

## CORI-FLOW® PRECISION MASS FLOW METER / CONTROLLER FOR LIQUIDS AND GASES

### INTRODUCTION

Bronkhorst High-Tech BV is the world-wide pioneer in the field of low flow liquid metering utilising a thermal measuring principle. The last 20 years have provided a wealth of mass flow metering and control experience, also based upon a Coriolis type sensor and it is this expertise that has resulted in the CORI-FLOW series.

The CORI-FLOW has a patented sensor design and offers four generic models based upon flow rate. The product group covers the standard range (full scale) of 200 g/h up to 600 kg/h.

Moreover, the standard CORI-FLOW configuration offers a controller function that forms a control loop with an optional close-coupled control valve or pump. In addition to operating the unit in either an analog or RS-232 mode, CORI-FLOW can be operated via FLOW-BUS, Profibus-DP, DeviceNet or Modbus communications.



### Coriolis technology i.e.:

- direct mass measurement
- independent of fluid properties
- patented design

### combined with:

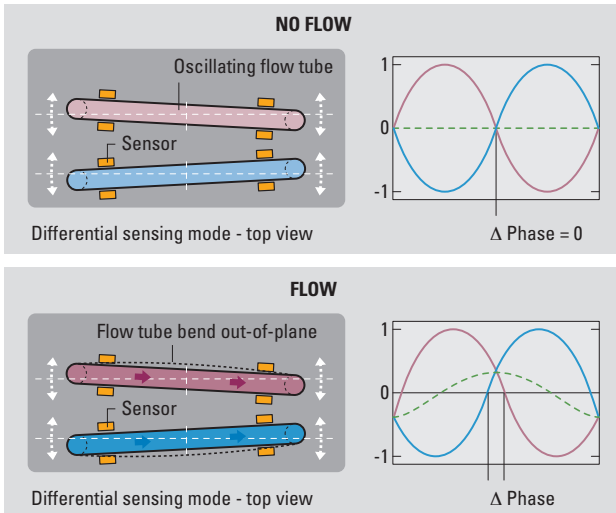
- integral control valve plus control loop electronics
- Profibus-DP®, DeviceNet™, FLOW-BUS, Modbus communication and / or analog output and RS-232
- ISO 9001 quality standards

### DESIGN FEATURES

- direct mass flow measurement
- fast response time
- high accuracy
- highly stable
- compact
- all wetted parts stainless steel
- IP65 housing
- analog plus digital communication
- integrated PID controller for control valve or pump
- integrated totalizer for batch control

## MEASURING PRINCIPLE

The CORI-FLOW contains two parallel tube loops, forming part of an oscillating system. When a fluid flows through the tubes, Coriolis forces cause a variable phase shift between the loops, which is detected by sensors and fed into the integrally mounted pc-board. The resulting output signal is strictly proportional to the real mass flow rate.



## SPECIFICATIONS

### Performance flow sensor

Accuracy Class A : 0,2% of rate + zero stability, range 20:1

Note: Class A for liquids only Class B : 0,5% of rate + zero stability, range 50:1  
Class C : 1,0% of rate + zero stability, range 100:1

Flow sensor performances (values in kg/h)

Accuracy	M52		M53		M54		M55	
	Gas	Liquid	Gas	Liquid	Gas	Liquid	Gas	Liquid
Class A min. FS rate	n.a.	1	n.a.	1	n.a.	10	n.a.	50
Class B min. FS rate	1	0,5	1	0,5	10	5	50	20
Class C min. FS rate	0,5	0,2	0,5	0,5	5	5	20	20
Recommended min. flow	0,02		0,05		0,2		0,5	
Zero stability	< 0,005		< 0,010		< 0,050		< 0,100	

Repeatability : 0,1% of rate

(based on digital output)

Mounting position : preferred mounting position on liquid service upside down

### Operating limits flow controller

Control range : 2...100%

(with elastomeric seat)

Auto shut off : valve closes when setpoint drops below 1,6%

Liquids and Gases : any clean, homogeneous liquid or gas compatible with AISI 316

Differential pressure mass flow controller : recommended  $\Delta P$  across control valve at least 50% of total  $\Delta P$  for liquids and 75% for gases.

