MCP3XXX A/D CONVERTER EVALUATION KIT USER'S GUIDE

Supports both the Single/Dual Evaluation Kit:
- **MCP3001, MCP3002,**
- **MCP3201, MCP3202,**
- **MCP3301**

Supports both the Quad/Octal Evaluation Kit:
- **MCP3004, MCP3008,**
- **MCP3204, MCP3208,**
- **MCP3302, MCP3304**

MCP3XXX EVAL KIT USER'S GUIDE

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MCP3XXX EVAL KIT USER'S GUIDE

Preface

Introduction

This section contains general information that will be useful to know before using the MCP3XXX Evaluation Board. These boards currently support the following devices:

- MCP3001, MCP3002, MCP3004, MCP3008
- MCP3201, MCP3202, MCP3204, MCP3208
- MCP3301, MCP3302, MCP3304

Highlights

This section covers the following topics:

- About this Guide
- Recommended Reading
- Warranty Registration
- Troubleshooting
- The Microchip Internet Web Site
- Customer Support

About This Guide

DOCUMENT LAYOUT

This document describes how to use the MCP3XXX Evaluation Board to evaluate Microchip's stand alone MCP3XXX A/D converters.

The User's Guide layout is as follows:

- **Chapter 1: System Overview and Installation** – Important information on how to install the MCP3XXX devices
- **Chapter 2: Overview of the Single/Dual MCP3XXX Evaluation Board** – For users evaluating the MCP3001, MCP3002, MCP3201, MCP3202, or MCP3301 devices, this chapter describes how to use the various features of the hardware
- **Chapter 3: Overview of the Quad/Octal MCP3XXX Evaluation Board** – For users evaluating the MCP3004, MCP3008, MCP3204, MCP3208, MCP3302, or MCP3304 devices, this chapter describes how to use the various features of the hardware
- **Chapter 4: Using the Filter Boards** – How to use the active filter boards in your evaluation

- **Chapter 5: Stand alone mode with the MXDEV Driver Board** – Explains how to demonstrate the devices using the supplied firmware and MXDEV driver board
- **Chapter 6: MXLAB Software** – Discusses the elements of MXLAB

Appendices:

- **Appendix A: Single/Dual Schematics and Layouts** – Shows the schematics and layouts diagrams for the Single/Dual Evaluation Board.
- **Appendix B: Quad/Octal Schematics and Layouts** – Shows the schematics and layouts diagrams for the Quad/Octal Evaluation Board.
- **Appendix C: Bill of Materials** – Lists the parts used to build the MCP3XXX Evaluation System
- **Index** – Cross-reference listing of terms, features, and sections of this document
- **Worldwide Sales and Service** – Gives the address, telephone and fax number for Microchip Technology Inc. sales and service locations throughout the world

Updates

All documentation becomes dated, and this user's guide is no exception. Since MXLAB and other Microchip tools are constantly evolving to meet customer needs, some MXLAB dialogs and/or tool descriptions may differ from those in this document. Please refer to the Microchip web site to obtain the latest documentation available.

Warranty Registration

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in your 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 the MCP3XXX Evaluation Board. For more information regarding the MCP3XXX devices, the following are recommended reading.

MCP3XXX Data Sheets

These data sheets provide detailed information regarding the MCP3XXX A/D converters:

- MCP3001 Data Sheet, DS21293
- MCP3002 Data Sheet, DS21294
- MCP3004/08 Data Sheet, DS21295

- MCP3201 Data Sheet, DS21290
- MCP3202 Data Sheet, DS21034
- MCP3204/08 Data Sheet, DS21298
- MCP3301 Data Sheet, DS21700
- MCP3302/04 Data Sheet, DS21697

README Files

Contains the latest information on the MCP3XXX Evaluation System.

MCP3XXX A/D Converter Evaluation Kit User's Guide (DS51220B)

This user's guide contains additional information on the MCP3XXX devices and how to use the MXLAB Analog Evaluation Tool.

Technical Library CD-ROM (DS00161)

This CD-ROM contains comprehensive application notes, data sheets, and technical briefs for all Microchip products. To obtain this CD-ROM, contact the nearest Microchip Sales and Service location (see back page).

Microchip Web Site

Our web site (http://www.microchip.com) contains a wealth of documentation. Individual data sheets, application notes, tutorials and user's guides are all available for easy download. All documentation is in Adobe Acrobat (pdf) format.

Microsoft® Windows® Manuals

This manual assumes that users are familiar with the Microsoft Windows operating system. Many excellent references exist for this software program and should be consulted for general operation of Windows.

The Microchip Internet Web Site

Microchip provides on-line support on the Microchip World Wide Web (WWW) site.

The web site is used by Microchip as a means to make files and information easily available to customers. To view the site, the user must have access to the internet and a web browser, such as Netscape® Communicator or Microsoft® Internet Explorer®. Files are also available for FTP download from our FTP site.

Connecting to the Microchip Internet Web Site

The Microchip web site is available by using your favorite Internet browser to attach to:

http://www.microchip.com

The file transfer site is available by using an FTP program/client to connect to:

ftp://ftp.microchip.com

The web site and file transfer site provide a variety of services. Users may download files for the latest Development Tools, Data Sheets, Application Notes, User's Guides, Articles, and Sample Programs. A variety of Microchip specific business information is also available, including listings of Microchip sales offices, distributors and factory representatives. Other data available for consideration is:

- Latest Microchip Press Releases
- Technical Support Section with Frequently Asked Questions
- Design Tips
- Device Errata
- Job Postings
- Microchip Consultant Program Member Listing
- Links to other useful web sites related to Microchip Products
- Conferences for products, Development Systems, technical information and more
- Listing of seminars and events

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Corporate Applications Engineer (CAE)
- Hot line

Customers should call their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. See the back cover for a listing of sales offices and locations.

Corporate applications engineers (CAEs) may be contacted at (480) 792-7627.

In addition, there is a Systems Information and Upgrade Line. This line provides system users a listing of the latest versions of all of Microchip's development systems software products. Plus, this line provides information on how customers can receive any currently available upgrade kits.

The Hot Line Numbers are:

- 1-800-755-2345 for U.S. and most of Canada, and
- 1-480-792-7302 for the rest of the world.

NOTES:

Chapter 1. Product Overview and Installation

1.1 Introduction

This chapter provides an overview of the MCP3XXX Evaluation Board, instructions on how to connect the system components, and how to install the MXLAB™ software.

1.2 Highlights

This chapter covers the following topics:

- What the MCP3XXX Evaluation Board Is
- System Requirements
- MCP3XXX Evaluation Board Kit Components
- MCP3XXX Evaluation Board Components
- Hardware Installation
- Software Installation

1.3 What the MCP3XXX Evaluation Board Is

The MCP3XXX Evaluation Board is an evaluation and demonstration tool for Microchip Technology's MCP3XXX stand alone A/D converters. The design provides for dynamic versatility while being able to handle accurate analog measurements.

The MCP3XXX Evaluation Board is designed to be used in conjunction with the MXDEV™ Driver Board (available separately). When connected to the driver board with the included microcontroller installed, this evaluation board allows for the programming and evaluation of the MCP3XXX devices in a variety of applications.

1.4 System Requirements

To take full advantage of the MCP3XXX features, you must install the MXLAB software (`MXLAB.EXE`) on a host computer. MXLAB requires:

- Microsoft® Windows® 95/98 or greater operating system
- One free serial port
- CD-ROM drive
- 32 MB of RAM
- 10 MB of hard drive space

1.5 MCP3XXX Evaluation Board Kit Components

The MCP3XXX Evaluation Board kit contains:

- MCP3XXX Evaluation Board
- Reprogrammable Microchip FLASH PICmicro® MCU
- MXLAB Software
- MCP3XXX Eval Kit User’s Guide
- Warranty/Registration Card (not shown)
- Analog Filter Board
- Sample Kit with MCP3XXX Devices (not shown)

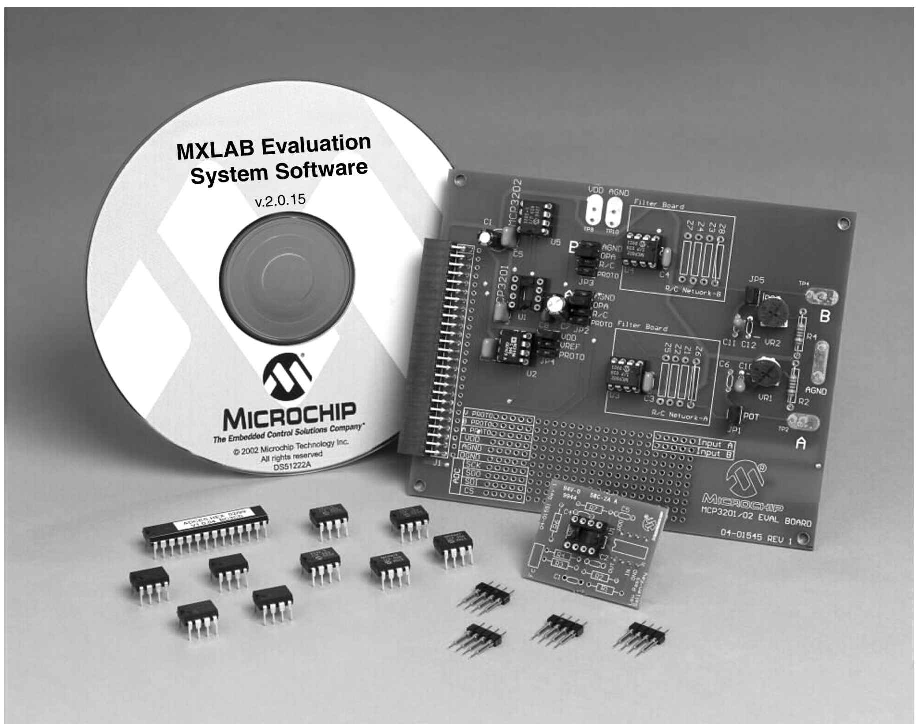


Figure 1.1: MCP3XXX Evaluation Board System

1.6 Changing the MCP3XXX Devices

The MCP3XXX Evaluation Board kit ships with a variety of MCP3XXX devices. The 12-bit A/D converters are initially installed in the sockets. You can remove and insert different MCP3XXX devices to test and evaluate other A/D converters.

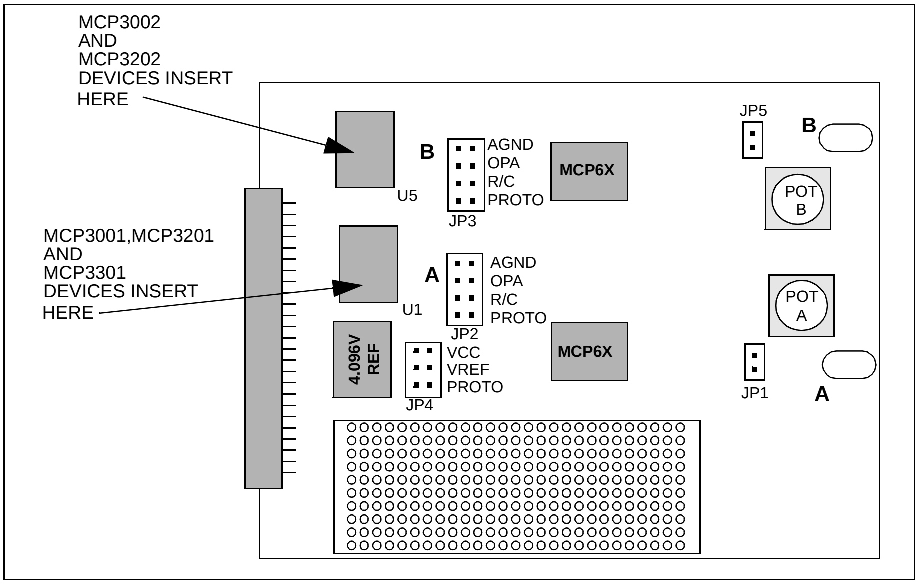


Figure 1.2: 8-lead ADC Board Device Locations for Single/Dual Board

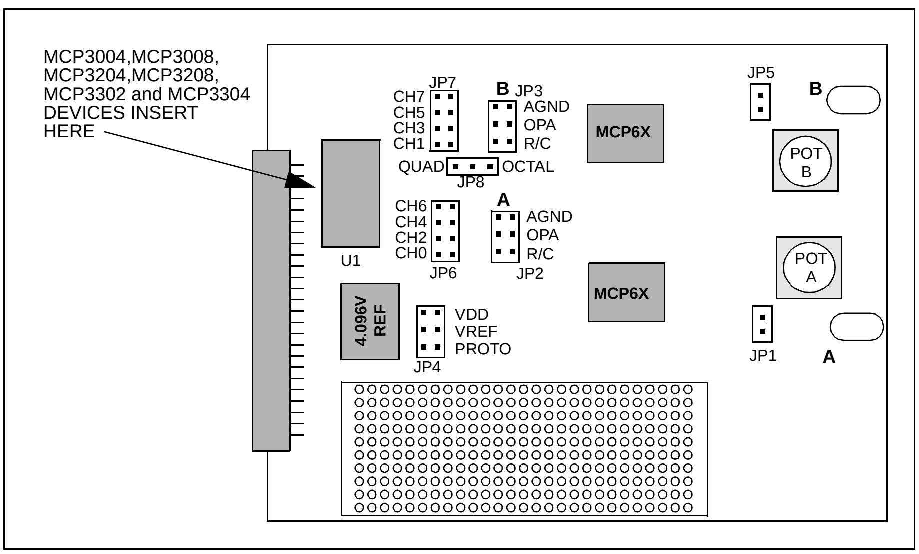


Figure 1.3: 14 and 16-pin ADC Board Device Locations for Quad/Octal Board

1. Using a chip puller or small flat-head screwdriver, carefully pry the existing MCP3XXX device(s) from the evaluation board.
2. Being careful not to bend the pins, insert the new MCP3XXX device(s) into either the correct DIP socket as described above.
3. For the 14 and 16-lead devices, JP8 needs to be set to the correct position:
   - For 14-lead devices (MCP3004,MCP3204, MCP3302), JP8 needs to be in the LEFT position
   - For 16-lead devices (MCP3008,MCP3208, MCP3304), JP8 needs to be in the RIGHT position

1.7 MXDEV™ and Driver Board Overview

The MXDEV system consists of two main parts:

1. MXDEV Driver Board (available separately).
2. MCP3XXX Evaluation Board.

1.7.1 MXDEV Driver Board

The MXDEV Driver Board enables you to evaluate and demonstrate Microchip Technology's analog products. For more information about the driver board, see the *MXDEV™ Driver Board User's Guide* (DS51221).

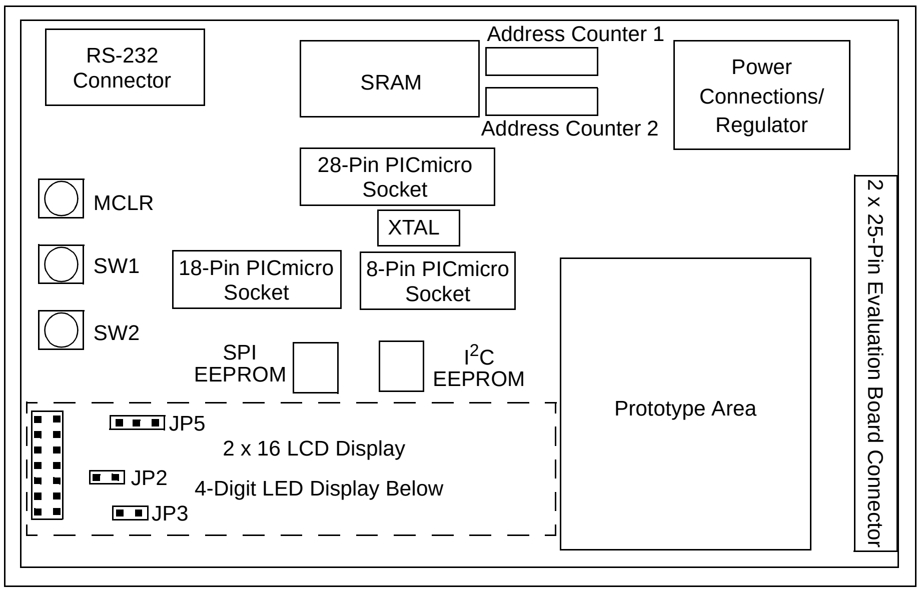


Figure 1.4: MXDEV Driver Board

1.8 Hardware Installation

This section describes how to connect the hardware components.

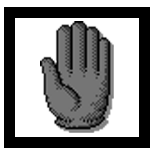
1.8.1 Tools Required

You will need the following tools:

- Chip puller or small flat-head screwdriver

1.8.2 Installing the FLASH PICmicro® MCU

Before you can begin using the MCP3XXX Evaluation Board with the Analog Evaluation Driver Board, you must replace the existing PICmicro MCU with the PICmicro FLASH device that comes with the MCP3XXX Evaluation Board kit.

WARNING	Be sure to disconnect the 9-volt power supply from the driver board when removing or installing the microcontroller.
	

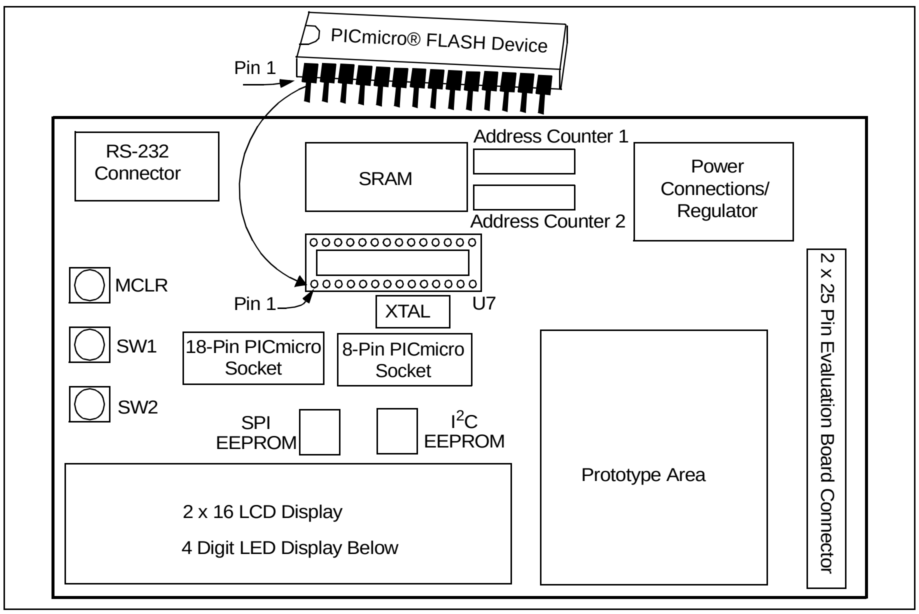


Figure 1.5: MXDEV Driver Board

1. If necessary, carefully remove the existing PICmicro device from the MXDEV Driver Board.
2. Being careful not to bend the pins, insert the FLASH device into the 28-pin DIP socket.

