

Pressure and Receiver Elements



Primary pressure elements measure process fluid gauge pressures from as low as full vacuum to as high as 550 MPa (80000 psi), and absolute pressures from 0 to 700 kPa absolute (0 to 100 psi absolute). Receiver elements receive measurement signals (from a remote transmitter) proportional to process fluid pressures in ranges of 20 to 100 kPa (3 to 15 psi), and higher. Pressure and receiver elements actuate indicating, recording, transmitting, and controlling mechanisms in Invensys standard instruments.

MANY ELEMENT TYPES AND MATERIALS

Numerous element types and materials are offered. A proper element type/material exists for practically all pressure-measuring applications.

DURABLE AND DEPENDABLE

The durability and dependability of these elements have been demonstrated over several decades of successful use in a large variety of Invensys standard indicators, recorders, transmitters, and controllers.

CORROSIVE OR VISCOUS FLUID APPLICATIONS

A selection of pressure seals is available to isolate the measuring element from corrosive or viscous process fluids. These seals can be removed from the process line for inspection and cleaning without loss of the seal fill liquid.

APPLICATION FLEXIBILITY

Application flexibility is provided by the availability of overrange and underrange protection, elevated-zero and suppressed-zero ranges, oxygen and nuclear service cleaning, and a variety of accessories.

STANDARD SPECIFICATIONS

Table 1. Element Spans, Ranges, and Accuracy (For a Torque Factor Rating of 30)

Element Code	Element Type	Element Material	Spans Available Between(a)		Accuracy (% of Span)
			kPa(b)	psi(c)	
PA-CA(h)	Absolute Bellows	316 ss(d)	17 and 240 kPa abs	2.5 and 35 psia	±0.5
PA-CC(h)		Bronze	13 and 270 kPa abs	1.9 and 39 psia	
PA-MA	Absolute Double Spiral	316 ss	140 and 700 kPa abs	20 and 100 psia	±0.5
PB-AA	Helical	316 ss	1400 and 40000 kPa	200 and 6000 psi	±0.5(e)
PB-AM(g)		K-Monel	1700 and 14000 kPa	250 and 2000 psi	±0.5
PB-BA	Spiral	316 ss	82 and 1400 kPa 82 and 100 kPa vac	12 and 200 psi 12 and 15 psi vac	±0.5
PB-BM(d)		K-Monel	140 and 1400 kPa	20 and 200 psi	
PB-CA(h)	Bellows	316 ss	35 and 200 kPa	4.5 and 29 psi	±0.75
PB-CC(h)		Brass	30 and 180 kPa 34 and 100 kPa vac	4 and 26 psi 4.9 and 15 psi vac	
PB-DF	Diaphragm 50 mm (2 in)	Cu-Ni-Sn Alloy	6 and 70 kPa 6 and 35 kPa vac	0.9 and 10 psi 0.9 and 5 psi vac	±0.5
PB-PF(k)	Diaphragm 75 mm (3 in)	Cu-Ni-Sn Alloy	2 and 10 kPa 2 and 6 kPa vac	0.3 and 1.5 psi 0.3 and 0.9 psi vac	±0.75
PB-GA(f)	Heavy Duty Helical	316ss	500 and 2000000 kPa	75 and 30000 psi	±0.5(f)
PC 3 to 15	Receiver (Bellows)	Brass	80 kPa	12 psi	±0.5
PC 3 to 18			100 kPa	15 psi	
PC 3 to 27			–	24 psi	

(a) All elements except Codes PC have zero-based ranges. Therefore, the lower range value is zero, and the minimum and maximum upper range values are as listed. Also, the above values are not applicable to concentric scale indicators. Contact Invensys for element span and range for concentric scale indicator applications.

(b) To convert kPa to bar or kg/cm², multiply kPa value by 0.01; to convert kPa to MPa, divide kPa value by 1000.

(c) To convert psi to inH₂O, multiply psi value by 2.7.73. To convert psi to inHg, multiply psi value by 2.036.

(d) AISI Type 316 stainless steel.

