

Brooks® Model 0550E Mass Flow Controller



Essential Instructions

Read this page before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use and maintain them 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, using and maintaining Brooks Products.

- 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.
- 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.
- Inform and educate your personnel in the proper installation, operation and maintenance of the product.
- 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.
- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- 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, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

Pressure Equipment Directive (PED)

All pressure equipment with an internal pressure greater than 0.5 bar (g) and a size larger than 25mm or 1" (inch) falls under the Pressure Equipment Directive (PED). The Directive is applicable within the European Economic Area (EU plus Norway, Iceland and Liechtenstein). Pressure equipment can be traded freely within this area once the PED has been complied with.

- Section 1 of this manual contains important safety and operating instructions related to the PED directive.
- Meters described in this manual are in compliance with EN directive 97/23/EC module H *Conformity Assessment*.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Meters larger than 25mm or 1" (inch) are in compliance with category I, II, III of PED.
- Meters of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

ESD (Electrostatic Discharge)

CAUTION

This instrument contains electronic components that are susceptible to damage by static electricity. proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.

Handling Procedure:

1. Power to unit must be removed.
2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.
3. Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.

Comments

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

Installation and Operation Manual

X-TMF-0550E-MFC-eng

Part Number: 541B065

October, 2008

Brooks® Model 0550E

Dear Customer,

We appreciate this opportunity to service your flow measurement and control requirements with a Brooks Instrument device. Every day, flow customers all over the world turn to Brooks Instrument for solutions to their gas and liquid low-flow applications. Brooks provides an array of flow measurement and control products for various industries from biopharmaceuticals, oil and gas, fuel cell research and chemicals, to medical devices, analytical instrumentation, semiconductor manufacturing, and more.

The Brooks product you have just received is of the highest quality available, offering superior performance, reliability and value to the user. It is designed with the ever changing process conditions, accuracy requirements and hostile process environments in mind to provide you with a lifetime of dependable service.

We recommend that you read this manual in its entirety. Should you require any additional information concerning Brooks products and services, please contact your local Brooks Sales and Service Office listed on the back cover of this manual or visit www.BrooksInstrument.com

Yours sincerely,

Brooks Instrument

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1-1 Purpose

The Brooks® Model 0550E Flow Controller is a mass flow measurement device designed for accurately measuring and rapidly controlling flows of gases. This instruction manual is intended to provide the user with all the information necessary to install, operate and maintain the Brooks 0550E Mass Flow Controller. This manual is organized into five sections:

Section 1	Introduction
Section 2	Installation
Section 3	Operation
Section 4	Maintenance
Section 5	Replacement Parts

It is recommended that this manual be read in its entirety before attempting to operate or repair the Model 0550E.

1-2 Description

The Brooks Model 0550E Mass Flowmeter consists of four basic units: a flow sensor, a control valve, an integral electronic control system, and a power supply. Designed to operate from 115 VAC line, the 0550E monitors and maintains a stable mass flow rate relatively independent of gas pressure and temperature variations. Standard features include:

Fast Response Control permits rapid gas settling times with little or no over/undershoot. Refer to Figure 1-1.

Soft Start provides a flow ramping function which slows down the introduction of the process gas for those processes which cannot tolerate rapid flow transition. Refer to Section 2-6 and Figure 1-2.

Valve Override permits the user to fully open and close the control valve independent of the setpoint (command) setting. Refer to Section 2-9.

Interchangeability with existing Applied Materials Mode AFC 550 (provided that the valve inhibit function is not needed.)

Valve Limit Logic which can provide feedback of improper pressure conditions or controller malfunctions.

Brooks® Model 0550E

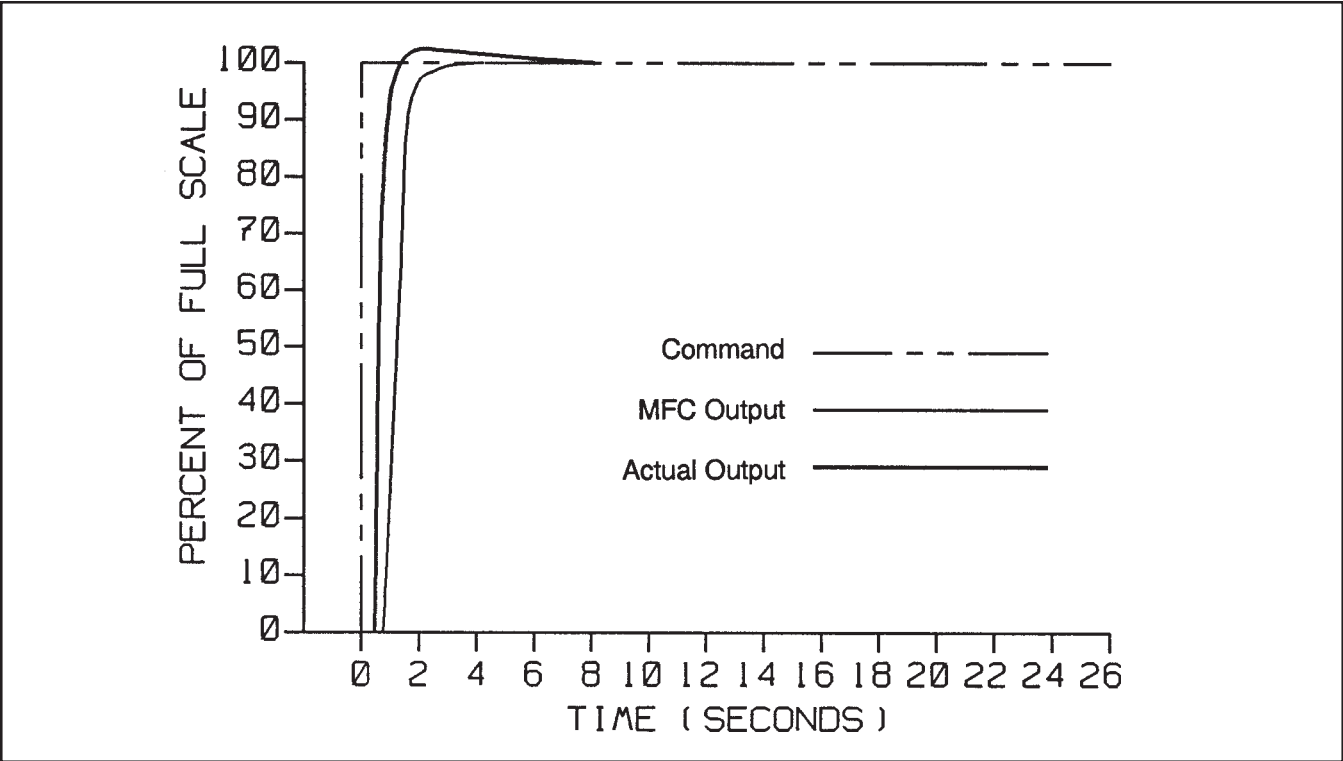


Figure 1-1 Fast Response Graph

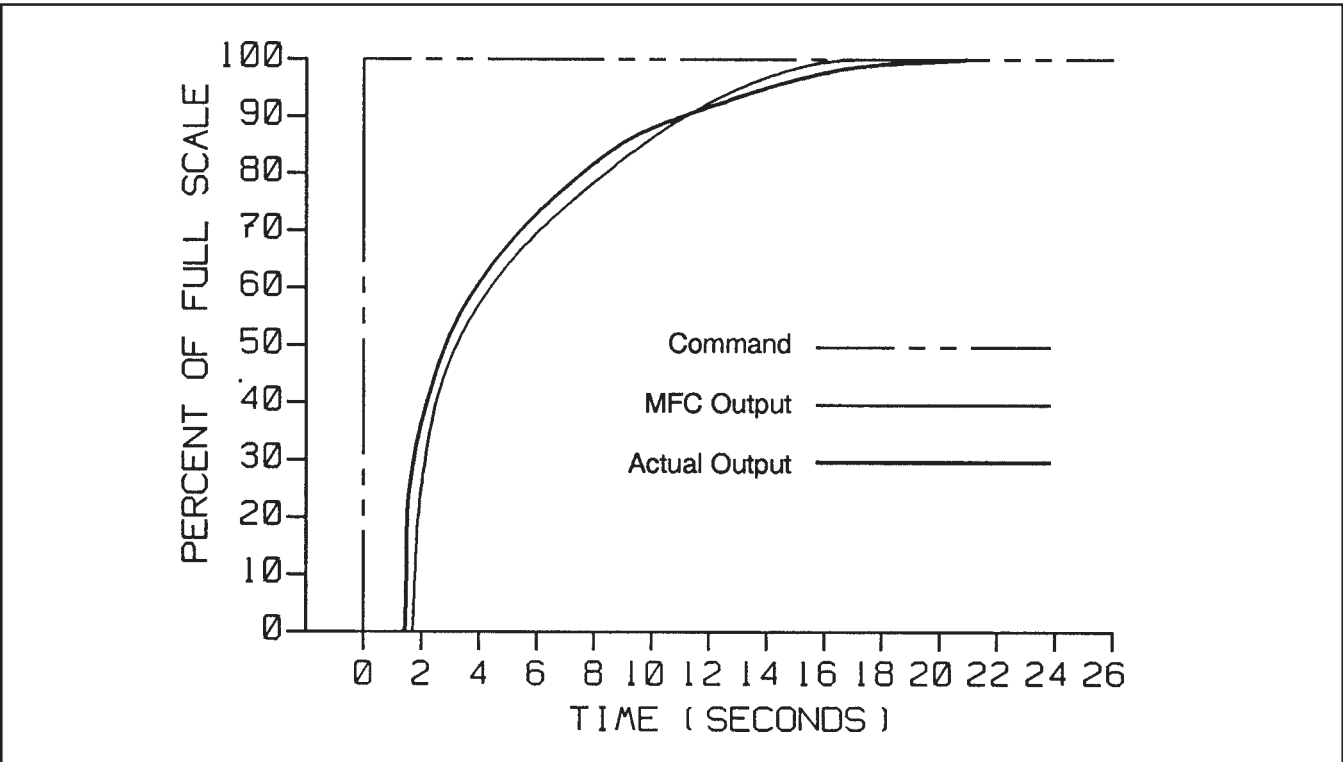


Figure 1-2 Soft Start Graph

1-3 Specifications

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.

Weight:

5 lbs. 10 oz.

Mating Electrical Connections:

Amphenol #165-10

Power Requirements:

105 - 125 Vac, 50/60 Hz 15 watts maximum

15 to 30 Vdc @ 50 mA for value limit logic

±10-24 Vdc @ 3 mA for value override

Input Signals:

Command Input Voltage: 0-5Vdc @ 0.25 mA

Valve Override Voltage: ±10-24 Vdc @ 13 mA

Output Signals:

Proportional to mass flow rate

0-10 Vdc minimum load resistance is 2k ohms

0-1 Vdc minimum load resistance is 1M ohms

Maximum Load Capacitance: 100 pF

5 Volt Reference Output: 5 volts ±0.2%. Maximum load 1k ohms.

Open Limit Output Current Sink:

Output sinks current (50 mA max) when valve voltage exceeds approximately 90% of the available supply. Output sinks less than 0.5mA when valve drive voltage is less than approximately 90% of the available supply. Current supply source must be limited to 30 V and capable of supplying a load current up to 50 mA.

Closed Limit Output Current Sink:

Output sinks current (50 mA) when valve voltage is less than approximately 10% of the available supply. Output sinks less than 0.5mA when valve drive voltage exceeds approximately 10% of the available supply. Current supply source must be limited to 30 V and capable of supplying a load current up to 50 mA.

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Accuracy:

± 1% of full scale over specified range
when used at calibration conditions.

Range:

2 - 100% of full scale

Repeatability:

0.25% of rate over specified range

Alignment Error:

± 20 mV nominal over specified range

Mounting Attitude Sensitivity:

± 0.5% maximum full scale deviation after re-zeroing
(for inlet pressure less than 50 psig)

Operation Temp. Range:

15° to 45°C

Minimum Inlet Pressure:

10 - 50 psig (15 - 50 psig on 200 slm H₂ units)

Calibration Pressure:

25 psig

Maximum Pressure:

1500 psig

Pressure Equipment Directive (PED) 97/23/EC
is Sound Engineering Practice (SEP).

Minimum Pressure:

10 psi at 10 psig inlet pressure
(15 psi and 15 psig inlet pressure at 200 slm H₂ units)

Response Time:

Output signal is within 2% F.S. of final value in 5 seconds or less for any
step change between 3 - 100%, including to or from a V.O.R. condition

Warm-up Time:

40 minutes

Leak Integrity:

3 x 10⁻⁸ cc atm/sec He max. inboard to outboard;
less than 2% F.S. through the valve

Dimensional Specifications:

See Figure 1-3

Standard Ranges:

See Table 4-5

Standard Conditions:

70°F(21.1°C) and 760 mm Hg

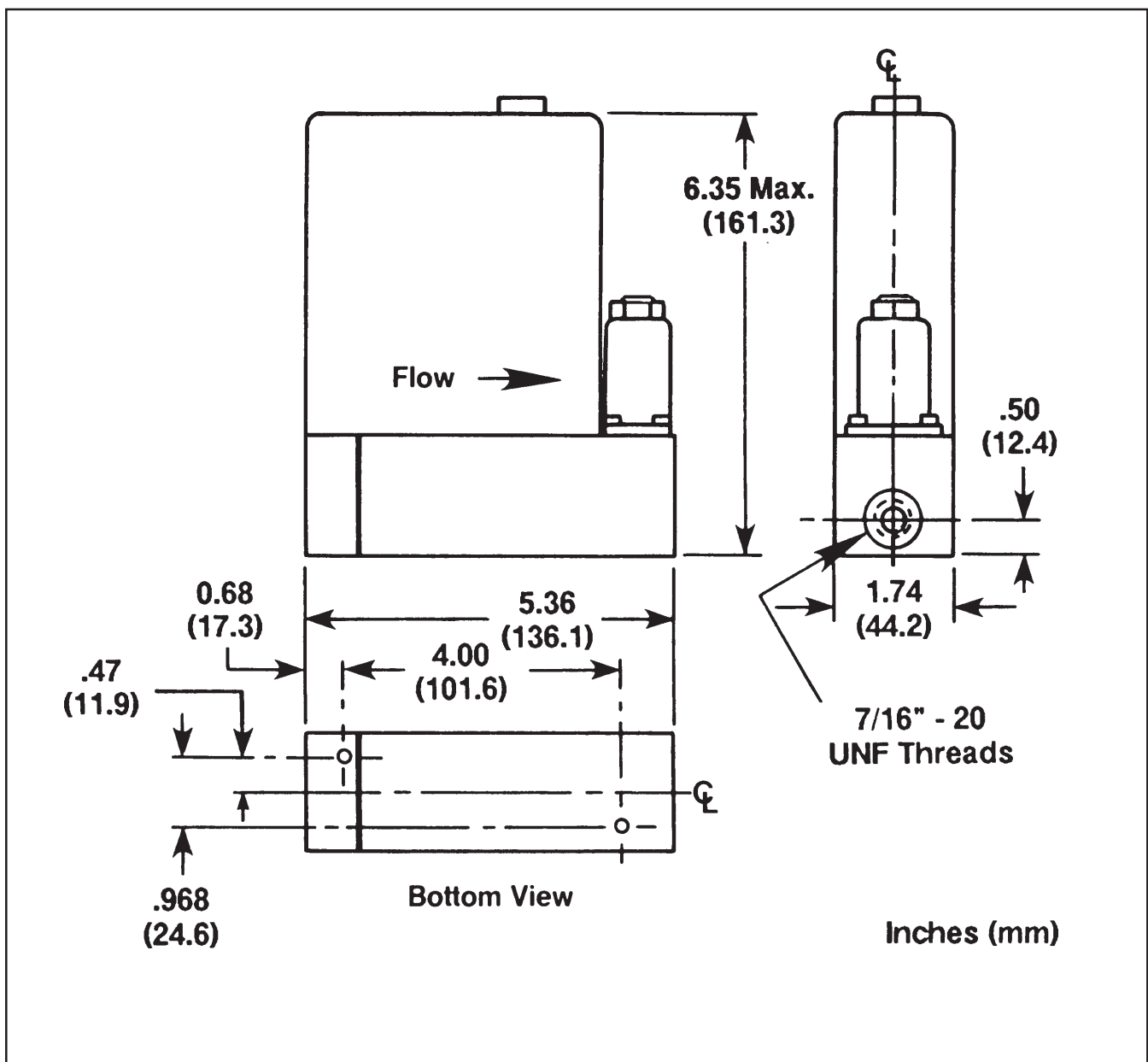


Figure 1-3 Outline Dimensions

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2-1 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 his liability. A report should be submitted to the Product Service Department, Brooks Instrument, Hatfield, Pennsylvania 19440-0903.

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

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2-2 Recommended Storage Practice

If intermediate or long-term storage is required for equipment as supplied by Brooks Instrument, it is recommended that said equipment be stored in accordance with the following:

- a. Within the original shipping container.
- b. Store in a sheltered area, preferably a warm, dry, heated warehouse.
- c. Ambient temperature 70°F (21.1°C) nominal/90°F max./45°F min. (32.1°C max./7.1° min.)
- d. Relative humidity 45% nominal, 60% maximum/25% minimum.

Upon removal from storage, a visual inspection should be conducted to verify its condition is "as received." If the equipment has been in storage for an excess of ten (10) months or in conditions in excess of those recommended, all pressure boundary seals should be replaced and the device subjected to a pneumatic pressure test in accordance with applicable vessel codes. (Refer to Table 5-1).

