

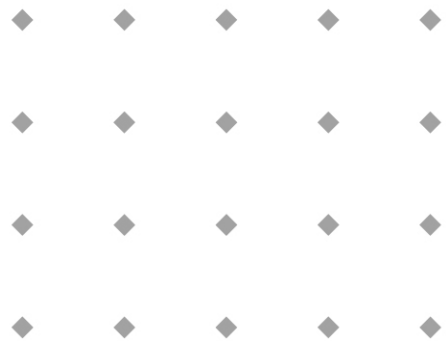


Instruction manual



Explosion proof Flow Measurement and control ATEX

Doc. no.: 9.17.028T Date: 26-01-2017



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.



Related drawing.
No modifications permitted without
approval of the authorised person.

Even though care has been taken in the preparation and publication of the contents of this manual, we do not assume legal or other liability for any inaccuracy, mistake, misstatement or any other error of whatsoever nature contained herein. The material in this manual is for information purposes only, and is subject to change without notice.

Warranty

The products of Bronkhorst® 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 the instructions in this manual and that they are not subjected to abuse, physical damage or contamination. Products that do not operated 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 paragraph 9 of the 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, dropping 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. 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 Bronkhorst High-Tech B.V., these costs are added to the repair invoice. Import and/or export charges, foreign shipping methods/carriers are paid for by the customer.

Short-Form Operation Instruction

Before installing your Mass Flow Meter/Controller it is important to read the attached label and check:

- flow rate
- fluid to be metered
- up- and downstream pressures
- input/output signal

Check the red-coloured sticker and make sure the test pressure is in agreement with normal safety factors for your application.

Check if the piping system is clean. For absolute cleanliness always install filters to assure a clean, moisture- and oil-free gas stream.

Install the Meter/Controller in the line and tighten the fittings according to the instructions of the supplier of the fittings. Choose the mounting position according to the directions given in this manual.

Check the system for leaks before applying fluid pressure

Electrical connections must be made with a standard cable or according to the hook-up diagram in the back of this manual.

Apply power to the instrument and allow for approx. 30 minutes to warm-up and stabilize. This may be done with or without fluid pressure, applied to the system.

Your instrument is now ready for operation.

TABLE OF CONTENTS

1 Intrinsic safe sensors

1.1	General description	page 7
1.2	Bronkhorst® flowhead.....	page 7
1.3	Software for conversion factor calculation	page 8
1.4	Control valve	page 8
1.4.1	Introduction.....	page 8
1.5	Ex-proof Coils.....	page 9
1.5.1	Introduction.....	page 9
1.5.2	Style XC-coil.....	page 9
1.5.3	Style XB-coil.....	page 10

2 Installation

2.1	Receipt of equipment	page 11
2.2	Return shipment.....	page 11
2.3	Service	page 11
2.4	Mounting.....	page 12
2.5	In-line filter	page 12
2.6	Gas connections.....	page 12
2.7	Piping	page 13
2.8	Electrical connections	page 13
2.9	Caution	page 13
2.10	Supply pressure	page 14
2.11	System purging	page 14
2.12	Seals	page 14
2.13	Equipment storage	page 14

3 Operation

3.1	General.....	page 15
3.2	Power and warm-up	page 15
3.3	Start-up.....	page 15
3.4	Operating conditions	page 15

4 Cables

4.1	Introduction.....	page 16
4.2	Cable for Bronkhorst® flowhead	page 16
4.3	Control system with XC-coil	page 16
4.4	Control system with XB-coil	page 16
4.5	EMC and cables	page 17
4.5.1	Cable gland assembly Bronkhorst® flowhead	page 17
4.5.2	Cable gland assembly XC / XB coil.....	page 17