1.8.3 Connecting the Evaluation Board to the Driver Board

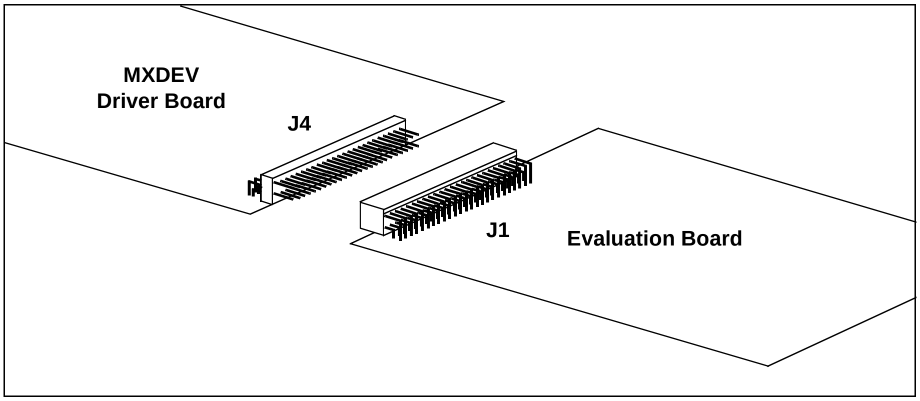


Figure 1.6: Connecting Evaluation Board to Driver Board

1. Connect the MCP3XXX Evaluation Board to the MXDEV driver board via the 50-pin, dual-row header connector.

   The male connector is on the driver board; the female header is on the evaluation board. Figure 1.7 shows the pin layout of the connector.

2. Connect the driver board to an available COM port on you PC via the 25-pin, RS-232 connector.
3. Connect the 9-volt power supply to the driver board.

> **Note:** Connecting the power supply to the driver board automatically powers up the system.

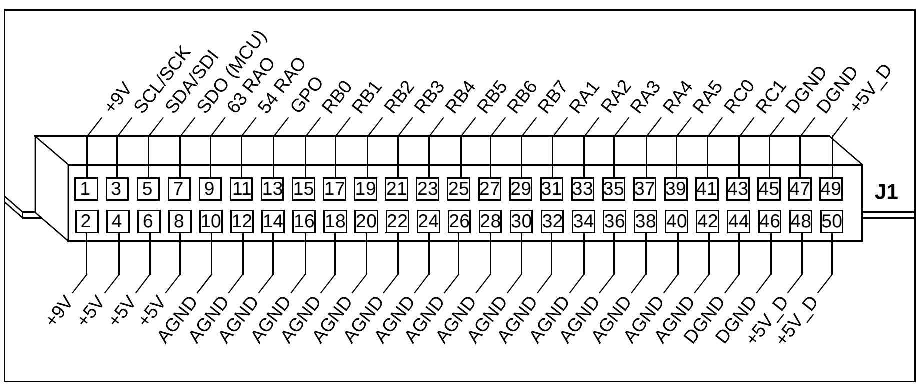


Figure 1.7: Evaluation Board Connector (J1)

1.9 Software Installation

Insert the MXLAB CD-ROM into your CD-ROM drive.

1.9.1 Autorun Enabled

If autorun is enabled, the installation program will automatically start. Follow the instructions on the screen to install the software.

1.9.2 Autorun Not Enabled

If autorun is not enabled:

1. Click the **Start** button and select Run. Enter `d:\mxlab.exe` (where `d:\` is your CD-ROM drive). Click **OK**.

> **Note:** Windows NT and Windows 2000 users must have administrative privileges in order to install the MXLAB software.

Follow the on-line instructions to install the software.

1.9.3 Starting MXLAB

1. Start MXLAB by executing `MXLAB.EXE` or click on the MXLAB icon. You will see the MXLAB desktop (Figure 1.8). Chapter 6 describes how to use this program.

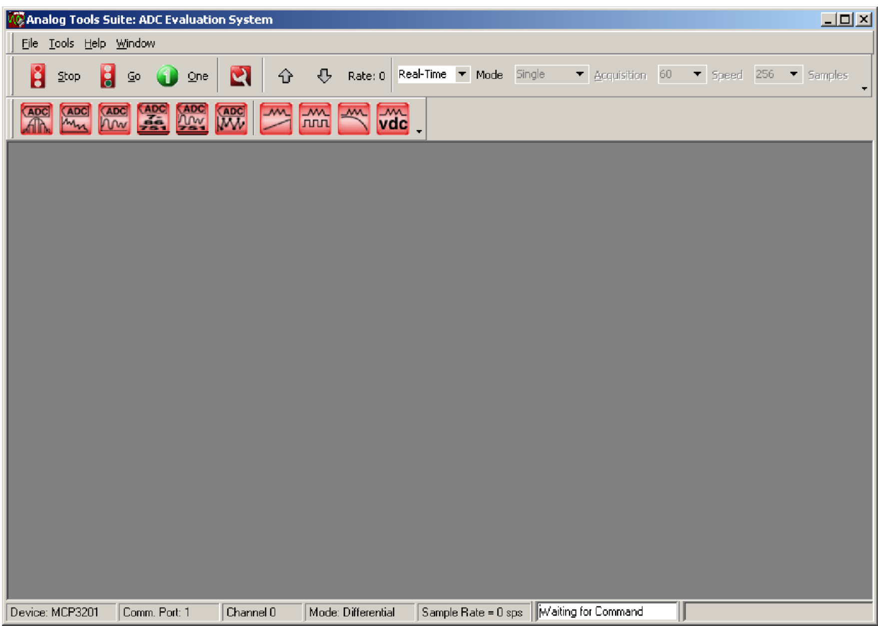


Figure 1.8: MXLAB Desktop

NOTES:

Chapter 2. Single/Dual MCP3XXX Daughter Board

2.1 Description

The Single/Dual MCP3XXX ADC Daughter Board is designed to be used with the Analog Evaluation Driver Board. The user can use it as a stand-alone board by adding additional circuitry either on the prototype area or on another board. When used in conjunction with the driver board and the supplied software, this board can be used to evaluate the Single/Dual MCP3XXX Analog-to-Digital Converter devices and can be used to evaluate signals applied to the ADC.

2.2 Features

The Single/Dual ADC daughter board provides the following features:

- Allows single or continuous conversions for any of the A/D Converters.
- Display data from conversions on PC in the following formats:
  - Real-time numeric
  - Real-time strip chart
  - FFT
  - Histogram
  - Scopeplot
  - Data list
- Signal source can be selected as DC signal from on-board potentiometer or an externally supplied signal
- Prototype area available for circuit evaluation
- Low-pass filter boards supplied for filter analysis

2.3 Layout Overview

The Single/Dual ADC daughter board is designed for maximum flexibility. Basic signal path flow from the signal source to the ADC is shown in Figure 2.1. The MCP3XXX board allows pseudo-differential inputs on IN+ and IN-, single-ended inputs on CH0 → CH7, and true differential inputs on IN+ and IN- for the MCP330X devices.

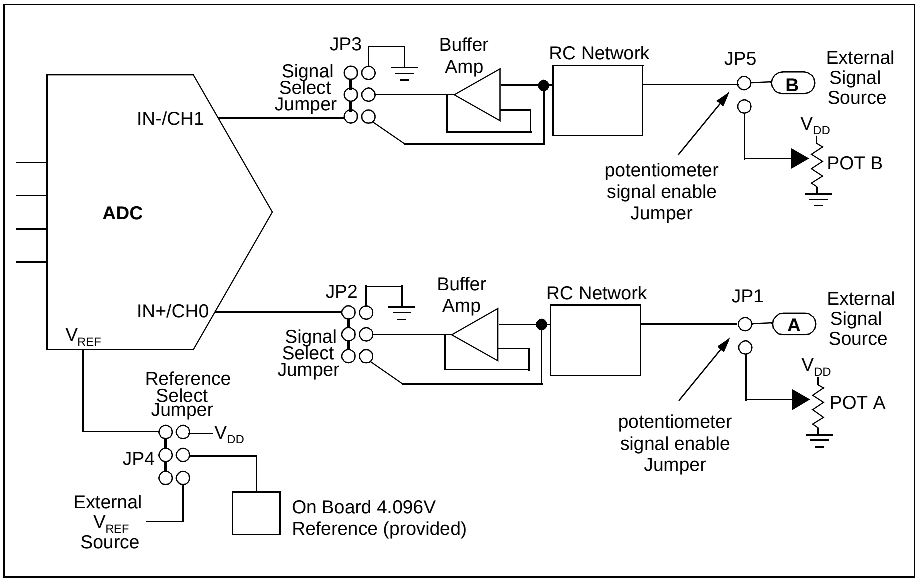


Figure 2.1: Basic Signal Chain for Single/Dual Daughter Board

2.4 Configuring the Daughter Board Jumpers

There are five jumpers that must be set for proper operation of the Single/Dual daughter board. Four of these jumpers determine the signal path to the ADC and one jumper determines the source of the ADC reference voltage.

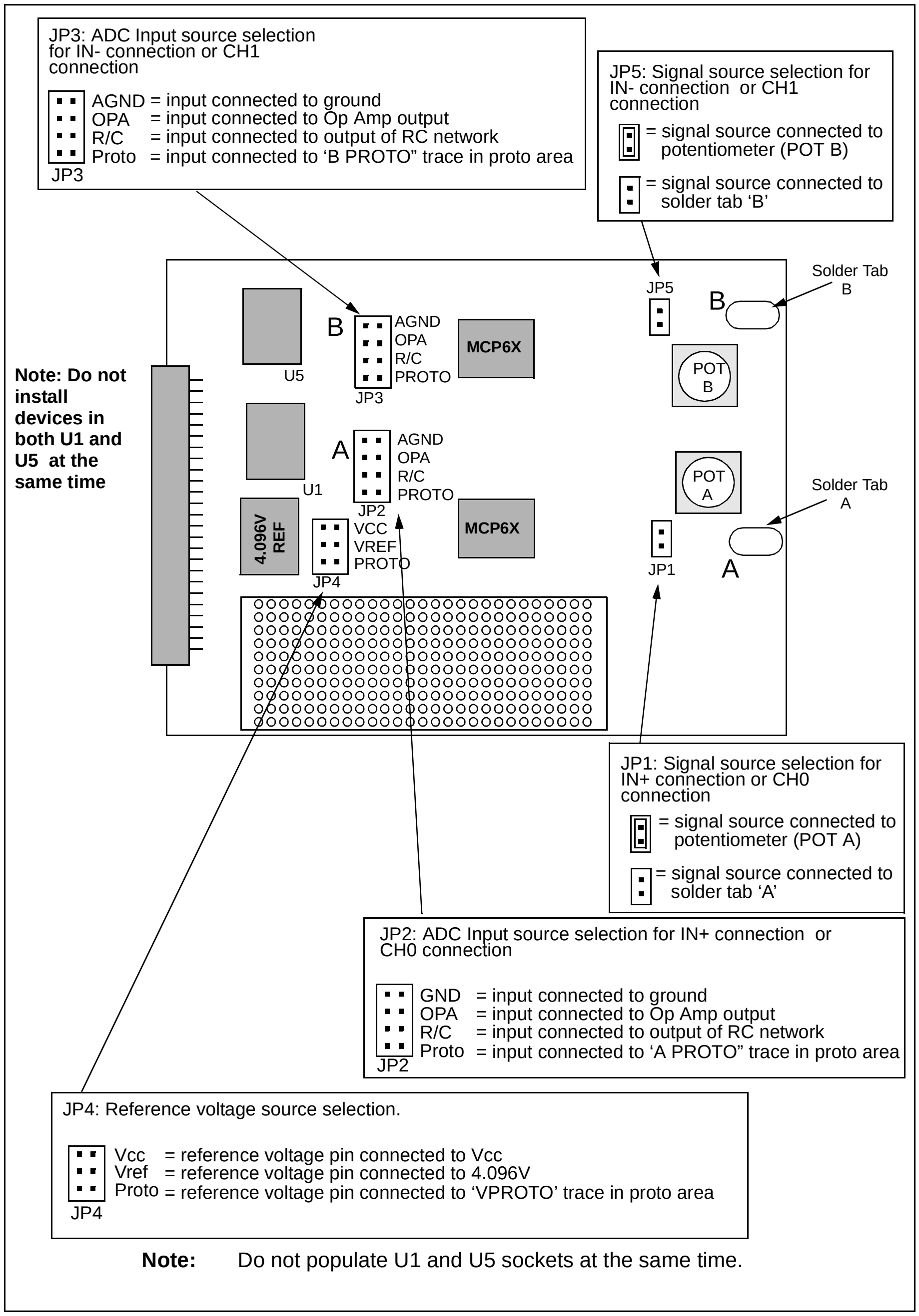


Figure 2.2: Jumper Locations on the Single/Dual Daughter Board

2.4.1 Jumper JP1

JP1 determines the input signal source of the 'A' input which is connected to the IN+ input or CH0 input. If the jumper is on, the input signal source is routed to potentiometer 'A'. If jumper JP1 is not installed, then the potentiometer is bypassed and an external signal from solder pad A or the prototype area must be used.

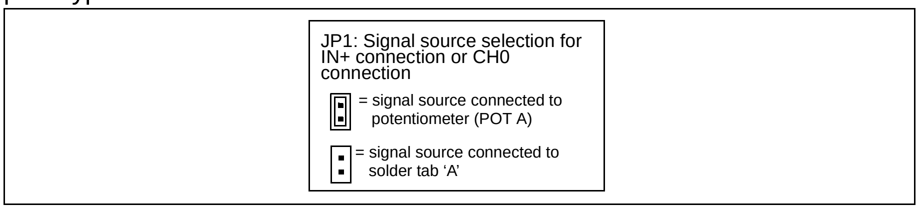


Figure 2.3: JP1 Jumper Selections

2.4.2 Jumper JP2

JP2 determines what the input of the ADC is actually connected to. This jumper is connected directly to the IN+ input pin or the CH0 input. There are four choices for this jumper.

> **Note:** There should never be more than one jumper installed on JP2 or damage to circuits may occur.

The four choices are:

- AGND: connects input to the analog ground plane
- OPA: connects input to the output of the buffer amplifier. This selection is also used when using the filter board (see Filter Board section)
- R/C: bypasses the amplifier and connects ADC input to the output of the RC network
- PROTO: connects input to the 'A PROTO' connection in the prototype area

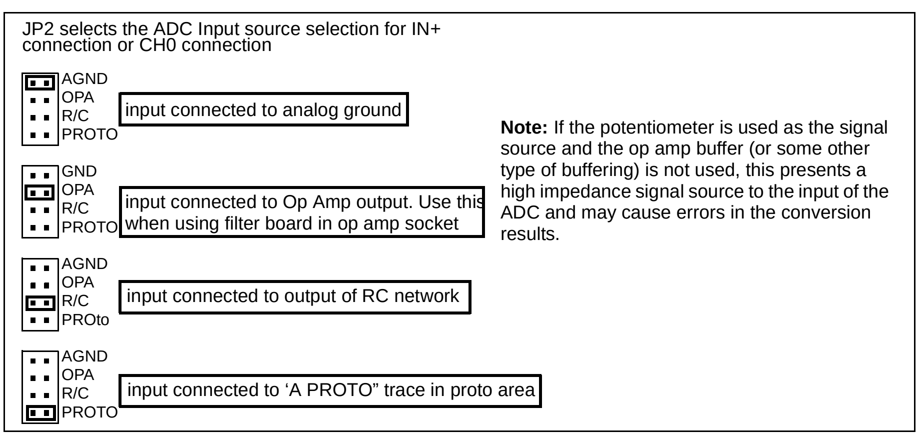


Figure 2.4: JP2 Jumper Selections

2.4.3 Jumper JP3

JP3 is identical in operation to JP2 except that this jumper is connected directly to the IN- input or the CH1 input.

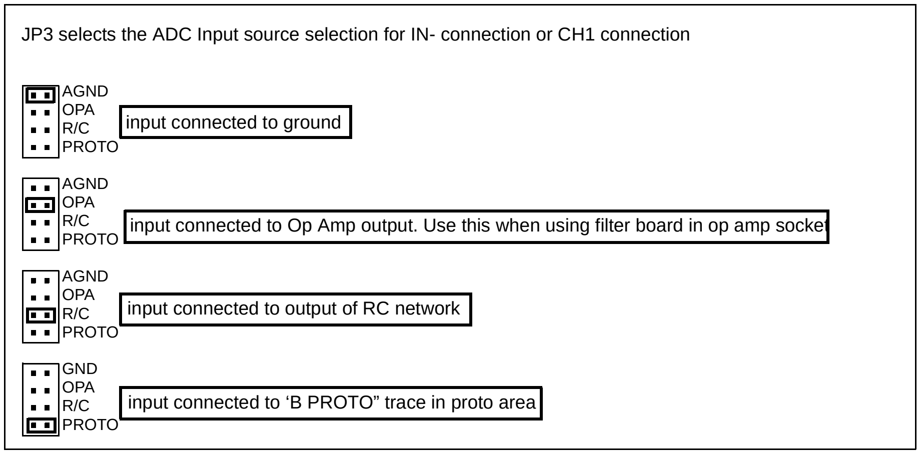


Figure 2.5: JP3 Jumper Selections

2.4.4 Jumper JP4

JP4 is used to select the reference voltage into the ADC. The MCP3002 and MCP3202 use V_{DD} as the reference voltage so this jumper has no affect on these devices. There are three choices for this jumper.

