Instruction Manual

EL-FLOW® Classic series
Thermal Mass Flow Controllers

Doc. no.: 9.17.085D Date: 18-09-2018

ATTENTION
Please read this Instruction Manual carefully before installing and operating the instrument.
Not following the guidelines could result in personal injury and/or damage to the equipment.

Bronkhorst®

Disclaimer

The information in this manual has been reviewed and is believed to be wholly reliable. No responsibility, however, is assumed for inaccuracies. The material in this manual is for information purposes only.

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Symbols

Important information. Disregarding this information could cause injuries to people or damage to the instrument or installation.

Helpful information. This information will facilitate the use of the instrument and/or contribute to its optimal performance.

Additional info available on the internet or from your local sales representative.

Receipt of equipment

Check the outside package box for damage incurred during shipment. If the box is damaged, then the local carrier must be notified at once regarding his liability, if so required. At the same time a report should be submitted to your local sales representative.

Carefully remove the equipment from the box. Verify that the equipment was not damaged during shipment. Should the equipment be damaged, then the local carrier must be notified at once regarding his liability, if so required. At the same time a report should be submitted to your local sales representative.

Check the packing list to ensure that you received all of the items within the scope of delivery.
Do not discard spare or replacement parts with the packaging material and inspect the contents for damage.

Refer to Removal and return instructions about return shipment procedures.

Equipment storage

The equipment should be stored in its original package in a cupboard warehouse or similar. Care should be taken not to subject the equipment to excessive temperatures or humidity.

Warranty

Bronkhorst® products are warranted against defects in material and workmanship for a period of three years from the date of shipment, provided they are used in accordance with the ordering specifications and not subject to abuse or physical damage. Products that do not operate properly during this period may be repaired or replaced at no charge. Repairs are normally warranted for one year or the balance of the original warranty, whichever is the longer.

See also section 9 (Guarantee) of the Conditions of sales:
www.bronkhorst.com/about/conditions-of-sales/

The warranty includes all initial and latent defects, random failures, and indeterminable internal causes.

It excludes failures and damage caused by the customer, such as contamination, improper electrical hook-up, physical shock etc.

Re-conditioning of products primarily returned for warranty service that is partly or wholly judged non-warranty may be charged for.

Bronkhorst High-Tech B.V. or affiliated company prepays outgoing freight charges when any part of the service is performed under warranty, unless otherwise agreed upon beforehand, however, if the product has been returned collect to our factory or service center, these costs are added to the repair invoice. Import and/or export charges, foreign shipping methods/carriers are paid by the customer.

General safety precautions

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Before operating, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables for cracks or breaks before each use.

The equipment and accessories must be used in accordance with their specifications and operating instructions, otherwise the safety of the equipment may be impaired.

If required, replace fuses with the same type and rating for continued protection against fire hazard.

Opening the equipment is not allowed. There are no repairable parts inside. In case of a defect please return the equipment to Bronkhorst High-Tech B.V.

One or more warning signs may be present on different parts of the product. These signs have the following meaning:

Consult the instruction manual for handling instructions

Surface may get hot during operation

Shock hazard; electrical parts inside

To maintain protection from electric shock and fire, replacement components must be obtained from Bronkhorst. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be obtained from other suppliers, as long as they are equivalent to the original component. Selected parts should be obtained only through Bronkhorst, to maintain accuracy and functionality of the product. If you are unsure about the relevance of a replacement component, contact your local Bronkhorst representative for information.

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1 Introduction

1.1 Scope of this manual

This user guide describes the **EL-FLOW® Classic** series mass flow controllers for gases. It covers product information, installation instructions, operation, maintenance, troubleshooting tips and technical specifications.

1.2 Intended use

EL-FLOW® Classic instruments were designed to measure an/or control gas flow rates of the specified gas as stated on the instrument label. The gas must be clean and dry. The instruments can be used for either (fast) switching or controlling a constant flow rate.

