



Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!



Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China





MICROCHIP

MCP3913
ADC Evaluation Board
for 16-Bit MCUs
User's Guide

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

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC³² logo, rPIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

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

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.


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

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

GestIC and ULPP are registered trademarks of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

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

© 2013, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

ISBN: 978-1-62077-520-2

**QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
= ISO/TS 16949 =**

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC[®] MCUs and dsPIC[®] DSCs, KEELOQ[®] code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Object of Declaration: MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

EU Declaration of Conformity

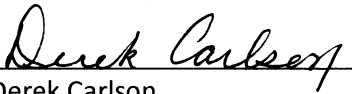
This declaration of conformity is issued by the manufacturer.

The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.

Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA



Derek Carlson

VP Development Tools

16-July-2013

Date

MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

NOTES:



MCP3913 ADC EVALUATION BOARD FOR 16-BIT MCUs USER'S GUIDE

Table of Contents

Preface	7
Introduction.....	7
Document Layout	7
Conventions Used in this Guide	8
Recommended Reading.....	9
The Microchip Web Site	9
Customer Support	9
Document Revision History	9
Chapter 1. Product Overview	
1.1 Overview	11
1.2 What the MCP3913 ADC Evaluation Board for 16-Bit MCUs Contains	12
Chapter 2. Hardware Description	
2.1 PIM Module/MCP3913 Connection and Peripheral Usage Overview	13
2.2 Analog Input Structure	14
2.3 Universal Serial Bus (USB)	15
Chapter 3. Firmware	
3.1 PIC24FJ256GA110 Firmware Description	17
3.2 Data Acquisition	17
3.3 UART Communication Protocol	18
Appendix A. Schematics and Layouts	
A.1 Introduction	19
A.2 Schematic – Power	20
A.3 Schematic – ADC	21
A.4 Schematic – Microcontroller (MCU)	22
A.5 Schematic – PIM Module	23
A.6 Schematic – LCD and UART	24
A.7 Board – Top Trace and Top Silk	25
A.8 Board – Bottom Trace and Bottom Silk	25
A.9 Board – Layer #2 GND	26
A.10 Board – Layer #3 VDD	26
A.11 Board – Top Silk and Pads	27
A.12 Board – Bottom Silk and Pads	27
Appendix B. Bill of Materials (BOM)	
Worldwide Sales and Service	32

MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

NOTES:



MCP3913 ADC EVALUATION BOARD FOR 16-BIT MCUs USER'S GUIDE

Preface

NOTICE TO CUSTOMERS

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

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXA”, where “XXXX” 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 MCP3913 ADC Evaluation Board for 16-Bit MCUs. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the MCP3913 ADC Evaluation Board for 16-Bit MCUs as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Provides important information about the MCP3913 ADC Evaluation Board for 16-Bit MCUs hardware.
- **Chapter 2. “Hardware Description”** – Provides information about the evaluation board software.
- **Chapter 3. “Firmware”** – Describes the MCP3913 ADC Evaluation Board for 16-Bit MCUs firmware.
- **Appendix A. “Schematics and Layouts”** – Shows the schematic and board layouts for the MCP3913 ADC Evaluation Board for 16-Bit MCUs.
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MCP3913 ADC Evaluation Board for 16-Bit MCUs.

MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB[®] IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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	<u><i>File>Save</i></u>
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	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [options]
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}
Ellipses...	Replaces repeated text	var_name [, var_name...]
	Represents code supplied by user	void main (void) { ... }

RECOMMENDED READING

This user's guide describes how to use MCP3913 ADC Evaluation Board for 16-Bit MCUs. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

- **MCP3913 Data Sheet – “3V Six-Channel Analog Front End” (DS20000000)**

THE MICROCHIP WEB SITE

Microchip provides online support via 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

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 field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

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

DOCUMENT REVISION HISTORY

Revision A (October 2013)

- Initial release of this document.

MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

NOTES:



MCP3913 ADC EVALUATION BOARD FOR 16-BIT MCUs USER'S GUIDE

Chapter 1. Product Overview

1.1 OVERVIEW

The MCP3913 ADC Evaluation Board for 16-Bit MCUs system provides the opportunity to evaluate the performance of the MCP3913 six-channel Analog Front End (AFE). It also provides a development platform for 16-bit microcontroller-based applications, using the existing 100-pin PIC[®] microcontroller Plug-in Module (PIM) systems that are compatible with the Explorer 16 and other high pin count PIC device based demo boards. The system comes with a programmed PIC24FJ256GA110 PIM module that communicates with the Energy Management Utility software for data exchange and ADC setup.

The MCP3913 ADC Evaluation Board for 16-Bit MCUs uses the Energy Management Utility software for evaluation of the MCP3913 via a USB connection to the board. A download link for this software can be found on the evaluation board's web page. For instructions on the use of this software, refer to the supporting documentation included within the application install package.

1.1.1 Feature Highlights

- Six-channel ADC MCP3913 output display using serial communication to the PC software interface.
- Simultaneous 57 ksp/s at OSR32 address loop ALL or 95 dB SINAD at OSR512 performance on MCP3913.
- System and ADC performance analysis through graphical PC tools showing noise histogram, frequency domain (FFT), time domain scope plot, and statistical numerical analysis.
- Robust hardware design with analog grounding and analog/digital separation, allowing low noise evaluation of the MCP3913 device; includes separate power supplies and power planes on a four-layer board.
- PICtail™ Plus connectors for Explorer 16 daughter board compatibility.

