

Engineering Information

Pressure and Temperature Switches

ASCO® pressure and temperature radiation resistant construction switches are designed to be used outside the containment area of nuclear power plants to monitor pressure and temperature.

Selection of the proper pressure/temperature switch for a specific application is of paramount importance. This engineering information section describes principles of operation, types of switches, types of enclosures, and materials to assist in the proper selection.

I. Principle of Operation

The pressure/temperature switch will control electrical circuits in response to changes in pressure or temperature.

The pressure transducers are generally of the diaphragm piston type pressure sensor. The exceptions are in the higher pressure ranges, which use a piston with an o-ring seal. The piston defines the area that the pressure is applied to, converting the pressure to a mechanical force.

The temperature transducer is also a diaphragm piston type pressure sensor converting pressure to a mechanical force. The internal pressure is the vapor pressure of a chemical in a contained volume that is in direct relation to the temperature.

The switch incorporates an adjustable spring force that opposes the transducer piston force. When the transducer force is greater than the spring force, the piston rod mechanism moves to operate an electrical snap switch. When the transducer force is less than the spring force the piston rod mechanism moves to restore the electrical snap switch to the normal position.

The switch units incorporate a unique ASCO TRI-POINT® balance plate and operates on an alternating fulcrum principle. This converts a single motion/force of a transducer piston to a two-step motion controlling one or more electrical snap switches. The spring forces of the two-step motion are independent of each other.

II. Types of Switch Units

There are three types of switch units: adjustable deadband, fixed deadband, and two-stage fixed deadband.

The adjustable deadband (SA) model has one electrical snap switch with two separate independent adjusting nuts to set the trip point on increasing pressure/temperature signal and the reset trip point on decreasing pressure/temperature signal over the range of the switch.

The fixed deadband (SB) model has one electrical snap switch with one adjusting nut to set the trip point over the full range of the switch. The reset trip point is fixed relative to the set point and cannot be adjusted.

The two-stage (SC) model has two electrical snap switches with independent adjustment by two separate adjusting nuts. Each may set the trip point over the full range of the switch. The reset point of each electrical snap switch is fixed with respect to the set point for that switch.

III. Electrical Enclosure

All pressure/temperature switches in this catalog are supplied with either a watertight or combination explosionproof/watertight electrical enclosure to withstand the environmental conditions of a Loss of Coolant Accident and Main Steam Line Break. Watertight models have a deep drawn aluminum cover secured by locking tabs and screws. Explosionproof/watertight models have a die cast aluminum cover that threads onto the body. Both enclosures have two 3/4" NPT conduit hubs for wiring.

Two types of electrical enclosures are available to satisfy the following (NEMA) classifications;

Watertight Types 3, 3S, 4

Explosionproof/Watertight Types 3, 3S, 4, 4x, 7, and 9

ASCO's qualification has not included simulation of any outdoor or explosive atmosphere conditions.

Connections to the switch should be such that any accumulated moisture or LOCA spray will not run into the enclosure. During qualification testing, wiring was run through conduit to a vented electrical junction box located outside the test chamber. (Wiring must comply with all applicable electrical codes).

IV. Transducer Construction

Pressure Internal parts in contact with the

fluid are comprised of a pipe fitting (process connection) and elastomer or metallic diaphragm. The pipe fitting is available in aluminum, brass, stainless steel type 303 or 316 in both 1/4" and 1/2" NPT. Diaphragms are available in Viton/fluoroelastomer, ethylene propylene, or 316 stainless steel.

Temperature Transducers are available with a direct mount or a remote-probe 316 stainless steel sensing bulb. The direct mount is a 4" long bulb with an integral 1/2" NPT connection for direct mounting to the process. The remote probe is a 3/8" OD probe at the end of a 6' - 80' stainless steel armored capillary.

V. Definitions & Terminology

Accuracy is the maximum deviation from the base set point under specified operating conditions. The value given by ASCO includes all the qualification life conditions. Accuracy is specified as a percent or the upper limit of the adjustable operating range.

Repeatability is the closeness of agreement among a number of consecutive measurements of output, for the same value of input, under the same operating conditions approaching from the same direction. Repeatability is specified as a percent of the upper limit of the adjustable operating range.

