MCP6XXX Amplifier Evaluation Board 4 User's Guide

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MCP6XXX AMPLIFIER EVALUATION BOARD 4 USER'S GUIDE

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MCP6XXX AMPLIFIER EVALUATION BOARD 4 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 4. 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 4. The manual layout is as follows:

- **Chapter 1. "Product Overview"** - Provides the important information about the MCP6XXX Amplifier Evaluation Board 4.
- **Chapter 2. "Installation and Operation"** – Covers the installation and operation of the MCP6XXX Amplifier Evaluation Board 4. 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 4.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP6XXX Amplifier Evaluation Board 4.

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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use MCP6XXX Amplifier Evaluation Board 4. 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
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- 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 (August 2007)

- Initial Release of this Document.

NOTES:

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Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP6XXX Amplifier Evaluation Board 4 is described by the following:

- Assembly # : 114-00154
- Order # : MCP6XXXEV-AMP4
- Name: MCP6XXX Amplifier Evaluation Board 4

Items discussed in this chapter include:

- **Section 1.2 "MCP6XXX Amplifier Evaluation Board 4 Kit Contents"**
- **Section 1.3 "MCP6XXX Amplifier Evaluation Board 4 Description"**

1.2 MCP6XXX AMPLIFIER EVALUATION BOARD 4 KIT CONTENTS

- MCP6XXX Amplifier Evaluation Board 4 - 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 4 User's Guide (DS51681)

FIGURE 1-1: *MCP6XXX Amplifier Evaluation Board 4 Kit.*

1.3 MCP6XXX AMPLIFIER EVALUATION BOARD 4 DESCRIPTION

MCP6XXX Amplifier Evaluation Board 4 is intended to support the inverting integrator circuit.

The MCP6XXX Amplifier Evaluation Board 4 has the following features:

- All amplifier resistors and capacitors are socketed
- 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 4. Lab equipment can be attached (via test points) to measure the amplifier response.

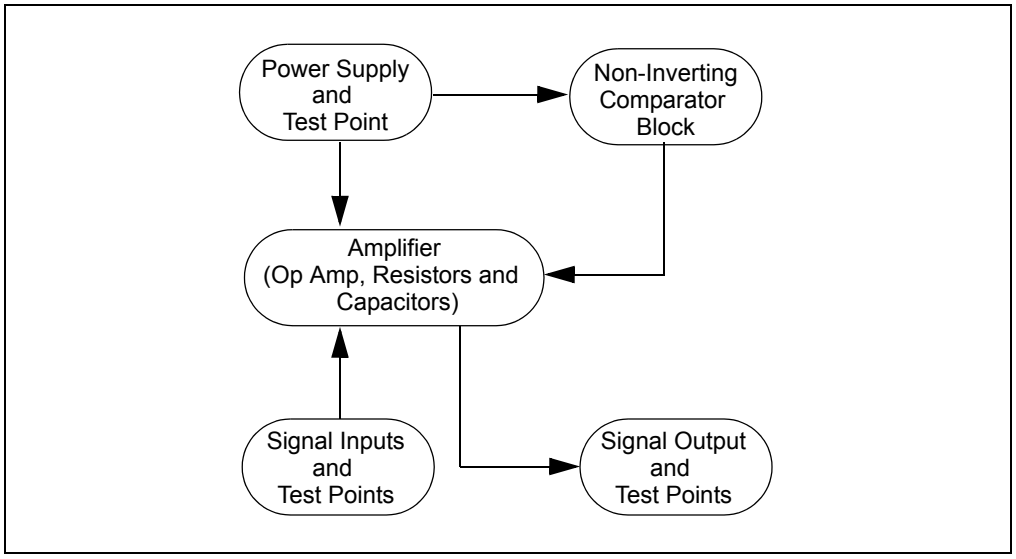

FIGURE 1-2: *MCP6XXX Amplifier Evaluation Board 4 Block Diagram.*

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

This chapter shows how to set up the MCP6XXX Amplifier Evaluation Board 4 and verify its operation. This chapter includes the following topics:

- Required Tools
- MCP6XXX Amplifier Evaluation Board 4 Set-Up
- MCP6XXX Amplifier Evaluation Board 4 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 4 SET-UP

The MCP6XXX Amplifier Evaluation Board 4 is designed to demonstrate an inverting integrator using one op amp and supporting circuitry. This section details the conversion of the topology to the MCP6XXX Amplifier Evaluation Board 4. Figure 2-1 shows the circuit diagram for the board.

