

## INTRODUCTION

This easy-to-use kit provides a platform for the evaluation of power op amps using the PA04 pin-out configuration. It can be used to analyze a multitude of standard or proprietary circuit configurations, and is flexible enough to do most standard amplifier test configurations.

The schematic of the PC board is shown in Figure 2. Note that all of the components shown on the schematic will probably not be used for any single circuit. The component locations on the PC board (See Figure 3) provide maximum flexibility for a variety of configurations. Also included are loops for current probes as well as connection pads on the edge of the PC board for easy interconnects.

The hardware required to mount the PC board and the device under evaluation to the heatsink are included in the kit. Because of the limitless combination of configurations and component values that can be used, no other parts are included in this kit. However, generic formulas and guidelines are included in the APEX DATABOOK.

## ASSEMBLY HINTS

The mating socket included with this kit has recessed nut sockets for mounting the device under evaluation. This allows assembly from one side of the heatsink, making it easy to swap devices under evaluation. The sizes of the stand-offs were selected to allow proper spacing of the board-to-heatsink and allow enough height for components when the assembly is inverted.

## PARTS LIST

Part #	Description	Quantity
HS11	Heatsink	1
EVAL04	PC Board	1
MS05	Mating Socket	1
HWRE01	Hardware Kit	1
TW05	Thermal Washer	1

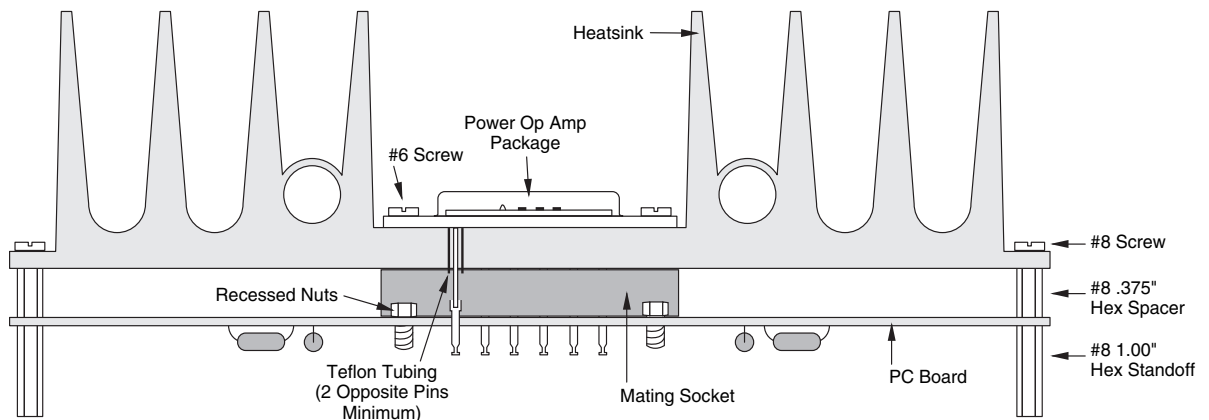
HWRE01 contains the following:

4 #8 Panhead Screws	4 #6 x 1.25" Panhead Screws
4 #8 .375" Hex Spacers	4 #6 x 5/16" Hex Nuts
4 #8 1.00" Hex Stand Offs	2 #6 x 1/4" Hex Nuts

## BEFORE YOU GET STARTED

- All Apex amplifiers should be handled using proper ESD precautions!

FIGURE 1.



- Initially set all power supplies to the minimum operating levels allowed in the device data sheet.
- Check for oscillations.
- Always use the heatsink included in this kit with thermal grease or TW05 and torque the part to the specified 8-10 in-lbs (.90-1.13 N•M).
- Do not change connections while the circuit is under power.
- Never exceed any of the absolute maximums listed in the device data sheet.
- Always use adequate power supply bypassing.
- Remember that internal power does not equal load power.
- Do not count on internal diodes to protect the output against sustained, high frequency, high energy kickback pulses.

