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MCP6XXX Amplifier Evaluation Board 3 User's Guide

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MCP6XXX AMPLIFIER EVALUATION BOARD 3 USER'S GUIDE

Table of Contents

NOTES:

MCP6XXX AMPLIFIER EVALUATION BOARD 3 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 "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP6XXX Amplifier Evaluation Board 3. 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 MCP6XXX Amplifier Evaluation Board 3. The manual layout is as follows:

- **Chapter 1. "Product Overview"** - Provides the important information about the MCP6XXX Amplifier Evaluation Board 3.
- **Chapter 2. "Installation and Operation"** – Covers the installation and operation of the MCP6XXX Amplifier Evaluation Board 3. It lists the required tools, shows how to set up the board, and demonstrates how to verify the amplifier operation.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and board layouts for the MCP6XXX Amplifier Evaluation Board 3.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP6XXX Amplifier Evaluation Board 3.

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 MCP6XXX Amplifier Evaluation Board 3. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP6021/2/3/4 Data Sheet, *"Rail-to-Rail Input/Output, 10 MHz Op Amps"* (DS21685)

This data sheet provides detailed information regarding the MCP602X product family.

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 (July 2007)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP6XXX Amplifier Evaluation Board 3 is described by the following:

- Assembly # : 114-00153
- Order # : MCP6XXXEV-AMP3
- Name: MCP6XXX Amplifier Evaluation Board 3

Items discussed in this chapter include:

- **Section 1.2 "MCP6XXX Amplifier Evaluation Board 3 Kit Contents"**
- **Section 1.3 "Microchip's Web-Based Mindi™ Analog Simulator Tool"**
- **Section 1.4 "MCP6XXX Amplifier Evaluation Board 3 Description"**

1.2 MCP6XXX AMPLIFIER EVALUATION BOARD 3 KIT CONTENTS

- MCP6XXX Amplifier Evaluation Board 3 - One partially assembled board
- Important Information "Read First"
- Accessory Bag - Contains loose parts for populating sockets on board
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912)
  - MCP6XXX Amplifier Evaluation Board 3 User's Guide (DS51673)

FIGURE 1-1: *MCP6XXX Amplifier Evaluation Board 3 Kit.*

1.3 MICROCHIP'S WEB-BASED MINDI™ ANALOG SIMULATOR TOOL

The Mindi™ Analog Simulator tool is an innovative software tool that simplifies analog circuit design. The Mindi™ Analog Simulator tool supports the following application circuits: 1) Active Filters, 2) Amplifiers, 3) Battery Chargers, and 4) DC-to-DC Converters. The Amplifier Designer provides full schematic diagrams of the amplifier application circuit with recommended component values and displays the responses in frequency and time domains.

The Mindi™ Analog Simulator tool is a free web-based design tool available on the Microchip web site at http://www.microchip.com under **"Online Simulation Tools"** or by going directly to the Mindi web site at http://www.microchip.com/mindi. The circuit simulator within the Mindi™ Analog Simulator tool can be downloaded and installed on a personal computer (PC) for more convenient simulations. Modified circuit files can also be downloaded to the PC.

1.4 MCP6XXX AMPLIFIER EVALUATION BOARD 3 DESCRIPTION

MCP6XXX Amplifier Evaluation Board 3 is intended to support the difference amplifier circuits which are generated by the Mindi™ Amplifier Designer.

The MCP6XXX Amplifier Evaluation Board 3 has the following features:

- All amplifier resistors and capacitors are socketed
- All of the component labels on board keep consistent with those on schematic generated in the Mindi™ Amplifier Designer
- Supports all Microchip single op amps
  - PDIP-8 package (e.g., MCP6021) are socketed
  - SOIC-8 package can be accomodated; see **Section 2.4.3 "Amplifier Modifications Using 8-Pin SOIC Op Amps"**
- Test points for connecting lab equipment
- Single supply configuration

Figure 1-2 shows the block diagram of the MCP6XXX Amplifier Evaluation Board 3. Lab equipment can be attached (via test points) to measure the amplifier response.

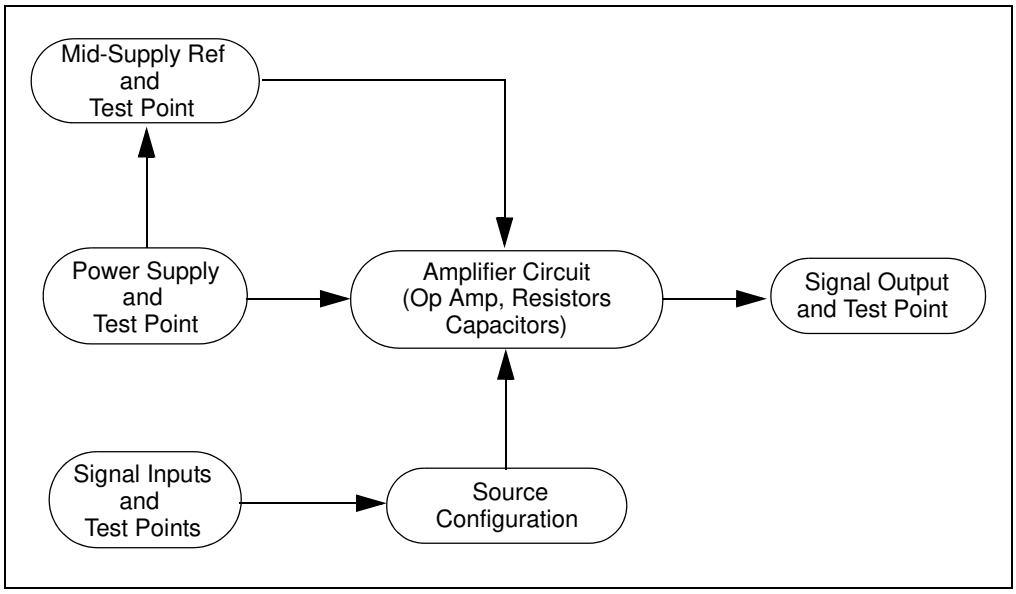


FIGURE 1-2: *MCP6XXX Amplifier Evaluation Board 3 Block Diagram.*

Chapter 2. Installation and Operation

2.1 INTRODUCTION

This chapter shows how to set up the MCP6XXX Amplifier Evaluation Board 3.

