

Ultrasonic Flow Measurement Instrument With Strap-On Sensors Intrasonic IS-100



Transit time sound measurement between ultrasound transmitter and ultrasound receiver in the direction, as well as opposite the direction of liquid flow to calculate volumetric flow, average flow velocity and speed of sound (to measure concentrations) in a liquid

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1 Introduction To Ultrasound Flow Measurement

Volumetric flow measurement by means of ultrasound was first suggested by von Rütten in 1931. Basic practical research goes back to the 1950's and dealt with the measurement of flow velocities in open channels and volumetric flow measurement in pipes and channels. Today's ultrasonic flow measuring devices can be classified by their installation methods into two groups:

- Installation into the pipe, so called intrusive assembly and
- Non intrusive installation to the outside of the pipe with strap on sensors

The advantage of an installation and measurement without having to shut down the process was recognized in all industrial segments and was the primary reason for the rapid deployment of this technology. The following list shows some of the many possible applications

Power plants

- Measurement of cooling water/ boiler feed water / condensate
- Measurement of thermal energy flows

Petro-chemical industry

- Leak detection in pipelines
- High pressure flow measurement

Water- and waste water

- Process measurement on large pipes
- Distribution- and consumption measurement
- Leakage and test of water meters

Food & beverage industry

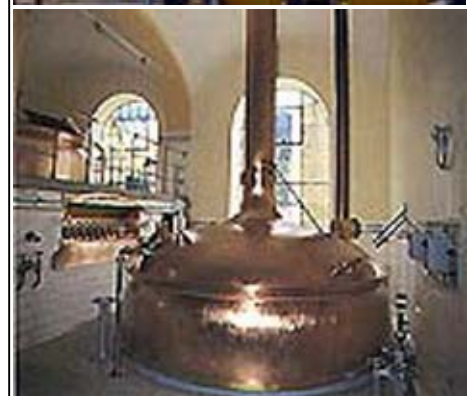
- No-contact sanitary flow measurement, steam sterilization possible

Ship building

- Control of cooling and lubrication cycles
- Measurement of fuel consumption

Chemical industry

- Non intrusive measurement, especially of aggressive or poisonous media
- Measurement of non conductive media
- Portable and thus mobile service



2 Advantages Of Intrasonic With Strap-On Sensors

2.1 Advantages At A Glance

IntraSonic is an ultrasonic flow measurement instrument designed to measure volumetric flow inside a pipe. Its working principle is the measurement of transit time differentials. It can also measure average flow velocities and fluid concentrations in closed pipes. The main advantages of IntraSonic are:

- **Non intrusive installation without process interruption**
- **Simple and cost effective installation on to the pipe**
- **Quick and easy functionality tests of other measurement systems**

Further advantages:

- **Cost effective and simple method to measure flow at different locations.**
- **Cost effective solution for large pipes or high pressures**
- **No pressure loss**
- **Measurement of speed of sound (e.g to measure concentrations)**
- **Measurement of sound dampening (e.g to measure sound dampening deposits)**
- **Clear and simple instrument operation**
- **Meaningful functionality checks to evaluate the received signals**
- **Detailed error- and status messages facilitate error corrections**

2.2 Installation With Out Process Interruption

With current technology only a few flow measuring devices can retroactively be installed at a measurement location without having to interrupt the process. The instrument selection must take into consideration: type of liquid to be measured, required accuracy, purchase-, installation- and operating costs. The following table compares the two available ultrasonic measurement methods. The IntraSonic ultrasound instrument will be the first choice for many flow measurement applications requiring a retroactive installation without process shut-down.

Measurement principle of ultrasound instrument	Liquids to be measured	Pipe intrusion required ?	Method to measure average flow velocity	Accuracy as % of rate	Installation costs
Transmit time differential principle	Liquids with air or gas portion of < 3 Vol. %	No	Averaging along ultrasound path between sensors	∂ 1	low
Doppler principle	Liquids with near homogenous distribution of air, gas or particles	No	Averaging in narrowly defined ultrasound path	∂ 3 - 10	low

2.3 Two Installation Methods Are Available

The instrument allows two operating modes: „direct-mode“ and „reflective-mode“.

In direct-mode both sensors are installed opposite each other on the pipe wall. The sound wave crosses the pipe once (see Fig 3.1).

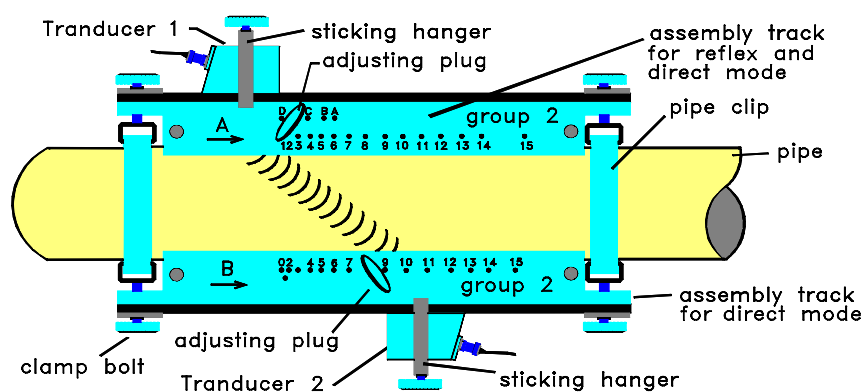


Fig 3.1: Pipe with ultrasonic converters mounted in direct-mode

In reflective-mode both ultrasonic converters are installed on the same side of the pipe (see Fig 3.2). The sound wave crosses the pipe twice.

