

“Sensing the pulse of industry”

## TekProbe PR3 Averaging Pitot Multivariable Flow Sensors

The **tekProbe PR3** Multivariable Averaging Pitot Flow Sensor brings new advances in the art of accurate, wide ranging, insertion averaging Pitot tubes for use with liquids, gases and steam . Pipe or duct sizes are from 50mm to 2000mm (2” to 80”). The **tekProbe PR3** introduces for the first time a multi-port insertion, multivariable averaging system, with noise free differential pressure (dp) between flow impact pressure and a **true** static pressure. The differential pressure is proportional to mass or volumetric flow rate.

Other averaging Pitots measure the differential between impact pressure and suction, or have an erroneously called ‘static’ pressure port on the sensor itself. Both methods compromise signal to noise ratio, the non-linearity of flow coefficient, as well as providing an erroneous static pressure signal to the dp cell. This results in compromised accurate flow measurement and multivariable computation uncertainty.

The **tekProbe PR3** averages velocity profile in a pipe or duct normally with a single averaging sensor. Six impact pressure ports are spaced on the upstream side of the **tekProbe**, in accordance with USA Code of Federal Regulations 40CFR60, the ASHRAE Handbook, and the internationally accepted log Tchebycheff rule to ISO 3966. The **true** static pressure is uniquely sensed and protected by the **tekProbe’s** pipe/duct connection, away from the flow cross section, such that it is unaffected by the turbulent media and provides a noise free signal.

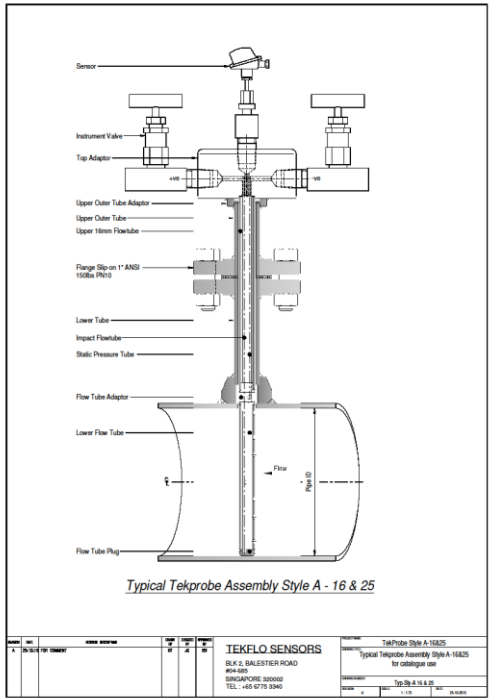
The **tekProbe PR3** in its simplest form may be used for NIST and UKAS traceable volumetric flow measurement. Alternatively, the multi-variable version may be used for density compensated mass flow, or volumetric flow corrected to reference conditions, where dp, **true** static pressure and temperature are measured on single device..

**tekProbe PR3** is compatible with any proprietary dp cell of suitable low range capability. However, Tekflo guarantees operation to specification straight out of the packing crate using its own low range, nanotechnology **tekFab DP02 and DP04 DP Cells**.

The **tekFab DP02** all-digital, multivariable dp cell embodies two nano molecular crystal silicon resonators, vibrating at their natural frequencies. When the **tekProbe** dp is applied across them, a +ve resonator vibrates in compression mode, and a -ve in tension mode. The differential frequency provides the dp signal, while the Tekprobe’s **true** static pressure provides an unmatched total system flow accuracy, repeatability, resolution, with zero hysteresis. The **tekFab DP04** is a low cost, nanotechnology, variable capacitance dp cell. It is non-multivariable, but without compromising accuracy and stability. (See separate TekFab DP02 and DP04 DP Cell specifications)



**tekProbe PR3 style A**



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## tekProbe PR3 Multivariable Flow Sensor Features

- The world's first all-digital Multivariable, **true static** averaging Pitot, with digital square root extraction
- The only averaging Pitot to measure impact pressure and **true static** pressure to provide uncompromised accurate volumetric, mass or energy flow sensing
- The only averaging Pitot with a linearity to  $\pm 0.5\%$  of reading  $> 0.5$  m/s (1.6 fps) liquids, or gas and steam Reynolds Numbers  $> 50,000$
- The only averaging Pitot offering true static sensing, truly in accordance with Classical Bernoulli Theory
- The only averaging Pitot to measure  $\sqrt{\text{mean dp}}$  to respond accurately to pulsatile flow
- The only **true profile averaging** Pitot with 6 sensing ports in accordance with USA 40CFR60 Code of Federal Regulations and ASHRAE Handbook and log Tchebycheff rule to ISO 3966 for a single diameter
- Complete multi-variable system available, including dp, **true static** pressure, with **tekprobe PR3** protected temperature sensor, all digital dp cell, steam flow condensate pots, valves, manifolds
- USA NIST and CEGB Hams Hall (UK Accreditation Service) traceable, customized Flow Certificate
- FM and CSA Explosion Proof Approval to Class 1, Div 1, or FM, CSA and ATEX intrinsic safety
- FOUNDATION Fieldbus, RS 485 Modbus and 4-20mA outputs with HART Protocols
- **tekProbe** installation costs  $> 25\%$  less than 100mm orifice plate, and  $> 75\%$  less than 500mm orifice

## tekProbe PR3 Specification

**Flow coefficient non-linearity:**  $\pm 0.5\%$  of reading  $> 0.5$  m/s (1.6 fps) liquids, over 4:1 range  
 $\pm 0.7\%$  of reading over 6: 1 range  
 $\pm 1.0\%$  of reading over 10:1 range  
 Reynolds Numbers  $> 50,000$  for gases and steam.

Note: Liquid flow cavitation due to insufficient static pressure, gas adiabatic compression factors, or Mach number effects may cause non-linearity deviation.

Consult factory for liquid mean velocities  $> 3.5$  m/s (11 fps), or gas/steam applications generating  $> 500$ mm wg (20" wg).

