Discrete Position Sensing
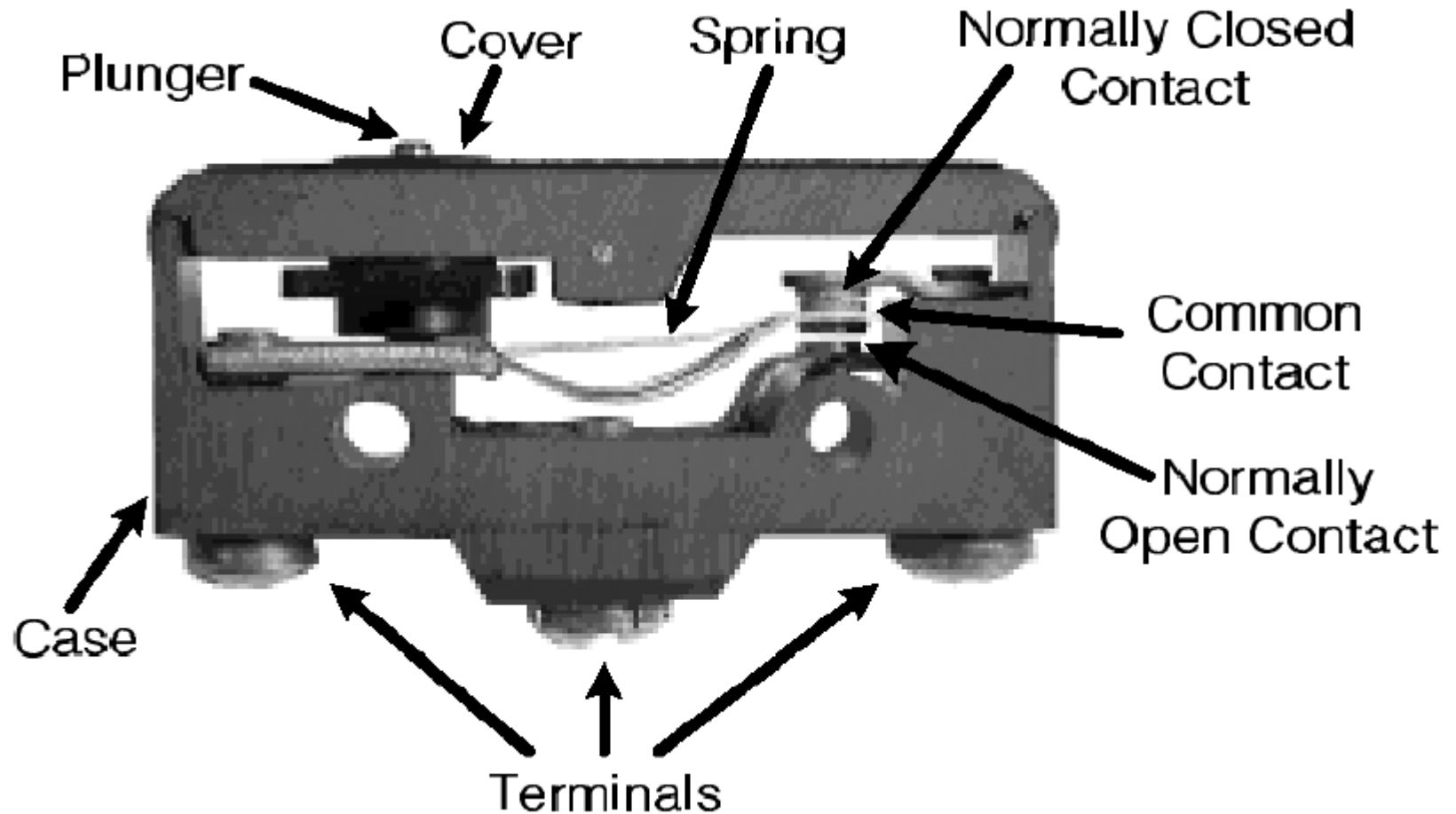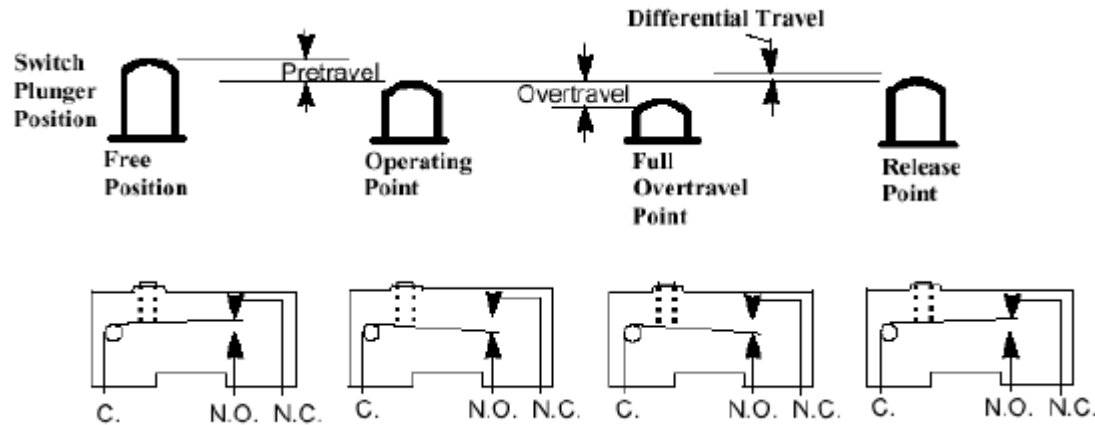
- Mechanical
- Optical
- Magnetic