(e) Accuracy value given is at spans to 20 MPa (3000 psi); accuracy value gradually increases to ±0.75% of span above 20 MPa (3000 psi)

(f) Accuracy value given is at spans to 20 MPa (3000 psi); accuracy value gradually increases to ±1.0% of span above 20 MPa (3000 psi)

(g) K-Monel elements comply with NACE Standard MR-01-75.

(h) Replacement element uncalibrated.

(j) Replacement element not recommended. Instrument should be returned to Invensys.

(k) PB-PF required for control instruments below 10 kPa (40 inH₂O, 0.2 bar or kg/cm²).

Table 2. Element Selection in Maximum Span Order

Maximum Span	Element Selection	Maximum Span	Element Section
Pressure:		Absolute Pressure:	
10 kPa (1.5 psi)	PB-PF	240 kPa abs (35 psia)	PA-CA
70 kPa (10 psi)	PB-DF	270 kPa abs (39 psia)	PA-CC
180 kPa (26 psi)	PB-CC	700 kPa abs (100 psia)	PA-MA
200 kPa (29 psi)	PB-CA	Vacuum:	
1400 kPa (200 psi)	PB-BA, BM	5 kPa vac (0.7 psi vac)	PB-PF
		35 kPa vac (5 psi vac)	PB-DF
		100 kPa vac (15 psi vac)	PB-BA, CC
14000 kPa (2000 psi)	PB-AM	Receiver(a):	
40000 kPa (6000 psi)	PB-AA	80 kPa or 12 psi	PC 3 to 15
200000 kPa (30000 psi)	PB-GA	100 kPa or 15 psi	PC 3 to 18
		24 psi	PC 3 to 27

(a)Receiver ranges are 20 to 100, 20 to 120, and 20 to 186 kPa (3 to 15, 3 to 18, and 3 to 27 psi) respectively.

ELEMENT USAGE

Table 3. Model/Element Configurations Available (Number of Elements Per Model)

Model	Element Code														
	PA-			PB-B									PC		
	CA(a)	CC(a)	MA	AA	AM(b)	BA	BM	CA	CC	DF	PF	GA(c)	3 to 15	3 to 18	3 to 27
39AFPTR/39BFPR Flow Recorder	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-
39AFPTR/39BFPR Flow Rec	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-
40M Concentric Scale Indicator	1	-	1	1	1	1	1	1	1	1	1	2	1	1	1
40P Concentric Scale Indicator	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1
40M Sector Scale Indicator	2	-	2	2	2	2	2	2	2	2	2	2	2	2	2
40P Sector Scale Indicator	2	-	2	2	2	2	2	2	2	2	2	1	2	2	2
40M Circular Chart Recorder	4	-	4	4	4	4	4	4	4	4	4	2	4	4	4
40P Circular Chart Recorder	4	-	4	4	4	4	4	4	4	4	4	1	4	4	4
40M Single Action Indicating Cntr	2	-	2	2	2	2	2	2	2	2	2	2	2	2	2
40P Single Action Indicating Cntr	2	-	2	2	2	2	2	2	2	2	2	1	2	2	2
40M Single Action Recording Cntr	3	-	3	3	3	3	3	3	3	3	3	2	3	3	3
40P Single Action Recording Cntr	3	-	3	3	3	3	3	3	3	3	3	1	3	3	3
40M/40P Other Indicating Cntr	-	-	1	1	1	1	1	-	1	1	-	-	1	1	1
40M/40P Other Recording Cntr	-	-	1	1	1	1	1	-	1	1	-	-	1	1	1
43AP-F Pneumatic Indicating Cntr	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-
43AP-P Pneumatic Indicating Cntr	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-
44BP Nonindicating Transmitter	-	-	1	1	1	1	1	1	1	1	1	-	-	-	-
45P Pneumatic Indicating Trans	1	1	1	1	-	1	-	1	1	1	1	1	-	-	-
E45P Electronic Indicating Trans	1	1	1	1	-	1	-	1	1	1	1	1	-	-	-

(a)Replacement element uncalibrated.

