ITT Controls

Measurement Systems

BARTON® MODEL 764 DIFFERENTIAL PRESSURE TRANSMITTER

User Manual

Part No. 9A-C10880, Rev. 03
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Contents

Safety

Before installing this product, become familiar with the installation instructions presented in Section 3 and all safety notes throughout.

⚠ **WARNING: This symbol identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.**

CAUTION: **Indicates actions or procedures which if not performed correctly may lead to personal injury or incorrect function of the instrument or connected equipment.**

IMPORTANT: Indicates actions or procedures which may affect instrument operation or may lead to an instrument response that is not planned.

Section 1—Introduction

General

The Model 764 Differential Pressure Transmitter provides a 4-20 mA or 10-50 mA proportional-to-differential pressure signal for transmission to remote receiving, control, or readout devices.

The electronic components of the Model 764 transmitter are housed in a pressure-sealed enclosure. The instruments are designed to operate beyond their normal operating environmental specifications for a limited period of time under such adverse conditions as may be encountered within the containment of a nuclear power plant under accident and post-accident conditions. These adverse environments include severe changes in ambient pressure, temperature and humidity, seismic events, and radiation exposure.

Product Description

The Model 764 transmitter combines a differential pressure unit (DPU) with an electronic circuit. The 4-20 mA or 10-50 mA output is compatible with a wide range of electronic receiving, control, and readout equipment. The instrument utilizes electronic circuits and a molecular-bonded strain gage sensing cantilever beam, actuated directly by the bellows travel within the DPU.

Differential Pressure Unit (DPU)

The mechanical actuating device for the Model 764 transmitter is a dual bellows assembly enclosed by a set of two pressure housings. The dual bellows assembly (Figure 2.1, page 7) consists of two internally-connected bellows, a center block, overrange valves, a temperature compensator, a strain gage assembly, and range springs. The internal volume of the bellows and center block is completely filled with a clean, non-corrosive, non-conductive liquid with a low freezing point and sealed. The motion-sensing cantilever beam is also sealed within this environment.

Electronic Transmitter

The electronic transmitter supplies either a 4-20 mA or 10-50 mA direct current output signal that is proportional to the differential pressure sensed by the DPU. The output signal is transmitted over a two-wire transmission line to remote receiving devices.

Power Supply

A regulated direct current (DC) power supply is required to operate the transmitting loop.

Specifications

Performance

Input Range	0-60 inches (water column) to 0-320 psid
Output	4-20 mA or 10-50 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 (4-20 mA) 15 VDC plus 5 VDC per 100 Ohm load to 52±1 VDC (53 VDC maximum) for 10-50 mA
Load Range (includes line and receiver)	50 Ohms per volt above 15 VDC (4-20 mA) 20 Ohms per volt above 15 VDC (10-50 mA)
Load Effect*	< ±0.05% of factory calibrated span per 100 Ohm change (4- 20 mA) < ±0.1% of factory calibrated span per 100 Ohm change (10-50 mA)
Power Supply Effect*	< ±0.025% of factory calibrated span per 1 Volt change (4-20 mA) < ±0.05% of factory calibrated span per 1 Volt change (10-50 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 change from +40°F to +150°F ±1.5% of factory-calibrated span per 100°F change from +150°F to +320°F
Radiation*	±10.0%@2 x 10^8 Rads TID 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) < ±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	3,000 psig
Static Pressure Effects*	
60" WC to 42 psid spans	±0.2% of the factory calibrated span per 1000 psig
43 to 320 psid spans	±0.5% of the factory calibrated span per 1000 psig
Overpressure Effects:	
60" WC to 42 psid spans	±0.5% of the factory calibrated span per 1000 psig
43 to 320 psid spans	±1.0% of the factory calibrated span per 1000 psig
Overpressure Limit	Up to maximum Safe Working Pressure on either side of DPU 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	2-wire (16 AWG) pigtail (20' long)

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

IMPORTANT: The 764 transmitter has no integral electronic interference suppression features. If an instrument is to be installed in an area containing EMI/RFI sources and this interference cannot be tolerated, take precautions to protect the transmitter signal. See also EMI/RFI Shielding, page 17.

Application

The Model 764 Differential Pressure Transmitter was subjected to IEEE 323-1974/344-1975 qualifications testing which found the device suitable for functional service in a harsh environment (LOCA/MSLB).

The service conditions associated with the Model 764 Transmitter nuclear service qualifications are presented below:

Qualified Service Life (accelerated aging for 1,830 hours at 257°F	100 years at normal conditions of 104°F 60 years at normal conditions of 113°F 40 years at normal conditions of 122°F 26 years at normal conditions of 131°F 11 years at normal conditions of 140°F
Radiation Exposure	200 x 10^6 Rads (TID Gamma)

DBE Environment........................... Two 10-second temperature ramps to 486ºF maximum; 24 hour duration chemical spray exposure; 15 day total exposure to saturated steam at 250ºF minimum
Long Term Severe Environment..... 85 days at 200ºF and 95% RH
Seismic Qualifications .... OBE @ 9.0 G (series of 5)
SSE @ 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 @ 1.0 octave/min.

Storage:

Storage per ANSI N45.2.2-1978 Level B @ 70ºF (20ºC) ±20ºF (±11ºC) in factory-sealed package for 2.5 years maximum will not affect installed service life.

Section 2—Theory of Operation

Basic Components

Differential Pressure Unit (DPU)

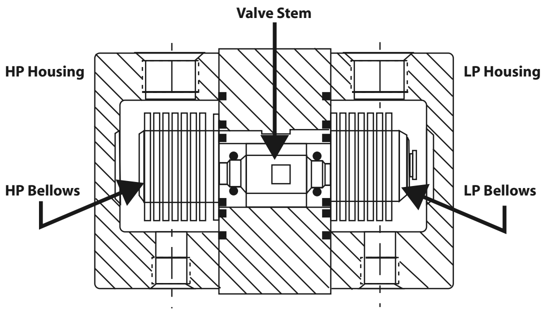


Figure 2.1—DPU

The differential pressure range of the dual-bellows type DPU is determined by the force required to move the bellows through their normal range of travel. To provide for various ranges, range springs are incorporated into the Bellows Unit Assembly (BUA). The range springs, which are available in various factory assemblies, accurately balance the differential pressure applied to the DPU.

In operation, the two bellows (which are connected by the valve stem shown in Figure 2.1) move in proportion to the difference in pressure applied across the BUA. The linear motion of the bellows is picked up by the tip of the silicone strain gage beam, which is actuated directly by the valve stem connecting the two bellows. If the bellows are subjected to a pressure greater than the differential pressure range of the DPU, they will move through their normal range of travel, plus a small additional amount of "overtravel," until the valve on the stem shaft seals against its valve seat. As the valve closes on the seat, it "traps" the fill liquid in the bellows, protecting the unit from damage or shift in calibration.

Since the fill fluid is essentially non-compressible, 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. Furthermore, since the unit contains opposed valves, protection against "overrange" in either direction is provided.

Draining or Venting. The high and low pressure housings of the DPU are provided with both top and bottom pressure connections which provide a draining feature when the unit is used in gas installations, or a venting feature when the unit is used in liquid installations, when installed in accordance with standard practices.

Temperature Compensation. The high pressure side of the DPU has extra bellows convolutions to provide for expansion and contraction of the fill liquid caused by ambient temperature changes. These extra convolutions are connected to the measuring bellows by a passageway to permit the fill liquid to change volume without materially affecting the internal pressure or the physical relationship of the measuring bellows.

