Instruction Manual

CORI-FILL™
Setting up (mini) CORI-FLOW™ instruments for filling applications

Doc. no.: 9.17.075 rev. G Date: 30-05-2023

ATTENTION
Please read this document carefully before installing and operating the product.
Not following the guidelines could result in personal injury and/or damage to the equipment.
Keep this document for future reference.

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Table of contents

1 Introduction

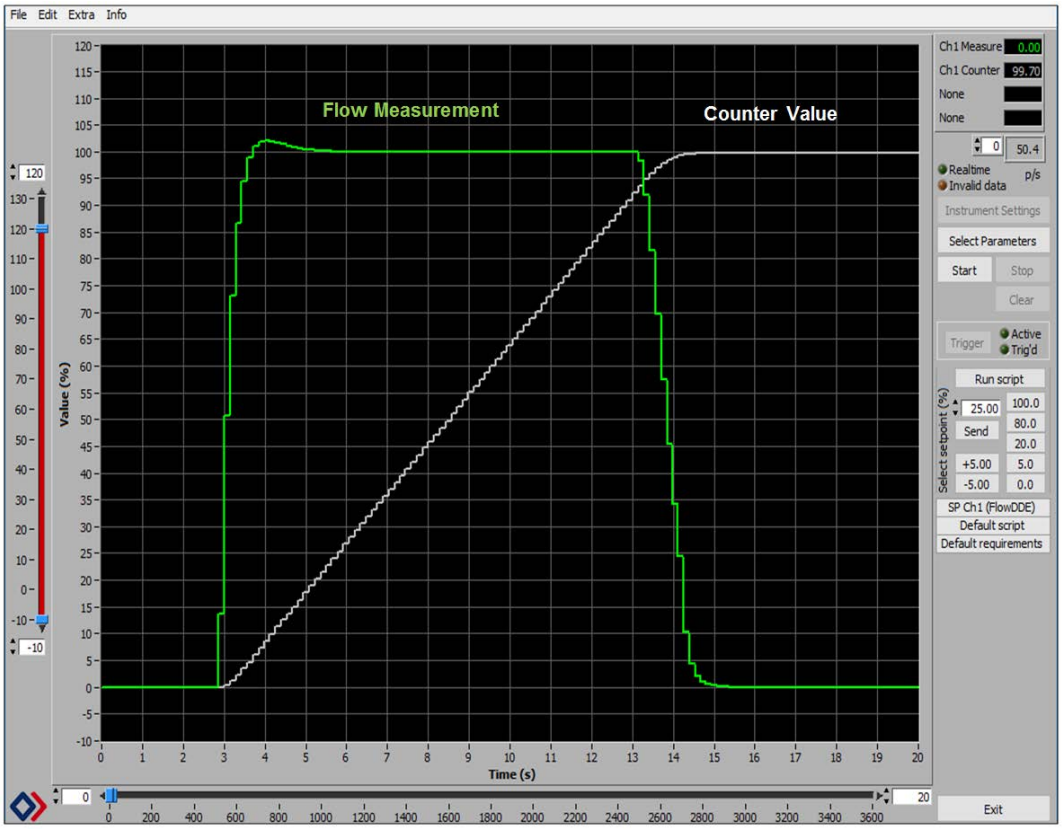
1.1 Scope of this manual

This manual describes how to use CORI-FILL™ and how it should be used for maximum performance. In this manual CORI-FILL™ will be explained from the context of the Bronkhorst® software tools FlowDDE and FlowPlot. Please read the fieldbus manuals for fieldbus communication and settings.

1.2 General description

The CORI-FILL™ technology is an integrated batch dosing feature within (mini) CORI-FLOW™ instruments. By measuring a flow rate during a certain time frame an amount of mass or volume can be obtained with the counter functionality. By setting the counter to “count up” or “count up to limit” the flow meter can be used as a batch meter or batch controller. The on board PID-controller can be used to directly control the batch counter, using a proportional valve or liquid pump. It’s also possible to control the counter with a shut-off valve.

Flow Measurement * Time = Counter value in mass or volume



1.3 Dosing methods

1.3.1 Mode A: on/off control based on measured batch size

- Available from firmware version 8.32 or higher (released in 31-08-2010)
- Used for short dosing time 0.5..5s
- Shut-off valve is on-off steered based on mass or volume
- The (mini) CORI-FLOW™ instrument uses its mass/volume measurement to correct setpoint level for the next batch, therefore compensating for overshoot with the overrun correction
- Overrun correction resolution 20ms
- Suitable for repeatable conditions, stable after 3 batches

1.3.2 Mode B: on/off control based on time and measured batch size

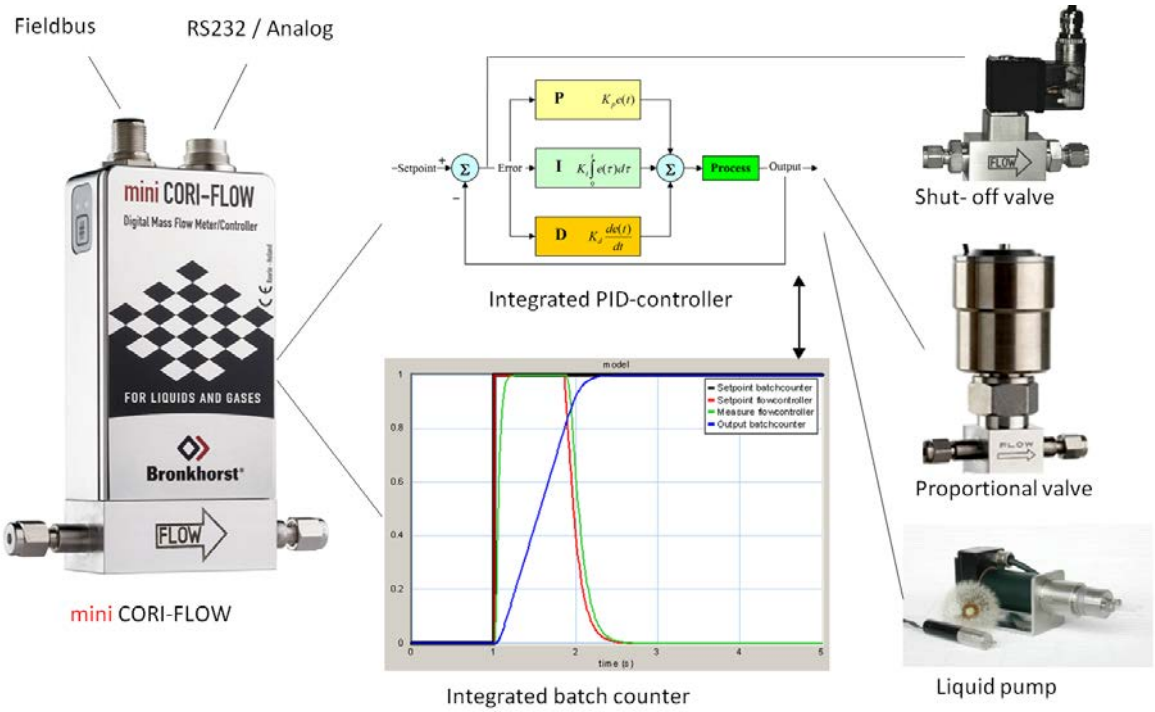
- Only available for mini CORI-FLOW™ M12, M13 M14 & M15 with firmware version 8.40c or higher (released in 11-12-2015)
- Used for short dosing times 0.1..5s
- Shut-off valve is on-off controlled during a certain time frame
- The mini CORI-FLOW™ instrument uses its flow measurement to correct the dosing time for the next batch, therefore compensating for overshoot with the overrun correction
- Overrun correction resolution <3.6ms
- Suitable for repeatable conditions, stable after 3 batches

Firmware version **8.40c** *should be upgraded to firmware version* **8.41d** *for optimal functionality.*

1.3.3 Mode C: proportional control

- Used for longer dosing times >2s
- Valve or pump control on actual mass measurement
- First time right dosing control no overshoot
- Sufficient supply pressure needed for proper flow control when using a control valve

	Mode A **On-Off control on batch size**	**Mode B** **On-Off control on time and batch size**	**Mode C** **Proportional batch control**
Dosing time	0.5 - 5s	0.1 - 5s	> 2s
Correction resolution	20ms	< 3.6ms	20ms
Works with:			
• **Shut-off valve**	Yes	Yes	No
• **Control valve**	No	No	Yes
• **Pump**	No	No	Yes
Control methode	Batch size compensation	Time & batch size compensation	Proportional batch size control



2 Other documents

Basic instructions	Dimensional drawings
Document 9.17.050 Instruction manual mini CORI-FLOW™	**Document 7.05.682** Dimensional drawing M12 / M13 / M14 Mass Flow Meters - compression type weld adapters -
	Document 7.05.848 Dimensional drawing M15 Mass Flow Meters
Document 9.17.031 Instruction manual CORI-FLOW™	**Document 7.05.455** Dimensional drawing M5X CORI-FLOW™

Advanced instructions	Hook-up diagrams
Document 9.17.023 Instruction manual Operational instructions for digital multibus Mass Flow/Pressure instruments	
Document 9.17.024 Instruction manual FLOW-BUS Interface for digital multibus Mass Flow/Pressure instruments	**Document 9.16.048/9.18.048/9.20.048** Hook-up diagram FLOW-BUS Interface
Document 9.17.025 Instruction manual PROFIBUS DP slave interface for digital multibus Mass Flow/Pressure/Gateway instruments	**Document 9.16.049/9.18.049/9.20.049** Hook-up diagram PROFIBUS DP Interface
Document 9.17.026 Instruction manual DeviceNet™ slave interface for digital multibus Mass Flow/Pressure instruments	**Document 9.16.050/9.18.050/9.20.050** Hook-up diagram DeviceNet™ Interface
Document 9.17.027 Instruction manual RS232 Interface with FLOW-BUS protocol for digital multibus Mass Flow/Pressure instruments	**Document 9.16.044/9.18.044/9.20.044** Hook-up diagram General (Analog I/O and RS232 Interface with FLOW-BUS protocol)
Document 9.17.035 Instruction manual Modbus slave interface for digital Mass Flow/Pressure instruments	**Document 9.16.066/9.18.066/9.20.066** Hook-up diagram Modbus Interface

*These documents can be found at **www.bronkhorst.com/downloads***

For instructions about how to install the instrument it is advised to read the mini CORI-FLOW™ or CORI-FLOW™ manual. For accurate dosing performance it is advised to follow the instructions in the Low Flow handling documentation.