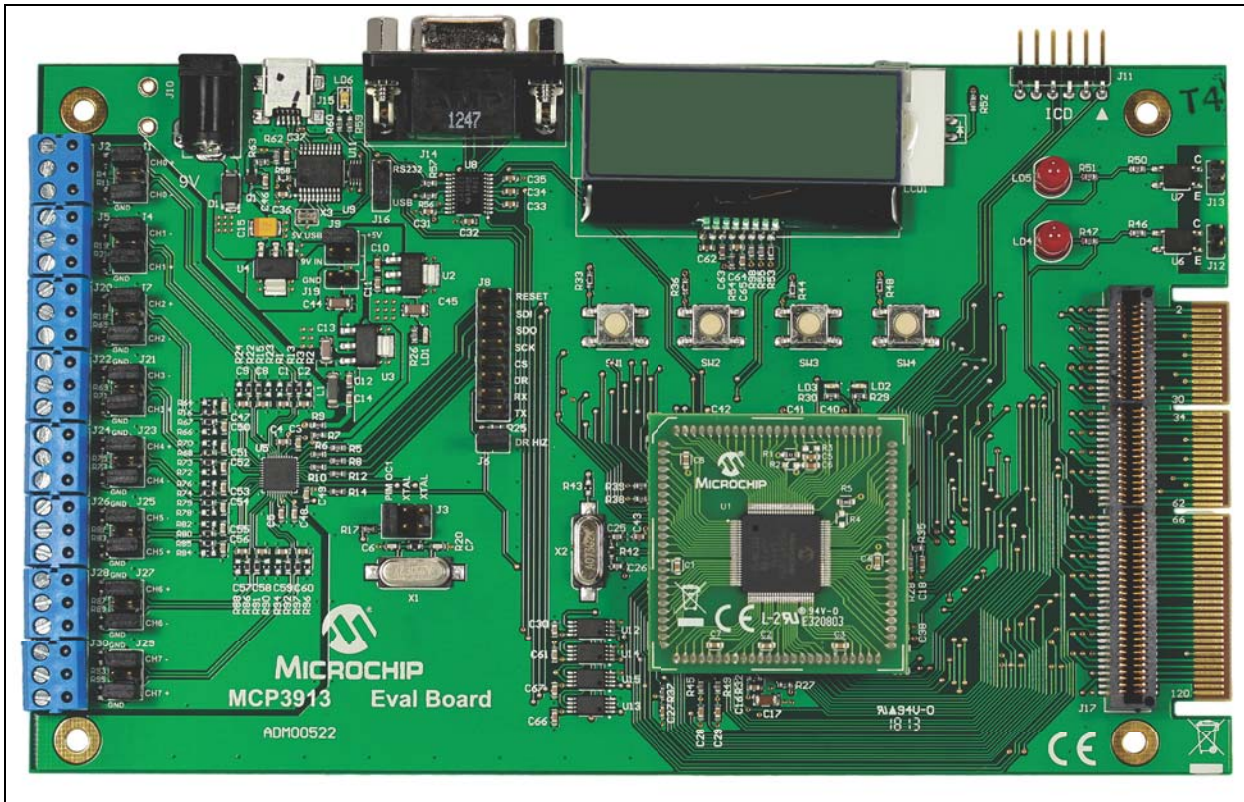


FIGURE 1-1: MCP3913 Evaluation Board.

1.2 WHAT THE MCP3913 ADC EVALUATION BOARD FOR 16-BIT MCUS CONTAINS

This MCP3913 ADC Evaluation Board for 16-Bit MCUs kit includes:

- MCP3913 ADC Evaluation Board for 16-Bit MCUs (Part number ADM00522)
- PIC24FJ256GA110 PIM
- USB Cable
- Important Information Sheet

Chapter 2. Hardware Description

2.1 PIM MODULE/MCP3913 CONNECTION AND PERIPHERAL USAGE OVERVIEW

The MCP3913 ADC Evaluation Board for 16-Bit MCUs contains a 100-pin PIM socket compatible with Microchip's PIM modules. The system comes with one PIM module, the PIC24FJ256GA110.

