CES Engineering

ELECTRONIC SYSTEM DESIGN

SENSORS (2)

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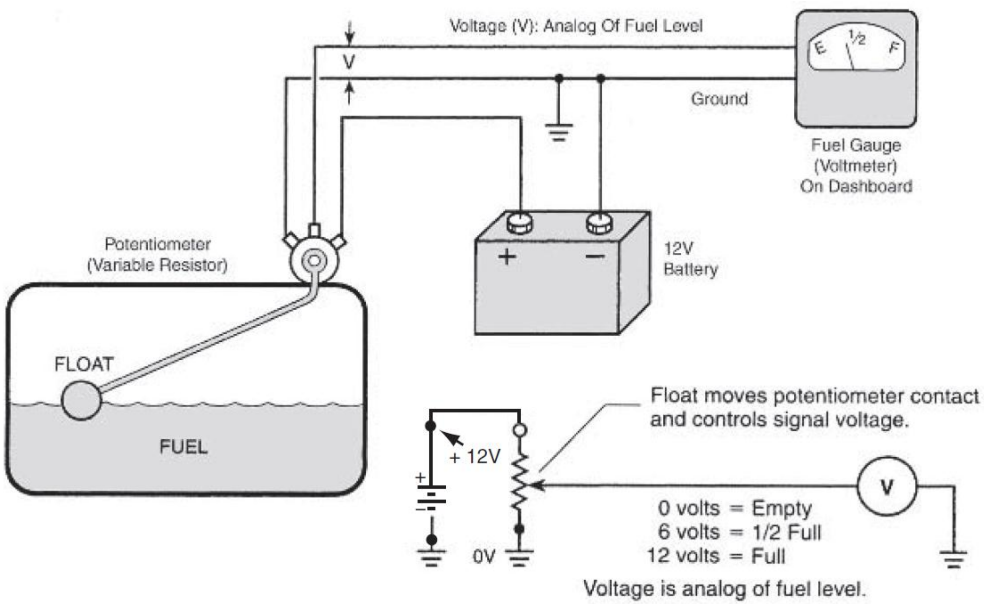
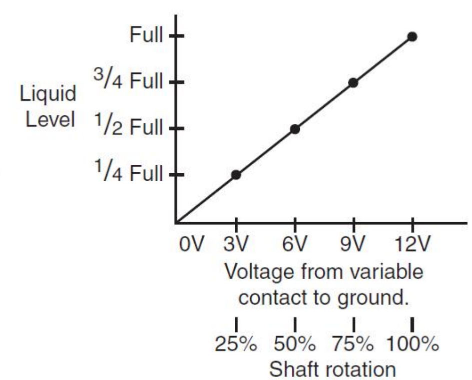
Position Sensor Example: Fuel Level

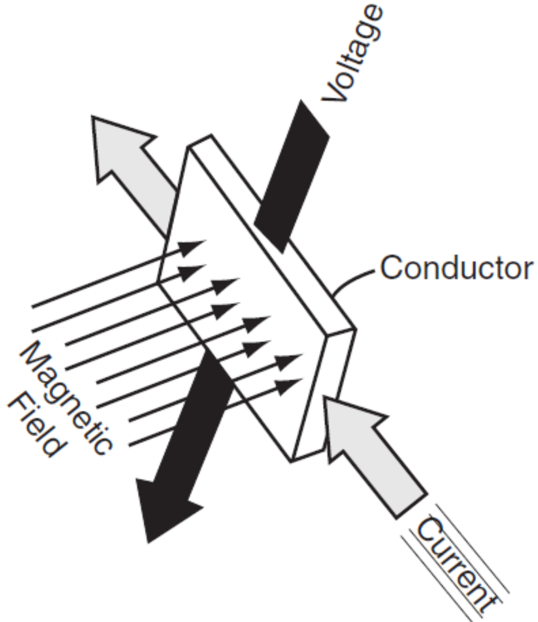
- Fuel sensor consists of a float that rides on the surface of fuel in a fuel tank, a lever arm connected to the float at one end, and, at the other end, connected to the shaft of a potentiometer
  - As the fuel level changes, the float moves and rotates the variable contact on the potentiometer





