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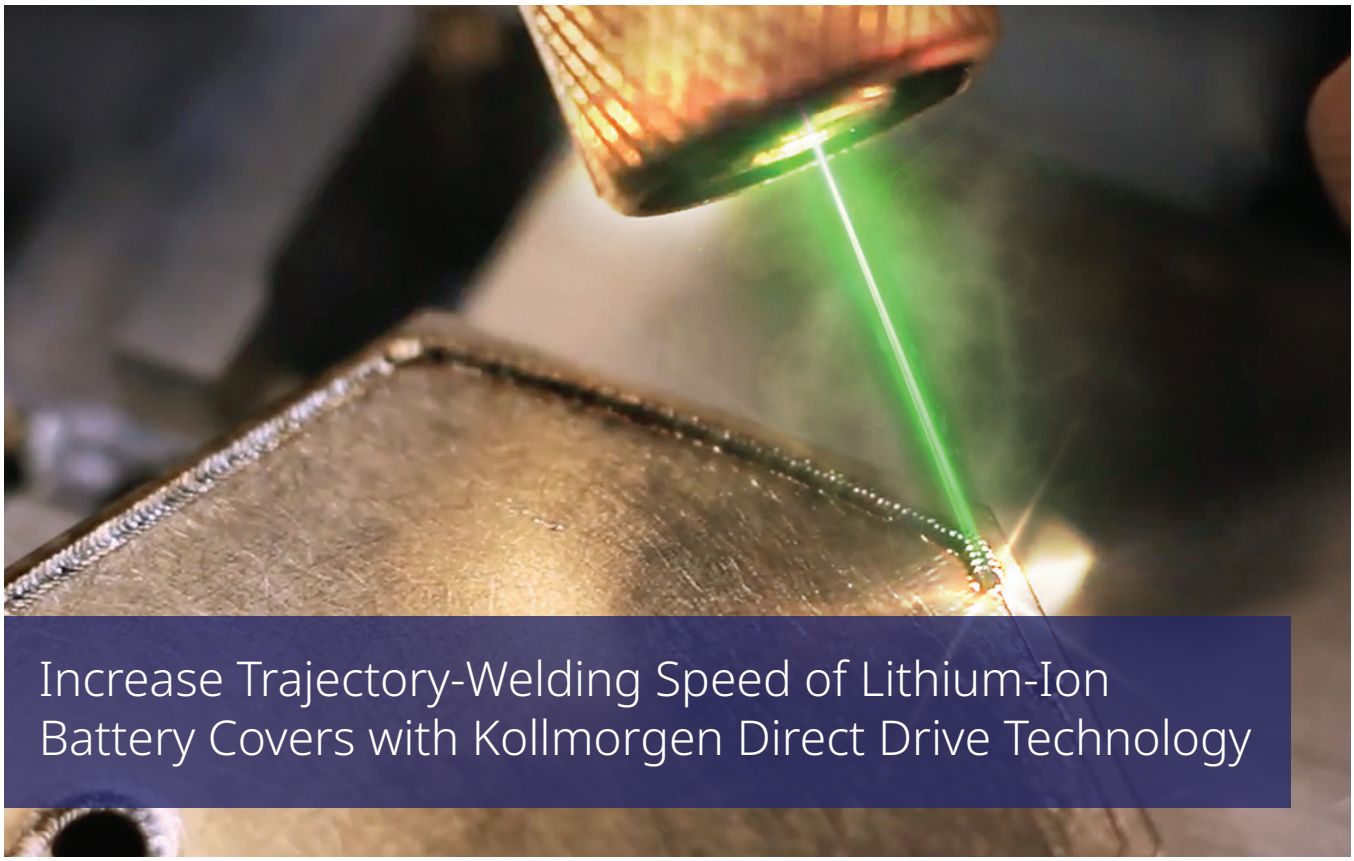


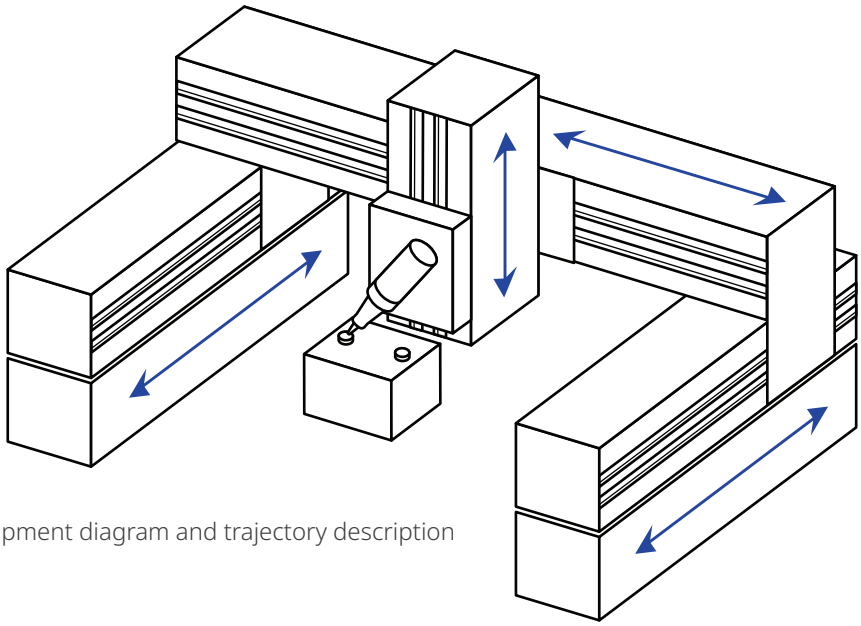
Increase Trajectory-Welding Speed of Lithium-Ion Battery Covers with Kollmorgen Direct Drive Technology