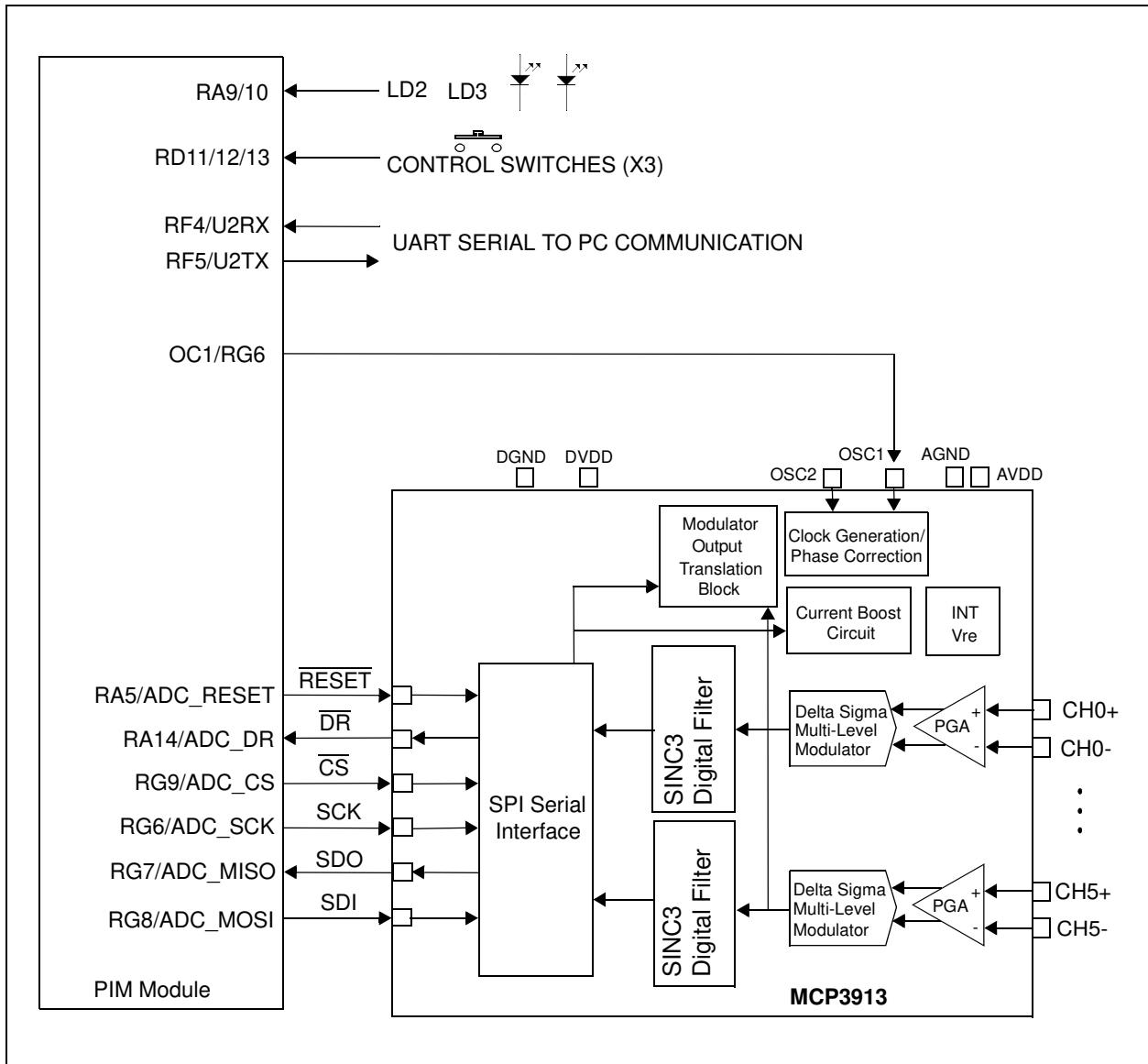


FIGURE 2-1: Digital Connection Overview PIM/MCP3913 Connections.

MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

Ports A, D, and G are used for signals such as push buttons, output LEDs, \overline{CS} and \overline{MCLR} (for the MCP3913 data mode setting). Output Compare 1 is used for clock generation in the MCP3913. Serial communication is achieved through the MSSP module 1.

The MCP3913 device is an AFE with six ADCs featuring a second order modulator and a third order sinc filter, plus a first order sinc filter used for higher OSR's values. The delta-sigma A/D converters have an adjustable oversampling ratio. The CLKIN pin of the MCP3913 is the oversampling clock (MCLK) input. The MCP3913 ADC Evaluation Board for 16-Bit MCUs offers two different options for the MCP3913 master clock (MCLK). The default setting for the ADC internal clock is an external clock driven by the MCU.

2.1.1 Using the Crystal X1

The MCP3913 ADC Evaluation Board for 16-Bit MCUs is populated with a 10 MHz crystal, used as a clock source, by placing jumpers in the following position on the MCP3913 Digital I/O header block:

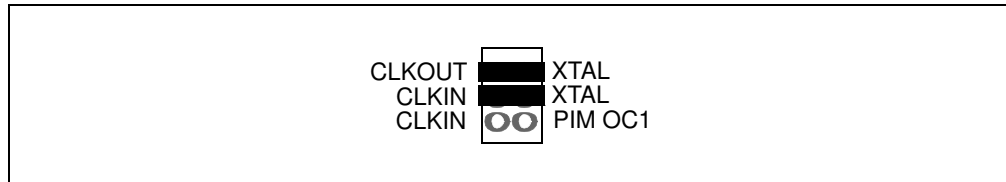


FIGURE 2-2: ADC Clock Selection Jumpers – External Crystal.

2.1.2 Driving the Clock with the PIM Module

The PIC MCU can be used to generate the CLKIN (MCLK) signal for the MCP3913, setting the ADC sample rate through the use of the output compare module OC1. To use this feature, make the following jumper change to the MCP3913 Digital I/O header block:

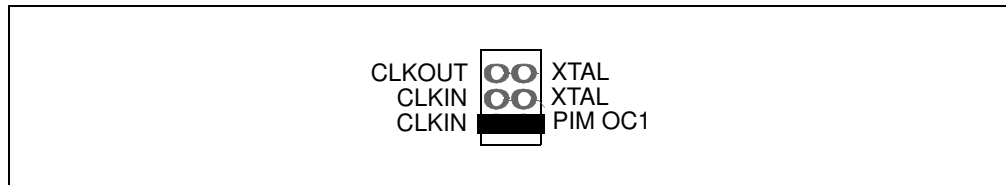


FIGURE 2-3: ADC Clock Selection Jumpers – Clock from MCU.

The frequency of the OC1 output is based on the PR1 bit settings in the firmware.

2.2 ANALOG INPUT STRUCTURE

Six differential input paths allow external signal sources to be easily connected to the MCP3913 inputs. Screw-terminal connectors J1, J4, J7, J21, J23, J25, J27 and J29 are 3-pin connectors that act as both screw-type and clip-on post connectors.

Note: To use a screw-terminal connector as a post connector, pull up the blue plastic top to access the posts.

The connectors J1, J4, J7, J21, J23 and J25 can be used to force either channel from a differential to single-ended configuration. R4 and R11 (on CH0), R19 and R21 (on CH1) R18 and R65 (on CH2), R69 and R71 (on CH3), R75 and R77 (on CH4), and R81 and RR83 (on CH5) act as locations for burden resistor connectors for any current transformer inputs.

2.3 UNIVERSAL SERIAL BUS (USB)

The MCP3913 ADC Evaluation Board for 16-Bit MCUs also contains a USB connection for connecting the evaluation board to a PC. On the board, there is an MCP2200 USB to UART converter that creates a virtual COM port on the PC. The MCP3913 ADC Evaluation Board for 16-Bit MCUs also features an RS-232 connector, just in case it is required. The RS-232 line driver is connected to the same UART pins of the MCU. For this reason, a 3-pin jumper (J16) is present on the evaluation board to select which serial communication will be used: USB or RS-232. The following figure summarizes the connections between the ADC, MCU, USB to serial converter and the RS-232 line driver.

