SENSORS AND LIMIT SWITCHES

Easy Selection Guide

Allen-Bradley

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Follow the six easy steps to select the right sensor for your application.

step 1

STEP 1: Identify your Sensor Type

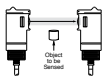
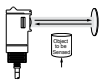
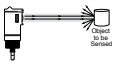
Identify the size and material of the object being detected. The sensor type can be defined based on the material properties. The table below gives an indication of applications and operating principles for different sensing technologies.

Sensor Type	Operating Principle	Application	Reference
Photoelectric	Detection of light	General sensing– used for presence/absence detection. Precaution – dusty/contaminated environments are not suitable. It is recommended to use ultrasonic sensors for these environments.	4
Inductive	Variations in induced magnetic field	Metal sensing only	9
Ultrasonic	Detection of sound waves	General sensing– used for presence/absence detection and level detection.	13
Capacitive	Variations in induced electrostatic fields	Liquid and non-metal sensing	14

step 2

STEP 2: Select the Required Sensing Distance

Select the sensing distance for the particular application. The maximum sensing distances available for different types of sensors are as follows:

Sensor Type				Max. Sensing Distance (Sensor Dependent)	Typical Sensing Distance
Photoelectric	Through beam			300m	6 – 15m
	Retroreflective			30m	2 – 6m
	Diffuse			6m	300 – 800mm
Inductive	Cylindrical body	M12	Shielded	6m	2 – 20mm
			Unsheilded	10mm	
		M18	Shielded	10mm	
			Unsheilded	20mm	
		M30	Shielded	20mm	
			Unshielded	40mm	
	Rectangular body	–	–	60mm	2 - 20mm
Ultrasonic	Cylindrical body	M18	–	1.5m	1 - 3.5m
		M30	–	3.5m	
Capacitive	Cylindrical body	M12	Shielded	2.5mm	2 – 20mm
			Unsheilded	N/A	
		M18	Shielded	5mm	
			Unsheilded	8mm	
		M30	Shielded	10mm	
			Unshielded	20mm	

step 3

STEP 3: Select the Housing Type and Material

- **Photoelectric sensors:** the most popular housing styles are - rectangular body, cylindrical body with 18mm diameter (plastic or metal) and miniature body
- **Inductive sensors:** cylindrical body is generally used in majority of applications (12, 18 or 30mm diameter). Rectangular housing is also available (plastic only). The housing materials available for the cylindrical type are plastic, stainless and nickel-plated brass
- **Ultrasonic sensors:** cylindrical body with 18 or 30mm diameter, housing material is plastic
- **Capacitive sensors:** cylindrical body with 12, 18, 30 or 34mm diameter; the housing materials available are plastic and nickel-plated brass

Note: *For inductive and capacitive proximity sensors the diameter of the sensor is directly proportional to the sensing range e.g. bigger diameter has longer sensing distance*

step 4

STEP 4: Output Considerations

Identify the output required:

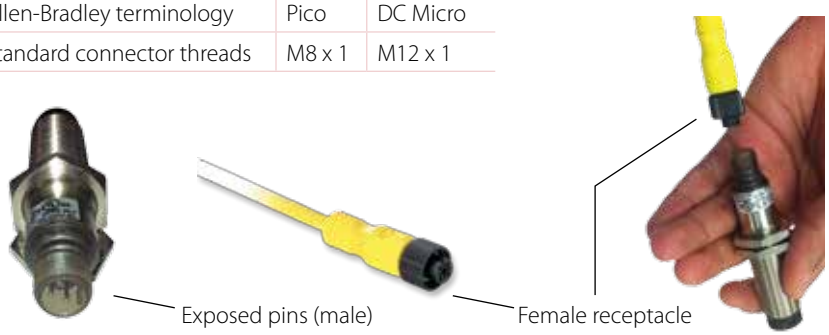
- Solid state output (NPN or PNP type)
- Relay output
- Analogue output (only available with ultrasonic sensors and certain photoelectric sensors)

step 5

STEP 5: Select the Connection Cables

Cordsets are used to connect to the sensors. The cordsets are cables that have a female connector on one end and flying lead on the other. The sensors have male connectors (exposed pins) that plug into the cordsets. The cordset can be chosen by matching the connector thread and the number of pins on the sensor (e.g. 4 pin DC Micro). The most commonly used connection styles are listed below:

Allen-Bradley terminology	Pico	DC Micro
Standard connector threads	M8 x 1	M12 x 1



step 6

STEP 6: Select the Mounting Brackets

The brackets can be chosen based on the mounting requirements. Suitable brackets are listed with the sensors in each of the respective sections for photoelectric, inductive, ultrasonic and capacitive sensors.

