

Bray

Your Global Flow Control Partner™

Series 70 2nd Generation Electric Actuator Operation and Maintenance Manual

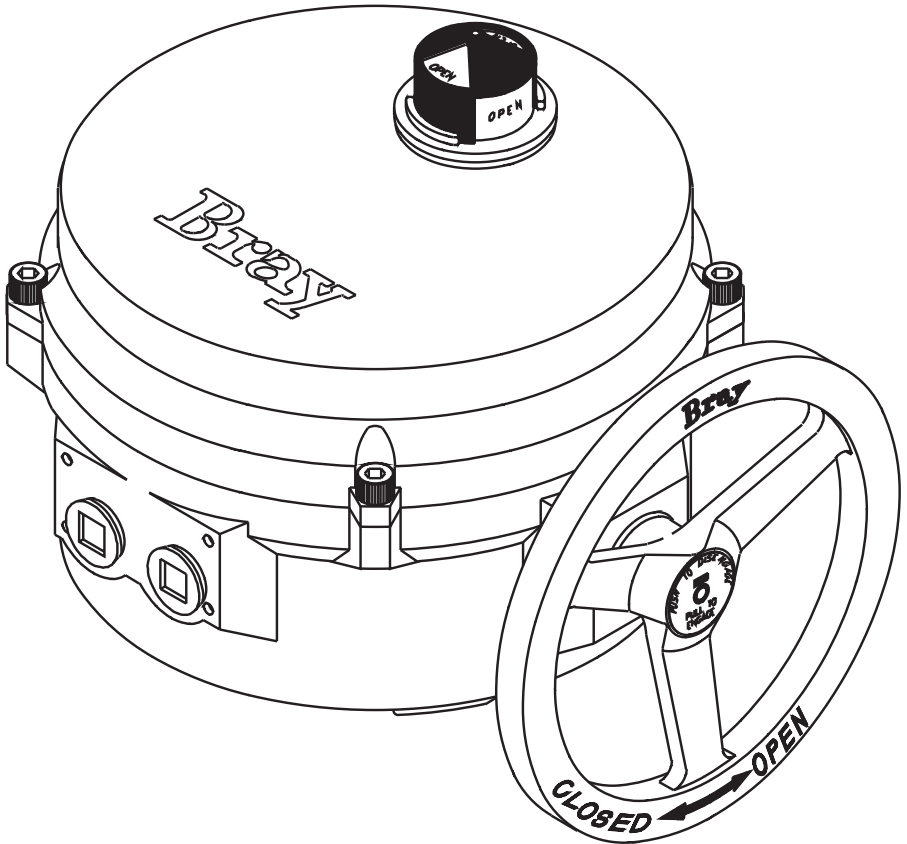


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Safety Instructions - Definition of Terms

**READ AND FOLLOW THESE INSTRUCTIONS
SAVE THESE INSTRUCTIONS**

	WARNING	indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	CAUTION	indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
	NOTICE	used without the safety alert symbol indicates a potential situation which, if not avoided, may result in an undesirable result or state, including property damage.

Hazard-Free Use

This device left the factory in proper condition to be safely installed and operated in a hazard-free manner. The notes and warnings in this document must be observed by the user if this safe condition is to be maintained and hazard-free operation of the device assured.

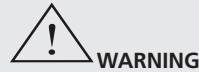
Take all necessary precautions to prevent damage to the actuator due to rough handling, impact, or improper storage. Do not use abrasive compounds to clean the actuator, or scrape metal surfaces with any objects.

The control systems in which the actuator is installed must have proper safeguards to prevent injury to personnel, or damage to equipment, should failure of system components occur.

Qualified Personnel

- A qualified person in terms of this document is one who is familiar with the installation, commissioning and operation of the device and who has appropriate qualifications, such as:
 - Is trained in the operation and maintenance of electric equipment and systems in accordance with established safety practices
 - Is trained or authorized to energize, de-energize, ground, tag and lock electrical circuits and equipment in accordance with established safety practices
 - Is trained in the proper use and care of personal protective equipment (PPE) in accordance with established safety practices

- Is trained in first aid
- In cases where the device is installed in a potentially explosive (hazardous) location – is trained in the operation, commissioning, operation and maintenance of equipment in hazardous locations



The actuator must only be installed, commissioned, operated and repaired by qualified personnel.

The device generates large mechanical force during normal operation.

All installation, commissioning, operation and maintenance must be performed under strict observation of all applicable codes, standards and safety regulations.

Reference is specifically made here to observe all applicable safety regulations for actuators installed in potentially explosive (hazardous) locations.

Part Numbering System Reference Chart

SERIES	TORQUE CODE	SPEED	PRODUCT	STYLE	VOLTAGE	TRIM
70	AAA	X	113	Y	Z	536

HOUSING SIZE	PART NUMBER	TORQUE (In.Lbs)	SPEED, ¼ TURN (Seconds)	SUPPLY (Z Voltage)
6	70-003X-113YZ-536	300	30/15	0/2/4
6	70-006X-113YZ-536	600	30	0/3/4
12	70-008X-113YZ-536	800	30/15/6	0/4/8
12	70-012X-113YZ-536	1200	30/15/6	0/4/9
12	70-020X-113YZ-536	2000	30/15	0/2/3/4/5/6/7/8
30	70-030X-113YZ-536	3000	30/18	0/2/4/5/6/7/8
30	70-050X-113YZ-536	5000	30/18	0/2/3/4/5/6/7/8
30	70-065X-113YZ-536	6500	30	0/2/4/5/6/7/8
180	70-13WX-113YZ-536	13000	110	0/4
180	70-18WX-113YZ-536	18000	110	0/4

Use this chart as a guide to interpret the S70 electric actuator part number.
Note: Not all combinations are possible.

W - DESIGNATES THE OUTPUT BORE DIAMETER

0	2.5 Inches
1	1.97 Inches

X - DESIGNATES THE SPEED

X:	0	1	2	3	4	5	6
Sec:	60	30	15/18	10	6	8	110

Y - DESIGNATES STYLE

A	Basic Unit - Dec clutchable
C	24VAC Unit with 24VAC Servo
D	With Interposing Relay Board*

*Only available for 120VAC or 220VAC On/Off units

Z - DESIGNATES THE VOLTAGE

Z:	0	1	2	3	4	5	6	7	8	9	
Voltage:	120VAC	12VDC	24VDC	24VAC	220VAC	380V 3-PH	400V 3-PH	200V 3-PH	140V 3-PH	180V 3-PH	208V 3-PH

Introduction

The Bray Series 70 is a quarter turn electric actuator with manual override for use on any quarter turn valve requiring up to 18000 in. lb of torque. Operating speeds vary between 6 to 110 seconds.

Principle of Operation

The Series 70 actuator is divided into two internal sections; the power center below the switchplate, and the control center above the switchplate. Below the switchplate the capacitor and gearmotor with its spur geartrain drive a non-backdriveable worm gear output. The override mechanism for manual operation is also housed here. Above the switchplate is where user required, readily accessible components are placed. The camshaft assembly, limit switches, terminal strips, torque switches, heater, and servo are all placed here for easy access. External to the unit are adjustable mechanical travel stops, a large easy to read indicator, the unique manual override handwheel and dual conduit entry ports. The external coating is a high quality polyester powder coat which has exceptional UV as well as chemical resistance.

Electrical Operation

The motors used in the Bray Series 70 are either permanent induction split capacitor design (single phase AC power), SCI (Three Phase AC Power) or PM (DC Power). Travel limit switches are mechanical form (SPDT) with contacts rated at 10 amp (0.8 PF), 1/2 HP 125/250 VAC. In cases where the torque capacity of the unit is exceeded to the point where the motor stalls and overheats, a thermal protector switch built into the motor windings will automatically disconnect the motor power. Once the motor cools sufficiently the thermal protector switch will reset. Optional torque switches are available in all units to prevent the possibility of stalling

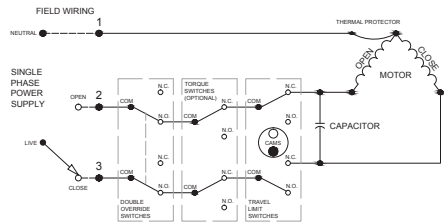
the motor, thus reducing the necessity for an inoperable thermal cooldown period. Torque switches installed by Bray are factory adjusted to the output torque rating of the unit using electronic torque testing equipment.



NOTICE

Torque switches are not field adjustable. Adjustment of torque switches in the field will void warranty.

General Electrical Schematic



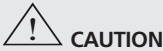
NOTE: this is only a reference. For the actual wiring diagram refer to the diagram placed inside the actuator cover.

Mechanical Operation

Mechanically, the ratio of the gearmotor determines the speed of the unit. The gearmotor utilizes high efficiency spur gears with various ratios for the different speeds. Initial gear reduction through the spur gears is then transferred to the worm shaft. The final gear reduction and output is through a non-backdriveable worm gear set. Positioning is determined by an indicator-cam shaft linked to the output shaft. In the declutchable condition the manual override drives the worm shaft when engaged.

Manual Override Operation (Declutchable)

The manual override operates similar to a watch adjusting knob. To engage the manual override, simply pull the handwheel to its outermost position. A yellow stripe is revealed for visual indication that the unit cannot run electrically. The two handwheel positions, engaged and disengaged, are held in place with the use of spring plungers. The handwheel remains in position until physically moved. Rotating the handwheel in the clockwise direction will rotate the output shaft in the same clockwise (closed) direction and vice-versa.

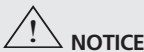


CAUTION

A label on the handwheel hub warns users not to exceed a specific rim pull force, for each size of actuator. If the rim pull force is exceeded, the roll pin securing the handwheel onto the manual override shaft is designed to shear, thus preventing more serious internal gearing damage.