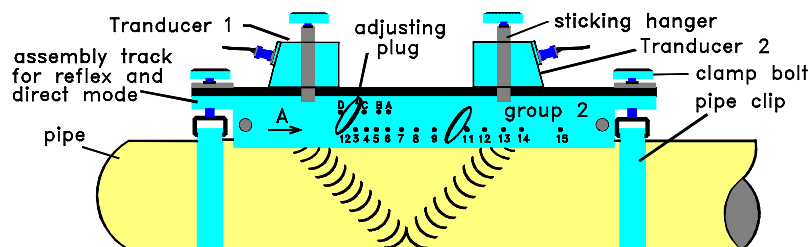


Fig 3.2: Pipe with ultrasonic converters mounted in reflective-mode

2.4 Simple Attachment To Pipe

The direct-mode assembly requires two assembly rails, the reflective-mode assembly requires one assembly rail. These rails have marked bore holes indicating the converter positions. The distance between converters is calculated and indicated by the instrument

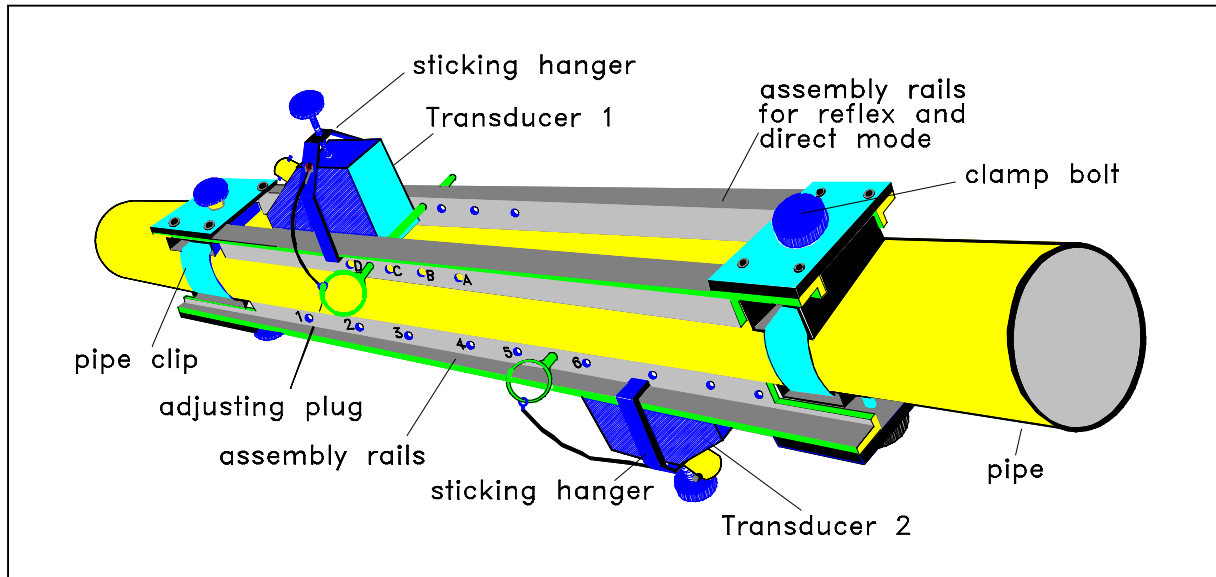


Fig 3.3: Required converter assembly components

2.5 Functionality Tests

Accoustic measurement test runs are available as accessories. They serve as a valuable aid for first installations, maintenance, tests, demonstrations and training. Two types of accoustic measurement test runs are available:

- The **pipe simulator** is a device suitable for two ultra sound converters. It consists of a synthetic material with good sound propagating properties. With the help of the pipe simulator conditions can be created which are very similar to actual pipe conditions.
- The **pipe enclosure** consists of a piece of pipe to be erected vertically, the lower end of which is to be welded to a plate. The pipe enclosure is an assembly structure designed to be used with the complete instrument set. With the pipe enclosure conditions can be created which match exactly the accoustic conditions in a fully filled pipe.



The following table shows the possible applications and functions of the accoustic measurement test runs:

Possible applications and functions	Pipe simulator	Pipe enclosure
Functionality test of the instrument on site	X	
Verifying and fine-tuning of zero; independent of pipe configuration and fluid (leaks, leaking valves,)	X	
Verification of transmitting quality of ultra sound converters (especially above temperature limits, under high mechanical stress...)	X	X
Measurement of sound characteristics of any liquid (sound dampening, speed of sound)		X
Useful for demonstrations, technical training, schooling		X

3 Requirements For A Successful Installation

3.1 Liquid Requirements

Completely filled pipe

During the measurement process the pipe must be completely filled with liquid. Liquids in partially filled pipes cannot be measured.

