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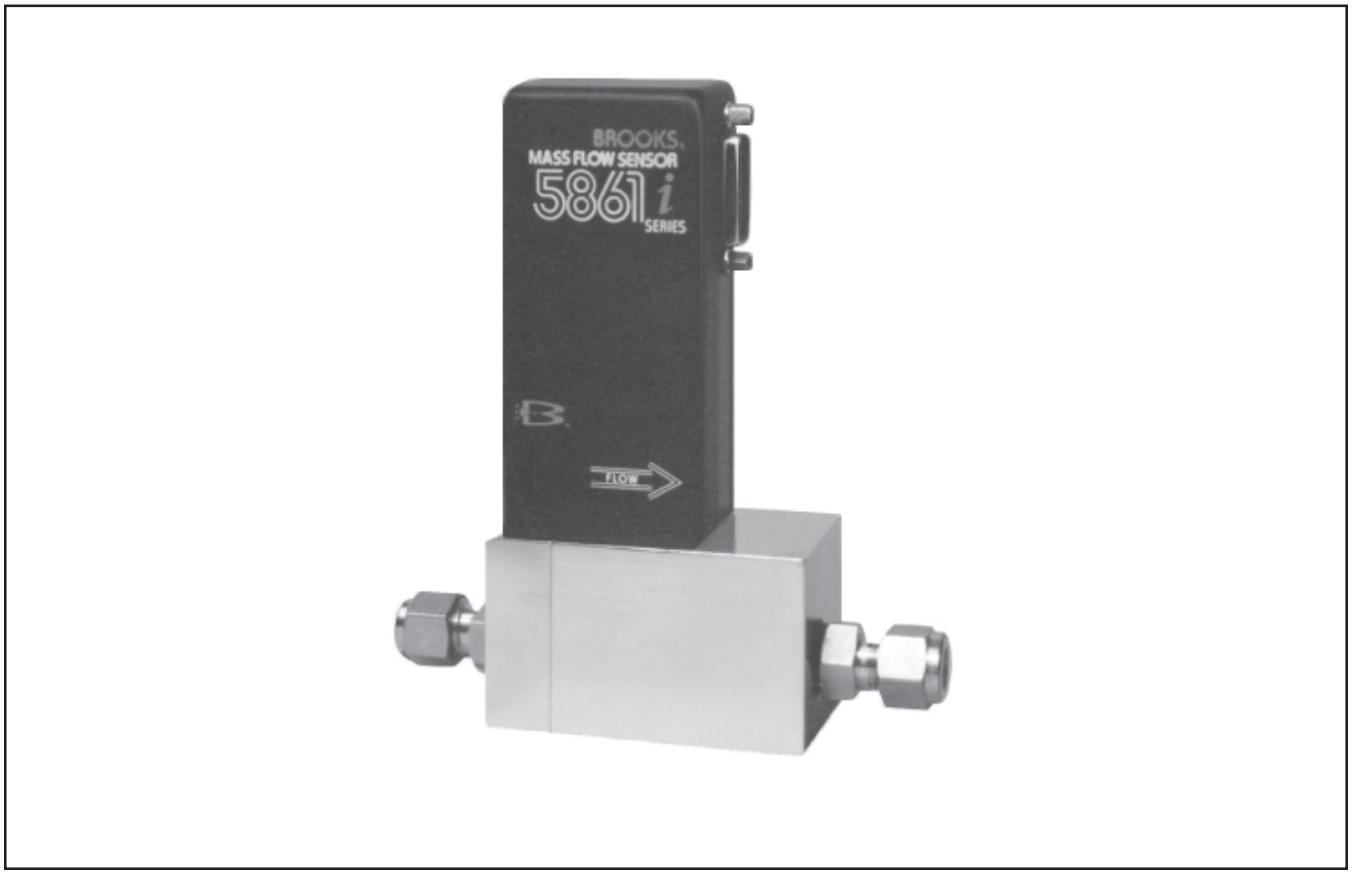
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Installation and Operation Manual
X-TMF-5861i-MFM-eng
Part Number: 541B111AAG
November, 2008

Model 5861*i*
Mass Flowmeter



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Essential Instructions

Read this page before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using and maintaining Brooks Products.

- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.
- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation and maintenance of the product.
- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

Pressure Equipment Directive (PED)

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

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

ESD (Electrostatic Discharge)

⚠CAUTION

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

Handling Procedure:

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

Comments

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

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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

Yours sincerely,

Brooks Instrument

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1-1 Purpose

The Brooks® Model 5861*i* Flowmeter is a mass flow measurement device designed for accurately measuring flows of gases. This instruction manual is intended to provide the user with all the information necessary to install, operate and maintain the Brooks 5861*i* Mass Flow Meter. This manual is organized into five sections:

Section 1 - Introduction
Section 2 - Installation
Section 3 - Operation
Section 4 - Maintenance
Section 5 - Parts List

It is recommended that this manual be read in its entirety before attempting to operate or repair the Model 5861*i*.

1-2 Description

The Brooks Model 5861*i* Mass Flowmeter is used widely in the semiconductor, as well as many other industries where manual, electronic or computer controlled gas handling occurs. The Model 5861*i* consists of two basic units: a flow sensor and an integral electronic signal conditioner. This combination produces a stable gas flow indication which eliminates the need to continuously monitor and compensate for changing gas pressures and temperatures.

1-3 Specifications

⚠ WARNING

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

Standard Ranges
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; 68°F±3°F;50%±5%RH

Repeatability
0.25% of rate

Response Time (Flow Output Signal)
Less than 6 seconds response to within 2% of full scale final value with a 0 to 100% flow step.

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Power Requirements
+15 to +28Vdc @ 90 mA
2.5 watts power consumption max.@28 volts

Ambient Temperature Limits
Operating: 5 to 65°C (40 to 150°F)
Non-Operating: -25 to 100°C (-13 to +212°F)

Working Pressure
1500 psi (10.34 MPa) maximum

Output Signal
0-5 Vdc into 2000 ohms or greater. Maximum ripple 3 mV.
Jumper selectable 4-20 mAdc or 0-20 mAdc. Refer to Figure 2-3 for maximum allowable loop resistance.

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

Pressure Sensitivity
0.03% per PSI up to 200 PSIG

Power Supply Sensitivity
±0.09% full scale per % power supply voltage variation

Mounting Attitude Sensitivity
±0.5% maximum full scale deviation after re-zeroing

Leak Integrity
1 x 10^{-9} Atm. scc/sec Helium

Usable Range
50 to 1

Mechanical Connection
Refer to Figure 2-1.

Electrical Connection
D-type, 15 pin male connector (DA-15P)
Refer to Figure 2-2.

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2-1 Receipt of Equipment

When the equipment is received, the outside packing case should be checked for damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding his liability. A report should be submitted to the Product Service Department, Brooks Instrument, Hatfield, Pennsylvania 19440-0903.

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

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2-2 Recommended Storage Practice

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

a. Within the original shipping container.

b. Store in a sheltered area with the following conditions:

1. Ambient temperature 21°C (70°F) nominal.
2. Relative humidity 50% nominal. 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.

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2-3 Return Shipment

Prior to returning any Brooks equipment to the factory, contact the factory - for a Return Materials Authorization Number (RMA#). This can be obtained at Brooks Instrument, Product Service Department, 407 West Vine Street, Hatfield, PA 19440-0903, 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 5861*i* are 3/8" compression fittings.

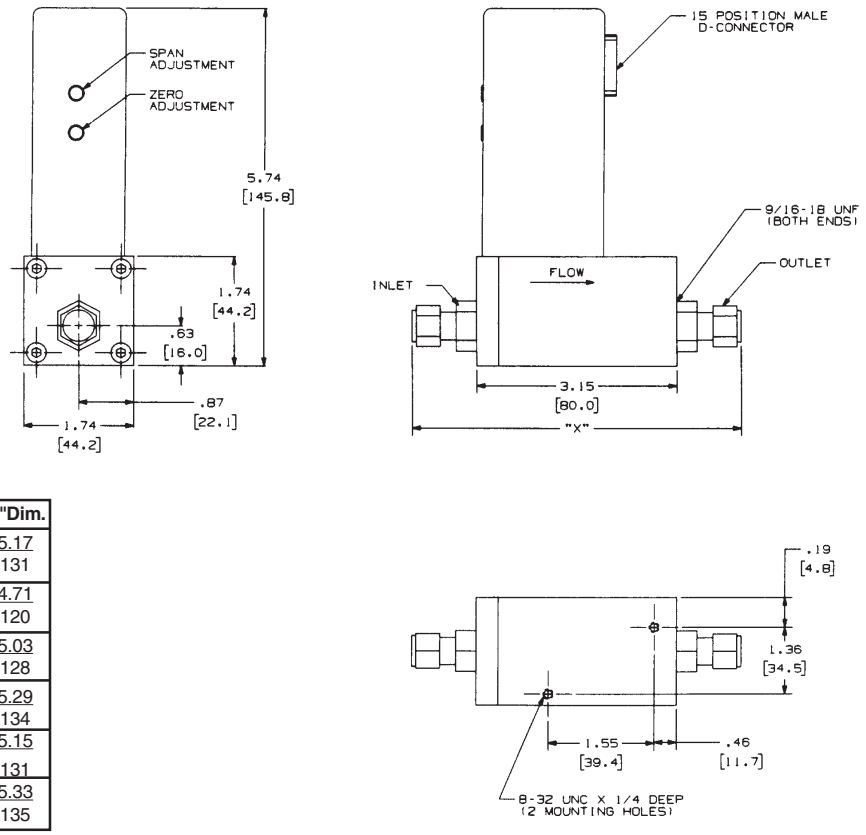
Optional VCO™ and VCR™ connections are available upon request. Prior to installation, make certain all piping is clean and free of obstructions. Install the piping in such a manner that permits easy removal if the instrument is to be removed for cleaning or test bench troubleshooting.

2-5 Installation (Refer to Figures 2-1 through 2-2)

⚠ CAUTION

When installing the flowmeter, 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.

