

Rosemount 405 Compact Orifice Series

**INTEGRATED DESIGN FOR LIMITED
STRAIGHT PIPE RUN, CLOSED LOOP
CONTROL, AND GENERAL PURPOSE
MONITORING APPLICATIONS**

- *Reduced installation cost compared to a traditional orifice plate*
- *Machined in a single cast design*
- *Accurate and repeatable*
- *Self-centering*
- *Based on ASME/ISO corner tap design*



**Rosemount 3051SFC
Compact Orifice Flowmeter**



**Rosemount 3095MFC
Compact Orifice Mass
Flowmeter**

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The Rosemount 405 Compact Orifice Series

Best-in-Class Integrated DP Flowmeters

By integrating Rosemount pressure transmitters with the 405 Compact Orifice Series primary element, Rosemount provides the highest performing DP Flowmeters. This fully integrated flowmeter eliminates the need for fittings, tubing, valves, adapters, manifolds, and mounting brackets, thereby reducing welding and installation time.

Less Expensive than an Orifice Plate Installation

Direct mounting minimizes total installed cost by reducing engineering, procurement, labor, and material expenditures while offering unsurpassed utility.

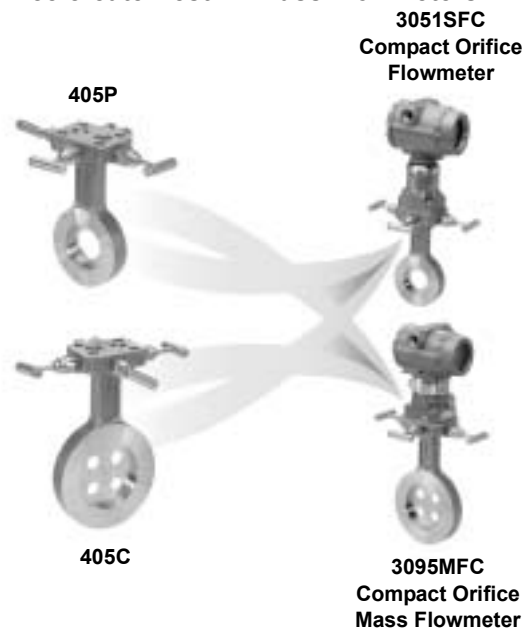
Machined from a Single Cast Part

A 3-valve isolation manifold and a 1-in. (25 mm) thick wafer-style body are machined from one cast part, eliminating all field connections between the process and the differential pressure-measuring device. The integral configuration results in a robust, inexpensive, and easy-to-install assembly.

Accurate and Repeatable

The 405C Conditioning Orifice is ideal for limited pipe run measurements in gas, liquid, or steam applications (8-in. (200 mm) nominal diameter and smaller lines). The 405C Conditioning Orifice delivers consistent and accurate measurements one would expect from traditional orifice plate technology.

Rosemount pressure transmitters combined with the Rosemount 405 Compact Orifice create Best-in-Class Flowmeters



Centering Mechanism

Improper centering of any orifice type device can cause an error of up to 5% in small line sizes. A centering mechanism independent of flange rating is standard with the 405 Compact Orifice Series.

Based on ASME/ISO Corner Tap Design

The incorporation of design features from proven standards results in a product that performs in a predictable manner and operates on well-known principles.

Rosemount DP Flow Solutions

Annubar Flowmeter Series: Rosemount 3051SFA, 3095MFA, and 485

The state-of-the-art, fifth generation Rosemount 485 Annubar combined with the 3051S or 3095MV MultiVariable transmitter creates an accurate, repeatable and dependable insertion-type flowmeter.

Compact Orifice Flowmeter Series: Rosemount 3051SFC, 3095MFC, and 405

Compact Orifice Flowmeters can be installed between existing flanges, up to a Class 600 (PN100) rating. In tight fit applications, a conditioning orifice plate version is available, requiring only two diameters of straight run upstream.

ProPlate Flowmeter Series: Rosemount ProPlate, Mass ProPlate, and 1195

These integral orifice flowmeters eliminate the inaccuracies that become more pronounced in small orifice line installations. The completely assembled, ready to install flowmeters reduce cost and simplify installation.

Orifice Plate Primary Element Systems: Rosemount 1495 and 1595 Orifice Plates, 1496 Flange Unions and 1497 Meter Sections

A comprehensive offering of orifice plates, flange unions and meter sections that is easy to specify and order. The 1595 Conditioning Orifice provides superior performance in tight fit applications.

405 Compact Orifice Series Selection Guide

Rosemount 3051SFC Compact Orifice Flowmeter

See ordering information on page 10.

- Combines the Rosemount 3051S scalable pressure transmitter with the 405 Compact Orifice Primary
- Accuracy of $\pm 0.85\%$ of volumetric flow rate in liquids
Accuracy of $\pm 1.30\%$ of volumetric flow rate in gas and steam
- Remote meter assembly enables direct mounting with “at-grade” operator interface
- FOUNDATION[®] fieldbus protocol available
- Ideal fluid type: liquid



**3051SFC Compact
Orifice Flowmeter**



**3095MFC Compact Orifice
Mass Flowmeter**

Rosemount 3095MFC Compact Orifice Mass Flowmeter

See ordering information on page 19.

- Combines the Rosemount 3095MV MultiVariable mass flow transmitter with the 405 Compact Orifice Primary
- Accuracy of $\pm 0.70\%$ of mass flow rate in gas and steam
- Measures differential pressure, static pressure, and process temperature (remotely) all in one flowmeter assembly
- Dynamically calculates compensated mass flow
- Ideal fluid types: gas and steam

Rosemount 405 Compact Orifice Primary

See ordering information on page 25.

- Integral manifold head allows direct mounting of DP transmitters
- Ideal fluid types: liquid, gas, and steam
- Accuracy of $\pm 0.5\%$ of discharge coefficient uncertainty
- Direct mounting capability to ANSI 600# rating
- Self-centering alignment ring



**405C Conditioning
Orifice 405P Compact
Orifice**

Rosemount 3051SFC Compact Orifice Flowmeter

SPECIFICATIONS

Performance

System Reference Accuracy

Percent (%) of volumetric flow rate

TABLE 1. 3051SFC Compact Orifice Flowmeter

Type	Beta	Liquid	Gas / Steam
Conditioning	0.4	0.85%	0.90%
Conditioning	0.65	1.30%	1.40%
Standard (1/2 to 1 1/2-in. line size)	0.4	2.00%	2.20%
Standard (1/2 to 1 1/2-in. line size)	0.65	2.00%	2.20%
Standard (2 to 8-in. line size)	0.4	1.40%	1.75%
Standard (2 to 8-in. line size)	0.65	1.40%	1.75%

Repeatability

±0.1%

Turndown

8:1 flow turndown

Line Sizes

- 1/2-in. (15 mm) – not available for the 3051SFCC
- 1-in. (25 mm) – not available or the 3051SFCC
- 1 1/2-in. (40 mm) – not available for the 3051SFCC
- 2-in. (50 mm)
- 3-in. (80 mm)
- 4-in. (100 mm)
- 6-in. (150 mm)
- 8-in. (200 mm)

Performance Statement Assumptions

- Density uncertainty is ±2.2 percent
- Measured pipe I.D
- Electronics are trimmed for optimum flow accuracy

Functional

Service

- Liquid
- Gas
- Steam

Process Temperature Limits

Direct Mount Electronics

- 450 °F (232 °C)

Remote Mount Electronics

- 850 °F (454 °C) – Stainless Steel

Electronics Temperature Limits

Ambient

- –40 to 185 °F (–40 to 85 °C)
- With Integral Mount LCD Display: –4 to 175 °F (–20 to 80 °C)

Storage

- –50 to 230 °F (–46 to 110 °C)
- With Integral Mount LCD Display: –40 to 185 °F (–40 to 85 °C)

Pressure Limits⁽¹⁾

Direct Mount Electronics

- Pressure retention per ANSI B16.5 600# or DIN PN 100

Power Supply

4–20 mA option

- External power supply required. Standard transmitter (4–20 mA) operates on 10.5 to 42.4 v dc with no load

FOUNDATION Fieldbus option

- External power supply required. Transmitters operate on 9.0 to 32.0 V dc transmitter terminal voltage

Range and Sensors Limits

Range	Minimum Span		Range and Sensor Limits	
	Ultra	Classic	Upper (URL)	Lower (LRL)
1A	0.5 inH ₂ O (1.24 mbar)	0.5 inH ₂ O (1.24 mbar)	25.0 inH ₂ O (0.0623 bar)	0 inH ₂ O (0 mbar)
2A	1.3 inH ₂ O (3.11 mbar)	2.5 inH ₂ O (6.23 mbar)	250.0 inH ₂ O (0.62 bar)	0 inH ₂ O (0 bar)
3A	5.0 inH ₂ O (12.4 mbar)	10.0 inH ₂ O (24.9 mbar)	1000.0 inH ₂ O (2.49 bar)	0 inH ₂ O (0 bar)

Turn-On Time

Performance within specifications less than 2.0 seconds after power is applied to the transmitter

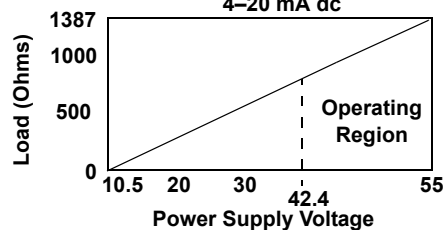
Damping

Analog output response to a step input change is user-selectable from 0 to 60 seconds for one time constant. This software damping is in addition to sensor module response time

Load Limitations

Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

$$\text{Max. Loop Resistance} = 43.5 \text{ (Power Supply Voltage} - 10.5) \text{ 4–20 mA dc}$$



HART communication requires a minimum loop resistance of 250 ohms.

Static Pressure Limits

- Range 1A: Operates within specification between static line pressures of 0.5 to 2000 psig (0.03 to 138 bar)
- Ranges 2A– 3A: Operates within specifications between static line pressures of 0.5 and 3626 psig (0.03 to 250 bar)

Humidity Limits

- 0–100% relative humidity

⁽¹⁾ Static pressure selection may effect pressure limitations.

Product Data Sheet

00813-0100-4810, Rev CB

October 2003

Rosemount 405 Compact Orifice Series

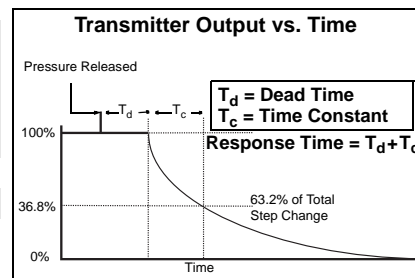
Dynamic Performance

	4 - 20 mA (HART®) ⁽¹⁾	FOUNDATION Fieldbus ⁽³⁾	Typical Transmitter Response Time
Total Response Time (Td + Tc)⁽²⁾:			
3051S_C, Ranges 2-5:	100 milliseconds	152 milliseconds	
Range 1:	255 milliseconds	307 milliseconds	
Range 0:	700 milliseconds	752 milliseconds	
3051S_T:	100 milliseconds	152 milliseconds	
3051S_L:	See Instrument Toolkit™	See Instrument Toolkit	
Dead Time (Td)	45 milliseconds (nominal)	97 milliseconds	
Update Rate	22 times per second	22 times per second	

(1) Dead time and update rate apply to all models and ranges; analog output only

(2) Nominal total response time at 75 °F (24 °C) reference conditions.

(3) Transmitter fieldbus output only; segment macro-cycle not included.



3051-3051_17A

Failure Mode Alarm

HART 4–20mA (output code A)

- If self-diagnostics detect a gross transmitter failure, the analog signal will be driven offscale to alert the user. Rosemount standard, NAMUR, and custom alarm levels are available (see Table 2 below)
- High or low alarm signal is software-selectable or hardware-selectable via the optional switch (option D1)

TABLE 2. Alarm Configuration

	High Alarm	Low Alarm
Rosemount	≥ 21.75 mA	≤ 3.75 mA
NAMUR compliant ⁽¹⁾	≥ 22.5 mA	≤ 3.6 mA
Custom levels ⁽²⁾	20.2 - 23.0 mA	3.6 - 3.8 mA

(1) Analog output levels are compliant with NAMUR recommendation NE 43 (June 27, 1996).

