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TURCK

Innovative Solutions for Automation

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Important Safety Warning!



TURCK sensors and peripheral devices **DO NOT** include the self-checking redundant circuitry required to permit their use in personnel safety applications. A device failure or malfunction can result in either an energized or a de-energized output condition.

Never use these products as sensing devices for personnel protection. Their use as safety devices may create unsafe conditions that could lead to serious bodily injury or death.

How does Proximity Sensing compare to conventional methods?

TURCK proximity sensors are entirely solid state electronic controls that contain no moving parts to wear out as do mechanical switches. They require no physical contact for actuation, no cams or linkages, have no contacts to bounce or arc and are completely encapsulated, making them impervious to most liquids, chemicals and corrosive agents. In addition, TURCK has a line of sensors that can be used in hazardous explosive environments without any special enclosures.
See Hazardous Area Locations in Section A.

If any of the following conditions exists, a Proximity Sensor should be used:

- The object being detected is too small, too lightweight, or too soft to operate a mechanical switch.
- Rapid response and high switching rates are required, as in counting or ejection control applications.
- Object has to be sensed through non-metallic barriers such as glass, plastic, or paper carton.
- Hostile environments demand improved sealing properties, preventing proper operation of mechanical switches.
- Long life and reliable service are required.
- Fast electronic control system requires bounce-free input signal.

Proximity Sensors are being used today in all industries:

Mining and Metallurgy
Foundries
Automatic Assembly and Robotics
Conveyor Systems in Airports and Factories
Chemical Plants and Oil Refineries
Semiconductor Equipment
Sheet Metal Fabrication
Automotive and Appliance Plants
Electroplating Installations
Can Plants, Food Processing and Breweries
Shipyards, Docks, and Off-shore Drilling Rigs
PC-board Handling Machinery

Typical applications:

Parts Detection
Parts Counting
Positioning
Motion and Speed Control
Bottle Cap or Can Lid Detection
Punch Press Feed and Ejection Control
Broken or Damaged Tool Detection
Void or Jam Control
Feed Control
Indexing
Inter-lock Control
Liquid Level Control
Leak Detection
Machine Programming
Valve Position Indication
Missing Parts Control
Parts Diverting
Coin Counting and Sorting
Edge Guide Control
Robotics and Conveyors

Axial Approach

The approach of the target with its center maintained on the sensor reference axis.

Axially Polarized Ring Magnet

A ring magnet whose poles are the two flat sides of the disk. Mounted on pistons for ***permaprox***® cylinder position sensing through nonmagnetic cylinder walls.

Capacitive Proximity Sensor

A proximity sensor producing an electrostatic field that senses conductive targets and nonconductive materials having a dielectric constant of >1 within its sensing zone.

Complementary Output

Two outputs, one N.O. and one N.C., that can be used simultaneously. ***The sum of both load currents cannot exceed the sensor's rated Continuous Load Current***.

Continuous Load Current

The maximum current allowed to continuously flow through the sensor output in the ON state.

Correction Factors

Percentage of the rated operating distance (Sn) that represents the operating distance for targets constructed from materials other than mild steel (mild steel's correction factor is 1.0).

Differential Travel (Hysteresis)

The difference between the operating point as the target approaches the sensor face, and the release point as the target moves away. Given as a percentage of the operating distance (Sn).

Dynamic Output

A sensor output that stays energized for a set duration of time, independent of the time the target is present (one-shot).

Embeddable (Shielded) Proximity Sensor

A sensor that can be flush-mounted in any material without that material influencing the sensing characteristics.

Free Zone

The space around a proximity sensor that must be kept free of any material capable of affecting the sensing characteristics.

Inductive Proximity Sensor

A proximity sensor producing an electromagnetic field that senses only metal targets within its sensing zone.

Inductive Magnet Operated Sensor (*permaprox*®)

A solid-state sensor consisting of a sensing element susceptible to magnetic field strengths of 20-350 Gauss, and switching circuitry similar to that of an inductive proximity sensor.

Inrush Current

The maximum short-term load current that the output of a sensor can tolerate.

IP Rating

Ingress Protection rating per IEC 529.

Lateral Approach

The approach of a target perpendicular to the sensor reference axis.

Load

A device or circuit that is operated by the energy output of another device such as a proximity sensor.

M Threading

ISO 68 Metric straight threading, designated as "Nominal Size" X "Pitch", in mm. (Ex. M5X0.5)

Minimum Load Current

The minimum amount of current that is required by the sensor for reliable operation.

NAMUR

The acronym for a European standards organization.

NAMUR Sensor

A 2-wire variable-resistance DC sensor whose operating characteristics conform to DIN 19 234. Requires a remote amplifier for operation. Typically used for intrinsically safe applications.

NEMA Rating

An enclosure rating per NEMA Standard 250.

No-Load Current

The current drawn by a DC proximity sensor from the power supply when the outputs are not connected to a load.

Nonembeddable (Nonshielded) Proximity Sensor

A sensor is nonembeddable when a specified free zone must be maintained around its sensing face in order not to influence the sensing characteristics.

Normally Closed (N.C.)

The output is OFF when the target is detected by the sensor.

Normally Open (N.O.)

The output is ON when the target is detected by the sensor.

NPN Output (Current Sinking)

A transistor output that switches the common or negative voltage to the load. Load is between sensor and positive supply voltage.

NPSM Threading

American National Standard Straight Pipe Thread for Free-Fitting Mechanical Parts.

NPT Threading

American National Standard Taper Pipe Thread.

Off-State (Leakage) Current

The current that flows through the load circuit when the sensor is in the OFF-state. Also known as leakage or residual current.

Operating Distance

A distance at which the target approaching the sensing face along the reference axis causes the output signal to change.

Overload Protection

The ability of a sensor to withstand load currents between continuous load rating and short-circuit condition with no damage.

PG Threading

Steel conduit threading per German standard DIN 40 430.

PNP Output (Current Sourcing)

Transistor output that switches the positive voltage to the load. Load is between sensor and common.

Programmable Output

Sensor output whose N.O. or N.C. function can be selected by means of a jumper or specific terminal connection.

Radially Polarized Ring Magnet

A ring magnet whose poles are the inner and outer diameter rings.

Rated Operating Distance (Sn)

A conventional quantity used to designate the operating distance. It does not take into account either manufacturing tolerances or variations due to external conditions such as voltage and temperature.

Reference Axis

An axis perpendicular to the sensing face and passing through its center.

Repeatability

The difference between actual operating distances measured at a constant temperature and voltage over an 8-hour period. It is expressed as a percentage (%) of rated operating distance (Sn).

Response frequency

The maximum rate that the output can change in response to the input and still maintain linearity.

Response Time

The time required for the device switching element to respond after the target enters or exits the sensing zone.

Reverse Polarity Protection

Internal components that keep the sensor from being damaged by incorrect polarity connection to the power supply.

Ripple

The alternating component remaining on a DC signal after rectifying, expressed in percentage of rated voltage.

Sensing Face

The surface of the proximity sensor through which the electromagnetic (or electrostatic) field emerges.

Short-Circuit Protection

The ability of a sensor to withstand a shorted condition (no current-limiting load connected) without damage.

Slew Rate

The rate of change of the output voltage with respect to a step change in input. A change in output of 0 to 10 volts at a slew rate of 1.25 V/ms would take 8 ms to slew to the new value.

Solid State

Pertains to devices using semiconductors instead of mechanical parts.

Static Output

A sensor output that stays energized as long as the target is present.

Switching Frequency

The maximum number of times per second that the sensor can change state (ON and OFF) under ideal conditions, usually expressed in Hertz (Hz).

Time-Delay Before Availability

The length of time after power is applied to the sensor before it is ready to operate correctly, expressed in milliseconds (ms).

***Uprox* Sensor ®**

An inductive proximity sensor that detects all metals at the same range. Uprox sensors are inherently weld-field immune, operate over a wider temperature range and have a higher switching frequency than standard inductive sensors.

***Uprox*+ Sensor ®**

Same basic characteristics as the Uprox Sensor, but with a redesigned multi coil system which provides increased sensing capabilities. Uprox+ also carries an IP68 environmental rating

Weld-Field Immunity (WFI)

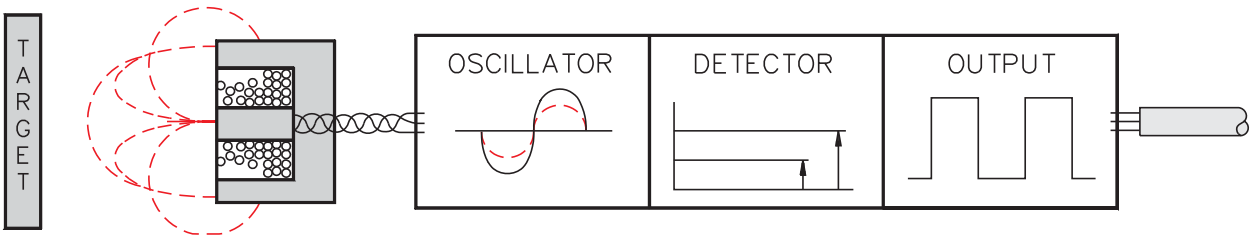
The ability of a sensor not to false-trigger in the presence of strong magnetic fields typically produced by resistance welders.

Wire-Break Protection

Results in the output being OFF on a DC sensor if either supply wire is broken.

Operating Principle Ferrite Core

Figure 1



An inductive proximity sensor consists of a coil and ferrite core arrangement, an oscillator and detector circuit, and a solid-state output (Figure 1). The oscillator creates a high frequency field radiating from the coil in front of the sensor, centered around the axis of the coil. The ferrite core bundles and directs the electro-magnetic field to the front.

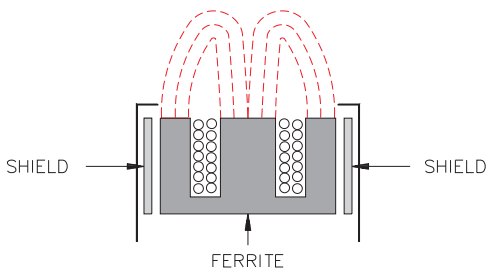
When a metal object enters the high-frequency field, eddy currents are induced on the surface of the target. This results in a loss of energy in the oscillator circuit and, consequently, a smaller amplitude of oscillation. The detector circuit recognizes a specific change in amplitude and generates a signal which will turn the solid-state output "ON" or "OFF". When the metal object leaves the sensing area, the oscillator regenerates, allowing the sensor to return to its normal state.

Embeddable (Shielded) vs. Nonembeddable (Nonshielded)

See mounting characteristics at the front of each section.

Figure 2

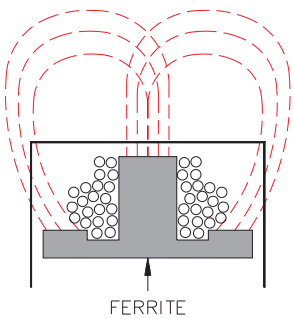
Embeddable (Shielded Sensor)



Embeddable construction includes a metal band that surrounds the ferrite core and coil arrangement. This helps to "bundle" or direct the electro- magnetic field to the front of the sensor.

Figure 3

Nonembeddable (Nonshielded Sensor)

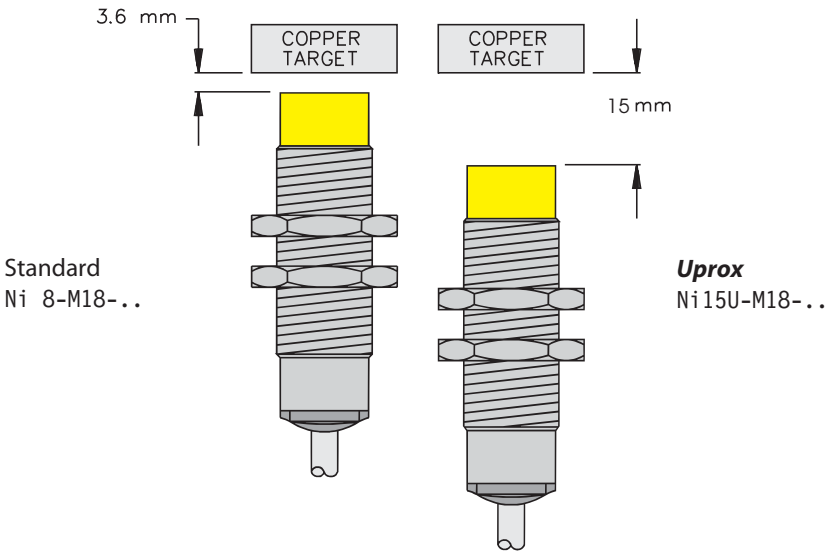


Nonembeddable sensors do not have this metal band; therefore, they have a longer operating distance and are side sensitive.

