Texas Instruments

Universal Operational Amplifier Evaluation Module With Shutdown

User's Guide

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Mixed-Signal Products

SLVU009

IMPORTANT NOTICE

Preface

Read This First

About This Manual

This User's Guide describes the universal operational amplifier (op amp) evaluation module (EVM) with shutdown that can be used to construct many op amp evaluation circuits. Schematics of the EVM and several example circuits are included.

How to Use This Manual

This document contains the following chapters:

- Chapter 1 Introduction
- Chapter 2 Schematics
- Chapter 3 Board Layout
- Chapter 4 Example Circuits

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

Trademarks

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Figures

Chapter 1

Introduction

This User's Guide describes a universal operational amplifier (op amp) evaluation module (EVM) with shutdown (#SLOP224). The EVM simplifies evaluation of Texas Instruments surface-mount op amps with the shutdown feature.

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1.1 Design Features

The board design allows many circuits to be constructed easily and quickly. The board has four circuit development areas that can be snapped apart. Areas 100 and 200 are for dual op amps in the SOIC and MSOP packages. Area 300 is for single op amps in SOIC packages. Area 400 is for single op amps in SOT23-6 packages. A few possible circuits are as follows:

- Voltage follower
- Noninverting amplifier
- Inverting amplifier
- Simple or algebraic summing amplifier
- Difference amplifier
- Current to voltage converter
- Voltage to current converter
- Integrator/low-pass filter
- Differentiator/high-pass filter
- Instrumentation amplifier
- Sallen-Key filter

Two-layer board construction with a ground plane on the solder side ensures that circuit performance will be on par with final production designs.

1.2 Power Requirements

The devices and designs that are used dictate the input power requirements. Three input terminals are provided for each area of the board:

Vx+	Positive input power for area x00	i.e., V1+ ⇒ area 100
GNDx	Ground reference for area x00	i.e., GND2 ⇒ area 200
Vx–	Negative input power for area x00	i.e., V4– ⇒ area 400

Each area has four bypass capacitors – two for the positive supply, and two for the negative supply. Each supply should have a 1-µF to 10-µF capacitor for low frequency bypassing and a 0.01-µF to 0.1-µF capacitor for high frequency bypassing.

When using single-supply circuits, the negative supply is shorted to ground by bridging C112 or C113 in area 100, C212 or C213 in area 200, C305 or C306 in area 300, or C405 or C406 in area 400. Power input is between Vx+ and GNDx. The voltage reference circuitry is provided for single-supply applications that require a reference voltage to be generated.

Chapter 2

Schematics

This chapter contains schematics and pin-outs for each of the four areas.

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2.1 Area Schematics

Figures 2–1 through 2–4 show schematics for each of the board areas. The schematics show all components that the board layout can accommodate. These should only be used as reference, since not all components will be used at any one time.

Figure 2–1. Area 100 Schematic – SOIC (14 pin)

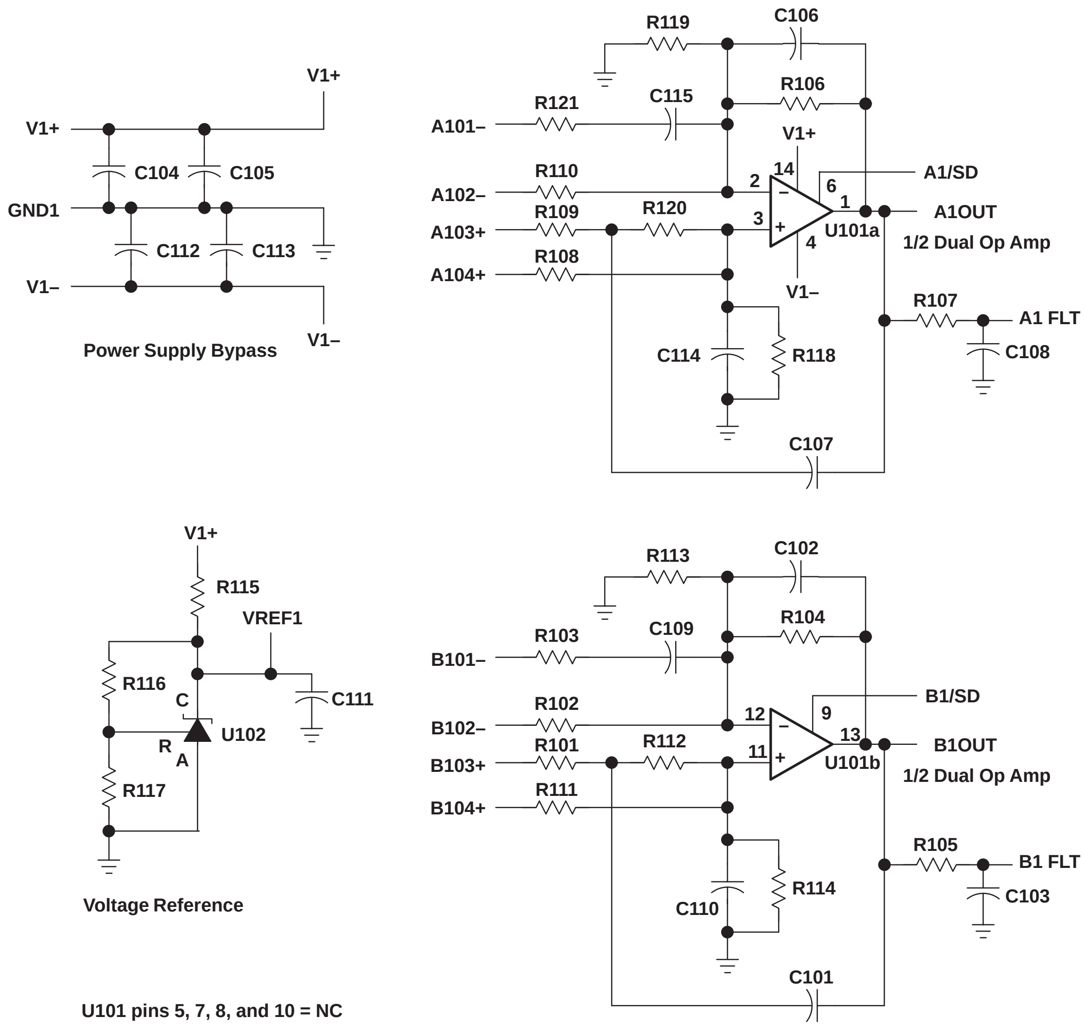


Figure 2–2. Area 200 Schematic – MSOP (10 pin)

