General Operating Instructions
Validyne Variable Reluctance Pressure Transducer

INTRODUCTION

Properly installed, operated, and maintained, the VALIDYNE PRESSURE TRANSDUCER will give you a lifetime of reliable service. To help ensure trouble-free operation, this manual describes the transducer's construction and capabilities. It also provides specific procedures for correct installation, calibration, maintenance, diaphragm replacement, and trouble shooting. Following these procedures will increase the unit's efficiency and save you considerable time and expense.

TRANSDUCER CONSTRUCTION AND CAPABILITIES

A. Typical Transducers

A typical variable reluctance pressure transducer consists of a diaphragm of magnetically permeable stainless steel clamped between two blocks of stainless steel. Embedded in each block is an inductance coil on an Eshaped core. This coil assembly, covered by an Inconel disc, has a corrosion resistant surface. In the undeflected position, the diaphragm is centered with equal gaps (about 0.005 inch) between it and the legs of each E-core to provide equal reluctances A pressure difference applied through the pressure ports deflects the diaphragm toward the cavity with the lower pressure, decreasing one gap and increasing the other. As the magnetic reluctance varies with the gap and determines the inductance value of each coil, the diaphragm deflection increases the inductance of one coil and decreases that of the other. [See Figure 1: Typical Transducer Cross Section.]

B. Transducer Connected In An AC Bridge Circuit

The transducer connected in an AC bridge circuit is able to take advantage of the inductance variations in the transducer coils. [See Figure 2: Transducer Bridge Circuit.] The coils form one half of a four-arm bridge, and the center tapped secondary of the carrier supply transformer Ti (in the carrier demodulator) forms the other half.

The electrical output of this bridge circuit is an AC signal whose phase depends on the direction of diaphragm displacement. When the diaphragm is in its undeflected (zero) position, the bridge output is at its minimum. Since the diaphragm displacement is linear with pressure applied, the bridge output is also linear with pressure. If the diaphragm is displaced in the opposite direction, the bridge output is again linear with pressure. However, the phase relationship between the bridge signal and excitation voltage has reversed 180°. The carrier demodulator takes this AC signal input, amplifies it, demodulates (rectifies) it, and filters it into a +/-DC voltage which represents the pressure polarity and magnitude.

C. Transducer Capabilities

The Validyne Variable Reluctance Pressure Transducer has a number of advantages over typical transducers.

1. **Acceptance of Corrosive Liquids and Gases**-This transducer has low symmetrical internal volumes which allow it to accept corrosive liquids and gases. To prevent damage, you must keep dirt particles or congealable fluids out of these cavities.

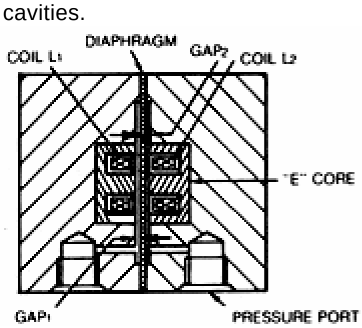


FIGURE I. Typical Transducer Cross-Section

2. **Good Dynamic Response**-Low volumetric displacement (full scale diaphragm deflection is only about 0.0013 inch) results in good dynamic response. For the best dynamic response, you should couple the transducer closely to any gaseous pressure source OR make sure it is free of entrapped air or gas in liquid systems.
3. **High Overload Capability**-The internal cavity walls provide effective overload stops; this allows high overloads. High overpressure can cause a permanent zero shift or diaphragm damage.
4. **High Output Signal**-This transducer provides a high output signal with low susceptibility to electrical noise, a recognized advantage of carrier systems. You should operate this transducer through a carrier demodulator designed for it.
5. **Replaceable Diaphragm**-This transducer has only one pressure sensitive element-the diaphragm-which you can replace if necessary. It is essential to read the diaphragm replacement instructions before replacing it.

   The following Validyne Differential Pressure Transducer models can be disassembled for cleaning and/or diaphragm replacement: DP15, DP22, DP45, DP103, DP215, DP303, DP360, and DP363.

   The following Validyne transducers CANNOT be disassembled in the field because they feature all-welded construction:

Absolute Pressure Transducers:	Model AP10
Differential Pressure Transducers:	Model DP10

INSTALLATION

Proper installation of a transducer is vital to its operation. This section contains specific procedures for unpacking, mounting, installing plumbing, making pressure connections, adjusting the bleed port, and making the electrical connections.