3 FlowPlot and FlowDDE

3.1 Installation

Follow the on-screen instructions when installing FlowPlot and FlowDDE.
The default installation folder is: **C:\Program files\Bronkhorst\FlowPlot** and **C:\Program files\Bronkhorst\FlowDDE**.

3.2 FlowDDE

First start-up FlowDDE, than start-up FlowPlot.

Start FlowDDE through the Start menu: **Start >> Programs >> Bronkhorst >> FlowDDE**

When FlowDDE is started and indicating that it is ready for any client, the main window is shown.

Select: **Communication >> Communication Settings** and select the COM-port on your PC which is connected to the instrument.

Select: **Communication >> Open communication** and wait until the message **"Server is active and ready for any client"** appears on the screen.

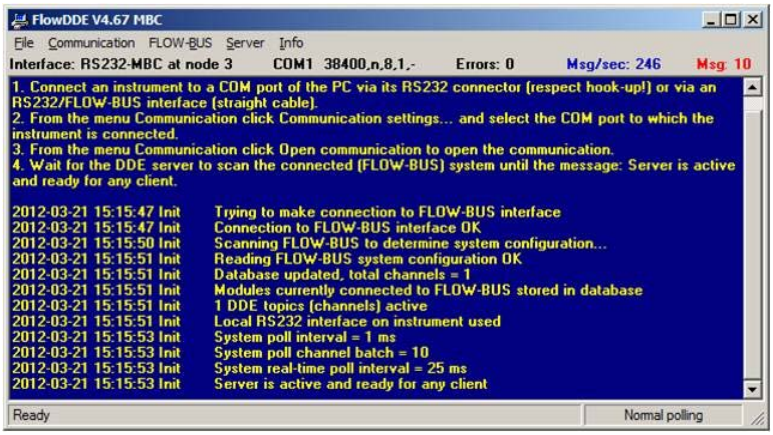
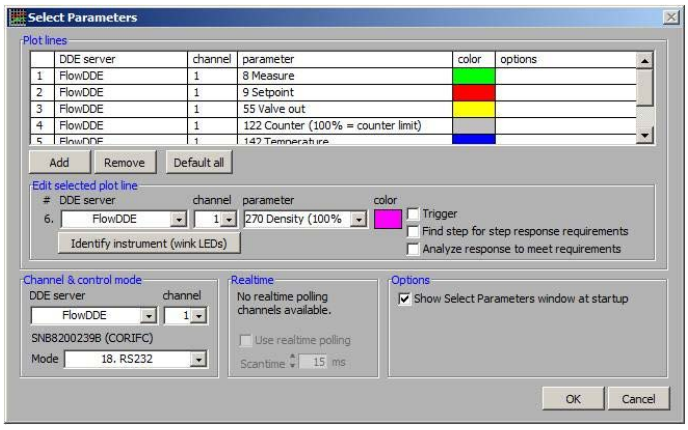


Figure 1 - The FlowDDE main window for communication between instrument and MS-Windows environment.

Start FlowPlot through the Start menu: **Start >> Programs >> Bronkhorst >> FlowPlot**

At the screen "Select parameters" connect the colored lines to:
- FlowDDE/FlowDDE2
- channel number (typically = 1)
- parameter number

e.g. like in picture on the right.

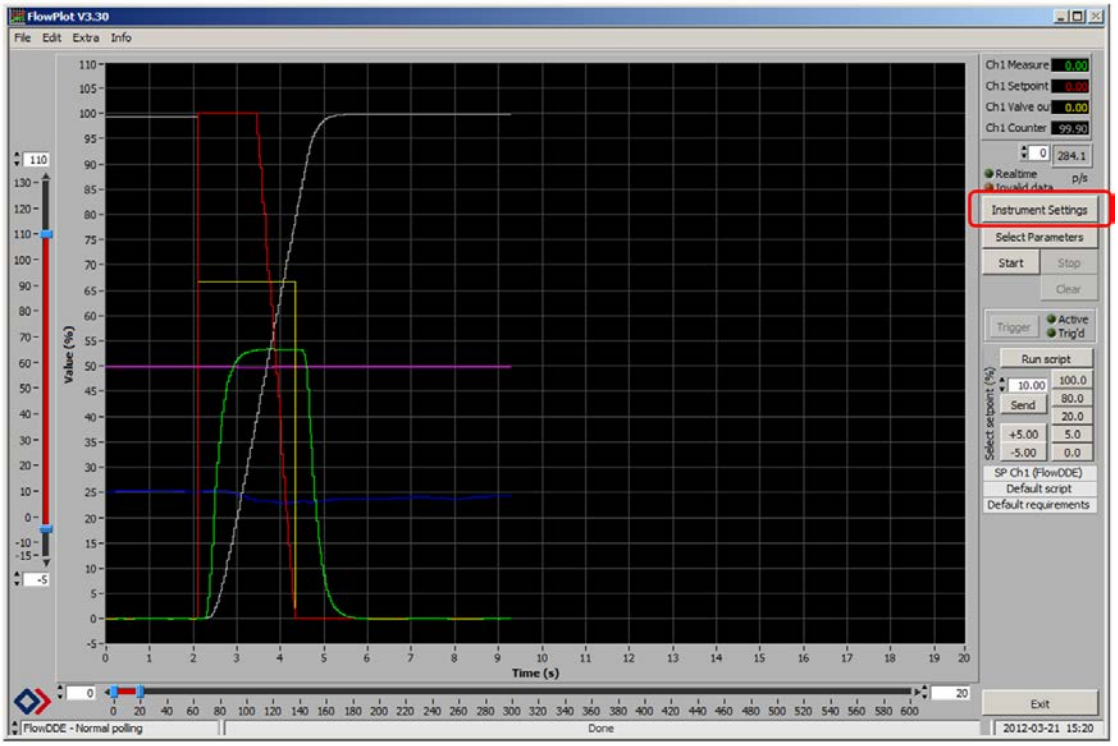


Press OK to go to the main screen.

It is possible to use up to 8 plot lines in different (predefined) colors to watch the dynamic behavior of these signals in time. Mode 18. RS232 (or mode 0 : bus & RS232) should be selected to enable your PC to take over setpoint control for the Coriolis instrument.

*For more detailed information about FlowPlot and FlowDDE consult the FlowPlot and FlowDDE manuals; these documents can be downloaded from **www.bronkhorst.com/downloads***

3.3 FlowPlot



In the beginning this screen is empty

This screen shows the selected parameter value sizes as a function of the time to get an impression of the dynamic flow (and other parameter) behavior.

Counter value (100% is counter limit)

Density (100% = 2000 kg/m3 - 0% = 0 kg/m3)

Temperature (percentage = °C)

Setpoint (wanted value; 100% = FS = capacity)

Measure (actual flow; 100% = FS = capacity)

Controller output value

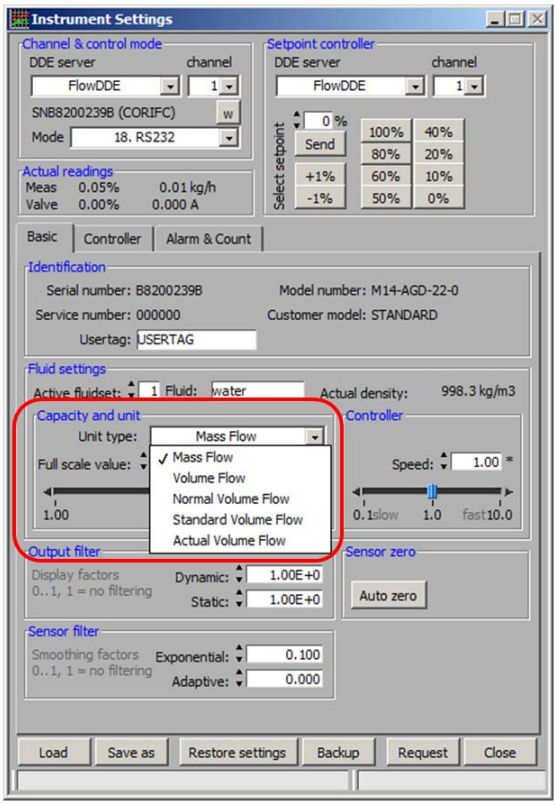
Pressing Instrument settings *will pop-up another screen for adjusting the instrument settings.*

