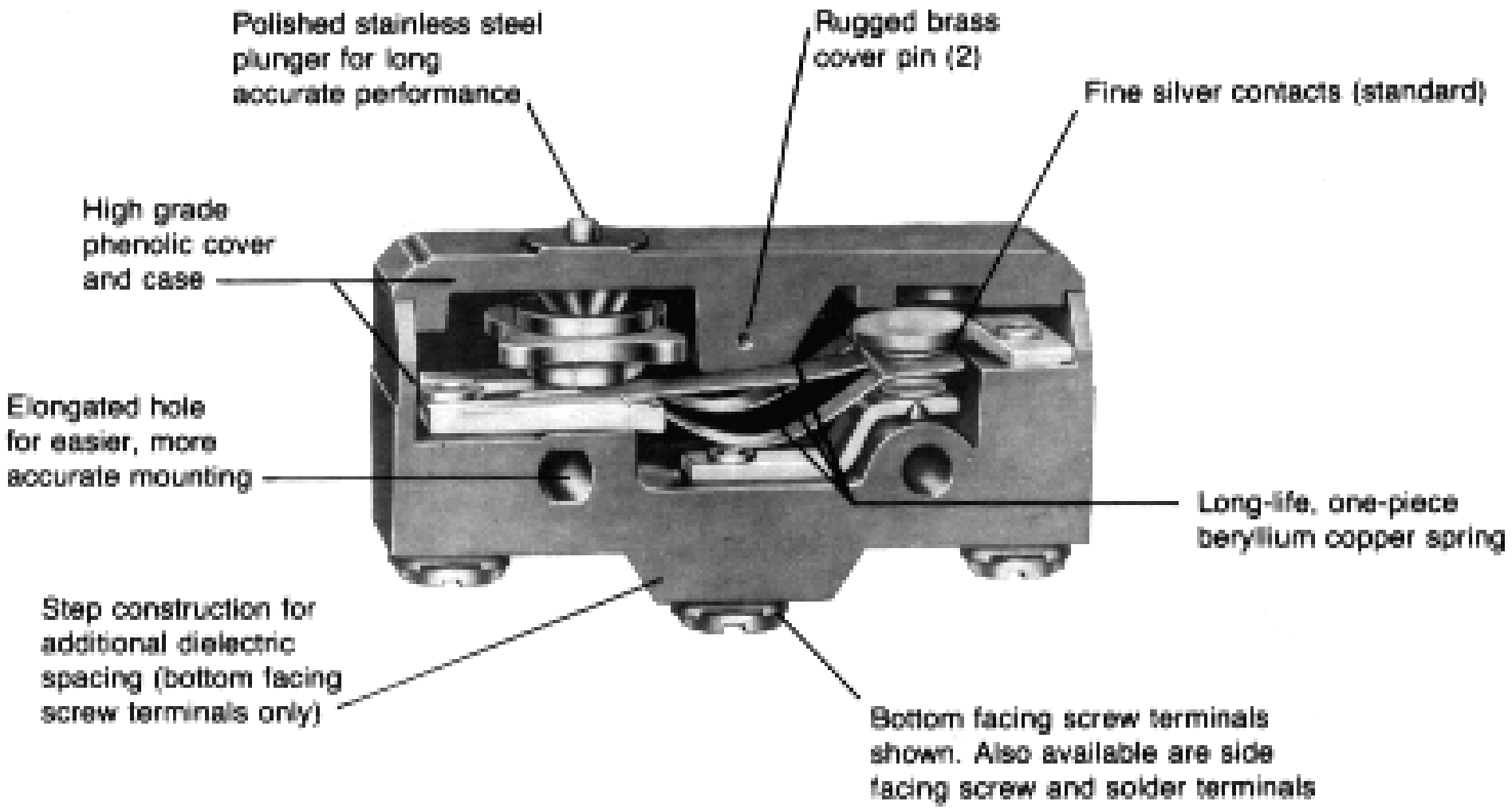
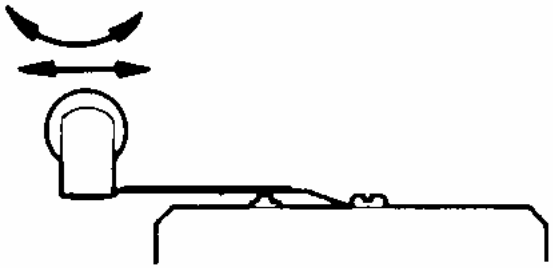
Proximity and Limit Switches

- A variety of sensors are available that give ON/OFF (or yes/no) binary outputs
- Mechanical limit switches
  - often called “microswitches”
  - activation causes electrical contacts to either “break” (“normally closed” or NC switch) or “make” (“normally open” or NO switch) - or both NC and NO
- More sophisticated binary sensors are collectively known as proximity switches

Standard Basic Switches



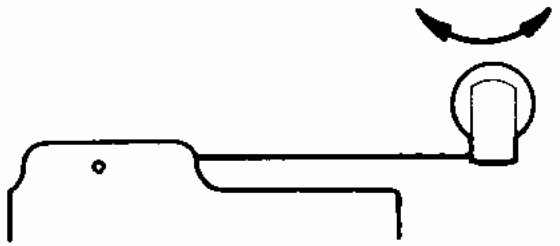
Standard Basic Switches



Roller leaf; Low-force, large movement actuation

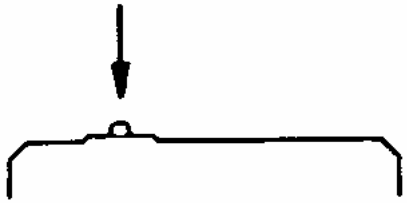
Lever; Very low force, slow cams and slides

Leaf; Low-force, slow moving cams or slides

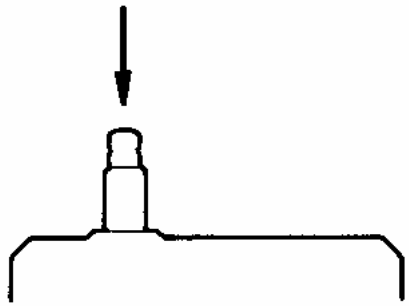


Roller lever; Very low force, fast moving cams

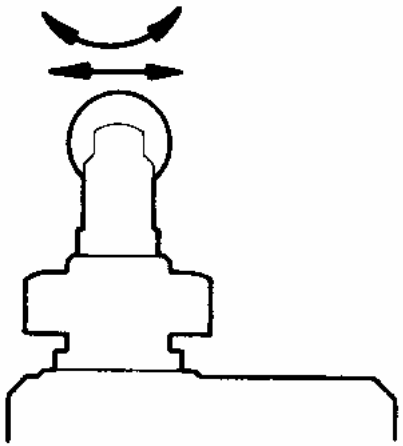
Standard Basic Switches



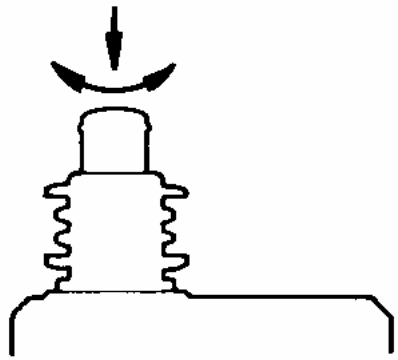
Pin plunger; In-line motion



Overtravel plunger; In-line applications requiring additional overtravel

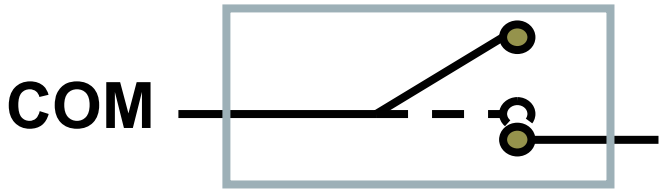


Panel-mount roller plunger; Actuation by cams

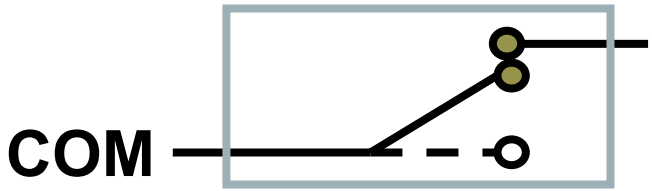


Panel-mount plunger; Heavy-duty in-line applications or slow cams. Cam rise should not exceed 30°

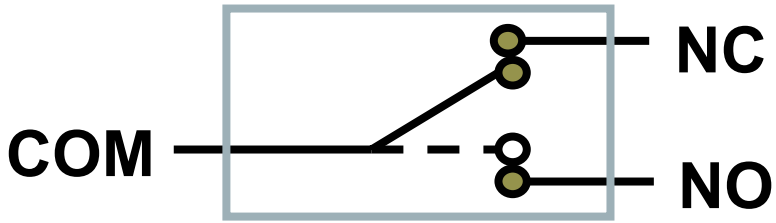
Switch Contact Configurations



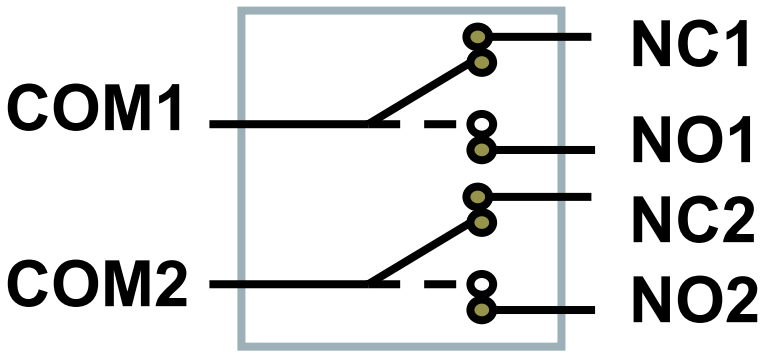
Single pole, single throw (SPST)
Normally Open (NO)



