

Lab 1: DC Measurements (R, V, I)

Introduction

Resistors are the most common component found in all electrical and electronic circuits. Resistors are found in many shapes, sizes, and values. The most common shape is a two-lead cylinder component with leads coming out each end and color bands painted around the cylinder to indicate the nominal resistor value and its tolerance.

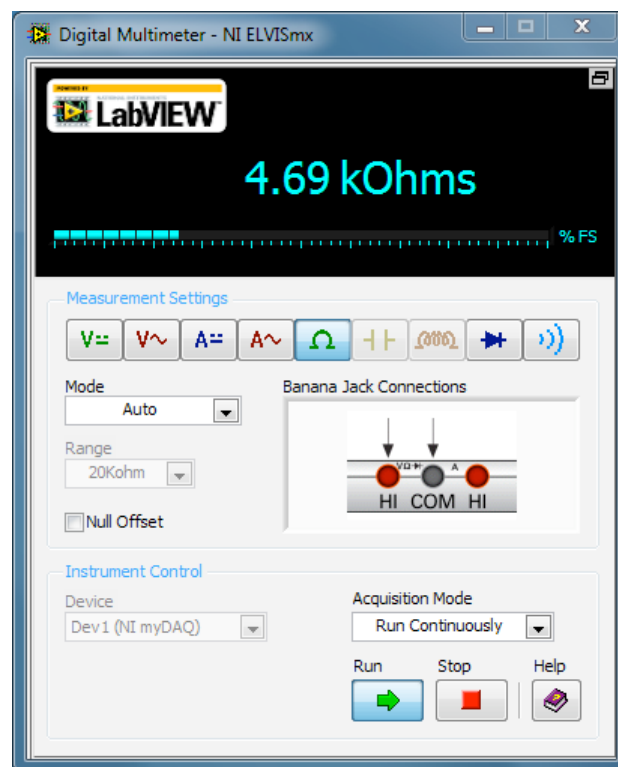


Fig. 1 NI ELVISmx Digital Multimeter Configured as an Ohmmeter

Purpose

This lab demonstrates how to use myDAQ to measure resistance R , current I , and voltage V . The relationship between R , I , and V (or Ohm's Law $V = IR$) is studied. Also shown are

sensors that convert physical measurements like temperature, pressure, and/or strain into a resistance, a current, or a voltage.

Equipment

- NI myDAQ
- Red and Black DMM Probes (supplied)
- Various Resistors: 47K, 10K, 10K Potentiometer
- Solderless Breadboard (recommended)

Prerequisite Reference Materials

Resistor Color Codes:

http://www.allaboutcircuits.com/vol_5/chpt_2/1.html

Using the myDAQ Digital Ohmmeter DMM(Ω):

<http://decibel.ni.com/content/docs/DOC-12938>

Using the myDAQ Digital Ammeter DMM(I):

<http://decibel.ni.com/content/docs/DOC-12878>

Using myDAQ Digital Voltmeter DMM(V):

<http://decibel.ni.com/content/docs/DOC-12937>

Exercise 1-1: Getting Started

Install the myDAQ software onto your computer and then connect your myDAQ to the computer with the USB cable (supplied).

Pick any three resistors and note the color bands. Reading from the end band closest to the leads, fill in the following chart. The nominal resistance can be found using the color code in the Appendix at the end of this lab.

	Color Band 1	Color Band 2	Color Band 3	Color Band 4	Nominal Resistance
Resistor 1					
Resistor 2					
Resistor 3					

Connect one of the resistors to your myDAQ using the supplied leads at the indicated inputs.

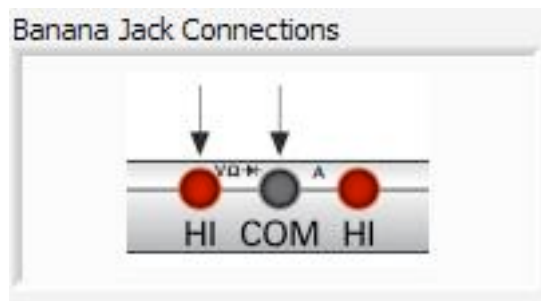


Fig. 2 Banana Jack Connections for Voltage or Resistance Measurements

Note: The myDAQ banana jack connections display changes with the function selected.

From the NI ELVISmx Instrument Launcher strip, select DMM. The default function voltage measurement DMM(V) pops up in a new window (see Fig. 5).

Select the resistance function [Ω] button and change the mode (*Specify Range*) to (*Auto*), see Fig. 1. Press [Run] to view the resistance measurement on the display.

