# BIMBA

# POSITION FEEDBACK CYLINDER

# LRT CONTROLLER MANUAL


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Form CONT-699

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# Table of Contents

# I. GENERAL INFORMATION

The control unit uses position feedback information provided by the position sensor installed within a PFC cylinder to direct its output action(s). The position sensor is basically a linear potentiometer. When a DC potential is applied, a voltage relative to piston position is created. This voltage provides the necessary information for system operation.

There are six different controllers available (see FIGURE 1). Each controller offers two similar relay outputs whose on/off points are adjustable to meet different application needs. Also, each of the controllers provides a specific scalable analog output. Each of the controller's actions are discussed in greater detail later in this manual.

| MODEL NUMBER | INPUT POWER | SCALABLE OUTPUT |
|---|---|---|
| 120AC4-20mA | 120 VAC (60 HZ) | 4 - 20 mA |
| 120AC0-10DC | 120 VAC (60 HZ) | 0 - 10 VDC |
| 12/24DC4-20mA | 12-24 VDC | 4 - 20 mA |
| 12/24DC0-10DC | 12-24 VDC | 0 - 10 VDC |
| 230AC4-20mA | 220-240 VAC (50-60 HZ) | 4 - 20 mA |
| 230AC0-10DC | 220-240 VAC (50-60 HZ) | 0 - 10 VDC |

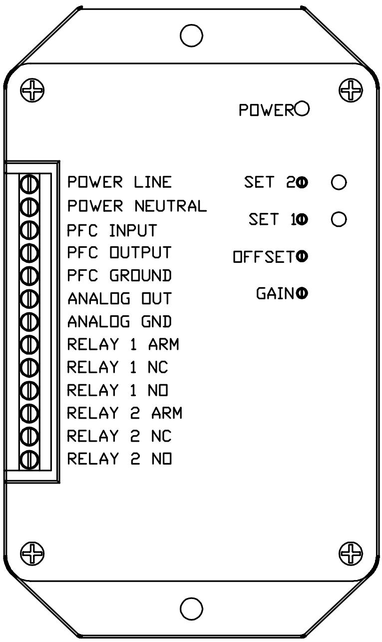
FIGURE 1
BIMBA CONTROLLERS

# II. RELAY OPERATION

Each control unit is equipped with two adjustable outputs that function as adjustable limit switches. If more than two outputs are needed, as many as three units may be slaved off of one master unit.

## A. Standard Installation

Standard electrical hookup for each dual output unit is illustrated in FIGURE 2.




| Wire Colors | | |
|---|---|---|
| Wires | 6" Leads | 3 Pin Connector |
| PFC Input | Red | Blue |
| PFC Output | White | Brown |
| PFC Ground | Black | Black |

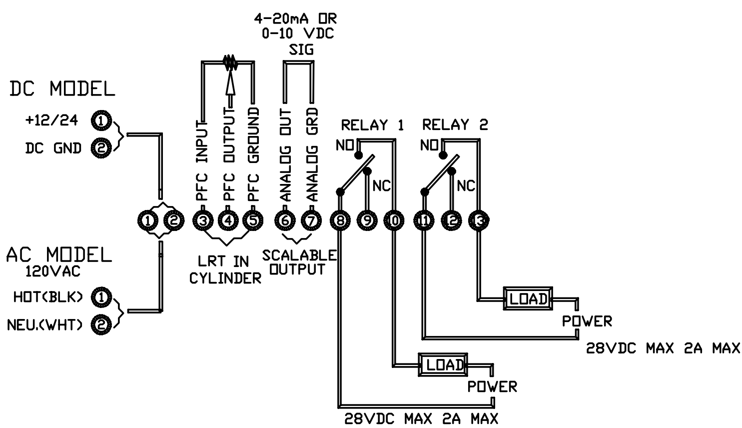



FIGURE 2
PIN LAYOUT

Standard electrical hookup produces standard output operation. FIGURE 3 illustrates ideal voltage output versus cylinder travel and the corresponding output actions. Notice that the analog output is minimum when the cylinder is fully retracted and increases as the cylinder is extended. This is standard output action. For an in-depth discussion of the effects that Jumper J1 (Latching Jumper) has on the output operation, refer to Section II B of this manual.

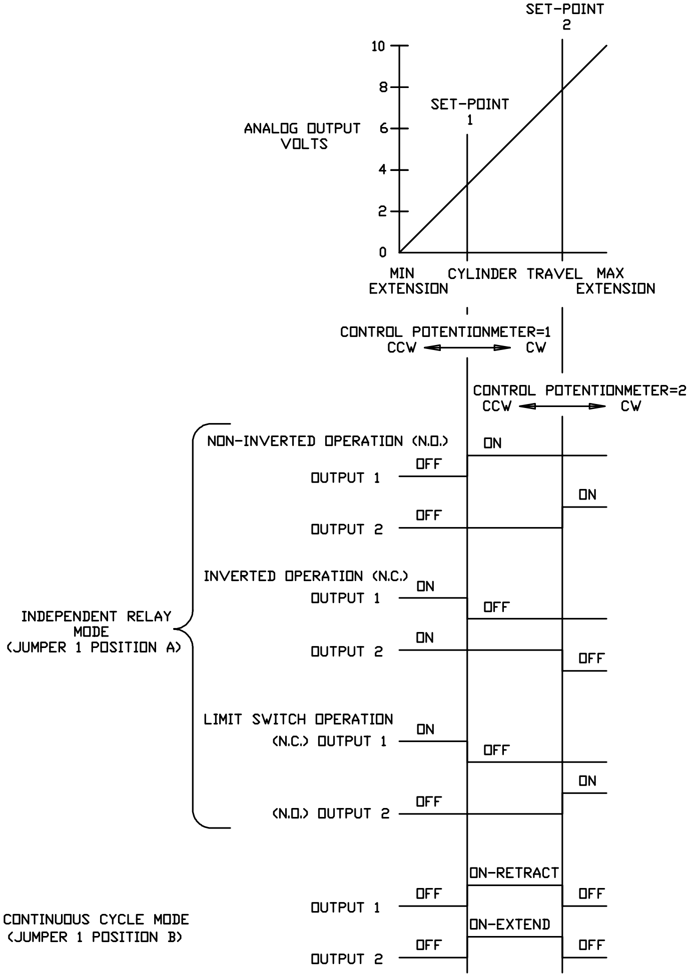



FIGURE 3
OUTPUT CONFIGURATIONS

NOTE: Outputs 1 and 2 are adjustable along the full range of cylinder movement and Set Point 1 can be adjusted beyond Set Point 2. If the Continuous Cycle Mode is used, Set Point 2 must be adjusted beyond Set Point 1 as in FIGURE 3.