The end user is considered to be familiar with the necessary safety precautions, and to comply with the appropriate protective measures as described in the Material Safety Data Sheets of the media to be used in the system (if applicable).

The wetted materials incorporated in the EL-FLOW® Classic are compatible with media and conditions (e.g. pressure, temperature) as specified at ordering time. If you are planning to use the product (including any third party components supplied by Bronkhorst, such as pumps or valves) with other media and/or other conditions, always be sure to check the wetted materials (including seals) for compatibility. See the technical specifications of the product and consult third party documentation (if applicable) to check the incorporated materials.

Responsibility for the use of the equipment with regard to suitability, intended use, cleaning and corrosion resistance of the used materials against the applied media lies solely with the end user. Bronkhorst High-Tech B.V. cannot be held liable for any damage resulting from improper use, use for other than the intended purpose or use with other media and/or under other conditions than specified on the purchase order.

1.3 Other documents

Basic instructions	Technical drawings
Quick installation guide EL-FLOW® Classic Document no. 9.17.086	**Hook-up diagram EL-FLOW® Classic** Document no. 9.16.117
	Dimensional drawing F-201CL Document 7.15.182

*These documents can be found at **http://www.bronkhorst.com/en/qrclassic***

1.4 Maintenance

No regular maintenance is required if the EL-FLOW® Classic is operated properly, with clean media, compatible with the wetted materials, avoiding pressure and thermal shocks and vibrations. Units may be purged with a clean, dry and inert gas.

In case of severe contamination, cleaning the inside of the device may be required. After cleaning, recalibration of the instrument is recommended.

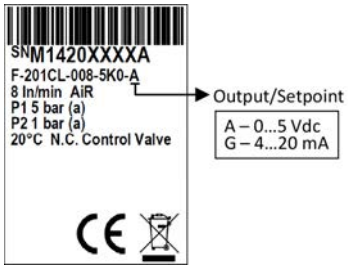
Inexpertly servicing instruments can lead to serious personal injury and/or damage to the instrument or the system it is used in. Therefore, servicing must be performed by trained and qualified personnel. Contact your local Bronkhorst representative for information about cleaning and calibration. Bronkhorst has a trained staff available.

2 Starting up

2.1 Functional properties

Before installing the EL-FLOW® Classic, check the serial number label to see if the functional properties match your requirements:

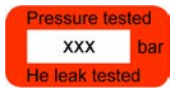
- Flow rate
- Media to be used in the instrument
- Input and output signal
- Upstream and downstream pressure(s)
- Operating temperature



2.2 Operating conditions

The EL-FLOW® Classic is fitted with Viton® seals. Be sure that the sealing material is compatible with the media and conditions used in the system. Bronkhorst High-Tech B.V. cannot be held responsible for any damage resulting from the use of other media and/or conditions than specified on the purchase order.

*Bronkhorst® instruments are pressure tested to at least 1.5 times the requested maximum allowed operating pressure (30 bar(g)) and outboard leak tested to at least 2 * 10^{-9} mbar l/s Helium. The tested pressure is specified on the instrument with a red sticker. If this sticker is missing or if the specified pressure is insufficient, the instrument must not be used and should be returned to the factory.*



Before installation, make sure that the tested pressure is in accordance with the safety factor of your application. The tested pressure must always be higher than the maximum operating pressure.

Disassembling the instrument and/or replacing parts of it will invalidate the pressure test specification.

2.3 Mounting

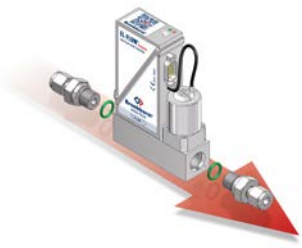
The bottom side of the **EL-FLOW® Classic** is fitted with two threaded mounting holes for stable mechanical fixation of the instrument. Refer to the dimensional drawing for the exact position of the mounting holes.

