SPCS-1
Servo Pneumatic Control System

User's Guide

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Warnings & Notices

WARNING:

Installation and operation of electric and high pressure systems (fluids and compressed gas) involves risk including property damage and personal injury or death.

Installers and users should be properly trained or certified and take safety precautions. This product may cause death, personal injury, or property damage if improperly used or installed.

The information in this document and other information from Bimba Mfg. and its authorized representatives are intended for use by persons having technical expertise in selecting and using these products. Product owners ("you") should analyze all technical and safety requirements of your specific application, including the consequences of any possible failure, before selecting a product. This product may not be suitable for all applications, such as those acting upon people. Suitability is solely your responsibility. Because the requirements for each application may vary considerably, you are solely responsible for conducting any testing or analysis that may be required to determine the suitability of the product for your application, and to ensure that all performance, safety and warning requirements for your application are met.

Caution:

While the product is low voltage, it contains open-frame electronic components and care should be taken to prevent un-intentional contact with the product to avoid damage to person or property.

Notice:

Use and purchase of this product is subject to Bimba Mfg. Terms and Conditions of Sale and Use. Improper installation or use voids warranty. Consult factory regarding special applications. Specifications are subject to change. Reasonable efforts have been made to provide useful and correct information in this document, but this document may contain errors and omissions, and it is subject to change.

Contact: Bimba Manufacturing Customer Support 800-44-Bimba or cs@bimba.com or your local Bimba distributor for additional information.

Warranty: This product is covered by a 1 year Bimba Mfg. limited warranty. Use without a coalescing filter voids the warranty. Contact Bimba Mfg. or visit website for more details.

Notice: Use and purchase of this product is subject to Bimba Manufacturing - Terms and Conditions of Sale and Use. Improper installation or use voids warranty. This product may not be suitable for all applications, such as those acting upon people, and suitability is solely the buyer's responsibility. Consult factory regarding special applications.

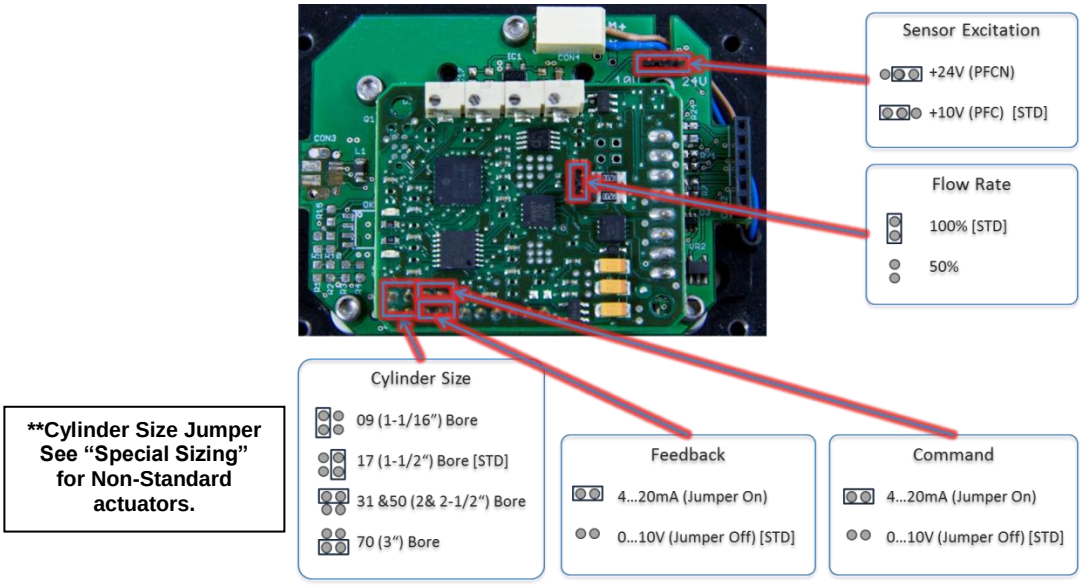
Quick Start Procedure

General Note: Low friction system design provides the best performance. With any pneumatic positioning system there are operational trade-offs. This means that the positioning accuracy that can be achieved is a function of the size of the load being moved, the velocity (in/sec) it is being moved at and the amount of friction present in the system.

System requirement:

- 0.3 µm Coalescing filter
- 0.5 µm particulate filter
- 3/8" O.D. tubing
- Signal generator or Oscilloscope
- A Bimba position feedback cylinder with Low Friction seals (Option L) Lower is recommended to maximize positioning performance.