Items discussed in this chapter include:

- Required Tools
- MCP6XXX Amplifier Evaluation Board 3 Set-Up
- MCP6XXX Amplifier Evaluation Board 3 Operation

2.2 REQUIRED TOOLS

- Lab power supply
- Lab signal source (e.g., function generator)
- Lab measurement equipment (e.g., oscilloscope)

2.3 MCP6XXX AMPLIFIER EVALUATION BOARD 3 SET-UP

The MCP6XXX Amplifier Evaluation Board 3 supports difference amplifier. This section details the conversion of these topologies to the MCP6XXX Amplifier Evaluation Board 3. Figure 2-1 shows the circuit diagram for the board.

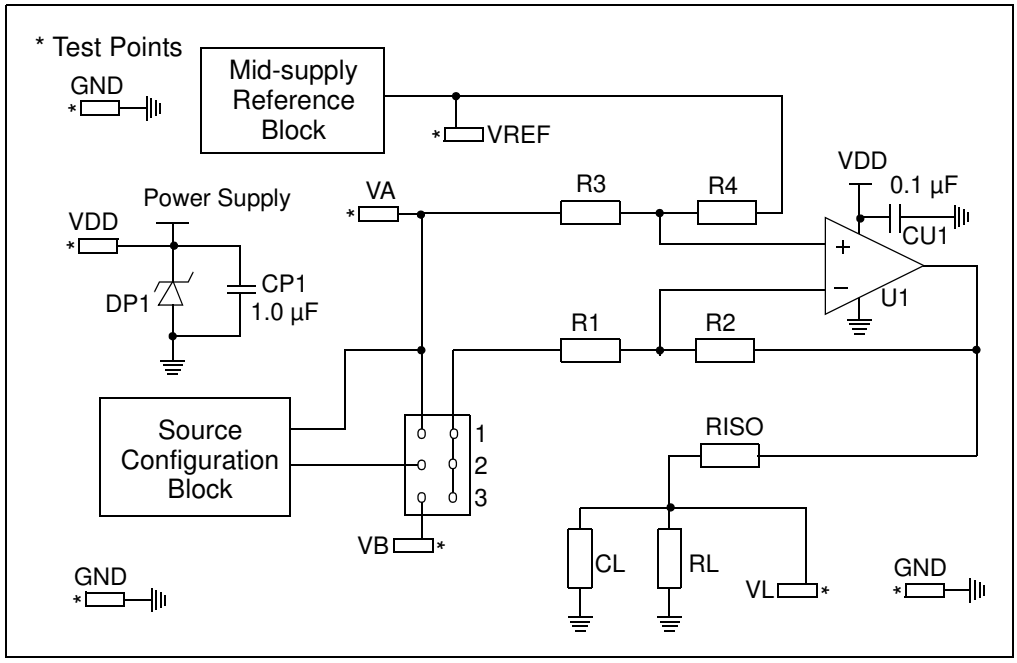


FIGURE 2-1: *MCP6XXX Amplifier Evaluation Board 3 Circuit Diagram.*

The power supply voltage needs to be in the allowed range for the installed op amps. Any of Microchip's op amps that operate below 5.5V can be used. Moreover, the power supply is protected by a zener diode with nominal voltage 6.2V and bypassed by a 1.0 µF capacitor. (See **Figure 2-3: "Power Supply Block."**)

The mid-supply reference consists of a voltage divider and a buffer amplifier. (See **Figure 2-4: "Mid-Supply Reference Block."**)

The resistors that are part of an amplifier are placed in pin sockets which are labeled. All of the component labels on board keep consistent with those on the schematic generated in the Mindi™ Amplifier Designer. The op amps are bypassed by 0.1 µF capacitors and the single op amp U1 can have either a PDIP-8 or SOIC-8 package.

- PDIP-8 packages are inserted into the DIP-8 socket to the right of the U1 label
- SOIC-8 packages can be accommodated; see **Section 2.4.3 "Amplifier Modifications Using 8-Pin SOIC Op Amps"**

The (surface mount) test points for power supply, ground, input signal and output signal allow lab equipment to be connected to the board. The MCP6XXX Amplifier Evaluation Board 3 top view is shown in Figure 2-2.

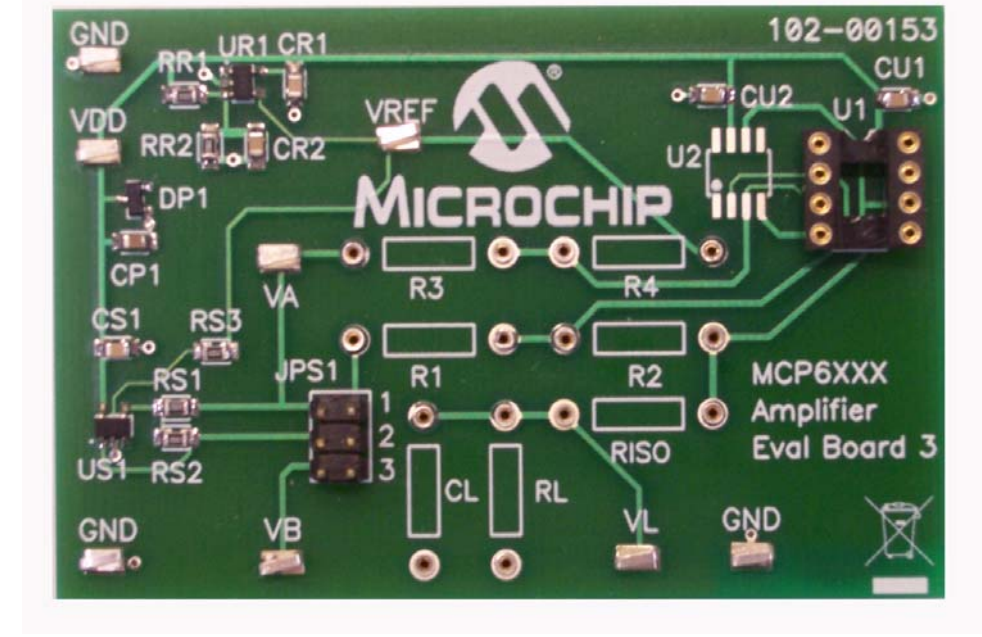
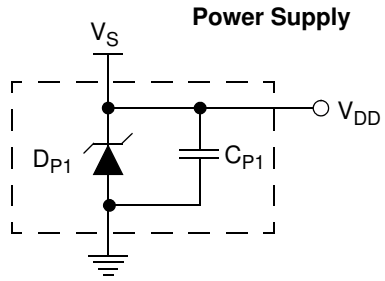


FIGURE 2-2: *MCP6XXX Amplifier Evaluation Board 3 Top View.*

2.3.1 Top Level Amplifier Circuit Diagrams

2.3.1.1 POWER SUPPLY BLOCK

The power supply is protected by a zener diode and bypassed by a capacitor. Figure 2-3 shows the circuit diagram for the power supply. C_{P1} = 1.0 µF.