**Repeatability:**  $\pm 0.1\%$  of reading

**Unrecovered head loss as % of differential pressure:** **tekProbe PR3** with 50mm (2") insert tubes have negligible pressure loss in pipes  $> 1000$ mm (40")

**Maximum Pressure for Insertion Under Pressure:** **tekProbe PR3** with 16mm insert tube diameter: 10 bar max (145 psig)  
**tekProbe PR3** with 25mm insert tube diameter: 4 bar max (60 psig)  
**tekProbe PR3** with 50mm insert tube diameter: 1 bar max (15 psig)

Under pressure insertion version not available for steam

**Maximum Pressure:** Without flanges, Styles B and C, max 16 bar g (232 psi g)  
 With flanges, Style A, according to flange rating max. ANSI 600, PN64

**Note: Only flanged versions are available for steam applications.**

**European Pressure Equipment Directive:** **PR3 tekProbes** conform to the European Pressure Directive PED97/23/EC, Article 3, Sound Engineering Practice (SEP), Table 7 Group 2, Table 8 Group 1, and Table 9, Group 2 up to the specified **tekProbe PR3** pressures. Group 1 is for dangerous gases, Group 2 for non-dangerous gases.

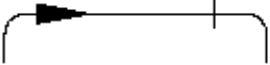


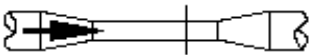
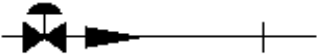
**Maximum Temperature:** Without flanges, Style B and C, maximum 150° C (300° F).  
 With flanges, Style A, according to flange rating max. ANSI 600, PN64

**Materials of Construction:** AISI 316 stainless steel throughout, except optional brass shut-off valves.  
**tekProbe PR3** Style C with brass shut-off valves are fitted with a brass/bronze isolation valve and epoxy protected carbon steel pressure chamber.  
 For other materials, consult **tekflo** or local Authorised distributor.

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\*\* Minimum Straight Run

tekProbe Type	Pipe Diameter or Minimum Duct Dimension							
	50 2"	80 3"	100 4"	150 6"	250 10"	450 18"	780 30"	>1000 >40"
PR3_25	—	—	—	—	—	4%	3%	Negligible
PR3_16	9%	7%	6%	5%	3%	—	—	—

Upstream Condition	Minimum Upstream Diameters or Equivalent Diameters		Minimum Downstream Diameters
	In Plane*	Out of Plane*	
<b>1 Elbow or Tee</b> 	7	10	3
<b>2 Elbow Same Plane</b> 	8	14	3
<b>2 Elbows Different Planes</b> 	16	23	4
<b>Upstream Reducer Downstream Expander</b> 	6	6	3
<b>Partially Closed** Upstream Valve</b> 	25	25	5

\* In plane with last upstream bend

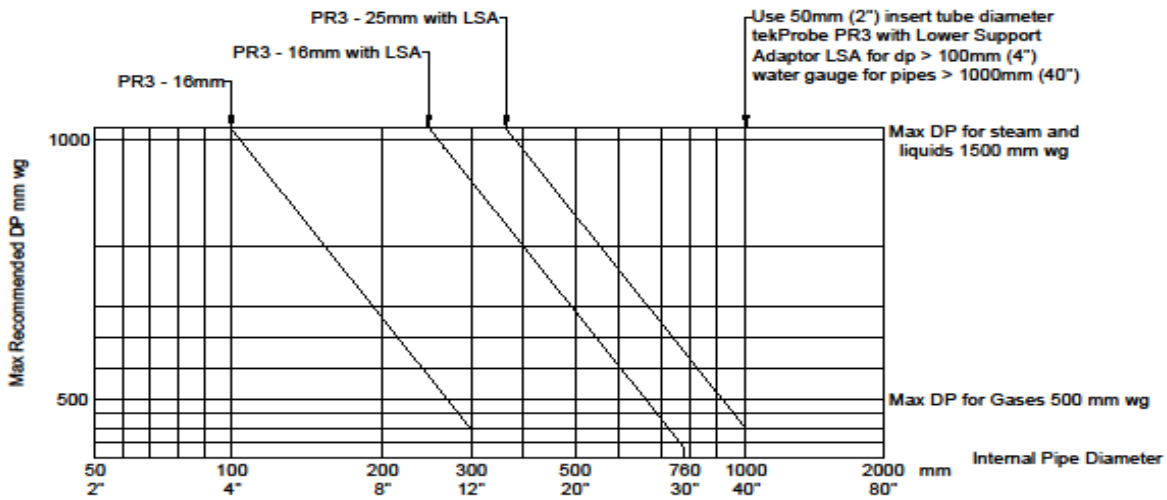
\*\* Partially closed valves should be downstream

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**Maximum DP Limits:** Steam flow rates producing < 25mm (1”) or > 1500mm (60”) water gauge dp are not recommended. Pipe sizes may be re-sized accordingly.  
 Maximum recommended dp for gases 500mm (20”) water gauge  
 Liquid flow rates producing < 50 mm (2”) water gauge dp **full scale** are not recommended. Pipe sizes may be re-sized accordingly.  
 Liquid viscosities > 300 cP are not recommended.  
 Recommended for Reynold Numbers > 30000

**Maximum DP for Various Pipe Sizes:**

**Note: For pipe sizes 1000mm (40”) and greater, where the dp is greater than 100mm (4”) water gauge, a 50mm (2”) insert tube diameter TekProbe PR3 with Lower Support Adaptor (LSA) must be used.**



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## tekProbe PR3 Differential Pressure (DP) Basic Formulae

The following are basic and approximate formulae provided to determine nominal dp ranges for dp cells. An exact Performance Certificate, traceable to USA National Institute of Standards and Technology (NIST) and UK CEGB Hams Hall with United Kingdom Accreditation Service (UKAS), is provided with each **tekProbe PR3**. Corrections for liquid viscosity, gas isotropic exponent, blockage factor, gas specific heat ratio factor, and expansion factors are detailed when relevant. However, these are omitted below for simplicity.

Gas reference conditions are to NIST and IEC 60770, ambient temperature to 20°C (68°F), 1.013 bar (101.3 kPascals) absolute.

