MCP355X Sensor Application Developer's Board User's Guide

MCP355X SENSOR APPLICATION DEVELOPER'S BOARD USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

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

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

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP355X Sensor Application Developer's Board. 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 MCP355X Sensor Application Developer's Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP355X Sensor Application Developer's Board.
- **Chapter 2. "Hardware Description"**– Includes detailed description of the hardware for the MCP355X Sensor Application Developer's Board.
- **Chapter 3. "Firmware Description"** – Includes detailed description of the software for the MCP355X Sensor Application Developer's Board.
- **Chapter 4. "DataView"** - Includes detail description of the DataView software.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP355X Sensor Application Developer's Board.
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the MCP355X Sensor Application Developer's Board

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

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

RECOMMENDED READING

This user's guide describes how to use MCP355X Sensor Application Developer's Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP3550/1/3 Data Sheet, *"Low-Power Single Channel 22-Bit Delta-Sigma ADCs"* (DS21950)

This data sheet provides detailed information regarding the MCP3550/1/3 device.

AN1007, *"Designing With The MCP3551 Delta Sigma ADC"* (DS01007)

This application note documents the design decisions associated with this device.

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
- Development Systems Information Line

Customers should contact their distributor, representative or field application engineer 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 (June 2006)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP355X Sensor Application Developer's Board and covers the following topics:

- What is the MCP355X Sensor Application Developer's Board?
- What the MCP355X Sensor Application Developer's Board Kit includes

1.2 WHAT IS THE MCP355X SENSOR APPLICATION DEVELOPER'S BOARD?

The MCP355X Sensor Application Developer's Board allows for easy system design of high resolution systems such as weigh scale, temperature sensing, or other small signal systems requiring precise signal conditioning circuits. The reference design includes firmware that performs all the necessary functions including ADC sampling, USB communication for PC data analysis, LCD display output, zero cancellation, full scale calibration, and units display in gram (g), kilogram (kg), or ADC output units. Figure 1-1 shows the LCD display output in kg of a high resolution system.

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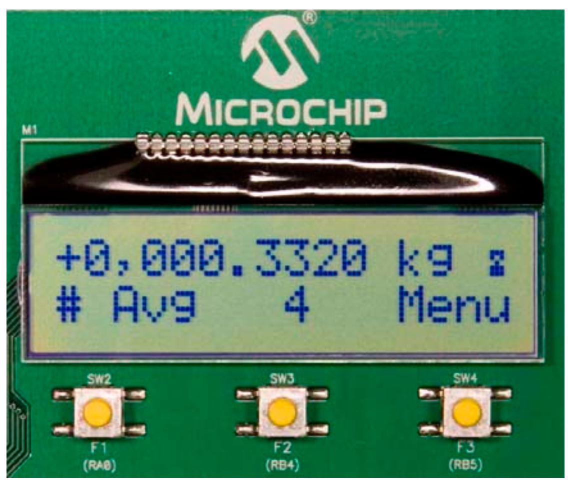

FIGURE 1-1: *MCP355X Sensor Application Developer's Board LCD showing weigh scale output in kilograms.*

Reference Design Features:

- Signal Conditioning Circuit Selection and Gain Selection
- Voltage Reference Selection
- PICmicro® microcontroller sockets and LCD for firmware development on-board
- Preprogrammed LCD firmware for ADC Output in g, kg or system code
- DataView USB connection for easy PC evaluation of system error
- High Resolution System Board Design

1.3 WHAT THE MCP355X SENSOR APPLICATION DEVELOPER'S BOARD KIT INCLUDES

This MCP355X Sensor Application Developer's Board Kit includes:

- The MCP355X Sensor Application Developer's Board, 102-00090
- MCP355X Sensor Application Developer's Board User's Guide (DS-51609)
- MCP3550/1/3 Data Sheet, *"Low-Power Single Channel 22-Bit Delta Sigma ADCs"* (DS21950)
- AN1030, *"Weigh Scale Applications for the MCP3551"* (DS01030)

Chapter 2. Hardware Description

2.1 OVERVIEW

The MCP355X Sensor Application Developer's Board's purpose is to ease development of small signal sensor MCP355X applications such as weigh scales. There are two circuits, or channels, to allow for comparison of different approaches to signal conditioning circuits. The first channel is a low-cost, low-power signal conditioning circuit that uses Microchip's MCP6XX amplifiers. This circuit is intended to be a reference design for low power, low cost MCP355X applications requiring intermediate ranges of signal gain.

The second channel uses a precision amplifier with high gain. It is intended to be a reference design for MCP355X circuits that can require higher resolution.

The board has jumper connections and screw terminals to connect external sensors such as load cells or RTD temperature sensors. The board easily accomodates both 4-wire and 6-wire load cells sensor connections.

The system includes two PICmicro MCUs for firmware development and data analysis through either an LCD display or graphically on a PC using a USB connection. A PIC16F877 communicates with the two MCP355X channels, push-buttons and LCD display.

For data analysis on the PC the USB PIC18F4550 is used. This device collects the post processed PIC16F877 data and passes it via USB to the PC for display on DataView software.

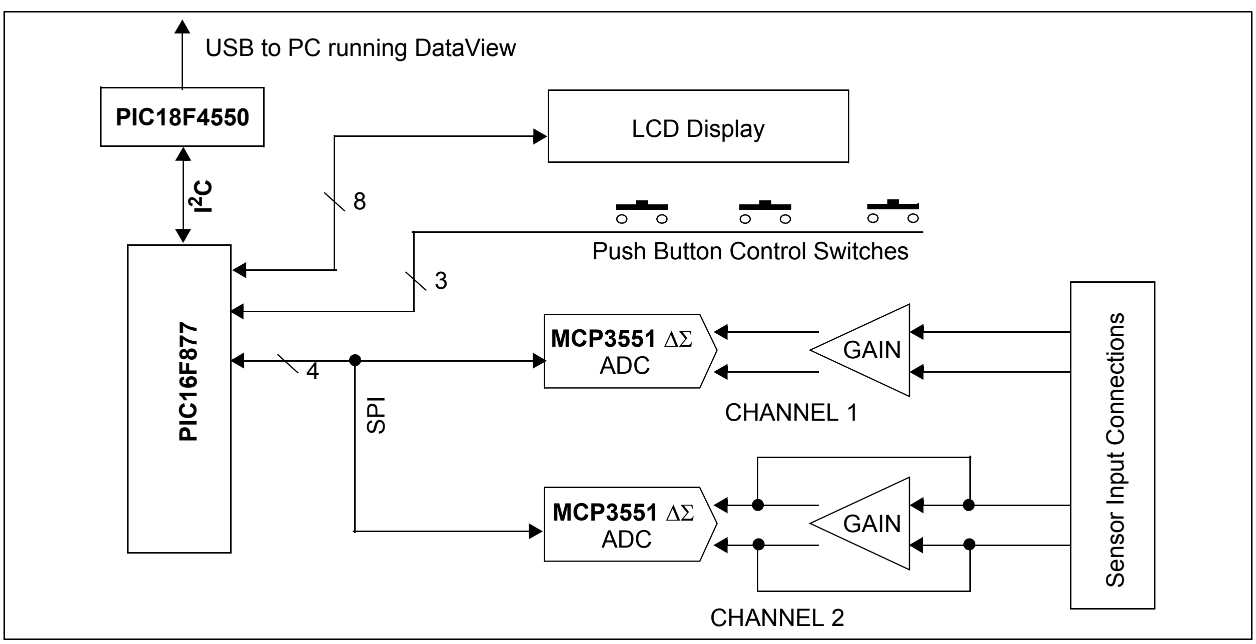

FIGURE 2-1: *MCP355X Sensor Application Developer's Board Functional Block Diagram and Results.*

The following table shows example noise results of the two different channels.

TABLE 2-1: MCP355X SENSOR APPLICATION DEVELOPER'S BOARD CHANNEL PERFORMANCE EXAMPLE RESULTS (NOTE 1)

Channel	Effective Number of Bits (ENOB)	"Noise-free" ENOB	"Noise-free Resolution"
Channel 1	15.8	13.1	8,800:1
Channel 2	18.8	16.1	70,000:1
Direct Connection (No Gain)	13	10.4	1,350:1

Note 1: Higher resolution systems are possible with averaging and other design approaches, table only serves as an example. Sensor used for these results was a 200 kg external load cell. Amplifier used in Channel 1 was MCP617 device. Amplifier used in Channel 2 was CS3002. All results using MCP3551 A/D Converter.

2.2 SENSOR INPUT CONNECTIONS

There are three connectors located on the right hand side of the board for external sensor input. The first is a standard DB9 connector that goes to a dual row 10-pin header. Jumper wires must be used to connect the output of the header to the 12-pin dual row headers going into either of the differential gain circuits described below.

In addition, there are two 3-terminal screw connectors, AUX1 and AUX2. These connectors go directly into the right hand side of the 40-pin dual row connector P8.