1) Shut-off the power and air supply
2) Configure Jumpers (See diagram below)
    a. Configure the "**Sensor Excitation**" jumper based upon the Bimba position feedback cylinder being used. The Default position is for a Bimba PFC cylinder that requires +10V. Set to 24V for a Bimba PFCN.
    b. Configure the "**Flow Rate"** jumper for either 100% or 50% flow. Default position is 100% flow.
    c. Configure the "**Command"** signal jumper to the command signal your electronics will supply. Selections; 0-10VDC or 4-20mA. Default is 0-10V.
    d. Configure the "**Feedback"** signal jumper to select the feedback signal required by your electronics. Selections; 10VDC or 4-20mA feedback. Default is 0-10V.
    e. Configure the "**Cylinder Size"** jumper to select the bore size being used. Default value is 1-1/2" (17) bore. Use the "Cylinder Size" diagram below to select and adjust the jumper to the cylinder being used. A Load versus Velocity performance chart is located on page 8 of this manual.



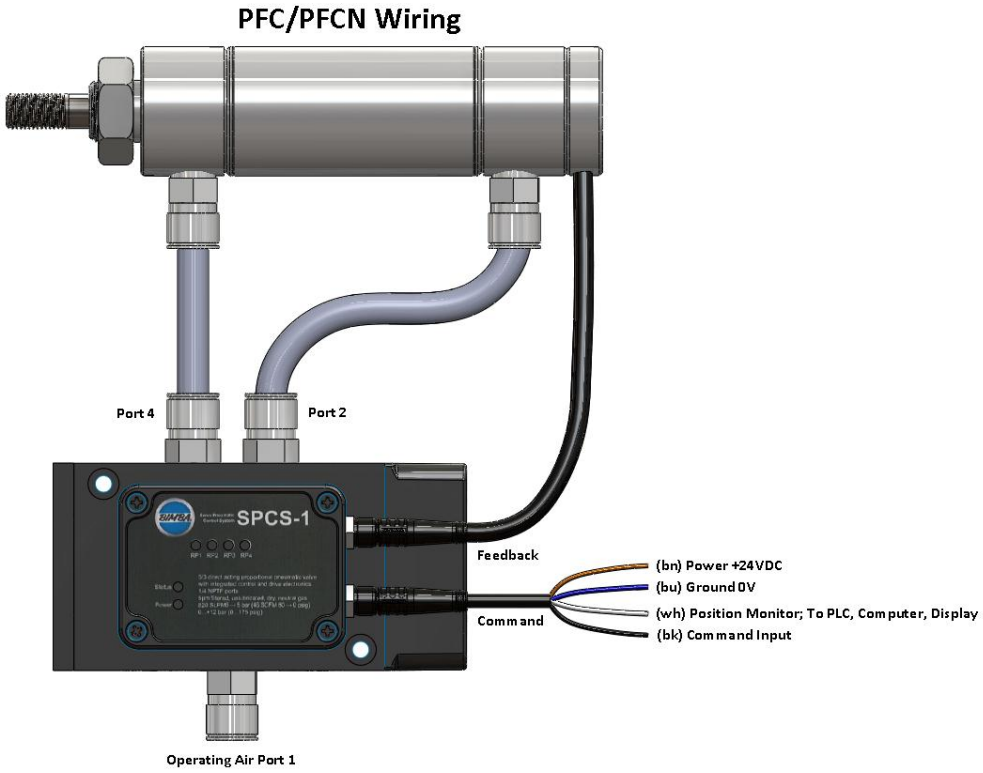
3) Wire Feedback
    a. For 4…20mA signals: 4mA should correspond to the cylinder fully retracted and 20mA should correspond to the cylinder fully extended. Also, for 4…20mA signals, low side should connect to ground.
    b. For 0…10V signals: 0V should correspond to the cylinder fully retracted and 10V should correspond to the cylinder fully extended

4) Connect Pneumatic Lines
    a. Connect port 2 of the SPCS-1 to the back of the cylinder and port 4 to the front as shown in "System Setup" Page 4
    (3/8" O.D. tubing – 10' or less length is recommended to prevent performance loss)
    b. Inlet air should be dry (-40F dew point) non-lubricated air, non-flammable & non-corrosive dry gases (0.3 micron fine grade coalescing filter with 5 micron pre-filter) at 0-150psig.
    c. Connect Inlet air to Port 1

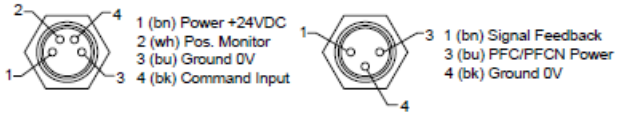
5) Tune System
    a. Restore potentiometers to factory default settings. See "Recommended Tuning Method" page 6
    b. Tune System According to "Recommended Tuning Method" page 6