For optimal performance, observe the following guidelines:

- *Preferably, mount the EL-FLOW® Classic in an upright position, especially if the operating pressure is higher than 10 bar*
- *When mounting the instrument in a position with upward or downward flow, adjusting the zero point is recommended*
- *Avoid installation in close proximity of mechanical vibration and/or heat sources*

2.4 Fluidic connections

- Install the EL-FLOW® Classic in the process line, in accordance with the direction of the FLOW arrow on the product label.
- The fluidic connections are provided with a ¼" BSPP female thread. The adapter chambers are optimized for the use of Swagelok® RS-type adapters combined with AS013 (70°Sh) O-rings for leak tight installation.
- Tighten connections according to the instructions of the supplier of the fittings. The use of Swagelok® RS-type stainless steel adapters is recommended (part no. SS-400-1-4RS). Adapters can be ordered separately. Contact your local distributor for more information.



- *Do not install small diameter piping on high flow rates and avoid abrupt angles or other disturbances within a distance of 10 pipe diameters from the inlet or outlet of the device.*
- *Do not install pressure regulators within a distance of 25 pipe diameters.*

Check the fluidic system for leaks before applying pressure, especially if toxic, explosive or other dangerous fluids are used.

2.5 Inlet filter

Fluids to be measured should be absolutely free of dirt, oil, moisture and other particles. Fluids that are heavily contaminated or contain particulates are detrimental to precision. If liquid phases enter the sensor chamber, the function of the sensor and the mass flow controller may be impaired. It is recommended to install an in-line filter (offered by Bronkhorst) or liquid separator upstream of the flow controller, and if backflow can occur, a downstream filter is recommended too. Be aware of the pressure drop caused by the filter(s). Contact your distributor for further information.

2.6 Electrical connection

2.6.1 Interface

EL-FLOW® Classic instruments are analog operated, I/O signals can be provided by means of:

1. Voltage I/O (0...5Vdc)
2. Current I/O (4...20mA sourcing)

For electrical hook-up diagram refer to the EL-FLOW® Classic hook-up diagram.

2.6.2 Power supply

EL-FLOW® Classic controllers are powered with +15 Vdc to +24 Vdc.
When providing your own power supply be sure that voltage and current rating are according to the specifications of the instrument(s) and that the source is capable of delivering enough power to the instrument(s). Refer to the EL-FLOW® Classic hook-up diagram, for more details.

*The device contains electronic components that are susceptible to damage by **electrostatic discharge**. Proper handling procedures must be followed during installation, (dis)connecting and removing the electronics.*

*The device described in this manual carries the CE-mark and is **compliant with the concerning EMC requirements**. However, compliance with the EMC requirements is not possible without the use of proper cables and connector/gland assemblies. Bronkhorst recommends the use of their standard cables. These cables have the right connectors and if loose ends are used, these are marked to help prevent wrong connection. When using other cables, cable wire diameters should be sufficient to carry the supply current, and voltage loss must be kept as low as possible. When in doubt, contact your local Bronkhorst representative.*

*When connecting the product to other devices, be sure that the integrity of the shielding is not affected; **always use shielded cabling for signals and communication and do not use unshielded wire terminals.***

2.7 Powering up and powering down

- *It is recommended to turn on power before applying pressure and to switch off power after removing pressure.*
- *For best performance, allow the device to warm up and stabilize for at least 30 minutes before starting measurement and/or control. This may be done with or without media flow.*

Be sure to apply the specified operating pressure(s). Avoid pressure shocks and bring the fluidic system gradually up to the level of operating conditions; open and close the fluid supply gently.

2.8 Purging before use

In systems for use with corrosive, reactive or explosive media, purging the fluidic lines of the device for at least 30 minutes with a dry, inert gas (like Nitrogen or Argon) is absolutely necessary before use. After use with these media, complete purging is also required before exposing the system to air.

