P64.36

ENS LYON

Hall-effect-module
Hall-effect *p*-Ge carrier board
Hall-effect *n*-Ge carrier board
Intrinsic conductivity of germanium carrier board

11801.00
11805.01
11802.01
11807.01

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CE The unit complies with the corresponding EC guidelines.

Operating Instructions

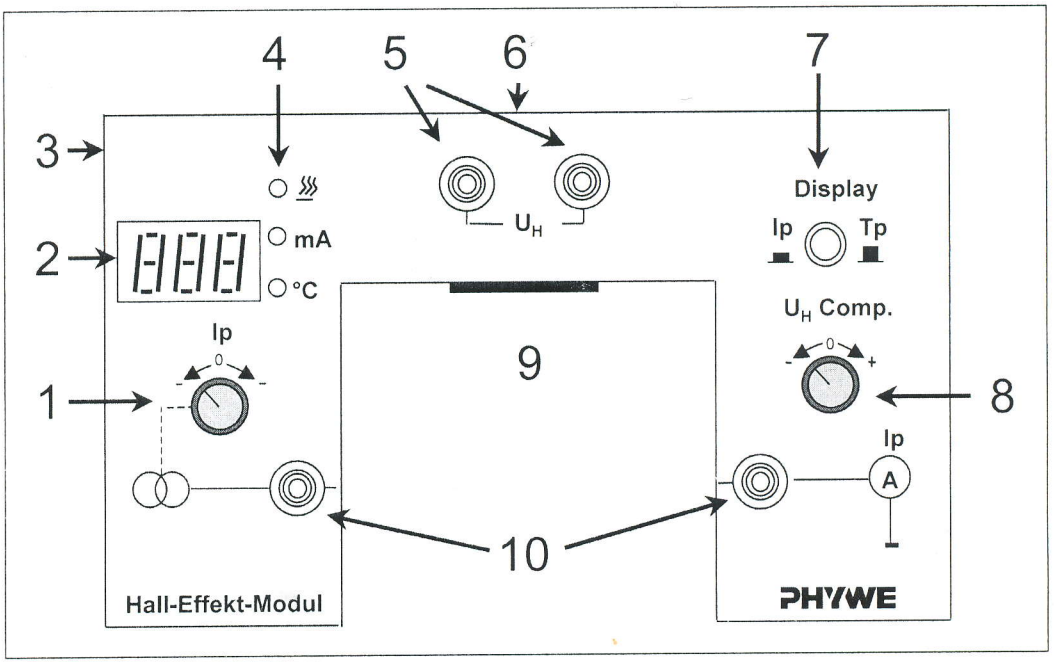

Fig. 1: View of the front of the Hall module with the various operating elements and displays.

1 SAFETY PRECAUTIONS

- Carefully read these operating instructions completly before operating this instrument. This is necessary to avoid damage to it, as well as for user-safety.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Caution! The exchangeable carrier board can get very hot during operation. There is a danger of burns to hands. Do not handle the board until the module has been switched off and an appropriate cooling-down time has elapsed.
- Do not start up this instrument should there be visible signs of damage to it or to the line cord.
- Only use the instrument for the purpose for which it was designed.

2 PURPOSE AND DESCRIPTION

The Hall-effect-module serves to hold and supply carrier boards which are equipped either with a *p*-Germanium or *n*-Germanium sample, or with a non-doped Germanium sample (intrinsic conductivity).
The doped Germanium samples are to be used to measure the Hall-voltage as a function of the sample current, the magnetic flux density or the sample temperature. The measured values and the sample geometry are to be used first to calculate the Hall-constant and the sample conductivity for each sample and then, from these, to determine the sign of the charge carriers, their mobility and their concentration.
The non-doped Germanium sample is to be used to measure its conductivity as a function of the temperature, and from this the band gap is to bedetermined.

The Hall effect module must be supplied with a 12 V alternating voltage. The module creates from this an adjustable and controlled sample direct current of each sign, a fault voltage compensator and the heating power for the meandering heating path on a carrier board.
Via the temperature sensor on the carrier board the sample temperature is controlled. Thus an exceeding of the max. alloved temperature of T = 170°C is avoided. This safety function avoids overheating, which would cause the soldering tin at the semiconductor sample contacts to be melted off.

