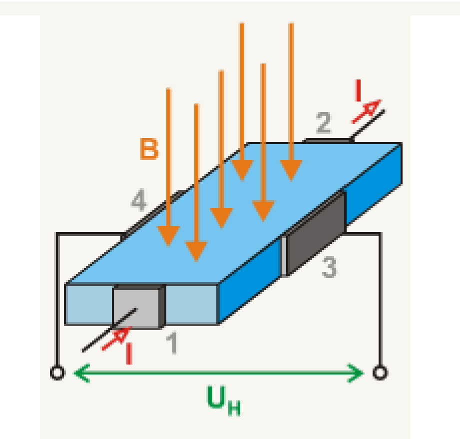
Hall effect sensor

Teória: Hall effect, Hall effect sensor

Hall effect

Consider a thin sheet of semiconductor material longitudinally conducting current *I* through connections 1 and 2 as depicted below. In the presence of a magnetic field *B* perpendicular to the sheet, the cross section distribution of charge carriers is disturbed due to the Lorentz force. This transverse gradient of charge concentration creates a voltage difference, which can be measured between pickups 3 and 4 and is called the Hall voltage V_H.

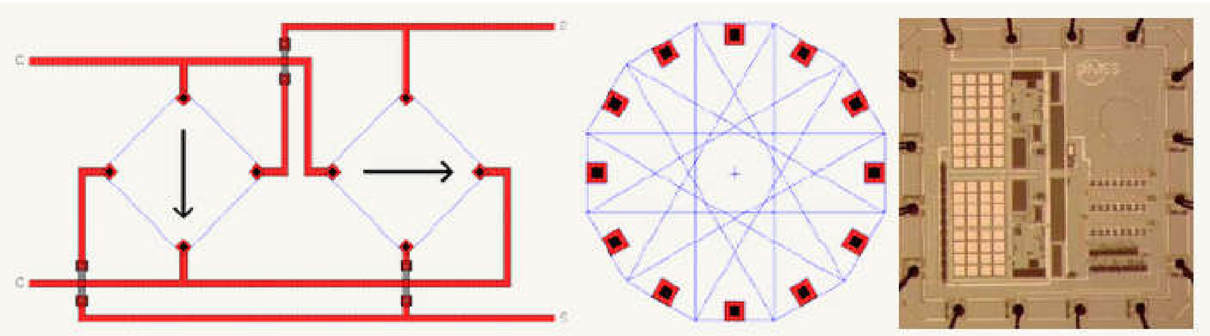
$$V_H \propto I \times B$$



Hall effect sensors

Hall effect is used in Hall sensors used to measure parameters of magnetic fields. The output voltage of a Hall sensor is proportional to the perpendicular component of applied B-field. With a suitable mechanical arrangement Hall effect sensors can be used for measurement of displacement, angle and speed of rotation, acceleration etc.

Hall effect sensors can be implemented by a conventional CMOS technology. They can be arranged into configurations such as the Wheatstone bridge and connected to preprocessing and digitizing circuits, all on the same chip. This makes them a preferable choice in a wide area of applications. In the picture below there is an example of electronic compass with Hall sensors.

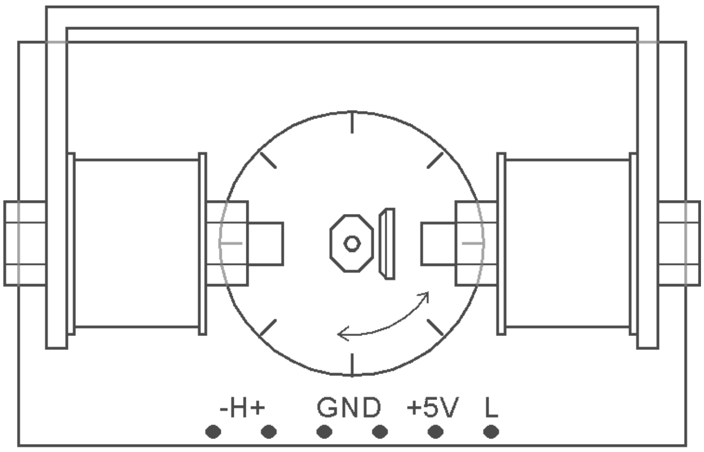


Exercises:

1. Familiarize yourself with the Hall effect workstation.
2. Measure the output voltage offset.
3. Measure the transfer characteristics of the Hall effect sensor jig – output voltage as a function of coil supply current.
4. Measure the transfer characteristics of the Hall effect sensor jig – output voltage as a function of relative rotation angle.

Measurement guide:

1. The Hall effect sensor jig consists of a pair of coils on a common magnetic circuit, and a pivoting console with the MAF100 Hall sensor.

   The MAF100 sensor was designed for measurement and regulation of direct or alternating magnetic fields. It's datasheet ratings are:

   nominal supply voltage 5V (5,5V max);
   supply current 3mA max;
   output voltage offset 1,5mV...10mV @ 20kΩ , 5V supply;
   nominal sensitivity 0,22mV/mT @ 20kΩ , 5V supply, B = 0...100mT.

   There is a 27kΩ load resistor on the console, which is permanently connected to the sensor output. The supply voltage connects to terminals *GND* and *+5V*. Do not connect supply voltage higher than 5V under any circumstances, it may damage the sensor. Output of the Hall sensor is connected to *-H+* terminals and should be measured by a precise millivoltmeter. The excitation coils should be connected to a DC current source through *GND* and *L* terminals. Windings have a resistance of app. 10Ω and they are designed for 1A current. The magnetic circuit is made of structural steel, and therefore is only suitable for DC magnetic fields.

2. Connect a +5V voltage supply for the Hall sensor and disconnect the coil supply (or set it to 0A). What is the output voltage? What can cause a non-zero offset? Try rotating the console to several positions (0 , 90 , 180 , 270) and measure the offset voltage in each of them. How is the offset changing and why?

3. Set the console to 90 position. With console position unchanged, adjust the coil supply current from 0 do 1A with 100mA step. Measure the output Hall voltage at each step and take notes of the measured voltages. Use measured values to chart output voltage as a function of coil supply current. Assess the sensor linearity. What may cause deviations from an ideal straight line? What is the B-field intensity affecting the sensor at 1A coil current? (use both datasheet ratings and a reference B-meter)
4. Set the coil supply current to 1A. With the coil supply current unchanged, rotate the console into positions 0 to 360 with 10 step. Measure the output Hall voltage at each position and take notes of the measured voltages. Use measured values to chart output voltage as a function of relative rotation angle. Assess the resulting curve. What curve should you ideally get? How does the measured curve differ and what could be the causes?