# Amplifier Mezzanine Card User Guide

UG-1224

One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

## Amplifier Mezzanine Card for ADC Drivers

### FEATURES

**Enables quick breadboarding and prototyping**
**User defined circuit configuration**
**Easy connection to other ADC evaluation boards**

### COMPATIBLE PULSAR EVALUATION BOARDS

**10-lead PulSAR® evaluation board**

### GENERAL DESCRIPTION

The Analog Devices, Inc., amplifier mezzanine card (AMC) analog-to-digital converter (ADC) driver evaluates the performance of amplifiers in 8-lead, single and dual SOIC, 6-lead single SOT23, 8-lead dual MSOP, and 16-lead LFCSP packages. This add on board can be inserted on ADC evaluation boards using its 7-pin header. Figure 1 shows the AMC mounted on an Analog Devices, Inc., ADC evaluation board.

The AMC can support any of Analog Devices operational amplifiers and ADC drivers in different packages. The user can configure the ADC driver as a Sallen-Key low-pass, high-pass, or band-pass filter, as a multiple feedback low-pass, high-pass, or band-pass filter, or as an inverting and noninverting operational amplifier. The user can also configure the AMC to drive a single-ended, fully differential, or a single-ended signal to a differential ADC.

Optimized power and ground planes ensure low noise and high speed operation. Component placement and power supply bypassing are optimized for maximum circuit flexibility and performance. The AMC evaluation board accepts 0402 or 0603 surface mount technology (SMT) components, 1206 bypass capacitors, and 2.54 mm headers.

All components are placed on the primary side. No components are placed on the secondary side.

### EVALUATION BOARD PHOTOGRAPH

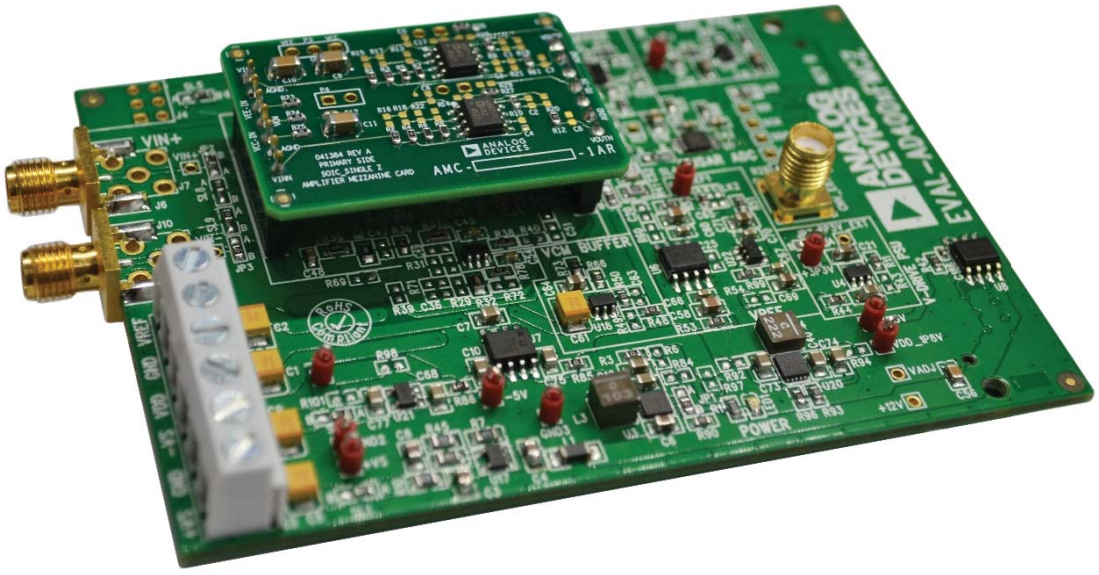


*Figure 1.*

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## REVISION HISTORY

**1/2019—Revision 0: Initial Version**

# BOARD ASSEMBLY

## INTRODUCTION

The AMC allows the user to set the ADC driver to different types of active filter configurations and op amp layouts such as inverting and noninverting. The user can also configure the AMC to drive a single-ended, fully differential, and a single-ended signal to differential ADC.

## SINGLE AMPLIFIER

The AMC for single amplifiers can support ADC drivers that come in 8-lead SOIC and 6-lead SOT23 packages (see Figure 2 and Figure 3).

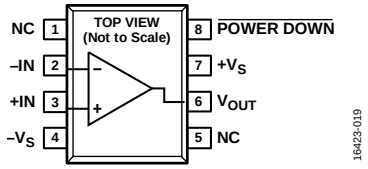


*Figure 2. Example of a Single Amplifier in SOIC Package*

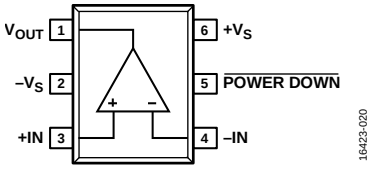


*Figure 3. Example of a Single Amplifier on SOT23 Package*

### *Low-Pass Filter*

The user can configure a Sallen-Key, low-pass filter on the AMC.

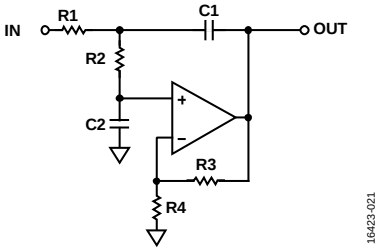


*Figure 4. Sallen-Key, Low-Pass Filter*

Place user defined capacitors on the R7 and R8 resistors, user defined capacitors on the C3 and C4 board positions, and resistors on the R1, R2, R3, R4, R9, R10, R17, and R18 resistors. Place a 0 Ω resistor on C5 and C6 for the feedback to achieve the Sallen-Key low-pass filter configuration.

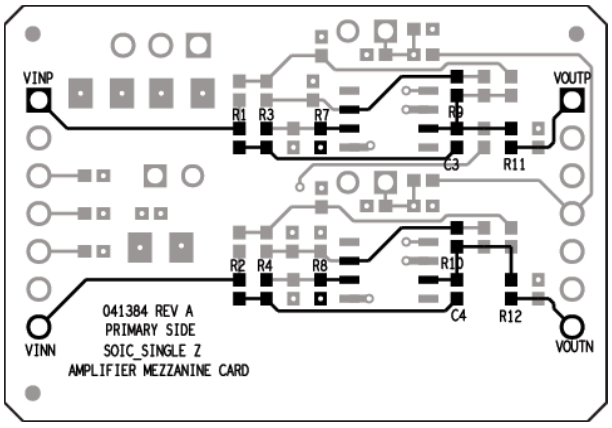


*Figure 5. Sallen-Key, Low-Pass Filter for 8-Lead SOIC, Single Board Connections*

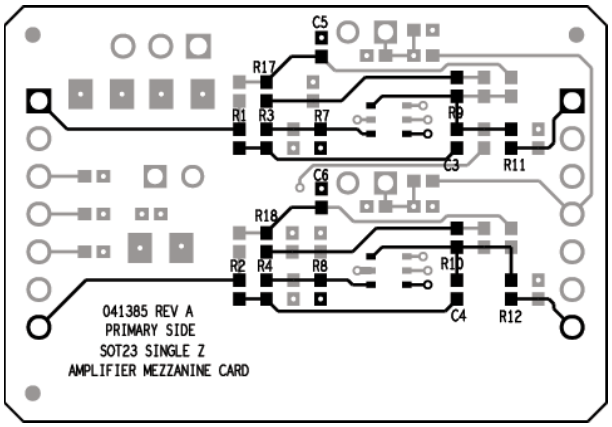


*Figure 6. Sallen-Key, Low-Pass Filter for 6-Lead SOT23, Single Board Connections*

### Multiple Feedback, Low-Pass Filter

The user can configure a multiple feedback, low-pass filter on the AMC.

Place a 0 Ω resistor on R7 and R8 to connect the noninverting input to ground, and place the user defined capacitors on the C1, C2, C5, and C6 capacitors and the resistors on the R15, R16, R17, R18, R19, and R20 resistors.