2.9 Zeroing before use

The zero-point of each instrument is factory adjusted at approximately 20 °C and atmospheric pressure. If the operating conditions differ significantly from the ambient conditions used for factory adjustment, the zero point may need to be re-adjusted.

Procedure for zeroing with the multifunctional switch on top of the instrument:
- Warm-up the instrument, pressurize the system and fill the instrument according to the process conditions.
- Make sure no flow is going through the instrument by closing valves near the instrument.
- The setpoint must be zero.
- Press and hold the multifunctional switch. After a short time the red LED will go ON and OFF, then the green LED will go ON. At that moment release the switch.
- The zeroing procedure will start at that moment and the green LED will blink fast. The zeroing procedure waits for a stable signal and saves the zero. If the signal is not stable, zeroing might take longer and the nearest point to zero is accepted. The procedure will take approximately 10 seconds.
- When the indication is showing 0% signal and the green indication LED is glowing continuously again, then the zeroing action was successful.

2.10 Calibration

EL-FLOW® Classic instruments are Air or N_2 calibrated. Bronkhorst High-Tech B.V. certifies that all instruments meet the rated accuracy. They have been calibrated using measurement standards traceable to the standards of the Dutch Metrology Institute (VSL).

The calibration is converted to the customer's gas and conditions using a detailed conversion model. This conversion adds a level of calibration uncertainty.

Rule of thumb for calculating the conversion uncertainty:

Uncertainty < 2% x CF	for CF > 1
Uncertainty < 2% / CF	for CF < 1

With CF defined as the approximate conversion factor, which can be calculated with:

$$CF = \frac{C_{p_1} \cdot \rho_1}{C_{p_2} \cdot \rho_2}$$

in which: C_{pn} specific heat

ρ_n density at normal conditions

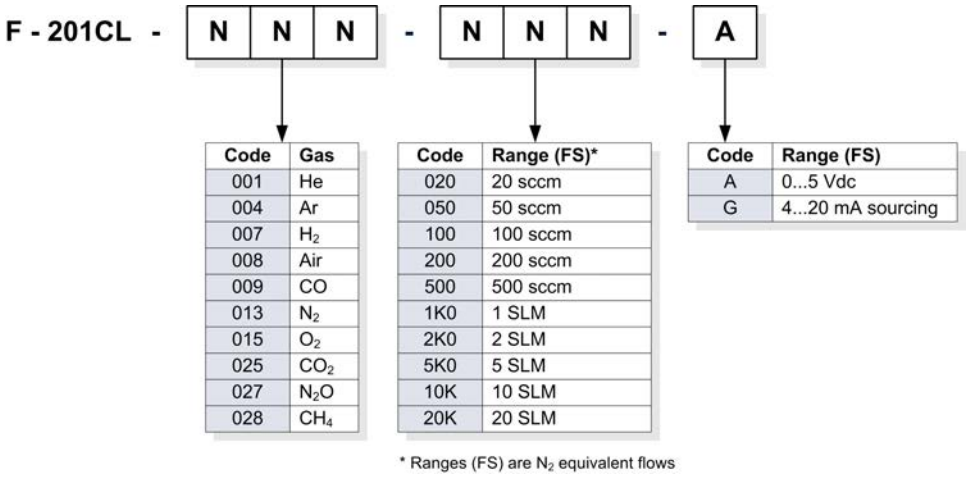
(1) calibration fluid (Air or N_2)

(2) customer fluid

***EL-FLOW® Classic** instruments are delivered with a statement of compliance. This document can be found at **http://www.bronkhorst.com/en/qrclassic**.*

Use the hyperlink above or scan the QR-code on the right or on top of the instrument.

