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SOLDERING CYCLE TIMES ALMOST HALVED

SMART AUTOMATION IN SELECTIVE SOLDERING

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The next generation of electronics manufacturing must be flexible and cost-efficient, even in manufacturing areas that have traditionally been dominated by manual processes. The only way to make this possible is via smart, scalable automation.

Siemens AG is among the pioneers of new manufacturing processes. In the modernization of the Siemens equipment manufacturing plant in Amberg, the project team had set itself ambitious goals – for the selective soldering process, these goals were achieved using a Seho SelectLine system.

The Siemens plant in Amberg is over 70 years old. It encompasses two large works, the Electronic Works Amberg with about 1,250 workers and the Equipment Works Amberg with about 1,700 workers, as well as development and service departments, high-performance test laboratories and switching test stations.

The Electrical Products Division is part of Siemens Smart Infrastructure and offers a comprehensive portfolio for electrical systems in buildings, infrastructure and industrial facilities – from switchgear to protection, switching and measuring equipment to industrial switching and control equipment to electrical installation equipment. "We offer our customers all products and technologies needed for an intelligent, electrical infrastructure that integrates seamlessly in networked, efficient and sustainable ecosystems," says Thomas Gubisch, Process Engineering at Siemens.

The electronic devices department at the equipment manufacturing plant in Amberg manufactures innovative electronic industrial switchgear for the global market. Even today, a competent planning and technology team applies value-stream optimization to plan all manufacturing processes at the optimal cost level. "The demands on the field of low-voltage switchgear are enormous," says Guenther Niebler of Process Engineering at Siemens Amberg. "The market expects cost-efficient solutions that easily integrate into switch cabinets or decentralized systems, and that harmonize and communicate perfectly with each other. Our Ergoflex products, motor starters and our monitoring and control devices give our customers a competitive edge." The flexible adjustment of production capacities to current customer demands makes it possible to satisfy customers' needs by delivering the desired quality within promised time frames. This is only possible if the manufacturing equipment is flexible, too, and delivers reliable process results.



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HIGH EXPECTATIONS FOR THE NEW MANUFACTURING LINE

The SelectLine from Seho is Siemens EA's latest milestone in the manufacturing of THT printed circuit boards. In addition to a greater, scalable level of automation as well as the continuous transparency and traceability of the process parameters, planning focussed on achieving great flexibility in the processing of the boards. The goal was to allow processing the printed circuit boards both with and without workpiece carriers. Another challenge was the cycle-time-optimized manufacturing of best-selling products in large volumes and of product variants up to batch size 1. Classic requirements for high-mix high-volume manufacturing, which in selective soldering, requires highly flexible machine equipment for a cost-efficient implementation.

"Even during the initial project discussions, it became clear that this would not be an 'off-the-shelf' system," says Alexander Blum, Product Manager at Seho.



Guenther Niebler, Thomas Gubisch and Martin Maier (from left to right) at the new SelectLine production line at Siemens Amberg source: Siemens AG

Seho's SelectLine uses a modular concept that provides extra flexibility and productivity. The system allows multiple modules of different sizes to be equipped individually with a variety of processing stations. This allows SelectLine to adjust to virtually all manufacturing requirements. If production conditions change, it can be easily expanded or re-configured, or individual modules can be moved to other lines. More than 15 parallel workstations can be integrated into a single system. "The entire project planning stage took more than a year, and we put a lot of time into designing the system as the best possible fit for Siemens' requirements. There were innumerable phone calls, meetings, soldering trials and of course quite a bit of development work," says Alexander Blum. He continues: "The cooperation with the Siemens team

was really exciting, and also very pleasant right from the start."

In order to optimally achieve Siemens' required cycle times, the SelectLine was fitted with a standard micro drop jet fluxer with two nozzle systems. This allows two different fluxes to be permanently available. Three pulsar pre-heating zones, four soldering units and one cooling station ensure the required board throughput.

In the soldering area, every two soldering units work in Synchro mode, an intelligent software tool that automatically coordinates the soldering process for multiple boards in a way that almost halves the cycle time.

In addition, the soldering areas are equipped with automatic ultrasonic cleaning systems for the solder

The modular SelectLine can be equipped with more than 15 parallel work stations. At Siemens Amberg, the system is designed for flexible high mix high volume production. Source: SEHO Systems GmbH



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nozzles. This process cleans the nozzles without the use of chemicals or other substances. Ultrasound-activated solder automatically removes residues of flux and oxide, and fully re-wets the nozzles while excluding the atmospheric oxygen. This provides the system with maximum process stability and also achieves higher system availability because interruptions of the production process are not required.

