OPERATING INSTRUCTIONS

HALL EFFECT

SIBA INDIA

SATISH BROTHERS

4309/20,MARBLE HOUSE,PUNJABI MOHALLA
AMBALA CANTT 133 001

Ph. 2642617, 2645237. Fax: 0171-2645237

STUDY OF HALL EFFECT

The set up consists an electromagnet, a dc regulated power supply for said magnet, a calibrated gauss meter, the hall probe with electrical connections and a current source for the crystal with a 3 1/2 digit digital meter with switch selection to read hall probe current and hall voltage. A digital multimeter is required as another apparatus required.

The method of measuring electrical conductivity with temperature variation does not provovide adequate informations since there is very much lag (thermometer lag), and unaccuracy involved. However the hall effect study of a specimen is useful to study the parameter called charge mobility and its effect is applied in several devices.

In fig 1, a semiconductor crystal is shown with its dimensions, where d is the thickness of crystal in Y axis, a constant current I flows through X direction called Ix and a magnetic field of Bz intensity is made by an electromagnet pole piece which devlope propotional voltage in Z direction called as Hall voltage Vh. Lx is the length of the crystal between current tips in X direction From the above said the electron or hole movement (depends upon the crystal nature) through the magnetic field yield a force ,f = v x B directed towards the near face create a surface charge of holes (or electron). An electric field Vz is established by this charge and equilibrium is reached when the electric field force the charge balance the magnetic force which is qV = q (v x B), as diagrammed the electric field is directed on Z axis and Vz = VxBz, where the Vx is the potential across the X direction.

At equilibrium the ratio of electric field intensity per unit current density to the magnetic field intensity is defined as 'Hall coefficient' Rh

$$Rh = \frac{Vz}{Ix} \times \frac{d}{Bz} \; 10^4 \; met^3 / col$$

where Vz is the hall voltage measured as Vh, d, is the thickness of given crystal .... mtr, and Ix is the current measured in X - direction, Bz is the magnetic field intensity measured in Gauss.

No. of charge carriers per unit volume in crystal (concetration of hole in p - type and elctron in n - type) is found from the reciprocal of Rh given as

$$n = 1 / Rh \cdot e \quad met^{-3}$$

where e is the charge on electron given = 1.6×10^{-19} coul

The cordinate angle pronounced as 'Hall angle' is given as

$$\phi = \frac{Vh}{Vx} \times \frac{Lx}{b} \quad rad$$

where Lx .... mtr and b is bredth in Z direction .... mtr, and Vx is the voltage measured across the crystal in X direction.

The mobility is given as

$$m\mu = \phi / Bz \qquad \text{rad met}^2/\text{Web, where 1Web = 10Kgauss,}$$

While evident of charge mobility the Hall effect has also been applied as multiplier, to produce an output voltage propotional to the product of two signals. If Ix is made propotional to one signal and magnetic field density is propotional to other the product Vh will be propotional to the product of two. In other words if Ix is known and Vh is known than B can be measured.

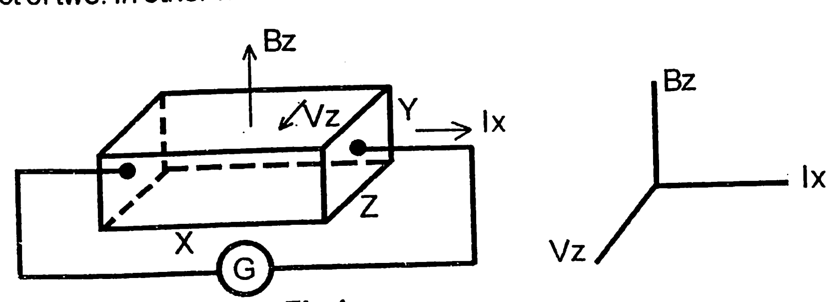


Fig 1.

Experiment procedure

Other apparatus required : a digital multimeter.

A. Calibration of electromegnat.

Connect the given electromagnet with given supply terminals. Switch on power.

