ES140 Series Electric Spring Return Actuators

Installation

IMPORTANT: The ES140 Series actuator is intended to control equipment under normal operating conditions. Where failure or malfunction of an ES140 actuator could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory) intended to warn of, or protect against, failure or malfunction of an ES140 actuator must be incorporated into and maintained as part of the control system.

Parts Included

- ES140 Series actuator
- NPT conduit adaptor and nut (two included for actuators with switches or a feedback potentiometer)
- M9000-160 anti-rotation bracket
- two No. 12-24 x 1/2 in. self-tapping hex washer-head screws
- 5 mm manual crank

For B2 models:

- one M9000-106 pluggable 4-terminal block

Note: For B2-S models:

- two M9000-105 pluggable 3-terminal blocks
- one M9000-106 pluggable 4-terminal block

Special Tools Needed

- drill with a 3/16 in. (No. 15, 4.57 mm) drill bit
- torque wrench with 10 mm socket
- 7 mm and 5/16 in. (8 mm) nut driver
- DVM or M9000-200 Commissioning Tool (for -ZS and -ZS-S models with zero and span potentiometers)

Spring Return Direction

The actuator is factory set to spring return in a Counterclockwise (CCW) direction.

Clockwise (CW)

To change the spring return direction to CW, refer to Figure 1 and proceed as follows:

1. Turn the actuator over. Use a flat-blade screwdriver to release the locking clip, and remove it from the coupler.
2. Remove the coupler and sleeve from the front of the actuator, and slide the sleeve off the coupler.

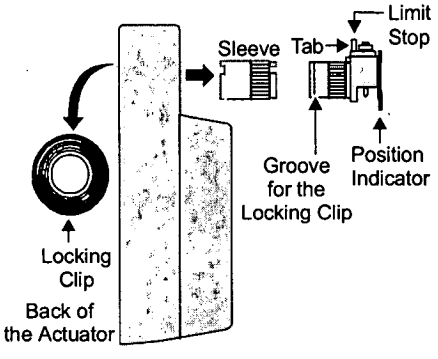


Figure 1: Changing the Spring Return Direction

3. Insert the sleeve into the back of the actuator with the smooth half of the sleeve inserted first. Make sure the gap in the sleeve rim aligns with the two guide marks on the back of the actuator shown in Figure 2.

Note: Note: The drive direction of the actuator is reversed when the sleeve is changed from the front to the back of the actuator.

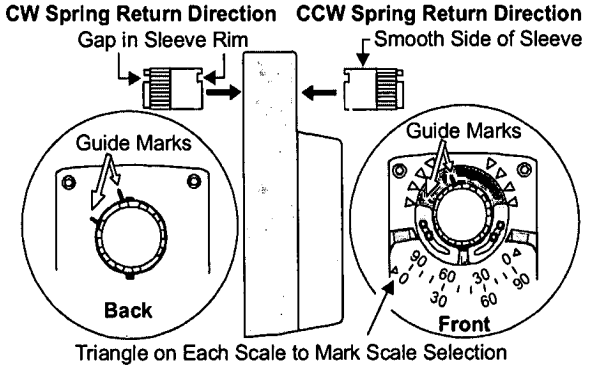


Figure 2: Location of Guide Marks

4. Align the tab on the coupler with the gap in the sleeve rim, and insert the coupler into the front of the actuator.
5. Replace the locking clip to secure the coupler and sleeve in the actuator.
6. Fill in the triangle on the actuator cover with a marking pen to indicate the scale being used.

Counterclockwise

For the actuator to spring return in a CCW direction, refer to Figure 3 and proceed as follows:

1. Turn the actuator over. Use a flat-blade screwdriver to release the locking clip, and remove it from the coupler.
2. Remove the coupler from the front of the actuator and the sleeve from the back of the actuator.
3. Insert the sleeve into the front of the actuator with the smooth half of the sleeve inserted first.

Note: Note: Make sure the gap in the sleeve rim aligns with the two guide marks on the front of the actuator.

4. Repeat Steps 4, 5, and 6 of the previous section.

Mounting on Dampers

IMPORTANT: Make sure the space between the back of the actuator and the mounting surface is at least 5/32 in. (4 mm).

ES140 actuators may be mounted in any convenient orientation. They may be installed on a 3/8 to 3/4 in. (9.5 to 19 mm) round or a 3/8 to 5/8 in. (9.5 to 16 mm) square shaft, 3 in. (76 mm) or longer. If the shaft is less than 3 in. (76 mm) long, install an extension recommended by the damper or valve manufacturer. For 1 in. (25.4 mm) outside diameter shafts, use the M9000-154 1 in. Jackshaft Coupler.

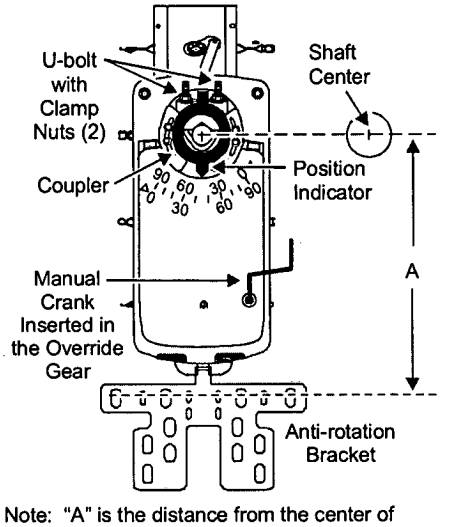
To mount the actuator, proceed as follows:

IMPORTANT: The tab on the anti-rotation bracket must fit midpoint in the actuator slot to prevent actuator binding and premature wear.

1. Refer to the "A" Dimensions in Table 1 and Figure 3 to ensure the tab on the anti-rotation bracket fits midway in the actuator slot.

Table 1: Shaft Sizes and Distances from the Anti-rotation Bracket to Shaft Center

Shaft Diameter	5/8 in.	1/2 in.	3/8 in.
"A" Dimensions	8-1/4 in.	8-5/16 in.	8-3/8 in.
(See Figure 3.)	209 mm	211 mm	213 mm



Note: "A" is the distance from the center of the holes in the anti-rotation bracket to the center of the shaft. (See Table 1.)

Figure 3: Mounting Positions

2. Bend or cut the anti-rotation bracket to fit the damper frame or duct as shown in Figure 4.

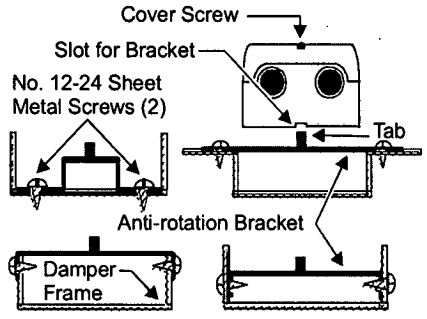


Figure 4: Anti-rotation Bracket Positions

3. Use the anti-rotation bracket as a guide, and drill the holes in the damper frame or duct for the bracket (based on the measurements obtained in Table 1 and Figure 3).
4. Attach the anti-rotation bracket to the damper frame or duct with the two self-tapping screws provided, using a 1/4 in. (7 mm) flat-blade screwdriver or 5/16 in. (8 mm) nut driver.

IMPORTANT: Do not overtighten the mounting screws to avoid stripping the threads.

5. Slide the actuator onto the damper shaft, positioning the anti-rotation bracket tab into the slot at the bottom of the actuator. (See Figure 4.)
6. Insert the manual crank. Push it in firmly, and turn it CW four or five turns (position indicator should be between the 3 and 5° mark on the actuator scale). Turn the manual crank 1/4 turn CCW to lock this position.
7. Close the damper tightly.
8. Keeping the actuator flat, evenly hand tighten each clamp nut onto the U-bolt. Secure the U-bolt to the damper shaft to achieve a torque of 100 to 125 lb·in (11 to 14 N·m).
9. Turn the manual crank CW to release the spring, and remove the manual crank. (The actuator spring returns to its starting position.)
10. Verify that the actuator rotates freely throughout the range. (This may be done by applying a full stroke control signal or reinserting the manual crank and turning it CW to rotate the coupler to the fully open position.)

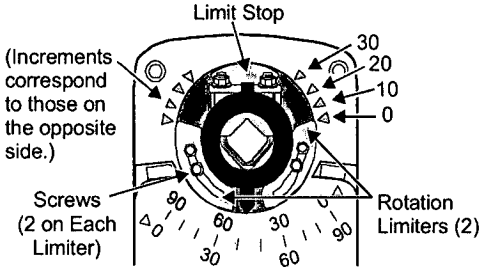
Rotation Range

The actuator is factory set for 0 to 93° rotation. The rotation range is changed by repositioning the coupler and adjusting the rotation limiters. This may be done by using an input signal or the manual crank.

To change the rotation range using the manual crank:

IMPORTANT: Turn the manual crank in a CW direction only, unless locking a new position.

