Some Notes on Operational Amplifier Based Circuits

by

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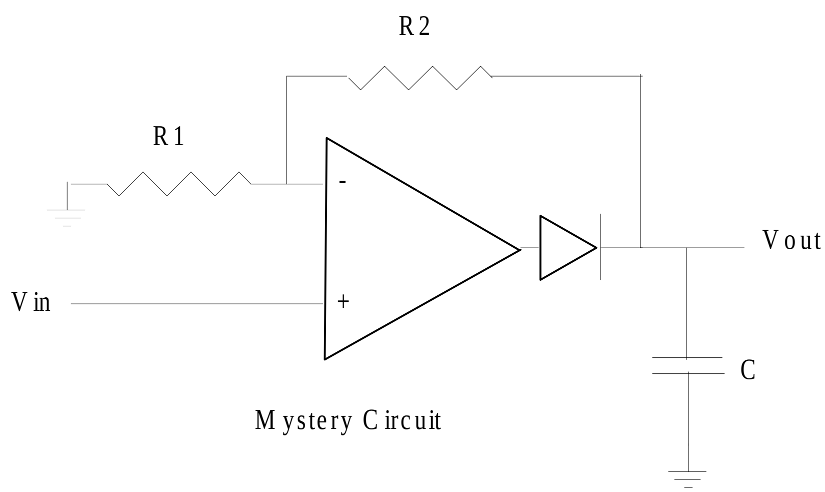


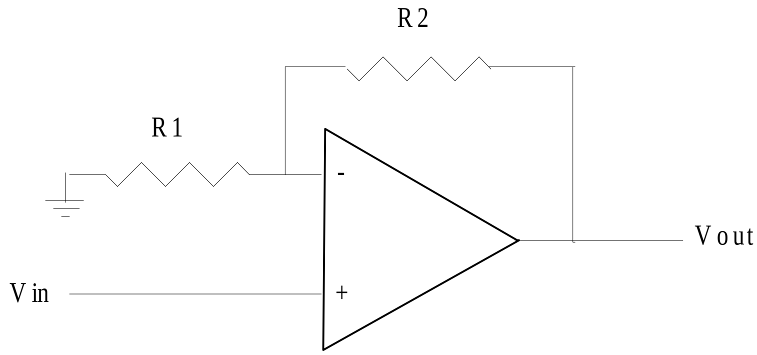
Mystery Circuit

Ideal Operational Amplifiers

Ideal operational amplifiers have infinite gain. If the voltage at the + terminal is larger than the voltage at the - terminal then the output voltage will increase until it reaches the positive power supply. Likewise, if the voltage at the + terminal is smaller than the voltage at the - terminal then the output voltage will decrease until it reaches the negative power supply. Of course, if both terminals are equal, the output will no longer be driven by the op amp. These characteristics allow feedback to be used in order to drive the output of the op amp to a useful value, and, for that reason, all of the circuits that I will be discussing use feedback.

Non Inverting Amplifier

Non inverting amplifiers are very powerful because you can amplify a signal without having a negative rail (depending on the op amp's specifications). When a voltage is applied to Vin, Vout begins to rise because of the infinite amplification. This rising voltage is consequently applied across the voltage divider of R1 and R2 in such a way that the voltage at the negative terminal of the op amp begins to rise as well. Once the voltage at the negative terminal has reached the same value as the positive terminal, the amplification stops and Vout remains constant. If for some reason the output voltage is pushed further up, the voltage at R1 will go up causing the op amp to have a negative voltage across it and pull Vout back down again. The formula expressing the ideal Vout is

