Sensors of the **SONOFLOW CO.56 Pro** series are used to measure the flow rate of liquids and to detect air bubbles in tubes of various diameters.

The lightweight non-invasive sensors with small footprint are intended to be clamped around the tubing, free-hanging. Specifically designed for implementation in medical devices such as cardiopulmonary bypass and dialysis machines the sensors fulfil explicitly high medical safety standards. Via RS485 interface the sensors are ready for bus operation up to 12 devices.

Overview sensors

Specification SONOFLOW CO.56 Pro	Order-No.	Max. flow range	Channel width	Dimensions L x W x H	Max. weight
1/4”x 1/16”	200 04 0037	4 000 ml/min	8.2 mm	46 x 35 x 32 mm	105 g
1/4”x 3/32”	200 04 0038		10 mm	46 x 35 x 34 mm	100 g
3/8”x 3/32”	200 04 0039	10 000 ml/min	12.3 mm	46 x 35 x 36 mm	110 g

Tubing properties

The selection of the right sensor depends on tubing dimensions as well as on tubing properties. If possible, please provide us with a tubing sample (minimum length 50 cm).

Material: PVC
Manufacturer: RAUMEDIC-ECC-Blood Line

Specification SONOFLOW CO.56 Pro	Tubing OD	Tubing ID	Wall thickness
1/4”x 1/16”	3/8″	1/4″	1/16″
1/4”x 3/32”	7/16″	1/4″	3/32″
3/8”x 3/32”	9/16″	3/8″	3/32″

Other materials and diameters upon request. Contact our service.

Calibration and conditions of use

Calibration	Sensors are factory calibrated under the following conditions: ▪ PVC tubing as listed in table above (Tubing properties) ▪ Water at 23 °C ± 2 °C ▪ Warm up: at least 30 min (to compensate thermal effects) ▪ Zero calibration just before measurement procedure ▪ Normal pressure Calibration to customer tubing, fluid, flow range, temperature, etc. on request.
Media	Water, human blood or other acoustically transparent liquids ⚠ **NOTE**: SONOTEC does not operate with human blood within the company premises. With respect to calibration, the difference between water and saline solution is negligible. For applications with blood (hemoglobin: Hb = 9 ± 2 g/dl) some special factors/settings can be modified after calibration (→ observe the instruction in the next chapter.)
Conditions of use	⚠ **CAUTION:** The sensors need to be adjusted individually to special operating conditions ▪ in case of operation with tubing not listed in the table 'Tubing properties', because the accuracy of flow measurement and bubble detection can be affected and ▪ if the sensor is intended to measure with human blood at normally 37 °C and hemoglobin between 6 g/dl to 12 g/dl. Contact our service for details!
	⚠ **NOTE:** Generally, the sensors are able to measure liquids in an extended operating temperature range of +1 to +50 °C and to measure blood within the ranges of Hb = 0 to 6 g/dl or Hb = 12 to 18.5 g/dl, but with limited accuracy only.

Accuracy depends on tubing, temperature, fluid properties and other conditions. Absolute accuracy is influenced by zero stability, resolution and zero offset effects. For details see next chapter.

Flow accuracy and repeatability

Specification SONOFLOW	Flow measurement accuracy after 30 min sensor warm-up, no thermal gradients, normal removing / inserting of tubing. Flow measurement repeatability at constant conditions, after 30 min warm-up, no thermal gradients, lid remains closed, no removing / inserting of tubing, no movements of sensor or tubing.			
1/4”x 1/16”	< 400 ml/min:	**± 20 ml/min** ± 8 ml/min	≥ 400 ml/min:	**± 5 %*** ± 2 %*
1/4”x 3/32”				
3/8”x 3/32”	< 1 000 ml/min:	**± 50 ml/min** ± 20 ml/min	≥ 1 000 ml/min:	**± 5 %*** ± 2 %*

* of reading

Zero point stability: Flow measurement drifts less than 0.02 l/min in 24 h at zero flow.

Bubble detection and sensitivity

If bubbles with a size larger than the threshold are detected a bubble alarm is set. The threshold depends on the sensor type. The bubble sensitivity depends on the diameter of tube and on the mounting position.