You can select whether the sample current or the sample temperature is to be displayed by the 3-place LED display.
The module has 4 mm safety sockets for feeding in the supply voltage and for the determination of the Hall and sample voltages. An additional RS 232 interface allows measured values to be alternatively collected, presented and evaluated by a Cobra3 interface system.

3 HANDLING

3.1 Function elements and operating elements

(Fig. 1 and 2)

Function elements at the front of the Hall module:

1 Rotary knob for the sample current I_p
2 Digital display, displays either sample current I_p or sample temperature T_p as selected
3 Threaded socket for screwing in the holding rod supplied
4 Series of LEDs which indicate the operating mode of the sample heating, and whether the digital display shows sample current I_p or sample temperature T_p
5 Pair of 4 mm safety sockets for pick up of the Hall voltage U_H
6 Positioning bore hole for a tangential magnetic field probe
7 Press switch for selection of the display of sample

current I_p or sample temperature T_p

8 Rotary knob for compensation of the Hall voltage U_H for fault voltage

9 Shaft for acceptance of the sample board with contact strip

10 4 mm safety sockets for pick up of the sample voltage U_p

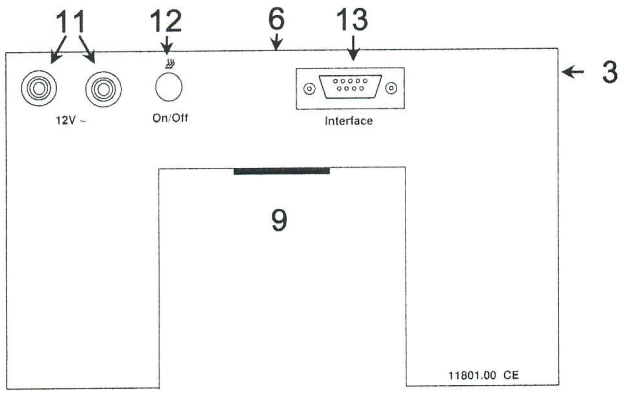

Fig. 2: View of the back of the Hall module with the various operating elements .

Function elements at the back of the Hall module:

11 Pair of 4 mm safety sockets for connection of the supply voltage

12 Press switch for heating to be "On" or "Off"

13 RS 232 interface for connection to the Cobra3 interface

3.2 Operating procedure

Insert the carrier board in the shaft guide slots (9) and ensure that the edge-board connection fits securely in the contact strip. Screw the holding rod that is supplied in the threaded socket in the side of the module (3). This will enable the sample on the inserted carrier board to be subsequently conveniently positioned between the pole pieces of an electromagnet, using additional stand material.

For the determination of the magnetic flux density, insert the tangential magnetic field probe as far as it can go into the bore hole (6). This will ensure that the measuring tip of the probe is at the height of the sample.

Supply the module with alternating voltage (12 V/5 A) via the pair of sockets at the back (11).

3.2.1 Experimental procedure without the Cobra3 interface system

Experiments with *n*- and *p*-doped Germanium

Connect a suitable digital multimeter to the appropriate pair of sockets (5) and (10) for the measurement of the Hall voltage, or the voltage drop at the sample for the conductivity determination.

Prior to using rotary knob (1) to adjust the stabilised sample current (0... approx. ±55 mA), operate the press switch (7) to switch the LED display (2) to the mA display (the "mA" diode (4) must light up).

It is possible that the Hall contacts do not lie directly opposite each other because of production reasons. In this case, a fault voltage will be measurable at sockets (5) when current passes through the sample and there is no magnetic field. Use rotary knob (8) to compensate for this voltage at each sample current intensity.

Caution!

The exchangeable carrier board can get very hot during operation. There is a danger of burns to hands. Do not handle the board until the module has been switched off and an appropriate cooling-down time has elapsed.

When the Hall-voltage is to be determined as a function of temperature, first operate the press switch (7) to switch the LED display (2) to the temperature display (the "°C" diode (4) must light up). Switch sample heating on with the press switch at the back (12). Active heating is shown by the appropriate control diode (4). When the maximum temperature of T = 170°C is reached, the heating is automatically switched off and the control diode (4) goes out. It is recommended that a control measurement be carried out during the cooling phase.

