

## Application report:

# Baumer SONUS – The smallest and lightest ultrasonic sensors worldwide

***With SONUS, Baumer introduces the world's smallest and most lightweight ultrasonic sensors. With housing dimensions of only 10 x 14 x 27 mm and weighing a mere 4 grams, these sensors set new standards. Counting, positioning, measuring – the SONUS family includes sensors with which precisely these tasks can be performed. The experience Baumer has gained from its proven ultrasonic and optical sensors has gone into the housing design, the connection options and the operation of the SONUS sensors. Prepare to be amazed!***



*Figure 1: SONUS: the smallest and lightest ultrasonic sensor on the market*

### Ultrasonic Technology and SONUS

In contrast to electromagnetic waves, sonic waves can only propagate themselves in matter. The prerequisite for this propagation is the particular medium's elasticity characteristics. It is therefore given that ultrasonic waves can propagate themselves through solid, liquid and gaseous media. All previous ultrasonic sensors from Baumer as well as the new SONUS line employ only air as the medium for sonic propagation. Just as is the case with those sound waves detectable by the human ear, sound

waves generated by ultrasonic sensors are also reflected by solid or liquid bodies. The frequency at which ultrasonic sensors operate lies in the range from approx. 250 kHz to higher than 400 kHz and is therefore far above the range audible to the human ear. Baumer employs only sonic transducers with piezo-ceramics and a corresponding adapter layer to transmit the sonic energy to the transport medium, air. Using a special manufacturing technique involving an optimized assembly process we have succeeded in installing a sonic transducer in the tiny SONUS housing which, despite its small dimensions, achieves a maximum sensing distance with a minimal blind region. In addition the SONUS exhibits an extraordinarily narrow sonic beam angle with practically no side cones. Only in this way can the SONUS "look into" vessels with opening diameters of far less than 1 cm.

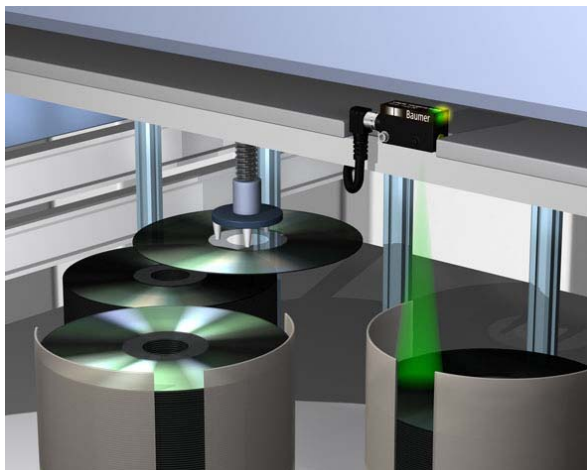
The use of ultrasonic technology in sensors can be described as representing the current state of the art. Baumer has offered a comprehensive product program of ultrasonic sensors for quite some time. However, the integration of ultrasonic technology into miniature housings which, until now, were reserved strictly for optical sensors represents a significant challenge. It was only the experience gained in the development of existing ultrasonic as well as very small optical sensors which made this step in the direction of miniaturization possible. Baumer has now achieved this quantum leap in miniaturization with the new SONUS product line of ultrasonic sensors.

With housing dimensions of only 10 x 14 x 27 mm, a weight of less than 4 grams and a measuring range of 10 to 200 mm at a resolution falling below the 0.3 mm mark, the latest technologies have all been implemented. The greatest challenge lay in accommodating the individual elements such as the special sonic transducer which lies at the heart of the sensor as well as the other electronic components in a miniature housing in order to create a sensor family with full industrial capability which still complies with all relevant standards. This included not only the integration of complete circuits into ASICs (Application Specific Integrated Circuitry), the employment of a microprocessor, the use of special PCB

technology and the essential utilization of the smallest available components, but also the development of specialized manufacturing processes to ensure the sensors' reliable and economical production. Yet despite their unique level of miniaturization, *SONUS* sensors are fully compliant with the specifications demanded of industrial equipment.