Small amounts of entrained air or gas

Air- and gas content, which is not absorbed in the liquid but is present in the form of bubbles can reflect the sound waves in an unpredictable manner and thus disturb the measurement. As a practical guideline gas and air should not exceed 3% by volume.

Small amounts of particles

Particles can also reflect the sound wave. Examples are liquids with a high degree of inorganic matter, e.g. minerals or metallic particles

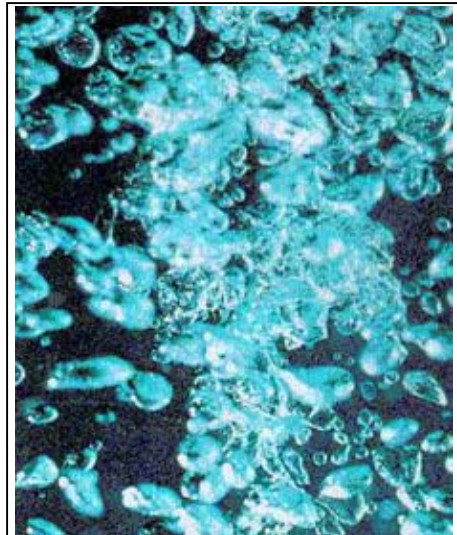


Fig. 4.1: Liquids containing a high degree of air and gas reflect the sound wave unpredictably and disturb the measurement

3.2 Pipe Requirements

Good sound propagation

A decisive factor for a proper functioning of the instrument is the ability of the pipe material to allow the sound waves to propagate. The measurement path consists of the liquid, the pipe wall and possibly a pipe liner. If small amounts of deposits can accumulate on the bottom of the pipe it is advisable to mount the sensors in a horizontal position. A good sound propagation is thus ensured even with deposits on the bottom inside pipe wall

Suitable pipe materials

Suitable pipe materials are most metals, synthetics and glass. Pipeline materials with a fine crystal structure (such as carbon- and rust free steels) are mostly stronger propagating as compared to cast iron-, pig iron- and copper pipes, even though these are also usable. Pipes made of cement or non-homogenous materials cannot be used.

Lined pipes

Lined pipes do not present a problem, as long as the liner is a material which allows sound to propagate and the liner is fixed to the pipe wall. Some acceptable liners are cement coating, thin bitumen layers or epoxy coats.

Roughness of pipe

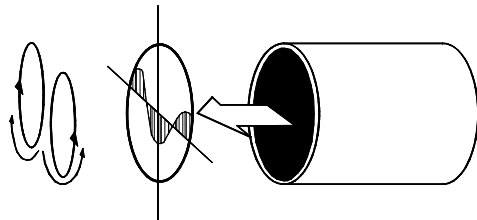
The pipe roughness should also meet ultra sound requirements:

- The pipe is to be cleaned of dirt build-up, corrosion or deposits
- Thick coats of paint on the pipe wall at the intended instrument installation need to be removed. Thinly applied paints with good adhesion might be acceptable.
- Pipe irregularities at the sensor location (e.g. welding seam) should be avoided, since they can effect the direction of a sound wave.

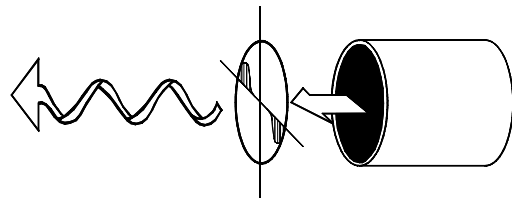
3.3 Flow Profile Requirements

A rotation symmetrical flow profile is ideal

An exact volumetric flow calculation requires flow information from across the entire pipe diameter. Ultrasonic flow measurement devices however do not measure the flow velocity across the entire pipe diameter, but only between the two converters. The flow between the two converters should be free of eddies because these would also be measured by the system. Such eddies detrimentally change the flow profile.



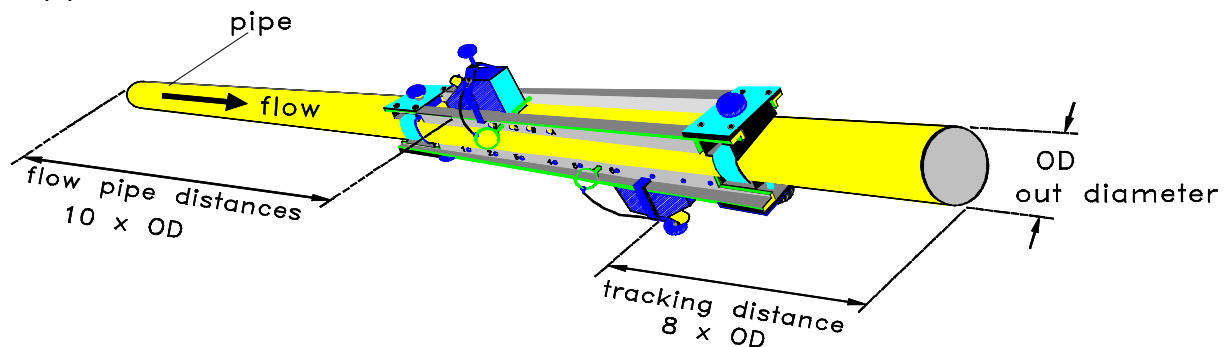
Eddies, with one 90°-bend on upstream side



Eddies, with two 90°-bends on upstream side

Improvement of flow profile

To improve the flow profile and thus the measurement accuracy straight pipe runs up- and downstream of the sensors are required. The length of these pipe runs is given in multiples of pipe O.D.