Experiment with non-doped germanium

To determine the band gap of Germanium, measure the conductivity of the sample at a constant sample current of approx. 5 mA as function of sample temperature without a magnetic field. Connect a suitable digital measuring instrument to the pair of sockets (10) for the measurement of the sample voltage. Avoid sample currents above 5 mA, as these would lead to self-heating, which would exert a falsifying effect on the measured values.

3.2.2 Experimental procedure with the Cobra3 interface system

When the experiment is to be carried out using a Cobra3 interface system, connect the module to Cobra3 via the RS 232 interface with a data cable. The RS 232 connection allows all measured values to be collected, presented and evaluated. No additional external measuring instruments are required.

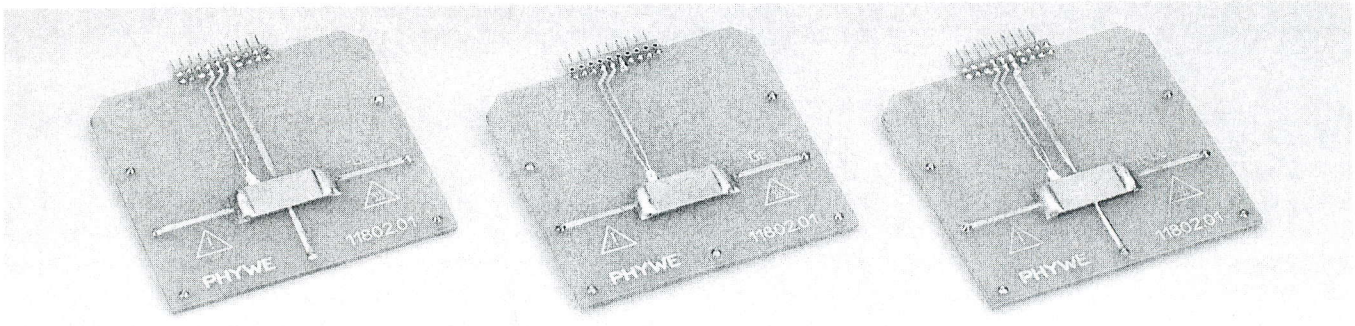

Fig. 3: Carrier boards with germanium samples.

