

Flow Measurement

SITRANS F S Clamp-on

Ultrasonic flowmeter SITRANS FS220

Overview



The SITRANS FS220 is a clamp-on ultrasonic flow system consisting of an FST020 transmitter and FSS200 clamp-on sensors.

The transmitter classification FST020 describes a basic clamp-on ultrasonic flowmeter for basic application requirements. Based on the same digitalized platform as the FST030 this system provides the same accuracy and similar functions on a lower cost level. This system is ideal for water measurement and any application not requiring temperature or viscosity compensation.

Benefits

- Easy installation at any time; no production stop, no need to cut pipe or stop flow
- Minimal maintenance; external sensors do not require periodic cleaning
- No moving parts to foul or wear. No contact with media
- No pressure drop or energy loss
- Wide turn-down ratio, bidirectional and high stability at zero flow conditions
- Anomaly compensation tool for correction of non-ideal straight pipe runs. Automatic compensation during backflow
- Optional WideBeam technology ensures highest performance and accuracy
- Compatible with all previously installed transit time sensors

Applications

The SITRANS FS220 can be used for the following application conditions:

- Pipe sizes from 10 mm to 10 m
- Pipe materials: ideal for all metals, glass, FRP and most PVC variants; NOT for concrete pipes and special compound pipes
- Pipe wall thickness from 1 to 35 mm; specials on request up to 65 mm
- Media temperatures from -40 to 121 °C; universal high temperature sensors for up to 230 °C max.
- Underground/submerged locations, non-ideal environments, strong pipe vibrations

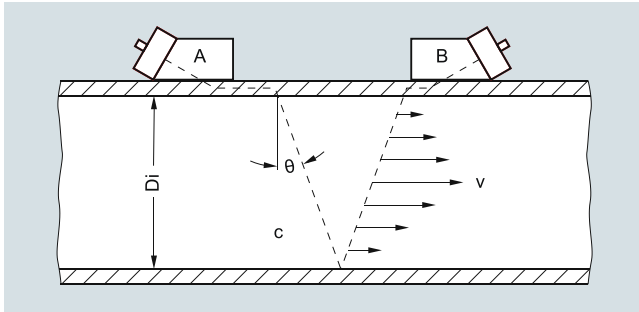
SITRANS FS220 flowmeters are suitable for most clean liquid applications, including the following:

- Water and wastewater industry
 - Potable water
 - Water and aqueous solutions
 - Wastewater, influent & effluent
 - Processed sewage, sludge
- Chemical feed industry
 - Sodium hypochlorite
 - Sodium hydroxide
- HVAC and power industries
 - Coolant flow
 - Fuel flow
 - Utility district heating, cooling
 - Refrigeration liquids
- Process control
 - Chemicals
 - Pharmaceuticals
 - Food products
 - Very low flow sensitivity (< 0.1 m/s)
 - High temperature liquids > 120 °C (248 °F).

Function

Operating Principle

The SITRANS F S system is a transit-time ultrasonic meter that provides exceptional performance using a non-intrusive clamp-on approach. Ultrasonic sensors transmit and receive acoustic signals directly through the existing pipe wall, where the fluid refraction angle is governed by Snell's law of refraction.



Clamp-on sensor mounted in a reflect configuration

The beam refraction angle is calculated as follows:

$$\sin\theta = c / V_{\phi}$$

c = Velocity of sound in fluid

V_{ϕ} = Phase velocity (a constant in the pipe wall)

The flowmeter automatically compensates for any change in fluid sound velocity (or beam angle) in response to variations in the average transit time between sensors A and B. By subtracting the computed fixed times (within the sensors and pipe wall) from the measured average transit time, the meter can then infer the required transit time in the fluid (T_{Fluid}).

