Installation & Operation Manual

AMF Series
Mass Flow Controllers & Meters

BROOKS® INSTRUMENT

Beyond Measure

Essential Instructions
Read before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. These products must be properly installed, operated and maintained to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, operating and maintaining Brooks Instrument products.

- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.

⚠ WARNING: Do not operate this instrument in excess of the specifications listed in the Instruction and Operation Manual. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.

- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.

⚠ WARNING: Prior to installation ensure this instrument has the required approval ratings to meet local and national codes. Failure to heed this warning can result in serious injury and / or damage to the equipment.

- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Operation: (1) Slowly initiate flow into the system. Open process valves slowly to avoid low surges. (2) Check for leaks around the flow meter inlet and outlet connections. If no leaks are present, bring the system up to the operating pressure.
- Please make sure that the process line pressure is removed prior to service. When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place to prevent electrical shock and personal injury, except when maintenance is being performed by qualified persons.

European Pressure Equipment Directive (PED)

All pressure equipment with an internal gauge pressure greater than 0.5 bar (g) and a size larger than 25mm or 1" (inch) falls under the Pressure Equipment Directive (PED).

- The Specifications Section of this manual contains instructions related to the PED directive.
- Products described in this manual are in compliance with EN directive 2014/34/EU.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Products larger than 25mm or 1" (inch) are in compliance with EN directive 2014/34/EU.
- Products of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

European Electromagnetic Compatibility (EMC)

The Brooks Instrument (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 2014/30/EU).

Special attention however is required when selecting the signal cable to be used with CE marked equipment.

Quality of the signal cable, cable glands and connectors:

Brooks Instrument supplies a limited selection of high quality cable(s) which meets the specifications for CE certification.

The power cable for the product is unshielded. The communication cables should be shielded.

Device chassis shall be connected to earth (PE) via mounting screws.

Communication cable shields shall be terminated via best practices for the appropriate communication network.

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How to Use This Manual

It is recommended to read this manual before installing, operating or troubleshooting your AMF Series Mass Flow Meter or Controller. This manual is organized into the following sections:

Section 1	Introduction
Section 2	Installation
Section 3	Operation
Section 4	Maintenance & Troubleshooting
Section A	Essential Instructions
Back Cover	Warranty, Local Sales/Service Contact Information

The Quality System at Brooks Instrument conforms to the quality standards set forth in ISO 9001.

This instruction manual is intended to provide the user with all the information necessary to install, operate, and maintain the AMF Series Mass Flow Meters and Controllers.

Supplemental manuals are available that provide more detailed instructions on protocol-specific features and commands, the embedded web interface, and the BEST software.

Description

Brooks Advanced Mass Flow (AMF) Series mass flow controllers and meters are designed to provide high performance gas flow control and measurement in a compact footprint utilizing proven thermal mass flow technology. These MFCs are optimized for lower flow ranges and precise stability, offering extremely low leak rates, wide turndown capability, and robust digital connectivity, alarms, and diagnostics to ensure consistent process quality and uptime.

Specifications

⚠ CAUTION

It is the user's responsibility to select and approve all materials of construction. Careful attention to metallurgy, engineered materials and elastomeric materials is critical to safe operation.

⚠ WARNING

Do not operate this instrument in excess of the specifications listed below. Failure to heed this warning can result in serious personal injury and/or damage to the equipment.

Table 1-1 AMF Series Specifications

	AMF
Performance	
Full Scale Flow Range (N_2, Eq. 0°C Ref)	0.005 - 27 slpm
Flow Accuracy—17025 Certified Devices (Includes linearity, excludes calibration system measurement uncertainty per SEMI E69)[1]	±0.6% of S.P. (20 - 100% F.S.), ±0.12% F.S. (<20% F.S.)
Flow Accuracy (Includes linearity and calibration system measurement uncertainty per SEMI E69)[1]	±1% of S.P. (20 - 100% F.S.), ±0.2% of F.S. (<20% F.S.)
Control Range N_2, eq.	Up to 1000:1
Repeatability & Reproducibility	0.25% of S.P.
Linearity	Included in accuracy
Response Time	Step changes ≥5% of F.S.: 0.9 seconds Step changes <5% of F.S.: 5 seconds
Zero Stability	<0.2% F.S. per year
Temperature Coefficient	Zero: <0.03% of F.S. per °C (N_2) Span: <0.05% of S.P. per °C (N_2)
Pressure Coefficient	±0.03% per psi
Attitude Sensitivity	Attitude insensitive when zeroed in new orientation
Ratings	
Operating Temperature Range	0 - 65°C (149°F)
Minimum Pressure Differential (Controllers)	0.5 psid (30 mbar)
Maximum Pressure Differential (Controllers)	150 psid (10 bar)
Leak Integrity (External)	$1x10^{-9}$ atm. cc/sec He
Valve Shut Down (Leak-by)	Standard: <0.01% of F.S. Optional: <0.005 sccm
Maximum Operating Pressure	Controller: 150 psig (10 bar) Meter: 400 psig (27 bar)
Proof Pressure	500 psig (34 bar)
Mechanical	
Valve Type	Normally Closed, Meter
Primary Wetted Materials	316, 316L, 430FR, 17-7PH Stainless Steel, and FKM fluoroelastomers
Diagnostics	
Status Lights	Network, Module
Alarms	See communications manuals for list.
Diagnostic / Service Port	USB Type C

[1] Accuracy at calibration conditions; accuracy spec valid across the full control range.