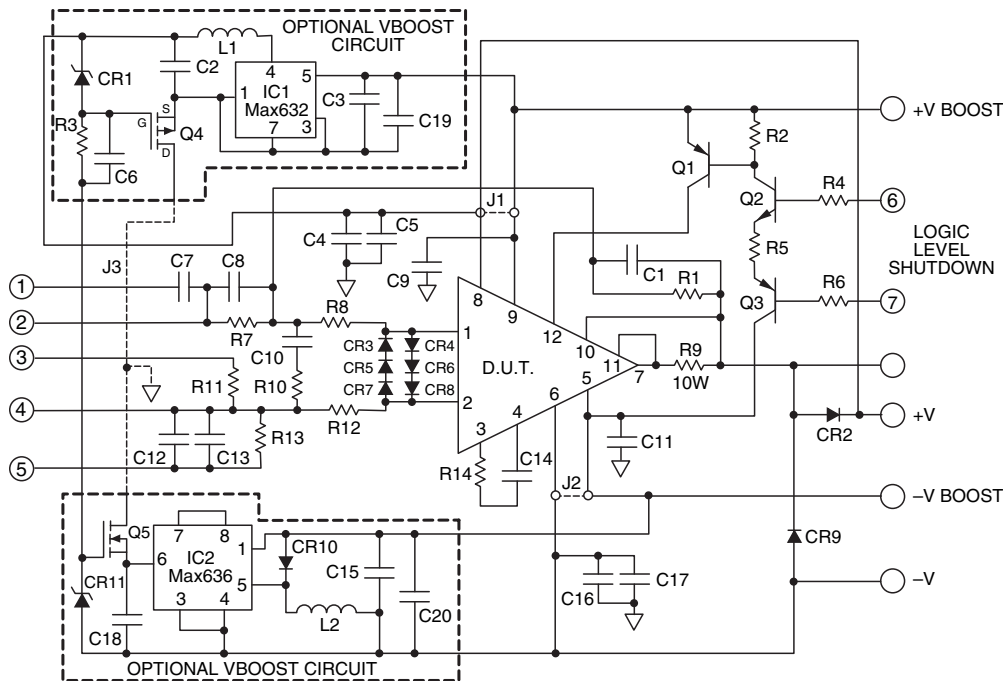
## ASSEMBLY

- Insert a #6 x 1/4" hex nut in each of the nut socket recesses located on the bottom of the mating socket.
- Insert the socket into the PC board until it is firmly pressed against the ground plane side of the PC board.
- Solder the socket in place (Figure 1). Be sure the nuts are in the recesses prior to soldering.
- Mount the PC board assembly to the heatsink using the stand-offs and spacers included.
- Apply thermal grease or a TW05 to the bottom of the device under evaluation. Insert into the mating socket through the heatsink.
- Use the #6 x 1.25" panhead screws to mount the amplifier to the heat sink. Do not overtorque. Recommended mounting torque is 8-10 in-lbs (.90-1.13 N•M).
- On the ground plane side of the board, between terminations for -V and OUT, scrape off the green solder mask for a ground connection. Connect the power supply common in this area. If using the onboard Vboost generation circuits, connect J3 to this ground also. If desired, the green solder mask may be scrapped away on the other end of the board for low current input signal ground connections also.

Mounting precautions, general operating considerations, and heatsinking information may be found in the APEX DATABOOK.

**NOTE:** Refer to HS11 in Accessories Section.

FIGURE 2.



## TYPICAL COMPONENT FUNCTIONS

COMPONENT	FUNCTION
R1	Feedback resistor
R2	Logic shutdown
R4	Input resistor logic input
R5	Current setting resistor
R6	Input resistor logic input
R7	Input resistor
R8	Input bias current measurement (Note 4)
R9	Current limit
R10	Noise gain compensation (Note 1)
R11	Resistor divider network for biasing inputs (Note 2)
R12	Input bias current measurement (Note 4)
R13	Resistor divider network for biasing inputs (Note 2)
R14	Compensation resistor
C1	AC gain or stability (Note 1)
C4	Power supply bypass (Note 3)
C5	Power supply bypass (Note 3)
C7	Input coupling
C8	AC gain set
C9	Power supply bypass (Note 3)
C10	Noise gain compensation (Note 1)
C11	Power supply bypass (Note 3)
C12	Bias node noise bypass (Note 2)
C13	Bias node noise bypass (Note 2)
C14	Compensation
C16	Power supply bypass (Note 3)
C17	Power supply bypass (Note 3)
CR2	Flyback protection (Note 5)
CR3-8	Input protection (Note 5)
CR9	Flyback protection (Note 5)
CR11	Zener reference for MAX636