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2-3 Return Shipment

Prior to returning any Brooks equipment to the factory, contact the factory - for a Return Materials Authorization Number (RMA#). This can be obtained at Brooks Instrument, Product Service Department, 407 West Vine Street, Hatfield, PA 19440, or call toll free 1-888-554-FLOW (3569).

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Also, completion of Form RPR003-1, Brooks Instrument Decontamination Statement, as well as, a Material Safety Data Sheet (MSDS) for the fluid(s) used in the meter, is required before any Brooks Personnel can begin processing the equipment. Copies of the form can be obtained at one of the locations above.

2-4 In-Line Filter

It is recommended that an in-line type filter be installed upstream from the flow sensor to prevent the possibility of any foreign material entering the flow sensor or control valve. Table 2-1 gives the maximum recommended filter size for the various full scale flow rates. Use of smaller size filters provides better protection for the controller and it is recommended as long as the pressure drop across the filter is tolerable.

2-5 Gas Connections

Standard inlet and outlet connections supplied on the Model 0550E are 1/4" compression fittings. Optional inch compression, -4 and -8 VCO™ and -4 VCR™ connections are available upon request. Prior to installation, make certain all piping is clean and free of obstructions. Install the piping in such a manner that permits easy removal if the instrument is to be removed for cleaning or test bench troubleshooting.

2-6 Soft Start

Refer to Figure 3-4. To enable soft start, place the red jumper on the controller printed circuit board in the right hand (ss) position.

To disable soft start, place the red jumper on the controller printed circuit board in the left hand position. The soft start feature is normally disabled unless requested on the factory order.

Table 2-1 Maximum Recommended Filter Size

Full Scale Flow Rate	Maximum Filter Size
<100 sccm	0.5 micron
300 sccm	2 micron
1 slpm	5 micron
3 slpm	10 micron
10 slpm	20 micron
50 slpm	30 micron
≥200 slpm	50 micron

2-7 Precision 5V Reference

The 0550E is equipped with a precision 5V reference ($\pm 0.2\%$). The reference voltage is available at terminal D (Refer to Figure 2-1) for use in conjunction with potentiometer (1k ohms minimum) to provide a 0-5 Vdc command.

2-8 Command Input

The command input hook-up is as follows: Connect the external command voltage to terminal F, (command input) and to terminal E (command input return). (Refer to Figure 2-1).

2-9 Valve Override

The valve override function allows full opening and closing of the valve independent of the command setting. The valve override function can be accessed from terminal H. (Refer to Figure 2-1).

The valve override for the mass flow controller is as follows:

- To open the valve apply +10 to +24 Vdc to the valve override terminal.
- To close the valve apply -10 to -24 Vdc to the valve override terminal.

NOTE: For normal operation terminal H can be left open (floating), grounded, or at any voltage between -5 and +5 Vdc.

2-10 Limit Outputs

The open (closed) limit output is activated when VOR is used to hold the valve open (closed), command input is less than 2%, or during an abnormal condition (i.e. gas starvation, valve failure). If a limit condition exists, the corresponding transistor switch closes which can sink up to 50 mAdc.

Brooks® Model 0550E

Pin	Function
A	115 V (Hot)
B	115 V (Neutral)
C	Chassis Ground
D	Ref Out
E	Signal Ground
F	Cmd In
H	VOR
J	Not Used
K	Closed Limit
L	Open Limit
M	Flow Signal (0-10 V)
N	Flow Signal (0-1 V)

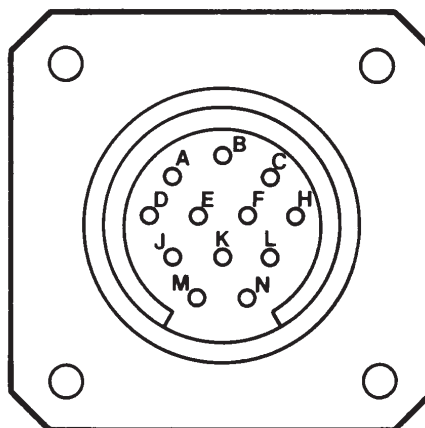


Figure 2-1 Electrical Pinout Connections

2-11 Installation

CAUTION

When installing the controller, care should be taken that no foreign materials enter the inlet or outlet of the instrument. Do not remove the protective end caps until time of installation.

Recommended installation procedures:

- a. The Model 0550E should be located in a clean dry atmosphere relatively free from shock and vibration.
- b. Leave sufficient room for access to the electrical components.
- c. Install in such a manner that permits easy removal if the instrument requires cleaning.
- d. The Model 0550E can be installed in any position. However, mounting orientations other than the original factory calibration (see data sheet) may result in a $\pm 0.5\%$ maximum full scale shift after re-zeroing.
- e. When installing controllers, be aware that sharp abrupt angles in the system plumbing directly upstream of the controller may cause a small shift in accuracy. If possible have at least 10 pipe diameters of straight tubing upstream of the Model 0550E Mass Flow Controller. For 200 slpm and higher H_2 , the Veriflo XSPR850 regulator is recommended.
- f. The flow controller should be inspected for cleanliness and any visible external damage after it is removed from it's shipping container.

- g. The controller body is machined to accept 7/16 inch -20 UNF, MS(16142) threaded inlet and outlet fittings. Make sure that the proper O-ring size (904) and material is used when securing the fittings.

NOTE: the control valve provides precision control and is not designed for positive shutoff. If positive shutoff is required, it is recommended that a separate shutoff valve be installed in-line.

CAUTION

Since the Model 0550E control valve does not provide positive shutoff, a separate shutoff valve may have to be installed 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 shutoff valve resulting in a surge upon acuation of the controller. This surge can be reduced in magnitude by locating the controller and shutoff valve close together or by moving the shutoff valve upstream of the controller.

2-12 Start-Up Guidelines

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 controller purged with nitrogen before use. (refer to step a.)

- a. After the flow controller has been installed in the flow system and the connecting cable attached (refer to Figure 2-1), apply power, set the command to 100% and purge the controller with nitrogen for a minimum of 15 minutes. This is most important if the process gas contains elements which react with the air components to form corrosive or precipative mixtures. This also helps preserve the accuracy and life of the controller. This purge should also be performed when a controller is removed from a reactive, corrosive, or toxic process gas line.
- b. Set the command to zero and block the flow downstream of the controller. Wait at least 30 minutes to allow the flow controller to reach operating temperature. Check the output signal from the controller (pin m) with a voltmeter. If necessary, adjust the 'zero' potentiometer under the center cover plug to set the output signal to 0 mV $\pm$ 20 mV.

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NOTE: An absolute zero shift may occur during normal controller operation if:

1. The process gas has a heat capacity which differs greatly from that of nitrogen.
2. The inlet pressure is substantially different from the pressure used when the 'zero' pot was adjusted.
3. The ambient gas or environment temperature is substantially different from the temperature when the adjustment was performed.
4. The mounting attitude of the controller has changed.

NOTE: The 'zero' pot can not be properly adjusted with the cover removed.

If possible, the "zero" pot should be adjusted while the controller is in it's normal working environment.

3-1 Theory of Operation

The thermal mass flow sensing technique used in the 0550E works as follows:

A precision power supply provides a constant power heat input (P) at the heater, which is located at the midpoint of the sensor tube. (Refer to Figure 3-1) At zero or no flow conditions, the heat reaching each temperature sensor is equal. Therefore, the temperatures T1 and T2 are equal. When gas flows through the tube, the upstream sensor is cooled and the downstream sensor is heated, producing a temperature difference. The temperature difference T2-T1 is directly proportional to the gas mass flow.

The equation is: $\Delta T = A * P * C_p * m$

Where,

ΔT	=	temperature difference T2 - T1 (°K)
C_p	=	specific heat of the gas at constant pressure (kJ/kg-°K)
P	=	heater power (kJ/s)
m	=	mass flow (kg/s)
A	=	constant of proportionality (S ² -°K ² /kJ ²)

A bridge circuit interprets the temperature difference and a differential amplifier generates a linear signal directly proportional to the gas mass flow rate.

The flow restrictor shown in Figure 3-1 performs a ranging function similar to a shunt resistor in an electrical ammeter. The restrictor provides a pressure drop that is linear with flow rate.

The sensor tube has the same linear pressure drop/flow relationship. The ratio of the restrictor flow to the sensor tube flow remains constant over the range of the meter.

Different restrictors have different pressure drops and produce meters with different full scale flow rates. The span adjustment in the electronics affects the fine adjustment of the meter's full scale flow.

In addition to the mass flow sensor, the Model 0550E Mass Flow Controller has an integral control valve and control circuit, as shown in Figure 3-2. The control circuit senses any difference between the flow sensor signal and command voltage input, then adjusts the current in the modulating solenoid valve to increase or decrease the flow.

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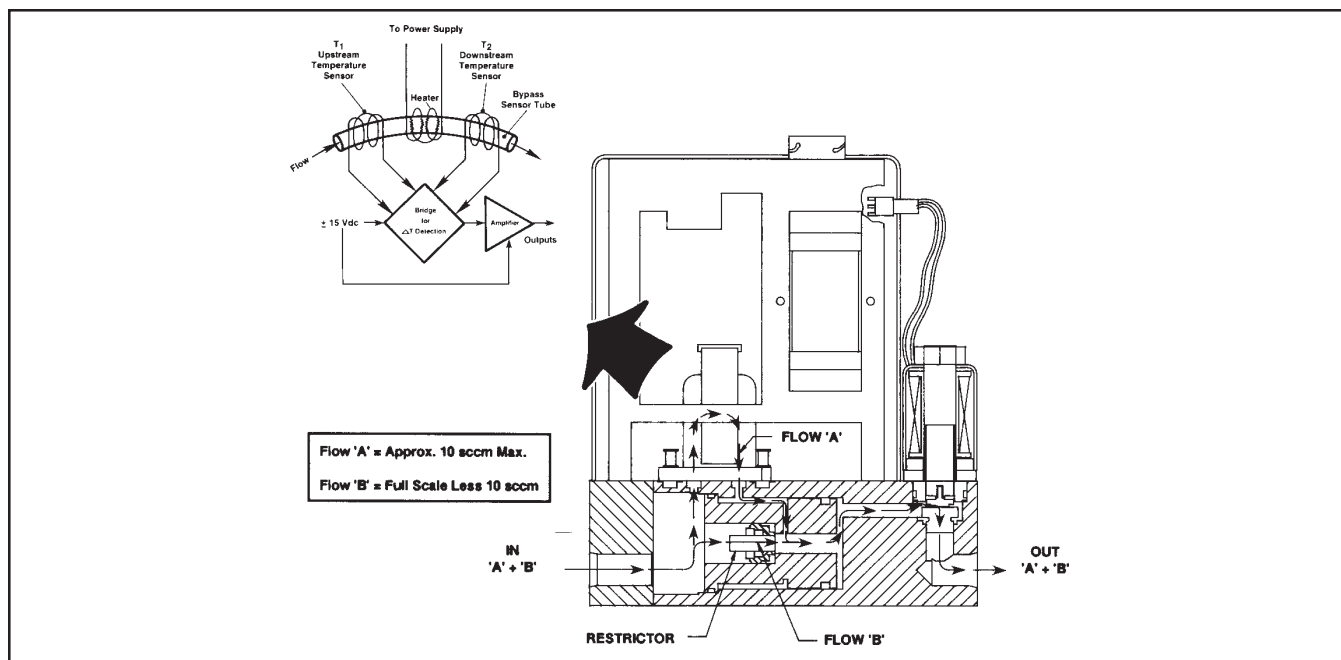


Figure 3-1 Flow Sensor Operational Diagram

3-2 Operating Procedure

- Apply power to the controller and allow approximately 40 minutes for the instrument to warm up and stabilize its temperature.
- Turn on the gas supply.
- Command 0% flow and observe the controller's output signal. If the output is not 0 mVdc (± 10 mVdc), check for leaks and if none are found, refer to the zero adjustment procedure in Section 3-3.
- Set the command for the desired flow rate to assume normal operation.

3-3 Zero Adjustment

Each 0550E is factory adjusted to provide a 0 ± 10 mVdc signal at zero flow. The adjustment is made in our calibration laboratory which is temperature controlled to 21.1°C ($70^\circ\text{F} \pm 2^\circ\text{F}$). After initial installation and warm-up in the gas system, the zero flow indication may be other than the factory setting. This is primarily caused by changes in temperature between our calibration laboratory and the final installation. The zero flow reading can also be affected, to a small degree, by changes in line pressure and mounting attitude.

To check zero, always mount the controller in its final configuration and allow a minimum of 40 minutes for the temperature of the controller and its environment to stabilize. Using a suitable voltmeter, check the controller output signal. If it differs from the factory setting, adjust it by removing the pot hole plug which is located on top of the electronics can. Adjust the zero potentiometer (refer to Figure 3-4) until the desired output signal is obtained.

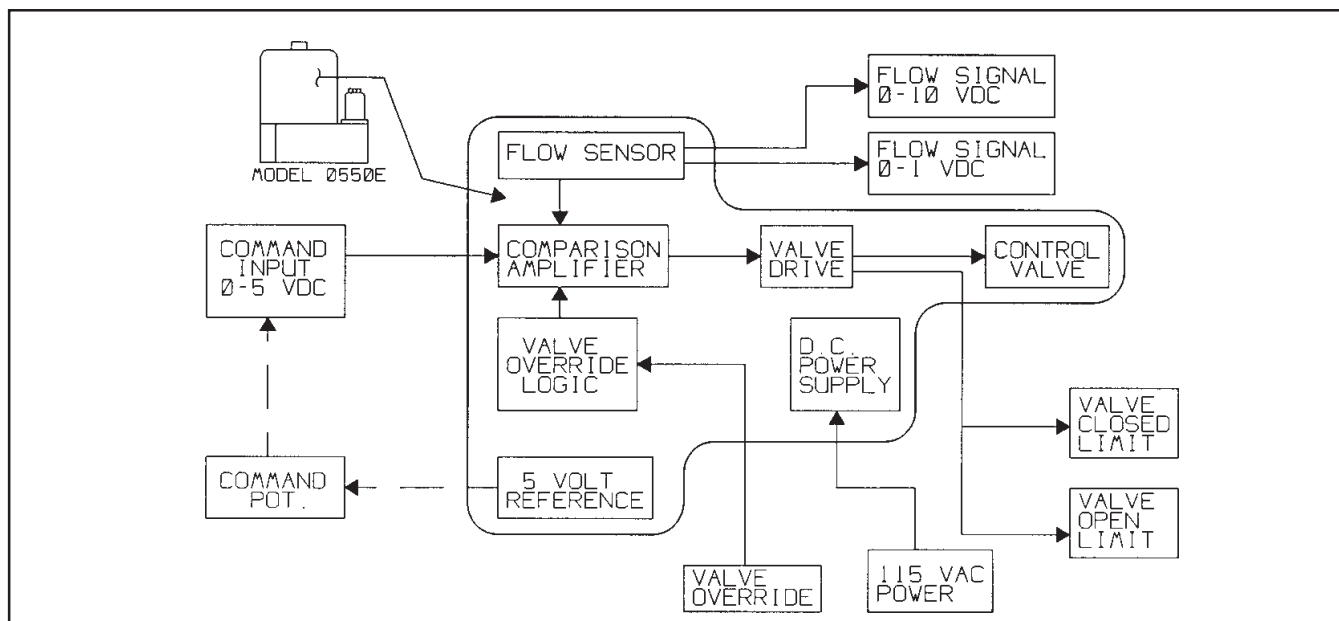


Figure 3-2 Flow Control System Block Diagram

3-4 Calibration Procedure

NOTE 1: If the valve has been disassembled and any of the parts listed below have been replaced, the control valve adjusting procedure in Section 4-4c must be performed before the Model 0550E is calibrated.

- orifice
- valve stem
- plunger
- lower guide spring
- valve seat

NOTE 2: Calibration of the 0550E mass flow controller requires the use of a digital voltmeter (DVM) and a precision flow standard calibrator such as the Brooks Vol-U-Meter®. It is recommended that the calibration be performed only by trained and qualified service personnel.

(See Figure 3-3 for calibration set-up.)

(See Figure 3-4 for adjustment potentiometer locations.)

NOTE 3: If the mass flow controller is to be used on a gas other than the calibration gas, apply the appropriate sensor conversion factor. Size the orifice for actual operating conditions

- a. With the controller installed in an unpressurized gas line, apply power and allow approximately 40 minutes for warm-up. During the warm-up, adjustment and calibration check procedures do not allow the control valve to open when gas flow is not present. This situation is not a normal operating mode; it will cause the control valve to abnormally heat up. A meter with an abnormally warm valve will be difficult to calibrate. This situation can be prevented by switching the valve override "closed" when there is no gas flow, or setting the command to less than 1%. Also avoid unnecessary periods with the valve override "open."

Brooks® Model 0550E

- b. Adjust the anticipate potentiometer fully clockwise (twenty turns). Then adjust the anticipate potentiometer ten turns counterclockwise to center the potentiometer. This will provide a rough adjustment of this circuit and make the flow more stable for calibration.
- c. Connect the DVM positive lead to the 0-10V signal output, pin m, and the negative lead to signal common (TP4). Adjust the zero potentiometer for an output of $0\text{mV} \pm 10\text{mV}$
- d. Apply pressure to the system and confirm that the zero signal repeats within 10 mV of the voltage set in step "c" above. If the zero does not repeat, check for leakage.