> **Note:** ***Connector P6 is the input for channel 1, and P7 is the input for channel 2. Depending on which sensor inputs (AUX1, AUX2, or the DB9 connector) are used to connect the external sensor to either channel, jumper wires must be connected to bring the input into either P6 or P7.***

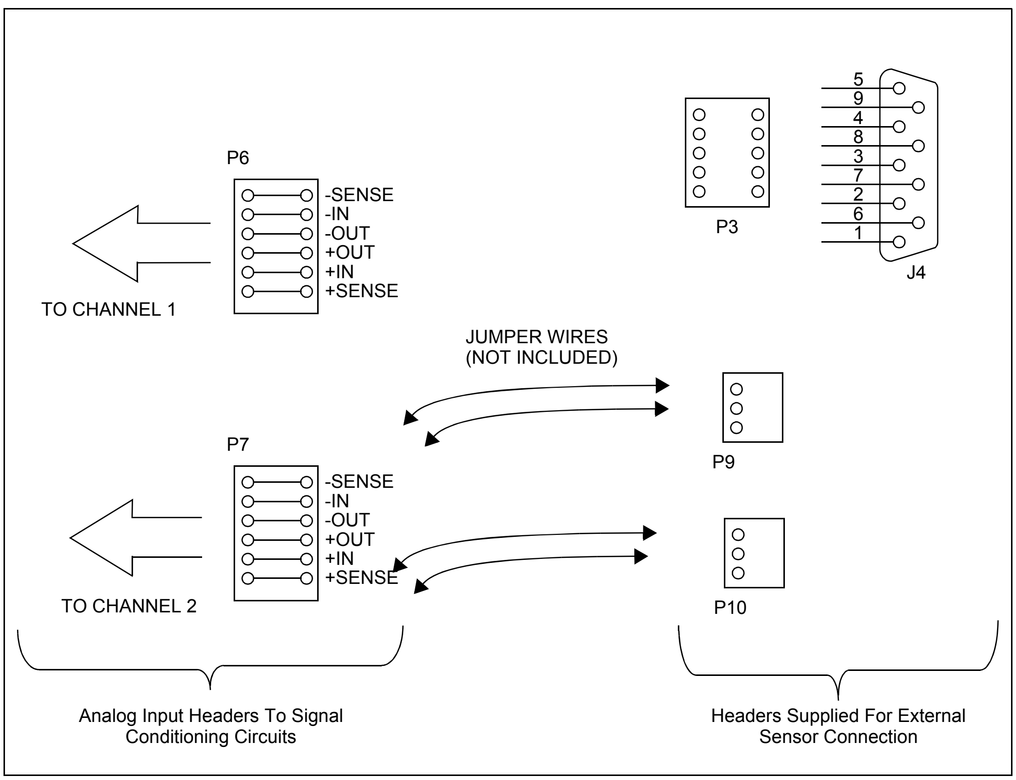

FIGURE 2-2: *Sensor Input Connections.*

2.2.1 6-Wire and 4-Wire Load Cell Connections

P6 and P7 can be used to easily connect either 4 or 6-wire external load cell sensors. Figure 2-3 describes how jumpers can be used to short the “In” and “Sense” inputs for 4-wire load cell connections.

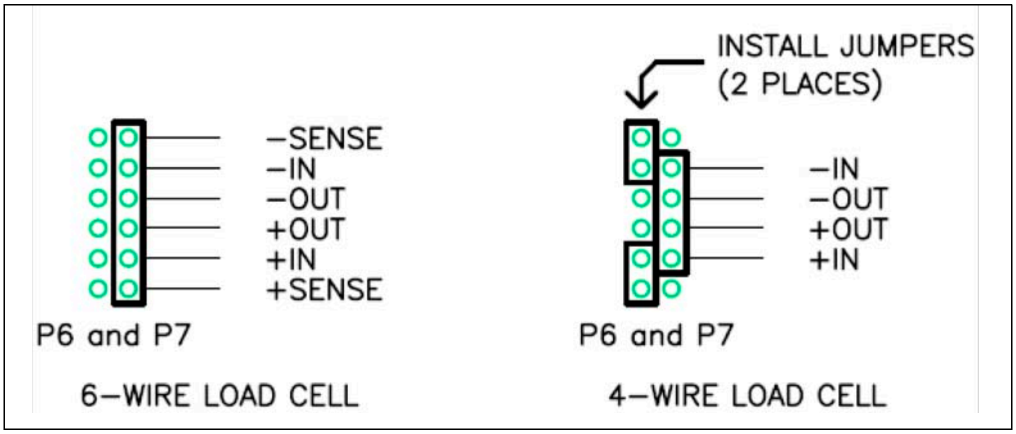

FIGURE 2-3: *6-Wire and 4-Wire Load Cell connections on P6 and P7.*

The MCP355X Sensor Application Developer’s Board comes with 2 “Bridge Simulator” Boards that can be used in place of external sensors during system development. These boards are plugged directly into P6 and P7, see **Section 2.5 “Bridge Simulator Boards”** for more information.

2.3 CHANNEL 1 - LOW-COST DIFFERENTIAL GAIN CIRCUIT USING MCP6XX AMPLIFIER

Channel 1 contains a differential gain circuit using a dual amplifier PDIP socket populated with Microchip’s MCP617 amplifier with two analog switches for offset cancellation. The goal of the circuit is to allow for the use of an operational amplifier with higher offset drift (which will generally mean a lower cost amplifier). The MCP617 is populated and configured to provide a differential gain of 21.

The board comes populated with $R_G = 100\Omega$ and $R_F = 1.0\ k\Omega$. The gain of 21 was chosen such that the voltage noise at the output of the amplifier will be approximately 10 μV_{RMS} , substantially above the 2.5 µV RMS noise of the MCP3551. Higher gains using the MCP617 amplifier will not provide any additional improvement to the system. Application note AN1030 details the operation of this circuit and also includes data and test results using a variety of external sensors.

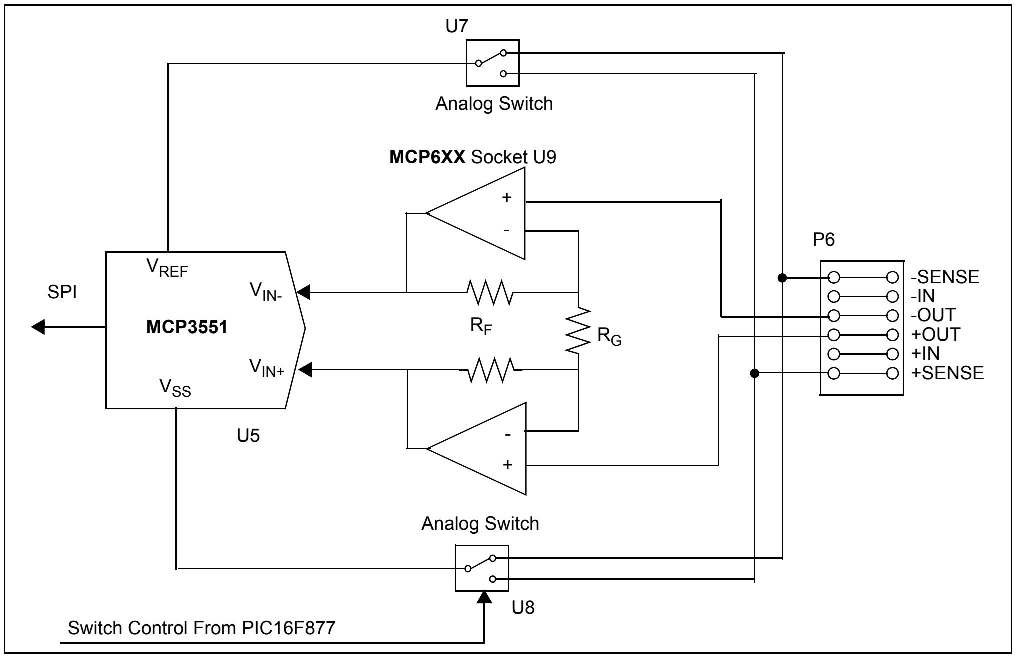

FIGURE 2-4: *Channel 1 Differential Gain Circuit with analog switch offset cancellation.*

2.3.1 Channel 1 Analog Switches and Offset Drift Cancellation

The analog switches are used with the amplifier to swap the sources driving the load cell, effectively cancelling any offset or offset drift. One conversion is performed with the load cell driven "normally" and a second while it is driven in an "inverted" configuration. The result of the second conversion is inverted and added to the result from the first and an average of the two is computed (computing the average is a simple shift operation for the microcontroller). This technique effectively cancels the offset of the amplifiers as well as the ADC. An offset residue will exist if the any of the offsets change between conversions. This is unlikely to happen unless the temperature changes rapidly after the first conversion. The offset of the sensor is not affected by this technique.

The firmware included with this developer's board performs this process when "Channel 1" is selected using the push button switches.

This process is described here:

1. Stop the output drive by configuring the outputs of the PICmicro MCU that drive the load cell as low.
2. Control the analog switches and switch the ground of the MCP3551 to the "bottom" of the load cell and the reference of the MCP3551 to the "top" of the load cell.
3. Start the output drive by configuring the output of the PICmicro MCU that drives the "top" of the load cell as high.
4. Perform a conversion and save the result.
5. Stop the output drive by configuring both outputs of the PICmicro MCU that drive the load cell as low.
6. Control the analog switches and switch the ground of the MCP3551 to the "top" of the load cell and the reference of the MCP3551 to the "bottom" of the load cell.
7. Start the output drive by configuring the output of the PICmicro MCU that drives the "bottom" of the load cell as high.
8. Perform a conversion, invert the result, add to the first conversion, divide by two, and save the result as the actual reading.

2.4 CHANNEL 2 - HIGH-PRECISION GAIN CIRCUIT

Channel 2 contains a differential gain circuit using a low noise amplifier from Cirrus Logic, CS3002. The noise allows a differential amplifier gain of 103 V/V.