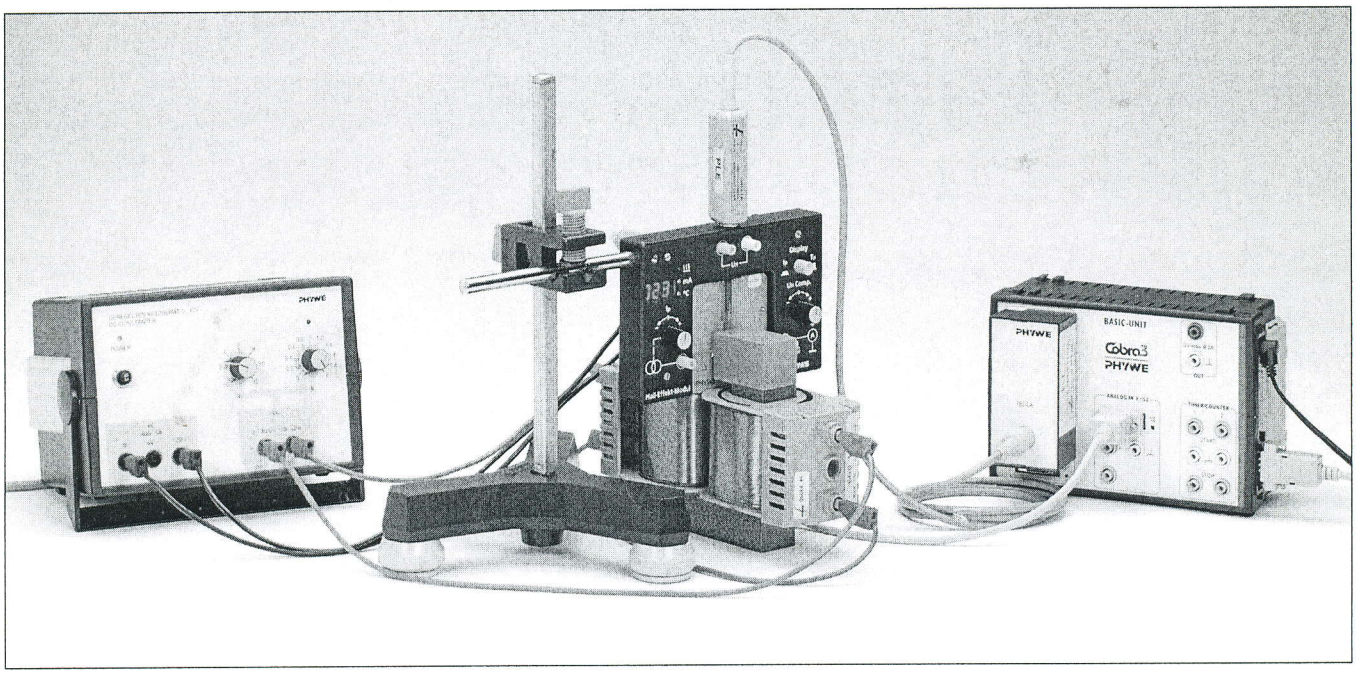

Fig. 4: Experimental set-up: Hall effect in doped germanium samples using the Cobra3 interface.

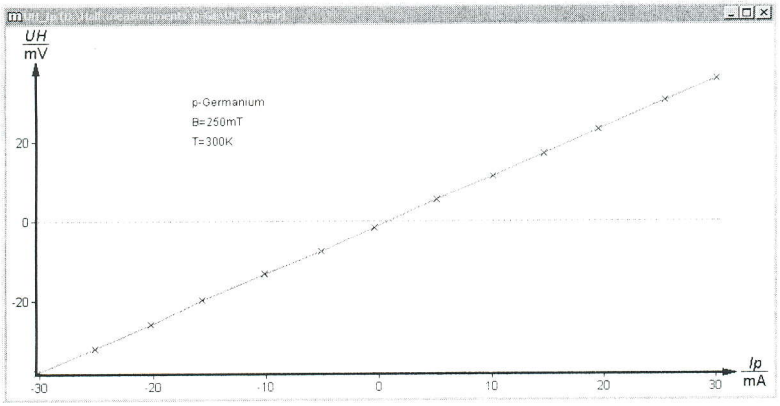

Fig. 5a: Hall voltage as a function of sample current.

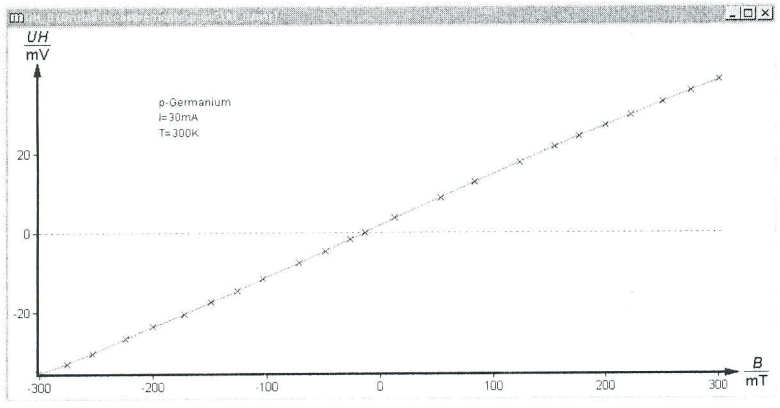

Fig. 5b: Hall voltage as a function of magnetic flux density.

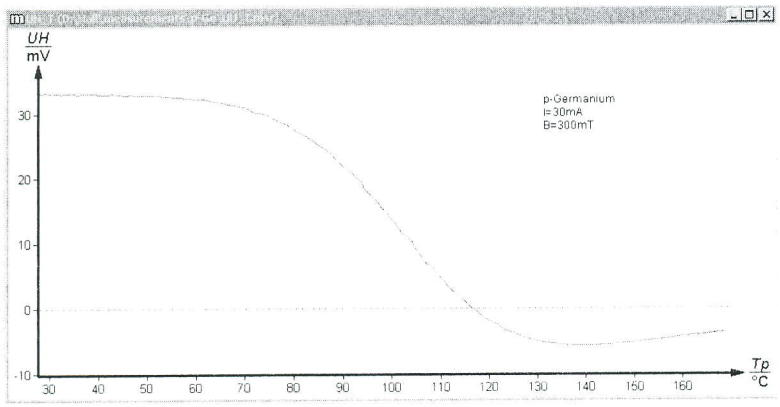

Fig. 5c: Hall voltage as a function of sample temperature.