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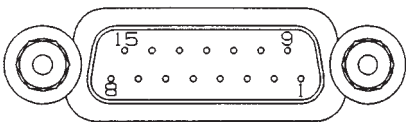


Connection	"X"Dim.
1/4"Compression Fitting	5.17 131
1/4" Tube VCO	4.71 120
1/4" Tube VCR	5.03 128
3/8"Compression Fitting	5.29 134
3/8" or 1/2" Tube VCO	5.15 131
3/8" or 1/2" Tube VCR	5.33 135

Figure 2-1 Model 5861i Dimensions

PIN NO.	FUNCTION	COLOR CODE
1*	Set Point Return	Black
2	Voltage Signal Output	White
3	Not Used	
4	Current Signal Output	Green
5	+15 to +28Vdc Supply	Orange
6	Not Used	
7*	Current Set Point Input	Wht/Blk
8*	Voltage Set Point Input	Red/Blk
9	Supply Common	Grn/Blk
10	Signal Output Return	Org/Blk
11*	+5 Volt Reference Output	Blu/Blk
12*	Valve Override Input	Blk/Wht
13	Not Used	
14	Chassis Ground	Grn/Wht
15	Not Used	

"D" Connector - Top View



NOTE:

1. **Cable shield tied to chassis ground in meter connector. Make no connection on customer end.**
2. **All power leads must be connected to power supply.**

*** These connections are used for the 5850*i* and 5851i Mass Flow Controllers. Make no connections to these pins.**

Figure 2-2 "D" Type Connector Pin Arrangement

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⚠ CAUTION

Any Brooks Instrument mass flowmeter 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).

Recommended installation procedures:

a. The Model 5861*i* 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.

⚠ WARNING

When used with a reactive (sometimes toxi) 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 dry Nitrogen before use. Failure to heed warning may result in serious personal injury and/or damage to the equipment.

d. The Model 5861*i* Mass Flowmeter can be installed in any position. However mounting orientations other than the original factory calibration (see data sheet) will result in a ±0.5% maximum full scale shift after re-zeroing.

e. When installing flowmeters, 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 10 pipe diameters of straight tubing upstream of the Model 5861*i* Mass Flowmeter.

2-6 In-Line Filter

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

Table 2-1 Recommended Filter Size

Maximum Flow Rate	Recommended Filter Size
10-30 slpm	15 micron
Above 30 slpm	30 micron

Note: The above 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.

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2-7 Electrical Interfacing

To insure proper operation the Model 5861*i* must be connected per Figures 2-2, 2-3, and 2-4 and configured according to Section 2-7.

Note: There are several functions on the printed circuit board which are not used by the Model 5861*i*. Avoid making connections marked in Figure 2-2 which are marked *.

The following minimum electrical connections must be made for new installations:

Chassis Ground
Voltage and/or Current Signal Output
Signal Output Return
+15 to +28 Vdc Supply
Supply Common

Electrical Hook-Up

Signal Output

A 0-5 Vdc flow signal output is always available. The current signal output is jumper - selectable for either 0-20 mAdc or 4-20 mAdc. The flow signal output can be measured as a voltage and a current simultaneously on two different pins of the D-connector. Pin 2 indicates the flowrate with a 0-5 Vdc signal proportional to the mass flow rate. Pin 4 indicates the flowrate with either a 0-20 mAdc or 4-20 mAdc current signal as determined by the jumpers on the printed circuit board (Refer to Section 2-7 for jumper positions). Both the current and voltage signals are returned on Pin 10 of the D-connector.

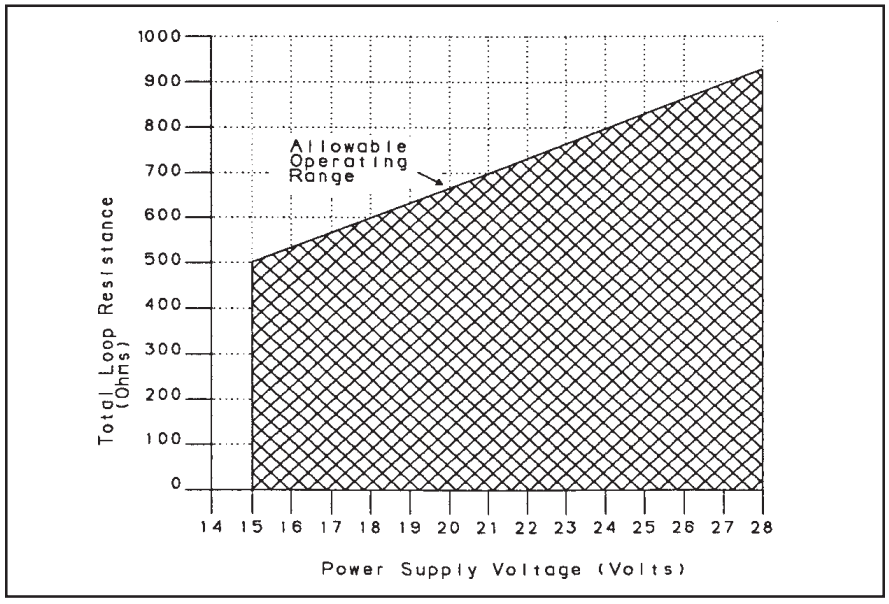


Figure 2-3 Maximum Allowable Loop Resistance

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Supply

The power of the mass flow meter is connected to Pin 5 (+15 to +28 Vdc) and Pin 9 (supply common) of the D-connector. Refer to Section 1-3 for the power requirements.

Note: The length of the wire for the power supply connection (Pins 5&9) must be selected as to insure a minimum of 15 Vdc is available at the mass flow meter.

Chasis Ground

Connect earth ground to Pin 14 of the D-connector.

2-8 Configuring PC Board

Note: To obtain easiest access to the jumpers, the electronics cover must be removed. Disconnect the power to the mass flow meter, and cables to the D-connector. Remove the three screws at the base of the can and remove the top jack post of the D-connector. Remove the can. The can must be replaced before returning the unit to service.

Refer to Section 2-6 for the proper electrical hook-up.

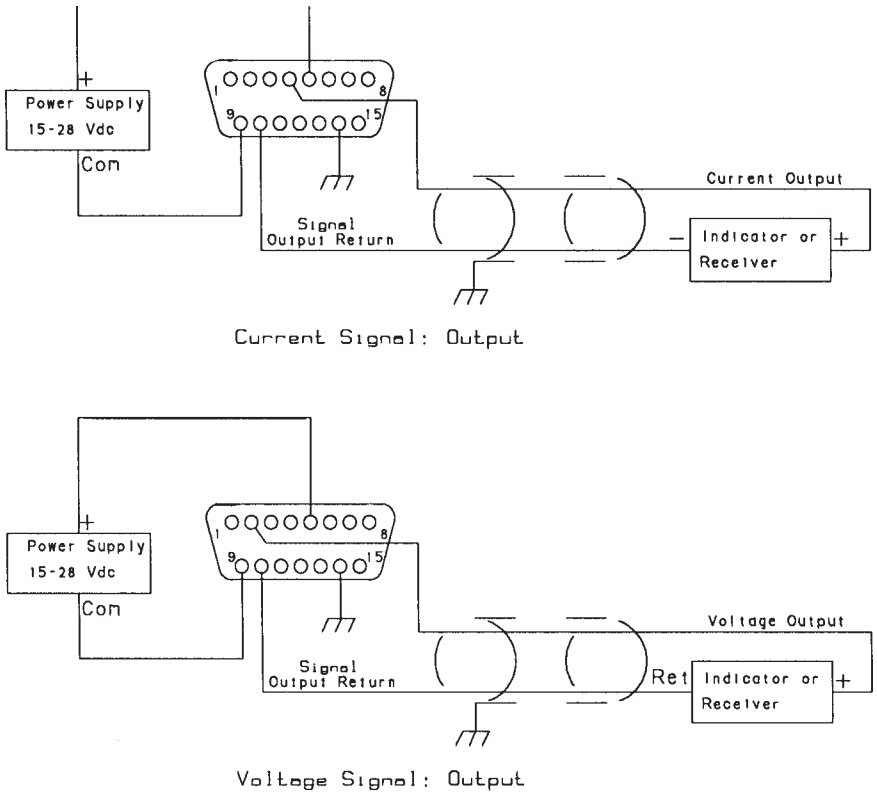
Refer to Section 3-5 for printed circuit board jumper locations and functions.

Jumper Setting

Jumpers J3 and J4 (blue) must be in the upper position for 0-20 mAdc output and in the lower position for 4-20 mAdc output.

Note: Both J3 and J4 must be in the same upper or lower position. Jumpers J3 and J4 do not affect voltage output.

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Notes:

1. Tie cable shields to ground at one end only.
2. Current and voltage outputs may be used simultaneously.

Figure 2-4 Common Electrical Hook-Ups

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3-1 Theory of Operation

The thermal mass flow sensing technique used in the 5861*i* works as follows:

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

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

Where,

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

A bridge circuit interprets the temperature difference and a differential amplifier generates a linear 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 controller's full scale flow.

