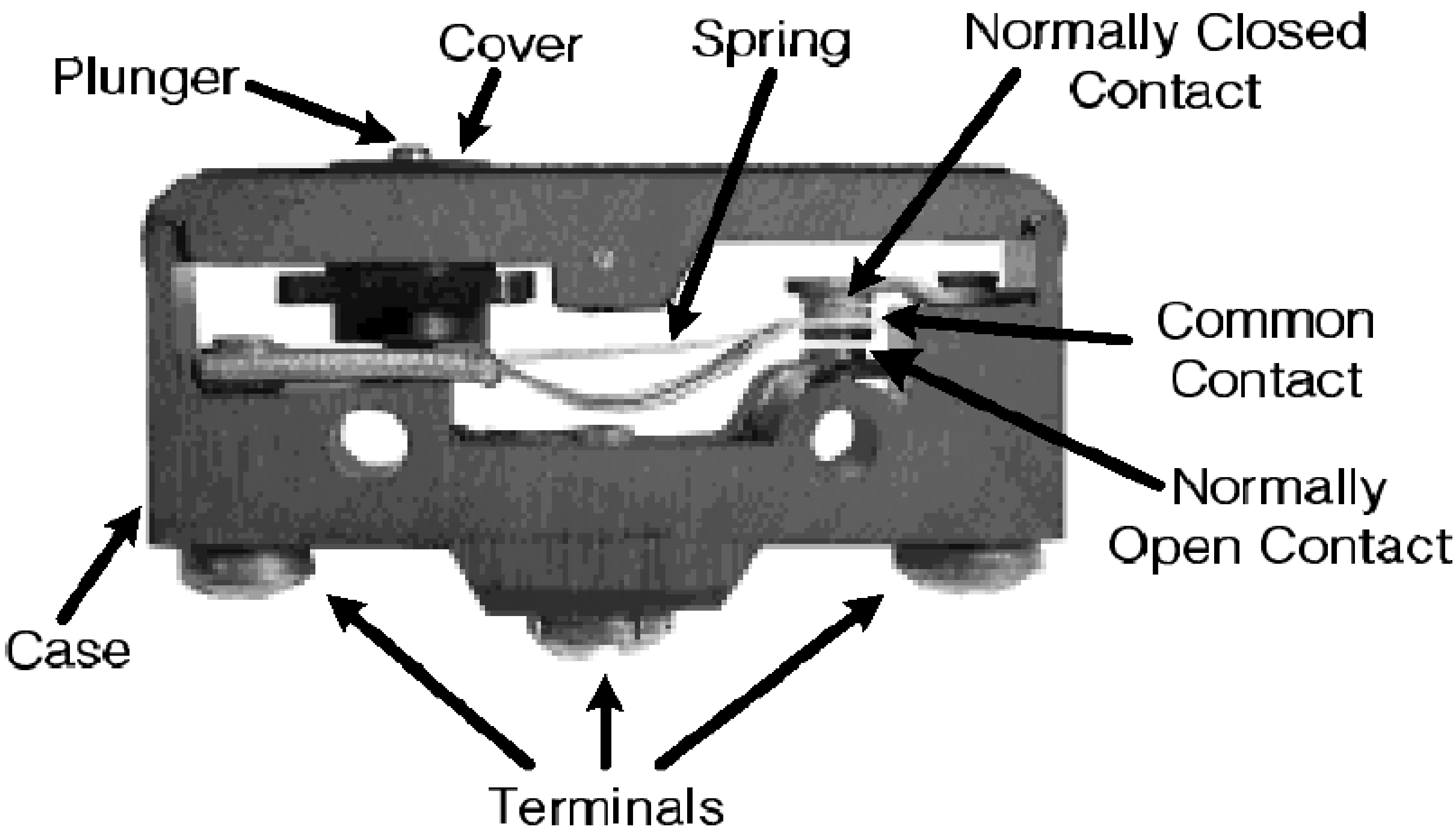
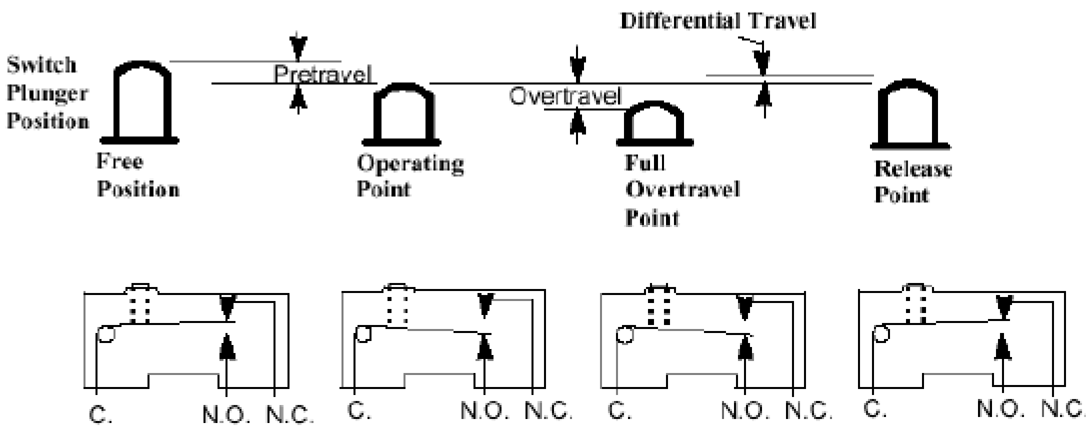
Position Sensing

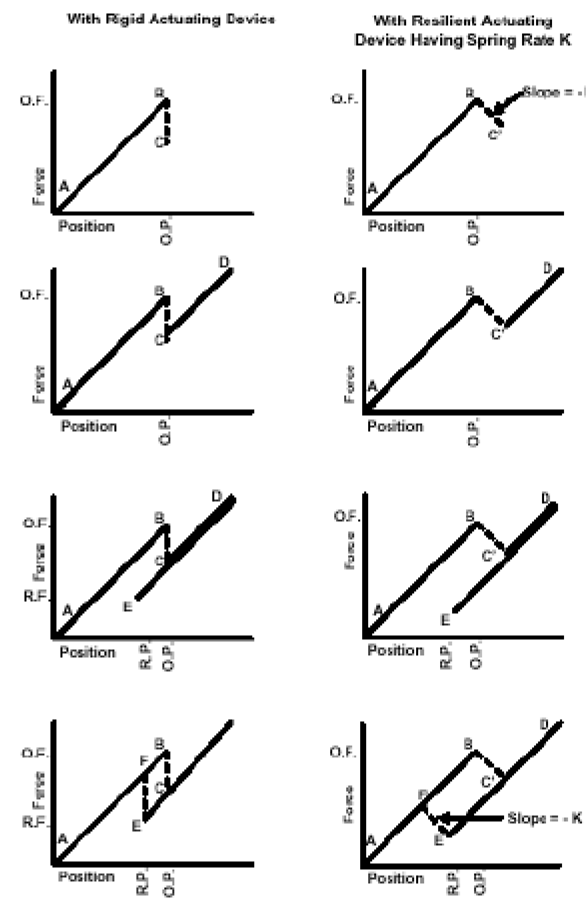
- Mechanical
- Optical
- Magnetic
- Capacitive, Ultrasonic