1. Push the manual crank firmly into the manual override gear (shown in Figure 3), and wind in a CW direction until the position indicator reaches the 45° position.
2. Lock this position by winding the manual crank 1/4 turn CCW or until a slight resistance is felt.
3. Use a 7 mm nut driver to loosen the screws on the rotation limiter. (See Figure 5.)



Note: Rotation limiters are shown factory set in the fully down position for 90° rotation.

Figure 5: Rotation Limiters

4. Slide the rotation limiter to the desired position, and retighten the screws to a maximum of 30 lb·in (3.4 N·m).

Examples of rotation limiter adjustments:

- For a rotation range of 30°, adjust both limiters fully up.
- For a range of 45°, adjust one rotation limiter to 30° and the other to 15°.
- For a range of 60°, adjust one limiter to 30°, and leave the other at 0°.

5. Reinsert the manual crank into the manual override gear.
6. Repeat Steps 2 through 5 to set the rotation range for the second rotation limiter.
7. Release the manual crank spring lock by winding the crank 1/4 turn in a CW direction.

8. Remove the manual crank, and return it to its original position on the actuator cover.

Note: Note: When changing the rotation range on -S models with auxiliary switches, one or both switches may need to be adjusted. See the *Auxiliary Switches (-S Models)* section.

Note: When changing the rotation range on –ZS and -ZS-S models with zero and span potentiometers, both potentiometers must be adjusted. See the *Potentiometers (-ZS Series Models)* section.

Feedback Signal

The feedback signal varies with a change to the rotation range. The resistance feedback is reduced corresponding to the reduced rotation range for the -P2 and -P models. For both -ZS and E2 models, a change to the rotation range changes the feedback signal and the operating range. This applies to the B2 and B2-S models in the Fixed mode. (See Figure 6.)

Note: Note: Refer to the *Setup and Adjustments, Fixed or Auto (B2 Series Models)* section for the B2 and B2-S models. Once calibrated, a change to the rotation range does not affect the feedback signal and operating range of these models.

		Rotation Range						
		Rotation Limiter Adjustment				Rotation Limiter Adjustment		
		90° / 0°	75° / 15°	60° / 30°	45° / 45°	30° / 60°	15° / 75°	0° / 90°
Direct Acting	0-10V Feedback	10.0V	8.3V	6.7V	5.0V	3.3V	1.7V	0.0V
	2-10V Feedback	10.0V	8.7V	7.3V	6.0V	4.7V	3.3V	2.0V
Reverse Acting	0-10V Feedback	0.0V	1.7V	3.3V	5.0V	6.7V	8.3V	10.0V
	2-10V Feedback	2.0V	3.3V	4.7V	6.0V	7.3V	8.7V	10.0V
Direct or Reverse Acting	0-135 ohms Feedback	135Ω	113Ω	90Ω	68Ω	45Ω	23Ω	0Ω
	0-1000 ohms Feedback	1000Ω	833Ω	667Ω	500Ω	333Ω	167Ω	0Ω

Note: 0-10V or 2-10V is available on all B2 and E2 models.
0-135 ohms feedback is available on -P2 models and
0 to 1000 ohms feedback on -P models. (Ω is ohms.)

Figure 6: Nominal Feedback Signal Relative to the Rotation Range

Wiring

CAUTION: Equipment Damage Hazard. Disconnect all power supplies before wiring connections are made, or prior to performing maintenance. Check all wiring connections before applying power to the system. Short-circuited or improperly connected wires will result in permanent damage to the equipment.

IMPORTANT: Install all quick-connect terminals in the same direction to prevent shorting. (See Figure 7.)

Figure 7: Orientation of Terminals

Observe the following when wiring an ES140 actuator:

- Make all wiring connections in accordance with the National Electrical Code and local regulations.
- Note that there is a 25-second delay for all models (except the A2, A2-S, B2, and B2-S), before the actuator responds after power is applied.
- Do not switch 24 VAC from CW to CCW (or CCW to CW) on the C2 models in less than 0.5 seconds.

Refer to Figure 8 for the applicable ES140 actuator.

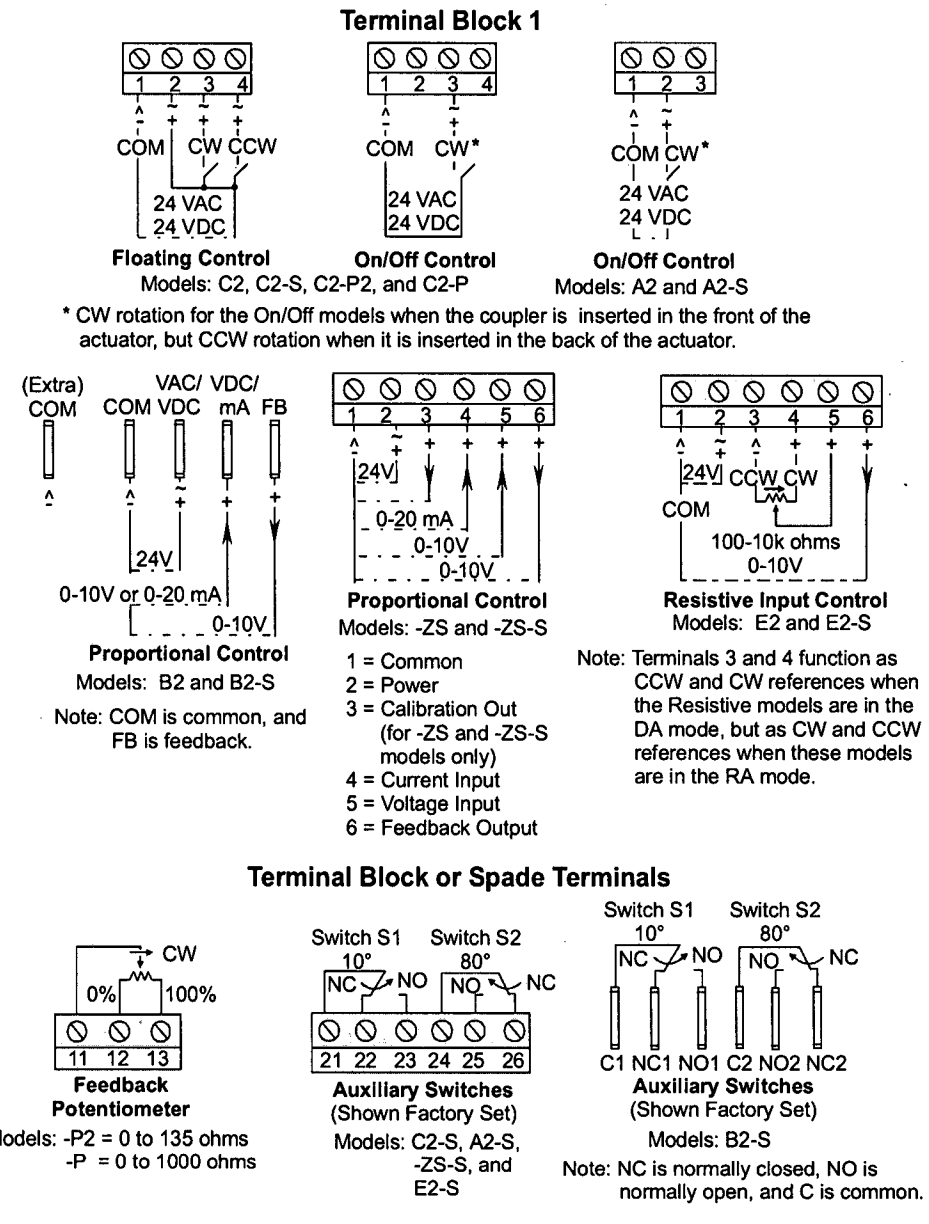


Figure 8: Wiring Diagrams for ES140 Models

Wiring is made through the conduit openings or through the conduit adaptor, which converts the opening for a threaded NPT conduit fitting.

Through the Conduit Openings

Depending on the ES140 model selected, one or both conduit openings are used. Refer to Figure 9 and proceed as follows:

1. Loosen the cover screw with a Phillips No. 2 screwdriver, and remove the actuator cover.
2. Push the plastic plug out of the conduit opening with fingertip.

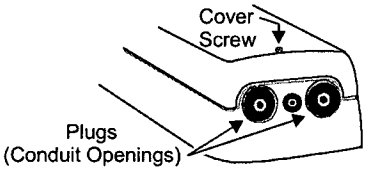


Figure 9: Location of the Conduit Openings

3. Insert the cable wires through the hole in the conduit plug, and connect to the terminals using the appropriate wiring diagrams in Figure 8.

With the M9000-100 Conduit Adaptor (Included)

To use a conduit adaptor, proceed as follows:

1. Push the plastic plug out of the conduit opening with fingertip.
2. Slide the capture nut into the slot located inside of the conduit opening. (See Figure 10.)

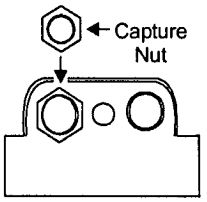


Figure 10: Capture Nut

3. Insert the conduit adaptor into the conduit opening, and hand tighten by turning in a CW direction as shown in Figure 11.