1. Connect the given 'Hall probe*' with the Gauss meter termination through 5 pin plug. Switch on power. Adjust Zero set control to read 0.00 in given display. leave zero set control. Slide the probe cover to lead side. Put the bared probe between pole pcs.

2. Increase supply current to 1 amps and bring it back to zero. there may be residual flux remains. Note it.

3. Now increase supply current in steps say 0.5, 1.00, 1.50, 2.00 and ..... , note the corrosponding magnetic field strength B from the gauss meter.

4. When supply current approach 4.00 amps, and corrosponding B, is tabulated bring the supply current back to minimum.

Table 1.

Supply current (amp)	flux (K.gauss)
0.00 Amp	......
0.50	......
1.00	......
1.50	....
2.00	....
....	....

5. From the table plot a curve between the magnetic field stregth B, and supply current. Find out the slope of the curve in linear region for next computation.

* Pen type.

b. The Hall probe set up.

1. Now connect the given hall crystal (on strip), with given set up, such that its green leads fasten with I terminals, and red with V terminals. The polarity does not matter. Select DISPLAY to I mA mode.

2. Keep the I adj control at minimum. Switch on power. Adjust the current Ix, to 8.00 mA (10 mA max).

3. Select the DISPLAY mode to mV side. There may be offset voltage. Note it.

4. Now put the probe between pole pcs. As there is residual magnetism present, note the change in the reading of mV from set up display.

5. Now increase the electromagnet supply current Is, in steps (see table 1) and note the corrosponding Vh (mV) from set up display.

Table 2. Ix .... mA

Is (amp)	Bz (K.Gauss from plot 1)	Vh (mV)
0.00	....	....
0.50	....	....
1.00	....	....
....	....	....

6. Plot a curve between Is and Vh for given Ix. From plot find out Vh and Bz to calculate hall coefficient Rh as given before.

For given crystal :

Type :

d : mm

b : mm

Lx : mm

0.17

c. For hall angle measurement.

1. Adjust the supply current for magnetic field stregth Bz, about 1 K.Gauss (use the plot 1 for required current).

2. Select the DISPLAY of set up for I mA mode. Adjust the current to 2.00 mA. Now put the hall probe between pole pcs. Note the voltage Vh by selecting display to mV. Measure the voltage across Vx terminals of set up and note it as Vx.

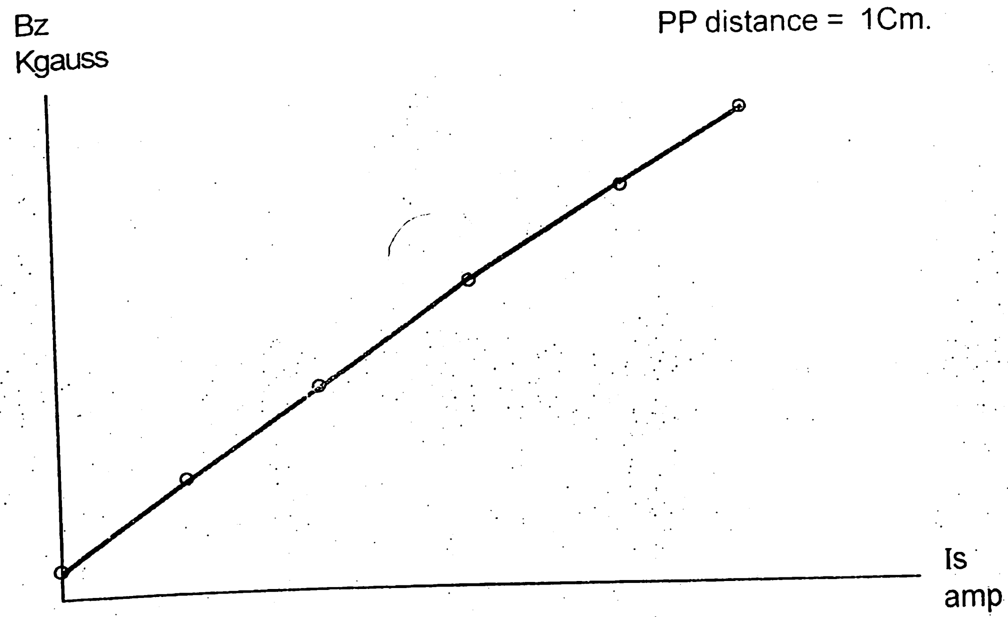
3. Now increase probe current to 4.00 mA and note the Vh and Vx for same Bz.

