board, and is marked with an arrow
4. **PICkit Serial Analyzer connector (J2):** This connector is used to exchange data to the Host PC through ASYNC using the PICkit Serial Analyzer.
5. **Power Supply (Q1):** This converts the +5 V_{DC} from V_{BUS} to the regulated+3.3 V_{DC} required by the evaluation board.
6. **Plug-in Sensor LEDs (D1-D16):** Sixteen LEDs (D1 through D16) are connected to one general purpose I/O ports of the PIC® microcontroller. These LEDs are lit based on the need of the application.
7. **Plug-in Interface Connector (J4/J3):** This is a 40-pin connector, which is used to interface the different plug-in boards to the microcontroller. This connector is interfaced to 14 analog channels of the microcontroller and the remaining pins are connected to ground of the evaluation board.

5.2.2 PIC18F CTMU, PIC24F CTMU, and PIC32MX CVD Evaluation Boards

Figure 5-7 identifies the key hardware components that are common for the PIC18F CTMU, PIC24F CTMU, and PIC32MX CVD Evaluation Boards. There is one evaluation board and four plug-in daughter boards. The four plug-in daughter boards are identified as direct keys, matrix keys, 2-channel slider and 4-channel slider.

FIGURE 5-7: PIC18F, PIC24F, AND PIC32MX EVALUATION BOARD COMPONENT LAYOUT (TOP SIDE)

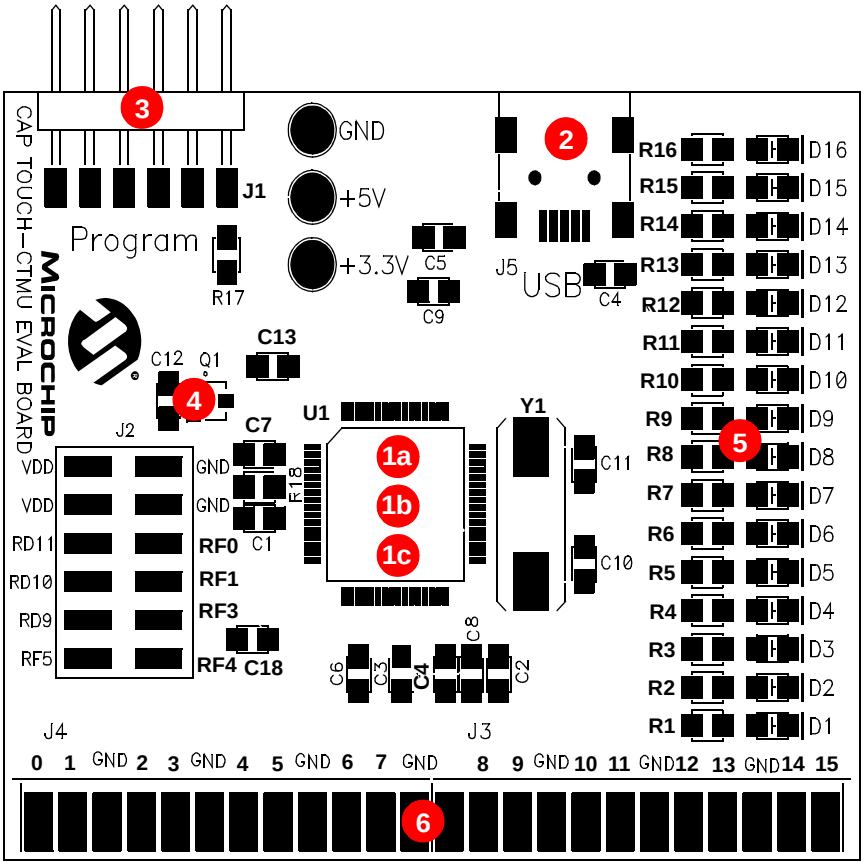


TABLE 5-2: BOARD COMPONENTS

Reference	Component
1a	PIC24FJ128GB106 Microcontroller (U1) for PIC24F CTMU Board
1b	PIC18F46J50 Microcontroller (U1) for PIC18F CTMU Board
1c	PIC32MX795F512H Microcontroller (U1) for PIC32MX CVD Board
2	USB mini-B Receptacle (J5)
3	ICSP™ Programming Header (J1)
4	Power Supply (Q1) to provide the VDD to the Evaluation Board
5	Plug-in Sensor LEDs (D1-D16)
6	Plug-in Interface Connector (J4/J3)

5.2.2.1 COMPONENT DESCRIPTIONS

The components listed here (in order of their reference tags in Figure 5-7) are the key components of the application side of an evaluation board, which are common for both PIC18F and PIC24F CTMU Evaluation Boards except for the microcontroller used in the board:

1a. **PIC24FJ128GB106 Microcontroller (U1):** This provides the processing power for the touch sense demonstration applications. The microcontroller features 64 Kbytes of Flash program memory and 16 Kbytes RAM, allowing sufficient space for the development of more complex touch sense applications.

The demonstration application uses an 8 MHz signal to create the 48 MHz USB clock, as well as the application's 32 MHz clock. Crystal, Y1, and associated components are used by the microcontroller's internal oscillator to maintain the frequency tolerances required by the USB specifications.