6) Troubleshooting
    a. See "Troubleshooting" Page 8
    b. Contact Bimba Mfg. for additional help

System Setup



Power/Command & Feedback Connectors



Factory Default Setting

Potentiometer	Factory Default Condition	Setting
RP1 - Responsiveness	11 Turns CCW	Responsiveness gain is zero
RP2 - Speed Damping	11 Turns CCW	Speed Damping gain is zero
RP3 - Force Damping	11 Turns CCW	Force Damping gain is zero
RP4 - Offset	Centered (Status LED on)	Offset is zero

**Potentiometers do not bottom out.

LED	On	Off
Power LED	Power is On	Power is Off
Status LED	Offset ≈ 0 (RP4 is centered)	0ffset ≠ 0

Special Sizing

The "Cylinder Size" jumper provides valve operation based upon the area of the cylinder being controlled. Use the following calculation to identify the appropriate jumper position for non-standard cylinders.

Cylinder Area Ratio = (Bore Diameter^2 - Rod Diameter^2) / (Bore Diameter^2)

Jumper	Bore	Cylinder Area Ratio
	**09 (1-1/16")**	**.88**
	**17 (1-1/2")**	**.905 (Default)**
	**31 & 50 (2 & 2-1/2")**	**.9375**
	**70 (3")**	**1**

Potentiometers/Tuning

The SPCS-1 has 4 potentiometers (Responsiveness, Speed Damping, Force Damping, and Offset) which allow for maximum flexibility. A polymer non-conductive screwdriver is the preferred method for adjusting the potentiometers. Care should be taken not to allow metal screwdrivers to touch other components on the board.

Increase or Decrease Responsiveness (RP1) –By adjusting RP1, the user can adjust the responsiveness of the pneumatic cylinder to changes in command or feedback. The responsiveness of the cylinder can be increased or decreased by turning RP1 clockwise or counterclockwise, respectively. A responsiveness that is too low can result in an unresponsive system while a responsiveness that is too high can cause the system to become unstable..

1) **Increase or Decrease Speed Damping (Avoids Overshoot) (RP2)** – By adjusting RP2, the user can set the speed damping applied to the system. This damping can be increased or decreased by turning RP2 clockwise or counterclockwise, respectively. Speed damping helps reduce overshoot and smooth's out system performance. However, too much speed damping can cause the system to undershoot and "creep" into the target position or become unstable.

2) **Increase or Decrease Force Damping (RP3)** – By adjusting RP3, the user can set force damping applied to the system. Damping can be increased or decreased by turning RP3 clockwise or counterclockwise, respectively. Force Damping helps increase the stability of the system. Too little force damping can result in an oscillatory system while too much damping can result in an unresponsive system, resulting in steady state error.

3) **Centered Offset -** By adjusting RP4, the user can set the centered offset of the system. Centered offset is used when the cylinder is mounted vertically to create symmetrical or balanced motion. If the cylinder is facing "rod up", the offset should be increased. When a cylinder is facing down the offset should be decreased to create symmetrical or balanced motion. The offset can be increased or decreased by turning RP4 clockwise or counterclockwise, respectively.

Recommended Tuning Method

General

- **Assure safety – no pinch points**
- **Tune with no load first**

Return SPCS-1 to Factory Defaults

1) With power and operating air off.
2) Turn RP1, RP2 and RP3 fully counterclockwise. Make sure to go at least 11 full turns. (FYI these pots do not have "bottoming out" indication).
3) Provide power to the controller.
4) Adjust RP4 until green LED is on. (center position)

Tuning

1) Turn on air to the SPCS-1.
2) Provide a continuously varying command signal to the SPCS-1. A 0.5Hz square wave would be ideal.
3) Turn RP3 – Force Damping - 3 turns (CW)
4) Turn RP1 – Responsiveness - clockwise slowly. The system should begin to move. If the system does not move or freezes in a fully retracted or extended position consult the system setup diagram to assure that the SPCS is set for the correct cylinder and wired correctly.
5) Once the system begins to follow the command signal, continue increasing RP1 until maximum velocity is achieved, the cylinder rod begins to oscillate or overshoot occurs.
6) Adjust RP3 - Force Damping - clockwise until oscillation stops.
7) Adjust RP2 – Speed Damping - until overshoot is removed.
8) Repeat steps 5 thru 7 as necessary, until the system exhibits the desired dynamics.
9) To optimize system performance, slowly decrease RP3 -force damping- and increase RP2 -speed damping- until optimum system performance is reached.
10) If the motion is asymmetrical, RP4 –offset- can be adjusted to compensate.

