

SERVOWELD® SYSTEM

ENDURANCE TECHNOLOGY™

G S W A INTEGRAL MOTOR
HIGH THRUST ACTUATOR



MAXIMUM DURABILITY

RESISTANCE SPOT WELDING (RSW) WITH SERVOWELD® GSWA

Tolomatic's ServoWeld® products offer RSW users a higher level of performance.

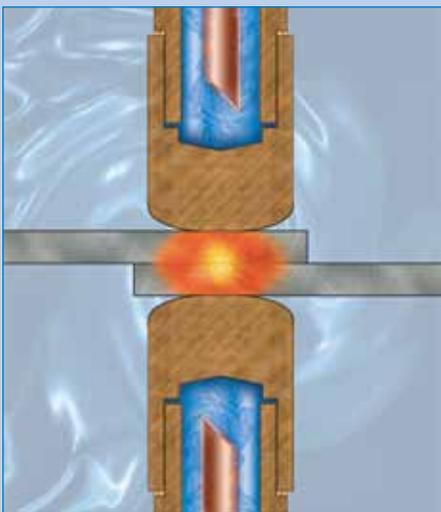
Perfect Servo Welds



Photo courtesy of The Weld Institute

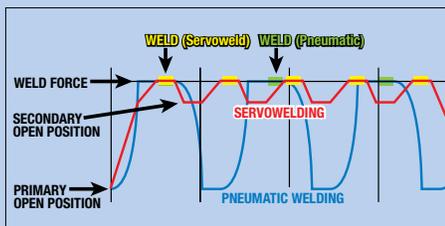
Perfect welds, as seen in this cross-section, can be achieved every time with the GSWA actuator.

Weld Nugget Formation



This illustration shows how a weld nugget is formed. The tips of the weld gun are programmed to close rapidly then slow to a 'soft touch' speed as they come in contact with the part for reduced part impact and low expulsion resulting in higher quality welds.

Improved Weld Cycle Rate



With ServoWeld there is no dwell time needed so weld begins as soon as weld force is achieved. Efficiency is improved since the gun tips only open enough to move onto the next weld.

HIGHER QUALITY WELDS

- Force repeatability for consistent welds
- "Soft-touch" position and speed control for high repeatability and eliminates high impact effects on part and weld gun for reduced wear
- Position and force can be recorded for each weld
- Position data from feedback device can provide data for weld cap wear and lost cap detection capability

LOWER LIFETIME COST

- ServoWeld offers longer overall service life:
 - Ball Screw/Ball Nut: +5,000,000 welds
 - Roller Screw/Roller Nut: +10,000,000 welds(Pneumatic actuators have a typical service life in the range of 3,000,000 welds and require regular preventative maintenance.)
- Unlike pneumatic actuators that require rebuilding or replacing, the GSWA actuator provides zero maintenance for increased productivity and less downtime.
- Increased energy efficiency over pneumatics of +80% with payback often less than a year.
- Supports multiple weld schedules, easily accommodating different materials and thicknesses.
- Fewer configurations required: Wide force range minimizes required configurations for varying force requirements. (Able to replace 35 to 40 different pneumatic cylinders by stocking 3 different GSWA models.)

FASTER WELDING CYCLES

- "At-force" indication allows for immediate welding (pneumatic actuators require a dwell time)
- Programmable open positions of the gun tips shorten move times between welds.

MINIMAL ENVIRONMENTAL IMPACT

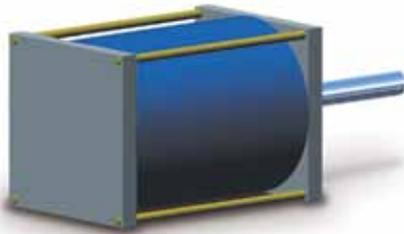
- Less energy, noise and contamination than pneumatically powered systems which employ air exhaust.

COMPLETE MANUFACTURING FLEXIBILITY

- Using weld or robot controls, the GSWA can be easily programmed to accommodate model or tool changes.
- Existing 6-axis robots can be retrofitted with multiple GSWA actuators to achieve all the advantages that servo welding offers.

SERVOWELD® GSWA - IMPROVED TECHNOLOGY, BETTER PERFORMANCE

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



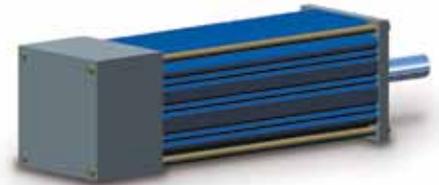
AIR CYLINDER

- High cost of use
- Frequent repair and maintenance
- Poor repeatability, reduced weld quality
- “Bang-bang” welds - greater tooling wear
- Limited adaptability
- More configurations required to address varying weld schedule requirements



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 maintenance item and failure point



SERVO: - Integrated motor segmented laminations

- Segmented stator design does not offer the performance of skewed windings
- Actuators employing segmented stators may compromise weld repeatability due to undesired high cogging torque
- Higher cogging torque results in force repeatability variations with position changes, potentially compromising weld quality

The SeroWeld GSWA integrated motor actuator design offers superior quality welds in a compact package.