Bellows. Individual bellows diaphragms are stamped from special order Type 316 ELC (Extra Low Carbon) stainless steel sheets. The diaphragms are assembled and seam welded to form the bellows.

Strain Gage Assembly. The strain gage assembly (Figure 2.2) consists of a strain gage beam and a glass-to-metal seal feed-through assembly. Strain gages are bonded to opposite sides of the strain gage beam. The end of the strain gage beam is installed directly into a cutout in the valve stem connecting the two bellows of the DPU. Any movement of the bellows in either direction causes a corresponding linear movement of the strain gage beam which acts upon the strain gages. Any action of the strain gages is monitored by the electronic transmitter circuit.

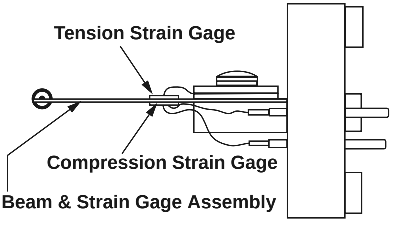


Figure 2.2—Strain Gage Assembly

Range Springs. The range springs act with the bellows to balance the differential pressure applied to the unit. The springs are fabricated of a material that is compatible with the specific bellows material used. The number of springs and their rate depends on the differential range desired.

Electronic Transmitter

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 gages by the strain gage beam. Motion of the end of the strain gage beam applies tension to one gage and compression on the other. The gage in tension increases in resistance, while the one under compression decreases in resistance. The two gages are connected to form two active arms of a bridge circuit. The bridge output signal is conditioned and converted to a 4-20 mA or 10-50 mA output signal by the transmitter electronics.

Basic Operation

The electronic transmitter is basically a loop current regulating device, where loop current is controlled by an input of mechanical force or motion. The block diagram (Figure 2.3, page 10) shows the relationships of the various stages and the main flow of the electrical currents. As shown, the transmitter, power supply, and load (line plus receiving device) are connected in series.

The current from the power supply enters the transmitter, passes through the reverse polarity protecting diode, then divides into two separate paths. The main current flows through the current amplifier stage and returns to the loop. The remainder of the current passes through the electronic regulator where it divides into two paths, through the bridge circuit and the voltage amplifier. The current is then returned to the loop. The total loop current flows through the load and back to the power supply.

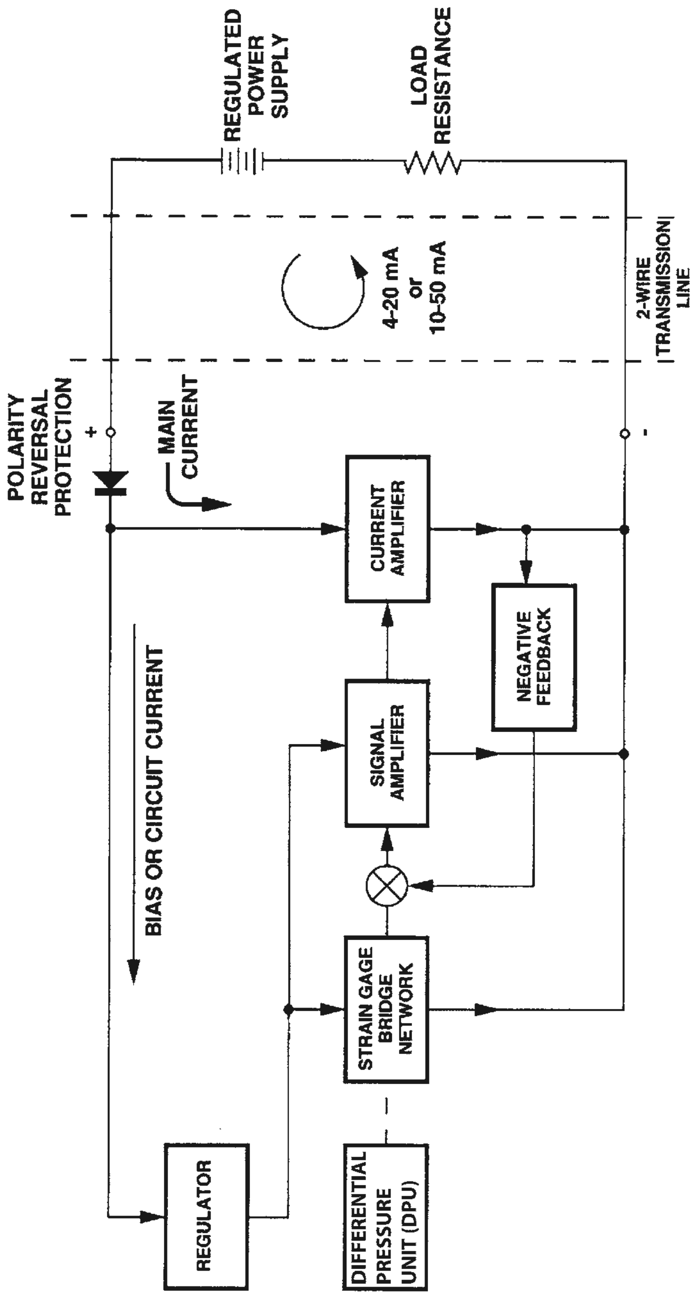


Figure 2.3—Operational block diagram

Reverse Polarity Protection

Reverse input polarity protection is provided by the forward-conducting diode. In the event the polarity of the input is reversed, the diode blocks the input and prevents the reversed input power from damaging the electronic circuit components.

Regulator

This stage of the circuit regulates that portion of the loop current which is not calibrated at the current amplifier stage, and provides stabilized voltage for bridge excitation and power for the signal amplifier.

Strain Gage Bridge Network

The strain gage bridge network consists of two silicone piezo-resistive strain sensors, the zero adjusting potentiometer, bridge completion resistors, and the temperature compensation components.

Signal Amplifier

The signal amplifier is an integrated circuit operational amplifier which provides amplification of the strain gage bridge network output voltage.

Current Amplifier

The current amplifier circuit converts the signal amplifier output voltage to current. The amount of current is precisely regulated with the feedback network to make it proportional to the bridge output.

Temperature Compensation

The Model 764 is temperature-compensated at the factory. Only those repairs described in Section 4 of this manual may be performed in the field without voiding the qualifications certification.

IMPORTANT: Combined zero and/or span changes more than ±5% of the factory calibration can adversely impact transmitter performance. The transmitter performance may be decreased in direct proportion to the changes to the factory calibration. If the combined zero and/or span changes represent a change in the factory calibration by a factor of 2, the transmitter performance may be decreased by a factor of 2.

Section 3—Installation and Operation

WARNING: Failure to follow instructions for removing the transmitter cover may damage the transmitter cover and case. This could result in a serious degradation of transmitter performance during design basis events, resulting in a potential degradation of safety systems. To avoid the potential for equipment degradation, see "Transmitter Cover Removal" on page 24.

Unpacking/Inspection

The instrument should be inspected at the time of unpacking to detect any damage that may have occurred during shipment.

IMPORTANT: The unit was checked for accuracy at the factory. Do not change any of the settings during examination or accuracy will be affected.

After final cleaning, a polyethylene bag is used to protect the instrument from contamination. This bag should be removed only in a clean area.

Pre-Operating Instructions

The following steps must be performed at the time of installation to ensure that the instrument will perform to its original calibration.

