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**SERIES 98C**

# **PNEUMATIC COMPACT SCOTCH YOKE ACTUATOR**

TECHNICAL SALES MANUAL



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**Bray**<sup>®</sup>

**BRAY.COM**

**THE HIGH PERFORMANCE COMPANY**

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## OVERVIEW

Series 98C actuators are designed for pneumatic operation to a maximum pressure of 150 psi (10.3 Bar) and temperature ranges of -50°F to 300°F (-46°C to 149°C).

With hundreds of possible configurations, the Series 98C meets a variety of application requirements making it suitable for various valve types and operational needs.

The non-pressurized central body minimizes air consumption by using all instrumentation air to power the actuator, rather than filling the empty void of the torque housing. This design reduces the number of pressure seals creating a more robust and reliable actuator design by reducing the potential for unintended air leak paths.

This compact scotch yoke actuator has been tested to withstand up to 1,000,000 cycles ensuring long-term performance and reliability.

- > Compact design offers a high torque-to-weight ratio
- > Torque output ranging up to 17,701 lbf-in (2,000 Nm)
- > Spring end torque ranging up to 6,325 lbf-in (715 Nm)
- > Premium epoxy/polyurethane coating as standard
- > Available power options include pneumatic, hydraulic or electro-hydraulic

### INDUSTRIES

- > Industrial Gas
- > Chemical & Petrochemical
- > Food & Beverage
- > Data Center
- > HVAC
- > Marine & Shipbuilding
- > Mining & Metals
- > Oil & Gas
- > Pharma & Biotech
- > Power/FGD
- > Pulp & Paper
- > Water & Wastewater

### APPLICATIONS

- > Open / Close
- > On / Off
- > Modulating
- > Emergency Shutdown
- > Blowdown



### COMPLIANCES

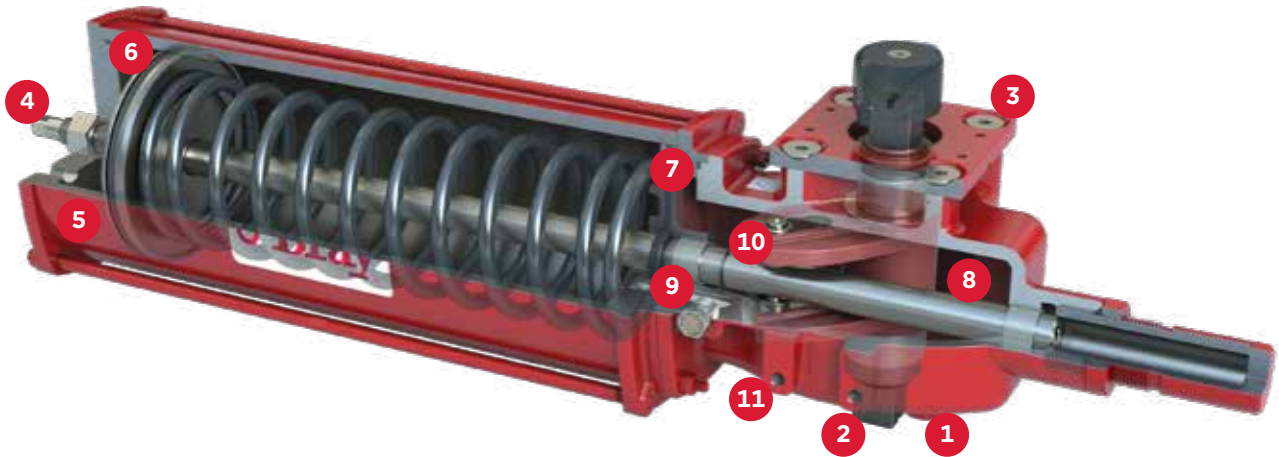
<b>Torque Base</b>	Mounting Dimensions as per ISO 5211: 2001(E)
<b>Accessories</b>	Shaft Driven Accessories mounting per NAMUR-VDE
<b>Performance Testing</b>	EN 15714-3:2022
<b>Ingress Protection</b>	IP66/IP67M per IEC 60529
<b>Safety</b>	ATEX, SIL 3 suitable, PED

### SPECIFICATIONS

<b>Media</b>	Dry Compressed Air/Inert Gas/Natural Gas
<b>Pressure Range</b>	40 - 150 psi (2.8 - 10.3 bar)
<b>Temperature Range</b>	Standard: -20°F to 200°F (-29°C to 93°C)
<b>Options</b>	High Temperature: Up to 300°F (149°C)
	Low Temperature: Down to -50°F (-46°C)

Contact factory for other media or non-standard temperature range.

**FEATURES & BENEFITS**



- 1 ISO 5211 Valve Mounting:** Two bolting surfaces for rapid integration in either Fail CW or CCW valve operation.
- 2 Dual Male Square Drive Stems:** Provides easy integration with various valve types ensuring compatibility and reducing installation complexity.
- 3 Standard NAMUR 3845 Interface:** Attached to the actuator ISO 5211 interface, easily convertible to support either Fail CW or Fail CCW configurations.
- 4 Blowout-proof Travel Stop:** Provides additional safety by minimizing risk of actuator damage caused by operator error during travel stop adjustment or mechanical failure.
- 5 Honed and Hard Chrome Plated Cylinder Barrel:** Improves actuator efficiency by reducing friction while providing superior corrosion resistance.
- 6 Quad Seal Rings:** Ensure long-term sealing reliability, reducing maintenance requirements and extending the product's lifecycle.
- 7 Pressure Seals:** Reduced number of pressure seals contributes to a more robust and reliable actuator design, reducing potential for unintended air leak paths.
- 8 Hard Chrome Plated Piston Rod:** Increases surface hardness which improves wear resistance of the piston rod and provides a smooth corrosion resistant surface for prolonged bearing and seal life.
- 9 Self-lubricating PTFE bushings:** Supports the torque shaft and piston rod offering extended life and secure alignment.
- 10 Dry Film Lubricated Roller Bearings:** Reduces friction and provides superior performance in demanding applications.
- 11 Dual Accessory Mounting Pads:** For attaching actuator accessories and controls.

**RANGE**

Model	ISO Base	Rated Torque		Spring End Torque, Nm		Spring End Torque, lbf-in		Drive Shaft Square Dimension		Drive Shaft Engagement	Over Travel
		Nm	lbf-in	Min	Max	Min	Max	mm	inch	mm	± Degrees
<b>25E1</b>	F07	250	2,213	57	122	501	1,078	17.0	0.67	22.5	5
<b>50E1</b>	F10	500	4,426	102	237	904	2,099	22.0	0.87	24	5
<b>10E2</b>	F12	1,000	8,851	150	450	1,187	3,554	27.0	1.06	32	5
<b>20E2</b>	F14	2,000	17,702	305	715	2,702	6,325	36.0	1.42	38	5

**Configurations**

DA	Double Acting
SR-CW	Spring Return - Fail CW
SR-CCW	Spring Return - Fail CCW

**Operating Conditions**

Pressure Range	40-150 psi	
Media	Dry Compressed Air / Inert / Natural Gas	Contact factory for other media
Temperature Range - Standard Options	Standard : -20°F to 199°F (-29°C to 93°C)	PED Contact factory for extended ranges
	High Temp : 14°F to 300°F (-10°C to 149°C)	
	Low Temp : -50°F to 140°F (-46°C to 60°C)	
		Non-PED

**Compliances**

Torque Base	Mounting dimensions per ISO 5211
Accessories	Shaft Driven Accessories Mounting Adaptation as per NAMUR-VDE
Testing	In accordance with EN 15714-3
Ingress Protection	IP66, IP67M & IP68 per IEC 60529
Safety	ATEX, SIL 3, PED

## ACCESSORIES

Add to the versatility of the S98C by choosing the applicable accessories from Bray's complete line of positioners, status monitors and solenoids. The combination of actuators and accessories offer the best compatibility, economy and quality performance in the flow control industry.

### S5A/S5B/S5C VALVE STATUS MONITORS

- > High visibility position indicator with double seal to prevent water ingress
- > Shatter and UV resistant dome
- > Stainless steel captive cover bolts
- > Easy access terminals
- > Splined cams for easy and accurate adjustment without tools



### S54 VALVE PROXIMITY SENSORS

- > Two independent sensors for open and close valve position indication
- > Optimized for indoor and outdoor use
- > Rugged design resistant to shock, vibration, UV and corrosion
- > Hermetically sealed to protect against the ingress of liquids or solids
- > Maintenance free design
- > Non-contact sensor eliminates the effect of mechanical wear
- > Eliminates potential switch welding, arcing and sparking
- > Quick and easy installation
- > LED indication for sensor power, switch and solenoid status
- > AS-i sensor available for digital network solution for valve actuator interface
- > DC 2-wire sensor available for hazardous area process environments

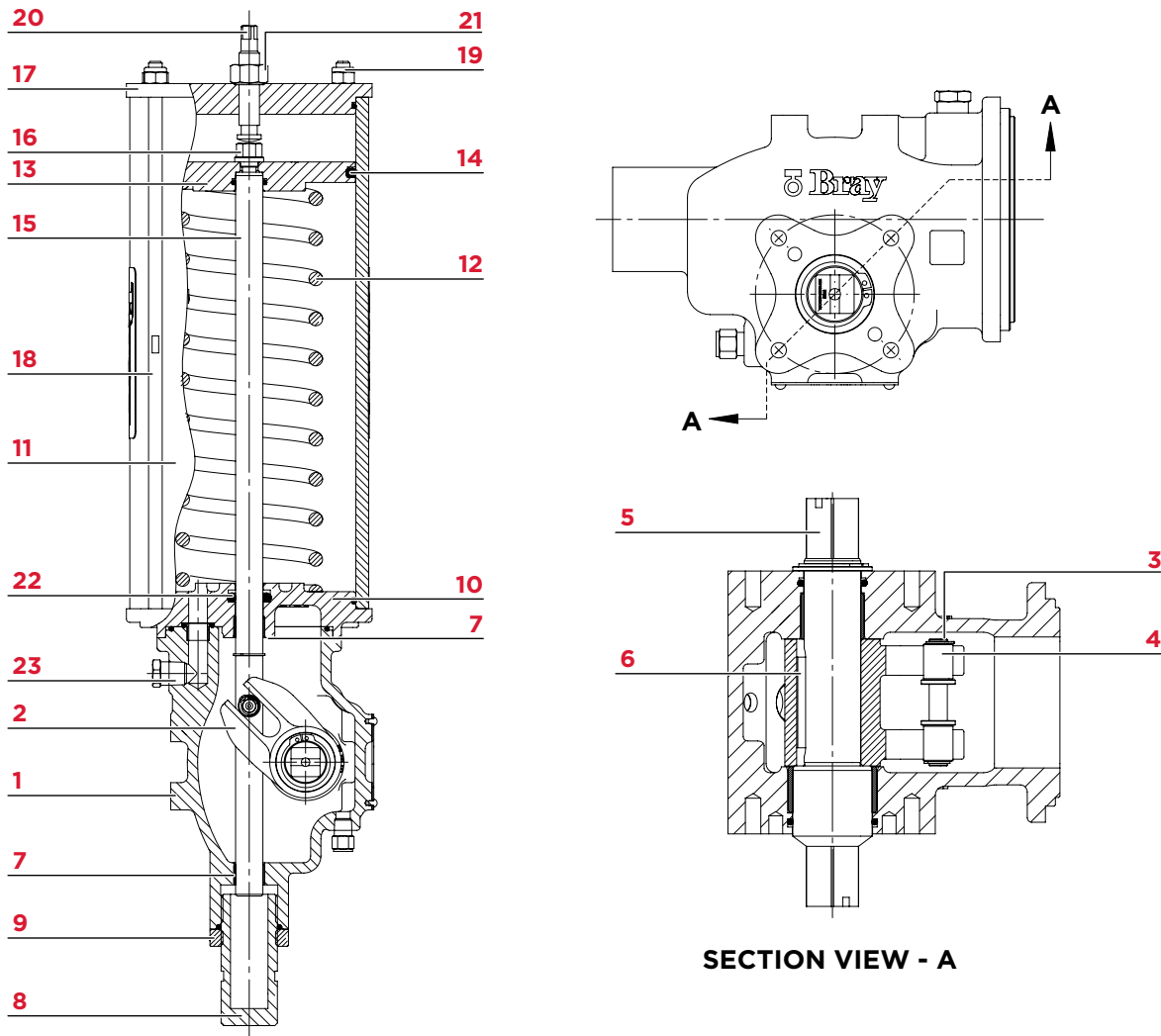


### SERIES 6A ELECTRO-PNEUMATIC POSITIONERS

- > Smart Digital Positioner for precise control of valve in various applications
- > Low air consumptions thanks to zero bleed design
- > Compatible with rotary or linear actuators for single and double acting applications
- > Various enclosure options available to withstand challenging environmental conditions
- > Equipped with on-board diagnostics checks to support preventative and efficient maintenance
- > Local user interface for quick and easy positioner configuration
- > Modular design capable of field upgradeable options
- > Integral volume booster available for fast operation of large valves
- > Fail safe, fail in place, fail to open options available
- > Advanced communications via PROFIBUS PA, Foundation Fieldbus and HART