Photoelectric Sensors: Overview

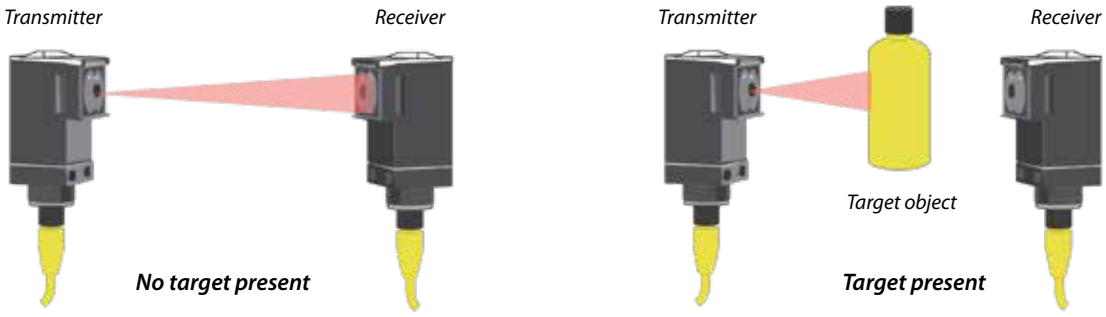
Mode of operation

The principle of operation of the photoelectric sensor is the detection of light.
The different types of photoelectric sensors operate in the following manner:

A. Transmitted beam (through beam) type sensor

Consists of a transmitter and a receiver unit (both are listed as two separate part numbers). The transmitter emits a beam of light which is detected by the receiver. When there is a target object present, it breaks the beam.

Transmitted beam sensors are reliable and achieve a longer sensing distance than other photoelectric sensors. However, the cost is usually higher due to the separate transmitter and receiver.

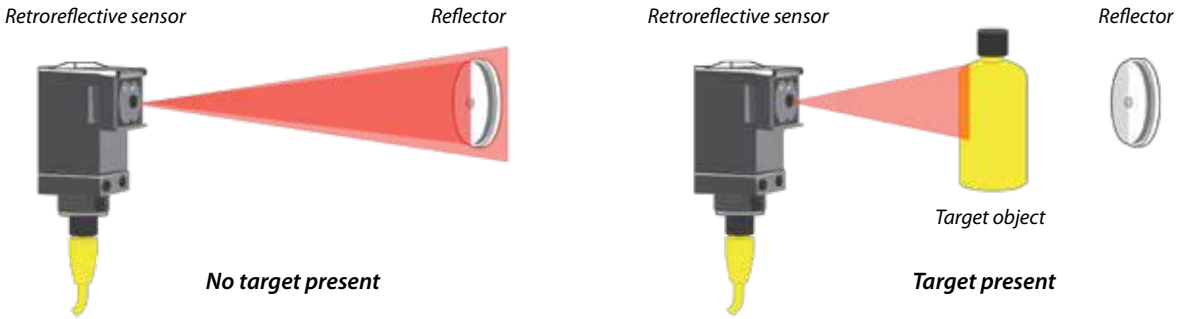


B. Retroreflective - most commonly used

Consists of a sensor which has inbuilt transmitter and receiver units. This sensor is used in conjunction with a reflector. The sensor emits a light beam and detects the light reflected back by the reflector. When there is a target present, it breaks the beam and hence no light is detected by the sensor.

Polarised retroreflective sensors are specialised retroreflective sensors which provide reliable detection of highly reflective objects or backgrounds e.g. metallic cans, water bottles.

Retroflective sensors are the most commonly used type of photoelectric sensor.



