Data Sheet 10/14-6.73-EN Rev. E

Sensyflow FMT200-D
Thermal Mass Flowmeter

Direct mass and standard volume flow measurement of compressed air and biogas
— independent of operating pressure and temperature

Wide measuring range of 1:100
— Precise measurement even with light flows
— Measured value display starting at 0 Nm³/h

High measuring accuracy

Quick response time < 0.5 s

Negligible pressure loss

No moving parts, no wear, maintenance-free

Defined, reproducible mounting position
— Easy installation via screwed or flanged pipe components
— Weld-on adapters for larger meter sizes

Compact unit with signal output on sensor head

Application areas
— Measurement of compressed air consumption
— Leakage detection
— Optimization of compressed air networks
— Measurement of the amount of biogas created
— Efficiency factor determination and balancing in biogas plants

Contents

1 General information

1.1 Principle of operation and construction

Sensyflow FMT200-D is a compact, highly dynamic measuring system for mass flow or standard volume flow measurement specifically designed for biogas or compressed air.

The flowmeter sensor uses the hot film anemometer working principle. This method allows for direct measurement of the gas mass flow. As a result, the normally necessary pressure and temperature compensation and, thus, additional measuring points and the compensation computer can be omitted.

The Sensyflow FMT200-D plus the corresponding pipe components are installed in a defined way and locked in place as a component of the measuring pipe. Pipe components made of galvanized steel are available with external thread fittings in imperial sizes. Pipe components with flange connections as well as the weld-on adapter for meters sizes DN 100 ... DN 250 (4 ... 10") are manufactured from CrNi steel.

The flowmeter sensor includes the sensor unit and the evaluation electronics. Sensyflow FMT200-D directly provides a linearized output signal. The device is calibrated and ready for operation. An LCI adapter is used to parameterize the output signal.

A standard power supply unit can be used for powering the device.

Physics of measurement

Thermal flow metering procedures use different ways to evaluate the flow dependent cooling of a heated resistor as measuring signal.

In a hotfilm anemometer with temperature difference control, the heated platinum resistor is maintained at a constant overtemperature in relation to an unheated platinum sensor inside the gas flow. The heating power required for maintaining the overtemperature depends directly on the flow rate and the material properties of the gas. With a known (and constant) gas composition the mass-flow can be determined by electronically evaluating the heater current/mass-flow curve without additional pressure and temperature compensation. Together with the standard density of the gas this results directly in the standard volume flow. Considering the high measuring range dynamics up to 1:100, an accuracy smaller than 1 % of the measuring value is achieved.

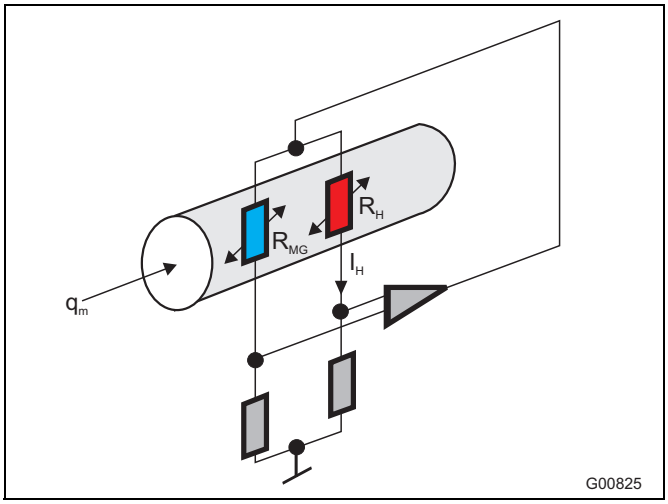


Fig. 1: Analog measuring principle

q_m	Gas mass-flow
R_{MG}	Gas temperature measuring resistor
R_H	Heating resistor
I_H	Actual value of heater

The gas stream flows past two temperature-sensitive resistors R_H and R_{MG} which are part of an electrical bridge circuit. Due to the chosen resistance ratio $R_H < R_{MG}$, R_H is heated by the current I_H. R_{MG} adopts the same temperature as the gas. The current I_H is preset by the electronic control circuit to produce a constant temperature difference between the heated resistor R_H and the temperature of the gas.

