Dual Universal Precision Op Amp Evaluation Board

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The EVAL-PRAOPAMP-2R/2RU/2RM is an evaluation board that accommodates dual op amps in SOIC, TSSOP, and MSOP packages. It provides the user with multiple choices and extensive flexibility for different application circuits and configurations.

This board is not intended to be used with high frequency components or high speed amplifiers. However, it provides 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 given in this application note.
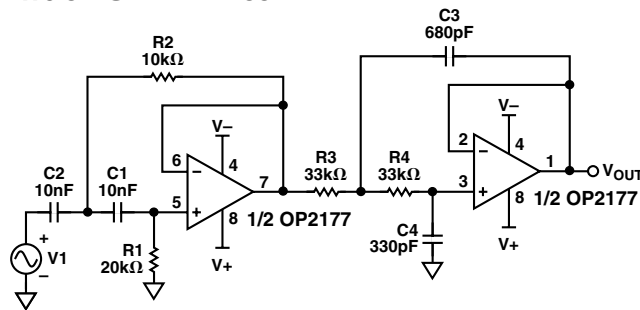
TWO STAGE BAND-PASS FILTER

Figure 1. KRC Filter

The low offset voltage and high CMRR makes the OP2177 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 OP2177 is required to minimize distortion. Furthermore, the low offset voltage of the OP2177 allows a wider dynamic range when the circuit gain is chosen to be high.

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

$$\frac{1}{2\pi\sqrt{C1C2R1R2}} \tag{1}$$

and whose

$$Q = K\sqrt{\frac{R1}{R2}} \tag{2}$$

K = is the dc gain.

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

$$\frac{1}{2\pi C\sqrt{R1R2}} \tag{3}$$

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

Setting $Q = 1/\sqrt{2}$ yields minimum gain peaking and minimum ringing. Use Equation 3 to determine the values for R1 and R2. For example, set $Q = 1/\sqrt{2}$, 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

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

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 AD8510/AD8512/AD8513 have very fast overdrive recovery time, which makes them 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.
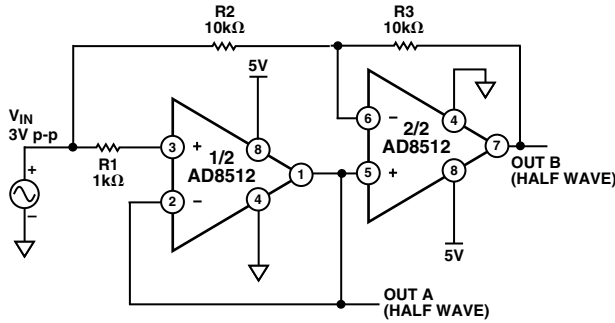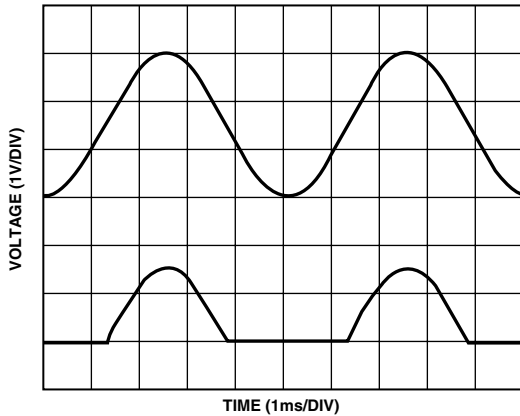
Figure 2a. Half-Wave and Full-Wave Rectifier

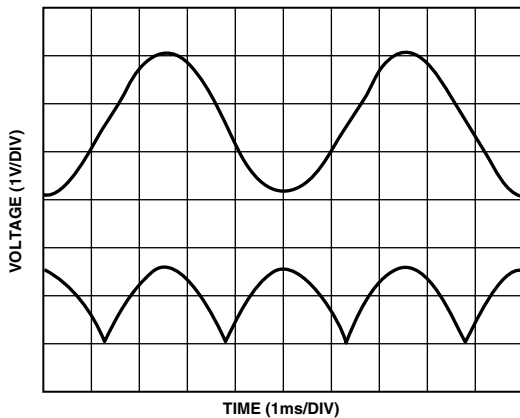
Figure 2b. Half-Wave Rectifier Signal (Output A)

Figure 2c. Full-Wave Rectifier Signal (Output B)

Figure 2a 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 2b and Figure 2c represents the signal response of the circuit at Output A and Output B, respectively.
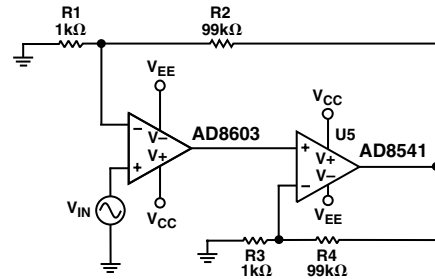
HIGH GAIN COMPOSITE AMPLIFIER