2.11 Model key



Code	Gas
001	He
004	Ar
007	H_2
008	Air
009	CO
013	N_2
015	O_2
025	CO_2
027	N_2O
028	CH_4

Code	Range (FS)*
020	20 sccm
050	50 sccm
100	100 sccm
200	200 sccm
500	500 sccm
1K0	1 SLM
2K0	2 SLM
5K0	5 SLM
10K	10 SLM
20K	20 SLM

* Ranges (FS) are N_2 equivalent flows

Code	Range (FS)
A	0...5 Vdc
G	4...20 mA sourcing

Example: F-201CL-009-1K0-A
Gas CO
Range 1 SLM
Analog output 0…5 Vdc

3 Basic operation

3.1 General

The following signals are available:
- input: setpoint
- output: measured value

The interface type of the instrument (0…5V or 4…20mA) can be found in the model key stated on the serial number label.

Input signals:
Setpoints below 2% of the full scale will be interpreted as 0% setpoint.

Output signals:
The 100% point of the measured value is based on the flow rate requested at ordering time. This flow rate can be found on the serial number label.

3.2 LED indications

● (green) Mode: operation mode indication
● (red) Error: error/warning messages

The tables below list the different LED indications:

● **Green**		
Pattern	**Time**	**Indication**
on	continuous	Normal operation mode
off	continuous	Power off or program not running
blink	0.2 sec on, 0.2 sec off	Special function mode; the instrument is busy performing a special function (e.g. auto-zero or self-test)

● **Red**		
Pattern	**Time**	**Indication**
on	continuous	Critical error; the instrument needs servicing before it can be used

● **Green and** ● **red (alternating)**		
Pattern	**Time**	**Indication**
fast wink	0.1 sec on, 0.1 sec off	Selected action started (after releasing the multifunctional switch)

3.3 Multifunctional switch

Some special functions of the instrument can be started manually using the multifunctional switch near the indication LEDs.

3.3.1 Normal operating functions

- In order to access these functions, press and hold the switch while the instrument is in normal operation mode (green LED glowing).
- As long as the switch is held, the LEDs show a repeating sequence of patterns, where each pattern indicates a function.
- All indications in this sequence are continuous.
- Each pattern is shown for a number of seconds; in the table below the column *Hold time* indicates the time frame within the sequence where the LEDs show the associated pattern.
- To start a function, release the switch when the LEDs show the pattern of the required function.

● (green)	● (red)	Hold time	Function
off	off	0…4 sec	No action
off	on	4…8 sec	Reset instrument; clear all warnings and error messages and restart the instrument
on	off	8…12 sec	Auto-zero; re-adjust the zero-point of the instrument (flow meters/controllers)
on	on	12…16 sec	Factory mode, do not use

See Zeroing before use for background information and instructions on how to adjust the zero point of an instrument. Never perform a zeroing procedure before having taken notice of the instructions.

3.3.2 Power-up functions

- In order to access these functions, press and hold the switch while powering up the instrument.
- As long as the switch is held, the LEDs show a repeating sequence of patterns, where each pattern indicates a function.
- All indications in this sequence are flashing (0.2 sec on, 0.2 sec off).
- Each pattern is shown for a number of seconds; in the table below the column *Hold time* indicates the time frame within the sequence where the LEDs show the associated pattern.
- To start a function, release the switch when the LEDs show the pattern of the required function.

● (green)	● (red)	Hold time	Function
off	off	0…4 sec	No action
off	on	4…8 sec	Restore factory settings (All parameter settings will be restored)
on	off	8…12 sec	No action
on	on	12…16 sec	Factory mode, do not use

4 Advanced operation

4.1 Using other gases than specified

Each instrument has been calibrated and adjusted for customer process conditions.

Controllers or valves may not operate correctly, if process conditions vary too much, because of the restriction of the orifice in the valve. The performance and accuracy of thermal Mass Flow Controllers may be affected tremendously if physical fluid properties such as heat capacity and viscosity change due to changing process conditions.

4.2 Conversion factor calculation

Bronkhorst has gathered the physical properties of over 600 fluids in a database called FLUIDAT® This database also provides a collection of routines to calculate physical properties of gases and liquids, not only at 20°C/1 atm but at any temperature/pressure combination, both for gases and for liquids.