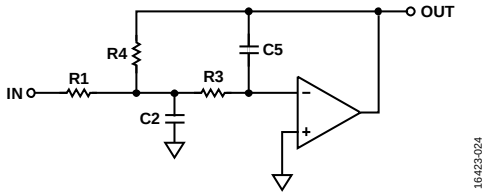


*Figure 7. Multiple Feedback, Low-Pass Filter*

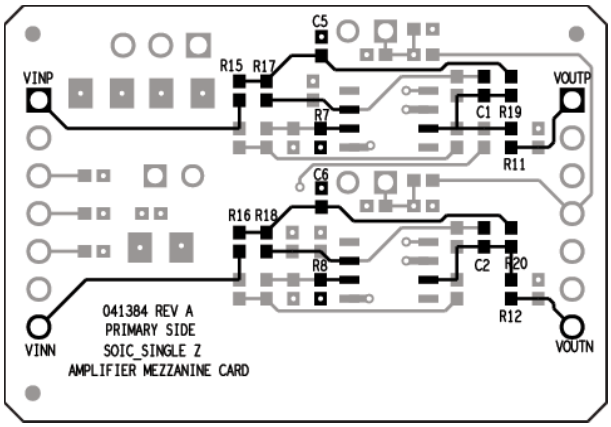


*Figure 8. Multiple Feedback, Low-Pass Filter for 8-Lead SOIC, Single Board Connections*

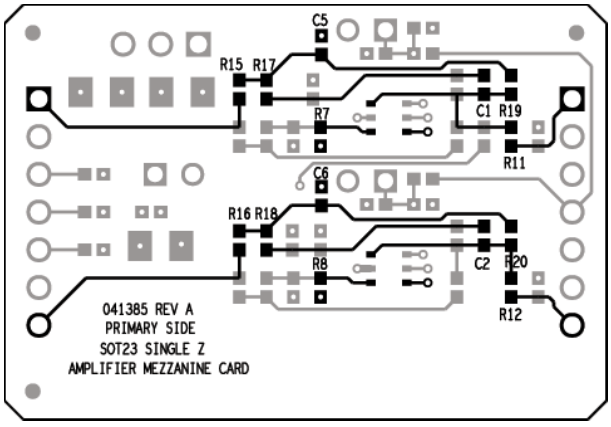


*Figure 9. Multiple Feedback, Low-Pass for 6-Lead SOT23, Single Board Connections*

### *High-Pass Filter*

Place capacitors on the R1, R2, R3, and R4 resistors, resistors on the R7, R8, R9, R10, R17, and R18 resistors, and resistors on the C3 and C4 capacitors. Place a 0 Ω resistor on C5 and C6 to configure the AMC board into a Sallen-Key high-pass filter. This configuration is similar to the low-pass filter except replace the resistors on the noninverting input to capacitors and vice versa.

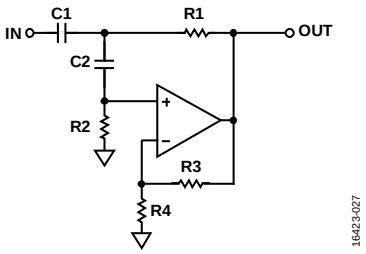


*Figure 10. Sallen-Key, High-Pass Filter*

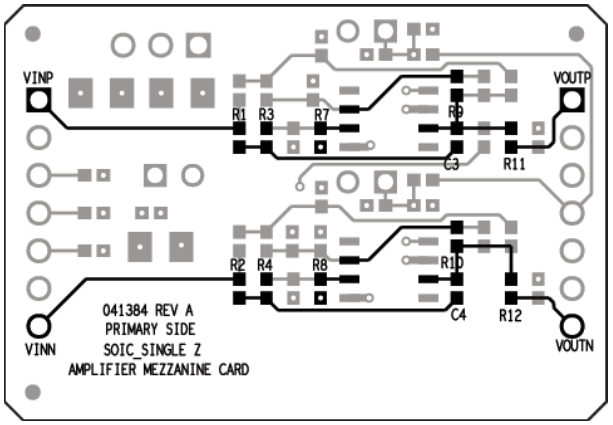


*Figure 11. Sallen-Key, High-Pass Filter for 8-Lead SOIC, Single Board Connections*

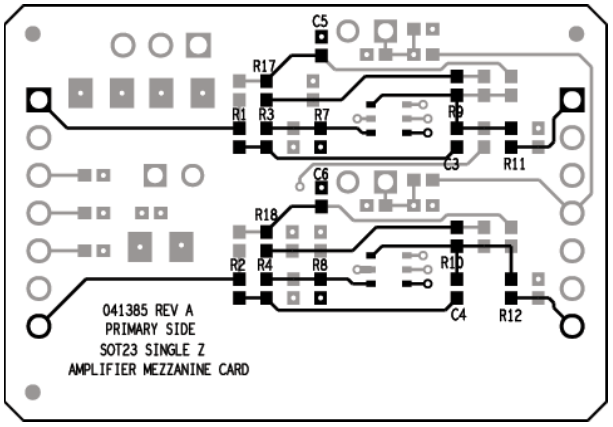


*Figure 12. Sallen-Key, High-Pass Filter for 6-Lead SOT23, Single Board Connection*

For the multiple feedback, high-pass filter configuration, place the user defined capacitors on the R15, R16, R17, R18, R19, and R20 resistors, resistors on the R9 and R10 resistors, and resistors on the C5 and C6 capacitors. Place a 0 Ω resistor on R7 and R8.

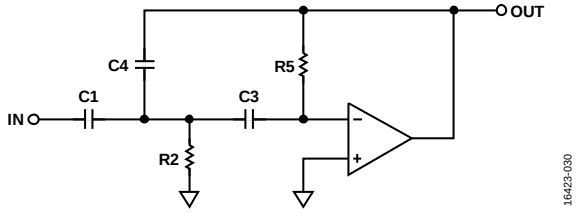


*Figure 13. Multiple Feedback, High-Pass Filter*

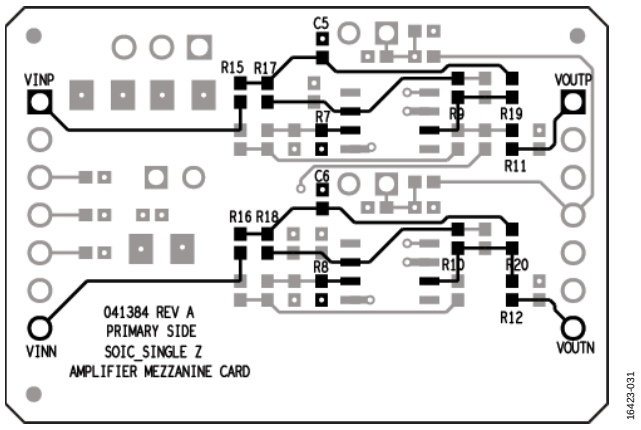


*Figure 14. Multiple Feedback, High-Pass Filter for 8-Lead SOIC, Single Board Connections*

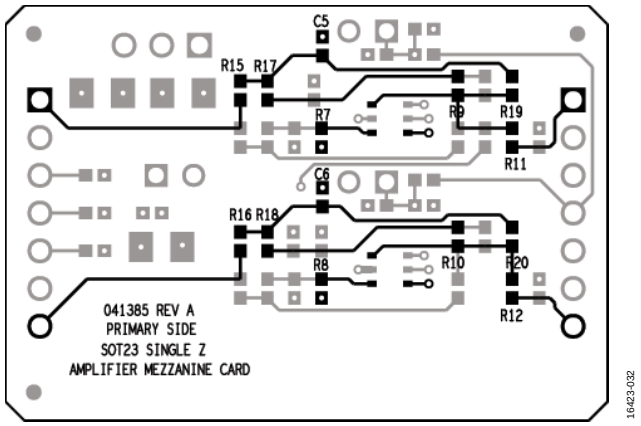


*Figure 15. Multiple Feedback, High-Pass Filter for 6-Lead SOT23, Single Board Connections*

### *Band-Pass Filter*

In a Sallen-Key, band-pass filter, place capacitors on the R3, R4, R5, and R6 resistors, resistors on the R1, R2, R7, R8, R9, R10, R13, and R14 resistors, and resistors on the C3 and C4 capacitors. Place a 0 Ω resistor on C5 and C6 and put a jumper on P3 to short VCM to ground.

