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ANALOG DEVICES

AN-763 APPLICATION NOTE

Dual Universal Precision Op Amp Evaluation Board

INTRODUCTION

The EVAL-PRAOPAMP-2RZ, EVAL-PRAOPAMP-2RMZ, and EVAL-PRAOPAMP-2CPZ are universal precision evaluation boards that accommodate dual op amps in 8-pin SOIC, MSOP, and LFCSP packages, respectively. For the exposed pad connection for the LFCSP package, see the appropriate product data sheet.

These PRAOPAMP evaluation boards provide multiple choices and extensive flexibility for different application circuits and configurations.

These boards are not intended to be used with high frequency components or high speed amplifiers. However, they provide the user with many combinations for various circuit types, including active filters, instrumentation amplifiers, composite amplifiers, and external frequency compensation circuits. Several examples of application circuits are provided in this application note.

TWO STAGE BAND-PASS FILTER

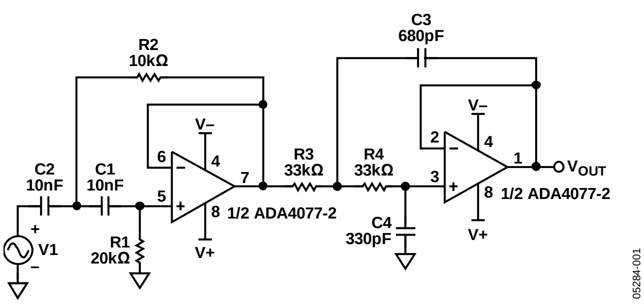

Figure 1. KRC Filter

The low offset voltage and high CMRR makes the ADA4077-2 a great choice for precision filters, such as the KRC filter shown in Figure 1.

This particular filter implementation offers the flexibility to tune the gain and the cut-off frequency independently.

Since the common-mode voltage into the amplifier varies with the input signal in the KRC filter circuit, a high CMRR amplifier, such as the ADA4077-2, is required to minimize distortion. Furthermore, the low offset voltage of the ADA4077-2 allows a wider dynamic range when the circuit gain is chosen to be high.

The circuit shown in Figure 1 consists of two stages. The first stage is a simple high-pass filter with a corner frequency, f_C, of

$$\frac{1}{2\pi\sqrt{C1C2R1R2}} \qquad (1)$$

and

$$Q = K\sqrt{\frac{R1}{R2}} \qquad (2)$$

where K is the dc gain.

Choosing equal capacitor values minimizes the sensitivity and simplifies the expression for f_C to

$$\frac{1}{2\pi C\sqrt{R1R2}} \qquad (3)$$

The value of Q determines the peaking of the gain vs. frequency (generally ringing in the time domain). Commonly chosen values for Q are near unity.

Setting Q = 1/√2 yields minimum gain peaking and minimum ringing. Use Equation 3 to determine the values for R1 and R2. For example, set Q = 1/√2 and R1/R2 = 2 in the circuit example, and pick R1 = 5 kΩ and R2 = 10 kΩ for simplicity. The second stage is a low-pass filter whose corner frequency can be determined in a similar fashion.

$$R3 = R4 = R$$

$$f_C = \frac{1}{2\pi \times R\sqrt{C3C4}}$$

and

$$Q = 1/2\sqrt{\frac{C3}{C4}}$$

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REVISION HISTORY

10/13—Rev. B to Rev. C

Updated Format .... Universal
Replaced All Figures 1
Changed EVAL-PRAOPAMP-2R/2RU/2RM to EVAL-PRAOPAMP-2RZ, EVAL-PRAOPAMP-2RMZ, and EVAL-PRAOPAMP-2CPZ Throughout 1
Deleted Authors Names and added Introduction Section Heading 1
Changes to Two Stage Band-Pass Filter Section 1
Changes to Half Wave, Full Wave Rectifier Section 3
Changes to High Gain Composite Amplifier Sections 3

HALF WAVE, FULL WAVE RECTIFIER

Rectifying circuits are used in a multitude of applications. One of the most popular uses is in the design of regulated power supplies where a rectifier circuit is used to convert an input sinusoid to a unipolar output voltage. There are some potential problems for amplifiers used in this manner.

When the input voltage V_{IN} is negative, the output is zero. When the magnitude of V_{IN} is doubled at the input of the op amp, this voltage could exceed the power supply voltage which would damage the amplifiers permanently. The op amp must come out of saturation when V_{IN} is negative. This delays the output signal because the amplifier needs time to enter its linear region.

The ADA4610-2 has a very fast overdrive recovery time, which makes it a great choice for rectification of transient signals. The symmetry of the positive and negative recovery time is also very important in keeping the output signal undistorted.

