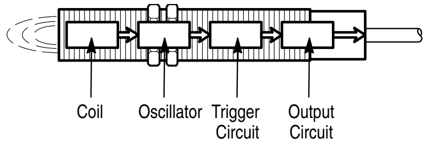
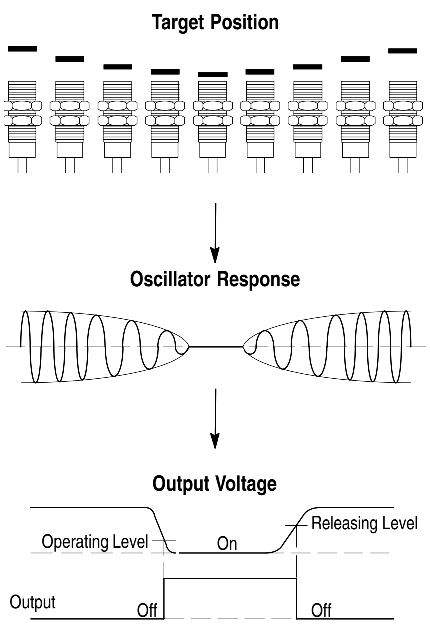
Principles of Operation for Inductive Proximity Sensors

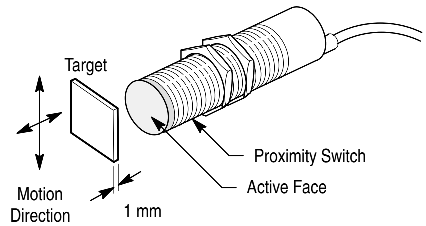


Inductive proximity sensors are designed to operate by generating an electromagnetic field and detecting the eddy current losses generated when ferrous and nonferrous metal target objects enter the field. The sensor consists of a coil on a ferrite core, an oscillator, a trigger-signal level detector and an output circuit. As a metal object advances into the field, eddy currents are induced in the target. The result is a loss of energy and a smaller amplitude of oscillation. The detector circuit then recognizes a specific change in amplitude and generates a signal which will turn the solid-state output “ON” or “OFF.”



A metal target approaching an inductive proximity sensor (above) absorbs energy generated by the oscillator. When the target is in close range, the energy drain stops the oscillator and changes the output state.

Standard Target for Inductive Proximity Sensors



The active face of an inductive proximity switch is the surface where a high-frequency electro-magnetic field emerges.

A standard target is a mild steel square, 1mm thick, with side lengths equal to the diameter of the active face or 3X the nominal switching distance, whichever is greater.

Target Correction Factors for Inductive Proximity Sensors

To determine the sensing distance for materials other than the standard mild steel, a correction factor is used. The composition of the target has a large effect on sensing distance of inductive proximity sensors. If a target constructed from one of the materials listed is used, multiply the nominal sensing distance by the correction factor listed in order to determine the nominal sensing distance for that target. Note that ferrous-selective sensors will not detect brass, aluminum or copper, while nonferrous selective sensors will not detect steel or ferrous-type stainless steels.

The correction factors listed below can be used as a general guideline. Common materials and their specific correction factors are listed on each product specification page.

(Nominal Sensing Range) x (Correction Factor) = Sensing Range.

Correction Factors

Target Material	Approximate Correction Factor
Mild Steel	1.0
Stainless Steel	0.85
Brass	0.50
Aluminum	0.45
Copper	0.40

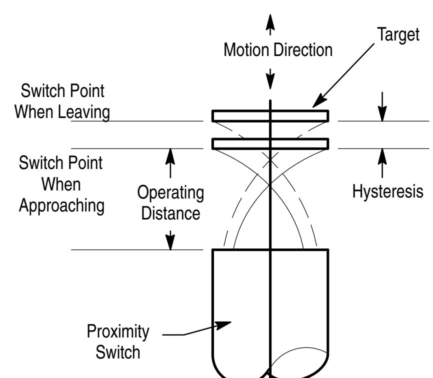
The size and shape of the target may also affect the sensing distance. The following should be used as a general guideline when correcting for the size and shape of a target:

- Flat targets are preferable
- Rounded targets may reduce the sensing distance
- Nonferrous materials usually reduce the sensing distance for all-metal sensing models
- Targets smaller than the sensing face typically reduce the sensing distance
- Targets larger than the sensing face may increase the sensing distance
- Foils may increase the sensing distance

Hysteresis (Differential Travel)

The difference between the operate and the release points is called hysteresis or differential travel. The amount of target travel required for release after operation must be accounted for when selecting target and sensor locations. Hysteresis is needed to help prevent chattering (turning on and off rapidly) when the sensor is subjected to shock and vibration or when the target is stationary at the nominal sensing distance.

Vibration amplitudes must be smaller than the hysteresis band to avoid chatter.



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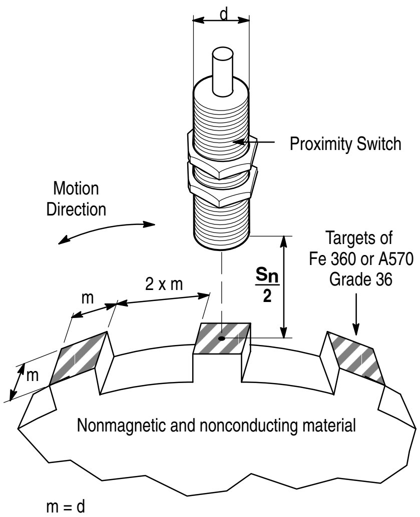
Introduction

Switching Frequency

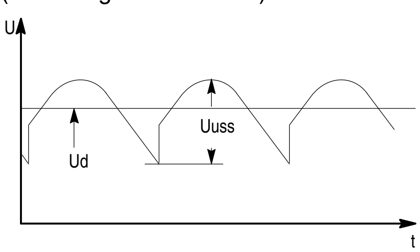
The switching frequency is the maximum speed at which a sensor will deliver discrete individual pulses as the target enters and leaves the sensing field. This value is always dependent on target size, distance from sensing face, speed of target and switch type. This indicates the maximum possible number of switching operations per second. The measuring method for determining switching frequency with standard targets is specified by IEC 60947–5–2.