### Liquids:

$$\begin{aligned} \text{DP mm water gauge} &= S \times 50.94 \times (\text{m/s})^2 \\ \text{DP inches water gauge} &= S \times 0.1864 \times (\text{fps})^2 \\ \text{DP mm water gauge} &= S \times 6384000 \times (\text{m}^3/\text{h})^2 / D^4 \\ \text{DP inches water gauge} &= S \times 0.03103 \times (\text{gpm})^2 / (\text{Di})^4 \end{aligned}$$

### Gases:

$$\begin{aligned} \text{DP mm water gauge} &= S \times 0.05100 \times (\text{m/s})^2 \times \rho_a \\ \text{DP mm water gauge} &= S \times 6377 \times (\text{sm}^3/\text{h})^2 \times (\text{Pa} \times \text{Top} \times \rho_a / \text{Pop} \times \text{Ta}) / D^4 \\ \text{DP inches water gauge} &= S \times 0.002989 \times (\text{fps})^2 \times \rho_{au} \\ \text{DP inches water gauge} &= S \times 0.02790 \times (\text{scfm})^2 \times (\text{Pau} \times \text{Topu} \times \rho_{au} / \text{popu} \times \text{Tau}) / (\text{Di})^4 \\ \text{Equivalent rectangular duct diameter } D_e &= 2 \sqrt{(H \times W) / \pi} \end{aligned}$$

### Steam:

$$\begin{aligned} \text{DP mm water gauge} &= 10850 \times (\text{kg/h})^2 / \rho_{op} \times D^4 \\ \text{DP inches water gauge} &= 0.0003345 \times (\text{lb/h})^2 / \rho_{opu} \times (\text{Di})^4 \end{aligned}$$

Note:  $\rho_{op}$  and  $\rho_{opu}$  are operational densities which are the reciprocal of specific volumes provided in steam tables

S **tekProbe** calibration factor. Approximate values for calculating liquid and gas flow dp:  
 PR3 50mm **tekProbes** S = 1.65, PR3 25mm **tekProbes** S = 1.59, PR3 16mm **tekProbes** S = 1.51

Exact values are provided in USA NIST Traceable Performance Certificates

(m/s)	mean velocity metres/second
(fps)	mean velocity feet/second
(m <sup>3</sup> /h)	volumetric flow rate metres/second
(gpm)	volumetric flow rate US gallons/minute
D	internal pipe diameter mille metres
(Di)	internal pipe diameter inches
$\rho_a$	gas density kg/m <sup>3</sup> at NIST standard conditions 20° C (293° K), 1.013 bar absolute
<b>Note:</b>	1.013 bar = 101.3 kPascals
sm <sup>3</sup> /h	gas flow rate cubic metres/hour at NIST standard conditions 20° C, 1.013 bar absolute
Pa	absolute pressure 1.013 bar
Top	operating absolute temperature ° K = operating °C + 273° K
Pop	operating pressure bar absolute = operating bar gauge + 1.013
Ta	absolute temperature at NIST conditions 293° K
$\rho_{au}$	gas density lb/ft <sup>3</sup> at NIST standard conditions 68° F (528° R), 14.70 psi absolute
scfm	gas flow rate foot <sup>3</sup> /minute at NIST standard conditions 68° F (528° R), 14.70 psi absolute
Pau	absolute pressure 14.70 psia at NIST standard conditions 68° F (528° R)
Topu	operating absolute temperature °R = operating °F + 460° R
Popu	operating pressure psi absolute = operating psi gauge +14.70
$\rho_{op}$	operational steam density kg/m <sup>3</sup> (reciprocal of specific volume given in steam tables)
$\rho_{opu}$	operational steam density lb/foot <sup>3</sup> (reciprocal of specific volume given in steam tables)
Tau	absolute temperature at NIST conditions 528° R
De	equivalent duct diameter in inches or mm. Take $\pi = 3.142$
H	height of rectangular duct inches or mm
W	width of rectangular duct inches or mm

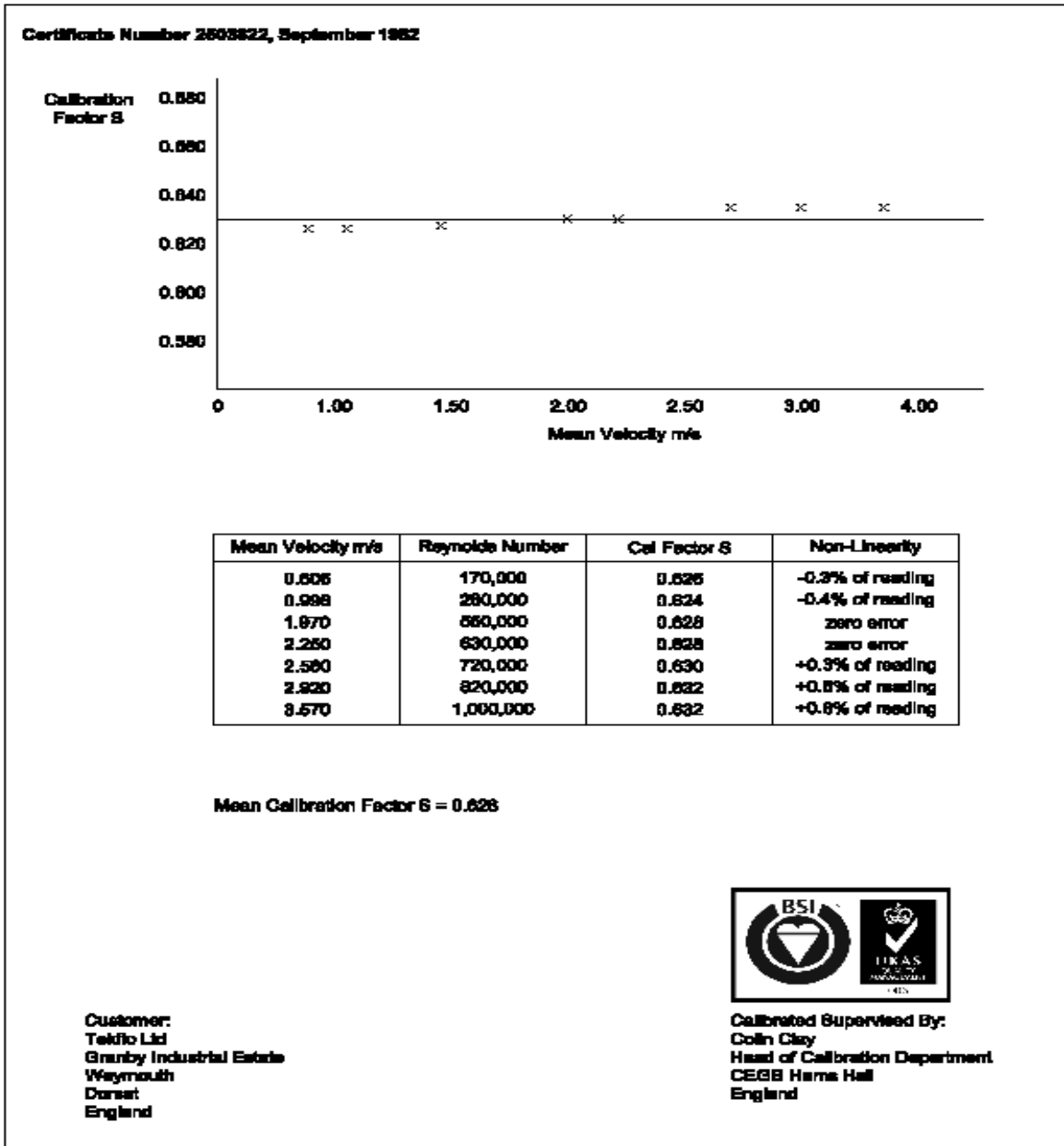
Multiple Tekprobes may be necessary for non-circular ducts. Consult factory