Uprox ® and Uprox+ ® Characteristics

- **No Correction Factor** - Same rated operating distance for all metals.
- **Extended Operating Distance** - Up to 400% greater than standard inductive sensors when using non-ferrous targets (Figure 4).
- **Weld Field Immunity** - ***Uprox*** is unaffected by strong electromagnetic AC or DC fields because of its unique patented design.
- **High Switching Frequencies** - Up to 10 times faster than standard inductive sensors.
- **Extended Temperature Range** - ***Uprox*** can withstand temperatures up to 85°C (+185°F) with a ±15% temperature drift.

Figure 4

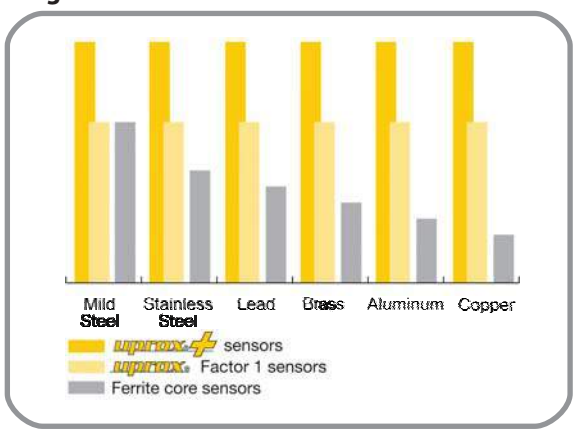


Operating Principle *Uprox* ® and Uprox+ ®

TURCK ***Uprox*** is a patented next generation development of inductive sensors that uses a multi-coil system. Active coil(s) induces eddy currents on the metal target and passive coil(s) are affected by these eddy currents. Ferrous and nonferrous metals have the same effect on the two coils. Therefore, all metals, including galvanized metals, have the same rated operating distance.

TURCK standard inductive sensors use a single coil randomly wound around a ferrite core. The single coil both induces eddy currents on the metal target and is affected by these eddy currents. Ferrous and nonferrous metals affect the sensor differently, making it impossible to detect both types of metals at the same rated operating distance.

Figure 5



Operating distances comparison of ***Uprox*** sensors and standard inductive sensors.

Operating Distance (Sensing Range) Considerations

The operating distance (S) of the different models is basically a function of the diameter of the sensing coil. Maximum operating distance is achieved with the use of a standard or larger target. Rated operating distance (Sn) for each model is given in the manual. **When using a proximity sensor the target should be within the assured range (Sa).**

Standard Target

A square piece of mild steel having a thickness of 1 mm (0.04 in) is used as a standard target to determine the following operating tolerances. The length and width of the square is equal to either the diameter of the circle inscribed on the active surface of the sensing face or three times the rated operating distance Sn, whichever is greater.

Operating Distance = S

The operating distance is the distance at which the target approaching the sensing face along the reference axis causes the output signal to change.

Rated Operating Distance = Sn

The rated operating distance is a conventional quantity used to designate the nominal operating distance. It does not take into account either manufacturing tolerances or variations due to external conditions such as voltage and temperature.

Effective Operating Distance = Sr $0.9\ Sn \leq Sr \leq 1.1Sn$

The effective operating distance is the operating distance of an individual proximity sensor at a constant rated voltage and 23°C (73°F). It allows for manufacturing tolerances.

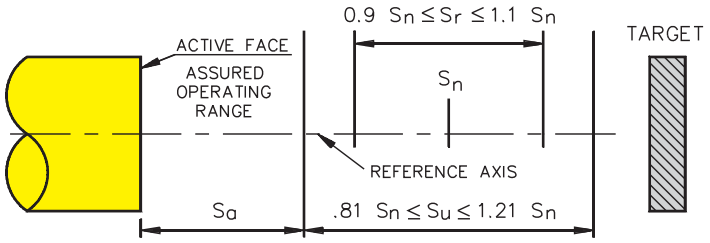
Usable Operating Distance = Su $0.81\ Sn \leq Su \leq 1.21Sn$

The usable operating distance is the operating distance of an individual proximity sensor measured over the operating temperature range at 85% to 110% of its rated voltage. It allows for external conditions and for manufacturing tolerances.

Assured Operating Range = Sa $0 \leq Sa \leq 0.81Sn$

The assured actuating range is between 0 and 81% of the rated operating distance. It is the range within which the correct operation of the proximity sensor under specified voltage and temperature ranges is assured.

Figure 6



Operating Distance (Sensing Range) Considerations

These correction factors apply to standard inductive sensors when a nonferrous target is being detected.
The correction factors are nominal values. Deviations may be due to variations in oscillator frequency, alloy composition, purity and target geometry.

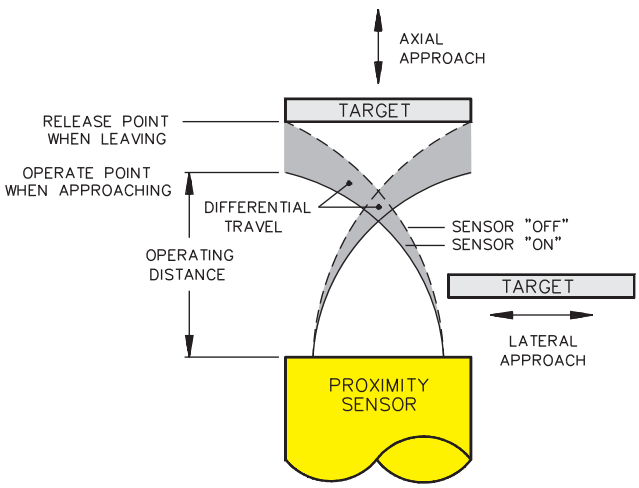
Aluminum foil	1.00
Stainless steel	0.60 to 1.00
Mercury	0.65 to 0.85
Lead	0.50 to 0.75
Brass	0.35 to 0.50
Aluminum (massive)	0.35 to 0.50
Copper	0.25 to 0.45

- Correction factors do not apply to TURCK ***Uprox***® sensors. These sensors see all metals at the same range.
- TURCK also manufactures "nonferrous only" sensors. These sensors will selectively detect nonferrous targets at the rated operating distance. They will not detect ferrous targets; however, ferrous targets positioned between them and a nonferrous target may mask the nonferrous target. The rated operating distance of these sensors is not subject to the correction factors that apply to standard inductive sensors.

Differential Travel (Hysteresis)

The difference between the "operate" and "release" points is called differential travel (See shaded area in Figure 7).It is factory set at less than 15% of the effective operating distance.
Differential travel is needed to keep proximity sensors from "chattering" when subjected to shock and vibration, slow moving targets, or minor disturbances such as electrical noise and temperature drift.

Figure 7

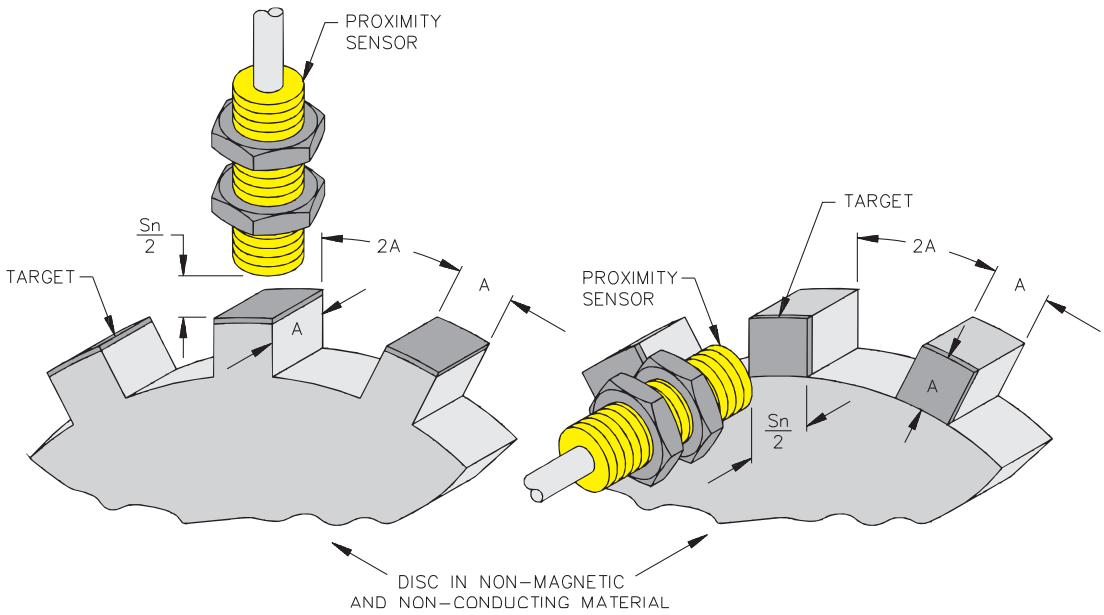


Actuation Mode

Inductive sensors can be actuated in an axial or lateral approach (See Figure 7). It is important to maintain an air gap between the target and the sensing face to prevent physically damaging the sensors.

Maximum Switching Frequency

Minimum parameters for measuring at maximum switching frequency are shown in Figure 8. Using a smaller target or space may result in a reduction of a specific sensor's maximum switching frequency and decrease sensor to target air gap tolerance. See page M7 for determining dimension "A" of **standard target**.



Weld Field Immunity

Many critical applications for proximity sensors involve their use in weld field environments. AC and DC resistance welders used in assembly equipment and other construction machines often require in excess of 20 kA to perform their weld function. Magnetic fields generated by these currents can cause false outputs in standard sensors.

TURCK has pioneered the design and development of inductive proximity sensors that not only survive such environments, but remain fully operative in them.

The limit of the weld field immunity depends on the kind of field (AC or DC), the housing size of the sensor and its location in the field. For example, in an AC or DC weld field, the "/S34" inductive sensors can be positioned one inch from a 20 kA current carrying bus. See Section H for a list of weld field immune sensors.

Reference values for magnetic induction:

	Distance [mm]			
I [kA]	**12.5**	**25**	**50**	**100**
5	80 mT	40 mT	20 mT	10 mT
10	160 mT	80 mT	40 mT	20 mT
20	320 mT	160 mT	80 mT	40 mT
50	800 mT	400 mT	200 mT	100 mT
100	1600 mT	800 mT	400 mT	200 mT

Gauss = 10 x mT

Mounting

TURCK inductive proximity sensors are manufactured with a shielded coil, designated by "Bi" in the part number, and a nonshielded coil, designated by "Ni" in the part number. Embeddable (shielded) units may be safely flush-mounted in metal. Nonembeddable (nonshielded) units require a metal free area around the sensing face. Because of possible interference of the electromagnetic fields generated by the oscillators, minimum spacing is required between adjacent or opposing sensors.

It is good engineering practice to mount sensors horizontally or with the sensing face looking down. Avoid sensors that look up wherever possible, especially if metal filings and chips are present.

Maximum Locknut Torque Specifications

The locknut torque should be considered for all threaded sensors to prevent the housing from being over stressed. The values below pertain to the locknut provided with each sensor. Liquid thread sealants of an anaerobic base, such as Loctite, are recommended if strong vibrations are likely.

Caution: Sensor barrels are typically brass. Consider break torque when selecting grade of thread sealant.

Barrel Size	Metal Barrel	Plastic Barrel
5 mm	5 Nm (3.7 ft-lb)	----
8 mm	10 Nm (7.4 ft-lb)	----
12 mm	10 Nm (11 ft-lb)	1 Nm (0.7 ft-lb)
18 mm	25 Nm (18 ft-lb)	2 Nm (1.4 ft-lb)
30 mm	90 Nm (66 ft-lb)	5 Nm (3.7 ft-lb)
47 mm	90 Nm (66 ft-lb)	----

Drill Hole Sizes for Metric Threads

Thread Size	Pitch	Thru Hole (mm)	Tap Hole Dia. (mm)	Thru Hole (in)	Tap Hole Dia. (in)
M5 x 0.5	0.5	5.0	4.5	13/64	5/32
M8 x 1	1.0	8.0	7	21/64	1/4
M12 x 1	1.0	12.0	11	31/64	13/32
M18 x 1	1.0	18.0	17	23/32	41/64
M30 x 1.5	1.5	30.0	28	1-3/16	1-5/64
PG 9	1.41	15.2	14	5/8	1/2
PG 13.5	1.41	20.4	19	13/16	23/32
PG 36	1.59	47.0	45.5	1-7/8	1-47/64

DC Outputs

Two-, three-, or four-wire proximity sensors contain a transistor oscillator and a snap-action amplifier. This provides exceedingly high accuracy to a set switching point, even with very slowly approaching targets. Switching characteristics are unaffected by supply voltage fluctuations within the specified limits.