5 Maintenance

5.1	General.....	page 18
5.2	Calibration	page 18

6 Troubleshooting

6.1	General.....	page 19
6.2	Troubleshooting summary.....	page 19

Appendices

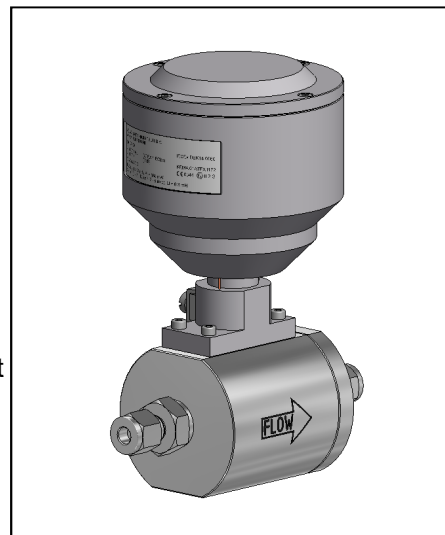
1 Enclosures

1 INTRINSIC SAFE SENSORS

1.1 General description

The Bronkhorst® series mass flow meter is an accurate device for measuring gas flows up to 700bar, virtually independent of pressure and temperature changes.

The system can be completed with a control valve and flexible readout to measure and control gasflows from 0 – 5 ml_n / min up to 1000 m³_n / h .



Model F-112AX

1.2 Bronkhorst® flowhead

The X100 flowhead has the following type of protection:

II 2 G Ex ib IIC T4 Gb

II 2 G = ATEX group and category

ib = intrinsic safe in zone 1

IIC = most dangerous explosion group with ignition energy of 20 μJ
for example: Acetylene and Hydrogen

T4 = surface temperature max. 135°C.

Gb = IEC equipment protection level

There is one gas which has a more dangerous temperature-class; CS₂ has temperature class T5. This gas may not be measured with our meters.

Type : X100	Bronkhorst High-Tech B.V.
Ex ib IIC T4 Gb (ATEX / IECEX)	7261 AK Ruurlo NL
Ex ib IIC T4 (TIIS)	
-10 ≤ Ta ≤ 70°C	
Intrinsically safe circuit (between terminal 1 and 3)	IECEX DEK14.0060
Ui = 28 V, li = 98 mA, Pi = 686 mW	KEMA 01ATEX1172
Ci = 1 nF, Li = 0.3 mH	CE 0344 Ex II 2 G

STANDARDS:

The electrical apparatus and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards:

EN 60079-0 : 2012 + A11:2013 Explosive atmospheres - Part 0: General requirements

EN 60079-11 : 2012 Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "I"

The signal processing is done with a pre-amplifier, which transforms the measuring signal into a linearized current signal.

For the power of the heater, a "zero" current of 15mA has been chosen.

The output current varies from 15 to 20mA.

1.3 Software for conversion factor calculation

Bronkhorst® gathered the physical properties of over 600 fluids in a database called FLUIDAT®. Application software, such as FLUIDAT® on the Net (FOTN), enable the user to calculate accurate conversion factors, not only at 20°C/1 atm (as shown in the conversion table, App.1) but at any temperature/pressure combination. Apply to your distributor for more details of this software.

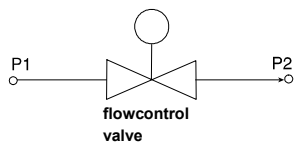
1.4 Control valve

1.4.1 Introduction

Control valves are not designed to provide positive shut-off, although some models have excellent capabilities for this purpose.

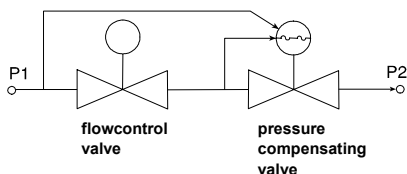
It is recommended to install a separate shut-off valve in the line if so required. Also pressure surges, as may occur during system pressurisation must be avoided. The following models can be distinguished:

Solenoid valve



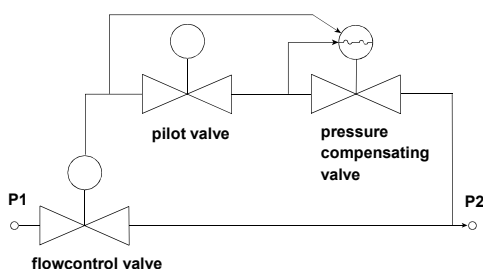
This is considered to be the standard (direct operated) control valve. In general it is a normally closed solenoid valve. The plunger is lifted by the force of the magnetic field of the coil. The orifice under the plunger is removable for optimising the orifice diameter. Also a normally opened solenoid valve is available.

