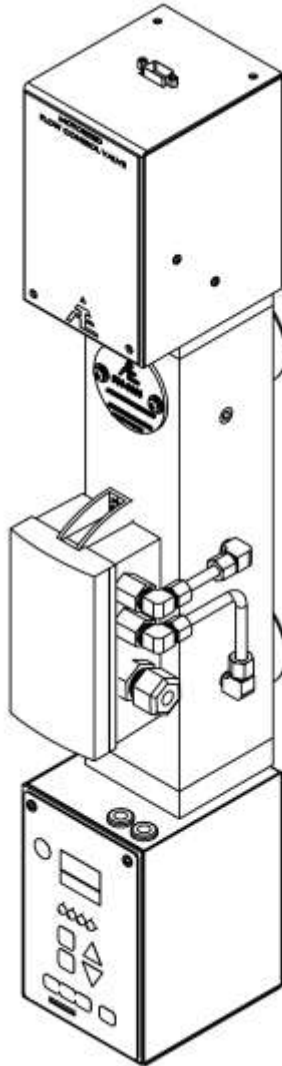




FURNACEMETER™ INSTALLATION AND OPERATION MANUAL



Document Control - Revision Notes

<u>Rev</u>	<u>Date</u>	<u>Technician</u>	<u>Revision Description</u>
R12	03/05/12	Brock Schupp	Updated FurnaceMeter Drawings and Manual Format

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NOTICE, CAUTIONS, AND WARNINGS

NOTICE

This Bulletin contains important safety information and should be read and understood by all individuals who install, operate, or service this equipment.

Failure to follow the precautions and recommendations of this manual may subject personnel and property to dangerous conditions.

WARNING

The valves provided by Atmosphere Engineering are designed to provide precision gas flow control and WILL NOT provide positive gas shut off. Failure to use automatic isolation valves may cause flammable gases to leak into the equipment. Properly rated and regularly inspected gas isolation valves shall be installed regularly and inspected on the gas supply lines feeding Atmosphere Engineering equipment per the guidelines outlined in the National Fire Protection Agency publication NFPA86.

CAUTION

The EndoInjector™ is designed to accurately mix air and gas together and precisely control the mixture ratio to produce high quality endothermic gas. However, setting the air gas ratio outside the recommended values described in this manual could subject personnel and property to dangerous conditions. Only properly trained and experienced personnel shall operate and maintain the EndoInjector™ generator control system.

TECHNICAL ASSISTANCE

Contact Atmosphere Engineering with all questions or concerns regarding the installation, operation, and setup of the EndoInjector™ mixing system.

Atmosphere Engineering Company
4343 South 27th Street
Milwaukee, Wisconsin 53221
United States of America

Phone: 414-331-2457
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E-Mail: support@atmoseng.com

EXPRESS WARRANTY ON ATMOSPHERE ENGINEERING EQUIPMENT

ATMOSPHERE ENGINEERING COMPANY (AEC) warrants products for a period of one (1) year from the date of shipment from AEC to the original purchaser to be free from defects in material and workmanship under normal recommended use, service, inspection, and maintenance. Normal recommended use, service, inspection, and maintenance, mean:

1. Not to be used in excess of nor below the rated capacity, pressure, and temperature ranges specified in the applicable quotation, purchase order, acknowledgment, marketing literature, nameplate, specification sheet, or the Installation, Operation, Inspection, and Maintenance Manual (THE MANUAL); and
2. Using only clean gases free of solids and other contaminants not considered constituents of the gas; and
3. Installation, operation, inspection, and maintenance in compliance with THE MANUAL; and
4. The AEC products being used only in:
 - a. Ambient environments lower than 132 °Fahrenheit (54 °Celsius) unless specifically designed and so labeled by AEC for higher temperatures; and
 - b. Non-corrosive environments; and
 - c. Completely protected from moisture, rain, snow, or other outside environments; and
 - d. Not to be used below 32 °Fahrenheit (0 °Celsius) unless precautions are taken for low temperature conditions as shown in THE MANUAL.
5. Being used only for applications permitted by THE MANUAL or other AEC literature or special applications approved in a separate written authorization by AEC.

WARRANTY EXCEPTIONS

This Warranty does not apply to damage caused by any or all of the following circumstances or conditions:

1. Freight damage;
2. Parts, accessories, materials, or components not obtained from nor approved in writing by AEC;
3. Any consequential or incidental damages including but not limited to loss of use, loss of profits, loss of sales, increased costs, arising from the use of any product system or other goods or services manufactured, sold, or provided by AEC;
4. Misapplication, misuse, and failure to follow THE MANUAL or other literature, instructions, or bulletins (including drawings) published or distributed prior to THE MANUAL.