The sensors can drive electromechanical relays, counters, solenoids, or electronic modules, and interface directly with logic systems or programmable controllers without additional interface circuitry. They are available with either NPN output transistors (current sinking) or PNP output transistors (current sourcing).

Load current ratings vary from 100 mA to 200 mA depending on physical size. Standard voltage range is 10-30 VDC with certain types available for 10-65 VDC. All models incorporate wire-break, transient and reverse polarity protection.
Power-On false pulse suppression is also standard.

Short-Circuit and Overload Protection

TURCK DC sensors with a Voltage Range designation of "4", "6" or "8" in the part number are short-circuit and overload protected (automatic reset). These sensors incorporate a specially designed circuit which continuously monitors the ON state output current for a short-circuit or overload condition. If either of these fault conditions occurs, the output is turned OFF and pulse tested until the fault is removed. This added protection causes a ≤1.8 V drop across the output in the normal ON state. This may be a problem when interfacing with some logic low inputs (see TTL compatibility).

TTL Compatibility

Some solid-state loads requiring NPN (sinking) input signals need a ≤0.8 V signal to reliably turn ON. The output of these sensors will have a voltage drop of ≤0.7 V (0.3 V typical), which will ensure reliable operation. Do not use voltage ranges "4" and '6" when TTL compatibility is required. Contact the factory for a list of part numbers with this specification.

Figure 1

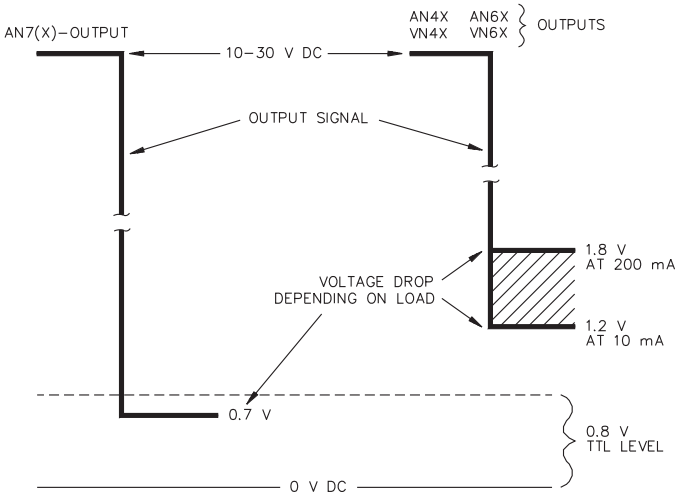
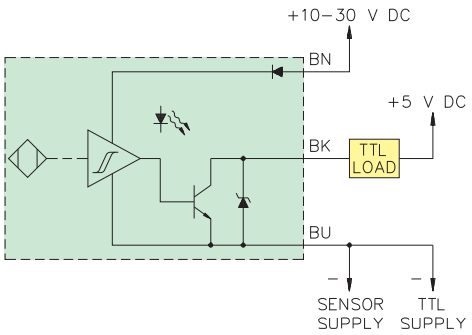


Figure 2



Voltage drop is measured from output wire black (BK) to ground wire blue (BU).

DC Sourcing and Sinking

2-Wire DC

Figure 3 *Source (PNP)*

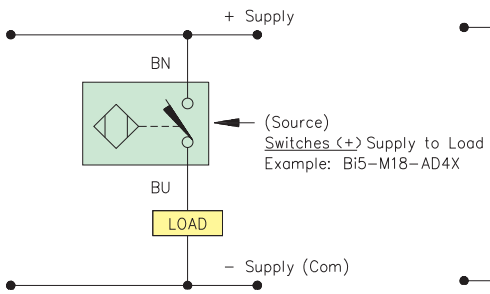
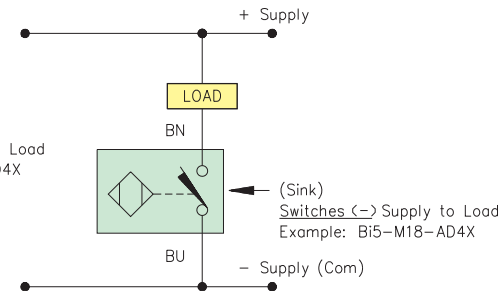


Figure 4 *Sink (NPN)*



Note: TURCK 2-wire DC sensors with an "AD" designation are not polarity sensitive and can be used to sink or source a load.

3-Wire DC

Figure 6 *Sink (NPN)*

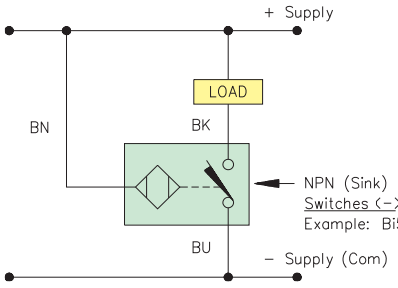
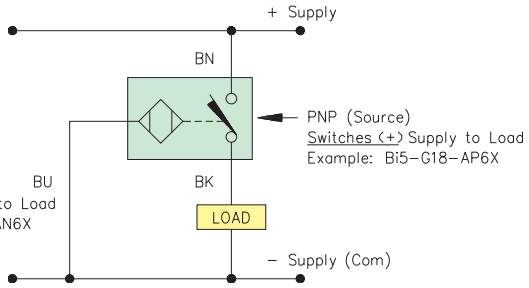


Figure 5 *Source (PNP)*



DC Outputs

"AD" 2-Wire DC Output

Figure 7

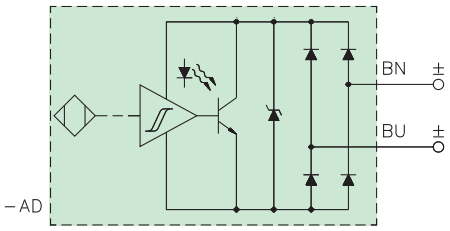
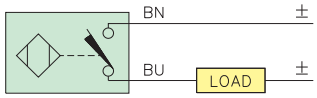
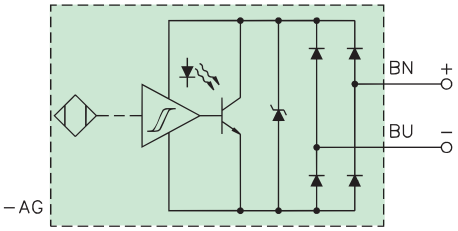


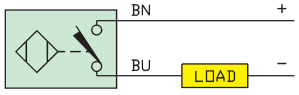
Figure 8



"AG" 2-Wire DC Output

Figure 9





DC Outputs

"AN4" and "AP4" 3-Wire DC Outputs

Figure 10 Electronic Output Circuit

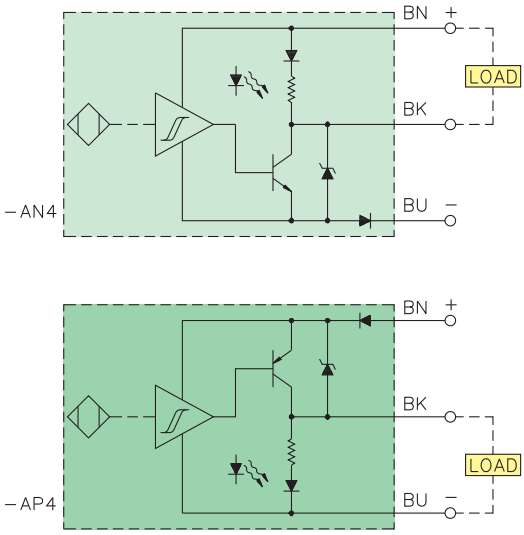
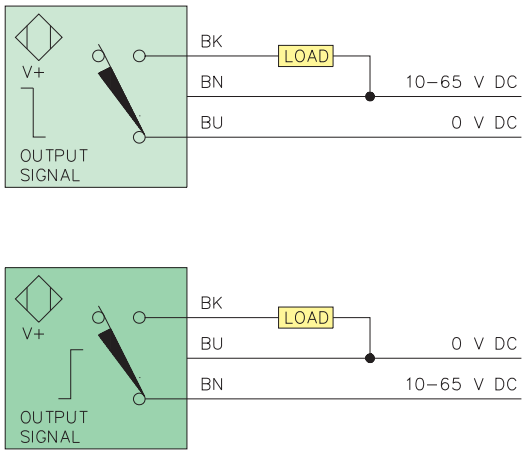


Figure 11 Wiring Diagram



NPN transistor (i.e. current sinking negative switching) N.O. output

PNP transistor (i.e. current sourcing positive switching) N.O. output

"AN6(7)" and "AP6" 3-Wire DC Outputs

Figure 12 Electronic Output Circuit

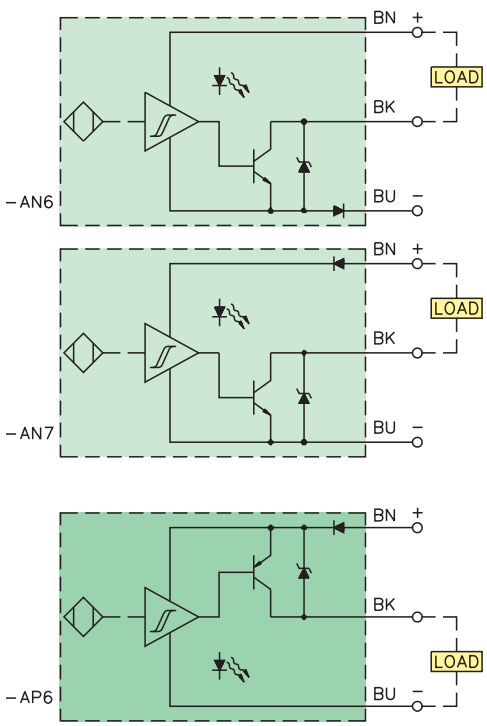
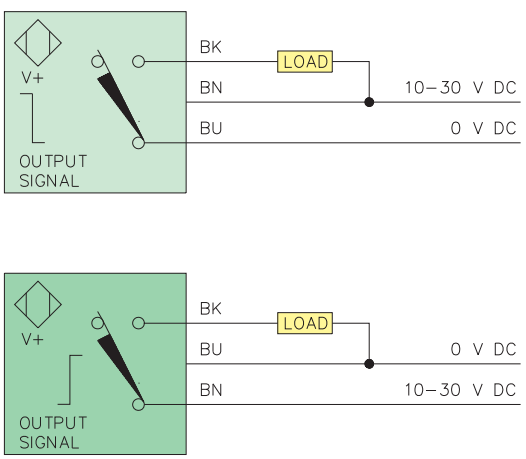


Figure 13 Wiring Diagram



NPN transistor (i.e. current sinking negative switching) N.O. output

PNP transistor (i.e. current sourcing positive switching) N.O. output

TURCK TIP

- Order current sinking (NPN) sensors with the voltage range "7" only when low voltage drop for TTL gates is required. In all other cases, order sensors with voltage ranges "4" or "6".

