Pietro Fiorentini

FioSonic

Industrial metering

FioSonic_technicalbrochure_ENG_revA

www.fiorentini.com

Who we are

We are a Global organization specialized in designing and manufacturing technologically advanced solutions for natural gas treatment, transmission and distribution systems.
We are the ideal partner for operators in the Oil & Gas sector, with a business offer that goes across the whole natural gas chain.

We are in constant evolution to meet our customers' highest expectations in terms of quality and reliability.

Our aim is to be a step ahead of the competition, with customized technologies and an after-sale service program undertaken with the highest grade of professionalism.

Pietro Fiorentini advantages
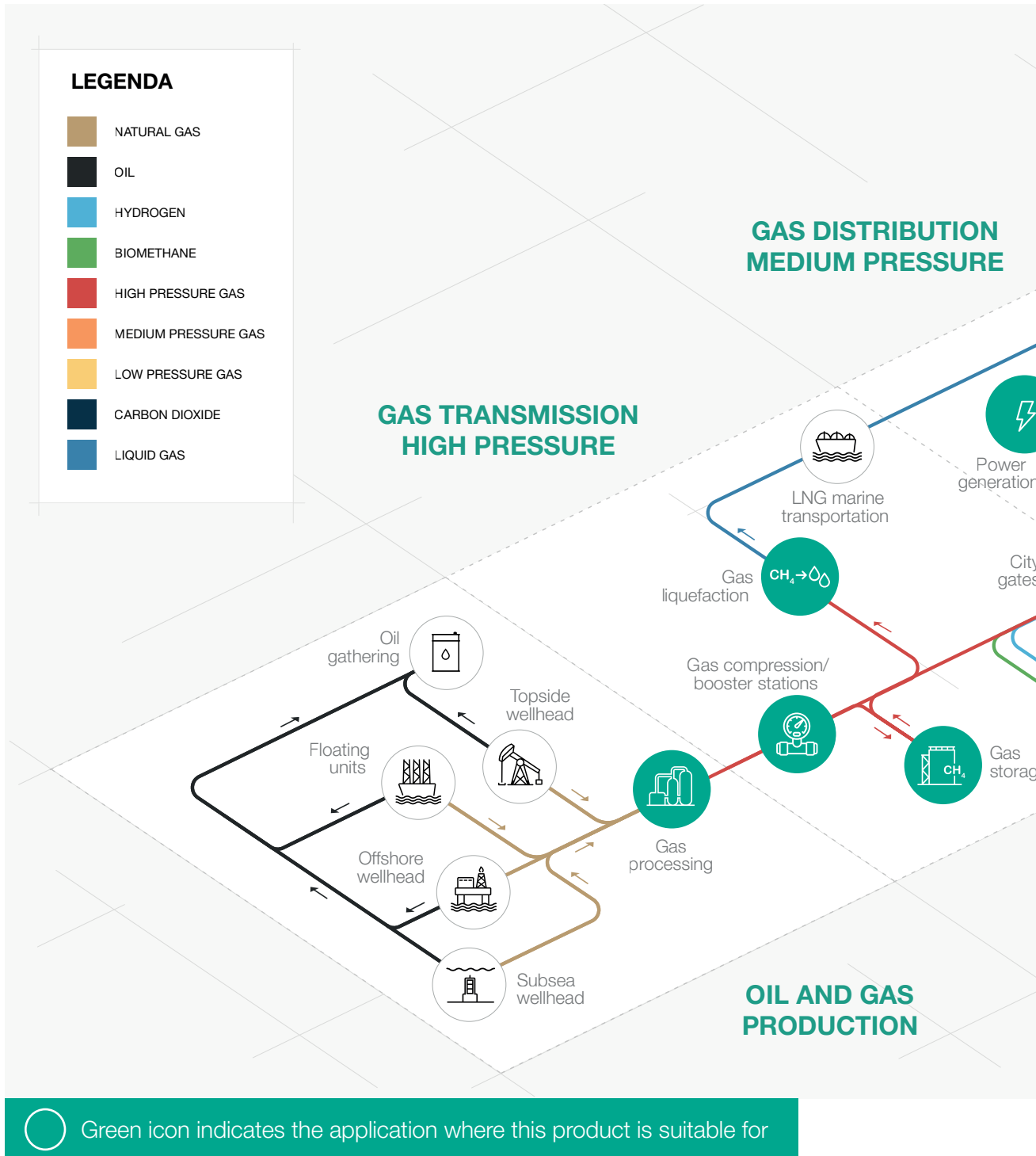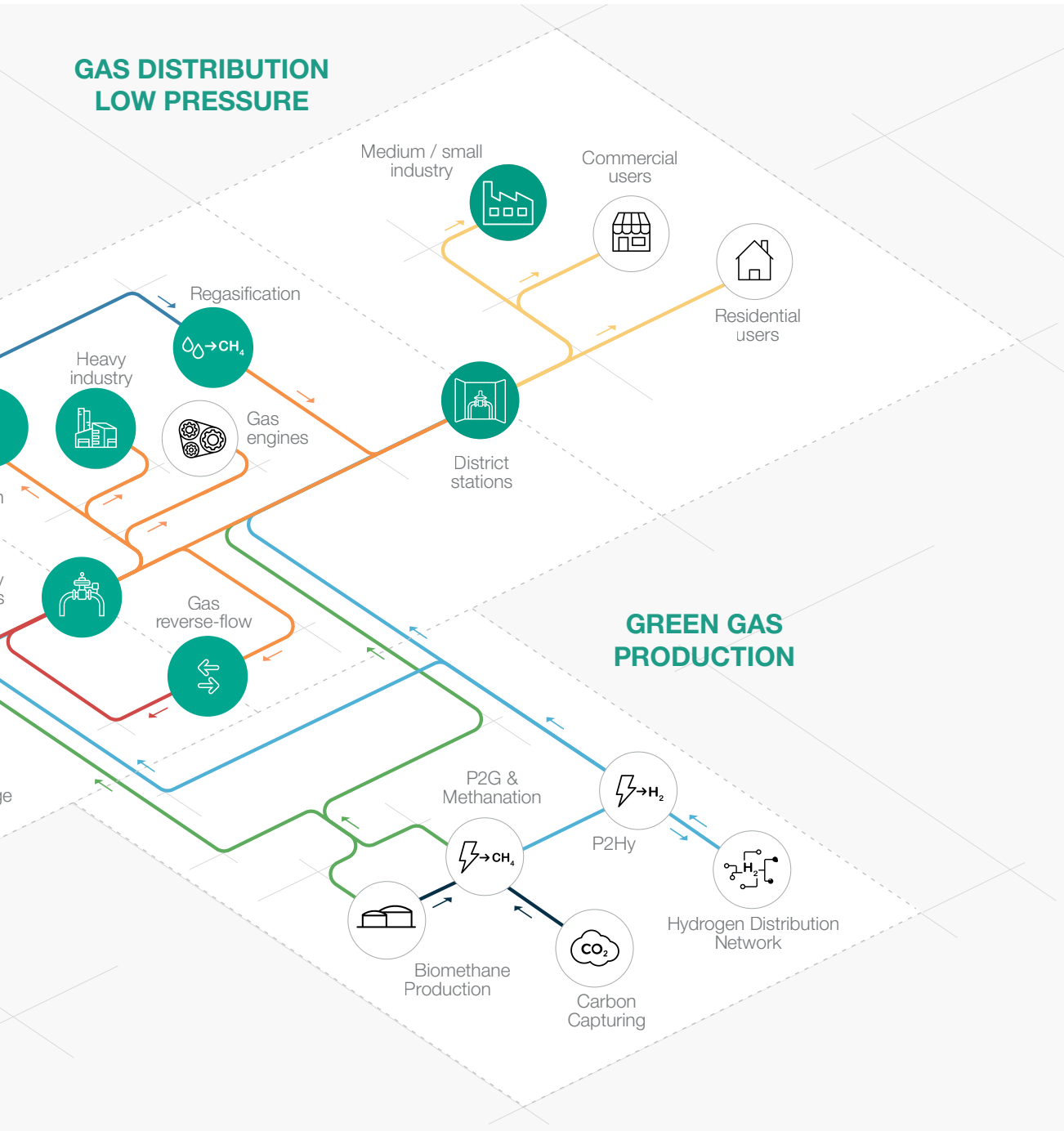
Localised technical support

