

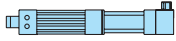
HT & SW SERIES ACTUATORS



SERVO WELDTM



TOL-O-MATIC, INC.



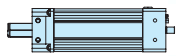
HT ACTUATOR

- UP TO 12 MILLION CYCLE LIFE
- NARROW BODY SIZE
- HIGH FORCE
- HIGH SPEED
- INTEGRATED ACTUATOR/MOTOR/FEEDBACK
- ANTI-ROTATION
- ZERO MAINTENANCE
- NO FORCED COOLING REQUIRED
- MANUAL OVERRIDE

ZERO MAINTENANCE ACTUATOR/MOTOR DESIGNS IDEALLY SUITED FOR INDUSTRIAL SPOT WELDING APPLICATIONS



HT23



SW ACTUATOR

- UP TO 12 MILLION CYCLE LIFE
- SHORT BODY LENGTH
- HIGH FORCE
- HIGH SPEED
- INTEGRATED ACTUATOR/MOTOR/FEEDBACK
- ANTI-ROTATION
- BALL SCREW OR ROLLER SCREW
- ZERO MAINTENANCE
- NO FORCED COOLING REQUIRED
- MANUAL OVERRIDE



SW44



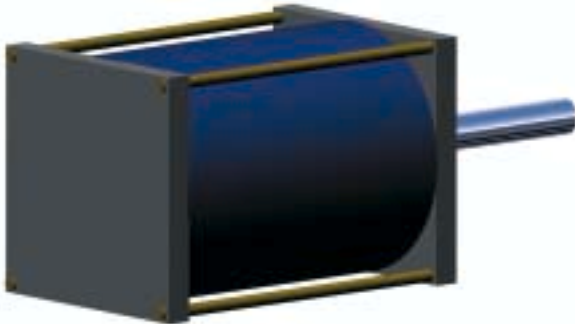
The Tol-O-Matic SW actuator incorporates an 8 pole, Nd-Fe-B, hollow core rotor with skewed stator laminations. This configuration significantly reduces force output variation in respect to rotor position.

- Low cogging torque for better repeatability, independent of position. This results in higher quality welds.
- Patent-pending hollow rotor motor provides a compact actuator package.

COMPETITIVE ACTUATOR DESIGNS

COMPETITION

AIR CYLINDER



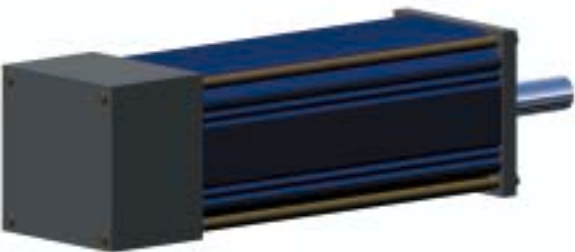
- High cost of use
- Frequent repair and maintenance
- Poor repeatability, inferior weld quality
- “Bang-bang” welds - greater tooling wear
- Limited adaptability

SERVO – PARALLEL MOTOR, BELT TRANSMISSION

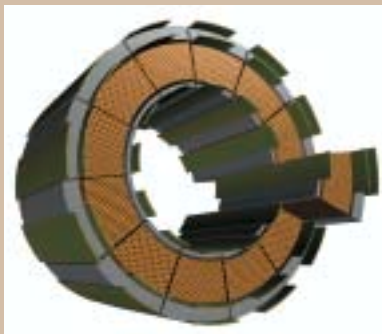


- Size and weight create payload challenge (increase of 10% to 30% compared with integrated design).
- Mechanical linkage of belt is not as responsive as direct drive.
- Transmission belt is a maintenance item and failure point.

SERVO – INTEGRATED MOTOR, SEGMENTED LAMINATIONS



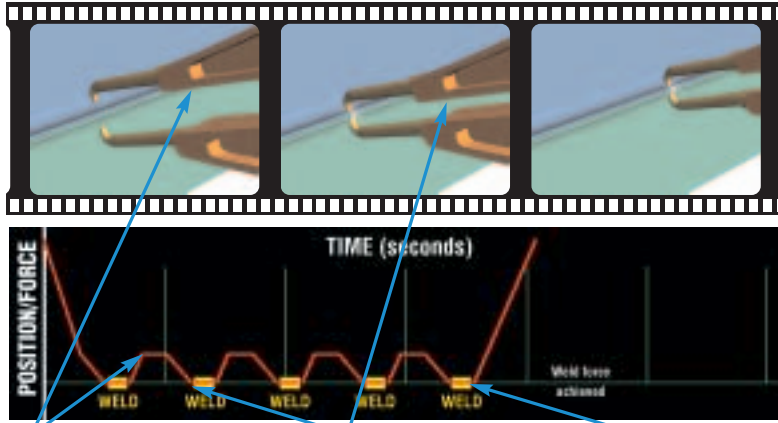
- Segmented stators cannot be designed with skewed windings. Actuators employing segmented stators may compromise weld repeatability due to undesired high cogging torque.
- Higher cogging torque results in force repeatability errors with position changes, potentially compromising weld quality.



