

CS 420 thermal mass flow sensor (in-line type)**Features**

- Inline type sensor for high accuracy in small tube diameters
- Particularly suitable for measuring process gases such as N₂, Ar, O₂, CO₂ etc.
- Thermal mass flow, independent of pressure and temperature changes
- IP65 casing provides robust protection in rough industrial environment
- Very fast response time

The CS flow sensor **CS 420** is based on the thermal mass flow principle. It measure volumetric standard flow over a wide measuring range. The result is pressure and temperature independent.

CS 420 is an in-line type sensor which is mounted into the pipe. There are several models available for different tube diameters and connections (thread or flange). The sensor is available with or without display.

The version with display shows the actual volumetric flow and the total consumption. Via the keyboard consumption counter can be reset.

Various settings such as gas type, flow unit, reference standards, can be set ex factory or through our service kit. The service kit consists of a PC software and a interface box which connects the sensor to the USB port of the PC. Every sensor includes an analogue output (4...20mA) for flow and an isolated pulse output for the consumption counter.

Important information

The operating instructions must be read in full and carefully observed before starting up the device. The manufacturer cannot be held liable for any damage which occurs as a result of non-observance or non-compliance with this manual.

Should the device be tampered with in any manner other than a procedure which is described and specified in the manual, the warranty is cancelled and the manufacturer is exempt from liability.

The device is destined exclusively for the described application.

CS offers no guarantee for the suitability for any other purpose and is not liable for errors which may have slipped into this operating manual. They are also not liable for consequential damage resulting from the delivery, capability or use of this device.

Area of application

CS 420 is designed for stationary and mobile use in gas pipes. It is used for the measurement of flow and consumption.

The principle of measurement is based on the evacuation of heat from an electrically heated sensor into the surrounding air flow.

The measuring devices operate independently of pressure and temperature.

When the sensor is fitted in a pipe, the sensor signal is used to calculate the standard volumetric flow or the actual mass flow of the medium. The relationship between standard and actual flows are described with the formula below.

$$Q_s = Q_{act} \frac{P_{act}}{P_s} \frac{T_s}{T_{act}} = Q_{act} \frac{\rho_{act}}{\rho_s}$$

Q_s = standard volumetric flow [m³/h]

Q_{act} = actual volumetric flow [m³/h]

P_{act} = actual absolute pressure [MPa]

P_s = standard or reference pressure [MPa]

T_s = standard or reference absolute temperature [K]

ρ_s = standard or reference density [kg/m³]

ρ_{act} = actual density [kg/m³]

$$q = Q * \rho$$

q = mass flow [kg/s]

ρ = density [kg/m³]

Q = volumetric flow [m³/s]

$$Q_s = \frac{q}{\rho} = \frac{q_{act}}{\rho_{act}} \frac{\rho_{act}}{\rho_s} = \frac{q_{act}}{\rho_s}$$

Notes on safety

Please read prior to operation!

- Do not exceed the pressure range of 1.6 MPa.
- Observe the measuring range of the sensor.
- Overheating destroys probes.
- Observe permissible storage, transport and operating temperatures.
- Improper handling or use of force when opening the device cancels all warranty claims.
- Adjustment and calibration work must only be carried out by trained personnel from the field of measuring and control engineering.
- Always observe the direction of flow when positioning the sensor.
- Avoid condensation on the sensor element or water drops in the measuring air at all costs as they cause faulty measuring results.
- The clearance of inlet and outlet sections must not fall below the specified minimum values as this causes increased deviations in the measuring results.

Installation considerations

In order to maintain the accuracy stipulated in the data sheets, the sensor must be installed in-line and fitted to tubes with the same diameter.

Unhindered flow characteristics are achieved if the sections in front of the sensor (inlet) and behind the sensor (outlet) are sufficiently long, absolutely straight and lack obstructions such as edges, seams, curves etc. (see page 4).

Careful attention must be paid to the design of the outlet section as obstructions can cause counter-flow turbulence as well as turbulence in the direction of the flow.

The sensor is for indoor use only! If installed outdoors, the sensor must be protected from direct sun and rain!

