How It Works

Bimba Pneumatic Control System Model PCS

The Bimba Pneumatic Control System (Model PCS) is designed to control any pneumatic Bimba position feedback actuator. This includes the Position Feedback Cylinder (PFC) for linear motion and the Position Feedback Pneu-Turn (PTF) for rotary motion. The system is a closed-loop electronic controller with pneumatic valves that can accurately position the actuator rod or shaft and hold it in position with a high degree of accuracy and force. The system accomplishes the long term goal of using pneumatic technology to accurately stop and hold the rod or shaft at any desired position.

The standard PCS accepts a 0 to 10 VDC analog command signal. The command signal is used as a reference to move to and hold a specific position. Order Option C if a 0 to 20 mA or a 4 to 20 mA analog command signal is required. For example, if the application has a stroke of 10 inches (i.e., the electrical zero and span is set for a 10 inch stroke), then a 1 volt change in the command voltage is equal to a 1 inch movement. Similarly, a change in command signal of 0.005 of a volt equals a position change of 0.005 of an inch for the same 10 inch stroke application. If the application has a stroke of 5 inches, a change of 1 volt in the command signal represents a 1/2" inch movement. For rotary applications, the convention is similar. If the application has a rotation of 180 degrees, then a 1 volt change in the command signal is equal to 18 degrees of rotation.

The system utilizes the feedback from the actuator to close the control loop. The control loop compares the system's command signal (the 0-10 VDC, 0-20mA, or 4-20mA input command signal) to the feedback signal from the actuator. The difference between the command and feedback is referred to as the error term. When the error term is zero, all valves close, trapping air on both sides of the actuator piston. (The error term is considered to be zero when it is within the deadband range. The deadband range is an adjustable range that determines the final repeatability of the system. The Application Sizing chart located later in this section shows recommended deadband ranges for given application parameters.) This holds the rod or shaft at it's commanded position. If some force or weight attempts to move the rod or shaft out of the commanded position, the system will react by increasing the restoring force eventually to full supply pressure, if necessary. Likewise, if the command signal changes, the system will respond to make the feedback equal the command signal.

There are four adjustments on the PCS system, adjustable via four trim pots. They include the Zero, Span, Decel, and Deadband adjustments. The Zero and Span adjustments allow you to set the zero and full scale position of the actuator to match the input (command) signal. The Decel and Deadband adjustments are used to optimize the performance of the system based on application parameters. These adjustments are described in detail in the Operating Manual, which is included with each system.

The actual accuracy/repeatability of the movements will depend on many factors, including signal noise, load, velocity, supply pressure, supply voltage, and application friction. Refer to the Application Sizing charts found later in this section for detailed information regarding sizing and suggestions for your application.

How to Order

The model number for all Pneumatic Control Systems consist of three alpha numeric clusters. These designate product type, flow size, and options. Please refer to the charts below for an example of model number PCS-1-Q. This is a system with a Cv of 0.02 and the Quick Connect connector option.

PCS-1-Q

PNEUMATIC CONTROL SYSTEM

FLOW TYPE

1 -	Cv = 0.02
2 -	Cv = 0.04
3 -	Cv = 0.08
4 -	Cv = 0.09
5 -	Cv = 0.10
6 -	Cv = 0.105
7 -	CV = 0.11

OPTIONS

Blank -	No cables or connectors (0-10 VDC command input)
C -	4-20mA command input
I -	Metric dimensions
N -	No enclosure
Q -	Quick connect receptacles (cables sold separately)