Table 1-2 AMF Series Enhancement Bundles

	Base Model	Performance[2]	Premium[2]
Materials of Construction	Welded Sensor	Welded Sensor	
Turndown	250:1	500:1	1000:1
Gas Pages[3]	1	4	4
Valve Shut Off	<0.01% F.S.	<0.005 sccm	<0.005 sccm
FDA/USP Class VI/ADI-Free Elastomers and Certificate	No	No	Yes
2.1 Material Certificate	No	No	Yes
International Calibration Certificate	No	No	Yes

[2] Each bundle can be configured with custom or biotech gases (Air, CO_2, N_2 & O_2); see model code for details
[3] Each bundle can be configured with up to 6 gas pages; see model code for details

Table 1-3 AMF Series Certifications

Mark	Agency	Certification	Applicable Standard	Details
CE	CE	EMC Directive 2014/30/EU Directive 2011/65/EU	EN:61326-1:2013	EMC RoHS

Table 1-4 AMF Series Model Codes

Code Description	Code Option	Option Description
I. Base Model Numbers	AMF	Advanced Mass Flow
II. Function	M	Meter
	C	Controller
III. Body Size	C	Compact
IV. I/O Communication	7	EtherNET/IP
V. Enclosure / Finish	S	Standard IP40
VI. Mechanical Connection	1A	Without adapters, 7/16" - 20 UNF
	1B	1/4" tube compression
	1C	1/8" tube compression
	1D	3/8" tube compression
	1E	1/4" VCR
	1F	1/4" VCO
	1G	1/4" NPT
	1H	6mm tube compression
	1J	10mm tube compression
	1Y	3mm tube compression
VII. O-Ring Material	A	FKM
	J	FDA/USP Class VI and ADI Free - FKM
VIII. Valve Seat	A	None (meter only)
	B	FKM
	J	FDA/USP Class VI and ADI Free - FKM
IX. Valve Type / Turndown	0	None (meter only)
	1	Normally closed (<0.01% F.S. leak rate / 250:1 turndown)[4]
	2	Normally closed (<0.005 sccm leak rate / 500:1 turndown)
	3	Normally closed (<0.005 sccm leak rate / 1000:1 turndown)
X. Bypass Size Max Flow[5]	A	None
	C	10 ccm
	K	55 ccm
	L	80 ccm
	M	120 ccm
	N	170 ccm
	P	230 ccm
	Q	310 ccm
	R	410 ccm
	S	590 ccm
	T	855 ccm
	U	1225 ccm
	V	1815 ccm
	W	2915 ccm
	X	4500 ccm
	2	7000 ccm
	3	10475 ccm
	4	17500 ccm
	5	27000 ccm
XI. Orifice Size	A	No orifice
	B	0.0013"
	C	0.002"
	D	0.003"
	E	0.004"
	F	0.0055"
	G	0.007"
	H	0.01"
	J	0.014"
	K	0.02"
	L	0.0292"
	M	0.042"
	N	0.0625"
	P	0.0938"

[4] For F.S flow rates of 50 sccm or less, leak specification is 0.005 sccm

[5] Nitrogen equivalent 0°C sccm flow rate

Table 1-4 AMF Series Model Codes (Cont.)

Code Description	Code Option	Option Description
XII. Enhancement Bundle[6]	A	Standard (none)
	Q	Performance Bundle with Custom Gas Selection[7]
	R	Premium Bundle with Custom Gas Selection[7]
	S	Biotech Performance Bundle[8]
	T	Biotech Premium Bundle[8]
XIII. Gas Pages	1	Standard Single Calibration
	2	2 Gas Pages
	3	3 Gas Pages
	4	4 Gas Pages
	5	5 Gas Pages
	6	6 Gas Pages
XIV. OEM Code	AA	Standard
XV. Certifications	1	Safe Area
XVI. Model Revision Level	A	Initial Release

[6] See "Enhancement Bundles" section for included features and certs.
[7] Can select 1-6 gas pages with any available gas.
[8] Limited to 4, 5, or 6 gas pages (Gas pages 1-4: Air, CO_2, N_2 & O_2)

Sample Model Code

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
AMF	C	C	7	S	1A	A	B	1	C	A	A	1	AA	1	A