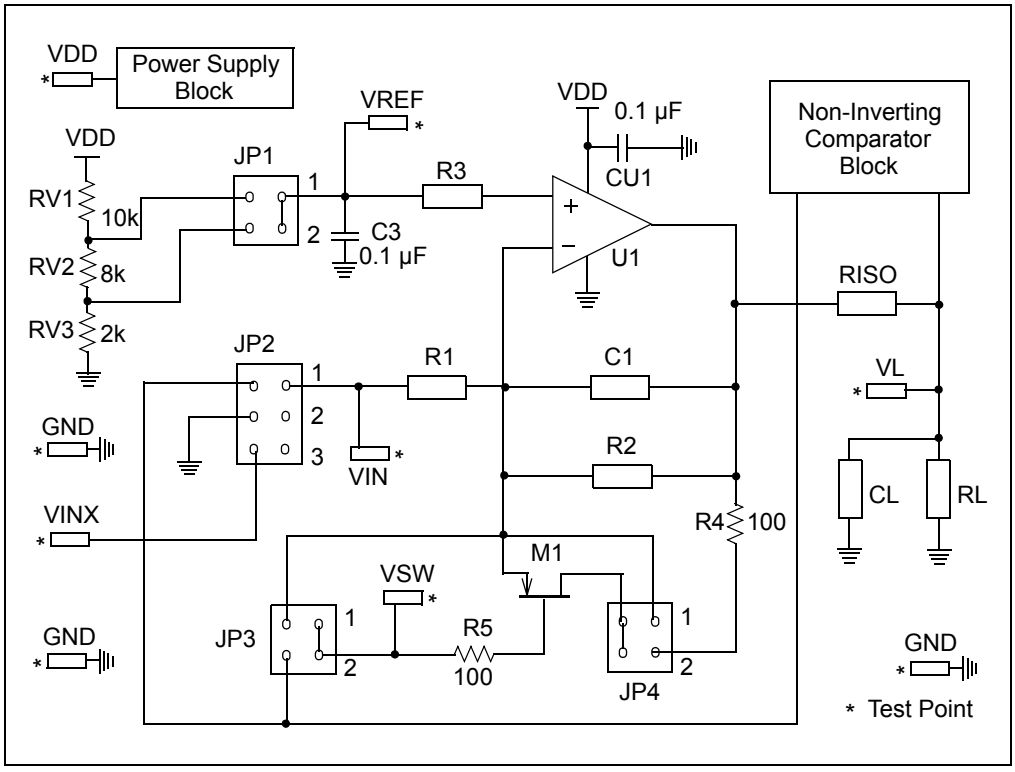

FIGURE 2-1: *MCP6XXX Amplifier Evaluation Board 4 Circuit Diagram.*

The power supply voltage needs to be in the allowed range for the installed operational amplifiers. 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 output load consists of a capacitor (C_L) and two resistors (R_L, R_{ISO}). R_{ISO} is used to stabilize the amplifier when it drives a large capacitive load. R_{ISO} is a short circuit (0Ω) when C_L is small.

The non-inverting comparator provides two trip points which are at $0.8V_{DD}$ and $0.2V_{DD}$. (See **Section Figure 2-4: "Non-Inverting Comparator Block."**)

The resistors that are part of an amplifier are placed in pin sockets which are labeled. 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 4 top view is shown in Figure 2-2.

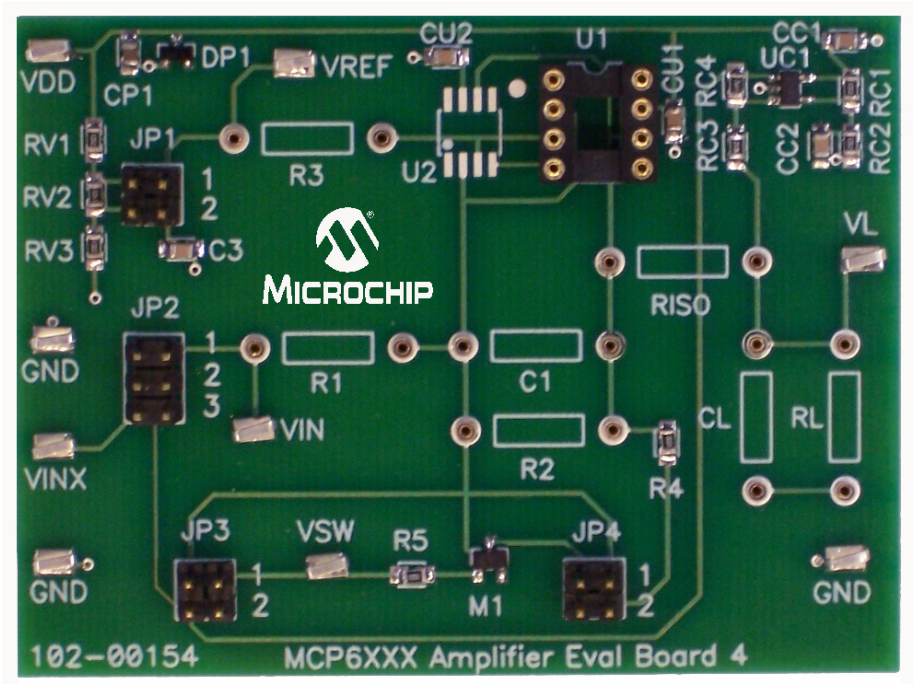

FIGURE 2-2: *MCP6XXX Amplifier Evaluation Board 4 Top View.*

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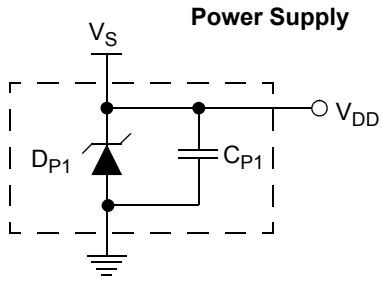
2.3.1 Top Level Amplifier Circuit Diagrams

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 NON-INVERTING COMPARATOR

Figure 2-4 shows the circuit diagram for the non-inverting comparator block. The non-inverting comprator's trip points are $0.8V_{DD}$ and $0.2V_{DD}$.
$R_{C1} = R_{C2} = 10.0\ k\Omega$, $R_{C3} = 30.0\ k\Omega$, $R_{C4} = 50.0\ k\Omega$, $C_{C1} = C_{C2} = 0.1$ uF.

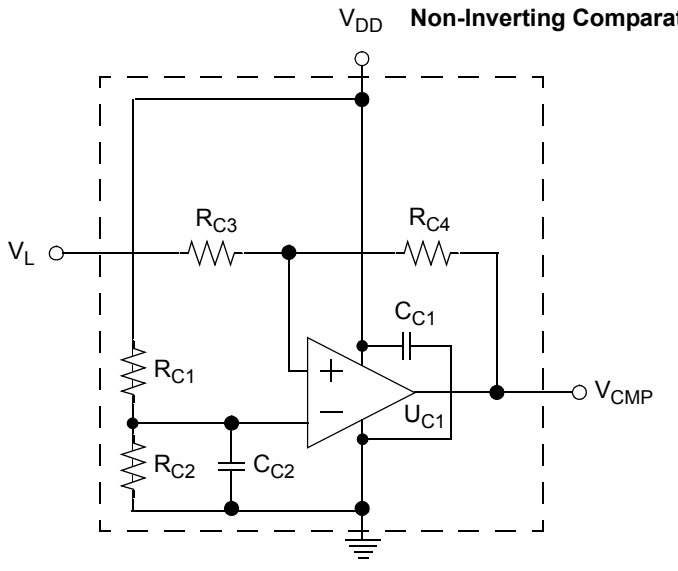


FIGURE 2-4: *Non-Inverting Comparator Block.*

2.3.2 Inverting Integrator

- It integrates and inverts a voltage with an integrating frequency $\omega = 1/R_1C_1$ (rad/s). Additional components control output clipping (wind-up) and initialization of the integrating capacitor (C_1). Refer to Figure 2-1.
- Figure 2-5 shows the circuit diagram for the inverting integrator block. C_{U1} = 0.1 uF, $R_4 = R_5$ = 100.0Ω, M_1 is N-MOSFET, $R_3 = R_1//R_2$

Note 1: Adding R_2 to avoid the integrator output clipping at DC.