DC Outputs

"VN4" and "VP4" 4-Wire DC Outputs

Figure 14 Electronic Output Circuit

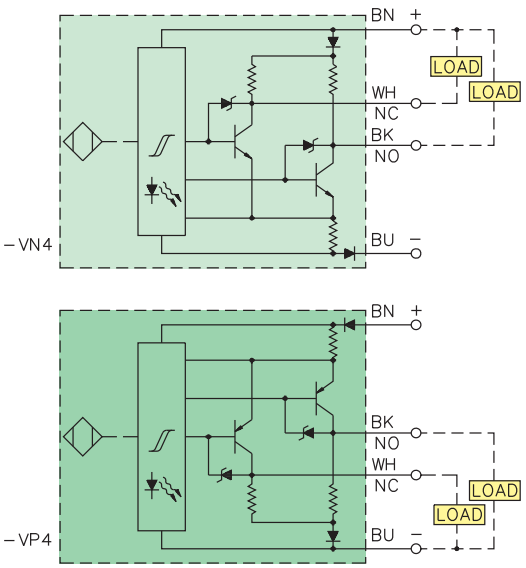
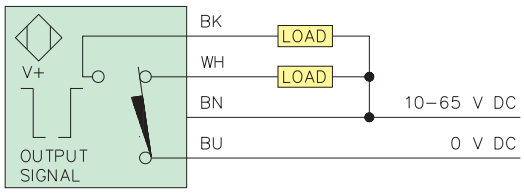
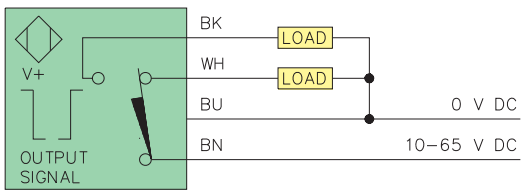


Figure 15 Wiring Diagram



NPN transistor (i.e. current sinking negative switching) complementary output (SPDT)



PNP transistor (i.e. current sourcing positive switching) complementary output (SPDT)

"VN6" and "VP6" 4-Wire DC Outputs

Figure 16 Electronic Output Circuit

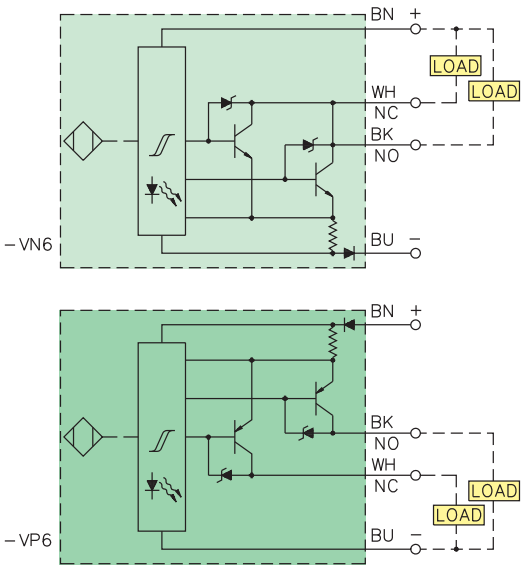
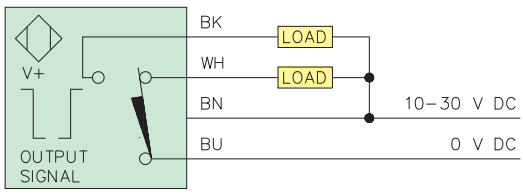
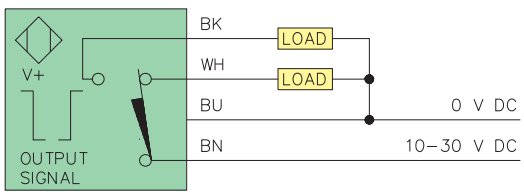


Figure 17 Wiring Diagram



NPN transistor (i.e. current sinking negative switching) complementary output (SPDT)



PNP transistor (i.e. current sourcing positive switching) complementary output (SPDT)

DC Outputs

"LIU" 4-Wire Linear Analog DC Output

Figure 18 Electronic Output Circuit

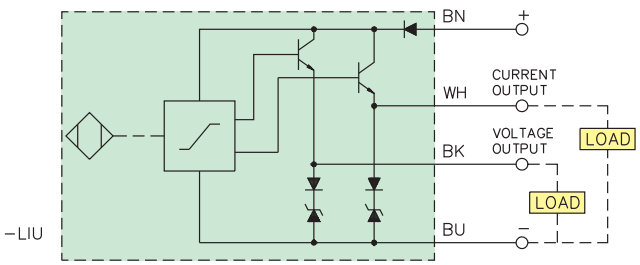


Figure 19 Typical Response Curve

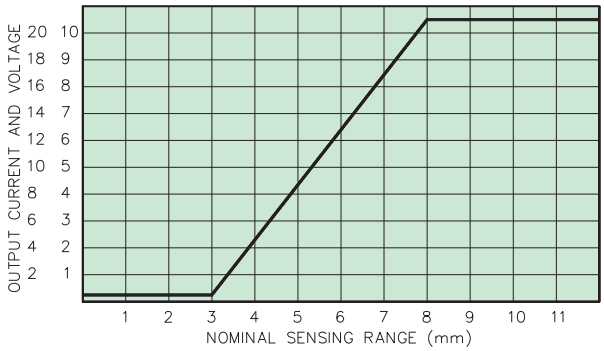
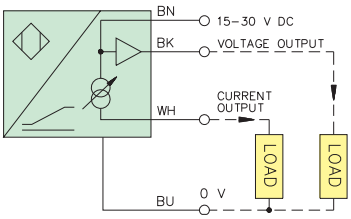


Figure 20 Wiring Diagram



Linear Analog Output; Current and Voltage

Series/Parallel Connection

Logic functions with DC proximity sensors:

Self-contained proximity sensors can be wired in series or parallel to perform such logic functions as AND, OR, NAND, NOR. The wiring diagrams show the hook-up of four sensors with NPN and PNP outputs.
Take into account the accumulated no-load current and voltage drop per sensor added in the series string.

Series-connection:

N.O. sensors: AND Function
(target present, all sensors: load "on")
N.C. sensors: NOR Function
(target present, any sensor: load "off")

Parallel-connection:

N.O. sensors: OR Function
(target present, any sensor: load "on")
N.C. sensors: NAND Function
(target present, all sensors: load "off")

TURCK TIP

- To prevent the load from seeing the cumulative voltage drop of multiple 3-wire sensors in series, alternating polarity sensors can be used provided that the desired polarity is at the load.
- Wiring 3-wire sensors in series delays the load by the accumulated "time delay before availability" of all sensors in the string.

Series/Parallel Connection

Figure 21 NPN Connection

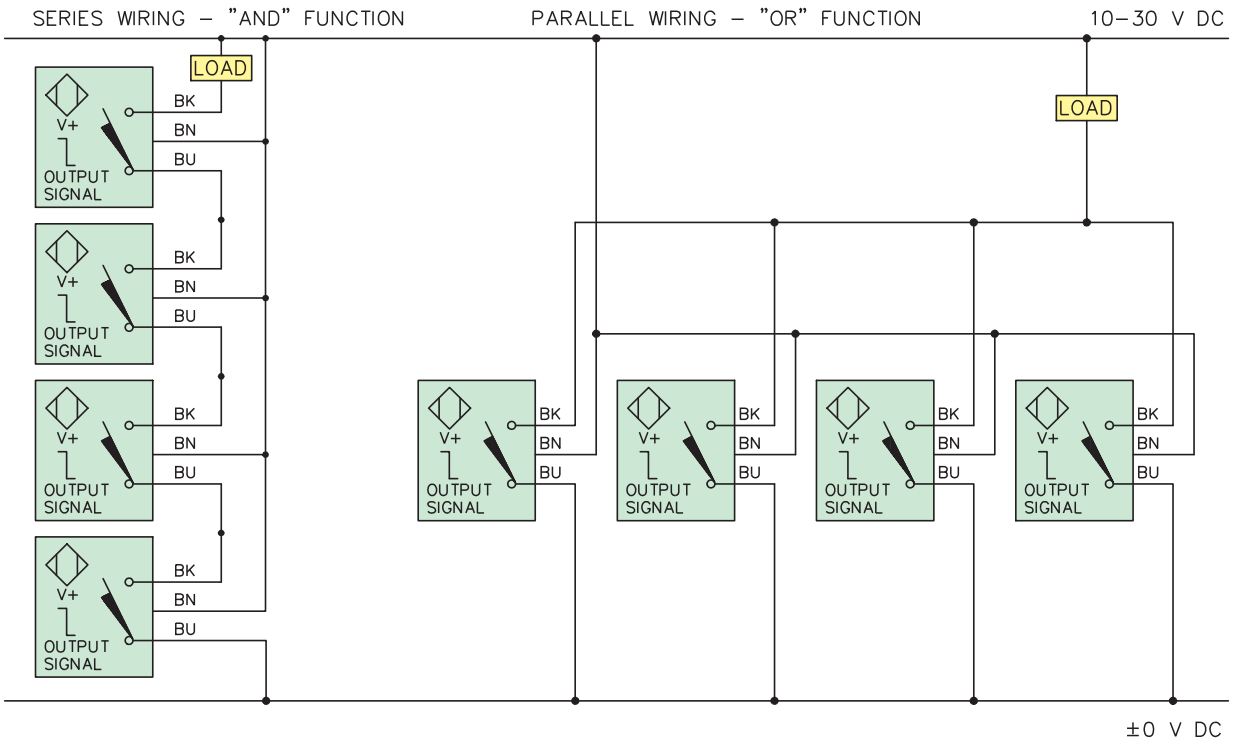
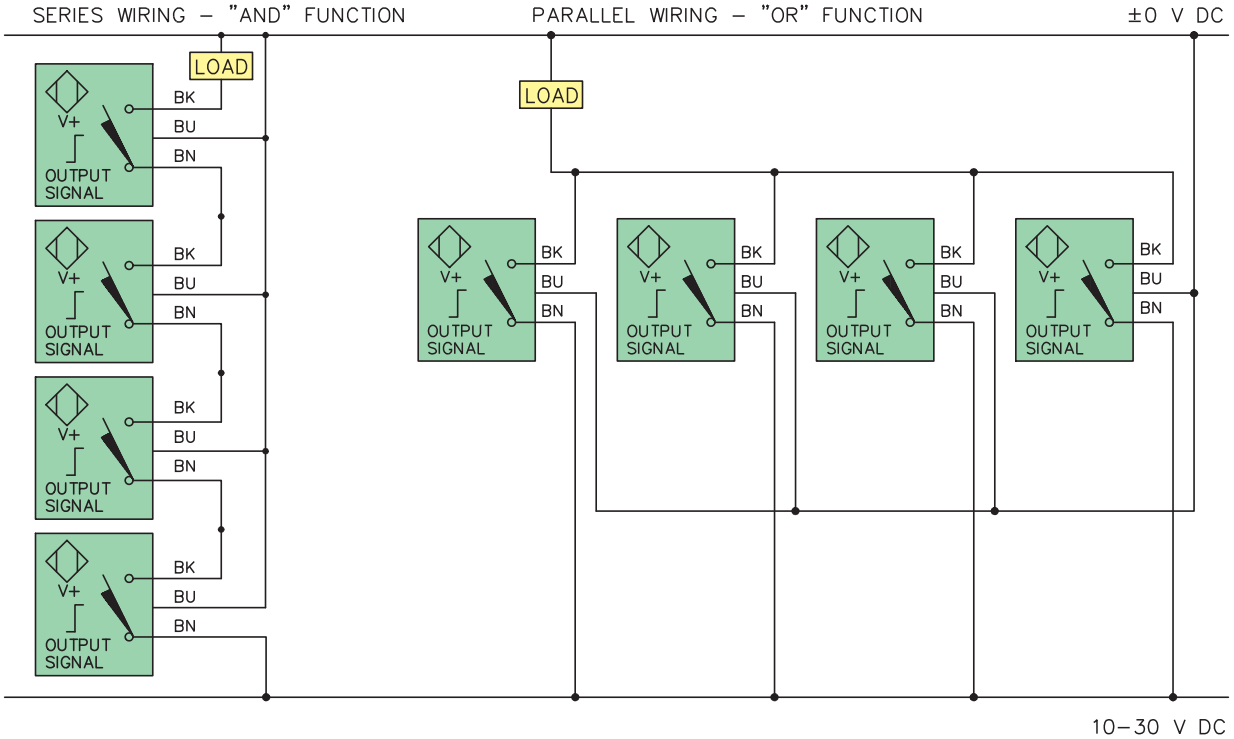


Figure 22 PNP Connection



Short-Circuit and Overload Protection

TURCK AC sensors with the Voltage Range designation "30", "32" or "40" are short-circuit and overload protected (manual reset). These sensors incorporate a specially designed circuit which continuously monitors the ON state output current for a short-circuit or overload condition. If either of these fault conditions occurs, the output is latched OFF until the power has been cycled OFF and ON again.

Always select short-circuit and overload protected sensors whenever possible.



CAUTION!



DO NOT…

operate an incandescent light bulb as a load.
The extremely high cold current will cause an overload condition.



DO NOT…

operate a proximity sensor from a wall outlet without a load.
This is considered a "dead" short and can cause catastrophic damage to nonshort-circuit protected sensors.