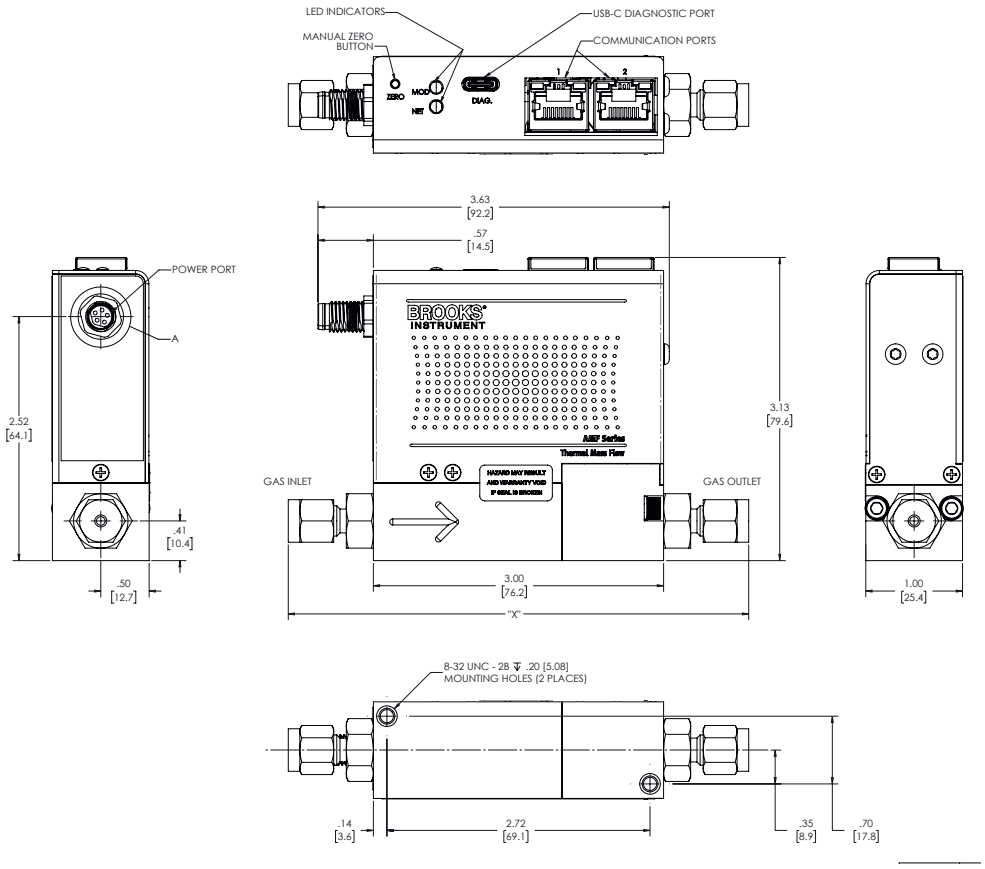
Reference Conditions

Due to effects of pressure and temperature on the compressibility of gases, specific reference conditions must be used when reporting volumetric flow rates in mass flow terms. For example, the unit of measure SCCM (standard cubic centimeters per minute) refers to a volumetric gas flow at a standard reference condition, NOT the actual volumetric gas flow at the actual operating pressure and temperature. The key point is that the MASS FLOW of the gas is fixed, but the reference volumetric flow can be reported differently based upon the standard reference condition used in the calculation.

Throughout the world, there are differences in terminology when describing reference conditions for gases. The words “normal conditions” and “standard conditions” are sometimes used interchangeably to describe the reference STP (Standard Temperature and Pressure) for gases. Further note that temperature and pressure values for standard or normal reference conditions vary in countries and industries worldwide. For example, the Semiconductor Equipment Manufacturing Industry (SEMI) defines standard temperature and pressure conditions as 273.15 K (0 °C) and 101,325 Pa (760 torr). The main concern is that no matter what words are used for descriptive purposes, a gas mass flow rate must have a defined standard pressure and temperature reference condition when performing a volumetric conversion.

Figure 1-1 AMF Dimensions

AMF Dimensions



Fittings - Dimension "X"

Fitting	mm / inch
1/8" Tube Compression	120.9 / 4.76 *
	95.5 / 3.76 **
1/4" Tube Compression	126 / 4.96 *
	95.5 / 3.76 **
3/8" Tube Compression	129 / 5.08 *
	95.5 / 3.76 **
3mm Tube Compression	124.8 / 4.91 *
	98.9 / 3.89 **
6mm Tube Compression	126.8 / 4.99 *
	95.7 / 3.77 **
10mm Tube Compression	129.8 / 5.11 *
	95.6 / 3.76 **
1/4" VCR	122.2 / 4.81
1/4" VCO	122 / 4.8
1/4" NPT	124.92 / 4.92

* With nut hand tight

** Length from tube locating shoulder fitting

General

This section contains the procedures for the receipt and installation of the instrument.