Pre-Installation Storage

Actuators are not weatherproof until properly installed on the valve or prepared for storage. Bray cannot accept responsibility for deterioration caused on-site once the cover is removed.



NOTICE

Units are shipped with two metal screw-in plugs to prevent foreign matter from entering the unit. To prevent condensation from forming inside these units, maintain a near constant external temperature and store in a well-ventilated, clean, dry room away from vibration.

For units with an internal heater, power should be supplied to the heater via conduit entry and appropriate sealing gland.

Store units on a shelf or wooden pallet in order to protect against floor dampness.

Keep units covered to protect against dust and dirt.

Installation

Mounting to a Valve

All Bray Series 70 electric actuators are suitable for direct mounting on Bray butterfly valves. With proper mounting hardware, the S70 actuator can be installed onto other quarter-turn valves or devices.



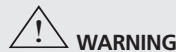
NOTICE

The standard mounting position for the actuator is to orient the unit with its handwheel in a vertical plane and parallel to the pipeline. If the actuator is to be mounted on a vertical pipe, it is recommended that the unit be positioned with the conduit entries on the bottom to prevent condensation from entering the actuator by way of the conduit. In all cases, the conduit should be positioned to prevent drainage into the actuator.

The actuator should be mounted to the valve as follows:

1. Manually operate the actuator until the output shaft of the actuator is in line with the valve stem. If possible, select an intermediate position (i.e. valve disc/stem and actuator both half open).
2. Place the proper adapter, if required, onto the valve stem. It is recommended that a small amount of grease be applied to the adapter to ease assembly.
3. Mount the actuator onto the valve stem. It may be necessary to swing or manually override the actuator to align the bolt patterns.
4. Install the furnished mounting studs by threading them all the way into the actuator base.
5. Fasten in place with the furnished hex nuts and lock washers.

Field Wiring

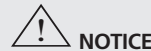


WARNING

Turn off all power and lock out service panel before installing or modifying any electrical wiring.

Each actuator is provided with two (2) conduit entries (one for power and one for control).

1. The motor full load current is noted on the nameplate of the actuator. The terminal strip will accept wire sizes ranging from 14 to 22 AWG (14 to 24 AWG for the servo).



NOTICE

18 AWG minimum wire is recommended for all field wiring.

Note that the optional heaters use approximately 0.5 amps at 110 volts.

2. **All actuators have their applicable wiring diagram attached to the inside of the cover.** Field wiring should be terminated at the actuator terminal strip in accordance with **this** wiring diagram.



NOTICE

The conduit connections must be properly sealed to maintain the weatherproof integrity of the actuator enclosure.

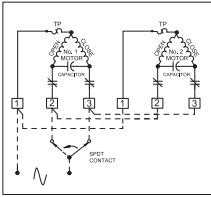
Multiple Actuator (Parallel) Wiring



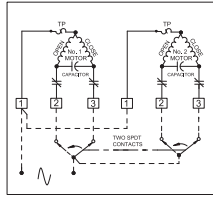
CAUTION

Do not connect more than one S70 actuator which do not have I.R.B. installed to a single SPDT switch. A voltage is present on the opposite winding to the powered one. If this winding is connected to another as shown in the INCORRECT diagram it will interfere with the motor performance. Use a multiple pole switch as shown in the CORRECT diagram.

Actuator Diagram without I.R.B.



INCORRECT



CORRECT



CAUTION

Do not reverse motor instantaneously when it is still running. Reversing direction to actuator motor when it is running can cause damage to motor, switches and gearing. Directional control switching can be done by PLC in 20ms or by a small relay in 46ms. Therefore time delay of 1s has to be incorporated into the control scheme to avoid damage.

Travel Limit Switch and Mechanical Travel Stop Adjustment



CAUTION

The electrical travel switches **must** be set to activate (depress) prior to reaching the mechanical travel stops. The cams are color coded (green for open, red for closed).

NOTE: Manual travel stops are designed to prevent manual overtravel from turning the handwheel, not to stop the electric motor. The travel stops have an adjustment range of approximately 10-degrees.

S70 On/Off Actuator with Interposing Relay Board (I.R.B.)

The back feeding of one actuator by another one wired in parallel is eliminated by using the I.R.B.

If actuator is running Open and customer switches "instantaneously" to run Closed, the Open relay will take time to 'drop-out' and the Close relay will take time to 'pull-in' this time lapse is ~ 40ms. The time delay provided by the I.R.B. will protect the switches

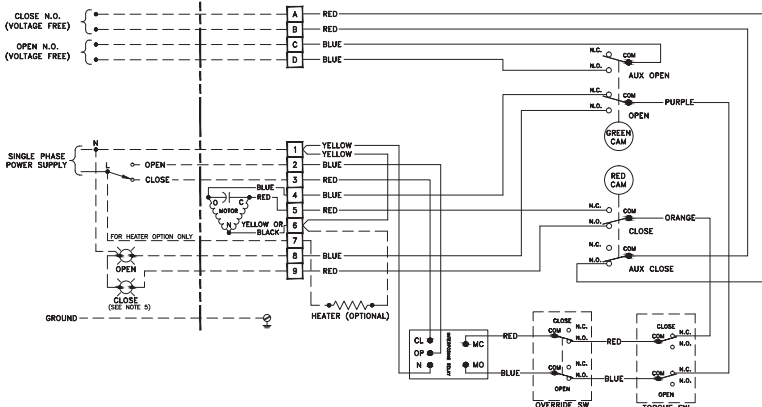
and gears from the controller's instantaneous command signal reversal.

Current draws and field wirings are not affected by adding I.R.B.

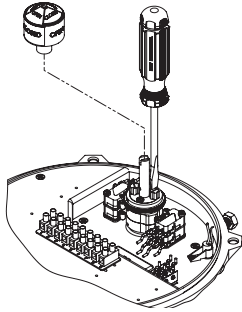
S70 120VAC I.R.B., auxiliary switch, heater, and torque switch option are UL certified units.

FIELD WIRING

ACTUATOR



Close Travel Switch Adjustment



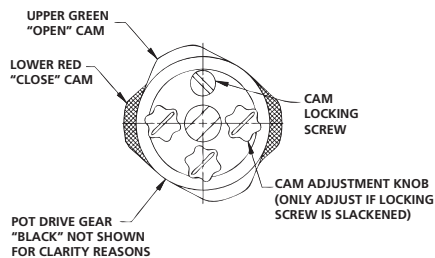
1. Loosen the mechanical stop for the closed position and back it off so that it does not interfere with actuator travel (closed stop located on right when viewed from travel stop side of actuator).
2. Remove the indicator rotor by pulling up it straight up away from the indicator shaft. This will expose the machined groove on the end of the cam shaft, which is the reference to the valve disc position.

NOTE: For Housing Size 180, ignore steps 2 and 6. The valve position indicator plate on the lower gearbox is the reference to the valve position.

3. Manually operate the actuator handwheel clockwise until the valve reaches the desired fully closed position.
4. Rotate the red adjusting knob by hand or with a flat head screwdriver until the cam lobe just activates (depresses) the switch from a clockwise direction.

NOTE: All continuous duty actuators have a cam locking screw. Cam locking screw must be slackened before cam adjustments and re-tightened after cam adjustments.

NOTE: It is possible that the rotation of one cam will move the other cam. If this occurs, hold the other knobs or cams during adjustment.



5. With the travel switch in the closed position, rotate the handwheel clockwise $\frac{1}{2}$ turn for Housing Size 6, 1 turn for Housing Size 12, $\frac{1}{2}$ turn for Housing Size 30, and 2 turns for Housing Size 180. Adjust the closed travel stop bolt until it bottoms against the output gear and lock it in position with the locknut.
6. After all travel switch adjustments have been completed, replace the indicator rotor and secure the actuator cover.

Open Travel Switch Adjustment

1. Loosen the mechanical stop for the open position and back it off, so that it does not interfere with actuator travel. The open stop is located on the left, when viewed from travel stop side of actuator.
2. Remove the indicator rotor by pulling it straight up away from the indicator shaft. This will expose the machined groove on the end of the cam shaft, which is the reference to the valve disc position.

NOTE: For Housing Size 180, ignore steps 2 and 6. The valve position indicator plate on the lower gearbox is the reference to the valve position.

3. Manually operate the actuator handwheel counterclockwise until the valve reaches the desired open position.
4. Rotate the green adjusting knob until the cam lobe just activates (depresses) the switch from a counterclockwise direction.

NOTICE: All continuous duty actuators have a cam locking screw. Cam locking screw must be slackened before cam adjustments and re-tightened after cam adjustments.

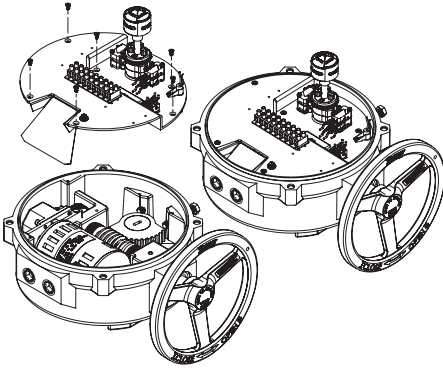
NOTE: It is possible that the rotation of one cam will move the other cam. If this occurs, hold the other knobs or cams during adjustment.

5. With the travel switch in the open position, rotate the handwheel counterclockwise $\frac{1}{2}$ turn for Housing Size 6, 1 turn for Housing Size 12, $\frac{1}{2}$ turn for Housing Size 30, and 2 turns for Housing Size 180. Adjust the open travel stop bolt until it bottoms against the output gear and lock in position with the locknut.
6. After all travel stop adjustments have been completed, replace indicator rotor and secure the actuator cover.

Disassembly and Assembly

Tools required:

See Appendix A for a complete list of basic tools.