The sound waves traveling in the same direction as the flow ($T_{A,B}$) arrive earlier than sound waves traveling against the direction of flow ($T_{B,A}$). This time difference (Δt) is used to compute the line integrated flow velocity (v) as shown in the equation below:

$$v = V_{\phi} / 2 \cdot \Delta t / T_{\text{Fluid}}$$

Once the raw flow velocity is determined, the fluid Reynolds Number (Re) must be determined to properly correct for fully developed flow profile. This requires the entry of the fluid's kinematic viscosity (visc) as shown in the equations below, where Q represents the final flow profile compensated volumetric flow rate.

$$Re = Di \cdot v / \text{visc} \cdot Q = K(Re) \cdot (\pi / 4 \cdot Di^2) \cdot v$$

v = Flow velocity

$\text{visc} = \mu / \rho$ = (dynamic viscosity / density)

$K(Re)$ = Reynolds flow profile compensation

In wetted type ultrasonic flowmeters the meter constants are configured prior to leaving the factory. As this is not possible with clamp-on meters, the settings must be made by the customer at the time of installation. These settings include pipe diameter, wall thickness, liquid viscosity, etc.

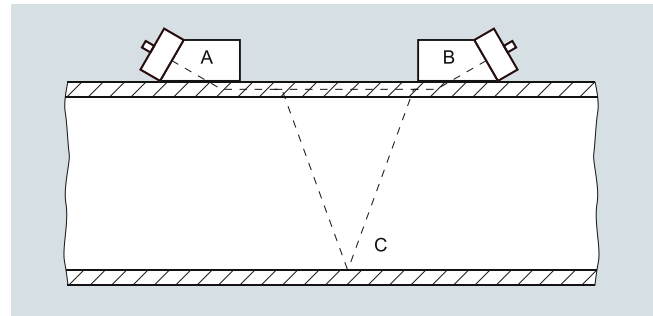
SITRANS clamp-on flowmeters that include temperature sensing can be configured to dynamically infer changes in fluid viscosity for the purpose of computing the most accurate flow profile compensation (K_{Re}).

Ultrasonic sensor types

Two basic types of clamp-on sensors can be selected for use with the SITRANS F S flowmeter. The lower cost "universal" sensor is the most common type in the industry and is suitable for most single liquid applications where the sound velocity does not vary much. This sensor type can be used on any sonically conductive pipe material (including steel) making it well suited for temporary survey applications. Universal sensors are selected based on the pipe diameter range alone, so wall thickness is less important to the selection process.

The second sensor type is the "WideBeam" sensor (called high precision), which utilizes the pipe wall as a kind of waveguide to optimize the signal to noise ratio and provide a wider area of vibration. This makes this kind of sensor less sensitive to any change in the fluid medium.

The WideBeam sensor is designed for steel pipes, but can also be used with aluminum, titanium and plastic pipe. It is the preferred sensor for HPI and gas applications. Note that unlike the universal type, this sensor selection is dependent only on the pipe's wall thickness.



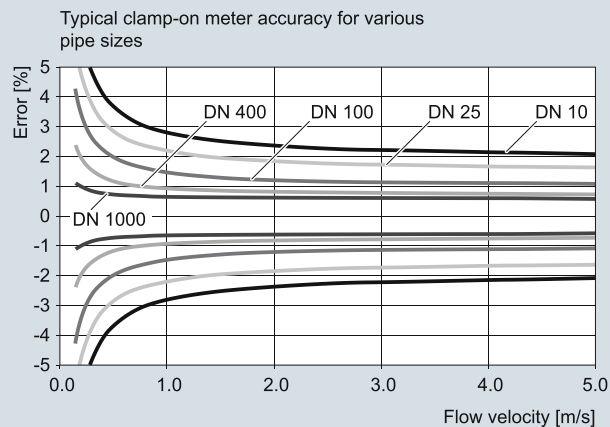
General installation guidelines for SITRANS FSS200 clamp-on sensors