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## tekProbe PR3 NIST Traceable Calibration and Certified UKAS Accredited Facility

The following sample **tekProbe PR3** calibration is extracted from a calibration performed at the United Kingdom Central Electricity Generating Board (CEGB), to whom acknowledgement is given. The CEGB Flow Calibration Facility is at Hams Hall, Coventry University Technology Park, England. This Calibration Facility is certified by the United Kingdom Accreditation Service (UKAS).

**PR3 tekProbes** have been further checked for agreement against a USA National Institute of Standards and Technology (NIST) traceable magnetic flow meter, having an accuracy to  $< \pm 0.2\%$  of reading.  
 Pipe Size : 12” Schedule 40 carbon steel. Media: Water, **tekProbe PR3/25**, Serial Number 9992.



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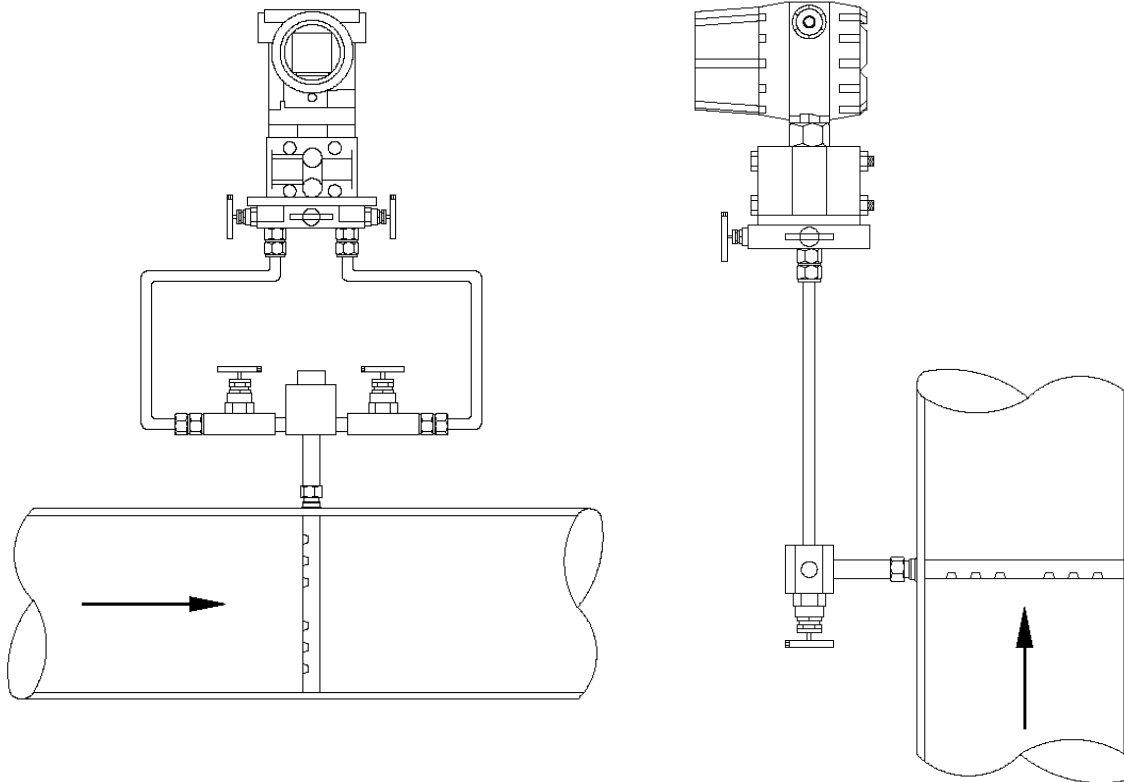
## tekProbe PR3 and Differential Pressure Sensor Orientation

**PR3 tekProbes** are uni-directional. For bi-directional flow a pair of Tekprobes must be used, with a minimum of distance of 5 diameters between them. The 6 impact pressure ports must face upstream. The static pressure is not in the flow stream. Pipes may be horizontal or vertical.

**Note:** All fittings shown in the diagrams are normally supplied as an option by **tekflo**, except those differential pressure pressure pipes shown dotted.

### Gases:

Gases may have entrained moisture or liquid droplets. The **tekProbe PR3** must therefore be inserted from the **top** of the pipe or duct, or from the side centerline, with the **tekProbe PR3** emerging at an angle **above** the horizontal plane. In this way any liquid returns to the pipe and prevents false differential pressures (dp) being measured by the dp sensor.