NOTE 1: Assembly is the opposite of removal.

NOTE 2: Pictures shown for Housing Size 6 are typical for all sizes.

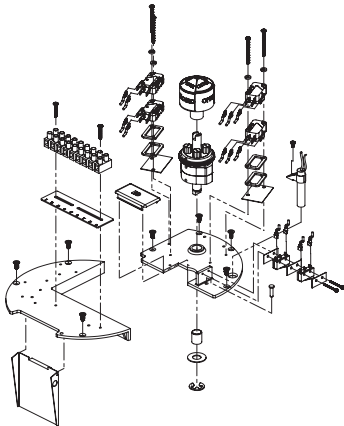
Procedure



WARNING

Turn off all power and lock out service panel before installing or modifying any electrical wiring.

1. Disconnect motor wires from the main terminal strip (motor neutral, open, and close).
2. Remove the switchplate by unscrewing the seven Phillips head mounting screws. The switchplate should lift out as an assembly with the camshaft attached.

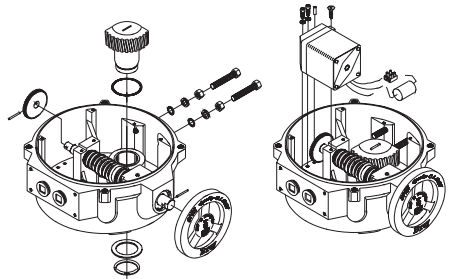


3. The switchplate can be independently disassembled.
4. To remove the Gearmotor, first disconnect the motor leads which run to the capacitor, and unscrew the mounting screws for Housing Size 6 (two lower, one upper) for other Housing Sizes (four lower, one upper). The motor can now be removed vertically out of the unit. Note: do not misplace the alignment pin.
5. To remove the worm shaft spur gear, remove the spring pin using a 3/32" punch, then slide the gear off the end of the worm shaft for Housing Sizes 6 and 12. Remove bowed E-clip retainer for Housing Size 30-180.
6. To remove the output drive worm gear, back off both mechanical travel stops. Remove the retaining ring and thrust washer, then lift the output drive worm gear out of its base.
7. The handwheel is held by a spring pin.



CAUTION

Further disassembly of the unit requires special tools and procedures, and thus will not be covered in this manual.

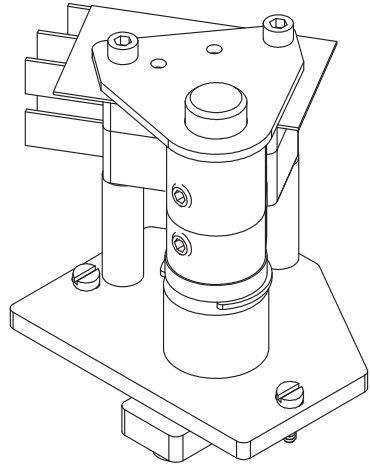


Field or Factory Installable Options Torque Switches

Torque switches are a factory installed and calibrated option available for all Series 70 units. Installation is simple, but due to the requirement for special calibration equipment, it is not recommended for field installation. In fact, modifying the factory torque setting voids the actuator warranty. Removal of the switchplate invalidates factory calibration

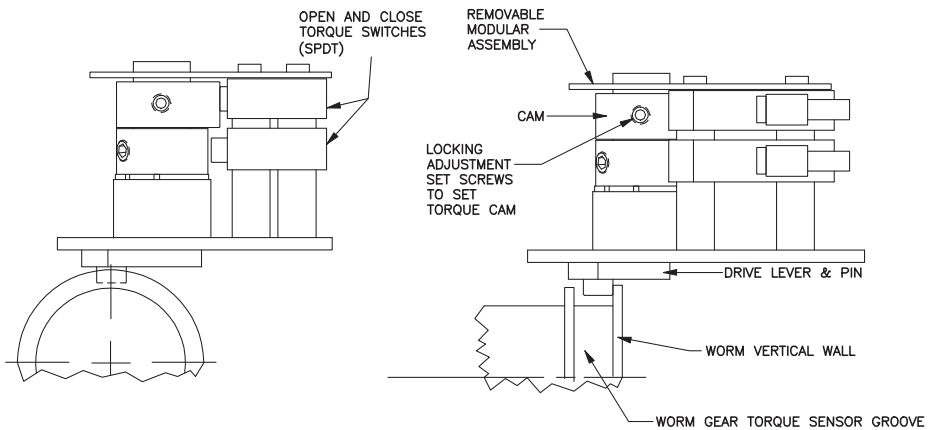
The unique mechanism is extremely accurate and has excellent repeatability. The worm is pinned to the worm shaft, which is held in position with a stack of disc springs at both ends. The torque transmitted through the worm to the output worm gear acts directly against the disc springs, which compress proportionately. The worm and worm shaft shift longitudinally as a result.

A specially designed drive lever and pin is incorporated into the worm, providing the profile for the torque switching mechanism. A drive lever & pin rides in the worm gear torque sensor groove, and in turn drives a cam. The cam then actuates its electrical switch, which interrupts the power to the motor winding when the torque exceeds the setting. The motor can still be powered to run in the opposite direction, the switch will release automatically.



Switching Mechanism

Torque Switch Mechanism




Heater

To prevent condensation from forming inside the actuator, Bray offers an optional heater. The heater is a PTC (Positive Temperature Coefficient) style which has a unique temperature - resistance characteristic. The heater self-regulates by increasing its electrical resistance relative to its temperature. The heater does not require external thermostats or switches to control its heat output. It is constructed of a polycrystalline ceramic, sandwiched between two conductors, and wrapped inside a thermally conductive electrical insulator.

Connect the heater wires to the terminal strip as indicated on the wiring diagram.

NOTE: *The heater must have a constant power supply to be effective.*

 WARNING
The heater surface can reach temperatures in excess of 200 degrees Celsius

Heater Kit Consists of:

1. Heater with flying leads
2. Heater Mounting Bracket
3. #10 pan head screw, Phillips drive

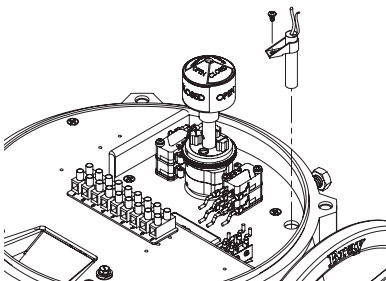
Tools required:

- For terminal wiring: Screwdriver, 3/16" tip flat blade
- For heater mounting screw: Screwdriver, No.1 Phillips

Installation Procedure

The heater is mounted through a hole provided in the switchplate.

Before servicing unit, switch all power off at the service panel and lock the service disconnecting means to prevent power from being switched on accidentally. When the service disconnecting means cannot be locked, securely fasten a prominent warning device, such as a tag, to the service panel.



Disconnect all power to the unit.

1. Place the heater snugly into its mounting bracket until approx. 1/2 to 1" is left above the bracket as shown in diagram.
2. Slip the heater into its mounting hole.
3. Align the fastening hole in the bracket with the threaded screw hole in the plate. Fasten the heater to the switchplate.
4. Connect the heater wires to the terminal strip as indicated on the wiring diagram.

Servo-Pro Module

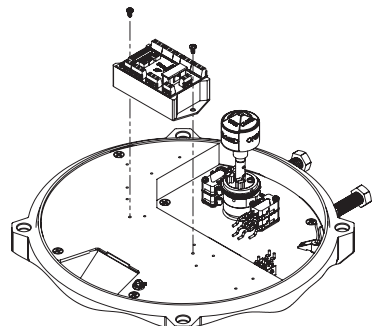
Servo kits can be field installed on any continuous duty actuator (30, 60, or 110 sec. operation speed) to provide proportional positioning in response to a control signal. Intermittent duty actuators are not adaptable for servo control.

Servo Kit Consists of:

1. One servo module
2. Four #6 cross drive pan head screw (two for servo, two for feedback potentiometer)
3. One potentiometer assembly
4. Two #6 type A internal lockwashers (for pot)
5. One wiring diagram sticker for attaching to inside of actuator's cover
6. One wiring diagram sticker for servo units with torque switches

Tools required:

- For actuator terminals wiring Screwdriver, 3/16" flatblade
- For servo terminals: Screwdriver, No.1 Phillips
- For servo and pot mounting screws: Screwdriver, No.2 Phillips



Installation Procedure

- Disconnect all power to the unit.
 - Remove the on/off duty, 9 point terminal strip and its marker.
1. Disconnect all wiring to the terminal strip.
 2. All wiring in the actuator is color coded to facilitate wiring, and does not need to be tagged or marked.
 3. Field wiring should be marked if it is not already color coded.

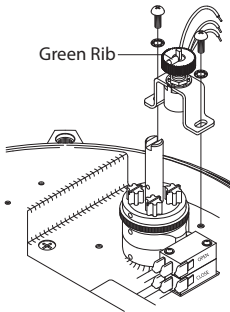
Mount the servo module

4. Secure the servo card module onto switchplate with the 2X #6 screws.

Install the potentiometer assembly

5. The potentiometer installs next to the camshaft where there are two threaded holes provided.
6. The potentiometer assembly must be mounted in the correct orientation, with the actuator in its fully open (counter clockwise) position, the indicator shaft should be in-line with raised green rib on pot gear.
7. Push the assembly towards the cam to mesh the pot gears. Then tighten the mounting screws.

Note: On Housing Size 180, the raised green rib on pot gear should be aligned with arrow on lower gear box's position indicator plate.



8. Rotate the actuator handwheel so that the red cam lobe is facing the body of the potentiometer. Make sure that the cam is not touching the potentiometer assembly. Readjust the assembly position if necessary.

Wire the potentiometer to the servo

9. Connect the potentiometer wires into the terminal strip on the servo module.
10. Wire according to the wiring diagram provided.

