Section C: Flowsensors

Contents

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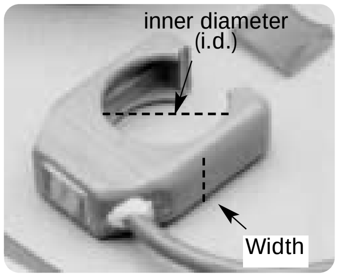
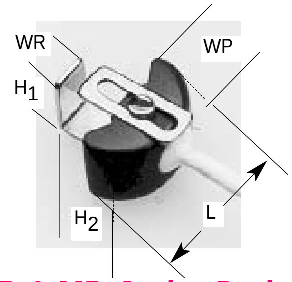
C. Perivascular Technical Specifications

C. Perivascular Physical Specifications



A-Series Probe



SB & MB-Series Probes

PROBE	PROBE BODY			REFLECTOR			CABLE	
Type	WGT (gm)	L length (mm)	WP width (mm)	H_1 height (mm)	H_2 height (mm)	WR width (mm)	CABLE length (m)	CABLE diameter (mm)
H1R	0.2	6.5	4.0	1.1	1.5	2.0	.6	1.5
H1.5R	0.25	7.6	3.5	6.6	1.7	2.5	.6	1.5
H2R	1.5	13.0	6.0	8.8	3.5	5.0	1.0	1.5
H2SMB	12	8.7	6.8	2.0	2.0	3.5	127	2.0
H2MB	16	9.0	13.0	2.5	3.5	5.0	127	2.0
H3MB	15	10.5	8.0	3.7	4.0	3.54	127	2.0
H4MB	17	13.0	8.0	4.4	5.5	3.8	127	2.0
H6MB	18	13.5	8.0	6.6	7.8	4.0	Handle Length 127	Total Length 2.0
H8MB	20	19.0	9.0	8.8	8.2	6.0	127	2.0
H10MB	20	19.0	9.0	11.0	10.0	6.0	127	2.0
H12MB	27	22.0	9.0	13.0	12.0	6.2	127	2.0
H14MB	29	26.0	10.0	15.0	14.5	7.5	127	2.0
H2SB	0.3	8.7	3.3	2.5	2.0	3.3	1.0	1.5
H2.5SB	0.3	8.7	3.3	2.5	3.2	3.3	1.0	1.5
H3SB	1.2	9.0	5.0	3.7	4.0	3.5	1.0	1.5
H4SB	1.5	13.3	6.0	4.4	5.5	3.8	1.0	2.0
H6SB	2.7	13.5	6.7	6.6	7.8	4.0	1.0	2.5
H8SB	5.0	18.8	7.5	8.8	8.2	6.0	1.0	2.5
H10SB	5.3	18.7	8.5	11.0	10.0	6.0	1.0	2.5
H12SB	9.3	22.5	8.5	13.0	12.0	6.2	1.0	3.0
H14SB	11.6	26.2	8.5	15.0	14.5	7.5	1.0	3.0
H16SB	16.6	36.0	10.0	17.7	17.0	9.0	1.0	3.0
H 8A	3	8 id	5				1.0	1.5
H10A	5	10 id	7.37				1.0	1.5
H12A	7	12 id	8				1.0	1.5
H14A	12	14 id	9				1.0	2.0
H16A	14	16 id	10				1.0	3.0
H20A	15	20 id	12		*N/A*		1.0	3.0
H24A	20	24 id	15				1.0	3.0
H28A	30	28 id	17				1.0	3.0
H32A	40	32 id	20				1.0	3.0
H36A	50	36 id	22				1.0	3.0

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PROCEDURE	CAT #	TUBING Inner Diameter (in inches)	TUBING Wall Thickness (in inches)	STOCK TUBING If using tubing of different diameter or type, please discuss tubing with customer service representative.
Carotid Shunts	H3C	1/8	1/32	
	H4C / H5C	3/16 1/8	1/16 1/16	
Pediatric CP Bypass	H6C / H7C	1/4	1/16	dideco XS - class VI BENTLEY BYPASS 70 MEDIFLEX TYGON R-3603 TYGON S-50-HL, - class VI
	H8CS	1/4	3/32	TYGON S-50-HL - class VI TYGON R-3603 MEDIFLEX
Adult CP Bypass	H8C / H10C	3/8	1/16	TYGON R-3603 TYGON S-50-HL, class VI
	H8C / H10C	3/8	3/32	TYGON S-50-HL - class VI TYGON R-3603 dideco XH - class VI INTERSEPT - class VI MEDIFLEX BENTLEY BYPASS 70 BENTLEY BYPASS 65

A 30 cm sample of tubing will be required for flowsensor calibration, if your tubing is not included on this list.