Vary-P valve



For process conditions where up- and downstream pressure vary much, a special type of valve, VARY-P has been designed. This valve consists of two valves, a solenoid operated control valve and a fixed adjusted pressure compensation valve.

Pilot operated valve



For high flow rates the pilot operated valve has been designed. A solenoid driven control valve controls the pressure difference across a piston, which lifts the main plunger.

1.5 Ex-proof Coils

1.5.1 Introduction

In our program we know two sorts of coils:

(1) Style: XC =



II 2 G Ex eb IIC T4
 II 2 D Ex tb IIIC T130°C
 Increased safety coil with LCIE approval.

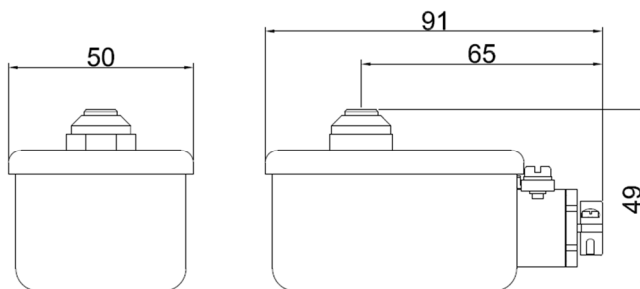
(2) Style: XB =



II 1 G Ex ia IIC T6
 II 1 D Ex ta IIIC T80°C
 Intrinsic safe coil with LCIE approval.
 This coil must be safeguarded with a isolating repeater.

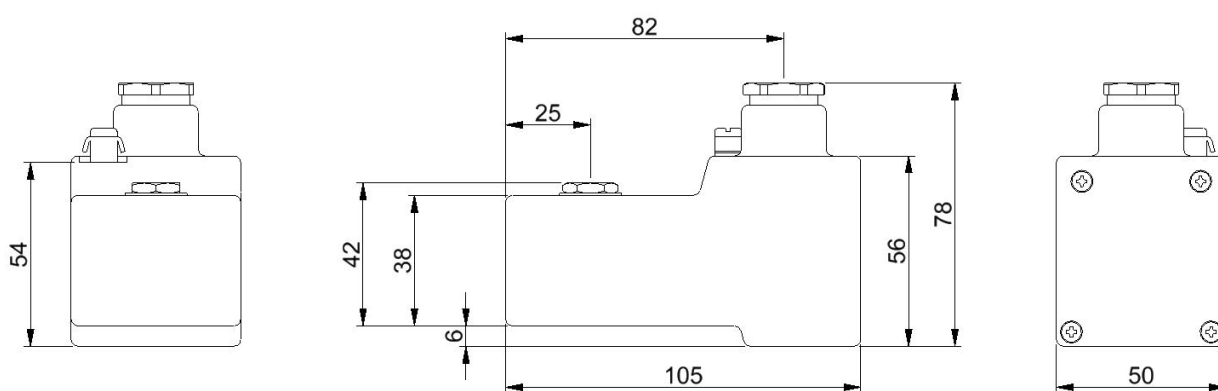
1.5.2 Style XC coil

Manufacturer	: Parker Lucifer
Type	: 483371 24Vdc
Type of protection	: II 2 G Ex eb IIC T4 II 2 D Ex tb IIIC T130°C
Certificate no.	: LCIE 02 ATEX 6011 X
Housing	: metal housing / IP 67
Max.supply voltage	: 24Vdc
Class of insulation	: F (155°C)
Max.power DC	: 8 Watt (hot) 9 Watt (cold) 20°C
Connecting coupling	: Cable gland M20 x 1.5 Exe
Ambient Temperature	: -40°C. to + 65°C