The electrical power generated with resistor R_H exactly compensates its loss of heat to the gas flow. As this loss of heat is dependent on the number of particles which collide with the surface of resistor R_H, I_H represents a measure of the mass flow rate.

Calibration for compressed air and biogas applications

The calibration of the devices is done on a highly precise flow test machine with air as calibration medium. For standard biogas applications, the calibration data are subsequently converted, whereby a medium gas composition is based on 53 Vol% methane, 45 Vol% carbon dioxide and 2 Vol% air.

For applications that clearly deviate from this gas composition devices must be ordered with a special calibration for biogas. In this case, the exact gas composition is to be specified with the order.

2 Specifications

Measuring ranges

Nominal diameter	Maximum measuring ranges for air/nitrogen				
	kg/h	Nm3/h[1]	Nl/min[2]	lb/h	SCFM
1“	165	125	2100	360	70
1 1/2“	430	330	5500	940	190
2“	740	570	9500	1600	330
3“	1775	1375	22800	3900	800
6“	7500	5800	97000	16500	3400

Nominal diameter	Maximum measuring ranges for standard biogas				
	kg/h	Nm3/h[1]	Nl/min[2]	lb/h	SCFM
1“	130	95	1600	280	55
1 1/2“	310	260	4300	680	150
2“	510	390	6500	1120	230
3“	1200	920	15000	2640	540
6“	5700	4400	73000	12500	2500

1) Notation also m³/h - qn
2) Notation also l/min - qn

All volume flow rate specifications are referenced to 0 °C / 1013.25 hPa (32 °F/14.696 psi).

Output

Analog output signal
0/4 … 20 mA, switchable

Load
< 750 Ω, electrically isolated

Characteristics

Measurement deviation
Air, nitrogen <1.5 % of rate plus ± 0.05 % of end value
Biogas <1.8 % of rate plus ± 0.1 % of end value
under calibration conditions in specified flow range

Reproducibility
< ± 0.25 % of rate, t_{meas} = 10 s

Response time
$T_{63} \approx$ 500 ms

Influences

Temperature effect
< 0.05 % / K of measured value

Pressure effect
± 0.2 % / 100 kPa (bar [14.5 psi]) of measured value

Pressure drop
< 1 kPa (10 mbar [0.145 psi]) at full scale
decreasing quadratically for smaller flow rates

Ambient conditions

Ambient temperature for flowmeter sensor
-25 … 70 °C (-13 ... 158 °F)
Ingress protection
IP 65, NEMA 4X
Storage temperature
-25 ... 85 °C (-13 ... 185 °F)

Measured medium conditions

Measured medium temperature, operating temperature
-25 … 150 °C (-13 ... 302 °F)

Measured medium pressure, maximum
Standard 1 MPa (10 bar [145 psi])

Construction

Weight in kg (lbs)

Threaded pipe component			Flange pipe component	
Nominal diameter	kg	(lbs)	kg	(lbs)
1“	1.5	3.3	5.6	12.3
1 1/2“	3.0	6.6	8.4	18.5
2“	5.5	12.1	11.0	24.3
3“	9.5	20.9	19.0	41.9

Weld-on adapter incl. lock nut		
	kg	(lbs)
	0.5	1.1

Flowmeter sensor		
	kg	(lbs)
	1.8	4.0

Materials, process connection
Flowmeter sensor CrNi steel, e.g. 1.4301

Pipe component with external threads
R 1" ... 3" Galvanized steel

Pipe component with connection flanges
DN 25 ... DN 80 CrNi steel, e.g. 1.4301

Weld-on adapter CrNi steel, e.g. 1.4301

Connection flanges to EN1092-1 Form B1, PN10

Supply power

Voltage
24 V AC / DC ± 25 %

Power consumption
< 15 W

Power consumption
< 600 mA, recommended fuse of at least 2 A, slow-blow
Cable gland M20 x 1.5

Communication interface

LCI adapter

Accessories (optional)

– Power supply unit
– Display unit
– Integrator with indicator (current pulse transformer)

Parameterize

The output signal of the Sensyflow FMT200-D flowmeter can be toggled between 0 … 20 mA and 4 … 20 mA. Additionally, a measuring range window can be expanded in such a way that a smaller span corresponds to a 20 mA current signal. A current < 3.5 mA or > 22 mA can be selected for the failure signal.