Mechanical Sensing - Microswitch



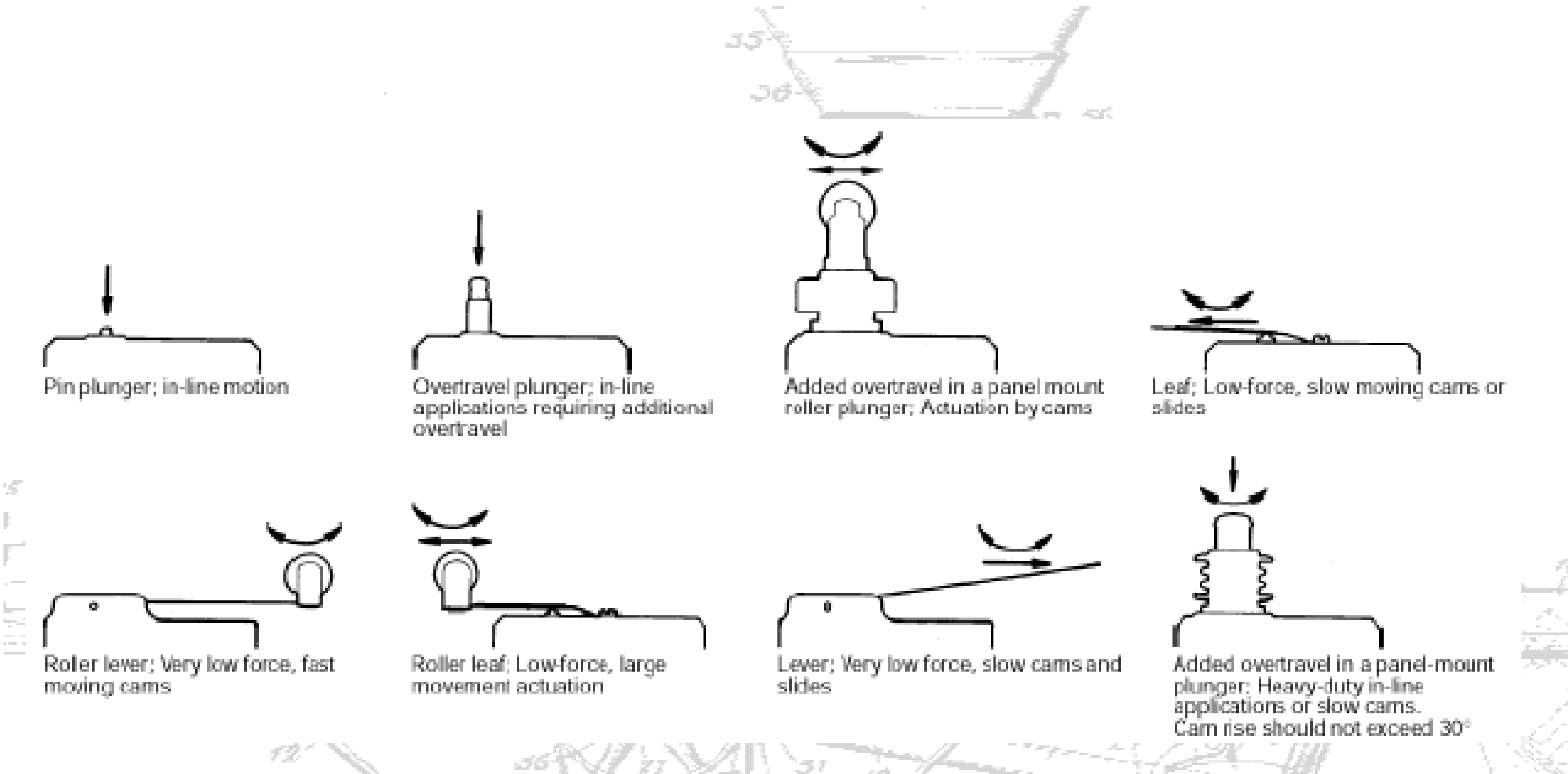
Microswitch Operation





Switch exhibits mechanical hysteresis.

Microswitch Actuators



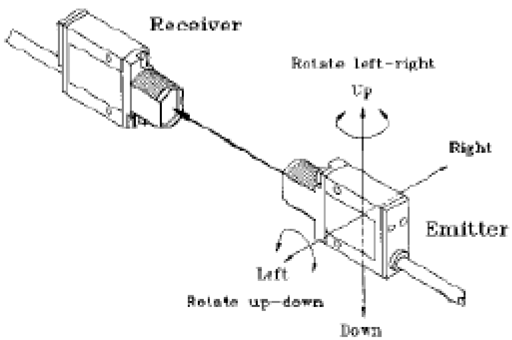
Optical Sensing

- LED's and Photodiodes
- Transmissive/Reflective
- Modulated/Unmodulated
- Light-on/Dark-on
- Fiber optic