Single pole, single throw (SPST)
Normally Closed (NC)

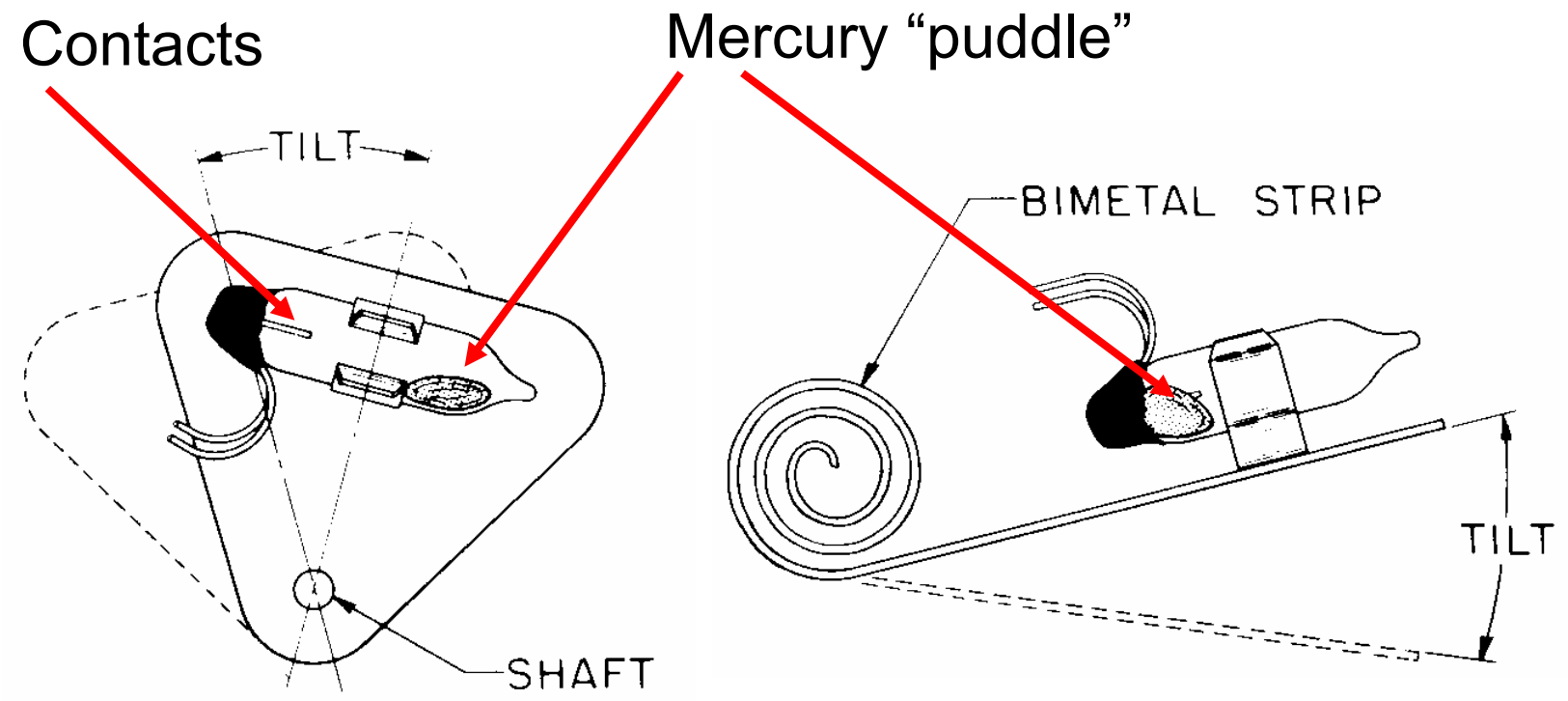


Single pole,
double throw (SPDT)

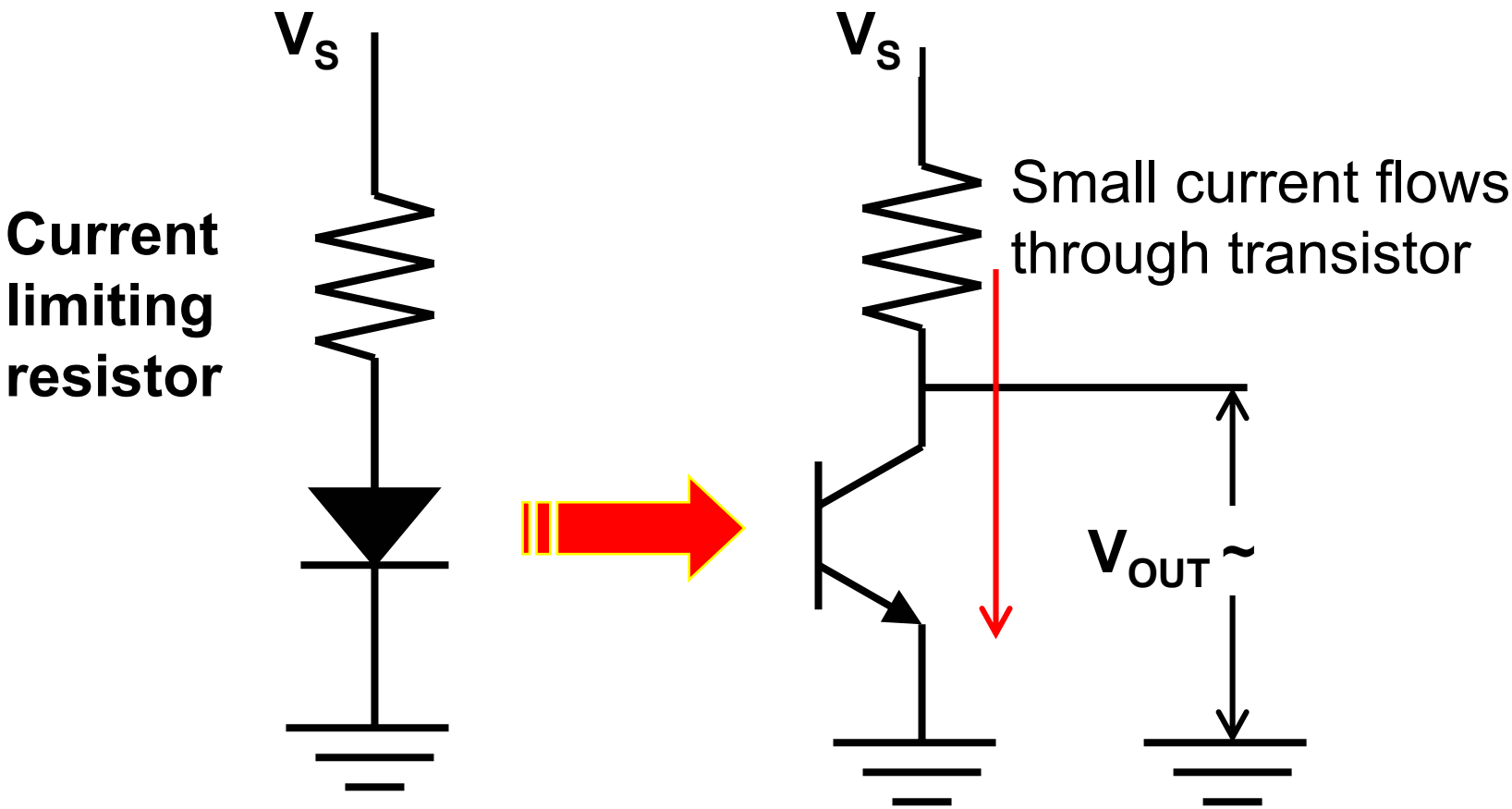


Double pole,
double throw (DPDT)

