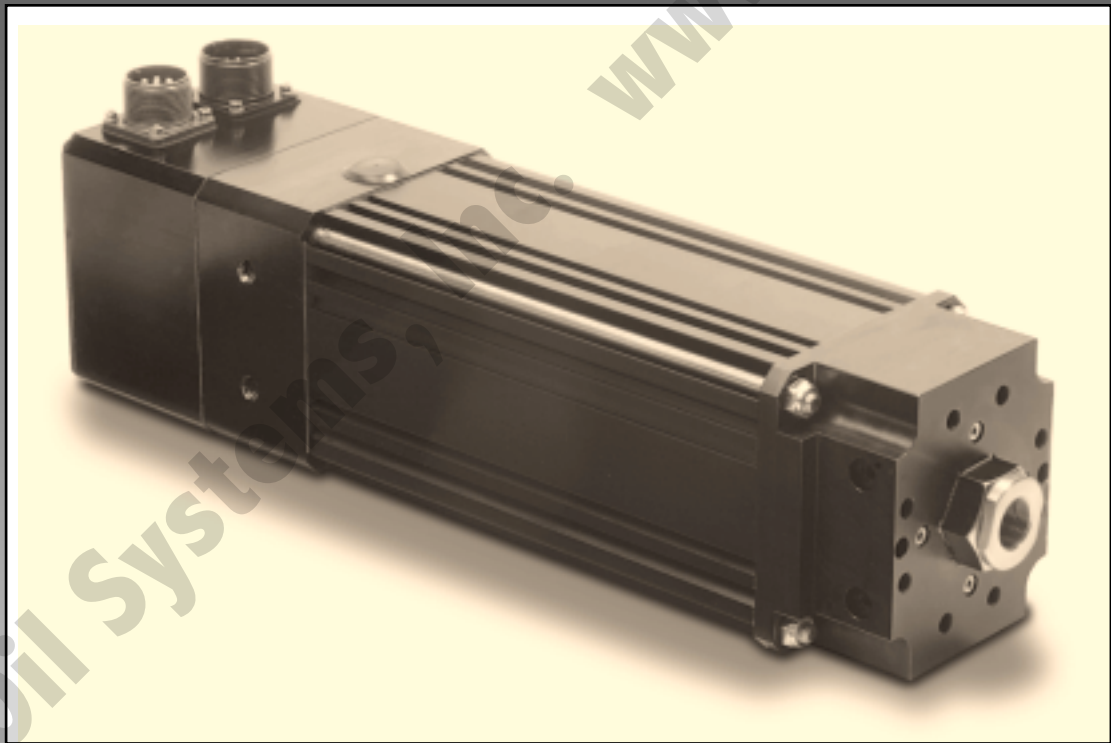


***Welding Actuator SW44  
with Fanuc Pulsecoder  
User Manual***



**TOL-O-MATIC, INC**  
*Excellence in Motion*<sup>®</sup>

Air-Oil Systems, Inc. [www.airoil.com](http://www.airoil.com)

Information furnished is believed to be accurate and reliable. However, Tol-O-Matic assumes no responsibility for its use or for any errors that may appear in this document. Tol-O-Matic reserves the right to change the design or operation of the equipment described herein and any associated motion products without notice. Information in this document is subject to change without notice.

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# HEALTH AND SAFETY REGULATIONS

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## General

Read completely through the applicable sections of the manual before the equipment/unit is unpacked, installed or operated. Pay careful attention to all of the dangers, warnings, cautions and notes stated in the manual.

Serious injury to persons or damage to the equipment may result if the information in the manual is not followed.

Items that are specifically marked **DANGER!**, **WARNING!**, **CAUTION!**, OR **NOTE!** Are arranged in a hierarchical system and have the following meaning:



**DANGER!** Indicates a very hazardous situation which, if not avoided, could result in death or serious injury. This signal word is limited to the most extreme situations.



**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, this situation may result in property damage or minor or moderate injury.

**NOTE!** Information that requires special attention is stated here.

.....

**Warning for Hot Surfaces**



WARNING! Normal operating temperature of weld actuator can range from 135 degrees F (57°C) to 175 degrees F (79°C).

**Modifications to the Equipment**



WARNING! The manufacturer takes no responsibility whatsoever if the equipment is modified or if the equipment is used in any way beyond performance specifications. Unauthorized modifications or changes to the equipment are strictly forbidden, and void all warranties.

**Requirement regarding Personnel**

NOTE! All personnel must be completely informed regarding all safety regulations and the function of the equipment.

**Packing, Transport and Unpacking**

NOTE! Anchor and secure actuator in such a way as to prevent damage during transport. Also make sure the actuator is clean and dry and protected from moisture.