Transmissive & Reflective Sensors

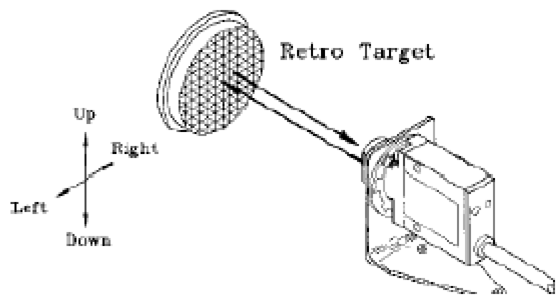
Opposed Mode Alignment

Opposed Mode Alignment: Move Emitter or Receiver Up-Down, Left-Right, and Rotate



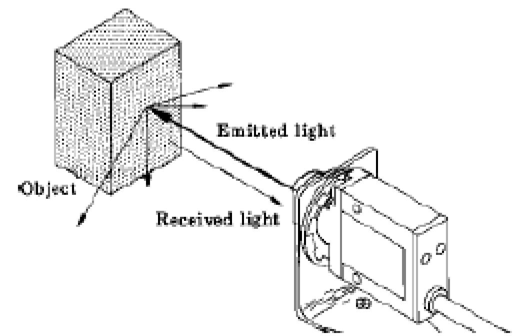
Retroreflective Mode Alignment

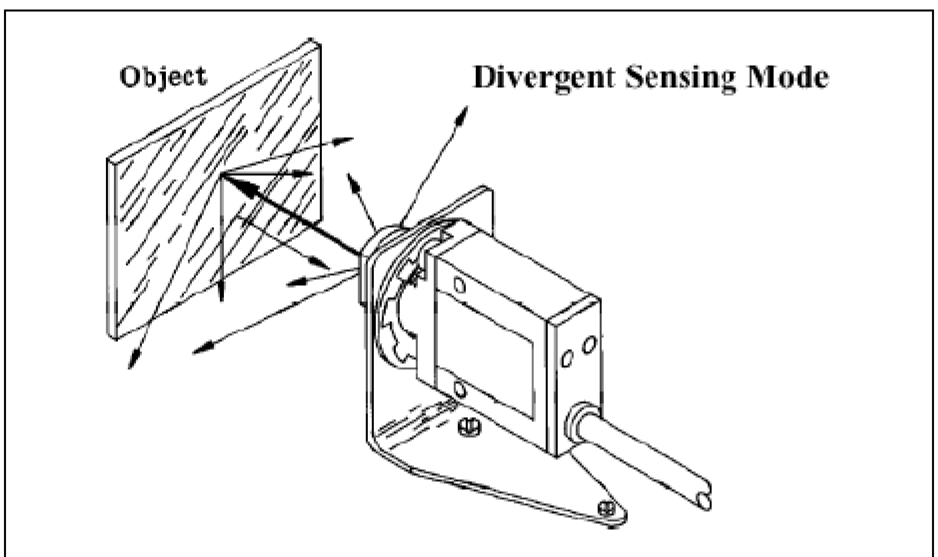
Retroreflective Mode Alignment:
Move Target Up-Down, Left-Right

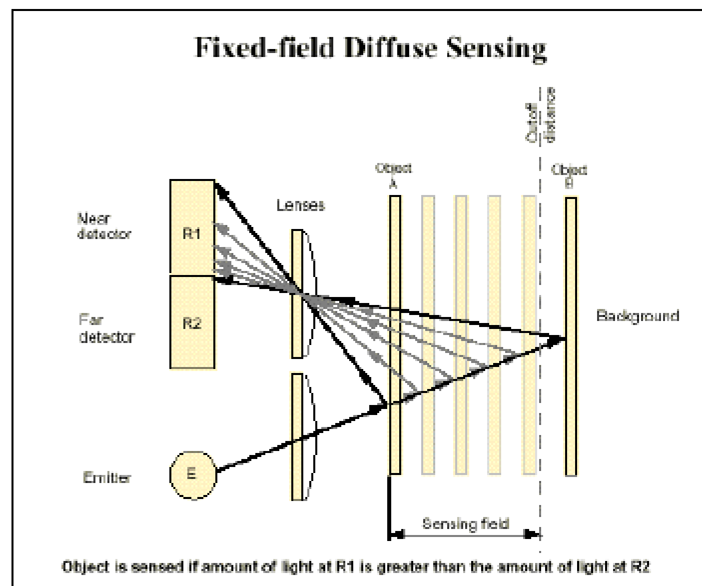


Proximity (Diffuse) Mode Alignment

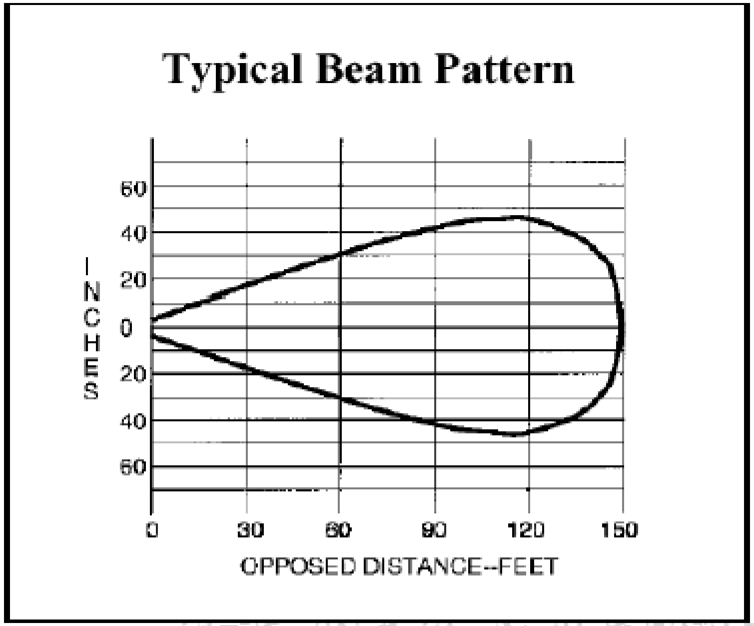
Diffuse Mode Alignment:
Rotate Up-Down, Left-Right

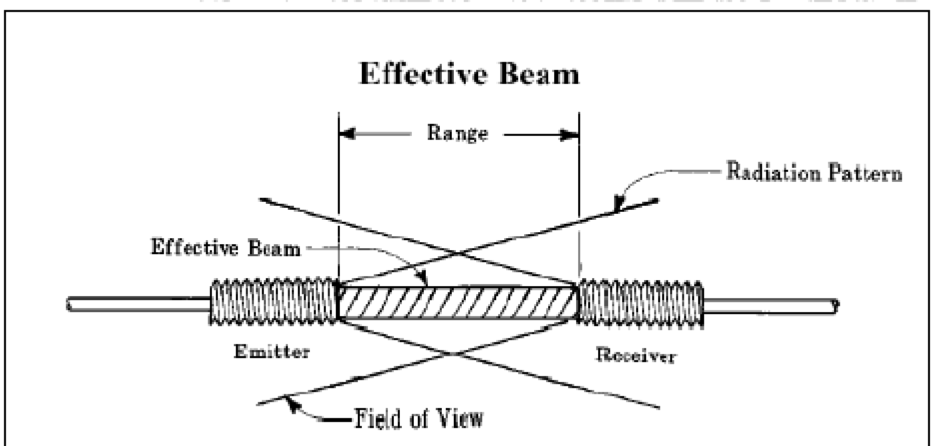






Beam Pattern and Reflectance



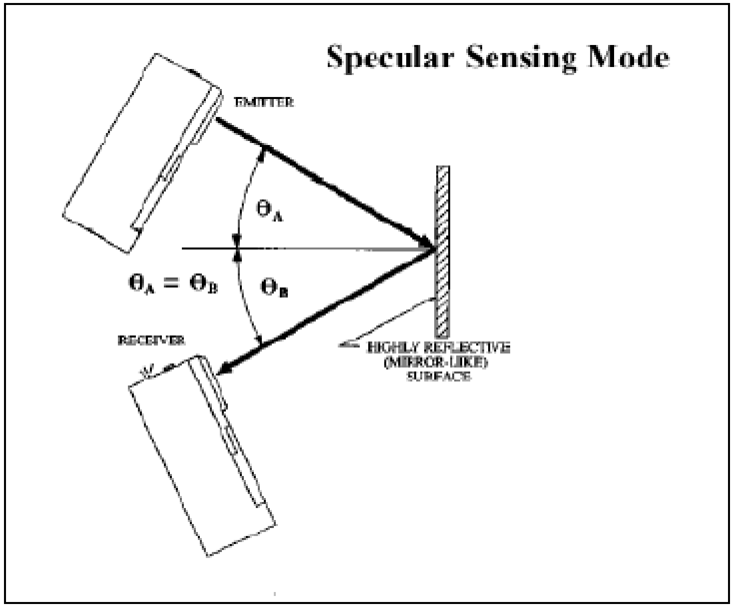


RELATIVE REFLECTIVITY TABLE

Material	Reflectivity (%)	Excess Gain Required
Kodak white test card	90%	1
White paper	80%	1.1
Masking tape	75%	1.2
Beer foam	70%	1.3
Clear Plastic*	40%	2.3
Rough wood pallet (clean)	20%	4.5
Black neoprene	4%	22.5
Natural alumi-num, unfinished*	140%	0.6
Stainless steel, microfinish	400%	0.2
Black anodized aluminum*	50%	1.8