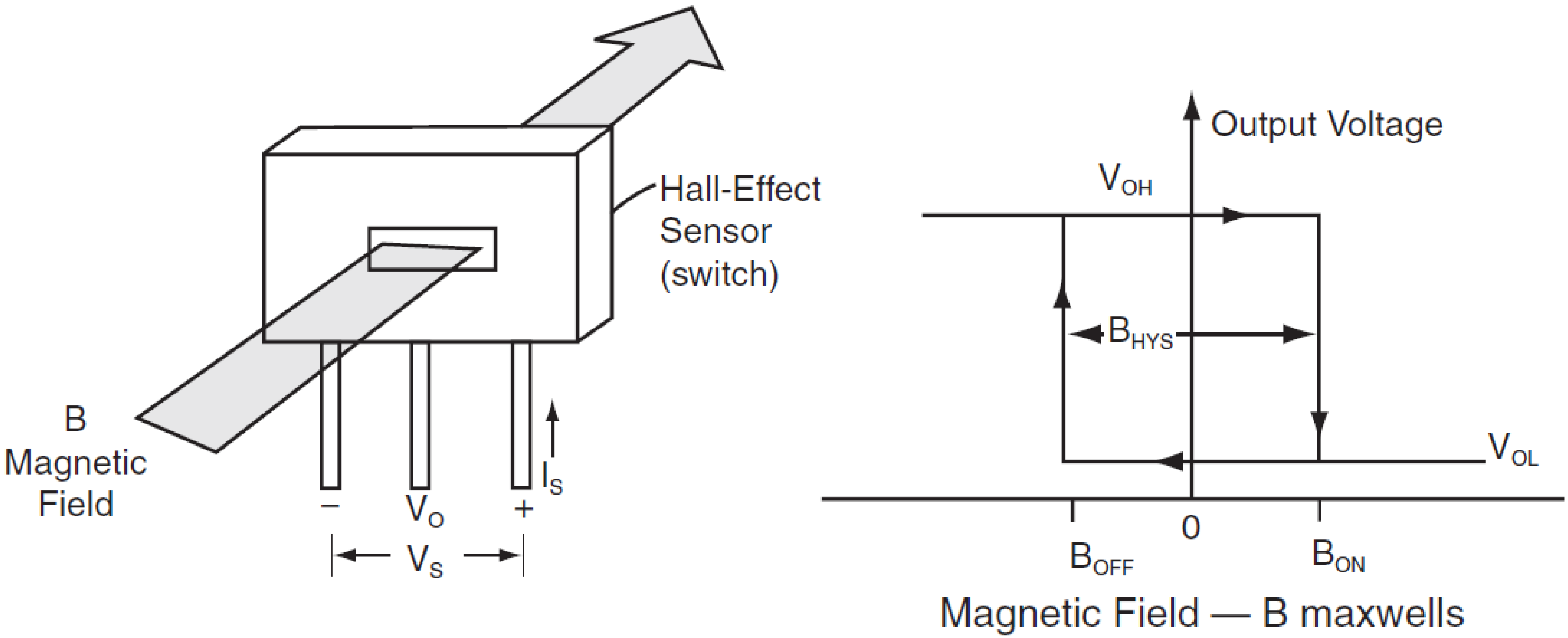
Hall Effect Position Sensor

- Hall Effect: If there is current in a conductor and a magnetic field is applied perpendicular to the direction of the current, a voltage will be generated in the conductor that has a direction perpendicular to both the direction of the current and the direction of the magnetic field



