3B SCIENTIFIC® PHYSICS

Hall Effect Basic Apparatus 1009934

Instruction manual

03/12 ALF

1 Decoupled measurement outputs (4-mm-safety sockets)
2 Earth socket
3 Power supply input, 12 V AC/3A
4 4-mm plugs for insertion into supplied U-shaped holder
5 Trimmer for sample current
6 Sample fixture
7 Measurement outputs, 4-mm safety sockets
8 Trimmer for Hall voltage compensation
9 Trimmer for temperature
10 Decoupled measurement outputs (8-pin mini-DIN sockets)
11 Display
12 Fixture for magnetic field sensor
13 Buttons for changing display

1. Safety instructions

The equipment conforms to safety regulations for electrical measuring instruments and control and laboratory equipment as per DIN EN 61010, part 1 and is designed to conform to protection class 3. It is intended for use in dry rooms which are suitable for the use of electrical equipment.

- If the equipment can no longer be operated without hazards arising, it should immediately be withdrawn from use.
- Do not expose the equipment to high humidity, extreme temperatures or severe shocks.
- Before using the equipment, read the instruction manual in order to avoid damage to the equipment or injury to users.

The board with the sample can become very hot when in operation (170°C) so that there is a risk of burns.

- Before removing the circuit board, allow it sufficient time to cool.

2. Description

The Hall effect basic apparatus provides contacts and power supply for the circuit boards with a germanium crystal (1008522, 1009810 and 1009760), also holding them in place in experiments measuring the Hall effect and how it depends on temperature, magnetic field or sample current, as well as experiments on electrical conductivity.

The apparatus contains an adjustable constant current source for the sample current, a measurement amplifier with offset compensation for the Hall voltage and adjustable heating for samples. The heating automatically cuts out at 170°C to protect fragile germanium crystals. Hall voltage, sample current, sample voltage and temperature can all be read off from the display, which can be switched between these various modes. In addition, Hall voltage and sample voltage can be tapped directly via contacts on the front, and three voltage equivalents for Hall voltage or sample voltage, sample current and sample temperature on the side. On the right-hand side of the case there are three mini-DIN sockets for computer-based measurement of the quantities mentioned above using a 3B NET*log*™ unit.

The equipment is set up on the U-shaped core of the multi-piece transformer kit. The magnetic field can be measured using a magnetic field sensor adjacent to the crystal.

3. Contents

1 Hall effect basic apparatus

1 U-shaped holder

2 Connector leads with 8-pin mini-DIN plugs

Instruction manual

4. Controls

4.1 Decoupled measurement outputs for measuring voltage equivalents for quantities

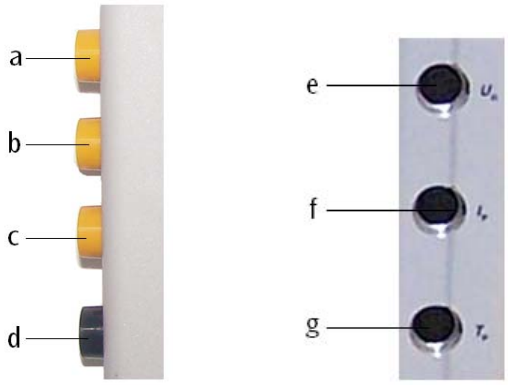

Fig.1 Measurement outputs using 4-mm sockets and 8-pin mini-DIN sockets for 3B NET*log*™

a/e Hall voltage/sample voltage*

b/f Sample current

c/g Sample temperature

d Earth socket

* only if U_p is being displayed, otherwise it outputs the Hall voltage

4.2 Measurement outputs for direct measurement

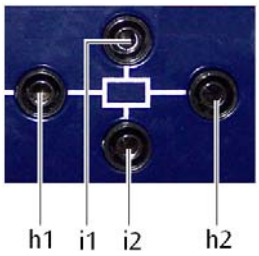

Fig. 2 Measurement outputs for direct measurement

h1, h2 Sample voltage

i1, i2 Hall voltage

- Caution: do not any apply an external voltage to the measurement outputs!

