magnetic field of a coil with AC (Item No.: P6300769)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 16-19
Topic: Electricty
Subtopic: Electric generator, motor, transformer
Experiment: Magnetic field of a coil with AC

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Difficult	10 Minutes	30 Minutes	2 Students

Additional Requirements:

- power supply
- Tablet with measure App

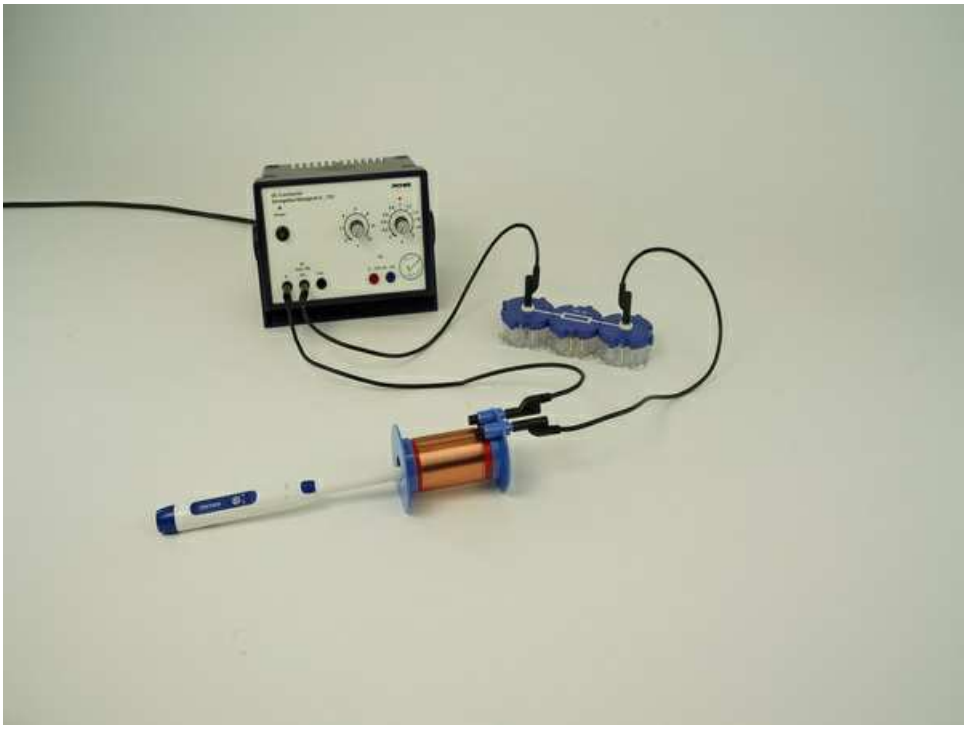
Experiment Variations:

Keywords:

magnetic field of a coil, Magnetic flux density, coil with AC, frequency of alternating current

Information for teachers

Introduction



Application
You can find the frequency of the Ac voltage with the help of a coil and magnetic field sensor. Ac voltage is in every household. The network frequency in th European Union has $f = 50Hz$.

Educational objective
The magnetic field of the coil has the same frequency as that of the AC. This is one method to find out the frequency of the AC current from the power source.

Task
1. Measure the magnetic flux density of coil with AC over time.
2. Calculate the frequency with the measured data.

Prior knowledge
The students should be falmiliar with the basics ofo magnetic flux density and schould know that a current-carrying coil generates a magnetic field

Principle
A current carrying coil generates a magnetic field. The magnetic flux density of a long coil is:

$$B = \mu \frac{NI}{l}$$

B is the magnetic flux density, μ is the magnetic permeability, N is the number of turns, I is the current and l is the length of the coil.
With a altenating current, the magnetic flux density alternating too.

Notes concerning the set-up and execution of the experiment
In this experiment, AC and not DC is used. The resistence is necessary, because the coils can overheat otherwise.
The students can use different coils, the result does not change.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic field	12947-00	1
2	Induction coil, 100 turns, d = 40 mm	11007-05	1
3	Junction modul, SB	05601-10	2
4	Resistor module 10 Ohm, SB	05612-10	1
5	Connection cord, 32 A, 500mm, black	07361-05	3
6	PHYWE power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

Safety information

For this experiment, the general notes and intructions concerning safe experimentation in science classes apply. Make sure that the resistance of 10Ω is build in, otherwise the coils get hot.

