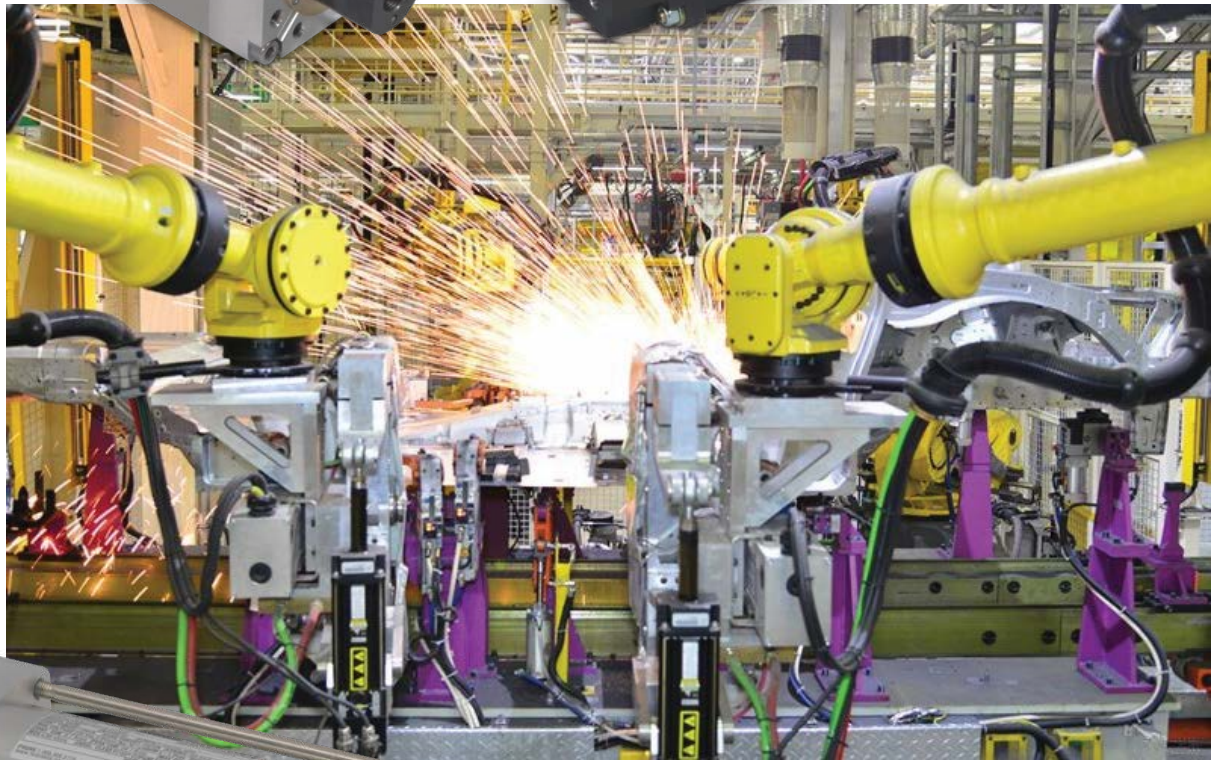
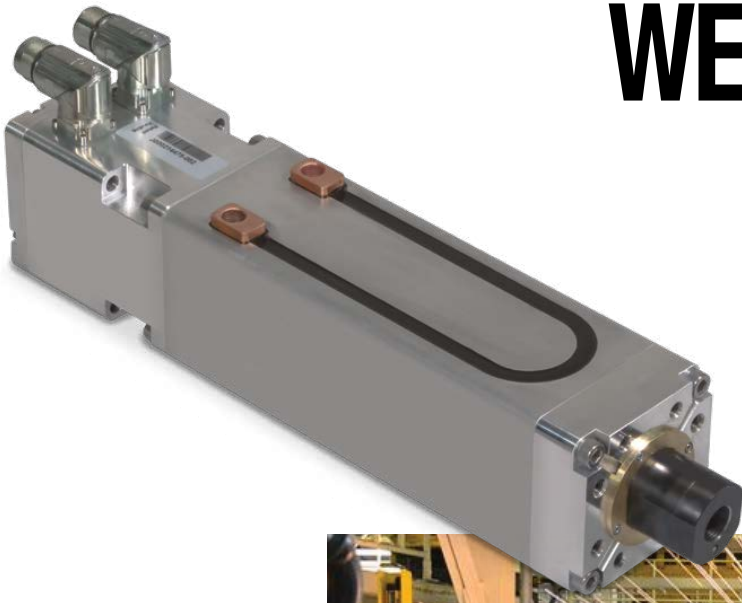


WELDING SOLUTIONS



The #1 Resistance Spot Welding Actuator Manufacturer

Tolomatic is the world's leading manufacturer of integrated servo actuators for resistance spot welding used by the world's top weld gun OEM's and numerous global vehicle manufacturers.