Wire the servo to the actuator

11. Wire according to the wiring diagram provided.
12. See the servo calibration instructions.

Servo Calibration

The calibration procedure defines the limits of operation of the Series 70 Actuator between the fully open valve position and the fully closed valve position. The cams on the Series 70 Actuator define the fully open and closed positions of the valve and may be set at any degree of opening. The only requirement is that the open cam limit setting must set at a higher degree of opening than the closed cam limit setting. In other words, the "Open" position must be more open than the "Closed" position.

Calibration is performed as follows:

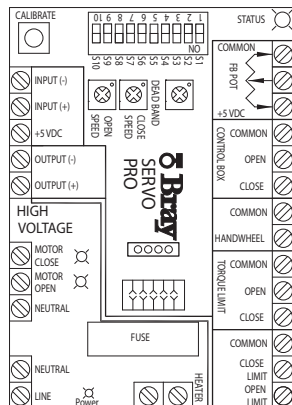
1. Adjust the Open and Closed limit switch cams on the Series 70 Actuator to the desired position.
2. Engage the handwheel and move the Series 70 Actuator to its mid position.

NOTE: An analog signal source is not required for calibration. Press and hold the "Calibrate" Set pushbutton for a minimum of 2 seconds. When the servo status LED begins to flag rapidly, release the button. The servo will now seek both travel limits and record these values to its nonvolatile memory. Following a successful calibration, the status LED will begin to flash a slow single green flash. If the calibration is unsuccessful, the status LED will alternately flash red and green. If this occurs, make sure the cams and the potentiometer are set correctly.

This completes the "Self Calibration" procedure.

After completing the calibration procedure, it is good practice to apply the fully closed and fully open Command Signals, and verify that the S70 Actuator moves to the proper positions.

* Refer to Servo Pro Version 3.0 Operation and Maintenance Manual for more details



External Signal Feedback Potentiometer

Potentiometers for external feedback can be field installed on all continuous duty actuators. Actuators which are not continuous duty do not have a pot gear fitted on their indicator shafts & must be fitted with a new shaft which has a pot drive gear for feedback pot (see Options: Auxiliary Switches).

Feedback Potentiometer Kit consists of:

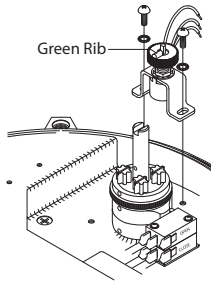
- One potentiometer assembly
- Two #6 cross drive pan head screws
- Two #6 internal lockwashers
- One 4 point terminal strip
- One terminal strip marker for feedback pot
- One small wiring diagram sticker for the additional potentiometer

Tools Required:

- For terminal wiring Screwdriver, 3/16" tip flat blade
- For pot mounting screws Screwdriver, No.2 Phillips

Installation Procedure

1. The potentiometer installs next to the camshaft where there are two threaded holes provided for it.
2. The potentiometer assembly must be mounted in the correct orientation, with the actuator in its fully open (counter clockwise) position, the indicator shaft should be in-line with raised green rib on pot gear.
3. Push the assembly towards the cam to mesh the pot gears. Then tighten the mounting screws.
4. Rotate the actuator handwheel so that the red cam lobe is facing the body of the potentiometer. Make sure that the cam is not touching the potentiometer assembly. Readjust the assembly position if necessary.
5. Fit the 4 point terminal strip and marker in the kit. Before laying down the marker, cut it to obtain a marker as illustrated: opposite
6. Wire the pot to the terminal strip using the small stick-on wiring diagram provided.
7. Adhere the wiring diagram sticker to the inside of the cover.



Set the Potentiometer

1. Manually operate the actuator handwheel until the unit is in the fully closed position.
2. Rotate the black potentiometer drive gear adjustment knob, to engage the potentiometer gear at the closed position.
3. Manually operate the actuator to the fully open position.

Auxiliary Switches

Auxiliary switches are available, refer to chart on next page.

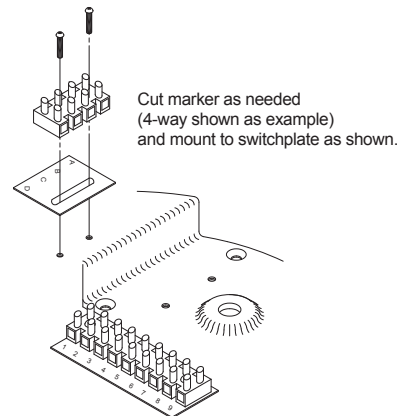
NOTES:

1. All auxiliary switches have voltage-free contacts.
2. Housing Sizes 6, 12, and 30 have double lobe cams. Housing Size 180 has single lobe cams.
3. Main limit switches are one OPEN and one CLOSE switch.
4. Auxiliary switches are one OPEN and one CLOSE switch, which are fixed to activate 3° before the main switches.
5. Adjustable auxiliary switches are adjustable to any position.

Installation Procedure

1. Cut terminal strip marker to length needed with letters facing up.
2. Mount terminal strip and marker to switchplate using two #4-40 screws.

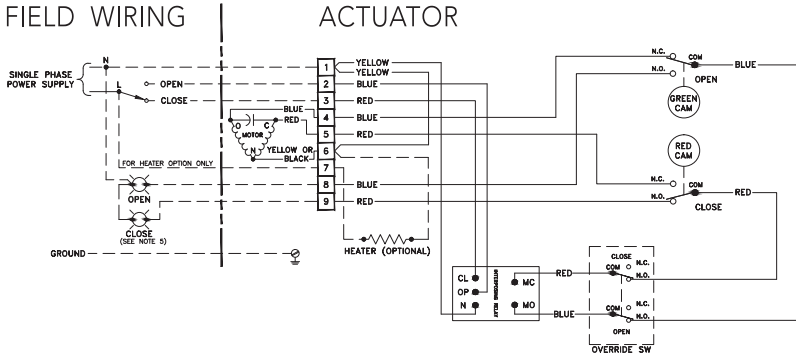
Aux Terminal Strip



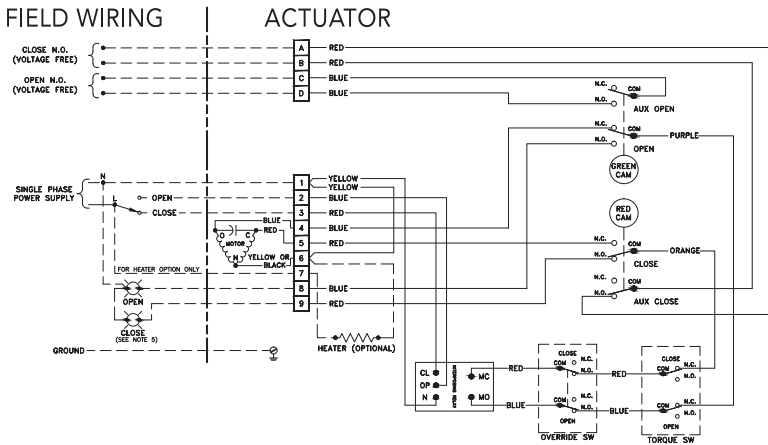
Auxiliary Switch Configuration Chart

CONFIGURATION	HOUSING SIZE 6	HOUSING SIZES 12 & 30	HOUSING SIZE 180
1. ON/OFF (Intermittent Duty Motor) with Main Switches (Standard OPEN and CLOSE switches)	2 Switch 2 Cams Standard Assembly P/N	2 Switch 2 Cams Standard Assembly P/N	N/A
2. ON/OFF (Continuous Duty Motor) with Main Switches (Standard OPEN and CLOSE Switches)	2 Switch 2 Cams & Pot Gear Standard Assembly P/N	2 Switch 2 Cams & Pot Gear Standard Assembly P/N	N/A
3. ON/OFF (Intermittent Duty Motor) with Main and 1 set of Auxiliary Switches	4 Switch 2 Cams Kit P/N/ 70-0006-22980-536	4 Switch 2 Cams Kit P/N/ 70-0012-22960-536	4 Switch 2 Cams & Pot Gear Standard Assembly P/N
4. ON/OFF (Continuous Duty Motor) with Main and 1 set of Auxiliary Switches	4 Switch 2 Cams & Pot Gear Kit P/N 70-0006-22980-536	4 Switch 2 Cams & Pot Gear Kit P/N 70-0012-22960-536	4 Switch 2 Cams & Pot Gear Standard Assembly P/N
5. ON/OFF with Main, 1 set of Auxiliary, and 1 Adjustable Auxiliary Switches	5 Switch 3 Cams Kit P/N 70-0006-22983-536	5 Switch 3 Cams Kit P/N 70-0012-22963-536	N/A
6. ON/OFF with Main, 1 set of Auxiliary, and 1 set of Adjustable Auxiliary Switches	6 Switch 3 Cams Kit P/N 70-0006-22984-536	6 Switch 3 Cams Kit P/N 70-0012-22964-536	N/A
7. ON/OFF with Main, 1 set of Auxiliary, and 2 adjustable Auxiliary Switches	For use with control station only. See Factory	6 Switch 4 Cams Kit P/N 70-0012-22961-536	6 Switch 4 Cams & Pot Gear
8. ON/OFF with Main, 1 set of Auxiliary, and 2 sets of adjustable Auxiliary Switches	N/A	8 Switch 4 Cams Kit P/N 70-0012-22962-536	N/A
9. Servo with Main, 1 set of Auxiliary, and 1 adjustable Auxiliary Switches	N/A	5 Switch 3 Cams & 1 Pot Gear Kit P/N 70-0012-22966-536	5 Switch 3 Cams & 1 Pot Gear
10. Servo with Main, 1 set of Auxiliary, and 2 Adjustable Auxiliary Switches	N/A	N/A	6 Switch 4 Cams & Pot Gear
11. ON/OFF with Main and 1 Adjustable Auxiliary Switch	3 Switches 3 Cams Kit P/N 70-0006-22988-536	3 Switch 3 Cams Kit P/N 70-0012-22968-536	N/A
12. Servo with Main and 1 Adjustable Auxiliary Switch	N/A	3 Switch 3 Cams & 1 Pot Gear Kit P/N 70-0012-22971-536	N/A

Typical Wiring Diagram: On/Off Service



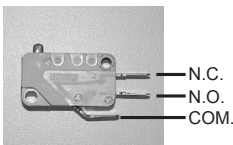
Wiring diagram for basic unit with Form-C (SPDT) travel limit switches, I.R.B., and double override switches.
(Drawn for actuator in its fully closed condition.)