**MATERIALS OF CONSTRUCTION - STANDARD ACTUATOR**



**SECTION VIEW - A**

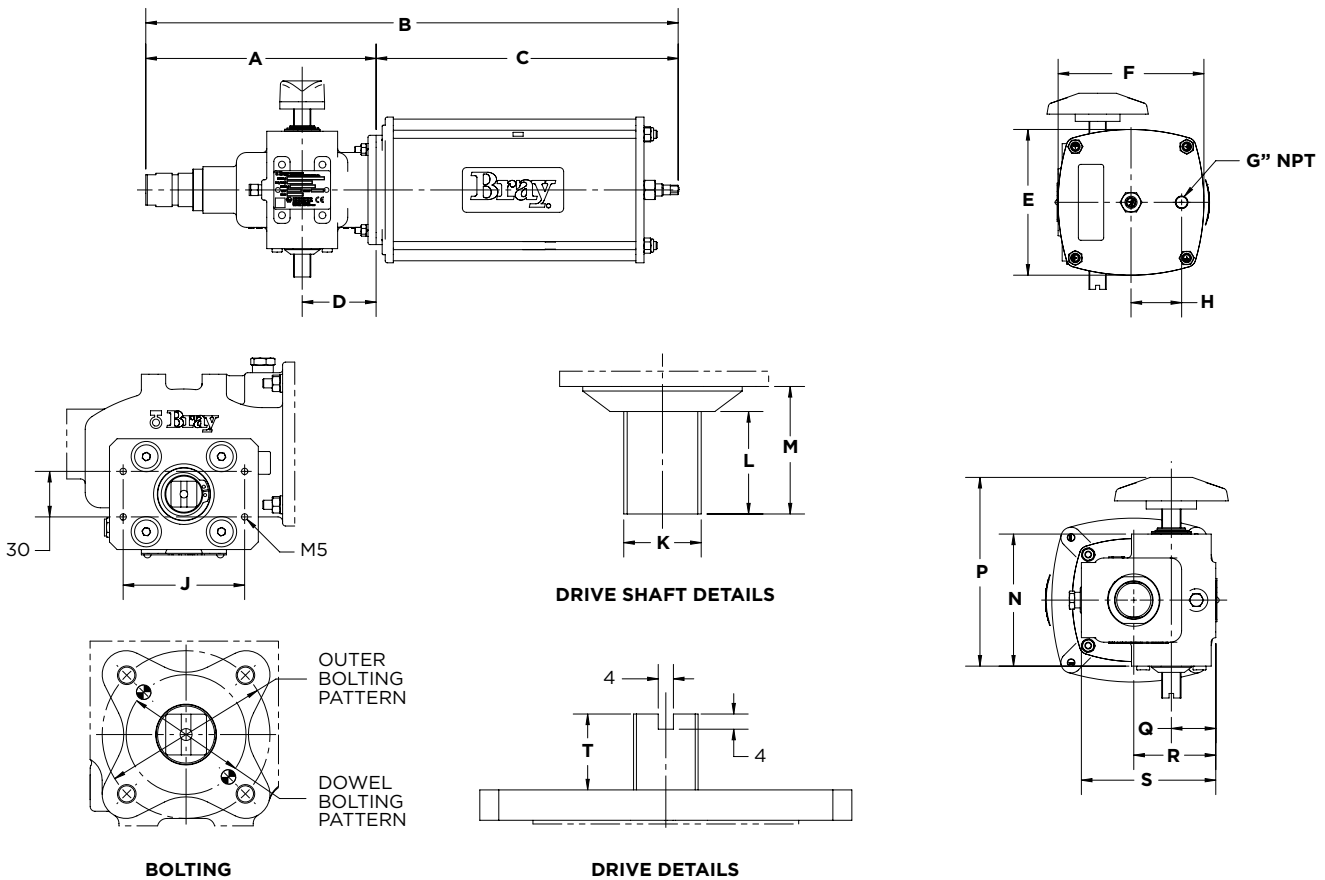
ITEM	DESCRIPTION	MATERIAL
1	HOUSING	DUCTILE IRON
2	YOKE	CARBON STEEL
3	YOKE PIN	ALLOY STEEL
4	ROLLER	ALLOY STEEL
5	DRIVE SHAFT	ALLOY STEEL
6	KEY	CARBON STEEL
7	BEARING	PTFE BRONZE
8	SLEEVE STOPPER	CARBON STEEL
9	STOPPER LOCK NUT	CARBON STEEL
10	ADAPTER PLATE	CARBON IRON
11	BARREL	CARBON STEEL
12	SPRING	ALLOY STEEL

ITEM	DESCRIPTION	MATERIAL
13	PISTON	CARBON STEEL
14	QUAD SEAL	NITRILE
15	PISTON ROD	ALLOY STEEL
16	HEX BOLT	ALLOY STEEL
17	END PLATE	CARBON STEEL
18	TIE ROD	ALLOY STEEL
19	TIE ROD NUT	CARBON STEEL
20	STOPPER BOLT	ALLOY STEEL
21	STOPPER BOLT NUT	STAINLESS STEEL
22	ROD SEAL	NITRILE
23	BREATHER	STAINLESS STEEL

**NOTES**

- 1 All fasteners on Standard actuators are Zinc plated with Blue Trivalent coating.
- 2 Standard coating is epoxy base coat (75-150 microns) with polyurethane top coat (50-75 microns).
3. For additional details, refer to pages 28-33

**NOMINAL MAXIMUM DIMENSIONS - DOUBLE ACTING**



**SERIES 98C MAX DIMENSIONS, mm**

Model	ISO Base	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T
25E1	F07	228	431	203	73	164	164	1/4"	57	80	17	23	28	116	166	39	72	118	20
50E1	F10	285	531	246	83	184	184	1/4"	67	80	22	24	30	124	176	50	95	151	20
10E2	F12	369	686	317	120	226	226	3/8"	85	130	27	32	40	148	210	57	114	180	30
20E2	F14	426	792	366	135	246	246	1/2"	93	130	36	38	47	181	265	72	137	213	30

**SERIES 98C MAX DIMENSIONS, inch**

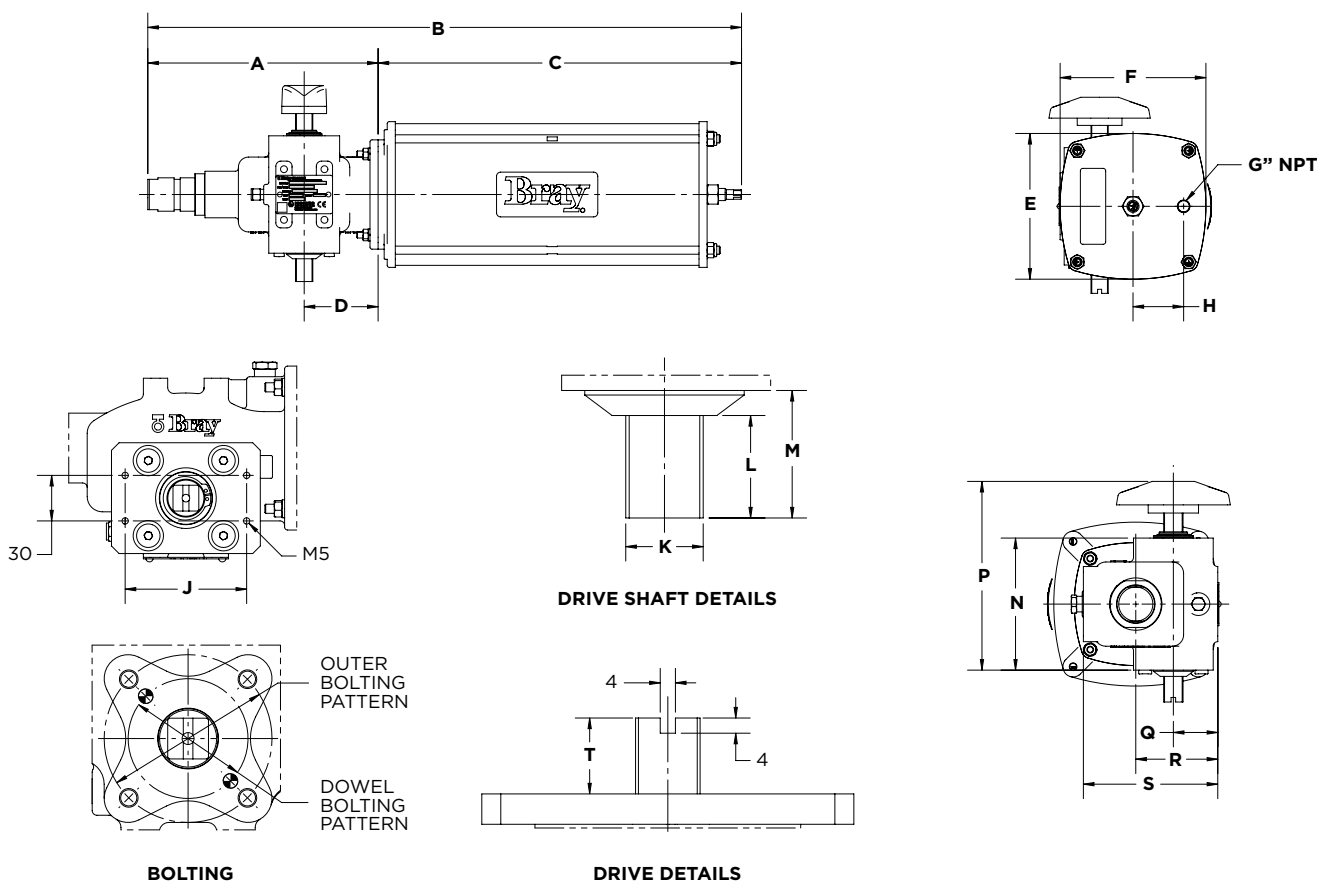
Model	ISO Base	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T
25E1	F07	8.98	16.97	8.00	2.87	6.46	6.46	1/4"	2.24	3.15	0.67	0.91	1.10	4.57	6.54	1.54	2.83	4.65	0.79
50E1	F10	11.22	20.91	9.69	3.27	7.24	7.24	1/4"	2.64	3.15	0.87	0.94	1.18	4.88	6.93	1.97	3.74	5.94	0.79
10E2	F12	14.53	27.00	12.48	4.72	8.90	8.90	3/8"	3.33	5.12	1.06	1.26	1.57	5.83	8.27	2.24	4.49	7.09	1.18
20E2	F14	16.77	31.18	14.41	5.31	9.69	9.69	1/2"	3.66	5.12	1.42	1.50	1.85	7.13	10.43	2.83	5.39	8.39	1.18

