1. Voltage, Current and Ohm's Law

Introduction

Current flows in an electrical installation and that current is the result of a voltage. How much electricity will flow? How fast is the battery discharged? How can the current be measured? What is the difference between a voltage source and a power source? A lamp has resistance, but is the relationship between voltage and current linear?

To understand the operation of the electrical installation and to be able to select parts, we need knowledge. In this first assignment, we will look at the principles that are generally valid, so that we can use our knowledge to tackle all kinds of electrical engineering problems.

Preparation

Before you can carry out this weekly assignment, you must have prepared this assignment before the start of the lesson. This means that you read the following carefully and find out any ignorances and make them your own. This way you can finish this assignment within the time limit to avoid falling behind.

Goals

1. Using the Multimeter for Measuring DC and DC Current
2. Using the reference direction of voltage and current
3. Use of the DC power supply, as a power source and voltage source
4. Reading circuit diagrams
5. Clear / logical construction of circuits
6. Verifying Ohm's Law
7. Describe electrical components (resistor, lamp and diode) with graphs

Language

DC	Direct Current = direct current
Fine	fine
Coarse	coarse
DC power supply	DC power supply device (but usually voltage source)
Characteristic:	A graph that shows you at a glance how an electrical network or an electronic component works
Diode:	An electronic component that only allows the current to pass in one direction.
'Hard' voltage:	Voltage from a source with low internal resistance
Measuring range	

Current flows <u>through</u> a resistor. Voltage stands <u>over</u> a resistor

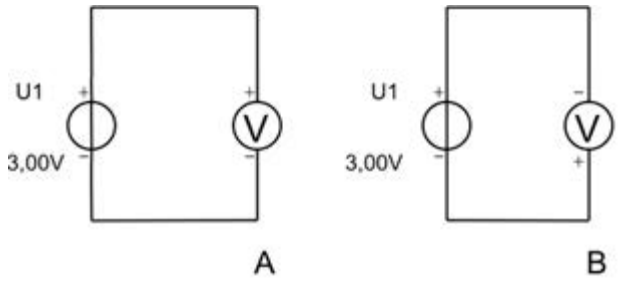
1. The DC power supply as a voltage source and current source

The DC power supply can work both as a current source and as a voltage source. LEDs indicate whether the current regulation (C.C. = Constant Current) or the voltage regulation (C.V. = Constant Voltage) is active.

DC power supply as a voltage source

In order for the DC power supply to work as a voltage source, the current control must be sufficiently open. When the DC power supply is overloaded, the current control will limit the output current and turn on the LED C.C. (= Constant Current).

Adjust the voltage on the DC power supply to exactly 3.00 V.
Then close a digital multimeter as shown in the measurement circuits A and B.



a. Read the tension for both schedules.

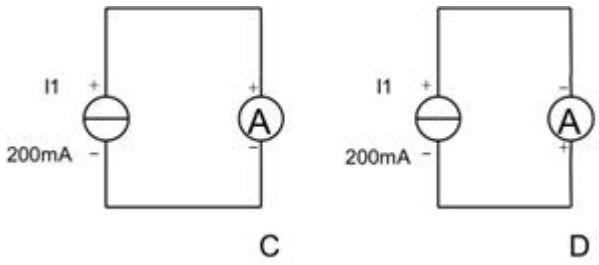
A: B:

b. How much current is flowing in the circuit? Read the ammeter of the DC power supply. (Keep in mind that the last digit of a digital readout can always be 1 more or 1 less)

I =

DC power supply as a current source

In order for the DC power supply to work as a current source, the voltage control must be sufficiently open. The current control allows the desired current to be set. Keep in mind that the current cannot flow through the air, to set the current source to the correct value you have to short-circuit the output of the DC power supply with a wire.



Set the current control to a minimum. Short circuit the output with a wire.
Set the current source to exactly 0.200 A (200 mA). Remove the short-circuit wire.
Then close a digital multimeter as shown in the measurement circuits C and D.

c. Read the current for both measurement circuits.

C:
D:

d. Record the meter's *measurement range* (question: what is this?)

Meaning:

The measuring range is:

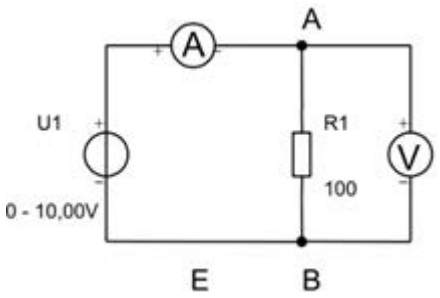
e. How much voltage is there across the ammeter? Read the voltmeter from the DC power supply or connect an additional voltmeter if necessary.

f. Calculate from the measurement data *the resistance of the multimeter as an ammeter* on this measuring range (compare the value with measurements of your colleagues !).