Attention:

We strongly recommend not to install CS 420 permanently in wet environment as it exists usually right after compressor outputs. It will cause wrong measurements and can degrade the sensor. Only temporary installations should be done.

CS 420 with tube diameters above 1 1/4" have reduced inlet sections and require additional straight sections upstream of the flow meter. Please take into consideration the recommended inlet and outlet sections on page 4.

Table of inlet / outlet sections

The following table shows the equalising sections necessary in relation to existing obstructions.

Flow obstruction before the measurement section	Min. length inlet (L1)	Min. length outlet (L2)
Slight curve (bend < 90°)	12 x D	5 x D
Reduction (Tube narrows towards measurement section)	15 x D	5 x D
Expansion (Tube expands towards measurement section)	15 x D	5 x D
90° bend or T piece	15 x D	5 x D
2 x 90° bends on one level	20 x D	5 x D
2 x 90° bends 3 dimensional change of direction	35 x D	5 x D
Shut-off valve	45 x D	5 x D

The respective minimum values required are indicated here. If it is not possible to observe the stipulated equalising sections, considerable deviations in measuring results must be expected. Please contact us in this case for flow conditioning solutions.

Measuring ranges

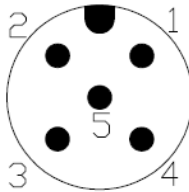
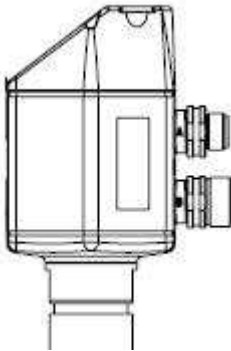
inner diameter			CS 420
inch	mm		meas. ranges from...to
1/4"	8.8	DN 8	0.5 ... 90.1 l/min
1/2"	16.1	DN 15	0.5 ... 90 m³/h
3/4"	21.7	DN 20	0.9 ... 170 m³/h
1"	27.3	DN 25	1.5 ... 290 m³/h
1 1/4"	36.0	DN 32	2.4 ... 480 m³/h
1 1/2"	41.8	DN 40	2.8 ... 550 m³/h
2"	53.1	DN 50	4.5 ... 900 m³/h
2 1/2"	68.9	DN 65	5.1 ... 1026.5 m³/h
3"	80.9	DN 80	7.1 ... 1424.4 m³/h

The above flow rates are standard flows with reference to P = 1000 hPa and T = 20 °C

The table below shows max flow rates of different gases at Norm conditions of P = 1013.25 hPa and T = 0 °C.

Gas	DN8	DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80
Unit	l/min	m ³ /h	m ³ /h	m ³ /h	m ³ /h	m ³ /h	m ³ /h	m ³ /h	m ³ /h
Air	78.2	76.1	143.8	245.2	405.9	467.5	761.1	868.1	1204.6
Ar	137.6	133.9	252.9	431.4	714.2	822.4	1338.9	1527.2	2119.2
CO ₂	78.3	76.2	143.9	245.5	406.4	468.0	762.0	869.2	1206.1
N ₂	75.7	73.6	139.0	237.1	392.5	452.0	735.9	839.4	1164.8
O ₂	81.1	78.9	149.0	254.3	420.9	484.6	789.1	900.0	1248.9
N ₂ O	83.4	81.2	153.3	261.6	432.9	498.6	811.7	925.9	1284.8
NG	50.3	48.9	92.5	157.8	261.2	300.8	489.8	558.6	775.2
He	98.9	23.5	45.9	76.2	137.4	189.2	309.6	529.5	734.8

Connection diagram

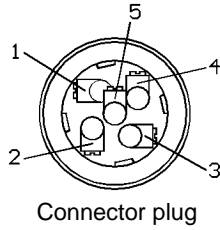


- SDI: Digital signal (internal use)
- VB: Negative supply voltage
- +VB: Positive supply voltage
- +I: Positive 4..20 mA signal
- +P: Pulse output
- NC: not connected
- SEL: internal signal
- SW: Isolated pulse switch output
- DIR: flow direction input

