

# Model 5851E Mass Flow Meter



Model 5851E  
Mass Flow Controller  
with Card Edge Connector



Model 5851E  
Mass Flow Controller  
with D-Connector

# 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, telephone 888-554-FLOW or 215-362-3700 and the requested manual will be provided. 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.

## 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 bag or other 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, CMOS, 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-5851E-MFC-eng

Part Number: 541B104AAG

November, 2008

Brooks® Model 5851E

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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](http://www.BrooksInstrument.com)

Yours sincerely,

Brooks Instrument

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# Installation and Operation Manual

X-TMF-5851E-MFC-eng  
Part Number: 541B104AAG  
November, 2008

Brooks® Model 5851E

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## 1-1 Purpose

The Brooks® Model 5851E 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 Model 5851E 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 5851E.

## 1-2 Description

The Brooks Model 5851E Mass Flow Controller is used widely in the Semiconductor Industry as well as many others, where manual, electronic or computer controlled gas handling occurs. The Model 5851E consists of three basic units: a flow sensor, a control valve and an integral electronic control system. This combination produces a stable gas flow, which eliminates the need to continuously monitor and readjust gas pressures. 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 command setting. Refer to Section 2-8.

-SETPOINT (Command) permits the user to program the mass flow controller with an external 0-5 Vdc command voltage in lieu of a command potentiometer. Refer to Section 2-7.

-LOW COMMAND VALVE INHIBIT (Auto Shut-off) typically prevents the valve from opening whenever the set-point is less than 2% of full scale.

-REMOVABLE CLEANABLE SENSOR permits the user to clean or replace the sensor. Refer to Section 4-4.

-OUTPUT LIMITING prevents possible damage to data acquisition devices by limiting the output to +6.8 Vdc and -0.7 Vdc.

-VALVE OFF accessed via Terminal J on the Card Edge or Pin 4 on the D-Connector version. This feature allows the user to close the control valve independently of the command signal by supplying a TTL level low signal to the proper terminal. This function is useful when performing repetitive flow operations or as a safety shutdown. Refer to Section 2-11.

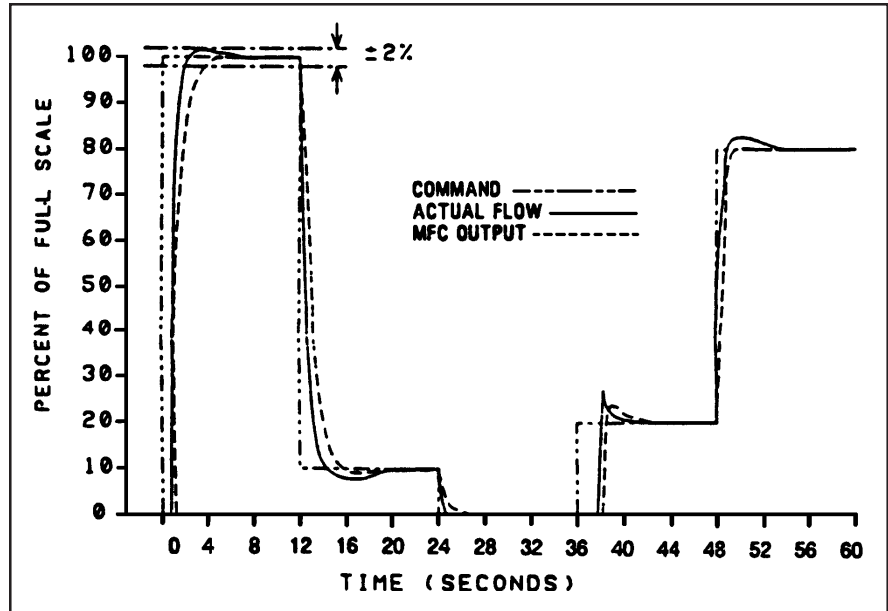


Figure 1-1 Command Steps, Soft Start Disabled

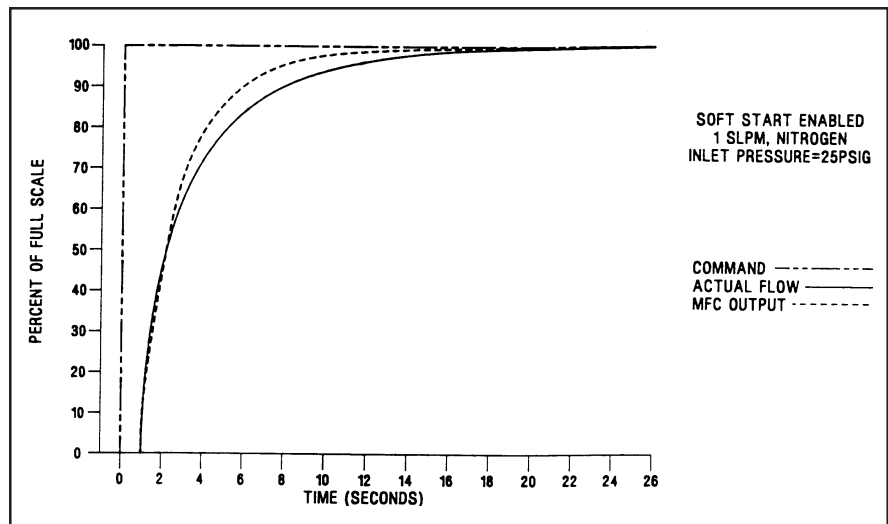


Figure 1-2 0 — 100% Command Step, Soft Start Enabled

-VALVE TEST POINT accessed via Terminal D on the Card Edge or Pin 7 on the D-Connector version. This feature allows the user to monitor the control valve voltage during operation. Refer to Section 2-10.

-REMOTE TRANSDUCER INPUT accessed via Terminal 5 on the Card Edge or Pin 15 on the D-Connector version. This features allows the use of the integral control electronics and valve to regulate flow in response to the signal from an external 0-5 Vdc signal. The mass flow signal from the Model 5851E is still available for process monitoring.



## 1-33 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.**

#### **Standard Ranges**

Any full scale flowrate from 10 slpm to 100 slpm\* (Nitrogen equivalent), up to 200 slpm Hydrogen.

\*Standard temperature and pressure in accordance with SEMI (Semiconductor Equipment and Materials International) standard: 0° C and 101.3 kPa (760 Torr).

#### **Accuracy**

±1% full scale including linearity at calibration conditions

#### **Repeatability**

0.25% of rate

#### **Response Time**

Less than 3 seconds ~~response~~ to within 2% of full scale final value with a 0 to 100% command step.

#### **Power Requirements**

+15 Vdc ±5%, 350 mA

-15 Vdc ±5%, 350 mA

10.5 watts power consumption

Class III Equipment: The dc Mains input shall be supplied from a SELV (Separated Extra-Low Voltage) source.

#### **Ambient Temperature Limits**

Operating: 40°F to 150°F (5°C to 65°C)

Non-Operating: -13°F to +212°F (-25°C to +100°C)

#### **Working Pressure**

1500 psi (10.342 MPa) maximum

#### **Differential Pressure**

10 to 50 psi (minimum pressure drop depends on gas and range). Refer to Orifice Sizing, Section 4-6.

#### **Output Signal**

0-5 Vdc into 1000 ohms or greater. Maximum ripple 3 mV

#### **5 Volt Reference Output**

5 Volts ±0.2%. Maximum load 1 k ohms

#### **Temperature Sensitivity**

Zero: Less than ±0.075% F.S. per degree C

Span: Less than ±1.0% F.S. shift over 10-50° C range

#### **Power Supply Sensitivity**

±0.09% full scale per % power supply voltage variation

Brooks® Model 5851E

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**Mounting Attitude Sensitivity**

±0.5% maximum full scale deviation after re-zeroing

**Command Input**

0-5 Vdc. Input resistance 200 k ohm

**Leak Integrity**

1 x 10<sup>-9</sup> Atm. scc/sec Helium

**Control Range**

50 to 1

**Mechanical Connection**

Refer to Figure 2-1

**Electrical Connection**

Card Edge, 20 terminals, gold over low stress nickel plated copper.

D-Connector, 15 pin (DA-15P)

**Environmental Conditions:**

Installation Category: "I"

Pollution Degree: 2

Humidity: 50-80% Relative Humidity

Meter Altitude: 2,000 meters (6,562 feet)

For Indoor Use ONLY

Mains supply voltage fluctuations not to exceed ±10% of the nominal voltage

## 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.

### Brooks Instrument

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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 with the following conditions:
  1. Ambient temperature 21°C (70°F) nominal.
  2. 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.

## Brooks® Model 5851E

**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 19440-0903, or call toll free 1-888-554-FLOW (3569).

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Email: BrooksAs@BrooksInstrument.com

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 Gas Connections**

Standard inlet and outlet connections supplied on the Model 5850*i* are 1/4" compression fittings.

Optional 1/8" compression, VCO™ and 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.

**2-5 Installation (Refer to Figures 2-1 through 2-4)****⚠ 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.**

**⚠ 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.**

**⚠ CAUTION**

Any Brooks Instrument mass flow meter or controller with a 15 pin D-Connector PC Board bearing the “CE Mark” must use a 100% shielded cable and metal shell mating connectors. The shield is tied over 360 degrees to the shell at both ends. This is mandatory to be in compliance with the EMC Directive (89/336/EEC). Refer to Appendix A.

**Recommended installation procedures:**

- a. The Model 5850E 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.

**⚠ 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 clean, dry N<sub>2</sub> before use.

- d. The Model 5850E Mass Flow Controller can be installed in any position. However, mounting orientations other than the original factory calibration (see data sheet) will result in a  $\pm 0.5\%$  maximum full scale shift after re-zeroing.
- e. When installing controllers with full scale flow rates of 10 slpm or greater, be aware that sharp abrupt angles in the system piping directly upstream of the controller may cause a small shift in accuracy. If possible, have at least ten pipe diameters of straight tubing upstream of the 5850E MFC.

Note: The control valve in the Model 5851E provides precision control and is not designed for positive shut-off. If positive shut-off is required, it is recommended that a separate shut-off valve be installed in-line.

**⚠ CAUTION**

Since the Model 5851E control valve is not a positive shut-off, a separate solenoid valve may have been 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 solenoid resulting in a surge upon actuation of the controller. This surge can be reduced in magnitude by locating the controller and solenoid valve close together or by moving the solenoid valve upstream of the controller.

## Brooks® Model 5851E

**2-6 In-Line Filter**

It is recommended that an in-line filter be installed upstream from the controller to prevent the possibility of any foreign material entering the flow sensor or control valve. The filtering element should be periodically replaced or ultrasonically cleaned.

*Table 2-1 Recommended Filter Size*

Maximum Flow Rate	Recommended Filter Size
10 to 30 slpm	15 Micron
Above 30 slpm	30 Micron

Note: The above table lists the maximum recommended porosity for each flow range. It is recommended that the minimum micron porosity that does not limit the full scale flowrate be used.

**Electrical Interfacing**

To ensure proper operation the Model 5851E must be connected per Figures 2-3 and 2-4, and configured according to Sections 2-6 and 2-12. At a minimum the following connections must be made for new installations.

- Chassis Ground
- 0-5 Volt Signal Common
- 0-5 Volt Signal Output
- +15 Vdc Supply
- 15 Vdc Supply
- Command Input
- Command Common
- Supply Voltage Common

For installations which replace Unit Instruments UFC-1000's, (Card Edge version) Pin 10 is frequently grounded. In these situations the 5 Volt reference output must be disabled. Refer to Section 2-12.

For installations which will be connected to Brooks secondary electronics, the Card Edge version must have the 5 Volt reference enabled on Pin 10. Refer to Section 2-12. If the Model 5851E was shipped as a system with Brooks secondary electronics then the electronics will already be configured properly.

Note: To obtain access to the jumpers for the following options the electronics cover can must be removed. Remove the can by removing the three screws and the valve connector. The can must be replaced before returning the unit to service.

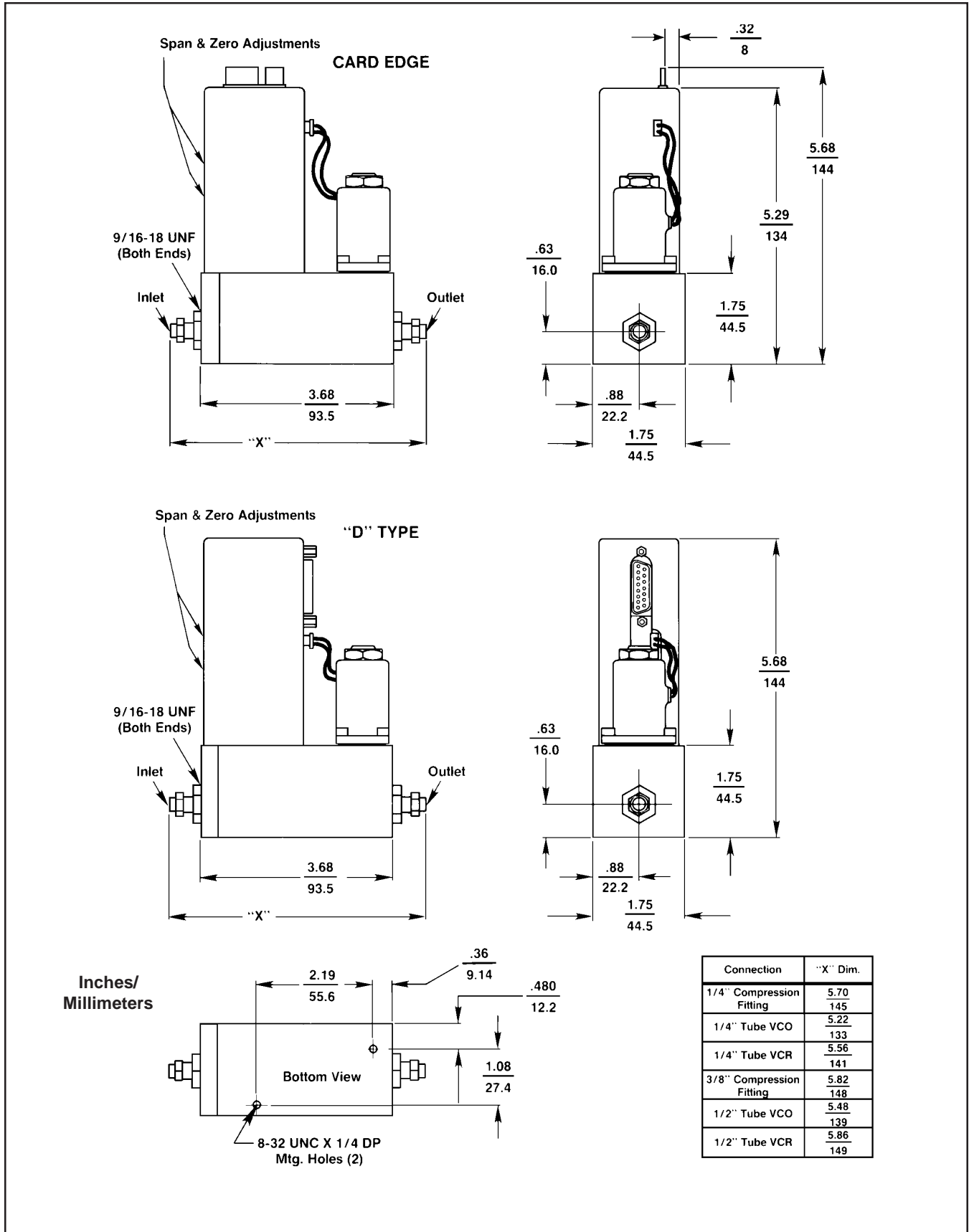
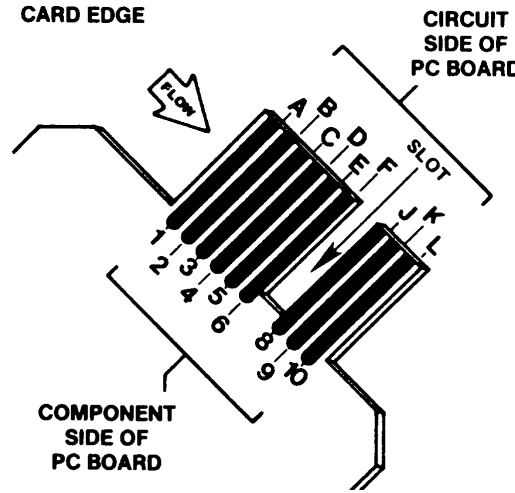