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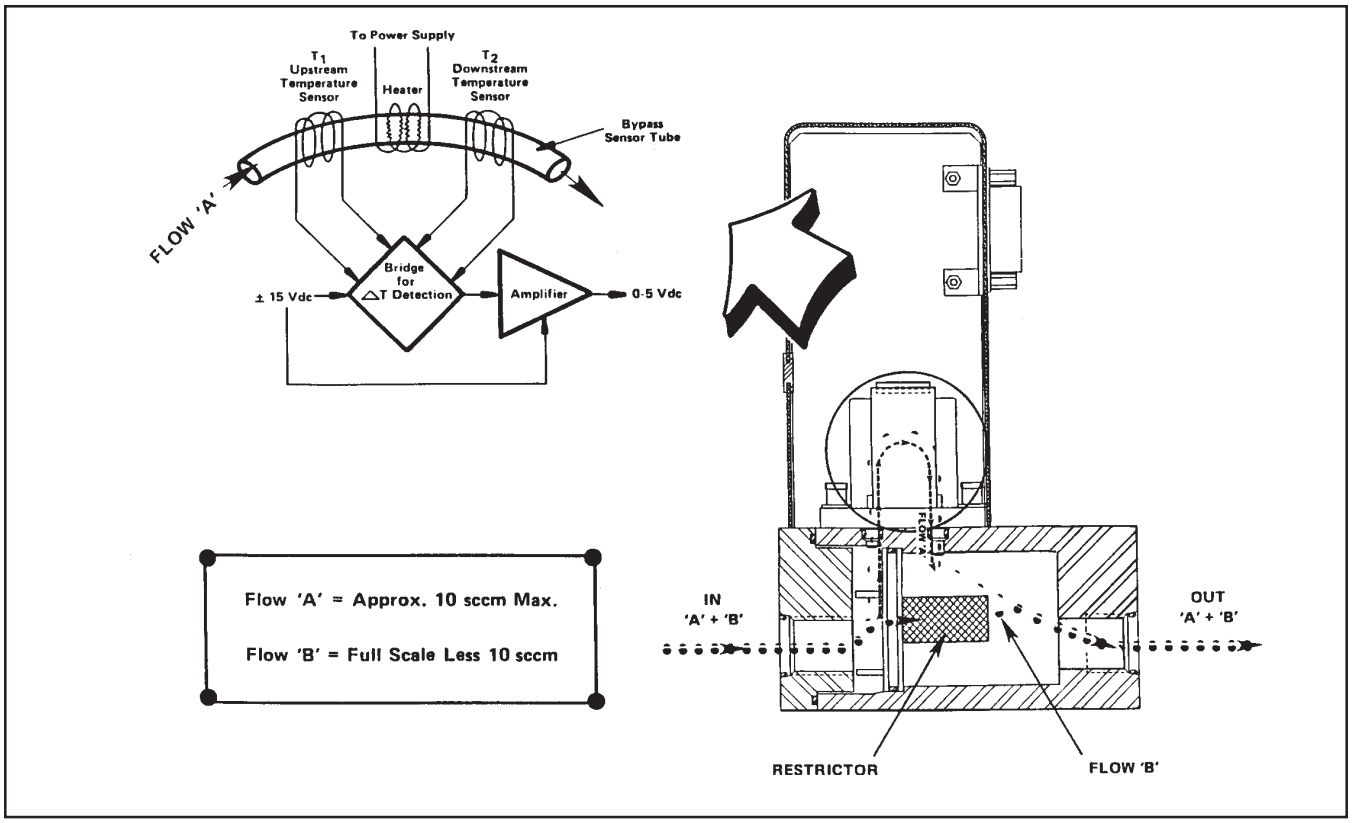


Figure 3-1 Flow Sensor Operational Diagram

3-2 Operating Procedure

a. Apply power to the flowmeter and allow approximately 45 minutes for the instrument to warm-up and stabilize its temperature.
b. Turn on the gas supply.
c. Shut-off flow to the meter and observe the flowmeter's output signal. If the output is not 0mVdc (±10mVdc), check for leaks and if none are found, refer to the re-zeroing procedure in Section 3-3.
d. Open valve to allow flow to pass through the meter. Monitor the flow output signal.

3-3 Zero Adjustment

Each Model 5861*i* is factory adjusted to provide a 0mVdc ±10mVdc signal at zero flow. This will equate to a 4mA or 0mA current output depending no the jumper selection. 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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To check zero always mount the flowmeter 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 flowmeter 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 3-3) until the desired output signal is obtained.

3-4 Calibration Procedure

NOTE 1: This calibration procedure is shown using the voltage output (not current). The conversion accuracy of the voltage to current convertor allows this with no loss in accuracy using the 4-20 mA output.

NOTE 2: If the mass flowmeter is to be used on a gas other than the calibration gas, apply the appropriate sensor conversion factor. (Refer to Section 4-5).

NOTE 3: Calibration of the Model 5861i mass flowmeter requiresthe use of a Digital Voltmeter (DVM), and a flow control valve or mass flow controller to set the flowrate and precision flow standard calibrator such as the Brok Uol-U-Meter. It is recommended that the calibration be performed only by trained and qualified service personnel.

a. Adjust the anticipate potentiometer fully clockwise (20 turns). Then adjust the anticipate potentiometer 10 turns counter clockwise to center the potentiometer. This will provide a rough adjustment of this circuit.
b. Connect the DVM positive lead to the 0-5V signal output (pin 2 D-connector) and the negative lead to circuit common (TP4). Adjust the zero potentiometer for an output of 0mV ±2mV.
c. Increase the flow rate until the flow signal output equals 5.000V. Connect the DVM positive lead to TP2 (linearity voltage) and the negative lead to TP4 (circuit common). Adjust the linearity potentiometer for an output of 0.0V (zero volts).
d. Connect the DVM positive lead to the 0-5V signal output (pin 2 of D-Connector) and the negative lead to TP4 (circuit common). Adjust the actual flow rate to within ±2% of desired full scale flow. Measure the flow rate using suitable volumetric calibration equipmentand record value. Calculate flow signal voltage with the following formula:

$$\text{Flow signal voltage} = \frac{\text{measured flow rate}}{\text{full scale flow rate}} \times 5.000$$

Adjust the span potentiometer (Refer to Figure 3-3) until the 0-5V signal output equals the flow signal voltage calculated above.

e. Connect the DVM positive lead to TP1 (sensor voltage). 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 stay between +2.0 to +9.0 volts for proper operation. If the recommended voltage range exceeds this than the desired accuracy and/or signal stability may not be achieved. If one of the limits is reached check the restrictor sizing procedure. (Refer to Section 4-6).

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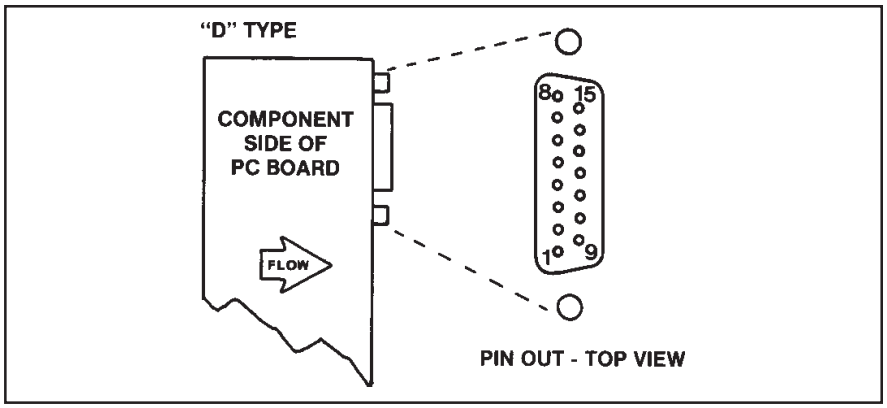


Figure 3-2 Model 5861i Calibration Connections

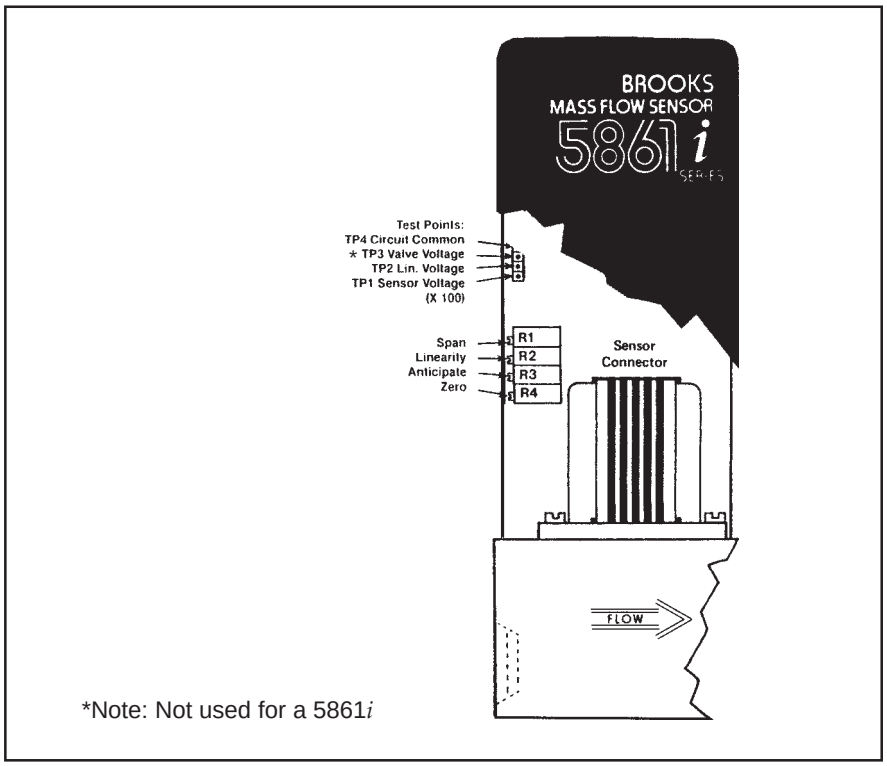


Figure 3-3 Adjustment Potentiometer Location

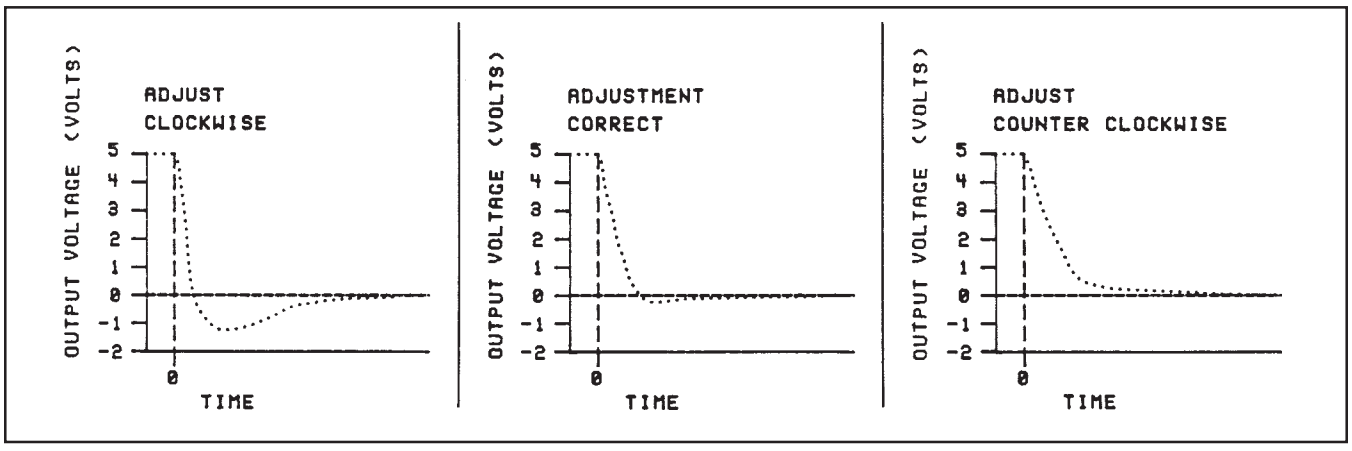


Figure 3-4 Fast Response Adjustment

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f. Shut off the flow. Connect the DVM positive lead to flow signal output (pin 2 D-connector) and the negative lead to TP4. Readjust the zero potentiometer for an output of 0mV±2mV as necessary.