(b)Elements comply with National Association of Corrosion Engineers (NACE) Standard MR-01-75.

(c)Element extends through rear surface of case. Replacement element not recommended; instrument should be returned to Invensys.

ELEMENT DESCRIPTION

Bellows: PB-CA; PB-CC

The bellows element is used for low process pressure and vacuum applications, and is able to generate high power relative to the input pressure. The bellows is compact and formed from homogeneous, seamless tubing with a uniform wall thickness. The PB-CA has a music wire calibration spring while the PB-CC has a thermally stable Ni-Span C alloy calibration spring. Refer to Figure 1.

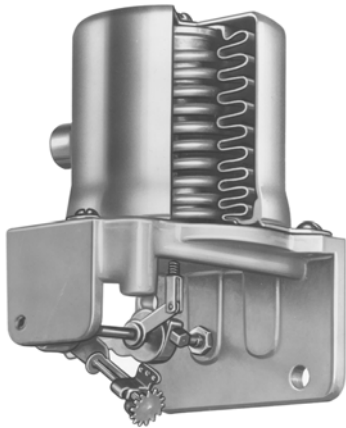


Figure 1. Bellows Element

Absolute Bellows: PA-CA; PA-CC

This element is used to measure low absolute pressures and consists of two bellows. One bellows is directly connected to the process. This first bellows is opposed by a second identical bellows which has been evacuated and sealed. Thus, all measurements are referenced to absolute zero, automatically compensating for ambient fluctuations. Refer to Figure 2.

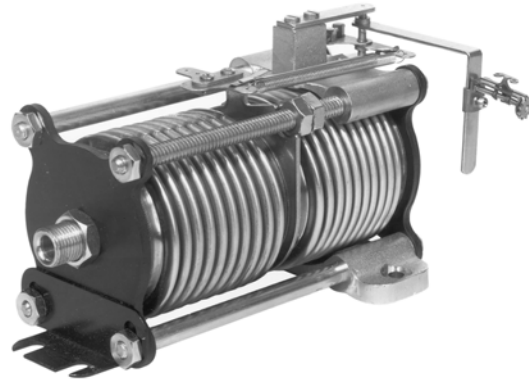


Figure 2. Absolute Bellows Element

Receiver Bellows: PC 3 to 15; PC 3 to 18; PC 3 to 27

The receiver bellow element is identical in design to the basic bellow element. It is used to receive a measurement signal from a remotely located pressure transmitter. Refer to Figure 1.

ELEMENT DESCRIPTION (CONT.)

Diaphragm: PB-DF; PB-PF

Diaphragm elements have a large surface area which provides high power and sustained accuracy on very low pressure and vacuum applications. Welded seams assure positive protection from leakage and provide high overrange margins. Straight-line travel ensures uniform motion even at the range limits, thereby resulting in a linear calibration. Refer to Figure 3.

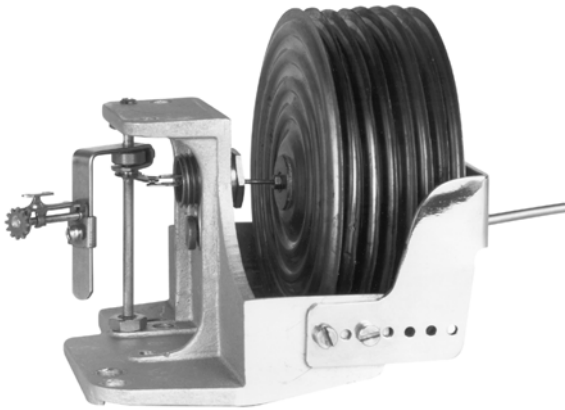


Figure 3. Diaphragm Element

Helical: PB-AA; PB-AM

Helical elements are helically-formed Bourdon tubes, precisely shaped to correct ratios of cross-section to length. Element construction provides ample motion (with low material stress) for accurate performance in the higher pressure ranges. Refer to Figure 4.