4. Increase hall current Ix to 6.00 mA and note Vh and Vx.

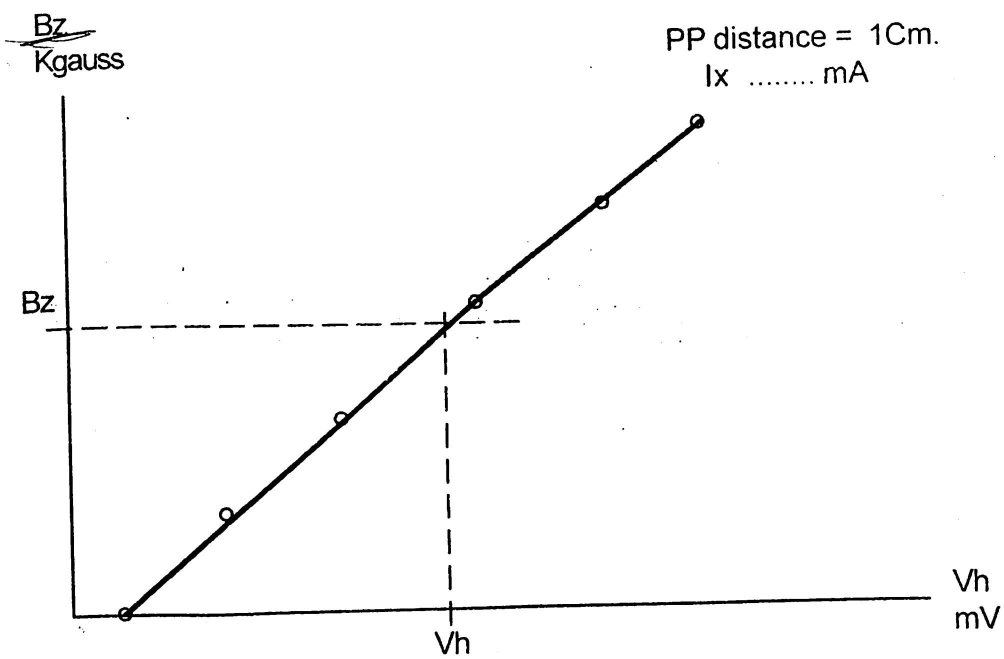
5. Plot a curve between Vh and Vx. Find out the slope s of the curve. Now the hall angle ϕ = s. (Lx/b).

Table 3. (Bz = 1 K.Gauss)

Ix (mA)	Vh (mV)	Vx
2.00	....	....
4.00	....	....
6.00	....	....



Plot 1 : Typical calibration curve for electromagnet.



Plot 2 : Typical curve for hall experiment.