g. Adjust flow rate for a flow signal output of 50% (2.500V) and measure the flow rate. Calculate the error as a percentage of full scale.

$$\text{Flow scale error} = 100 \left[\frac{\text{indicated* flow rate} - \text{measured flow rate}}{\text{full scale flow rate}} \right]$$

Note: indicated flow rate can be found using the following formula:

$$\text{indicated flow rate} = \frac{\text{flow signal out (volts)}}{5.000} \times \text{full scale flow}$$

Example:
What is the percent of full scale error when full scale is equal to 50 slpm?
Measured flow rate = 25.75 slpm
Indicated flow rate = 25 slpm

$$\text{Full scale error} = 100 \frac{25-25.75}{50} = -1.5\%$$

h. Calculate the TP2 correction voltage:
(error recorded in step g) 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

i. Adjust flow rate for a flow signal output of 100% (5.000V). Connect the DVM positive lead to TP2 and the negative lead to TP4.

j. Adjust the linearity potentiometer for an output equal to the new calculated TP2 voltage.

Note: the output signal should be kept at

5.000 V during this adjustment.

This can be done by varying the actual flowrate.

k. Repeat steps d, e, f and g.

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

$$\text{New TP2 voltage} = \text{error recorded in step g} \times -0.450\text{v} + \text{measured TP2 voltage}$$

Example:
Full scale error = 0.7% (found in step g)
Measured TP2 voltage = -0.567 volts
TP2 correction = 0.7 x -0.450 = -0.315 volts
New TP2 correction = -0.315 + (-0.567) = -0.882 volts

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3. Adjust the linearity potentiometer for an output equal to the new TP2 voltage and then repeat step k.

Note: The voltage at TP2 can range from -3 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 4-6.

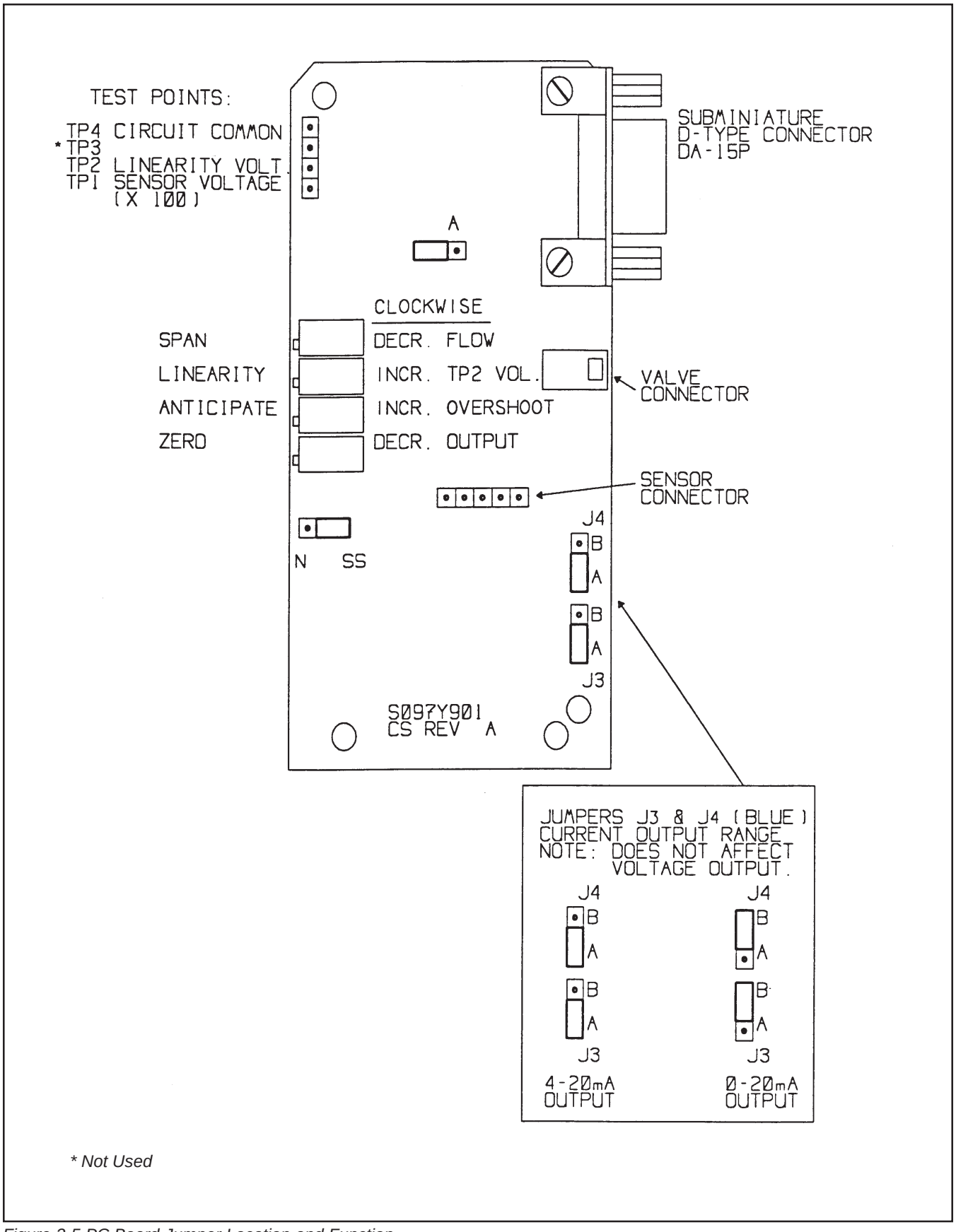
3-5 Response (Flow Output Signal)

To achieve the proper response characteristics the response compensation circuit must be adjusted. This adjustment is performed by observing the output signal of the meter when the flow is suddenly stopped. Place a metering valve upstream of the Model 5861*i* to control the flow rate. A Brooks NRS™ precision metering valve is well suited for this application. Also place a fast acting shut-off valve immediately downstream of the flowmeter. A solenoid valve is ideal for this, but a manual toggle valve will do. Keep the length of interconnecting tubing as short as possible between the valves and the Model 5861*i* since the tubing can have a dampening effect on the flow and the gas may not stop flowing the instant the downstream valve is closed. Adjustment of the fast response circuit will not alter the steady state accuracy of the flowmeter as adjusted in Section 3-4.

Note: This procedure requires an oscilloscope chart recorder, or a DVM with a sampling speed of three samples per second or greater to monitor the rate of change of the output signal during the test. Monitor the output signal at pin 2 of D-Connector. TP4 may be used for circuit common.

a. With the shut-off valve open adjust the metering valve so that the output voltage of the Model 5861*i* is 4.050 to 5.000 Vdc. Allow the output to stablize at this setting.
b. Close the shut off valve to stop the flow. Observe the output signal as it decays.
c. The behavior of the output signal during the transition between 100% and 0% flow indicates the adjustment required of the anticipate potentiometer. Refer to Figure 3-4.
1. If the flow signal decays to -0.05 to -0.5V then rises to 0.0V, the anticipate potentiometer is properly adjusted.
2. If the flow signal decays rapidly and goes below -0.5V before rising to 0.0V, 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 -0.05V, the anticipate potentiometer must be adjusted counterclockwise and steps a and b repeated.

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** Not Used*

Figure 3-5 PC Board Jumper Location and Function

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4-1 General



⚠ WARNING

METER/CONTROLLER SEAL COMPATIBILITY

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

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

No routine maintenance is required on the Model 5861*i* other than an occasional cleaning. If an in-line filter is used, the filtering element should periodically be replaced or ultrasonically cleaned.

4-2 Troubleshooting

⚠ CAUTION

It is important that this flowmeter be serviced only by properly trained and qualified personnel.

A. System Checks

The Model 5861*i* 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 and that the correct power supply voltage and signals are reaching and leaving the meter. The Break-out Board (refer to Table 5-2) listed in section 5 , will make this job much easier.

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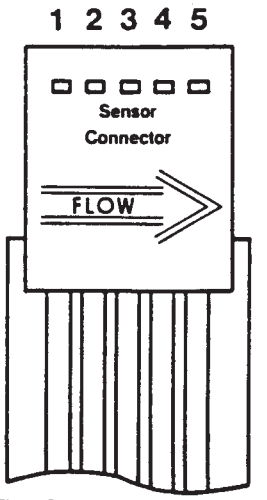
Table 4-1 Bench Troubleshooting

Trouble	Possible Cause	Check/Corrective Action
Output stays at 0 Volts regardless of flow.	Clogged Sensor.	Clean sensor. Refer to cleaning procedure. Section 4-2.
Output signal stays at a voltage greater than 5.000 volts and there is no flow through meter	Defective PC Board. Defective Sensor.	Replace PC Board. Refer to Section 4-4. Replace Sensor Assembly. Refer to Section 4-4.
Meter grossly out of calibration. Flow is higher than indicated.	Partially clogged sensor.	Clean sensor, refer to the cleaning procedure. Refer to Section 4-2.
Meter grossly out of calibration. Flow is lower than indicated.	Partially clogged restrictor.	Replace restrictor. Refer to Section 4-4.
Meter output oscillates.	Anticipate potentiometer out of adjustment. Faulty pressure regulator. Defective PC Board.	Adjust anticipate potentiometer. Refer to Section 3-4. Check regulator output. Replace PC Board. Refer to Section 4-4.
Output voltage works properly but output current doesn't change	Loop resistance is too high. Loop reading device not isolated. Defective PC board	Lower loop resistance. Use isolated reading device. Replace board,Refer to Section 4-4.

