

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.

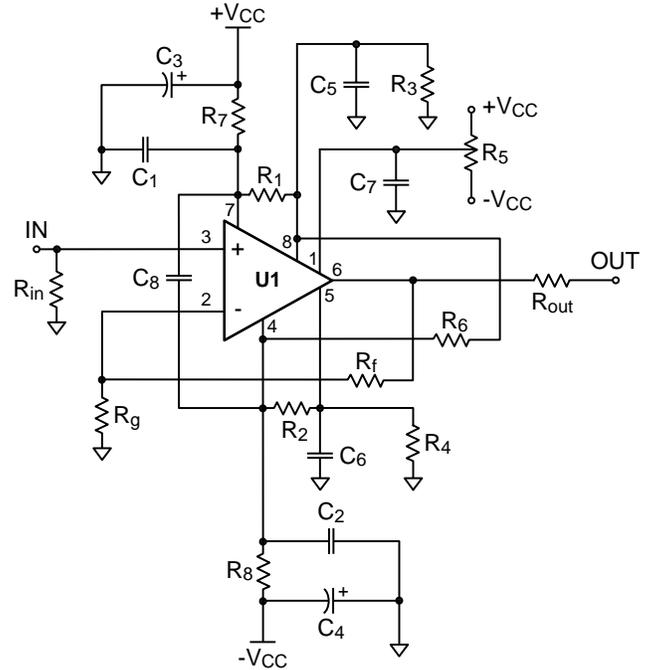


Figure 1: Non-inverting Gain Configurations

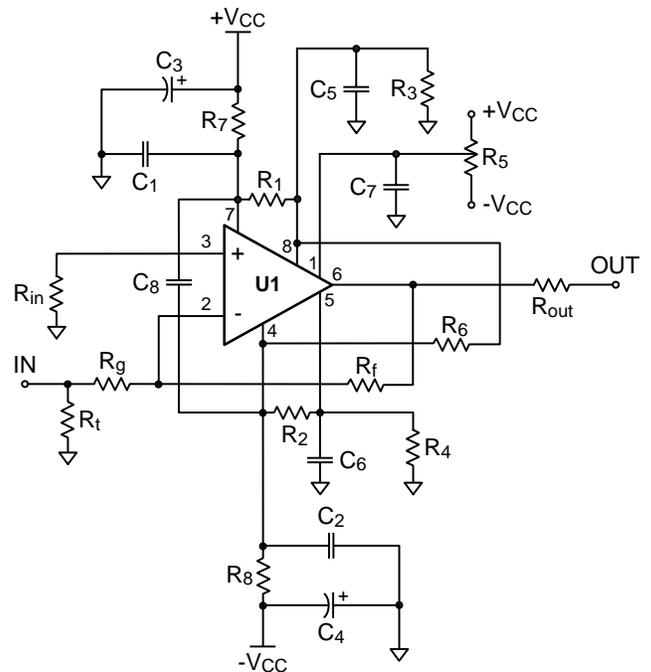


Figure 2: Inverting Gain Configurations

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 25Ω 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 = $R_g || R_t$)

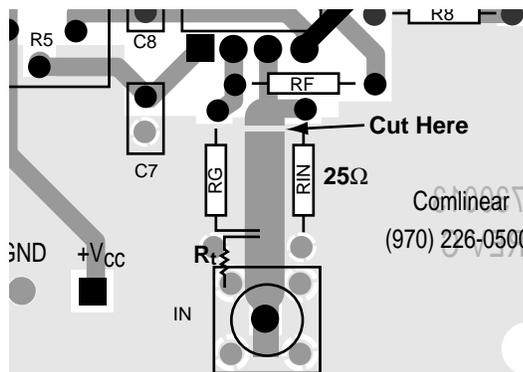


Figure 3: Modifications for Inverting Gains (CLC730013 board shown)

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 50Ω 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 500Ω . If a low impedance probe is not available, then a section of 50Ω coaxial cable and a low impedance resistor (10Ω to 50Ω) 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 50Ω .
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.

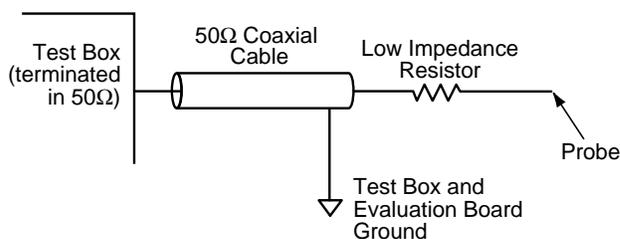


Figure 4: “Cable/Resistor” Probe Configuration

This “cable/resistor” probe, shown in Figure 4, forms a voltage attenuator between the resistor and the 50Ω 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.

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

Common Components for all amplifiers:

- R_f , R_g - Use the product data sheet to select values
 - R_{in} , R_{out} - 50 Ω (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 μ F ceramic capacitors
 - C3, C4 - 6.8 μ F tantalum capacitors
-

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 Ω pot (optional input offset null)
- C7 - 0.01 μ 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 Ω (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 Ω to 1k Ω 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 (± 1 to ± 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- R6 - 0 Ω to 1k Ω 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- C8 - 0.01 μ 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- R5 - 20k Ω pot (optional input offset null)
- C7 - 0.01 μ F ceramic capacitor (should be used for best fine scale settling even if R5 is not used)
- R6 - 0 Ω to 1k Ω 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 ± 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- C6, C7 - 0.01 μ F ceramic capacitors (used to reduce high frequency noise, >10MHz)
- R6 - 0 Ω to 1k Ω 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- R6 - supply current adjustment (refer to data sheet for details)
- R7, R8 - 10 Ω (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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 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 ± 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- R6 - 0Ω 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 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 - 10Ω (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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 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 ± 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 1 for details)
- C1, C2, C3, C4 - Common Components, (see **Common Components for all amplifiers** on page 1 for details)
- R6 - 0Ω to $1k\Omega$ open collector disable control
Note: Cut trace connecting R6 to $-V_{CC}$. Connect R6 to disable logic.

This page intentionally left blank.

Customer Design Applications Support

National Semiconductor is committed to design excellence. For sales, literature and technical support, call the National Semiconductor Customer Response Group at **1-800-272-9959** or fax **1-800-737-7018**.

Life Support Policy

National's products are not authorized for use as critical components in life support devices or systems without the express written approval of the president of National Semiconductor Corporation. As used herein:

1. Life support devices or systems are devices or systems which, a) are intended for surgical implant into the body, or b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



National Semiconductor Corporation

1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe

Fax: (+49) 0-180-530 85 86
E-mail: europe.support.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Francais Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.

13th Floor, Straight Block
Ocean Centre, 5 Canton Road
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.

Tel: 81-043-299-2309
Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.