An LCI adapter is used to parameterize the device. It is possible to change the output signals or the settings of the measuring ranges and signals by using a standard PC or laptop.

3 Dimensions

3.1 Pipe component

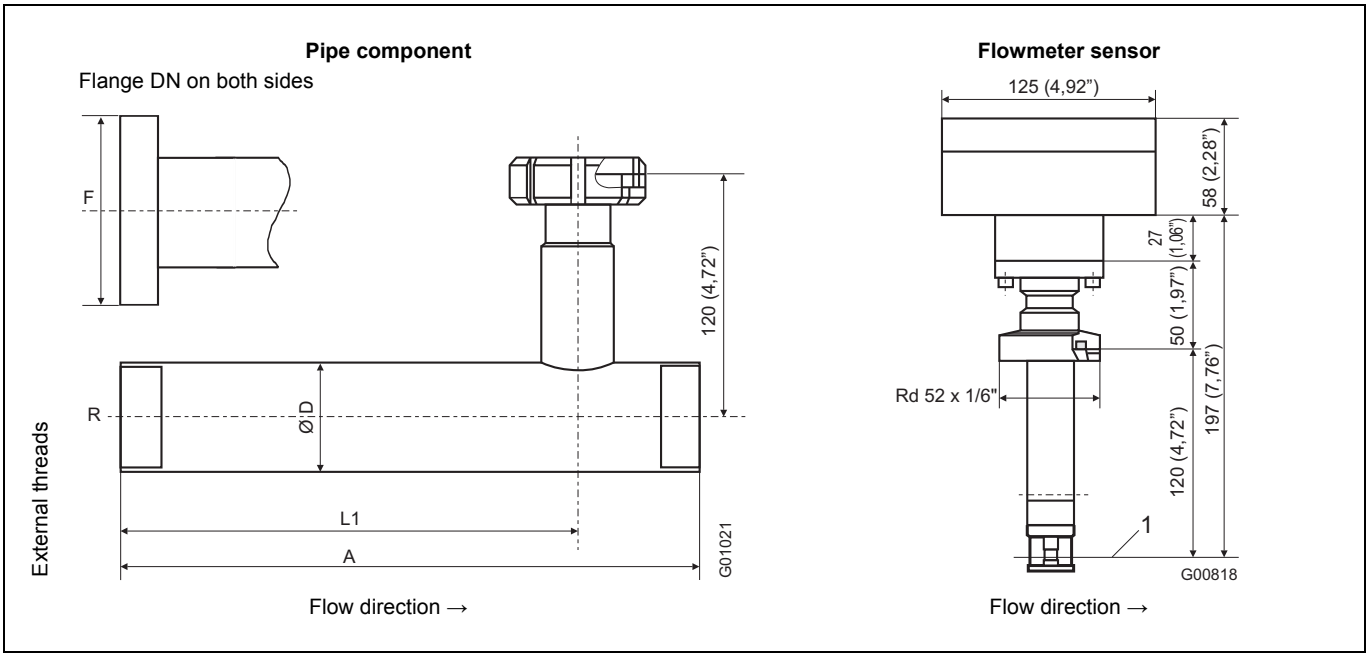


Fig. 2: Dimensions in mm (inch) 1 Middle of pipe component

DN	A	L1	Ø D interior	External threads R	Flange F
25 (1“)	550 (21.65“)	410 (16.14“)	27.3 (1.07“)	R1“: 33.7 x 1.2	115 (4.53“)
40 (1 1/2“)	820 (32.28“)	615 (24.21“)	41.9 (1.65“)	R1 1/2“: 48.3 x 3.2	150 (5.91“)
50 (2“)	1080 (42.52“)	810 (31.89“)	53.9 (2.12“)	R2“: 60.3 x 3.2	165 (6.50“)
80 (3“)	1600 (62.99“)	1200 (47.24“)	79.9 (3.15“)	R3“: 88.9 x 4.5	200 (7.87“)

Dimensions in mm (inch)

3.2 Weld-on adapter for Sensyflow FMT200-D

Length of weld-on adapter at delivery: L = 117 mm (4.6").