Table 4-2 Sensor Troubleshooting

SENSOR SCHEMATIC

PIN NO.	FUNCTION
1	Heater
2	Upstream Temperature Sensor(Su)
3	Downstream Temperature Sensor (Sd)
4	Sensor Common
5	Heater Common



Flex Circuit Wire Numbers

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

OHMMETER CONNECTION	RESULT IF ELECTRICALLY FUNCTIONAL
Pin 1 or 4 to Body (Ground)	Open circuit on ohmmeter. If either heater (1) or sensor common (4) are shorted, an ohmmeter reading will be obtained.
Pin 4 to Pin 2	Nominal 1100 ohms reading, depending on temperature and ohmmeter current.
Pin 4 to Pin 3	
Pin 5 to Pin 1	Nominal 1200 ohm reading.

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2. Verify that the process gas connections have been correctly terminated and leak checked.

⚠ WARNING

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

B. Bench Troubleshooting

1. Properly connect the mass flow controller to a +15 to +28 Vdc power supply, and connect an output signal readout device (4-1/2 digit voltmeter recommended) to (Pins 2 and 10 D-connector) (Refer to Figure 2-2). Apply power, and allow the flowmeter to warm up for 45 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 flowmeter to a source of the gas on which it was originally calibrated. Increase the flow until 100% indication (5.00Vdc) is achieved. Vary the flow rate over the 2 to 100% range and verify that the output signal follows the flow rate. If possible, connect a flow measurement device in series with the mass flowmeter to observe the actual flow behavior and verify the accuracy of the mass flowmeter. If the mass flowmeter functions as described above, it is functioning properly and the problem may lie 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 the 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.

Note: Do not attempt to disassemble the sensor.

Cleaning Procedures

Should the Model 5861*i* Mass Flowmeter 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 meter.

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⚠ CAUTION

Do not soak the sensor assembly in a cleaning solution. If solvent seeps into the sensor assembly, it will probably damage the sensor, or, at least, significantly alter its operating characteristics.

3. 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 opening of the sensor. The sensor tube can be flushed with a non-residuous. A hypodermic needle filled with solvent is a convenient means to accomplish this.
4. Deposits of silicon dioxide may be removed from the remainig parts by soaking the internal parts in solution of 5% of hydrofluoric acid (5 parts hydrofluoric acid (HF), 95 parts water (H_2O)) followed by a non-residuous solvent rinse.
5. Sintered type restrictor elements should be replaced as it is not always possible to adequately remove deposits from them.
6. Blow all parts dry with dry nitrogen and reassemble. Refer to Section 4-4 (assembly).
7. Purge the assembled flowmeter with dry nitrogen.
8. Perform the calibration procedure in Section 3-4.
9. When the flowmeter is reinstalled in the system, the connections should be leak tested and the system should be purged with dry nitrogen for 30 minutes prior to start-up to prevent the formation of deposits.

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

The Model 5861*i* Mass Flowmeter may be disassembled in the field by user for cleaning, re-ranging or servicing. Disassemble and assemble the meter as fllows:

Note: the Model 5861*i* Mass Flowmeter 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

Do not attempt to disassemble the mass flowmeter until pressure has been removed and purging has been performed. Hazardous gas may be trapped in the meter assembly which cuold result in explosion, fire, or serious injury.

1. Remove the three screws (27) attaching the electronics cover and loosen the upper jack post on the D-Connector. Remove the electronics cover (40).

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⚠ WARNING

Be careful not to stress the flex circuit to sensor assembly junction when removing the sensor connector from the PC board. If the sensor flex circuit connections are stressed an open in the sensor wiring could result.

2. Unplug the sensor connector from the PC Board. Remove the two screws securing the bracket (26) and PC Board (28). Remove the bracket and PC Board.
3. Remove the two allen nuts (9) using an 1/8" allen wrench and washers (10) securing the sensor assembly (7). Remove the sensor assembly.

Note: Do not attempt to disassemble the sensor assembly.

⚠ WARNING

Do not scratch the O-ring sealing surface.

4. Remove the sensor assembly O-rings (8) from the flowmeter body (1). Using the Brooks O-ring removal tool will help prevent scratching the sealing surface. (part of service tool kit liisted in Section 5, Table 5-2).
5. Remove the inlet and outlet fittings(11) from the flowmeter body (1).
6. Remove the 4 screws (5) from the end block (3) and carefully remove the end block.
7. Remove the restrictor assembly (37) from the inlet side of the body(1) using the header removal tool(part of service kit tool kit listed in section 5, Table 5-2). Note the rotational position of the restrictor assembly. (Refer to Figure 4-2).

B. Assembly

⚠ CAUTION

Do not get Fomblin™ grease on the restrictor element (37) or hands. This is a special inert lubricant which is not easily removed.

Note: It is recommended that all O-rings be replaced during meter assembly. All O-rings should be lightly lubricated with Fomblin grease, (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 a lightly lubricated O-ring (35) onto the header plate of the restrictor assembly (37).
3. Install restrictor assembly into the restrictor cavity using the header removal tool. Rotating the assembly slightly assists installation. It is important that the restrictor assembly is put into the body in the same orientation as it was prior to removal. (Refer to Section 4-6). Do not press header assembly into body with an arbor press as it may damage the O-ring.
4. Place the end block O-ring (6) in position and install end block (3) with the 4 hex socket screws (5). Tighten these screws to 34 inch lbs. Do not over tighten.
5. Install O-rings (19) on inlet and outlet fittings. Install fittings into body (1) and end block (3).

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⚠ CAUTION

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

6. Press the lubricated sensor O-rings (8) into the flowmeter body (1).
7. Install the sensor assembly (7) as shown in Figure 5-1 and secure with the 2 allen nuts (9) and washers (10). Tighten the allen nuts to 10 inch lbs.
8. Install the printed circuit board(28), secure with bracket (26) and 2 screws (27). Plug the connector from the sensor assembly (7) into the PC board.The flow arrow on the connector should be pointing in the direction of the flow.
9. Install the electronics cover (40) on the meter and secure with 3 screws (27).Tighten the upper jack post on the "D" connector.
10. Prior to installation, leak and pressure test the assembled flowmeter to any applicable pressure vessel codes.

4-5 Use of the Conversion Tables

If a mass flowmeter is operated on a gas other than the gas it was calibrated with, a scale shift will occur in the relationship between the output signal and the mass flow rate. This is due to the difference in heat capacities between the two gases. This scale shift can be approximated by using the ratio of the molar specific heat of the two gases, or 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 sensor factor for the desired gas to the sensor factor for the calibration gas.

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

Example:
The flowmeter is calibrated for 100slpm Nitrogen.
The process gas is Carbon Dioxide.
The flowmeter output is 75 % (3.750 volts).
What is the actual carbon dioxide flow?

$$\text{Actual } CO_2 \text{ flow rate} = 75 \text{ slpm} \times \frac{.773}{1}$$

$$= 57.98 \text{ slpm}$$

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

$$\text{Sensor Conversion Factor Mixture} = \frac{100}{\frac{P1}{\text{Sensor Conversion Factor 1}} + \frac{P2}{\text{Sensor Conversion Factor 2}} + \frac{Pn}{\text{Sensor Conversion Factor n}}}$$

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Table 4-3 Conversion Factors (Nitrogen Base)