Mechanical Sensing - Microswitch
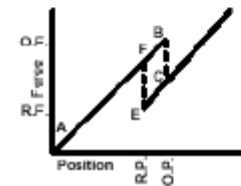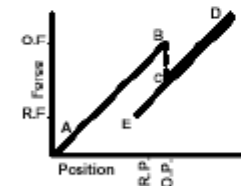
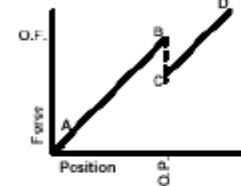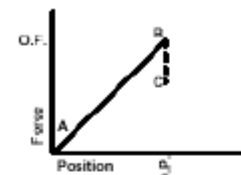# Microswitch Operation

Switch exhibits mechanical hysteresis.
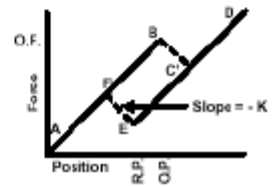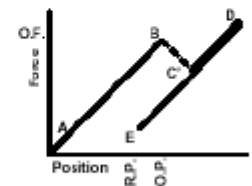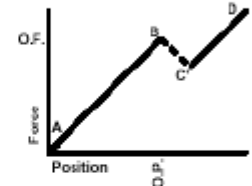
Microswitch Actuators

Pin plunger; in-line motion
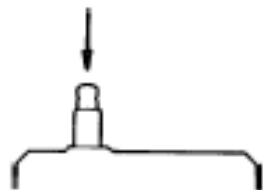
Overtravel plunger; in-line applications requiring additional overtravel
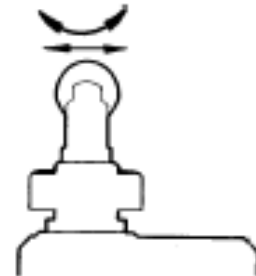
Added overtravel in a panel mount roller plunger; Actuation by cams

Leaf; Low-force, slow moving cams or slides

Roller lever; Very low force, fast moving cams

Roller leaf; Low-force, large movement actuation

Lever; Very low force, slow cams and slides

Added overtravel in a panel-mount plunger: Heavy-duty in-line applications or slow cams. Cam rise should not exceed 30°

Optical Sensing

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

Transmissive & Reflective Sensors
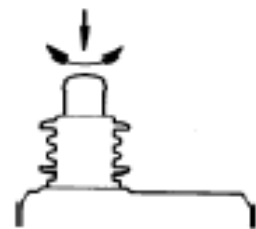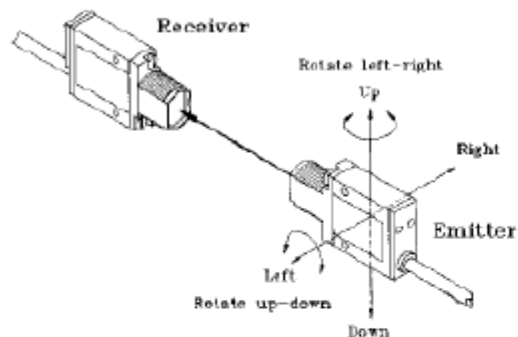
Opposed Mode Alignment