- Minimum measuring range: 0 to ± 0.3 m/s velocity (see meter accuracy graph on next page for more detail)
- Maximum measuring range: 0 to ± 12 m/s (± 30 m/s for high precision sensors). Final flow range determination requires application review

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Ultrasonic flow sensor SITRANS FSS200



- Pipe must be completely full within the sensor installation volume for accurate flow measurement
- Typical MINIMUM straight pipe requirements are: 10 Diameters upstream/5 Diameters downstream. Additional straight run is required for double out-of-plane elbows and partially open valves.
- Sensors should be installed at least 20° off vertical for horizontal pipes. This reduces the chance of beam interference from gas buildup at the top of the pipe
- Operation inside the Reynolds transition region, between $1000 < Re < 5000$ should be avoided for best accuracy
- Submersible and direct burial installations can be accommodated. Consult sales representative for details
- Ultrasonic coupling compound is provided with all sensor orders. Insure that a permanent coupling compound is used for long term installations
- Refer to the "Sensor type selection guide" to insure proper application of the equipment

Sensor type selection guide



Standard sensor supported in MLFB

Application condition	High precision	Universal	Notes
Note all that apply before making selection.			
Media			
General survey (clean liquids) on non-steel pipes		X	
General survey (clean liquids) on a limited range of steel pipes	X		
Moderately aerated liquid or slurry, up to 121 °C (250 °F)	X		
Permanent installation on steel pipe (clean liquids)	X		
Installation in offshore or corrosive environment	X		With optional stainless steel mounting
Liquid temperature greater than 120 °C (248 °F)	O	X	High temperature metal block sensors available to 230 °C (446 °F)
Operation on single pipeline flowing multiple products	X	O	
Pipe material			
Steel	X		
Steel pipe with diameter/wall thickness ratio <10	O	X	
Non-steel pipe material (copper, ductile iron, cast iron, etc.)	O	X	High precision sensors can also be used on plastic and aluminum pipes in special cases

O = not suitable X = preferred choice

Definitions

Sensor chart	Description
FSS200	Formerly 1011 clamp-on sensors of the 1010 systems
Standard	Standard system sensor, selectable as part of a configured product
Special	Sensors available for non-standard applications and pipes. Contact tech support for application use
Corrosion resistant	Stainless steel metal parts on all Size C, D and E and all high temperature sensors
Aluminum	Aluminum metal parts on all HP and Universal size A and B (Corrosion resistant on request for size B)
Spare	Not available as part of a configured product, must be ordered separately
CE	Transmitter and sensors certified for sale in the EU
Trackless mount	Sensors fixed only by straps, no other mounting (spacer bar as an option) - not recommended
Tracks	Permanent installation for universal size A/B, high precision size A/B and all sizes of high temperature. Tracks always come as dual-part for either direct or reflect mounting, and always with straps.
Frames	Three sizes, for permanent installation for universal size C/ D/ E, and for high precision size C/D. For universal and high precision size B available for pipes > 125 OD (Spare)
T1	Usable from -40 ... +120 °C (-40 ... +248 °F), but best for Ø temperature below 80 °C (< 176 °F), standard
T2	Usable from -40 ... +120 °C (-40 ... +248 °F), but best for Ø temperature above 80 °C (> 176 °F)
Submersible	Sensors can be used submerged; adding Denso for supplemental protection is recommended

