

350 Series Electrohydraulic Actuators

350 Series electrohydraulic actuators (figure 1) use a dc milliampere signal to operate a variety of sliding-stem or rotary valves for proportional or two-position control. Configurations of specific types are described in table 1.

Available with an assortment of options including side-mounted handwheels, these actuators can be used in installations where only electric power is available or wherever accurate, reliable valve control is required in an all-electric system. **However, for hazardous area applications, the actuator must be equipped with an intrinsically safe control circuit. An explosion-proof motor is also required as part of the intrinsically safe application.**

Separate use of either an intrinsically safe control circuit or an explosion-proof motor results in an actuator with no hazardous area rating. For more information, refer to the hazardous area classifications bulletin.

Features

- **Simple Field Connections**—The self-contained design of the actuator houses all hydraulic and electrical components inside the case. No external piping is needed and the only field hookups are a control signal and a power line.
- **Versatility**—The 350 Series product line offers choices of stem connections, yoke boss sizes, thrusts and torques, and failure modes.
- **Minimum Downtime**—As a single assembly, the pump, motor, and coil are easily removed and replaced.
- **Easy, Convenient Adjustment**—When the cover is removed, zero and span adjustments are readily accessible (see figure 2).
- **High Thrust/High Torque**—Depending on construction, the actuators are able to deliver up to 22240 N (5000 pounds) of thrust or 794 N•m (7031 inch-pounds) of torque to handle requirements of large valves.



Figure 1. Type 350 Actuator with Side-Mounted Handwheel Mounted on Design ED Valve Body



Specifications

Type Number/Configuration Descriptions

See table 1

Input Signals⁽¹⁾

See table 2

Internal Resistance of Transducer Force Motor

See table 2

Power Supply Required

See table 3

Actuator Sizes

Types 350, 352, and 353: See table 4

Type 354:

■ Size 60 for 31.8, 38.1, or 50.8 mm (1-1/4, 1-1/2, or 2 inch) valve shaft spline diameter or

■ Size 80 for 63.5 mm (2-1/2 inch) valve shaft spline diameter

Action

Actuators with standard control circuits are field-reversible between direct (increasing input signal extends actuator piston rod) and reverse (increasing input signal retracts actuator piston rod). Actuators with intrinsically safe control circuits are not field reversible; either a direct- or reverse-acting coil is required.

Maximum Usable Output Thrust and Torque

Types 350, 352, and 352: See table 5

Type 354: See table 6

Bench Stroking Speed⁽²⁾

■ 8.6 mm/second (0.37 inches/second) for 8900 N (2000 pounds) output thrust or 318 N•m (2812 inch-pounds) output torque and

■ 3.8 mm/second (0.15 inches/second) for 22200 N (5000 pounds) output thrust or 794 N•m (7031 inch-pounds) output torque

Maximum Actuator Travel

Types 350, 352, and 353: See table 4

Type 354: 90 degrees

Pump Type

Positive-displacement, gear-type pump with relief valves

Hydraulic Fluid Requirements

10.4 liters (11 quarts) of Type A automotive automatic transmission fluid. If the actuator is used in ambient temperatures below -4°C (25°F), use an aircraft-type hydraulic fluid that conforms to MIL-H-5606A specifications.

Construction Materials

Casing, Mounting Plate, and Cover: Aluminum

Piston Rod: Chrome-Plated Steel

Cylinder: Steel

Piston and Bushing: Brass

O-Rings: Nitrile

Bellows Assembly and Nozzle: Stainless Steel

Yoke: Cast iron (fabricated steel for standard 127 mm [5-inch] yoke boss without handwheel)

Operative Temperature⁽¹⁾

Weather-Proof Motor: -40 to 40°C (-40 to 104°F)

Explosion-Proof Motor: -25 to 40°C (-13 to 104°F)

Performance

Hysteresis⁽¹⁾: 0.50 percent of span

Load Sensitivity: Stem position change 0.3 to 1.0 percent of total travel per 488 Newton (100 pound) change in load

Terminal-Based Linearity⁽¹⁾: ± 2 percent of total travel

Dead Band⁽¹⁾: Less than 0.5 percent of total travel

Frequency Response⁽¹⁾: See figure 4 for typical frequency response curves

Adjustments

Zero and span adjustments located under cover (figure 2)

Hazardous Area Classification

Actuators with intrinsically safe actuator control circuits are available. However, intrinsically safe control circuits must be combined with an explosion-proof motor. Separate use of either an intrinsically safe control circuit or an explosion-proof motor results in an actuator with no hazardous area rating. For more information, refer to the hazardous area classifications bulletin.

Motor Type

See table 3. Motor type designations refer to the motor only; not to the entire actuator.