(2) Low alarm must be 0.1 mA less than low saturation and high alarm must be 0.1 mA greater than high saturation.

FOUNDATION Fieldbus (output code F)

- The AI block allows the user to configure HI-HI, HI, LO, or LO-LO, alarms

FOUNDATION Fieldbus (output code F)

Power Supply

- External power supply required; transmitters operate on 9.0 to 32.0 V dc transmitter terminal voltage

Current Draw

- 17.5 mA for all configurations (including LCD display option)

Overpressure Limits

Flowmeters withstand the following limits without damage:

- Range 1A: 2000 psig (138 bar)
- Ranges 2A–3A: 3626 psig (250 bar)

TABLE 3. Overpressure Limits⁽¹⁾

Standard	Type	Carbon Steel Rating	Stainless Steel Rating
ANSI/ASME	Class 150	285 (20)	275 (19)
ANSI/ASME	Class 300	740 (51)	720 (50)
ANSI/ASME	Class 600	1480 (102)	1440 (99)
At 100 °F (38 °C), the rating decreases with increasing temperature.			
DIN	PN 10/40	580 (40)	580 (40)
DIN	PN 10/16	232 (16)	232 (16)
DIN	PN 25/40	580 (40)	580 (40)
At 248 °F (120 °C), the rating decreases with increasing temperature.			

(1) Carbon Steel and Stainless Steel Ratings are measured in psig (bar).

Installation Considerations

Straight Run Requirements

TABLE 4. 3051SFCC Straight Pipe Requirements

	Beta	0.40	0.65
Upstream (inlet) side of primary	Reducer (1 line size)	2	2
	Single 90° bend or tee	2	2
	Two or more 90° bends in the same plane	2	2
	Two or more 90° bends in different plane	2	2
	Up to 10° of swirl	2	2
	Butterfly valve (75% open)	2	2
Downstream (outlet) side of primary		2	2

TABLE 5. 3051SFCP Straight Pipe Requirements⁽¹⁾

	Beta	0.40	0.65
Upstream (inlet) side of primary	Reducer	10	11
	Single 90° bend or tee	14	22
	Two or more 90° bends in the same plane	18	32
	Two or more 90° bends in different plane	36	54
	Expander	16	25
	Globe valve fully open	20	28
Downstream (outlet) side of primary	Gate valve fully open	12	16
		6	7

(1) Recommended lengths represented in pipe diameters per ISO 5167.

Pipe Orientation

Pipe orientation for both 3051SFCC Compact Conditioning and standard 3051SFCP Compact Orifice.

Orientation/ Flow Direction	Process ⁽¹⁾		
	Gas	Liquid	Steam
Horizontal	D/R	D/R	D/R
Vertical Up	R	D/R	R
Vertical Down	D/R	NR	NR

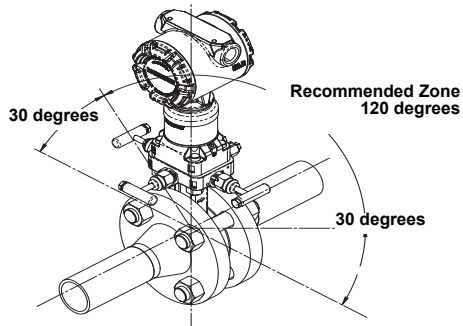
(1) D = Direct mount acceptable (recommended)
R = Remote mount acceptable
NR = Not recommended

Rosemount 405 Compact Orifice Series

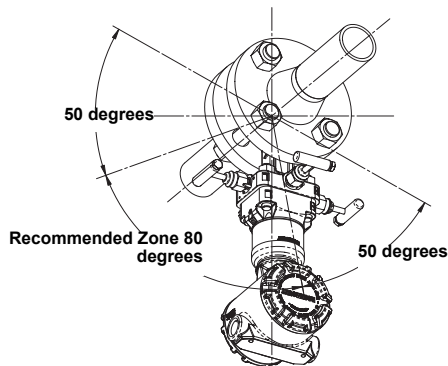
Flowmeter Orientation

Flowmeter orientation for both 3051SFC Conditioning Compact Orifice and standard Compact Orifice.

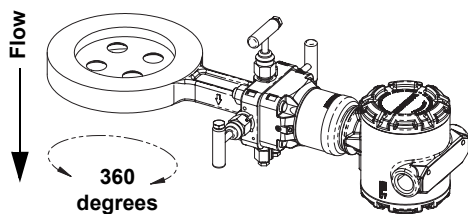
Gas (Horizontal)



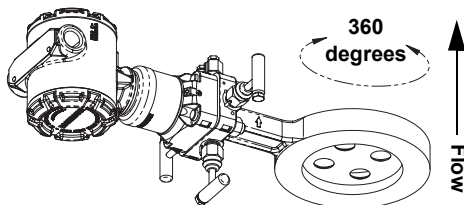
Liquid and Steam (Horizontal)



Gas (Vertical)



Liquid (Vertical)



Physical

Material of Construction

Body/Plate

- 316 SST

Flange Studs and Nuts

- Customer supplied
- Available as a spare part

Transmitter Connection Studs and Nuts

- Studs— A193 Grade B8M.
- Nuts— A194 Grade 8M.

Gasket and O-rings

- Gaskets are customer supplied.
- Durlon 8500 fiber gaskets are recommended. Consult factory for use with other gaskets.
- Available as a spare part

NOTE

Gaskets and O-rings must be replaced when the 405 is disassembled.

Transmitter Connections

Remote Mount

- Available with 1/4-in. (standard) or 1/2-in. (option code E) connections

Orifice Type

- Square edged
- Corner tapped
- Concentric
- Wafer-style

Weight

Line Size	Direct Mount (D3) ⁽¹⁾	Remote Mount (R3) ⁽¹⁾
1/2-in. (15 mm)	8.0 (3.63)	8.0 (3.63)
1-in. (25 mm)	8.5 (3.86)	8.5 (3.86)
1 1/2-in. (40 mm)	9.25 (4.20)	9.25 (4.20)
2-in. (50 mm)	10.0 (4.54)	10.0 (4.54)
3-in. (80 mm)	11.75 (5.33)	11.75 (5.33)
4-in. (100 mm)	13.5 (6.12)	13.5 (6.12)
6-in. (150 mm)	17.25 (7.83)	17.25 (7.83)
8-in. (200 mm)	21.75 (9.87)	21.75 (9.87)

(1) Measurement in lb (kg).

Product Data Sheet

00813-0100-4810, Rev CB

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Rosemount 405 Compact Orifice Series

Temperature Measurement

Remote RTD

- 100 Ohm platinum RTD, spring loaded with $\frac{1}{2}$ -in. NPT nipple and union
- Remote RTD material is the same as the specified pipe material

Thermowell

- $\frac{1}{2}$ -in. x $\frac{1}{2}$ -in NPT, 316 Stainless Steel with $\frac{1}{2}$ -in. Carbon Steel weld couplet

Electronic Connections for Remote Mount

$\frac{1}{2}$ –14 NPT, G $\frac{1}{2}$, and M20 x 1.5 (CM20) conduit. HART interface connections fixed to terminal block for output code A

Process Connections

Mounts between the following flange configurations:

ASME B16.5 (ANSI):

- Class 150
- Class 300
- Class 600

DIN:

- PN16
- PN40
- PN100

Bore Sizes (d)

For 3051SFCC, Beta (β) is calculated by $2 \times d$ / pipe size.

TABLE 6. $\beta = 0.4^{(1)(2)}$

Line Size	3051SFCC	3051SFCP
$\frac{1}{2}$ -in. (15 mm)	Not Available	0.249 (6.325)
1-in. (25 mm)	Not Available	0.420 (10.668)
1 $\frac{1}{2}$ -in. (40 mm)	Not Available	0.644 (16.358)
2-in. (50 mm)	0.413 (10.490) ⁽³⁾	0.827 (21.006)
3-in. (80 mm)	0.614 (15.596)	1.227 (31.166)
4-in. (100 mm)	0.805 (20.447)	1.610 (40.894)
6-in. (150 mm)	1.213 (30.810)	2.426 (61.620)
8-in. (200 mm)	1.596 (40.538)	3.192 (81.077)

(1) Measurement is in inches (millimeters)

(2) Tolerance = ± 0.002 -in.

(3) Beta (β) = 0.60-in. (15.24 mm) for 2-in. line size only.

TABLE 7. $\beta = 0.65^{(1)(2)}$

Line Size	3051SFCC	3051SFCP
$\frac{1}{2}$ -in. (15 mm)	Not Available	0.404 (10.262)
1-in. (25 mm)	Not Available	0.682 (17.323)
1 $\frac{1}{2}$ -in. (40 mm)	Not Available	1.047 (26.594)
2-in. (50 mm)	0.620 (15.748) ⁽³⁾	1.344 (34.138)
3-in. (80 mm)	0.997 (25.324)	1.994 (50.648)
4-in. (100 mm)	1.308 (33.223)	2.617 (66.472)
6-in. (150 mm)	1.971 (50.063)	3.942 (100.127)
8-in. (200 mm)	2.594 (65.88)	5.188 (131.775)

(1) Measurement is in inches (millimeters)

(2) Tolerance = ± 0.002 -in.

(3) Beta (β) = 0.60-in. (15.24 mm) for 2-in. line size only.

PRODUCT CERTIFICATIONS

Approved Manufacturing Locations

Rosemount Inc. — Chanhassen, Minnesota USA
Fisher-Rosemount GmbH & Co. — Wessling, Germany
Emerson Process Management Asia Pacific Private Limited — Singapore
Beijing Rosemount Far East Instrument Co., LTD — Beijing, China

European Directive Information

The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting our local sales office.

ATEX Directive (94/9/EC)

Emerson Process Management complies with the ATEX Directive.

European Pressure Equipment Directive (PED) (97/23/EC)

3051S_CA4; 3051S_CD2, 3, 4, 5; (also with P9 option)
Pressure Transmitters — QS Certificate of Assessment - EC No. PED-H-20, Module H Conformity Assessment

All other 3051S Pressure Transmitters —
Sound Engineering Practice

Transmitter Attachments: Diaphragm Seal - Process Flange -
Manifold — Sound Engineering Practice

3051SFC Compact Orifice Flowmeter —
Sound Engineering Practice

Electro Magnetic Compatibility (EMC) (89/336/EEC)

All Models: EN 50081-1: 1992; EN 50082-2: 1995;
EN 61326-1: 1997 – Industrial

Ordinary Location Certification for Factory Mutual

As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

Rosemount 405 Compact Orifice Series

Hazardous Locations Certifications

North American Certifications

Factory Mutual (FM)

E5 Explosion proof for Class I, Division 1, Groups B, C, and D; dust-ignition proof for Class II and Class III, Division 1, Groups E, F, and G; hazardous locations; enclosure Type 4X, conduit seal not required when installed according to Rosemount drawing 03151-1003.

I5/IE Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 when connected in accordance with Rosemount drawing 03151-1006; Temperature Code T4; Non-incendive for Class I, Division 2, Groups A, B, C, and D), Enclosure Type 4X

For entry parameters see control drawing 03151-1006.

Canadian Standards Association (CSA)

E6 Explosion-Proof for Class I, Division 1, Groups B, C, and D; Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G; suitable for Class I, Division 2, Groups A, B, C, and D, when installed per Rosemount drawing 03151-1013, CSA Enclosure Type 4X; conduit seal not required.

I6 Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 03151-1016; Temperature Code T3C

For entry parameters see control drawing 03151-1016.

European Certifications


I1 ATEX Intrinsic Safety
Certificate No.: BAS01ATEX1303X  II 1G
EEx ia IIC T5 (-60°C ≤ Ta ≤ 40°C)
T4 (-60°C ≤ Ta ≤ 70°C)
CE 1180

TABLE 8. Input Parameters

Loop / Power	Groups
U _i = 30V	All
I _i = 300 mA	All
P _i = 1.0W	HART/4-20mA
C _i = 30nF	SuperModule™
C _i = 11.4nF	With a Housing option
C _i = 0	Remote Display
L _i = 0	All Except Remote Display
L _i = 60 μH	Remote Display

Special Conditions for Safe Use (X)

The apparatus, excluding the Types 3051 S-T and 3051 S-C (In-line and Coplanar SuperModules respectively), is not capable of withstanding the 500V test as defined in Clause 6.4.12 of EN 50020. This must be considered during installation. The terminal pins of the Types 3051 S-T and 3051 S-C must be protected to IP20 minimum.



