

The CLC730013, CLC730027, and CLC730077 evaluation boards are designed to aid in the characterization of National Semiconductor's 8-pin, monolithic amplifiers.

- CLC730013 - DIP packages  
Uses all through-hole components
- CLC730027 - SOIC packages  
Uses all through-hole components with a surface-mount amplifier
- CLC730077 - MSOP packages  
Uses all surface-mount components with an MSOP amplifier

Both boards have identical circuit configurations and are designed for non-inverting gains. Inverting gains or other circuit configurations can be obtained with slight modifications to the boards. Use the evaluation boards as a:

- Guide for high frequency layout
- Tool to aid in device testing and characterization

The evaluation boards accommodate general purpose amplifiers, as well as amplifiers with the following features:

- Supply current adjustment
- Output disable
- Output clamps
- Input offset voltage nulling

The evaluation board schematic is shown. And for each amplifier that uses these evaluation boards, a table is given that includes recommended values and components that are not needed to evaluate that amplifier. Refer to the product data sheet for amplifiers that use these evaluation boards and are not listed in this document.

### Basic Operation

Figure 1 shows the non-inverting schematic for both boards. The input signal is brought into the board through SMA connectors to the non-inverting input of the amplifier. The resistor  $R_{in}$  is used to set the input termination resistance to the op amp. The non-inverting gain is set by the following equation:

$$\text{Non-inverting Gain: } 1 + \frac{R_f}{R_g}$$

The value of the feedback resistor,  $R_f$ , has a strong influence on AC performance. Refer to the product data sheet for feedback resistor selection. The output of the op amp travels through a series resistance,  $R_{out}$ , and then leaves the board through an SMA connector. The series resistance,  $R_{out}$ , matches transmission lines or isolates the output from capacitive loads.