A. Unpacking and Checking

Your transducer is shipped with plastic caps/plugs or adhesive stickers over the pressure ports to prevent dirt from entering the pressure cavities. It is best to keep these covers on the ports until you are ready to make pressure connections. On very low range units, the port cover may have a small hole in it. This hole eliminates internal pressures caused by putting on the cover.

Before unpacking the unit, check the transducer identification to make sure it has the right pressure range. The ID number for most Validyne transducers consists of a model number (alpha-numeric) followed by a two digit dash number which identifies the diaphragm pressure range, connector, O-rings, temperature range, and pressure port configuration. Check this dash number against the Diaphragm Selection Chart on page 4 of these instructions to make sure the pressure range is correct for your needs.

Also, check the shipment for any mating connectors, cables, or adaptor fittings you may have ordered; they might be packaged separately.

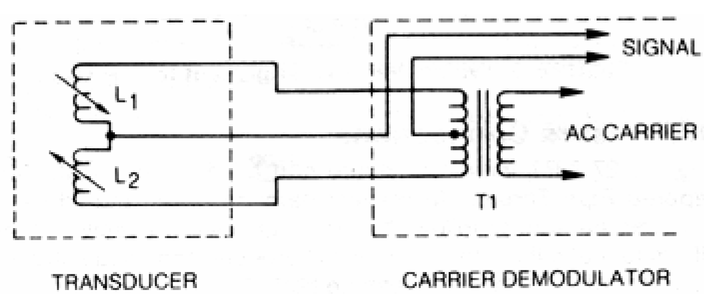


FIGURE 2. Transducer Bridge Circuit

B. Mounting

Before mounting and plumbing up your transducer, be sure to make a system calibration. (See the Calibration Section of these instructions.)

Transducers with 1/8-27 NPT female ports usually can be supported by rigid pipe connections. However, transducers connected to tubing systems should be attached to a support or bracket to prevent strains on tubing connections. Below are the steps for mounting your transducer correctly.

1. Since most transducers have tapped holes in the body for mounting screws, check the data sheet for the screw thread size.
2. If the unit is mounted by screws into its body, make sure the mounting surface is flat so that it does not strain the transducer body. On low range transducers, such strains can cause small zero shifts which can become worse by temperature changes.
3. If possible, mount the transducer so that its diaphragm is in the vertical plane. Vertical mountings must be rigid since any change in the mounting will cause a zero shift because of gravity. This type of mounting has two advantages. For one, it results in zero gravitational deflection of the diaphragm (noticeable in very low range units, particularly with liquid media). For another, it allows dirt particles to fall to the outer edge of the pressure cavity where they won't hinder diaphragm movement.
4. If you mount the transducer above the point of pressure measurement, it will trap less dirt and the interior will remain cleaner.
5. When you mount the transducer, make sure to leave room for the electrical connector, and for access to the bleed ports.

C. Plumbing Connections

Make plumbing connections that allow you to remove the transducer, if necessary, without shutting down the entire plant.

1. If you will be using the transducer for gage pressure measurement (PSIG) where one port is open to the atmosphere, install a simple shutoff valve in the line to the transducer. Cover the open port of a differential pressure transducer with a porous filter to prevent entry of dirt and dust; a plastic cap with a small hole or a wad of fine wire is sufficient.
2. If you will be using a differential pressure unit for measuring the DP across an opening or filter, it requires more extensive valving to place it into operation, and also to remove it without overpressure damage. In this case, use a valve arrangement as shown in Figure 3. [See Figure 3: Typical Valve Arrangement for DP Use.]
3. To pressurize the DP transducer safely, close the drain valve and open the bypass valve. Then open both shutoff valves to apply the pressure to both sides of the transducer. Finally, close the bypass valve.
4. To depressurize the transducer, open the bypass valve, close the shutoff valves, and open the drain valve. Valve manifolds for this purpose are available from commercial valve and fitting suppliers.