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Sensor availability guide

Sensor models	Availability									
	Standard	Spare only	Corrosion resistant	Trackless	Tracks	Frames	T1 best use below 80 °C (176 °F)	T2 best use 80 ... 120 °C (176 ... 248 °F)	Submersible	Catalog
Universal Sensor -40 ... 120 °C (-40 ... +248 °F) housing CE IP68										
A1 Universal for pipe OD – 5.8 ... 50.8 mm (0.23" ... 2")		X			X				X	
A2 Universal for pipe OD – 12.7 ... 50.8 mm (0.5" ... 2")	X				X				X	X
B1 Universal for pipe OD – 12.7 ... 76 mm (0.5" ... 3")		X			X	X			X	
B2 Universal for pipe OD – 12.7 ... 76 mm (0.5" ... 3")		X			X	X			X	
B3 Universal for pipe OD – 19 ... 127 mm (0.75" ... 5")	X				X	X			X	X
C1 Universal for pipe OD – 51 ... 254 mm (2" ... 10")		X	X	X		X			X	
C2 Universal for pipe OD – 51 ... 254 mm (2" ... 10")		X	X	X		X			X	
C3 Universal for pipe OD – 51 ... 305 mm (2" ... 12")	X		X	X		X			X	X
D1 Universal for pipe OD – 102 ... 508 mm (4" ... 20")		X	X	X		X			X	
D2 Universal for pipe OD – 152 ... 610 mm (6" ... 24")		X	X	X		X			X	
D3 Universal for pipe OD – 203 ... 610 mm (8" ... 24")	X		X	X		X			X	X
E1 Universal for pipe OD – 254 ... 3048 mm (10" ... 120")		X	X	X		X			X	
E2 Universal for pipe OD – 254 ... 6096 mm (10" ... 240")	X		X	X		X			X	X
E3 Universal for pipe OD – 304 ... 9144 mm (12" ... 360")		X	X	X		X			X	
High Precision Sensor -40 ... +120 °C (-40 ... +248 °F) T1 (T2) CE IP68										
A1H (High Precision) for pipe WT - 0.64 ... 1.0 mm (0.025" ... 0.04")		X			X		X		X	X
A2H (High Precision) for pipe WT - 1.0 ... 1.5 mm (0.04" ... 0.06")	X				X		X		X	X
A3H (High Precision) for pipe WT - 1.5 ... 2.0 mm (0.06" ... 0.08")	X				X		X		X	X
B1H (High Precision) for pipe WT - 2.0 ... 3.0 mm (0.08" ... 0.12")	X				X	X	X	X	X	X
B2H (High Precision) for pipe WT - 3.0 ... 4.1 mm (0.12" ... 0.16")	X				X	X	X	X	X	X
B3H (High Precision) for pipe WT - 2.7 ... 3.3 mm (0.106" ... 0.128")		X			X	X	X	X	X	X
C1H (High Precision) for pipe WT - 4.1 ... 5.8 mm (0.16" ... 0.23")	X		X	X		X	X	X	X	X
C2H (High Precision) for pipe WT - 5.8 ... 8.1 mm (0.23" ... 0.32")	X		X	X		X	X	X	X	X
D1H (High Precision) for pipe WT - 8.1 ... 11.2 mm (0.32" ... 0.44")	X		X	X		X	X	X	X	X
D2H (High Precision) for pipe WT - 11.2 ... 15.7 mm (0.44" ... 0.62")	X		X	X		X	X	X	X	X
D3H (High Precision) for pipe WT - 7.4 ... 9.0 mm (0.293" ... 0.354")		X	X	X		X	X	X	X	X
D4H (High Precision) for pipe WT - 15.7 ... 31.8 mm (0.62" ... 1.25")	X		X	X		X	X	X	X	X
High Temperature Universal Sensor -40 ... +230 °C (-40 ... +446 °F)										
High Temperature size 1 ... 230 °C (Ø 12.7 ... 100 mm)		X	X		X					X
High Temperature size 2 ... 230 °C (Ø 30 ... 200 mm)	X		X		X					X
High Temperature size 3 ... 230 °C (Ø 150 ... 610 mm)	X		X		X					X
High Temperature size 4 ... 230 °C (Ø 400 ... 1200 mm)	X		X		X					X
High Temperature size 2A ... 230 °C (Ø 30 ... 200 mm)		X	X		X					
High Temperature size 3A ... 230 °C (Ø 150 ... 610 mm)		X	X		X					
High Temperature size 4A ... 230 °C (Ø 400 ... 1200 mm)		X	X		X					