Section One: Sensors

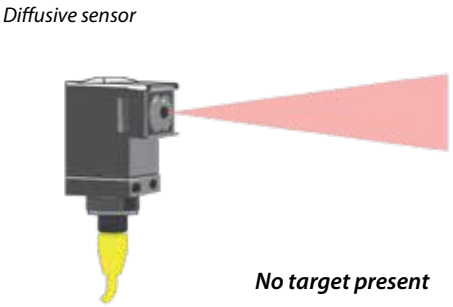
Photoelectric Sensors: Overview

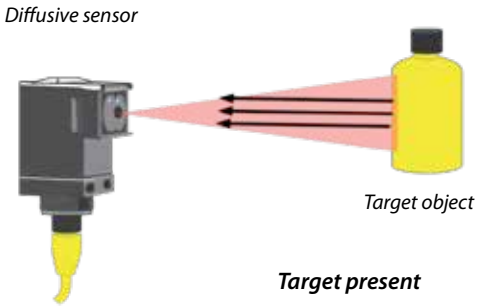
C. Diffuse

It is a single stand-alone sensor which has inbuilt transmitter and receiver units which does not require a reflector. The operating principle is based on the detection of the reflected beam from the target object. It is extremely dependent on target material properties which include colour, texture. (e.g. black objects would have extremely low reflectivity and would not be ideal targets)

Background suppression diffuse – specialised diffuse sensors which provide reliable and consistent detection of objects irrespective of the reflectivity, colour and target material properties.

Diffuse sensors are used when the target object cannot be accessed from both sides.





Light Source

Photoelectric sensors are available with either LED or laser light source.

Sensors with laser light source are used for applications which require:

- Longer sensing distances
- Narrow beam of light for precise measurements e.g. edge detection

Target factors

- Dusty, polluted environments affect the sensing capabilities for photoelectric sensors. Ultrasonics sensors are recommended for these applications
- Targets that are transparent are not reliably detected by photoelectric sensors It is recommended to use specialised 'clear object detection' photoelectric sensors or ultrasonic sensors (please contact NHP for details)
- Retroreflective sensors are easily affected by highly reflective targets or surroundings hence it is recommended to use polarised retroreflective sensors for these applications
- Diffuse sensors are extremely dependent on target material properties (i.e. reflectivity, shape, size, colour). It is recommended to use background suppression diffuse which provides reliable detection irrespective of target material properties

Section One: Sensors

Photoelectric Sensors

42CA Cylindrical

- 18mm cylindrical housing
- Linear sensitivity adjustment, stability indication, excellent noise immunity
- Stability indication for ease of alignment
- Complementary light/dark operation

Operating Mode	Sensing Distance	Output	Voltage	Operation[1)]	Cat. No.
Standard diffuse	100mm	PNP	10-30 VDC	LO/DO	42CA-D1MPAE-D4
Retroflective	4.8m	PNP	10-30VDC	LO/DO	42CA-U2MPB-D4

42EF (Right Sight) General Purpose

- Compact right angle housing
- IP 67 - 1200psi washdown rating
- LED status indicators
- Universal 18mm and thru-hole mounting options

Operating Mode	Sensing Distance	Output	Voltage	Operation[1)]	Cat. No.
Transmitted beam - emitter	*see receiver	N/A	10-30VDC	N/A	42EF-E1EZB-F4
Transmitted beam - receiver	20m	PNP/NPN	10-30VDC	DO	42EF-R9KBB-F4
Transmitted beam - receiver	20m	PNP	10 -30VDC	LO/DO	42EF-R9MPB-F4
Standard diffuse	500mm	NPN/PNP	10-30VDC	LO	42EF-D1JBAK-F4
Standard diffuse	500mm	PNP	10-30VDC	LO/DO	42EF-D1MPAK-F4
Standard diffuse	500mm	N-MOSFET	21.6-264VAC/DC	LO	42EF-D1RCAK-G4
Background suppression	100mm	PNP	10-30VDC	LO/DO	42EF-B1MPBE-F4
Polarised retroreflective	3m	PNP	10-30VDC	LO/DO	42EF-P2MPB-F4
Polarised retroreflective	3m	N-MOSFET	21.6-264VAC/DC	LO/DO	42EF-P2SCB-G4
Polarised retroreflective	3m	NPN/PNP	10.8-30VDC	DO	42EF-P2KBB-F4
Retroreflective	4.5m	NPN/PNP	10-30VDC	DO	42EF-U2KBB-F4

[1)] *LO – Light Operation, DO – Dark Operation*

* For transmitted beam emitter, refer sensing distance of receiver

Section One: Sensors

Photoelectric Sensors

42G (Series 9000) Harsh Duty

- Right angle housing
- IP 67 - 1200psi washdown rating
- Universal 30mm and thru-hole mounting options
- LED status indicators
- Laser version available

