TwinCAT 3 controls testing stations in oven and stove manufacturing

Miele: Best practices for control, safety and measuring technology

At a highly automated facility in Oelde, Germany, high end appliance manufacturer, Miele produces around 300,000 electric ovens and cookers per year, all of which are comprehensively tested before delivery. To this end, the corresponding manufacturing cells are equipped with semi- and fully-automatic testing stations. These stations benefit from integrated engineering and the close interaction of standard control, safety, and measurement technology, all powered by the TwinCAT 3 automation software suite.

The high quality Miele ovens and cookers are designed for the European and North American markets. Export share at Miele is over 70 percent, which is reflected in seven country-specific voltage versions and corresponding appliance tests. Maik Hartmann, a member of the industrial engineering dept. for electrical equipment at the Miele facility in Oelde, comments on the new manufacturing and testing concept, which was implemented in 2013: "Originally, the appliances were produced in an assembly line with several integrated and consecutive testing stations. With the goal of 'production cycles based on customer demand', the system was converted to production in U-shaped assembly cells, resulting in an extended variety of tasks for all staff, including appliance testing, and improved productivity overall."

Thorsten Nagel, also from the industrial engineering dept. for electrical equipment at the Miele facility, describes specific advantages: "With the previous three synchronized assembly lines, the cycle time of the conveyor belts was between one and three minutes, depending on the line and device type, which corresponded to the working cycle of a worker for each appliance. Now, the work comprises the complete assembly and testing of an appliance, which takes around 30 minutes and enhances job satisfaction for the workers. In addition, the changeover effort was quite high in the past, with associated cycle time losses and fluctuating staffing requirements, due to the high number of appliance variants (around 800) and the large variety of lot sizes between one and ten. With the new concept that offers a total of seven assembly cells, we were able to increase the volume and variant flexibility while reducing lead times. This means that any device can be manufactured any day, basically without the need to plan ahead, which enables us to respond much better to rapidly changing customer demand and short-term orders."

Assembly cells with fully and semi-automatic testing stations

Depending on the intended production capacity, each of the seven production cells has one or more semi-automatic testing stations – 17 in total. In addition, there are nine automatic stations in the conveying segments of the assembly

Function tests, protective conductor measurements and high-voltage tests are performed at the semi-automatic inspection stations using a guided test sequence.

In addition to the semi-automatic testing stations, the production process is monitored from the workstations, which are controlled via 19" multi-touch CP2219 built-in Panel PCs.

At a glance:

Solutions for testing station automation
Testing and automatic workstations in oven and cooker production

Customer benefits
Control, safety, and measurement technology with integrated software and hardware

Applied PC Control
- TwinCAT 3: Consistent engineering and runtime system, integrated into Visual Studio®
- TwinSAFE: Safety technology, seamlessly integrated within standard control technology
- EL34xx: EtherCAT power measurement terminals for integration of measurement functions
- EL6614: Ethernet switch port terminal for integration of TCP/IP-capable measuring devices and sensors
- CP3919, CP2219: Multi-touch Control Panels and Panel PCs for convenient operation

cells, which monitor the tests and the presence of "test content", forward the appliances to the central packing area and generate delivery notes, or divert them for repair if faults are found.

The actual functional testing, i.e. the statutory safety inspections, protective conductor measurements and high voltage tests, as well as numerous function tests, are carried out by a worker in the semi-automatic testing stations, based on a guided test sequence. Depending on the design of the around 1,000 appliances produced each day, the tests take between two and three minutes. Thanks to the underlying automation technology, all values can be logged in a central database.

Flexible and open control technology required

In order to integrate the test stations in the respective production environment, flexible and open control technology is required, just like in the previous production line environment. Maik Hartmann continues: "From the outset, we benefited from the Beckhoff Bus Terminal system, which enables us to implement a uniform and compact I/O architecture. An additional benefit is the openness regarding the different bus systems, so that it was also quite easy to operate the test stations in a CANopen or PROFIBUS environment." Thorsten Nagel agrees: "By leveraging the modular Bus Terminal technology, it is easy to log the numerous test signals and integrate them into the system. A key factor for efficient individual testing stations, particularly in the new assembly cells with their extended task requirements, is an error-free and comfortable dialogue with the tester. It therefore made sense to use not only the I/Os, but also PC-based control technology from Beckhoff."