1.5.3 Style XB coil

Manufacturer	: Parker Lucifer
Type	: 48.8650
Type of protection	: II 1 G Ex ia IIC T6 II 1 D Ex ta IIIC T80°C
Certificate no.	: LCIE 02 ATEX 6024 X
Housing	: polyamid with fiberglass housing / IP 66
Max.supply voltage	: 28 V / 110mA
Max.power DC	: 3 Watt
Coil resistance	: 295 Ω 20°C
Impedance	: 345 Ω
Apparent inductance	: 0 mH
Apparent capacitance	: 0 μ F
Connecting coupling	: Cable gland M20x1.5
Ambient temperature	: -40°C to + 65°C



2 INSTALLATION

2.1 Receipt of equipment

Check the outside packing box for damage incurred during shipment. Should the packing box 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:

BRONKHORST HIGH-TECH B.V.
RUURLO HOLLAND

If applicable, otherwise contact your distributor.

Remove the envelope containing the packing list; carefully remove the equipment from the packing box.

Do not discard spare or replacement parts with the packing material and inspect the contents for damaged or missing parts.

2.2 Return shipment

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

It is absolutely required to notify the factory if toxic or dangerous fluids have been metered with the instrument!

This to enable the factory to take sufficient precautionary measures to safe-guard the staff in their repair department. Take proper care of packing, if possible use the original packing box; seal instrument in plastic etc.

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

Note:

If the instruments have been used with toxic or dangerous fluids the customer should pre-clean the instrument.

Important:

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

NL801989978B01

If applicable, otherwise contact your distributor for local arrangements.

2.3 Service

If the equipment is not properly serviced, serious personal injury and/or damage to the equipment could be the result. It is therefore important that servicing is performed by trained and qualified service personnel. Bronkhorst® has a trained staff of servicemen available.

2.4 Mounting

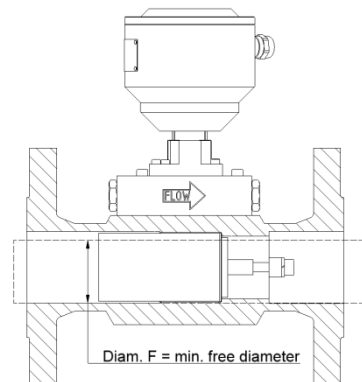
The mounting position depends on the type of meter. The preferred position is horizontal and at high pressures (> 10 bar), Bronkhorst® strongly advises to mount the instrument in this position. Avoid installation in close proximity of mechanic vibration and/or heat sources.

For mounting the F-106/F-107 series handle the following rules:

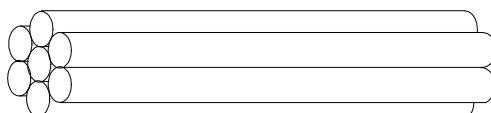
STRAIGHT PIPE LENGTH REQUIREMENTS (in number of diameters F)

	Upstream	Downstream
one 90° bend before meter	10	4
two 90° bend before meter	13	4
two 90° bend in two planes	20	4
three 90° bend in three planes	30	4
reduction before meter	10	4
expansion before meter	20	4
pressure reducing valve / control valve / partially closed valve before meter	30	4

For further information see dimensional drawing.



In general flow straighteners have a suspicious influence on the free length of the meter. A flow straightener can be imagined as a bundle of parallel tubes which is placed in the tube.



In general, these flow straighteners must be placed at least 6 à 8 D upstream of the meter. In general, use a flow straightener in case of control valves and curves in unequal levels.

Next to these prescriptions for free length, the flow has to be steady, shock and pulsation free. The flanges also must fit well to each other and there may not stick seals into the tube.

2.5 In-line filter

Although fluids to be measured should be absolutely free of dirt, oil, moisture and other particles, it is recommended to install an in-line filter upstream of the flowmeter / controller, and if backflow can occur, a downstream filter is recommended too. Be aware of the pressure drop caused by the filter.

On the inlet of some instruments a screen is placed to prevent foreign matter from entering the instrument and to maintain a good flow pattern. This device **cannot** be seen as a filter element.

Contact your distributor for further information.