**Risk Area and Personnel**

When installed on a weld gun, pinch points are generated capable of high damaging forces. The risk area surrounding the weld actuator must either be enclosed or clearly marked, including display signage in accordance with all applicable national and international legal requirements for welding actuators. The risk area must be protected by a safety system that stops the equipment if anyone enters the risk area. Personnel who enter the risk area must be authorized, trained and qualified for the different tasks inside the risk area.

**Repair and Maintenance**

All power and supply media must be shut OFF before any work is performed on any equipment that is associated with the welding gun application.

## 1.1 Identification Label



Figure 1.1: Actuator identification label

Do not remove the identification label. Do not render it unreadable!

## 1.2 Manufacturer

Tol-O-Matic, Inc.  
3800 County Road 116  
Hamel, MN 55340, USA  
763-478-8000  
www.tolomatic.com  
email: help@tolomatic.com

### 1.3 Intended Use

The SW44 weld actuator (see figure 1.2) is a compact high force screw drive servo actuator. The weld actuator provides linear motion of the moveable weld gun tip and develops the required thrust (squeeze) force for spot welding.

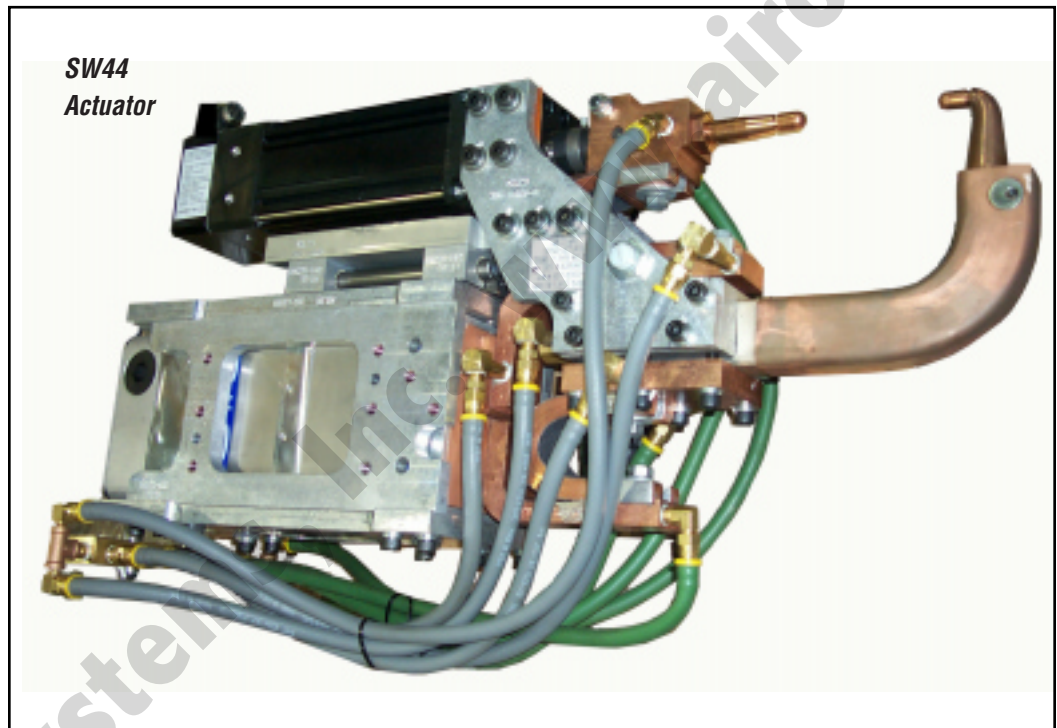


Figure 1.2: Example of welding actuator installed on “C” Style weldgun unit.



**WARNING!** Before installation and commissioning of the equipment, this manual and all accompanying manufacturer documents and manuals **MUST** be completely read by the appropriate personnel. All warning texts must be given special attention.



## 1.4 General Operation

The SW44 actuator functions by translating the rotary motion of the integral brushless servo motor into linear motion using a planetary roller screw or a ball screw. The linear travel, speeds and forces are controlled in conjunction with a properly sized brushless servo drive.

The relationship between the rotary motion of the motor and the linear motion of the actuator corresponds to the following relationships:

**Linear distance traveled = (motor revolutions) \* (displacement ratio)**

**Linear Speed = ((motor RPM)/60) \* (displacement ratio)**

**Linear Force (lbf) =  $\frac{\text{Motor Torque (in-lbf)} * 2 * \pi * \text{efficiency}}{\text{Roller Screw Lead (in/rev)}}$**



Motor RMS current must be maintained at a level below the continuous current rating of the SW44 actuator or damage to the motor stator will result.

The peak current setting must be maintained at a level below the peak current rating of the SW44 actuator or damage to the motor stator will result.