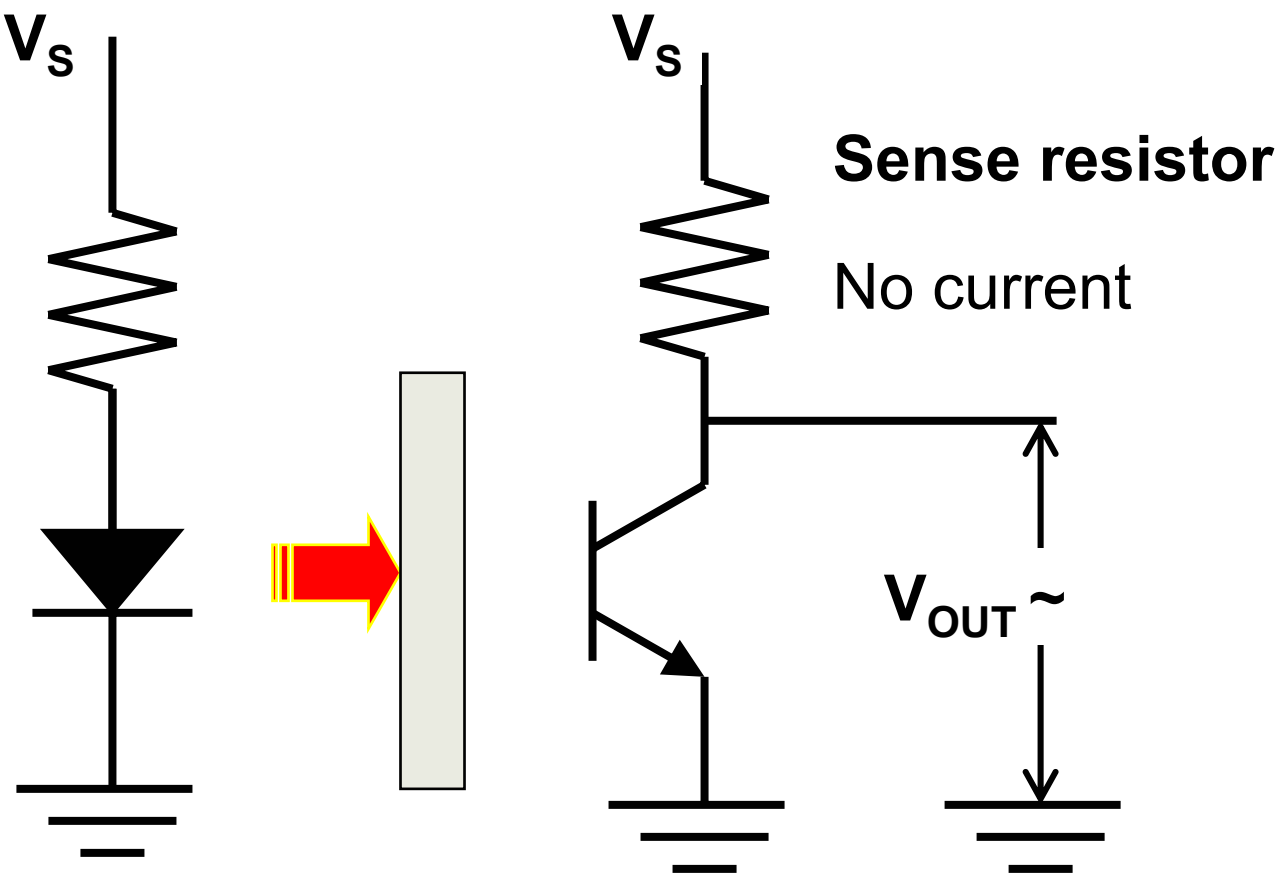
Mercury Switch



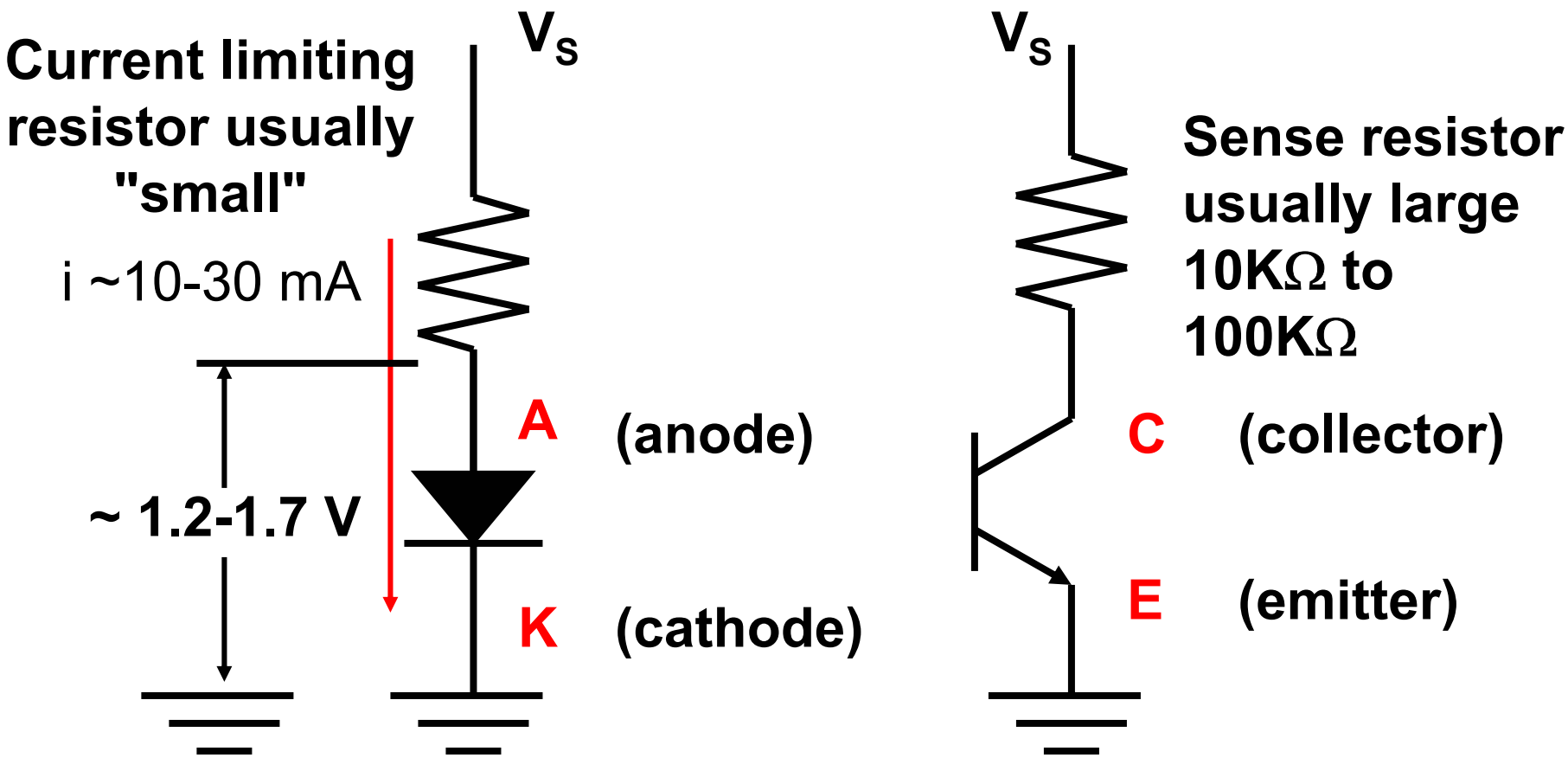
Photoelectric Proximity Sensor

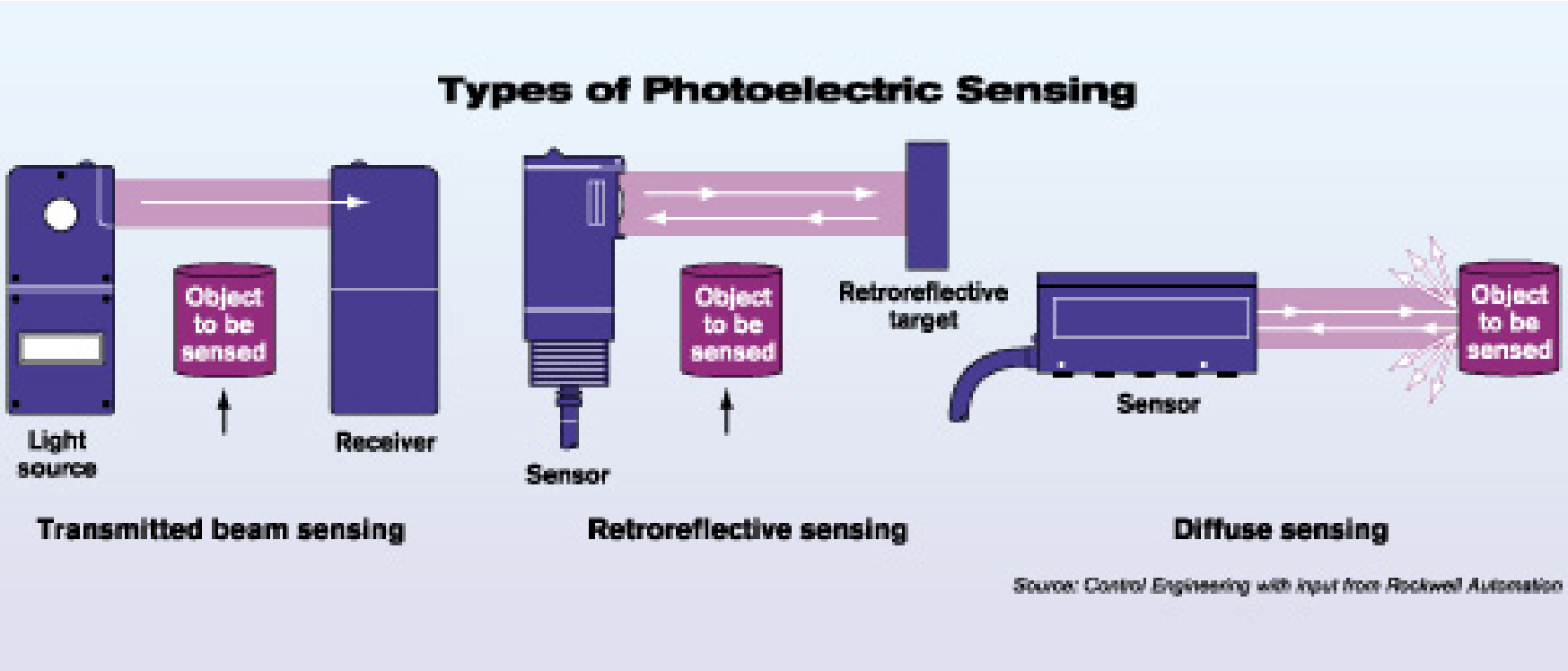


Photoelectric Sensor - Blocked



Photoelectric Sensor - Design

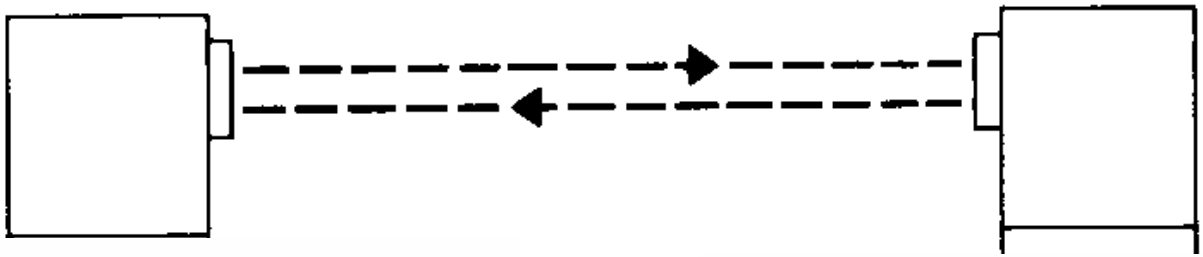


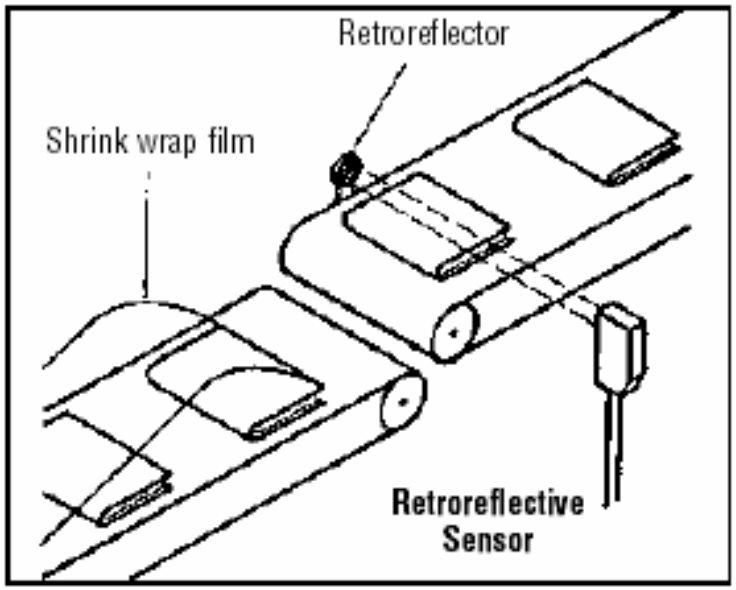


"There are three basic types of photoelectric sensors. Transmitted beam, or through-beam, requires a sender and a receiver. Retroreflective senses light returning from a reflector. Both types switch an output when the beam is broken. Diffuse sensors sense light returning from the object to be detected and switch the output when it senses"