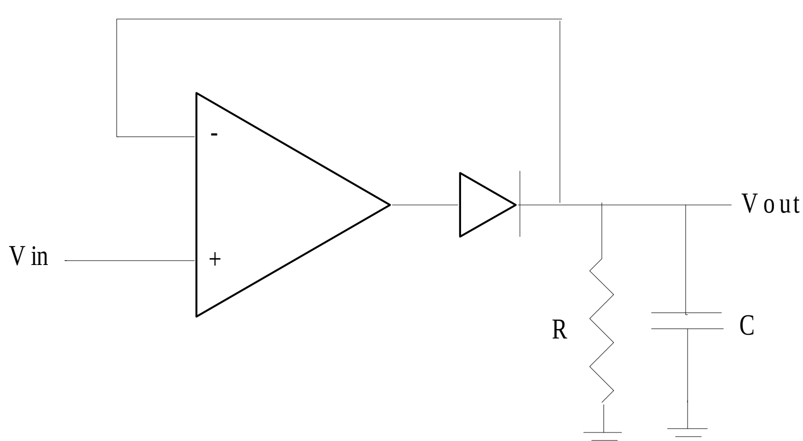


Non Inverting Amplifier

$$Vin\left(\frac{R_1+R_2}{R_1}\right)$$

Non Inverting Peak Detector

Peak detectors allow you to determine the highest voltage value that a signal produces over a period of time. The one shown here does not do precisely this, but for many slowly varying signals it is good enough. The diode located at the output of the op amp allows the op amp to add charge to the capacitor C while not allowing it to discharge the capacitor. Because of this, Vout will rise until both the -



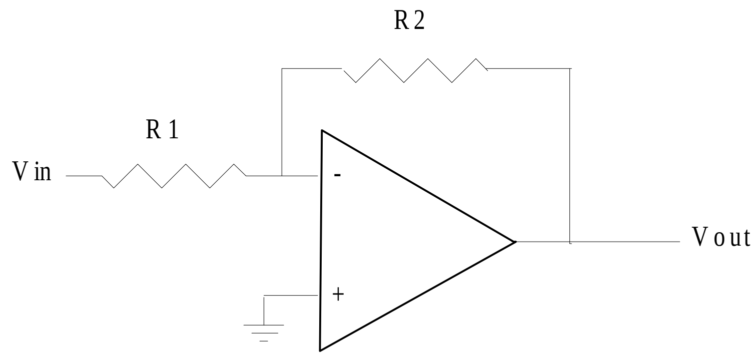
Simple Peak Detector

and + terminals of the op amp are equal. Then, if Vin drops, the op amp will no longer be pumping charge into the capacitor, and the resistor R will allow charge to slowly escape and the voltage at Vout to drop. R and C must be picked based on how fast you want Vout to drop after detecting a peak.

Inverting Amplifier

Inverting amplifiers invert your signal and, as a result, require a negative power supply (assuming Vin is positive). In this circuit, the current flowing from Vin goes through both R1 and R2. As you can see from the location of the + and - terminals, the op amp will pull down Vout until the voltage at the - terminal is equal to ground. Once this happens Vout can be found by the following equation:

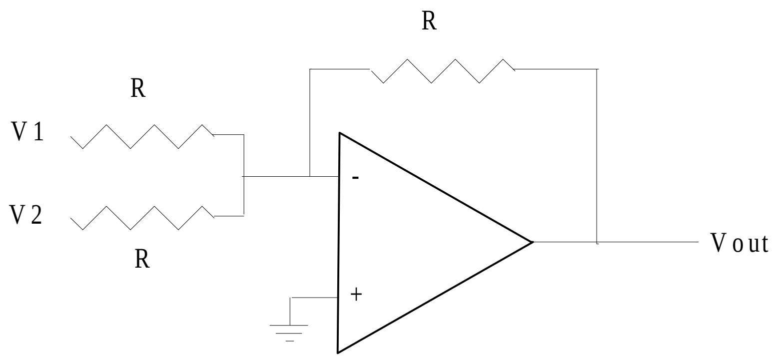
$$Vout = -Vin(\frac{R_2}{R_1})$$



Inverting Amplifier

Inverting Voltage Adder

The inverting voltage adder is based on the exact same principle as the inverting amplifier. The op amp pulls Vout down such that the - terminal is the same as ground and the currents produced by V1 and V2 both add at the negative terminal and produce a summed voltage drop across the third resistor on the way to Vout. Thus Vout can be calculated by the following equation:



Inverting Voltage Adder

$$Vout = -(V_1 + V_2)$$

Additional voltage inputs can also be tied to the - terminal if necessary.