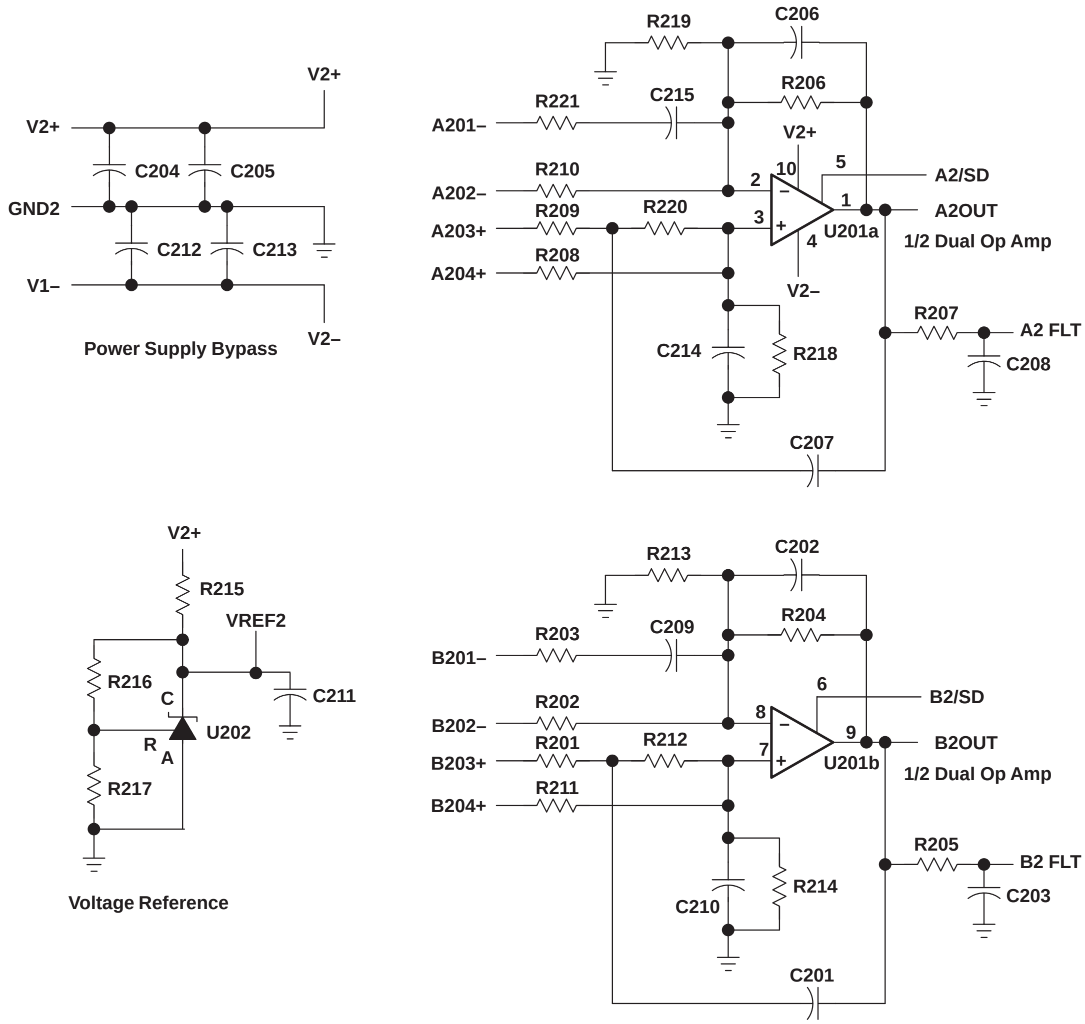


Figure 2–3. Area 300 Schematic – SOIC (8 pin)