For strictly extracorporeal applications the HT109 flowmeter offers higher accuracy with X-style sterile tubing flowsensors on a broader spectrum of tubing types.

Specifications

TYPE	TUBING I.D. inches	TUBING Wall Thickness inches	TUBING Material	BIDIRECTIONAL FLOW Resolution ml/min	BIDIRECTIONAL FLOW Low Flow Scale Factor ml/min	BIDIRECTIONAL FLOW Normal Scale Factor ml/min	BIDIRECTIONAL FLOW Maximum Range L/min	ACCURACY Typical 8 Hr. Zero Stability2 ml/min	ACCURACY Absolute Accuracy3 %	ACCURACY Relative Accuracy3 %	ULTRA-SOUND Frequency MHz
H3C	1/8	1/32	S,U,P	0.5	50	200	1L	± 2.5	± 7	± 2	3.6
H4C / H5C	3/16 1/8	1/16 1/16	S,U, S	1.0	100	400	2L	± 4.0	± 7	± 2	2.4
H6C / H7C	1/4 1/4	1/16 3/32	S,U,P S,U	2.5	250	1 L	5L	± 7.5	± 7	± 2	1.8
H8CS H8C / H10C	1/4 3/8 3/8	3/32 1/16 3/32	P S,U,P S,U,P	5.0	500	2 L	10 L	± 10	± 7	± 2	1.2

1 S = Silicone or C-Flex; U = polyurethane such as Tygothane, Nalgene 8030,290; P = PVC type, with durometer hardness (shore A) between 40 and 64 such as Tygon R3603, R1000, S-50, Mediflex, Nalgene 8000. Note: probes for tubing materials with sizes not listed may be custom built. Preferred tubings are "S" and "U" types.

2 Stability: Zero offset variation in the above table represents the maximum variation, after pre-zeroing of the flowmeter over an 8-hour time period for a liquid temperature change not exceeding 5° C.

3 Accuracy: The sterile tubing (clamp-on) flowsensors are precalibrated for the liquid on which they are used. Total accuracy will be the sum of absolute accuracy (or relative accuracy [linearity] of only relative measurements are made) and zero offset drift. The absolute accuracy is ± 7% of the flow reading and is the maximum deviation from 1.00 of the slope of the plot of measured flow versus true flow. Absolute accuracy varies with temperature, composition of fluid, and tubing diameters and can be increased to ± 2% by calibrating *in situ* on the tube with a given fluid and temperature. Relative accuracy is ± 2% of flow reading and is the maximum deviation from linearity of the above plot.

C. Flowprobe Calibration

A. FACTORY CALIBRATED FLOWPROBES

All Transonic flowprobes are factory calibrated. The Transonic factory routine is presented below to demonstrate flowprobe operation in a bench setting. The "Publications Reprint List" in Appendix C provides a bibliography of *in vivo* studies which have validated the Transonic flowmetering system for numerous models. *In vivo* or *in situ* calibration is recommended for new applications.

B. BENCH CALIBRATION PROCEDURE

Transonic perivascular flowprobes can be calibrated using a gravity-fed constant flow set-up (Fig. B.1). Within the water bath, a thin-walled latex cylinder (e.g., drainage tube, tubular balloon) or dialysis tube is mounted and the perivascular probe is positioned around it. The tubing's diameter should be 3/4 of the probe's size (i.e. 6 mm inner diameter tube for an 8 mm probe). To assess whether the walls of this tube are sufficiently transparent to ultrasound to act as a surrogate vessel, observe the received signal amplitude on the front panel analog display with the flowmeter in the "TEST" mode. This amplitude should drop less than 5% when the liquid-filled tube is introduced into the probe's acoustic window.