Superior Integrated Servo Motor Actuators

Tolomatic's ServoWeld family of integrated servo actuators are designed for best-in-class performance with the factors that are most important for resistance spot welding gun applications.

NUMBER OF WELDS/PRODUCT LIFE

Tolomatic's superior roller screw design has the **highest dynamic load rating for more welds** than any competitive technology (other roller screws, ball screw, pneumatic).

FORCE REPEATABILITY

Skewed winding designed for welding minimizes motor cogging and **provides industry best actuator force repeatability:** • $\pm 3\%$ Over the Lifetime of the Actuator

EFFICIENCY

All elements of actuator (winding, screw, rod scraper, bearings) are designed to optimize the efficiency of the actuator system and provide the **most energy efficient solution on the market.**

WELDS/MINUTE

All elements of the actuator (winding, screw, rod scraper, bearings) are designed to last and run as cool as possible in welding applications, with the ability to add water cooling as an option. This means **more welds per minute than any competitive technology** (other roller screws, ball screw, pneumatic).

WEIGHT

Tolomatic integrated servo actuators minimize weight when designed into the weldgun. Additionally, Tolomatic can customize actuators for a specific weldgun applications to provide **industry leading light weight designs.**

LIFETIME COST

By building the longest lasting, most efficient and highest weld per minute actuators on the market, Tolomatic actuators provide the **lowest total cost per spot weld.**

ServoWeld Applications

PINCH STYLE

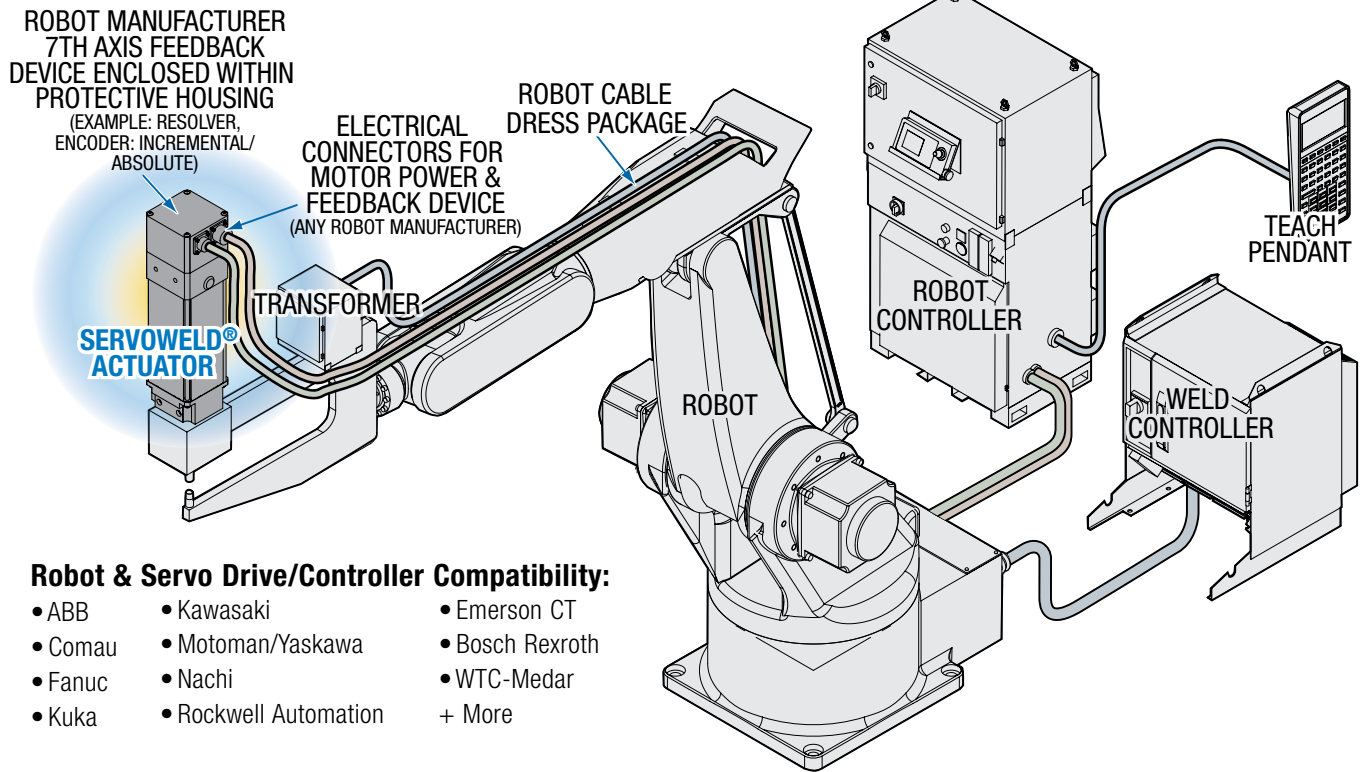
Additional Welding Applications:

- Pedestal Welding
- Projection Welding

"X" STYLE

"C" STYLE

Typical Robotic ServoWeld Installation



Tolomatic Offers the Broadest, Most Capable Family of Integrated Servo Actuators for Resistance Spot Welding

Model:	GSWA	SWA/SWB	CSWX
Number of Welds¹ (millions):	20+	20+ (10+ SWB)	30+ (20+ CSW)
Re-lubrication without Disassembly:	Yes ⁴	Yes	Yes
Peak Force:	36.7 kN [8,243 lbf]	24.0 kN [5,395 lbf] SWA 22.0 kN [4,950 lbf] SWB	18.0 kN [4,047 lbf] CSWX 15.6 kN [3,500 lbf] CSW
Actuator Output Force² (Lifetime) Repeatability:	±3%	±3% (±5% SWB)	±3%
Weight (size 33,3)³ (size 44,04)³ (size 55)³:	8.3 kg [18.3 lb] 13.8 kg [30.4 lb] 30.5 kg [67.2 lb]	7.2 kg [15.9 lb] 14.2 kg [31.2 lb]	min: 10.2 kg [22.6 lb]
Water Cooling:	Optional	Optional	Optional
Manual Override:	Optional	No	Optional
Full Force Direction:	Push and Pull	Push	Push and Pull

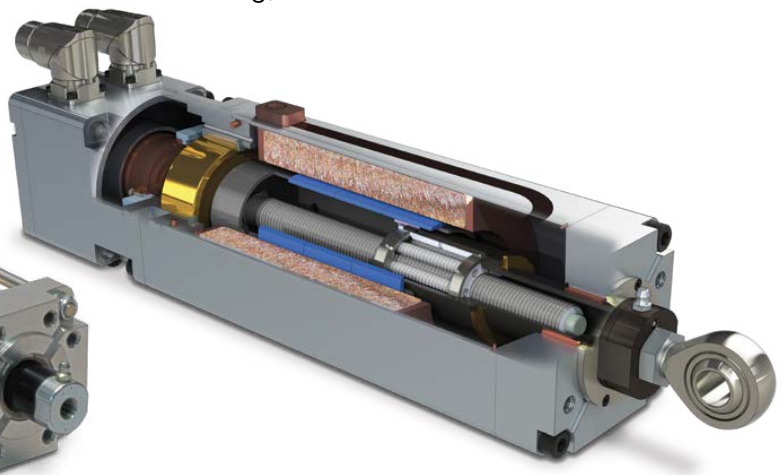
¹ Based on properly lubricated ServoWeld unit used as recommended in user manual. Weld schedule, tip force, environment and lubrication are factors in the total number of welds achievable with ServoWeld actuators.

