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# HALL SENSORS FOR MAGNETIC FIELD

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**Abstract**

The development of electronic devices is increasing the need for magnetic sensors, which in turn is driving the development of magnetic sensors. In this work, the theory, principle of operation, efficiency and economic value of magnetic sensors based on the Hall effect were considered.

**Keywords**: Hall sensor, Transducer, CMOS,

Hall sensors are "transducers" that measure magnetic fields based on the principle of the Hall effect (Transducer is an electronic device that converts energy from one form to another). This effect was discovered by the American physicist Edwin Herbert Hall in 1879 on gold foils [1]. When a semiconductor carrying an electric current is placed in a magnetic field, the phenomenon that occurs due to the Lorentz force on charge-carrying free electrons is called the Hall effect.

$$U_H = \frac{1}{qn}\frac{IB}{w}\ , \qquad U_H = R_H\frac{IB}{w} \quad (1)$$

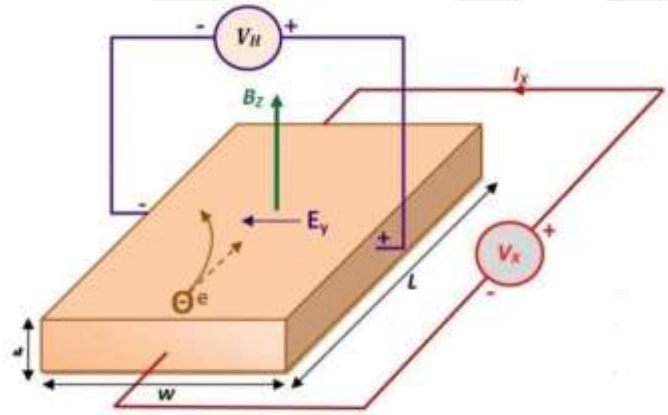


*Figure 1 shows a schematic view of the Hall effect, where I represents the direction of the current, Bz the direction of the magnetic field, and VH the direction of the Hall voltage.*

This gives us an expression for the Hall voltage, and the expression is called the Hall coefficient. By taking all the quantities in the expression using experiment, it is possible to determine the concentration of mobile electrons in the semiconductor by determining RH, or the magnetic field induction vector B using (1). The following table shows the methods for determining the sensitivity of sensors based on the Hall effect.

| **Mode** | **sensitivity** | **unit** |
|---|---|---|
| Power mode | $S_{VI} = \left\|\frac{V_{Hall}}{IB}\right\|$ | $\left[\frac{V}{AT}\right]$ |
| Voltage mode | $S_{VI} = \left\|\frac{V_{Hall}}{VB}\right\|$ | $\left[\frac{V}{VT}\right] = T^{-1}$ |
| Current mode | $S_{VI} = \left\|\frac{I_{Hall}}{IB}\right\|$ | $\left[\frac{A}{AT}\right] = T^{-1}$ |

Sensors based on the Hall effect have been the main magnetic sensors for decades, and their performance, size, and low cost have made them the most widely used compared to other magnetic devices because Hall sensors are easily integrated into modern commercial CMOS (complementary metal-oxide-semiconductor) technologies. Typical silicon-based Hall sensors have a sensitivity of 100-1000 V/AT, accuracy up to -10mT [2]. to create devices, it is required to have sensors with sensitivity >1000 V/AT, accuracy up to -1mT. Hall sensors are mainly made of GaAs, InAs semiconductor materials with high mobility, which is somewhat expensive [3]. Currently, Graphene element is considered effective for Hall sensors [4]. Hall sensors made of graphene element have a sensitivity of 5700V/AT in laboratory conditions, and an accuracy of [5]. However, Hall effect sensors have several disadvantages. Compared to MR sensors, the output signal is weak, and they are manufactured with complex electronic circuits to perform output voltage amplification, offset compensation, offset correction, signal digitization, and signal processing.

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