Mass Flow Controllers
Vortex Shedding Meters

AALBORG®

Worldwide Distribution

Visit our web site at: **www.aalborg.com**

About the Company

Founded in 1972, AALBORG® is well-known throughout the world as a primary manufacturer of precision instrumentation for flow measurement and control.

We operate two divisions:

The Variable Area Division manufactures a complete line of glass tube rotameters. These flow meters are available with aluminum, brass, stainless steel or PTFE wetted components. AALBORG® also manufactures a unique line of PFA tube meters for ultrapure or corrosive applications. Precision barstock stainless steel or brass needle valves, as well as PTFE valves, are also manufactured in this division.

The Electronics Division produces analog and digital mass flow meters and controllers, as well as a diverse line of wafer and insertion type vortex flow meters for steam, liquid or gases. In addition, stepping motor driven valves made in this department are highly useful in processing and OEM applications.

NIST Traceable

NIST traceable flow meter calibrations are performed in our state of the art laboratories.

Technical Assistance

Technical Assistance is readily available. Customers are invited to contact the company or our distributors to discuss individual requirements. OEM applications are welcome.

ISO9001 /2000 Certification

AALBORG® has been ISO 9001 certified since April of 1995. We are very proud of the design features and the exceptionally high quality for which our products which have been known since 1972. It is our policy that through strict enforcement of exacting manufacturing standards the AALBORG® brand name continues to be associated with a reputation of high quality and reliability. Our products are backed by meticulous innovative engineering combined with efficient manufacturing practices and a highly skilled work force guaranteeing total customer satisfaction.

Our Mission

It is the policy of AALBORG® to develop, produce and deliver products and services which consistently conform to or exceed customer requirements.

Our commitment is to provide cutting-edge technology combined with a sincere desire to serve our customers and produce the highest quality products attainable.

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www.aalborg.com - e-mail ✉ info@aalborg.com - ☎ **845.770.3000** - fax 845.770.3010 - **Toll Free in U.S.A. and Canada 1.800.866.3837**

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NIST Traceable Calibrations

Our laboratories are fully equipped to perform NIST traceable flow calibrations for Rotameters, Mass Flow instruments and many other flow products.

We also offer calibration service on equipment and instrumentation of other manufactures products which are comparable to those manufactured by AALBORG®.

- Calibrations are performed at standard (STP) conditions (70°F/21.1 °C and 14.7 psia/1 atm abs).
- Gas calibrations for up to 2000 sL/min and water calibrations up to 4 L/min available.
- Calibrated to a primary NIST standard or to an NIST traceable instrument.
- State-of-the-art Precision Glass-Piston, and Bell Prover type calibrations.

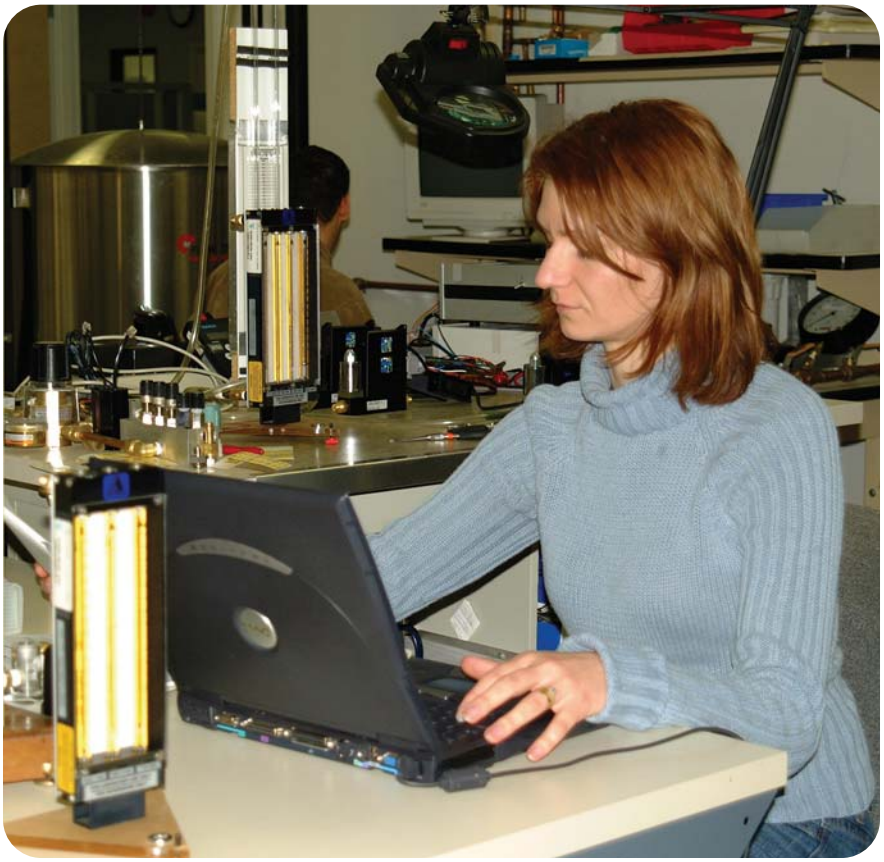
Pressure Limits Of Calibrations

Up to 500 PSIG for routine gases (Air, N_2, He, $C0_2$, Ar and O_2) with a maximum flow of 250 L/min. Up to 80 PSIG for Air, with a maximum flow of 1000 L/min.

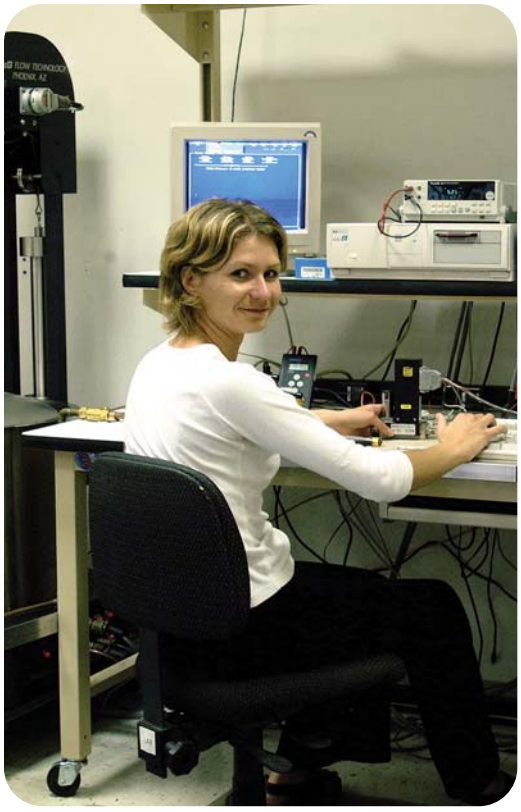
SGS ISO9001 Certification is not applicable.

Typical Bell Prover
used for NIST traceable calibrations

BULLETIN EM200810 CAL

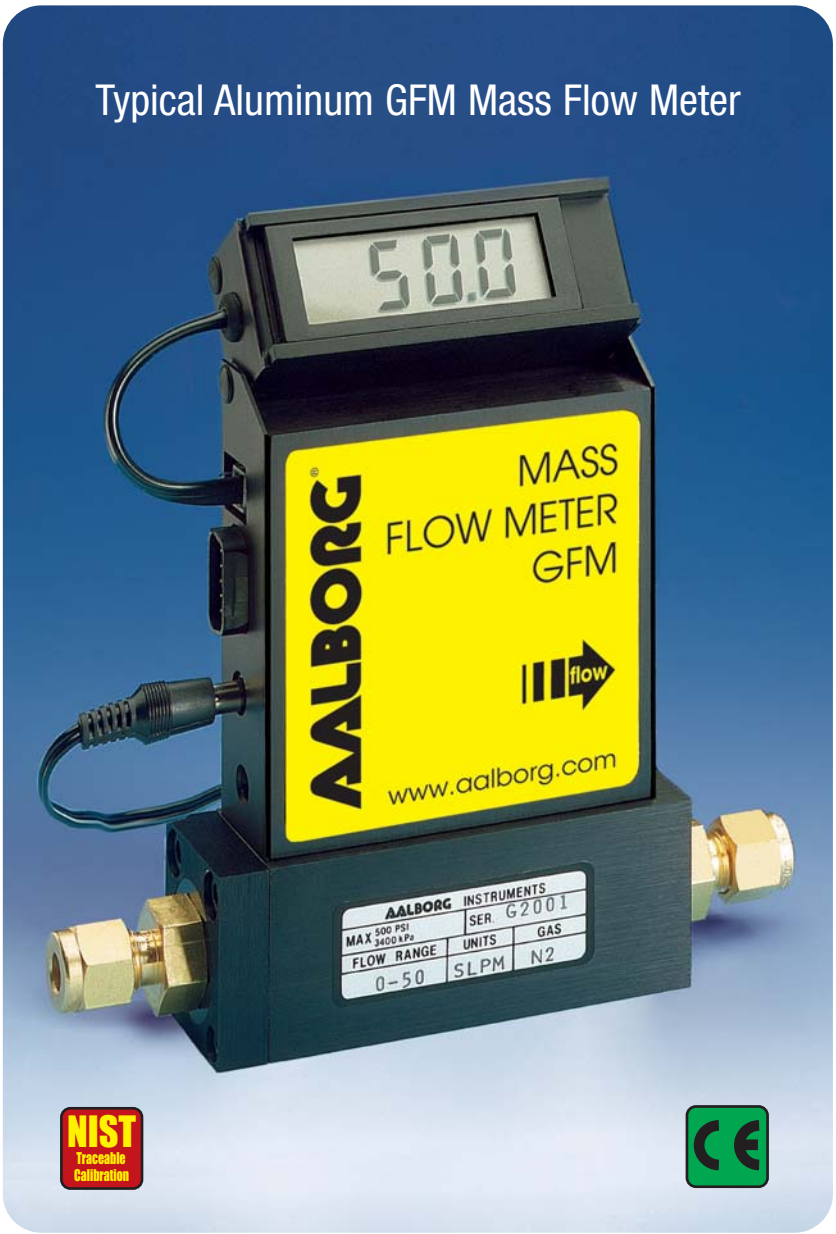


Typical
Calibrators
Used for Flow Rates



Design Features

- Rigid metallic construction.
- Maximum pressure of 1000 psig (70 bars).
- Leak integrity 1 x 10^{-7} of helium.
- NIST traceable certification.
- Built-in tiltable LCD readout.
- 0-5 Vdc and 4-20 mA signals.
- Circuit protection.
- Can be used as a portable device.
- Engineering units or 0 to 100% displays.
- Totalizer option.



Principles of Operation

Metered gases are divided into two laminar flow paths, one through the primary flow conduit, and the other through a capillary sensor tube. Both flow conduits are designed to ensure laminar flows and therefore the ratio of their flow rates is constant.

Two precision temperature sensing windings on the sensor tube are heated, and when flow takes place, gas carries heat from the upstream to the downstream windings. The resultant temperature differential is proportional to the change in resistance of the sensor windings.

A Wheatstone bridge design is used to monitor the temperature dependent resistance gradient on the sensor windings which is linearly proportional to the instantaneous rate of flow.

Output signals of 0 to 5Vdc and 4 to 20mA are generated indicating mass molecular based flow rates of the metered gas.

Flow rates are unaffected by temperature and pressure variations within stated limitations.

General Description

Compact, self-contained GFM mass flow meters are designed to read flow rates of gases. The rugged design coupled with instrumentation grade accuracy provides versatile and economical means of flow control.

Aluminum or stainless steel models with readout options of either engineering units (standard) or 0 to 100 percent displays are available.

The mechanical layout of the design includes an LCD readout built into the top of the transducer. This readout module is tiltable over 90 degrees to provide optimal reading comfort. It is connected to the transducer by a standard modular plug, and is also readily removable for remote reading installations.

BULLETIN EM200810 GFM

GFM

GFM 57, 67 and 77
High Flow Mass Flow Meters

TABLE 1 - SPECIFICATIONS FOR GFM	
ACCURACY (including linearity):	±1.5% of full scale, including linearity for gas temperatures of 59 °F to 77 °F (15 °C to 25 °C) and pressures of 5 to 60 psia (0.4 to 4.1 bars). Optional ±1% of full scale (certified calibration accuracy) associated with a given set of temperature and pressure values.
REPEATABILITY:	±0.5% of full scale.
RESPONSE TIME:	Generally 2 seconds to within ±2% of actual flow rate over 25 to 100% of full scale.
TEMPERATURE COEFFICIENT:	0.15% of full scale / °C.
PRESSURE COEFFICIENT:	0.01% of full scale / psi (0.07 bar).
MAXIMUM PRESSURE DROP:	See Table 3.
GAS and AMBIENT TEMP.:	32 °F to 122 °F (5° to 50 °C).
OUTPUT SIGNALS:	Linear 0-5 Vdc. 1000 ohms min. load impedance and 4-20 mA 0-250 ohms loop resistance.
TRANSDUCER INPUT POWER:	+12 Vdc; 200 mA of maximum. +24 Vdc optional.
TIME CONSTANT:	800 ms.
GAS PRESSURE:	1000 psig (70 bars) maximum GFM 17, 37, 47. 20 psig (1.4 bars) optimum. 500 psig (34.5 bars) GFM 57, 67, 77. 20 psig (1.4 bars) optimum.
** **MATERIALS IN FLUID CONTACT:**	**a.** Aluminum models GFM Series: anodized aluminum, 316 stainless steel, brass and Viton® O-rings.
	b. Stainless steel models GFM17S, 37S,47S, 57S, 67S and 77S: 316 stainless steel and Viton® O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
ATTITUDE SENSITIVITY:	No greater than +15 degree rotation from horizontal to vertical; standard calibration is in horizontal position.
CONNECTIONS:	**GFM 17 and 37:** 1/4" compression fittings. Optional: 1/4" VCR®, 1/8" or 3/8" compression fittings (GFM17).
	GFM 47: 3/8" compression fittings.
	GFM 57: 3/8" compression fittings.
	GFM 67: 1/2" compression fittings.
	GFM 77: 3/4" FNPT fittings or 3/4" compression fittings (GFM 77).
LEAK INTEGRITY:	1 x 10^{-7} smL/sec of helium maximum to the outside environment.
CE COMPLIANT:	EN 55011 class 1, class B; EN50082-1.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

Transducers without LCD readout are offered for OEM applications.

GFM mass flow meters are available with flow ranges from 10 mL/min to 1000 sL/min N_2. Gases are connected by means of 1/4" 3/8" 1/2" compression fittings and 3/4" FNPT fittings. Optional fittings are available. These meters may be used as bench top units or mounted by means of screws in the base.

Transducer power supply ports are fuse and polarity protected.

Leak Integrity

1 x 10^{-7} smL/sec of helium max to outside environment.

TABLE 2 - FLOW RANGES FOR GFM

CODE	smL/min [N_2]
GFM 17 LOW FLOW MASS FLOW METERS	
01	0 to 10
02	0 to 20
03	0 to 50
04	0 to 100
05	0 to 200
06	0 to 500
CODE	**sL/min [N_2]**
07	0 to 1
08	0 to 2
09	0 to 5
10	0 to 10
GFM 37 MEDIUM FLOW MASS FLOW METERS	
11	0 to 15
30	0 to 20
31	0 to 30
32	0 to 40
33	0 to 50
GFM 47 HIGH FLOW MASS FLOW METERS	
40	0 to 60
41	0 to 80
42	0 to 100
GFM 57 HIGH FLOW MASS FLOW METERS	
50	0 to 200
GFM 67 HIGH FLOW MASS FLOW METERS	
60	0 to 500
GFM 77 HIGH FLOW MASS FLOW METERS	
70	0 to 1000

TABLE 3 - MAXIMUM PRESSURE DROP FOR GFM

MODEL	FLOW RATE [std liters/min]	MAXIMUM PRESSURE DROP		
		[mm H_2O]	[psid]	[mbar]
GFM 17	up to 10	25	0.04	2.5
GFM 37	20	300	0.44	30
	30	800	1.18	81
	40	1480	2.18	150
	50	2200	3.23	223
GFM 47	60	3100	4.56	314
	80	4422	6.5	448
	100	5500	8.08	557
GFM 57	200	2720	4.0	280
GFM 67	500	3400	5.0	340
GFM 77	1000	6120	9.0	620

TABLE 4 - ACCESSORIES FOR GFM

TOTALIZER	
TOT-10-0C	Totalizer (5Vdc - 10Vdc signals), calibrated.
TOT-10-0N	Totalizer (5Vdc - 10Vdc signals), uncalibrated.
CBL-TOT10	Cable & splitter, used in conjunction w/ display.
IO INPUT/OUTPUT	
IO-232-C	Input/output to RS232, 0-5Vdc.
IO-232-E	Input/output to RS232, 4-20mA.
IO-485-C	Input/output to RS485, 0-4Vdc.
IO-485-E	Input/output to RS485, 4-20mA.
POWER SUPPLY - BATTERY PACK - CABLES	
PS-GFM-110NA-2	Power Supply, 110 V / 12 Vdc /North America
PS-GFM-110NA-4	Power Supply, 110 V / 24 Vdc /North America
PS-GFM-230EU-2	Power Supply, 220 V / 12 Vdc /Europe
PS-GFM-230EU-4	Power Supply, 220 V / 24Vdc /Europe
PS-GFM-240UK-2	Power Supply 240 V / 12 Vdc /United Kingdom
PS-GFM-240UK-4	Power Supply 240 V / 24 Vdc /United Kingdom
PS-GFM-240AU-2	Power Supply 240 V / 12 Vdc /Australia
PS-GFM-240AU-4	Power Supply 240 V / 24 Vdc /Australia
BP110	Battery Pack, 110 V (includes case)
BP220	Battery Pack, 220 V (includes case)
CBL-D4	Cable with 9-pin D-connector, (4 - 20 mA)
CBL-D5	Cable with 9-pin D-connector, (0 to 5 Vdc)
17/3RC	17/3RC Remote cable, 3 ft long
17/R	17/R Remote LCD readout with 3 ft long cable

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GFM Mass Flow Meters

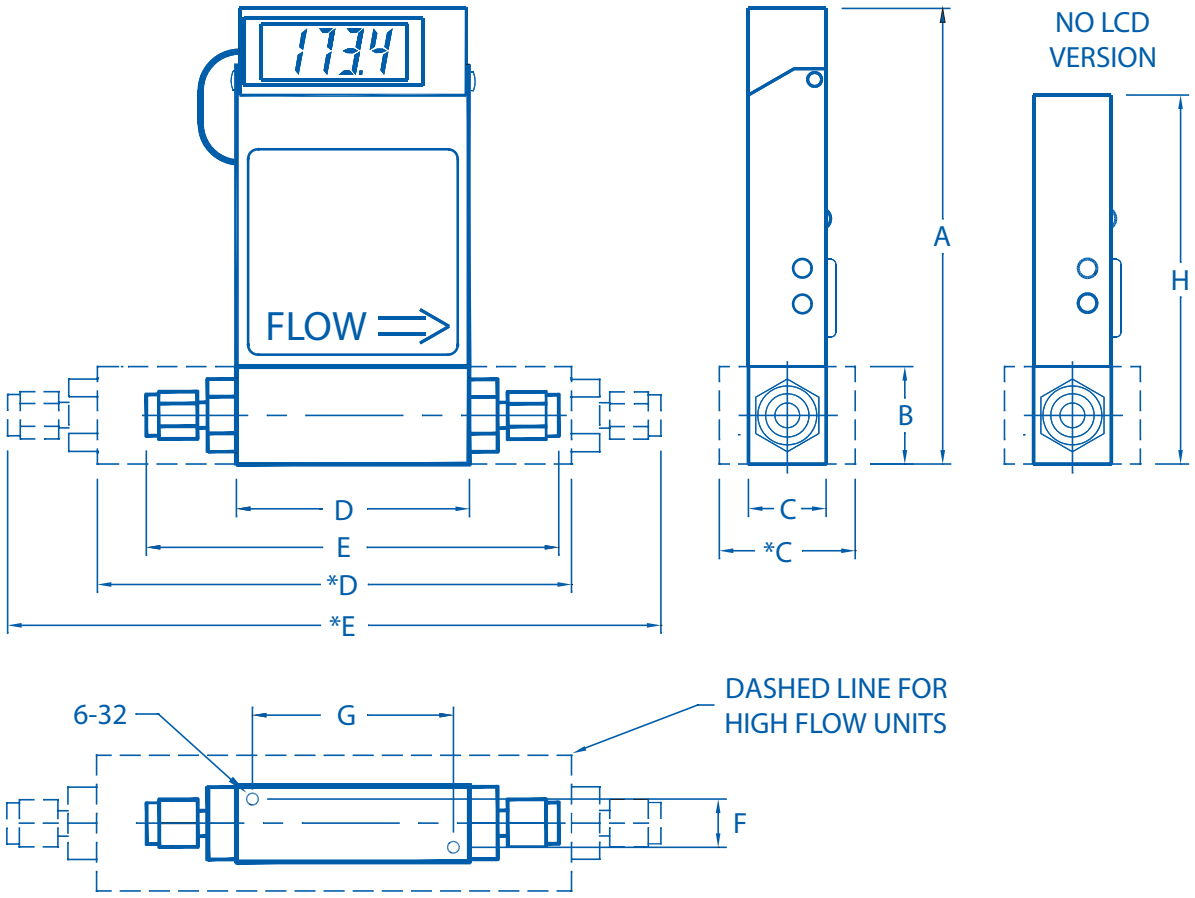


TABLE 5 - DIMENSIONS FOR GFM

MODEL	CONNECTION Compression Fitting (except model GFM 77)	DIMENSION (INCH)							
		LCD VERSION							NO LCD
		A	B	C/*C	D/*D	E/*E	F	G	H
GFM 17	1/4" Tube O Diameter	5.60	1.00	1.00	3.00	5.02	0.69	2.69	4.50
GFM 37	1/4" Tube O Diameter	5.98	1.37	1.25	4.13	6.15	0.69	2.69	4.88
GFM 47	3/8" Tube O Diameter	5.98	1.37	1.25	4.13	6.27	0.69	2.69	4.88
GFM 57	3/8" Tube O Diameter	6.60	2.00	1.75	6.69	8.83	0.99	4.69	5.50
GFM 67	1/2" Tube O Diameter	7.60	3.00	3.00	7.25	9.67	1.69	-	6.50
GFM 77	3/4" NPT Female	8.60	4.00	4.00	7.30	-	-	-	7.50

GFM

GFM	MODEL

MAX FLOW (N_2)	
17	10 L/min
37	50 L/min
47	100 L/min
57	200 L/min
67	500 L/min
77	1000 L/min

MATERIAL	
A	Aluminum
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE / Kalrez®

FITTINGS	
A	1/4" Compression
B	1/8" Compression
C	1/4" VCR®
D	3/8" Compression
E	1/2" Compression
F	3/4" FNPT
G	3/4" Compression
X	Special

CONNECTOR	
D	D Connector

DISPLAY	
N	No Display
L	LCD Readout

POWER	
2	12 VDC
4	24 VDC

INPUT / OUTPUT SIGNAL	
A	*n.a./0-5 VDC
B	*n.a./4-20 mA

DIGITAL INTERFACE	
0	None

GFM	17	S	–	V	A	D	L	2	–	A	0

EXAMPLE: GFM17S-VADL2-A0 5 L/min [N_2] 20 psig

SPECIFY: *GAS, FLOW RANGE and PRESSURE*

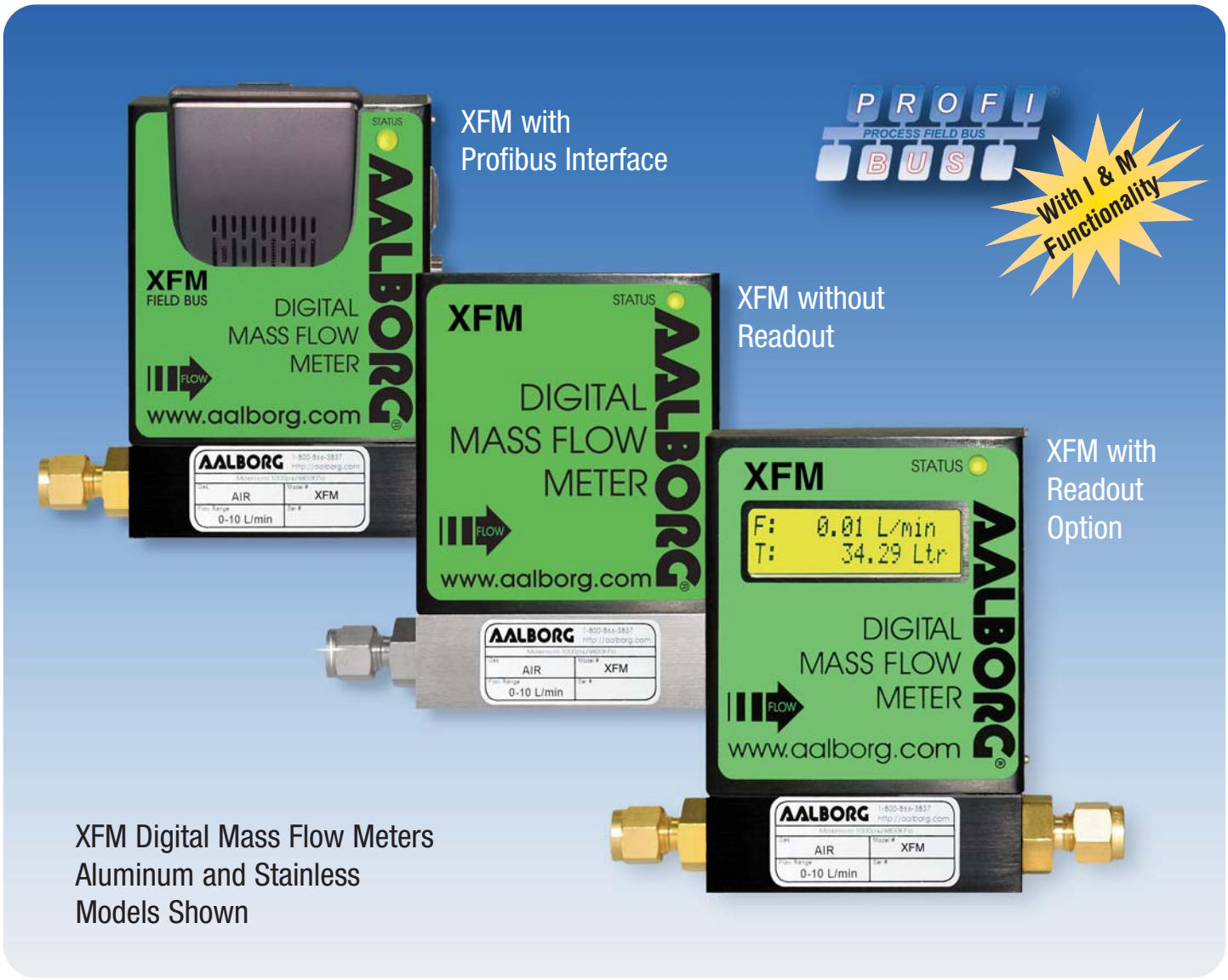
**n.a. = not applicable.*

GFM17 stainless steel, Viton® seals, 1/4" compression fittings, D connector with display, 12Vdc, 0-5 Vdc, Output signal, No digital interface.

BULLETIN EM200810 GFM

Design Features

- Supports up to 23 Engineering Units (including User Defined).
- Stores calibration data for up to 10 gases.
- Programmable Totalizer indicates total gas quantity.
- High and low gas flow Alarm limits with preset delay interval.
- Two sets of user-programmable electromechanical SPDT relays with latch option.
- User-selectable analog 0-5 Vdc or 4-20mA outputs.
- Internal Conversion factors for up to 32 gases.
- Digital Interface (RS-232 / RS-485, Profibus DP available).
- Multi-Drop Capability of up to 256 units (RS-485 option).
- Optional Profibus DP interface with I&M functionality.
- Automatic sensor zero offset adjustment (via digital interface or local push button).
- Self-Diagnostic Tests.
- Local 2 x 16 characters LCD display* with adjustable back light (optional).



** LCD display is not available for Profibus DP interface option.*

XFM Digital Mass Flow Meters

The flow rate can be displayed in 23 different volumetric flow or mass flow engineering units including user specific. Flow meters can be programmed remotely via RS-232 /RS-485 or optional Profibus DP interface.

XFM flow meters support various functions including: programmable flow totalizer, high and low flow alarm, automatic zero adjustment, 2 relay outputs, jumper selectable 0-5 Vdc or 4-20 mA analog outputs, status LED diagnostic, capable to store calibration for up to 10 different gases, internal or user-specific K-factors. Optional local 2 x 16 characters LCD display* with adjustable back light provides Flow, Total and diagnostic reading simultaneously.