- Segmented stators offer higher torque ratings for comparable sizes, but for spot welding, repeatability (minimal cogging torque) is a more important factor than torque density.

SERVO CONTROL: SOFT TOUCH + QUALITY WELDS + FASTER CYCLE TIME

SERVO WELDING

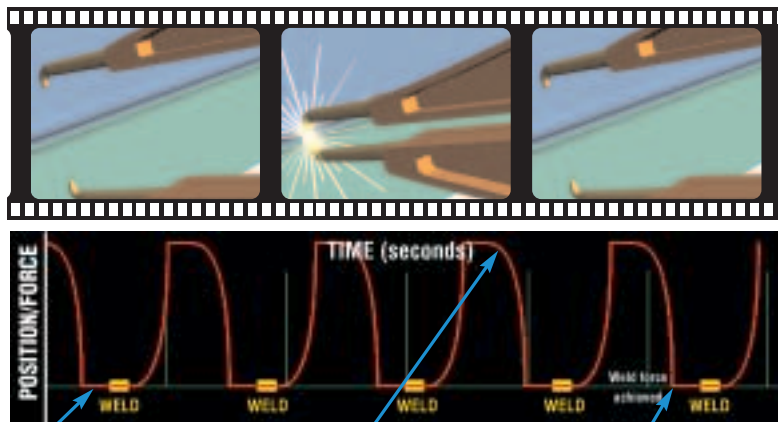


Small open position for a series of welds, large open only when moving around obstacles

Weld takes place as soon as force is achieved and position is verified

Position and force are recorded for each weld

PNEUMATIC WELDING



Dwell is required before weld because there is no signal that position and force are achieved

Move continues to accelerate until meeting an obstacle

Material is impacted with highest speed & force of entire cycle

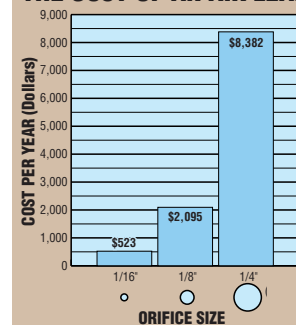
SEE THE ANIMATED COMPARISON SEQUENCE AT WWW.TOLOMATIC.COM

Reduced Cycle Time:

Example –

- In a welding application, a servo system can perform each weld 1/4 second faster than a pneumatic system. If 80 welds are performed, this will reduce the weld cycle time by 20 seconds.
- Cycle time improvements can be achieved because a servo system does not always require the fully open position. It can open fully to accommodate objects, such as frame rails, then open only far enough to move to the next several welds in that area through easy programming changes.
- Force feedback: a servo system will send a signal when it has achieved proper force for welding. A pneumatic system requires a delay time to assure the cylinder is achieving force. This fixed time must be greater than the maximum time for the cylinder to make its move.

THE COST OF AN AIR LEAK



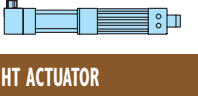
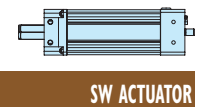
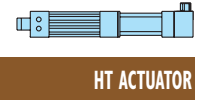
Costs calculated using electricity rate of \$0.05 per kWh, assuming a constant operation and an efficient compressor.

From: Improving Compressed Air System Performance, A Sourcebook for Industry published by the Office of Industrial Technologies, US Department of Energy

COMPARISON

ADVANTAGES OF TOL-O-MATIC'S SERVO ACTUATOR vs PNEUMATIC ACTUATOR

	ELECTRIC SERVO ACTUATOR	PNEUMATIC ACTUATOR
SERVICE LIFE	Very good to excellent, depending upon actuator type and distance traveled under load. Over 6,000,000 welds achieved with ball screws, and +12,000,000 with roller screws.	Acceptable if compressed air filtration and lubrication adequate; usually less than 3,000,000 welds achieved with preventative maintenance.
MAINTENANCE REQUIREMENTS	Zero maintenance.	Frequent, either cylinder rebuilding or replacement.
SOFT-TOUCH WELDING CONTROL	Easy to achieve--the #1 desired feature mentioned most often by end-users. Position and speed are controlled for rapid closing, slowing to a soft touch speed before tips come in contact with part. Reduces force on part and weld gun.	Repeatable performance difficult to maintain; tips contact part at full speed, generating a high impact on both part and weld gun. Pneumatic system enhancements (proportional and cushioning controls) do not approach servo performance.
COST OF USE	Due to increased energy efficiency (+80%), cost of use vs. pneumatic operation is significantly lower. Cost of use is a decided advantage of electric servo systems over pneumatic systems.	Expensive. Compressed air is a costly utility. At \$0.05/kWh, a cumulative system leak of 1/4" at 100 psig costs over \$8,300/year. The power transmission efficiency of compressed air systems ranges between 20% to 35%.
COST OF ACQUISITION	More Expensive – but reduced life cycle costs. Payback can be less than one year.	Inexpensive; but costs more over life cycle of system. Cylinder, valves, connectors, tubing, filter-regulator-lubricator all add up.
CYCLE RATE Improved production rate/reduced cycle time	Servos move fast to point-of-work, then slow for soft-touch welding. In retract mode, servos can be programmed to travel less distance, thereby reducing overall cycle time. Also, servos eliminate the need for squeeze time--signal sent when at force.	Pneumatic systems have ability to move fast, but full-open to full-close operation with "bang-bang" controls adds to cycle time.
WELD CAP LIFE	Weld cap life improvements range from 5% to 35%, depending upon application.	Frequent replacement; weld caps deform under full force.
ENVIRONMENTAL IMPACT	Minimal from every aspect: noise, contamination, and energy/power efficiency.	Noise and concentrated contaminants in exhaust air are undesirable conditions.
SUPPORTS MANUFACTURING FLEXIBILITY	Through weld or robot controls, servos can be easily programmed to accommodate model or tool changes. Existing 6-axis robots can be retrofitted with servos to achieve all desirable aspects of servo welding.	Pneumatic weld systems require more engineering support to accommodate model or tool changes; more spare parts.