## OPTIONAL Vboost COMPONENT FUNCTIONS AND RECOMMENDED VALUES

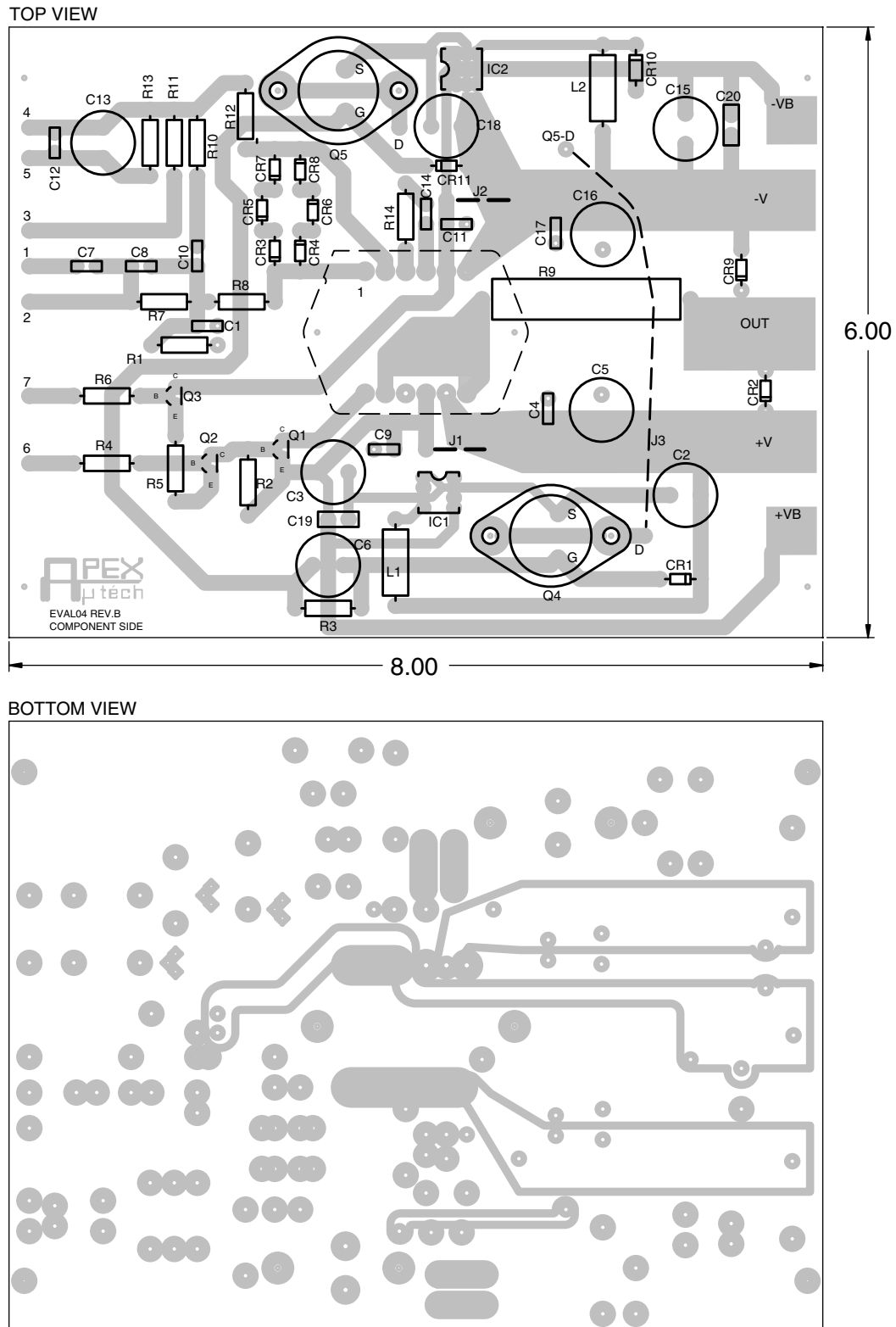
C2	100µF 25V	Regulator Input Capacitor
C3	100µF 100V	Boost Output Filter Capacitor
C6	10µF 200V	Bias Filter Capacitor
C15	100µF 100V	Boost Output Filter Capacitor
C18	100µF 25V	Regulator Input Capacitor
C19	1µF X7R 100V	Boost Output Filter Capacitor
C20	1µF X7R 100V	Boost Output Filter Capacitor
CR1	1N5242	Positive Input Boost Reference
CR10	1N5819	Negative Boost Flyback Diode
CR11	1N5242	Negative Input Boost Reference
IC1	MAX632	Positive Boost Regulator
IC2	MAX636	Negative Boost Regulator
L1	330µH	Positive Boost Output Inductor
L2	330µH	Negative Boost Output Inductor
Q4	IRF9240	Positive Pass Element
Q5	IRF240	Negative Pass Element
R3	50KΩ 1Watt	Reference Bias Resistor