2: Adding R_3 to minimize the output error due to the input bias current

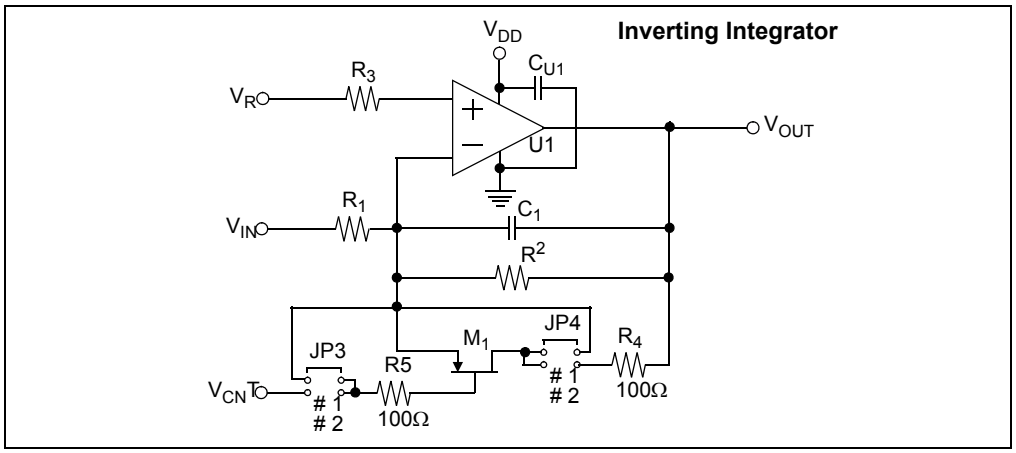


FIGURE 2-5: *Inverting Integrator Block.*

Table 2-1 shows the jumper positions and the corresponding effects

TABLE 2-1: JUMPER POSITIONS AND EFFECTS

Jumper	Position	Effect
JP_1	1	Set the Input Reference (V_{REF}) to $0.5V_{DD}$
	2	Set the Input Reference (V_{REF})) to $0.1V_{DD}$
JP_2	1	Drive Integrator with Comparator
	2	Ground Integrator's Resistor (contstant input current)
	3	Drive Integrator with External Source
JP_3, JP_4	1	Ground (de-activate) Integrator's Reset Switch (M_1)
	2	Drive Integrator's Reset Switch (M_1) with Comparator

Table 2-2 shows the integrator control strategies

TABLE 2-2: INTEGRATOR CONTROL STRATEGY

Integrator Control Strategy	Jumper Positions				Integrator's Input Voltage	R2 (Integrator)
	JP1	JP2	JP3	JP4		
Feedback Loop(1)	1	1	1	1	VCMP (internal)	open
	2	1	1	1		
Reset Switch(2)	2	2	2	2	GND (internal)	open
Stand Alone	1	3	1	1	VINX	>> R1
	2	3	1	1		

Note 1: The circuit shown uses a non-inverting comparator to close the feedback loop.

2: The reset switch (MOSFET) in the circuit is controlled by a non-inverting comparator.

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2.4 MCP6XXX AMPLIFIER EVALUATION BOARD 4 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

This inverting integrator is described as follows:

- Power Supply V_{DD} is 5.0V
- Load Capacitance C_L is 56 pF
- Load Resistance R_L is 1.6 kΩ
- R_1= 8.06 kΩ, R_2 is open, R_3 = 8.06 kΩ, C_1 = 1 µF, R_{ISO} = 0Ω
- Input Reference $V_{REF} = 0.5V_{DD}$
- Integrator Control Strategy: Feedback Loop (JP1: Position 1, JP2: Position 1, JP3: Position 1, JP4: Position 1)
- The fully assembled inverting integrator is shown in Figure 2-6.

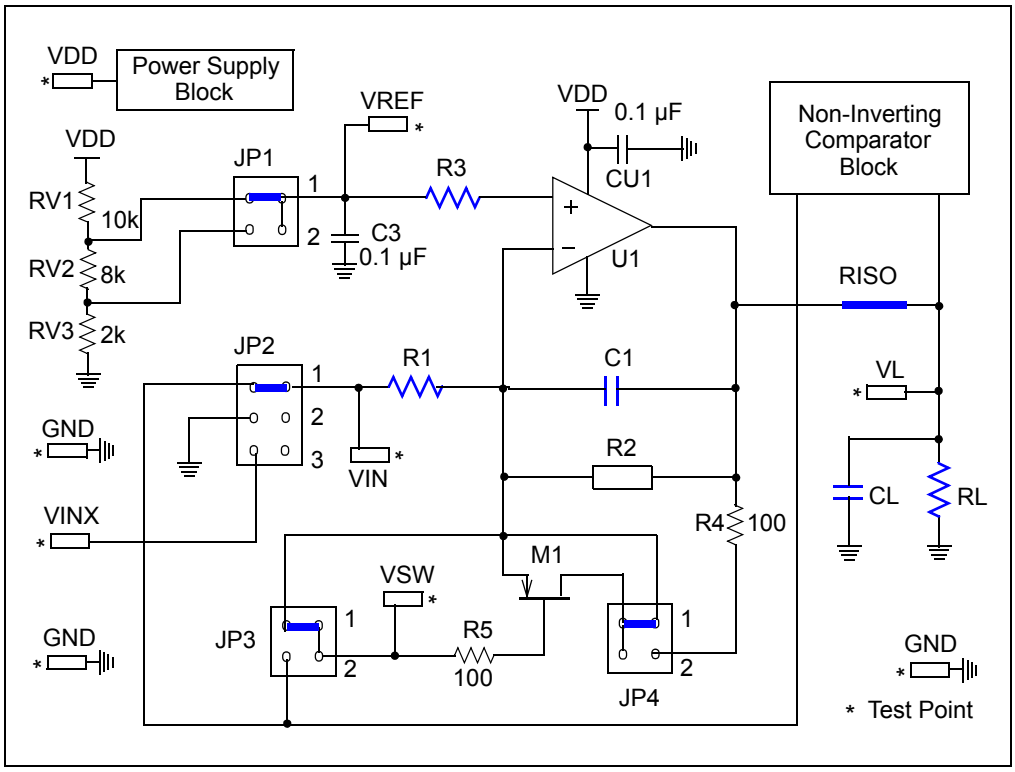

FIGURE 2-6: *Inverting Integrator Example Supported by the MCP6XXX Amplifier Evaluation Board 4.*

The fully assembled MCP6XXX Amplifier Evaluation Board 4 top view is shown in Figure 2-7 (without any user selected components).