DO NOT…

directly operate a motor with a proximity sensor.
The inrush current can cause an overload condition.
Always use a motor starter, relay or other appropriate device.



DO NOT…

forget to ground. AC and AC/DC sensors must be grounded or there exists a potential of electrical shock.

AC and AC/DC Outputs

Figure 1 **AC/DC Outputs - "3", "31", "33", non-SCP**

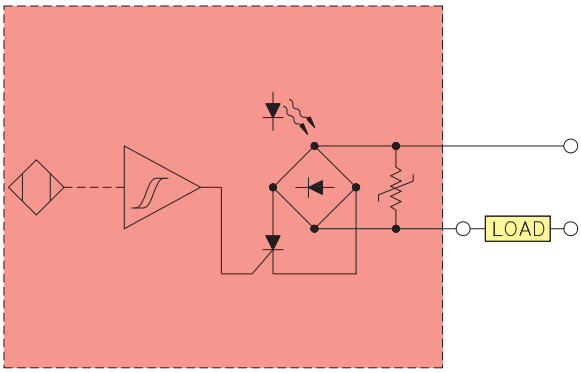
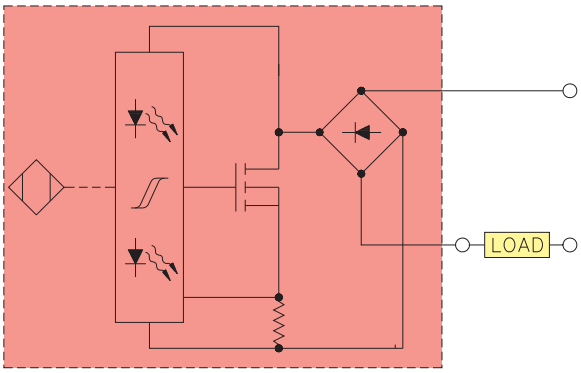


Figure 2 **AC/DC Outputs - "30", "32", "40" SCP**

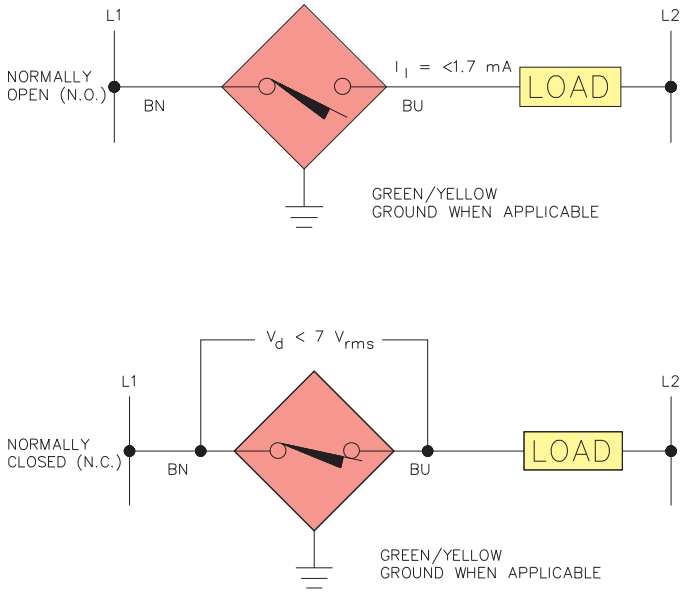


SCP = Short-circuit Protected

These sensors are used as pilot devices for AC-operated loads such as relays, contactors, solenoids, etc. The solid-state output permits use of the sensors directly on the line in series with an appropriate load. They, therefore, replace mechanical limit switches without alteration of circuitry, where operating speed or environmental conditions require the application of solid-state sensors.

These sensors are typically available in a voltage range of 20-250 VAC. All models are available with either normally open (N.O.), normally closed (N.C.) or programmable outputs (from N.O. to N.C.). Careful consideration must be given to the voltage drop across AC/DC sensors when used at 24 VDC.

Figure 3 **Electro-Mechanical Equivalents**



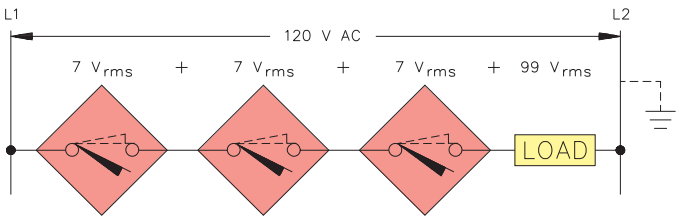
Since the sensors are connected in series with the load by means of only two leads, an off-state current flows through the load in the magnitude of approximately 1.7 mA.

This, however, does not affect the proper and reliable performance of most AC loads. Another characteristic of solid state sensors is a 5 to 7 volt drop developed across the sensor in the ON state.

All models contain a snubber network to protect against transients from inductive loads, which can cause false triggering.

Series Connection

Figure 4



Series-connection: (Figure 4)

N.O. sensors: AND Function
(target present, all sensors: load "on")

N.C. sensors: NOR Function
(target present, any sensor: load "off")

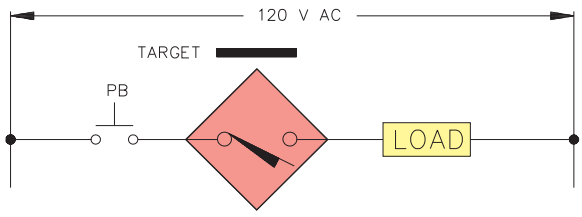
The maximum number of sensors to be operated in series depends on the stability of the line voltage and the operating characteristics of the load in question. The supply voltage minus the accumulative on state voltage drop across the series connection (approximately 7 Vrms per sensor) must be ≥ the minimum required load voltage.

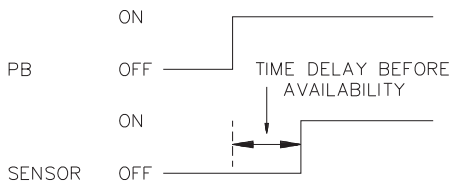
Mechanical Switches in Series

Problem:

Mechanical switches in series with proximity sensors should always be avoided because they can create an open circuit, leaving the proximity sensor without power. In order to operate properly, a proximity sensor should be powered continuously. A typical problem encountered when the mechanical contact closes while the target is present is a short time delay that is experienced before the load energizes (time delay before availability).

Figure 5

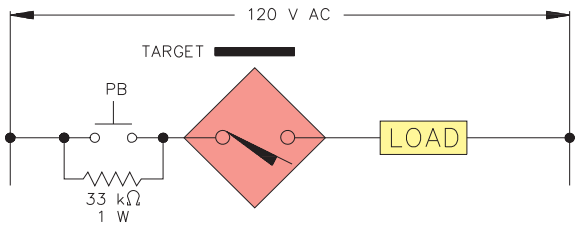




Solution:

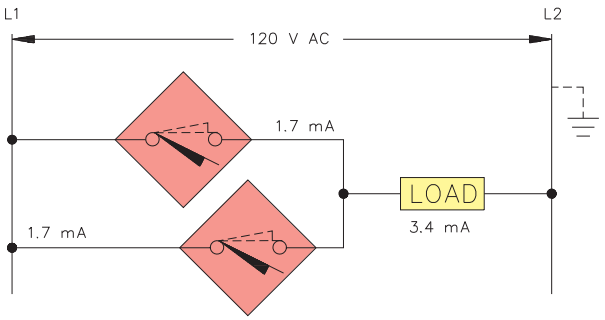
A 33 kΩ, 1W by-pass resistor can be added across the mechanical contact to eliminate the time delay before availability. This will allow enough leakage current to keep the sensor ready for instantaneous operation.

Figure 6



Parallel Connection

Figure 7



Parallel Connection: (Figure 7)

N.O. sensors: OR Function
(target present, any sensor: load "on")

N.C. sensors: NAND Function
(target present, all sensors: load "off")

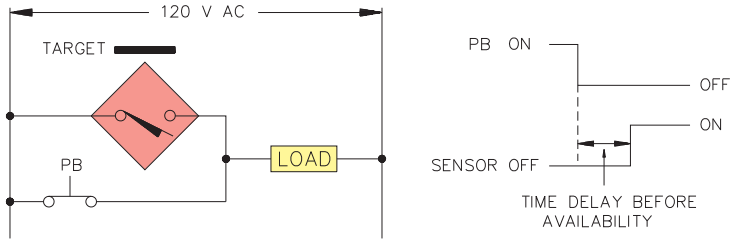
Wiring AC proximity sensors in parallel can result in inconsistent operation and should generally be avoided.

On-state voltage drop: With any sensor ON, the voltage across all other sensors is typically 7 Vrms. Since the minimum rated voltage for AC sensors is 20 Vrms, no other sensor with a target present can turn ON until the first sensor turns OFF. This transition is not instantaneous due to the time delay before availability, during which the load may drop out.

Leakage current through the load: This is equal to the total leakage of all sensors wired in parallel. Too much leakage into a solid state load can cause the input to turn ON and not turn OFF. Small relays may not drop out if the leakage current exceeds the relay's holding current.

Mechanical Switches in Parallel

Figure 8

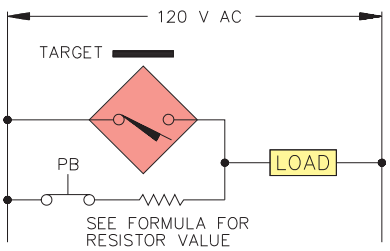


Problem:

As previously discussed, proximity sensors should be powered continuously to avoid the time delay before availability during power-up.

With mechanical switches in parallel, the sensor is shorted out every time the contact is closed, leaving it without power. If the target is present when the mechanical contact is opened, a small delay will be experienced during which the load may drop out.

Figure 9



Solution:

This delay can be avoided by adding a resistor in series with the mechanical contact. The voltage drop developed across the resistor with the contact closed will be enough to keep the sensor active. Use the formula below to determine the value and wattage.

Formula:

$$R = \frac{\text{minimum operating voltage of proximity sensor}}{\text{load current at operating voltage}}$$

Example:

$$R = \frac{20\ V}{180\ mA}$$

$$R = 110\ W$$

Minimum resistor wattage rating: E x I

Example: 20 V x 180 mA = 3.6 W ≈ 5 watts recommended

Specifications

NAMUR (Y0 and Y1) Output

NAMUR sensors are 2-wire sensing devices used with switching amplifiers. Because of the small amount of energy needed to operate NAMUR sensors, they can be used in intrinsically safe applications.

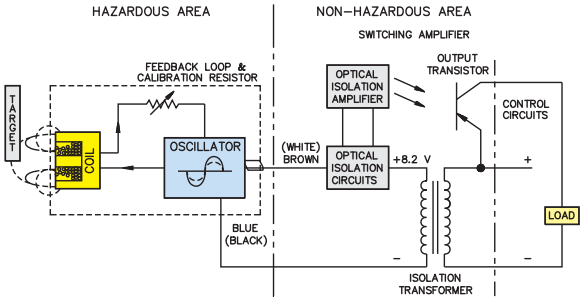
The operation of this sensor is similar to that of a variable resistor with a change in impedance as a target approaches the sensor. When no metal is being sensed, the inductive sensor is in a low impedance state and draws a current of more than 2.2 mA. When a metal target enters the high-frequency field radiated from the sensor head, the impedance increases as the target approaches. When fully damped, the sensor draws less than 1.0 mA. *Note: For capacitive and inductive magnet operated sensors, the current change characteristics are opposite.*

The current differential from the undamped to the damped (metal present) state is used to trigger an amplifier at a defined switching point. These sensors contain a relatively small number of components, which allows the construction of small devices and also assures a high degree of reliability.

In the undamped and damped state, the devices have fairly low impedance and are therefore, unaffected by most transients. NAMUR sensor circuits operate on direct current. Therefore, cable runs of several sensors may be run parallel to one another without mutual interference.

The NAMUR (Y0 and Y1) sensor behaves like a variable resistor when a target approaches.
The impedence increases or decreases between 1 kΩ and 8 kΩ.