4 NOTES ON OPERATION

The instrument which this information accompanies is a quality product that complies with the technical requirements that are summarized in the currently valid European Community Guideline. The characteristics of the product justify the CE mark.

It is only permitted to operate this instrument under appropriately skilled supervision in a controlled electromagnetic environment in research, teaching and training facilities (schools, universities, institutions and laboratories).

This means that in such an environment, transmitting radio devices such as mobile phones are not allowed to be used in direct neighbourhood. The individual cables used for connection must not be longer than 2 m.

Electrostatic discharges or other electromagnetic phenomena can so influence the instrument, that it no longer works within the specified data.

The following measures reduce or eliminate disturbing influences:

Avoid fitted carpets; balance potentials, experiment on a conductive, earthed floor covering, use screened cables, do not operate high-frequency emitters (radio sets, mobile phones) in the direct vicinity. Carry out a "reset" after a total blackout caused by turning off the mains switch.

5 TECHNICAL SPECIFICATIONS (typical for 25°C)

Operating temperature range	5 - 40°C
Relative humidity	< 80%
Hall-effect-module	
Power supply	max.12 VAC/35 VA
Max. sample current	approx. ±55 mA
Max. sample temperature	170°C
Outer dimensions	(160 × 25 × 105) mm^3
Fork width	70 mm
Mass with holding rod	0.4 kg
Carrier boards	
Sample dimensions	(10 × 20 × 1) mm^3
Spec. resistance	
n-germanium	(2...2.5) Ω cm
p-germanium	(2.5...3) Ω cm
intrinsic germanium	approx. 50 Ω
Temperature probe	Pt 100
Heating meander	approx. 3 Ω
Dimensions	(73 × 70 × 2.5) mm^3
Weight	0.028 kg

6 MATERIALS

A. The Hall effect in *p*- or *n*-Germanium

Hall-effect-module	11801.00
Hall-effect *p*-Ge carrier board	11805.01
Hall-effect *n*-Ge carrier board	11802.01
Power supply 0 - 12 VDC/6 V,12 VAC	13505.93
Coil, 600 turns	(2 ×) 06514.01
Iron core, U-shaped, laminated	06501.00
Pole pieces, plane	06489.00
Hall probe, tangential	13610.02
Tripod base "PASS"	02002.55
Support rod "PASS", *l* = 250 mm	02025.55
Right angle clamp "PASS"	02040.55
Connecting cables	

The following are additionally required for A:

B. Without Cobra3 interface

Teslameter, digital	13610.93
Digital multimeter	07134.00

C. With Cobra3 interface

Cobra3 Basic-Unit	12150.00
Cobra3 power supply, 12 V DC/2 A	12151.99
Cobra3 measuring module Tesla	12109.00
Data cable, 2 × SUB-D, 9 pin	(2 ×) 14602.00
Software Hall effect	14521.61

D. Intrinsic conductivity (non-doped Germanium)

Hall effect module	11801.00
Intrinsic conductivity of Germanium carrier board	11807.01
Power supply 0-12 V DC/6 V,12 V AC	13505.93
Tripod base "PASS"	02002.55
Support rod "PASS", l = 250 mm	02025.55
Right angle clamp "PASS"	02040.55
Connecting cables	

The following are additionally required for D:

E. Without Cobra3 interface

Digital multimeter	07134.00

F. With Cobra3 interface

Cobra3 Basic-Unit	12150.00
Cobra3 power supply, 12 V DC/2 A	12151.99
Cobra3 measuring module Tesla	12109.00
Data cable, 2 × SUB-D, 9 pin	(2 ×) 14602.00
Software Hall effect	14521.61

7 NOTES ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 24 months within the EU, or for 12 months outside of the EU. This guarantee does not cover natural wear nor damage resulting from improper handling.

The manufacturer can only be held responsible for the function and technical safety characteristics of the instrument, when maintenance, repairs and changes to the instrument are only carried out by the manufacturer or by personnel who have been explicitly authorized by him to do so.

8 WASTE DISPOSAL

The packaging consists predominately of environmental compatible materials that can be passed on for disposal by the local recycling service.

Should you no longer require this product, do not dispose of it with the household refuse. Please return it to the address below for proper waste disposal.

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