Experience since 1940

We operate in over 100 countries

Area of Application

LEGENDA

- NATURAL GAS
- OIL
- HYDROGEN
- BIOMETHANE
- HIGH PRESSURE GAS
- MEDIUM PRESSURE GAS
- LOW PRESSURE GAS
- CARBON DIOXIDE
- LIQUID GAS

GAS DISTRIBUTION MEDIUM PRESSURE

GAS TRANSMISSION HIGH PRESSURE

LNG marine transportation

Power generation

Gas liquefaction

City gates

Oil gathering

Topside wellhead

Gas compression/ booster stations

Floating units

Gas storage

Offshore wellhead

Gas processing

Subsea wellhead

OIL AND GAS PRODUCTION

Green icon indicates the application where this product is suitable for

GAS DISTRIBUTION LOW PRESSURE

Medium / small industry

Commercial users

Residential users

Regasification

Heavy industry

Gas engines

District stations

Gas reverse-flow

GREEN GAS PRODUCTION

P2G & Methanation

P2Hy

Biomethane Production

Carbon Capturing

Hydrogen Distribution Network

Figure 1 Area of Application Map

Introduction

FioSonic is the natural evolution of the Pietro Fiorentini know-how and experience in the gas industry.

With its multi path-chordal ultrasonic technology **FioSonic** provides real time diagnostics high accuracy and redundancy for custody transfer gas flow measurement.

This device is mainly used for high-pressure transmission systems, power plants, heavy industry and for medium - low pressure natural gas distribution networks, from 5 KPa(a) | 0,05 bar(a) to 15.3 MPa(a) | 153 bar(a) of pipeline operating pressure.
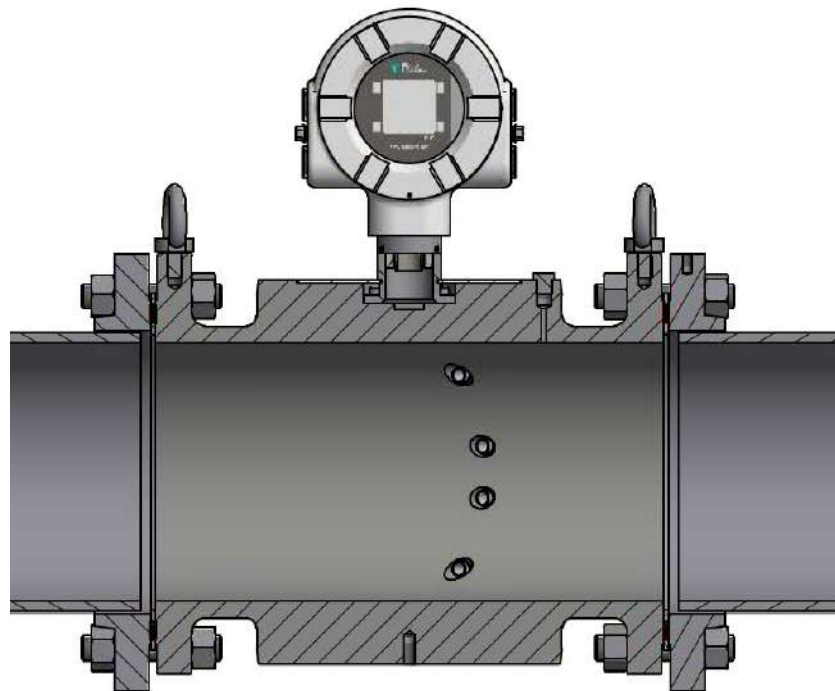
Figure 2 FioSonic - Ultrasonic Gas Flow Meter

Features

FioSonic Series standard product has three or four paths, depending on measurement purpose. This design guarantees stable accurate flow reading over the full range of flow, pressures and gas compositions.