1b. **PIC18F46J50 Microcontroller (U1):** This provides the processing power for the touch sense applications in the PIC18F Evaluation Board. The microcontroller features 64 Kbytes of Flash program memory and 3.8 Kbytes RAM. The demonstration application uses an 8 MHz signal to create the 48 MHz USB clock, as well as the application's 32 MHz clock. Crystal, Y1, and associated components are used by the microcontroller's internal oscillator to maintain the frequency tolerances required by the USB specifications.

1c. **PIC32MX795F512H Microcontroller (U1):** This provides the processing power for the touch sense applications in the PIC32MX CVD Evaluation Board. The microcontroller features 512 Kbytes of Flash program memory and 128 Kbytes RAM. The demonstration application uses an 8 MHz signal to create the 48 MHz USB clock, as well as the application's 40 MHz clock. Crystal, Y1, and associated components are used by the microcontroller's internal oscillator to maintain the frequency tolerances required by the USB specifications.

2. **USB mini-B Receptacle (J5):** This provides a convenient interface to the PC side of the demonstration application. As the evaluation board functions as a bus-powered device, this connection also provides power to the board.

3. **ICSP™ Programming Header (J1):** This provides a standard Microchip ICD interface for programming and debugging applications on an evaluation board. It is designed to connect directly with Microchip's PICkit™ Starter Kit. Pin 1 (N/C) is located on the right side of the interface, as viewed from the front of the board, and is marked with an arrow.

4. **Power Supply (Q1):** This converts the +5 V_{DC} from V_{BUS} to the regulated +3.3 V_{DC} required by the evaluation board.

5. **Plug-in Sensor LEDs (D1-D16):** Sixteen LEDs (D1 through D16) are connected to PORTD and PORTE of the PIC® microcontroller. These LEDs are lit based on the need of the application.

6. **Plug-in Interface Connector (J4/J3):** This is a 48-pin connector, which is used to interface the different plug-in boards to the microcontroller. This connector is interfaced to 16 analog channels of the microcontroller and the remaining pins are connected to ground of the evaluation board.

5.2.3 PIC24H CVD Evaluation Board

Figure 5-8 identifies the key hardware components for the PIC24H CVD Evaluation Board. There is one evaluation board and four plug-in daughter boards. The four plug-in daughter boards are identified as direct keys, matrix keys, 2-channel slider and 4-channel slider.

FIGURE 5-8: PIC24H CVD EVALUATION BOARD COMPONENT LAYOUT (TOP SIDE)