According to the two Miele experts, these system benefits enable uniform, well-structured control hardware. Due to its high degree of flexibility, PC-based control can be extended easily to cover new testing requirements. EtherCAT offers particular advantages as a communication system that is not only extremely powerful, but also offers the choice of bus topology based on the individual

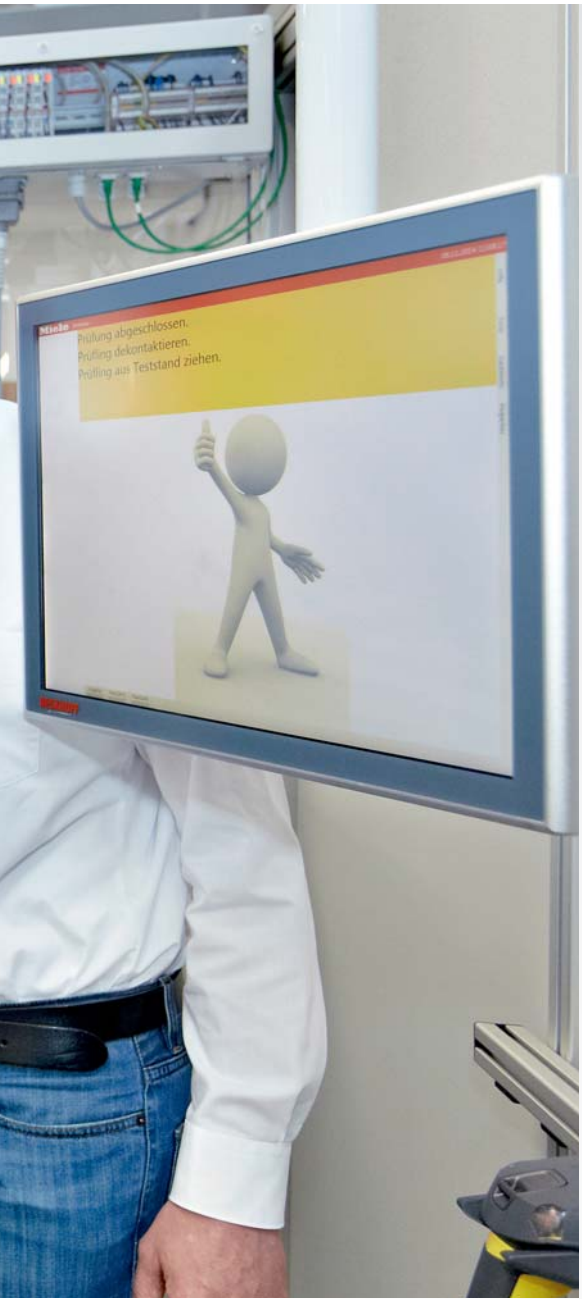
requirements. This is complemented by excellent diagnostic capabilities, which facilitate working from the development environment right into the fieldbus or I/O level.