The exclusive remedy under this Warranty or any other express warranty is the repair or replacement without charge for labor and materials of any AEC parts found upon examination by AEC to have been defective. Since certain AEC equipment is heavy, bulky and not deliverable by U.S. mail or other parcel service, AEC equipment may be returned only upon written consent of AEC and then only to the location designated by AEC. Generally such consent will be given only upon the condition that the customer assume and prepay all carrier charges and responsibility for damage in transit.

Purchasers of AEC products, equipment, goods, or services waive subrogation on all items covered under their own or any other insurance.

(CONTINUED ON NEXT PAGE)

EXPRESS WARRANTY ON ATMOSPHERE ENGINEERING EQUIPMENT

(CONTINUED FROM PREVIOUS PAGE)

DISCLAIMER

THIS WARRANTY IS EXCLUSIVE. AEC EXPRESSLY DISCLAIMS ANY AND ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY PURPOSE.

No person, including dealer, seller, or other representative of AEC is authorized to make, on behalf of AEC, any representations beyond those contained in AEC literature and documents or to assume for AEC any obligations or duties not contained in this Warranty and Warranty Policy.

AEC reserves the right to make design and other changes, modifications or improvements to products, services, literature, or systems, without any obligation, to furnish or install same on any previously sold or delivered products or systems.

LIMITATION OF LIABILITY

It is expressly agreed that the liability of AEC is limited and AEC does not function as an insurer. The purchaser and/or user agree that AEC is not liable for loss, harm, or damage due directly or indirectly to any occurrence or consequences there from. If AEC should be found liable to anyone on any theory (except any express warranty where the remedy is set forth in Section 2 of this Warranty and Warranty Policy) for loss harm or damage, the liability of AEC shall be limited to the lesser of the actual loss, harm or damage or the purchase price of the involved AEC equipment or service when sold (or when service performed) by AEC to customer. This liability is exclusive and regardless of cause or origin resulting directly or indirectly to any person or property from:

1. The performance or nonperformance of any obligations set forth in this Warranty and Warranty Policy;
2. Any agreement including specifications between AEC and the customer;
3. Negligence, active, passive or otherwise of AEC or any of agents or employees;
4. Breach of any judicially imposed warranty or covenant of workmanship, durability or performance; and
5. Misrepresentation (under the Restatement, common law or otherwise) and/or strict liability involvement;
6. Liability for fraud-in-the-inducement.

WARRANTY FIELD SERVICE

If Warranty Field Service is rendered at the request of the purchaser or user and the difficulty is found not to be with AEC's product, the purchaser shall pay the time and expense (at the prevailing rate at the time of the service) of AEC's field representative(s). Charges for service, labor, and other expenses that have been incurred by the purchaser, customer, or agent without written approval of AEC will not be accepted. The OEM or other reseller is responsible for transmitting installation and operating instructions, THE MANUAL or other service literature supplied by AEC with the equipment.

(END OF WARRANTY TEXT)