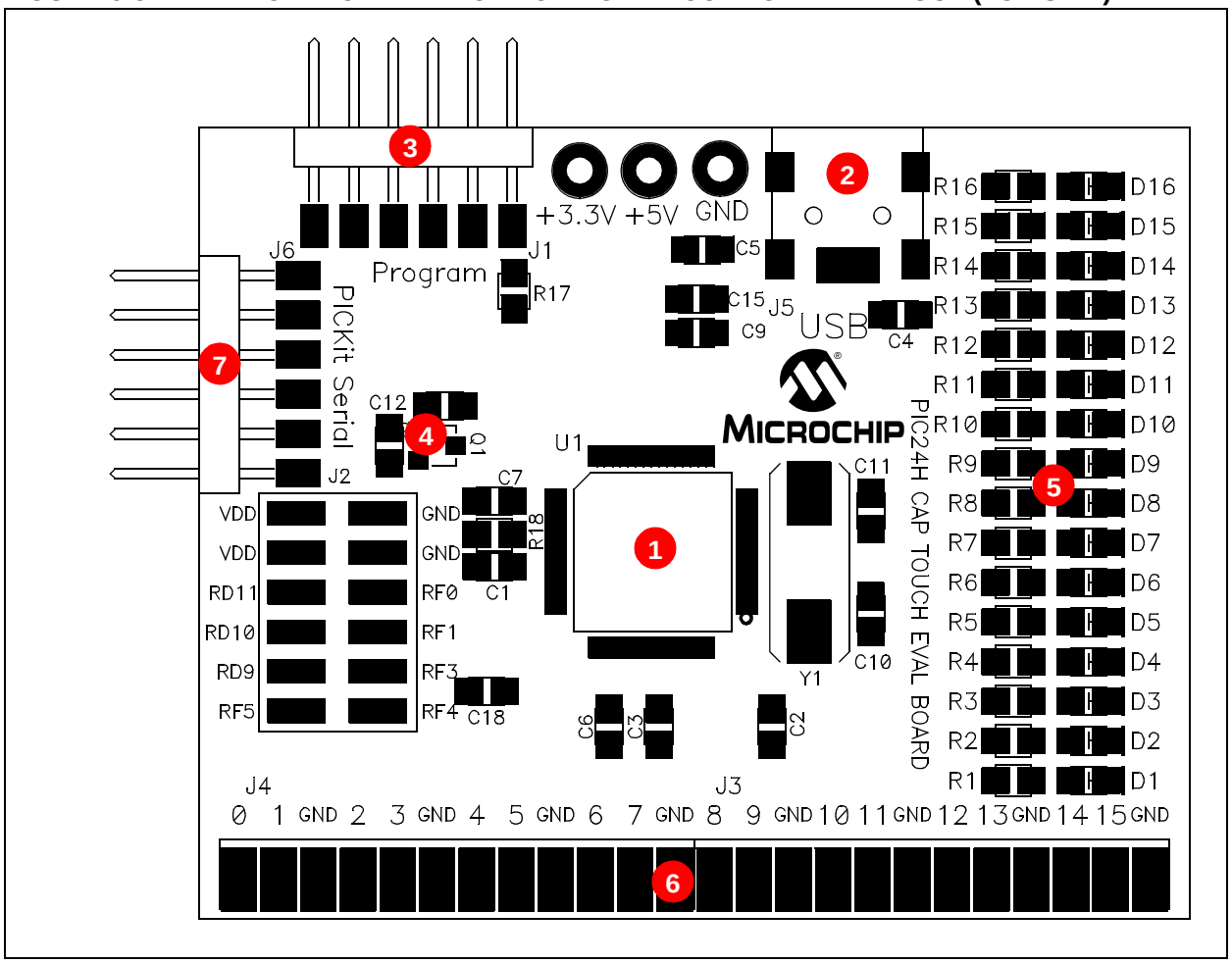


TABLE 5-3: BOARD COMPONENTS

Reference	Component
1	PIC24HJ128GP506A Microcontroller (U1) for PIC24H CVD Board
2	USB mini-B Receptacle (J5)
3	ICSP™ Programming Header (J1)
4	Power Supply (Q1) to provide the VDD to the Evaluation Board
5	Plug-in Sensor LEDs (D1-D16)
6	Plug-in Interface Connector (J4/J3)
7	PICkit™ Serial Analyzer Connector

5.2.3.1 COMPONENT DESCRIPTIONS

The components listed here (in order of their reference tags in Figure 5-8) are the key components of the application side of the PIC24H CVD Evaluation Board:

1. **PIC24HJ128GP506A Microcontroller (U1):** This provides the processing power for the touch sense applications in the PIC24H Evaluation Board.
2. USB mini-B Receptacle (J5): This provides power to the board via USB.
3. **ICSP™ Programming Header (J1):** This provides a standard Microchip ICD interface for programming and debugging applications on an evaluation board. It is designed to connect directly with Microchip's PICkit 3, REAL ICE™ or ICD 3. Pin 1 is located on the right side of the interface, as viewed from the front of the board, and is marked with an arrow.
4. **PICkit Serial Analyzer Connector (J2):** This connector is used to exchange data to the Host PC through I^2C using the PICkit Serial Analyzer.
5. **Power Supply (Q1):** This converts the +5 V_{DC} from V_{BUS} to the regulated+3.3 V_{DC} required by the evaluation board.
6. **Plug-in Sensor LEDs (D1-D16):** Sixteen LEDs (D1 through D16) are connected to one general purpose I/O ports of the PIC microcontroller. These LEDs are lit based on the need of the application.
7. **Plug-in Interface Connector (J4/J3):** This is a 48-pin connector, which is used to interface the different plug-in boards to the microcontroller. This connector is interfaced to 16 analog channels of the microcontroller and the remaining pins are connected to ground of the evaluation board.

5.3 INTERFACING TO THE EVALUATION BOARDS

5.3.1 PIC16F CVD and PIC24H CVD Evaluation Boards with I²C Communication

To interface the plug-in boards to the evaluation boards in the mTouch Advanced Capacitive Evaluation Kits:

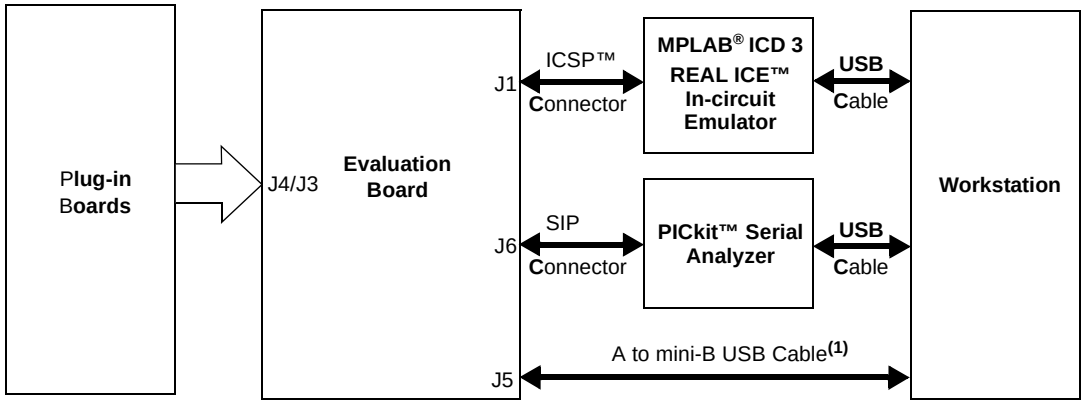
1. Connect the evaluation board to the MPLAB ICD programmer interface through the ICSP connector, J1.
2. Connect the USB receptacle from the workstation to connector J5 of the evaluation board. This is also used to power-up the evaluation board.
3. Connect the PICkit serial analyzer to the evaluation board through the J6 connector.

CAUTION

Do not use the PICkit serial analyzer to power the PIC24H CVD Evaluation Board.

4. Connect any of the 4 plug-in boards to the evaluation board through the J4/J3 connector.
5. After the hardware connections are done, open the working project in the MPLAB IDE and make the required changes for the corresponding plug-in board, which are explained in the `Readme.txt` files included in the project folder. However, the default values of the channel settings of the corresponding header files are mentioned in **Section 2.2 "Individual Touch Sense Demonstrations"**. The default settings of the configured channels are also explained in the `Readme.txt` file.
6. Download the Hex file onto the evaluation board using the MPLAB ICD 3, PICkit 3 or REAL ICE programming interface.
7. Check the working of the respective plug-in boards and view their output through the 16 LEDs on the evaluation board.