² At weld force

³ Weight varies with choice of feedback device and mounting options

⁴ Some exceptions, see GSWA user manual

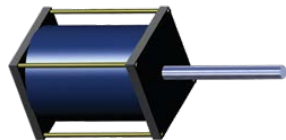
ServoWeld: Best-in-Class Integrated Servo Actuators



- **Most welds and longest life** with highest DLR (dynamic load rating) roller screws
- **Most welds per minute** with highest efficiency skewed windings and roller screw
- **Best weld force repeatability** due to low cogging skewed winding servo motor
- **Light weight, compact designs** fit any robot carried weld gun
 - **Lowest total cost of ownership** with longest lasting, most efficient actuator solution

Improved Technology, Better Performance

Air cylinders, and competing servo actuator designs can't compare to ServoWeld®



SERVO PNEUMATIC

- High electric utility cost
- Frequent repair and maintenance
- Low efficiency (typically ≤20%)
- No 7th axis controls. Limited coordinate move capabilities
- 10 bar [145 PSI] air needs to stay on 24/7 to limit leaks and is therefore very expensive to operate.



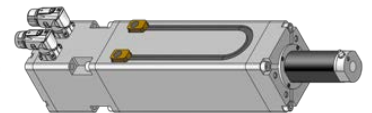
SERVO: Reverse-parallel motor configuration, belt driven

- Size and weight create payload challenge (increase of 10% to 30% compared with an integrated design)
- Mechanical linkage of belt is not as responsive as direct drive
- Transmission belt is a potential failure point and maintenance item
- Force repeatability suffers with belt/pulley backlash



SERVO: - Integrated motor with segmented laminations

- Force repeatability suffers due to increased cogging of segmented stator
- Less welds per minute as more heat is generated from more current to overcome cogging torque
- Higher cogging torque results in force repeatability variation with position changes, potentially compromising weld quality
- Segmented stator design does not offer the performance (welds per minute & efficiency) of skewed windings

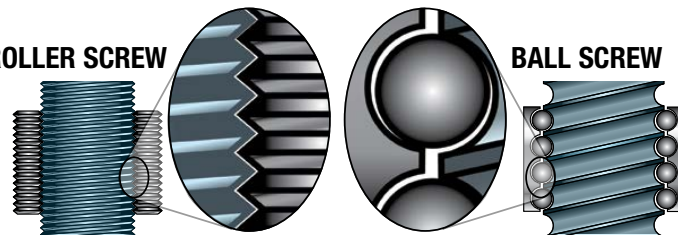


SERVOWELD: - Integrated motor with skewed windings

- Force repeatability consistent no matter how much weld tip wear
- More welds per minute as less heat is generated without the need to overcome cogging torque
- Force repeatability does not vary with position changes, resulting in consistent high quality welds
- Skewed winding design delivers higher performance (welds per minute & efficiency) than segmented windings

Planetary Roller Screws vs Ball Screws vs Inverted Roller Screws

Roller screws have significantly more contact points in the same space compared to ball screws



Comparison Video:

YouTube

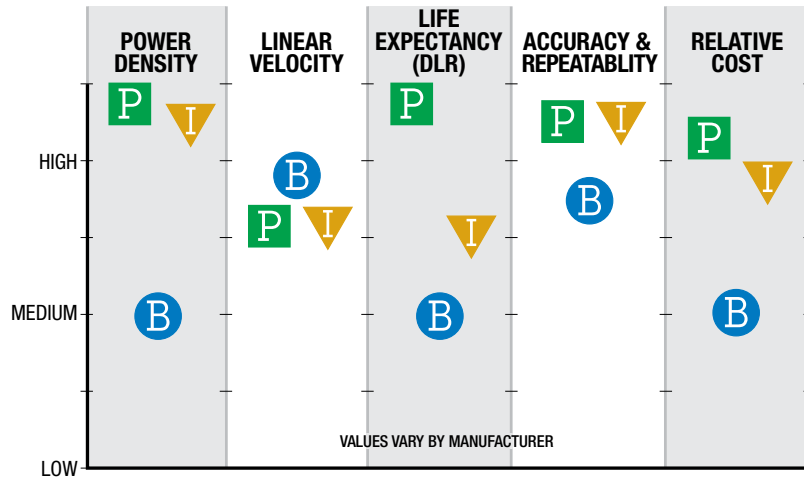
<https://youtu.be/9kVaWtUgpNA>



PLANETARY ROLLER SCREW **P**

- For heavy loads
- Precision ground rollers, screw and nut
- More points of contact + larger contact radius = less stress per contact point
- Higher DLR = longer life
- Higher loads per given size actuator
- Allows for smaller, lighter weight actuator

Screw Performance: Planetary Roller vs Inverted Roller vs Ball



BALL SCREW **B**

- For moderate loads
- Minimum ball bearing size = constraint on minimum assembly size
- Compared to roller screw, ball bearings' radius requires a coarser pitch = fewer points of contact.
- Oil filled designs add some service life yet increase required maintenance and are prone to leakage.