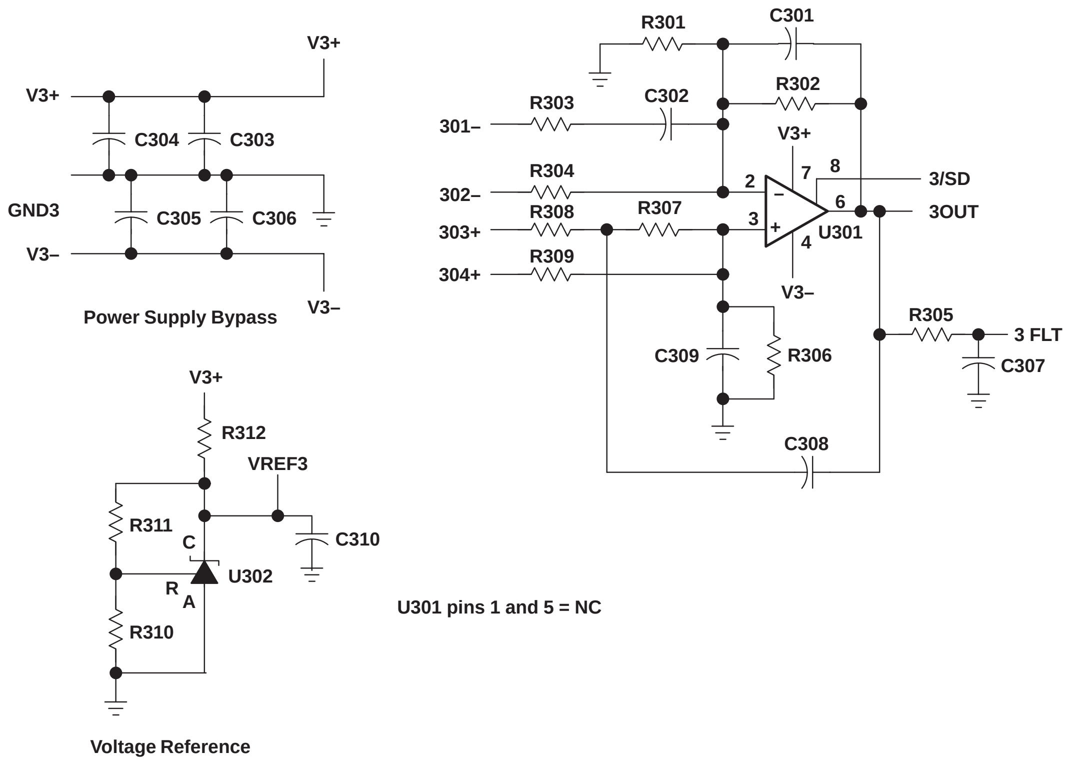
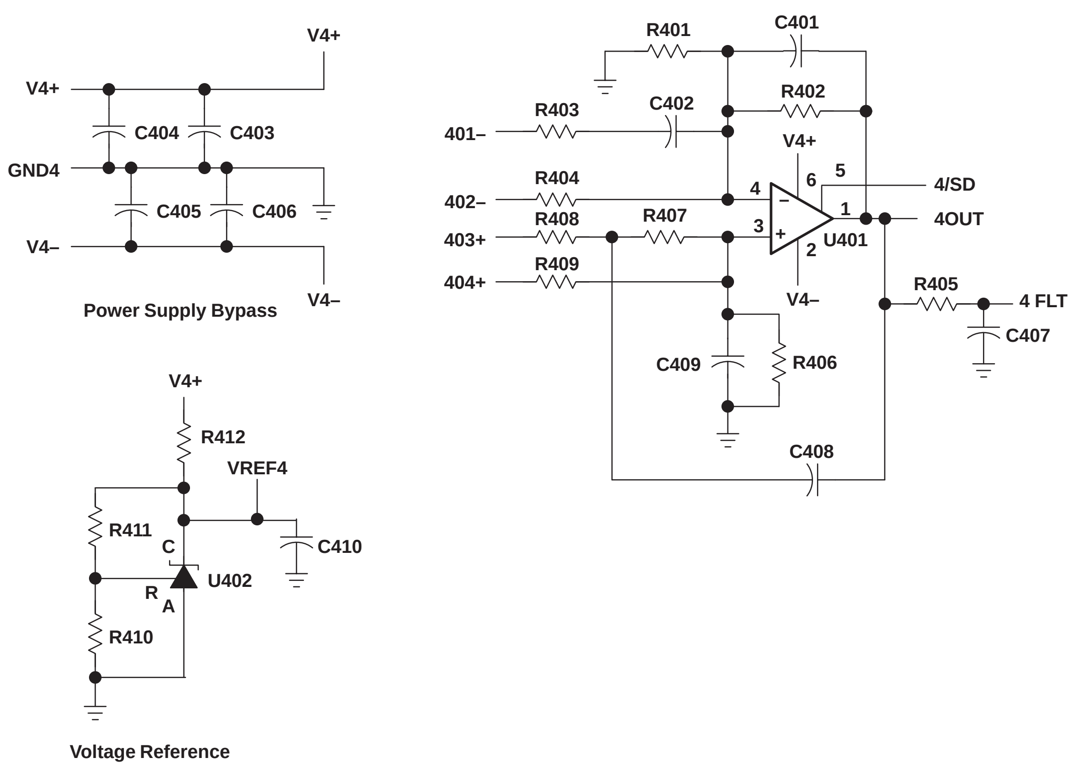


Figure 2–4. Area 400 Schematic – SOT23-6 (6 pin)



Chapter 3

Board Layout

This chapter shows the universal op amp EVM with shutdown board layout, and describes the relationships between the four areas.

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3.1 Physical Considerations

The EVM board has four circuit development areas. Each area can be separated from the others by breaking along the score lines. The circuit layout in each area supports an op amp package, voltage reference, and ancillary devices. The op amp package is unique to each area as described in the following paragraphs. The voltage reference and supporting devices are the same for all areas. Surface-mount or through-hole components can be used for all capacitors and resistors on the board.

The voltage reference can be either surface-mount or through-hole. If surface mount is desired, the TLV431ACDBV5 or TLV431AIDBV5 adjustable shunt regulators can be used. If through hole is desired, the TLV431ACLP, TLV431AILP, TL431CLP, TL431ACLP, TL431ILP or TL431AILP adjustable shunt regulators can be used. Refer to Texas Instruments' *Power Supply Circuits Data Book* (literature number SLVD002) for details on usage of these shunt regulators.

Each passive component (resistor or capacitor) has a surface mount 1206 footprint with through holes at 0.2″ spacing on the outside of the 1206 pads. Therefore, either surface-mount or through-hole parts can be used.

3.1.1 Area 100 – SOIC

Area 100 uses 1xx reference designators, and is compatible with dual op amps with shutdown packaged as a 14-pin SOIC. This surface-mount package is designated by a D suffix in TI part numbers, as in TLV2463CD, TLV2363ID, TLV2263AID, etc. Refer to Figure 2–1 for a schematic.

3.1.2 Area 200 – MSOP

Area 200 uses 2xx reference designators, and is compatible with dual op amps with shutdown packaged as a 10-pin MSOP. The MSOP package is designated by a DGS suffix in TI part numbers, as in TLV2463CDGS. Refer to Figure 2–2 for a schematic.

3.1.3 Area 300 – SOIC

Area 300 uses 3xx reference designators, and is compatible with single op amps with shutdown packaged in the 8-pin SOIC package. This surface-mount package is designated by a D suffix in TI part numbers, as in TLV2461CD. Refer to Figure 2–3 for a schematic.