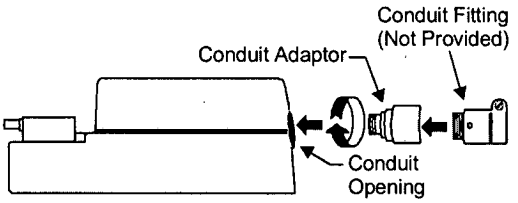


Figure 11: Conduit Adaptor Wiring

IMPORTANT: Use flexible metallic conduit or its equivalent with the fitting. Do not overtighten the conduit adaptor assembly into the actuator to avoid damaging the actuator housing.

4. Insert the conduit fitting (not provided) into the adaptor, and hand tighten in a CW direction. (See Figure 11.)
5. Insert the cable wires through the conduit adaptor assembly, and connect to the terminals using the wiring diagrams in Figure 8.
6. Tighten the clamp on the conduit fitting.

Tandem Operation

The tandem configuration provides 280 lb·in (32 N·m), twice the torque of a single unit. The actuators operate in exact synchronization, ensuring the load is split evenly between each unit.

Use two actuators from the same model group (A2, A2-S; B2, B2-S; or -ZS, -ZS-S) for tandem operation. A2 and A2-S models must be wired in parallel for tandem operation. B2 and B2-S models employ Mode Switch 5, and -ZS and -ZS-S models employ Jumper W4.

IMPORTANT: When connecting two actuators back-to-back on the same shaft, set the coupler on one unit to spring return in the opposite direction from the other unit. (Refer to the *Installation, Spring Return Direction* section.)

Note: Note: Manual override does not function after the actuators configured for tandem operation are mounted to a shaft.

B2 Series Models

B2 and B2-S models are factory set with Mode Switch 5 in the "master" position. Designate this unit as the master actuator. Refer to Figure 12, and proceed as follows:

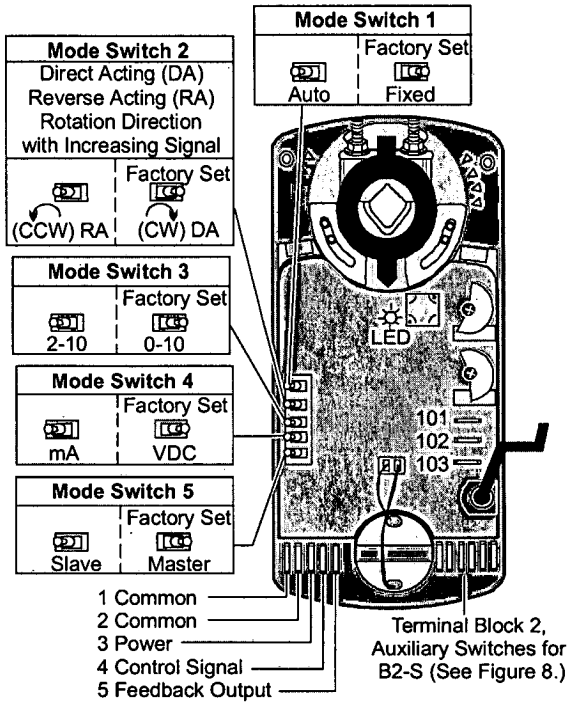


Figure 12: Mode Switch Settings for B2 Models

1. Move Mode Switch 5 on the other B2 or B2-S actuator to the "slave" position.
2. Connect the control signal to the master actuator only, and set the remaining mode switches on the master unit according to the action and signal range desired. (Refer to the *Calibration* section.)
3. Connect Terminals 101, 102, and 103 from the master actuator to the corresponding terminals on the slave actuator. (See Figure 12.)

Note: Note: The total wire length for these connections may be up to 30 ft (9 m).

4. Connect 24 VAC/VDC power to each actuator.

-ZS Series Models

The -ZS and -ZS-S models are factory set with Jumper W4 in the "master" position. Designate this unit as the master actuator. Refer to Figure 13, and proceed as follows:

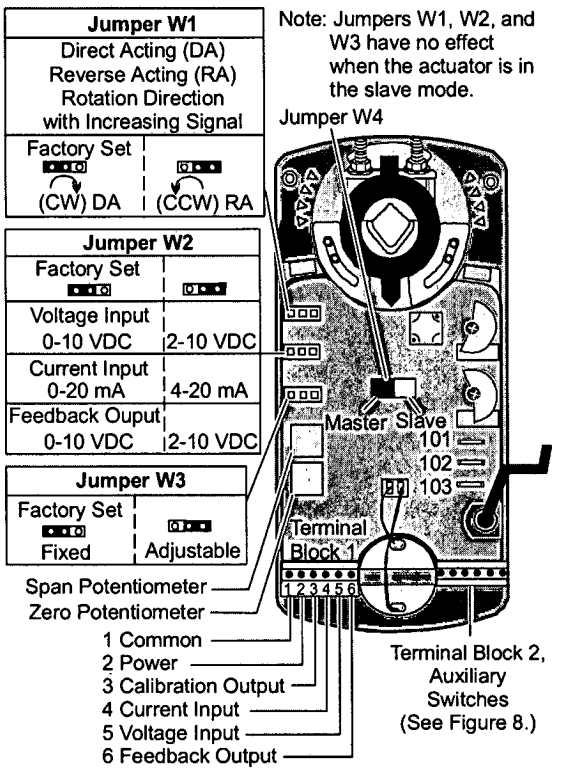


Figure 13: Settings for -ZS and -ZS-S Models

1. Move Jumper W4 on the other -ZS actuator to the "slave" position.
2. Connect the control signal to the master actuator only, and set the remaining jumpers on the master unit according to the action and signal range desired. (Refer to the *Calibration* section.)
3. Repeat Steps 3 through 4 from the *B2 Series Models* section.

If the actuators configured for tandem operation stall or do not drive:

- Make sure both actuators are from the same model group.
- Make sure one actuator is set as the master and the other actuator as the slave.
- Make sure the control signal is connected to the master actuator only.
- Make sure Terminals 101, 102, and 103 are connected properly.
- Make sure the couplers are properly installed. (Refer to the *Installation, Spring Return Direction* section.)

Setup and Adjustments

Calibration

Only the actuator designated as the master needs to be calibrated when two A2, A2-S, B2, B2-S, -ZS, or -ZS-S models are used in tandem.

Direction of Action

Drive direction is dependent on the position of Jumper W1 or Mode Switch 2 and the spring return direction as shown in Table 2. To change the spring return direction, see the *Installation, Spring Return Direction* section.

Table 2: Settings for Direction of Action

Location of Jumper or Mode Switch/ Direction of Spring Return	Drive Direction with a Minimum Input Signal	Drive Direction with a Maximum Input Signal
DA/CCW	CCW	CW
RA/CCW	CW	CCW
DA/CW	CW	CCW
RA/CW	CCW	CW

To set an actuator for Reverse Acting (RA), proceed to the section for the applicable model.

C2 Series Models

Reverse the control wiring connections at Terminals 3 and 4 to select RA operation for the C2x models. (See Terminal Block 1 in Figure 8.)

A2 Series Models

RA is selected by changing the actuator coupler for on/off operation for the A2x models. (See the *Installatoin, Spring Return Direction* section.)

B2 Series Models

B2 and B2-S models are factory set with Mode Switch 2 in the DA mode. Move Mode Switch 2 to the RA mode. (See Figure 12.)

-ZS and E2 Series Models

-ZS, -ZS-S, E2, and E2-S models are factory set with Jumper W1 in the DA position. Move Jumper W1 to the RA position. (See Figure 13.) Apply power and a control signal to the actuator to verify proper operation. (See Table 2.)

Note: Note: Both -ZS models may require potentiometer settings. Proceed to the *Potentiometers (-ZS Series Models)* section.

Fixed or Auto (B2 Series Models)

The B2 and B2-S models are factory set with Mode Switch 1 in the FIXED position, where a 0 to 10 VDC input signal (selected with Mode Switches 3 and 4) corresponds with a 0 to 93° rotation. If the rotation range is reduced, the end-stop is reached with a reduced input signal. For example, if a 0 to 10 VDC input signal is selected and the rotation range is limited to 75°, the end-stop is reached at 8 VDC.

The auto calibration or AUTO mode enables the actuator to redefine the selected input signal and feedback proportionally across a reduced rotation range. The actuator stores the reduced range in nonvolatile memory (retains data when power is lost or removed).

To activate the AUTO mode, move Mode Switch 1 to the AUTO position, and leave it in this position. The actuator spring returns to the normal position, drives to the full stroke position, and stores these positions in nonvolatile memory. The actuator drives to the setpoint determined by the control signal applied after going through the AUTO mode.

During normal operation, if the actuator stroke increases in the AUTO mode due to seal or seat wear, the input is redefined to the increased rotation range in approximately 2° increments.

Note: Note: If the actuator's direction of spring return, rotation range, or the linkage is changed, reinitiate the AUTO mode by moving Mode Switch 1 to FIXED for 5 seconds and then back to AUTO. (The feedback output remains 0 to 10 VDC, unless Mode Switch 3 is positioned for 2 to 10 VDC.)

