White Paper

Selecting Optimal Electromechanical Actuator Solutions for Automotive Welding Applications

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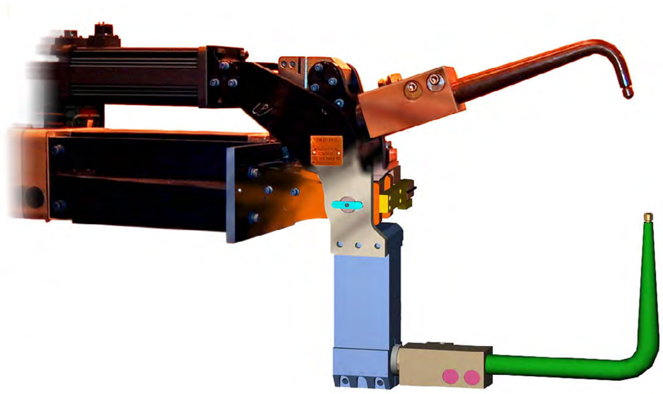
To meet customer expectations for continual improvements in value and performance, manufacturers are increasingly turning to process automation to increase productivity, reduce cost, drive product quality, and improve operator safety on the shop floor. Industrial robots are now commonplace in many manufacturing operations, including robotic welding applications where speed, precision, and repeatability deliver immediate improvements in throughput and efficiency.

In automotive body-in-white applications, joining sections of metal parts to form the car frame require hundreds of spot welds. Pneumatic cylinders were traditionally utilized to actuate weld guns and apply the specified amount of force during the weld cycle. While these components were relatively inexpensive and easy to install, the compressibility of air and its susceptibility to drift with changes in air temperature and humidity contributed to inconsistent and unacceptable weld quality. In addition, pneumatic systems required frequent maintenance to repair inevitable leaks, and adjustments were required each time there was a model changeover.

Integrating precision, programmable servo controls and motors with rugged and reliable mechanical screw mechanisms in a package similar in form factor to pneumatic actuators, is a significant step forward for robotic spot welding. Electromechanical actuators not only offer significantly better control of the gun clamping force (thus significantly improving both the weld quality and repeatability), but also enable push-button changeover between car models while eliminating much of the maintenance and repair required by pneumatic-based systems.

Selecting the Right Electromechanical System

When designing new or retrofit robotic welding systems, engineers must determine the optimal combination of speed, quality, and cost to gain the most benefit for their process automation investment. While robotic welding provides speed and accuracy to the process, achieving specific desired outcomes often requires hours of research and careful planning. Choosing the correct electromechanical actuator for the weld gun can make significant differences in weld quality, total manufacturing cost, and throughput. Answering the following key questions can assist in the planning and decision-making process.



What is the target move profile?

When selecting an electromechanical actuator, the actuator must be capable of executing the full motion profile expected of the weld gun. Understanding the profile is paramount to ensure the actuator can meet the speed requirements of the weld process, create and maintain the proper weld force, and deliver repeatable and quality welds throughout the expected lifetime. Considerations include the full movement required to load and unload parts, the short-stroke move distance when completing a sequence of welds, how many welds per sequence are required and how many sequences per hour there are (see Figure 1).