> **Note:** There should never be more than one jumper installed on JP4 or damage to circuits may occur.

The three choices are:

- VCC: connects reference input to V_{CC}
- VREF: connects reference input to the 4.096 voltage reference device
- PROTO: connects reference input to the ‘V Proto’ connection on the prototype area

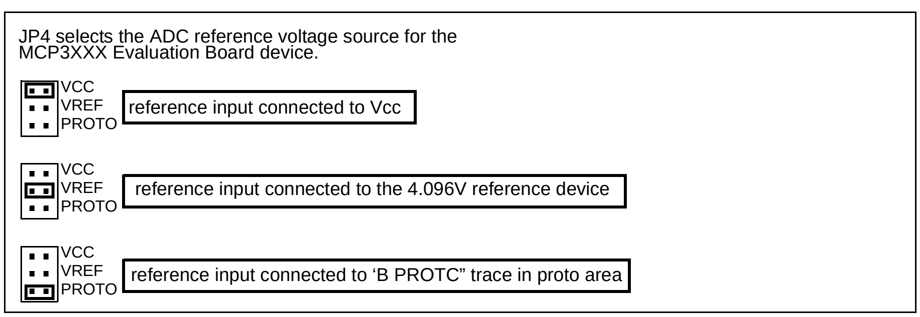


Figure 2.6: JP4 Jumper Selections

2.4.5 Jumper JP5

JP5 is identical in operation to JP1, although it determines the signal source for the B input which is connected to the IN- input or the CH1 input.

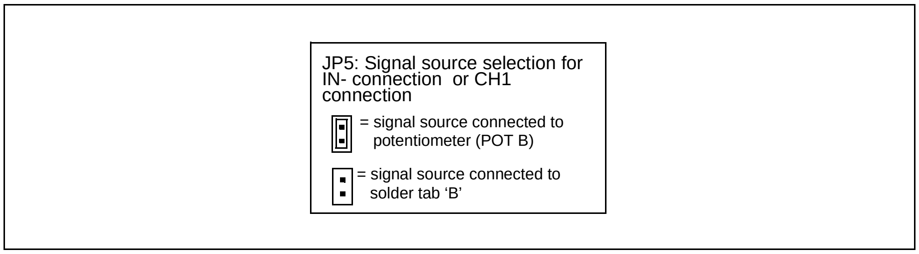


Figure 2.7: JP5 Jumper Selections

2.4.6 Channel Configuration Example

In the following example, the daughter board is configured using the MCP3202 ADC. Note that there is no device in the other socket. For the ‘A’ signal path, the output of potentiometer ‘A’ is used as the signal source and is routed through the Op Amp and into channel 0 of the ADC. For the ‘B’ signal, an external signal source is used (JP5 removed) and is routed into channel 1 of the ADC. The Op Amp is bypassed in this case by setting the jumper JP3 to R/C. The reference voltage is V_{DD} for these devices.

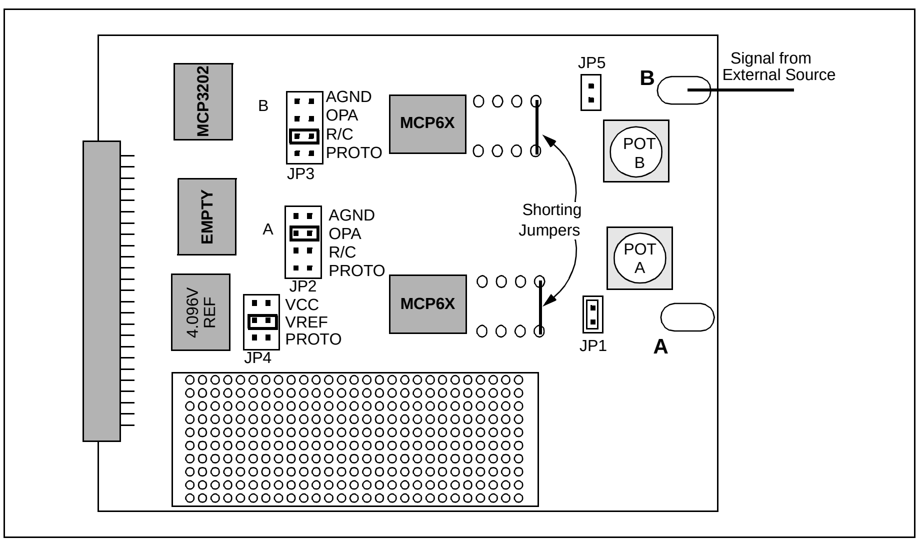


Figure 2.8: Daughter Board Configuration Example

2.5 RC Network

The RC network connectors provided for both signal path ‘A’ and signal path ‘B’ allow the user to add resistor and capacitor components to the signal path. The connectors provide the means to attach the components without having to solder them on the board. The overall path for the RC network is shown below with the Op Amp inserted in the socket. Note that the shorting jumper is installed when the board comes from the factory.

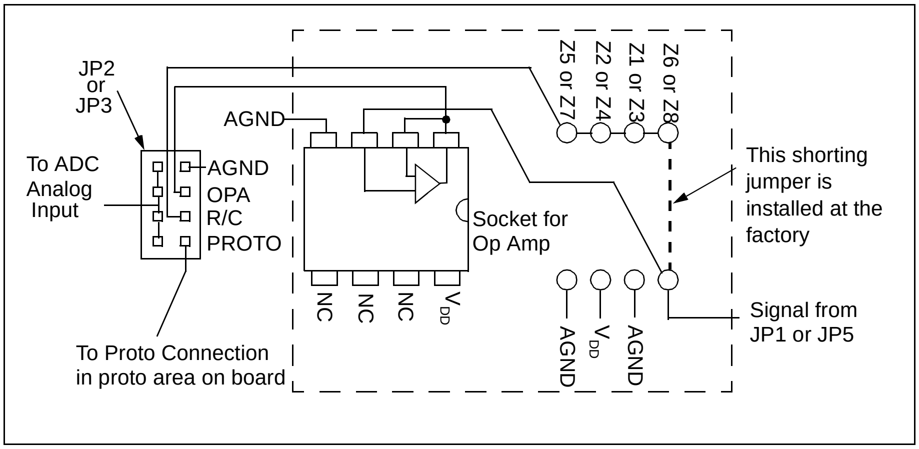


Figure 2.9: RC Network Layout

NOTES:

Chapter 3. Quad/Octal MCP3XXX Daughter Board

3.1 Description

The Quad/Octal MCP3XXX ADC daughter board is designed to be used with the Analog Evaluation Driver board. The user can use it as a stand-alone board by adding additional circuitry either on the prototype area or on another board. When used in conjunction with the driver board and the supplied software, this board can be used to evaluate the MCP3004, MCP3008, MCP3204, MCP3208, MCP3302 or MCP3304 Analog to Digital Converter devices.

3.2 Features

The Quad/Octal MCP3XXX ADC daughter board provides the following features:

- Allows single or continuous conversions for any of the supported Analog-to-Digital Converters.
- Display data from conversions on PC in the following formats:
  - Real-time numeric
  - Real-time strip chart
  - FFT
  - Histogram
  - Scopeplot
  - Data list
- Signal source can be selected as DC signal from on-board potentiometer or an externally supplied signal
- Prototype area available for circuit evaluation
- Low-pass filter boards supplied for filter analysis

3.3 Layout Overview

The Quad/Octal MCP3XXX ADC daughter board is laid out for maximum flexibility. This board allows signal connections to each of the analog inputs and can be used in both pseudo differential or single ended mode.

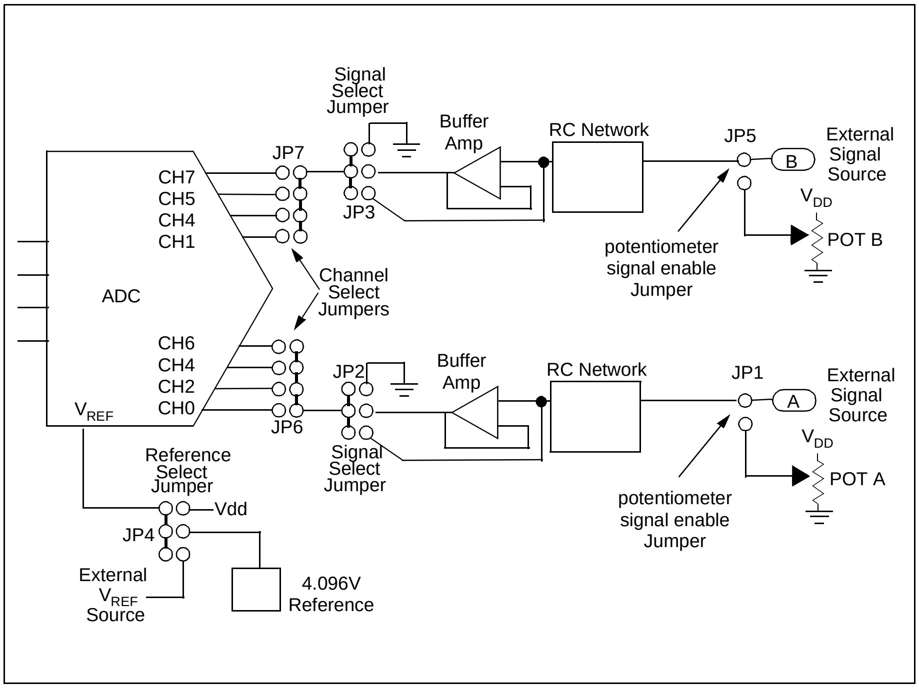


Figure 3.1: Basic Signal Chain for Quad/Octal MCP3XXX Daughter Board

3.4 Configuring the Daughter Board Jumpers

There are eight jumpers that must be set for proper operation of the daughter board. One jumper selects the ADC installed as the 14 lead or the 16-lead devices. Six of these jumpers determine the signal path to the ADC. Another jumper determines the ADC reference voltage source. The same socket is used for both the 14 lead or the 16-lead devices. Pin 1 on the device needs to be lined up with pin 1 on the socket in either case.

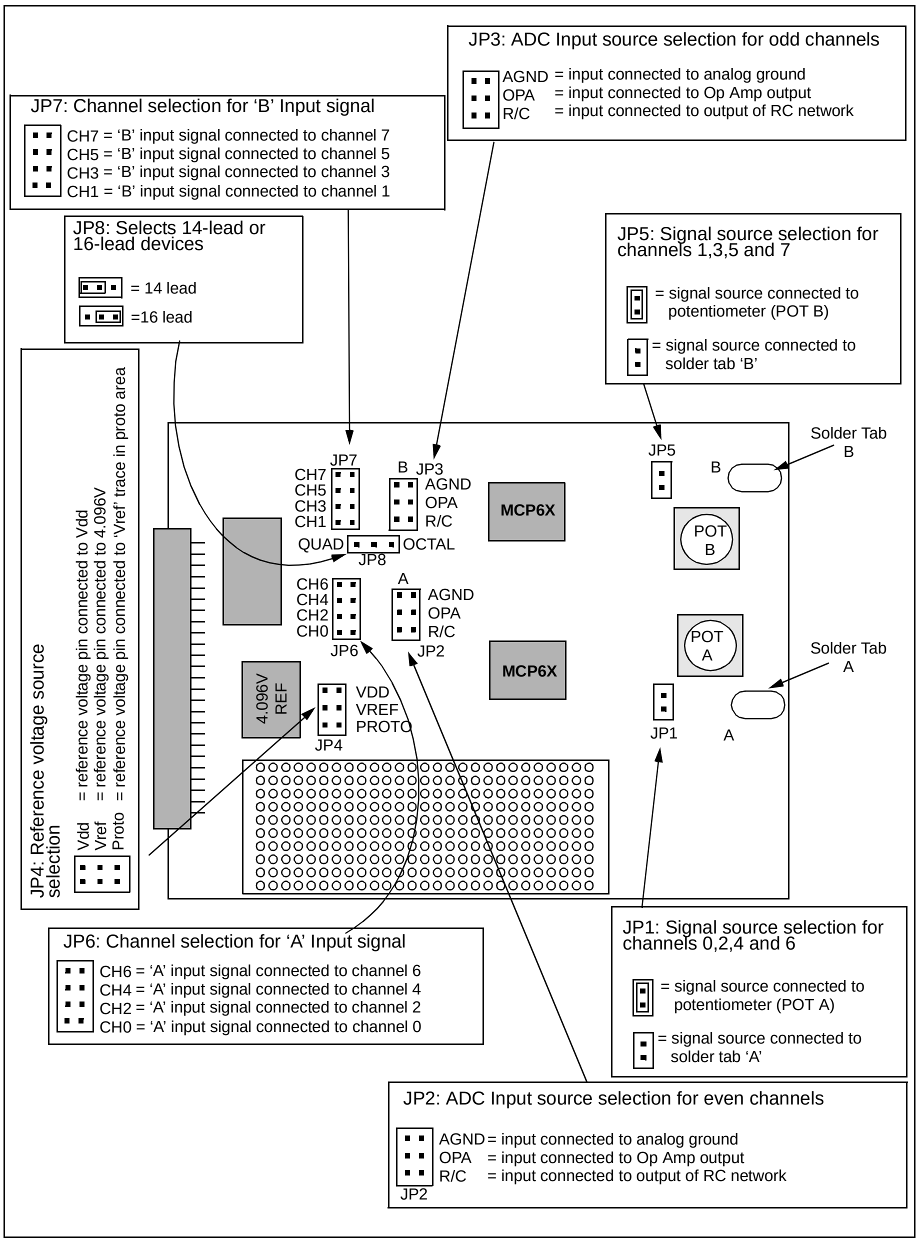


Figure 3.2: Jumper Locations on the Daughter Board

3.4.1 Jumper JP1

JP1 determines the input signal source of the 'A' input which is connected to the even numbered input channels of the devices. If the jumper is on, the input signal source is routed to potentiometer 'A'. If jumper JP1 is not installed, then the potentiometer is bypassed and an external signal from solder pad A or the prototype area must be used.

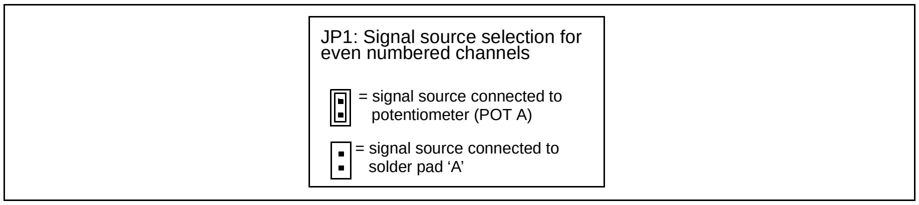


Figure 3.3: JP1 Jumper Selections

3.4.2 Jumper JP2

JP2 determines what the input of the ADC is actually connected to. This jumper is connected directly to even-numbered channels on the A/D Converters. There are three choices for this jumper.

> **Note:** There should never be more than one jumper installed on JP2 or damage to circuits may occur.

The four choices are:

- AGND: connects input to the analog ground plane
- OPA: connects input to the output of the buffer amplifier
- R/C: bypasses the amplifier and connects the ADC input to the output of the RC network

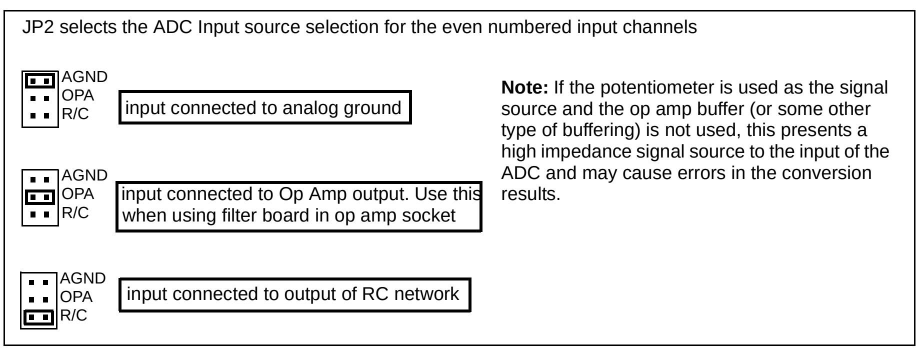


Figure 3.4: JP2 Jumper Selections

3.4.3 Jumper JP3

JP3 is identical in operation to JP2 except that this jumper is connected directly to odd-numbered input channels of the ADC.

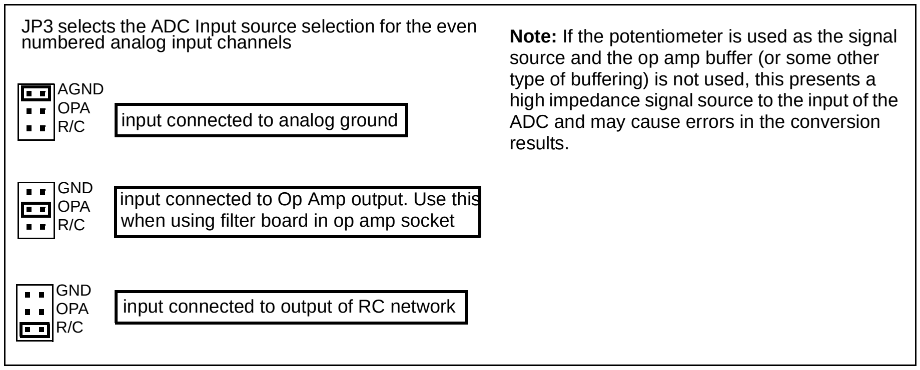


Figure 3.5: JP3 Jumper Selections

3.4.4 Jumper JP4

JP4 is used to select the reference voltage into the ADC for the devices. There are three choices for this jumper. Note: there should never be more than one jumper installed on JP4 or damage to circuits may occur. The three choices are:

- VDD: connects reference input to V_{DD}
- VREF: connects reference input to the 4.096 voltage reference device
- PROTO: connects reference input to the ‘VREF’ connection on the prototype area

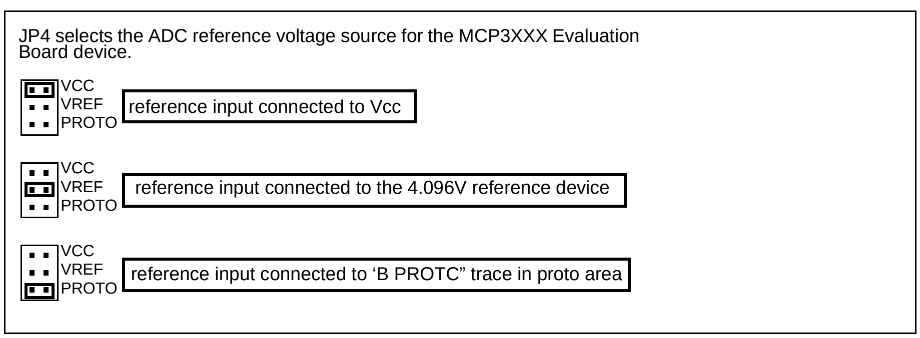


Figure 3.6: JP4 Jumper Selections

3.4.5 Jumper JP5

JP5 is identical in operation to JP1, although it determines the signal source for the 'B' input which is connected to the odd-numbered analog input channels on the A/D converters.