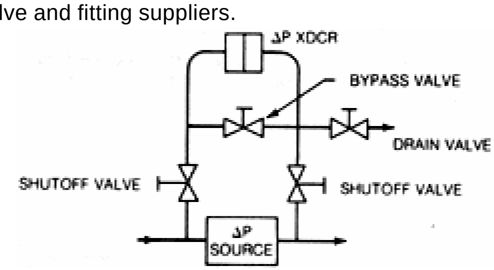


FIGURE 3. Typical Valve Arrangement for ?P Use

D. Pressure Connections

The 1/8-27 NPT female pressure port accepts American Standard Tapered Pipe Thread. To prevent damage to the transducer case, however, be sure to follow the procedure below exactly. Otherwise, efforts to make the connector joint fit properly can cause stress in the case material around the pressure port.

1. Before you connect the pipe to the transducer, make sure the pipe is free of loose internal scale, and check the threads for cleanliness or damage. If they are torn or nicked, clean with a die or chaser.
2. Wrap the tapered pipe thread with two layers of 1 inch wide Teflon Pipe Thread Tape, available at plumbing supply stores.
3. As you wrap, stretch the tape tightly enough to conform to the threads. Also, wrap in the direction of the thread (as though screwing on a fitting). The Teflon functions as lubricant and sealant, minimizes thread galling, and makes disassembly easier.
4. To attach the pipe or fitting, screw it in with a small wrench until it's snug; then give it another half turn. Transducers with ports that have straight threads (AP10, DP22) require mating fitting adaptors with 0-rings to make a leak-free connection at the transducer.

E. Transducer Bleeding

Most Validyne transducers are equipped with bleed ports to facilitate cleaning and filling pressure cavities. This port is closed by a set screw machined to carry a flat circular Teflon washer at its inner end that functions as the bleedport seal.

1. To measure static pressure, it is not necessary to fill the transducer cavity with air; any entrapped air or gas will transmit the pressure to the diaphragm.
2. When there are changes in the response to dynamic pressure, or when oscillations in liquid-filled systems are important, make sure the pressure cavity and transducer connections are free of gas. Acting as a pneumatic spring, the entrapped gas can seriously decrease the frequency response of the measuring system.
3. To remove gas from the pressure cavity, loosen the bleed screw one or two turns with the system pressure ON. **To prevent loss of the Teflon washer, DO NOT remove the bleed screw.** After the internal gas has been expelled, the liquid will flow out around the screw. Close the screw tightly, and wipe up the excess liquid.

F. Electrical Connections

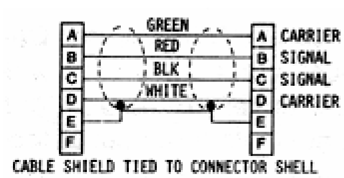
Normally, the electrical connector on the transducer is a six-pin PT02A-10-6P or the equivalent. Pins A and D are for carrier excitation, and pin B is the output signal. Pin C is not used.

The mating connector is a PT06A-10-6S (SR) or the equivalent. Connecting the transducer to the carrier demodulator requires a three or four conductor shielded cable. Validyne carrier demodulators and module cases use PT02A-10-6P connectors for the transducer input, so a cable with a PT06A-10-6S (SR) connector at each end is required.

Ideally, this cable should contain one shielded pair for the excitation leads and another shielded conductor for the signal lead. Separating the signal lead from the excitation leads minimizes the capacitive coupling between the signal and excitation leads.

Unequal capacitance values connected across each transducer coil produces an impedance imbalance in the transducer bridge that results in an output zero offset. (See Figure 2.) In short cables (10 feet), the effect of this imbalance is slight, but in long cables (500 feet) it can cause a large zero offset.

For transducer connections, Validyne has standardized on Belden Type 8434 cable, a readily available four conductor cable consisting of two shielded pairs. Although the fourth conductor is not needed for connection to variable reluctance transducers, it is useful with other equipment such as strain gage or LVDT transducers. The standard Validyne cable is wired as follows:



To minimize pickup from nearby AC power sources or lines, always use shielded cable. Also, it is best not to run transducer cables in trays or conduits carrying AC power. Because the 3 or 5 kHZ transducer signal is about 200 mV rms full scale, a high current 230 Vac line lying next to it can cause an excessive 60 Hz noise signal.

