

Ohm's Law with Cobra3

Related Topics

Ohm's law, Resistivity, Contact resistance, Conductivity, Power and Work

Principle

The relation between voltage and current is measured for different resistors. The resistance is the derivative of the voltage with respect to current and is measured in dependence on current. In case of an incandescent lamp the temperature rise with higher current leads to a considerable higher resistance.

Equipment

Cobra3 Basic Unit	12150.00	1
Power supply, 12 V-	12151.99	2
RS232 data cable	14602.00	1
PowerGraph	14525.61	1
Cobra3 Function generator module	12111.00	1
Connection box	06030.23	1
Resistor 100 Ω , 1 W	39104.63	1
Resistor 220 Ω , 1 W	39104.64	1
Resistor 330 Ω , 1 W	39104.13	1
Lamp socket E10	17049.00	1
Filament lamps, 12 V / 0.1 A	07505.03	1
Connecting cord, $l = 500$ mm, red	07361.01	2
Connecting cord, $l = 500$ mm, blue	07361.04	2
PC, Windows [®] 95 or higher		

Tasks

1. Measure the voltage-current characteristic of an incandescent bulb and its power and the work dissipated.
2. Measure the resistance of several resistors in dependency of the current strength.

Set up and procedure

Connect the Function Generator Module to the Cobra3 unit. Connect the Cobra3 unit to your computer to port COM1, COM2 or to USB port (for USB computer port use USB to RS232 Converter 14602.10). Connect both Cobra3 and Function Generator Module to their 12 V supplies. Set up the equipment according to Fig. 1. Start the "measure" program on your computer. Select the "Gauge" "PowerGraph".

On the "Setup" chart click on the "Analog In 2 / S2" symbol and configure this sensor like this:

Fig. 2

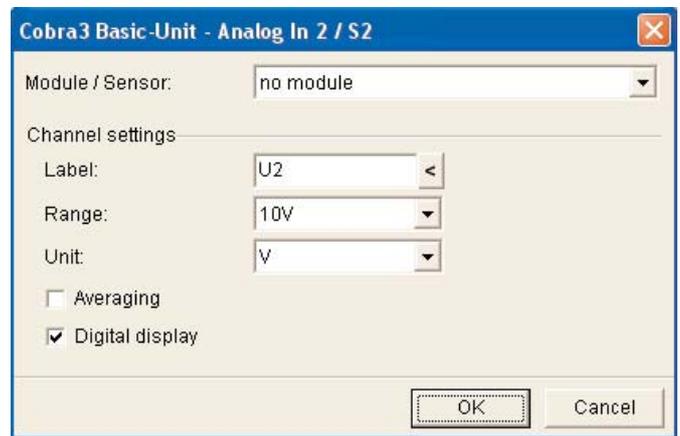
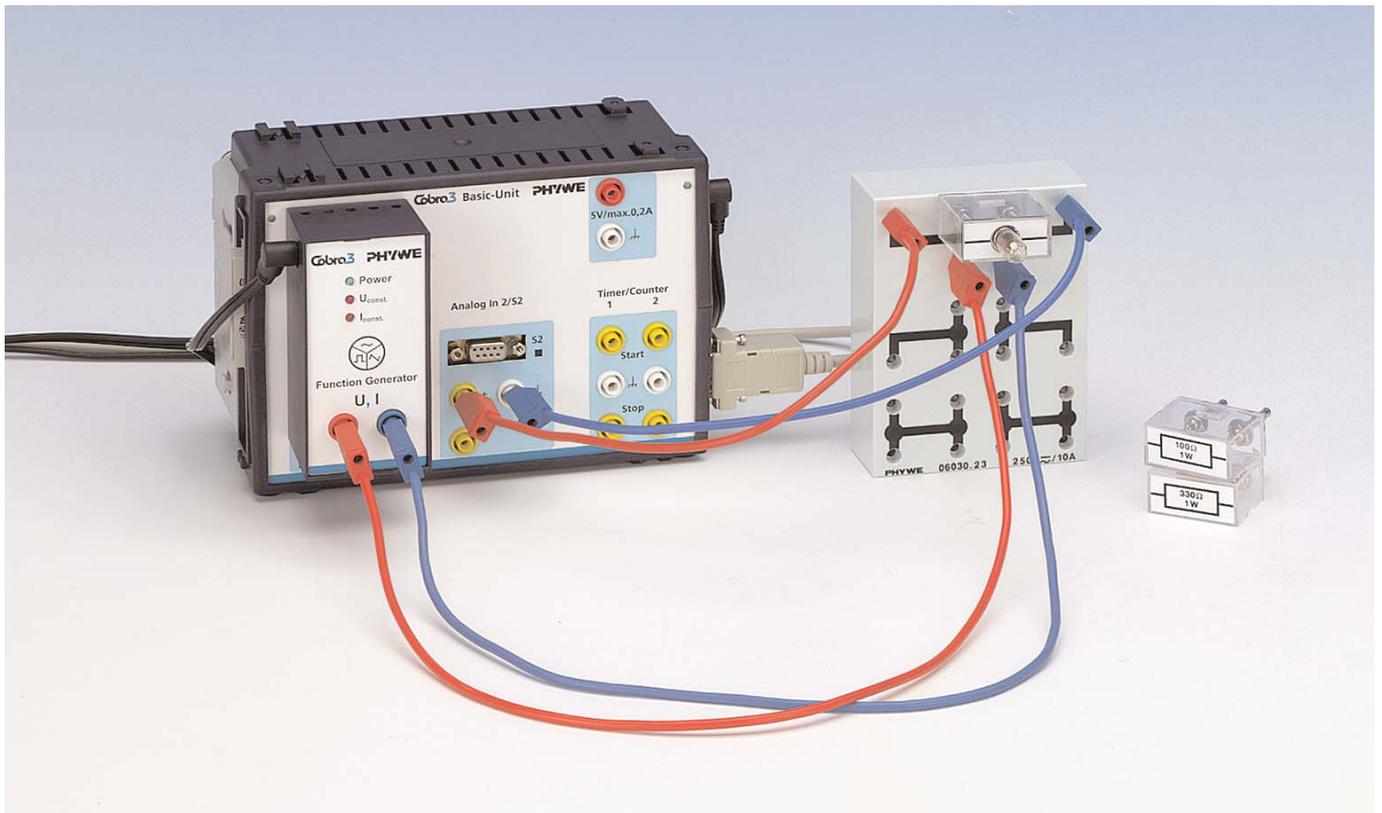