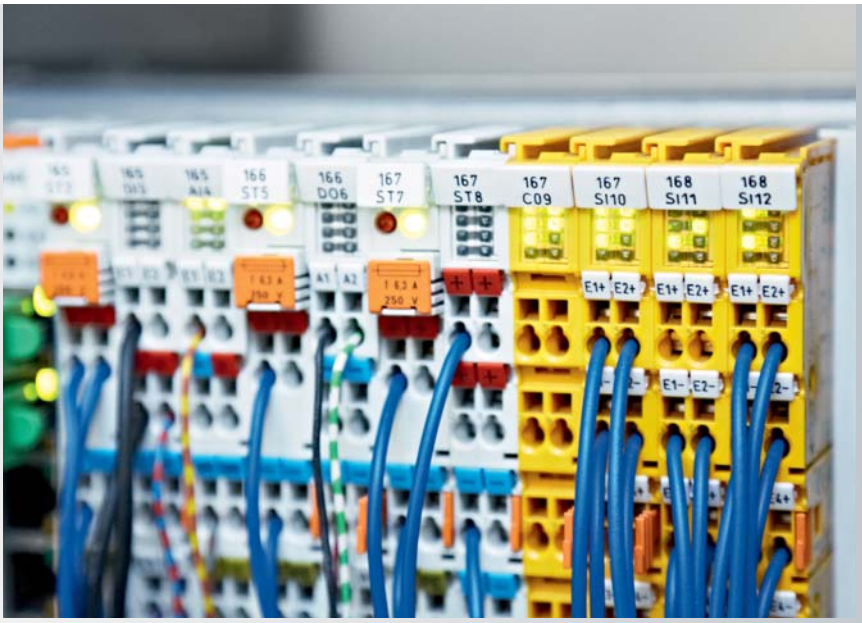
TwinCAT 3 as integrated and consistent software

With the transition to the new manufacturing and testing station concept, the new TwinCAT 3 software generation was introduced as the automation suite. According to Maik Hartmann, the biggest advantages of the platform include integration into the Visual Studio® engineering environment and integrated TwinSAFE safety functionality.

The given software structure of a testing station comprises the internally developed "Miele testing and workstation" (MPA), which provides visualization and data exchange with the ERP level. Additionally, the system reads the device-specific test sequences from the central production database, for example. As a subordinate system, which is linked to the MPA via ADS communication, TwinCAT 3 deals with traditional control tasks and I/O data processing. Particularly with respect to this overall architecture, TwinCAT 3 offers the decisive advantage, according to Thorsten Nagel: "Thanks to the full integration of TwinCAT in Visual Studio®, we can now work consistently in a single development environment. This makes project development much easier. In the past, we had to use a large number of tools – for different PLC generations, robot and safety controllers, as well as special real-time operating systems – which weren't even able to run on the same computer in some cases. An additional benefit was the straightforward and efficient nature of porting the existing TwinCAT 2 projects to TwinCAT 3."

According to Maik Hartmann, the seamless integration of safety technology is another important aspect relating to the use of TwinCAT: "The semi-automatic testing stations include a light curtain, emergency stop, and a door contact switch as safety elements. In addition, we have to meet the safety requirements of the Low-Voltage Directive, to ensure safe switching of the test voltages. All





Via TwinSAFE terminals, the safety technology also becomes an integrated part of the control technology for the testing station.

Maik Hartmann and Thorsten Nagel, from the industrial engineering dept. for electrical equipment at the Miele facility in Oelde, Germany (from left to right)

this can be configured in a unified engineering environment with the TwinSAFE Editor. TwinSAFE also results in a significant reduction in hardware requirements, because the previously required special safety systems, and the corresponding cabling and communication efforts are a thing of the past now that we use Safety over EtherCAT, the TwinSAFE EL6900 logic terminal and the TwinSAFE I/O terminals."

Control technology with advanced measurement functionality

The project design is further simplified with the direct integration of measurement technology into the control technology. The EL3403 three-phase power measurement terminals (up to 500 V AC) and EL3413 (up to 690 V AC) are used to check the function of the heating elements installed in the ovens as well as compliance with the power limit values. They are also used for high voltage tests. The EL3413 power measurement terminals, which are designed for up to 690 V AC, are also used to test the pin assignment of the 16-pin connector for the hob and the correct allocation of the energy regulators.

The openness of PC-based control technology has additional benefits: other measuring devices and sensors required for the appliance tests can also be integrated with little effort. Maik Hartmann notes that: "To avoid the need for additional interfaces or communication modules, we chose TCP/IP-capable devices – a high voltage meter and a hand-held scanner for the testing station and a bar code scanner for the automatic workstation. These can be integrated via the EL6614 Ethernet switch port terminal and supplied with the current parameter set via TCP/IP."

Further information:
www.miele.com
www.beckhoff.com/TwinCAT3