If you mount the transducer so that its case is grounded through the plumbing, disconnect the cable shield from the transducer connector. This breaks the electrical path for AC ground currents which might circulate through the cable shield and cause signal zero instability. Such ground loops result from differences in potential between ground points in the electrical systems. Grounding the shield only at the signal conditioning end will provide a single-point ground for the instrumentation.

CALIBRATION

Although Validyne has factory tested the transducer to make sure that it meets specifications, your system-transducer, cable, and carrier demodulator-has not been calibrated unless specified on the purchase order. Since the output depends on where you set the zero, gain, and other controls, system calibration is necessary to obtain a known relationship between input pressure and output reading.

1. Read the calibration section of the instruction manual for your unit before calibrating your system. This step is necessary because the various Validyne carrier demodulators and transducer indicators differ in their control capabilities, ranging from simple zeroand span controls to sophisticated suppression, auto-zero, and phase controls.
2. Use a known source of pressure of a pressure standard to calibrate your system.
3. For the greatest accuracy, calibrate the transducer and its carrier demodulator with the actual cabling you will be using, preferably with the transducer at its installation location if a cable run of 100 feet or more is involved. This will also help prove out the installation.
4. Once you have calibrated your system control positions, lock, tape, or record them in case you need to re-calibrate the system because of accident or human error.

MAINTENANCE

The transducer does not require any special maintenance. The occasional malfunctions are nearly always caused by one of two problems: a transducer clogged by dirt or a diaphragm damaged by overpressure.

A. Dirt in the Transducer

The usual symptoms of dirt are decreased output, excessive nonlinearity and hysteresis, and zero shift. To correct this problem, it is best to remove the transducer from its installation before cleaning it, as follows:

1. Inject Freon or some other low-residue solvent into the cavity. To do this, remove the pressure fittings, if any, and the bleed screw.

DO NOT LOSE THE SMALL TEFLON WASHER ON THE END OF THE BLEED SCREW.

2. Flush the cavity with solvent and drain it by holding the transducer so the solvent can flow out through the pressure port. Repeat this step until the solvent comes out clean.
3. If the dirt consists of hardened material, you will have to disassemble the transducer for cleaning. To do this, see the diaphragm replacement instructions.
4. When the transducer is clean, check the system calibration before reinstalling it.

B. Damaged Diaphragm

The usual symptom of overpressure damage to the diaphragm is a permanent zero shift. A small zero shift, 15-20 percent of full scale, does not necessarily mean that the diaphragm is useless. Follow these steps to check and correct damage:

1. Rezero the system with the carrier demodulator zero control, and check the calibration. You will probably find that the transducer is operating correctly. However, a heavy zero shift, over 50% of full scale, may mean that the diaphragm is seriously damaged and must be replaced.
2. To determine the usefulness of the diaphragm after a substantial overpressure, loosen the body bolts and retorque to the values shown on the Torque Chart. This permits the diaphragm to return fully to an unstressed null position.
3. Perform a calibration test, looking particularly at zero stability, linearity, full scale output, and plus-to-minus full scale symmetry. Symptoms of a badly distorted diaphragm include unstable zero, excessive non-linearity, and/or severe loss of full scale output sensitivity.

C. Other Problems - If neither of the above procedures corrects the problem, malfunction is usually caused by one of the following: pinched 0-rings, improperly torqued body bolts, or damaged electrical connections.
Check the Troubleshooting Guide on the last page of these instructions, or call Validyne, whose staff of Application Engineers will help you solve the problem. Calls to Validyne are toll-free in continental USA, except in California and Alaska.

DIAPHRAGM REPLACEMENT

A. Disassembly and Cleaning

1. Remove the transducer's body bolts on each side with a spline head, TORX or hex wrench. Spline or TORX wrenches are required for all models except DP22, DP303, DP360, and DP363. [See Figure 4: Typical Transducer Assemblies.]
2. Separate the case halves carefully, and remove the diaphragm.
3. Clean the diaphragm and case halves with a low residue solvent such as Freon or alcohol. Make sure no particles of foreign matter are left inside to interfere with the diaphragm motion (clearance between the diaphragm and the case is only .005" in the center), or in the O-ring grooves. (The DP45 does not have 0-rings.) If you have to replace the diaphragm, refer to the Diaphragm Selection Chart.\

B. Reassembly

Validyne strongly recommends that you reassemble the transducer while it is connected to a transducer indicator or carrier demodulator. To provide a zero reference, zero the indicator before connecting the transducer; the indicator is especially useful during the final tightening of the body bolts since it will show the effects of individual bolt tightening. It is not necessary to adjust the bolts to get an absolute zero output, although it should be within +/-0% of full scale, and not highly sensitive to small changes in any bolt torque.