NOTE: Controllers supplied with all-metal valve seats do not provide tight shut-off. A 0-8% leak-through is typical. For metal seat controllers, close a downstream shut-off valve and observe the zero signal.

- e. Set the command potentiometer (connected to terminals D, E and F of the connector for 100% of flow (5.000V). Connect the DVM positive lead to TP2 (linearity voltage) and the negative lead to TP4 (signal common). Adjust the linearity potentiometer for an output of 0.0V (zero volts).
- f. Connect the DVM positive lead to TP1 (-100x sensor voltage) and the negative lead to TP4 (circuit common). The command potentiometer should still be set at 100% flow (5.000V). Measure the flow rate using suitable volumetric calibration equipment. To adjust the controller to the proper full scale flow, calculate a new TP1 voltage using the following equation:

$$\frac{\text{New TP1 Voltage}}{\text{measured flow rate}} = \frac{\text{measured TP1 voltage}}{\text{measured flow rate}} \times \text{desired flow rate}$$

Adjust the span potentiometer until the voltage at TP1 is equal to the value calculated above. Recheck the flow rate after the flow is stable (at least two minutes). Repeat this check and adjustment procedure until the measured flow rate is within 1% of the desired flow rate.

NOTE: The voltage at TP1 is -100 times the output voltage of the sensor. This voltage can range from -1.2 to -12 volts. However, it is recommended that this voltage stays between 2.0 and 9.0 volts for proper operation. If the recommended voltage range exceeds desired accuracy and or signal, stability may not be achieved. If one of the limits is reached, check the orifice and restrictor sizing procedures. (Refer to Sections 4-6 and 4-7 respectively).

- g. Set the command potentiometer for 0% of flow. Connect the DVM positive lead to flow signal output (pin m) and the negative lead to TP4. Readjust the zero potentiometer for an output of $0\text{mV} \pm 2\text{mV}$ if necessary.
- h. Set the command potentiometer for 50% flow (2.500V) and measure the flow rate. Calculate the error as a percentage of full scale.

$$\text{Full Scale Error} = 100\% \times \frac{\text{Measured Flow Rate} - \text{Desired Flow Rate}}{\text{Full Scale Flow Rate}}$$

Example:

What is the percent of full scale error when full scale is equal to 100 slpm?

Measured flow rate = 48.5 slpm

Desired flow rate = 50.0 slpm

$$\text{Full Scale Error} = 100 \frac{(48.5-50)}{100} = -1.5\%$$

- i. Calculate the TP2 correction voltage: (error recorded in step "h") x 0.450 volts

Example:

Error = -1.5%

TP2 correction voltage = -1.5×0.450 = -0.675 volts

New TP2 voltage = 0 volts + (-0.675) = -0.675 volts

- j. Set the command potentiometer for 100% flow (5.000V). Connect the DVM positive lead to TP2 and the negative lead to TP4.
 k. Adjust the linearity potentiometer for an output equal to the new calculated TP2 voltage.
 l. Repeat steps f, g and h.

1. If the error recorded in step "h" is less than 0.5%, then the calibration procedure is complete.
2. If the error is greater than 0.5% set the command potentiometer for 100% (5.000V). Connect the DVM positive lead to TP2 (linearity voltage) and the negative lead to TP4 (circuit common). Calculate a new TP2 voltage as follows:

$$\text{New TP2 voltage} = \frac{\text{error recorded in Step i}}{\text{Step i}} \times 0.450\text{V} + \text{measured TP2 voltage}$$

Example:

Controller error = 0.7%

Measured TP2 voltage = -0.567 volts

TP2 correction = $0.7 \times 0.450 = 0.315$ volts

New TP2 correction = $0.315 + (-0.567) = -0.252$ volts

Adjust the linearity potentiometer for an output equal to the new TP2 voltage and then repeat steps f, g and h.

NOTE: The voltage at TP2 can range from -10 to +3 volts. However, it is recommended that this voltage stays between -2.5 and +2.5 volts for proper operation. If the recommended voltage range is exceeded, the desired accuracy and/or signal stability may not be achieved. If one of the limits is reached, check the restrictor sizing. Refer to Section 4-7.

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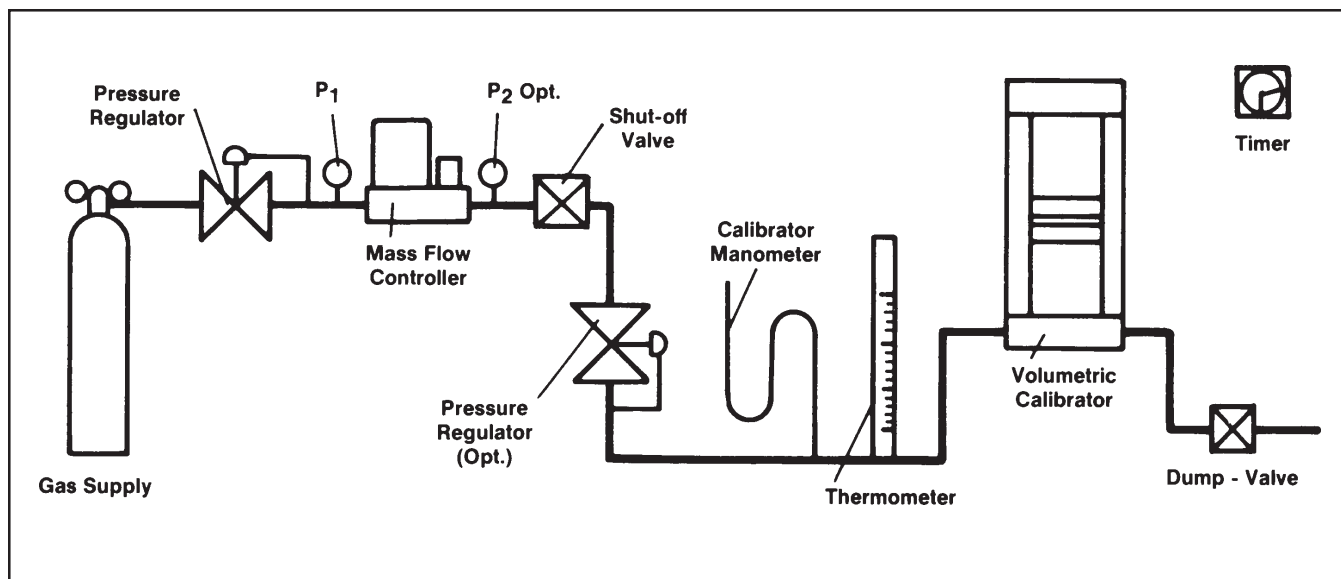


Figure 3-3 Model 0550E Calibration Set-Up

3-5 Response

Fast Response Adjustment

Two methods of adjusting the step response of the 0550E mass flow controller can be used.

Method Number 1 describes a procedure that will get the step response close to optimum, (0 - 100% in 5 seconds or less) without the use of flow measuring equipment.

Method Number 2 describes a method that allows the adjustment of the 0550E mass flow controller to be optimized for 0 - 100 step. This method is the preferred way to adjust the step response. Adjustment of the fast response does not affect the accuracy of the flow controller.

1. Fast response adjustment (5 second response specification not guaranteed)

NOTE: This procedure requires a voltmeter.

- a. Turn the anticipate pot full counterclockwise. (20 turns or until pot "clicks").
- b. Set the command potentiometer for 100% of flow (5.00 volts) on a calibrated meter and wait about 45 seconds for flow output to stabilize.
- c. Read the voltage at TP2. Compare this voltage with the voltages listed in Table 3-1 and adjust the anticipate potentiometer counterclockwise the appropriate number of turns.

2. Fast response adjustment (5 second response specification guaranteed)

Adjustment of the anticipate potentiometer to obtain a flow rate performance to be within 2% of flow rate commanded in less than 5 seconds after a setpoint change from 0 -100% requires the use of a fast response flowmeter (500 milliseconds response to be within 0.2% of final value or better) in series with the 0550E mass flow controller and a storage oscilloscope or chart recorder.

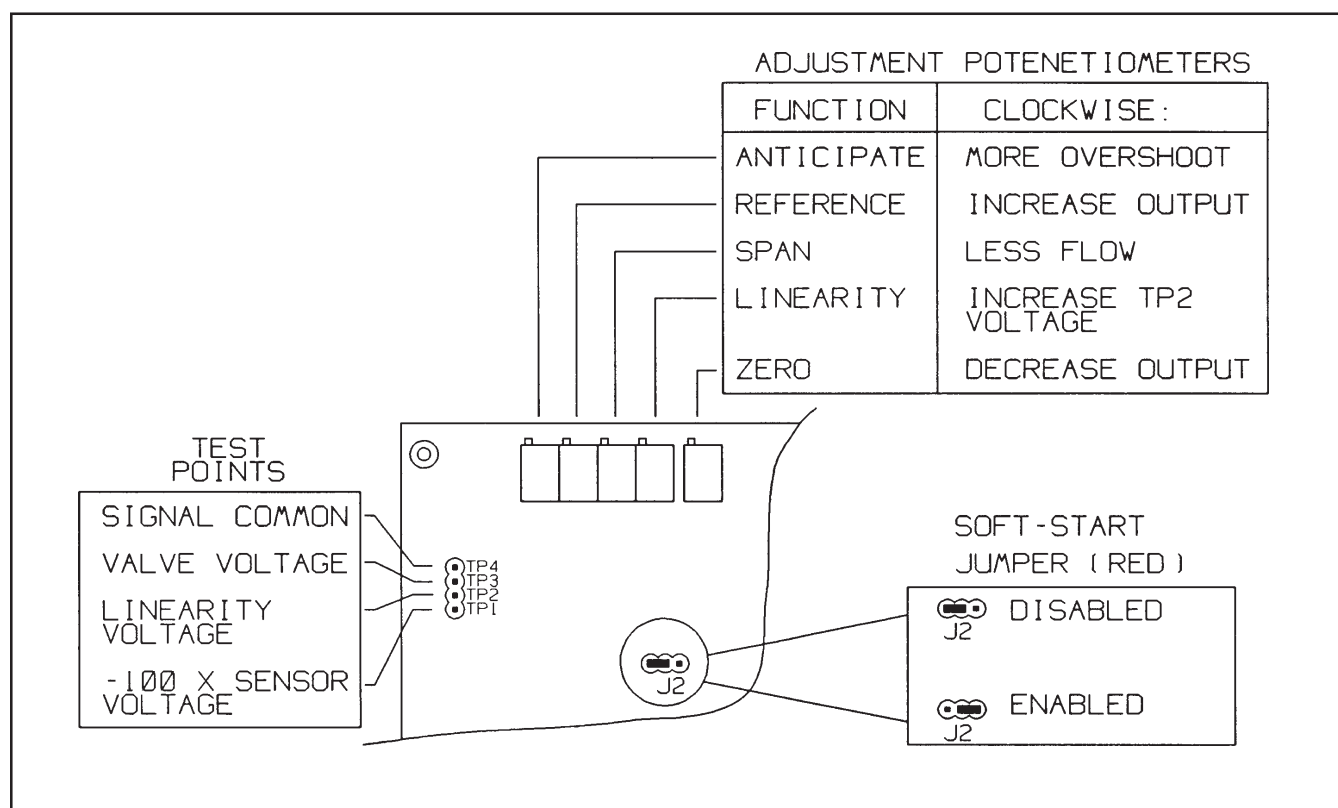


Figure 3-4 Adjustment Potentiometer Location

- Make a step in command to the 0550E mass flow controller from 0 - 100% of full scale flow and record the output signal response of the fast response flowmeter.
- If this signal does not show overshoot, it is not within 2% full scale of final value by 5 seconds, adjust the anticipate potentiometer 1/2 to 1 turn clockwise. Set command potentiometer for 0% flow and wait 60 seconds.

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Table 3-1 Potentiometer Adjustment

TP2 Voltage (DC) with flow at 100%	Anticipate Potentiomet Turns CCW
>2V	4
1V - 2V	8
0V - 1V	12
-1V - 0V	16
<-1V	20

- c. Repeat steps a and b until the fast response flowmeter output signal indicates that flow meets the specified response requirements.

NOTE: With the above equipment, the anticipate potentiometer can be adjusted to give the optimum response characteristics for any process.

3-6 Rangeability

NOTE: This section only applies to the 8 hydrogen and 6 nitrogen standard Applied Materials flow ranges. (See Table 4-6) Model 0550E's which were sized using Section 4-7 have less pressure rangeability.

The 0550E is designed to control mass flows from 2% to 100% of the specified full scale flow rate at an inlet pressure of 25 psig and a pressure differential of 25 psi with an accuracy of 1% of full scale when used to control nitrogen (N units) or hydrogen (H units). Operation on other gases, inlet or differential pressures is possible as long as certain guidelines are observed.

If a controller is operated with a process gas other than it's calibration gas, a scale shift occurs in the relationship between the output signal and the mass flow rate. This is due to the difference in heat capacities between the two gases. The scale shift can be approximated by:

Equation 1.

$$MF_{pg} = V_o \times FSMF_{cg} \times G_f$$

Where:

MF_{pg} = Mass Flow Rate of
Process Gas (sccm or slpm)

V_o = Output signal in volts (pin M)

$FSMF_{cg}$ = Full scale mass flow rate of
calibration gas (sccm or slpm)

$G_f = \frac{\text{Heat Capacity of Calibration Gas}}{\text{Heat Capacity of Process Gas}}$

The maximum usable output voltage from the controller is from 0.200 V to 10.000 V. Therefore:

Equation 2.

$$0.02 < \frac{MF_{pg}}{FSMF_{cg} \times G_f} < 1$$

Table 3-2 G-Factor and D-Factor

Process Gas	G _f [*]	G _f ^{**}	D _f [*]	D _f ^{**}
Ammonia	0.79	0.77	1.27	0.34
Arsine	0.75	0.73	0.60	0.16
Carbon Dioxide	0.77	0.75	0.80	0.21
Dichlorosilane	0.44	0.44	0.52	0.14
Diborane	0.55	0.47	1.00	0.27
Freon-12	0.39	0.37	0.48	0.13
Hydrogen	1.01	1.00	3.73	1.00
Hydrngen Chloride	0.98	0.99	0.87	0.23
Nitrogen	1.00	0.99	1.00	0.27
Nitrous Oxide	0.75	0.72	0.80	0.21
Oxygen	0.99	0.98	0.94	0.25
Phosphine	0.78	0.75	0.90	0.24
Silane	0.63	0.64	0.93	0.25

*Reference N₂

**ReferenceH₂

A list of G_f factors is given in Table 3-2 for both nitrogen and hydrogen as the calibration gas. The G_f factors are calculated based on a gas temperature of 70°F and a pressure of one atmosphere. Process gas temperatures or pressures which vary widely from these reference conditions may cause an additional error due to the range in heat capacity with pressure and/or temperature.

In addition to the constraints placed on the process gas flow by Equation 1, an additional restriction must be placed on the process gas flow due to the difference in process and calibration gas densities and operating pressures. This restriction can be summarized by:

Equation 3.

$$0.007 < \frac{MF_{pg}}{D_f \times P_f \times FSMF_{cg}} < 1$$

$$D_f = \sqrt{\frac{SG_{cg}}{SG_{pg}}}$$

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$$P_r = \left[\frac{\Delta P_{pg}}{\Delta P_{cg}} \right]^{-0.46} \times \left[\frac{P_{in}(psia)_{pg}}{P_{in}(psia)_{cg}} \right]^{-0.56} \Delta P < \frac{P_{in}}{2}$$

$$\Delta P = P_{inlet} - P_{outlet}$$

Applying this restriction ensures that the control valve is operating in a region of displacement of which it has been designed and tested. The flow controller is sized for a P_{cg} and 10 psi and P_{incg} of 24.7 psia.

The pressure factor calculated above is accurate until the outlet pressure (psia) equals or is less than half the inlet pressure (psia) or $P_{outlet} < P_{inlet} / 2$. After this critical pressure point has been reached, further changes in outlet pressure does not significantly change the pressure factor P_r . If the critical pressure point has been exceeded, then P should be set equal to P_{in} (psia)/2 when using the above equation.

Since D_f and G_f are fixed physical constants, the rangeability of the controller can be improved only by manipulating P_r . A list of D_f factors for various gases is given in Table 3-2.

Example:

A 3000 sccm N_2 controller is used on ammonia at 50 psig in and 5 psia out. What are the maximum and minimum flow rates that can be controlled? What will the output voltages be at these rates?

$$G_f(\text{ammonia}) = 0.79$$

$$D_f(\text{ammonia}) = 1.27$$

By Equation 3:

$$P_r = \left[\frac{32.32}{10} \right]^{0.46} \times \left[\frac{64.7}{24.7} \right]^{0.56} = 2.94$$

NOTE: P_{pg} is set equal to P_{in} (psia) $_{pg}/2$ since the critical pressure point was passed.