-Continued -

Specifications (Continued)

Connections

Power: 1/2-inch NPT female conduit connection on motor

Input Signal: 1/2-inch NPT female conduit connection on side of casing

Seal Drain Off: 1/4 inch NPT female connection with vent assembly on top of yoke. This connection is furnished only on 72 mm (2-13/16 inch) and 90 mm (3-9/16 inch) yoke boss sizes of the Type 350, 352, and 353 actuators.

Approximate Weight

Types 350, 352, and 353 without Handwheels
72 mm (2-13/16 inch) Yoke Boss: 49 kg (110 pounds)

90 mm (3/9/16 inch) Yoke Boss: 64 kg (142 pounds)

127 mm (5-inch) Yoke Boss: 91 kg (200 pounds)

Type 354

Size 60: 86 kg (194 pounds)

Size 80: 123 kg (275 pounds)

Options

Lock Valves: Locks actuator in last position with loss of hydraulic pressure or electrical power

Cylinder Bypass Valve: Manually operated valve to equalize pressure above and below the piston; when open, allows handwheel operation

Side-Mounted Handwheel: See table 7 for information

1. This term is defined in ISA S51.1.
2. Stroking speed with actuator operating a valve under no load.

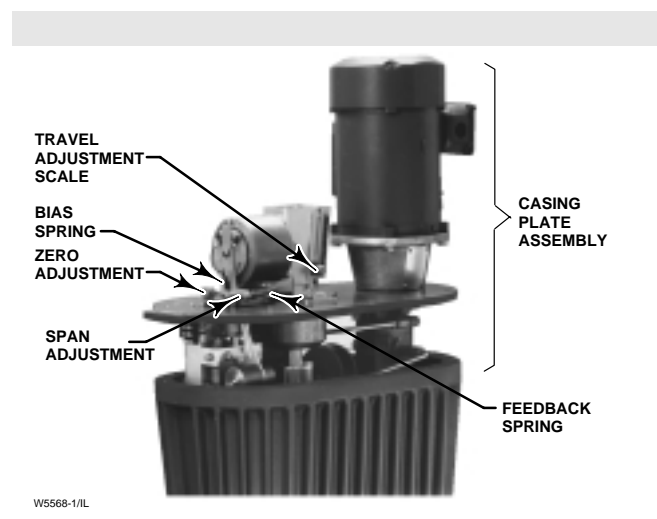
Table 1. Available Configurations

Type Number	Description	Used with
350	Electrohydraulic actuator with threaded stem connection	Sliding stem valves
352	Electrohydraulic actuator with threaded stem connection. A spring ensures that the piston rod completely retracts upon loss of hydraulic pressure or electrical power.	Sliding stem valves
353	Electrohydraulic actuator with threaded stem connection. A spring ensures that the piston rod completely extends upon loss of hydraulic pressure or electrical power.	Sliding stem valves
354	Electrohydraulic actuator with splined shaft connection.	Rotary shaft valves

Table 2. Input Signals and Coil Resistance

Control Circuit Type	Action	Input Signal, mA dc	Internal Resistance Ohms
Standard	Either - Field Reversible	1-5	2200
		4-20, 4-12, or 12-20	260
		10-50	380
Intrinsically safe	Direct ⁽¹⁾	4-20	160
	Reverse ⁽¹⁾	4-20	160

1. Action must not be reversed.



W5568-1/IL

Figure 2. Type 350 Actuator—Casing Plate Assembly

Bulletin 61.5:350

Table 3. Motor Types and Corresponding Power Supplies Required

	Weather-Proof Motor		Explosion-Proof Motor ⁽¹⁾	
Electrical Classification of Motor	Totally Enclosed; Continuous Service—Intrinsically safe control circuit not available with this motor		Explosion-proof. See the hazardous area classifications bulletin for the certification rating of the motor and actuator. Unless the control circuit is intrinsically safe and the motor is explosion proof, the actuator cannot be used in hazardous atmospheres.	
Type	Capacitor Start, Induction Run		Capacitor or Repulsion Start, Induction Run	
Horsepower	1/3		1/3	
Power Supply	115/230 ± 10% Vac, Single Phase, 60 Hz	220/440 ± 10% Vac, Three Phase, 50/60 Hz	115/230 ± 10% Vac, Single Phase, 60 Hz	220/440 ± 10% Vac, Three Phase, 50/60 Hz
Starting Current (Amps)	31 Max @ 115 Vac 15.5 Max @ 230 Vac	8 Max @ 220 Vac 4 Max @ 440 Vac	31 Max @ 115 Vac 15.5 Max @ 230 Vac	8 Max @ 220 Vac 4 Max @ 440 Vac
Running Current (Amps)	7.2 @ 115 Vac 3.6 @ 230 Vac	1.8 @ 220 Vac 0.9 @ 440 Vac	7.2 @ 115 Vac 3.6 @ 230 Vac	1.8 @ 220 Vac 0.9 @ 440 Vac
Speed	1725 RPM	1425/1725 RPM	1725 RPM	1425/1725 RPM

