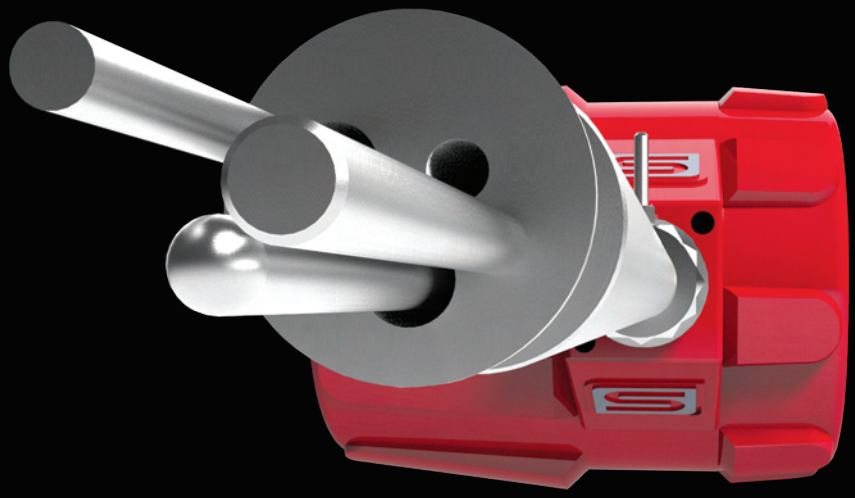
SIERRA



QuadraTherm® 640i / 780i

HIGH ACCURACY : FOUR-SENSOR : MASS FLOW METER


SIERRA
QuadraTherm
33.7 SCFM
70.5 F

Introducing the World's Most Accurate Thermal Mass Flow Meter

From Sierra's beginning over forty years ago, Founder Dr. John G. Olin was driven by the vision of supplying industrial customers with the world's most accurate mass flow meter. And, he knew it was a "sensor" game.

The development of an industrialized metal-sheathed sensor in the early 80s was Sierra's first big step, but Dr. Olin is a driven innovator, and this was only the beginning for someone who saw "Thermal Mass Flow" as his life's work. Many successful innovations followed, but in 1999 Sierra experienced a major breakthrough with the introduction of their patented no-drift DrySense™ mass velocity sensor. Sierra engineers now recognized they were on the cusp of realizing Dr. Olin's vision.

Realizing the Vision

Thermal technology, by its very nature, uses the physics of heat transfer and conservation of energy in an open system to measure mass flow rate. This means that for a thermal mass flow meter to achieve the greatest accuracy, it must solve the First Law of Thermodynamics (Heat Energy In = Heat Energy Out) for each data point.

As you can imagine, solving the First Law in a flow instrument was no easy task. By Dr. Olin's own accounting, decades of "hard-nosed dedication to excellence" by himself and Sierra's engineering team, years of testing, and his stack of yellow note pads over five feet high, jammed with his handwritten equations and designs, finally yielded the secret in the form of two revolutionary technologies—QuadraTherm® and qTherm™, now both patented worldwide.

QuadraTherm, Beyond Traditional Thermal

Traditional thermal sensors have two sensors-—one temperature sensor and one velocity sensor, each in a separate probe sheath. QuadraTherm (the term "Quad" meaning "four") introduces four sensors—three precision platinum temperature sensors and one patented DrySense mass velocity sensor. Sensor performance improvements never thought possible are gained with QuadraTherm as forced convection is completely isolated (the critical variable for measuring gas mass flow rate) by calculating and then eliminating unwanted heat-transfer components, like sensor stem conduction, one of the major causes of false flow readings.

qTherm, the Brains Behind it

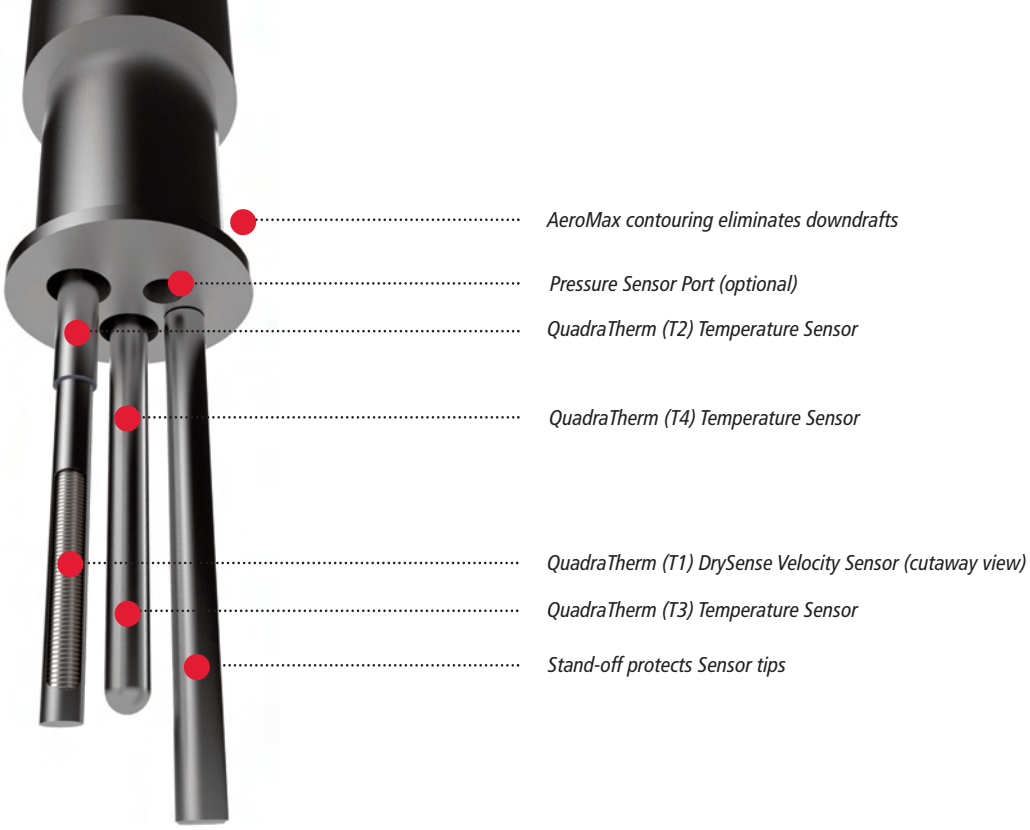
qTherm is the true "Brain" of the instrument and a revolutionary, living, learning algorithm set made possible by today's hyper-fast microprocessors and QuadraTherm sensor inputs. qTherm manages changes in gas flow, gas temperature and gas pressure, as well as outside temperature, via a comprehensive heat-transfer model. The result is a proprietary, fundamentally different gas mass flow rate calculation using all pertinent variables for the most precise, stable and accurate mass flow measurement possible.

QuadraTherm 640i / 780i

- Accuracy: +/- 0.5% of Reading*
- Multivariable: Mass flow rate, temperature & pressure
- Revolutionary QuadraTherm® four-sensor design
- DrySense™ no-drift sensor with lifetime warranty
- qTherm™ living, learning "Brain" manages all inputs
- Dial-A-Pipe™ : Change pipe size
- Dial-A-Gas® : Change gas type
- qMix™: Make & upload gas mixtures
- qTherm Gas Database: Most common gases & mixtures (growing & improving)
- ValidCal™ Diagnostics: Assure performance
- Smart Interface Program: Computer interface software
- Foundation Fieldbus, Modbus, Profibus DP, HART
- CE, cFMus, ATEX, IECEx approved

- 780i inline version has built-in flow conditioning (note transparent pipe)

* Verified by an independent NIST and NVLAP accredited metrology laboratory



QuadraTherm Makes it Possible

The challenge for Dr. Olin and the Sierra engineering team was to develop a sensor that isolated forced convection, a prominent source of heat loss.

In traditional thermal mass flow meters, the heated velocity sensor is inserted into the tip of a tubular probe and is surrounded by potting compounds, such as epoxy, ceramic cement, thermal grease, or alumina powder. These so-called "wet" sensors have several weaknesses. They have an increased skin resistance which creates a "droop" in the output curve and decreased sensitivity (specially at high flows) as a consequence. They are hard to produce repeatably, which ultimately means reduced accuracy. And finally, wet sensors can create long-term measurement errors caused by aging and cracking due to differential thermal expansion between the parts of the heated velocity sensor.

QuadraTherm builds on the long-term stability of our patented no-drift DrySense velocity sensor technology. As the name implies, Sierra's velocity sensor is the only thermal sensor in the world that is truly "dry". Our proprietary swaging process eliminates all air gaps between the heated velocity sensor and the tubular probe without the need for any potting compounds. The result is maximum sensitivity, reproducibility, immunity to cracking and shifting over time, and ultimately greatly improved accuracy. We back our DrySense Technology with a lifetime warranty.

In addition, by radically reworking the physical sensor head design, Sierra's engineering team minimized the effects of downdrafts and other interferences that cause false flow readings in traditional thermal flow meters. As Dr. Olin states, "We are trying to create a flow field for the velocity sensor where it is unaffected by anything else around it, so it can do what it was meant to do—measure the free-stream mass flow rate." Wind-tunnel testing and CFD modeling verified that we accomplished our goal.

QuadraTherm's Four-Sensor Design

Sierra's biggest breakthrough occurred when two new temperature sensors (T2 and T4—See Figure) were added to the existing two-sensor design (T3 temperature & T1 DrySense velocity) used in previous models. The two additional sensors perform real-time correction for the heat lost to the outside environment due to a phenomenon called "stem conduction." To better understand the benefits, let's look at a typical example.