DLR (Dynamic Load Rating) is an industry standard term that represents an applicable constant load (in direction and magnitude) where a ball bearing device (or power screw) will achieve 1,000,000 revolutions of rated life or L10 life estimation at 90% reliability.

Planetary vs. Inverted Roller Screws

Planetary Roller Screw



Planetary roller screws are case (surface) hardened before precision grinding, resulting in a much deeper case hardness depth and much higher DLR. The deeper surface hardness and higher DLR give this design a large advantage in life (and managing lubrication) over the inverted design.

- Higher DLR = longer life
- 100x deeper hardening
- Easier to re-lubricate

PLANETARY AND INVERTED ROLLER SCREW ACTUATOR PERFORMANCE COMPARISONS

		PLANETARY	INVERTED
Manufacturing Method		Precision Ground	Mixed
	Case Hardness Depth	~1.0 mm (~100x greater)	~0.01 mm
Screw DLR	Size 3	53.6 kN 12,050 lbf	~25.8 kN ~5,800 lbf
	Size 4	73.3 kN 16,479 lbf	~36.9 kN ~8,300 lbf
Lubrication Maintenance		NO removal or disassembly required	Must remove and disassemble the front of actuator

Planetary roller screws have a 100x deeper case (surface) hardening depth and are easier to maintain lubrication

Inverted Roller Screw



Inverted roller screws use a process other than grinding to economically create threads along the internally threaded tube. Because of this, the hardening process is performed after the internally threaded tube is machined. The required hardening process results in a much shallower case hardness depth and softer threads than Standard roller screws. This leads to a significantly lower DLR (lower life) and more challenges with maintaining lubrication.

Superior Force Repeatability and Weld Quality in a Compact Package

ServoWeld integrated motor actuators use an 8 pole, hollow core rotor with skewed stator laminations. This allows the magnets to remain over multiple windings throughout the weld cycle. The result is maximum torque efficiency and consistent force output at any location along the actuator stroke, independent of weld tip wear.

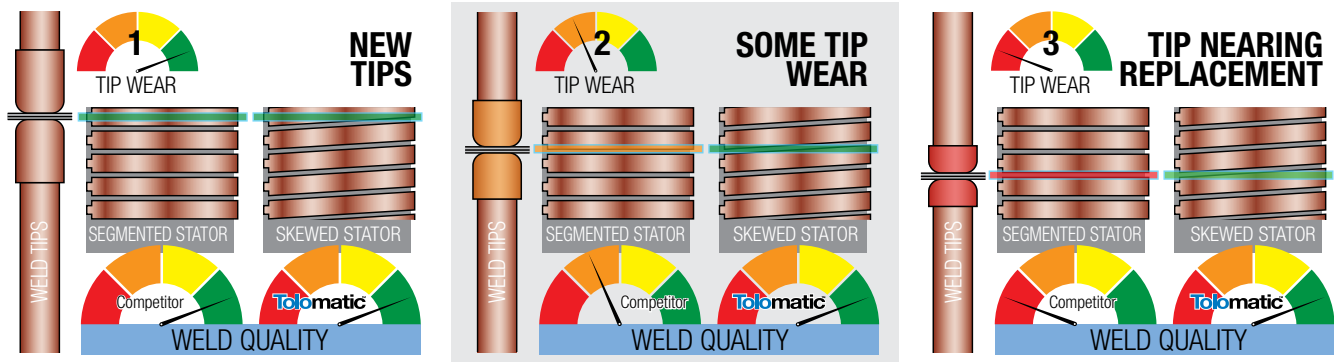
The result:

- Low cogging torque for better repeatability
- Better force repeatability independent of position
- Higher quality welds

Quality Welds:

YouTube 

<https://youtu.be/I2GvrsirKLC>



The above diagrams depict the expected weld quality at different amounts of weld tip wear. Both the competitor's segmented stator and the Tolomatic skewed stator will be required to apply force at a different part of the motor lamination as the weld tips wear. With segmented stators the motor often must stop in between or on the side of the lamination segments. This will result in poor or bad welds as seen in panel 2 and 3 above. Because the lines of magnetic force of the **Tolomatic skewed stator** provide peak performance at any location, the resulting **weld quality is always good** no matter the amount of weld tip wear.