1. Explosion-proof classification pertains to the motor only, not the entire actuator.

Table 4. Maximum Actuator Travel for Types 350-353

TYPES	YOKE BOSS SIZE		TRAVEL	
	mm	Inch	mm	Inch
350 without handwheel	72 90 or 127	2-13/16 3-9/16 ⁽¹⁾ or 5	38 76	1-1/2 3
350 with handwheel	72 90 127	2-13/16 3-9/16 ⁽¹⁾ 5	38 64 76	1-1/2 2-1/2 3
352 with or without handwheel	72 90	2-13/16 3-9/16 ⁽¹⁾	38 76	1-1/2 3
353 with or without handwheel	72 90	2-13/16 3-9/16 ⁽¹⁾	38 51	1-1/2 2

1. An actuator with this yoke boss size uses a 19.1 mm (3/4 inch) stem. When this size actuator stem is used, the valve stem must be less than the standard length.

Table 5. Usable Thrust Output of Type 350, 352, and 353 Actuators at Maximum Travel⁽¹⁾

Actuator Type	350		352						353			
	(w/ or w/o handwheel)								(w/ or w/o handwheel)			
Yoke Boss Size, mm (Inch)	72 (2-13/16)	90 or 127 (3-9/16 or 5)	72 (2-13/16) w/ or w/o handwheel		90 (3-9/16) w/o handwheel		90 (3-9/16) w/handwheel		72 (2-13/16)		90 (3-9/16)	
Travel, mm (Inch)	38 (1-1/2)	64 or 76 (2-1/2 or 3)	38 (1-1/2)		76 (3)		76 (3)		38 (1-1/2)		51 (2)	
Gross Cylinder Output Thrust, N (Lb)	8896 (2000)	8896 or 22240 (2000 or 5000)	8896 (2000)		22240 (5000)		22240 (5000)		8896 (2000)		22240 (5000)	
Usable Output Thrust, N (Lb)	8896 (2000)	8896 or 22240 (2000 or 5000)	Up ⁽³⁾ 2322 (522)	Down ⁽³⁾ 4252 (956)	Up ⁽³⁾ 2224 (500)	Down ⁽³⁾ 6672 (1500)	Up ⁽³⁾ 6538 (1470)	Down ⁽³⁾ 4492 (1010)	Up ⁽³⁾ 3478 (782)	Down ⁽³⁾ 3096 (696)	Up ⁽³⁾ 6672 (1500)	Down ⁽³⁾ 6672 (1500)
Spring Rate, N/mm (Lb/Inch)	---	---	60.9 (348)		175.1 (1000)		147.1 (840)		60.9 (348)		175.1 (1000)	
Maximum Initial Spring Compression, N (Lb)	---	---	2322 (522)		2224 (500)		6539 (1470)		3069 (696)		6672 (1500)	
Maximum Allowable Spring Load, N (Lb)	---	---	5496 (1220)		15568 (3500)		18236 (4100)		5337 (1220)		15568 (3500)	

1. Thrusts given are the thrusts available for operation of control valves. Under some conditions, such as with the valve plug stalled, higher thrusts can be developed. The control valve stem must be capable of withstanding this higher thrust; see "Maximum Thrust Output" section. Usable output thrust shown for Type 352 and 353 actuators are attained only with maximum initial spring compression and valve plug travel given in this table. Thrust in the down position for Type 352 actuators and in the up position for Type 353 actuators is the gross cylinder output thrust [8896 or 22240 Newtons (2000 or 5000 pounds)] less the total force of spring compression (initial spring compression plus compression due to travel).

2. Specific configurations are shown in table 4.

3. "Up"—piston rod retracted; "Down"—piston rod extended.

**Table 6. Usable Torque Output of Type 354
Size 60 and 80 Actuators at Maximum Travel**

Gross Cylinder Output Thrust, N (Lb)	8800 (2000)	22000 (5000)
Valve Disk or Ball Rotation, Degrees	0-90	0-90
Usable Torque Output, N•m (Lbf•in)	318 (2812)	794 ⁽¹⁾ (7031) ⁽¹⁾
1. Do not exceed torque capabilities of the valve shaft.		