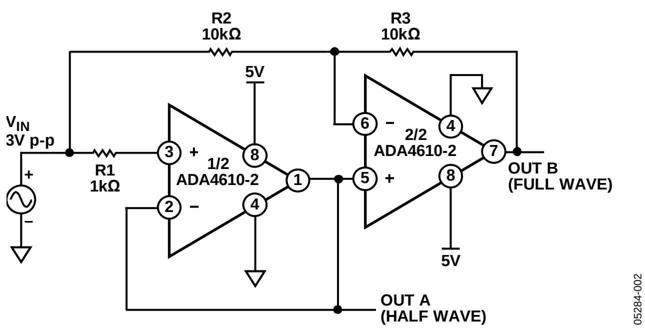

Figure 2. Half Wave and Full Wave Rectifier

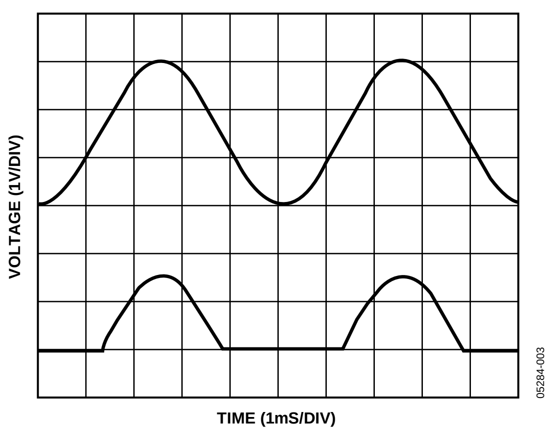

Figure 3. Half Wave Rectifier Signal (Output A)

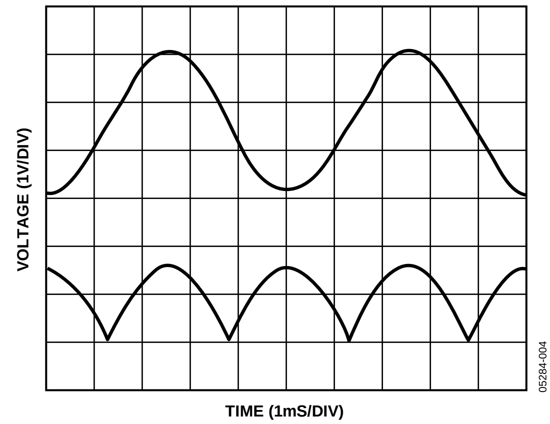

Figure 4. Full Wave Rectifier Signal (Output B)

Figure 2 is a typical representation of a rectifier circuit. The first stage of the circuit is a half wave rectifier. When the sine wave applied at the input is positive, the output follows the input response. During the negative cycle of the input, the output tries to swing negative to follow the input, but the power supplies restrains it to zero. Similarly, the second stage is a follower during the positive cycle of the sine wave and an inverter during the negative cycle. Figure 3 and Figure 4 represents the signal response of the circuit at Output A and Output B, respectively.

HIGH GAIN COMPOSITE AMPLIFIER

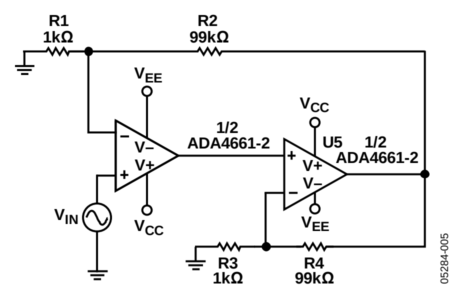

Figure 5. High Gain Composite Amplifier

A composite amplifier can provide a very high gain in applications where high closed-loop dc gain is needed. The high gain achieved by the composite amplifier comes at the expense of a loss in phase margin.

Placing a small capacitor, C_F, in the feedback loop and in parallel with R2 improves the phase margin. For the circuit of Figure 5, picking a C_F = 50 pF yields a phase margin of about 45°.

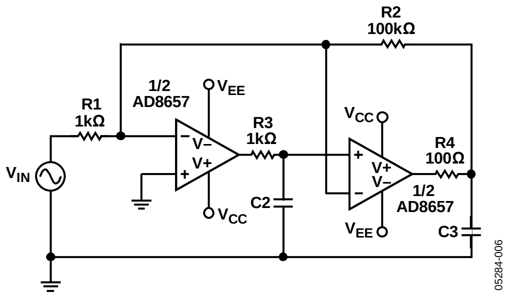

Figure 6. Low Power Composite Amplifier

A composite amplifier can be used to optimize the dc and ac characteristics. Figure 6 shows an example using the AD8657, which offers many circuit advantages. The bandwidth is increased substantially and the input offset voltage and noise of the AD8657 becomes insignificant because they are divided by the high gain of the amplifier. The circuit offers a high bandwidth, a high output current, and a very low power consumption of less than 100 μA.