Care should be taken not to exceed the physical travel limits of the SW44 actuator. Doing so will cause the actuator to reach mechanical end of stroke internally. Although protected by the end of stroke bumpers frequently reaching internal end of stroke can physically damage the screw and the internal components of the actuator.

## 1.5 Storage

Pay attention to the following when storing the weld actuator and/or weld gun equipment:

- Perform repairs, maintenance and inspections before storing equipment to ensure that the equipment is in good working order.
- Make sure the equipment is placed in a suitable storage position to prevent damage to the connectors and electronics.
- Protect the feedback device, which is located at the blind (non-rod end) of the SW44 actuator.

## 2.1 Actuator

The weld actuator provides movement to the moveable electrode bringing the moveable electrode in contact with the material to be welded and the stationary electrode. Once the electrodes are in position the weld actuator maintains thrust (squeeze) force throughout the weld cycle.



WARNING! The welding actuator stroke must be compatible with the weld gun tip opening



WARNING! Do not attempt any repairs or equipment modifications without authorized factory assistance.

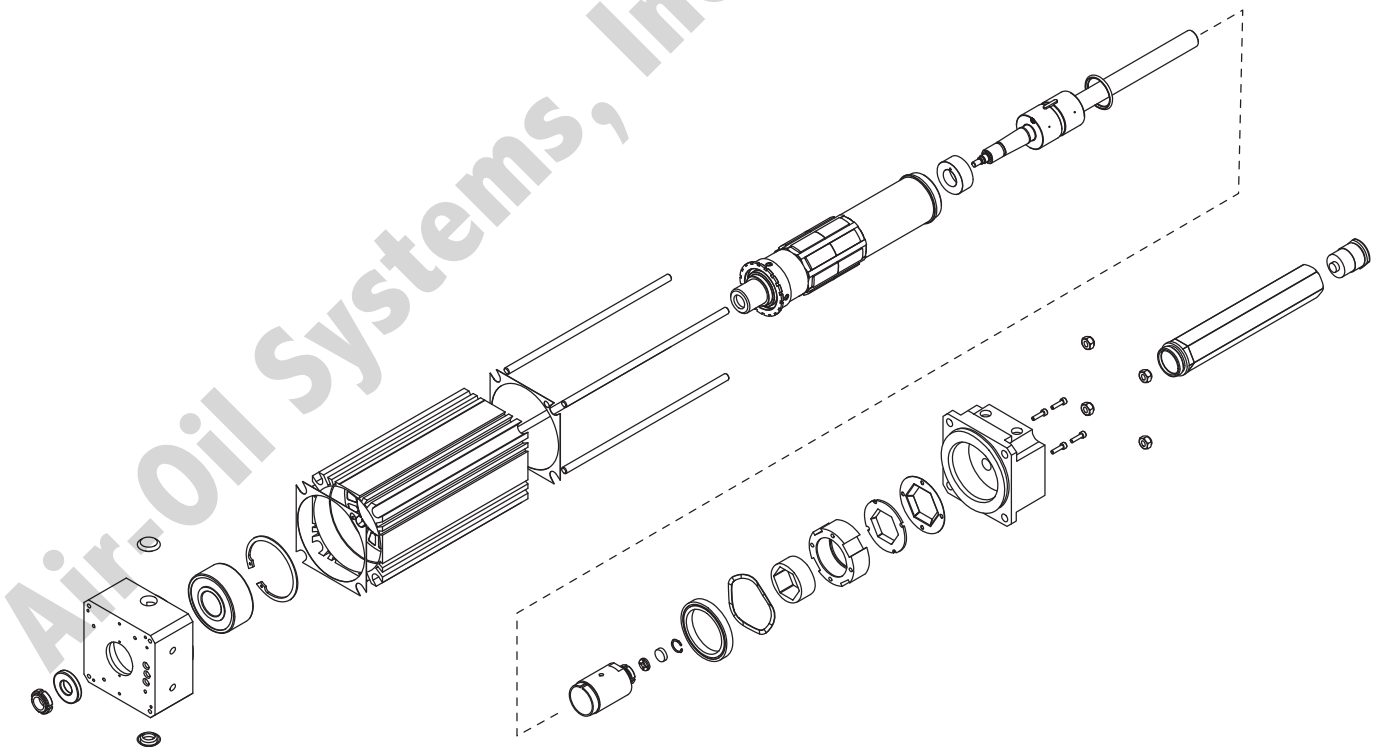


Figure 2.1: Exploded view of SW 44 actuator (Roller Screw)

## 2.2 Fanuc Pulsecoder

The Fanuc Pulsecoder is mounted in a housing on the rear of the SW44. The pulsecoder provides position feedback to the 7th axis controller/drive of the robot controller.