Deadband is the difference between the set point and reset point readings either increasing or decreasing. The values in this catalog are nominal, representative of the deadbands of units at the middle of the range.

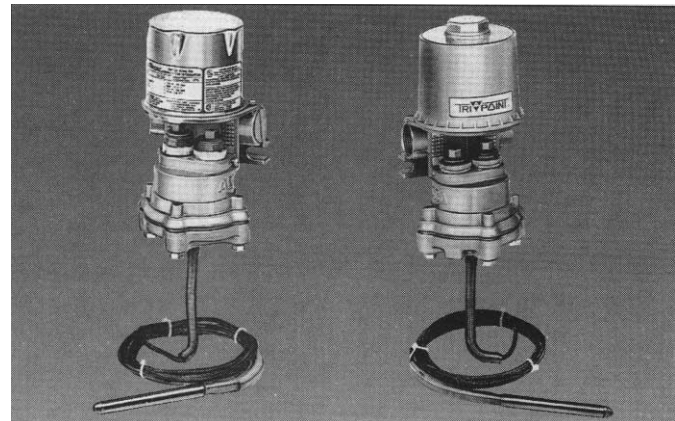
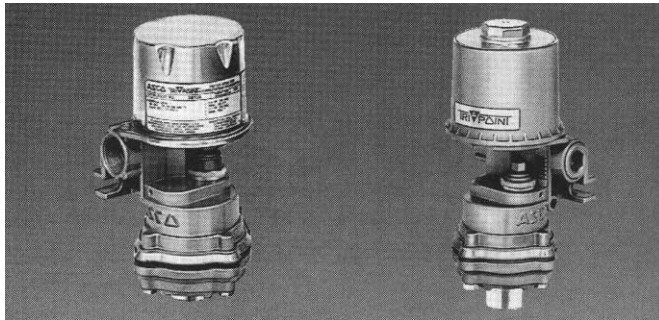
Separation (on the two stage unit) is the minimum difference between the two set points increasing or two set points decreasing that may be set.

Proof Pressure or Rated Overrange Temperature is the sensing maximum medium value that a device can be subjected to for extended periods of time without changes to its operating characteristics.

Adjustable Operating Range is the set point limits between which the instrument can be adjusted to operate.

ASCO® Pressure and Temperature Switches

IEEE Qualified Switches for Pressures to 8000 psig, Vacuum, Differential or Level Control; Temperature Switches from -30° F through 510° F (-32° C through 265° C), with Watertight or Explosionproof Enclosures.



Photos (left to right): Pressure Switches with watertight and explosionproof housing. Temperature Switches (capillary and bulb), with watertight and explosionproof housing.

General Description

Pressure and temperature switches for Class 1E service are modified versions of the industrial ASCO TRI-POINT product line. Special features include radiation resistance and high-temperature construction. Class 1E switches are available only as factory assembled units consisting of a single switch and transducer assembly, factory set at operating points, and tested as a single unit before shipping from ASCO.

Applications

ASCO TRI-POINT pressure and temperature switches are available for safety-related (Class 1E) applications outside containment in nuclear power plants. They are also suitable for the less stringent balance-of-plant requirements.

Test Program

The Qualification Test Program consists of subjecting representative units to the following tests:

- **Thermal Aging** Short-term representation of an installed life.
- **Radiation Aging** Exposure to gamma radiation.
- **Wear Aging** Operating cycle testing at full electrical load.
- **Vibration Endurance** Exposure to low-level multiaxial vibration simulating installed condition.

- **Accident Simulation** Operating basis and design basis events — including both seismic shaker testing and high-level radiation dosage.
- **Environmental Simulation** Exposure to high temperature and humidity.

Qualification

The ASCO Qualification Specification (AQS-21623) has been prepared in order to provide generic qualification of pressure and temperature switches. It is based on the suggestions and requirements of IEEE 323-1974—“IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations” and IEEE 344-1975—“IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.”