N1 ATEX Non-incendive
Certificate No.: BAS01ATEX3304X  II 3 G
EEx nL IIC T5 (Ta = -40 °C TO 70 °C)

TABLE 9. Input Parameters

Loop / Power	Groups
U _i = 45V dc	All
C _i = 11.4nF	HART/4-20mA
L _i = 0	All


Special Conditions for Safe Use (x)

The apparatus is not capable of withstanding the 500V insulation test required by Clause 9.1 of EN 50021: 1999. This must be taken into account when installing the apparatus.

ND ATEX Dust
Certificate No.: BAS01ATEX1374X  II 1 D
T105°C (T_{amb} = -20°C to 85°C)
V_{max} = 42.4 V
A = 22 mA
IP66
CE 1180

Special Conditions for Safe Use (x)

1. The user must ensure that the maximum rated voltage and current (42.4 volts, 22 milliamps, DC) are not exceeded. All connections to other apparatus or associated apparatus shall have control over this voltage and current equivalent to a category "ib" circuit according to EN 50020.
2. Cable entries must be used which maintain the ingress protection of the enclosure to at least IP66.
3. Unused cable entries must be filled with suitable blanking plugs which maintain the ingress protection of the enclosure to at least IP66.
4. Cable entries and blanking plugs must be suitable for the ambient range of the apparatus and capable of withstanding a 7J impact test.
5. The 3051S must be securely screwed in place to maintain the ingress protection of the enclosure.

E1 ATEX Flame-Proof
Certificate No.: KEMA 00ATEX 2143X  II 1/2 G
EEx d IIC T6 (T_{amb} = -50 °C to 65 °C)
EEx d IIC T5 (T_{amb} = -50 °C to 80 °C)
V_{max} = 42.4V
CE 1180

Special conditions for safe use (x)

This device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime. The 3051S pressure transmitter must include a Series 300S housing integrally mounted to a Series 3051S Sensor module as per Rosemount drawing 03151-1023.

Combinations of Certifications

Stainless steel certification tag is provided when optional approval is specified. Once a device labeled with multiple approval types is installed, it should not be reinstalled using any other approval types. Permanently mark the approval label to distinguish it from unused approval types.

- K1** Combination of **E1**, **I1**, and **N1**
- K4** Combination of **E4** and **I4**
- K5** Combination of **E5** and **I5**
- K6** Combination of **E6** and **I6**
- KA** Combination of **E1**, **I1**, **E6**, and **I6**
- KB** Combination of **E5**, **I5**, **I6** and **E6**
- KC** Combination of **E5**, **E1**, **I5** and **I1**

Rosemount 405 Compact Orifice Series

DIMENSIONAL DRAWINGS

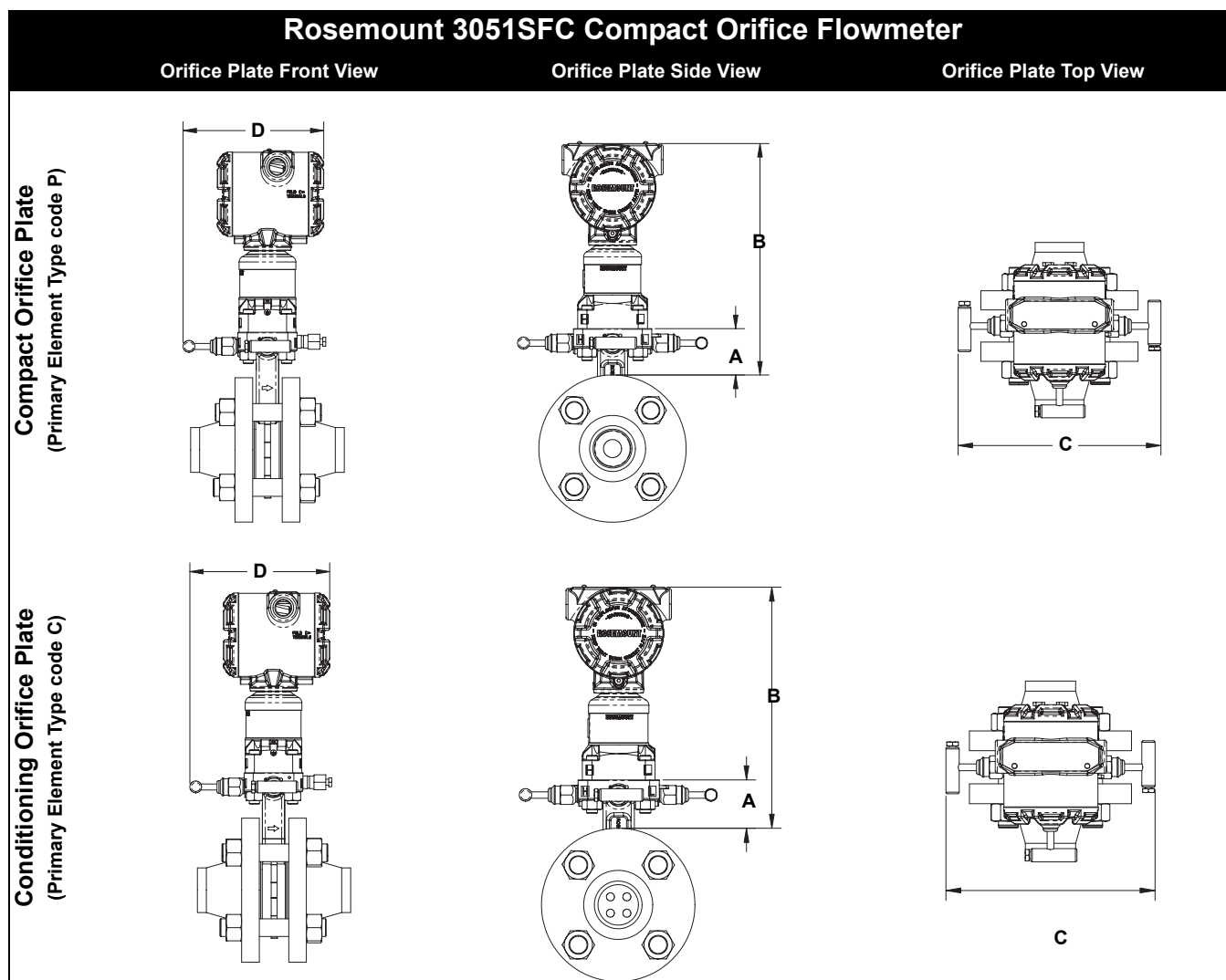


TABLE 10. Dimensional Drawings

Plate Type	A	B	Transmitter Height	C	D
Type P	see chart below	Transmitter Height + A	7.75-in. (197 mm)	7.91-in. (200 mm) - closed 8.65-in. (220 mm) - open	6.00-in. (152 mm) - closed 6.25-in. (159 mm) - open
Type C	see chart below	Transmitter Height + A	7.75-in. (197 mm)	7.91-in. (200 mm) - closed 8.65-in. (220 mm) - open	6.00-in. (152 mm) - closed 6.25-in. (159 mm) - open

Flange Rating	Line Size ⁽¹⁾							
	0.5 ⁽²⁾	1 ⁽²⁾	1.5 ⁽²⁾	2	3	4	6	
300# (PN 40)	2.225 (56.52)	2.050 (52.07)	1.930 (49.02)	1.990 (50.55)	1.925 (48.90)	2.040 (48.90)	3.050 (77.49)	3.050 (77.47)
600# (PN 100)	2.225 (56.52)	2.050 (52.07)	1.930 (49.02)	1.990 (50.55)	1.925 (48.90)	1.665 (42.29)	2.300 (58.42)	2.300 (58.42)

(1) Measurement is in inches (millimeters).

(2) Plate type option P only.

Rosemount 405 Compact Orifice Series

ORDERING INFORMATION

Rosemount 3051SFC Compact Orifice Flowmeter Ordering Information

Model	Product Description		
3051SFC	Compact Orifice Flowmeter		
Code	Primary Element Type		
DC	Conditioning Orifice Plate		
DP	Orifice Plate		
Code	Material Type		
S	316 Stainless Steel (SST)		
Code	Line Size		
005 ⁽¹⁾	1/2-in. (15 mm)		
010 ⁽¹⁾	1-in. (25 mm)		
015 ⁽¹⁾	1 1/2-in. (40 mm)		
020	2-in. (50 mm)		
030	3-in. (80 mm)		
040	4-in. (100 mm)		
060	6-in. (150 mm)		
080	8-in. (200 mm)		
Code	Primary Element Style		
N	Square Edged		
Code	Beta Ratio		
040	0.40 Beta Ratio (β)		
065	0.65 Beta Ratio (β)		
Code	Temperature Measurement		
R	Remote Thermowell and RTD		
0	No Temperature Sensor		
9	Special		
Code	Electronics Connection Platform		
3	Direct-mount, 3-valve integral manifold, SST		
7	Remote-mount, 1/4-in. NPT connections		
Code	Differential Pressure Range		
1A	0 to 25 in H ₂ O (0 to 62.2 mbar)		
2A	0 to 250 in H ₂ O (0 to 623 mbar)		
3A	0 to 1000 in H ₂ O (0 to 2.5 bar)		
Code	Output Protocol		
A	4–20 mA with digital signal based on HART protocol		
F	FOUNDATION fieldbus: AI block, Link Master, Input Selector Block (requires PlantWeb housing)		
Code	Electronics Housing Style	Material	Conduit Entry Size
1A	PlantWeb Housing	Aluminum	1/2-14 NPT
1B	PlantWeb Housing	Aluminum	M20 x 1.5 (CM20)
1C	PlantWeb Housing	Aluminum	G1/2
1J	PlantWeb Housing	316L SST	1/2-14 NPT
1K	PlantWeb Housing	316L SST	M20 x 1.5 (CM20)
1L	PlantWeb Housing	316L SST	G1/2
2A	Junction Box Housing	Aluminum	1/2-14 NPT
2B	Junction Box Housing	Aluminum	M20 x 1.5 (CM20)
2C	Junction Box Housing	Aluminum	G1/2
2E	Junction Box Housing with remote mount meter output	Aluminum	1/2-14 NPT
2F	Junction Box Housing with remote mount meter output	Aluminum	M20 x 1.5 (CM20)
2G	Junction Box Housing with remote mount meter output	Aluminum	G1/2
2J	Junction Box Housing	316L SST	1/2-14 NPT
2M	Junction Box with remote mount meter output	316L SST	1/2-14 NPT

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Rosemount 405 Compact Orifice Series

Rosemount 3051SFC Compact Orifice Flowmeter Ordering Information

Code	Electronics Performance Class
1	3051S Ultra
2	3051S Classic
3	High Accuracy DP Flow Transmitter
Code	Options
Installation Accessories	
G	DIN alignment ring (PN 16)
H	DIN alignment ring (PN 40, PN 100)
Remote Adapters	
E	Flange adapters 316 SST (¹ / ₂ -in. NPT)
High Temperature Applications	
T	Graphite valve packing (Tmax = 850 °F)
Flow Calibration	
WC	Flow calibration certification (3 points)
WD	Discharge coefficient verification (full 10 points)
Special Cleaning	
P2	Cleaning for special processes
PA	Cleaning per ASTM G93 Level D (section 11.4)
Special Inspection	
QC1	Visual and Dimensional Inspection with certification
QC7	Inspection and performance certification
Transmitter Calibration Certification	
Q4	Calibration data certificate for transmitter
Material Traceability Certification	
Q8	Material certification per ISO 10474 3.1.B and EN 10204 3.1.B
Code Conformance	
J2	ANSI B31.1
J3	ANSI B31.3
J4	ANSI B31.8
J5 ⁽²⁾	NACE MR-0175-91
Country Certification	
J1	Canadian Registration
Product Certifications	
E1	ATEX Flame-Proof
I1	ATEX Intrinsic Safety
N1	ATEX Type N
K1	ATEX Flame-Proof, Intrinsic Safety, Type N (combination of E1, I1, and N1)
ND	ATEX Combustible Dust
E5	FM Explosion-Proof
I5	FM Intrinsic Safety and Non-Incendive
K5	FM Explosion-Proof, Intrinsic Safety, and Non-Incendive
E6	CSA Explosion-Proof
I6	CSA Intrinsic Safety and Non-Incendive
K6	CSA Explosion-Proof, Intrinsic Safety, and Non-Incendive
KA	ATEX and CSA Flame-Proof and Intrinsic Safety (combination of E1, I1, E6, and I6)
KB	FM and CSA Explosion-Proof and Intrinsic Safety (combination of E5, E6, and I6)
KC	FM and ATEX Explosion-Proof and Intrinsic Safety (combination of E5, E1, I5, and I1)
Alternative Transmitter Material of Construction	
L1	Inert Sensor Fill Fluid
L2	Graphite-filled Teflon® (PTFE) o-ring
LA	Inert sensor fill fluid and graphite-filled Teflon (PTFE) o-ring
Display	
M5	PlantWeb LCD display (requires PlantWeb housing)
M8	Remote mount LCD display and interface, PlantWeb housing, 50 foot cable, SST bracket ⁽³⁾
M9	Remote mount LCD display and interface, PlantWeb housing, 100 foot cable, SST bracket ⁽³⁾