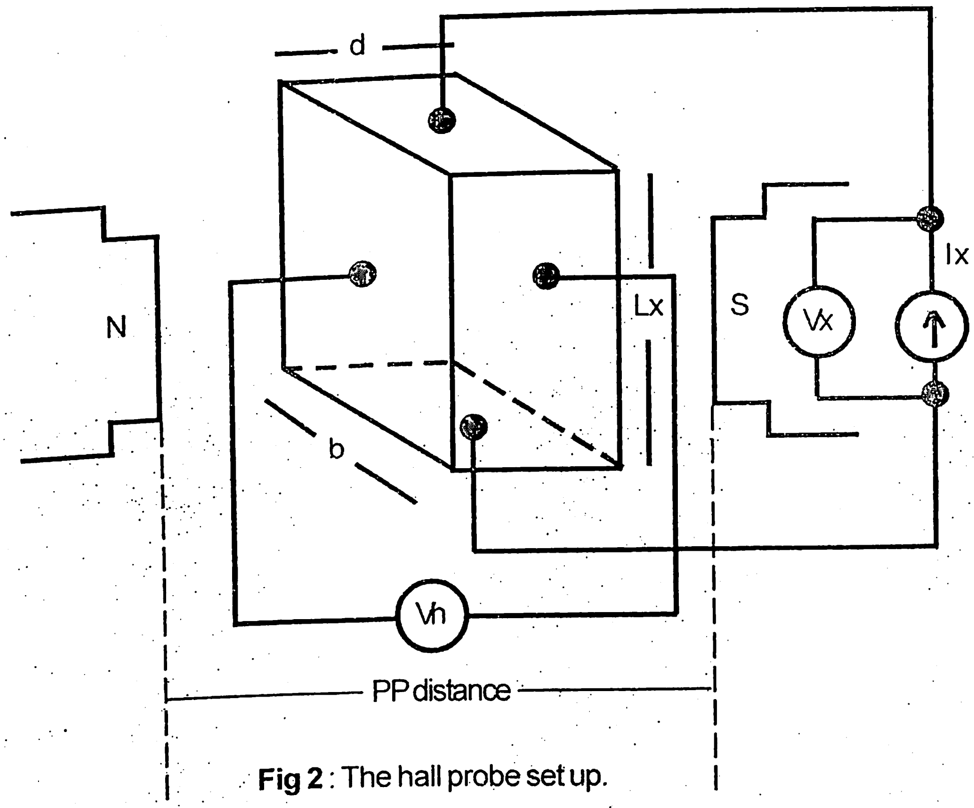
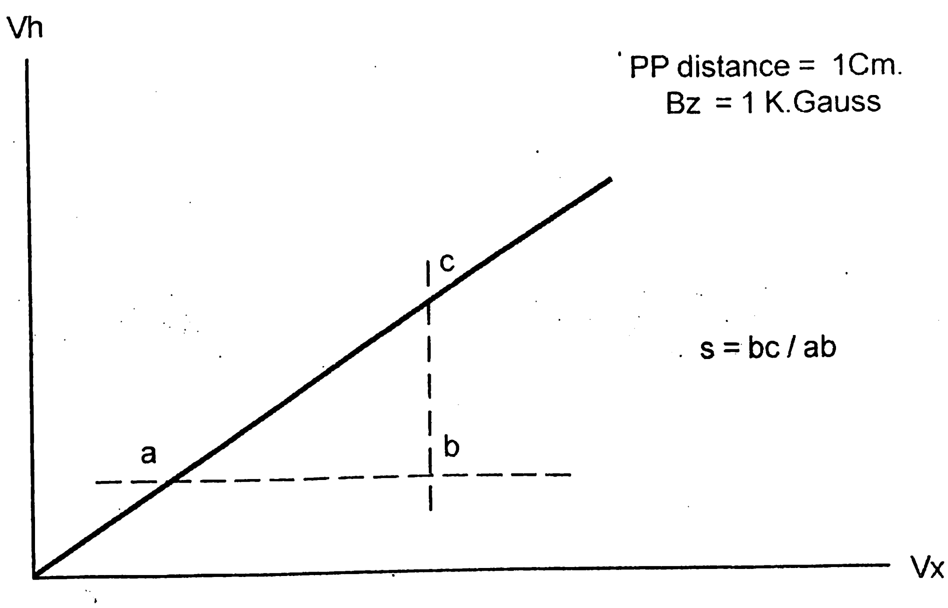
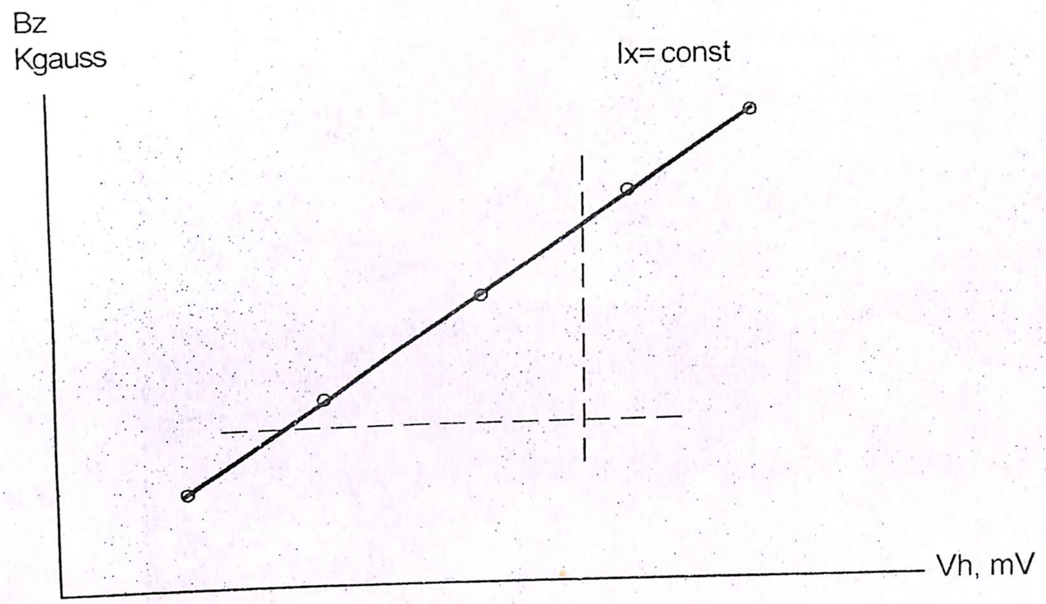