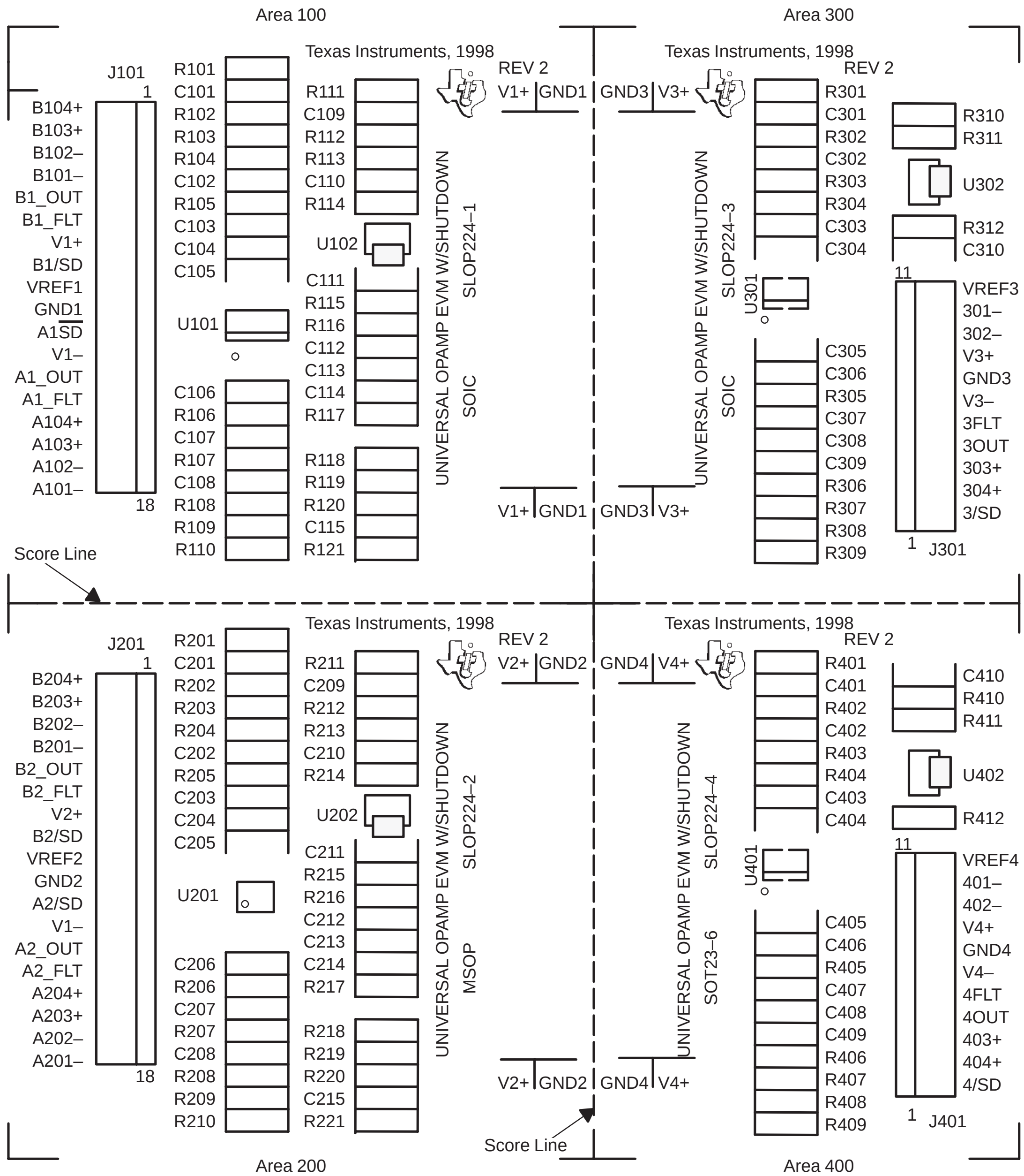
3.1.4 Area 400 – SOT23-6

Area 400 uses 4xx reference designators, and is compatible with single op amps with shutdown packaged in the 6-pin SOT-23 package. This surface-mount package is designated by a DBV suffix in TI part numbers, as in TLV2460CDBV. Refer to Figure 2–4 for a schematic.

3.2 Component Placement

Figure 3–1 shows component placement for the EVM board.

Figure 3–1. Component Placement



3.3 Board Layout

Figures 3–2 and 3–3 show the EVM top and bottom board layouts, respectively.

Figure 3–2. Board Layout Top

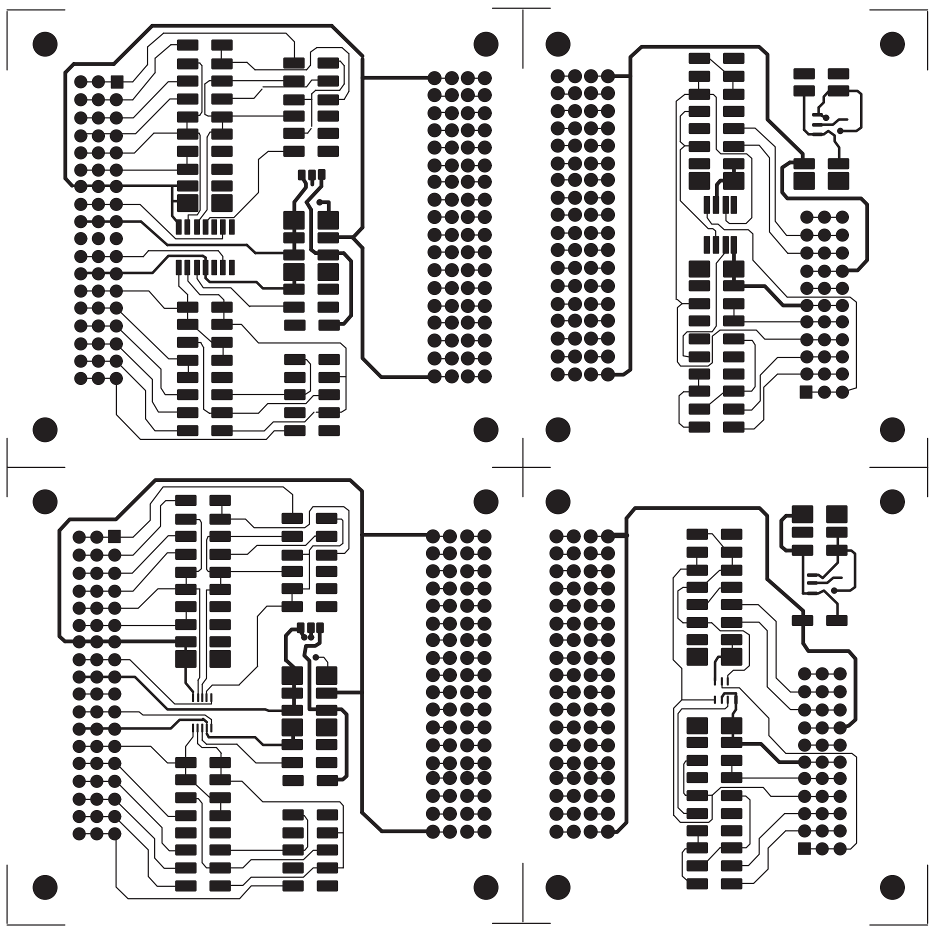
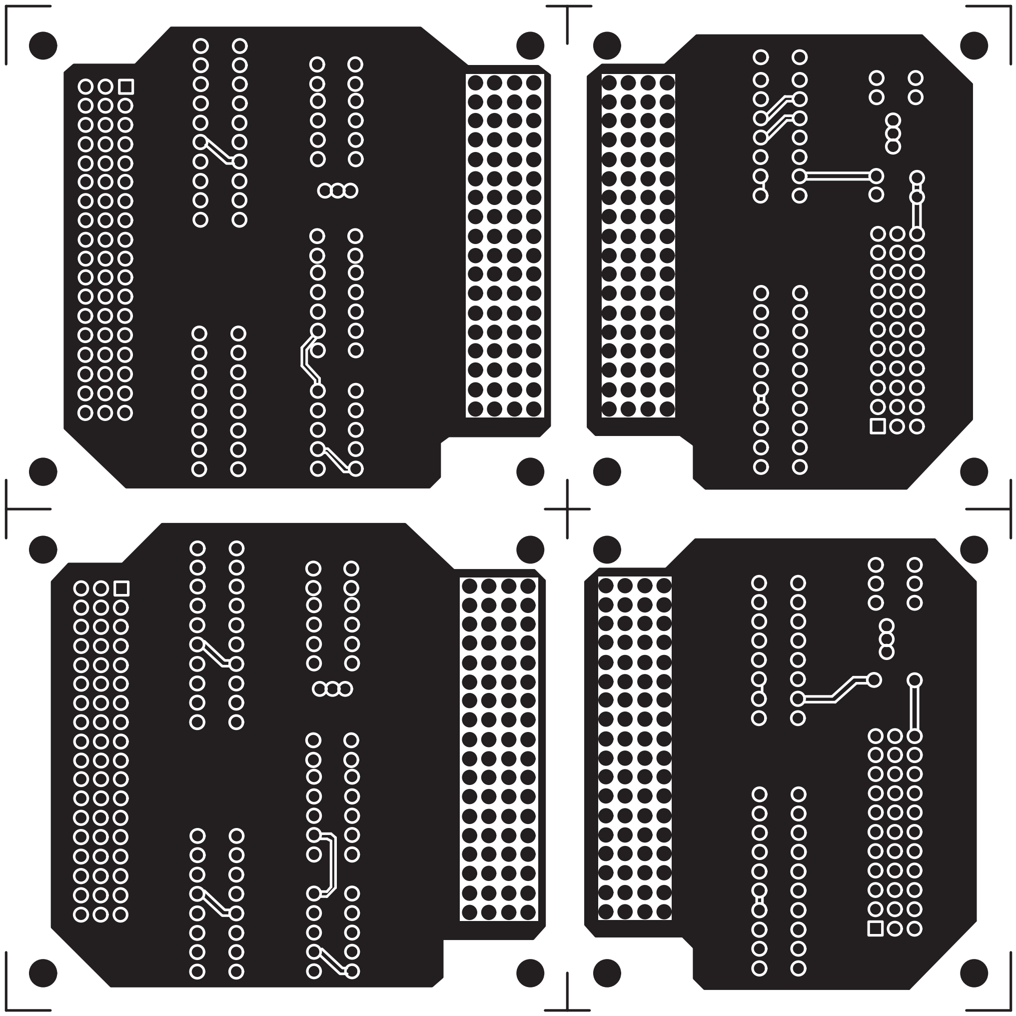