How It Works:

YouTube 

<https://youtu.be/JG-Do6wCzP4>

Tested Performance Results

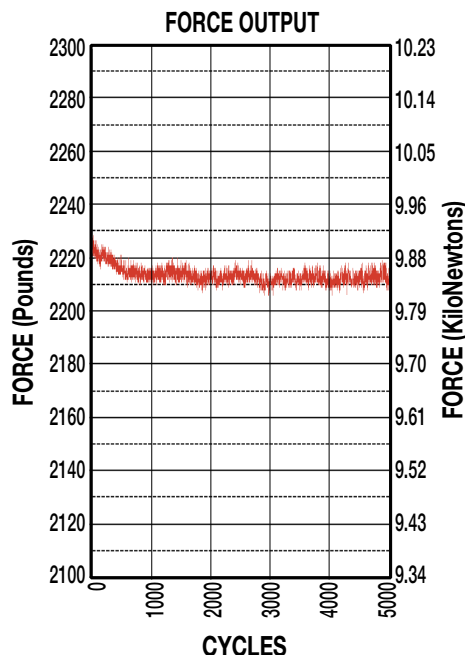
Tolomatic's ServoWeld actuators (with roller screw/nut selection) are designed and built to maintain $\pm 3\%$ force repeatability throughout the actuator life.

The data presented in the "ServoWeld Force Output" chart below was collected from a ServoWeld[®] configured unit with a roller screw and low-voltage windings.

The force output data in this chart is from ServoWeld actuator run at a fixed current. Each sample is representative of a single "weld cycle."

DATA POINTS OF INTEREST:

- The overall range of 5,000 samples is 120 N (27 lbf), or less than 1.2% of nominal.
- 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.



- Standard deviation remains relatively constant regardless of weld force, which means repeatability improves relative to higher weld forces. Tolomatic measures repeatability as $(6) (\text{Std. Dev.})/\text{Nominal Force}$.

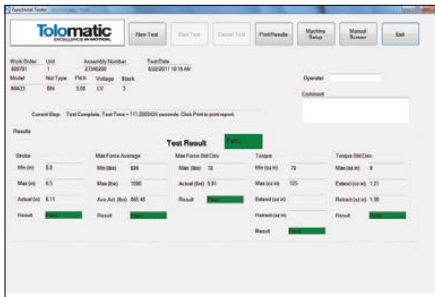
Modifications:

- Force feedback sensor
- Motor cooling
- Integral front guide
- Custom mounting

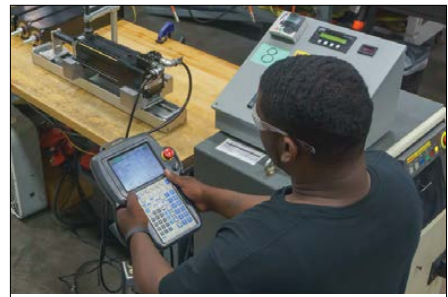
Complete Verification Testing is Performed on Every Actuator



Functional unit testing for hundreds of cycles quantifies stroke, length, torque under no load, input current vs force standard deviation.



Testing parameter results in progress for the Functional Test procedure.



Final system test ensures the feedback device is properly aligned with the ServoWeld motor poles.

EVERY SERVOWELD ACTUATOR HAS TO PASS RIGOROUS TESTING AT OUR FACTORY.

We verify the performance of each individual unit before delivery to ensure they conform to Tolomatic's high standard of performance.

- 1. High POT (High Potential/High Voltage Test)**
 This standard electric motor test procedure is a 3-part test that checks the insulation system of the assembly to verify proper armature and thermal wire insulation.
- 2. Electronic phasing of ServoWeld® and feedback device (Encoder, Resolver, Feedback Device)**
 Using a fixed current and a specially designed fixture the feedback device is physically and electronically aligned relative to the phasing of the Tolomatic motor.