Ripple

Ripple is the alternating voltage superimposed on the DC voltage (peak to peak) in %.

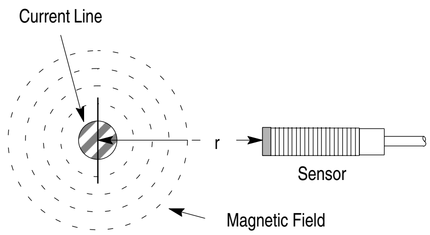
For the operation of DC voltage switches, a filtered DC voltage with a ripple of 10% maximum is required (according to DIN 41755).



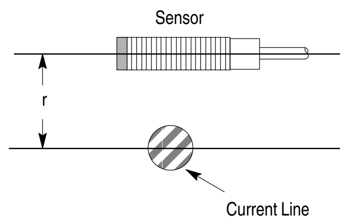
Mounting Considerations for Weld Field Immune Proximities

Reliable operation is dependent on the strength of the magnetic field and the distance between the current line and the sensor.

Perpendicular Mounting to the Current Line



Parallel Mounting to the Current Line



Use the following chart or formulas to determine the spacing requirements between the current line and proximity sensor. Select a distance that falls within the safe zone.

- $H = \frac{I}{2\pi r}$
- $B = \frac{H}{0.796}$
- Gauss = 10* B

where:

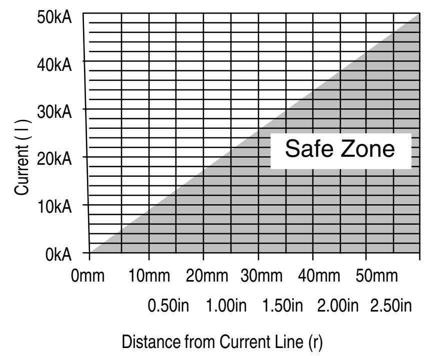
I = welding current (in kA),

H = field strength (in kA/m),

B = flux (in mT), and

r = distance between sensor and current carrying lines (in meters).

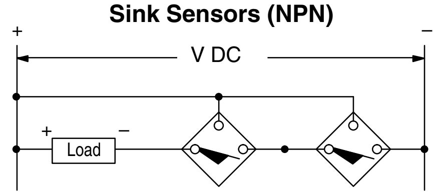
Weld Field Immunity



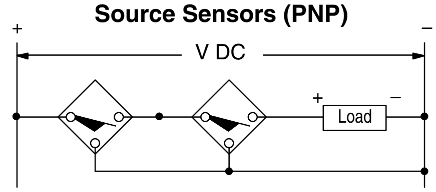
Series Connected Sensors

Sensors can be connected in series with a load. For proper operation, the load voltage must be less than or equal to the minimum supply voltage minus the voltage drops across the series-connected proximity sensors.

Wiring Diagram for Series Connected Current Sink Sensors (NPN)



Wiring Diagram for Series Connected Current Source Sensors (PNP)

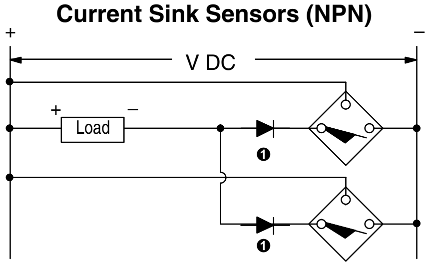


Parallel Connected Sensors

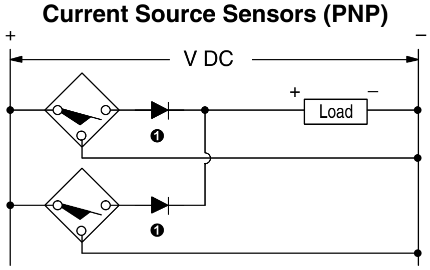
Sensors can be connected in parallel to energize a load. To determine the maximum allowable number of sensors for an application, the sum of the maximum leakage current of the sensors connected in parallel must be less than the maximum OFF-state current of the load device.

Note: Care should be taken when designing parallel proximity circuits. If too much leakage current flows into the load it may cause the solid state input to change state or a small relay not to drop out. Sensors connected in parallel do not provide a higher load current capability.

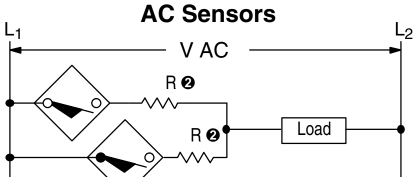
Wiring Diagram for Parallel Connected Current Sink Sensors (NPN)



Wiring Diagram for Parallel Connected Current Source Sensors (PNP)



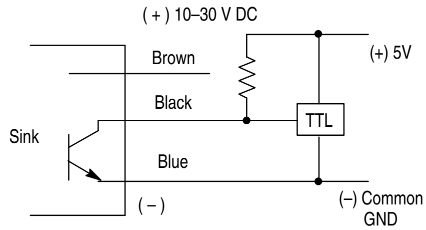
Wiring Diagram for Parallel Connected AC Sensors

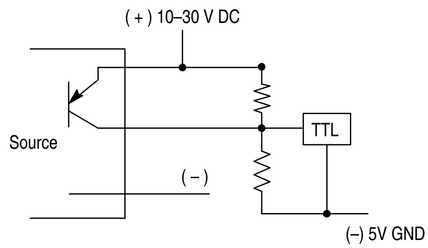


❶ Add diode as shown to each output to maintain individual output indicator function.