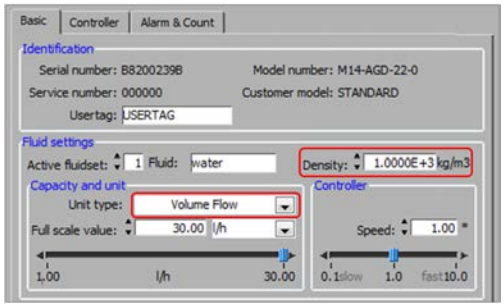
4 Readout in mass flow or volume flow

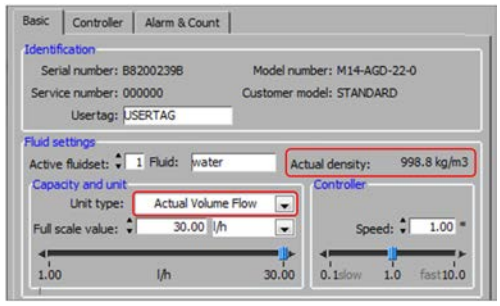
The (mini) CORI-FLOW™ mass flow meters/controllers operate according to the Coriolis principle. The instrument can simultaneously measure mass flow, temperature and density. Mass flow can be converted to volume flow by using the measured (actual) density.
At the Tab "Basic" it is possible to prepare the instrument for mass flow readout like: g/h or kg/h or volumetric readout values like: l/min or ml/h. The counter will automatically switch to similar units; g or ml etc.

Volumetric flow options:
To measure in volume, select "Volume Flow", the density should be specified manually.
When "Actual Volume Flow" is selected, the actual measured density will be used to calculate from mass to volume flow.
Note: this is only possible with the mini CORI-FLOW™ series and the CORI-FLOW™ M55.

Normal Volume Flow and Standard Volume Flow are typical gas flow units. It will be necessary to enter the density at normal 0 °C and 1 atm. or at standard 20 °C and 1 atm. conditions to be able to get the correct volumetric readout.

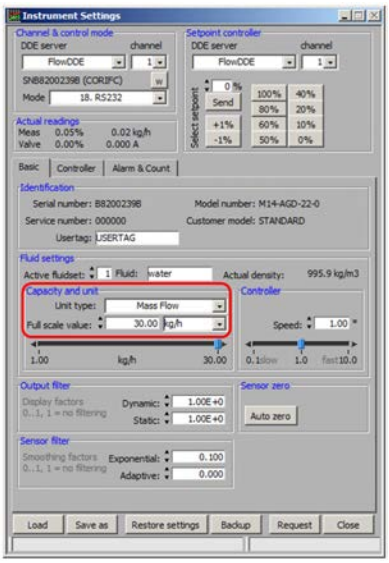






5 Adjust instrument capacity (FS range)

In the Tab "Basic" it is possible to (re)range the full scale value of the instrument. A value between the shown minimum and maximum can be selected.



For the best performance it's advised to optimize the Capacity. Especially when proportional filling is used, this will result in a minimum loss of AD-DA resolution.

At [Capacity and unit] a full scale value can be entered with digits or by using the slider. Depending on the instrument the full scale value will be a value between a minimum and a maximum capacity.
The optimum value depends on the amount to be dosed and will be indicated as 100% value in FlowPlot.

Analog output signals will also be re-scaled for this new capacity: 4-20mA: 20 mA will correspond with 100% = FS capacity value.

5.1 Capacity settings in combination with shut-off valves

Full scale value in kg/h = (Batch (g) / Time (s)) * 3.6

When the system is perfect (degassed), a square wave should be seen at the flow output. If the batch cannot be reached within the specified time, the inlet pressure should be increased.

5.2 Capacity settings for proportional control

For proportional control an estimate should be made.
Full scale value ≥ Batch/Time. It will strongly depend on the following settings:

- System response (system and PID-Controller settings)
- Dosing time
- Counter control gain
- Exponential filter settings

As rule of thumb: ***Full scale value in kg/h = 1.2 * (Batch (g) / Time (s)) * 3.6***

Please mind that this is a theoretical approach, it is meant to give you an indication of the full scale value. In practice the full scale value will need to be a little higher, because of the opening and closing time of the actuator.
The "counter control gain" value will also influence the total dosing time (see section Counter control gain).

Please note this can only be used for proportional filling.

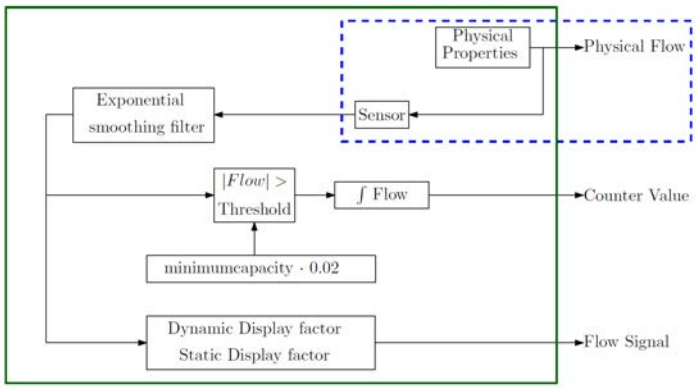
When a shut-off valve is used, the inlet pressure will determine the flow rate. Therefore it is very important to use a correct and stable inlet pressure.

Auto zero

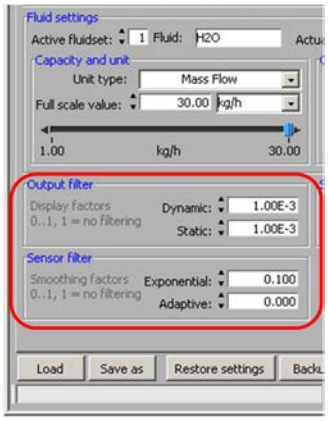
For information regarding Auto Zero please consult document: operation instructions digital instruments: 9.17.023

6 Filter settings and counter functionality

When a "Physical Flow" is applied to the "Sensor" the sensor will measure flow. This signal will go through the "Exponential smoothing Filter". When the absolute exponential smoothed signal is greater than the threshold (minimum capacity * 0.02) the flow signal will be integrated and shown as the "Counter Value".
When the filter settings are switched off (value= 1) or close to off, the threshold might be too low. Meaning the counter could start counting RMS (root mean square) noise instead of actual flow. To prevent this, the minimum capacity should be increased.



Schematic figure counter functionality



Filter values for proportional batch control

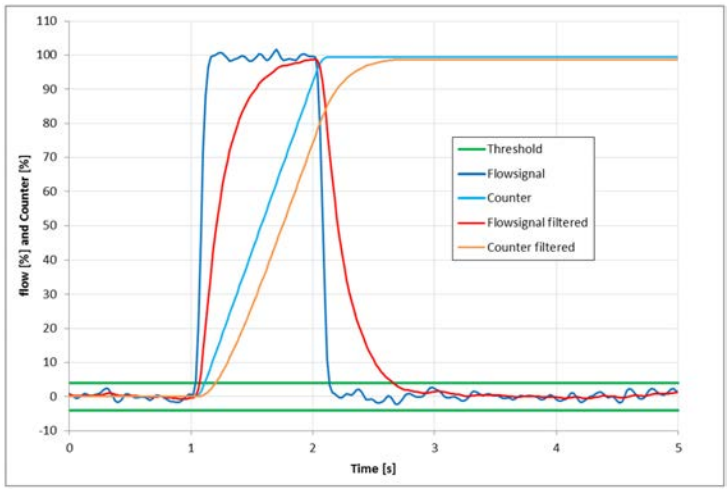
Typical filter values are shown in the red box. Please note that these filter settings have to be adjusted per CORI-FILL application. For proportional control these values can be used.

For fast dosing applications (<2 sec) with shut-off valves these have to be switched off [value 1]. Please find information regarding optimal filter settings for On-Off dosing and minimum capacity level at section On/off control using a shut-off valve.

For fast proportional batch control (<5 sec) it is advised to use the settings explained in section Proportional filling [MODE C].

The flow signal shown as output can be extra filtered by the "Dynamic Display factor" and the "Static Display factor" these filters will not influence the "Counter Value".

All filters have values between 0…1. Values close to 0 means more filtering.
Filters are switched off when the value = 1.0
The adaptive filter setting will not be used. Value = 0

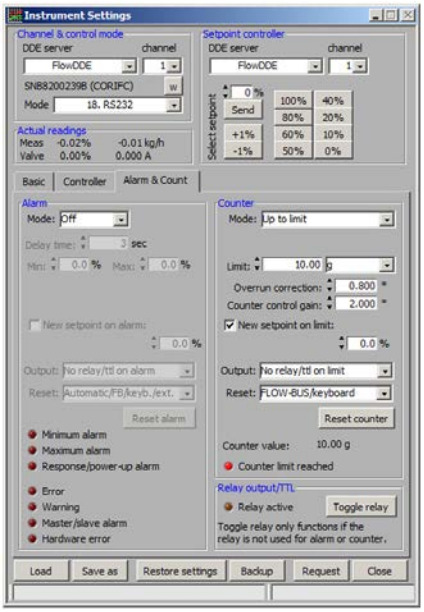


This figure shows the difference between filtered and unfiltered signals.