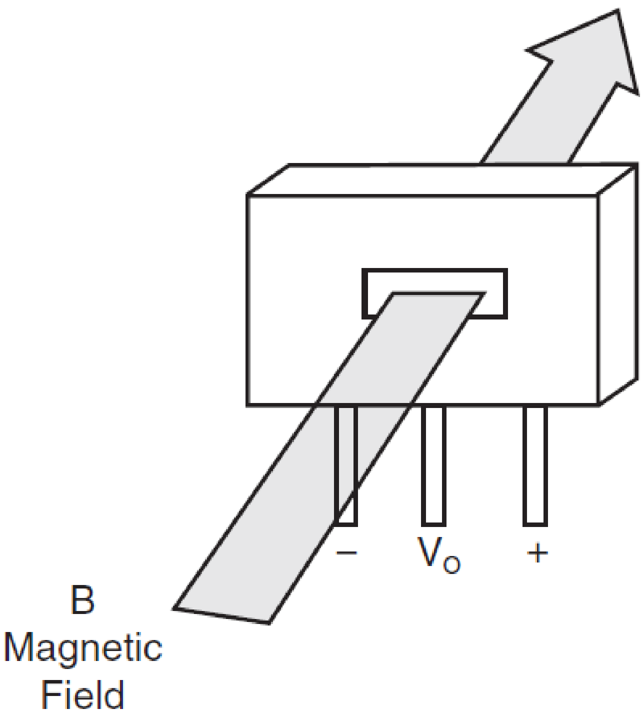
Hall Effect Position Sensor

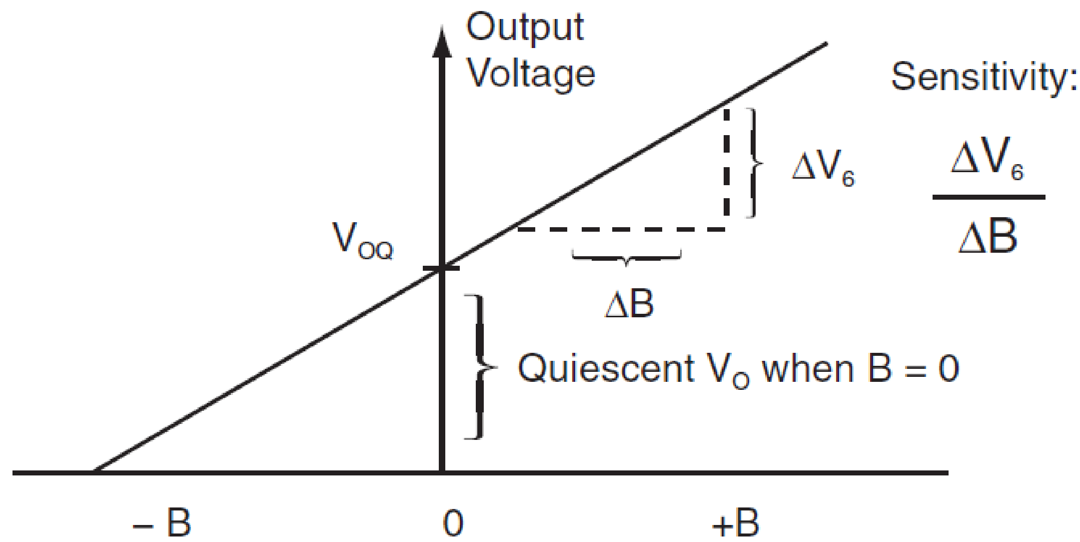
- Hall effect switch



Hall Effect Position Sensor

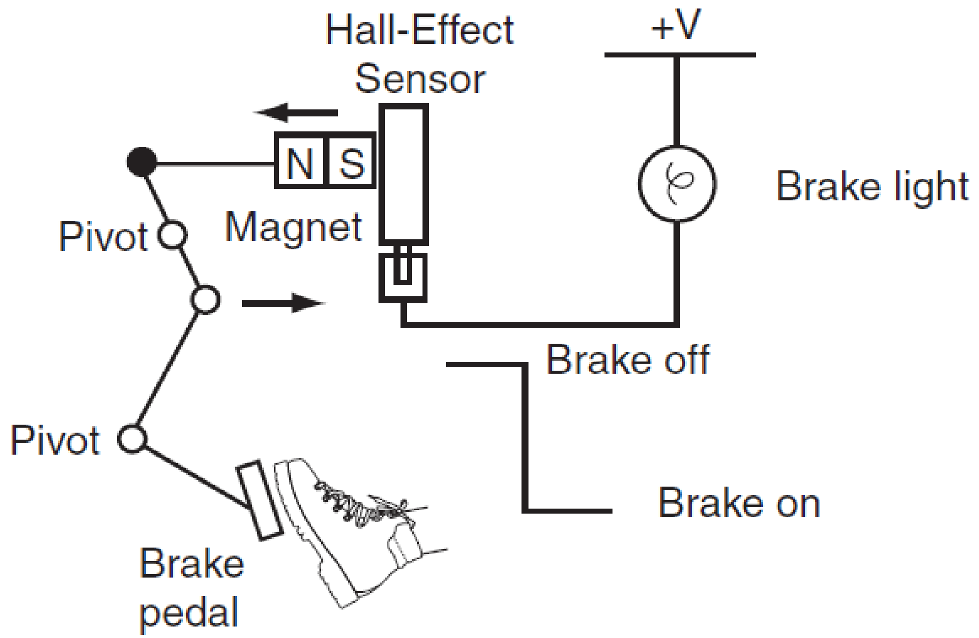
- Hall effect linear position sensor





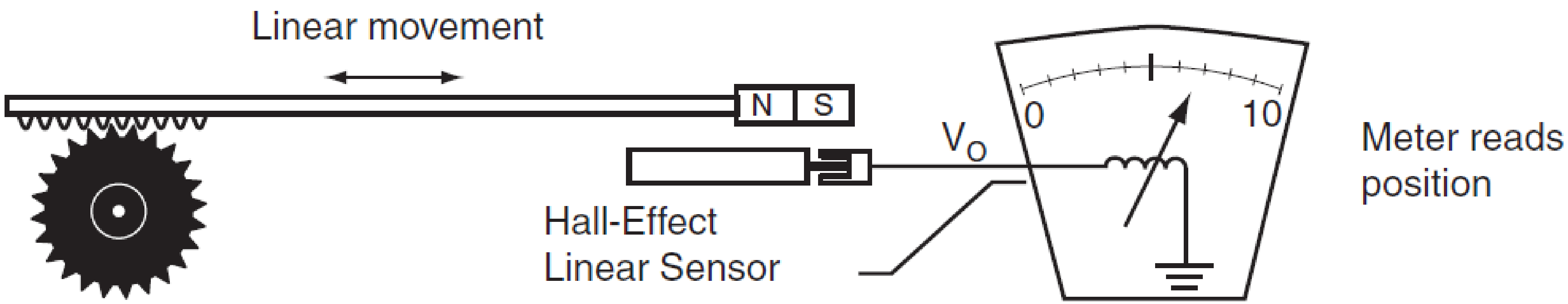
Hall Effect Position Sensor

- Hall effect brake pedal sensor
  - Stepping on the brake moves a magnet away from the Hall-effect sensor and its output switches to a low voltage level turning on the brake light
  - When the brake is released, the magnetic field is again strong enough to switch the output V_o to a high level, turning off the brake light.