Let's say the temperature of the flowing gas is higher than the outside temperature. In this case, stem conduction causes a substantial fraction (between 10% to 25%) of the electrical power supplied to the heated velocity sensor to be lost through the probe shaft to the outside environment. What happens if this is a traditional thermal mass flow meter and the outside temperature in the field application drops by a few degrees? The heat lost via stem conduction will increase and a flow measurement error will occur. QuadraTherm eliminates this source of error by first accurately measuring, and then correcting for, the heat lost via stem conduction.

And with qTherm, it Learns.

QuadraTherm's four-sensor technology provides the critical inputs for qTherm's living, learning algorithm set and gas library to accurately manage changes in gas and pipe selection, gas temperature, gas pressure, and outside temperature.

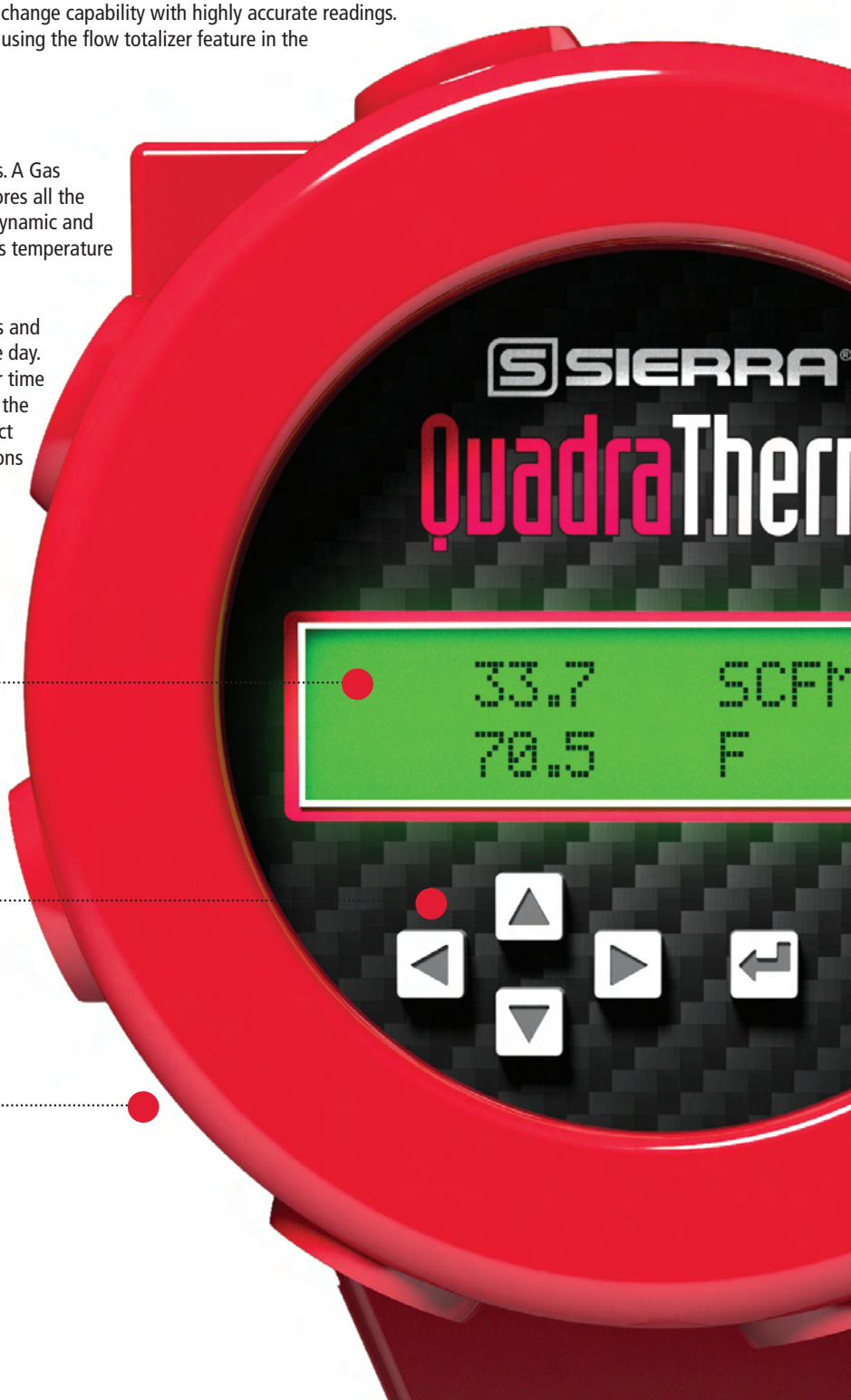
qTherm solves the First Law of Thermodynamics in a fraction of a second for each mass flow data point. It calculates stem conduction and all other unwanted heat loss components, subtracts them out, and then computes the mass flow rate from the remaining forced convection component.

And, with Dial-A-Pipe, it lets you relocate the probe to different pipe sizes and types in the field. With Dial-A-Gas, it provides gas change capability with highly accurate readings. Totalize each gas independently using the flow totalizer feature in the Smart Interface Program (SIP).

qTherm's Expanding Gas Library

The qTherm Gas Library stores proprietary Gas Packets. A Gas Packet is analogous to the DNA of a specific gas. It stores all the parameters needed to instantly calculate the thermodynamic and transport properties of every gas or gas mixture versus temperature and pressure.

Currently, the library has mapped most common gases and mixtures, and it continues to grow and improve by the day. Furthermore, the millions of data points collected over time in Sierra's metrology laboratories can be used to tune the instrument for better performance and accuracy. Expect hundreds of data sets and gas/gas mixture combinations in the future that can be downloaded to your QuadraTherm meter via the internet.



Multivariable Readout: Mass flow, temperature, pressure, totalizer, and alarms

Pushbutton control for Dial-A-Gas, Dial-A-Pipe, alarms, and engineering units

Explosion proof glass and enclosure

PERFORMANCE SPECIFICATIONS

Gas Measured
All inert gases and all non-condensing clean gases
Flammable gases: methane, propane, hydrogen, digester gas, natural gas
Corrosive gases compatible with 316L stainless steel
qTherm Gas Library: most common gases and mixtures; air is standard;
qTherm Dial-A-Gas option for choice of three additional gases

Mass Velocity Range for Air
0 to 60,000 sfpm (0 to 305 smps) at 21.1°C (70°F), 1 atm

Multivariable Outputs
Mass flow rate (standard)
Temperature (standard)
Pressure (optional)
Totalized flow: totalized value is stored in non-volatile memory

Mass Flow Accuracy
780i Inline version accuracy (highest accuracy):*
+/- 0.5% of reading above 50% of the full scale flow
+/- 0.5% of reading plus 0.5% of full scale below 50% of full scale flow

640i Insertion version accuracy:*
+/- 0.75% of reading above 50% of the full scale flow
+/- 0.75% of reading plus 0.5% of full scale below 50% of full scale flow

See Table 1: qTherm Dial-A-Gas Selection Chart on next page for accuracy.
Gas pressure accuracy +/- 1.0% full scale
Totalize each gas independently with the flow totalizer

* Accuracy statements verified by an independent NIST and NVLAP accredited metrology laboratory.

Gas Temperature Accuracy
+/- 1°C (1.8°F)

Gas Pressure Ranges
30 psia (2.1 bara), 100 psia (6.9 bara), 300 psia (20.7 bara),
500 psia (34.5 bara), VTP only.

Repeatability
Mass flow rate: +/- 0.15% of full scale
Gas temperature: +/- 0.5°C (0.9°F)
Gas pressure: +/- 0.5% of full scale

Response Time
Three seconds to achieve 63% (one time constant) of final value

Mass Flow Rate Turndown
100:1

ANALOG AND DIGITAL OUTPUTS

Output Signals
4-20 mA flow, 4-20 mA temperature, 4-20 mA pressure (optional)
Alarm output (contact SPST/opto relays)
User definable pulse output for totalized flow

Optional Communications Modules
Modbus, Foundation Fieldbus, Profibus DP, HART

SOFTWARE

Smart Interface Program (SIP) Software
Use Dial-A-Gas and Dial-A-Pipe for easy field setup
Use Meter Tune to optimize performance
Use ValidCal to validate all meter functions
Use flow totalizer to totalize all four Dial-A-Gases independently
Use qMix gas mixing feature to create custom gas and gas mixtures

POWER REQUIREMENTS

Input Power
100 to 240 VAC (0.4 Amps RMS at 230 VAC)
24 VDC +/- 10%, 1 Amp

OPERATING SPECIFICATIONS

780i Inline Version Gas Pressure Requirements
NPT: 500 psia (34.5 bara) maximum

Flange process connections defined by the ASME B 16.5a – 1998 spec. group rating of 316L stainless steel ANSI class 150 or 300 class flanges (special)
316L stainless steel 150 class flanges:
230 psig at -20°F to 100°F; 195 psig at 200°F;
175 psig at 300°F; 160 psig at 400°F; and 145 psig at 500°F
Equivalent DN PN16 flanges are available (see page 10 for sizes)
316L stainless steel 300 class flanges (special):
600 psig at -20°F to 100°F; 505 psig at 200°F; 455 psig at 300°F;
415 psig at 400°F

640i Insertion Version Gas Pressure Maximums (or limits)
Compression fittings: 500 psia (34.5 bara)
1-inch 150 class flange (-40°F to 250°F) 185 psia (12.8 bara)
Low pressure hot tap: 150 psia (10.3 bara)
High pressure hot tap: 230 psia (15.9 bara)
Minimum pipe size 2 inches (50 mm)

Gas Temperature Requirements (all versions)
-40°F (-40°C) to 392°F (200°C)
High temperature (HT) option to 750°F (400°C) available in 640S model only

Ambient Temperature (NAA and cFMus versions)
-40F° (-40°C) to 140°F (60°C)
ATEX/IECEx Versions -4°F(-20°C) to 140°F (60°C)

PHYSICAL SPECIFICATIONS

User Interface
Local keypad with a six-button interface
Exit ⊗ Enter ↵ Four-way directional arrows ◀ ▲ ▶ ▼
RS-232 with PC software for communication and programming

Digital Display
UltraBright, backlit, LCD digital display, 2 x 16, 2 x 32 scrolling

780i Inline Version Process Connections
See page 9 and 10 for NPT, ANSI class 150 flange and PN16 DN sizes.