Maximum Moving Mass

The table below recommends the maximum moving mass controlled by a SPCS-1 for horizontal and vertical applications. Actual mass will vary based on cylinder speed and mechanical assembly (e.g. friction in cylinder or system, air pressure, etc.)

Linear Cylinder
Horizontal Applications

Bore Size	Average Velocity Without Overshoot @ Max Payload [in/sec]	Maximum Payload [lbs.]	Average Velocity @ 50% Max Payload [in/sec]	Average Velocity @ 25% Max Payload [in/sec]
09	20	50	20	30
17	10	100	20	30
31	15	200	20	30
50	15	315	25	30
70	15	450	20	20

Linear Cylinder
Vertical Applications

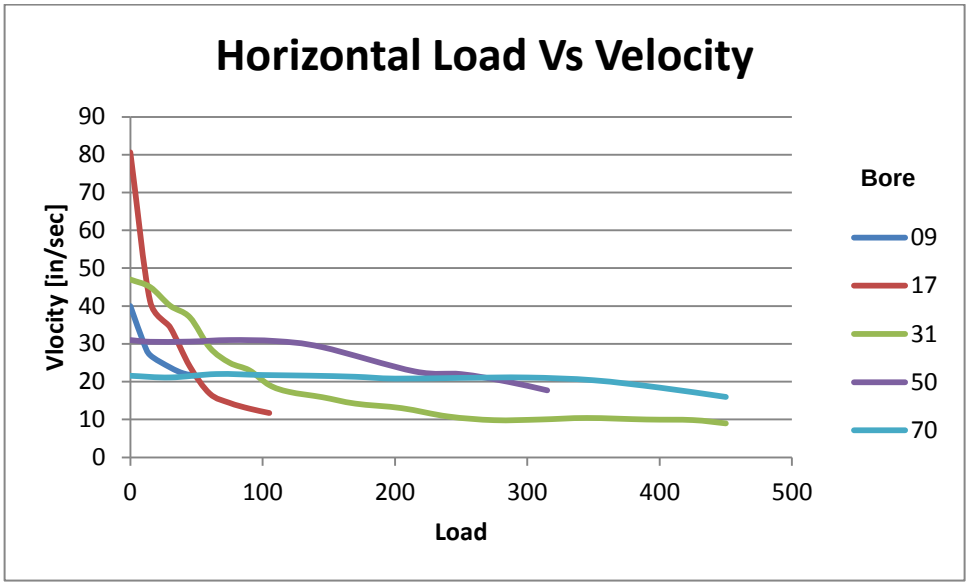
Bore Size	Average Velocity Without Overshoot @ Max Payload [in/sec]	Maximum Payload [lbs.]	Average Velocity @ 50% Max Payload [in/sec]	Average Velocity @ 25% Max Payload [in/sec]
09	70	5	100	100
17	70	10	60	60
31	50	30	40	60
50	15	95	30	30
70	20	135	20	20

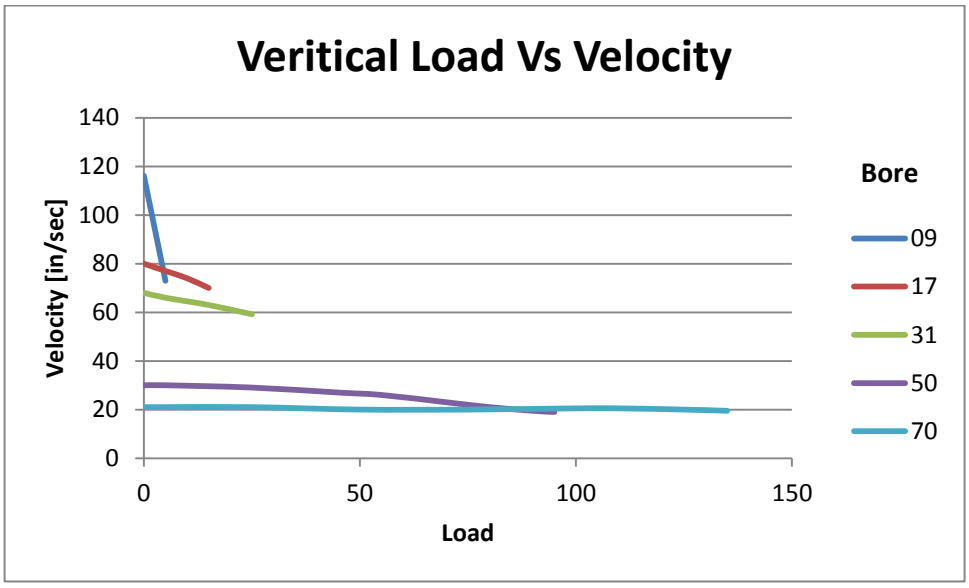
Rotary Actuator

Rack and Pinion - Single Rack			
Bore Size	**Rotation**	**Average Velocity**	**Max Torque**
1-1/2"	0 to 360°	150° per second	30 in/lb.
2"	0 to 360°	150° per second	84 in/lb.

