

T400-Series Technical Note

Glossary of Flowmetry Terms

ACCURACY: the quality of adhering closely to a standard of correctness.

Absolute Accuracy: the accuracy of an instrument's measurement at most physiological flows; offset error is insignificant compared to slope error. The term absolute accuracy has therefore evolved as a synonym for the range of error resulting from an incorrect slope.

Relative Accuracy: the accuracy of the instrument: often a linear correction with a slope and offset. Relative accuracy is often known as linearity.

ACOUSTIC COUPLANT: Gel, such as Surgilube, H-R Jelly or NALCO 1181, used during acute use in the acoustic window to surround Flowprobe to complete the acoustic pathway.

ACOUSTIC GEL: see Acoustic Couplant.

ACOUSTIC WINDOW/FIELD: the area defined by the pathway of the ultrasound beam between the transducers in the Flowprobe body and the acoustic reflector.

ACUTE: short-term use of a device as for intraoperative studies under anesthesia, typically less than one day. (Also see chronic & sub-acute.)

ANALOG OUTPUT SIGNAL: voltage output corresponding to the parameter measured by a device. The signal generated is calibrated by a scaling factor. The voltage range of Transonic® transit-time Flowmeters is -5 to +5 volts DC with 1 volt equivalent to full scale of the Flowprobe used.

APPLICATIONS: documented uses for Transonic® Flowmeters, Sensors and Probes.

BI-DIRECTIONAL FLOW: flow measured in positive and negative directions.

BI-DIRECTIONAL ILLUMINATION: with ultrasonic transit-time Flowprobes, a tube or vessel is positioned between transducers which generate wide beams of ultrasound to fully illuminate the vessel or tube. The ultrasound beams alternately intersect the flowing liquid in upstream and downstream directions. The Flowmeter derives an accurate measure of the changes in "transit-time" (time it takes for the wave of ultrasound to travel from one transducer to the other) influenced by the motion of the liquid.

BLF: Transonic's Laser Doppler Tissue Perfusion Monitor employing the Bonner algorithm.

BLF-FLOW: red blood cell flow reported in tissue perfusion units by BLF Monitor. This is proportional to volume flow in the tissue sampled.

BLF - MASS: mass of blood corresponding to the number of moving red blood cells within the sampled tissue. The mass of the red blood cells is proportional to the number of shifted photons in the received light.

BLF-PERFUSION UNITS: units used to report flow in BLF Monitors. Since the volume and mass of a tissue sample vary based on the

tissue's optical properties, an across-the-board calibration in ml/min/100g is not valid. The Tissue Perfusion Unit is equivalent to milliliters per minute per 100 grams of tissue (the amount of tissue actually sampled).

BLF - VELOCITY: mean velocity of the moving red blood cells within a sampled tissue. Mean velocity is proportional to the mean Doppler shift of the received light.

CALIBRATION: (often misused as a synonym for validation)

In Situ: adjustment or correction made to a measurement device for errors produced under actual conditions of use by comparing the measurement with a known standard.

In Vivo: adjustment or correction made to a measurement device during use in a "living body".

CHARBEL MICRO-FLOW PROBE®: a bayonet-style Flowprobe used in cerebrovascular neurosurgery.

CHRONIC: long in duration. Long-term studies generally involving implanting a Flowprobe so that measurements made be made in the conscious animal. (Also see acute & sub-acute.)

CONFIDENCE FLOWPROBE®: a U-shaped, four-crystal Flowprobe with an Ultrafit Liner for measuring flows in vessels with turbulent flow profiles.

Glossary of Flowmetry Terms Cont.

CUFF (SADDLEBACK): for chronic implants, a silicone sleeve is used to stabilize a Probe's CM4 or CA4 connector that has been tunneled subcutaneously to the exit site. The cuff is then sutured to the skin.

ELECTRICAL ISOLATION: grounding of the Flowmeter circuitry to prevent accidental electrical conductance between the Flowmeter and the test subject.

EPROM: (Acronym for "erasable programmable read only memory") programmed component that contains the identification and calibration information specific to each Flowprobe.

EXTENSION CABLE: cable, one end of which plugs into the connector of a Transonic® Flowprobe and the other end of which plugs into the Flowmeter; generally 1, 2, or 3 Meters long.

EXTRACORPOREAL: measurements outside of a body.