DESCRIPTION

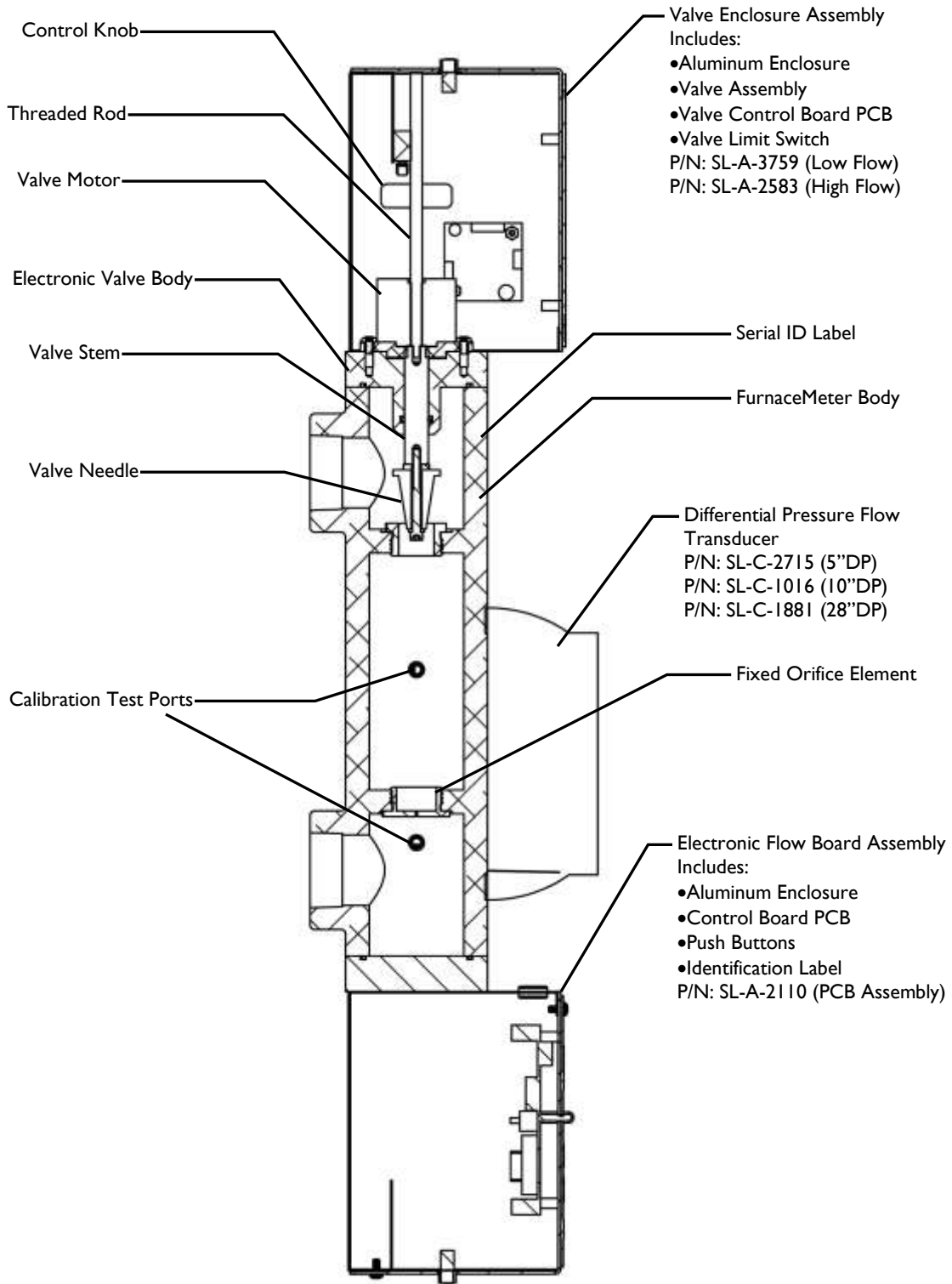
The FurnaceMeter™ is a precision flow measurement and control instrument designed specifically to meet the rugged requirements of industrial flow measurement for heat treating furnace applications. The FurnaceMeter™ utilizes differential pressure flow measurement across a fixed orifice. The differential pressure produced is referenced to a NIST traceable flow measurement transfer standard. The resulting data is programmed into the FurnaceMeter™ control board and is provided in this manual as the “Calibration Curve”. The calibration of the FurnaceMeter™ can be certified in-situ by measuring the actual differential pressure and comparing this value with the attached calibration curve.

The FurnaceMeter™ is coupled with a motorized needle and orifice control valve. The valve can be operated in either manual or automatic control modes. In automatic control mode the flow control board will compare the actual flow rate with the desired flow rate setpoint and if necessary drive the valve in the appropriate direction and speed to correct for differences. The FurnaceMeter™ can receive the desired flow rate setpoint either manually through the “SETPT” button or it can be sent remotely with a 4-20mA setpoint signal.

Specifications

Power Required.....	24 VDC @ 400 mA
Flow Rate Capacity.....	See Calibration Report
Accuracy.....	4%
Repeatability.....	2%
Turndown Capability.....	6:1
Medium Temperature Limits.....	-10°F to 180°F
Ambient Temperature Limits.....	-10°F to 180°F
Flow Output Signal (Linear).....	4-20 mA
Max. Output Signal Load.....	500Ω Max.
Input Control Signal (Linear).....	4-20 mA
Response Time.....	1-10 seconds
Communications.....	RS-232, RS-485
Communication Protocol.....	MODBUS RTU
Pressure Drop @ 100% Capacity.....	5”wcg (Standard Model)
(see Calibration Record for specific pressure drop).....	10”wcg (Standard Model) 1 psig (High Pressure Model)
Flow Meter Pressure Limits.....	5 psig max (Standard Model), 40 psig max (High Pressure Model)