The Broadband Continuous Wave signal processing allows more than one path to be interrogated simultaneously avoiding the slow response typical of first generations of ultrasonic meters.

FioSonic transducers frequency is from 100-250 kHz depending on the meter's size to guarantee the best performances..

Figure 3 FioSonic

Figure 4 FioSonic BX

Natural Gas blended with Hydrogen

The **FioSonic** is suitable for use with Natural Gas with up to 30% of Hydrogen blending.

Titanium transducers

The titanium ultrasonic sensors are remarkably efficient and coupled with the Broadband Continuous Wave processing can reliably measure the most challenging applications such as wet and dirty gases. The combination of the efficient transducers and the Broadband Continuous Wave processing is also resistant to acoustic noise such as valve noise which has been the bane of other ultrasonic meters.

The power efficient design of the ultrasonic transducers allow them to operate at the very low transmitting voltage of 3.6V compared to tens or even hundreds of volts required by other manufacturers.

All wetted surfaces are metallic to provide the best resistance against the harshest conditions.. Transducers are available up to 15.3 MPa(a) | 153 bar(a) versions. Transducers Extraction Tool intended for transducers removal under pressure (Max 10 MPa | 100 bar(g)) is available as option on sizes above DN 200 (8").
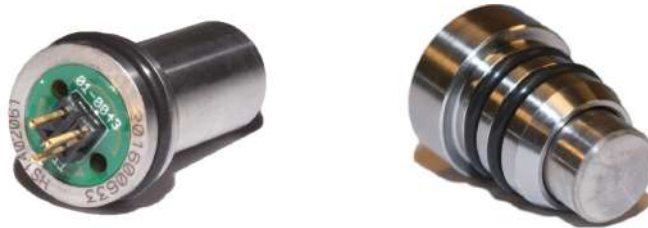
Figure 5 Ultrasonic Transducers

# BCW - Broadband Continuous Wave signal processing

Most ultrasonic flow meters transmit a short burst of ultrasonic energy consisting of between one and four pulses or cycles.

A few ultrasonic meters use a short code typically much less than 100 cycles.
The **FioSonic** flow meter transmits many thousands of cycles in an almost continuous stream of encoded pulses. At the receiver the signal is decoded in real time to reconstruct the receive signal that is precise and resistant to signal noise and interferences in difficult applications.

The Broadband Continuous Wave system allows transmission of two or more paths at the same time without interferences. Simultaneous transmission means a faster response time and a better performance in fluctuating or pulsating flow conditions.
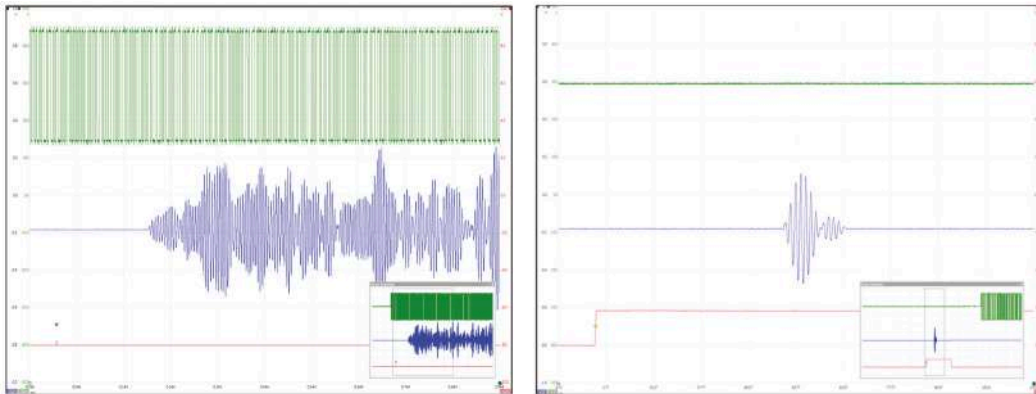
Figure 6 - Left: Encoded Transmitted Signal (green) and received signal (blue)
Right: Decoded receive signal (blue)

Simplified design

Having all on-board electronics on a single circuit board FioSonic offers simple design and maintenance.

Figure 7 On-board electronics

Additional boards

Extended I/O board

The **FioSonic** Series comes standard with the Pulse/Frequency output and a USB port for commissioning and field service. Optional I/O Boards can provide an isolated RS485 and two additional isolated Pulse-Frequency outputs and 4-20mA.

Pressure and temperature input board

For applications requiring integrated volume conversion the FioSonic flowmeter is capable of interfacing directly with pressure and temperature sensors. The standard volume flow is calculated using the traditional volume conversion equations using fixed parameters for gas composition.

Flow computer connectivity

FioSonic meter can be connected to all major flow computer brands available in the market either with pulses or serial line (Modbus protocol).

Environment Protections

The **FioSonic** Series epoxy coated aluminum alloy electronic housing rated to IP66 and NEMA 4X is designed to be used outdoor in almost any environment.