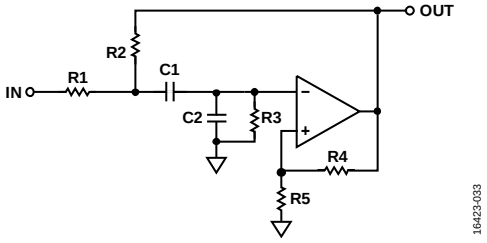


*Figure 16. Sallen-Key, Band-Pass Filter*

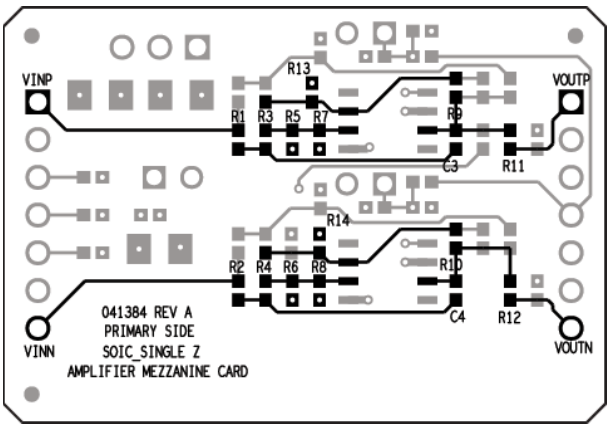


*Figure 17. Sallen-Key, Band-Pass Filter for 8-Lead SOIC, Single Board Configuration*

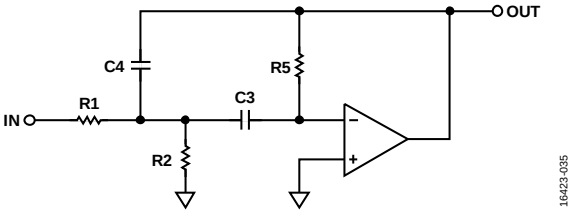


*Figure 18. Multiple Feedback, Band-Pass Filter*

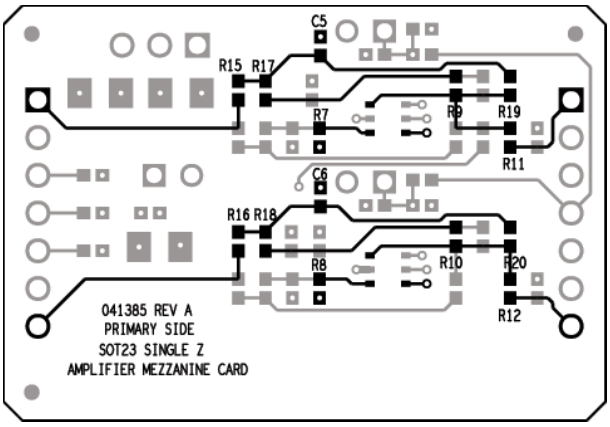


*Figure 19. Multiple Feedback, Band-Pass Filter for 8-Lead SOIC, Single Board Connections*

To achieve a multiple feedback, band-pass filter, place capacitors on the R17, R18, R19, and R20 resistors, resistors on the R9, R10, R15, and R16 resistors, and resistors on the C5 and C6 capacitors. Place a 0 Ω resistor on R7 and R8.

### *Inverting Configuration*

For the inverting configuration, place 0 Ω resistors on R7, R8, R15, and R16. Place the user defined resistor values to set the gain of the amplifier on R9 and R10 for $R_F$ and R17 and R18 for $R_G$.

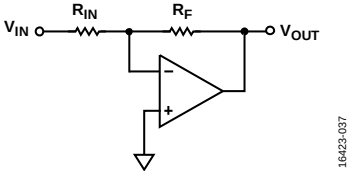


*Figure 20. Inverting Amplifier*

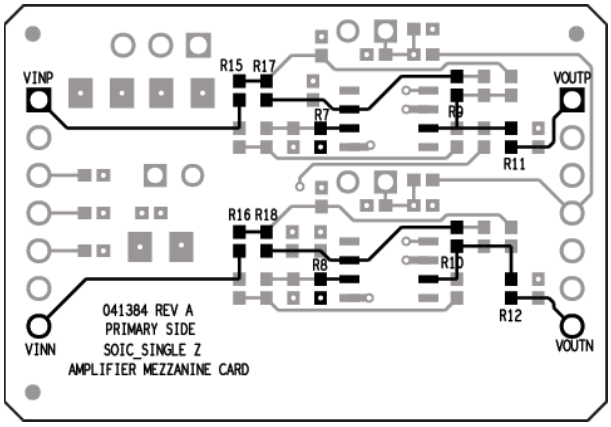


*Figure 21. Inverting Amplifier for 8-Lead SOIC, Single Board Configuration*

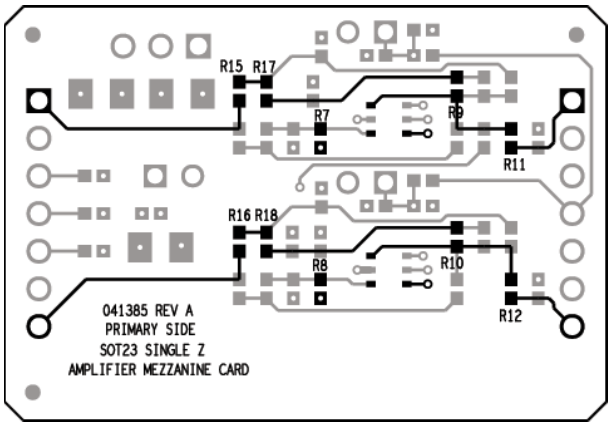


*Figure 22. Inverting Amplifier for 6-Lead SOT23, Single Board Configuration*

### *Noninverting Configuration*

To configure the AMC board into a noninverting amplifier, place 0 Ω resistors at R1, R2, R3, and R4 to connect the input to the noninverting input of the amplifier. To set the gain of the amplifier, place the user defined resistor values on R9 and R10 for $R_F$ and R17 and R18 for $R_G$ and place a 0 Ω resistor on C5 and C6 to connect $R_G$ to ground.

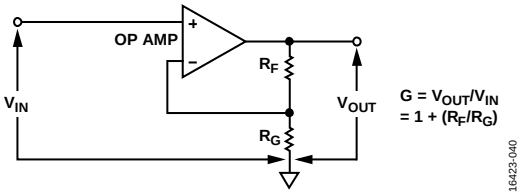


*Figure 23. Noninverting Amplifier Configuration*

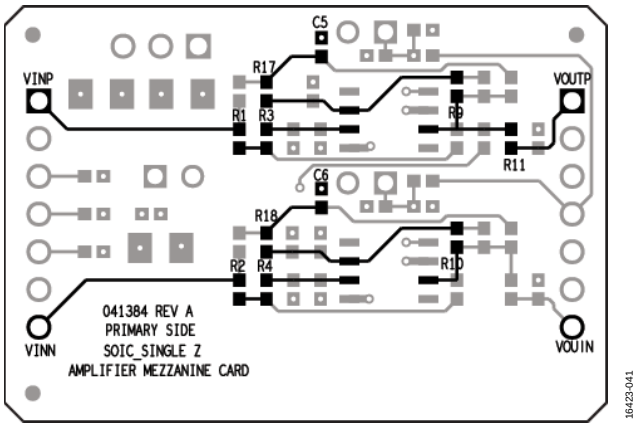


*Figure 24. Noninverting Amplifier for 8-Lead SOIC, Single Board Configuration*

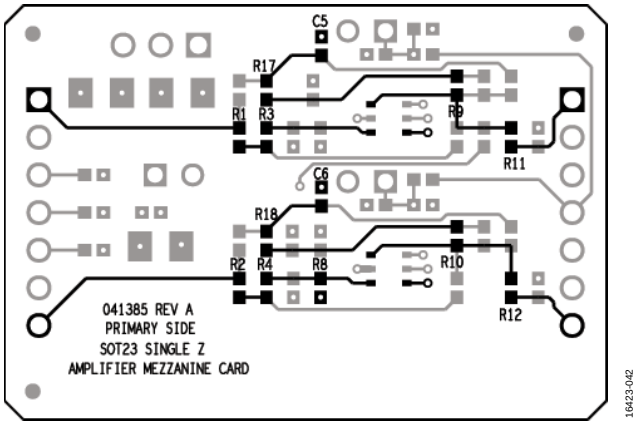


*Figure 25. Noninverting Amplifier Configuration for 6-Lead SOT23, Single Board Configuration*