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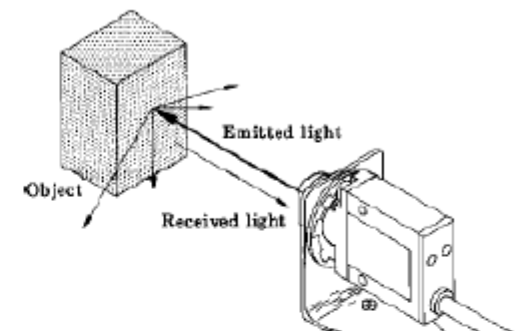
Retroreflective Mode Alignment

Retroreflective Mode Alignment: Move Target Up-Down, Left-Right
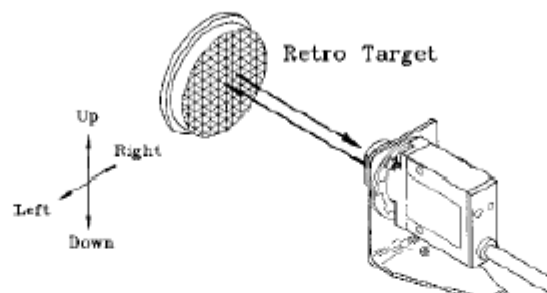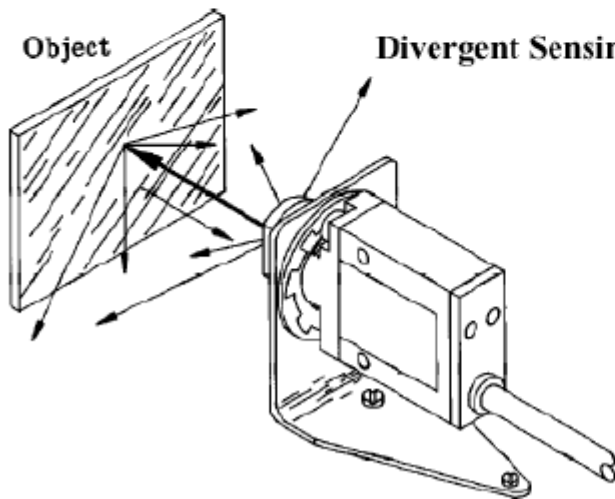
Proximity (Diffuse) Mode Alignment

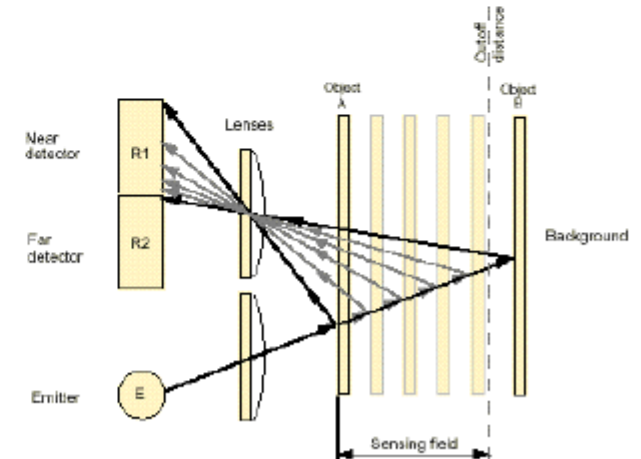Diffuse Mode Alignment: Rotate Up-Down, Left-Right
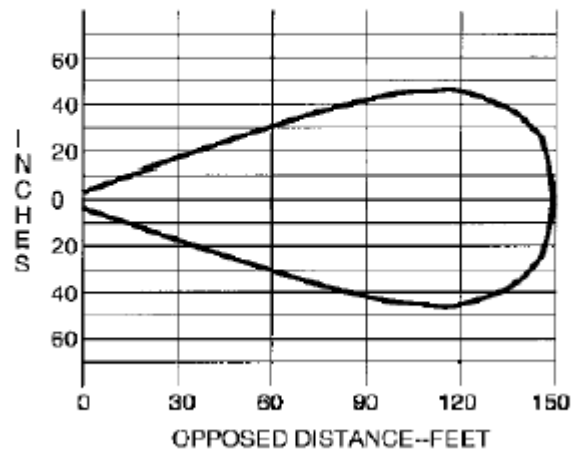
Divergent Sensing Mode