Figure 3. 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 3, picking a $C_F = 50$ pF will yield a phase margin of about $45°$.
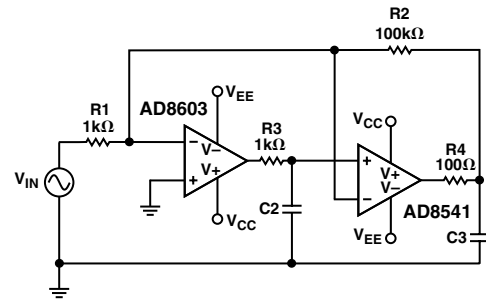

Figure 4. Low Power Composite Amplifier

A composite amplifier can be used to optimize the dc and ac characteristic. Figure 4 shows an example using the AD8603 and the AD8541 that offers too many circuit advantages. The bandwidth is increased substantially and the input offset voltage and noise of the AD8541 becomes insignificant since they are divided by the high gain of the AD8603. 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 5a is 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 $5\,\Omega$ to $50\,\Omega$ 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.
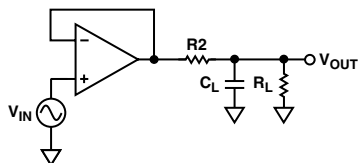
Figure 5a. Series Resistor Compensation
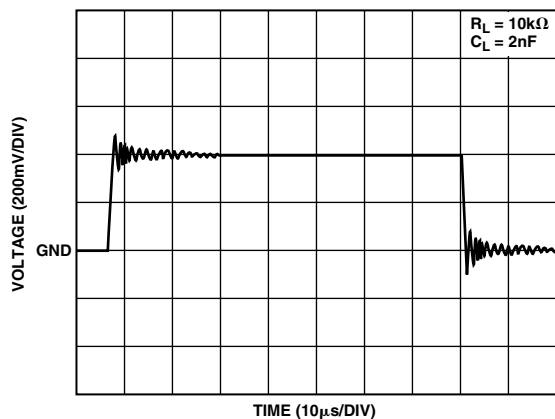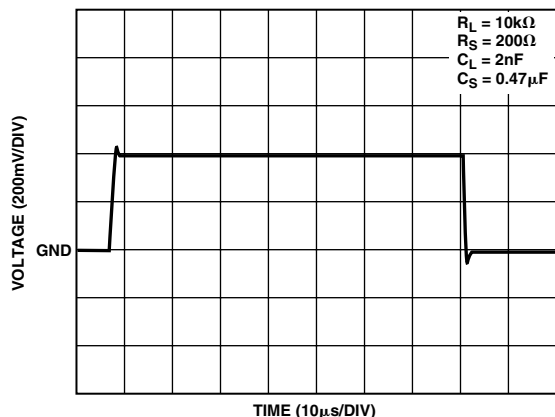
Figure 5b. Cap Load Drive Without Resistor

Figure 5c. Cap Load Drive with Resistor

Snubber Network
Another way to stabilize an op amp driving a capacitive load is the use of a snubber, as shown in Figure 6a. 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.
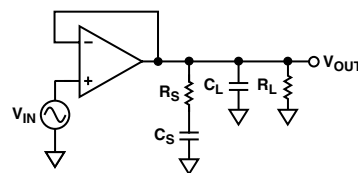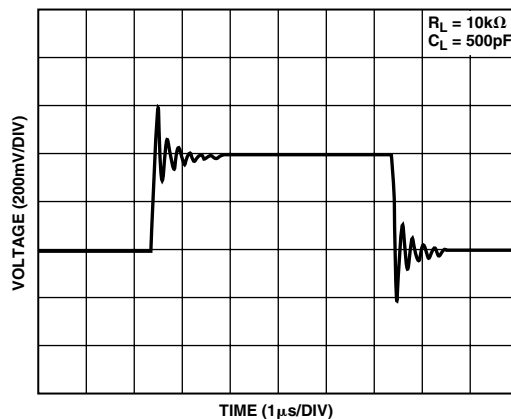
Figure 6a. Snubber Network

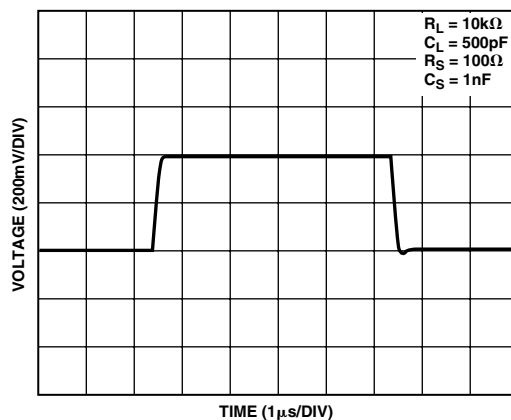Figure 6b. Cap Load Drive Without Snubber