## B. Operating Mode Configurations

1. Independent Relay Mode

The standard operation of a dual output unit is the Independent Relay Mode.

a. Non-inverted Operation
b. Inverted Operation
c. Limit Switch Operation

a. Non-inverted Operation

To implement—install load to Normally Open (NO) side of the relays. Terminal 10 for Relay 1 and Terminal 13 for Relay 2. Terminal configuration is shown in FIGURE 2. When the load is connected to the (NO) sides of the relays, the output will turn on when the analog output is greater than its set point and turn off as the analog output drops below the set point (see FIGURE 3).

b. Inverted Operation

To implement—install load to Normally Closed (NC) side of the relays. Terminal 9 for Relay 1 and Terminal 12 for Relay 2.

When the load is connected to the NC sides of the relays, the output will turn off when the analog output is greater than its set point and turn on as the analog output drops below the set point. (See FIGURE 3)

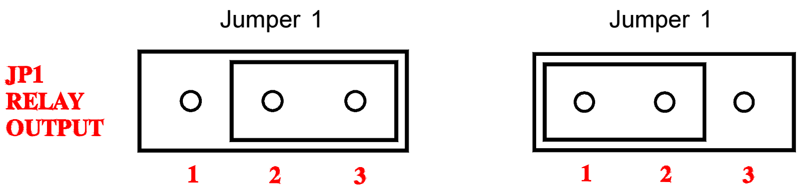
c. Limit Switch Operation

To implement—load must be installed to one Normally Closed (NC) Relay lead and one Normally Open (NO) Relay lead. Use Terminal 9 for Relay 1; Set Point 1 and Terminal 13 for Relay 2; Set Point 2. (Terminal configuration is shown in FIGURE 2). This arrangement turns on Relay 1 when the analog output is less than Set Point 1 and turns on Relay 2 when the Analog Output is greater than Set Point 2. This is traditionally the information provided by a set of limit switches.

As indicated in FIGURE 4, the Independent Relay Mode of operation is factory enabled with Jumper 1 in Position A.

To change the operation of the controller, the following procedures should be followed. Jumper 1 is located on the bottom side of the circuit board. The jumper can be accessed by removing all four corner screws of the controller. At this point, the cover and circuit board should come out of the base. Turn the cover and circuit board over so that the bottom of the circuit board is visible. It should look like Figure 5. The jumper can be moved into Position A or B by pulling up on the black jumper and placing it over the appropriate pins.

When the jumper is located in the desired position, place the circuit board and cover back into the base and tighten all four corner screws.




POSITION A
INDEPENDENT RELAY MODE

POSITION B
CONTINUOUS CYCLE MODE

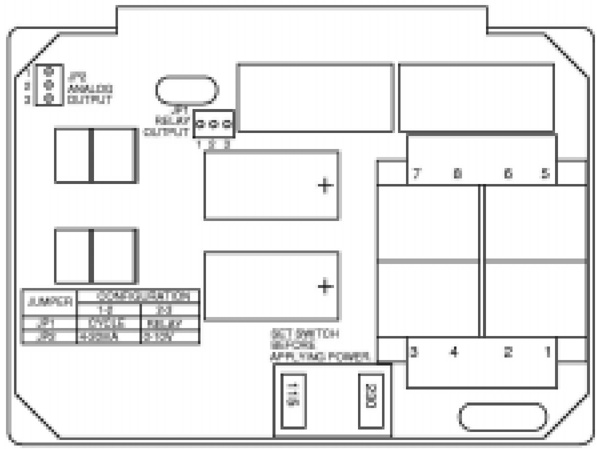
FIGURE 4
OPERATING MODE SELECTION

2. Continuous Cycle Mode

To activate the Continuous Cycle Mode, move Jumper 1 to Position B (see FIGURE 4). This enables the Continuous Cycle Mode and disables the Independent Relay Mode.

As one output turns on, the other turns off and vice-versa. (See FIGURE 3) This mode of operation allows for continuous cycling of a cylinder between two adjustable limits. Set Point 1 control potentiometer is used to set the inner limit and Set Point 2 control potentiometer is used to set the outer limit. Set Point 1 must be less than Set Point 2.

In this mode of operation, the load is connected to the Normally Open (NO) side of the relays; pins 10 and 13 in FIGURE 2. This means an output is turned on as the analog output is greater than its set point and turned off as the analog output drops below its set point.




SCALE = 1:1

FIGURE 5
CIRCUIT LAYOUT

### C. Setting the Switch Points of Output

At this point make sure all electrical connections have been made properly and apply power to the controller. Each controller has the same controls and uses the same set-up procedure. To set the output 1 switch point:

1. Turn Set Point potentiometer 1 (Set 1) fully counterclockwise.
2. Move the piston to the position where output 1 should switch on and off.
3. Observe Set Point 1 LED.
4. Rotate Set Point potentiometer 1 (Set 1) clockwise until Set Point 1 LED just changes state (on to off or vice-versa).

Follow the same procedure (using Set Point 2 controls) to set the switch point of output 2.

1. Turn Set Point potentiometer 2 (Set 2) fully clockwise.
2. Move the piston to the position where output 2 should switch on and off.
3. Observe Set Point 2 LED.
4. Rotate Set Point potentiometer 2 (Set 2) counterclockwise until Set Point 2 LED just changes state (on to off or vice-versa).

## III. SCALABLE OUTPUT

There are two different output types: OV to +10V and 4mA to 20mA. Each type is available with AC or DC power input. Each output is scalable. For detailed information on scaling, refer to Section III B.

### A. Output Boundaries and Actions

Standard output operation produces minimum analog output at minimum cylinder extension and maximum analog output at maximum extension. FIGURE 6 plots ideal analog output versus cylinder extension.