Figure 2-1 Model 5851E Dimensions

Brooks® Model 5851E



Terminal Designation

Unit UFC-1000	Tylan FC-280	Tylan FC-260	Brooks 5851E	Card Edge	Brooks 5851E	Tylan FC-260	Tylan FC-280	Unit UFC-1000
Chassis Ground	Chassis Ground	Chassis Ground	Chassis Ground	1   A	Command Input	Command Input	Command Input	Command Input
0-5 Volt Signal Common	0-5 Volt Signal Common	0-5 Volt Signal Common	0-5 Volt Signal Common	2   B	Command Common	Command Common	Command Common	Command Common
0-5 Volt Signal Output	0-5 Volt Signal Output	0-5 Volt Signal Output	0-5 Volt Signal Output	3   C	Supply Voltage Common	Supply Voltage Common	Return	Supply Voltage Common
+ 15 Vdc Supply	+ 15 Vdc Supply	+ 15 Vdc Supply	+ 15 Vdc Supply	4   D	Valve Test Point (See Note 1)	Valve Test Point	Not used	Valve Test Point/Purge
Not Used	Not Used	Not Used	Remote Transducer Input***	5   E	Not used	Not used	Valve Test Point	Not used
Not Used	Zener Test	Zener Test	Not used	6   F	- 15 Vdc Supply	- 15 Vdc Supply	- 15 Vdc Supply	- 15 Vdc Supply
Slot	Slot	Slot	Slot	7   H*	Slot	Slot	Slot	Slot (G)
Not used	Not used	Not used	Not used	8   J*	Not used	Not used	Not used	Not used (H)
Not used	Not used	Not used	Valve Override	9   K*	Not Used	Not used	Valve Open/Close	Not used (I)
Common	Not used	Not used	+ 5V Ref. ** or Not Used (See Note 2)	10   L*	Valve Off	Not used	Not used	Valve Off (J)

\* Unit designates Pins H, J, K, & L as G, H, I, & J.  
 \*\* Jumper Selectable  
 \*\*\* Factory Actuated Option

Note:

1. The purge feature is not available on the 5851E. Do not ground pin D of the card edge connector.
2. The 5851 does not use pin 10 for valve current return.



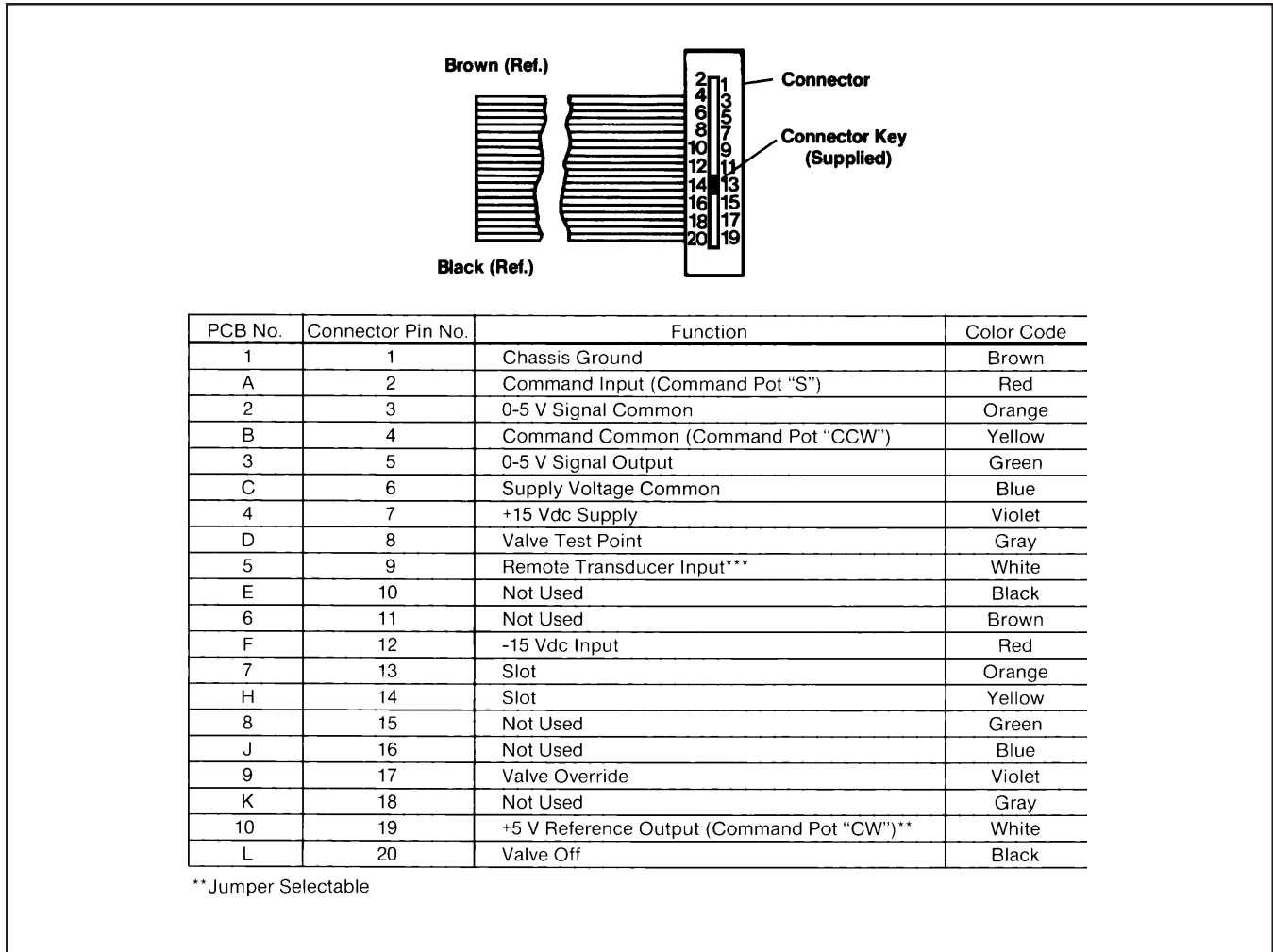


Figure 2-3 Model 5851E Card Edge Connector Hookup Diagram

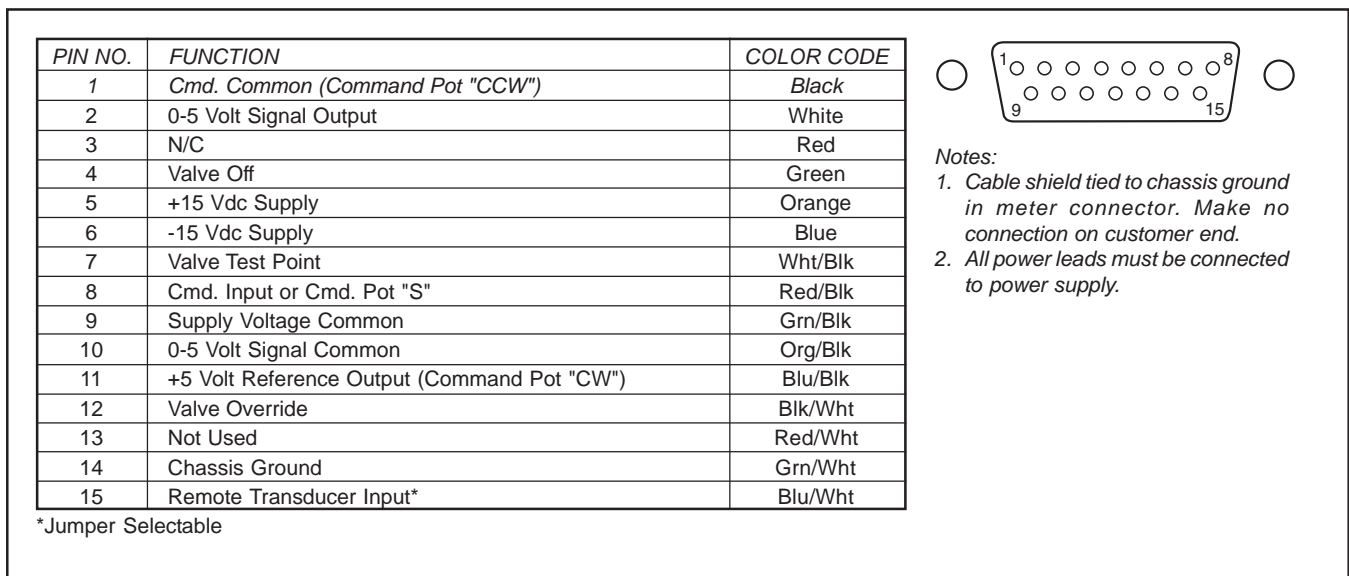


Figure 2-4. D-Connector Pin Arrangement.

## Brooks® Model 5851E

**2-7 Soft Start**

Refer to Figures 3-3, 3-4. To enable soft start, place the jumper on the controller printed circuit board at J2 in the right hand (ss) position.

To disable soft start, place the jumper on the controller printed circuit board at J2 in the left hand (n) position.

**2-8 Remote Set-Point (Command) Input**

If the mass flow controller is to be commanded by an external 0-5 Vdc signal, the command potentiometer is not used.

The command input hookup is as follows:

- A. Card Edge Connector  
Connect the external command voltage to Terminal A, and external command return to Terminal B. Refer to Figures 2-2 and 2-3.
- B. D-Connector  
Connect the external command voltage to Terminal 8 and external command return to Terminal 1. Refer to Figure 2-4.

**2-9 Valve Override**

The valve override function allows full opening and closing of the valve independent of the command setting. The unique command reset feature prevents flow overshoot when the controller goes from valve override closed to normal control.

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

- a. To open the valve apply +15 Vdc to the valve override terminal.
  - b. To close the valve apply -15 Vdc to the valve override terminal.
  - c. Isolating the valve override terminal returns the controller to normal operation.
- A. Card Edge  
The valve override function can be accessed from Terminal 9. Refer to Figure 2-3.  
Note: For normal operation Terminal 9 must be left open (floating).
  - B. D-Connector  
The valve override function is accessed from Terminal 12. Refer to Figure 2-4.

**2-10 Remote Transducer Input**

Refer to Figures 3-3 and 3-4. To allow the Model 5851E control circuitry and valve to be used with an 0-5 Vdc external transducer signal, the jumper at J7 is moved to the lower two pins (R). With this feature enabled a 0-5 Vdc signal may be applied to the external transducer input terminal. The Model 5851E controller circuitry will modulate the valve position to increase or decrease the flow rate to maintain the transducer output at the

desired set point. The control circuitry is reverse acting, e.g. for an increase in transducer output the flow will correspondingly be decreased.

### 2-11 Valve Test Point

Refer to Figures 2-2, 2-3, and 2-4. The valve voltage can be monitored on Pin D of the Card Edge version and Pin 7 of the D-Connector version. This voltage relative to circuit common is approximately proportional to the valve voltage per the following equation when using 15 V valve drive:

$$\text{Valve Voltage} = 1.95 \times \text{TP3} + 33.4 \text{ V}$$

The Model 5851E does not have a purge feature. Do not ground Pin D of the Card Edge version or Pin 7 of the D-Connector version.

### 2-12 Valve Off

Refer to Figures 2-2, 2-3, and 2-4. The control valve can be forced closed regardless of command input signal by applying a TTL level low (<0.4 Vdc) to Terminal L of the Card Edge version or Pin 4 of the Terminal L of the Card Edge version or Pin 4 of the D-Connector version. A TTL level high or floating at this pin has no effect.

### 2-13 Five Volt Reference Out/Valve Drive Configuration

#### A. Card Edge

Refer to Figures 2-3 and 3-3. Terminal 10 can be jumper selected as 5 Volt reference output or "not used". The 5 Volt reference output is required by older Brooks secondary electronics (Ex. Model 5896), or if a potentiometer is to be used to generate the command signal. To enable the 5 Volt reference output on Terminal 10 place the Jumper J8 in the D-E position. To disable the 5 Volt reference output place Jumper J8 in the E-F position.

#### **⚠ CAUTION**

**Do not ground Terminal 10 when 5 Volt reference output is enabled. Irreparable damage to the PC Board may result.**

To enable the Model 5851E to operate satisfactorily with the larger orifice size used for higher flow rates, the P.C. board must be jumper configured for a high voltage valve drive. For Model 5851E, Jumper J3, must be in the A-B (left most) position.

#### B. D-Connector

Refer to Figures 2-4 and 3-4. The 5 Volt reference is always available on Pin 11.

To enable the Model 5851E to operate satisfactorily with the larger orifice size used for higher flow rates, the P.C. board must be jumper configured for a high voltage valve drive. For the Model 5851E Jumper J3 must be in the A-B (left most) position.

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### 3-1 Theory of Operation

The thermal mass flow sensing technique used in the Model 5851E works as follows: A precision power supply provides a constant power heat input (P) to 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. When gas flows through the tube the upstream sensor is cooled and the downstream sensor is heated, producing a temperature difference. The temperature difference  $T_2 - T_1$ , is directly proportional to the gas mass flow.

The equation is:

$$\Delta T = A * P * C_p * m$$

Where,

$\Delta T$  = Temperature difference  $T_2 - T_1$  (°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 ( $S^2 \cdot K^2 / kJ^2$ )

A bridge circuit interprets the temperature difference and a differential amplifier generates a linear 0-5 Vdc 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 meters full scale flow.

In addition to the mass flow sensor the Model 5851E 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 adjusts the current in the modulating solenoid valve to increase or decrease the flow.

The Model 5851E has the following features incorporated in the integral control circuit:

- Fast Response

Adjusted by the anticipate potentiometer, this circuit, when properly adjusted, allows the high frequency information contained in the sensor signal to be amplified to provide a faster responding flow signal for remote indication and use by the control valve.

## Brooks® Model 5851E

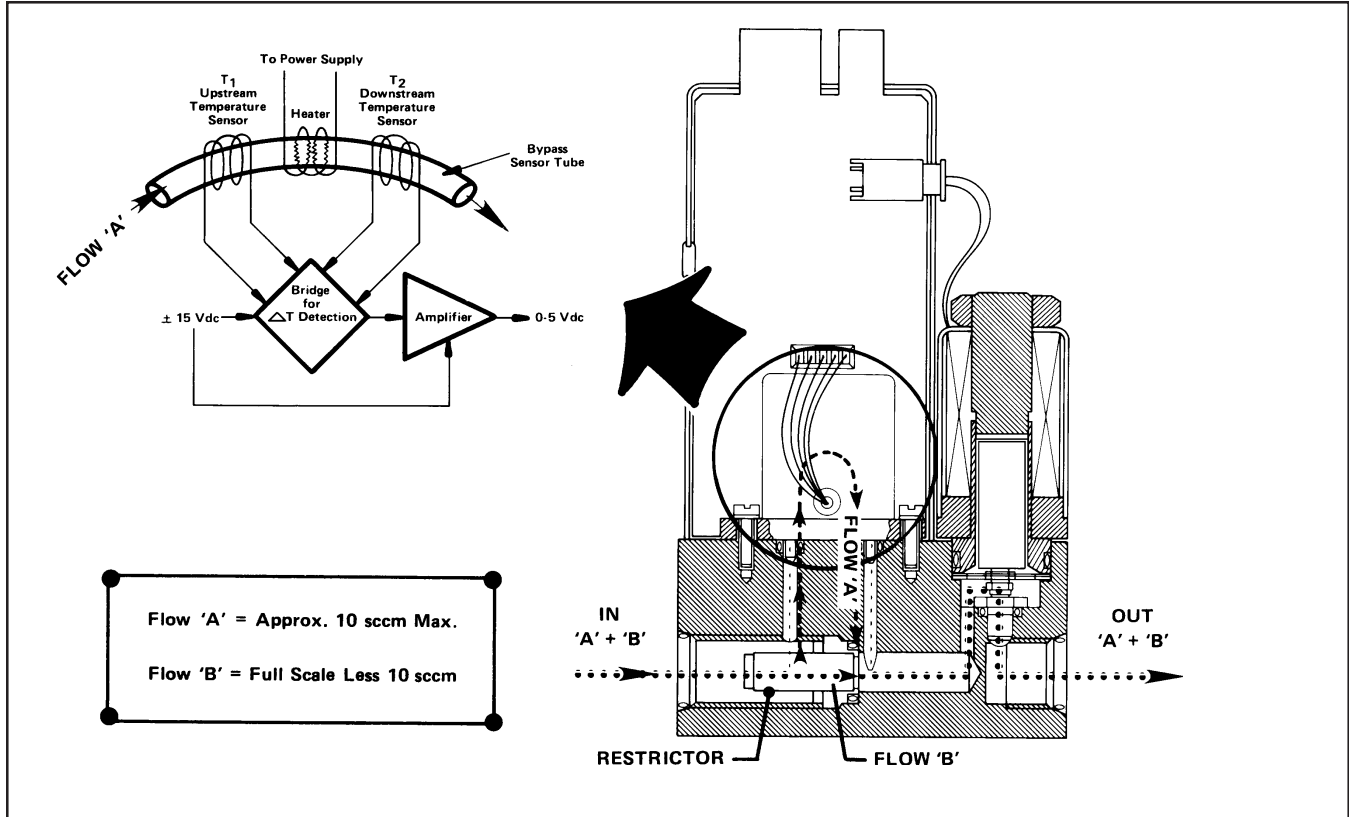


Figure 3-1 Flow Sensor Operational Diagram

- Soft Start

Enabled by moving a jumper on the PC board. Provides a slow injection of gas as a protection to the process, particularly those using a volatile or reactive gas. Full gas flow is achieved in approximately 15 seconds. Refer to Section 2-6.