2.6 Gas connections

Bronkhorst® series mass flow meters/controllers are standard equipped with compression fittings. For leak tight installation be sure that the tube is inserted to the shoulder in the fitting body and that no dirt or dust is present on tube, ferrules or fitting. Tighten the nut fingertight; while holding the instrument, then tighten the nut 1 turn. If applicable follow the guidelines of the supplier of the fittings.

Special types of fittings are available on request.

The flanges also must fit good to each other and there may not stick seals into the tube.

* **Note:** Always check your system for leaks, before applying fluid pressure. Especially if toxic, explosive or other dangerous fluids are used.

2.7 Piping

BE SURE THAT PIPING IS ABSOLUTELY CLEAN!

DO NOT install small diameter piping on high flowrates, because the inlet jetflow will affect the accuracy.

DO NOT mount abrupt angles direct on in- and outlet, especially not on high flow rates. We recommend at least 10 pipe diameters distance between the angle and the instrument.

DO NOT mount pressure regulators direct on the inlet of flow meters/controllers, but allow some meters of piping (at least 25 D). Special attention should be taken at high flow rates with flow controllers. An up- and downstream buffer is needed with a volume calculated according to the following formula:

$$V \leq \frac{0.15d^2}{\sqrt{\rho}}$$

in which:

V = Volume in litres

d = orifice diameter in mm

ρ = density at normal conditions

$d = 7.6 \sqrt{k_v}$

Example:

Flow controller at 500 l/min Air and orifice diameter d = 4 mm, needs for stable control a buffer volume of:

$$V \geq 0.15 \cdot 4^2 : \sqrt{1.29} = 2.1 \text{ litres}$$

Also the capacity of the pressure regulator should be at least 2 times the flow controller, so in this case
 $2 \cdot 500 = 1,000 \text{ l} / \text{min}$

2.8 Electrical connections

Bronkhorst® recommends to use standard cables, which have been tested together with the appropriate flow meter/controller. These cables have the right connector and if loose ends are used, these will be marked to prevent wrong connection.

Hook-up diagrams are enclosed in the back of this manual.

To comply with the IP classification it is necessary to follow the assemble guidelines of the connector manufacturer.

2.9 Caution

Each flow meter/controller is pressure tested to at least 1.5 time the working pressure of the process conditions stipulated by the customer, with a minimum of 8 bar.

For pressure meter/controllers. The test pressure depends on the range of the pressure transducer.

In general 2 x F.S. value for ranges 1 and 2 bar

 1,5 x F.S. value for ranges up to 200 bar

 1,25 x F.S. value for ranges up to 400 bar

This tested pressure is stated on the flow meter/controller with a RED COLOURED sticker. Check test pressure before installing in the line.

If this sticker is **not** available or the test pressure is incorrect, the instrument should **not** be mounted in the process line and be returned to the factory.

Each instrument is helium leak tested to at least $2 \cdot 10^{-9}$ mbar l/s Helium.

2.10 Supply pressure

Do not apply pressure until electrical connections are made. When applying pressure to the system, take care to avoid pressure shocks in the system and increase pressure gradually, especially on high pressure units incorporating a membrane/piston operated control valve.

2.11 System purging

If explosive gases are going to be used, purge the process with inert dry gas like Nitrogen, Argon etc. for at least 30 minutes.

In systems with corrosive gases like silane, purging with an inert gas is absolutely necessary, because if the tubing has been exposed to air, introducing these gases will tend to clog up or corrode the system due to a chemical reaction with air or moist air.

Complete purging is also required to remove such gases from the system before exposing the system to air. It is preferred not to expose the system to air, when working with these corrosive gases.

2.12 Seals

Bronkhorst® has gathered a material compatibility chart from a number of sources believed to be reliable. However, it is a general guide only. Operating conditions may substantially change the accuracy of this guide. Therefore is no liability for damages accruing from the use of this guide.

The customer's application demands its own specific design or test evaluation for optimum reliability.

So check if the seals like O-rings, plunger and packing glands of capillary are correct for your process.

2.13 Equipment storage

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

3 OPERATION

3.1 General

The Bronkhorst® Mass Flow Meters/Controllers are designed in such a way that they will meet user process requirements.