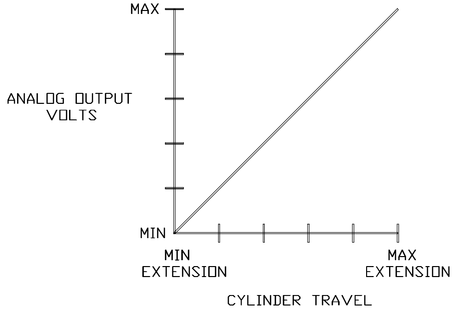



FIGURE 6
STANDARD ANALOG OUTPUT

For some applications it may be desirable to reverse this operation and have maximum analog output at minimum extension and minimum output at maximum extension. This can be achieved by switching the wires at Terminals 3 and 5 of the control unit as shown before in FIGURE 2.

The resulting output action is opposite from standard (FIGURE 6). FIGURE 7 illustrates this reversed output action.

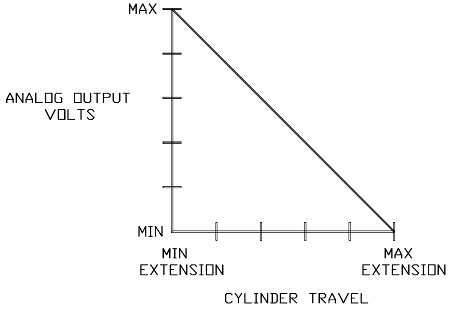



FIGURE 7
REVERSED ANALOG OUTPUT

## B. Scaling the Output

Scaling is a feature that allows a unit’s output boundaries to be adjusted to individual application needs. The minimum analog output point (offset) is adjustable, as well as the distance from minimum output that the cylinder must travel until maximum analog output is achieved (this will be referred to as “gain” from here on). The output boundaries provide minimum and maximum output with linear output between the two limits.

FIGURE 8 illustrates the allowable output adjustment range for standard output operation as a percentage of full cylinder extension. FIGURE 9 illustrates the allowable output range for reversed output operation. The shaded region of each graph represents the allowable area.

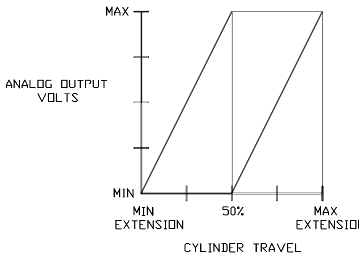



FIGURE 8
STANDARD OUTPUT RANGE

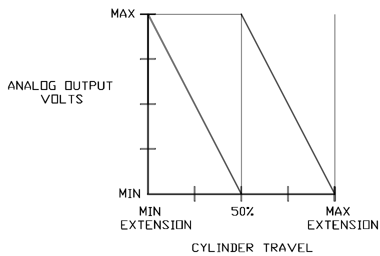
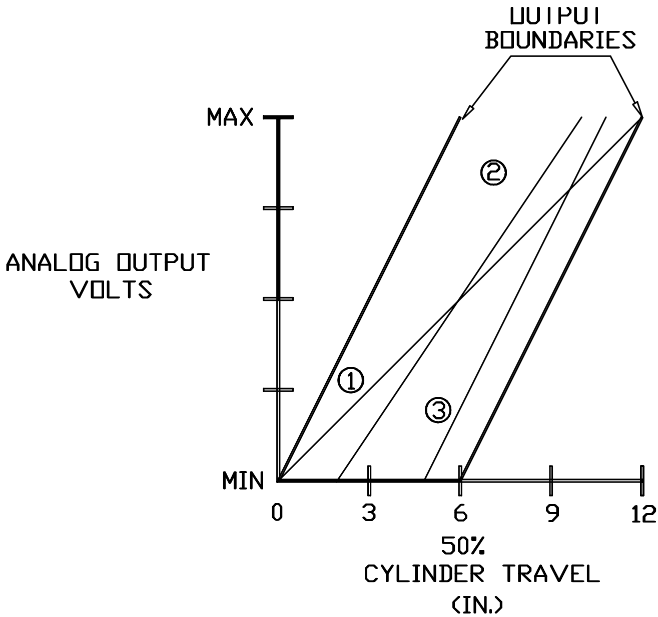



FIGURE 9
REVERSED OUTPUT RANGE

The figures illustrate two important facts.

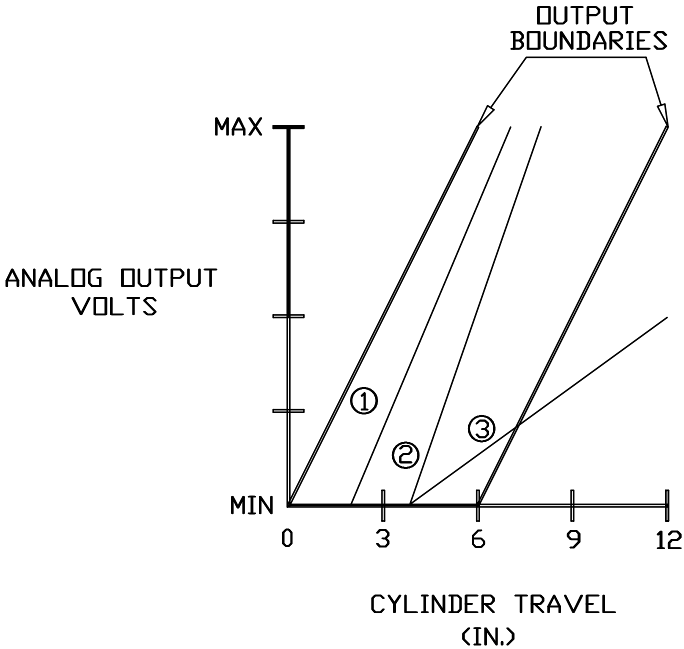
1. The maximum offset that the minimum output point can have is 50% of cylinder stroke.
2. The smallest “gain” range can be no less than 50% of cylinder stroke.

The figures below illustrate several acceptable output schemes and then several improper output schemes for a 12" cylinder.




| | MINIMUN OUTPUT "OFFSET" | MAXIMUM OUTPUT POINT | OUTPUT "GAIN" | |
|---|---|---|---|---|
| ① | 0" | 12" | 12" | |
| ② | 2" | 10" | 8" | |
| ③ | 5" | 11" | 6" | (MINIMUM GAIN) |

FIGURE 10
ACCEPTABLE OUTPUT




| | MINIMUN OUTPUT "OFFSET" | MAXIMUM OUTPUT POINT | OUTPUT "GAIN" | |
|---|---|---|---|---|
| ① | 2" | 7" | 5" | (LESS THAN ALLOWABLE) |
| ② | 4" | 8" | 4" | |
| ③ | 4" | NEVER REACHED | | |

FIGURE 11
UNACCEPTABLE ANALOG OUTPUT

The setting of output boundaries is accomplished by adjusting the potentiometers offset and gain (refer to FIGURE 2).