The ambient operating temperature covers the range -40°C to +60°C | -40°F to +140°F. The ultrasonic sensors have all titanium wetted surfaces and are designed for process gas temperature from -30°C to +80°C | -22°F to +176°F.

Intrinsically Safe Design

The FioSonic has a fully Intrisically Safe design (Exia) for both transducers and electronic board components.
This design increase the safety and allow the maintenance without interruption of gas measurement.

Diagnostic and performance monitoring

The FioSonic series provide extensive diagnostic information both on the graphic display screen and remotely via the PF Instruments Manager PC interface.

Flow information and diagnostics may be logged over time to show trending and enabling real time condition monitoring.

The velocity profile is a function of the upstream pipework. By calculating velocity ratios between the ultrasonic paths a good indication of the flow profile is realized. The flow meter calculates Profile and Symmetry Factors which can be used for condition monitoring of the measurement and the gas flow. In addition the FioSonic flow meter provides diagnostics for turbulence by means of the standard deviation of the instantaneous path velocity measurements.

The standard deviation provides an excellent diagnostic for turbulence fluctuations and may serve as an indicator of upstream disturbances. Additional meter diagnostics such as velocity of sound signal-to-noise ratio and signal strength are available to the user as well.

FioSonic competitive advantages

Titanium transducers for long durability

Low voltage sensors

No moving parts

1:160 High rangeability

Bi-directional Flow measurements

BCW processing for reduction of noise interferences

Easy maintenance

30% Hydrogen blending compatible. Higher blending available on request

Metallic wetted parts

Features

Features	Values
Design pressure*	up to 15.3 MPa(a) up to 153 bar(a)
Ambient temperature*	• Ambient Temperature for Non custody Transfer: from -40 °C to +60 °C from -40 °F to +140 °F • Ambient Temperature Custody Transfer (MID and OIML certified): from -25 °C to +55 °C from -13 °F to +131 °F
Operating (gas) temperature*	from -30 °C to +80 °C from -22 °F to +176 °F
Accuracy	Up to 0.5% with factory calibration Up to 0.2% with high pressure flow calibration
Rangeability	Up to 1:160 for non-custody transfer Up to 1:125 for custody transfer acc. to OIML R-137/MID
Repeatability	0.1%
Ingress Protection	IP 66 / NEMA 4X
Applicable metrology standards	AGA-9; OIML R137-1&2 ; MID 2014/32/EU
Power supply and consumption	Main power: 14 - 0,710 mW max I/O option board power: 10.8 - 1,626 mW max
Hazardous area certification	ATEX II 1 G Ex ia IIC/IIB T4 Ga (intrinsically safe) IECEx Ex ia IIC/IIB T4 Ga (intrinsically safe) cQPSus Class 1 Div.1 Gr. ABCD T4-T1(intrinsically safe)
Accessories	Transducers Extraction Tool ≥ 8" (DN200)
Nominal dimensions DN	From DN80 | 3" to DN 750 | 30" for four-paths meter From DN50 | 2" to DN 750 | 30" for three-paths meter Above DN750 | 30" on request
Connections*	Class 150/300/600/900 RF / RTJ according to ASME B 16.5 or PN 16/25/40 according to EN 1092-1
(*) REMARK: Different functional features and/or extended temperature ranges available on request. Stated temperature ranges are the maximum for which the equipment's full performance, including accuracy, are fulfilled. Standard product may have a narrower range.	

Table 1 Features

FioSonic for Custody Transfer Flow Metering: four paths for enhanced accuracy and reliability

The FioSonic model "FSN-4P" has four paths. It has been designed and certified to meet the international standards for custody transfer metering including AGA-9,OIMLR137 1&2 (class 0.5-1) and MID class 1.
The integration of the flow across the paths provides accurate measurement even with varying flow profiles caused by changes in flow velocity, gas composition and pressure or upstream pipe configuration.

Fast response is maintained by the simultaneous transmission on more than one path using Broadband Continuous Wave processing.

The measured flow profile provides a diagnostic tool.
Should one path fail the Path Substitution Algorithm uses historical flow data to continue reliable flow measurements until the path recovers or remediation action is taken.
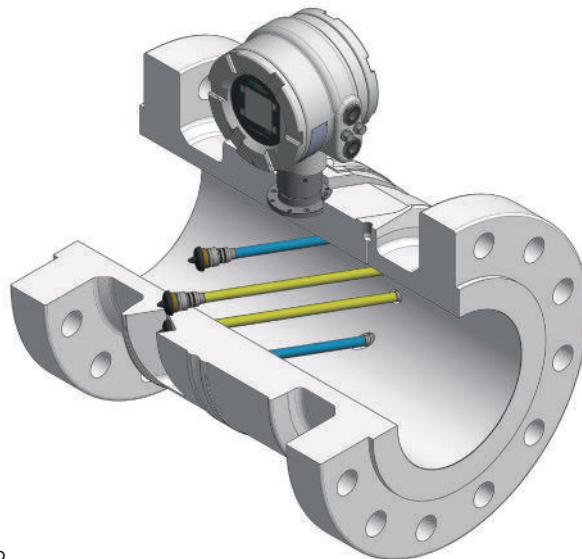
Figure 9 FioSonic-FSN-4P

FioSonic for Technical Metering: three paths

The FioSonic model "FSN-3P" has three paths as standard. It has been tested to meet the international standards AGA-9 and has an accuracy <1%.