❷ Add R in series with sensor to maintain minimum voltage when sensor is switching.

TTL Wiring





Note: When using sourcing outputs, ground must be floating and cannot be common, or short circuit will result.

PLC Wiring

For PLC wiring information for Inductive and Capacitive sensors, refer to publication 871–4.5, June 1996.

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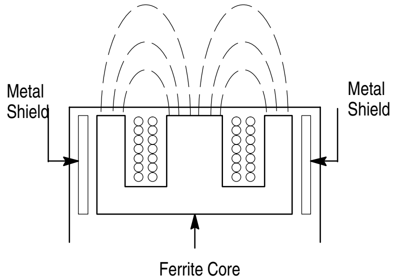
Introduction

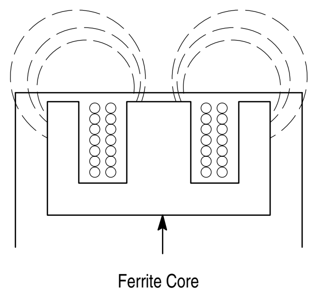
Shielded vs. Unshielded Inductive Sensors

Shielded Sensor



Shielded construction includes a metal band which surrounds the ferrite core and coil arrangement.

Unshielded Sensor

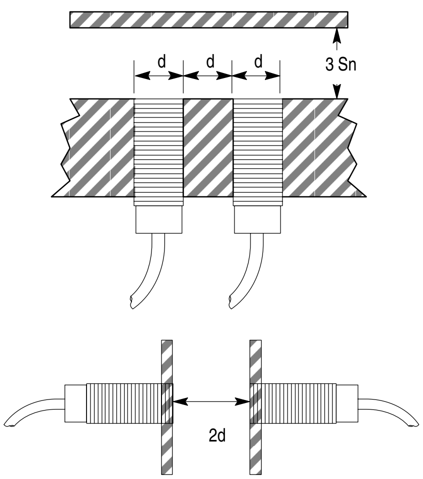


Unshielded sensors do not have this metal band.

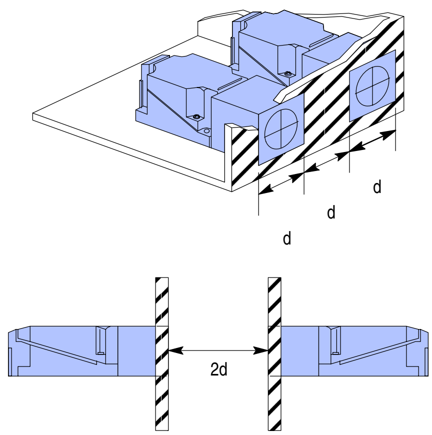
Spacing Between Shielded Sensors (Flush-Mountable) and Nearby Metal Surfaces

Shielded proximity sensors allow the electro-magnetic field to be concentrated to the front of the sensor face. Shielded construction allows the proximity to be mounted flush in surrounding metal without causing a false trigger.

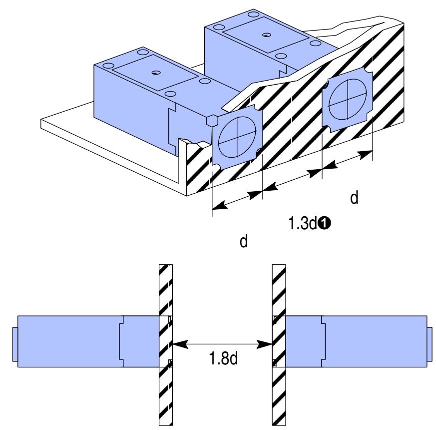
Tubular Style



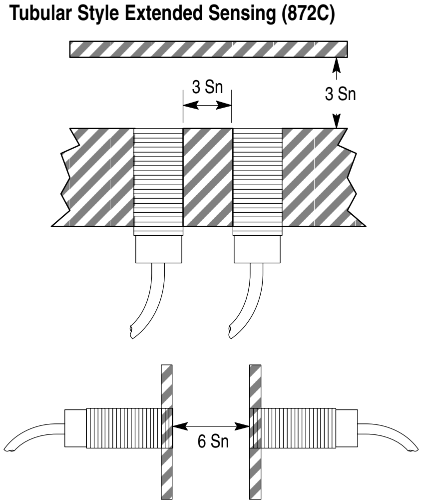
Limit Switch Style (871L and 872L)



Limit Switch Style (802PR)



Tubular Style Extended Sensing (872C)

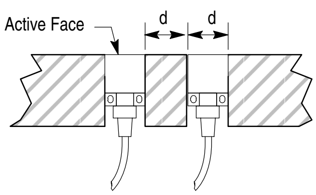


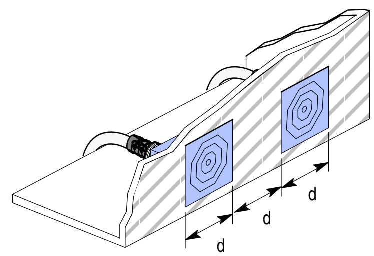
d = diameter or width of active sensing face
Sn = nominal sensing distance

❶ 802PR–LB or 802PR–XB can be mounted side by side.