Rack and Pinion - Double Rack			
Bore Size	**Rotation**	**Average Velocity**	**Max Torque**
1-1/2"	0 to 360°	150° per second	60 in/lb.
2"	0 to 360°	150° per second	144 in/lb.

Performance Graphs





Troubleshooting

Symptom	Probable Causes	Corrective Action
System Totally Unresponsive	Power Not Applied	Apply power, check all power wiring
	Air Off	Turn air on
	Speed Damping too High	Increase Responsiveness (RP1) or Decrease Damping RP2 or RP3
	Inverted Polarity	Verify signal wiring for command and feedback; also verfiy mechanical system polarity
	Signal Wiring	Verify all Wiring
System Mildly Responsive or Sluggish	Speed Damping too Low	Increase Speed Damping (RP1)
	Force Damping Gain too High	Decrease Force Damping (RP3)
	Power Supply Voltage not Stable	Check power wiring; change power supply
	Cylinder too Small	Decrease moving mass, increase cylinder size, or increase inlet pressure.
System Freezes Fully Extended or Retracted	No Feedback Signal	Connect Feedback Signal
	Feedback Connected Improperly	Verify all wiring is as shown in application examples and as described in the "System Setup" section of this document
	Cylinder Connected Improperly	Verify airline connections
System Fails to Operate or is Inaccurate	Incorrect Wiring	Verify all wiring is as shown in the System Setup section of this document
	Mechanical System	Insure mechanical system is free from binding and high friction.
	Speed Damping too Low	Increase Speed Damping (RP1)
	Force Damping too high	Decrease Force Damping Gain (RP3)
	Offset Gain Adjusted incorrectly	Adjust offset gain (RP4)
	Wrong Bore Size	Set jumper for correct bore size. See Jumpers Section.
	Air Leaks	Insure there are no air leaks in the system
	SPCS-1 Sticking	Insure that inlet air meets valve specifications. See "System Setup" – Contact Bimba
System Oscillates	Not Enough Force Damping	Increase Force Damping (RP3)
	Reponsiveness too High	Decrease Responsiveness (RP1)
System Overshoots	Speed Damping too Low	Increase Speed Damping. (RP2)
System 'Buzzes'	Input Signal Noise (possibly 60Hz)	Verify that large or high power machinery is not operating nearby. Also, verify input signal integrity by examining the signal with an oscilloscope.
	Input Signals not connected	Verify all wiring as shown in the "System Setup" section of this document
	DC Common not connected	Verify all DC common connections
High Pitched Tone (Dither) or Whine from SPCS-1	Dither	Dither is built-in" and is intended to keep the electro-mechanical device in constant motion.
Power/Status Light Blinks	System Shutdown	Reset by disconnecting power to reset the SPCS – then re-tune the SPCS

Technical Data

Mechanical Specifications
Pressure: 0 – 150 psig (0 – 10 bar) Un-lubricated, Dry, Neutral Gas
Ports: 1/4" NPT
Connector: 4-pin M8 x 1 (male) and 3-pin M8 x1 (male)
Mounting: 2 x 10-32 thru Holes
Temperature Range: 32°F- 104°F (0°C - 40°C)
Filtration: 5 µm particulate 0.3µm coalescing
Weight: 2.0Lbs. (0.91 kg)
Body: Aluminum 6061
Performance
Position Accuracy: +- 1% of full stroke
Repeatability: 3mV
Flow: 46 SCFM @ 80 psig (820 SLPM @ 6 bar)
Leak Rate: 12 SCFM @ 150 psig (5.7 SLPM @ 10 bar)
Electrical Specifications
Power: 24 VDC nominal @ 20W
Command Input Impedance: 100kΩ
Feedback Input Impedance: 100kΩ
Command Input: Configurable 0…10 VDC; 4…20mA
Feedback Input: Configurable 0…10 VDC; 4…20mA
Excitation: +10V (15mA max)