

VISIR REMOTE LAB: Resistors in serial and parallel

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1 Objectives and complexity level

As you will see in the next section, through the remote laboratory VISIR you can experiment with electronic components creating real connections between them and connecting real instruments to check their operation.

The objectives of the experiments that we propose in these practical sessions are:

1. Learn how to create simple resistor circuits using the remote laboratory VISIR
2. Understand the models of series and parallel associations of resistances.
3. Learn to measure using a multimeter series and / or parallel configurations of resistors.

The level of complexity of these laboratory sessions is low, being able to reach an average level based on the configurations of resistances that are proposed to the student.

2 The Lab

Using the VISIR remote analog electronics laboratory, we will be able to measure the equivalent resistance of different resistor associations.

This remote lab allows to create physically the circuit that you implement on the user interface. This is thanks to a switching matrix that creates the connections between the components. In addition, on the built circuit with real components, we can connect different instruments to check and characterize their behaviour: a power supply, a function generator, an oscilloscope and a multimeter. In this case, to measure the equivalent resistance of different resistor associations, we will use the multimeter provided by the VISIR laboratory.

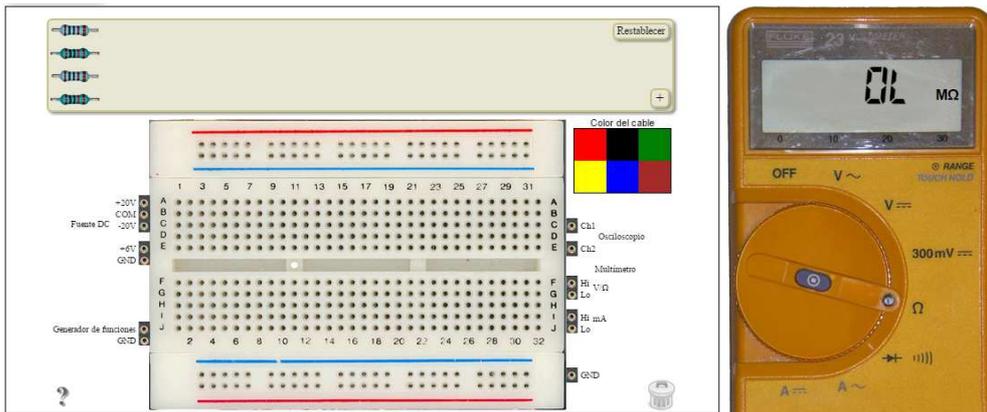


Figure 1. Breadboard and multimeter at VISIR remote Lab

In this experiment on the VISIR remote laboratory it is possible to control the following parameters:

- We have four resistors: 2 resistors of $1\text{k}\Omega$ and 2 resistors of $10\text{k}\Omega$
- With a maximum of these 4 resistors in the circuit, we can create any possible association and obtain its equivalent resistance value.

Thus, some possible associations that can be made are shown in the following figure.