http://www.manufacturing.net/ctl/article/CA204923

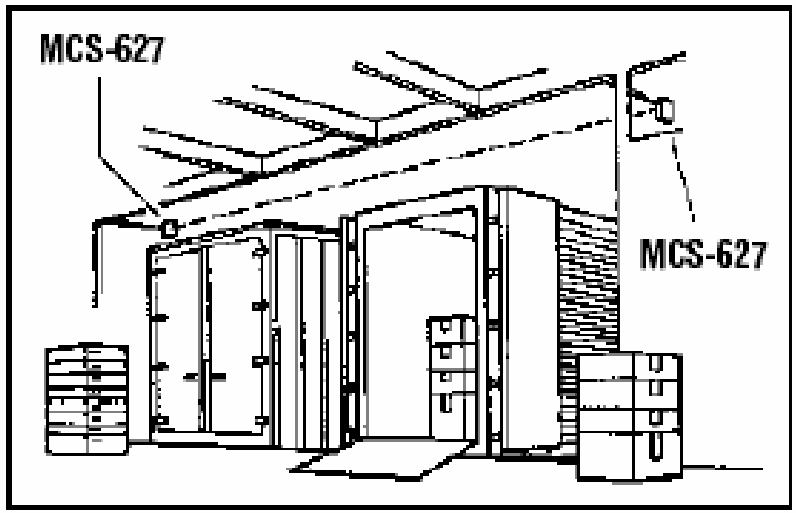
Thru-Beam Photoelectric





Conveyor/Material Handling

A retroreflective sensor was chosen to look across the conveyor at the retroreflector. When the book blocks the beam, a signal is given to stop the conveyor.

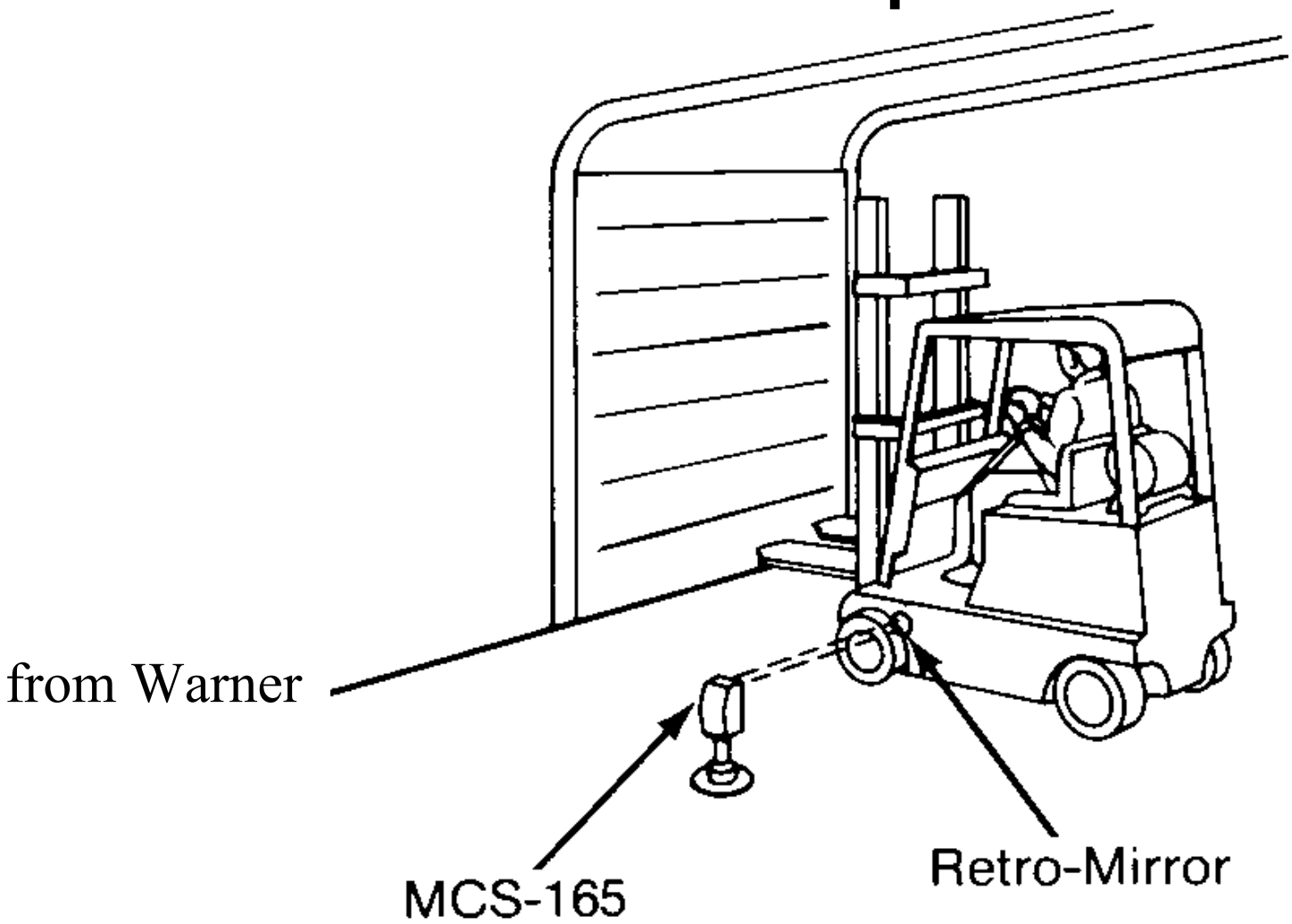


Truck Height Control

A long range through-beam sensor was positioned at a height just below the over-hanging roof and a couple of feet in front, so the breaking of the beam would activate an output wired to an alarm alerting the driver to stop.