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Introduction

Application and Task

Application
AC has a frequency. In Europe is the usually frequency $50Hz$. What is the frequency of the power supply?

Task
1. Measure the magnetic flux density in a coil with alternating current over time.
2. Calculate the frequency from your measurement data.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic field	12947-00	1
2	Induction coil, 100 turns, d = 40 mm	11007-05	1
3	Junction modul, SB	05601-10	2
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Setup and Procedure

Setup

Set up the experiment as shown in fig. 1. Connect the power supply, the 10 Ω resistor and the coil in series. Connect your circuit to the power supply to the 6V AC source.

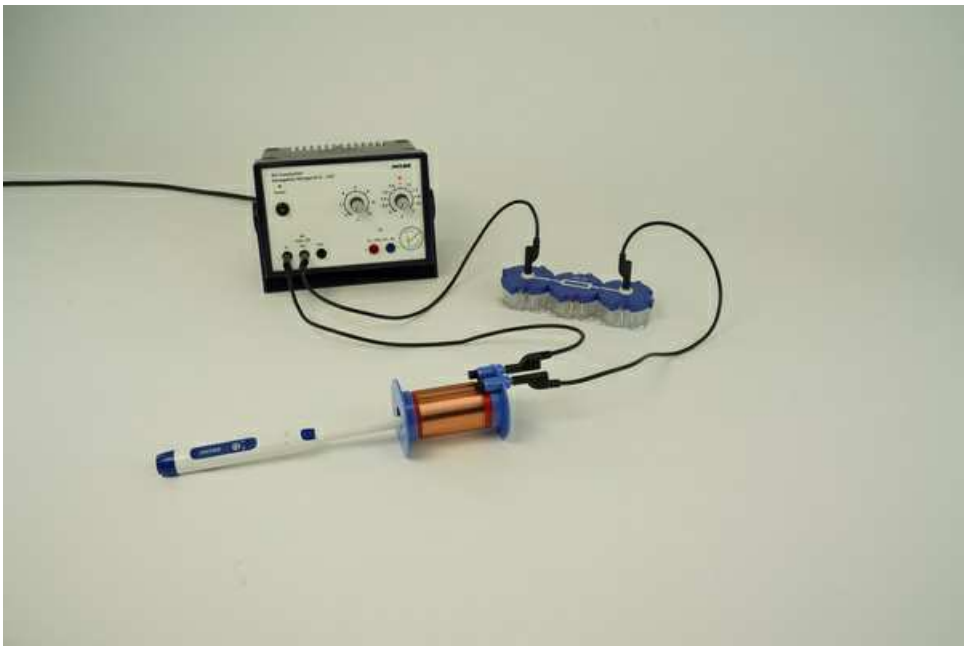

fig. 1

Connect the magnetic field sensor to your tablet. Select the fine measerung range of the magnetic field ssensor from -5...5mT (fig. 2). Set only the magnetic field direction in the longitudinal direction of the magnetic field sensor B_x (fig. 3.).

fig. 2

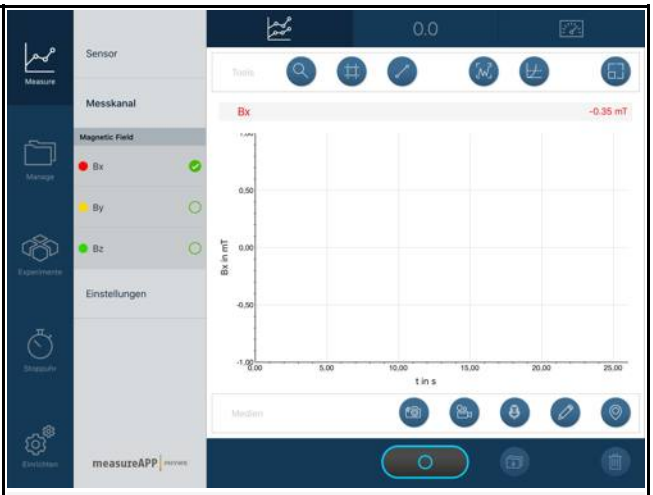

fig. 3

Under [Settings] you can set the accuracy of your measurement under [Sampling rate]. Set this to the maximum (fig. 4 and fig. 5.).