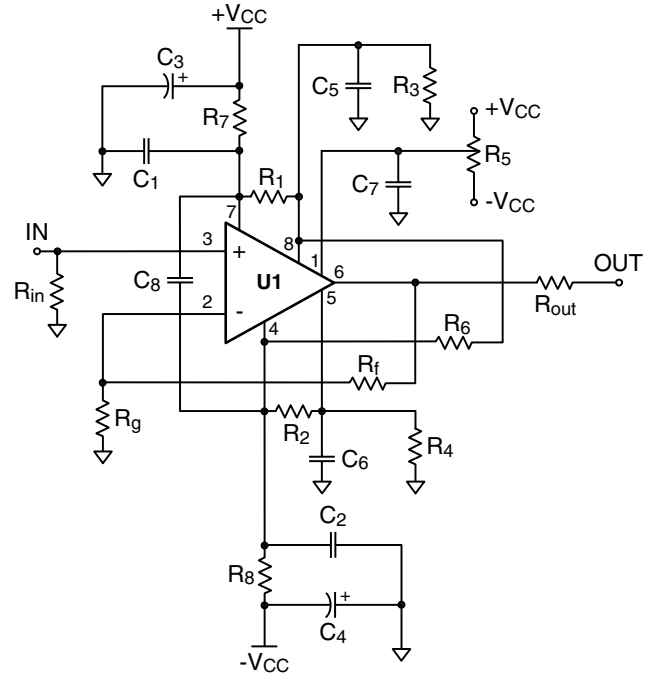


Figure 1: Non-inverting Gain Configurations

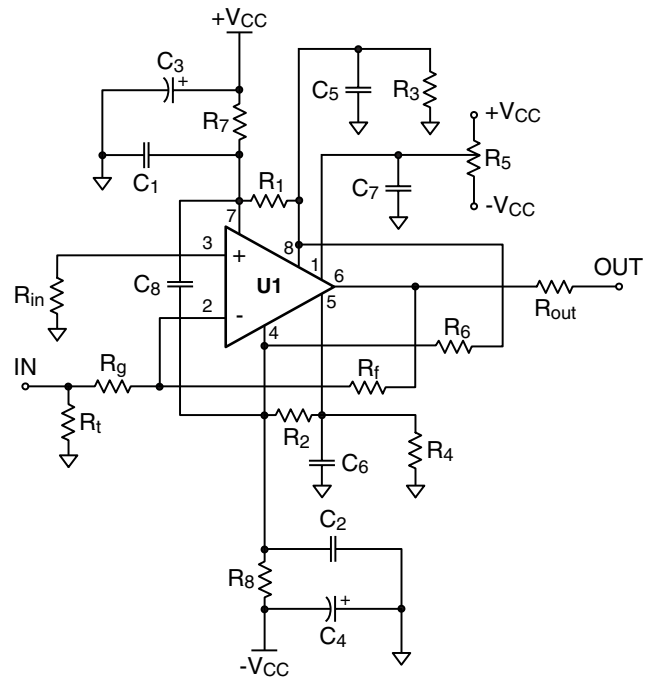
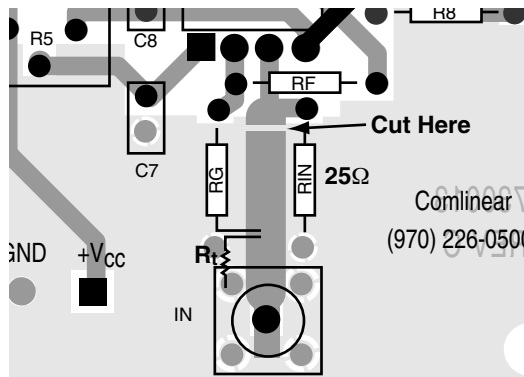


Figure 2: Inverting Gain Configurations

## Inverting Gain Operation

The evaluation boards can be modified to provide an inverting gain configuration. Figure 2 illustrates the inverting gain configuration. Complete these steps to modify the board:

1. Cut the input trace as shown in Figure 3
2. Use  $25\Omega$  for  $R_{in}$
3. Terminate  $R_g$  at the input trace instead of ground (See Figure 3)
4. Add  $R_t$  for desired input impedance (input impedance =  $R_g || R_t$ )



**Figure 3: Modifications for Inverting Gains (CLC730013 board shown)**

## Layout Considerations

General layout and supply bypassing play major roles in high frequency performance. When designing your own board, use the evaluation board as a guide and follow these steps as a basis for high frequency layout:

1. Use a ground plane.
2. Include  $6.8\mu\text{F}$  tantalum and  $0.1\mu\text{F}$  ceramic capacitors on both supplies.
3. Place the  $6.8\mu\text{F}$  capacitors within 0.75 inches of the power pins.
4. Place the  $0.1\mu\text{F}$  capacitors less than 0.1 inches from the power pins.
5. Remove the ground plane under and around the part, especially near the input and output pins to reduce parasitic capacitance.

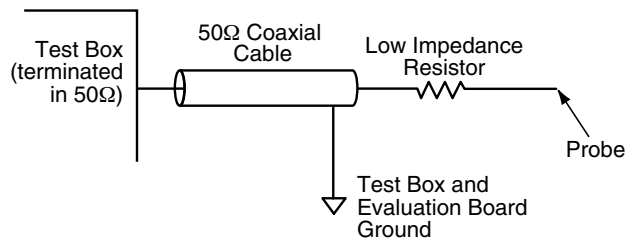
6. Minimize all trace lengths to reduce series inductances.
7. Use individual flush-mount sockets, for prototyping.

## Measurement Hints

If  $50\Omega$  coax and  $50\Omega$   $R_{in}/R_{out}$  resistors are used, many of the typical performance plots found in the product data sheets can be reproduced.

