Mini Tutorial
MT-213

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Inverting Amplifier

by Hank Zumbahlen,
Analog Devices, Inc.

IN THIS MINI TUTORIAL

The inverting operational amplifier, a basic op amp circuit, is one in a set of discrete circuits described in a series of mini tutorials.

The inverting amplifier is one of the basic op amp circuits.

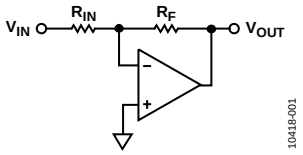

Figure 1. Inverting Rectifier

Assume that the input impedance of the op amp is infinite This means no current flows into or out of the op amp inverting input. Since the op amp forces the voltage at the two inputs to be the same, the inverting input (−) also appears to be ground. This is commonly referred to a virtual ground. In addition, according to Kirchoff's Law, all currents flowing into the node must also flow out of the node.

The input voltage sets up a current

$$I_{IN} = \frac{V_{IN}}{R_{IN}} \quad \text{(Equation 1)}$$

The current out of the summing node is equal to the input current.

$$I_{IN} = I_{OUT} \quad \text{(Equation 2)}$$

The voltage across the feedback resistor (R_F) is, therefore,

$$-V_{OUT} = R_F \times I_{OUT} \quad \text{(Equation 3)}$$

The voltage is negative (relative to the input voltage), since the current is flowing out of the node. This is why the circuit is referred to as an inverting amplifier. Note that the input voltages will be scaled by the values of the input resistors.

The major error sources in this circuit are the offset voltage and the bias current of the op amp. The offset voltage will affect the apparent voltage at the inverting input. It will no longer be 0 V. The bias current will cause an error in summing the currents since a small current will be flowing into or out of the op amp's input.

For ac inputs, there will be the limitations of the bandwidth of the op amp.

The input impedance of the amplifier circuit will be the value of the input resistor. Remember that the other end of the resistor is at (virtual) ground.

The above discussion is based on bipolar power supplies. If single supplies are used, the ground is replaced by the reference node, which has a voltage level of V_{REF}, which is typically half of the supply voltage. The input and output voltages are then referenced to this voltage rather than ground.

The input current becomes

$$I_{IN} = \frac{V_{IN} - V_{REF}}{R_{IN}} \quad \text{(Equation 4)}$$

The output becomes

$$V_{REF} - V_{OUT} = \frac{R_F}{R_{IN}}(V_{IN} - V_{REF}) \quad \text{(Equation 5)}$$

REVISION HISTORY

2/13—Rev. 0 to Rev. A

Changes to Figure 1 1

2/12—Revision 0: Initial Version

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