By Equation 2:

$$0.02 \times FSMF_{cg} \times G_f < MF_{pg} < FSMF_{cg} \times G_f$$

$$0.02 \times 3000 \times 0.79 < MF_{pg} < 3000 \times 0.79$$

$$46.2 \text{ sccm} < MF_{pg} < 2370 \text{ sccm}$$

By Equation 3:

$$0.007 \times D_f \times P_f \times FSMF_g < MF_{pg} < D_f \times P_f \times FSMF_{pg}$$

$$0.007 \times 1.27 \times 2.94 \times 3000 < MF_{pg} < 1.27 \times 2.94 \times 3000$$

$$78 \text{ sccm} < MF_{pg} < 11,201 \text{ sccm}$$

The minimum flow rate is 78 sccm NH₃ and
the maximum flow rate is 2370 sccm

By Equation 1:

$$V_o = \frac{10 \times MF_{pg}}{FSMF_{cg} \times G_f}$$

$$V_o(\text{max}) = \frac{10 \times 2370}{3000 \times 0.79} = 10.00V$$

$$V_o(\text{min}) = \frac{10 \times 78}{3000 \times 0.79} = 0.329$$

These equations are somewhat conservative therefore, under actual operating conditions, the controller will generally exceed the maximum process gas flow rate calculated.

Table 3-3 Maximum Flow Rates

Process Gas	N ₂ Controllers Max Flow (% of F.S.)	H ₂ Controllers Max Flow (% of F.S.)
Ammonia	79	34
Arsine	60	16
Carbon Dioxide	77	21
Dichlorosilane	44	14
Diborane	55	27
Freon-12	39	13
Hydrogen	100	100
Hydrogen Chloride	87	23
Nitrogen	100	27
Nitrous Oxide	75	21
Oxygen	94	25
Phosphine	90	24
Silane	93	25

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4-1 General

No routine maintenance is required on the Model 0550E other than an occasional cleaning. If an in-line filter is used, the filtering element should periodically be replaced or ultrasonically cleaned.

	! WARNING METER/CONTROLLER SEAL COMPATIBILITY
Products in this manual may contain metal or 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 conditions 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 both metal and elastomeric seals, gaskets, O-rings and valve seats may change with age, exposure to process fluid, temperature, and /or pressure.	

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4-2 Troubleshooting

⚠ WARNING

It is important that this instrument be serviced only by properly trained and qualified personnel. Failure to heed this warning may result in serious personal injury or death due to electrical shock.

System Checks

The 0550E is generally used as a component in gas handling systems which can be quite complex. This can make the task of isolating a malfunction in the system a difficult one. An incorrectly diagnosed malfunction can cause many hours of unnecessary downtime. If possible, make the following system checks before removing a suspected defective mass flow controller for bench troubleshooting or return, especially if the system is new:

1. Verify a low resistance power supply connection and that the correct signals are reaching and leaving the controller. The breakout board (Reference Table 5-2, listed in Section 5 will make this job much easier).
2. Verify that the process gas connections have been correctly terminated and leak checked.
3. If the mass flow controller appears to be functioning but cannot achieve setpoint, verify that sufficient inlet pressure and pressure drop are available at the controller to provide the required flow.

⚠ CAUTION

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

Bench Troubleshooting/Performance Tests

A properly functioning controller should pass the following tests. The tests may also be used as a method for detecting problems. Table 4-1 lists possible malfunctions which may be encountered during bench troubleshooting.

Properly connect the mass flow controller to a 115 Vac power source, command voltage source and connect an output signal readout device (4-1/2 digit voltmeter recommended) to pins M and E (0- 10V) or pins N and E (0-1V). Refer to Figure 2-1. The response time test (E) requires a downstream blocking valve. A + 15 to 30 Vdc voltage source should be connected through 1k ohm of resistance to connector pins K and L. The voltage source common should be connected to pin E (refer to Figure 2-1).

- A. Apply power, set the command voltage to zero, and allow the controller to warm up for 40 minutes. Do not connect to a gas source at this time. Observe the output signal and, if necessary, perform the zero adjustment procedure (Section 3-3). If the output signal does not zero properly, refer to the sensor troubleshooting section and check the sensor. If the sensor is electrically functional, the printed circuit board is defective and requires replacement. Connect the controller to a source of the gas on which it was originally calibrated.
- B. Control and stability (This section applies to all units except 200 and 300 slm H₂). Verify that the controller will stabilize and control flow at 2% and 100% command at inlet pressures 10 and 50 psig (outlet at atmospheric). The output signal, after stabilization, should be within 100 mV of the command signal and be stable to with ± 0.010 Vdc. Both limit outputs should be within a few millivolts of the voltage source output (high).
- C. Control Stability (200 and 300 slm H₂ units). Verify that the controller will stabilize and control at 2% and 100% command at inlet pressures of 15 and 30 psig (outlet at atmospheric). The output signal, after stabilization, should be within 100mV of the command signal and be stable to within ± 0.02 Vdc. Both limit outputs should be high (switch open) after stabilization D. Valve Override and Limit Output Check all units
 1. Set the input pressure to 10 psig (15 psig on 200 and 300 slm H₂ units).
 2. Apply +15 Vdc to connector pin H (V.O.R. input), verify that pin L (open limit) is low (switch closed) and pin K closed limit is high (switch open). Verify that the output signal is above 10 V.
 3. Apply -15 Vdc to pin H, verify that pin L is high and pin K is low.
- E. Response Time Checks
 1. Apply -15 Vdc to connector pin H (V.O.R. input), pin K, should go low.
 2. Wait until the output signal decays below 0.050 Vdc.
 3. Set the command signal to 0.150 Vdc (3%). Remove the V.O.R. voltage and start the timer. Pin K should go high (switch open) in 25 seconds or less and the output signal (pin M) should go above 0.100 Vdc in 35 seconds or less.
 4. Close the downstream shutoff valve.
 5. Wait until the output signal decays below 0.050 Vdc. Pin L should go low (switch closed).
 6. Open the shutoff valve and start the timer. There is a flow surge which drives the valve closed, causing pin K to go low (switch closed) and the output signal (pin M) to go below 0 Vdc. Pin K should return to a high state (switch open) in 25 seconds or less and the output signal should go above 0.100 Vdc in 35 seconds or less.

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Table 4-1 Bench Troubleshooting

Trouble	Possible Cause	Check/Corrective Action
Actual flow overshoots setpoint by more than 5% full scale.	Anticipate potentiometer out of adjustment.	Adjust anticipate potentiometer. Refer to Section 3-5.
Output stays at zero regardless of setpoint and there is no flow through the controller.	Clogged Sensor. Refer to Section 4-4. Clogged Control Valve. Valve override input is grounded. Defective PC Board.	Clean sensor. Refer to cleaning. Check TP3 with the setpoint at 100%. If the voltage is greater than 11V, disassemble and repair the control valve. Refer to Sections 4-4c and 2-10. Check valve override input (Pin 12) Replace PC Board. Refer to Section 4-4.
Output signal stays at +6.8V or 26 mA regardless of command and there is flow through the controller.	Valve stuck open or leaky. +22.5V -28Vdc applied to the valve override input. Defective PC Board.	Clean and/or adjust control valve. Refer to cleaning procedure and/or Section 4-4C. Check the valve override terminal. (Pin 12) Replace PC Board. Refer to Section 4-4.
Output signal follows setpoint at higher setpoints but will not go below 2% (8% for all-metal seat).	Leaky control valve.	Disassemble and repair valve. Refer to Section 4-4C.
Output signal follows setpoint at lower setpoints but does not reach full scale.	Insufficient inlet pressure or pressure drop. Partially clogged sensor. Partially clogged valve. Valve out of adjustment. Valve guide spring failure.	Adjust pressure, inspect the filters and clean/replace as necessary. Check calibration. Refer to Section 3-4. Disassemble and repair control valve. Refer to Section 4-4. Adjust valve. Refer to Section 4-4. Controller oscillates (see below).
Controller grossly out of calibration. Flow is higher than desired.	Partially clogged sensor.	Clean sensor, refer to the cleaning procedure.
Controller grossly out of calibration. Flow is lower than desired.	Partially clogged restrictor.	Replace restrictor. Refer to Section 4-4.
Controller oscillates.	Pressure drop or inlet pressure excessive. Oversized orifice. Valve out of adjustment. Anticipate potentiometer out of adjustment. Faulty pressure regulator. Defective PC Board.	Adjust pressures. Check orifice size. Refer to Section 4-6. Adjust valve. Refer to Section 4-4. Adjust anticipate potentiometer. Refer to Section 3-5. Check regulator output. Replace PC Board. Refer to Section 4-4.

Sensor Troubleshooting

The sensor tube is part of a calibrated flow divider that is designed to operate within a preset gas flow range. If it is believed the the sensor coils are either open or shorted, troubleshoot using Table 4-2. If any of the steps do not produce the expected results, the sensor assembly is defective and must be replaced. Refer to Section 4-4 for disassembly and assembly procedures to be used when replacing the sensor. If the sensor assembly is cleaned and reinstalled, a calibration check should be performed. Refer to Section 3-4.

NOTE: Do not attempt to disassemble the sensor.

4-3 Cleaning Procedures

Should the Model 0550E Mass Flow Controller require cleaning due to contamination, use the following procedures:

1. Remove the unit from the system.
2. Refer to Section 4-4 to disassemble the controller.

⚠ CAUTION

Do not soak the sensor assembly in a cleaning solution. If solvent seeps into the sensor assembly it can damage the sensor or significantly alter its operating characteristics.

3. Use a hemostat or tweezers to push a 0.007" diameter piano wire through the flow sensor tube to remove any contamination. For best results, push the wire into the downstream opening of the sensor tube (end closest to the control valve). The sensor tube can be flushed with a non-residuous solvent (Freon TF** recommended). A hypodermic needle filled with solvent is a convenient means to accomplish this.

An alternate method for flushing out the sensor is to replace the restrictor element with a low flow plug restrictor. (PN 618-K-019-BMT) This plug forces all the flow through the sensor and may dislodge any obstructions. With the valve orifice removed, subject the flow controller to a high differential pressure. Pressurizing the outlet of the MFC higher than the inlet may help force the obstruction upstream and out of the sensor tube.

4. Inspect the orifice for clogging by holding it in front of a light source and looking for light through the bore. Clean by soaking in a suitable non-residuous solvent and directing a stream of compressed dry nitrogen through the bore.
5. Deposits of silicon dioxide may be removed by soaking the internal parts in a solution of 5 parts hydrofluoric acid (HF) and 95 parts water (H₂O) followed by Freon TF.
6. Sintered type restrictor elements should be replaced as it is not always possible to adequately remove deposits from them.
- 6a. Clean the inlet screen by placing the end block in an ultrasonic bath.
7. Blow all parts dry with dry nitrogen and reassemble. Refer to Section 4-4b (assembly).
8. Purge the assembled controller with dry nitrogen.
9. Perform the calibration procedure in Section 3-4.
10. When the controller is re-installed in the system, the connections should be leak-tested and the system should be purged with dry nitrogen for 30 minutes prior to start-up to prevent the formation of deposits.

Table 4-2. Sensor Troubleshooting.

<table><tr><th>PIN NO</th><th>FUNCTION</th></tr><tr><td>4</td><td>Sensor common</td></tr><tr><td>1</td><td>Heater</td></tr><tr><td>5</td><td>Heater common</td></tr><tr><td>2</td><td>Upstream temperature sensor (Su)</td></tr><tr><td>3</td><td>Downstream temperature sensor (Sd)</td></tr></table>	PIN NO	FUNCTION	4	Sensor common	1	Heater	5	Heater common	2	Upstream temperature sensor (Su)	3	Downstream temperature sensor (Sd)	12345 Sensor Connector FLOW Flex Circuit Wire Numbers
PIN NO	FUNCTION												
4	Sensor common												
1	Heater												
5	Heater common												
2	Upstream temperature sensor (Su)												
3	Downstream temperature sensor (Sd)												
<table><tr><th>OHMMETER CONNECTION</th><th>RESULT IF ELECTRICALLY FUNCTIONAL</th></tr><tr><td>(ground) Pin 1 Or 4 to body</td><td>Open circuit on ohmmeter. If either heater, or sensor common are shorted, an ohmmeter will be obtained.</td></tr><tr><td>Pin 4 to Pin 2</td><td>Nominal 1100 ohms reading.</td></tr><tr><td>Pin 4 to Pin 3</td><td>Depending on temperature and ohmmeter current.</td></tr><tr><td>Pin 5 to Pin 1</td><td>Nominal 1200 ohm reading.</td></tr></table>	OHMMETER CONNECTION	RESULT IF ELECTRICALLY FUNCTIONAL	(ground) Pin 1 Or 4 to body	Open circuit on ohmmeter. If either heater, or sensor common are shorted, an ohmmeter will be obtained.	Pin 4 to Pin 2	Nominal 1100 ohms reading.	Pin 4 to Pin 3	Depending on temperature and ohmmeter current.	Pin 5 to Pin 1	Nominal 1200 ohm reading.			
OHMMETER CONNECTION	RESULT IF ELECTRICALLY FUNCTIONAL												
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Pin 4 to Pin 2	Nominal 1100 ohms reading.												
Pin 4 to Pin 3	Depending on temperature and ohmmeter current.												
Pin 5 to Pin 1	Nominal 1200 ohm reading.												
Note: Remove the sensor connector from the PC Board for this procedure.													

4-4 Disassembly and Assembly

NOTE: The 0550E Mass Flow Controller should be disassembled and assembled in a clean environment to prevent particulate contamination.

A. Disassembly

The numbers in parentheses refer to the spare parts exploded view in Figure 5-1.

⚠ CAUTION

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

1. Remove the jam nut (1) on top of the valve assembly.
2. Remove the two screws (20) and two lock washers (20A) from the top of the electronics cover (23).
3. Unplug the valve connector from the electronics cover and remove the coil assembly (2).
4. Remove the hex socket screws (3) securing valve retaining plate (4). Remove the valve retaining plate.

⚠ CAUTION

When performing the following procedure, the valve stem must be removed without cocking it to prevent damage to the valve spring.

5. Carefully remove the stem (6).
6. Remove the plunger assembly (7,8,9,11).
7. Remove and note the position of the valve spring spacers (10), which may be located above and/or below the lower valve spring (8).
8. Unscrew the orifice (12) from the flow controller body (14) using the orifice removal tool (See Section 5, Table 5-2).

⚠ CAUTION

Be careful not to stress the sensor lead wire to sensor assembly junction when removing the sensor connector from the PC Board. If the sensor lead wires are stressed an opening in the sensor wiring could result.

9. Unplug the sensor connector from the PC board. Remove the two screws (25) and the two washers (25A) securing the electronics module (15) to the body. Remove the module
10. Remove the two allen nuts using an inch allen wrench (18) and washers (19) securing the sensor assembly (16). Remove the sensor assembly.

NOTE: Do not attempt to disassemble the sensor assembly.

⚠ CAUTION

Do not scratch the O-ring sealing surface.

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11. Remove the sensor assembly O-rings (17) from the flow controller body (14). Using the Brooks O-ring removal tool helps prevent scratching the sealing surface.
12. Remove the adapter fittings from the flow controller body (14).
13. Remove the 4 screws (29) from the end block (28) and carefully remove the end block.
14. Remove the restrictor assembly (21) from the inlet side of the flow controller body (14) using the header removal tool (Section 5, Table 5-2). Note the rotational position of the restrictor assembly. (Refer to Section 4-7). On units with full scale flows less than 20 slpm, the restrictor assembly in the cylinder may be removed with the "E" Series restrictor removal tool (Section 5, Table 5-2).

B. Assembly**⚠ CAUTION**

Do not get Halocarbon lubricant on the restrictor element (21) or hands. This is a special inert lubricant which is not easily removed.

NOTE: It is recommended that all O-rings be replaced during controller assembly. All O-rings should be lightly lubricated with Halocarbon lubricant (part of O-ring kit, Table 5-2) prior to their installation.

1. Examine all parts for signs of wear or damage, replace as necessary.
2. Place the restrictor O-ring on the header assembly, (two O-rings are used on the cylinder assembly for flows of 20 slpm and below). Install O-rings on restrictor (flows 20 slpm and below) and Screw into cylinder using restrictor tool. Tighten hand tight.
3. Install header or cylinder into the restrictor cavity using the header removal tool. Rotating the assembly slightly assists installation. Do not press header assembly into body with an arbor press as this may damage the O-ring.
4. Place the end block O-ring in position and install the end block with the 4 hex socket screws. Tighten these screws to 49 inch-lbs. Do not over tighten.

⚠ CAUTION

The end block screws (29) and the valve screws (3) are not interchangeable. The end block screws are stronger and are needed for the pressure rating. The end block screws are darker in color, longer and can be attracted by a magnet.

⚠ CAUTION

The following steps must be performed as written. Placing the O-rings on the sensor before it is installed results in damage to the O-rings causing a leak.

5. Press the lubricated sensor O-rings (17) into the flow controller body (14). Install the sensor assembly and secure with two allen nuts (18) and washers (19). Tighten to 10 inch/lbs.

6. Install the orifice (12) and its O-rings (13) using the orifice removal tool. Insure that the orifice is fully seated but do not overtighten.
7. Insert the valve preload spacers(10), if used, into the valve cavity in the flow controller body (14). Use care to preserve the correct order.
8. Install the valve plunger assembly (7,8,9,11) on the preload spacers (10). Install air gap spacers (10), if used, on top of the valve springs.
9. Install the valve stem assembly (6), secure with the valve retaining plate (4) and four hex socket screws (3). When installing the screws, they should first make light contact with the plate, which should be checked to insure that it makes full contact around the stem assembly. Torque the screws securing the valve retaining plate in a diagonal pattern (Refer to Figure 4-1) to 17 inch/lbs.
10. Install the coil assembly (2) over the valve stem assembly (6) and secure with jam nut (1).
11. Install the electronics module (15), secure with two sockethead screws (25) and the two external tooth washers (25A). Plug the connector from the sensor assembly onto the PC board. The flow arrow on the connector should be pointing towards the valve assembly.
12. Plug the connector from the valve coil into the PC board through the hole in the electronics cover. Install the electronics cover (23) on the controller, secure with two screws (20) and the two lock washers (20A).