The current ASCO qualification reports are:

- AQR-101083/Rev. 1 - pressure switch
- AQR-020184/Rev. 1 - temperature switch

Operation

Pressure Switches

When pressure is applied to the transducer it is converted into movement of the piston. This piston movement is then used to control the operation of the electrical snap action switch(es) in the switch unit.

Temperature Switches

Temperature sensed by the bulb creates an internal pressure within the transducer. This

pressure is then converted into movement of the piston. This piston movement is then used to control the operation of the electrical snap action switch(es) in the switch unit. Temperature transducers are available in two constructions, a direct-mount or capillary and bulb construction. The direct-mount unit includes a 1/2" NPT connection for direct mounting to the process. The capillary and bulb construction allows remote mounting from the process.

Features

- Set point repeatability of $\pm 3\%$ of operating range.
- Accuracy of $\pm 10\%$ of operating range for qualified life of the unit.
- Choice of watertight or explosionproof enclosures.
- Mounts in any position.
- Visual adjustment scales of pressure switches in psi and bars; of temperature switches in °F and °C.
- External adjusting nuts.
- Separate electrical, pressure, and adjusting chambers.
- Wide selection of pressure switch transducer wetted material suitable for air, water, oil, or corrosive fluids.
- 316 stainless steel temperature switch transducers available in direct-mount or armored capillary and bulb in standard 6 and 12 foot lengths, and optional lengths to 80 feet.

Switch/Transducer

ASCO® qualified switch units incorporate the unique ASCO TRI-POINT® alternating fulcrum balance plate to control the operation of one or more electrical snap-action switches. Pressure switch transducer units incorporate a diaphragm piston-type pressure sensor.

Temperature transducer units use a vapor pressure principle where the internal pressure within the unit is generated by the vapor pressure of a chemical within a sealed system. Switch and transducers

(both pressure and temperature) are factory assembled and fully tested and supplied as a complete switch and transducer unit only.

Specifications:

Types of Operation: Adjustable deadband, fixed deadband, and two-stage fixed deadband

Pressure Switches: Vacuum to 30" Hg, pressure levels to 8000 psig.

Wetted Materials: Viton/fluoroelastomer, ethylene propylene, aluminum, brass, and stainless steel.

Process Connection: 1/4" NPT, optional 1/2" NPT.

Temperature Switches: Temperature ranges -30°F to 510°F (-32°C to 265°C).

Process Connection: Direct-mount 316 stainless steel probe or remote-mount 316 stainless steel armored capillary.

Electrical: Standard: 5 amp, 250 VAC switch; Optional: 10 amp, 125 VDC switch.

Types of Enclosures: Watertight or Explosionproof/Watertight.

Standard Electrical Ratings

SA, SB, SC Series
5 Amp Res., 125, 250 VAC
1/8 HP 125 VAC
1/4 HP 250 VAC
1/2 Amp Res., 125 VDC
1/4 Amp Res., 250 VDC

Optional High DC Rated Switches

(See optional features page 39)

10 Amp Res., 125 VAC or VDC
1/8 Horsepower, 125 VAC or VDC

Environment of Service Conditions

Temp: 50°F to 104°F (10°C to 40°C)

Fluid: Pressure Switches—

Ethylene propylene diaphragm:

-4°F to 180°F (-20°C to 82°C)

Viton/fluoroelastomer diaphragm:

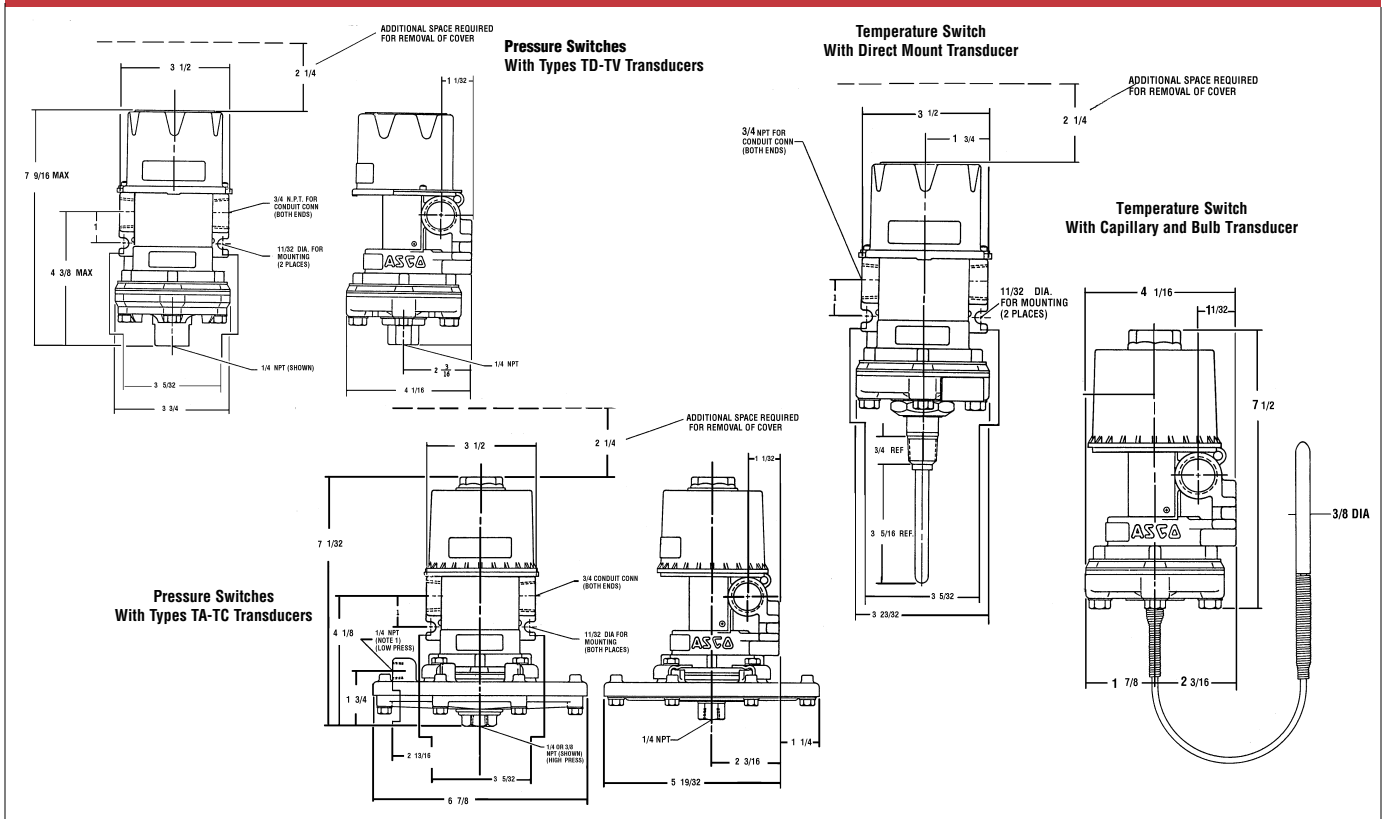
-4°F to 250°F (-20°C to 121°C)

316 S.S. diaphragm:

-50°F to 300°F (-45°C to 149°C)

Fluid: Temperature Switches—See specification table for rated overrange temperature.

Dimensions (inches)



