

BARTON Model 764 Differential Pressure Transmitter

NUCLEAR
SAFETY



Cameron's BARTON[®] Model 764 Differential Pressure Transmitter utilizes a dual-bellows differential pressure unit and provides a 4 to 20 mA or 10 to 50 mA output signal for transmission to remote receiving, control or readout devices. It is ideal for a variety of safety-related applications in nuclear power generating stations such as steam flow, coolant flow, feedwater flow, steam generator level, pressurizer level, torus level, scram discharge level and containment pressure.

The instrument is designed to operate beyond its normal operating environmental specifications for a limited period of time under the adverse conditions encountered within the containment of a nuclear power plant during and after an accident. These adverse environments include severe changes in ambient pressure, temperature and humidity, seismic events and radiation exposure.

Benefits

Qualified for Class 1E in containment service in accordance with IEEE-323-1974/344-1975 and NUREG 0588

Excellent performance and reliability

Ranges of up to 60" w.c., up to 320 psid

Factory calibration for any increments within the given ranges

0.5% accuracy of factory-calibrated span

Radiation-resistant electronics

Continuous operation in adverse environments

Rugged housing

Product Description

The Model 764 transmitter is mechanically actuated by a differential pressure unit (DPU) and equipped with an electronic circuit for sensing the differential pressure signal and converting it to a 4 to 20 mA or 10 to 50 mA output. A regulated direct current (DC) power supply is required to operate the transmitting loop.

The electronic components of the Model 764 transmitter are housed inside a rugged, pressure-sealed enclosure to prevent steam penetration. An EGS quick-disconnect connector assures the integrity of the electrical connections, and specially designed radiation resistant electronic components minimize degradation associated with exposure to nuclear radiation. A standard enclosure cover allows easy access to the zero/span adjustment controls.

The DPU features a dual bellows assembly enclosed by two pressure housings. The bellows assembly consists

of two bellows connected by a valve stem, a center block, over-range valves, a temperature compensator, a strain gauge assembly and range springs. The bellows and center block are filled with a clean, non-corrosive, non-conductive liquid with a low freezing point and sealed.

Basis of Operation

The DPU senses the difference in pressure applied across the bellows unit assembly. The pressure causes a linear motion of the bellows which is mechanically transmitted to the strain gauges by the strain gauge beam. Motion of the end of the strain gauge beam applies tension to one gauge and compression on the other. The gauge in tension increases in resistance, while the one under compression decreases in resistance. The two gauges form a bridge circuit, and the bridge output signal is conditioned and converted to a 4 to 20 mA or 10 to 50 mA output signal by the transmitter electronics.

The output signal is transmitted over a two-wire transmission line to remote receiving devices.

Over-range Protection

The fill fluid inside the bellows is essentially non-compressible. Therefore, the bellows are fully supported and cannot rupture regardless of the over-pressure (up to the full rated pressure of the instrument) applied to the unit. Additionally, the unit contains opposed valves, providing protection against over-range in either direction.

Draining or Venting

Top and bottom pressure connections on each DPU housing serve as drains for gas installations and vents for liquid installations.

Storage

Storage per ANSI N45.2.2-1978 Level B at 70° F (21° C) ± 20° F (± 7° C) in factory-sealed package for 2.5 years maximum will not affect installed service life.

General Specifications

Performance	
Input Range	up to 60" (water column), up to 320 PS ID
Output	4 to 20 mA or 10 to 50 mA, direct and reverse acting
Reference Accuracy*	± 0.5% of factory calibrated span, including effects of conformance (non-linearity), deadband, hysteresis, and repeatability
Adjustability	± 5% field adjustability of factory calibrated span, without affecting normal or accident condition performance. Span is field adjustable from 20% to 100% of factory calibrated span. Zero is field adjustable for up to 30% suppression. Zero or span adjustments beyond ± 5% affect normal and accident condition performance. Calibration is by the end-point method with zero and full scale outputs held to ± 0.05% of true.
Sensitivity*	± 0.01% of factory calibrated span
Power Requirements	15 VDC plus 2 VDC per 100 ohm load to 53 VDC maximum (4 to 20 mA)
	15 VDC plus 5 VDC per 100 ohm load to 52 ± 1 VDC (53 VDC maximum) for 10 to 50 mA
Load Range (includes line & receiver)	50 ohm per volt above 15 VDC (4 to 20 mA)
	20 ohm per volt above 15 VDC (10 to 50 mA)