FIGURE 12
SET POINT ADJUSTMENT

Each adjustment affects the output in a different way. The offset adjustment is used to set the minimum analog output point. When adjusted, it shifts the entire output response range. FIGURE 13 illustrates the effect of adjusting the offset potentiometer. Notice how the offset changes but the "gain" remains the same.

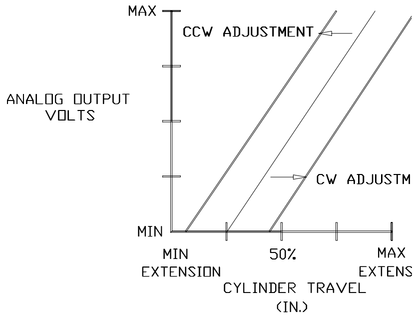



FIGURE 13
OFFSET ADJUSTMENT

When the "gain" potentiometer is rotated clockwise, the gain is decreased and when rotated counterclockwise, the gain is increased. FIGURE 14 shows how potentiometer adjustment affects the gain, but doesn't change the minimum output offset.

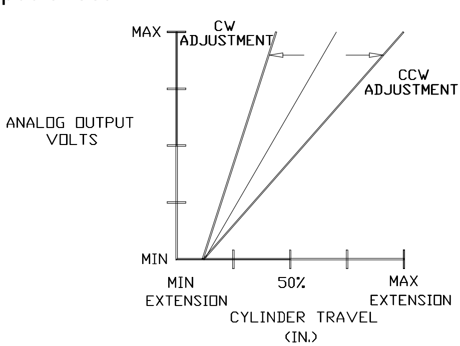



FIGURE 14
MAXIMUM OUTPUT (GAIN) ADJUSTMENT

### C. Setting Scalable Output

The procedure used to set the two boundaries is as follows:

1. Setting the Offset (minimum output point)

   a. Move the piston to the minimum output wanted.
   b. On 0-10VDC Controllers: Place a voltmeter across Terminal 6 (Analog Out) and 7 (Analog GND). On 4-20mA Output Controllers: Place an ammeter in series with the load to be driven. Current sources from Terminal 6 (Analog Out) and returns to Terminal 7 (Analog GND).
   c. Adjust the offset potentiometer until the respective minimum output is reached.

2. Setting the Gain (distance between minimum and maximum analog output)

   a. Move the piston to the maximum output point wanted.
   b. On 0-10VDC Output Controllers: Place a voltmeter across Terminal 6 (Analog Out) and 7 (Analog GND). On 4-20 mA Output Controllers: Place an ammeter in series with the load to be driven. Current sources from Terminal 6 (Analog Out) and returns to Terminal 7 (Analog GND).
   c. Adjust the gain potentiometer until the respective maximum output is reached.

This completes the scaling procedure. At this point the unit is set up and ready for use.

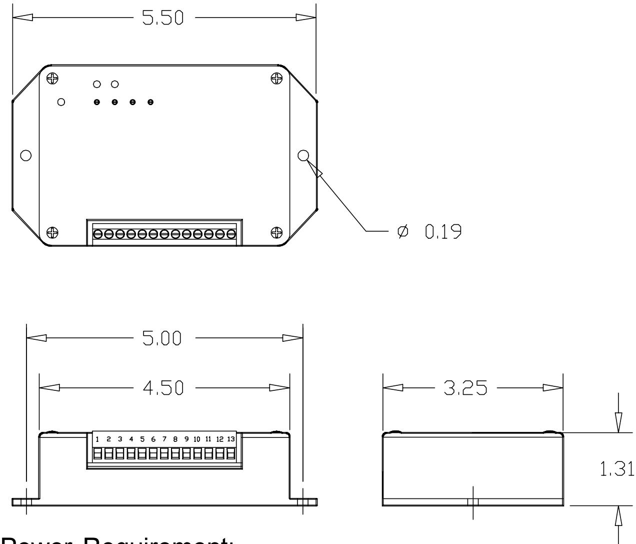
## IV. TROUBLESHOOTING

The controllers operate on very fundamental principles which greatly reduce the likelihood of problems. If a problem arises, there are several items to check before consulting your distributor.

1. Verify that all connections have been made properly.
2. Verify that the required power source is working.
3. Verify that the wiper signal (0 to 10VDC) at Terminal 4 is changing with cylinder movement.

If all of these check out, contact your distributor for further assistance.

## V. SYSTEM SPECIFICATIONS




Auxiliary Power Requirement:
AC Models ............................................. 100 to 135 VAC (115 VAC Input)
200 to 270 VAC (230 VAC Input)
DC Models ........................................... 11.8 to 26 VDC (12/24 VDC Input)

Power Requirement:
AC Models ............................................ 5 VA maximum (120 to 230 VAC)
DC Models ..................................................... 1.2 VA maximum (12 VDC)
2.4 VA Max (24 VDC)

Frequency Range ......................................................................... 50/60 HZ
Transducer Excitation Voltage ......................................... 10 VDC (Nominal)
Electrical Connections ....................... 13 position Euro Style terminal block

Dielectric Strength:
AC Models ....................................... 2000 VAC (All Inputs to all Outputs)
2000 VAC (Terminals to case)
DC Models .................................... 2000 VAC (All Inputs to relay Outputs)
2000 VAC (terminals to Case)

Note: The Negative power supply connection is common to the analog signal output.

Transient Protection ......... All inputs and outputs are designed to withstand transient energy levels normally associated with Category III service locations as defined by IEC 644. Industrial installations that are typical of this environment would include most distribution, feeder or branch circuit connections that are not located at the immediate service entrance.