For outer pipe diameter 100 ... 150 mm (4 ... 6“)
Prior to welding the weld-on adapter must be shortened to the appropriate length so that it has the length L after welding. This results in a measuring position in the middle of the pipeline.

$$L = H1 - 1/2 \times Ø\ D_{outer} \quad \text{with } H1 = 120 \text{ mm } (4.72“)$$

For outer pipe diameter 150 ... 250 mm (6 ... 10“)
Shorten the weld-on adapter in such a way that the fixed length L = 45 mm (1.77“) is achieved after welding. As a result, the measuring position is not in the middle of the pipeline. For a correct calibration it is therefore mandatory to specify the exact inside diameter and wall thickness of the pipe in mm when ordering.

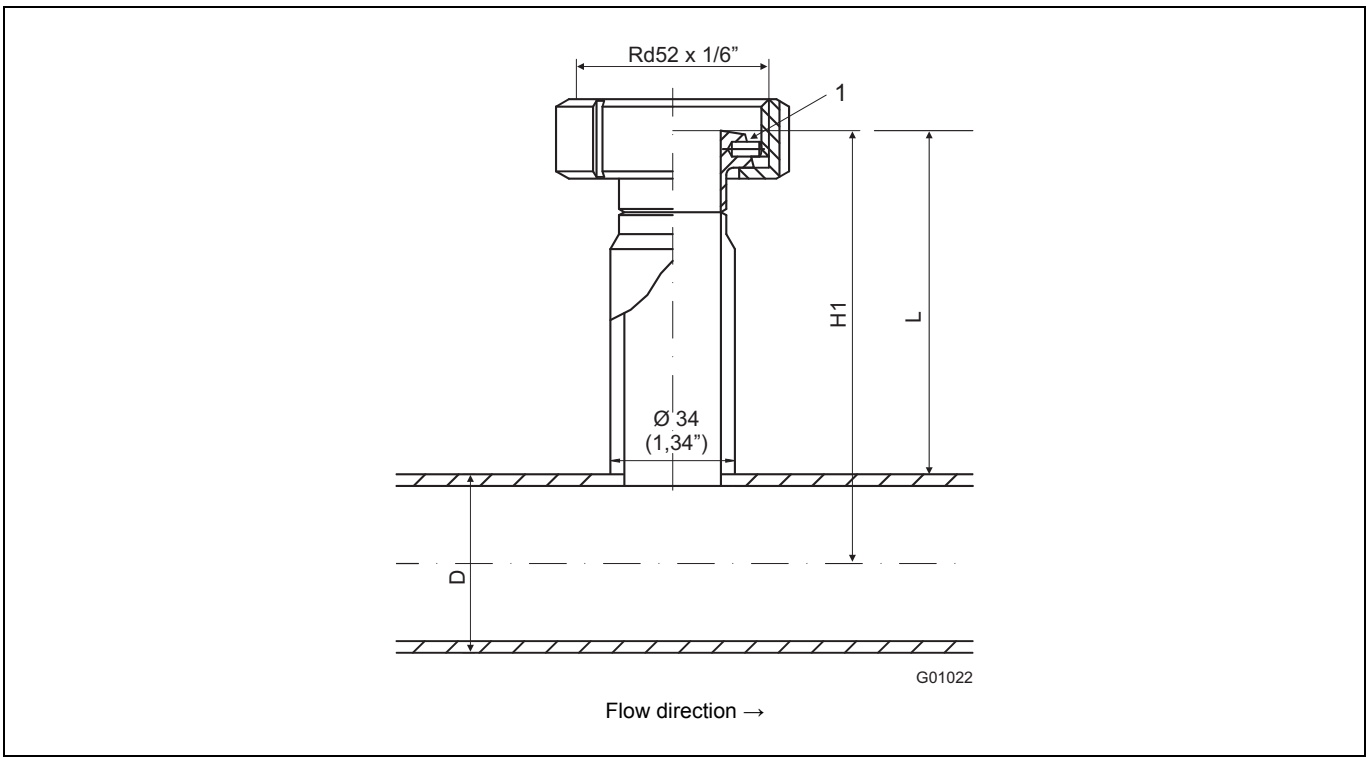


Fig. 3: Weld-on adapter DIN 11851 with lock nut. Dimensions in mm (inch)
1 Centering pin

IMPORTANT (NOTE)
Always mount the weld-on adapter together with the lock nut to the pipeline. Mounting it at a later time is not possible.

