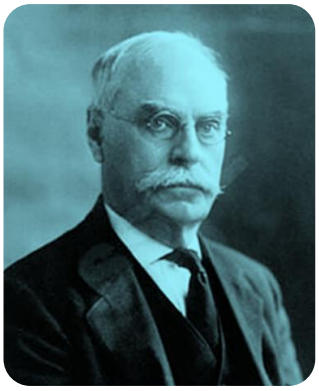
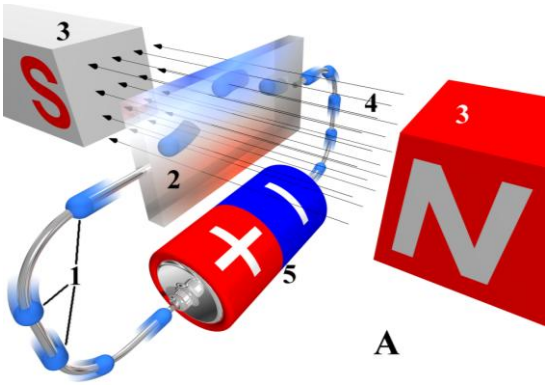
HALL SENSORS

Hall sensors, or Hall effect sensors, are magnetic field sensors that operate based on the Hall effect—discovered by Edwin Hall in 1879.

- **These sensors detect the presence, strength, and direction of a magnetic field**
- **These are widely used in applications like speed sensing, position detection, proximity sensing, and current measurement.**
- **They are non-contact, durable, and suitable for harsh environments, making them indispensable in modern electronics, automotive systems, and industrial automation.**

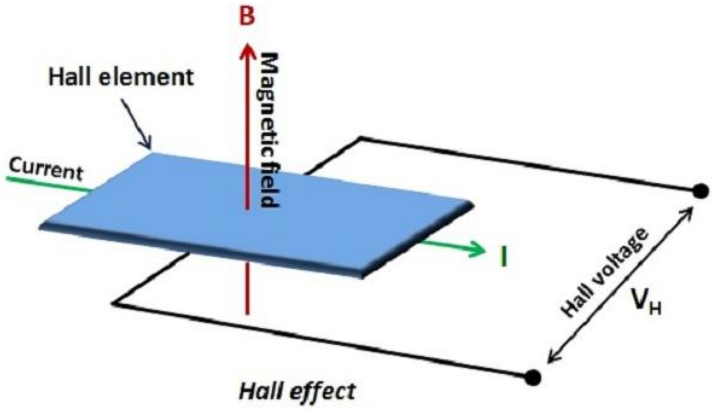


Edwin Herbert Hall
1879



HALL EFFECT

When a conductor (metal or semiconductor) carrying current (I) is placed in a magnetic field (B) perpendicular to this current, a potential difference (electric field) is developed inside the conductor in a direction of both current and magnetic field

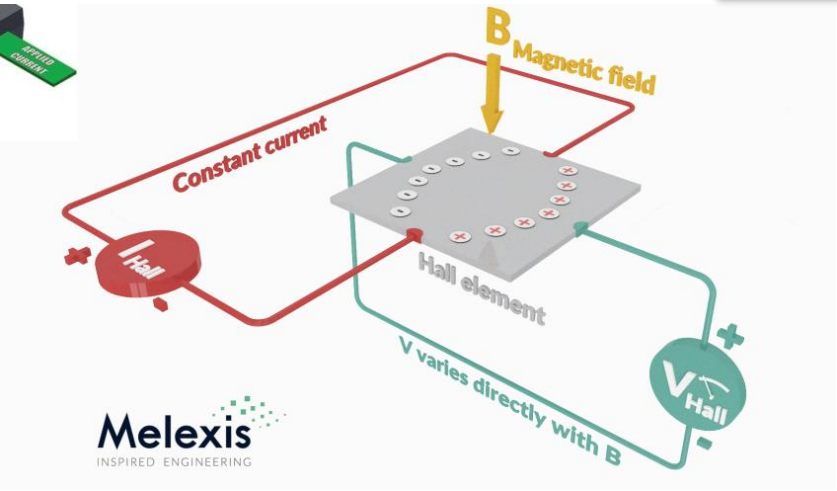


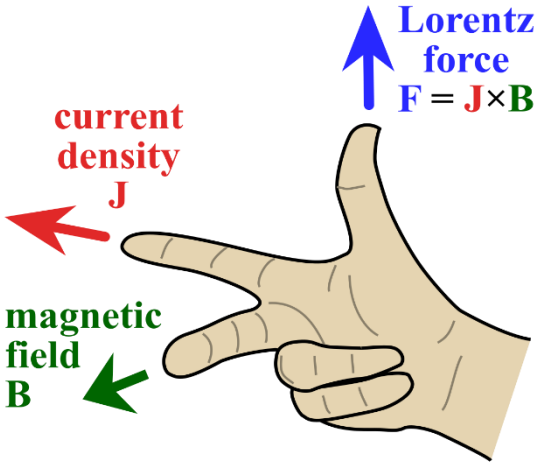
Current → **SEMICONDUCTOR/ CONDUCTOR** → **MAGNETIC FIELD** → **VOLTAGE**