Prior to installation, leak and pressure test to any applicable pressure vessel codes.

C. Adjusting the Control Valve

The 0550E control valve has been factory adjusted to insure proper operation. Readjustment is only required if any of the following parts have been replaced:

- orifice (12)
- valve stem (6)
- plunger (7)
- lower guide springs (8)
- valve seat (11)

The valve is adjusted in Brooks Mass Flow Controllers by adding spacers (9 and 10) to the control valve assembly to vary the air gap and initial preload. Spacers are used to affect the proper adjustment because they provide a reliable and repeatable means for adjustment. Screw type adjustment mechanisms can change with pressure or vibration and introduce an additional dynamic seal that is a potential leak site and source for contamination. Refer to Figure 4-2 for spacer locations.

The preload determines the initial force that is required to raise the valve seat off the orifice and start gas flow. If the preload is insufficient, the valve does not fully close and gas leaks through. If the preload is excessive, the magnetic force generated between the plunger and stem is insufficient to raise the plunger and the valve does not open.

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The airgap is the space between the top of the plunger and stem. The airgap determines the force between the plunger and stem at a given voltage and the total travel of the valve. If the airgap is too small, the plunger travel may be insufficient to fully open the valve. Also, the magnetic force may be too high for a given valve coil voltage. If the airgap is too large, the magnetic force is insufficient to raise the plunger and the valve does not open.

NOTE 1: Prior to starting the valve adjustment procedure, check to insure that the orifice is properly seated and that the valve parts are not bent or damaged.

NOTE 2: In most cases, valves with orifices less than or equal to 0.014 inch have two lower guide springs (8) and 0.010 inch small airgap spacer. Valves with orifices greater than 0.014 inches have one lower guide spring and no airgap spacers. These spring and spacer combinations may vary from valve to valve.

Preload/Shutoff Adjustment

(Refer to Section 5, Spare Parts for Spacer Kit)

- a. Remove the electronics cover (23) from the controller. Insure that the connector from the coil assembly (2) is properly connected to the PC Board after the electronics cover is removed.
- b. Perform the electrical and gas connections to the controller following the instructions in Section 2 of this manual. Use a clean dry inert gas, such as nitrogen, for this procedure. Do not apply gas pressure to the controller at this time.
- c. Disassemble the control valve following the procedure given in Section 4-4A above. Note the number, locations and thicknesses of all spacers (9 and 10).
- d. Decrease the preload of the valve by 0.005 inches by either removing a 0.005-inch small preload spacer or by adding a 0.005-inch large preload spacer. (Refer to Figure 4-2).
- e. Reassemble the valve following the assembly procedure in Section 4-4b.
- f. Command 0% flow, apply normal operating gas pressure and check for leak-thru by observing the output signal.
- g. If the valve leaks-thru, increase the preload by 0.005" and go to Step 2 (Airgap adjustment). If the valve does not leak-thru repeat steps d, e, f, and g.

2. Airgap Adjustment

The airgap adjustment can be done in one of three ways. ("A", "B" or "C" as follows).

- A. 1. Proceed using controller as set up in previous preload adjustment section.
2. Apply the normal operating gas pressure and command 100% flow.

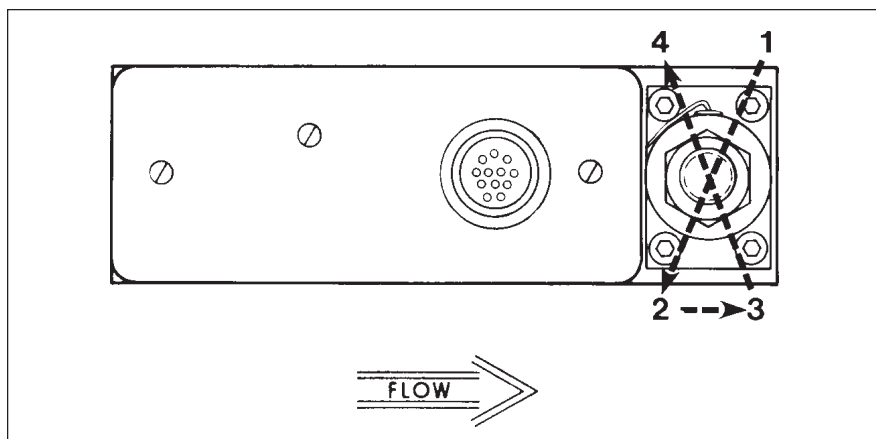


Figure 4-1 Torque Sequence for the Valve Retainer Plate

Note: Due to possible heat capacity and density differences between the test gas and actual process gas for which the MFC was sized, it may be necessary to increase the inlet pressure to obtain proper control at 100% flow.

3. Measure the valve voltage by connecting a voltmeter between test point 3 (TP3) and test point 4 (TP4). Refer to Figure 4-3.
Valve Voltage = -15.0 - Voltage at TP3

Example:

$$\begin{aligned}
 &\text{Voltage at TP3 is 5.00 Volts} \\
 &\text{Valve Voltage} = -15.0 - (-5) \text{ V} \\
 &\quad = -15.0 + 5 \text{ Volts} \\
 &\quad = -10.0 \text{ Volts}
 \end{aligned}$$

4. If the flow controller output is 100% and the valve voltage is less than 16V, the valve adjustment is complete.
 5. If the flow controller output signal is 100% (5.0V) and the valve voltage is greater than 16V, decrease the airgap with a small 0.005 inch airgap spacer. Refer to Figure 4-2. Repeat steps 2 and 3.
 6. If the flow controller output signal is less than 100 % and the valve voltage is greater than 16V, first check Section 4-6 to insure that the orifice size is correct.
 7. Proceed to Section 3-4 and perform calibration procedure, if required.
- B.** This method requires a secondary flow measurement device, a variable 0-22 Vdc (minimum 300 mA) power supply and a nitrogen gas source.
1. The unit must be disassembled far enough to disconnect the valve (connector P8) from the main PC board. Connect the valve to the DC supply (polarity does not matter). It is not necessary to power the electronics.
 2. Apply 10 psig of nitrogen gas pressure (15 psig on 200 and 300 slm units) to the controller inlet.

NOTE: The outlet pressure of the controller must be kept below 10 inches of water column (0.5 psi).

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3. Apply 22 Vdc to valve and measure the flow rate. The flow must be greater than the value in Table 4-3.
 4. If the flow exceeds these values, go to the next step. If it is less, recheck the orifice size (Refer to Section 4-6, orifice sizing) and inspect the orifice for clogging.
 5. Reduce the valve voltage to 0 then increase it to 16V. Measure the flow rate. If the flow rate is the same as it was in step 3, then the procedure is finished. If the flow rate is less, add a small diameter 0.005 inch spacer to decrease the airgap and repeat this step.
 6. For units with orifices greater than 0.046 inches, this procedure should also be done at 50 psig supply pressure. At 50 psig only, record the flow in step 3. A chart of maximum flows is not necessary.
- C.** Install the flow controller in the process line and apply normal operating gas and gas pressure. Command 100% flow and measure the valve voltage as in step A3. If this voltage is less than 16V the airgap is properly adjusted. If the voltage is greater than 16V, disassemble the valve and add a small diameter airgap spacer and repeat this step.

NOTE: This method is the most accurate for adjusting airgaps. However, it is not recommended for applications which require minimal exposure to the environment.

Table 4-3 Orifice Capacity

Orifice Size	N ₂ Flow Rate (sccm) 70°F
0.004	93
0.0067	296
0.0091	660
0.012	1,045
0.016	1,950
0.021	3,410
0.026	5,170
0.031	7,480
0.036	9,900
0.041	12,656
0.0465	15,950
0.055	22,000
0.0635	29,150
0.070	35,200
0.076	40,150
0.082	46,750
0.0935	55,000
0.1065	68,200
0.120	82,000
0.1405	108,000

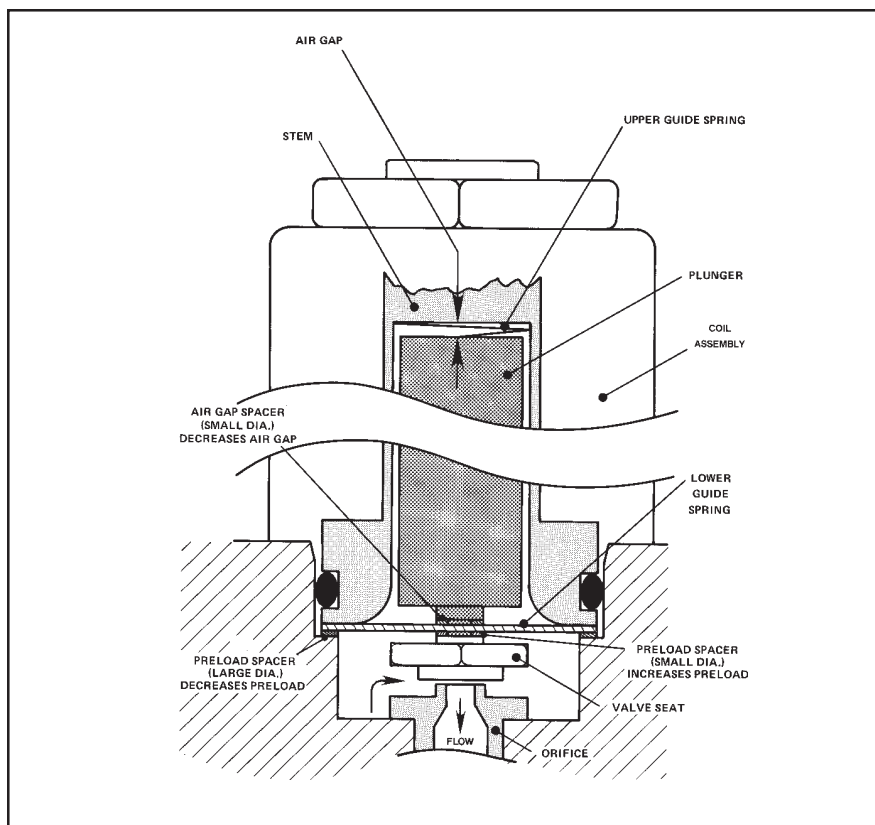


Figure 4-2 Valve Adjusting Spacer Locations

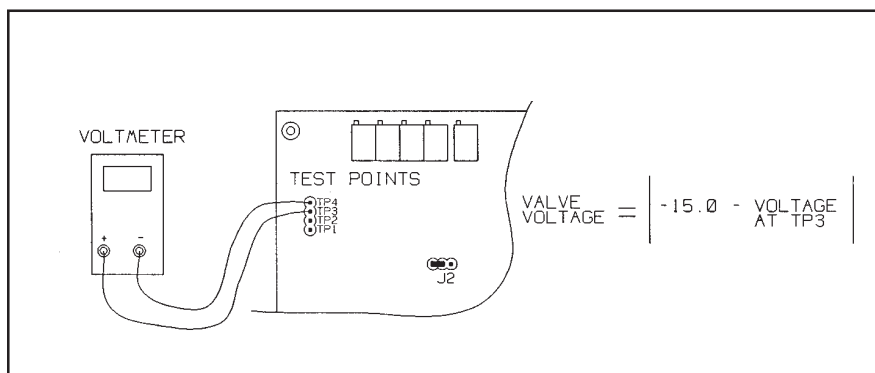


Figure 4-3 Voltmeter Connections for Valve Adjustment

4-5 Use of the Conversion Tables

If a mass flow controller is operated on a gas other than the gas it was calibrated with, a scale shift will occur in the relation between the output signal and the mass flow rate. This is due to the difference in heat capacities between the two gases. This scale shift can be approximated by using the ratio of the molar specific heat of the two gases or by sensor conversion factor. A list of sensor conversion factors is given in Table 4-5.

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To change to a new gas, multiply the output reading by the ratio of the gas factor for the desired gas to the gas factor for the calibration gas.

In addition to gas changes, changes in pressure conditions can also cause changes in the MFC's rangeability. A complete explanation of this change for the Standard Applied Materials flow rate can be seen in Section 3-6.

$$\text{Actual gas flow rate} = \text{Output reading} \times \frac{\text{factor of the new gas}}{\text{factor of the calibrated gas}}$$

Example:

The controller is calibrated for Nitrogen.

The desired gas is Carbon Dioxide.

The output reading is 75 slpm when Carbon Dioxide is flowing.

$$\text{Then } 75 \times 0.78 = 58.50$$

In order to calculate the conversion factor for a gas mixture, the following formula should be used:

$$\text{Sensor Conversion Factor Mixture} = \frac{100}{\frac{P1}{\text{Sensor Conversion Factor1}} + \frac{P2}{\text{Sensor Conversion Factor2}} + \frac{Pn}{\text{Sensor Conversion Factorn}}}$$

Where,

P1 = percentage (%) of gas 1 (by volume)

P2 = percentage (%) of gas 2 (by volume)

Pn = percentage (%) of gas n (by volume)

Example: The desired gas is 20% Helium (He) and 80% Chlorine (Cl) by volume. The desired full scale flow rate of the mixture is 20 slpm.

Sensor conversion factor for the mixture is:

$$\text{Mixture Factor} = \frac{100}{\frac{20}{1.386} + \frac{80}{.876}} = .946$$

$$\text{Nitrogen equivalent flow} = 20 / 0.946 = 21.15 \text{ slpm ai}$$

It is generally accepted that the mass flow rate derived from this equation is only accurate to $\pm 5\%$. The sensor conversion factors given in Table 4-5 are calculated based on a gas temperature of 21°C and a pressure of one atmosphere. The specific heat of most gases are not strongly pressure and temperature dependent. However, gas conditions that vary widely, from these reference conditions, may cause an additional error due to the change in specific heat caused by temperature and/or pressure.

4-6 Use of Orifice Sizing Nomograph

The Orifice Sizing Nomograph, Table 4-4, is used to calculate the control valve's orifice size when changing any or all of the following factors from the original factory calibration:

gas
operating pressure (inlet and outlet)
flow range

The flow controller's orifice is factory-sized to a preselected gas, operating pressure and flow rate. Note that the orifice is marked with its size in thousandths of an inch. When changing the aforementioned factors, calculate the new orifice size by following the procedure and example outlined below.

A list of the orifices used for the standard Applied Materials flow rates can be seen in Table 4-7. For a complete explanation of the reduction of the operating range of the flow controller when varying the operating pressures see Section 3-6.

Example:

Determine the orifice size for the following conditions:

Gas: Hydrogen
Flow Rate: 100 slpm
Outlet Pressure: 30 psig
Inlet Pressure: 50 psig

1. Determine air equivalent flow rate (refer to Table 4-5).

$$Q_{\text{Nitrogen}} = Q_{\text{gas}} \sqrt{\frac{D_{\text{gas}}}{D_{\text{air}}}}$$

or

$$Q_{\text{Nitrogen}} = Q_{\text{gas}} \sqrt{SG_{\text{gas}}}$$

Where:

$$SG_{\text{Nitrogen}} = 1.00$$

Q_{Nitrogen}	=	Nitrogen equivalent flow rate (sccm)
Q_{gas}	=	Desired flow rate of the gas (sccm) (Based on 70°F Standard temperature)
D_{Nitrogen}	=	Density of Nitrogen at 70°F
D_{gas}	=	Density of the gas (taken at customer temperature)
SG_{gas}	=	Specific gravity of the gas (taken at customer temperature)

Refer to Table 4-5 for specific gravities.

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Example:

What is the Nitrogen equivalent flow rate of 100 slpm Hydrogen?

$$\begin{aligned}
 Q_{\text{gas}} &= 100 \text{ slpm} \\
 \sqrt{SG_{\text{gas}}} &= 0.269 \\
 Q_{\text{Nitrogen}} &= Q_{\text{gas}} \sqrt{SG_{\text{gas}}} \\
 &= 100 \times 0.269 \\
 &= 26.9 \text{ slpm air}
 \end{aligned}$$

In order to calculate the orifice conversion factor when using a gas mixture, the following formula must be used:

$$\text{Orifice Conversion Factor Mixture} = \sqrt{\frac{P_1 \left(\text{Orifice Conversion Factor 1} \right)^2 + P_2 \left(\text{Orifice Conversion Factor 2} \right)^2 + P_n \left(\text{Orifice Conversion Factor n} \right)^2}{100}}$$

Where P1 = percentage by volume of gas 1
P2 = percentage by volume of gas 2
Pn = percentage by volume of gas n

Example: Find the Nitrogen equivalent flow for 20 slpm of a 20% Helium and 80% Chlorine gas mixture.

$$\begin{aligned}
 Q_{\text{Nitrogen}} &= Q_{\text{gas}} (\text{orifice conversion factor}) \\
 &= 20 \times 1.434 \\
 &= 28.78 \text{ slpm Nitrogen}
 \end{aligned}$$

2. If inlet and outlet pressures are given in gauge pressure (psig) add 14.7 to convert to absolute pressure (psia).

Outlet Pressure — 30 psig + 14.7 = 44.7 psia
Inlet Pressure — 50 psig + 14.7 = 64.7 psia

3. Determine Critical Pressure Drop

Critical pressure drop occurs when the outlet pressure (psia) is less than half the inlet pressure (psia) or

$$P_{\text{outlet}} < \frac{P_{\text{inlet}}}{2}$$

If these conditions exist, the pressure drop (Dp) should be calculated as follows:

$$\Delta P = \frac{P_{in}}{2}$$

ΔP = Pressure Drop (psi)

P_{IN} = Inlet Pressure (psia)

If these conditions do not exist, pressure drop equals the inlet pressure minus the outlet pressure.

$$\text{Is } 44.7 \text{ psia} < \frac{64.7 \text{ psia}}{2} \quad ? \quad \text{No.}$$

$$\text{Then } D_p = 64.7 - 44.7 = 20 \text{ psi}$$

Refer to Figure 4-4 for Steps 4 through 9.