Sensor
Messkanal
Einstellungen
Abtastrate
200 Hz
Wiederholungs-messung
Messung auf Tastendruck
Modus
X-Achse
Zeit
Auf Null setzen
measureAPP
0.0
Bx
-0.39 mT
Bx in mT
t in s

fig. 4


Abbrechen
Speichern
200
Hz
1 Hz
200 Hz

fig. 5

Procedure

Start a measurement with your tablet and switch on the power supply. Switch off the power supply after approx. 10 seconds and stop the measurement (fig. 6). You can use the magnifying glass to select a measuring range more precisely. Choose a time period of 1 second (fig. 7).

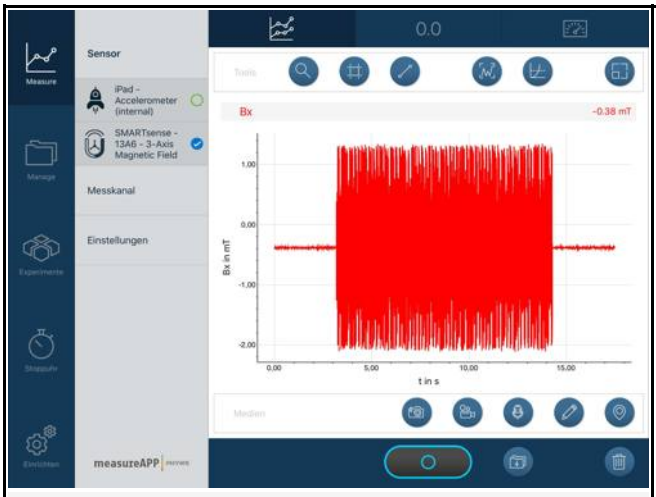

fig. 6

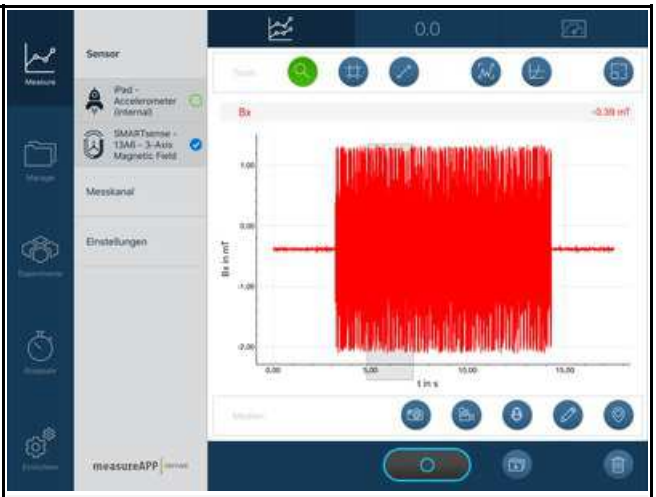

fig. 7

Count the periods and calculate the resulting frequency from the power supply.

fig. 8

Report: magnetic field of a coil with AC

Question 1 (1 point)

What exactly does the unit Hertz [Hz] mean?
Note: "s" stands for seconds, "V" stands for volts.

- [x] 1/s
- [ ] s/1
- [ ] V/s

Question 2 (50 points)

Wie hoch ist deine gemessene Frequenz? 48 - 52

Question 3 (1 point)

Is the frequency you measured the same as the frequency of the AC voltage from the power supply?

- [ ] No, the AC voltage is only half as meadured frequency.
- [x] Yes, the AC voltage must be the same.
- [ ] No, the AC voltage is twice as the measured frequency.