Two Reasons Two Paths Improve Meter Accuracy

James Matson
Product Consultant at General Electric

Channel Partner
GE Oil & Gas

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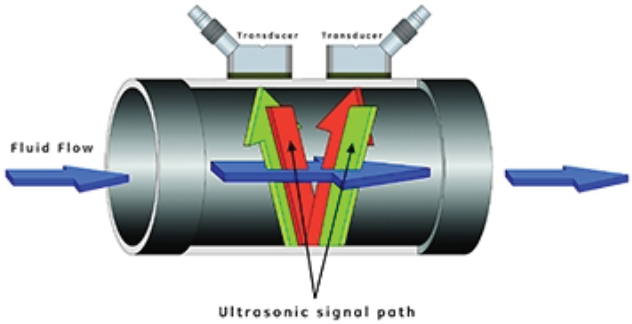
The most common ultrasonic transit time fluid flow meter measures the flow velocity of liquids or gases in typically round, full pipes. Meters of this type come in a wide array of variations, including Clamp-On (non-wetted) and Wetted (non-Clamp-On), portable or permanent installation, large and small pipes, and for virtually all industries. One of the most common, but perhaps not universally understood variations is one or two paths. There are two major differences, or benefits, between using one or two paths.

The first reason for measurement improvement is simply better resolution. The ultrasonic transit time meter actually measures the time it takes an ultrasonic sound pulse to traverse the distance between two sensors. In a single path set up, one sensor is upstream and one sensor downstream, and it is the time difference between the transit time up to down and down to up that is directly proportional to flow velocity. In a single path system, the



accuracy is limited by how precisely the time is measured. There is a practical limit both technologically and commercially, on what level of resolution in time measurement can be achieved. Another way to improve precision with the same resolution in time measurement, is to take more measurements. This is done by adding a second path, another set of sensors, to make another set of time measurements with the same resolution.

When the measurements by the two individual paths are averaged together there is 30% improvement in the time measurement resolution. This then means a 30% improvement in the measurement accuracy. A quick example to illustrate:

Path one has reading x with accuracy ±a%, Path two has reading y with accuracy ±b%.

Average of path one with path two and average of their accuracies is:

$$\text{Avg} = \frac{\{x \pm a\% + y \pm b\%\}}{2}, \quad \text{Avg} = \frac{(x+y) \pm \sqrt{(a\%^2 + b\%^2)}}{2}$$

When both paths have the same accuracy, then a=b=c, and then:

$$\text{Avg} = \frac{(x+y) \pm c\%/\sqrt{2}}{2}, \quad \text{Avg} = \frac{(x+y) \pm 0.7071\ c\%}{2}$$

Therefore, the 2-path accuracy is improved over one path accuracy by 0.707, or 30%.

The second reason for measurement improvement with two paths is not so easy to calculate or quantify, but is real nonetheless. As has been described elsewhere, flow rate measurement accuracy is also dependent of the shape of the flow velocity distribution, or profile, in a pipe. A single path of measurement may be through the diameter, or on an off-diameter location. In either case the measurement does not interrogate, or "see", the entire flow profile. If the profile is known and well defined, then standard formulas for relating the measured flow rate to the true flow rate can be applied, and a single path may be sufficient. When the profile is even just a little bit distorted, meter accuracy will degrade. The addition of a second path allows the meter to "see" (interrogate) more of the flow profile. Averaging the two paths together will reduce the inaccuracy due to the distorted flow profile. Typically, the improvement is estimated at about the same 30% as above. It is estimated, since the inaccuracy with just the

one path, in the absence of other information, is not truly known but estimated to begin with. The accuracy with two paths is therefore better than with one path, but not necessarily well quantified.

A single path measurement may be quite accurate and sufficient in some applications of the transit time ultrasonic flow meter, but in general, two paths are better for two reasons.

Flow meters with one or two (or more) paths, as well as application assistance, can be found at GE Measurement and Sensing here: https://www.gemeasurement.com/flow-meter

James Matson is a Product Consultant for GE Measurement Solutions.