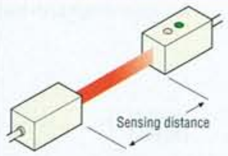
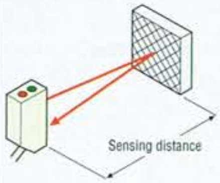
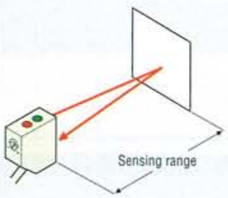
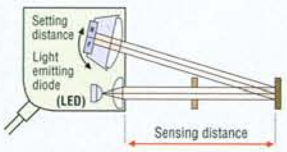
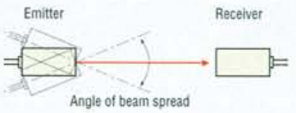
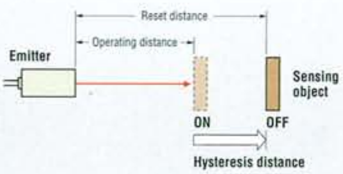
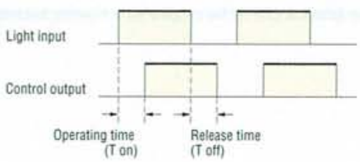
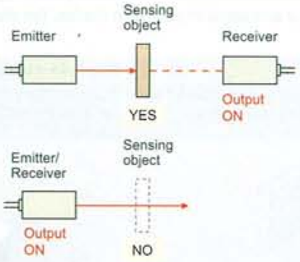
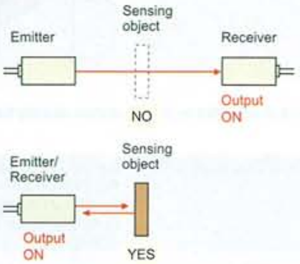
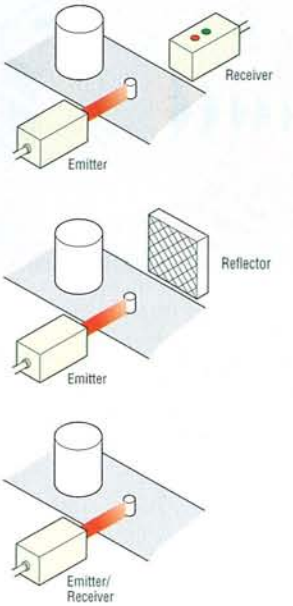
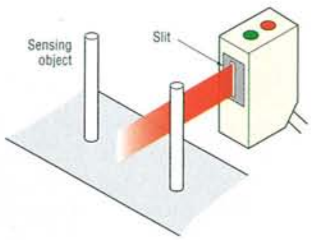
Explanation of terms

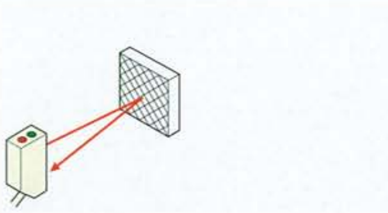
Item		Explanatory diagram	Meaning
Sensing distance	Through-beam		The rated sensing distance is the distance allowing a stable object detection for through-beam and retro-reflective models, taking into account product deviations and temperature fluctuations. Actual distances in standard conditions will be longer than the rated sensing distances for both models.
	Retro-reflective		
	Diffuse-reflective		The sensing distance for diffuse-reflective models is the distance allowing a stable detection of a standard test object (square white paper) taking into account product deviations and temperature fluctuations. Actual maximum sensing distances may vary according to object colour, size or surface structure. These influences can be reduced using the background suppression (BGS) functionality.
	Diffuse-reflective (coaxial)		Diffuse-reflective (coaxial) models operate like diffuse-reflective models but the optical axes of emitter and receiver are identical. This reduces the -> deadzone to a minimum and allows a higher precision for the detection or positioning of edges or small parts.
	Diffuse-reflective (background suppression)		Diffuse-reflective models with background suppression (BGS) reduce the influence from backgrounds for example using a position detection device (PSD). The sensing distance is the distance range allowing a stable detection of a standard test object (square white paper) taking into account product deviations and temperature fluctuations. The sensing distance is fixed and cannot be set.
	Limited-reflective		Limited-reflective sensors operate like diffuse-reflective sensors but sender and receiver are mounted at an angle. This triangulation principle reduces the influence from background reflections or can be used to detect edges or height differences.
	Distance-settable (background suppression)		The distance-settable photoelectric sensors detect the presence of an object based on its position using a position detection device (PSD). The distance-settable photoelectric sensors are less influenced by differences in color or reflected light from backgrounds (background suppression) providing an enhanced detection stability. Sensing distance: the distance allowing a stable object detection taking into account product deviations and temperature fluctuations. The maximum sensing distance can be modified by mechanically adjusting the position of the sender and/or receiver or electronically modifying the PSD signal evaluation. Setting range: the actual maximum sensing distance can be set within the rated setting range. Background suppression (BGS): using a position detection device (PSD) the reflected light from objects in the background can be differentiated from the reflected light of the object to be detected. This allows a stable detection for example of objects with low reflectivity in front of backgrounds with high reflectivity.
Directional angle			Through-beam models, retro-reflective models The range of angles where operation as a photoelectric sensor is possible.
Differential distance			Diffuse-reflective model The difference between the operating distance and the reset distance. Generally expressed in catalogs as a percentage of the detection distance.
Dead zone			The "dead zone" is the non-operational area outside of the emission and detection areas near the lens surface in mark sensors, the distance-settable type, the limited-reflective model, the diffuse-reflective model, and the retro-reflective model. Detection is not possible in this area. For applications requiring a minimal deadzone use coaxial sensors.
Response time			The "response time" is the lag time from the on/off of the light input to activation or reset of the control output. In general, for photoelectric sensors, activation time (Ton) ≈ release time (Toff).