LED (B2 Series Models)

The B2 and B2-S models have a Light Emitting Diode (LED) indicator shown in Figure 13. When the actuator is driving to position, the LED flashes five times every second. When the unit is auto calibrating, the LED flashes ten times every second. When the unit is idle, the LED flashes once every 2-1/2 seconds.

Jumpers (-ZS and E2 Series Models)

-ZS and -ZS-S models are factory set with Jumper W1 in the DA position, Jumper W2 in the 0 to 10 VDC or 0 to 20 mA position, and Jumper W3 in the fixed position. (See Figure 13.) E2 and E2-S models are factory set for Direct Acting (DA) with Jumper W1 in the DA position.

Potentiometers (-ZS Series Models)

IMPORTANT: Both zero and span potentiometers must be adjusted to ensure full actuator travel and complete calibration.

-ZS and -ZS-S models have two potentiometers, zero and span. These potentiometers do not require adjustment when Jumper W3 is in the fixed position (factory set). When Jumper W3 is in the adjustable (ADJ) position, proceed as follows:

Use either Terminals 3 and 5 or Terminals 3 and 4, a control signal, and a voltmeter. The zero and span potentiometers may be adjusted as follows without waiting for the actuator to drive to the final position.

Adjusting the Zero and Span

1. Verify that Jumper W2 is in the 0 to 10 VDC position, and Jumper W3 is in the ADJ position. (See Figure 13.)
2. Provide 24 VAC or 24 VDC power to Terminal 1 (Common) and Terminal 2.
3. Connect the Common from the controller to Terminal 1, and either a voltage signal to Terminal 5 or a current signal to Terminal 4.
4. Connect Terminals 1 and 3 to a voltmeter to monitor the calibration output.
5. Use a 1/8 in. (3 mm) flat-blade screwdriver to turn the zero potentiometer fully CW and the span potentiometer fully CCW.

6. Apply the minimum (zero point) control signal required for positioning the actuator at the minimum position.
7. Monitor DC calibration output. To adjust the zero potentiometer, turn it CCW until the voltmeter displays 0 volts or slightly less.
8. Adjust the control signal to the maximum voltage desired to cause full rotation. (Signals greater than 10 volts have no further effect.)
9. Monitor calibration output at Terminals 1 and 3. Adjust the span potentiometer CW to increase the calibration output to 10 volts.
10. Verify that the actuator is properly calibrated by adjusting the control signal to the minimum and maximum levels.

Example for a zero of 3 VDC and a span of 5 VDC:

a. Apply a 3-volt control signal to the actuator, and turn the zero potentiometer CCW until the calibration output at Terminal 3 is 0 volts.
b. Apply maximum voltage. (In this case, it is 8 VDC, which results in a span of 5 volts.)
c. Monitor calibration output at Terminal 3, and adjust the span potentiometer CW until 10 volts is reached.

Note: Note: Mechanical movement is not immediate due to a delay in the actuator's response to the control signal.

Auxiliary Switches (-S Models)

The -S models have two built-in auxiliary switches, which may be set for any angle between 0 and 90° (factory set for 10 and 80°, nominal) using either an input signal or the manual crank. (Refer to the *Technical Data* section for auxiliary switch ratings.)

The following procedures serve as examples to change the position of the auxiliary switch angles.

Switch S1

To change the angle of Switch S1 to 20°, refer to Figure 14 and proceed as follows:

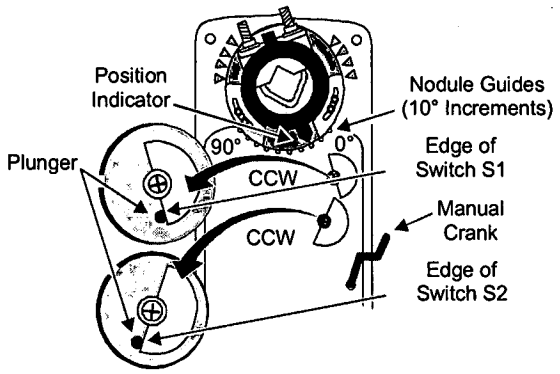


Figure 14: Switch Angle Settings

1. Insert the manual crank into the manual override gear.
2. Push in and turn the manual crank CW. Using the 0 to 90° nodule guides, rotate the coupler until the position indicator is at 20°.
3. Rotate Switch S1 CCW, aligning the edge of the switch with the plunger until the plunger rises. (See Figure 14.)

Note: Note: The normally closed contact closes, and the normally open contact opens. (See Terminal Block or Spade Terminals in Figure 8.)

Switch S2

To change the angle of Switch S2 to 70°, refer to Figure 14 and proceed as follows:

1. Push in and turn the manual crank CW. Using the 0 to 90° nodule guides, rotate the coupler until the position indicator is at 70°.
2. Rotate Switch S2 CCW, aligning the edge of the switch with the plunger until the plunger rises. (See Figure 14.)

Note: Note: The normally closed contact opens, and the normally open contact closes. (See Terminal Block or Spade Terminals in Figure 8.)

3. Turn the manual crank CW to release the spring, and remove it. (The actuator will spring return the coupler to the 0° position.)
4. Replace the actuator cover, and return the manual crank to its original position on the actuator cover.

Repairs and Replacement

Field repairs must not be made. For a replacement or an accessory, refer to Dodge's *ES140 Series Electric Spring Return Actuators Product Bulletin, LIT-10000045.*

Technical Data

Product	ES140 Series Electric Spring Return Actuators	
Power Requirements (Class 2)	C2, B2-ZS, E2:	20 to 30 VAC at 50/60 Hz or 24 VDC ±10%, 12 VA supply minimum
	A2, A2-S:	20 to 30 VAC at 50/60 Hz or 24 VDC ±10%, 10 VA supply minimum
	B2, B2-S:	20 to 30 VAC at 50/60 Hz or 24 VDC ±10%, 14 VA supply from 32 to 122°F (0 to 50°C) or 18 VA supply from -22 to 32°F (-30 to 0°C) minimum
Input Signal	C2:	24 VAC at 50/60 Hz or 24 VDC, 4.8 mA (on/off mode, 500 mA maximum)
	A2:	24 VAC at 50/60 Hz or 24 VDC, 420 mA maximum
	B2:	0 to 10 VDC or 0 to 20 mA
	E2:	Potentiometer value is 100 ohms minimum to 10,000 ohms maximum
Input Signal Adjustments	C2 Factory Setting:	Terminals 1 and 3, CW rotation; Terminals 1 and 4, CCW rotation
	A2 Factory Setting:	Terminals 1 and 2, CW rotation
	B2, B2-S (Voltage or Current Input):	
	Switch Selectable:	0 (2) to 10 VDC or 0 (4) to 20 mA
	Factory Setting:	0 to 10 VDC, CW rotation with signal increase
	B2-ZS, B2-ZS-S (Voltage Input or Current Input):	
	Jumper Selectable,	Fixed: 0 (2) to 10 VDC or 0 (4) to 20 mA
		Adjustable: Zero, 0 to 6 V (0 to 12 mA); Span, 2 to 10 V (4 to 20 mA)
	Factory Setting:	0 to 10 VDC, 0 to 20 mA, CW rotation with signal increase
	B2, E2:	Direction of action is user selectable Direct (CW) or Reverse (CCW) with signal increase.
Input Impedance	B2:	Voltage Input, 200,000 ohms; Current Input, 500 ohms
	E2:	1.8 Megohms
Feedback Signal	C2-P2:	135 ohm feedback potentiometer
	C2-P:	1,000 ohm feedback potentiometer
	B2:	0 to 10 VDC or 2 to 10 VDC for 90° (10 VDC at 1 mA) Corresponds to input signal span selection and rotation limits.
	E2:	0 to 10 VDC for 90° (10 VDC at 1 mA)
Auxiliary Switch Rating	-S Models:	Two SPDT (Single-Pole, Double-Throw) switches rated at 24 VAC, 1.5 A inductive, 3.0 A resistive, 35 VA maximum per switch, Class 2
Spring Return	Factory Setting:	CCW; Direction is selectable with the coupler.
Mechanical Output	Running Torque:	140 lb·in (16 N·m) for a single unit, 280 lb·in (32 N·m) for two in tandem
Rotation Range	Adjustable from 30 to 90°, CW or CCW, mechanically limited to 93°	
Rotation Time	70 to 130 seconds for 0 to 140 lb·in (0 to 16 N·m); 90 seconds nominal at 50% rated load (Powered rotation is faster in the spring return direction than in the spring winding direction; power failed spring return is less than 15 seconds.)	
Cycles	65,000 full stroke cycles	
Electrical Connection	B2 and B2-S:	1/4 in. spade terminals with pluggable terminal blocks
	All Other Models:	Screw terminals for 22 to 14 AWG; maximum of two 18, 20, or 22 AWG each
	M9000-100:	One included with all models; two included with -P2, -P, and -S models
Mechanical Connection	3/8 to 3/4 in. (10 to 20 mm) diameter round shaft; 3/8 to 5/8 in. (10 to 16 mm) square shaft	
Enclosure	NEMA 2, IP42	
Ambient Conditions	Operating, B2 and B2-S:	-22 to 122°F (-30 to 50°C); 0 to 95% RH, non-condensing
	All Others:	-4 to 122°F (-20 to 50°C); 0 to 95% RH, non-condensing
	Storage, All Models:	-40 to 186°F (-40 to 86°C); 0 to 95% RH, non-condensing
Dimensions (H x W x D)	9.82 x 4.57 x 3.62 in. (249.4 x 116 x 91.9 mm)	
Shipping Weight	6.4 lb (2.9 kg)	
Agency Compliance	UL 873 Listed, File E191697, CCN XAPX CSA C22.2 No. 139 Certified, File LR703163, Class 3221 02 CE Mark, EMC Directive 89/336/EEC	