GSWA integrated motor actuator uses an 8 pole, Nd-Fe-B hollow core rotor with skewed stator laminations. This allows the magnet to remain over multiple windings throughout the weld cycle for maximum torque efficiency and consistent force output at any location along the actuator stroke.

The result:

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

All in one compact actuator/motor package!

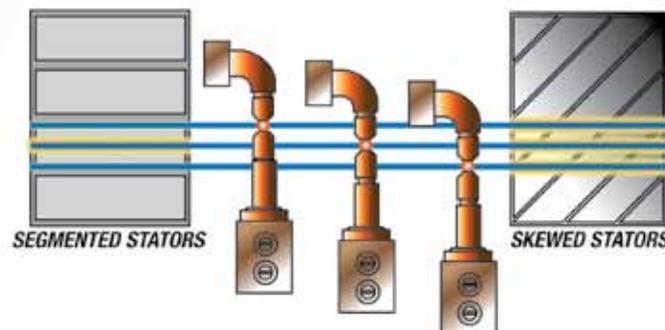


Skewed Stators

Segmented Stators

The GSWA has skewed stator laminations for low cogging torque and better repeatability, independent of tip position.

By nature of their design, segmented stators limit the number of weld positions that deliver optimal torque and repeatability.



As the weld gun tips close on a part, the final position of the servo actuator's thrust rod is dependent on the metal thickness and tolerances, weld cap wear, etc. When the thrust rod reaches its final position and finishes the “squeeze”, the motor rotor stops turning. The illustration above represents various final positions (the orange ovals between the weld tips, representing the weld nugget “squeeze” in the RSW cycle) and the varying positions of the motor rotor magnets (the straight blue lines) in comparison to the servo motor windings. The diagonal lines in the skewed stators represent the laminated motor windings used in the GSWA. At any point the rotor magnets stop, they are always positioned in an orientation that provides peak performance. In contrast, the segmented stator windings will only provide peak performance when the rotor is positioned in the center of the segmented stator phase.

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

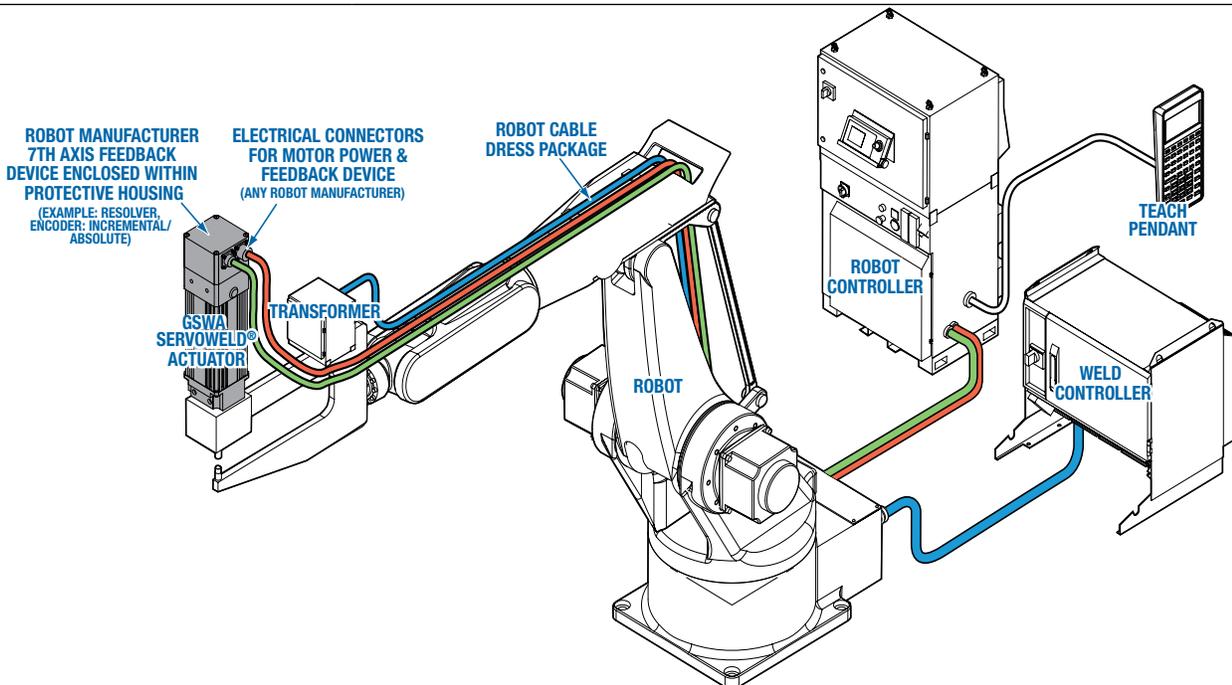
Off-the-shelf actuators, designed for general applications, do not perform well in the spot welding environment. Tight tolerances for force repeatability, zero maintenance, service life, side loads, cycle times...all require a servo actuator that can stand up to this demanding application. From roller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

engineered a product specifically designed for resistance welding that exceeds customer expectations.