1. Verify that the transmitter is mounted in an approximately level plane (see Mounting below).
2. Verify that the transmitter is properly connected to the pressure source (see Piping, page 14).
3. Verify that electrical connections are in accordance with the schematic diagram (see Electrical Connections, page 15).

Perform the initial calibration adjustments (see Initial Calibration Adjustments, page 18).

Mounting

Mount the instrument on wall or rack with four 5/16" (8mm) bolts, Grade 5 or better, and torque to 10-20 ft-lb. Mounting structures shall be designed to avoid resonance and/or keep resulting amplification below 33 Hz. Interfacing process tubing and conduit shall be supported by the same mounting as the instrument base to minimize relative motion of the instrument and connections.

Vibration

Minimize vibration by mounting the instrument on a secure support.

Piping

The practices described in this section should be followed for all instrument piping.

Distance

The distance between the primary device and the instrument should be as short as possible.

Slope

Slope all piping at least one inch per linear foot to prevent liquid or gas entrapment in the lines or the instrument.

- Slope all piping downward from the transmitter when used in gas installations to prevent liquid entrapment.
- Slope all piping upward from the transmitter when used in liquid applications to prevent gas entrapment.

Process Temperature

If the process temperature exceeds 135°F, provide a minimum of 1-foot of uninsulated pipe between the instrument and the primary device for each 100°F above 135°F.

Pulsation

Minimize pulsation. Severe pulsation will affect the performance of the instrument.

Leakage

Prevent leakage by using a suitable sealing compound on all joints. Measurement errors can be caused by leaks in the piping.

High-Pressure Connection

Connect the high-pressure chamber to the upstream side of the orifice or the high-pressure side in a standard liquid level application.

Manifolding

The use of manifolds is recommended for shutting off sensing lines while removing or calibrating the instrument.

Electrical Connections

WARNING: Failure to properly calculate power supply DC output voltage may result in inaccurate transmitter readings, possibly leading to safety system performance degradation during design basis events. To avoid equipment inaccuracy hazards, follow the examples and tables in this section for determining the proper power supply DC output voltage.

Field wiring connections for the transmitter are presented in Figure 3.1. If the transmitter is equipped with an EGS Quick Disconnect connector assembly, make sure the two halves of the connector are secured with the bayonet ring. See Operation of the EGS Quick Disconnect Connector Assembly, page 25, for details.

It is important that the total loop resistance be less than the maximum calculated value and greater than or equal to the minimum value for proper operation under post-accident conditions. See Figure 3.2, page 16, for reference.

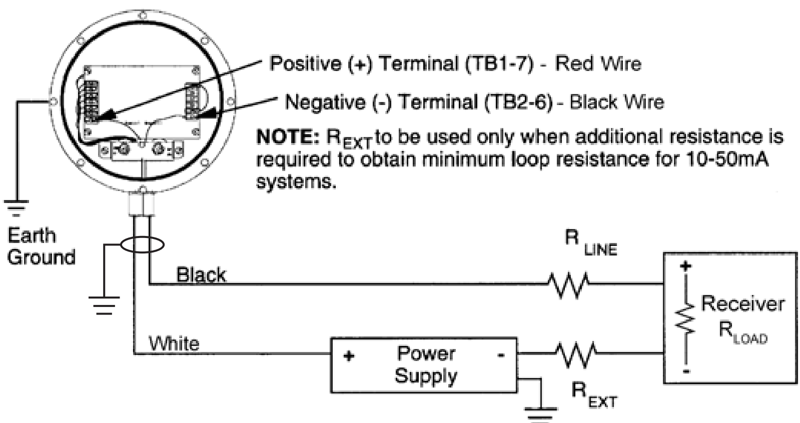
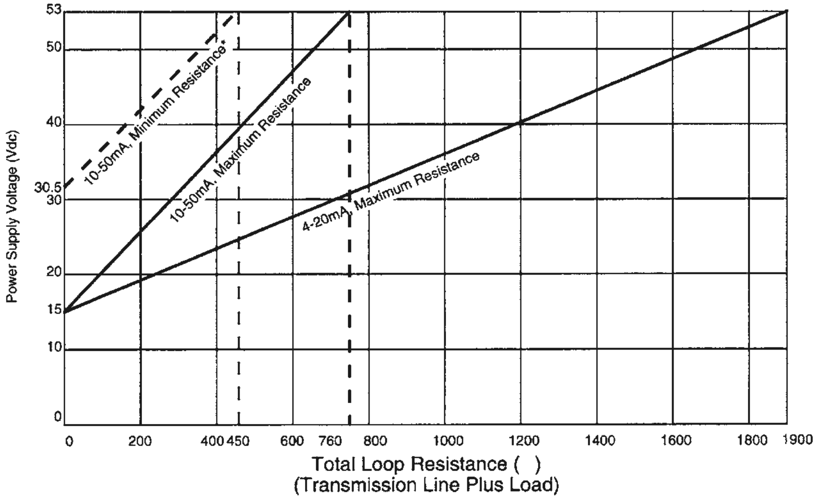


Figure 3.1—Typical field wiring connections



* Minimum resistance is based upon maximum transmitter power dissipation (Watts) at the maximum design temperature conditions. For proper operation at post-accident conditions, this minimum resistance must exist. This minimum resistance is not applicable for 4-20 mA output instruments.

Figure 3.2—Power supply and loop resistance

Load and Line Resistance Calculations

Use the following method to calculate values of load and line resistance:

Total Loop Resistance (R_T) = $R_{Line} + R_{Load} + R_{Ext}$
Power Supply Voltage = V_{DC} (53 V max. for 4-20 mA or 10-50 mA Systems)
Maximum Transmitter Voltage = T_{VDC} (15 V for both 4-20 mA and 10-50 mA Systems)
Minimum Transmitter Voltage = T_{VDC} (30.5 V for 10-50 mA Systems)
Transmitter Current = I_{DC} (20 mA or 50 mA)

$$R_T = \frac{V_{DC} - T_{VDC}}{I_{DC}}$$

Example 1: (Maximum loop resistance for 10-50 mA system):

V_{DC} = 53 Vdc T_{VDC} = 15 Vdc

I_{DC} = 50 mA $R_T = \frac{53-15}{0.05}$ = 760 Ohms

Example 2: (Maximum loop resistance for 4-20 mA system):

V_{DC} = 53 Vdc T_{VDC} = 15 Vdc

I_{DC} = 20 mA $R_T = \frac{53-15}{0.02}$ = 1,900 Ohms

Example 3: (Calculation to determine maximum loop resistance with power supply ≥30.5 Vdc, but ≤ 53 Vdc for 10-50 mA systems):

V_{DC} = 40 Vdc T_{VDC} = 30.5 Vdc

I_{DC} = 50 mA $R_T = \frac{40-30.5}{0.05}$ = 190 Ohms

Minimum loop resistance is determined based on maximum power supply voltage, maximum transmitter current, and maximum transmitter voltage.

Example 4: (Minimum loop resistance for 10-50 mA system):

V_{DC} = 53 Vdc T_{VDC} = 30.5 Vdc

I_{DC} = 50 mA $R_T = \frac{53\text{-}30.5}{0.05}$ = 450 Ohms

For 10-50 mA systems, if R_{Load} = 200 Ohms (Example 1, loop resistance and Example 4, minimum loop resistance), then $R_{Ext} + R_{Line}$ must be ≥250 Ohms, but ≤560 Ohms to satisfy both the maximum and minimum loop resistance values.

For 4-20 mA systems, maximum loop resistance is determined using Example 2. No minimum loop resistance is required with a 53 Vdc power supply.