⚠ WARNING

Operating Procedure: Do not operate this instrument outside the specifications listed in Section 1. Before bringing this unit into operation, make sure that all fluid connections have been correctly tightened and that all necessary electrical connections have been made.

Receipt of Equipment

When the equipment is received, the outside packing case should be checked for damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding their liability. A report should be submitted to the nearest Brooks Instrument location listed on the Global Service Network page on our website:
https://www.brooksinstrument.com/en/service-support

Remove the envelope containing the packing list. Carefully remove the instrument from the packing case. Make sure spare parts, accessories and documentation are not discarded with the packing materials. Inspect for damaged or missing parts.

Recommended Storage Best Practice

If intermediate or long-term storage is required, it is recommended that the instrument be stored in accordance with the following:

a. Within the original shipping container.

b. In a sheltered area with the following conditions: Ambient temperature 70°C (160°F) maximum and 0°C (32°F) minimum.

c. Relative humidity 45% nominal, 60% maximum, 25% minimum.

Upon removal from storage a visual inspection should be conducted to verify the condition of equipment is “as received”.

Return Shipment

Prior to returning any instrument to the factory for any reason, visit our website for instructions on how to obtain a Return Materials Authorization Number (RMA #) and complete a Decontamination Statement to accompany it:
https://www.brooksinstrument.com/en/service-support.
All instruments returned to Brooks also require a Safety Data Sheet (SDS) for the fluid(s) used in the instrument. Failure to provide this information will delay processing of the instrument.

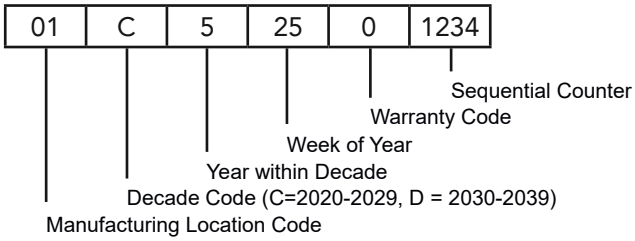
Instrument must have been purged in accordance with the following:

⚠ WARNING

Before returning the device, purge thoroughly with a dry inert gas, such as Nitrogen before disconnecting process connections. Failure to correctly purge the instrument could result in fire, explosion or death. Corrosion or contamination may occur upon exposure to air.

Serial Number

Current Brooks Instrument serial number format became effective January 1st, 2015. Serial number is 11 characters long with the following format:



Transit Precautions

To safeguard against damage during transit, transport the instrument to the installation site in the same container used for transportation from the factory if circumstances permit.

Removal from Storage

Upon removal from storage, a visual inspection should be conducted to verify the condition of the equipment is “as received.” If the equipment has been in storage in conditions in excess of those recommended (See “Recommended Storage Best Practice”), the device should be subjected to a pneumatic pressure test in accordance with applicable vessel codes.

Gas Connections

Prior to installation ensure all piping is clean and free from obstructions. Install piping in such a manner that permits easy access to the instrument if removal becomes necessary.

In-Line Filter

It is recommended that an in-line filter be installed upstream from the mass flow controller or meter to prevent the possibility of any foreign material entering the flow sensor or control valve MFC. The filtering element should be replaced periodically. Consult factory for filter recommendations.

Installation

⚠ CAUTION

Care should be taken so that no foreign materials enter the inlet or outlet of the instrument during installation or operation. Failure to do so may result in degraded accuracy and valve leak-by performance. It is recommended that protective end caps are not removed until the time of installation and piping systems are adequately purged before installing the instrument.

⚠ CAUTION

Any sudden change in system pressure may cause mechanical damage to elastomer materials. Damage can occur when there is a rapid expansion of fluid that has permeated elastomer materials. The user must take the necessary precautions to avoid such conditions.

⚠ CAUTION

When used with a reactive (sometimes toxic) gas, contamination or corrosion may occur as a result of plumbing leaks or improper purging. Plumbing should be checked carefully for leaks and the instrument purged with clean, dry N_2 before use.

Recommended installation guidelines:

a. The Brooks Digital MFC or MFM should be located in a clean, dry atmosphere relatively free from shock and vibration.

b. Leave sufficient room for access to Self-zero function push-button.

c. Install in such a manner that permits easy removal if the instrument requires servicing.

d. For optimal performance, when installing a mass flow controller or meter, have at least ten pipe diameters of straight tubing upstream of the mass flow controller or meter if possible.

⚠ CAUTION

Since the Model AMF control valve may not provide positive shut-off, a separate shut-off valve may be installed downstream for that purpose. It should be noted that a small amount of gas may be trapped between the downstream side of the mass flow controller and the shut-off valve which will result in a surge upon accuation of the shut-off valve. This surge can be reduced in magnitude either by positioning the controller and the shut-off valve close together or by moving the shut-off valve upstream of the controller.