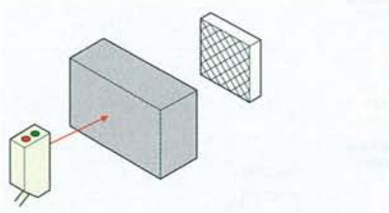
<table>
<tr><th>Item</th><th>Explanatory diagram</th><th>Meaning</th></tr>
<tr><td>Dark-on operation</td><td>
</td><td>"Dark on" is a model that outputs when the light entering the detector is shielded or decreases. The output method is expressed as DARK ON.
"Light on" is a model that outputs when the light entering the detector increases. The output method is expressed as LIGHT ON.</td></tr>
<tr><td>Light-on operation</td><td>
</td><td></td></tr>
<tr><td>Minimum detection object</td><td>
</td><td>Typical examples are given of the smallest objects that can be detected using Through-beam and retro-reflective models with the sensitivity correctly adjusted to the light-on activation level at the rated detection distance.
For the reflection model, typical examples are given of the smallest objects that can be detected with the sensitivity set to the highest level.</td></tr>
<tr><td>Smallest detection object with slit attached</td><td>
</td><td>Typical examples are given of the smallest objects that can be detected using through-beam and retro-reflective models with a slit attached. The sensitivity is correctly adjusted to the light-on activation level at the rated detection distance, and the slit is moved along its length and parallel to the object.</td></tr>
</table>

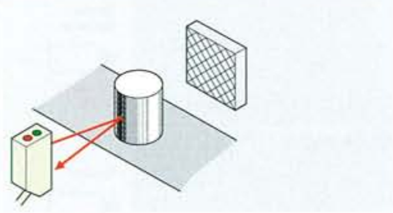
M.S.R. function

The Mirror Surface Rejection (M.S.R.) is a function using the effect that light can be polarized and filtered according to the polarization direction. This effect can be used to avoid wrong detection of objects with smooth glossy surfaces like aluminium cans.

No object	Non-glossy object	Object with a smooth, glossy surface
The light from the emitter hits the reflective plate and returns to the detector.	Light from the emitter is obstructed by the object, does not reach the reflective plate, and does not return to the detector.	(Example: battery, can, etc.) Light from the emitter is reflected by the object and returns to the detector.