When SMA connectors and cables are not available to evaluate the amplifier, do not use normal oscilloscope probes. Use low impedance resistive divider probes of 100 to  $500\Omega$ . If a low impedance probe is not available, then a section of  $50\Omega$  coaxial cable and a low impedance resistor ( $10\Omega$  to  $50\Omega$ ) may be used. Follow these 3 steps to create a “cable/resistor” probe:

1. Connect one end of the coax's center to a test measurement box terminated in  $50\Omega$ .
2. Connect the other end of the cable's center conductor to the low impedance resistor. (The open side of the resistor is now a probe.)
3. Connect the ground shield of the cable to evaluation board ground and test box ground.



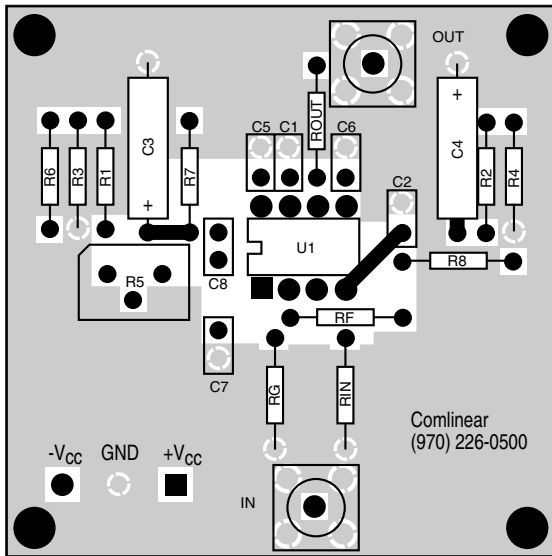
**Figure 4: “Cable/Resistor” Probe Configuration**

This “cable/resistor” probe, shown in Figure 4, forms a voltage attenuator between the resistor and the  $50\Omega$  termination resistance of the test box. This method allows measurements to be performed directly on the output pin of the amplifier.

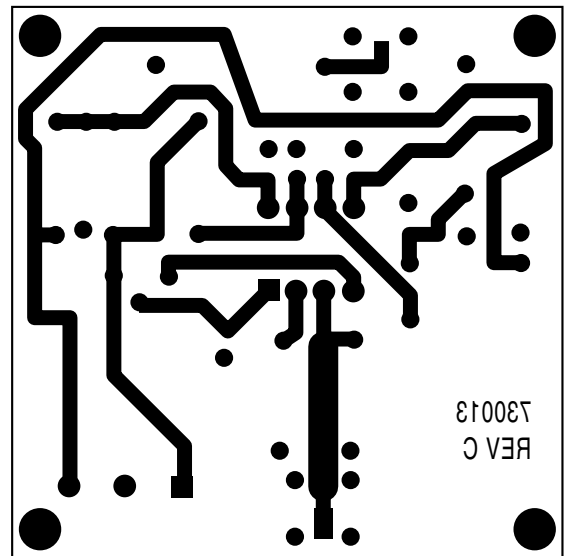
## Power Supplies

Refer to the product data sheet for the recommended supply voltages.