Rosemount 405 Compact Orifice Series

Rosemount 3051SFC Compact Orifice Flowmeter Ordering Information

Terminal Blocks

T1 Transient Protection

Manifold for Remote Mount Option

F2 3-Valve Manifold, SST

F6 5-Valve Manifold, SST

PlantWeb Control Anywhere Software

A01 Regulatory control suite: PID, arith, signal char, integ, etc. (requires PlantWeb housing and FOUNDATION fieldbus)

PlantWeb Advanced Diagnostic Software

D01 Diagnostics suite: Plugged Impulse Line and SPM diagnostics (requires PlantWeb housing and FOUNDATION fieldbus)

Alarm Limits

C4⁽³⁾ NAMUR alarm and saturation signal levels, high alarm

C5⁽³⁾ NAMUR alarm and saturation signal levels, low alarm

C6⁽³⁾ Custom alarm and saturation signal levels, high alarm

C7⁽³⁾ Custom alarm and saturation signal levels, low alarm

C8⁽³⁾ Low alarm (standard Rosemount alarm and saturation signal levels)

Special Transmitter Configuration (Hardware)

D1⁽³⁾ Hardware Adjustment (zero, span, security)

D4 External ground screw

DA⁽³⁾ Hardware adjustment (zero, span, security) and external ground screw

Primary Specials

Exxxx Specials

Transmitter Specials

Axxxx Specials

(1) Not available for Primary Element Type code C.

(2) Materials of Construction meet NACE material recommendation per MR 01-75. Environmental limits apply to certain materials. Consult latest standard for details.

(3) Not available with FOUNDATION fieldbus protocol.

Rosemount 3095MFC Compact Orifice Mass Flowmeter

SPECIFICATIONS

Performance

System Reference Accuracy

Percent (%) of mass flow rate

TABLE 11. 3095MFC Compact Orifice Flowmeter

Type	Beta	Liquid	Gas / Steam
Conditioning	0.4	0.70%	0.70%
Conditioning	0.65	0.90%	0.90%
Standard (1/2 to 1 1/2-in. line size)	0.4	1.90%	1.90%
Standard (1/2 to 1 1/2-in. line size)	0.65	1.90%	1.90%
Standard (2 to 8-in. line size)	0.4	1.40%	1.40%
Standard (2 to 8-in. line size)	0.65	1.40%	1.40%

Repeatability

±0.1%

Turndown

8:1 flow turndown

Line Sizes

- 1/2-in. (15 mm) – not available for the 3095MFCC
- 1-in. (25 mm) – not available for the 3095MFCC
- 1 1/2-in. (40 mm) – not available for the 3095MFCC
- 2-in. (50 mm)
- 3-in. (80 mm)
- 4-in. (100 mm)
- 6-in. (150 mm)
- 8-in. (200 mm)

Performance Statement Assumptions

- Measured pipe I.D
- Electronics are trimmed for optimum flow accuracy

Functional

Service

- Liquid
- Gas
- Steam

Process Temperature Limits

Direct Mount Electronics

- 450 °F (232 °C)

Remote Mount Electronics

- 850 °F (454 °C) – Stainless Steel

Electronics Temperature Limits

Ambient

- –40 to 185 °F (–40 to 85 °C)
- With Integral Mount LCD Display: –4 to 175 °F (–20 to 80 °C)

Storage

- –50 to 230 °F (–46 to 110 °C)
- With Integral Mount LCD Display: –40 to 185 °F (–40 to 85 °C)

Pressure Limits⁽¹⁾

Direct Mount Electronics

- Pressure retention per ANSI B16.5 600# or DIN PN 100

Power Supply

4–20 mA option

- External power supply required. Standard transmitter (4–20 mA) operates on 11 to 55 v dc with no load

Output Protocol

Two-wire 4–20 mA, user-selectable for DP, AP, GP, PT, mass flow, or totalized flow. Digital HART protocol superimposed on 4–20 mA signal, available to any host that conforms to the HART protocol.

Turn-On Time

Digital and analog measured variables will be within specification 7 – 10 seconds after power is applied to the transmitter.

Digital and analog flow output will be within specifications 10 – 14 seconds after power is applied to the transmitter.

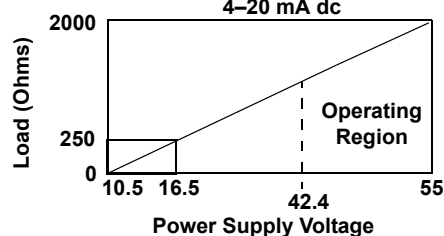
Damping

Analog output response to a step input change is user-selectable from 0 to 29 seconds for one time constant. This software damping is in addition to sensor module response time

Load Limitations

Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

$$\text{Max. Loop Resistance} = \frac{\text{Power Supply Voltage} - 11.0}{0.022}$$



For CSA approval, power supply must not exceed 42.4 V dc. HART communication requires a minimum loop resistance of 250 ohms.

Static Pressure Limits

- Operates within specification between static pressures of 0.5 psia (34 mbar) and the URL of the absolute pressure sensor.

Humidity Limits

- 0–100% relative humidity

Failure Mode Alarm

HART 4–20mA (output code A)

- If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 3.75 mA or above 21.7 mA to alert the user. High or low alarm signal is user-selectable by internal jumper.)

(1) Static pressure selection may effect pressure limitations.

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Overpressure Limits

- Zero to two times the absolute pressure range with a maximum of 3626 psia (250 bar).

Installation Considerations

Straight Run Requirements

TABLE 12. 3095MFCC Straight Pipe Requirements

Upstream (inlet) side of primary	Beta	0.40	0.65
	Reducer (1 line size)	2	2
	Single 90° bend or tee	2	2
	Two or more 90° bends in the same plane	2	2
	Two or more 90° bends in different plane	2	2
	Up to 10° of swirl	2	2
	Butterfly valve (75% open)	2	2
Downstream (outlet) side of primary		2	2

TABLE 13. 3095MFCP Straight Pipe Requirements⁽¹⁾

Upstream (inlet) side of primary	Beta	0.40	0.65
	Reducer	10	11
	Single 90° bend or tee	14	22
	Two or more 90° bends in the same plane	18	32
	Two or more 90° bends in different plane	36	54
	Expander	16	25
	Globe valve fully open	20	28
	Gate valve fully open	12	16
Downstream (outlet) side of primary		6	7

(1) Recommended lengths represented in pipe diameters per ISO 5167.

Pipe Orientation

Pipe orientation for both 3095MFCC Compact Conditioning Mass Orifice and standard 3095MFCP Compact Mass Orifice.

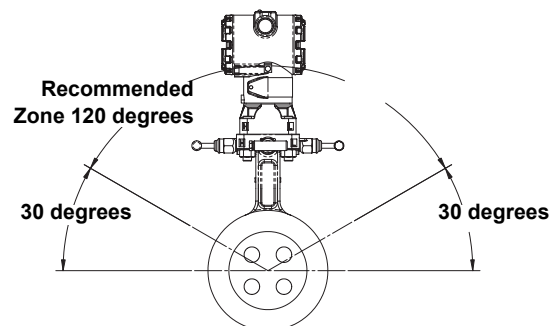
Orientation/ Flow Direction	Process ⁽¹⁾		
	Gas	Liquid	Steam
Horizontal	D/R	D/R	D/R
Vertical Up	R	D/R	R
Vertical Down	D/R	NR	NR

(1) D = Direct mount acceptable (recommended)
R = Remote mount acceptable
NR = Not recommended

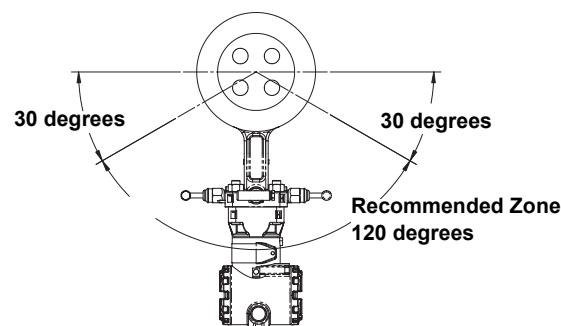
Flowmeter Orientation

Flowmeter orientation for both 3095MFC Conditioning Compact Orifice and standard Compact Orifice.

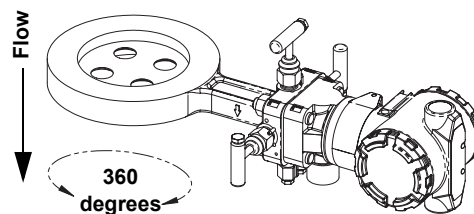
Gas (Horizontal)



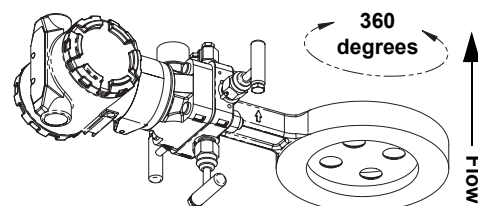
Liquid and Steam (Horizontal)



Gas (Vertical)



Liquid (Vertical)



Physical

Material of Construction

Body/Plate

- 316 SST

Flange Studs and Nuts

- Customer supplied
- Available as a spare part

Transmitter Connection Studs and Nuts

- Studs— A193 Grade B8M.
- Nuts— A194 Grade 8M.

Gasket and O-rings

- Gaskets are customer supplied.
- Durlon 8500 fiber gaskets are recommended. Consult factory for use with other gaskets.
- Available as a spare part

NOTE

Gaskets and O-rings must be replaced when the 405 is disassembled.

Transmitter Connections

Remote Mount

- Available with $\frac{1}{4}$ -in. (standard) or $\frac{1}{2}$ -in. (option code E) connections

Orifice Type

- Square edged
- Corner tapped
- Concentric
- Wafer-style

Weight

Line Size (in.)	Direct Mount (D3) ⁽¹⁾	Remote Mount (R3) ⁽¹⁾
$\frac{1}{2}$ -in. (15 mm)	8.0 (3.63)	8.0 (3.63)
1-in. (25 mm)	8.5 (3.86)	8.5 (3.86)
$1\frac{1}{2}$ -in. (40 mm)	9.25 (4.20)	9.25 (4.20)
2-in. (50 mm)	10 (4.54)	10 (4.54)
3-in. (80 mm)	11.75 (5.33)	11.75 (5.33)
4-in. (100 mm)	13.5 (6.12)	13.5 (6.12)
6-in. (150 mm)	17.25 (7.83)	17.25 (7.83)
8-in. (200 mm)	21.75 (9.87)	21.75 (9.87)

(1) Measurement in lb (kg).

Temperature Measurement

Remote RTD

- 100 Ohm platinum RTD, spring loaded with $\frac{1}{2}$ -in. NPT nipple and union
- Remote RTD material is the same as the specified pipe material

Thermowell

- $\frac{1}{2}$ -in. x $\frac{1}{2}$ -in NPT, 316 Stainless Steel with $\frac{1}{2}$ -in. Carbon Steel weld couplet

Electronic Connections for Remote Mount

$\frac{1}{2}$ –14 NPT, G $\frac{1}{2}$, and M20 × 1.5 (CM20) conduit. HART interface connections fixed to terminal block for output code A

Process Connections

Mounts between the following flange configurations:

ASME B16.5 (ANSI):

- Class 150
- Class 300
- Class 600

DIN:

- PN16
- PN40
- PN100

Bore Sizes (d)

For 3095MFCC, Beta (β) is calculated by $2 \times d$ / pipe size.