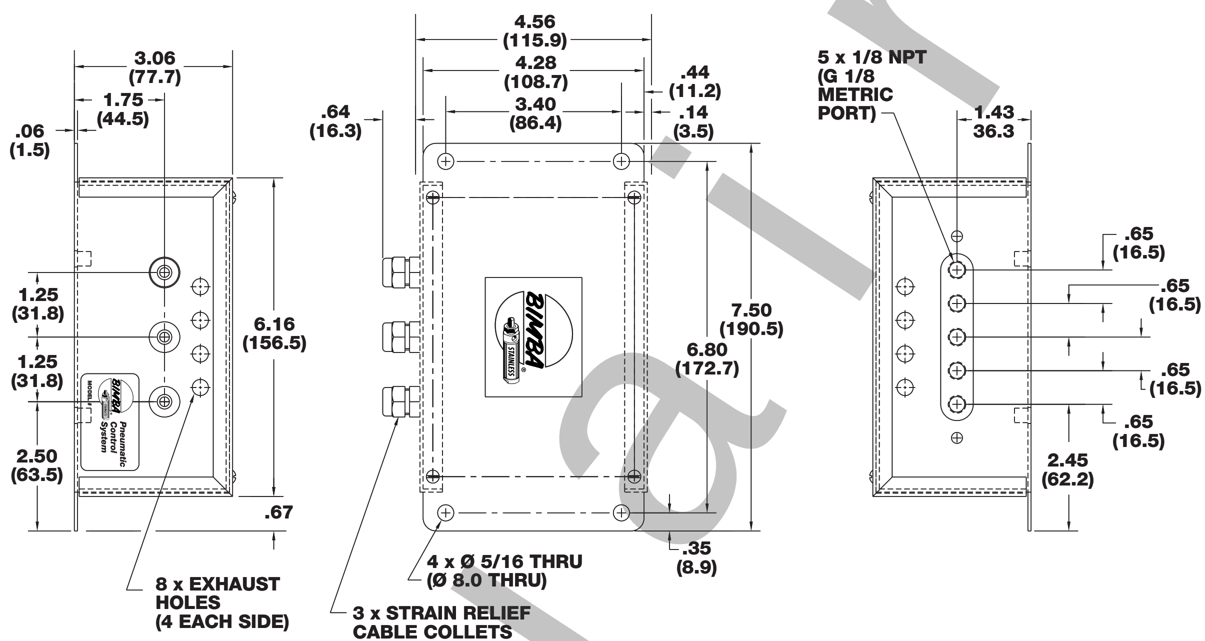
This initial offering covers 1-1/16" (09) through 2" (31) bore size Position Feedback Cylinders. Larger flow PCS Systems are available for the larger bore sizes Refer to TRD Position Control System Product Catalog or contact Bimba for further details. Refer to the Position Feedback Cylinder section (page 7.6) and the Position Feedback Pneu-Turn section (page 7.17) for ordering information regarding either actuator. Ensure that the Position Feedback Cylinder -L option is specified for motion control applications.

*The Cv values are approximated. The velocities for the different systems are shown in the sizing recommendations table.

