Nov. 10, 2005

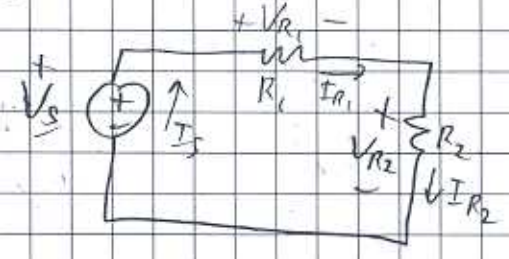
Ohm's Law

Purpose: to verify Ohm's law for several resistors and over a range of voltages and currents. Additionally, to verify the voltage-divider rule and the current divider rule.

Equipment

Multimeter
Resistors,
Protoboard

Method: Here is the basic circuit:

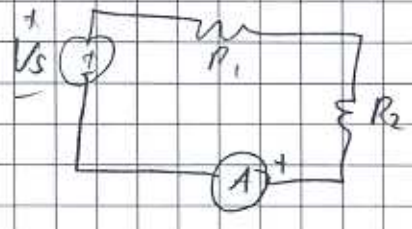


Theory suggests that

$$V_{R_2} = I_{R_2} R_2$$

and $$V_{R_2} = \frac{R_2}{R_1 + R_2} V_S$$

to measure I_{R_2}, place an ammeter between V_S and R_2:



Let V_S be taken from the set
$\{10\,mV, 100\,mV, 1\,V, 10\,V\}$

Let $R_1 = 10\ \Omega$

Let R_2 range over the set $\{1\ \Omega, 10\ \Omega, 100\ \Omega, 1\,k\Omega, 10\,k\Omega, 100\,k\Omega, 1\,M\Omega\}$

~~Instead of letting $R_1 = 10\ \Omega$, let~~

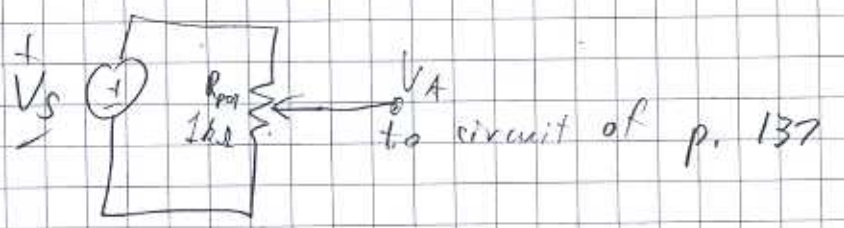
Here is a table of predictions and measured results. The first column of predictions is based on the use of nominal voltages and resistances. The second set is based on measured voltages and resistances.

V_S Planned	V_S Measured	R_1 Planned	R_1 Measured	R_2 Planned	R_2 Measured	I_{R_2} Pred 1	I_{R_2} Pred 2	I_{R_2} Meas.	V_{R_2} P_1	V_{R_2} P_2	V_{R_2} Meas
10mV	10.30mV	10Ω	9.909Ω	1Ω	1.091Ω	909μA		880μA	909μV		982μV
	10.1mV			10Ω	9.964Ω	500μA		459μA	5mV		5.10mV
	9.61mV			100Ω	980.8Ω	90.9μA		89.0μA	9.09mV		8.83mV
	9.786mV	See correction on p. 139		1kΩ	1.058kΩ	9.90μA		9.8μA	9.9mV		9.68mV
	10.168mV			10kΩ	9.834kΩ	999nA		1.0μA	9.99mV		10.17mV
	10.51mV			100kΩ	99.33kΩ	100nA		100nA	10.0mV		10.08mV
	10.27mV			1MΩ	1.035MΩ	10.0nA		0	10.0mV		10.08mV
100mV	105.3mV			1Ω		9.09mA		9.30mA	9.09mV		10.11mV
	98.90mV			10Ω		5.00mA		4.89mA	50.0mV		49.73mV
	100.9mV			100Ω		909μA		859μA	90.9mV		90.6mV
	100.1mV			1kΩ		99.0μA		100.7μA	99.0mV		99.15mV
	99.54mV			10kΩ		9.99μA		10.1μA	99.9mV		99.50mV
	100.7mV			100kΩ		1.00μA		1.0μA	100mV		100.9mV
	101.6mV			1MΩ		100nA		100nA	100mV		101.6mV
1V	1.014V			1Ω		90.9mA		68.9mA	90.9mV		96.9mV
	1.069V			10Ω		50.0mA		43.8mA	500mV		538mV
	1.021V			100Ω		9.09mA		8.51mA	9.09mV		9.35mV
	1.037V			1kΩ		990μA		1.013mA	990mV		1.027V
	1.039V			10kΩ		99.9μA		105.6μA	999mV		1.038V
	1.055V			100kΩ		10.0μA		10.5μA	1.00V		1.055V
	1.061V			1MΩ		1.00μA		1.0μA	1.00V		1.056V
10V				1Ω		909mA		—	909mV		10.61V
				10Ω		500mA		—	5.00V		
				100Ω		90.9mA		—	9.09V		
	10.00V			1kΩ		9.90mA		9.97mA	10.0V		9.86V
	9.90V			10kΩ		999μA		1.03mA	10.0V		9.90V
	10.0V			100kΩ		100μA		103μA	10.0V		9.97V
	10.1V			1MΩ		10.0μA		9.8μA	10.0V		10.0V

Three combinations above were not used because they lead to excessive power dissipation in R_2.

of the protoboard

The power supply couldn't generate less than about 1.5V. I used a potentiometer to lower it further:



Because the current to the circuit under test varied, I had to adjust the potentiometer repeatedly and then measured the applied voltage.
What is shown above as V_A is labeled V_S on p. 139, except where $V_S = 10V$, I was able to eliminate the voltage divider above.

I haven't made any measurements of current dividing, so for the moment I won't be able to draw any conclusions about the current divider rule.

The multimeter was an HP 34401A Multimeter
The protoboard was a Global Specialties Proto-Board PB-503.

The resistors were of various physical sizes: the 10Ω, 1kΩ, 10kΩ and 100kΩ resistors were 1/8W resistors. The others were all larger than these.

I found the table opposite to be too crammed for me to enter predictions based on measured values. I can calculate these and include them in the report.

I see I recorded the 100Ω resistor as 980.8Ω. Surely it's 98.08Ω? I decided to remeasure it. I found it value to be 105.2 Ω.