640i Insertion Version Process Connections
See page 6 through 8 for insertion sizes.
ANSI 1-inch - ANSI class 150 flange (optional)
Low pressure hot tap rated to 150 psia (10.3 bara)
High pressure hot tap and retractor 230 psia (15.9 bara)

Wetted Materials
316 SS and 316L SS flow body and Pt/Ir (velocity sensor)
Viton® VTP Pressure Option
Neoprene®, Kal-Rez® optional

Leak Integrity
1 x 10^{-4} sccs of helium

Approval Agencies
cFMus–Explosion proof for Class I, Div I, Groups B,C,D
CE–European Conformity
ATEX/IECEx

Enclosure
NEMA 4 (IP66), hazardous-area explosion proof, flow pointer, meter information tag. NEMA 4X (E2 option only).

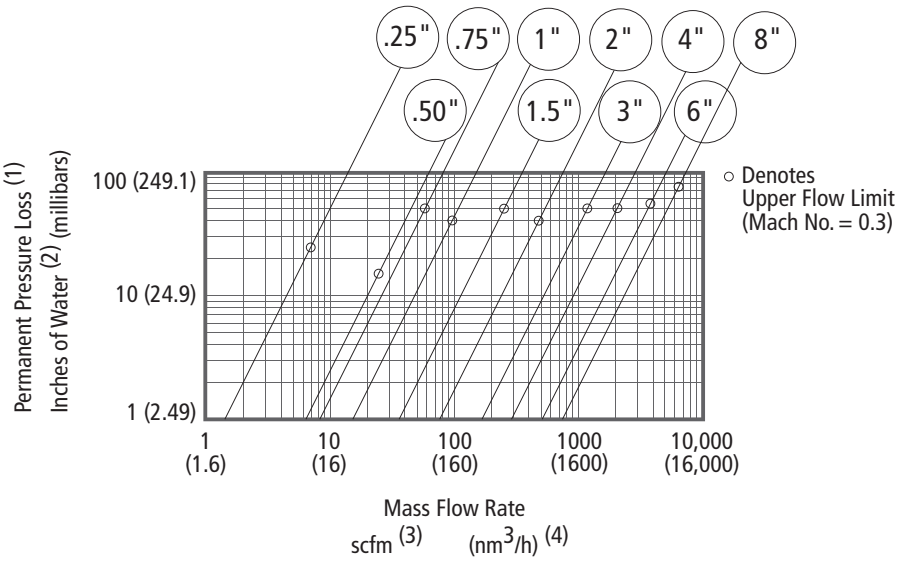
TABLE 1: qTherm Dial-A-Gas Selection Chart				
	780i Accuracy		640i Accuracy	
Gas	Actual Gas[1]	qTherm Dial-A-Gas[2]	Actual Gas[1]	qTherm Dial-A-Gas[2]
Air[3]	±0.5%	N/A	±0.75%	N/A
Argon	±0.5%	±3.0%	±0.75%	±3.0%
Carbon Dioxide	±0.5%	±3.0%	±0.75%	±3.0%
Chlorine	N/A	±3.0%	N/A	±3.0%
Digester Gas (60% CH_4, 40% CO_2)	±0.5%	±3.0%	±0.75%	±3.0%
Helium	±0.5%	±3.0%	±0.75%	±3.0%
Hydrogen	±0.5%	±3.0%	±0.75%	±3.0%
Methane	±0.5%	±3.0%	±0.75%	±3.0%
Nitrogen	±0.5%	±3.0%	±0.75%	±3.0%
Oxygen	N/A	±3.0%	N/A	±3.0%
Propane	±0.5%	±3.0%	±0.75%	±3.0%
Other[4]–Consult Factory	Special Calibration Request (SCR)	Special Calibration Request (SCR)	Special Calibration Request (SCR)	Special Calibration Request (SCR)

Notes: (1) % of reading at >50% of full scale flow; add 0.5% of full scale below 50% of full scale flow
(2) % of full scale
(3) Air is standard on the instrument and cannot be removed
(4) The qTherm Gas Library is a proprietary gas property index that is continually updated and improved

TABLE 2: 640i/780i Straight Run Requirements			
Piping Condition	Upstream 640i Insertion	Upstream 780i Inline with Flow Conditioning[1]	Downstream[2]
Single 90° Elbow or T-Piece	15D	5D	1D
Reduction (4:1)	20D	5D	3D
Expansion (4:1)	40D	10D	3D
After Control Valve	15D	5D	3D
Two 90° Elbows (in same plane)	30D	5D	3D
Two 90° Elbows (different planes)	40D	10D	5D

Notes: (1) Number of diameters (D) of straight pipe required between upstream disturbance and the flow meter
(2) Number of diameters (D) of straight pipe required downstream of the flow meter

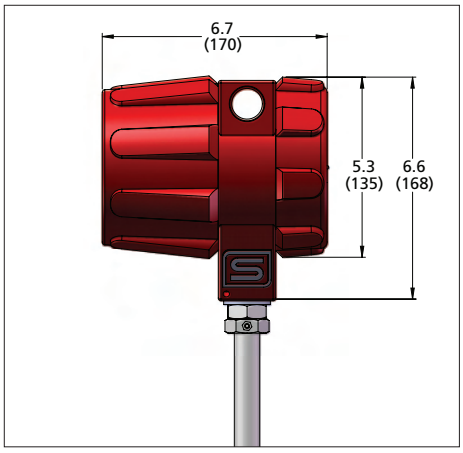
780i INLINE PRESSURE DROP



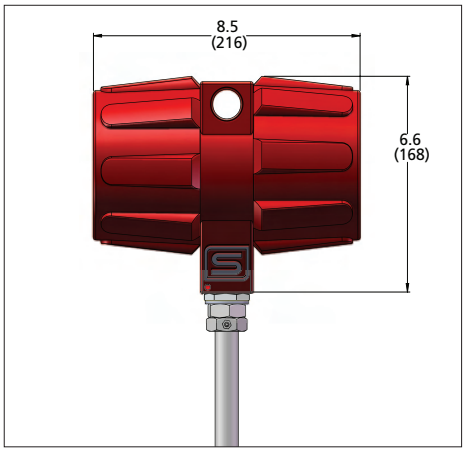
Notes: (1) For air and nitrogen at 20°C temperature and 1 atmosphere pressure
(2) 1 inch of water at 60°F = 0.0361 psi
(3) At base conditions of 21.1°C temperature and 1 atmosphere pressure
(4) At base conditions of 0°C temperature and 1 atmosphere pressure