EQUATION 2-1:

$$G = 1 + 2\left\langle \frac{R_F}{R_G} \right\rangle$$

This was chosen so that the amplifier noise would be similar to that of the MCP3551 device, maximizing the resolution of the circuit. The board comes populated with $R_G = 100\Omega$ and $R_F = 5.1\ k\Omega$. Higher gains can be chosen, however in this case, the gain was chosen to allow for headroom near the supply rails (+5V and ground) to handle a large variety of sensors. For more information regarding gain selection and circuit results, refer to application note AN1030, *"Weigh Scale Applications for the MCP3551".*

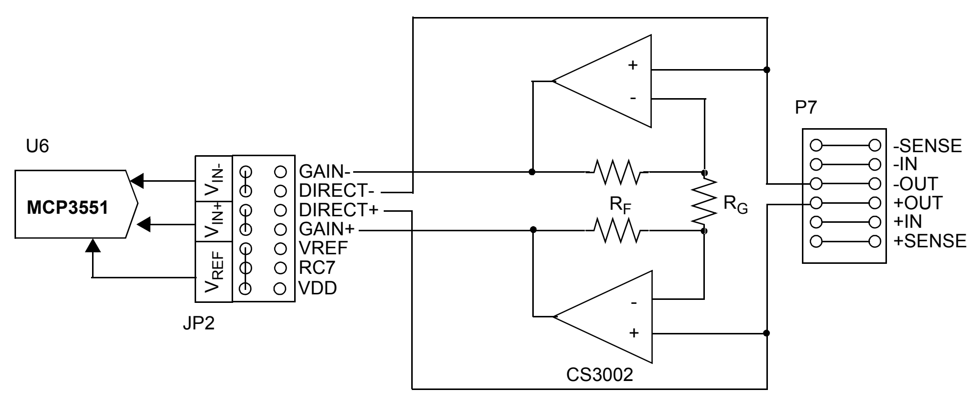

FIGURE 2-5: *High Gain Circuit Using CS3002.*

2.4.1 Channel 2 - Voltage Reference Selection

There are three options to select voltage reference for the MCP355X device for channel 2. This is accomplished using the 14-pin dual row header JP2. There are three options for voltage reference evaluation on the bottom of this header.

- V_{REF}
- PICmicro port pin RC6-7
- V_{DD}

The first selection uses the stand-alone voltage reference circuit included on the board, populated with the low noise reference LM4140 from National Semiconductor® Corporation.The second selection allows for evaluation of using the PICmicro port pins to supply the voltage reference for the circuit. The board uses two pins of the PICmicro microcontroller for increased drive, RC6 and RC7 of the PIC16F877. The third selection, V_{DD}, will supply the V_{REF} directly from the output of JP1, which selects the power supply for the board.

2.4.2 Channel 2 - Direct-Connect Applications (No Amplifier or Gain)

Channel 2 can also be used to evaluate the MCP355X in a direct-connect sensor configuration. This is accomplished using the 14-pin dual row header JP2. Changing the headers to DIRECT+ and DIRECT- will take the signal present on the channel input header (P7) directly into the MCP355X. Figure 2-6 represents this circuit configuration using channel 2.

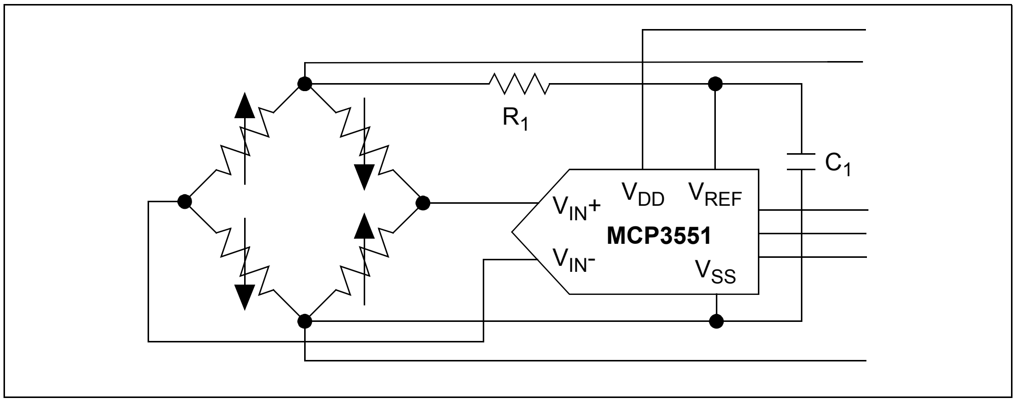

FIGURE 2-6: *A Direct-connect Weigh Scale.*

2.5 BRIDGE SIMULATOR BOARDS

There are two small boards included with the MCP355X Sensor Application Developer's Board. These boards represent a simulation of an external wheatstone bridge that is either at zero-scale or full-scale. These boards come populated with resistors that have a temperature drift specification of 10 ppm/C. For the best bridge simulation, it is recommended that the bridges be populated with *very* low drift resistors with a tempco value of 0.1 ppm/C. Typical load cell bridges will exhibit this output temperature drift. These boards can be plugged in to either P6 or P7 to assist in eliminating any error associated with an external sensor. Figure 2-7 represents the bridge simulator boards and how they should be connected to the MCP355X Sensor Application Developer's Board. Refer to **Appendix A. "Schematic and Layouts"** for complete schematic.

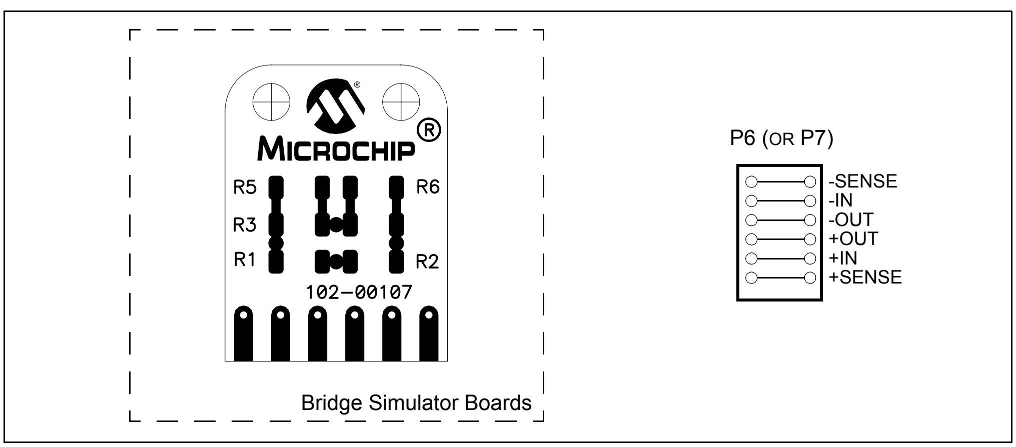

FIGURE 2-7: *Bridge Simulator Boards.*

Chapter 3. Firmware Description

3.1 FIRMWARE OVERVIEW

The MCP355X Sensor Application Developer's Board contains two PICmicro MCUs, the PIC18F4550, which is solely used to send ADC data to DataView on the PC and the PIC16F877 which interfaces to the LCD display. Both controllers come programmed with dedicated firmware that is described in this chapter.

3.2 PIC16F877

This device comes programmed with LCD firmware to ease weigh scale or other system design. The three push buttons F1, F2, and F3 control both the MCP3551 sampling and LCD output through the PIC16F877.

3.2.1 LCD Numerical Output Display

This display will change depending on the units selected and the values that are loaded into the zero calibrate, full-scale calibrate, and full-scale value registers. To show raw ADC output, the unit menu is used to select A/D units. When grams (g), or kilograms (kg) is selected, Equation 3-1 represents the algorithm and formula applied to yield an output on the LCD display.

EQUATION 3-1:

$$Output = \left(\frac{ADC_{VAL} - ZERO_{CAL}}{FS_{CAL}}\right) \times DISPLAY\_FS\_VAL$$

Where:

ADC_{VAL}	=	The most recent value from the ADC after averaging.
$ZERO_{CAL}$	=	The most recent ADC_{VAL} when the calibrate zero switch is pressed.
FS_{CAL}	=	The most recent (ADC_{VAL} - $ZERO_{CAL}$) when the calibrate full-scale switch is pressed.
DISPLAY_FS_VAL	=	1, 2, 5, 10, 20, 50, 100, 200, or 500 (value selected using push button switches.) See **Section 3.2.2.5 "Full-Scale Value Selection"**

Note: The $ZERO_{CAL}$ subtraction to remove zero offset can be enabled or disabled. See **Section 3.2.2.1 "Zero calibrate"** for complete description

3.2.2 Controlling the LCD Menu

The right most button **F3** is the menu control button.

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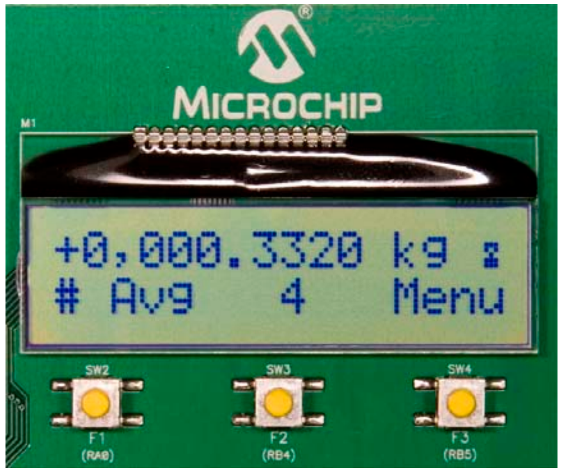


FIGURE 3-1: *LCD showing the Averaging Menu. Also shown are the F1, F2 and F3 buttons.*

Pressing this button will cycle through the menu options and change the functionality of the other two buttons, **F1** and **F2**. The LCD text above the buttons describes the functionality for the different menus.