Model	Outer Bolting Pattern				Dowel Hole Pattern			
	ISO Base	Thread Size	Bolt Circle	No. of Bolt Holes	Bolt Circle	Dowel Hole Size Dia. X depth	No. of Dowel Holes	
25E1	F07	M8 x 12mm	70	4	50	6.1 +0.05/0, X 8	2	
50E1	F10	M10 x 15mm	102	4	70	8.1 +0.05/0, X 8	2	
10E2	F12	M12 x 18mm	125	4	88	10.1 +0.05/0, X 10	2	
20E2	F14	M16 x 24mm	140	4	102	10.1 +0.05/0, X 10	2	

**NOTE:** Refer to ES drawings for dimensions of specific models



**NOMINAL MAXIMUM DIMENSIONS - SPRING RETURN**



**SERIES 98C MAX DIMENSIONS, mm**

Model	ISO Base	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T
25E1	F07	228	588	361	73	164	164	1/4"	57	80	17	23	28	116	166	39	72	118	20
50E1	F10	285	721	436	83	184	184	1/4"	67	80	22	24	30	124	176	50	95	151	20
10E2	F12	369	925	556	120	226	226	3/8"	85	130	27	32	40	148	210	57	114	180	30
20E2	F14	426	1151	725	135	246	246	1/2"	93	130	36	38	47	181	265	72	137	213	30

**SERIES 98C MAX DIMENSIONS, inch**

Model	ISO Base	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T
25E1	F07	8.98	23.15	14.21	2.87	6.46	6.46	1/4"	2.24	3.15	0.67	0.91	1.10	4.57	6.54	1.54	2.83	4.65	0.79
50E1	F10	11.22	28.39	17.17	3.27	7.24	7.24	1/4"	2.64	3.15	0.87	0.94	1.18	4.88	6.93	1.97	3.74	5.94	0.79
10E2	F12	14.53	36.42	21.89	4.72	8.90	8.90	3/8"	3.33	5.12	1.06	1.26	1.57	5.83	8.27	2.24	4.49	7.09	1.18
20E2	F14	16.77	45.31	28.54	5.31	9.69	9.69	1/2"	3.66	5.12	1.42	1.50	1.85	7.13	10.43	2.83	5.39	8.39	1.18

Model	Outer Bolting Pattern				Dowel Hole Pattern			
	ISO Base	Thread Size	Bolt Circle	No. of Bolt Holes	Bolt Circle	Dowel Hole Size Dia. X depth	No. of Dowel Holes	
25E1	F07	M8 x 12mm	70	4	50	6.1 +0.05/0, X 8	2	
50E1	F10	M10 x 15mm	102	4	70	8.1 +0.05/0, X 8	2	
10E2	F12	M12 x 18mm	125	4	88	10.1 +0.05/0, X 10	2	
20E2	F14	M16 x 24mm	140	4	102	10.1 +0.05/0, X 10	2	

**NOTE:** Refer to ES drawings for dimensions of specific models

**TECHNICAL DATA**

**DOUBLE ACTING ACTUATORS**

Model	Maximum Operating Pressure		Actuator Weight		Volume			
	psi	bar	lbs	kg	cu.in		Lts	
					Rod End	Cap End	Rod End	Cap End
25E1-80	132	9.1	24	11	24	28	0.4	0.5
25E1-100	84	5.8	29	13	39	45	0.6	0.7
25E1-125	54	3.7	35	16	62	70	1.0	1.2
50E1-100	124	8.5	40	18	50	56	0.8	0.9
50E1-125	79	5.5	46	21	81	90	1.3	1.5
50E1-140	63	4.3	55	25	102	114	1.7	1.9
10E2-125	125	8.6	73	33	99	115	1.6	1.9
10E2-140	100	6.9	82	37	126	147	2.1	2.4
10E2-160	76	5.3	90	41	168	192	2.8	3.1
10E2-180	60	4.2	101	46	215	243	3.5	4.0
20E2-140	150	10.3	108	49	140	164	2.3	2.7
20E2-160	134	9.2	128	58	189	222	3.1	3.6
20E2-180	106	7.3	139	63	243	281	4.0	4.6
20E2-200	86	5.9	150	68	304	348	5.0	5.7
20E2-220	71	4.9	163	74	371	421	6.1	6.9

**TECHNICAL DATA**

**SPRING RETURN ACTUATORS**

Model	Spring #	MOP		Actuator Weight		Volume	
		psi	bar	lbs	kg	Cap End	
						cu.in	Lts
25E1-100	1	106	7.3	36	16.5	45	0.7
25E1-125	1	68	4.7	46	21	70	1.2
25E1-140	1	54	3.7	60	27	88	1.4
25E1-100	2	115	7.9	37	17	45	0.7
25E1-125	2	74	5.1	47	21.5	70	1.2
25E1-140	2	59	4.1	61	27.5	88	1.4
25E1-100	3	128	8.8	37	17	45	0.7
25E1-125	3	82	5.6	49	22	70	1.2
25E1-140	3	65	4.5	61	27.5	88	1.4
50E1-125	1	98	6.7	60	27	90	1.5
50E1-140	1	78	5.4	74	33.5	114	1.9
50E1-160	1	60	4.1	84	38	148	2.4
50E1-125	2	106	7.3	61	27.5	90	1.5
50E1-140	2	84	5.8	75	34	114	1.9
50E1-160	2	65	4.4	84	38	148	2.4
50E1-125	3	119	8.2	63	28.5	90	1.5
50E1-140	3	95	6.5	77	35	114	1.9
50E1-160	3	72	5.0	86	39	148	2.4
10E2-140	1	125	8.6	110	50	147	2.4
10E2-160	1	96	6.6	121	55	192	3.1
10E2-180	1	76	5.2	136	61.5	243	4.0
10E2-200	1	61	4.2	151	68.5	300	4.9
10E2-140	2	138	9.5	114	51.5	147	2.4
10E2-160	2	106	7.3	134	61	192	3.1
10E2-180	2	83	5.8	139	63	243	4.0
10E2-200	2	68	4.7	154	70	300	4.9
10E2-140	3	146	10.1	115	52	147	2.4
10E2-160	3	112	7.7	127	57.5	192	3.1
10E2-180	3	89	6.1	141	64	243	4.0
10E2-200	3	72	4.9	157	71	300	4.9
10E2-140	4	150	10.3	116	52.5	147	2.4
10E2-160	4	121	8.3	128	58	192	3.1
10E2-180	4	96	6.6	141	64	243	4.0
10E2-200	4	78	5.3	157	71	300	4.9
20E2-160	1	150	10.3	171	77.5	222	3.6
20E2-180	1	138	9.5	184	83.5	281	4.6
20E2-200	1	112	7.7	201	91	348	5.7
20E2-220	1	92	6.4	217	98.5	421	6.9
20E2-160	2	150	10.3	174	79	222	3.6
20E2-180	2	149	10.2	187	85	281	4.6
20E2-200	2	120	8.3	204	92.5	348	5.7
20E2-220	2	100	6.9	220	100	421	6.9
20E2-160	3	150	10.3	193	87.5	222	3.6
20E2-180	3	150	10.3	207	94.0	281	4.6
20E2-200	3	128	8.8	225	102	348	5.7
20E2-220	3	106	7.3	243	110.0	421	6.9
20E2-160	4	150	10.3	196	89	222	3.6
20E2-180	4	150	10.3	211	95.5	281	4.6
20E2-200	4	137	9.4	228	103.5	348	5.7
20E2-220	4	113	7.8	246	111.5	421	6.9

**AIR CONSUMPTION - METRIC**

**DA ACTUATORS - AIR CONSUMPTION/CYCLE, NORMAL LITERS, L<sub>N</sub> PER CYCLE**

Supply Pr, bar	3	3.5	4	4.5	5	5.5	6	7	8	9	10
<b>AMBIENT TEMPERATURE: 25° C</b>											
25E1-80	3	3	4	4	5	5	5	6	7	8	8
25E1-100	5	6	6	7	7	8	9	10	11	12	14
25E1-125	8	9	10	11	12	13	14	16	18	20	22
50E1-100	6	7	8	9	9	10	11	13	14	16	17
50E1-125	10	11	13	14	15	17	18	20	23	25	28
50E1-140	13	14	16	18	19	21	22	26	29	32	35
10E2-125	13	14	16	17	19	21	22	25	29	32	35
10E2-140	16	18	20	22	24	26	28	32	37	41	45
10E2-160	21	24	27	29	32	35	37	43	48	53	59
10E2-180	27	31	34	37	41	44	48	54	61	68	75
20E2-140	18	20	23	25	27	29	32	36	41	45	50
20E2-160	24	27	31	34	37	40	43	49	55	61	67
20E2-180	31	35	39	43	47	51	55	62	70	78	86
20E2-200	39	44	48	53	58	63	68	77	87	97	106
20E2-220	47	53	59	65	71	76	82	94	106	118	129

**SR ACTUATORS - AIR CONSUMPTION/CYCLE, NORMAL LITERS, L<sub>N</sub> PER CYCLE**

Supply Pr, bar	3	3.5	4	4.5	5	5.5	6	7	8	9	10
<b>AMBIENT TEMPERATURE: 25° C</b>											
25E1-100	3	3	3	4	4	4	5	5	6	7	7
25E1-125	4	5	5	6	6	7	7	8	9	10	11
25E1-140	5	6	7	7	8	9	9	10	12	13	14
50E1-125	5	6	7	7	8	9	9	11	12	13	15
50E1-140	7	8	8	9	10	11	12	13	15	17	19
50E1-160	9	10	11	12	13	14	15	18	20	22	24
10E2-140	9	10	11	12	13	14	15	17	20	22	24
10E2-160	11	13	14	16	17	19	20	23	26	29	31
10E2-180	14	16	18	20	22	23	25	29	33	36	40
10E2-200	18	20	22	25	27	29	31	36	40	45	49
20E2-160	13	15	17	18	20	21	23	26	30	33	36
20E2-180	17	19	21	23	25	27	29	33	38	42	46
20E2-200	21	23	26	28	31	34	36	41	46	52	57
20E2-220	25	28	31	34	38	41	44	50	56	63	69

## **SIZING S98C PNEUMATIC ACTUATOR**

### **Introduction**

Valves in services such as,

- > Frequent and/or fast operation
- > Hazardous areas
- > Remote locations
- > Emergency Shutdown or Venting applications
- > Process control
- > Reliable and consistent operation

are almost always automated, besides the ones that require very high thrust/torque to operate which would be very tedious or not practical, manually.

Valve actuators are required to move the valve's closure element (ball/disc/plug) to end positions of open or close with adequate torque/thrust to seat or unseat, or to move and positively hold the closure element at a desired intermediate position for process control requirements. Actuators also need to accomplish the fail-safe function for an application, to drive the valve to close or open position, on loss of motive power.