Shipping Weight ................................................................... Approx. 12 oz.
Operating Temperature Range .................. (-30°C to +70°C) -22°F to 160° F
(0°C to +70°C) 32°F to 160° F for 12 VDC Operation
Storage Temperature Range ...................... (-40°C to +85°C) -40°F to 185° F
Enclosure Dimensions .................................... 1.31" H x 5.50" W x 3.25" D

**Position Feedback Control Module**

Unless noted otherwise:

Ambient Temperature = (25°C) 77°F Nominal
Aux Power (AC Models) = 120 VAC, 60 HZ
Aux Power (DC Models) = 24 VDC

*Relay Outputs*

Control Limit Set Point Range ............. 2 independent adjustments settable from 0 to 100% of cylinder stroke

Temperature Influence on Control Limits ......................... ±0.01% stroke /°C (-30°C to +70°C)

Output Contact Ratings .......... 5 A, 250 VAC, 0.8 power factor (general use)
5 A, 30 VDC (resistive)
360 VA, 240V, 0.4 power factor (Pilot Duty)

Output Contact Configuration ............... 2 independent form C (SPDT) relays
Each relay has a corresponding control limit set point adjustment

Response Time (Excluding Bounce)
Operate Time = 8 mS TYP/12 mS maximum
Release Time = 4mS TYP/6 mS maximum

Mechanical Life .......................................... 20,000,000 operations minimum

*Analog Outputs*

Output Load Specifications ....................... 0 to 10 VDC @ 10 mA maximum
4 to 20 mA @ 500 Ω maximum loop resistance
350 Ω for 12 VDC input

Zero Offset Adjustment Range .................................... ±5V (10 VDC output)
±8mA (4 to 20 mA output)

Gain Adjustment Range .......................... From 0.5 to 2.0 times input signal

Output Limits ...................................................... 13v typical (10 VDC output)
25mA typical (4 to 20 mA output)

Temperature Influence on Analog Output ..... <±0.02% Full Scale Output /°C (-30°C to +70°C)

Output Ripple ..................................................... <0.2% of Full Scale Output

Response Time (0 to 90% of final value)
0 to 10 VDC = 2mS TYP/3 mS maximum
4 to 20 mA = 2 mS TYP/3 mS maximum

## VI. APPLICATIONS

### A. Single-Solenoid Two-Position Valve

DESIRED RESULTS: A cylinder/system that will cycle between two adjustable limits.

EQUIPMENT:

- Single solenoid (12VDC) 2 position valve
- Bimba Controller (Continuous Cycle Mode)
- 10" Stroke cylinder (any bore)

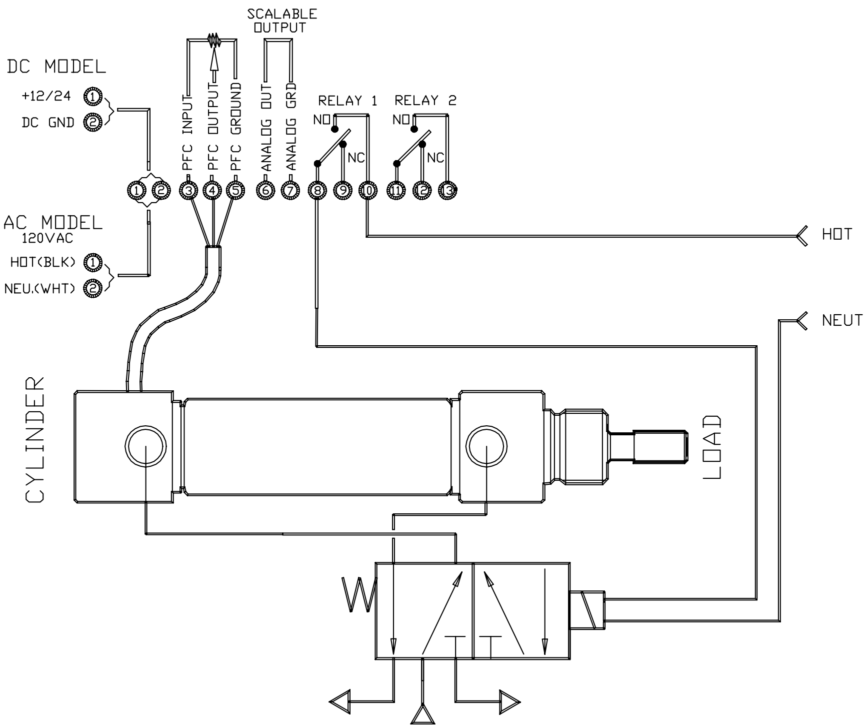



FIGURE 15

FIGURE 15 illustrates a typical pneumatic operating system. Movement of the 10" cylinder is controlled by the single solenoid two-position valve. When the solenoid is energized, the cylinder will retract. When the solenoid is not energized, the cylinder will extend.