640i INSERTION DIMENSIONAL DRAWINGS

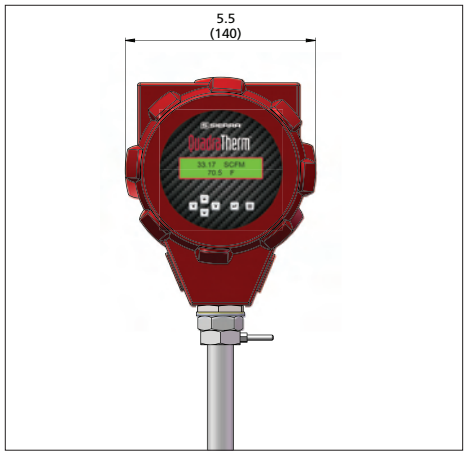
P2-DD—Side View



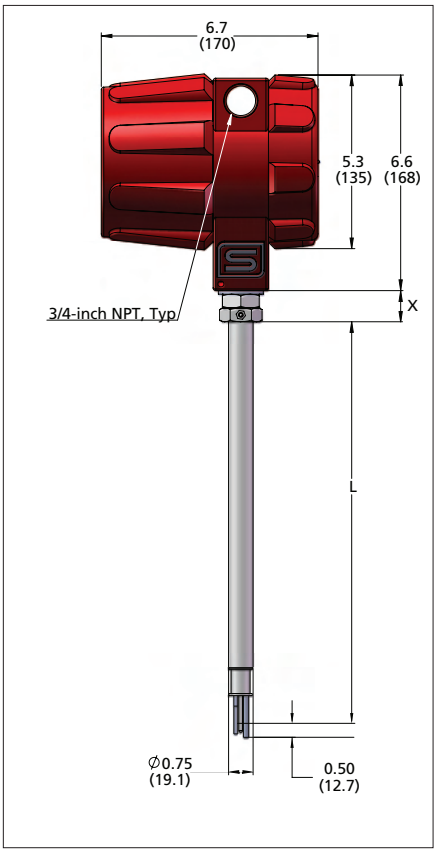
P3-DD—Side View



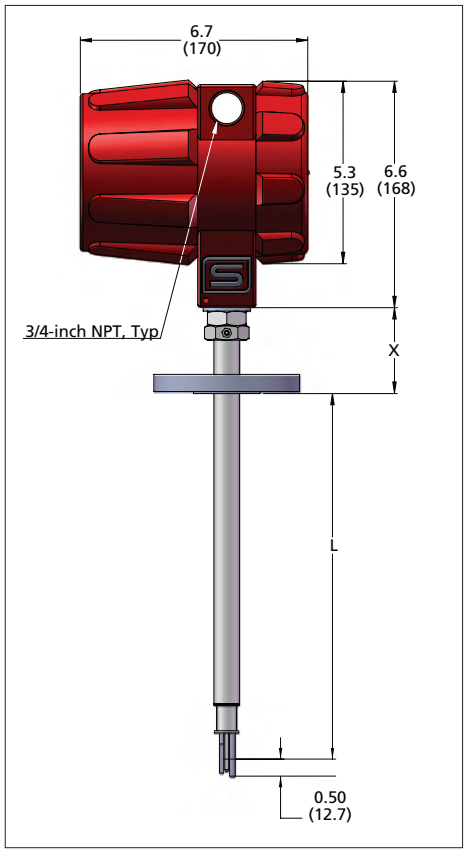
All Versions—Front View



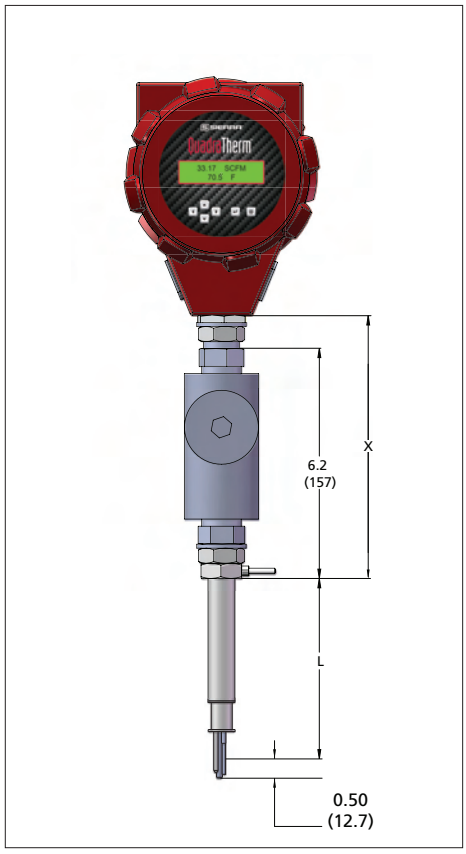
P2-DD Compression Fitting—Side View



P2-DD Flange Fitting—Side View



cFMus, ATEX, IECEx Approved Probes (> 13")



Note: All dimensions in inches with (mm) in brackets; certified drawings available upon request. All drawings have ± .25 inch (6.4 mm) tolerance.

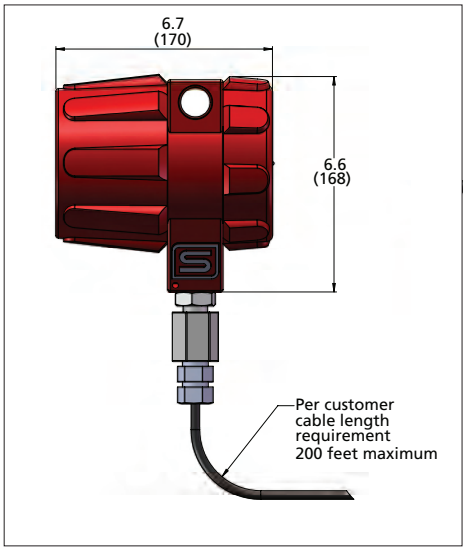
Length Chart 640i Compressions Fittings		
Code	L	X
L06	6.0 (152)	1.25 (31.75)
L09	9.0 (229)	1.25 (31.75)
L13	13.0 (330)	1.25 (31.75)
L18	18.0 (457)	1.25 (31.75)
L24	24 (610)	1.25 (31.75)
L36	36 (914)	1.25 (31.75)
L48	48 (1219)	1.25 (31.75)

Length Chart 640i Flange Mounting		
Code	L	X
L06	6.0 (152)	2.69 (68.33)
L09	9.0 (229)	2.69 (68.33)
L13	13.0 (330)	2.69 (68.33)
L18	18.0 (457)	2.69 (68.33)
L24	24 (610)	2.69 (68.33)
L36	36 (914)	2.69 (68.33)
L48	48 (1219)	2.69 (68.33)

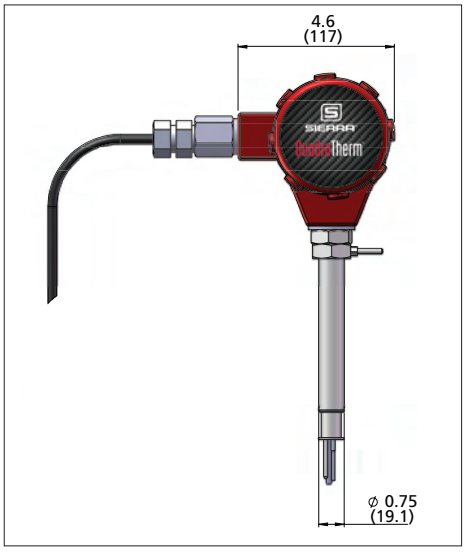
Length Chart 640i FM Version		
Code	L	X
L06	6.0 (152)	10.25 (260.35)
L09	9.0 (229)	10.25 (260.35)
L13	13.0 (330)	10.25 (260.35)
L18	18.0 (457)	10.25 (260.35)
L24	24 (610)	10.25 (260.35)
L36	36 (914)	10.25 (260.35)
L48	48 (1219)	10.25 (260.35)

640i INSERTION DIMENSIONAL DRAWINGS

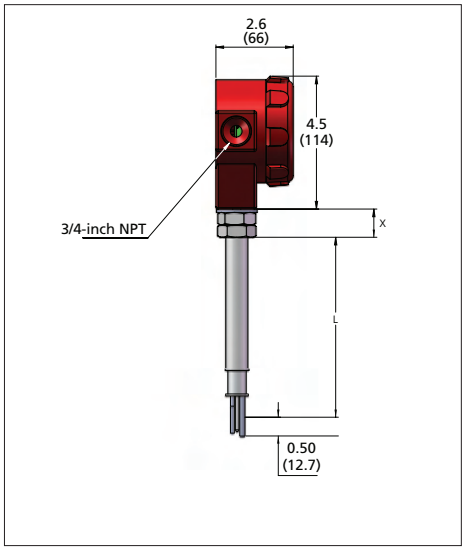
Remote Electronics—Side View



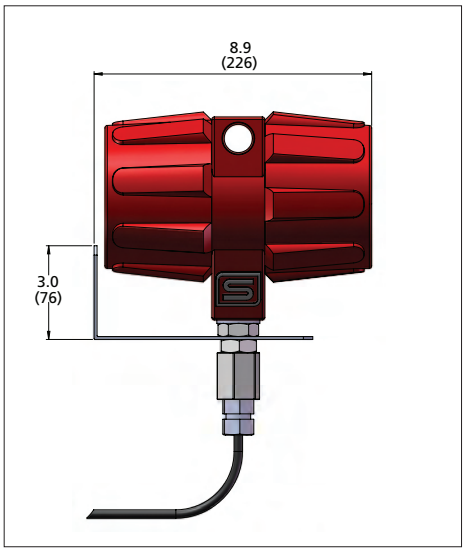
Remote Probe—Front View



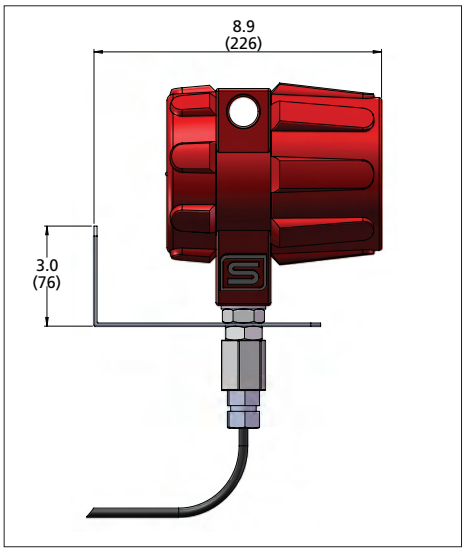
Remote Probe—Side View



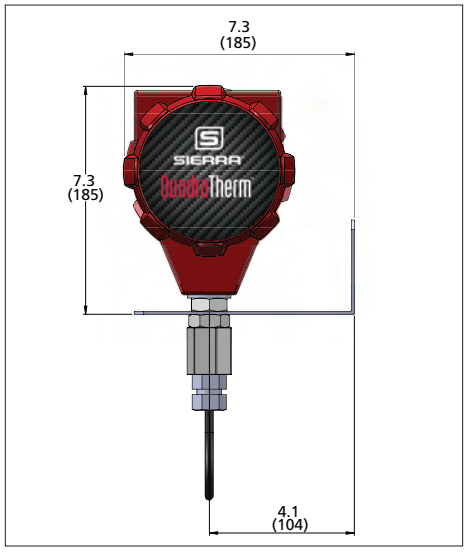
P3-DD Remote Bracket—Side View



P2-DD Remote Bracket—Side View

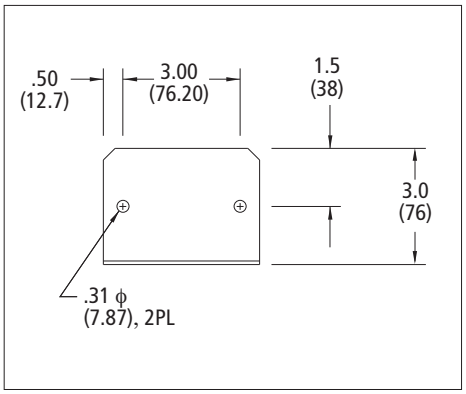


Remote Bracket—Front View



Note: All dimensions in inches with (mm) in brackets; certified drawings available upon request. All drawings have ± .25 inch (6.4 mm) tolerance.