Fixed-field Diffuse Sensing

Object is sensed if amount of light at R1 is greater than the amount of light at R2
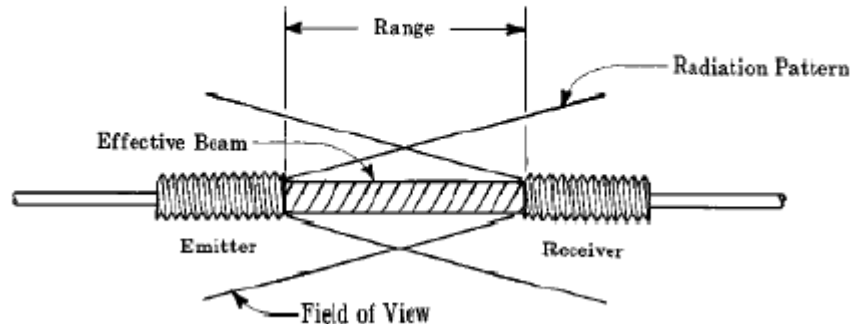
Beam Pattern and Reflectance

Typical Beam Pattern

INCHES — 60, 40, 20, 0, 20, 40, 60
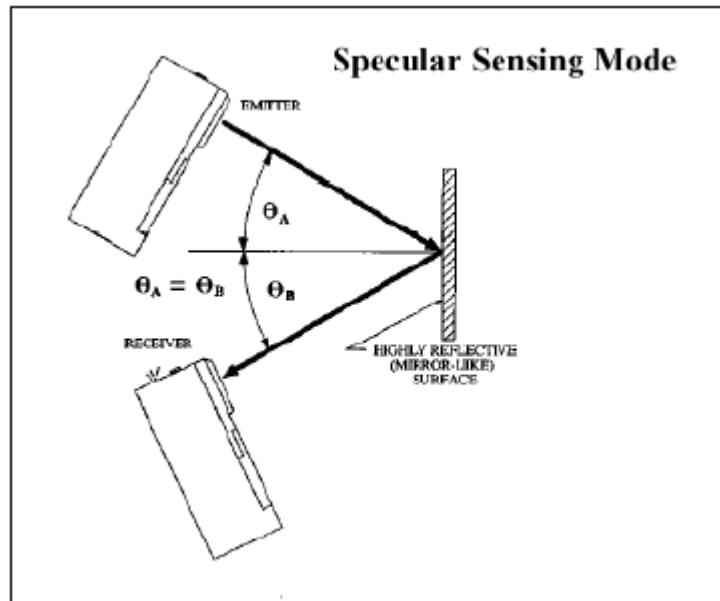
OPPOSED DISTANCE--FEET — 0, 30, 60, 90, 120, 150

Effective Beam

Range

Radiation Pattern

Effective Beam

Emitter

Receiver

Field of View

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 aluminum, 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