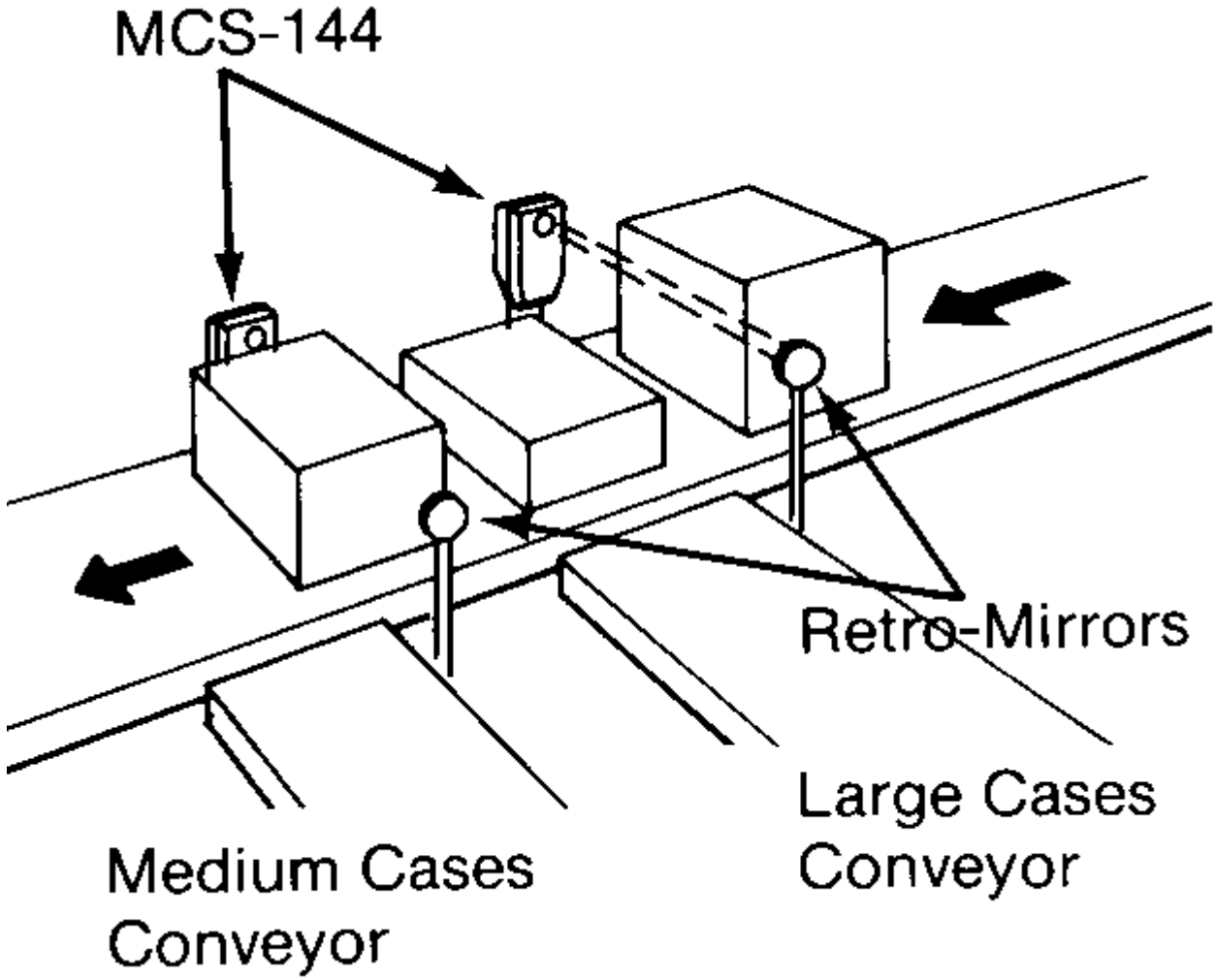
http://www.warnernet.com/smartcat/warnerweb/PDF/P-1201-WE_sensors-pg03-11.pdf