ASCO® TRI-POINT® Pressure & Temperature Switch Specifications

Pressure, Vacuum and Differential Switches IEEE-Qualified For Nuclear Service

Specifications		Adjustable Deadband			Fixed Deadband			Two-Stage Fixed Deadband				Pressure, Vacuum, and Differential Transducers						
Adjustable Operating Range (P.S.I.G.)	Proof Pressure (P.S.I.G.)	Adjustable Deadband	Watertight Enclosure	Explosionproof Enclosure	Fixed Deadband At Mid-Range (P.S.I.G.)†	Watertight Enclosure	Explosionproof Enclosure	Fixed Deadband At Mid-Range (P.S.I.G.)†	Separation Maximum Full Scale	Watertight Enclosure	Explosionproof Enclosure	Aluminum Viton*	Aluminum EPDM	Brass Viton	Brass EPDM	316 (46) or 303 (36) SS EPDM*	All 316 SS**	316 (42) or 303 (32) SS Viton*
		Maximum Full Scale																
		Minimum At Mid-Range (P.S.I.G.)†																
Regular Gauge Type																		
0-27" W.C.	25	2.5" W.C.	SA31AR	SA32BR	1.5" W.C.	SB31AR	SB32BR	1.8" W.C.	3.4" W.C.	SC31BR	SC32CR	TA30A12R	TA30A16R	---	---	TA30A36R	---	TA30A32R
0-65" W.C.	25	3.2" W.C.	SA21AR	SA22BR	1.8" W.C.	SB21AR	SB22BR	2.0" W.C.	8.2" W.C.	SC21BR	SC22CR	TA20A12R	TA20A16R	---	---	TA20A36R	---	TA20A32R
15-140" W.C.	40	7.5" W.C.	SA21AR	SA22BR	3.8" W.C.	SB21AR	SB22BR	5.0" W.C.	18" W.C.	SC21BR	SC22CR	TB20A12R	TB20A16R	---	---	TB20A36R	---	TB20A32R
15-250" W.C.	40	13" W.C.	SA11AR	SA12BR	7.5" W.C.	SB11AR	SB12BR	8.8" W.C.	32" W.C.	SC11BR	SC12CR	TB10A12R	TB10A16R	---	---	TB10A36R	---	TB10A32R
25-400" W.C.	40	19" W.C.	SA11AR	SA12BR	10" W.C.	SB11AR	SB12BR	17" W.C.	50" W.C.	SC11BR	SC12CR	TC10A12R	TC10A16R	---	---	TC10A36R	---	TC10A32R
0.7-9.0	100	0.8	SA31AR	SA32BR	0.4	SB31AR	SB32BR	0.5	1.2	SC31BR	SC32CR	TD30A12R	TD30A16R	TD30A22R	TD30A26R	TD30A46R	---	TD30A42R
1.0-18	100	1.4	SA21AR	SA22BR	0.5	SB21AR	SB22BR	0.8	2.4	SC21BR	SC22CR	TD20A12R	TD20A16R	TD20A22R	TD20A26R	TD20A46R	---	TD20A42R
1.0-18	150	2.0	SA31AR	SA32BR	1.4	SB31AR	SB32BR	1.5	2.4	SC31BR	SC32CR	---	---	---	---	---	TE30A44R	---
1.5-36	150	2.8	SA21AR	SA22BR	1.2	SB21AR	SB22BR	1.8	4.5	SC21BR	SC22CR	TE20A12R	TE20A16R	TE20A22R	TE20A26R	TE20A46R	TE20A44R	TE20A42R
2-60	150	4.5	SA11AR	SA12BR	1.9	SB11AR	SB12BR	2.8	7.5	SC11BR	SC12CR	TE10A12R	TE10A16R	TE10A22R	TE10A26R	TE10A46R	TE10A44R	TE10A42R
5-60	3000	7.5	SA31AR	SA32BR	5.0	SB31AR	SB32BR	7.0	10	SC31BR	SC32CR	---	---	TG33A22R	TG33A26R	TG33A46R	---	TG33A42R
3-100	200	7.5	SA11AR	SA12BR	3.2	SB11AR	SB12BR	4.4	13	SC11BR	SC12CR	TF10A12R	TF10A16R	TF10A22R	TF10A26R	TF10A46R	TF10A44R	TF10A42R
5-120	3000	13	SA21AR	SA22BR	6.4	SB21AR	SB22BR	8.8	15	SC21BR	SC22CR	---	---	TG23A22R	TG23A26R	TG23A46R	---	TG23A42R
5-200	3000	18	SA11AR	SA12BR	7.5	SB11AR	SB12BR	10.2	25	SC11BR	SC12CR	---	---	TG13A22R	TG13A26R	TG13A46R	---	TG13A42R