Table 7. Side-Mounted Handwheels for Type 350, 352, and 353 Actuators

YOKE BOSS SIZE, mm (INCHES)	ACTUATOR TYPE	HANDWHEEL TYPE	OPERATION			MAXIMUM ACTUATOR TRAVEL WITH HANDWHEEL mm (INCHES)
			Positioning of Valve	Use As Travel Stop	Action Required for Unrestricted Travel	
72 (2-13/16)	350	Bolt-On	Non-Declutchable	Open or Close	Up or Down	38 (1-1/2)
			Declutchable	Open, Close, or Throttle	- - -	
	352 & 353	Bolt-On	Non-Declutchable	Open, Close, or Throttle	Up or Down	
			Declutchable	Open, Close, or Throttle	- - -	
90 (3-9/16)	350	Bolt-On	Non-Declutchable	Open or Close	Up or Down	51 (2)
			Declutchable	Open, Close, or Throttle	- - -	64 (2-1/2)
	352	Integrally Mounted	Open, Close, or Throttle	Up or Down	Neutral Position	76 (3)
	353	Bolt-On	Non-Declutchable	Open, Close, or Throttle	Up or Down	51 (2)
			Declutchable	Open, Close, or Throttle	- - -	64 (2-1/2)
	350	Integrally Mounted	Open, Close, or Throttle ⁽¹⁾	Up or Down	Neutral Position & Disengage Pin	76 (3)
1. Can also open or close valve in emergency without inserting engaging pin.						

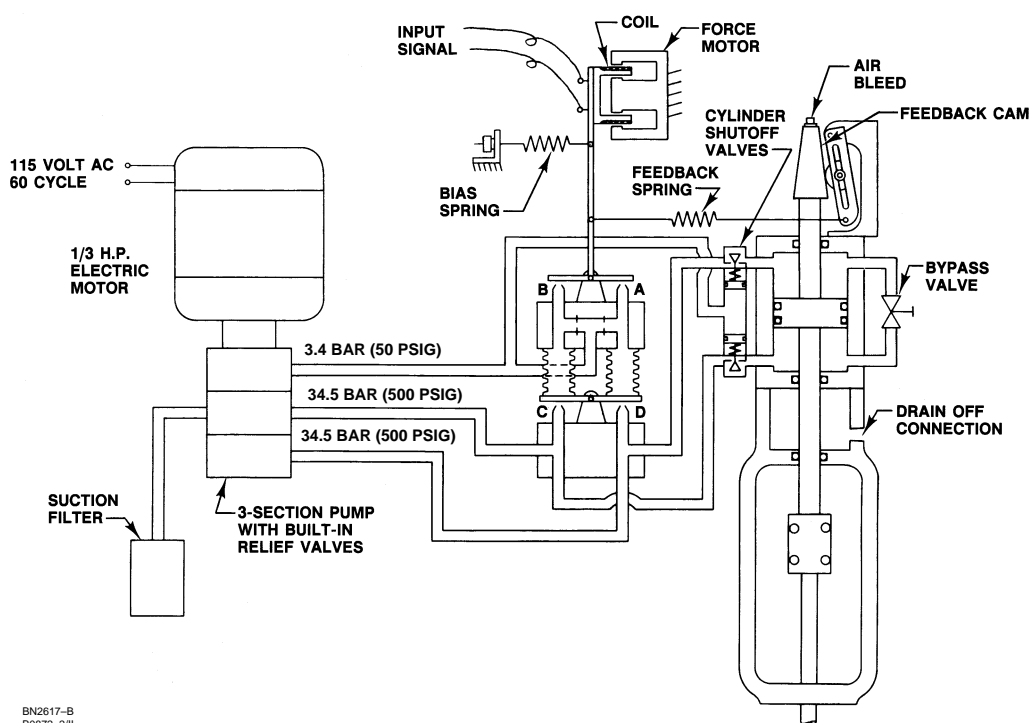


Figure 3. Operational Schematic of Type 350 Actuator

Principle of Operation

Figure 3 is the operational schematic of a direct-acting actuator. A reverse-acting actuator operates similarly except that an increasing input signal retracts the actuator piston rod.

As the input signal increases, the magnetic field around the coil builds, moving the coil toward the force motor and pivoting a flapper closer to nozzle A and farther from nozzle B. The unbalanced pressure in the bellows pivots a flapper closer to nozzle D and farther from nozzle C. Capping nozzle D increases the pressure that is piped to the top of the cylinder. Increased pressure on top of the piston pushes the piston and piston rod downward. Fluid below the piston is exhausted into the casing through nozzle C.

As the piston moves downward, the taper of the feedback cam allows the feedback lever to move to the left, decreasing tension in the feedback spring. Downward movement occurs until the tension in the feedback

spring balances the force created by the force motor. At equilibrium, the flappers are in a steady state condition and the valve stem is positioned as dictated by the input signal.

In a similar manner, a decreasing input signal moves the coil away from the force motor and the piston rod moves upward.