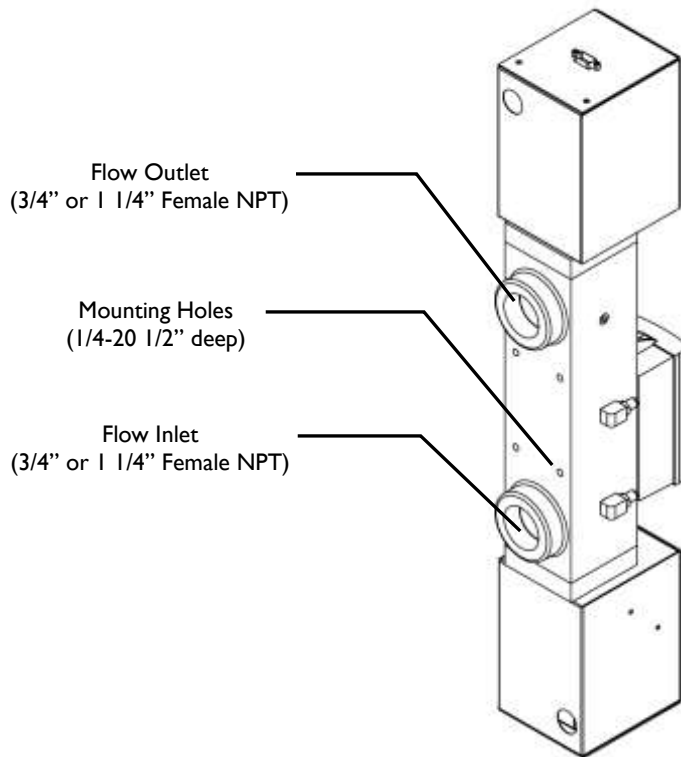
MECHANICAL COMPONENT OVERVIEW



MECHANICAL INSTALLATION

The FurnaceMeter™ is shipped as a complete unit and ready to be mounted and plumbed per your local codes for the gas or liquid to be measured. It is recommended that the following items be considered to ensure proper mechanical operation.

- Inspect the instrument for any obvious damaged or missing components.
- Secure the meter to a solid surface using the provided mounting holes.
- Attach pipe fittings to the inlet and outlet of the FurnaceMeter™ as identified in Figure 2 below. It is acceptable to utilize bushings or reducers at the FurnaceMeter™ ports to accommodate the desired pipe size. However, undersized piping may limit the maximum flow rate capability. Consult pipe sizing charts or contact Atmosphere Engineering to ensure that the desired flow rates will not be compromised.
- Ensure that the inlet pressure is within the limits of the installed FurnaceMeter™. Note that pressure deviations from that of the calibrated specification will introduce an offset into the flow reading.
- It is recommended that manual isolation valves be installed prior to the FurnaceMeter™ to ensure positive flow rate shut off. The integrated valve provided with the FurnaceMeter™ is designed for precision control and will not guarantee positive shutoff.



ELECTRICAL INSTALLATION

The electrical connections are made to the DB9 connector provided on the bottom of the valve assembly enclosure. Alternate connectors are available upon request and will be provided with separate wiring diagram. Below is a reference table that describes each connection. Please review the electrical schematic attached to this manual for more detailed information.

DB-9 Pin#	PC Board Term	Signal Type	Description
1	1	+ VDC	Power Supply 24 VDC (250 mA)
2	2	- VDC	
3	3	+ mA	Output Flow Signal (4 - 20 mA)
4	4	- mA	
5	15	+ mA	Input Setpoint Signal (4 - 20 mA)
6	16	- mA	
7	9	+ RS-485	Communications Signal*
8	8	- RS-485	
9	17	24V Sinking Output	Flow Alarm Output

*Communication is MODBUS over RS232 or RS485. RS-232 communications are provided through an alternate DB9 serial connector mounted directly to the PC board.

MODBUS RTU REGISTER LIST

Modbus RTU registers in the FurnaceMeter internal circuit board (flowboard) can be accessed in order to monitor and modify parameters from a remote location. Below is a table describing each Modbus register and its address.

MODBUS REGISTER	DESCRIPTION
16	ACTUAL FLOW
17	FLOW SENSOR MA INPUT VALUE
18	FLOW SETPOINT
19	DECIMAL PLACE FOR DISPLAY OF FLOW AND SETPOINT
20	INSTRUMENT MODBUS ADDRESS
21	FLOW METER FULL SCALE VALUE
22	CONTROL GAIN
23	MA ZERO VALUE
24	MA SPAN VALUE
25	DEADBAND FOR CONTROL
26	SETPOINT ZERO
27	SETPOINT SPAN
28	NOT USED
29	ANALOG OUTPUT ZERO IN FLOW UNITS
30	ANALOG OUTPUT SPAN IN FLOW UNITS
31	(NOT USED)
32	LOW FLOW ALARM SETPOINT
33	HIGH FLOW ALARM SETPOINT
34	ALARMS
35	AUTO (1) / MANUAL (0) FOR CONTROL
36	(NOT USED)
37	RESET TOTALIZER VALUES TO ZERO
38	(NOT USED)
39	TOTALIZER UNITS (0 TO 9999)
40	TOTALIZER 10K'S (0 TO 9999 => 0 TO 99,990,000)
41	TOTALIZER 100MILLION'S (0 TO 9999 => 0 TO 999,900,000,000)