HALL SENSORS

- **The basic physical principle underlying the Hall effect is the Lorentz force.**
- **When an electron moves along a direction perpendicular to an applied magnetic field, it experiences a force acting normal to both directions and moves in response to this force and the force effected by the internal electric field.**
- **The Lorentz force is given by**

$$F = q[E + (v * B)]$$





Types of Hall Sensors

1.Analog Hall Sensors

1. **Output a continuous voltage that varies with the magnetic field strength.**
2. **Used in linear position or current sensing applications.**

2.Digital Hall Sensors

1. **Output is either HIGH or LOW depending on whether the magnetic field exceeds a threshold.**
2. **Ideal for on/off, proximity, or switch-like functions.**

3.Bipolar/Unipolar/Omnipolar Sensors

1. **Unipolar: Respond to one magnetic polarity.**
2. **Bipolar: Require one polarity to turn on, the opposite to turn off.**
3. **Omnipolar: Detect either north or south poles.**

HALL SENSORS

Applications of Hall Sensors

1.Automotive

1. Seat buckle detection
2. Wheel speed sensors (ABS).
3. Throttle position and gear detection.

2.Consumer Electronics

1. Open/close detection in phones and laptops (e.g., lid sensors).
2. Brushless DC motor commutation.

3.Industrial

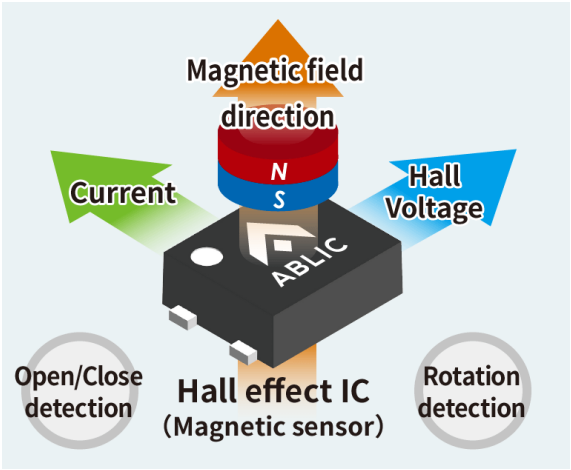
1. Conveyor belt speed monitoring.
2. Magnetic encoders.
3. Proximity and limit switches.

4.Power Electronics

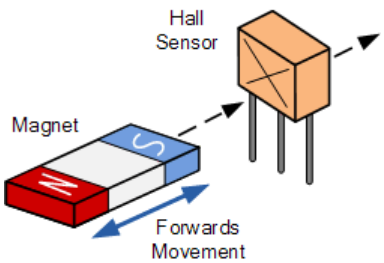
1. Current sensing in power converters.
2. Overcurrent protection.