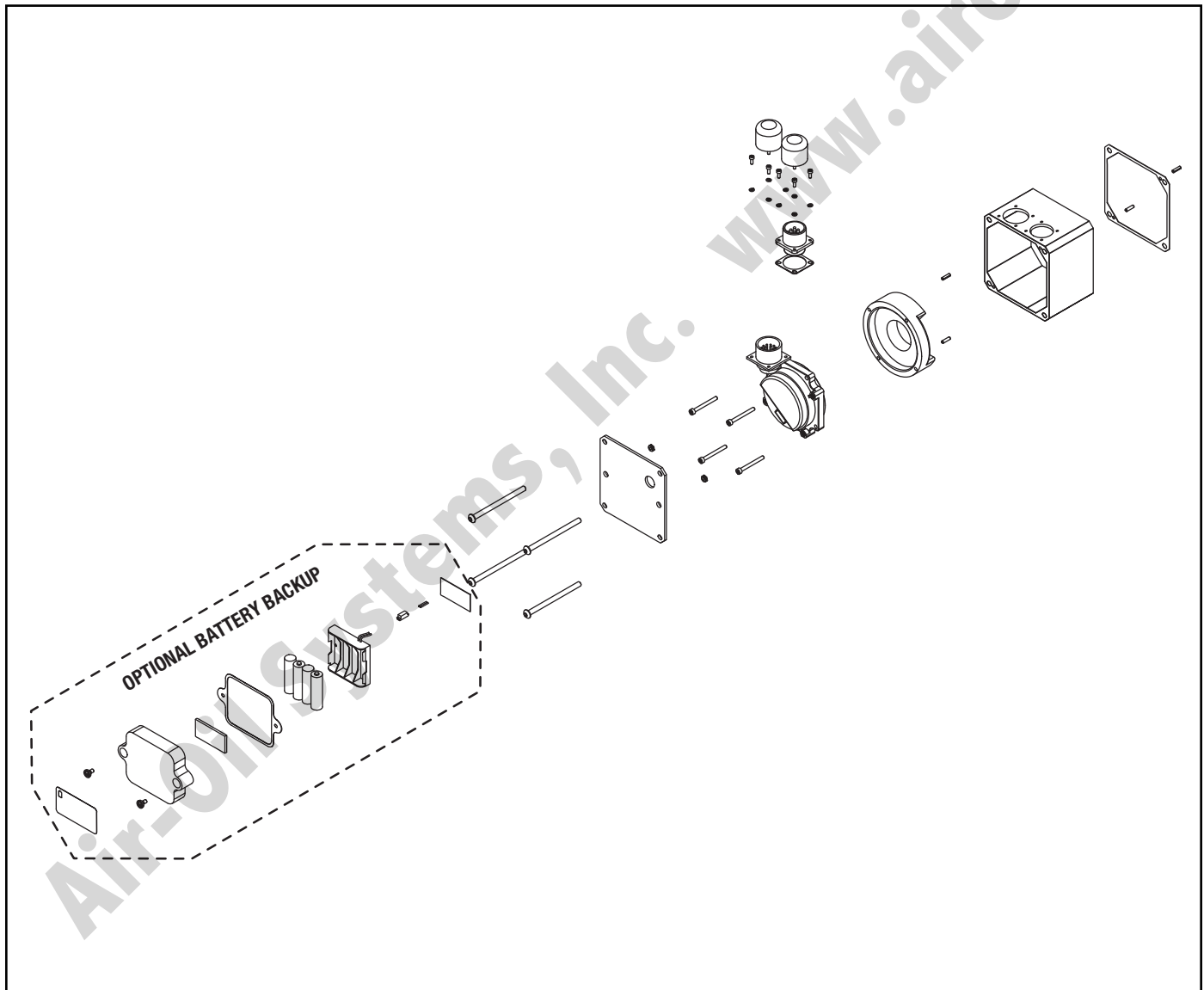


Figure 2.2: Exploded view of Fanuc Pulsecoder for SW44

## 3.1 Installing the Weld Actuator.

Please refer to the weld gun documentation supplied by the weld gun manufacturer for mechanical installation

## 3.2 Electrical Wiring

See the electrical circuit diagram, supplied by the weld gun manufacturer, that accompanied the weld gun at delivery.



**CAUTION!** Excessive side load on the output thrust rod of the actuator will dramatically reduce the life of the actuator and should be avoided. Side load can be caused from misalignment or loading that is not inline with the actuator output thrust rod.



**NOTE!** The distance travelled under load dramatically affects life, when specified in cycle count. Tol-O-Matic recommends loaded stroke of less than 0.10" (2.5mm) when used at maximum actuator output specifications.

## 3.3 Cable Routing

Over time, liquid contaminants such as oil and cleaning solutions will run down the cables and into the connectors if they are of an exposed type. To minimize the introduction of contaminants to the connector, route the cables so that there is a loop in the cable just prior to its attachment to the connector.