TYPICAL SERVO WELDING APPLICATIONS

ROBOTIC		NON-ROBOTIC	
ROBOT WELDING	PEDESTAL WELDING	FIXTURE WELDING	HANDGUN WELDING
<ul style="list-style-type: none"> • Robot moves weldgun to part • Automotive • Appliance • Industrial assembly 	<ul style="list-style-type: none"> • Robot moves part to weldgun • Automotive • Appliance • Industrial assembly 	<ul style="list-style-type: none"> • Automotive • Appliance • Industrial assembly • Stamping & metal forming 	<ul style="list-style-type: none"> • Automotive • Appliance • Industrial assembly • Stamping & metal forming

6-AXIS ROBOT / RETROFIT / NON-ROBOTIC

- Requires external control of weld actuator from Tol-O-Matic or weld controller supplier
- Cost effective servo upgrade solution
- Potential for optimized weld with WeldAxis

CONTROL & DRIVE SYSTEM CHOICE

SEPARATE CONTROL & DRIVE SYSTEM
(supplied by weld controller integrator) or Tol-O-Matic

TOL-O-MATIC WELDAXIS

IMPORTANT FEATURES:

- Seamless retrofit to 6-axis robots, or fixture welding applications, I/O for retrofit to existing devices or communication with master device
- Uses existing signals when replacing pneumatic actuators, no programming necessary
- Optimizes performance by reducing cycle time, monitoring tip wear, reliable tip positioning feedback
- Available as complete panel or as kit to place in existing panel
- Lower cost than 7-axis robot system
- Available in multi-axis applications up to 16+ simultaneous control.
- 460 Vac / 680 Vdc — 230 Vac / 325 Vdc

7-AXIS ROBOT / NEW INSTALLATIONS

- Weld actuator controlled by robot or PLC
- Robot feedback & connectors are matched

ACTUATOR ONLY

ACTUATOR CHOICE

SERVO ACTUATOR					PNEUMATIC ACTUATOR (REPEATABILITY, COST, PERFORMANCE ISSUES - SEE PAGE 5)																																																						
<p>SW ACTUATOR</p> <p>IMPORTANT FEATURES:</p> <ul style="list-style-type: none"> • Factory lubricated for life – ZERO MAINTENANCE • 8 pole hollow core motor for short body length, high force and fast moves • Integrated actuator/motor/feedback <p>SIGNIFICANT OPTIONS:</p> <ul style="list-style-type: none"> • High and low voltage <p>MODELS AND KEY SPECIFICATIONS</p> <table border="1"> <thead> <tr> <th>MODEL</th> <th>MAX. STROKE</th> <th>WELD FORCE</th> <th>MAX. SPEED</th> <th>UNIT WEIGHT</th> </tr> </thead> <tbody> <tr> <td>SW44</td> <td>6 in.</td> <td>2,500 lbf.</td> <td>16 in./sec.</td> <td>31 lbs.</td> </tr> <tr> <td></td> <td>152mm</td> <td>11.12 kN</td> <td>406 mm/sec.</td> <td>14.1 kgs.</td> </tr> </tbody> </table>					MODEL	MAX. STROKE	WELD FORCE	MAX. SPEED	UNIT WEIGHT	SW44	6 in.	2,500 lbf.	16 in./sec.	31 lbs.		152mm	11.12 kN	406 mm/sec.	14.1 kgs.	<p>HT ACTUATOR</p> <p>IMPORTANT FEATURES:</p> <ul style="list-style-type: none"> • Factory lubricated for life – ZERO MAINTENANCE • Dimensions and weight comparable to pneumatic footprints • Integrated actuator/motor/feedback <p>MODELS AND KEY SPECIFICATIONS</p> <table border="1"> <thead> <tr> <th>MODEL</th> <th>MAX. STROKE</th> <th>WELD FORCE</th> <th>MAX. SPEED</th> <th>UNIT WEIGHT</th> </tr> </thead> <tbody> <tr> <td>HT7</td> <td>2 in.</td> <td>700 lbf.</td> <td>14.5 in./sec.</td> <td>14 lbs.</td> </tr> <tr> <td></td> <td>51mm</td> <td>3.1 kN</td> <td>368 mm/sec.</td> <td>6.4 kgs.</td> </tr> <tr> <td>HT12</td> <td>6 in.</td> <td>1,200 lbf.</td> <td>14.5 in./sec.</td> <td>24 lbs.</td> </tr> <tr> <td></td> <td>152mm</td> <td>5.3 kN</td> <td>368 mm/sec.</td> <td>10.9 kgs.</td> </tr> <tr> <td>HT23</td> <td>6 in.</td> <td>2,300 lbf.</td> <td>14.5 in./sec.</td> <td>28 lbs.</td> </tr> <tr> <td></td> <td>152mm</td> <td>10.2 kN</td> <td>368 mm/sec.</td> <td>12.7 kgs.</td> </tr> </tbody> </table>					MODEL	MAX. STROKE	WELD FORCE	MAX. SPEED	UNIT WEIGHT	HT7	2 in.	700 lbf.	14.5 in./sec.	14 lbs.		51mm	3.1 kN	368 mm/sec.	6.4 kgs.	HT12	6 in.	1,200 lbf.	14.5 in./sec.	24 lbs.		152mm	5.3 kN	368 mm/sec.	10.9 kgs.	HT23	6 in.	2,300 lbf.	14.5 in./sec.	28 lbs.		152mm	10.2 kN	368 mm/sec.	12.7 kgs.
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ADVANTAGES OF SERVO ACTUATED WELD GUNS