Figure 3–3. Board Layout Bottom



Chapter 4

Example Circuits

This chapter shows and discusses several example circuits that can be constructed using the universal operational amplifier EVM. The circuits are all classic designs that can be found in most operational amplifier design books.

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4.1 Schematic Conventions

Figures 4–1 through 4–6 show schematic examples of circuits that can be constructed using the universal operational amplifier EVM with shutdown. The components that are placed on the board are shown in bold. Unused components are blanked out. Jumpers and other changes are noted. These examples are only a few of the many circuits that can be built.

4.2 Sallen-Key Low-Pass Filter

Figure 4–1 shows area 100 equipped with a dual operational amplifier configured as a second-order Sallen-Key low-pass filter using dual-power supplies.

Basic setup is done by proper choice of resistors R and mR, and capacitors C and nC. The transfer function is:

$$\frac{V_{OUT}}{V_{IN}} = \frac{1}{1 - \left(f/f_o\right)^2 + \left(j/Q\right)\left(f/f_o\right)}$$

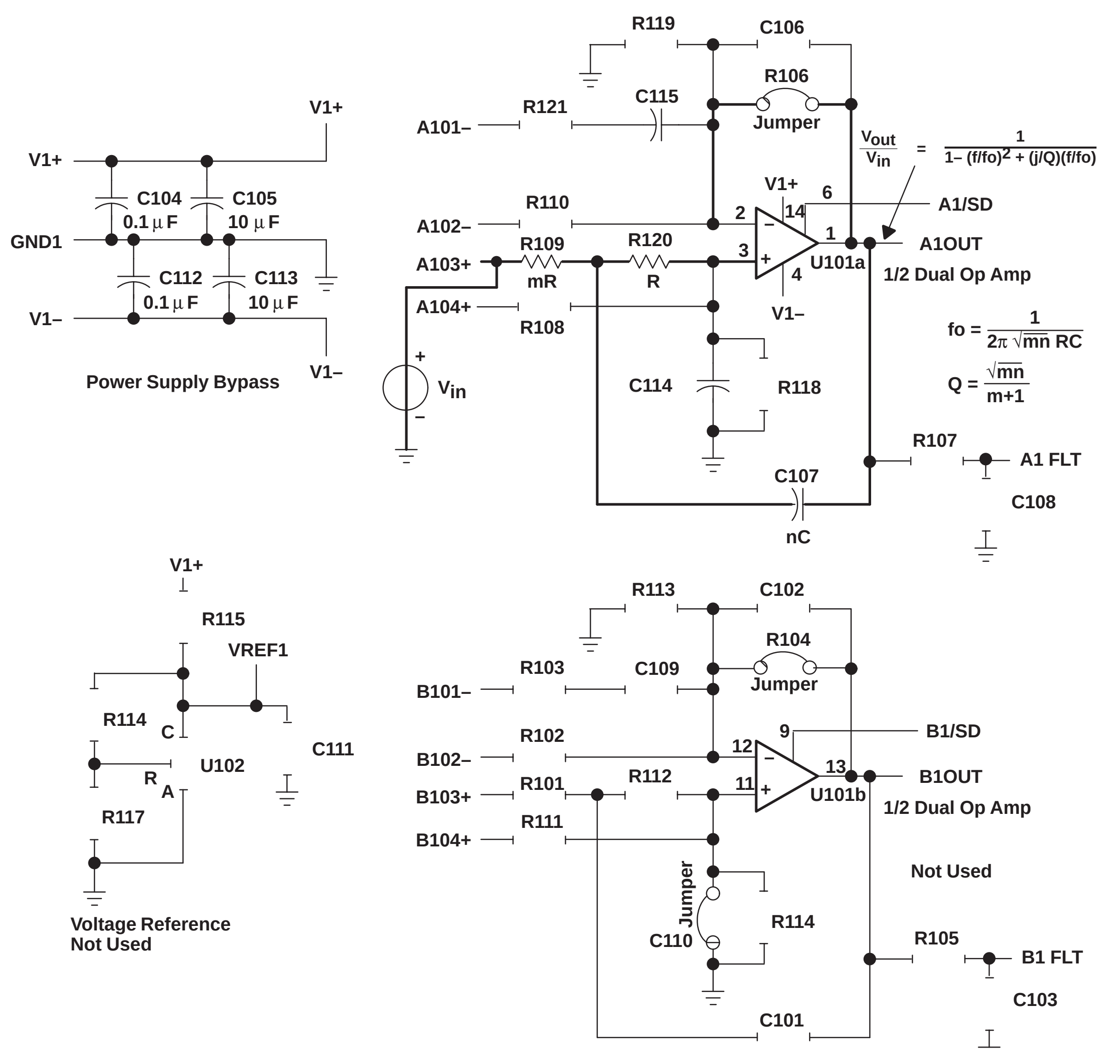
Where:

$$f_o = \frac{1}{2\pi\ \sqrt{m\ n}\,RC}$$

And

$$Q = \frac{\sqrt{m\ n}}{m + 1}$$

Figure 4–1. Sallen-Key Low-Pass Filter with Dual Supply Using Area 100



4.3 Sallen-Key High-Pass Filter

Figure 4–2 shows area 200 equipped with a dual operational amplifier configured as a second-order Sallen-Key high-pass filter using single-supply power input.

Basic setup is done by proper choice of resistors R and mR, and capacitors C and nC. Note that capacitors should be used for components R211 and R212, and a resistor for C201. The transfer function for the circuit as shown is:

$$V_{OUT} = V_{IN} \times \left[\frac{-\left(f/f_O\right)^2}{1 + \left(j/Q\right)\left(f/f_O\right) - \left(f/f_O\right)^2} \right] + VREF2$$

Where:

$$f_O = \frac{1}{2\pi \sqrt{m\ n}\,RC}$$

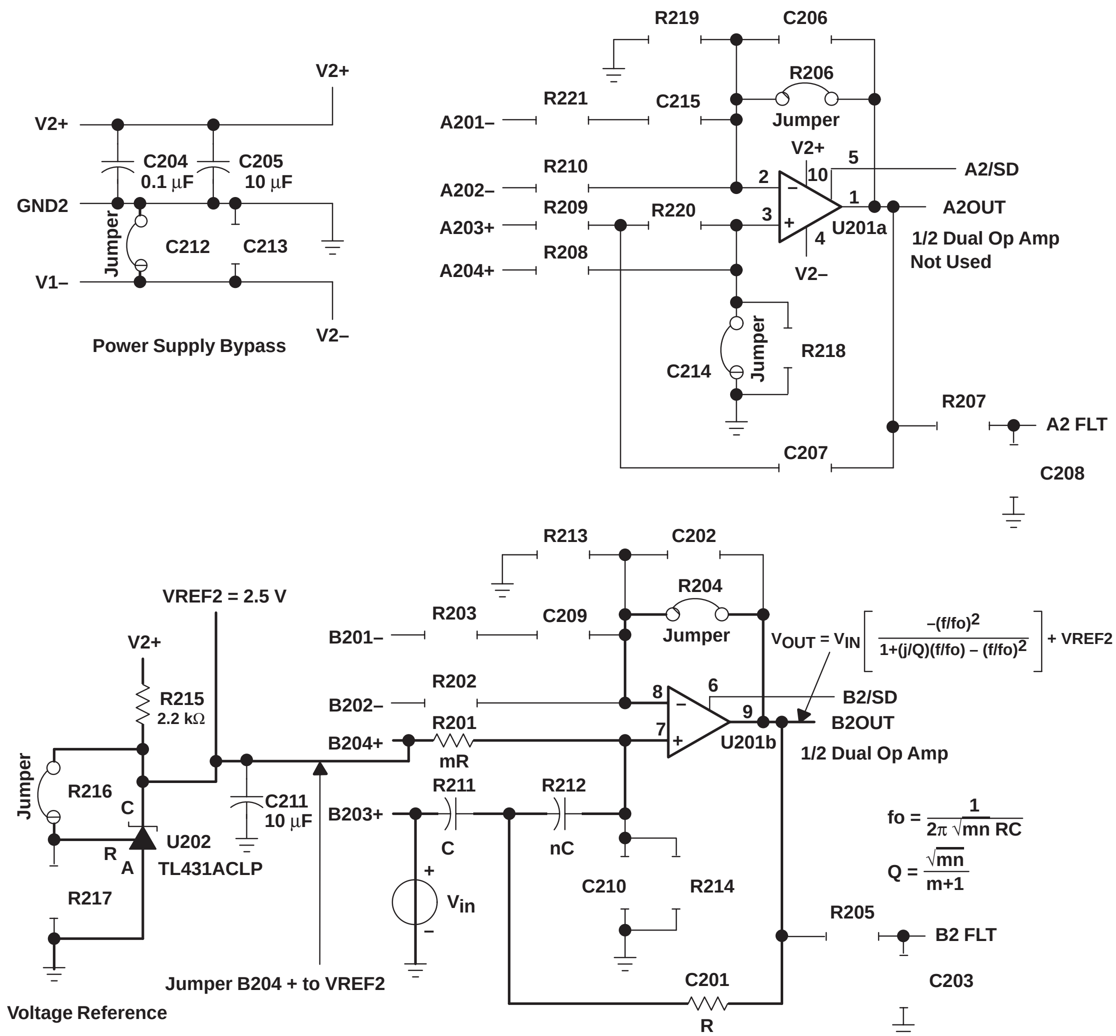
And

$$Q = \frac{\sqrt{m\ n}}{n + 1}$$

The TL431 adjustable precision shunt regulator, configured as shown, provides a low impedance reference for the circuit at about 1/2 V2+ in a 5 V system. Another option is to adjust resistors R216 and R217 for the desired VREF2 voltage. The formula for calculating VREF2 is:

$$VREF2 = 2.50\ V\left(\frac{R216 + R217}{R217}\right)$$

Figure 4–2. Sallen-Key High-Pass Filter with Single Supply Using Area 200



$$V_{OUT} = V_{IN}\left[\frac{-(f/fo)^2}{1+(j/Q)(f/fo)-(f/fo)^2}\right] + VREF2$$

$$fo = \frac{1}{2\pi\sqrt{mn}\,RC}$$

$$Q = \frac{\sqrt{mn}}{m+1}$$

4.4 Inverting Amplifier

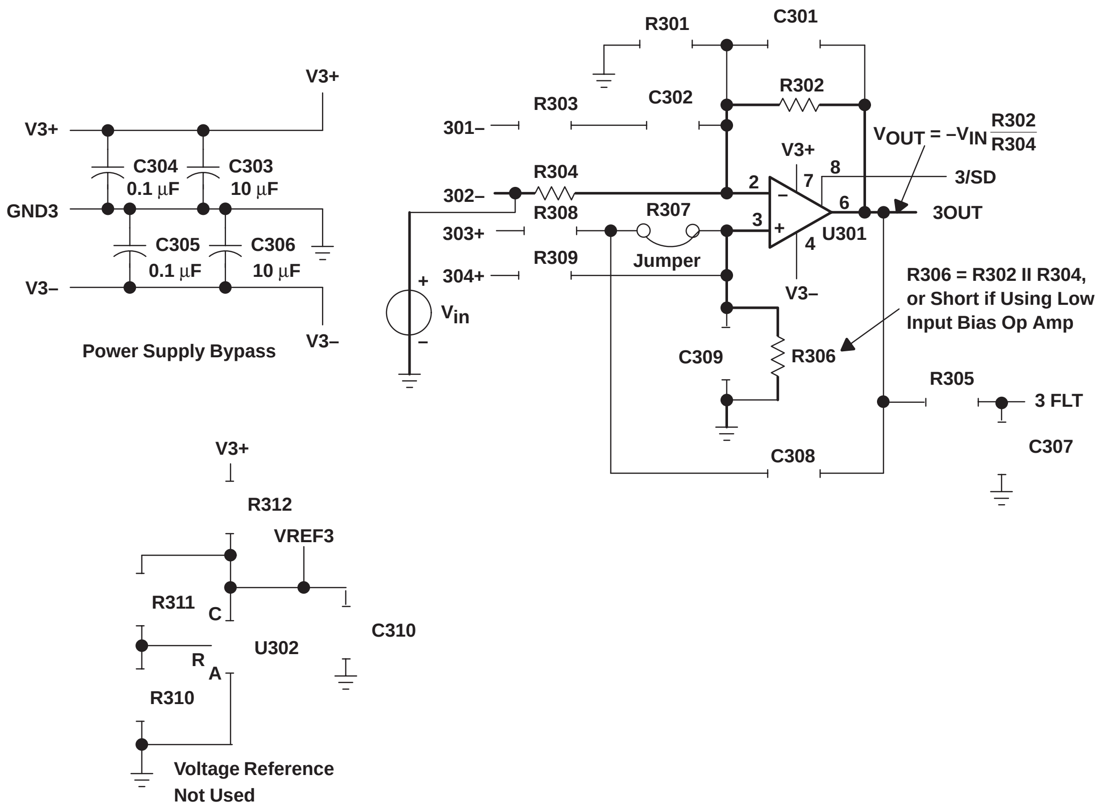
Figure 4–3 shows area 300 equipped with a single operational amplifier configured as an inverting amplifier using dual power supplies.

Basic setup is done by choice of input and feedback resistors. The transfer function for the circuit as shown is:

$$V_{OUT} = -V_{IN} \frac{R302}{R304}$$

To cancel the effects of input bias current, set R306 = R302 || R304, or use a 0-Ω jumper for R306 if the operational amplifier is a low input bias operational amplifier.

Figure 4–3. Inverting Amplifier with Dual Supply Using Area 300



4.5 Noninverting Amplifier

Figure 4–4 shows area 400 equipped with a single operational amplifier configured as a noninverting amplifier with single-supply power input.

Basic setup is done by choice of input and feedback resistors. The transfer function for the circuit as shown is:

$$V_{OUT} = V_{IN}\left(1 + \frac{R402}{R404}\right) + VREF4$$

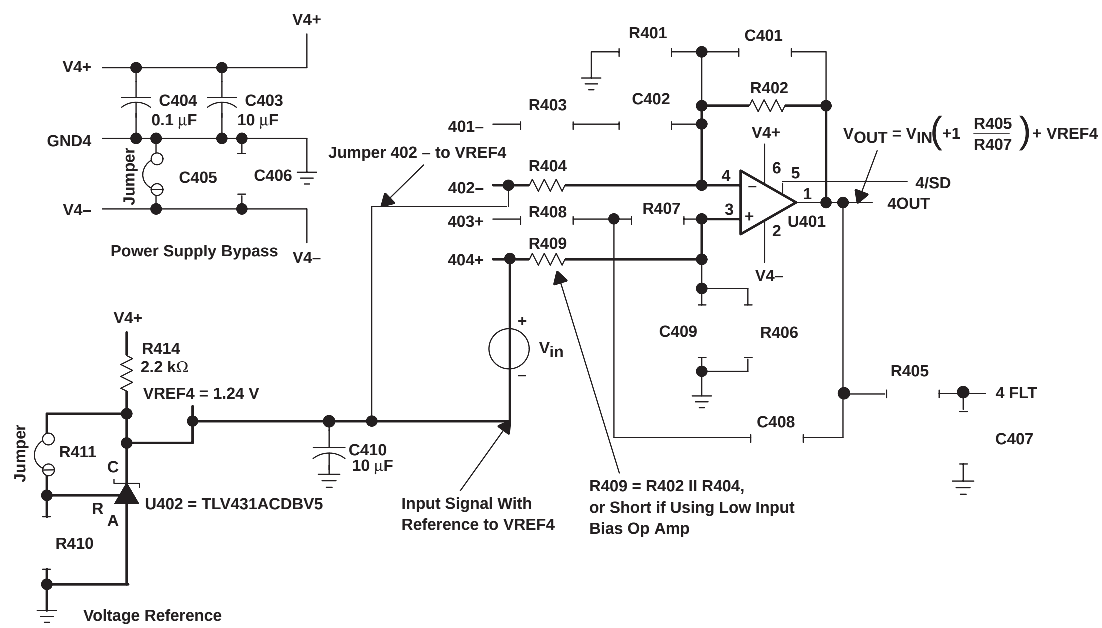
The input signal must be referenced to VREF4.