Operating Mode	Sensing Distance	Output	Voltage	Operation[1)]	Cat. No.
Transmitter beam - emitter	61m	N/A	10-264VAC/DC	N/A	42GRL-9000-QD
Transmitted beam - receiver	* see emitter	PNP/NPN	10-40VDC	LO/DO	42GRR-9000-QD
Standard diffuse	1.52m	NPN/PNP	10-40VDC		42GRP-9000-QD
Standard diffuse	1.52m	Relay	10-55VDC/ 20-40VAC	LO/DO	42GRP-9001
Standard diffuse	1.52m	Relay	70-264VDC/ 60-264VAC	LO/DO	42GRP-9002
Standard diffuse with timing	1.52m	Relay	10-55VDC/ 20-40VAC	LO/DO	42GTP-9001-QD
Polarised retroreflective	4.87m	NPN/PNP	10-30VDC	LO/DO	42GRU-9200-QD
Polarised retroreflective (laser)	40m	PNP/NPN	10-30VDC	LO/DO	42GRU-92L0
Retroreflective	9.14m	PNP/NPN	10-30VDC	LO/DO	42GRU-9000-QD
Retroreflective	9.14m	Relay	10-55VDC/ 20-40VAC	LO/DO	42GRU-9001
Retroreflective	9.14m	Relay	70-264VAC/DC	LO/DO	42GRU-9002

* For transmitted beam receiver, refer sensing distance of emitter

42JS & 42JT (VisiSight) Miniature

- Miniature rectangular housing
- IP67
- Visible light source makes it easy to align
- Linear sensitivity adjustment
- Compact sealed housing
- Auto PNP/NPN output (42JT only)

Operating Mode	Sensing Distance	Output	Voltage	Operation[1)]	Cat. No.
Polarised retroflective (laser)	13m	Auto PNP or NPN	10-30VDC	LO/DO	42JT-P8LAT1-P4
Background suppression	400m	Auto PNP or NPN	10-30VDC	LO/DO	42JT-B2LAT2-P4
Polarised retroflective	3.5m	PNP	10-30VDC	LO/DO	42JS-P2MPA2-F4

[1)] *LO – Light Operation, DO – Dark Operation*

Photoelectric Sensors: Accessories

Cordsets

Connection Type	Description	Cat. No.
T4, D4, F4, QD	DC Micro QD (quick disconnect) cordset straight 4-pin 2m	889D-F4AC-2
P4	Pico QD cordset straight 4-pin 2m	889P-F4AB-2
G4	AC Micro QD (quick disconnect) cordset straight 4-pin 2m	889R-F4AEA-2
A2	2m 300 V cable (prewired cable, no separate cordsets required)	-

Mounting Brackets

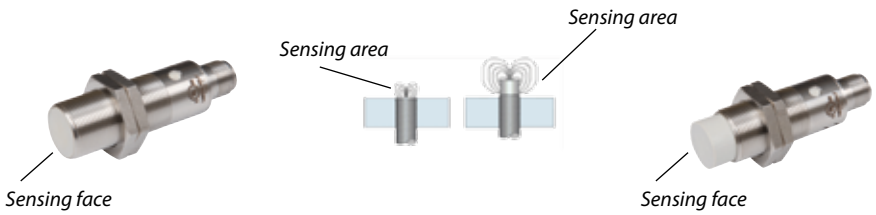
	Suitable for	Description	Cat. No.
	42EF (laser version only), 42GR, 42GT	Right angle mounting bracket	60-2421
	42EF (LED or non-laser versions only), 42KL, 42CA	Right angle mounting bracket	60-2657
	42EF (LED or non-laser versions)	Swivel/ tilt bracket (allows 10° vertical adjustment and 360° rotation adjustment)	60-2649
	42G (except laser versions) 42Q, 42EF (laser versions) 42GR (laser versions)	Swivel/ tilt bracket (allows 10° vertical adjustment and 360° rotation adjustment)	60-2439
	42JS, 42JT	L-shaped mounting bracket	60-BJSL1