### **Common Terminology**

Some of the most used terms in the quarter turn actuator sizing for valves:

- > **DA** or Double Acting: The actuation is by compressed media on either side of the piston.
- > **SR** or Spring Return: Actuation by compressed media on one side and by the compressed spring in other direction.
- > **Fail Safe:** Actuator's response to loss of motive energy to mitigate unsafe consequence of a system's failure.
- > **Fail Close:** The actuator turns the valve stem (normally clockwise) to close the valve, in event of loss of motive power or signal.
- > **Fail Open:** The actuator turns the valve stem (normally counterclockwise) to open the valve, in event of loss of motive power or signal.
- > **Fail Last:** Also referred to as Fail in Place and Fail Freeze, holds the last position on failure of power or signal.
- > **BTO:** Also called as Break to Open Torque, Unseating Torque, Pneumatic / Hydraulic Break or Start Torque is the Actuator's maximum output torque at the start of the power stroke to unseat or open a valve, usually at the Zero degrees position of the quarter turn travel.
- > **RTO:** Run to Open Torque is the torque output of actuator at the mid position of travel or the minimum torque output along the torque curve.
- > **ETO:** End to Open Torque, Pneumatic/Hydraulic End, Air/Hydraulic End Torque is the torque output of the actuator at the end of the quarter turn travel or at the valve's full open or 90-degree position of the travel.
- > **BTC:** Break to Close, Spring Break Torque or Spring Start Torque (for SR actuators) is the actuator's output torque at the start of the step stroke or valve closing stroke, either by the fluid power on DA actuators or by the compressed spring in SR actuators.
- > **RTC:** Run to Close Torque is the torque output of the actuator at mid position of travel or the minimum torque along the torque curve.
- > **ETC:** End to Close, Seating Torque, Spring End Torque, Pneumatic/Hydraulic End Torque is the maximum output torque of actuator at the end of the return power stroke or valve closing/seating position either by fluid power on DA actuator or by the expanded spring in SR actuators, at the zero degree position of travel.
- > **MAST:** The Maximum Allowable Stem Torque of the valve.
- > **FOS:** A factor equal or greater than 1 multiplied by the valve's torque requirement, used for sizing an actuator for the valve.
- > **MOR:** Manual Override
- > **Stroke:** A 90-degree operation in either clockwise (CW) or counterclockwise (CCW) direction. A Power Stroke is by compressed Air or hydraulic pressure and the Spring Stroke is the return stroke by the stored energy in a spring, compressed by the power stroke.
- > **Cycle:** Sequential operation of two strokes of actuator, opening or counterclockwise stroke and closing or clockwise stroke.
- > **Sizing Pressure:** Minimum operating pressure available, at which the actuator is to be sized for the valve.
- > **MOP:** The Maximum Operating Pressure of the actuator that outputs the rated torque/thrust of the actuator.

## **Series 98C Actuators**

S98C are the Pneumatic Scotch Yoke Actuators with an operating pressure range of 40 to 150psig pneumatic pressure. The actuators range from 2,213 lbf-in (250 Nm) to 17,701 lbf-in (2,000 Nm) rated torque in 4 sizes, with multiple pressure and spring configurations to choose from and optimize the selection. Refer to General Specifications and the Configurations sections for more details. These pneumatic actuators use dry compressed Air / Inert / Natural Gas as the media.

## **Sizing S98C for a valve**

- 1** Establish the Valve's torque requirements for the application and service that it would be put in, from the valve manufacturer's technical documentation. The differential pressure across the valve closure element (Ball/Disc/Plug) bears on this torque value.
- 2** The maximum torque step during the dynamic operation and direction of rotation in which this is encountered shall also be determined. The maximum torque would normally be the unseating torque of the valve in the selected operating conditions, for most cases.
- 3** The FOS or the factor of safety in the sizing an actuator for this valve shall be determined, as recommended by the valve manufacturer or by the application engineering.
- 4** Multiply the FOS factor with each of the 3 (BTO, RTO & ETC), or the 6 (BTO, RTO, ETO, BTC, RTC & ETC) torque values provided by the valve manufacturer, to determine the max. and min. torque requirements of the actuator.
- 5** Note the MAST or the maximum allowable stem torque value of the valve.
- 6** Next, determine if the application requires Double Acting or a Spring Return actuator.
- 7** Note the Sizing Pressure value for selecting the actuator that will output required torques at this pressure.

## **Selecting a DA actuator (for clockwise to close operation)**

- 8** Look up the torque charts for the required configuration of the actuator, i.e., DA, under the sizing pressure column. Scroll down to locate the Starting and Mid torques that are same or higher than the required.
- 9** Verify actuator torque output does not exceed the maximum.
- 10** Note the S98C actuator model corresponding to these values.

## **Selecting a SR actuator (fail close or Fail clockwise)**

- 11** Look up the torque charts for SR actuators for the Spring End Torque that meets or exceeds the ETC torque determined in step 4. Scroll along to the right to the sizing pressure column to check if the Pneumatic Start torque meets or exceeds the BTO value determined in step 4. The Pneumatic End torque also must meet or exceed the ETO value.
- 12** If the pneumatic torques meet the requirement, note the actuator model and the spring number.
- 13** If the pneumatic torques fall short, then move down along the sizing pressure column to the next pressure module size with the same spring number as previous one and verify if the pneumatic torque values satisfy. Note the actuator model and the spring #.
- 14** Check the MOP for the selected model of the actuator to confirm that the maximum supply pressure does not exceed the MOP. If it does, then the supply pressure must be restricted to selected actuator's MOP or select an actuator with higher MOP.
- 15** Verify actuator torque output does not exceed the maximum.

Contact Bray Sales or Distributor for any assistance required with optimizing the sizing.

**OUTPUT TORQUE - IMPERIAL - lbf-in**

**DOUBLE ACTING ACTUATORS**

Actuator	Position	Operating Pressure, psig	Torque Output, lbf-in										
			40	50	60	70	80	90	100	120	130	140	150
<b>DA</b>			<b>Torque Output, lbf-in</b>										
25E1-80	Cap End	Start/End	672	840	1009	1177	1345	1513	1681	2017	2185		
		Mid	365	456	547	638	729	820	911	1094	1185		
	Rod End	Start/End	646	807	968	1130	1291	1452	1614	1937	2098		
		Mid	350	437	525	612	700	787	875	1050	1137		
25E1-100	Cap End	Start/End	1051	1313	1576	1839	2101						
		Mid	570	712	854	997	1139						
	Rod End	Start/End	1024	1280	1536	1792	2047						
		Mid	555	694	833	971	1110						
25E1-125	Cap End	Start/End	1642	2052									
		Mid	890	1113									
	Rod End	Start/End	1615	2018									
		Mid	875	1094									
50E1-100	Cap End	Start/End	1433	1791	2149	2507	2865	3223	3582	4298	4656		
		Mid	777	971	1165	1359	1553	1748	1942	2330	2524		
	Rod End	Start/End	1375	1719	2063	2407	2751	3095	3438	4126	4470		
		Mid	746	932	1119	1305	1491	1678	1864	2237	2423		
50E1-125	Cap End	Start/End	2239	2798	3358	3917	4477						
		Mid	1214	1517	1820	2124	2427						
	Rod End	Start/End	2181	2727	3272	3817	4362						
		Mid	1183	1478	1774	2070	2365						
50E1-140	Cap End	Start/End	2808	3510	4212								
		Mid	1522	1903	2284								
	Rod End	Start/End	2751	3438	4126								
		Mid	1491	1864	2237								
10E2-125	Cap End	Start/End	2835	3544	4253	4962	5671	6380	7089	8506	9215		
		Mid	1537	1922	2306	2690	3075	3459	3843	4612	4996		
	Rod End	Start/End	2722	3403	4083	4764	5444	6125	6805	8166	8847		
		Mid	1476	1845	2214	2583	2952	3321	3690	4427	4796		
10E2-140	Cap End	Start/End	3557	4446	5335	6224	7114	8003	8892				
		Mid	1928	2410	2893	3375	3857	4339	4821				
	Rod End	Start/End	3443	4304	5165	6026	6887	7748	8609				
		Mid	1867	2334	2800	3267	3734	4201	4667				
10E2-160	Cap End	Start/End	4646	5807	6968	8130	9291						
		Mid	2519	3148	3778	4408	5037						
	Rod End	Start/End	4532	5665	6798	7931	9064						
		Mid	2457	3072	3686	4300	4914						
10E2-180	Cap End	Start/End	5880	7350	8819								
		Mid	3188	3985	4782								
	Rod End	Start/End	5766	7208	8649								
		Mid	3126	3908	4689								

Continued

**OUTPUT TORQUE - IMPERIAL - lbf-in**

**DOUBLE ACTING ACTUATORS**

Actuator	Position	Operating Pressure, psig											
		40	50	60	70	80	90	100	120	130	140	150	
<b>DA</b>		<b>Torque Output, lbf-in</b>											
20E2-140	Cap End	Start/End	4056	5070	6084	7098	8112	9126	10140	12168	13182	14196	15210
		Mid	2199	2749	3299	3848	4398	4948	5498	6597	7147	7697	8246
	Rod End	Start/End	3803	4753	5704	6654	7605	8556	9506	11408	12358	13309	14259
		Mid	2062	2577	3092	3608	4123	4639	5154	6185	6700	7216	7731
20E2-160	Cap End	Start/End	5298	6622	7947	9271	10595	11920	13244	15893	17217	18542	
		Mid	2872	3590	4308	5026	5744	6463	7181	8617	9335	10053	
	Rod End	Start/End	5044	6305	7566	8827	10088	11349	12610	15133	16394	17655	
		Mid	2735	3418	4102	4786	5470	6153	6837	8204	8888	9572	
20E2-180	Cap End	Start/End	6705	8381	10057	11734	13410	15086	16762				
		Mid	3635	4544	5453	6362	7270	8179	9088				
	Rod End	Start/End	6451	8064	9677	11290	12903	14516	16128				
		Mid	3498	4372	5247	6121	6995	7870	8744				
20E2-200	Cap End	Start/End	8278	10347	12416	14486	16555						
		Mid	4488	5610	6732	7854	8976						
	Rod End	Start/End	8024	10030	12036	14042	16048						
		Mid	4350	5438	6526	7613	8701						
20E2-220	Cap End	Start/End	10016	12520	15024	17528							
		Mid	5430	6788	8145	9503							
	Rod End	Start/End	9762	12203	14644	17084							
		Mid	5293	6616	7939	9263							



**OUTPUT TORQUE - IMPERIAL - lbf-in**

**RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque lbf-in	Operating Pressure, psig											
				40	50	60	70	80	90	100	110	120	130	140	150
				<b>Pneumatic Torque, lbf-in</b>											
25E1-100	1	Start	755	541	794	1047	1300	1553	1806	2060	2313				
		Mid	337	227	366	506	645	784	923	1062	1202				
		End	490	285	538	791	1044	1298	1551	1804	2057				
	2	Start	1121			812	1066	1319	1572	1825	2078				
		Mid	503			344	483	622	762	901	1040				
		End	733			438	691	944	1197	1451	1704				
	3	Start	1637					1011	1264	1517	1770	2023			
		Mid	729					401	540	679	819	958			
		End	1053					448	701	954	1207	1460			
25E1-125	1	Start	755	1110	1506	1901	2297								
		Mid	337	540	758	975	1193								
		End	490	855	1250	1646	2041								
	2	Start	1121	876	1271	1667	2062								
		Mid	503	379	596	814	1031								
		End	733	501	897	1292	1688								
	3	Start	1637		963	1359	1754	2150							
		Mid	729		375	592	810	1028							
		End	1053		400	796	1191	1587							
25E1-140	1	Start	755	1513	2009										
		Mid	337	762	1035										
		End	490	1257	1753										
	2	Start	1121	1278	1774	2271									
		Mid	503	600	873	1146									
		End	733	904	1400	1896									
	3	Start	1637	970	1466	1963									
		Mid	729	379	652	925									
		End	1053	407	903	1399									
50E1-125	1	Start	1338	1307	1846	2386	2925	3464	4004						
		Mid	602	598	895	1191	1488	1785	2081						
		End	883	868	1407	1947	2486	3025	3565						
	2	Start	2000		1421	1961	2500	3039	3579	4118					
		Mid	901		602	899	1196	1492	1789	2086					
		End	1324		769	1309	1848	2387	2927	3466					
	3	Start	3176				1800	2340	2879	3418	3958	4497			
		Mid	1417				692	988	1285	1582	1878	2175			
		End	2050				714	1254	1793	2333	2872	3411			
50E1-140	1	Start	1338	1856	2532	3209	3886	4562							
		Mid	602	900	1272	1644	2016	2389							
		End	883	1417	2093	2770	3447	4123							
	2	Start	2000	1431	2107	2784	3461	4137							
		Mid	901	608	980	1352	1724	2096							
		End	1324	779	1455	2132	2809	3485							
	3	Start	3176			2084	2761	3437	4114						
		Mid	1417			848	1220	1592	1964						
		End	2050			998	1675	2352	3028						