Note: D_{P1} is a zener diode with nominal voltage of 6.2V

FIGURE 2-3: *Power Supply Block.*

2.3.1.2 MID-SUPPLY REFERENCE BLOCK

The mid-supply reference consists of a voltage divider and a buffer amplifier. Figure 2-4 shows the circuit diagram for the mid-supply reference.
$C_{R1} = C_{R2}$ = 0.1 µF, $R_{R1} = R_{R2}$ = 20.0 kΩ.

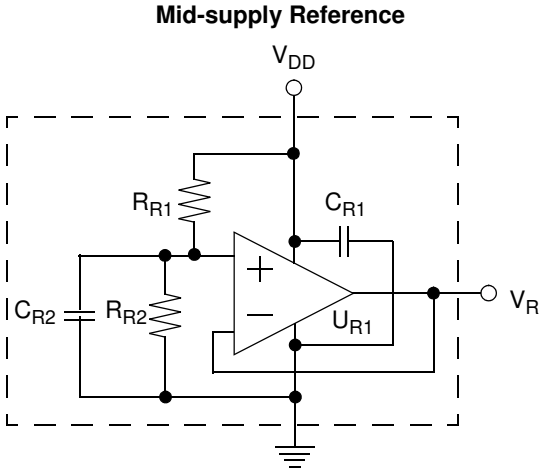


FIGURE 2-4: *Mid-Supply Reference Block.*

2.3.1.3 OUTPUT LOAD BLOCK

The output load consists of a capacitor and two resistors. Figure 2-5 shows the circuit diagram for the output load. R_{ISO} is used to stabilize the amplifier when it drives a large capacitive load (C_L). R_{ISO} is a short circuit (0Ω) when C_L is small.

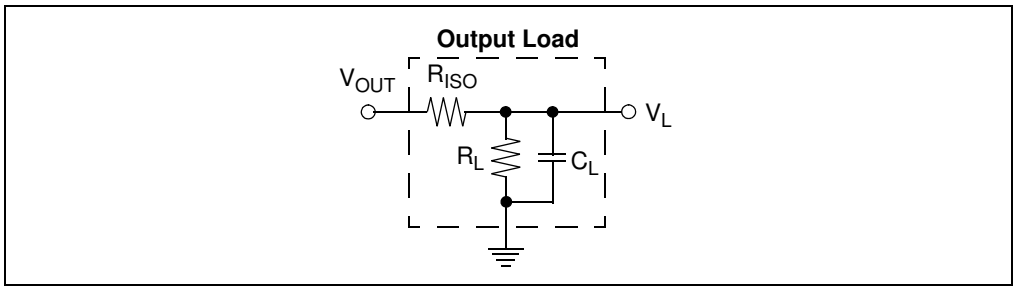


FIGURE 2-5: *Output Load Block.*

2.3.1.4 DIFFERENCE AMPLIFIER

- Amplifies the difference between two voltages, while rejecting the common mode (average) input voltage. Output voltage is shifted by a reference voltage for single supply
- The Mindi™ Amplifier Designer gives design recommendations for the difference amplfier circuit; see the circuit diagram shown in Figure 2-6
  - Fill the sockets with the recommended resistors and capacitors

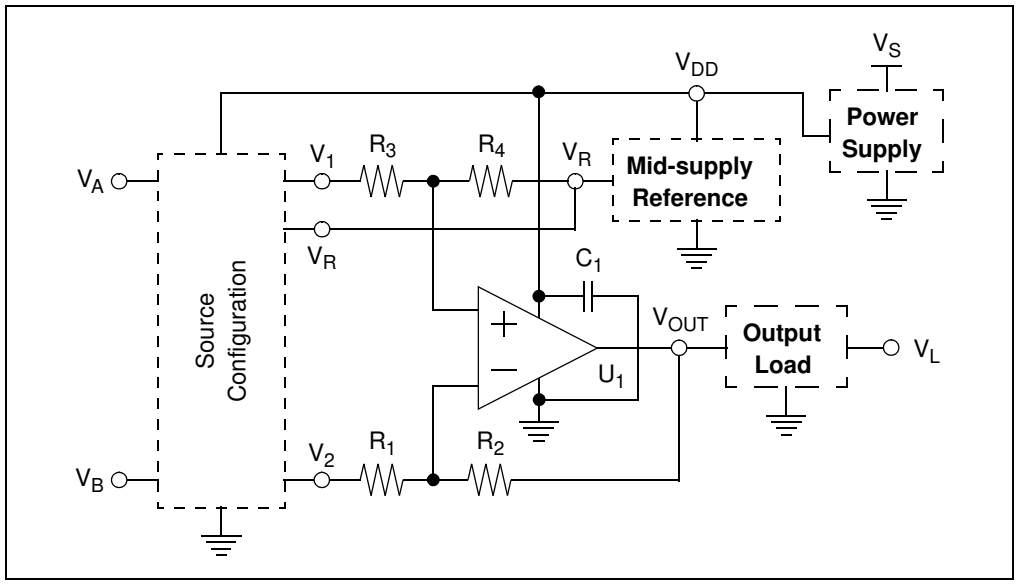


FIGURE 2-6: *Difference Amplifier Circuit Diagram.*

- Source configuration consists of an inverting amplifier and a jumper. Figure 2-4 shows the circuit diagram for the source configuration.
  C_{S1} = 0.1 uF, R_{S1} = R_{S2} = 20.0 kΩ, R_{S3} = 10.0 kΩ