- Precision 5 Volt Reference

Allows the direct connection of a command potentiometer to a 0-5 Volt command signal to the controller. A precision 10-turn 2 k ohm potentiometer with an integral turns counter is recommended, this will permit repeatable adjustments of command to 1 part in 1000. Refer to Section 2-12 for activation.

- Valve Override

Allows full opening and closing of the control valve independent of the command setting. Refer to Section 2-8.

- Valve Off

Accessed via Terminal J on the Card Edge or Pin 4 on the D-Connector version. This feature allows the user to close the control valve independently of the command signal by supplying a TTL Level low signal to the proper terminal. This function is useful when performing repetitive flow operations or as a safety shutdown. Refer to Section 2-11.

- Valve Test Point

Accessed via Terminal D on the Card Edge or Pin 7 on the D-Connector version of the Model 5850E only. This feature allows the user to monitor the control valve voltage during operation. Refer to Section 2-10.

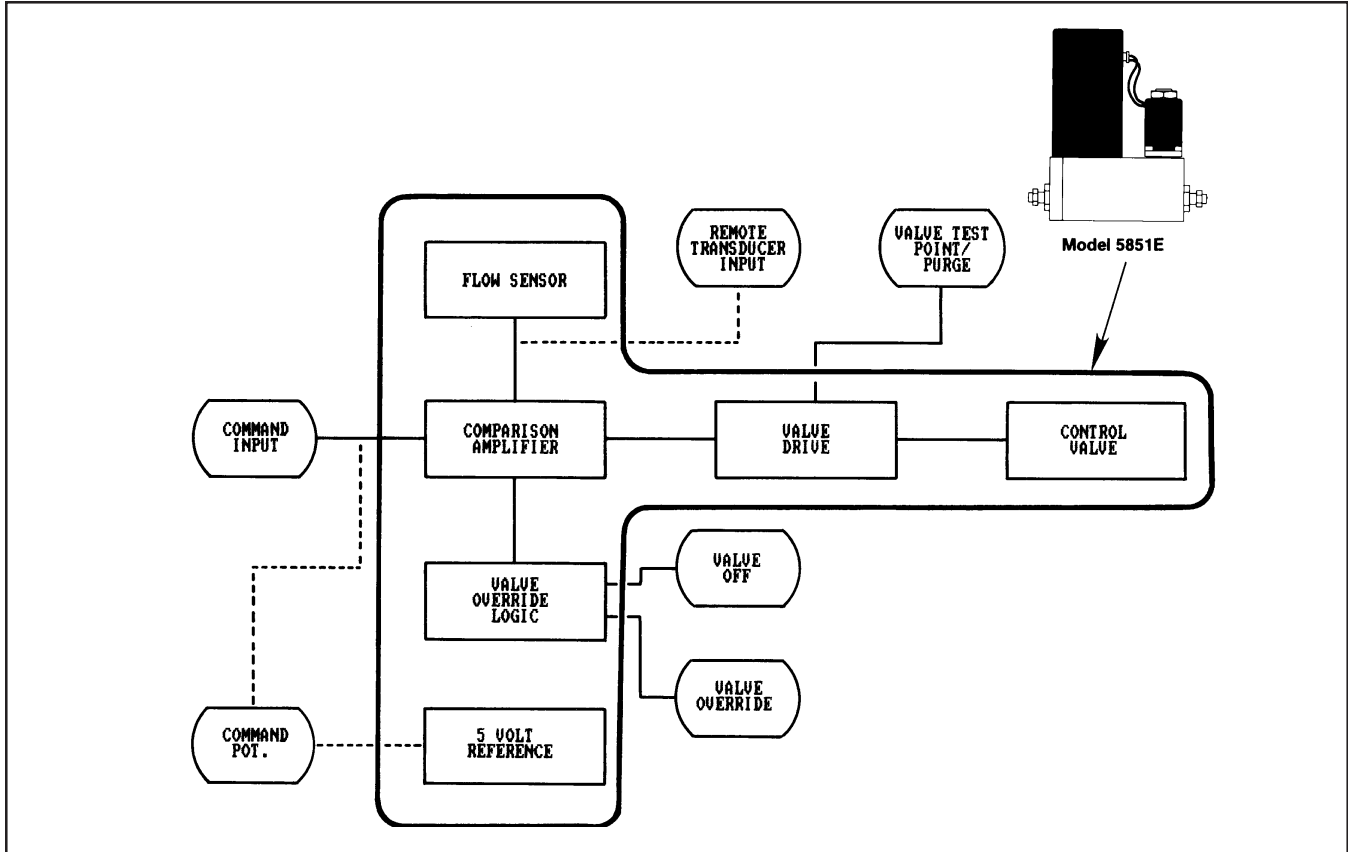


Figure 3-2 Flow Control System Block Diagram

- Remote Transducer Input

Accessed via Terminal 5 on the Card Edge or Pin 15 on the D-Connector version. This feature allows the use of the integral control electronics and valve with the signal from an external 0-5 Vdc signal. The mass flow signal from the Model 5851E is still available for process monitoring. This function is jumper selectable. Refer to Section 2-9.

### 3-2 Operating Procedure

- Apply power to the controller and allow approximately 45 minutes for the instrument to warm-up and stabilize its temperature.
- Turn on the gas supply.
- Command 0% flow and observe the controllers output signal. If the output is not 0 mVdc ( $\pm 10$  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 Model 5851E is factory adjusted to provide a  $0 \pm 10$  mVdc signal at zero flow. The adjustment is made in our calibration laboratory which is temperature controlled to  $21.1^\circ\text{C}$  ( $70^\circ\text{F} \pm 2^\circ\text{F}$ ). 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.

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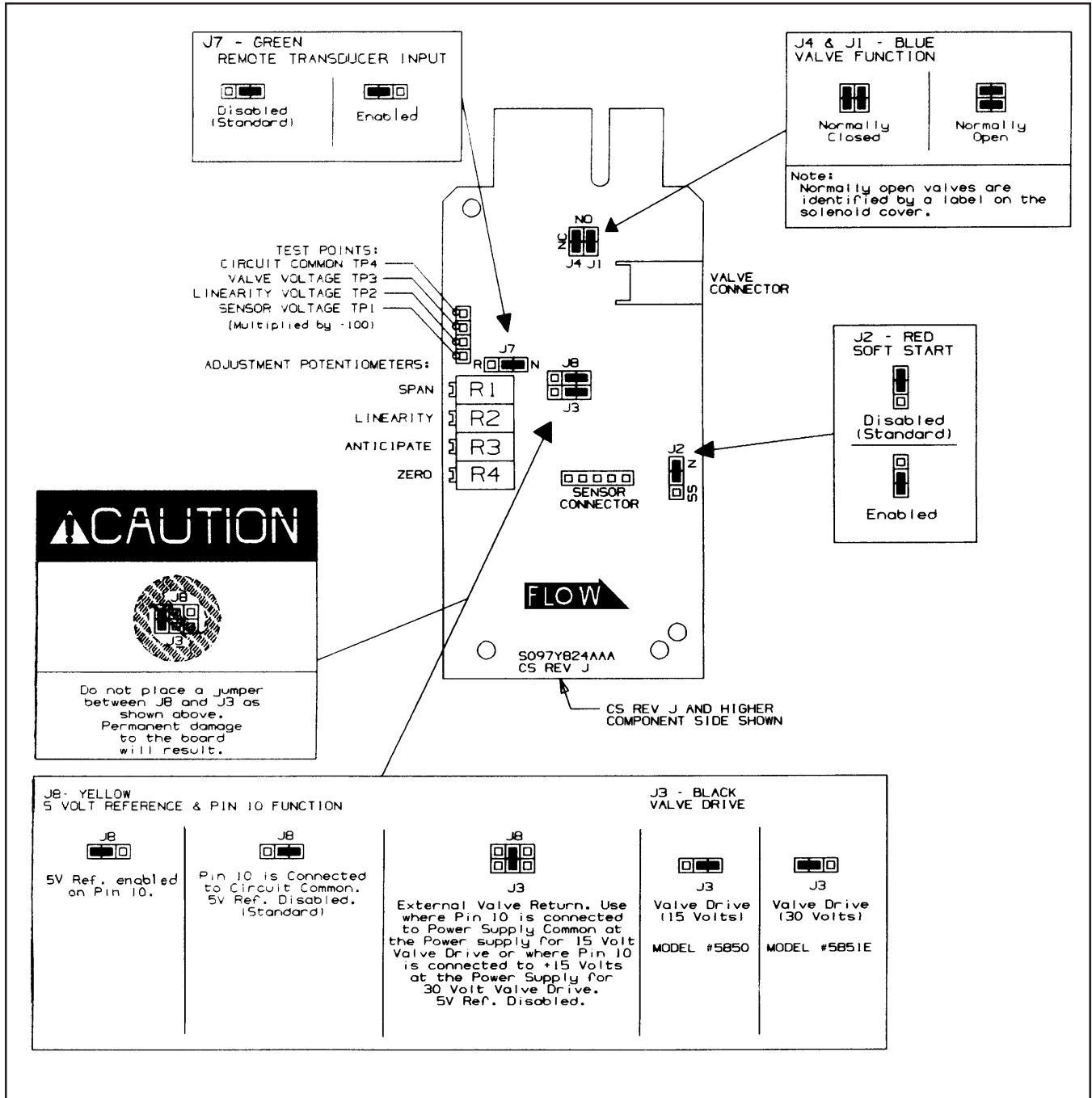


Figure 3-3 Card Edge PC Board Jumper Location & Function



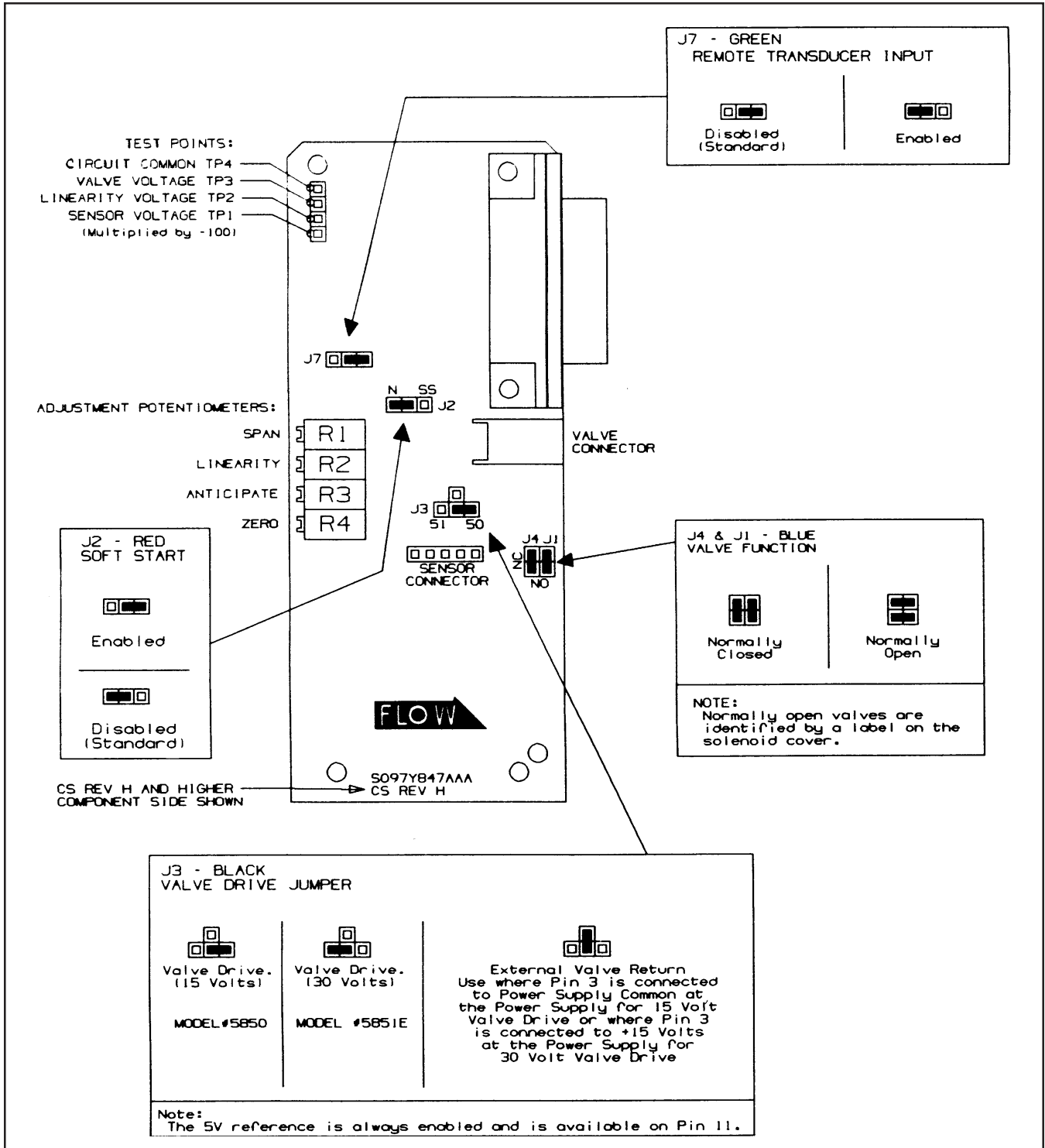


Figure 3-4 D-Connector PC Board Jumper Location & Function

## Brooks® Model 5851E

To check zero always mount the controller in its final configuration and allow a minimum of 20 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 lower pot hold plug, which is located closest to the controller body. Adjust the zero potentiometer (refer to Figure 3-6) until the desired output signal is obtained.

### 3-4 Calibration Procedure

Note 1: If the valve has been disassembled and any of the following parts have been replaced the control valve adjusting procedure in Section 4-4C must be performed before the Model 5851E is calibrated.

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

Note 2: Calibration of the Model 5851E 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.

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.

### **⚠ CAUTION**

**For the card edge model do not ground Pin 10 with the 5Volt reference enabled. Irreparable damage to the PC board may result.**

Note 4: If Brooks secondary electronics are being used as a power supply during the calibration the 5 V reference must be enabled on the Card Edge version for proper operation, see Section 2-12. Remember to deactivate the 5 V reference before installing the calibrated mass flow controller in the system where Terminal 10 is grounded.