Flow profile disturbance		Minimum upstream runs (multiples of pipe OD)	Minimum downstream runs (multiples of pipe OD)
90°- bend	Two bends	10	5
	Two bends in same plane	13	5
	Three or more bends in same plane	15	5
	Two bends in different planes	15	5
	Three bends in different planes	20	5

Expansion	Pipe expansion w/ $\zeta/2 > 7^\circ$ ($\zeta/2$: angle to pipe axis)	10	5
	Pipe expansion w/ $\zeta/2 < 7^\circ$	0	5
Reducer	Pipe reduction w/ $\zeta/2 > 7^\circ$ ($\zeta/2$: angle to pipe axis)	10	5
	Pipe reduction w/ $\zeta/2 < 7^\circ$	0	5
T-piece		20	5..10
Valve	Any degree of opening	40	5
Pump		25	5

3.4 Installation Requirements

Installation recommendations for horizontal pipes

In horizontal pipes the measuring path should if possible also run in a horizontal direction – see Fig. 4.8. A deviation from the horizontal plane by $\pm 60^\circ$ is allowed. A vertical installation is to be avoided for these reasons:

- Sound reflective gas bubbles can be carried along in the upper part of the pipe
- Contaminations can be carried or be deposited in the pipe's lower part, thus dampening the sound waves

The ultrasound converters should not be installed in the upper part of a u-shaped pipe, as shown in Fig. 4.9,. Air- or gas bubbles tend to accumulate at this location.



Fig. 4.8: Recommended positioning of ultra sound converter for horizontal pipes.

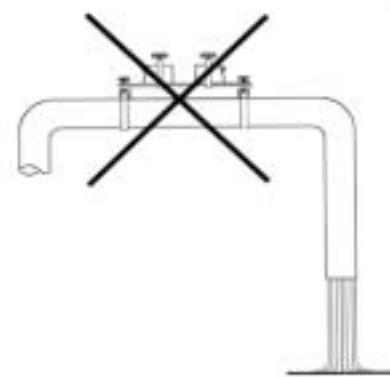


Fig. 4.9: Improper positioning of the ultrasound converters in a u-shaped pipe

Installation recommendation for vertical pipes

In vertical pipes an upward flow direction is recommended, see Fig. 4.9. The reason: gas bubbles rise when there is no flow and thus leave the measurement location.

Installations in vertically downward flows with downstream pipe openings are to be avoided, see Fig. 4.10. The likelihood of the pipe running empty back to the measurement location is too great. Fig 4.11 illustrates a possible remedy if no other measurement location is available: a back pressure is to be created large enough to maintain a full pipe.

Several ultrasonic instruments on the same pipe

Measurement errors can be created if a second ultrasonic instrument of the same or another make is installed near-by. This is not the case for the dual-channel IntraSonic unit because of a shift in its sound waves.



Fig. 4.9: Recommended ultrasonic converter positioning in vertical pipes

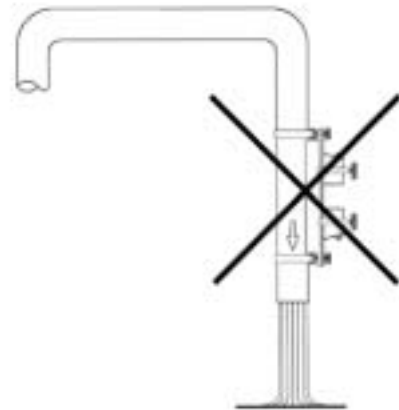


Fig. 4.10: Not recommended positioning of the ultrasonic converter in vertically downward flow

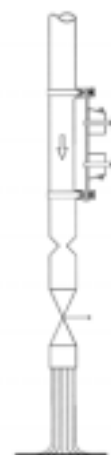


Fig. 4.11: Possible positioning of the ultrasonic converters in a vertically downward flow with a downstream valve

4 Specifications For The Measurement Location

The selection of the suitable ultrasonic flow measuring instrument can be accomplished quickly and reliably by the manufacturer, as long as the necessary data for the existing pipe and the media to be measured are available (see list below):

Pipeline:

Pipe material:

Pipe O.D.: mm

Pipe wall thickness: mm

Upstream straight runs to recommendations: yes ☐ no ☐
(if non, please scetch installation location)

Downstream straight runs to recommendations: yes ☐ no ☐
(if non, please scetch installation location)

Pipe always full? yes ☐ no ☐

Pipe accessible (unobstructed 15 cm all around)? yes ☐ no ☐

Liquid:

Name:

Solids entrained? : yes ☐ no ☐
(if yes, please provide description and concentration)

Gas/air bubbles entrained in liquid? : yes ☐ no ☐
(if yes, please provide concentration)

Physical Values:	Desired Unit-of-measure	Min. value:	Oper.value:	Max. value:
Flow				
Temperature				