4. Using the nomograph, locate the pressure drop (psi) on the vertical line marked "Dp" (Point A).
5. Locate the Nitrogen equivalent flow rate (sccm Nitrogen) on the vertical line marked " $Q_{Nitrogen}$ " (Point B).
6. Draw a line connecting Dp and $Q_{Nitrogen}$ and extend it to the baseline. Mark this point (Point C).
7. Locate inlet pressure (psia) on the vertical line marked " P_{in} " (Point D).
8. Draw a line connecting P_{in} (Point D) and baseline (Point C) and then extend this line to the vertical line marked D_o (orifice diameter, inches). (Point E).
9. This point on the D_o line is the minimum orifice size for the given conditions. If this point is between two orifice sizes, select the next largest size orifice to ensure adequate flow. If the orifice selected falls below 0.004, choose 0.004 size orifice.

For this example the 0.041 inch size orifice would be selected.

P/N S-778-D-017-AAA Permits the disassembly of Brooks "E" Series Mass Flow Controllers for servicing Contains: 1 O-ring Removal Tool 1 Potentiometer Adjustment Tool 2 Ball Point Allen Wrench, 1/8" and 9/64" 1 Phillips Screw Driver 1 Nut Driver for Orifice 1 Restrictor Removal Tool (up to 20 slpm) 1 Common Screw Driver	0550/5851 Orifice Removal Tool P/N S-908-Z-049-AAA 0550/5851 Header Removal Tool P/N S-817-Z-036-AAA (above 20 slpm)
0550E Break Out Board Assembly P/N S-273-M-144-AAA Installs directly between mass flow controller and interconnecting cable. Allows convenient access to all signals for easy troubleshooting of system.	Valve Shim Kit P/N S-810-A-372-BMA Contains: 1 0.010" Large Spacer 1 0.005" Larger Spacer 1 0.010" Small Spacer 1 0.005" Small Spacer
O-Ring Kits Buna P/N S-375-Z-294-SUA Viton P/N S-375-Z-294-QTA Kalrez P/N S-375-Z-294-TTA Contains: 1 Orifice O-Ring 1 Restrictor O-Ring 1 Valve O-Ring 2 Sensor O-Rings 2 Adaptor O-Rings 1 Syringe with Fomblin Grease 1 Information Sheet 1 Inlet Block O-Ring 1 Header Plate O-Ring 1 Header Plate O-Ring (Rear)	

Figure 4-4 Example Nomograph

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Table 4-4 Model 0550E Orifice Sizing Nomograph

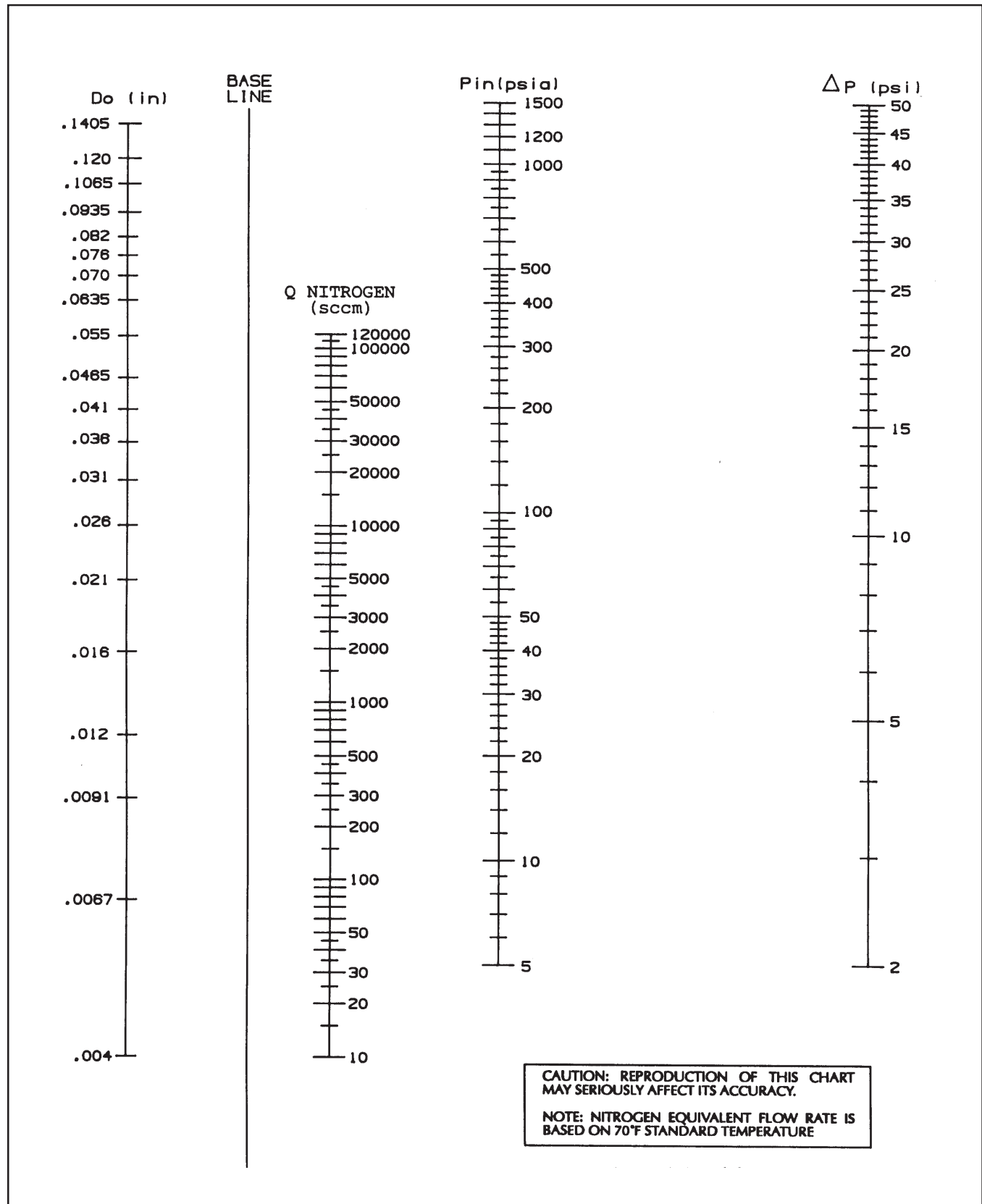


Table 4-5 Conversion Factors (continued on next page)

Gas	Symbol	Sensor Factor	Orifice Factor	Density (kg/m ³)
Acetylene	C ₂ H ₂	0.615	0.970	1.173
Air	(mixture)	0.998	1.018	1.293
Allene	C ₃ H ₄	0.478	1.199	1.787
Ammonia	NH ₃	0.786	0.781	0.771
Argon	Ar	1.395	1.195	1.784
Arsine	AsH ₃	0.754	1.661	3.478
Boron Trichloride	BCl ₃	0.443	2.044	5.227
Boron Trifluoride	BF ₃	0.579	1.569	3.025
Bromine Pentafluoride	BrF ₅	0.287	2.502	7.806
Bromine Trifluoride	BrF ₃	0.439	2.214	6.108
Bromotrifluoroethylene	C ₂ BrF ₃	0.326	2.397	7.165
Bromotrifluoromethane	CBrF ₃	0.412	2.303	6.615
1, 3 Butadiene	C ₄ H ₆	0.354	1.413	2.491
Butane	C ₄ H ₁₀	0.257	1.467	2.593
1-Butene	C ₄ H ₈	0.294	1.435	2.503
CIS-2-Butene	C ₄ H ₈	0.320	1.435	2.503
Trans-2-Butene	C ₄ H ₈	0.291	1.435	2.503
Carbon Dioxide	CO ₂	0.773	1.255	1.977
Carbon Disulfide	CS ₂	0.638	1.650	3.393
Carbon Monoxide	CO	0.995	1.000	1.250
Carbon Tetrachloride	CCl ₄	0.344	2.345	6.860
Carbon Tetrafluoride	CF ₄	0.440	1.770	3.926
Carbonyl Fluoride	COF ₂	0.567	1.555	2.045
Carbonyl Sulfide	COS	0.680	1.463	2.680
Chlorine	Cl ₂	0.876	1.598	3.214
Chlorine Dioxide	ClO ₂	0.693	1.554	3.011
Chlorine Trifluoride	ClF ₃	0.433	1.812	4.125
2-Chlorobutane	C ₄ H ₉ Cl	0.234	1.818	4.134
Chlorodifluoromethane	CHClF ₂	0.505	1.770	3.906
Chloroform (Trichloromethane)	CHCl ₃	0.442	2.066	5.340
Chloropentafluoroethane	C ₂ ClF ₅	0.243	2.397	7.165
Chlorotrifluoroethylene	C ₂ ClF ₃	0.337	2.044	5.208
Chlorotrifluoromethane	CClF ₃	0.430	1.985	4.912
Cyanogen	C ₂ N ₂	0.498	1.366	2.322
Cyanogen Chloride	ClCN	0.618	1.480	2.730
Cyclobutane	C ₄ H ₈	0.387	1.413	2.491
Cyclopropane	C ₃ H ₆	0.505	1.224	1.877
Deuterium	D ₂	0.995	0.379	0.177
Diborane	B ₂ H ₆	0.448	1.000	1.235
Dibromodifluoromethane	CBr ₂ F ₂	0.363	2.652	8.768
1,2-Dibromotetrafluoroethane	C ₂ Br ₂ F ₄	0.215	2.905	10.53
Dichlorodifluoromethane	CCl ₂ F ₂	0.390	2.099	5.492

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Table 4-5 Conversion Factors (continued on next page)

Gas	Symbol	Sensor Factor	Orifice Factor	Density (kg/m ³)
Dichlorofluoromethane (Ethylene Dichloride)	CHCl ₂ F	0.456	1.985	4.912
Dichlorosilane	SiH ₂ Cl ₂	0.442	1.897	4.506
1,2-Dichloroethane	C ₂ H ₄ Cl ₂	0.382	1.879	4.419
1,2-Dichlorotetrafluoroethane	C ₂ Cl ₂ F ₄	0.231	2.449	7.479
2,2-Dichloro1,1,1-Trifluoroethane	C ₂ HCl ₂ F ₃	0.259	2.336	6.829
1,1-Difluoro-1-Chloroethane	C ₂ H ₃ ClF ₂	0.341	1.957	4.776
1,1-Difluoroethane	CH ₃ CHF ₂	0.415	1.536	2.940
1,1-Difluoroethylene	CH ₂ :CF ₂	0.458	1.512	2.860
Diethylsilane	C ₄ H ₁₂ Si	0.183	1.775	3.940
Difluoromethane	CF ₂ H ₂	0.627	1.360	2.411
Dimethylamine	(CH ₃) ₂ NH	0.370	1.269	2.013
Dimethylether	C(CH ₃) ₂ O	0.392	1.281	2.055
2,2-Dimethylpropane	C(CH ₃) ₄	0.247	1.613	3.244
Disilane	Si ₂ H ₆	0.332	1.493	2.779
Ethane	C ₂ H ₆	0.490	1.038	1.357
Ethanol	C ₂ H ₆ O	0.394	1.282	2.057
Ethylacetylene	C ₄ H ₆	0.365	1.384	2.388
Ethyl Chloride	C ₂ H ₅ Cl	0.408	1.516	2.879
Ethylene	C ₂ H ₄	0.619	1.000	1.261
Ethylene Oxide	C ₂ H ₄ O	0.589	1.254	1.965
Fluorine	F ₂	0.924	1.163	1.695
Fluoroform	CHF ₃	0.529	1.584	3.127
Germane	GeH ₄	0.649	1.653	3.418
Germanium Tetrachloride	GeCl ₄	0.268	2.766	9.574
Halothane	C ₂ HBrClF ₃	0.257	2.654	8.814
Helium	He	1.386	0.378	0.178
Hexafluoroacetone	C ₃ F ₆ O	0.219	2.434	7.414
Hexafluorobenzene	C ₆ F ₆	0.632	2.577	8.309
Hexafluoroethane	C ₂ F ₆	0.255	2.219	6.139
Hexafluoropropylene (HFP)	C ₃ F ₆	0.249	2.312	6.663
Hexafluoromethyldisilane (HMDS)	(CH ₂) ₆ Si ₂	0.139	2.404	7.208
Hexane	C ₆ H ₁₄	0.204	1.757	3.847
Hydrogen	H ₂	1.008	0.269	0.090
Hydrogen Bromide	HBr	0.987	1.695	3.645
Hydrogen Chloride	HCl	0.983	1.141	1.639
Hydrogen Cyanide	HCN	0.744	0.973	1.179
Hydrogen Fluoride	HF	0.998	0.845	0.893
Hydrogen Iodine	HI	0.953	2.144	5.789
Hydrogen Selenide	H ₂ Se	0.837	1.695	3.613
Hydrogen Sulfide	H ₂ S	0.850	1.108	1.539
Iodine Pentafluoride	IF ₅	0.283	2.819	9.907
Isobutane	C ₄ H ₁₀	0.260	1.440	2.596

Table 4-5 Conversion Factors (continued from previous page)

Gas	Symbol	Sensor Factor	Orifice Factor	Density (kg/m3)
Isobutene	C_4H_8	0.289	1.435	2.503
Isopentane	C_5H_{12}	0.211	1.605	3.222
Krypton	Kr	1.382	1.729	3.708
Methane	CH_4	0.763	0.763	0.717
Methylacetylene	CH_3NH_2	0.473	1.196	1.782
Methyl Bromide	CH_3Br	0.646	1.834	4.236
3-Methyl-1-butene	C_5H_{10}	0.252	1.584	3.127
Methyl Chloride	CH_3Cl	0.687	1.347	2.308
Methyl Fluoride	CH_3F	0.761	1.102	1.518
Methyl Mercaptan	CH_4S	0.588	1.313	2.146
Methyl Silane	CH_6Si	0.393	1.283	2.061
Methyl Trichlorosilane (MTS)	CH_3Cl_3Si	0.267	2.310	6.675
Methyl Vinyl Ether	C_3H_6O	0.377	1.435	2.567
Monoethanolamine	C_2H_7NO	0.305	1.477	2.728
Monoethylamine ($CH_3CH_2NH_2$)	C_2H_7	0.359	1.269	2.013
Monomethylamine	CH_3NH_2	0.565	1.067	1.420
Neon	Ne	1.398	0.847	0.902
Nickel Carbonyl	$Ni(CO)_4$	0.212	2.371	7.008
Nitric Oxide	NO	0.995	1.030	1.339
Nitrogen	N_2	1.000	1.000	1.251
Nitrogen Dioxide	NO_2	0.758	1.713	2.052
Nitrogen Trifluoride	NF_3	0.501	1.598	3.168
Nitrogen Trioxide	N_2O_3	0.443	1.649	3.389
Nitrosyl Chloride	NOCl	0.644	1.529	2.913
Nitrous Oxide	NO_2	0.752	1.259	1.964
Octofluorocyclobutane	C_4F_8	0.169	2.672	8.933
Oxygen	O_2	0.988	1.067	1.429
Oxygen Difluoride	OF_2	0.672	1.388	2.402
Ozone	O_3	0.738	1.310	2.138
Pentafluoroethane	C_2HF_5	0.287	2.070	5.360
Pentane (n-Pentane)	C_5H_{12}	0.212	1.605	3.222
Perchloryl Fluoride	ClO_3F	0.448	1.905	4.571
Perfluorobutane	C_4F_{10}	0.738	2.918	10.61
Perfluoro-2-Butene	C_4F_8	0.268	2.672	8.933
Perfluoromethyl-vinylether	PMVE	0.269	2.029	5.131
Perfluoropropane	C_3F_8	0.179	2.591	8.396
Phosgene	$COCl_2$	0.504	1.881	4.418
Phosphine	PH_3	0.783	1.100	1.517
Phosphorous Pentafluoride	PF_5	0.346	2.109	5.620
Phosphorous Trifluoride	PF_3	0.495	1.770	3.906
Propane	C_3H_8	0.343	1.274	2.008
Propylene (Propene)	C_3H_6	0.401	1.234	1.875

Brooks® Model 0550E

Table 4-5 Conversion Factors (continued from previous page)

