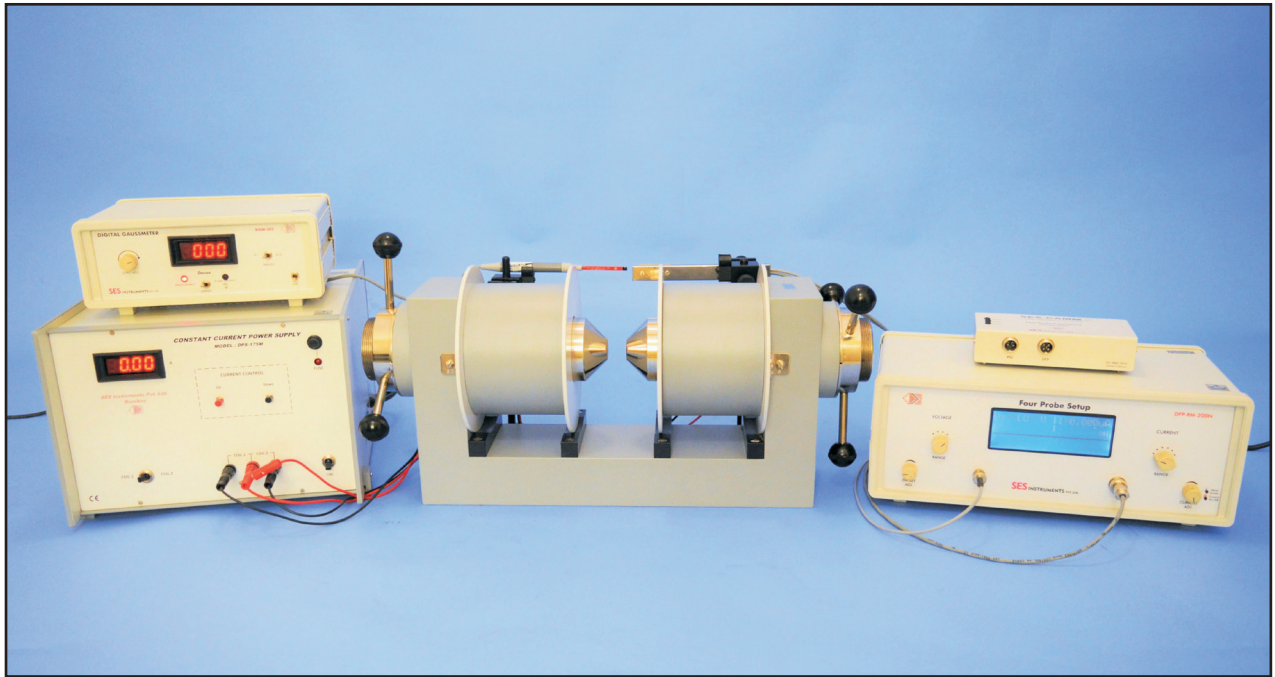


Magnetoresistance Setup (Research Model)

MRX-RMN

SES Instruments Pvt Ltd.

MEASUREMENT OF MAGNETORESISTANCE OF WIDE VARIETY OF SAMPLES



Description

It is noticed that the resistance of the sample changes when the magnetic field is turned on. The phenomenon, called magnetoresistance, is due to the fact that the drift velocity of all carriers is not same. With the magnetic field on; the Hall voltage $V = E_y t = |\mathbf{v} \times \mathbf{H}|$ compensates exactly the Lorentz force for carriers with the average velocity; slower carriers will be over compensated and faster one under compensated, resulting in trajectories that are not along the applied field. This results in an effective decrease of the mean free path and hence an increase in resistivity.

Here the above referred symbols are defines as:

\mathbf{v} = drift velocity

\mathbf{E} = applied electric field

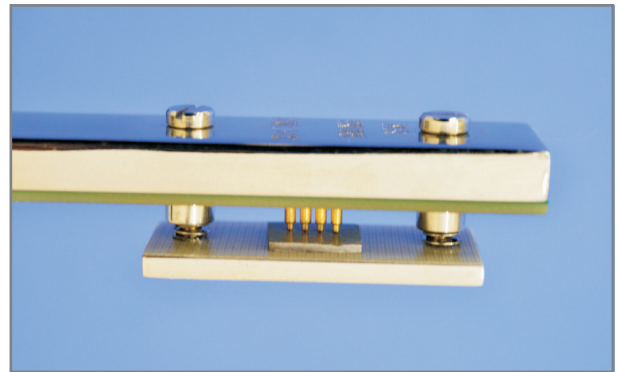
t = thickness of the crystal

\mathbf{H} = magnetic field

Description of Experimental Set-up

1. Probes Arrangement

It consists of 4 collinear, equally spaced (2mm) and individually spring loaded probes mounted on a PCB strip. Two outer probes for supplying the constant current to the sample and two inner probes for measuring the voltage developed across these probes. This eliminates the error due to contact resistance which is particularly serious in semiconductors. A platform is also provided for placing the sample and mounting the Four Probes on it.



2. Control Unit of Four Probe Setup

The unit comprises of two sections – a totally isolated constant current source, and a grounded voltage measurement system. Features of these two sections are described below in some detail.

(A) Constant Current Source

It is an IC regulated current generator that is galvanically isolated from the rest of the circuit which is a basic requirement of four probe method. The isolation is achieved by using an optically coupled amplifier and associated circuits. This circuit sends a constant Current. To the changing resistance of the sample due to change in temp..



A judicious choice of the current setting as detailed in the user manual is necessary depending on the resistance value that is measured. Brief technical details of the current section are as under:

- Current Range: 2 μ A, 20 μ A, 200 μ A, 2mA, 20mA and 200mA with over ranging
- Open Circuit Voltage: 15V in the lower four ranges and 9V in the upper two
- Accuracy : $\pm 0.25\%$ of the reading ± 1 digit
- 4-line LCD display with indication when current needs decreasing

(b) Digital Voltmeter Section

The voltmeter is used to read the voltage developed between the middle pins of the four probe arrangement. A primary requirement is to have very high input resistance so that the measurement is not disturbed in case of high resistance samples. The input range of the voltmeter is thus limited by avoiding the use of any potential divider. Brief technical details are as under:

- Voltage Range: 2mV, 20 mV, 200 mV, 2V with over ranging
- Manual adjustment of Offset Voltage whenever current/voltage range is changed
- Accuracy : $\pm 0.25\%$ of the reading ± 1 digit
- 4-line LCD display with over voltage indication

3. Standard Sample

Ge Crystal (n-type) dimensions: 10 x 10 x 0.5mm.

(This standard sample is included to enable the user to check the functioning of the setup)

4. Electromagnet, EMU-75T (Refer datasheet for specifications)

5. Constant Current Power Supply, DPS-175-C2 (Refer datasheet for specifications)

6. Digital Gaussmeter, DGM-202-C1 (Refer datasheet for specifications)

In addition to the above, this Magnetoresistance Setup may be connected to a computer for data logging purposes. Necessary hardware and software are optional and can be purchased separately .

The setup is complete in itself