Two examples are shown below depending on the orientation of the connectors. Units mounted in such a way that the connectors are on the bottom surface of the actuator require no looping.

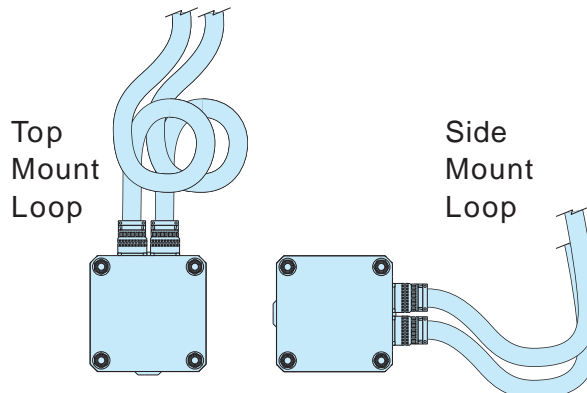


Figure 3.1: Cable routing for top and side mounted connectors

# 4 *Inspection and Settings*

---

## 4.1 *Inspection and Settings*

Before commissioning the weld actuator, there are certain inspections and settings that must be completed. After all maintenance activities, the gun must be inspected before it is returned to service.

## 4.2 *Inspection of Mechanical Travel Limits.*

The mechanical travel limits of the actuator must be verified to ensure the actuator will not reach an internal hard limit during normal operation. The end of stroke bumpers should NOT be engaged during normal programmed servo actuator operation.

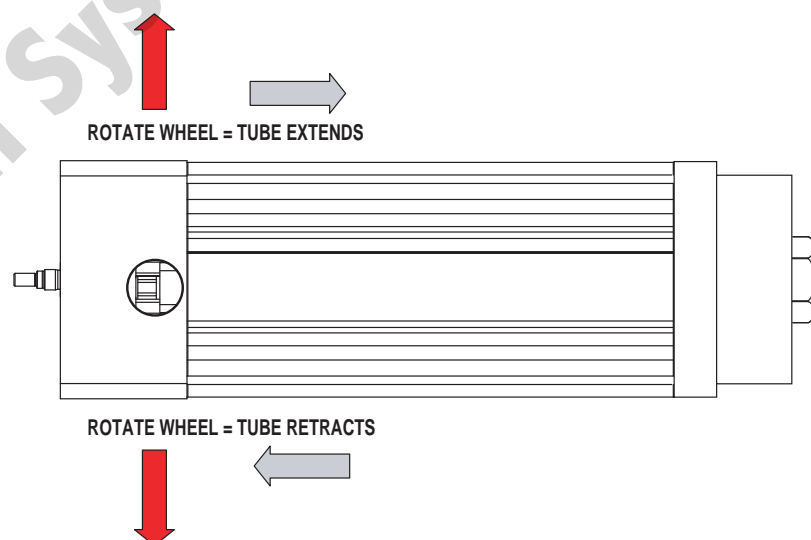
[Step 1] Turn the controller power off (see documentation for controls system for details).

[Step 2] With the actuator installed on a weld gun, manually rotate the servo gear extending the rod until the weld gun tips are closed. Record the distance the rod is extended as ( $d1$ ).

[Step 3] Remove one cap and manually rotate the servo gear, extending the rod, until the actuator reaches its end of travel. Record the distance the rod is extended as ( $d2$ ).

The difference between the two measurements minus the gun deflection ( $d3$ ) should be greater than end of stroke bumper (5 mm):

$$d2 - d1 - d3 \geq 5mm$$



**Figure 4.1: Manual operation of welding actuator**

### 4.3 Weld Motion Profile

The rated force of 2500 lbs. (1.1 kN) is based on a duty cycle that will not cause the maximum surface temperature of the actuator to exceed 155° F (68° C). The motion profile for the duty cycle used to determine rated force is shown below. The motion profile is a 6 inch (152mm) move at max speed and acceleration. The weld move is repeated with a one second dwell between welds and a 3 second dwell every 10 welds.