	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5
A	SDI	-VB	+VB	+I	+P
B	SEL	-VB	DIR	SW	SW
Wire color	Brown	White	Blue	Black	Grey

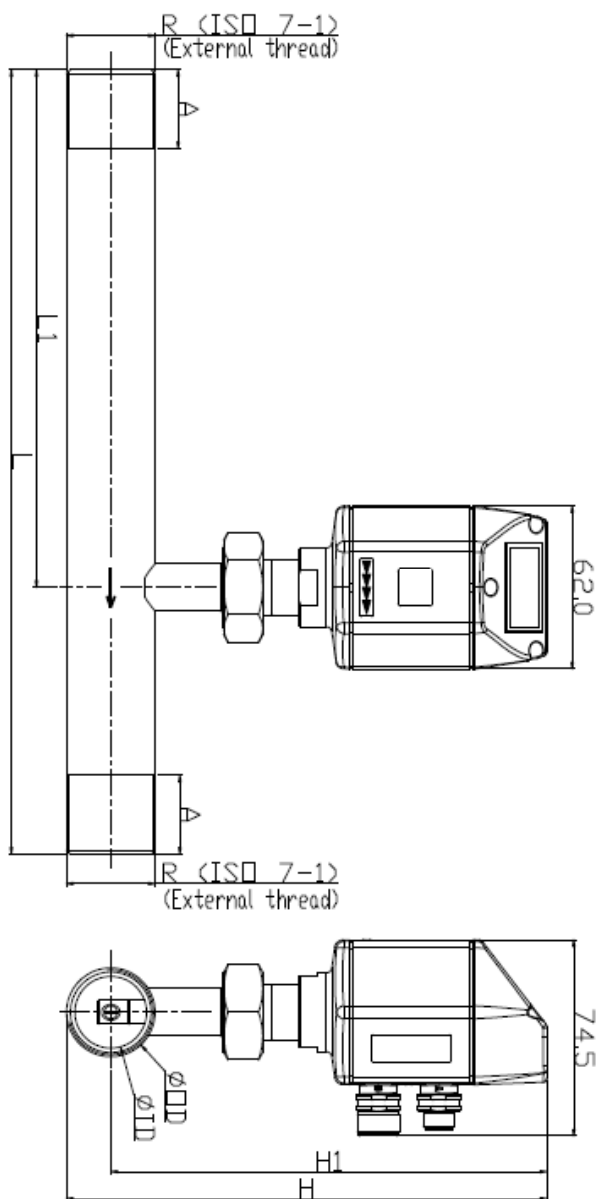
Attention: The signals DIR, SW, SW are available on CS 400 / CS 420 only if the serial number consists of an „8“ at this position: XXXX 7XXX