6-200	400	15	SA11AR	SA12BR	6.4	SB11AR	SB12BR	9.0	25	SC11BR	SC12CR	TG10A12R	TG10A16R	TG10A22R	TG10A26R	TG10A46R	TG10A44	TG10A42R
13-300	600	23	SA11AR	SA12BR	10	SB11AR	SB12BR	12.5	38	SC11BR	SC12CR	TH10A12R	TH10A16R	TH10A22R	TH10A26R	TH10A46R	TH10A44	TH10A42R
15-400	600	30	SA11AR	SA12BR	13	SB11AR	SB12BR	17.5	50	SC11BR	SC12CR	TJ10A12R	TJ10A16R	TJ10A22R	TJ10A26R	TJ10A46R	TJ10A44	TJ10A42R
30-600	900	45	SA11AR	SA12BR	19	SB11AR	SB12BR	25	75	SC11BR	SC12CR	---	---	TK10A22R	TK10A26R	TK10A46R	---	TK10A42R
50-1000	1500	94	SA11AR	SA12BR	38	SB11AR	SB12BR	50	125	SC11BR	SC12CR	---	---	TL10A22R	TL10A26R	TL10A46R	---	TL10A42R
75-1500	2300	144	SA11AR	SA12BR	58	SB11AR	SB12BR	75	188	SC11BR	SC12CR	---	---	TM10A22R	TM10A26R	TM10A46R	---	TM10A42R
200-3500	5000	282	SA11AR	SA12BR	158	SB11AR	SB12BR	188	438	SC11BR	SC12CR	---	---	TN10B22R	TN10B26R	TN10B46R	---	TN10B42R
500-8000	9000	564	SA11AR	SA12BR	344	SB11AR	SB12BR	375	1000	SC11BR	SC12CR	---	---	TQ10B22R	TQ10B26R	TQ10B46R	---	TQ10B42R
Vacuum Switch Units																		
0-30" H.G.	50	2.5" H.G.	SA31AR	SA32BR	1.5" H.G.	SB31AR	SB32BR	2.2" H.G.	3.4" H.G.	SC31BR	SC32CR	TV34A12R	TV34A16R	TV34A22R	TV34A26R	TV34A36R	---	TV34A32R
15 PSI-30" H.G.	50	3.8" H.G.	SA21AR	SA22BR	2.2" H.G.	SB21AR	SB22BR	2.5" H.G.	10" H.G.	SC21BR	SC22CR	TV24A12R	TV24A16R	TV24A22R	TV24A26R	TV24A36R	---	TV24A32R
0-27" W.C.	15	2.5" W.C.	SA31AR	SA32BR	1.5" W.C.	SB31AR	SB32BR	2.2" W.C.	3.4" W.C.	SC31BR	SC32CR	TA31A12R	TA31A16R	---	---	---	---	---
0-65" W.C.	15	3.8" W.C.	SA21AR	SA22BR	1.8" W.C.	SB21AR	SB22BR	2.5" W.C.	8.2" W.C.	SC21BR	SC22CR	TA21A12R	TA21A16R	---	---	---	---	---
15-140" W.C.	25	7.5" W.C.	SA21AR	SA22BR	3.8" W.C.	SB21AR	SB22BR	5.0" W.C.	18" W.C.	SC21BR	SC22CR	TB21A12R	TB21A16R	---	---	---	---	---
15-250" W.C.	25	13" W.C.	SA11AR	SA12BR	7.5" W.C.	SB11AR	SB12BR	8.8" W.C.	32" W.C.	SC11BR	SC12CR	TB11A12R	TB11A16R	---	---	---	---	---
25-400" W.C.	25	19" W.C.	SA11AR	SA12BR	10" W.C.	SB11AR	SB12BR	17" W.C.	50" W.C.	SC11BR	SC12CR	TC11A12R	TC11A16R	---	---	---	---	---
Differential Switch Units																		
0-27" W.C.	15	2.5" W.C.	SA31AR	SA32BR	1.5" W.C.	SB31AR	SB32BR	2.2" W.C.	3.4" W.C.	SC31BR	SC32CR	TA31A12R	TA31A16R	---	---	---	---	---
0-65" W.C.	15	3.8" W.C.	SA21AR	SA22BR	1.8" W.C.	SB21AR	SB22BR	2.5" W.C.	8.2" W.C.	SC21BR	SC22CR	TA21A12R	TA21A16R	---	---	---	---	---
15-140" W.C.	25	7.5" W.C.	SA21AR	SA22BR	3.8" W.C.	SB21AR	SB22BR	5.0" W.C.	18" W.C.	SC21BR	SC22CR	TB21A12R	TB21A16R	---	---	---	---	---
15-250" W.C.	25	13" W.C.	SA11AR	SA12BR	7.5" W.C.	SB11AR	SB12BR	8.8" W.C.	32" W.C.	SC11BR	SC12CR	TB11A12R	TB11A16R	---	---	---	---	---
25-400" W.C.	25	19" W.C.	SA11AR	SA12BR	10" W.C.	SB11AR	SB12BR	17" W.C.	50" W.C.	SC11BR	SC12CR	TC11A12R	TC11A16R	---	---	---	---	---