- a. With the controller installed in an unpressurized gas line, apply power and allow approximately 45 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 heat up abnormally. 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".
- b. Adjust the anticipate potentiometer fully clockwise (20 turns). Then adjust the anticipate potentiometer 10 turns counterclockwise to center the potentiometer. This will provide a rough adjustment of this circuit and make the flow more stable for calibration.

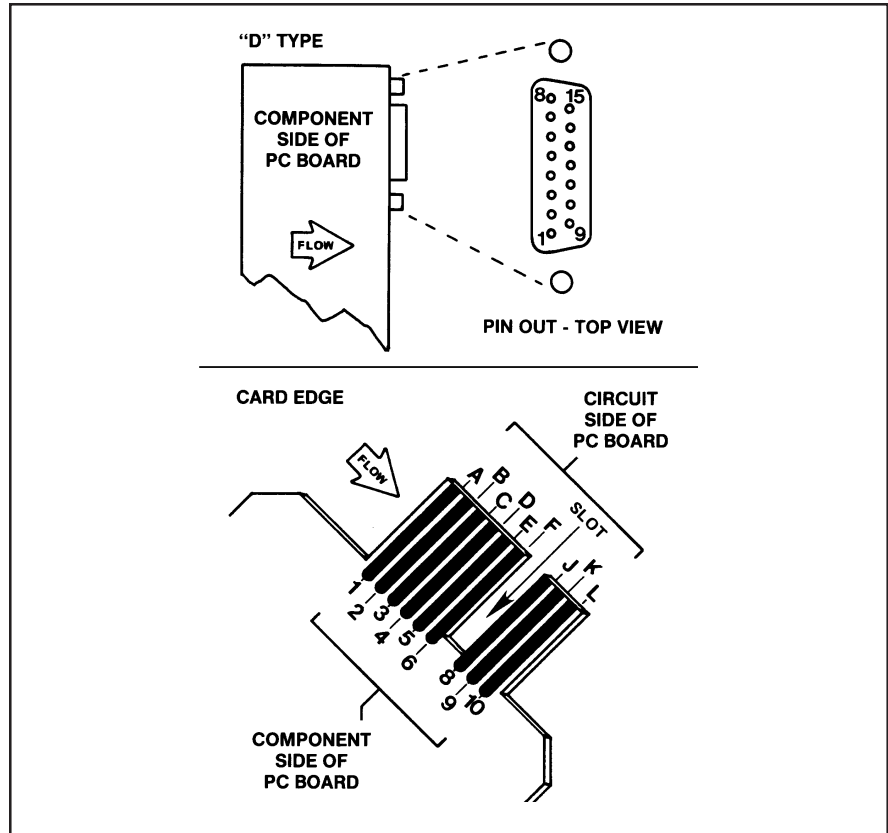


Figure 3-5 Model 5851E Calibration Connections

- c. Connect the DVM positive lead to the 0-5 V signal output (Terminal 3 Card Edge, Pin 2 D-Connector) and the negative lead to signal common (TP4). Adjust the zero potentiometer for an output of 0 mV  $\pm$ 2 mV.
- d. Apply pressure to the system and insure that the zero signal repeats within 2 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 to 3% 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 A, B and 10 of the Card Edge connector and Terminals 8, 1 and 11 of the D-Connector for 100% of flow (5.000 V). 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 0.0 V (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 (5.000 V). 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.

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

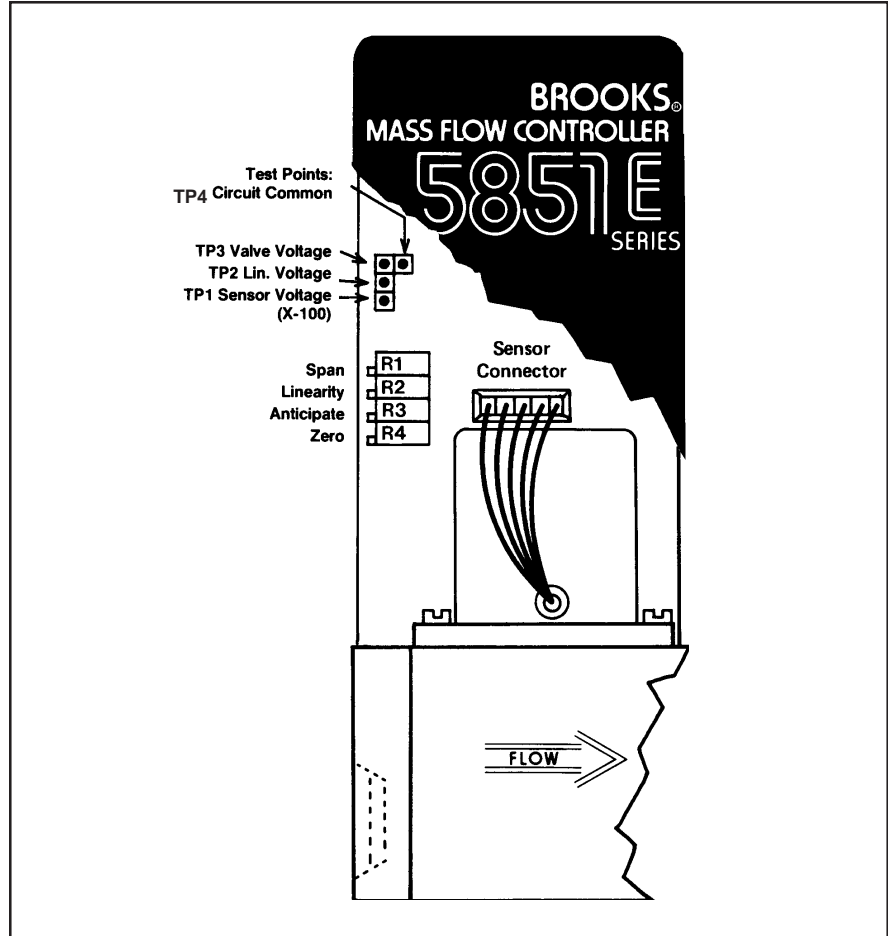


Figure 3-6 Adjustment Potentiometer Location

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 2 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 the desired accuracy 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 (Terminal 3 Card Edge, Pin 2 D-Connector) and the negative lead to TP4. Readjust the zero potentiometer for an output of 0 mV ±2 mV as necessary.
- h. Set the command potentiometer for 50% of flow (2.500 V) 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 x 0.450 = -0.675 Volts

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

- j. Set the command potentiometer for 100% flow (5.000 V). 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% (5.000 V). Connect the DVM positive lead to TP2 (linearity voltage) and the negative lead to TP4 (circuit common). Calculate a new TP2 voltage as follows:

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

Example:

Controller error = 0.7%

Measured TP2 voltage = -0.567 Volts

TP2 correction = 0.7 x 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 stay 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.

### 3-5 Response

#### Fast Response Adjustment

Two methods of adjusting the step response of the Model 5851E mass flow controllers can be used. No. 1 describes a method that will get the step response close to optimum quickly and without any flow measuring equipment. This method should be used when the response time of the

flow controller is not critical to overall system performance. No. 2 describes a method that will allow adjustment of your Model 5851E mass flow controller to optimum step response performance. This method is the preferred way to adjust the step response. Adjustment of the fast response circuit will not affect the accuracy of the flow controller as adjusted in Section 3-4.

1. Fast response adjustment (3 seconds response specification not guaranteed)

Note: This procedure requires an oscilloscope, chart recorder or a DVM with a sample speed of three samples per second or greater to monitor the rate of change of the output signal.

- a. Set the command potentiometer for 100% of flow (5.00 V) and wait about 45 seconds for the flow output signal to stabilize.
- b. Step the command signal to 0% or activate valve override closed to stop the flow. Observe the flow signal output as it decays.
- c. The behavior of the flow signal during this transition between 100% and 0% flow indicates the adjustment required of the anticipate potentiometer. Refer to Figure 3-7.
  1. If the flow signal decays to  $-.05$  to  $-.5$  V then rises to 0 V the anticipate potentiometer is properly adjusted.
  2. If the flow signal decays rapidly and goes below  $-.5$  V before rising to 0 V the anticipate potentiometer must be adjusted clockwise and Steps a and b repeated.
  3. If the flow signal decays slowly and does not go below  $-.05$  V the anticipate potentiometer must be adjusted counterclockwise and Steps a and b repeated.

2. Fast response adjustment (3 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 3 seconds after set-point change requires the use of a fast response flowmeter (500 millisecond response to be within 0.2% of final value or better) in series with the Model 5851E and a storage oscilloscope or recorder.

- a. Make a step in command to the controller from 0 to 100% of full scale flow and record the output signal of the fast response flowmeter.
- b. If this signal shows more than 4% overshoot, adjust the anticipate potentiometer 1/2 to 1 turn counterclockwise. If the signal does not show overshoot, but is not within 2% full scale of final value after 3 seconds, adjust the anticipate potentiometer 1/2 to 1 turn clockwise. Set command potentiometer for 0% of flow.
- c. Repeat Steps a and b until the fast response flowmeter output signal meets the specified response requirements.

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

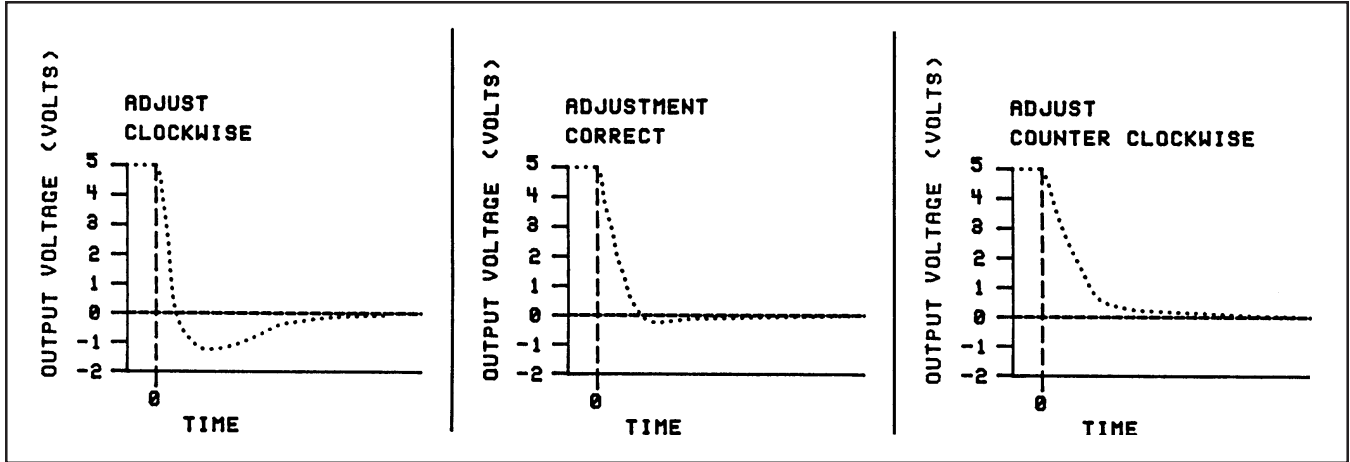


Figure 3-7 Fast Response Adjustment


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#### 4-1 General

No routine maintenance is required on the Model 5851E. If an in-line filter is used, the filtering element should periodically be replaced or ultrasonically cleaned.

#### 4-2 Troubleshooting

	<p><b>⚠ WARNING</b></p> <p><b>METER/CONTROLLER SEAL COMPATIBILITY</b></p>
<p>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.</p> <p>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.</p>	

<p><b>⚠ CAUTION</b></p>
<p>The end block screws (31) and the valve screws (3) are not interchangeable. The end block screws are stronger and are needed to achieve the pressure rating. The end block screws are darker in color and can be attracted by a magnet.</p>

#### A. System Checks

The Model 5851E 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 common connection, correct power supply voltage and that signals are reaching and leaving the controller. The breakout board, P/N S273Z649AAA Card Edge version or P/N S273Z668AAA D-Connector version listed in Section 5, will make this job much easier.

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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.
4. Verify that all user selectable jumpers are in their desired positions (refer to Figs. 3-3 and 3-4).

**⚠ CAUTION**

**Any Brooks Instrument mass flow meter or flow controller with a 15 pin D-Connector PC Board bearing the "CE Mark" must use a 100% shielded cable and metal shell mating connectors. The shield is tied over 360 degrees to the shell at both ends. This is mandatory to be in compliance with the EMC Directive (89/336/EEC). Refer to Appendix A.**

**B. Bench Troubleshooting**

1. Properly connect the mass flow controller to a  $\pm 15$  Vdc power supply command voltage source and connect an output signal readout device (4-1/2 digit voltmeter recommended) to Terminals 2 and 3 or D-Connector Pins 2 and 10 (refer to Figs. 2-2 and 2-3). Apply power, set the command voltage to zero and allow the controller to warm-up for 15 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 will 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 will require replacement.
2. Connect the controller to a source of the gas on which it was originally calibrated. Command 100% flow and adjust the inlet and outlet pressures to the calibration conditions. Verify that the output signal reaches and stabilizes at 5.000 Volts. Vary the command voltage over the 2 to 100% range and verify that the output signal follows the setpoint.

Apply +15 Volts to the valve override input (refer to Figs. 2-3 and 2-4 for terminal assignments) and verify that the output exceeds 5.000 Volts.

Apply -15 Volts to the valve override terminal and verify that the output signal falls below 0.100 Volts. If possible, connect a flow measurement device in series with the mass flow controller to observe the actual flow behavior and verify the accuracy of the mass flow controller. If the mass flow controller functions as described above, it is functioning properly and the problem is most likely elsewhere. Table 4-1 lists possible malfunctions which may be encountered during bench troubleshooting.

**C. Sensor Troubleshooting**

If it is believed the sensor coils are either open or shorted, troubleshoot using Table 4-2. If any of the steps do not produce expected results, the sensor assembly is defective and must be replaced. Refer to Section 4-4 for the disassembly and assembly procedures to use when replacing the sensor.

Table 4-1 Bench Troubleshooting

Trouble	Possible Cause	Check/- Corrective Action	Trouble	Possible Cause	Check/- Corrective Action
Actual flow overshoots set-point by more than 5% full scale.	Anticipate potentiometer out of adjustment.	Adjust anticipate potentiometer. Refer to Section 3-5.	Output signal follows setpoint at higher commands but will not go to zero.	Leaky control valve	Disassemble and repair valve. Refer to Section 4-4C.
Output stays at 0 volts regardless of command, and there is flow through the controller	Clogged Sensor	Clean sensor. Refer to cleaning procedure, Section 4-4.		Excessive resistance in valve voltage return line	Reduce wiring resistance or reconfigure controller for "External Valve Return". Refer to Section 2-13.
Output stays at 0 volts regardless of command and there is no flow through the controller.	Clogged Control Valve	Check TP3 with the command valve at 100%. If the voltage is more negative than -18V, disassemble and repair the the control valve. Refer to Sections 4-4C and 2-11. Refer to Section 2-12.	Output signal follows set-point at lower commands but does not reach full scale.	Insufficient inlet pressure or pressure drop.	Adjust pressures. Inspect inline filters and clean/replace as necessary. Check calibration. Refer to Section 3-4.
	Card Edge Version Internal reference is being used as the command source and the yellow jumper is in the E-F position. -15 volts applied to the valve override input.	Check valve override input. Refer to Figures 2-3 and 2-4 for terminal assignments.		Partially clogged sensor	Disassemble and repair control valve. Refer to Section 4-4.
	Defective printed circuit board	Replace printed circuit board. Refer to Section 4-4.		Partially clogged valve	Clean inlet screen. Refer to Section 4-4.
	Improper valve drive configuration	Check jumper for valve configuration. Refer to Section 2-12.		Partially clogged inlet screen	Adjust valve. Refer to Section 4-4.
Valve Off Pin Grounded	Check valve off input. Refer to Figures 2-3 and 2-4 for terminal assignments.	Valve out of adjustment		Controller Oscillates (See below)	
Output signal stays at +6.8V regardless of command and there is flow through the controller.	Valve stuck open or leaky	Clean and/or adjust control valve. Refer to cleaning procedure and/or Section 4-4C.		Controller grossly out of calibration, flow is higher than desired.	Partially clogged sensor
	+15V applied to the valve override input	Check the valve override terminal. Refer to Figures 2-3 and 2-4 for terminal assignments.	Controller grossly out of calibration, flow is lower than desired.	Partially clogged restrictor	Replace restrictor. Refer to Section 4-4.
	Defective printed circuit board	Replace printed circuit board. Refer to Section 4-4.	Controller oscillates	Pressure drop or inlet pressure excessive	Adjust pressures
	Command input floating	Connect command signal. Refer to Figures 2-3 and 2-4 for terminal assignments		Oversized orifice	Check orifice size. Refer to Section 4-6.
Pin D connected to common	Remove pin D from common		Valve out of adjustment	Adjust valve. Refer to Section 4-4.	
			Anticipate potentiometer out of adjustment	Adjust anticipate potentiometer. Refer to Section 3-5.	
			Faulty pressure regulator	Check regulator capacity.	
			Defective printed circuit board	Replace printed circuit board. Refer to Section 4-4.	