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

GSWA DESIGN CONSIDERATIONS

VOICE OF THE CUSTOMER	TOLOMATIC SERVO ACTUATOR
COMPACT DESIGN	Width-- GSWA : 4.4" (111.7 mm)
*SERVICE LIFE EXPRESSED IN CONJUNCTION WITH REPEATABILITY:	Roller screw: up to 10M cycles; ball screw: up to 5M cycles (application variables will affect service life) *Life of the actuator is expressed in the number of welds. When repeatability of 50 consecutive welds (as measured statistically by a calculated range of 6 times that of the standard deviation for the 50 weld sample) exceeds 10% total of the nominal output force, the actuator is considered to have failed.
ZERO MAINTENANCE	Zero maintenance over the life of the actuator (as described above).
CONNECTOR PROTECTION	Connectors may be oriented in multiple locations; many styles available to match desired control specification.
ROBOT INTERFACE	Feedback devices to interface with any robot manufacturer and commercially available motion control hardware.
MANUAL OVERRIDE	Built-in, and requires no special tools.
FORCE REPEATABILITY CURRENT	In open loop, Tolomatic actuators with roller screw/nut achieve maximum $\pm 3.0\%$ force repeatability (output force vs input current) over the life of the actuator, from start-up to the end of service life. This includes variations from initial startup.
INTERCHANGEABILITY/RETROFIT EXISTING PNEUMATIC ACTUATOR	Easy retrofit due to compact design of Tolomatic actuators.
LOW OR HIGH VOLTAGE CAPABILITY	Low voltage: 230 Vac / 325 Vdc High voltage: 460 Vac / 680 Vdc

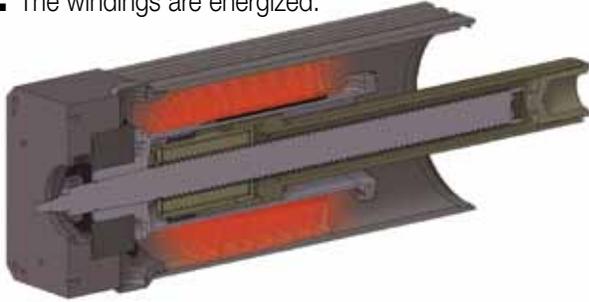


This illustration shows a typical robot carried weld installation utilizing a Tolomatic GSWA actuator with a 7th axis feedback device enclosed within the actuator.

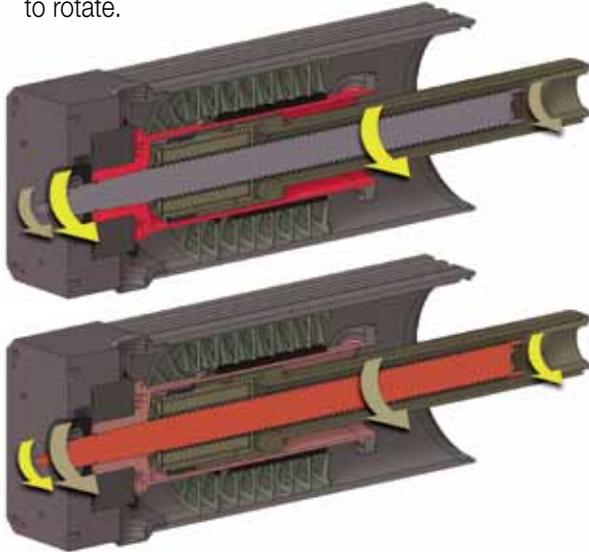
HOW THE GSWA WORKS

The illustrations below show how the inner components of the GSWA work together to provide optimal performance and anti-rotation of the nut/thrust rod. For clarity, only the extend movement is shown.