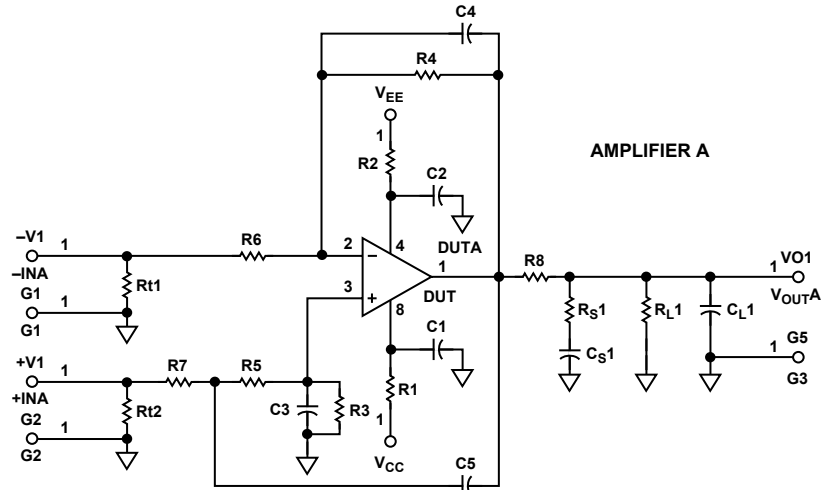Figure 6c. Cap Load Drive with Snubber

Figure 7. Dual Universal Precision Op Amp Evaluation Board Electrical Schematic
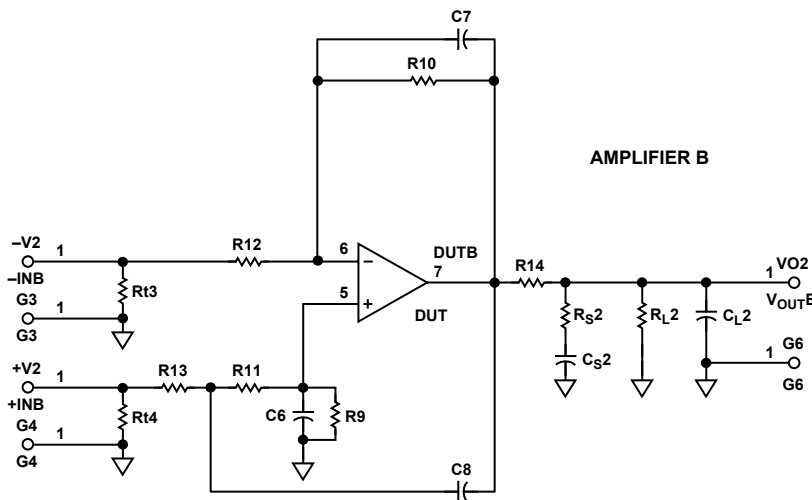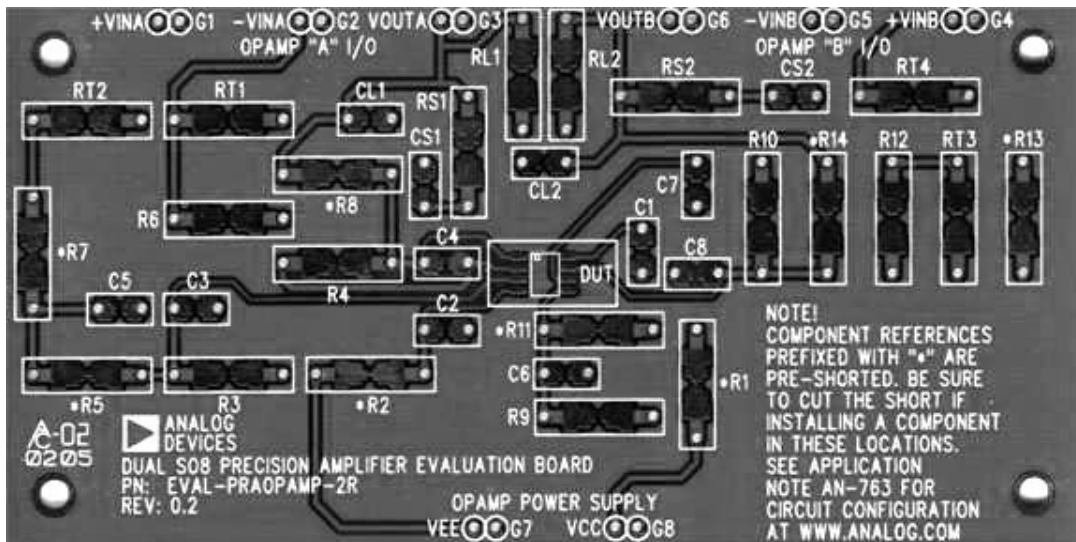

Figure 8. Dual Universal Precision Op Amp Evaluation Board

Figure 9. Layout Patterns