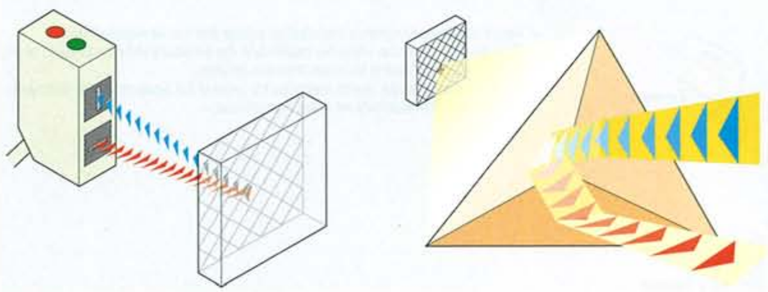




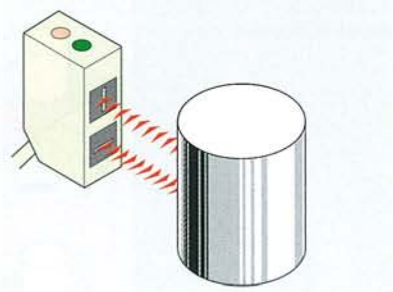


A direct reflection to the receiver from the surface of the object can be avoided by mounting the sensor at an angle. But for higher detection reliability the M.S.R. (Mirror Surface Rejection) function provides a solution for this type of application.

The light from the emitter is now polarized. The polarization plane is turned 90° by a reflector consisting of many small mirrors aligned so the light is reflected three times (triple reflector).



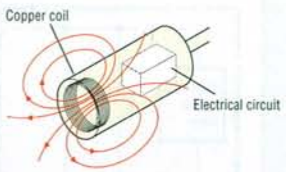
If an object with a smooth, glossy surface passes the emitted polarized light is returned to the receiver. As the polarization plane is not turned 90° the light does not pass the polarization filter in front of the receiver and the objects can be detected independant of their surface.



Inductive proximity switch

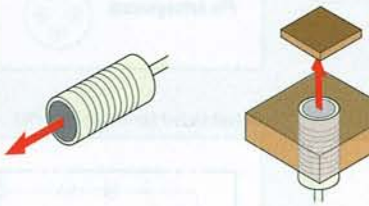
Item

Principle of operation



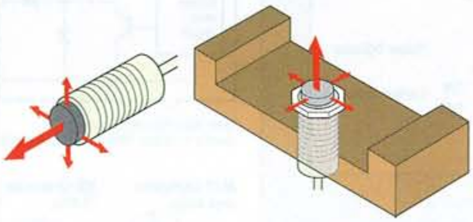
An inductive proximity sensor consists of a coil wound around a ferrite core at the sensing head. A high frequency is applied to this, generating an oscillating electromagnetic field around it. This is monitored by internal circuitry.
When a metallic object travels toward the field, electric currents are created in the object (eddy currents). As the target approaches the sensing face these increase in size.
These currents cause a transformer like effect, as a result the energy in the detecting coil lessens and the oscillations reduce. As the object moves in closer the oscillation finally stops.
The monitoring circuitry detects the stopping of the oscillations and then switches the output on. The object has now been detected.
Because the operating principle uses an electromagnetic field, proximity sensors excel over the likes of photoelectric sensors in environmental resistance. The likes of water, oil or dirt generally have no influence on the operation of the sensor making the use on machine tools etc. common place.

Shielded sensors



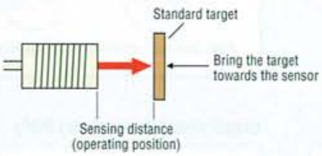
Shielded sensors are made with a shielding plate around the ferrite core. This has the effect of limiting the electromagnetic field to the front of the head. The sensor can be mounted flush in metal surfaces. This gives the advantage of mechanical protection, along with sensing directly adjacent to the sensing face. This limits the sensing range, but the sensor can be mounted with ease with surrounding metals taking no effect.

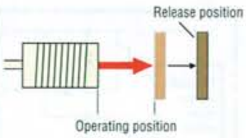
Unshielded sensors



Unlike the shielded sensor there is no shielding around the ferrite core.
This gives a greater sensing range than the equivalent diameter shielded proximity sensor. For the same diameter the range is generally doubled.
As the field extends to the side of the proximity switch it can be influenced by metals in this area. Thus it cannot be flush mounted and requires more distance to other proximity sensors or metal parts.

Sensing distance





The sensing distances quoted in the specifications for the proximity sensors are based on a standard target. This target (known as a standard object) is a square plate of mild steel 1 mm thick, a primarily ferrous object.
When the target reaches the point where the sensor operates, this is the sensing distance.
The sensor will release (i.e. turn off) at a point lightly further from the sensing face (hysteresis).