Continued

**OUTPUT TORQUE - IMPERIAL - lbf-in**

**RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque lbf-in	Operating Pressure, psig												
				40	50	60	70	80	90	100	110	120	130	140	150	
50E1-160	1	Start	1338	2684	3568	4452										
		Mid	602	1356	1842	2328										
		End	883	2245	3129	4013										
	2	Start	2000	2259	3143	4027										
		Mid	901	1063	1549	2035										
		End	1324	1607	2491	3375										
	3	Start	3176	1559	2443	3327	4211									
		Mid	1417	559	1045	1531	2017									
		End	2050	474	1357	2241	3125									
10E2-140	1	Start	2291	1913	2727	3541	4355	5169	5984	6798	7612	8426	9240			
		Mid	1019	889	1360	1832	2303	2775	3246	3717	4189	4660	5132			
		End	1468	1220	2077	2934	3791	4648	5505	6362	7219	8076	8933			
	2	Start	4075			2508	3322	4136	4951	5765	6579	7393	8207	9022		
		Mid	1809			1060	1531	2003	2474	2946	3417	3888	4360	4831		
		End	2596			1214	2071	2929	3786	4643	5500	6357	7214	8071		
	3	Start	5227					3447	4261	5075	5890	6704	7518	8332	9146	
		Mid	2325					1498	1969	2441	2912	3383	3855	4326	4798	
		End	3349					1819	2676	3533	4390	5247	6104	6961	7818	
	4	Start	7078							4117	4931	5745	6559	7374	8188	
		Mid	3110							1673	2144	2615	3087	3558	4030	
		End	4396							1749	2606	3463	4320	5177	6034	
10E2-160	1	Start	2291	2910	3973	5036	6100	7163	8227							
		Mid	1019	1466	2082	2698	3313	3929	4545							
		End	1468	2269	3389	4508	5627	6747	7866							
	2	Start	4075		2940	4003	5067	6130	7194	8257						
		Mid	1809		1310	1926	2541	3157	3773	4389						
		End	2596		1669	2789	3908	5027	6147	7266						
	3	Start	5227			3314	4378	5441	6504	7568	8631					
		Mid	2325			1421	2037	2652	3268	3884	4499					
		End	3349			1679	2798	3918	5037	6156	7276					
	4	Start	7078					4482	5546	6609	7673	8736				
		Mid	3110					1884	2500	3116	3731	4347				
		End	4396					2134	3253	4372	5492	6611				
10E2-180	1	Start	2291	4039	5385	6731	8077									
		Mid	1019	2120	2900	3679	4458									
		End	1468	3459	4875	6292	7709									
	2	Start	4075	3006	4352	5698	7044	8390								
		Mid	1809	1349	2128	2907	3686	4465								
		End	2596	1739	3156	4573	5990	7406								
	3	Start	5227		3663	5009	6355	7701	9047							
		Mid	2325		1623	2402	3181	3961	4740							
		End	3349		2046	3463	4880	6296	7713							
	4	Start	7078			4050	5396	6742	8088							
		Mid	3110			1634	2413	3193	3972							
		End	4396			1679	3096	4512	5929							

Continued

**OUTPUT TORQUE - IMPERIAL - lbf-in**

**RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque lbf-in	Operating Pressure, psig														
				40	50	60	70	80	90	100	110	120	130	140	150			
10E2-200	1	Start	2291	5302	6964	8626												
		Mid	1019	2852	3814	4776												
		End	1468	4788	6537	8286												
	2	Start	4075	4269	5931	7593	9254											
		Mid	1809	2080	3042	4004	4966											
		End	2596	3068	4818	6567	8316											
	3	Start	5227	3580	5242	6903	8565											
		Mid	2325	1575	2537	3499	4461											
		End	3349	1959	3708	5457	7206											
	4	Start	7078		4283	5945	7606	9268										
		Mid	3110		1769	2731	3693	4655										
		End	4396		1924	3673	5422	7171										
20E2-160	1	Start	5602			3787	5000	6213	7425	8638	9851	11063	12276	13489	14702			
		Mid	2552			1718	2420	3122	3824	4526	5228	5930	6633	7335	8037			
		End	3811			2260	3537	4813	6090	7366	8643	9919	11196	12473	13749			
	2	Start	8660				4586	5799	7011	8224	9437	10650	11862	13075				
		Mid	3862				1841	2543	3245	3947	4649	5351	6053	6755				
		End	5587				1866	3142	4419	5695	6972	8248	9525	10801				
	3	Start	11338							6727	7940	9153	10365	11578				
		Mid	5031							2804	3506	4208	4910	5612				
		End	7222							3114	4390	5667	6943	8220				
	4	Start	14273											8810	10022			
		Mid	6288											3682	4384			
		End	8921											4114	5391			
20E2-180	1	Start	5602		4185	5720	7255	8790	10324	11859	13394	14929	16464	17999				
		Mid	2552		1948	2837	3725	4614	5503	6391	7280	8168	9057	9946				
		End	3811		2679	4295	5910	7526	9142	10757	12373	13988	15604	17220				
	2	Start	8660				5628	7163	8698	10233	11768	13302	14837	16372	17907			
		Mid	3862				2444	3332	4221	5110	5998	6887	7775	8664	9553			
		End	5587				2963	4578	6194	7809	9425	11041	12656	14272	15888			
	3	Start	11338							7201	8736	10271	11806	13340	14875	16410		
		Mid	5031							3078	3967	4855	5744	6632	7521	8410		
		End	7222							3612	5228	6844	8459	10075	11691	13306		
	4	Start	14273									8715	10250	11785	13319	14854		
		Mid	6288									3627	4515	5404	6292	7181		
		End	8921									4014	5630	7246	8861	10477		
20E2-200	1	Start	5602	4090	5985	7880	9775	11670	13565	15460	17354							
		Mid	2552	1893	2990	4087	5184	6281	7378	8476	9573							
		End	3811	2579	4574	6568	8563	10558	12552	14547	16542							
	2	Start	8660			6253	8148	10043	11938	13833	15728	17623						
		Mid	3862			2806	3903	5000	6097	7194	8291	9388						
		End	5587			3621	5615	7610	9605	11599	13594	15588						
	3	Start	11338				6652	8546	10441	12336	14231	16126	18021					
		Mid	5031				2760	3857	4954	6051	7148	8245	9342					
		End	7222				3034	5029	7023	9018	11012	13007	15002					
	4	Start	14273							8885	10780	12675	14570	16465	18360			
		Mid	6288							3725	4822	5919	7017	8114	9211			
		End	8921							4194	6189	8183	10178	12172	14167			

Continued

**OUTPUT TORQUE - IMPERIAL - lbf-in**

**RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque lbf-in	Operating Pressure, psig											
				40	50	60	70	80	90	100	110	120	130	140	150
20E2-220	1	Start	5602	5682	7975	10268	12560	14853	17146						
		Mid	2552	2815	4142	5470	6797	8124	9452						
		End	3811	4255	6668	9082	11495	13909	16322						
	2	Start	8660		6348	8641	10934	13227	15519	17812					
		Mid	3862		2861	4188	5516	6843	8170	9498					
		End	5587		3721	6134	8547	10961	13374	15788					
	3	Start	11338			7144	9437	11730	14023	16315					
		Mid	5031			3045	4372	5700	7027	8355					
		End	7222			3553	5966	8380	10793	13207					
	4	Start	14273				7881	10174	12467	14759	17052				
		Mid	6288				3144	4471	5799	7126	8454				
		End	8921				3137	5550	7964	10377	12791				

**OUTPUT TORQUE - METRIC - Nm**

**DOUBLE ACTING ACTUATORS**

Actuator		Position	Operating Pressure, bar								
			3.0	3.5	4.0	5.0	5.5	6.0	7.0	8.0	9.0
<b>DA</b>			<b>Torque Output, Nm</b>								
25E1-80	Cap End	Start/End	83	96	110	138	152	165	193	220	248
		Mid	45	52	60	75	82	90	105	119	134
	Rod End	Start/End	79	93	106	132	145	159	185	212	238
		Mid	43	50	57	72	79	86	100	115	129
25E1-100	Cap End	Start/End	129	151	172	215	237	258			
		Mid	70	82	93	117	128	140			
	Rod End	Start/End	126	147	168	210	231	252			
		Mid	68	80	91	114	125	136			
25E1-125	Cap End	Start/End	202	235	269						
		Mid	109	128	146						
	Rod End	Start/End	198	232	265						
		Mid	108	126	143						
50E1-100	Cap End	Start/End	176	205	235	293	323	352	411	470	528
		Mid	95	111	127	159	175	191	223	255	286
	Rod End	Start/End	169	197	225	282	310	338	394	451	507
		Mid	92	107	122	153	168	183	214	244	275
50E1-125	Cap End	Start/End	275	321	367	459	504				
		Mid	149	174	199	249	273				
	Rod End	Start/End	268	313	357	447	491				
		Mid	145	170	194	242	266				
50E1-140	Cap End	Start/End	345	403	460						
		Mid	187	218	249						
	Rod End	Start/End	338	394	451						
		Mid	183	214	244						
10E2-125	Cap End	Start/End	348	407	465	581	639	697	813	929	1045
		Mid	189	220	252	315	346	378	441	504	567
	Rod End	Start/End	335	390	446	558	613	669	781	892	1004
		Mid	181	212	242	302	333	363	423	484	544
10E2-140	Cap End	Start/End	437	510	583	729	801	874	1020		
		Mid	237	277	316	395	435	474	553		
	Rod End	Start/End	423	494	564	705	776	846	987		
		Mid	229	268	306	382	421	459	535		
10E2-160	Cap End	Start/End	571	666	761	952	1047				
		Mid	310	361	413	516	568				
	Rod End	Start/End	557	650	743	928	1021				
		Mid	302	352	403	503	554				
10E2-180	Cap End	Start/End	723	843	964						
		Mid	392	457	522						
	Rod End	Start/End	709	827	945						
		Mid	384	448	512						

Continued

**OUTPUT TORQUE - METRIC - Nm**

**DOUBLE ACTING ACTUATORS**

Actuator	Position	Operating Pressure, bar										
		3.0	3.5	4.0	5.0	5.5	6.0	7.0	8.0	9.0	10.0	
<b>DA</b>		<b>Torque Output, Nm</b>										
20E2-140	Cap End	Start/End	498	582	665	831	914	997	1163	1329	1495	1662
		Mid	270	315	360	450	495	541	631	721	811	901
	Rod End	Start/End	467	545	623	779	857	935	1090	1246	1402	1558
		Mid	253	296	338	422	465	507	591	676	760	845
20E2-160	Cap End	Start/End	651	760	868	1085	1194	1302	1519	1736	1953	
		Mid	353	412	471	588	647	706	824	941	1059	
	Rod End	Start/End	620	723	827	1033	1137	1240	1447	1653	1860	
		Mid	336	392	448	560	616	672	784	896	1008	
20E2-180	Cap End	Start/End	824	961	1099	1373	1511	1648	1923			
		Mid	447	521	596	745	819	894	1042			
	Rod End	Start/End	793	925	1057	1321	1454	1586	1850			
		Mid	430	502	573	716	788	860	1003			
20E2-200	Cap End	Start/End	1017	1187	1356	1696	1865	2035				
		Mid	552	644	735	919	1011	1103				
	Rod End	Start/End	986	1151	1315	1644	1808	1972				
		Mid	535	624	713	891	980	1069				
20E2-220	Cap End	Start/End	1231	1436	1641	2052						
		Mid	667	779	890	1112						
	Rod End	Start/End	1200	1400	1600	2000						
		Mid	651	759	867	1084						