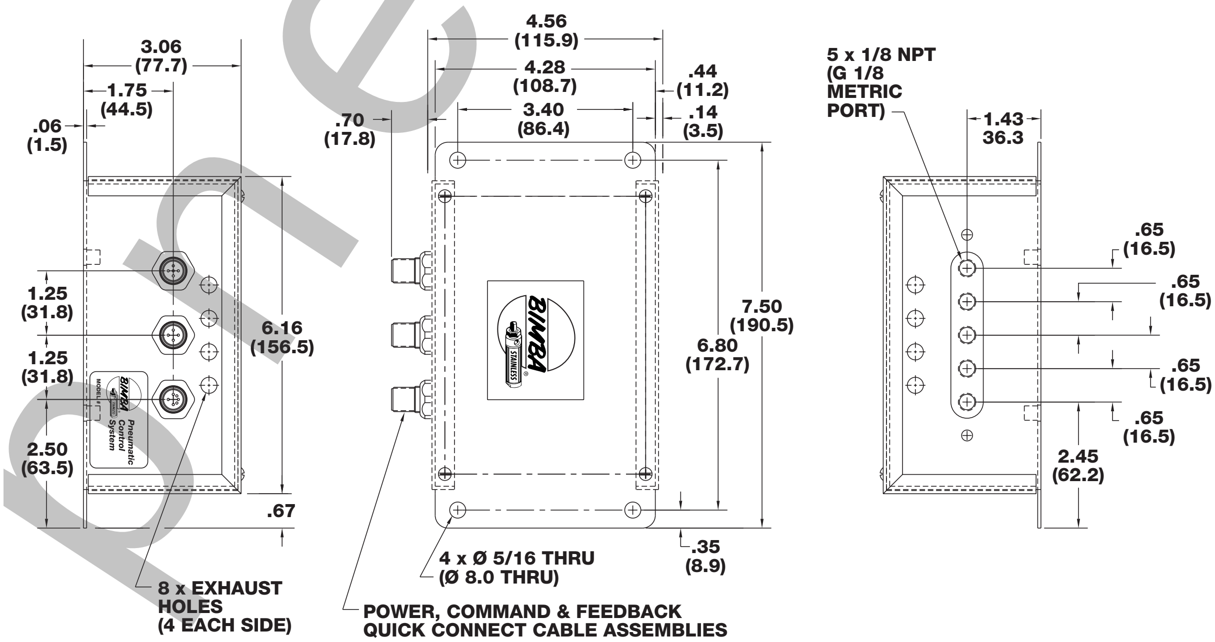
Dimensions

Shown in inches (millimeters)

Enclosure



Option Q (Quick Connect Receptacal)



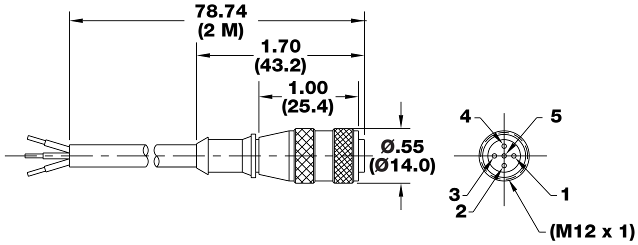
Dimensions

Shown in inches (millimeters)

Quick Connect Cables

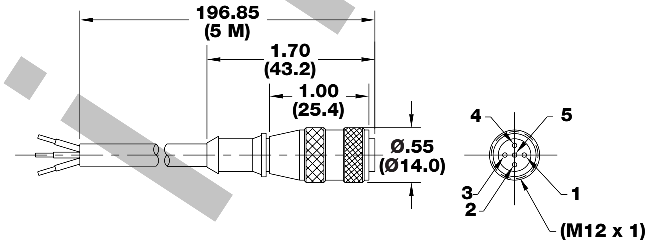
PCS-CBL-PWR

SPECIFICATIONS
5 CONDUCTORS OF 22 AWG LEADS RATED
TO 250 V AT 4 AMPS
SHIELDED



PCS-CBL-PWR-X

SPECIFICATIONS
5 CONDUCTORS OF 22 AWG LEADS RATED
TO 250 V AT 4 AMPS
SHIELDED



PCS-CBL-PWR Wire Color Codes

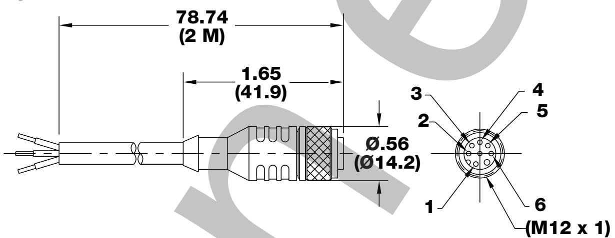
Color	Pin	Description
Brown	1	Positive
White	2	N/C
Blue	3	Negative
Black	4	N/C
Green/ Yellow	5	N/C

PCS-CBL-CMD Wire Color Codes

Color	Pin	Description
Brown	1	Input
White	2	@ Position
Blue	3	Ground
Black	4	Current Position
Grey	5	N/C
Pink	6	N/C