Bubble sensitivity	Bubbles larger than approx. 30 % of internal tube diameter are detected Larger amounts of foam in the liquid will be detected as air.
Reaction time	Internal evaluation of bubbles within intervals of max. 1.6 ms
Response time	< 10 ms; faster response time possible if needed

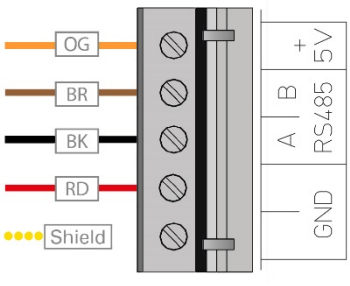
Technical data

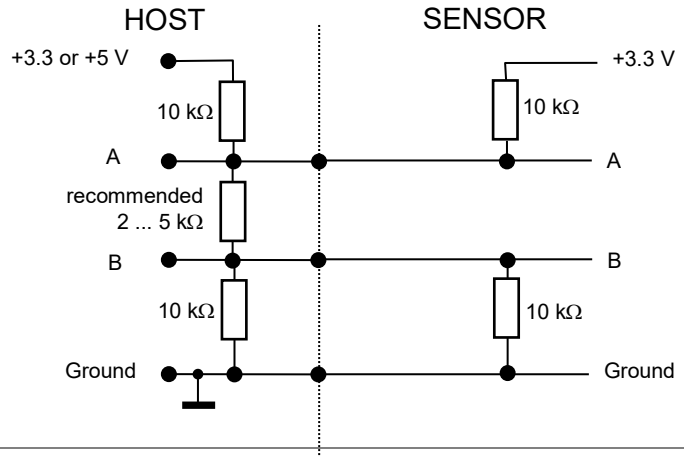
SONOFLOW CO.56 Pro **FlowBubble Sensor for liquids**	
Measuring method	Ultrasonic transit time difference measurement in transmission with two redundant measurement paths, dry coupling, no couplant required
Mounting	Clamped on the tube, hanging freely (cable outlet at the side of the sensor)
Tube insertion	▪ Tube must be put in manually without tools. Lid must be closed. ▪ No couplant (e.g. gel) permitted. ▪ Prevent excessive bending or tube compressing close to sensor (10 x inner tube diameter before, 5 x inner tube diameter behind the sensor)

Sensor materials	Measuring channel: PMMA black, Housing: aluminium, anodized black (optional: individual colors) Rating plate with label: stainless steel Bend relief and cable: plastics black
Sensor materials	Measuring channel: PMMA black | Housing: aluminium, anodized black (optional: individual colors) | Rating plate with label: stainless steel Bend relief and cable: plastics black
Labeling	Laser engraving: arrow on lid indicating flow direction; size of specified tube on lid inside; rating plate: label on rear side (sensor type, hardware version, serial number, manufacturer with address); others upon request
Operating voltage	5 VDC +0.5/-0.1 VDC Internal suppressor diode to protect the sensor: Overvoltage protection: 5 V / 600 W, shortly Inverse-polarity protection: In case of inverse polarity, the sensor is protected by the diode. A high short-circuit current flows.
Electrical safety	For MOPP (MEANS OF PATIENT PROTECTION) acc. IEC 60601-1: The protection from SECONDARY CIRCUITS requires to install a SELV (Safety Extra-Low Voltage) converter prior to connecting the SONOFLOW flow bubble sensor into medical devices. This ensures that no higher voltage than 60 V can occur at the sensor under any circumstances. Classification as Applied Part “CF” in combination with MDEV and tubing is possible, depending on application (electrical insulation: tested with 500 V).
Current consumption	< 150 mA Power supply of the sensor needs a current limiter, e.g. a fuse (minimize risk of a heating / fire as consequence of short-circuit) ⚠ **ATTENTION**: Current must be limited externally to max. 250 mA (e.g. fuse)
Electrical connection	Type: UL-LifYDY / 5 x 0.08 mm² / shielded / Ø 3.5 ±0.1 mm Length: 2.5 m (± 10 cm), strain reliefs at each end, WECO terminal block for connection of SONOFLOW Monitor