It is the ideal solution for any technical measurement focus on applications where measurement is required, but not necessary for custody transfer like pipelines branches, grid balancing or as input for gas network modeling.
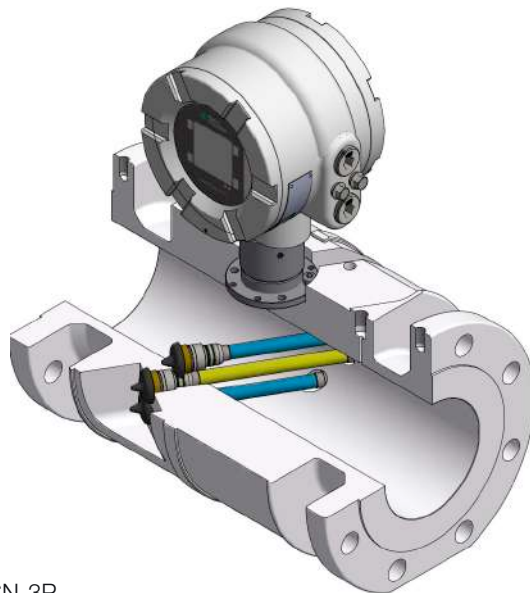
Figure 10 FioSonic-FSN-3P

FioSonic for redundant measurements applications

FioSonic BX series consists of two fully independent measurement systems integrated in one single standard meter body. This solution provides a remarkable space and cost saving. The meter can have 2 configurations:

- FioSonic BX model "**FSN-BX-4P-4P**" where both metering systems have 4 paths each. This solution is suitable for redundant custody transfer metering line.

- FioSonic BX model "**FSN-BX-4P-3P**" where 1 metering systems has 4 paths and 1 has 3 paths. This solution is suitable for only 1 custody transfer metering line with a second electronic as check.

Each metering system works independently without any signal synchronization maintaining the full range of versatile I/O.
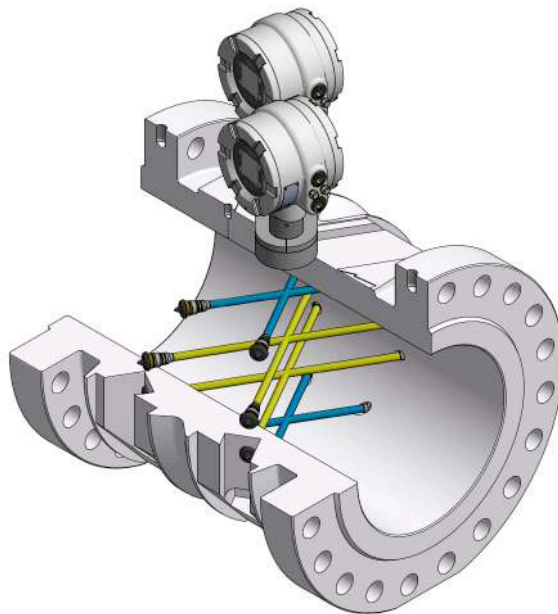
Figure 11 FioSonic-BX-4P-4P

Materials and Approvals

Part	Material
Body	Forged steel ASTM A350 LF2 Cl.1 Other material on request
Electronic enclosure	Epoxy painted low copper aluminum alloy Stainless Steel 316, on request
Transducers	Titanium ASTM B348 Ti GR.2
Sealing ring	FKM or other material according to process conditions

REMARK: The materials indicated above refer to the standard models. Different materials can be provided according to specific needs.

Table 2 Materials

Construction Standards and Approvals

The **FioSonic** is designed to meet AGA report N.9, ISO 17089-1, OIML R137-1&2 requirements.

AGA9   ISO17089-1

The product is certified according to European Directives 2014/68/EU (PED) as well as 2014/32/EU (MID), OIML R137 -1&2, ATEX, IECEx, CSA, UL (cQPSus).

OIML R137-1&2   PED-CE   MID   IECEx   cQPSus   ATEX

Capacity table

Custody transfer measurement with OIML R137 -1&2 certification

Class 0.5 OIML R-137 FioSonic 4P Capacity table [pipe configuration 1 or 2]								
Nominal size		Pipe schedule	Capacity					
			Qmin		Qt		Q max		Turndown
Inches	DN	SCH	m3/h	cfh	m3/h	cfh	m3/h	cfh	1:X
2"	50	STD	-	-	-	-	-	-	-
3"	80	STD	9	300	60	2.100	601	21.200	67
4"	100	STD	15	500	99	3.400	991	34.900	66
6"	150	STD	27	900	99	3.400	2.014	71.100	75
8"	200	STD	35	1.200	99	3.400	3.487	123.100	100
10"	250	STD	55	1.900	99	3.400	5.492	193.900	100
12"	300	STD	79	2.700	99	3.400	7.878	278.100	100
14"	350	STD	96	3.300	99	3.400	9.608	339.200	100
16"	400	STD	127	4.400	99	3.400	12.728	449.400	100
18"	450	STD	163	5.700	99	3.400	16.285	575.000	100
20"	500	STD	203	7.100	99	3.400	20.280	716.000	100
24"	600	STD	296	10.400	99	3.400	28.597	1.009.700	97
30"	750	STD	468	16.500	99	3.400	43.700	1.543.000	93