Settling time : approx. 0,5 s

## Mechanical

Process connections : std. 1/4" face seal male, or 1/8", 1/4" or 6 mm OD compression type; other on request

Material of construction : stainless steel AISI 316 or equivalent for all wetted parts

Weight : meter: approx. 3,1 kg  
meter + integral valve: 4,4 kg (max.)

Ingress protection : IP 65 (weatherproof) for meter; for controller on request

Leak integrity : < 2 x 10<sup>-9</sup> mbar l.s<sup>-1</sup> He

Pressure test : 1,5 times max. stated operating pressure prevailing at customer

Max. operating pressure : 100 bar

Temperature range : 0...70°C for standard version, (ambient + fluid)  
0...120°C with remote electronics,  
130°C  $\leq$  1 hour allowed for CIP

## Electrical

Power supply : +15...24 Vdc  $\pm$  10%;  
(DeviceNet +24 Vdc only)

Consumption electronics : approx. 80 mA at 15 Vdc

Consumption valve : 250 mA (max) at 15 Vdc

(if present)

Output signal analog : 0...5 (10) Vdc; 2 kOhm min. load  
0 (4)...20 mA (sourcing); 375 Ohm max. load

digital : Profibus-DP, DeviceNet, FLOW-BUS, RS-232, Modbus

Command signal analog : 0...5 (10) Vdc; 424 kOhm load  
0 (4)...20 mA (sinking); 250 Ohm load  
digital : Profibus-DP, DeviceNet, FLOW-BUS, RS-232, Modbus

Electr. connection : male, 8-pin Amphenol for power, analog I/O and RS-232  
option : standard M12 connector for Profibus (female) or DeviceNet / FLOW-BUS (male) / Modbus (male)

CE approved design



CORI-FLOW Mass Flow Meter  
with pressure actuated control valve

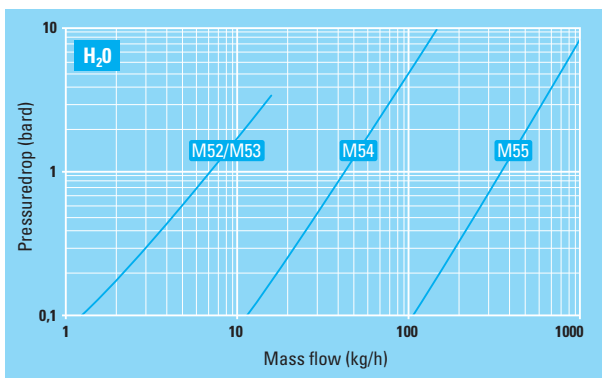
## Flow capacity liquid

Basic model	DN (mm)	Nominal Flow*	Capacities (kg/h)														
			0,2	0,5	1,0	2,0	5,0	10	20	50	100	200	500	600			
M52	1	0,5 kg/h**	●	■	●												
M53	1	5 kg/h		●	●	■	●										
M54	2	50 kg/h				●	●	●	■	●							
M55	4	500 kg/h								●	●	●	●	■	●		

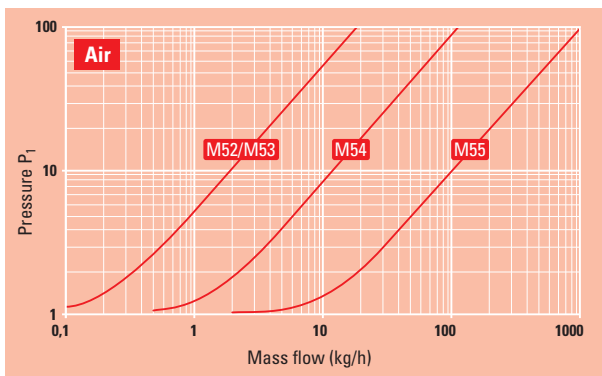
\* Nominal flow: mass flow rate of liquid at a pressure drop of approx. 1 bar and based on reference conditions of water at approx. 20°C.

\*\* Lowest recommended value for optimal performance is 20 g/h.