FIGURE 5-9: EVALUATION BOARD BLOCK DIAGRAM (PIC16F AND PIC24H ONLY)



Note 1: USB connection between an evaluation board and a workstation is used for power purposes only can cannot be used for USB communication.

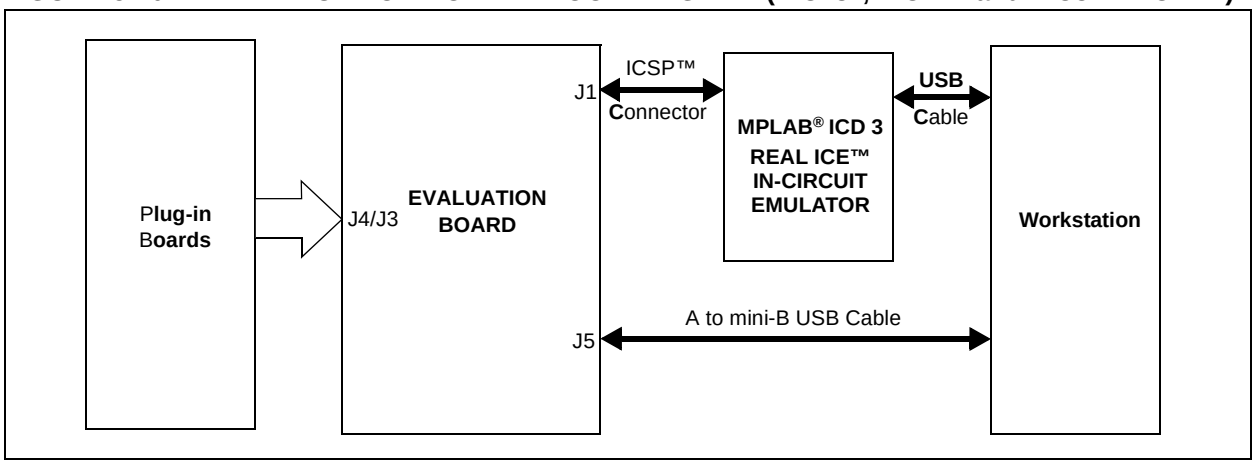
Note: The number of plug-in boards that can be interfaced with the evaluation board simultaneously is limited by the number of channels in the evaluation board. Please refer to the specific evaluation board schematic in **Appendix A. "Evaluation Board Schematics"** to verify the number of channels available.

5.3.2 PIC18F CTMU, PIC24F CTMU, and PIC32MX CVD Evaluation Boards with USB Communications

To interface the plug-in boards to the evaluation boards in the mTouch Advanced Capacitive Evaluation Kits:

1. Connect the evaluation board to the MPLAB® ICD programmer interface through the ICSP connector, J1.
2. Connect the USB receptacle from the workstation to connector J5 of the evaluation board. This is also used to power-up the evaluation board. For the CTMU boards, it is also used to interface to the PC.
3. Connect any of the 4 plug-in boards to the evaluation board through the J4/J3 connector (48-pin).
4. After the hardware connections are done, open the working project in the MPLAB IDE and make the required changes for the corresponding plug-in board, which are explained in the `Readme.txt` file. However, the default values of the channel settings of the corresponding header files are mentioned in **Section 2.2 "Individual Touch Sense Demonstrations"**. The default settings of the configured channels are also explained in the `Readme.txt` file.
5. Download the Hex file onto the evaluation board using the MPLAB ICD 3 interface.
6. Check the working of the respective plug-in boards and view their output through the 16 LEDs on the evaluation board.

FIGURE 5-10: EVALUATION BOARD BLOCK DIAGRAM (PIC18F, PIC24F and PIC32MX ONLY)



Note: The number of plug-in boards that can be interfaced with the evaluation board simultaneously is limited by the number of channels in the evaluation board. In the case of the PIC24F CTMU Evaluation Board, the ICD interface (PGD and PGC) shares two of the input channels of the connector, J4/J3 (channel 6 and channel 7), the operation might fail if any of the plug-in boards is connected to these two channels when the Debugger mode is enabled in the MPLAB® IDE.

NOTES:

Chapter 6. Troubleshooting

This chapter discusses common operational issues and methods to resolve them.

6.1 COMMON ISSUES

1. **The evaluation board does not respond to inputs (i.e., no lights when a key plug-in or touch sensor is touched)**

   Check the evaluation board for power:

   - Verify that USB power (V_{USB}, +5 V_{DC}) is present on the USB connection.
   - If the evaluation board is connected to a computer through a USB hub, verify the hub is powered and capable of providing power to downstream devices.
   - If the evaluation board is directly connected to a computer, verify that the USB port used is active; try switching to another port.

2. **The touch sensors are abnormally sensitive or insensitive (generally insensitive) to inputs**

   Check to make sure that the plug-in daughter boards are connected to the channels that are mentioned in the `Readme.txt` file.

   Check the bar graph settings for the sensors in the mTouch Sensing Solution software. The evaluation board's trip point and other settings may have been changed to values that interfere with the default operation. To correct:

   - In the Settings dialog, verify that the **Use Firmware Settings** option is selected.
   - If the **Use Saved Value** option is selected instead, change the trip point values for each affected channel to a value that produces an appropriate response.