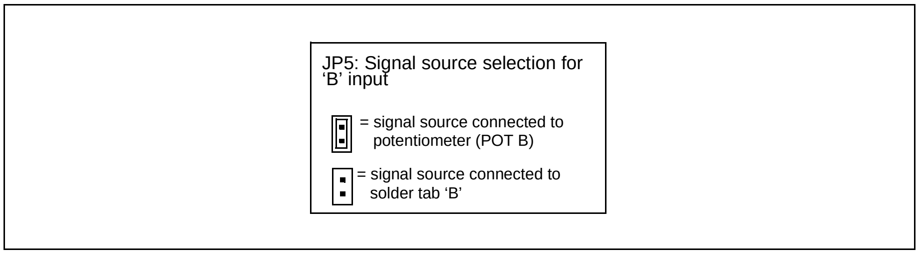


Figure 3.7: JP5 Jumper Selections

3.4.6 Jumper JP6

JP6 is used to direct the signal 'A' to one or more of the even numbered channels on the devices.

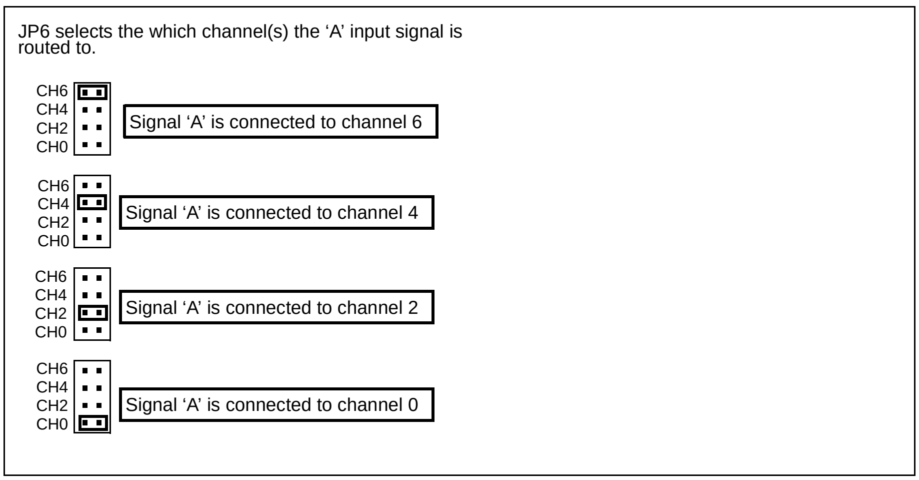


Figure 3.8: JP6 Jumper Selections

3.4.7 Jumper JP7

JP7 is used to direct the signal ‘B’ to one or more of the odd-numbered channels on the MCP3XXX devices.

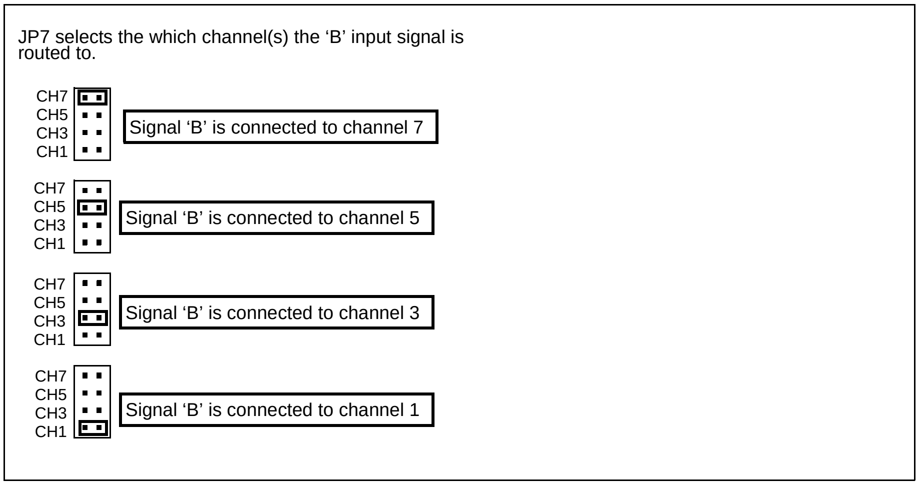


Figure 3.9: JP7 Jumper Selections

3.4.8 Jumper JP8

JP8 is used to determine whether the 14-lead (MCP3004, MCP3204, MCP3302) or the 16-lead (MCP3008, MCP3208, MCP3304) is being used on the board. The same socket is used for both devices. When installing the device, make sure that pin 1 on the device lines up with pin 1 on the socket in either case.

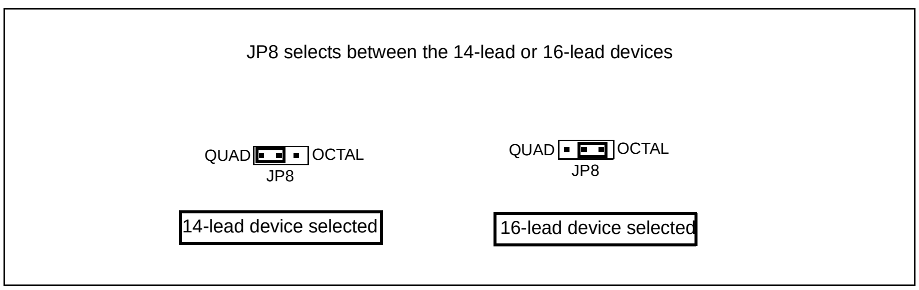


Figure 3.10: JP8 Jumper Selections

3.4.9 Channel Configuration Example

In the following example, the daughter board is configured to use an MCP3208 and get the output of potentiometer 'A' through the Op Amp and into channel 0 of the ADC. For the 'B' signal path, an external signal source is used (JP5 removed) and is routed directly into channel 5 of the ADC. The Op Amp is bypassed by setting jumper JP3 to 'R/C.' The reference voltage is set to 4.096 volts.

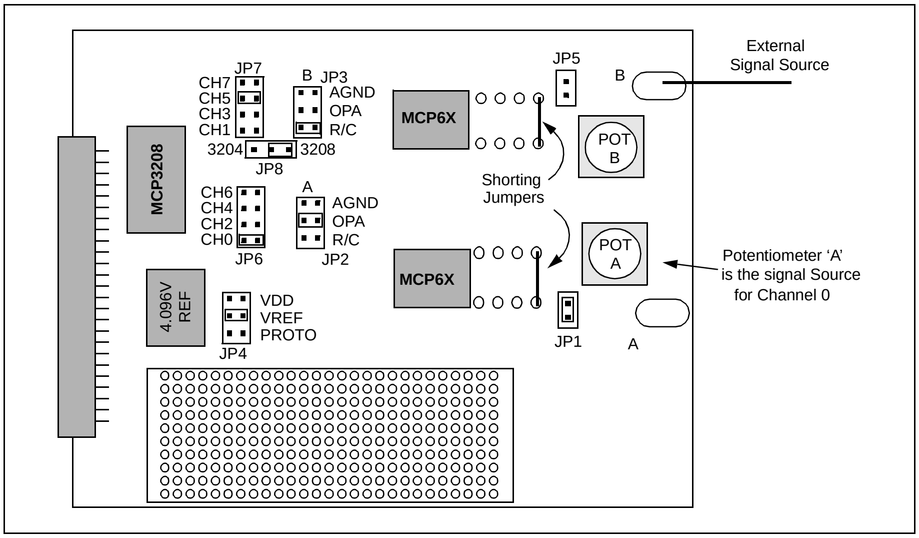
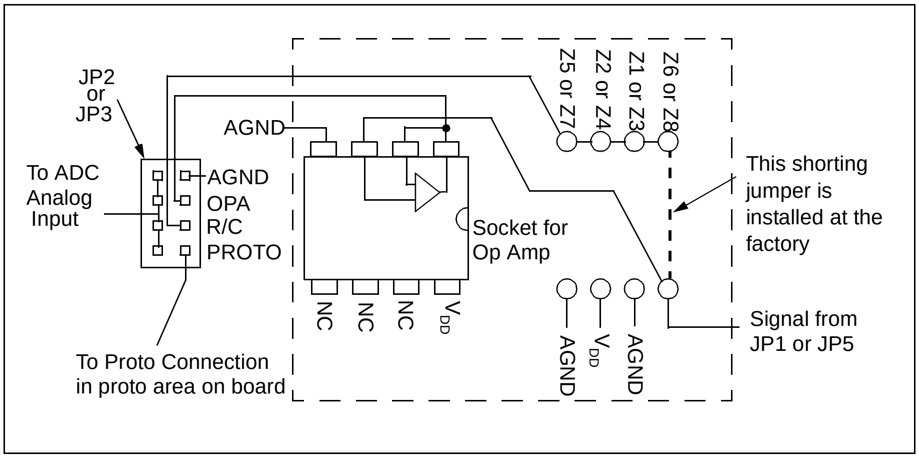


Figure 3.11: Daughter Board Configuration Example

3.5 RC Network

The RC network connectors provided for both signal path 'A' and signal path 'B' allow the user to add resistor and capacitor components to the signal path. The connectors provide the means to attach the components without having to solder them on the board. The overall path for the RC network is shown below with the Op Amp inserted in the socket. Note that the shorting jumper is installed when the board comes from the factory.



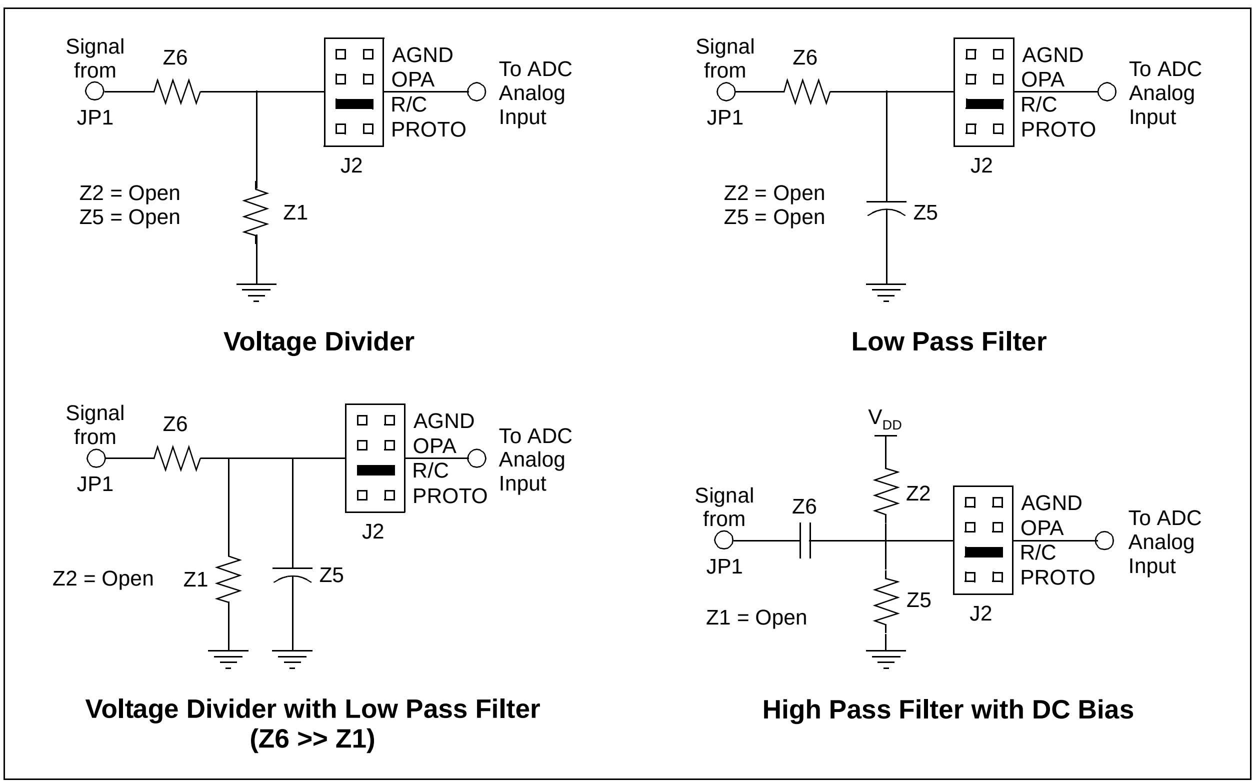


Figure 3.12: RC Network Circuit Examples using "A" Signal Path

NOTES:

Chapter 4. Filter Boards

4.1 Overview

Two Analog Filter boards are provided with each daughter board so that the user has the option of experimenting with analog filters in the signal path. A filter board is meant to be used by inserting it into the Op Amp socket after the Op Amp has been removed. See Figure 4.1. Keep in mind that when using the Filter Board, the R/C network section must be configured so that the signal passes through the Op Amp (filter).

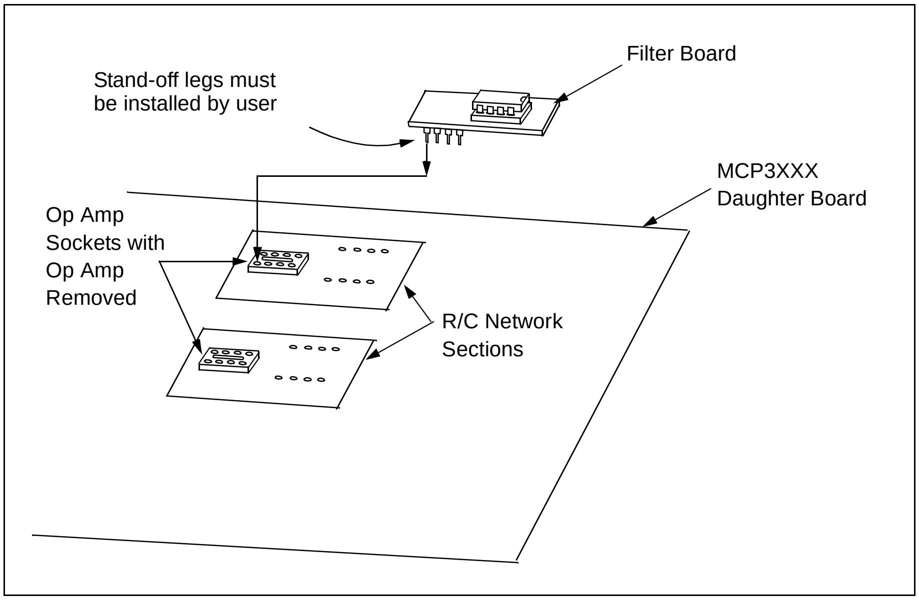


Figure 4.1: Inserting Filter Board into Op Amp Socket

4.2 Selecting Components for the Filter Board

The filter board layout is shown in Figure 4.2 and allows the user to construct their own filter and insert it into the signal path. The filter board allows construction of low pass filters (up to 4th order) in the Sallen-Key configuration. The only component that is populated is the Op Amp. The stand-off legs are provided for insertion into the socket, but the user must install them. Microchip's FilterLab® program is an excellent tool for designing filters and will create component values for this filter board based on your filter parameters. The FilterLab program is available free of charge from Microchip's web site at www.microchip.com.

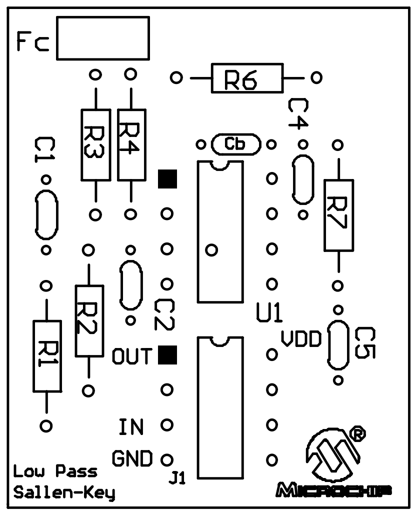


Figure 4.2: Filter Board Layout (Sallen-Key Configuration)

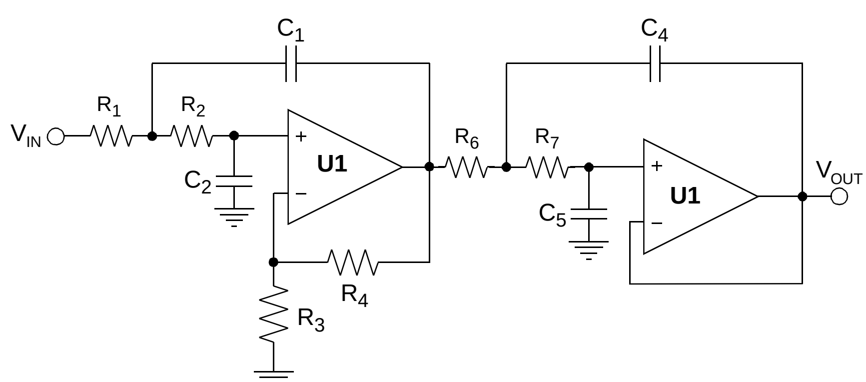


Figure 4.3: Filter Board Schematic

Chapter 5. Using the Daughter Boards with the MXDEV™ Driver Board

5.1 Using the MXDEV Driver Board to Set the ADC Configuration

5.1.1 Power-up State

When the MCP3XXX daughter board is connected to the Driver Board (with the ADC Evaluation System microcontroller installed) and it is powered up, the LCD display will look similar to what is shown below in Figure 5.1. From this point, it is possible to change the ADC device number and the channel configuration using the switches on the Driver Board SW1 and SW2. See the next sections for details on selecting a device and input channel configuration. The microcontroller is constantly sampling the ADC selected in the LCD Display and when it is properly configured will show the ADC conversion results. The sampling rate is approximately 10 Hz for a 20 MHz crystal. As shown in the diagram below, the ADC conversion results will be shown in Binary, Hex and decimal formats.