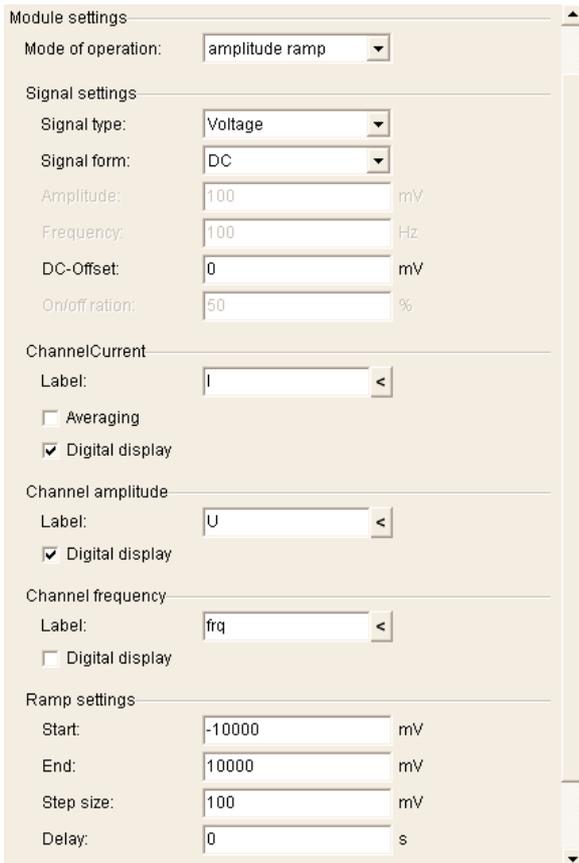
Fig. 1: Experimental set-up



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Then click the "Function Generator" symbol and set the parameters like this:

Fig. 3: FG module settings



Add a "Virtual device" to the "Setup" chart and configure a calculated channel for the recording of the power: (Therefore click on the small triangle under the Setup button and choose Add device.)

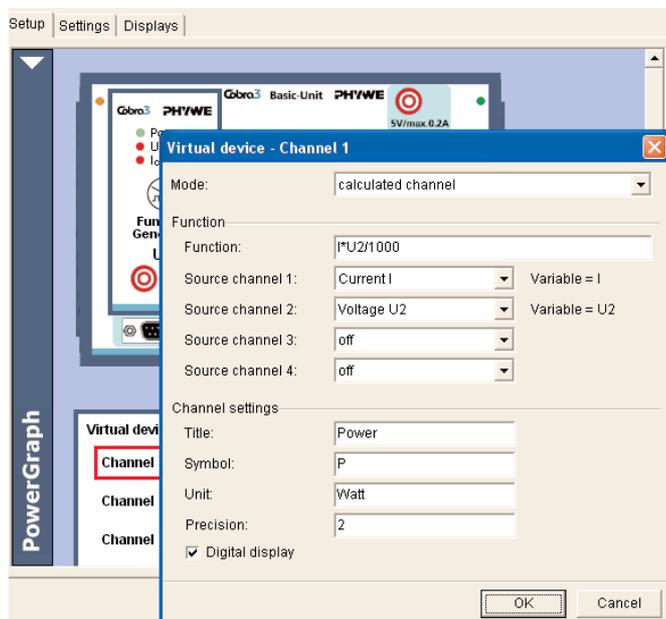
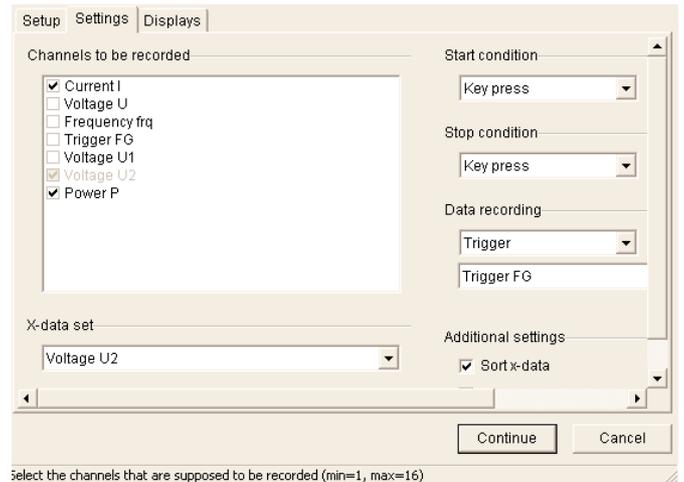