In the manufacture of lithium-ion batteries, laser-welding technology has been widely used to seal-weld stainless steel and aluminum shells, and to seal-weld the top cap to the shell. In recent years, with rapid growth and ongoing innovation in the battery industry, the pressure has been on to continuously improve laser-welding capabilities. However, today's widely available welding machines have the problems of limited trajectory welding speed, poor accuracy control and low welding yield.

As lithium-ion battery manufacturers seek to improve yield and quality, laser-welding machine manufacturers are turning to Kollmorgen direct drive technology to optimize motion control, increase trajectory welding speed to 240 millimeters per second, and achieve a gravitational acceleration of 2.5g. At the same time, Kollmorgen's direct drive solution achieves high-precision motion control within ±30 microns for the highest-quality welds.

Laser welding technology as a solution for battery sealing requirements

Laser welding is a relatively new welding method After laser welding, no additional treatment or only simple treatment is required because the weld quality is high and there are no pores. Laser welding can be accurately controlled because the laser light focus is small, the positioning accuracy is high, and the process can be easily automated. These characteristics make laser welding particularly suitable for incorporating into an automated battery-production assembly line. Laser welding also improves the sealing performance and the appearance of the lithium-ion battery shell.



Equipment diagram and trajectory description

Usually the top of the lithium-ion battery shell has a rectangular cover plate with rounded corners and a positive input end on the plate. This cover plate is inserted into the shell level with the mouth when sealing. The laser-welding machine is used to weld the battery shell to the electrode cover plate, with the rectangular gap between the cover plate and the shell welded and sealed by repeated laser pulses.

When the laser parameters are suitable, the square battery can be sealed successfully in one pass. To accomplish this, the welding process requires the speed of the entire welding trajectory to be uniform, with minimal fluctuation; otherwise, the weld will be bad. To meet the production needs of lithium-ion battery manufacturers, laser welding equipment needs to reach a yield of well over 99%. However, the yield rate of mainstream welding machines is far lower than this target rate.

As the demand for batteries skyrockets in the era of electric vehicles and other rechargeable battery-powered products, the need to improve the motion control accuracy and yield of laser-welding machines is urgent.

Direct drive technology as a laser-welding solution

To solve the motion control challenges of laser welding, Kollmorgen applies direct drive technology featuring ICH series high-voltage, iron-core linear direct drive motors controlled by the AKD servo drive. This solution increases the trajectory welding speed to 240 millimeters per second, improves control accuracy by 30%, and enables the welder to achieve a yield rate higher than 99%.

As the welding trajectory changes from a straight line to the fillet position, it is necessary to increase acceleration and speed to achieve stability of the small fillet weld. As expressed in the formula amax=v2/R, the faster the welding speed, the smaller the radius of the winding trajectory, and the greater the acceleration required.

With its high-quality control performance and fast response speed, the Kollmorgen ICH linear motor achieves a welding speed of 240 millimeters per second, and its maximum acceleration can reach 2.5g when welding the fillet of R 2.3. The gravity increases the speed, reducing the fluctuation of fillet welding and making the entire fillet welding trajectory more uniform and stable to ensure the feasibility of small fillet welding.

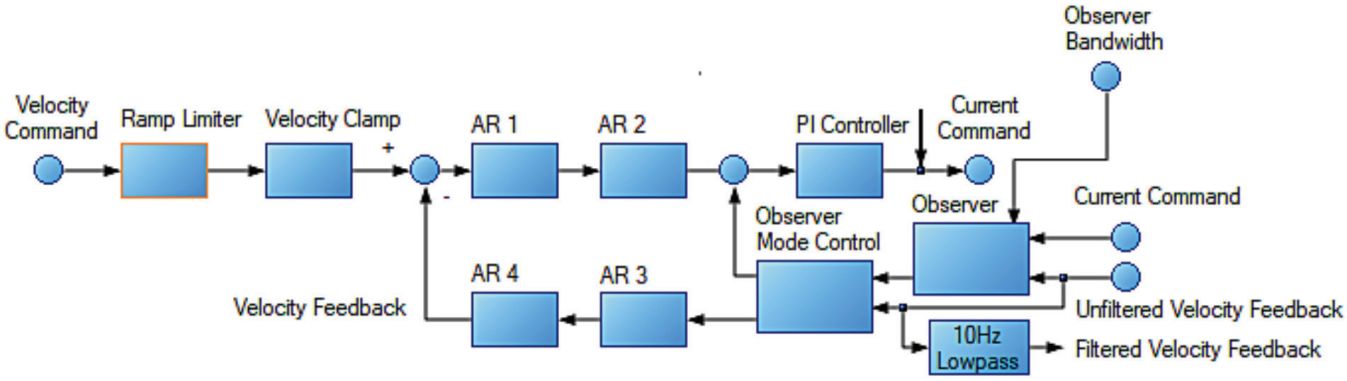
As the rounded trajectory then transitions to the next linear trajectory, the speed of the X or Y axis drops to zero, and the motor overshoots due to the inertia of the load (the faster the speed, the greater the overshoot). The motor adjusts after the overshoot. If the maximum position deviation of the overshoot is not controlled, a wave shape will appear. Achieving the necessary battery-welding tightness is a challenge.