Between the threshold lines the noise signals are shown. By using unfiltered signals the minimum capacity should be increased to make sure that the noise will not affect the counter. By increasing the minimum capacity the threshold level will also increase. Please see section Disabling filtering and adjusting minimum capacity for more information.

7 Preparing the counter for batch dosing

After setting the counter mode in [up to limit] a limit can be entered. The overrun correction and counter control gain need to be set according the actuation type. Please note that these parameters will only work when the (mini) CORI-FLOW™ is controlling the actuator. For more details regarding these settings please see sections 8, 9 and 10.



The counter control gain is of no influence when batch dosing is performed with a shut-off valve.

[New setpoint on limit] should be enabled. The [New setpoint] value will normally be = 0% (= setpoint when reaching the batch).

[Output] can be set as shown left, but will not have any effect on batching.

[Reset] will determine the enabled sources for resetting the counter.
Following options are available:

- FLOW-BUS (Field Bus and RS232
- Keyboard (using the button on the instrument)
- Ext. (external input on optional pc-board)
- Analog setpoint (external setpoint input)

Pressing [Reset counter] sets the counter value to 0, after which the batch is immediately restarted using the original setpoint.

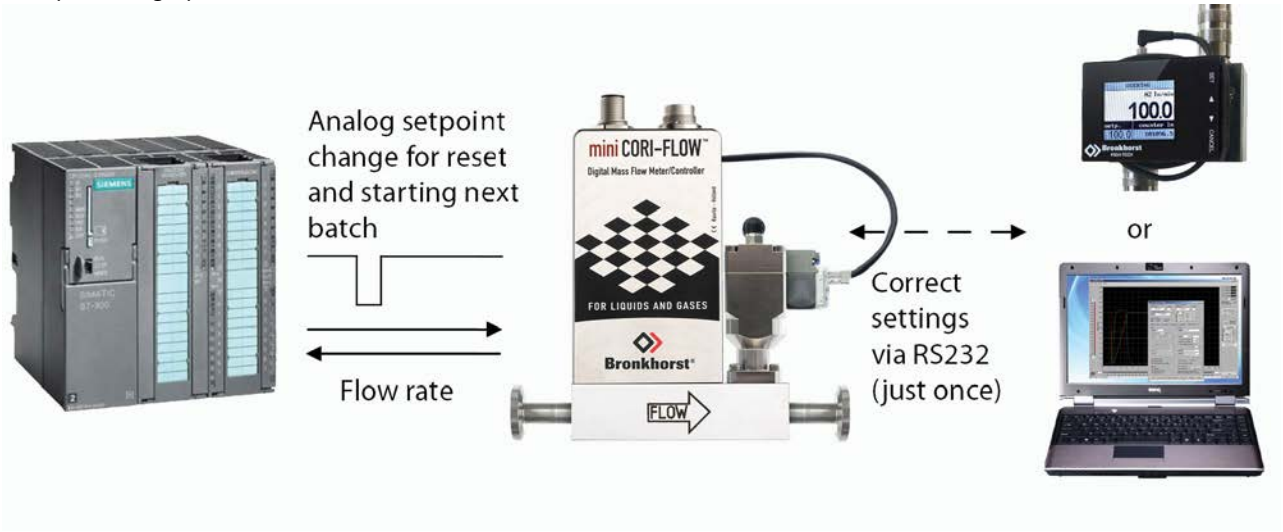
Please find fieldbus settings in the according fieldbus manuals.

7.1 Analog operation

When this counter reset source has been enabled, the analog input for the setpoint (normally 0..5V/0..10V/0..20mA/4..20mA), will be used.
When the setpoint input will be set to 0, the counter will be reset. When the setpoint will be set to a value >0, the batch counter will restart the next batch.

When using this option in on-off dosing mode (with shut-off valves) the setpoint value is irrelevant, as long as it is >2%. For proportional filling with a proportional valve the setpoint value is important!

Example analog operation:



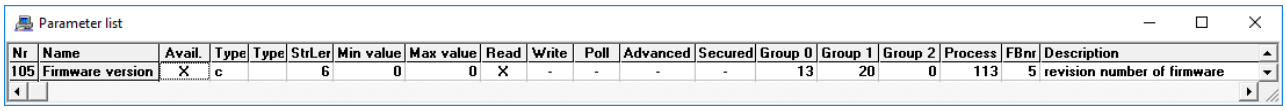
8 On/off control using a shut-off valve

For fast dosing applications (<2 sec) shut-off valves are used. The mini CORI-FLOW™ instruments are able to operate shut-off valves in two modes:

MODE A: On-Off control on batch size is available from Firmware version 8.32 (31-Aug-2010)
MODE B: On-Off control on time & batch size is available from Firmware version 8.40C (11-Dec-2015)

Firmware version **8.40c** *should be upgraded to firmware version* **8.41d** *for optimal functionality.*

Firmware version can be found via FlowDDE →F6 →Read Parameter 105



8.1 Setting up optional on/off batch dosing conditions

For optimal accuracy it is very important that the following conditions are taken into account:

- Stable and the correct inlet pressure should be provided
- The inlet pressure will determine the flow velocity. Too high pressure will lead to overshoot and unstable results, too low pressure will result in non-achieved batch limits.
- The system or liquid should not contain any gas bubbles since they will work like an “expansion vessel”. This leads to slow system response times and flow measurement when the valves are closed, because the gas bubbles will be filled up with liquid due to the inlet pressure. Therefore a degasser is recommended especially in applications within mg and ms dosing range.
- The amount of piping, reducers, connections and t-parts should be restricted to the absolute minimum.
- Use tubing/piping size which is appropriate to the flowrate.
- (mini) CORI-FLOW™ should be auto zeroed at actual process conditions.

8.2 Disabling filtering and adjusting minimum capacity

Although digital filtering can stabilize measurement signals by smoothing out external disturbances, it also slows down signal response, which stands in the way of fast batch dosing. Conversely, disabling digital filtering speeds up the response, but also makes the instrument more sensitive to vibrations, pulsations and RMS noise, causing the flow sensor to always register a (very small and fluctuating) flow, even when there actually is none (and even after adjusting the zero point).

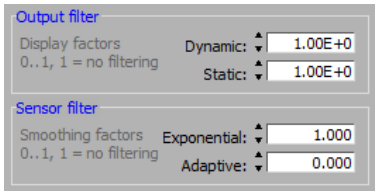
This typical noise level of an instrument is the result of all kinds of signal disturbances and can be eliminated by increasing the minimum capacity. The table below shows the minimum capacity that is mostly sufficient to eliminate the typical noise level for different mini CORI-FLOW™ models:

Instrument model	Minimum capacity
M12	14 g/h
M13	140 g/h
M14	1.4 kg/h
M15	6 kg/h

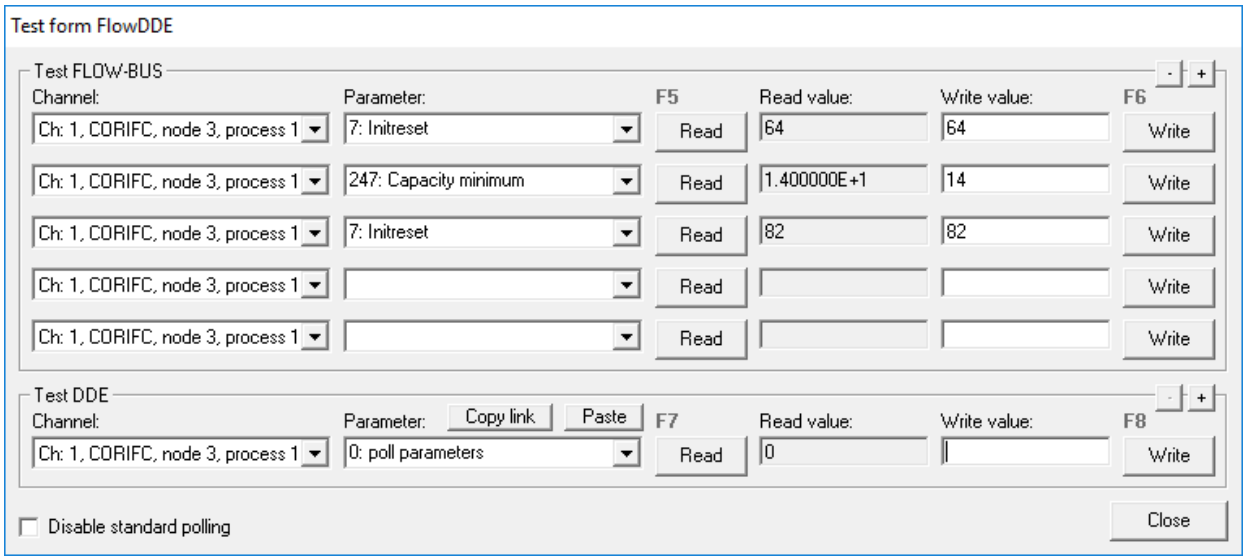
To disable digital filtering and adjust the minimum capacity, follow these steps:

1. Make sure the instrument is mounted as vibration-free as possible. If necessary, using a mass block and shock absorbers can help isolate the instrument from external vibrations.
2. Make sure the instrument is homogeneously filled with the process fluid
3. Block the flow by closing a valve immediately after the instrument outlet (control valve, shut-off valve)
4. Adjust the zero point to neutralize the zero-stability error

5. Using FlowPlot, disable the exponential smoothing filter and the display filter by setting the concerning values to 1:



6. Open the parameter test form in FlowDDE (*FLOW-BUS > Test FLOW-BUS and DDE*) and set the minimum capacity according to the table above:



- *If the minimum capacity still proves to be lower than the typical noise level, the first thing to do is eliminate disturbances like external vibrations as far as possible.*
- *If that does not help enough, increase the minimum capacity further to above the typical noise level*

9 Difference between on/off control [MODE A] & [MODE B]

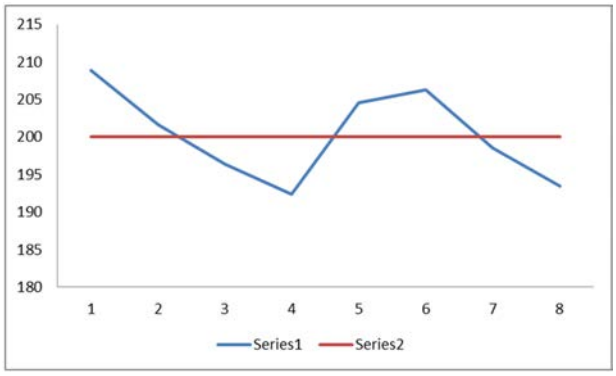
The difference between MODE A and MODE B on-off control is the correction algorithm.