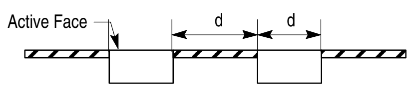
Spacing Between Shielded Sensors (Flush-Mountable) and Nearby Metal Surfaces (continued)

Cube Style (871P VersaCube)

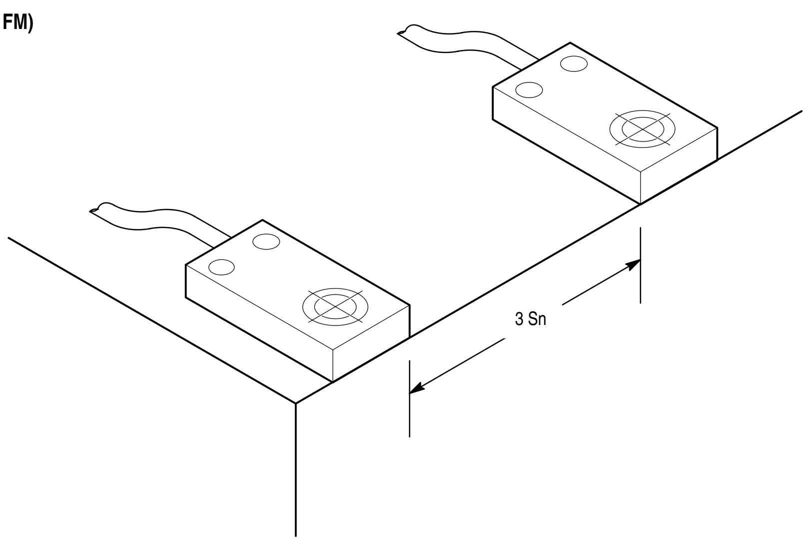




Flat Pack Style (871F)



Miniature Flat Pack Style (871FM)



d = diameter or width of active sensing face
Sn = nominal sensing distance

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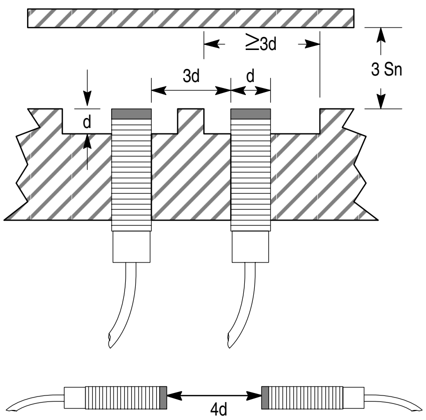
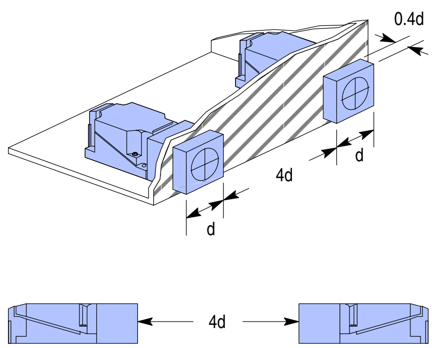
Spacing Between Unshielded Sensors (Nonflush-Mountable) and Nearby Metal Surfaces

Longer sensing distances can be obtained by using an unshielded sensor. Unshielded proximity sensors require a metal-free zone around the sensing face. Metal immediately opposite the sensing face should be no closer than 3 times the rated nominal sensing distance of the sensor.

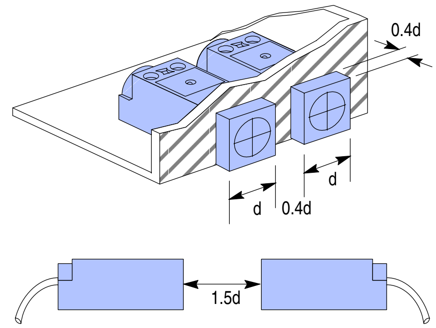
Tubular Style



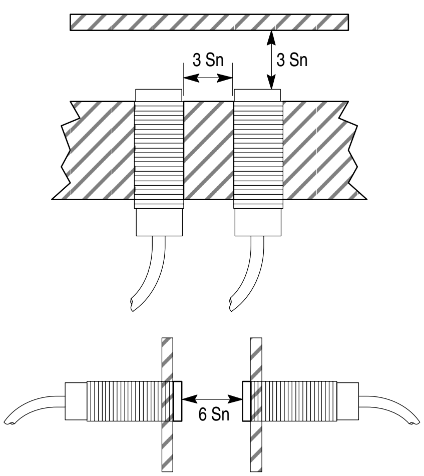
Limit Switch Style (871L and 872L)



Limit Switch Style (802PR)

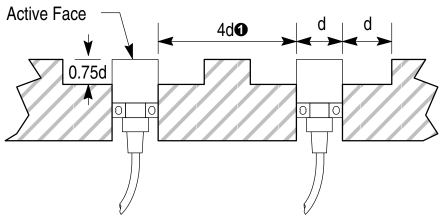


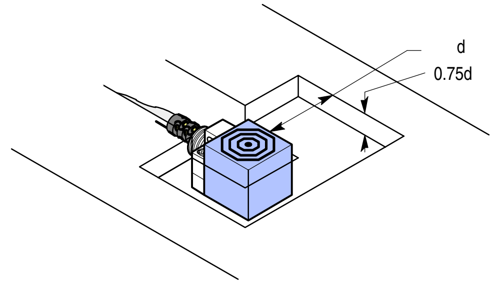
Tubular Style Extended Sensing (872C)

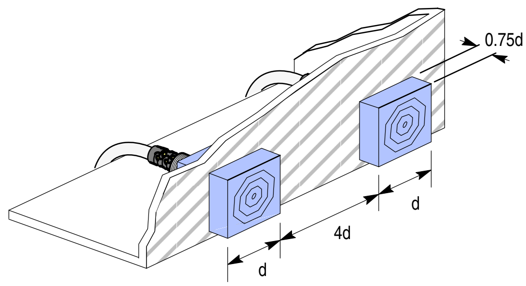


Spacing Between Unshielded Sensors (Nonflush-Mountable) and Nearby Metal Surfaces (continued)