**tekProbes** on Gases

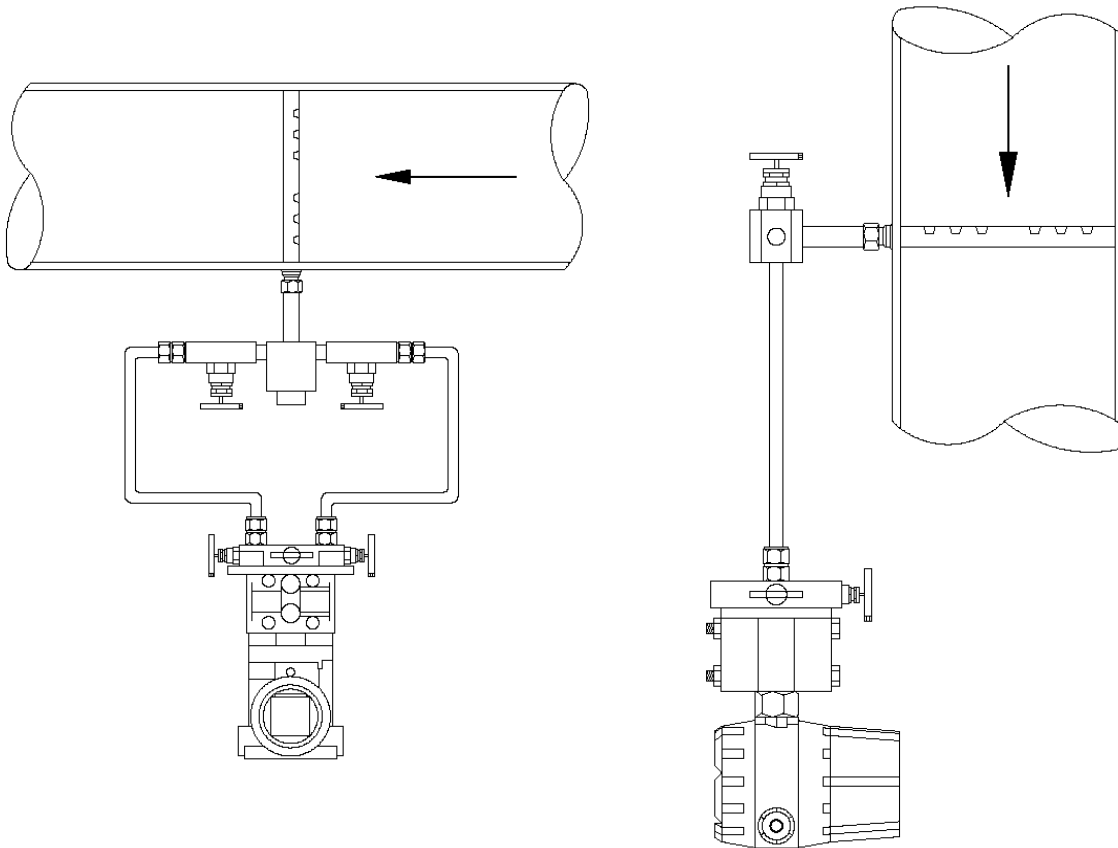
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### Liquids:

Liquids may have entrained gas or contain gas bubbles. The **tekProbe PR3** must therefore be inserted from **below** the pipe, or from the side centerline, with the **tekProbe PR3** emerging at an angle **below** the horizontal plane. In this way any gas bubbles return to the pipe and prevent false differential pressures (dp) being measured by the dp sensor.

Note: For liquids flowing downwards in a vertical pipe, care must be taken that a non-full pipe does not occur. This can be achieved by installing a check valve a minimum of 15 diameters downstream (below) the Tekprobe. Alternatively the pipe may be oriented downstream such that there is always a head of liquid above the level of the **tekProbe**.