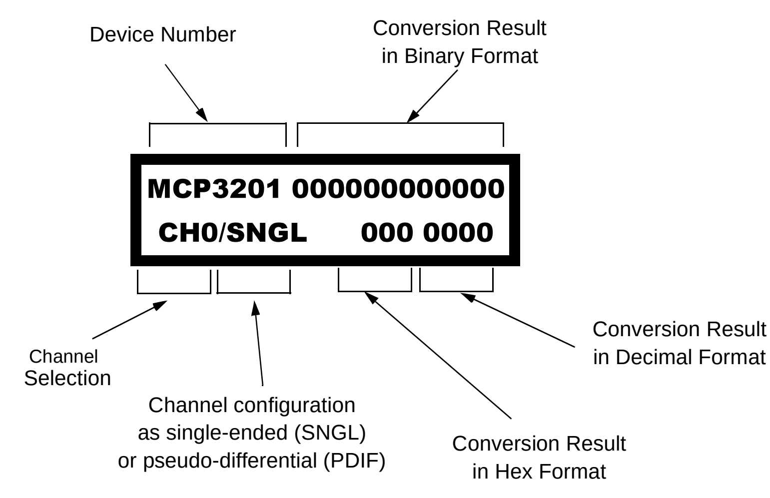


Figure 5.1: Power-Up State of LCD display on Analog Driver Board

5.1.2 Changing the Device Number

Pressing the switch SW1 on the analog driver board will cause the display to cycle through all the ADC part numbers. See Figure 5.2.

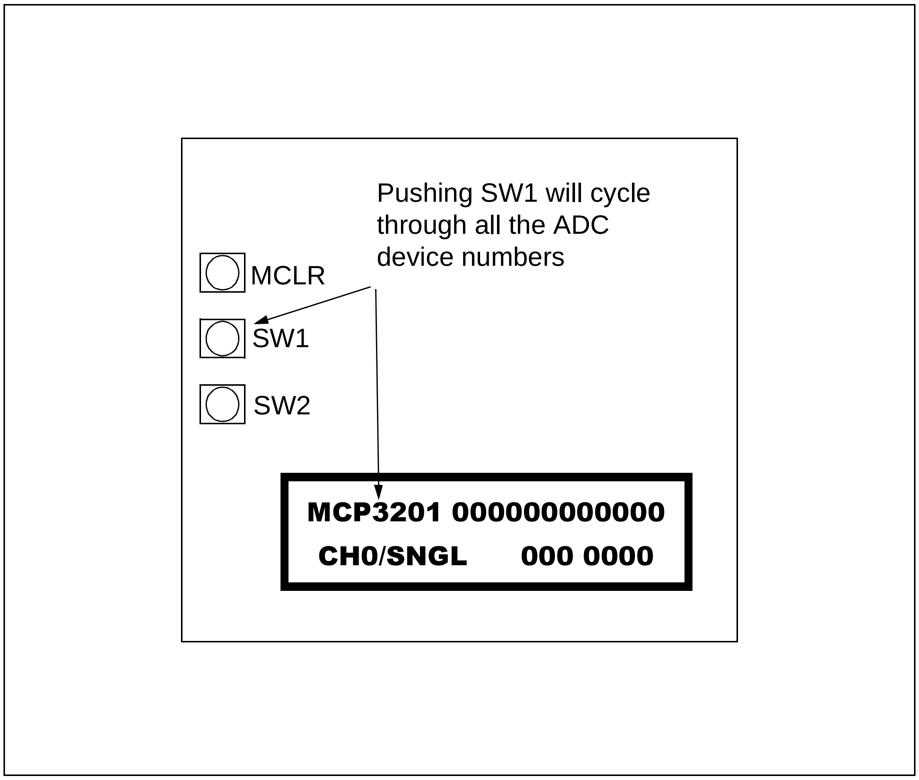


Figure 5.2: Using the Push Buttons to Set Device Number

5.1.3 Changing the Channel Configuration

Pressing the switch SW2 on the analog driver board will cause the display to cycle through all the channel configurations based on the ADC part number that has been selected. See Figure 5.3.

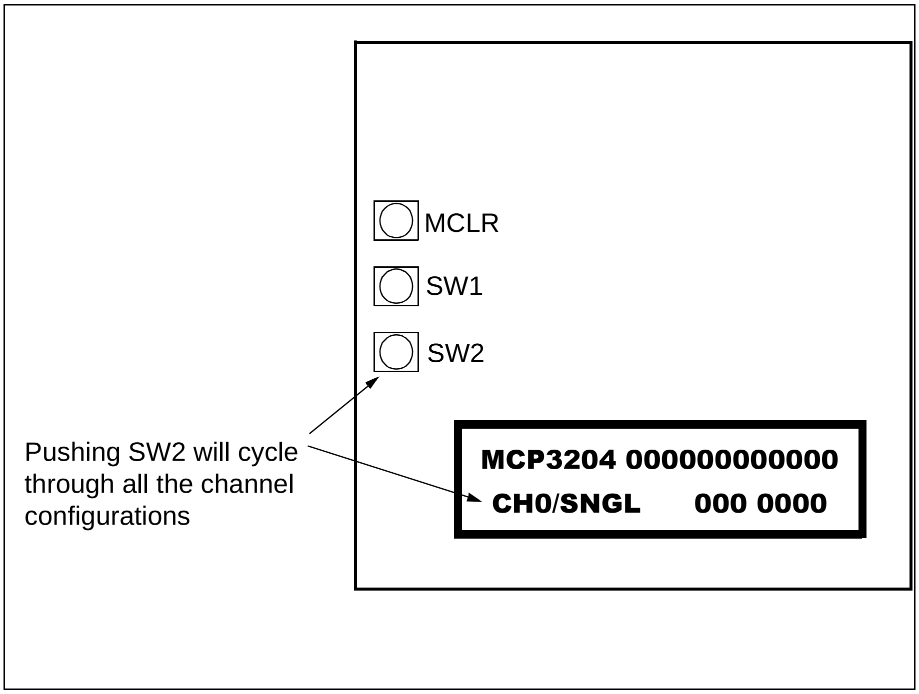


Figure 5.3: Using the Push Buttons to Set Channel Configuration

NOTES:

Chapter 6. ADC Evaluation Software Tools of MXLAB™

6.1 Introduction

The ADC Evaluation software is part of the Microchip MXLAB™ Analog Tool Suite. This software enables you to select the proper Analog/Digital Converter (ADC), choose channel configurations, and show conversion results in a series of different display screens. This software provides tools to the system designer to evaluate ADC and circuit performance to ultimately produce faster design cycles.

6.2 Highlights

This chapter covers the following topics:

- Control Toolbar
- Selecting the Sample Mode
- More Tools Selection
- Selecting the ADC Input Channel
- A/D Tools

6.3 Control Toolbar

The Control Toolbar is located at the top of the screen. The control buttons and drop-down boxes enable you to set up the ADC configuration and select the data display window.

6.3.1 Control Toolbar Functions

Figure 6.1 shows all of the Sample functions available on the Control Toolbar.

Figure 6.1: Control Toolbar

Table 6.1: Control Toolbar Items and Descriptions

Item	Description
Stop	Stop Button. Stops the ADC conversion process.
Go	Go Button. Starts the ADC conversion process for all sample modes.
One	Starts a single ADC conversion for real time sample modes.
Tools	Displays the ADC/Digital Potentiometer Toolbar.  The selection list from left to right is as follows: • Histogram • FFT • Scope Plot • Data List • Stopchart Real-Time • Numeric Real-Time • Programmable Gain • Low-Pass Filter • VREF/Offset • Basic Functions
Up/Down Arrows	Real-Time Speed. Selects the conversion speed for acquisitions.
Rate	Continuous Rate Speed.
Mode	Sample Mode. Selects the sample mode as real time, acquisition or trigger mode. Default is acquisition.
Acquisition	Selects the conversion speed for acquisitions.
Speed	Selects the number of data points to acquire.
Samples	Displays the sample time.
More Tools arrow	Enables you to add or remove any or all of the tools on the Control Toolbar.

6.4 Selecting the Sample Mode

The sample mode selection determines how the system gets data from the ADC and how to display the data. Use the Sample Mode drop-down menu on the Control Toolbar to change the sample mode selection (Figure 6.2). The sample mode automatically changes whenever one of the display windows is selected with the mouse. The three sample mode selections are: Real Time, Acquisition and Trigger.

Figure 6.2: Selecting The Sample Mode

6.4.1 Real-Time Mode

Real-Time Mode samples the ADC input channel and immediately transmits the data for display on the PC. The display options for this mode are the Numeric Real-Time Display or the Numeric Strip Chart Display. The Speed Selection slider on the Control Toolbar controls the relative conversion speed. The actual conversion speed varies according to the type of computer being used. To start the conversion process for multiple conversions, click **Go**; for a single conversion, click **One**.

6.4.2 Acquisition Mode

Acquisition Mode samples the ADC input channel and temporarily stores the data from each conversion in the SRAM on the control board. When all of the conversions are complete, the data is uploaded to the PC for display and analysis. Display options for this mode are the Histogram, FFT, Scopeplot, and Data List displays. To start the conversion process, click **Go**.

6.4.3 Trigger Mode

Trigger Mode operation is identical to Acquisition Mode; however, pressing **Go** configures the system to wait on the trigger (high-to-low transition) before executing an acquisition. To provide a trigger, either press SW1 switch or apply an external signal connection to SW1.

6.5 More Tools Selection

The More Tools selection enables you to select which tools you want to view on the Control Toolbar.

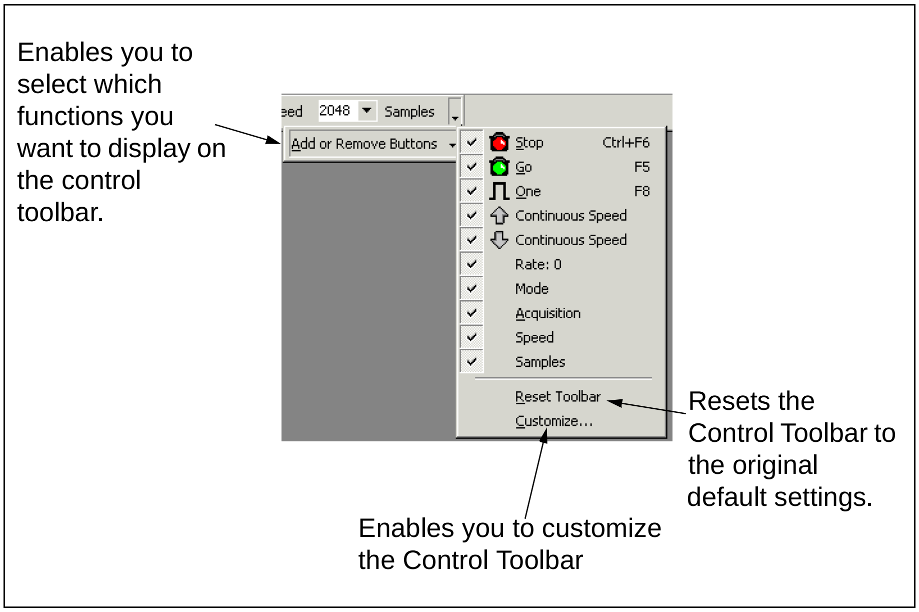


Figure 6.3: More Tools Menu

6.6 Selecting the ADC Input Channel

When preparing to do data acquisitions, you must configure the input channel prior to executing a conversion. From the menu, select *Tools > ADC Tools > Configure*.

The channel configuration dialog allows you to select the input channel for the ADC to be sampled. Each device allows for the selection of a single-ended or pseudo-differential mode. The Channel Selection on the left in Figure 6.4 is for single-ended mode; the dialog on the right is for pseudo-differential mode selection. If single-ended mode is chosen, the channel number is selected. Note that all channels are not available on all devices, and the radio selection buttons will reflect that. If the pseudo-differential mode is chosen, then the polarity of the channel pairs must be chosen as well. See the device data sheets for more details.

> **Note:** Select MCP3208 for this evaluation board. You must click **OK** to execute the change configuration.

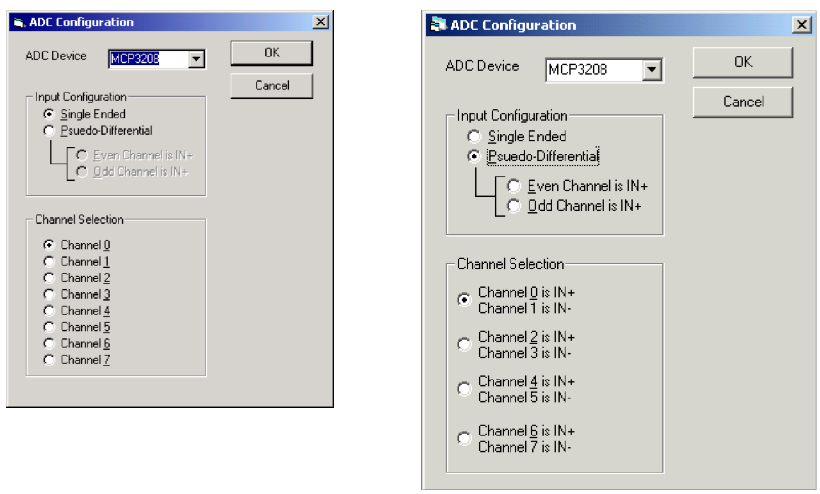


Figure 6.4: ADC Configuration Window

6.7 A/D Tools

6.7.1 Real-Time Numeric Display

The Real-Time Numeric display shows the results of a single or continuous conversion as it is transmitted from the ADC (Figure 6.5). The value is displayed in Decimal, Hex, and Binary formats. The display updates each time a conversion is completed. Use the Real Time Speed slider to control the sample speed.

A second set of values provides the ability to observe the effects of averaging (Figure 6.6). To enable averaging to take place with each conversion, click the Enable Averaging check box.

Selecting Arithmetic Average adds the value of each conversion until reaching the Counts value. Upon reaching the Counts value, the total conversion sum is divided by the Counts value. The final mean value is displayed.

> **Note:** For this averaging method, the average display values are only updated after the number of conversions has reached the value in Counts. If this number is high, and the sampling speed is slow, then the averaged value display may take a long time before it is updated. If the rolling average mode is enabled, the display is updated after every conversion based on the average of the last n conversions where n = Counts (Figure 6.6).

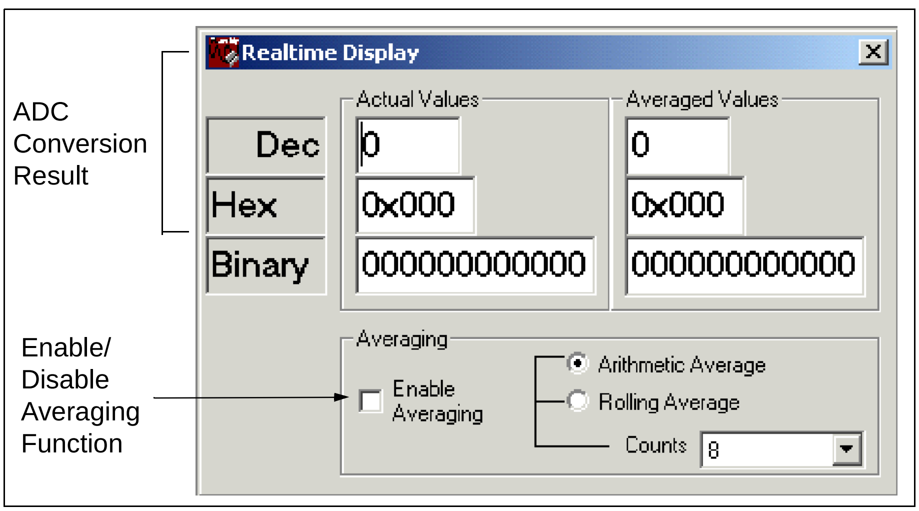


Figure 6.5: Real-Time Numeric Display Window

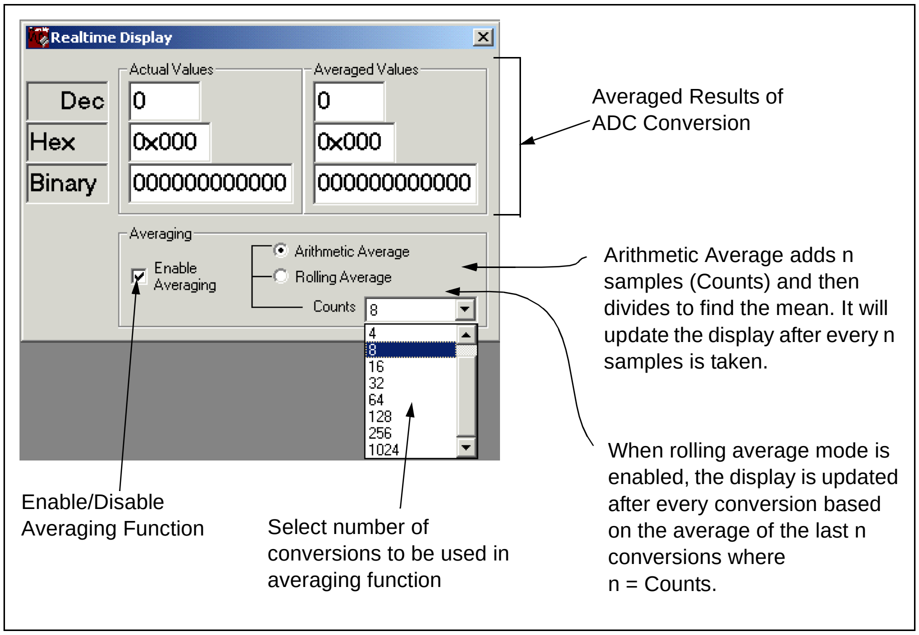


Figure 6.6: Using the Averaging Function

6.7.2 Real-Time Strip Chart Tool

The Strip Chart display allows you to observe the changing output of the ADC in a strip chart format. This display always shows the last 20 codes returned from the ADC. You can either lock the Y-Axis to show a certain range of codes or you can set the Y-Axis to automatic so that all of the codes in the buffer are visible. The buffer selection allows you to choose how many codes on top of the largest code and how many codes below the smallest code are displayed. For example, if the buffer size is set to 10 codes, then the window displays 10 codes on top of the largest code and 10 codes below the smallest code captured in the present window.