Specular Sensing Mode

EMITTER

Θ_A

$\Theta_A = \Theta_B$ Θ_B

RECEIVER

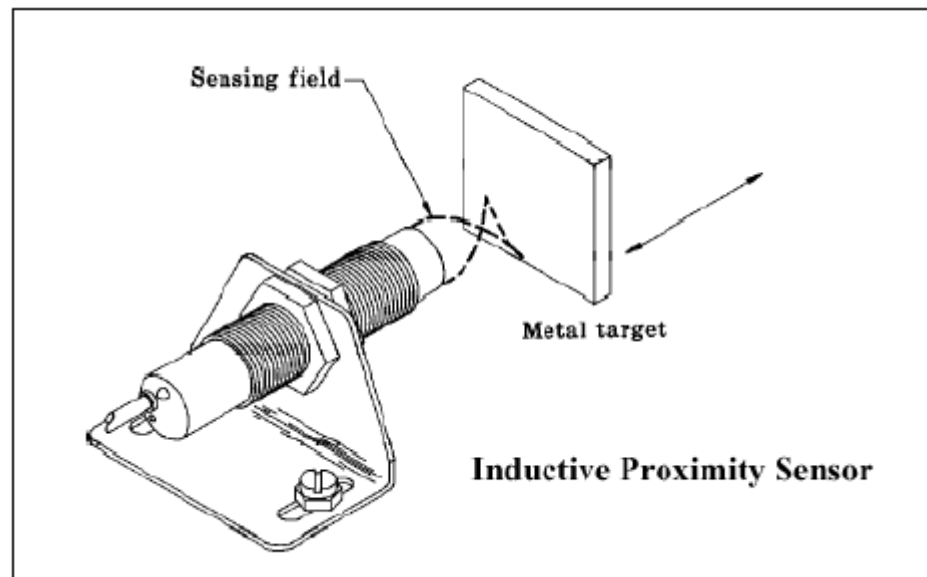HIGHLY REFLECTIVE
(MIRROR-LIKE)
SURFACE

Modulation

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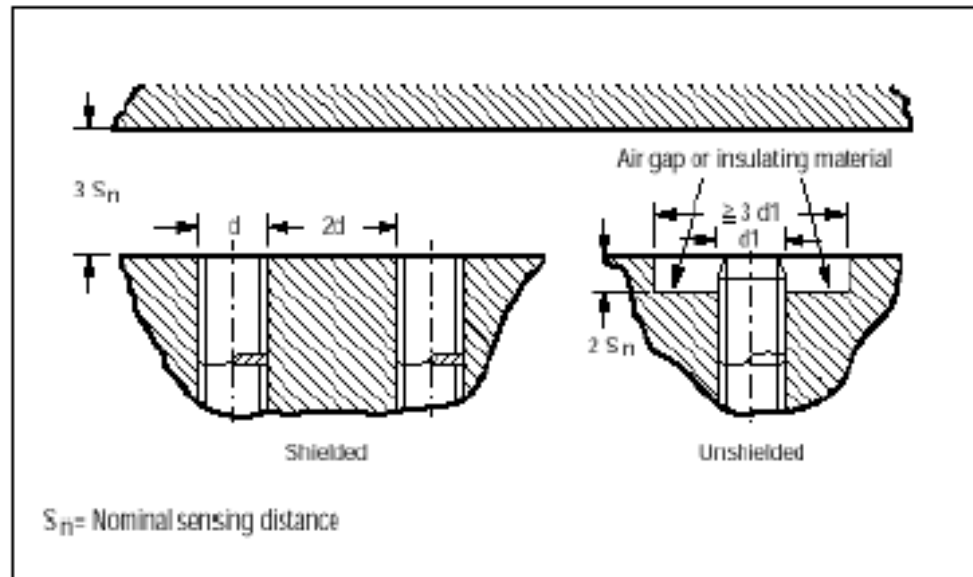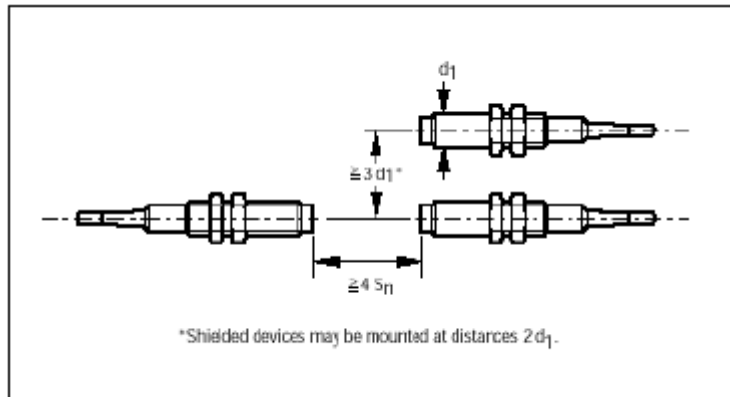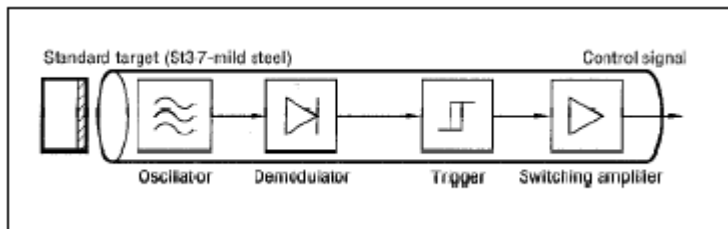- Threshold circuit after BPF generates on/off output

Magnetic Position Sensors

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

Inductive Proximity Sensor

Sensing field

Metal target

Inductive Proximity Sensor

Inductive Proximity Sensors

*Shielded devices may be mounted at distances $2d_1$.