Note: Do not attempt to disassemble the sensor.

#### D. Cleaning

No routine external cleaning is required for Brooks Thermal Mass Flow Controller. Should the Model 5851E require cleaning due to deposition, use the following procedures:

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

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Table 4-2 Sensor Troubleshooting

**SENSOR SCHEMATIC**

WIRE COLOR	PIN NO.	FUNCTION
White	4	Sensor common
Yellow	1	Heater
Blue	5	Heater common
Red	2	Upstream temperature sensor (Su)
Black	3	Downstream temperature sensor (Sd)

**Flex Circuit Wire Numbers**

OHMMETER CONNECTION	RESULT IF ELECTRICALLY FUNCTIONAL
Yellow and white to body (ground) (Pin 1 or 4 to body)	Open circuit on ohmmeter. If either heater (yellow), or sensor common (white) are shorted, an ohmmeter reading will be obtained.
White to red (Pin 4 to Pin 2)	Nominal 1100 ohms reading.
White to black (Pin 4 to Pin 3)	Depending on temperature and ohmmeter current.
Blue to yellow (Pin 5 to Pin 1)	Nominal 1200 ohm reading.

Note: Remove the sensor connector from the PC Board for this procedure.

**CAUTION**

**Do not ground Terminal 10 when 5 Volt reference output is enabled. Irreparable damage to the PC Board may result.**

- Use a hemostat or tweezers to push a 0.007" dia. piano wire through the flow sensor tube to remove any contamination. For best results push the wire into the downstream end 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. 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 clean, dry Nitrogen through the bore.
5. Deposits of silicon dioxide may be removed by soaking the internal parts in solution of 5% hydrofluoric acid (5 parts hydrofluoric acid and 95 parts water (H<sub>2</sub>O)) followed by Freon TF.
6. Sintered type restrictor elements should be replaced as it is not possible to adequately remove deposits from them. Wire mesh and A.C.L.F.E. type restrictor elements can be cleaned in an ultrasonic bath. Refer to Section 4-7 for the correct restrictor to use.
7. Blow all parts dry with clean, dry Nitrogen and reassemble Refer to Section 4-4b, (assembly).
8. Purge the assembled controller with clean, dry Nitrogen.
9. Perform the calibration procedure in Section 3-4.
10. When the controller is reinstalled in the system, the connections should be leak-tested and the system purged with clean, dry Nitrogen for 30 minutes prior to start-up to prevent the formation of deposits.

#### 4-3 Sensor Tube

The sensor tube is part of a calibrated flow divider that is designed to operate within a preset gas flow range. The sensor assembly may be removed or replaced by referring to Section 4-4, Disassembly and Assembly. If the sensor assembly is cleaned and reinstalled, a calibration check should be performed. Refer to Section 3-4.

#### 4-4 Disassembly and Assembly

Note: The Model 5851E Mass Flow Controller should be disassembled and assembled in a clean environment to prevent particulate contamination.

##### A. DISASSEMBLY

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

### **⚠ WARNING**

**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 the 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. Unplug the valve connector from the electronics cover and remove the coil assembly (2).
3. Remove the hex socket screws (3) securing the valve retaining plate (4) attaching the valve stem assembly (6).

**⚠ CAUTION**

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

4. Carefully remove the valve stem assembly (6).
5. Remove the plunger assembly (7, 8, 9, 11).
6. Remove and note the position of the valve spring spacers (10), which may be located above and/or below the lower valve spring (8).
7. Unscrew the orifice (12) from the flow controller body (14) using the orifice removal tool (See Section 5, Table 5-2).
8. Remove the three screws (20) attaching the electronics cover. Remove the electronics cover (23).

**⚠ 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 open in the sensor wiring could result.**

9. Unplug the sensor connector from the PC Board. Remove the two screws securing the bracket (24) and PC Board (15). Remove the bracket and PC Board.
10. Remove the two allen nuts using an 1/8" 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.**

11. Remove the sensor assembly O-rings (17) from the flow controller body (14). Using the Brooks O-ring removal tool will help prevent scratching the sealing surface.
12. Remove the adapter fittings (27) from the flow controller body (14).
13. Remove the 4 screws (31) from the end block (30) 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).

**B. ASSEMBLY****⚠ CAUTION**

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

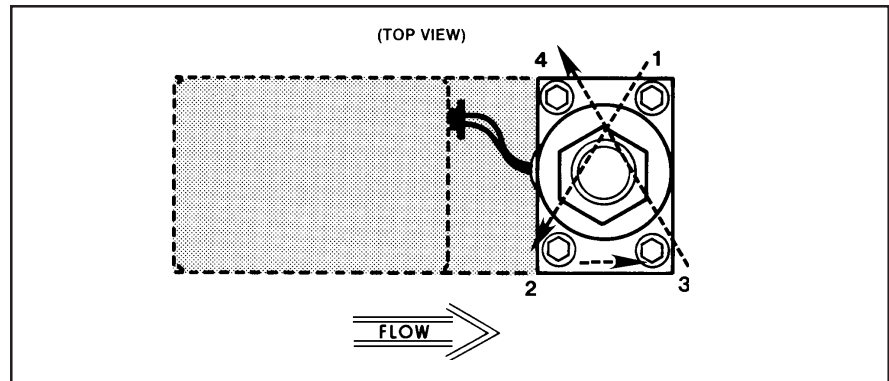


Figure 4-1 Torque Sequence for the Valve Retainer Plate

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, Section 5) 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 restrictor assembly. Screw the restrictor assembly (21) into the inlet side of the flow controller body using the restrictor tool, tighten hand tight.

#### **⚠ CAUTION**

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

3. 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 (31) 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 and can be attracted by a magnet.**

4. Press the lubricated sensor O-rings (17) into the flow controller body (14). Install the sensor assembly and secure with two screws (18) and washers (19) tightened to 15 in/lbs.
5. Install the orifice (12) and its O-ring (13), using a 3/8 nut driver. Insure that the orifice is fully seated but do not overtighten.
6. 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.
7. Install the valve plunger assembly (7, 8, 9 and 11) on the preload spacers (10). Install air gap spacers (10), if used, on top of the valve springs.
8. 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 15 in/lbs.

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9. Install the coil assembly (2) over the valve stem assembly (6) and secure with jam nut (1).
10. Install the printed circuit (PC) board (15), secure with the bracket (24) and two screws. Plug the connector from the sensor assembly onto the PC Board. The flow arrow on the connector should be pointing toward the valve assembly.
11. Install the electronics cover (23) on the controller, secure with three screws (20). Plug the connector from the valve coil into the PC Board through the hole in electronics cover.
12. Prior to installation leak and pressure test to any applicable pressure vessel codes.

**C. ADJUSTING THE CONTROL VALVE**

The Model 5851E 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 will not fully close and gas will leak through. If the preload is excessive the magnetic force generated between the plunger and stem will be insufficient to raise the plunger and the valve will not open.

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 will be insufficient to raise the plunger and the valve will not open.

Note: 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.

1. Adjustment Procedure (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 reconnected 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



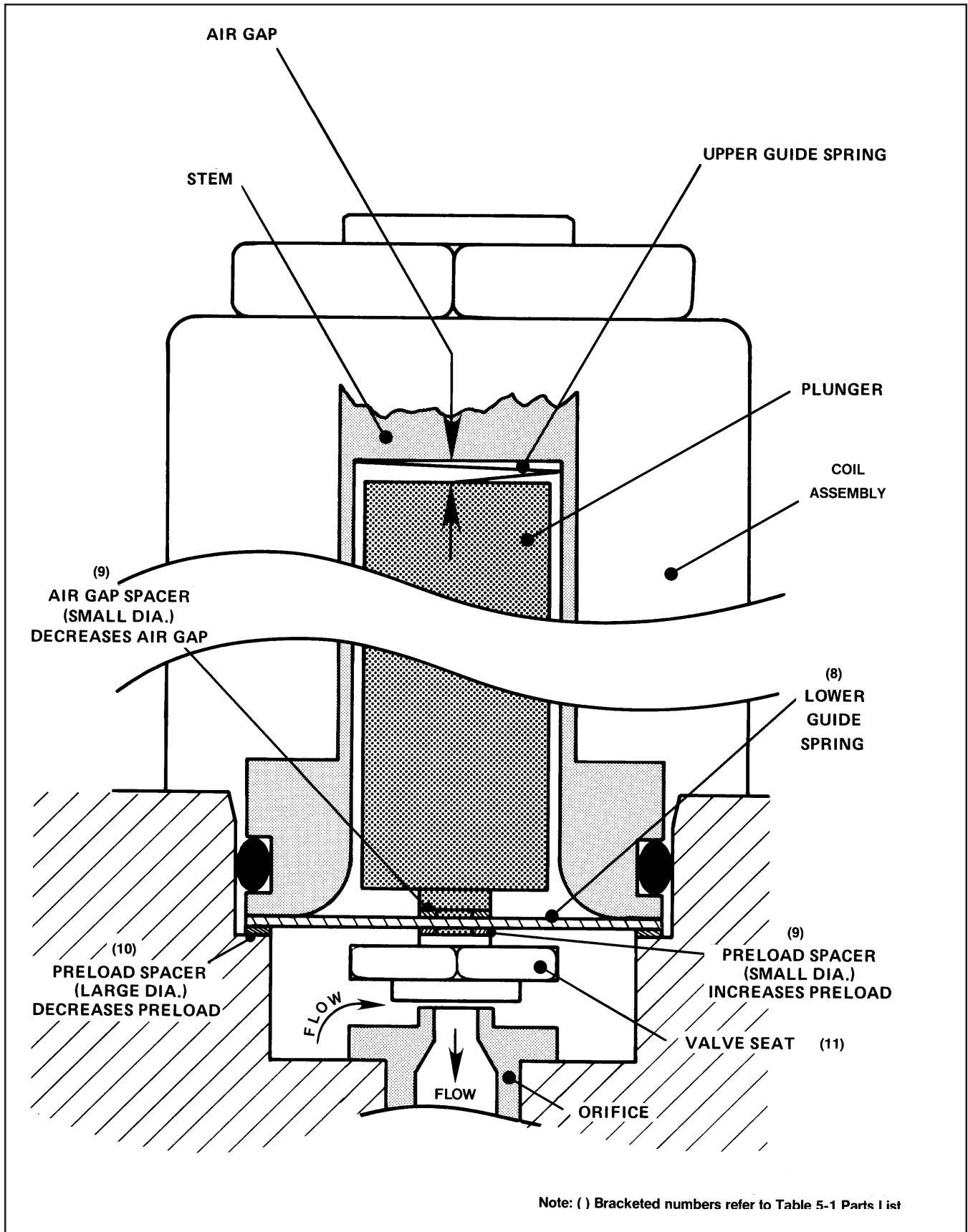
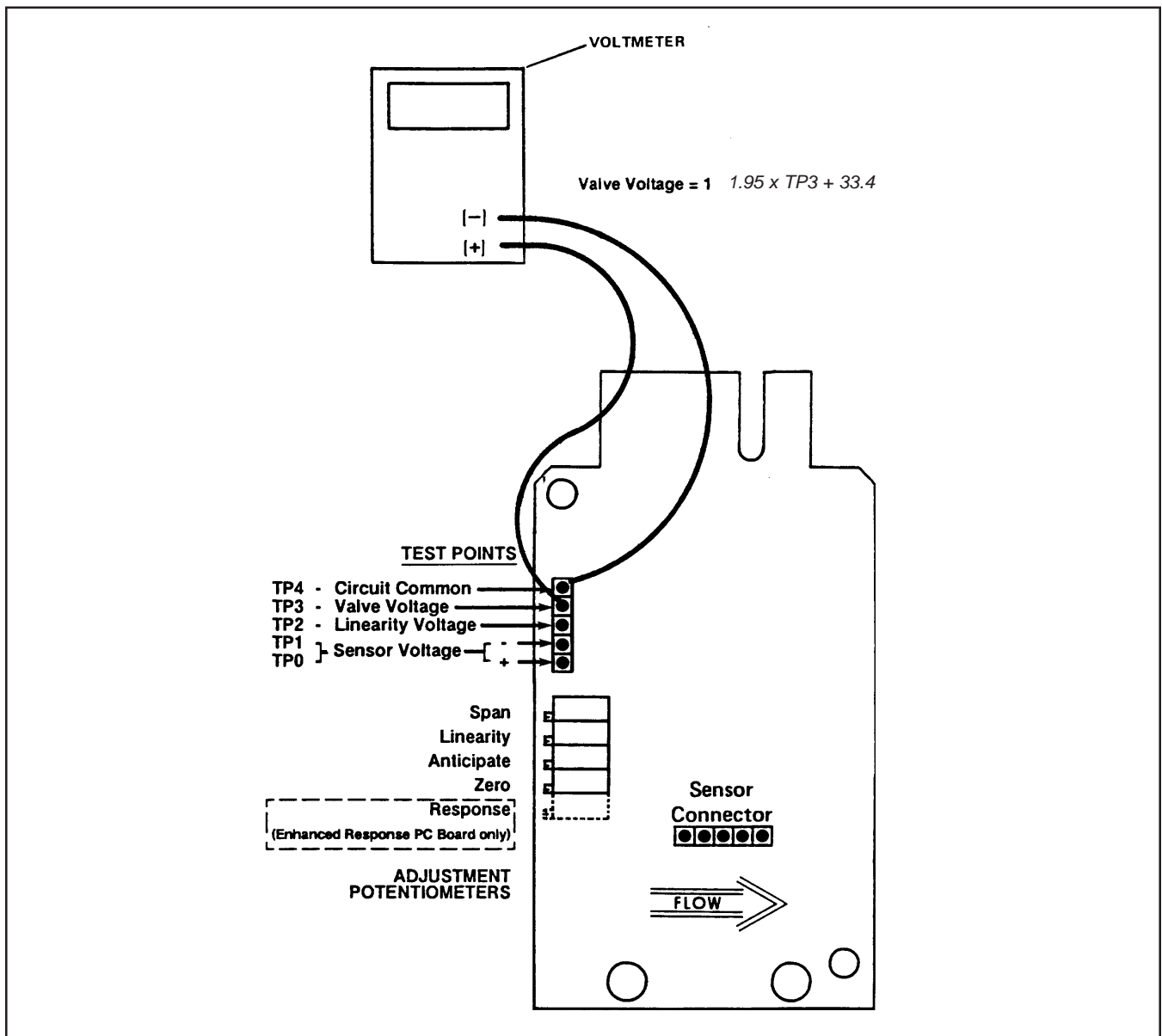


Figure 4-2 Valve Adjusting Spacer Locations

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- Section 4-4A. Note the number, locations and thickness of all spacers (9 and 10).
- d. Decrease the preload of the valve by 0.005 inches by either removing a 0.005 inches small preload spacer or by adding a 0.005 inches large preload spacer. Refer to Figure 4-2.
  - e. Reassemble the valve following the assembly procedure in Section 4-4A.
  - f. Command 0% flow, apply normal operating gas pressure and check for valve leak-thru by observing the output signal.
  - g. If the valve leaks-thru increase the preload by 0.005" and go to Step h. If the valve does not leak-thru repeat Steps d, e, f and g.
  - h. Apply the normal operating gas pressure and command 100% flow (5.000 Volts on Terminal A, Pin 2).



