

PC-based control technology for plastic injection molding

Integrated plastic flow simulation increases efficiency and flexibility



Yudo EU was founded in Portugal in 2003 and develops hot runner injection systems primarily for the European and American markets. According to Yudo EU, the new Yudrive 2 hot runner solution, developed with Beckhoff as an innovative automation partner and the powerful PC-based control technology, sets new standards in terms of flexibility, precision and efficiency.

Yudo EU, S.A., is part of the multinational company Yudo, founded in 1980 with headquarters in South Korea, which specializes in solutions for the plastic industry and hot runner systems for injection molds, and is present on five continents with nine production facilities, 19 subsidiaries and 19 representatives. Yudo operates in all application areas of the plastic injection molding industry, such as automotive, medical, household appliances, packaging and personal care products. In this regard, the continuous search for smarter and optimized solutions is part of the company's DNA, explains Francisco Milhinhos, Managing Director of Yudo EU: "We saw the need for an innovative hot runner solution that would overcome the shortcomings of previous solutions. This called for an innovation-driven partner in the field of automation. Through Portuguese distributor Bresimar, we came across Beckhoff and its powerful PC-based control technology. Together we developed the extremely flexible, precise and efficient Yudrive 2 hot runner system."

Hot runner systems are used in injection molds to prevent the molten plastic from cooling and hardening before injecting it into the cavity. A hot runner system consists of hot channels and valve gates for controlling the injection process into the cavity as well as a control unit. The development process for Yudrive 2 began with the idea of implementing a hot runner system based on servomotor technology. In conventional hot runner systems, the valve gates are controlled by a hydraulic or pneumatic system moving a needle to open and close the valve gate. However, this proven and easy-to-use technology has drawbacks in terms of process control and quality, as well as energy efficiency, size and cleanliness. In these regards, a servomotor solution offers advantages. From the point of view of the experts from Yudo, it quickly became clear that PC-based control from Beckhoff could meet and even exceed the requirements set.

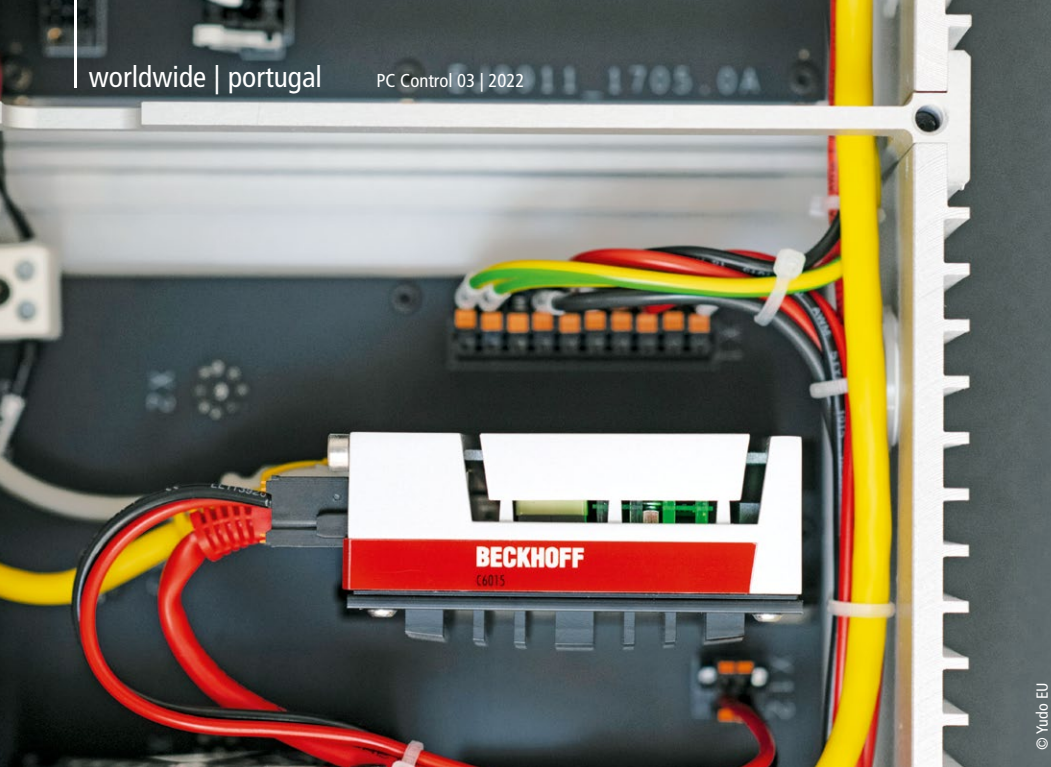
Yudo EU experts next to the new Yudrive 2 hot runner solution (from left to right): Henrique Neves, R&D Department and Managing Director Francisco Milhinhos



With the EtherCAT plug-in modules from the EJ series, the design of the I/O level can be extremely compact.

Compact solutions for I/O, IPC and motion control

As compactness was one of the main criteria in the search for a solution, Yudo decided to use EtherCAT plug-in modules from the EJ series as I/O level. These are based on the proven EtherCAT Terminals, but instead of clamping contacts on the front, the EJ modules have a plug connector on the back that enables direct plugging on an application-specific circuit board. In addition to the plug-in modules, this signal distribution board – in this case developed for the customer by Beckhoff – also includes the connection level for the sensors and actuators. This allows a smaller form factor of the complete I/O solution as well as further benefits in the manufacturing process of the Yudrive 2. By simply connecting EJ modules and prefabricated cables to the signal distribution boards, the time-consuming and error-prone process of connecting individual wires can be eliminated. This saves time and reduces costs as well as the need for skilled personnel. The same advantage is evident in repair and maintenance.