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult the local DEI - Dodge Engineering & Controls, Inc. office. DEI - Dodge Engineering & Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

Dodge Engineering & Controls, Inc.
196 Riverneck Road
Chelmsford, MA 01824
978-244-1200 or 877-DEI-CTRL (Toll Free)
978-244-1422 (FAX)

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Electronic Ball Valve Guide Specifications

Control Valve Assemblies

Ball Valve Bodies

All ball valves used for modulating or floating (tri-state) control must be furnished with a stainless steel ball & stem, RPTFE or PTFE seat seals and a high performance graphite impregnated stem seal that are rated for four times the modulation life of RTFE. Standard RTFE stem seals will not be acceptable. Two-way bronze bodies up to 3 inches must be rated for 600 PSI WOG, cold, non-shock service. Three-way bronze bodies up to 2 inches must be rated for 400 PSI WOG, cold, non-shock service. The valves must have a blowout proof stem design. Each valve must be tested by the valve manufacturer with air and under water at each end of travel. The stem packing gland must be adjustable to compensate for wear. Stem O-rings are not acceptable. Valve design must allow for disassembly of valve top, inspection and replacement of packing without system shutdown or valve body removal. Reduced port Cv's on valves must be set using a gauge and end stops. Modified balls which do not have equal percentage flow curves are not acceptable. Valves with nonmetallic characteristic discs are not acceptable.

Valve/Actuator Mounting

All ball valve actuator brackets must be metallic. Nonmetallic brackets are not acceptable. Mounting brackets must differ dimensionally for both "standard" and "high/low" temperature applications. Separation must be provided between the mounting bracket and electronic valve actuators to allow complete free air movement around the actuator to minimize heat transfer and condensation. Valve assemblies without the standoffs described above are not acceptable.

Application

Hot or Chilled Water

The pressure drop of the coil and the added pressure drop incurred when reducing the line size to the control valve (adjustment of the Cv for the Piping Geometry Factor, Fp) must be taken into consideration when sizing the valve. Three-way ball valves must be piped as diverting valves or mixing valves depending on the application. When used for coil applications, the valve must be piped before the coil (as a diverting valve) and not after the coil (as a mixing valve). The manufacturer's recommendations must be followed with regard to mounting, locating, insulating, wiring and applying the control valve assembly.

Steam

Ball valves may be used to control steam only when the complete assembly is specifically designed for high temperature applications. This applies to modulating applications up through 15 PSIG saturated steam and to two-position control applications up through 150 PSIG saturated steam. All seats and seals used for steam applications must be MTFE. Standard RTFE is not acceptable. Extra high brackets specifically designed for high temperature must be used. Brackets must separate the actuator from the valve body with a minimum of the following dimensions: for 1/2" to 1" valves a minimum of 4-5/8"; for 1-1/4" to 2" reduced port, and 1" and 1-1/4" full port valves a minimum of 6-1/2"; for full port valves 1-1/2" and larger and 3" reduced port a minimum of 5-1/2". All stem adapters between the valve stem and the electronic actuator must be close tolerance machined stainless or nickel plated steel, so as to provide low thermal conductivity and precise positioning throughout the full travel of the valve.

The manufacturer's recommendations must be followed with regard to mounting, locating, insulating, wiring and applying the products.

Valve Actuator - Commercial Type:

The valve actuator must be capable of providing the minimum torque required for proper valve close-off for the application. Each actuator must have current limiting or stall detection circuitry incorporated into its design to prevent damage to the actuator. A gear release mechanism or manual override crank must be provided on all non-spring return motors to allow for manual override. Applications that require fail-safe operation of the valve assembly must use actuators with mechanical spring return or the addition of a centralized battery backup module at the control panel for ease of maintenance.

The actuator must be modulating, floating (tri-state) or two-position with spring return as called out in the control sequence of operation. All modulating valves must have positive positioning and respond to a 0(2)-10 VDC or a 0(4)-20 mA (with a dropping resistor) control signal. These modulating units must each have a position feedback signal corresponding to the actual valve position that can be wired back to the control system. An optional feedback potentiometer or auxiliary switch must be available, if required, for floating or two-position type actuators. All control valves must have a visual position indicator. The actuator must be powered by a 24 VAC, 120 VAC or 24 VDC signal. Actuators must be UL listed.

NEMA 4/4X type housing constructed of marine grade aluminum with an epoxy coating must be available as an option for all single actuator and dual assemblies. Field fabrication or non-NEMA 4/4X type enclosures are not acceptable.

The manufacturer must warranty the control valve assembly for a period of 2 years from the date of installation, not to exceed 30 months from the original date of shipment.

Control Valves must be provided by (DEI) Dodge Engineering and Controls, Chelmsford, MA.

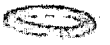
Ball Valve Features

Stem Gland Nut
- Adjustable for wear

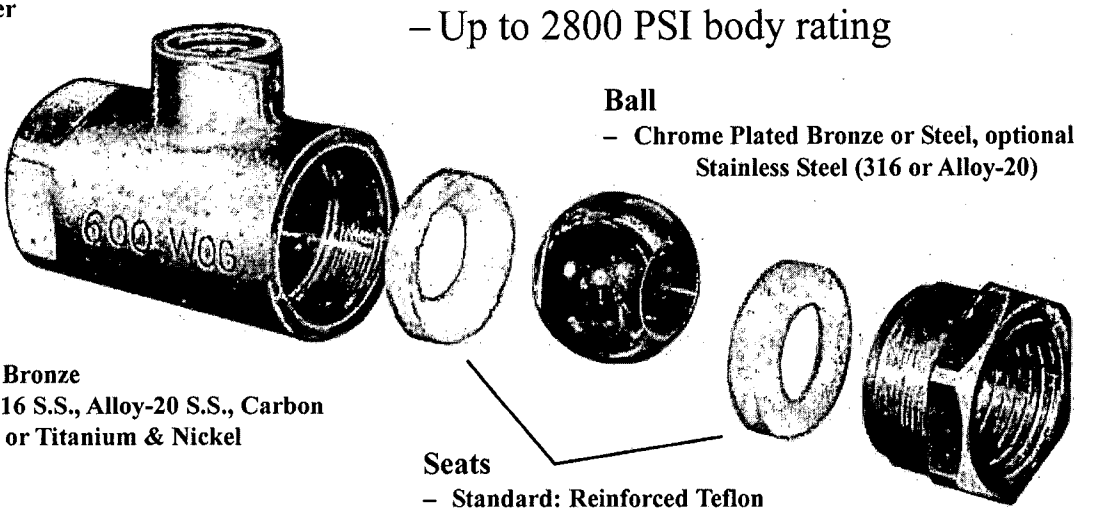
Stem Packing
- High performance graphite impregnated Teflon (MTFE)

Stem
- Blowout proof design

Stem Bearing
- Reinforced Teflon (RPTFE) Thrust Seal Washer



- Valve can be repacked without system shutdown or valve body removal
- High close-off capabilities
- Equal percentage flow characteristics
- High rangeability
- 600 PSI body rating for Two-Way valves
- 400 PSI body rating for Three-Way valves
- Industrial strength
- Self-cleaning
- Optional features include:
  - Stainless Steel Ball and Stem
  - Stainless Steel or Carbon Steel Bodies
  - Up to 2800 PSI body rating



Ball
- Chrome Plated Bronze or Steel, optional Stainless Steel (316 or Alloy-20)

Body
- Standard: Bronze
- Options: 316 S.S., Alloy-20 S.S., Carbon Steel or Titanium & Nickel

Seats
- Standard: Reinforced Teflon (RPTFE) or Teflon (PTFE)
- MTFE for extreme temp. applications

Retainer

Note:
- All valves are tested with 100 PSI air under water, in open and closed positions.