Users of servo actuated weld guns identify several clear advantages of servo linear motion:

Quality

- Force repeatability is required for consistent welds
- “Soft-touch” eliminates high impact wear
- Position and force can be recorded for each weld
- Cap wear detection and lost cap detection

Speed

- “At-force” indication allows immediate welding
- Multiple open positions shortens move time

Cost

- Lower operating cost offsets acquisition cost
- Minimizes preventative maintenance and unscheduled downtime
- Supports multiple weld schedules, easily accommodating different materials and thicknesses

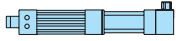
Higher levels of surface expulsion can occur when weld controller fires before the proper weld force is established.

Inadequate motion and force control adds cycle time, decreases quality levels, and requires much more attention. A few common signs that motion and force are not being effectively controlled:

- ✓ Excessive electrode wear
- ✓ Expulsion and burn-through
- ✓ Sticking weld tips
- ✓ Inconsistent weld quality
- ✓ Excessive part indentation or deflection



Servo Weld Actuators



HT ACTUATOR

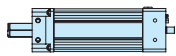
“VOICE-OF-THE-CUSTOMER” YIELDS SUPERIOR ACTUATOR DESIGN

Off-the-shelf actuators, designed for general applications, do not perform well in the spot welding environment. Tight tolerances for force repeatability, zero maintenance, service life, side loads, cycle times ...all require a servo actuator that can stand up to this demanding application. From roller screw specifications to the finish on the thrust tube, Tol-O-Matic has engineered a product, specifically designed for resistance welding, that exceeds customer expectations.

Using Voice-of-the-Customer and Design of Experiments disciplines, Tol-O-Matic servo actuators get the job done...weld after weld...for millions of trouble free cycles.

DESIGN CONSIDERATIONS

VOICE OF THE CUSTOMER	TOL-O-MATIC SERVO ACTUATOR
COMPACT DESIGN	Width-- HT: 3.84" ; SW : 4.4"
LIFE	Roller screw: up to 12.0M cycles; ball screw: to 6.0M cycles (application variables affect service life.)
ZERO MAINTENANCE	Zero maintenance over the life of the actuator.
SIDE-LOAD PREVENTION	Internal bearing system sustains unidirectional side loading of up to 3 degrees without requiring external guidance.
INTEGRAL ANTI-ROTATION	Built-in. Since anti-rotation is integral to the Tol-O-Matic actuator; the weld gun supplier is not required to design and build this as an add-on feature.
CONNECTOR PROTECTION	Connectors may be oriented in any direction; many styles available to match desired control specification.
ROBOT INTERFACE	Feedback devices to interface with any robot manufacturer.
MANUAL OVERRIDE	Built-in, and requires no special tools.
FORCE REPEATABILITY	In open loop, Tol-O-Matic actuators achieve maximum $\pm 3.0\%$ force repeatability ...over the life of the actuator, from start-up to the end of service life. This includes variations from cold startup.
INTERCHANGEABILITY/RETROFIT EXISTING PNEUMATIC ACTUATOR	Easy retrofit due to compact design of Tol-O-Matic actuators.
ABILITY TO "READ" AND INTERPRET I/Os IN PNEUMATIC SYSTEM	Using Tol-O-Matic's WeldAxis™ control, existing signals to pneumatic valves can be used to signal the electric servo actuator. (Patented by Tol-O-Matic, Inc.)
HIGH VOLTAGE CAPABILITY	SW is available in low voltage (230 Vac / 325 Vdc) and high voltage models (460 Vac / 680 Vdc)
COMPLETE SOLUTION DESIGNED FOR OPTIMUM PERFORMANCE IN WELDING APPLICATIONS	Tol-O-Matic offers two styles of actuators plus the WeldAxis™ panel control system ...designed specifically for weld applications. (See tolomatic.com for more details about the WeldAxis.)