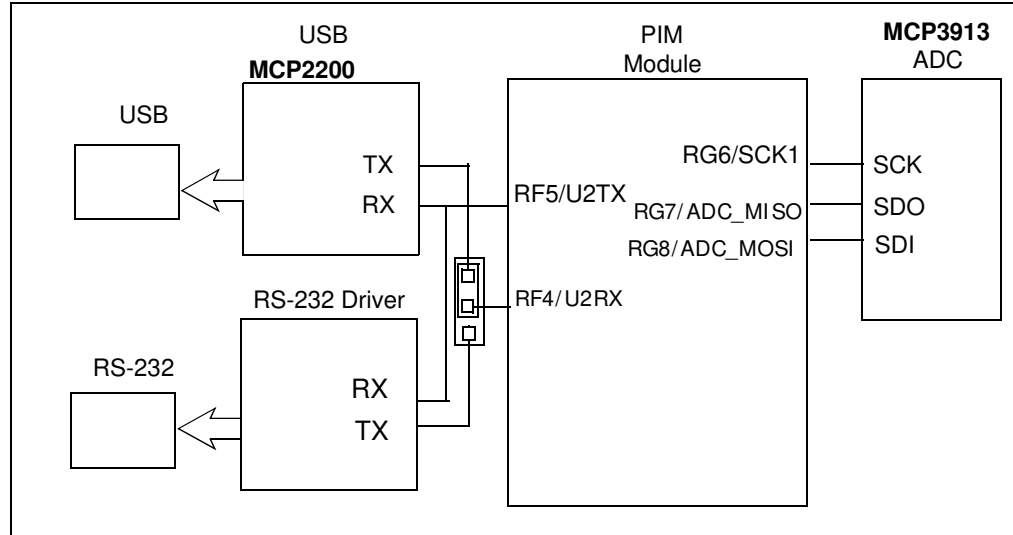


FIGURE 2-4: USB Block Diagram.

The MCP2200 is powered from the USB with 5V. The Q1 transistor (see [Appendix A](#)) is used to disconnect the board from the PC when it is powered down to avoid power consumption. By changing the jumper J9 setting, the user can select the source of the power supply for the board to be either +5V derived from the USB or an external +9V power supply.

Since the PIC24F runs at 3.3V, a level shifter was used to modify the signal level to 5V as required by the MCP2200; this is done with U11 (see [Appendix A](#)).

The 7.3728 MHz value of the crystal is required to achieve the correct baud rate values for higher speed. This design uses a baud rate of 921.6 kbaud and for this baud rate, the register (U1BRG) value is 3 (decimal).

MCP3913 ADC Evaluation Board for 16-Bit MCUs User's Guide

NOTES:

Chapter 3. Firmware

3.1 PIC24FJ256GA110 FIRMWARE DESCRIPTION

3.1.1 MCU Initialization

The microcontroller used for the code example is the 16-bit XLP with 16 MIPS PIC24FJ256GA110. The MCU has remappable pins and output compare with a dedicated time base.

The MCU uses a 7.3278 MHz crystal for the clock and the internal PLL to increase the frequency by four times. The uncommon crystal value was chosen to obtain the correct baud rate, even for high baud rates. The remappable pins are configured to make the PIM compatible with the Explorer 16 development board. The MCP3913 is linked with the MCU through the SPI1 port. The ADC clock is given by OC1. The DR pin of the MCP3913 is tied to external Interrupt 2.

Serial data transmission is carried out through the UART2 module. For transmission, OC2 interrupt is used; for receiving, the _U1RX Interrupt is used. The UART communication speed is 921.6 kbaud. OC2 is used for the serial transmission to create short bursts of data that can be processed by the MCP2200. Sending too many characters, with no time between them at the current baud rate, will cause the MCP2200 to lose data.

<p>Note: The PIC24FJ256GA110 must be Rev. A5 or newer, in order for this code example to work.</p>

3.2 DATA ACQUISITION

External Interrupt 2 is used for detecting the end of conversion on the MCP3913. In the INT2 Interrupt, the data samples are read from the ADC using SPI.

When a new buffer begins to be read, Timer4 is started. This is set as a 32-bit timer together with Timer5. It will be stopped when the buffer is full and is used to measure the sampling speed.

Before reading the data samples, the MCU investigates the address loop setting (READ <1:0> bits) in the STATUSCOM register and adjusts the read sequence accordingly (when the address is not incremented automatically in hardware, the MCU has to do that in firmware, leading to a longer read sequence). The acquired samples are written in six long vectors created in the RAM of the MCU. The six vectors hold the first, second and third byte from both channels.

The vectors have a length of 2048. The value of Timer 4, and the values of the other registers inside the ADC, are stored in a vector called "internal_registers[26]".

3.3 UART COMMUNICATION PROTOCOL

The serial connection is used to send the acquired data to the PC at a speed of 921.6 kbaud, and the MCP2200 is used for the UART-to-USB conversion.

The communication uses handshaking, meaning that the board will not send data to the PC unless the board receives a command from the PC.

The UART transmission is triggered by the output compare module OC2. This allows the data to be transmitted to the PC in short bursts that are separated by a dead time. This method of sending data allows the MCP2200 to handle the high throughput. If the entire amount of data is sent continuously to the PC at the current baud rate, the MCP2200 will not be able to process the data for correct USB transfer.

After a complete transmission, the UART RX interrupt is enabled by increasing its priority, while all other interrupts have lower priorities. In this interrupt, the MCU needs to receive the values of the internal registers as the user is setting them in the PC GUI.