Mounting Holes for Remote Bracket

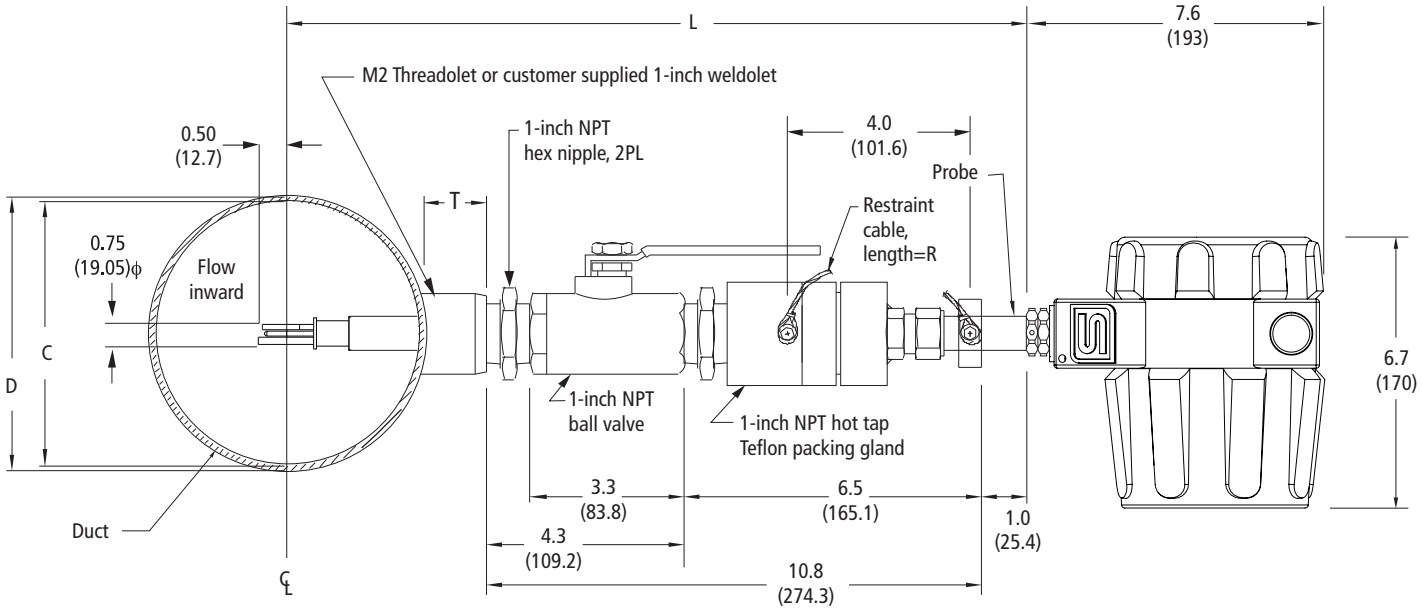


Length Chart 640i
Remote Mount Junction Box

Code	L	X
L06	6.0 (152)	1.25 (37.75)
L09	9.0 (229)	1.25 (37.75)
L13	13.0 (330)	1.25 (37.75)
L18	18.0 (457)	1.25 (37.75)
L24	24 (610)	1.25 (37.75)
L36	36 (914)	1.25 (37.75)
L48	48 (1219)	1.25 (37.75)

Note: All dimensions in inches with (mm) in brackets; certified drawings available upon request. All drawings have ± .25 inch (6.4 mm) tolerance.

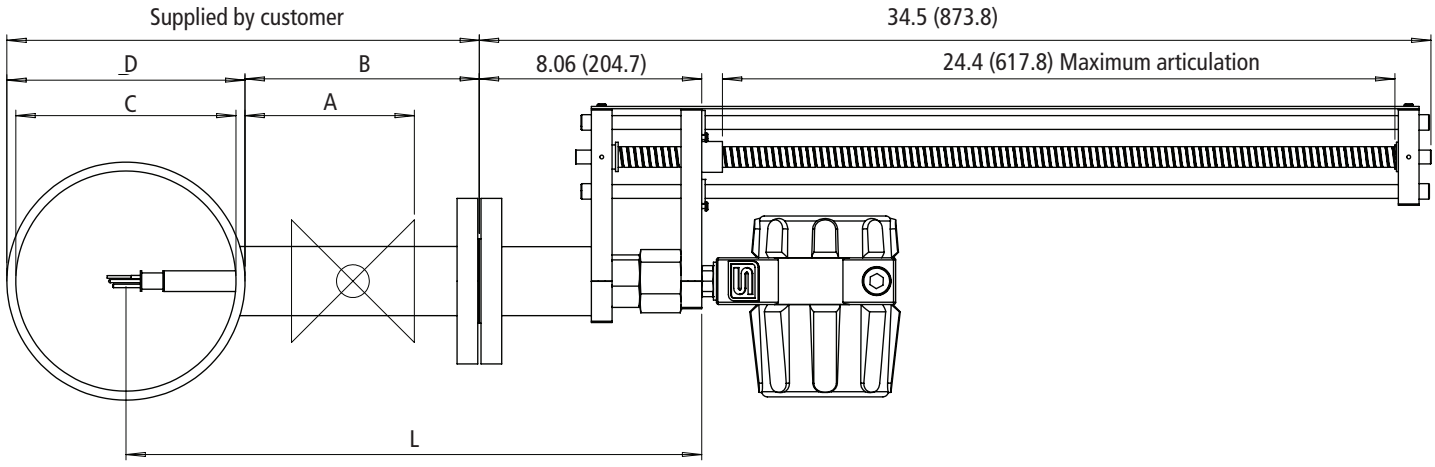
640i INSERTION LOW PRESSURE HOT TAP to 150 psig (10.3 barg)



Variables
L = Nominal Probe Length
D = Duct O.D.
C = Duct I.D.
T = Height of "Threadolet"
or Customer Provided Weldolet
R = Restraint Cable Length

Formula
L > 12.3 + T + D/2
So L must be equal
or greater than 12.3-inches
plus the height of the
"Threadolet" plus half the duct O.D.
R = D/2 + T + 7.3

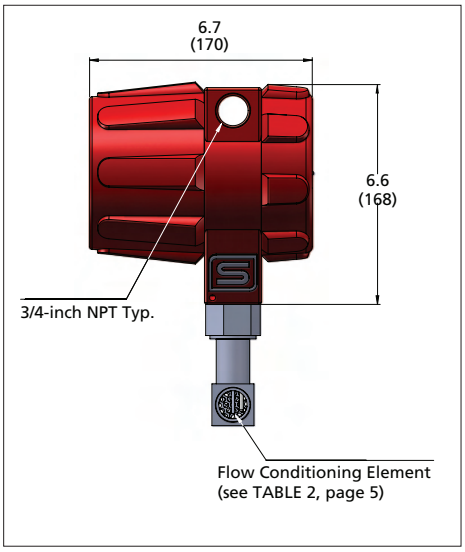
640i HIGH PRESSURE HOT TAP to 400 psig (27.6 barg)



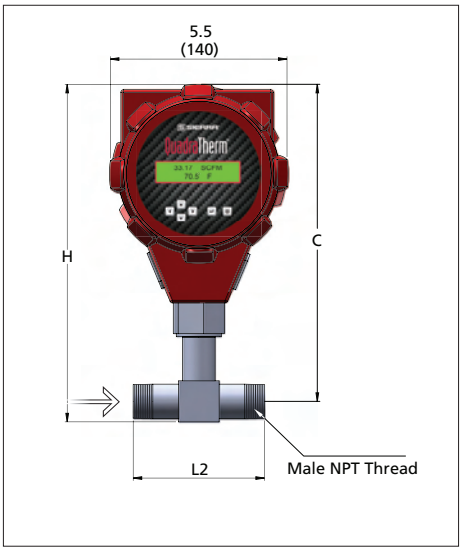
Note: All dimensions in inches with (mm) in brackets; certified drawings available upon request