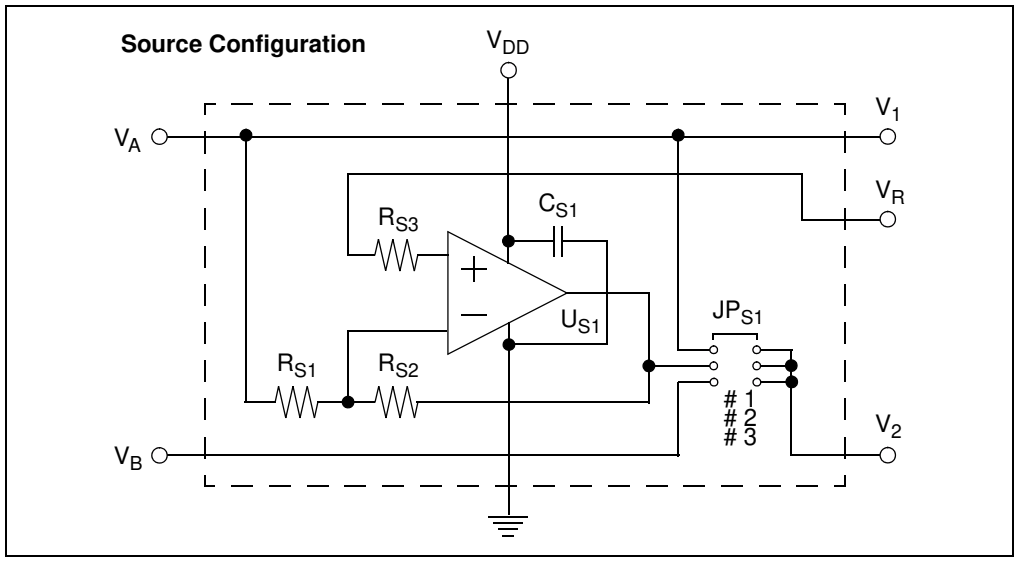


FIGURE 2-7: *Source Configuration Block.*

The jumper JP_{S1} positions have the following effects:

Jumper JP_{S1} Position	Effects		
	V_1 =	V_2 =	
1	V_A	V_A	V_A is a common mode input signal
2	V_A	$-V_A$	V_A is a diffential mode input signal
3	V_A	V_B	V_A and V_B are connected directly to V_1 and V_2

Note 1: When JP_{S1} is in position 2, V_2 is actually described by the following equation:

$$V_2 = V_R - (V_A - V_R)(R_{S2}/R_{S1})$$
$$= V_R(1 + R_{S2}/R_{S1}) - V_A(R_{S2}/R_{S1})$$

It is assumed that $R_{S2} = R_{S1}$.

Figure 2-8 shows an example supported by the MCP6XXX Amplifier Evaluation Board 3. It is assumed that V_A is a differential mode input signal.

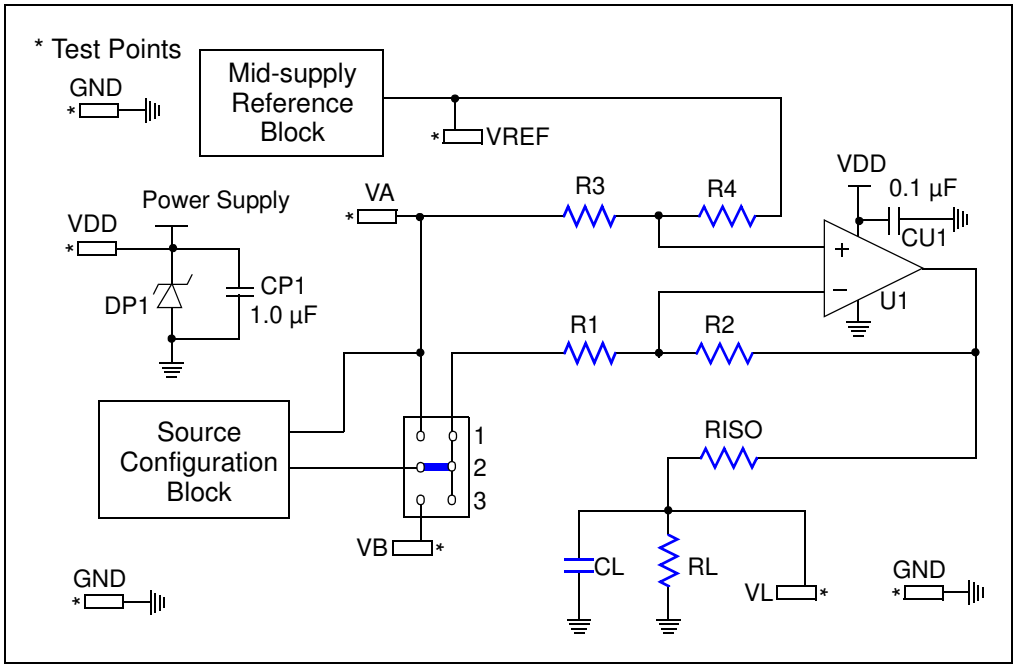


FIGURE 2-8: *Difference Amplifier Example Supported by the MCP6XXX Amplifier Evaluation Board 3.*

2.4 MCP6XXX AMPLIFIER EVALUATION BOARD 3 OPERATION

Items discussed in this section include:

- Building the Amplifier
- Testing the Amplifier
- Amplifier Modification: Using 8-Pin SOIC Op Amps

2.4.1 Building the Amplifier

The accessory bag that comes with this kit makes it quick and easy to evaluate the amplifier described below, which was designed in the Mindi™ Amplifier Designer.

This amplifier is described as follows:

- Difference Amplifier (Single Supply Configuration)
- Power Supply Voltage is 5.0V
- Differential Mode Input Signal
- Desired Closed Loop Gain is 1 V/V
- Load Capacitance is 56 pF