Special considerations for high pressure installations

The AMF Series mass flow devices are capable of operation in high pressure applications. To ensure proper operation the user must be aware of the pressure conditions specified for the device. Inlet and outlet pressure conditions can be found on the device label and calibration sheet. The device was sized and tuned to operate at the specified pressure conditions. If the differential pressure during start up exceeds the specified differential pressure, hydraulic forces may keep the valve from opening and/or controlling properly. In these applications it is important to bring the pressure up in a controlled manner.

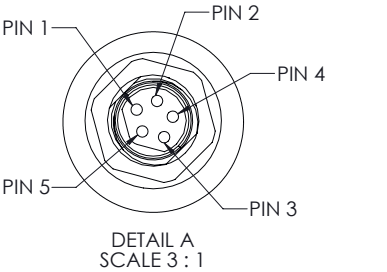
One method to assure successful startups is to set a 100% setpoint command or valve override open command and then gently ramp the pressure up to operating (specified) conditions. This will allow you to bring your process pressure up to normal operating conditions where the AMF mass flow controller will function as specified.

Another method is to utilize a bypass valve to allow pressure around the device while ramping up the back pressure to normal operating conditions.

Stable Operating Conditions:

All thermal mass flow controllers are factory tested with stable and equal ambient and process temperatures. If the process temperature does not equal the ambient temperature, the bypass ratio/accuracy will be affected. When a hot or cold process fluid is being measured, ensure that the piping system is designed to allow the gas temperature to equalize with the flow controller ambient temperature.

For more information, please contact the Brooks Technical Service group.



Pinout Table

Pin	Wire Color	Function
1	Brown	V+
2	White	NC
3	Blue	Common
4	Black	NC
5	Grey	NC

Figure 2-1 M8 Power Connection and Pinouts

Electrical Interfacing

The available physical interfaces are listed below:

- 5 pin M8 threaded male connector for power.
- Ethernet interface with RJ-45 connectors with industry standard pin outs, labeled “1” and “2”.
- USB-C port indicated by “DIAG”

Embedded Browser Interface:

- Default network address is 192.168.1.100 (EtherNET)
- Note: Default network address can be changed following instructions found in the supplemental web interface manual

Power Supply

Power connection to the device is made via pins 1 and 3 on the 5 pin M8 connector. A power supply voltage of 14 to 27 Vdc is required for proper operation.

⚠ CAUTION

Care must be taken when connecting the mating M8 power cable to ensure the key is properly aligned. Damage to the device connector and or mating cable connector may result if the cable connection is not aligned properly.

⚠ WARNING

User must ensure the minimum required voltage and current is available at the flow meter taking into consideration any losses in the interconnecting cable.

Protective Earth (PE) Connections:

In order to achieve proper EMC compliance, it is recommended to connect the device chassis to protective earth (PE). The connection can be made via the 8-32 mounting connections on the flow body of the meter/controller. Note: See supplemental manual for communication-specific guidlines.

Interconnection with Peripheral Equipment

The M8 mating cable can be purchased as accessory item.

Table 2-1 M8 Power Cables

Description	Length	Part Number
M8 Power Cables (Flying Leads)	6 ft [2 m]	124X049AAA
M8 Power Cables (Flying Leads)	16 ft [5 m]	124X050AAA

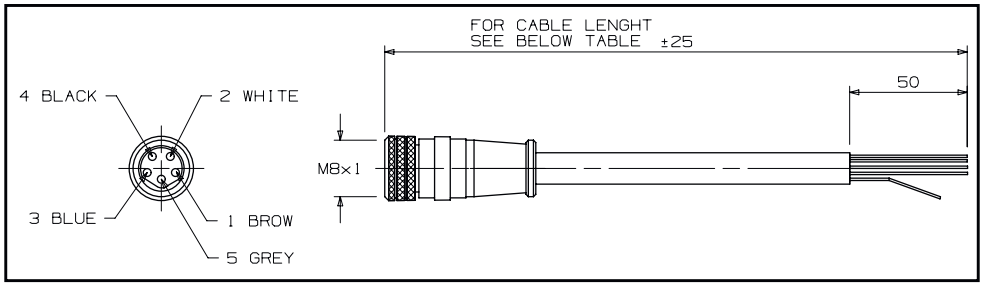


Figure 2-2 AMF M8 Power Cable

A diagnostic cable can be purchased from Brooks Instrument or any standard USB-C cable can be used to connect to the diagnostic port.

Table 2-2 BEST Cables

Description	Part Number
BEST software cable kit & power supply	778Z027AAA
AMF BEST Diagnostic cable (USB Type C to Type A)	124Y408AAA

When using the diagnostic interface (USB-C) to connect to the BEST software, care should be taken to prevent ground loops between the power supplying the MFC/MFM and PC. To prevent this case, ensure that the M8 power connector is inserted correctly per the pinout diagram above AND the device powers on before connecting the USB-C diagnostic cable.