3.2 Power and warm-up

Before switching on power check if you have connected all the pins according to the hook-up diagram which belongs to the flow meter/controller.

It is recommended to turn on power before applying pressure on the instrument and to switch off power after removing pressure.

Check gas connections, and make sure there is no leakage. If needed, purge the system with a proper gas. Turn on power and allow for at least 30 minutes to warm-up and stabilize. During warm-up period gas pressure may either be on or off.

3.3 Start-up

Be sure your tubing is absolutely clean, free of dust, moisture etc., and your gas is cleaned by an adequate filter. Turn on fluid supply gently. Avoid pressure shocks, and bring the instrument gradually up to the level of the actual operating conditions. Also switch off fluid supply gently.

3.4 Operating conditions

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.

For flow meters performance and accuracy may be affected tremendously if physical fluid properties such as heat capacity and viscosity change due to changing process conditions.

4 Cables

4.1 Introduction

Bronkhorst® uses two-wire Lapp Unitronic LiYCY shielded cable.
When the Bronkhorst® cables are not used, Bronkhorst® advises to use this cable or equivalent.

4.2 Cable for Bronkhorst® flowhead

Bronkhorst® uses two-wire Lapp Unitronic LiYCY shielded cable.
When using a Bronkhorst® Readout unit E-7000/E-8000 series and Bronkhorst® cables, the maximum cable length is 400 meter.

When using a non Bronkhorst® Readout unit and cables, the total system should comply with the Ex specifications of the flowhead and of the used intrinsic safe isolating repeater.
Also consider the fact that the minimum voltage on the flowhead should be 15Vdc for a good measurement.

4.3 Control system with XC coil

Bronkhorst® uses two-wire Lapp Unitronic LiYCY shielded cable.
When using Bronkhorst® Readout unit E-7000 series and cables, the maximum cable length is 30 meter.
When using Bronkhorst® Readout unit E-8000 series and cables, the maximum cable length is 150 meter.

When using a non Bronkhorst® Readout unit and cables, the total system should comply with the Ex specifications of the XC coil.

4.4 Control system with XB-coil

Bronkhorst® uses two-wire Lapp Unitronic LiYCY shielded cable.
When using Bronkhorst® Readout unit E-7000 series and cables, the maximum cable length is 80 meter.
When using Bronkhorst® Readout unit E-8000 series and cables, the maximum cable length is 150 meter.

When using a non Bronkhorst® Readout unit and cables, the total system should comply with the Ex specifications of the XB coil and of the used intrinsic safe isolating repeater.

4.5 EMC and cables

All instruments described in this manual carry the CE-mark.
Therefore they have to comply with the EMC requirements as are valid for this kind of instruments.

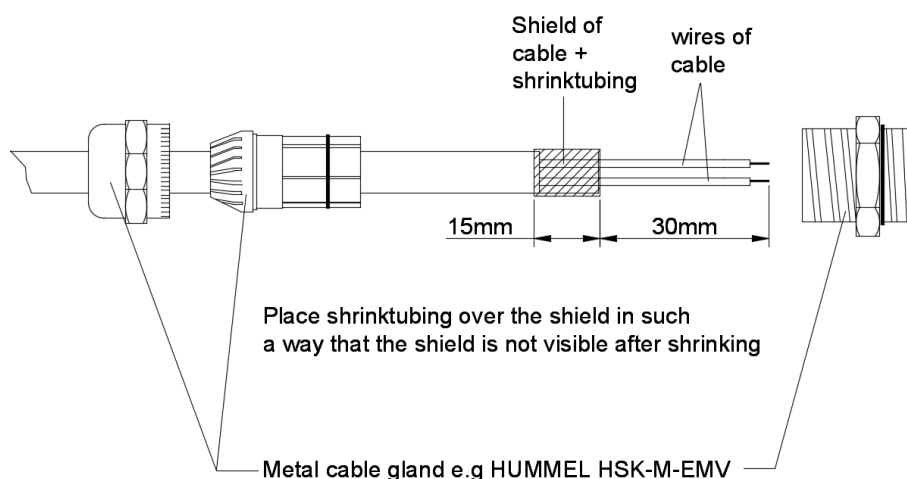
However compliance with the EMC requirements is not possible without the use of proper cables and connector/cable gland assemblies and assembled according to the assembly guidelines of the connector/cable gland manufacturer.