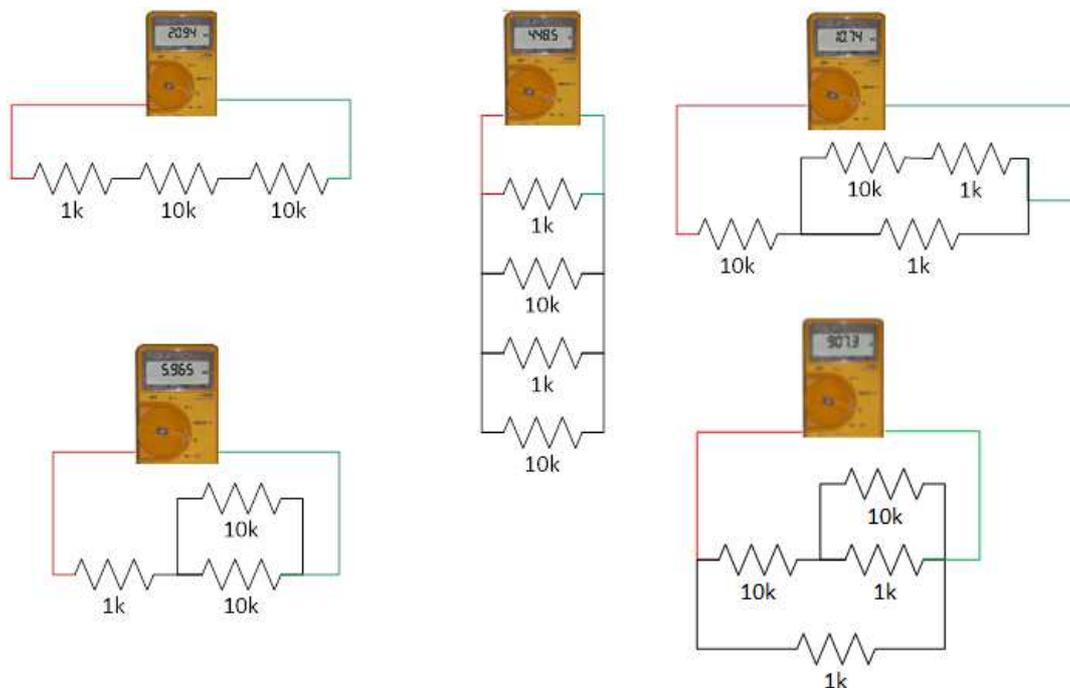


Figure 2. Resistors associations

Thanks to the obtained measurements we can determine how the association of resistances in series and / or in parallel influence the total value of the resistivity of the equivalent circuit. In short, this experiment based on resistances will

allow us to empirically contrast the results obtained on the real circuit with the mathematical formulas that define the series and parallel association of resistances:

$$\text{Serial Equivalent Resistor} \rightarrow R_{TOTAL} = R_1 + R_2 + \dots + R_N$$

$$\text{Parallel Resistor} \rightarrow \frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_N}$$

$$\rightarrow R_{TOTAL} = \frac{R_1 \cdot R_2 \cdot \dots \cdot R_n}{R_1 + R_2 + \dots + R_n}$$

3 Examples of experiments

To answer the hypotheses that can be analysed in this lab, there are at least three paths: use a mathematical model, use a simulator or use a laboratory equipment. In our case, we will use laboratory equipment through the Internet, remotely, our hands and eyes will be Internet. For this we will use VISIR the remote laboratory offered from the portal of LabsLand.

3.1 Experiment 1. Measuring one resistor

This experiment aims to learn how to connect a resistance on breadboard or protoboard and how to connect and configure the multimeter to measure its resistance value. To do this we will follow the following steps:

1. We will access the Labsland portal with our username and password.
2. Access the remote electronics lab and follow the steps indicated

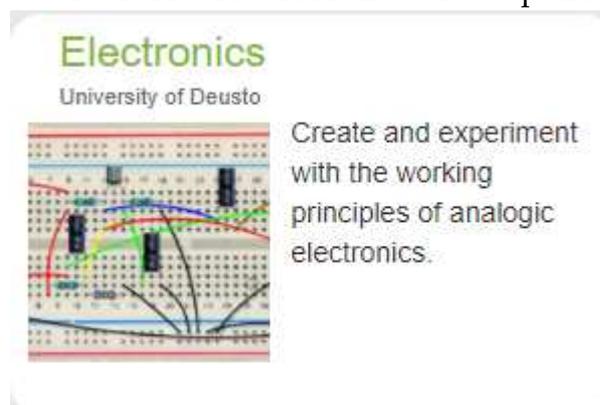


Figure 3. Access to the VISIR remote lab

3. Once inside the laboratory, we will see the user interface of the following figure. We see that we have 4 resistors by default, 2 resistors of 1kΩ and 2 resistors of 10kΩ. In case they did not appear, we could look in the "component library" that appears when clicking on the "+" icon. As we

select a component with the mouse, it will be included in the component box.