⚠ CAUTION

Misconnection and energizing of the M8 power cable while the MFC/MFM is connected to a PC via the diagnostic cable may result in damage to the MFC/MFM.

Zeroing the MFC

It is recommended that the device be properly zeroed once installed in its final mounting attitude and pressurized with gas for the best performance.

To properly zero the MFC, use the following steps. Ideally, the MFC should be zeroed when filled with process gas and at the inlet pressure used when running process. A shutoff valve is required downstream of the MFC to zero the device properly. If a shutoff valve is not present on the system, and/or it is not possible to install one, the zero procedure can be performed at atmospheric pressure (with both inlet and outlet exposed to atmosphere).

1. Allow the MFC to warm up for at least 45 minutes.
2. Apply gas pressure at the inlet (only if shutoff valve is installed downstream: otherwise, skip to step 4 below).
3. If a downstream shutoff valve is installed, close it; then either apply a positive setpoint to the MFC, or VOR open, to pressurize the downstream volume (See protocol-specific supplemental manual for additional guidelines on executing this command). Once the flow signal goes down to near zero, close the MFC valve (zero setpoint, and VOR normal). The idea here is to have equal pressure on both sides of the MFC valve to prevent any leak past the MFC valve (the MFC is a precision control valve, and is not intended for positive shutoff).
4. Press and hold the zero button for 2 seconds. This is located on top of the MFC, next to the MOD LED.
5. There is no external indication that the device is zeroing. After 15 seconds, the new zero will be applied to the flow signal.
6. Repeat step 4 above as required.

⚠ CAUTION

Before zeroing the instrument, zero pressure differential MUST be established across the device. If there is pressure difference across the instrument during the zero process, any detected flow through the sensor will be misinterpreted as the zero flow reading. This will result in calibration inaccuracy during normal operation. Once zero differential pressure is established and verified, press the recessed, momentary push-button (zero button) located on the top of the device (See Figure 3-1) to start the zero function.

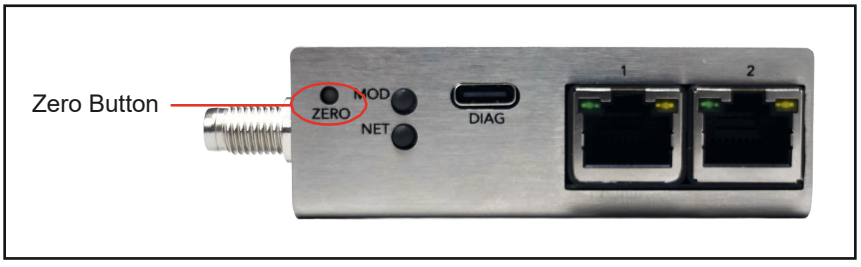


Figure 3-1 Externally Accessible Adjustment (Zero Button) for all Meters/Controllers.

Operation Check Procedure (Digital I/O)

a. Mount the MFC/MFM in its final orientation.

b. Apply power to the MFC/MFM and allow approximately 45 minutes for the instrument to completely warm up and stabilize its temperature.

c. Turn on the gas supply. A positive flow signal may be present due to slight valve leak-thru (MFC only).

d. Zero the device per recommended zeroing procedure.

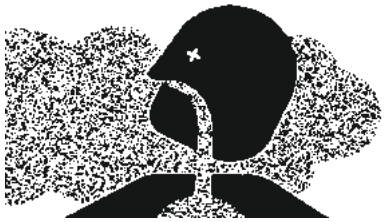
e. Provide the proper UOM setpoint between 20% and 100% FS to the MFC via the digital network controller.

f. Check the MFC Flow value. It should match the setpoint UOM Value within response time spec.

g. If flow output signal does not match the setpoint, and pressure settings are correct, this could indicate a problem in the MFC. A secondary issue could be the gas type. When checking with a surrogate gas, ensure that there is enough pressure to the MFC in order to flow the correct amount of the surrogate gas. If verifying a device configured for a gas other than N_2 using N_2 as a surrogate gas, ensure the N_2 verification procedure found in the Supplemental BEST software manual is followed.

General

There are no routine maintenance procedures required to keep your Brooks AMF Series MFC or MFM in good operating condition.



⚠ WARNING

METER/CONTROLLER SEAL COMPATIBILITY

Products in this manual may contain elastomeric seals, gaskets, O-rings or valve seats. It is the "user's" responsibility to select materials that are compatible with their process and process conditions. Using materials that are not compatible with the process or process condition could result in the Meter or Controller leaking process fluid outside the pressure boundary of the device, resulting in personnel injury or death.