TABLE 14. $\beta = 0.4^{(1)(2)}$

Line Size	3095MFCC	3095MFCP
$\frac{1}{2}$ -in. (15 mm)	Not Available	0.249 (6.325)
1-in. (25 mm)	Not Available	0.420 (10.668)
$1\frac{1}{2}$ -in. (40 mm)	Not Available	0.644 (16.358)
2-in. (50 mm)	0.413 (10.490) ⁽³⁾	0.827 (21.006)
3-in. (80 mm)	0.614 (15.596)	1.227 (31.166)
4-in. (100 mm)	0.805 (20.447)	1.610 (40.894)
6-in. (150 mm)	1.213 (30.810)	2.426 (61.620)
8-in. (200 mm)	1.596 (40.538)	3.192 (81.077)

(1) Measurement is in inches (millimeters)

(2) Tolerance = ± 0.002 -in.

(3) Beta (β) = 0.60-in. (15.24 mm) for 2-in. line size only.

TABLE 15. $\beta = 0.65^{(1)(2)}$

Line Size	3095MFCC	3095MFCP
$\frac{1}{2}$ -in. (15 mm)	Not Available	0.404 (10.262)
1-in. (25 mm)	Not Available	0.682 (17.323)
$1\frac{1}{2}$ -in. (40 mm)	Not Available	1.047 (26.594)
2-in. (50 mm)	0.620 (15.748) ⁽³⁾	1.344 (34.138)
3-in. (80 mm)	0.997 (25.324)	1.994 (50.648)
4-in. (100 mm)	1.308 (33.223)	2.617 (66.472)
6-in. (150 mm)	1.971 (50.063)	3.942 (100.127)
8-in. (200 mm)	2.594 (65.88)	5.188 (131.775)

(1) Measurement is in inches (millimeters)

(2) Tolerance = ± 0.002 -in.

(3) Beta (β) = 0.60-in. (15.24 mm) for 2-in. line size only.

PRODUCT CERTIFICATIONS

Approved Manufacturing Locations

Rosemount Inc. — Chanhassen, Minnesota USA
Fisher-Rosemount GmbH & Co. — Wessling, Germany
Emerson Process Management Asia Pacific
Private Limited — Singapore
Beijing Rosemount Far East Instrument Co., LTD — Beijing, China

European Directive Information

The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting our local sales office.

ATEX Directive (94/9/EC)

Emerson Process Management complies with the ATEX Directive.

European Pressure Equipment Directive (PED) (97/23/EC)

3095F_2/3,4/D and 3095M_2/3,4/D Flow Transmitters — QS
Certificate of Assessment - EC No. PED-H-20
Module H Conformity Assessment

All other 3095_ Transmitters/Level Controller —
Sound Engineering Practice

Transmitter Attachments: Process Flange - Manifold —
Sound Engineering Practice

3095MFC Compact Orifice Mass Flowmeter —
Sound Engineering Practice

Electro Magnetic Compatibility (EMC) (89/336/EEC)

3095MV Flow Transmitters
— EN 50081-1: 1992; EN 50082-2:1995;
EN 61326-1:1997 — Industrial

Ordinary Location Certification for Factory Mutual

As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

Hazardous Locations Certifications

North American Certifications

Factory Mutual (FM)

- E5 Explosion Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II/Class III, Division 1, Groups E, F, and G. Enclosure type NEMA 4X. Factory Sealed. Provides nonincendive RTD connections for Class I, Division 2, Groups A, B, C, and D.
- I5 Combination of Approval Code A and the following:
Intrinsically Safe for use in Class I, II and III, Division 1, Groups A, B, C, D, E, F, and G hazardous outdoor locations. Non-incendive for Class I, Division 2, Groups A, B, C, and D. Temperature Code T4. Factory Sealed.
For input parameters and installation see control drawing 03095-1020.

Canadian Standards Association (CSA) Approvals

- E6 Explosion Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II/Class III, Division 1, Groups E, F, and G. CSA enclosure Type 4X suitable for indoor and outdoor hazardous locations. Provides nonincendive RTD connection for Class I, Division 2, Groups A, B, C, and D. Factory Sealed. Install in accordance with Rosemount Drawing 03095-1024. Approved for Class I, Division 2, Groups A, B, C, and D.
- K6 Combination of Approval Code C and the following:
Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D when installed in accordance with Rosemount drawing 03095-1021. Temperature Code T3C.

For input parameters see control drawing 03095-1020.

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European Certifications

I1 ATEX Intrinsic Safety Certification

Certificate Number: BAS98ATEX1359X  II 1 G

EEx ia IIC T5 ($T_{amb} = -45^{\circ}\text{C}$ to 40°C)

EEx ia IIC T4 ($T_{amb} = -45^{\circ}\text{C}$ to 70°C) **CE** 1180

TABLE 16. Connection Parameters

(Power/Signal Terminals)

$U_i = 30\text{V}$

$I_i = 200\text{mA}$

$P_i = 1.0\text{W}$

$C_i = 0.012\text{ }\mu\text{F}$

$L_i = 0$

TABLE 17. Temperature Sensor Connection Parameters

$U_o = 30\text{V}$

$I_o = 19\text{mA}$

$P_o = 140\text{mW}$

$C_i = 0.002\text{ }\mu\text{F}$

$L_i = 0$

TABLE 18. Connection Parameters for
Temperature Sensor Terminals

$C_o = 0.066\text{ }\mu\text{F}$ Gas Group IIC

$C_o = 0.560\text{ }\mu\text{F}$ Gas Group IIB

$C_o = 1.82\text{ }\mu\text{F}$ Gas Group IIA

$L_o = 96\text{ mH}$ Gas Group IIC

$L_o = 365\text{ mH}$ Gas Group IIB

$L_o = 696\text{ mH}$ Gas Group IIA

$L_o/R_o = 247\text{ }\mu\text{H}/\text{ohm}$ Gas Group IIC


$L_o/R_o = 633\text{ }\mu\text{H}/\text{ohm}$ Gas Group IIB

$L_o/R_o = 633\text{ }\mu\text{H}/\text{ohm}$ Gas Group IIA

Special Conditions for Safe Use

The 3095, when fitted with the transient terminal block (order code B), are not capable of withstanding the 500 volts insulation test required by EN50 020, Clause 6.4.12 (1994). This condition must be accounted for during installation.

N1 ATEX Type N Certification

Certificate Number: BAS98ATEX3360X  II 3 G

EEx nL IIC T5 ($T_{amb} = -45^{\circ}\text{C}$ to 40°C)

EEx nL IIC T4 ($T_{amb} = -45^{\circ}\text{C}$ to 70°C)

$U_i = 55\text{V}$


CE

The apparatus is designed for connection to a remote temperature sensor such as a resistance temperature detection (RTD)

Special Conditions for Safe Use

The 3095, when fitted with the transient terminal block (order code B), are not capable of withstanding the 500 volts insulation test required by EN50 021, Clause 9.1 (1995). This condition must be accounted for during installation.

E1 ATEX Flameproof Certification

Certificate Number: KEMA02ATEX2320X  II 1/2 G

EEx d IIC T5 ($-50^{\circ}\text{C} \leq T_{amb} \leq 80^{\circ}\text{C}$)

T6 ($-50^{\circ}\text{C} \leq T_{amb} \leq 65^{\circ}\text{C}$)

CE 1180

ND ATEX Dust Certification

Certificate Number: KEMA02ATEX2321X  II 1 D

T90°C ($-50^{\circ}\text{C} \leq T_{amb} \leq 80^{\circ}\text{C}$)

$V = 55\text{Vdc MAX}$

$I = 23\text{mAdc MAX}$

IP66

CE 1180

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DIMENSIONAL DRAWINGS

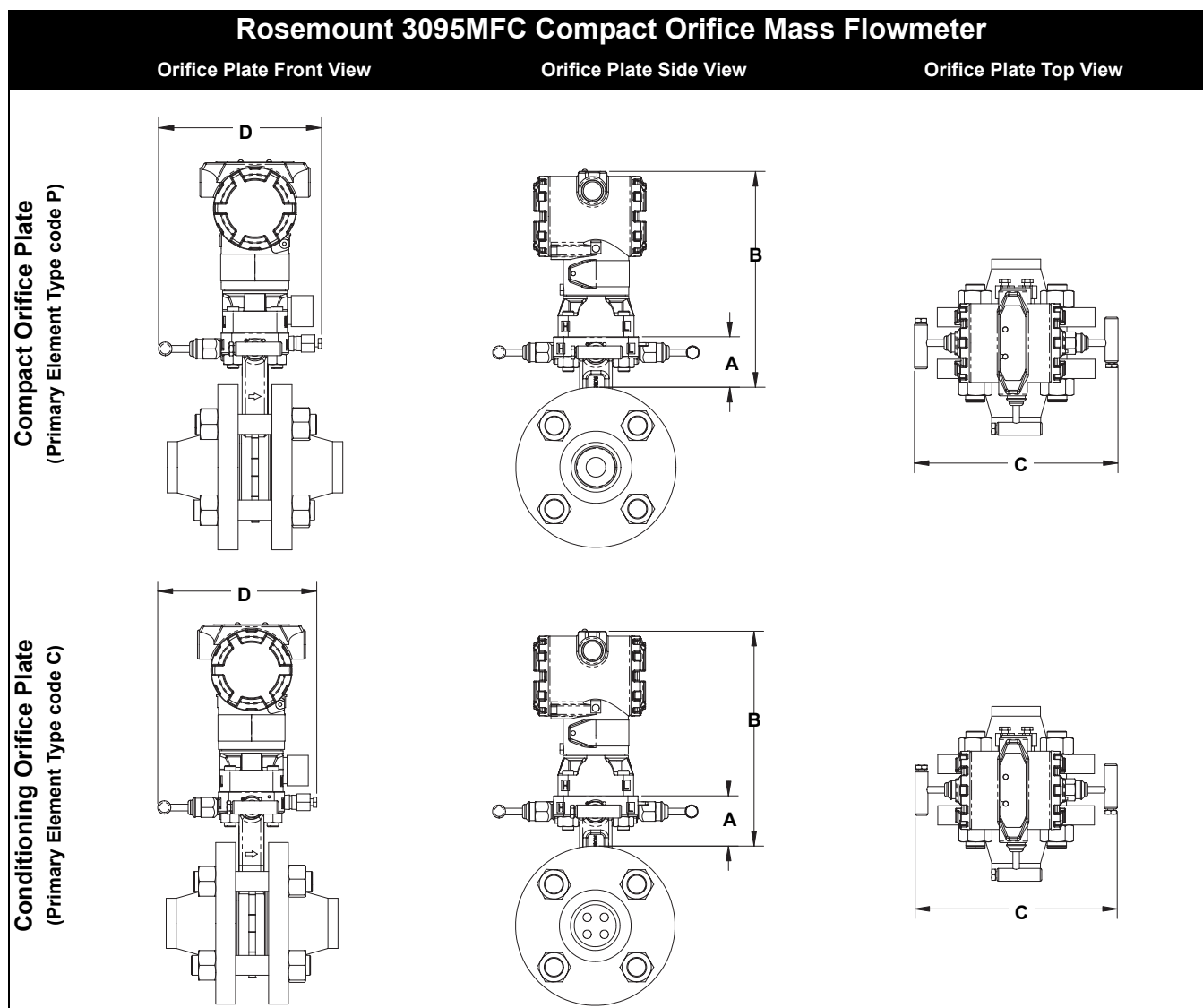


TABLE 19. Dimensional Drawings

Plate Type	A	B	Transmitter Height	C	D
Type P	see chart below	Transmitter Height + A	7.75-in. (197 mm)	7.90-in. (200 mm) - closed 8.65-in. (220 mm) - open	6.00-in. (152 mm) - closed 6.25-in. (159 mm) - open
Type C	see chart below	Transmitter Height + A	7.10-in. (180 mm)	7.90-in. (200 mm) - closed 8.65-in. (220 mm) - open	6.00-in. (152 mm) - closed 6.25-in. (159 mm) - open

Flange Rating	Line Size ⁽¹⁾							
	0.5 ⁽²⁾	1 ⁽²⁾	1.5 ⁽²⁾	2	3	4	6	8
300# (PN 40)	2.225 (56.52)	2.050 (52.07)	1.930 (49.02)	1.990 (50.55)	1.925 (48.90)	2.040 (48.90)	3.050 (77.49)	3.050 (77.47)
600# (PN 100)	2.225 (56.52)	2.050 (52.07)	1.930 (49.02)	1.990 (50.55)	1.925 (48.90)	1.665 (42.29)	2.300 (58.42)	2.300 (58.42)

(1) Measurement is in inches (millimeters).

