2.0 Introduction

This chapter starts with operational amplifiers in general and then moves to comparators, which are one of the amplifiers configurations and its designing.

2.1 Operational amplifiers

An operational amplifier is a low cost integrated circuit widely used in analogue electronics. It is so named from its versatility in providing a variety of mathematical operations such as differentiation, integration and summing. Its typical applications are Analogue Computers, Oscilloscope and Processing.

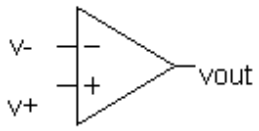


Figure 2.0 An operational amplifier (comparator)

The operational amplifier obeys the input-output relationship:

$$v_o = A\left(v^+ - v^-\right)$$

Where v_o is the output voltage, v^+ and v^- are, respectively, the voltages at the non-inverting and inverting inputs, and A is the amplifier gain. For an ideal operational amplifier there are two important facts:

a) The gain of the amplifier is infinite.
b) The internal resistances between the inputs (v^+ and v^-) and ground are infinite.

These two facts lead to two important relationships used to analyze op amp circuits:

1) The voltages at the two inputs are the same.
2) There is no current from the input of the operational amplifier.

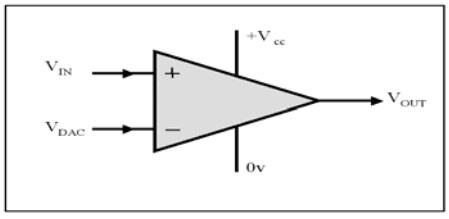
Number 1 can be seen from fact *a*. In order for the output voltage, v_o, to be finite with an infinite gain, then v^+ must equal v^-. In practice the gain is typically about 10^6, so v^+ and v^- are within several microvolts of each other.

Number 2 can be seen from fact *b*. If there is a resistance to ground from v^+, then the voltage at v^+ must be equal to the current times the voltage. If v^+ is to be finite, and the resistance is infinite, then the current must be zero. The same argument follows for v^-. Typically the input resistance is at least several mega ohms.

2.2 Comparator designing

A comparator is a device that has the same schematic symbol as the operational amplifier, but it exhibits somewhat different behavior. The comparator is a device that is designed to be used without negative feedback, so its output is always either at its maximum value, or its minimum value. In other words the output is digital, either logic 1 (high) or logic 0 (low).
A comparator is a one use of the operational amplifier. Comparator is a circuit that accepts input of linear voltages and provides a digital saturated output.

The circuit shown in figure 2.2 below compares the two inputs. If V_{IN} is greater than V_R, the output is high and if V_R is greater than V_{IN} the output is low like ground. A high output is characterized by the output appearing as an open circuit, which is no current in or out, and zero voltage as a short circuit to ground characterizes a low output. The output can be as a switch connected to ground so for a low output the switch is closed and work as shorted to ground, and for a high output the switch is open and the output voltage can be float. What makes it useful is that we can use this to switch high voltages (for motors, lights...) on the output from low voltages on the input. Figure 2.1 below shows the comparator with its inputs.



Comparator