*NOTE: For materials with shiny or glossy surfaces, the reflectivity figure represents the maximum light return, with the sensor beam *exactly perpendicular* to the material surface

Specular Reflection



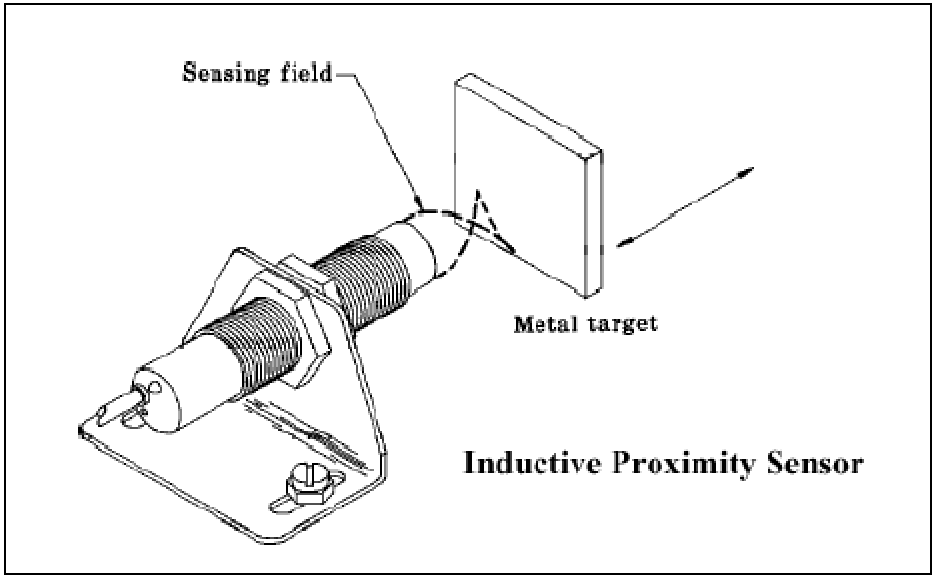
Modulation

- "Chop" LED on and off at many kHz rate
- Bandpass filter after photodiode at the same frequency as chopping
- Threshold circuit after BPF generates on/off output

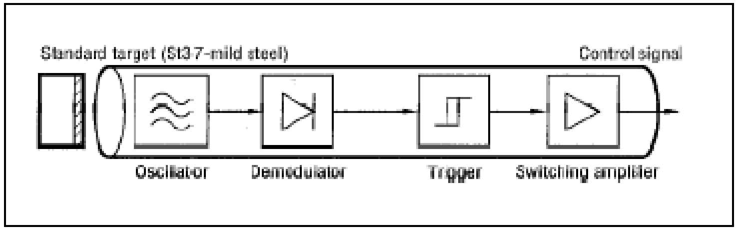
Magnetic Position Sensors

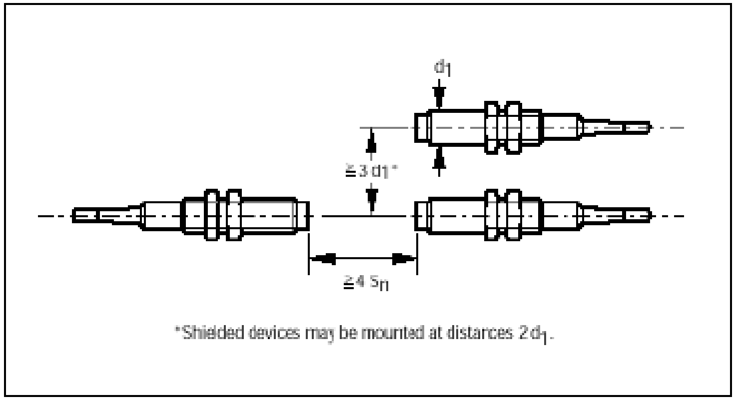
- Reed switches (sense permanent magnet)
- Inductive proximity sensors (eddy current)
- Hall Sensors (sense permanent magnet)