(2) Plate type option P only.

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Rosemount 405 Compact Orifice Series

ORDERING INFORMATION

Rosemount 3095MFC Compact Orifice Mass Flowmeter Ordering Information

Model	Product Description	
3095MFC	Compact Orifice Mass Flowmeter	
Code	Primary Element Type	
C	Conditioning Orifice Plate	
P	Orifice Plate	
Code	Material Type	
S	316 Stainless Steel (SST)	
Code	Line Size	
005 ⁽¹⁾	1/2-in. (15 mm)	
010 ⁽¹⁾	1-in. (25 mm)	
015 ⁽¹⁾	1 1/2-in. (40 mm)	
020	2-in. (50 mm)	
030	3-in. (80 mm)	
040	4-in. (100 mm)	
060	6-in. (150 mm)	
080	8-in. (200 mm)	
Code	Primary Element Style	
N	Square Edged	
Code	Beta Ratio	
040	0.40 Beta Ratio (β)	
065	0.65 Beta Ratio (β)	
Code	Temperature Measurement	
R	Remote Thermowell and RTD	
0	No Temperature Sensor	
9	Special	
Code	Electronics Connection Platform	
3	Direct-mount, 3-valve integral manifold, SST	
7	Remote-mount, 1/4-in. NPT connections	
Code	Differential Pressure Range	
1	0 to 25 in H ₂ O (0 to 62.2 mbar)	
2	0 to 250 in H ₂ O (0 to 623 mbar)	
3	0 to 1000 in H ₂ O (0 to 2.5 bar)	
Code	Static Pressure Range	
B	0 – 8 to 0 – 800 psia (0 –55.16 to 0 – 5515.8 kPa)	
C	0 – 8 to 0 – 800 psia (0 –55.16 to 0 – 5515.8 kPa)	
D	0 – 36.2 to 0 – 3626 psia (0 –250 to 0 – 25000 kPa)	
E	0 – 36.2 to 0 – 3626 psia (0 –250 to 0 – 25000 kPa)	
Code	Output Protocol	
A	4–20 mA with digital signal based on HART protocol	
Code	Transmitter Housing Material	Conduit Entry Size
1A	Polyurethane-covered aluminum	1/2-14 NPT
1B	Polyurethane-covered aluminum	M20 x 1.5 (CM20)
1C	Polyurethane-covered aluminum	G1/2
1J	SST	1/2-14 NPT
1K	SST	M20 x 1.5 (CM20)
1L	SST	G1/2
Code	Options	
Installation Accessories		
G	DIN alignment ring (PN 16)	
H	DIN alignment ring (PN 40, PN 100)	

Rosemount 405 Compact Orifice Series

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Rosemount 3095MFC Compact Orifice Mass Flowmeter Ordering Information

Remote Adapters

E Flange adapters 316 SST (¹/₂-in. NPT)

High Temperature Applications

T Graphite valve packing (Tmax = 850 °F)

Flow Calibration

WC Flow calibration certification (3 points)

WD Discharge coefficient verification (full 10 points)

Special Cleaning

P2 Cleaning for special processes

PA Cleaning per ASTM G93 Level D (section 11.4)

Special Inspection

QC1 Visual and Dimensional Inspection with certification

QC7 Inspection and performance certification

Transmitter Calibration Certification

Q4 Calibration data certificate for transmitter

Material Traceability Certification

Q8 Material certification per ISO 10474 3.1.B and EN 10204 3.1.B

Code Conformance

J2 ANSI B31.1

J3 ANSI B31.3

J4 ANSI B31.8

J5⁽²⁾ NACE MR-0175-91

Country Certification

J1 Canadian Registration

Product Certifications

E1 ATEX Flame-Proof

I1 ATEX Intrinsic Safety

N1 ATEX Type N

K1 ATEX Flame-Proof, Intrinsic Safety, Type N (combination of E1, I1, and N1)

ND ATEX Combustible Dust

E5 FM Explosion-Proof

I5 FM Intrinsic Safety and Non-Incendive

K5 FM Explosion-Proof, Intrinsic Safety, and Non-Incendive

E6 CSA Explosion-Proof

K6 CSA Explosion-Proof, Intrinsic Safety, and Non-Incendive

Alternative Transmitter Material of Construction

L1 Inert Sensor Fill Fluid

Display

M5 Integral mount LCD display

Terminal Blocks

T1 Transient Protection

Manifold for Remote Mount Option

F2 3-Valve Manifold, SST

F6 5-Valve Manifold, SST

Primary Specials

Exxxx Specials

Transmitter Specials

Axxxx Specials

Typical Model Number: 3051MFC C S 040 N 040 0 3 B A 1A

(1) Not available for Primary Element Type code C.

(2) Materials of Construction meet NACE material recommendation per MR 01-75. Environmental limits apply to certain materials. Consult latest standard for details.

Rosemount 405C Compact Orifice Primary Element

SPECIFICATIONS

Performance

Discharge Coefficient Uncertainty

TABLE 20. 405C Compact Orifice Flowmeter

Type	Beta	Discharge Coefficient Uncertainty
Conditioning	0.4	0.50%
Conditioning	0.65	0.75%
Standard (1/2 to 1 1/2-in. line size) ⁽¹⁾	0.4	1.75%
Standard (1/2 to 1 1/2-in. line size) ⁽¹⁾	0.65	1.75%
Standard (2 to 8-in. line size)	0.4	1.25%
Standard (2 to 8-in. line size)	0.65	1.25%

(1) Discharge Coefficient Uncertainty for 1/2-in. units with Beta = 0.65 is $\pm 2.25\%$ (2.5% of flow).

Line Sizes

- 1/2-in. (15 mm) – not available for the 405C
- 1-in. (25 mm) – not available for the 405C
- 1 1/2-in. (40 mm) – not available for the 405C
- 2-in. (50 mm)
- 3-in. (80 mm)
- 4-in. (100 mm)
- 6-in. (150 mm)
- 8-in. (200 mm)

Sizing

Perform a flow calculation using the Instrument Toolkit™ software package. Alternatively, contact a Rosemount sales representative or Rosemount Customer Central at 1-800-999-9307 for assistance. A "Configuration Data Sheet" is required prior to order for application verification.

Functional

Service

- Liquid
- Gas
- Vapor

Operating Process Temperature Limits

Standard (direct/remote mount):

- -40 to 450 °F (-40 to 232 °C)

Extended (remote mount only with option code T):

- -148 to 850 °F (-100 to 454 °C)

Maximum Working Pressure

- Pressure retention per ANSI B16.5 600# or DIN PN100

Assembly to a transmitter

Select option code C11 for the Rosemount 3051S transmitter (or option code S3 for the Rosemount 3051C or 3095MV transmitters) to factory assemble the Rosemount 405 to a Rosemount pressure transmitter. The C11 (or S3) option will drive square-root mode operation (output proportional to flow rate.) If the 405 and transmitter are not factory assembled, they may be shipped separately. For a consolidated shipment, inform the Rosemount representative when placing the order.

Physical

Material of Construction

Body/Plate

- 316 SST

Flange Studs and Nuts

- Customer supplied
- Available as a spare part

Transmitter Connection Studs and Nuts

- Studs– A193 Grade B8M.
- Nuts– A194 Grade 8M.

Gasket and O-rings

- Gaskets are customer supplied.
- Durlon 8500 fiber gaskets are recommended. Consult factory for use with other gaskets.
- Available as a spare part

NOTE

Gaskets and O-rings must be replaced when the 405 is disassembled.

Process Connections

Mounts between the following flange configurations:

ASME B16.5 (ANSI):

- Class 150
- Class 300
- Class 600

DIN:

- PN16
- PN40
- PN100

Rosemount 405 Compact Orifice Series

Bore Sizes (d)

For 405C, Beta (β) is calculated by $2 \times d$ / pipe size.

TABLE 21. $\beta = 0.4^{(1)(2)}$

Line Size	405C	405P
1/2-in. (15 mm)	Not Available	0.249 (6.325)
1-in. (25 mm)	Not Available	0.420 (10.668)
1 1/2-in. (40 mm)	Not Available	0.644 (16.358)
2-in. (50 mm)	0.413 (10.490) ⁽³⁾	0.827 (21.006)
3-in. (80 mm)	0.614 (15.596)	1.227 (31.166)
4-in. (100 mm)	0.805 (20.447)	1.610 (40.894)
6-in. (150 mm)	1.213 (30.810)	2.426 (61.620)
8-in. (200 mm)	1.596 (40.538)	3.192 (81.077)

(1) Measurement is in inches (millimeters)

(2) Tolerance = ± 0.002 -in.

(3) Beta (β) = 0.60-in. (15.24 mm) for 2-in. line size only.

TABLE 22. $\beta = 0.65^{(1)(2)}$

Line Size	405C	405P
1/2-in. (15 mm)	Not Available	0.404 (10.262)
1-in. (25 mm)	Not Available	0.682 (17.323)
1 1/2-in. (40 mm)	Not Available	1.047 (26.594)
2-in. (50 mm)	0.620 (15.748) ⁽³⁾	1.344 (34.138)
3-in. (80 mm)	0.997 (25.324)	1.994 (50.648)
4-in. (100 mm)	1.308 (33.223)	2.617 (66.472)
6-in. (150 mm)	1.971 (50.063)	3.942 (100.127)
8-in. (200 mm)	2.594 (65.88)	5.188 (131.775)

(1) Measurement is in inches (millimeters)

(2) Tolerance = ± 0.002 -in.

(3) Beta (β) = 0.60-in. (15.24 mm) for 2-in. line size only.

Transmitter Connections

Direct Mount

- Integrally mount to 3051 and 3095 transmitters, range 1, 2, and 3.

Remote Mount

- Available with 1/4-in. (standard) or 1/2-in. (option code E) connections

Orifice Plate Type

- Square edged
- Corner tapped
- Concentric
- Wafer-style

Weight

Line Size (in.)	Direct Mount (D3) ⁽¹⁾	Remote Mount (R3) ⁽¹⁾
1/2-in. (15 mm)	4.0 (1.81)	8.0 (3.63)
1-in. (25 mm)	4.5 (2.04)	8.5 (3.86)
1 1/2-in. (40 mm)	5.25 (2.38)	9.25 (4.20)
2-in. (50 mm)	6.0 (2.72)	10 (4.54)
3-in. (80 mm)	7.75 (3.52)	11.75 (5.33)
4-in. (100 mm)	9.5 (4.31)	13.5 (6.12)
6-in. (150 mm)	13.25 (6.01)	17.25 (7.83)
8-in. (200 mm)	17.75 (8.05)	21.75 (9.87)

(1) Measurement in lb (kg).

Installation Consideration

Straight Pipe Requirement

Use the appropriate lengths of straight pipe upstream and downstream of the 405 to minimize the effects of moderate flow disturbances in the pipe. Table 23 and Table 24 lists recommended lengths of straight pipe per ISO 5167.

TABLE 23. 405C Straight Pipe Requirements

	Beta	0.40	0.65
	Reducer (1 line size)	2	2
Upstream (inlet) side of primary	Single 90° bend or tee	2	2
	Two or more 90° bends in the same plane	2	2
	Two or more 90° bends in different plane	2	2
	Up to 10° of swirl	2	2
	Butterfly valve (75% open)	2	2
Downstream (outlet) side of primary		2	2

TABLE 24. 405P Straight Pipe Requirements⁽¹⁾

	Beta	0.40	0.65
	Reducer	10	11
Upstream (inlet) side of primary	Single 90° bend or tee	14	22
	Two or more 90° bends in the same plane	18	32
	Two or more 90° bends in different plane	36	54
	Expander	16	25
	Globe valve fully open	20	28
	Gate valve fully open	12	16
Downstream (outlet) side of primary		6	7

(1) Recommended lengths represented in pipe diameters per ISO 5167.