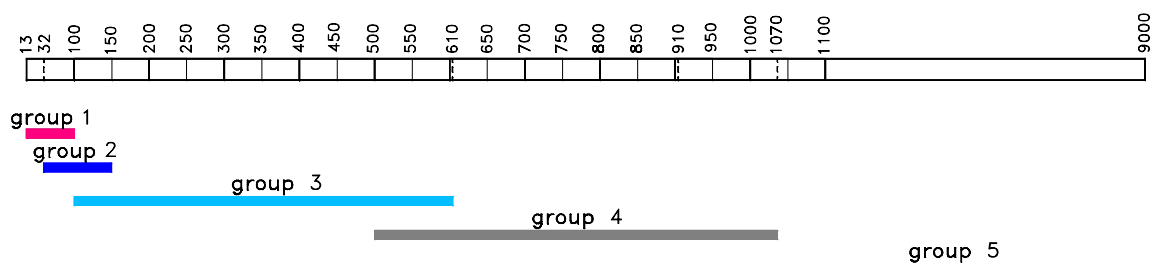
Peculiarities of measurement location :

5 What Type Of Pipe Will The Sensors Be Used On?

Overview of the transducers

	For portable use	For the firm installation	For hight temperature use
group 1	 M10		 M15
group 2	 M20	 M21	 M25
group 3	 M30	 M31	 M35
group 4	 M40	 M41	 M45
group 5		 M51	
	Operating temperature to +120°C	Operating temperature to +120°C	Operating temperature to +190°C

For every pipe (OD/mm) the fitting transducers



A few converter types cover the entire range of pipes from 13 to 9000 mm (0.5" to 360")

6 Intrasonic IS-100 For Portable Applications

Model IS-100 for liquid volumetric flow measurement is also available for portable service:

- Completely equipped for all applications
- Handy, rugged, water- and dust tight carrying case made of high density polypropylene
- Instrument includes batteries with up to 8-hour operating time
- Battery charger included in package
- Converter, assembly kit and measurement instrument all in stainless steel



6.1 Order Codes For Intrasonic IS-100 In Portable Applications

1. Converter pair (stainless steel version)

Pipe O.D.		Temperature range of liquid	
		- 40 ...120 °C - 40 ... 248 °F 233, 16 ... 393,16 K	- 40 ...190 °C - 40 ... 374 °F 233,16 ... 463,16 K
mm	inches		
13 – 100	¼" – 3 ½"	M10	M15
32 – 200	1" – 8"	M20	M25
150 – 610	6" – 24"	M30	M35
500 – 1070	20" – 42"	M40	M45
910 – 2133	36" – 85"	M51	
1829 – 3048	73" – 122"	M51	
3048 – 5486	122" – 220"	M51	
5486 – 9000	220" – 354"	M51	

Converters with the letters M...0 have BNC-connector, letters M...5 indicate threaded metric connectors rated IP 65 (Nema4).



2. Assembly set (stainless steel version)



Fig.: The assembly set consists of 2 each: assembly rails, straps, adjustment screws, clamps

Pipe O.D.		Code
mm	inches	
13 – 100	½" – 3 ½"	S10
32 – 200	1" – 8"	S20
150 – 610	6" – 24"	S30
500 – 1070	20" – 42"	S40
910 – 2133	36" – 85"	S51
1829 – 3048	73" – 122"	S51
3048 – 5486	122" – 220"	S51
5486 – 9000	220" – 354"	S51

Code	Length of assembly rail A (mm)	Length of assembly rail B (mm)	Total length across both rails (S5.. is installed with its axis off-set in axial direction mm)	Length of straps (m) m	Weight of assembly sets kg
S10	280 ± 1	280 ± 1	280 ± 1	13,5 cm	2,0
S20	395 ± 1	395 ± 1	395 ± 1	34 cm	2,5
S30	760 ± 1	760 ± 1	760 ± 1	1,3 m	4,0
S40	1180 ± 1	1180 ± 1	1180 ± 1	20 m	9,5
S51	508 ± 1	610 ± 1	1423	40 m	12,5
S52	508 ± 1	610 ± 1	1423	40 m	12,5
S53	508 ± 1	610 ± 1	1423	40 m	12,5
S54	508 ± 1	610 ± 1	1423	40 m	12,5

3. Ultrasound paste

Version	Picture	Temperature range of liquid		
		- 40 ... -23 °C - 40 ... -9,4 °F 233,16 ... 250,16 K	- 23 ... 149 °C - 40 ... 300 °F 233,16 ... 422,16 K	- 149 ... 230 °C - 40 ... 446 °F 233,16 ... 503,16 K
Water soluble ultra sound paste, Content: 370 ml		---	P1	---
Non water soluble ultra sound paste, Content: 90 ml		P2	P2	P2

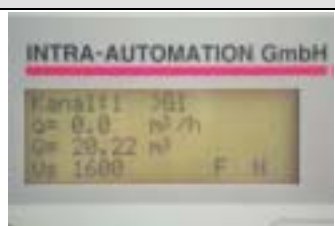
4. Wire pair to connect the measurement converter

Connection to sensor	Connection to converter	To be used with converter	Length / m				
			5	10	15	30	50
 Threaded connection	 BNC-connection	M...5	L11	L12	L13	L14	L15
 BNC-connection	 BNC-connection	M...0	L21	L22	L23	L24	L25

5. Signal converter

The converter consists of a IP67 rated stainless steel enclosure. The instrument package also includes a rugged carrying case and an operating manual (language according to order code). To connect it to the sensors two BNC connections are available. See the following table for technical data regarding power supply and batteries.