M12 connector



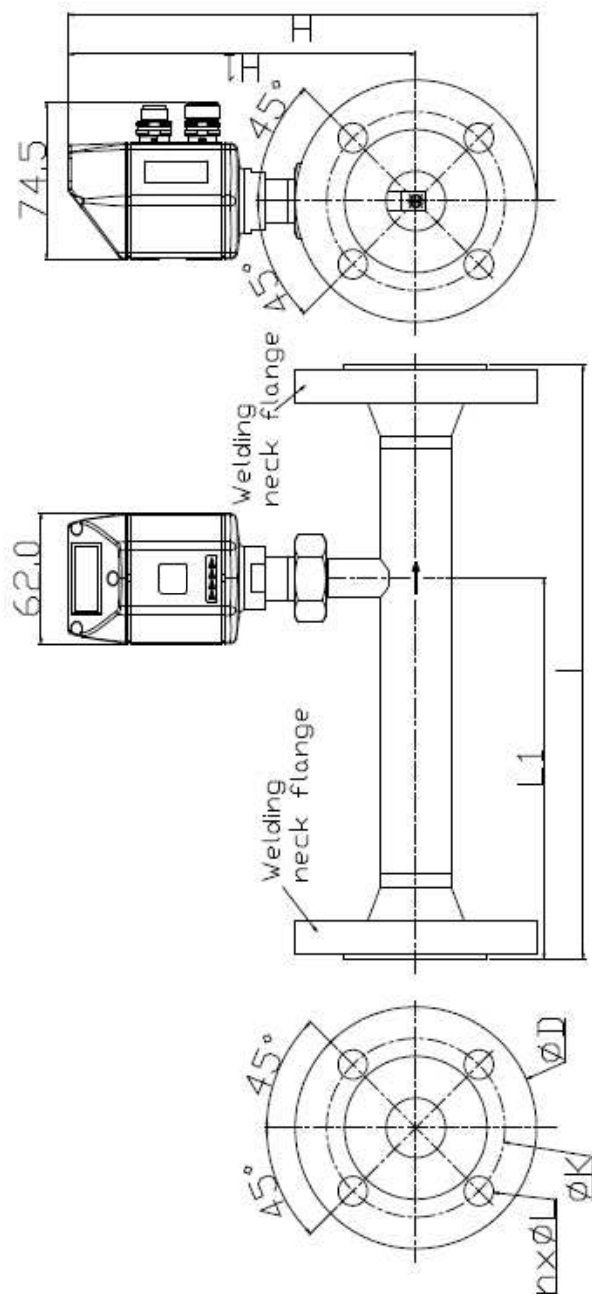
The sensor is delivered with two M12 connectors. The user can connect the supply and signals according to the connection diagram on top. If a connection cable is ordered (0553 0104, 0553 0105) M12 connector is replaced by a connection cable, with open wires at one side (see color code in table above) and M12 connector at another side.

Dimensions



CS 420 with R thread ISO7-1

Pipe size	Pipe size	OD / ID (mm)	L (mm)	L1 (mm)	H (mm)	H1 (mm)	R	A (mm)
1/4"	DN 8	13.5 / 8.9	194	137	176.0	165.7	R 1/4"	15
1/2"	DN 15	21.3 / 16.1	300	210	176.4	165.7	R 1/2"	20
3/4"	DN 20	26.9 / 21.7	475	275	179.2	165.7	R 3/4"	20
1"	DN 25	33.7 / 27.3	475	275	182.6	165.7	R 1"	25
1 1/4"	DN 32	42.4 / 36.0	475	275	186.9	165.7	R 1 1/4"	25
1 1/2"	DN 40	48.3 / 41.9	475	275	189.9	165.7	R 1 1/2"	25
2"	DN 50	60.3 / 53.1	475	275	195.9	165.7	R 2"	30



CS 420 with weld neck flange EN 1092-1 PN 40

Pipe size	Pipe size	OD / ID (mm)	L (mm)	L1 (mm)	H (mm)	H1 (mm)	ØD (mm)	ØK (mm)	nxØL (mm)
1/2"	DN 15	21.3 / 16.1	300	210	213.2	165.7	95	65	4 x 14
3/4"	DN 20	26.9 / 21.7	475	275	218.2	165.7	105	75	4 x 14
1"	DN 25	33.7 / 27.3	475	275	223.2	165.7	115	85	4 x 14
1 1/4"	DN 32	42.4 / 36.0	475	275	235.7	165.7	140	100	4 x 18
1 1/2"	DN 40	48.3 / 41.9	475	275	240.7	165.7	150	110	4 x 18
2"	DN 50	60.3 / 53.1	475	275	248.2	165.7	165	125	4 x 18
2 1/2"	DN 65	76.1 / 68.9	475	275	266.1	173.6	185	145	4 x 18
3"	DN 80	88.9 / 80.9	475	275	280.0	180.0	200	160	4 x 18

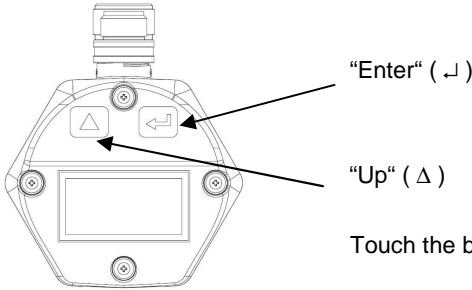
CS 420 with weld neck flange ANSI/B16.5 class 300