Solder balls and stuck-on solder residue on printed circuit boards are a critical phenomenon, which can occur in THT processes in spite of all precautions. The causes can vary widely, from issues related to the materials such as the PCB solder mask to suboptimal process settings. The production line therefore includes an additional process step, a selective brush system that automatically removes any substances adhering to the printed circuit boards immediately after the soldering process.



The automatic ultrasonic cleaning for wetted solder nozzles ensures a safe process and increases system availability. Source: SEHO Systems GmbH

The integration of another process step moves the company towards the goal of zero-defect manufacturing. Another workstation of the SelectLine is equipped with an AOI system designed specially for THT processes. In addition to selective, wave and reflow soldering systems and automation technology, the THT-AOI system PowerVision is another product line at SEHO with dedicated development, design and software teams. This guarantees the complete integration of the system and the test results into the hardware and software architecture of the soldering systems. The PowerVision AOI system checks solder joints for typical defects such as insufficient wetting, bridges or missing wire leads even before the printed circuit boards exit the system.

The additional process steps built into the soldering system are performed in parallel for different boards and so do not affect the cycle time of the overall system. The benefits are obvious: stable processes

and high quality of the manufactured products on the one hand and reduced production costs on the other hand thanks to minimal floor space requirements.

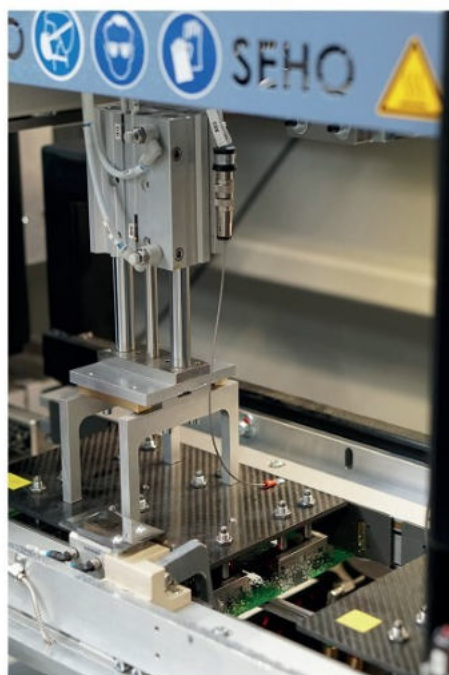
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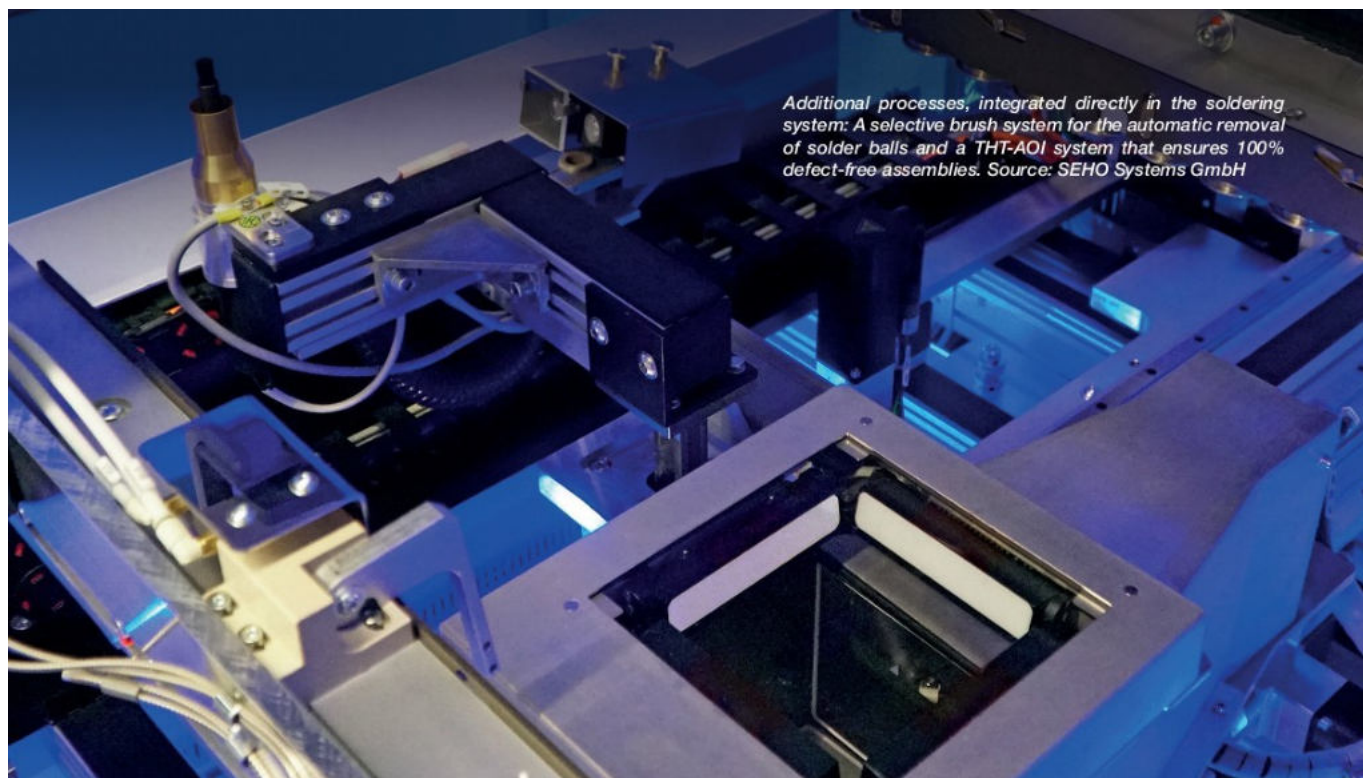
Says Thomas Herz, Technical Director of Selective Soldering at Seho: "The modular design of the SelectLine provides a wide range of configuration possibilities and thus optimal adaptability for specific manufacturing requirements. Still, some modifications both of the hardware and software were necessary in order to fulfil all of Siemens EA's requirements." These requirements included the actual products that would be manufactured. "The challenge of the ergoFlex products is in the positioning and soldering of upright add-on PCBs as well as the soldering of large-volume, temperature-critical components," says Guenther Niebler. Another tricky requirement was the processing of the boards without the use of workpiece carriers, and the fact that some of the horizontal PCBs had a thickness of only 1 mm, so that sagging was an important consideration for this project.