3. **The evaluation board and the mTouch Sensing Solution Diagnostic Tool are installed and operating properly, but are not communicating with each other**

   The USB host controller may not have enumerated the evaluation board correctly upon connection. To correct, try the following:

   - If the evaluation board is connected through an external USB hub, try connecting it directly to a USB port on the host computer.
   - Disconnect the board, wait for 5 to 10 seconds, then reconnect the board.

   It is also possible that the USB host controller has dropped the communication channel. This happens occasionally when the evaluation board is placed into Standby mode and then powered up using the power control. In this case, disconnect the evaluation board and reconnect after 5 to 10 seconds.

4. **The board's edge connector will add some additional parasitic capacitance to the system.**
5. **Touching the solder connections can create a very strong coupling to the sensor and trigger buttons.**

NOTES:

Appendix A. Evaluation Board Schematics

This appendix provides the following schematics:

- **Figure A-1: "mTouch™ – PIC16F CVD Evaluation Board Schematic"**
- **Figure A-2: "mTouch™ – PIC18F CVD Evaluation Board Schematic"**
- **Figure A-3: "mTouch™ – PIC24F CTMU Evaluation Board Schematic"**
- **Figure A-4: "mTouch™ – PIC24H CVD Evaluation Board Schematic"**
- **Figure A-5: "mTouch™ – PIC32MX CVD Evaluation Board Schematic"**

FIGURE A-1: mTouch™ – PIC16F CVD EVALUATION BOARD SCHEMATIC

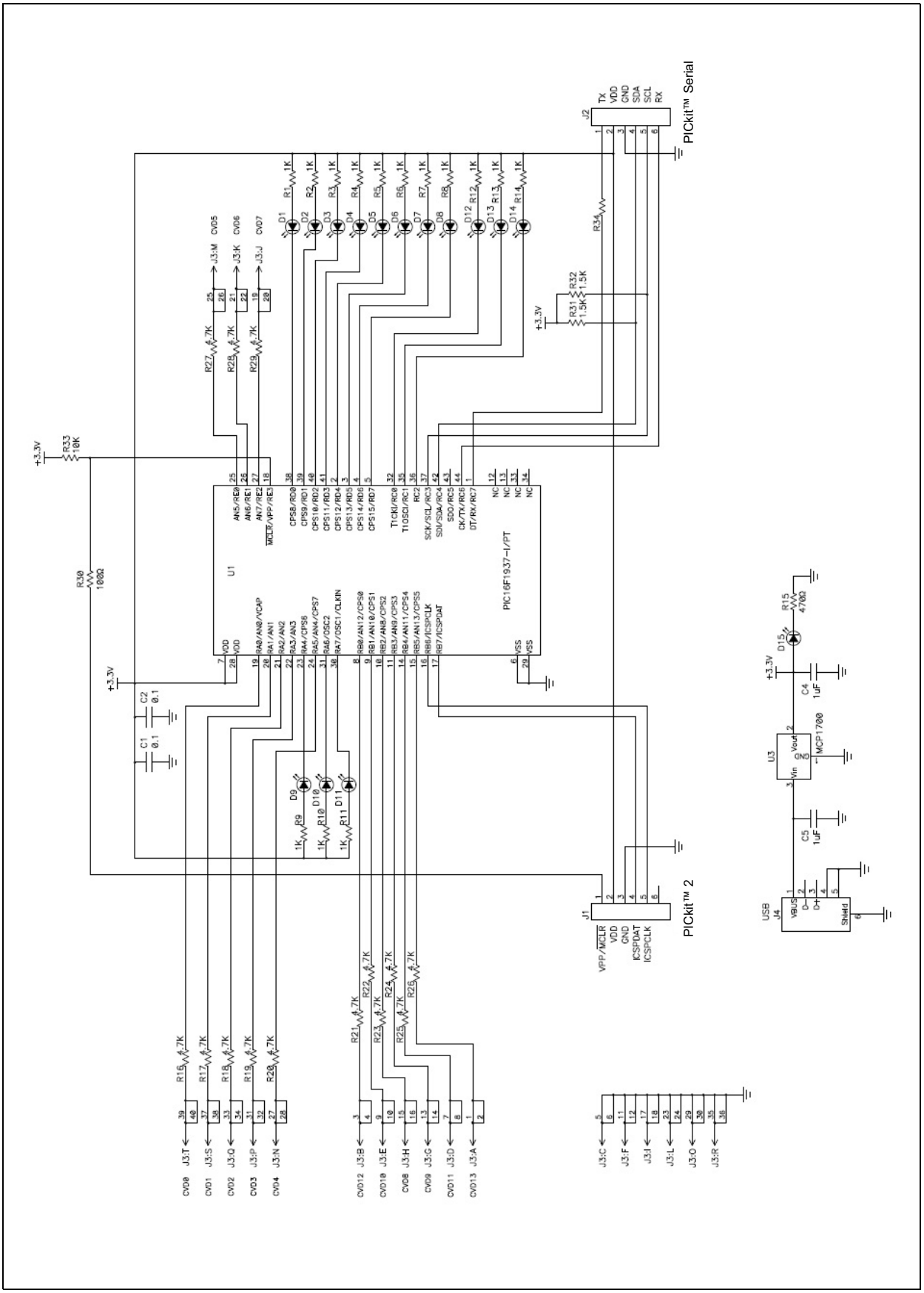
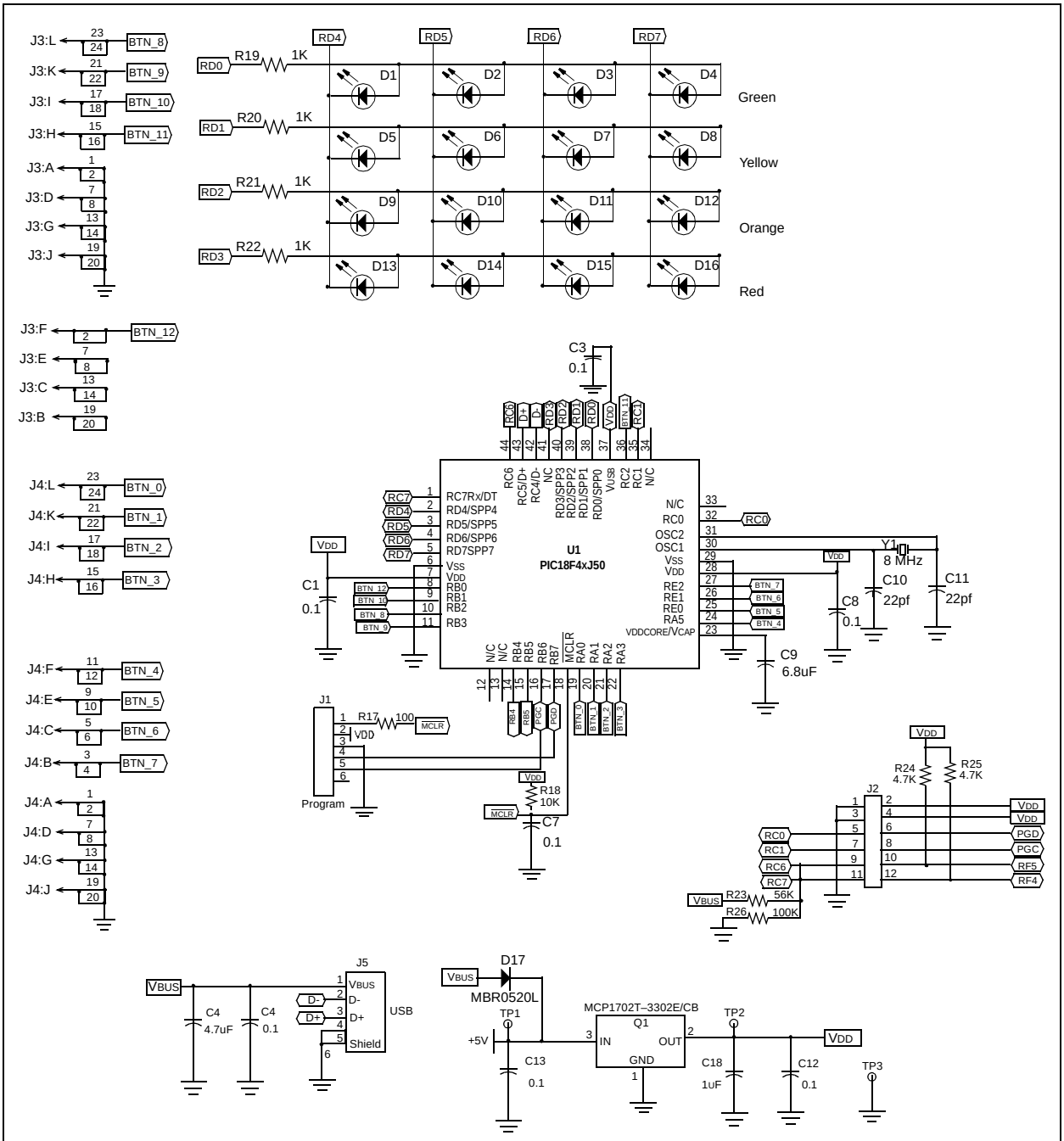