Pipe size	Pipe size	OD / ID (mm)	L (mm)	L1 (mm)	H (mm)	H1 (mm)	ØD (mm)	ØK (mm)	nxØL (mm)
1/2"	DN 15	21.3 / 16.1	300	210	213.3	165.7	95.2	66.5	4 x 15.7
3/4"	DN 20	26.9 / 21.7	475	275	224.4	165.7	117.3	82.5	4 x 19
1"	DN 25	33.7 / 27.3	475	275	227.7	165.7	123.9	88.9	4 x 19
1 1/4"	DN 32	42.4 / 36.0	475	275	232.4	165.7	133.3	98.5	4 x 19
1 1/2"	DN 40	48.3 / 41.9	475	275	243.4	165.7	155.4	114.3	4 x 22.3
2"	DN 50	60.3 / 53.1	475	275	248.3	165.7	165.1	127.0	4 x 19
2 1/2"	DN 65	76.1 / 68.9	475	275	268.9	173.6	190.5	149.3	4 x 22.3
3"	DN 80	88.9 / 80.9	475	275	284.8	180.0	209.5	168.1	4 x 22.3

Technical data

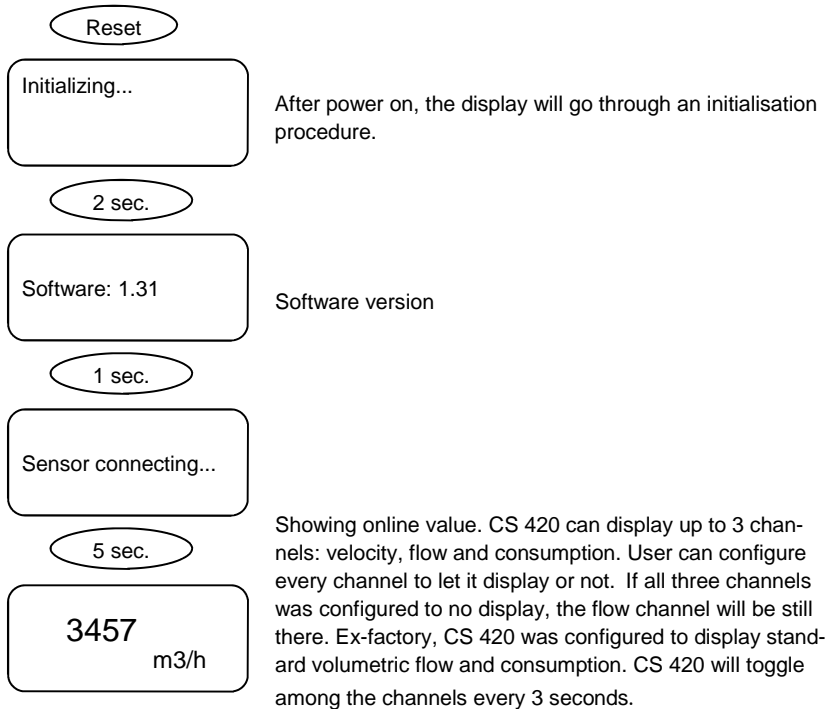
Measured unit:	m ³ /h, m ³ /min, l/min, cfm, m/s, kg/min, kg/h, kg/s (Reference standard can be programmed. Default values: Air: Ps=1000 hPa, Ts=20 °C All other gases: Ps=1013 hPa, Ts=0 °C)
Accuracy:	± (2% of measured value + 0.3% full scale) Temperature drift: 0.05 % / K Pressure drift: 0.05 % / Bar
Stated accuracy at:	Ambient/process temperature 23 °C ± 3°C Ambient/process humidity < 90 %, no condensation Process pressure at 0.6 MPa
Process connection:	R thread (ISO 7-1) Flange EN 1092-1, ANSI 16.6, JIS B2220
Principle of measurement:	Thermal mass flow
Sensor:	Glass coated resistive sensor
Measuring medium:	Air, N ₂ , O ₂ , Ar, N ₂ O, CO ₂ , other gases on request
Operating temperature:	-30 to 50 °C , -10 ... 50 °C (with display)
Operating pressure:	up to 1.6 MPa
Analogue output:	Signal: 4 to 20 mA Scaling: 0 to maximum volume flow Accuracy: 0.06 mA
Pulse output:	1 pulse per m ³ , amplitude: + Vb, 10 mA (active signal) 1 pulse per m ³ , isolated switch, max 30 VDC, 10 mA (pulse length: 30-120 ms, depends on consumption rate)
Power supply:	12-30 VDC, 100 mA
Display:	128 x 64 pixel, with backlight
Material:	Measuring section: Stainless steel 1.4404
Transport temperature:	without display: -30 ... 70 °C