## DUAL AMPLIFIER

The AMC also supports dual amplifiers that can aid op amps and ADC drivers that come in 8-lead MSOP and 8-lead SOIC packages. Dual amplifier have two amplifiers inside one package.

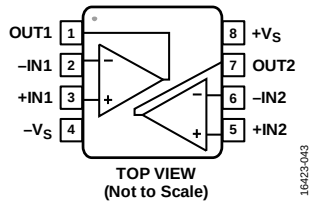


*Figure 26. Dual Amplifier, 8-Lead MSOP (RM) and 8-Lead SOIC (R) Package*

### *Low-Pass Filter*

Similar to single amplifiers, the user can configure the dual amplifier to different types of filter topologies except instead of two ICs, the user only uses one IC.

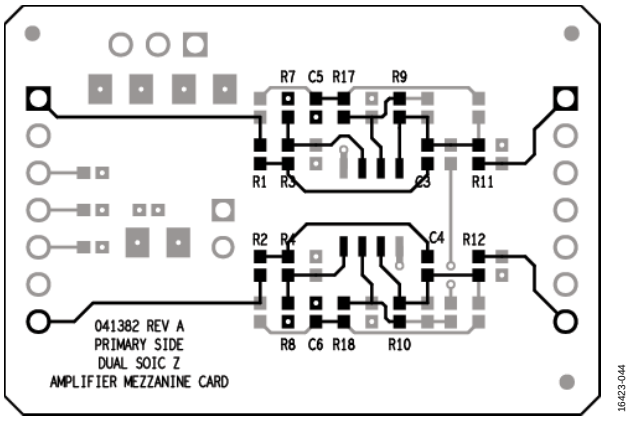


*Figure 27. Sallen-Key, Low-Pass Filter 8-Lead SOIC, Dual Board Configuration*

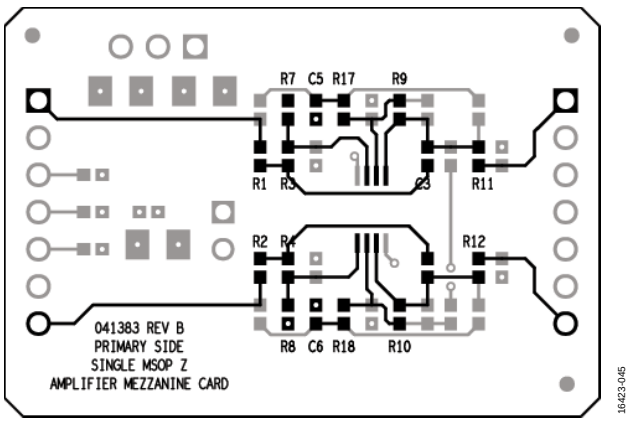


*Figure 28. Sallen-Key, Low-Pass Filter 8-Lead MSOP, Dual Board Configuration*

A Sallen-Key, low-pass filter can also be configured on the dual AMC. To set the cutoff frequency of the filter, place the user defined resistor values for the filter on R1 and R3 on one amplifier and R2 and R4 for the other one. Place the user defined capacitor values on R7 and C3 for the first amplifier and R8 and C4 for the second amplifier. To set the gain of the amplifier, place the necessary feedback resistors on R9 and R10 for the first and second amplifiers, as well as $R_G$ on R17 and R18. Then, place a 0 Ω resistor on C5 and C6 to connect $R_G$ straight to ground.

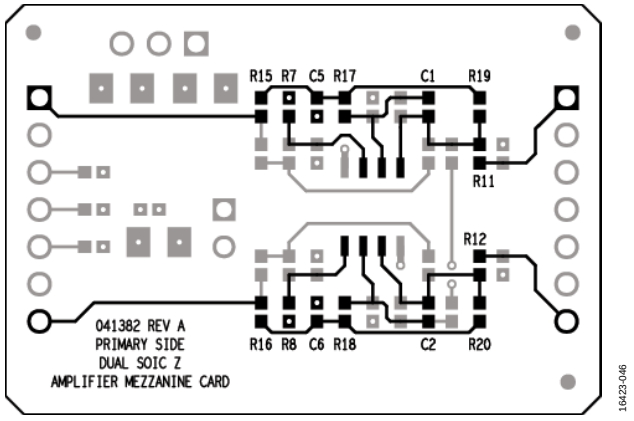


*Figure 29. Multiple Feedback Low-Pass Filter 8-Lead SOIC, Dual AMC Configuration*

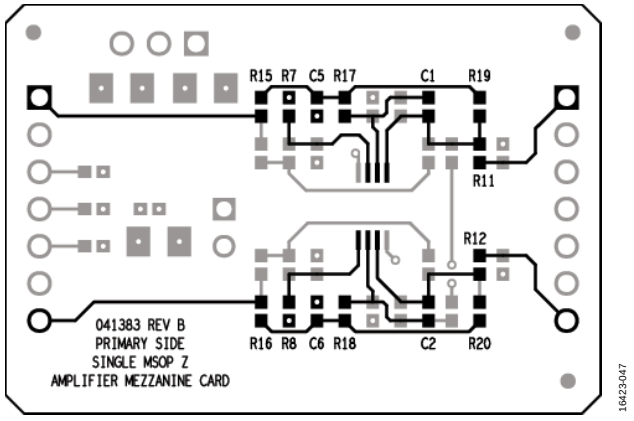


*Figure 30. Multiple Feedback, Low-Pass Filter 8-Lead MSOP, Dual AMC Configuration*

For a multiple feedback configuration, place the user defined resistor values on R15, R17, and R19 for the first amplifier and R16, R18, and R20 for the second amplifier. Place the capacitors on C1 and C5 for the first amplifier and C2 and C6 for the second amplifier.

### *High-Pass Filter*

To achieve a Sallen-Key, high-pass filter configuration, place a 0 Ω resistor at C5 and C6, then place the user defined resistor values for the gain setting on R9 and R10 ($R_F$) and R17 and R18 ($R_G$). Place resistors on R7, R8, C3, and C4 as well as capacitors on R1, R2, R3, and R4 to dictate the cutoff frequency. The configuration is almost the same as in Sallen-Key, low-pass filter, but the resistors and capacitors interchange in the noninverting input of the amplifier.

In the case of a multiple feedback, high-pass filter, place the 0 Ω resistor on R7 for the first amplifier and R8 for the second. Then, place the user defined resistor values on C5 and R9 for the first amplifier and C6 and R10 for the second amplifier. Then, place capacitors on R15, R17, and R19 for the first amplifier and on R16, R18, and R20 for the second amplifier.

### Band-Pass Filter

For a band-pass filter in a Sallen-Key configuration, connect VCM to ground and place the user defined resistor values to design the filter on R1, R2, R7, R8, C3, C4, R4, R3, R5, and R6. To set the gain of the amplifier, place $R_F$ on R9 and $R_G$ on R13. Do the same for the second amplifier with $R_G$ on R14 and $R_F$ on R10.