Gas	Symbol	Sensor Factor	Orifice Factor	Density (kg/m3)
Rhenium Hexafluoride	ReF ₆	0.230	3.279	13.41
Silane	SiH ₄	0.625	1.070	1.440
Silicon Tetrachloride	SiCl ₄	0.310	2.462	7.579
Silicon Tetrafluoride	SiF ₄	0.395	1.931	4.648
Sulfur Dioxide	SO ₂	0.728	1.529	2.858
Sulfur Hexafluoride	SF ₆	0.270	2.348	6.516
Sulfur Tetrafluoride	SF ₄	0.353	1.957	4.776
Sulfur Trioxide	SO ₃	0.535	1.691	3.575
Sulfur Fluoride	SO ₂ F ₂	0.423	1.931	4.648
Tetrachloromethane	CCl ₄	0.344	2.345	6.858
Tetrafluoroethylene (TFE)	C ₂ F ₄	0.361	1.905	4.526
Tetrafluorohydrazine	N ₂ F ₄	0.367	1.926	4.624
Trichlorofluoromethane	CCl ₃ F	0.374	2.244	6.281
Trichloromethane (Chloroform)	CHCl ₃	0.442	2.066	---
Trichlorosilane	SiHCl ₃	0.329	2.201	6.038
Trimethyloxyborane	B(OCH ₃) ₃	0.300	1.929	4.638
1,1,2-Trichloro-1,2,2-Trifluoroethane	C ₂ Cl ₃ F ₃	0.231	2.520	7.920
Trimethylamine	(CH ₃) ₃ N	0.316	1.467	2.639
Tungsten Hexafluoride	WF ₆	0.227	3.264	13.28
Uranium Hexafluoride	UF ₆	0.220	3.548	15.70
Vinyl Bromide	C ₂ H ₃ Br	0.524	1.985	4.772
Vinyl Chloride	C ₂ H ₃ Cl	0.542	1.492	2.788
Vinyl Fluoride	C ₂ H ₃ F	0.576	1.281	2.046
Water Vapor	H ₂ O	0.861	0.802	0.804
Xenon	Xe	1.383	2.180	5.851

Table 4-6 Model 0550E Standard Restrictors

Size	Range sccm Nitrogen Equiv. Flow*		Part Number		
	Low	High	Sintered	ACLFE	Wire Mesh
L	90.92	128.7	S-110-Z-303-BMA	S-110-Z-282-BMT	
M	127.3	180.2	S-110-Z-304-BMA	S-110-Z-304-BMA	
N	178.1	252.4	S-110-Z-305-BMA	S-110-Z-284-BMT	
P	249.5	353.3	S-110-Z-306-BMA	S-110-Z-285-BMT	
Q	349.2	494.5	S-110-Z-307-BMA	S-110-Z-286-BMT	
R	489.0	692.4	S-110-Z-308-BMA	S-110-Z-287-BMT	
S	684.6	969.3	S-110-Z-309-BMA	S-110-Z-288-BMT	
T	958.4	1357.0	S-110-Z-310-BMA	S-110-Z-289-BMT	
U	134.1	1900.0	S-110-Z-311-BMA	S-110-Z-290-BMT	
V	1878.0	2660.0	S-110-Z-312-BMA	S-110-Z-291-BMT	
W	2630.0	3724.0	S-110-Z-313-BMA	S-110-Z-292-BMT	
X	3681.0	5214.0			S-110-Z-319-BMA
Y	5155.0	7299.0			S-110-Z-321-BMA
1	7215.0	10218.0			S-110-Z-317-BMA
2	10073.0	14311.0			S-110-Z-228-BMA
3	14138.0	20030.0			S-110-Z-226-BMA
1-40 micron	20000.0	28000.0	S-613-E-636-BMT		
2-40 micron	28000.0	45000.0	S-613-E-523-BMT		
3-40 micron	45000.0	65000.0	S-613-E-526-BMT		
2-40/1-60 micron	65000.0	85000.0	S-613-E-528-BMT		
1-40/2-60 micron	85000.0	10000.0	S-613-E-529-BMT		
3-60 micron	100000.0	140000.0**	S-613-E-527-BMT		

* Based on 70°F Standard Reference Temperature

** For Hydrogen at 140 slpm to 200 slpm use 3-60 micron restrictor elements. Above 200 slpm, use 2-60 micron, 1-100 micron (P/N S- 613-E-533-BMT)

NOTE 1: If Nitrogen equivalent flow is between two sizes, choose the large size.

NOTE 2: When using a size "3" or smaller restrictor, a low flow cylinder housing must be used (S-613-E-640-BMA).

Brooks® Model 0550E

Table 4-7 Standard Flow Ranges

Model No.	Full Scale Flowrate	Gas	Restrictor Size	Orifice Size (inches)
12N*	100 sccm	N ₂	L	.0040
22N	200 sccm	N ₂	N	.0067
32N*	300 sccm	N ₂	P	.0067
52N	500 sccm	N ₂	R	.0091
13N*	1000 sccm	N ₂	T	.0160
23N	2000 sccm	N ₂	V	.0210
33N*	3000 sccm	N ₂	W	.0210
53N	5000 sccm	N ₂	X	.0310
14N*	10 slpm	N ₂	1	.0460
24N	20 slpm	N ₂	3	.0550
34N	30 slpm	N ₂	2-40 micron	.0635
54N	50 slpm	N ₂	3-40 micron	.0700
12H*	100 sccm	H ₂	L	.0040
22H	200 sccm	H ₂	N	.0040
32H*	300 sccm	H ₂	P	.0040
52H	500 sccm	H ₂	R	.0067
13H*	1000 sccm	H ₂	T	.0067
23H	2000 sccm	H ₂	V	.0091
33H*	3000 sccm	H ₂	W	.0160
53H	5000 sccm	H ₂	X	.0160
14H*	10 slpm	H ₂	1	.0210
24H	20 slpm	H ₂	3	.0310
34H*	30 slpm	H ₂	2-40 micron	.0360
54H*	50 slpm	H ₂	3-40 micron	.0550
25H*	200 slpm	H ₂	3-60 micron	.1065
35H*	300 slpm	H ₂	2-60 m. 1-100 m	.1065

* Standard Applied Materials Range

4-7 Restrictor Sizing

The restrictor assembly is a ranging device for the sensor portion of the controller. It creates a pressure drop which is linear with flow rate. This diverts a sample quantity of the process gas flow through the sensor. Each restrictor maintains the ratio of sensor flow to restrictor flow, however the total flow through each restrictor is different. Different restrictors (micron porosity and active area) have different pressure drops and produce meters with different full scale flow rates. For a discussion of the interaction of the various parts of the meter, you are urged to review Section 3-1 (Theory of Operation).

If the restrictor assembly has been contaminated with foreign matter, the pressure drop vs. flow characteristics is altered and the restrictor assembly must be cleaned or replaced. It may also be necessary to replace the restrictor assembly when the mass flow controller is to be calibrated to a new flow rate.

Restrictor assembly replacement should be performed only by trained personnel. The tools required for the removal/replacement procedure are as follows:

- 9/64 inch Allen wrench, for the removal of the inlet process connection
- Restrictor removal tool (Refer to Table 5-2)
- Restrictor O-rings, refer to the spare parts Section 5, for the correct part numbers.

The 0550E Mass Flow Controller utilizes two restrictor assembly configurations depending on the flow rate. Nitrogen equivalent flows equal to or less than 20 slpm utilize a cylinder into which the restrictor assembly is inserted. Flows greater than 20 slpm utilize porous metal restrictor assemblies (Refer to Figure 4-5).

Flow controllers sized for one of the standard Applied Materials Flow rates contain the restrictor element listed in Table 4-7.

Restrictor Types

100 sccm thru 20 slpm Air Equivalent Flow

For flows in this range, a cylinder (Figure 4-5) in combination with one of three different restrictors must be used. The restrictor selected depends on full scale flow rate and expected service conditions.

1. Porous sintered metal restrictors are used for air equivalent flow rates up to and including 3.7 slpm. The porosity ranges from 1-40 microns. This type of assembly is least expensive and should be used when the gas stream does not contain any particulate matter.
2. Anti-clog Laminar Flow Element (ACLFE). These restrictor assemblies are also used for Nitrogen equivalent flow rates less than 3.7 slpm. The ACLFE is much more tolerant to particulate contamination than the sintered metal assembly. This is especially important when handling semiconductor gases that tend to precipitate particles. The ACLFE also improves accuracy when operating at very low inlet pressures.
3. Sintered wire mesh restrictors are used for air equivalent flow rates above 3.7 slpm. These restrictor assemblies are made from a cylinder of sintered wire mesh and are easily cleaned if they become contaminated in service.

For flow rates greater than 20 slpm, the 0550E utilizes porous metal restrictor assemblies (Figure 4-5).

Restrictors with porosities of 40 and 60 microns are used in different combinations. Up to 3 restrictor elements can be placed in one assembly. These restrictors are assembled by pressing the porous metal elements into the header plate.

Brooks® Model 0550E

When sizing a restrictor assembly for gases other than air, the sensor conversion factor must be included as the restrictor is used to divert a portion of the process flow through the sensor. Use the following equation to obtain the desired output in air equivalent units. Refer to Table 4-5 for the conversion factor list.

Using this Nitrogen equivalent flow, select a restrictor assembly from Table 4-5.

Example:

The desired gas is cyanogen

The desired full scale flow rate is 30 slpm.

Sensor conversion factor = 0.498 (Table 4-5)

Nitrogen equivalent flow = $30 / 0.498 = 60.24$ slpm

In the example above, the restrictor should be sized for a 60.24 slpm flow rate (P/N S-613-E-526-BMT)

$$\text{Example:} \quad \begin{array}{l} \text{Nitrogen} \\ \text{Equiv.} \\ \text{Flow} \end{array} = \frac{\text{desired gas flow}}{\text{sensor conversion factor}}$$

The desired gas is Silane (SiH_4).

The desired full scale flow rate is 200 sccm.

Sensor conversion factor is 0.625 (Table 4-5).

Nitrogen equivalent flow = $200 / 0.625 = 320.00$ sccm Nitrogen.

In the example above a size 'P' restrictor would be selected. Both the sintered metal and the ACLFE are available for this size. Either type will work. However, in this case, since Silane is known to precipitate silicon dioxide particles, the anti-clog laminar flow element should be selected.

NOTE: If the calculated flow rate is such that two different size restrictors can be used, always select the larger size.

If a mixture of two or more gases is being used the restrictor selection must be based on the Nitrogen equivalent flow rate of the mixture.

Example:

The desired gas is 20% Helium (He) and 80% Chlorine (Cl) by volume.

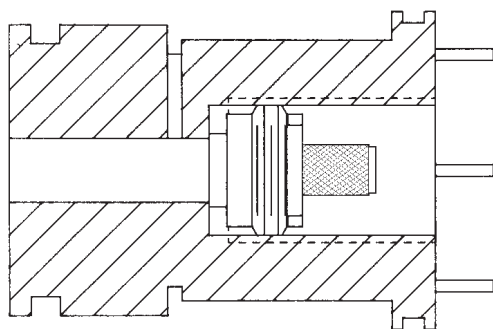
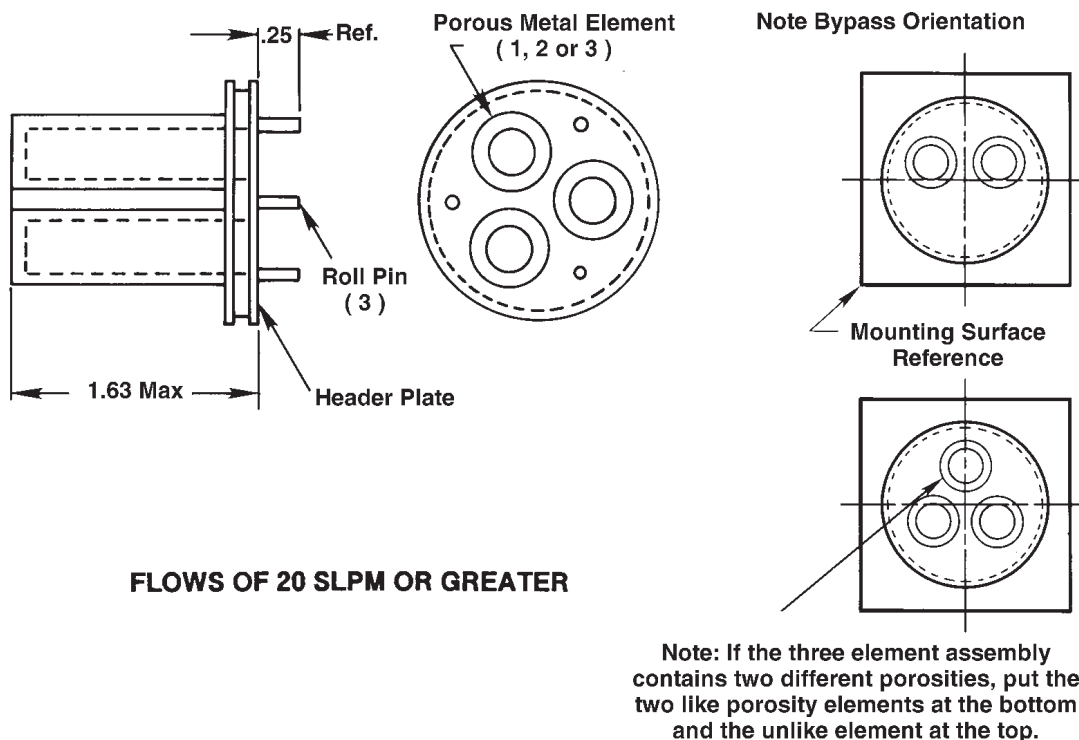
The desired full scale flow rate of the mixture is 5 slpm.

Sensor conversion factor for the mixture is:

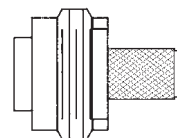
$$\begin{array}{l} \text{Mixture} \\ \text{Factor} \end{array} = \frac{100}{\frac{20}{1.386} + \frac{80}{.876}} = 0.946$$

Nitrogen equivalent flow = $5 / 0.946 = 5.285$ slpm Nitrogen. In this example a size Y wire mesh assembly would be selected.

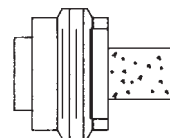
The restrictor subassembly for the last two examples can also include a restrictor cylinder. Refer to Figure 4-5.



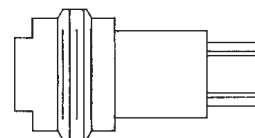
FLows FROM 100 SCCM TO 20 SLPM



WIRE MESH



SINTERED



ACLFE

Figure 4-5 Restrictor Element Assemblies

Brooks® Model 0550E

If a restrictor assembly is being replaced because the original has become contaminated, the original may be used as a guide to select the replacement assembly. The porosity of the original element or elements is marked on the calibration sheet which was shipped with the flow controller. The replacement assembly should be replaced in the same orientation as the original restrictor.

Assembly procedure

1. Select the proper restrictor element combination.
2. When handling restrictor elements use care to insure that they are not contaminated with dirt, grease, oil etc. The use of rubber gloves is recommended.
3. Put a lightly lubricated O-ring onto the header plate. Assemblies which require a restrictor cylinder, two lightly lubricated O-rings are used.
4. For restrictor assemblies that require cylinders install O-ring (375-B-109) onto the restrictor. Using a restrictor tool, insert restrictor into the cylinder and tighten hand tight.
5. Install header or cylinder into MFC body, the end opposite the roll pins goes in first. It is important that the header plate type restrictors be installed in the correct orientation. Refer to Figure 4-5. Push the assembly in with your fingers or use the header removal tool. Do not use an arbor press or hammer to install the restrictor assembly. The restrictor assembly should be pushed in until it bottoms out. Do not force it beyond this point. Rotating the header plate or cylinder as it goes into the body aids insertion.

⚠ CAUTION

The end block screws (29) and the valve screws (3) are not interchangeable. The end block screws are stronger and needed for the pressure rating. The end block screws are darker in color, longer and can be attracted by a magnet.

6. Place the end block O-ring in position and install the end block with the 4 hex socket screws. Tighten these screws to 49 inch lbs. Do not overtighten.
7. Install the inlet adapter fitting.
8. Calibrate the mass flow controller. Refer to Section 3-4.
If the TP1 voltage as calculated in the calibration procedure, Section 3-4 step f, is greater than -2.0 volts the flow rate is greater than desired. If this occurs, the restrictor assembly should be replaced with the next lower flow rate assembly. If the TP1 procedure, Section 3-4 step f, is less than -9.0 volts, the flow through the controller is less than desired. If this occurs, the restrictor assemblies should be replaced with the next higher flow rate assembly.

Dansk

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Emne : Tillæg til instruktions manual.
Reference : CE mærkning af Masse Flow udstyr
Dato : Januar-1996.

Brooks Instrument har gennemført CE mærkning af elektronisk udstyr med succes, i henhold til regulativet om elektrisk støj (EMC direktivet 89/336/EEC).

Der skal dog gøres opmærksom på benyttelsen af signalkabler i forbindelse med CE mærkede udstyr.

Kvaliteten af signal kabler og stik:

Brooks lever kabler af høj kvalitet, der imødekommer specifikationerne til CE mærkning.

Hvis der anvendes andre kabel typer skal der benyttes et skærmet kabel med hel skærm med 100% dækning.

Forbindelses stikket type "D" eller "cirkulære", skal være skærmet med metalhus og eventuelle PG-forskrutninger skal enten være af metal eller metal skærmet.

Skærmen skal forbindes, i begge ender, til stikkets metalhus eller PG-forskrutningen og have forbindelse over 360 grader.

Skærmen bør være forbundet til jord.

"Card Edge" stik er standard ikke af metal, der skal derfor ligeledes benyttes et skærmet kabel med hel skærm med 100% dækning.

Skærmen bør være forbundet til jord.

Forbindelse af stikket; venligst referer til vedlagte instruktions manual.

Med venlig hilsen,

Deutsch

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Subject : Nachtrag zur Bedienungsanleitung.
Referenz : CE Zertifizierung für Massedurchflußgeräte
Datum : Januar-1996.