SYSTEM OPERATION

The FurnaceMeter is a differential pressure flow meter that utilizes a custom built calibration and control board assembly designed specifically for furnace atmosphere control systems. The calibration and control board assembly has an integrated high and low flow rate alarm, flow rate totalizer, and an integrated valve control capability that can be operated in either manual or automatic flow rate control modes.

Valve Control Modes

The FurnaceMeter can be placed in either manual or automatic control mode. The “AUTO” LED indicates which mode the FurnaceMeter is currently using.

Automatic Mode “AUTO” LED = ON
Manual Mode “AUTO” LED = OFF

The valve control mode can be changed holding the “AUTO/MAN” button down for 5 seconds. During a power failure the valve will store the last control mode and return to this state when the power returns. Flow alarms and totalizing features continue to operate in either control mode.

- **Manual Control Mode**

When the FurnaceMeter is in manual control mode, the motorized valve will only drive when the “Up” or “Down” buttons are pressed. The “Up” button will drive the valve open and the “Down” button will close the valve. If no button is pressed then the valve will remain in the current position. This mode should be used when flow control solenoids are used to provide “on/off” flow rate control. The mode can also be used to test the meter calibration and valve operation.

Note: This mode shall be used when FurnaceMeter is not fitted with an integrated motorized control valve.

- **Automatic Control Mode**

When the FurnaceMeter is in automatic control mode, the motorized valve will continue to drive until the actual flow rate equals the flow rate setpoint. The flow rate setpoint value can be displayed by pressing the “SETPOINT” button. If the actual flow is less than the flow rate setpoint then the motor will drive the valve open and if the actual flow is greater than the flow rate setpoint then the motor will drive the valve closed.

The flow rate setpoint can be set in three ways:

1. Manually Setting: Press and Hold the “SETPOINT” button and press either the “UP” or “DOWN” buttons to manually enter a new flow rate setpoint.
2. External Signal: 4 mA = 0 flow; 20 mA = Full Scale flow
(See Wiring diagram for location of where to wire the flow rate setpoint input signal)
3. Modbus Communication via RS-485 or RS-232

Note: The control board will automatically recognize when an external flow rate setpoint signal is provided. Once a setpoint signal is received, any other programmed setpoint will be overwritten. To set the flow rate manually or through Modbus then no external signal wiring should be connected to the control board.

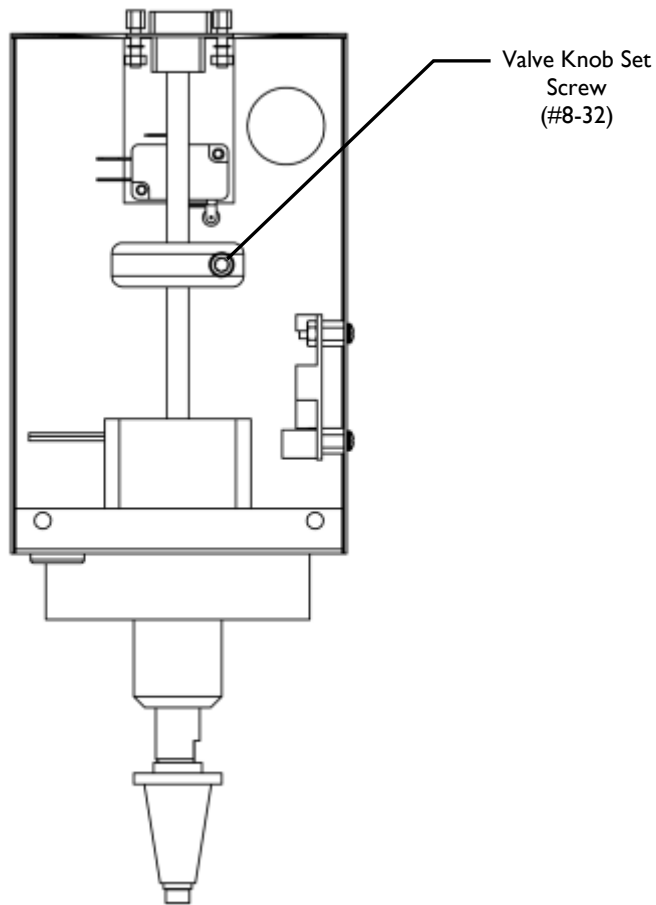
SYSTEM OPERATION

Flow Limit Control (Automatic Mode)