Figure 1



Typical Output Curves

Figure 2

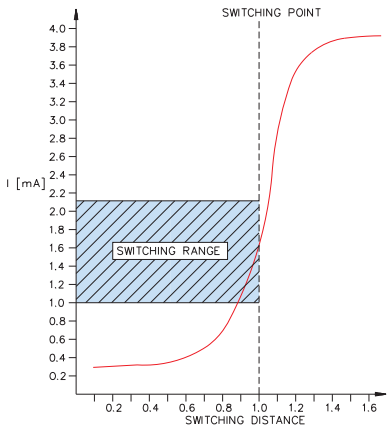
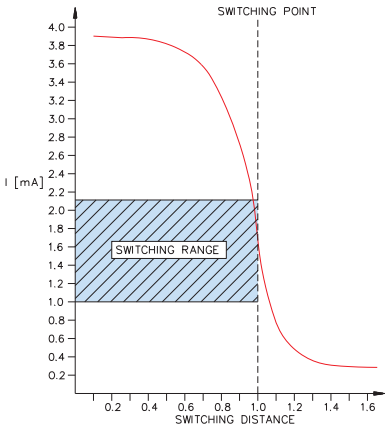


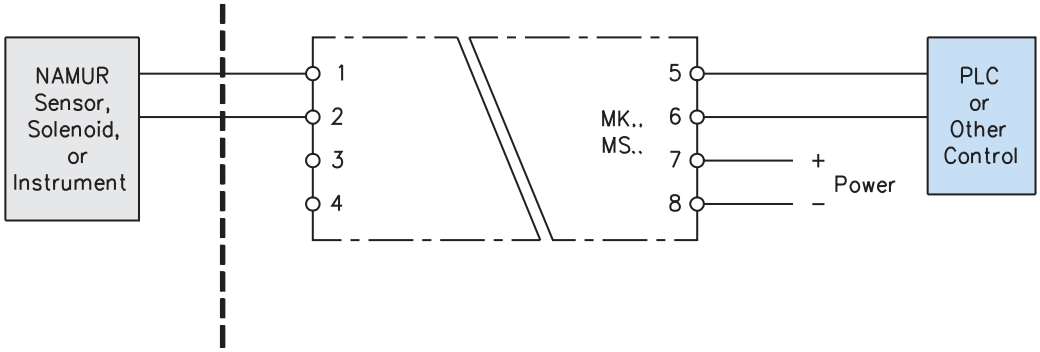
Figure 3



Note:
The typical curve of current versus sensing distance with 8.2 V DC supply and 1 kΩ source impedence. All NAMUR (Y0 and Y1) sensors are calibrated to pass through 1.55 mA at nominal sensing range ±10%.

Typical Intrinsically Safe Installation

Figure 4



For guidance on installation of TURCK intrinsically safe systems, refer to the Instrument Society of America publication ISA-RP12.6-1995, "Wiring Practices for Hazardous (Classified) Locations Instrumentation".

The complete line of Intrinsically Safe and Associated Apparatus is featured in the TURCK "Isolated Barriers and Amplifiers" catalog.

Custom Interface Circuits

Figure 5

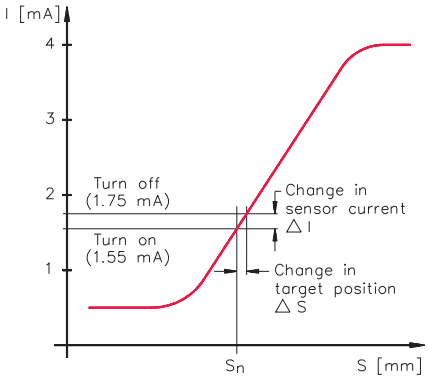
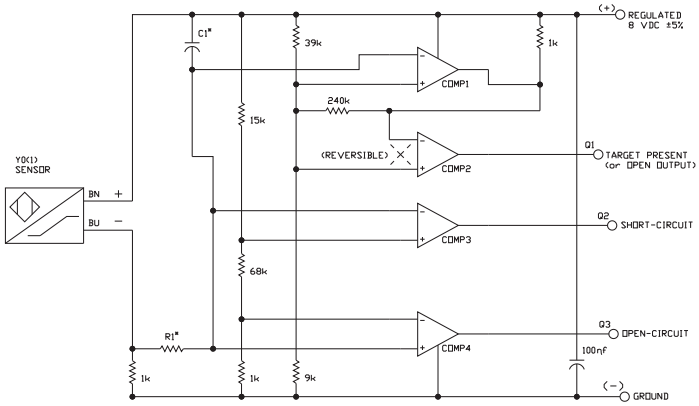


Figure 6



NAMUR sensors can operate outside the nominal operating values when the sensor is used in a nonhazardous area. The supply voltage limits are: V_{min} = 5 VDC; V_{max} = 30 VDC

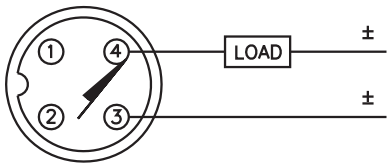
Within this voltage range the load resistance R_i must be adjusted for the supply voltage. The following table gives typical values:

V_{supply} (DC)	R_i (kΩ)	I_{sn} (mA)	Δ I (mA)
5	0.39	≈0.7	≈0.1
12	1.8	≈2.3	≈0.3
15	2.2	≈2.9	≈0.4
24	3.9	≈3.8	≈0.5

If these values are used, the current I_{sn} corresponds to the rated operating distance (S_n) of the sensor. NAMUR sensors are short-circuit protected up to 15 VDC and reverse polarity protected up to 10 VDC.

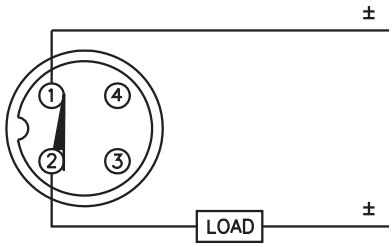
eurofast ® Pinout Diagrams and Mating Cordset

AD4X-H1141



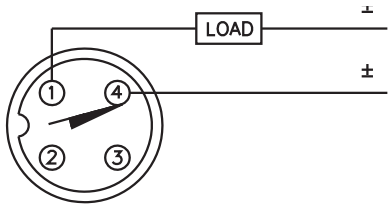
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RD4X-H1141



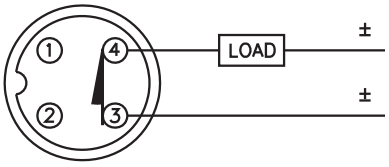
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AD4X-H1144



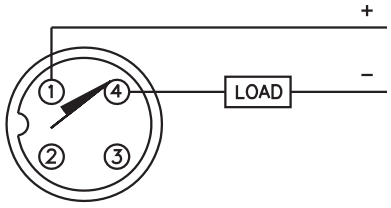
Mating Cordset: RK 4.2T-*/S674

RD4X-H1143



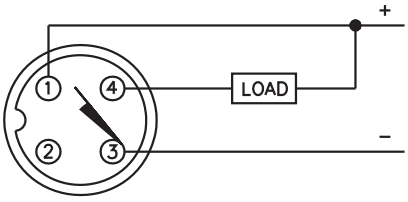
Mating Cordset: RK 4.2T-*

AG41X-H1341



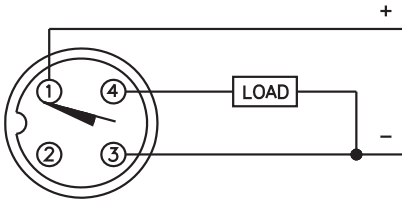
Mating Cordset: RK 4.23T-*/S748

AN6X-H1141/H1341



Mating Cordset: RK 4T-*

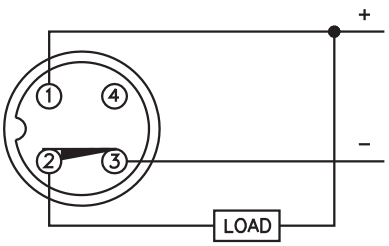
AP6X-H1141/H1341



Mating Cordset: RK 4T-*

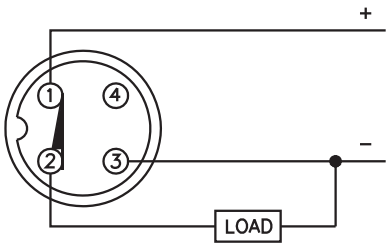
eurofast ® Pinout Diagrams and Mating Cordset

RN6X-H1141



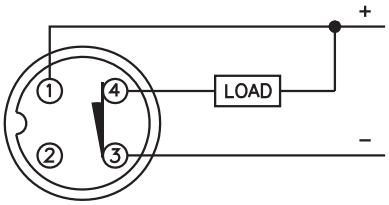
Mating Cordset: RK 4.4T-*

RP6X-H1141



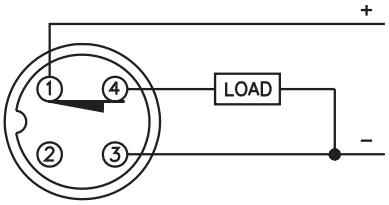
Mating Cordset: RK 4.4T-*

RN6X-H1143/H1343



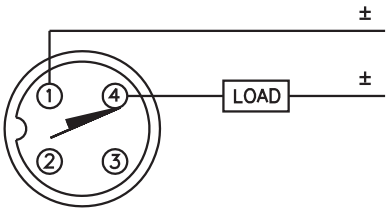
Mating Cordset: RK 4.42T-*

RP6X-H1143/H1343



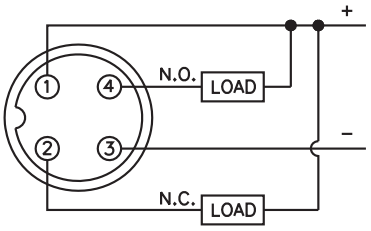
Mating Cordset: RK 4T-*

AG41X-H3141



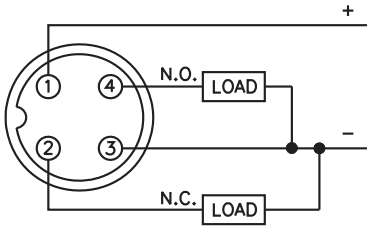
Mating Cordset: RK 4.23T-*/S748

VN4X2-H1141/H1341



Mating Cordset: RK 4.4T-*

VP4X2-H1141/H1341



Mating Cordset: RK 4.4T-*

Innovative Sensor and Connector Solutions

TURCK is the market leader in providing innovative sensor and connectivity solutions for industrial automation. Combine TURCK's high quality, high performance sensors with our ability to quickly mold multiple styles of cordsets give our customers an infinite selection of unique connectorized sensing solutions.

All TURCK sensors with potted-in cable are available with customized cable length and connector options. The broadest selection of connector options provides custom sensing solutions for the most diverse industrial applications.
Because it is TURCK, you can expect the same fast, flexible support. Even with custom configurations, YOUR sensor can often be made within several days. Best of all, minimum quantity for YOUR sensor; ONE!

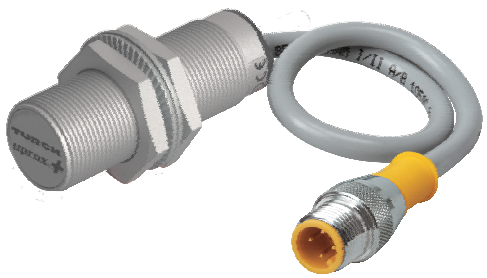
Part numbers are developed through your TURCK representative or application support.
In general, the formula below illustrates how to configure a custom, connectorized TURCK sensor.