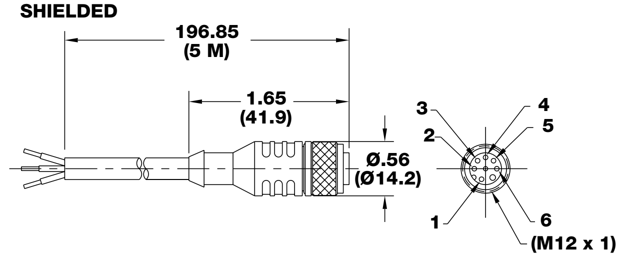
PCS-CBL-CMD

SPECIFICATIONS
6 CONDUCTORS OF 24 AWG LEADS RATED
TO EITHER 30 VAC OR 36 VDC AT 4 AMPS
SHIELDED



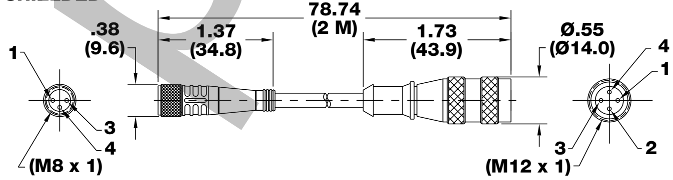
PCS-CBL-CMD-X

SPECIFICATIONS
6 CONDUCTORS OF 24 AWG LEADS RATED
TO EITHER 30 VAC OR 36 VDC AT 4 AMPS
SHIELDED



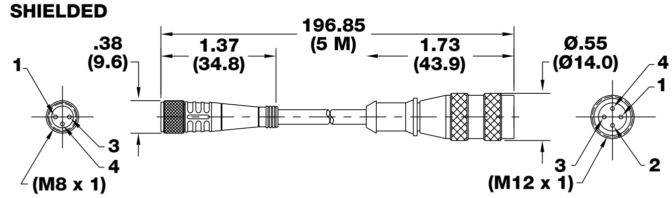
PCS-CBL-FBK

SPECIFICATIONS
3 CONDUCTORS OF 24 AWG LEADS RATED
TO 120 V AT 4 AMPS
SHIELDED



PCS-CBL-FBK-X

SPECIFICATIONS
3 CONDUCTORS OF 24 AWG LEADS RATED
TO 120 V AT 4 AMPS
SHIELDED

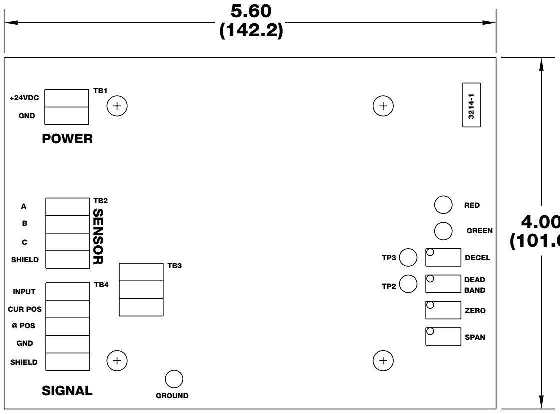


Dimensions

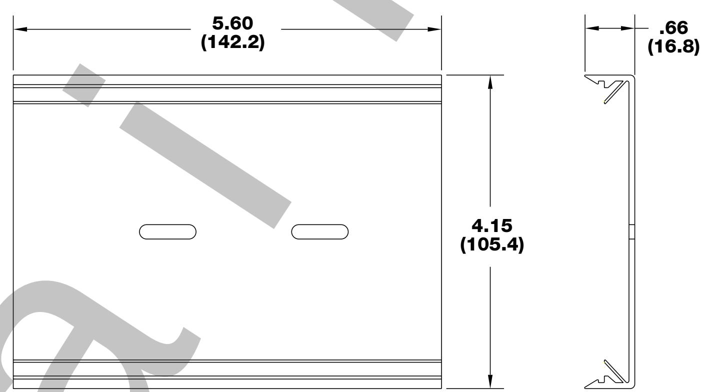
Shown in inches (millimeters)