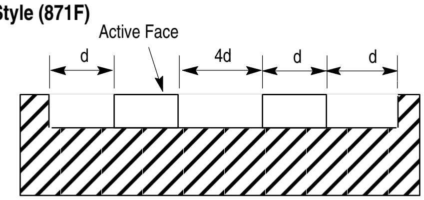
Cube Style (871P VersaCube)



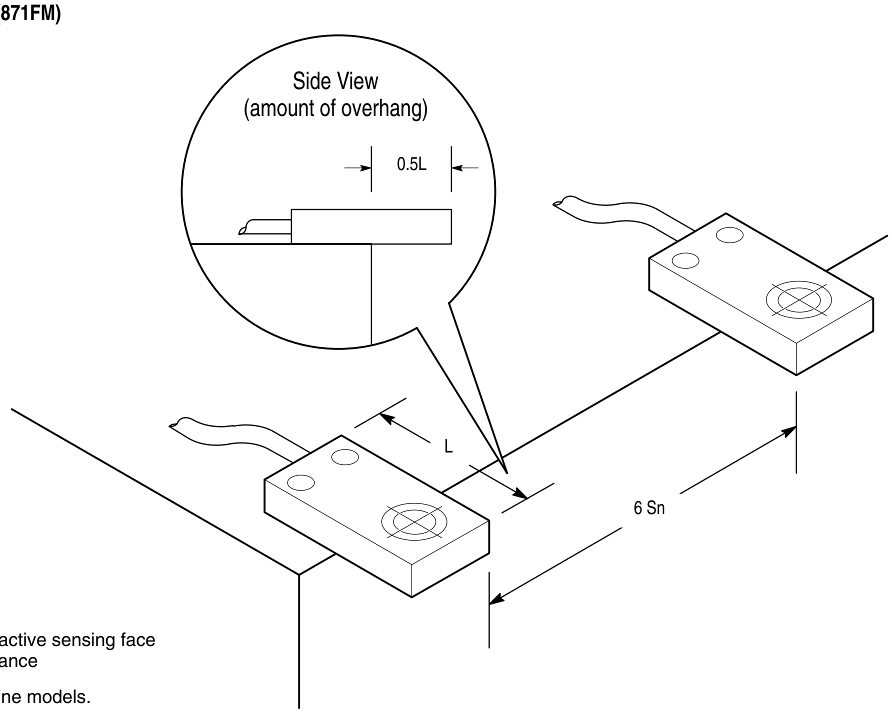




Flat Pack Style (871F)



Miniature Flat Pack Style (871FM)



d = diameter or width of active sensing face
Sn = nominal sensing distance

❶ 3d for Weld Field Immune models.

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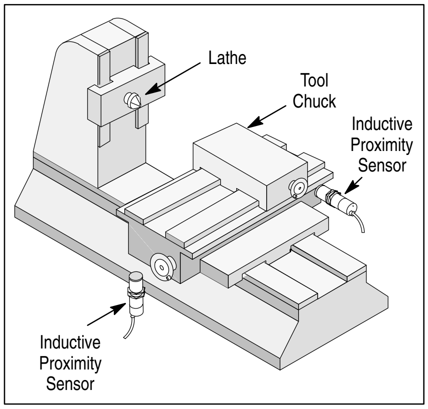
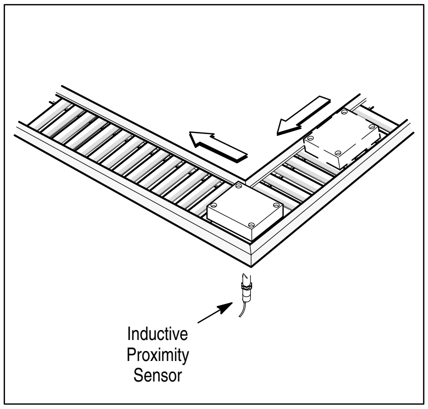
Applications