Principle Of Operation

The stream of gas entering the Mass Flow transducer is split by shunting a small portion of the flow through a capillary stainless steel sensor tube. The remainder of the gas flows through the primary flow conduit. The geometry of the primary conduit and the sensor tube are designed to ensure laminar flow in each branch. According to principles of fluid dynamics, the flow rates of a gas in the two laminar flow conduits are proportional to one another. Therefore, the flow rates measured in the sensor tube are directly proportional to the total flow through the transducer. In order to sense the flow in the sensor tube, heat flux is introduced at two sections of the sensor tube by means of precision-wound heater sensor coils. Heat is transferred through the thin wall of the sensor tube to the gas flowing inside. As gas flow takes place, heat is carried by the gas stream from the upstream coil to the downstream coil windings.

The resultant temperature dependent resistance differential is detected by the electronic control circuit. The measured temperature gradient at the sensor windings is linearly proportional to the instantaneous rate of flow taking place. An output signal is generated that is a function of the amount of heat carried by the gases to indicate mass molecular based flow rates. Additionally, the XFM model Mass Flow Meter incorporates a Precision Analog Microcontroller (ARM7TDMI® MCU) and non-volatile memory that stores all hardware specific variables and up to 10 different calibration tables.

** LCD display is not available for Profibus DP interface option.*

Interface

The digital RS485 or RS-232 interface (optional Profibus DP interface is available) provides access to applicable internal data including: flow, CPU temperature, auto zero, totalizer and alarms settings, gas table, conversion factors and engineering units selection, dynamic response compensation and linearization table adjustment. The analog interface provides 0 to 5Vdc or 4 to 20 mA (jumper selectable) outputs for flow reading.

Auto Zero

The XFM supports automatic sensor zero offset adjustment which can be activated locally via the maintenance push button or remotely via digital interface. The auto zero feature necessitates a condition of absolutely no flow through the meter during the adjustment process. Provisions are made to either start, read, or save the current auto zero value via digital commands.

Totalizer

The total volume of the gas is calculated by integrating the actual gas flow rate as a function of time.

The digital interface commands are provided to:

- Set the totalizer to ZERO.
- Start the totalizer at a preset flow.
- Assign action at a preset total volume.
- Start/stop totalizing the flow.
- Read totalizer.

Totalizer conditions become true when the totalizer reading and the “Stop at Total” volumes are equal. In addition, the provision is made to automatically disable Totalizer during sensor warm up period.

Flow Alarm

High and Low gas flow ALARM limits can be preprogrammed via digital interface. ALARM conditions become true when the current flow reading is equal or higher/lower than corresponding values of high and low alarm levels. Alarm action can be assigned with preset delay interval (0-3600 seconds) to activate the contact closer (separate for High and Low alarm). Latch Mode control feature allows each relay to be latched on or follow the corresponding alarm status.

TABLE 6 - SPECIFICATIONS

FLOW MEDIUM:	Please note that XFM Mass Flow Meters are designed to work only with clean gases. **Never** try to measure flow rates of liquids with any XFM.
CALIBRATIONS:	Performed at standard conditions [14.7 psia (101.4 kPa) and 70 °F (21.1°C)] unless otherwise requested or stated.
ENVIRONMENTAL (PER IEC 664):	Installation Level II; Pollution Degree II.
FLOW ACCURACY (INCLUDING LINEARITY):	±1% of FS at calibration temperature and pressure.
REPEATABILITY:	±0.15% of full scale.
FLOW TEMPERATURE COEFFICIENT:	0.15% of full scale/ °C or better.
FLOW PRESSURE COEFFICIENT:	0.01% of full scale/psi (6.895 kPa) or better.
FLOW RESPONSE TIME:	600ms time constant; approximately 2 seconds to within ±2% of set flow rate for 25% to 100% of full scale flow.
MAXIMUM GAS PRESSURE:	500 psig (3447 kPa gauge).
MAXIMUM PRESSURE DROP:	0.18 PSID (at 10 L/min flow). 8 psi (at 100 L/min flow). See Table 9 for pressure drops associated with various models and flow rates.
GAS AND AMBIENT TEMPERATURE:	41° F to 122° F (5° C to 50° C).
RELATIVE GAS HUMIDITY:	Up to 70%.
LEAK INTEGRITY:	1 x 10^{-9} smL/sec He maximum to the outside environment.
ATTITUDE SENSITIVITY:	Deviation of up to 1% from stated accuracy, after re-zeroing.
OUTPUT SIGNALS:	Linear 0-5 Vdc (3000 ohms min load impedance); Linear 4-20 mA (500 ohms maximum loop resistance). Maximum noise 20mV peak to peak (for 0-5 Vdc output).
TRANSDUCER INPUT POWER:	11 to 26 Vdc, 100 mV maximum peak to peak output noise. POWER CONSUMPTION: +12Vdc (200 mA maximum); +24Vdc (100 mA maximum); Circuit board have built-in polarity reversal protection, 300mA resettable fuse provide power input protection.
WETTED MATERIALS:	Aluminum Models: Anodized aluminum, brass, 316 stainless steel, Viton® O-rings. Stainless Steel Models: 316 stainless steel, Viton® O-rings. Optional O-ring Materials: Buna-N®, EPR® (Ethylene Propylene), or Kalrez®.
CAUTION:	Aalborg makes no expressed or implied guarantees of corrosion resistance of mass flow meters as pertains to different flow media reacting with components of meters. It is the customers' sole responsibility to select the model suitable for a particular gas based on the fluid contacting (wetted) materials offered in the different models.
INLET AND OUTLET CONNECTIONS:	Model XFM 17: Standard 1/4" compression fittings. *Optional:* 1/8" or 3/8" compression fittings and 1/4" VCR® fittings are available.
DISPLAY:	*Optional local 2x16 characters LCD with adjustable backlight (2 lines of text).
CALIBRATION OPTIONS:	Standard is one 10 points NIST traceable calibration. Optional, up to 9 additional calibrations may be ordered at additional charge.
CE COMPLIANCE:	EMC Compliance with 89/336/EEC as amended. Emission Standard: EN 55011:1991, Group 1, Class A Immunity Standard: EN 55082-1:1992.

** LCD display is not available for Profibus DP interface option.*

Multi-Gas Calibration

The XFM is capable of storing primary calibration data for up to 10 gases. This feature allows the same XFM to be calibrated for multiple gases while maintaining the rated accuracy on each.

Conversion Factors

Conversion factors for up to 32 gases are stored in the XFM. In addition, provision is made for a user-defined conversion factor. Conversion factors may be applied to any of the ten gas calibrations via digital interface commands.

Contact Closure

Two sets of electromechanical SPDT relay outputs are provided to actuate user-supplied equipment.

These are programmable via digital interface such that the relays can be made to switch when a specified event occurs (e.g. when a low or high flow alarm limit is exceeded or when the totalizer reaches a specified value) or may be directly controlled by user.

TABLE 7 - FLOW RANGES FOR XFM

XFM 17 LOW FLOW MASS FLOW METERS	
CODE	**smL/min [N_2]**
00	0 to 5
01	0 to 10
02	0 to 20
03	0 to 50
04	0 to 100
05	0 to 200
06	0 to 500
CODE	**sL/min [N_2]**
07	0 to 1
08	0 to 2
09	0 to 5
10	0 to 10

Leak Integrity

1 x 10^{-9} smL/sec of Helium maximum to the outside environment.

Engineering Units

The measured gas flow and associated totalizer data are scaled directly in engineering units via the digital interface.

The following 23 units of measure are supported:

TABLE 8 - UNITS OF MEASURE FOR XFM

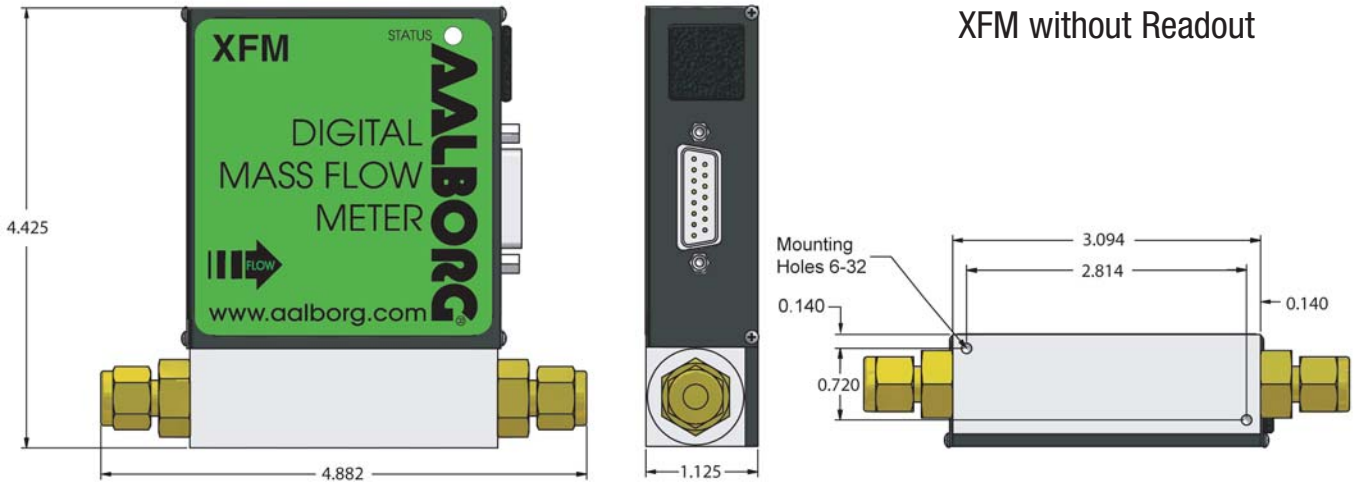
NUMBER	INDEX	FLOW RATE ENGINEERING UNITS	TOTALIZER ENGINEERING UNITS	DESCRIPTION
1	0	%	%s	Percent of full scale
2	1	mL/sec	mL	Milliliter per second
3	2	mL/min	mL	Milliliter per minute
4	3	mL/hr	mL	Milliliter per hour
5	4	L/sec	Ltr	Liter per second
6	5	L/ min	Ltr	Liter per minute
7	6	L/hr	Ltr	Liter per hour
8	7	m^3/sec	m^3	Cubic meter per second
9	8	m^3/ min	m^3	Cubic meter per minute
10	9	m^3/hr	m^3	Cubic meter per hour
11	10	ft^3/sec	f^3	Cubic feet per second
12	11	ft^3/min	f^3	Cubic feet per minute
13	12	ft^3/hr	f^3	Cubic feet per hour
14	13	g/sec	g	Grams per second
15	14	g/min	g	Grams per minute
16	15	g/hr	g	Grams per hour
17	16	kg/sec	kg	Kilograms per second
18	17	kg/min	kg	Kilograms per minute
19	18	kg/hr	kg	Kilograms per hour
20	19	Lb/sec	Lb	Pounds per second
21	20	Lb/min	Lb	Pounds per minute
22	21	Lb/hr	Lb	Pounds per hour
23	22	User	UD	User defined

TABLE 9 - MAXIMUM PRESSURE DROP FOR XFM

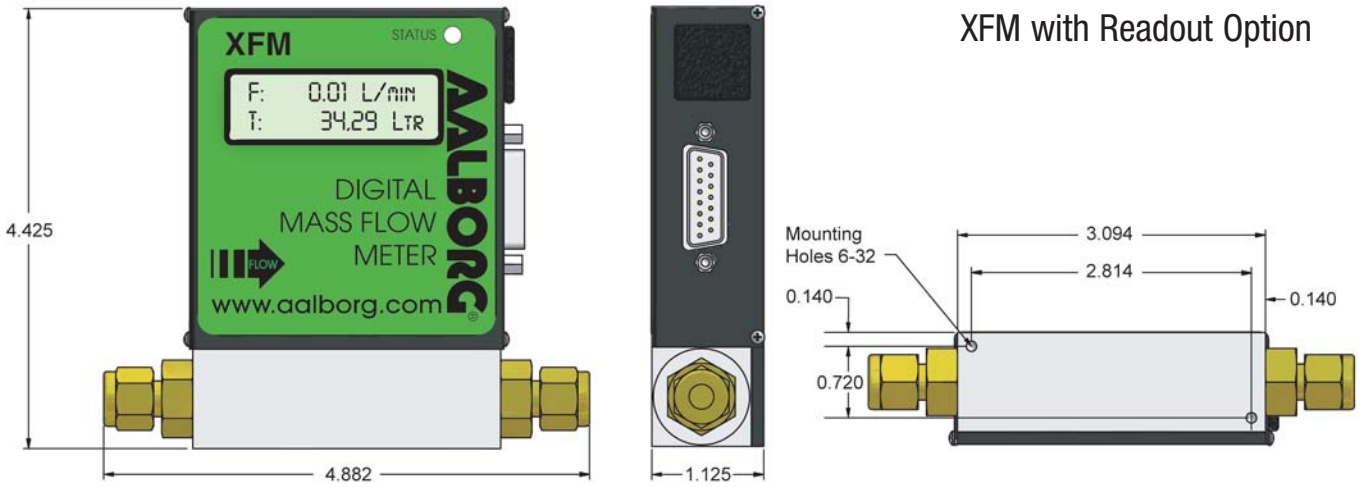
MODEL	FLOW RATE [std liters/min]	MAXIMUM PRESSURE DROP		
		[mm H_2O]	[psid]	[kPa]
XFM 17	up to 10	130	0.18	1.275

BULLETIN EM20810 XFM

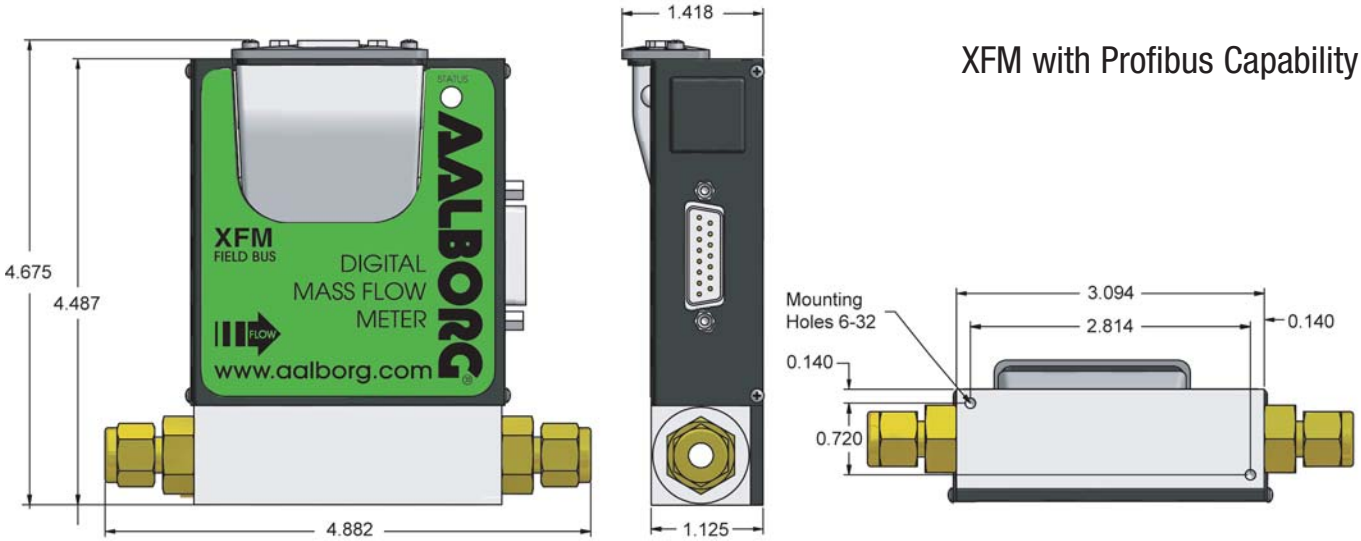
XFM without Readout



XFM with Readout Option



XFM with Profibus Capability



ORDERING INFORMATION FOR DIGITAL MASS FLOW METER

XFM

XFM	MODEL

MAX FLOW (N_2)	
17	10 L/min

MATERIAL	
A	Aluminum
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE / Kalrez®

FITTINGS	
A	1/4" Compression
B	1/8" Compression
C	1/4" VCR®
D	3/8" Compression
X	Special

CONNECTOR	
D	D Connector

DISPLAY	
N	NO Display
L	LCD Readout

POWER	
6	Universal 11-26 VDC

INPUT / OUTPUT SIGNAL	
A	*n.a./0-5 VDC
B	*n.a./4-20 mA

DIGITAL INTERFACE	
2	RS232
5	RS485
9	PROFIBUS

XFM	17	S	–	V	A	D	L	6	–	A	2

EXAMPLE: XFM17S-VADL6-A2 5 L/min [N_2] 20 psig

SPECIFY: *GAS, FLOW RANGE and PRESSURE*

**n.a. = not applicable.*

XFM17 stainless steel, Viton® seals, 1/4" compression fittings, D connector, With LCD readout, 11-26 VDC, 0-5 Vdc output signal with RS232 digital interface.

BULLETIN EM20081O XFM

Model GFC thermal Mass Flow Controllers are designed to indicate and control set flow rates of gases.

The GFC combines the characteristics and accuracy of conventional mass flow devices into a unique compact design at low costs previously unattainable.

Each of these controllers incorporates an advanced straight tube sensor in conjunction with flow passage elements constructed of aluminum and brass for non-corrosive gases or 316 stainless steel for corrosive applications. Zero and span adjustments are accessible from the outside of transmitters.

Principles of Operation

Metered gases are divided into two laminar flow paths, one through the primary flow conduit, and the other through a capillary sensor tube. Both flow conduits are designed to ensure laminar flows and therefore the ratio of their flow rates is constant.

Two precision temperature sensing windings on the sensor tube are heated, and when flow takes place, gas carries heat from the upstream to the downstream windings. The resultant temperature differential is proportional to the change in resistance of the sensor windings.

A Wheatstone bridge design is used to monitor the temperature dependent resistance gradient on the sensor windings which is linearly proportional to the instantaneous rate of flow.

Output signals of 0 to 5Vdc and 4 to 20mA are generated indicating mass molecular based flow rates of the metered gas. The combined gas streams flow through a proportionating electromagnetic valve with an appropriately selected orifice.The closed loop control circuit continuously monitors the mass flow output and maintains it at the set flow rate.

Flow rates are unaffected by temperature and pressure variations within stated limitations.

Design Features

- Rigid metallic construction.
- Maximum pressure of 1000 psig (70 bars).
- Leak integrity 1 x 10^{-7} smL/sec of helium.
- NIST traceable certification.
- Built-in tiltable LCD readout.
- Local or remote setpoint control.
- 0-5 Vdc and 4-20 mA signals.
- Circuit protection.
- Totalizer option.

General Description

Compact, self-contained GFC mass flow controllers are designed to indicate and control flow rates of gases.

The rugged design coupled with instrumentation grade accuracy provides versatile and economical means of flow control. Aluminum or stainless steel models with readout options of either engineering units (standard) or 0 to 100 percent displays are available.

Typical Stainless Steel GFC Mass Flow Controller

GFC 57, 67 and 77 Series Aluminum Mass Flow Controllers

TABLE 10 - SPECIFICATIONS	
ACCURACY (including linearity):	±1.5% of full scale, including linearity for gas temperatures of 59 °F to 77 °F (15 °C to 25 °C) and pressures of 5 to 60 psia (0.4 to 4.1 bars). Optional ±1% of full scale (certified calibration accuracy) associated with a given set of temperature and pressure values.
REPEATABILITY:	±0.5% of full scale.
RESPONSE TIME:	Generally 2 seconds to within ±2% of actual flow rate over 25 to 100% of full scale.
TEMPERATURE COEFFICIENT:	0.15% of full scale / °C.
PRESSURE COEFFICIENT:	0.01% of full scale / psi (0.07 bar).
PRESSURE DROP:	See Table 12.
OPTIMUM GAS PRESSURE:	25 psig (1.73 bars).
MAX GAS PRESSURE:	1000 psig (70 bars) maximum GFC 17, 37, 47. 500 psig (34.5 bars) GFC 57, 67, 77.
MAX DIFF. PRESSURE:	GFC 17, 37, 57, 67, and 77 50 psi (3.4 bars), GFC 47, 40 psi (2.7 bars).
GAS and AMBIENT TEMP:	41 °F to 122 °F (5 °C to 50 °C).
****MATERIALS FLUID CONTACT:**	**a.** Aluminum models GFC Series: anodized aluminum, 316 stainless steel, brass and Viton® O-rings.
	b. Stainless steel models GFC17S, 37S, 47S, 57S, 67S and 77S: 316 stainless steel and Viton® O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
ATTITUDE SENSITIVITY:	No greater than ±15 degree rotation from horizontal to vertical; standard calibration is in horizontal position.
OUTPUT SIGNALS:	Linear 0-5 Vdc. (1000 ohms min. load impedance); 4-20 mA (0-500 ohms loop resistance) Max noise ±20mV.
COMMAND SIGNALS:	Analog 0-5 Vdc or 4-20 mA for remote set point mode; NPN compatible purge /valve off.
CONNECTIONS:	**GFC 17 and 37**: 1/4" compression fittings. Optional: 1/4" VCR®, 1/8" or 3/8 compression fittings (GFC17). **GFC 47:** 3/8" compression fittings. **GFC 57:** 3/8" compression fittings. **GFC 67:** 1/2" compression fittings. **GFC 77:** 3/4" FNPT fittings. Optional: 3/4" compression fittings (GFC77).
LEAK INTEGRITY:	1 x 10^{-7} smL/sec of helium maximum to the outside environment.
TRANSDUCER INPUT POWER:	+12 Vdc, 800 mA; +24 Vdc, 650 mA optional.
CIRCUIT PROTECTION:	Circuit boards have built-in polarity reversal protection. Resettable fuses provide power input protection.
DISPLAY:	3-1/2 digit LCD, 0.5" high characters.
CE COMPLIANT:	EN 55011 class 1, class B; EN50082-1.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

TABLE 11 - FLOW RANGES FOR GFC	
GFC 17 LOW FLOW MASS FLOW CONTROLLER	
CODE	**scc / min [N_2]**
01	0 to 10
02	0 to 20
03	0 to 50
04	0 to 100
05	0 to 200
06	0 to 500
CODE	**std liters / min [N_2]**
07	0 to 1
08	0 to 2
09	0 to 5
10	0 to 10
GFC 37 MEDIUM FLOW MASS FLOW CONTROLLER	
11	0 to 15
30	20
31	30
32	40
33	50
GFC 47 /57 /67 /77 HIGH FLOW MASS FLOW CONTROLLER	
40	60
41	80
42	100
50	200
60	500
70	1000

TABLE 12 - MAXIMUM PRESSURE DROP FOR GFC

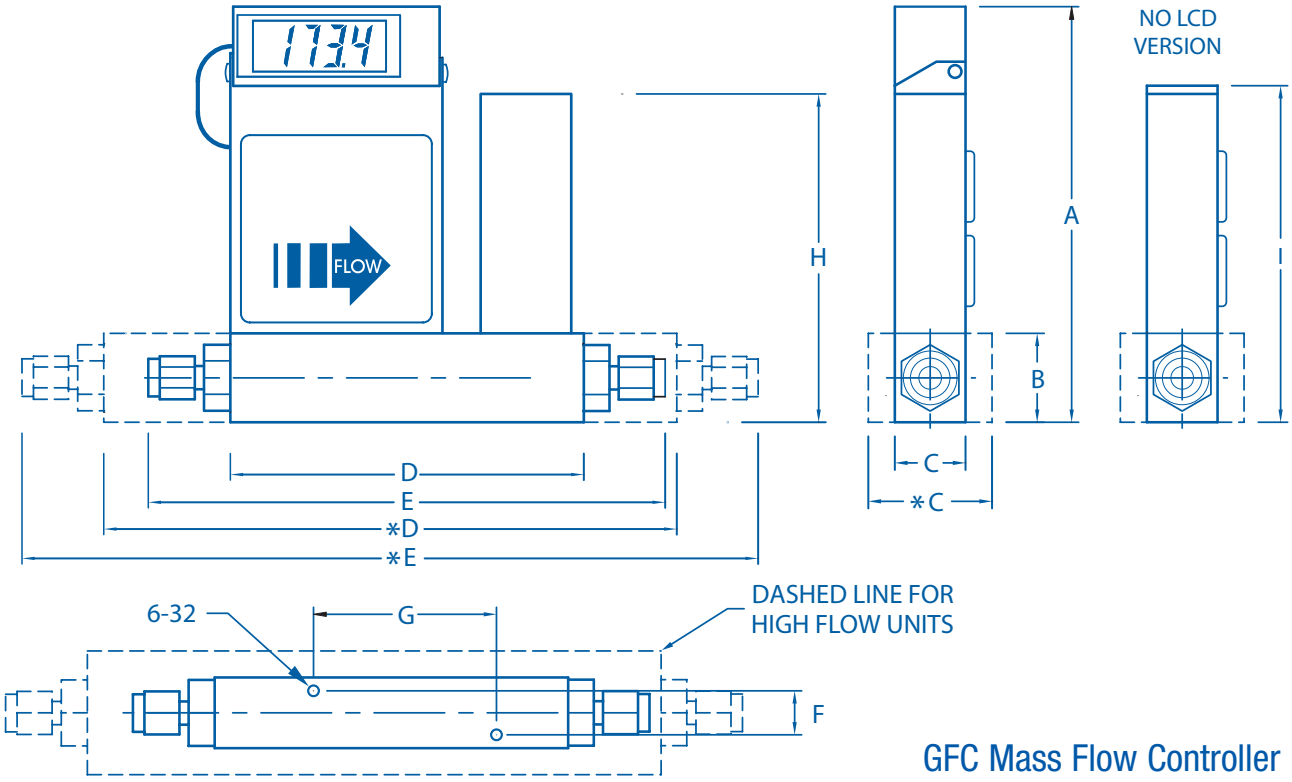
MODEL	FLOW RATE [std liters/min]	MAXIMUM PRESSURE DROP		
		[mm H_2O]	[psid]	[mbar]
GFC 17	UP to 10	720	1.06	75
GFC 37	15	2630	3.87	266
	20	1360	2.00	138
	30	2380	3.50	241
	40	3740	5.50	379
	50	5440	8.00	551
GFC 47	60	7480	11.00	758
	100	12850	18.89	1302
GFC 57	200	7031	10.00	690
GFC 67	500	8437	12.00	827
GFC 77	1000	10547	15.00	1034

The built-in electromagnetic valve allows the flow to be set to any desired flow rate within the range of the particular model. Setpoints are controlled either locally or remotely. The valve is normally closed as a safety feature to ensure that gas flow is shut off in case of a power outage. The LCD readout built into the top of the transducer is tiltable over 90 degrees to provide optimal reading comfort. It is connected to the transducer by a standard modular plug, and is readily removable for remote reading installations. Transducers without LCD readout are offered for OEM applications. GFC mass flow controllers are available with flow ranges from 10 mL/min to 1000 sL/min N_2.Gases are connected by means of 1/4", 3/8", or optional 1/8" compression fittings and 3/4" FNPT fittings. Optional fittings are available. These controllers may be used as bench top units or mounted by means of screws in the base.Transducer power supply ports are fuse and polarity protected.

Leak Integrity

1 x 10^{-7} smL/sec of helium maximum to the outside environment.

TABLE 13 - ACCESSORIES FOR GFC	
TOTALIZER	
TOT-10-0C	Totalizer (5Vdc - 10Vdc signals), calibrated.
TOT-10-0N	Totalizer (5Vdc - 10Vdc signals), uncalibrated.
CBL-TOT10	Cable & splitter, used in conjunction w/ display.
IO INPUT /OUTPUT	
IO-232-C	Input/output to RS232, 0-5Vdc.
IO-232-E	Input/output to RS232, 4-20mA.
IO-485-C	Input/output to RS485, 0-4Vdc.
IO-485-E	Input/output to RS485, 4-20mA.
POWER SUPPLY - BATTERY PACK - CABLES	
PS-GFC-110NA-2	Power Supply, 110 V/12 Vdc /North America
PS-GFC-110NA-4	Power Supply, 110 V/24 Vdc /North America
PS-GFC-230EU-2	Power Supply, 220 V/12 Vdc /Europe
PS-GFC-230EU-4	Power Supply, 220 V/24 Vdc /Europe
PS-GFC-240UK-2	Power Supply 240 V/12 Vdc /United Kingdom
PS-GFC-240UK-4	Power Supply 240 V/24 Vdc /United Kingdom
PS-GFC-240AU-2	Power Supply 240 V/12 Vdc /Australia
PS-GFC-240AU-4	Power Supply 240 V/24 Vdc /Australia
CBL-DGS	Cable, Shielded 15-pin D-connector /end terminated
17/ 3RC	Remote Cable, 3 feet long
17/ R	Remote LCD readout with 3 feet long cable



GFC Mass Flow Controller

TABLE 14 - DIMENSION FOR GFC

MODEL	CONNECTION Compression Fitting (except model GFC 77)	DIMENSION (INCH)							
		LCD VERSION							NO LCD
		A	B	C/*C	D/*D	E/*E	F	G	H
GFC17	1/4" Tube O Dia.	5.60	1.00	1.00	4.27	6.29	0.69	2.69	4.50
GFC37	1/4" Tube O Dia.	5.98	1.37	1.25	5.19	7.21	0.69	2.69	4.88
GFC47	3/8" Tube O Dia.	5.98	1.37	1.25	5.19	7.33	0.69	2.69	4.88
GFC57	3/8" Tube O Dia.	6.60	2.00	1.75	10.2	12.3	0.99	4.69	5.50
GFC67	1/2" Tube O Dia.	7.56	3.00	3.00	10.2	12.4	1.69	-	6.46
GFC77	3/4" NPT Female	8.56	4.00	4.00	10.5	-	-	-	7.46

NOTE: Only 12Vdc for models GFC 57, 67 and 77. For Specific Flow Ranges Contact Aalborg Customer Service Department.