Care must be exercised when calculating the power supply output voltage. A power supply specified as 50Vdc ±1 volt must be considered a 49Vdc source to ensure the minimum required voltage at the transmitter. Use the actual value when available; otherwise, use "worst case" value.

Use Figure 3.2 as a reference to determine if the maximum calculated value of $R_T = R_{Line} + R_{Load} + R_{Ext}$ is correct.

EMI/RFI Shielding

IMPORTANT: The 764 transmitter has no integral electronic interference suppression features. If an instrument is to be installed in an area containing EMI/RFI sources and this interference cannot be tolerated, take precautions to protect the transmitter signal.

The following precautions are recommended to limit EMI/RFI interference:

1. Run signal wires in solid conduit or use high quality shielded cable to connect the transmitter to the power equipment.
2. The transmitter leads should be housed in solid conduit up to the junction box where the shielded cable is connected to the leads.
3. Ground the electronic transmitter, junction box (including the cover), conduit, and cable shield.

Initial Calibration Adjustments

If a transmitter is installed after an extended period of storage, a calibration test should be performed before operating the transmitter to ensure correct performance.

Accuracy of the test equipment used for the calibration test should be approximately four times the accuracy of the instrument under test. See Table 4.1, page 22, for general requirements.

Calibration Check

The transmitter should be tested at minimum, maximum and 50% calibrated range pressures for at least three cycles.

To test the transmitter calibration, perform the following steps:

1. Remove the calibration access plugs from the transmitter cover using a socket or a wrench.

IMPORTANT: If there are no calibration access plugs in the cover, the cover must be removed to adjust calibration. See Transmitter Cover Removal, page 24, for instructions.

2. Connect the electrical readout device to the transmitter as shown in Figure 3.3 for either current or voltage readout. If the transmitter is equipped to an EGS Quick Disconnect connector assembly, secure the two mating connectors with the bayonet ring (see page 25 for details).
3. With minimum calibration pressure applied, check the output signal. Table 3.1, page 19, presents the transmitter output values in current or voltage, along with the associated tolerance, for both the 4-20 mA and 10-50 mA variations. If the output signal is not the required reading, adjust the zero control potentiometer in the compensating direction.

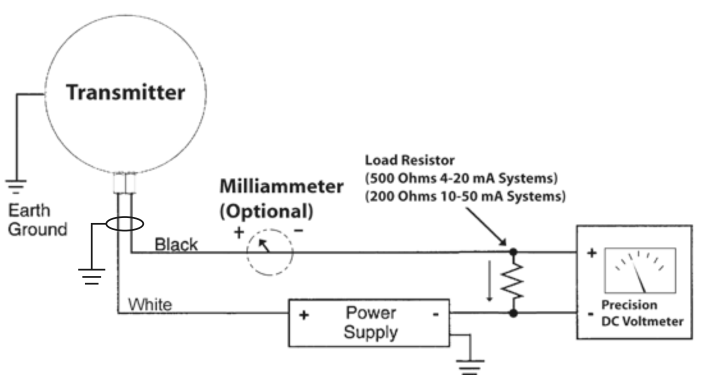


Figure 3.3—Electrical connections for calibration

Table 3.1—Caliatration Checkpoints

Applied Calibration Pressure Check-point (% of Full Scale)	Output*			
	4-20 mA Transmitter**		10-50 mA Transmitter***	
	Current (±0.08 mA)	Voltage (±0.04 Vdc	Current (±0.2 mA)	Voltage (±0.04 Vdc)
0%	4 mA	2 Vdc	10 mA	2 Vdc
25%	8 mA	4 Vdc	20 mA	4 Vdc
50%	12 mA	6 Vdc	30 mA	6 Vdc
75%	16 mA	8 Vdc	40 mA	8 Vdc
100%	20 mA	10 Vdc	50 mA	10 Vdc

*This value includes the effects of conformance (non-linearity), deadband, hysteresis, and repeatability.
**This value was obtained using a 500-Ohm load resistor.
***This value was obtained using a 200-Ohm load resistor.

4. Apply calibration pressure corresponding to maximum output. If the output signal is not the required reading per Table 3.1, adjust the span control potentiometer in the compensating direction.
5. Zero and span controls have a minimum of interaction when adjusted; however, steps 3 and 4 may be repeated as necessary to obtain desired accuracy.
6. Apply 50% calibration pressure. Check that the output is within Table 3.1 specifications.
7. If the proper output is not obtained in step 6, recalibrate according to the calibration procedure on page 22 or return the transmitter to the factory.
8. Replace the calibration access plugs as follows (or if the cover has no calibration access plugs and was removed, see page 24 for instructions on replacing the cover).
    a. Replacement of the calibration plug O-rings is recommended (coat with a small amount of silicone grease). If the O-rings cannot be replaced, inspect the ring surface to verify that the ring surfaces have no damage and coat them with a small amount of silicone grease before reinstalling.
    b. Install the calibration plugs.
    c. Tighten the plugs until they are snug (no applicable torque values).

IMPORTANT: The plugs should be tightened only to prevent loosening due to vibration without interfering with zero and span potentiometer adjustments.

Startup Procedure

To operate the transmitter, perform the following steps. See Figure 3.1, page 15, for valve locations.

1. Close the transmitter shut-off valves.
2. Close the transmitter drain valves and calibration connection valves.
3. Open the main block valves at the process connections.
4. Slowly open the transmitter shut-off valves.
5. Apply electrical power to the transmitter loop.

Shutdown Procedure

To shut down operations, perform the following steps. See Figure 3.1, page 15, for valve locations.

1. Remove electrical power from the transmitter loop.
2. Close the transmitter shut-off valves.
3. Close the main block valves at the process connections.
4. Open the transmitter drain valves and remove all pressure from the unit.

Section 4—Maintenance

General Field and Periodic Maintenance

The electronic transmitter is basically maintenance free and does not require a routine preventative maintenance program other than periodic calibration checks.

⚠ **WARNING: Except for cleaning the DPU and replacement of O-rings, fasteners, and connector assemblies, no field repair or component replacement on the Model 764 is authorized. Unauthorized repairs void any certification to qualification reports for design basis event performance.**

DPU Inspection and Cleaning

⚠ **WARNING: Improper disassembly of DPU products in high-pressure gas applications (working pressures greater than 200 psig) can cause severe injury, death, or substantial property damage. Before removing DPU housing bolts, perform the following pressure check procedure.**

Pressure Check

1. Back off all housing bolts (approximately 4 turns).
2. Check for internal pressure by attempting to move the housing in and out along the bolts.
    a. If the housing moves freely, no pressure is present and servicing/ repair may continue.
    b. If housing does NOT move freely, the bellows may be pressurized and be potentially hazardous if further disassembled. In this case, tighten all bolts, tag the unit to specify "Gas in Bellows" and return to the factory for repair.

Cleaning the DPU

1. After verifying that no internal pressure exists in the DPU, remove the instrument from service and remove the eight pressure housing bolts.
2. Carefully remove the pressure housings from the unit.

IMPORTANT: If the accumulation of material is extensive, rapid removal of the housings may damage the bellows convolutions.

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3. Remove accumulation from between bellows convolutions and housings using a solvent, if possible.

IMPORTANT: Do not use sharp instruments to clean between bellows convolutions.