For good results Bronkhorst® can provide standard cables.

Otherwise it is necessary to connect the cable shield to the enclosure of the used connector or cable gland of the readout unit.

Readout units with its intrinsic safe isolating repeaters should be situated outside zone 2.

4.5.1 Cable gland assembly Bronkhorst® flowhead



Do not connect the cable shield to the Bronkhorst® flowhead.

See included hook-up diagram.

4.5.2 Cable gland assembly XC coil

For assembling the cable to the coil follow the instructions of the manufacturer of the coil and cable gland.

See included hook-up diagram.

4.5.3 Cable gland assembly XB coil

For assembling the cable to the coil follow the instructions of the manufacturer of the coil and cable gland.

Do not connect the cable shield to the coil.

See included hook-up diagram.

5 MAINTENANCE

5.1 General

At normal use, no routine maintenance is required to be performed on the meters or controllers. Units may be flushed with clean, dry inert gas.

For further information contact supplier or factory.

5.2 Calibration

All flow meters are factory calibrated. For re-calibration or re-ranging contact supplier or factory.

6 TROUBLESHOOTING

6.1 General

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

Energizing or de-energizing of the instrument may already indicate whether there is an electronic failure.

After that gas pressure is to be applied in order to check flow behaviour.

If there should be suspicion of leakage do not check for bubbles with a leak detection liquid as this may lead to a short-circuit in the sensor capillary assembly or p.c. board.

6.2 Troubleshooting summary

Symptom	Possible cause	Action
No output signal	No power supply	1a) check power supply 1b) check cable connection
	Output stage blown-up due to long lasting shortage and/or high-voltage peaks	1c) return to factory
	Supply pressure too high, or differential pressure across meter too high	1d) lower supply pressure
	Valve blocked/contaminated	1e) return to factory
	Screen in inlet fitting blocked	1f) return to factory
	Sensor/capillary failure	1g) return to factory
	Maximum output signal	Output stage blown-up Sensor/capillary failure
Output signal much lower than setpoint signal or desired flow	Screen blocked/contaminated	3a) return to factory
	LFD blocked/contaminated and/or liquid in meter	3b) return to factory
	Valve blocked/contaminated	3c) return to factory
	Valve internals damage (swollen seat in plunger)	3d) return to factory
	Incorrect type of gas is used and/or pressure/diff. pressure	3e) try instrument on conditions for which it was designed
Flow is gradually decreasing	Condensation, occurs with NH ₃ , hydrocarbons such as C ₃ H ₈ , C ₄ H ₁₀ etc.	4a) decrease supply pressure and/or heat gas to be measured
	Valve adjustment has changed	4b) see '1e'
Oscillation	Supply pressure/diff. pressure too high	5a) lower pressure
	Pipeline too short between pressure regulator and MFC	5b) increase length or diameter of piping upstream
	Pressure regulator is oscillating	5c) replace pressure regulator or try '5b'
	Valve sleeve or internals damaged	5d) return to factory
	Controller adjustment wrong	5e) return to factory
Small flow at zero setpoint	Valve leaks due to damaged plunger or dirt in orifice	6a) return to factory
	Pressure too high or much too low	6b) apply correct pressure

APPENDIX 1

Enclosures (if applicable)

EC Declaration of Conformity *

Calibration certificate(s)

Declaration on contamination

Dimensional drawings

Hook-up diagram

Translation of essential safety instructions (**enclosed by order and available on Documentation / software tool CD**)

EC Type Examination certificate **

Product Quality Assurance Notification **

Manual XB coil **

Manual XC coil **

EC Type Examination certificate XB coil **

EC Type Examination certificate XC coil **

* Also available on the Documentation / software tool CD

** Enclosed on Documentation / software tool CD