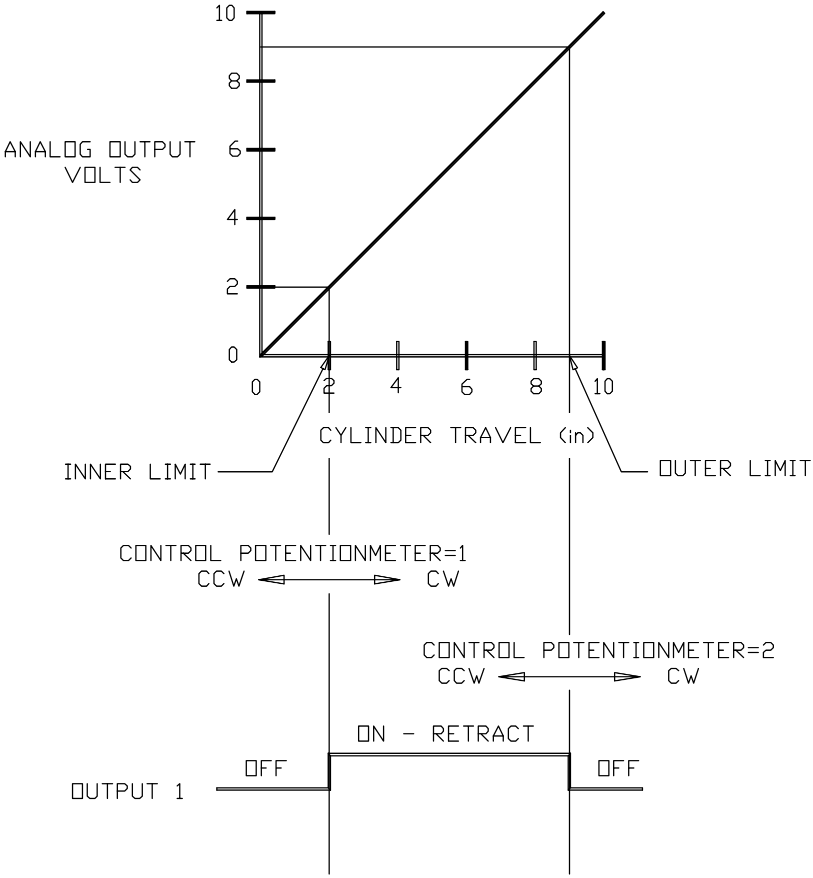



FIGURE 16

By using the Continuous Cycle Mode of the controller, a continuous cycling process can be obtained. The N.O. contact of Relay 1 is the only output necessary for cycling. The control potentiometers are used for setting the inner and outer limits of the stroke. At each limit the cylinder will reverse direction and move toward the other limit. This process will continue indefinitely until interrupted.

FIGURE 16 illustrates Relay 1 operation and the ideal voltage output versus cylinder travel (seen at Terminals 6 and 7). Control potentiometer 1 is used to set the inner limit (2") and control potentiometer 2 is used to set the outer limit (9"). The cylinder will extend while the N.C. contact of Relay 1 is closed. When the cylinder reaches the outer limit, the N.O. contact of Relay 1 will close. When this happens, power is applied to the solenoid causing the cylinder to retract. When the inner limit is reached, the relay returns to normal and the process repeats itself.

## B. Manual Control Using a Three-position Valve

DESIRED RESULTS: A cylinder/system that is manually operated between two adjustable limits.

EQUIPMENT:

- Double solenoid (24VDC) 3 position valve
- Bimba Controller (Independent Relay Mode)
- 16" cylinder (any bore)

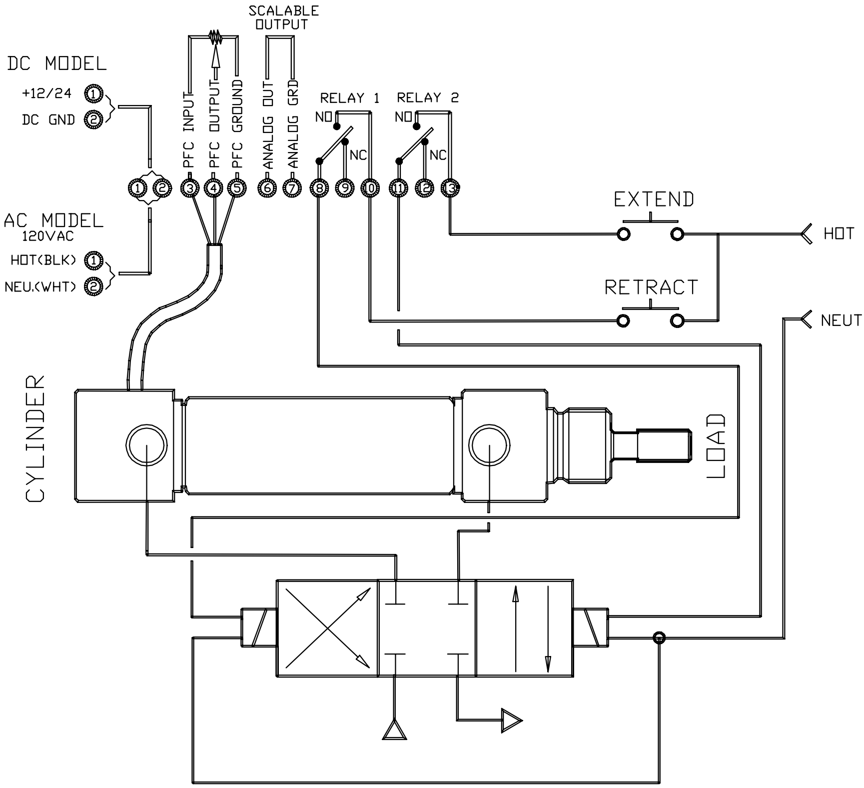



FIGURE 17

FIGURE 17 illustrates the internal connections of typical pneumatic application. Movement of the cylinder is controlled by the double solenoid three position valve in conjunction with the manual push button switches. For any movement to occur, an output must be energized and its respective push button switch must also be pushed. In this application Relay 1 is used to retract the cylinder and Relay 2 is used for extension.

NOTE: Relay operation is the same on extend and retract strokes.