**OUTPUT TORQUE - METRIC - Nm**

**SPRING RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque Nm	Operating Pressure, bar									
				3.0	3.5	4.0	5.0	5.5	6.0	7.0	8.0	9.0	10.0
				Pneumatic Torque, Nm									
25E1-100	1	Start	85	71	92	113	154	175	196	237			
		Mid	38	31	43	54	77	88	100	122			
		End	55	42	63	84	125	146	167	208			
	2	Start	127			86	128	148	169	211	252		
		Mid	57			36	59	70	81	104	127		
		End	83			44	85	106	127	168	210		
	3	Start	185					114	134	176	217	259	
		Mid	82					45	56	79	102	125	
		End	119					50	71	112	154	195	
25E1-125	1	Start	85	141	174	206							
		Mid	38	70	88	105							
		End	55	112	145	177							
	2	Start	127	115	147	179	244						
		Mid	57	51	69	87	123						
		End	83	72	105	137	202						
	3	Start	185		112	145	209	242					
		Mid	82		44	62	98	116					
		End	119		49	81	146	178					
25E1-140	1	Start	85	191	231								
		Mid	38	97	119								
		End	55	162	202								
	2	Start	127	164	205	245							
		Mid	57	79	101	123							
		End	83	122	162	203							
	3	Start	185	129	170	211							
		Mid	82	54	76	98							
		End	119	66	106	147							

Continued

**OUTPUT TORQUE - METRIC - Nm**

**SPRING RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque Nm	Operating Pressure, bar										
				3.0	3.5	4.0	5.0	5.5	6.0	7.0	8.0	9.0	10.0	
50E1-125	1	Start	151	169	213	257	346	390	434	523				
		Mid	68	79	104	128	177	201	225	274				
		End	100	119	164	208	296	340	385	473				
	2	Start	226		165	209	298	342	386	475				
		Mid	102		71	95	144	168	192	241				
		End	150		92	136	224	268	313	401				
	3	Start	359				219	263	307	396	484			
		Mid	160				87	111	135	184	232			
		End	232				96	140	184	273	361			
50E1-140	1	Start	151	237	292	347	458							
		Mid	68	116	147	177	238							
		End	100	187	242	298	409							
	2	Start	226	188	244	299	410	466						
		Mid	102	83	114	144	205	236						
		End	150	115	170	226	337	392						
	3	Start	359			220	331	387	442					
		Mid	160			87	148	179	209					
		End	232			98	208	264	319					
50E1-160	1	Start	151	338	411	483								
		Mid	68	172	212	252								
		End	100	289	361	434								
	2	Start	226	290	363	435								
		Mid	102	139	179	219								
		End	150	217	289	361								
	3	Start	359	211	284	356	501							
		Mid	160	82	122	162	242							
		End	232	89	161	233	378							

Continued



**OUTPUT TORQUE - METRIC - Nm**

**SPRING RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque Nm	Operating Pressure, bar									
				3.0	3.5	4.0	5.0	5.5	6.0	7.0	8.0	9.0	10.0
				Pneumatic Torque, Nm									
10E2-140	1	Start	259	248	315	382	515	582	649	782	916		
		Mid	115	119	158	196	274	312	351	428	505		
		End	166	172	242	312	453	523	593	734	874		
	2	Start	460			265	399	465	532	665	799	932	
		Mid	204			109	186	225	264	341	418	495	
		End	293			118	258	329	399	539	680	820	
	3	Start	591					387	454	587	721	854	988
		Mid	263					168	207	284	361	438	516
		End	378					203	273	414	554	695	835
	4	Start	800							479	613	746	879
		Mid	351							197	274	352	429
		End	497							212	353	493	634
10E2-160	1	Start	259	371	458	545	719	807	894				
		Mid	115	190	241	291	392	442	493				
		End	166	301	393	484	668	759	851				
	2	Start	460		341	428	603	690	777	951			
		Mid	204		153	204	305	355	406	506			
		End	293		198	290	473	565	657	840			
	3	Start	591			351	525	612	699	873	1048		
		Mid	263			147	248	298	349	449	550		
		End	378			165	348	440	531	715	898		
	4	Start	800					504	591	765	939		
		Mid	351					211	262	363	464		
		End	497					238	330	513	697		
10E2-180	1	Start	259	510	620	730	951						
		Mid	115	270	334	398	526						
		End	166	447	563	679	911						
	2	Start	460	393	503	614	834	944					
		Mid	204	183	247	311	439	503					
		End	293	253	369	485	717	833					
	3	Start	591		425	536	756	867					
		Mid	263		190	254	382	445					
		End	378		243	359	592	708					
	4	Start	800			427	648	758	869				
		Mid	351			167	295	359	423				
		End	497			158	390	506	622				
10E2-200	1	Start	259	665	801	937							
		Mid	115	360	439	518							
		End	166	610	754	897							
	2	Start	460	548	684	821							
		Mid	204	273	352	431							
		End	293	416	559	703							
	3	Start	591	470	607	743	1015						
		Mid	263	216	295	374	531						
		End	378	291	434	577	864						
	4	Start	800		498	634	907						
		Mid	351		208	287	445						
		End	497		232	376	662						

Continued

**OUTPUT TORQUE - METRIC - Nm**

**SPRING RETURN ACTUATORS**

Actuator	Spring #	Position	Spring Torque Nm	Operating Pressure, bar									
				3.0	3.5	4.0	5.0	5.5	6.0	7.0	8.0	9.0	10.0
				Pneumatic Torque, Nm									
20E2-160	1	Start	633		401	599	699	798	997	1196	1394	1593	
		Mid	288		178	293	351	408	524	639	754	869	
		End	431		227	436	541	645	854	1063	1273	1482	
	2	Start	978				515	614	813	1012	1211	1409	
		Mid	436				206	264	379	494	609	724	
		End	631				207	312	521	730	940	1149	
	3	Start	1281							843	1041	1240	
		Mid	568							365	480	595	
		End	816							439	648	857	
	4	Start	1613								866	1064	
		Mid	710								341	456	
		End	1008								328	538	
20E2-180	1	Start	633	486	612	863	989	1115	1366	1618	1869		
		Mid	288	228	301	446	519	592	737	883	1029		
		End	431	317	449	714	846	979	1243	1508	1773		
	2	Start	978			680	805	931	1183	1434	1686	1937	
		Mid	436			301	374	447	593	738	884	1029	
		End	631			381	513	645	910	1175	1440	1704	
	3	Start	1281					762	1013	1265	1517	1768	
		Mid	568					318	463	609	755	900	
		End	816					354	619	883	1148	1413	
	4	Start	1613							1089	1341	1592	
		Mid	710							470	616	762	
		End	1008							564	828	1093	
20E2-200	1	Start	633	537	693	848	1158	1314	1469	1779	2090		
		Mid	288	257	347	437	617	707	797	977	1156		
		End	431	371	534	697	1024	1188	1351	1678	2005		
	2	Start	978			664	975	1130	1285	1596	1906		
		Mid	436			292	472	562	652	832	1012		
		End	631			364	691	855	1018	1345	1672		
	3	Start	1281			805	961	1116	1426	1737	2048		
		Mid	568			343	433	523	703	882	1062		
		End	816			400	563	726	1053	1380	1707		
	4	Start	1613						940	1251	1561	1872	
		Mid	710						384	564	744	923	
		End	1008						407	734	1060	1387	
20E2-220	1	Start	633	733	921	1109	1484	1672	1860				
		Mid	288	371	479	588	806	915	1023				
		End	431	576	774	972	1367	1565	1763				
	2	Start	978		737	925	1301	1488	1676	2052			
		Mid	436		335	443	661	770	878	1096			
		End	631		441	639	1034	1232	1430	1825			
	3	Start	1281			756	1131	1319	1507	1883			
		Mid	568			314	532	641	749	967			
		End	816			347	743	941	1138	1534			
	4	Start	1613				956	1144	1331	1707	2083		
		Mid	710				393	502	611	828	1046		
		End	1008				423	621	819	1214	1610		

**PART NUMBERING**

Sample Part Number: 98CQ0C1-213C01N000S0

Series	Size Code							Base Number				
	Actuator Size		Drive Size		Cylinder Size <sup>1</sup>		Spring Size		-	Base Code	Action	
98C	Q		0		C		1		-	213	C	
98C	P	25E1	0	STD	A	080 MM	0	None (DA)		213	A	Double Acting
	Q	50E1			B	100 MM	1	Spring 1			C	Spring Return
	R	10E2			C	125 MM	2	Spring 2				
	S	20E2			D	140 MM	3	Spring 3				
					E	160 MM	4	Spring 4				
					F	180 MM						
					G	200 MM						
					H	220 MM						

Base Number							Trim Code (XXX - Special requirements)						
Default Modifier		Ports		Standard Options		Design Code		MOC		Temp Trim		Coating	
0		1		N		00		0		S		0	
0	STD	1	Standard, NPT	N	None	00	Standard	0	Standard (DI/CS)	S	Standard	0	Standard
				J	Jackscrew					L	Low Temp		
				E	Extended Stopper 90° deg - Pressure and Torque Module					H	High Temp		
				F	Extended Stopper 90° deg - Pressure Module Only								
				T	Extended Stopper 90° deg - Torque Module Only								

**NOTES**

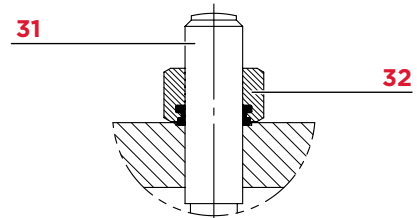
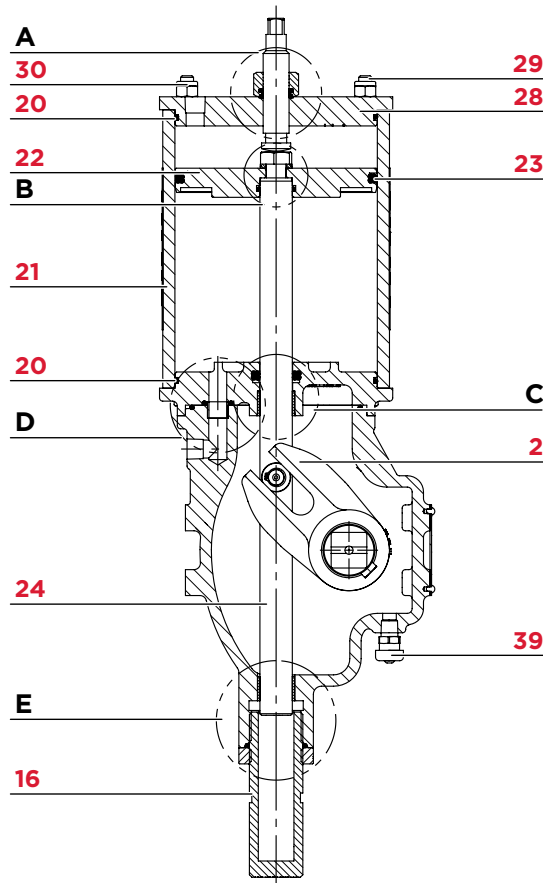
1. Cylinder size is the Pressure Module Size
2. Contact factory for special trims assignment

**STANDARD COMBINATIONS - DA/SR**

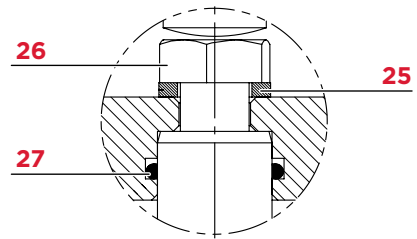
STANDARD COMBINATIONS - DA								
Model	Cylinder Bore, mm							
	80	100	125	140	160	180	200	220
25E1	█	█	█	█				
50E1		█	█	█	█			
10E2			█	█	█	█	█	
20E2				█	█	█	█	█

STANDARD COMBINATIONS - SR												
Model	Cylinder Bore, mm								Spring Number			
	80	100	125	140	160	180	200	220	1	2	3	4
25E1		█	█	█	█				█	█	█	
50E1			█	█	█	█			█	█	█	
10E2				█	█	█	█	█	█	█	█	█
20E2					█	█	█	█	█	█	█	█