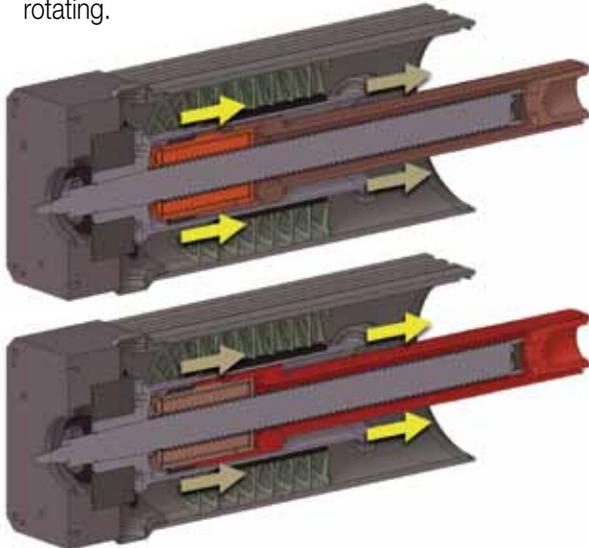
1. The windings are energized.



2. The rotor, which is rigidly connected to the screw, begins to rotate.



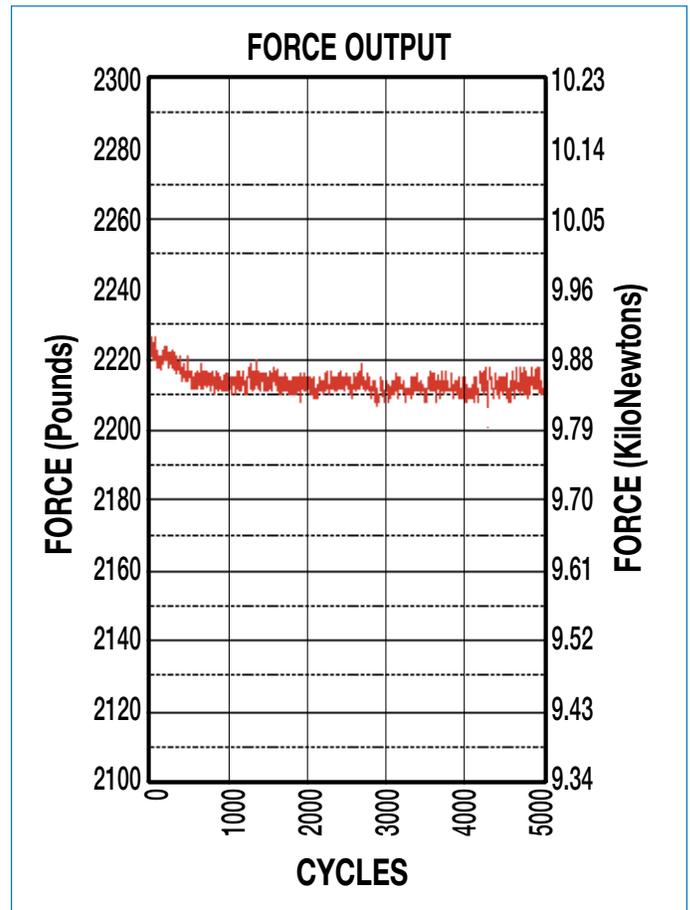
3. The nut, mechanically captured by the thrust rod, moves in a linear motion. The bearing and front plate of the GSWA prevents the nut/thrust rod assembly from rotating.



Tested performance results

Tolomatic's GSWA actuator (with roller screw/nut selection) is designed and built to maintain $\pm 3.0\%$ force repeatability throughout the actuator life.

The data presented in the "GSWA Force Output" chart below was collected from a ServoWeld[®] configured unit with a roller screw and low-voltage windings. The temperature of the actuator was not monitored during the test.



The force output data in this chart is from GSWA actuator run at a fixed current. Each sample is representative of a single "weld cycle." The test was run for 4-1/2 hours.