Automatic Door Opener



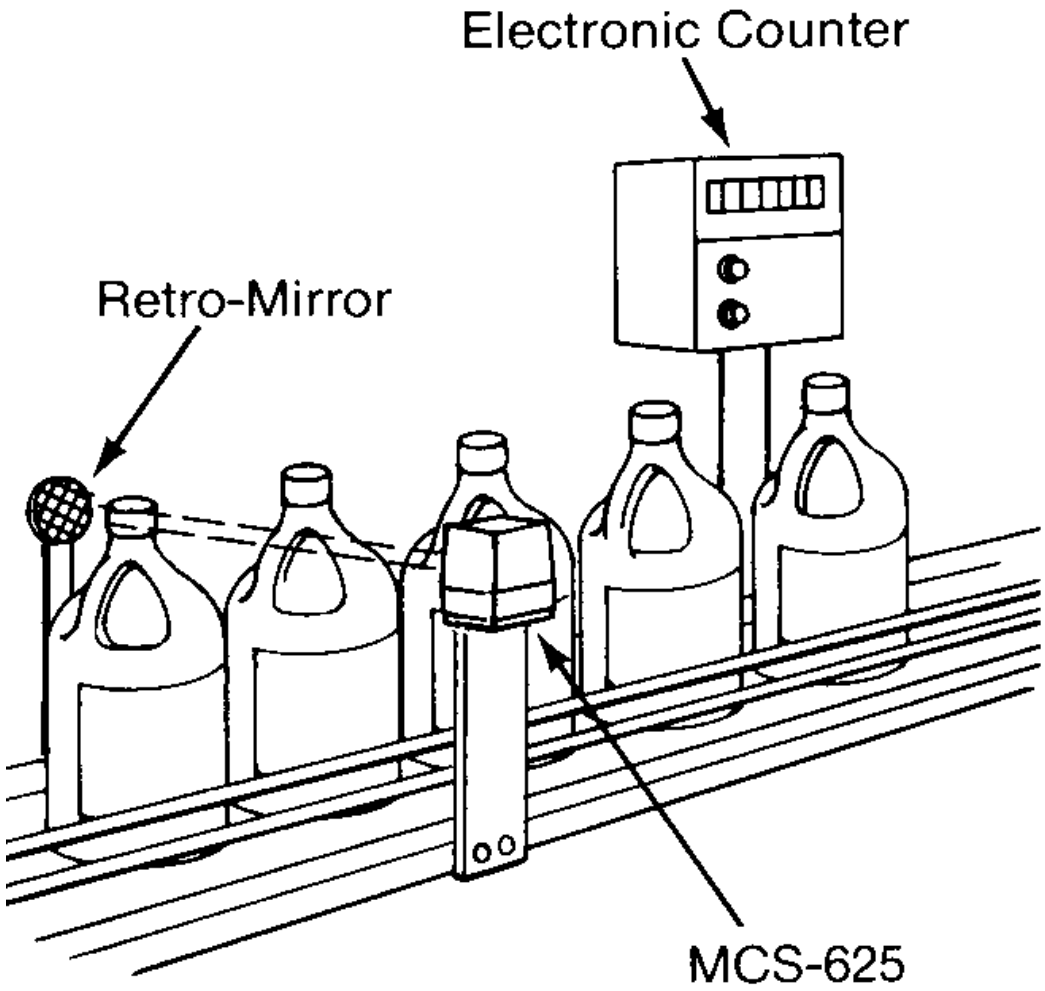
Case Sorting - By Size

from Warner

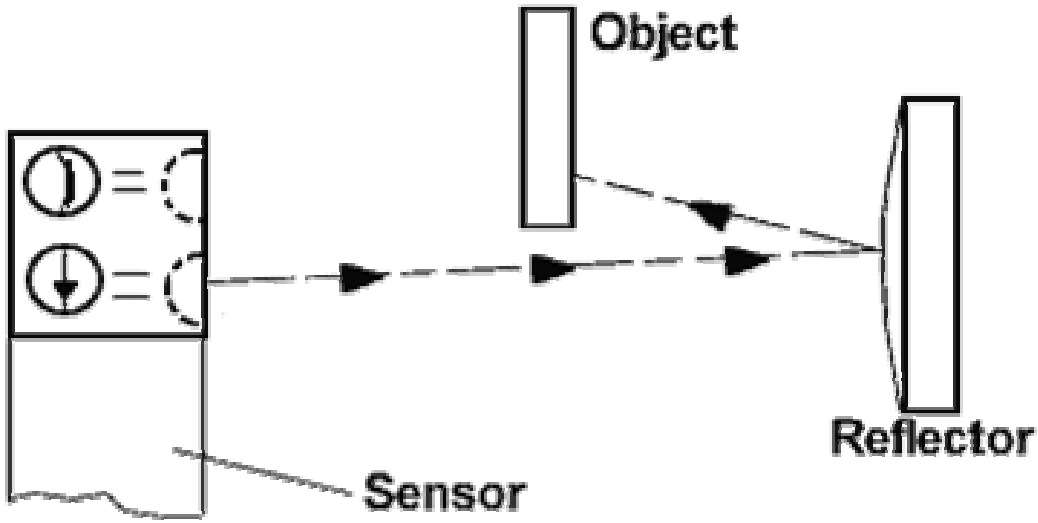


Production Counting

from Warner



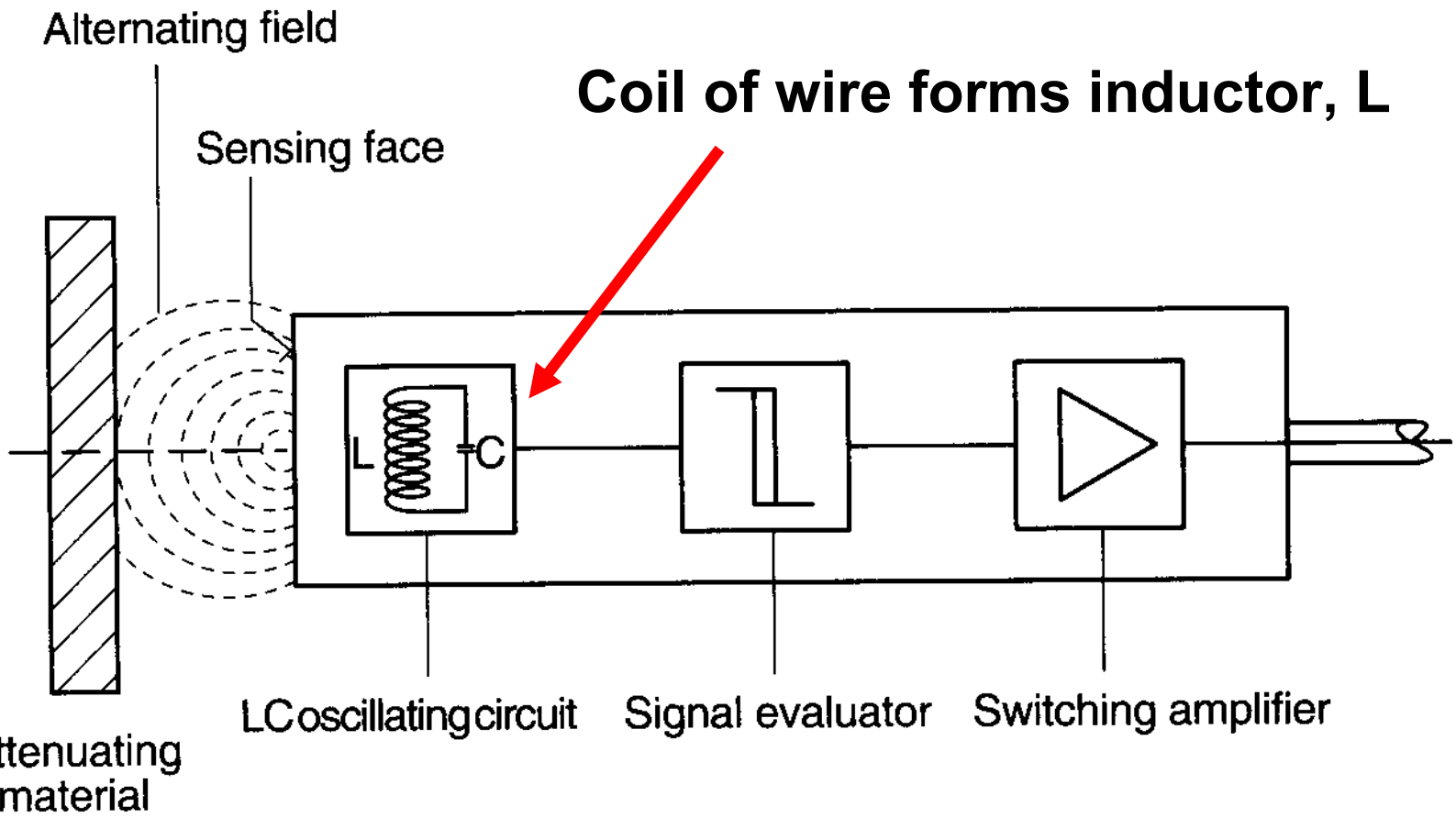
Reflective Photoelectric



"This type of sensor utilizes a special reflector to return the beam directed at it from the sensor. An object between the sensor and reflector is senses when it interrupts the beam. Medium sensing range. "

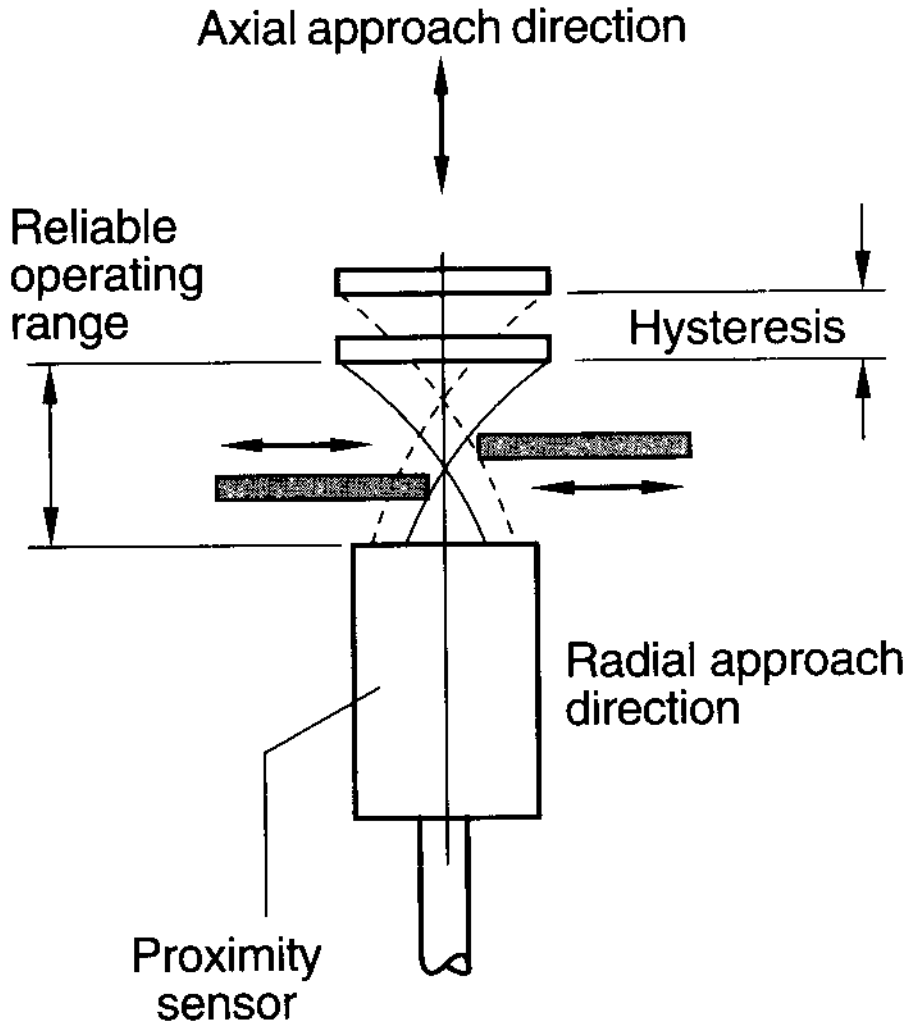
http://www.westernextralite.com/resources/basicsensor.htm

Inductive Proximity Sensor



http://www.sick.es/es/es0/sensores/es.toolboxpar.0004.file.tmp/Sensick_Industrial%20Sensors_C_EN_8007755_0703.pdf

