Technical Note
Ultrasonic Transit-Time Method

The demand for non-invasive measurement technologies is rising to enhance process efficiency and to measure without risiking media contamination. This information guide provides basic facts on engineering and physical principles of the non-invasive ultrasonic sensors SONOFLOW and SEMIFLOW; how they work and what their operational advantages are – compared to invasive and intrusive measuring methods.

Advantages of Clamp-On Sensors | Non-Invasive & Non-Intrusive

Non-invasive or non-contact devices do not physically affect the flowing liquid and are simply clamped from outside onto the tube, whereas invasive devices directly affect the fluids and are thus not free of contamination.

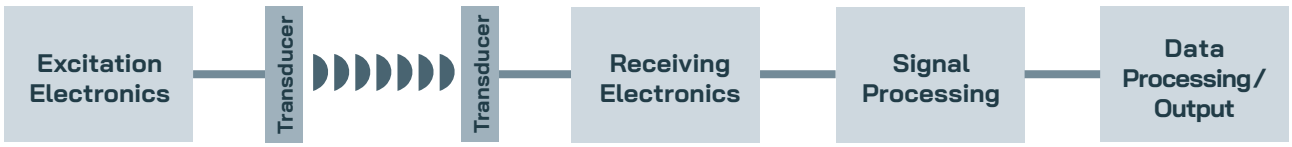
Intrusive sensors, in turn, “intrude” into the liquid channel. This measuring method can cause disturbances or asymmetries of the flow profile and thus corresponding with incorrect measurements.

SONOFLOW and SEMIFLOW flow sensors combine the best features of being both, non-invasive and non-intrusive.

- **The sensors do not protrude into the flow and do not cause turbulences**
- **The sensors do not come into contact with the liquids**
- **The sensors do not genereate any pressure loss**

Engineering Principles of Ultrasonic Flow Meters

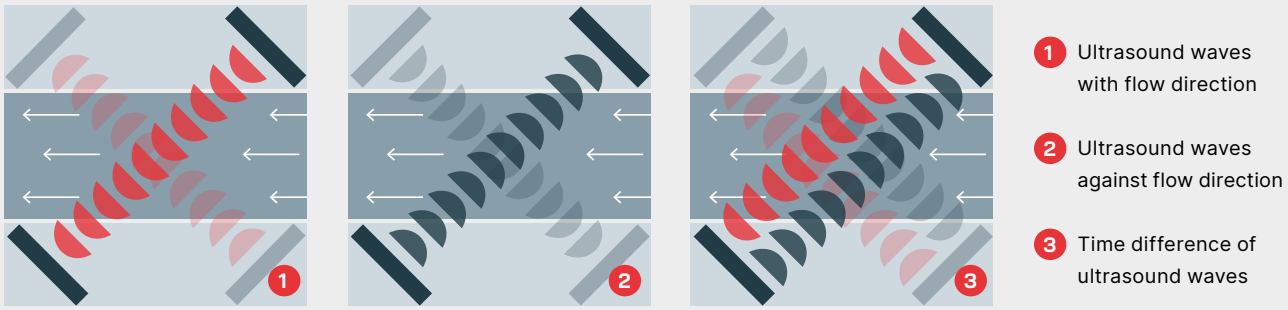
Ultrasonic transducers are the heart of any ultrasonic flow sensor. They consist of piezoelectric ceramics or composites that expand or contract when a DC voltage is applied, depending on the sign of the voltage (inverse piezoelectric effect). By applying an alternating voltage, the piezoelectric expands and contracts periodically and emits a sound wave corresponding to the excitation frequency. This sound wave is sent out as a pulsating ultrasonic beam from an excitation transducer and is detected by a receiving transducer. The signal is evaluated electronically and output via various signal outputs (digital and analog).



Physical Principles of Ultrasonic Transit-Time Flow Sensors

There are different ways how ultrasonic signals can be utilized to calculate flow rates. The non-contact ultrasonic SONOFLOW CO.55 and SEMIFLOW CO.65 sensors work on the basis of the transit-time difference measurement method. This method causes neither a pressure drop in the tube nor a risk of leaks. When appropriately calibrated, transit-time can work on almost all liquids, viscosity, density, color, and electromagnetic properties of fluids.

How does the transit-time difference measurement principle actually work?



The transit-times in and against the flow direction of a medium are measured with high precision by time-to-digital converters. In the direction of flow, the transit-time of an ultrasonic wave is faster than in the opposite way. Like a sport boat that moves in and against the flow direction of a river. A simple difference of both times allows the calculation of the flow.

Regarding the non-contact clamp-on ultrasonic SONOFLOW CO.55 and SEMIFLOW CO.65 flow sensors, the transmitted sound waves are sloped through the flowing liquid. In order to improve the measuring effect, two measuring parts are used.

Four ultrasonic transducers are arranged in an X-pattern. The transducers emit pulsating ultrasonic waves in a given frequency from one side to the other. The resulting transit-time difference is directly proportional to the mean flow velocity. The flow volume results from multiplying this mean flow velocity by the cross-sectional area of the tubing.

Non-Contact Flow Sensors Based On Ultrasonic Transit-Time Method

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SEMIFLOW® CO.65

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