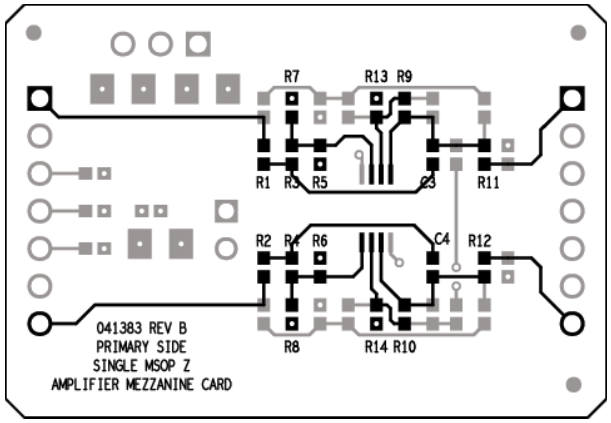


*Figure 31. Sallen-Key, Band-Pass Filter for 8-Lead MSOP, Dual Board Configuration*

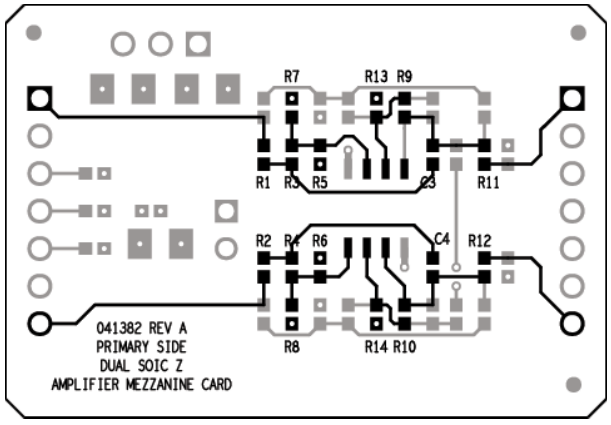


*Figure 32. Sallen-Key, Band-Pass Filter for 8-Lead SOIC, Dual Board Configuration*

In the case for multiple feedback, band-pass filters, mount a 0 Ω resistor on R7 and R8. Place the user defined resistor values on R9, R10, R15, R17, C5, and C6. As well as the user defined capacitors values on R17, R18, R19, and R20 (see Figure 44).

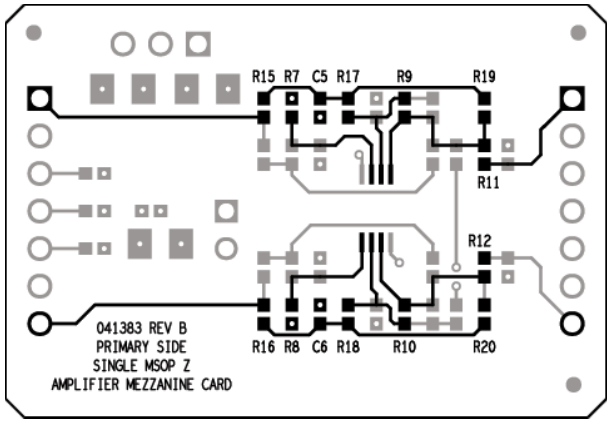


*Figure 33. Multiple Feedback, Band-Pass Filter for 8-Lead MSOP, Dual Board Configuration*

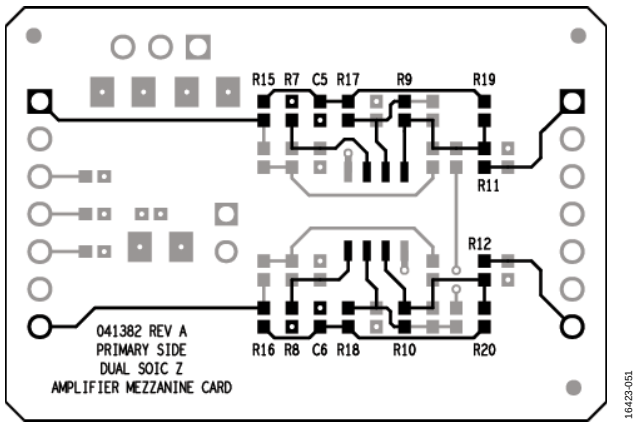


*Figure 34. Multiple Feedback, Band-Pass Filter for 8-Lead SOIC, Dual Board Configuration*

### Inverting Configuration

Place 0 Ω resistors on R7, R8, R15, and R16. Set the gain of the amplifier with R9 and R10 for $R_F$ and R17 and R18 for $R_G$.

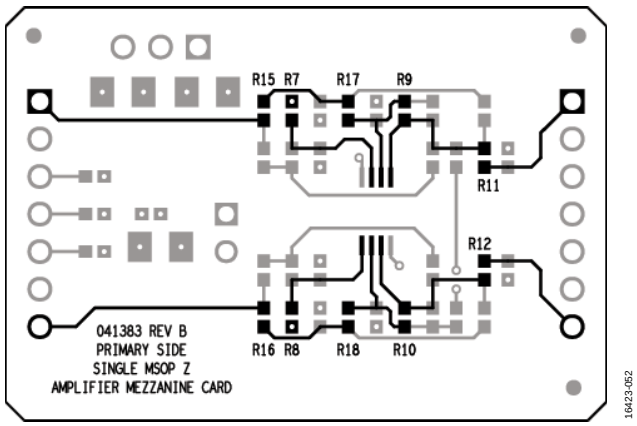


*Figure 35. Inverting Amplifier for 8-Lead MSOP, Dual Board Configuration*

### Noninverting Configuration

Place 0 Ω resistors on R1, R2, R3, and R4 to connect the input to the noninverting input of the amplifier. Set the gain with R9 and R10 for $R_F$ and R17 and R18 for $R_G$ and place a 0 Ω resistor on C5 and C6 to connect $R_G$ to ground.

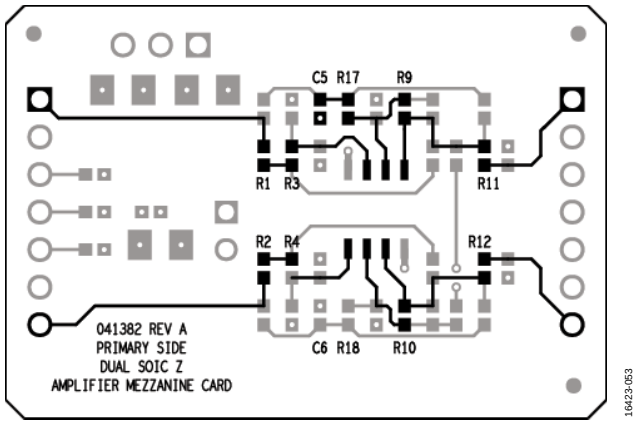


*Figure 36. Noninverting Amplifier for 8-Lead SOIC, Dual Board Configuration*

## FULLY DIFFERENTIAL AMPLIFIER

The AMC for fully differential amplifiers supports 16-lead LFCSP packages. Two basic configurations are shown in Figure 37 and Figure 38. For additional configurations, refer to the schematic in Figure 49.