Pipe Orientation

Orientation/ Flow Direction	Process ⁽¹⁾		
	Gas	Liquid	Steam
Horizontal	D/R	D/R	D/R
Vertical Up	R	D/R	R
Vertical Down	D/R	NR	NR

(1) D = Direct mount acceptable (recommended)

R = Remote mount acceptable

NR = Not recommended

Product Data Sheet

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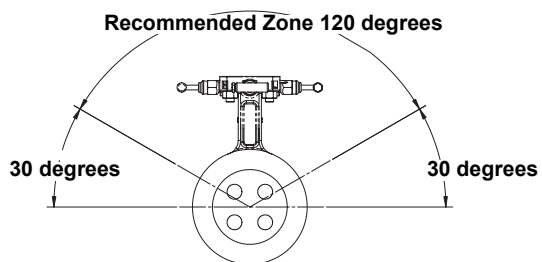
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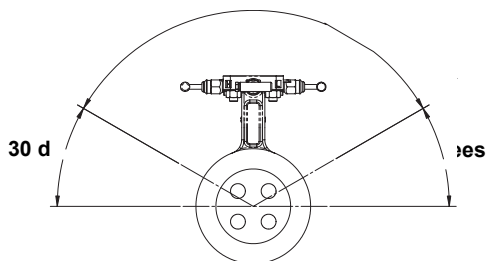
Flowmeter Orientation

Flowmeter orientation for the Conditioning Compact Orifice and standard Compact Orifice.

Gas (Horizontal)

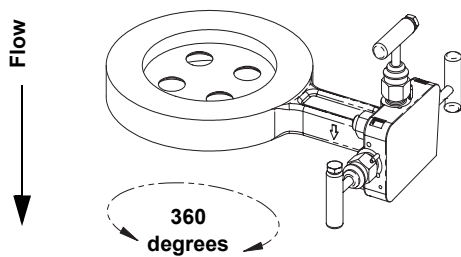


Liquid and Steam (Horizontal)

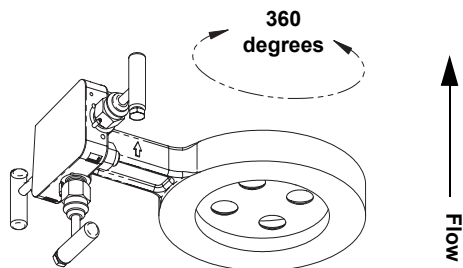


Recommended Zone 120 degrees

Gas (Vertical)



Liquid (Vertical)



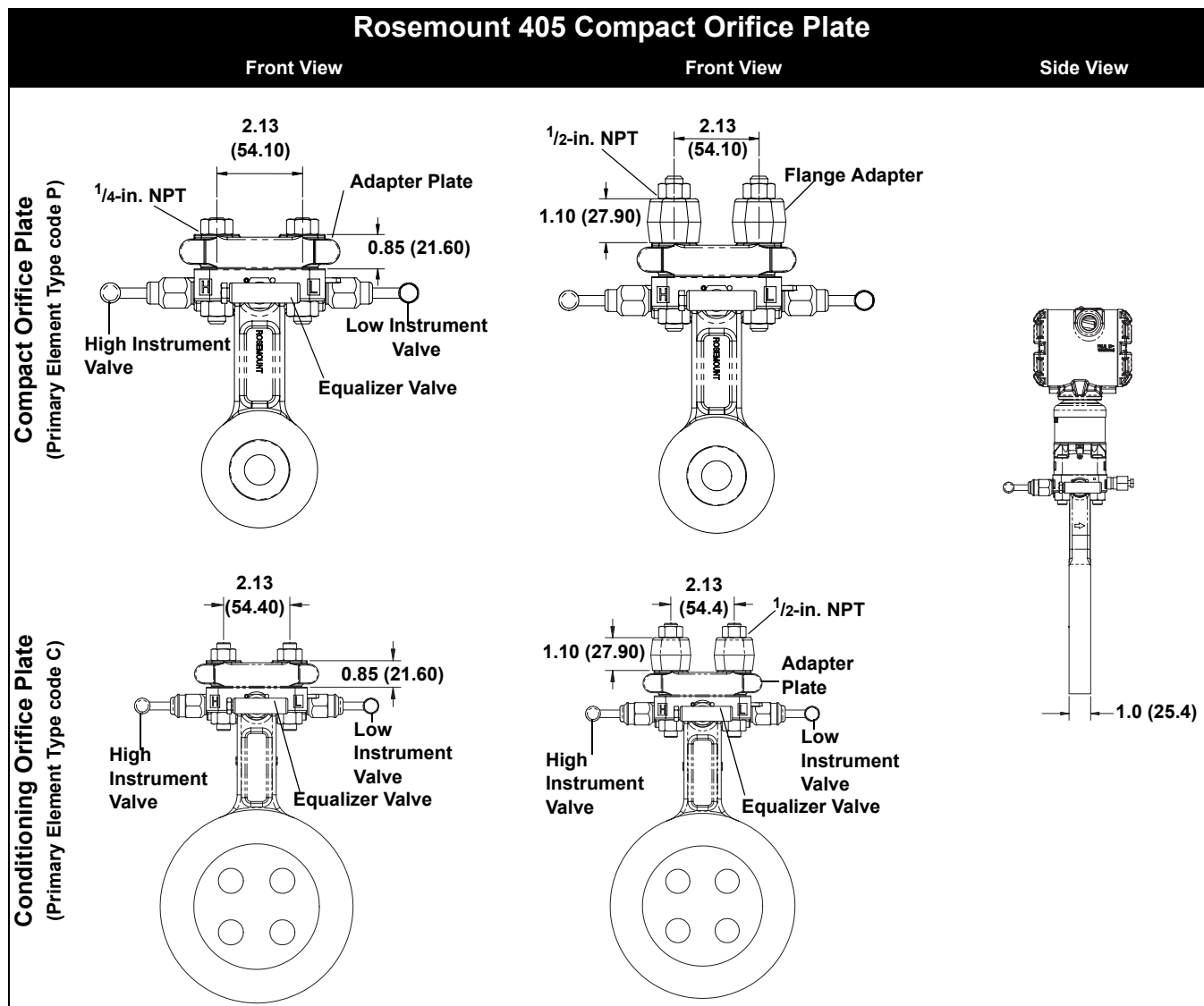
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DIMENSIONAL DRAWINGS



ORDERING INFORMATION

Rosemount 405 Compact Orifice Primary Element Ordering Information

Model	Product Description
405	Compact Primary Element
Code	Primary Element Type
C	Conditioning Orifice Plate
P	Orifice Plate
Code	Material Type
S	316 Stainless Steel (SST)
Code	Line Size
005 ⁽¹⁾	1/2-in. (15 mm)
010 ⁽¹⁾	1-in. (25 mm)
015 ⁽¹⁾	1 1/2-in. (40 mm)
020	2-in. (50 mm)
030	3-in. (80 mm)
040	4-in. (100 mm)
060	6-in. (150 mm)
080	8-in. (200 mm)
Code	Primary Element Style
N	Square Edged
Code	Beta Ratio
040	0.40 Beta Ratio (β)
065	0.65 Beta Ratio (β)
Code	Transmitter Connection
A3	Traditional, Direct mount, 3-valve integral manifold with adapter plate, SST
D3	CoPlanar, Direct mount, 3-valve integral manifold, SST
R3	Remote-mount, 1/4-in. NPT connections
Code	Options
Installation Accessories	
G	DIN alignment ring (PN 16)
H	DIN alignment ring (PN 40, PN 100)
Adapters	
E	Flange adapters 316 SST (1/2-in. NPT)
High Temperature Applications	
T	Graphite valve packing (Tmax = 850 °F)
Flow Calibration	
WC	Flow calibration certification (3 points)
WD	Discharge coefficient verification (full 10 points)
Special Cleaning	
P2	Cleaning for special processes
PA	Cleaning per ASTM G93 Level D (section 11.4)
Special Inspection	
QC1	Visual and Dimensional Inspection with certification
QC7	Inspection and performance certification
Material Traceability Certification	
Q8	Material certification per ISO 10474 3.1.B and EN 10204 3.1.B
Code Conformance	
J2	ANSI B31.1
J3	ANSI B31.3
J4	ANSI B31.8
J5 ⁽²⁾	NACE MR-0175-91
Country Certification	
J1	Canadian Registration
Primary Specials	
Exxxx	Specials
Typical Model Number: 405 C S 040 N 040 D	

(1) Not available for Primary Element Type code C.

(2) Materials of Construction meet NACE material recommendation per MR 01-75. Environmental limits apply to certain materials. Consult latest standard for details.

Rosemount 405 Compact Orifice Series

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Configuration Data Sheet (CDS)

DP FLOW CDS

Complete this form to define a custom flow configuration for DP Flowmeters. Unless specified, the flowmeter will be shipped with the default values identified by the H symbol.

For technical assistance in filling out this CDS, call a Rosemount representative.

NOTE

Any missing information will be processed with the indicated default values.

* = Required Item

★ = Default

Customer Information

Customer:	Contact Name:
Customer Phone:	Customer Fax:
Customer Approval Sign-Off:	Customer PO:

Calculation Approval

☐ Check this box if you require a calculation for approval prior to manufacturing

Application and Configuration Data Sheet (Required with Order)

Tag:

Model No ⁽¹⁾

* **Select fluid type** ☐ Liquid ☐ Gas ☐ Steam

* **Fluid name**⁽²⁾

Flowmeter Information (optional)

* Failure Mode Alarm Direction (select one) ☐ Alarm High★ ☐ Alarm Low

Software Tag: _____ (8 characters)

Descriptor: _____ (16 characters)

Message: _____
_____ (32 characters)

Date: Day ____ (numeric) Month ____ (numeric) Year ____ (numeric)

(1) A complete model number is required before Rosemount Inc. can process the order.

(2) If the Fluid is not located in Table 25 on page 28, the "Fluid Data Sheet (FDS)" on page 29 must be completed.

For Rosemount Use Only

S.O.:	LI
CHAMP:	DATE:
	ADMIN:

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* = Required Item

★ = Default

Primary Element Information

* Select Differential Producer (Select One)

Annubar

- ☐ 485 Annubar/ 3095MFA Mass ProBar, 3051SFA ProBar
- ☐ Annubar Diamond II + / Mass Probar
- ☐ Long Radius Wall Taps, ASME
- ☐ Long Radius Wall Taps, ISO
- ☐ ISA 1932, ISO

Venturi

- ☐ Nozzle, ISO
- ☐ Rough Cast/Fabricated Inlet, ASME
- ☐ Round Cast Inlet, ISO
- ☐ Machined Inlet, ASME
- ☐ Machined Inlet, ISO
- ☐ Welded Inlet, ISO

Other (All options require a discharge coefficient value)

- ☐ Calibrated Orifice: Flange, Corner, or D & D/2 Taps.

Discharge coefficient: _____

- ☐ Calibrated Orifice: 2 1/2 D & 8D Taps

Discharge coefficient: _____

- ☐ Calibrating Nozzle

Discharge coefficient: _____

- ☐ Calibrating Venturi

Discharge coefficient: _____

- ☐ Area Averaging Meter

Discharge coefficient: _____

- ☐ V-Cone®

Discharge coefficient: _____

Diameter (d) _____

Orifice

- ☐ 1195, Mass ProPlate, ProPlate
- ☐ 405C, 405P, 3051SFC, 3095MFC
- ☐ 1595 Conditioning Orifice
- ☐ 2 1/2 D & 8D Taps, ASME
- ☐ Corner Taps, ASME
- ☐ Corner Taps, ISO
- ☐ D & D/2 Taps, ASME
- ☐ D & D/2 Taps, ISO
- ☐ D & D/2 Taps, ISO 99 Amendment 1
- ☐ Flange Taps, AGA
- ☐ Flange Taps, ASME
- ☐ Flange Taps, ISO
- ☐ Flange Taps, ISO 99 Amendment 1
- ☐ Small Bore, Flange Taps, ASME

☐ inch★

☐ millimeters

at _____

☐ °F

☐ °C

☐ 68 °F★

☐ ODF _____

☐ ODT _____

Special Annubar dimension (required if customer supplies mounting hardware).