4. All O-rings exposed during the preceding steps must be discarded. New O-rings installed during reassembly must be identical to those removed. Consult parts list (Table 5.1) for correct part numbers. O-rings should be given a light application of silicone grease prior to installation. Special care should be given to proper assembly. Take care that O-rings are not pinched between two surfaces and are properly seated in the O-ring groove.
5. Replace housings and 5/8-in. head bolts. Tighten bolts with 5/16-in. Allen wrench to a torque value of 40 ft-lb lubed. The head bolts should be lubricated with Molykote G paste or other similar lubricant.

Periodic Calibration

Transmitter calibration is recommended at periodic intervals, determined primarily by the usage of the transmitter, historical performance, the desired accuracy of the output signal, or indications that the instrument may be out of calibration.

A calibration should consist of at least nine checkpoints from minimum to full scale calibrated pressure and back to minimum. For optimum results, the test equipment should meet the requirements noted in Table 4.1.

Table 4.1—Calibration Equipment

Equipment	Requirements
Digital Multimeter	±0.05% precision (minimum)
Power Supply	15-55 Vdc, 60 mA minimum, regulation 3%, ripple 1%
Precision Load Resistor (if voltage measurement of output is made)	200 Ohm, ±0.05%, 1W (10-50 mA Transmitter) 500 Ohm, ±0.05%, 1W (4-20 mA Transmitter)
Pressure Source	To provide zero to full scale pressure (Accuracy: ±0.05%)
Milliamp Meter	To provide 0-50 mA minimum (Accuracy: ±0.05%)

To check for calibration accuracy, perform the following steps.

1. Shut down the transmitter as follows.
   a. Remove electrical power from the transmitter loop.
   b. Close the transmitter shut-off valves.
   c. Close the main block valves at the process connections.
   d. Open the transmitter drain valves and remove all pressure from the unit.
2. Remove the calibration access plugs from the transmitter cover using a socket or a wrench.

IMPORTANT: If there are no calibration access plugs in the cover, the cover must be removed to adjust calibration (see Transmitter Cover Removal, page 24).

3. Connect the electrical readout device to the transmitter as shown in Figure 3.3, page 18, for either current or voltage readout. If the transmitter is equipped to an EGS Quick Disconnect connector assembly, secure the two mating connectors with the bayonet ring (see page 25 for details).
4. With minimum calibration pressure applied, check the output signal. Table 4.2 presents the transmitter output values in current or voltage, along with the associated tolerance, for both the 4-20 mA and 10-50 mA variations.
5. If the output signal is not the required reading, adjust the zero control potentiometer in the compensating direction.

Table 4.2—Calibration Checkpoints

Applied Calibration Pressure Checkpoint (% of Full Scale)	Output*			
	4-20 mA Transmitter**		10-50 mA Transmitter***	
	Current (±0.08 mA)	Voltage (±0.04 Vdc)	Current (±0.2 mA)	Voltage (±0.04 Vdc)
0%	4 mA	2 Vdc	10 mA	2 Vdc
25%	8 mA	4 Vdc	20 mA	4 Vdc
50%	12 mA	6 Vdc	30 mA	6 Vdc
75%	16 mA	8 Vdc	40 mA	8 Vdc
100%	20 mA	10 Vdc	50 mA	10 Vdc

*This value includes the effects of conformance (non-linearity), deadband, hysteresis, and repeatability.
**This value was obtained using a 500-Ohm load resistor.
***This value was obtained using a 200-Ohm load resistor.

6. Repeat steps 4 and 5 at eight or more checkpoints (pressures) from minimum to full-scale calibrated pressure and back to minimum pressure. Check that the output is within Table 4.2 specifications, making adjustments to zero and span potentiometers as required.
7. Replace the calibration access plugs as follows (or if the cover has no calibration access plugs and was removed, see page 24 for instructions on replacing the cover).
   a. Replacement of the calibration plug O-rings is recommended (coat with a small amount of silicone grease). If the O-rings cannot be replaced, inspect the ring surface to verify that the ring surfaces have no damage and coat them with a small amount of silicone grease before reinstalling.
   b. Install the calibration plugs.
   c. Tighten the plugs until they are snug (no applicable torque values).

IMPORTANT: The plugs should be tightened only to prevent loosening due to vibration without interfering with zero and span potentiometer adjustments.

Transmitter Cover Removal

WARNING: Never pry on the transmitter cover to remove it. The transmitter cover and/or case may be damaged. Operating a transmitter with a damaged cover and/or case may result in a serious degradation of transmitter performance during design basis events, resulting in a potential degradation of safety systems. To avoid the potential for equipment degradation, remove the cover using the procedure provided below.

An O-ring seal installed between the transmitter cover and the housing protects the internal circuitry from moisture during design basis events. Two threaded jackholes assist in the removal of the transmitter cover.

To remove the transmitter cover, perform the following steps:

1. Remove the eight cap screws from the transmitter cover using an Allen-head wrench.
2. Insert a cap screw into each of the threaded jackholes on the transmitter cover.
3. Tighten the cap screws to break the seal between the cover and the O-ring.

Transmitter Cover Reinstallation

IMPORTANT: Replacement of the transmitter cover O-ring is recommended each time the transmitter is disassembled. Replacement O-rings must be identical to those removed. Consult the parts list (Table 5.1) for the correct part numbers.

In the event that O-rings are not replaced, inspect the O-ring surface to verify that there is no apparent degradation or damage.

To install the transmitter cover, perform the following steps:

1. Remove the two cap screws from the jacking holes in the transmitter cover.
2. Apply a small amount of silicone grease to the O-rings.
3. Install the O-rings into their respective grooves.

WARNING: Do not allow the cover O-rings to unseat and become pinched between two surfaces during cover installation. Operation of a transmitter with damaged O-rings may result in serious degradation of transmitter performance during design basis events resulting in a potential degradation of safety systems. To avoid the potential for O-ring damage during cover installation, visually inspect the O-rings as the cover screws are tightened.

4. Carefully install the transmitter cover on the transmitter case.
5. Replace the eight cap screws and torque to 3-6 ft-lb (dry).

Operation of the EGS Quick Disconnect Connector Assembly

IMPORTANT: Make sure that the O-ring and the connector sealing surface are clean prior to performing the following steps.

To secure the connector in a locked position, perform the following steps:

1. Place the O-ring (Part No. 9A-C0001-1218R) onto the socket backshell and seal it against the O-ring seating surface, stretching the O-ring slightly to pass over the socket end. Do not roll the O-ring. The O-ring can be applied dry or lubricated with a very thin coating of silicone lubricant such as Parker "Super-O-Lube" or DC High Vacuum Grease (Part No. 9A-C0002-1003U). Lubricated O-rings should be rubbed with a clean cloth prior to installation to remove excess lubricant.
2. Align the connector halves by positioning the "male D" plug into the "female D" hole. When the two parts are aligned, they can be pushed together until the O-ring is seated against the sealing surface on the connector halves. When the connector halves are correctly aligned, the set screws on the two halves will also be aligned.
3. Rotate the bayonet ring until its three pins are aligned with the three slots on the pin backshell. Simultaneously push forward and twist the bayonet ring clockwise (90 degrees) until the ring locks into place. The orange dots on the bayonet ring should align with the orange slots on the mating half. If they do not align, the connector is not locked properly.