## Pressure drop liquid (H<sub>2</sub>O)



## Pressure P<sub>1</sub> vs. mass flow for Air (P<sub>2</sub> = 1 bara)



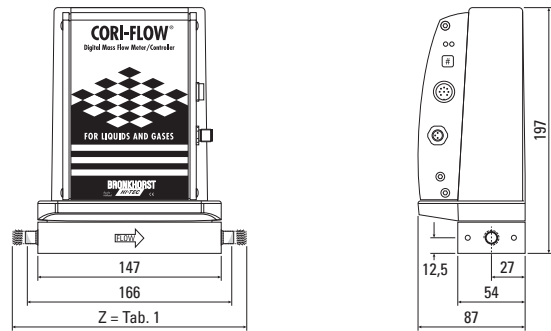
\* Capacity based on air flow measurement: capacity shown increases with pressure; max. allowable pressure is 100 bara.

## Table 1 (Z-values in mm)

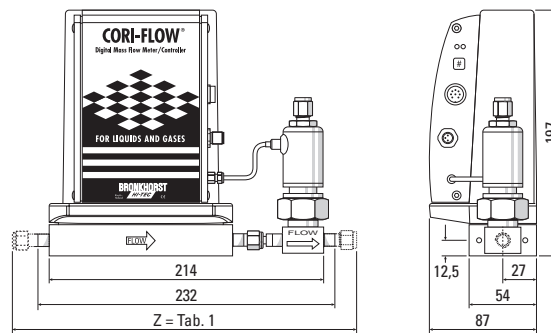
Connections (in/out)	M50	M50C2/ M50C5I	M50C4
1/8" compression type	201	267	-
1/8" face seal male	194	260	-
1/4" compression type	204	270	306
1/4" face seal male	202	267	301
1/4" face seal female	202	267	-
6 mm compression type	204	270	306

## DIMENSIONS (mm)

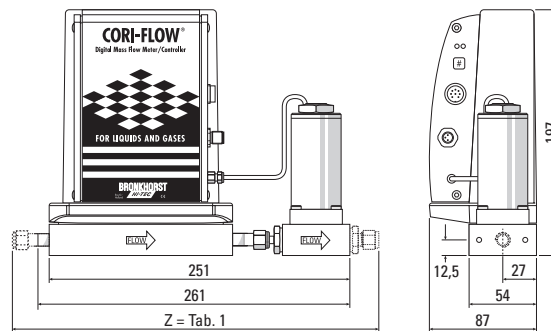
### M50-Series Mass Flow Meter



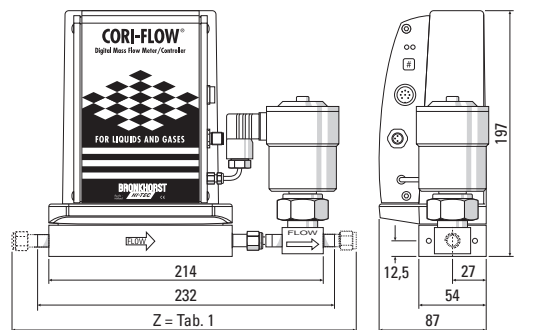
### M50C2-Series Mass Flow Controller



### M50C4-Series Mass Flow Controller



### M50C5I-Series Mass Flow Controller

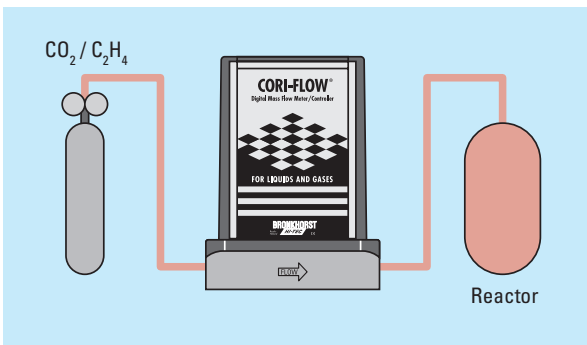


Technical specifications and dimensions subject to change without notice.  
Dimensional drawings for other MFCs available on request.