Measure the other resistors used in above chart.

How do the measured values compare with the nominal value from the colored bands?

Resistor tolerance is defined as the percentage difference between the measured resistance R_m and its nominal value R_n .

$$\text{Tolerance} = (R_m - R_n) / R_n \times 100$$

The fourth band indicates your chosen resistor's tolerance. It should have a tolerance less than

1% brown, 2% red, 5% Gold, or 10% silver

How does your calculated tolerance agree with the manufacturer's color tolerance?

Ohm's Law (Current and Voltage Measurements)

Use the following resistors

R: 10 k Ω resistor (brown, black, orange)

R_x: 10K potentiometer (set in the middle of the range)

Use DMM(Ω) to measure each of these resistors:

R = _____ Ohm R_x = _____ Ohm

Build the following circuit.

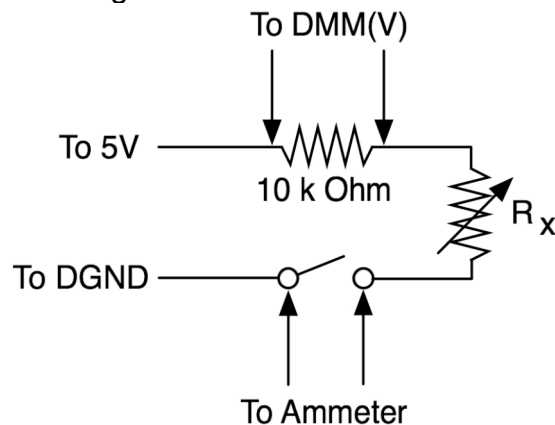


Fig. 3 Voltage Divider Circuit

Now reconfigure the DMM front panel to read current by pressing the function ammeter [A-] button. Adjust the range to 20 mA.

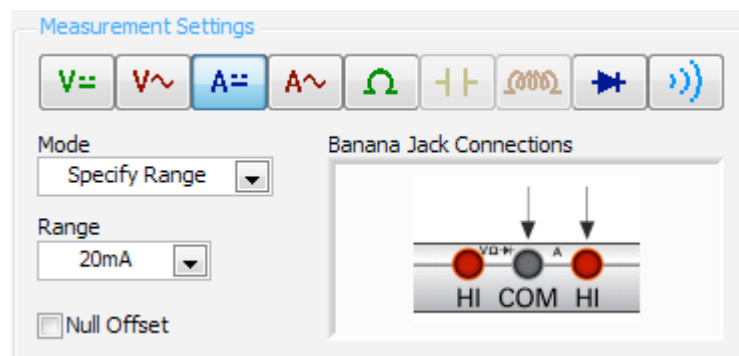


Fig. 4 Measurement Settings for DMM Configured as an Ammeter

Next connect leads from the myDAQ banana jack connections (Fig. 4) to your circuit (Fig. 3).

Press [Run] to make a measurement of the current flowing in your circuit:

$$I = \underline{\hspace{2cm}} \text{ ma}$$

Remove the +5 V power lead.

Set the myDAQ for DMM(V) for voltage measurement.

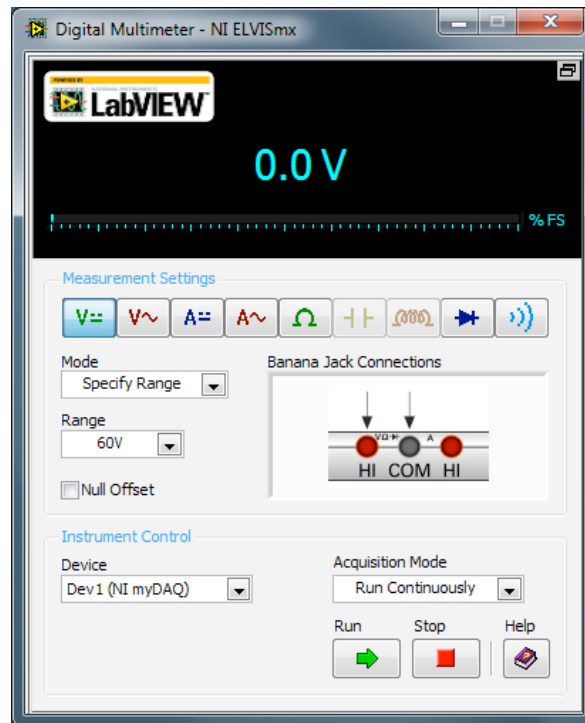


Fig. 5 Measurement Settings for DMM Configured as a Voltmeter

Change the myDAQ banana jack leads to the voltage positions (Fig. 5). In the circuit of Fig. 3, replace the probe leads with wire as a short (bypass). Place the voltage probe leads across a 10 k Ω resistor.