Figure 4. Helical Element

Heavy Duty Helical: PB-GA

This element is used for very high pressures, continuously fluctuating pressures, and other heavy-duty applications. The multi-coil construction, along with a greater wall thickness than the lower pressure helicals, provide a reduced metal stress, a high safety factor, and extended element life. Refer to Figure 5.



Figure 5. Heavy Duty Helical Element

Spiral: PB-BA; PB-BM

A long spirally-formed Bourdon tube, large in cross-section, provides abundant power and uniform motion for vacuum and medium pressure ranges. The element construction assures friction-free motion with uniform response, even to slight pressure changes. Refer to Figure 6.



Figure 6. Spiral Element

ELEMENT DESCRIPTION (CONT.)

Absolute Double Spiral: PA-MA

Used for absolute pressure measurement greater than that available with the absolute bellows element. One spiral element is directly connected to the process. The second identical spiral is evacuated and sealed, thus providing barometric and ambient temperature compensation and direct reading of absolute pressure. Refer to Figure 7.



Figure 7. Absolute Double Spiral Element

PHYSICAL SPECIFICATIONS

AISI Type 316 Stainless Steel (316 ss) Element

316 ss provides excellent corrosion resistance and offers high, safe overrange limits. It is the only element material used for process pressure exceeding 40 MPa (6000 psi).

Brass or Bronze Elements

Both brass and bronze have good (not as good as Be-Cu) spring characteristics at the least cost. Either material is an ideal selection for general purpose measurements where corrosive vapors are not likely to contact elements.

Copper-Nickel-Tin (Cu-Ni-Sn) Alloy Elements

Cu-Ni-Sn is an excellent spring material, which also provides a high degree of overrange protection. This material is used exclusively with the low pressure diaphragm elements.

K-Monel Element

K-Monel provides excellent corrosion resistance and is offered with helical and spiral elements. K-Monel elements comply with NACE Standard MR-01-75.

Enclosure (Case) Process Connections

The following case connections are standard for the pressure ranges listed below:

Up to 14 MPa (2000 psi)	1/4 NPT
>14 to 70 MPa (>2000 to 10000 psi)	1/2 NPT
>70 MPa (>10000 psi)	9/16-19 Aminco

Tubing and Process Connection Material

Table 4 lists the process tubing and process connection material for each element material.

Table 4. Process Tubing and Process Connection Material

Element Material	Process Tubing Material	Process Connection Material		
		1/4 NPT	1/2 NPT	9/16-18 Aminco
Brass	Copper	Brass	316 ss	Not Applicable
Bronze	Copper	Brass	316 ss	Not Applicable
Cu-Ni-Sn	Copper	Brass	316 ss	Not Applicable
K-Monel	K-Monel	K-Monel	K-Monel	Not Applicable
316 ss	316 ss	316 ss	316 ss	316 ss

ACCESSORIES

Pressure Seals

Pressure seals are used to isolate the measuring element from corrosive, viscous, or solids-forming process fluids. Sealed measurement systems (element, seal, and connecting tubing) are evacuated and filled with an appropriate fill fluid which transmits the pressure changes. Pressure seal assemblies are connected to the pressure element by means of tubing for remote recording, indicating, transmitting, or control. These seals can be removed from the process line for inspection or cleaning without the loss of fill fluid. Refer to Figures 8 through 13 for typical pressure seals.

PSS 3-2C1 A lists the many pressure seals available and their standard specifications. They are used with 316 ss helical or 316 ss spiral pressure elements. Seals are provided with 1.5 m (5 ft) or 316 ss connection tubing, except the sanitary type seals which are provided with 3 m (10 ft) of 316 ss tubing with 304 ss flexible armor. In addition to the standard offerings listed, many optional features are available. Different fill fluids can be used for either low- or high-temperature operation. Correction for operating temperature can be provided. Connecting tubing can be longer and can be PVC-coated or enclosed with 304 ss flexible armor. Contact Invensys for more specifics regarding pressure seal options.