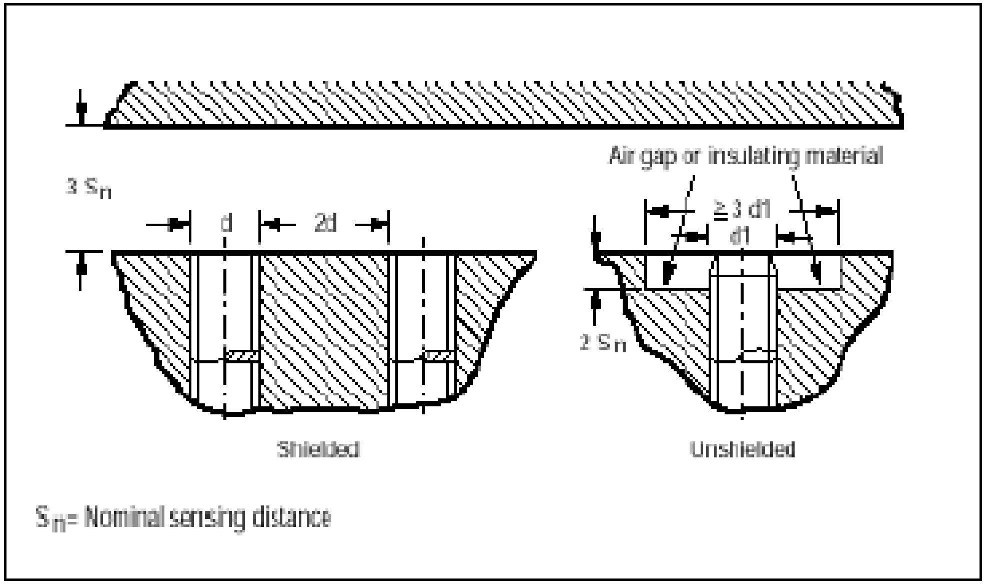
Inductive Proximity Sensor



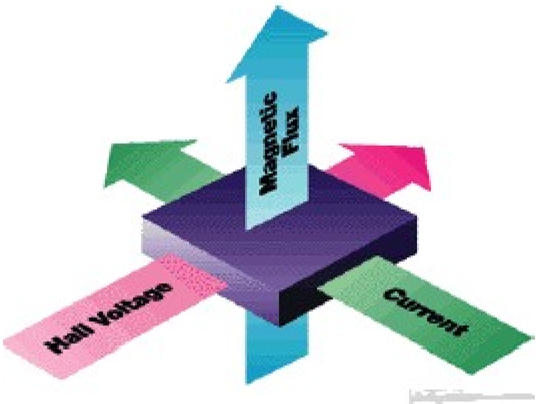
Inductive Proximity Sensors







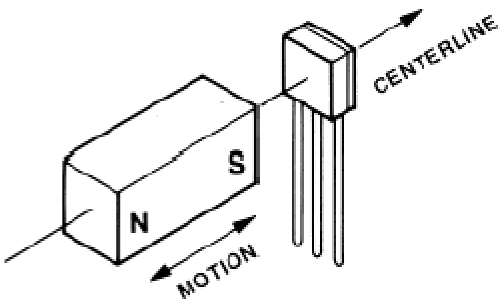
Hall Sensors

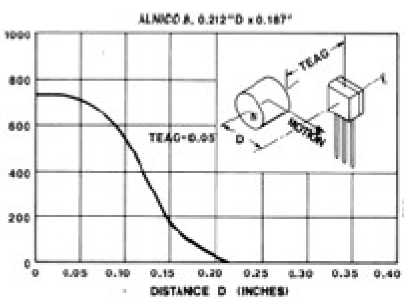


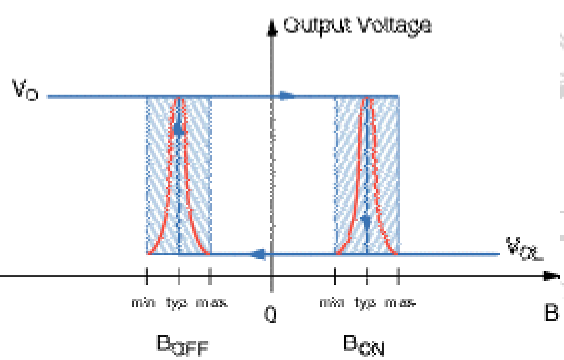
- Hall effect:
  - constant voltage forces a constant current in semiconductor sheet
  - magnetic field flux lines perpendicular to current cause proportional voltage across sheet.
  - discovered by E.F.Hall in 1879
- Linear sensor needs voltage regulator and amplifier
- Switch also needs threshold circuit, with hysteresis

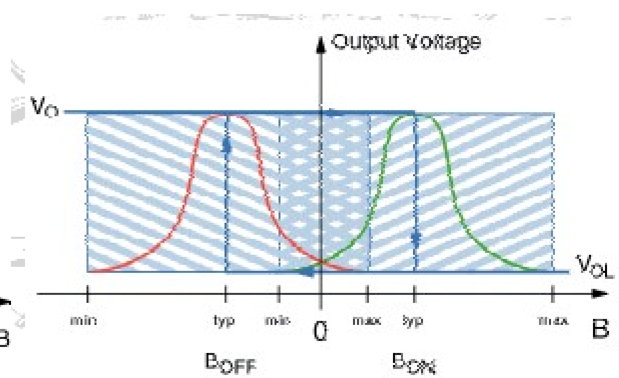
Hall Switch

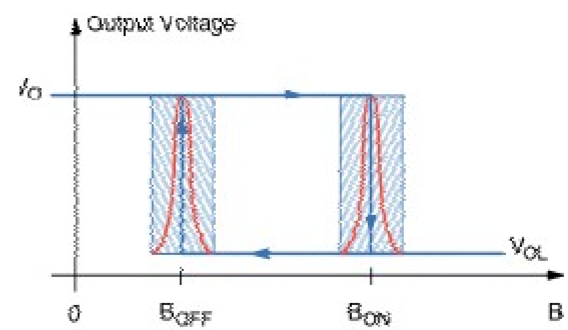
- Magnet motion
  - head-on
  - bypass or slide-by
- Total effective air gap (TEAG)
- Sensitivity, Hysteresis, & Temperature