GFC

GFC	MODEL

MAX. FLOW (N_2)	
17	10 L/min
37	50 L/min
47	100 L/min
57	200 L/min
67	500 L/min
77	1000 L/min

MATERIAL	
A	Aluminum
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE/ Kalrez®

FITTINGS	
A	1/4" Compression
B	1/8" Compression
C	1/4" VCR®
D	3/8" Compression
E	1/2" Compression
F	3/4" FNPT
G	3/4" Compression
X	Special

CONNECTOR	
D	D Connector

DISPLAY	
N	No display
L	LCD readout

POWER	
2	12 Vdc
4	24 Vdc

INPUT/OUTPUT SIGNAL	
A	Local 0-5 Vdc
B	Local 4-20mA
C	0-5Vdc/0-5Vdc
D	0-5Vdc/4-20mA
E	4-20mA/4-20mA
F	4-20mA/0-5Vdc

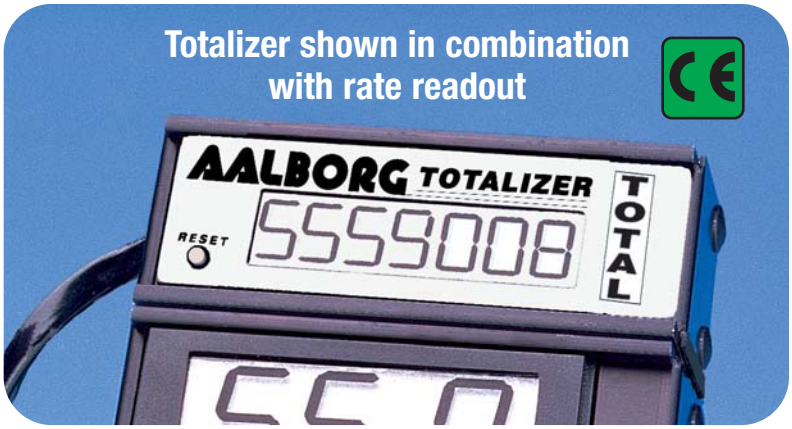
DIGITAL INTERFACE	
0	None

GFC	17	S	—	V	A	D	L	2	—	C	0

EXAMPLE: GFC17S-VADL2-C0 10 L/min [N_2] 20 psig

SPECIFY: *GAS, FLOW RANGE and PRESSURE*

GFC17 stainless steel, Viton® seals, 1/4" compression fittings, D connector with display, 12Vdc, 0-5 Vdc. Out put signal, No digital interface



Totalizer

This compact totalizer is designed to be used primarily with mass flow meters and mass flow controllers. It can also be used in conjunction with other types of instrumentation with 0-5 Vdc signal outputs.

The totalizer takes analog output flow signals of either 5 to 10 Vdc, from GFM mass flow meters and GFC mass flow controllers, or 0 to 5 Vdc from AFC mass flow controllers, AFM mass flow meters and other compatible products (jumper selectable).

TABLE 15 - SPECIFICATIONS	
INPUT ANALOG RANGE:	5 to 10 Vdc/0 to 5 Vdc optional.
POWER CONSUMPTION:	10 mA at 12 Vdc, less than 0.125 watts.
ACCURACY:	±0.5% of full scale.
TEMPERATURE STABILITY:	±200 ppm/ °C in the range of 5 °C to 50 °C.
DISPLAY:	7 digit, 8mm figure height.
READING BACKUP:	20 year lithium battery, no external power required.
RESET:	Push button switch.
WEIGHT:	3.5 oz.

TABLE 16 -ORDERING INFORMATION FOR TOTALIZER	
TOT-10-0C	Totalizer (5Vdc-10Vdc signals) calibrated.
TOT-10-0N	Totalizer (5Vdc-10Vdc signals) uncalibrated.
TOT-5-0C	Totalizer (0Vdc-5Vdc signals) calibrated.
TOT-5-0N	Totalizer (0Vdc-5Vdc signals) uncalibrated.
CBL-TOT10	Cable & splitter, used in conjunction w/ display
CBL-TOT5	Cable with stripped end

The totalizer integrates and accumulates up to 7 digits of direct engineering units for the given gas and flow rate (i.e. standard liters, standard cubic centimeters, etc.).

In order to reduce low signal (noise) totalizing, provision is made for 1% cut off.

A built-in battery back-up holds the total reading for up to 20 years.

The totalizer can be connected to GFM mass flow meters or GFC mass flow controllers via either a modular jack replacing the LCD display or with an additional connector in conjunction with the LCD display.

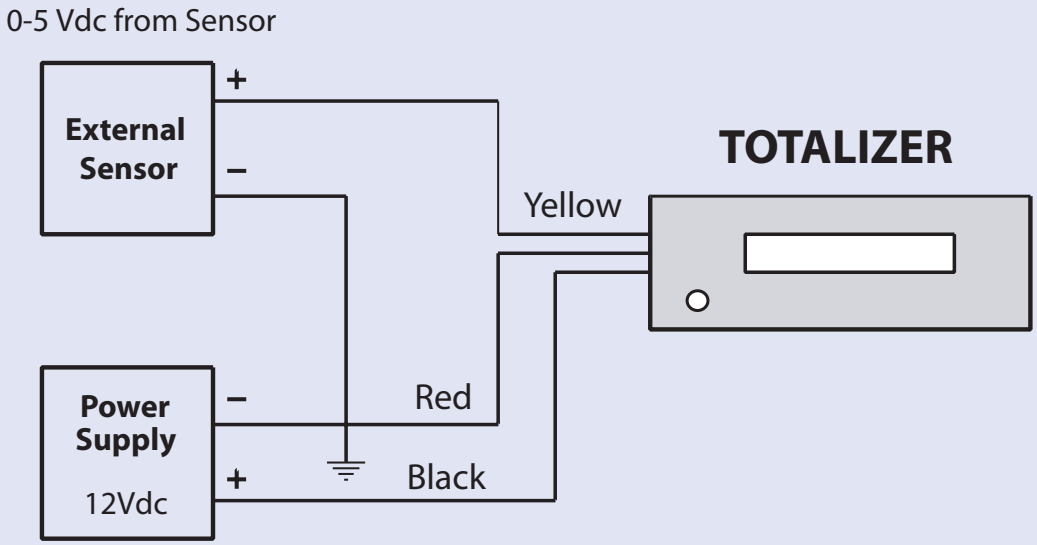
Each totalizer is shipped from the factory with adjustments made for specified flow rates.

The totalizer can be re-scaled for a different flow range or engineering unit.

Design Features

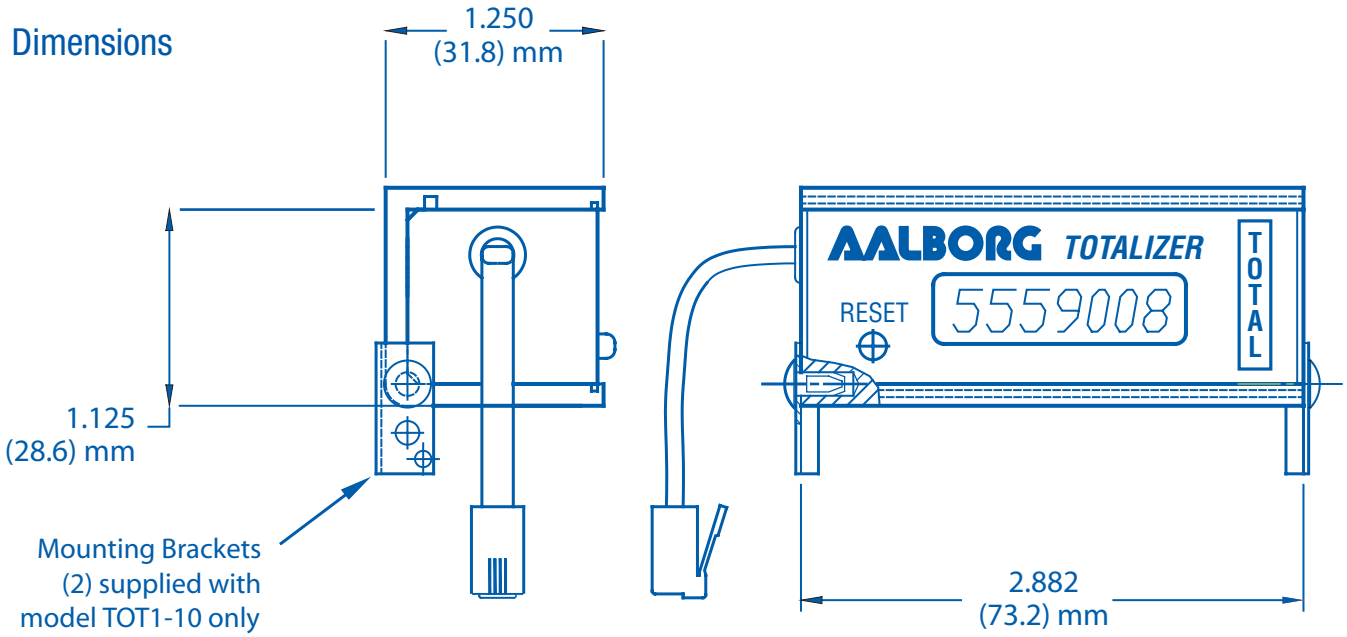
- Used with Mass Flow Meters and Mass Flow Controllers.
- Integrates and accumulates up to seven digits.
- Built-in battery holds reading for up to 20 years.

Cable Connection

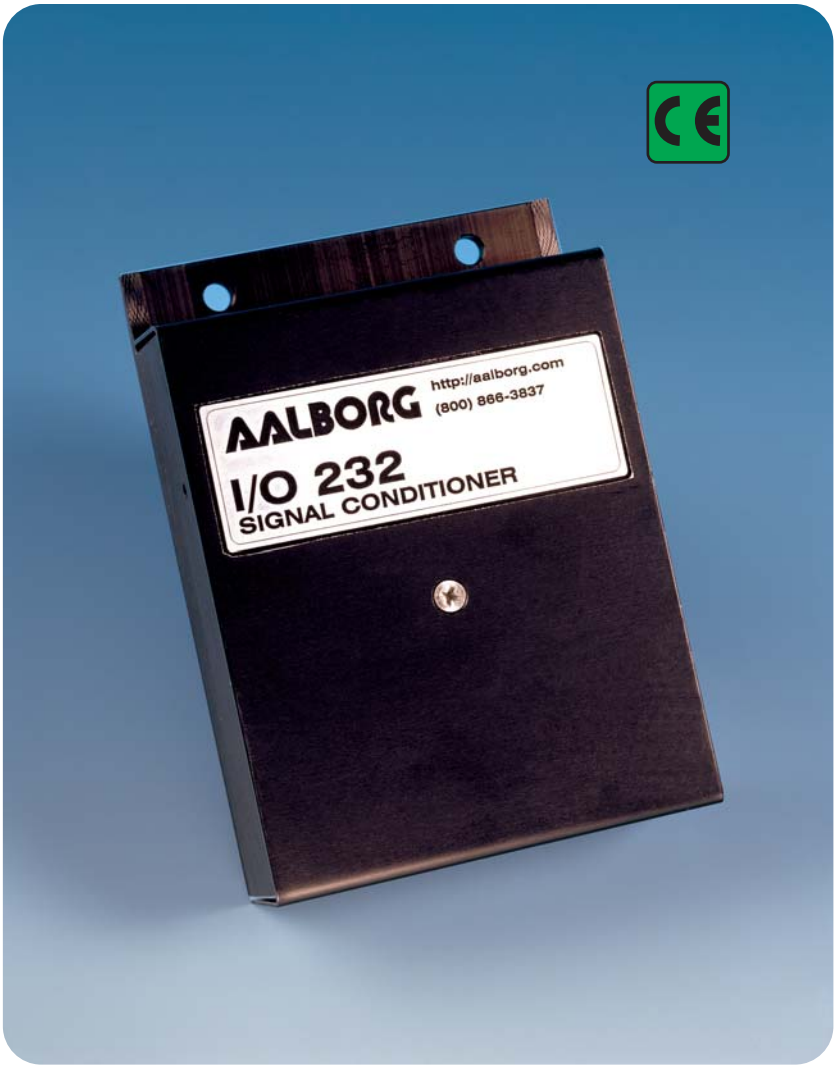


Connection Diagram: Totalizer to other compatible Product

Dimensions



BULLETIN EM200810 TOT



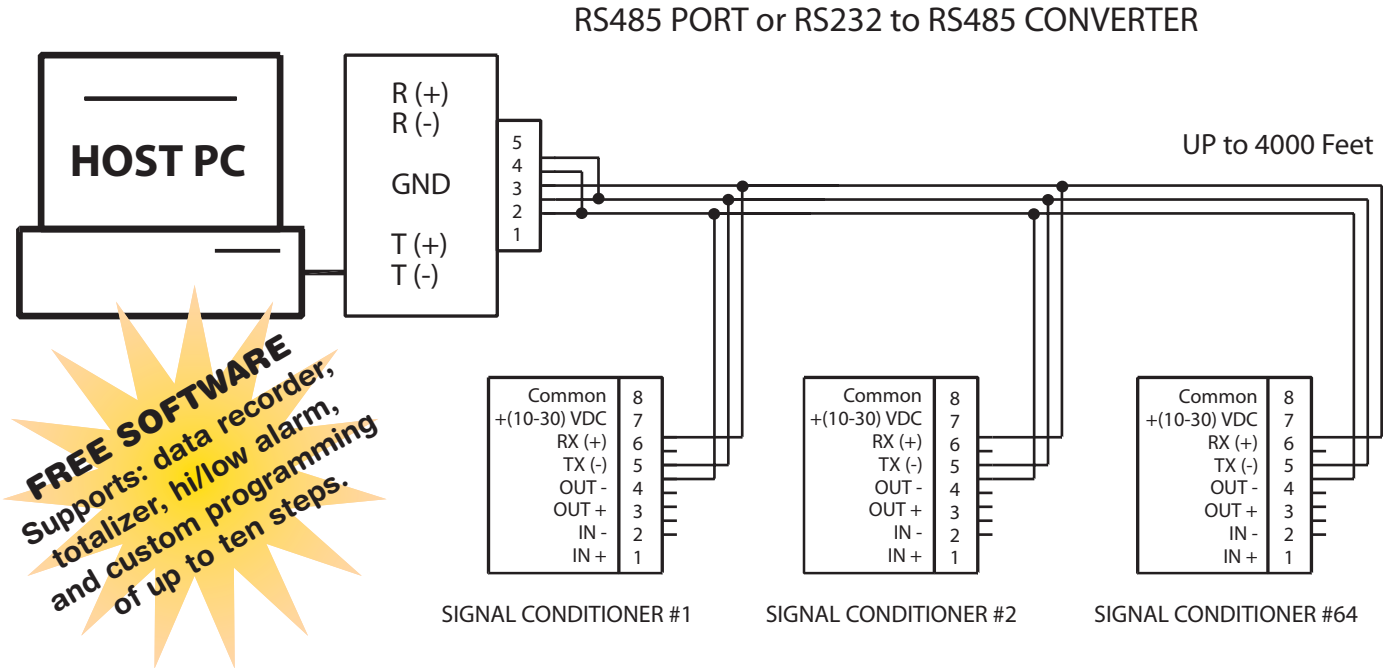
Microprocessor driven Signal Conditioner allows analog voltage levels to be set and read via its RS-232 or RS-485 serial port.

The simple set of commands is included to perform various functions: an analog output, read an analog input, verify communications link, programming communication parameters and ADC/DAC calibration mode.

I/O 232 and I/O 485 units may also be used with other instrumentation with analog outputs.

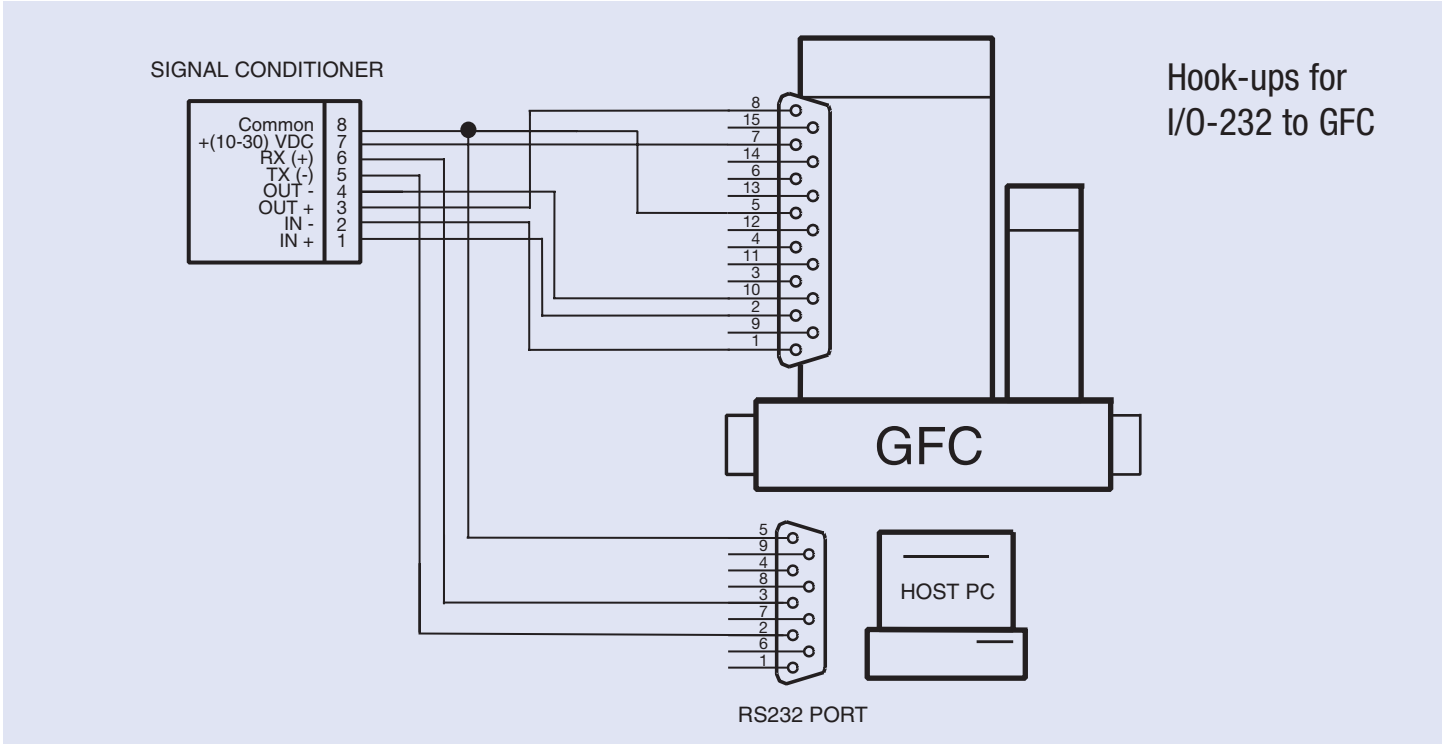
TABLE 17 - ORDERING INFORMATION IO INPUT/OUTPUT	
IO-232-C	Input/output to RS232, 0-5Vdc.
IO-232-E	Input/output to RS232, 4-20mA.
IO-485-C	Input/output to RS485, 0-5Vdc.
IO-485-E	Input/output to RS485, 4-20mA.

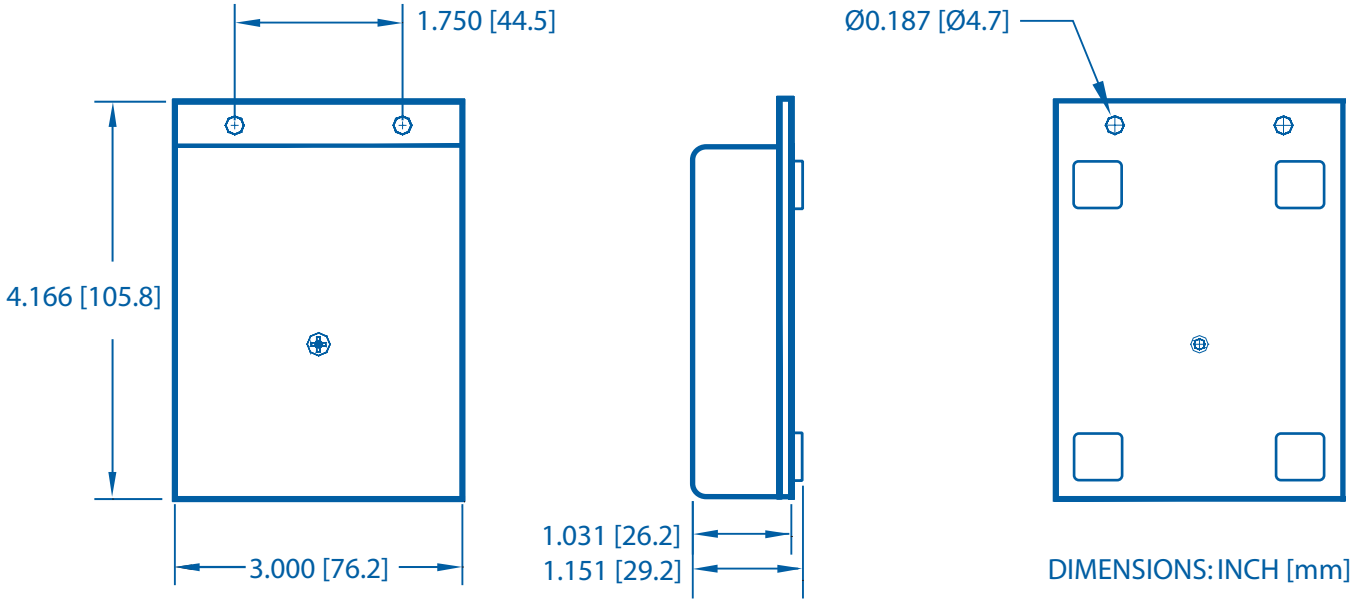
RS-485 Multidrop 2-Wire Half-Duplex System



Design Features

- Selectable input and output analog ranges 0-5Vdc or 4-20mA.
- Multi-Drop Capability of up to 64 units (for RS-485 version).
- User-selectable data transfer rate from 300 to 9600 baud.
- CRC error check ON/OFF.
- DAC/ADC 10 bits (0.1%) resolution.





Design Features

- Digital and Analog modes operate simultaneously.
- Programmable Flow Configurations.
- Multi-Drop Capability of up to 256 units.
- Stores calibration data for up to 10 gases.
- Totalizer indicates total gas quantity.
- Alarm limits for high and low gas flow.
- Conversion factors for up to 256 gases.
- Auto Tune function for optimum control response.
- Self-Diagnostic Tests.

Programmable Mass Flow Controller with Digital Signal Processing

Microprocessor driven **digital** flow controllers allow one to program, record, and analyze flow rates of various gases with a computer via an RS-485 interface

Optional RS-232 is available.

Controllers can be programmed for various control functions including flow set point, totalizer, stop totalizer, read totalizer, totalizer from preset flow, stop at preset total, auto zero, and more.

Principles of Operation

Metered gases are divided into two laminar flow paths, one through the primary flow conduit, and the other through a capillary sensor tube. Both flow conduits are designed to ensure laminar flows and therefore the ratio of their flow rates is constant. Two precision temperature sensing windings on the sensor tube are heated, and when flow takes place, gas carries heat from the upstream to the downstream windings. The resultant temperature differential is proportional to the change in resistance of the sensor windings.

A Wheatstone bridge design is used to monitor the temperature dependent resistance gradient on the sensor windings which is linearly proportional to the instantaneous rate of flow. The output of the Wheatstone bridge is converted to digital format with a 12 Bit ADC (analog to digital converter).

BULLETIN EM200810 DFC

An on-board microprocessor and non-volatile memory store all calibration factors and directly control a proportionating electromagnetic valve. The digital closed loop control system continuously compares the mass flow output with the selected flow rate. Deviations from the set point are corrected by compensating valve adjustments, with PID algorithm thus maintaining the desired flow parameters with a high degree of accuracy. Output signals of 0 to 5Vdc or 4 to 20mA are generated indicating mass molecular based flow rates of the metered gas.

Interface

The **digital interface** operates via RS485 (optional RS232) and provides access to applicable internal data including **FLOW SET POINT, ACTUAL FLOW, ZERO ADJUSTMENTS, and LINEARIZATION TABLE ADJUSTMENTS.**

The analog interface provides 0 to 5Vdc, 0 to 10Vdc and 4 to 20 mA inputs and outputs.

Auto Zero

The DFC automatically nulls the sensor zero offset whenever the flow set point is below 2% of full scale. To accommodate this feature the control valve must fully close under that condition. Provisions are made to either disable, force or store the current auto zero via digital commands.

Totalizer

The firmware for the DFC provides functions to register total gas quantity. The total mass of gas is calculated by integrating the actual gas flow rate with respect to time.

Digital interface commands are provided to:

- SET the totalizer to ZERO.
- START /STOP totalizing the flow.
- READ the totalizer.
- START the totalizer at a preset flow.
- STOP the flow at a preset total.

Multi-Gas Calibration

The DFC is capable of storing primary calibration data for up to 10 gases. This feature allows the same DFC to be calibrated for multiple gases while maintaining the rated accuracy on each.

Optional Display

Conversion Factors

Conversion factors for up to 256 gases are stored in the DFC. Conversion factors may be applied to any of the ten gas calibrations via digital interface commands.

Flow Alarms

High and Low gas flow ALARM limits are programmed using the digital interface. Alarm conditions are reported via the digital interface or can activate the contact closure outputs.

Programmable Flow

Aalborg software supports programmable flow modes, allowing execution of custom programming of up to ten steps. Various flow configurations include ramping, linearized increasing and decreasing modes.

Auto Tune

The AUTO TUNE function allows the DFC to automatically optimize control response for the gas under actual process conditions. During the AUTO TUNE process, the instrument adjusts PID gains for optimum step response and determine key control valve characteristics (only available on units with less than 80 L/min maximum flow).

Contact Closure

Two sets of dry contact relay outputs are provided to actuate user supplied equipment. These are programmable via the digital interface such that the relays can be made to switch when a specified event occurs (e.g. when a low or high flow alarm limit is exceeded or when the totalizer reaches a specified value).

Valve Override

Means are provided to force the control valve fully open (purge) or fully closed via either the analog or digital interfaces.

Self-Diagnostics

Whenever power is first applied, the DFC runs a series of SELF-DIAGNOSTIC TESTS to ensure that it is in optimum working condition.

