Balaji B. Shankhavaram, An ultrasonic flowmeter based on the direct transit time technique, M. Tech. Thesis, Department of Electrical Engineering, Indian Institute of Technology Bombay, 1997.

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*Abstract* – Ultrasonic flowmeters are suited to applications where the flowmeter should not obstruct the flow. Transit time flowmeters are useful in single-phase flow measurements. The direct transit time flowmeter involves the measurement of transit time differences in the transit time of ultrasound pulses in the upstream and downstream directions. This difference for water flow is in the range of tens to hundreds of nanoseconds. The vernier technique suited to short time-interval measurements suffers from the instability of quick-start oscillators.

In many applications the flow pattern changes slowly. Therefore, repeated observations of the transit time difference intervals remain approximately the same. Accumulation of counts over several intervals can be used to improve the resolution, provided that the clock period is not a sub-multiple of the time interval. Therefore a clock waveform with a stable mean frequency, but with a certain randomness associated with the arrival of clock pulses has been employed.

A direct transit time flowmeter based on a simultaneous transmission scheme, incorporating a pseudo-random binary sequence (PRBS) clock waveform for the measurement of the transit time differences has been developed. The upstream transit time is measured to provide acoustic velocity compensation. Variable delays are introduced in the paths of transmitted and received signals to reduce the error due to the effect of delays in the non-flow parts of the flowmeter and the electronic measuring delays. FAST TTL ICs have been used to obtain better resolutions. High speed ICs have been used in the receiver circuits to reduce the electronic measuring delay. The flowmeter developed yields repeatable results and the relationship between the actual flow (measured using a venture meter) and the measured flow is monotonic.