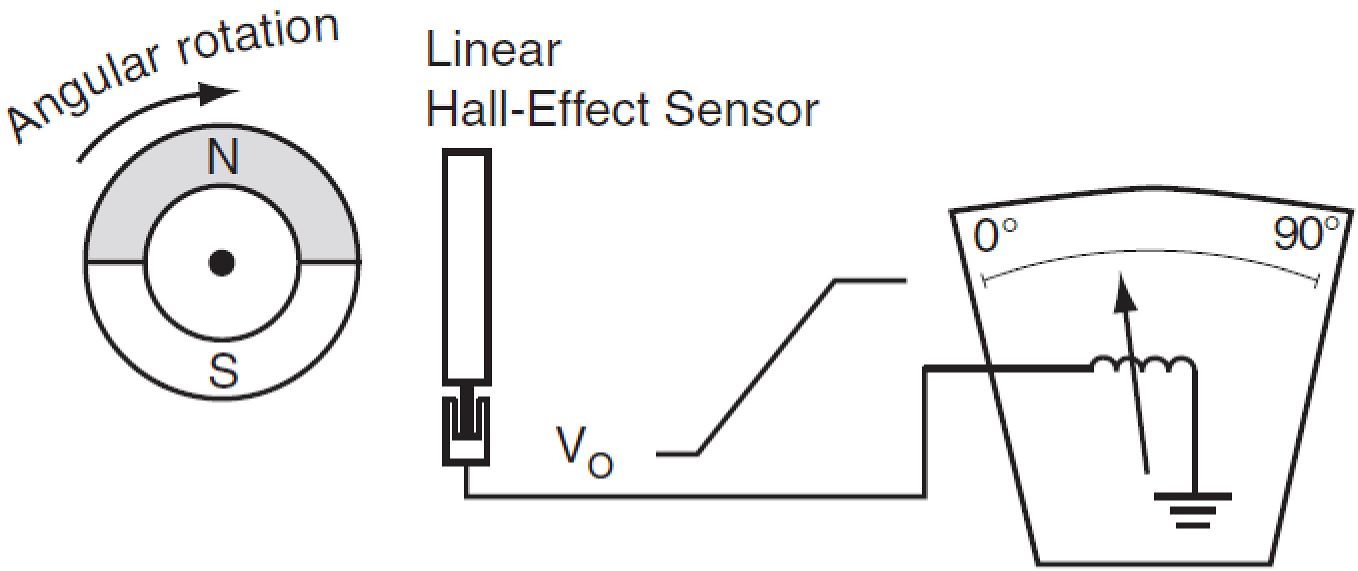
Hall Effect Position Sensor

- Hall effect linear position sensor
  - As the magnet is moved over the sensor the magnetic field produces an output V_o that is proportional to the strength of the field

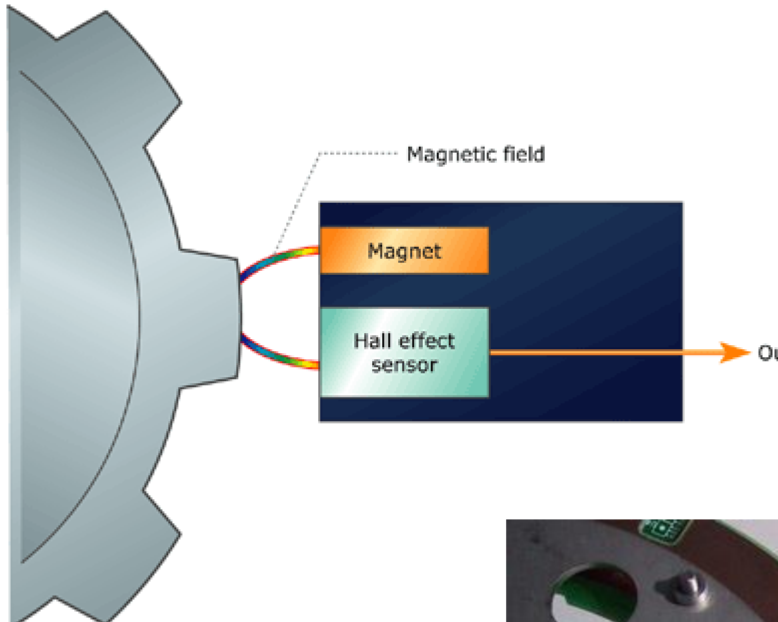


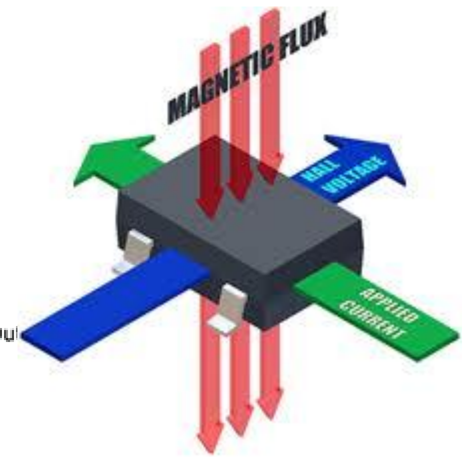
Hall Effect Position Sensor

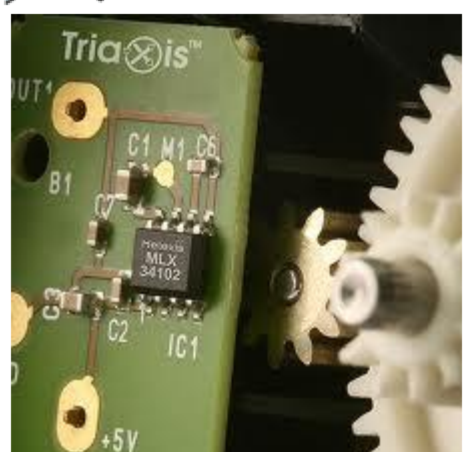
- Hall effect angular position sensor
  - As the magnet turns the magnetic field varies and produces an output VO that is proportional to the angular rotation