- For on-off control on batch size [MODE A], the valve will be open until the limit (in gram or ml) is reached. The counter value will be corrected by the overrun correction to compensate for overshoot. This functionality has a correction resolution of 20 ms.
- For on-off control on time & batch size [MODE B], the valve will be open for a predetermined time frame (max dosing time), the counter value will be used to adjust the dosing time to achieve the desired (batch) limit. The dosing time correction has a resolution of <3.6 ms.

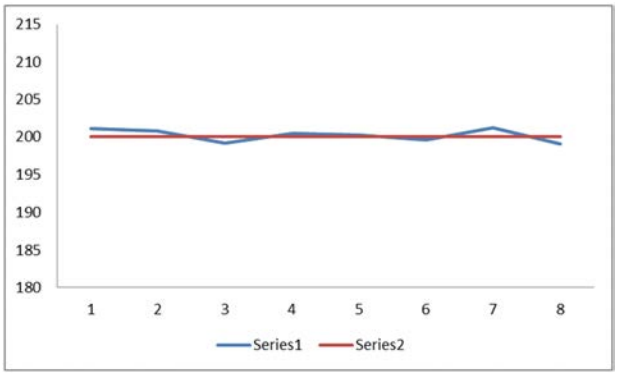
Example in practice:
Limit (batch) = 200 mg
Dosing time = 500 ms
Flow = 0.4 mg/ms = 0.4g/s = 1440 g/h

On-off control on Flow [MODE A] Accuracy: - 0.2% Rd + ZS - 20ms resolution on correction - RMS noise	208.9 mg	201.6 mg	196.4 mg	192.4 mg	204.5 mg	206.3 mg	198.5 mg	193.4 mg
On-off control on Time [MODE B] Accuracy: - 0.2% Rd + ZS - <3.6ms resolution on correction - RMS noise	201.1 mg	200.8 mg	199.2 mg	200.5 mg	200.2 mg	199.6 mg	201.2 mg	199.1 mg

MODE A

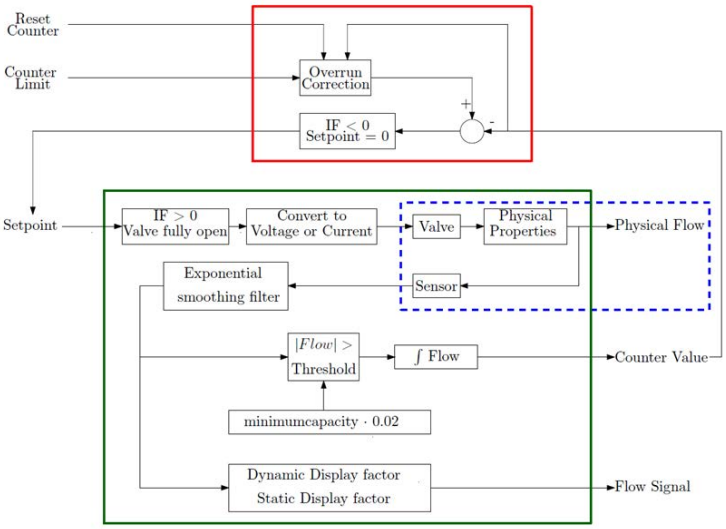


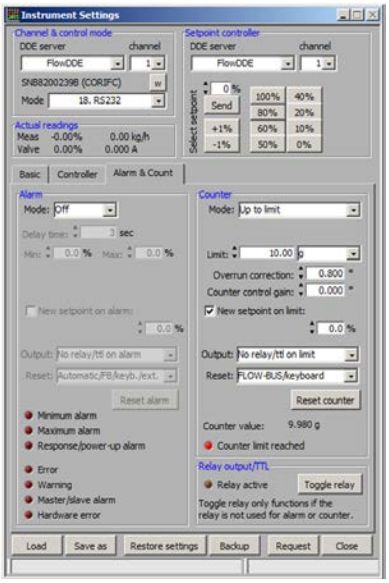
MODE B



9.1 On/off control [MODE A]

For on-off control on batch size, the valve will be open until the set limit (in gram or ml) is reached. The counter value will be corrected by the overrun correction to compensate for overshoot or undershoot. This functionality has correction resolution of 20 ms. Please see the following schematic overview for more detailed information regarding the process steps of PC-board.





Dosing Example:

Counter limit	= 10.00 gram
Measured counter value	= 9.98 gram
Overrun correction	= 0.8
Counter control gain	= 0 because this has no function in combination with shut-off valves
Reset counter	= will reset/restart the counter value
Setpoint value	= >2% because a shut-off valve will be either open or closed
Correction resolution	= 20ms

Overrun correction (on-off control on flow):
The [Overrun Correction] is a self-learning, continuous and fully automatic principle. After every [Reset Counter] command it will determine the optimal "Valve Closing Value" in mass or volume to achieve the desired limit.
A correction value between 0 and 1 can be entered. Therefore, when a value is entered, the system will close the shut-off valve a fraction earlier or later, depending on overrun or underrun measured by the [Counter Value]. Higher values result in fast correction and less cycles before desired limit is reached. An overrun correction of 0.8 has proven to be a proper functioning value. The closing value for the valve is calculated with the formula below. Underneath the formula a filled out example is shown based on a [Limit] of 10 gram and an [Overrun Correction] of 0.8.

For the first dosing sample: Closing Value [n-1] = Counter Limit

$$Closing\ Value[n] = Closing\ Value[n-1] - Overrun\ Correction * (Counter\ Value - Counter\ Limit)$$

10	=	10	-	0.8	* (	0	-	10	)
2.4	=	10	-	0.8	* (	19.5	-	10	)
2.78	=	2.4	-	0.8	* (	9.53	-	10	)
2.76	=	2.78	-	0.8	* (	10.02	-	10	)

Measured [Counter Values] are the main input for this formula. The used [Counter Values] are measured data.

If the measured [Counter Value] is ≥ 2x the set [Limit] the overrun correction principle cannot function. When this occurs the inlet pressure is usually too high. Please lower the inlet pressure.

9.2 On/off control [MODE B]

For on-off control on time & batch size, the valve will be open for a predetermined time frame [Maximum Allowed Dosing Time], the counter value will be used to adjust the dosing time to achieve the desired (batch) limit. The dosing time correction has a resolution of <3.6 ms. making it more accurate, faster and stable than the correction resolution of MODE A.

Additional Parameters:
Bronkhorst has improved the CORI-FILL™ functionality for On-Off dosing with firmware versions ≥ 8.40C.
Within this firmware the parameters for time control [P359 Maximum Allowed Dosing Time] and [P360 Most Recent Dosing Time] are introduced.