S_n= Nominal sensing distance

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
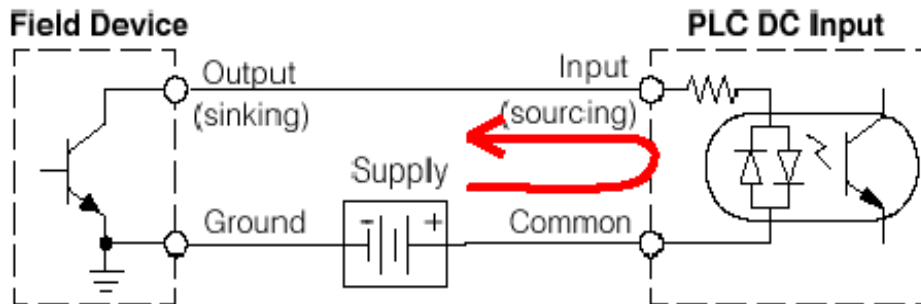- Switch also needs threshold circuit, with hysteresis
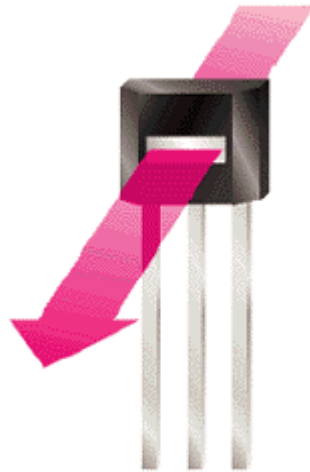
Hall Switch