4.3 Buttons for switching display and corresponding LEDs

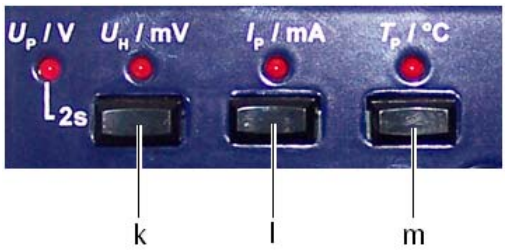

Fig. 3 Buttons for switching display

k Hall voltage or sample voltage (Hold down for 2 s to display sample voltage)

l Sample current

m Sample temperature

5. Technical data

Power supply:
max. 12 V AC, 3 A via 4-mm safety sockets

Constant current source for sample current:

Current:	0 to ±34 mA, tol.: ±1 mA
Display precision:	±2.5 %
Display resolution:	0.1 mA
Measurement output:	I_P = *U*meas * 0.1 A/V

Hall voltage and compensation:

Display:	0 to ±199.9 mV
Display precision:	±2.5%
Display resolution:	0.1 mV
Compensation:	±10 mV, tol.: +5 mV
Measurement output:	U_H = *U*meas * 0.1

Sample voltage:

Display:	0 to ±1.999 V
Display precision:	±2.5%
Display resolution:	1 mV
Measurement output:	U_P = *U*meas

Sample temperature:

Range:	T_0 to 170°C, tol.: ±3°C
Display precision:	±2%
Display resolution:	0.1 °C
Measurement output:	*T* (°C) = *U*meas * 100/V

Attachment for circuit boards:

Connector:	Multi-pin socket

Outputs:

Hall voltage:	4-mm safety sockets
Voltage drop across germanium crystal:	4-mm safety sockets
Voltage equivalents:	4-mm safety sockets 8-pin mini-DIN sockets (for 3B NET*log*™)

General data:

Dimensions:	180x110x50 mm approx.
Weight:	0.5 kg approx.

6. Operation

6.1 Experiment set-up for uniform magnetic field and attachment of circuit boards

The following equipment is necessary to set up a uniform magnetic field:

1 P-doped germanium on circuit board	1009810
or	
1 N-doped germanium on circuit board	1009760
or	
1 Undoped germanium on circuit board	1008522
1 U-shaped core	1000979
1 Pair of pole pieces for Hall effect plus clamps	1009935
2 Coils, 600 windings	1000988
1 Magnetic field sensor, ±2000 mT	1009941

- Place the U-shaped core on a stable, level surface.
- Place coils over the core in such a way that their connectors are facing the front.
- Insert the U-shaped holder all the way into the hole in the U-shaped core and secure it in place with the knurled screw.
- Place the pole pieces on the legs of the core and secure them in place with clamps (see Fig. 4).

Fig. 4 Set-up on U-shaped core with coils, pole pieces and U-shaped holder

- Insert the circuit board into the attachment on the console until the contact pins slot into the multi-pin socket. Make sure the circuit board is correctly aligned (see Fig. 5).
- Insert the console with the circuit board attached onto the U-shaped holder. Make sure the board is held parallel with the U-shaped core. You may need to turn the U-shaped holder slightly (see Fig. 6).
- Insert the magnetic field sensor into the corresponding attachment on the console.
- Undo the clamps and move the pole pieces as far as the spacers on the circuit board (make sure the board does not get warped) (see Fig. 7/8).