780i INLINE DIMENSIONAL DRAWINGS

1/2" and 1 1/2" NPT—Side View

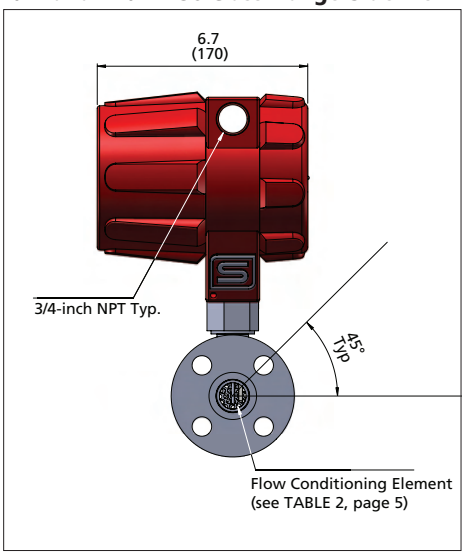


1/2" and 1 1/2" NPT—Front View

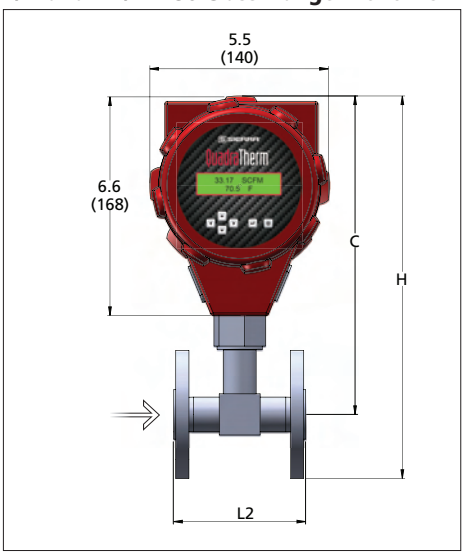


Sizes for NPT			
Size	H	C	L2
1/2-inch	10.5 (267)	9.9 (251)	7.5 (191)
3/4-inch	10.8 (274)	9.9 (251)	7.9 (201)
1-inch	11.2 (284)	9.9 (251)	8.3 (211)
1 1/2-inch	11.5 (292)	9.9 (251)	9.5 (241)

1/2" and 1 1/2" 150 Class Flange-Side View

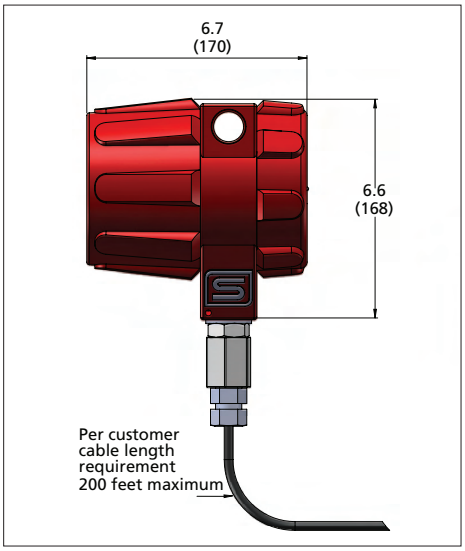


1/2"and 1 1/2" 150 Class Flange-Front View

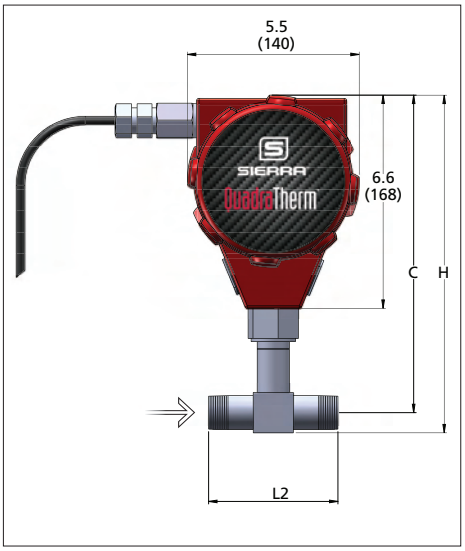


Sizes For ANSI Class 150 Flange			
Size	H	C	L2
1/2-inch	11.6 (295)	9.9 (251)	7.5 (191)
3/4-inch	11.8 (300)	9.9 (251)	7.9 (201)
1-inch	12.0 (304)	9.9 (251)	8.3 (211)
1 1/2-inch	12.2 (310)	9.9 (251)	9.5 (241)

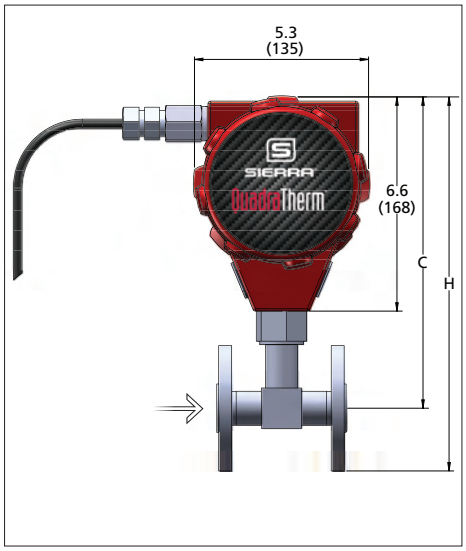
NPT Remote—Side View



NPT Remote—Front View



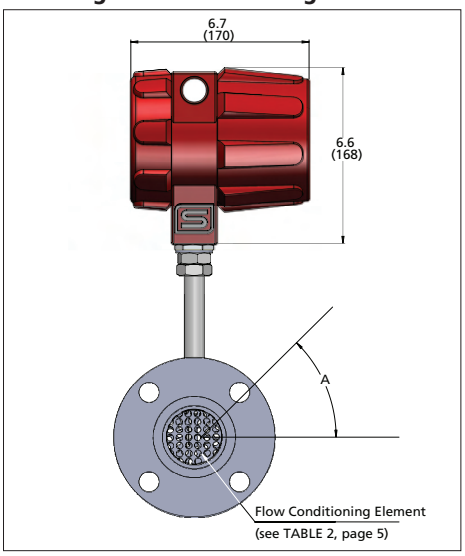
150 Class Flange Remote—Front View



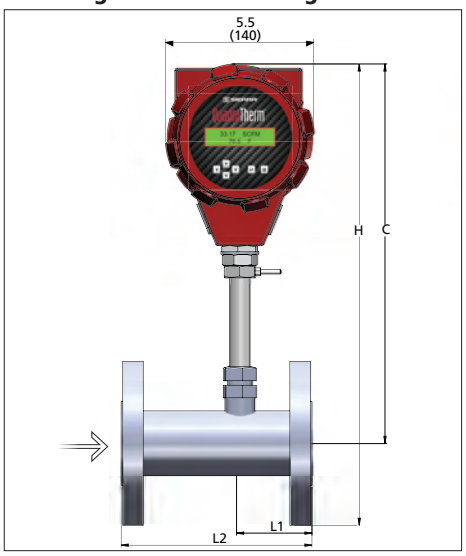
Note: All dimensions in inches with (mm) in brackets; certified drawings available upon request

780i INLINE DIMENSIONAL DRAWINGS

2" Through 8" 150 Class Flange—Side View

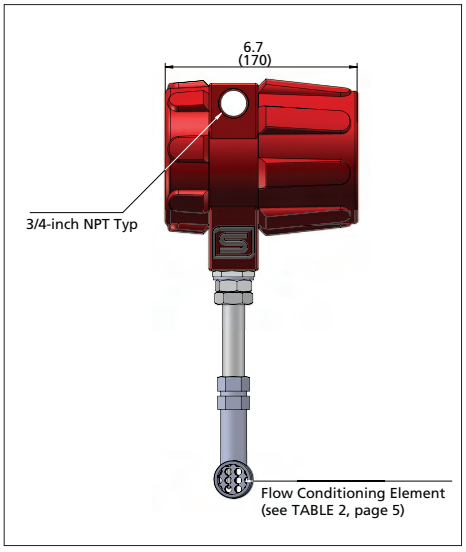


2" Through 8" 150 Class Flange—Front View

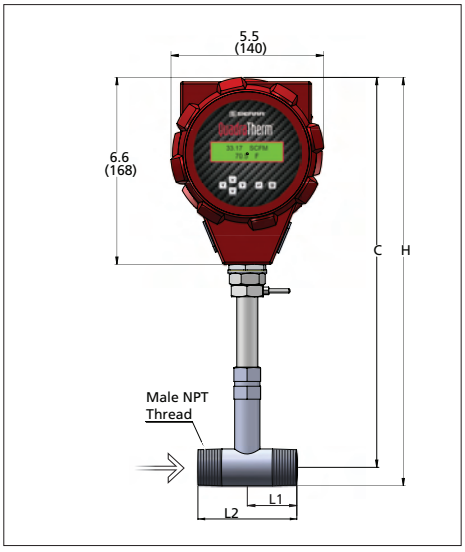


Sizes for ANSI Class 150 Flanges					
Size	H	C	L1	L2	A
2-inch	17.0 (432)	14.0 (356)	2.6 (66)	7.0 (178)	45
3-inch	17.7 (450)	14.0 (356)	2.6 (66)	10.0 (254)	45
4-inch	18.5 (470)	14.0 (356)	3.6 (91)	12.0 (305)	22.5
6-inch	19.5 (495)	14.0 (356)	5.6 (142)	18.0 (547)	22.5
8-inch	20.7 (526)	14.0 (356)	7.6 (193)	29.0 (737)	22.5