SW ACTUATOR

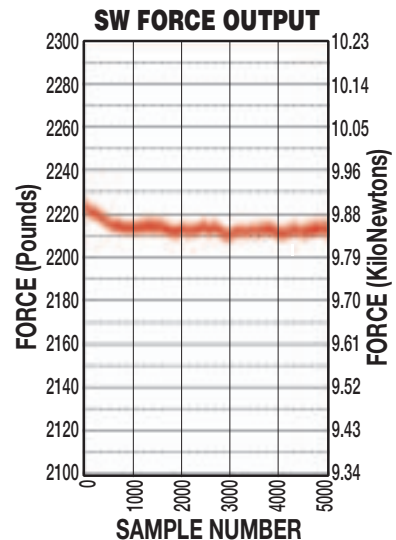
THE TOL-O-MATIC ADVANTAGE: PERFORMANCE BY DESIGN

Tol-O-Matic's SW and HT actuators are designed and built to maintain $\pm 3.0\%$ force repeatability...at any point during the actuator life.

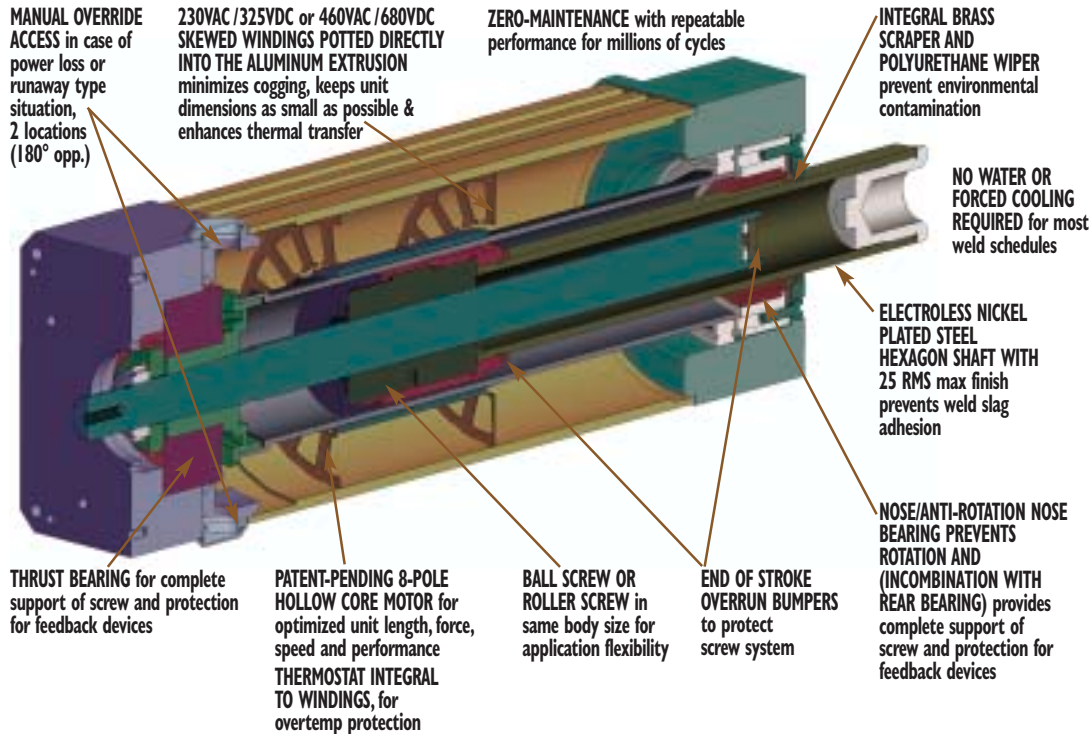
The data presented in the "SW Force Output" chart at right was collected from a new SW44-RN-LV3. The actuator was run with a fixed weld current. Each sample is representative of a single "weld cycle." The test was run over the course of four and a half-hours. The temperature of the actuator was not monitored during the test.

Points of interest:

- 1.) The overall range of 5,000 samples is 27 lbf., or less than 1.2% of nominal.
- 2.) The drop in force from cold start is 0.5% nominal (appr.), which means the weld-to-weld force variation is relatively constant regardless of temperature.
- 3.) Standard deviation remains relatively constant regardless of weld force, which means repeatability improves relative to higher weld forces. Tol-O-Matic measures repeatability as $(6)(Std. Dev.)/Nominal Force$.