Engineering Units

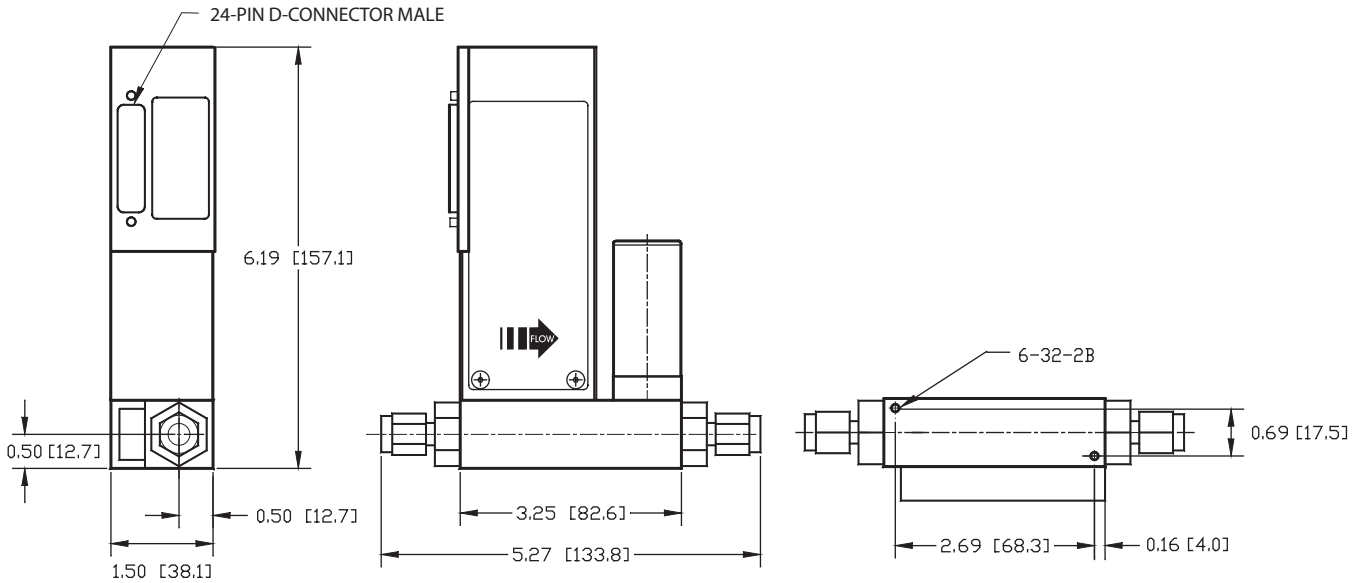
The flow set point, measured gas flow and associated totalizer data is scaled directly in engineering units via digital interface commands.

TABLE 18 - SPECIFICATIONS

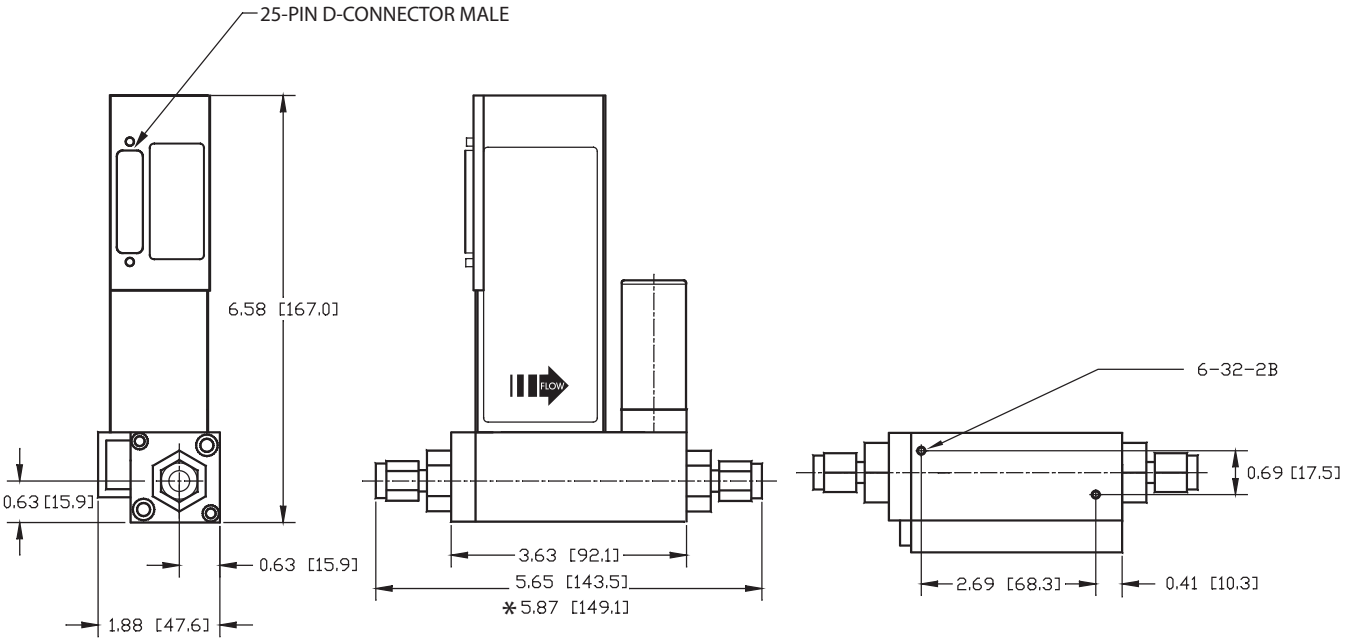
ACCURACY (including linearity):	15 °C to 25 °C and 10 to 60 psia (0.7-4 bars): ±1% of FS, 0 °C to 50 °C and 5 to 150 psia (0.3-10 bars): ±2% of FS, ±1% of FS at a specific temperature and pressure with special calibration.
REPEATABILITY:	±0.15% of full scale.
RESPONSE TIME:	0.6 to 1.0 second to within ±2% of set point over 20% to 100% of full scale.
TEMPERATURE COEFFICIENT:	0.05% of full scale/ °F or better.
PRESSURE COEFFICIENT:	0.01% of full scale /psi (0.07 bar) or better.
OPTIMUM GAS PRESSURE:	25 psig (1.73 bars).
MAXIMUM GAS PRESSURE:	1000 psig (70 bars).
MAXIMUM DIFFERENTIAL PRESSURE:	50 psig (3.4 bars) for DFC26 and DFC36 40 psig (2.8 bars) for DFC46
MAX PRESSURE DROP:	Refer to Table 20.
GAS and AMBIENT TEMP:	41 °F to 122 °F (5 °C to 50 °C)
COMMUNICATION INTERFACE:	RS485 - Standard. RS232 - Optional.
OUTPUT SIGNALS:	Linear 0-5 Vdc (2000 ohms min load impedance); impedance); 0-10Vdc (4000 ohms min impedance); 4-20 mA optional (0-500 ohms\ loop resistance). Maximum noise 20mV peak to peak.
CIRCUIT PROTECTION:	Circuit boards have built-in polarity reversal protection. Resettable fuses provide power input protection.
****MATERIALS IN FLUID CONTACT:**	316 stainless steel, 416 stainless steel, Viton® O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
ATTITUDE SENSITIVITY:	No greater than +15 degree rotation from horizontal to vertical; standard calibration is in horizontal position.
CONNECTIONS:	Model DFC26 standard 1/4" compression fittings, Model DFC36 standard 1/4" compression fittings, Model DFC46: standard 3/8" compression fittings, Optional 1/8" or 3/8" compression fittings and 1/4" VCR® fittings available.
LEAK INTEGRITY:	1 x 10^{-9} smL/sec of helium maximum to the outside environment.
TRANSDUCER INPUT POWER:	±15Vdc, 450 mA maximum.
CALIBRATION OPTIONS:	Standard 10 point NIST traceable calibration. Optional up to 9 additional 10 point calibrations may be ordered for an additional charge.
CE COMPLIANCE:	EN 55011 class 1, class B; EN50082-1.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

DFC26 Mass Flow Controller



DFC36 / 46 Mass Flow Controller



* FOR HIGH FLOW MASS FLOW CONTROLLERS

TABLE 19 - FLOW RANGES FOR DFC	
DFC 26 LOW FLOW CONTROLLERS	
CODE	**Units [Nitrogen]**
01	0 to 10 smL/min
02	0 to 20 smL/min
03	0 to 50 smL/min
04	0 to 100 smL/min
05	0 to 200 smL/min
06	0 to 500 smL/min
07	0 to 1 sL/min
08	0 to 2 sL/min
09	0 to 5 sL/min
10	0 to 10 sL/min
DFC 36 MEDIUM FLOW CONTROLLERS	
CODE	**sL/min [N_2]**
11	0 to 15 sL/min
30	0 to 20 sL/min
31	0 to 30 sL/min
32	0 to 40 sL/min
33	0 to 50 sL/min
DFC 46 HIGH MASS FLOW CONTROLLERS	
CODE	**sL/min [N_2]**
40	0 to 60 sL/min
41	0 to 80 sL/min
42	0 to 100 sL/min

The following units of measure are supported:% of FS, mL/min, mL/hr, scfm, scfh, sL/min, sL/hr, lbs/hr, lbs/min, and one user defined unit of measure.

Leak Integrity

1 x 10^{-9} smL/sec of Helium maximum to the outside environment.

Balanced Power Supply

The DFC operates on ±15Vdc. The current requirements for the positive and negative power supplies are balanced such that the current in the power supply common connection is minimized. Maximum power consumption is 13.5 watts at ±15Vdc.

TABLE 21 - MAXIMUM PRESSURE DROP FOR DFC

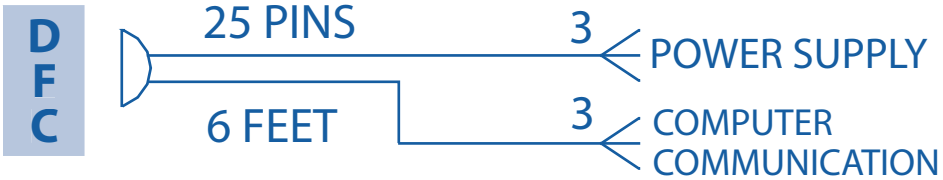
MODEL NO.	MAX. FLOW (N_2)	MAXIMUM PRESSURE DROP		
		[mm H_2O]	[psid]	[mbar]
DFC 26	up to 10	720	1.06	75
DFC 36	15	2630	3.87	266
	20	1360	2.00	138
	30	2380	3.50	241
	40	3740	5.50	379
	50	5440	8.00	551
DFC 46	60	7480	11.00	758
	100	12850	18.89	1302

TABLE 20 - ACCESSORIES AND READOUTS FOR DFC

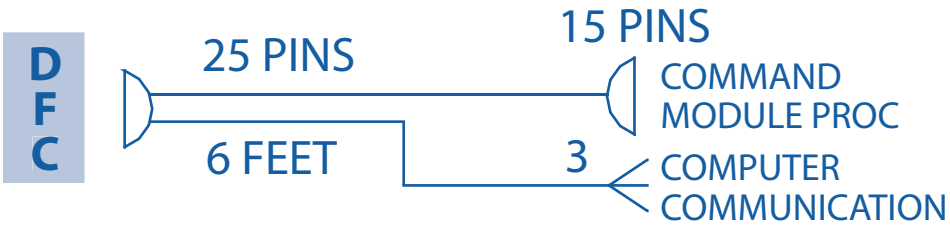
CBL-DFC	25 pin D-connector with 6 ft. wire to computer port stripped, Branch 6ft. wire to customers power supply.
CBL-DFC-DPM-AIO	Cable stripped for DFC with LCD jack and analog input/output.
CBLDFC-PROC	25 pin D-connector with 6ft. wire to 15 pin DM, Branch 6ft. wire to computer port stripped.
PS-DFC-110NA-5-S	Power supply with 25 pin female D-connector 110/vac (±15Vdc.) Branch 6ft wire to computer port stripped /North America.
PS-DFC-110NA-5-A	Power supply with 25 pin D-connector, analog interface 110/vac (+ - 15Vdc.) (North America).
PS-DFC-230EU-5-S	Power supply with 25 pin female D-connector 230/vac (±15Vdc.) Branch 6ft wire to computer port stripped /Europe.
PS-DFC-240UK-5-S	Power supply with 25 pin female D-connector 240/vac (±15Vdc.) Branch 6ft wire to computer port stripped /United Kingdom.
PS-DFC-240AU-5-S	Power supply with 25 pin female D-connector 240/vac (±15Vdc.) Branch 6ft wire to computer port stripped /Australia.
BCKUPEG-DFC	Digital panel meter / led backlight.
PS-DFC-110NA-5-S-D	Power supply DFC 110/Vac +/-15Vdc standard interface and LCD jack. (United States).
PS-DFC-110NA-5-A-D	Power supply DFC 110/Vac +/-15Vdc analog interface and LCD jack. (United States).

Cable Options

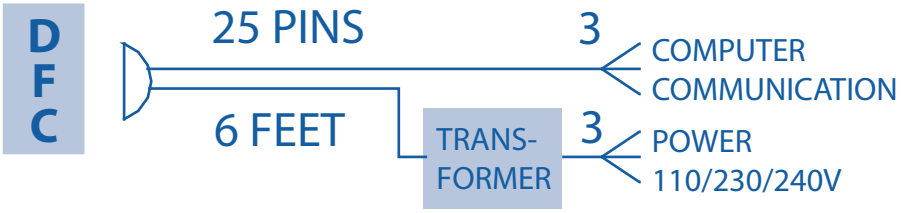
Standard Cable (supplied with Transducer) CBL-DFC



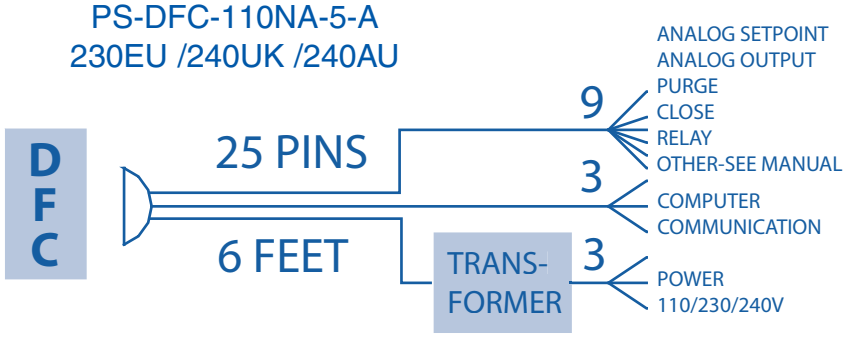
CBL-DFC-SDPROC



PS-DFC-110NA-5-S 230EU /240UK /240AU



PS-DFC-110NA-5-A
230EU /240UK /240AU



DFC

DFC	MODEL

MAX. FLOW (N_2)	
26	10 L/min
36	50 L/min
46	100 L/min

MATERIAL	
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE / Kalrez®

FITTINGS	
A	1/4" Compression
B	1/8" Compression
C	1/4" VCR®
D	3/8" Compression

CONNECTOR	
D	D Connector

DISPLAY	
N	No Display
L	LCD Readout

POWER	
5	±15 Vdc

INPUT / OUTPUT SIGNAL	
C	0-5Vdc/ 0-5Vdc
D	0-5Vdc/ 4-20mA
E	4-20mA/ 4-20mA
F	4-20mA/ 0-5Vdc

DIGITAL INTERFACE	
2	RS232
5	RS485

DFC	36	S	–	V	A	D	N	5	–	C	5

EXAMPLE: DFC36S-VADN5-C5 50L/min [N_2] 20 psig

***SPECIFY**: GAS, FLOW RANGE and PRESSURE.*

DFC36 stainless steel, Viton® seals, 1/4" compression fittings, D Connector, No display, ±15 Vdc power, 0-5 Vdc/0-5 Vdc input output signal, RS485 digital interface.

BULLETIN EM20810 DFC

Multi Parameter flow meters provide accurate data on three different fluid parameters:

- **flow**
- **pressure**
- **temperature**

The flow rate can be displayed in volumetric flow or mass flow engineering units for standard or actual (temperature, pressure) conditions. Flow meters can be programmed locally by the four button keypad and LCD or remotely via RS-232/RS-485 interface.

DFM flow meters support various functions including: flow totalizer, flow, temperature, pressure alarms, automatic zero adjustment, 2 relay outputs, 0-5 Vdc / 0-10 Vdc / 4-20 mA analog outputs for flow, pressure and temperature.

DFM's are offered either as Digital Mass Flow Meters, Model Numbers: DFM26, 36, & 46 or as a Digital Multi-Parameter Meters, Model Numbers, DFM27, 37 & 47. Model Numbers are displayed in Table 24.

THERE ARE 3 VOLTAGE (POWER) OPTIONS:
+/-15Vdc, 12Vdc, & 24Vdc.

Interface

All features of the flow meter can be accessed via the local four button keypad and LCD. The digital interface operates via RS485 (optional RS-232 is available) and provides access to applicable internal data including: flow, temperature, pressure reading, auto zero, totalizer and alarms settings, gas table, conversion factors and engineering units selection, dynamic response compensation and linearization table adjustment. The analog interface provides 0 to 5Vdc or 0 to 10Vdc or 4 to 20 mA outputs for flow, pressure and temperature (jumper selectable).

Auto Zero

The DFM supports automatic sensor zero offset adjustment which can be activated locally via the keypad or remotely via digital interface. The auto zero feature requires absolutely no flow through the meter during auto zero process. Provisions are made to either start, read, or save the current auto zero value via digital commands.

Totalizer

The total volume of the gas is calculated by integrating the actual gas flow rate with respect to time. Both keypad menu and digital interface commands are provided to:

- set the totalizer to ZERO.
- start the totalizer at a preset flow.
- assign action at a preset total volume.
- start/stop totalizing the flow.
- read totalizer.

Totalizer conditions become true, when the totalizer reading and the “Stop at Total” volumes are equal.

Flow Alarm

High and Low gas flow ALARM limits can be preprogrammed via keypad or remotely via digital interface. ALARM conditions become true when the current flow reading is equal or higher/lower than corresponding values of high and low alarm levels. Alarm action can be assigned with preset delay interval (0-3600 seconds) to activate the contact closer (separate for High and Low alarm).

Pressure Alarm

High and Low gas pressure ALARM limits can be preprogrammed via the keypad or remotely via digital interface. Pressure alarm conditions become true when the current pressure reading is equal or higher than corresponding values of high pressure alarm settings or equal or lower than corresponding values of low pressure alarm settings. Alarm action can be assigned to activate the contact closer (separate for High and Low pressure alarm).

Temperature Alarm

High and Low gas temperature ALARM limits can be preprogrammed via the keypad or remotely via digital interface. Temperature alarm conditions become true when the current temperature reading is equal or higher than corresponding values of high temperature alarm settings or equal or lower than corresponding values of low temperature alarm settings. Alarm action can be assigned to activate the contact closer (separate for High and Low temperature alarm).

TABLE 22 -SPECIFICATIONS	
MODELS 27, 37, 47: Flow accuracy with temp/press hardware (including linearity):	±1% of FS for 32 °F to 122 °F (0 °C to 50 °C) and 0.35 to 5 to 100 psia (6.8 bars).
MODELS 26, 36, 46: Flow accuracy w/o temp/press hardware (including linearity):	±1.0% of full scale, including non-linearity, at calibration temperature and pressure.
PRESSURE RANGE (MEASUREMENT):	5 to 100 psia (0.34 to 6.8 bars).
PRESSURE ACCURACY:	±1% of FS.
TEMPERATURE RANGE (MEASUREMENT):	32 °F to 122 °F (0 °C to 50 °C).
TEMPERATURE ACCURACY:	±1 °C.
REPEATABILITY:	±0.15% of full scale.
RESPONSE TIME:	0.6 to 1.0 second to within ±2% of set point over 20% to 100% of full scale.
TEMPERATURE COEFFICIENT:	0.15% / °C or better.
PRESSURE COEFFICIENT:	0.01% of full scale/ 1 psi (0.07 bar) or better.
OPTIONAL GAS PRESSURE:	25 psig (1.73 bars).
MAXIMUM GAS PRESSURE:	100 psia (6.8 bars).
MAXIMUM BURST PRESSURE:	200 psia (13.6 bars).
MAXIMUM PRESSURE DROP:	8 psi (0.55 bars) at 100 L/min flow.
GAS and AMBIENT TEMP:	41 °F to 122 °F (5 °C to 50 °C).
OUTPUT SIGNALS:	Linear 0-5 Vdc (3000 ohms min load impedance); 0-10Vdc (6000 ohms min impedance); 4-20 mA optional (500 ohms max loop resistance). Maximum noise 20mV peak to peak.
INPUT POWER:	May be configured for three different options: ±15Vdc (±200 mA maximum); +12Vdc (300 mA maximum); +24Vdc (250 mA maximum); Circuit boards have built-in polarity reversal protection. Resettable fuses provide power input protection.
****MATERIALS IN FLUID CONTACT:**	316 stainless steel, Viton® O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
CONNECTIONS:	**Model DFM26:** Standard 1/4" compression fittings. **Model DFM36:** Standard 1/4" compression fittings. **Model DFM46:** Standard 3/8" compression fittings. Optional 1/8" or 3/8" compression fittings and 1/4" VCR® fittings are available.
DISPLAY:	128 x 64 graphic LCD with backlight (up to 8 lines of text).
CALIBRATION OPTIONS:	Standard one 10 points NIST traceable calibration. Optional up to 9 additional calibrations may be ordered for an additional charge.
CE COMPLIANCE:	EN 55011 class 1, class B; EN50082-1.
ENVIRONMENTAL (PER IEC 664):	Installation Level II; Pollution Degree II.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

Engineering Units

The measured gas flow and associated totalizer data are scaled directly in engineering units via the front panel keypad or digital interface.

The following units of measure are supported:

%F.S., L/min, L/h, mL/min, mL/h, scuft/h, scuft/min, lb/h, lb/min, one user defined engineering unit.

Multi-Gas Calibration

The DFM is capable of storing primary calibration data for up to 10 gases. This feature allows the same DFM to be calibrated for multiple gases while maintaining the rated accuracy on each.

Conversion Factors

Conversion factors for up to 32 gases are stored in the DFM. In addition provision is made for a user defined conversion factor. Conversion factors may be applied to any of the ten gas calibrations via keypad or digital interface commands.

Contact Closure

Two sets of dry contact relay outputs are provided to actuate user supplied equipment. These are programmable via the local keypad or digital interface such that the relays can be made to switch when a specified event occurs (e.g. when a low or high flow, pressure or temperature alarm limit is exceeded or when the totalizer reaches a specified value).

TABLE 23 - FLOW RANGES FOR DFM

DFM 26 / 27 LOW FLOW MASS METERS	
CODE	**smL/min [N_2]**
01	0 to 10
02	0 to 20
03	0 to 50
04	0 to 100
05	0 to 200
06	0 to 500
CODE	**sL/min [N_2]**
07	0 to 1
08	0 to 2
09	0 to 5
10	0 to 10
DFM 36 / 37 MEDIUM FLOW MASS FLOW METERS	
CODE	**sL/min [N_2]**
11	0 to 15
30	20
31	30
32	40
33	50
DFM 46 / 47 HIGH FLOW MASS FLOW METERS	
CODE	**sL/min [N_2]**
40	60
41	80
42	100

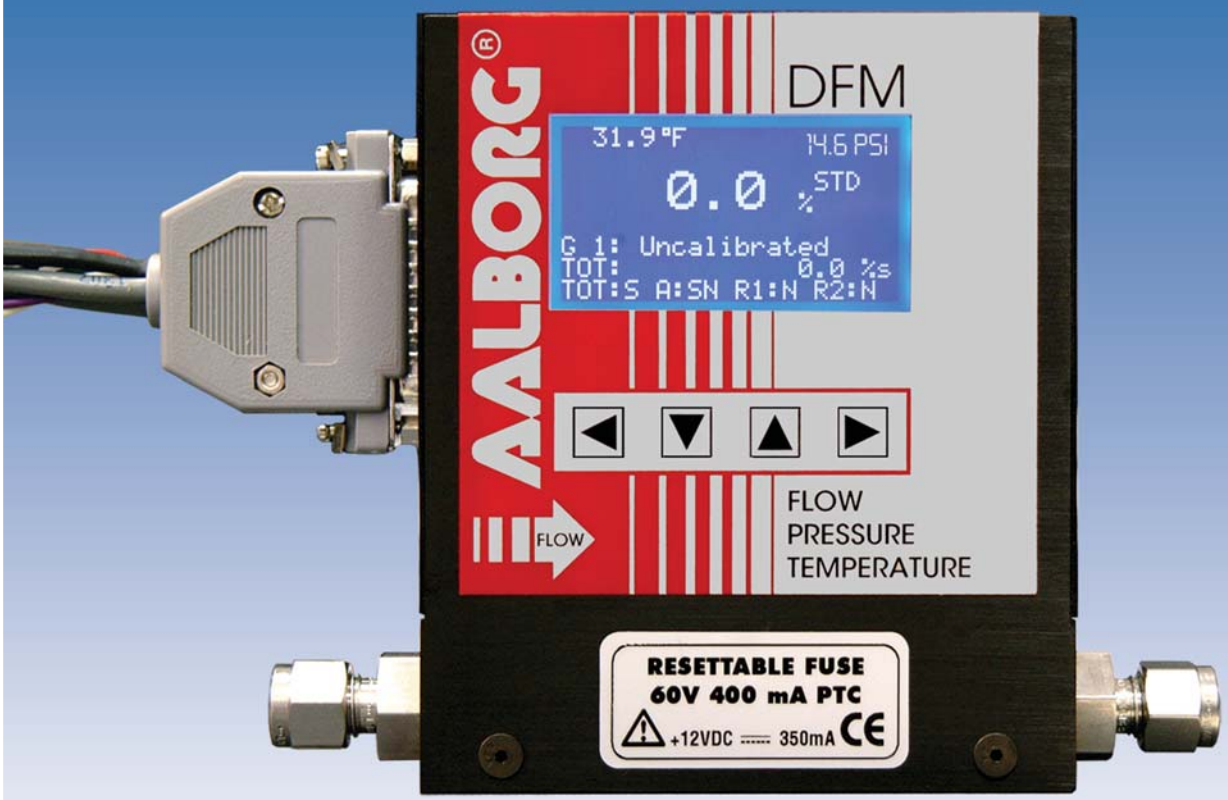
Leak Integrity

1 x 10^{-9} smL/sec of Helium maximum to the outside environment.