Ball Valve Specifications

Flow Characteristics:	Two-Way: Equal Percentage, Three-Way: Linear		
Bronze Valve Body Rating:	600 PSI for Two-Way 400 PSI for Three-Way		
Operating Temperature:*	Refer to Temperature/Pressure curves (BV-5)		
Maximum Recommended Inlet Pressure:	Water: Temp./pressure curve (BV-5) Steam ("-HT" option only): Modulating: 15 PSIG (Sat.) Two-Position: 150 PSIG * (Sat.)		
Maximum Close-off Pressure:	Refer to Control Valve Close-Off Rating Charts (BV–6-7)		
Materials:	"Standard"	"-SBS"	"-HT"
Body	Bronze	Bronze	Bronze
Ball	Chrome Plated Brass	Stainless	Stainless
Stem	Brass	Stainless	Stainless
Stem Bearing	RPTFE	RPTFE	RPTFE
Packing	MTFE	MTFE	MTFE
Seat Seals	RPTFE or PTFE	RPTFE or PTFE	MTFE
Connections:	Threaded		

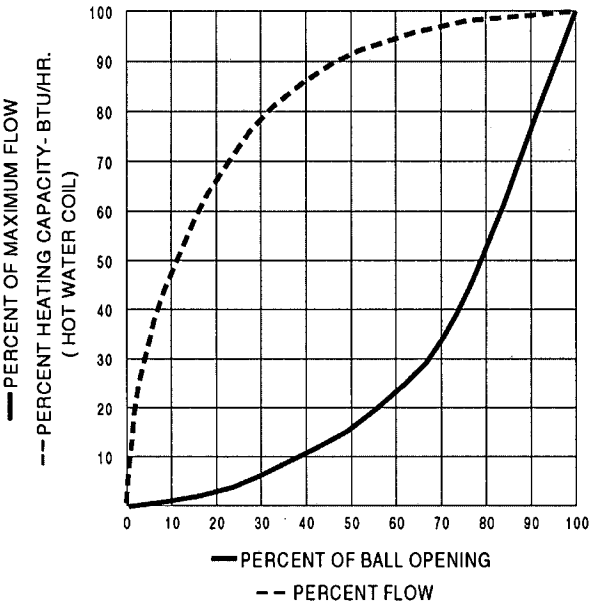
Notes:

– Special models are available for extreme temperature or chemical compatibility requirements.

* Care must be taken to maintain the actuator's temperature limits as excess heat or condensation will cause premature failure.

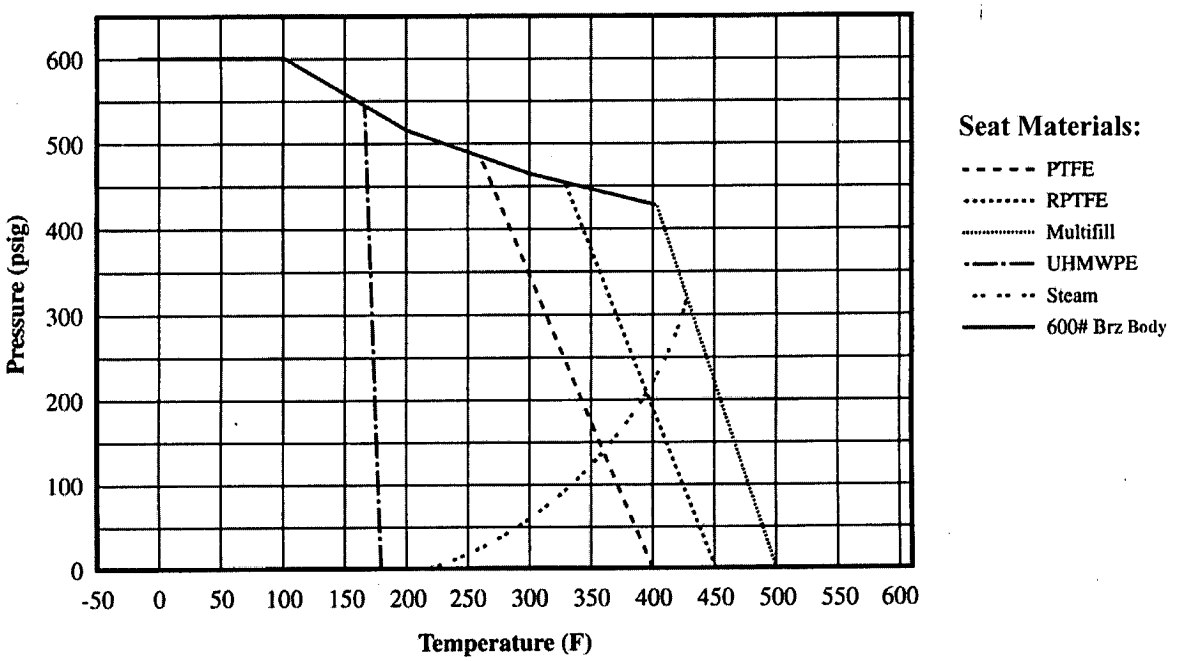
— Percent of Maximum Flow vs. Percent of Ball Opening

---- Percent Heating Capacity (Hot Water Coil) vs. Percent Flow

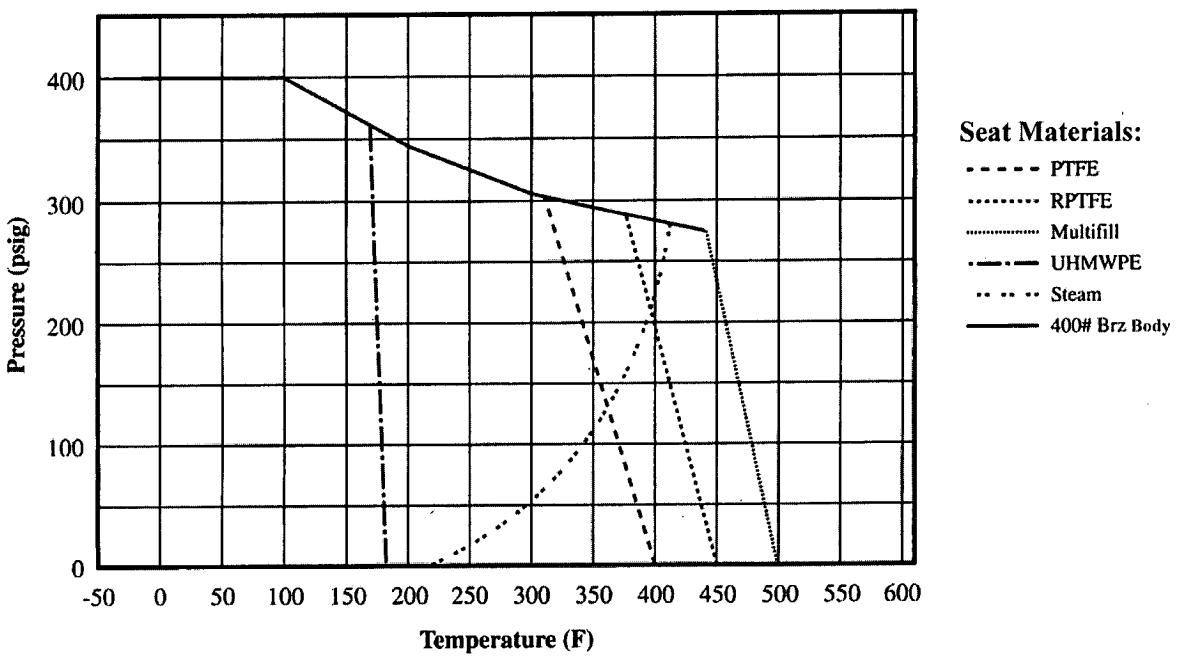


Note: The bottom curve indicates average Flow Characteristics for Two and Three-way Ball Valves. The top curve indicates average Coil Flow Characteristics.

Pressure / Temperature Ratings
Two-Way Bronze Bodies (600 PSI)



Pressure / Temperature Ratings
Three-Way Bronze Bodies (400 PSI)



Control Valve Close-off Rating Chart

Two-Way Valves			CLOSE-OFF RATING (PSI Differential)									
			Type A Non-Spring Return Motors (Actuator Type)						Type A Spring Return Motors (Actuator Type)			
NPT	CV	Model # [2 or 3-way] - [valve size] - [Cv]	EN44	EN88	EN132	EN177	EN310	Dual EN310	ES62	ES75	ES142	Dual ES142
1/2"	*	2-050-Cv	123	212	373	500	600	-	169	212	401	600
1/2"	9.8	2-050-9.8	123	212	373	500	600	-	169	212	401	600
3/4"	25	2-075-025	-	212	373	500	600	-	169	212	401	600
3/4"	33	2-075-033	-	143	283	380	600	-	-	143	305	600
1"	35	2-100-035	-	117	232	311	545	600	-	117	250	500
1"	47	2-100-047	-	-	118	159	280	559	-	-	128	351
1-1/4"	47	2-125-047	-	-	99	133	233	466	-	-	107	320
1-1/4"	81	2-125-081	-	-	-	79	139	278	-	-	64	128
1-1/2"	81	2-150-081	-	-	-	106	186	336	-	-	85	170
1-1/2"	105	2-150-105	-	-	-	-	104	208	-	-	-	95
2"	105	2-200-105	-	-	-	99	174	348	-	-	80	160
2"	360	2-200-360	-	-	-	-	90	180	-	-	-	80
2-1/2"	440	2-250-440	-	-	-	-	-	139	-	-	-	-
3"	390	2-300-390	-	-	-	-	-	139	-	-	-	-

Three-Way Valves			CLOSE-OFF RATING (PSI Differential)									
			Type A Non-Spring Return Motors (Actuator Type)						Type A Spring Return Motors (Actuator Type)			
NPT	CV	Model # [2 or 3-way] - [valve size] - [Cv]	EN44	EN88	EN132	EN177	EN310	Dual EN310	ES62	ES75	ES142	Dual ES142
1/2"	*	3-050-Cv	123	212	298	400	-	-	169	212	400	-
1/2"	6	3-050-006	123	212	298	400	-	-	169	212	400	-
3/4"	12	3-075-012	-	212	298	400	-	-	169	212	400	-
1"	14	3-100-014	-	117	232	311	400	-	-	117	250	400
1-1/4"	22	3-125-022	-	-	99	133	233	400	-	-	107	320
1-1/2"	30	3-150-030	-	-	79	106	186	348	-	-	85	170
2"	50	3-200-050	-	-	-	-	81	163	-	-	-	74
2"	91	3-200-091	-	-	-	-	81	163	-	-	-	74

Notes:

* Specify Cv in closest number when ordering reduced Cv (i.e., .5, 1, 2, 3... up to 5 for three-way and 9 for two-way).