Actuator Frequency Response

Figure 4 shows how a 350 Series actuator responds when the input signal is cycled at a small amplitude and increasing frequency. Assume the cycling input signal and the movement of the actuator rod are represented by sine waves. As the actuator rod is forced to move faster, its motion begins to fall behind the input in both time (shown here as phase lag) and amplitude (shown as normalized gain).

Both phase lag and normalized gain are affected by the inertia of the actuator rod. Consequently, changes are more pronounced during longer travels.

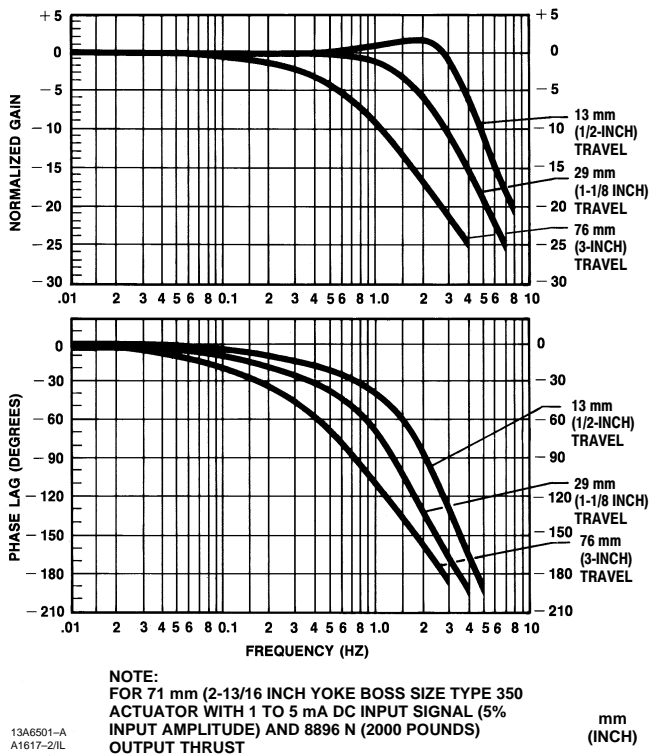


Figure 4. Typical Frequency Response Curves

Installation

For proper operation, the actuator must be installed in a vertical position above the valve. If oil leakage will create a fire hazard, remove the vent from the actuator yoke (if the unit is equipped with a double piston rod seal and seal drain-off connection) and install a remote drain pipe to carry oil seal leakage away from the actuator. Dimensions of the actuator are shown in figures 5 and 6.

Split-Range Capabilities

Should the need arise, two 350 Series actuators can be operated from one input signal. For example, using a 4 to 20 mA dc signal, one actuator accepts half the signal and is adjusted to begin travel (0 percent of span) at 4 mA dc and reach 100 percent of span at

12 mA dc. The other actuator accepts the other half of the signal and is adjusted to begin travel (0 percent of span) at 12 mA dc and reach 100 percent of span at 20 mA dc.

The coil used for the standard 4 to 20 mA dc signal can also be used for a 4 to 12 and 12 to 20 mA dc split. However, for split range operation with a 1 to 5 mA dc input signal, special coils must be obtained.

Intrinsically safe control circuits cannot be used for split ranges.

Maximum Thrust Output

Usable thrust outputs are shown in table 5. Under normal conditions, the output thrust of Type 352 and 353 actuators (with spring) is the cylinder output thrust minus the spring force. In some cases, such as with the valve plug stalled, the output thrust of the cylinder and the spring force can act in the same direction. Therefore, for the purpose of determining suitability of a valve plug stem material, the maximum output thrust of Type 352 and 353 actuators must be considered to be the sum of cylinder output thrust and total spring force (initial spring compression plus spring compression due to travel).

Ordering Information

When ordering, please specify,

Application

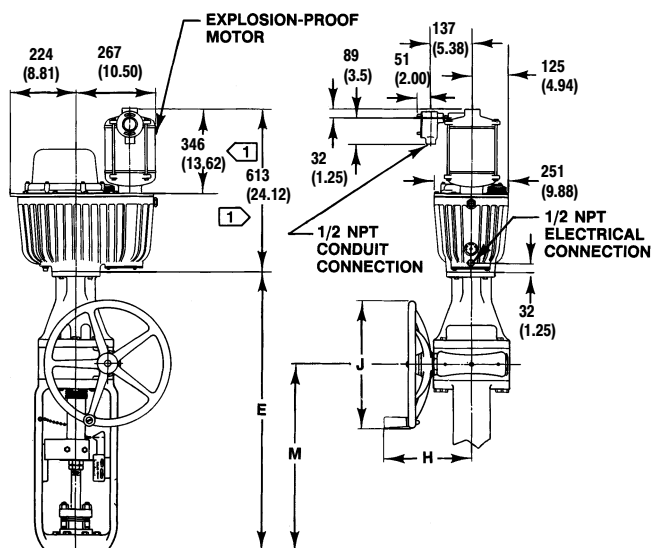
1. Control valve information, including type number or design designation, size, stem connection size, and action.
2. Control valve inlet pressure, shutoff pressure drop, flowing pressure drop, and process fluid temperature.