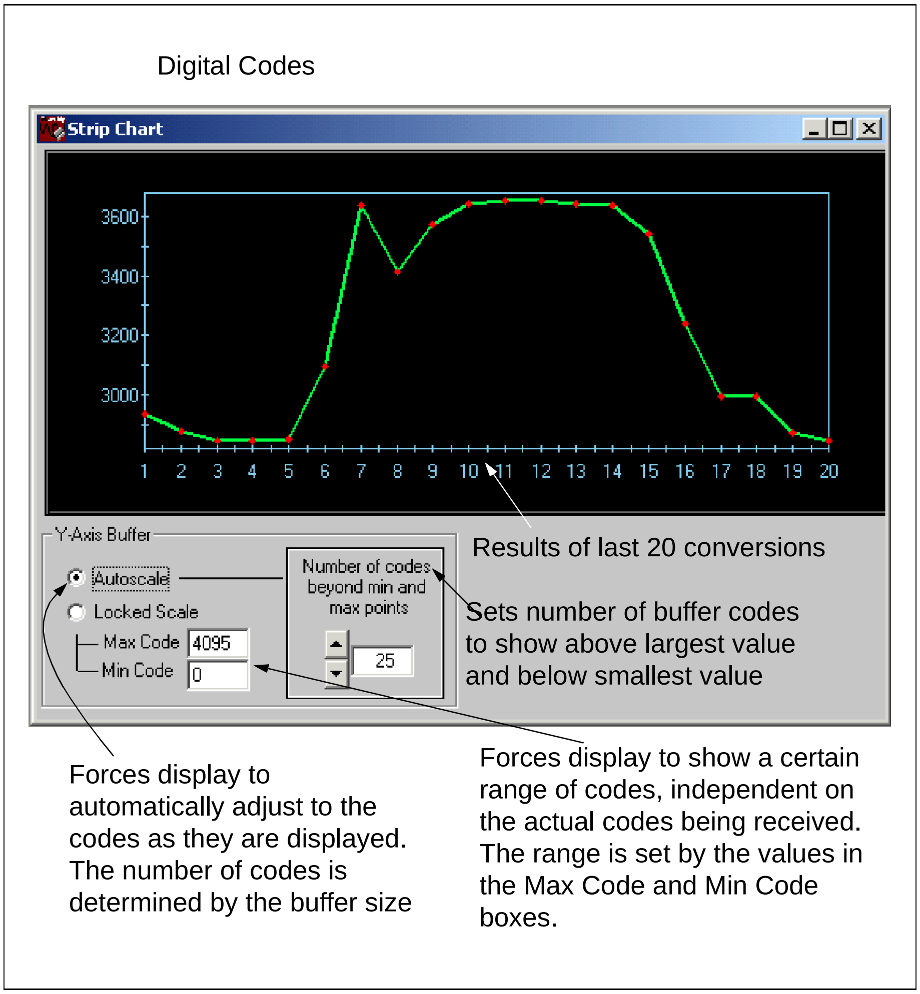


Figure 6.7: Real-Time Strip Chart Display

6.7.3 Data Display Tool

The Data Display window shows the actual conversion values from the ADC. Upon completion of an acquisition, all of the data values are loaded into the table in the order that they were taken. Buttons at the bottom of the window allow you to examine the data list in the actual order or sorted in ascending order. When the data is displayed in the actual order, the Min and Max values are indicated as well as the first occurrence of the Min and Max values.

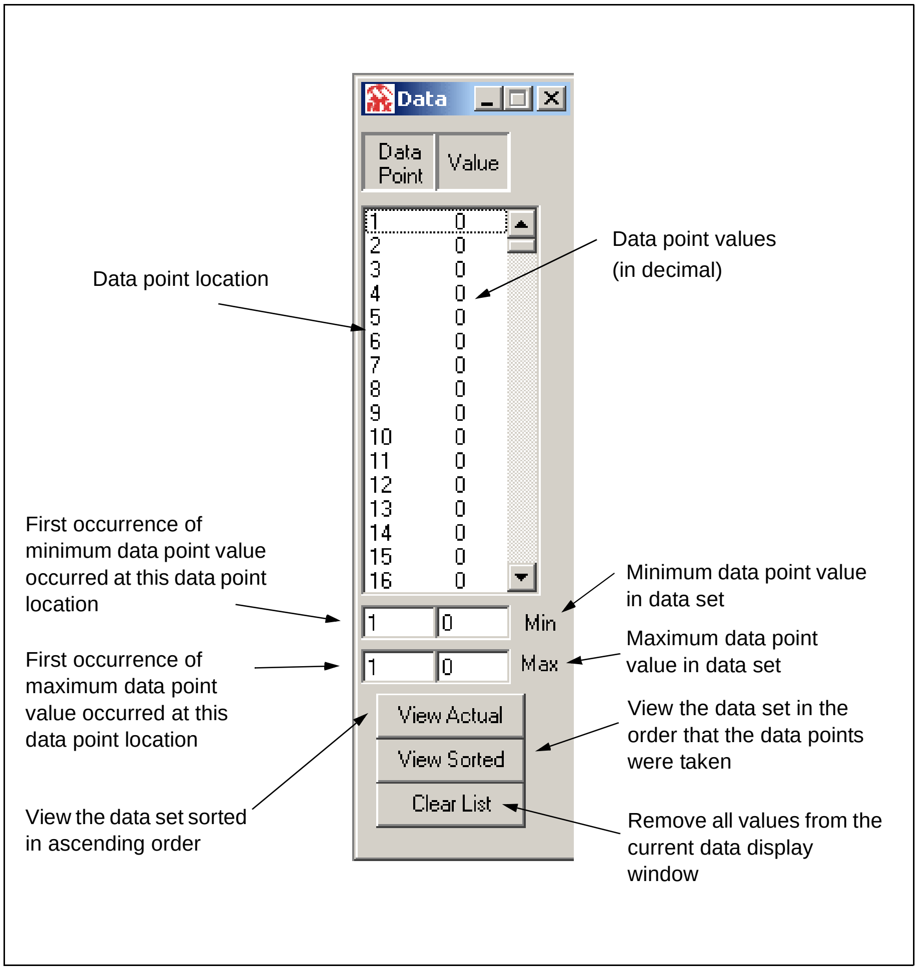


Figure 6.8: Data Display

6.7.4 FFT (Fast Fourier Transform) Tool

The FFT display displays the Fast Fourier Transformation of the data in the frequency domain. This display is typically used to analyze AC signals or to help locate the source of AC noise.

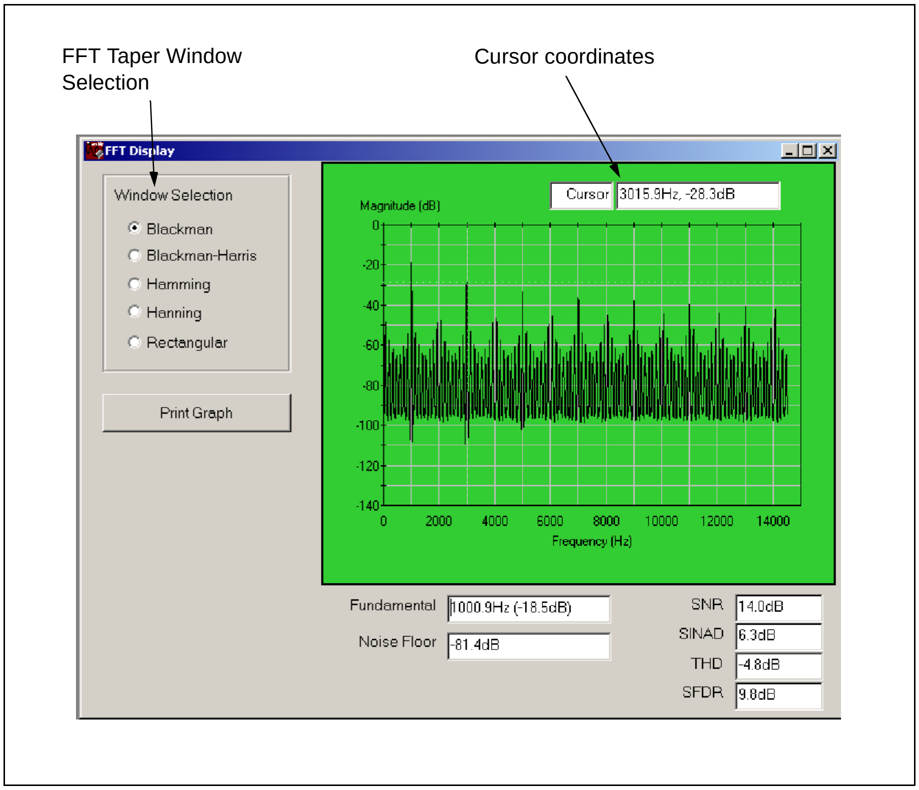


Figure 6.9: FFT Display

The size of the data set of the FFT analysis determines the resolution and accuracy of the FFT. The accuracy is equal to:

$$\text{FFT Accuracy} = (\pm 4/(\text{n}\sqrt{N})dB$$

Where:

n = number of converter bits

N = Number of data points

In instances where the input signal is not periodic with respect to the sampling frequency of the converter (as is the case with this tool), windowing algorithms are advantageous when looking at FFT results. The windows that are available with the MXLAB software are the Blackman, Blackman-Harris, Hamming, Hanning and Rectangular. Basically, an FFT window is multiplied times the measured signal data set taken during the specified length of time of the conversion. Typically this multiple reduces the magnitude of the beginning and end of the sample and consequently minimizing discontinuities seen with the FFT calculation.

Blackman – This window has a bell-shaped characteristic similar to the Blackman-Harris window. The peak resolution of this window is not as fine as the Hanning, but the response flares out less and the rejection of the sidelobes is better.

Blackman-Harris – This window has a bell-shaped characteristic. The initial data at the beginning and end of the data tapers to zero as is with the Hanning window. However, there is a larger number of zeros at each end as compared to the Hanning window. This window is typically used to analyze the harmonics of continuous time signal. The main lobe width of this window function is wider as compared to other windows. Additionally, the adjacent side lobes as well as farther side lobes are lower than any other window.

Hamming -This window also has a bell-shaped characteristic. The initial samples from the conversion data are multiplied by a small number as are the last samples. With this window, the side lobes adjacent to the main lobes are lower than the results from the Hanning Window.

Hanning – This window also has a bell-shaped characteristic, where the initial samples are multiplied by zero as well as the last samples. The samples between the beginning and end are multiplied with the Hanning bell-shape curve. The side lobes of this window are farther from main lobe as compared to the Hamming Window. This window is typically used for harmonic analysis of continuous time signals as well as random noise.

Rectangular – This window is a rectangular shaped window, where every point of the time scale is multiplied by a constant. This window provides the best frequency resolution with the narrowest lobe width. Amplitude accuracy errors occur if frequency of observed signal has a non-integer number of cycles in the FFT time record. Most typically, this window is best used when viewing transients, impulses, pseudo-random noise and when the input signal is correlated with the sampling frequency.

When the FFT windows are implemented there is a certain amount of energy that is spread across adjacent frequency bins. This spreading is a result of converting non-coherent signals and the particular window. Consequently, there is not a direct correlation between the amplitude of the analog input signal to the A/D converter and the height of the spur in the FFT analysis.

6.7.5 Histogram Tool

The Histogram display allows you to observe the data taken from a conversion and determine the relative variation of the digital codes. The histogram plot shows the digital codes on the X-Axis and the number of occurrences for each code on the Y-Axis. The statical values of the dataset are shown at the bottom of the window. The Span Control allows you to lock in the number of codes shown on the X-Axis or allow the program to automatically scale the axis for every conversion.

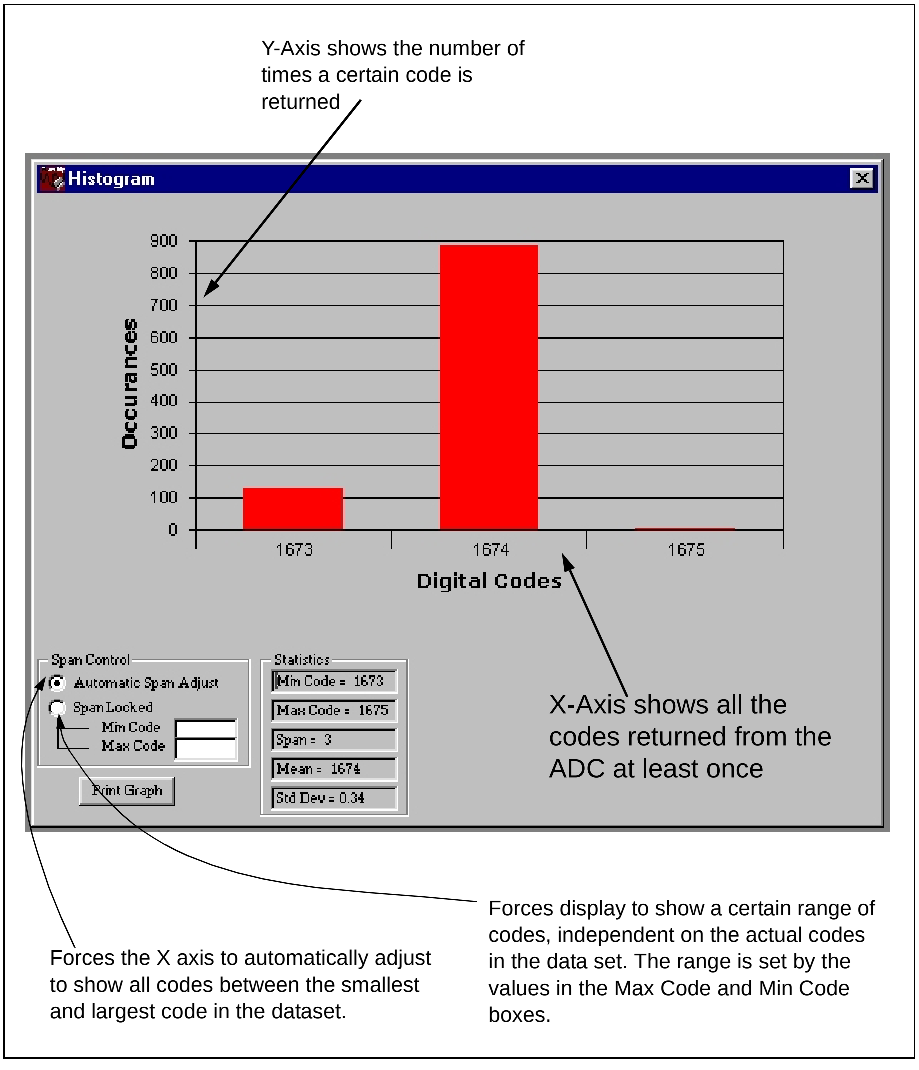


Figure 6.10: Histogram Display Window

6.7.6 Scope Plot Tool

The Scope plot display shows the results of a conversion with respect to time. This plot shows time on the X-Axis and the digital codes on the Y-Axis. Controls on the window allow you to zoom in on both axis, automatically adjust the display based on the first data point taken or on the entire signal envelope.

When the cursor is over the plot area, a marker appears that moves from data point to data point as the mouse is moved. Location of the marker is updated constantly in the Marker frame in the lower right of the window. If the left mouse button is clicked, the marker position will lock and a crosshair cursor will appear. At this point, the crosshair will now follow the mouse movements and the Marker frame will show the distance between the locked marker and the crosshair.