Operating mode:	Battery operation with battery charger 100 – 240 VAC, 50 and 60 Hz
Operating time with fully charged battery	Min. 7 hours
Charge time with instrument off	Apprx. 4 hours
Capacity	6 Amp hours

Picture LC-Display	Language	Number of measurement channels	
		Single channel	Dual channel
	German	C1AD	C2AD
	English	C1AE	C2AE

6. Plug-in boards with electrical outputs

Outputs	Code								
	A00	A0U	A4U	A0I	A4I	A0P	A4P	A0K	A4K
4x voltage output: 0 – 10VDC	---	X	x	x	x	x	x	x	x
1x current output: 4 – 20mA	---	---	---	x	x	---	---	x	x
1x scaleable TTL- pulse output: 0 – 500Hz	---	---	---	---	---	x	x	x	x
4x reed contact relais (rating 300VAC / 0,5A, max. 10W)	---	---	x	---	x	---	x	---	x

	
AOI	A4K

7. Additional documentation (to be used w/out additional documentation code D0)

DPD x	x = Number of operating manuals (German), 1 copy no charge
DPE x	x = Number of operating manuals (English), 1 copy no charge
DC x	x = Number of operating manuals on CD ROM, German & English

8. Accoustic measuring runs

8.1 Pipe simulator

	Suitable for measuring converters with code				
	M1...	M2...	M3...	M4...	M5...
Order pipe simulator	R1	R2	R3	R4	R5
Picture of typical pipe simulator with strapped on converters					

8.2 Pipe enclosure

	Suitable for sensors with code				
	M1...	M2...	M3...	M4...	M5...
Code for pipe enclosure	RL1	RL2	RL3	RL4	RL5
Pipe O.D. (mm)	88,9	114,3	168,28	a. A.	a. A.
Pipe wall thickness(mm)	1,5	2,0	1,5	a. A.	a. A.
Height of pipe (mm)	320	440	800	a. A.	a. A.
Side dimensions with square stand off plate (mm)	250	250	350	a. A.	a. A.
Weight in kg, approx values	2,0	3,5	7,0	a. A.	a. A.
Picture of typical pipe with strapped on converters					

9. Calibration

	
Verification of measurement accuracy and repeatability under reference conditions at the factory calibration facility	Verification of measurement accuracy and repeatability under reference conditions at an independent lab

7 Intrasonic IS 100 For Fixed Installations

Model series IS-100 is available to measure liquid volumetric flow in a fixed installation at a selected pipe location. The delivered package is designed accordingly:

- Modularly constructed measurement converter with plug-in circuit boards
- Measuring sensor, assembly kit and measurement converter made of stainless steel
- Wall mounting bracket made from stainless steel
- Completely equipped for all applications



7.1 Order Codes For Intrasonic IS-100 For Fixed Installations

1. Converter, pair (stainless steel version)

Pipe O.D.		Temperature range of liquid	
		- 40 ...120 °C - 40 ... 248 °F 233, 16 ... 393,16 K	- 40 ...190 °C - 40 ... 374 °F 233,16 ... 463,16 K
mm	inches		
13 – 100	½" – 3 ½"		M15
32 – 200	1" – 8"	M21	M25
150 – 610	6" – 24"	M31	M35
500 – 1070	20" – 42"	M41	M45
910 - 2133	36" – 85"	M51	
1829 – 3048	73" – 122"	M51	
3048 – 5486	122" – 220"	M51	
5486 – 9000	220" – 354"	M51	

Converters M...1 have a IP65 (Nema4) rated metric thread connection



2. Assembly set (stainless steel version)



Fig.: The assembly set consists of two each of assembly rails, straps, adjustments screws and clamps

Pipe O.D.		Code
mm	inches	
13 – 100	0,5 – 3,9	S10
32 – 200	1,25 – 7,9	S20
150 – 610	5,9 – 24,0	S30
500 – 1070	19,7 – 42,1	S40
910 – 2133	35,8 – 84,0	S51
1829 – 3048	72,0 – 120,0	S51
3048 – 5486	120,0 – 216,0	S51
5486 – 9000	216,0 – 354,0	S51

Code	Length of assembly rail A mm	Length of assembly rail B mm	Total length across both assembly rails (S5...is installed off-set in axial direction) mm	Length of straps	Weight of assembly kit kg
S10	280 ± 1	280 ± 1	280 ± 1	13,5 cm	2,0
S20	395 ± 1	395 ± 1	395 ± 1	34 cm	2,5
S30	760 ± 1	760 ± 1	760 ± 1	1,3 m	4,0
S40	1180 ± 1	1180 ± 1	1180 ± 1	20 m	9,5
S51	508 ± 1	610 ± 1	1423	40 m	12,5
S52	508 ± 1	610 ± 1	1423	40 m	12,5
S53	508 ± 1	610 ± 1	1423	40 m	12,5
S54	508 ± 1	610 ± 1	1423	40 m	12,5

