

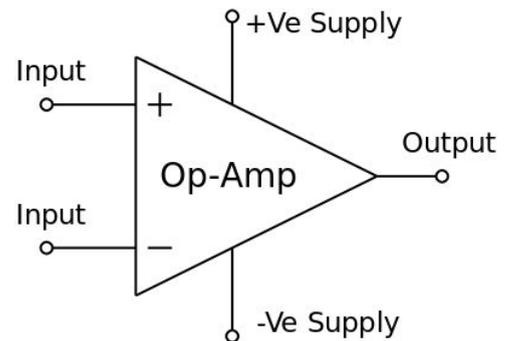
# Operational Amplifiers

## Introduction

Operational amplifiers are standard building blocks for analogue circuits.

The circuit symbol shows that they have two inputs and a single output and usually operate from a dual rail power supply i.e. a positive and a negative power supply.

This allows the output to have both positive and negative values.



The Input labelled with a '+' sign is called the **Non-Inverting Input**

The Input labelled with the '-' sign is the **Inverting Input**

The generic features of an operational amplifier are:

- Very high input resistance
- Low output resistance
- Very high open loop gain ( $A_0$ )

## Basic Operation

The operation of an Operational Amplifier (Op-Amp) is very simple. The Output voltage is the difference between the Input voltages multiplied by the open loop gain.

The Op Amp increases the difference between the two inputs by a large multiplying factor.

This can be written as:

$$V_{out} = A_0 (V_+ - V_-)$$

Where  $V_+$  is the voltage at the non-inverting input of the amplifier and  $V_-$  is the voltage at the inverting input.

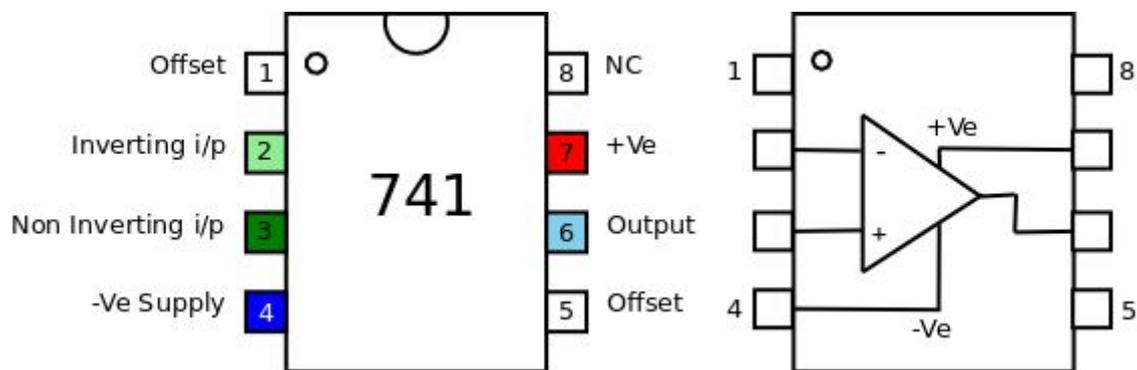
Note that the output voltage is positive when  $V_+ > V_-$

The output voltage is negative (or zero) when  $V_+ < V_-$

The output saturates (reaches its maximum value) 2 V below the supply voltage although it is often enough to assume that the output saturates at the supply voltage. As the Op-Amp has a very high open loop gain, even a very small difference of just a few mV (or even  $\mu\text{V}$ ) will cause the output to saturate.

The output of a standard Op-Amp can either source or sink sufficient current to drive an LED. The output is usually internally protected and, although most Op-Amps are robust, care should be taken to provide suitable current limiting resistors for the load.

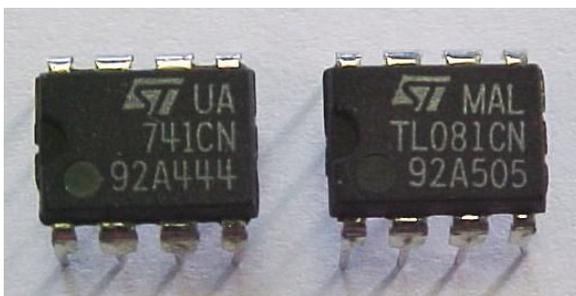
## 741 Pin Layout



The 741 Op-Amp IC is a cheap and robust general purpose operational amplifier although it is an old design and there are many much better Op-Amps available. The 741 Op-Amp is usually in the form of an 8 pin DIL package although other varieties are available.

The pin layout is common to most Op-Amps and can be treated as generic for the 8 pin packages. It should be noted that the 741 is not really suitable for audio applications.

## 741 Specifications



Supply voltage:	$\pm 22 \text{ V}$ max
Input impedance:	$2 \text{ M}\Omega$ typically
Input current:	$100 \text{ nA}$ approx
Output impedance:	$75 \Omega$ approx
Output Current:	$13 \text{ mA}$ max
Output voltage:	$\pm 13 \text{ V}$
Open loop gain:	$> 100,000$

# Website

[https://www.electronicsteaching.com/Electronics\\_Resources/DocumentIndex.html](https://www.electronicsteaching.com/Electronics_Resources/DocumentIndex.html)

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