Table 3 Capacity and rangeability table

1   **PTB** flow conditioner piping configuration

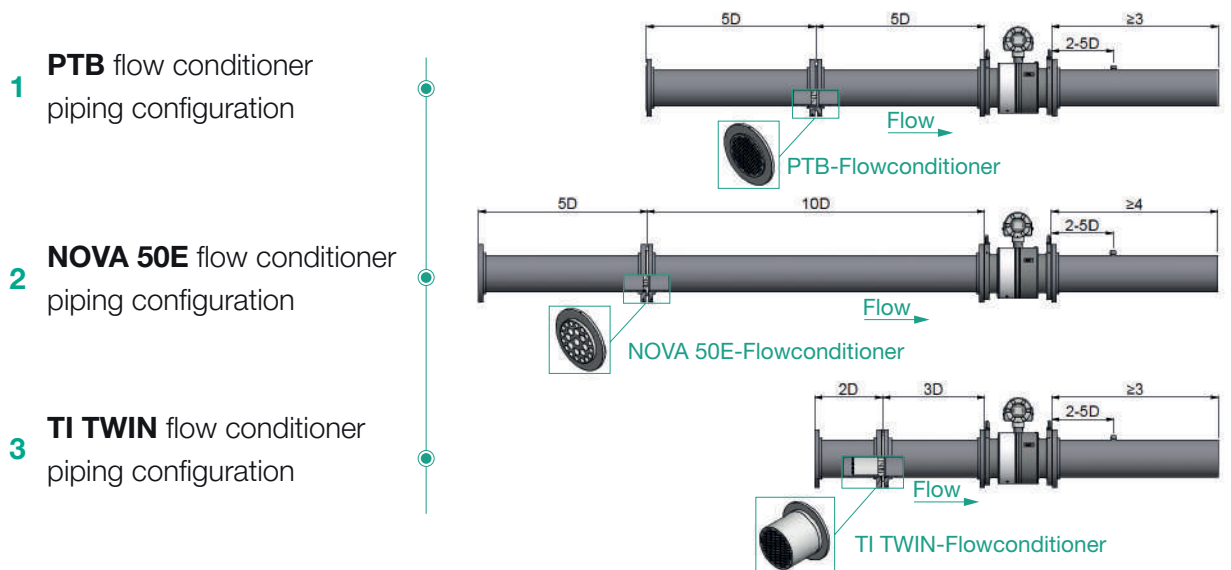**2**   **NOVA 50E** flow conditioner piping configuration
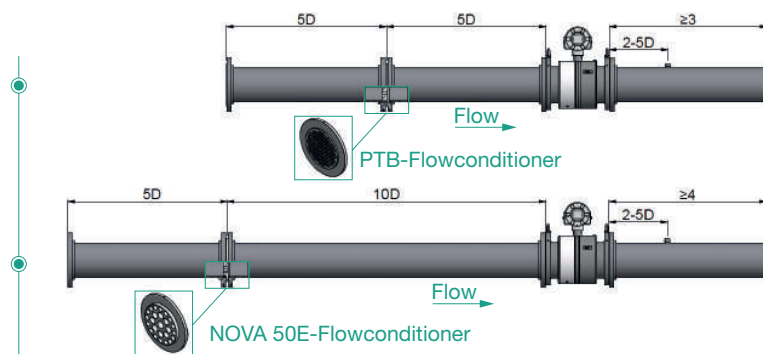
Custody transfer measurement with OIML R137 -1&2 or MID certification

Class 1 OIML R-137 and MID class 1 FioSonic 4P Capacity table [pipe configuration 1 - 2 - 3]								
Nominal size		**Pipe schedule**	**Capacity**					
			Qmin		Qt		Q max		Turndown
Inches	DN	SCH	m3/h	cfh	m3/h	cfh	m3/h	cfh	1:X
2"	50	STD	-	-	-	-	-	-	-
3"	80	STD	9	300	60	2.100	601	21.200	67
4"	100	STD	15	500	99	3.400	991	34.900	66
6"	150	STD	16	500	201	7.100	2.014	71.100	125
8"	200	STD	28	900	349	12.300	3.487	123.100	125
10"	250	STD	44	1.500	549	19.300	5.492	193.900	125
12"	300	STD	63	2.200	788	27.800	7.878	278.100	125
14"	350	STD	77	2.700	961	33.900	9.608	339.200	125
16"	400	STD	102	3.600	1.273	44.900	12.728	449.400	125
18"	450	STD	130	4.500	1.629	57.500	16.285	575.000	125
20"	500	STD	162	5.700	2.028	71.600	20.280	716.000	125
24"	600	STD	237	8.300	2.860	100.900	28.597	1.009.700	121
30"	750	STD	375	13.200	4.370	154.300	43.700	1.543.000	117

Table 4 Capacity and rangeability table

1 **PTB** flow conditioner piping configuration

PTB-Flowconditioner

2 **NOVA 50E** flow conditioner piping configuration

NOVA 50E-Flowconditioner

3 **TI TWIN** flow conditioner piping configuration

TI TWIN-Flowconditioner

Non Custody transfer measurement (technical measurement) without OIML R137 -1&2 or MID certification with accuracy up to 0.2%

FioSonic 3P and 4P extended range Capacity table [pipe configuration 1 - 2 - 3]									
Nominal size		Pipe schedule	Capacity						
			Qmin		Qt		Q max		Turndown
Inches	DN	SCH	m3/h	cfh	m3/h	cfh	m3/h	cfh	1:X
2"	50	STD	3	100	28	900	281	9.900	94
3"	80	STD	7	200	62	2.100	620	21.800	89
4"	100	STD	12	400	102	3.600	1.022	36.000	85
6"	150	STD	13	400	208	7.300	2.077	73.300	160
8"	200	STD	22	700	360	12.600	3.596	126.900	163
10"	250	STD	35	1.200	567	20.000	5.665	200.000	162
12"	300	STD	51	1.800	813	28.600	8.127	286.900	159
14"	350	STD	62	2.100	991	34.900	9.911	349.900	160
16"	400	STD	82	2.800	1.313	46.300	13.129	463.500	160
18"	450	STD	105	3.700	1.680	59.300	16.798	593.100	160
20"	500	STD	130	4.500	2.092	73.800	20.919	738.600	161
24"	600	STD	190	6.700	2.950	104.100	29.498	1.041.500	155
30"	750	STD	301	10.600	4.508	159.100	45.078	1.591.700	150