It is recommended that the user check the Meter or Controller on a regular schedule to ensure that it is leak free as elastomeric seals, gaskets, O-rings and valve seats may change with age, exposure to process fluid, temperature, and/or pressure.

⚠ WARNING

If it becomes necessary to remove the MFC/MFM from the system after exposure to toxic, pyrophoric, flammable or corrosive gas, purge the MFC/MFM thoroughly with a dry inert gas such as Nitrogen before disconnecting the gas connections. Failure to correctly purge the MFC/MFM could result in fire, explosion or death. Corrosion or contamination of the MFC/MFM upon exposure to air, may also occur.

⚠ WARNING

If it becomes necessary to remove the instrument from the system, power to the device must be disconnected.

⚠ CAUTION

It is important that this MFC/MFM only be serviced by properly trained and qualified personnel.

⚠ WARNING

Device cover and body may become hot to the touch when left in either of the following conditions for an extended period of time:

-In a starved flow condition with a setpoint greater than 0

-In a valve override condition

System Checks

The Brooks AMF Series Mass Flow Controllers and Meters are generally used as a component in gas handling systems, which can be complex in nature. It can therefore be very difficult to isolate a malfunction in the system. An inaccurately diagnosed malfunction can cause many hours of unnecessary downtime. If possible, perform the following system checks before removing a suspect Mass Flow Meter or Controller for bench troubleshooting or return to the factory. (especially if the system is new):

1. Verify power supply voltage wiring and that the correct power supply voltage and signals are present on the connector of the AMF.

2. Verify that the process gas connections have been made correctly, and that they have been tested for leaks.

3. If the Mass Flow Controller appears to be functioning but cannot achieve setpoint, verify that there is sufficient inlet pressure and pressure drop at the controller to provide the required flow.

Bench Troubleshooting

1. Establish a proper connection between the Brooks AMF Series Mass Flow Meter or Controller (using Figure 4-1 as a reference) Switch on the power and allow the instrument to warm-up for 45 minutes. In case of a Controller model, adjust the Setpoint to zero. Do not connect the device to a gas source yet. Observe the output signal and, if necessary, perform the zero adjustment procedure (See “Zeroing the MFC”). If the output signal does not zero properly, please contact Brooks Instrument.

2. Connect the instrument to a source of the same gas used for it’s original calibration. Follow the N_2 verification process outlined in the BEST software supplemental manual. Regulate the Setpoint to 100% flow and adjust the inlet and outlet pressures to calibration conditions. Verify that the output signal reaches its full scale value and stabilizes at that value. Vary the setpoint over the 1 to 100% range and verify that the output signal follows the Setpoint If possible, connect a flow measurement device to monitor the actual flow behavior and verify the accuracy of the mass flow instrument. If the mass instrument performs as described above, then it is functioning correctly and the problem may lie elsewhere.

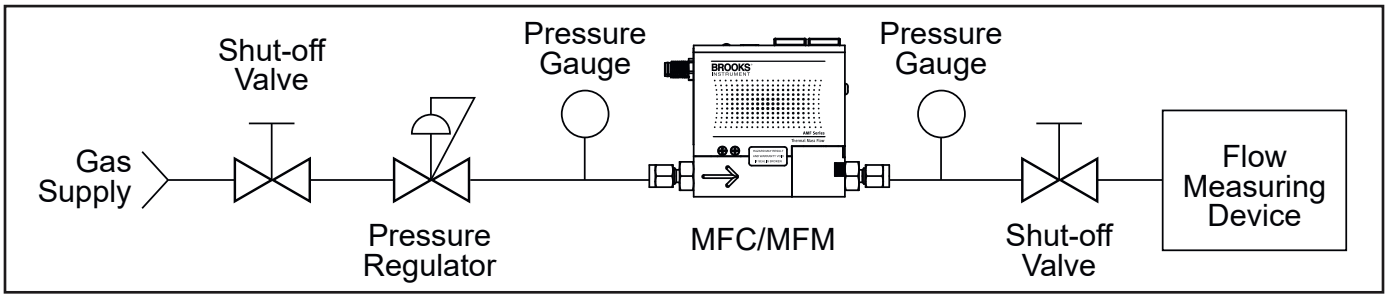


Figure 4-1 Bench Troubleshooting Circuit

Tables 4-1 and 4-2 list possible malfunctions which may be encountered during bench troubleshooting.