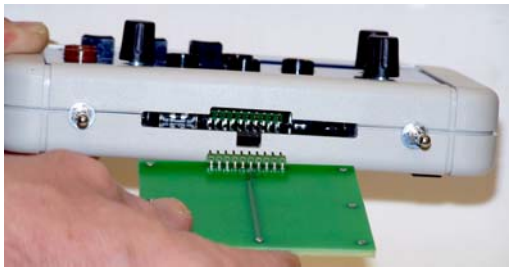

Fig. 5 Insertion of circuit board

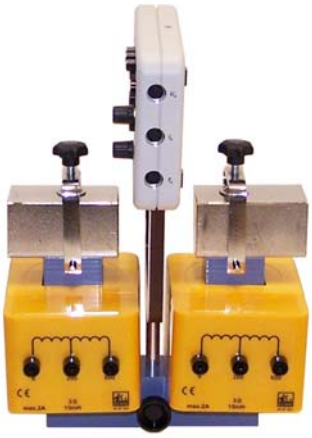

Fig. 6 Console inserted onto U-shaped holder

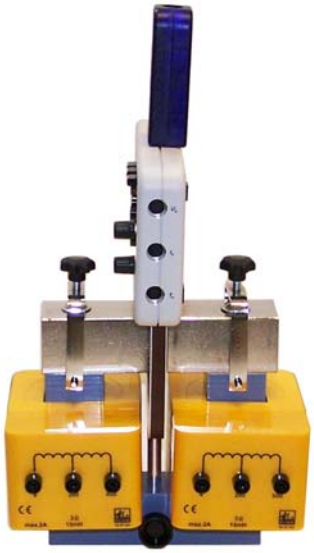

Fig. 7 Set-up with magnetic field sensor, side view

Fig.8 Set-up with magnetic field sensor, front view

7. Experiments

7.1 Measurement of Hall voltage as a function of magnetic flux density *B*, temperature *T* or sample current *I* for n- or p-doped germanium

The following equipment is needed for the experiments:

1 Transformer with rectifier, 3 A (230 V, 50/60 Hz) 1003316

or

1 Transformer with rectifier, 3 A (115 V, 50/60 Hz) 1003315

1 DC power supply, 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz) 1003312

or

1 DC power supply, 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz) 1003311

1 3B NET*log*™ unit (230 V, 50/60 Hz) 1000540

or

1 3B NET*log*™ unit (115 V, 50/60 Hz) 1000539

1 Set of 15 safety experiment leads 1002843

- Complete the experiment set-up as shown in Fig. 9.
- Connect the AC output of the transformer to the input sockets for the power supply and set an output voltage of 12 V.
- Connect the coils to the DC power supply.
- Connect the magnetic field sensor to the 3B NET*log*™ unit.
- Select sample current I_P (for max. sample current see instruction manual for germanium crystal), select the Hall voltage on the console and adjust the zero point for the Hall voltage with the help of the compensation trimmer.

7.1.1 Hall voltage as a function of sample current I_P

- Turn on the DC power supply and set it up as a constant current source
- Select magnetic flux density *B* or coil current and record the Hall voltage U_H as a function of the sample current I_P.
- For your measurement plots, see the manual for the relevant circuit boards.

7.1.2 Hall voltage as a function of magnetic flux density *B*

- Select a constant sample current, e.g. 20 mA.
- Vary the magnetic flux density *B* by changing the current through the coils and record the corresponding Hall voltage U_H.
- For your measurement plots, see the manual for the relevant circuit boards.

7.1.3 Hall voltage as a function of temperature *T*

- Select magnetic flux density *B* or coil current.
- Switch on the heating controller and record the Hall voltage U_H as a function of temperature.
- It is recommended that the sample be heated to 170°C and to write down the Hall voltage as it cools down.
- Turn on the heating controller and record the Hall voltage U_H as a function of temperature.
- For your measurement plots, see the manual for the relevant circuit boards.

7.2 Measurement of conductivity as a function of temperature *T*

The following equipment is needed for the experiments:

1 Transformer with rectifier, 3 A (230 V, 50/60 Hz) 1003316

or

1 Transformer with rectifier, 3 A (115 V, 50/60 Hz) 1003315

- Select a small sample current I_P. Since the current will cause the sample to heat up, you should **not** exceed a current of **5mA**.
- Switch the display to sample voltage.
- Turn on the heating controller and record the sample voltage U_P as a function of temperature.
- For your measurement plots, see the manual for the relevant circuit boards.

8. Care and maintenance

- Before cleaning the equipment, disconnect it from its power supply and remove the circuit board.
- Use a soft, damp cloth to clean it.
- Keep the circuit board in the original box after it has been used and has cooled down.

9. Disposal

- The packaging should be disposed of at local recycling points.
- Should you need to dispose of the equipment itself, never throw it away in normal domestic waste. Local regulations for the disposal of electrical equipment will apply.

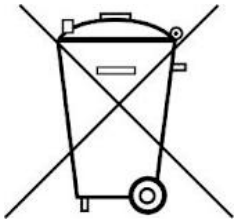

Fig. 9 Experiment set-up for investigating the Hall effect with a uniform magnetic field