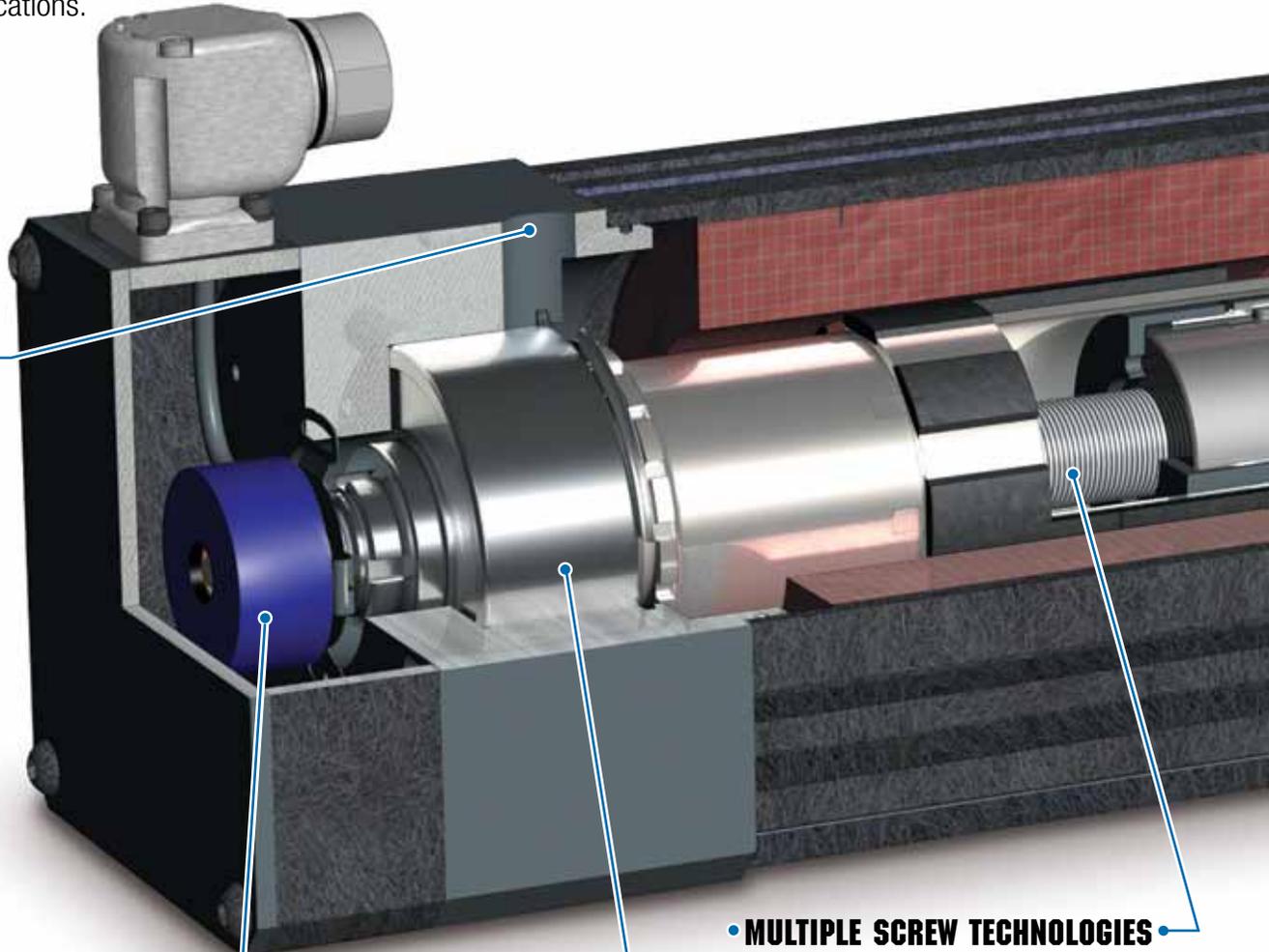
DATA POINTS OF INTEREST:

- The overall range of 5,000 samples is 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) (Std. Dev.)/Nominal Force.

G S W A INTEGRATED MOTOR ACTUATOR

ENDURANCE TECHNOLOGYSM

The **G S W A** integrated motor rod screw actuator is ideal for high thrust applications of guided loads in an ultra-compact design. The integral motor design and cylinder style operation make this product ideal for applications that were historically solved with hydraulic or pneumatic power. The high forces and longer life of a roller screw design allow you to install this actuator in a variety of demanding applications.



MANUAL OVERRIDE

- Access port to manual override in power off situations (2 access ports 180° apart)

TOLOMATIC FEEDBACK DEVICE

- Tolomatic standard feedback device is a 5000 line incremental encoder
- Customer may specify their own feedback device as an option

HIGH THRUST BEARING

- Provides complete support of screw and protects the feedback device from linear forces

MULTIPLE SCREW TECHNOLOGIES

YOU CAN CHOOSE:

- Ball nuts offer positioning accuracy and repeatability with longer life
- Roller nuts provide the highest thrust and life ratings available



TOLOMATIC... LINEAR SOLUTIONS MADE EASY

INTERNAL ANTI-ROTATION BEARING

- Unique nose bearing and thrust tube design prevent rotation of the thrust tube
- Supports the thrust tube and nut assembly through entire stroke length

ROD WIPER WITH SCRAPER

- Prevents contaminants from entering the actuator for extended life

THREADED ROD END

- Solid stainless steel construction for corrosion resistance
- Provides a common interface to multiple rod end options

NICKEL PLATED STEEL THRUST TUBE

- Steel thrust tube supports extremely high force capabilities
- Nickel plating provides excellent corrosion resistance from many chemicals and resists damages due to incidental contact

INTERNAL BUMPERS

- Bumpers protect the screw and nut assembly from damage at end of stroke

LIGHTWEIGHT ALUMINUM DESIGN

- Black anodized extrusion design is optimized for rigidity, strength and heat dissipation