- All sizes indicated are available with DEI RE Series actuators for outside applications where NEMA 4 is required or where a higher close-off is required.
- Add "-SBS" to end of model number if stainless ball and stem is desired (i.e., 2-050-9.8-SBS).
- Add "-SBS-HT" to end of model number for steam applications.
- Plastisol coated steel handle for manual override on larger non-spring models, optional on EN44 & 88.

Control Valve Close-off Rating Chart

Two-Way Valves			CLOSE-OFF RATING (PSI Differential)								
			Type B Non-Spring Return Motors (Actuator Type)						Type B Spring Return Motors (Actuator Type)		
NPT	CV	Model # [2 or 3-way] - [valve size] - [Cv]	EN53	EN70	EN140	EN210	EN280	Dual EN280	ES53	ES140	Dual ES140
1/2"	*	2-050-Cv	148	199	395	600	-	-	148	395	600
1/2"	9.8	2-050-9.8	148	199	395	600	-	-	148	395	600
3/4"	25	2-075-025	100	199	395	600	-	-	100	395	600
3/4"	33	2-075-033	-	133	300	451	600	-	-	300	600
1"	35	2-100-035	-	93	246	369	492	600	-	246	492
1"	47	2-100-047	-	-	126	189	252	504	-	126	252
1-1/4"	47	2-125-047	-	-	105	158	210	420	-	105	210
1-1/4"	81	2-125-081	-	-	62	117	155	311	-	62	155
1-1/2"	81	2-150-081	-	-	84	125	168	332	-	84	168
1-1/2"	105	2-150-105	-	-	-	88	117	234	-	-	117
2"	105	2-200-105	-	-	78	117	157	314	-	78	157
2"	360	2-200-360	-	-	-	-	81	162	-	-	81
2-1/2"	440	2-250-440	-	-	-	-	-	125	-	-	-
3"	390	2-300-390	-	-	-	-	-	125	-	-	-

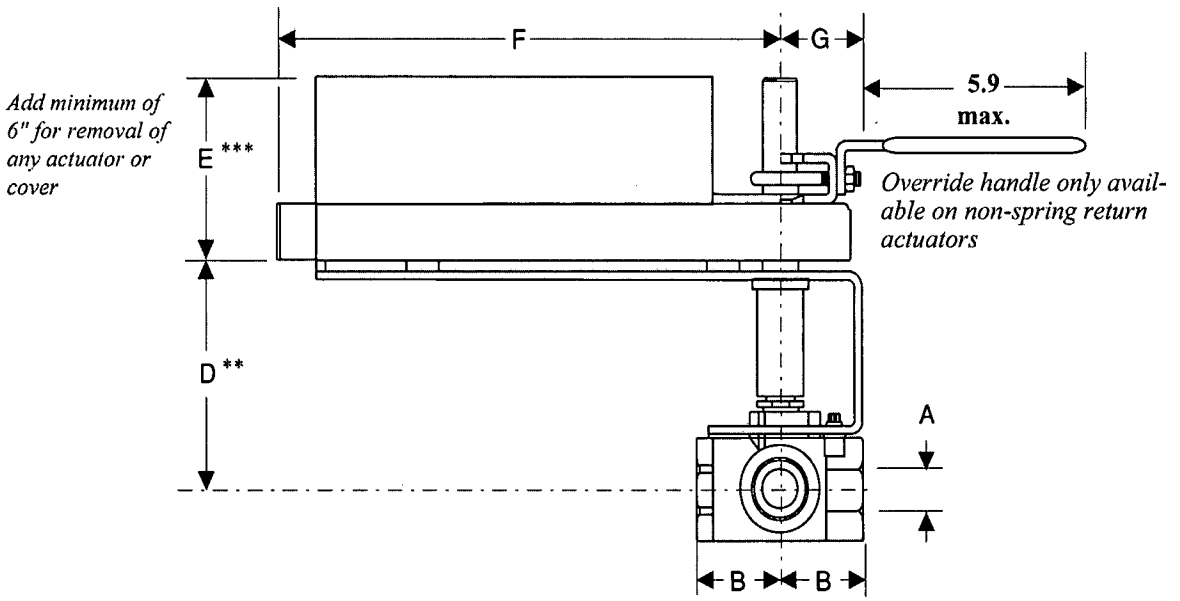
Three-Way Valves			CLOSE-OFF RATING (PSI Differential)								
			Type B Non-Spring Return Motors (Actuator Type)						Type B Spring Return Motors (Actuator Type)		
NPT	CV	Model # [2 or 3-way] - [valve size] - [Cv]	EN53	EN70	EN140	EN210	EN280	Dual EN280	ES53	ES140	Dual ES140
1/2"	*	3-050-Cv	148	199	395	400	-	-	148	395	400
1/2"	6	3-050-006	148	199	395	400	-	-	148	395	400
3/4"	12	3-075-012	100	133	300	400	-	-	100	395	400
1"	14	3-100-014	-	93	246	369	400	-	-	246	400
1-1/4"	22	3-125-022	-	-	105	158	210	400	-	105	210
1-1/2"	30	3-150-030	-	-	84	125	166	332	-	84	168
2"	50	3-200-050	-	-	-	55	73	146	-	-	73
2"	91	3-200-091	-	-	-	55	73	146	-	-	73

Notes:

* Specify Cv in closest number when ordering reduced Cv (i.e., .5, 1, 2, 3... up to 5 for three-way and 9 for two-way).

- All sizes indicated are available with DEI RE Series actuators for outside applications where NEMA 4 is required or where a higher close-off is required.
- Add "-SBS" to end of model number if stainless ball and stem is desired (i.e., 2-050-9.8-SBS).
- Add "-SBS-HT" to end of model number for steam applications.
- Plastisol coated steel handle for manual override on larger non-spring return models, optional on EN35 or EN53.

Two and Three-Way Commercial Electronic Ball Valves* (1/2" through 1" RP)



Two-Way Valve						
Size	Cv	Model No.	Dimensions (inches)			
			A	B	C†	D**
1/2" RP	****	2-050-Cv	0.5	1.1	NA	3.1
1/2" FP	9.8	2-050-9.8	0.5	1.1	NA	3.1
3/4" RP	25	2-075-025	0.7	1.5	NA	3.3
3/4" FP	33	2-075-033	0.8	1.6	NA	3.3
1" RP	35	2-100-035	0.9	1.7	NA	3.4
Three-Way Valve						
1/2" RP	****	3-050-Cv	0.5	1.1	1.2	3.1
1/2" RP	6	3-050-006	0.5	1.1	1.2	3.1
3/4" RP	12	3-075-012	0.7	1.5	1.6	3.3
1" RP	14	3-100-014	1.0	2.0	1.7	3.4

Actuator Selection Chart				
Actuator Type	Dimensions (inches)			
	E***	F	G	H‡
Type A Spring Return				
ES62	2.5	6.4	1.7	3.2
ES75/142	2.9	8.8	2.3	4.0
Type A Non-Spring Return				
EN44/88	2.4	3.8	1.7	2.8
EN132	2.5	6.4	1.7	3.2
EN177	2.9	8.8	2.3	4.0
Type B Spring Return				
ES53	3.6	5.7	1.6	3.3
ES140	3.5	7.7	2.2	4.6
Type B Non-Spring Return				
EN53	2.7	4.8	1.2	4.2
EN70/140 EN210/280	2.7	4.9	1.2	4.0

Notes:

* See Actuator Selection Chart (AC-A-1&2 and AC-B-1&2) and Control Valve Close-off Rating Chart (BV-6&7) to select actuator.

** Add 2.3 inches to dimension "D" for "-HT" applications.

*** Add 3" to dimension "E" for cover removal on Type B actuators.

**** Limited Cv set to specifications (i.e.: .5, 1, 2, 3...).

† "C" dimension is from center line of valve to face of port (three-way valves only).