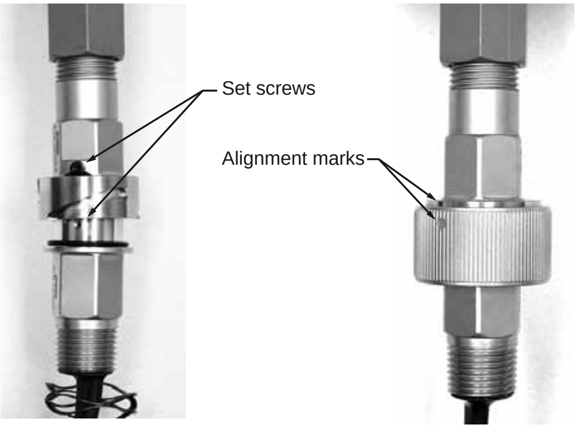

Figure 4.1—EGS quick disconnect connector assembly

To disconnect the connector, simultaneously push the bayonet ring towards the socket backshell and twist it counter-clockwise 90 degrees). Pull the mated halves apart to separate.

Leadwire/Connector Replacement

Leadwires are part of the connector assembly. Therefore, replacement of leadwires requires the replacement of the connector assembly. The EGS Quick Disconnect connector is installed on all 764 transmitters manufactured by Cameron.

The Barton style connector assembly previously used with 764 transmitters is not manufactured by Cameron and is no longer available for purchase. The EGS Quick Disconnect connector is an ideal replacement for the Barton connector assembly.

The following procedures describe the steps required to remove or install either connector assembly.

Removal of the EGS Quick Disconnect Connector Assembly

To remove the EGS Quick Disconnect connector assembly, perform the following steps.

1. Remove the transmitter from service and de-energize it.
2. Remove the transmitter cover (see procedure on page 24).
3. Disconnect the red and black signal leads from the transmitter circuit board (TB 1-7 & TB 2-6) as shown in Figure 4.2, page 27.
4. Loosen or remove the two base screws on the Zero and Span mounting bracket to provide room for the lead wires.
5. Disconnect the connector assembly, if applicable.
6. Carefully unscrew and remove the unmated connector assembly. Take care not to damage the wires and prevent damage to the transmitter by using a wrench to hold the conduit hub in place while the quick disconnect is loosened.

Installation of the EGS Quick Disconnect Connector Assembly

To install the EGS Quick Disconnect connector assembly (Part No. 9A-C0764-1304B), perform the following steps.

1. Remove the installed connector, as applicable.
2. Carefully insert the red and black leads of the unmated EGS Quick Disconnect (QDC) connector through the transmitter conduit opening and under the Zero and Span mounting bracket.
3. Apply EGS QDC thread sealant (Part No. 9A-C0002-1067U) to the male NPT threads, starting with the second thread, on the end of the QDC con-

taining the red and black leads. Securely holding the transmitter conduit hub in place with a wrench, carefully thread the QDC into the transmitter conduit hub and tighten to 50 to 75 ft-lb. Take care to protect the QDC leads during the connector tightening process.

4. Connect the red and black signal leads to the transmitter circuit board (TB 1-7 & TB 2-6) as shown in Figure 4.2.
5. Install/tighten the two base screws on the Zero and Span mounting bracket.
6. Install the transmitter cover (see procedure on page 24).

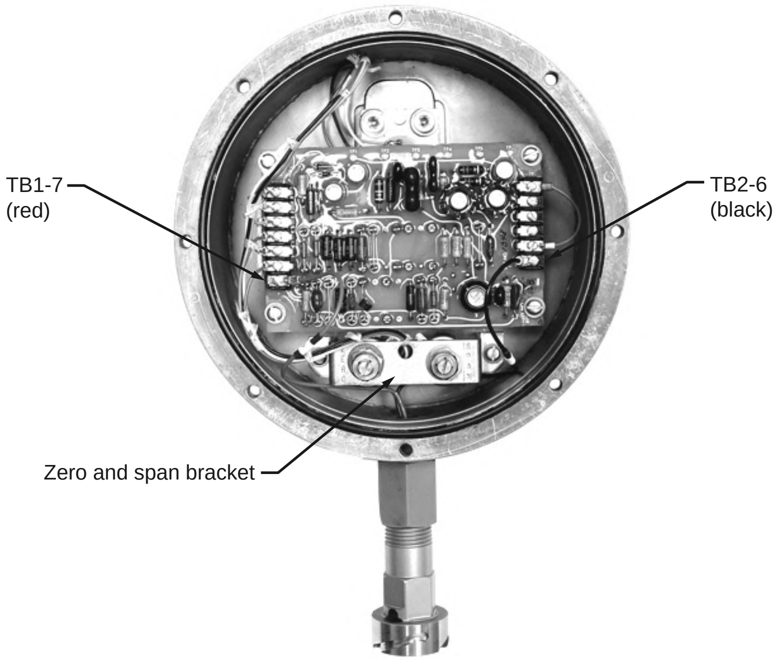

Figure 4.2—Wiring for EGS quick disconnect connector assembly

Removal of the Barton Style Connector Assembly

A special connector tool is required for removal of the Barton style connector assembly, and is available from Cameron (Part No. 9A-0764-1174B).

To remove the Barton style connector assembly, perform the following steps.

1. Remove the transmitter from service and de-energize it.
2. Remove the transmitter cover (see procedure on page 24).
3. Disconnect red and black signal leads from the transmitter circuit board (TB 1-7 and TB 2-6) as shown in Figure 4.3, page 29.
4. Loosen or remove the two mounting screws on the Zero and Span mounting bracket to provide additional room for the lead wires.
5. Insert the connector tool (Part No. 9A-0764-1174B) into the transmitter conduit hub opening and carefully unscrew and remove the connector assembly (connector and two O-rings) as shown in Figure 4.3, page 29.

Installation of the Barton Style Connector Assembly

To install a Barton style connector assembly, perform the following steps:

1. Mate the connector tool (Part No. 9A-0764-1174B) to the connector assembly.
2. Install two O-rings onto the threaded end of the connector assembly. Lightly lubricate the threads and O-rings with DC High Vacuum Grease (P/N 9A-C0002-1003U).
3. Screw the assembly into the transmitter conduit hub opening.
4. Replace the two mounting screws in the Zero and Span mounting bracket and tighten.
5. Connect the red and black signal leads of the connector assembly to the transmitter circuit board (TB 1-7 and TB 2-6) as shown in Figure 4.3, page 29.
6. Install new O-rings into the grooves of the transmitter cover. Lightly lubricate the O-rings with DC High Vacuum Grease (P/N 9A-C0002-1003U).
7. Replace the transmitter cover (see procedure on page 24).

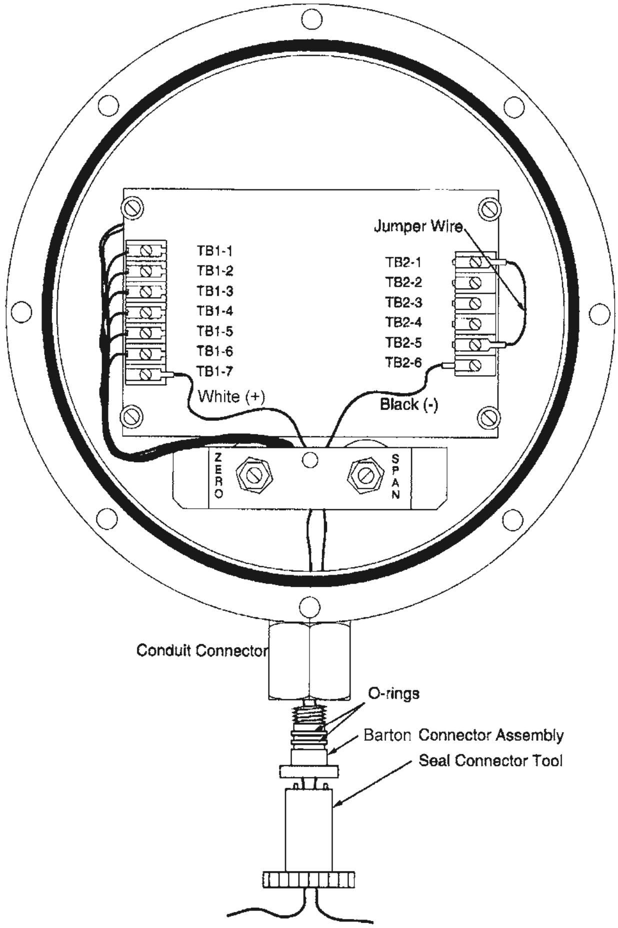

Figure 4.3—Wiring for connector assembly (leadwire) replacement, shown with Barton style connector assembly