EXTERNAL COMPENSATION TECHNIQUES

Series Resistor Compensation

The use of external compensation networks may be required to optimize certain applications. Figure 7 shows a typical representation of a series resistor compensation to stabilize an op amp driving capacitive loads. The stabilizing effect of the series resistor can be thought of as a means to isolate the op amp output and the feedback network from the capacitive load. The required amount of series resistance depends on the part used, but values of 5 Ω to 50 Ω are usually sufficient to prevent local resonance. The disadvantage of this technique is a reduction in gain accuracy and extra distortion when driving nonlinear loads.

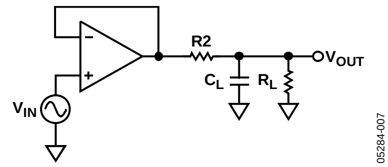

Figure 7. Series Resistor Compensation

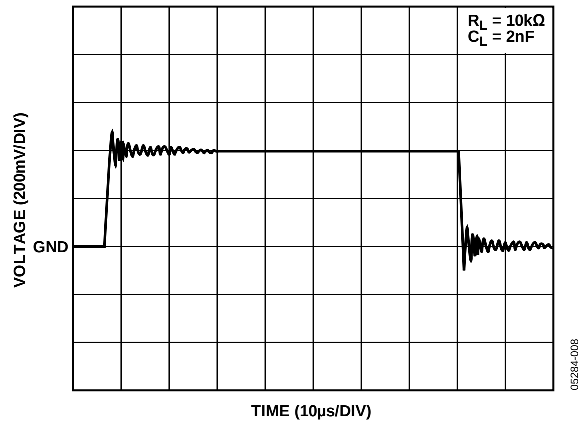

Figure 8. Capacitor Load Drive Without Resistor

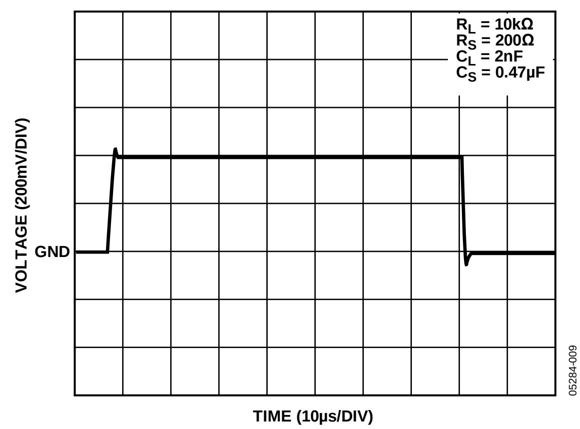

Figure 9. Capacitor Load Drive with Resistor

SNUBBER NETWORK

Another way to stabilize an op amp driving a capacitive load is through the use of a snubber as shown in Figure 10.

This method has the significant advantage of not reducing the output swing because there is no isolation resistor in the signal path. Also, the use of the snubber does not degrade the gain accuracy or cause extra distortion when driving a nonlinear load. The exact R_S and C_S combination can be determined experimentally.