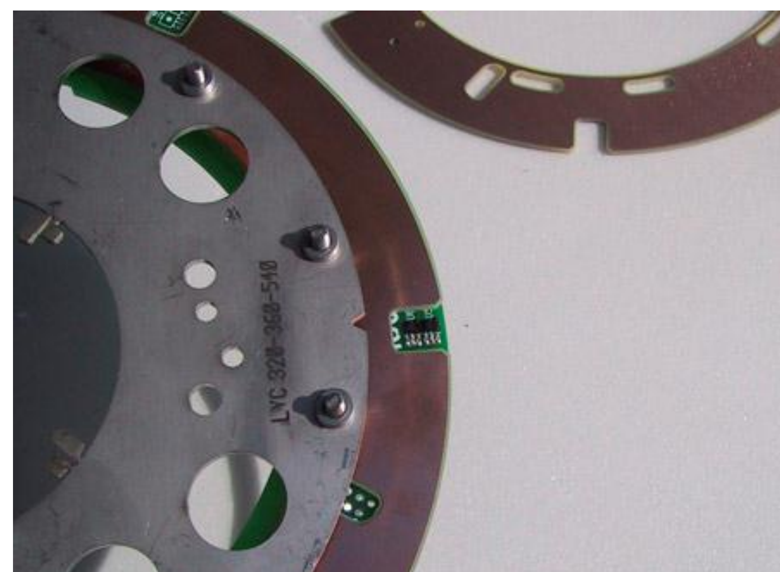


Hall Effect Senor Examples



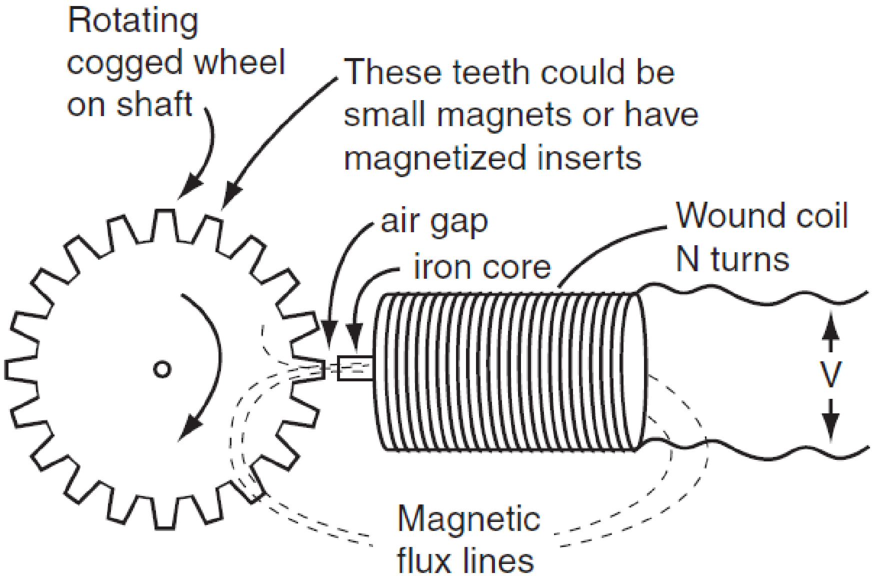


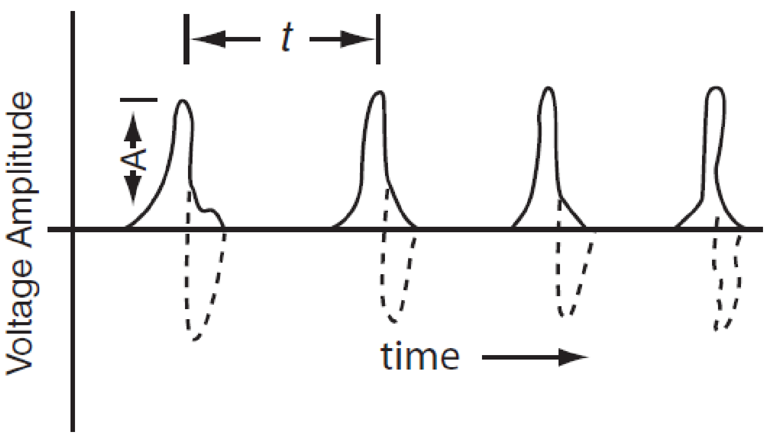




Variable Reluctance Sensor

- When the cog on the wheel is aligned with the iron core, the concentration of flux is greatest, and is much less as it moves toward or away from the core of the coil,
  - magnetic flux changes generate voltage pulses in the wires.
- The time, t, between the pulses varies as the speed of the cogged wheel varies and can be used to compute speed