Here are the LCD menus that can be selected using the F3 button:

- Zero Calibrate - Enable/Disable/Hold
- Channel Select
- Units
- Averaging
- Full-Scale Value Selection
- Full-Scale Calibration

There are four different menu options that will be described in individual sections.

3.2.2.1 ZERO CALIBRATE

When in this menu, the first button becomes the **ZERO** button. When this button is selected, the most recent ADC value after averaging will be loaded into the $ZERO_{CAL}$ register.

Zero calibration is also enabled or disabled by pressing the **ZERO** button. This is indicated by a change of the spinning character on the far top-right of the display, (i.e.: a LINE is inserted under the spinning character when zero calibration is turned ON.) When enabled, $ZERO_{CAL}$ is subtracted as per Equation 3-1. Refer to Figure 3-2.

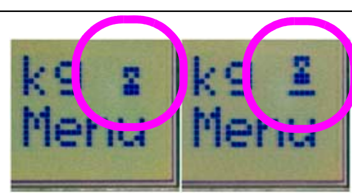


FIGURE 3-2: *These two icons show the presence of the zero offset substraction in the calculation. The icon on the right has a bar underneath that represents when zero subtraction is enabled.*

In disabled mode, $ZERO_{CAL}$ is not subtracted per Equation 3-1. When displaying the direct ADC value (units = ADU), the output is simply the decimal representation of ADC_{VAL}. If zero calibrate is enabled, then $ZERO_{CAL}$ is subtracted before the value is displayed.

Pressing the **HOLD** button freezes the LCD display to allow for viewing in fast sampling modes (less averaging). Pressing the **HOLD** button again will resume normal operation.

3.2.2.2 CHANNEL SELECT

In this menu, the user has control over which channel is being sampled. There are four options. Pressing either **F1** or **F2** cycles through these options:

Channel 1 Normal

In this mode, the PIC16F877 samples the MCP3551 on channel 1. The LCD text above **F2** will display “1N”. In the normal mode, the analog switches on this channel are set to the “positive” polarity. Refer to **Chapter 2. “Hardware Description”** for more description on the analog switch sampling.

Channel 1 Inverted

In this mode, the analog switches set to reverse polarity, and the inverted ADC sample is displayed on the LCD display. The LCD text above **F2** will display “1I”. Refer to **Chapter 2. “Hardware Description”** for more description on the analog switch sampling.

Channel 1 Switched

In this mode, the PIC16F877 is switching back and forth between positive and reverse polarity and the averaged value is displayed on the LCD display. The LCD text above **F2** will display “1S”. Refer to **Chapter 2. “Hardware Description”** for more description on the analog switch sampling.

Channel 2

In this mode, the PIC16F877 is sampling channel 2. This channel is the high gain circuit using amplifier CS3002. The resulting code is displayed on the LCD display.

3.2.2.3 UNITS

There are three units: A/D Units (ADU), grams (g), or kilograms (kg). When in this menu, pressing either **F1** or **F2** will change the text to the right of the numerical output to the proper unit and also display the appropriate representation of the A/D sample.

3.2.2.4 AVERAGING

In the averaging menu, the user can select how many samples are collected before the value is applied to the LCD output. This averaging applies all sampling situations, i.e. when calibrating zero, full scale, or displaying the output after calibration. The user can select between 1 (no averaging), 2, 4, 8, or 16 averages. The output noise of the system will be reduced by the square root of the number of averages per the equation below.

EQUATION 3-2:

$$MCP3551\ Output\ Noise = \frac{2.5\ \mu V\ RMS}{\sqrt{N}}$$

Where:

N = the number of conversions

> **Note:** If the channel mode "Channel 1 Switching" is selected, the averaging will actually be twice due to the positive and reverse polarity switched samples being collected.

3.2.2.5 FULL-SCALE VALUE SELECTION

This menu options loads the DISPLAY_FS_VAL register. This is to allow for proper LCD display during system design. For example, if a system is being designed that uses "100 grams" as the full-scale calibration weight, this menu is used to set the value "100" into the DISPLAY_FS_VAL register. The full-scale value options are 1, 2, 5, 10, 20, 50, 100, 200, or 500.

> **Note:** When displaying the value on the LCD display, the decimal point does not move. This is to relax the LCD activity and keep the decimal point (and all digits) from constantly switching location when the LCD output is calculated.

3.2.2.6 FULL-SCALE CALIBRATION

When in this menu, the second button becomes the calibrate full-scale button, labeled **OK**. When this button is selected, the most recent ADC value, after averaging, will be loaded into the FS_{CAL} register.

3.3 PIC18F4550

This device acts as I^2C slave and passes the PIC16F877 output data from either channel 1 or channel 2 to the DataView on the PC. All averaging and channel 1 switching that is performed by the PIC16F877 occurs before the data is passed to the PIC18F4550 and PC.

> **Note:** The PIC18F4550 passes data to DataView on the PC coming *from* the PIC16F877. This allows a system developer to write PIC16F877 firmware that averages or otherwise post processes ADC data and then use the PC to view this post processed data, see section below. Refer to Figure 2-1 for Data Flow.

Chapter 4. DataView

4.1 OVERVIEW

DataView is a graphical data analysis tool that interfaces to many of Microchip's stand-alone A/D converter demonstration or evaluation boards via USB interface. Each installation of Dataview is specific to the A/D converter and will contain one or more of the following graphical output windows:

- Scope Plot
- Histogram
- Auxiliary Data

Note:	**IMPORTANT!** For the MCP355X Sensor Application Developer's Board, the USB microcontroller (PIC18F4550) is collecting post-processed data from the PIC16F877. By pressing the push button switches on the reference design and changing the processing that occurs on the PIC16F877, the data shown on DataView is also changed.

4.2 SCOPE PLOT WINDOW

The scope plot window graphs the A/D output as a function of sample or time. Each consecutive sample is added to the right of the data set and when the sample size is full, the scope plot will scroll to the left. The y-axis is displayed as the ADC code and the x-axis is given as sample number. The sample size can be changed in the configuration window.

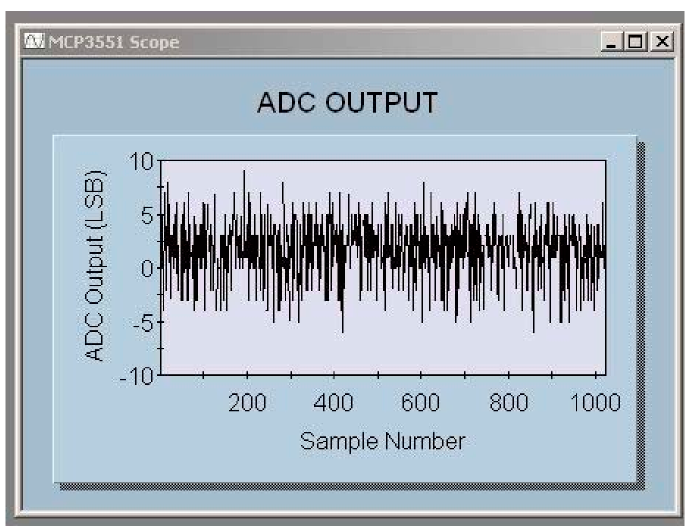


FIGURE 4-1: *Scope Plot Window.*

4.3 NOISE HISTOGRAM WINDOW

The noise histogram window displays the ADC output in histogram form, building the number of occurrences in each bin with each consecutive sample. The difference between each bin from the mean in units of LSB is given as the y-axis. The sample size can be changed in the configuration window.

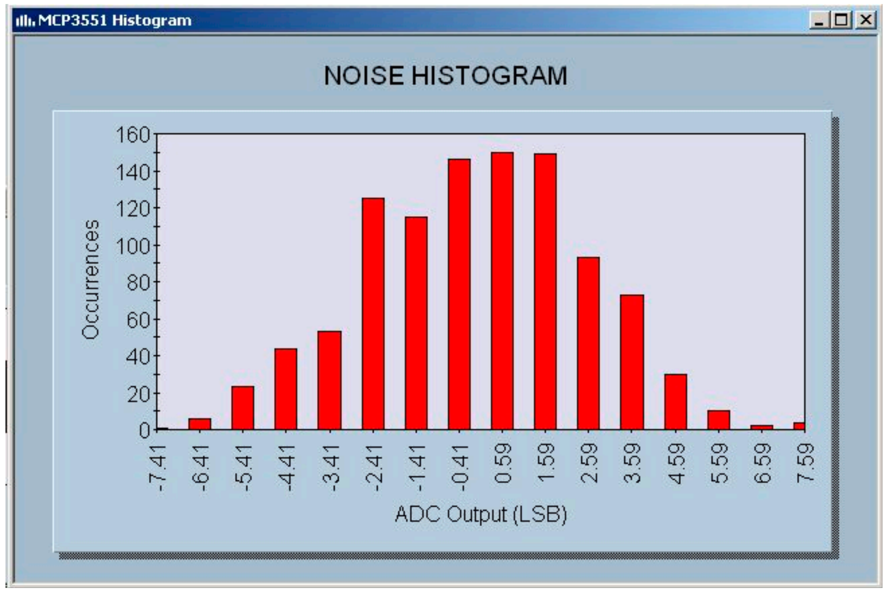


FIGURE 4-2: *Noise Histogram Window.*

4.4 AUXILIARY DATA WINDOW

The auxiliary data window shows calculated data based on the current sample size. The mean of the sample set is given in both LSB and PPM. The standard deviation or RMS output noise is given in units PPM. The overflow bits of the MCP3551 are also monitored and the overflow bits are also given for both overflow high and overflow low situations.