R_{Ameter} =

2. Verification of ohm's law

Draw measurement circuit E in your logbook and build it up. Set the DC power supply as the voltage source (maximum current control).



a. For R1, use a resistor of 100 Ω. Set the voltage across the resistor in steps to 2.00 V, 4.00 V,....10.00 V, and measure the current each time. Fill in the readings in the table.
Pay attention to the correct units in the table.
Always calculate the expected value for the current and check that the calculated and measured values match.

100 Ω	U (V)	I ( ) measured	I ( ) calculated
	2,		
	4,		
	6,		
	8,		
	10,		

b. Repeat the measurement but use a resistor of 470 □ for R1.

470 Ω	U (V)	I ( ) measured	I ( ) calculated
	2,		
	4,		
	6,		
	8,		
	10,		

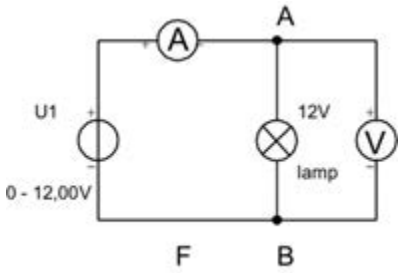
c. Draw a graph I =f(U) for both measurements (R1=100 Ω, and R1= 470 Ω) in one figure on graph paper and determine the measured resistance values using the directional coefficients of the lines.

100 Ω	Measured resistance:
470 Ω	Measured resistance:

d. How much do these values deviate from the given values? Does this fall within the tolerance limits of the resistors?

3. Relationship between voltage and current in an incandescent bulb

Draw measurement circuit F in your logbook and build it up. Set the DC power supply as the voltage source (maximum current control).
Use a 12 V halogen light.



a. Set the voltage across the lamp to 2.00 V, 4.00 V, ...12.00 V (step 2 V), and measure the current each time.

U (V)	I ( )

b. Draw a graph I =f(U) on graph paper. Determine the resistance of the lamp at 1, 3, 6 and 12 V from the graph.

U (V)	I ( )	R ( )
1		
3		
6		
12		

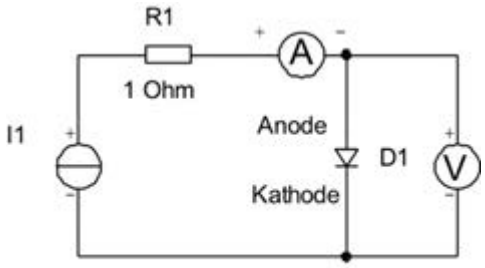
c. Explain the course of the curve

4. Relationship between voltage and current at a diode

Draw the diagram in your logbook and build circuit G. Use a 3 A diode on the switchboard for this measurement. A diode should **never** be connected directly to a voltage source, so the measuring circuit is adjusted with a resistance of 1 Ohm.

A current is sent through the diode with a current source, while the voltage drop across the diode is measured, as seen in circuit G.

At the beginning of the measurement, set the source to 0 A.



G

a. Let the current increase in steps from 0 A to a maximum of 1.0 A. You will see that the voltage suddenly changes little. Choose the current in such a way that you have measured sufficient voltage differences in the range 0.3 to 0.7 Volts (see also assignment c).

I1 ()	U_{ak} ()

b. Connect the diode the other way around (with the Anode at the minus – of the power supply) and measure the current at U_{ak} = -20 V.

U_{ak} ( )	I1 ( )	R( )

c. On graph paper, draw a graph I = f (U_{ak}). From the graph, determine the resistance of the diode at 0.3 V, 0.6 V and 0.9 V.

U_{and} (V)	I1 ( )	R ( )
0,3		
0,6		
0,9		

5. Conclusion on the results

a. These tests involved linear and non-linear elements. Indicate which ones are linear, and which are not.

Resistance	
Halogen light	
Diode	

b. True or False:

I. If the voltage on a lamp increases 2 times, the current also increases 2 times.
II. If the current through a diode becomes 2 times smaller, then the voltage also becomes 2 times smaller.
III. Ohm's law is a linear function.

Theorem	True / False
I.	
II.	
III.	