BODY BOLT TORQUE CHART

MODEL NO.	FINAL BOLT TORQUE	RECOMMENDED SEQUENCE
DP15, DP215 (S-183 Spline or T27 TORX)	125-130 INCH LB	Snug one side and then the other until O- rings are compressed. Final torque each side in turn.*
DP22, DP303 (3/16 Hex Wrench)	150-170 INCH LB	Same procedure as above.
DP45 (S-133 Spline or T15 TORX)	20-25 INCH LB	Same procedure as above, except DP45 has no 0-rings.
DP103 (S-183 Spline or T27 TORX)	30-35 INCH LB	Same procedure as above. Note: Tighten 4 bolts per side in diametrically opposed pairs.
DP360, DP363 (3/16 Hex Wrench)	150-170 INCH LB	Same procedure as above.
	BLEED SCREW TORQUE	
ALL STANDARD MODELS	15 to 20 INCH LB	

***NOTES:** 1. Validyne pressure transducers may be equipped with Spline head OR TORX head body bolts. Please use the appropriate wrench.
2. P/N 11873 Torque Wrench Adaptor for S-183 Spline head bolts is available from the factory.
3. The S-183 and S-133 Spline Wrench designators are Bristol Corp. or equivalent, and are available from Validyne.
4. Wrenches for TORX head bolts are available from most hand tool suppliers.

1. To reassemble, place the O-rings in the grooves in each half, and the diaphragm between the case halves. If the diaphragm is corrugated, face the raised portion of the corrugations toward the negative case half.
2. Make sure the bolt holes in the diaphragm are aligned exactly with the holes in the case halves, and replace the body bolts on one side of the transducer; tighten the bolts until just snug.
3. Inspect the other diaphragm bolt holes to see that they are also aligned with the case halves, and replace the last body bolts; tighten all bolts to the torque values given in the Body Bolt Torque Table. If a torque wrench is not available, tighten the bolts as much as possible.

   Make sure that the threads on the body bolts do not catch on the holes in the diaphragm, and that the O-rings are seated in their grooves. Otherwise, the transducer zero may shift out of tolerance.
4. Before calibration, pressure cycle the transducer between zero and full scale several times to seat the diaphragm completely. Some temperature cycling would also enhance the stabilization.

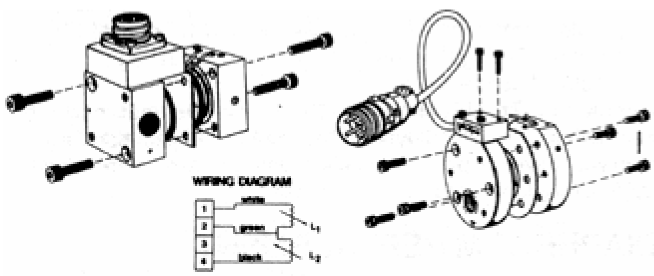


FIGURE 4. Typical Transducer Assemblies

C. How to Use the Diaphragm Selection Chart

First, look at the bottom section of the chart to determine if the full scale pressure range you need is available for your transducer. The column to the right of the model number shows the correct diaphragm number for each transducer model. EXAMPLE: For a DP15 transducer, use P/N3-XX; the dash number (XX) will indicate the correct range.

To select the engineering units desired (PSI, kPa, etc.), move down the appropriate range column until you locate the proper full scale pressure range. Then choose the diaphragm dash number in the left column that corresponds to that range. If the pressure range desired falls between the ranges listed, use the diaphragm dash number for the next higher range.

EXAMPLE: For a 100 PSI transducer, select a -50 diaphragm. Your transducer may then be calibrated for any full scale pressure range from 81 through 125 PSI.

If the desired pressure range is listed, use the corresponding diaphragm dash number in the left column.