Section One: Sensors

Inductive Sensors: Overview

Mode of operation

- Inductive sensors operate by generating a magnetic field around the 'sensing face' This magnetic field helps detect the presence of a metal object as it approaches the sensor
- Inductive sensors can ONLY be used for the detection of metals and cannot be used to detect any other materials
- Diameter of the sensors is directly proportional to the sensing range. ie: bigger diameter has longer sensing range
- **Shielded (flush mount) sensors:** can be flush mounted in metal up to the plane of the sensing face
- **Unshielded (non-flush mount) sensors:** have longer sensing distances and wider magnetic fields but are more sensitive to surrounding metal. These sensors cannot be flush mounted in metal up to the plane of the sensing face



Shielded (flush mount) ***Unshielded (non-flush mount)***

Target factors

The table below gives an indication of the 'actual' sensing distance for different metals e.g. an Inductive proximity sensor with rated sensing distance of 10 mm can only sense up to 4.5mm for a material with a correction factor of 0.45 (10mm x 0.45 = 4.5mm).

Materials	871TM/872 series
Mild steel	1.0 x rated distance
Stainless steel	0.9 x rated distance
Brass	0.5 x rated distance
Aluminium	0.4 x rated distance
Copper	0.4 x rated distance

Inductive Sensors

871L Limit Switch Style

- 17 sensing head positions (1 top, 16 side)
- Side sensing head can be rotated in 22.5º increments
- Conduit or quick disconnect styles
- Selectable normally open or normally closed output

Sensing Distance	Housing size	Output	Voltage	Shielded	Cat. No.
20mm	40mm	N/O or N/C (PNP)	20 - 250VAC/DC	N	871L-B20E40-T2
40mm	40mm	N/O or N/C (PNP)	20 - 250VAC/DC	N	871L-B40E40-T2

871TM Stainless Steel

- Heavy duty range
- Stainless steel face and barrel
- Ideal for harsh environments
- Radio frequency interference protection

Sensing Distance	Housing size	Output	Voltage	Shielded	Cat. No.
2mm	12mm	N/O (PNP)	10 - 30VDC	Y	871TM-DH2NP12-D4
4mm	12mm	N/O	20 - 250VAC/DC	N	871TM-BH4N12-R3
4mm	12mm	N/O (PNP)	10 - 30VDC	N	871TM-DH4NP12-D4
5mm	18mm	N/O	20 - 250VAC/DC	Y	871TM-B5N18-R3
5mm	18mm	N/O	20 - 250VAC/DC	Y	871TM-BH5N18-R3
5mm	18mm	N/O (PNP)	10 - 30VDC	Y	871TM-DH5NP18-D4
8mm	18mm	N/O	20 - 250VAC/DC	N	871TM-B8N18-H2
8mm	18mm	N/O (PNP/NPN)	10 - 30VDC	N	871TM-DH8NE18-D4
8mm	18mm	N/O (PNP)	10 - 30VDC	N	871TM-DH8NP18-D4
10mm	30mm	N/O	20 - 250VAC/DC	Y	871TM-BH10N30-H2
15mm	30mm	N/O	20 - 250VAC/DC	N	871TM-B15N30-H2
15mm	30mm	N/O	20 - 250VAC/DC	N	871TM-BH15N30-H2
15mm	30mm	N/O (PNP/NPN)	10 - 30VDC	N	871TM-DH15NE30-D4
40mm	30mm	N/O (PNP)	10 - 30VDC	N	871TM-N40NP30-D4

Section One: Sensors

Inductive Sensors

872C General Purpose

- Nickel plated brass
- Economic
- Plastic face and nickel plated brass body
- 360º visible status indicator

Sensing Distance	Housing size	Output	Voltage	Shielded	Cat. No.
2mm	8mm	N/O (PNP)	10 - 30VDC	Y	872C-D2NP8-D4
2mm	12mm	N/O	20 - 240VAC	Y	872C-A2N12-R3
3mm	12mm	N/O (PNP)	10 - 30VDC	Y	872C-D3NP12-D4
3mm	12mm	N/O (NPN)	10 - 30VDC	Y	872C-DH3NN12-D4
4mm	12mm	N/O (PNP)	10 - 30VDC	N	872C-D4NP12-D4
5mm	18mm	N/O (PNP)	10 - 30VDC	Y	872C-D5NP18-D4
5mm	18mm	N/O and N/C	10 - 30VDC	Y	872C-D5BP18-D4
8mm	12mm	N/O (PNP)	10 - 30VDC	N	872C-N8NP12-D4
10mm	18mm	N/O	20 - 240VAC	N	872C-A10N18-R3
12mm	18mm	N/O (NPN)	10 - 30VDC	N	872C-N12NP18-D4
15mm	30mm	N/O (PNP)	10 - 30VDC	N	872C-DH15NP30-E2
20mm	30mm	N/O (PNP)	10 - 30VDC	N	872C-N20NP30-D4

