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

11801-01
11805-01
11802-01
11807-01

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Operating instructions

CE The unit complies with the corresponding EC guidelines.

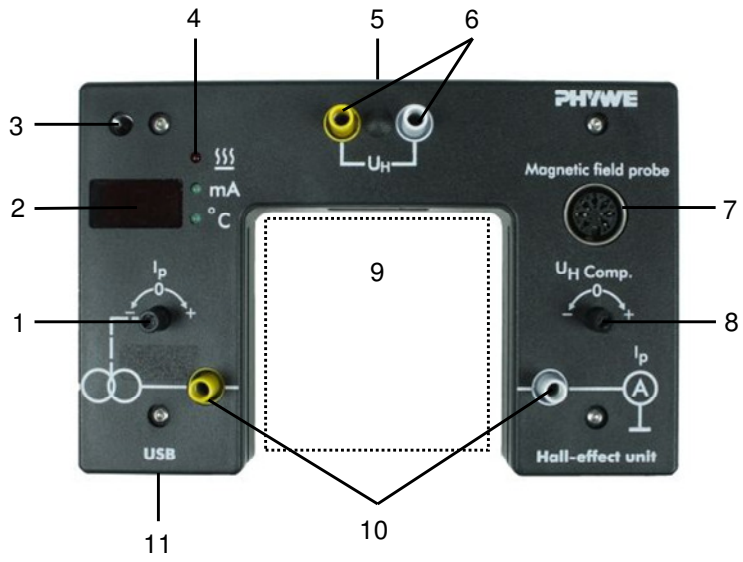

Fig. 1: View of the front of the Hall-effect unit with the various operating elements and displays.

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1 SAEFTY PRECAUTIONS

Caution!

- Carefully read these operating instructions completely before operating this instrument. This is necessary to avoid damage to it, as well as for user-safety.
- 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 touch the conducting tracks on the printed circuit board.
- Only use the instrument for the purpose for which it was designed.
- Do not use the unit without supervision.
- Take care that no liquids or objects enter in through the unit.
- Protect the instrument from dust, moisture and vapours. Only clean it in voltage-free state with a slightly moistened, lint-free cloth. Aggressive cleaning agents and solvents are unsuitable.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Do not operate if there are visible signs of damage to the unit, the connection cord or the measuring lines.
- Do not use the Hall-effect unit without a power supply unit 13506-93.
- Do not connect any devices to the unit other than the ones that are intended for this purpose
- Do not open the unit.

2 PURPOSE AND DESCRIPTION

The Hall-effect unit 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 be determined.
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 allowed temperature of $T = 140$ °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.
The additional USB port can be used for recording, displaying and evaluating the measured values with the aid of the measureLAB software (ref. no. 14580-61).
If a tangential Hall probe (ref. no.: 13610-02) is connected to the Hall effect unit (*7*), the magnetic flux density/magnetic induction can be measured in combination with measureLAB.

3 HANDLING

3.1 Function 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 Positioning bore hole for a tangential magnetic field probe
6 Pair of 4 mm safety sockets for pick up of the Hall voltage U_H.
7 Port for connecting a tangential magnetic field probe
8 Rotaryknob 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
11 USB port

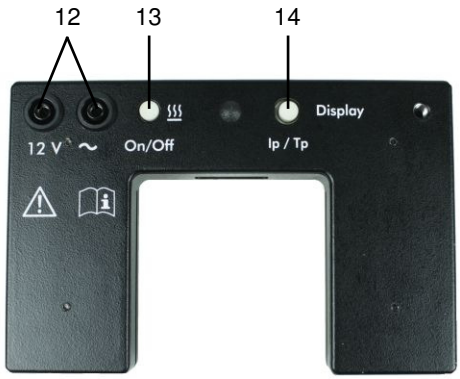

Fig. 2: View of the back of the Hall module with the various operating

Function elements at the back of the Hall module:

12 Pair of 4 mm safety sockets for connection of the supply voltage
13 Press knob for heating to be "On" or "Off"
14 Press knob for selection of the display of sample current I_p or sample temperature T_p

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.
To measure the magnetic flux density/induction, a zero adjustment must be performed. When the tangential Hall probe (ref. no.: 13610-02) is connected to the Hall-effect unit and no field acts upon the Hall probe (the geomagnetic field can be neglected), the zero adjustment can be performed in measureLAB.
Perform the following steps in measureLAB:
“Settings” → Open the "Sensors/Channels" section → Select the connected sensor → Select the "Tesla" tab → Press the button >0<.
Supply the module with alternating voltage (12 V/5 A) via the pair of sockets at the back (*12*).

3.2.1 Experimental procedure without measureLAB

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" LED (*4*) must light up).

Caution!

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! Hot!

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 knob (*14*) to switch the LED display (*2*) to the temperature display (the "°C" LED (*4*) must light up). Switch sample heating on with the press switch at the back (*12*). Active heating is shown by the appropriate control LED (*4*). When the maximum temperature of T = 140 °C is reached, the heating is automatically switched off and the control LED (*4*) goes out.

