

Application report:

Ultrasonic Sensors Resistant to Aggressive Media

Ultrasonic sensors have the outstanding capability of surely and reliably detecting media and objects regardless of their surface properties and color. For this reason, ultrasonic sensors are frequently used to monitor the levels of liquids, granules or pastes. However, in many of these applications media are often found whose liquids or emitted gases can have a long-term detrimental effect on the materials and thereby the functions of standard sensors. These aspects of their application were specifically taken into account in the design of the new UNAR ultrasonic sensor range.

Principle of operation of ultrasonic sensors

Ultrasonic sensors for level measurement are based on the principle of propagation time measurement. They employ the surrounding air to convey the sound energy, in which sound is propagated at a velocity of around 330 m/s under normal conditions. The time between emission and reception is measured using an accurate electronic timer. This precise timer permits accurate distance measurement, a constant resolution in the range of tenths of millimeters and precise, reproducible switching points.

The transducer, the heart of the ultrasonic sensor

The so-called transducer is designed as both an emitter and receiver and is optimized for frequencies far beyond the range of human hearing. When activated by an oscillator, the diaphragm of the transducer emits short ultrasonic packages, so-called bursts, in the surrounding air, which takes up and propagates the sound waves. Each emission sequence is followed by a period of reception. In operation, the transducer and the electronic circuit alternate constantly between emission and reception. When the emitted sound packages strike an object, such as the surface of a liquid, the sound reflects from this and a part of the energy is returned to the transducer, or sensor. If this registers a defined number of successive signals within a time window chosen by the user, the output of the sensor responds. As mentioned above, the surface properties or color of the object to be detected plays an unimportant part

with this method of measurement. As long as an echo of the emitted sound energy is returned with a sufficient amplitude to the receiver, it is fundamentally possible to measure the distance to the reflecting body. For this reason, ultrasonic sensors are used mainly to detect and scan objects which are difficult to detect. In industrial processes, this pertains mainly to measurements on the surfaces of bulk materials, liquids, pastes and similar substances. The vapors and gases emitted by these, which can be very aggressive, have become more of a problem than ever for most sensors now in practical use, as they can corrode and attack the front of the sensor. This can lead to permanent damage or even to a total failure. So how and, in particular, with what can the sensor, particularly the active surface of the transducer, be optimally protected against these external effects?

Stainless steel combined with a protective Parylene coating

The stainless steel type 1.4435 used for the housing makes a substantial contribution to protecting the sensor. This material, which is in widespread use in the food and processing industry, resists all aggressive effects. However, the far greater challenge is to protect the transducer of the sensor, which is usually most exposed to the aggressive media, as well as possible against an extensive range of corrosive substances. Of course, this must be conducted without negative effects on the properties of the transducer diaphragm and thereby the emission and reception characteristics of the transducer and its typically narrow sonic beam angle. One of the outstanding properties of the ultrasonic transducers used in the UNAR 18 sensors is the extremely narrow sonic beam. This permits simple sensing in containers with small diameters or detection through narrow openings, a demand which must be frequently fulfilled in process and medical technology (Fig. 1). The most optimum solution to comply with all specifications is: Parylene condensation coating. Parylene combines the required properties of excellent adhesion to the materials to be protected - ceramic and PUR - with an exceptional barrier effect to most substances used in modern processes such as inorganic acids and alkalis,

organic solvents and water vapor, and even at the required layer thickness of just a few microns.

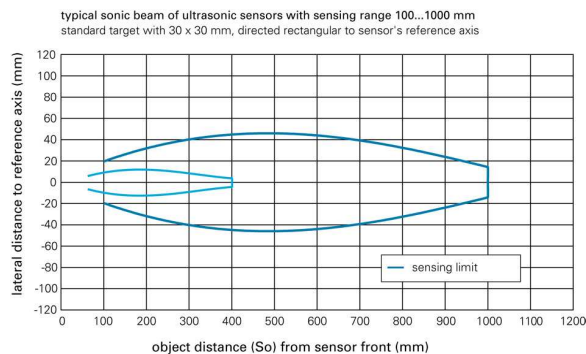


Fig. 1: Extremely fine sonic cone profiles make the sensors capable of measuring in narrow containers and through small openings

The front section of the UNAR

At a first glance, no noticeable mechanical differences can be seen between a UNAR and a standard ultrasonic sensor of the same size. In contrast to other solutions, it was possible to avoid a bulky mechanical covering of the active surface due to the Parylene coating. The M18 thread is retained unchanged over the entire length of the housing. In particular, the latter simplifies installation (Fig. 2).



Fig. 2: The front surface of the UNAR coated with Parylene and specially sealed, including execution with an integrated digital display

Diverting sound energy by 90°

Level-measuring ultrasonic sensors are usually mounted vertically with the active surface facing downwards, as they are normally adjusted from above to the media to be monitored. However, if this is impossible due to lacking space, a screw-on 90° deflector made of stainless steel is available for the UNAR sensor series (Fig. 3).

Switching and also distance measuring sensors can be operated with this accessory. Its influence on the measuring accuracy of the level sensor is practically negligible. When correctly fitted, the deflector even provides additional mechanical protection for the Parylene-coated transducer. Due to the deflector, the UNAR can also be easily used when the installation depth is very limited.



Fig. 3: 90° deflector made of stainless steel fitted to a UNAR 18

Programming by a pushbutton or Teach-in input

Ultrasonic level sensors can not only be mechanically integrated in an optimum way for the respective application, but also electrically. All level sensors of the UNAR series are equipped with the proven Teach-in function with which the measuring range can be programmed specifically for the application up to a maximum end value of 1000 mm. The effective direction of the analog output signal, rising or falling with the distance, can also be chosen at any time. Programming is conducted directly on the sensor with a pushbutton or externally via an electric Teach-in input. A few minutes after having completed the programming, access is electronically locked, which strongly increases operational reliability.

Level sensor with digital display

Baumer provides a solution with an integrated liquid crystal display for applications in which the level is to be indicated directly at the place where it is measured (Fig. 2). The measured data visible on the display is also accessible as a 4 – 20 mA current signal.

Measuring ultrasonic sensors protected against aggressive media by the use of stainless steel and Parylene offer the most reliable solution for all kinds of level measurement in industrial processing from a current point of view.