NOTE: Q4 and Q5 can optionally be attached to heatsinks, Apex part # HS01. This should be done when the total supply voltage to the PA04 exceeds 60 Vdc.

NOTES: Please refer to the following sections of the APEX DATABOOK as noted.

1. See Stability section of "General Operating Considerations."
2. See "General Operating Considerations."
3. See Power Supplies section of "General Operating Considerations."
4. See "Parameter Definitions and Test Methods."
5. See Amplifier Protection section of "General Operating Considerations."

FIGURE 3.



## TYPICAL APPLICATION

The PA04 is well suited for wideband, low distortion, high power applications. The circuit in Figure 4 displays the simplicity of use offered by the PA04. The circuit is in an inverting gain of 10. This relatively low gain allows the amplifier to have more than adequate loop gain available, resulting in extremely low distortion at the power levels delivered. The use of the invert-

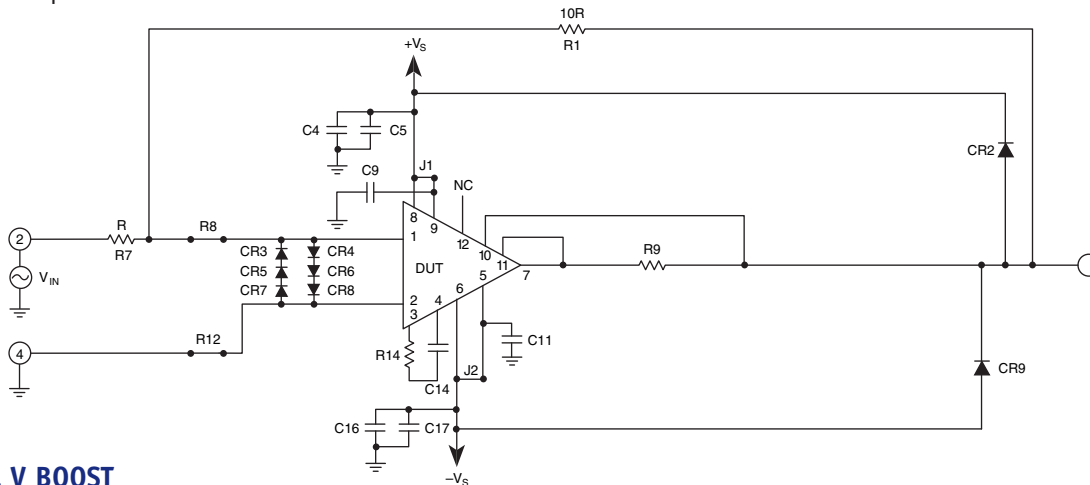
ing configuration avoids any concern of common mode effects. Typical specs of such a circuit would read as follows:

$$P_o = 200W$$

$$F = 10kHz$$

$$R_L = 4 \text{ Ohms}$$

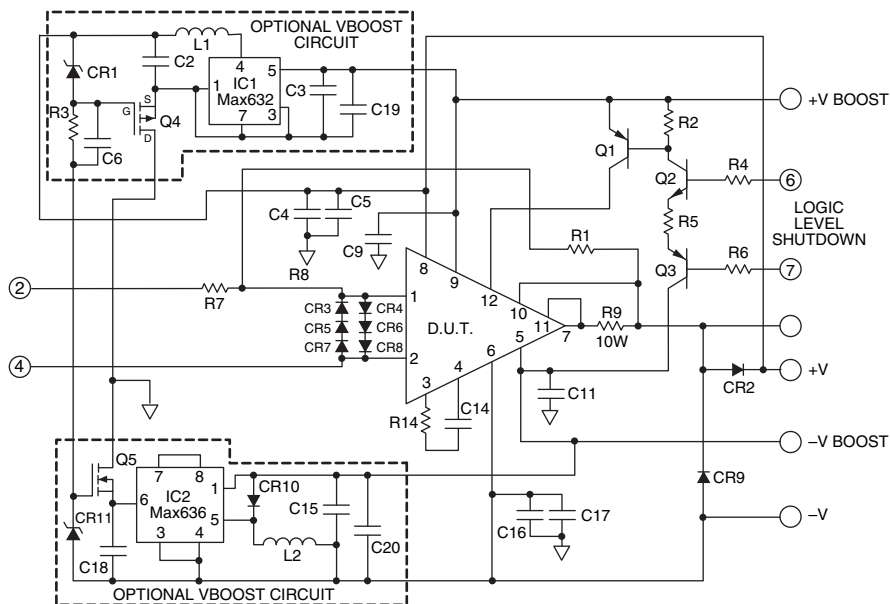
$$THD = .0061$$



## OPTIONAL V BOOST

One of many inexpensive ways to acquire V boost for the PA04 has been included as an option on this evaluation kit. The addition of these parts not only increases swing, but also

extends the common mode range of the amplifier. The ground connection of J3 needs to be made when assembled.

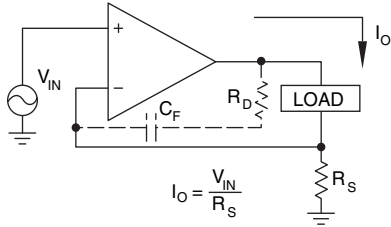


## HS11 HEATSINK NOTE

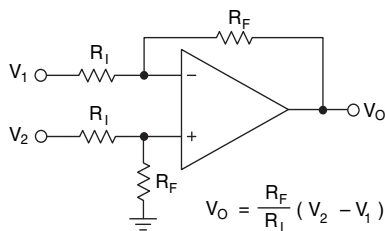
The HS11 Heatsink is overkill for the average application. Once maximum power dissipation for the application is determined (refer to "General Operating Considerations" and Application Note 11 in the APEX DATABOOK), the final mechanical design will probably require substantially less heatsinking.

APEX MICROTECHNOLOGY makes no representation that the use or interconnection of the circuits described herein will not infringe on existing or future patent rights, nor do the descriptions contained herein imply the granting of licenses to make, use, or sell equipment constructed in accordance therewith.