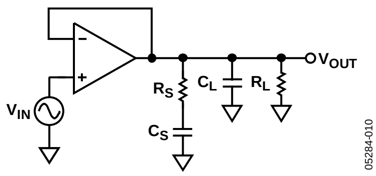

Figure 10. Snubber Network

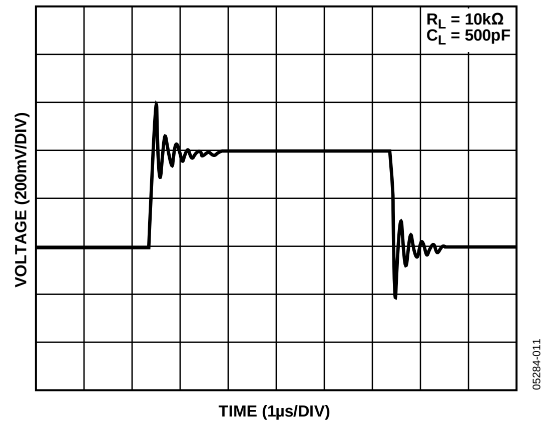

Figure 11. Capacitor Load Drive Without Snubber

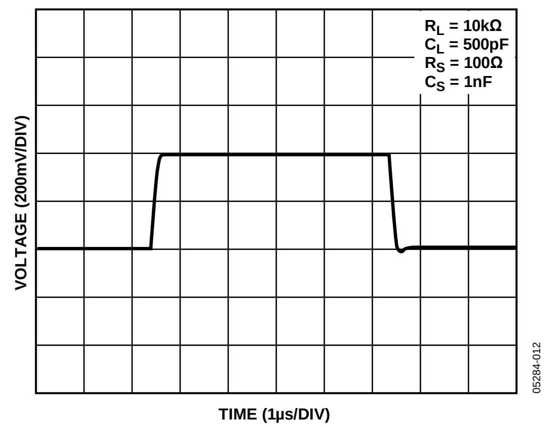

Figure 12. Capacitor Load Drive with Snubber

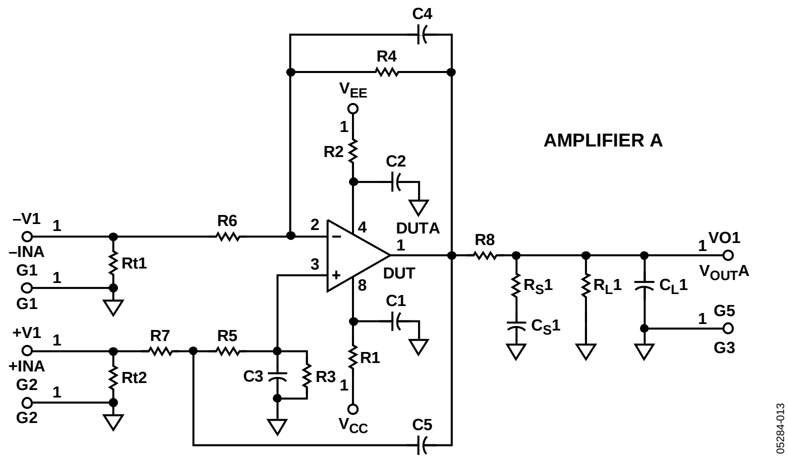

Figure 13. Dual Universal Precision Op Amp Evaluation Board Electrical Schematic

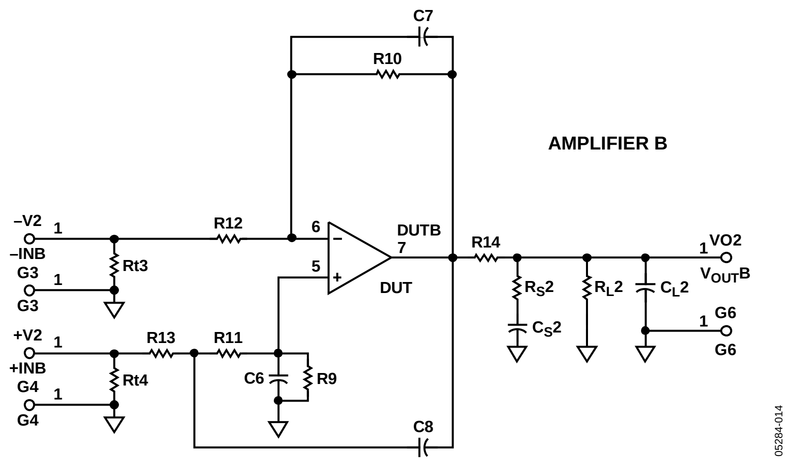

Figure 14. Dual Universal Precision Op Amp Evaluation Board

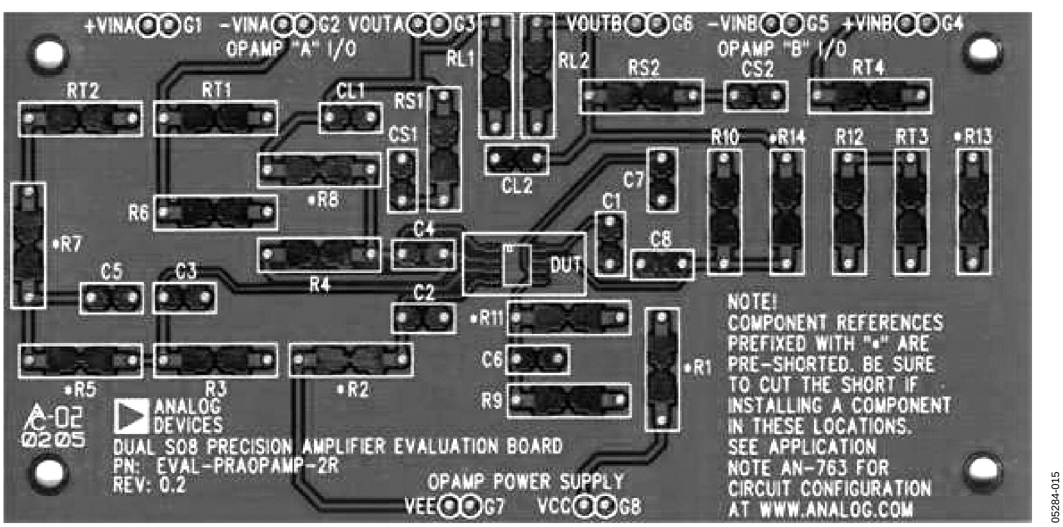

Figure 15. Dual SOIC Layout Patterns

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