Observe thickness of pipeline wall and degree of shrinkage when welding on.

It is essential to maintain a right angle to the pipe axis (max. tolerance: 2°).

The adapter centering pin must be exactly aligned with the pipe axis in the flow direction (outflow side, behind the measuring point).

Once welding is complete, there must be a passage of at least 28 mm (1.10 inches) free for the purpose of mounting the flowmeter sensor; drill to create if necessary.

For outer pipe diameter 100 ... 150 mm (4 ... 6“) The distance H1 from the upper edge of the adapter to the the pipe central axis must be within a tolerance of ± 2 mm (0.08“).

4 Electrical connections

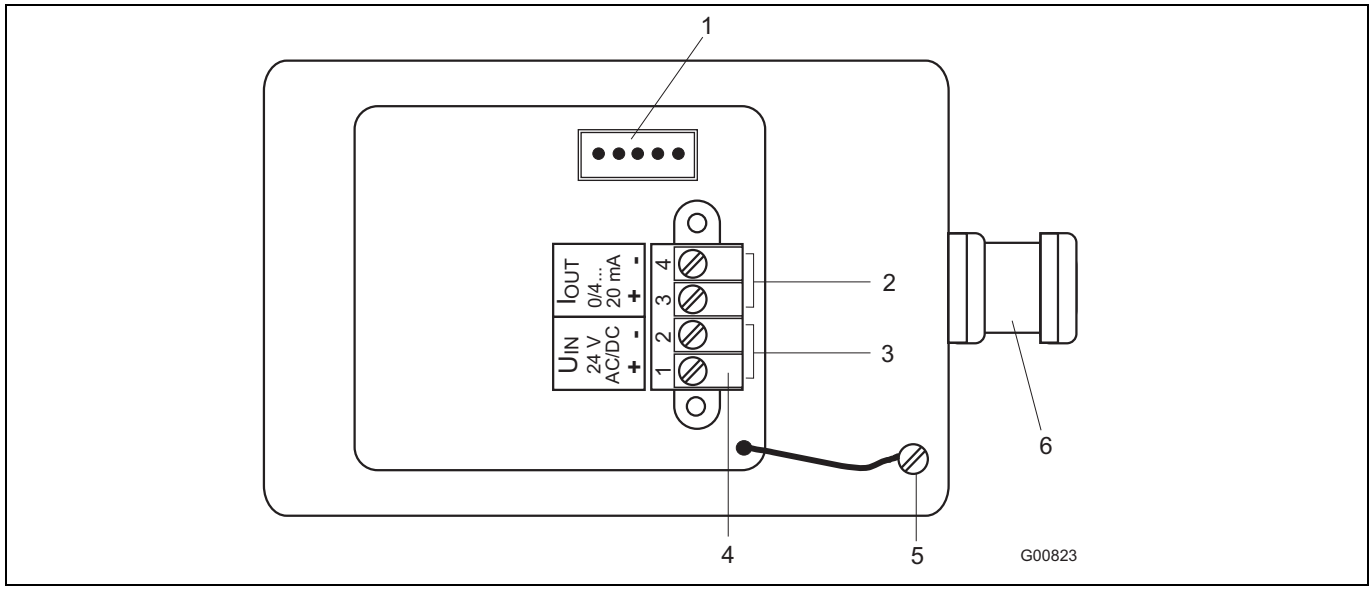
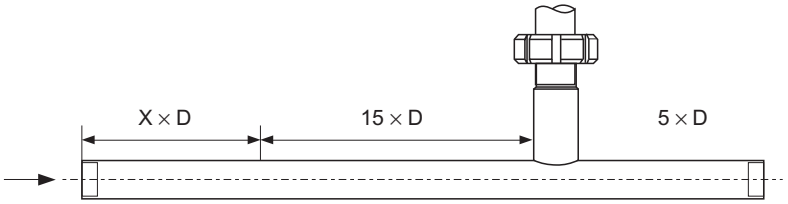
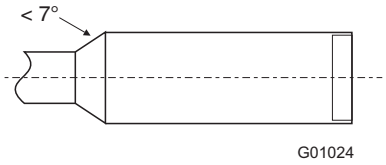
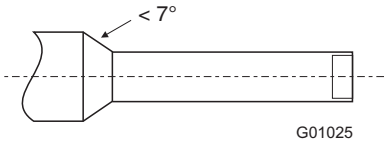
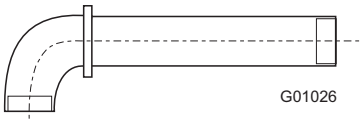
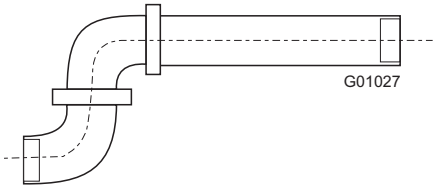
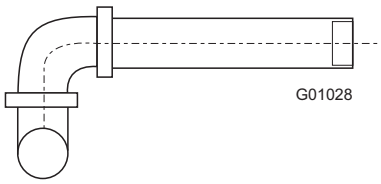
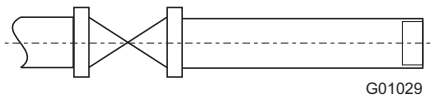