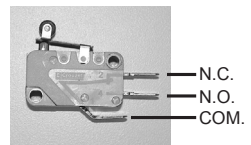
Wiring diagram for unit with Form-C (SPDT) travel limit switches, "Voltage Free" Auxiliary open/close switches, I.R.B., double override switches and torque switches.
(Drawn for actuator in its fully closed condition.)

Actuator Form-C Switches, SPDT

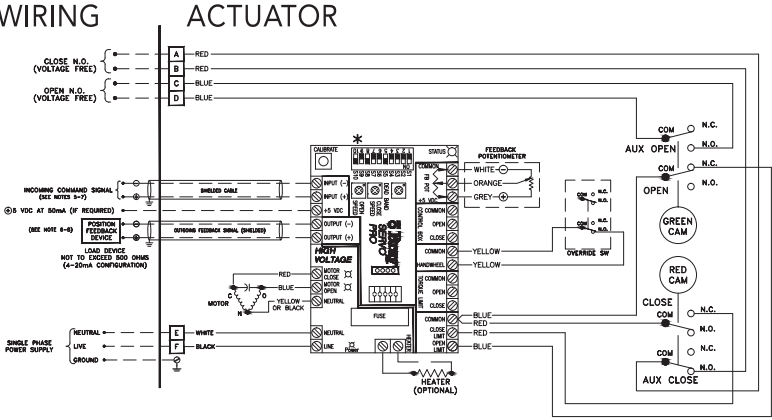
Housing Size: 6
V3-Sw



Housing Size: 12, 30 & 180
V3-Sw with Lever



Typical Wiring Diagram: Modulating Service



Wiring diagram for unit with Form-C (SPDT) travel limit switches, "Voltage Free" Auxiliary open/close switches, Servo and double override switches. (Drawn for actuator in its full closed position.)

Warning: Turn ALL Power Off prior to adjusting DIP switches.

SWITCH	COMMAND INPUT			
	4-20 mA DC	0-5 VDC *	0-10 VDC	2-10 VDC
1	Off	On	On	On
2	Off	Off	On	On
3	Off	Off	Off	On
	Output			
	4-20 mA DC	0-5 VDC	0-10 VDC	2-10 VDC
4	Off	On	On	N/A
5	On	Off	Off	N/A
6	Off	On	Off	N/A
	Forward Acting	Reverse Acting		
7	Off	On		
	Fail in Last Position	Fail Enable **		
8	Off	On		
	Fail Close	Fail Open		
9	Off	On		
	Torque Switch Enable	Torque Switch Disable		
10	Off	On		

*To control servo with a remote potentiometer, set the Command Input to 0-5VDC (see Command Signal Connector section; page 8 Servo Pro Manual).

**Fail position is the position that the servo will travel to when the control signal is removed. It does not apply to 0-5VDC or 0-10VDC Command Signals.

Adjustments, Calibration and Status LED of Servo Pro

A. Adjust the open and close speed of your actuator (The fastest closing speed of your actuator is printed on the label of the unit):

1. Use the Close Speed trim pot to adjust the closing speed of your actuator (pot in the fully CCW position equals fastest close speed).
2. Use the Open Speed trim pot to adjust the opening speed of your actuator (pot in the fully CCW position equals fastest open speed).

B. Calibrate the Servo:

1. Manually position your actuator somewhere in mid position; away from the travel limits.
2. Disengage your handwheel (push it back in towards the actuator), hold down the Calibration push button for two seconds and release, the servo will begin to drive the actuator in the close direction and then in the open direction in order to save these limits to memory.
3. Following a successful calibration the servo's Status LED will begin to flash the normal operation code, an unsuccessful calibration will yield a Red-Green-Red-Green flash immediately following the attempted calibration (for more information on the Status LED flash codes see the Status LED Flash Code Table).

Status LED

The "Status LED" is a bi-color LED which provides detailed information regarding the operation of the S70 Servo Pro. Table 2 below illustrates the different combinations of LED flash codes and their corresponding conditions. Following the table is a more descriptive explanation of the Flash Code. Whenever the LED is flashing green, regardless of the flash code, the servo will operate, but not necessarily optimally. Whenever the LED flash codes are RED, the servo will not operate. An example is an engaged handwheel, the Status LED will flash a single red flash code and will not operate.

Table 2: Status LED Flash Codes

Green Status LED warning and information Flash Codes:

#	Indication	Reason	Solution
1	Steady Green Flash	Normal Operation	Servo Functioning Ok
2	2 Green Flashes	Calibration Defaults Loaded	Adjust travel limits, push autocalibration PB
3	3 Green Flashes	Reverse Acting Mode	If you would like your servo to not operate in reverse acting mode, set DIP switch 7 accordingly
4	4 Green Flashes	2-10VDC Input Command Signal Selected	If you require a different configuration, set DIP switches 1, 2, and 3 accordingly
5	1 Red Flashes	Handwheel engaged	Push the Handwheel in towards the actuator
6	2 Red Flashes	Command Signal Failure	Set DIP switches accordingly, send servo appropriate signal
7	3 Red Flashes	Feedback Pot Fault	Position the feedback Pot correctly, see Feedback Pot calibration
8	4 Red Flashes	Limit Switch Fault	Check wiring of limit switches, ensure that both switches are not tripped simultaneously
9	5 Red Flashes	Torque Switch Fault	Ensure that DIP switch 10 is positioned correct, check wiring of torque switches, reverse direction of actuator, correct over torque condition
10	6 Red Flashes	Feedback Pot Wired In Reverse	Correctly wire the Feedback Pot

Note: A flashing green LED provides status and warning information. The servo will operate normally in this state. Some flash codes indicate a warning, where the servo has recovered automatically such as the detection of an invalid calibration. In this case, a default calibration is automatically loaded that will allow the Servo to operate, but may not be a perfect match to the actuator. The servo should be re-calibrated as soon as possible.

Receptacles (Quick Connectors)

Unless otherwise specified, power receptacles will be 5-pin mini style standard duty with a black anodized aluminum finish. They conform to ANSI B93.55M except in wire color. Euro receptacles will be used for low power instrument and signal cable since they can be supplied shielded. Wiring diagrams for plug-in receptacles for either the Bray Series 70 or the local control station will be provided as a separate diagram. Units ordered with pin connector receptacles factory installed are wired and tested. Cordsets which fit these receptacles may be ordered in several lengths.

Receptacle Kit consists of:

1. Receptacle(s), male pin and male thread 1/2" -NPT, in the quantity, style, and number of pins ordered
2. Reducing bushing 3/4" to 1/2" NPT for installation in Housing Sizes 12 - 180 and control stations
3. Wiring diagram (SK-# below)

Tools required:

- For terminal wiring: Screwdriver, 3/16" tip flat blade
- For Mini or Euro receptacle: Wrench, 1"

Installation procedure:

1. Screw the receptacle into the actuator conduit entry using Teflon tape or similar.
2. Wire to the terminal strip according to the wiring diagram or the field wiring requirements.

Wiring Schematic for Optional Pin Connector Receptacles

REQUIREMENTS	RECEPTACLES REQ'D	NO L.C.S. ¹ DIAGRAM	WITH L.C.S. ¹ DIAGRAM
ON - OFF UNITS (INTERMITTENT OR CONTINUOUS)			
POWER _____	ONE MINI	SK-960517	SK-960515
POWER _____ POSITION INDICATION ² _____	ONE MINI ONE EURO	SK-960717	SK-960513
POWER _____ POSITION INDICATION ³ _____	ONE MINI ONE EURO	SK-960516	SK-960716 ⁵
POWER _____ FEEDBACK POTENTIOMETER _____	ONE MINI ONE EURO	SK-960718	SK-960720
POWER _____ POSITION INDICATION ³ _____ FEEDBACK POTENTIOMETER _____	ONE MINI 6-PIN EURO ⁴	SK-960719	N/A

Custom configurations are possible - consult the factory.

¹ L.C.S.: Local Control Station, WHICH implies mounted to the actuator

² Travel indication is wired to the supply voltage

³ Travel indication wiring is voltage free

⁴ A 6-pin EURO connector is required for this application, consult factory for price and availability.

⁵ The Local Control Station comes standard with 120 Volt lamp bulbs, for other voltages consult factory.

Note: *the Control Station lights must be wired to the same voltage as the remote end of travel indication.*

Euro receptacles use 22 AWG wire rated at 250V, 4 Amp. Pin configuration interfaces with European standards.

Mini receptacles use 18 AWG wire rated at 300 V, 9 Amp. Pin configuration conforms to ANSI B93.55M.

*** For requirements beyond these ratings consult the factory.**

Spinner

A spinner is available to ease and speed the manual override of the Bray Series 70 actuator. The Housing Size 6 units mount the spinner on a lever which screws onto the back of the handwheel. The Housing Size 12-180 units mount the spinner on the rim of the handwheel. Note that care should be exercised in the use of spinner equipped handwheels. Rapid operation of the handwheel to close the valve may cause water hammer. Also, rapid travel into a travel stop may cause damage.