3. Functional Testing

Performed with Tolomatic motion control components and dedicated data acquisition equipment. Operated for hundred of cycles, this test quantifies these parameters - stroke length, torque under no load, input current vs force average, input current vs force standard deviation - using an electronic load cell in conjunction with data acquisition equipment.

4. Tolomatic System Test

Using a single-axis control unit the test ensures that the feedback device is properly aligned with the poles of the Tolomatic motor.

ServoWeld Application Guidelines

SIDE LOADING: Weld gun designs may subject the actuator to excessive side loading, reducing overall service life. The GSWA33 and CSW(x) Guided actuators will accommodate side loading caused by the mass of the electrode, misaligned weld tips and tip skid. For other ServoWeld configurations additional measures are required to limit side loading, especially in "C" style gun designs. For maximum service life, external guiding is recommended to minimize side loading to the thrust rod and provide consist weld gun alignment throughout the service life. Reference the side load capacity charts in the GSWA, SWA/SWB, and CSW(x) manuals and/or brochures.

THRUST ROD WIPER/SCRAPER: For maximum service life, measures should be taken to reduce/eliminate contamination, weld slag, and water in the thrust rod wiper/scraper interface area. Implementation of industrial thrust rod boot and/or deflective device can be effectively utilized in this area.

CABLES: Shielded power & feedback cables are recommended to minimize electrical noise/grounding issues. Electrical noise or inadequate grounding can corrupt the feedback device signal.

RSW SERVO SYSTEM CALIBRATION: RSW weld gun servo system consists of robot 7th axis amplifier, robot feedback device, robot RSW software, weld gun chassis, & ServoWeld.

For optimal RSW weld gun servo system performance the calibration process should include maximum weld tip force from the production weld schedule, tip dress force, and multiple weld tip forces in-between. Utilizing all the available robot manufacturer force table inputs will provide best RSW weld gun servo system performance. The same weld tip part contact speed should be used for both RSW weld gun servo system calibration and production weld schedule.

WELD TIP / PART CONTACT SPEED: Tolomatic testing confirms the highest ServoWeld repeatability (**INPUT CURRENT** verses **OUTPUT FORCE**) at a weld tip part contact speed of 25mm/second or less. Speeds greater than 25mm/second can create "impact contribution" to the weld force. This impact contribution to the weld force deteriorates prior to completion of the weld cycle.

ROBOT CARRIED APPLICATIONS: Robot carried RSW gun applications have reduced exposure to water pooling/water ingress by virtue of the continuous robot movement and various RSW gun positions. In addition, in robot carried applications positioning of the RSW gun can be programmed as part of the weld cap change program/routine to eliminate ServoWeld exposure to water. (ServoWeld above weld caps)

ROBOT MANUFACTURER SERVO FILE: Robot manufacturer servo parameter files for operation of ServoWeld are available only from the robot manufacturer. Each robot manufacturer creates 3rd party motor servo parameter files, validates operation of ServoWeld via their 7th axis, and maintains servo motor parameter file for operation of ServoWeld.

TOOL CHANGER APPLICATIONS: Weld gun storage fixture in cell should position weld gun so movable electrode is not loading ServoWeld thrust rod - back driving the ServoWeld. Weld gun tips should be positioned to weld gun closed at low force prior to disconnect from robot/tool changer. Consider ServoWeld configured with integral brake option.

FIXED / PEDESTAL APPLICATIONS: One of the more challenging RSW applications is a pedestal RSW gun, ServoWeld mounted vertical - thrust rod up. Measures should be taken to reduce and/or eliminate the ServoWeld to water exposure, water pooling/spray in the access areas of the ServoWeld unit to maximize overall service life.

The Tolomatic Difference Expect More From the Industry Leader:



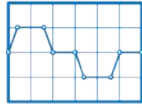
INNOVATIVE PRODUCTS

Solutions with Endurance TechnologySM for challenging applications.



FAST DELIVERY

Built-to-order with configurable stroke lengths and flexible mounting options.



ACTUATOR SIZING

Size and select electric actuators with our online software.



YOUR MOTOR HERE[®]

Match your motor to compatible mounting plates with Tolomatic actuators.