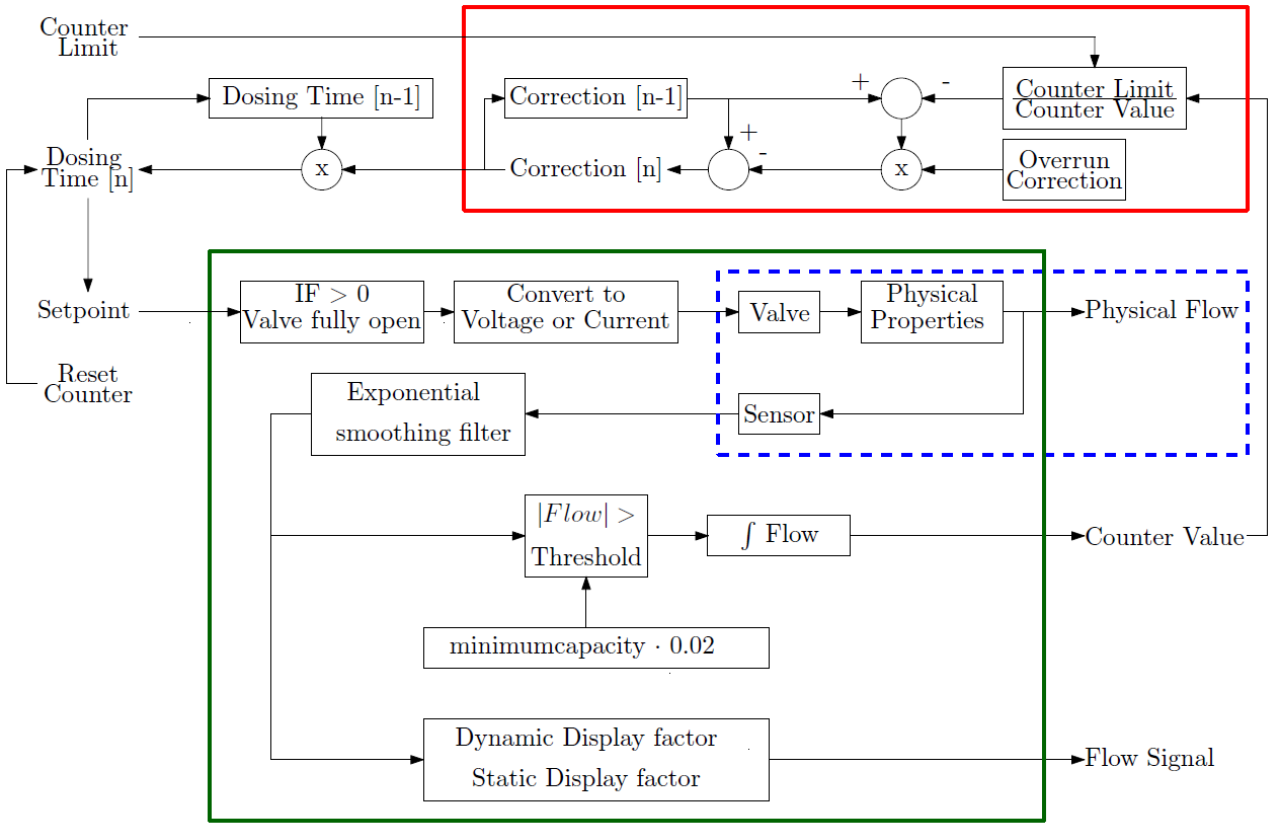
Parameter list

Nr	Name	Avail.	Type	Type	StrLen	Min value	Max value	Read	Write	Poll	Secured	Group 0	Group 1	Group 2	Process	FBnr	Description
359	Maximum allowed dosing time	X	f		0	0	3.40282E+38	X	X	-	-	16	0	0	104	15	Maximum allowed dosing time (s)
360	Most recent dosing time	X	f		0	0	3.40282E+38	X	-	-	-	16	0	0	104	16	Most recent dosing time (s)

The above parameters cannot be seen in FlowPlot, however can be Read & Written by FlowDDE (version ≥ V4.74) or Fieldbus. Both parameters will use a unit type in seconds. CORI-FILL™ MODE B is active if parameter 359 has a value > 0 seconds (e.g. 0.5s) and inactive at value 0. With parameter 360 the [Most recent dosing time] can be shown.
When the functionally is inactive the other CORI-FILL™ modes A & C can be used.

Please note: the first dosage will use the full predetermined [maximum allowed dosing time] as reference. When the reference point is determined the correction functionally will adjust the dosing time.

Please see the following schematic overview for more detailed information regarding the process steps of PC-board.



Overrun correction (on-off control on time):
The [Overrun Correction] is a self-learning, continuous and fully automatic principle. After every [Reset Counter] command it will determine the optimal [Dosing Time] based on the measured Counter Value.
A correction value between 0 and 1 can be entered. Higher values result in fast correction and less cycles before desired limit is reached. An overrun correction of 0.8 has proven to be a proper functioning value.
The [Dosing Time] is calculated with the formula below. On the next page the formula a filled out example is shown.

Starting values:

[Limit] =250 mg
[Max Dosing Time] = 1.5s
[Overrun Correction] =0.8
Time Correction [n-1] =1 (this value is used for the first correction)

Time Correction [n] =Time Correction [n-1]–Overrun Correction*[Time Correction [n-1]-Counter Limit/Counter value]
Dosing Time [n] =Dosing Time [n-1] * Time Correction[n]

Dosing sequence:

Step 1:
Valve is opened for 1.5 seconds [Max Dosing Time]
During the [Max Dosing Time] a value of 1200 mg is measured [Counter Value]

Step 2:

0.367	=	1	-	(	0.8	*(	1	-	250/1200	)	)
0.551	=	1.5	*	0.367							

Step 3:

0.527	=	0.367	-	(	0.8	*(	0.367	-	250/440.8	)	)
0.290	=	0.551	*	0.527							

Step 4:

0.967	=	0.527	-	(	0.8	*(	0.527	-	250/232.27	)	)
0.280	=	0.290	*	0.967							

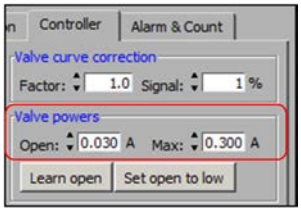
Repeating these steps will lead to the following Counter Values:

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
1200	440.8	232.27	224.52	243.41	252.78	252.5	250.45	249.68

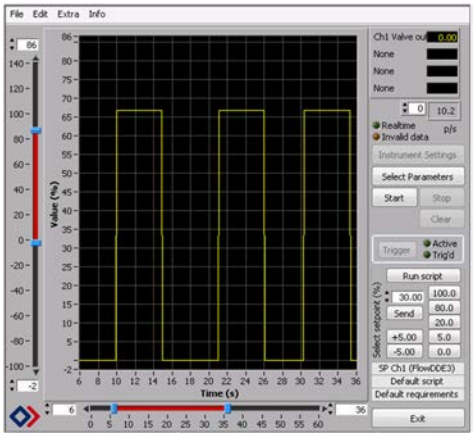
The dosing sequence will be restarted when [Max Dosing Time] is adjusted.

9.3 Using hold current for energy saving with shut-off valves

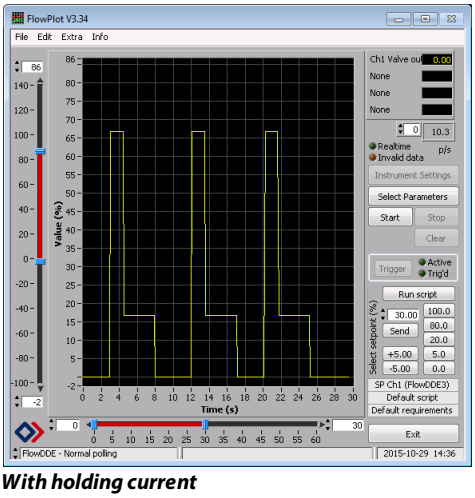
In order to open the valve (open current) the output signal can be set at valve maximum. The hold signal (current) can be separately set at valve open. These values might differ for each type of valve, depending on e.g. the coil. Using the energy saving option will result in less power dissipation at the valve and thus in lower temperature. For fluids sensitive to evaporation/boiling, this option might be very useful.



Valve output:



Without holding current

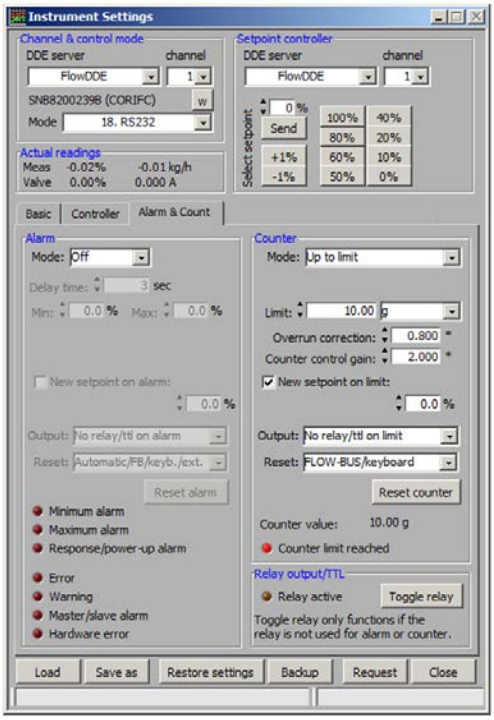


With holding current

10 Proportional filling [MODE C]

In the "Alarm & Count" tab, the counter setting can be found. The counter will count the total amount of flow passing through the instrument. The counter has three modes: [Off], [Up] and [Up to limit]. For filling applications [Up to limit] has to be selected. In order to perform a dosage a setpoint value (e.g. 100%) has to be selected. The setpoint value is related to the full scale value. Setpoint can be changed once the limit has been (or will be) reached.
By enabling [new setpoint on limit] and set it at 0.0%, the dosing set-up is created.
Select [reset counter] to perform a dosage. (When the desired limit has been reached, setpoint will be set to zero)

10.1 Counter control gain



The value set as counter control gain is related to a percentage. This percentage will be connected to the Counter Limit. When a certain percentage of the counter limit is reached the proportional actuator will be slowly forced to stop/close due to a decreasing setpoint level. This is needed in order to approach the counter limit carefully and avoid overshoots. The point of slowing down can be set by means of counter control gain. This value can be changed from 1…100.