871P Rectangular Style

- Plastic body/zinc base
- 5 position sensing head
- Weld field immunity
- Equal sensing
- Short circuit protection
- False pulse protection
- Overload protection
- Transient noise protection
- Reverse polarity protection

Sensing Distance	Housing size	Output	Voltage	Shielded	Cat. No.
40mm	40mm	N/O (PNP)	10 - 60VDC	N	871P-D20NP40-D4

Inductive Sensors: Accessories

Cordsets

Connection Type	Description	Cat. No.
D4	DC micro cordset 2m	889D-F4AC-2
R3	AC micro cordset 2m	889R-F3ECA-2
H2	2m toughlink cable (pre-wired, no cord required)	-
E2	2m PVC cable (pre-wired, no cordset required)	-

Mounting Brackets

Suitable for	Description	Cat. No.
18mm barrel housing	Stainless steel	871A-BRS18
30mm barrel housing	Stainless steel	871A-BRS30
30mm barrel housing	Spring return mounting bracket for protecting the sensor against collision	871A-BXS30

Section One: Sensors

Capacitive Sensors: Overview

Mode of operation

- Capacitive sensors operate by generating an electrostatic field and detecting changes caused in this field when a target approaches it
- It is mainly used to detect the presence of non-metals and liquids
- **Shielded:** have a more concentrated electric field (directed from the face of the sensor) It allows the sensor to be flush mounted in surrounding material without causing a false trigger
- **Unshielded:** have a less concentrated electric field than shielded types They can be easily affected by surrounding material (non metals and liquids) and hence cannot be flush mounted in these materials

Target factors

Capacitive sensors are typically used for targets which are liquids or have moisture content in them. Some typical examples of certain materials and their compatibility with capacitive sensors are listed below.

Material	Sensing	Material	Sensing
Bakelite	Average / good	Water	Excellent
Alcohol	Excellent	Wet wood	Good
Glass	Poor / average	Aqueous solutions	Good / excellent
Nylon	Poor	Ammonia	Average / good
Cement powder	Poor	Glycerine	Excellent

875 Cylindrical

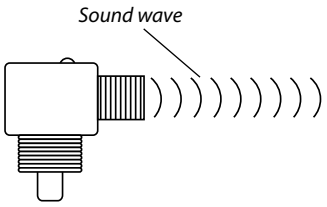
- Industry standard barrel style housing
- IP67 rated
- Adjustable sensing distances
- Short-circuit overload, transient noise and reverse polarity protection
- Plastic face with metal body

Sensing Distance	Housing size	Output	Voltage	Shielded	Cat. No.
20mm	30mm	N/O (PNP)	10 - 48VDC	N	875CP-N20NP30-D4

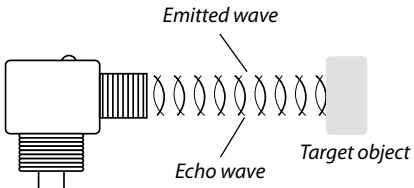
Ultrasonic Sensors: Overview

Mode of operation

- Ultrasonic sensors operate by emitting and receiving high frequency sound waves
- The most common type is the diffuse ultrasonic. This is a single sensing unit with in-built emitter and detector
- The sensor emits the sound wave and then looks for an echo that bounces off the target object whereas in the absence of a target object there is no echo



No echo in the absence of target object



Target present

Emitted sound wave is reflected back and echo wave is detected

Target factors

- Ultrasonic sensors are used for applications where standard photoelectric sensors are ineffective dusty or polluted environments, detecting transparent materials. Ultrasonic sensors are not affected by target color or dusty atmosphere
- Targets such as foam, rubber, cloth or even liquid targets with bubbles/foam are unsuitable for ultrasonic sensor detection
- Ultrasonic sensors are also used for level measurement applications where an analogue output is required, such as grain silos

873P Cylindrical

- IP67 rated
- Programmable versions with pushbutton teach available
- Electronic circuitry potted to protect against shock and vibration
- Short-circuit, overload, false pulse, transient noise and reverse polarity protection
- Plastic cylindrical barrel