Table 5 Capacity and rangeability table

1 **PTB** flow conditioner piping configuration

2 **NOVA 50E** flow conditioner piping configuration

3 **TI TWIN** flow conditioner piping configuration
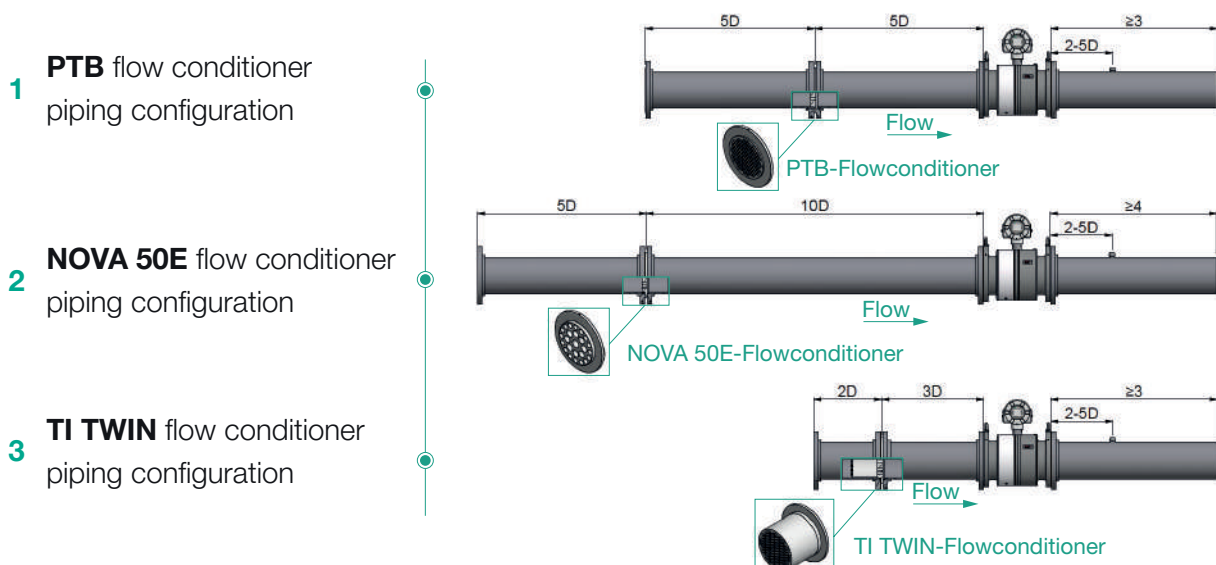
Accessories

For the electronic:

- Extended I/O board
- PT board

For the meter:

- Transducers Extraction Tool
- Flow straightener

Flow Conditioner

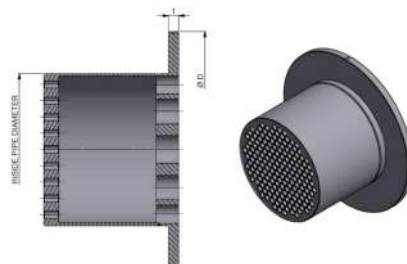**FioSonic** flow-conditioner is selected according to target accuracy, piping configuration constrains and certification required between the below 3 models.

It is mandatory for Custody Transfer measurements, while can be avoided for technical measurements (non custody transfer)

Flowconditioner-**PTB**

Flowconditioner-**NOVA 50-E**

Flowconditioner-**TI TWIN**

Figure 12 FioSonic flow conditioner

Transducers extraction tool

The **FioSonic** transducer maintenance can be performed while gas is flowing in the pipeline using a suitable extraction tool (available for sizes ≥ 8" (DN200).
The extraction tool (available for sizes >= 8" (DN200) makes possible to remove FioSonic transducers for maintenance or replacement while the meter is flowing with gas.
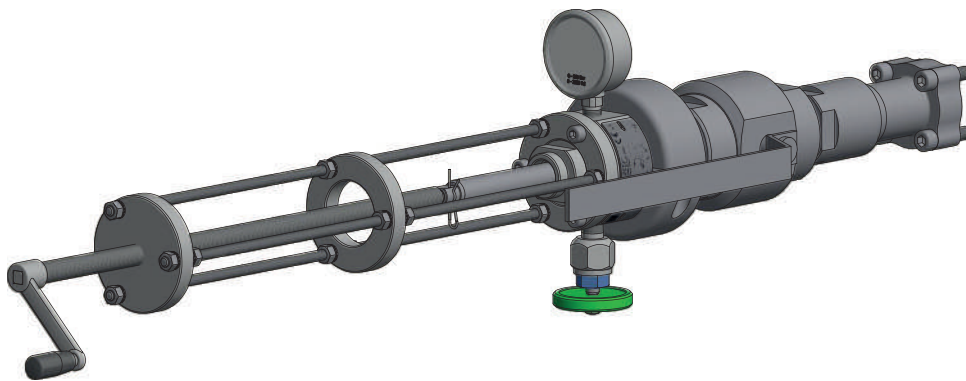
Figure 13 FioSonic extraction tool

Weights and Dimensions

FioSonic

Figure 14 FioSonic dimensions

Below table shows the minimum standard FioSonic dimensions for all FioSonic models (4P-3P or BX).

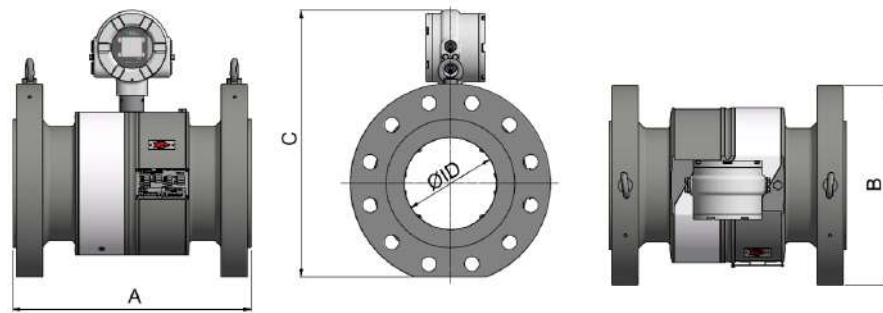Different dimensions (i.e. face to face length of 3D) can be customized according to customer's need.