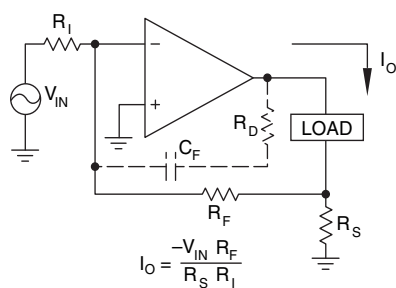
VOLTAGE-TO-CURRENT CONVERSION  
NON-INVERTING CONFIGURATION



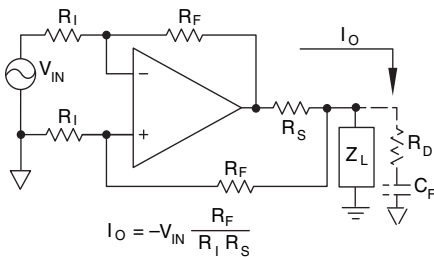
DIFFERENCE AMPLIFIER



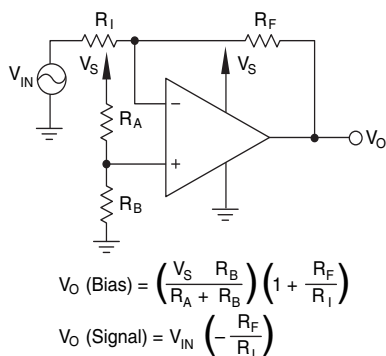
VOLTAGE-TO-CURRENT CONVERSION  
INVERTING CONFIGURATION



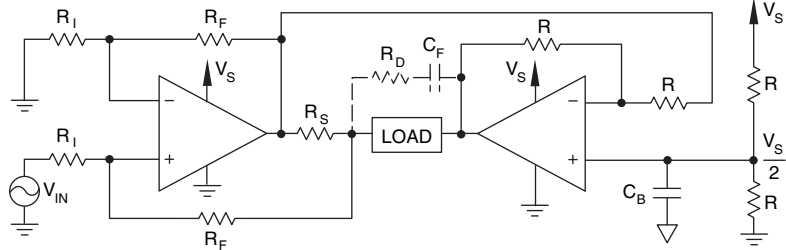
VOLTAGE-TO-CURRENT CONVERSION  
IMPROVED HOWLAND CURRENT PUMP



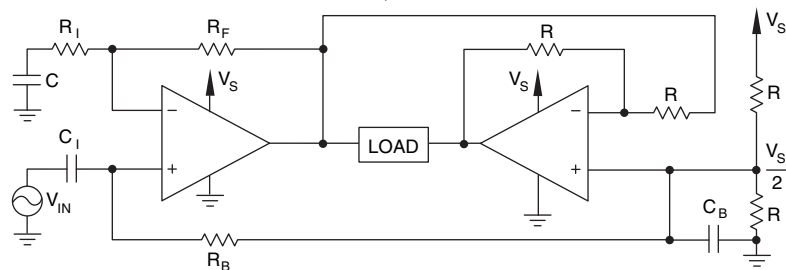
SINGLE SUPPLY OPERATION  
INVERTING CONFIGURATION



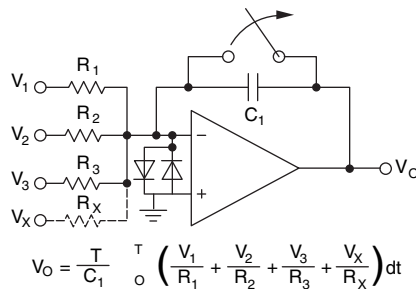
VOLTAGE-TO-CURRENT CONVERSION  
SINGLE SUPPLY, BRIDGE MODE



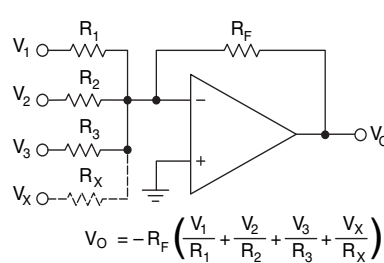
VOLTAGE FOLLOWER WITH GAIN  
SINGLE SUPPLY, BRIDGE MODE



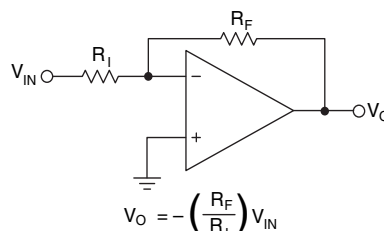
INTEGRATION



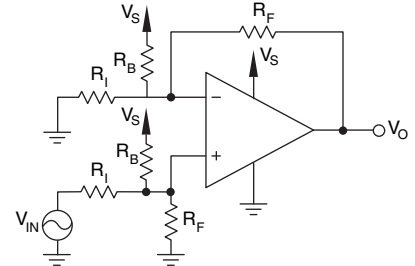
SUMMING / SCALING



INVERTER



SINGLE SUPPLY  
NON-INVERTING CONFIGURATION



- i)  $V_O = \frac{R_F}{R_1} V_{IN}$
- ii) For  $V_{IN} = 0$   
 $V_{CM} = \frac{V_S (R_1 // R_F)}{R_B + (R_1 // R_F)}$
- iii)  $V_{CM\Delta} = \frac{V_{IN} (R_B // R_F)}{R_1 + (R_B // R_F)}$
- iv) For  $V_{IN} > 0$   
 $V_{CM} = V_{CM} @ V_{IN} = 0 + V_{CM\Delta}$

PARALLEL OPERATION