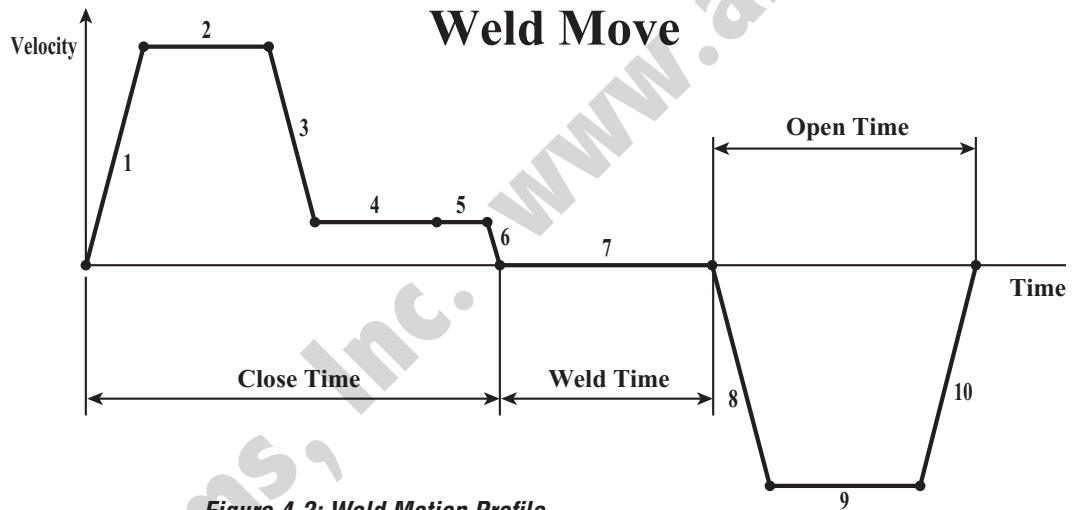


Figure 4.2: Weld Motion Profile

Move #	Initial Velocity (in/sec)	Final Velocity (in/sec)	Accel/ Decel (in/sec <sup>2</sup> )	Move Time (s)	Move Distance (in)
1	0	10	300	0.02	0.1
2	10	10	0	0.55	2.8
3	10	1	300	0.02	0.1
4	1	1	0	0.13	0.13
5	1	1	0	0.05	0.05
6	1	0	300	0.002	0
7	0	0	0	0.5	0
8	0	10	300	0.02	0.1
9	10	10	0	0.58	2.8
10	10	0	300	0.02	0.1

# 5 **Repair and Maintenance**

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NOTE! Before starting any maintenance activities, make sure that the supply power is shut OFF.

- No lubrication is required during the service life of the servo weld actuator.

- The only user serviceable component in the servo weld actuator is the Fanuc Pulsecoder. The pulsecoder is aligned to the servo weld actuator motor by an Oldham coupling. One segment of the Oldham coupling is pressed onto the servo weld actuator shaft during manufacturing of the actuator. Should this press fitting become altered, it is recommended that the actuator be returned to Tol-O-Matic for realignment. The remaining Oldham components assure appropriate motor phasing alignment between the Pulsecoder and motor windings through slotted connections. See figure 2.2 (page 4) for an exploded assembly view.

Disassembly of the weld actuator is not recommended. Servo weld actuators should be returned to Tol-O-Matic for evaluation and repair.

Contact the weldgun manufacturer for instructions on how to return the weld actuator for evaluation.



**WARNING!** Never rotate the actuator via the Pulsecoder connection. Doing so may result in the loss of phasing between the Pulsecoder and motor windings.