GAS NAME	FORMULA	SENSOR FACTOR	ORIFICE FACTOR	DENSITY (kg/m³)
Acetylene	C_2H_2	0.615	0.970	1.173
Air	Mixture	0.998	1.018	1.293
Allene	C_3H_4	0.478	1.199	1.787
Ammonia	NH_3	0.786	0.781	0.771
Argon	Ar	1.395	1.195	1.784
Arsine	AsH_3	0.754	1.661	3.478
Boron Trichloride	BCL_3	0.443	2.044	5.227
Boron Trifluoride	BF_3	0.579	1.569	3.025
Bromine Pentafluoride	BrF_5	0.287	2.502	7.806
Bromine Trifluoride	BrF_3	0.439	2.214	6.108
Bromotrifluoroethylene	C_2BrF_3	0.326	2.397	7.165
Bromotrifluoromethane f-13B1	$CBrF_3$	0.412	2.303	6.615
1,3-Butadiene	C_4H_6	0.354	1.413	2.491
Butane	C_4H_{10}	0.257	1.467	2.593
1-Butene	C_4H_8	0.294	1.435	2.503
CIS-2-Butene	C_4H_8	0.320	1.435	2.503
Trans-2-Butene	C_4H_8	0.291	1.435	2.503
Carbon Dioxide	CO_2	0.773	1.255	1.977
Carbon Disulfide	CS_2	0.638	1.650	3.393
Carbon Monoxide	CO	0.995	1.000	1.250
Carbon Tetrachloride	CCL_4	0.344	2.345	6.860
Carbon Tetrafluoride f-14	CF_4	0.440	1.770	3.926
Carbonyl Fluoride	COF_2	0.567	1.555	2.045
Carbonyl Sulfide	COS	0.680	1.463	2.180
Chlorine	CL_2	0.876	1.598	3.214
Chlorine Dioxide	CLO_2	0.693	1.554	3.011
Chlorine Trifluoride	CLF_3	0.433	1.812	4.125
2-Chlorobutane	C_4H_9Cl	0.234	1.818	4.134
Chlorodifluoromethane f-22	$CHCLF_2$	0.505	1.770	3.906
Chloroform (Trichloromethane)	$CHCL_3$	0.442	2.066	5.340
Chloropentafluoroethane f-115	C_2CLF_5	0.243	2.397	7.165
Chlorotrifluoroethylene	C_2CLF_3	0.337	2.044	5.208
Chlorotrifluoromethane f-13	$CCLF_3$	0.430	1.985	4.912
Cyanogen	$(CN)_2$	0.498	1.366	2.322
Cyanogen Chloride	CLCN	0.618	1.480	2.730
Cyclobutane	C_4H_8	0.387	1.413	2.491
Cyclopropane	C_3H_6	0.505	1.224	1.877
Deuterium	D_2	0.995	0.379	0.177
Diborane	B_2H_6	0.448	1.000	1.235
Diboromodifluoromethane f-12B2	CBr_2F_2	0.363	2.652	8.768
1,2-Dibromotetrafluoroethane f-114B2	$C_2Br_2F_4$	0.215	2.905	10.53
Dichlorodifluoromethane f-12	CCL_2F_2	0.390	2.099	5.492
Dichlorofluoromethane f-21	$CHCL_2F$	0.456	1.985	4.912
Dichlorosilane	SiH_2CL_2	0.442	1.897	4.506
1,2-Dichloroethane	$C_2H_4Cl_2$	0.382	1.879	4.419
1,2-Dichlorotetrafluoroethane f-114	$C_2CL_2F_4$	0.231	2.449	7.479
2,2 Dichloro	$C_2HC_{12}F_3$	0.259	2.336	6.829
1,1-Difluoro-1-Chloroethane	$C_2H_3CLF_2$	0.341	1.957	4.776
1,1-Difluoroethane	CH_3CHF_2	0.415	1.536	2.940
1,1-Difluoroethylene	CH_2CF_2	0.458	1.512	2.860
Diethylsilane	$C_4H_{12}Si$	0.183	1.775	3.940
Difluoromethane f-32	CF_2H_2	0.627	1.360	2.411
Dimethylamine	$(CH_3)_2NH$	0.370	1.269	2.013
Dimethylether	$(CH_3)_2O$	0.392	1.281	2.055
2,2-Dimethylpropane	$C(CH_3)_4$	0.247	1.613	3.244
Disilane	Si_2H_6	0.332	1.493	2.779
Ethane	C_2H_6	0.490	1.038	1.357
Ethanol	C_2H_6O	0.394	1.282	2.057
Ethylacetylene	C_4H_6	0.365	1.384	2.388
Ethyl Chloride	C_2H_5CL	0.408	1.516	2.879
Ethylene	C_2H_4	0.619	1.000	1.261
Ethylene Oxide	C_2H_4O	0.589	1.254	1.965
Fluorine	F_2	0.924	1.163	1.695
Fluoroform f-23	CHF_3	0.529	1.584	3.127
Germane	GeH_4	0.649	1.653	3.418
Germanium Tetrachloride	$GeCl_4$	0.268	2.766	9.574
Halothane (R-123B1)	$C_2HBrClF_3$	0.257	2.654	8.814
Helium	He	1.386	0.378	0.178
Hexafluoroacetone	F_3CCOCF_3	0.219	2.434	7.414
Hexaflorobenzine	C_6F_6	0.632	2.577	8.309
Hexafluoroethane f-116	C_2F_6	0.255	2.219	6.139
Hexafuoropropylene (HFP)	C_3F_6	0.249	2.312	6.663
Hexamethyldisilane (HMDS)	$(CH_3)_6Si_2$	0.139	2.404	7.208
Hexane	C_6H_{14}	0.204	1.757	3.847

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Table 4-3 Conversion Factors (Nitrogen Base) Continued

GAS NAME	FORMULA	SENSOR FACTOR	ORIFICE FACTOR	DENSITY (kg/m³)
Hydrogen	H_2	1.008	0.269	0.090
Hydrogen Bromide	HBr	0.987	1.695	3.645
Hydrogen Chloride	HCL	0.983	1.141	1.639
Hydrogen Cyanide	HCN	0.744	0.973	1.179
Hydrogen Fluoride	HF	0.998	0.845	0.893
Hydrogen Iodide	HI	0.953	2.144	5.789
Hydrogen Selenide	H_2Se	0.837	1.695	3.613
Hydrogen Sulfide	H_2S	0.850	1.108	1.539
Iodine Pentafluoride	IF_5	0.283	2.819	9.907
Isobutane	C_4H_{10}	0.260	1.440	2.593
Isobutene	C_4H_8	0.289	1.435	2.503
Isopentane	C_5H_{12}	0.211	1.605	3.222
Krypton	Kr	1.382	1.729	3.708
Methane	CH_4	0.763	0.763	0.717
Methylacetylene	C_3H_4	0.473	1.196	1.782
Methyl Bromide	CH_3Br	0.646	1.834	4.236
3-Methyl-1-butene	C_5H_{10}	0.252	1.584	3.127
Methyl Chloride	CH_3CL	0.687	1.347	2.308
Methyl Fluoride	CH_3F	0.761	1.102	1.518
Methyl Mercaptan	CH_4S	0.588	1.313	2.146
Methyl Silane	CH_6Si	0.393	1.283	2.061
Methyl Trichlorosilane (MTS)	CH_3Cl_3Si	0.267	2.310	6.675
Methyl Vinyl Ether	C_3H_6O	0.377	1.435	2.567
Monoethanolamine	C_2H_7NO	0.305	1.477	2.728
Monoethylamine	$C_2HH_5NH_2$	0.359	1.269	2.013
Monomethylamine	CH_3NH_2	0.565	1.067	1.420
Neon	Ne	1.398	0.847	0.902
Nickel Carbonyl	$Ni(CO)_4$	0.212	2.371	7.008
Nitric Oxide	NO	0.995	1.030	1.339
Nitrogen	N_2	1.000	1.000	1.251
Nitrogen Dioxide	NO_2	0.758	1.713	2.052
Nitrogen Trifluoride	NF_3	0.501	1.598	3.168
Nitrogen Trioxide	N_2O_3	0.443	1.649	3.389
Nitrosyl Chloride	NOCL	0.644	1.529	2.913
Nitrous Oxide	N_2O	0.752	1.259	1.964
Octofluorocyclobutane	C_4F_8	0.169	2.672	8.933
Oxygen	O_2	0.988	1.067	1.429
Oxygen Difluoride	OF_2	0.672	1.388	2.402
Ozone	O_3	0.738	1.310	2.138
Pentafluorethane f-125	C_2HF_5	0.287	2.070	5.360
Pentane (n-Pentane)	C_5H_{12}	0.212	1.605	3.222
Perchloryl Fluoride	CLO_3F	0.448	1.905	4.571
Perfluorobutane	C_4F_{10}	0.738	2.918	10.61
Perfluoro-2-Butene	C_4F_8	0.268	2.672	8.933
Perfluoromethyl-vinylether	PMVE	0.296	2.029	5.131
Perfluoropropane	C_3F_8	0.179	2.591	8.396
Pentane (n-Pentane)	C_5H_{12}	0.212	1.605	3.222
Phosgene	$COCL_2$	0.504	1.881	4.418
Phosphine	PH_3	0.783	1.100	1.517
Phosphorous Pentafluoride	PF_5	0.346	2.109	5.620
Phosphorous Trifluoride	PF_3	0.495	1.770	3.906
Propane (same as $CH_3CH_2CH_3$)	C_3H_8	0.343	1.274	2.008
Propylene (Propene)	C_3H_6	0.401	1.234	1.875
Rhenium Hexafluoride	ReF_6	0.230	3.279	13.41
Silane	SiH_4	0.625	1.070	1.440
Silicon Tetrachloride	$SiCL_4$	0.310	2.465	7.579
Silicon Tetrafluoride	SiF_4	0.395	1.931	4.648
Sulfur Dioxide	SO_2	0.728	1.529	2.858
Sulfur Hexafluoride	SF_6	0.270	2.348	6.516
Sulfur Tetrafluoride	SF_4	0.353	1.957	4.776
Sulfur Trioxide	SO_3	0.535	1.691	3.575
Sulfuryl Fluoride	SO_2F_2	0.423	1.931	4.648
Tetrachloromethane	CCL_4	0.344	2.345	6.858
Tetrafluoroethylene (TFE)	C_2F_4	0.361	1.905	4.526
Tetrafluorohydrazine	N_2F_4	0.367	1.926	4.624
Trichlorofluoromethane f-11	CCL_3F	0.374	2.244	6.281
Trichlorosilane	$SiHCL_3$	0.329	2.201	6.038
Trimethyloxyborane (TMB)	$B(OCH_3)_3$	0.300	1.929	4.638
1,1,2-Trichloro-1,1,2-Triflouroet f-113	$C_2CL_3F_3$	0.231	2.520	7.920
Trimethylamine	$(CH_3)_3N$	0.316	1.467	2.639
Tungsten Hexafluoride	WF_6	0.227	3.264	13.28
Uranimum Hexafluoride	UF_6	0.220	3.548	15.70
Vinyl Bromide	C_2H_3Br	0.524	1.985	4.772
Vinyl Chloride	C_2H_3CL	0.542	1.492	2.788
Vinyl Fluoride	C_2H_3F	0.576	1.281	2.046
Water Vapor	H_2O	0.861	0.802	0.804
Xenon	Xe	1.383	2.180	5.851

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Where,

P1 = percentage (%) of gas 1 (by volume)
P2 = percentage (%) of gas 2 (by volume)
Pn = percentage (%) of gas n (by volume)

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

Sensor conversion factor for the mixture is:

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

N_2 equivalent flow = 20/0.946 = 21.14 slpm

It is generally accepted that the mass flow rate derived from this equation is only accurate to ±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. Gas conditions that vary widely from these reference conditions may cause an additional error due to the change in specific heat due to temperature and/or pressure.

4-6 Restrictor Sizing

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

If the restrictor assembly has been contaminated with foreign matter, the pressure drop vs. flow characteristics will be altered and it must be cleaned or replaced. It may also be necessary to replace the restrictor assembly when the mass flowmeter 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 and end block screws.
- Restrictor removal tool (Refer to Table 5-2)
- Restrictor O-ring, refer to the spare parts Section 5, for the correct part number.