+ Length in Meters +

Bi 8U-MT18-AN6X	+	0.5 Meters	+	RS 4T

New Part Number = Bi 4-M12-AN6X-0.5-RS 4T

Sensors with Connector Examples:



Bi 5-MT18-AN6X - 0.2M - RS 4T

- Bi 5-MT18-AN6X: Cable Sensor
- 0.2M: Cable Length (meters)
- RS 4T: *eurofast*® Male Connector



Bi 2-EG08K-AP6X - 0.5M - RS 4T

- Bi 2-EG08K-AP6X: Cable Sensor
- 0.5M: Cable Length (meters)
- RS 4T: *eurofast* Male Connector

Innovative Sensor and Connector Solutions

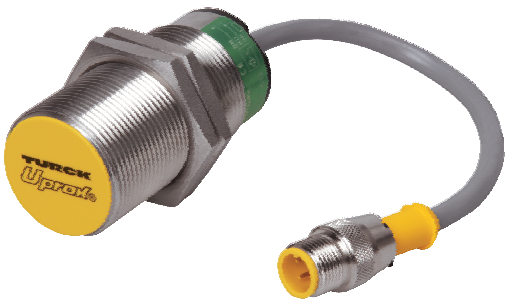
Sensors with Connector Examples:



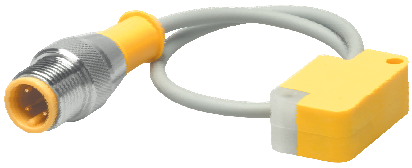
Bi 2-Q5.5-AP6X	-	0.3M	-	PSG 3
Cable Sensor		Cable Length (meters)		*picofast*® Male Connector



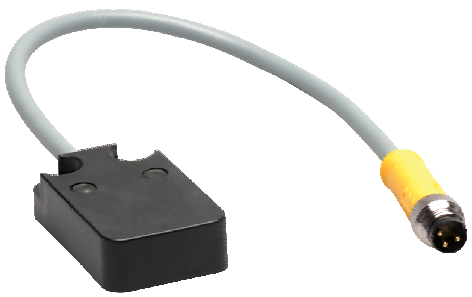
Bi 8-M18-AN6X	-	0.1M	-	RSM 40
Cable Sensor		Cable Length (meters)		*minifast*® Male Connector



Bi10U-EM30-AP6X	-	0.2M	-	RS 4T
Cable Sensor		Cable Length (meters)		*eurofast* Male Connector



Ni 5U-Q10S-AN6X	-	0.4M	-	RS 4T
Cable Sensor		Cable Length (meters)		*eurofast* Male Connector



Bi 8U-Q10-APX2	-	0.1M	-	PSG 3M
Cable Sensor		Cable Length (meters)		*picofast*® Male Connector

2-Wire DC NAMUR - (Y0 and Y1)

Differential Travel (Hysteresis)	1-10% (5% typical)
Nominal Voltage	8.2 VDC (EN60947-5-6)
Resistance Change from Nonactivated to Activated Condition	Typical <1.0 to >8.0 kΩ
Resulting Current Change	≥2.2 mA to ≤1.0 mA
Recommended Switching Point for Remote Amplifier	>1.2 to <2.1 mA, typ. 1.55 mA ON/1.75 mA OFF
Power-On Effect	Realized in Amplifier
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Realized in Amplifier
Transient Protection	Realized in Amplifier
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance

2-Wire DC - (AD4, RD4, AG41 and RG41)

Ripple	≤10%
Differential Travel (Hysteresis)	3-15% (5% typical)
Voltage Drop Across Conducting Sensor	Non-polarized (AD) <5.0 V Polarized (AG) <4.0 V
Trigger Current for Overload Protection	≥120 mA
Minimum Load Current	≥3.0 mA
Off-State (Leakage) Current	≤0.8 mA
Power-On Effect	Per IEC 947-5-2
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance

REED (AC) and (DC) - (AR7X)

Ripple	≤10%
Differential Travel (Hysteresis)	≤1 mm (Depends on magnet)
Maximum Switching Capacity	10 W
No-Load Current	0 mA
Maximum Approach Velocity	≤10 m/s
Power-On Effect	Per IEC 947-5-2
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz,1 mm Amplitude in all 3 Planes
Repeatability	≥ ±0.1 mm (constant temperature & voltage)
Temperature Drift	≤0.1 mm
Voltage Drop	≤0.5 Volts

3-Wire DC - (AN, RN, AP, RP)

Ripple	≤10%
Differential Travel (Hysteresis)	3-15% (5% typical)
Voltage Drop Across Conducting Sensor	≤1.8 V
	- Si...K08/K10(AP71, AN7) ≤0.7 V
	- Bi/Ni../S34 ≤1.8 V
	- Bi 2-Q8SE-AP/AN.. ≤2.5 V
Trigger Current for Overload Protection	≥220 mA on 200 mA Load Current
	≥170 mA on 150 mA Load Current
	≥120 mA on 100 mA Load Current
Off-State (Leakage) Current	<100 µA
No-Load Current	<10 mA (***Uprox*** ≤15 mA)
Time Delay Before Availability	≤8 ms
Power-On Effect	Per IEC 947-5-2
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance
	Bi 2-Q8SE-AP/AN.. ≤5% of Rated Operating Distance

4-Wire DC (VN, VP)

Ripple	≤10%
Differential Travel (Hysteresis)	3-15% (5% typical)
Voltage Drop Across Conducting Sensor	≤1.8 V at 200 mA
Trigger Current for Overload Protection	≥220 mA on 200 mA Load Current
	≥170 mA on 150 mA Load Current
	≥120 mA on 100 mA Load Current
Off-State (Leakage) Current	<100 µA
No-Load Current	<10 mA (Uprox ≤15 mA)
Power-On Effect	Per IEC 947-5-2
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance

Solid State Relay (AM6 and VM6)

Ripple	≤10%
Rated Operational Current	10-30 VDC
Differential	3-15% (5% typical)
Voltage Drop	
(Across Conducting Sensor) at I_e	400 m V
Continuous Load Current	≤6 Amp
Off-State (leakage) Current	≤0.1 mA
Inrush Current	≤8.0 A (10.0 ms max)
No-Load Current	≤25 mA
Time Delay before availability	≤50 ms
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Short Circuit Protected	No
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude, in all 3 planes
Repeatability	≤2%

2-Wire AC w/o Short-Circuit Protection - (AZ, RZ, FZ)

Line Frequency	40-60 Hz
Differential Travel (Hysteresis)	3-15% (5% typical)
Voltage Drop Across Conducting Sensor	≤6.0 V at 400 mA
	8 and 12 mm ≤6.0 V at 100 mA
Continuous Load Current	≤400 mA
	8 and 12 mm ≤100 mA
Off-State (Leakage) Current	≤1.7 mA
Minimum Load Current	≥5.0 mA
Inrush Current	≤8.0 A (≤10 ms, 5% Duty Cycle)
Power-On Effect	Per IEC 947-5-2
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance

2-Wire AC/DC w/Short-Circuit Protection - (ADZ, RDZ, FDZ, VDZ)

Line Frequency	40-60 Hz
Differential Travel (Hysteresis)	3-15% (5% typical)
Voltage Drop Across Conducting Sensor	≤6.0 V at 400 mA
	8 and 12 mm ≤6.0 V at 100 mA
Trigger Current for Overload Protection	AC: ≥440 mA; DC: ≥330 mA
	8 and 12 mm AC: ≥120 mA; DC: ≥120 mA
Continuous Load Current	AC: ≤400 mA; DC: ≤300 mA
	8 and 12 mm AC: ≥100 mA; DC: ≥100 mA
Off-State (Leakage) Current	≤1.7 mA (AC)
	≤1.5 mA (DC)
Minimum Load Current	≥3.0 mA
Inrush Current	4.0 A (≤20 ms, 10% Duty Cycle)
Power-On Effect	Per IEC 947-5-2
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance

3-Wire DC Capacitive - (AP, RP, AN, RN)

Ripple	≤10%
Differential Travel (Hysteresis)	2-20% (5% typical)
Voltage Drop Across Conducting Sensor	≤1.8 V at 200 mA
Trigger Current for Overload Protection	≥220 mA
Off-State (Leakage) Current	<100 μA
No-Load Current	≤15 mA
Power-On Effect	Per IEC 947-5-2
Reverse Polarity Protection	Yes
Wire-Break Protection	Yes
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance
Temperature Drift	<±20% of Rated Operating Distance

4-Wire DC Capacitive - (VP, VN)

Ripple	≤10%
Differential Travel (Hysteresis)	2-20 (5% typical)
Voltage Drop Across Conducting Sensor	≤1.8 V at 200 mA
Trigger Current for Overload Protection	≥220 mA
Leakage (Off-State) Current	<100 μA
No-Load Current	≤15 mA
Power-On Effect	Per IEC 947-5-2
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance
Temperature Drift	<±20% of Rated Operating Distance

2-Wire AC Capacitive - (AZ, RZ)

Line Frequency	50-60 Hz
Hysteresis (Differential Travel)	2-20% (5% typical)
Voltage Drop Across Conducting Sensor	≤7.0 V at 500 mA
Off-State (Leakage) Current	≤1.7 mA
Minimum Load Current	≥5.0 mA
Inrush Current	≤8.0 A (≤10 ms, 5% Duty Cycle)
Power-On Effect	Per IEC 947-5-2
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude in all 3 Planes
Repeatability	≤2% of Rated Operating Distance
Temperature Drift	<±20% of Rated Operating Distance

4-Wire DC Analog - (LIU)

Ripple	≤10%
No-Load Current	≤8.0 mA
Voltage Output	0-10 V/R_L ≥4.7 kΩ
Current Output	0-20 mA/R_L ≤500 Ω
Linearity Tolerance	±3% of full scale
Temperature Tolerance	±0.06% / °C
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude, in all 3 planes
Repeatability	≤1% (0.5% after 30 min. warm up)

3-Wire DC Analog - (LI2)

Ripple	≤10%
No-Load Current	≤8.0 mA
Current Output	4-20 mA/R_L ≤500 Ω
Linearity Tolerance	±3% of full scale
Temperature Drift	±0.06% / °C
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude, in all 3 planes
Repeatability	≤1% (0.5% after 30 min. warm up)

LI = indicates current output only.
2 = Indicates a variance to standard which is 0-20 mA.

3-Wire DC Analog - (LF10)

Ripple	≤10%
No-Load Current	≤8.0 mA
Frequency Output	1-10 kHz
Linearity Tolerance	±5% of full scale
Temperature Tolerance	±0.06% / °C
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude, in all 3 planes
Repeatability	≤1% (0.5% after 30 min. warm up)

LF = Linear frequency (1-10 kHz) output.

4-Wire DC Analog - (LUAP6X)

Ripple	≤10%
No-Load Current	≤8.0 mA
Voltage Output	0-10 V/R_L ≥4.7 kΩ
Linearity Tolerance	±5% of full scale
Temperature Tolerance	±0.06% / °C
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Off-State (Leakage) Current	<100 mA
Voltage Drop Across Conducting Sensor	≤1.8 V
Trigger Current for Overload Protection	≥220 mA on 200 mA load current
No-Load Current	<10 mA
Vibration	55 Hz, 1 mm Amplitude, in all 3 planes
Repeatability	≤1% (0.5% after 30 min. warm up)

3-Wire DC Analog - (LU)

4-Wire DC Analog - (LIU5)

Ripple	≤10%
No-Load Current	≤8.0 mA
Voltage Output	0-10 V/R_L ≥4.7 kΩ
Current Output	4-20 mA/R_L ≤500 Ω
Linearity Tolerance	±3% of full scale
Temperature Drift	±0.06% / °C
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Incorporated
Transient Protection	Per EN 60947-5-2
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude, in all 3 planes

LIU = Linear voltage or current output.
5 = Indicates 4-20 mA and 0-10 V output.

Variations:

No Load Current	
WIM 40-Q20L60	≤23.0 mA
WIM 70-Q20L100	≤23.0 mA
WIM 40-NTL/STL	≤23.0 mA
Linearity Tolerance	
WIM 40-Q20L60	≤2%
WIM 70-Q20L100	≤8%
WIM 40-NTL/STL	≤2%

Repeatability	≤1% (0.5% after 30 min. warm up)

LIU = Linear voltage or current output.
5 = Indicates 4-20 mA and 0-10 V output.

Variations:

No Load Current	
WIM 40-Q20L60	≤23.0 mA
WIM 70-Q20L100	≤23.0 mA
WIM 40-NTL/STL	≤23.0 mA
Linearity Tolerance	
WIM 40-Q20L60	≤2%
Relative Temp. Drift	
WIM 40-Q20L60	≤±0.06% °C
WIM 70-Q20L100	≤±0.06% °C
WIM 40-NTL/STL	≤±0.06% °C

2-Wire DC Analog NAMUR - (LI-EXI)

Linearity Tolerance	≤5% of final value
Nominal Voltage	8.2 VDC (EN 50227)
Current Output	4-20 mA
Power-On Effect	Realized in Amplifier
Reverse Polarity Protection	Incorporated
Wire-Break Protection	Realized in Amplifier
Transient Protection	Realized in Amplifier
Temperature Drift	≤ ±0.06% per °C
Shock	30 g, 11 ms
Vibration	55 Hz, 1 mm Amplitude, in all 3 Planes
Repeatability	≤1% (0.5% after 30 min. warm up)

Third Party Compliances

CSA - Canadian Standards Association

CSA certifies devices for use in Canadian and American hazardous and non-hazardous locations.

FM - Approvals

FM approves devices for use in explosive hazardous locations in the US. Intrinsically safe (IS) devices are approved for Division 1 areas; nonincendive (NI) devices are approved for Division 2 areas.