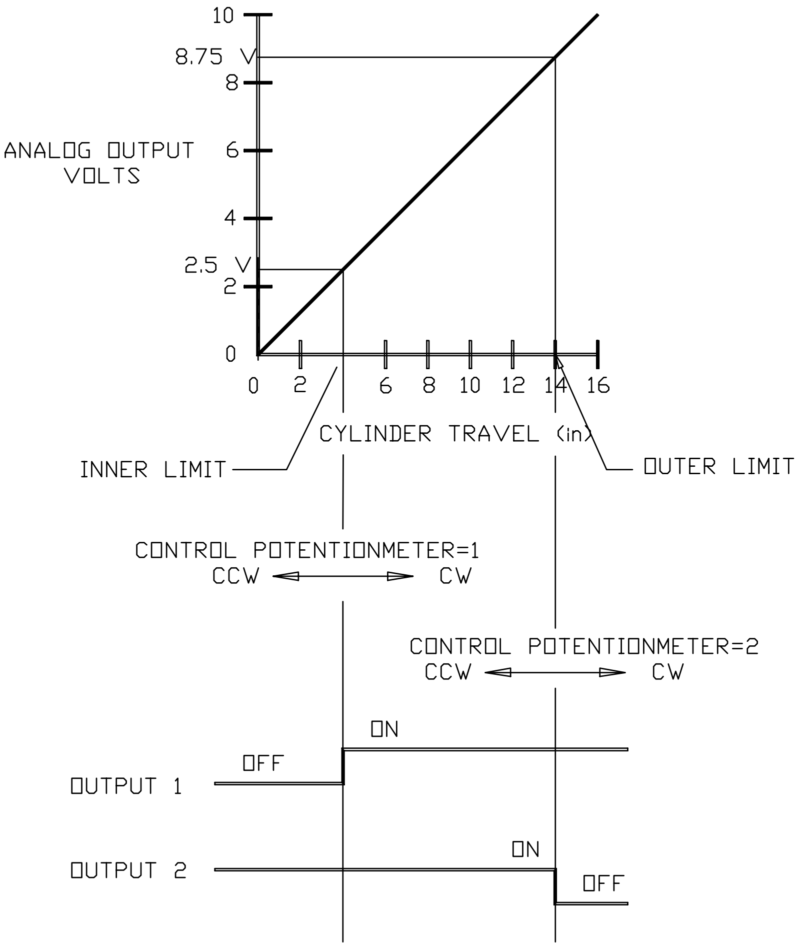



FIGURE 18

When the cylinder is fully retracted, Relay 2 is turned on. Pushing the manual extend push button will cause the cylinder to extend until it reaches the set point (14"). At this time, Relay 2 will turn off and motion will cease. Relay 1 will be on and depressing the retract switch will cause the cylinder to retract until Relay 1 turns off at 4". When Relay 1 turns off, motion will cease and the process can be repeated whenever desired.

FIGURE 18 illustrates the relay operations and the ideal voltage output versus piston travel (seen at Terminals 6 and 7). Control potentiometer 1 is used to set the inner limit (4") and control potentiometer 2 is used to set the outer limit (14"). Relay 1 is energized any time the cylinder is extended more than 4". Relay 2 is energized any time the cylinder is less than 14". These two points are the boundaries of cylinder travel.

## C. Continuous Cycling Between Two Adjustment Limits

DESIRED RESULTS: A cylinder/system that will cycle between two adjustable limits.

OPERATING SITUATION EQUIPMENT:

3 position valve
DC solenoids (2 amp max.)
Bimba Controller (using the Continuous Cycle Mode) and the inverted mode on relay
12" cylinder (any bore)

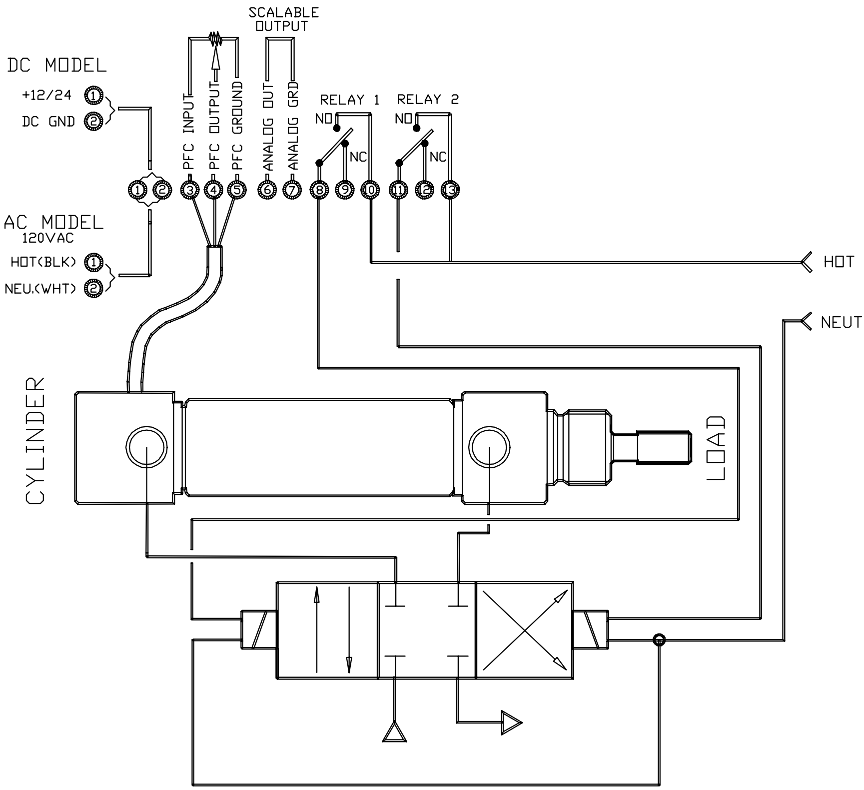



FIGURE 19

FIGURE 19 illustrates a typical pneumatic application. In this application, cylinder will continually cycle between boundaries of 2" and 10" of overall cylinder stroke.

VOLTAGE OUTPUT VS POSITION

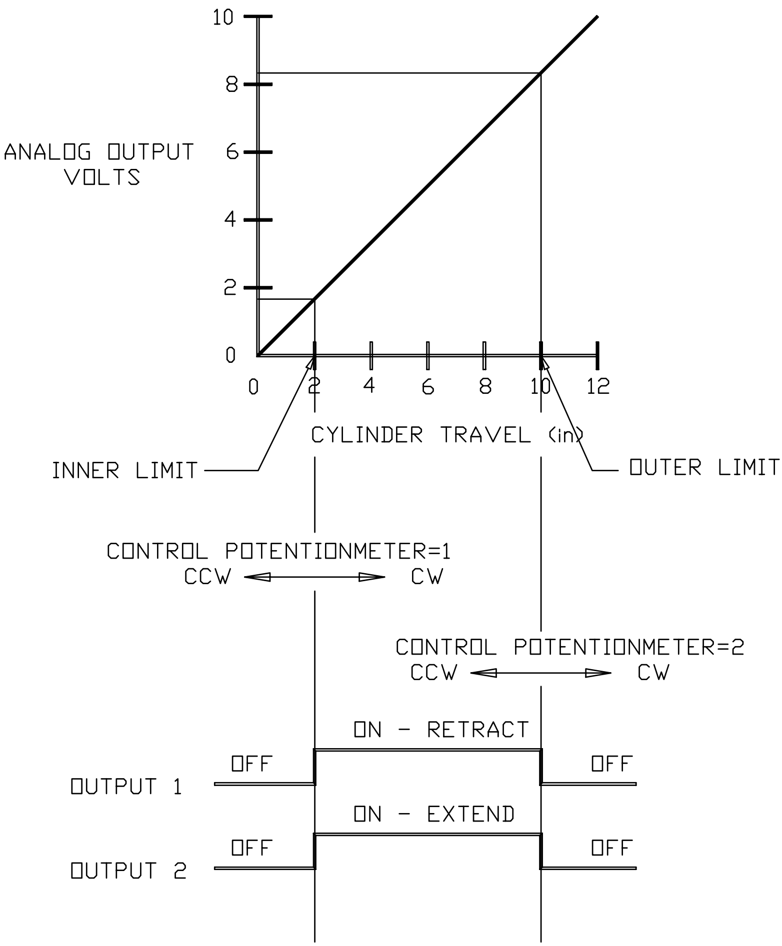



FIGURE 20

By using the Continuous Cycle Mode of the controller, the cylinder will continually cycle between the two set point limits. In this case, there will be 8" of piston travel in each direction to perform the desired task.