FIGURE A-2: mTouch™ – PIC18F CVD EVALUATION BOARD SCHEMATIC



Note: The Channels13,14 and 15 are not used, and are grounded in the PIC18F CTMU Evaluation Board.

FIGURE A-3: mTouch™ – PIC24F CTMU EVALUATION BOARD SCHEMATIC

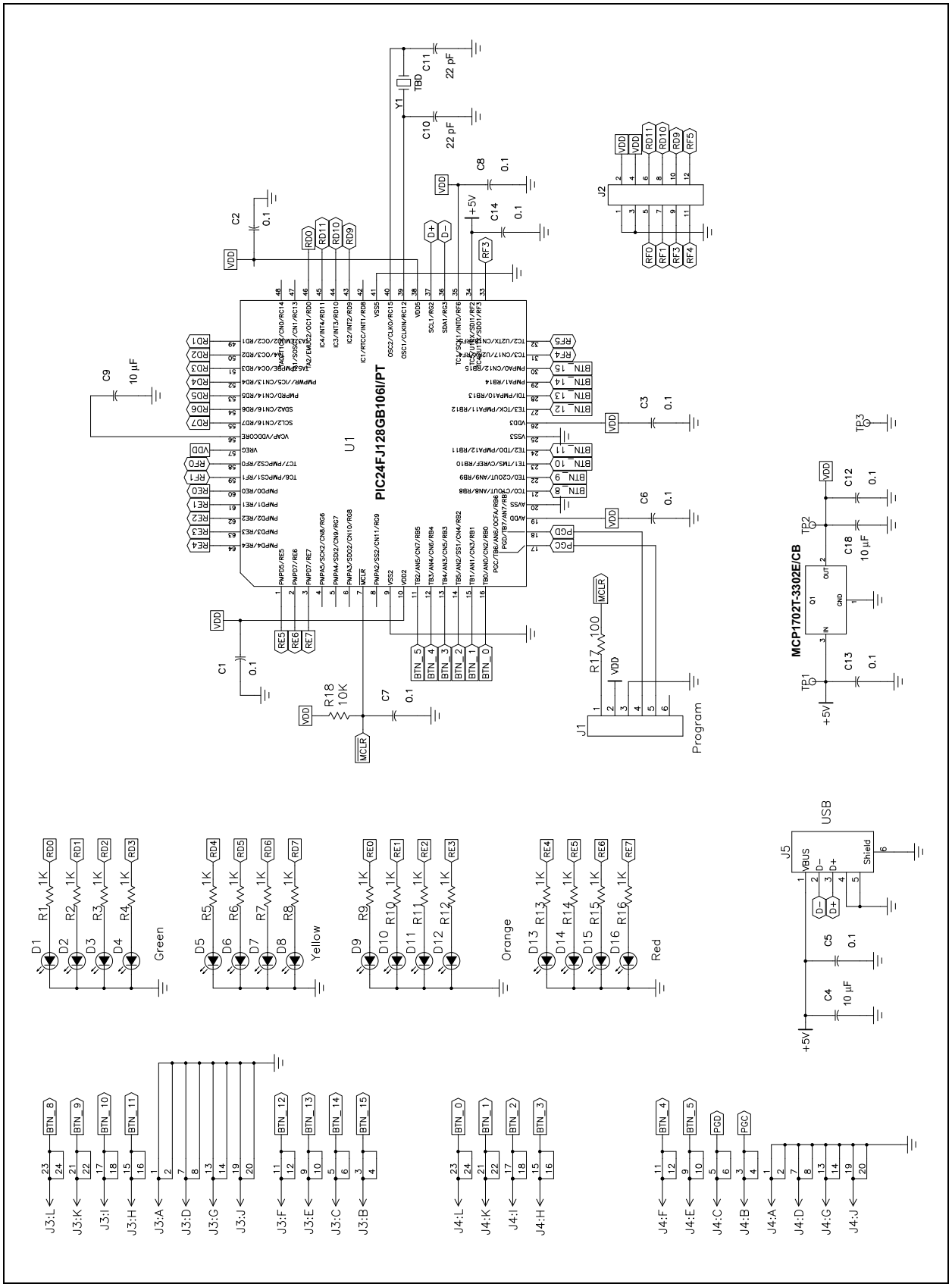