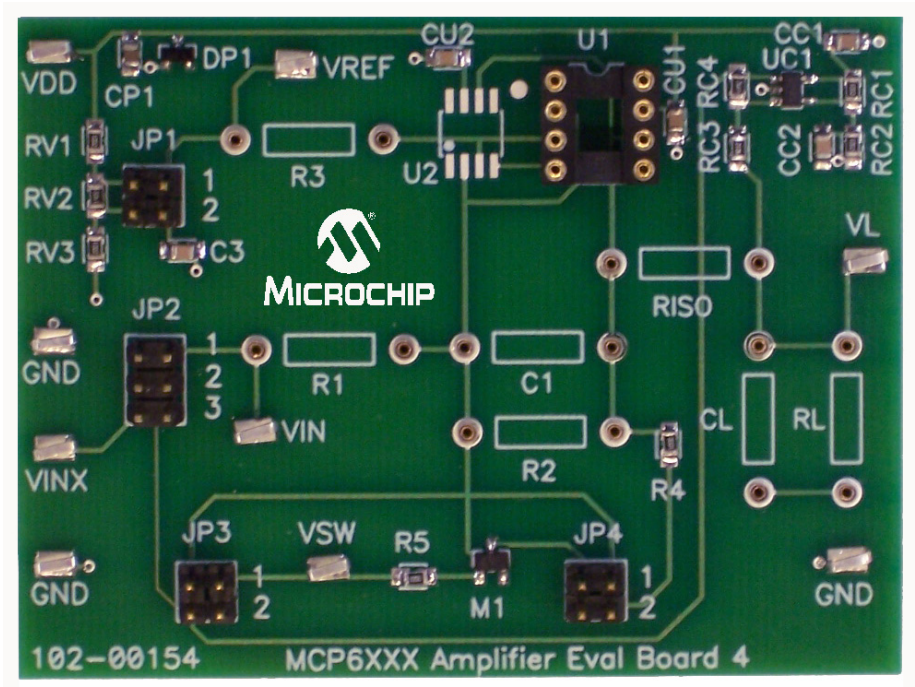

FIGURE 2-7: *Picture of the Inverting Integrator Supported by the MCP6XXX Amplifier Evaluation Board 4.*

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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 2-8 shows the test points to check.

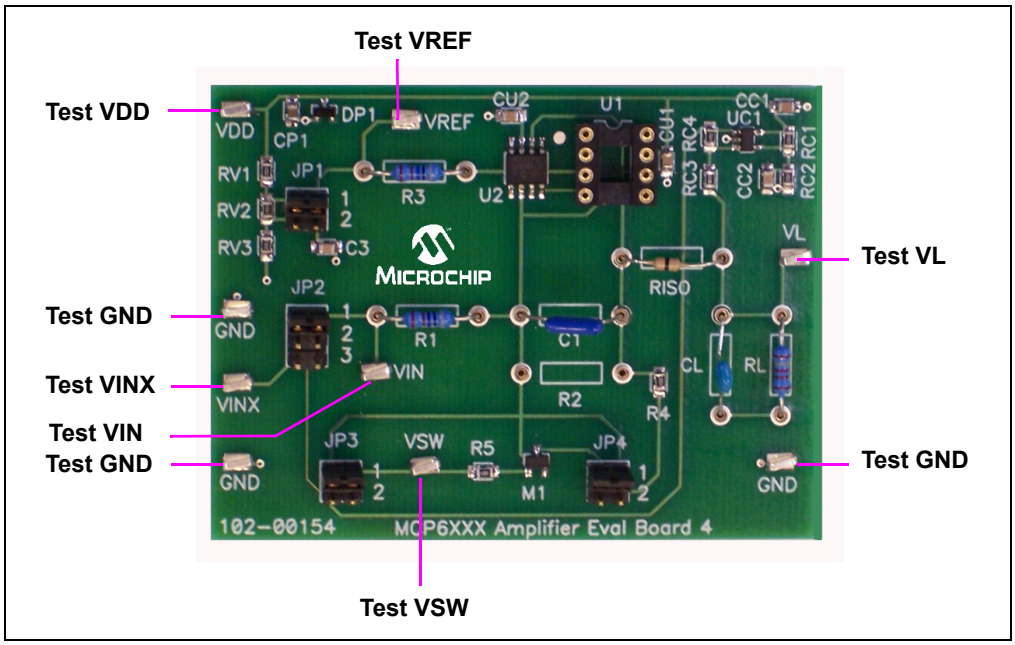

FIGURE 2-8: *Checking the Test Points.*

2.4.2.2 INVERTING INTEGRATOR RESPONSE

The MCP6021 op amp, 1% resistors, and 5% capacitors were used to build an inverting integrator circuit. The measured response with feedback control strategy is shown in Figure 2-9.