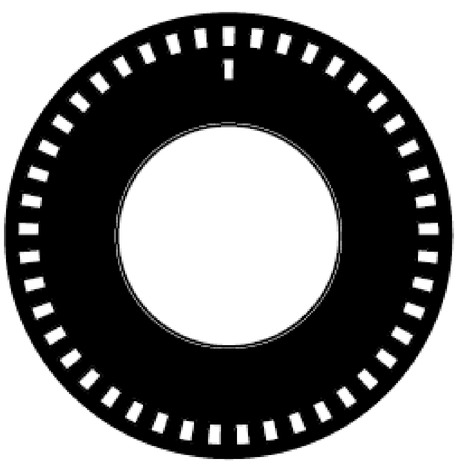


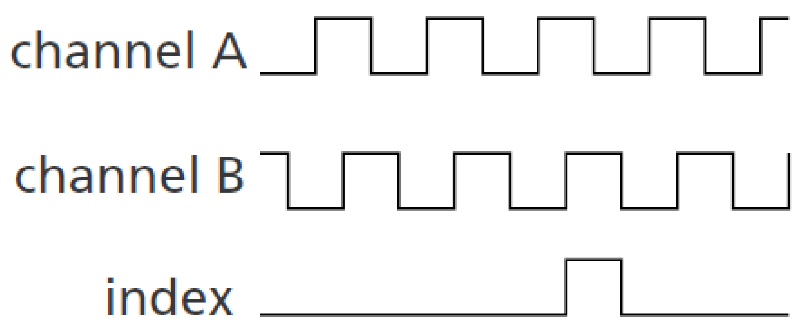
Optical Encoders

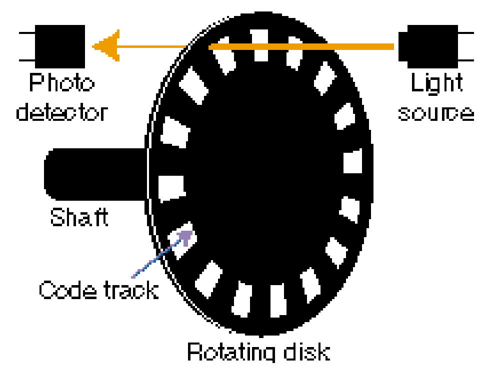
- Optical encoders are devices that convert a mechanical position into a representative electrical signal by means of a patterned disk or scale, a light source and photosensitive elements.
- With proper interface electronics, position and speed information can be derived.
- Encoders can be classified as rotary or linear for measurements of respectively angular and linear displacements.
- Encoders are also classified as either incremental (relative) or absolute types

Incremental Optical Encoders

- Uses a disk with a single track of lines around its periphery where disk count is defined as the number of dark/light line pairs that occur per revolution
- As a rule, a second track is added to generate a signal that occurs once per revolution (index signal), which can be used to indicate an absolute position.

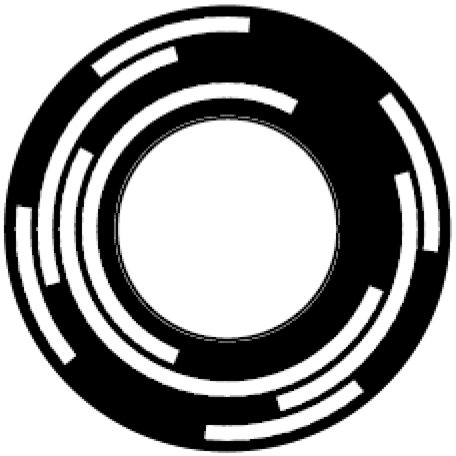


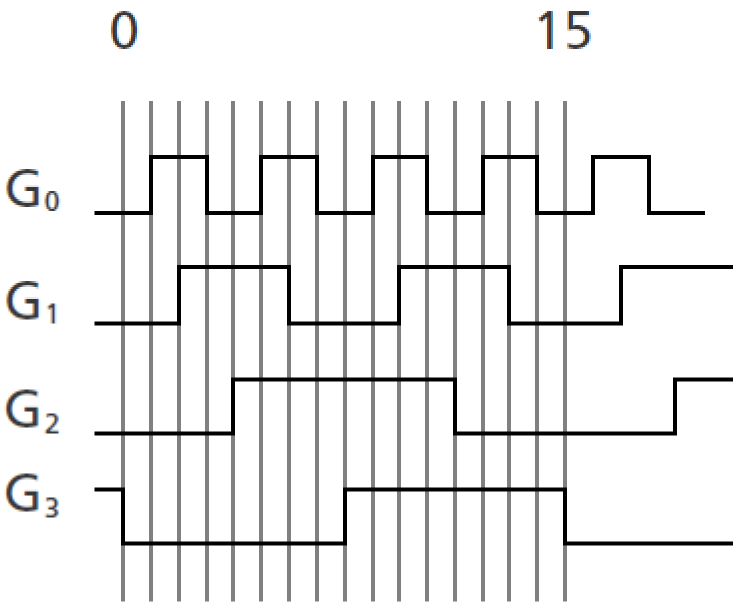




Absolute Optical Encoders

- The disk of an absolute encoder is patterned with a number of discrete tracks, corresponding to the word length