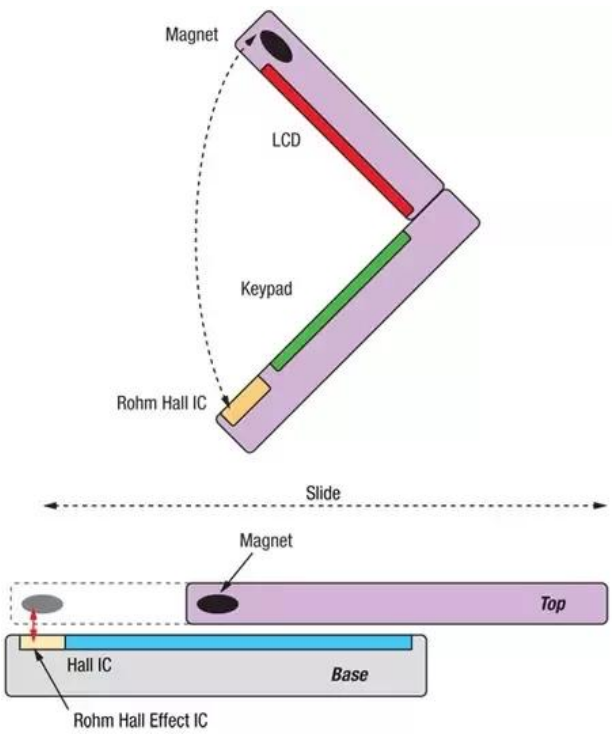
5.Medical Devices

1. Non-contact position sensors in surgical tools and infusion pumps.



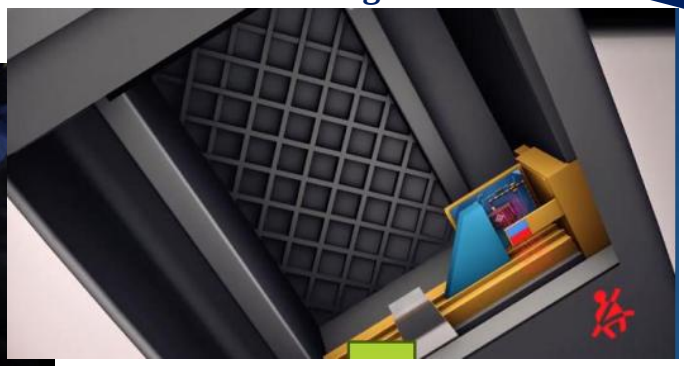
Hall effect IC switches

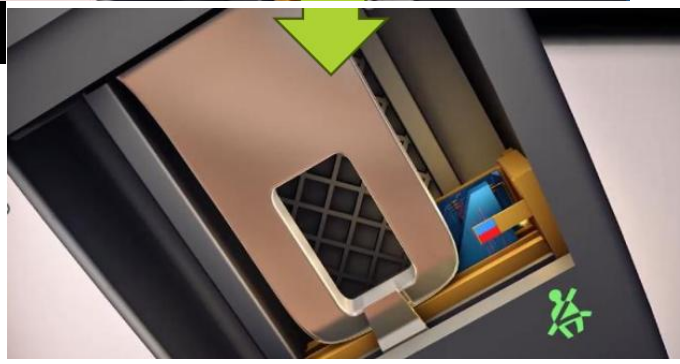




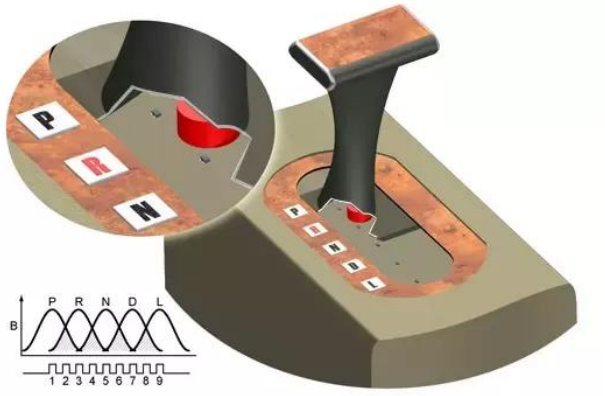
HALL SENSORS

Seat Belt Buckle Sensing





Gear shifting mechanism in a motor vehicle.

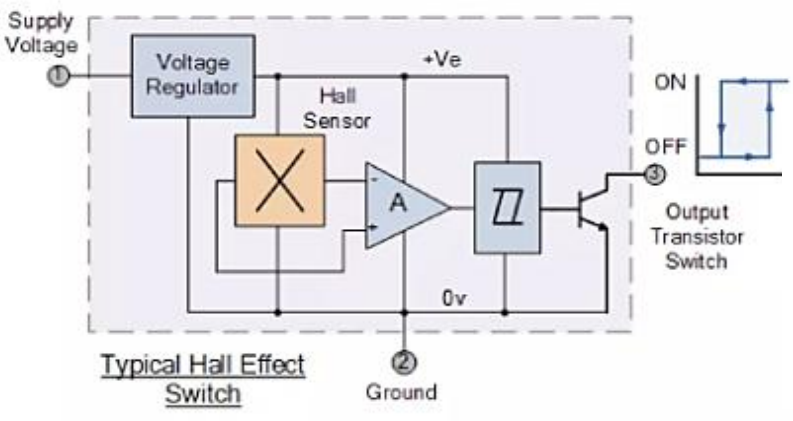


Hall Effect Sensors are available with either linear or digital outputs. The output signal for linear (analogue) sensors is taken directly from the output of the operational amplifier with the output voltage being directly proportional to the magnetic field passing through the Hall sensor. This output Hall voltage is given as:

$$V_H = R_H\left(\frac{I}{t} \times B\right)$$

$$V_H = \frac{R_H I_x B}{b}$$

$$R_H = \frac{V_H b}{I_x B}$$



Typical Hall Effect Switch

Where:
V_H is the Hall Voltage in volts
R_H is the Hall Effect co-efficient
I is the current flow through the sensor in amps
t is the thickness of the sensor in mm
B is the Magnetic Flux density in Teslas

HALL SENSORS

Feature	Reed Switch	Hall Sensor
Working Principle	Magnetic field closes mechanical contacts	Uses Hall Effect to generate voltage in response to a magnetic field
Lifespan	Limited (mechanical wear)	Long (no moving parts)
Switching Capability	Can directly switch high voltages and currents	Cannot switch high power directly (requires additional circuitry)
Sensitivity	ON/OFF switching only	Can detect varying magnetic field strengths
Power Consumption	None (passive device)	Requires external power
Response Time	Slower due to mechanical contacts	Faster, solid-state operation
Durability	Sealed, resistant to dust and moisture	More resistant to vibrations and mechanical stress
Cost	Generally lower	Typically more expensive
Applications	Security sensors, power switching, industrial position sensing	Speed sensing, proximity detection, contactless switches