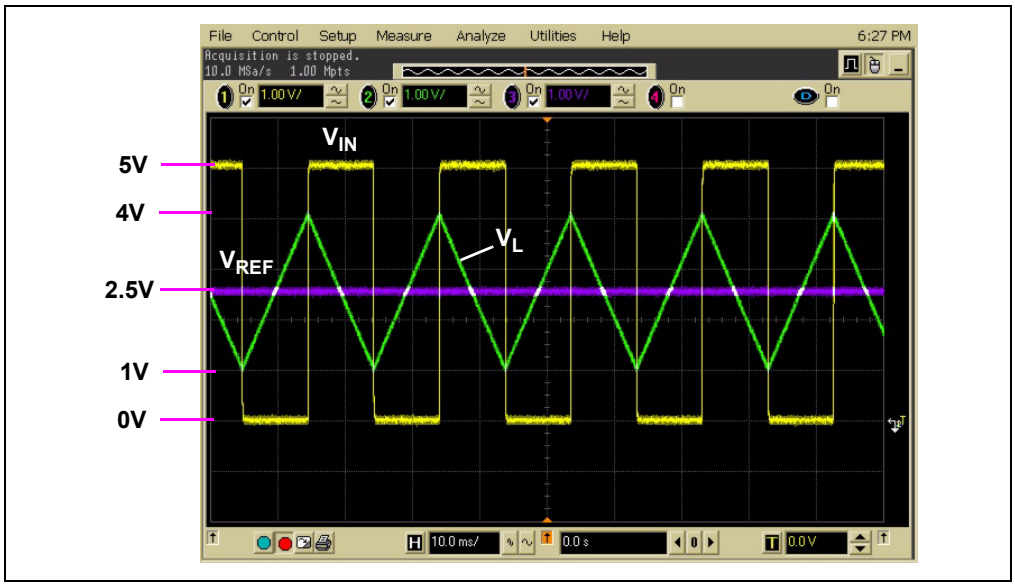

FIGURE 2-9: *Measured Output Response.*

2.4.3 Amplifier Modifications Using 8-Pin SOIC Op Amps

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

- Soldering onto the MCP6XXX Amplifier Evaluation Board 4, 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 2-10 shows a SOIC-8 op amp soldered onto the MCP6XXX Amplifier Evaluation Board 4.

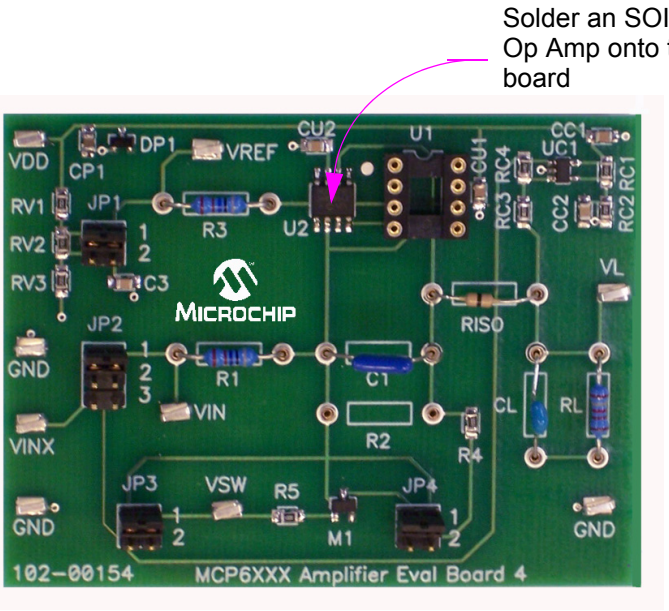

FIGURE 2-10: *Op Amp in SOIC-8 package soldered onto MCP6XXX Amplifier Evaluation Board 4.*

Figure 2-11 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 2-12 shows this board plugged into the MCP6XXX Amplifier Evaluation Board 4.

Note:	Insert the interconnect strips into the DIP-8 socket on the MCP6XXX Amplifier Evaluation Board 4. 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.

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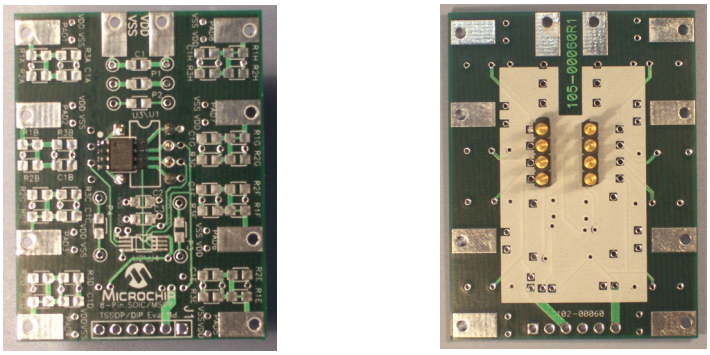

(Front View) (Back View)

FIGURE 2-11: *Op Amp in SOIC-8 package soldered to a separate board.*

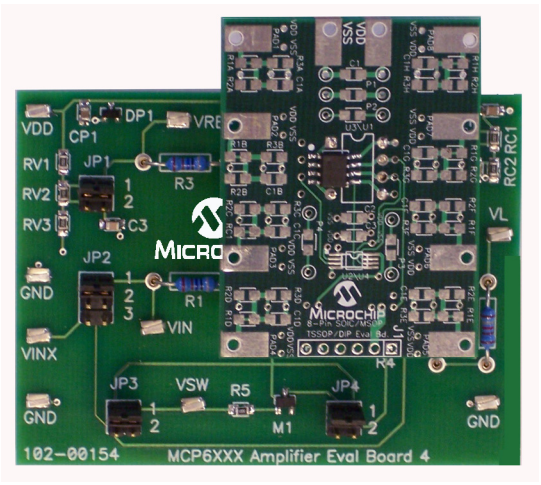

FIGURE 2-12: *Connecting Adaptor Board onto MCP6XXX Amplifier Evaluation Board 4.*

NOTES:

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Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP6XXX Amplifier Evaluation Board 4:

- Board – Schematic
- Board – Top Silk and Metal Layers
- Board – Top Metal Layer
- Board – Bottom Metal Layer