Connect the power back up and make a voltage reading by pressing [Run]:

$$V = \underline{\hspace{2cm}} \text{ volts}$$

Ohm's law states that the voltage developed across a resistor is equal to the current flowing through the resistor times the value of the resistor or $V = IR$.

Rearranging, the resistance is given by the ratio (V/I) , both of which you have just measured.

Calculate this ratio and compare it with your DMM(Ω) measurement.

Exercise 1-2: Resistance Sensors

Our ability to monitor real-world parameters like temperature, pressure, light intensity, etc. depends on sensors, which convert the real-world parameters into a resistance, a current, or a voltage. In fact, the circuit built for Ohm's law demonstrates this concept.

Our voltage divider circuit in Fig. 3 outputs a voltage V_x across the resistor pot given by

$$V_x = R_x / (R + R_x) \times V_{\text{Power}}$$

where R_x is the current value of the pot and the power supply voltage is fixed at +5 V.

Rearranging this expression gives the unknown (pot) resistance as

$$R_x = R / (+5 \text{ V} - V_x)$$

Reconfigure the probes in Fig. 3 to measure the voltage across the resistor pot.

Run DMM(V) continuously. With a small screwdriver, rotate the slider in the pot and watch the voltage change. With the transfer equation above, you can calculate the resistance for each position. You have built an angle shaft encoder, which converts the angle of rotation into a resistance.

Take a look at the Lab 1 video to see other examples of real-world resistance, current, and voltage sensors.

Summary

Thus far, we have shown how to make measurements for resistance, current, and voltage using the myDAQ Virtual Instrument DMM. But there is more! You can embed your resistance meter inside a LabVIEW program and create a new instrument.

Normally, you would read the color codes to select a particular resistor value; then you would verify your selection with the DMM(Ω). A LabVIEW program called Resistance to Colors.vi takes the reverse approach by telling you what the color code on the resistor should be based on an actual resistance measurement of a LabVIEW embedded ohmmeter.

Load and view the front panel of Resistance to Colors.vi.



Fig. 6 Measurement and Colors of a Nominal 47 kW Resistor

Try this yourself. Hook one of your resistors to the myDAQ banana jack leads. Click on [Run]. Amazing! Try some other resistors.

How Did They Do That?

Look at the Fig. 7 block diagram for the answer.

Lab 1. DC Measurements

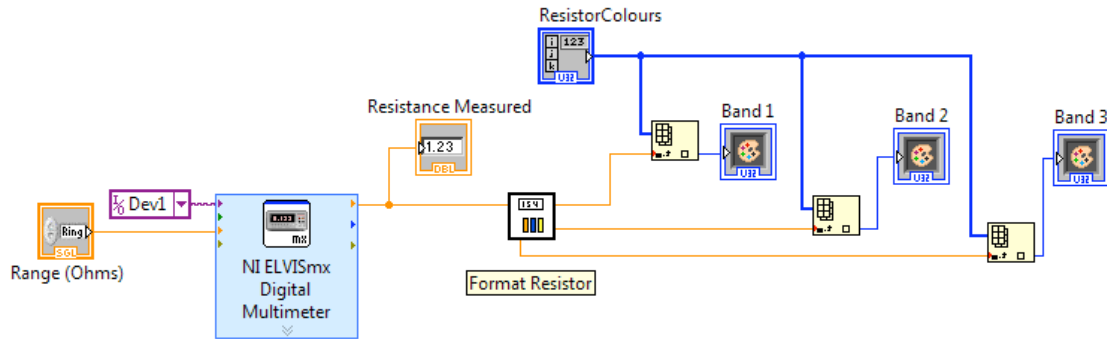


Fig. 7 LabVIEW block diagram for program Resistance to Colors.vi

The resistance measurement is made within a Digital Multimeter VI. It is found in Functions/Programming/Masurement IO/NI ELVISmx/NI ELVISmx Digital Multimeter.

The resistance measurement, a double precision number, is converted in the sub-VI called Format Resistor.vi into a color index number for the first two numbers of the resistance and the exponential power. The colors are stored in an array of LabVIEW color boxes labelled 'ResistorColors'.

Example: $R = 10000 \Omega \rightarrow 1(\text{Brown}), 0(\text{Black}), \text{and } 3(\text{Orange})$
LabVIEW is cool!

Appendix: Resistor Color Codes