Nominal size table

ØID Nominal Size inches | [DN]	Rating [ANSI] | PN	A-Length [mm] | inches	B-Width [mm] | inches	C-Height [mm] | inches	Weight [Kg] | lbs
3" | DN80	150 | 16	300 | 11.81	190 | 7.48	385 | 15.16	55 | 121
	300 | 50	350 | 13.78	210 | 8.27	396 | 15.59	60 | 132
	600 | 100	350 | 13.78	210 | 8.27	396 | 15.59	65 | 75
	900 | 150	400 | 17.75	240 | 9.45	408 | 16.06	75 | 165
4" | DN100	150 | 16	350 | 13.78	230 | 9.06	416 | 16.38	70 | 154
	300 | 50	350 | 13.78	255 | 10.04	425 | 16.73	80 | 176
	600 | 100	400 | 15.75	275 | 10.83	435 | 17.13	90 | 198
	900 | 150	450 | 17.72	290 | 11.42	447 | 17.60	100 | 220
6" | DN150	150 | 16	350 | 13.78	280 | 11.02	465 | 18.31	88 | 194
	300 | 50	400 | 15.75	320 | 12.60	485 | 19.09	106 | 234
	600 | 100	400 | 15.75	355 | 13.98	500 | 19.69	130 | 287
	900 | 150	450 | 17.72	380 | 14.96	515 | 20.28	150 | 331

NOMINAL SIZE TABLE

ØID Nominal Size inches | [DN]	Rating [ANSI] | PN	A-Length [mm] | inches	B-Width [mm] | inches	C-Height [mm] | inches	Weight [Kg] | lbs
8" | DN200	150 | 16	400 | 15.75	345 | 13.58	522 | 20.55	130 | 287
	300 | 50	500 | 19.69	380 | 14.96	545 | 21.46	160 | 353
	600 | 100	500 | 19.69	420 | 16.54	560 | 22.05	195 | 430
	900 | 150	500 | 19.69	470 | 18.50	588 | 23.15	235 | 518
10" / DN250	150 | 16	450 | 17.72	405 | 15.94	588 | 23.15	184 | 406
	300 | 50	550 | 21.65	445 | 17.52	606 | 23.86	220 | 485
	600 | 100	550 | 21.65	510 | 20.08	633 | 24.92	295 | 650
	900 | 150	550 | 21.65	545 | 21.46	656 | 25.83	335 | 739
12" | DN300	150 | 16	500 | 19.69	485 | 19.09	546 | 21.50	245 | 540
	300 | 50	600 | 23.62	520 | 20.47	666 | 26.22	305 | 672
	600 | 100	600 | 23.62	560 | 22.05	688 | 27.09	393 | 866
	900 | 150	600 | 23.62	610 | 24|02	713 | 28.07	440 | 940
14" | DN350	150 | 16	600 | 23.62	745 | 29.33	950 | 37.40	505 | 1113
	300 | 50	650 | 25.59	535 | 21.06	775 | 30.51	565 | 1246
	600 | 100	650 | 25.59	585 | 23.03	775 | 30.51	615 | 1356
	900 | 150	700 | 27.52	605 | 23.82	815 | 32.09	705 | 15.54
16" | DN400	150 | 16	600 | 23.62	595 | 23.43	840 | 37.07	640 | 1411
	300 | 50	700 | 27.56	650 | 25.59	840 | 37.07	715 | 1576
	600 | 100	700 | 27.56	685 | 26.97	870 | 34.25	805 | 1775
	900 | 150	750 | 29.53	705 | 27.76	870 | 34.25	880 | 1940
18" | DN450	150 | 16	700 | 27.56	635 | 25.00	900 | 35.43	760 | 1676
	300 | 50	750 | 29.53	710 | 27.95	900 | 35.43	875 | 1929
	600 | 100	900 | 35.43	745 | 29.33	950 | 37.40	1035 | 2282
	900 | 150	900 | 35.43	785 | 30.91	950 | 37.40	1150 | 2535
20" | DN500	150 | 16	750 | 29.53	700 | 27.56	970 | 38.19	950 | 2094
	300 | 50	800 | 31.10	775 | 30.51	970 | 38.19	1085 | 2392
	600 | 100	1000 | 39.37	815 | 32.09	1005 | 39.57	1315 | 2899
	900 | 150	1000 | 39.37	855 | 33.66	1005 | 39.57	1460 | 3219
24" | DN600	150 | 16	850 | 33.46	815 | 32.09	1090 | 42.91	1280 | 2822
	300 | 50	900 | 35.43	915 | 36.02	1090 | 42.91	1500 | 3307
	600 | 100	1100 | 43.31	940 | 37.01	1115 | 43.90	1800 | 3968
	900 | 150	1100 | 43.31	1040 | 40.94	1150 | 45.28	2260 | 4982
30" | DN750	150 | 16	1100 | 43.31	985 | 38.78	1250 | 49.21	2450 | 5401
	300 | 50	1150 | 45.28	1090 | 42.91	1250 | 49.21	2790 | 6151
	600 | 100	1300 | 51.18	1130 | 44.49	1270 | 50.00	3220 | 70.99
	900 | 150	1400 | 55.12	1230 | 48.43	1310 | 51.57	4150 | 9149

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