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The flexibly mountable C6015 ultra-compact Industrial PC serves as the central control unit of the hot runner solution.



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The DIN rail power supplies of the PS series from Beckhoff ensure the supply of the signal distribution boards with the EtherCAT plug-in modules.

The C6015 ultra-compact Industrial PC, which is also mounted on the signal distribution board, further contributes to the small footprint of the entire solution. In total, the size of the control unit could be reduced by 70% in comparison to a conventional solution, according to Francisco Milhinhos. Encapsulated in an aluminum housing, the whole control unit can be either placed directly on the injection mold or next to it, depending on the mounting situation at the customer.

A single signal distribution board can accommodate up to 4 EJ7211-9414 servomotor output stages with One Cable Technology (OCT) and STO function-

ality, each controlling an AM8122 servomotor. A 1-phase power supply from Beckhoff is available for each signal distribution board: a PS1011-2410-0000 24 V DC device with 10 A output current and 240 W output power, and two PS3011-4820-0000 48 V DC devices with 20 A output current and 960 W output power. Typical hot runner systems controlled by Yudo 2 consist of up to 16 valve gates requiring the connection of 16 servomotors. In these cases, further signal distribution boards can be connected with a freely adjustable number of valve gates and the corresponding number of EJ7211-9414 EtherCAT plug-in modules and AM8122 servomotors. This enables a modular system architecture with a single C6015 ultra-compact Industrial PC as the central control unit.

During the injection process, servomotor and worm gear provide a linear movement of the needle with appropriate torque. The motor characteristic curve and the gear ratio had to be optimally tuned to match space and torque requirements. Thanks to the in-house development and production of servomotors, Beckhoff was able to meet the special requirements of this injection process. A modified winding as well as the adaptation of shaft and flange ensure that the AM8122 servomotor delivers the required power without enlarging the form factor and enable the mechanical coupling to the worm gear. This also ensured the compact design of the solution as well as helped keep the known, proven type of gear in the configuration. In consequence, servo technology replaced the common hydraulics and pneumatics, eliminating the risk of product contamination from oil leaks and consequently avoiding scrap in production. In addition, the higher efficiency of the servomotor solution reduced energy requirements compared to conventional concepts.

Consistent and open control software

On the software side, Yudrive 2 also benefits from the Beckhoff PC based control philosophy, as Francisco Milhinhos confirms: "Yudo had already developed a flow simulation software for the entire injection process considering the solidification speed of the injected raw material and other process variables like pressure and temperature. This software could be seamlessly integrated into the new control architecture." As a result of software-based simulation, a recipe can be generated and then loaded onto the C6015 to be executed in TwinCAT 3.

With the start of the injection process, the mold valves are gradually opened and closed. The usage of TwinCAT 3 NC PTP Motion Control in combination with the dynamic and compact servo solution enables highly precise control of the valve gates. This results in increased process quality, cost savings and reduced material consumption by minimizing the occurrence of material run-offs, surface blemishes and part defects. TwinCAT 3 NC PTP also allows a change from position to torque control at runtime. In this way, the torque of the servo axis can be controlled during the opening and closing of the valve gate, which prevents the needle from being overloaded and thus increases the service life. The intelligent control approach improves on the one hand the product quality but also brings unprecedented flexibility to the end user. Yudrive 2 can be combined with a variety of molds to produce different parts because TwinCAT 3, which is at the heart of Yudrive 2, automatically detects the type of mold connected to the controller. And the adaptation of the injection process is then possible within the known workflow from simulation to recipe deployment and execution. The versatility of Yudrive 2 also leads to extensive standardization options, giving users investment security even for future products because the same control system can still be used in combination with new molds.

A common control platform further simplifies operation and maintenance as only one type of system needs to be maintained. Operators are supported by comprehensive diagnostic information. Diagnostic data is displayed via a responsive HTML5-based HMI developed by Yudo, which communicates with TwinCAT 3 via ADS. A remote access point is set up via a CU8210-D001 WLAN USB stick mounted outside the housing and protected by a CU8210-M001 IP66-rated cabinet dome from Beckhoff. This allows easy connection of mobile devices such as tablets on which the HMI is displayed in a browser. This provides the operator with a wide range of functions, such as manual loading of a recipe, testing the opening and closing of valves gates, and monitoring



A WLAN USB stick mounted in the CU8210-M001 IP66-rated cabinet dome facilitates remote access the system on site.

temperature, torque and motor position. As a result, the process transparency could be significantly improved, which further increases the quality of the products and the availability of the machine.

Conclusion

Francisco Milhinhos summarizes what has been achieved in terms of the numerous benefits: "Yudrive 2 has enabled us to position ourselves one step ahead of our competitors. This solution has brought to the market a new model of compact, robust and efficient electric drive that allows the customer to solve a number of problems that cannot be solved using conventional methods. All the requirements set have been met." As Yudo is a multinational company with several manufacturing centers for molds and hot runner systems, other markets should benefit from the innovative solution. For example, Yudrive 2 is currently being distributed to Yudo's facilities in China.

More information:

www.yudo.eu

www.bresimar.pt

www.beckhoff.com/plastic