MULTIPLE MOTOR WINDINGS

YOU CAN CHOOSE:

- 460V or 230V rated windings potted directly into actuator housing

- Skewed motor windings provide minimal torque ripple for smooth linear motion

- Integral thermal switch or thermistor for over temperature protection



OPTIONS



INTEGRAL FORCE FEEDBACK DEVICE

Provides a linear signal for verification or data acquisition of actual force

GSWA ACTUATOR SCREW SELECTIONS AND LOADING CONSIDERATIONS

Tolomatic uses only the highest grade roller and ball screw systems. More accurate machining processes and highly stringent tolerance requirements result in greater repeatability with long-lasting Endurance Technology performance.

Outlined below are the basic features and benefits of roller and ball screws along with a performance comparison chart. All GSWA actuators are available with either roller or ball screws.

ROLLER SCREW



Capable of handling heavy loads. Force is transmitted via multi-threaded helical roller assemblies engaged with a fine threaded roller screw. Roller screws have exceptional loading capability based on many points of contact.

- 10+ million welds at high force repeatability
- $\pm 3\%$ force repeatability
- Up to 5,000 lbf. (22,000 N)
- Speeds to 16" (400 mm) per sec.

BALL SCREW



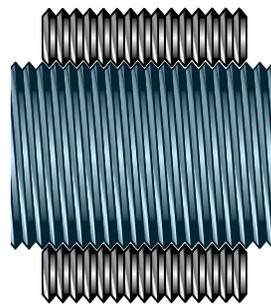
Ball nut housings contain multiple ball bearings. Compared to roller nut design the ball nut has a limited number of contact points resulting in lower load capability. However, it is a robust mechanical drive system when properly applied.

- 5+ million welds at rated force repeatability
- $\pm 5\%$ force repeatability
- Up to 5,000 lbf. (22,000 N)
- Speeds to 16" (400 mm) per sec.

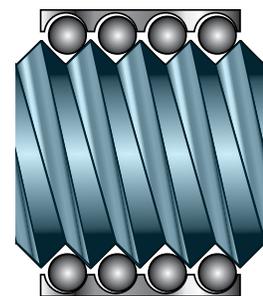
ROLLER SCREW AND BALL SCREW PERFORMANCE COMPARISONS

	ROLLER SCREW	BALL SCREW
Load ratings	Very High	High
Lifetime	Very long, many times greater than ball screw	Moderate
Speed	Moderate	Moderate
Acceleration	Very high	Moderate
Stiffness	Very high	Moderate
Shock Loads	Very high	Moderate
Space Requirements per Load Rating	Minimal	Moderate
Maintenance	None	Minimal

HELICAL ROLLER SCREW



BALL SCREW



Roller screws have a greater surface area and number of contact points compared to ball screws

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 GSWA actuator. For life optimization, Tolomatic 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.