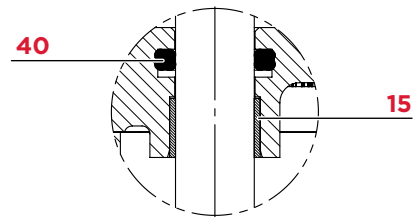
**PARTS CALLOUT - DOUBLE ACTING ACTUATOR**



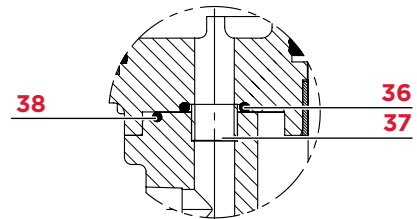
**DETAIL A**



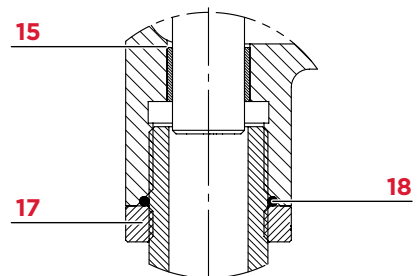
**DETAIL B**



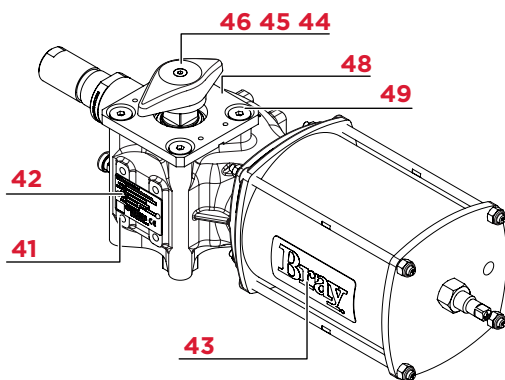
**DETAIL C**



**DETAIL D**

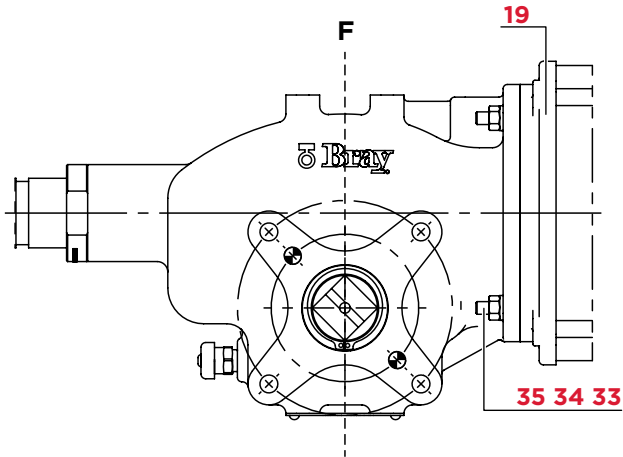


**DETAIL E**

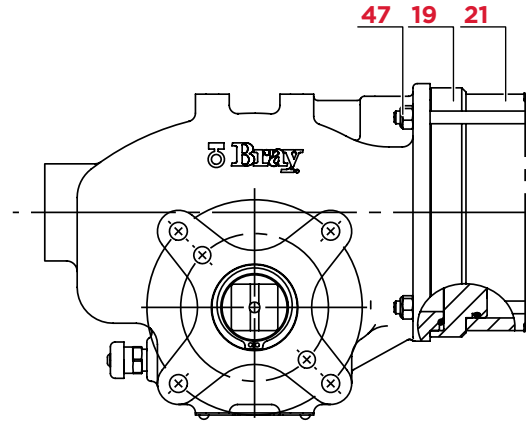


For reference only. Please refer to ES-00897 drawing for current information.

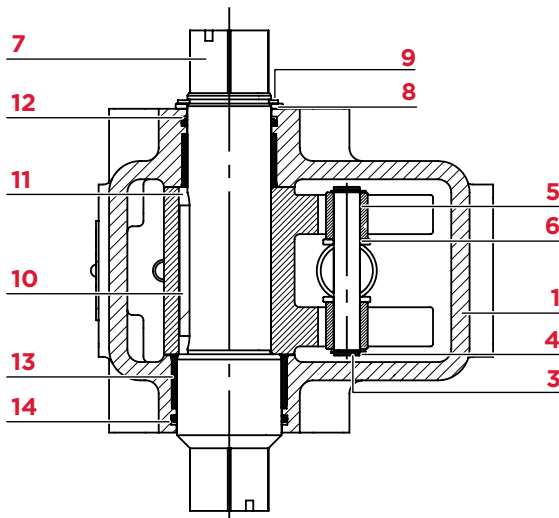
**PARTS CALLOUT - DOUBLE ACTING ACTUATOR**



**STANDARD Adapter**



**SANDWICH TYPE Adapter**



**SECTION VIEW - F**

For reference only. Please refer to ES-00897 drawing for current information.

**PARTS CALLOUT - DOUBLE ACTING ACTUATOR**

ITEM	DESCRIPTION	MATERIAL	QTY.
1	Yoke Housing	Ductile Iron	1
2	Yoke	Carbon Steel	1
3	Yoke Pin	Alloy Steel	1
4 <sup>1</sup>	Retaining Ring (Yoke Pin)	Spring Steel	2
5 <sup>1</sup>	Roller	Steel	2
6	Roller Washer	Steel	2
7	Drive Shaft	Alloy Steel	1
8	Drive Shaft Washer	Stainless Steel	1
9 <sup>1</sup>	Retaining Ring (Drive Shaft)	Stainless Steel	1
10	Key (Drive Shaft)	Carbon Steel	1
11 <sup>1</sup>	Bearing (Smaller Dia-Drive Shaft)	Steel / Self-Lubricating Bronze	1
12 <sup>2</sup>	O-ring (Smaller Dia-Drive Shaft)	BUNA-N	1
13 <sup>1</sup>	Bearing (Bigger Dia-Drive Shaft)	Steel / Self-Lubricating Bronze	1
14 <sup>2</sup>	O-ring (Bigger Dia-Drive Shaft)	BUNA-N	1
15 <sup>1</sup>	Bearing (Piston Rod)	Steel / Self-Lubricating Bronze	2
16	Sleeve Stopper	Carbon Steel	1
17	Stopper Lock Nut	Carbon Steel	1
18 <sup>2</sup>	O-ring (Sleeve Stopper)	BUNA-N	1
19	Adapter	Ductile Iron / Carbon Steel	1
20 <sup>2</sup>	O-ring (Barrel)	BUNA-N	2
21	Barrel	Carbon Steel	1
22	Piston	Carbon Steel	1
23 <sup>2</sup>	Quad Seal (Piston)	BUNA-N	1

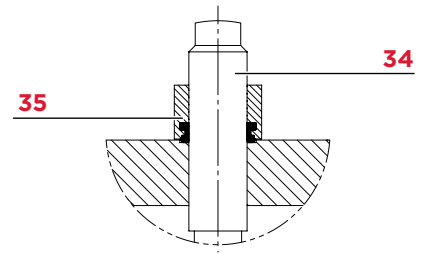
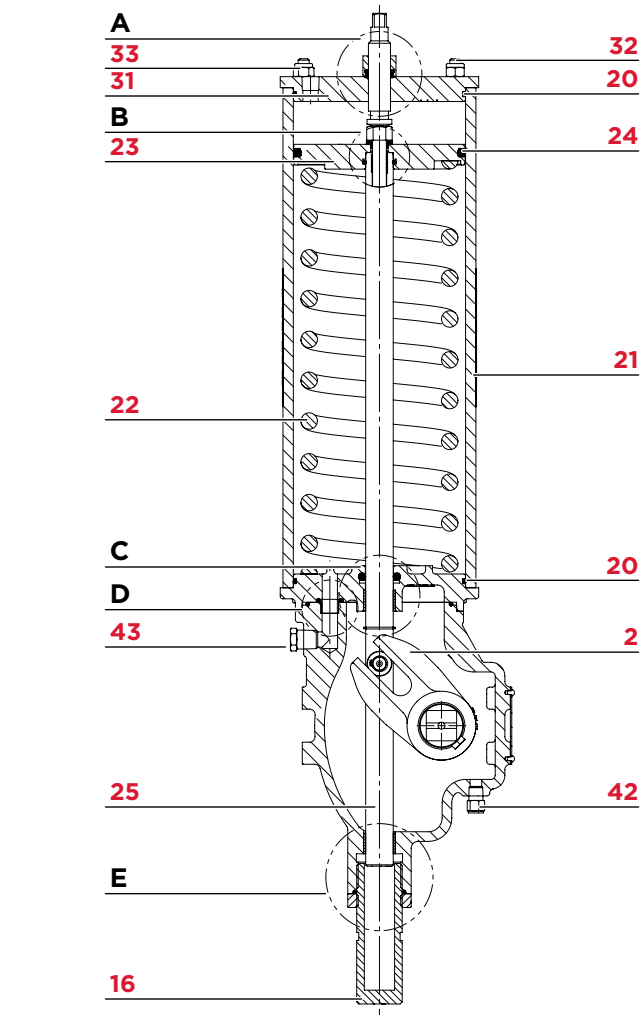
ITEM	DESCRIPTION	MATERIAL	QTY.
24	Piston Rod	Alloy Steel	1
25	Washer (Wedge Lock)	Steel	1
26	Bolt	Carbon Steel	1
27 <sup>2</sup>	O-ring Piston Rod	BUNA-N	1
28	End Cap Plate	Carbon Steel	1
29	Tie Rod	Alloy Steel	4
30	Lock Nut, Nylock	Steel	4
31	Stopper Bolt	Steel	1
32 <sup>2</sup>	Seal Nut	Steel	1
33 <sup>3</sup>	Stud	Steel	4
34 <sup>3</sup>	Spring Washer	Carbon Steel	4
35 <sup>3</sup>	Nut	Steel	4
36 <sup>2</sup>	O-ring (Tube)	BUNA-N	1
37	Tube	Stainless Steel	1
38 <sup>2</sup>	O-ring (Module)	BUNA-N	1
39	Vent Relief Valve	Stainless Steel	1
40 <sup>2</sup>	Quad Seal (Piston Rod)	BUNA-N	1
41	Name Plate	Stainless Steel	1
42	Rivets	Stainless Steel	2
43	Label, Logo	Metalized Polyester	2
44	Position Indicator	Plastic	1
45	Indicator Adapter	Plastic	1
46	Cap Screw, Flat Head, Hex	Steel	1
47 <sup>4</sup>	Lock Nut, Nylock	Steel	4
48	NAMUR Adapter Plate	Carbon Steel	1
49	Cap Screw (NAMUR Kit)	Steel	4

**NOTES:**

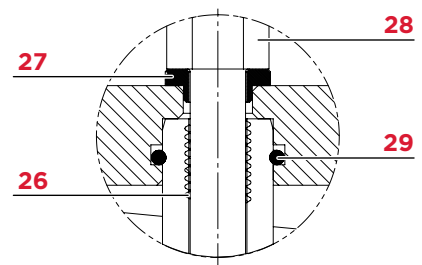
1. Parts in seal kits and repair kits
2. Parts in seal kits only
3. Applicable for standard adapter
4. Not applicable for standard actuator

For reference only. Please refer to ES-00897 drawing for current information.