Option N (No Enclosure) *PCS – 1, 2, 3*

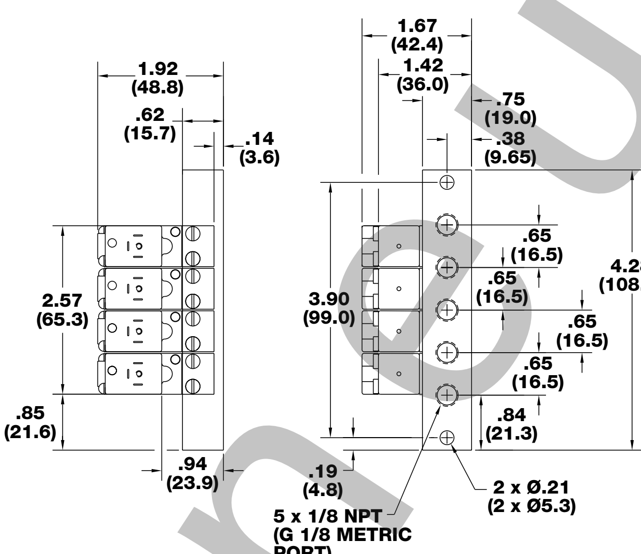
PC Board



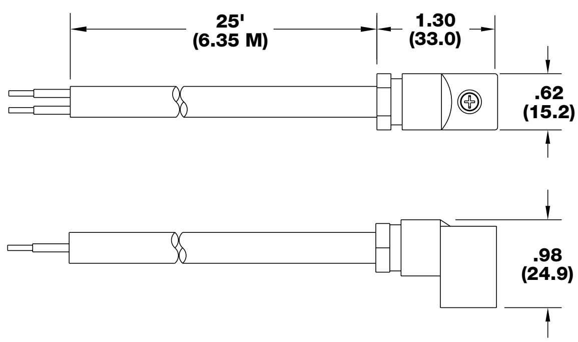
Snap Track



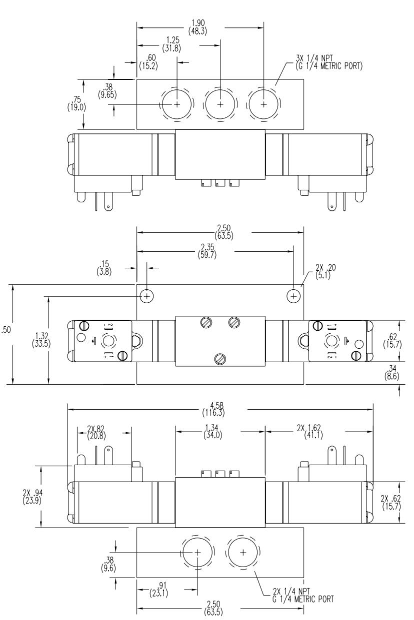
Valve/Manifold



Valve Cable



PCS – 4, 5, 6, 7



Specifications

Description	Specification
Zero Adjustment	50% of total full scale output between both adjustments
Span Adjustment	
DECEL Adjustment	Approximately 0.5 to 13.5 volts
Deadband Adjustment	Approximately 0.005 to 0.500 volts
@ Position	Discrete output that sinks to ground when within deadband zone. **20mA Maximum**
Current Position	0 to 10 VDC signal, 1M ohm input impedence required for input device. Scaled with zero and span adjustments
Operation at Power Loss	All valves close at power loss
Input Supply Voltage	23.5 to 24.5 VDC, 1 amp
Operating Pressure	70 to 80 psig
Air Requirement	Regulated and filtered to 5 micron
Operational Temperature Range	0 to 100 degrees F (Electronics\PC Board)
Reverse Polarity Protected	
Overvoltage Protected	

Application Sizing and "Rules of Thumb"

PFC Cylinder/PCS Valve System Matching and Sizing Recommendations[1]