SW FEATURES



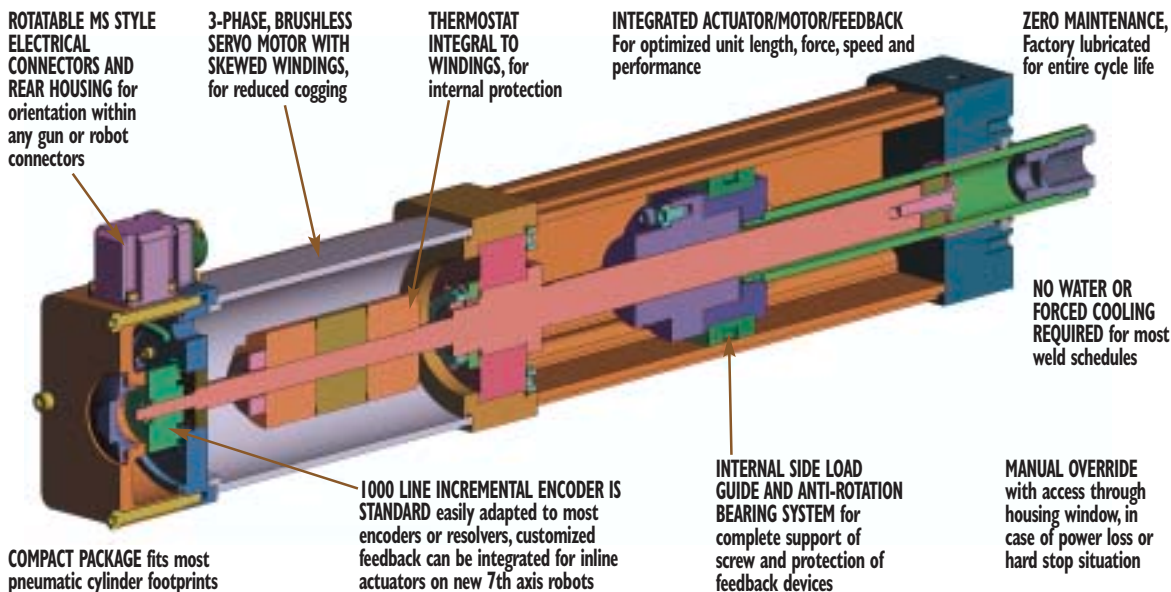
FACTORS AFFECTING ACTUATOR LIFE

SIDE LOADING
Some weld gun designs may subject the actuator to excessive side loading, reducing service life. Measures are required to limit side loading, especially in "C" guns with the SW actuator. For life optimization, Tol-O-Matic recommends side loads of less than 5% of axial load (weld force) for roller screws, and less than 1% of axial load for ball screws.

DISTANCE TRAVELED UNDER LOAD
Tests demonstrate the service life of ball screw actuators is extended when travel distance under load is limited.

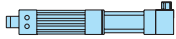
When these service life factors are considered at the design phase, millions of trouble free cycles are possible. Please contact Tol-O-Matic for more information.

HT FEATURES





SERVO WELD™ SW & HT Actuators



HT ACTUATOR

SPECIFICATIONS

FEATURES	SW SERIES		HT 23	HT 12	HT 07
	ROLLER SCREW Up to 2500 lbf [11.1 kN]	BALL SCREW Less than 1000 lbf [4.4 kN]	Up to 2300 lbf [10.2 kN]	Up to 1200 lbf [5.3 kN]	Up to 700 lbf [3.1 kN]
Weld Force*					
Peak Force*	>4400 lbf [19.6 kN]		>5000 lbf [22.2 kN]	>3000 lbf [13.3 kN]	>1000 lbf [4.4 kN]
Continuous Force*	1850 lbf [8.2 kN]		1500 lbf [6.7 kN]	1000 lbf [4.4 kN]	350 lbf [1.6 kN]
Weight (with 6 in stroke) [152.4mm]	31 lbs [14.1 kg]		28 lbs [12.7 kg]	24 lbs [10.9 kg]	14 lbs [6.4 kg]
Stroke (max.)	6 in [152.4 mm]		4 in [101.6 mm] and 6 in [152.4 mm] Std.,		2 in [50.8 mm]
Peak Speed	13 in/sec [330.2mm/sec]		14.5 in/sec [368.3mm/sec]		
Feedback Device	Any robot manufacturer				

*Note: Weld Force is based on a typical weld duty cycle with actuator surface temperature less than 155° F (69° C), for further information see SW manual
 Peak Force is a result of the limit of the drive
 Continuous Force is achieved with actuator surface temperature less than 155° F (69° C)



SW ACTUATOR

ORDERING INFORMATION

SW & HT ACTUATOR ORDERING

IM SW44 RN2005 SK06 FB TQM LV3

ACTUATOR TYPE IM Integral Motor									
MODEL & SIZE SW44 4.4" Face Width, up to 2500 lbf weld force HT07 3.84" Face Width, up to 700 lbf weld force HT12 3.84" Face Width, up to 1200 lbf weld force HT23 3.84" Face Width, up to 2300 lbf weld force									
NUT/SCREW RN2005 Roller Nut/Screw, 20 Dia./5mm lead (SW ONLY) BN2505 Ball Nut/Screw, 25 Dia./5mm lead (SW ONLY) RN2504 Roller Nut/Screw, 20 Dia./4mm lead (HT ONLY)									
STROKE LENGTH SK02 2" Stroke Length (HT ONLY) SK04 4" Stroke Length (HT ONLY) SK06 6" Stroke Length (SW OR HT)									
FEEDBACK DEVICE FB Feedback Device, then enter desired feedback device: TQM Quantum, Tol-O-Matic Standard Call factory for additional feedback devices.									
VOLTAGE & MOUNTING LV3 230 VAC / 325 VDC HV3 460 VAC / 680 VDC									