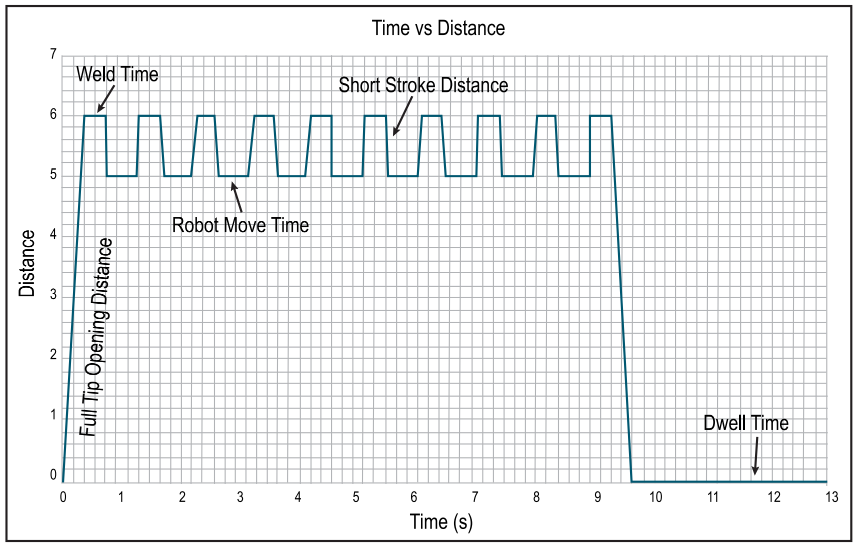


Figure 1. Example motion profile of weld gun actuator for automotive weld

What are the weld tip force requirements?

Repeatable, controlled force on weld tips is required for consistent, high quality welds. Depending on gun configuration (C-gun or X-gun), the force ratio between the weld tips can vary. In C-guns, the ratio is always 1:1. In X-guns, where more force is required at the actuator than at the weld tips, the force ratio can vary. Determining the actuator force is a key factor as it determines actuator size. Higher-force actuators are larger in size, which can be prohibitive from a robot payload or a capital cost perspective. In addition, life expectancy of the electromechanical actuator is greatly influenced by the force profile. Technology advancements have reduced the size of actuators to meet the same force requirements. Inverted roller screw technology offers high force in a small package while extending the life expectancy of the actuator considerably.

What is the total time the actuator must maintain weld tip force?

During the weld process, the actuator positions the weld gun tips against the parts to be joined and enters a torque control mode to hold the parts in position. Once the weld tip force is reached, current flows through the weld tips, permanently welding the parts together. For a high-quality weld, the actuator must maintain the clamp force as the weld is created. To accomplish this, motor current is used to generate torque which is translated into linear force. As the motor draws current, it generates heat. The higher the current and the longer the weld time, the more heat is generated. Although motors are designed with thermal protection devices, weld sequences should be calculated to stay below the motors' thermal limits and keep the cell running at optimal performance.

What is the robot move time between welds and dwell time between sequences?

As is true in most manufacturing processes, there are trade-offs between speed, cost, and quality to consider when designing an automotive weld cell. Maximizing throughput produces the greatest number of units in the least amount of time but at what cost? Pushing manufacturing equipment to its limits can adversely affect productivity due to increased maintenance time and expense, it can also affect product quality. The welds holding a vehicle together must be of the highest quality to keep drivers safe.

Optimizing throughput, on the other hand, produces the greatest number of products with minimal wear and tear on machinery. Extending weld gun actuator life is achieved by keeping the actuator cool, well lubricated, and free of containments. In the weld gun motion profile, actuator move time and the dwell time between sequences are effectively 'cooling-time' as the actuator is not performing any work to complete a weld. Therefore, the longer the robot move time between welds and the longer dwell time between sequences, the cooler the actuator will run. If the dwell time between weld sequences is long relative to the weld time, the weld actuator may require less maintenance and have potentially longer life.

Conclusion

Once an actuator is selected that meets the weld cell requirements, the next step is integrating the actuator control into the new or existing control methodology. Exlar® actuators from Curtiss-Wright provide plug-and-play compatibility with virtually all industrial robots used in automotive welding today. Simply install the actuator, connect the cabling, download the servo file, and weld.

This paper provides an overview of the electromechanical actuator selection process. For more detailed sizing and selection information, a Weld Gun Sizing Worksheet is available that can be completed and shared with a Curtiss-Wright application engineer to provide a cost effective solution.

About Curtiss-Wright/Exlar

Curtiss-Wright's Exlar electromechanical actuators provide some of the most compact and lightest weld gun actuator solutions available. Exlar's unique roller screw technology delivers higher force in a smaller package than comparable ball screw technology, as well as greater flexibility, higher efficiency, and lower overall maintenance than traditional fluid power solutions. Exlar actuators are being used in thousands of weld guns around the world, improving efficiency, throughput, and total cost of ownership.