TABLE 24 - PRESSURE DROP FOR DFM

MODEL	FLOW RATE [std liters/min]	MAXIMUM PRESSURE DROP FOR DFM		
		[mm H_2O]	[psid]	[kPa]
DFM 26 /27	up to 10	25	0.04	0.276
DFM 36 /37	20	300	0.44	3.03
	30	800	1.18	8.14
	40	1480	2.18	15.03
	50	2200	3.23	22.3
DFM 46 /47	60	3100	4.56	31.4
	100	5500	8.08	55.7

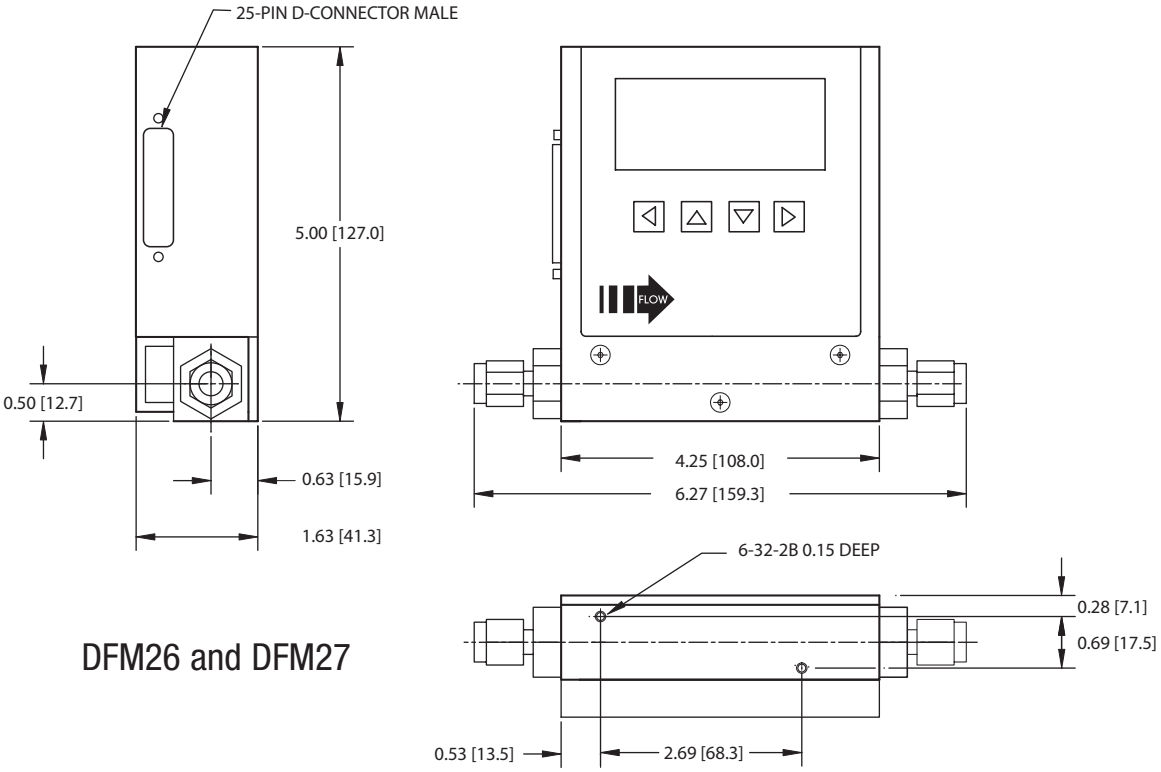
Multi Parameter Mass Flow Meter with Digital Signal Processing



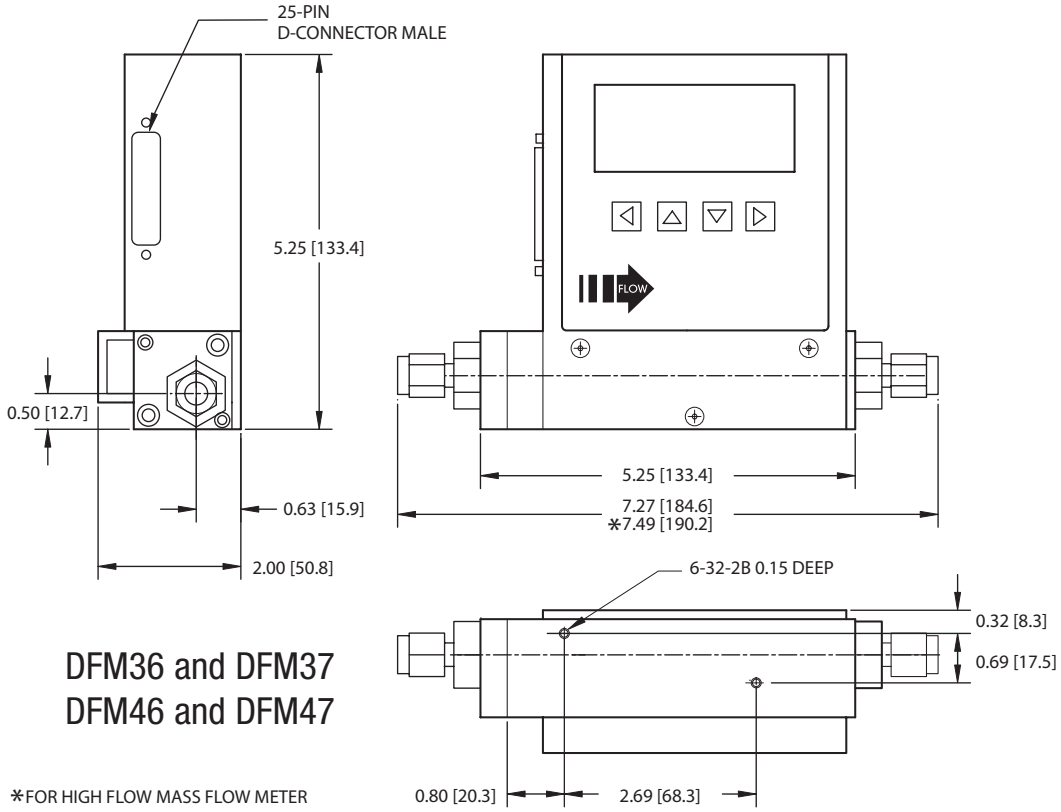
Design Features

- Multi-Drop Capability of up to 255 units (for RS-485 option).
- Stores calibration data for up to 10 different gases.
- Supports 10 different engineering units including user defined.
- Programmable 12 digits Totalizer indicates total gas volume.
- Flow Alarm limits for high and low gas flow with relay output.
- Pressure Alarm limits for high and low gas pressure with relay output.
- Temperature Alarm limits for high & low gas temp. with relay output.
- Four button keypad and large 128x64 graphical LCD with back light.
- Digital (RS-232 or RS-485) and Analog outputs operate simultaneously.
- Internal Conversion factors for up to 32 gases.
- Automatic Zero Adjustment.
- Self-Diagnostic Tests.

BULLETIN EM20810 DFM



DFM26 and DFM27



DFM36 and DFM37
DFM46 and DFM47

*FOR HIGH FLOW MASS FLOW METER

ORDERING INFORMATION MULTI PARAMETER DIGITAL MASS FLOW METERS

DFM

DFM	MODEL

SERIES	MAX FLOW (N_2)
26	10 L/min
36	50 L/min
46	100 L/min
27	10 L/min
37	50 L/min
47	100 L/min

MATERIAL	
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE / Kalrez®

FITTINGS		FOR MODEL
A	1/4" Compression	26, 27, 36, 37
B	1/8" Compression	26 & 27
C	1/4" VCR®	26, 27, 36, 37
D	3/8" Compression	36, 37, 46, 47
X	Special	

CONNECTOR	
D	D Connector

DISPLAY	
L	LCD readout

POWER	
2	12 Vdc
4	24 Vdc
5	±15 Vdc

INPUT OUTPUT SIGNAL	
A	n.a. 0-5 Vdc
B	n.a. 2-20 mA

TEMP & PRESSURE OUTPUT SIGNAL (A only 26, 36, 46)

CODE	TEMP OUT	PRESSURE OUT
A	n.a.	n.a.
B	0-5Vdc	0-5Vdc
C	0-5Vdc	4-20mA
D	0-5Vdc	0-10Vdc
E	4-20mA	0-5Vdc
F	4-20mA	4-20mA
G	4-20mA	0-10Vdc
H	0-10Vdc	0-5Vdc
I	0-10Vdc	4-20mA
J	0-10Vdc	0-10Vdc

**DIGITAL INTERFACE	
2	RS232
5	RS485

***RS485** is standard. No cost optional **RS232** is selected by changing the last digit of part number from 5 to 2.*

LABELS	
A	Aalborg

DFM	36	S	–	V	A	D	L	5	–	A	A	5	A

EXAMPLE: DFM36S-VADL5-AA5A 50 L/min [N_2] *n.a. = not applicable.

***SPECIFY**: GAS, FLOW RANGE and PRESSURE*

DFM36 stainless steel, Viton® seals, 1/4" compression fittings, D connector, LCD readout display, ±15 Vdc power, 0-5Vdc output signal, RS485 digital interface, Aalborg label.

BULLETIN EM20810 DFM

AFC AFM

Model **AF** mass flow meters and controllers are designed to indicate flow rates and control set flow rates of gases.

Each of these units incorporates an advanced straight tube sensor in conjunction with flow passage elements constructed of stainless steel.

LED readouts of command modules are supplied with 0 to 100 percent calibrations. Zero and span adjustments are conveniently accessible from outside of the transmitters.

Design Features

- Rigid metallic construction.
- Maximum pressure of 1000 psig (70 bars).
- 0-5 Vdc or 4-20mA signals.
- Leak integrity 1 x 10^{-9} smL/sec of helium.
- Accuracy of ±1% F.S.
- Totalizer option.
- Circuit protection.

Principles of Operation

Metered gases are divided into two laminar flow paths - one through the primary flow conduit and the other through a capillary sensor tube.

Both flow conduits are designed to ensure laminar flows and therefore the ratio of their flow rates is constant.

Two precision temperature sensing windings on the sensor tube are heated, and when flow takes place, gas carries heat from the upstream to the downstream windings. The resultant temperature differential is proportional to the change in resistance of the sensor windings.

A Wheatstone bridge design is used to monitor the temperature dependent resistance gradient on the sensor windings which is linearly proportional to the instantaneous rate of flow.

Output signals of 0 to 5Vdc or 4 to 20mA are generated indicating mass molecular based flow rates of the metered gas.

SDPROC and AFC Analog Mass Flow Controller

AFC AFM

In AFC mass flow controllers the combined gas streams flow through a proportionating electromagnetic valve with an appropriately selected orifice. The closed loop control circuit continuously monitors the mass flow output and maintains it at the set flow rate.

Flow rates are unaffected by temperature and pressure variations within stated limitations.

Transducer power supply ports are fuse and polarity protected.

AFC mass flow controllers include an electromagnetic control valve that allows the flow to be set to any desired flow rate within the range of the particular model. The valve is normally closed as a safety feature to ensure that gas flow is shut off in case of a power outage.

AF mass flow meters and controllers are designed to meter and control flow rates of gases.

AF mass flow meters and controllers are available with flow ranges from 10 mL/min to 100LPM [N2]. Gases are connected by means of 1/4", 3/8", or optional 1/8" compression fittings.

These controllers may be used as bench top units or mounted by means of screws in the base.

TABLE 25 - SPECIFICATIONS

ACCURACY:	±1% of full scale, including linearity for gas temperatures ranging from 59 °F to 77 °F (15 °C to 25 °C) and pressures of 10 to 60 psia (0.7 to 4.1 bars); ±2% of full scale including linearity ranging from 41 °F to 122 °F (5 °C to 50 °C) and pressures of 5 to 150 psia (0.35 to 10.3 bars).
REPEATABILITY:	±0.2% of full scale.
TIME CONSTANT:	**AFM SERIES** - 300 ms. **AFC26** (Qmax = 10 sL/min): 300 ms. **AFC36** (Qmax = 50 sL/min): 600 ms. **AFC46** (Qmax = 100 sL/min): 600 ms.
RESPONSE TIME:	**AFM SERIES:** Approximately 1 second to within ±2% of set flow rate for 25% to 100% of full scale flow. **AFC26** (Qmax = 10 sL/min): Approximately 1 second to within ±2% of set flow rate for 25% to 100% of full scale flow. **AFC36** (Qmax = 50 sL/min) and **AFC46** (Qmax=100 sL/min): Approximately 2 second to within ±2% of set flow rate for 25% to 100% of full scale flow.
TEMPERATURE COEFFICIENT:	0.1% of full scale/ °C.
PRESSURE COEFFICIENT:	0.01% of full scale/psi (0.07 bar).
OPTIMUM GAS PRESSURE:	25 psig (1.73 bars).
MAXIMUM GAS PRESSURE:	1000 psig (70 bars) maximum. Standard calibration is at 20 psig (1.4 bars) inlet pressure.
MAX. PRESSURE DROP: [cm H_2O] (at full scale flow)	Refer to Table 27.
GAS AND AMBIENT TEMPERATURE:	41 °F to 122 °F (5 °C to 50 °C).
LEAK INTEGRITY:	1 x 10^{-9} smL/sec of helium maximum, to the outside environment.
****MATERIALS IN FLUID CONTACT:**	316 stainless steel, 416 stainless steel, Viton® O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
ATTITUDE SENSITIVITY:	No greater than ±15 degree rotation from horizontal to vertical; standard calibration is in horizontal position.
OUTPUT SIGNALS:	Linear 0-5 Vdc (2000 W min. load impedance); 4 - 20 mA optional (0 - 500 Ω loop resistance); maximum noise 20 mV peak to peak.
CONNECTIONS:	**AFM /AFC26, AFM /AFC36:** 1/4" compression fittings. **AFM /AFC46:** 3/8" compression fittings. **Optional:** 1/8" or 3/8" compression fittings or 1/4" VCR® fittings.
TRANSDUCER INPUT POWER:	**AFM /AFC26:** +15 ±5% Vdc, 80 mA max, 1.2W; -15 ± 5% Vdc, 200 mA max, 3W; **AFC36 /AFC46:** +15 ±5% Vdc, 220 mA max, 3.3W; -15 ±5% Vdc, 600 mA max, 9W.
CIRCUIT PROTECTION:	Circuit boards have built-in polarity reversal protection. Replaceable fuses provide power input protection.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

Leak Integrity

1 x 10^{-9} smL/sec of helium max to outside environment.

Mass Flow Systems

Complete Mass Flow Systems include Command Modules, transducers and cables. Command modules contain appropriate power supplies, 24x2 alpha-numeric dot matrix display read-out, and four panel buttons which provide complete control over all the various functions necessary to measure and/or control flow.

Optional built in Ethernet interface allows accessing any Internet-connected SDPROC from a browser on your work station, PC, or laptop computer.

TABLE 27 - FLOW RANGES FOR AFC / AFM

AFC 26 / AFM 26	
CODE	**UNITS [NITROGEN]**
01	0 to 10 smL/min
02	0 to 20 smL/min
03	0 to 50 smL/min
04	0 to 100 smL/min
05	0 to 200 smL/min
06	0 to 500 smL/min
07	0 to 1 sL/min
08	0 to 2 sL/min
09	0 to 5 sL/min
10	0 to 10 sL/min
AFC 36 / AFM36	
11	0 to 15 sL/min
30	0 to 20 sL/min
31	0 to 30 sL/min
32	0 to 40 sL/min
33	0 to 50 sL/min
AFC 46 / AFM46	
40	0 to 60 sL/min
41	0 to 80 sL/min
42	0 to 100 sL/min

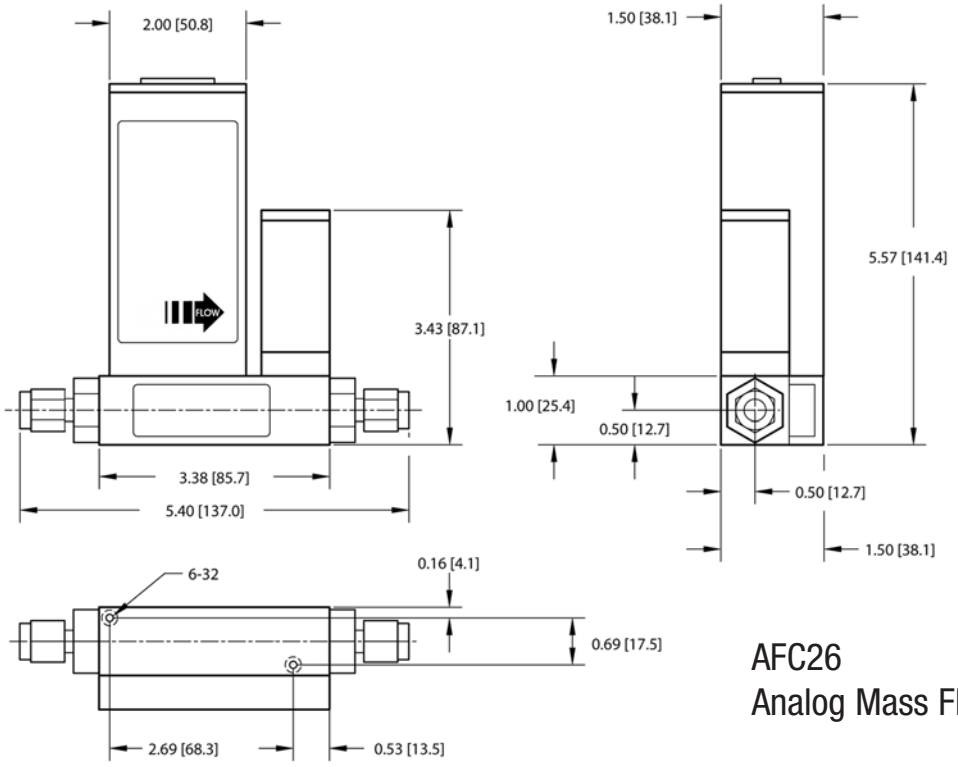
TABLE 26 - MAXIMUM PRESSURE DROP FOR AFC / AFM

FLOW RATE [std liters/min]	AFC SERIES		AFM SERIES	
	[psid]	[bars]	[psid]	[bars]
up to 10	1.06	0.072	0.04	0.003
up to 15	3.87	0.26	0.09	0.006
up to 20	2.0	0.136	0.44	0.030
up to 30	3.5	0.238	1.18	0.080
up to 40	5.5	0.374	2.18	0.148
up to 50	8	0.544	3.23	0.220
up to 100	18.9	1.302	8.08	0.557

NIST Traceable Calibration

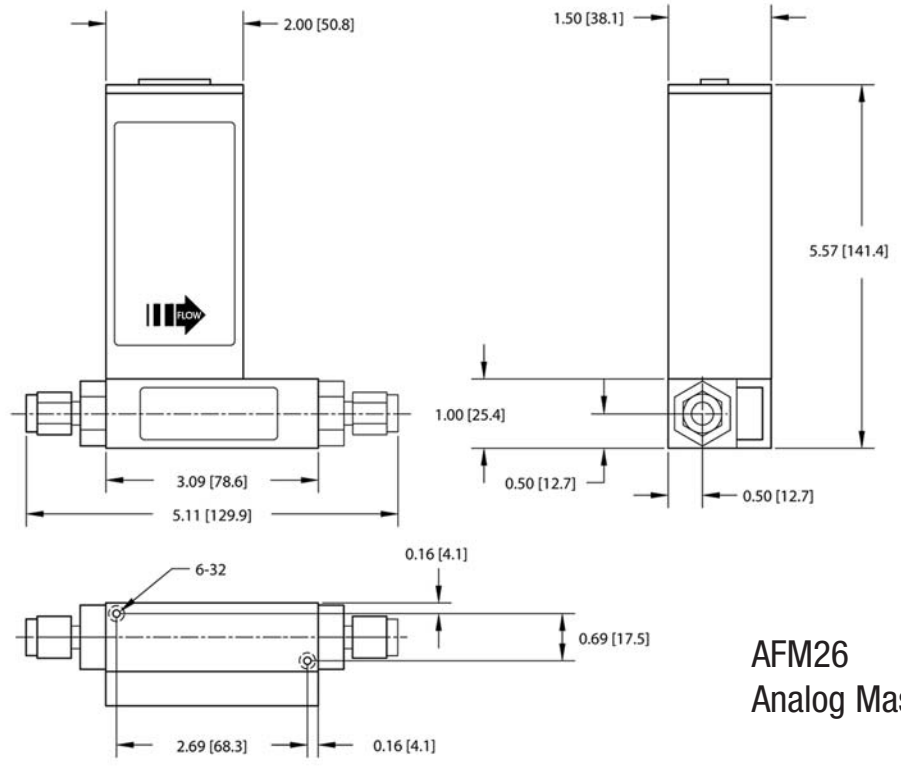
AFC Analog Mass Flow Controller

CE



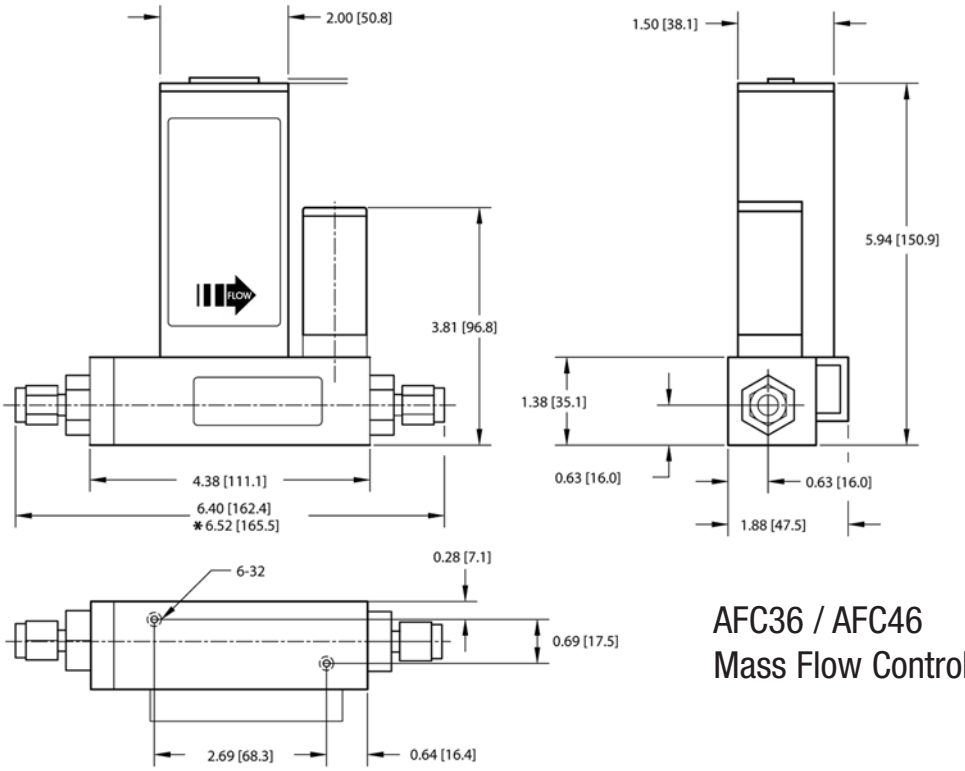
DIMENSIONS: INCH [mm]

AFC26
Analog Mass Flow Controller



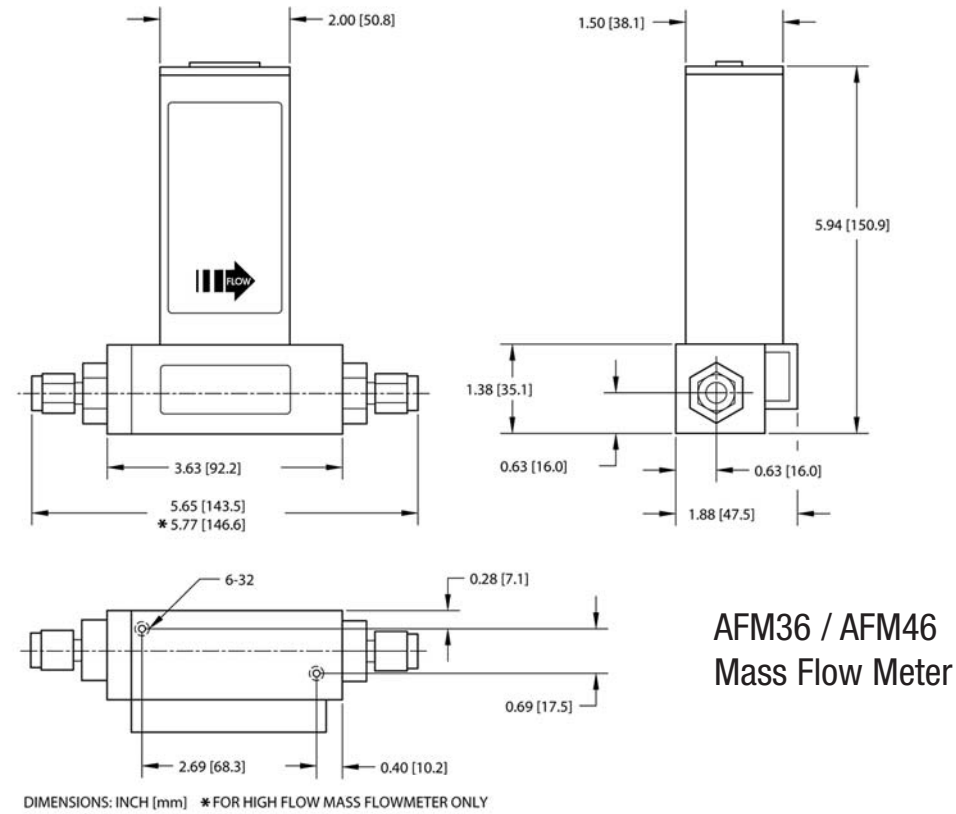
DIMENSIONS: INCH [mm]

AFM26
Analog Mass Flow Meter



DIMENSIONS: INCH [mm] *FOR HIGH FLOW MASS FLOW CONTROLLER ONLY

AFC36 / AFC46
Mass Flow Controller



DIMENSIONS: INCH [mm] *FOR HIGH FLOW MASS FLOWMETER ONLY

AFM36 / AFM46
Mass Flow Meter

MODEL	
AFC	
AFM	

SERIES	MAX. FLOW (N_2)
26	10 L/min
36	50 L/min
46	100 L/min

MATERIAL	
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE / Kalrez®

FITTINGS	
A	1/4" Compression
B	1/8" Compression
C	1/4" VCR®
D	3/8" Compression

CONNECTOR	
D	D Connector

DISPLAY	
N	No Display

POWER	
5	±15 Vdc

INPUT / OUTPUT SIGNAL **AFM** ONLY	
A	*n.a. / 0-5 Vdc
B	*n.a. / 4-20mA
INPUT / OUTPUT SIGNAL **AFC** ONLY	
C	0-5Vdc / 0-5Vdc
D	0-5Vdc / 4-20mA

DIGITAL INTERFACE	
0	NONE

AFM	36	S	–	V	A	D	N	5	–	A	0

EXAMPLE: DFM36S-VADN5-A0 50 sL/min [N_2] 20 psig

SPECIFY: *GAS, FLOW RANGE and PRESSURE.*

AFM36 stainless steel, Viton® seals with 1/4" compression fittings, D connector, Without a display, ±15 Vdc, *n.a./0-5Vdc input/output signal, and no digital interface.

SDPROC

Microprocessor driven digital Command Modules are used in conjunction with any analog or digital mass flow meters or controllers with 0-5 Vdc input /output signals. One, two, three and four channel Command Module configurations are available. Command Modules contain appropriate power supplies, 24x2 alpha-numeric dot matrix display readout, and four panel buttons which provide complete control over all the various functions necessary to measure and/or control flow.

Programming

It is easy to program the SMART DPROC using a logically organized, modular menu. The operator quickly accesses a desired function by branching through the multi-level tree structure, rather than scrolling through the entire menu. RS-232 serial communication interface is standard for all models and supported via a 9 pin “D”-connector on the back panel of the Command Module. RS-232 Software interface commands set allows communications with the unit using either a custom software program or a “dumb terminal” and provide complete control over all modes and functions.

PROGRAMMABLE BATCH FLOW CONTROL

The Batch Flow Control allows execution of custom, user preset program of up to sixteen steps. During execution of the program the user can activate or deactivate the LOOP mode. Various flow configurations may be preprogrammed: ramping, pulsing, linearized increasing and/or decreasing of the flow.

Optional built-in Ethernet interface allows accessing any Internet-connected SDPROC from a browser on your work station, PC, or laptop computer.

Regardless of where you are, your Command Module is as close as the nearest browser! There are two levels of Ethernet based Remote Controls: HTML web server and TELNET. The HTML web server, which is hosted on the Command Module lets one view CURRENT FLOW RATE, CONTROL VALVE MODE and/or SET POINT, MONITOR TOTALIZER READING FOR SELECTED CHANNEL. The TELNET console provides complete control over all modes and functions and using the same Software interface commands set as the RS-232 communication interface.

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Design Features

ENGINEERING UNITS

The flow set points, measured gas flow and associated totalizer data are scaled directly in engineering units via front panel keypad, RS-232 or Ethernet interface.

The following units of measure are supported:

%F.S., SLPM, L/s, mL/min, mL/h, SCFM, SCFH, SCMM, SCMH, LBPM, LBPH, GRPM, GRPH.

USER SELECTABLE REFERENCE FOR SET POINT

The INTERNAL, EXTERNAL, PROGRAM refers to the point of origin for the Set Point signal.

In INTERNAL REFERENCE MODE, the user sets the control signal with SDPROC controls (via front panel keypad, RS-232 or Ethernet interface).

In EXTERNAL REFERENCE MODE, the user sets the control signal from a remote location (via the DATA IN/OUT 25-pin “D”-connector on the rear panel).

In PROGRAM MODE the set point signal will be driven by user's custom program stored in the EEPROM. There are three Program modes: BATCH, TIMER and RATIO*.

*RATIO mode not available for one channel module.

PROGRAMMABLE TIMER FLOW CONTROL

The Timer Flow Control allows execution of custom, user preset program of up to 96 steps.

Each step can be preprogrammed for a particular date, time, and set point value. Every step has two fields: starting date, time and set point in % F.S.

RATIO FLOW CONTROL

The Ratio Flow allows controlling flow of the mixture of up to four different gases (for 4 channel Command Module) with preset values of the ratio in % for each channel. The flow rate of the mixture can be incremented or decremented by changing the set point of the master channel #1.

FLOW ALARMS

High and Low gas flow ALARM limits can be preprogrammed for each channel. ALARM conditions become true when the difference between current readings and installed set points are equal or more than corresponding values of high and low alarm levels.

Alarm action can be assigned with preset delay interval (0-3600 seconds) to one of the following:

- Contact closer (separate for High and Low alarm).
- Buzzer audible signal.
- Valve shut down (Close).

CONTACT CLOSURES

Two sets of dry contact relay outputs for each channel are provided to actuate user supplied equipment. The relays can be assigned to switch when a specified event occurs (e.g. when a low or high flow alarm limit is exceeded or when the totalizer reaches a specified value).

TOTALIZER

The total volume of the gas is calculated by integrating the actual gas flow rate with respect to time.