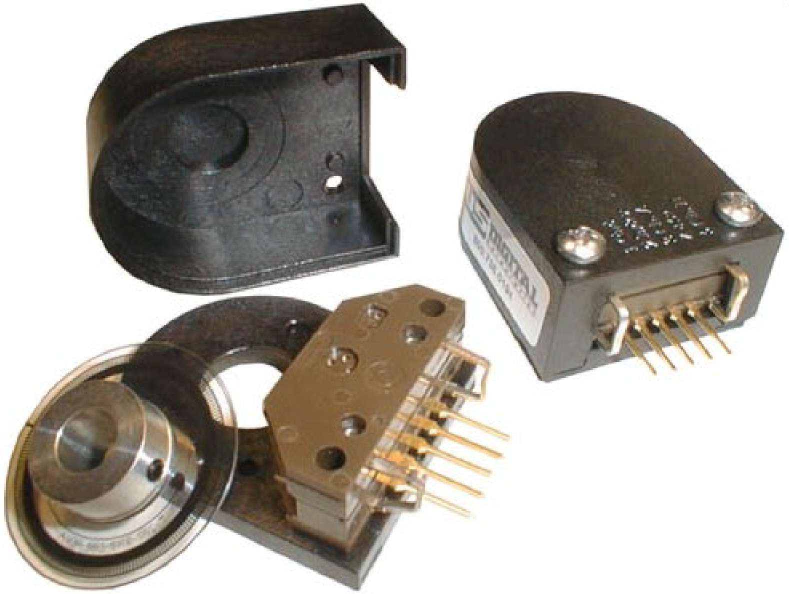


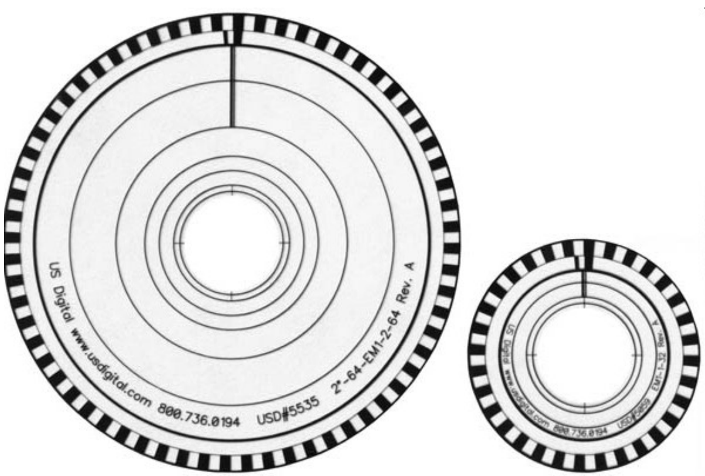


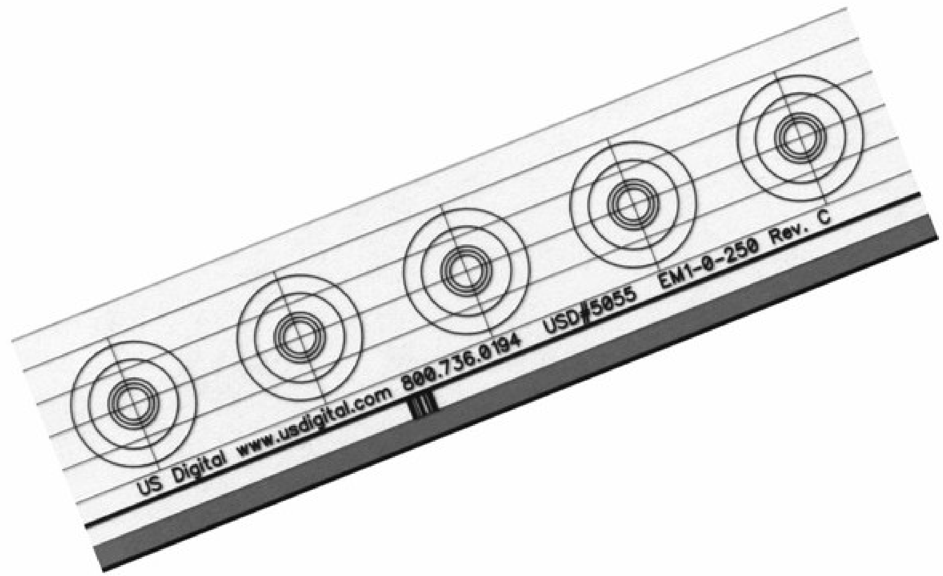
Other Discrete Position Sensors

- capacitive
- ultrasonic
- variable reluctance (coil around magnet, senses moving ferrous material)

Incremental Encoders



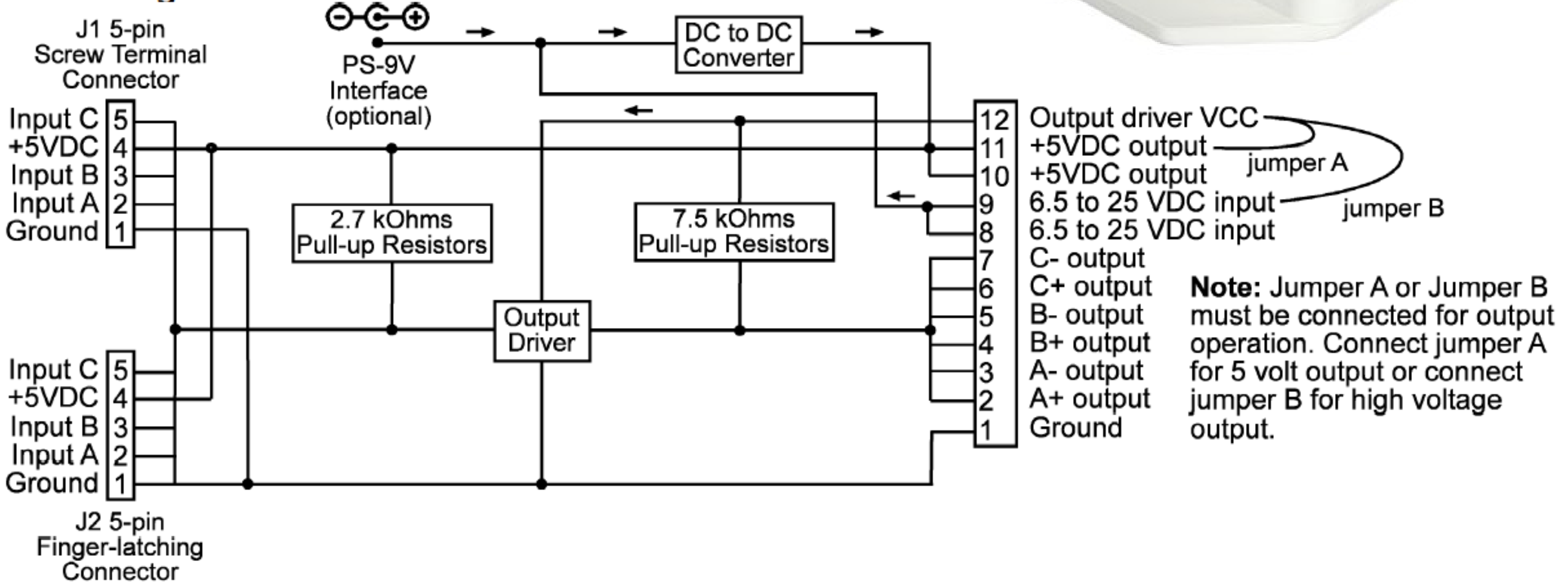




Incremental Encoders

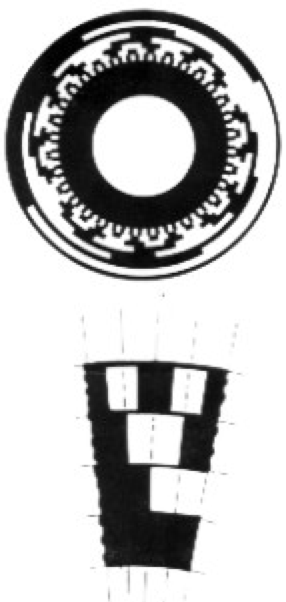
- Encoders typically run on +5V, not +24V
- Outputs are typ. not 24V compatible either

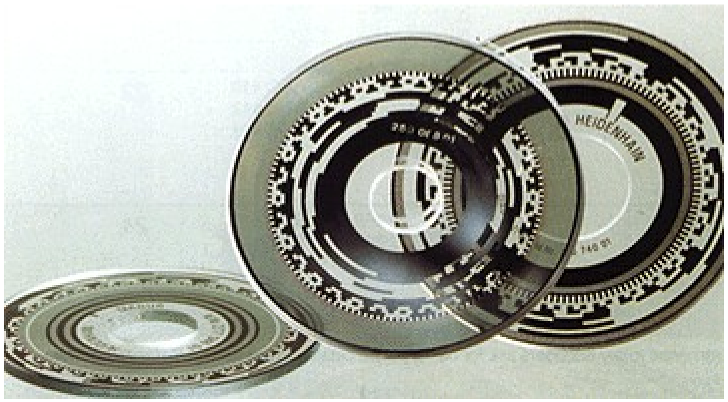
Block Diagram:

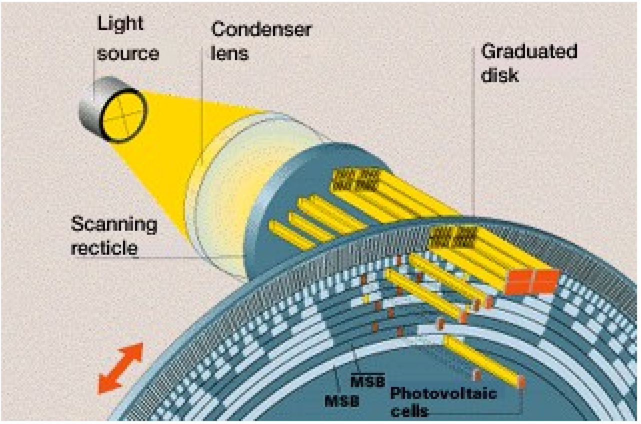


Absolute Encoders

- doubling resolution requires adding another photodiode/LED pair
- cost is much higher than incremental
- does not require seeking to establish reference location