MCP3913 ADC EVALUATION BOARD FOR 16-BIT MCUs USER'S GUIDE

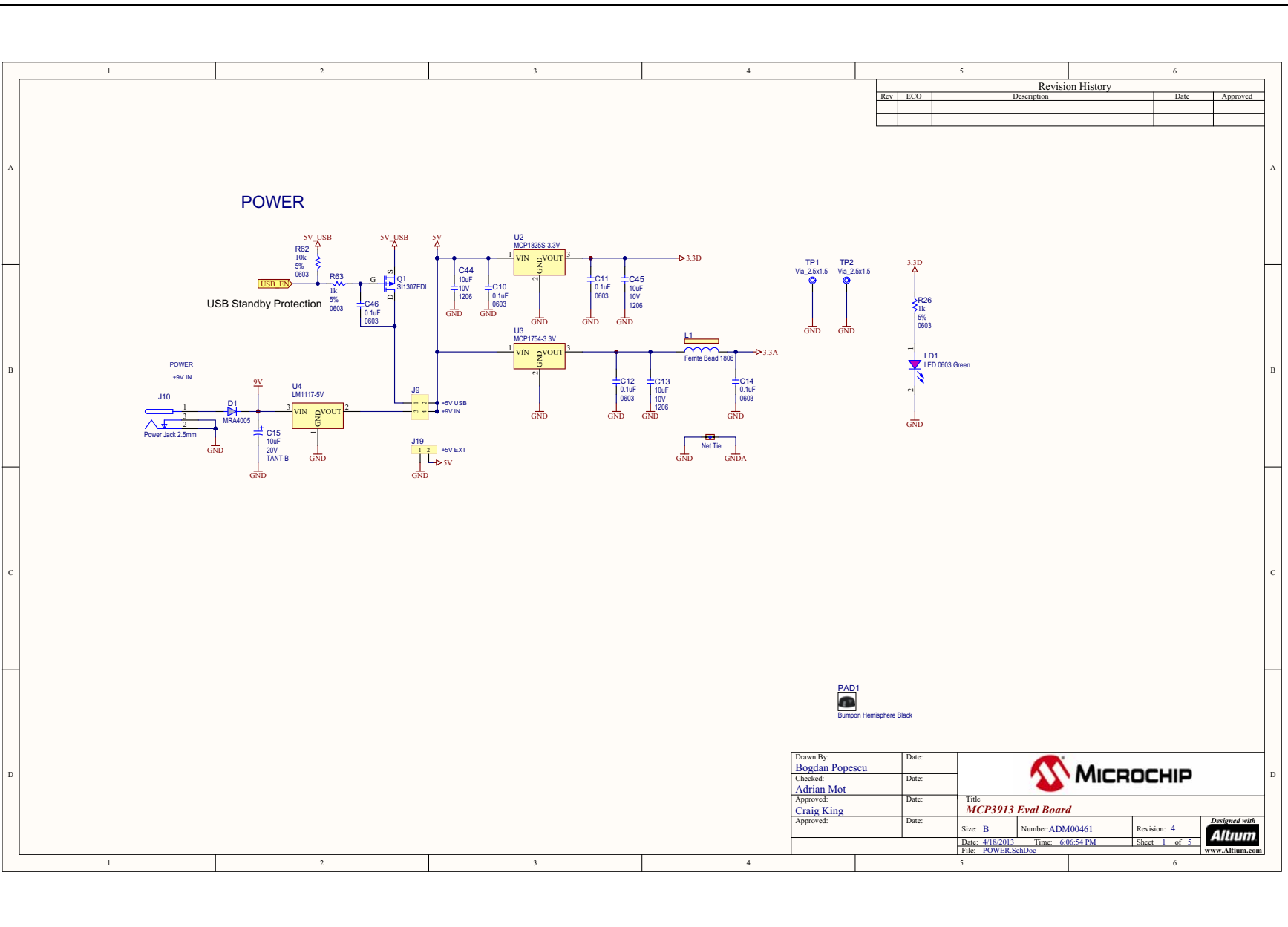
Appendix A. Schematics and Layouts

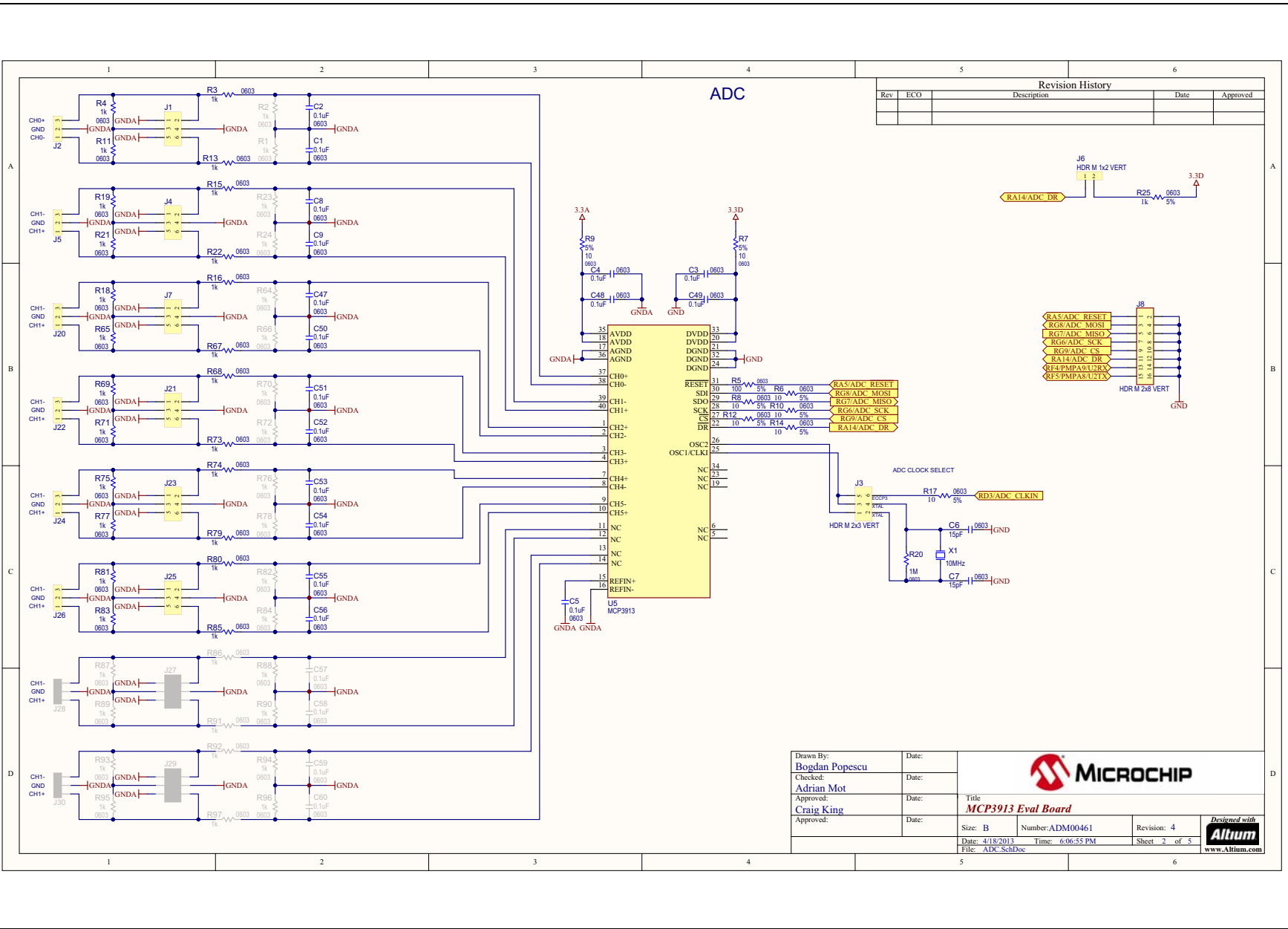
A.1 INTRODUCTION

This appendix contains the following schematics of the MCP3913 ADC Evaluation Board for 16-Bit MCUs:

- Schematic – Power
- Schematic – ADC
- Schematic – Microcontroller (MCU)
- Schematic – PIM Module
- Schematic – LCD and UART
- Board – Top Trace and Top Silk
- Board – Bottom Trace and Bottom Silk
- Board – Layer #2 GND
- Board – Layer #3 V_{DD}
- Board – Top Silk and Pads
- Board – Bottom Silk and Pads