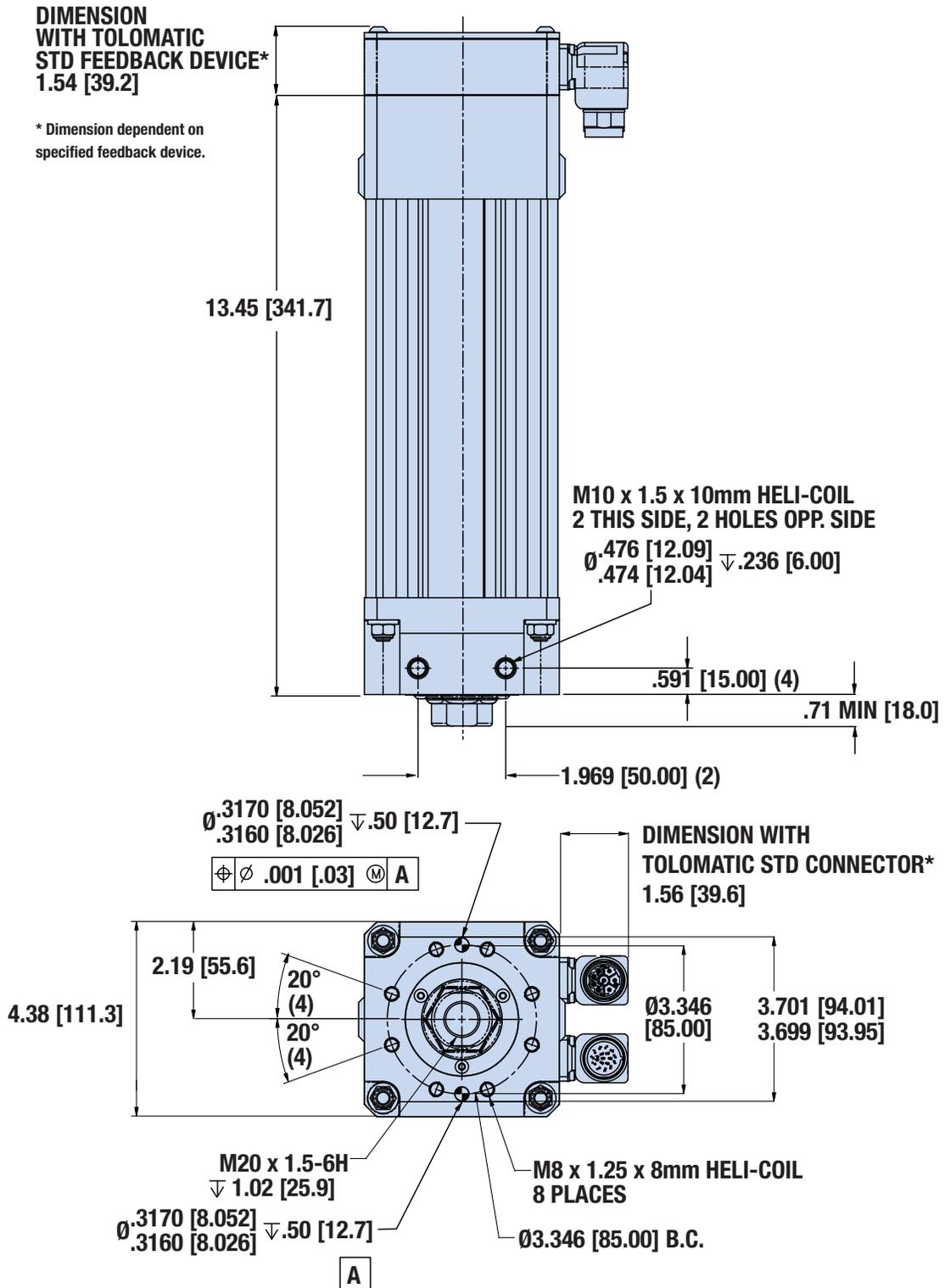
DISTANCE TRAVELED UNDER LOAD

Distance traveled under load is a derivative of weld gun deflection/spring rate. Tests demonstrate the overall service life of actuators is extended when travel distance under load is minimized.

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

GSWA ACTUATOR DIMENSIONS

MODEL GSWA-UNIVERSAL

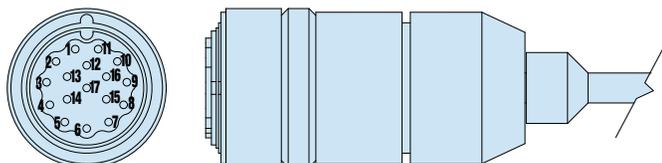


GSWA ACTUATOR MOTOR AND CABLE SPECIFICATIONS

GSWA MOTOR SPECIFICATIONS

SPECIFICATION	LOW VOLTAGE WINDINGS	HIGH VOLTAGE WINDINGS
Continuous Stall Torque	49.6 in-lbs (5.6 Nm)	43.4 in-lbs (4.9 Nm)
Peak Stall Torque	148.8 in-lbs (16.7 Nm)	129.2 in-lbs (14.6 Nm)
Continuous Stall Current	7.5 Amps RMS	3.8 Amps RMS
Peak Current	22.4 Amps RMS	11.4 Amps RMS
Number of Poles	8	8
Kt	0.74 Nm/Amp per phase RMS	1.28 Nm/Amp per phase RMS
Ke	46.7 V/kRPM L-L RMS	75.8 V/kRPM L-L RMS
Resistance @ 25C	.90 ohms L-L	4.2 ohms L-L
Stator Inductance	3.65 mH L-L	15.7 mH L-L
Maximum Bus Voltage	325 Vdc	650 Vdc
Rated Speed @ Maximum Voltage	5000 RPM	5000 RPM
Moment of Inertia	0.19 lb-ft ² (0.008 kg-m ²)	0.19 lb-ft ² (0.008 kg-m ²)
Mass	31.1 lb (14.1 kg)	31.1 lb (14.1kg)

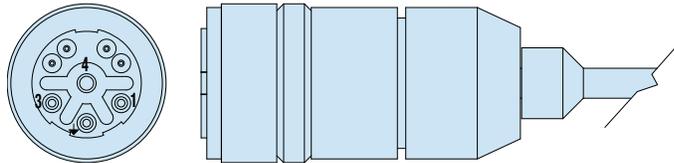
GSWA 5000 LINE ENCODER CABLE PIN-OUT



SIGNAL	PIN	LEAD COLOR
A	1	Black
A-	2	White/Black
B	3	Red
B-	4	White/Red
I	5	Green
I-	6	White/Green
Hall A	7	Brown
Hall A-	8	White/Brown
Hall B	9	Blue
Hall B-	10	White/Blue
Hall C	11	Yellow
Hall C-	12	White/Yellow
Thermal	13	Orange
Thermal	14	White/Orange
Vcc (+5V)	15	Grey
COM	16	White/Grey