Check FLUIDAT® on the Net on ***http://www.fluidat.com***
Consult your distributor for more details.

Also see section Calibration.

4.3 Maximum pressure drop

For (pilot) solenoid operated control valves with small orifices, the maximum allowable pressure drop for gases is according to the table.

Diameter [mm]	Kv	Normally closed Δp max. [bard]
0,05	$4{,}33 \times 10^{-5}$	30
0,07	$8{,}48 \times 10^{-5}$	30
0,10	$1{,}73 \times 10^{-4}$	30
0,14	$3{,}39 \times 10^{-4}$	30
0,20	$6{,}93 \times 10^{-4}$	30
0,30	$1{,}56 \times 10^{-3}$	30
0,37	$2{,}37 \times 10^{-3}$	30
0,50	$4{,}33 \times 10^{-3}$	30
0,70	$8{,}48 \times 10^{-3}$	24
1,00	$1{,}73 \times 10^{-2}$	12
1,30	$2{,}93 \times 10^{-2}$	8
1,50	$3{,}90 \times 10^{-2}$	6
1,70	$5{,}00 \times 10^{-2}$	5
2,00	$6{,}63 \times 10^{-2}$	3,6

5 Troubleshooting and service

For a correct analysis of the proper operation of a flow meter/controller it is recommended to remove the unit from the process line and check it without applying fluid supply pressure. In case the unit is dirty, this can be ascertained immediately by loosening the compression type couplings on the inlet side.

Energizing and de-energizing the instrument can indicate if there is an electronic failure. After energizing, control behavior can be checked by applying fluid pressure.

If you suspect leakage, do not check for gas bubbles with a leak detection liquid under the cover, as this may short-circuit the sensor or the printed circuit board.
Do not disassemble the instrument for inspection, but contact your local distributor for service or repairs.

5.1 Errors

See LED indications for an explanation of the LED indications the instrument can give.

5.2 Common issues

Symptom	Possible cause	Action
No output signal	No power supply	• Check power supply • Check cable connection • Check cable hook-up
	No setpoint given or setpoint too low	Give setpoint ≥ 2%
	Inlet pressure or differential pressure too low	Increase inlet pressure
	Piping, filters and/or control valve clogged or blocked	• Flush fluidic system with clean, dry air. If problem persists, contact Bronkhorst. • For external proportional control valves: supply 0…15 Vdc and operational inlet pressure to valve and slowly increase voltage. If valve does not open, clean parts and re-adjust valve
	Laminar flow element clogged or blocked	Return equipment to factory
	Sensor failure	Return equipment to factory
Control behavior unstable	Measurement disturbed by vibrations	If possible, avoid installation in close proximity of mechanical vibration
	Inlet pressure unstable	Install pressure regulator or increase buffer volume between controlling instruments
	Inlet and/or outlet pressure too high or too low	Adjust pressure and/or set instrument pressure in accordance with actual process pressure
	Wrong process fluid supplied	Supply instrument with fluid it was configured for
	Control valve damaged	Return equipment to factory
No flow (sending a setpoint has no effect)	No fluid supply	Check upstream components for obstruction, e.g.: • fluidic lines • valves • filters
	Setpoint too low	Give setpoint ≥ 2%