3. Ultrasound paste

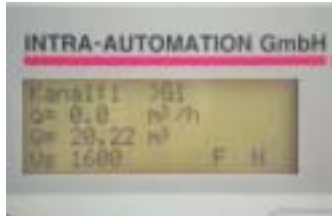
Version	Picture	Temperature range of liquid		
		- 40 ... -23 °C - 40 ... -9,4 °F	- 23 ... 149 °C - 40 ... 300 °F	- 149 ... 230 °C - 40 ... 446 °F
		233,16 ... 250,16 K	233,16 ... 422,16 K	233,16 ... 503,16 K
Non water soluble ultra sound paste, content: 90 ml		P2	P2	P2

4. Wire pair to connect measurement sensors

Connection to sensor	Connection to measurement instrument	Usable converters for	Length (m)				
			5	10	15	30	50
 threaded connection	 threaded connection	M...1 oder M...5	L01	L02	L03	L04	L05

5. Signal converter

The signal converter consists of a IP67 rated stainless steel enclosure. Also included with the instrument package are two rails for wall mounting of the converter as well as one operating manual (language per order code). A wire pair with metric threads is provided for the connection to the sensors. Power supply options are 85 – 264 VAC, 47 – 440 Hz or 110 – 370 VDC.

Picture LC-Display	Language	Number of measurement channels	
		Single channel	Dual channel
	German	C5ND	C6ND
	English	C5NE	C6NE

6. Plug-in circuit boards with electrical outputs

Signal outputs	Code								
	A00	A0U	A4U	A0I	A4I	A0P	A4P	A0K	A4K
4x voltage output: 0 – 10VDC	---	X	X	X	X	X	X	X	X
1x current output: 4 – 20mA	---	---	---	X	X	---	---	X	X
1x scalable TTL- pulse output: 0 – 500Hz	---	---	---	---	---	X	X	X	X
4x reed relays (contact 300VAC / 0,5A, max. 10W)	---	---	X	---	X	---	X	---	X

	
AOI	A4K

7. Additonal documentation

DPD x	x = Number of operating manuals (German), 1 copy at no charge
DPE x	x = Number of operating manuals (English), 1 copy at no charge
DC x	x = Number of operating manuals on CD-ROM, German & English

8. Accoustic measurement run

8.1 Pipe simulator

Pipe simulator code	Suitable for measurement converter with code				
	M1...	M2...	M3...	M4...	M5...
	R1	R2	R3	R4	R5
Picture of a typical pipe simulator with strapped-on measurement converters					

8.2 Pipe enclosure

Code of pipe enclosure	Suitable for measurement converter with code				
	M1...	M2...	M3...	M4...	M5...
Code of pipe enclosure	RL1	RL2	RL3	RL4	RL5
Pipe O.D. /mm	88,9	114,3	168,28	a. A.	a. A.
Pipe wall thickness /mm	1,5	2,0	1,5	a. A.	a. A.
Height of pipe /mm	320	440	800	a. A.	a. A.
Side dimensions of square stand-off plate /mm	250	250	350	a. A.	a. A.
Weight/kg, approx values	2,0	3,5	7,0	a. A.	a. A.
Picture of a typical pipe with strapped-on measurement converters					

8 Technical Data

The following values are applicable if the recommended straight up- and down stream runs are observed

8.1 Measurement Related Properties

Measurement accuracy (standard):	±1% to ±3% of rate, depending on application
Measurement accuracy (reference calibration with pipe section)	±0,5 % of rate
Response time	±0,003 m/s
Stability	better than ±0,009 m/s in most applications.
Linearity:	±1 mm/s

8.2 Measurement Accuracy

To calculate the measurement accuracy or tolerance, measurement-value dependent as well as independent factors have to be considered. For ease of demonstration the following values are referenced to the flow velocity

Medium flow velocity (m/s)	Error: 1 % of rate. in m/s	Stability ±0,009 m/s	Linearity ±1 m/s	Measurement accuracy m/s	Measurement accuracy as % of rate, (values rounded off)
0,1	±0,00125	±0,009	±0,001	±0,01125	±11,3
0,25	±0,0025	±0,009	±0,001	±0,0125	±5,0
0,5	±0,005	±0,009	±0,001	±0,015	±3,0
1,0	±0,01	±0,009	±0,001	±0,02	±2,0
2,0	±0,02	±0,009	±0,001	±0,03	±1,5
3,0	±0,03	±0,009	±0,001	±0,04	±1,3
4,0	±0,04	±0,009	±0,001	±0,05	±1,3
5,0	±0,05	±0,009	±0,001	±0,06	±1,2
6,0	±0,06	±0,009	±0,001	±0,07	±1,2
7,0	±0,07	±0,009	±0,001	±0,08	±1,1
8,0	±0,08	±0,009	±0,001	±0,09	±1,1
9,0	±0,09	±0,009	±0,001	±0,1	±1,1
10,0	±0,1	±0,009	±0,001	±0,11	±1,1
15,0	±0,15	±0,009	±0,001	±0,16	±1,1

8.3 Reproducibility

To calculate the reproducibility or repeatability of the measurement results only the stability is of importance – see table