To achieve the required tightness, Kollmorgen recommends AKD drives with high-performance, low-latency control loops and high-response bandwidth. AKD drives feature Kollmorgen's industry-leading refresh rates of 670 nanoseconds current loop refresh (1.5 MHz), 62.5 microseconds speed loop refresh (16 kHz) and 125 microseconds position loop refresh (8 kHz).

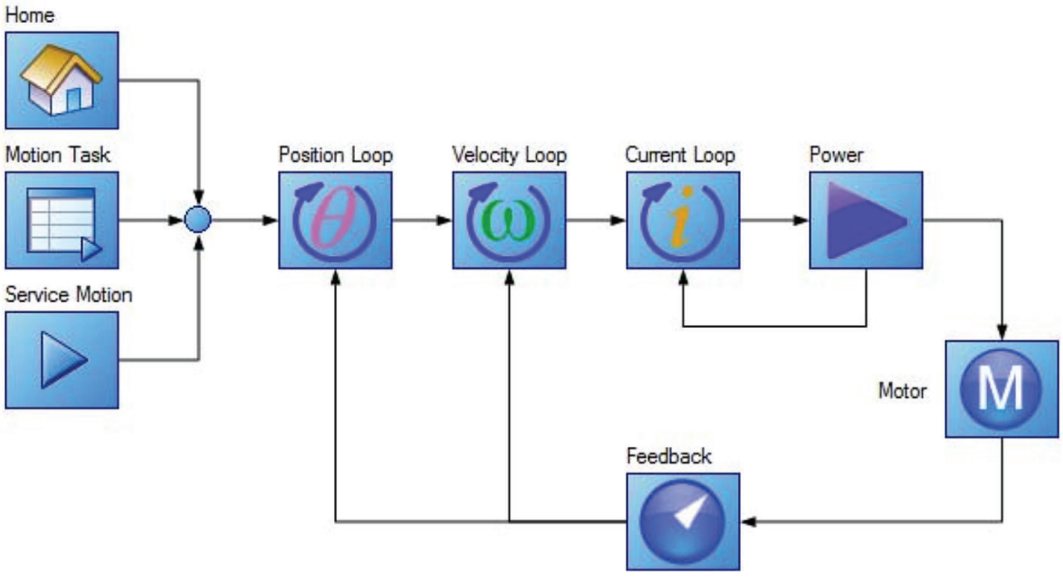
These exceptional three-loop refresh rates enable faster and more timely motion control while improving control accuracy and reducing overshoot to keep maximum position deviation within ±30 microns. The tightness of battery welding and the yield of the laser-welding equipment are both greatly improved as a result.

At the same time, the AKD drive can improve response bandwidth and reduce setup time to increase machine productivity. In addition, while enhancing sealing quality and improving production efficiency, the AKD drive also has strong filtering performance, which can address the noise problems that occur during debugging and improve the performance of welding machine equipment.

Upper cover of EV battery used for cars



Control loops diagram



Velocity loop filters and gains diagram

To meet the diverse welding requirements and different trajectories involved in welding the top cover to lithium-ion battery shells, Kollmorgen's direct drive technology delivers a continuous force range of 21 to 450 N (4.7 to 101 lbf) to meet the needs of different load force values. At the same time, peak forces of 60 to 1600 N (13.6 to 360 lbf) meet the instantaneous high acceleration requirements of different top cover welding scenarios. This laser-welding motion control is more flexible than conventional welding equipment, which improves the welding quality of different welding trajectories.

By adopting Kollmorgen direct drive technology, the lithium-ion battery top cover welding process achieves double the welding speed, and at the same time improves accuracy by 30% with a maximum position deviation within ±30 microns. This effectively helps laser-welding machine manufacturers improve their market competitiveness. Optimization of the laser-welding process greatly improves production efficiency and product quality for lithium-ion batteries while boosting the welding yield rate to over 99% and greatly reducing production costs.

ICH series high voltage iron core linear motor

AKD servo drives

Ready to move forward?

Contact Kollmorgen to discuss your needs and goals with a Kollmorgen expert for industrial automation applications.

About Kollmorgen

Kollmorgen, a Regal Rexnord Brand, has more than 100 years of motion experience, proven in the industry's highest-performing, most reliable motors, drives, linear actuators, AGV control solutions and automation platforms. We deliver breakthrough solutions that are unmatched in performance, reliability and ease of use, giving machine builders an irrefutable marketplace advantage.

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