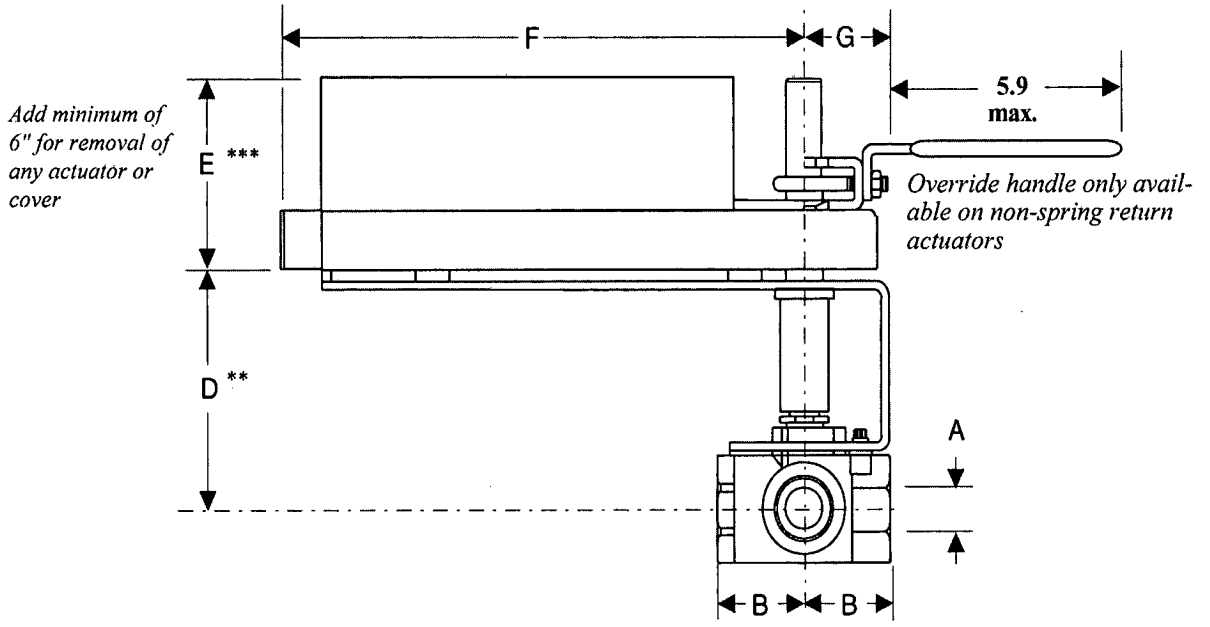
‡ "H" dimension is width of motor.

– FP=Full Port, RP=Reduced Port.

– Most assemblies are available with an optional NEMA 4/4X type housing. See applicable data sheets for details.

– Add "-SBS" to end of model number if stainless ball and stem is desired (i.e., 2-050-9.8-SBS).

Two and Three-Way Commercial Electronic Ball Valves*
(1" FP through 2")

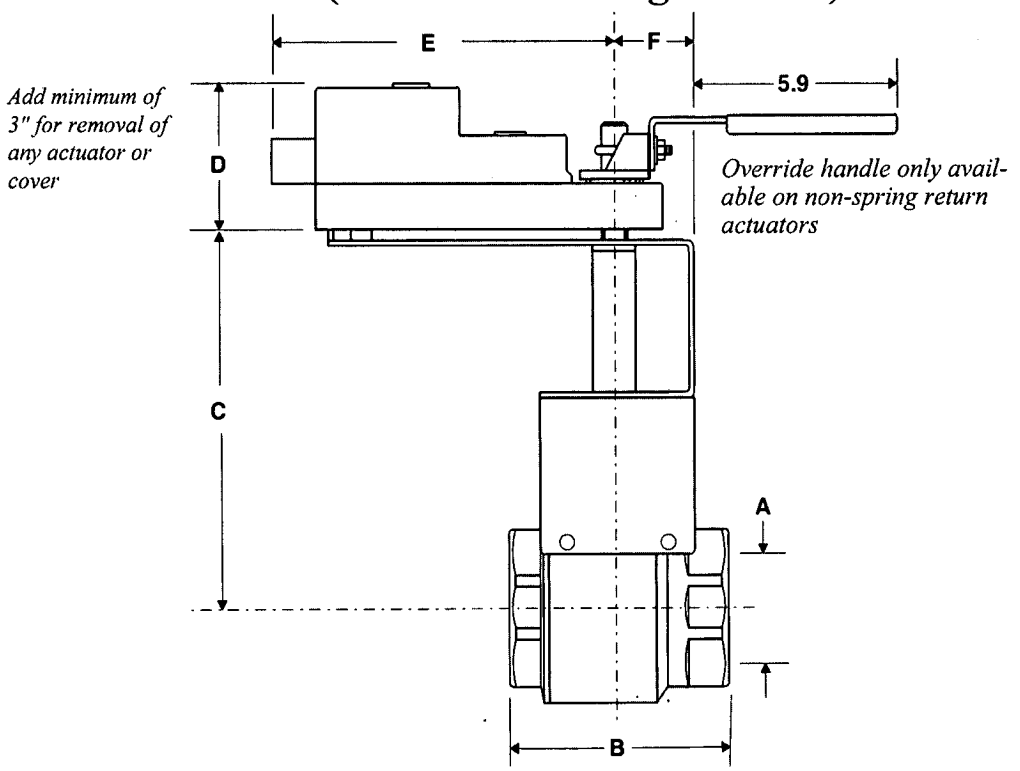


Two-Way Valve						
Size	Cv	Model No.	Dimensions (inches)			
			A	B	C†	D**
1" FP	47	2-100-047	1	1.8	NA	3.4
1-1/4" RP	47	2-125-047	1	2	NA	4.1
1-1/4" FP	81	2-125-081	1.3	2.1	NA	4.1
1-1/2" RP	81	2-150-081	1.3	2.2	NA	4.4
2" RP	105	2-200-105	1.5	2.4	NA	5.9
Three-Way Valve						
1-1/4" RP	22	3-125-022	1	2	2.4	4.1
1-1/2" RP	30	3-150-030	1.3	2.2	2.4	4.4
2" RP	50	3-200-050	1.5	2.4	2.5	5.9
2" FP	91	3-200-091	2	2.7	2.7	7.7

Actuator Selection Chart				
Actuator Type	Dimensions (inches)			
	E***	F	G	H‡
Type A Spring Return				
ES142	2.9	8.8	2.3	4.0
Type A Non-Spring Return				
EN132	2.5	6.4	1.7	3.2
EN177/310	2.9	8.8	2.3	4.0
Type B Spring Return				
ES140	3.5	7.7	2.2	4.6
Type B Non-Spring Return				
EN140/210/280	2.7	4.9	1.2	4.0

Notes:
* See Actuator Selection Chart (AC-A-1&2 and AC-B-1&2) and Control Valve Close-off Rating Chart (BV-6&7) to select actuator.
** Add 4.0 inches to dimension "D" for "-HT" applications.
*** Add 4.0 inches to dimension "E" for Dual actuator applications.
† "C" dimension from center line of valve to face of port (three-way valves only).
‡ "H" dimension is width of motor.
– FP= Full Port, RP=Reduced Port.
– Most assemblies are available with an optional NEMA 4/4X type housing. See applicable data sheets for details.
– Add "-SBS" to end of model number if stainless ball and stem is desired (i.e., 2-050-9.8-SBS).

Two-Way Side Mount Commercial Electronic Ball Valves* (1-1/2" FP through 3" RP)



Two-Way Valve					
Size	Cv	Model No.	Dimensions (inches)		
			A	B	C**
1-1/2" FP	105	2-150-105	1.5	4.8	8.2
2" FP	360	2-200-360	2	5.4	8.5
2-1/2" FP	440	2-250-440	2.5	6.5	8.9
3" RP	390	2-300-390	2.5	6.8	8.9

Actuator Selection Chart				
Actuator Type	Dimensions (inches)			
	D***	E	F	G†
Type A Spring Return				
ES142	2.9	8.8	2.3	4.0
Type A Non-Spring Return				
EN310	2.9	8.8	2.3	4.0
Type B Spring Return				
ES140	3.5	7.7	2.2	4.6
Type B Non-Spring Return				
EN210/280	2.7	4.9	1.2	4.0

Notes:

* See Actuator Selection Chart (AC-A-1-2 and AC-B-1-2) and Control Valve Close-off Rating Chart (BV-6-7) to select actuator.

** Dimensions in chart are valid for both standard and "-HT" applications.

*** Add 4.0 inches to dimension "D" for dual actuator applications.

† "G" dimension is width of motor.

– FP=Full Port, RP=Reduced Port.

– Most assemblies are available with an optional NEMA 4/4X type housing. See applicable data sheets for details.

– Add "-SBS" to end of model number if stainless ball and stem is desired (i.e., 2-050-9.8-SBS).

Electronic Ball Valves