Temperature Switches

Specifications		Adjustable Deadband			Fixed Deadband			Two-Stage Fixed Deadband				Temperature Transducers						
Adjustable Operating Range °F	Rated Overrange Temperature °F		Adjustable Deadband	Watertight Enclosure	Explosionproof Enclosure	Fixed Deadband At Mid-Range °F†	Watertight Enclosure	Explosionproof Enclosure	Fixed Deadband At Mid-Range °F†	Separation Maximum Full Scale	Watertight Enclosure	Explosionproof Enclosure	Direct Mount 316 SS Catalog No.	316 Stainless Steel Armored Capillary with 316 Stainless Steel Bulb				
	Direct Mount	SS	Maximum Full Scale											Catalog No.	Catalog No.	Catalog No.	Catalog No.	Catalog No.
		Minimum at Mid-Range °F†											The Exact Capillary Length Required Must Be Identified for the Model Numbers Listed Below					
													6' Capillary Catalog No.	12' Capillary Catalog No.	13-20' Capillary Catalog No.	21-50' Capillary Catalog No.	51-80' Capillary Catalog No.	
-30 - 60	250	250	10	SA11AR	SA12BR	3.8	SB11AR	SB12BR	5	10	SC11BR	SC12CR	QB10A4R	QB11A4CR	QB11A4CDR	QB11A4CER	QB11A4CFR	QB11A4CGR
0 - 90	260	300	10	SA11AR	SA12BR	3.8	SB11AR	SB12BR	5	10	SC11BR	SC12CR	QD10A4R	QD11A4CR	QD11A4CDR	QD11A4CER	QD11A4CFR	QD11A4CGR
50 - 160	260	350	10	SA11AR	SA12BR	3.8	SB11AR	SB12BR	5	10	SC11BR	SC12CR	QF10A4R	QF11A4CR	QF11A4CDR	QF11A4CER	QF11A4CFR	QF11A4CGR
100 - 220	260	450	10	SA11AR	SA12BR	3.8	SB11AR	SB12BR	5	10	SC11BR	SC12CR	QJ10A4R	QJ11A4CR	QJ11A4CDR	QJ11A4CER	QJ11A4CFR	QJ11A4CGR
160 - 260	260	500	11.5	SA11AR	SA12BR	3.8	SB11AR	SB12BR	5	11.5	SC11BR	SC12CR	QL10A4R	QL11A4CR	QL11A4CDR	QL11A4CER	QL11A4CFR	QL11A4CGR
225 - 340	---	600	15	SA11AR	SA12BR	7.5	SB11AR	SB12BR	10	15	SC11BR	SC12CR	---	QN11A4CR	QN11A4CDR	QN11A4CER	QN11A4CFR	QN11A4CGR
300 - 450	---	700	15	SA11AR	SA12BR	7.5	SB11AR	SB12BR	10	15	SC11BR	SC12CR	---	QT11A4CR	QT11A4CDR	QT11A4CER	QT11A4CFR	QT11A4CGR
350 - 510	---	800	22.5	SA11AR	SA12BR	8.8	SB11AR	SB12BR	12.5	22.5	SC11BR	SC12CR	---	QU11A4CR	QU11A4CDR	QU11A4CER	QU11A4CFR	QU11A4CGR

*NOTE: ASCO stainless steel & EPDM or stainless steel & Viton® transducers are only available in transducer construction listed in table. For other special transducer materials contact ASCO.

**For all 316 stainless steel construction increase deadband by 50%.
† Deadband values listed are nominal.