To cancel the effects of input bias current, set R409 = R402 || R404, or use a 0-Ω jumper for R409 if the operational amplifier is a low input bias operational amplifier.

The TL431 adjustable precision shunt regulator, configured as shown, provides a low impedance reference for the circuit at about 1/2 V4+ in a 3 V system. Another option is to adjust resistors R410 and R411 for the desired VREF4 voltage. The formula for calculating VREF4 is:

$$VREF4 = 1.24\ V\left(\frac{R411 + R410}{R410}\right)$$

Figure 4–4. Noninverting Amplifier with Single Supply Using Area 400



4.6 Two Operational Amplifier Instrumentation Amplifier

Figure 4–5 shows area 200 equipped with a dual operational amplifier configured as a two-operational-amplifier instrumentation amplifier using a voltage reference and single power supply.

Basic setup is done by choice of input and feedback resistors. The transfer function for the circuit as shown is:

$$V_{OUT} = V_{IN}\left(1 + \frac{2R206}{R210} + \frac{R206}{R221}\right) + VREF2$$

Where

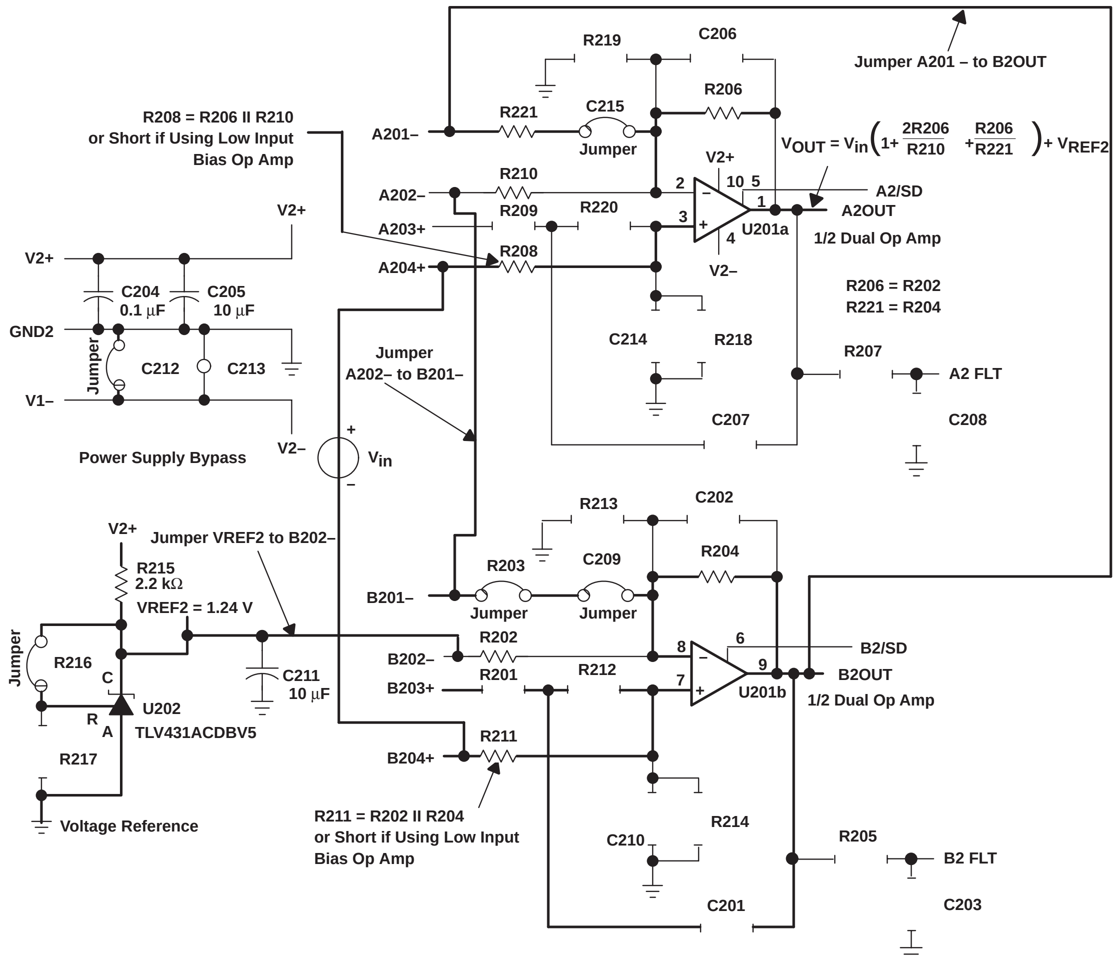
R206 = R202 and R221 = R204

To cancel the effects of input bias current, set R208 = R206 || R210 and set R211 = R202 ||R204, or use a 0-Ω jumper for R208 and R211 if the operational amplifier is a low input bias operational amplifier.

The TLV431 adjustable precision shunt regulator, configured as shown, provides a low impedance reference for the circuit at about 1/2 V2+ in a 3 V system. Another option is to adjust resistors R216 and R217 for the desired VREF2 voltage. The formula for calculating VREF2 is:

$$VREF2 = 1.24\ V\left(\frac{R216 + R217}{R217}\right)$$

Figure 4–5. Two Operational Amplifier Instrumentation Amplifier with Single Supply Using Area 200



4.7 Differential Amplifier

Figure 4–6 shows area 300 equipped with a single operational amplifier configured as a differential amplifier using a voltage reference and single power supply.

Basic setup is done by choice of input and feedback resistors. The transfer function for the circuit as shown is:

$$V_{OUT} = V_{IN}\left(\frac{R302}{R304}\right) + VREF3$$

Where

$$\frac{R302}{R304} = \frac{R309}{R308}$$

The TLV431 adjustable precision shunt regulator, configured as shown, provides a low impedance reference for the circuit at about 1/2 V3+ in a 3 V system. Another option is to adjust resistors R311 and R310 for the desired VREF3 voltage. The formula for calculating VREF3 is:

$$VREF3 = 1.24\ V\left(\frac{R311 + R310}{R310}\right)$$

Figure 4–6. Single Operational Amplifier Differential Amplifier with Single Supply Using Area 300