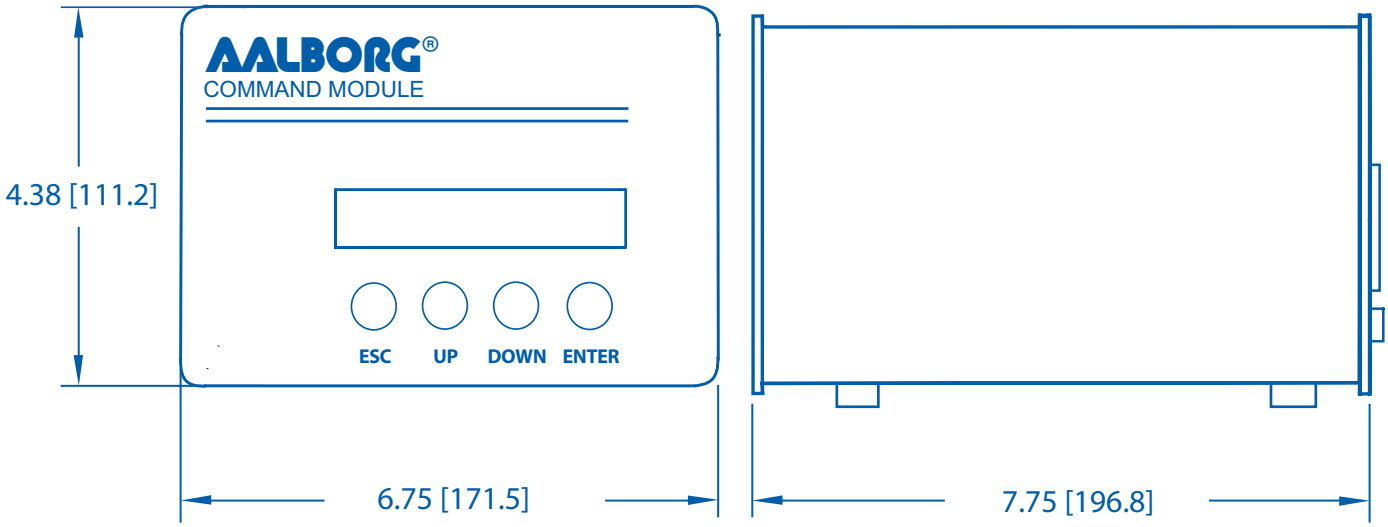
Both keypad menu and digital interface commands are provided to:

- Set the totalizer to ZERO.
- Start the totalizer at a preset flow.
- Assign action at a preset total volume.
- Start/Stop totalizing the flow.
- Read totalizer.

Totalizer conditions become true, when the totalizer, and the “Stop at Total” volumes are equal.

Totalizer action can be assigned to one of the following:

- Contact closer.
- Buzzer audible signal.
- Valve shut down (Close).



DIMENSIONS SHOWN IN BRACKETS ARE IN MILLIMETERS

TABLE 28 - SPECIFICATIONS	
ENVIRONMENTAL (per IEC 664)	Installation Level II; Pollution degree II.
POWER SUPPLY:	85 to 240 VAC (47 to 440 Hz); 120 to 370 VDC 2A max.
FUSE:	2A on input power line. When changing, unplug the device from power source. Replace only with fuse 5mm 2A/250V FF.
DISPLAY:	24 x 2 LCD dot matrix with backlight; 24x2 Vacuum Fluorescent display optional.
ADC/DAC RESOLUTION:	12 bits (0.025%).
COMMUNICATION STANDARD:	RS-232 9600 baud rate, 8 bits, two stop bits, no parity (8,2.N).
OPTIONAL:	Ethernet TCP/IP. (HTML Server or TELNET Console).
DIMENSIONS:	Length: 7.75" (19.5 cm), width: 6.75" (17 cm), height: 4.5" (11cm).
WEIGHT:	4.5 lbs (2 kg).
INTERFACE CABLE:	Flat cable with male 15-pin "D" connector and female 15-pin "D" connector on the ends is standard. Optional round shielded cable is available with male/female 15-pin "D" connector ends. [Cable length may not exceed 9.5 feet (3 meters)]
DATA PORT AND RELAY CABLE:	Optional shielded cable with male 25-pin "D" connector to connect to command module data and relay ports. [Cable length may not exceed 9.5 feet (3 meters)].

MODEL	
SDPROC	

CHANNELS	
1	
2	
3	
4	

CONFIGURATION	
A	AFC /AFM
D	DFC
G	GFM /GFC
C	CUSTOM

DIGITAL INTERFACE	
1	RS232
2	RS232 Ethernet

AC INPUT VOLTAGE	
NA	100-240VAC North America
EU	100-240VAC Europe
AU	100-240VAC Australia
UK	100-240VAC United Kingdom

DISPLAY	
L	LCD
V	VFD

SDPROC — 4 A 2 — NA L

EXAMPLE: SDPROC-4A2-NAL

Smart Digital Command Module, 4-Channel, AFC /AFM configuration, RS232 with Ethernet, 100-240 VAC North America plug, LCD display.

Principles of Operation

Vortices are created when a fluid passes around a bluff body as shown below. Vortices are alternately shed on each side of the body, 180 degrees out of phase to each other, resulting in an oscillating pressure gradient. As flow increases the frequency of vortices increases in proportion to the increased flow thereby creating a linear relationship. Aalborg's unique dual signal processing technology independently measures each vortex on either side of the bluff body and filters out non-flow noise. This results in less noise and higher accuracy throughout the flow range.

Dual signal processing technology independently measures each vortex providing increased accuracy and turndown.

TABLE 29 - BENEFITS	
RELIABLE	No moving parts to wear or fail. Electronics can be remote mounted up to 30.5 m (100 ft). No fluid to sensor contact. No holes to clog.
WIDE RANGEABILITY	High flow turndown ratio up to 80:1. Dual signal processing technology improves accuracy at low flows.
HIGH ACCURACY	±0.5% of rate. Increased noise cancellation as a result of dual signal processing technology.

TABLE 30 - FUNCTIONAL SPECIFICATIONS	
FLUID TYPES	Steam, Gas, Liquid.
MAXIMUM PRESSURE	103 bar (1500 psig) with wafer mount See Table 40 for flange mount.
FLUID TEMPERATURE	-73° to 232 °C std./to 316 °C opt. (-100° to 450 °F std./to 600 °F opt).
LOW FLOW CUT-OFF	Adjustable: Set @min. per Tables 34 to 38.
HIGH FLOW CUT-OFF	Adjustable: Set @max. per Tables 34 to 38.
VOLTAGE	115 /230 VAC selectable or 24 VDC.
FREQUENCY	50 /60 Hz.
OUTPUTS	Analog: 4-20 mA DC into 600 ohm or less.
LINEAR RANGE	Reynolds number of >10,000.

Figure 1

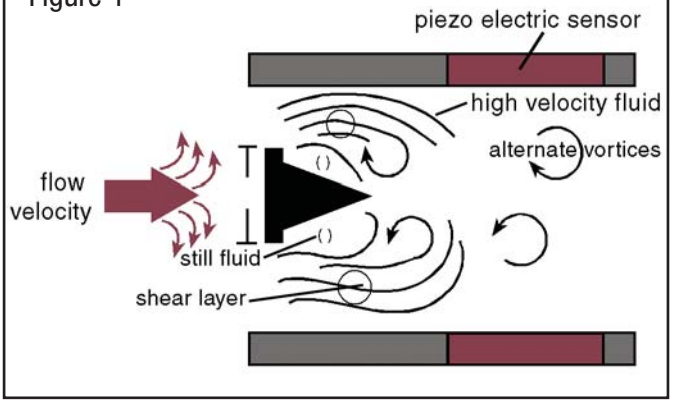


TABLE 31 - PERFORMANCE SPECIFICATIONS	
ACCURACY	± 0.5% of rate.
REPEATABILITY	± 0.25% of rate.
FLOW TURNDOWN RATIO	See Tables 34 to 38.
RESPONSE TIME	1000 ms.
DAMPING	Adjustable: 1 to 10 sec.
VELOCITY RANGE	Liq.: 1.32 or $\frac{10000\mu}{\tilde{n}d \bullet 124}$ to 30 ft/sec Steam & Gas: (144/ñ)1/3 to 250 ft/sec ñ= density (lb/ft3) d= pipe diameter (in) µ= viscosity (cp)
AGENCY APPROVALS*	FM and CSA Class 1 Div 2 Groups B,C,D.

** Designed to meet.*
Contact Aalborg for status of the agency approval.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

Vortex In-line Flow Meter Shown with Flange Mounting

TABLE 32 - PHYSICAL SPECIFICATION	
****MATERIALS OF CONSTRUCTION**	
SHEDDER BAR	304 SS or 316 SS.
ELECTRODES	304 SS or 316 SS encapsulated ceramic.
METERING TUBE	304 SS or 316 SS.
FLANGES	304L SS or 316L SS.
ELECTRONICS HOUSING	Epoxy coated aluminum.
CONNECTIONS AND MOUNTINGS	
MOUNTING POSITION	Vertical, horizontal, angle.
TYPICAL STRAIGHT PIPE REQUIREMENTS	Upstream: 20 x D. Downstream: 5 x D.
TEMPERATURE TAP (BY CUSTOMER)	Downstream: 3.5 x D.
PRESSURE TAP (BY CUSTOMER)	Upstream: 3.5 x D.
PROCESS CONNECTIONS	ANSI Class 150 RF, 300 RF, 600 RF, Wafer.
ELECTRICAL CONNECT	3/4" FNPT.

TABLE 33 - ELECTRONIC SPECIFICATIONS	
AMBIENT TEMPERATURE	-12° to 65 °C (-15° to 149 °F).
TRANSMITTER	Microprocessor-based.
DISPLAY	Two lines, simultaneous rate and total, 16 alphanumeric characters each.
FUNCTIONS	Zero, span, hi cutoff, low cutoff, response time, sample time, engineering units, totalizer, data logger, RS-232 interface.
OUTPUT SIGNAL	4-20mA output into 600 Ohm or less, 5V TTL Pulse Output. Use 18 or 20 gauge twisted pair shielded cable.
ENCLOSURE PROTECTION	NEMA 4X.
ENCLOSURE APPROVALS	UL, CSA, FM Class I Groups B, C, D Class II Groups E, F, G KEMA/CENELEC EEx d IIB
POWER SUPPLY	15-30 VDC or 115 / 230 VAC (optional).

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Flow Ranges

Minimum and maximum flow rates to achieve accuracy in Gal/min, L/min. Pipe ID based on schedule 80 steel.

TABLE 34 - WATER FLOW RATES AT 60 °F

SIZE (INCH)	3/4"		1"		1.5"		2"		3"		4"	
	min	max	min	max	min	max	min	max	min	max	min	max
Gal/min	2.6	40.4	3.4	67.2	7.3	164.9	12.1	276.0	27.2	617.6	47.3	1075.3
L/MIN	9.9	152.9	12.8	254.3	27.5	624.4	46.0	1044.9	102.9	2337.9	179.1	4070.4

Minimum and maximum flow rates to achieve accuracy lb/hr. Pipe ID based on schedule 80 steel.

TABLE 35 - SATURATED STEAM FLOW RATES AT SELECTED PROCESS PRESSURES (English)

SIZE (INCH)	3/4"		1"		1.5"		2"		3"		4"	
PRESSURE (psig)	min	max	min	max	min	max	min	max	min	max	min	max
10	8.7	83.6	14.5	203.5	35.7	668.1	59.7	1118.1	133.5	2501.7	232.5	4355.6
25	11.7	129.9	19.5	316.0	48.0	1041.9	80.3	1743.5	179.6	3901.2	312.6	6792.1
50	16.0	204.9	26.5	498.6	65.1	1649.3	109.0	2760.1	243.9	6175.9	424.7	10752.4
75	19.6	278.5	32.6	677.7	80.0	2245.8	133.9	3758.3	299.6	8409.3	521.7	14640.7
100	22.9	351.3	38.1	854.8	93.4	2833.4	156.4	4741.7	349.9	10609.7	609.1	18471.6
125	25.9	423.5	43.1	1030	105.9	3417.8	177.2	5719.5	396.5	12797.7	690.2	22280.9
150	28.8	492.7	47.9	1199	117.6	4001.0	196.8	6695.5	440.4	14981.6	766.7	26083.1
200	34.1	639.2	56.8	1555	139.4	5160.8	233.2	8636.4	521.8	19324.6	908.5	33644.2
250	39.1	782.7	65.0	1904	159.6	6323.9	267.0	10582.9	597.5	23679.9	1040.3	41226.9
300	43.7	883.6	72.8	2150	178.6	7489.3	298.9	12533.1	668.8	28043.5	1164.5	48824.0
350	48.2	1057	80.2	2573	196.8	8663.4	329.4	14498.0	737.0	32440.2	1283.2	56478.6
400	52.5	1174	87.3	2857	214.3	9844.2	358.7	16474.0	802.6	36861.6	1397.3	64176.3
450	56.6	1316	94.2	3202	231.3	11036.0	387.1	18468.5	866.1	41324.3	1507.9	71945.9
500	60.7	1460	101.0	3552	247.8	12240.0	414.7	20483.2	928.0	45832.4	1615.7	79794.5
550	64.7	1605	107.5	3905	264.0	13456.0	441.8	22518.2	988.5	50385.9	1721.0	87722.2
600	68.5	1752	114.0	4262	279.8	14684.2	468.3	24573.6	1047.8	54984.8	1824.2	95729.0

Minimum and maximum flow rates to achieve accuracy in (kg/hr) Pipe ID based on schedule 80 steel.

TABLE 36 - SATURATED STEAM FLOW RATES AT SELECTED PROCESS PRESSURES (Metric)

Size (mm)	20		25		40		50		80		100	
Pressure (bara)	min	max	min	max	min	max	min	max	min	max	min	max
1	2.5	22.8	4.1	54.9	10.2	184.6	17.0	307.7	38.1	689.9	66.3	1201.7
2	3.9	43.5	7.7	105	15.7	353.2	26.2	588.6	58.7	1319.8	102.2	2298.8
4	5.9	84.0	11.9	206	24.2	676.6	40.4	1127.6	90.5	2528.2	157.6	4403.6
6	7.7	123	15.3	300	31.2	991.3	52.1	1652.2	116.7	3704.3	203.3	6452.1
10	10.6	200	21.2	489	43.2	1609.6	71.9	2682.6	161.3	6014.7	280.9	10476.3
14	13.1	276	26.3	673	53.5	2222.3	89.2	3703.9	200.0	8304.4	348.3	14464.5
18	15.5	353	30.9	862	62.9	2834.7	104.9	4724.5	235.2	10592.8	409.6	18450.4
22	17.6	426	35.2	1037	71.7	3449.7	119.6	5749.5	268.1	12891.1	466.9	22453.5
26	19.7	505	39.3	1229	80.1	4069.0	133.5	6781.6	299.3	15205.0	521.2	26483.9
28	20.7	531	41.3	1294	84.1	4380.6	140.2	7300.9	314.4	16369.4	547.5	28512.0
30	21.6	569	43.3	1369	88.1	4693.7	146.8	7822.9	329.2	17539.8	573.3	30550.5
32	22.6	607	45.2	1461	92.0	5008.5	153.3	8347.5	343.7	18715.9	598.7	32599.0
34	23.5	637	47.1	1530	95.8	5325.0	159.7	8874.9	358.0	19898.5	623.6	34658.9
36	24.5	675	48.9	1622	99.6	5643.3	166.0	9405.5	372.2	21088.1	648.3	36731.0
38	25.4	713	50.8	1714	103.3	5963.7	172.2	9939.5	386.1	22285.4	672.6	38816.3
40	26.3	751	52.6	1806	107.0	6286.0	178.4	10476.7	399.9	23490.0	696.6	40914.5

Minimum and maximum flow rates to achieve accuracy in CFPM (14.7 psia 70 °F) CFM at actual process temperature = min. or max values below *520/ (Actual Temp. (°F) + 460) Pipe ID based on schedule 80 steel. Flow Temp. 60 °F.

TABLE 37 - AIR FLOW RATES AT SELECTED PROCESS PRESSURES (English)

Size (inch)		3/4"		1"		1.5"		2"		3"		4"	
Density (lb/ft3)	Pressure (psig)	min	max	min	max	min	max	min	max	min	max	min	max
0.076	0	2.2	22.2	3.7	54.2	9.1	183.8	15.2	307.5	34.0	688.1	59.2	1197.9
0.103	5	2.7	29.8	4.5	72.7	11.0	246.3	18.5	412.1	41.3	922.1	71.9	1605.3
0.128	10	3.1	37.4	5.2	91.9	12.8	308.8	21.5	516.7	48.1	1156.1	83.7	2012.8
0.180	20	3.9	52.6	6.6	128	16.1	433.8	26.9	725.9	60.3	1624.2	104.9	2827.7
0.232	30	4.7	67.7	7.8	164	19.1	558.8	31.9	935.1	71.4	2092.2	124.2	3642.6
0.284	40	5.3	82.9	8.9	201	21.8	683.8	36.5	1144.2	81.7	2560.3	142.2	4457.5
0.336	50	6.0	98.1	9.9	238	24.4	808.8	40.8	1353.4	91.3	3028.4	159.0	5272.4
0.388	60	6.6	113.2	10.9	275	26.8	933.8	44.9	1562.6	100.5	3496.4	175.0	6087.3
0.440	70	7.1	128.4	11.9	312	29.2	1058.8	48.8	1771.8	109.3	3964.5	190.2	6902.2
0.493	80	7.7	143.6	12.8	349	31.4	1183.8	52.6	1981.0	117.7	4432.5	204.9	7717.1
0.545	90	8.2	158.7	13.7	386	33.6	1308.8	56.2	2190.2	125.8	4900.6	219.0	8532.0
0.596	100	8.7	173.9	14.6	423	35.7	1433.8	59.8	2399.3	133.8	5368.7	232.9	9346.9
0.649	110	9.2	189.1	15.4	460	37.7	1558.8	63.2	2608.5	141.3	5836.7	246.1	10161.8
0.700	120	9.7	204.2	16.2	497	39.8	1683.8	66.5	2817.7	148.9	6304.8	259.2	10976.7
0.752	130	10.2	219.4	17.0	534	41.7	1808.8	69.8	3026.9	156.2	6772.8	271.9	11791.6
0.804	140	10.7	234.6	17.8	570	43.6	1933.8	73.0	3236.1	163.3	7240.9	284.2	12606.5
0.856	150	11.1	249.7	18.5	607	45.5	2058.8	76.1	3445.3	170.2	7709.0	296.4	13421.4
1.116	200	13.3	325.6	22.1	792	54.2	2683.8	90.8	4491.2	203.1	10049.3	353.6	17495.9
1.636	300	17.1	477.2	28.5	1161	70.0	3933.8	117.1	6583.0	262.1	14729.9	456.3	25644.8

Minimum and maximum flow rates to achieve accuracy in M³/min (°C, 1.013 bar). M³/min at actual process temperature = minimum or maximum values below x 273 (actual temp (°C) + 273). Pipe ID based on schedule 80 steel. Flow Temp 0 °C.

TABLE 38 - AIR FLOW RATES AT SELECTED PROCESS PRESSURES (Metric)

Size (mm)		20		25		40		50		80		100	
Density (kg/m3)	Pressure (barg)	min	max	min	max	min	max	min	max	min	max	min	max
1.293	0	0.05	0.63	0.09	1.53	0.22	5.21	0.37	8.69	0.83	19.48	1.44	33.92
1.93	0.5	0.07	0.94	0.12	2.30	0.29	7.78	0.48	12.97	1.08	29.08	1.88	50.66
2.568	1	0.09	1.26	0.14	3.07	0.35	10.35	0.58	17.26	1.31	38.69	2.28	67.39
3.844	2	0.11	1.89	0.18	4.60	0.46	15.49	0.76	25.82	1.71	57.90	2.98	100.85
5.12	3	0.14	2.52	0.22	6.14	0.55	20.64	0.92	34.39	2.07	77.11	3.61	134.31
6.39	4	0.16	3.15	0.26	7.68	0.64	25.78	1.07	42.96	2.40	96.32	4.19	167.77
7.67	5	0.18	3.78	0.29	9.21	0.73	30.92	1.21	51.53	2.71	115.54	4.72	201.24
8.95	6	0.20	4.41	0.32	10.75	0.80	36.06	1.34	60.10	3.00	134.75	5.23	234.70
10.22	7	0.21	5.05	0.35	12.29	0.88	41.20	1.46	68.67	3.28	153.96	5.72	268.16
11.5	8	0.23	5.68	0.38	13.82	0.95	46.34	1.58	77.24	3.55	173.17	6.19	301.63
12.77	9	0.25	6.31	0.41	15.36	1.02	51.48	1.70	85.80	3.81	192.38	6.64	335.09
14.05	10	0.27	6.94	0.44	16.89	1.09	56.62	1.81	94.37	4.06	211.59	7.07	368.55
15.32	11	0.28	7.57	0.46	18.43	1.15	61.76	1.92	102.94	4.30	230.81	7.49	402.01
16.6	12	0.30	8.20	0.49	19.97	1.21	66.91	2.02	111.51	4.54	250.02	7.90	435.48
17.88	13	0.31	8.83	0.51	21.50	1.28	72.05	2.13	120.08	4.77	269.23	8.30	468.94
19.15	14	0.33	9.47	0.54	23.04	1.34	77.19	2.23	128.65	4.99	288.44	8.69	502.40
22.98	17	0.37	11.36	0.61	27.65	1.51	92.61	2.51	154.35	5.63	346.08	9.81	602.79
26.81	20	0.41	13.25	0.67	32.26	1.67	108.04	2.78	180.06	6.24	403.71	10.88	703.18

ANSI Flange Pressure - Temperature Ratings.
Maximum Pressure in psig.

TABLE 39 - FLOW METER PRESSURE RATING

MATERIAL	TEMP. °F					
	-100 to 100	200	300	400	500	600
304L SS/316L SS 150# RF	230	195	175	160	145	140
304L SS/316L SS 300# RF	600	505	455	415	380	360
304L SS/316L SS 600# RF	1200	1015	910	825	765	720
304L SS/316L SS 900# RF	1500	1500	1360	1240	1145	1080
304L SS/316L SS 1500# RF	1500	1500	1500	1500	1500	1500

Ambient Temperature Range for Electronics

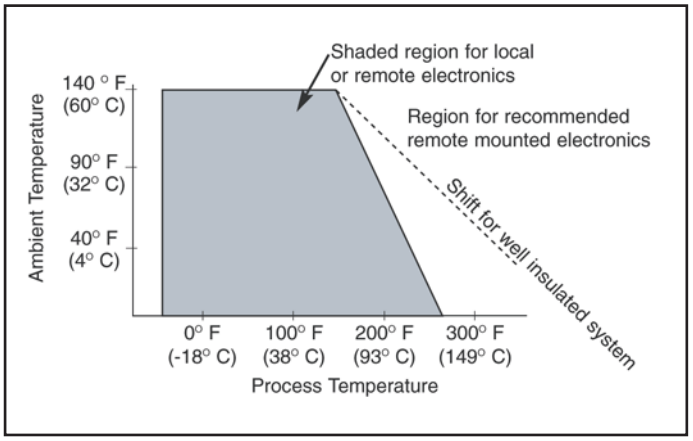
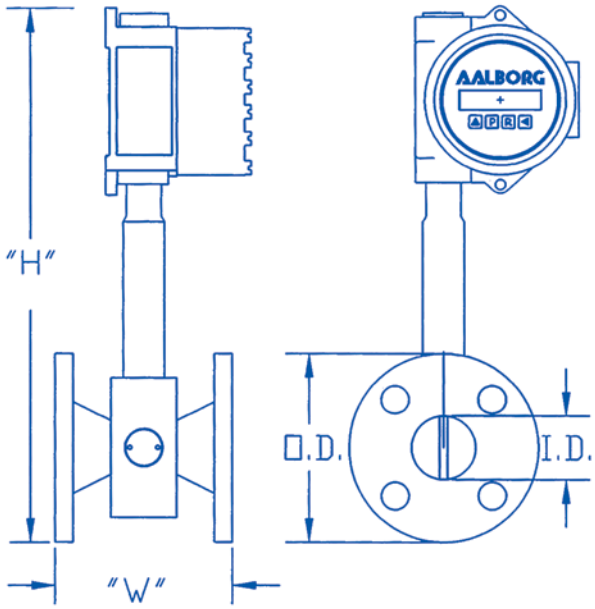


TABLE 40

Meter Size	Flange Rating	Bolt diameter	Bolts	I.D.	O.D.	"W"	"H"
in.	psi	in.	no.	in.	in.	in.	in.
3/4	150 300 600 900 1500	1/2 5/8 5/8 7/8 7/8	4 4 4 4 4	0.742	3.875 4.625 4.625 5.125 5.125	5.88 6.25 6.25 7.25 7.25	9.75 10.125 10.125 10.375
1	150 300 600 900 1500	1/2 5/8 5/8 1 1	4 4 4 4 4	0.957	4.25 4.875 4.875 5.875 5.875	6.13 6.63 6.63 7.5 7.5	9.95 10.27 10.27 10.76 10.76
1.5	150 300 600 900 1500	1/2 3/4 3/7 1-1/8 1-1/8	4 4 4 4 4	1.50	5.00 6.125 6.125 7.00	6.63 7.13 7.25 8.25 8.25	10.35 10.91 10.91 11.35 11.35
2	150 300 600 900 1500	5/8 5/8 5/8 1 1	4 4 4 4 4	1.937	6.00 6.50 6.50 8.50	6.75 7.25 7.50 9.75 9.75	10.875 11.125 11.125 12.125 12.125
3	150 300 600 900 1500	5/8 3/4 3/4 1 1-1/4	4 8 8 8 8	2.900	7.50 8.25 8.25 9.50 10.50	7.25 8.00 8.25 9.75 11.00	11.60 11.98 11.98 12.60 13.10
4	150 300 600 900 1500	5/8 3/4 7/8 1-1/4 1-3/8	4 8 8 8 8	3.826	9.00 10.00 10.75 11.50 12.125	8.25 9.00 10.25 11.285 12.00	12.37 12.87 13.25 13.62 13.93

Flange Mounting



Wafer Mounting

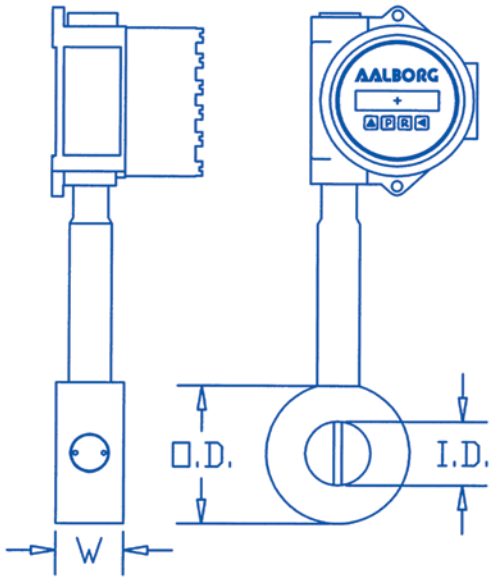


TABLE 41

Meter Size	Flange Rating	Bolt diameter	Bolts	I.D.	O.D.	"W"	"H"
in.	psi	in.	no.	in.	in.	in.	in.
3/4	150 300 600	1/2 5/8 5/8	4 4 4	0.742	2.370	2	9.00
1	150 300 600	1/2 5/8 5/8	4 4 4	0.957	2.740	2	9.20
1.5	150 300 600	1/2 3/4 3/4	4 4 4	1.500	3.500	2	9.60
2	150 300 600	5/8 5/8 5/8	4 8 8	1.937	4.250	2	10.00
3	150 300 600	5/8 3/4 3/4	4 8 8	2.900	5.497	2	10.60
4	150 300 600	5/8 3/4 7/8	8 8 8	3.826	6.997	2.5	11.37

TABLE 42 - BENEFITS	
RELIABLE	No moving parts to wear or fail. Electronics can be remote mounted up to 100 ft. (30.5 m) No fluid to sensor contact. No holes to clog.
WIDE RANGEABILITY	High flow turndown ratio up to 80:1. Dual signal processing technology improves accuracy at low flows.
HIGH ACCURACY	±0.5% of rate. Increased noise cancellation as a result of dual signal processing technology.

Principles of Operation

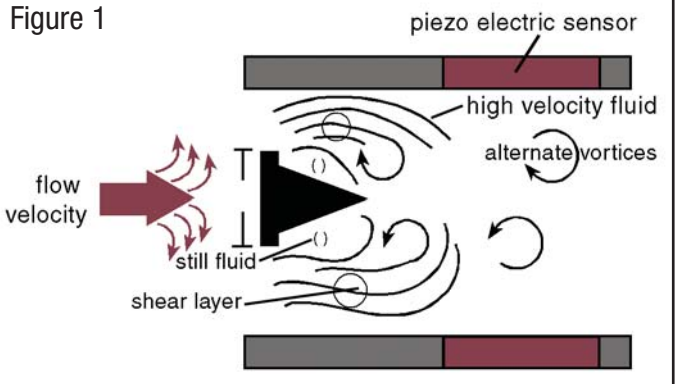
Vortices are created when a fluid passes around a bluff body as shown below. Vortices are alternately shed on each side of the body, 180 degrees out of phase to each other, resulting in an oscillating pressure gradient. As flow increases the frequency of vortices increases in proportion to the increased flow thereby creating a linear relationship. Aalborg's unique dual signal processing technology independently measures each vortex on either side of the bluff body and filters out non-flow noise. This results in less noise and higher accuracy throughout the flow range.