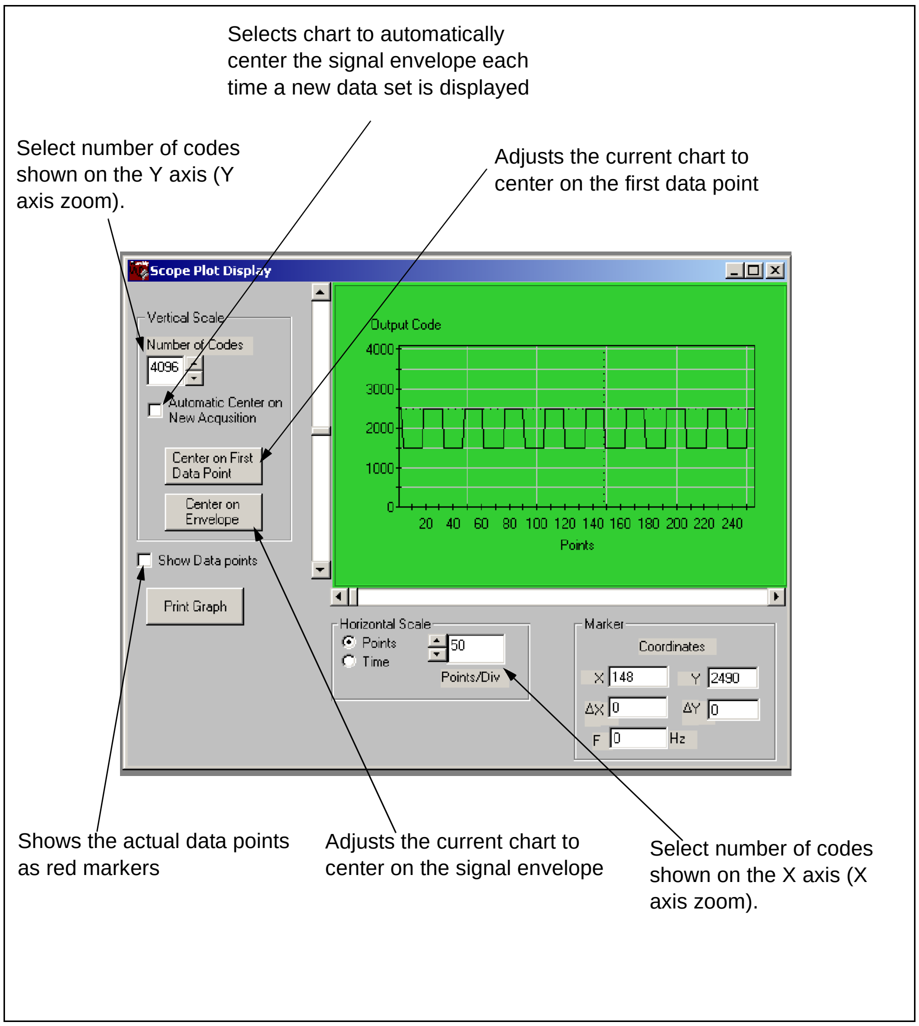


Figure 6.11: Scopeplot Display Window

NOTES:

Appendix A. Single/Dual Schematics and Layouts

A.1 Introduction

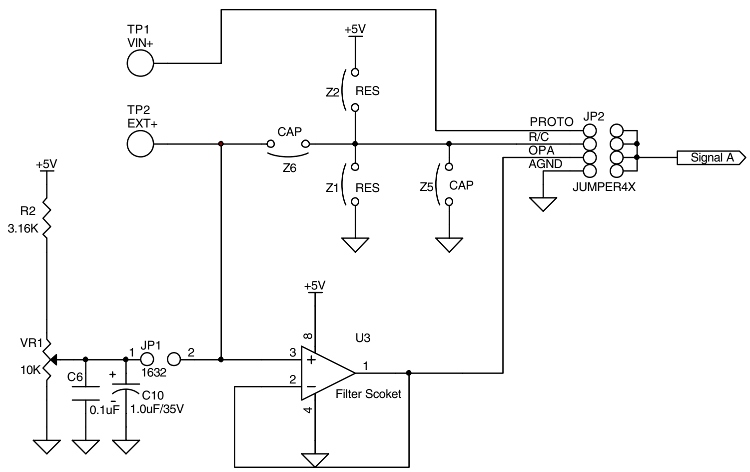
This appendix contains the schematics and layouts for the Single/Dual Evaluation Board.

A.2 Highlights

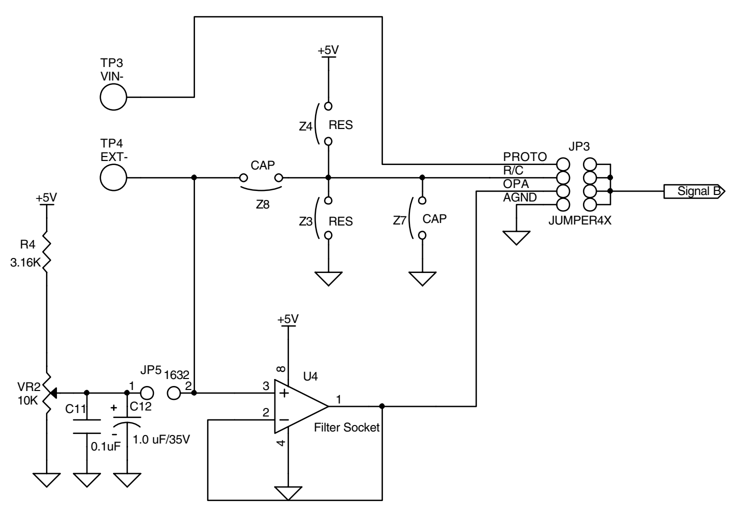
Diagrams included in this appendix:

- Single/Dual Board Schematic (1 of 3)
- Single/Dual Board Schematic (2 of 3)
- Single/Dual Board Schematic (3 of 3)
- Single/Dual Board - Top Assembly
- Single/Dual Board - Top Layer
- Single/Dual Board - Bottom Layer

A.3 Single/Dual Board Schematic (1 of 3)

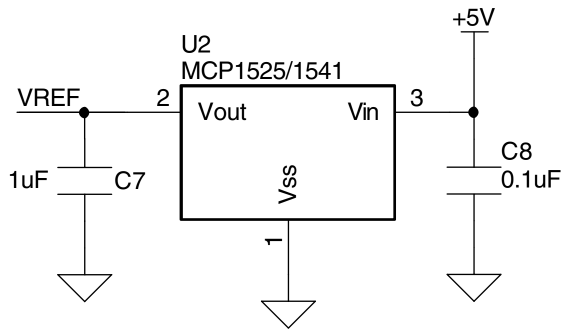


“A” Signal Path

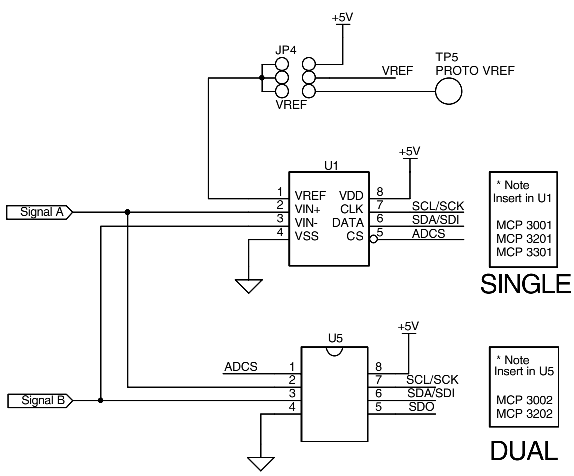


“B” Signal Path

A.4 Single/Dual Board Schematic (2 of 3)

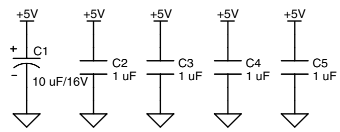


Reference Circuit

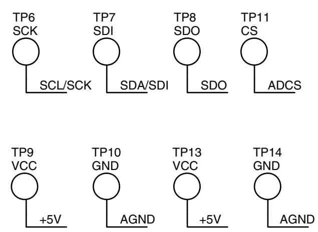


ADC Sockets

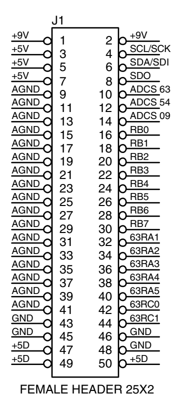
A.5 Single/Dual Board Schematic (3 of 3)



Bypass Capacitors

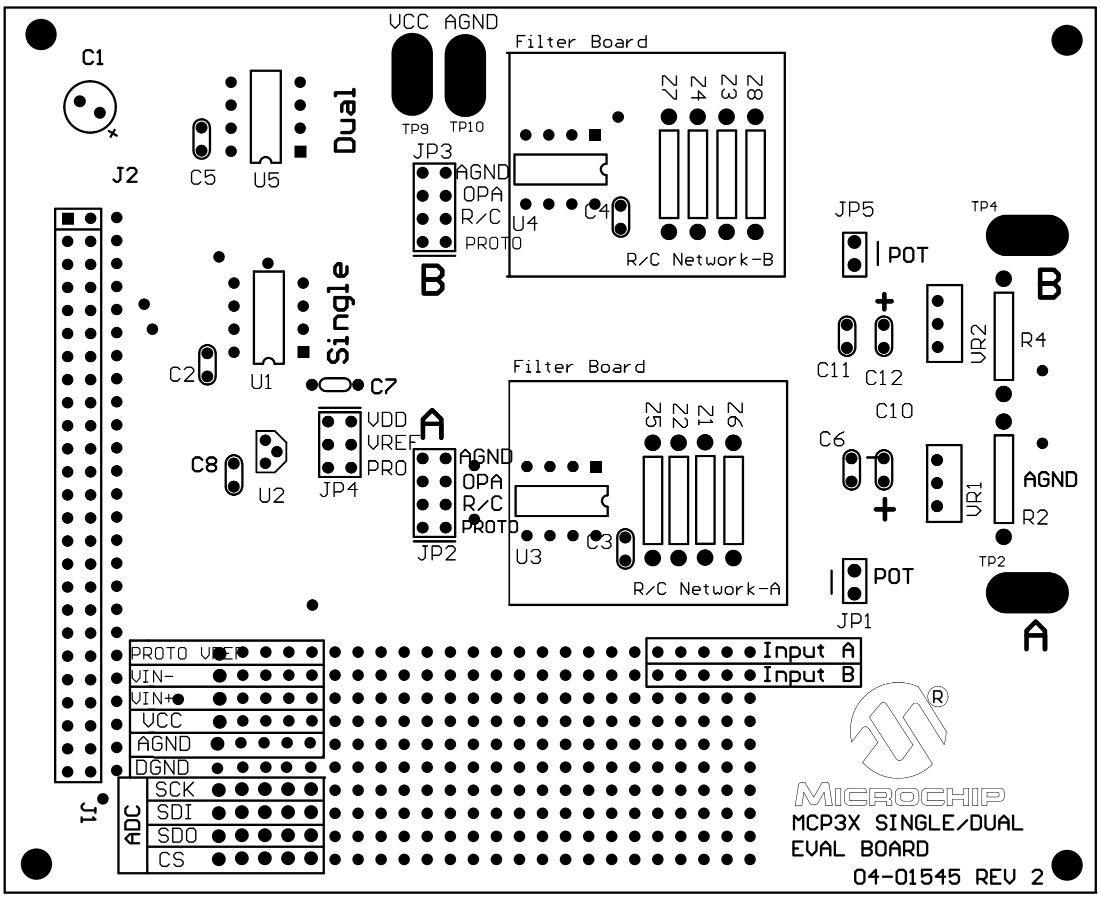


Test Points

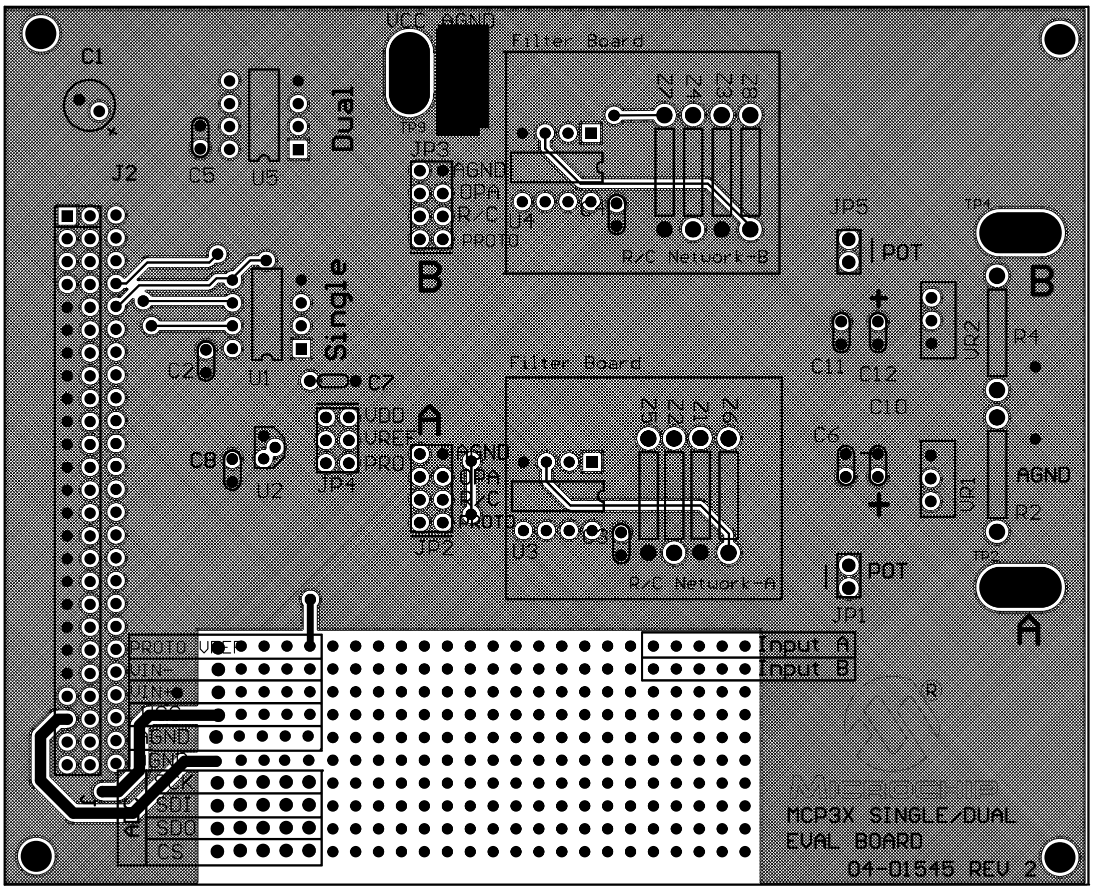


Driver Board Connector

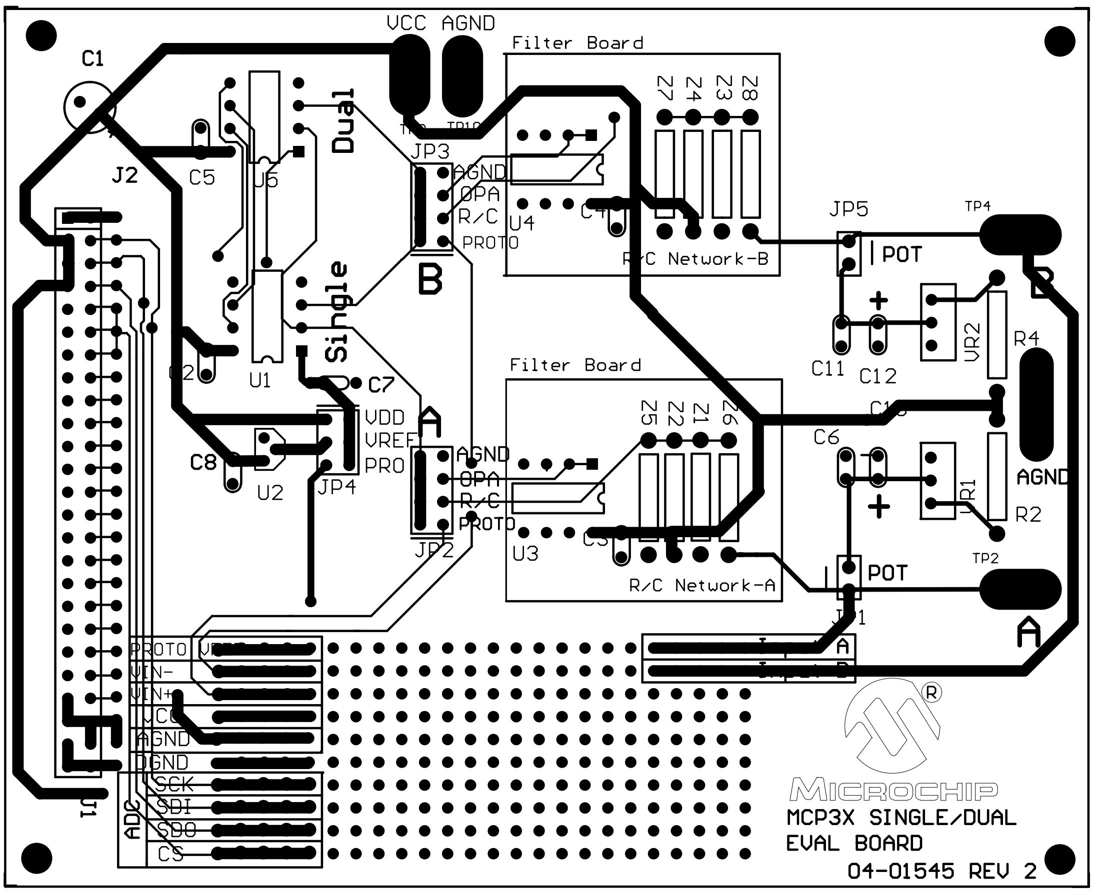
A.6 Single/Dual Board Top Assembly



A.7 Single/Dual Board Bottom Layer



A.8 Single/Dual Board Top Layer



NOTES:

Appendix B. Quad/Octal Schematics and Layouts

B.1 Introduction

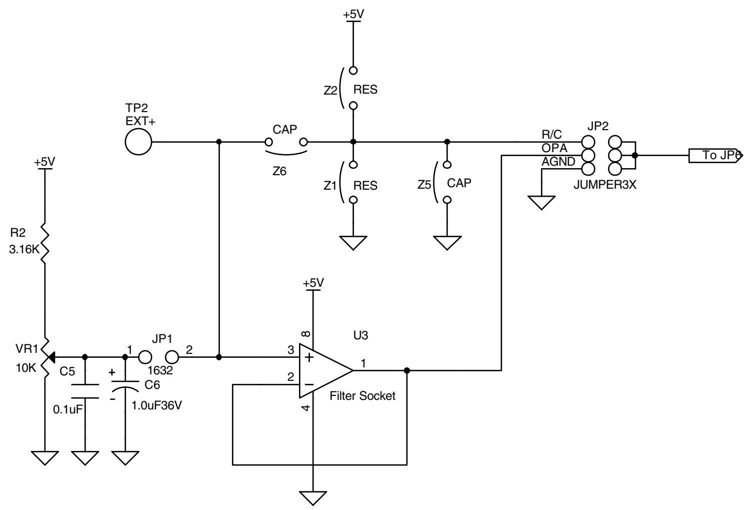
This appendix contains the schematics and layouts for the Quad/Octal Evaluation Board.