Figure 8. PES-FE Seal



Figure 9. PES-FV Seal

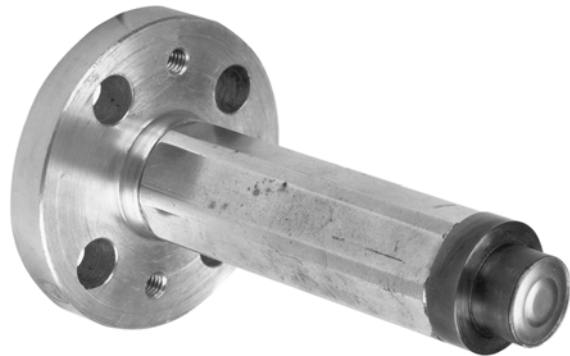


Figure 10. PES-FG Seal



Figure 11. PES-FG Seal

ACCESSORIES (CONT.)



Figure 12. PES-SB Seal

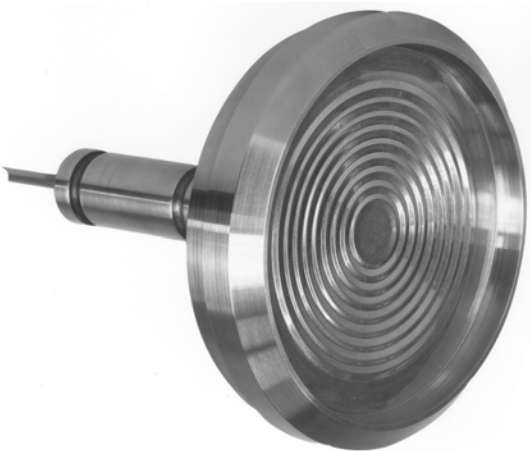


Figure 13. PES-CSA Seal

Pressure Snubbers

A pressure snubber dampens any sudden or frequent variation in process pressure. It is installed between the process and the pressure element and is typically used with gas, oil, or thin and thick liquid applications. It is available in brass for pressures to 10 MPa (1500 psi), and in stainless steel for pressures to 100 MPa (15000 psi). Refer to Figure 14.

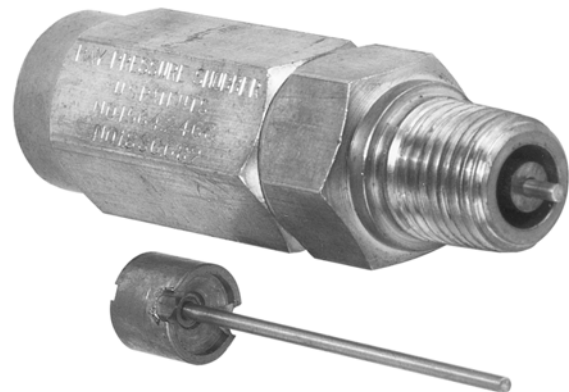


Figure 14. Pressure Snubber

ACCESSORIES (CONT.)

External Damping Devices

These devices are used to dampen the output signal of a transmitter, and are used with pneumatic receiver elements only. They are located external to the instrument case. There is a sensitive needle valve type with 1/8 NPT connections, or an adjustable restrictor type (complete with strainer) with 1/4 NPT connections.

Internal Damping Device

Performs the same function as an external damping device and is also used with pneumatic receiver elements only. It is located internal to the instrument case and has an adjustable restrictor type damper. It is used in 40M and 40P instruments. up to four dampers can be accommodated, each with a maximum pressure of 210 kPa (30 psi).

Flexible Connections

Located between the process and the pressure element. Available in 1 or 2 m (3 or 6 ft) lengths with 1/4 NPT connections. Maximum rating is 17 MPa (2500 psi) at 90°C (200°F).

Pipe Unions

General purpose brass unions available with 1/4 NPT end connections. Steel damping union (with orifice) is available for liquid purge at pressures up to 14 MPa (2000 psi). Steel damping union (with capillary) is available for intermediate process pressures to 10 MPa (1500 psi).

