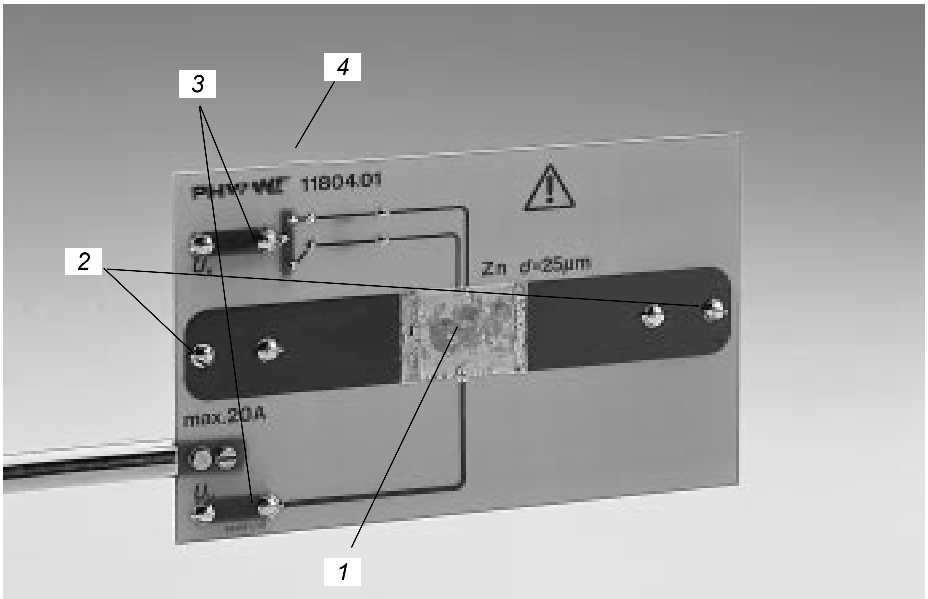
Hall effect of zinc, carrier board

11804.01

Operating instructions



1 PURPOSE AND CHARACTERISTIC FEATURES

The carrier board is used to determine the Hall effect on those metals (here zinc) with which the polarity of the Hall voltage generated corresponds to a conducting mechanism based on positive charge carriers (abnormal Hall effect).

2 DESCRIPTION AND USAGE

2.1 Function elements and operating elements

The carrier board with holding rod consists of a circuit board which has 4 mm sockets on the back for use from the side. The conductor *1* consists of a thin zinc foil, with copper for carrying the current on each side of it. A base current of max. 20 A is passed through the zinc foil via the sockets *2*. The Hall voltage is picked up at the sockets *3*. The loss in voltage - voltage drop between the Hall voltage pick-ups resulting from the base current or thermal tension - which is superimposed by the Hall voltage, can be compensated for using the potentiometer adjusting knob *4* at the back (Fig. 2). The Hall voltage contacts on the crystal must, namely, only be slightly staggered sideways to each other in the direction of the base current, for the base current to cause a voltage drop which falsifies the Hall voltage which is to be determined, even when no external magnetic field is applied. When one pick-up for the Hall voltage is replaced by two pick-ups, and these are positioned one on each side of the ideal pick-up, then an equalizing potentiometer can be inserted, as is done on the carrier board.

2.2 General set-up

Hold the carrier board between the pole shoes of an electromagnet so that the homogeneous magnetic field completely permeates the marked measurement field.

Connect a source of direct current to the sockets *2*, from which a current of up to 20 A is to be taken.

First regulate the adjusting knob *4* to equalize the Hall voltage pick-ups without application of a magnetic field. When this equilization is correctly carried out and the base current flows, no voltage should be found at the sockets *3*. Now switch on the magnetic field. A magnetic flux density of about 300 mT and a base current of approx. 12 A are necessary to generate a Hall voltage of 7 µV. It is absolutely necessary that the electromagnet be driven by smoothed direct current, as otherwise interfering induction voltages could occur.

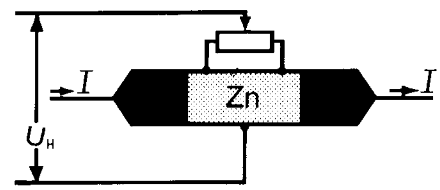


Fig. 2

A thermoelectric voltage is generated in the measurement circuit, and is superimposed on the Hall voltage. This interfering voltage is, because of the very small Hall constant for zinc, of the same order of magnitude as the Hall voltage. To determine the correct Hall voltage, therefore, measure the voltage at the sockets *3* with and without an applied magnetic field. The difference in voltages is the Hall voltage.

2.3 Experimental notes

For feeding in the base current, an adjustable heavy current power supply is best used (see Accessories). Alternatively to this, a six cell Ni-Cd accumulator whose cells are switched parallel in pairs can be used. Manganin strips serve as series resistance (0.220 ohms/m).

To generate the magnetic field, a magnet constructed from a U-shaped iron core with two coils, each with 300 turns, and two plane pole shoes is used. A direct current of approx. 4 A is needed to feed the coils. As alternative, the PHYWE electromagnet, which generates greater field strengths, can be used with appropriate plane pole shoes.

To determine the Hall voltage, a sensitive voltmeter (measuring range 30 mV or 100 mV) must be connected to the sockets *3*.
The accuracy of the measurement of the Hall voltage can be considerably increased by passing an alternating current instead of a direct current through the sample. In this case, a Hall alternating voltage is obtained which can be determined as amplification using an NF amplifier. A further advantage is that the superimposed thermoelectric voltage has no influence on the result.
The alternating current method does not give any information on the sign of the effective charge carriers, however.
The PHYWE Teslameter, with a tangential Hall probe, is suitable for the determination of the magnetic flux density.

3 SPECIFICATIONS

Thickness of the zinc sample	25 µm
Surface area of the zinc sample	(35 x 25) mm
Max. base current	20 A

4 LITERATURE REFERENCE

Hochschulpraktikum Physik 1-3	16502.01

5 ACCESSORIES

For the generation of a magnetic field

Power supply, universal		13500.93
Coil, 300 turns	(2 x)	06513.01
Pole pieces, plane, 30x30x48 mm, 2	(2 x)	06489.00
Iron core, U-shaped, laminated		06501.00
alternatively		
Electromagnet w/o pole shoes		06480.01
Pole piece, plane	(2 x)	06480.02

For the base current

Power supply 0-30VDC/20A, stable	13536.93
alternatively	
Ni-Cd accumulator cell, 7.2 VDC	07490.26

For the alternating current method

Var. transformer, 25VAC/20VDC, 12A	13531.93
Rheostat, 10 Ohm, 5.7 A	06110.02
Universal measuring amplifier	13626.93

For the determination of the magnetic flux density

Teslameter, digital	13610.93
Hall probe, tangential, prot. cap	13610.02

Measuring instruments for current and voltage are additionally required