## 5.2 Pulsecoder Replacement

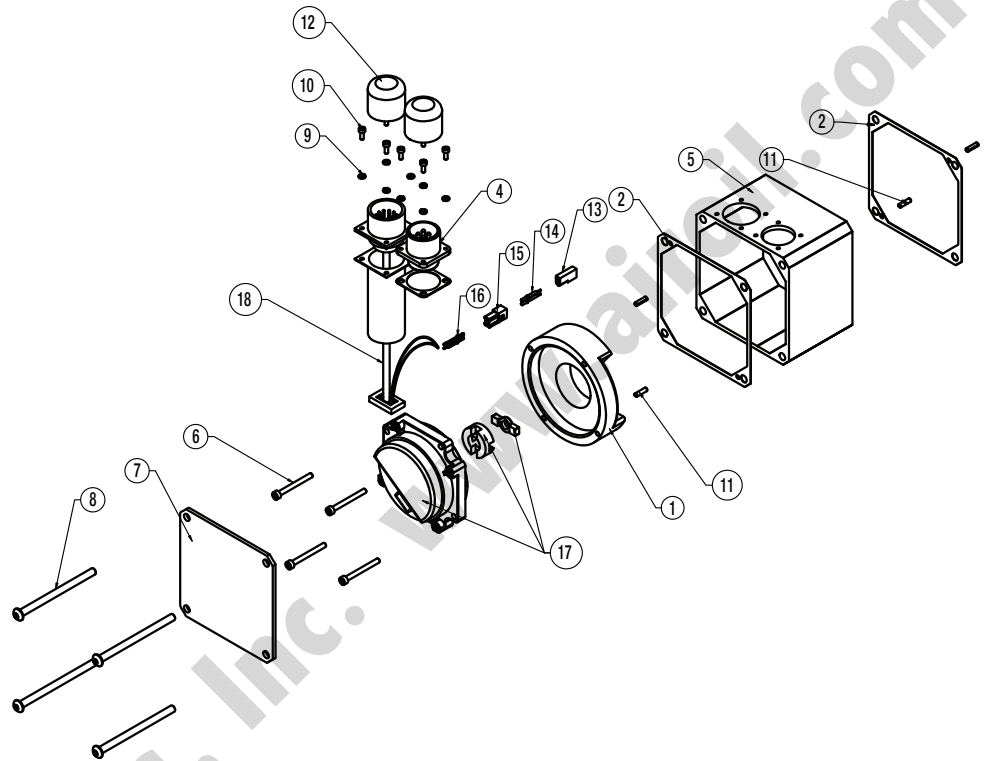


Figure 5.1: Exploded view of Fanuc Pulsecoder

### DISASSEMBLY:

1. Remove the 4 cover plate cap screws (8).
2. Remove cover (7).
3. Remove the gasket (2).
4. Disconnect the pulsecoder harness (18) from the pulsecoder (17).
5. Disconnect the motor temp sensor harness from motor leads (15, 13).
6. Remove the harness from the assembly.
7. Remove the 4 stainless steel socket head cap screws (6). The pulsecoder is now free to come off the assembly. \*Do not remove the black oxide fasteners, as they are holding the pulsecoder together.

**ASSEMBLY:**

1. Orient the leadscrew shaft such that the pulsecoder coupler half is oriented up/down with one starwheel port up and the other down.
2. Install the connecting portion of the pulsecoder coupler onto the coupler half on the actuator.  
Orient the connector on the pulsecoder bottom left.
3. Position a connector gasket between the motor connector and encoder housing and with 4 socket head cap screws (10) and lock washers attach the motor connector to the pulsecoder housing. – Use no Loctite on these fasteners.
4. Position the rubber boot over the pulsecoder harness and the inboard side of the connector.
5. Install the pulsecoder connector to the housing with 4 socket head cap screws, and lock washers (no Loctite). Be sure to locate the rubber boot/gasket between the inboard side of connector and the outside of the cap. Connect harness to the pulsecoder and connect 2 pin motor temp leads to the harness connector.
6. Locate a gasket (2) between the pulsecoder housing (5) and the pulsecoder cover plate (7) and with the 4 cap screws (8), attach the pulsecoder housing and cover to the main bearing plate. Coil the harness so that it will not create any interference.

## 6.1 Specifications

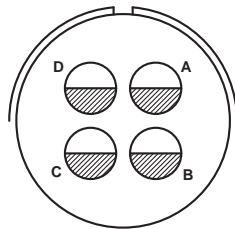
SW44 Motor Specifications	LV3 (Low Voltage)	HV3 (High Voltage)
Continuous Stall Torque	8.5 Nm (75.23 lb-in)	7.6 Nm (67.27 lb-in)
Peak Stall Torque	17.1 Nm (151.35 lb-in)	15.3 Nm (135.42 lb-in)
Continuous Stall Current	10.6 A RMS	5.9 A RMS
Peak Current	21.2 A RMS	11.9 A RMS
Number of Poles	8	8
Kt	0.80 Nm/A per phase RMS	1.29 Nm/A per phase RMS
Ke	0.46 V/rad/s L-L RMS	75.8 V/kRPM L-L RMS
Resistance @ 25C	0.74 ohms L-L	4.18 ohms L-L
Stator Inductance	3.65 mH L-L	15.7 mH L-L
Maximum Bus Voltage	325 Vdc	680 Vdc
Rated Speed @ Maximum Voltage	4,000 RPM	5000 RPM
Moment of Inertia	0.0013 Kg-m <sup>2</sup>	0.0013 kg-m <sup>2</sup>
Demagnetization Current	26 A RMS	26 A RMS
SW44 Actuator Specifications	Ball Screw	Roller Screw
Operating Force	Up to 1,000 lbs. (4448 N)	Less than 2,500 lbs. (11,120 N)
Peak Force	4400 lbf (19.6 kN)	4400 lbf (19.6 kN)
Continuous Force	1850 lbf (8.2 kN)	1850 lbf (8.2 kN)
Travel Under Force	Up to 0.10" (2.5mm) travel under max load for 5M cycles	Up to 0.10" (2.5mm) travel under max load for 10M cycles
Side Load	Unidirectional side load less than 1% axial load	Unidirectional side load less than 3% axial load
Peak Speed	13 in/sec (330.2 mm/sec)	13 in/sec (330.2 mm/sec)
Max. Acceleration (no load)	350 in/sec <sup>2</sup>	350 in/sec <sup>2</sup>
SW44 Assembly Specifications	Ball Screw	Roller Screw
Frame Size	4.38 (111.3) x 4.38 (111.3)	4.38 (111.3) x 4.38 (111.3)
Length (with Fanuc Encoder)	15.53 (394.4)	15.53 (394.4)
Stroke	6.00 (152.4)	6.00 (152.4)
Screw Lead	5mm	5mm
Weight	30.9 lbs (14 kg)	30.9 lbs (14 kg)

## 6.2 Thermal sensor specifications

The current thermal sensor will shut down the motor at 155° F (68°C). The motor should not perform a duty cycle that repeatedly generate motor temperatures above 155° F (68° C) or premature bearing failure will result.