FILTERS: in electronics, a circuit that only passes certain signals. For blood flow measurement, a low pass filter is often used to strip out high frequency noise, leaving only the biological components of interest.

FLANGE: a silicone rim or collar that can be cemented around PR-or PS-Series Probes to suture the Probe to surrounding tissue; used in coronary artery and umbilical artery applications.

FLOW: volume or velocity movement of a liquid (blood, saline, isotonic solutions) passing a given point in a given time (measured in L/min or ml/min).

FLOWMATTER™: Transonic's e-mail newsletter distributed quarterly to scientists worldwide.

FLOW/DILUTION SENSOR: sensor used in conjunction with a HD Hemodialysis Monitor. The Sensor measures volume flow by transit-time ultrasound technology and concentration of the blood by standard dilution technique.

FLOW VELOCITY PROFILE: the distribution of velocity across the vessel.

FLOWMETER: a device for measuring velocity or volume of flow of liquids or gases passing a given point per unit of time. Specifically, with regard to Transonic® Flowmeters, the box which houses the power supply and signal processing circuitry; a digital readout of the flow is displayed on the front panel.

FLOWMETRY: the monitoring or study of flow parameters.

FLOWPROBE: a device which measures flow. Transonic® Perivascular Flowprobes contain the ultrasonic transducers for insonating vessels to measure volume flow of blood or other liquids.

FLOWSENSOR: a device which measures flow. Transonic® Inline & Clamp-on Flowsensors measures the volume flow of a liquid passing through tubing by transit-time ultrasound technology.

GAIN: a linear factor in electronic circuitry used in a device as a multiplier after calibration. The sensitivity of a Probe is adjusted by changing the gain.

HZ: a cycle or repetition per second. In ultrasound: Transonic's specification for the frequency of the ultrasound from the Probe crystals is listed in Megahertz (MHz). For a 4PS Probe it is 2.4 MHz (2,400,000 cycles per second). In Data Acquisition: Sampling rates are reported in hertz; 100 Hz means 100 data points recorded per second.

KEY: EPROM separate from and specific to each Flowprobe that contains the identification and calibration information for Probes with 4-pin miniature connectors used in chronic applications. This programmed device plugs into a port on the Flowmeter.

MICROPROCESSOR: miniaturized integrated circuit capable of processing a high volume of signals to report results or control functions of instruments or machines.

MRI: (acronym for Magnetic Resonance Imaging): diagnostic imaging modality using nuclear magnetic resonance technology in which a patient's body is placed in a magnetic field and its nuclei (hydrogen) are excited by radio frequency pulses at angles to the field's axis; resulting signals are processed through a computer to produce an image. MRI compatible Flowprobes can be custom ordered.

Glossary of Flowmetry Terms Cont.

NANOPROBES: Transonic® 0.5 and 0.7 PS-Series Precision Flowprobes scaled to fit mouse anatomy; manufactured using nanofabrication techniques to phototech miniature structures to precision spec for accurate transducer alignment.

OEM SYSTEMS: Original Equipment Manufacturer (OEM) systems are custom engineered by Transonic® to be embedded within clinical OEM products such as bypass pumps, ECMO apparatus, infusion/transfusion/perfusion systems, dialysis apparatus and organ preservation apparatus.

OPTIMAX FLOWPROBE®: Specially-designed minimally invasive Flowprobe with tape-on supports affixed to an elongated flexible Probe neck, to stabilize the Probe on the vessel for continuous measurements.

PERFUSION: the supplying of fluid to an organ or tissue. The passing of blood through the vasculature of an organ or tissue.

PERIVASCULAR: surrounding a blood or lymph vessel as in Transonic® Perivascular Flowprobes for use on vessels.

PRECISION: the quality of repeatable recognition of minute changes in measuring a parameter. An instrument may be precise but inaccurate and vice versa.

PULSATILE FLOW: biological flows vary instantaneously throughout the cardiac cycle. The analog output can be filtered to give a pulsatile or mean flow signal.

RANGE: the set of numbers between the limits of the maximum and minimum values measurable.

REFLECTOR: stationary plate component of Transonic® PR-& PS-Series Flowprobes. Each transducer alternately emits an ultrasound beam which is reflected from the stationary plate to a receiving transducer. The fixed distance of the reflective pathway is critical to ultrasonic transit-time measurements and accurate measurement of volume flow.