Bore Size	PCS Model	Stroke Range	Maximum Payload	Average Velocity	Maximum External Friction	Zero Friction Deadband[2]	1/2 Maximum Friction Deadband	Maximum Friction Deadband	Minimum Step[3]
PFC-09 (1-1/16")	PCS-1	2" to 7"	l lb.	2.75 in/sec	zero	±50mV	N/A	N/A	0.080"
PFC-09 (1-1/16")	PCS-1	8" to 24"	30 lbs.	4.00 in/sec	5 lbs.	±40mV	±80mV	±160mV	0.2-0.39"
PFC-17 (1-1/2")	PCS-1	1" to 3"	2 lbs.	2.50 in/sec	zero	±25mV	N/A	N/A	0.040"
PFC-17 (1-1/2")	PCS-2	4" to 24"	50 lbs.	5.50 in/sec	10 lbs.	±20mV	±40mV	±80mV	2 times deadband
PFC-31 (2")	PCS-2	1" to 2"	4 lbs.	2.75 in/sec	zero	±50mV	N/A	N/A	0.020"
PFC-31 (2")	PCS-3	3" to 24"	90 lbs.	6.50 in/sec	20 lbs.	±15mV	±30mV	±60mV	2 times deadband
PFC-50 (2-1/2")	PCS-4	3" to 4"	120 lbs.	2 in/sec	35 lbs.	±90mV	N/A	N/A	2 times deadband
PFC-50 (2-1/2")	PCS-5	5" to 24"	150 lbs.	2.5 in/sec	35 lbs.	±40mV	±60mV	±60mV	2 times deadband
PFC-70 (3")	PCS-6	3" to 4"	200 lbs.	2 in/sec	50 lbs.	±80mV	N/A	N/A	2 times deadband
PFC-70 (3")	PCS-7	5" to 24"	200 lbs.	2 in/sec	50 lbs.	±40mV	±40mV	±60mV	2 times deadband

1 *If your application requires lower velocities or payloads, you may be able to reduce the minimum recommended deadband setting, or if your deadband requirements can accommodate a large range, you may be able to increase your payload higher than the recommended values.*

2 *Note: The following formula can be used to convert the deadband voltage to displacement: w = 0.1(V) x t, where w is the deadband width, V is deadband voltage listed above and t is full scale travel of the actuator. For example: If the deadband is set for 20mV (0.02 of a volt) for a 6 inch stroke cylinder, w = 0.1 (0.02) x 6 = ±0.012 of an inch.*

3 *Minimum step is stroke dependent.*

Application Sizing Cont.

Assumptions used for Sizing Values recommendations:

- Values shown in sizing table are with no overshoot. If overshoot is acceptable for your application, the deadband may possibly be less than specified. However, be sure your system cannot go unstable.
- PFC cylinder with Option L is used. (Option L has very low friction seals. The standard PFC utilizes a rod wiper which increases friction significantly, which will have adverse effects on positioning capabilities).
- 80 psi air supply.
- Minimum of 23.5 VDC provided to the PCS.
- Clean Command Signal for Main Control. (<5mV noise/ripple)
- Leak free system (The system will actually perform well with some system leakage, however, the best performance is with no leakage).
- Short (<18 inches), hard air lines (nylon) between the valves and the actuator.
- No backlash in the system.
- Horizontally guided load. The system can handle vertical or inclined loads and still meet the minimum deadband specified above, however, the velocity may be effected by up to 40%.

Typical “Rules of Thumb”:

- Deviations from the recommended parameters, such as air pressure, power supply voltage, external friction, etc, will negatively effect system performance. However, the system may still perform adequately for your application.
- Applications with loads less than 10% of actuator capacity and strokes greater than 4 inches will yield better repeatability than the minimum deadband shown in the sizing table above.
- Reducing actuator velocity by use of Flow Controls may enable the deadband to be adjusted tighter for a given application. The Flow Controls must be inserted into the exhaust ports of the valve manifold, NOT in the actuator.
- Oversizing the actuator for a given application typically yields better repeatability.
- Generically, following are relative influences on velocity:
  - – As Mass increases, Velocity decreases (up to 20%)
  - – As Friction increases, Velocity decreases (up to 20%)
  - – As Pressure decreases, Velocity decreases (up to 20%)
- Increased Friction decreases repeatability. Maximum external friction should not exceed 20% of the maximum rated payload. Any external friction in the application will degrade system performance. Ensure the system is aligned properly to any guiding systems. Misalignment will cause external application friction.
- A borderline solution can be effective through any/all of the following:
  - – sacrificing performance in one area for another,
  - – limiting velocity with external flow controls,
  - – employing a small central portion of a longer probe,
  - – using a larger bore cylinder.
- The PCS system is not suited for applications where accurate velocity control is needed by controlling the rate of command signal change. Flow controls can be used if lower velocities are required.

