Electricity

Magnetostatics

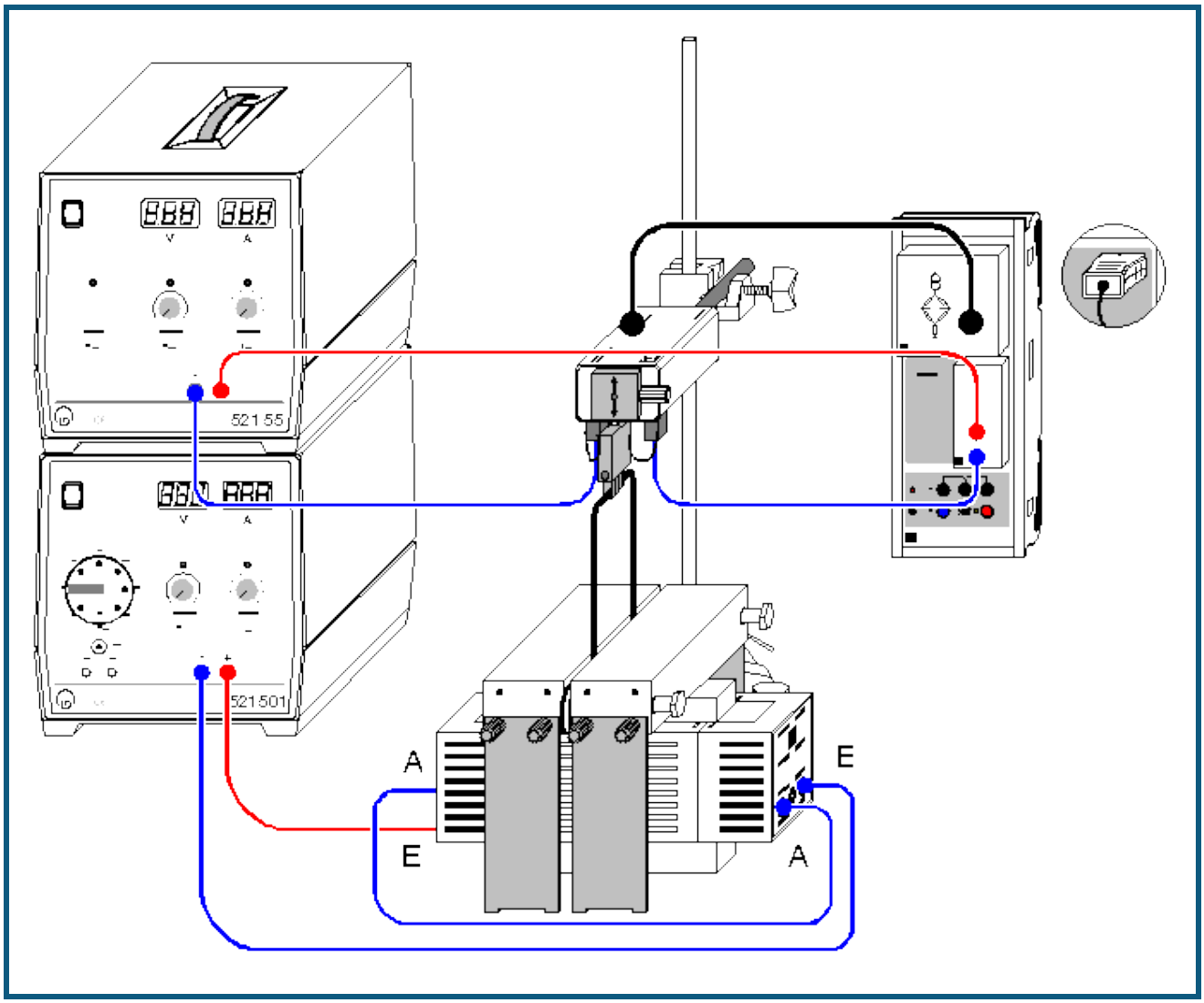
Effects of force in a magnetic field

Measuring the force acting on current-carrying conductors in a homogeneous magnetic field - Recording with CASSY

Description from CASSY Lab 2

For loading examples and settings, please use the CASSY Lab 2 help.