Fig. 4

1 Socket for LCI adapter
2 Analog output 0/4 ... 20 mA (electrically isolated)
3 Power supply 24 V AC/DC
4 Terminals
5 Ground
6 Cable entry

5 Recommended steadying lengths according to DIN EN ISO 5167-1



	Expansion X = 0
	Reduction X = 0
	90° manifold X = 5
	Two 90° manifolds at the same level X = 10
	Two 90° manifolds at two levels X = 25
	Valve / gate X = 35

To achieve the stated measuring accuracy, the steadying lengths seen above must be provided. For combinations of inlet run disturbances, e. g. valve and reducer, you must always consider the longer inlet run length. In confined spaces at the mounting location the outlet run length can be shortened to 3 x D. The reduction of the minimum inlet run length, however, will impact on the achievable accuracy.

High repeatability of the measuring value is still provided. Under certain circumstances, special calibration can be performed for insufficient steadying lengths. For this purpose and in individual cases consulting is necessary.

For gases with extremely low density (hydrogen, helium) the steadying lengths must be doubled.

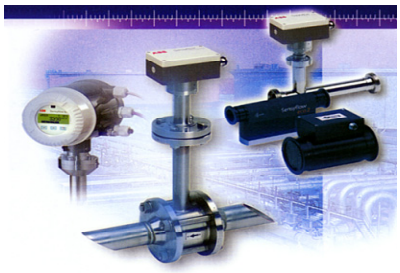
6 Ordering information

	Main order number				Add. order no.
Version number	1 - 6	7	8	9	
Sensyflow FMT200-D thermal mass flowmeter for biogas and compressed air	**V14223**	**X**	**X**	**X**	**XXX**
Type of calibration					
Standard calibration for air	1)	1			
Special calibration for air		2			
Standard calibration for biogas	1)	3			
Special calibration for biogas		4			
Analog output					
4 ... 20 mA, failure message < 3.5 mA			1		
4 ... 20 mA, failure message > 22 mA			2		
0 ... 20 mA			3		
Pipe component					
Without pipe component				0	
1 in. thread				1	
1 -1/2 in. thread				2	
2 in. thread				3	
3 in. thread				4	
DN 25 (1 in.) Flanges, DIN PN 10, nominal pressure 10 bar (1 MPa / 145 psi)				A	
DN 40 (1-1/2 in.) Flanges, DIN PN 10, nominal pressure 10 bar (1 MPa / 145 psi)				B	
DN 50 (2 in.) Flanges, DIN PN 10, nominal pressure 10 bar (1 MPa / 145 psi)				C	
DN 80 (3 in.) Flanges, DIN PN 10, nominal pressure 10 bar (1 MPa / 145 psi)				D	
Weld-on adapter, DIN 11851, with lock nut, for pipe diameter 100 ... 200 mm (4 ... 8 in.), stainless steel				N	
Certificates: Calibration					
Factory certificate					0
DAkkS certificate, calibration with air (not for process gas calibration)				2)	1
Certificates and material traceability					
Material certificate 3.1 to EN 10204					CBB
Test report 2.1 to EN 10204 for order conformity					CF3
Certificates: GOST					
GOST Russia, metrological					CG1
GOST Kazakhstan, metrological					CG2
Adapter					
LCI adapter					GL
Language of documentation					
German					M1
English					M5