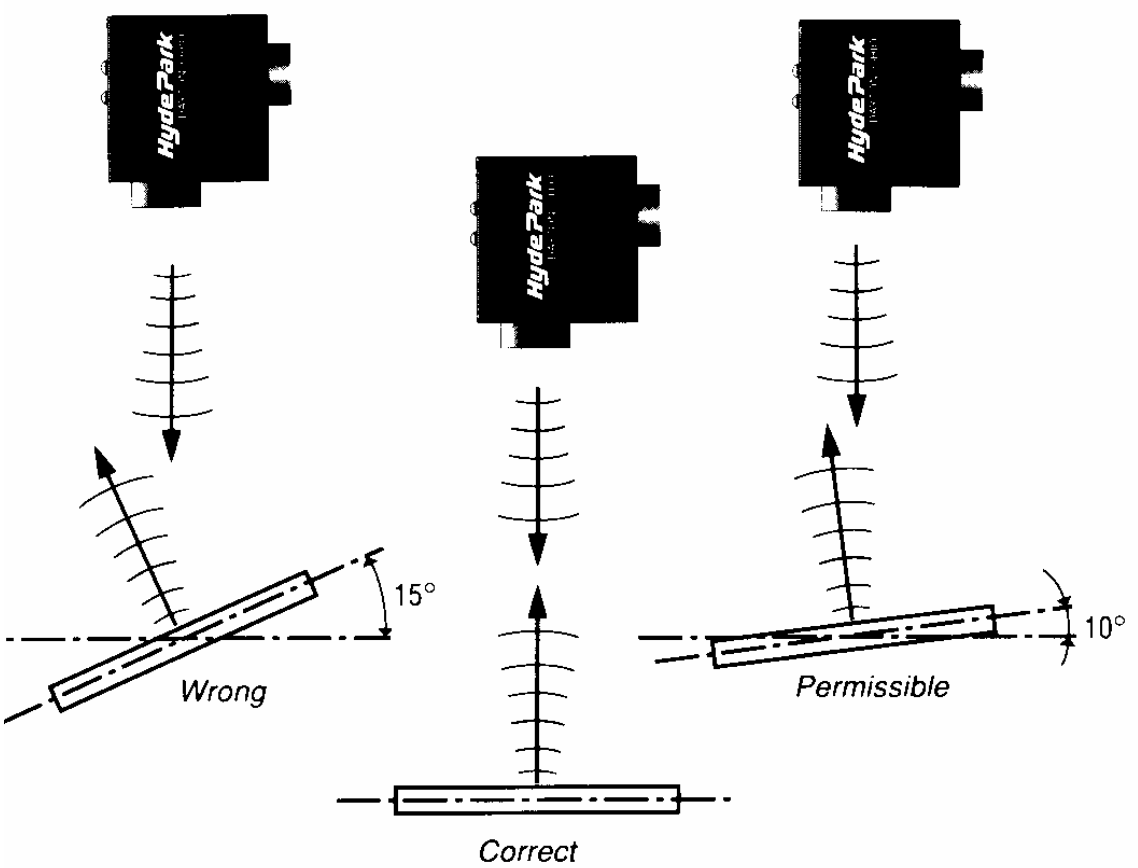
Inductive Sensor Considerations



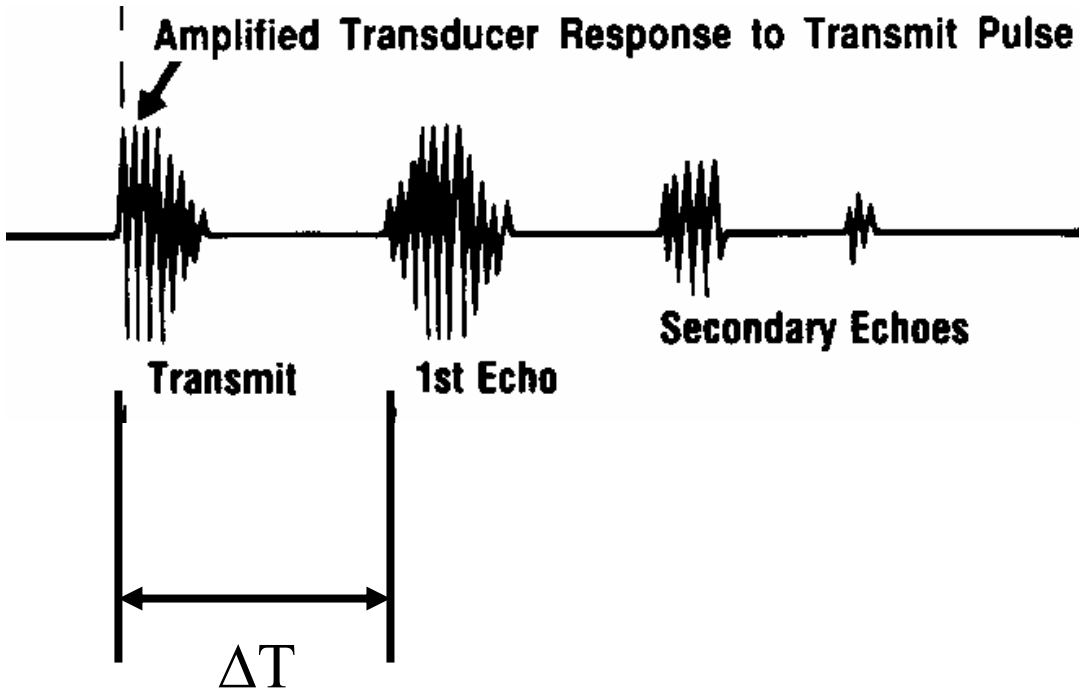
from Sick

Ultrasonic Proximity Sensing

High frequency (200 kHz) sound waves reflect from object



Ultrasonic Proximity Sensing



$$\text{Distance} = \frac{(\text{Speed of sound in air}) * \Delta T}{2}$$

Proximity Switches

Industrial Automation by D.W. Pessen, Wiley Interscience

Sensor	Targets	Sense Distance (typ. max)	Switch Rate (typ. max)
Limit switch	Any	0 (physical contact req'd)	3 Hz
Mercury switch	Any	0 (physical contact req'd)	3 Hz
Reed switch	Magnet	20 mm	500 Hz
Photo-electric	Opaque	0.1 to 50 m, depends on target shape	100-1000 Hz
Ultrasonic	Nonporous, large	30 mm to 10 m	50 Hz

Proximity Switches

Industrial Automation by D.W. Pessen, Wiley Interscience

Sensor	Targets	Sense Distance (typ. max)	Switch Rate (typ. max)
Inductive	Conductive material	Ferrous:50 mm, Non-ferrous: less	300-5000 Hz
Capacitive	Most solids, liquids	30 mm	500 Hz
Magnetic inductance	Ferro-magnetic	50 mm (depends on target mass)	300 Hz
Hall effect	Magnet	20 mm	100 kHz
Wiegand effect	Magnet		100 kHz

Proximity Switches

Industrial Automation by D.W. Pessen, Wiley Interscience

Sensor	Environmental Sensitivities	Advantages	Disadvantages
Limit switch	Temperature moisture	Simple, inexpensive	Physical contact, arcing
Mercury switch	Vibration, mounting angle	Low contact resistance, sealed unit	Physical contact, SPST contacts only
Reed switch	Vibration	Small size, inexpensive	Contact arcing, magnet actuator
Photo-electric	Dust, dirt, ambient light	Good resolution	
Ultrasonic	Noise, air motion		Poor resolution large target

Proximity Switches

Industrial Automation by D.W. Pessen, Wiley Interscience

Sensor	Environmental Sensitivities	Advantages	Disadvantages
Inductive	Other nearby sensors	Usually fails ON, good resolution	
Capacitive	Humidity, temperature		Complex circuitry, false triggering
Magnetic inductance	Other nearby sensors	Good resolution	Collects debris, no static sense
Hall effect	Temperature	Simple, inexpensive	Poor resolution, needs magnet
Wiegand effect			No static sense, magnet

Limit & Proximity Switch Applications

- Don't use the limit switch as a mechanical stop (use another component)
- Use cam surfaces to allow gradual actuation
- Don't apply side forces to the switch roller or lever (will wear bearings quickly)
- Use appropriate switch actuator for type of force/motion applied
- Don't switch excessive currents through the switch contacts

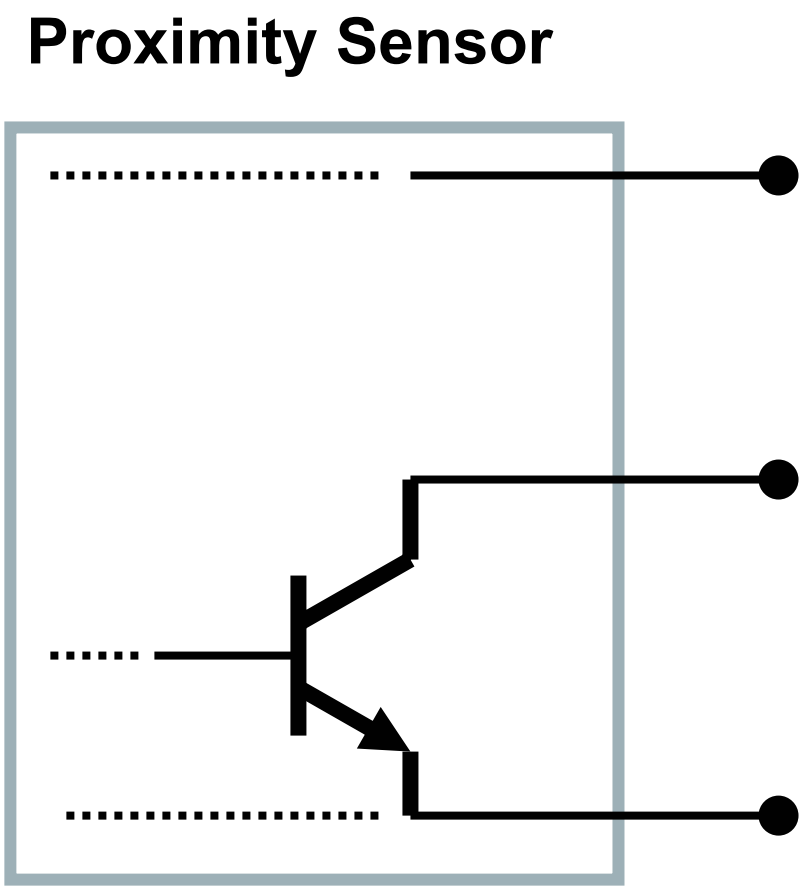
Factors in Selecting Limit & Proximity Switches

- Type of output signal (high/low voltage? high/low current?, DC or AC?, relay or triac?)
- Is mechanical contact with sensed object OK?
- Available space
- Environmental conditions
- Nature of target: size, shape, material, surface