Pipe Information

* Orientation / Flow Direction: ☐ Vertical Up ☐ Vertical Down ☐ Horizontal

* Line Size / Schedule: _____ Body I.D. (D): _____

Materials of Construction

* Pipe Material ☐ Carbon Steel ☐ 304 SST ☐ 316 SST ☐ Hastelloy ☐ Other _____

* Primary Element Material ☐ 316 SST ☐ Hastelloy ☐ Other _____ (Please verify material availability)

Operating Conditions

	4 mA value	Minimum	Normal	Maximum	Full Scale:20 mA flow rate (design to P and T)	Design
Flow Rate	0	*(1)	*	*		
Pressure (P)	—	*(1)	*	*(1)	*(2)	
Temperature (T)	—	*(1)	*	*(1)	*	

RTD Mode

☐ Normal Mode ★ (Requires a RTD to be connected. If the RTD is disconnected or fails, the 3095MV output goes to alarm value)

☐ Fixed Temperature Mode: Specify the fixed temperature value _____ ☐ °F ☐ °C

☐ Backup Mode (Uses the connected RTD for temperature measurement. If the RTD is disconnected or fails, the transmitter uses a fixed temperature value as a backup. This will not cause the mA output to go to alarm value and can potentially cause inaccurate flow measurement.) Fixed temperature value to be used as backup _____ ☐ °F ☐ °C

Rosemount 405 Compact Orifice Series

* = Required Item

★ = Default

Base Conditions

☐ Standard Base (P=14.696 psia / 101.325 kPa abs, T= 60 °F (15.56 °C))

☐ Normal Base (P=14.696 psia / 101.325 kPa abs, T= 32 °F (0 °C))

☐ Standard Base for Natural Gas (AGA) (P=14.73 psia, T= 60°F (15.56 °C))

☐ User Defined: P= _____ Units: _____ T= _____ Units = _____

Compressibility at Base: _____ OR Density at Base: _____

(1) Operating ranges for pressure and temperature are needed for transmitter configuration.

(2) Required to verify that the product selection meets design criteria.

TABLE 25. Rosemount Fluids Database⁽¹⁾

Acetic Acid	Divinyl Ether	Methane	n-Hexane	1-Heptanol
Acetone	Ethane	Methanol	n-Octane	1-Heptene
Acetonitrile	Ethanol	Methyl Acrylate	n-Pentane	1-Hexene
Acetylene	Ethylamine	Methyl Ethyl Ketone	Oxygen	1-Hexadecanol
Acrylonitrile	Ethylbenzene	Methyl Vinyl Ether	Pentafluorothane	1-Octanol
Air	Ethylene	m-Chloronitrobenzene	Phenol	1-Octene
Allyl Alcohol	Ethylene	Neon	Propadiene	1-Nonanol
Ammonia	GlycolEthylene	Neopentane	Pyrene	1-Pentadecanol
Argon	Oxide	Nitric Acid	Propylene	1-Pentanol
Benzene	Fluorene	Nitric Oxide	Styrene	1-Pentene
Benzaldehyde	Furan	Nitrobenzene	Sulfur Dioxide	1-Undecanol
Benzyl Alcohol	Helium-4	m-Dichlorobenzene	Propane	1-Nonanal
Biphenyl	Hydrazine	Nitroethane	Toluene	1,2,4- Trichlorobenzene
Carbon Dioxide	Hydrogen	Nitrogen	Trichloroethylene	1,1,2- Trichloroethane
Carbon Monoxide	Hydrogen Chloride	Nitromethane	Vinyl Acetate	1,1,2,2- Tetrafluoroethane
Carbon Tetrachloride	Hydrogen Cyanide	Nitrous Oxide	Vinyl Chloride	1,2-Butadiene
Chlorine	Hydrogen Peroxide	n-Butane	Vinyl Cyclohexane	1,3-Butadiene
Chlorotrifluoroethylene	Hydrogen Sulfide	n-Butanol	Water	1,3,5- Trichlorobenzene
Chloroprene	Isobutane	n-Butyraldehyde	1-Butene	1,4-Dioxane
Cycloheptane	Isobutene	n-Butyronitrile	1-Decene	1,4-Hexadiene
Cyclohexane	Isobutyl benzene	n-Decane	1-Decanal	2-Methyl-1-Pentene
Cyclopentane	Isopentane	n-Dodecane	1-Decanol	2,2-Dimethylbutane
Cyclopentene	Isoprene	n-Heptadecane	1-Dodecene	
Cyclopropane	Isopropanol	n-Heptane	1-Dodecanol	

(1) This list is subject to change without notice. Steam per ASME Steam tables. All other fluids per AIChE.

Drawing/Notes

Fluid Data Sheet (FDS)

For custom fluid not in the Rosemount Fluid Database

For technical assistance in filling out this CDS, call your local Rosemount representative. Complete this form to define a custom fluid. The H symbol identifies the default value.

NOTE

This form is not required if using the Rosemount Fluid Database.

* = Required Item

★ = Default

Customer Information

Customer:

Contact Name:

Customer Phone:

Customer Fax:

Customer PO:

Fluid Properties

☐ Custom Liquid– Complete Table

☐ Liquid

☐ Custom Gas– Complete Table

☐ Gas

☐ Custom Natural Gas– Complete Table

☐ Natural Gas

For Rosemount Use Only

S.O.:

LI

CHAMP:

DATE:

ADMIN:

Rosemount 405 Compact Orifice Series

TABLE 26. Custom Liquid Worksheet

* = Required Item

★ = Default

Mass Liquid Density and Viscosity Information

1. Fill in the following operating temperatures

- a) _____ min
b) _____ [$^{1/3}(\text{max} - \text{min})$] + min
c) _____ [$^{2/3}(\text{max} - \text{min})$] + min
d) _____ max

2. Transfer the values from the above section to the numbered lines below.

3. Check one Density box, then enter the values for each temperature and the standard density.

4. Check one Viscosity box, then enter values for each temperature. (At least one viscosity value is required).

Density

- ☐ Density in lbs/CuFt
☐ Density in kg/CuM

Viscosity

- ☐ Viscosity in centipoise
☐ Viscosity in lbs/ft sec
☐ Viscosity in pascal sec

Temperature

- a) _____ min
b) _____ [$^{1/3}(\text{max} - \text{min})$] + min
c) _____ [$^{2/3}(\text{max} - \text{min})$] + min
d) _____ max

Temperature

- a) _____ min.
b) _____ [$^{1/3}(\text{max} - \text{min})$] + min
c) _____ [$^{2/3}(\text{max} - \text{min})$] + min
d) _____ max

Base density: _____
(at base reference conditions specified)

Volumetric Liquid Density and Viscosity Information

* Density at Flow: _____ Units: ☐ lb/ft³ ☐ Kg/m³ ☐ Other:

OR

Specific Gravity at Flow: _____

* Viscosity at Flow: _____ Units: ☐ Centipoise ☐ Other:

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TABLE 27. Custom Gas Worksheet

* = Required Item

★ = Default

Mass Gas Compressibility and Viscosity Information

1. Fill in the following operating pressures and operating temperatures

Operating Pressures

- 1) _____ min
2) _____ [$^{1/3}$ (max - min))] + min
3) _____ [$^{2/3}$ (max - min))] + min
4) _____ max

Operating Temperatures

- 5) _____ min
6) _____ [$^{1/2}$ (max - min))] + min
7) _____ max
8) _____ [$^{1/3}$ (max - min))] + min
9) _____ [$^{2/3}$ (max - min))] + min

2. Transfer the values from the above section to the numbered lines below

3. Check one Density/Compressibility box, then enter the 12 values for each pressure/temperature range.
4. Check one Viscosity box, then enter values for each temperature. (At least one viscosity value is required).
5. Enter values for molecular weight, isentropic exponent, and standard density (or standard compressibility).

Density

☐ Density in lbs/CuFt

☐ Density in kg/CuM

☐ Compressibility

Pressure

Temperature

- | | |
|----------|----------|
| 1) _____ | 5) _____ |
| 2) _____ | 5) _____ |
| 3) _____ | 5) _____ |
| 4) _____ | 5) _____ |
| 1) _____ | 6) _____ |
| 2) _____ | 6) _____ |
| 3) _____ | 6) _____ |
| 4) _____ | 6) _____ |
| 1) _____ | 7) _____ |
| 2) _____ | 7) _____ |
| 3) _____ | 7) _____ |
| 4) _____ | 7) _____ |

Viscosity

☐ Viscosity in centipoise

☐ Viscosity in lbs/ft sec

☐ Viscosity in pascal sec

Temperature

- 5) _____
8) _____
9) _____
7) _____

Molecular Weight: _____

Isentropic Exponent: _____ 1.4 ★

Standard density/compressibility: _____

Volumetric Gas Compressibility and Viscosity Information

* Density at Flow: _____ Units: ☐ lb/ft³ ☐ Kg/m³ ☐ Other: _____

OR

M.W. / Specific Gravity at Flow: _____

Compressibility at Flow: _____

Compressibility at Base: _____

* Viscosity at Flow: _____ Units: ☐ Centipoise ☐ Other: _____ Isentropic Exponent (K): _____ 1.4 ★

Product Data Sheet

00813-0100-4810, Rev CB

October 2003

Rosemount 405 Compact Orifice Series

TABLE 28. Natural Gas Worksheet

NOTE

The minimum requirement for the Volumetric options is highlighted gray on page 32.

Compressibility Factor Information

Choose desired characterization method and only enter values for that method.

☐ Detail Characterization Method (AGA8 1992)

		Mole	Valid Range
CH ₄	Methane mole percent	%	0 – 100 percent
N ₂	Nitrogen mole percent	%	0 – 100 percent
CO ₂	Carbon Dioxide mole percent	%	0 – 100 percent
C ₂ H ₆	Ethane mole percent	%	0 – 100 percent
C ₃ H ₈	Propane mole percent	%	0 – 12 percent
H ₂ O	Water mole percent	%	0 – Dew point
H ₂ S	Hydrogen Sulfide mole percent	%	0 – 100 percent
H ₂	Hydrogen mole percent	%	0 – 100 percent
CO	Carbon monoxide mole percent	%	0 – 3.0 percent
O ₂	Oxygen mole percent	%	0 – 21 percent
C ₄ H ₁₀	i-Butane mole percent	%	0 – 6 percent ⁽¹⁾
C ₄ H ₁₀	n-Butane mole percent	%	0 – 6 percent ⁽¹⁾
C ₅ H ₁₂	i-Pentane mole percent	%	0 – 4 percent ⁽²⁾
C ₅ H ₁₂	n-Pentane mole percent	%	0 – 4 percent
C ₆ H ₁₄	n-Hexane mole percent	%	0 – Dew Point
C ₇ H ₁₈	n-Heptane mole percent	%	0 – Dew Point
C ₈ H ₁₈	n-Octane mole percent	%	0 – Dew Point
C ₉ H ₂₀	n-Nonane mole percent	%	0 – Dew Point
C ₁₀ H ₂₂	n-Decane mole percent	%	0 – Dew Point
He	Helium mole percent	%	0 – 3.0percent
Ar	Argon mole percent	%	0 – 1.0 percent

☐ Gross Characterization Method, Option Code 1 (AGA8 Gr-Hv-CO₂)

	Mole	Valid Range
Specific Gravity at 14.73 psia and 60 °F		0.554 – 0.87
Volumetric gross heating value at base conditions	BTU/SCF	477 – 1150 BTU/SCF
Carbon Dioxide mole percent	%	0 – 30 percent
Hydrogen mole percent	%	0 – 10 percent
Carbon Monoxide mole percent	%	0 – 3.0 percent

☐ Gross Characterization Method, Option Code 2 (AGA8 Gr-CO₂-N₂)

	Mole	Valid Range
Specific Gravity at 14.73 psia and 60 °F	%	0.554 – 0.87
Carbon Dioxide mole percent	%	0 – 30 percent
Nitrogen mole percent	%	0 – 50 percent
Hydrogen mole percent	%	0 – 10 percent
Carbon Monoxide mole percent	%	0 – 3.0 percent

(1) The summaries of i-Butane and n-Butane cannot exceed 6 percent.

(2) The summaries of i-Pentane and n-Pentane cannot exceed 4 percent.

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