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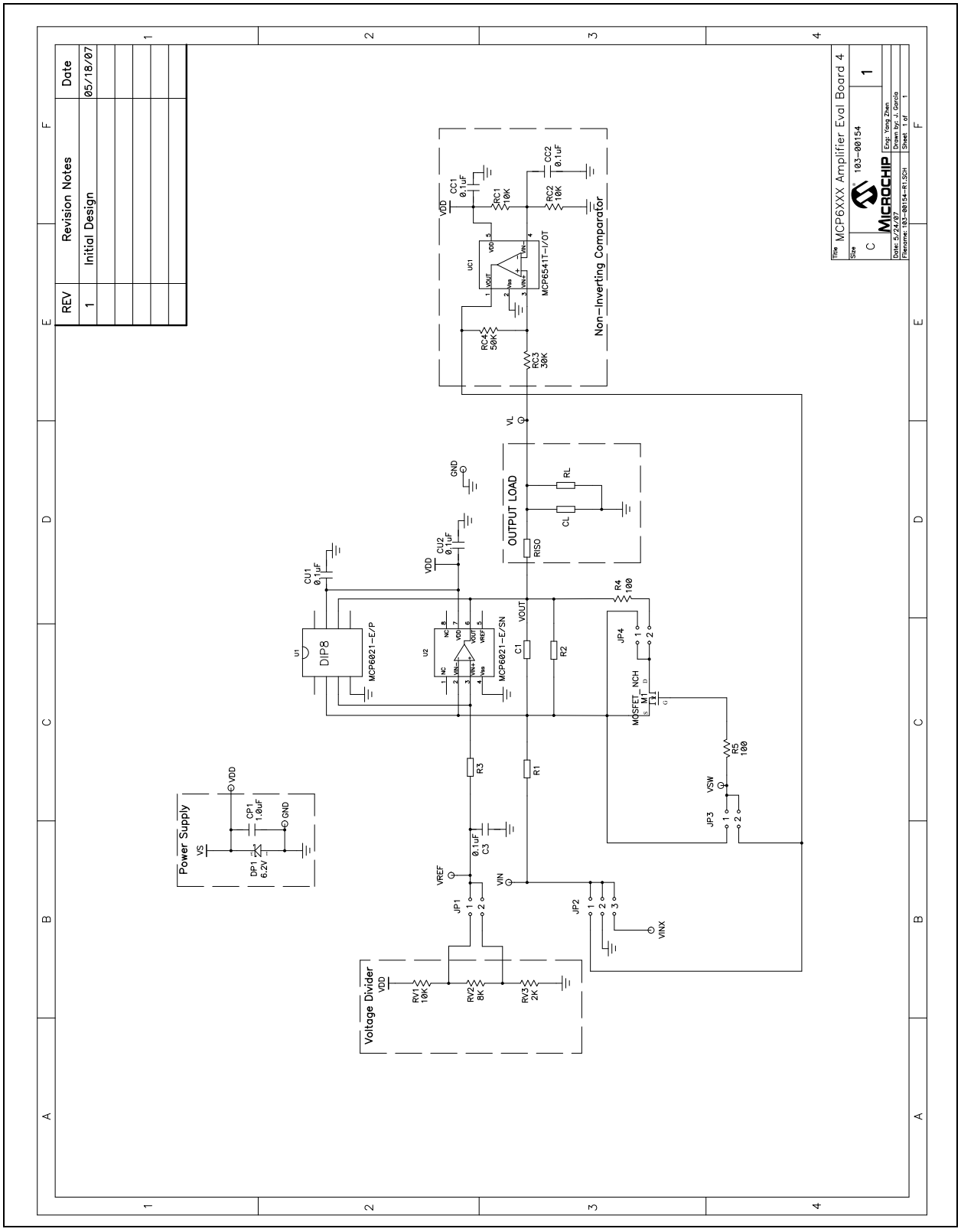
A.2 BOARD - SCHEMATIC