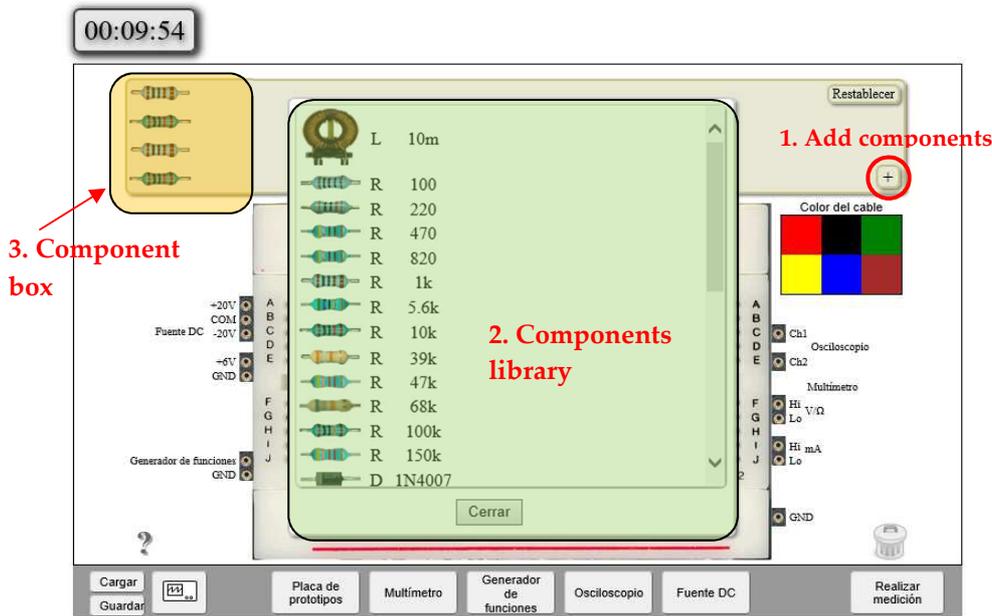


Figure 4. VISIR User Interface

4. Once we have the components in the component box, we can place them on the protoboard. We can add components whenever we want.
5. Once we have mounted the circuit, in this case a single resistance, we proceed to connect the instruments, in this experiment it is the multimeter to measure the value of the resistance.
6. Press the "Multimeter" button under the prototype board to access the instrument interface
7. Select the resistance measure on the multimeter by turning the centre roulette wheel, and press the "Perform Measurement" button to build the circuit, connect the instruments and capture the measurements. While this is happening, a lightning bolt icon will appear next to the "Perform Measurement" button. Remember that the whole process is real and not simulated.

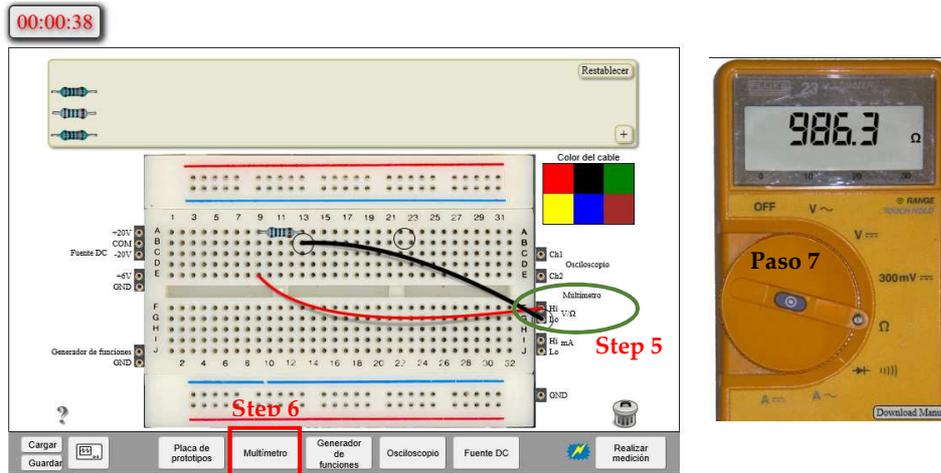


Figure 7. Measuring 1kΩ resistance with the multimeter

3.2 Experiment 2. Measuring different association of resistors

Once we have seen how to measure a resistance with the multimeter, in this experiment we will see how we can measure several resistors in series or in parallel. For this, we will follow the following steps:

1. Starting from step 3, we will perform some of the following examples:

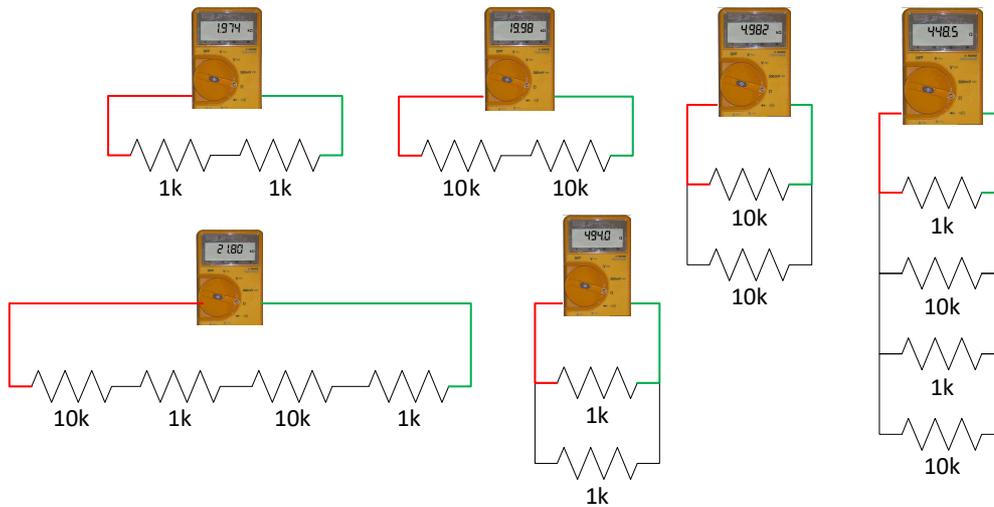


Figure 5. Examples of serial and parallel associations

2. Remember that VISIR works with real components and creates real circuits, so the number of components and the way they are interconnected are limited. In this case, we can interconnect, as desired, up to 2 resistances of 1kΩ and 2 resistances of 10kΩ. For example, we can not create an experiment with 3 resistances of 1kΩ, because the system will return an error message:

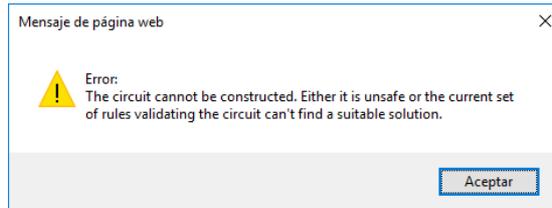


Figure 6. Error message when a circuit is not valid or it cannot be built.

- To measure resistances in series and / or in parallel, it is very important that you remember how the holes in the protoboard are interconnected. If you click on the interrogation that appears in the interface below to the left you will be able to see a guide like the one of the following figure.

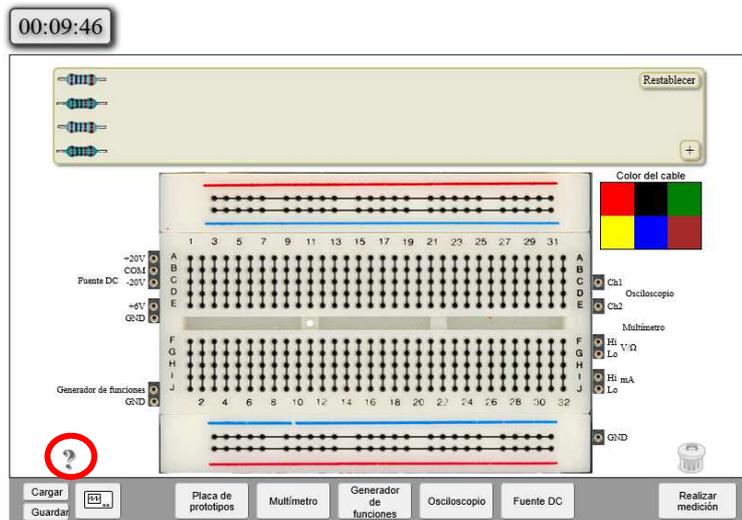


Figure 7. Breadboard interconnections

- Let's take an example of series resistors connection. Notice how the right leg of resistance 1 is in the same column of holes as the left leg of resistance 2. Also look where the multimeter is connected: in the left leg of resistance 1 and in the right leg of the resistance 2.