Load Effect*	< ± 0.05% of factory calibrated span per 100 ohm change (4 to 20 mA)
	< ± 0.1% of factory calibrated span per 100 ohm change (10 to 50 mA)
Power Supply Effect*	< ± 0.025% of factory calibrated span per 1 V change (4 to 20 mA)
	< ± 0.05% of factory calibrated span per 1 V change (10 to 50 mA)
Suppression	100% of calibrated span (factory adjustment), 30% with potentiometer
Span Control	20% to 100% of maximum span (± 5% only without degradation of specifications); potentiometer range is greater than 2:1 at maximum span and greater than 1.5:1 at minimum span
Noise*	< 0.5% peak-to-peak of factory-calibrated span
Thermal Effect* (combined effect on zero and span)	± 1.0% of factory-calibrated span per 100° F (38° C) change from 40° F to 150° F (4° C to 66° C)
	± 1.5% of factory-calibrated span per 100° F (38° C) change from 150° F to 320° F (66° C to 160° C)
Radiation*	± 10.0% at 2 x 10 ⁻⁸ Rads T ID Gamma; pressure boundaries tested to 9 x 10 ⁻⁸ TID Beta



Seismic:	
During Event*	< ± 5.0% error
After Event*	< ± 0.5% error
LOCA Performance*	< ± 5.0% error during the first five minutes of LOCA 420° F (216° C)
	< ± 10.0% error thereafter to the conclusion of the LOCA test, as performed per Document No. 9A-CR3-764-9
	The LOCA errors include the cumulative effects of thermal, mechanical, radiation and seismic aging, as performed per Document No. 9A-CR3-764-9.
Long Term Drift*	± 1.0% of factory calibrated span per year, cumulative
Time Response	< 180 msec. to reach 50% for 10% to 90% step function
Maximum Safe Working Pressure	3000 psig
Static Pressure Effects*	60" w.c. to 42 PS ID spans ± 0.2% of the factory calibrated span per 1000 psig
	43 to 320 PS ID spans ± 0.5% of the factory calibrated span per 1000 psig
Overpressure Effects	60" w.c. to 42 PS ID spans ± 0.5% of the factory calibrated span per 1000 psig
	43 to 320 PS ID spans ± 1.0% of the factory calibrated span per 1000 psig
Overpressure Limit	Up to maximum safe working pressure on either side of DP U without damage to unit
Process Connections	1/4" and 1/2" NPT on both high and low pressure sides
Weight	20.5 lb
Electrical Interface	Two-wire (16 AWG) pigtail (20' long)

*Note: Turndown has a directly proportional effect on the indicated specifications.

Materials of Construction

Materials constituting the pressure boundary are traceable to the raw material heat number through physical marking (if possible) and through material certification.

Heads	316 Stainless Steel
Bellows	316 Stainless Steel
Head Bolts	17-4 P H SST
Vent Plugs	316 Stainless Steel
O-Rings	Ethylene-Propylene Terpolymer
Mounting Bracket	Carbon Steel
Housing	Carbon Steel
Finish	Amerlock Gray Epoxy Paint
Labels and Tags	Stainless Steel
Fill Fluid	Silicone Oil

1E Qualification

The Model 764 Differential Pressure Transmitter is qualified for Class 1E in-containment service per IEEE 323-1974/344-1975 and NUREG 0588. The service conditions associated with these qualifications include the following:

Qualified Service Life

Accelerated Aging for 1830 hours at 257° F (125° C)	100 years at normal conditions of 104° F (40° C)
	60 years at normal conditions of 113° F (45° C)
	40 years at normal conditions of 122° F (50° C)
	26 years at normal conditions of 131° F (55° C)
	11 years at normal conditions of 140° F (60° C)
Radiation Exposure	200 x 10 ⁻⁶ Rads (T ID Gamma)
DBE Environment	Two 10-second temperature ramps to 486° F (252° C) maximum
	24-hour duration chemical spray exposure
	15 day total exposure to saturated steam at 250° F (121° C) minimum
Long-Term Severe Environment	85 days at 200° F (93° C) and 95% R H
Seismic Qualifications	OBE at 9.0 G (series of 5)
	SSE at 12.5 G
	5% critical damping
	No resonance in frequencies below 75 Hz
Mechanical Aging	500,000 pressure cycles during accelerated aging
	Cycled electrically to induce stress during accelerated aging
	Vibration cycling using 0.2 G sweeps over the 1-100 Hz range at 1.0 octave/min.

Quality Assurance

BARTON Model 764 transmitters are manufactured in accordance with 10 CFR 50, Appendix B and ANSI N45.2. For safety related applications, specific procedures exist which provide for:

1. Configuration control of pressure boundary components
2. Chemical and physical certifications on pressure boundary components
3. Configuration control of electronic components
4. Configuration control of manufacturing processes
5. Hydrostatic testing of pressure boundaries to 150% of maximum safe working pressure