Optical Encoder Example

SERIES HD35R

STANDARD OPERATING CHARACTERISTICS

Code: Incremental

Resolution: to 5000 PPR (pulses/revolution) See Ordering Information

Format: Two channel quadrature (AB) with optional Index (Z), and complementary outputs

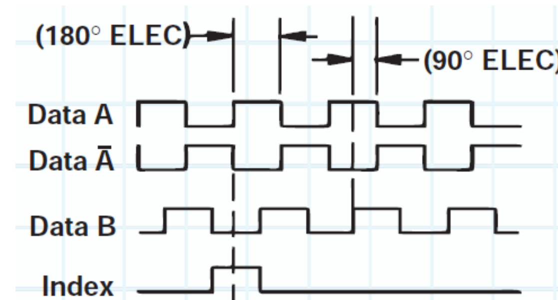
Phase Sense: A leads B for CW shaft rotation viewing the shaft end of the encoder

Quadrature Phasing: For resolutions to 1200 PPR: 90° ± 15° electrical; For resolutions over 1250 PPR: 90° ± 30° electrical

Symmetry:

For resolutions to 1024PPR: 180° ±18° electrical
For resolutions over 1024PPR: 180° ±25° electrical

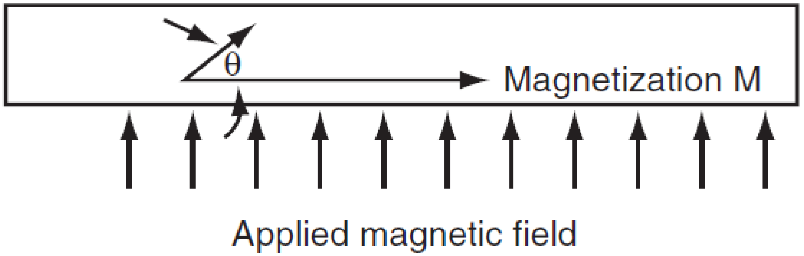
Waveforms: Squarewave with rise and fall times less than 1 microsecond into a load capacitance of 1000 pf

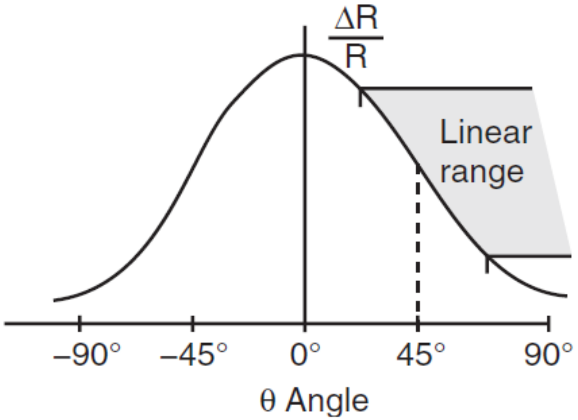


A leads B, CW (from shaft end)

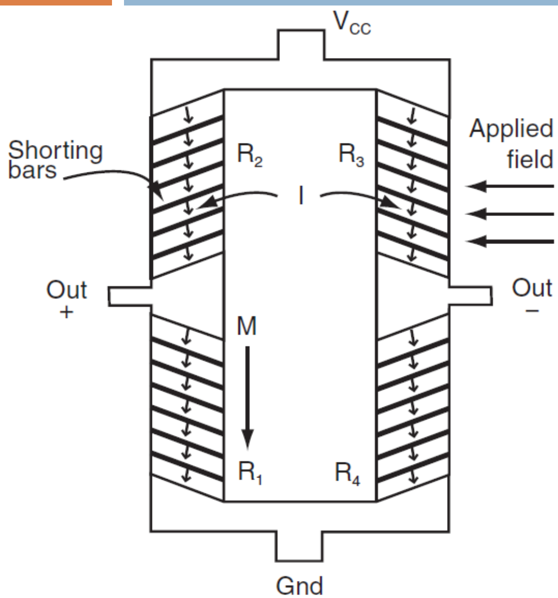
Magneto-Resistor Sensor

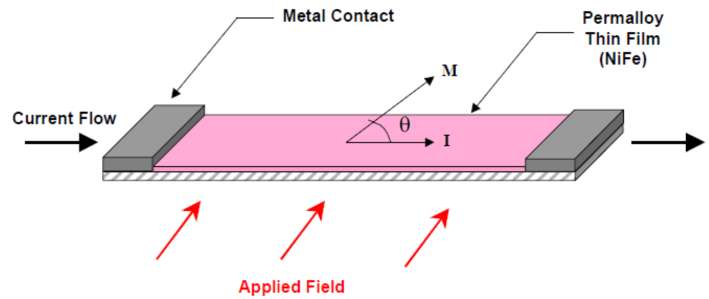
- A magnetoresistor sensor changes its resistance proportional to the magnetic flux density to which it is exposed.
  - Made of a nickel-iron (Permalloy) which is deposited as a thin film onto a semiconductor surface
- Magnetic position sensing can be done using Anisotropic Magneto-Resistive (AMR) sensors