Operation



Touch the button on the top of CS 420 for operation.

Starting process



Special indicators



If this icon is shown on the top right corner of LCD it means that CS 420 has been connected to CS 320. In such case, all the key function are disabled.

Wrong information

Error:
Auto transmission!

It will show this message if “Auto transmission” function of the sensor was enabled. Please contact technician of CS for such case.

Error:
Communication fail!

As soon as communication fails, the instrument will show this message. Please restart the power supply to fix the problem. If it is still there please contact technician of CS .

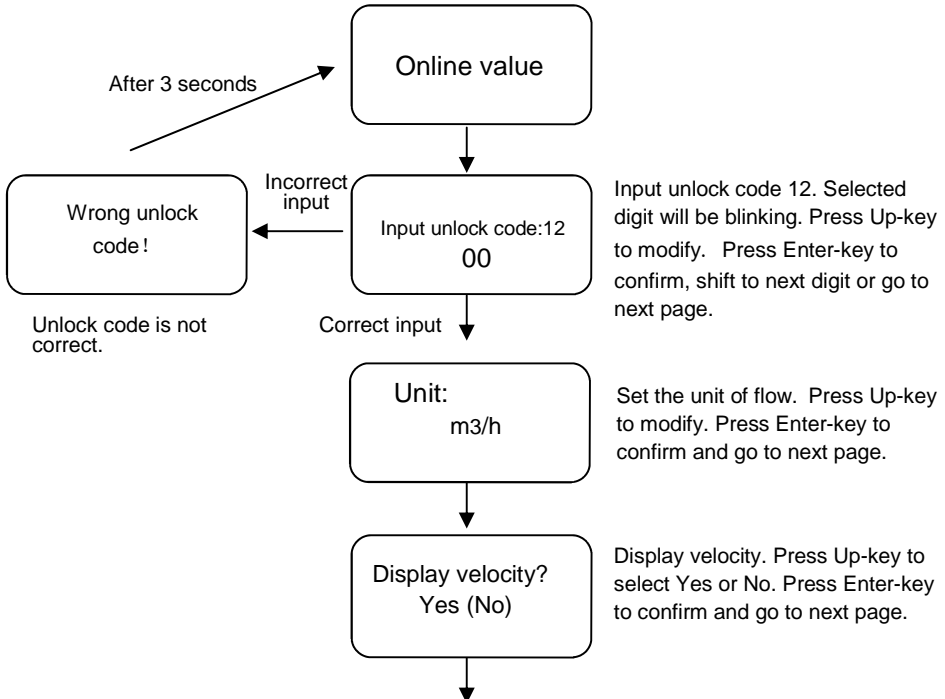
Error:
Sensor unmatched!