## APPLICATIONS

The CORI-FLOW is suitable for application in industrial environment, laboratories and OEM installations in the following markets (typically):

- Surface treatment,
- Energy (fuel cells),
- Semiconductor industry,
- Chemical industry,
- Pharmaceutical industry,
- Food industry,
- Optical fibre industry, etc.



## CORI-FLOW Application:

### CRITICAL GAS MEASUREMENT

Fluids like carbon dioxide (CO<sub>2</sub>) and ethylene (C<sub>2</sub>H<sub>4</sub>) are difficult to measure when they are in the interphase stage between being a liquid and a gas. This occurs at temperatures >20°C when pressure ranges from approx. 20 bara to approx. 60...95 bara (depending on temperature).

Under these conditions, physical properties like density ( $\rho$ ) and heat capacity ( $C_p$ ) change very rapidly which makes an accurate mass flow measurement, based on the thermal principle, very difficult.

CORI-FLOW offers a solution here because of the true mass flow measurement, **independent of physical properties**. The **true** mass flow of the molecules is measured, regardless of whether the fluid is in gas phase, in liquid phase or indeed somewhere in between. Experiences in the field have proven that this principle of measuring is very accurate and reliable.

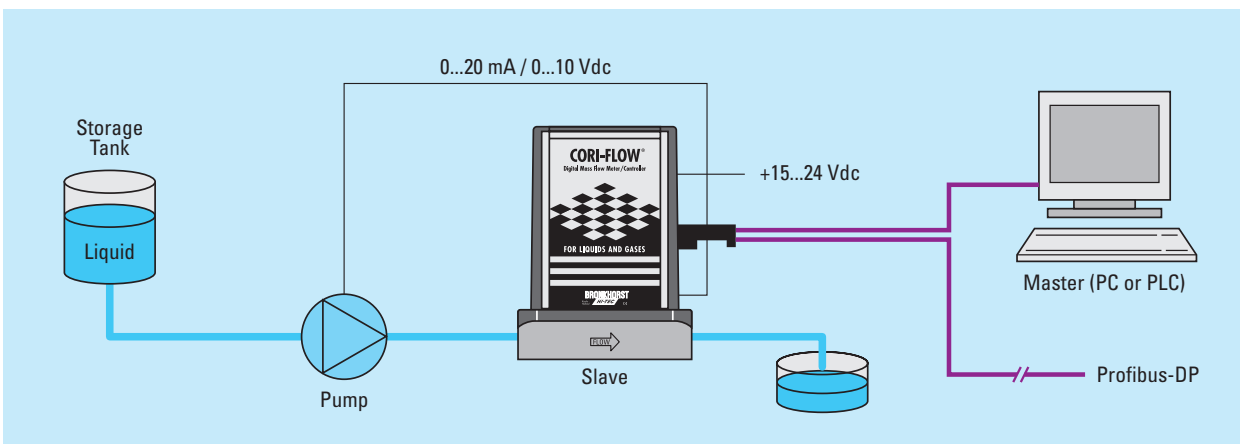
## CORI-FLOW Application:

### CORI-FLOW WITH PUMP CONTROL, PROFIBUS-DP OPERATED

By utilising the integrated PID-control function on the CORI-FLOW meter, a desired mass flow can be controlled with either a traditional proportional valve or now, more commonly, with a pump as the actuator. The PID-control to the pump can either be via a direct analogue signal (0...10 V, 0...15 V, 0...20 mA, 4...20 mA) or can be via a voltage/current to frequency converter if this feature is available. The maximum power load for the PID-controller output is ~3.75 Watt. PID-settings for optimal pump control can be set using FlowPlot, a Bronkhorst tooling

program. Most commonly this will be performed in the factory, however, in line with the Bronkhorst Total Service Concept it is also possible to do this on site.

CORI-FLOW instruments can be operated using normal analog signals or via digital interfaces such as RS-232 or fieldbus communication. Profibus-DP is popular within the process industry as it offers a straight forward connection between a master, a PC or PLC (e.g. Siemens S7-300/400) and its slave devices. Within such a system, the CORI-FLOW instrument would act as one of the slave devices and as such would have its control behaviour influenced by the master device. This offers high flexibility in mass flow control.