## Applications

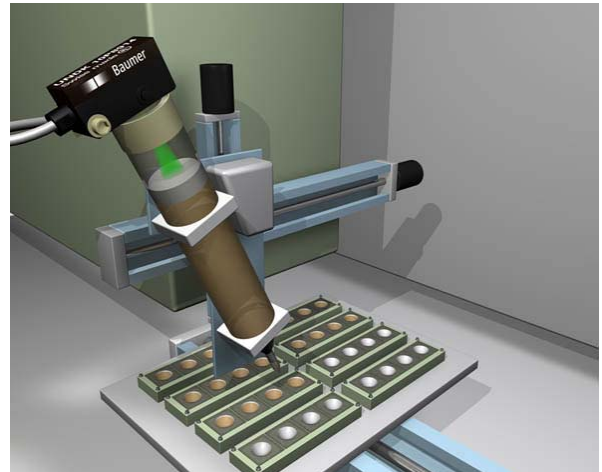
Through its shape and functionality, *SONUS* opens entirely new areas of application to the field of ultrasonic technology. Level monitoring measurements of miniature containers have, until now, been the sole preserve of optical or even fiber optic sensors. With *SONUS*, measurements will also be possible in this area in the future, regardless of the color or transparency of the media. The narrow sonic beam angle prevents the sensors from influencing one another. If, due to the installation conditions, there is nonetheless a risk of mutual interference, it can be further reduced through the appropriate accessories. Synchronization or multiplex mode are additional options available to eliminate reciprocal interference where the installation conditions are very crowded. All *SONUS* sensors are available with this supplementary function. *SONUS* makes it possible for the first time to set up rows of ultrasonic sensors, housing-to-housing, to "gaze into" test tubes or micro-titration plates.



*Figure 2: Height measurement of different colored, reflecting or transparent objects*

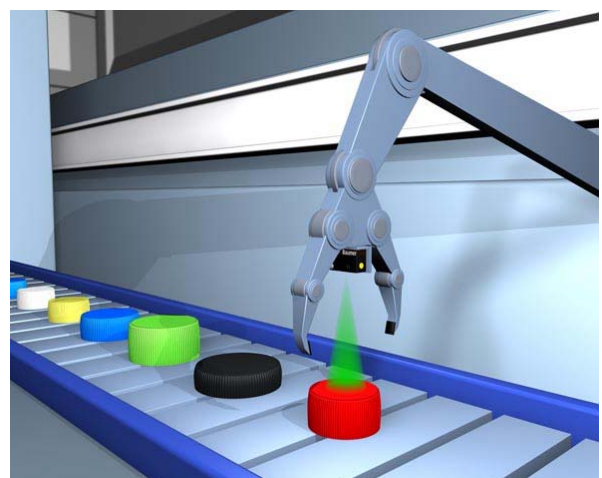
Where rapid movements or mobility are required, weight savings of only a few grams can frequently make all the difference. The application of lacquers and adhesives in electronics and print production, analytical instruments and automated

pipetting systems in the medical and pharmaceutical industry are but a few of the applications which present precisely this challenge. Weighing a mere 4 grams, the sensors in the *SONUS* family are far and away the lightest ultrasonic sensors in their class and provide the user with new ways of mounting sensors directly on moving components or subassemblies.



*Figure 3: Cartridge with integrated, measuring sensor on a XY-table*

Thanks to *SONUS*, even filigree robot arms can now be equipped with ultrasonic sensors, since dimensions and weight are no longer deterrents. This now gives robots a "sense of vision". The measuring *SONUS* transmits information regarding subassembly height to the controller even before the robot closes its gripper thus permitting significantly more efficient processing.



*Figure 4: Robot gripper with an integrated ultrasonic sensor as the measuring sensor*

Other outstanding advantages of ultrasonic sensors include object color and transparency independence as well as resistance to dust, contamination and vibrations. A further significant advantage for industrial applications lies in their immunity to interfering light sources and reflections which can often result in faulty operation with other techniques. In this respect, *SONUS* sensors perfectly complement the already widely employed optical sensors.