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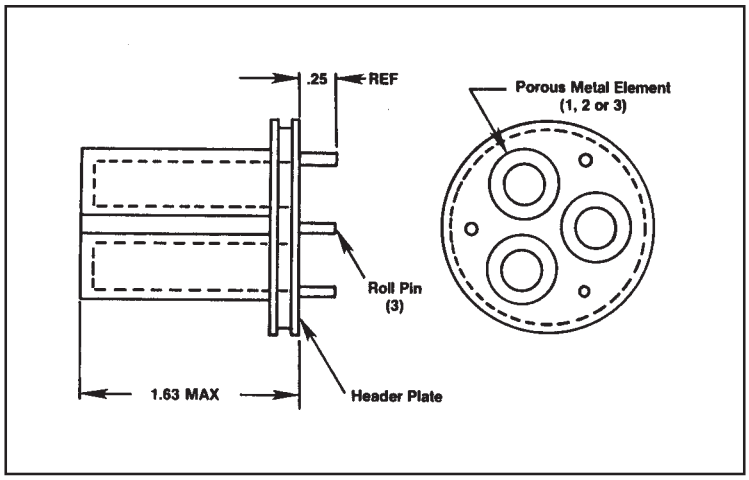


Figure 4-1 Restrictor Element Assembly

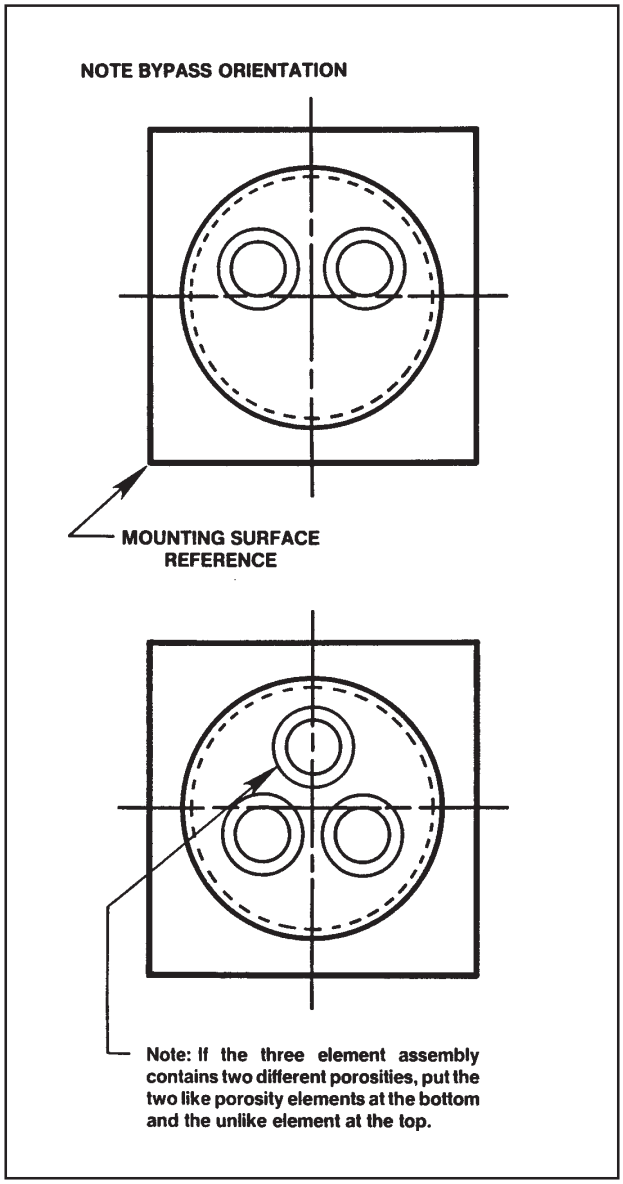


Figure 4-2 Restrictor Element Orientation in Meter Body

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Table 4-4 Restrictor Selection Guide

Range slpm N_2 Equivalent Flow*	Restrictor Element Combination	Part Number
4.6 to 15	1-40 micron (1 inch)	S-613-E-604-BMT
15 to 26	1-40 micron	S-613-E-636-BMT
26 to 42	2-40 micron	S-613-E-523-BMT
42 to 60	3-40 micron	S-613-E-526-BMT
60 to 79	2-40 micron/1-60 micron	S-613-E-528-BMT
79 to 93	1-40 micron/2-60 micron	S-613-E-529-BMT
93 to 130**	3-60 micron	S-613-E-527-BMT

Based on 0°C Standard Reference Temperature

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

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

The Model 5861*i* Mass Flowmeter 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 three 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 used to calculate a nitrogen equivalent flow rate. Use the following equation to obtain the desired flow in nitrogen equivalent units. Refer to Table 4-3 for the conversion factor list.

$$N_2 \text{ equivalent} = \frac{\text{desired gas flow}}{\text{sensor conversion factor}}$$

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

Example:
The desired gas is cyanogen
The desired full scale flow rate is 30 slpm.
Sensor conversion factor is 0.498 from Table 4-3.
Nitrogen equivalent flow = 30/0.498 = 60.24 slpm

In the previous example , the restrictor should be sized for a 60.24 slpm flow rate (P/N S613E528BMT).

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 flowmeter. The replacement assembly should be replaced in the same orientation as the original restrictor. (Refer to Section 4-4 for assembly procedure).

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5-1 General

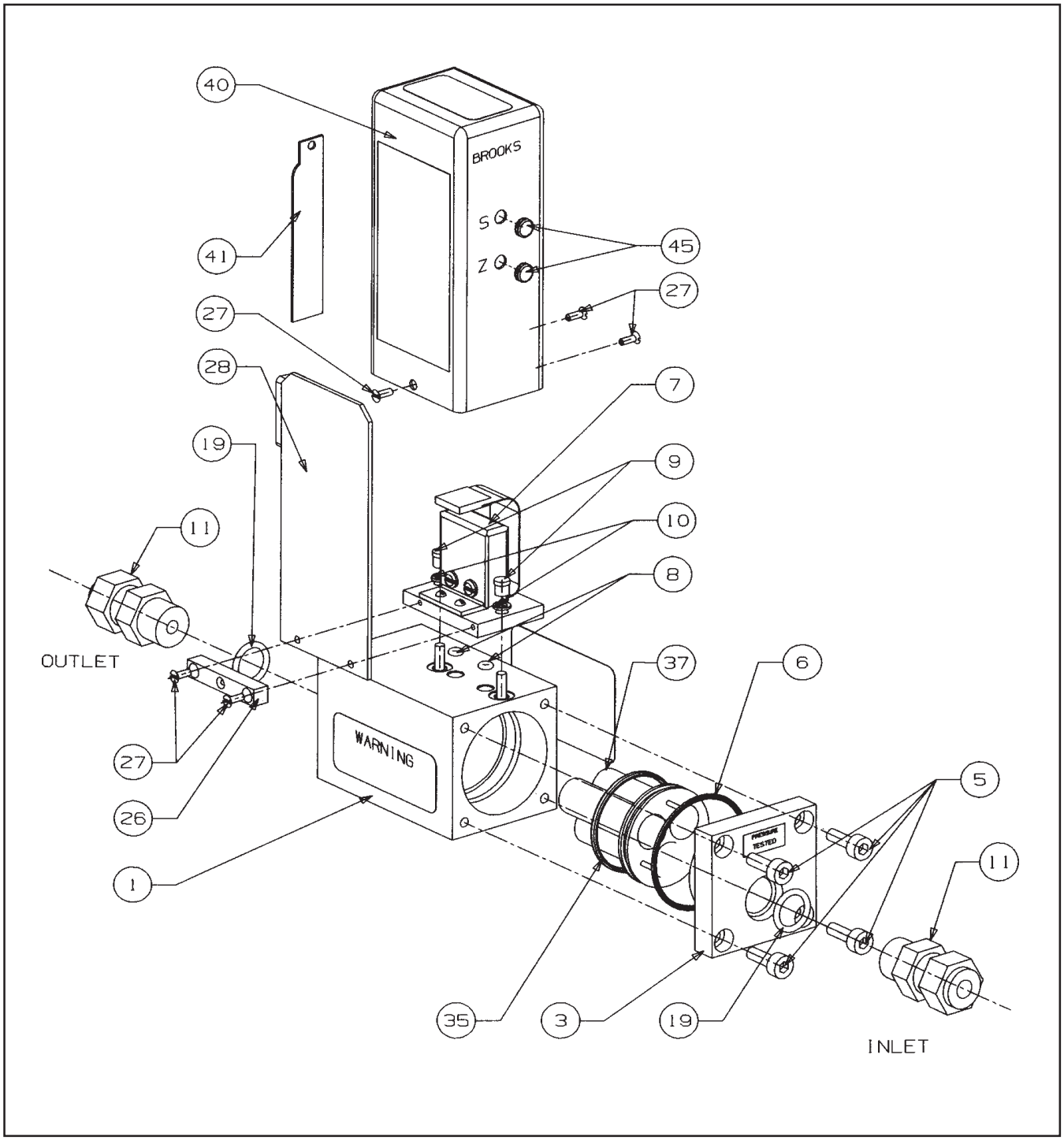
When ordering parts, please specify:

Brooks Serial Number
Model Number
Part Description
Part Number
Quantity

(Refer to Figure 5-1 and Tables 5-1 and 5-2).

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Figure 5-1 Model 5861i Parts Drawing.