Vortex Insertion Flow Meter Shown with Retractable Mounting

Vortex Insertion Flow Meter Shown with Fixed Mounting

TABLE 43 - FUNCTIONAL SPECIFICATIONS	
FLUID TYPES	Steam, Gas, Liquid.
MAXIMUM PRESSURE	1500 psig (103 bar) see Table 47 for flange ratings.
FLUID TEMPERATURE	-100° to 450 °F std. to 600 °F opt. (-73° to 232 °C std., to 316 °C opt.)
LOW FLOW CUT-OFF	Adjustable: Set @min. per Tables 48 to 50.
HIGH FLOW CUT-OFF	Adjustable: Set @max. per Tables 48 to 50.
VOLTAGE	15÷30 VDC or 115/230 VAC (optional).
FREQUENCY	50/60 Hz.
OUTPUTS	Analog: 4-20 mA DC into 600 ohm or less.
LINEAR RANGE	Reynolds number of >10,000.

Figure 1



Dual signal processing technology independently measures each vortex providing increased accuracy and turndown.

TABLE 44 - PERFORMANCE SPECIFICATIONS	
ACCURACY	± 0.5% of rate.
REPEATABILITY	± 0.25% of rate.
FLOW TURNDOWN RATIO	See Tables 48 to 50.
RESPONSE TIME	1000 ms.
DAMPING	Adjustable: 1 to 10 sec.
VELOCITY RANGE	Liq.: 1.32 or $\frac{10000\mu}{\rho d \bullet 124}$ to 30 ft/sec Steam & Gas: (144/r) 1/3 to 250 ft/sec ρ= density (lb/ft3) d= pipe diameter (in) μ= viscosity (cp)
AGENCY APPROVALS*	FM and CSA Class 1 Div 2 Groups B,C,D.

**Designed to meet.*
Contact Aalborg for status of the agency approval.

***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

TABLE 45 - PHYSICAL SPECIFICATIONS	
****MATERIALS OF CONSTRUCTION**	
SHEDDER BAR	304 SS or 316 SS.
ELECTRODES	304 SS or 316 SS encapsulated ceramic.
METERING TUBE	304 SS or 316 SS.
FLANGES	304L SS or 316L SS.
ELECTRONICS HOUSING	Epoxy coated aluminum.
CONNECTIONS AND MOUNTINGS	
MOUNTING POSITION	Vertical, horizontal, angle.
TYPICAL STRAIGHT PIPE REQUIREMENTS	Upstream: 20 x D. Downstream: 5 x D.
PROCESS CONNECTIONS	MNPT, ANSI Class 150 RF, 300 RF, 600 RF, Welded Flange.
ELECTRICAL CONNECT	3/4" FNPT.

Ambient Temperature Range for Electronics

Figure 2

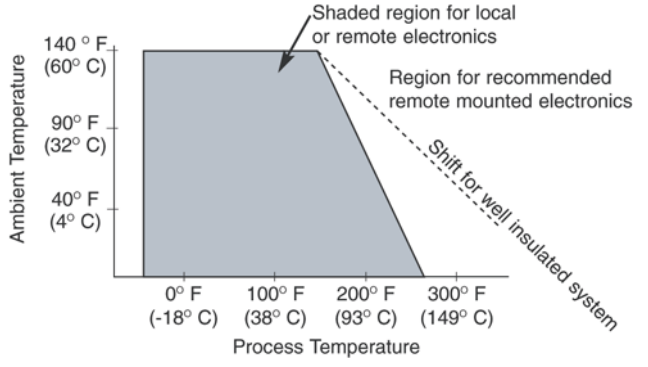


TABLE 46 - ELECTRONIC SPECIFICATIONS	
AMBIENT TEMPERATURE	-15° to 149 °F (-12° to 65 °C).
TRANSMITTER	Microprocessor-based.
DISPLAY	Two lines, simultaneous rate and total, 16 alphanumeric characters each.
FUNCTIONS	Zero, span, hi cutoff, low cutoff, flow rate units, response time, sample time, and engineering units, data logger, RS-232 interface.
OUTPUT SIGNAL	4-20mA into 600 Ohm or less. 5V TTL pulse output. Use 18 or 20 gauge twisted pair shielded cable.
ENCLOSURE PROTECTION	NEMA 4X/IP 66.
ENCLOSURE APPROVALS*	UL, CSA, FM Class I Groups B, C, D Class II Groups E, F, G KEMA/CENELEC EEx d IIB

**Designed to meet.*
Contact Aalborg for status of the agency approval.

Flow Meter Pressure Rating

ANSI Flange Pressure - Temperature Ratings. Maximum Pressure in psig.

TABLE 47 - FLOW METER PRESSURE RATING

MATERIAL	TEMP. °F					
	-100 to 100	200	300	400	500	600
304L SS/316L SS 150# RF	230	195	175	160	145	140
304L SS/316L SS 300# RF	600	505	455	415	380	360
304L SS/316L SS 600# RF	1200	1015	910	825	765	720
304L SS/316L SS 900# RF	1500	1500	1360	1240	1145	1080
304L SS/316L SS 1500# RF	1500	1500	1500	1500	1500	1500

Flow Ranges

Minimum and maximum flow rates to achieve accuracy. Pipe ID based on schedule 40 steel.

TABLE 48 - WATER FLOW RATES AT 60 °F

	4"		5"		6"		8"		10"		12"		14"	
	min	max	min	max	min	max	min	max	min	max	min	max	min	max
Gal/min	52.4	1190.3	82.4	1871.6	118.8	2701.1	205.7	4675.0	324.4	7372.0	460.5	10466.3	556.6	12648.9
L/MIN	198.2	4505.6	311.7	7084.7	449.9	10224.3	778.6	17696.4	1227.8	27905.4	1743.2	39618.1	2106.7	47880.1

	16"		18"		20"		24"		30"		36"	
	min	max	min	max	min	max	min	max	min	max	min	max
Gal/min	727.1	16524.1	920.3	20915.1	1143.7	25994.0	1654.2	37595.4	2624.5	59648.2	3845.6	59648.2
L/MIN	2752.2	62549.0	3483.5	79169.9	4329.4	98395.3	6261.6	142310.1	9934.6	225786.9	14556.7	330833.6

Minimum and maximum flow rates to achieve accuracy in (lb/hr).
Pipe ID based on schedule 40 steel.

TABLE 49 - SATURATED STEAM FLOW RATES AT SELECTED PROCESS PRESSURES (English)

Pressure (psig)	4"		6"		8"		10"		12"		14"		16"		18"		20"	
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
10	257.3	4821.3	404.7	7581.1	584.0	10940.7	1011.4	18947.2	1593.9	29860.7	2262.9	42393.9	2734.8	51234.9	3572.6	66931.5	4522.0	84717.0
25	346.1	7518.4	544.2	11822.0	785.3	17061.0	1360.0	29546.4	2143.4	46564.9	3043.0	66109.4	3677.6	79896.0	4804.3	104373.4	6080.9	132108.2
50	470.1	11902.2	739.1	18715.0	1066.7	27008.8	1847.3	46773.9	2911.4	73715.4	4133.3	104655.7	4995.3	126480.8	6525.7	165230.2	8259.7	209136.3
75	577.5	16206.4	908.0	25482.9	1310.4	36776.0	2269.4	63688.8	3576.6	100373.2	5077.8	142502.4	6136.7	172220.2	8016.8	224982.6	10147.0	284766.5
100	674.3	20446.9	1060.2	32150.7	1530.1	46398.8	2649.8	80353.6	4176.0	126636.8	5928.8	179789.5	7165.2	217283.2	9360.4	283851.4	11847.7	359278.3
125	764.0	24663.6	1201.4	38781.0	1733.8	55967.4	3002.6	96924.6	4732.0	152752.5	6718.2	216866.7	8119.2	262092.6	10606.7	342388.8	13425.2	433370.7
150	848.7	28872.3	1334.4	45398.8	1925.8	65518.0	3335.1	113464.3	5256.1	178819.0	7462.3	253874.0	9018.4	306817.4	11781.4	400815.8	14912.0	507323.3
200	1005.6	37242.0	1581.2	58559.3	2282.0	84510.8	3952.0	146356.1	6228.3	230656.3	8842.4	327468.7	10686.4	395759.8	13960.4	517007.1	17670.0	654389.8
250	1151.5	45635.6	1810.7	71757.4	2613.1	103557.7	4525.4	179341.8	7132.0	282641.4	10125.5	401273.4	12237.1	484955.9	15986.2	633529.7	20234.1	801875.6
300	1289.0	54045.1	2026.8	84980.4	2925.0	122640.8	5065.6	212389.9	7983.3	334725.1	11334.1	475217.9	13697.7	574321.0	17894.2	750273.3	22649.2	949641.0
350	1420.4	62518.2	2233.5	98303.6	3223.3	141868.3	5582.1	245688.2	8797.3	387203.0	12489.7	549722.1	15094.4	664362.5	19718.8	867900.4	24958.6	1098524.8
400	1546.7	71039.1	2432.1	111701.8	3509.9	161204.2	6078.4	279174.1	9579.5	439976.5	13600.3	624646.1	16436.5	754911.2	21472.1	986190.2	27177.8	1248247.4
450	1669.2	79639.6	2624.6	125225.1	3787.7	180720.5	6559.6	312972.7	10337.8	493242.8	14676.9	700269.6	17737.7	846305.5	23171.9	1105584.5	29329.3	1399368.0
500	1788.4	88327.5	2812.2	138886.0	4058.4	200435.5	7028.4	347115.1	11076.6	547051.1	15725.8	776662.6	19005.3	938629.7	24827.9	1226193.7	31425.3	1552026.3
550	1905.0	97103.0	2995.5	152684.6	4322.9	220349.1	7486.5	381601.5	11798.7	601401.4	16750.9	853825.2	20244.1	1031883.9	26446.2	1348017.8	33473.7	1706222.4
600	2019.2	105966.0	3175.1	166620.7	4582.1	240461.2	7935.4	416431.9	12506.1	656293.7	17755.2	931757.3	21458.0	1126068.2	28031.9	1471056.9	35480.8	1861956.2

Minimum and maximum flow rates to achieve accuracy in (kg/hr).
Pipe ID based on schedule 40 steel.

TABLE 50 - SATURATED STEAM FLOW RATES AT SELECTED PROCESS PRESSURES (Metric)

Line Size (mm)	100		150		200		250		300		350		400		450		500	
Pressure (bara)	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
1	73.4	1329.7	115.4	2090.9	166.6	3018.9	288.4	5226.4	454.5	8237.2	645.3	11695.0	779.9	14134.1	1018.9	18464.4	1289.6	23370.9
2	113.1	2543.6	177.8	3999.7	256.7	5774.9	444.4	9997.6	700.4	15757.0	994.5	22371.5	1201.9	27037.3	1570.1	35320.7	1987.3	44706.4
4	174.4	4872.5	274.2	7661.9	396.0	11062.5	685.5	19151.7	1080.4	30184.5	1533.9	42855.4	1853.8	51793.3	2421.7	67661.2	3065.3	85640.8
6	225.0	7139.1	353.8	11226.0	510.8	16208.6	884.3	28060.7	1393.7	44225.8	1978.7	62790.8	2391.4	75886.4	3124.1	99135.8	3954.2	125479.1
10	310.8	11591.7	488.7	18227.6	705.6	26317.8	1221.6	45561.9	1925.3	71809.1	2733.5	101953.1	3303.6	123216.3	4315.8	160966.2	5462.6	203739.6
14	385.4	16004.6	606.0	25166.8	874.9	36336.8	1514.7	62907.1	2387.3	99146.5	3389.4	140766.2	4096.3	170124.2	5351.3	222245.3	6773.2	281302.3
18	453.2	20414.8	712.7	32101.7	1029.1	46349.7	1781.5	80241.7	2807.8	126467.1	3986.5	179555.5	4817.9	217003.3	6293.9	283486.8	7966.4	358817.5
22	516.6	24844.1	812.4	39066.7	1173.0	56406.1	2030.7	97651.6	3200.5	153906.4	4544.0	218513.1	5491.7	264085.9	7174.2	344994.2	9080.6	436669.2
26	576.7	29303.6	906.9	46079.1	1309.4	66531.0	2266.9	115180.0	3572.9	181532.6	5072.7	257736.3	6130.7	311489.3	8008.9	406920.6	10137.1	515051.3
28	605.8	31547.7	952.6	49607.9	1375.5	71625.9	2381.3	124000.5	3753.0	195434.2	5328.5	277473.6	6439.8	335343.0	8412.7	438082.4	10648.3	554493.7
30	634.4	33803.2	997.5	53154.6	1440.3	76746.9	2493.4	132866.0	3929.9	209407.1	5579.5	297311.9	6743.2	359318.8	8809.1	469403.7	11149.9	594138.1
32	662.4	36069.8	1041.6	56718.8	1504.0	81893.0	2603.7	141775.0	4103.6	223448.3	5826.2	317247.4	7041.3	383412.0	9198.6	500878.3	11642.9	633976.3
34	690.0	38349.0	1085.1	60302.8	1566.7	87067.6	2712.2	150733.5	4274.7	237567.6	6069.2	337293.7	7334.9	407639.2	9582.1	532528.0	12128.4	674036.3
36	717.3	40641.7	1127.9	63908.0	1628.5	92273.0	2819.3	159745.2	4443.4	251770.7	6308.7	357458.9	7624.4	432010.0	9960.3	564365.3	12607.1	714333.7
38	744.2	42949.1	1170.2	67536.2	1689.6	97511.6	2925.0	168814.4	4610.1	266064.4	6545.3	377752.9	7910.3	456536.4	10333.8	596405.9	13079.8	754888.5
40	770.8	45270.6	1212.0	71186.8	1749.9	102782.4	3029.5	177939.3	4774.7	280446.1	6779.1	398171.6	8192.9	481213.7	10703.0	628643.6	13547.0	795692.6

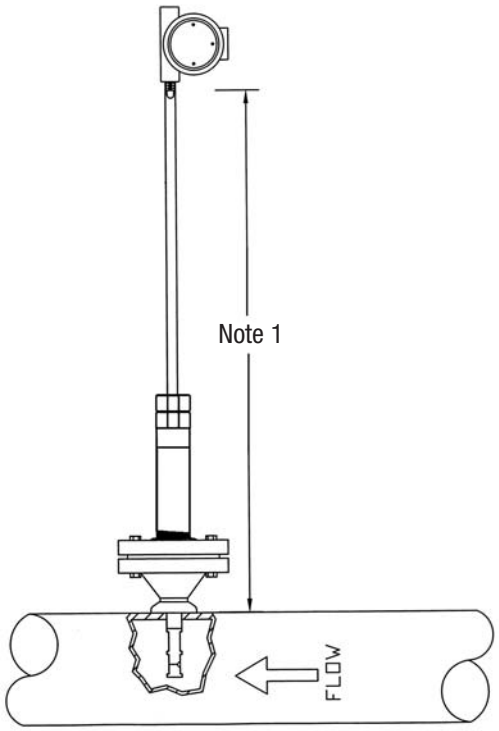
Minimum and Maximum Flow Rates to achieve Accuracy in CFPM (177 PSIA and 70 °F).
PipeID Based on Schedule 40 Steel.

TABLE 51 - AIR FLOW RATES AT 60 °F CONDITIONS

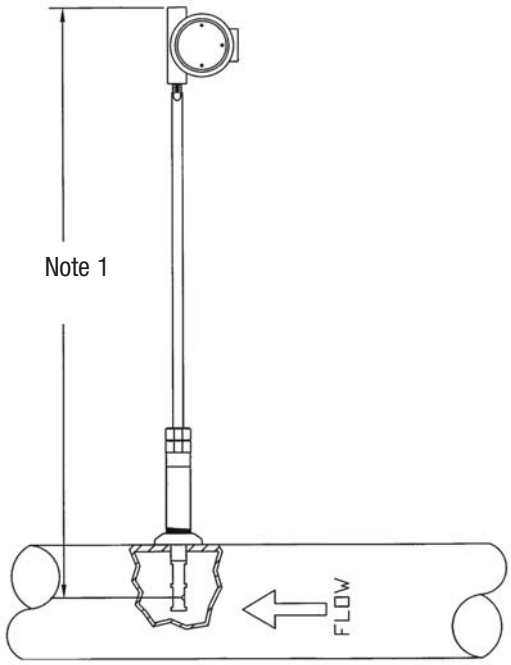
DENSITY (lb/ft3)	PRESSURE (PSIG)	4"		6"		8"		10"		12"		14"	
		min	max	min	max	min	max	min	max	min	max	min	max
0.076	0	59.2	1197.9	134.1	2715	257.4	5211	405	8214	576	11659	696	14093
0.103	5	71.9	1605.3	163.0	3638	312.9	6983	493	11007	700	15625	846	18887
0.128	10	83.7	2012.8	189.6	4562	363.8	8756	573	13802	814	19591	984	23681
0.180	20	104.9	2827.7	237.8	6409	456.4	12301	719	19389	1021	27523	1234	33268
0.232	30	124.2	3642.6	281.6	8256	540.3	15846	852	24977	1209	35454	1461	42855
0.284	40	142.2	4457.5	322.2	10103	618.2	19391	974	30564	1383	43386	1672	52443
0.336	50	159.0	5272.4	360.3	11950	691.4	22936	1089	36152	1547	51317	1870	62030
0.388	60	175.0	6037.3	396.5	13797	760.9	26481	1199	41740	1702	59249	2058	71618
0.440	70	190.2	6902.2	431.2	15644	827.4	30026	1304	47328	1851	67181	2238	81205
0.493	80	204.9	7717.1	464.3	17490	891.3	33571	1405	52915	1994	75113	2410	90792
0.545	90	219.0	8532.0	496.4	19337	952.9	37116	1502	58504	2132	83044	2577	100379
0.596	100	232.9	9346.9	527.8	21184	1021.7	40661	1596	64091	2265	90976	2739	109967
0.649	110	246.1	10161.8	557.7	23031	1070.8	44206	1688	69979	2396	98907	2896	119554
0.700	120	259.2	10976.7	587.4	24878	1127.3	47751	1777	75266	2522	106839	3049	129142
0.752	130	271.9	11791.6	616.2	26725	1182.4	51296	1864	80854	2645	114771	3198	138729
0.804	140	284.2	12606.5	644.2	28572	1236.3	54841	1949	86442	2766	122703	3343	148317
0.856	150	296.4	13421.4	671.7	30419	1289.0	58386	2032	92030	2884	130634	3486	157904
1.116	200	353.6	17495.9	801.5	39654	1538.2	76111	2425	119968	3442	170293	4160	208841
1.636	300	456.3	25644.8	1034.2	58123	1984.9	111560	3129	175846	4441	249609	5368	301714

DENSITY (lb/ft3)	PRESSURE (PSIG)	16"		18"		20"		24"		30"		36"	
		min	max	min	max	min	max	min	max	min	max	min	max
0.076	0	909	18407	1151	23300	1430	28953	2068	41875	3458	69995	4810	97377
0.103	5	1105	24669	1399	31225	1738	38800	2514	56118	4203	93803	5847	130498
0.128	10	1285	30930	1627	39150	2021	48648	2924	70362	4887	117611	6799	163620
0.180	20	1612	43452	2040	55000	2536	68344	3667	98848	6130	165227	8528	229863
0.232	30	1908	55974	2416	70851	3002	88039	4342	127335	7257	212843	10096	296106
0.284	40	2184	68497	2764	86701	3434	107735	4967	155821	8303	260459	11551	362348
0.336	50	2442	81019	3091	102552	3841	127431	5555	184308	9287	308075	12919	428591
0.388	60	2688	93541	3402	118402	4227	147127	6114	212794	10220	355691	14218	494834
0.440	70	2923	106063	3699	134253	4597	166822	6649	241281	11113	403307	15461	561077
0.493	80	3148	118586	3985	150103	4952	186518	7162	269767	11972	450923	16655	627320
0.545	90	3366	131108	4261	165953	5295	206214	7658	298254	12800	498539	17809	693503
0.596	100	3577	143630	4528	181804	5627	225909	8138	326741	13603	546155	18924	759806
0.649	110	3782	156152	4788	197654	5949	245605	8604	355227	14383	593771	20009	826048
0.700	120	3982	168675	5040	213505	6263	265301	9058	383713	15142	641387	21065	892291
0.752	130	4177	181197	5287	229355	6569	284996	9502	412200	15882	689003	22095	958534
0.804	140	4367	193719	5528	245205	6869	304692	9934	440687	16606	736619	23102	1042777
0.856	150	4553	206242	5763	261056	7162	324387	10358	469173	17314	784235	24087	1091020
1.116	200	5434	268853	6878	340307	8546	422866	12361	611606	20661	1022315	28744	1422234
1.636	300	7011	394076	8875	498812	11028	619823	15950	896471	26661	1498474	37090	2084663

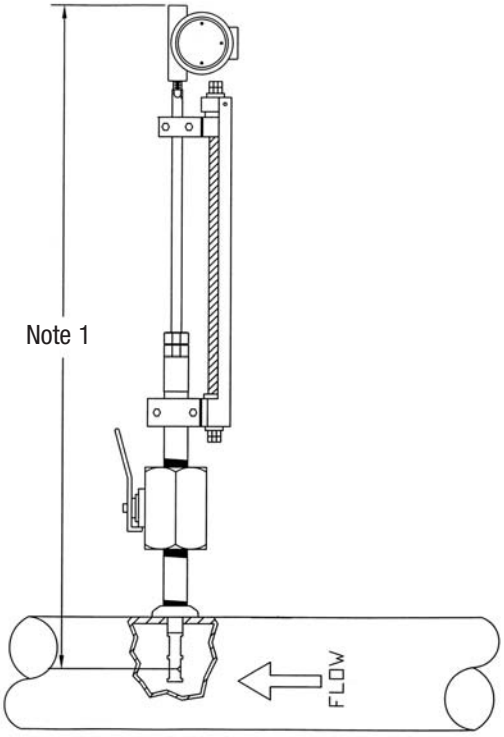
Flanged Insertion Meter



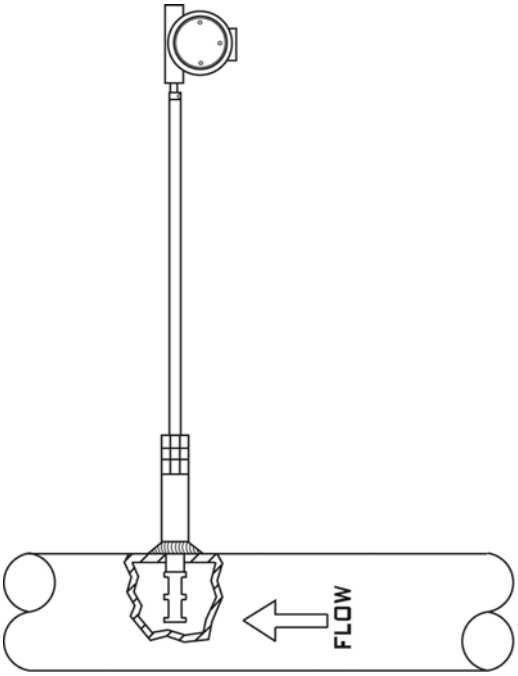
1-1/2" MNPT Insertion Meter



1-1/2" Insertion Meter Assembly with Insertion Tool and Ball Valve



1-1/2" Welded Insertion Meter



Note 1: *Length dependent on pipe diameter, thickness, and mounting.*

ORDERING INFORMATION VORTEX FLOW METERS

MODEL
VX

STYLE	
W	Wafer
F	Flange
I	Insertion

SIZE: **WAFER or FLANGE**	
07	3/4" (20mm)
10	1.0" (25mm)
15	1.5" (40mm)
20	2.0" (50mm)
30	3.0" (80mm)
40	4.0" (100mm)
SIZE: **INSERTION**	
04"-36"	PIPE DIAMETER

FLUID TYPE	
G	Gas
L	Liquid
S	Steam

MAX TEMP.	
4	450 °F
6	600 °F

MATERIAL	
S4	304 SS
S6	316 SS

MOUNTING CONNECTION	
A	Wafer. Using Customer Flanges.
B	Flange Mounting.
C	Insertion with Flange.
D	Insertion. With 1.5 MNPT Thread.
E	Insertion, Welded.
F	Other.

FLANGE RATING†	
A	150# ANSI RF (Alignment Rings Not Required for Wafer Style)
B	300# ANSI RF (Wafer Style Includes Alignment Rings)
C	600# ANSI RF (Wafer Style Includes Alignment Rings)
D	OTHER
N	NONE

DISPLAY	
L	Local
R	Remote

POWER	
04	24VDC
12	120VAC
22	220VAC

VX	W	—	10	L	—	4	S4	A	B	—	L	22

To allow us to confirm selection please return completed application data sheet found on Aalborg's web site at www.aalborg.com.

1. Select style (wafer, flange or insertion).
2. Select meter size to match internal pipe diameter (for insertion style select pipe diameter).
3. Confirm minimum and maximum flow ranges to maintain stated accuracy from liquid, steam, or air from Tables 34 to 38 are within your requirements.
4. For other gas applications consult factory.
5. Select fluid type.
6. Select maximum temperature capability.
7. Select desired **Material of Construction.
8. Select mounting connection.
9. Confirm maximum pressure capability of flange/meter rating with process conditions and select flange rating from Table 39.
10. Confirm suitability of standard local mounted electronics.
11. Select desired transmitter power.
12. Provide: Fluid, Fluid Viscosity, Minimum & Maximum Operating Pressure, Minimum & Maximum Operating Temperature, Density/Specific Gravity or Specific Volume.
13. Provide minimum and maximum flow range.

Options: Remote mount electronics up to 100 ft. (30.5 m).

† = Flange and Insertion Style. Wafer Style for Alignment Ring Selection.
** = The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.

EXAMPLE: VXW-10L-4S4AB-L22

***SPECIFY**: FLUID NAME OR MEASURING DENSITY, FLOW RATE, and PRESSURE (STEAM, GASES).*

Vortex meter, Wafer style, 10" diameter size, Liquid at maximum 450 °F, 304 stainless steel, Customer flanges, Flange 300# ANSI RF, Local display, 220V power.

www.aalborg.com - e-mail ✉ info@aalborg.com - ☎ **845.770.3000** - fax 845.770.3010 - **Toll Free in U.S.A. and Canada 1.800.866.3837**

PSV Proportionating Electromagnetic Valve

PSV Proportionating Electromagnetic Valves are designed to respond to variable power inputs to proportionately regulate the flow of liquids and gases.

For added safety PSV valves are normally closed (NC) when de-energized. They can also serve as “ON-OFF” valves. For control functions see the PSV-D Driver Module.

Flow is controlled by increasing or decreasing the voltage applied to the coil. This causes a magnetic force which raises the core and allows gas to flow.

PSV valves, constructed of stainless steel are available in five different sizes covering flow ranges from 3.5 sL/min - 100 sL/min air and 125 mL/min - 2.85 L/min H_2O.

Design Features

- Leak Integrity 1 x 10^{-9} mL/min
- Rigid metallic construction
- Gas and liquids.
- Max pressure of 500 psig (34.8 bars)

Principle of Operation

A variable stroke electromagnetic valve featuring a valve seat design which permits increasing or decreasing flow rates of liquids or gases through it in proportion to variable input power.

Regulator Systems

Complete flow regulating systems include a PSV electromagnetic valve connected to a pulse width modulated PSV-D Driver Module. For details see Driver Module description. Optional external RS-232 or RS-485 modules are available. (See page 23).