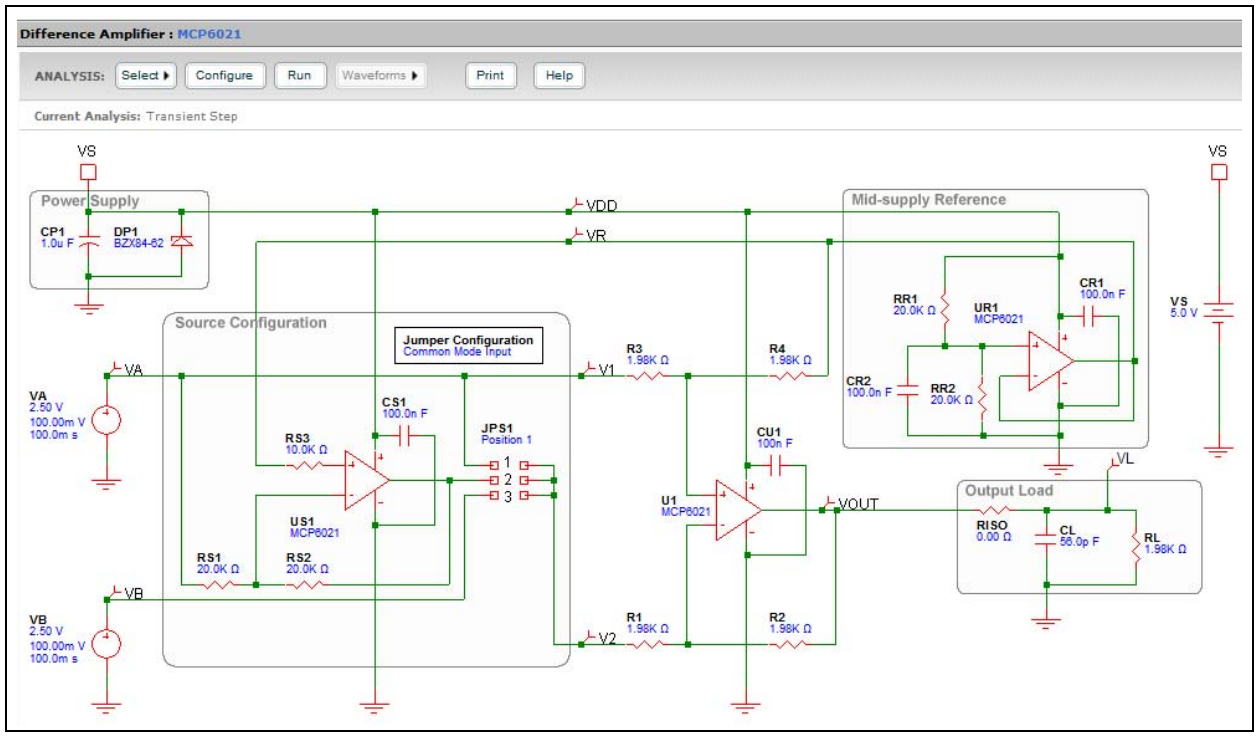


FIGURE 2-9: *Difference Amplifier Designed In the Mindi™ Amplifier Designer.*

Figure 2-10 shows the same circuit redrawn to emphasize the difference amplifier.

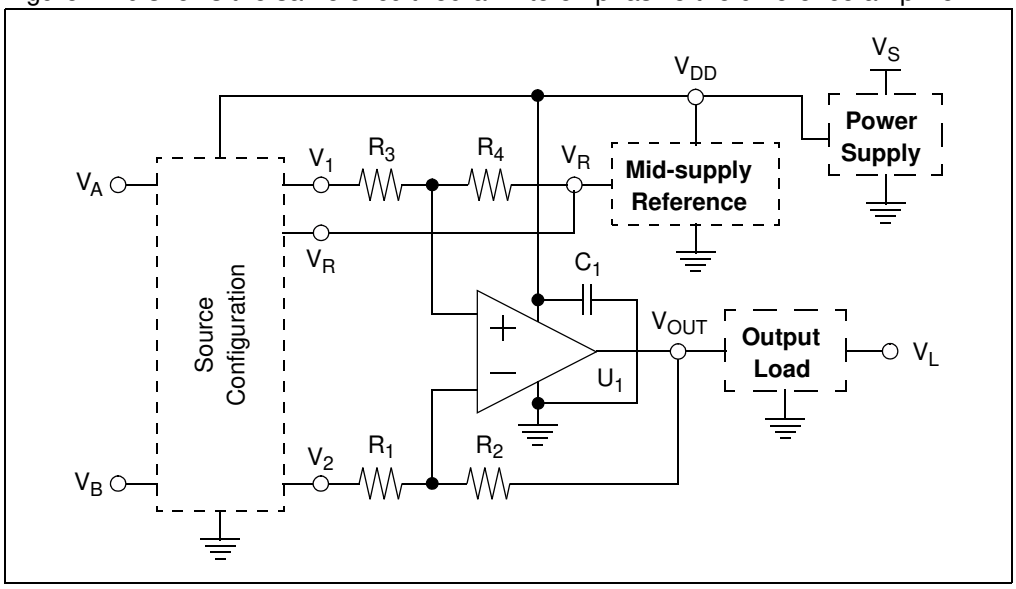


FIGURE 2-10: *Difference Amplifier Supported by the MCP6XXX Amplifier Evaluation Board 3 Kit.*

Each of the components in Figure 2-10 that needs to be inserted in a socket on the MCP6XXX Amplifier Evaluation Board 3 is listed in Table 2-1.

TABLE 2-1: AMPLIFIER COMPONENTS LIST

PCB Labels	Component Values
R1	1.98 kΩ
R2	1.98 kΩ
R3	1.98 kΩ
R4	1.98 kΩ
RISO	0Ω
RL	1.98 kΩ
CL	56 pF
U1	MCP6021, PDIP-8, 10 MHz

For the differential mode input signal, the jumper JP_{S1} position is listed in Table 2-2.

TABLE 2-2: JUMPER POSITION

Jumper	Position
JPS1	2

The fully assembled difference amplifier circuit diagram is shown in Figure 2-11.

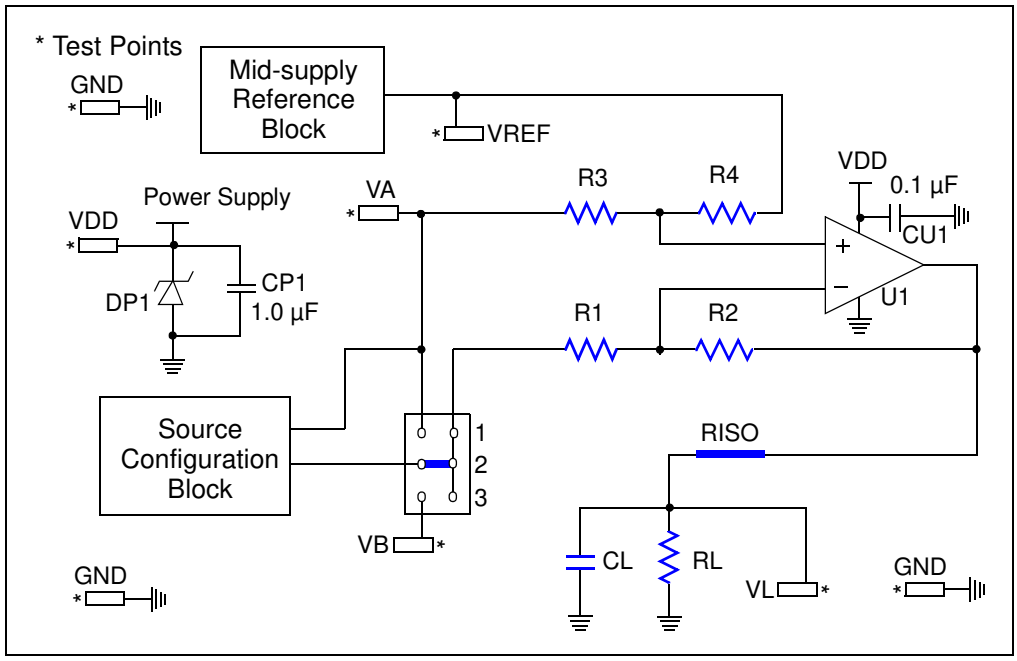


FIGURE 2-11: *Fully Assembled Difference Amplifier Supported by the MCP6XXX Amplifier Evaluation Board 3.*

The fully assembled MCP6XXX Amplifier Evaluation Board 3 top view is shown in Figure 2-12.