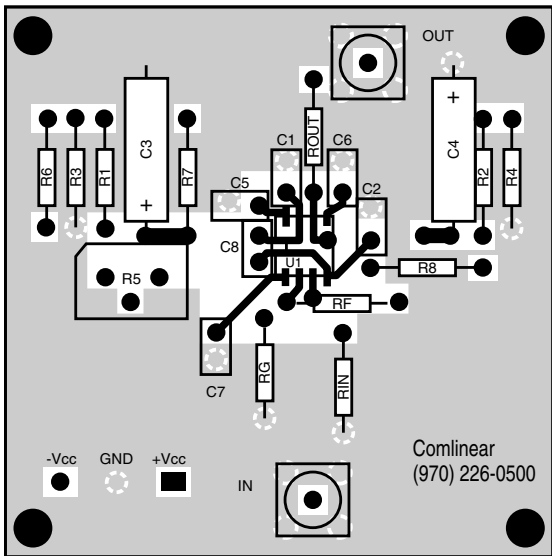
DIP – Top Side



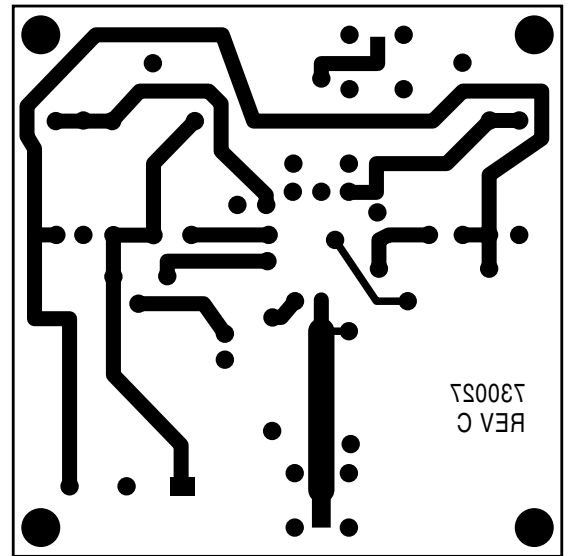
DIP – Bottom Side



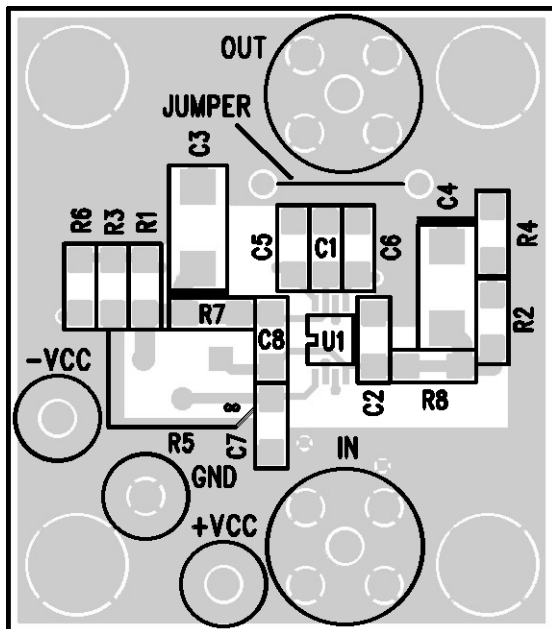
SOIC – Top Side



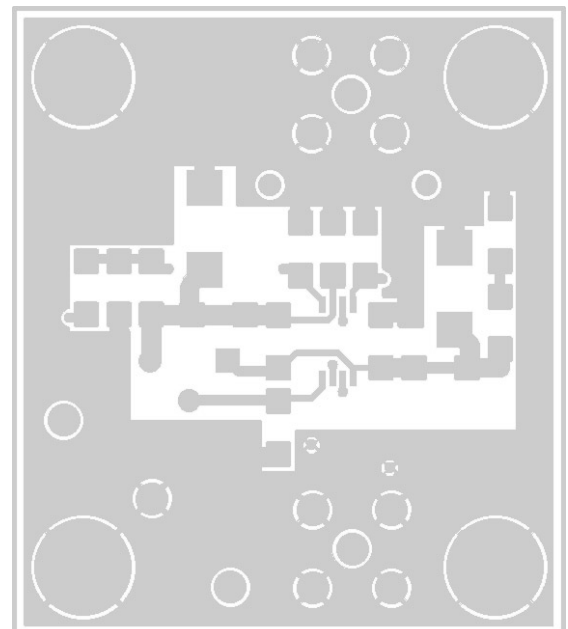
SOIC – Bottom Side



MSOP – Top Side



MSOP – Bottom Side



Refer to the product data sheet for amplifiers that use the CLC730013 and CLC730027 evaluation boards and are not listed below.