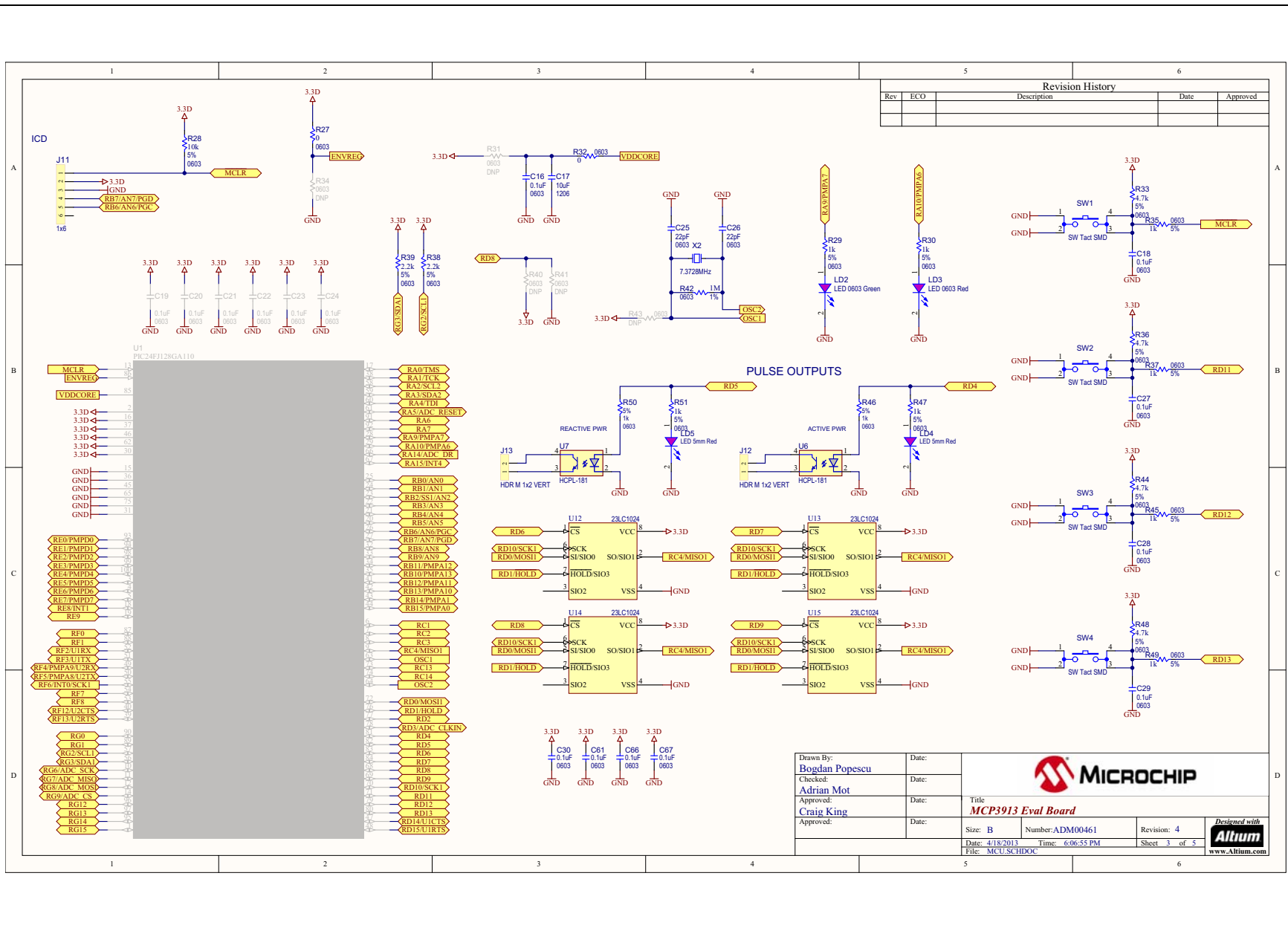
A.2 SCHEMATIC – POWER

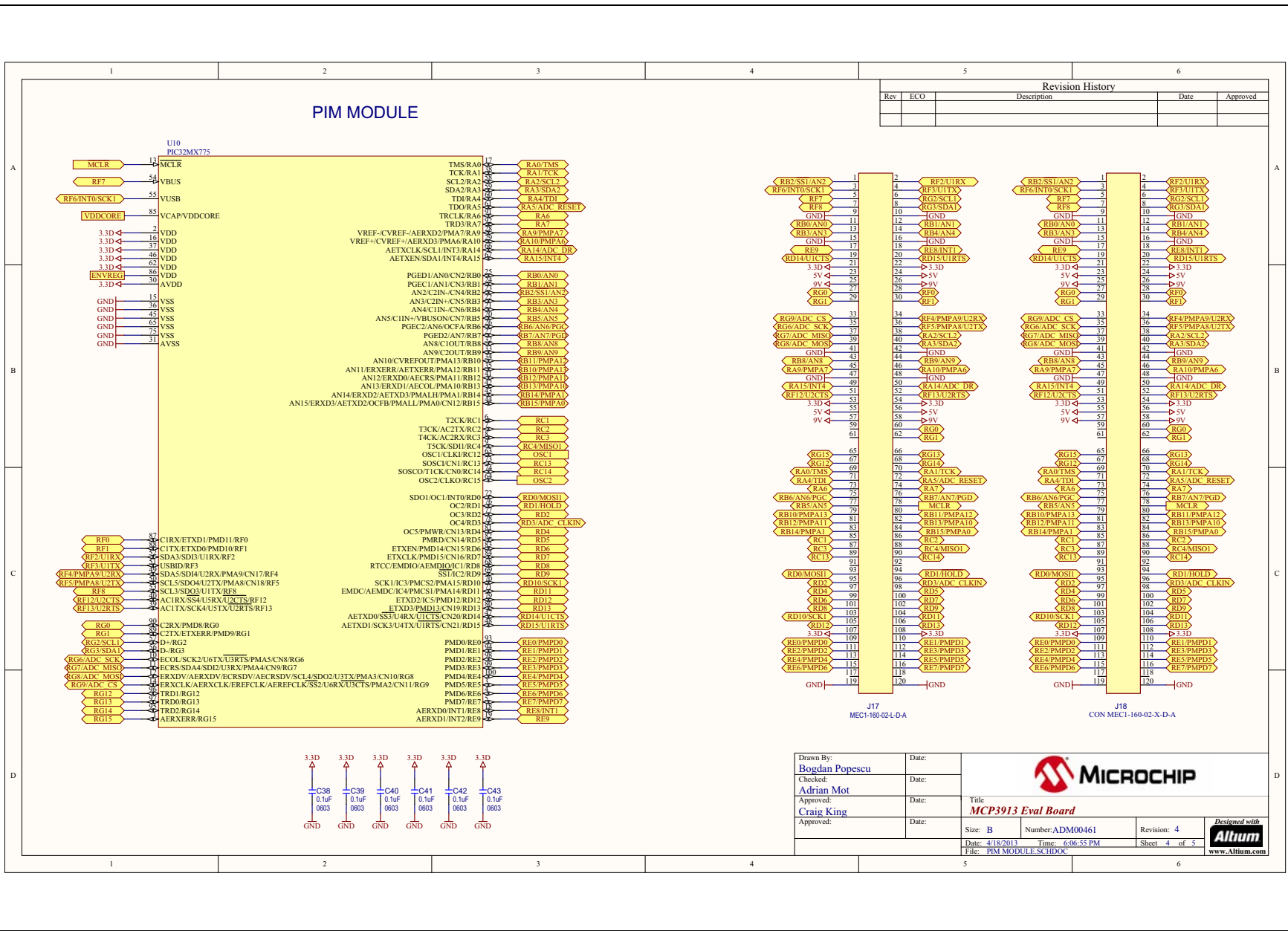




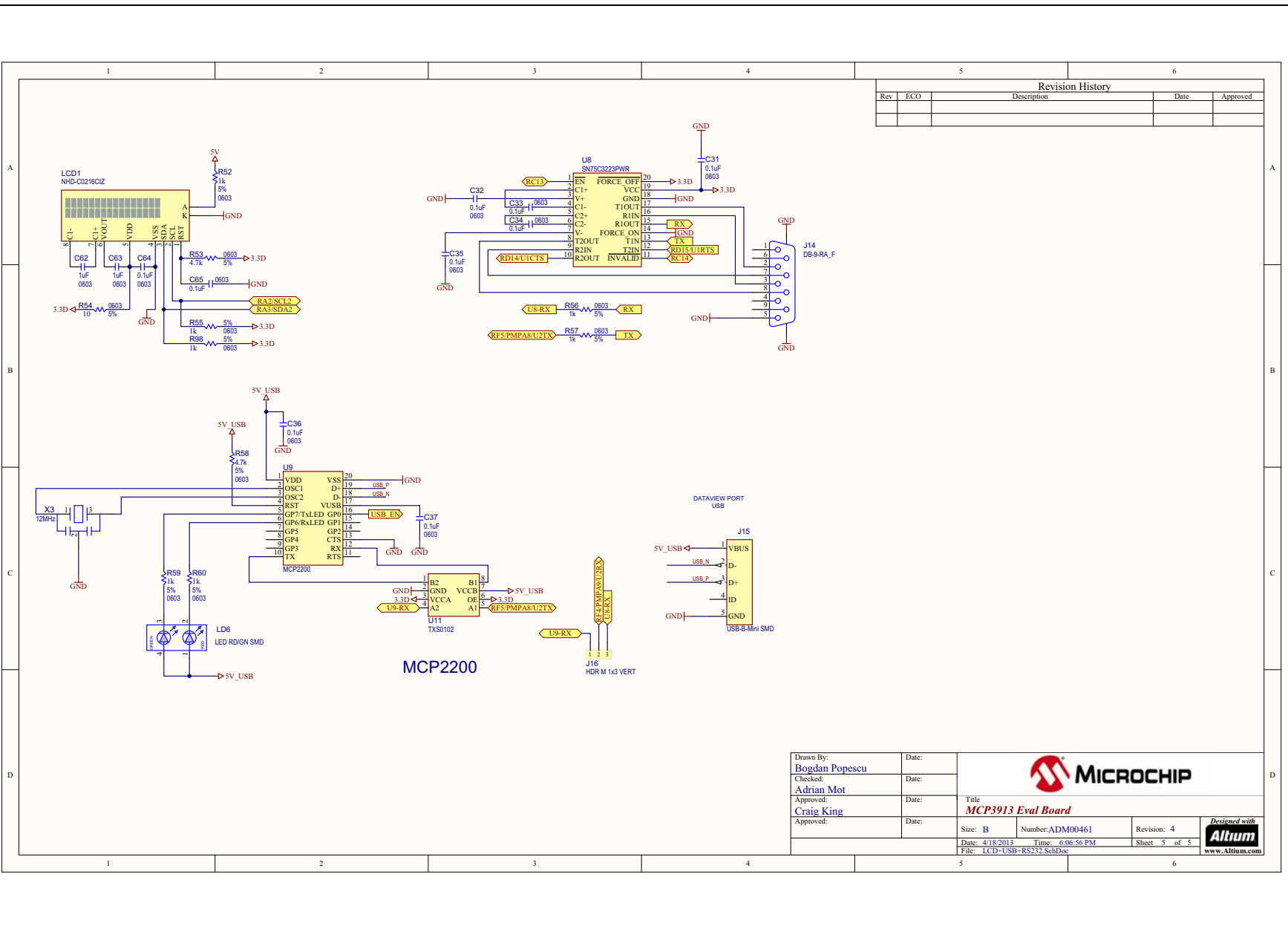
Drawn By: Bogdan Popescu	Date:		MICROCHIP
Checked: Adrian Mot	Date:		
Approved: Craig King	Date:	Title MCP3913 Eval Board	
Approved:	Date:	Size: B	Number: ADM00461
		Date: 4/18/2013	Time: 6:06:55 PM
		File: ADC_SchDoc	Revision: 4
			Sheet 2 of 5
			Altium www.Altium.com