Actuator

Refer to the specifications table on page 2. Review the description to the right of each specification and in the referenced tables. Specify your choice wherever there is a selection to be made. For Type 354 actuators, specify mounting style and position from figure 7.

ACTUATOR TYPE	C		E			H			J			M		
	Millimeters													
	Yoke Boss Size		Yoke Boss Size			Yoke Boss Size			Yoke Boss Size			Yoke Boss Size		
	71	90	71	90	127	71	90	127	71	90	127	71	90	127
350	279	348	346	459	422 ⁽¹⁾ 951 ⁽²⁾	286	378	303	305	356	432	248	370	645
352	641	849 ⁽¹⁾ 1026 ⁽²⁾	653	861 ⁽¹⁾ 1037 ⁽²⁾	---	375	292	---	356	432	---	306	446	---
353	694	710	705	721	---	375	378	---	356	356	---	362	378	---
ACTUATOR TYPE	Inches													
	Yoke Boss Size		Yoke Boss Size			Yoke Boss Size			Yoke Boss Size			Yoke Boss Size		
	2-13/16	3-9/16	2-13/16	3-9/16	5	2-13/16	3-9/16	5	2-13/16	3-9/16	5	2-13/16	3-9/16	5
350	11	13.69	13.62	18.06	16.62 ⁽¹⁾ 37.44 ⁽²⁾	11.25	14.88	11.94	12.00	14.00	17.00	9.75	14.56	25.38
352	25.25	33.44 ⁽¹⁾ 40.38 ⁽²⁾	25.69	33.88 ⁽¹⁾ 40.81 ⁽²⁾	---	14.75	11.50	---	14.00	17.00	---	12.06	17.56	---
353	27.31	27.94	27.75	28.38	---	14.75	14.88	---	14.00	14.00	---	14.25	14.88	---
1. Without handwheel. 2. With handwheel.														

1. Without handwheel.
2. With handwheel.



NOTE:

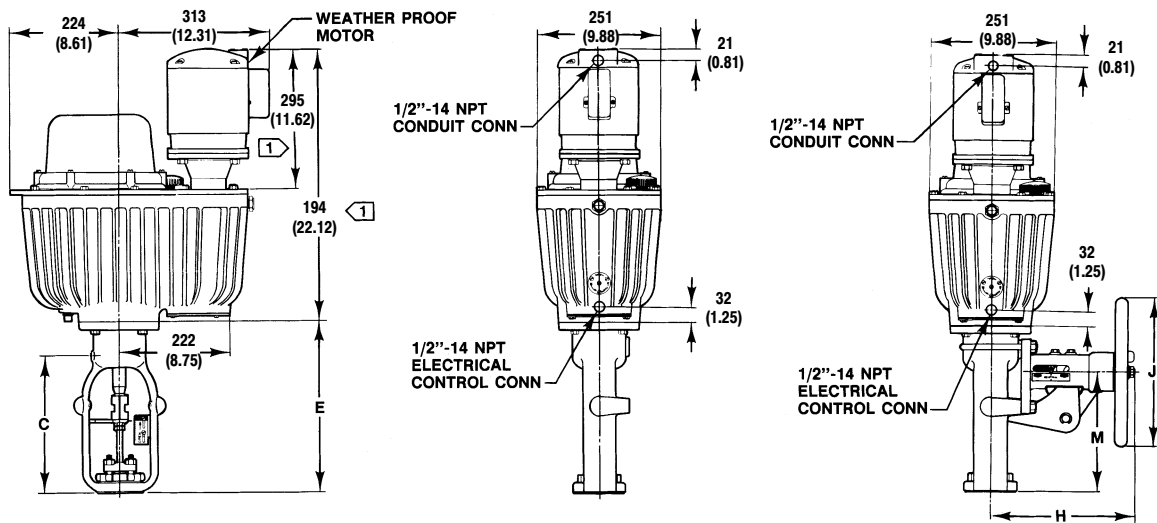
1 DIMENSIONS SHOWN ARE TYPICAL DIMENSIONS
AND MAY VARY WITH MOTOR MANUFACTURER.

mm
(INCH)