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### Common Components for all amplifiers:

- $R_f$ ,  $R_g$  - Use the product data sheet to select values
  - $R_{in}$ ,  $R_{out}$  - 50 $\Omega$  (Refer to **Basic Operation** section for details)
  - $R_t$  - Optional resistor for inverting gain configurations (Refer to **Inverting Gain Operation** section for details)
  - C1, C2 - 0.1 $\mu$ F ceramic capacitors
  - C3, C4 - 6.8 $\mu$ F tantalum capacitors
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**CLC400** wideband current feedback op amp optimized for low gains

#### Component Values:

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see **Common Components for all amplifiers** above for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** above for details)
- R5 - 20k $\Omega$  pot (optional input offset null)
- C7 - 0.01 $\mu$ F ceramic capacitor (should be used for best fine scale settling even if R5 is not used)

#### Components not used:

- C5, C6, C8
- R1, R2, R3, R4, R6, R7, R8

**CLC401** wideband current feedback op amp optimized for high gains

#### Component Values:

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see **Common Components for all amplifiers** above for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** above for details)

#### Components not used:

- C5, C6, C7, C8
- R1 thru R8

**CLC402** wideband current feedback op amp optimized for low gains, offering extremely fast settling to 0.0025% accuracy

#### Component Values:

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see **Common Components for all amplifiers** above for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** above for details)
- R7, R8 - 10 $\Omega$  (optional series supply resistors)  
**Note:** Cut the component side supply traces that short R7 and R8 to use these resistors.

#### Components not used:

- C5, C6, C7, C8
- R1 thru R6

**CLC404** wideband current feedback op amp optimized for intermediate gain and broad full power bandwidth

#### Component Values:

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see **Common Components for all amplifiers** above for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** above for details)

#### Components not used:

- C5, C6, C7, C8
- R1 thru R8

**CLC405** wideband, low power, current feedback op amp, offering low input bias current and a disable feature

#### Component Values:

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see **Common Components for all amplifiers** above for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** above for details)
- R6 - 0 $\Omega$  to 1k $\Omega$  open collector disable control  
**Note:** Cut trace connecting R6 to  $-V_{CC}$ . Connect R6 to disable logic.

#### Components not used:

- C5, C6, C7, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC406** intermediate performance, low power op amp optimized for midrange gains ( $\pm 1$  to  $\pm 10$ )

#### Component Values:

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see **Common Components for all amplifiers** above for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** above for details)

#### Components not used:

- C5, C6, C7, C8
- R1 thru R8

**CLC407** wideband, low power, programmable gain buffer, offering low input bias current and a disable feature

**Component Values:**

- $R_f, R_g$  - Internal resistors (refer to data sheet for gain selection, +2, +1, -1V/V)
- $R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R6 - 0 $\Omega$  to 1k $\Omega$  open collector disable control  
**Note:** Cut trace connecting R6 to  $-V_{CC}$ . Connect R6 to disable logic.  
**Note:** To optimize off-isolation, cut the  $R_f$  trace. Refer to data sheet for details.

**Components not used:**

- C5, C6, C7, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC409** very wideband current feedback op amp optimized for low gains, offering exceptionally low harmonic distortion

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C8 - 0.01 $\mu$ F ceramic capacitor (optional supply-to-supply de-coupling for reduced distortion)

**Components not used:**

- C5, C6, C7
- R1 thru R8

**CLC410** wideband op amp optimized for low gains (similar to the CLC400) with output disable capability

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R5 - 20k $\Omega$  pot (optional input offset null)
- C7 - 0.01 $\mu$ F ceramic capacitor (should be used for best fine scale settling even if R5 is not used)
- R6 - 0 $\Omega$  to 1k $\Omega$  open collector disable control  
**Note:** Cut trace connecting R6 to  $-V_{CC}$ . Connect R6 to disable logic.