The limit switch located within the FurnaceMeter electrical enclosure prevents the control valve from opening beyond the full flow capacity of the meter. In cases where flow is shut off upstream of the meter and a Set Point of zero is not set on the Furnacemeter, the valve will continue to drive open when in Automatic mode. When properly set, the limit switch will prevent the valve from opening beyond this limit.

To properly set the flow limiter:

- Adjust the FurnaceMeter valve to full capacity flow (i.e. 200 CFH on a 0 - 200 CFH meter).
- Using a 9/64" hex driver, loosen the set screw on the Manual Flow Adjustment Knob.
- Position the adjustment knob to 1/4 inch (or so) from the actuator of the limit switch.



SYSTEM OPERATION

Flow Alarm

The FurnaceMeter is provided with a flow alarm output that can be used to trigger a relay. When in non-alarm state, the relay coil will be energized. Conversely, in the alarm state the relay will be de-energized. A normally open contact could then be used to power an alarm horn. Proper wiring of the alarm output is detailed on the attached wiring diagram. The “ALARM” LED indicates when the flow rate is outside the desired range.

Flow Alarm ON “ALARM” LED = ON
Flow Alarm OK “ALARM” LED = OFF

The flow alarm is on when either the actual flow is greater than the “High Flow Alarm Setpoint” or the actual flow is less than the “Low Flow Alarm Setpoint”. The alarm is not latching. The flow alarm set points can be set either through Modbus communications or by using the FurnaceMeter Configuration Software available on the Atmosphere Engineering website.

Note: As a default, the FurnaceMeter comes preprogrammed with the high and low alarm set points set outside the scale range of the flow meter. This setting essentially deactivates the flow alarm since the flow rate will never trigger an alarm event.

Flow Totalizer

The flow rate totalizer will automatically accumulate the total amount of volume passed through the flow meter. This totalizer is always enabled and can be reset manually.

The maximum totalized value is 999,999,999,999 engineering units (ft³, m³, liters, etc.). This value can be read directly using Modbus communication or it can be displayed manually on the flow rate display LEDs. However, since the control board is only fitted with 4 digits the operator must read the amount in 4 digit increments by pressing the one of the three buttons highlighted in yellow on the display:



Note:

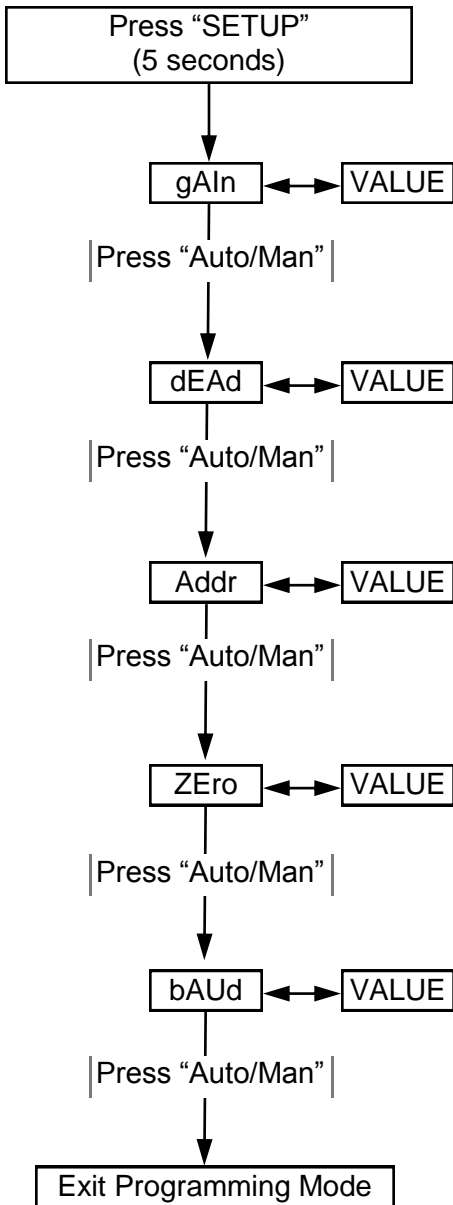
Press the “RESET” button and hold for 5 seconds to reset the totalized amount to zero.