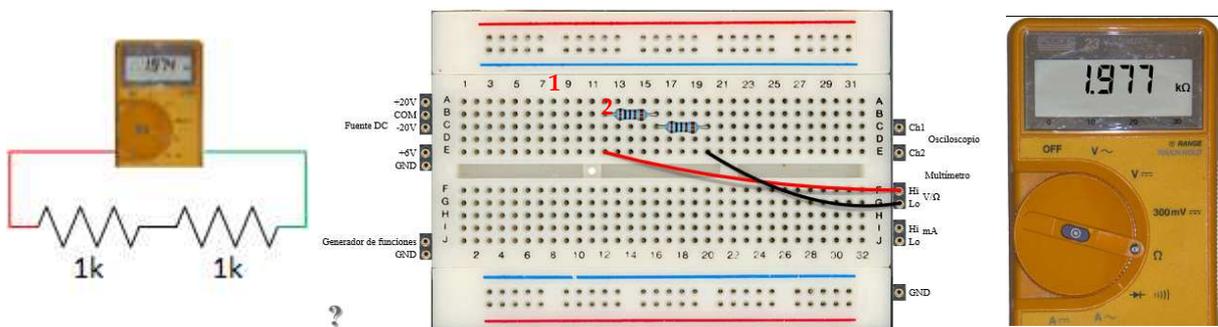


Figure 8. Serial connection example

- Let's take an example of parallel wiring. Notice how the left legs of all the resistors are connected in the same column (as well as the red wire that goes to the multimeter), and the right legs are also in the same column (like the black wire that goes to the multimeter)

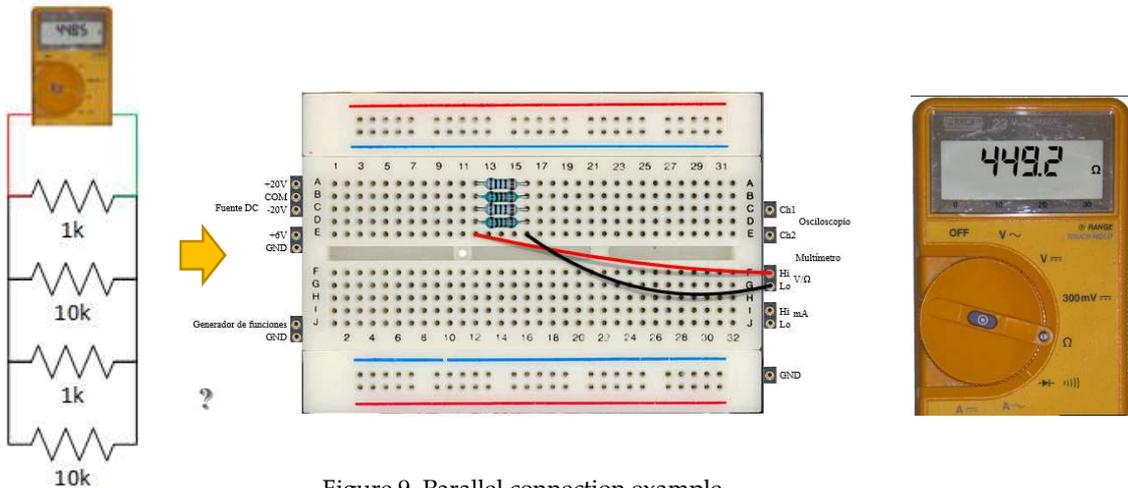


Figure 9. Parallel connection example

3.3 Experiment 3. Measuring resistors in serial and parallel

We will now experiment with more complex circuits, combining resistors in series with resistors in parallel, following these steps:

- Starting from step 2 of the previous experiment, we will perform some of the following examples:

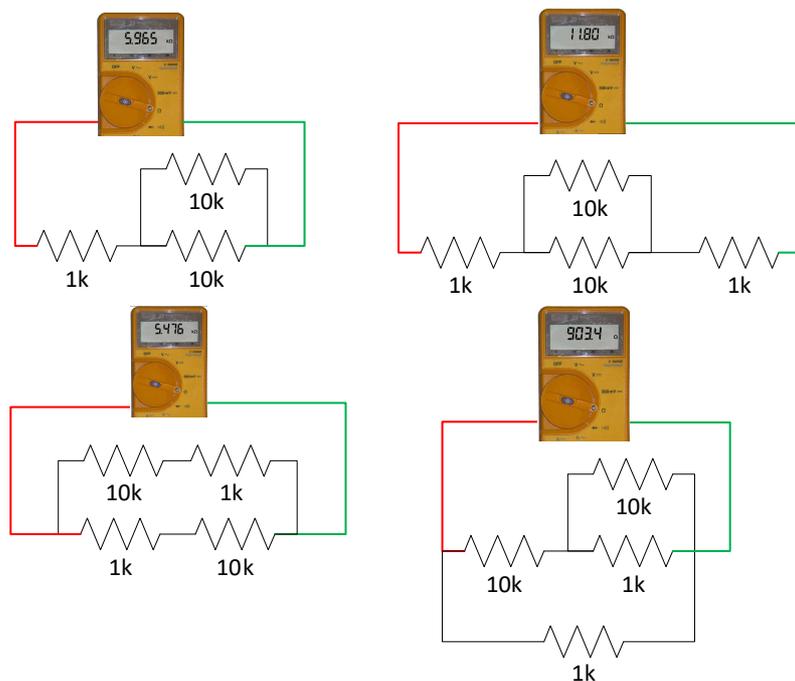


Figure10. Serial and parallel combinations

- Remember that VISIR works with real components and creates real circuits, so the number of components and the way they are interconnected are limited. In this case, we can interconnect, as desired, at most 2 resistances of $1k\Omega$ and 2 resistances of $10k\Omega$. For example, we cannot create an experiment with 3 resistances of $1k\Omega$, because the system will return an error message:

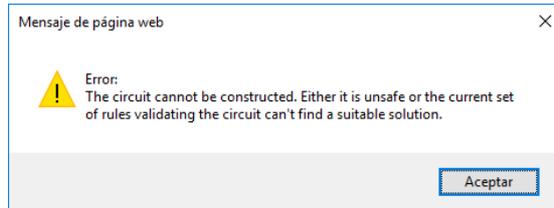


Figure 11. Error message when a circuit is not valid or it cannot be built

- Let's take an example by connecting a resistor of $1k\Omega$ in parallel with a resistor of $10k\Omega$ in series with a resistance of $1k\Omega$ and $10k\Omega$.

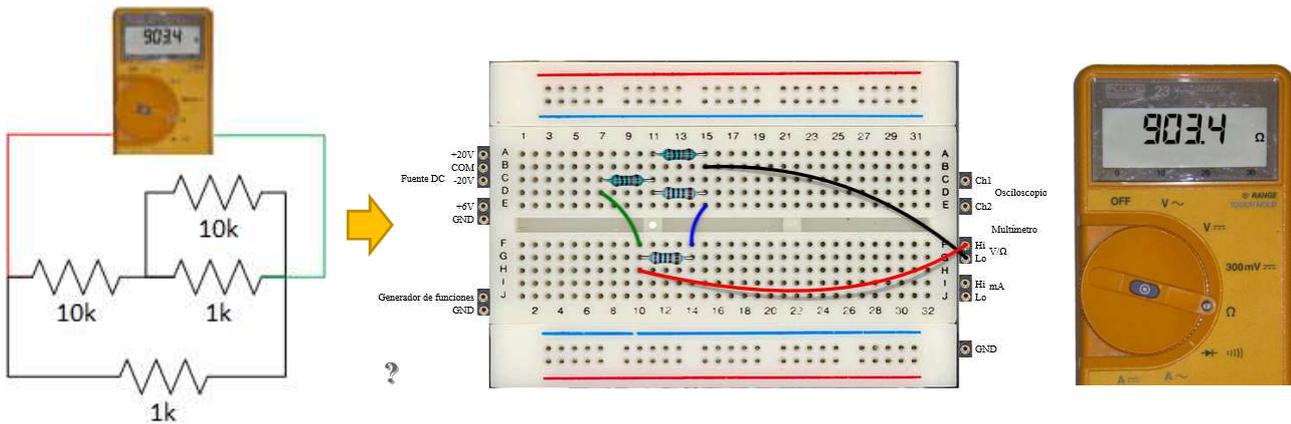


Figure 12. Example of serial and parallel combination