FIGURE 20 illustrates the output actions and the ideal voltage output versus piston travel (seen at Terminals 6 and 7). Control potentiometer 1 is used to set the inner limit (2") and control potentiometer 2 is used to set the outer limit (10"). Relay 1 will be on while the cylinder is retracting to the inner limit (2"). When the piston reaches the inner limit, Relay 1 will shut off and Relay 2 will be energized. Relay 2 will cause the cylinder to extend until the piston reaches the outer limit (10"), where Relay 1 will turn on and the process will repeat.

## D. Two-speed System Using Two Bimba Controllers

DESIRED RESULTS: A cylinder/system that operates at two different speeds. It is desired to have high-speed movement between 2 and 6 inches of the stroke. It is also desired to have the motion slow down for low-speed operation between 1 and 2, and 6 and 7 inches.

OPERATING SITUATION EQUIPMENT:

- 2 three-position valves
- DC solenoids (12VDC 2 AMP max)
- 2 Bimba Controllers
- 8" cylinder (any bore)

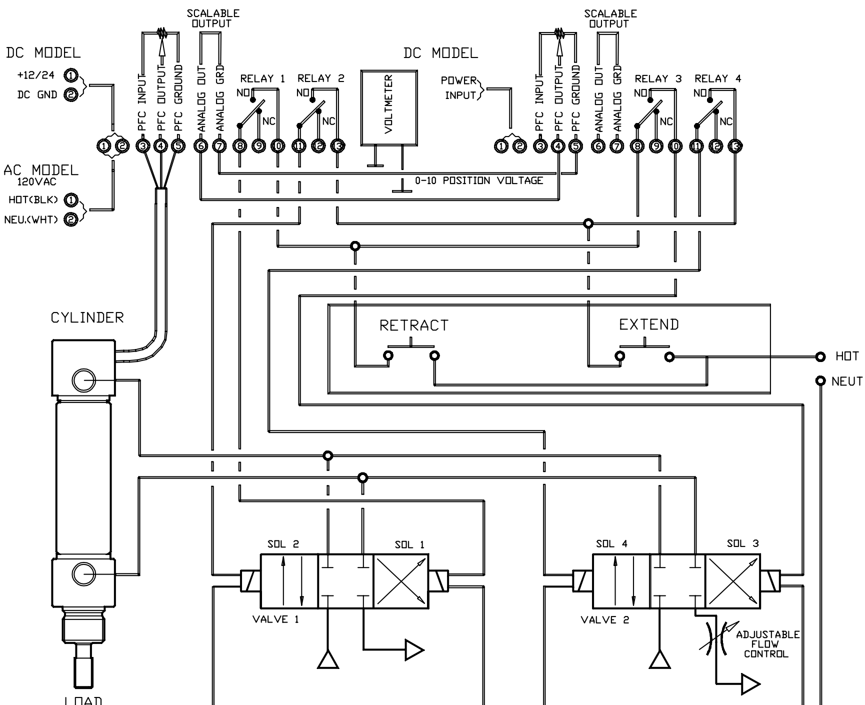



FIGURE 21

FIGURE 21 shows a two speed system using two three-position valves and two controllers. The external extend and retract switches can be manual push buttons or some other configuration which is actuated by the machine being controlled by the cylinder. In this example when the extend switch is closed, power is supplied to Relays 2 and 4.

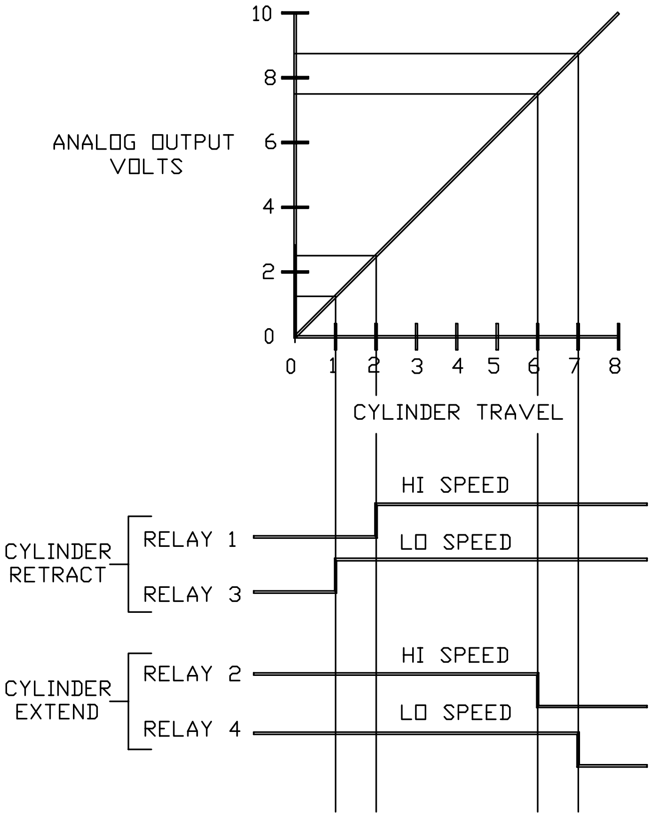



FIGURE 22

FIGURE 22 shows the condition of the output relays during cylinder movement. The cylinder extends with both relays 2 and 4 on and solenoid 2 and 4 energized. At 6 inches solenoid 2 turns off, removing the high speed source from the cylinder. The pressure coming from valve 2 is reduced, therefore, the cylinder moves slower between 6 inches and 7 inches. Solenoid 4 remains on until the cylinder reaches 7 inches where it stops. The operation is similar on the retract cycle (using the retract switch and solenoids 1 and 3). Controls 1, 2, 3, and 4 determine the switching positions of relays 1 through 4 respectively. The panel LED's correspond to relay operation.