SYSTEM OPERATION

Programming Mode

The FurnaceMeter programming mode provides access to the most common parameters through the front display LEDs. The programming mode is entered by firmly pressing the “SETUP” button and holding it for 5 seconds. The display LEDs will indicate that programming mode when the display changes to the “GAIN” parameter. To cycle through the available parameters, press the “AUTO/MAN” button. To change the displayed parameter value press the r or s arrow. See the Programming Overview below for further details.

Programming Overview



Valve Speed Gain (Typical: 100; Range: 10 to 500)

The valve speed gain value can adjust the speed of the motorized valve control motor. The higher the value the faster the response time. However, setting this value too high can result in overshoot.

Deadband (Typical: 1% of Full Scale; Range: 1 to Full Scale)

The deadband dictates how far away from setpoint the actual flow can stray before the valve drives. (e.g.: for a deadband of 5 and setpoint of 50, the valve will close when flow is above 55 and open when flow is below 45).

Modbus Instrument Address (Typical: 1; Range: 1 to 249)

The Modbus instrument address sets the address of the FurnaceMeter on the communications network.

mA Zero Function (Typical: 4.00; Range: +/- 0.50 mA)

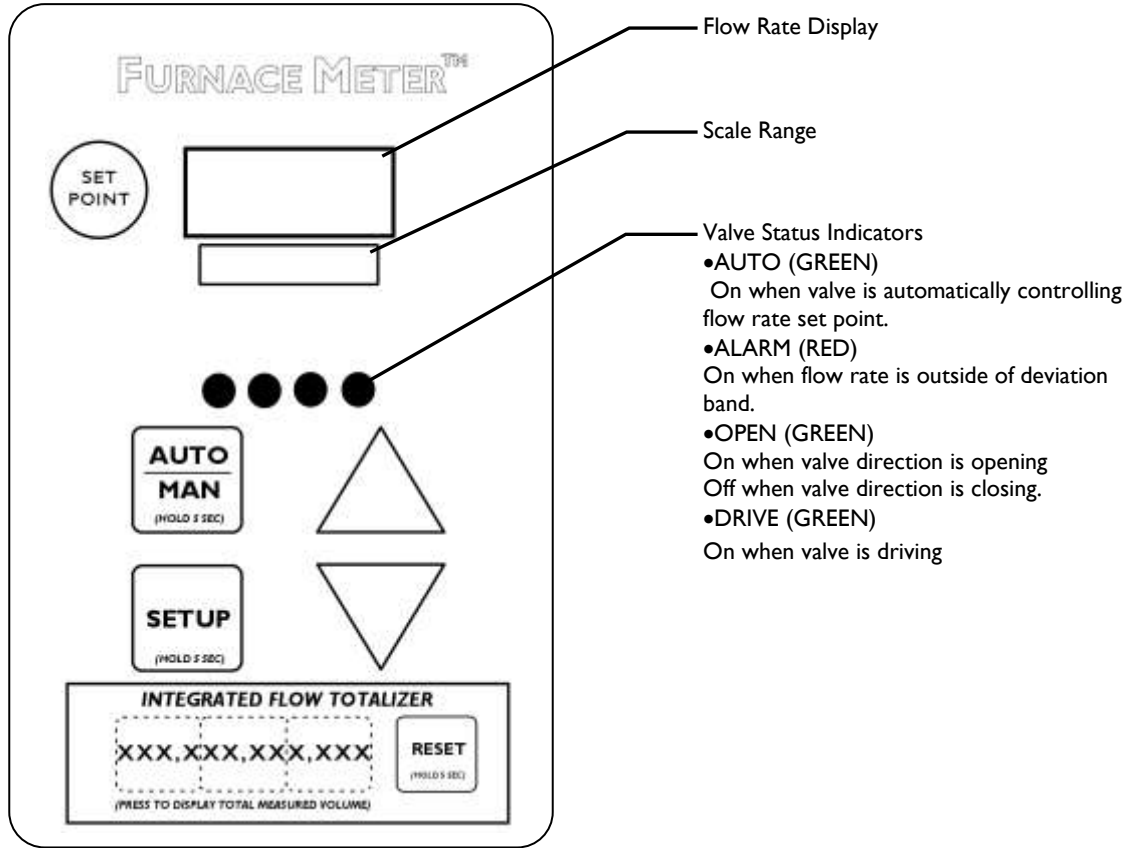
This value shows the current mA input from the pressure transducer (4-20mA). This function allows the operator to bring the transducer back into calibration by adjusting the resting mA value (should read approximately 4.00 when no flow is present). Pressing the UP and DOWN arrows simultaneously will reset any previous adjustments.