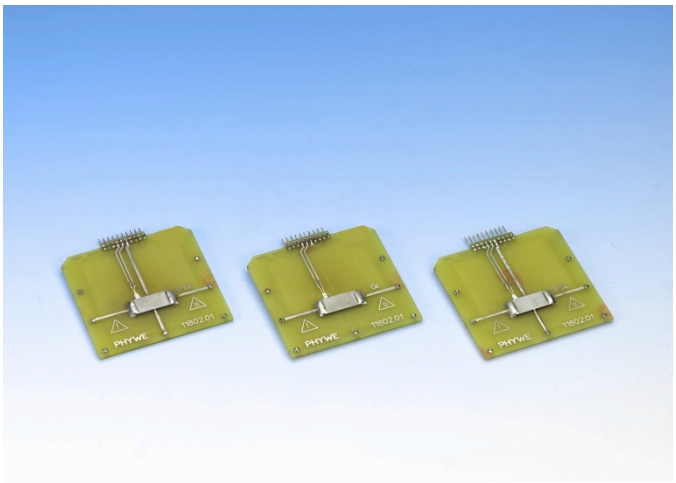

Fig. 3: Carrier boards with germanium-probes.

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 measureLAB

If the experiments are performed with the aid of the measureLAB software, the module must be connected to the computer via the USB port (*11*) and with a USB cable. With measureLAB, all of the parameters of the experiment can be visualised. In addition, the software also enables the recording, visualisation and evaluation of the measurement values. Additional, external measuring instruments are not required.

If the connection to the "Hall effect" sensor unit is interrupted, check the connection or restart measureLAB. Then, lock the unit and load the last setting.

Note:

We recommend checking for software and firmware updates on a regular basis. By doing so, you ensure that the Hall-effect unit will be detected correctly and you ensure to have the latest functions available.

Free updates of the software and the firmware update programme *deviceupdate.exe* can be found on our website:

www.phywe.com → Downloads → Software download

4 NOTES ON OPERATION

CE

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 (HF, burst, indirect flash discharge, etc.) 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.

Disturbances, such as energy transients, can affect the processor and communication with the computer. The heating control might fail and the temperature could rise above 140 °C. Do not use the unit without supervision. Carry out a "reset" after a total blackout caused by turning off the mains switch.

5 TECHNICAL DATA

(typical for 25 °C)	
Operating temperature range	5–40 °C
Relative humidity	<80 %
Hall-effect unit	
Power supply	max.12 V AC/48 VA~
Max. sample current	approx. ±55 mA
Max. sample temperature	140 °C
Outer dimensions	(160 × 25 × 105) mm^3
Fork width	70 mm
Mass with holding rod	0.6 kg
Carrier boards	
Sample dimensions	(10 × 20 × 1) mm^3
Spec. resistance	
n-germanium	(2.0…2.5) Ω cm
p-germanium	(2.5…3.0) Ω cm
Intrinsic germanium	approx. 50 Ω
Temperature probe	Pt 100
Heating meander	approx. 3 Ω
Dimensions	(73 × 70 × 2.5) mm³
Weight	0.028 kg

6 SCOPE OF DELIVERY

Hall-effect unit	11801-01
Rod with thread	329827
Data cable USB, plug type A/B mini	170643

7 MATERIAL

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

Hall-effect-unit	11801-01
Hall-effect *p*-Ge carrier board	11805-01
Hall-effect *n*-Ge carrier board	11802-01
Power supply 0–12 V DC/6 V, 12 V AC	13506-93
Coil, 600 turns (2x)	06514-01
Iron core, U-shaped, laminated	06501-00
Pole pieces, plane	06489-00
Hall probe, tangential	13610-02
Tripod base PHYWE	02002-55
Support rod, l = 250 mm, d = 10 mm	02025-55
Right angle clamp expert	02054-00
Connecting cables	

The following are additionally required for A:

A1. Without measureLAB

Teslameter, digital	13610-93
Digital multimeter	07129-00

A2. With measureLAB

Software measureLAB	14580-61

B. Intrinsic conductivity (non-doped Germanium)

Hall-effect unit	11801-01
Intrinsic conductivity of Ge, carrier board	11807-01
Power supply 0–12 V DC/6 V, 12 V AC	13506-93
Tripod base PHYWE	02002-55
Support rod, l = 250 mm, d = 10 mm	02025-55
Right angle clamp expert	02054-00
Connecting cables	

The following are additionally required for B:

B1. Without measureLAB

Digital multimeter	07129-00

B2. With measureLAB

Software measureLAB	14580-61

8 WASTE DISPOSAL

The packaging mainly consists of environmentally-friendly materials that should be returned to the local recycling stations.

Do not dispose of this product with normal household waste. If this unit needs to be disposed of, please return it to the address that is stated below for proper disposal.

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