⚠ *Do not allow the PCS valves to stay on for prolonged time periods unless the valves are well ventilated, as they may overheat potentially causing damage to the valves.*

Application Sizing

PTF Cylinder and PCS Valve System Matching and Sizing Recommendations

Single Rack Model

PTF Single Rack Models Valve Sizing Recommendations						
Bore	Valve	Rotation	Minimal Deadband	Maximum Torque	Average Velocity	Minimum Step
1-1/2"	PCS-1	45° - 325°	28 mV	27 in.-lb.	150° per sec.	2 times deadband
2"	PCS-2	45° - 325°	28 mV	70 in. - lbs.	150° per sec.	2 times deadband

Double Rack Model

PTF Double Rack Models Valve Sizing Recommendations						
Bore	Valve	Rotation	Minimal Deadband	Maximum Torque	Average Velocity	Minimum Step
1-1/2"	PCS-2	45° - 325°	28 mV	55 in.-lb.	150° per sec.	2 times deadband
2"	PCS-3	45° - 325°	28 mV	135 in. - lbs.	150° per sec.	2 times deadband

If your application requires lower velocities or payloads, you may be able to reduce the minimum recommended deadband setting, or if your deadband requirements can accommodate a large range, you may be able to increase your payload higher than the recommended values.

**Testing was performed with an offset load in a vertical direction. Performance will improve with a balanced payload and the plane of motion is horizontal.

Deadband voltage conversion to shaft displacement

- The following formula can be used to convert the deadband voltage to displacement:

w = 1/10V * t , where w = deadband width, V = voltage reading from the PCS, t = full scale travel of the actuator (Note: for PTF rotary actuators with total rotation less than 180° always make t = 180)

Example: If the deadband is set for 30mV (0.03 of a volt) for a 180° actuator, the width of the deadband zone will be 1/10 * .028 * 180 = ±0.50°.

Specification Comments

- PTF Feedback signal 0 to 10 VDC only.
- Bearing Loads - Maximum Axial and Radial loads are identical to the standard Pneu-Turn with the ball bearing option.
- Maximum Allowable Kinetic Energy is identical to the standard Pneu-Turn with Cushions.
- Refer to the PCS New Product Bulletin for additional PTF performance information.

Application

Example

The following section will review two examples, one example shows a PFC application, and the second example shows a PTF rotary example.

PFC Example

Let's say we have just finished the installation procedure for a Bimba PFC Cylinder with 10 inches of stroke, and are using a 0-10 VDC input command signal. There is a retracted hard stop at 1.5 inches of cylinder stroke and an extended hard stop at the 9.0 inches of cylinder stroke.

Therefore:

- After adjusting the Span setting, 10 volts is equivalent to 9.0 inches of cylinder rod extension.
- After adjusting the Zero setting, 1.5 inches of cylinder rod extension will equal 0 volts.

Therefore, 0 to 10 volts covers the 7.5 inch (9.0" - 1.5") range of motion .

Using the following formula:

The command signal can be translated into actuator displacement with the following formula:

CS = d * R / t + Z

where:

CS	=	the command signal required to achieve a desired position
d	=	the displacement the desired position is from the zero position
R	=	the full range of the command signal
t	=	full scale travel of the actuator (Note: for PTF rotary actuators with total rotation less than 180° always make t = 180)
Z	=	the command signal for the zero position

Position Feedback Cylinders
Position Feedback Cylinder Rod Lock
Position Feedback Cylinder Accessories
Position Feedback Pneu-Turn
Position Control System
Digital Panel Meter
Electronic Controller
PFC/PCS Application Checklist

Application

To command the PFC to go to a position that is 2.0 inches extended from the retracted hard stop, the command signal would be calculated as follows:

CS = 2 x 10/7.5 + 0 = 2.667 VDC Command Input Signal

If a 4-20 mA signal is used, the command input signal would be calculated as follows:

CS = 2 x 16/7.5 + 4 = 8.267 mA Command Input Signal

Note: The positional repeatability of the system will be determined by the Deadband adjustment. If the deadband was adjusted to +\– 20mV in this example, the system would position to the 2 inch position within +\– 0.015" (w =0.1 (V) * t).