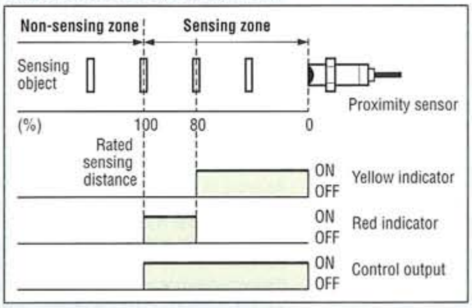
Item

Output and Connection

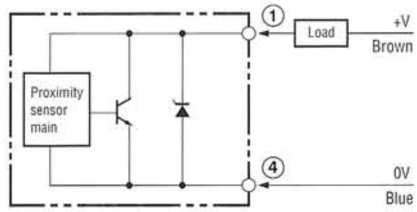
DC 2-wire

For the output mode NO (normally open) the control output is OFF if no object is present.

Timing chart for NO (normally open)

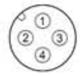


Output circuit



Load can be connected to +V or 0V side.

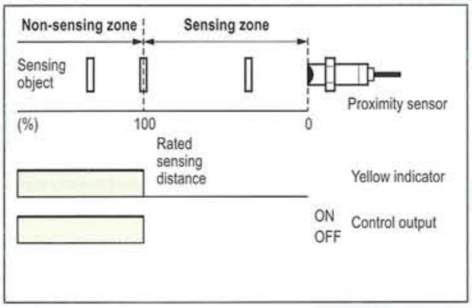
M12 Connector Pin Arrangement



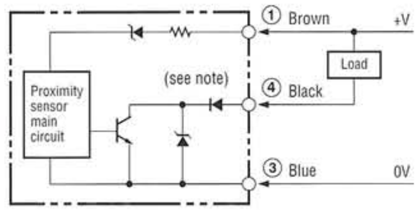
DC 3-wire

For the output mode NC (normally closed) the control output is ON if no object is present.

Timing chart for NC (normally closed)

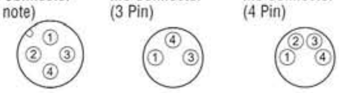


Output circuit (example for NPN)



Note: With M8 connector models, there is no output reverse polarity protection diode.

M12 Connector (see note) **M8 Connector** (3 Pin) **M8 Connector** (4 Pin)

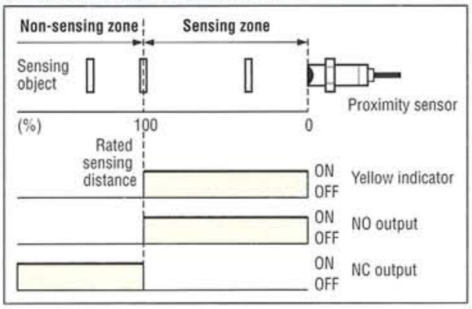


Note: Terminal 2 of the M12 connector is not used.

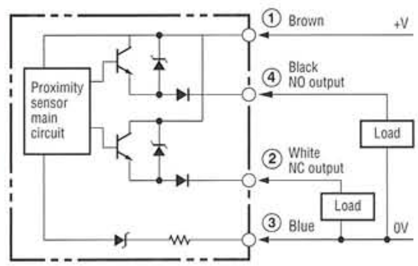
DC 4-wire

For the output mode NO+NC (antivalent) the NO output is OFF and the NC output is ON if no object is present.

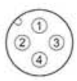
Timing chart for NO+NC (antivalent)



Output circuit (example for PNP)



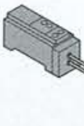
M12 Connector Pin Arrangement



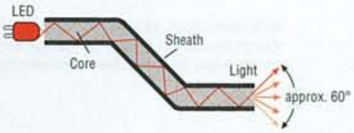
Fiber optics

Item

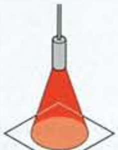
Principle of operation



Fiber optic photoelectric sensors comprise two parts, the amplifier and the sensing head. The amplifier contains the emitter (the light source) and receiver (detector) along with their associated electronics. The fiber optic cable is the means used to transfer the light to the sensing head.