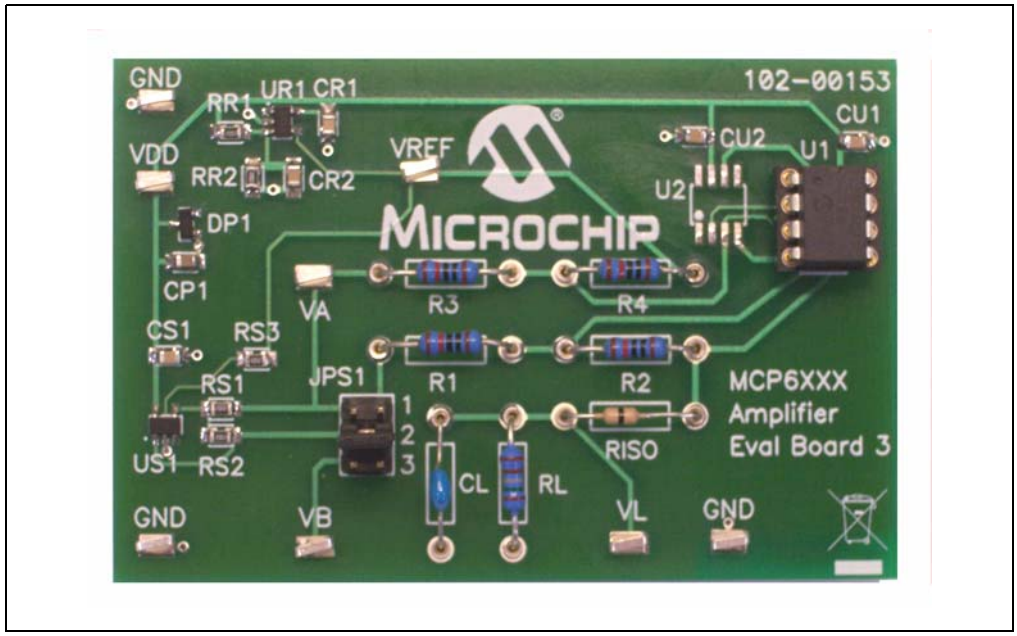


FIGURE 2-12: *Picture of the Difference Amplifier Supported by the MCP6XXX Amplifier Evaluation Board 3.*

2.4.2 Testing the Amplifier

2.4.2.1 CHECKING THE TEST POINTS

The (surface mount) test points for power supply, ground, input signal and output signal allow lab equipment to be connected to the board. Figure 2-13 shows the test points to check.

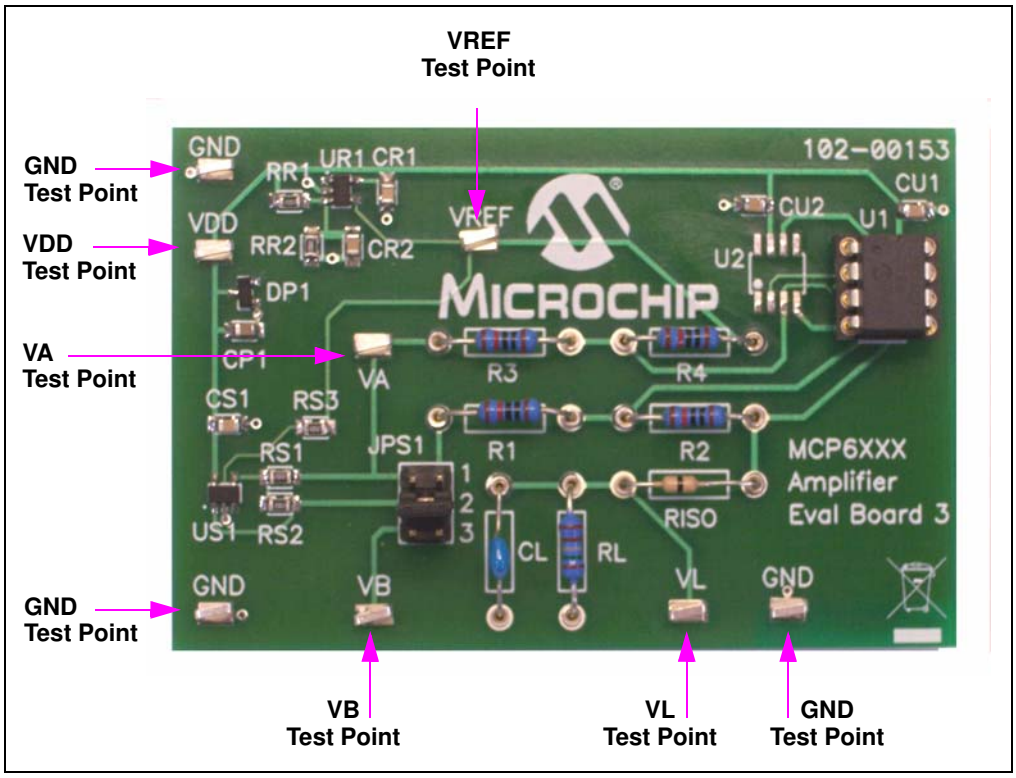


FIGURE 2-13: *Checking the Test Points.*

2.4.2.2 TRANSIENT RESPONSES

This difference amplifier was built, and its responses were measured. A MCP6021 op amp, 1% resistors, and 5% capacitors were used. Notice how close the measured and simulated data are.