Force in the magnetic field of an electromagnet



can also be carried out with Pocket-CASSY and Mobile-CASSY

Experiment description

In this experiment, a homogeneous magnetic field B is generated using an electromagnet with U core and pole-shoe yoke. The object is to measure the force F acting on a conductor loop as a function of the current I (F proportional to I). The measuring results for different conductor lengths s are compiled and evaluated in the overview graph (F/I proportional to s). The ultimate aim is to verify

$F = I \cdot s \cdot B$

By means of differentiation we verify Faraday's law of induction

Equipment list

1	Sensor-CASSY	524 010 or 524 013
1	CASSY Lab 2	524 220
1	Bridge box	524 041
	with Force sensor and	314 261
	Multicore cable, 6-pole, 1.5 m	501 16
	or	
1	Force sensor S, ±1 N	524 060
1	30-A box	524 043

1	Support for conductor loops	314 265
1	Conductor loops for force measurement	516 34
1	U-core with yoke	562 11
2	Coils with 500 turns	562 14
1	Pole-shoe yoke	562 25
1	High current power supply	521 55
1	AC/DC power supply 0...15 V	521 501
1	Stand base, V-shape, 20 cm	300 02
1	Stand rod, 47 cm	300 42
1	Leybold multiclamp	301 01
2	Connecting leads, 50 cm, blue	501 26
2	Connecting leads, 100 cm, red	501 30
2	Connecting leads, 100 cm, blue	501 31
1	PC with Windows XP/Vista/7/8	

Experiment setup (see drawing)

Slide the two coils onto the U-core. Place the two heavy pole pieces transversely on top of them. You can adjust the height using the lateral stand. The gap can be changed by moving one of the two pole pieces and adjusted with non-magnetic spacers.

The force sensor holds a conductor loop via the support and is positioned so that the conductor loop is inserted in the gap between the pole pieces of the electromagnet. The conductor loop must not touch the pole pieces. The two 4-mm sockets on the bottom of the force sensor are intended for supplying the conductor loop support. They are not connected internally. The force sensor is connected to the bridge box at input A of Sensor-CASSY.

The current flows from the 20 A supply unit via the 30 A box on input B of Sensor-CASSY through the conductor loop and back to the power supply. The current of the second 5 A power supply flows through the two coils on series. Make sure that the magnetic fields of the two coils add together (connect A to A and both E to the power supply as shown in the drawing).

Carrying out the experiment

- Load settings
- Set the force zero point in Settings Force FA1 with → **0** ← and, where necessary, switch on the smoothing LED of the bridge box with **LED On/Off**.
- You may want to set the current zero point in Settings IB1 with → **0** ←.
- At the power supply of the coils, set about 2.5 A.
- Increase the conductor loop current I from 0-20 A in steps of 2 to 5 A, and record a measured value with ⏱ each time. You can delete a faulty measurement from the table with Table → Delete Last Table Row.
- If only negative forces are measured, reverse the connections on the conductor loop support.
- Carry out the experiment rapidly, as the conductor loop and support may be subjected to loads of 20 A only briefly.
- At the end of the experiment, set the conductor loop current to 0 A.
- Record additional measurement curves with a different conductor loop length s. Select **Measurement → Append new Measurement Series**.

Evaluation

Fit a straight line to each measurement series F(I). After each best-fit straight line, switch to the display **Magnetic Field** (click the tab with the mouse). Here, an additional table is filled out by dragging the slope F/I just determined from the status line using the mouse and dropping it next to the respective conductor loop length (drag & drop). Enter the conductor loop length s directly via the keyboard. The desired diagram is generated as you enter the values.

In this display, the slope of the best-fit straight line gives us the magnetic field strength B between the pole pieces, as $F/I = B \cdot s$ (in this example, B = 164 mN/(A·m) = 164 mT).