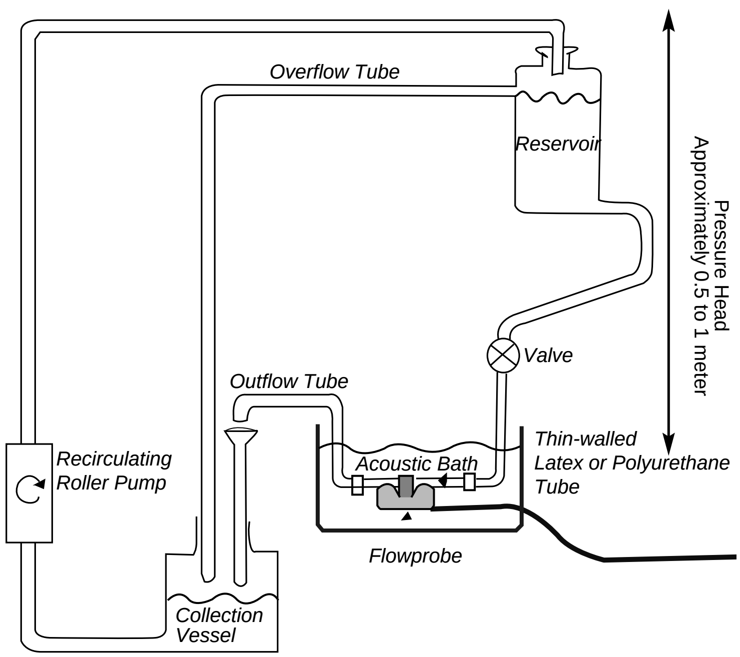

Fig. B.1: Gravity-fed constant flow set-up used for the bench calibration of perivascular flowprobes. The temperature of water within the bath and the circulating water should be approximately the same. A roller pump is preferred to a centrifugal pump, as the latter heats up the circulating liquid. Tap water that has been standing overnight or long enough so it does not form air bubbles on the surfaces of probe and containers should be used in both the water bath and the circulating system. Sterile tubing (clamp-on) flowsensors are calibrated on the user-selected laboratory tubing for which they are specified using a similar apparatus without a water bath.

(Sterile tubing (clamp-on, C-Series) flowsensors should not be immersed. They are individually calibrated on the tubing for which they are specified.)

Calibrate the constant flow setup by collecting the outflow into a graduated cylinder over a measured period of time and calculating the volume flow. Be sure to convert units to ml/min. Also, take care that the pressure head is not altered when the outflow tube is moved from the collection vessel to the graduated cylinder.

Record both the calculated flow and the indicated flow. You may wish to graph the data as shown in figure B 2. (Normal convention is to place the calculated flow on the X axis and the measured flow on the Y axis.)

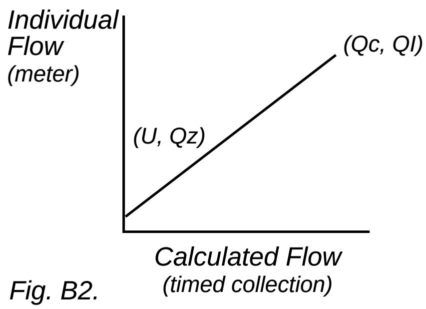

Fig. B2.

Once graphed, we need to correct the flow for the zero offset and then compute the slope of the curve. This is easily accomplished in a two point calibration (when one point is a zero) by taking the difference between the indicated zero and the indicated flow and dividing it by the calculated flow.

$$\text{SLOPE} = \frac{(QI - QZ)}{QC}$$

This slope of the calibration graph should be approximately equal to one. There will be small deviations because the ideal of a constant ultrasonic field within the flowsensing area is not fully achieved. In practice, the field strength is stronger in the center of the window and declines somewhat at the edges. Because of this small variation, Transonic Systems offers two types of factory calibrations.

Measurement Accuracy Definitions

For the curve $y = a + bx$, in Fig. B.3:

Zero baseline offset:
Apparent flow measured by meter at true flow = 0.

Zero baseline stability:
In situ variation of zero baseline offset over an 8 hour period (at a temperature not to exceed change of five degrees Celsius).

Flow Resolution:
Minimal change discernable in volume flow, with the meter output filter in the 10Hz setting.

Absolute accuracy:
Limits within which true flow $x2$ is known, given a flow measurement $y2$.

Relative Accuracy (linearity):
The extent to which true change in flow, $x2/x1$, is expressed by the ratio $y2/y1$, given flow measurements $y1$ and $y2$.

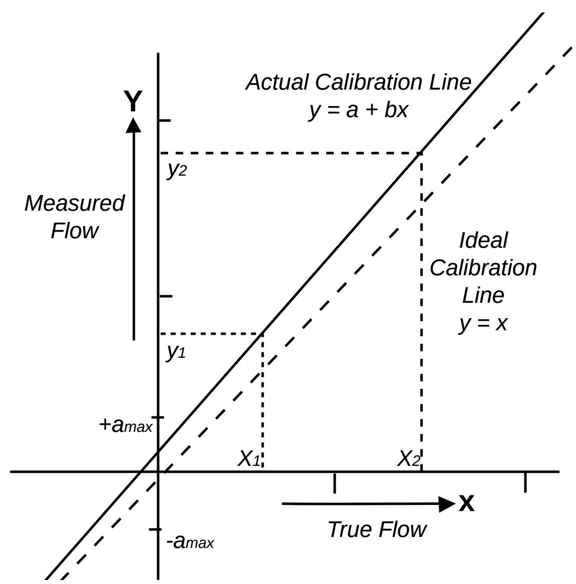

Fig. B.3: Definition of Accuracy Specifications