Communications Baud Rate (Typical: 1920; Range: 9600 or 1920)

This value sets the instrument communication baud rate.
Note: 1920 = 19,200

SYSTEM OPERATION

Valve Interface Overview



Push Button Details

- **SETPOINT**
Displays Desired Flow Rate Setpoint. If no external signal is utilized this value can be internally set by holding the SETPOINT. button and pressing the up or down arrows to change the desired internal setpoint.
- **AUTO/MAN (HOLD FOR 5 SECONDS)**
Used to turn the automatic valve control function on and off as indicated by the AUTO LED. When the “AUTO” mode is on the valve will automatically open or close to maintain the desired flow rate setpoint. When the “AUTO” mode is turned off the valve will only respond the UP and DOWN arrow keys to drive the valve motor.
- **SETUP (HOLD FOR 5 SECONDS)**
Used to change parameters through the front display
- **(UP ARROW)**
Used to open the valve when “AUTO” mode is off. Can be used in conjunction with the SETPOINT button to increase the internal setpoint.
- **(DOWN ARROW)**
Used to close the valve when “AUTO” mode is off. Can be used in conjunction with the SETPOINT. button to decrease the internal setpoint.
- **INTEGRATED FLOW TOTALIZER**
Displays Totalized flow rate
- **RESET**
Resets Totalized flow rate
- Used to close the valve when “AUTO” mode is off. Can be used in conjunction with the SETPOINT button to decrease the internal setpoint.

MAINTENANCE

General Preventative Maintenance

The FurnaceMeter is designed to be a generally maintenance free instrument. To ensure many years of reliable performance it is recommended that precautions be taken to keep the inside of the valve control assembly and pressure transducer enclosures clean and free from carbon or water contamination. Annually, it is recommended that the valve stem be rubbed clean with a cloth and lightly coated with a silicone o-ring lubricant to prevent the seal from drying out.

Calibration Certification

The FurnaceMeter is supplied with calibration test ports for added quality control. These ports provide a location to test the actual differential pressure across the integrated flow orifice. This differential pressure can be measured with a portable calibrated instrument and checked against the original calibration certificate attached to this manual to confirm the long term accuracy of the FurnaceMeter differential pressure transducer.

To perform a calibration certification requires the following items:

- Calibrated Handheld Manometer (Minimum: 28" wcd)
- Small Standard Screwdriver (to open and close the test ports)
- Original Calibration Certificate (for the Serial # of the meter to be tested)

Calibration Certification Procedure

1. Open the High and Low Pressure Ports by inserting a small standard screw driver into the port and turning small valve counterclockwise 1 time. *Note: There is a very small flow limiting orifice integrated into the port valve to ensure only a small amount of gas will escape during testing.*

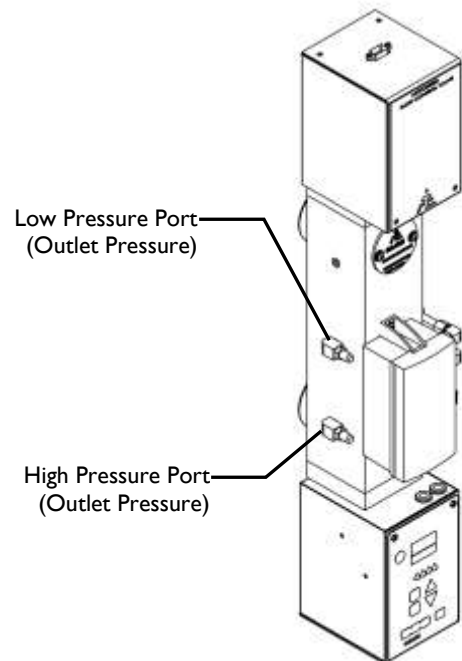
2. Connect a calibrated differential pressure manometer to the test ports. Verify that the "high" and "low" ports of the test instrument are attached to the correct ports on the FurnaceMeter as shown.

3. Set the actual flow to a value on the original calibration certificate.

4. Take a reading of the actual differential pressure at this flow rate and verify this value against the original differential pressure on the calibration certificate.

(Rule of Thumb: 0.5"wc deviation = 5% flow error)

5. If actual differential pressure is outside acceptable limits then the zero/span potentiometers within the differential pressure transducer can be accessed by opening the transducer cover. *Note: Only small adjustments should ever be necessary to bring the transducer back into calibration. If large adjustments or deviations are found please contact the support staff at Atmosphere Engineering directly.*



Additional Documentation

- Internal Wiring Drawing
- FurnaceMeter Calibration Curve