## DIFFERENTIAL INPUT CONFIGURATION

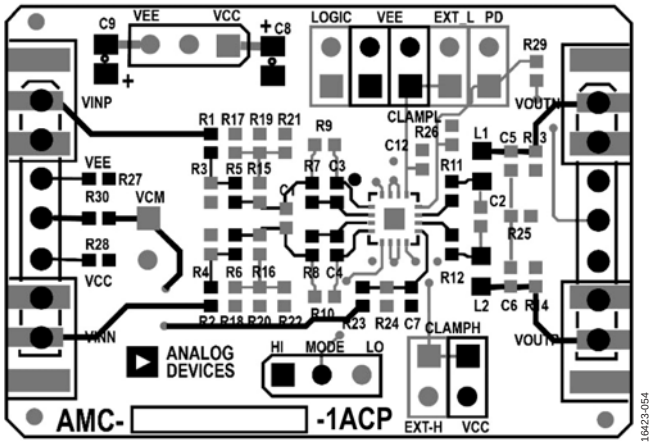


*Figure 37. Standard Differential Input Configuration*

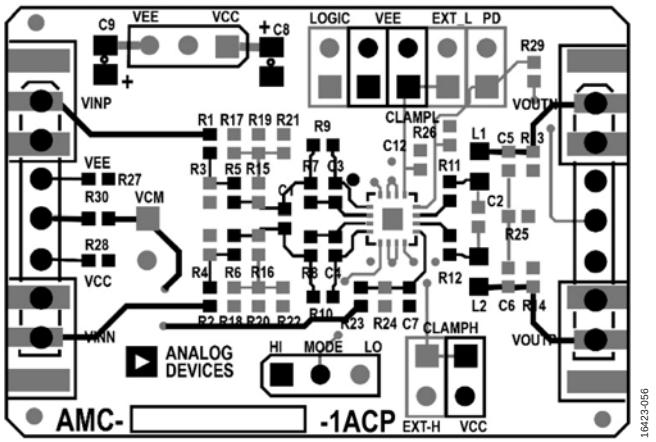


*Figure 38. Multiple Feedback, Low Pass Filter Configuration*

Install 0 Ω resistors on R1, R2, R5, R6, R11, R12, L1, and L2. Install 0 Ω resistors on R27, R28, R30, and R23. Install a 0.1 µF capacitor on C7. Install supply bypass capacitors on C8 and C9. C3 and C4 are the feedback resistors. R7 and R8 are the gain resistors. Install jumpers on the second and third positions on the MODE jumper and CLAMPH jumper (see Figure 37).

## MULTIPLE FEEDBACK LPF CONFIGURATION

Fully differential amplifier based, multiple feedback, low-pass filters (LPFs) can be designed using an op-amp based, multiple feedback filter configuration, as shown in Figure 39.

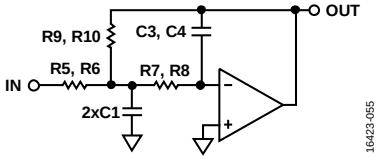


*Figure 39. Multiple Feedback, Low Pass Filter*

Install 0 Ω resistors on R1, R4, R11, R12, L1, L2, R27, R28, R30, and R23. Install a 0.1 µF capacitor on C7. Install jumpers on the second and third positions on the MODE jumper and CLAMPH jumper (see Figure 38).