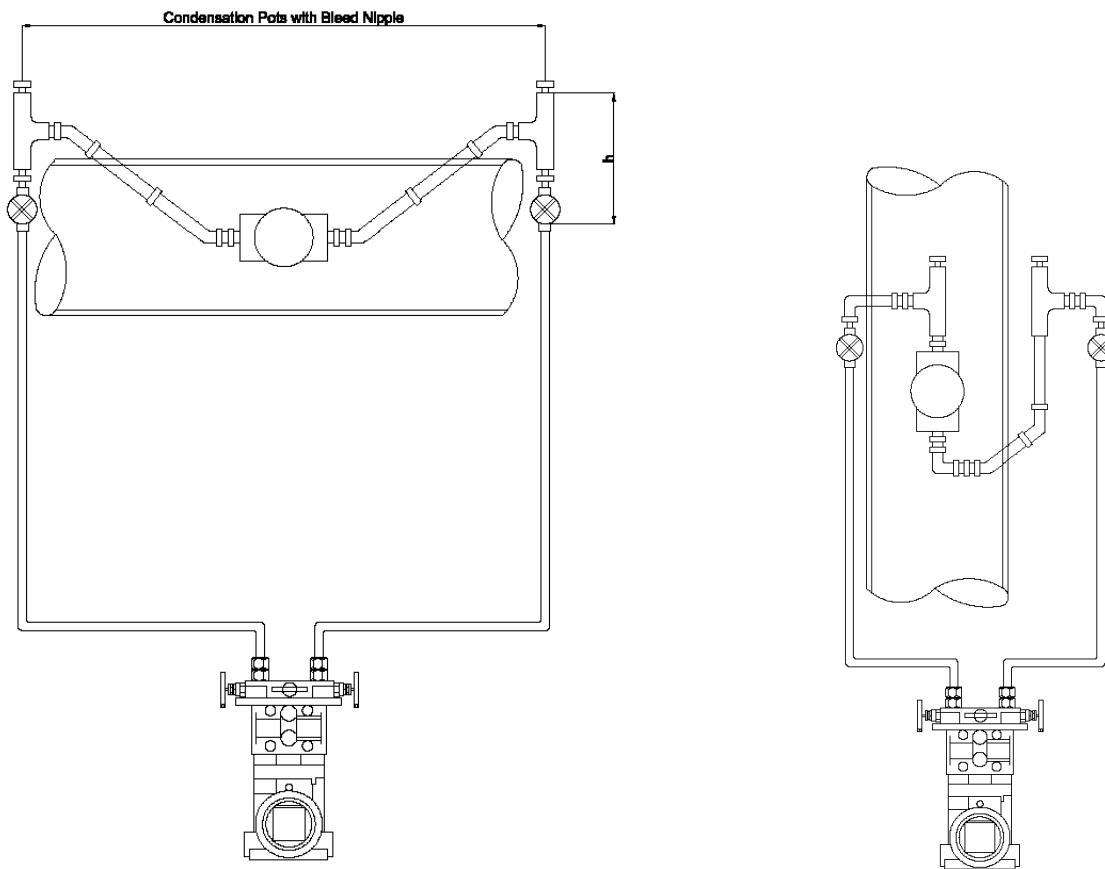
**tekProbes** on Liquids



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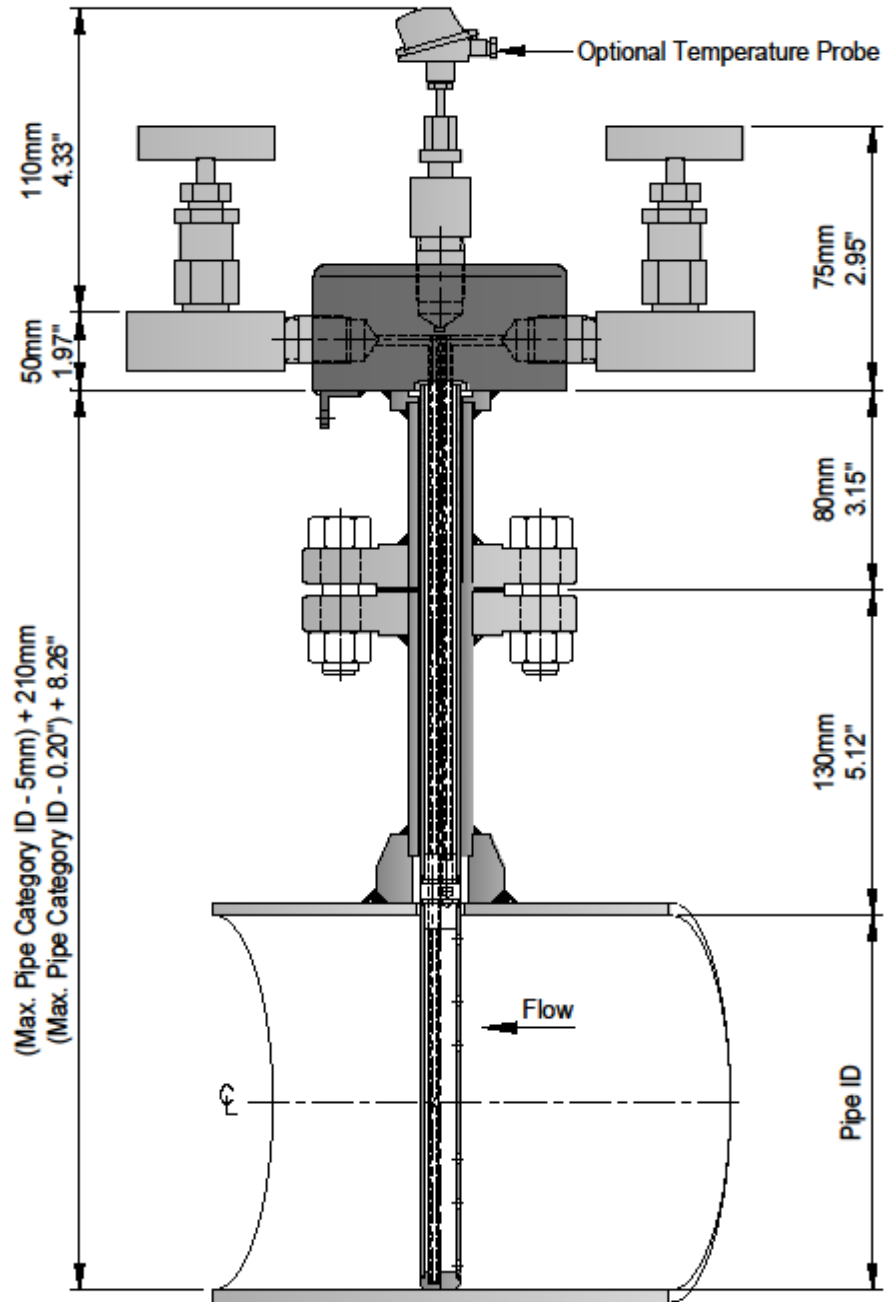
### Saturated or Superheated Steam

**PR3 tekProbes** on steam may be fitted to horizontal or vertical pipes. However, they must always be inserted into the **side** of the pipe in a **horizontal** plane, with the differential pressure (dp) sensor **below** the **tekProbe PR3** process connections. **PR3 tekProbes** on steam must always be fitted with condensation pots filled with water, such that there are constant and equal heads of water **above** the dp sensor, shown as dimension **h** in the diagram. This prevents false dp being measured by the dp sensor. The condensation pots with all basic fittings shown in the diagram may be provided as an option by **tekflo**. The dp piping shown in dotted lines are not included.