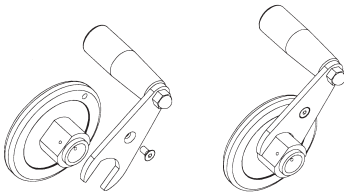
Spinner Kit Consists of:	
For Housing Size 6	For Housing Sizes 12-180
Spinner and lever assembly	Spinner handle
Flat head socket cap screw, #10-32UNF x 3/8	Socket head shoulder bolt, 1/4-20UNC x .75

Tools required:

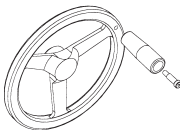
- For socket head shoulder bolt and flat head cap screw
- Hex key, 1/8" for Housing Size 6
- Hex key, 3/16" for Housing Sizes 12-180

Installation procedure:

For Housing Size 6 units simply position the lever onto the back of the handwheel then screw the flat head cap screw in to place from behind.



For Housing Size 12-180 units, put the socket head shoulder bolt through the spinner handle and screw it firmly into the handwheel rim.



Local Control Station (Single Phase Powered Actuators)

Bray's local control station gives the user the ability to locally override the actuator electrically. The station is open / stop / close operation in the local control mode. Red and green end of travel indication lights are also provided. Depending on how it is wired the control station can be used on the on - off units and the servo controlled modulating units. Optional key operated locking switches are available.

Note: The control station used with On - Off S70 and that used with modulating S70 have different contact blocks internally, the correct part number must be used to ensure you order the correct unit (see price sheet).

Local Control Station Kit consists of:

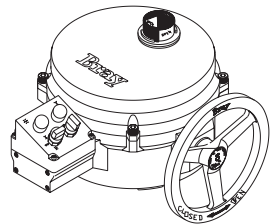
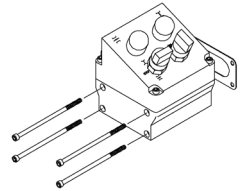
1. Local control station assembly
2. Four socket head cap screws, #10-24UNC x 4.50 long, for mounting the station to the actuator
3. A gasket for sealing the station to the actuator
4. Wiring diagram

Tools required:

- For tapping control station mounting holes on actuator, #10-24UNC Tap.
- For wiring Screwdriver, 3/16" flat blade.
- For mounting and cover screws Hex key, 5/32"

Installation procedure:

1. Tap #10-24UNC holes using the cored holes on the side of actuator.
2. Adhere the gasket to the control box.
3. Mount the control box to the actuator using the 4 long socket head cap screws.
4. Wire the control box to the actuator in accordance to the wiring diagram provided. The local control station contains no terminal strips, and all wiring is direct to the switches and lights via 2" x 3/4" NPT holes in bottom of housing. Ordering the control station with optional pin connector receptacles will eliminate the necessity of field wiring. The units will be completely factory wired and tested.



Note: The inclined cover of the local control station can be mounted in any of its four symmetrical positions. If field wiring is required, first mount the base to the actuator, then remove the cover to gain access for wiring.

*Local Control Station requires a dedicated set of auxiliary switches for control station use only. Two additional adjustable auxiliary switches are needed for remote indication of open/close position in ON/OFF configurations

Appendix A

Basic Tools

Common To All Units	
Terminal connections, cam adjustment	Screwdriver, ¼" tip flat tip blade
All switches, terminal strip, torque switch plate	Screwdriver, No.1 Phillips
Switchplate screws, capacitor	Screwdriver, No. 2 Phillips
Servo trimmer pots	Screwdriver, ⅛" flat tip for trim pots
Housing Size 6	
Mounting nuts	Wrench, ½"
Cover captivated capscrews	Hex key, ¼"
Travel stop adjusting bolts	Wrench, ⅞"
Travel stop jam nuts	Wrench, ⅞"
Motor mount socket flat head capscrew	Hex key, ⅜"
Motor mount socket head capscrew	Hex key, ⅜"
Conduit Entry Plug	Hex key, ⅜"
Housing Size 12	
Mounting nuts (small pattern)	Wrench, ½"
Mounting nuts (large pattern)	Wrench, ¾"
Cover captivated capscrews	Hex key, ⅜"
Travel stop adjusting bolts	Wrench, ⅞"
Travel stop nuts	Wrench, ⅞"
Motor mount socket head capscrew	Hex key, ⅜"
Conduit Entry Plug	Hex key, ⅜"
Housing Size 30	
Mounting nuts, travel stop jam nuts	Wrench, ¾"
Cover captivated capscrews	Hex key, ⅜"
Travel stop adjusting studs	Wrench, ¾"
Motor mount socket head shoulder bolt	Hex key, ⅜"
Motor mount socket head cap screws	Hex key, ⅜"
Conduit Entry Plug	Hex key, ⅜"
Housing Size 180	
Mounting nuts, travel stop jam nuts	Wrench, ¾"
Cover captivated capscrews	Hex key, ⅜"
Travel stop adjusting studs	Wrench, ⅞"
Motor mount socket head shoulder bolt	Hex key, ⅜"
Motor mount socket head cap screws	Hex key, ⅜"
Conduit Entry Plug	Hex key, ⅜"

Appendix B

Actuator Troubleshooting Chart

Problem	Possible Cause	Solutions
Actuator does not operate	Override is engaged	Push handwheel in all the way
	Wiring is incorrect	Check wiring and power supply
	Actuator motor has reached its thermal shutdown temperature	Allow time to cool
Actuator operates in reverse directions	Field wiring is reversed	Rewire field wiring
Actuator does not fully close valve (or open valve)	Limit switches are depressed	Readjust travel limit switches
	Mechanical travel stop is stopping actuator	Adjust mechanical travel stops
	Valve torque requirement is higher than actuator output	Manually override out of seat, try angle seating or larger actuator
	Optional torque switches are activating	Valve torque exceeds actuator torque rating - consult factory
	Voltage power supply is low	Check power source.
Engaging override handwheel does not shut off motor	Override pin is corroded or damaged	Clean and check for smooth operation of the override switch pin
	Override switch is damaged	Replace switch
Disengaging override hand-wheel does not restart motor	Not completely disengaged	Push handwheel in as far as possible (no yellow showing)
	Override pin is damaged or and does not activate switch	Replace override pin
	Incorrect wiring of override switch	Check wiring
Motor runs but worm and gear segment do not	Worm gear segment is not meshing with worm	Remove switchplate and inspect, adjust travel stops to prevent gear disengaging
	Pin/Key on Worm/Motor drive gear sheared	Replace Pin/Key on drive gear
Corrosion inside unit	Condensation forming	Test heater wiring, should have constant power
	Water leaking in	Check all seals and possible water entry through conduit

570 Servo Pro Troubleshooting Chart

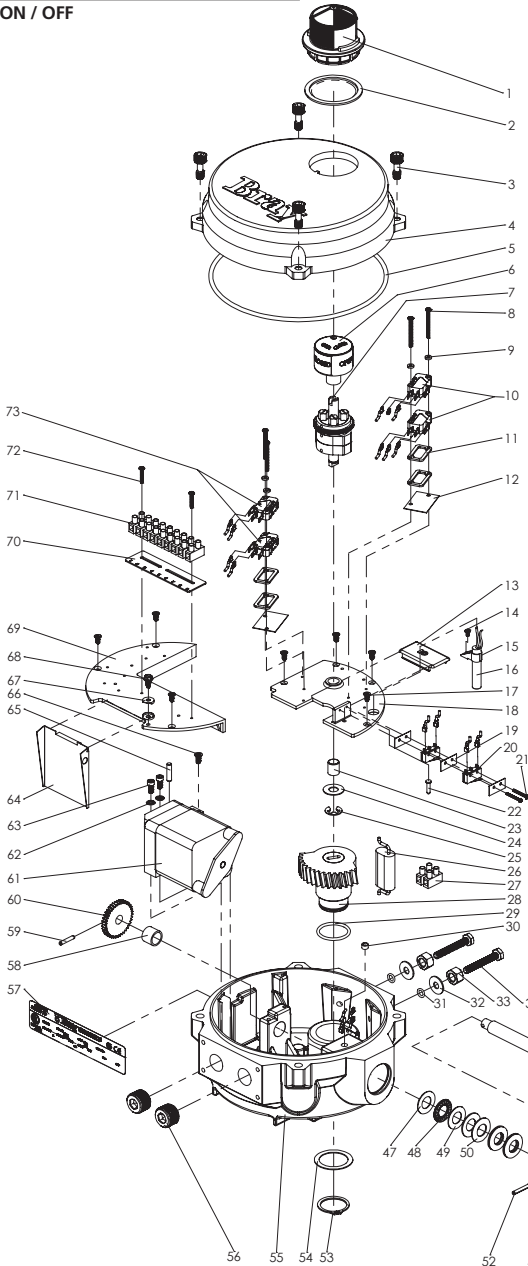
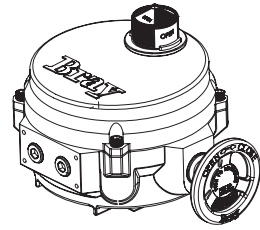
Refer to the Servo Pro Operation Manual for more information.

