

Application report:

When a μ -liter makes the difference

Precise level measurement with new ultrasonic sensors

In laboratory automation small containers such as microwell plates and test tubes are used in the process of analyzing liquids. With the new Series 09 ultrasonic sensors Baumer rises to the challenge of fast and precise level measurement in these receptacles.

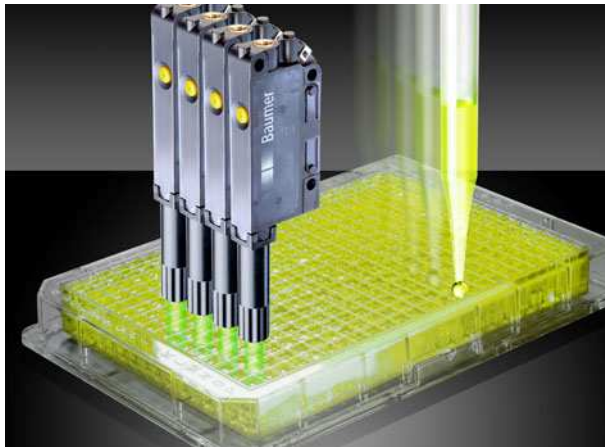


Figure 1: Baumer's Series 09 sensors detect the level in microwell plates

It is in man's nature to be curious. Therefore, we research everything that is unknown. New diseases, vaccines or artificial ingredients as well as substitutes are analyzed in labs and can be refined thanks to the results. However, even in scientific research economical thinking and acting are important. Thus, process automation is progressing continuously in every area. Today it is mainly machines that carry out lab tasks such as pipetting or analyzing samples. They work more efficiently and accurately than a human being. However, in order to receive results in the desired quality, precisely working sensors are required.

Precise level measurement in microwell plates

By way of illustration, we take a look at a liquid handling station in a laboratory. An important stage in the work routine is the filling of the microwell plates with the liquid that is to be analyzed, e.g. blood. After small quantities of the substance have been pipetted and before the analysis begins, the level in the cavities of the microwell plates is measured. This is necessary to check whether the quantities are sufficient for

the analysis and whether too much liquid has been filled into the wells respectively. Thus, waste can be held at a minimum. Now the Series 09 ultrasonic sensors have been specifically developed for these inspections.

In this particular field, manufacturers of lab automation systems as well as the users demand, above all, precision with good repeatability and high measuring speed from the sensors. As the openings of the cavities partly only measure 3 mm in diameter, there is little space for the sensor to detect any discrepancy as quickly as possible. Presently used capacitive measuring technology does not yet measure with the desired resolution of 1 μ l under these circumstances. Occasionally used photoelectric or ultrasonic sensors achieve these high resolutions, but they are rather costly. Baumer presents a solution with the new Series 09.



Figure 2: Liquid handling station for laboratory automation

Advantages of the new Series 09 ultrasonic sensors

Ultrasonic sensors are based on the principle of measuring sound's time of flight through the air. Ultrasonic waves that are not audible to the human ear are emitted by the sensor, reflected by an object and again received by the sensor. As a result, the sensors operate completely contact-free. Especially in the lab several advantages result from this operating mode, as neither the medium to be analyzed nor the sensor are contaminated during the measurement. Additionally, an ultrasonic sensor is particularly resistant to humidity and dust, which makes it constantly reliable. In contrast to photoelectric sensors it does not work with light but with

acoustic waves. Therefore, it can detect a variety of different media reliably – independent of their transparency and color. The texture of the medium does not influence the measurement either.

Conventionally operating ultrasonic sensors send out conical acoustic waves. As a result, their spot size is too big for measuring into openings of less than 10 mm in diameter. To avoid these limitations, the sensor specialist Baumer has developed the new Series 09 in close co-operation with its customers. These ultrasonic sensors are equipped with a special beam columnator that concentrates the acoustic waves, which allows for the sensor to measure even into the very small openings of a type 384 microwell plate. Depending on the preferred installation, the sensors are available with the columnator on the short or long side. The nozzle is removable and exchangeable, which facilitates the cleaning and maintenance of the sensor. Naturally, one is not limited to the smaller openings but can also measure into larger ones. The new sensor family can be used in a wide range of applications to detect liquids in containers of any size.

The sensors measure with a very high resolution and repeatability of up to 0.1 mm. The minimum response time amounts to only 7 ms. Thanks to the special housing width of only 9 mm – corresponding with the grid of a type 96 microwell plate – the sensors can be cascaded ideally. By this means, eight sensors arranged in-line can scan such a plate in one single cycle, which reduces the scanning time considerably. The same sensors can also control the presence of the pipette tips in their storage containers before the process of filling the liquid into the wells. The whole process is monitored efficiently with a single type of sensor.

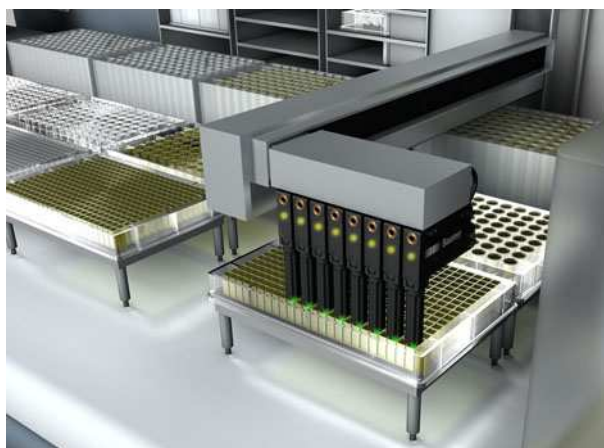


Figure 3: Due to optimal cascading, the only 9 mm wide sensors reduce the scanning time of a type 384 microwell plate

Various possibilities for installation provide great flexibility for the sensors' insertion into lab automation systems. Depending on the requirements, the sensors are installed vertically or horizontally and can be fixed from above, the side or from below with a single screw – an efficient and above all simple installation! The sensors are available with RS232, analog, or digital interface as well as the new communications standard IO-Link. Thus, an easy connection to a multitude of controls is guaranteed. Cable as well as flylead connectors are available.



Figure 4: Ultrasonic sensors with beam columnator on the short and long side as well as cable or flylead connectors

Applicable also for the detection of smallest objects

Thanks to the versatile ultrasonic technology, the sensors can perform many other tasks besides level measurement and tip detection. Apart from lab automation they are used in the packaging industry. In this industry they are equally used to detect objects through small openings. As shown exemplarily in figure 5 they check the presence of tablets or other small objects in blister packages. When capsules are to be filled and packaged the ultrasonic sensors can check the presence of the capsule halves as well as detect the fill level within.

Additionally, they assure that contact lenses are packaged according to the hygienic standards by detecting reliably the level of the saline solution in the blister package. To save the consumers of cosmetic products unpleasant surprises after the

purchase, the sensors inspect levels of mascara, creams or the like during the packaging process. The sensors are also applied in machine tool manufacturing. Thanks to their concentrated ultrasonic waves, they are ideally applicable to check drillings for swarf or broken tools.



Figure 5: Ultrasonic sensors monitor the presence of tablets in blister packagings

Résumé

Nowadays, everything is optimized for profitability. Speed and precision are also obligatory for a good automation solution in the lab. With their very high resolution and short response times the Series 09 ultrasonic sensors contribute to the operating efficiency of the automation systems. They detect process errors at an early stage and therefore ensure a high quality. Thanks to the diversity of possible applications and their precision, the sensors stand for flexibility and reliability.