# SCHEMATIC, ASSEMBLY DRAWINGS, AND BOARD LAYOUT

## 8-LEAD SOIC SINGLE AMC SCHEMATIC

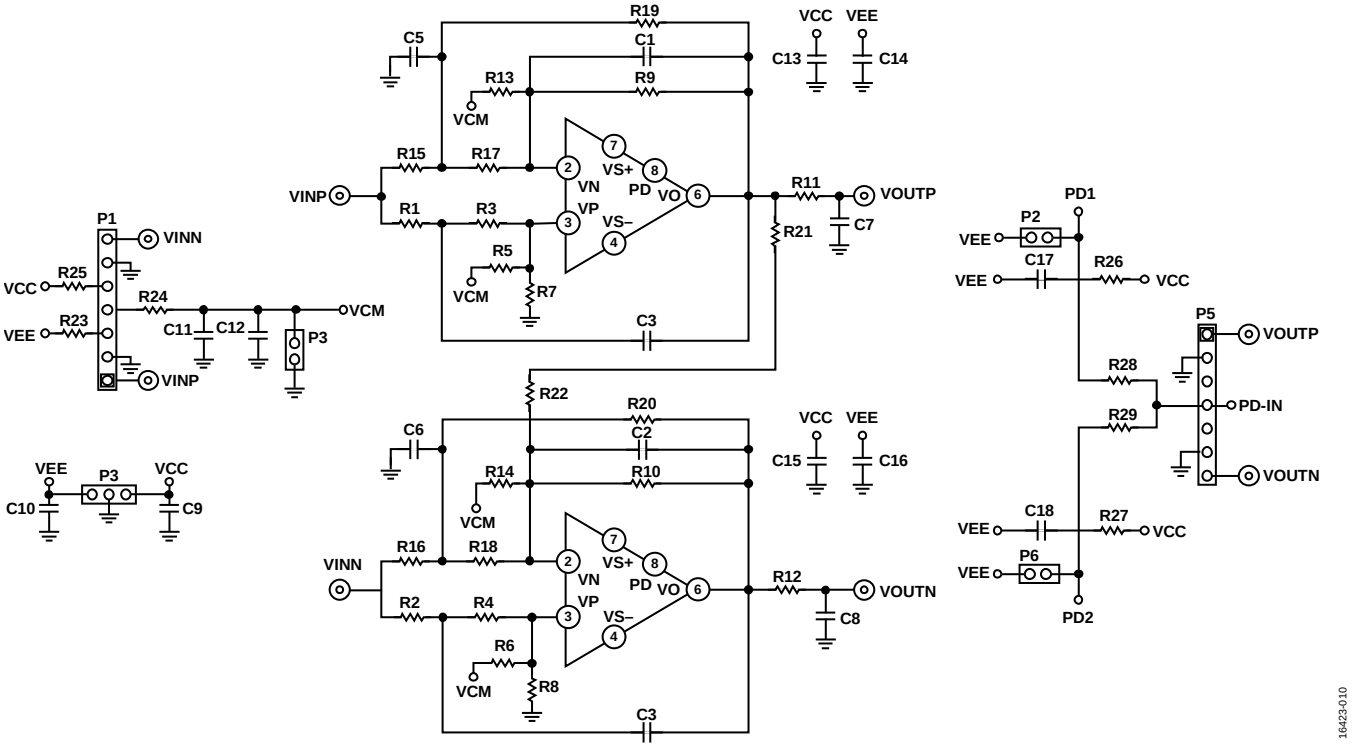


*Figure 40. 8-Lead SOIC, Single AMC Schematic*

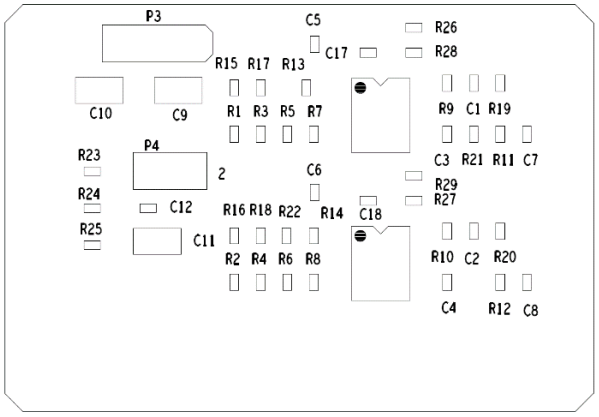


*Figure 41. 8-Lead SOIC, Single AMC Assembly Drawing, Primary Side*

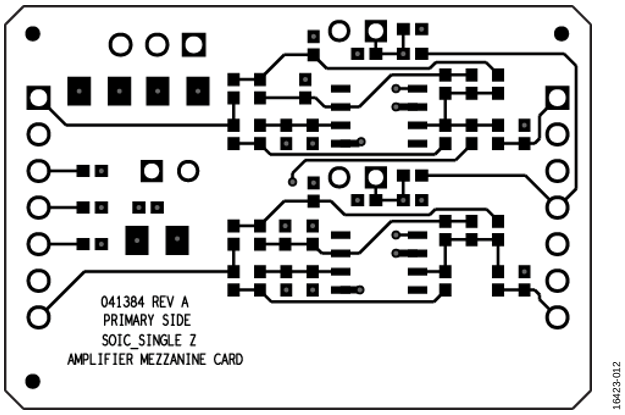


*Figure 42. 8-Lead SOIC, Single AMC Layout Pattern, Primary Side*

## 6-LEAD SOT23 SINGLE AMC SCHEMATIC

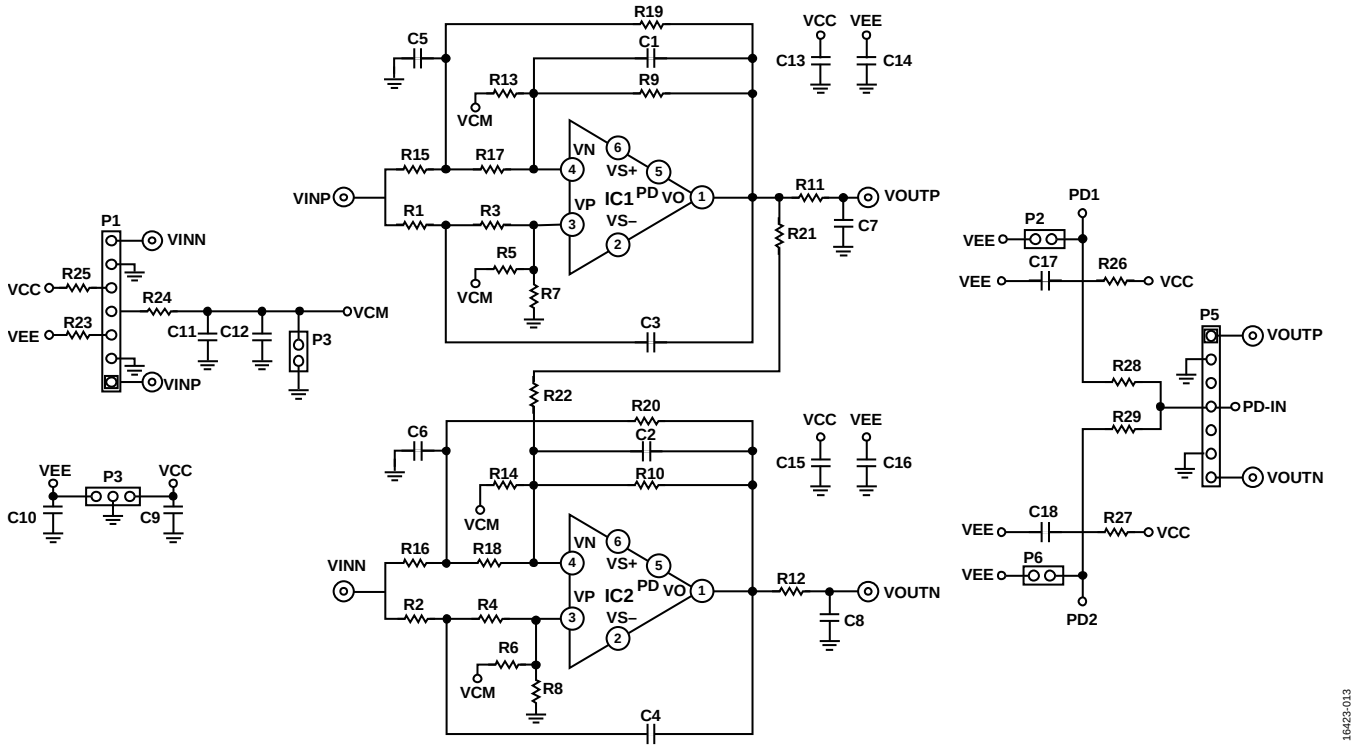


*Figure 43. 6-Lead SOT23, Single AMC Schematic*

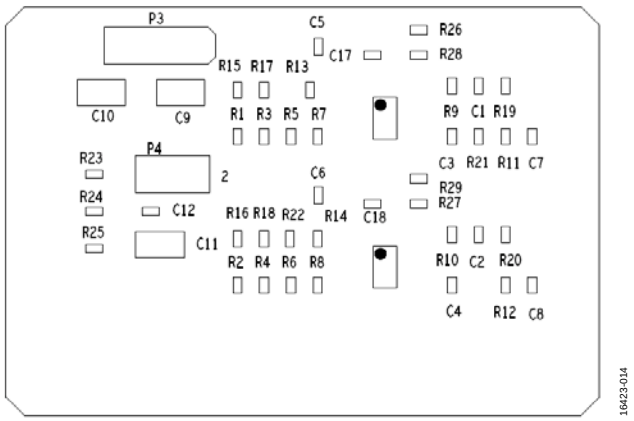


*Figure 44. 6-Lead SOT23, Single AMC Assembly Drawing, Primary Side*

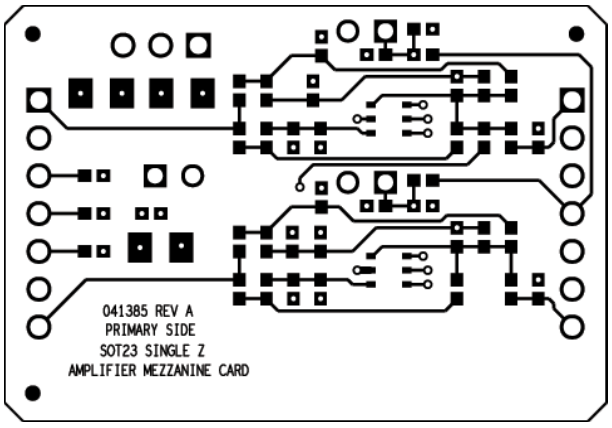


*Figure 45. 6-Lead SOT23, Single AMC Layout Pattern, Primary Side*

## 8-LEAD MSOP AND SOIC DUAL AMC SCHEMATIC

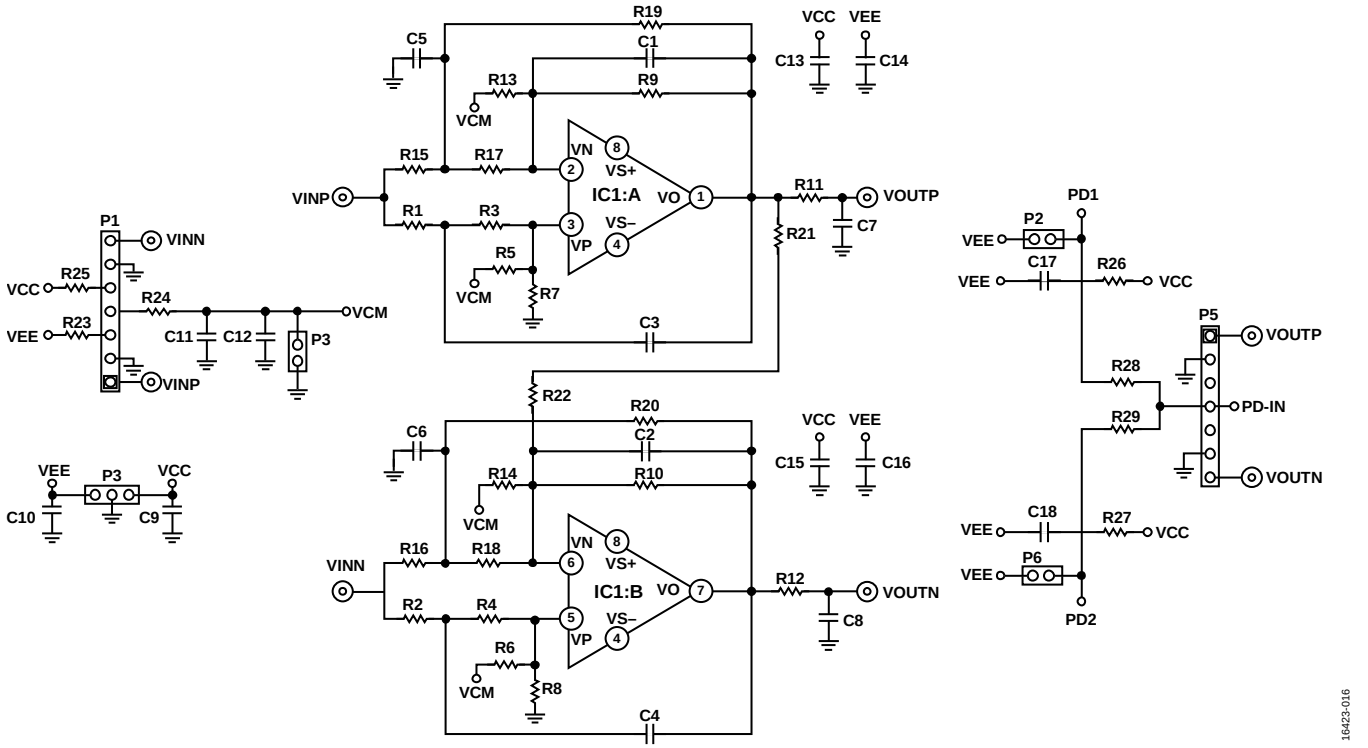