**CORI-FLOW Application:**  
**BATCH CONTROL**

Bronkhorst CORI-FLOW instruments include an integrated counter for totalisation of preferred mass units, e.g. grams or kilograms. The counter can be programmed for continuous increase or for totalisation up to a pre-set limit. Upon reaching this limit, several further actions can be programmed; for example, an alarm signal and/or a change of setpoint to the integrated controller. By utilising the integrated counter function, a CORI-FLOW instrument is able to totalize the measured mass flow extremely accurately. The full program cycle is very fast (< 50 msec) so the true flow will be integrated in almost real-time. The user-set counter and counter limit can then be employed for exact dosing of the desired batch.

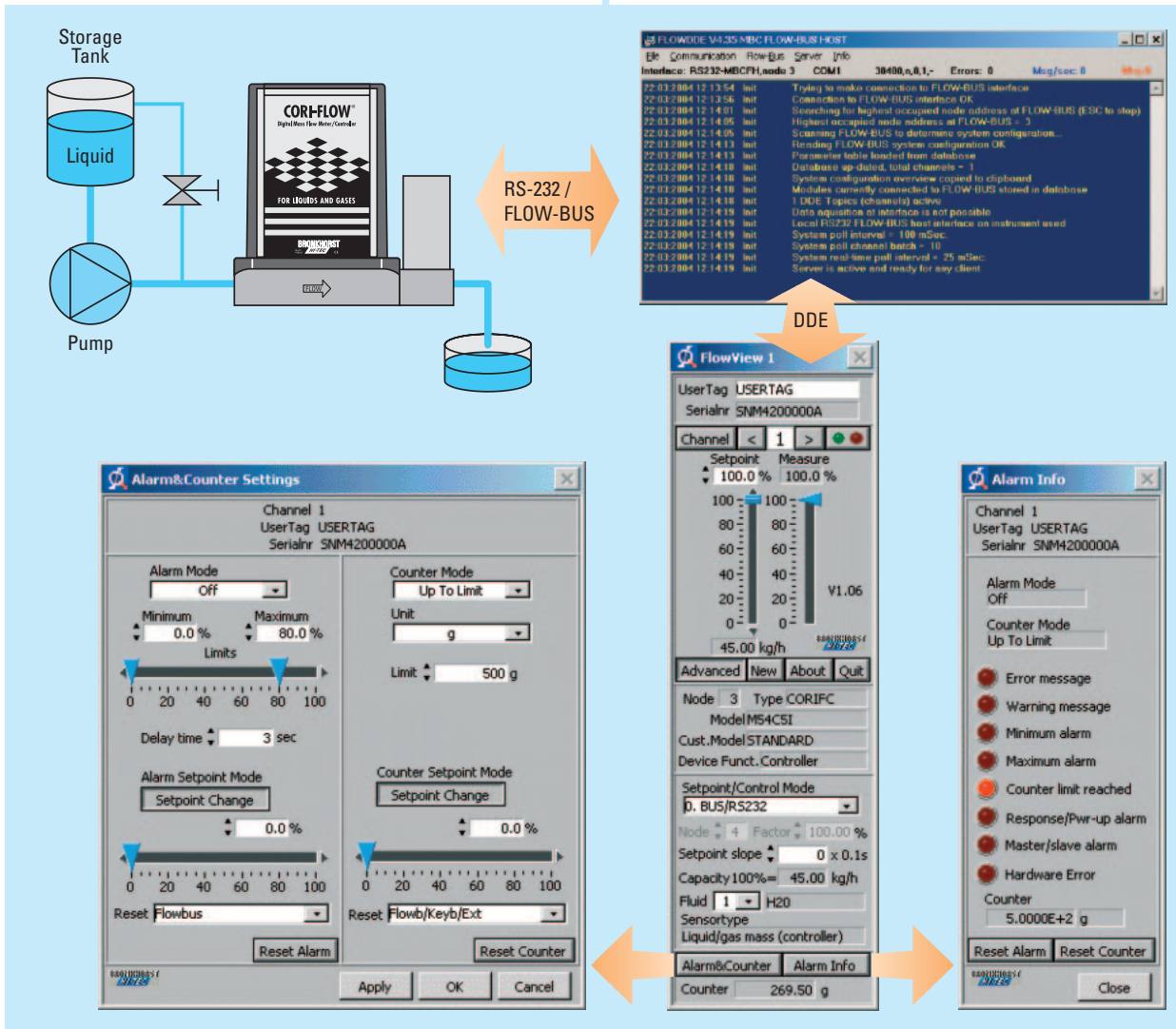
First a setpoint will be provided to the integrated PID-controller connected to a proportional valve or to a pump. Upon reaching the limit/batch total, the instrument can close the valve or stop the pump by generating a setpoint of 0% for the controller.