2" Through 8" NPT—Side View

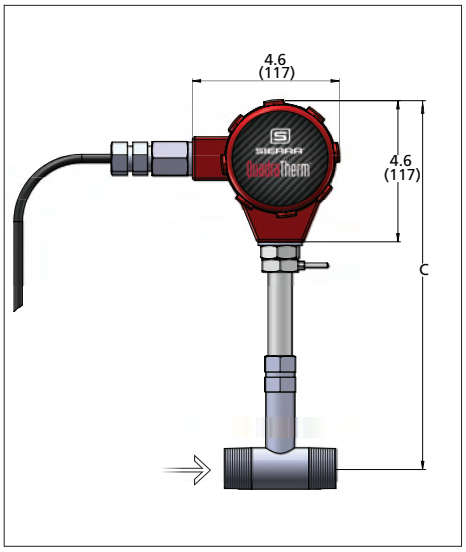


2" Through 8" NPT—Front View

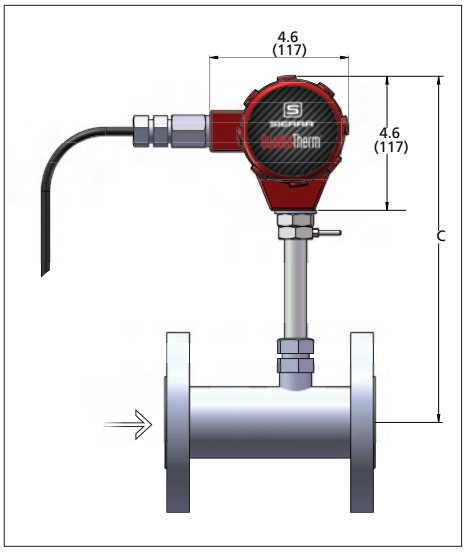


Sizes for 1-inch Through 8-inch NPT				
Size	H	C	L1	L2
2-inch	15.1 (384)	14.0 (356)	3.50 (89)	7.50 (191)
3-inch	15.7 (399)	14.0 (356)	4.00 (102)	10.00 (254)
4-inch	16.2 (411)	14.0 (356)	4.00 (102)	12.00 (305)
6-inch	17.3 (439)	14.0 (356)	6.00 (152)	18.00 (457)
8-inch	18.3 (465)	14.0 (356)	8.00 (203)	24.00 (610)

NPT Remote—Front View



Flange Remote—Front View



Sizes for PN16 DN Flanges				
Size	H	C	L1	L2
DN50	17.2 (437)	14.0 (356)	3.34 (85)	7.10 (180)
DN80	17.9 (455)	14.0 (356)	4.14 (105)	10.20 (259)
DN100	18.3 (465)	14.0 (356)	4.57 (116)	12.60 (320)
DN150	19.6 (498)	14.0 (356)	6.77 (172)	18.90 (480)
DN200	20.7 (526)	14.0 (356)	8.47 (215)	24.40 (620)

ORDERING THE 640i INSERTION

Dial-A-Gas Selection

640i - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [0] - [ ] - [ ] - [ ]

Feature	1	2	3	4	5	6	7	8	9	*10	11	12	13

Instructions: To order a 640i, please fill in each feature number block by selecting the codes from the corresponding features below.

*Feature 10 is air (always included)

Option 1 [ ]

Feature 1: Multivariable	
640i VT	Thermal Insertion Mass Flow Meter; all 316L stainless steel construction; linear 4-20 mA output signals for Mass Flow Velocity and Temperature, temperatures -40°F to 392°F (-40°C to 200°C); pressure to 500 psig (34.5 barg); standard accuracy (air) +/- 0.75% of reading above 50% of full scale flow and +/- 0.75% of reading plus 0.5% of full scale below 50% of full scale flow; includes qTherm™ Electronics with PC configuration software; 24 VDC +/- 10.0% or 100-240 VAC input power with a 3/4-inch (2 cm) diameter 316 SS insertion sensor probe; configurable alarm and pulse outputs; CE, cFMus, ATEX, IECEx approved
640i VTP	Add a pressure output to the 640i VT version; three 4-20 mA linear outputs for mass flow velocity, temperature, and pressure; includes pressure sensor to 500 psia (34.5 bara)

Note: Minimum pipe size for insertions is 2 inches (50 mm) diameter.

Feature 2: Approvals	
1	**NAA.** Non-agency approved.
2	**cFMus.** Process Temperature Range: -40°C to 200°C (-40°F to 392°F). Class I, Division 1, Groups B,C, and D T3C Ta = -40°C to 60°C (-40°F to 140°F). Type 4x. Maximum probe length is 48 inches (1.22 m). Note: Requires Killark seal for probes >L13, see Note 1
3	**ATEX and IECEx.** II 2 G Ex d IIC T3 Gb. II 2 D Ex tb IIIC T200°C Db. Ta = -20°C to 60°C (-4°F to 140°F). Process Temperature Range: -40°C to 200°C (-40°F to 392°F). Maximum probe length is 48 inches (1.22 m)

Feature 3: Probe Length	
L06	6-inch (15 cm)
L09	9-inch (23 cm)
L13	13-inch (33 cm)
L18	18-inch (46 cm) If agency approved, see Note 1.
L24	24-inch (61 cm) If agency approved, see Note 1.
L36	36-inch (91 cm) If agency approved, see Note 1.
L48	48-inch (122 cm) If agency approved, see Note 1.
L(x)	Special length not listed above or over 48 inches (122 cm). specify length in parentheses; maximum probe length 72 inches (1.83 m). Maximum for agency approved 48 inches (1.22 m). **This price applies to sizes below 48 inches (1.22 m) not listed above. If agency approved, see Note 1.**
L( )M5 Adder	Probe with 1-inch, ANSI class 150 flange If agency approved, see Note 1. Specify length in parentheses; includes M5 option diagram with ADS

Note 1: Killark seal is required for agency approved meters with >L13. Adds 6.2 in (157 mm) to probe length listed above.

Feature 4: Mounting Options: Standard 3/4" (19.1mm) Diameter Sensor Probe. Note: If you want the optional sensor shield, skip this section and specify proper Sensor Shield Mounting Kit below in Feature 4B.	
M0	Customer to supply own mounting hardware
M1	Compression fitting, 3/4-inch (2 cm) with 1-inch (2.5 cm) male NPT
M2( )	Threadolet 1-inch Female NPT; specify pipe O.D. in parenthesis
M1-M2( )	Compression fitting plus Threadolet. 3/4-inch probe feed through by 1-inch male NPT. Threads into 1-inch Female NPT, which is welded to the pipe. Specify pipe O.D. in parenthesis. **We strongly advise to purchase this as a set, since we've seen non compatible NPT threads in the past.**
M3	Flat duct bracket, 3/4-inch (2 cm) tube compression fitting
M4( )	Curved duct bracket, 3/4-inch (2 cm) tube compression fitting; specify duct O.D. in parentheses
M8( )	**Low pressure hot tap,** includes ball valve and packing gland; maximum 150 psig (10.3 barg); specify duct O.D. in parenthesis. **Note: M8 option not available for probes less than 18 inches**
L( )M9	High pressure hot-tap with removable retractor kit assembly includes probe (probe length L in parentheses, MINIMUM length is process connection dependent, maximum as desired), removable retractor assembly, packing gland probe seal with a 2-inch ANSI class 150 process connection (other classes available, contact factory) and Conax fitting. Max pressure flange dependent or 400 psig (27.6 barg). Contact factory for 1000 psig (68.9 barg) option.
M15	Quick removal hot-tap, includes ball valve and compression fitting rated for 40 psig (2.8 barg)

ORDERING THE 640i INSERTION (continued)

Feature 4B: Sensor Shield & Mounting Option Kits: Add 1-inch (25.4 mm) diameter stainless steel welded-on sensor shield to the end of the insertion probe for improved sensor protection.	
S1( )	This assembly includes a sensor shield and a captured Conax fitting 3/4-inch (19.1 mm) with 1-inch (25.4 mm) male NPT. Max pressure 400 psig (27.6 barg). Contact factory for 1000 psig (68.9 barg) option. Specify probe length in parenthesis
S2( )	Assembly is a 1-inch (25.4 mm) Female NPT weldolet, which customer welds to the pipe. Commonly used with S1, Specify pipe O.D. in Parenthesis for S2. Max pressure 400 psig (27.6 barg). Contact factory for 1000 psig (68.9 barg) option.
S1-S2( )	This assembly includes a sensor shield and a captured Conax fitting plus weldolet. 3/4-inch (19.1 mm) probe with 1-inch (25.4 mm) male NPT. Threads into 1-inch (25.4 mm) Female NPT weldolet, which customer welds to the pipe. Specify probe lenth in parenthesis for S1 and Specify pipe O.D. in Parenthesis for S2. Max pressure 400 psig (27.6 barg). Contact factory for 1000 psig (68.9 barg) option.
S1( )-S8( )	**Low pressure hot tap** assembly includes a sensor shield, a ball valve and packing gland with Conax fitting plus weldolet. Maximum 150 psig (10.3 barg). Retractor is required for greater than >150 psig(10.3 barg) if hot tapping (see S9 ( )). Specify probe length in parenthesis for S1 and Specify pipe O.D. in Parenthesis for S8.
S9( )	**High pressure hot-tap with removable retractor kit** assembly includes a sensor shield, removable retractor assembly, packing gland probe seal with a 2-inch ANSI class 150 process connection (other classes available, contact factory), and Conax fitting. Specify probe length in parentheses, MINIMUM length is process connection dependent. Max pressure flange dependent or 400 psig (27.6 barg). Contact factory for 1000 psig (68.9 barg) option.