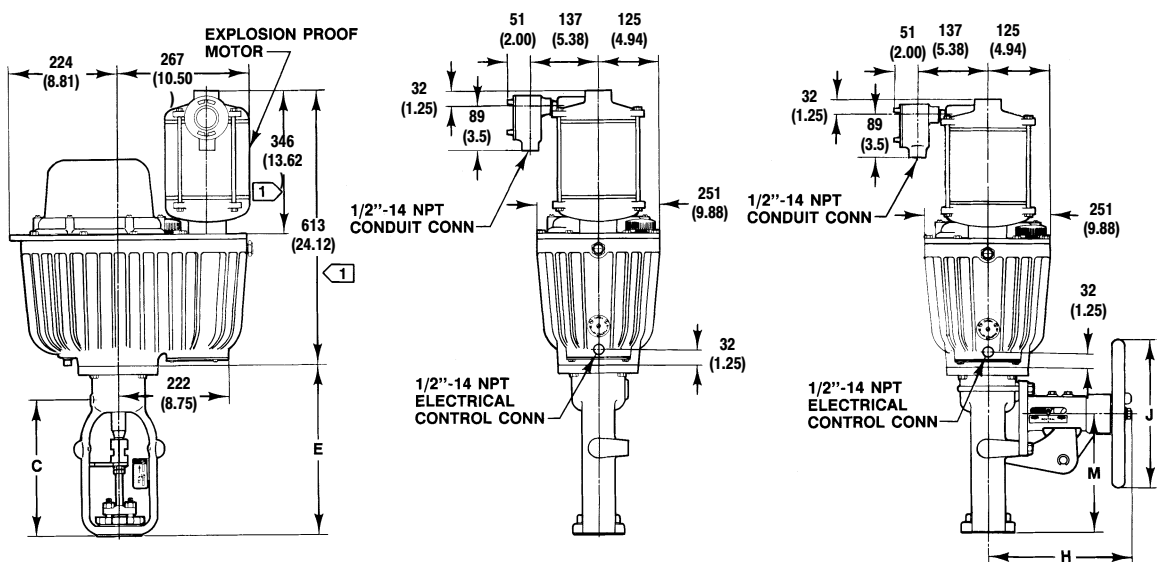
**127 mm (5-INCH) YOKE BOSS SIZE TYPE 350 ACTUATOR
WITH EXPLOSION-PROOF MOTOR & INTEGRAL HANDWHEEL**

CK1314-B
A1618-2/IL

Figure 5. Type 350-353 Dimensions



72 mm (2-13/16 INCH) AND 90 mm (3-9/16 INCH) YOKE BOSS SIZE TYPE 350 ACTUATOR WITH WEATHER-PROOF MOTOR—SEE TABLE FOR LETTERED DIMENSIONS



72 mm (2-13/16 INCH) AND 90 mm (3-9/16 INCH) YOKE BOSS SIZE TYPE 350 ACTUATOR WITH EXPLOSION-PROOF MOTOR—SEE TABLE FOR LETTERED DIMENSIONS

NOTE:
 1 DIMENSIONS SHOWN ARE TYPICAL DIMENSIONS
 AND MAY VARY WITH MOTOR MANUFACTURER.

AK1187-F
 AL3675-F
 C0238-3/IL

mm
 (INCH)

Figure 5. Type 350-353 Dimensions (Continued)

ACTUATOR SIZE	SHAFT DIAMETER	E	F	H	P	T	U	V	W DIAMETER	Y
Millimeters										
60	31.8	441	63	124	186	234	46	148	17.5	76
60	50.8	441	63	124	186	273	51	286	20.6	76
80	63.5	597	123	213	346	337	76	235	23.9	127
Inches										
60	1-1/4	17.38	2.50	4.88	7.31	9.25	1.81	5.81	0.69	3.00
60	2	17.38	2.50	4.88	7.31	10.75	2.00	11.25	0.81	3.00
80	2-1/2	23.50	4.84	8.38	13.62	13.25	3.00	9.25	0.94	5.00