A.4 SCHEMATIC – MICROCONTROLLER (MCU)



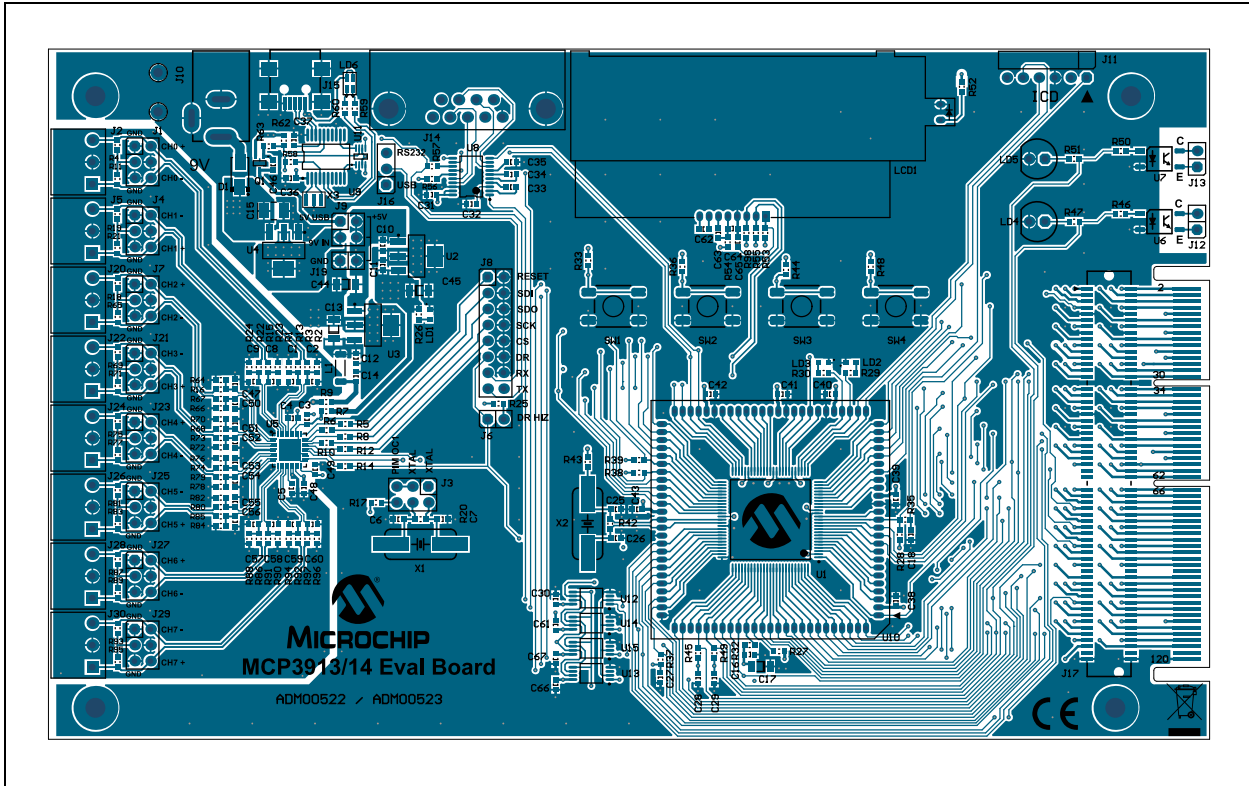


A.6 SCHEMATIC – LCD AND UART



Drawn By: Bogdan Popescu	Date:		MICROCHIP
Checked: Adrian Mot	Date:		
Approved: Craig King	Date:	Title MCP3913 Eval Board	
Approved:	Date:	Size: B	Number: ADM00461
		Date: 4/18/2013	Time: 6:06:56 PM
		File: LCD+USB+RS232.SchDoc	Revision: 4
			Sheet 5 of 5
		 www.Altium.com	

A.7 BOARD – TOP TRACE AND TOP SILK



A.8 BOARD – BOTTOM TRACE AND BOTTOM SILK