EXAMPLE: To obtain a 650 mmHg transducer, select a -40 diaphragm; your transducer may then be calibrated for any full scale pressure range from 415 to 650 mmHg.

When you use the Diaphragm Selection Chart according to the above instructions, your transducer will meet all of the performance specifications for that model.

DIAPHRAGM SELECTION CHART
PRESSURE RANGE

DIAPH DASH NO.	PSI	IN HG	IN H20	KPA	MM HG/TORR	CM H20
10	0.0125	0.026	0.35	0.086	0.65	0.88
12	0.020	0.041	0.55	0.140	1.03	1.40
14	0.032	0.065	0.89	0.22	1.65	2.25
16	0.05	0.102	1.40	0.35	2.58	3.50
18	0.08	0.16	2.22	0.55	4.14	5.60
20	0.125	0.25	3.5	0.86	6.5	8.80
22	0.20	0.41	5.5	1.40	10.3	14.0
24	0.32	0.65	8.98	2.2	16.5	22.5
26	0.50	1.02	14.0	3.5	25.8	35.0
28	0.80	1.6	22.2	5.5	41.4	56.0
30	1.25	2.5	35.0	8.6	65.0	88.0
32	2.0	4.1	55.0	14.0	103	140
34	3.2	6.5	90	22.0	165	225
36	5.0	10.2	140	35.0	258	350
38	8.0	16.0	222	55.0	414	560
40	12.5	25.0	350	86.0	650	880
42	20	41.0	550	140	1030	1400
44	32	65.0	890	220	1650	2250
46	50	102	1400	350	2580	3500
48	80	160	2220	550	4140	5600
50	125	250	3500	860	6500	8800
52	200	410	5500	1400	10300	14000
54	320	650	8900	2200	16500	22500
56	500	1020	14000	3500	25800	35000
58	800	1600	22200	5500	41400	56000
60	1250	2500	35000	8600	65000	88000
62	2000	4100	55000	14000	103000	140000
64	3200	6500	89000	22000	165000	225000
68	5000	10200	140000	35000	258000	350000
70	8000	16000	222000	55000	414000	560000
	125000	25000	350000	86000	650000	880000

MODEL NO.	DIAPH NO.	DASH NO. AVAILABLE	MODEL NO.	DIAPH NO.	DASH NO. AVAILABLE
DP9	2	30-50	DP303	5	20-66
DP15-P24	3	20-64	DP45	6	16-40
P300-P305	3	20-64	DP103	8	10-40
DP22	4	48-70	DP215	9	40-64
DP360	11	48-68	DP363	12	38-50
P365	11	48-68	P378	12	38-50

TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	SOLUTION
ZERO BALANCE OUT OF SPEC	1. Warped or damaged diaphragm	Reverse diaphragm. If still out of spec. with opposite sign. Replace diaphragm.
	2. Contaminated pressure cavity	Clean & reassemble
	3. Body bolts improperly torqued	Loosen & retorque bolts. Follow sequence & torque levels in Section V.
OUTPUT NOT IN SPECIFICATION	1. Diaphragm range incorrect	Check diaphragm by dash number. Required range should be between 50 & 100% of tabulated value.
	2. Body bolts improperly torque	Retorque in sequence to levels specified in Section V.
	3. Obstruction in port or pressure cavity	Clean transducer halves & diaphragm, clear ports.
NON-LINEAR RESPONSE OR EXCESSIVE HYSTERESIS	1.Over-ranging diaphragm 2. Obstruction in pressure cavity or dirty clamping surface	Check diaphragm dash number with chart. Clean and reassemble.
	3. Body bolts not torqued correctly	Retorque in sequence to levels in Section V.
	4. Swollen or torn O-ring	Check for compatibility with pressure media; replace as required.
EXCESSIVE OR ERRATIC ZERO SHIFT UNDER LINE PRESSURE	1. Leak in system	Recheck all fittings
	2. Loose body bolts	Retorque per level & sequence instructions of Section V.
	3. Damaged diaphragm	Replace as necessary
	4. Missing or damage O-rings	Replace as necessary
	5. Loose bleed screw	Check bleed screws are tight
	6. Improperly bled pressure cavity	Bleed pressure cavities to remove entrapped air.
	7. Missing bleed screw gasket(s)	Replace bleed screw gasket(s)