- Magnet motion
  - head-on
  - bypass or slide-by
- Total effective air gap (TEAG)
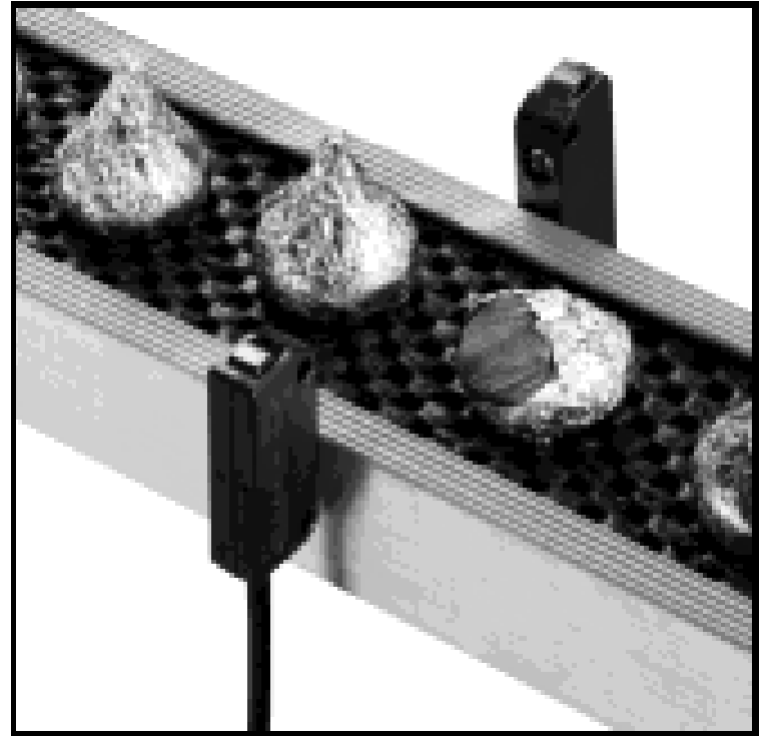- Sensitivity, Hysteresis, & Temperature
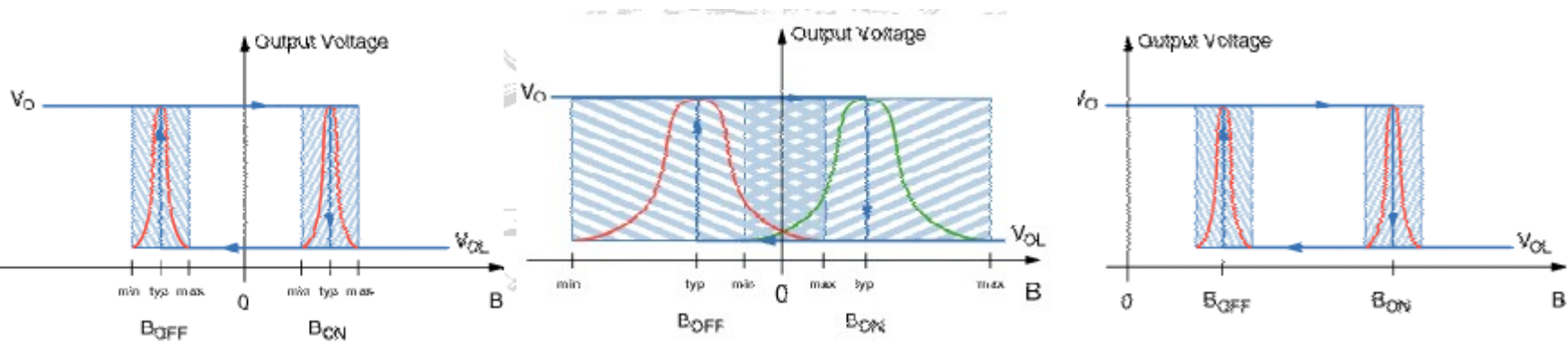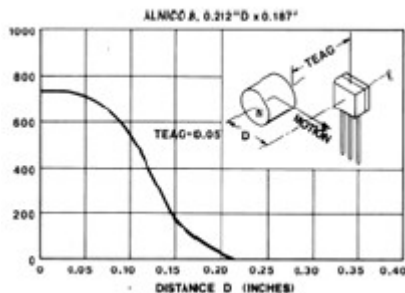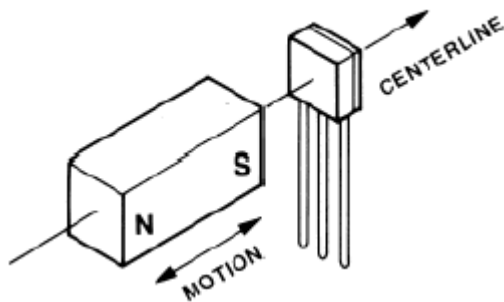
- The tag indicates that the LOAD (PLC input) has a +DC common
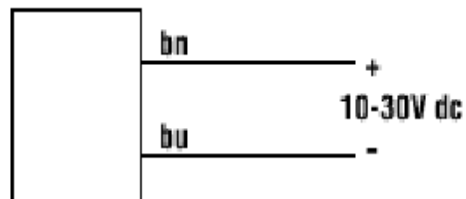 - this is a sinking output
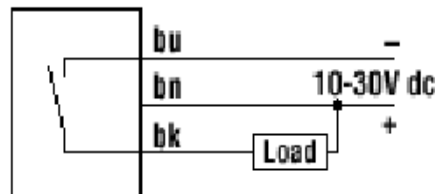 - Sinking output => sourcing input

Sinking/Sourcing

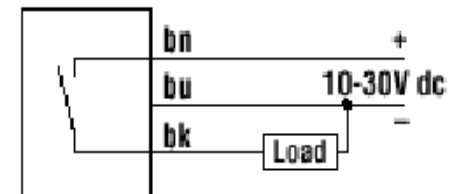- Photosensor – comes in either NPN (sinking) or PNP (sourcing)

Emitters
Cabled Hookup

bn — +
bu — −
10-30V dc

Receivers with NPN Outputs
Cabled Hookup

bu — −
bn — 10-30V dc
bk — +
Load

Receivers with PNP Outputs
Cabled Hookup

bn — +
bu — 10-30V dc
bk — −
Load

Terminal Blocks