4-10 Figure 4-3 Voltmeter Connections for Valve Adjustment

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.

- i. 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 = 1.95 x TP3 + 33.4
- j1. If the flow controller output signal is 100% (5.0 V) and the valve voltage is less than 18 V, the valve adjustment is complete.
- j2. If the flow controller output signal is 100% (5.0 V) and the valve voltage is greater than 18 V, decrease the air gap with a small 0.005 in. air gap spacer. Refer to Figure 4-2. Repeat Steps h and i.
- j3. If the flow controller output signal is less than 100% (5.0 V) and the valve voltage is greater than 18 V, first check Section 4-6 to insure that the orifice size is correct.
- k. Proceed to Section 3-4 and perform calibration procedure, if required.

#### 4-5 Gas Conversion Factors

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 4-3. To change to a new gas, multiply the output reading by the ratio of the gas sensor factor for the desired gas by the gas sensor factor for the calibration gas used.

$$\text{Actual Gas Flow Rate} = \text{Output Reading} \times \frac{\text{Sensor Factor of the New Gas}}{\text{Sensor Factor of the Calibration Gas}}$$

Example:

The controller is calibrated for Nitrogen.

The desired gas is Carbon Dioxide

The output reading is 75 sccm when Carbon Dioxide is flowing

Then  $75 \times 0.773 = 57.98$  sccm

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

$$\text{Sensor Conversion Factor Mixture} = \frac{100}{\frac{P_1}{\text{Sensor Conversion Factor}_1} + \frac{P_2}{\text{Sensor Conversion Factor}_2} + \frac{P_3}{\text{Sensor Conversion Factor}_3}}$$

Where,

$P_1$  = percentage (%) of gas 1 (by volume)

$P_2$  = percentage (%) of gas 2 (by volume)

$P_n$  = percentage (%) of gas n (by volume)

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Table 4-3 Conversion Factors (Nitrogen Base)

GAS NAME	FORMULA	SENSOR FACTOR	ORIFICE FACTOR	DENSITY (kg/m <sup>3</sup> )
Acetylene	C <sub>2</sub> H <sub>2</sub>	0.615	0.970	1.173
Air	Mixture	0.998	1.018	1.293
Allene	C <sub>3</sub> H <sub>4</sub>	0.478	1.199	1.787
Ammonia	NH <sub>3</sub>	0.786	0.781	0.771
Argon	Ar	1.395	1.195	1.784
Arsine	AsH <sub>3</sub>	0.754	1.661	3.478
Boron Trichloride	BCL <sub>3</sub>	0.443	2.044	5.227
Boron Trifluoride	BF <sub>3</sub>	0.579	1.569	3.025
Bromine Pentafluoride	BrF <sub>5</sub>	0.287	2.502	7.806
Bromine Trifluoride	BrF <sub>3</sub>	0.439	2.214	6.108
Bromotrifluoroethylene	C <sub>2</sub> BrF <sub>3</sub>	0.326	2.397	7.165
Bromotrifluoromethane f-13B1	CBrF <sub>3</sub>	0.412	2.303	6.615
1,3-Butadiene	C <sub>4</sub> H <sub>6</sub>	0.354	1.413	2.491
Butane	C <sub>4</sub> H <sub>10</sub>	0.257	1.467	2.593
1-Butene	C <sub>4</sub> H <sub>8</sub>	0.294	1.435	2.503
CIS-2-Butene	C <sub>4</sub> H <sub>8</sub>	0.320	1.435	2.503
Trans-2-Butene	C <sub>4</sub> H <sub>8</sub>	0.291	1.435	2.503
Carbon Dioxide	CO <sub>2</sub>	0.773	1.255	1.977
Carbon Disulfide	CS <sub>2</sub>	0.638	1.650	3.393
Carbon Monoxide	CO	0.995	1.000	1.250
Carbon Tetrachloride	CCl <sub>4</sub>	0.344	2.345	6.860
Carbon Tetrafluoride f-14	CF <sub>4</sub>	0.440	1.770	3.926
Carbonyl Fluoride	COF <sub>2</sub>	0.567	1.555	2.045
Carbonyl Sulfide	COS	0.680	1.463	2.180
Chlorine	CL <sub>2</sub>	0.876	1.598	3.214
Chlorine Dioxide	CLO <sub>2</sub>	0.693	1.554	3.011
Chlorine Trifluoride	CLF <sub>3</sub>	0.433	1.812	4.125
2-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	0.234	1.818	4.134
Chlorodifluoromethane f-22	CHCLF <sub>2</sub>	0.505	1.770	3.906
Chloroform (Trichloromethane)	CHCL <sub>3</sub>	0.442	2.066	5.340
Chloropentafluoroethane f-115	C <sub>2</sub> CLF <sub>5</sub>	0.243	2.397	7.165
Chlorotrifluoroethylene	C <sub>2</sub> CLF <sub>3</sub>	0.337	2.044	5.208
Chlorotrifluoromethane f-13	CClF <sub>3</sub>	0.430	1.985	4.912
Cyanogen	(CN) <sub>2</sub>	0.498	1.366	2.322
Cyanogen Chloride	CLCN	0.618	1.480	2.730
Cyclobutane	C <sub>4</sub> H <sub>8</sub>	0.387	1.413	2.491
Cyclopropane	C <sub>3</sub> H <sub>6</sub>	0.505	1.224	1.877
Deuterium	D <sub>2</sub>	0.995	0.379	0.177
Diborane	B <sub>2</sub> H <sub>6</sub>	0.448	1.000	1.235
Diboromodifluoromethane f-12B2	CB <sub>2</sub> F <sub>2</sub>	0.363	2.652	8.768
1,2-Dibromotetrafluoroethane f-114B2	C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	0.215	2.905	10.53
Dichlorodifluoroethane f-12	CCL <sub>2</sub> F <sub>2</sub>	0.390	2.099	5.492
Dichlorofluoromethane f-21	CHCL <sub>2</sub> F	0.456	1.985	4.912
Dichlorosilane	SiH <sub>2</sub> CL <sub>2</sub>	0.442	1.897	4.506
1,2-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	0.382	1.879	4.419
1,2-Dichlorotetrafluoroethane f-114	C <sub>2</sub> CL <sub>2</sub> F <sub>4</sub>	0.231	2.449	7.479
2,2 Dichloro	C <sub>2</sub> HC <sub>2</sub> F <sub>3</sub>	0.259	2.336	6.829
1,1-Difluoro-1-Chloroethane	C <sub>2</sub> H <sub>4</sub> CLF <sub>2</sub>	0.341	1.957	4.776
1,1-Difluoroethane	CH <sub>3</sub> CHF <sub>2</sub>	0.415	1.536	2.940
1,1-Difluoroethylene	CH <sub>2</sub> :CF <sub>2</sub>	0.458	1.512	2.860
Diethylsilane	C <sub>2</sub> H <sub>12</sub> Si	0.183	1.775	3.940
Difluoromethane f-32	CF <sub>2</sub> H <sub>2</sub>	0.627	1.360	2.411
Dimethylamine	(CH <sub>3</sub> ) <sub>2</sub> NH	0.370	1.269	2.013
Dimethylether	(CH <sub>3</sub> ) <sub>2</sub> O	0.392	1.281	2.055
2,2-Dimethylpropane	C(CH <sub>3</sub> ) <sub>4</sub>	0.247	1.613	3.244
Disilane	Si <sub>2</sub> H <sub>6</sub>	0.332	1.493	2.779
Ethane	C <sub>2</sub> H <sub>6</sub>	0.490	1.038	1.357
Ethanol	C <sub>2</sub> H <sub>6</sub> O	0.394	1.282	2.057
Ethylacetylene	C <sub>4</sub> H <sub>6</sub>	0.365	1.384	2.388
Ethyl Chloride	C <sub>2</sub> H <sub>5</sub> CL	0.408	1.516	2.879
Ethylene	C <sub>2</sub> H <sub>4</sub>	0.619	1.000	1.261
Ethylene Oxide	C <sub>2</sub> H <sub>4</sub> O	0.589	1.254	1.965
Fluorine	F <sub>2</sub>	0.924	1.163	1.695
Fluoroform f-23	CHF <sub>3</sub>	0.529	1.584	3.127
Germane	GeH <sub>4</sub>	0.649	1.653	3.418
Germanium Tetrachloride	GeCl <sub>4</sub>	0.268	2.766	9.574
Halothane (R-123B1)	C <sub>2</sub> HBrClF <sub>3</sub>	0.257	2.654	8.814
Helium	He	1.386	0.378	0.178
Hexafluoroacetone	F <sub>3</sub> CCOCF <sub>3</sub>	0.219	2.434	7.414
Hexafluorobenzene	C <sub>6</sub> F <sub>6</sub>	0.632	2.577	8.309
Hexafluoroethane f-116	C <sub>2</sub> F <sub>6</sub>	0.255	2.219	6.139
Hexafluoropropylene (HFP)	C <sub>3</sub> F <sub>6</sub>	0.249	2.312	6.663
Hexamethyldisilane (HMDS)	(CH <sub>3</sub> ) <sub>6</sub> Si <sub>2</sub>	0.139	2.404	7.208
Hexane	C <sub>6</sub> H <sub>14</sub>	0.204	1.757	3.847

Table 4-3 Conversion Factors (Nitrogen Base) (continued)

GAS NAME	FORMULA	SENSOR FACTOR	ORIFICE FACTOR	DENSITY (kg/m <sup>3</sup> )
Hydrogen	H <sub>2</sub>	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 Iodide	HI	0.953	2.144	5.789
Hydrogen Selenide	H <sub>2</sub> Se	0.837	1.695	3.613
Hydrogen Sulfide	H <sub>2</sub> S	0.850	1.108	1.539
Iodine Pentafluoride	IF <sub>5</sub>	0.283	2.819	9.907
Isobutane	C <sub>4</sub> H <sub>10</sub>	0.260	1.440	2.593
Isobutene	C <sub>4</sub> H <sub>8</sub>	0.289	1.435	2.503
Isopentane	C <sub>5</sub> H <sub>12</sub>	0.211	1.605	3.222
Krypton	Kr	1.382	1.729	3.708
Methane	CH <sub>4</sub>	0.763	0.763	0.717
Methylacetylene	C <sub>3</sub> H <sub>4</sub>	0.473	1.196	1.782
Methyl Bromide	CH <sub>3</sub> Br	0.646	1.834	4.236
3-Methyl-1-butene	C <sub>6</sub> H <sub>10</sub>	0.252	1.584	3.127
Methyl Chloride	CH <sub>3</sub> CL	0.687	1.347	2.308
Methyl Fluoride	CH <sub>3</sub> F	0.761	1.102	1.518
Methyl Mercaptan	CH <sub>3</sub> S	0.588	1.313	2.146
Methyl Silane	CH <sub>3</sub> Si	0.393	1.283	2.061
Methyl Trichlorosilane (MTS)	CH <sub>3</sub> Cl <sub>3</sub> Si	0.267	2.310	6.675
Methyl Vinyl Ether	C <sub>3</sub> H <sub>6</sub> O	0.377	1.435	2.567
Monoethanolamine	C <sub>2</sub> H <sub>5</sub> NO	0.305	1.477	2.728
Monoethylamine	C <sub>2</sub> H <sub>5</sub> NH <sub>2</sub>	0.359	1.269	2.013
Monomethylamine	CH <sub>3</sub> NH <sub>2</sub>	0.565	1.067	1.420
Neon	Ne	1.398	0.847	0.902
Nickel Carbonyl	Ni(CO) <sub>4</sub>	0.212	2.371	7.008
Nitric Oxide	NO	0.995	1.030	1.339
Nitrogen	N <sub>2</sub>	1.000	1.000	1.251
Nitrogen Dioxide	NO <sub>2</sub>	0.758	1.713	2.052
Nitrogen Trifluoride	NF <sub>3</sub>	0.501	1.598	3.168
Nitrogen Trioxide	N <sub>2</sub> O <sub>3</sub>	0.443	1.649	3.389
Nitrosyl Chloride	NOCL	0.644	1.529	2.913
Nitrous Oxide	N <sub>2</sub> O	0.752	1.259	1.964
Octofluorocyclobutane	C <sub>4</sub> F <sub>8</sub>	0.169	2.672	8.933
Oxygen	O <sub>2</sub>	0.988	1.067	1.429
Oxygen Difluoride	OF <sub>2</sub>	0.672	1.388	2.402
Ozone	O <sub>3</sub>	0.738	1.310	2.138
Pentafluoroethane f-125	C <sub>2</sub> HF <sub>5</sub>	0.287	2.070	5.360
Pentane (n-Pentane)	C <sub>5</sub> H <sub>12</sub>	0.212	1.605	3.222
Perchloryl Fluoride	ClO <sub>3</sub> F	0.448	1.905	4.571
Perfluorobutane	C <sub>4</sub> F <sub>10</sub>	0.738	2.918	10.61
Perfluoro-2-Butene	C <sub>4</sub> F <sub>8</sub>	0.268	2.672	8.933
Perfluoromethyl-vinylether	PMVE	0.296	2.029	5.131
Perfluoropropane	C <sub>3</sub> F <sub>8</sub>	0.179	2.591	8.396
Pentane (n-Pentane)	C <sub>5</sub> H <sub>12</sub>	0.212	1.605	3.222
Phosgene	COCL <sub>2</sub>	0.504	1.881	4.418
Phosphine	PH <sub>3</sub>	0.783	1.100	1.517
Phosphorous Pentafluoride	PF <sub>5</sub>	0.346	2.109	5.620
Phosphorous Trifluoride	PF <sub>3</sub>	0.495	1.770	3.906
Propane (same as CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub> )	C <sub>3</sub> H <sub>8</sub>	0.343	1.274	2.008
Propylene (Propene)	C <sub>3</sub> H <sub>6</sub>	0.401	1.234	1.875
Rhenium Hexafluoride	ReF <sub>6</sub>	0.230	3.279	13.41
Silane	SiH <sub>4</sub>	0.625	1.070	1.440
Silicon Tetrachloride	SiCL <sub>4</sub>	0.310	2.465	7.579
Silicon Tetrafluoride	SiF <sub>4</sub>	0.395	1.931	4.648
Sulfur Dioxide	SO <sub>2</sub>	0.728	1.529	2.858
Sulfur Hexafluoride	SF <sub>6</sub>	0.270	2.348	6.516
Sulfur Tetrafluoride	SF <sub>4</sub>	0.353	1.957	4.776
Sulfur Trioxide	SO <sub>3</sub>	0.535	1.691	3.575
Sulfuryl Fluoride	SO <sub>2</sub> F <sub>2</sub>	0.423	1.931	4.648
Tetrachloromethane	CCL <sub>4</sub>	0.344	2.345	6.858
Tetrafluoroethylene (TFE)	C <sub>2</sub> F <sub>4</sub>	0.361	1.905	4.526
Tetrafluorohydrazine	N <sub>2</sub> F <sub>4</sub>	0.367	1.926	4.624
Trichlorofluoromethane f-11	CCL <sub>3</sub> F	0.374	2.244	6.281
Trichlorosilane	SiHCL <sub>3</sub>	0.329	2.201	6.038
Trimethyloxyborane (TMB)	B(OCH <sub>3</sub> ) <sub>3</sub>	0.300	1.929	4.638
1,1,2-Trichloro-1,1,2-Trifluoroet f-113	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	0.231	2.520	7.920
Trimethylamine	(CH <sub>3</sub> ) <sub>3</sub> N	0.316	1.467	2.639
Tungsten Hexafluoride	WF <sub>6</sub>	0.227	3.264	13.28
Uranium Hexafluoride	UF <sub>6</sub>	0.220	3.548	15.70
Vinyl Bromide	C <sub>2</sub> H <sub>3</sub> Br	0.524	1.985	4.772
Vinyl Chloride	C <sub>2</sub> H <sub>3</sub> CL	0.542	1.492	2.788
Vinyl Fluoride	C <sub>2</sub> H <sub>3</sub> F	0.576	1.281	2.046
Water Vapor	H <sub>2</sub> O	0.861	0.802	0.804
Xenon	Xe	1.383	2.180	5.851

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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:

$$\text{Mixture Factor} = \frac{100}{\frac{20}{1.386} + \frac{80}{0.876}} = 0.945$$

Nitrogen equivalent flow =  $20 / 0.945 = 21.16$  slpm Nitrogen

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 4-3 are calculated based on a gas temperature of 21°C and a pressure of one atmosphere. The specific heat of most gases is not strongly pressure, and/or 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 pressure and/or temperature.