Nach erfolgreichen Tests entsprechend den Vorschriften der Elektromagnetischen Verträglichkeit (EMC Richtlinie 89/336/EEC) erhalten die Brooks-Geräte (elektrische/elektronische Komponenten) das CE-Zeichen.

Bei der Auswahl der Verbindungskabel für CE-zertifizierte Geräte sind spezielle Anforderungen zu beachten.

Qualität der Verbindungskabel, Anschlußstecker und der Kabeldurchführungen

Die hochwertigen Qualitätskabel von Brooks entsprechen der Spezifikation der CE-Zertifizierung.

Bei Verwendung eigener Verbindungskabel sollten Sie darauf achten, daß eine 100 %igen Schirmabdeckung des Kabels gewährleistet ist.

"D" oder "Rund" -Verbindungsstecker sollten eine Abschirmung aus Metall besitzen.

Wenn möglich, sollten Kabeldurchführungen mit Anschlußmöglichkeiten für die Kabelabschirmung verwendet werden.

Die Abschirmung des Kabels ist auf beiden Seiten des Steckers oder der Kabeldurchführungen über den vollen Umfang von 360 ° anzuschließen.

Die Abschirmung ist mit dem Erdpotential zu verbinden.

Platinen-Steckverbindungen sind standardmäßige keine metallgeschirmten Verbindungen. Um die Anforderungen der CE-Zertifizierung zu erfüllen, sind Kabel mit einer 100 %igen Schirmabdeckung zu verwenden.

Die Abschirmung ist mit dem Erdpotential zu verbinden.

Die Belegung der Anschlußpins können Sie dem beigelegten Bedienungshandbuch entnehmen.

Brooks® Model 0550E

English

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Subject : Addendum to the Instruction Manual.
Reference : CE certification of Mass Flow Equipment
Date : January-1996.

The Brooks (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 89/336/EEC).

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 supplies high quality cable(s) which meets the specifications for CE certification.

If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.

"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screen clamping.

The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.

The shield should be terminated to a earth ground.

Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification.

The shield should be terminated to a earth ground.

For pin configuration : Please refer to the enclosed Instruction Manual.

Español

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Asunto : Addendum al Manual de Instrucciones.
Referencia : Certificación CE de los Equipos de Caudal Másico
Fecha : Enero-1996.

Los equipos de Brooks (eléctricos/electrónicos) en relación con la marca CE han pasado satisfactoriamente las pruebas referentes a las regulaciones de Compatibilidad Electro magnética (EMC directiva 89/336/EEC).

Sin embargo se requiere una atención especial en el momento de seleccionar el cable de señal cuando se va a utilizar un equipo con marca CE.

Calidad del cable de señal, prensaestopas y conectores:

Brooks suministra cable(s) de alta calidad, que cumple las especificaciones de la certificación CE .

Si usted adquiere su propio cable de señal, debería usar un cable que esté completamente protegido en su conjunto con un apantallamiento del 100%.

Cuando utilice conectores del tipo "D" ó "Circular" deberían estar protegidos con una pantalla metálica. Cuando sea posible, se deberán utilizar prensaestopas metálicos provistos de abrazadera para la pantalla del cable.

La pantalla del cable deberá ser conectada al casquillo metálico ó prensa y protegida en ambos extremos completamente en los 360 Grados.

La pantalla deberá conectarse a tierra.

Los conectores estandar de tipo tarjeta (Card Edge) no son metálicos, los cables utilizados deberán ser protegidos con un apantallamiento del 100% para cumplir con la certificación CE.

La pantalla deberá conectarse a tierra.

Para ver la configuración de los pines: Por favor, consultar Manual de Instrucciones adjunto.

Français

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Sujet : Annexe au Manuel d'Instructions.
Référence : Certification CE des Débitmètres Massiques à Effet Thermique.
Date : Janvier 1996.

Messieurs,

Les équipements Brooks (électriques/électroniques) portant le label CE ont été testés avec succès selon les règles de la Compatibilité Electromagnétique (directive CEM 89/336/EEC).

Cependant, la plus grande attention doit être apportée en ce qui concerne la sélection du câble utilisé pour véhiculer le signal d'un appareil portant le label CE.

Qualité du câble, des presse-étoupes et des connecteurs:

Brooks fournit des câbles de haute qualité répondant aux spécifications de la certification CE.

Si vous approvisionnez vous-même ce câble, vous devez utiliser un câble blindé à 100 %.

Les connecteurs « D » ou de type « circulaire » doivent être reliés à la terre.

Si des presse-étoupes sont nécessaires, ceux ci doivent être métalliques avec mise à la terre.

Le blindage doit être raccordé aux connecteurs métalliques ou aux presse-étoupes sur le pourtour complet du câble, et à chacune de ses extrémités.

Tous les blindages doivent être reliés à la terre.

Les connecteurs de type « card edge » sont non métalliques. Les câbles utilisés doivent être blindés à 100% pour satisfaire à la réglementation CE.

Tous les blindages doivent être reliés à la terre.

Se référer au manuel d'instruction pour le raccordement des contacts.

Greek

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

α : Προσθήκη στο Εγχειρίδιο Οδηγιών.
ικά : Πιστοποίηση CE των Οργάνων Μέτρησης Παροχής Μάζας.
ρομηγία : Ιανουάριος - 1996

Συρίες και Κύριοι,

Για όργανα (ηλεκτρικά/ηλεκτρονικά) της Brooks τα οποία φέρουν το σήμα CE έχουν επιτυχώς ελεγχθεί σύμφωνα με τους κανονισμούς της Ηλεκτρο-Μαγνητικής Συμβατότητας (EMC ντιρεκτίβα 89/336/EEC).

Ωποσδήποτε χρειάζεται ειδική προσοχή κατά την επιλογή του καλωδίου μεταφοράς του σήματος το οποίο (καλώδιο) πρόκειται να χρησιμοποιηθεί με όργανα που φέρουν ο σήμα CE.

Ιδιότητα του καλωδίου σήματος των τυποιοθλιπτών και των συνδέσμων .

Η Brooks κατά κανόνα προμηθεύει υψηλής ποιότητας καλώδια τα οποία πληρούν τις προδιαγραφές για πιστοποίηση CE.

Εάν η επιλογή του καλωδίου σήματος γίνει από σας πρέπει να χρησιμοποιήσετε αλβώδιο το οποίο να φέρει εξωτερικά πλήρες πλέγμα και να παρέχει θωράκιση 100%.

Η σύνδεσμοι τύπου "D" ή "Κυκλικοί" των καλωδίων, πρέπει να θωρακίζονται με εταλλική θωράκιση. Εάν είναι εφαρμόσιμο, πρέπει να χρησιμοποιούνται μεταλλικοί τυποιοθλίπτες καλωδίων που να διαθέτουν ακροδέκτη σύνδεσης του πλέγματος του αλωδίου.

Ο πλέγμα του καλωδίου πρέπει να συνδέεται στο μεταλλικό περίβλημα ή στον τυποιοθλίπτη και να θωρακίζεται και στα δύο άκρα κατά 360 μοίρες.

Η θωράκιση πρέπει να καταλήγει σε κάποιο ακροδέκτη γείωσης.

Η σύνδεσμοι καρτών είναι μη-μεταλλικοί, τα καλώδια που χρησιμοποιούνται πρέπει να φέρουν πλέγμα θωράκισης 100% για να υπακούουν στην πιστοποίηση CE.

Η θωράκιση πρέπει να καταλήγει σε κάποιο ακροδέκτη γείωσης.

Για την διάταξη των ακροδεκτών: Παρακαλούμε αναφερθείτε στο εσώκλειστο γχειρίδιο Οδηγιών.

Brooks® Model 0550E

Italiano

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Oggetto : Addendum al manuale di istruzioni.
Riferimento : Certificazione CE dei misuratori termici di portata in massa
Data : Gennaio 1996.

Questa strumentazione (elettrica ed elettronica) prodotta da Brooks Instrument, soggetta a marcatura CE, ha superato con successo le prove richieste dalla direttiva per la Compatibilità Elettromagnetica (Direttiva EMC 89/336/EEC).

E' richiesta comunque una speciale attenzione nella scelta dei cavi di segnale da usarsi con la strumentazione soggetta a marchio CE.

Qualità dei cavi di segnale e dei relativi connettori:

Brooks fornisce cavi di elevata qualità che soddisfano le specifiche richieste dalla certificazione CE. Se l'utente intende usare propri cavi, questi devono possedere una schermatura del 100%.

I connettori sia di tipo "D" che circolari devono possedere un guscio metallico. Se esiste un passacavo esso deve essere metallico e fornito di fissaggio per lo schermo del cavo.

Lo schermo del cavo deve essere collegato al guscio metallico in modo da schermarlo a 360° e questo vale per entrambe le estremità.

Lo schermo deve essere collegato ad un terminale di terra.

I connettori "Card Edge" sono normalmente non metallici. Il cavo impiegato deve comunque avere una schermatura del 100% per soddisfare la certificazione CE.

Lo schermo deve essere collegato ad un terminale di terra.

Per il corretto cablaggio dei terminali occorre fare riferimento agli schemi del manuale di istruzioni dello strumento.

Nederlands

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Onderwerp : Addendum voor Instructie Handboek
Referentie : CE certificering voor Mass Flow Meters & Controllers
Datum : Januari 1996

Dames en heren,

Alle CE gemarkeerde elektrische en elektronische producten van Brooks Instrument zijn met succes getest en voldoen aan de wetgeving voor Electro Magnetische Compatibiliteit (EMC wetgeving volgens 89/336/EEC).

Speciale aandacht is echter vereist wanneer de signaalkabel gekozen wordt voor gebruik met CE gemarkeerde producten.

Kwaliteit van de signaalkabel en kabelansluitingen:

- Brooks levert standaard kabels met een hoge kwaliteit, welke voldoen aan de specificaties voor CE certificering. Indien men voorziet in een eigen signaalkabel, moet er gebruik gemaakt worden van een kabel die volledig is afgeschermd met een bedekkingsgraad van 100%.
- "D" of "ronde" kabelconnectoren moeten afgeschermd zijn met een metalen connector kap. Indien kabelwartels worden toegepast, moeten metalen kabelwartels worden gebruikt die het mogelijk maken het kabelscherm in te klemmen. Het kabelscherm moet aan beide zijden over 360° met de metalen connectorkap, of wartel verbonden worden. Het scherm moet worden verbonden met aarde.
- "Card-edge" connectors zijn standaard niet-metallisch. De gebruikte kabels moeten volledig afgeschermd zijn met een bedekkingsgraad van 100% om te voldoen aan de CE certificering. Het scherm moet worden verbonden met aarde.

Voor pin-configuraties a.u.b. verwijzen wij naar het bijgesloten instructie handboek.

Hoogachtend,

Norsk

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Vedrørende : Vedlegg til håndbok
Referanse : CE sertifisering av utstyr for massestrømsmåling og regulering
Dato : Januar 1996

Til den det angår

Brooks Instrument elektrisk og elektronisk utstyr påført CE-merket har gjennomgått og bestått prøver som beskrevet i EMC forskrift om elektromagnetisk immunitet, direktiv 89/336/EEC.

For å opprettholde denne klassifisering er det av stor viktighet at riktig kabel velges for tilkobling av det måletekniske utstyret.

Utførelse av signalkabel og tilhørende plugger:

- Brooks Instrument tilbyr levert med utstyret egnet kabel som møter de krav som stilles til CE-sertifisering.
 - Dersom kunden selv velger kabel, må kabel med fullstendig, 100% skjerming av lederene benyttes. "D" type og runde plugger og forbindelser må være utført med kappe i metall og kabelnipler må være utført i metall for jordet innfesting av skjermen. Skjermen i kabelen må tilknyttes metallet i pluggen eller nippelen i begge ender over 360°, tilkoblet elektrisk jord.
 - Kort-kantkontakter er normalt utført i kunststoff. De tilhørende flatkabler må være utført med fullstendig, 100% skjerming som kobles til elektrisk jord på riktig pinne i pluggen, for å møte CE sertifiseringskrav.
- For tilkobling av medleverte plugger, vennligst se håndboken som hører til utstyret.
- Vennlig hilsen

Português

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Assunto : Adenda ao Manual de Instruções
Referência : Certificação CE do Equipamento de Fluxo de Massa
Data : Janeiro de 1996.

O equipamento (eléctrico/electrónico) Brooks com a marca CE foi testado com êxito nos termos do regulamento da Compatibilidade Electromagnética (directiva CEM 89/336/EEC).

Todavia, ao seleccionar-se o cabo de sinal a utilizar com equipamento contendo a marca CE, será necessário ter uma atenção especial.

Qualidade do cabo de sinal, buchas de cabo e conectores:

- A Brooks fornece cabo(s) de qualidade superior que cumprem os requisitos da certificação CE.
 - Se fornecerem o vosso próprio cabo de sinal, devem utilizar um cabo que, na sua totalidade, seja isolado com uma blindagem de 100%.
 - Os conectores tipo "D" ou "Circulares" devem ser blindados com uma blindagem metálica. Se tal for necessário, deve utilizar-se buchas metálicas de cabo para o isolamento do aperto do cabo.
 - O isolamento do cabo deve ser ligado à blindagem ou bucha metálica em ambas as extremidades em 360°.
 - A blindagem deve terminar com a ligação à massa.
 - Os conectores "Card Edge" não são, em geral, metálicos e os cabos utilizados devem ter um isolamento com blindagem a 100% nos termos da Certificação CE..
 - A blindagem deve terminar com ligação à massa.
- Relativamente à configuração da cavilha, queiram consultar o Manual de Instruções.

Brooks® Model 0550E

Suomi

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Asia : Lisäys Käyttöohjeisiin
Viiite : Massamäärämittareiden CE sertifiointi
Päivämäärä : Tammikuu 1996

Brooksin CE merkillä varustetut sähköiset laitteet ovat läpäissyt EMC testit (direktiivi 89/336/EEC).
Erityistä huomiota on kuitenkin kiinnitettävä signaalikaapelin valintaan.

Signaalikaapelin, kaapelin läpiviennin ja liittimen laatu

Brooks toimittaa korkealaatuisia kaapeleita, jotka täyttävät CE sertifiointivaatimukset. Hankkiessaan signaalikaapelin itse, olisi hankittava 100%:sti suojattu kaapeli.

”D” tai ”Circular” tyyppisen liittimen tulisi olla varustettu metallisuojaalla. Mikäli mahdollista, tulisi käyttää metallisia kaapeliliittimiä kiinnitettäessä suoja.

Kaapelin suoja tulisi olla liitetty metallisuojaan tai liittimeen molemmissa päissä 360°:n matkalta.

Suojan tulisi olla maadoitettu.

”Card Edge Connector”it ovat standarditoimituksina ei-metallisia. Kaapeleiden täytyy olla 100%: sesti suojattuja jotta ne olisivat CE sertifiointin mukaisia.

Suoja on oltava maadoitettu.

Nastojen liittäminen; katso liitteenä oleva manuaali.

Ystävällisin terveisin,

Svensk

Brooks Instrument
407 West Vine St.
Hatfield, PA 19440
U.S.A.

Subject : Addendum to the Instruction Manual
Reference : CE certification of Mass Flow Equipment
Date : January 1996

Brooks (elektriska / elektronik) utrustning, som är CE-märkt, har testats och godkänts enligt gällande regler för elektromagnetisk kompatibilitet (EMC direktiv 89/336/EEC).

Speciell hänsyn måste emellertid tas vid val av signalkabel som ska användas tillsammans med CE-märkt utrustning.

Kvalitet på signalkabel och anslutningskontakter:

Brooks levererar som standard, kablar av hög kvalitet som motsvarar de krav som ställs för CE-godkännande.

Om man använder en annan signalkabel ska kabeln i sin helhet vara skärmad till 100%. ”D” eller ”runda” typer av anslutningskontakter ska vara skärmade. Kabelgenomföringar ska vara av metall alternativt med metalliserad skärmning.

Kabelns skärm ska, i bada ändar, vara ansluten till kontakternas metallkåpor eller genomföringar med 360 graders skärmning. Skärmen ska avslutas med en jordförbindelse.

Kortkontakter är som standard ej metalliserade, kablar som används måste vara 100% skärmade för att överensstämma med CE-certifieringen.

Skärmen ska avslutas med en jordförbindelse.

För elektrisk anslutning till kontaktstiften hänvisas till medföljande instruktionsmanual.

Installation and Operation Manual

X-TMF-0550E-MFC-eng

Part Number: 541B065

October, 2008

Brooks® Model 0550E

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Brooks® Model 0550E**LIMITED WARRANTY**

Seller warrants that the Goods manufactured by Seller will be free from defects in materials or workmanship under normal use and service and that the Software will execute the programming instructions provided by Seller until the expiration of the earlier of twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller. Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer.

All replacements or repairs necessitated by inadequate preventive maintenance, or by normal wear and usage, or by fault of Buyer, or by unsuitable power sources or by attack or deterioration under unsuitable environmental conditions, or by abuse, accident, alteration, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense.

Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Seller and can be amended only in a writing signed by an authorized representative of Seller.

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. The primary standard calibration equipment to calibrate our flow products 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.

CUSTOMER SEMINARS AND TRAINING

Brooks Instrument can provide customer seminars and dedicated training to engineers, end users and maintenance persons. Please contact your nearest sales representative for more details.

HELP DESK

In case you need technical assistance:

Americas ☎ 1-888-554-FLOW

Europe ☎ +(31) 318 549 290 Within Netherlands ☎ 0318 549 290

Asia ☎ +011-81-3-5633-7100

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

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