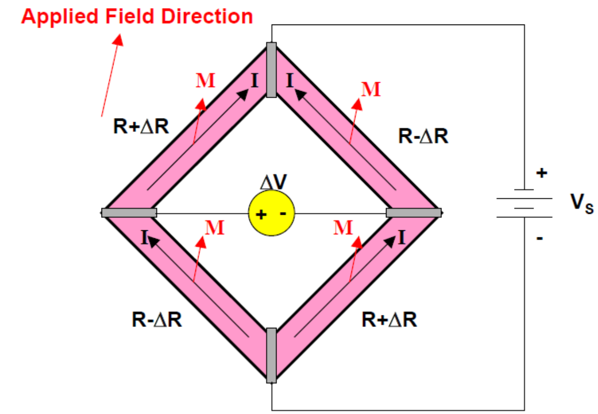


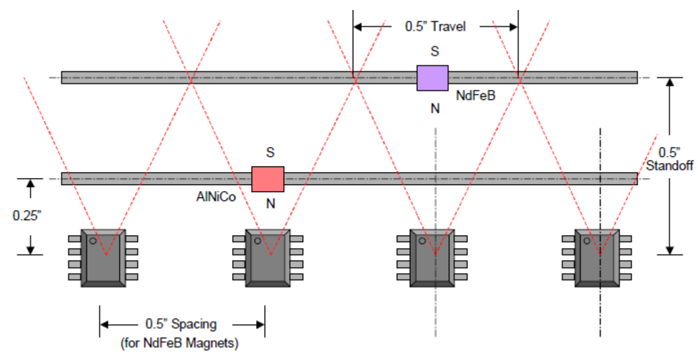


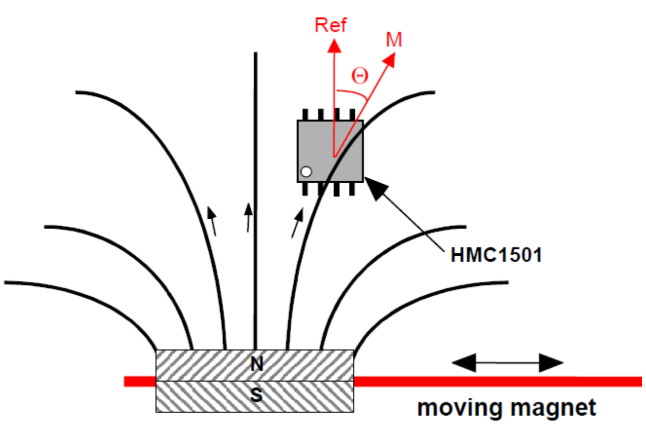
Magneto-Resistor Sensor

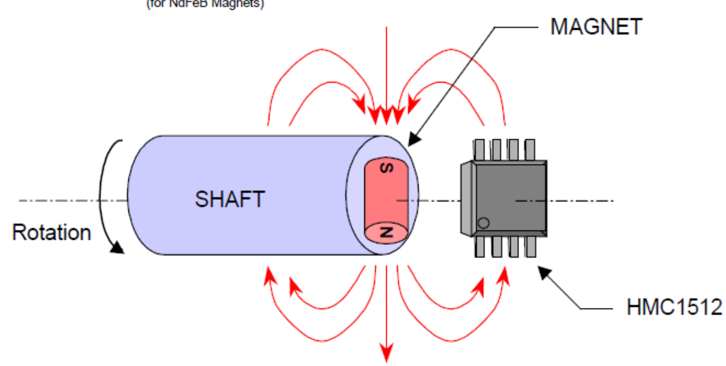


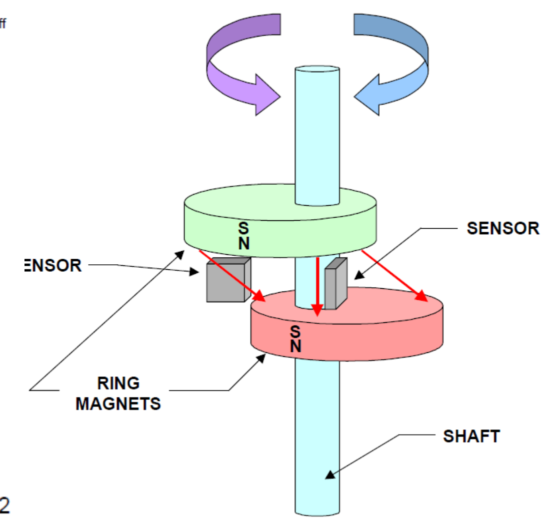












Assignments

- Implement one example of a position sensor in the lab.
- Obtain real part numbers and data sheets for 5 example sensor types considered here in the lecture.