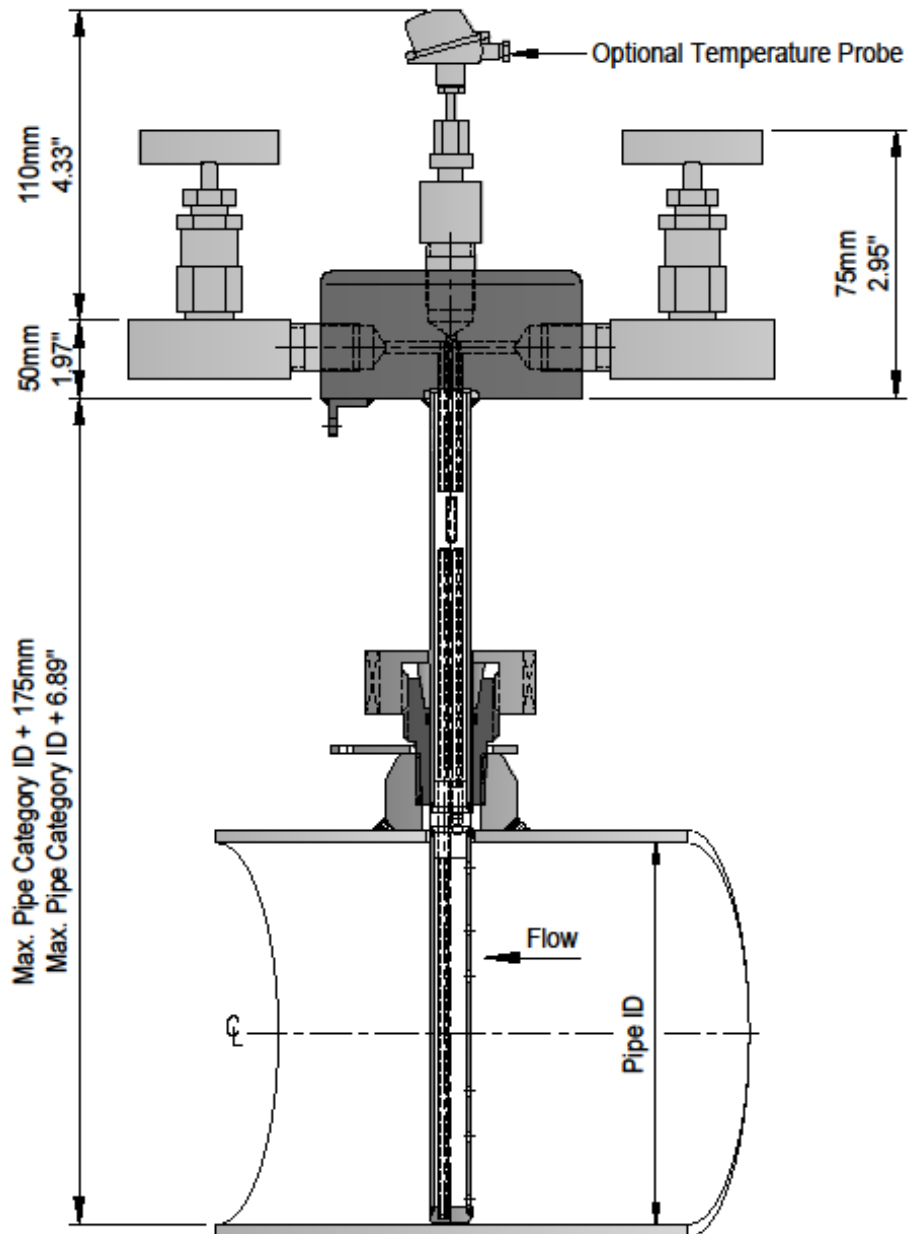


**tekProbes** on Steam

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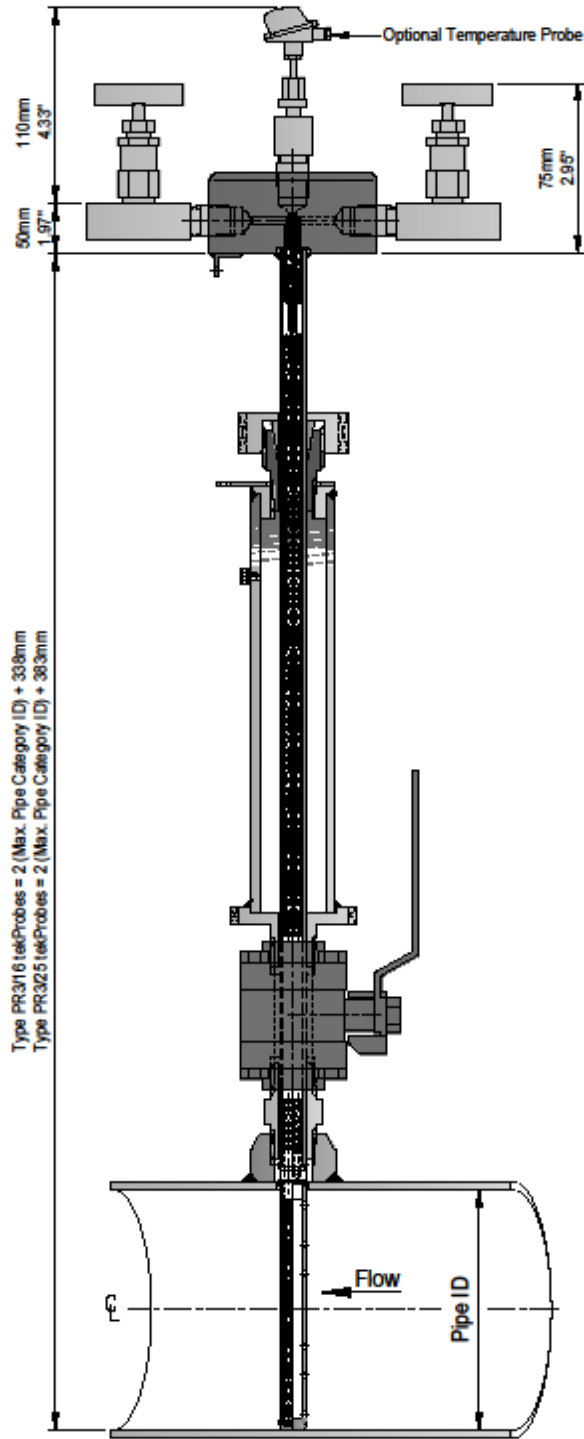


## tekProbe PR3 Style A Dimensional Drawings



**tekProbe PR3 Style B Dimensional Drawings**

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**tekProbe PR3 Style C Dimensional Drawings**