The following formula is used:

$$SlowingDown\% = \left(1 - \frac{1}{Counter\ Control\ Gain}\right) * 100\%$$

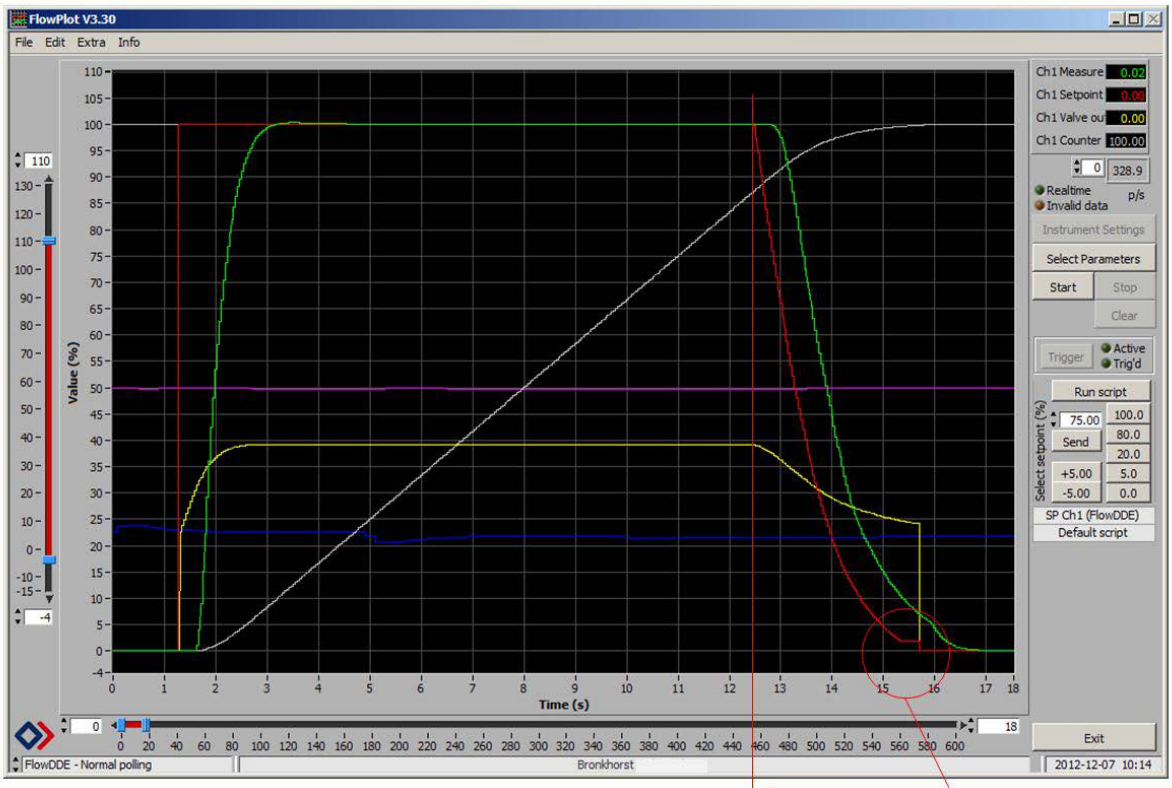
In the example on the left, counter control gain = 2, which means that the setpoint will go downwards after reaching 50% of the counter limit (10 g). When reaching 5g, the counter will force the controller to decrease its setpoint down to 2% (automatically controlled by an additional P- controller for the counter). The last part of the batch will be dosed at 2% flow rate of the capacity.
An example is shown at chapter 10.2 proportional filling example..

Fast and accurate proportional filling is possible, therefore it is necessary to set a few controller options, such as FS value, counter control gain and the PID-Kp value. See section Controller settings example.

Counter control gain (X)	Counter value where controller will slow down
0	No slowing down; controller stops if limit has been reached
1	0%, so immediately when counter starts running
2	50% of max. limit of counter
3	67% of max. limit of counter
4	75% of max. limit of counter
5	80% of max. limit of counter
10	90% of max. limit of counter
50	98% of max. limit of counter
100	99% of max. limit of counter

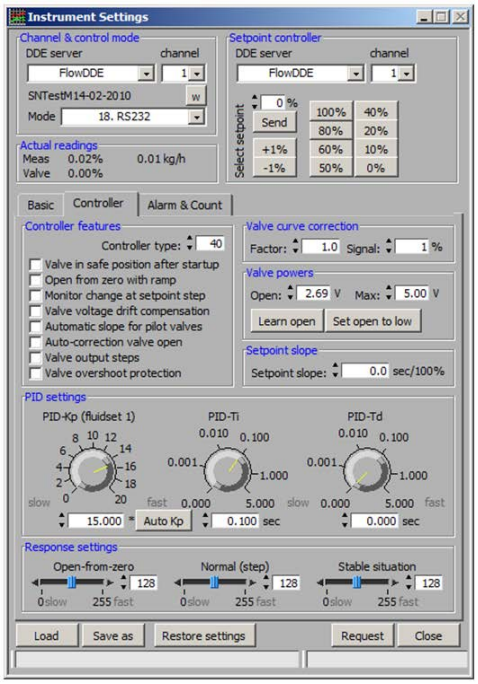
Please try to make sure that the last phase of dosing will be performed at 2% setpoint, otherwise there could be an overdose. If this cannot be avoided or when dosing at 2% will still give an overdose, you might consider enabling the overrun correction or lower the FS value. Both mechanisms can be active at the same time with proportional filling.

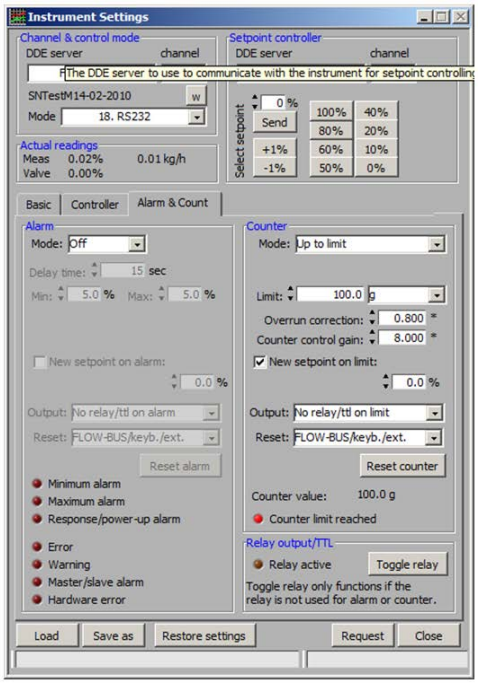
10.2 Proportional filling example



Counter controller gain
This value determines when the additional P-controller on the batch counter will force the setpoint downwards. In this example this value = 8, meaning at 87.5% setpoint will go down.

Dosing settings
Note: Make sure setpoint will be controlled down to 2%. The last drop should be dosed at 2% to avoid overshoots for the batch

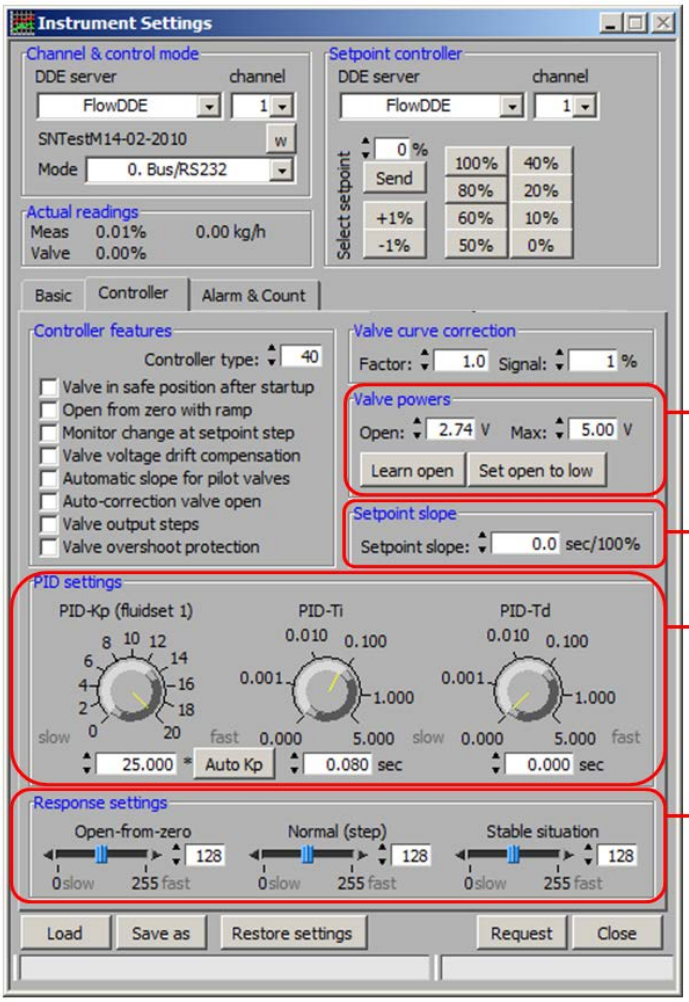




Test instrument: M14 with Tuthill DGS.23 gear pump; 100% FS = 30 kg/h water.

10.3 Controller options

Controller options should be set for fast response. Below typical (fast response) settings for a pump controlled by a mini CORI-FLOW™ instrument.



Valve powers, with the learn open function the instrument will determine what the opening/start voltage of the used actuator is (e.g. a valve or a pump). After this value is known the opening response will be adapted to decrease the dead time during setpoint steps from zero.

Setpoint slope. Normally = 0, except when PID-Td > 0.