## 6.3 Connector pinout

### MOTOR POWER CONNECTIONS

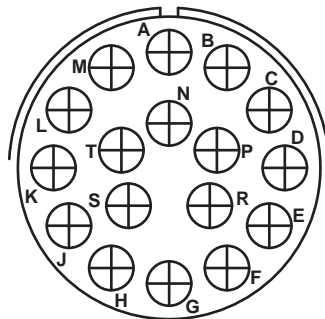


MS3102A-18-10P

MOTOR CONNECTOR	SERVO AMP. PHASE	MOTOR LEAD
A	U	RED
B	V	BLK
C	W	WHT
D	GND	GRN/YEL

Figure 6.1: Motor Power Connections

### A64 PULSECODER CONNECTIONS AS SUPPLIED BY FANUC



MS3102A-20-29PW

PULSECODER SIGNAL	PIN NO.
SD	A
SD	D
REQ	F
REQ	G
+5V	J,K
0V	N,T
SEALED	H
+6VA	R
0VA	S

Figure 6.2: Pulsecoder Connections

## 6.4 Troubleshooting Procedure

SYMPTOM	CAUSE	SOLUTION
No response from SW actuator	Controller / Drive not enabled	Enable Controller/Drive
	Controller / Drive faulted	Reset the Controller/Drive
	Improper / Failed wiring	Check the wiring
SW Actuator is enabled but is not operating or is operating erratically.	Feedback cable may be damaged	Test the feedback cable
	Feedback wiring may be incorrect	Verify feedback wiring
SW Actuator is operating but is not up to rated speeds/force	Motor phases are wired incorrectly or in incorrect order	Verify correct wiring of motor armature
	Amplifier may be improperly tuned	Check all gain settings
	Amplifier may be set up improperly for SW actuator used	Check amplifier settings for number of poles, voltage, current, resistance, inductance, inertia, etc.
	Feedback is improperly aligned	Contact Tol-O-Matic, Inc.
Actuator cannot move the weld gun.	Force is too large for the capacity of the actuator or too much friction is present	Verify force requirements
	Excessive side load	Verify correct gun operation
	Misalignment of output rod to weld gun	Verify correct alignment
	Amplifier has too low current capacity or is limited to too low of current capacity	Verify correct amplifier and settings
Actuator housing moves or vibrates when shaft is in motion.	Loose mounting	Check actuator mounting
	Amplifier is improperly tuned – wrong gain settings	Tune amplifier
Actuator is overheating	Duty cycle is higher than actuator rating	Verify weld forces and actuator ratings
	Actuator is being operated outside of continuous ratings	Reduce time that weld force exceeds 1800 lbf (8007N)
	Amplifier is poorly tuned, causing excessive unnecessary current to be applied to motor	Check gain settings

## 6.5 Warranty

Tol-O-Matic, Inc., warrants product manufactured by it to be free from defects in material and workmanship for a period of one year from date of shipment by Tol-O-Matic, Inc. If within such period any such product shall be proved to Tol-O-Matic, Inc.'s satisfaction to be defective, such product shall either be repaired or replaced at Tol-O-Matic, Inc.'s option.

This warranty shall not apply:

- a. To product not manufactured by Tol-O-Matic, Inc. with respect to product not manufactured by Tol-O-Matic, Inc. the warranty obligations of Tol-O-Matic, Inc. shall in all respects conform and be limited to the warranty actually extended to Tol-O-Matic, Inc. by its supplier.
- b. To product which shall have been repaired or altered by parties other than Tol-O-Matic, Inc., so as, in Tol-O-Matic, Inc.'s judgment, to affect the same adversely, or
- c. To product which shall have been subject to negligence, accident, or damage by circumstances beyond the control of Tol-O-Matic, Inc. or to improper operation maintenance or storage, or to other than normal use and service.

The foregoing warranties are exclusive and in lieu of all other expressed and implied warranties whatsoever, including but not limited to implied warranties of merchantability and fitness for a particular purpose. Tol-O-Matic, Inc. shall not be subject to any other obligations or liabilities whatsoever with respect to product manufactured or supplied by Tol-O-Matic, Inc. or service rendered by it.

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