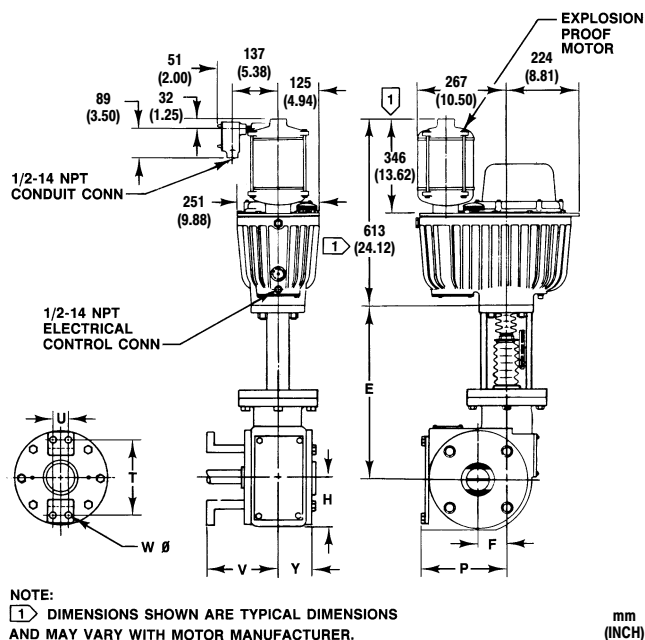
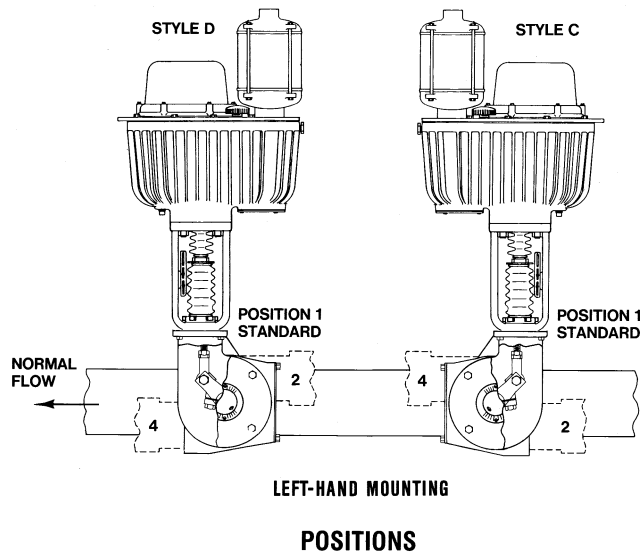
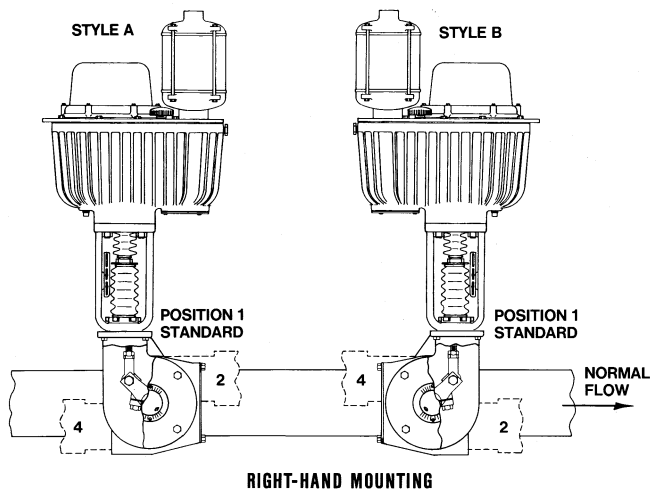


Figure 6. Type 354 Dimensions



NOTE:
USE POSITIONS 2 OR 4 ONLY WITH VERTICAL PIPELINES WHERE
ACTUATOR CASING WILL BE VERTICAL ABOVE THE VALVE.

43A6505-A
C0683

MOUNTING	ACTION ⁽¹⁾	VALVE SERIES OR DESIGN		
		V100, V150, V200 V250, V300	8500 Series, 7600	CV500, V500
Right-hand	PDTC	A	B	A
	PDTO	B	A	B
Left-hand	PDTC	C	C	D
	PDTO	D	D	C

1. PDTC—Push-down-to-close; PDTO—Push-down-to-open.

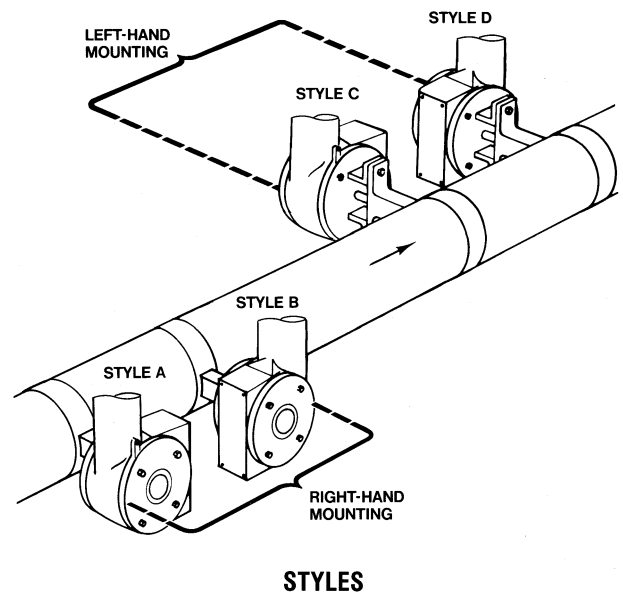


Figure 7. Mounting Styles and Positionings for the Type 354 Actuator

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