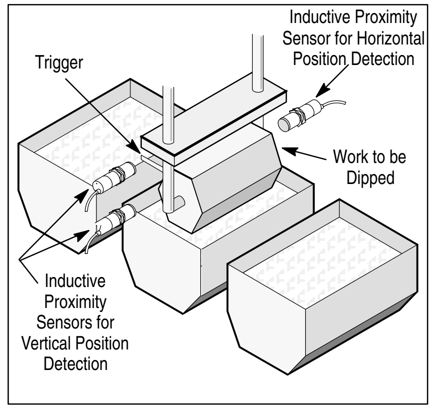
Machine Tools



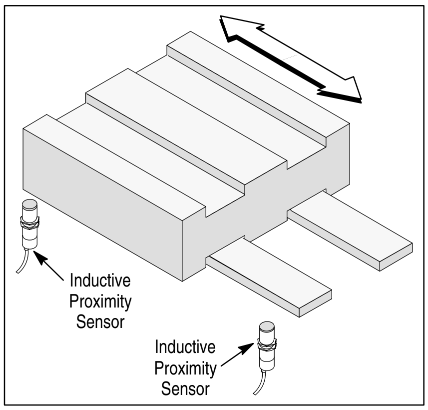
Plating Line



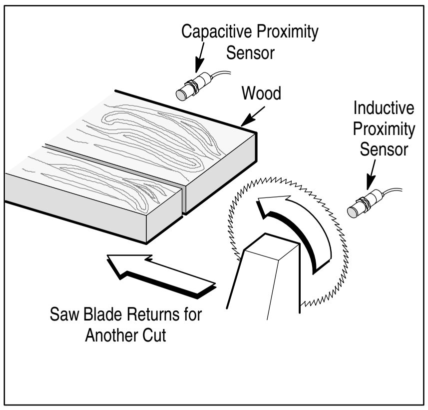
Plating Line



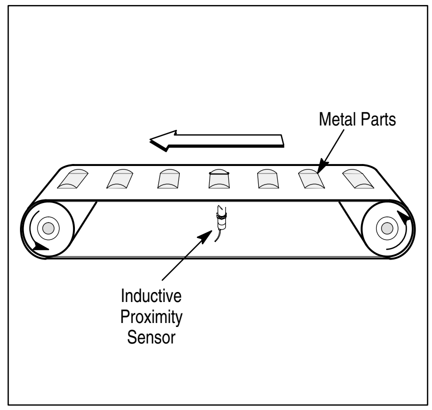
Grinding Machines



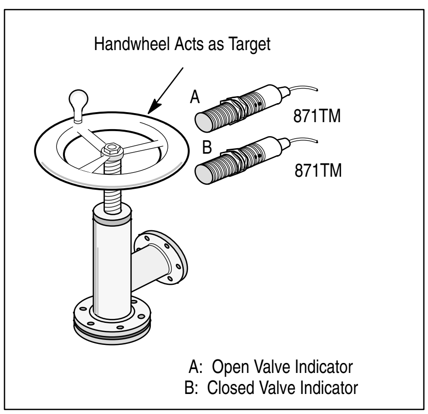
Wood Industry

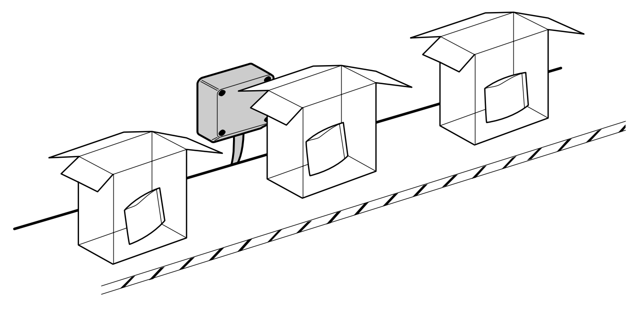


Conveyor Belts

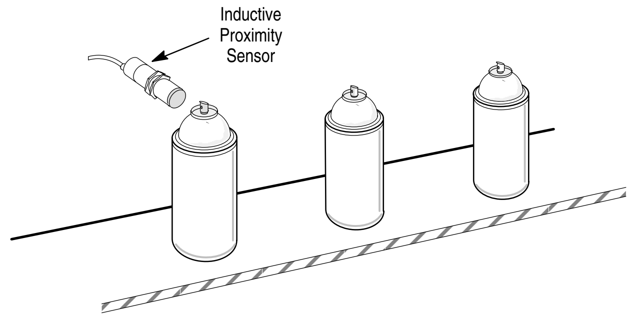


Petroleum Industry— Valve Position



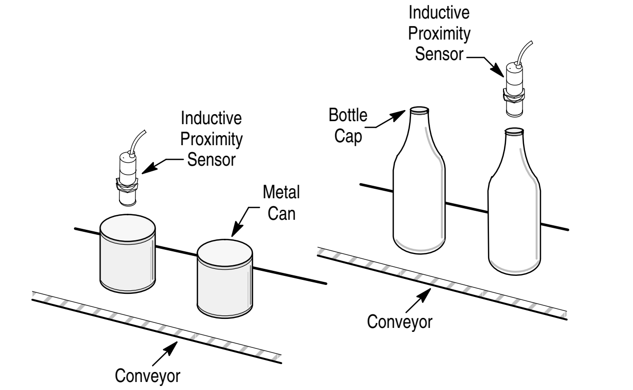


Inductive proximity sensor used to detect a foil seasoning bag inside of a cardboard container.

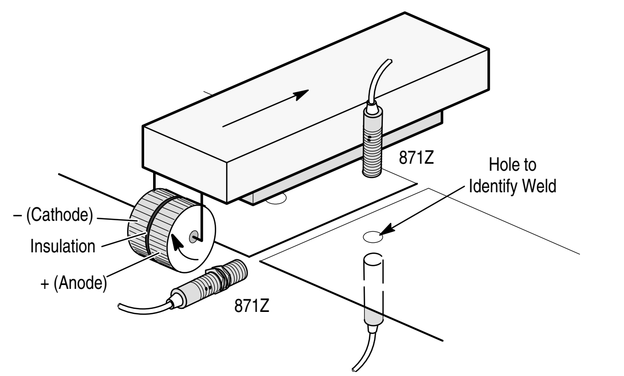


Ferrous selective inductive proximity sensor used to sort ferrous and nonferrous can tops.

Food Industry



Stainless Steel Sheet Welder



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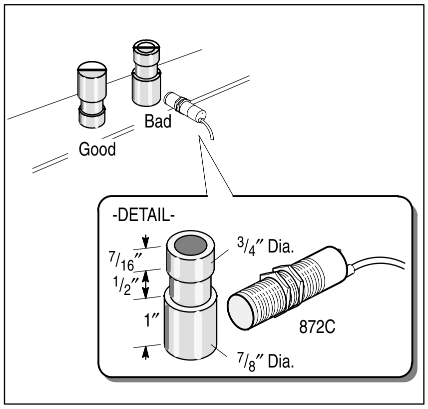
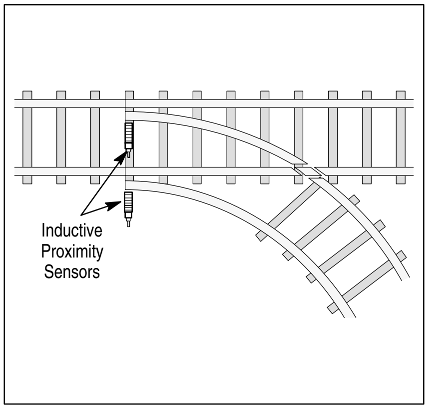
Applications