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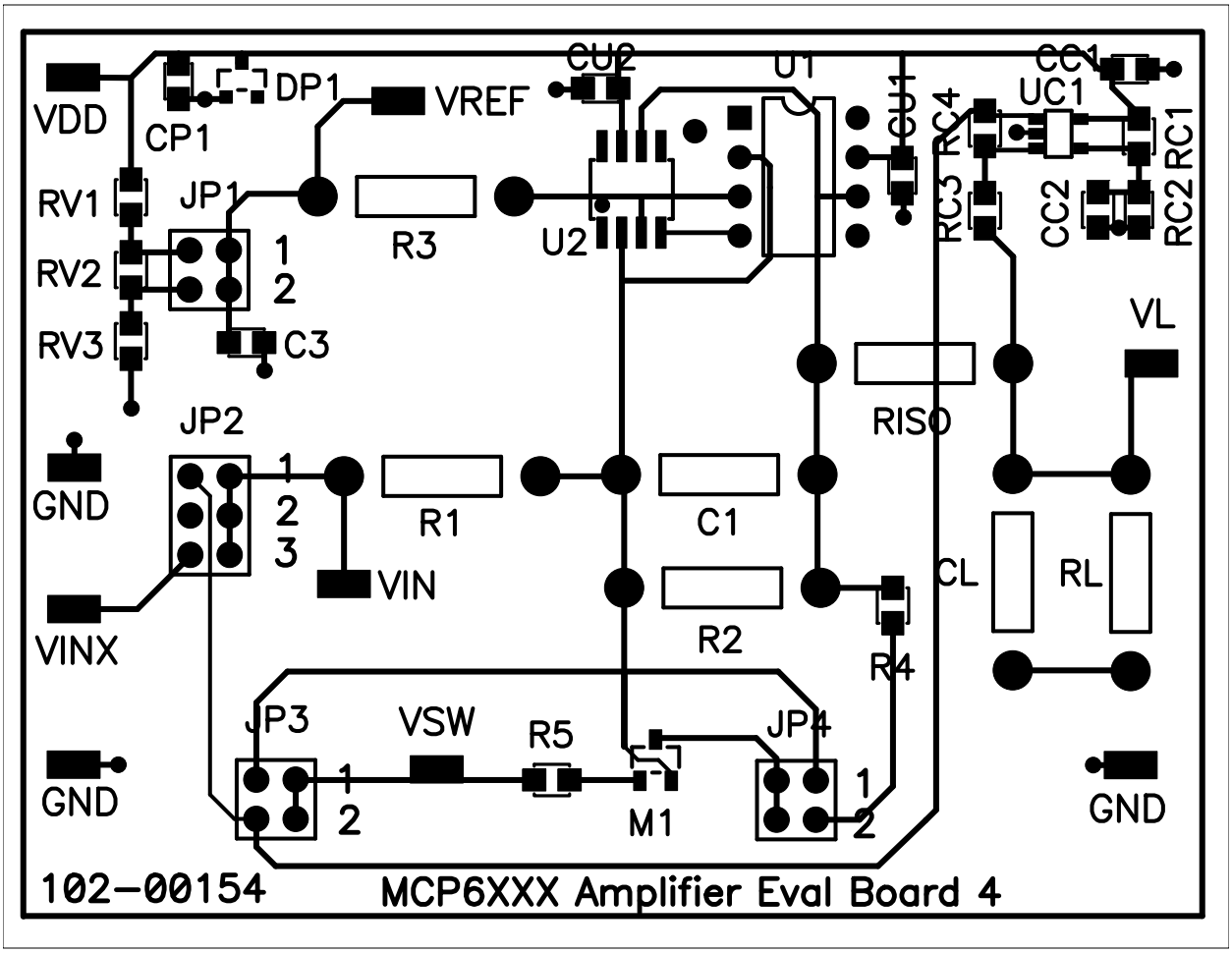
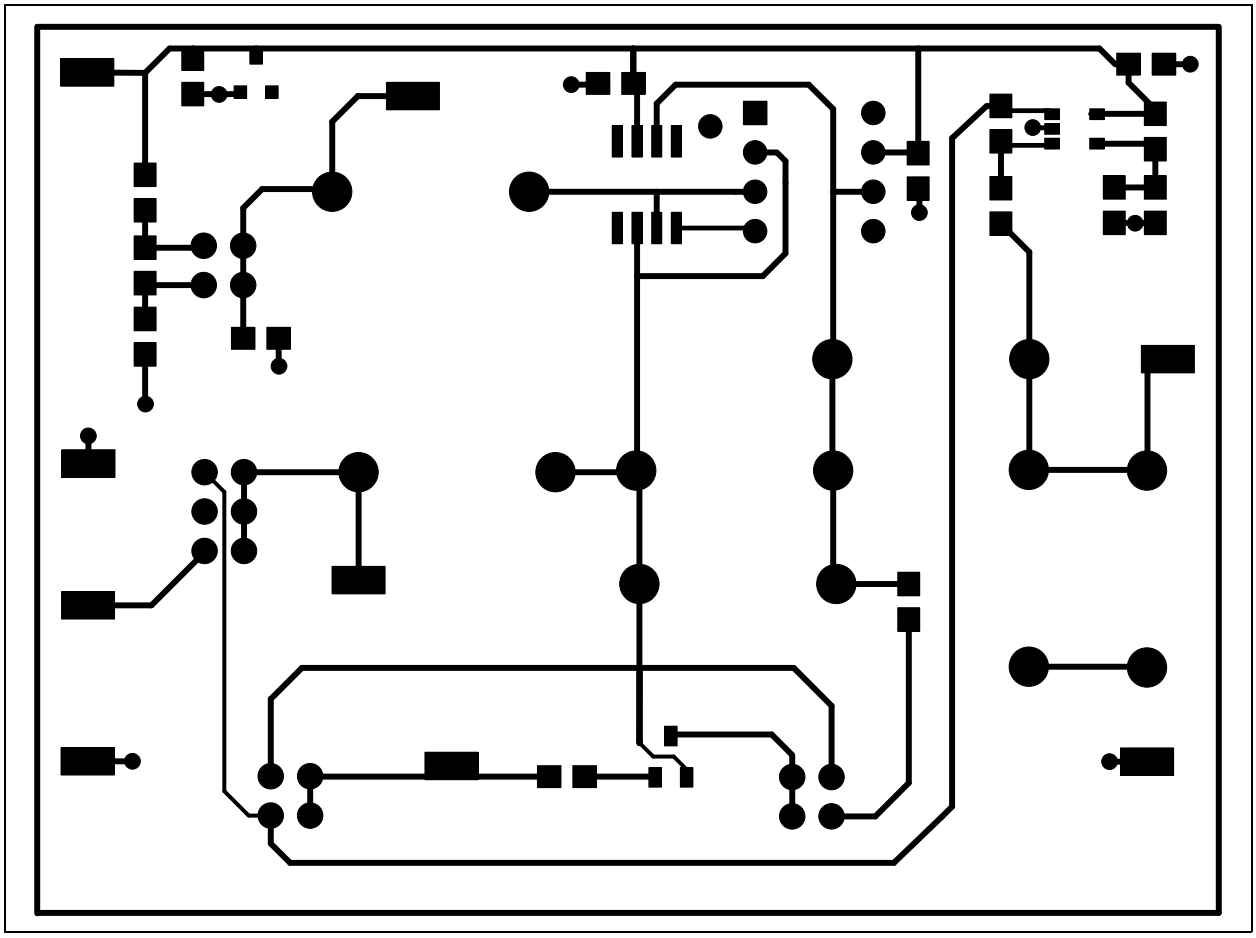
A.3 BOARD - TOP SILK AND METAL LAYERS