Troubleshooting

WARNING: Except for cleaning the DPU and replacement of O-rings, fasteners, and connector assemblies, no field repair or component replacement on the Model 764 is authorized. Unauthorized repairs void any certification to qualification reports for design basis event performance.

Table 4.3—764 Troubleshooting

Problem	Possible Source	Probable Cause	Corrective Action
No Output	Power Source	Blown fuse, faulty component	Replace fuse, repair power supply.
	Transmission Cable	Loose terminal connection	Tighten terminal connection; locate and replace broken wire.
	Receiver (or load)	Blown fuse, faulty component	Replace fuse; repair or replace receiver or load.
	Transmitter	Loose terminal, reversed power connection, faulty component	Tighten terminal, reverse power connection, return to factory for repair.
Transmitter "zeros" but cannot get full output	Power Source	Low voltage	Repair power source.
	Load Resistance	Resistance too high	Replace load resistance or repair as required.
	Transmission Cable	Resistance or length of cable in excess of specifications	Measure cable loop resistance and bring within specifications
	Electronic Module	Loss of gain	Return to factory for repair
	Range Selector	Wrong connection or terminal resistance increased	Check circuit and operating procedure for range selector; clean and tighten terminal connections
	Strain Gage Beam	Physical damage	Return to factory for repair
	Pressure Line	Loose fitting, broken tube or valve	Determine source by closing valves and monitoring for pressure decay
Out of Calibration	Electronic	Component shifted	Return to factory for repair
Erratic Operation	Terminal Connections	Loose or dirty	Tighten and/or clean as required
	Electronic Component	Intermittent	Check connector assembly - these are field replaceable as a complete assembly only, any other repair requires factory service
	Mechanical Component	Switch not properly adjusted	Check and tighten all process and mechanical connections
	Strain Gages	Physical damage	Return to factory for repair

Section 5—Assembly Drawing and Parts List

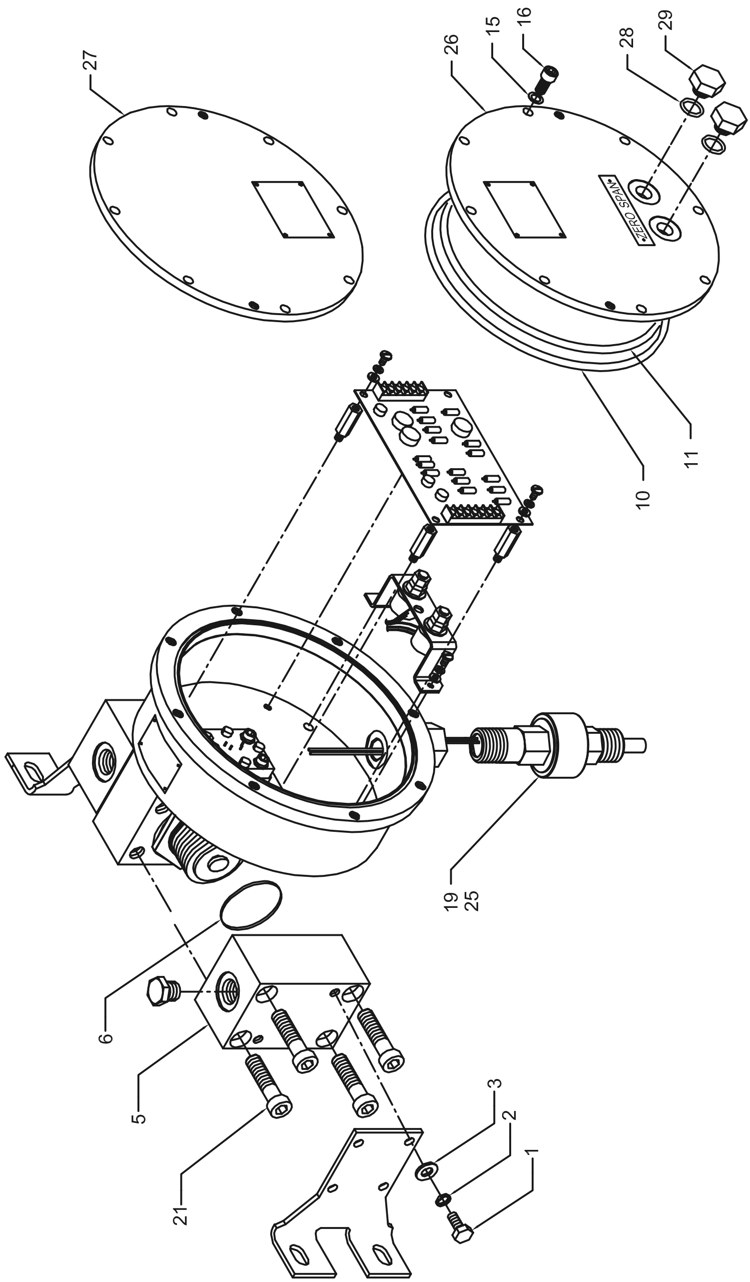

Figure 5.1—764 assembly

WARNING: Except for cleaning the DPU, replacing O-rings, or replacing connector assembly, no field repair or component replacement on the Model 764 is authorized, if it is desirable to maintain certification of the instrument.

Table 5.1—Model 764 Replacement Parts

ITEM	DESCRIPTION	PART NO.	PER UNIT
1	Bolt, Hex Hd., 1/4-28 x 5/8	9A-C0116-1007J	4
2	Washer, Lock, 1/4	9A-C0003-0037K	4
3	Washer, Flat, 1/4	9A-C0003-1003K	4
4	Bracket, Mounting	9A-C0764-1222C	2
5	Screw,Soc. Hd., Cap., 3/8-24 x 1-1/2	9A-C0220-1028J	8
6	Housing, DPU	9A-C0764-1025C	2
7	O-ring, Housing	9A-C0001-1054R	2
8	Assembly, Connector, EGS QDC	9A-C0764-1304B	1
9*	O-ring, QDC (not shown)	9A-C0001-1218R	1
10*	O-ring, Case	9A-C0001-1057R	1
11*	O-ring, Cover	9A-C0001-1056R	1
12	Case Cover (standard external adjustment)	9A-C0764-1262B	1
13	Case Cover (optional)	9A-C0764-1066C	1
14	Washer, Flat, 1/4	9A-C0003-1029K	8
15	Screw, Soc. Hd. Cap., 1/4-20 x 1/2	9A-C0220-1009J	8
16	O-ring, External Adjustment	9A-C0001-1050R	2
17	Plug, External Adjustment	9A-C0001-1247C	2
18*	Tool, Barton Style Connector Assembly Installation (not shown)	9A-0764-1174B	1
19	Lubricant, Thread, EGS QDC Connector	9A-C0002-1067U	A/R
20	Lubricant, O-Ring, Dow Corning High Vacuum Grease (not shown)	9A-C0002-1003U	A/R
21**	Lubricant, Molykote G (not shown)	9A-C0002-0010U	A/R