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tekProbe Style			Pipe Internal Diameter (ID) Categories and Standard Lengths						
	ID	mm Inches	60 100 2 - 4	101 200 4 - 8	201 300 8 - 12	301 400 12 - 16	401 500 16 - 20	501 600 20 - 24	601 780 24 - 30
A	L1	mm	260	405	505	605	705	805	965
		Inches	10.24	15.95	19.88	23.82	27.76	31.68	37.99
B	L2	mm	230	375	475	575	675	775	935
		Inches	9.05	14.76	18.70	22.64	26.57	30.51	36.81
C	L3	mm	320	465	565	665	765	865	1025
		Inches	12.60	18.31	22.24	26.18	30.12	34.06	40.36
tekProbe Basic Type			PR3_16 Only			PR3_16_LSA or PR3_25 Only*			
tekProbe Style			Pipe Internal Diameter (ID) Categories and Standard Lengths						
	ID	mm Inches	781 914 30 - 36	916 1016 36 - 40	1017 1219 40 - 48	1220 1422 48 - 60	1423 1625 60 - 64	1626 1829 64 - 72	1830 2032 72 - 80
A	L1	mm	1119	1221	1424	1627	1830	2034	2237
		Inches	44.06	48.07	56.06	64.06	72.05	80.08	88.07
B	L2	mm	1089	1191	1394	1597	1800	2004	2207
		Inches	42.87	46.89	54.88	62.87	70.87	78.89	86.89
C	L3	mm	1179	1281	1487	1687	1890	2094	2297
		Inches	46.42	50.43	58.54	66.42	74.41	82.44	90.43
tekProbe Basic Type			PR3_25 and PR3_25/LSA Only*						

**Note :** Pipe sizes > 1000mm (40”) where the tekProbe PR3 generates a dP > 100mm (4”) water gauge then 50mm (2”) insert tube diameter tekprobe PR3 with Lower Support Adaptor (LSA) must be used. The 50mm insert tube LSA has a 2 ½” NPT threaded connection.

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## tekProbe PR3 Ordering Code

<b>Basic type Example :</b>	<b>tekProbe PR3</b>	<b>A</b>	<b>16</b>	<b>0450</b>	<b>1</b>	<b>L</b>	<b>3</b>	<b>N</b>	<b>C</b>	<b>1</b>
<b>tekProbe Style</b>	Flanged connections	<b>A</b>								
	Locking Gland	<b>B</b>								
	Under Press Install / Retrievable	<b>C</b>								
<b>tekProbe Tube Diameter mm</b>	16 mm outside diameter		16							
	25 mm outside diameter		25							
	50 mm outside diameter		50							
<b>Pipe Internal Diameter or Duct Size. Choose pipe ID between</b>	50 mm ID (minimum)			0050						
	2000 mm ID (maximum)			2000						
	Duct Width x Height Size			DUCT						
<b>Flange Type For tekProbe A Style Only</b>	ANSI B16.5 150 rf				1					
	ANSI B16.5 300 rf				2					
	ANSI B16.5 600 rf weld neck				3					
	DIN 2633 PN10				4					
	DIN 2633 PN16				5					
	DIN 2633 PN40 weld neck				6					
	No flanged connection				0					
<b>Fluid ( Full details to be on Enquiry Form )</b>	Liquid					L				
	Gas					G				
	Steam in Horizontal Pipe					H				
	Steam in Vertical Pipe					V				
<b>Differential Pressure (dp) Connections</b>	Pair of shut-off valve in brass						1			
	Pair of shut-off valve in AISI 316 stainless steel						2			
	Pair of condensate ports & shut-off valves AISI316						3			
	No dp connections at all						4			
	Note: See tekProbe DP Sensor Orientation. DP piping shown is not included. tekProbe style C isolation valves are normally in same mat'l as shut-off valves									
<b>Lower Support Adaptor</b>	Lower support adaptor included (determine by TEKFL0). See Max dp for various pipe sizes graph								L	
	No lower support adaptor								N	
<b>DP Sensor Type</b>	<b>tekFab DP02</b> Multivariable All Digital DP Cell with Differential Pressure Cell and 3-way manifold. See separate data sheets								C	
	<b>tekFab DP04</b> series low cost non-multivariable capacitive DP Cell with 3-way manifold. See separate data sheets								L	
	Customer specified DP Sensor. Pls provide specs to TEKFL0								S	
	No differential pressure sensor								N	
<b>tekProbe PR3 Protected Temperature Sensor with Junction Box. Note: L length determined by TEKFL0 factory</b>	RTD-100L-SS-18-L-W2 (max 260°C / 500°F) ½ NPT male fitting, 2 wire RTD sensor in AISI316 stainless steel									1
	RTD-100H-SS-18-L-W2 (max 650°C / 1202°F) ½ NPT male fitting, 2 wire RTD sensor in AISI316 stainless steel									2
	Matched pair of RTD-100L-SS-18-W2 / 2wire transmitter (4-20ma) Specs as code 1 except for energy systems									3
	No temperature sensor included									



## Technical Data Sheet & General Specifications

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### tekprobe PR3 Enquiry Form

Customer's Name, Project Name, & Location:						
Detail	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6
Quantity						
<b>Media Type</b> ADD any special notes, such as Dirty (D), Clean (C), Deionised Water(DW) Note: For energy measurement, solutions of ethylene glycol, propylene glycol, glycol substitutes, or brine, a special flow configuration is necessary. Please provide % solution by weight.....						
Typical Flow Rate With Units						
Min & Max Flow Rate With Units						
For Gases Confirm Normal (NTP) or Standard Conditions (STP) or Actual Conditions (ATP)						
Bi-directional (B)/ Uni-directional (U) Bi-directional requires 2 Tekprobes						
Pressure Range and Units						
Temperature Range and Units						
Viscosity (Liquids Only) and Units						
Explosive Atmosphere and Type Required						
Nominal Pipe Size (N) or ID ( I ) Specify mm or inches						
Pipe Schedule or Wall Thickness Specify mm or inches						
Straight Pipe Runs Available						
Pipe Material						
Confirm Hot Tap (Yes) or Not (No)						
Electronics Weatherproof (WP), Local (L), or Remote (R)						
Analog and Pulse Frequency With (WD) or Without Display (ND)						
Is Communication Network Required? Please see Tekflo DP Cell Spec						
Complete Energy System (Yes/No) Requires 2 temperature sensors						
Mass (M) or Volumetric (V) Flow. Gas and steam mass flow requires integral temperature sensor						
Sensor Submersible (Yes/No) If yes, to how many metres w.g. Not available with temperature sensors						

Note: For energy flow applications a separate Energy Flow Computer is necessary, with an integral temperature sensor and remote temperature sensor for supply and return pipes. Both temperature sensors are matched and require 4-20mA outputs and are provided with identical **tekProbe PR3** protection.

**tekflo sensors®**

Factory & Flow Laboratories:  
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Website: [www.tekflosensors.com](http://www.tekflosensors.com)