Symptom	Possible cause	Action
	Inlet pressure or differential pressure out of bounds	Set inlet pressure to a value within specifications
Measured value rises, but never reaches setpoint	Piping, filters and/or control valve clogged or blocked	• Flush fluidic system with clean, dry air. If problem persists, contact Bronkhorst. • For external proportional control valves: supply 0…15 Vdc and operational inlet pressure to valve and slowly increase voltage. If valve does not open, clean parts and re-adjust valve
	Inlet pressure too low	Increase inlet pressure
	Outlet pressure too high	Check/decrease outlet pressure
	Process outlet blocked	Check process outlet and downstream piping
Measured value or output signal (much) lower than setpoint	Inlet pressure or differential pressure too low	• Increase inlet pressure • Use instrument in conditions it was designed for
	Process gas condensation	Decrease inlet pressure or increase gas temperature
	• Piping, filters and/or control valve clogged or blocked • Sensor blocked or contaminated	Flush fluidic system with clean, dry air. If problem persists, contact Bronkhorst.
	Supplied fluid type does not match configured fluid type	Supply instrument with fluid it was configured for
Measured value or output signal indicates a flow, while there is none	Mounting orientation and/or ambient conditions changed significantly	• Use instrument in conditions it was designed for • Adjust zero point (see Zeroing before use)
	System leakage	Check the fluidic system for leakage. Follow vendor instructions when installing third party components (e.g. adapters, tubing, valves)
Continuous maximum measured value or output signal	Inlet pressure too high	Check inlet pressure
	Valve fully open	Close valve
	Sensor failure	Return equipment to factory

5.3 Service

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

 **http://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:

 **sales@bronkhorst.com**

For after-sales questions, our Customer Service Department is available with help and guidance.
To contact CSD by e-mail:

 **support@bronkhorst.com**

No matter the time zone, our experts within the Support Group are available to answer your request immediately or ensure appropriate further action. Our experts can be reached at:

 **+31 859 02 18 66**

Bronkhorst High-Tech B.V.
Nijverheidsstraat 1A
NL-7261 AK Ruurlo
The Netherlands

6 Returns

6.1 Removal and return instructions

When returning materials, always clearly describe the problem, and, if possible, the work to be done, in a covering letter.

Instrument handling:
1. Purge all fluidic lines (if applicable)
2. If toxic or dangerous fluids have been used, the instrument must be cleaned before shipping
3. Disconnect all external cabling and tubing and remove the instrument from the process line
4. If applicable, secure movable parts with appropriate transport safety materials, to prevent damage during transportation
5. The instrument must be at ambient temperature before packaging
6. Insert the instrument into a plastic bag and seal the bag
7. Place the bag in an appropriate shipping container; if possible, use the original packaging box

Add documentation:
- Reason of return
- Failure symptoms
- Contaminated condition
- Declaration on decontamination

It is absolutely required to notify the factory if toxic or dangerous fluids have been in contact with the device!
This is to enable the factory to take sufficient precautionary measures to safeguard the staff in their repair department.

All instruments must be dispatched with a completely filled in 'Declaration on decontamination'. Instruments without this declaration will not be accepted.

*A safety information document containing a 'Declaration on decontamination' form (document no 9.17.032) can be downloaded from the **Service & Support** section of the Bronkhorst website (**www.bronkhorst.com**).*

Important:
Clearly note, on top of the package, the customs clearance number of Bronkhorst High-Tech B.V.:

NL801989978B01

(only if applicable, otherwise contact your local Bronkhorst representative for local arrangements.)

6.2 Disposal (end of lifetime)

Within the scope of the European Union, manufacturers of electrical and electronic equipment (EEE) are bound to comply with the WEEE Directive (Waste Electrical and Electronic Equipment). As a consequence, Bronkhorst is obligated to offer its customers in the EU the possibility to return EEE for disposal once it has reached the end of its lifetime, and take all necessary steps to dismantle it properly and recycle or re-use its components whenever possible.

All Bronkhorst® products that fall under the regime of the WEEE Directive (which is the majority) have an image of a crossed-out wheeled bin printed somewhere on the product (typically the serial number label). If you wish to dispose of Bronkhorst® equipment bearing this symbol, you can simply return it in accordance with the removal and return instructions, and Bronkhorst will take care of proper dismantlement and recycling. In the covering letter, just mention that you are returning the product for disposal. Within the EU, returning products for disposal is of course free of charge (except for shipping and handling costs).

For customers outside the EU, local or national directives and/or legislation may apply to EEE disposal. If applicable, consult local or national authorities to learn how to handle EEE properly in your area.