Operational amplifiers
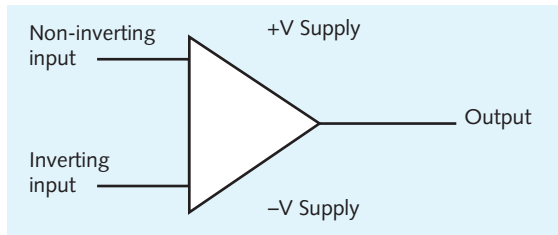
The term **operational amplifier** or "op-amp" refers to a class of high-gain amplifiers with a non-inverting input (+), an inverting input (–) and a single output.

The output voltage is the difference between the + and – inputs multiplied by the open-loop gain.

The output of the amplifier V_0 is given by the formula:

$$V_0 = A\ (V_+ - V_-)$$

Where **A** is the open-loop voltage gain of the amplifier, V_+ is the non-inverting input voltage and V_- is the inverting input voltage. The gain is given by the formula

$$A = \frac{V_0}{V_+ - V_-}$$

Originally, op-amps were made from discrete components and they were used to perform the basic mathematical operations (add, subtract, multiply, divide, integrate, differentiate, etc) in analogue computers. Nowadays they are built with integrated circuits and are widely employed in the field of linear electronics. Modern op-amps are high-performance and very versatile electronic devices. They are the basis of different kinds of devices: differentiators, integrators, comparators, AD/DA converters and filters.

The most common and most famous op-amp is the μA741C or just 741 which has become the standard tool for achieving amplification and a series of other tasks. Though it has some practical limitations, the 741 is an electronic bargain at less than a dollar.

The 741 is used in two ways:

- **as an inverting amplifier**. Leg two is the input and the output is always reversed. If the polarity is positive going into the chip, it is negative by the time it comes out through leg six. The polarity has been "inverted".

- **as a non-inverting amplifier**. Leg three is the input and the output is not reversed. This time if it is positive going into the 741, then it is still positive coming out. Polarity remains the same.
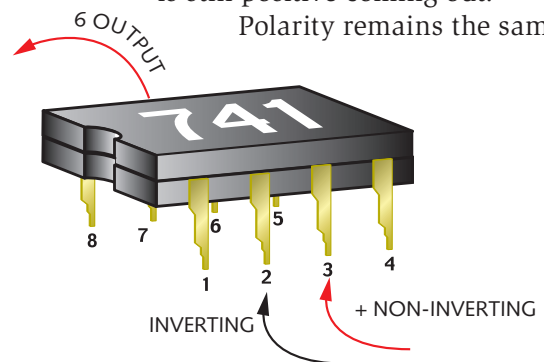
bargain: *affare*
to differentiate: *differenziare (studio delle differenziate)*
Inverting: *invertente*
Non-inverting: *non invertente*
Open-loop: *ad anello aperto*

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1 📋 **Say if the statements below are true (T) or false (F). Correct the false ones.**

	T	F
1. The op-amp is a low-gain amplifier.	☐	☐
2. The op-amp has a single input and two outputs.	☐	☐
3. The operational amplifiers were used to carry out mathematical calculations in analogue computers.	☐	☐
4. The output voltage in an op-amp corresponds to the difference between inverting and non-inverting input voltages divided by the gain.	☐	☐
5. The 741 op-amp can be used as an inverting or non-inverting amplifier.	☐	☐
6. In a non-inverting amplifier the output is always reversed.	☐	☐

2 **The words below are the Italian translations of some terms from the text. Which ones?**

1. Guadagno ....
2. Separati ....
3. Fondamentali ....

4. Strumento ....
5. Compiti ....
6. Ancora ....

3 **Give the Italian translations of the following words.**

1. Originally ....
2. Perform ....
3. Add ....

4. Nowadays ....
5. Achieving ....
6. Though ....

4 **Find in the text the opposite of the words below.**

1. Loss ....
2. Multiple ....
3. Closed ....

4. Old-fashioned ....
5. More ....
6. Different ....

5 **PAIR WORK** **Answer the following questions using your own words. Then exchange roles.**

1. How does an operational amplifier differ from other amplifiers?
2. How can you calculate the gain of the op-amp? Write the formula.
3. What were op-amp used for in the past?
4. What are the features of an ideal amplifier?
5. What sort of components does a 741 contain?
6. How can the 741 be used?