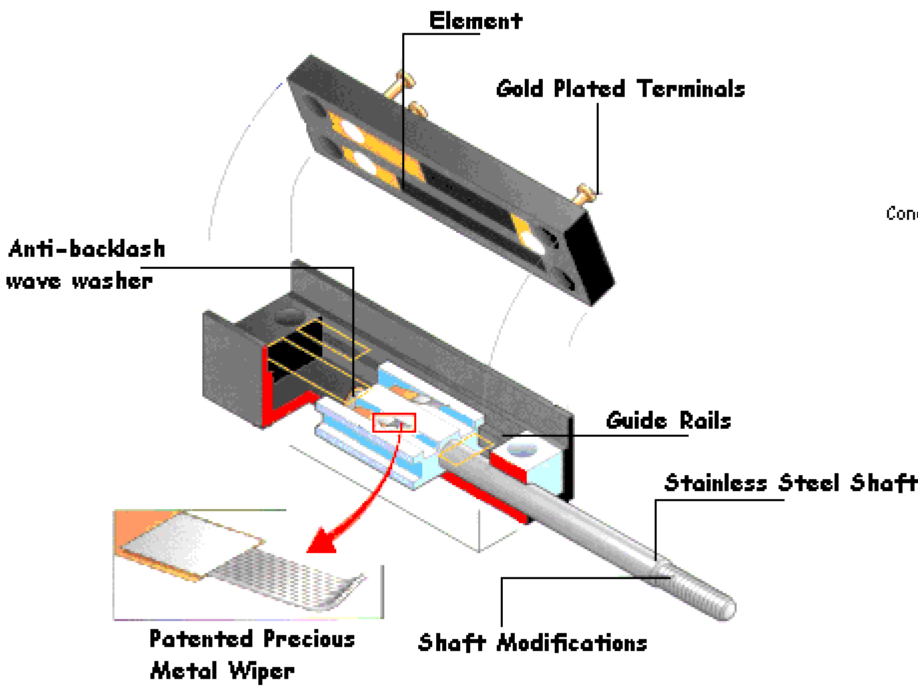


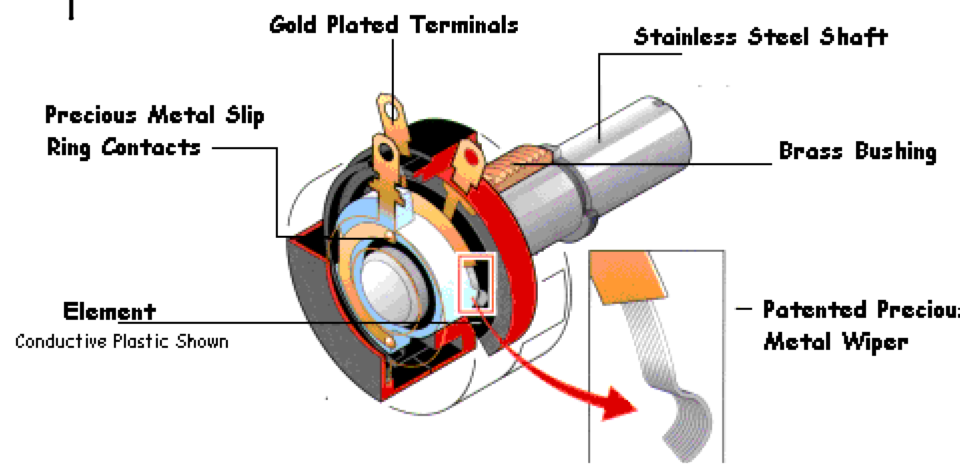




Potentiometer

- A potentiometer (or pot) is a variable resistor wired to obtain a variable DC voltage proportional to position

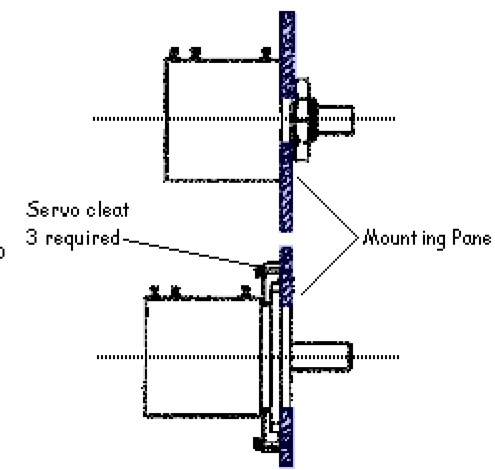




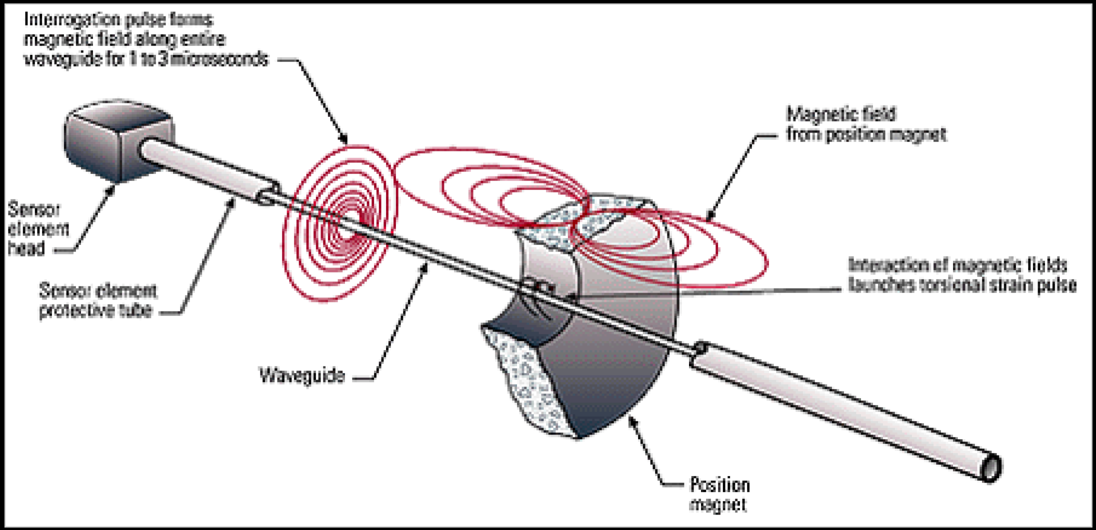
Mounting Types

Bushing mount : Most commonly used. Mounts easily in the panel hole and secures with a mounting nut.