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*Table 5-1 Model 5861*i *Replacement Parts List*

Item No.	Qty.	Description		Part Number
1	1	Body and Stud Weldment		S854Z165BMA
3	1	Endblock and Screen Weldment		S079Z200AAA
5	4	Soc. Hd. Cap Screw, #8-32x1/2"		751Z105AAO
6	1	#029 O-rings Viton 375B029QTA		
	1	(between endblock Buna		375B029SUA
	1	& body) Kalrez		375B029TTA
7	1	Removable Sensor		S774Z508BMA
8	2	#004 O-rings Viton		375B004QTA
	2	(for sensor) Buna		375B004SUA
	2	Kalrez		375B004TTA
9	2	Allen nut, #5-40		573Q103ACZ
10	2	Lockspring washer,#5		962D005AWA
11	2	Fittings, 1/4" Compression Swagelok		320B136BMA
	2	1/4" Male VCR, Cajon		315Z036BMA
	2	1/4" Male VCO, Cajon		315Z035BMA
	2	3/8" Compression Swagelok		320B150BMA
	2	3/8" Male VCR (3/8" or 1/2" Tube)		315Z034BMA
	2	3/8" Male VCO (3/8" or 1/2" Tube)		315Z033BMA
19	2	#906 O-rings Viton		375B906QTA
	2	(for fittings) Buna		375B906SUA
	2	Kalrez		375B906TTA
26	1	Can Mtg. Bracket Block		079Z135EAA
27	5	Screws - Cover to Block		753L056AWZ
28	1	PCA: D-Conn		S097Y847AAA
35	1	#026 O-ring Viton		375B026QTA
	1	(for Header assy.) Buna		375B026SUA
	1	Kalrez		375B026TTA
37		Restrictor Assembly & Components (Refer to Section 4-6 for sizing)		
40	1	Silkscreened Cover		219Z490EA%
41	1	Blinding Strip		852Z213EA%
45	2	Plug for Potentiometer Holes		620Z434SXA
NS	2	O-ring, VCO Gland, Size 010 Viton		375B010QTA
		Buna		375B010SUA
		Kalrez		375B010TTA
		Interconnecting Cables:	Length:	D-type
NS	1	Connector on one end	5 Feet	S124Z361AAA
		with no termination	10 Feet	S124Z362AAA
		on other end	25 Feet	S124Z363AAA
			50 Feet	S124Z435AAA
NS	1	Connector on one end	5 Feet	S124Z576AAA
		with Connector for Model 5870	10 Feet	S124Z577AAA
		Series Secondary	25 Feet	S124Z578AAA
		Electronics on other end	50 Feet	S124Z579AAA
NS	2	8-32 Mounting Screw		753A330AWA

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

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*Table 5-2 Tool and Spare Part Kits for Model 5861*i

5850 Series Service Tool Kit P/N S778D017AAA Permits the complete disassembly of the Model 5861*i* for servicing. Contains: 1 - O-ring Removal Tool 1 - Potentiometer Adjustment Tool 1 - Ball Point Allen Wrench 1 - Phillips Screw Driver 1 - Nut Driver for Orifice 1 - Restrictor Removal Tool	5850/5860 Series Break Out Board Assembly P/N S273Z668AAA for D Connector version Installs directly between mass flow sensor/ controller and interconnecting cable. Allows convenient access to all signals for easy troubleshooting of system. 1 - Break Out PC Board 1 - 5 foot Extension Cable 1 - Terminal PC Board
5851*i*/5861*i* Header Removal Tool P/N S817Z036AAA 5861*i* O-ring Kit P/N S375Z334***	

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

Additional publications available:
MFC Contamination Control
Valve Application Guide/Service Manual

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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-forskruninger skal enten være af metal eller metal skærmet.
Skærmen skal forbindes, i begge ender, til stikkets metalhus eller PG-forskruningen 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 enstprechend den Vorschiften 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 %igenSchirmababdeckung des Kabels gewährleistet ist.
“D” oder “Rund” -Verbindungsstecker sollten eine Abschirmung aus Metall besitzen.
Wenn möglich, sollten Kabeldurchführungen mit Anschlußmöglichkeiten für die Kabelabschrimung 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-Steckverbindunger sind standardmäßige keine metallgeschirmten Verbindungen. Um die Anforderungen der CE-Zertifizierung zu erfüllen, sind Kabel mit einer 100 %igen Schirmababdeckung zu verwenden.
Die Abschirmung ist mit dem Erdpotential zu verbinden.
Die Belegung der Anschlußpins können Sie dem beigelegten Bedienungshandbuch entnehmen.

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English

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

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

The Brooks (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 89/336/EEC).
Special attention however is required when selecting the signal cable to be used with CE marked equipment.

Quality of the signal cable, cable glands and connectors:

Brooks supplies high quality cable(s) which meets the specifications for CE certification.
If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.
"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screen clamping.
The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.
The shield should be terminated to a earth ground.
Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification.
The shield should be terminated to a earth ground.
For pin configuration : Please refer to the enclosed Instruction Manual.

Español

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

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

Los equipos de Brooks (eléctricos/electrónicos) en relación con la marca CE han pasado satisfactoriamente las pruebas referentes a las regulaciones de Compatibilidad Electro magnética (EMC directiva 89/336/EEC).
Sin embargo se requiere una atención especial en el momento de seleccionar el cable de señal cuando se va a utilizar un equipo con marca CE

Calidad del cable de señal, prensaestopas y conectores:

Brooks suministra cable(s) de alta calidad, que cumple las especificaciones de la certificación CE .
Si usted adquiere su propio cable de señal, debería usar un cable que esté completamente protegido en su conjunto con un apantallamiento del 100%.
Cuando utilice conectores del tipo "D" ó "Circular" deberían estar protegidos con una pantalla metálica. Cuando sea posible, se deberán utilizar prensaestopas metálicos provistos de abrazadera para la pantalla del cable.
La pantalla del cable deberá ser conectada al casquillo metálico ó prensa y protegida en ambos extremos completamente en los 360 Grados.
La pantalla deberá conectarse a tierra.
Los conectores estandar de tipo tarjeta (Card Edge) no son metálicos, los cables utilizados deberán ser protegidos con un apantallamiento del 100% para cumplir con la certificación CE.
La pantalla deberá conectarse a tierra.
Para ver la configuración de los pines: Por favor, consultar Manual de Instrucciones adjunto.

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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.

Θέμα :Προσθήκη στο Εγχειρίδιο Οδηγιών.
Σχετικά :Πιστοποίηση CE των Οργάνων Μέτρησης Παροχής Μάζας.
Ημερομηνία :Ιανουάριος - 1996

Κυρίες και Κύριοι,

Τα όργανα (ηλεκτρικά/ηλεκτρονικά) της Brooks τα οποία φέρουν το σήμα CE έχουν επιτυχώς ελεγχθεί σύμφωνα με τους κανονισμούς της Ηλεκτρο-Μαγνητικής Συμβατότητας (EMC ντιρεκτίβα 89/336/EEC).
Οπωσδήποτε χρειάζεται ειδική προσοχή κατά τήν επιλογή του καλωδίου μεταφοράς του σήματος το οποίο (καλώδιο) πρόκειται να χρησιμοποιηθεί με όργανα που φέρουν το σήμα CE.

Ποιότητα του καλωδίου σήματος των στυπιοθλιπτών και των συνδέσμων .

Η Brooks κατά κανόνα προμηθεύει υψηλής ποιότητας καλώδια τα οποία πληρούν τις προδιαγραφές για πιστοποίηση CE.
Εαν η επιλογή του καλωδίου σήματος γίνει από σας πρέπει να χρησιμοποιήσετε καλώδιο το οποίο να φέρει εξωτερικά πλήρες πλέγμα και να παρέχει θωράκιση 100%.

Οι σύνδεσμοι τύπου "D" ή "Κυκλικοί" των καλωδίων, πρέπει να θωρακίζονται με μεταλλική θωράκιση. Εάν είναι εφαρμόσιμο, πρέπει να χρησιμοποιούνται μεταλλικοί στυπιοθλίπτες καλωδίων που να διαθέτουν ακροδέκτη σύνδεσης του πλέγματος του καλωδίου.
Το πλέγμα του καλωδίου πρέπει να συνδέεται στο μεταλλικό περίβλημα ή στον στυπιοθλίπτη και να θωρακίζεται και στα δύο άκρα κατά 360 μοίρες.
Η θωράκιση πρέπει να καταλήγει σε κάποιο ακροδέκτη γείωσης.

Οι σύνδεσμοι καρτών είναι μη-μεταλλικοί, τα καλώδια που χρησιμοποιούνται πρέπει να φέρουν πλέγμα θωράκισης 100% για να υπακούουν στην πιστοποίηση CE.
Η θωράκιση πρέπει να καταλήγει σε κάποιο ακροδέκτη γείωσης.

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

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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 Elettomagnetica (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 estemità.

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 produkten 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 produkten.

Kwaliteit van de signaalkabel en kabelaansluitingen:

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

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

Hoogachtend,

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Norsk

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

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

Til den det angår

Brooks Instrument elektrisk og elektronisk utstyr påført CE-merket har gjennomgått og bestått prøver som beskrevet i EMC forskrift om elektromagnetisk immunitet, direktiv 89/336/EEC.
For å opprettholde denne klassifisering er det av stor viktighet at riktig kabel velges for tilkobling av det måletekniske utstyret.

Utførelse av signalkabel og tilhørende plugger:

- Brooks Instrument tilbyr levert med utstyret egnet kabel som møter de krav som stilles til CE-sertifisering.
- Dersom kunden selv velger kabel, må kabel med fullstendig, 100% skjerming av lederene benyttes.

"D" type og runde plugger og forbindelser må være utført med kappe i metall og kabelnipler må være utført i metall for jordet innfesting av skjermen. Skjermen i kabelen må tilknyttes metallet i pluggen eller nippelen i begge ender over 360°, tilkoblet elektrisk jord.

- Kort-kantkontakter er normalt utført i kunststoff. De tilhørende flatkabler må være utført med fullstendig, 100% skjerming som kobles til elektrisk jord på riktig pinne i pluggen, for å møte CE sertifiseringskrav.For tilkobling av medleverte plugger, vennligst se håndboken som hører til utstyret.

Vennlig hilsen

Português

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

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

O equipamento (eléctrico/electrónico) Brooks com a marca CE foi testado com êxito nos termos do regulamento da Compatibilidade Electromagnética (directiva CEM 89/336/EEC).
Todavia, ao seleccionar-se o cabo de sinal a utilizar com equipamento contendo a marca CE, será necessário ter uma atenção especial.

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

A Brooks fornece cabo(s) de qualidade superior que cumprem os requesitos 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 360º.
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.

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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).
Erityistä 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 liitimen tulisi olla varustettu metallisuojalla. Mikälì mahdollista, tulisi käyttää metallisia kaapeliliittimiä kiinnitettäessä suojaa.
Kaapelin suoja tulisi olla liitetty metallisuojaan tai liittimeen molemmissa päissä 360°:n matkalta.
Suojan tulisi olla maadoitettu.
“Card Edge Connector”it ovat standarditoimituksina ei-metallisia. Kaapeleiden täytyy olla 100%: sesti suojattuja jotta ne olisivat CE 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 kompabilitet (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% skarmade för att överensstämma med CE-certifieringen.
Skärmen ska avslutas med en jordförbindelse.
För elektrisk anslutning till kontaktstiften hänvisas till medföljande instruktionsmanual.

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