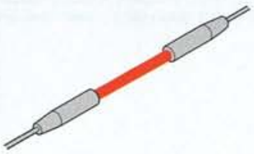


The light source (an LED) transmits the light beam down the fiber optic cable by repeatedly reflecting the light off the boundary between the fiber core and its sheath. When it reaches the end of the fiber the light is dispersed at the end.

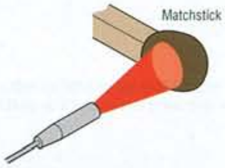


When the light is dispersed it spreads out and forms a beam much like that of other sensors, but on a smaller scale. With smaller light sources and lens areas the sensing ranges are on the whole much shorter.

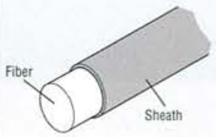
Types of fibre



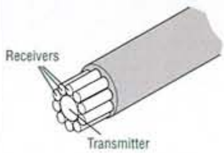
Fiber optic heads mainly split into two types, through-beam and diffuse (although there are a few retro-reflective types). The principle of operation of both types is exactly that of standard photoelectric sensors.



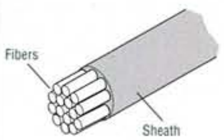
Construction



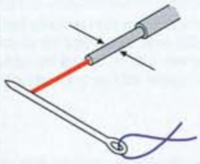
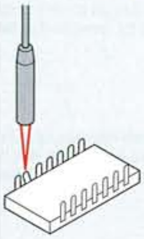
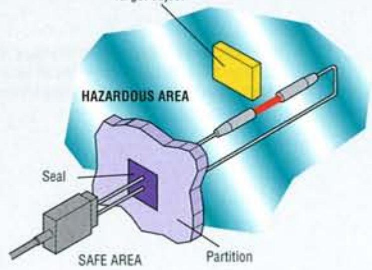
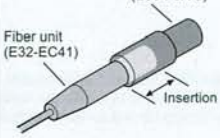
Standard fiber: Most fiber optic sensing heads use this configuration of fiber (i.e. a single fiber covered by a protective sheath). The fibers are usually plastic, 0.5 to 1 mm in diameter and covered in a plastic protective sheath.



Coaxial fiber: This gives greater accuracy. The core is used as the transmitter and the surrounding fibers are bundled together to form the receiver. This gives better accuracy, the target can enter the detecting area from any direction.



Multicore: These consist of large numbers of small fibers. This results in a more flexible cable (E32-R types) which can literally be tied in a knot.

Item		
Using fiber optic sensors		The main advantage of fiber optics is that they are small. This means that they can be mounted in places where other sensors couldn't fit.
		As the sensor heads are extremely compact, they are ideal for the stable detection of small objects. As a result of the less light that is emitted they generally do have smaller ranges than conventional photoelectric sensors.
		Fiber optic sensor heads can be used in areas that standard sensors are unable to go, for instance hazardous areas, This is because no electric current flows through them. This also means they are totally unaffected by electrical noise (provided the amplifier is suitably positioned). By using glass fibers instead of plastic they can be used in areas of up to 350°C.
		Extremely small objects can be detected with a diffuse coaxial sensor and additional focal lens. Using these, objects as small as 100 µm can be detected.

Laser classes

Laser classes

Laser products are defined by class types which are set in European and international standards. The table below refers to standard EN 60825.

Requirements: Sub-clause	Classification				
	Class 1	Class 2	Class 3A	Class 3B	Class 4
Description of Hazard Class	Safe inherently by engineering design	Low power: eye protection normally afforded by aversion responses	Same as class 2, Direct intrabeam viewing with optical aids may be hazardous	Direct intrabeam viewing with optical aids may be hazardous	High power; diffused reflection may be hazardous
Protective Housing	Required for each laser product; limits access necessary for performance of functions of the products,				
Safety Interlock in Protective Housing	Designed to prevent removal of the panel until accessible emission values are below the AEL for the class assigned				
Remote Control	Not required			Permits easy addition of external interlock in laser installation	
Key Control	Not required			Laser inoperative when key is removed	
Emission Warning Device	Not required			Give audible or visible warning when laser is switched on if capacitor bank of pulsed laser is being charged	
Attenuator	Not required			Give means beside ON/OFF switch to temporarily block beam	
Location Controls	Not required		Controls located so adjustment does not require exposure to AEL above class 1 or 2		
Viewing Optics	Emission from all viewing systems must be below class 1 AEL's as applicable				
Scanning	Scan failure shall not cause product to exceed its classification				
Class Label	Required wording	Warning and explanatory labels and specified wording			
Aperture Label	Required wording			Specified wording required	
Service Entry Label	Required as appropriate to the class of laser used				
Override Interlock Label	Required under certain conditions as appropriate' to the class of laser used				
User Information	Operation manuals must contain instructions for safe use				
Purchasing and Service Information	Promotion brochures must reproduce classification labels; service manuals must contain safety information				
Medical Products	Special calibration instructions required		Special calibration instructions, means for measurement and target-indicator required		
Fibre Optic	Cable service connections require tool to disconnect if disconnection breaks protective housing and permits access above class 1				