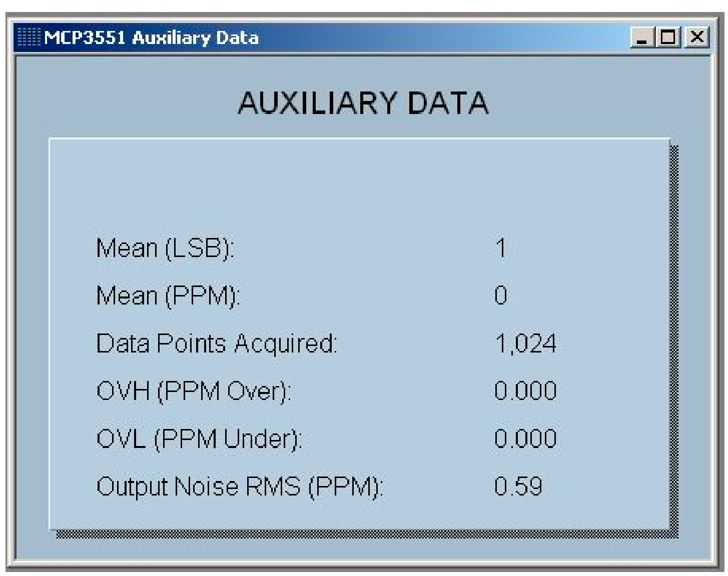


FIGURE 4-3: *Noise Histogram Window.*

4.5 CONFIGURING DATAVIEW

The sample size and polling interval of the USB interface can be changed to accommodate customized firmware on the PICmicro microcontroller side. The units of millisecond, seconds, minute, hour or day can be used to change the functionality of the system. This allows the device to be used as a "Data Logger". Note that if the polling interval is shorter than the sampling rate on the hardware size, duplicate data will be included in the sample set.

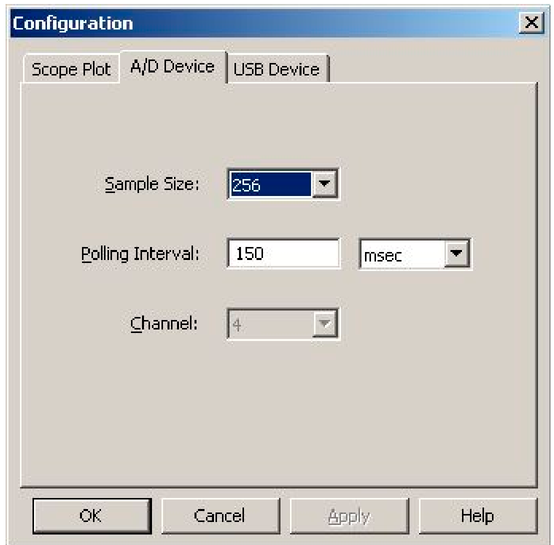


FIGURE 4-4: *Configuration Window.*

NOTES:

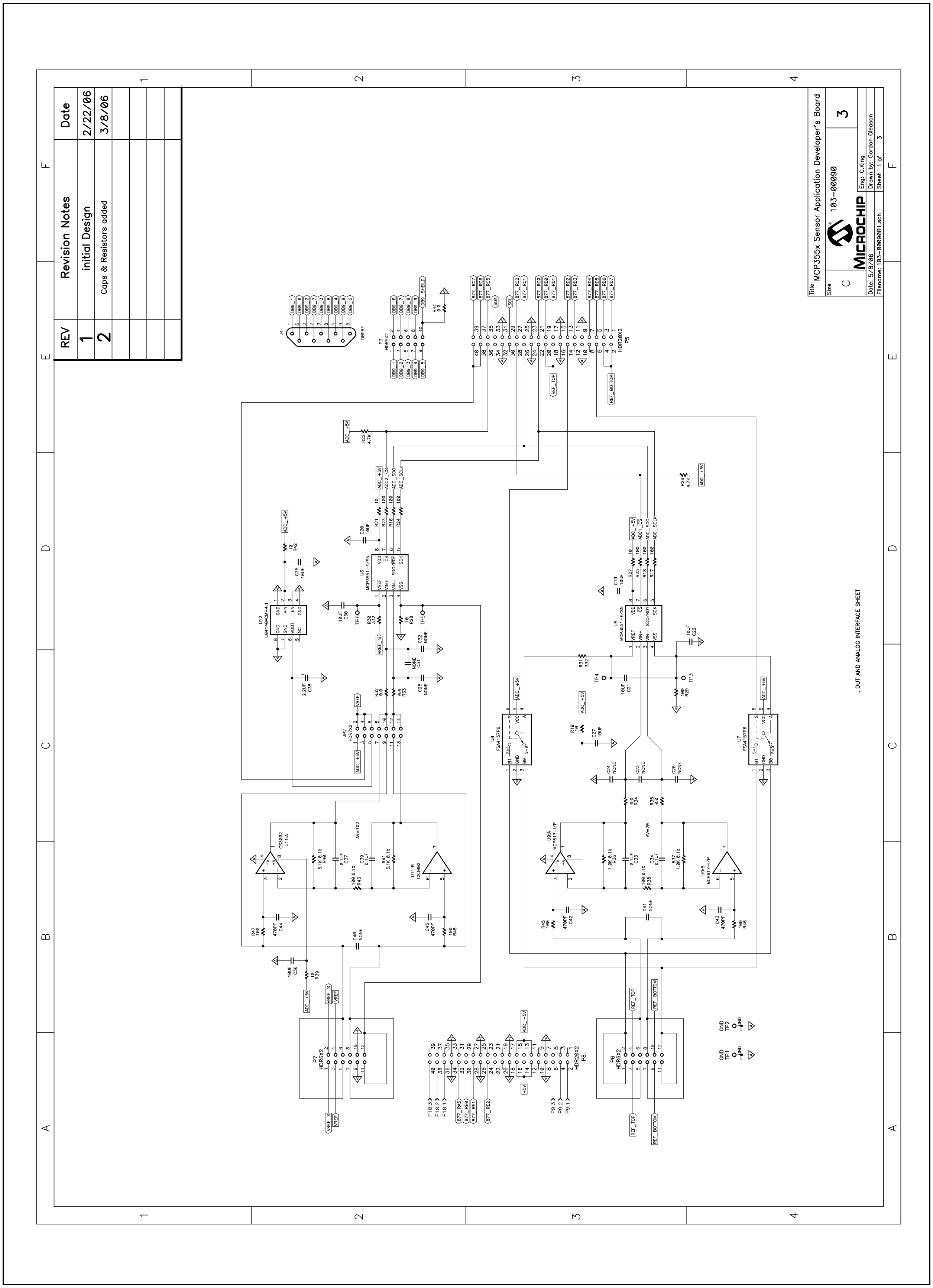
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

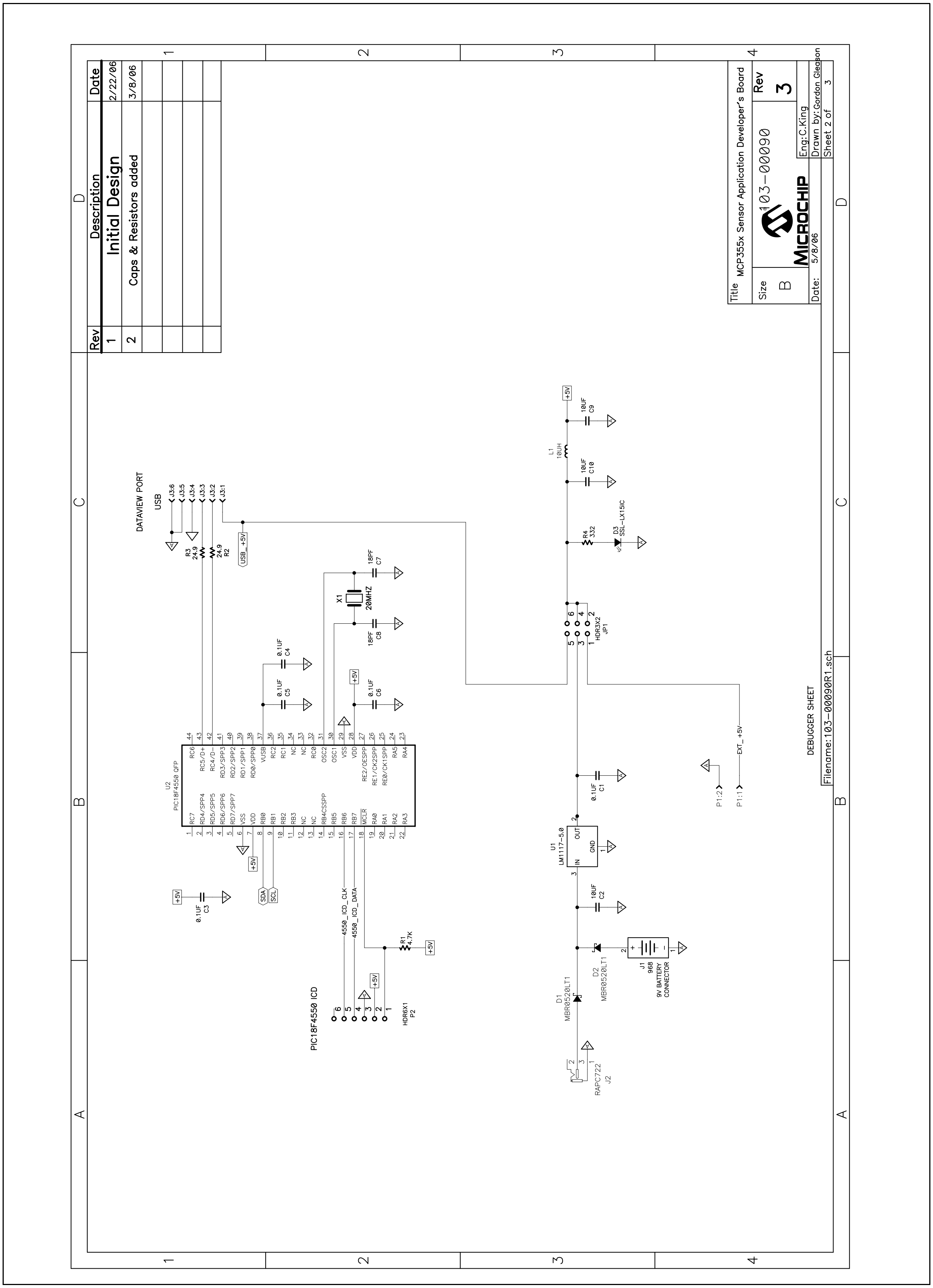
This appendix contains the following schematics and layouts for the MCP355X Sensor Application Developer's Board:

- Board Schematic, Pages 1 thru 3
- Board Schematic - Bridge Simulator
- Board - Top Layer and Silk Screen
- Board - Top Layer
- Board - Bottom Layer and Silk Screen
- Board - Bottom Layer
- Board - Bridge Simulator Layout

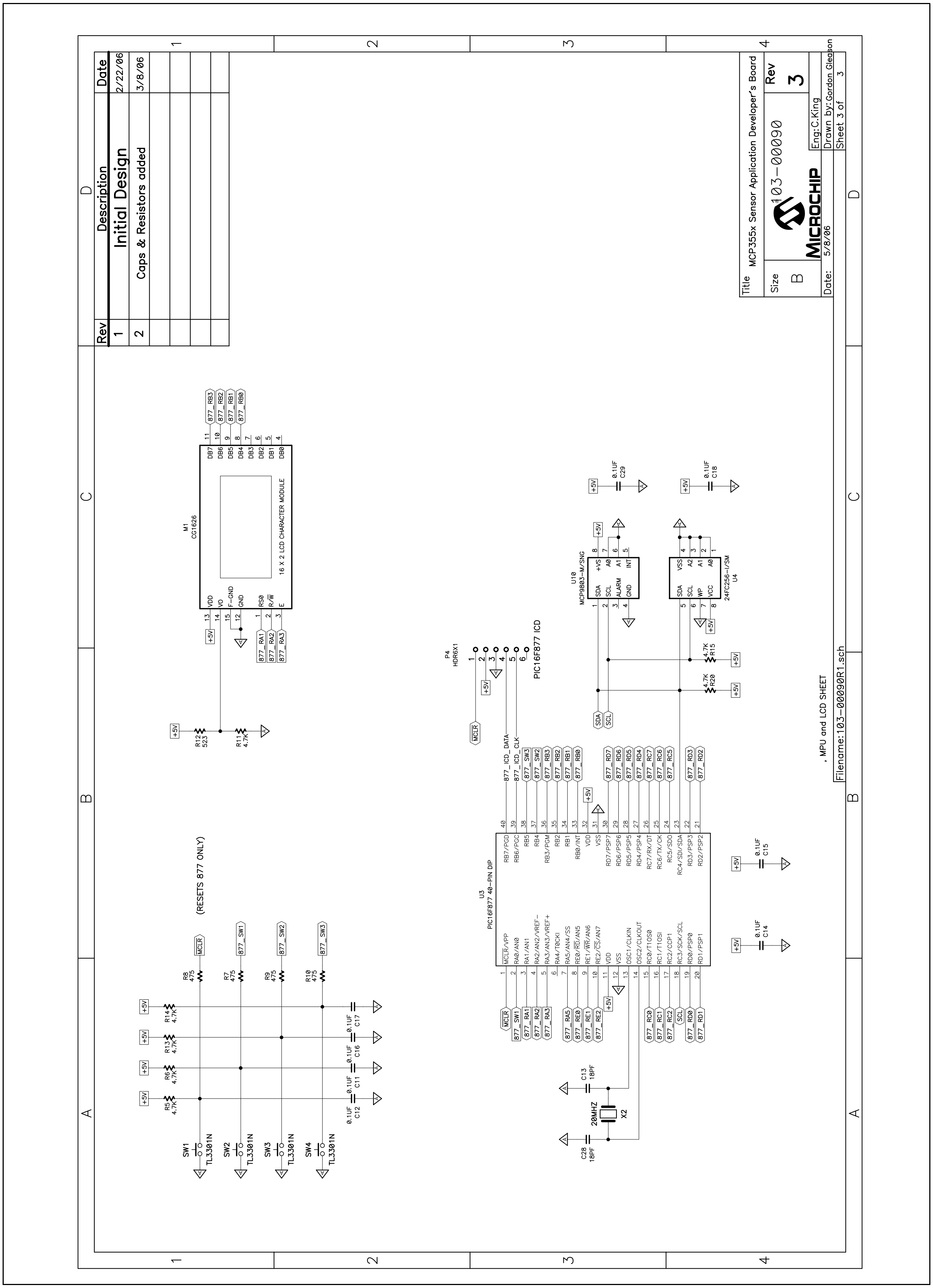
A.2 SCHEMATIC - PAGE 1



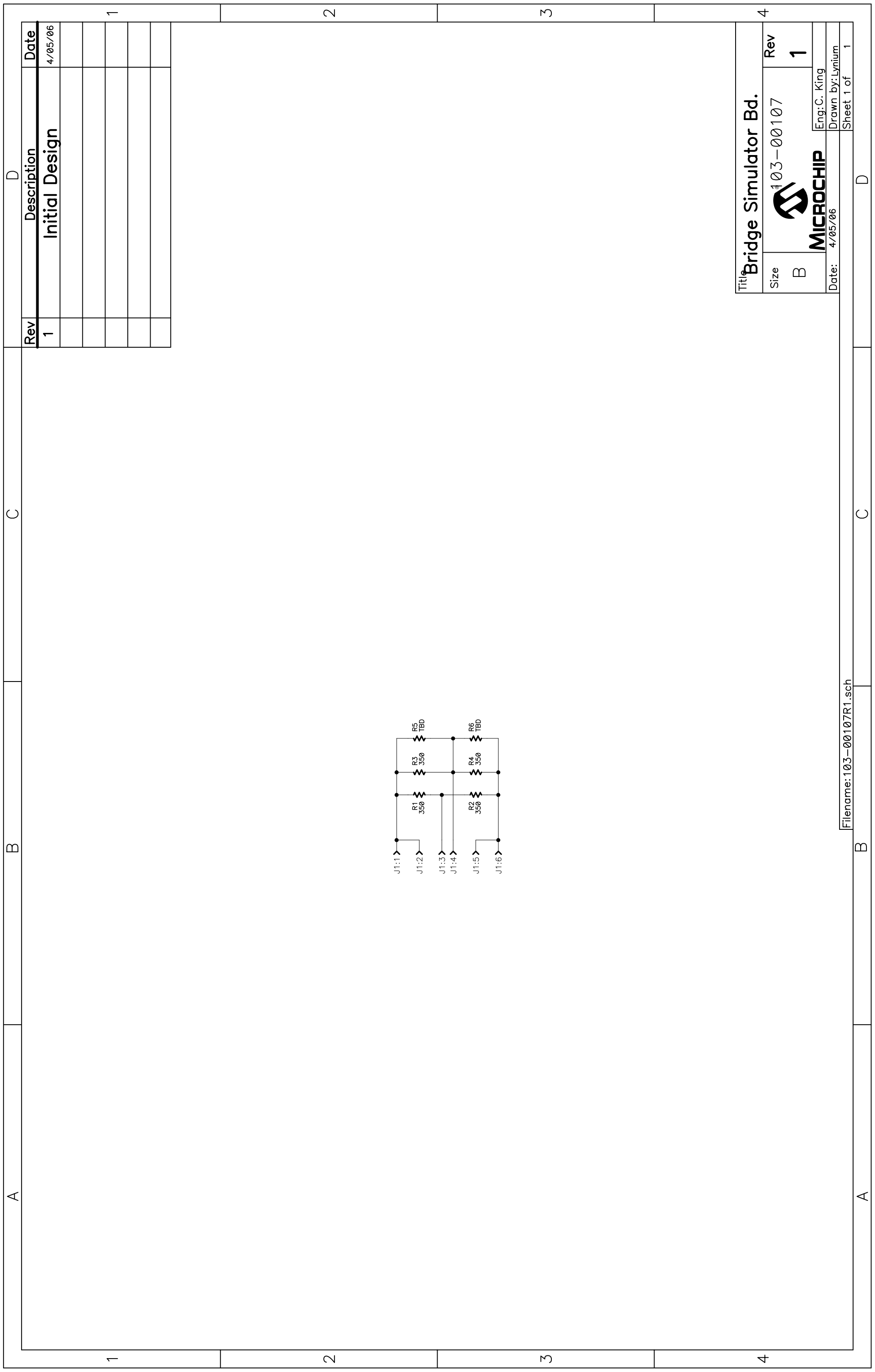
A.3 SCHEMATIC - PAGE 2



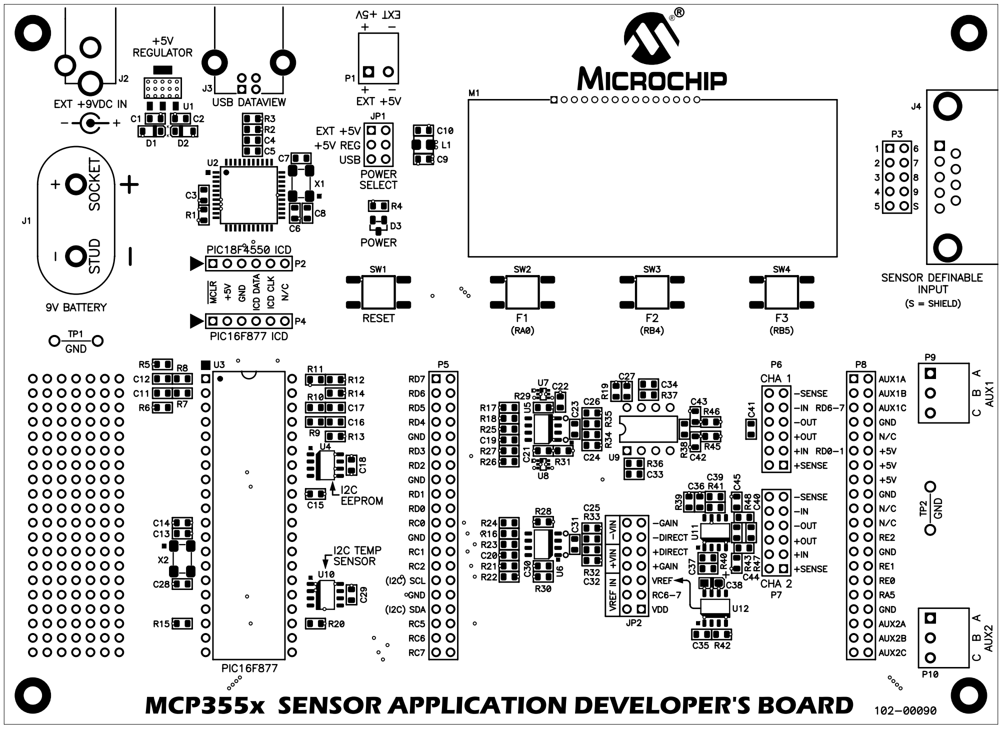
A.4 SCHEMATIC - PAGE 3



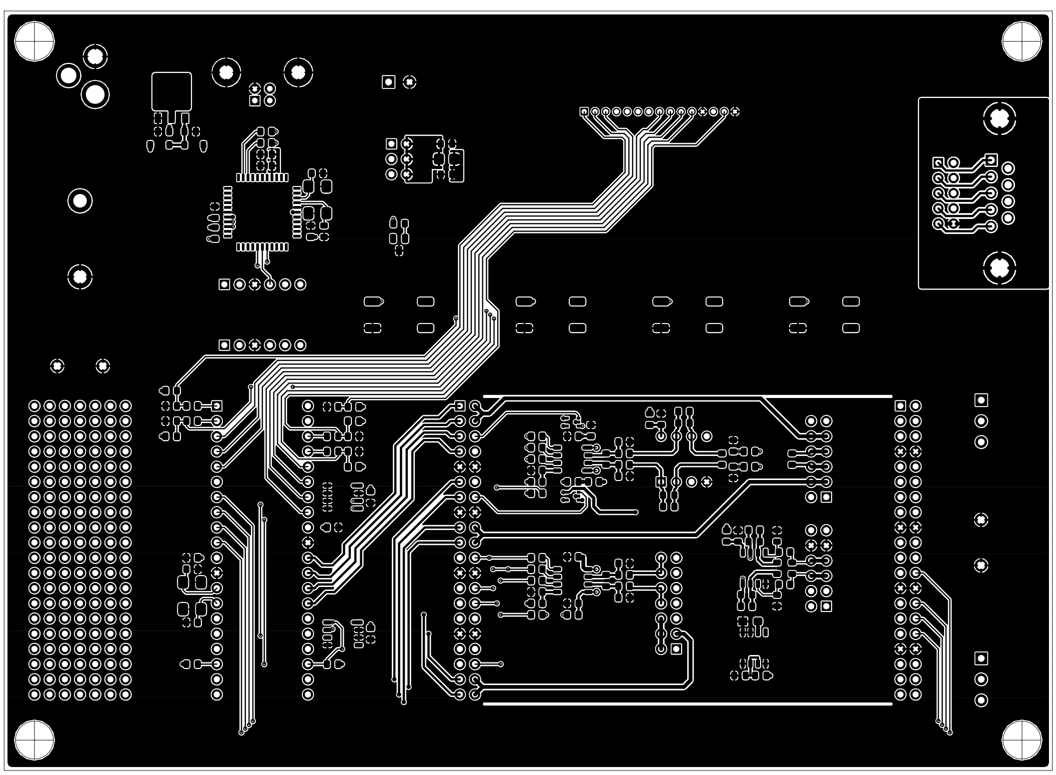
A.5 SCHEMATIC - BRIDGE SIMULATOR



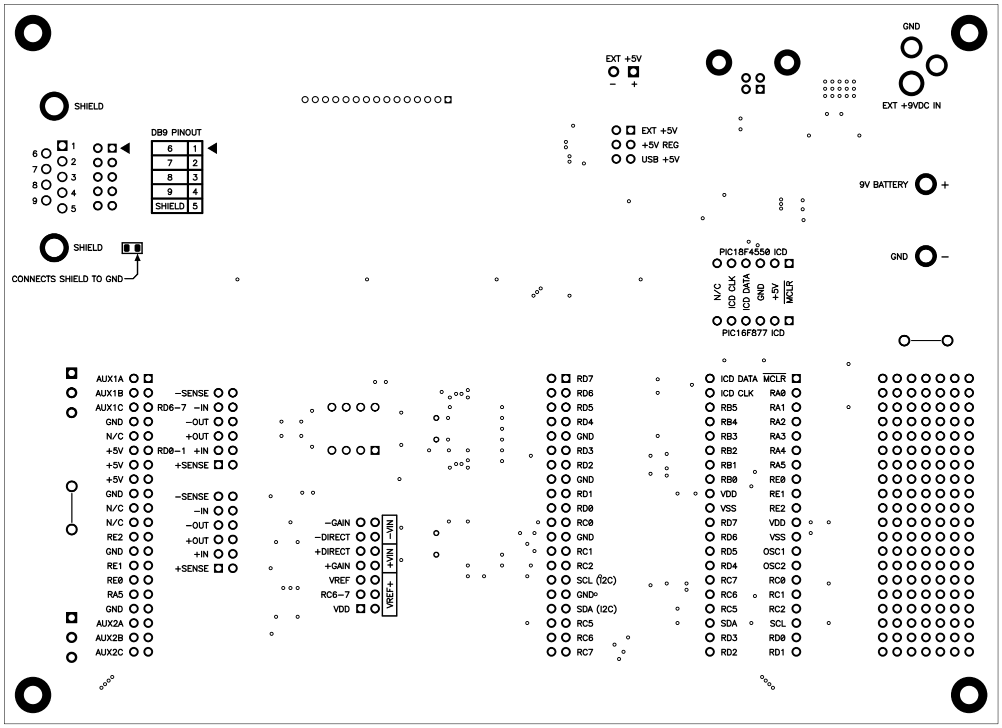
A.6 BOARD LAYOUT - TOP LAYER AND SILK SCREEN



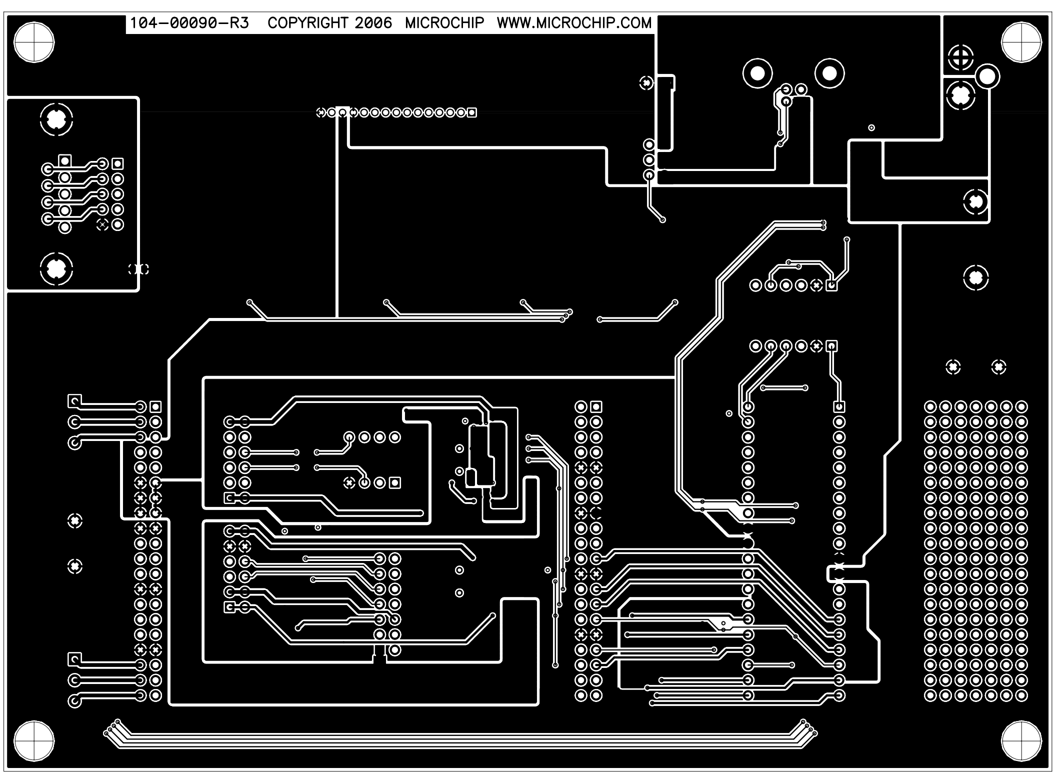
A.7 BOARD LAYOUT - TOP LAYER



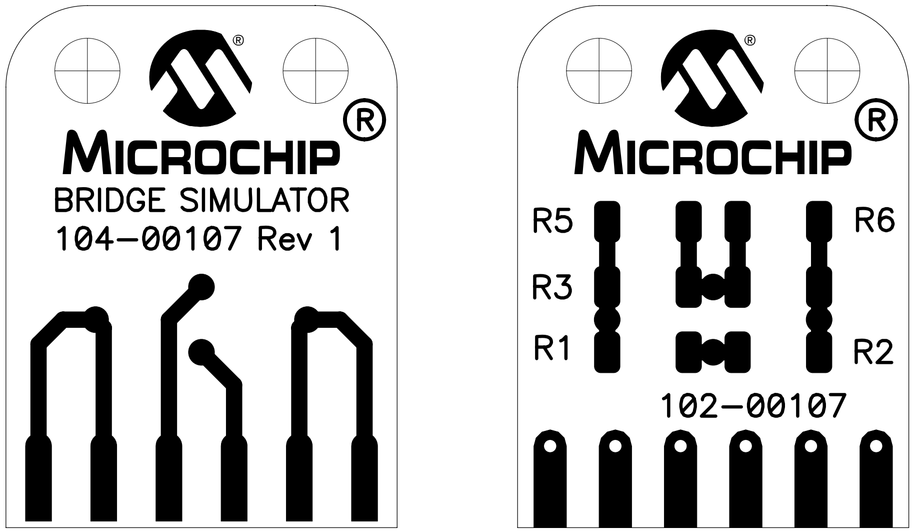
A.8 BOARD LAYOUT - BOTTOM LAYER AND SILK SCREEN



A.9 BOARD LAYOUT - BOTTOM LAYER



A.10 BOARD LAYOUT - BRIDGE SIMULATOR



Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Designator	Description	Manufacturer	Part Number
17	C1, C3, C4, C5, C6, C11, C12, C14, C15, C16, C17, C18, C29, C33, C34, C37, C39	CAP .1UF 25V CERAMIC X7R 0805	Panasonic® - ECG	ECJ-2VB1E104K
11	C2, C9, C10, C19, C20, C21, C22, C27, C30, C35, C36	CAP CER 10UF 6.3V X7R 0805	Murata Electronics® North America	GRM21BR70J106KE76L
4	C7, C8, C13, C28	CAP CERAMIC 18PF 50V NP0 0805	Yageo® America	CC0805JRNPO9BN180
8	C23, C24 C25, C26, C31 C32, C40, C41	DO NOT INSTALL	—	—
1	C38	CAP TANTALUM 2.2UF 16V 10% SMD 3216	EPCOS Inc	B45196H3225K109
4	C42, C43, C44, C45	CAP 470PF 50V CERM CHIP 0805 SMD	Panasonic - ECG	ECJ-2VC1H471J
2	D1, D2	DIODE SCHOTTKY 20V 0.5A SOD123	ON Semiconductor®	MBR0520LT1G
1	D3	LED SMD Standard SOT-23 HI EFF RED WTR CLR	Kingbright	AM23EC-F
4	EA Corner	BUMPON HEMISPHERE .44X.20 BLACK	3M/ESM	SJ-5003 (BLACK)
1	J1	9V Battery PCB Mount Vert Connector Snap-on	Keystone Electronics®	968