Siphon

A pigtail-style siphon is available for capturing and removing steam condensate. Material is 1/4 in Schedule 40 steel pipe, with 1/4 NPT external thread on both ends. Pressure/Temperature rating is:

Up to 7 MPa (1000 psi)	-30 to +480°C (-20 to +900°F)
Up to 14 MPa (2000 psi)	-30 to +345°C (-20 to +650°F)

REPLACEMENT PRESSURE ELEMENTS

Element with Link, Tubing, and Connection

Available with calibrated or uncalibrated. For round case instruments supplied prior to 1953, and for all 44BP Transmitters, replacements elements are supplied uncalibrated. Specify Model Number (including element code).

Element Only

Available uncalibrated only. Specify part number stamped on element.

OPTIONAL FEATURES

Elevated-Zero Ranges

Refer to Table 5 for the availability of elevated-zero ranges for each element. Specify the zero elevation value, span, and applicable pressure element. Contact Invensys for limits.

Suppressed-Zero Ranges

Refer to Table 5 for the availability of suppressed-zero ranges for each element. Specify the zero suppression value, span, and applicable pressure element. Contact Invensys for limits.

Overrange Protection

Overrange protection is provided for pressure and absolute pressure measurements only. Protection is provided to the linkage and pointer, but not the element itself. Refer to Table 5 for the availability of overrange protection for each element type. Specify the operating range and applicable pressure element. Contact Invensys for limits.

Underrange Protection

Underrange protection is provided for vacuum pressure applications only. Protection is provided to the linkage and pointer, but not the element itself. Refer to Table 5 for the availability of underrange protection for each element type. Specify the vacuum range and applicable pressure element. Contact Invensys for limits.

Oxygen Service Preparation

Provided for 316 ss helical and spiral elements only. Copper bearing brazing material is in contact with process. Specify Auxiliary Specification (AS) OS-W.

Cleaning for Nuclear Service

This option is offered for 316 ss helical elements only. Specify AS Code NS-C.

Table 5. Optional Feature Availability

Element Code	Elevated-Zero Range	Suppressed-Zero Range	Overrange Protection	Underrange Protection	Oxygen Service Protection	Nuclear Service Cleaning
PA-CA	N/A	YES	STD	N/A	NO	NO
PA-CC	N/A	YES	STD	N/A	NO	NO
PA-MA	N/A	YES	YES	N/A	NO	NO
PB-AA	YES	YES	YES	N/A	YES	YES
PB-AM	YES	YES	YES	N/A	NO	NO
PB-BA	YES	YES	YES	YES	YES	NO
PB-BM	YES	YES	YES	N/A	NO	NO
PB-CA	NO	YES	STD	STD	NO	NO
PB-CC	NO	YES	STD	STD	NO	NO
PB-DF	YES	YES	STD	NO	NO	NO
PB-PF	YES	YES	STD	NO	NO	NO

Table 5. Optional Feature Availability

Element Code	Elevated-Zero Range	Suppressed-Zero Range	Overrange Protection	Underrange Protection	Oxygen Service Protection	Nuclear Service Cleaning
PB-GA	NO	YES	YES	N/A	NO	NO
PC 3 to 15	NO	N/A	STD	STD	NO	NO
PC 3 to 18	NO	N/A	STD	STD	NO	NO
PC 3 to 27	NO	N/A	STD	STD	NO	NO

NOTE

N/A means not applicable; YES means available; NO means not available; and STD means standard with that particular element.

ORDERING INSTRUCTIONS

1. Base Instrument Recorder or Indicator, Controller or Transmitter
2. Element Code
3. Pressure, Absolute Pressure, or Vacuum Range
4. Accessories
5. Replacement Pressure Elements
6. Optional Features
7. Tag and Application

OTHER M&I PRODUCTS

Invensys provides a broad range of measurement and instrument products, including solutions for pressure, flow, analytical, positioners, temperature, controlling and recording. For a listing of these offerings, visit the Invensys Operations Management web site at:

www.iom.invensys.com

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