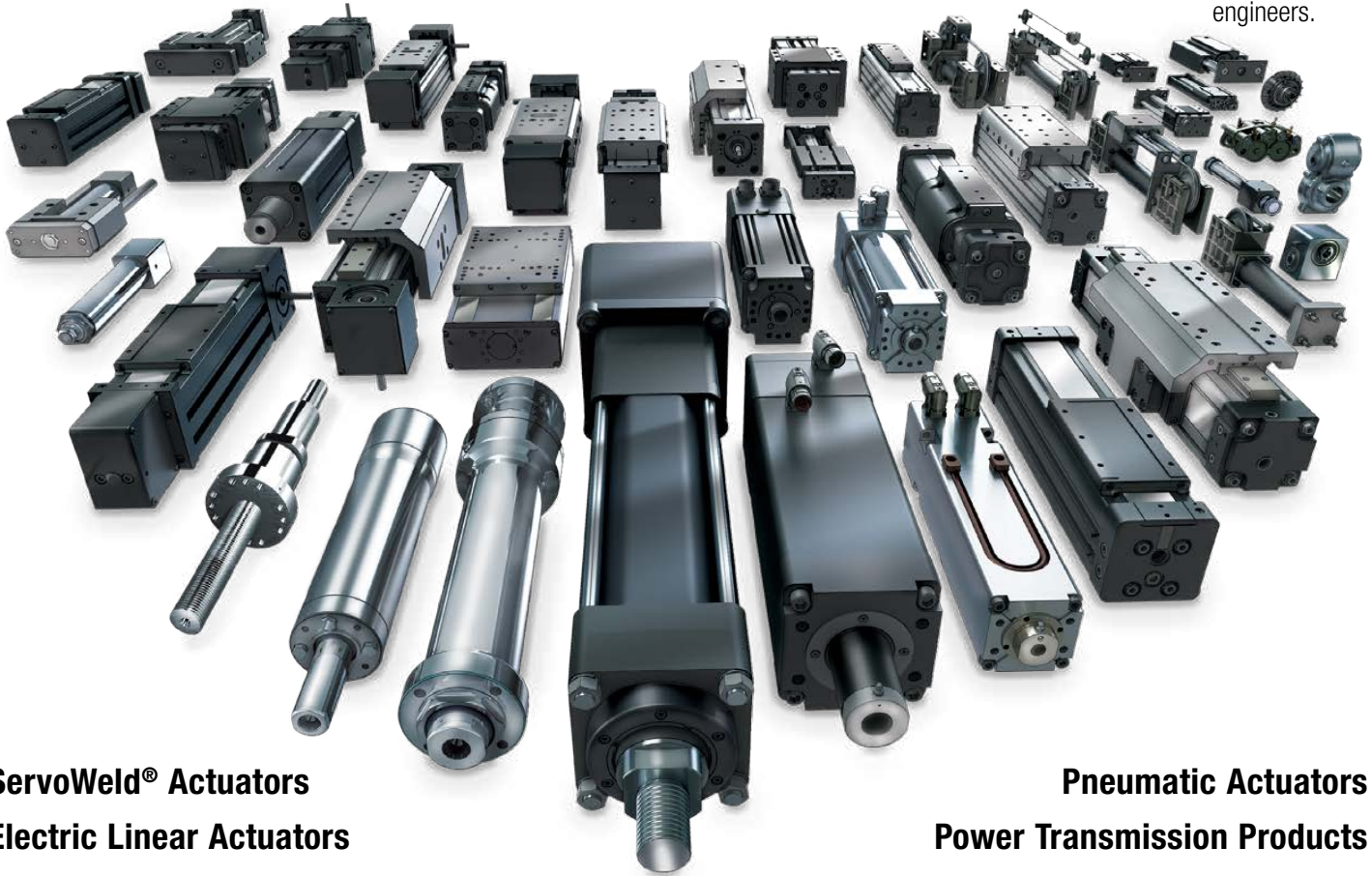
CAD LIBRARY

Download 2D or 3D CAD files for Tolomatic products.



TECHNICAL SUPPORT

Get a question answered or request a virtual design consultation with one of our engineers.



ServoWeld[®] Actuators
Electric Linear Actuators

Pneumatic Actuators
Power Transmission Products



MADE IN U.S.A.

TolomaticTM
EXCELLENCE *IN MOTION*

COMPANY WITH
QUALITY SYSTEM
CERTIFIED BY DNV
= ISO 9001 =
Certified site: Hamel, MN

USA - Headquarters

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