UL - Underwriter's Laboratories

UL is a nationally recognized US test laboratory that tests equipment to meet US standards and jurisdictional requirements. UL lists stand-alone devices, such as sensors, and recognizes system components, such as relays.

Note: TURCK products comply with many International standards. Consult factory for more information.

Hazardous Location Approvals

The NAMUR sensors shown in this catalog are Intrinsically Safe per the following:

EUROPE: CENELEC Standards EN 50 014 and EN 50 020; EC Directive 94/9/EC (ATEX)

USA, CANADA: Class I, II, III Division 1 Groups A, B, C, D, E, F, G*

Any FM approved or CSA certified associated apparatus with the following Entity Concept parameters can be used with these sensors:

V_{OC} or $V_T \leq 15$ V $C_a \geq C_{cable} + 220$ nF
I_{SC} or $I_T \leq 60$ mA $L_a \geq L_{cable} + 280$ µH

* Note: CSA does not allow the use of quick disconnects in Groups E and F

Many 3-wire DC sensors are Nonincendive for Class I, Division 2 hazardous areas. Only those 3-wire sensors identified with the FM logo have this approval.

USA: Class I Division 2 Groups A, B, C, D
-AN6X, -AP6X
-RN6X, -RP6X
Factory P/N's ending in /S1751
Integrated cables and cordsets must have ITC-ER Rating.

Nonincendive

More on Hazardous Locations

Standards for Intrinsically Safe systems in hazardous locations are found in the following publications:

United States:	National Electrical Code 1996 (ANSI/NFPA 70) Articles 504 and 505 Factory Mutual Approval Standard Class No. 3610 Underwriters Laboratory Standard UL 913
Canada:	Canadian Electrical Code C22.1-94 Section 18 and Appendix F.
Europe:	CENELEC Standards EN 50 020 and EN 50 014

Hazardous Location Definitions (U.S. and Canada)

Class I	Locations in which flammable gases or vapors exist or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.
Class II	Locations that are hazardous because of the presence of combustible dust.
Class III	Locations that are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be suspended in the air in quantities sufficient to produce ignitable mixtures.
Division 1	Locations in which hazardous concentrations in the air exist continuously, intermittently, or periodically under normal operating conditions.
Division 2	Locations in which hazardous materials are handled, processed or used, but in which they are normally confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown.
Group A	Atmospheres containing acetylene.
Group B	Atmospheres containing hydrogen, fuel and combustible process gases containing more than 30% hydrogen by volume, or gases or vapors of equivalent hazard such as butadiene, ethylene oxide, propylene oxide and acrolein.
Group C	Atmospheres such as ethyl ether, ethylene, acetaldehyde, cyclopropane, or gases or vapors of equivalent hazard.
Group D	Atmospheres such as acetone, alcohol, ammonia, benzene, butane, cyclopropane, ethylene dichloride, gasoline, hexane, lacquer solvent vapors, methane, natural gas, naphtha, propane, xylene, or gases or vapors of equivalent hazard.
Group E	Atmospheres containing combustible metal dusts, including aluminum, magnesium, and their commercial alloys, and other combustible dusts with similarly hazardous characteristics.
Group F	Atmospheres containing combustible carbonaceous dusts, including carbon black, charcoal and coal.
Group G	Atmospheres containing other combustible dusts, such as chemical, agricultural or plastic dusts.

Exerpt from National Electrical Code:

Intrinsically safe apparatus and wiring shall be permitted in any hazardous (classified) location for which it is approved, and the provisions of Articles 501 through 503 and 510 through 516 shall not be considered applicable to such installations except as required by Article 504.

Wiring of intrinsically safe circuits shall be physically separated from wiring of all other circuits that are not intrinsically safe. Means shall be provided to minimize the passage of gases and vapors. Installation of intrinsically safe apparatus and wiring shall be in accordance with the requirements of Article 504.

Enclosure Ratings

NEMA 250-1991

NEMA 1 Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.

NEMA 3 Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and damage from external ice formation.

NEMA 4 Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.

NEMA 4X Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water and damage from external ice formation.

NEMA 6 Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during occasional temporary submersion at a limited depth, and damage from external ice formation.

IEC 529

IP 40 Protection against solid bodies larger than 1 mm. No protection against liquids.

IP 65 Dust tight. Protection against water spray from all directions at 14.2 PSI through a 12.5 mm nozzle.

IP 67 Dust tight. Protection against the effects of immersion in water for 30 minutes at 1 meter.

IP 68 Dust tight. Protection against the effects of indefinite immersion in water at a pressure specified by the manufacturer. Ex. TURCK's IP 68 definitions is IP 67 plus.

- 24 hours at 70°C
- 24 hours at -25°C
- 7 days at 1 meter under water at a constant temperature
- 10 cycles +70°C and -25°C, minimum of 1 hour at each temperature

IP 69K

Hot steam jet cleaning per EN 60529 (IP enclosure ratings) and DIN 40050-9.

TURCK TIP



For oily environments - Use plastic sensors with quick disconnects and TURCK PUR "/S90" cordsets.



For washdown environments - Use TURCK's WashdownSensors and appropriate mating cordsets.

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Material Descriptions

Plastics

ABS - Acrylonitrile-Butadiene-Styrene	Impact resistant, rigid. Resistant to aqueous acids, alkalis, salts, alcohols, oils, concentrated hydrochloric acid; disintegrated by concentrated sulfuric or nitric acids, esters, ketones
CPE, Thermoset (rubber cables)	Excellent resistance to oils, acids, chemicals, ozone, extreme temperatures, cuts, abrasions; flame retardant in welding applications
PA - Polyamide (nylon)	Good mechanical strength, temperature resistant
PA, Amorphous (Trogamid T)	Similar properties to nylon, but transparent. Hard, rigid, good chemical resistance.
PA 12-GF30	Nylon 12, 30% glass filled
PA 66-GF25-V0	Nylon 66, 25% glass filled, self-extinguishing
PBT - Polybutylene Terephthalate (when glass reinforced, Crastin®)	Good mechanical strength; resistant to abrasion; resistant to alcohols, oils, some acids, trichloroethylene
PBT-GF30-V0	PBT, 30% glass filled, self-extinguishing
PEI - Polyetherimide (Ultem®)	Excellent resistance to most commercial automotive fluids, fully hydrogenated hydrocarbons, alcohols, weak aqueous solutions. Withstands higher temperatures.
POM - Polyoxymethylene / Polyacetal (Delrin®)	High impact resistance; good mechanical strength; good resistance to oils, alcohols, alkalis, gasoline, xylene, toluene. Dielectric constant 3.7
PP - Polypropylene	Excellent resistance against chemicals including acids, solvents and solutions. High temperature resistance and good mechanical strength
PTFE - Polytetrafluoroethylene	Optimum resistance against high temperature and chemicals; low dielectric constant (2.0)
TPU, Thermoplastic Polyurethane	Elastic, resistant to abrasion, impact-resistant, oil- and grease-tolerant
PVC - Polyvinylchloride	Good mechanical strength, viscosity to impact; resistant to acids, alkalis
PVC, irradiated	Heat and chemical resistant, withstands short-term temperatures to 482° F
PVDF - Polyvinylideneflouride (Kynar®)	Resistant to high and low temperatures, good resistance to chemicals (similar to PTFE), high mechanical strength
Silicon	For use at high or low ambient temperatures (-50...+180 °C), moderate mechanical strength, average resistance against alkalis, acids, oils, and solvents
IRPA12 - Irradiated Polyamide (nylon)	Good mechanical strength, temp. resistant
EPTR - Elastomer, Polymer Thermal Plastic	Good fluid resistance
TROG - Trogamid T	Hard, rigid, good chemical resistance

Metals

AG	***armorguard®***
SS - 306 Stainless Steel	Excellent atmospheric resistance
CPB	Chrome Plated Brass
CuZn - Brass	Generally good resistance to industrial atmospheres
GD - AlSi12 - Aluminum, die-cast	Low specific weight, long-life characteristics
GD - ZnAl4Cu1 (Z410) - Zinc, die-cast	Long-life characteristics
TC	PTFE Coated
WG	***weldguard®***
AL - Anodized Aluminum	Long-life characteristics
SF - Stoneface®	High abrasion resistance, excellent for MIG welding applications, high heat and weld flow immunity
TS - Tool Steel	Excellent durability

Matrix of TURCK Sensor Materials *

Housing Style	ABS	PA, Trog. T	PA	PBT	POM	PP	PUR	PVC	PVDF	PEI	306 SS	Al	Brass	Zinc	Thermoset Plastic
CA25, CA40												X	X	X	X
CK40				X									X	X	
CP40			X**	X											
CP80, K90SR		X	X	X											
DS20				X				X							
EG			X				X	X			X				
EM			X								X				
G, M (potted-in cable)			X				X	X					X		
G, M (connector)			X										X		
G..SK		X	X										X		
G47SR	X		X										X		
INR, INT			X				X						X		
K..SK, P..SK		X	X												
K40SR, P30SR	X		X												
KT34									X						
M..T			X					X					X		
PCS				X			X	X					X		
P, S (potted-in cable)			X				X	X							
P, S (connector)			X												
P.../S139			X		X		X								
PT30									X						
QF5.5						X									
Q06			X					X							
Q6.5 (World Clamp)				X			X						X		
Q6.5				X			X								
Q5.5, Q9.5, ISI			X			X	X								
Q08, Q8SE			X					X					X	X	
Q10				X											
Q10S			X				X	X							
Q11S, Q12				X				X							
Q14, Q20				X			X	X					X		
Q14, Q20 Ring				X	X			X					X		
Q18, Q25, Q30				X			X	X							
Q26			X	X				X							
Q34, Q80				X									X		
S185							X	X	X						
Cable Gland			X												
Wet Suit				X					X	X					

Matrix of TURCK Sensor Materials *

Housing Style	ABS	PA, Trog. T	PA	PBT	POM	PUR	PVC	PVDF	PEI	306 SS	Al	Brass	Zinc	Thermoset Plastic
A23			X				X				X	X	X	
AKT			X				X			X	X		X	
CRS			X									X	X	
FST, NST, QST			X				X				X	X		
IKE, IKM, IKT			X				X				X	X	X	
KST			X				X			X		X	X	
PSM			X				X			X	X	X		
PST			X				X			X		X		

Chemical Compatability

The information in this chart is derived from reputable industry sources and is to be used only as a guide in selecting materials suitable for your application. TURCK does not warrant in any fashion that the information in this chart is accurate or complete, or that any material is suitable for any purpose.

Most ratings listed here apply to a 48-hour exposure period.

Ratings: A - No effect
B - Minor effect
C - Moderate effect
D - Severe effect
φ - No specific data, but probable rating.

	ABS	Trog. T	PA 12	PBT	PEI	POM	PP	PTFE	PUR	PVC	PVDF	306 SS	Al	Brass	Zinc
Ammonia, liquid	B	B	A	B	D	C/D	A	A	C	A	A	B	A	D	A
Chlorine anhydrous liquid	nd	nd	D	D	nd	C	D	A	C	D	A	C	D	D	nd
De-ionized water	nd	nd	A	nd	A	nd	A	A	nd	A	A	A	A	A	nd
Formic acid	D	D	D	A	nd	C	A	A	C	A	A	A/B	A	D	D
Gasoline	D	A	A	A	A	A	C	A	A	C	A	A	A	A	nd
Hydrochloric acid <40%	A	A/B	D	A	A	C	C	A	D	B	A	D	D	D	D
Hydrofluoric acid <50%	C	D	D	B	A	D	A	A	C	B	A	D	D	D	nd
Methanol	D	D	B	A	A	A	A	A	B	A	A	A	A	A	A
Phosphoric acid <40%	B(C)	D	B	A	A	D	A	A	Dφ	B	B	D	C	D	D
Potassium hydroxide <15%	A	A	C	B	A	B	A	A	C	A	A	B	D	D	nd
Sodium hydroxide <55%	A	A	C	B	A	B	A	A	B	A	D	B	D	D	D
Sodium hypochlorite ≤13%	B	nd	B	A	nd	C	A	A	B	A	A	C	D	D	A
Sulfuric acid <75%	B	A	D	A	A	D	A	A	C	A	A	D	D	D	D
Toluene	D	A	A	A	A	A	C	A	C	D	A	A	A	A	nd
Trichloroethylene	D	A	C	A	nd	B		A	D	D	B	A/B	D	A	A

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