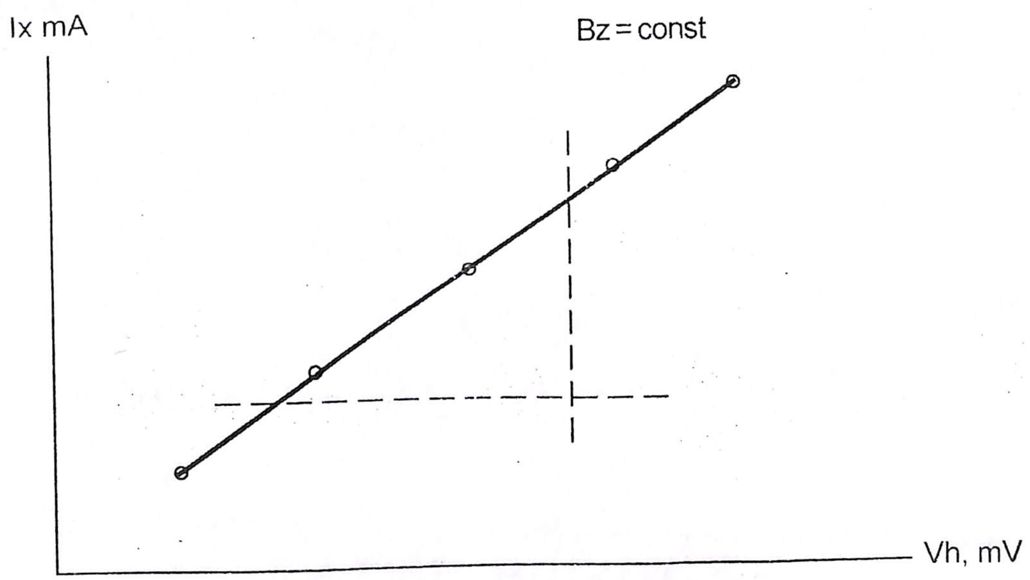
Fig 2 : The hall probe set up.



Plot 3 : Typical curve for hall angle experiment.



Plot 2 : Bz v/s Vh (Vz), where Ix = constant (4mA).



Plot 3 : plot between Ix v/s Vh, while Bz = constant (1Kgauss).

Red - Current
Green voltage