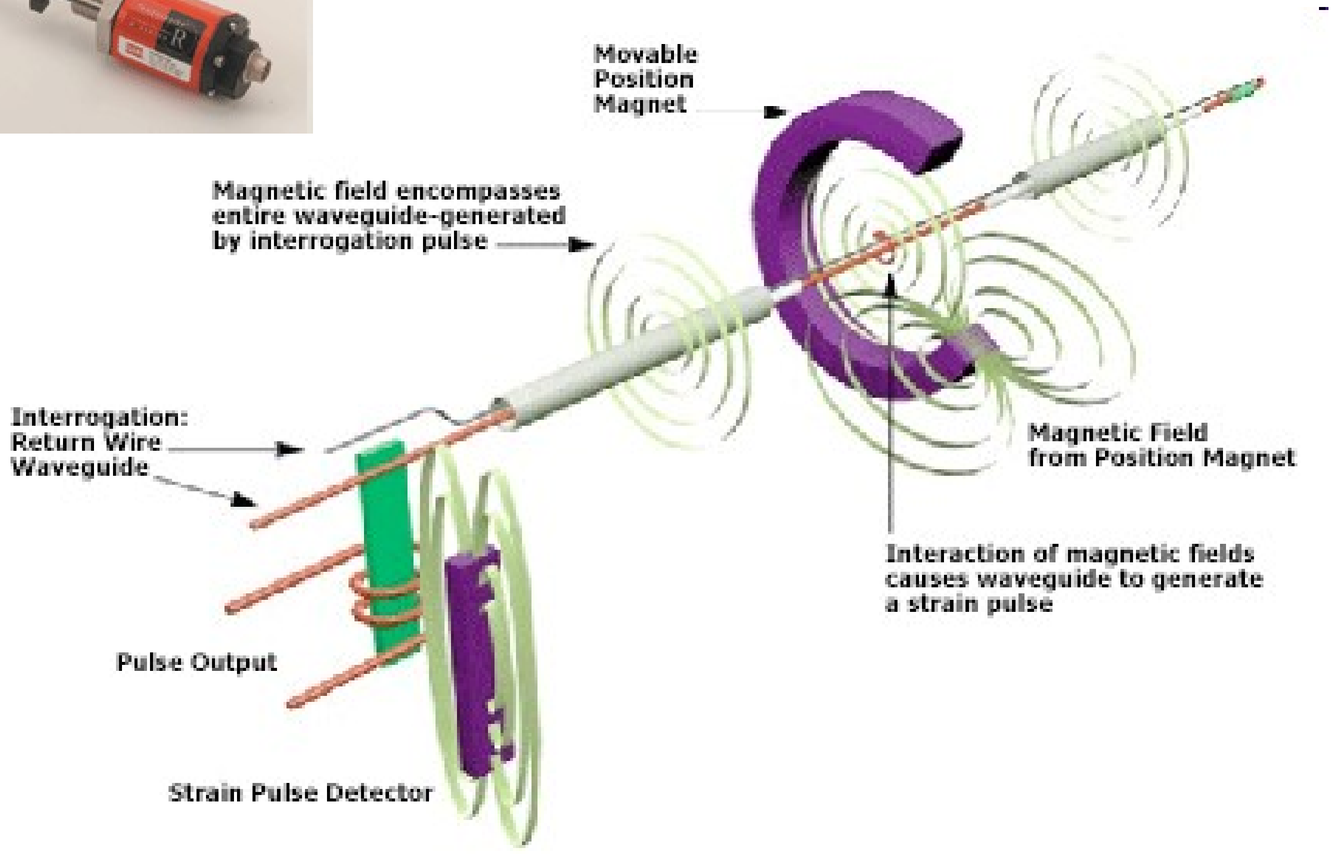
Servo mount : Recommended when the shaft is to be attached to a gear or other mechanism. Allows the operator to index to zero adjustment by turning the potentiometer.



Magnetostrictive Pos. Sensor

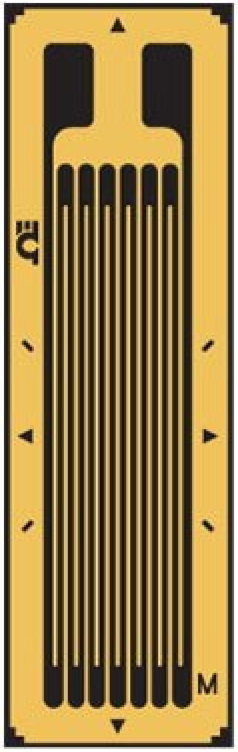


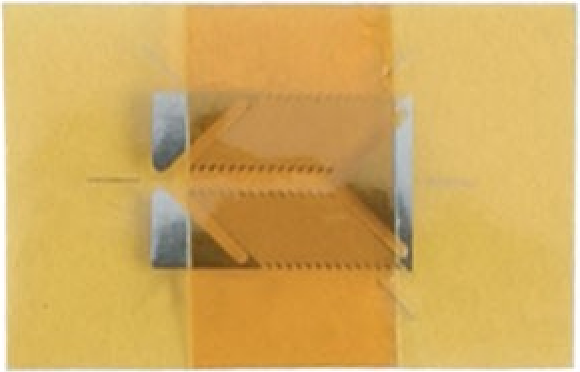
Magnetostrictive Sensor



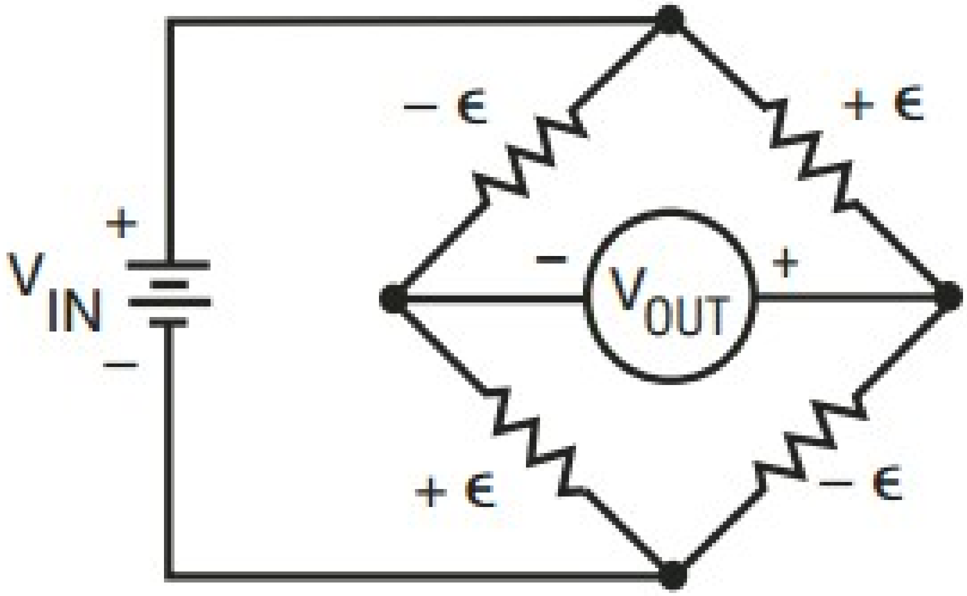
Force Sensing

- Strain gage
- Piezoelectric





Strain Gages and Load Cells



Vr = Vout/Vin(strained) – Vout/Vin(unstrained)

GF = gage factor

$$\epsilon = \frac{-V_r}{GF}$$

Load Cells