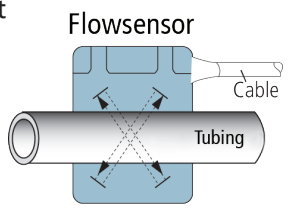
HD03 Theory of Operation

Transit-Time Ultrasound Technology: Delivered Flow

A Transonic® Clamp-on Flow/Dilution Flowsensor houses ultrasonic transducers and a tubing channel which holds the dialysis tubing containing the fluid being measured. The transducers in the sensor are positioned on opposite sides of the tubing. An electrical excitation from the flowmeter causes the transducers to emit ultrasound waves that intersect the tubing in both upstream and downstream directions. The ultrasound waves are received by the opposing transducers where they are converted into electrical signals. As the ultrasound waves travel downstream or with the flow within the tube, its velocity increases. As ultrasound waves travel upstream or against the flow, its velocity decreases. From these velocity signals, the Flowmeter derives an accurate measure of the "transit time" it takes for the ultrasound wave to travel from one transducer to the other from which it then derives volume flow.



Schematic representation of a Flow/ Dilution Sensor showing the paths of ultrasound signals across the tubing.

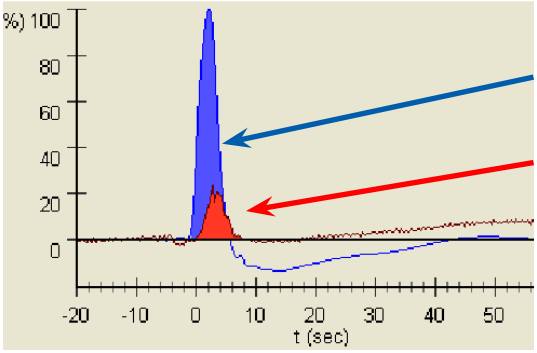
Paired arterial & venous Flow/Dilution Sensors.

A touch screen HD03 Monitor attached to an IV pole with paired arterial and venous Flow/Dilution Sensors clamped onto respective arterial and venous lines of Flow-QC tubing. Sensors can be clipped directly on the arterial and venous lines for most measurements and options. This schematic demonstrates the option for saline release into the arterial line for recirculation and access flow measurements.

Ultrasound Indicator Dilution Technology: Recirculation and Access Flow

The Transonic Hemodialysis Monitor with its Flow/Dilution Sensors measure ultrasound velocity. The velocity (1560-1590 m/sec) of ultrasound in blood is determined primarily by its blood protein concentration. A bolus of isotonic saline (ultrasound velocity: 1533 m/sec) introduced into the blood stream dilutes the blood and, thereby, reduces its ultrasound velocity. When a bolus of saline indicator is introduced into the blood line, arterial and venous Flow/Dilution Sensors record this saline bolus as a conventional indicator dilution curve.

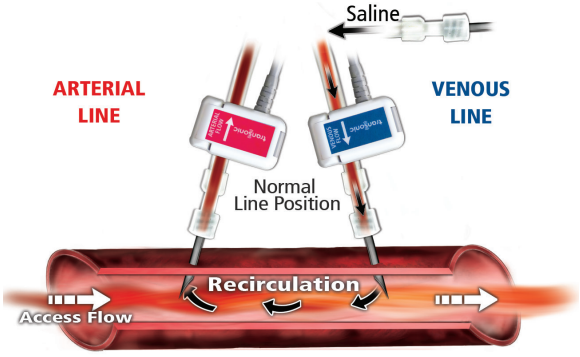
The following measurements can be selected:



Bell-shaped saline indicator dilution curve.

RECIRCULATION

The Hemodialysis Monitor identifies the direct reflux of the venous saline indicator bolus into the arterial line. The ratio of indicator concentrations equals access recirculation. The HD03 Monitor's high timing resolution separates cardiopulmonary circulation from systemic circulation and allows identification of zero access recirculation.



Normal sensor and reverse line position for access recirculation measurement.

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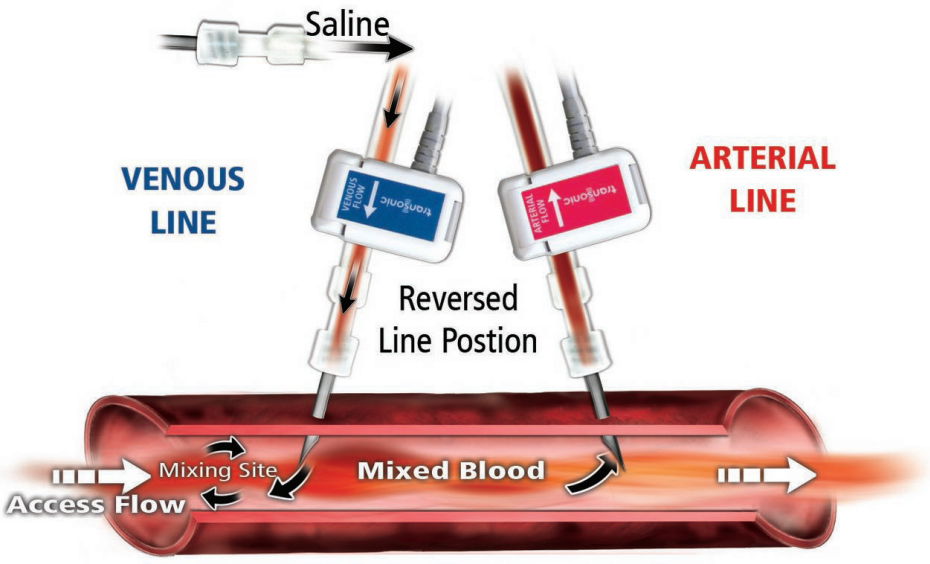
HD03 Theory of Operation cont.

ACCESS FLOW

Access Flow is measured by The Krivitski Method®, a pioneering Transonic® contribution to vascular access management. After reversing the blood lines at the needle connections, the upstream (venous) access needle introduces an indicator into the access flow stream. The downstream (arterial) access needle samples the blood concentration diluted by the indicator.



Reversed line position for access recirculation measurement. Saline injection is still made into the venous line which is now the upstream line.

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Transonic Systems Inc. is a global manufacturer of innovative biomedical measurement equipment. Founded in 1983, Transonic sells "gold standard" transit-time ultrasound flowmeters and monitors for surgical, hemodialysis, pediatric critical care, perfusion, interventional radiology and research applications. In addition, Transonic provides pressure and pressure volume systems, laser Doppler flowmeters and telemetry systems.

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