**Components not used:**

- C5, C6, C8
- R1, R2, R3, R4, R7, R8

**CLC411** wideband current feedback op amp optimized for low gains, using  $\pm 15$ V power supplies

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C6, C7 - 0.01 $\mu$ F ceramic capacitors (used to reduce high frequency noise, >10MHz)
- R6 - 0 $\Omega$  to 1k $\Omega$  open collector disable control  
**Note:** Cut trace connecting R6 to  $-V_{CC}$ . Connect R6 to disable logic.

**Components not used:**

- C5, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC420** wideband unity gain stable, voltage feedback op amp, offering low quiescent power dissipation

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)

**Components not used:**

- C5, C6, C7, C8
- R1 thru R8

**CLC425** low noise, wideband, voltage feedback op amp optimized for high gains, with adjustable supply current

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R6 - supply current adjustment (refer to data sheet for details)
- R7, R8 - 10 $\Omega$  (optional series supply resistors)  
**Note:** Cut the component side supply traces that short R7 and R8 to use these resistors.

**Components not used:**

- C5, C6, C7, C8
- R1 thru R5

**CLC426** low noise, wideband, voltage feedback op amp optimized for low gains, with adjustable supply current and unity gain stability with external compensation

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C6 - compensation capacitor for unity gain stability (refer to data sheet for details)
- R6 - supply current adjustment (refer to data sheet for details)

**Components not used:**

- C5, C7, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC430** intermediate performance, current feedback op amp using  $\pm 5$  to  $\pm 15V$  power supplies with a disable feature

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R6 -  $0\Omega$  to  $1k\Omega$  open collector disable control  
**Note:** Cut trace connecting R6 to  $-V_{CC}$ . Connect R6 to disable logic.

**Components not used:**

- C5, C6, C7, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC501** wideband current feedback op amp optimized for high gains, offering an extremely fast output voltage clamping capability

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R1, R2, R3, R4 - clamp setting resistors (refer to data sheet for details)
- C5, C6 -  $0.01\mu F$  ceramic capacitors (optional clamp de-coupling)

**Components not used:**

- C7, C8
- R5 thru R8

**CLC502** wideband current feedback op amp optimized for low gains, with exceptional settling to 0.0025% offering an extremely fast output voltage clamping capability

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R1, R2, R3, R4 - clamp setting resistors (refer to data sheet for details)
- C5, C6 -  $0.01\mu F$  ceramic capacitors (optional clamp de-coupling)
- R7, R8 -  $10\Omega$  (optional series supply resistors)  
**Note:** Cut the component side supply traces that short R7 and R8 to use these resistors.

**Components not used:**

- C7, C8
- R5, R6

**CLC505** wideband current feedback op amp optimized for intermediate gains, adjustable supply current

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C5 -  $100pF$  ceramic capacitor
- R6 - supply current adjustment (refer to data sheet for details)

**Components not used:**

- C6, C7, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC5665** low distortion, current feedback op amp using  $\pm 5$  to  $\pm 15V$  power supplies with a disable feature

**Component Values:**

- $R_f, R_g, R_{in}, R_{out}, R_t$  - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 4 for details)
- R6 -  $0\Omega$  to  $1k\Omega$  open collector disable control  
**Note:** Cut trace connecting R6 to  $-V_{CC}$ . Connect R6 to disable logic.

**Components not used:**

- C5, C6, C7, C8
- R1, R2, R3, R4, R5, R7, R8

**CLC5801** high speed, low noise, voltage feedback op amp optimized for high gains, with adjustable supply current

**Component Values:**

- $R_f$ ,  $R_g$ ,  $R_{in}$ ,  $R_{out}$ ,  $R_t$  - Common Components, (see on page 4 for details)
  - C1, C2, C3, C4 - Common Components, (see on page 4 for details)
  - R6 - supply current adjustment (refer to data sheet for details)
  - R7, R8 -  $10\Omega$  (optional series supply resistors)
- Note:** Cut the component side supply traces that short R7 and R8 to use these resistors.

**Components not used:**

- C5, C6, C7, C8
- R1 thru R5

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