2.4.2.2.1 Transient Step Response

In Bench Measurement:

- Set V_{IN} as a differential mode signal with a step amplitude of 2.0V and a center voltage of 2.5V. (i.e. V_{IN} starts 1.0V below center and ends 1.0V above center
- The measured step response is shown in Figure 2-14. It is a signal with a step amplitude of 4.0V and a center voltage of 2.5V. (i.e. V_{OUT} starts 2.0V below center and ends 2.0V above center

Note: The center voltage of V_{IN} is set at $V_{REF} = V_{DD}/2$ (For V_{DD} = 5.0V, V_{REF} = 2.5V)

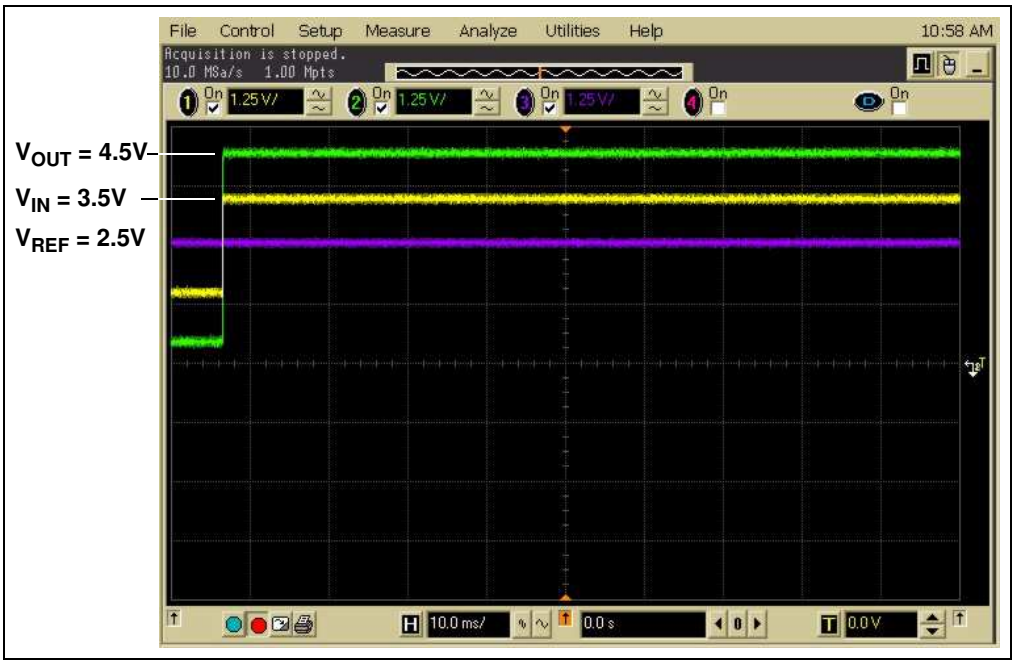


FIGURE 2-14: *Measured Step Response.*

In the Mindi™ Amplifier Designer:

- Set V_{IN} as a differential mode signal with a step amplitude of 2.0V and a center voltage of 2.5V. (i.e. V_{IN} starts 1.0V below center and ends 1.0V above center)
- The simulated step response is shown in Figure 2-15. It is a signal with a step amplitude of 4.0V and a center voltage of 2.5V. (i.e. V_{OUT} starts 2.0V below center and ends 2.0V above center)

Note: The center voltage of V_{IN} is set at $V_{REF} = V_{DD}/2$ (For V_{DD} = 5.0V, V_{REF} = 2.5V)

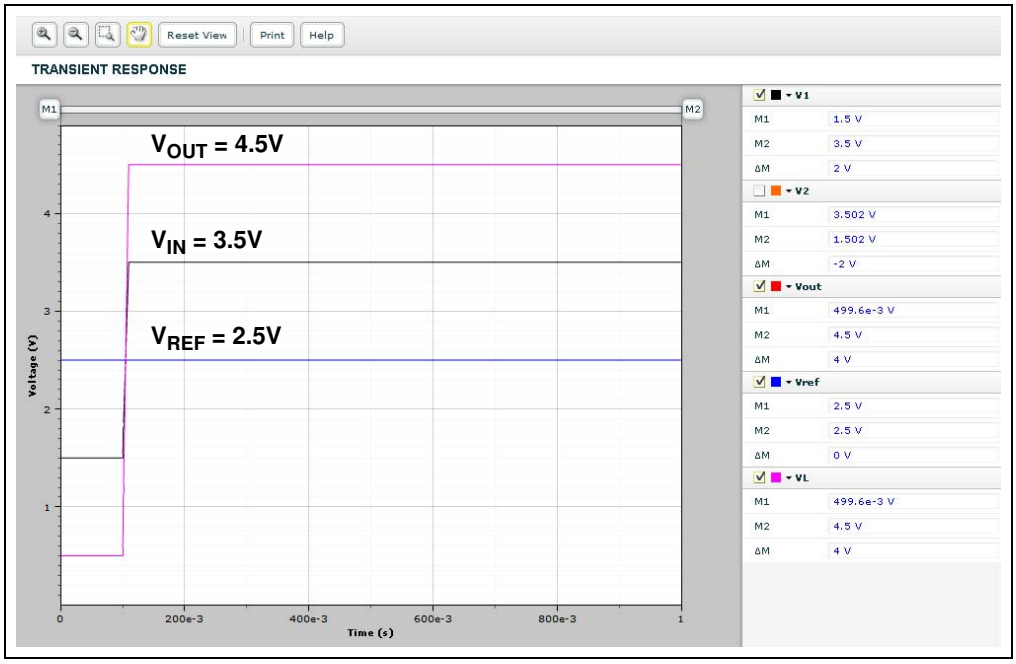


FIGURE 2-15: *Simulated Step Response.*

2.4.2.2.2 Transient Sine Wave Response

In Bench Measurement:

- Set V_{IN} as a sine wave with a frequency of 100.0 Hz, a peak-to-peak voltage of 2.0V and a center voltage of 2.5V
- The measured sine wave response is shown in Figure 2-16. It is a sine wave signal with a frequency of 100.0 Hz, a peak-to-peak voltage of 4.0V and a center voltage of 2.5V

Note: The center voltage of V_{IN} is set at $V_{REF} = V_{DD}/2$ (For V_{DD} = 5.0V, V_{REF} = 2.5V)