#### 4-6 Orifice Sizing

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 range. 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 in the following paragraphs.

**Example: Determine the orifice size for the following conditions:**

Gas: Hydrogen  
Flow Rate: 2,000 sccm  
Outlet Pressure: 30 psig  
Inlet Pressure: 50 psig

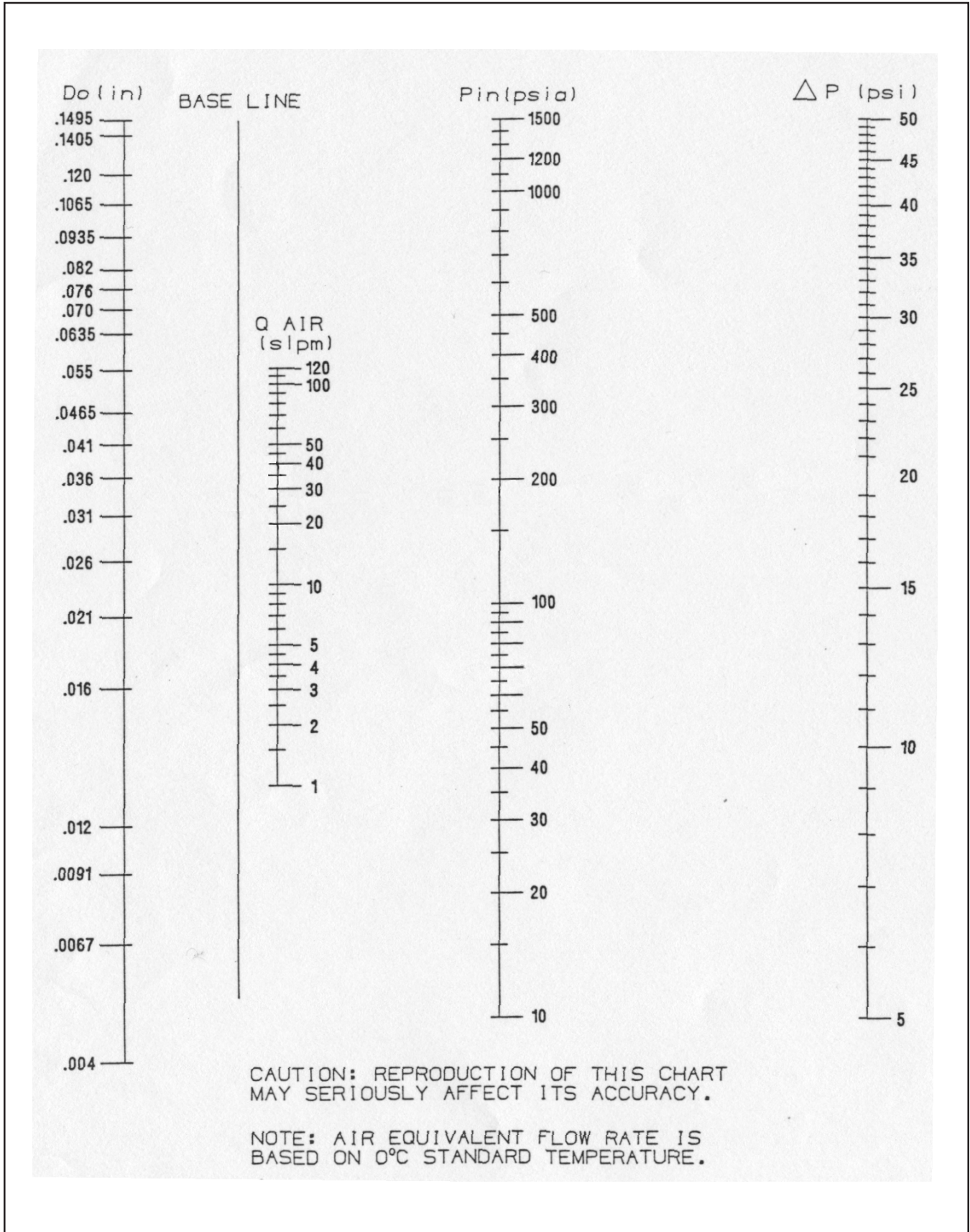
1. Determine Nitrogen equivalent flow rate (refer to Table 4-3).

$$Q_{\text{NITROGEN}} = Q_{\text{GAS}} \times \sqrt{\frac{\frac{18}{\text{GAS}}}{\frac{18}{\text{NITROGEN}}}}$$

OR

$$Q_{\text{NITROGEN}} = Q_{\text{GAS}} \times \sqrt{\frac{SG_{\text{GAS}}}{SG_{\text{NITROGEN}}}}$$

Table 4-4 Orifice Sizing Nomograph



## Brooks® Model 5851E

Where:

$Q_{\text{NITROGEN}}$  = Nitrogen equivalent flow rate (sccm)

$Q_{\text{GAS}}$  = Desired flow rate of the gas (sccm)

$\bar{\rho}_{\text{NITROGEN}}$  = Density of Nitrogen at 70°F

$\bar{\rho}_{\text{GAS}}$  = Density of the gas (taken at customer temperature)

$SG_{\text{GAS}}$  = Specific gravity of the gas (taken at customer temperature)

Refer to Table 4-3 for densities.

Example:

$$\begin{aligned}
 Q_{\text{gas}} &= 2,000 \text{ sccm} \\
 \sqrt{\frac{\bar{\rho}_{\text{gas}}}{\bar{\rho}_{\text{Nitrogen}}}} &= .269 \\
 Q_{\text{Nitrogen}} &= Q_{\text{GAS}} \times \sqrt{\frac{\bar{\rho}_{\text{gas}}}{\bar{\rho}_{\text{Nitrogen}}}} \\
 &= 2,000 \times .269 \\
 &= 538 \text{ sccm Nitrogen}
 \end{aligned}$$

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

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

Where  $P_1$  = percentage by volume of gas 1  
 $P_2$  = percentage by volume of gas 2  
 $P_n$  = percentage by volume of gas n

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

$$\begin{aligned}
 \text{Orifice Conversion Factor Mixture} &= \frac{20(.378) + 80(1.598)}{100}
 \end{aligned}$$

$$\begin{aligned}
 Q_{\text{Nitrogen}} &= Q_{\text{gas}} (\text{orifice conversion factor}) \\
 &= 20 \times 1.439 \\
 &= 28.78 \text{ slpm Nitrogen}
 \end{aligned}$$



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 ( $\Delta p$ ) should be calculated as follows:

$$\Delta p = \frac{P_{\text{in}}}{2}$$

$\Delta p$  = Pressure drop (psi)  
 $P_{\text{in}}$  = Inlet pressure (psia)

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

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

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

4. Using the nomograph, locate the pressure drop (psi) on the vertical line marked " $\Delta p$ " (Point A).

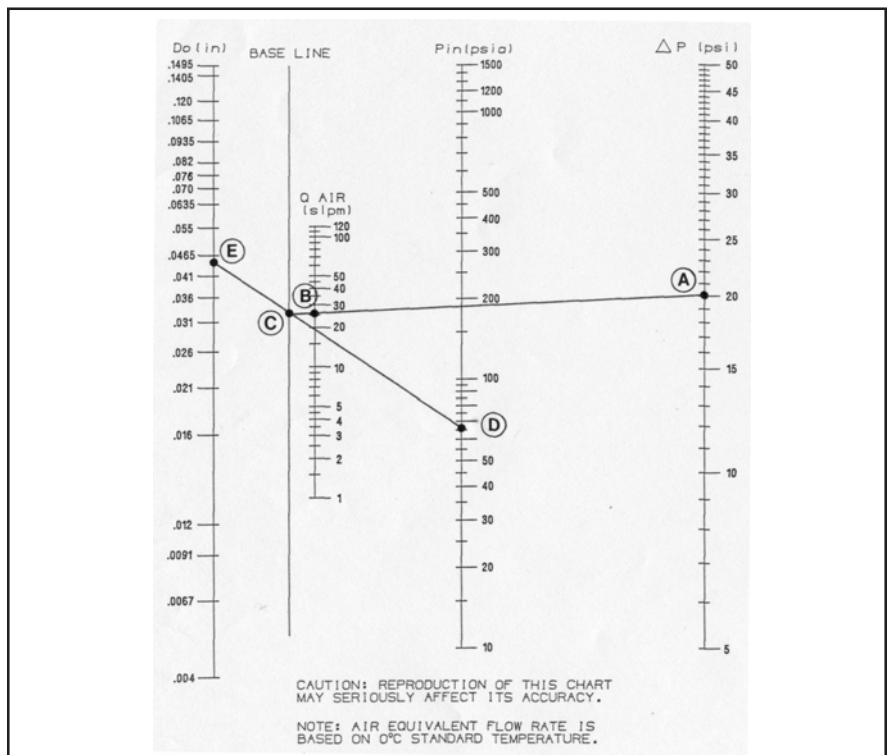


Figure 4-4 Example Nomograph

## Brooks® Model 5851E

5. Locate the Nitrogen equivalent flow rate (sccm Nitrogen) on the vertical line marked " $Q_{\text{Nitrogen}}$ " (Point B).
6. Draw a line connecting  $\Delta p$  and  $Q_{\text{Nitrogen}}$  and extend it to the baseline. Mark this point (Point C).
7. Locate inlet pressure (psia) on the vertical line marked " $P_{\text{in}}$ " (Point D).
8. Draw a line connecting  $P_{\text{in}}$  (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 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 .0013, choose .0013 size orifice.

For the example in Figure 4-4, the .007 size orifice would be selected.

#### 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 controllers 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 will be altered and it 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:

- Appropriate size wrench for the removal of the inlet process connection
- Restrictor removal tool (Refer to Table 5-2)
- Restrictor O-ring, refer to the spare parts Section 5, for the correct part number.

The Model 5851E Mass Flow Controller utilizes porous metal restrictor assemblies for all full scale flow rates. Restrictor elements 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.

When sizing a restrictor assembly for gases other than Nitrogen, 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 4-3 for the conversion factor list.

Example:

The desired gas is Silane (SiH<sub>4</sub>)

The desired full scale flow rate is 200 sccm.

Sensor conversion factor is 0.625 from Table 4-3.

Nitrogen equivalent flow = 200/0.625 = 320 sccm Nitrogen

In the example above, the restrictor should be sized for a 320 sccm flow rate.

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 O-ring onto the header plate. The restrictor assembly can then be installed in the MFC body (restrictor element(s) go in first). It is important that the restrictor assembly is put into the body in the correct orientation (Refer to Figure 4-6). Push this assembly in with your fingers. 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.
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.

<b>⚠ CAUTION</b>
<b>The end block screws (31) and the valve screws (3) are not interchangeable. The end block screws are stronger and are needed to achieve the pressure rating. The end block screws are darker in color and can be attracted by a magnet.</b>

5. Install the inlet adaptor fitting.

Table 4-5 Restrictor Selection Guide

Range slpm Nitrogen Equivalent Flow*	Restrictor Element Combination	Part Number
4.6 to 15	1-40 micron (1 inch)	S613E604BMT
15 to 26	1-40 micron	S613E636BMT
26 to 42	2-40 micron	S613E523BMT
42 to 60	3-40 micron	S613E526BMT
60 to 79	2-40 micron/1-60 micron	S613E528BMT
79 to 93	1-40 micron/2-60 micron	S613E529BMT
93 to 130**	3-60 micron	S613E527BMT

\*Based on 0°C Standard Reference Temperature

\*\*For Hydrogen from 130 slpm to 200 slpm use 3-60 micron restrictor elements.

Note: If the air equivalent flow is between two sizes, choose the larger size.