Fig. 4

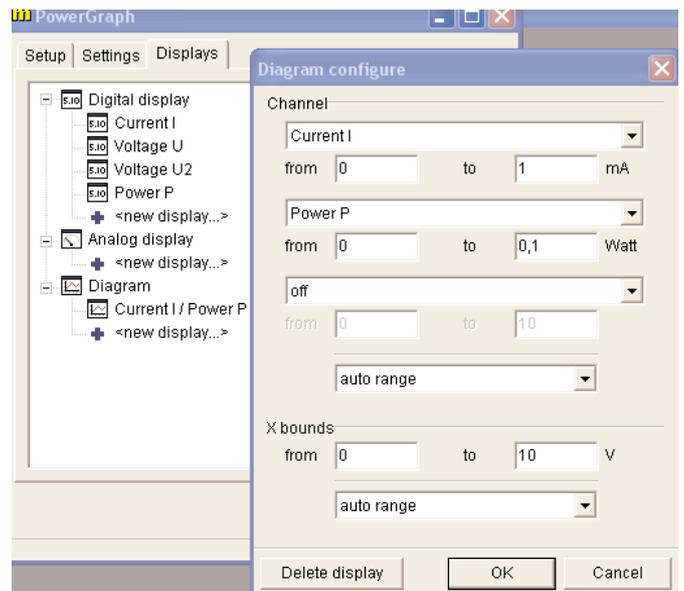
On the "Settings" chart of PowerGraph set the parameters like this:

Fig. 5: PowerGraph settings



And the "Displays" chart may look like this after adding a diagram:

Fig. 6: PowerGraph displays settings



Start the measurement with the "Continue" button.

Add a new channel to the recorded curves named "Time" with the unit "s" with the „Analysis“ > “Channel modification...” function. Since the program records a value every 0.7 seconds if the delay is set to "0", the formula for the time is with e.g. 100 mV steps "0,7*U2/10". Set the time channel as x-axis with the "Measurement" > "Channel manager..." function. Create a new channel named "Work" by integrating the "Power P" channel with the "Channel modification..." function.

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2. Resistance measurement

Now put a resistor into the place where the bulb had been. Record a curve again. You may put several curves into one diagram with "Measurement" > "Assume channel...". The curves may look like this :

Theory and evaluation

1. Incandescent bulb

With the "Regression" tool of the "measure" software it is possible to determine the resistance of the bulb at different applied voltages. E.g. around zero Volt the slope of a slowly measured curve is 90 mA/V, thus is the resistance of the bulb 11.1 Ohm at room temperature. A check with an ohmmeter yields 11.2 Ohm. Around 9 Volt is the slope about 5.6 mA/V and that yields a resistance of 179 Ohm, sixteen times the resistance at room temperature.

The curve is not symmetrical because of the heat capacity of the bulb. When increasing the voltage, a part of the dissipated energy is necessary to warm the bulb and so the temperature is not the same as with the same voltage when decreasing the voltage. If the curve is recorded very slow, the state of thermal equilibrium is better approximated and the curve gets more symmetrical. You can do so by setting the "delay" in the function generator's parameters to some seconds. The rise of resistance with temperature in metals is due to electron scattering at phonons, the quanta of crystal lattice vibrations. The rise can only be considered to be linear for small temperature changes.

2. Resistors

The resistors for industrial use are usually metal film resistors or carbon resistors. The thermal coefficient of them is usually 0.025%/K or 0.0125%/K. The allowed power dissipation specified for them is such that they don't heat up much. Here no deviation from linearity can be seen – the resistance stays the same over all the range of the measurement and they follow Ohm's law,

$$R = \frac{U}{I}$$

with resistance R , current I and voltage U .

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- 1) Draw the voltage vs current graph and voltage versus power graph using the measurement at the lab for $R=100\ \Omega$
- 2) Draw the voltage vs current graph and voltage versus power graph using the measurement at the lab for $R=220\ \Omega$
- 3) Draw the voltage vs current graph and voltage versus power graph using the measurement at the lab for $R=680\ \Omega$