*Figure 46. 8-Lead MSOP and SOIC, Dual AMC Schematic*

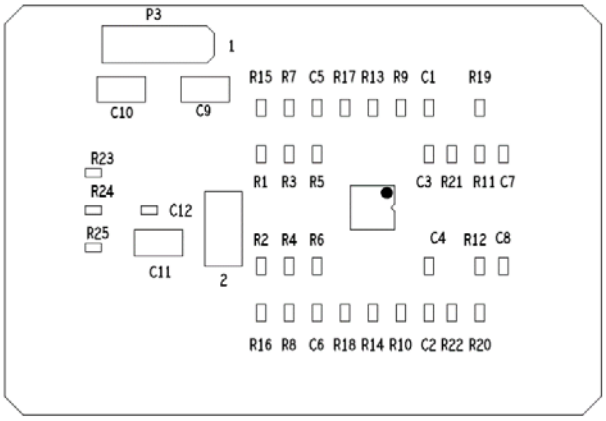


*Figure 47. 8-Lead MSOP, Dual AMC Assembly Drawing, Primary Side*

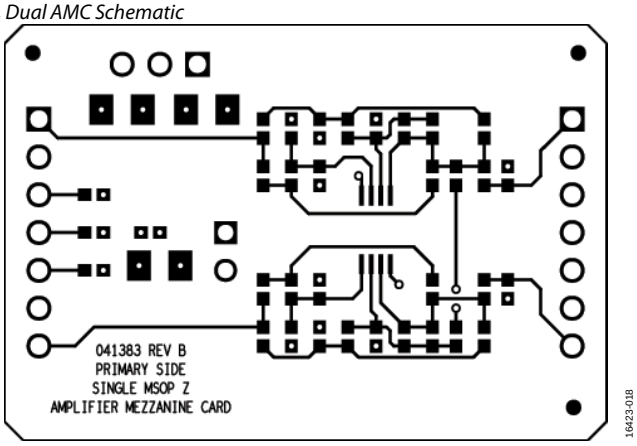


*Figure 48. 8-Lead MSOP, Dual AMC Layout Pattern, Primary Side*

## 16-LEAD LFCSP FULLY DIFFERENTIAL AMC SCHEMATIC

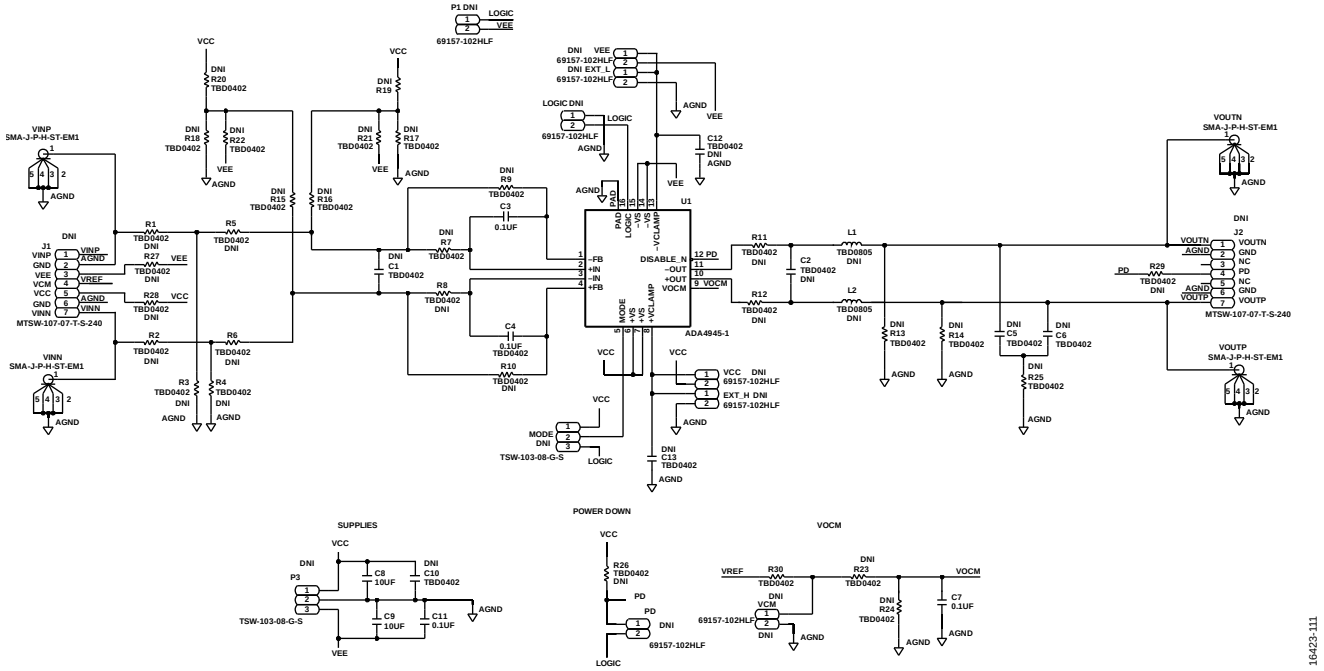


*Figure 49. 16-Lead LFCSP, Single AMC Schematic*

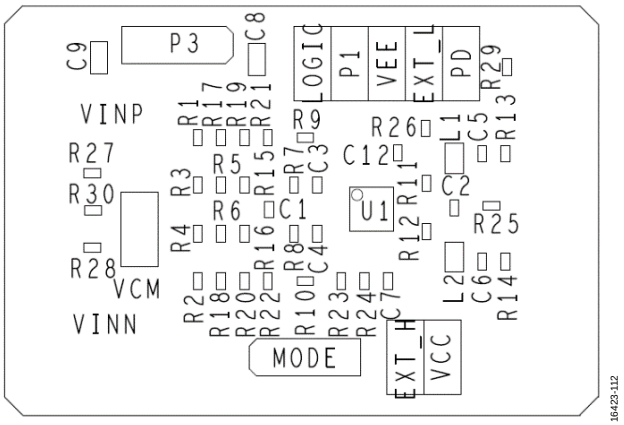


*Figure 50. 16-Lead LFCSP, Single AMC Assembly Drawing, Primary Side*

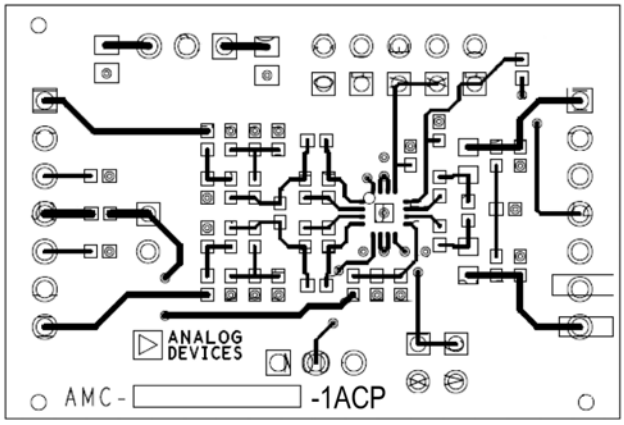


*Figure 51. 16-Lead LFCSP, Single AMC Layout Pattern, Primary Side*

# NOTES

**ESD Caution**

**ESD (electrostatic discharge) sensitive device**. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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