Brooks® Model 5851E

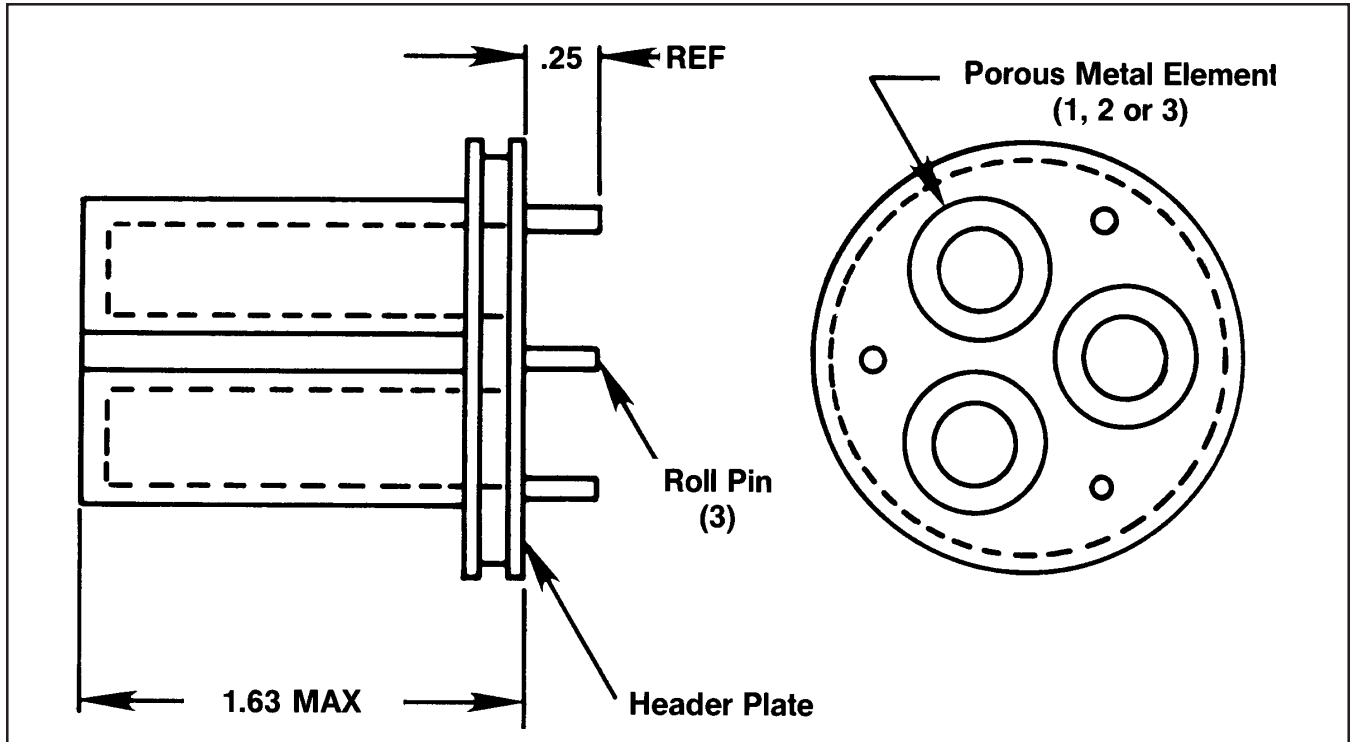


Figure 4-5 Restrictor Element Assembly

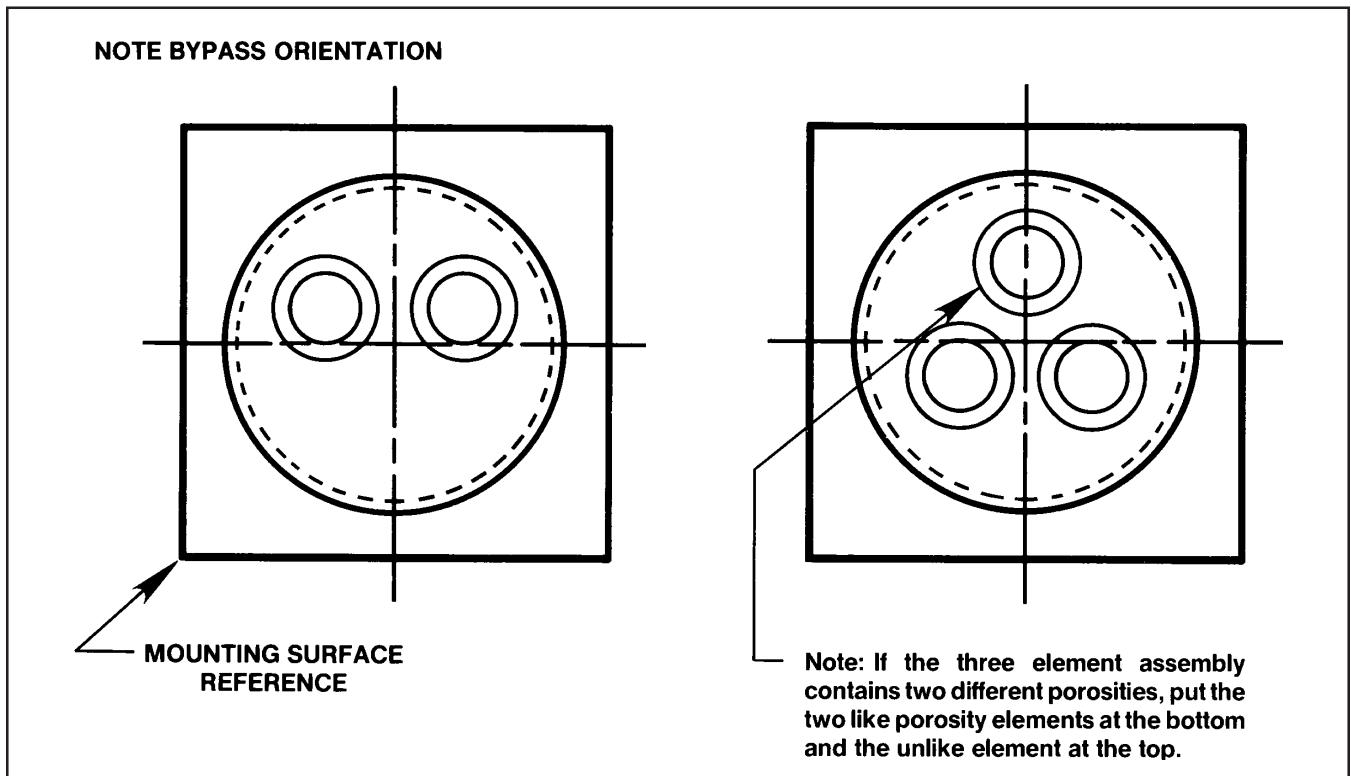


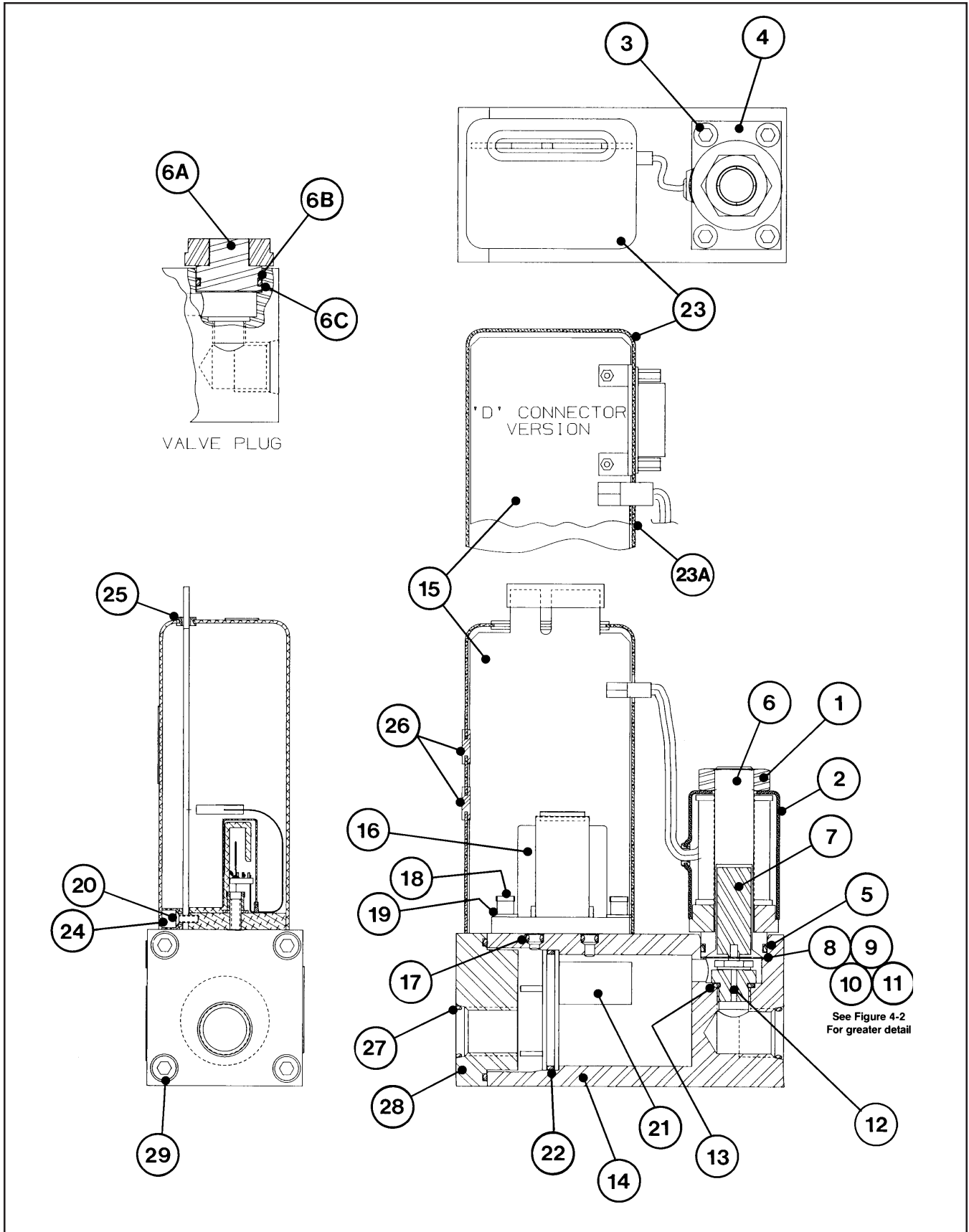
Figure 4-6 Restrictor Element Orientation in Controller Body

#### 4-1 General

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When ordering parts, please specify: Brooks serial number, model number, part description, part number, and quantity. (Refer to Figure 5-1 and Table 5-1 and 5-2).

Brooks® Model 5851E



5-2 Figure 5-1 Model 5851E Parts Drawing

Table 5-1 Model 5851E Replacement Parts List

Item No.	Qty.	Description	Part Number	
1	1	Jam Nut	573B027ACK	
2	1	Coil Assembly	S185Z271AAA	
3	4	Screw, Valve	751C322AWA	
4	1	Retaining Plate	715Z169CZ%	
5	1	O-ring, Valve Stem, Size 016	375B016***	
6	1	Valve Stem, High Flow	S949Z203QOA	
6A	1	Valve Plug	953Z068BMT	
6B	1	Valve Ring	763Z064***	
6C	1	Valve O-ring	375B016***	
7	1	Valve Plunger Assy., High Flow	S622Z165AAA	
8	1	Lower Guide Spring	820Z083BMA	
9	AR	Small Valve Spacer, 0.005" Thick	810A362BMA	
9	AR	Small Valve Spacer, 0.010" Thick	810A363BMA	
10	AR	Large Valve Spacer, 0.005" Thick	810A368BMA	
10	AR	Large Valve Spacer, 0.010" Thick	810A361BMA	
11	1	Valve Seat with Viton Insert	S715Z051AAG	
		Valve Seat with Buna Insert	S715Z050AAG	
		Valve Seat with Kalrez Insert	S715Z163AAA	
		Valve Seat Solid 316 Stainless Steel	715Z181BNT	
12	1	Orifice  (Refer to Section 4-6 for sizing)	Stainless	
			577Z275BMT	
			ID 0.0040	577Z277BMT
			ID 0.0067	577Z280BMT
			ID 0.0091	577Z283BMT
			ID 0.0120	577Z286BMT
			ID 0.0160	577Z289BMT
			ID 0.0210	577Z293BMT
			ID 0.0260	577Z296BMT
			ID 0.0310	577Z300BMT
			ID 0.0360	577Z305BMT
			ID 0.0410	577Z308BMT
			ID 0.0465	577Z310BMT
			ID 0.0550	577Z312BMT
			ID 0.0635	577Z314BMT
			ID 0.0700	577Z316BMT
			ID 0.0760	577Z319BMT
			ID 0.0820	577Z322BMT
			ID 0.0935	577Z328BMT
			ID 0.1065	577Z333BMT
ID 0.1200	577C336BMT			
ID 0.1405				
13	1	O-ring, Orifice, Size 011	375B011***	
14	1	Controller Body w/ Weld Studs	S854Z157BMA	
15	1	PC Board Assembly (Card Edge) (D-Connector)	S097Y824AAA S097Y847AAA	
16	1	Sensor Assembly	S774Z607AAA	
17	2	O-ring, Sensor, Size 004	375B004***	
18	2	Allen Nut, Sensor-Body	573Q103ACZ	
19	2	Lock Washer, Sensor	962D005AWA	
20	5	Screw, Sensor-PC Board-Cover	753L056AWZ	
21	1	Restrictor Assembly and Components (Refer to Section 4-7 for sizing)		
22	1	O-ring, Restrictor, Size 026	375B026***	
23	1	Electronics Cover Can (Card Edge) (D-Connector)	219Z389EA% 219Z390EA%	
23A	1	Cover Plate (D-Con. Version Only)	852Z209EA%	
24	1	PC Board Mounting Bracket	079Z135EAA	
25	1	Centrating Ring (Card Edge Only)	106D073MDQ 106D072MDQ	
26	2	Pot Hole Plug	620Z434SXA	

\*\*\*QTA = Viton, SUA = Buna, TTA = Kalrez, AR = As Required, NS = Not Shown

Brooks® Model 5851E

Table 5-1 Model 5851E Replacement Parts List (Continued)

Item No.	Qty.	Description	Part Number			
NS	2	<b>Fittings:</b>				
		1/4" Compression, Swagelok				320B136BMA
		1/4" Male VCR, Cajon				315Z036BMA
		1/4" Male VCO, Cajon				315Z035BMA
		3/8" Compression Fitting				320B150BMA
		3/8" Male VCO (3/8" or 1/2" Tube)				315Z033BMA
		3/8" Male VCR (3/8" or 1/2" Tube)				315Z034BMA
27	2	O-ring, Fitting, Size 906				375B906***
NS	2	O-ring, Fitting, Size 010				375B010***
NS	1	O-ring, End Block, Size 029				375B029***
NS	1	<b>Interconnecting Cables:</b>		<b>Length</b>	<b>Card Edge</b>	<b>D-Connector</b>
		Connector on one end with no termination on other end		5 Feet	S124Z469AAA	S124Z361AAA
				10 Feet	S124Z470AAA	S124Z362AAA
				25 Feet	S124Z471AAA	S124Z363AAA
				50 Feet	S124Z472AAA	S124Z435AAA
NS	1	Connector on one end with Connector for Model 5870 Series Secondary Electronics on other end		<b>Length</b>	<b>Card Edge</b>	<b>D-Connector</b>
				5 Feet	S124Z669AAA	S124Z576AAA
				10 Feet	S124Z539AAA	S124Z577AAA
				25 Feet	S124Z562AAA	S124Z578AAA
		50 Feet	S124Z670AAA	S124Z579AAA		
NS	2	8-32 Mounting Screw		Customer Supplied		
28	1	End-block with integral inlet screen		S079Z200AAA		
29	4	Screw, End-block		751Z105AA0		

\*\*\*QTA = Viton, SUA = Buna, TTA = Kalrez, AR = As Required, NS = Not Shown

Table 5-2. Tool and Spare Kits for Model 5851E.

<p>5850 Series Service Tool Kit P/N S778D017AAA</p> <p>Permits the complete disassembly of the 5850E Series for servicing</p> <p>Contains:</p> <ul style="list-style-type: none"> <li>1 - O-ring Removal Tool</li> <li>1 - Potentiometer Adjustment Tool</li> <li>1 - Ball Point Allen Wrench</li> <li>1 - Nut Driver for Orifice</li> <li>1 - Restrictor Removal Tool</li> <li>1 - Common Screw Driver</li> </ul>	<p>Model 5851 Header Removal Tool P/N S817Z036AAA</p> <p>Model 0550/5851 Orifice Removal Tool P/N S908Z049AAA</p>
<p>5850 Series Break Out Board Assembly P/N S273Z649AAA for Card Edge version S273Z668AAA for D-Connector version</p> <p>Installs directly between mass flow controller and interconnecting cable. Allows convenient access to all signals for easy troubleshooting of system</p> <p>Contains:</p> <ul style="list-style-type: none"> <li>1 - Break Out PC Board</li> <li>1 - 5 foot Extension Cable</li> <li>1 - Terminal PC Board</li> </ul>	<p>5850 Series Valve Shim Kit P/N S810A372BMA</p> <p>Contains:</p> <ul style="list-style-type: none"> <li>1 - .010" Large Spacer</li> <li>2 - .005" Large Spacers</li> <li>1 - .010" Small Spacer</li> <li>2 - .005" Small Spacers</li> </ul>

\*\*\*QTA = Viton, SUA = Buna, TTA = Kalrez  
Note: Refer to Brooks publication DS-5800 for additional accessories.



**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 5851E

**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.

**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.

**αριθμ** : **μικροσηκη στο Εγχειριδιο Οδηγιών.**  
**Εχρτικά** : **Πιστοποίηση CE των Οργάνων Μέτρησης Παροχής Μάζας.**  
**Ημερομηνία** : **Ιανουάριος - 1996**

Συρίες και Κύριοι,

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

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

**Ιοιότητα του καλωδίου σήματος των τυποθλιπτιών και των συνδέσμων .**

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

άν η επιλογή του καλωδίου σήματος γίνει από σας πρέπει να χρησιμοποιήσετε αλώδιο το οποίο να φέρει εξωτερικά πλήρες πλέγμα και να παρέχει θωράκιση 00%.

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

ο πλέγμα του καλωδίου πρέπει να συνδέεται στο μεταλλικό περιβλήμα ή στον τυποθλιπτιη και να θωρακίζεται και στα δύο άκρα κατά 360 μοίρες.

Η θωράκιση πρέπει να καταλήγει σε κάποιο ακροδέκτη γείωσης.

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

θωράκιση πρέπει να καταλήγει σε κάποιο ακροδέκτη γείωσης.

ια την διάταξη των ακροδεκτών: Παρακαλούμε αναφερθείτε στο εσώκλειστο γχειριδιο Οδηγιών.

## Brooks® Model 5851E

**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.

**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 kablen 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 (elétrico/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 5851E

**Suomi**

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

**Asia** : Lisäys Käyttöohjeisiin

**Viite** : Massamäärämittareiden CE sertifiointi

**Päivämäärä** : Tammikuu 1996

Brooksin CE merkillä varustetut sähköiset laitteet ovat läpäissyt EMC testit (direktiivi 89/336/EEC).

Erytystä huomiota on kuitenkin kiinnitettävä signaalikaapelin valintaan.

**Signaalikaapelin, kaapelin läpiviennin ja liittimen laatu**

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

“D” tai “Circular” tyyppisen liittimen tulisi olla varustettu metallisuojualla. Mikäli mahdollista, tulisi käyttää metallisia kaapeliliittimiä kiinnitettäessä suojava.

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 suojattu jotta ne olisivat CE sertifikaatin 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 överensstämja med CE-certifieringen.

Skärmen ska avslutas med en jordförbindelse.

För elektrisk anslutning till kontaktstiften hänvisas till medföljande instruktionsmanual.

**Installation and Operation Manual**

X-TMF-5851E-MFC-eng

Part Number: 541B104AAG

November, 2008

Brooks® Model 5851E

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# Brooks® Model 5851E

## 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](http://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
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Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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