Problem	Possible Cause	Solutions
Actuator moves back and forth near setpoint (hunts)	Signal is fluctuating beyond deadband setting	Increase the deadband using the Deadband trim pot.
	Signal has interference	Shield signal from interference
Actuator does not travel fully open or fully closed	Travel limit switches are not set correctly	Set travel limit switches for 90° operation
	Servo DIP switches are not set correctly	See Quick Setup Instructions on page 5
	Mechanical travel stops are not set correctly	Set mechanical travel stops for 90° operation
Actuator motor does not run and green servo power light is off	Power is disconnected	Connect power
Actuator motor does not run and green servo power light is on	Limit switches or torque switches are triggered	Ensure that there is continuity between the two wires going to each switch
	Handwheel is engaged	Push handwheel in (disengage)
	Servo is not wired correctly	Check servo wiring to all points
	Motor has thermally tripped	Allow motor to cool down
Actuator does not properly respond to command signal	Potentiometer gear is not engaged	Engage and adjust pot. gear
	Command signal DIP switch selection is not correct	Set the DIP switches correctly
	Command signal polarity is incorrect	Wire the command signal correctly
Actuator runs in one direction only	Wiring is incorrect	Correct Wiring
	Potentiometer wired backwards	Reverse white and gray wires, see wiring diagram inside cover
	Limit switch or torque switch is triggered	Ensure that there is continuity between the wires coming from the switches. If your actuator has reached its travel limit, reverse direction. If one of your torque switches has tripped, reverse the actuator direction and correct the over torque condition.
	Command signal DIP switch selection is not correct	Set the DIP switches correctly

Appendix C - Exploded Views

Series 70 - Housing Size 6

ON / OFF

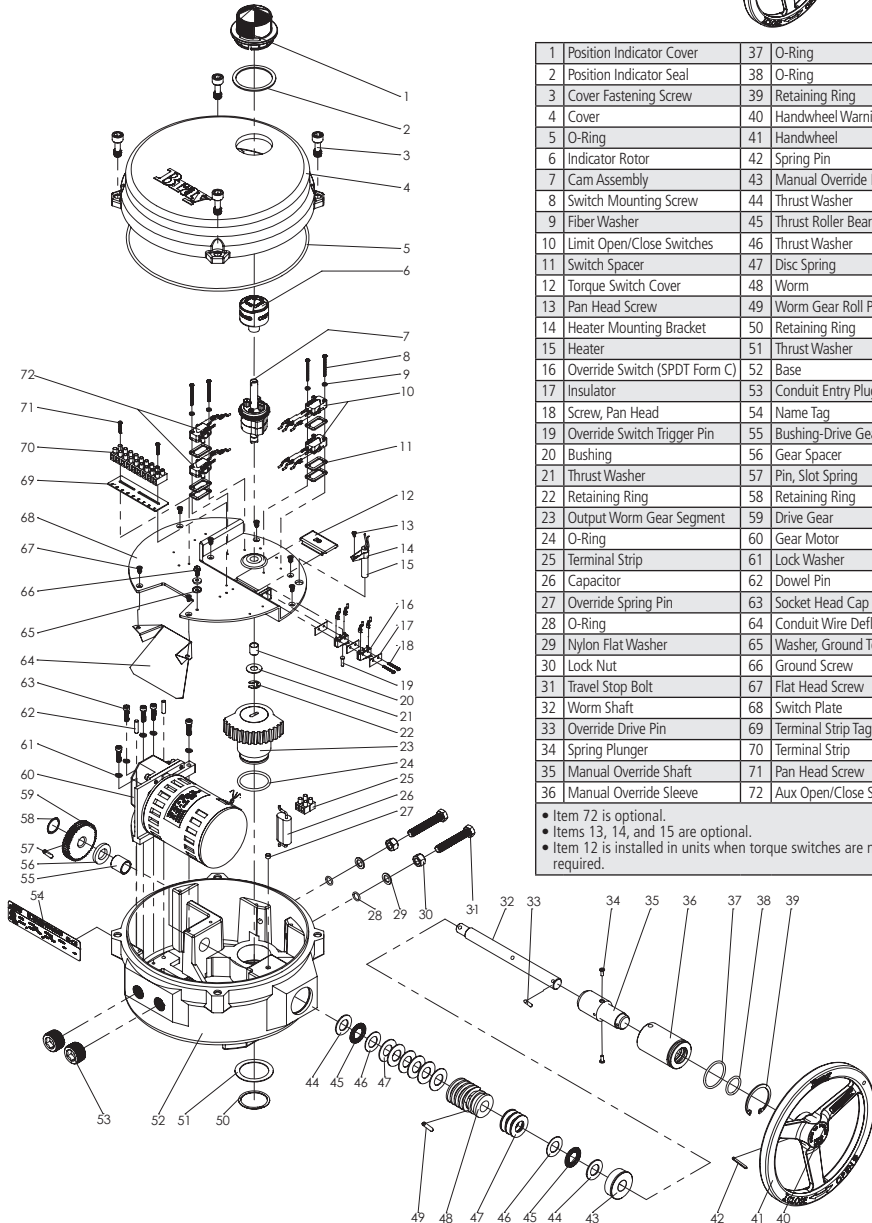
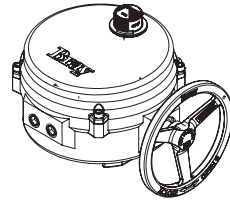


1	Position Indicator Cover	38	Manual Override Shaft
2	Position Indicator Seal	39	Manual Override Sleeve
3	Cover Fastening Screws	40	O-Ring
4	Cover	41	O-Ring
5	O-Ring	42	Retaining Ring
6	Indicator Rotor	43	Handwheel
7	Indicator Shaft Assembly	44	Handwheel Warning Label
8	Switch Mounting Screw	45	Spring Pin
9	Fiber Washer	46	Manual Override Bushing
10	Limit Open/Close Switches	47	Thrust Washer
11	Switch Spacer	48	Thrust Roller Bearing
12	Switch Insulator	49	Thrust Washer
13	Torque Switch Cover	50	Disc Spring
14	Pan Head Screw	51	Worm
15	Heater Mounting Bracket	52	Pin, Slot Spring
16	Heater	53	Retaining Ring
17	Flat Head Screw	54	Thrust Washer
18	Switch Plate, Fixed	55	Base
19	Insulator	56	Conduit Entry Plug
20	Override Switch (SPDT Form C)	57	Name Tag
21	Screw, Pan Head	58	Bushing
22	Override Switch Trigger Pin	59	Drive Gear Pin
23	Bushing	60	Drive Gear
24	Thrust Washer	61	Gear Motor
25	Retaining Ring	62	Lock Washer
26	Capacitor	63	Socket Head Cap Screw
27	Terminal Strip	64	Conduit Wire Deflector
28	Output Worm Gear Segment	65	Dowel Pin
29	O-Ring	66	Flat Head Screw
30	Override Spring Pin	67	Washer, Ground Terminal
31	O-Ring	68	Ground Screw
32	Nylon Flat Washer	69	Switch Plate Removable
33	Lock Nut	70	Terminal Strip Tag: 1-9
34	Travel Stop Bolt	71	Terminal Strip
35	Worm Shaft	72	Pan Head Screw
36	Override Drive Pin	73	Aux Open/Close Switches
37	Spring Plunger		

- Item 73 is optional.
- Items 14, 15 and 16 are optional.
- Item 13 is installed in units when torque switches are not required.

Series 70 - Housing Size 12

ON / OFF

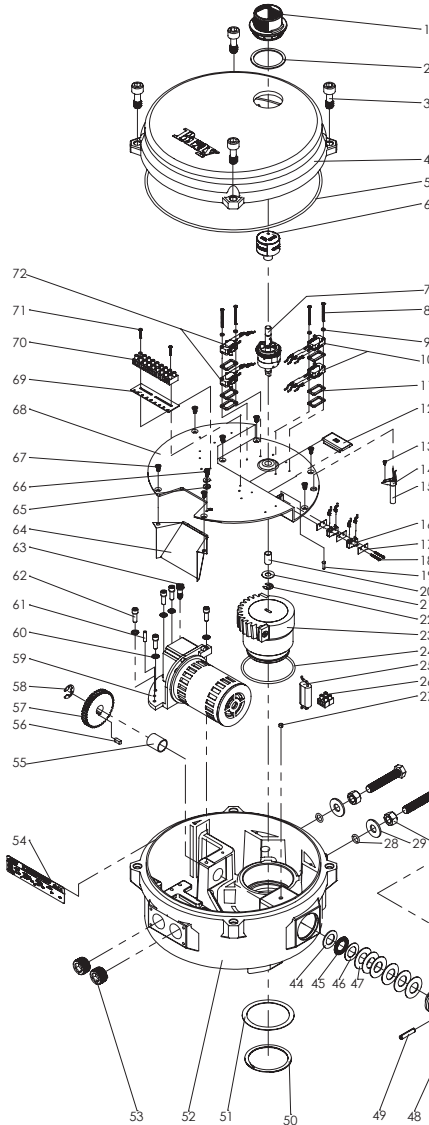
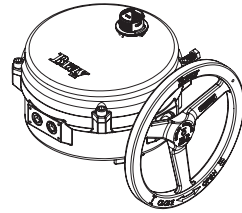


1	Position Indicator Cover	37	O-Ring
2	Position Indicator Seal	38	O-Ring
3	Cover Fastening Screw	39	Retaining Ring
4	Cover	40	Handwheel Warning Label
5	O-Ring	41	Handwheel
6	Indicator Rotor	42	Spring Pin
7	Cam Assembly	43	Manual Override Bushing
8	Switch Mounting Screw	44	Thrust Washer
9	Fiber Washer	45	Thrust Roller Bearing
10	Limit Open/Close Switches	46	Thrust Washer
11	Switch Spacer	47	Disc Spring
12	Torque Switch Cover	48	Worm
13	Pan Head Screw	49	Worm Gear Roll Pin
14	Heater Mounting Bracket	50	Retaining Ring
15	Heater	51	Thrust Washer
16	Override Switch (SPDT Form C)	52	Base
17	Insulator	53	Conduit Entry Plug
18	Screw, Pan Head	54	Name Tag
19	Override Switch Trigger Pin	55	Bushing-Drive Gear
20	Bushing	56	Gear Spacer
21	Thrust Washer	57	Pin, Slot Spring
22	Retaining Ring	58	Retaining Ring
23	Output Worm Gear Segment	59	Drive Gear
24	O-Ring	60	Gear Motor
25	Terminal Strip	61	Lock Washer
26	Capacitor	62	Dowel Pin
27	Override Spring Pin	63	Socket Head Cap Screw
28	O-Ring	64	Conduit Wire Deflector
29	Nylon Flat Washer	65	Washer, Ground Terminal
30	Lock Nut	66	Ground Screw
31	Travel Stop Bolt	67	Flat Head Screw
32	Worm Shaft	68	Switch Plate
33	Override Drive Pin	69	Terminal Strip Tag: 1-9
34	Spring Plunger	70	Terminal Strip
35	Manual Override Shaft	71	Pan Head Screw
36	Manual Override Sleeve	72	Aux Open/Close Switches

- Item 72 is optional.
- Items 13, 14, and 15 are optional.
- Item 12 is installed in units when torque switches are not required.