Table 4-1 Troubleshooting

Observation	Possible cause	Check/Corrective Action
Output stays at zero (regardless of Setpoint) and there is flow through the meter/controller.	Clogged Sensor	Contact Brooks Instrument.
	Defective electronic board	Contact Brooks Instrument.
Flow cannot be achieved regardless of Setpoint. (applicable to MFC)	Clogged Control Valve	Contact Brooks Instrument.
	Digital network controller is commanding a valve override	Check the valve override command.
	Defective electronic board	Contact Brooks Instrument.
Flow rate in excess of 100% at zero setpoint.	Clogged Sensor	Contact Brooks Instrument.
	Digital network controller is commanding a valve override	Check the valve override command.
Output signal follows Setpoint at higher Setpoints but will not go below 2%.	Control valve leaks or is stuck open.	Contact Brooks Instrument.
Output signal does not match setpoint.	Insufficient inlet pressure or pressure drop	Ensure actual pressure conditions align with process conditions specified on the order. Adjust pressures, inspect in-line filters and clean/replace as necessary.
	Incorrect gas page selected or process gas used	If checking the MFC with a surrogate gas, ensure that there is enough pressure to the MFC in order to flow the correct amount of the surrogate gas and you are following the AMF N_2 verification procedure to ensure accurate gas conversion.
Output signal follows Setpoint at lower Setpoints, but does not reach full scale.	Insufficient inlet pressure or pressure drop.	Ensure actual pressure conditions align with process conditions specified on the order. Adjust pressures, inspect in-line filters and clean/replace as necessary.
	Partially clogged sensor.	Contact Brooks Instrument.
	Partially clogged valve. (applicable to MFC)	Contact Brooks Instrument.
	Valve out of adjustment. (applicable to MFC)	Contact Brooks Instrument.
	Valve guide spring failure. (applicable to MFC)	Contact Brooks Instrument.
Flow signal matches setpoint, but actual flow is significantly below setpoint.	Partially clogged bypass.	Contact Brooks Instrument.
Instrument grossly out of calibration. Flow is higher than desired.	Partially clogged sensor.	Contact Brooks Instrument.
Instrument grossly out of calibration. Flow is lower than desired.	Partially clogged restrictor	Contact Brooks Instrument
Controller oscillates. (applicable to MFC)	Pressure drop or inlet pressure deviates from calibrated values.	Adjust pressures to original specifications.
	Valve out of adjustment.	Contact Brooks Instrument.
	Unstable inlet pressure.	Check external pressure regulator.
	Defective PC board.	Contact Brooks Instrument.

Cleaning Procedures

When deposition makes it necessary to clean the Brooks Digital Series Mass Flow Controller or Mass Flow Meter, use the following procedures:

⚠ WARNING

If it becomes necessary to remove the MFC/MFM from the system after exposure to toxic, pyrophoric, flammable or corrosive gas, purge the MFC/MFM thoroughly with a dry inert gas such as Nitrogen before disconnecting the gas connections. Failure to correctly purge the MFC/MFM could result in fire, explosion or death. Corrosion or contamination of the MFC/MFM upon exposure to air, may also occur.

1.Remove the unit from the system.

2.Purge with dry nitrogen gas, which removes virtually all particulate matter from the device. Should contamination persist, subject all wetted[1] components to ultrasonic cleaning. Following this, purge the device thoroughly with dry nitrogen gas once again.

NOTE: Do not soak the sensor assembly in a cleaning solvent. If solvent seeps into the sensor assembly, it will likely damage or significantly alter the sensor's operating characteristics.

Calibration and Verification Procedures

The calibration of Brooks Digital Series Mass Flow devices is not described in this manual. Such calibration requires accurate and traceable calibration equipment in addition to digital communications.

The AMF MFC/MFM flow measurement calculations incorporate a flow correction with respect to Reynolds Number to accurately predict flow rates of a process gas other than the calibration gas.With this in mind, AMF devices are calibrated to an optimized calibration gas flow rate that reaches a flow Reynolds Number equivalent to the customer requested full scale process gas(es) flow rate(s).The AMF calibration sheet displays the factory accuracy results of the device at the calibration gas full scale range.The gas, full scale flow, and flow units for each requested gas page can be found on the calibration sheet.

When evaluating the MFC/MFM on a process gas, the instrument must be set to the correct process gas page so that the corresponding gas properties are referenced in the flow calculations. The full-scale flow of the process gas page under evaluation can be multiplied by the setpoint value to determine the expected flow output in engineering units. The error values shown on the calibration sheet can be considered a reference for the expected errors at each setpoint for all gas page(s) in the device excluding additional gas specific errors due to discrepancies in gas properties.

Please consult the AMF Brooks Expert Support Tool (BEST) manual for instructions regarding verifying AMF devices on surrogate nitrogen gas.

If your device needs calibration Brooks Instrument can provide this service at one of its service locations. Visit www.BrooksInstrument.com to locate the service location nearest to you. However, if traceable calibration equipment is available at your facility, calibration software, along with training, is available for purchase.

LIMITED WARRANTY

Visit www.BrooksInstrument.com for the terms and conditions of our limited warranty.

BROOKS SERVICE AND SUPPORT

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required.
For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

SEMINARS AND TRAINING

Brooks Instrument can provide seminars and dedicated training to engineers, end users and maintenance persons.

Please contact your nearest sales representative for more details.

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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