PTF Example

Let's say we have just finished the installation procedure for a Bimba PTF Rotary actuator with 200 degrees of rotation, and a 0-10 VDC command input signal. There is a zero rotational hard stop at 10 degrees of rotation and a full scale rotational hard stop at 190 degrees of rotation.

Therefore:

• After adjusting the Span setting, 10 volts is equivalent to 190 degrees of rotation.

• After adjusting the Zero setting, 10 degrees of rotation will equal 0 volts.

Therefore, 0 to 10 volts covers 180 degrees (190 - 10) of motion .

To command the actuator shaft to rotate to a position that is 45 degrees rotated from the zero hard stop, the command voltage would be calculated as follows:

CS = 45 x 10/180 + 0 = 2.50 VDC Input Command Signal

If a 4-20 mA input command signal is used, the command input would be calculated as follows:

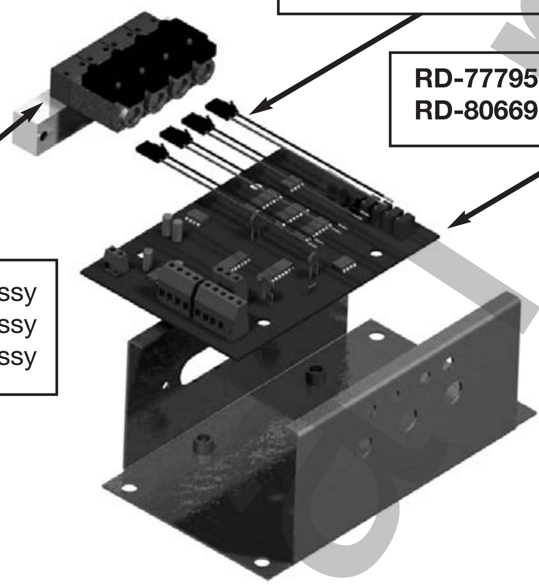
CS = 45 x 16/180 + 4 = 8 mA Command Input Signal

Note: The positional repeatability of the system will be determined by the Deadband adjustment. If the deadband was adjusted to +\– 20mV in this example, the system would position to the 45 degree position within +\– 0.36 degrees (w = 0.1 (V) * t).

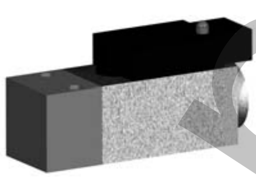
PCS Repair Parts Breakdown

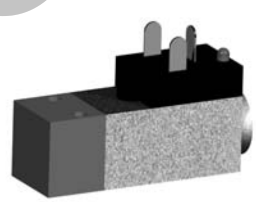
RD-82635: GRN/BLK Electronic Wire Harness
RD-82636: RED/BLK Electronic Wire Harness

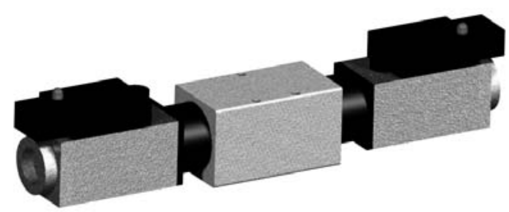
RD-77795: PCS-1 thru PCS-3 PC Board
RD-80669: PCS-4 thru PCS-8 PC Board



RD-82480: PCS-1 Valve Manifold Assy
RD-82481: PCS-2 Valve Manifold Assy
RD-82482: PCS-3 Valve Manifold Assy







RD-78913: PCS-1 Std Valve
RD-78915: PCS-2 Std Valve
RD-78917: PDCS Std Valve

RD-78914: PCS-1 DIN Valve
RD-78916: PCS-2 DIN Valve
RD-78918: PDCS DIN Valve

RD-80670: PCS-4 Thru PCS-8 Std. Valve Assy

Note: *The PCS-4 thru PCS-8 systems use the same valve, the difference is the orifice sizes in the manifold.*

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