*Recommended spare part
**To be applied to fastener threads requiring lubrication

Table 5.2—Model 764 Recommended Torque Values

ITEM	TORQUE VALUE
1	8 ft-lb dry
15	3-6 ft-lb dry
5	40 ft-lb lubed
8	50-75 ft-lb lubed

Section 6—Dimensional Drawings

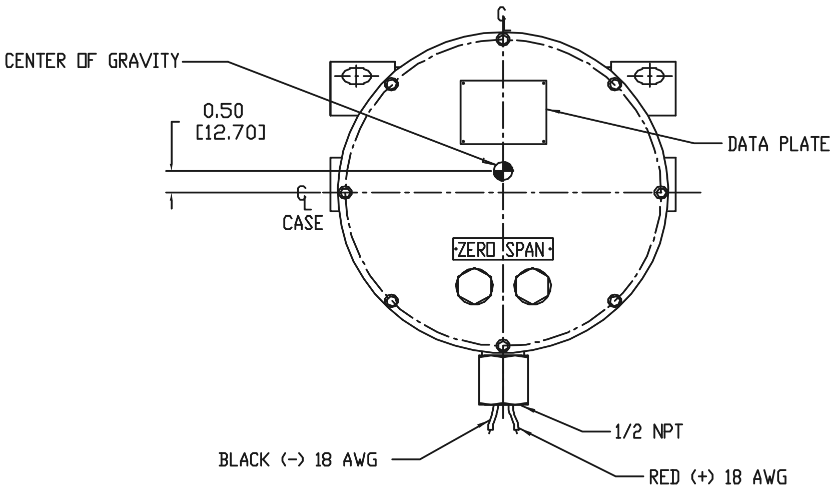

Figure 6.1—764 transmitter, front view (connector assembly not shown)

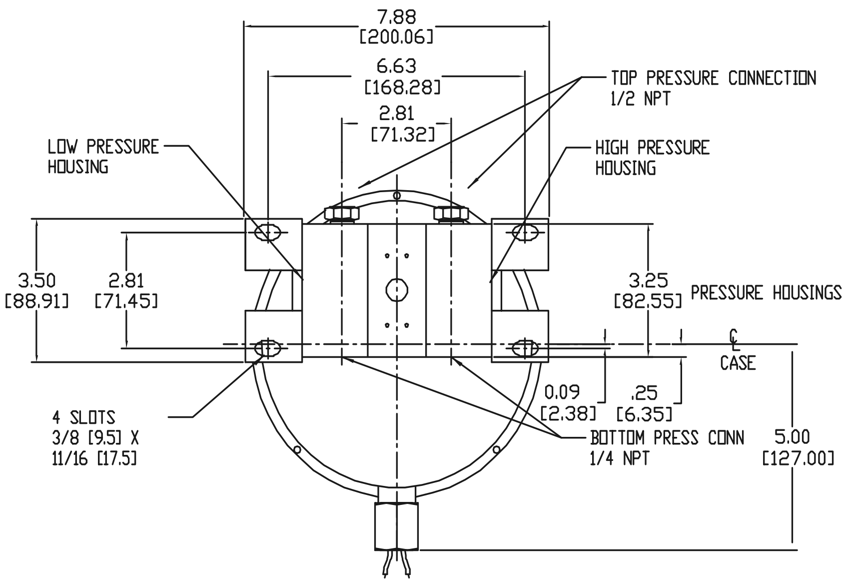

Figure 6.2—764 transmitter, rear view (connector assembly not shown)

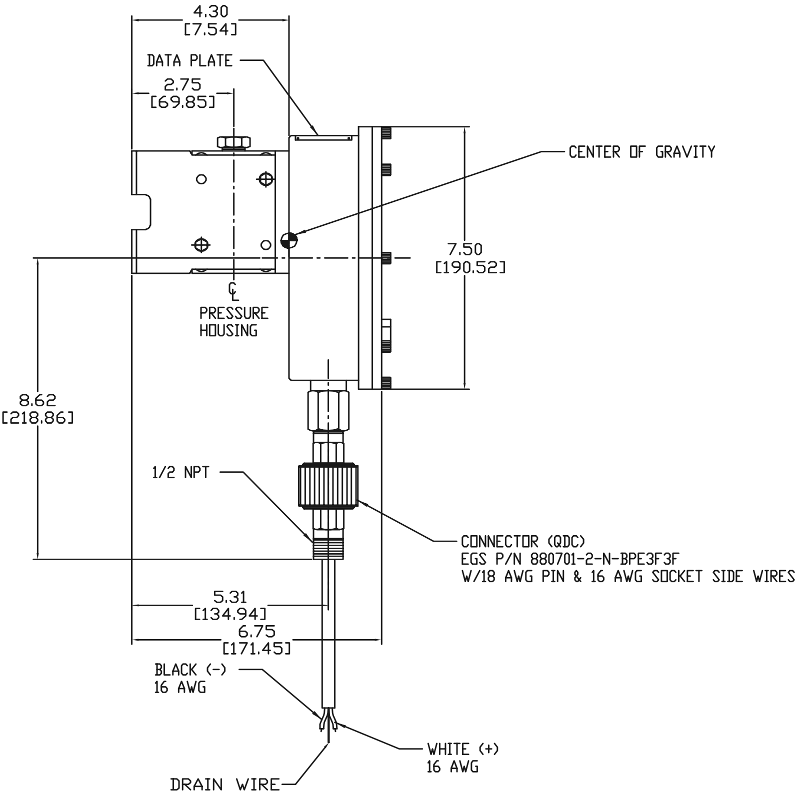

Figure 6.3—764 transmitter side view

Product Warranty

A. Warranty
Cameron International Corporation ("Cameron") warrants that at the time of shipment, the products manufactured by Cameron and sold hereunder will be free from defects in material and workmanship, and will conform to the specifications furnished by or approved by Cameron.

B. Warranty Adjustment
1. If any defect within this warranty appears, Buyer shall notify Cameron immediately
2. Cameron agrees to repair or furnish a replacement for, but not install, any product which within one (1) year from the date of shipment by Cameron shall, upon test and examination by Cameron, prove defective within the above warranty.
3. No product will be accepted for return or replacement without the written authorization of Cameron. Upon such authorization, and in accordance with instructions by Cameron, the product will be returned shipping charges prepaid by Buyer. Replacements made under this warranty will be shipped prepaid.

C. Exclusions from Warranty
1. THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.
2. Components manufactured by any supplier other than Cameron shall bear only the warranty made by the manufacturer of that product, and Cameron assumes no responsibility for the performance or reliability of the unit as a whole.
3. "In no event shall Cameron be liable for indirect, incidental, or consequential damages nor shall the liability of Cameron arising in connection with any products sold hereunder (whether such liability arises from a claim based on contract, warranty, tort, or otherwise) exceed the actual amount paid by Buyer to Cameron for the products delivered hereunder."
4. The warranty does not extend to any product manufactured by Cameron which has been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by Cameron.
5. The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than at Cameron's factory or service locations by persons not expressly approved by Cameron.

Product Brand

Barton® is a registered trademark of Cameron International Corporation ("Cameron").