Assignment

Colour	Connection	WECO Terminal
Orange	VCC	1
Brown	RS485 - B	2
Black	RS485 - A	3
Red	GND	4
Shield / Yellow	Housing of sensor	5



RS485 interface (SONOTEC protocol)	Half-duplex operation / 115.2 kbaud / 8 bit data 1 stop bit / no parity bit/ no handshaking Dialog mode (on demand): machine is intended to ask results cyclically, sensor does not have an own alarm equipment) Query cycle: 20 … 200 ms (typically) ⚠ **NOTE:** Description of serial protocol with details upon request. 
RS485 Bus operation	Bus operation supported up to 12 subscribers, default address is #01 (can be changed with the help of SONOFLOW Monitor, permitted are addresses from #01 … #12)
Maintenance	Maintenance-free
Operating temperature	+10 … +50 °C (see also chapter ‘Calibration and conditions of use’)
Ambient- / Media temperature	+15 ... +43 °C
Storage & transportation temperature	-20 ... +60 °C
Humidity	10 … 95 % relative. humidity (not condensing)
Atmospheric pressure	70 … 106 kPa
Humidity	10 … 95 % (values below not tested), non-condensing
Degree of protection	IP67
Scope of delivery	• SONOFLOW CO.56 Pro according to specification • User documentation
Optional accessories	• Calibration report
	SONOFLOW Monitor Software for setting parameters, recording measurements and update of sensor software consisting of • USB Data Converter (type 012), for the connection to a computer • USB cable, type A-B, length 2 m • CD with Software SONOFLOW Monitor and driver for Windows

Directives and standards

Medical safety	Medical safety: IEC 60601-1 3rd edition
Electromagnetic compatibility	EMC tests must be performed by manufacturer of MDEV after built-in MDEV. Precondition for EMC is the safe, functional earthing of housing by means of screws or connection line. Pretests have been performed by SONOTEC acc. IEC 60601-1-2, 4th edition. ▪ IEC 61000-4-3 (electromagnetic immunity) 10 V/m | 80 MHz to 2.7 GHz | 80 % AM at 1 kHz ▪ IEC 61000-4-3 (electromagnetic immunity, wireless frequencies) Section 8.10 ▪ IEC 61000-4-8 (magnetic fields) 30 A/m | 50 Hz und 60 Hz ▪ IEC 55011 class B / CISPR 11 (electromagnetic emission), tests according to IEC 55016: 30 … 1000 MHz | 30 dBµV @ 10 m ▪ IEC 61000-4-2 (electrostatic discharges) ± 8 kV direct and indirect contact | ± 15 kV air ▪ IEC 61000-4-4/ IEC 61000-4-5/ IEC 61000-4-6: not applicable Rationale: Sensor doesn‘t provide a patient-coupled line and the cable length is below 3 m.
Further standards	• Software development: DIN EN 62304, class C • RoHS: 011/65/EU, exception: III 7cl/ IV 15 • Acoustic emission: IEC 61157, suitable for use on human blood