For safety purposes all laser products are labelied clearly with a safety warning message.

Protective structure

Note: IP-XX is based on the following testing method. Please verify sealing in the actual environment and conditions of use before using.

IEC (International Electrotechnical Commission) Standards (IEC60529:2001)

IP-■■

- Protective characteristic symbol (International Protection)
- Symbol 1: Level of protection against solid objects

Level		Amount of protection
0		No protection
1		Solid objects 50 mm or larger in diameter (hand, etc.) do not penetrate.
2		Solid objects 12.5 mm or larger in diameter do not penetrate.
3		Wires or other solid objects 2.5 mm or larger in diameter do not penetrate.
4		Wires or other solid objects 1 mm or larger in diameter do not penetrate.
5		An amount of dust sufficient to interfere with normal operation of the device or create a safety problem does not enter.
6		Dust does not enter.

JEM (Japan Electrical Manufacturers Association) Standards (JEM1030:1991)

IP-■■■

- Symbols 1 and 2 of IEC60529
- Level of protection against oil penetration

Level		Amount of protection
f	Oil resistant	Suffers no damaging effects from oil drop or oil spray incident from any direction
g	Oil proof	Oil drops or oil spray incident from any irection does not penetrate.

Note: Other levels (h, c, d and e) also exist.

NEMA (National Electrical Manufacturers Association)

Table for converting NEMA enclosures to IEC60529
(conversion from IEC60529 to NEMA is not possible)

Nema 250	IEC 60529	Nema 250	IEC 60529
1	IP10	4, 4X	IP56
2	IP11	5	IP52
3	IP54	6, 6P	IP67
3R	IP14	12, 12K	IP52
3S	IP54	13	IP54

Note: From Appendix A of NEMA standard 250. NEMA enclosure levels and IEC60529 differ in the areas of corrosion resistance, rust resistance, and icing characteristics.

Symbol 2: Level of protection against water penetration

Level		Amount of protection	Summary of test method (test uses fresh water)	
0	No special protection	No protection against water penetration.	No test	
1		Suffers no damaging effects from vertically dripping water.	Placed under vertically dripping water from a dripping tester for 10 minutes.	
2		Suffers no damaging effects from water dripping no more than 15° out of plumb.	Placed at an inclination of 15° under dripping water from a dripping tester for 10 minutes (2.5 minutes in each direction).	15°
3		Suffers no damaging effects from water sprayed from an angle up to 60° from plumb.	Using the tester at right, the device is sprayed from each side up to an angle of 60° from plumb for 10 minutes).	
4		Suffers no damaging effects from water sprayed from all directions.	Using the tester at right, the device is sprayed from all directons for 10 minutes.	
5		Suffers no damaging effects from and direct jet spray from all directions.	Using the tester at right, each square meter of the case is sprayed from all directions for 1 minute, for a total of at least 3 minutes.	
6		Suffers no damaging effects from strong and direct jet spray from all directions.	Using the tester at right, each square meter of the case is sprayed from all directions for 1 minute, for a total of at least 3 minutes.	
7		Water does not penetrate when the device is submerged for a specified amount of time at a specified pressure.	The device is submerged for 10 minutes at depth of 1 m in water (if the height of the device is less than 850 mm)	1 m
8		The device can be used on a regular basis under water.	Decided by the manufacturer and the user of the device.	

IP69k according to DIN40 050/9

The IP69k test according to DIN 40 050 part 9 is intended to simulate high pressure / steam cleaning. During the test 14-16 l/min water at 80°C is sprayed onto the sensor from different angles with 8000-10000 kPa. The sensor may not suffer any damaging effects from high pressure water in appearance and functionality.