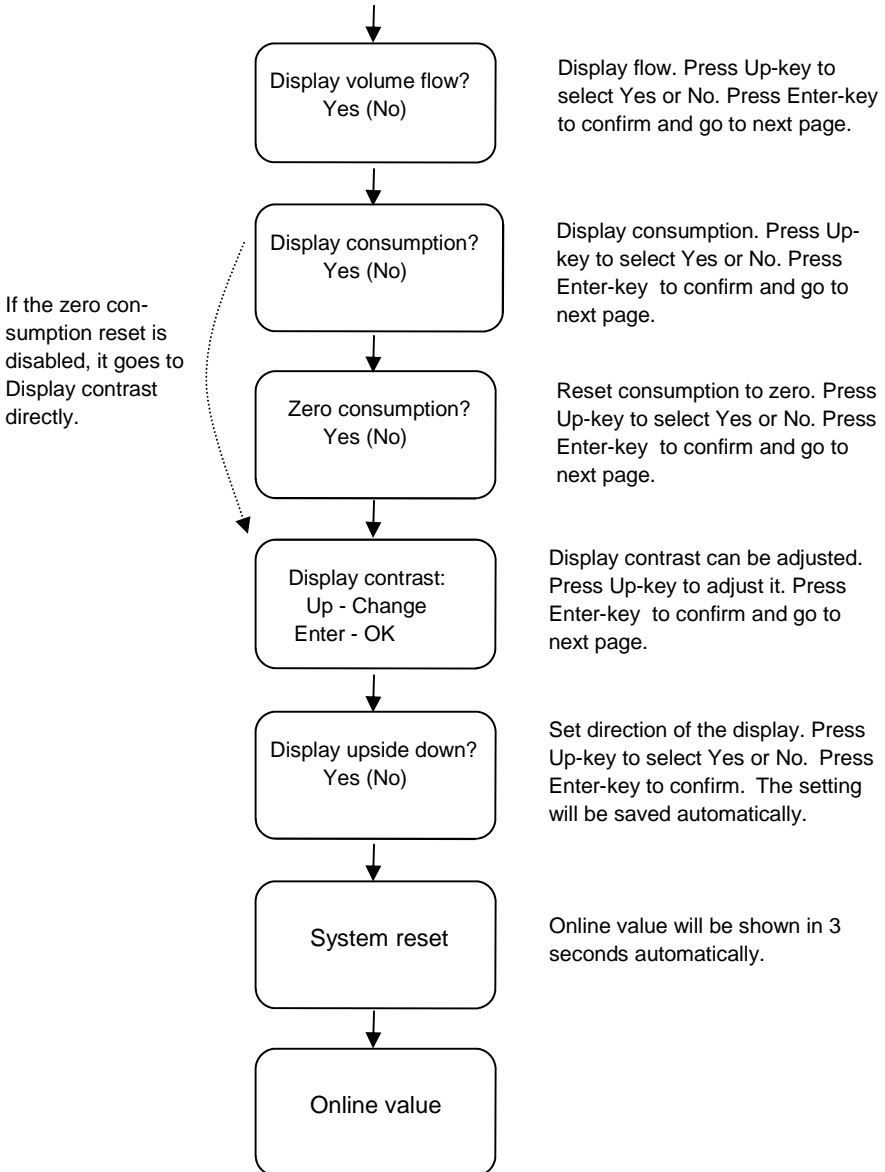
If the sensor is not matching the display setting, the instrument will show this frame. Please contact technician of CS for such case.

Configuration setting

CS 420 is usually configured ex factory according to customer settings ordered.

In case settings have to be changed, please keep the Enter-key (↵) pressed for 3 seconds, CS 420 will ask to enter the unlock key.

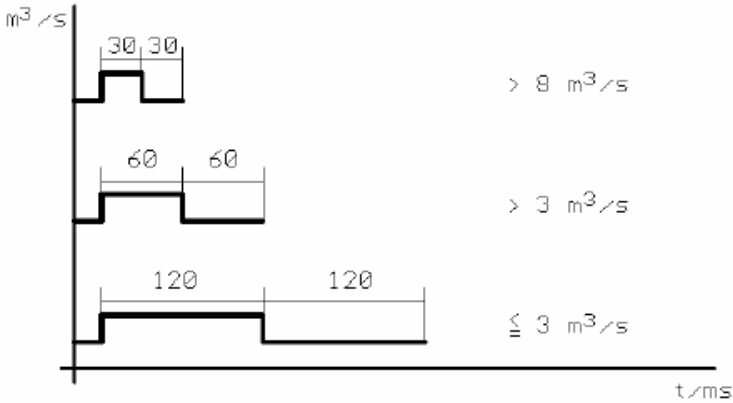




Notes:

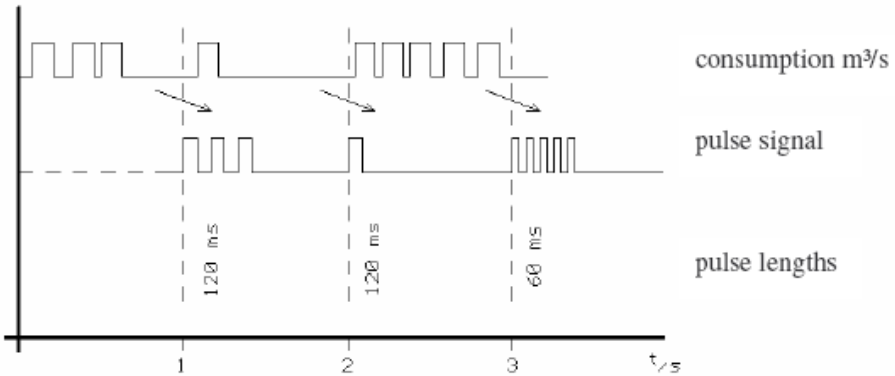
1. To abort the entry process keep Enter-key pressed for 3 seconds.
2. Online value will be shown automatically if there is no key pressed for more than 20 seconds.

Pulse output



CS 420 will send out one pulse per m^3 , l, ft^3 or kg. This pulse output can be connected to an external counter to count the total consumption. The numbers of m^3 per second are summed up and indicated after one second.

Pulse lengths depending on consumption



Analogue output

The analogue output is scaled ex factory to the maximum flow rate.

Order information

CS 420		Line size	Connection	Medium	Display	
0695 4200	-					CS 420, flow sensor, inline type
		Z				DN8
		A				DN15
		B				DN20
		C				DN32
		D				DN40
		E				DN50
		F				DN65
		G				DN80
			A			R thread (ISO 7-1)
			B			Flange EN 1092-1, PN40
			C			Flange ANSI 16.5
			D			Flange JIS B2220
A1007				A		Air
A1008				B		CO ₂
A1009				C		O ₂
A1010				D		N ₂
A1011				E		N ₂ O
A1012				F		Ar
A1013				G		Natural gas (exact mix required)
A1015				I		Others (please specify the gas or gas mix)
					A	No display
A1022					B	With display
0553 0104	Connection cable 5m, 5 pole					
0553 0105	Connection cable 10 m, 5 pole					
0554 2005	Service kit for sensor configuration including software					
0190 0001	Closing cap for measuring section CS 420					
0554 0007	Mains unit in wall housing 100-240 VAC, 10 VA, 50-60 Hz / 24 VDC, 0.35 A					
0554 0107	Mains unit 100-240 VAC / 24 VDC, 0.5 A for CS 200/400 Series, 2 m cable					
3200 0001	Flow calibration with certificate					
3200 0005	Oil and grease free cleansed (for O ₂ already included in A1009)					

Warranty

CS provides a warranty for this product of 24 months covering the material and workmanship under the stated operating conditions from the date of delivery.

Please report any findings immediately and within the warranty time guaranteed by us.

Excluded from this warranty is damage caused by improper use and non-adherence to the instruction manual.

The warranty is also cancelled once the measuring instrument has been opened provided this is not described in the instruction manual for maintenance purposes. This is also the case if the serial number has been changed, damaged or removed.

If in addition to the warranty service necessary repairs, adjustments or similar are carried out, the warranty services are free of charge but there is a charge for other services such as transport and packing costs. Other claims, especially those for damage occurring outside the instrument are not included unless responsibility is legally binding.

ATTENTION: Batteries have a reduced warranty time of 12 months.

CS-ITEC GmbH

Werkstrasse 2
D-79426 Buggingen
Germany
Tel: +49 (0) 7631 9387 387
Fax: +49 (0) 7631 9387 388
Email: sales@cs-itec.com
Website: <http://www.cs-itec.com>

CS Instruments (Asia) Co. Ltd.

Room 31, Tower B, Cambridge Plaza
188 San Wan Road
Sheung Shui, N.T.
Hong Kong

Tel: +86 (0)755 - 8619 3164
Fax: +86 (0)755 - 8619 3165
email: sales@csinstrument.com
website: www.csinstrument.com