SW & HT Actuators

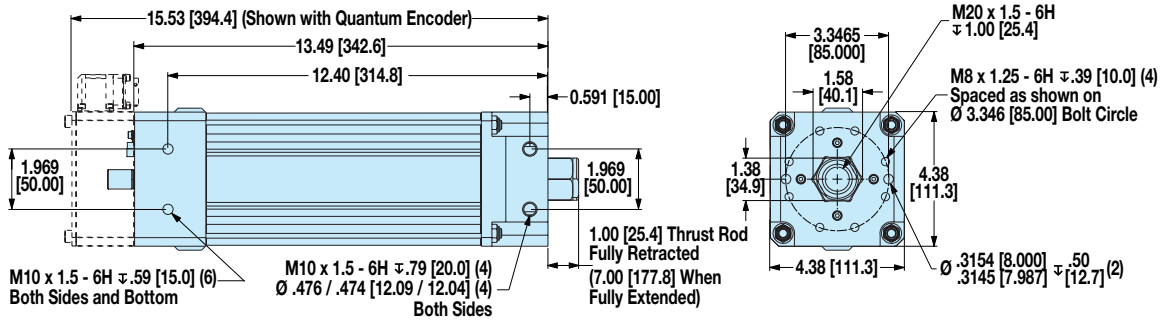


DIMENSIONS

SW ACTUATOR (shown with feedback option)
 3D SOLID MODELS AVAILABLE – CONTACT TOL-O-MATIC

FACTORS AFFECTING REPEATABILITY:

SW44



NOTE: Base actuator shown with feedback device. Dimensions are for reference only. Contact Tol-O-Matic for solid models.

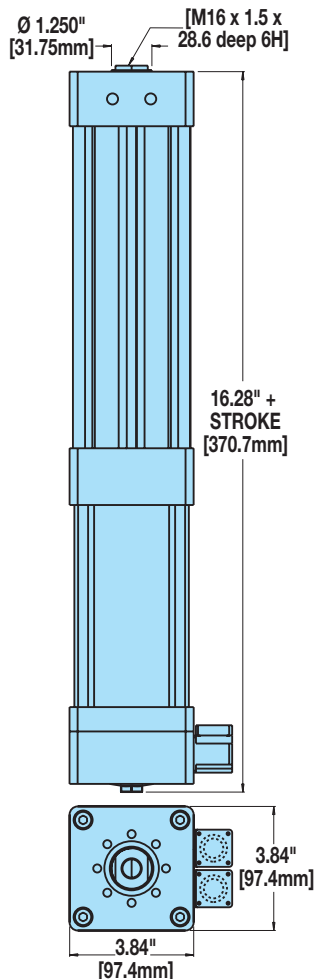
DRIVE:
 All servo actuators are tested with the Tol-O-Matic AxiomPlus drive/controller before leaving the factory and are validated to meet performance specifications. Actual performance may be affected by the choice of the motor drive.

MOTION PROFILE:
 Soft-touch velocity control greatly affects force repeatability. For best performance, the motion profile should be programmed so the soft-touch velocity occurs before the weld tips contact the material, and not in transition.

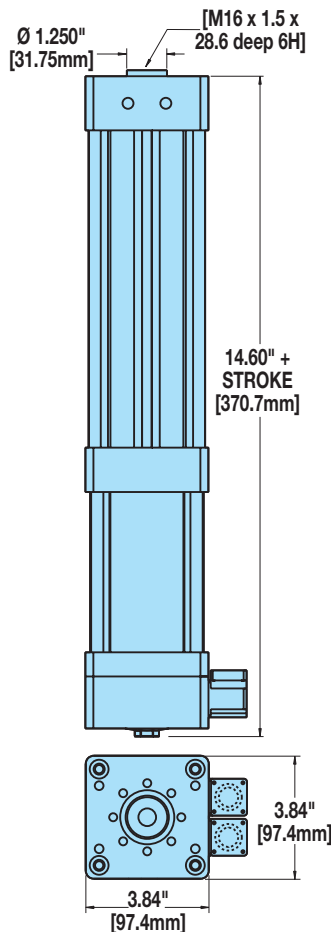
HT ACTUATORS

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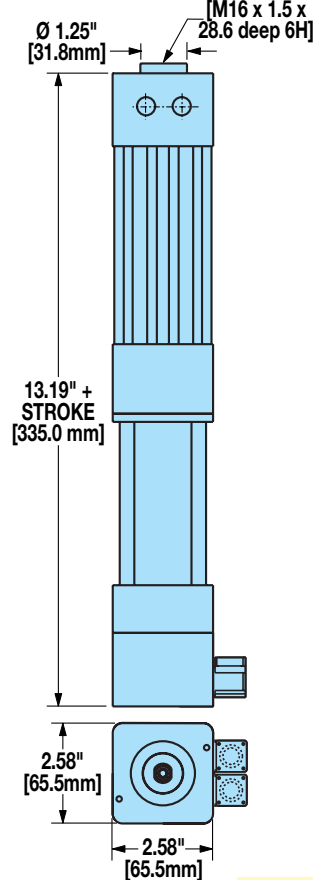
HT23