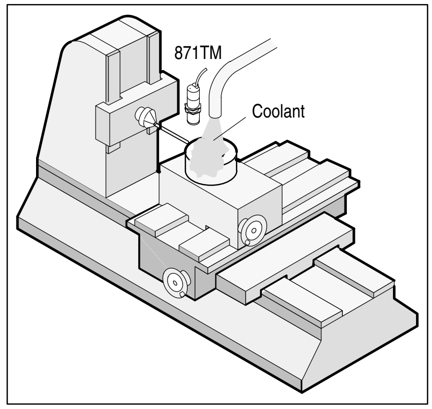
On Line Parts Sorting



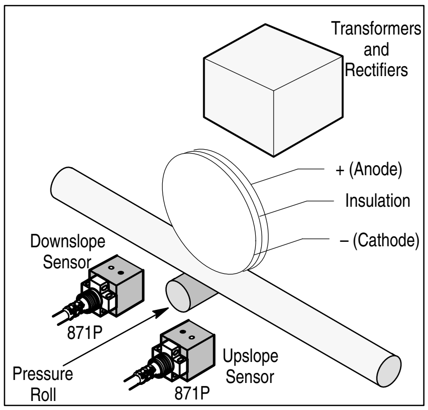
Railroad Yard Position Sensing



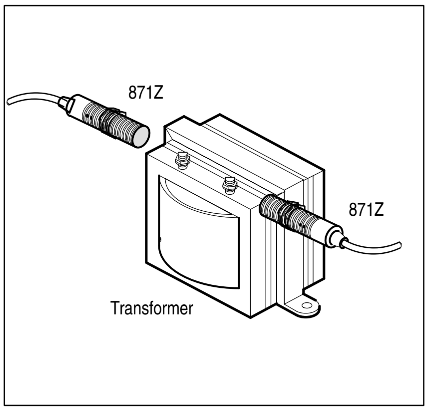
Coolant Resistant Sensing



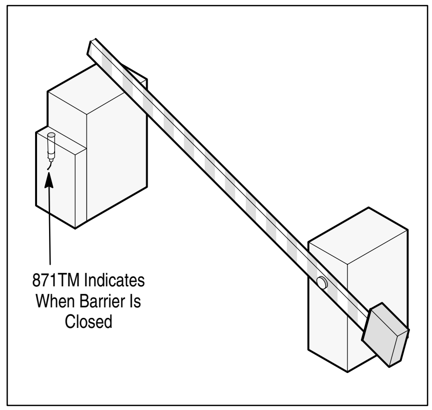
Up and Downslope Control of Continous Tube Welder