Average flow velocity m/s	Stability: ±0,009 m/s	Reproducibility % of rate, (values rounded off)
0,1	± 0,009	± 9,0
0,25	± 0,009	± 3,6
0,5	± 0,009	± 1,8
1,0	± 0,009	± 0,9
2,0	± 0,009	± 0,5
3,0	± 0,009	± 0,3
4,0	± 0,009	± 0,2
5,0	± 0,009	± 0,2
6,0	± 0,009	± 0,2
7,0	± 0,009	± 0,1
8,0	± 0,009	± 0,1
9,0	± 0,009	± 0,1
10,0	± 0,009	± 0,1
15,0	± 0,009	± 0,1

8.4 Dimensions And Weights

Portable version

Total weight /kg: (carrying case incl. converter, sensors, size 2 assembly rails, ultrasound paste and other accessories)	15.2
Dimensions of carrying case (W x D x H) /cm:	52.4 x 43.7 x 21.7

Stationary / fixed version

Weight of converter /kg:	6.2
Dimensions of carrying case (W x D x H) /cm:	23 x 29 x 20

9 Services

9.1 Measurement Services

Measurement services performed by our experienced service personnel

Since 1977 Intra-Automation GmbH has been offering measurement services. Our strengths lie in our experience, reliability, flexibility (especially in processing urgent inquiries and orders) and neutrality

The service to be accomplished is tailored to specific customer requirements and is therefore effective and valuable. The service includes consulting, the selection of proper measurement locations and instruments as well as the processing and interpretation of the collected data.

Which physical dimensions can be measured?

- Volumetric flow
- Liquid temperature
- Average flow velocity
- Fluid's speed of sound
- Pipe wall thickness
- Time (to illustrate events over time)

Advantages at a glance

- Non intrusive measurement, therefore no process interruption and associated costs.
- Trained, experienced and neutral service personnel
- Complete registration and illustration of measured values
- Customer personnel need not be trained, thus cost- and time savings
- No investment and repair risks



9.2 Calibration

Upon customer demand the ultrasound flowmeter measurement accuracy can be verified in independent calibration test labs or at the manufacturer's calibration facility, see Fig 10.1. Calibrations undertaken at the manufacturer's site are documented with a test certificate.



Fig. 10.1: Manufacturer's water calibration rig for pipe sizes 0.5 through 12 inches, max volumetric flow 400 m³/h (1760 GPM).

9.3 Rentals

The ultrasonic flowmeter IntraSonic IS-100 can be rented on a weekly basis. Without big investments and without any risk a customer can take measurements without having to interrupt any process.

Advantages at a glance:

- Ultrasound flow measurement at your facility done by your own personnel
- Registration of measured values
- Non intrusive measurement
- No process interruption and associated costs
- No investment risks
- Allows testing of the meter before purchasing
-

The rental includes:

- Weekly rental of IntraSonic incl.all necessary accessories
- The unit must be returned complete and undamaged
- Any required repair or cleaning costs are charged to the user
- Return freight costs to be paid by customer
- Rental fee 100% applicable towards later purchase
- The rented instruments are and remain the property of Intra-Automation



10 Test- And Calibration Facility At ABB, Goettingen/ Germany



10.1 Accuracy Test

Calibration test Calibration facility ABB in Göttingen / Germany, Eichplatz PS0014

Tests with **IntraSonic IS-100**, transducer group 3 and group 4

Test protocol dated Februar 15th,2002

Test object Transducer	Operating- temperature	Time s	Flow m³/h	Test object m³	Calib refer m³	Deviation-
Group 3	+11°C	100	3000	83,751	84,176	-0,5049 %
Group 3	+11°C	100	3000	83,964	84,432	-0,5543 %
Group 3	+11°C	100	3000	83,629	84,143	-0,6109 %
Group 3	+11°C	100	3000	83,781	84,250	-0,5567 %
Average valuert		100		83,781	84,250	-0,557 %

Test object Transducer	Operating- temperature	Time s	Flow m³/h	Test object m³	Calibr refer m³	Deviation-
Group 3	+11°C	100	4650	129,270	129,100	0,1317 %
Group 3	+11°C	100	4650	129,180	129,100	0,0620 %
Group 3	+11°C	100	4650	128,730	128,830	-0,0776 %
Group 3	+11°C	100	4650	129,060	129,010	0,0388 %
Average value		100		129,060	129,010	0,039 %

Test object Transducer	Operating - temperature	Time s	Flow m³/h	Test object m³	Calibr refer m³	Deviation--
Group 4	+9°C	100	2000	52,978	53,065	-0,1644 %
Group 4	+9°C	100	2000	53,545	53,074	0,8871 %
Group 4	+9°C	100	2000	53,484	53,062	0,7961 %
Group 4	+9°C	100	2000	53,336	53,067	0,5069 %
Average value		100		53,336	53,067	0,506 %

Test object Transducer	Operating - temperature	Time s	Flow m³/h	Test object m³	Calibr refer m³	Deviation-
Group 4	+9°C	100	3000	83,046	82,725	0,3877 %
Group 4	+9°C	100	3000	82,751	82,680	0,0859 %
Group 4	+9°C	100	3000	82,881	82,666	0,2606 %
Group 4	+9°C	100	3000	82,893	82,690	0,2456 %
Average value		100		82,893	82,690	0,245 %

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