PART NUMBER	CABLE LENGTH
2750-1249	6 meters
2750-1250	15 meters

GSWA MOTOR POWER CABLE PIN-OUT



SIGNAL	PIN	LEAD COLOR
Phase R	1	Brown
Phase T	3	Blue
Phase S	4	Black
Ground		Red

PART NUMBER	CABLE LENGTH
2750-1251	6 meters
2750-1252	15 meters

CAUTION: The ServoWeld® GSWA is not intended for repetitive, high speed operation at full stroke. Operations under these conditions can result in internal damage to the actuator. Contact Tolomatic for specific application guidelines and assistance.

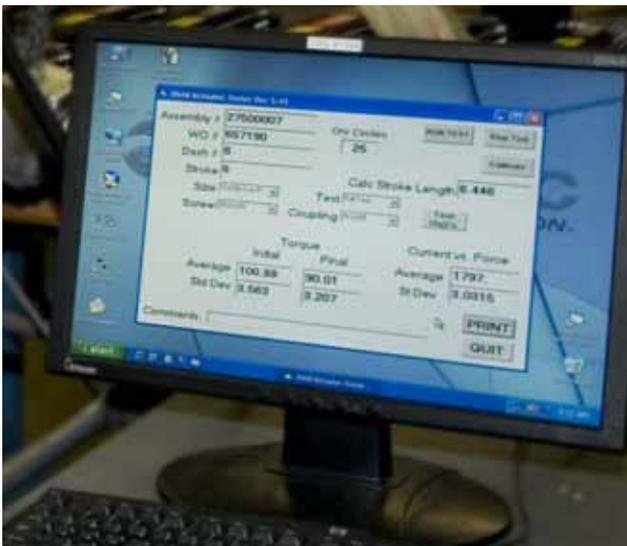
COMPLETE VERIFICATION TESTING IS PERFORMED ON EACH ACTUATOR

Properly applied, every GSWA actuator shipped is guaranteed for millions of cycles of maintenance free performance.

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



Functional unit testing for 350 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 GSWA motor poles.

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 ServoWeld motor.

3. Functional Testing

Performed with Tolomatic motion control components and dedicated data acquisition equipment. Operated for 350 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 GSWA motor.

THE TOLOMATIC DIFFERENCE

What you expect from the industry leader:



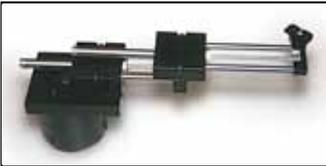
EXCELLENT CUSTOMER SERVICE & TECHNICAL SUPPORT

Our people make the difference! Expect prompt, courteous replies to all of your application and product questions.



INDUSTRY LEADING DELIVERIES

Tolomatic continues to offer the fastest delivery of standard catalog products. Modified and custom products ship weeks ahead of the competition.



INNOVATIVE PRODUCTS

From standard catalog products... to modified products... to completely unique custom products, Tolomatic designs and builds the best solutions for your challenging applications.



ONLINE SIZING & SELECTION SOFTWARE

Online sizing that is easy to use, accurate and always up-to-date. Input your application data and the software will determine a Tolomatic electric actuator to meet your requirements.



3D MODELS & 2D DRAWINGS AVAILABLE ON THE WEB

Easy to access CAD files are available in many popular formats.

ALSO CONSIDER THESE OTHER TOLOMATIC PRODUCTS:

PNEUMATIC PRODUCTS



RODLESS CYLINDERS: Band Cylinders, Cable Cylinders, MAGNETICALLY COUPLED CYLINDERS/SLIDES; GUIDED ROD CYLINDER SLIDES

"FOLDOUT" BROCHURE #9900-9075
PRODUCTS BROCHURE #9900-4028

ELECTRIC PRODUCTS



POWER TRANSMISSION PRODUCTS



GEARBOXES: Float-A-Shaft®, Slide-Rite®; DISC CONE CLUTCH; CALIPER DISC BRAKES

"FOLDOUT" BROCHURE #9900-9076
PRODUCTS BROCHURE #9900-4029

ROD & GUIDED ROD STYLE ACTUATORS, HIGH THRUST ACTUATORS, SCREW & BELT DRIVE RODLESS ACTUATORS, MOTORS, DRIVES AND CONTROLLERS

"FOLDOUT" BROCHURE #9900-9074
PRODUCTS BROCHURE #9900-4016



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