Use in medical devices and safety

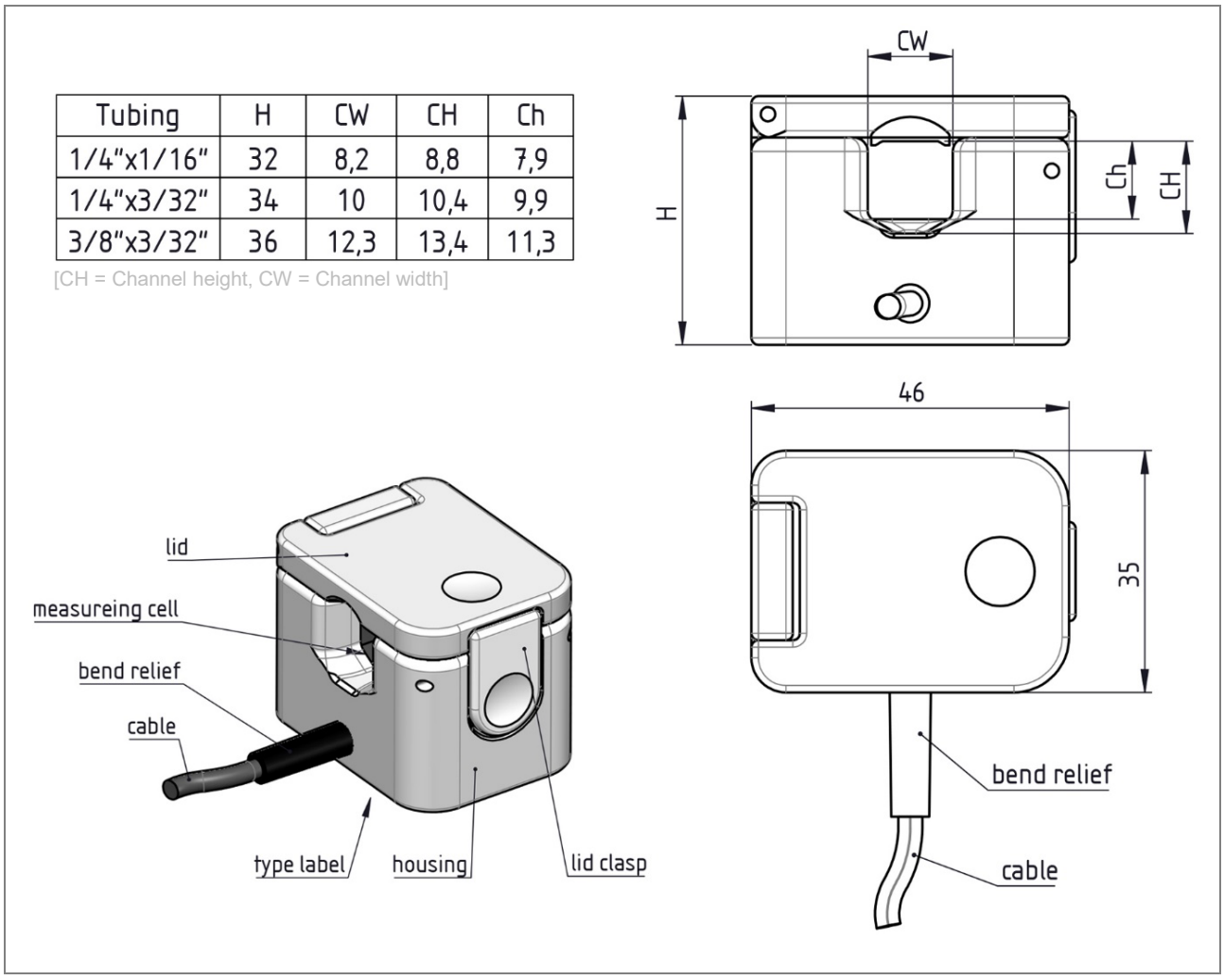
The manufacturer of the medical device is responsible for the medical approval. SONOTEC as supplier supports the approval process and shares documents with a notified body (3rd party).

Medical safety	• PESS (Programmable Electrical Sub System) according to the IEC 60601. • One-channel architecture / Fail Safe • Cyclical self-tests of safe functionality of all essential components • Output secured by watchdog: in case of major errors (for example software crashes), the output will be blocked • After power on or software reset: initial test procedure (check of output circuit, watchdog functionality and locking of output)
Self-test	FTT: 0.7 s (cycle time of self-test), MFTT: 24 h (tests after power on or restart only; sensor must be restarted within the defined period)
Special applications	⚠ **ATTENTION**: The sensors are not suitable to be applied in immediate proximity to operating surgical devices using high energized pulses e.g. electrosurgical knifes (radio frequency cautery). The sensors might be destroyed, the values of flow could be affected or the sensor could raise false bubble alarm due to the strong radiation along the tubing. Customized sensors with additional protection are available.

Technical drawings

Tubing	H	CW	CH	Ch
1/4"x1/16"	32	8,2	8,8	7,9
1/4"x3/32"	34	10	10,4	9,9
3/8"x3/32"	36	12,3	13,4	11,3

[CH = Channel height, CW = Channel width]



Dimensions SONOFLOW CO.56 Pro

Drawings are not to scale. Dimensions in mm, unless otherwise specified. Information is subject to change without notice!

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