RESOLUTION: represents the smallest detectable change in flow. Probe resolutions are generally specified at 0.1Hz filtering.

ROM: (Acronym for "read only memory") microchip component in Probe connector that contains the identification and specific calibration information for each Flowprobe.

SAMPLING RATE: number of samples taken per unit of time. In digital signal processing (Nyquist theory) it is necessary to sample twice as fast as the highest frequency component.

SCALE: Factor used to calibrate a voltage signal. Transonic® Flowprobes operate in either of two scales; low flow or normal flow scale determined by the range of flow under study.

SENSITIVITY: amount of voltage output per unit of parameter measured.

SENSITIVITY ERROR: error resulting from incorrect gain. Total error is the sum of sensitivity error and the offset error.

SIGNAL-TO-NOISE RATIO: the ratio of desired signal to undesired noise; often expressed in decibels, a logarithmic scale commonly used by engineers.

SILICONE SHIELD: a silicone protective plate which encapsulates a U reflector on a PS-Series Flowprobe; used to maintain Probe orientation, cushion pulsatile vessels and retard fat ingress.

SILICONE WRAP: a reinforced mesh which is wrapped around a Transonic® Flowprobe at an implant site to retard fat ingress and stabilize the Probe's position.

SUB-ACUTE: duration longer than acute, but not as long term as chronic; typically 8 hours to 3 days. In this context, subacute applications of Transonic® ultrasound instruments are similar to acute applications where the implanted Flowprobe is not stabilized by fibrotic tissue ingrowth, and the ultrasound signal may yet be interrupted by the presence of air.

TIMED COLLECTION: a calibration technique combining a known volume with a measured time, as in the use of a beaker and stopwatch.

TRANSDUCER: a device that transforms a physical parameter into an electrical signal, as in a Transonic ultrasound Flowprobe; the ultrasound signal produced by the piezoelectric crystals is transformed and converted into an electrical signal proportional to volume flow.

TRANSIT-TIME: time it takes for a pulse of ultrasound to travel from one transducer to another.

Glossary of Flowmetry Terms Cont.

ULTRASONIC: relating to energy waves similar to those of audible sound but of higher frequency (above 30,000 Hz)

ULTRASONIC COUPLANT: a material that propagates acoustical waves; for blood flow measurement, a material is chosen that mimics the acoustic characteristics of biological tissue.

ULTRASONIC SIGNAL COUPLING: a term used to describe the state of sound propagation between the transducer and tissue. Signal coupling is degraded by air bubbles and materials that do not conduct sound.

ULTRASONIC TRANSIT-TIME: a technology to measure volume flow of liquids by using wide-beam illumination; transducers pass ultrasonic signals back and forth, alternately intersecting a flowing liquid in upstream and downstream directions. The Transonic® Flowmeter derives an accurate measure of the “transit-time” it took for the wave of ultrasound to travel from one transducer to the other. The

difference between the upstream and downstream integrated transit times is a measure of volume flow.

ULTRASOUND DILUTION: a technology which unites dilution and ultrasonic transit-time to measure the changes that occur in the velocity of a liquid when diluted with isotonic saline; measures recirculation, access flow and cardiac output during hemodialysis.

VALIDATION: test to confirm calibration and accuracy of a measurement, usually by comparing to a known standard such as timed collection.

WAVEFORM: the record of a signal that varies over time. A blood flow signal usually varies periodically with the cardiac cycle.

WIDE-BEAM ILLUMINATION: the use of an ultrasonic beam wider than the vessel of interest. Wide-beam illumination is necessary for volume flow measurement with the ultrasonic transit-time technique.

X-ILLUMINATION: ultrasonic illumination which fully illuminates the vessel or tube to provide a measure of volume flow by ultrasonic transit-time. A vessel or tube is positioned between four transducers that generate wide beams of ultrasound that fully illuminate the vessel or tube. The ultrasonic beams alternately intersect the flowing liquid in upstream and downstream directions. The integrated difference between the two upstream and downstream transit-times is a measure of volume flow.

ZERO OFFSET DRIFT: zero offset change over time.

ZERO OFFSET: the measurement registered by the instrument under conditions of zero input. In blood flow, this is the Flowmeter reading when flow is known to be zero due to occlusion of the vessel or other means. A two point calibration can be performed by combining a zero offset determination with a timed collection.



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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