A.4 BOARD - TOP METAL LAYER



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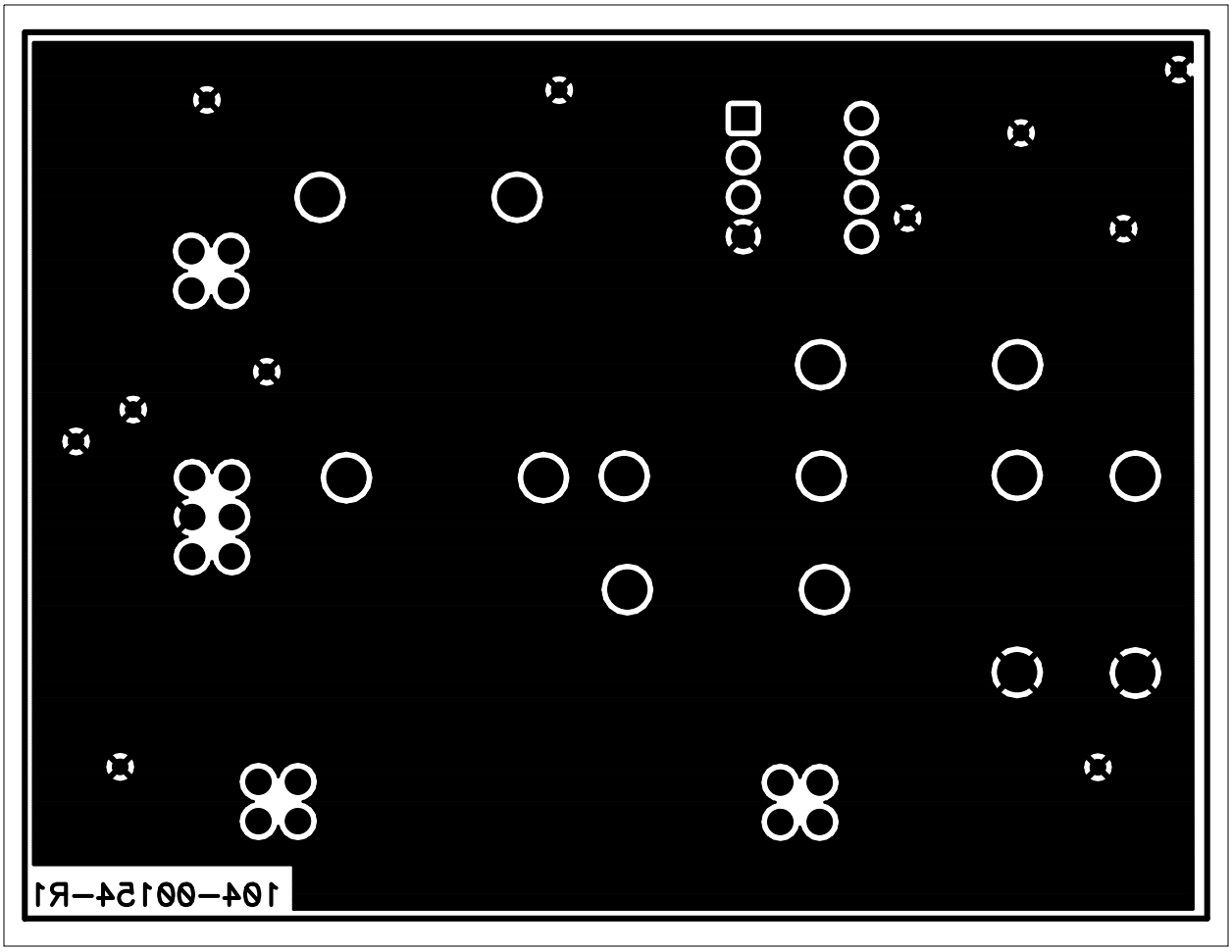
A.5 BOARD - BOTTOM METAL LAYER



NOTES:

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Appendix B. Bill of Materials (BOM)

B.1 MCP6XXX AMPLIFIER EVALUATION BOARD 4 BOM

The Bill of Materials (BOM) in Table B-1 corresponds to Figure 2-1 and Figure 2-2. Unpopulated parts are in Table B-2.

TABLE B-1: BILL OF MATERIALS (102-00154R1) (NOTE 1)

Qty	Reference	Description	Manufacturer	Part Number
1	CP1	CAP CERAMIC 1UF 10% 25V X5R 0805	Panasonic® - ECG	ECJ-2FB1E105K
5	CC1, CC2, C3, CU1, CU2	CAP CERAMIC .1UF 10% 25V X7R 0805	Panasonic - ECG	ECJ-2VB1E104K
1	DP1	DIODE ZENER 6.2V 350MW SOT-23	Fairchild Semiconductor®	BZX84C6V2
4	EA Corner	BUMPER CLEAR .375 x .15" DOME	Richco Plastic Co	RBS-12
2	JP1, JP3	CONN HEADR BRKWAY .100 04POS STR	Tyco® Electronics/Amp	9-146258-0-02
1	JP2	CONN HEADR BRKWAY .100 06POS STR	Tyco Electronics/Amp	4-103327-0-06
1	M1	MOSFET N-CH 30V 500MA SOT-346	Rohm	RJK005N03T146
1	PCB	RoHS Compliant Bare PCB, MCP6XXX Amplifier Eval Board #4	—	104-00154
14	Pin Socket	PIN RECPT .015/.025 DIA 0667 SER	Mill-Max®	0667-0-15-01-30-27-10-0
3	RC1, RC2, RV1	RES 10.0K OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1002V
1	RC3	RES 30.1K OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF3012V
1	RC4	RES 49.9K OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4992V
1	RV2	RES 8.06K OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF8061V
1	RV3	RES 2.0K OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF2001V
2	R4,R5	RES 100 OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1000V
3	Shunt for JP1, JP2, JP3	SOCKET,SHORT BLKS W TAB BLK	Jameco Value-Pro	2012JH-R
9	Test Points	PC TEST POINT COMPACT SMT	Keystone Electronics®	5016
1	UC1	MCP6541 SOT-23-5 Single Op Amp	Microchip Technology Inc.	MCP6541T-I/OT
1	For U1	CONN IC SOCKET 8POS DIP TIN	Tyco Electronics/Amp	2-641260-1

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

TABLE B-2: BILL OF MATERIALS – UNPOPULATED PARTS (102-00154R1)

Qty	Reference	Description	Manufacturer	Part Number
1	U1	MCP6021 PDIP-8, Single Op Amp	Microchip Technology Inc	MCP6021-E/P
7	R1-R3, C1, RISO, RL, CL	Not Populated when shipped to customer	—	—

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

The BOM in Table B-3 corresponds to the collection of resistors, capacitorys, jumpers and MCP6021 op amps that come in the Accessory Bag which is shipped in the MCP6XXX Amplifier Evaluation Board 4 Kit. These components are placed in an separate ESD bag. They support the circuit in **Section 2.4.1 "Building the Amplifier"**. Customers need to provide the resistors and capacitors for more amplifier circuits.

TABLE B-3: BILL OF MATERIALS – ACCESSORY BAG PARTS (102-00148R1)

Qty	Reference	Description	Manufacturer	Part Number
1	Accessory Bag	CAP CER 56PF 50V C0G RADIAL	Murata Electronics®	RPE5C1H560J2P1Z03B
1	Accessory Bag	CAP CER 1UF 25V X7R RAD	TDK® Corporation	FK24X7R1E105K
1	Accessory Bag	JUMPER ZERO OHM 1/8W	Yageo® Corporation	ZOR-12-B-52
2	Accessory Bag	RES 8.06K OHM 1/4W 1% METAL FILM	Yageo Corporation	MFR-25FBF-8K06
1	Accessory Bag	RES 1.58K OHM 1/4W 1% METAL FILM	Yageo Corporation	MFR-25FBF-1K58

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

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