B.2 Highlights

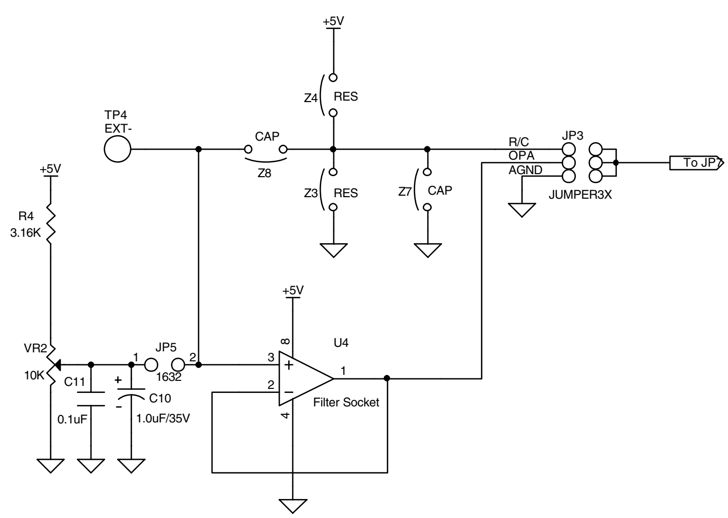
Diagrams included in this appendix:

- Quad/Octal Board Schematic (1 of 3)
- Quad/Octal Board Schematic (2 of 3)
- Quad/Octal Board Schematic (3 of 3)
- Quad/Octal Board - Top Assembly
- Quad/Octal Board - Top Layer
- Quad/Octal Board - Bottom Layer

B.3 Quad/Octal Board Schematic (1 of 3)

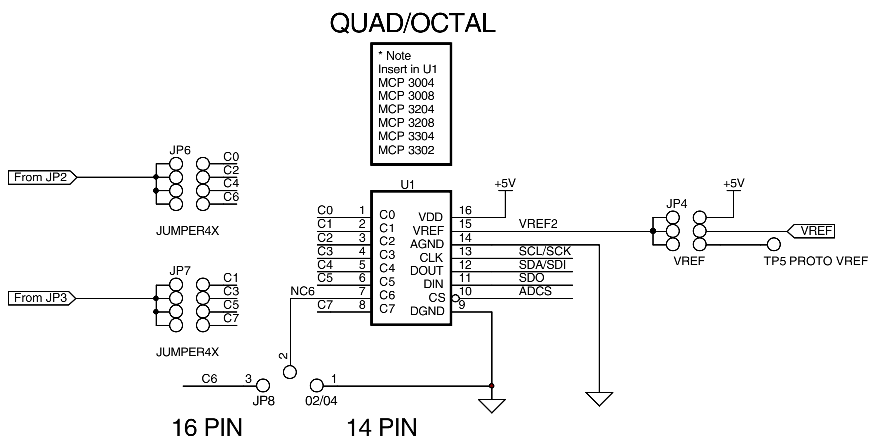


"A" Signal Path



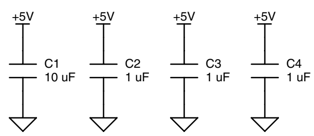
"B" Signal Path

B.4 Quad/Octal Board Schematic (2 of 3)

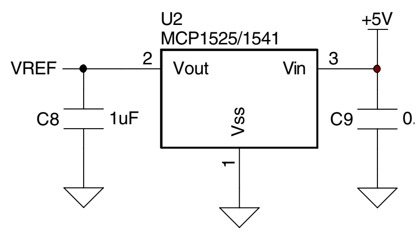


ADC Socket

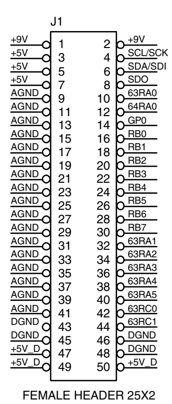
B.5 Quad/Octal Board Schematic (3 of 3)



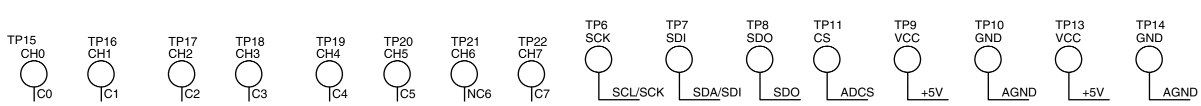
Bypass Capacitors



Reference Circuit

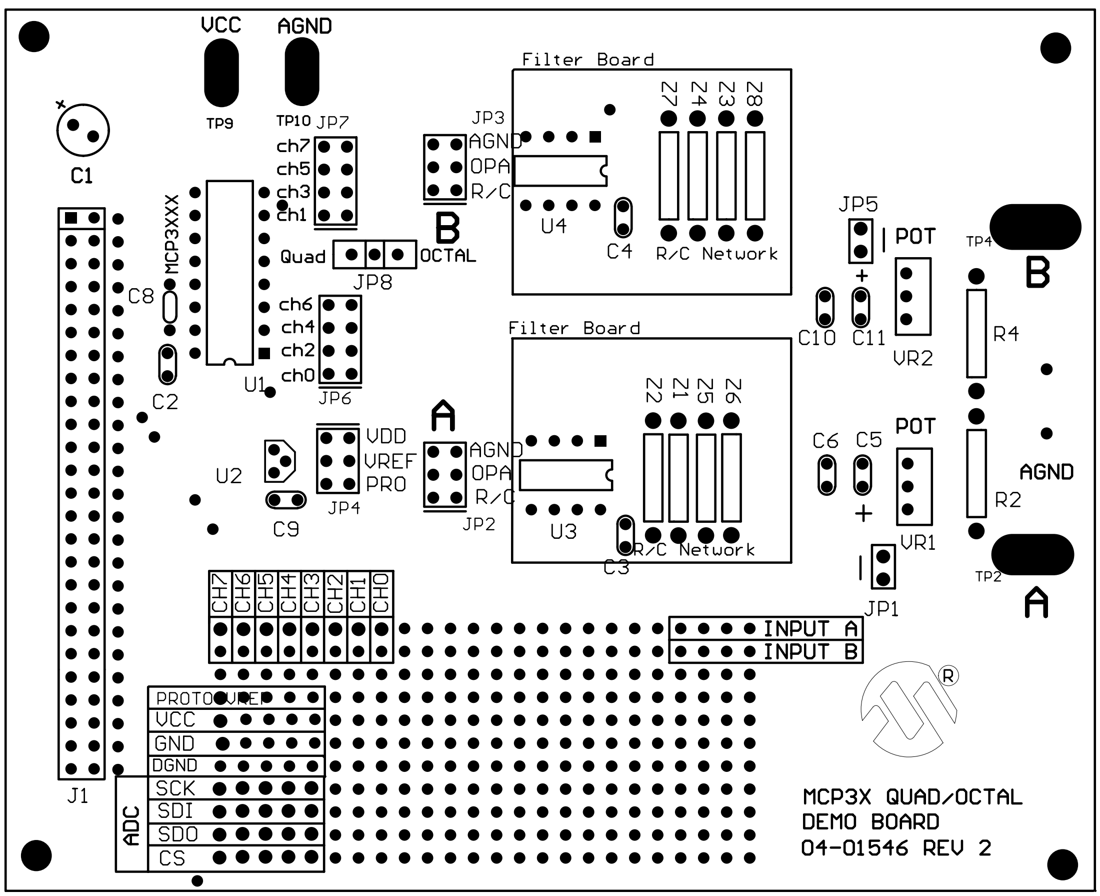


Driver Board Connector

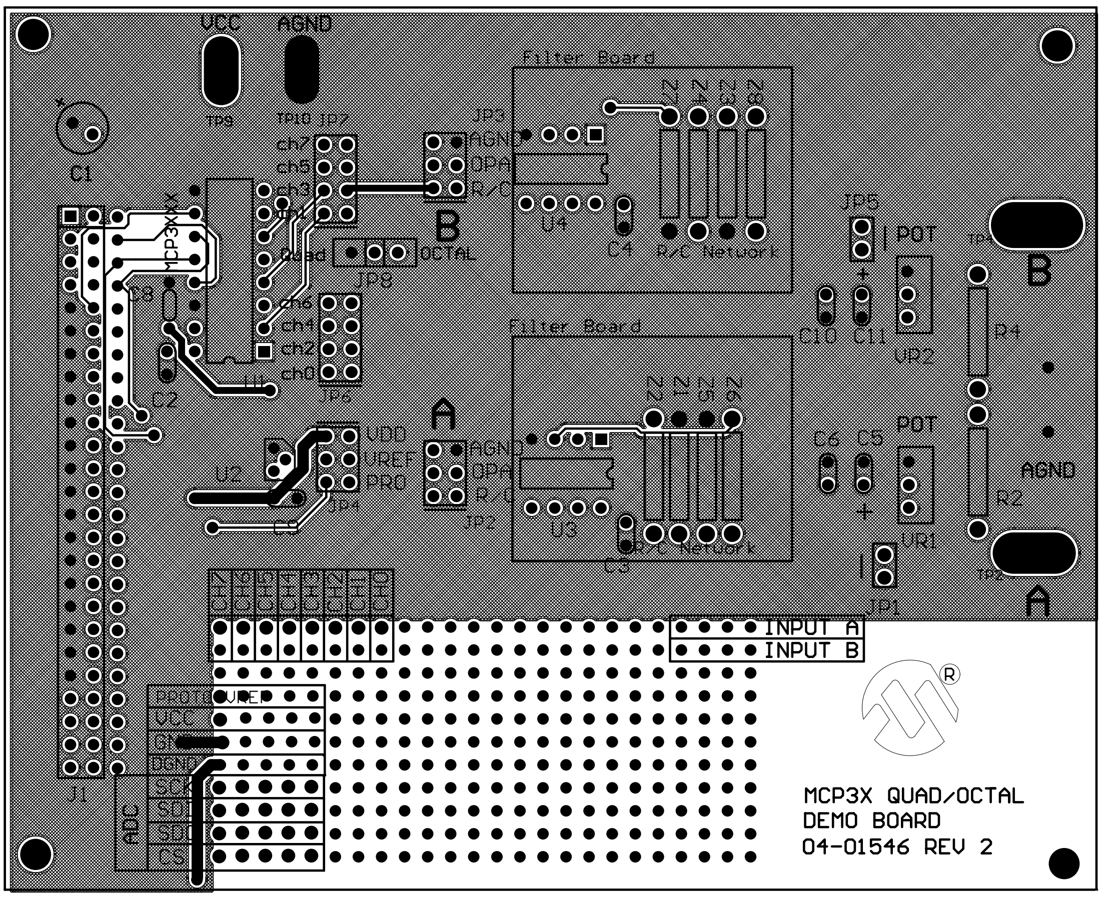


Test Points

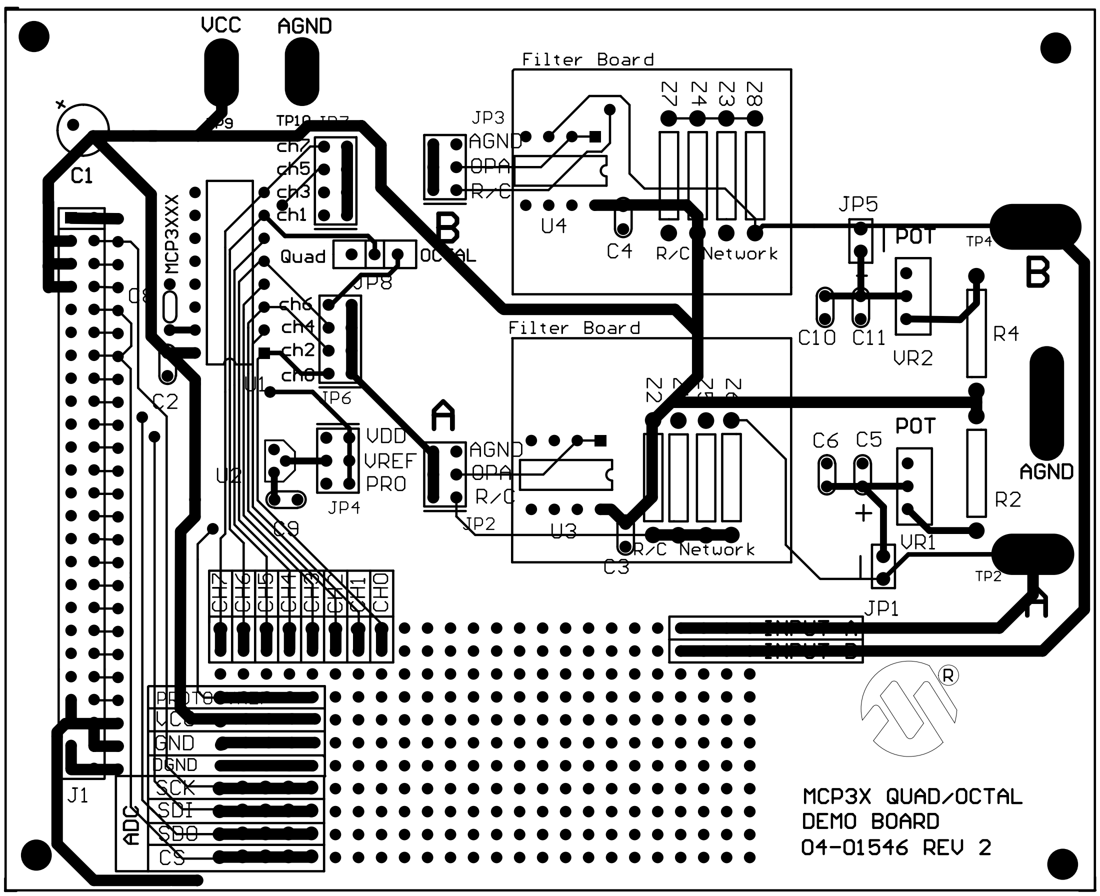
B.6 Quad/Octal Board Top Assembly



B.7 Quad/Octal Board Bottom Layer



B.8 Quad/Octal Board Top Layer



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Appendix C. Bill Of Materials (BOM)

Table C.1: Single/Dual Bill Of Materials (BOM)

Reference Designator	Qty	Description	Manufacturer	Vendor	Vendor's Part #
C2,C3,C4,C5,C8	5	0.1 µF Capacitor	Panasonic	Digi-Key	P4923-ND
C7	1	1 µF	Panasonic	Digi-Key	P4962-ND
C1	1	10 µF/16V Elec	Panasonic	Digi-Key	P5134-ND
C10,C12	2	1.0 µF/35V Tant	Panasonic	Digi-Key	P2059-ND
C6, C11	2	SPARE	N/A	N/A	N/A
R2,R4	2	3.16K	YAGEO	Digi-Key	3.16KXTR.ND
VR1, VR2	2	10K RES POT [THUMBWHEEL]	Bourns	Digi-Key	3352W-103-ND
Z1-Z8 & R2,R4	20	PIN RECEPTICAL	MIL-MAX	Digi-Key	ED5004-ND
J1	1	FEMALE HEADER 25X2	SAMTEC	SAMTEC	SSW-125-02-T-D-RA
JP1, JP5	2	HDR 1X2 PIN	SAMTEC	SAMTEC	TSW-102-07-S-S
JP2, JP3	2	CONN HDR, 2X4 DUAL ROW	SULLINS	Digi-Key	S2011-04-ND
JP4	1	CONN HDR, 2X3 DUAL ROW	SULLINS	Digi-Key	S2011-03-ND
U1	1	MCP3201	Microchip	Microchip	MCP3201-CI/P
U5	1	MCP3202	Microchip	Microchip	MCP3202-CI/P
U3, U4	2	OP AMP	Microchip	Microchip	MCP602-I/P
U2	2	V_{REF} 4.096V	Microchip	Microchip	MCP1541-I/TO
U1, U3-U5	4	SOCKET DIP8	MIL-MAX	Digi-Key	ED3108-ND
EA. Corner	4	Mics Rubber Feet	3M	Digi-Key	SJ5518-0-ND
JP1 JP2(OPA) JP3(OPA) JP4(V_{REF}) JP5	5	CONN SHUNT, 2 Pin Shorting	SAMTEC	SAMTEC	SNT-100-BK-G
Z6, Z8	2	Jumper -22AWG Bus Wire	N/A	N/A	N/A

Table C.2: Quad/Octal Bill Of Materials (BOM)

Reference Designator	Qty	Description	Manufacturer	Vendor	Vendor's Part #
C2, C3, C4, C9	4	0.1 µF	Panasonic	Digi-Key	P4923-ND
C8	1	1.0 µF	Panasonic	Digi-Key	P4962-ND
C1	1	10 µF/16V Elect	Panasonic	Digi-Key	P5134-ND
C5, C11	2	CAP 1.0 µF/16V TANT	Panasonic	Digi-Key	P-2059-ND
C6, C10	2	SPARE (NOT USED)	N/A	N/A	N/A
R2, R4	2	3.16K	Yageo	Digi-Key	3.16KXTR-ND
VR1,VR2	2	10K RES POT [THUMBWHEEL]	Bourns	Digi-Key	3352W-103-ND
JP1,JP5	2	CONN, HDR 1X2 Pin	SAMTEC	SAMTEC	TSW-102-07-S-S
JP8	1	CONN, HDR 1X3 Pin	SAMTEC	SAMTEC	TSW-103-07-S-S
JP2-JP4	3	CONN, HDR 2X3 Pin	Digi-Key	Digi-Key	S2011-03-ND
JP6, JP7	2	CONN, HDR 2X4 Pin	Digi-Key	Digi-Key	S2011-04-ND
Z1-Z8 R2,R4	20	PIN RECEPTICAL	MIL-MAX	Digi-Key	ED5004-ND
J1	1	FEMALE HEADER 25X2	SAMTEC	SAMTEC	SSW-125-02-T-D-RA
U2	1	VREF 4.096V	Microchip	Microchip	MCP1541-I/TO
U1	1	MCP3208 A/D CONVERTER	Microchip	Microchip	MCP3208-CI/P
U3-U5	3	OP AMP	Microchip	Microchip	MCP602-I/P
U3, U4 SOCKET	2	SOCKET DIP8	MIL-MAX	Digi-Key	ED3108-ND
U1 SOCKET	1	SOCKET DIP16	MIL-MAX	Digi-Key	ED3116-ND
EA. Corner	4	Misc. Rubber Feet	3M	Digi-Key	SJ5518-0-ND
JP1 JP2(OPA) JP3(OPA) JP4(VREF) JP5, JP6(CH0) JP7(CH1) JP8(OCTAL)	8	CONN SHUNT, 2 Pin Shorting	SAMTEC	SAMTEC	SNT-100-BK-G
Z6, Z8	2	Jumper -22AWG Bus Wire	N/A	N/A	N/A

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