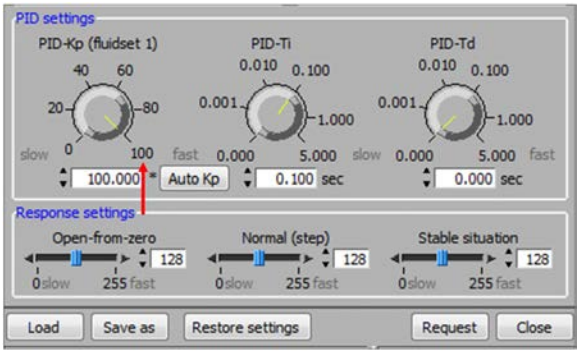
PID-Kp: Typical = 10. Increase in range 10…100 to make controller faster. Decrease to slow down.
PID-Ti: Typical = 0.1. Decrease in range 0.02..0.1 to make controller faster. Increase from 0.1…2 to slow down. PID-Td: Typical = 0. Increase a little (0…2 sec.) to differentiate dead volume if necessary.

Special adjustment for PID-Kp at certain situations for extra
speeding up or slowing down.

For more detailed information about settings see FlowPlot manual 9.17.030.

Test instrument: M14 with Tuthill DGS.23 gear pump; 100% = 30 kg/h water.

Extra information: The PID scale can be adjusted by double clicking the highest value on the scale as shown below.



10.4 Controller settings example

In the table below several controller settings are shown at different batch limits. This test is performed with an M14 mini CORI-FLOW™ and Tuthill DGS.23 gear pump based on water.

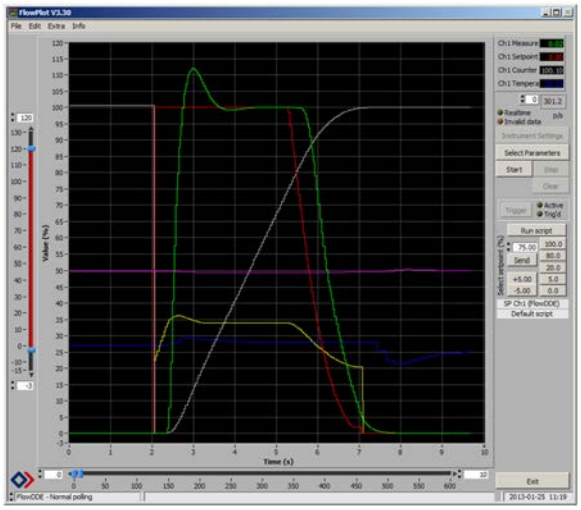
- Filters are enabled and set to default values as shown on the next page
- The overrun correction is set to zero.
- The counter control gain (CCG) has to be adjusted to the batch size.
- The PID controller settings vary per application

Please note that these values are indicative, it can vary per application. On the next page the flowplot settings are shown for a batch of 20 gram.

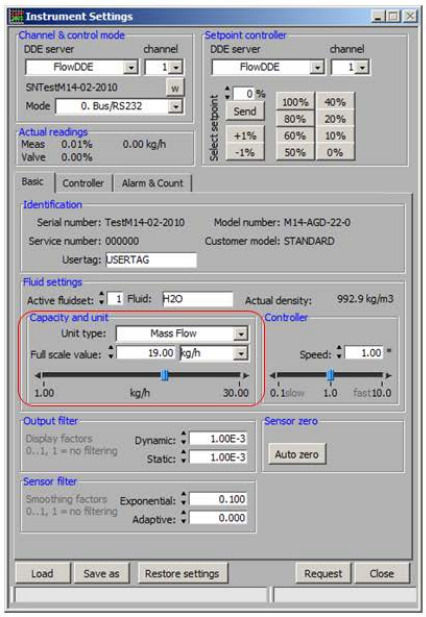
M14 mini CORI-FLOW	Dosing accuracy better than 0.5%												
Limit in gram	**2g**	**5g**	**10g**	**15g**	**20g**	**30g**	**40g**	**50g**	**75g**	**100g**	**150g**	**200g**	**500g**
FS value in kg/h	2.5	6	11	15.5	19	26.5	30	30	30	30	30	30	30
Dosing time in seconds	5.5	5.5	5	5.5	5.5	6	7	8	11	14	20	26	62
CCG	2.5	3	4	4	4	4	4.5	5.3	8	11	16	22	50
PID-Kp	25	25	25	25	25	25	25	20	20	20	20	20	20
PID-Ti	0.08	0.08	0.08	0.07	0.08	0.08	0.1	0.1	0.1	0.1	0.1	0.1	0.1

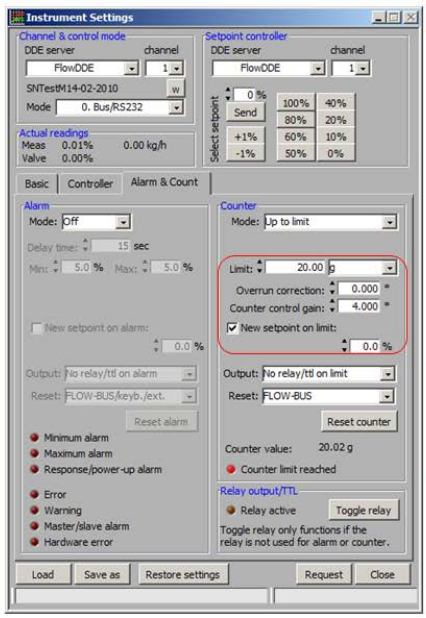
Important settings:
For fast and accurate proportional dosing it is import to create a small overshoot in flow, like 10% as shown on the left. By doing this the Coriolis instrument has more time to control the requested dosage.
This is especially important for small dosages. The graph shows a dosage of 20 gram in 5.5 seconds. Please see the correct settings below.

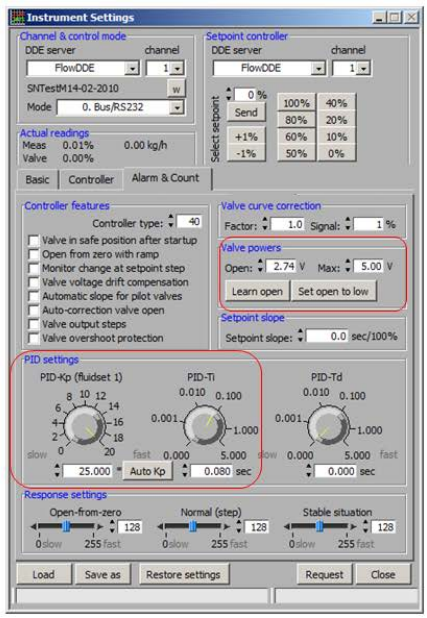
An overshoot can be created by increasing the PID-Kp and PID-Ti value.



Flowplot settings:
These settings are used to dose a batch of 20 gram.







11 Troubleshooting

Problem	Possible cause	Action
Suddenly a wrong value will be dosed among a sequence of right values when using on-off dosing with shut-off valves.	(Back) pressure waves caused at valve closing with high force might give erratic reading at (mini) CORI-FLOW™.	*Select a different valve type*
		Make sure to have some volume or dampener between valve and meter
		Monitor 'hardware error' at alarm info byte at instrument interface to indicate this
		Monitor 'counter value' at instrument interface to detect this
Even when dosing time is very short flow signal is too slow	Filter settings might not be optimal.	*Change filter settings according to the CORI-FILL™ mode*
Large deviation on sequential batches	Filter settings might not be optimal.	*Change filter settings according to the CORI-FILL™ mode*
	Supply pressure not stable	*Check and stabilize pressure*
	Controller settings not optimal	*Increase control stability by optimizing PID settings.*
Flow signal is >130%	Pressure too high	*Lower the supply pressure*
	Resistance of flow line too low	*Restrict the flow by using a manual valve*
	PID-Kp too high	*Select a lower Kp value*
	FS value (capacity) too low	*Increase the FS (capacity) value*
Dosed value is not accurate enough	Flow meter has wrong zero point	*Perform new auto-zero*
	Too many gas bubbles in liquid	*Degas the liquid and purge the flow meter*
	Vibrations disturbing the meter	*Follow instructions for mounting*
	Flow signal >130%	*Try to limit flow signal < 130%*
	Dosing time is too short	*Increase dosing time*
	Proportional dosing is too fast	*Adjust counter control gain to ensure last part of dosing at 2%*
	Counter control gain too low (Dosing too long at low flow)	*Increase counter control gain to dose longer at high flow (more accurate)*
	Reference instrument to check with is not a weighing scale (e.g. volumetric device)	*Use a weighing scale and handle it according to the instructions*
	Proportional dosing @2% gives too much overshoot	*Lower flow rate (dosing speed) or enable overrun correction*
Parameter 359 and 360 cannot be found	Firmware version =8.40c	*Ask your local sales office for options*
	FlowDDE Version ≤ V7.74	*Download the latest version from www.bronkhorst.com/downloads*
Reset counter command can be given and physical flow can be seen at the outlet but the counter keeps indicating 0 gram or ml	Firmware issue	*Ask your local office for support*

Firmware version **8.40c** *should be upgraded to firmware version* **8.41d** *for optimal functionality.*

12 Service

For current information about Bronkhorst® and worldwide service addresses, please visit our website:

www.bronkhorst.com

Do you have any questions about our products? Our Sales department will gladly assist you selecting the right product for your application. Contact sales by e-mail:

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For after-sales questions, help and guidance, our Customer Care department is available by e-mail:

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No matter the time zone, our experts within the Customer Care department are available to answer your request immediately or take appropriate further action. Our experts can be reached at:

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