HT12



HT07



NOTE: Dimensions are for reference only. Contact Tol-O-Matic for solid models

INDUSTRY PROVEN PRODUCTS

PRODUCT INNOVATIONS MAKE TOL-O-MATIC THE LEADER IN LINEAR MOTION.

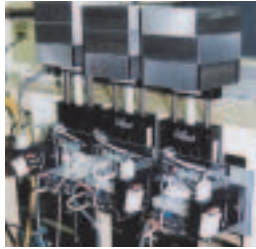
- Invented the first rodless cylinder in 1955.
- Introduced the first load carrying band cylinder.
- Created the first rodless cylinder with integral recirculating load-bearing feature.
- Offered the first cut-to-length rodless electric actuator.
- Offered the first fully programmable, pneumatic, linear motion positioning system.
- Innovations continue with products for resistance welding, plastic injection molding and medical industries.

TOL-O-MATIC, INC.

COMMITTED TO BEING THE PREMIER SUPPLIER OF WORLD CLASS MOTION CONTROL PRODUCTS

FIELD TESTED / INDUSTRY PROVEN

- Precision tooling is built on site at Tol-O-Matic with the highest standards of quality, care and dedication to details.
- Before a new product is released, extensive lab and field testing is conducted.
- Over 50 years of motion and control experience.



EXPERIENCED KNOWLEDGE BASE

- Our sales and engineering staff is your resource, only a phone call away. 1-800-328-2174
- Get valuable information at www.tolomatic.com, or email us at help@tolomatic.com.
- Knowledgeable local distributor and representative network.



TOL-O-MATIC TRAINING CENTER

- We supply the most advanced in-depth training in the industry—free of charge to all our distributors and customers.
- Our commitment to training includes:
 - On-site classroom
 - On-site training lab
 - Computer based education materials
 - Traveling education at your location

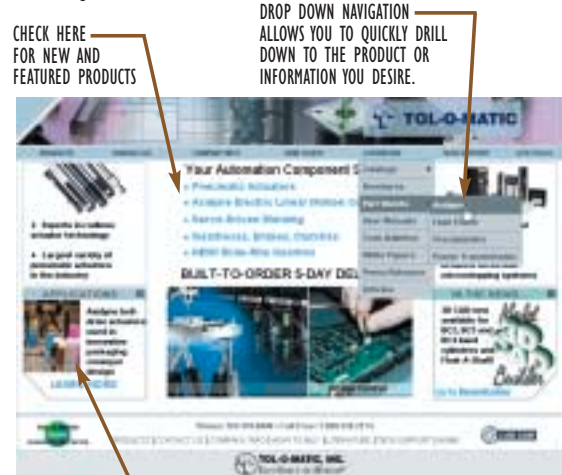
OUR HIGH QUALITY COMMITMENT

ISO certified management system since 1997.



A USEFUL WEB SITE

Product support available 24-7 at www.axidyne.com
 Our web site is your definitive source for Tol-O-Matic information. This database driven site has the most up-to-date literature, product information, CAD files (3D models available!), distributor information ... everything you want to know about Tol-O-Matic and our products.



ALSO CONSIDER THESE OTHER TOL-O-MATIC PRODUCTS:

AXIDYNE LINEAR MOTION PRODUCTS
 BROCHURE #9900-9074 CATALOG #9900-4609

FLUID POWER PRODUCTS
 BROCHURE #9900-9075 CATALOG #9900-4000

POWER TRANSMISSION PRODUCTS
 BROCHURE #9900-9076 CATALOG #9900-4009



TOL-O-MATIC, INC.

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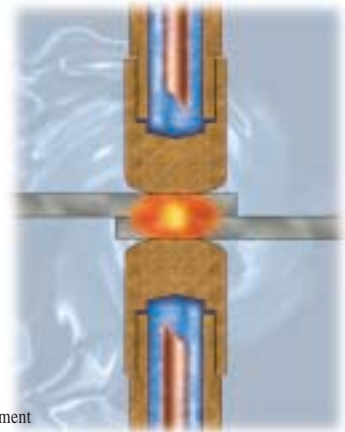
Toll-Free: 1-800-328-2174

Email: help@tolomatic.com

URL: <http://www.axidyne.com>

or <http://www.tolomatic.com>

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Visit www.tolomatic.com to get the most up-to-date technical information