FIGURE A-4: mTouch™ – PIC24H CVD EVALUATION BOARD SCHEMATIC

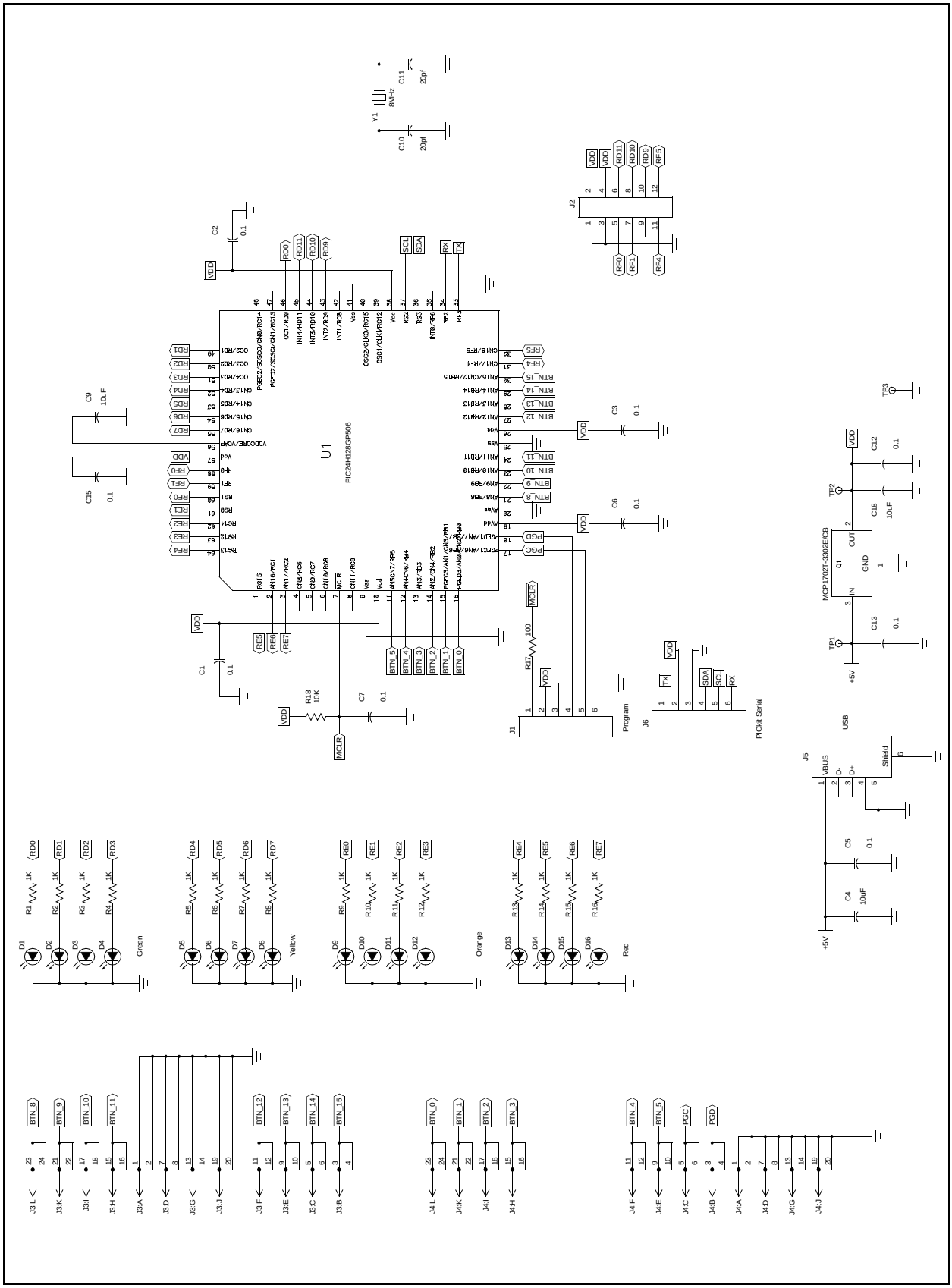
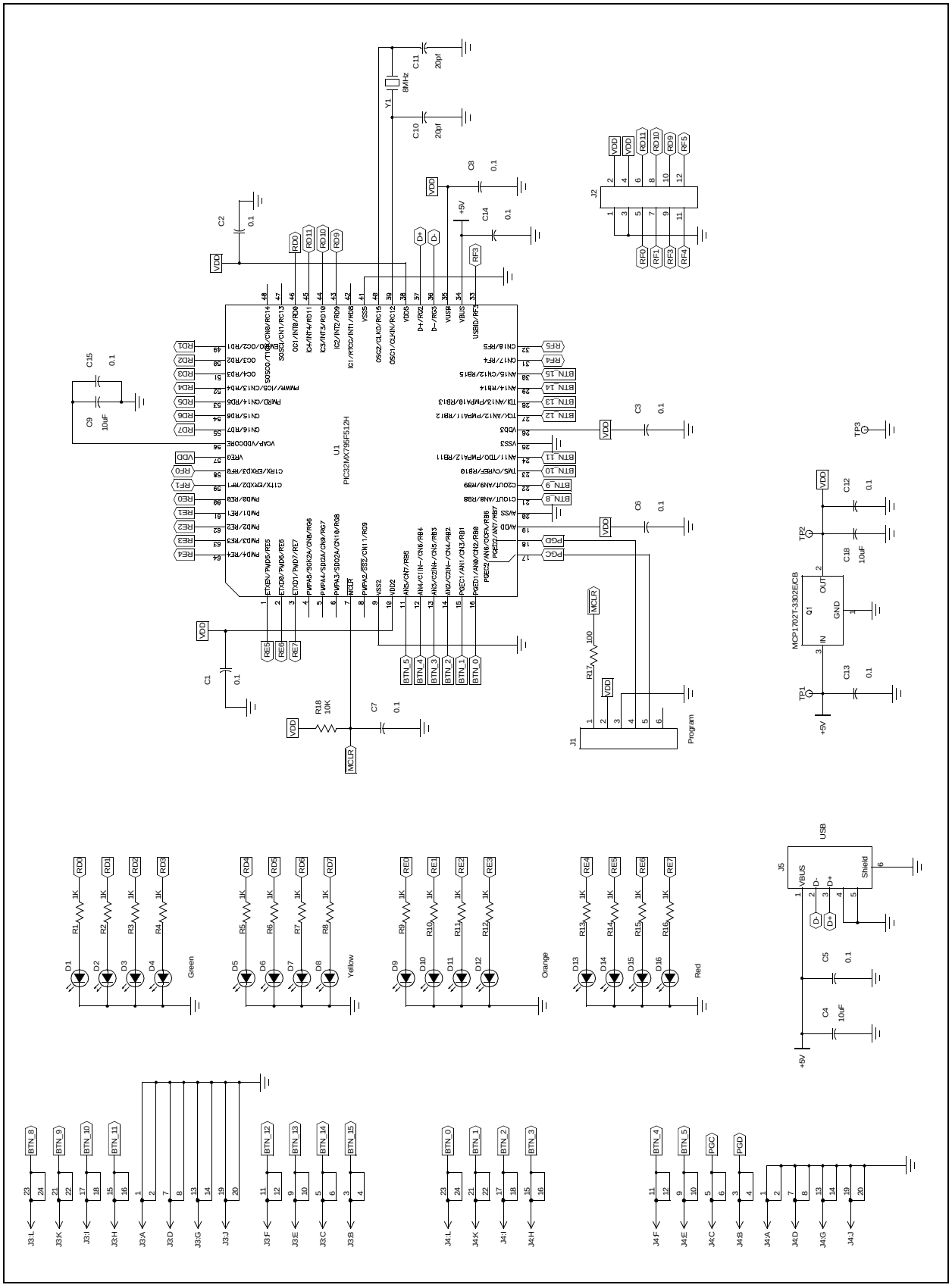


FIGURE A-5: mTouch™ – PIC32MX CVD EVALUATION BOARD SCHEMATIC



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