Factors in Selecting Limit & Proximity Switches

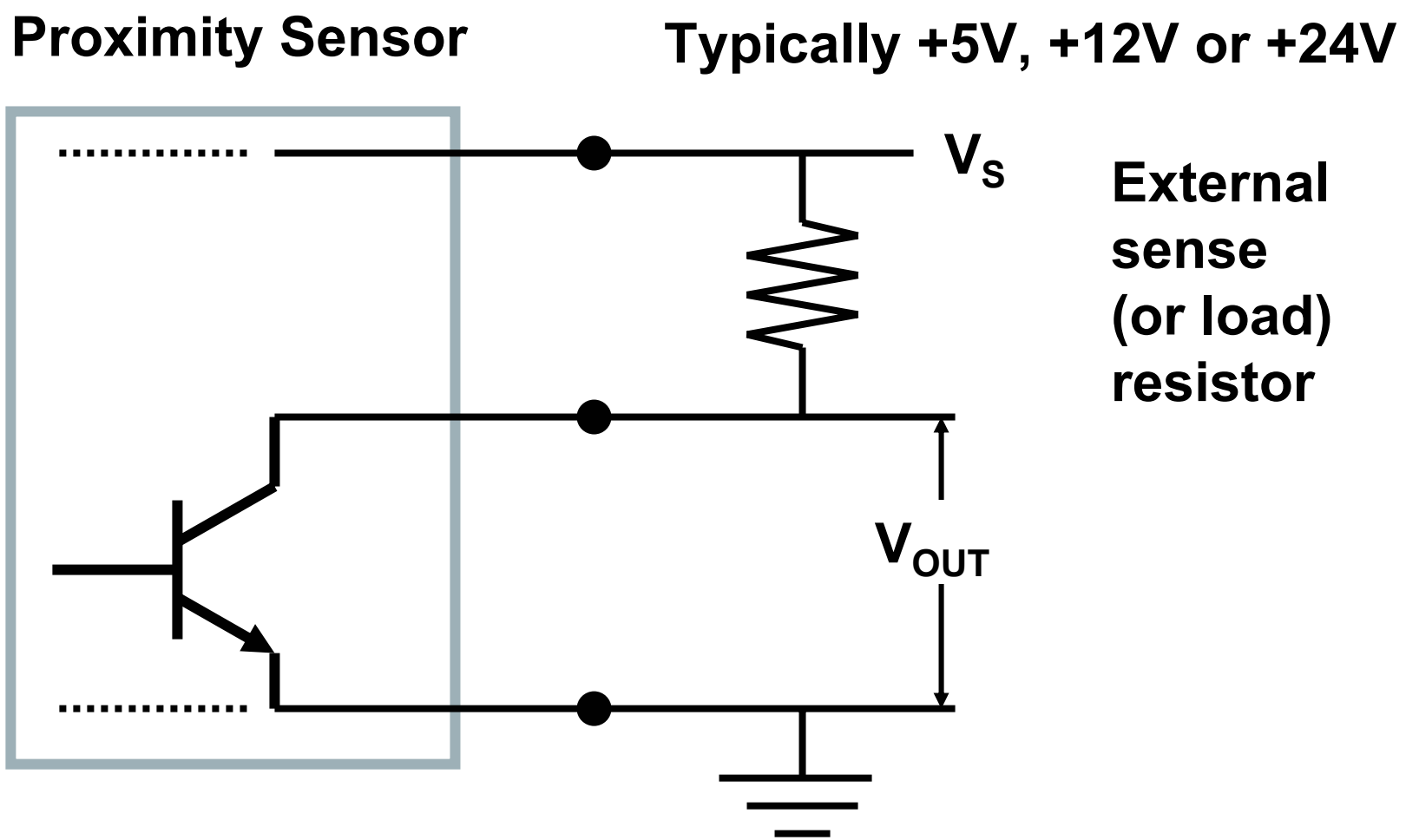
- Sensor-to-target distance (max and min)
- Positional accuracy required
- Speed of target (will it remain in sensing area long enough?)
- Switching rate - how often will inputs be presented to the sensor? Can it recover quickly?
- Reliability and life expectancy - can you detect a failure?

Prox Sensor Output - NPN

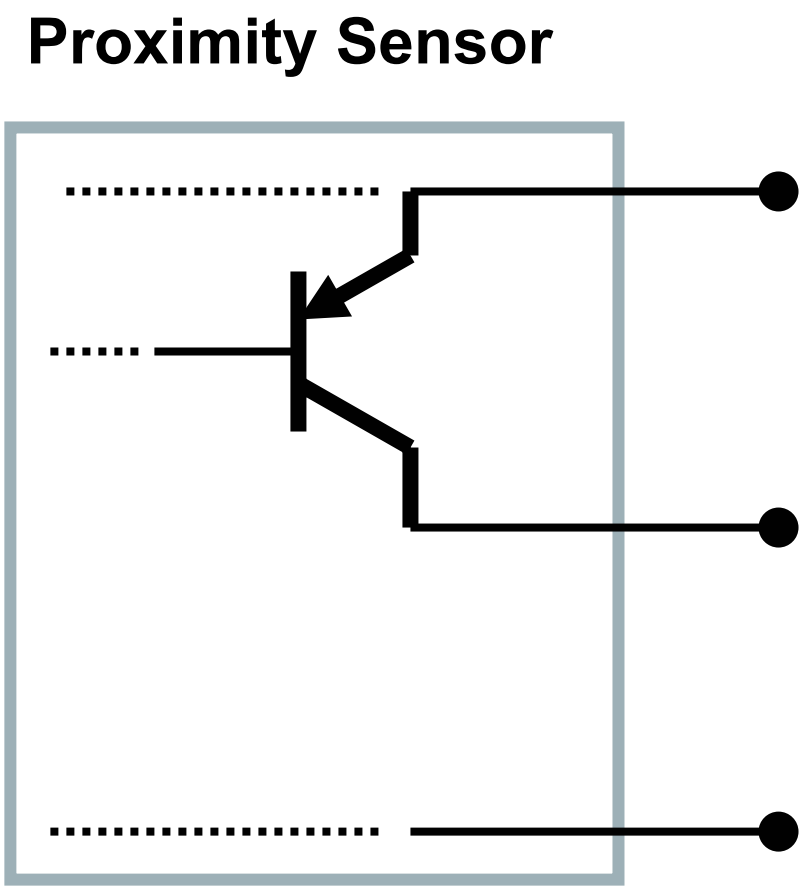


NPN output
or
Open-Collector output
or
Current "sinking" output

Prox Sensor Output - NPN

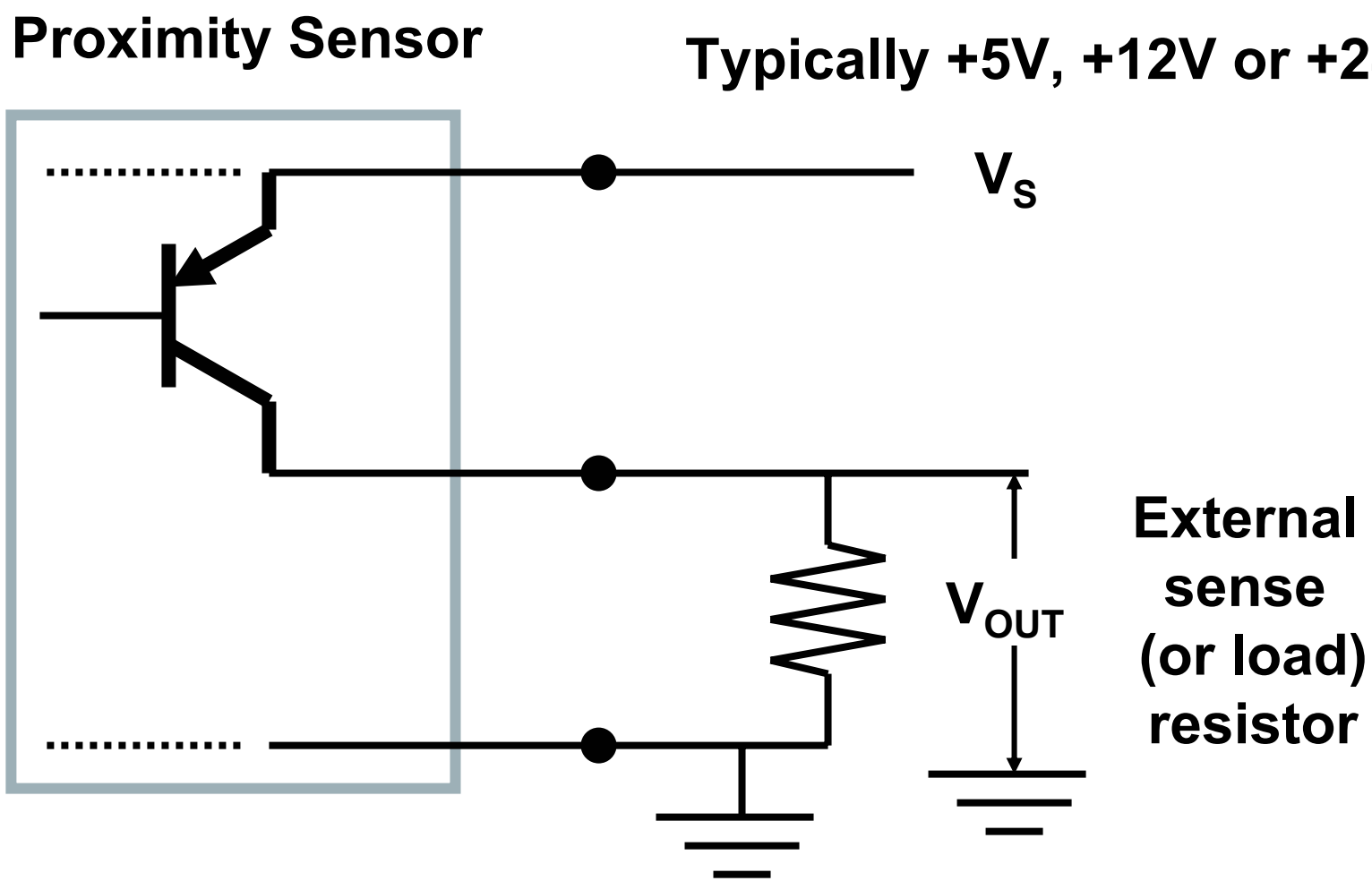


Prox Sensor Output - PNP



PNP output
or
Current "sourcing" output

Prox Sensor Output - PNP



Both NPN and PNP outputs