Hall effect sensors remain vital for contactless magnetic sensing in IoT, automotive, and industrial sectors. They convert magnetic field variations directly into electrical signals through a fundamental physics phenomenon

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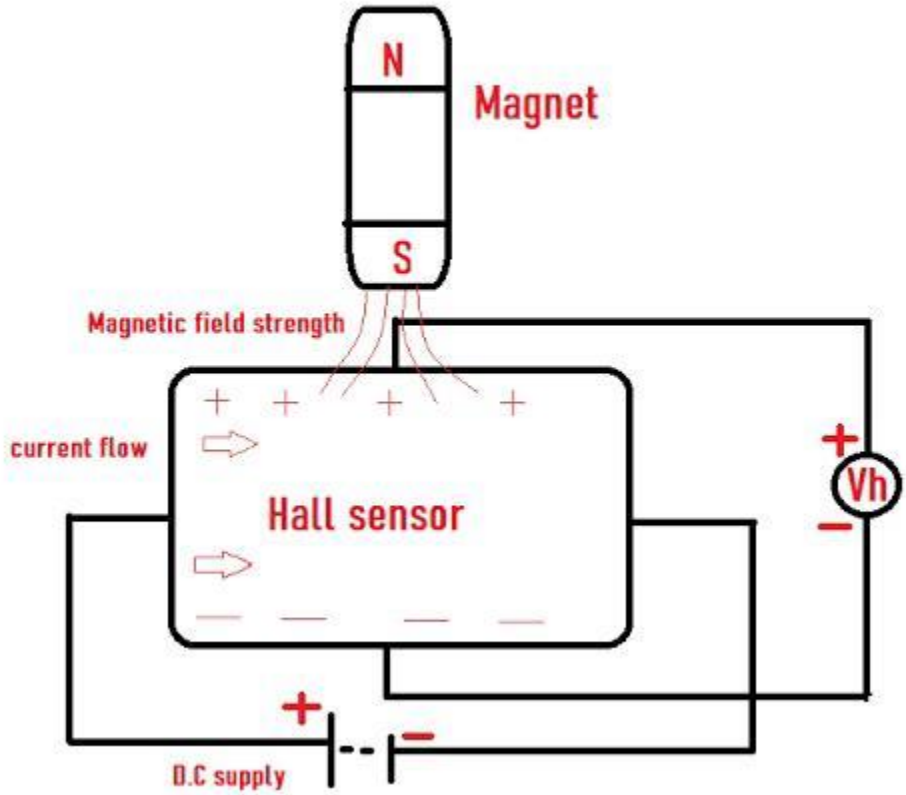
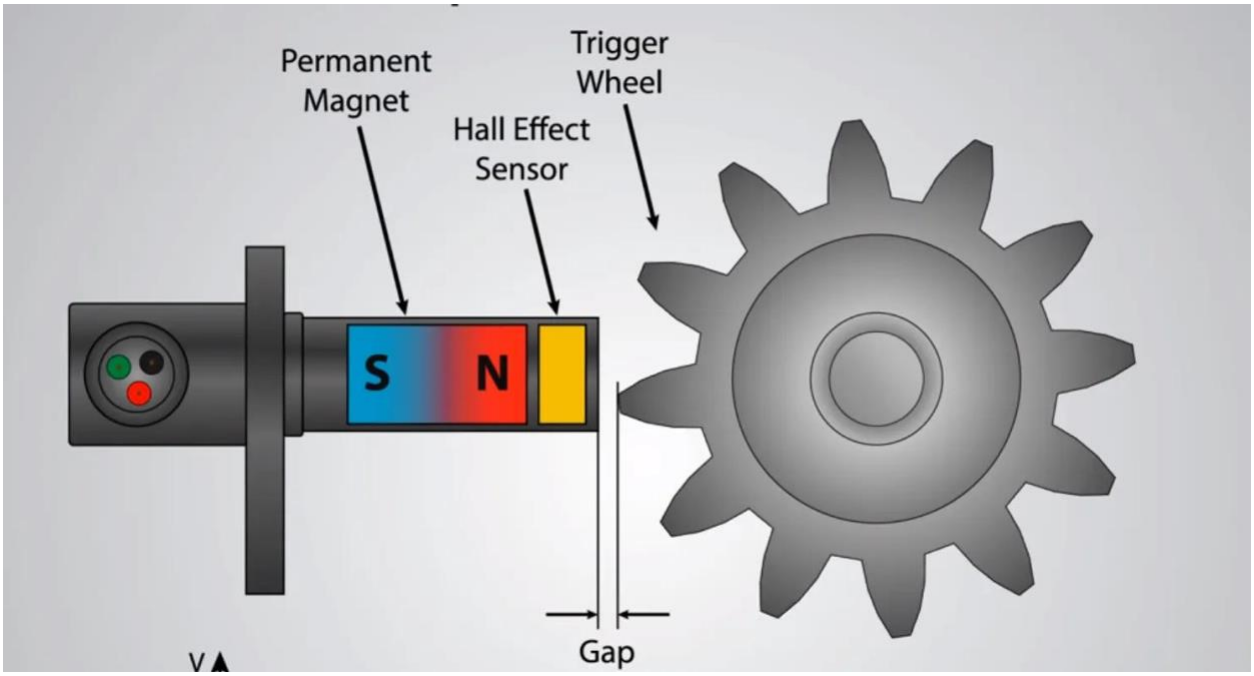
Working Principle: The Hall Effect



- **Fundamental Principle**: When a constant electric current flows through a thin conductor (the **Hall element**) and a magnetic field is applied perpendicular to it, the magnetic field exerts a **Lorentz force** on the moving charge carriers (electrons).
- **Charge Separation**: This force pushes electrons toward one side of the conductor, creating a buildup of negative charge on one edge and leaving a positive charge on the opposite edge.
- **Hall Voltage**

  This separation creates a measurable potential difference across the conductor, known as the Hall voltage. This voltage is **directly proportional** to the strength of the magnetic field and the current density.

Core Internal Components



Standard Hall effect Integrated Circuits (ICs) typically include:

1. **Hall Element**: A thin semiconductor plate (often made of Gallium Arsenide or Indium Antimonide).
2. **Voltage Regulator**: Ensures a stable power supply for consistent readings.
3. **Differential Amplifier**: Boosts the raw Hall voltage, which is typically in the microvolt range, to a usable level.
4. **Schmitt Trigger (Digital only)**: Adds **hysteresis** to prevent rapid output switching (bouncing) near the detection threshold.

Types of Hall Effect Sensors

- **Linear (Analog) Sensors**: Provide a continuous voltage output proportional to the magnetic field strength.
    - *Usage*: Precise distance measurement, current sensing, and throttle position.
- **Digital Switches**: Produce a simple "ON" or "OFF" signal when a magnetic threshold is crossed.
    - **Unipolar**: Responds to only one magnetic pole (typically the south pole).
    - **Omnipolar**: Responds to both north and south poles.
- **Latching Sensors**: Change state when a south pole is detected and **remain in that state** even if the magnet is removed. They only turn off when a north pole is presented.

- *Usage*: Brushless DC (BLDC) motor commutation and rotary encoding.

Key Advantages

- **Contactless & Rugged**: No physical contact means no mechanical wear, making them highly reliable for decades of use.
- **Environmentally Immune**: When properly packaged, they are resistant to water, dust, and vibration.
- **High Speed**: Capable of switching at frequencies up to 100 kHz, suitable for high-RPM motor tracking.
- **Galvanic Isolation**: In current sensing, they provide a safe, non-contact way to measure high-voltage lines.
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