In order to handle the highly unusual solder joints – pads that need to be joined in the connection fillet of the PCBs – Seho developed a special, wettable solder nozzle. "This nozzle technology includes an anti-twist device but is still compatible with the standard solder nozzles and can be combined with them," says Thomas Herz.

In order to guarantee the process-stable position accuracy required for selective soldering, in particular for the upright add-on boards, a special hold-down system combined with a centre support was developed and integrated into the soldering areas of the

In order to process the demanding assemblies reliably, automatic hold-down systems and a central support were integrated into the soldering areas of the SelectLine. Source: SEHO Systems GmbH





Additional processes, integrated directly in the soldering system: A selective brush system for the automatic removal of solder balls and a THT-AOI system that ensures 100% defect-free assemblies. Source: SEHO Systems GmbH

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SelectLine manufacturing line. It supports the boards during the soldering process from below while at the same time, the hold-down system holds and positions them accurately from above. The tilt value of <0.123 mm or 0.5° required by Siemens was tested as part of a PFMEA (process failure mode and effects analysis), which the machine passed with flying colours. "In order to guarantee quick set-up times and the required flexibility of the system, both the centre support and the hold-downs are easily exchangeable. At the same time, they have extreme positioning accuracy and use electric encoding for the automated prevention of collisions with other products," says Thomas Herz.

TRANSPARENT AND SMART

A controlled and stable process is the basis for an automated manufacturing workflow and at the same time, ensures the expected high product quality. To this end, sensors and software tools monitor all work steps: From flux volume monitoring to the pyrometer measurements that ensure compliance with the specified pre-heating temperatures, to the solder area with automatic nitrogen flow rate control to the automatic nozzle measurement and touchless wave height control. Last but not least, the fully automated solder joint inspection via the built-in AOI system, for which additional artificial intelligence is planned for the next project.

"With a view to automation in this manufacturing area, we found it was of the utmost importance to have end-to-end process traceability including all relevant soldering parameters at the printed circuit board level and the assignment of the workpiece carriers to the product," says Martin Maier, Process Engineering at Siemens. He adds: "The SelectLine system implements

this perfectly." This is against the background of integrating automated guided vehicles with the new production line so that the complete flow of materials is coordinated with the greatest efficiency. Smart assistance systems (smart watches) ensure smooth workflows; the fact that all systems connect to the MES achieves complete transparency and constant traceability of all processes and workflows.

"We particularly appreciate SelectLine's compact, space-saving system design as well as the integration of the additional process steps – a seamless solution from a single source. In spite of the high production volumes, the complete manufacturing line measures only 9.2 metres in length, and that includes the connected loading and unloading transport systems," says Guenther Niebler. "Seho provided highly competent project management and all-round support during the entire design and implementation stage and also afterwards when there were still details to be optimized. Today, the manufacturing line works in 3 shifts, 5 days a week," adds Martin Maier.

CONCLUSION

Automation will continue to be a major topic in electronics manufacturing over the coming years, and it will also be required in areas that traditionally have not been prepared for it, such as THT component placement.

For the modernization of the Siemens EA manufacturing plant, the SelectLine system modules were designed to allow largely unmanned production in the future, preparing the manufacturing plant perfectly for new production tasks.

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