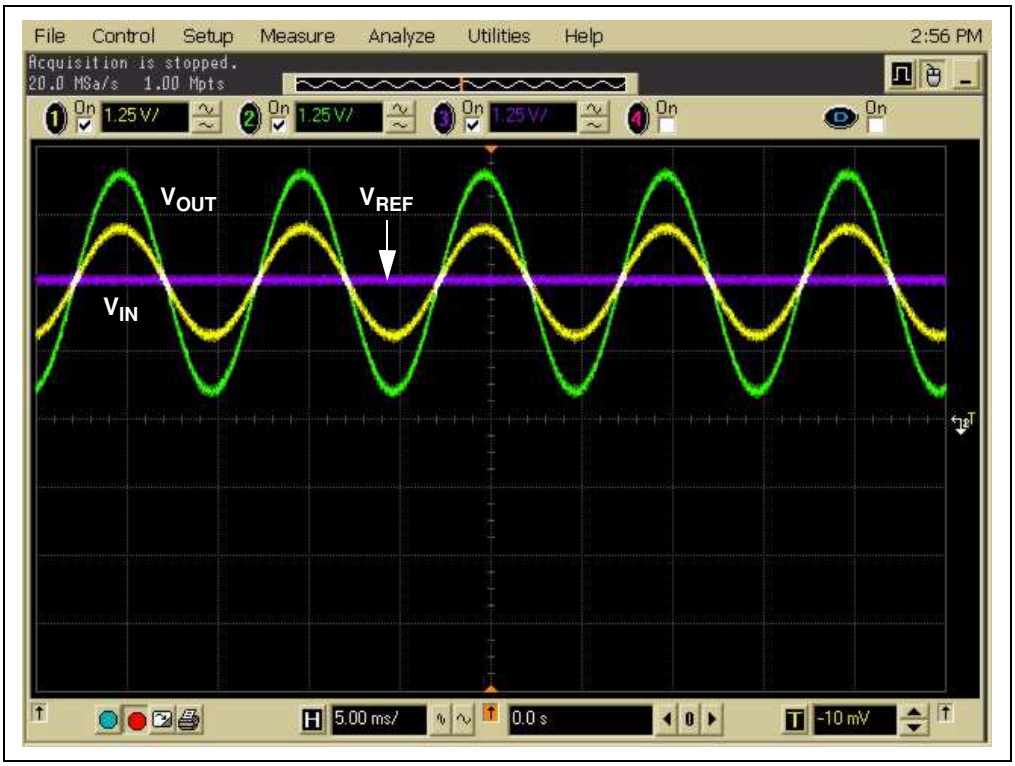


FIGURE 2-16: *Measured Sine Wave Response.*

In the Mindi™ Amplifier Designer:

- Set V_{IN} as a sine wave with a frequency of 100.0 Hz, a peak-to-peak voltage of 2.0V and a center voltage of 2.5V
- The simulated sine wave response is shown in Figure 2-17. It is a sine wave signal with a frequency of 100.0 Hz, a peak-to-peak voltage of 4.0V and a center voltage of 2.5V

Note: The center voltage of V_{IN} is set at $V_{REF} = V_{DD}/2$ (For V_{DD} = 5.0V, V_{REF} = 2.5V)

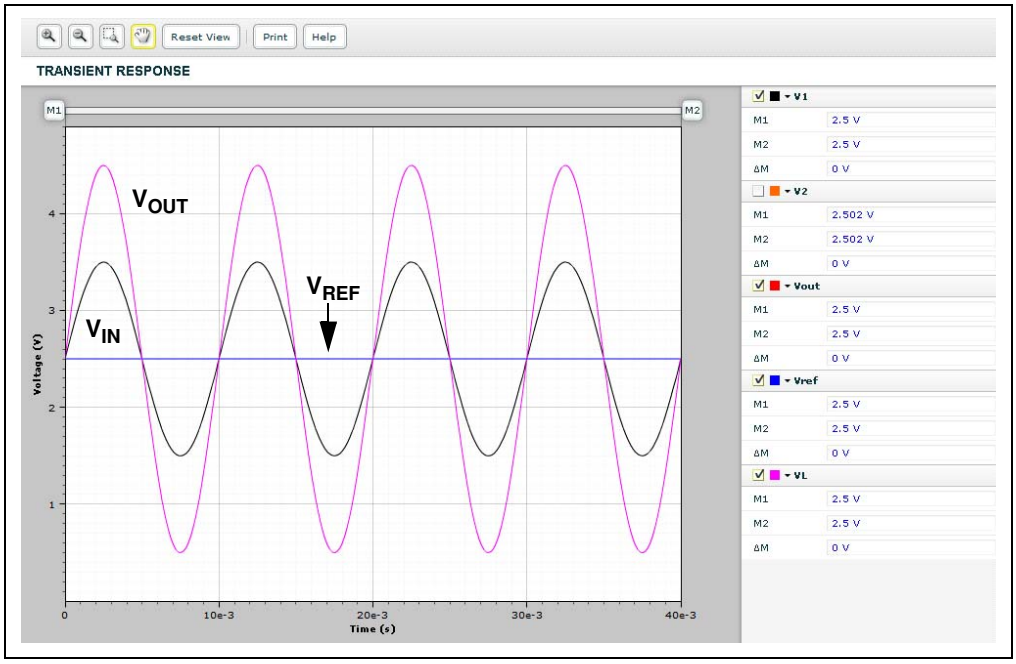


FIGURE 2-17: *Simulated Sine Wave Response.*

2.4.3 Amplifier Modifications Using 8-Pin SOIC Op Amps

There are two options available to use single op amps in SOIC-8 packages (150 mil wide):

- Soldering onto the MCP6XXX Amplifier Evaluation Board 3, or
- Soldering it onto a separate board which is connected to the DIP-8 socket

Note:	The DIP-8 socket must be empty; only one op amp can be used at a time.

Figure 2-18 shows a SOIC-8 op amp soldered onto the MCP6XXX Amplifier Evaluation Board 3.

FIGURE 2-18: *Op Amp in SOIC-8 package soldered onto MCP6XXX Amplifier Evaluation Board 3.*

Figure 2-19 shows a SOIC-8 op amp and a DIP-8 socket, soldered onto the 8-Pin SOIC/MSOP/TSSOP/DIP Evaluation Board available from Microchip Technology Inc. (order # SOIC8EV). The two interconnect strips on the bottom are Samtec part # BBS-14-T-B or equivalent and are soldered into the through holes for the DIP-8 socket. Figure 2-20 shows this board plugged into the MCP6XXX Amplifier Evaluation Board 3.

Note:	Insert the interconnect strips into the DIP-8 socket on the MCP6XXX Amplifier Evaluation Board 3. Place the SOIC8EV board on the top of the interconnect strips with the same pin orientation. Now solder the strips to the top board; this procedure ensures correct alignment of the strips. Clip the pins flush with the top surface of the SOIC8EV board, then solder the SOIC-8 op amp on the top.