TABLE 52 -
MAX FLOW RATES AND CV VALUES FOR PSV

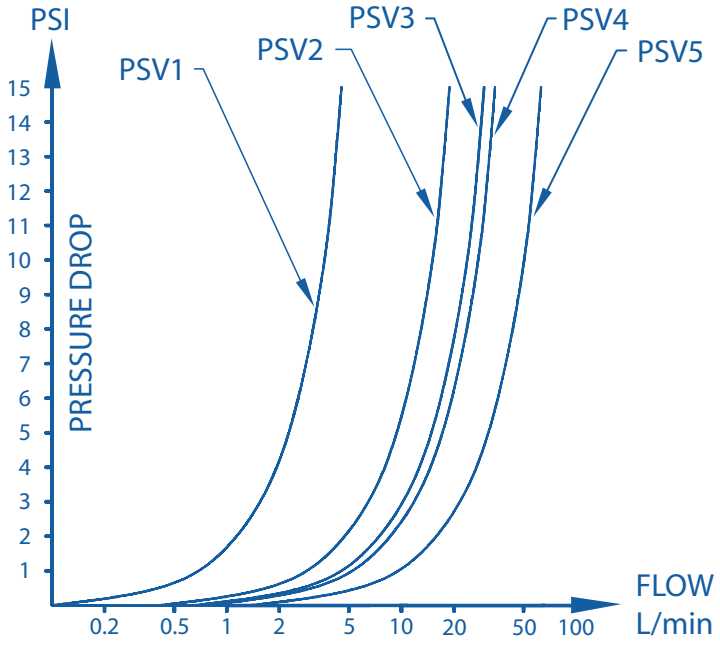
MODEL NUMBER	ORIFICE SIZE		Cv	*MAXIMUM FLOW [mL/min]	
	[in]	[mm]		AIR	WATER
PSV1S-VA	0.02	0.51	0.009	3500	125
PSV2S-VA	0.04	1.02	0.033	13000	400
PSV3S-VA	0.055	1.4	0.055	21500	700
PSV4S-VA	0.063	1.6	0.068	25000	850
PSV5S-VA	0.125	3.18	0.24	100000	2850

Based on 10 psig (690 mbar) differential pressure.

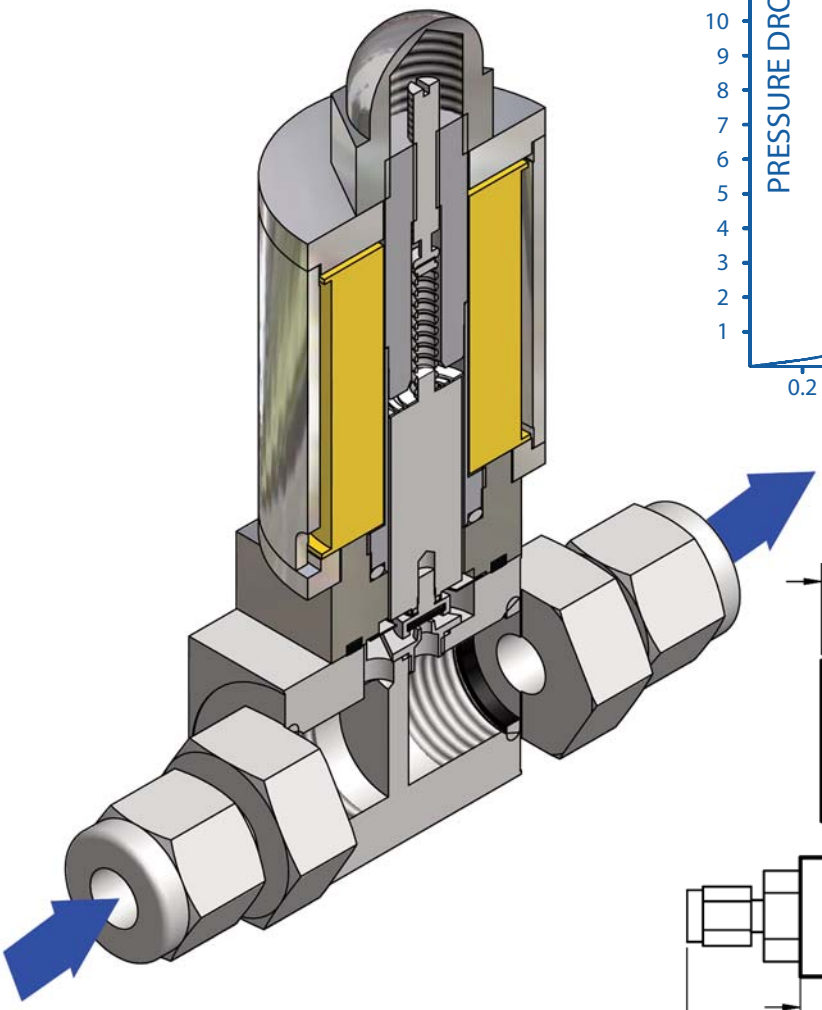
***The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

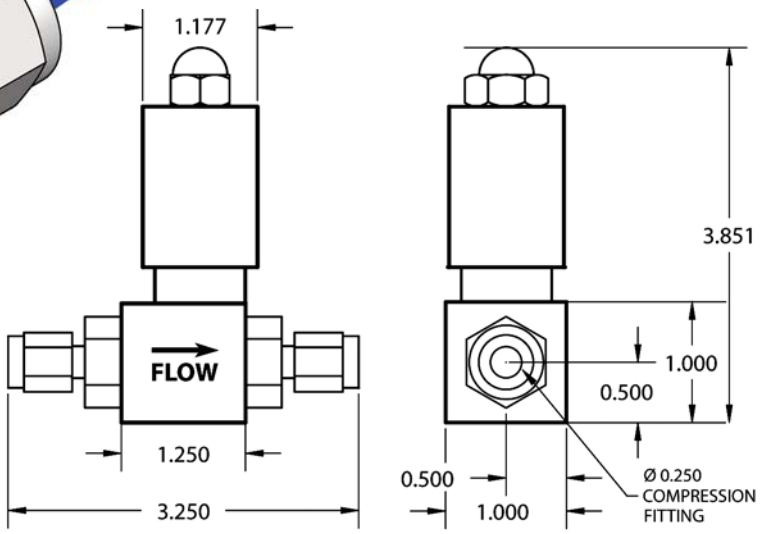
TABLE 53 - SPECIFICATIONS	
POWER INPUT:	0-30Vdc.
MAXIMUM POWER REQUIRED:	400 mA.
TYPE OF OPERATION:	Normally closed (NC) when de-energized.
CONNECTIONS:	1/4" Compression fittings optional 1/8" and 3/8".
DIMENSIONS:	3.45" (87.6mm) high x 3.25" (82.6mm) long (including compression fittings) x 1.00" (25.4mm) deep.
**MATERIALS IN FLUID CONTACT:	Types 316 and 416 stainless steel, Viton® O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
MAXIMUM PRESSURE:	1000 psig (3448 kPa).
MAXIMUM DIFFERENTIAL PRESSURE:	50 psid (345 kPa).
LEAK INTEGRITY:	1 X 10^{-9} smL/sec Helium individually tested.
MAXIMUM TEMPERATURE (typical):	174°F (79°C) inside, 130°F (54°C) outside surface at 24Vdc.

Pressure Drops Across PSV Valves

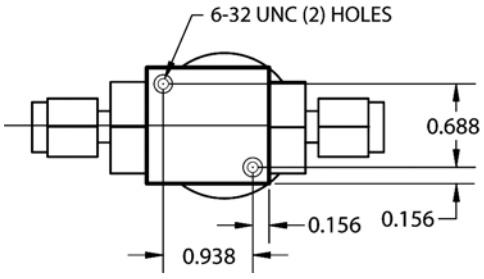


Cross Sectional View PSV Valve





PSV Proportionating Electromagnetic Valves



MODEL	
PSV	

SERIES	
1	
2	
3	
4	
5	

MATERIAL	
S	Stainless Steel

SEALS	
V	Viton®
B	Buna®
E	EPR
T	PTFE / Kalrez®

FITTINGS	
A	1/4" Compression
B	1/8" Compression
D	3/8" Compression
X	Special

PSV	4	S	–	V	A

EXAMPLE: PSV4S-VA

PSV4 stainless steel, Viton® seals with 1/4" compression fittings.

PSV-D

Pulse width modulated PSV-D Driver Modules regulate the power supplied to PSV Regulating valves based on a reference signal.

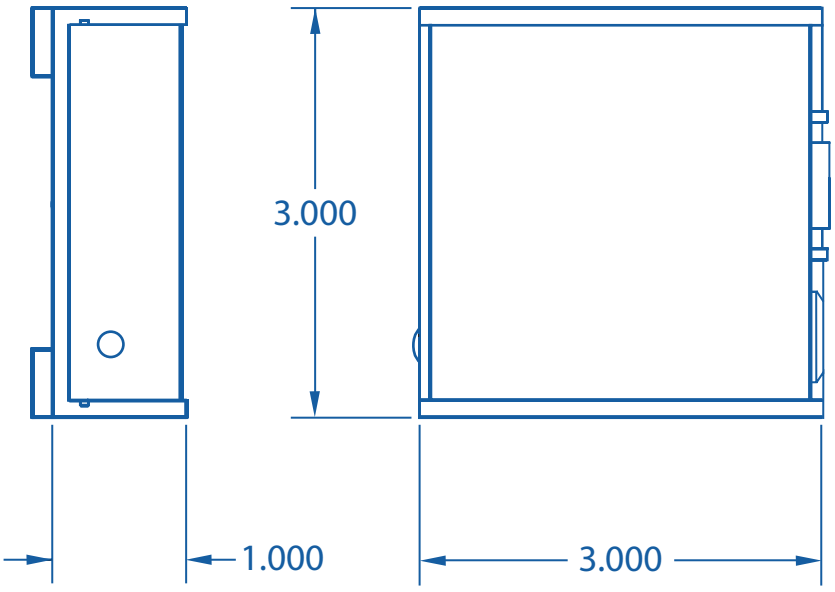
Set-point signals, 0-5 Vdc or 4-20 mA, input are employed to control the output pulse width modulated voltage at a fixed frequency (≈30KHz) and amplitude. Incoming power to the valve coil is applied and discontinued for predetermined periods of time by a low loss solid state switching element.

As incoming power is applied, energy in the inductive coils increases and when it is discontinued energy stored in the coil maintains the magnetic flux level required to hold flow at the controlled rate. This cycle takes place many thousands of times per second.

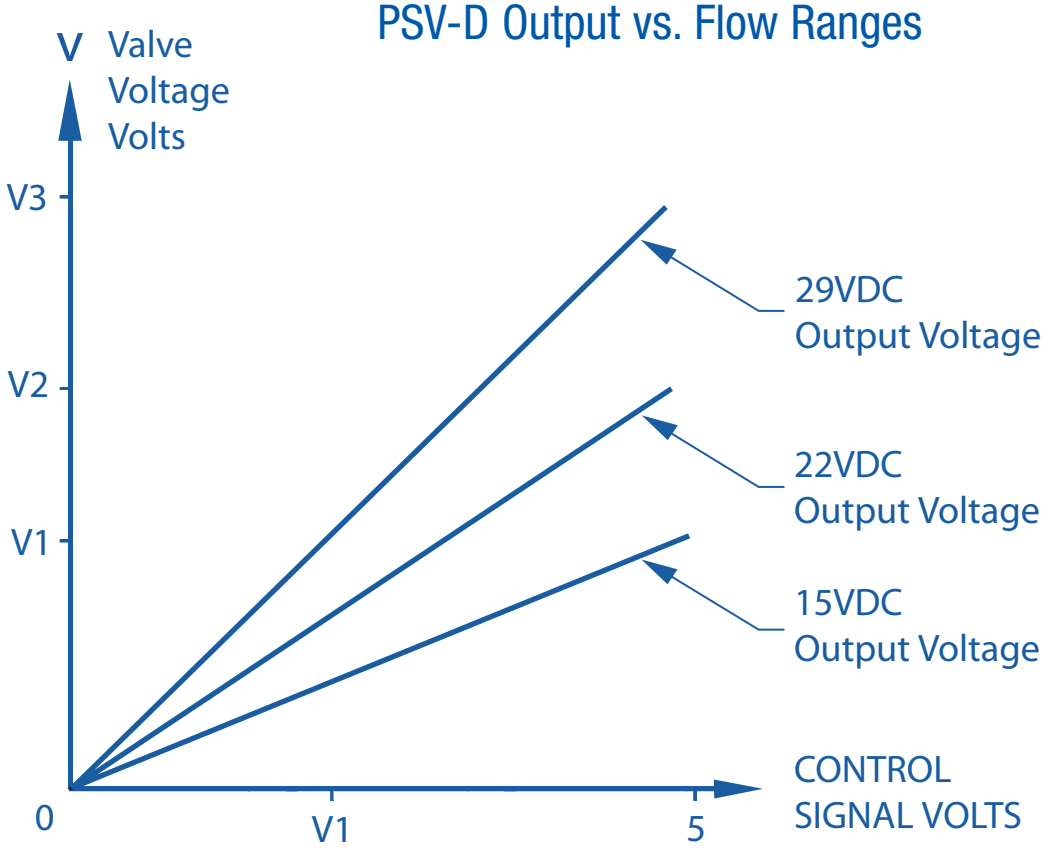
The wide range of power input features conveniently accommodates 12 to 32 Vdc sources.

The Auto-Select feature of the Driver Module recognizes the type of reference signal received and defaults to 0 - 5 Vdc if both signals are provided.

Dimensions Pulse Width Modulated Driver Module



PSV-D Output vs. Flow Ranges



Jumper selectable output power allows a choice of dc voltage range for cooler more efficient operation, as a function of flow rates.

Internal resettable fuse protects electronics and rectifier circuits, prevents polarity reversal damage.

The maximum output voltage supplied to the PSV Valve can be set or changed in the field to allow for optimal use of the input reference signal to output voltage based on the specific flow rate and operating pressure applied to the valve.

TABLE 54 - SPECIFICATIONS	
CONNECTION:	9-pin male “D” subconnector for input/output signals.
POWER INPUT REQUIRED:	+12 to 30 Vdc 1A @12 Vdc, 0.5A (not supplied) @24 Vdc via 9-pin “D”-connector or dc power jack (center positive).
INPUT SIGNAL:	Auto-Select feature allows circuit to recognize which analog input reference (0 to 5 Vdc or 4-20 mA) signal is provided.
TTL ON/OFF:	Jumper selectable LOW (0 Vdc) OFF-HIGH (5 Vdc) on, or reverse, to select valve ON/OFF status.
VALVE OUTPUT POWER:	Jumper selectable to +15, +22, and +29 Vdc with adjacent potentiometer to obtain ±2 Vdc.
FUSE RATING:	An internal resettable 1.6A fuse protects the electronics on the power input.
POLARITY PROTECTION:	Internal rectifier circuit protects from reversed polarity on the power input.
OPERATING TEMPERATURE:	32 °F (0 °C) to 122 °F (50 °C).
DIMENSIONS:	3" (7.62mm) wide x 3" (7.62mm) deep x 1" (25.4mm) high.
CE COMPLIANCE:	EMC Directive 89/336/EEC EN55011:1991 Group 1, Class A EN50082-2:1995.

ORDERING INFORMATION FOR PSV-D	
MODEL	
PSV-D	Proportionating Solenoid Valve Driver

PSV-D

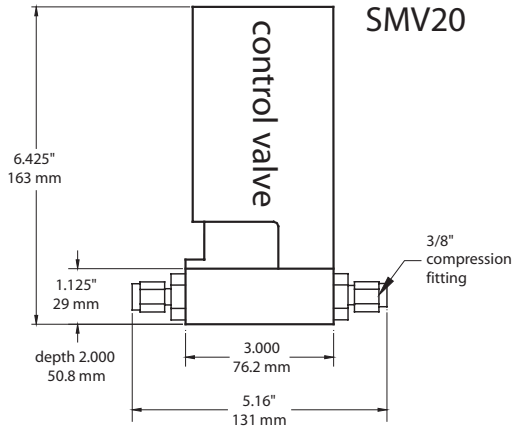
TABLE 55 - ACCESSORIES FOR FOR PSVD DRIVER MODULE	
PS-PSV-110NA-4	Power Supply, 110vac/24 Vdc /North America
PS-PSV-230EU-4	Power Supply, 230vac/24 Vdc /Europe
PS-PSV-240AU-4	Power Supply 240vac/24 Vdc /Australia
PS-PSV-240UK-4	Power Supply 240vac/24 Vdc /United Kingdom
CBL-DP9-6	Female 9 pin D-connector with 6 ft.cable

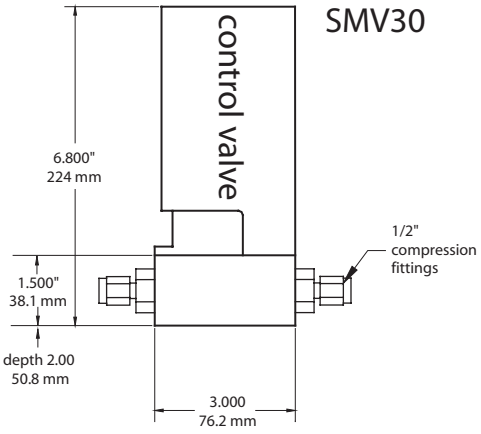
Design Features

- High precision two-way metering valves in aluminum or 316 SS for air/water.
- Unparalleled precision and resolution in controlling flow rates (0.0005" per step resolution standard, 0.000125" optional).
- Operate continuously without overheating.
- Eliminates coil heating problems associated with solenoid designs.

SMV Stepping Motor Valves

Dimensions SMV Stepping Motor Valves





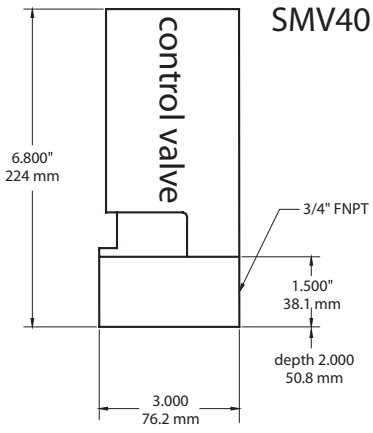


TABLE 56 - SPECIFICATIONS	
ALUMINUM MODELS:	Aluminum housings and valve blocks, Viton® O-Rings, PFA closing pins.
STAINLESS STEEL /PTFE MODELS:	316 stainless steel valve blocks, PTFE-lined aluminum housing blocks, Viton® O-Rings, and PFA closing pins.
MAXIMUM FLOW RATES:	1000 sL/min (air), 28 L/min (H_2O).
CONNECTIONS:	3/8", 1/2", compression and 3/4" FNPT.
ELECTRICAL CONNECTIONS:	9-pin "D"-connector, located at the side of the valve.
POWER INPUT:	12Vdc @ 800 mA, or +24 Vdc @ 600 mA, protected by a 1600mA resettable fuse.
DIRECTIONAL CONTROL SIGNAL:	12Vdc CMOS compatible logic level signal (10K input impedance). (Logic High >= 7.5 Vdc, Low <2.3 Vdc).
SPEED CONTROL SIGNAL:	Analog 0 to 2.5 Vdc (100K input impedance). TTL ON/OFF override: TTL low level to pins 7 and 3 (10K input impendence).
RESPONSE TIME:	100ms time constant.
DIFFERENTIAL PRESSURES:	(700 to 1000) mbars 10 to 15 psid.
MAXIMUM OPERATING PRESSURE:	500 psig (35 bars).
MAXIMUM DIFFERENTIAL PRESSURE:	40 psig (2.7 bars).

Operation

When the "DIRECTION" is set LOW (GND) the valve spindle travels downward (closes), when it is set HIGH, the valve spindle moves upward (opens). The "SPEED" voltage on pin 4 determines how quickly the valve opens or closes. The signal amplitude for the "SPEED" control signal must remain within the limits of 0 to +2.5 VDC. It may be necessary to override "DIRECTION" and "SPEED" signals with the preset (2.75 Vdc) speed control signal.

This can be accomplished with valve CLOSE and PURGE control signals (open collector NPN compatible). In order to CLOSE the valve, pin 3 on the 9-pin "D"- connector has to be connected to GND (pin 2). A GREEN light on the top of the valve will indicate a CLOSED valve condition. In order to PURGE the valve, pin 7 on the 9-pin "D"-connector has to be connected to GND (pin 2). A RED light on the top of the valve will indicate a fully OPEN valve condition. During normal operation the valve remains in the last position as it is deenergized.

After powering up, the valve will be automatically closed within the first 10 seconds and after that resumes control operation. Operating power and valve control signals are supplied via the "D"-connector.

General Description

A line of electronic two-way metering needle valves is presented. High precision linear stepping motors drive the valve spindle.

The resolution of the stepping motor driven needles is 0.0005"/step. Standard optional 0.000125" /step resolution available. Low differential pressure valves, may be operated continuously (100% duty cycle). Valves stay in position as when de-energized.

Advantages over solenoid operated valves include cool operations, i.e. there are no control operating problems due to coils heating up, extremely fine resolution, very low differential pressures and high operating pressures. Valves are controllable by TTL compatible logic level and analog 0 to 2.5 Vdc signals.

TABLE 57 - FLOW RATE FOR SMV

MODEL NUMBERS	MAXIMUM FLOW RATE				Cv	CONNECTIONS	MATERIAL
	AIR		H_2O				
	[sL/min]	[scfh]	[L/min]	Gal/min			
SMV20-A	200	424	5.6	1.48	0.336	3/8" compression	Aluminum
SMV20-S	200	424	5.6	1.48	0.336	3/8" compression	Stainless Steel
SMV30-A	500	1060	14.2	3.75	0.855	1/2" compression	Aluminum
SMV30-S	500	1060	14.2	3.75	0.855	1/2" compression	Stainless Steel
SMV40-A	1000	2119	28	7.4	1.735	3/4" FNPT	Aluminum
SMV40-S	1000	2119	28	7.4	1.735	3/4" FNPT	Stainless Steel

TABLE 58 - CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
atm	14.70	lbs/sq. in
atm	1.0333	kg/sq. cm
lbs/sq. in	0.07031	kg/sq. cm
ml/min	0.001	liters/min
ml/min	3.531 X 10^{-5}	cu. ft/min
ml/min	1.585 x 10^{-2}	gal/hr
cu. ft/hr	472	ml/min
gal/min	3785	ml/min
g/ml	62.43	lbs/cu. ft
g/ml	0.03613	lbs/cu. in
cc/min	1	mL/min
cfm (ft^3/min)	28.31	L/min
cfm (ft^3/min)	1.699	m^3/hr
oz/min	29.57	mL/min

TABLE 59 - PRESSURE CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
psi	27.71	in. H_2O
psi	2.036	in. Hg
psi	703.1	mm/H_2O
psi	51.75	mm/Hg
psi	.0703	kg/cm^2
psi	.0689	bar
psi	68.95	mbar
psi	6895	Pa
psi	6.895	kPa

TABLE 60 - TEMPERATURE

°F = (1.8 x °C) + 32
°C = (°F - 32) x 0.555
°Kelvin = °C + 273.2

TABLE 61 - LENGTH

MULTIPLY	BY	TO OBTAIN
inch	2.54	cm
inch	12	foot
ft.	0.305	meter
yard	1.914	meter
Angstrom	10^{10}	meter

COMMON EQUIVALENTS AND CONVERSIONS

Approximate Common Equivalents

1 inch	= 25 millimeter
1 foot	= 0.3 meter
1 yard	= 0.9 meter
1 mile	= 1.6 kilometers
1 square inch	= 6.5 sq centimeters
1 square foot	= 0.09 square meter
1 square yard	= 0.8 square meter
1 acre	= 0.4 hectare +
1 cubic inch	= 16 cu centimeters
1 cubic foot	= 0.03 cubic meter
1 cubic yard	= 0.8 cubic meter
1 quart (lq)	= 1 liter +
1 gallon	= 0.004 cubic meter
1 ounce (avdp)	= 28 grams
1 pound (avdp)	= 0.45 kilogram
1 horsepower	= 0.75 kilowatt
1 millimeter	= 0.04 inch
1 meter	= 3.3 feet
1 meter	= 1.1 yards
1 kilometer	= 0.6 mile
1 square centimeter	= 0.16 square inch
1 square meter	= 11 square feet
1 square meter	= 1.2 square yards
1 hectare +	= 2.5 acres
1 cubic centimeter	= 0.06 cubic feet
1 cubic meter	= 35 cubic feet
1 cubic meter	= 1.3 cubic yards
1 liter +	= 1 quart
1 cubic meter	= 250 gallons
1 gram	= 0.035 ounces (avdp)
1 kilogram	= 2.2 pounds (avdp)
1 kilowatt	= 1.3 horsepower

Conversions Accurate to Parts Per Million

inches X 25.4*	= millimeters
feet X 0.3048*	= meters
yards X 0.9144*	= meters
miles X 1.603 34	= kilometers
square inches X 6.4516*	= square centimeters
square feet X 0.92 903 0	= square meters
square yards X 0.836 127	= square meters
acres X 0.404 686	= hectares
cubic inches X 16.3871	= cubic centimeters
cubic feet X 0.028 316.8	= cubic meters
cubic yards X 0.764 555	= cubic meters
quarts (lq) X 0.946 353	= liters
gallons X 0.003 785 41	= cubic meters
ounces (avdp) X 28.3495	= grams
pounds (avdp) X 0.453 592	= kilograms
horsepower X 0.745 700	= kilowatts
millimeters X 0.039 370 1	= inchs
meters X 3.280 84	= feet
meters X 1.093 61	= yards
kilometers X 0.621 371	= miles
sq centimeters X 0.155 000	= square inchs
square meters X 10.7639	= square feet
square meters X 1.195 99	= square yards
hectares X 2.471 05	= acres
cu centimeters X 0.061 623 7	= cubic inches
cubic meters X 35.3147	= cubic feet
cubic meters X 1.307 95	= cubic yards
liters X 1.056 69	= quarts (lq)
cubic meters X 264.172	= gallons
grams 0.035 274 0	= ounces (avdp)
kilograms X 2.204 62	= pounds (avdp)
kilowatts 1.341 02	= horsepower

THESE PREFIXES MAY BE APPLIED TO ALL SI UNITS
Multiples and Submultiples

1 000 000 000 000	= 10^{12}
1 000 000 000	= 10^{9}
1 000 000	= 10^{6}
1000	= 10^{3}
100	= 10^{2}
10	= 10
0.1	= 10^{-1}
0.01	= 10^{-2}
0.001	= 10^{-3}
0.000 001	= 10^{-6}
0.000 000 001	= 10^{-9}
0.000 000 000 001	= 10^{-12}
0.000 000 000 000 001	= 10^{-15}
0.000 000 000 000 000 001	= 10^{-18}

Prefixes	Symbols
tara (ter'a)	T
giga (ji ga)	G
mega (meg'a)	M
kilo (kil o)	k+
hecto (hek'to)	h
deka (dek'a)	da
deci (des'i)	d
centi (sen'ti)	c+
milli (mil'i)	m+
micro (mi' kro)	*u+*
nano (nan'o)	n
pico (pe'ko)	p
femto (fem'to)	f
atto (at'to)	a

+ common term not used in S1 Source: NBS Special Pub. 304.

NOTE: The company reserves the right to change all dimensions without notice. For certified dimensions please contact Aalborg® Instruments and Controls.

EUROPEAN SERVICE CENTER

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TELEFON: +49 (07) 631.5545 ● **FAX:** +49 (07) 631.14740 ● **INTERNET:** www.analyt-mtc.de ● **E-MAIL:** info@analyt_mtc.de

**Keine Zertifizierung nach SGS ISO9001.*

PRODUCTS MANUFACTURED BY AALBORG®

ROTAMETERS

Single Tube
Aluminum / Brass / Stainless ● Interchangeable Glass Flow Tubes ● Optional Valves
Multiple Tube
Two to Six Channels ● Aluminum/ Stainless
PTFE Single and Multiple Tube
Chemically Inert ● 1 to 4 Channels ● Interchangeable Glass Flow tubes
Gas Proportioners
Aluminum / Stainless ● Used for Blending Two or Three Gases
Kits
Aluminum / Stainless / PTFE ● Including Five Glass Flow Tubes and a Set of Floats
PTFE - PFA
Chemically Inert ● Low to Medium Flow of Corrosive Liquids with PFA Flow Tube
Medium Range
Glass Safety Shield ● Dual Air and Water Scale
Optical Sensor Switch
Non-Invasive Means for Detection of a High or Low Flow
High Flow Industrial Stainless Steel Flow Meters
Heavy Duty Stainless Steel ● Direct Reading Air and Water Scales

VALVES

Barstock
Brass / Stainless ● Standard or High Precision
PTFE
Chemically Inert ● Needle or Metering
Proportionating Solenoid
Stainless ● For Controlling Gas or Liquid Flow ● Pulse width Modulated
SMV ● Stepping Motor Valve

ELECTRONIC METERS and CONTROLLERS

Low Cost Mass Flow Meters
Aluminum / Stainless ● With or Without LCD Readout
Low Cost Mass Flow Controllers
Aluminum / Stainless ● With or Without LCD Readout
Mass Flow Controllers
Stainless ● One to Four Channel Systems
Totalizer
Accumulation Up to 7 Digits
Digital Mass Flow Controller
Auto Zero ● Totalizer ● Alarms ● Built in RS485
Multi Parameter Digital Mass Flow Meter
Displays flow Pressure and Temperature
Vortex In-Line and Insertion Flow Meters
Steam / Liquid and Gas Service
Input / Output Devices
RS232 / RS485 - Converts Analog to Digital and Digital to Analog