Feature 5: Electronics Enclosure	
E2	Hazardous-area location enclosure NEMA 4X (IP66) mounted directly on probe
E4( )	Remote hazardous-area location enclosure, includes NEMA 4 (IP66) junction box mounted on probe and mounting bracket for remote electronics enclosure; maximum 200 feet (61 m) housing mounted up to 200 feet (61 m) from flow body; specify cable length in parenthesis.

Feature 6: Input Power	
P2	24 VDC +/- 10.0%
P3	100-240 VAC

Feature 7: Output	
V4	Two linear 4-20mA outputs for mass flow velocity and temperature
V6 (VTP only)	Three linear 4-20mA outputs for mass flow velocity, temperature and pressure (only available with Feature 1: Multivariable 640i VTP)

Feature 8: Display	
DD	Digital Display: UltraBright LCD indicates mass flow velocity, T, P, alarms and totalized mass flow in engineering units; 6-push button user interface makes selection easy: Dial-A-Gas, Dial-A-Pipe, change units, change language, set alarms and much more…
NR	No readout

Feature 9: Pressure (VTP only)	
MP1	30 psia (2.1 bara), VTP only
MP2	100 psia (6.9 bara), VTP only
MP3	300 psia (20.7 bara), VTP only
MP4	500 psia (34.5 bara), VTP only

Note: Put N/A in feature block 9 for VT or E4 meters. Maximum operating pressure must not exceed the full scale of the pressure transducer if the VTP option is ordered or damage may occur.

Feature 10: Dial-A-Gas (Air)	
0	Air (+/- 0.75% of reading); Add three qTherm Dial-A-Gases, see Feature 11-13 below to choose additional gases (Default Gases: Nitrogen, Carbon Dioxide, Methane). You may choose qTherm calibration or actual gas calibration for each one of your three additional choices.

Feature 11-13 : qTherm Dial-A-Gas Selection

*Select three additional gases to be programmed into the instrument; Air is standard on the instrument and cannot be removed. qTherm gas is +/- 3.0% of full scale for all qTherm gases unless otherwise noted. Derated to 5% for 1" shroud option

qTherm Gas Code	Gas	Actual Gas Calibration Code
0	**Air (standard)**	0
1	**Argon**	1A
2	**Carbon Dioxide**	2A
3	**Chlorine**	N/A
4	**Digester Gas**	4A
6	**Helium**	6A
7	**Hydrogen**	7A
8	**Methane**	8A
10	**Nitrogen**	10A
11	**Oxygen (0.75% reading plus 0.5% full scale qTherm accuracy)**	N/A
12	**Propane**	12A
14	**Ammonia**[1]	14A
99	**Other–Consult Factory**	99

[1]Correlation calibration - consult Gas Table for accuracy.

Option 1: Digital Communications	
DP1	Profibus DP using an M12 connector, NAA only full device description (DC power only)
DP2	Profibus DP using a 2-wire terminal block connection with full device description (DC power only)
FF	Foundation Fieldbus full device description
MB	Modbus RTU full device description
HART	HART with full device description

Note: Available with cFMus and ATEX/IECEx except DP1. All Digital Communications options available in P2 only.

ORDERING THE 780i INLINE

Dial-A-Gas Selection — Option 1

780i - [ ]-[ ]-[ ]-[ ]-[ ]-[ ]-[ ]-[ ]-[0]-[ ]-[ ]-[ ] [ ]

Feature	1	2	3	4	5	6	7	8	*9	10	11	12

Instructions: To order a 780i, please fill in each feature number block by selecting the codes from the corresponding features below.

*Feature 9 is air (always included)

Feature 1: Multivariable	
VT	Inline Thermal Mass Flow Meter with Flow Conditioning; all 316L stainless steel construction; linear 4-20 mA output signals for Mass Flow Rate and Temperature; temperature range -40°F to 392°F (-40°C to 200°C) and pressure to 500 psig (34.5 barg); standard accuracy +/- 0.5% of reading above 50% of full scale flow and +/- 0.5% of reading plus 0.5% of full scale below 50% of full scale flow; configurable alarm and pulse outputs; CE, cFMus, ATEX, and IECEx approved
VTP	Add a pressure output to the 640i VT version; three 4-20 mA linear outputs for mass flow velocity, temperature, and pressure; includes pressure sensor to 500 psia (34.5 bara)

Feature 2: Approvals	
1	**NAA.** Non-agency approved.
2	**cFMus.** Process Temperature Range: -40°C to 200°C (-40°F to 392°F). Class I, Division 1, Groups B,C, and D T3C Ta = -40°C to 60°C (-40°F to 140°F). Type 4x.
3	**ATEX and IECEx.** II 2 G Ex d IIC T3 Gb. II 2 D Ex tb IIIC T200°C Db. Ta = -20°C to 60°C (-4°F to 140°F). Process Temperature Range: -40°C to 200°C (-40°F to 392°F).

Feature 3: Inline Flow Bodies with Flow Conditioning	
N2	1/2-inch (1 cm) NPT male 316 SS
N3	3/4-inch (2 cm) NPT male 316 SS
N4	1-inch (2.5 cm) NPT male 316 SS
N5	1.5-inch (4 cm) NPT male 316 SS
N6	2-inch (5 cm) NPT male 316 SS
N7	3-inch (8 cm) NPT male 316 SS
N8	4-inch (10 cm) NPT male 316 SS
N9	6-inch (15 cm) NPT male 316 SS
N10	8-inch (20 cm) NPT male 316 SS
F2	1/2-inch ANSI class 150 flange 316 SS
F3	3/4-inch ANSI class 150 flange 316 SS
F4	1-inch ANSI class 150 flange 316 SS
F5	1.5-inch ANSI class 150 flange 316 SS
F6	2-inch ANSI class 150 flange 316 SS
F7	3-inch ANSI class 150 flange 316 SS
F8	4-inch ANSI class 150 flange 316 SS
F9	6-inch ANSI class 150 flange 316 SS
F10	8-inch ANSI class 150 flange 316 SS
FD6	DN50, PN16, flange
FD7	DN80, PN16, flange
FD8	DN100, PN16, flange
FD9	DN150, PN16, flange
FD10	DN200, PN16, flange
GD4	DN25, PN40, DIN flange
GD5	DN 40, PN40, DIN flange
GD6	DN50, PN40, DIN flange
GD7	DN80, PN40, DIN flange
GD8	DN100, PN40, DIN flange
GD9	DN150, PN40, DIN flange
GD10	DN200, PN40, DIN flange

Feature 4: Electronics Enclosure	
E2	Hazardous-area location enclosure NEMA 4X (IP66) mounted directly on probe
E4( )	Remote hazardous-area location enclosure includes NEMA 4 (IP66) junction box mounted on probe and mounting bracket for remote electronics enclosure; specify cable length in parenthesis; maximum 200 feet (61m) housing mounted up to 200 feet (61m) from flow body.

Feature 5: Input Power	
P2	24 VDC +/- 10.0%
P3	100-240 VAC

Feature 6: Output	
V4	Two linear 4-20mA outputs for T and mass flow rate
V6 (VTP only)	Three linear 4-20mA outputs for T, P, mass flow rate

Feature 7: Display	
DD	UltraBright, local LCD display indicates mass flow rate, T, P and totalized mass in engineering units
NR	No readout

Feature 8: Pressure	
MP1	30 psia (2.1 bara), VTP only
MP2	100 psia (6.9 bara), VTP only
MP3	300 psia (20.7 bara), VTP only
MP4	500 psia (34.5 bara), VTP only

Note: Put N/A in feature block 9 for VT or E4 meters.
Maximum operating pressure must not exceed the full scale of the pressure transducer if the VTP option is ordered or damage may occur.

Feature 9: Dial-A-Gas (Air)	
0	Air (+/- 0.75% of reading); Add three qTherm Dial-A-Gases, see Feature 11-13 below to choose additional gases (Default Gases: Nitrogen, Carbon Dioxide, Methane). You may choose qTherm calibration or actual gas calibration for each one of your three additional choices.

Feature 10-12 : qTherm Dial-A-Gas Selection

*Select three additional gases to be programmed into the instrument; Air is standard on the instrument and cannot be removed. qTherm gas is +/- 3.0% of full scale for all qTherm gases.

qTherm Gas Code	Gas	Actual Gas Calibration Code
0	**Air (standard)**	0
1	**Argon**	1A
2	**Carbon Dioxide**	2A
3	**Chlorine**	N/A
4	**Digester Gas**	4A
6	**Helium**	6A
7	**Hydrogen**	7A
8	**Methane**	8A
10	**Nitrogen**	10A
11	**Oxygen (0.5% reading plus 0.5% full scale less than 50% qTherm accuracy)**	N/A
12	**Propane**	12A
14	**Ammonia[1]**	
99	**Other[1]–Consult Factory**	99

[1]Correlation calibration - consult Gas Table for accuracy.

Option 1: Digital Communications	
DP1	Profibus DP using an M12 connector, NAA only full device description
DP2	Profibus DP using a 2-wire terminal block connection with full device description
FF	Foundation Fieldbus full device description
MB	Modbus RTU full device description
HART	HART with full device description

Note: Available with cFMus and ATEX/IECEx except DP1. P2 only. All Digital Communications options available in P2 only.

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