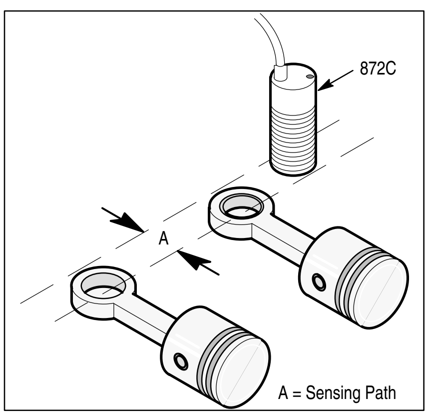
Nut Placement on Transformer



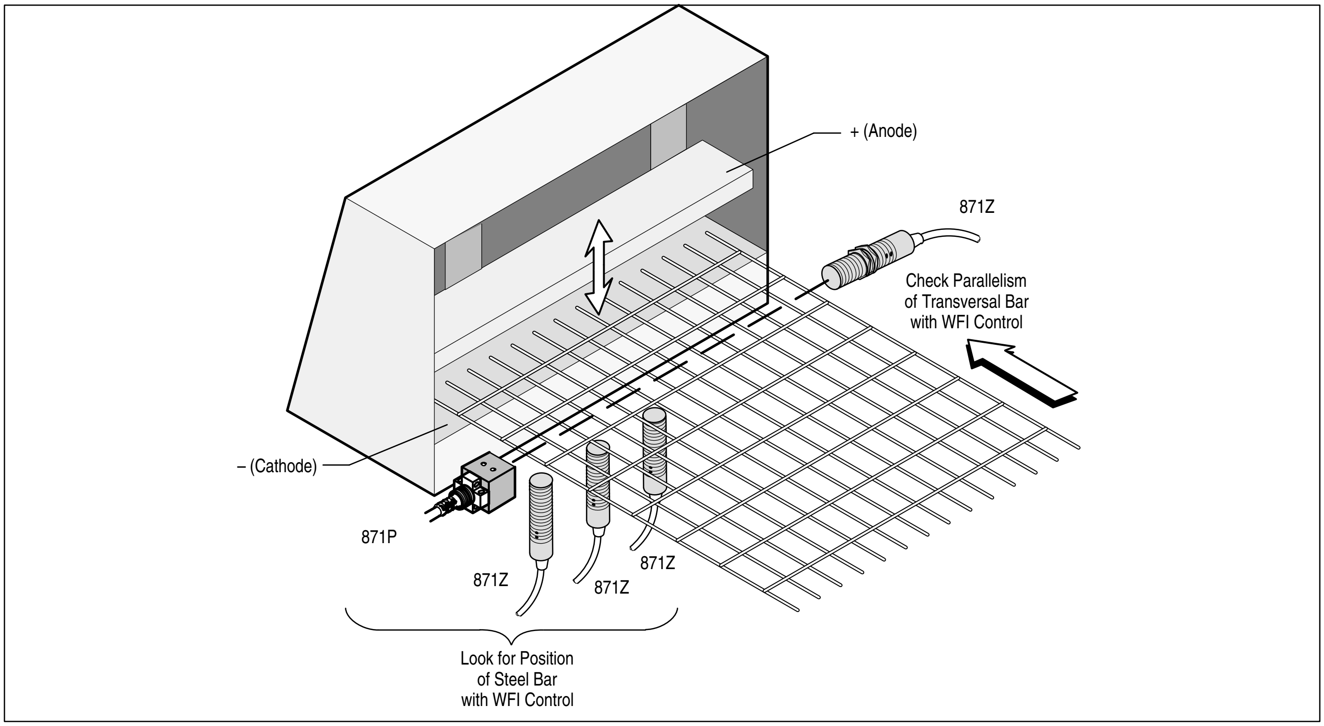
Closed Barrier Indicator



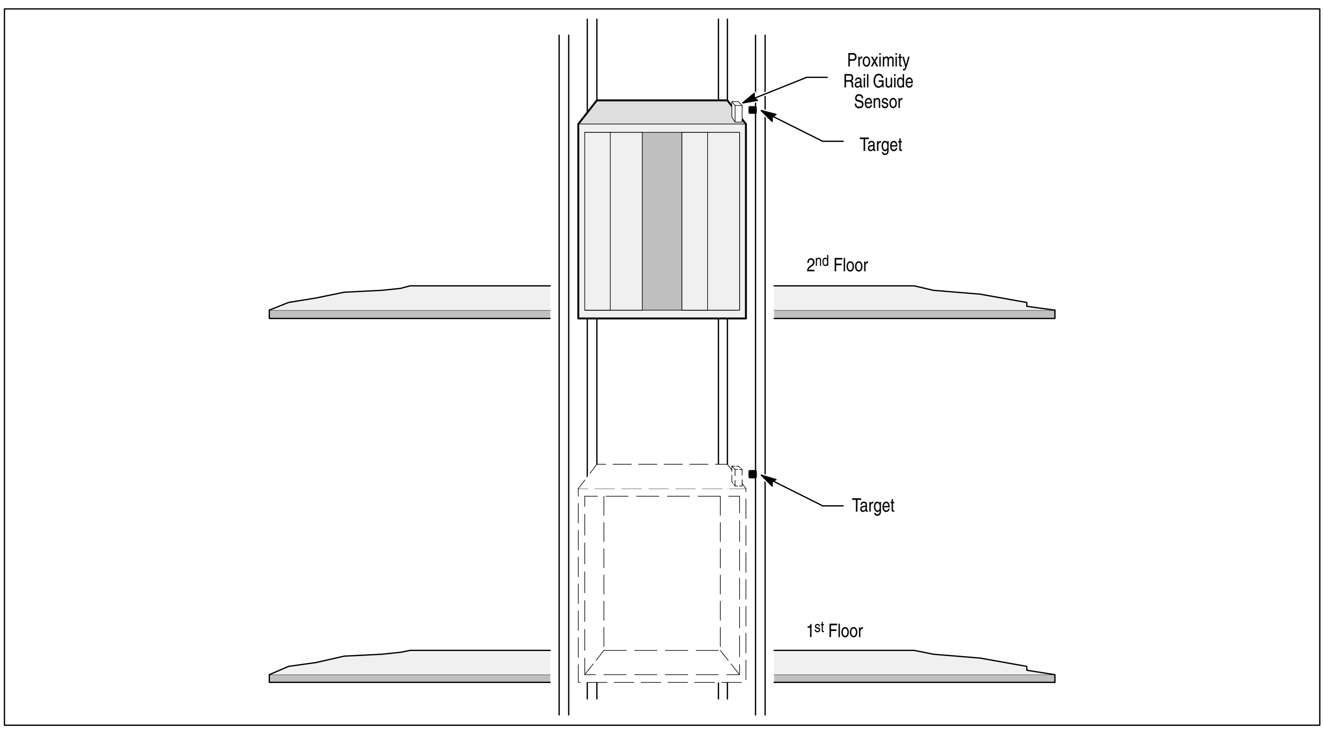
Detect Presence of Bushing in Piston



Control Presence of Mild Steel Bars in Grate Welding



Elevator Positioning



Allen-Bradley produces rail guide inductive proximity sensors for the positioning of elevator cars. These sensors offer increased accuracy and longer life when compared to typical mechanical switches. They are a cost effective solution for lowering your repair costs and down-time. Contact your local Allen-Bradley salesperson for a proximity tailored to your requirements!

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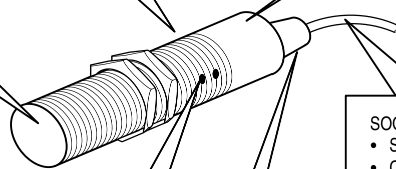
Applications

Top 23 Reasons to Use the 871TM

Robust Electrical Design
- Your choice of AC/DC, 2-wire or 3-wire DC
- Short circuit protection ❶
- Overload protection ❶
- Reverse polarity protection (DC models)
- Radio frequency protection
- Transient noise protection
- False pulse protection
- Epoxy potted for protection against mechanical shock and vibration

Stainless Steel Barrel
- Superior Strength of Impact and Abrasion Resistant Stainless Steel
- Superior Chemical and Cutting Fluid Resistance
- One Piece Barrel for Mini Q.D. Eliminates "Joint" Leaking
- Increased Mounting Torque

Stainless Steel Face
- Superior Strength of Impact and Abrasion Resistant Stainless Steel
- Superior Chemical and Cutting Fluid Resistance
- Leakproof



SOOW–A ToughLink™ Cable
- Superior Abrasion and Chemical Resistance
- Cutting Fluid Resistant
- Superior Strength of #18AWG Conductors and Jacket Materials
- Fire Retardant
- Outdoor Approved
- Plastic Filler Provides Increased "Fluid Wicking" Resistance

LED Lens and Grommet
- Provide Mechanical Seals for Primary Fluid Barrier
- Chemical Resistant

❶ DC and long barrel AC/DC models only.