### SONUS Versions and Functions

The range of applications for ultrasonic sensors under conditions of extremely limited installation space is already very large and continues to expand rapidly. The *SONUS* family offers not only programmable proximity sensors with PNP or NPN outputs and NC/NO function for presence checks or object counting, but also programmable sensors with analog outputs for distance and travel measurements. Proximity sensors have difficulty detecting sound absorbent materials such as open pore foams, coarse fiber textiles or rough cut faces on soft wood. In these cases, the ultrasonic retro reflexive sensor can help. It is directed at a smooth background surface and the resulting value is then stored in the sensor as a reference. Any other objects – regardless of whether they are sound absorbent, optically reflective or transparent – that then pass between the sensor and the reference surface cause an interruption in sound propagation thus activating the switch output.

Level monitoring is among the most common tasks performed by ultrasonic sensors. Simple proximity sensors are also employed to quickly check high and low levels in containers. Distance measuring sensors from the *SONUS* family are available for continuous level monitoring tasks. The linear signal output precisely reflects the distance between the active sensor face and the surface of the medium. A resolution of less than 0.3 mm allows even the smallest changes in volume to be reliably measured.

With all these advantages, the new *SONUS* family represents the ideal solution for counting, positioning and measuring duties in the areas of handling, robotics, laboratory instrument construction, filling equipment of all types and the semiconductor and packaging industries to name but a few.

### Programming

The measuring ranges of all sensors can be quickly adapted to their individual application

conditions by means of a Teach-in button in the housing or an external Teach-in input. The external Teach-in input is available as a separate pin or wire. This allows the programming function to be taken over directly by the application controller, opening entirely new application possibilities. A new feature is the ability to program the NC/NO function. Despite this expanded functionality, the goal of maintaining a programming structure that is as user-friendly as possible was nonetheless achieved. This means that the operation of all Baumer sensors – regardless of whether they are optical, inductive or ultrasonic – is based on the same underlying framework.



Figure 5: *SONUS* connector version



Figure 6: *SONUS* cable version

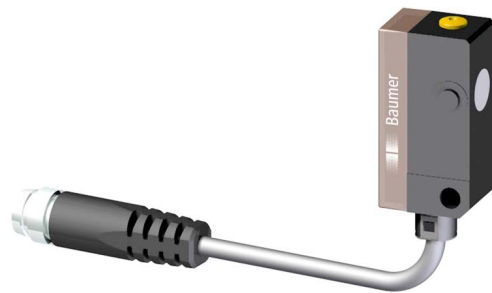


Figure 7: *SONUS* fly-lead connector version

### Connection Options and Accessories

As the integration density of machinery increases, development engineers are faced with ever greater challenges with regard to the installation conditions. Baumer has an answer to this trend: the extremely compact housing of the *SONUS* family together with a comprehensive line of installation and mounting accessories offer clear advantages. The utility offered by the minimum housing dimensions is further supported by the

space-saving cable version. The bend radius of the highly flexible cable allows the sensor to be installed in spaces which are barely larger than the housing itself. In addition, the cable can exit in any desired direction. The *SONUS* connector version permits easy connection to existing cables or wire harnesses. And the fly-lead connector version combines both these advantages – space-saving and simple installation.

The clever fastening concept involving only a single screw will prove its worth during the installation of the *SONUS* by significantly reducing mounting times – and, time is money! A stud which has been injection molded into the housing provides security against twisting. This is a concept which has already proven its worth with laser and infrared sensors as well as fiber optic sensors manufactured by Baumer.

### **Concluding Remarks**

Despite their tiny size, *SONUS* ultrasonic sensors offer a comprehensive range of functions and are available with a wide variety of installation and mounting accessories. The new family of products is the end result of innumerable discussions with experienced sensor users coupled with intensive technology development. With *SONUS* – a new product family intended to bring increased utility – Baumer offers proof of its experience in developing high technology sensors.