Simultaneously, an alarm can be given to the external computer or simply signal to LED's. Following a reset command (manual or remote) the next batch can commence.

By using these integrated facilities a very stable, accurate and compact dosing solution is provided.

**Example:**

*A vial needs to be filled repeatedly with 375 grams of water in 30 seconds. Correct sizing ensures that the equivalent flow rate of 45 kg/h can be fulfilled by our M54C5I model. If the outlet pressure (P2) is atmospheric (1 bara) the minimum inlet pressure (P1) should be  $\geq 3$  bara. The pressure drop over the sensor will be approx. 1 bar and we recommend an equal value across the valve. The orifice needed will be 1.7 mm. Batch control will be performed using the FlowView application programme (Freeware) connected to the instrument via Flow-DDE and RS-232 interface.*



## MODEL NUMBER IDENTIFICATION

M5N A N (I) - A A A - N N - A - A

### Mass flow meter

M52	Nominal range	500 g/h
M53	Nominal range	5 kg/h
M54	Nominal range	50 kg/h
M55	Nominal range	500 kg/h

### Control valve

C0 (I)	Low Flow control valve (nc) PN100	gas; $K_v\text{-max} = 6,6 \times 10^{-2}$
C1 (I)	Low Flow control valve (no) PN100	gas; $K_v\text{-max} = 6,6 \times 10^{-2}$
C2 (I)	Low Flow control valve + purge connection (nc) PN100	liquid; $K_v\text{-max} = 2,3 \times 10^{-3}$
C3 (I)	Low Flow control valve + purge connection (no) PN100	liquid; $K_v\text{-max} = 2,3 \times 10^{-3}$
C4 (I)	Medium Flow control valve (nc) PN10	gas or liquid; $K_v\text{-max} = 3,0 \times 10^{-1}$
C5I	Medium Flow control valve (nc) PN100, IP65	gas or liquid; $K_v\text{-max} = 6,6 \times 10^{-2}$

add 'I' for IP65 coil on control valve

### PC-board

A	with RS-232 and analog I/O	(nc) controller-function
B	with RS-232 and analog I/O	(no) controller-function
D	with RS-232 and DeviceNet I/O	(nc) controller-function
E	with RS-232 and DeviceNet I/O	(no) controller-function
M	with RS-232 and Modbus I/O	(nc) controller-function
N	with RS-232 and Modbus I/O	(no) controller-function
P	with RS-232 and Profibus I/O	(nc) controller-function
Q	with RS-232 and Profibus I/O	(no) controller-function
R	with RS-232 and FLOW-BUS I/O	(nc) controller-function
S	with RS-232 and FLOW-BUS I/O	(no) controller-function

### Output

A	0...5 V
B	0...10 V
F	0...20 mA sourcing
G	4...20 mA sourcing

### Supply voltage

B	+ 24 Vdc (DeviceNet)
D	+ 15...24 Vdc (analog, FLOW-BUS, Profibus, Modbus)



M50C5I series  
Mass Flow Controller

### Connections (in/out)

1	1/8"	OD compression type
2	1/4"	OD compression type
3	6 mm	OD compression type
4	12 mm	OD compression type
5	1/2"	OD compression type
7	1/4"	Face seal female
8	1/4"	Face seal male
9		Other

### Internal seals

0	None (sensors)
V	Viton (valves for gas)
E	EPDM
K	Kalrez-6375

### Accuracy class

A	0,2% Rd. + 0-stability
B	0,5% Rd. + 0-stability
C	1,0% Rd. + 0-stability

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