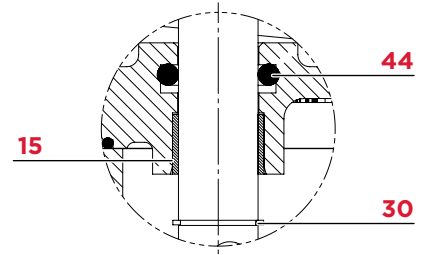
**PARTS CALLOUT - SPRING RETURN ACTUATOR**



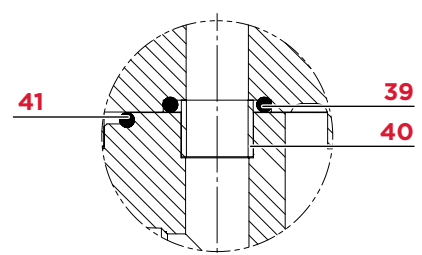
**DETAIL A**



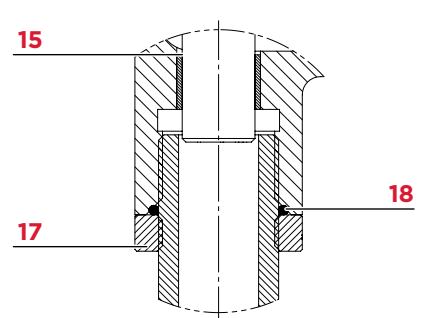
**DETAIL B**



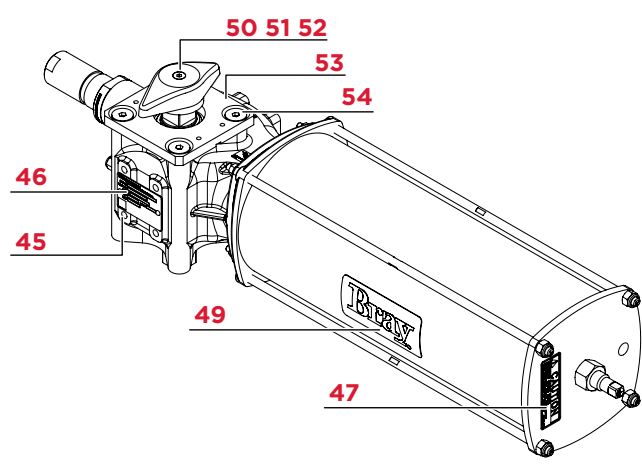
**DETAIL C**



**DETAIL D**



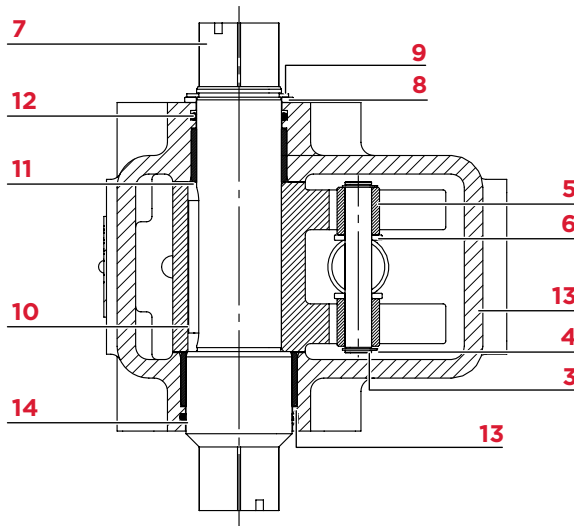
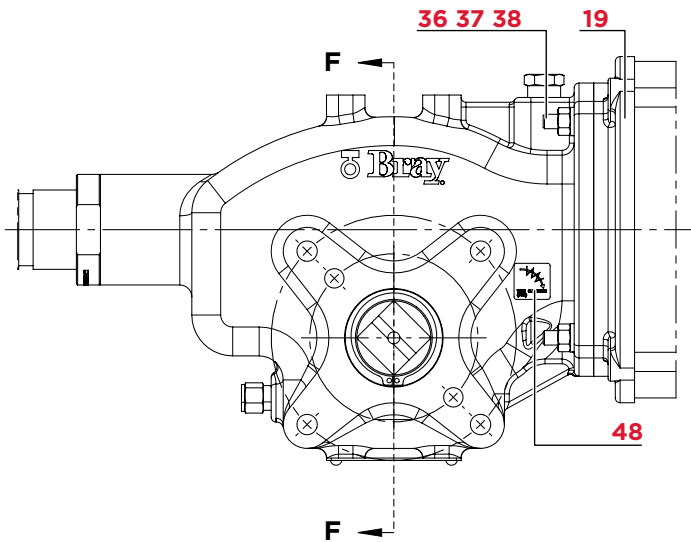
**DETAIL E**



For reference only. Please refer to ES-00895 drawing for current information.



**PARTS CALLOUT - SPRING RETURN ACTUATOR**



**SECTION VIEW - F**

For reference only. Please refer to ES-00895 drawing for current information.

**PARTS CALLOUT - SPRING RETURN ACTUATOR**

ITEM	DESCRIPTION	MATERIAL	QTY.
1	Yoke Housing	Ductile Iron	1
2	Yoke	Carbon Steel	1
3	Yoke Pin	Alloy Steel	1
4 <sup>1</sup>	Retaining Ring (Yoke Pin)	Spring Steel	2
5 <sup>1</sup>	Roller	Steel	2
6	Roller Washer	Steel	2
7	Drive Shaft	Alloy Steel	1
8	Drive Shaft Washer	Stainless Steel	1
9 <sup>1</sup>	Retaining Ring (Drive Shaft)	Stainless Steel	1
10	Key (Drive Shaft)	Carbon Steel	1
11 <sup>1</sup>	Bearing (Smaller Dia-Drive Shaft)	Steel / Self-Lubricating Bronze	1
12 <sup>2</sup>	O-ring (Smaller Dia-Drive Shaft)	BUNA-N	1
13 <sup>1</sup>	Bearing (Bigger Dia-Drive Shaft)	Steel / Self-Lubricating Bronze	1
14 <sup>2</sup>	O-ring (Bigger Dia-Drive Shaft)	BUNA-N	1
15 <sup>1</sup>	Bearing (Piston Rod)	Steel / Self-Lubricating Bronze	2
16	Sleeve Stopper	Carbon Steel	1
17	Stopper Lock Nut	Carbon Steel	1
18 <sup>2</sup>	O-ring (Sleeve Stopper)	BUNA-N	1
19	Adapter	Ductile Iron	1
20 <sup>2</sup>	O-ring (Barrel)	BUNA-N	2
21	Barrel	Carbon Steel	1
22	Spring, Compression	Alloy Steel	1
23	Piston	Carbon Steel	1
24 <sup>2</sup>	Quad Seal (Piston)	BUNA-N	1
25	Piston Rod	Alloy Steel	1
26	Thread Insert	Stainless Steel	1

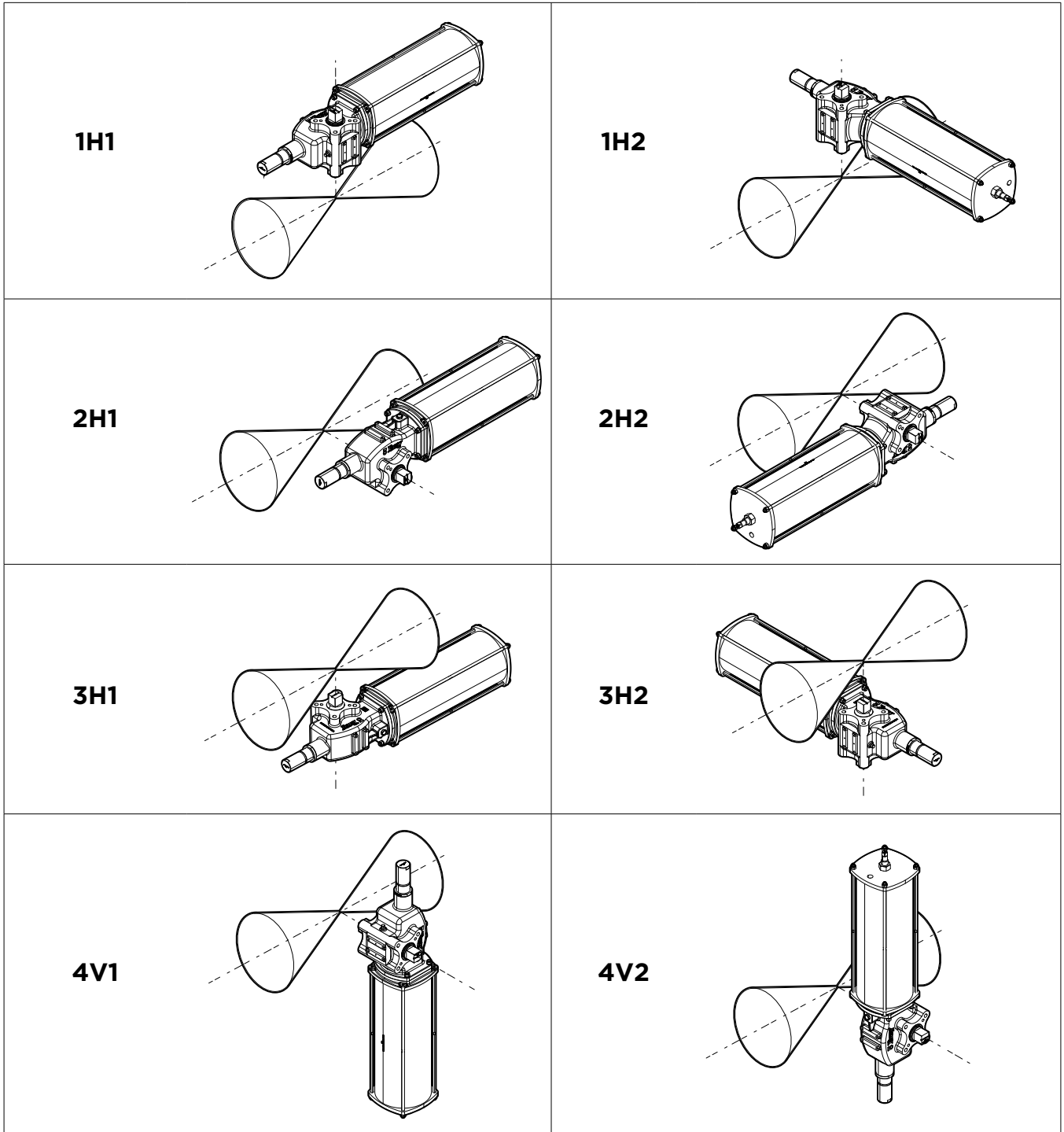
ITEM	DESCRIPTION	MATERIAL	QTY.
27	Piston Bolt Spacer	Carbon Steel	1
28	Hex Bolt	Alloy Steel	1
29 <sup>2</sup>	O-ring (Piston Rod)	BUNA-N	1
30	Retainer Ring (Piston Rod)	Carbon Steel	1
31	End Cap Plate	Carbon Steel	1
32 <sup>2</sup>	Tie Rod	Alloy Steel	4
33	Lock Nut, Nylock	Steel	4
34	Stopper Bolt	Steel	1
35 <sup>2</sup>	Seal Nut	Steel	1
36	Stud	Steel	4
37	Spring Washer	Carbon Steel	4
38	Nut	Steel	4
39 <sup>2</sup>	O-ring (Tube)	BUNA-N	1
40	Tube	Stainless Steel	1
41 <sup>2</sup>	O-ring (Module)	BUNA-N	1
42	Plug	Stainless Steel	1
43	Breather Vent	Stainless Steel	1
44 <sup>2</sup>	O-ring / Quad seal(Piston-Piston Rod)	BUNA-N	1
45	Name Plate	Stainless Steel	1
46	Rivets	Stainless Steel	2
47	Label, Caution	Metalized Polyester	1
48	Orientation Sticker	Metalized Polyester	1
49	Label, Logo	Metalized Polyester	2
50	Position Indicator	Plastic	1
51	Indicator Adapter	Plastic	1
52	Cap Screw, Flat Head, Hex	Steel	1
53	NAMUR Adapter Plate	Carbon Steel	1
54	Cap Screw (NAMUR Kit)	Steel	4

**NOTES:**

1. Parts in seal kits and repair kits
2. Parts in seal kits only

For reference only. Please refer to ES-00895 drawing for current information.

**ACTUATOR ORIENTATIONS**



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