Sensing Distance	Housing Size	Output	Voltage	Shielded	Cat. No.
600mm	18mm	N/O (PNP)	18 - 30 VDC	Y	873P-DBNP1-F4
3.5m	30mm	2 PNP with 4 - 20mA	19 - 30 VDC	N	873P-DCAC2S-D5

Section One: Sensors

Capacitive and Ultrasonic Sensors: Accessories

Cordsets

Connection Type	Description	Cat. No.
F4, D4	4 pin DC micro cordset 2m	889D-F4AC-2
D5	5 pin DC micro cordset 2m	889D-F5AC-2

Mounting Bracket

Suitable for	Description	Cat. No.
18mm barrel housing	Stainless steel	871A-BRS18
30mm barrel housing	Stainless steel	871A-BRS30

How to Select a Limit Switch

Follow the three easy steps to select the right limit switch.

step 1

STEP 1: Identify Actuator

Identify what kind of actuator would be best suited for the application.

Note: *The 802T range of limit switches are available as complete units as well as separate switch bodies and actuators, while the 440P range offers the complete unit.*

802T lever heads

440P limit switch family

step 2

STEP 2: Determine the Number of Outputs

The more common arrangement is 1N/C – 1N/O contacts, which are also referred to as 1 circuit. 2N/C – 2N/O contact arrangements are also available and referred to as 2 circuit.

step 3

STEP 3: Select the Housing Type or Switch Body

The 802T has a rugged body suited for heavy duty applications, while the 440P offers a more compact housing.

802T Limit Switch bodies

Action	Contacts	Cat. No.
Spring return	1N/O 1N/C	802T-AP
Spring return	2N/O 2N/C	802T-ATPD

Section Two: Limit Switches

802T Complete Switch

Output	Body Size	Housing	Actuator Type	Cat. No.
1N/O 1N/C	20 mm	Metal	Lever	802T-APS6

802T Limit Switch Actuators

Item	Lever Type	Material	Cat. No.
	Roller lever – non - adjustable	Nylon	802T-W1
	Roller lever – non - adjustable	Steel	802T-W1A
	Looped rod	Nylatron	802T-W14
	Adjustable lever – 1.19" to 3.5" radius	Nylon	802T-W17
	Adjustable lever – 1.19" to 3" radius	Nylon	802T-W2
	"Adjustable lever – 1.19" to 3" radius"	Steel	802T-W2B
	Rod lever – 11.5" long	Stainless steel	802T-W3A
	Rod lever – 8.5" long	Stainless steel	802T-W3B
	Rod lever – 12" long	Nylon	802T-W3C
	Fork roller Lever	Steel	802T-W4C

440P Limit Switches

Item	Output	Body Size	Housing	Actuator type	Cat. No.
	1N/C 1N/O Snap	22mm	Plastic	Adjustable lever	440P-CALS11B
	1N/C 1N/O Snap	30mm	Metal	Adjustable lever	440P-MALS11B
	1N/C 1N/O Snap	22mm	Plastic	Dome plunger	440P-CDPS11B
	2N/C 2N/O BBM	30mm	Metal	Short lever	440P-MSLB22B
	1N/C 1N/O Snap	30mm	Metal	Telescopic arm	440P-MTAS11B
	1N/C 1N/O Snap	30mm	Metal	Roller plunger	440P-MRPS11B
	1N/C 1N/O Snap	30mm	Metal	Spring rod	440P-MSRS11B
	1N/C 1N/O Snap	30mm	Metal	Dome plunger	440P-MDPS11B

Section Two: Limit Switches

440P Limit Switches

Item	Output	Body Size	Housing	Actuator type	Cat. No.
	1N/C 1N/O Snap	30mm	Metal	Short lever	440P-MSLS11B
	1N/C 1N/O Snap	22mm	Plastic	Roller plunger	440P-CRPS11B
	1N/C 1N/O Snap	30mm	Metal	Rod lever	440P-MARS11B
	2N/C 1N/O BBM	22mm	Plastic	Short lever	440P-CSLB12B
	1N/C 1N/O Snap	22mm	Plastic	Short lever	440P-CSLS11B
	2N/C 1N/O BBM	22mm	Plastic	Adjustable lever	440P-CALB12B
	2N/C 1N/O BBM	22mm	Plastic	Hinge lever	440P-CHLB12B
	1N/C 1N/O Snap	22mm	Plastic	Hinge lever	440P-CHLS11B

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