1	J2	Power Jack ,08" RA PCB	Switchcraft	RAPC722X
1	J3	CONN USB RECEPT R/A TYPE B 4POS	AMP®/Tyco® Electronics	292304-1
1	J4	9 Pin Right Angle Female Connector D-Sub	Amphenol Canada	205A-09FGTBBC3
1	JP1	CONN HEADER RT/A .100 6POS 15AU	AMP/Tyco Electronics	87230-3
1	JP2	CONN HDR 14PIN GOLD VERT PCB	CW Industries	CWN-350-14-0000
1	L1	Shielded 10uH Power Inductor 0805	Coilcraft	0805PS-103KLB
1	M1	16 X 2 LCD Character Display	Fema	CG1626-SGR1
1	P1	Conn header pins used W/TERM BLK PLUG	Keystone Electronics	8724
1	P1	CONN TERM BLK PLUG 6A 3.5MM 2POS	Keystone Electronics	8722

TABLE B-1: BILL OF MATERIALS (BOM) (CONTINUED)

Qty	Designator	Description	Manufacturer	Part Number
2	P2, P4	6 X 1 Header 2.54mm on center 6 mm/2.5mm	Samtec	TSW-106-07-G-S
1	P3	5 X 2 Header 2.54mm on center 6 mm/2.5mm	Samtec	TSW-105-07-G-D
2	P5, P8	20 X 2 Header 2.54mm on center 6 mm/2.5mm	Samtec	TSW-120-07-G-D
2	P6, P7	6 X 2 Header 2.54mm on center 6 mm/2.5mm	Samtec	TSW-106-07-G-D
2	P9, P10	3.5mm Plugable 3-Position Screw Terminal Blocks	Keystone Electronics	8723
2	P9, P10	Conn header pins used W/TERM BLK PLUG	Keystone Electronics	8724
1	PCB	RoHS-compliant Bare PCB	—	104-00090
10	R1, R5, R6, R11, R13, R14, R15, R20, R22, R26	4.7K 1% 0805 Thick Film Chip Resistor	Yageo® America	RC0805FR-074K7L
2	R2, R3	RES 24.9 OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF24R9V
3	R4, R30, R31	RES 332 OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF3320V
4	R7, R8, R9, R10, R12	RES 475 OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4750V
1	R14	RES 887 OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF8870V
11	R16, R17, R18, R23, R24, R25, R29, R45, R46, R47, R48	RES 100 OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1000V