1) Operating pressure 1 ... 10 bar abs. (0.1 ... 1 MPa abs. / 14.5 ... 145 psi abs.), operating temperature 0 ... 60 °C (32 ... 140 °F)
2) DAkkS- / ILAC-accredited calibration equipment D-K-15081-01-00

Accessories	**Code**
SMD130 DAkkS calibration for thermal mass flowmeter, certificate of calibration with air, DAkkS / ILAC - accredited calibration equipment D-K-15081-01-00	3KXS310130L1001
FMT power supply, housing for rail mounting 62.5 mm x 75 mm x 139 mm, input 230 V AC, output 24 V DC / 2.5 A	7962800
FMT200-D operating instruction, English	3KXF421005R4201
FMT200-D operating instruction, German	3KXF421005R4203

7 Questionnaire



Questionnaire
Thermal Mass Flowmeter
Sensyflow FMT

Customer address: _____
Company: _____
Zip code and location: _____ Date: _____
Cust. no.: _____ Telephone: _____
Contact person: _____ E-mail: _____

Media data for gaseous, pure media:

Description of media Mixed gas, gas composition in vol.%[1)]

Type of gas (no mixtures): _____ Component 1/name/vol.%: _____
Operating pressure (bar abs.) Component 2/name/vol.%: _____
Min./norm./max., approx. _____ Component 3/name/vol.%: _____
Operating temperature (°C) Component 4/name/vol.%: _____
Min./norm./max., approx. _____ Component 5/name/vol.%: _____

Flowrate [2)] Min.: ____ Norm.: _____ Max.: _____ **Pipeline/pipe component**[3)]

Flow unit:

Standard volume
- Nm^3/h ☐
- Nm^3/min ☐
- Nl/min ☐
- SCFM ☐
- Other _____

Mass flow units
- kg/h ☐
- kg/min ☐
- g/min ☐
- t/h ☐
- Other _____

°Standard condition, e.g., 0°C/1,013 mbar or _____

DN/PN: _____
ANSI/lbs _____
Diameter [mm] _____
Inside diameter specified in mm
Wafer flange form 1 ☐
Partial meas. section form 2 ☐
Weld-on adapter ☐
Other_____

Required device designs:

- FMT500-IG ☐
- FMT400-VTS ☐
- FMT400-VTCS ☐
- FMT700-P[4)] ☐
- FMT200-ECO2 ☐
- FMT200-D ☐

Design:

- Integral mount design ☐
- Remote design with
  - Cable length 5 m ☐
  - Cable length 15 m ☐
  - Cable length 25 m ☐

Output signal:

- 0/4...20 mA ☐
- 4...20 mA/HART ☐
- PROFIBUS DP-V1 ☐

Ex protection class:

- None ☐
- ATEX Zone 1/21 ☐
- ATEX Zone 0/21 ☐
- Zone 2/22 ☐
- GOST ☐
- FM/CSA ☐

- 24 V ☐
- 110 V ☐
- 230 V ☐

Comments:

1) Please specify the composition of mixed gases
(e.g., North Sea natural gas: 1) CH_4 90%, 2) C_2H_6 5%, 3) N_2 3%, 4) C_3H_8, 1%, 5) CO_2 1%).
2) Calibration is performed at the max. possible flow in the nominal size specified.
3) Please observe/determine the minimum inflow and outflow sections.
4) Output signal: 0...10 V as standard

Note: An order can only be confirmed and a delivery date specified once full technical clearance has been obtained.

Notes

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