Series 70 - Housing Size 30

ON / OFF

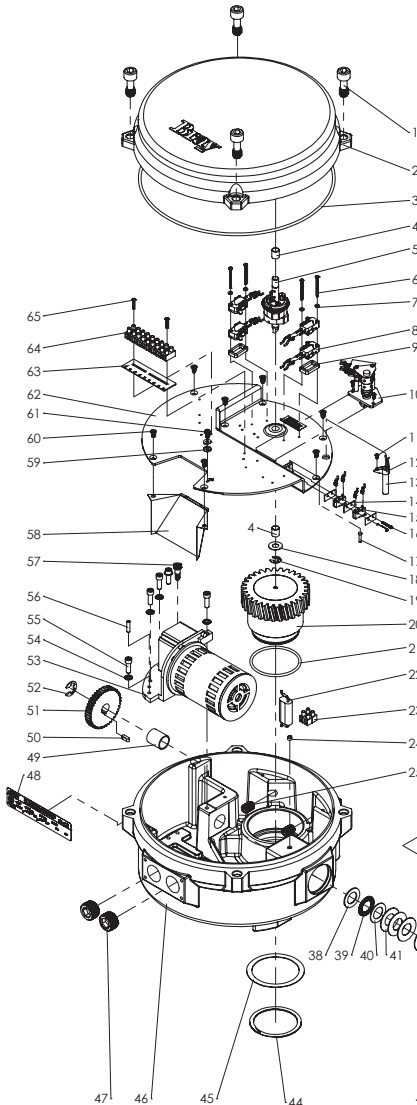
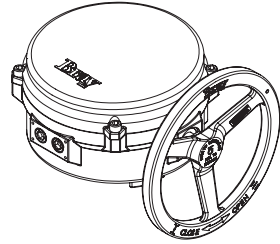


1	Position Indicator Cover	37	O-Ring
2	Position Indicator Seal	38	O-Ring
3	Cover Fastening Screw	39	Retaining Ring, Internal
4	Cover	40	Spring Pin
5	O-Ring	41	Handwheel Warning Label
6	Indicator Rotor	42	Handwheel
7	Cam Assembly	43	Manual Override Bushing
8	Switch Mounting Screw	44	Thrust Washer
9	Fiber Washer	45	Thrust Roller Bearing
10	Limit Open/Close Switches	46	Thrust Washer
11	Switch Spacer	47	Disc Spring
12	Torque Switch Cover	48	Worm
13	Pan Head Screw	49	Worm Gear Roll Pin
14	Heater Mounting Bracket	50	Retaining Ring, Ext.
15	Heater	51	Thrust Washer
16	Override Switch (SPDT Form C)	52	Base
17	Insulator	53	Conduit Entry Plug
18	Screw, Pan Head	54	Name Tag
19	Override Switch Trigger Pin	55	Bushing
20	Bushing	56	Drive Gear Key
21	Thrust Washer	57	Drive Gear
22	Retaining Ring	58	Retaining Ring, Bowled E-Ring
23	Worm Segment With Pads	59	Motor Assembly
24	O-Ring	60	Lock Washer
25	Capacitor	61	Dowel Pin
26	Terminal Strip	62	Socket Head Cap Screw
27	Override Spring Pin	63	Socket Head Shoulder Screw
28	O-Ring	64	Wire Entry Guard
29	Nylon Flat Washer	65	Washer, Ground Terminal
30	Lock Nut	66	Ground Screw
31	Travel Stop Bolt	67	Flat Head Screw
32	Worm Shaft	68	Switch Plate
33	Override Drive Pin	69	Terminal Strip Tag: 1-9
34	Spring Plunger	70	Terminal Strip
35	Manual Override Shaft	71	Pan Head Screw
36	Manual Override Sleeve	72	Aux Open/Close Switches

- Item 72 is optional.
- Items 13, 14, and 15 are optional.
- Item 12 is installed in units when torque switches are not required.

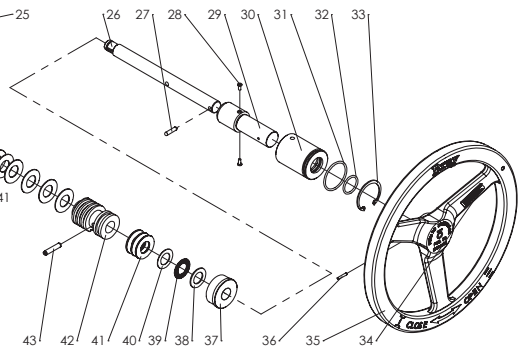
Series 70 - Housing Size 180 for 3:1 Gear Box

ON / OFF



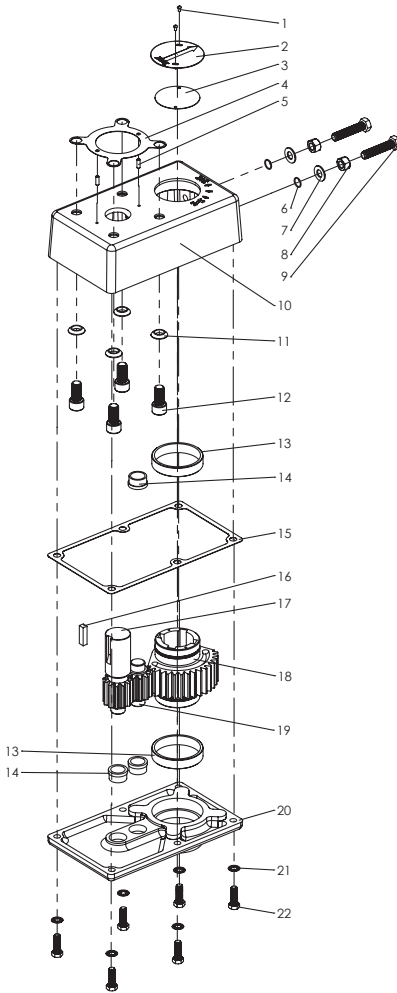
1	Cover Fastening Screw	34	Handwheel Warning Label
2	Cover	35	Handwheel
3	O-Ring	36	Spring Pin
4	Bushing	37	Manual Override Bushing
5	Cam Assembly	38	Thrust Washer
6	Switch Mounting Screw (1.375)	39	Thrust Roller Bearing
7	Flat Insulation Washer	40	Thrust Washer
8	Open Switch Assembly	41	Disc Spring
9	Switch Spacer	42	Worm
10	Torque Switch Assembly	43	Worm Gear Roll Pin
11	Pan Head Screw	44	Retaining Ring, External
12	Heater Mounting Bracket	45	Thrust Washer
13	Heater	46	Base
14	Insulator	47	Conduit Entry Plug
15	Override Switch (Spdt Form C)	48	Name Tag
16	Screw, Pan Head	49	Bushing
17	Override Switch Trigger Pin	50	Drive Gear Key
18	Thrust Washer	51	Drive Gear
19	Retaining Ring	52	Retaining Ring, Bowed E-Ring
20	Output Worm Gear Segment	53	Gear Motor
21	O-Ring	54	Lock Washer
22	Capacitor	55	Socket Head Cap Screw
23	Terminal Strip	56	Dowel Pin
24	Override Drive Pin	57	Socket Head Shoulder Screw
25	Set Screw, Soc. Hd. Cap.	58	Wire Entry Guard
26	Worm Shaft	59	Washer Terminal Ground
27	Override Drive Pin	60	Flat Head Screw
28	Spring Plunger	61	Ground Screw
29	Manual Override Shaft	62	Switch Plate
30	Manual Override Sleeve	63	Terminal Strip Tag: 1-9
31	O-Ring	64	Terminal Strip
32	O-Ring	65	Pan Head Screw
33	Retaining Ring, Internal		

• Items 11, 12, and 13 are optional.

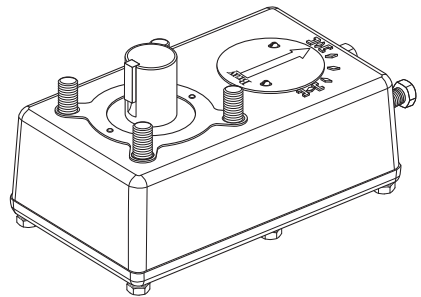


Series 70 - 3:1 Gear Box

ON / OFF



1	Fastening Screw
2	Position Indicator Plate
3	Position Indicator Gasket
4	Actuator/Gear Box Gasket
5	Dowel Pin
6	O-Ring
7	Washer, Flat, Nylon
8	Nut, Hex
9	Bolt, Hex Head
10	Cover
11	Washer, Conical
12	Actuator/Gear Box Fastening Screw
13	Output Gear Bearing
14	Idler/Input Gear Bearing
15	Cover Gasket
16	Input Gear Key
17	Input Gear
18	Output Gear
19	Idler Gear
20	Base
21	Lock Washer
22	Base Fastening Screw



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