6	R19, R21, R27, R28, R39, R42	RES 10.0 OHM 1/10W 1% 0805 SMD	Panasonic - ECG	ERJ-3EKF10R0V
4	R32, R33, R34, R35	RES 0.0 OHM 1/8W 5% 0805 SMD	Panasonic - ECG	ERJ-6GEY0R00V
2	R36, R37	1K Ohm 0.1% 0805 10ppm Thin Film Chip Resistor	Susumu	RG2012N-102-B-T1
2	R38, R43	100 Ohm 0.1% 0805 10ppm Thin Film Chip Resistor	Susumu	RG2012N-101-B-T1
2	R40, R41	5.1K Ohm 0.1% 0805 10ppm Thin Film Chip Resistor	Susumu	RG2012N-512-B-T1
1	R44	DO NOT INSTALL	—	—
4	SW1 - SW4	SWITCH TACT 6MM SMD MOM 230GF	Omron Electronics Inc	B3S-1002
2	TP1, TP2	Wire Test Point 0.3" Length	Nedco Electronics	PJ-202-30
4	TP3, TP4 TP5, TP6	DO NOT INSTALL	—	—
1	U1	5.0V 3-Terminal 800mA Positive Regulator SOT-223	National Semiconductor®	LM1117-5.0
1	U2	44-Pin, High-Performance, Enhanced Flash, USB Microcontroller	Microchip Technology Inc.	PIC18F4550-I/PT
1	U3	IC SOCKET STRAIGHT 40POS .600 TIN	Assmann Electronics Inc	A40-LC-TT-R

TABLE B-1: BILL OF MATERIALS (BOM) (CONTINUED)

Qty	Designator	Description	Manufacturer	Part Number
1	U3	40-Pin Enhanced Flash Microcontrollers	Microchip Technology Inc.	PIC16F877A-I/P
1	U4	256K I2C™ CMOS Serial EEPROM	Microchip Technology Inc.	24FC256-I/SN
2	U5, U6	22-Bit Delta Sigma ADC SO-8	Microchip Technology Inc.	MCP3551-E/SN
2	U7, U8	IC SWITCH ANALOG SPDT LV SC70-6	Fairchild Semiconductor®	FSA4157P6X_NL
1	U9	Dual Op-Amp DIP-8 (Install in socket))	Microchip Technology Inc.	MCP617-I/P
1	U9	IC SOCKET STRAIGHT 8POS TIN	Assmann Electronics Inc	A08-LC-TT-R
1	U10	I2C Temperature Sensor SO-8	Microchip Technology Inc.	MCP9803-M/SNG
1	U11	Dual Op-Amp SO-8	Cirrus Logic	CS3002-ISZ
1	U12	4.096V Voltage Reference SO-8	National Semiconductor	LM4140ACM-4.1
2	X1, X2	20.000MHZ Crystal 10PF 5mm X 3.2mm SMD	Abracon Corporation	ABM3B-20.000MHZ-10-1-U-T

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