

Limtronik GmbH – Automated X-ray inspection 4.0 in a Smart Factory environment

Introduction

If you want to be well placed for the future, you have to live a digital and connected life. This applies to virtually all sectors in the professional environment but it plays a central role in the electronics industry. The machinery is without doubt an important resource. They must be able to think for themselves and optimise processes. Yet the people behind the machines are important too. Without them, the factories would fall silent. That's why it's vital that the systems are easy to operate. The use of an automated X-ray inspection system by GÖPEL electronic in Limtronik Smart Factory demonstrates how intelligent machines can be operated in a simple way to take make good use of this interconnectedness.

Production at Limtronik GmbH

Limtronik GmbH is an EMS (Electronics Manufacturing Service) provider based in Limburg, Germany. The company specialises in the manufacture of electronic assemblies to customer specifications. As a Joint Development Manufacturing (JDM) partner, Limtronik offers its customers advice and support at every stage—from product development right through to the finished, ready-to-deliver product. The pillars supporting this production are a total of three SMD assembly lines, one of which is a prototyping line. The two main lines are each equipped with powerful pick-and-place machines, which handle a wide range of components thanks to up to 10 feeder modules. The two lines are each equipped with an SPI (Solder Paste Inspection) system upstream of the soldering furnace and AOI (Automatic Optical Inspection) downstream of the soldering process. As is typical amongst EMS providers, product diversity varies greatly: Individual assemblies and prototypes are every bit as much a part of day-to-day business as high-volume production runs. The complexity of the assemblies is vastly different, too.

Assembly testing and quality assurance using automated X-ray

Outstanding quality is vital to be able to survive the fierce competition between contract manufacturers. Customers from the security technology, automotive and medical technology sectors require almost 100% test coverage. Thanks to inspection systems in the assembly line and electrical testing in the test bay (in-circuit test, function test and JTAG/Boundary Scan), Limtronik is well positioned. In order to check the quality of solder joints, especially in BGAs and QFNs, a Göpel electronic AXI system (Automatic X-ray Inspection) was purchased in 2010.

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This X-ray system—called X · Line 3D, Series 100 —was at the time one of the first systems to enable full-surface 3D X-ray imaging within the cycle time. After several years in continuous operation, it was replaced by a new model from the Series 300.



Fig. 1: Verification station for viewing detected faults: BGA with void

The X · Line 3D is operated as a separate stand-alone solution in addition to the SMD production to enable flexible inspection of the products from all three SMD lines. Whether or not each individual assembly in a production run is tested is down to individual customer requirements. Even if X-ray inspection is not required, spot samples from each production run are nevertheless tested in the X · Line 3D for verification purposes. X-ray inspection focuses on non-visible solder joints (BGA, QFN, LGA, THT), and solder joints that are critical for AOI are also tested using AXI. The X · Line 3D makes a 100% solder-joint check possible. Face-to-face assemblies are common, that is assemblies in which BGAs are populated congruently on both the top and underside. Reliable quality control is only possible with 3D X-ray. Superpositions of BGA and SMD capacitors likewise pose a major challenge, since they have a high density and complicate the evaluation of the X-ray images. However, layered reconstruction of the solder joints offered by X · Line 3D also provides reliable analysis. This is all done in a very short time: a 4-way panel of an assembly with multiple BGAs and a size of 216 mm x 164 mm, for example, needs on average just 26 seconds for the full 3D X-ray inspection (see assembly in the overview image on the X-ray system in Figure 2).

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Fig. 2: Andreas Türk from GÖPEL electronic (left) with Limtronik AOI/AXI Technician Manuel Sehr at the X-Line 3D

Software and smart operation

It is not just adhering to cycle times that is important in production. A low level of programming complexity and simple operation are valued in particular by contract manufacturers with frequently changing assemblies with varying lot sizes. Thanks to a complete offline programming concept with the programming software PILOT AXI, test programs can be created and optimised remotely. A test procedure wizard guides the user through creating the program, from importing the CAD data to debugging the test program.

The tuning wizard helps with quick parametrisation of the test functions. The machine software PILOT Inspect makes handling the X-ray system even more convenient for the operator. The app-style touch-control operating concept clearly displays the most important information and allows even new operators to get to grips with the system quickly thanks to integrated information messages, images and videos. The inspection system can also be controlled and operated remotely using a tablet. Manuel Sehr, AOI/AXI Technician at Limtronik, is impressed: 'Even at my workstation in the office, I have all the information that I would otherwise only have at the machine itself. I can monitor and control the system, thus enabling me to avoid downtimes and diagnose problems remotely. I can even chat with the system operator from the comfort of my office. It may sound trivial, but it helps clear up questions and problems quickly.'

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Fig. 3: Monitoring and controlling the X-ray system from a tablet

The machine software PILOT Inspect also communicates with the Göpel electronic software PILOT Connect. This enables connection to the customer MES system. This is particularly significant, especially at Limtronik.

Limtronik Smart Factory

The terms 'Industry 4.0' and 'Smart Factory' have been circulating for many years in the electronics industry. There is barely a company in existence that doesn't adorn itself with these particular feathers. Whereas in some quarters it is only applied to machine labelling, Limtronik is one of the most cutting-edge EMS companies in the country and is a pioneer of smart manufacturing. Concrete implementation is based on the interconnectedness of all elements and on creating added value by leveraging useful information from a large data pool. Gerd Ohl, Director at Limtronik, refers to it as 'turning big data into smart data'. It's not simply a matter of collecting data, then—it's more about data mining. This is understood to mean using statistical methods to obtain empirical relationships from a database—in other words, recognising patterns and trends and prompting machines to take action as required. A project such as this is implemented in collaboration with partners from research and IT fields. All the data—from the assembly process or the manufacturing execution system (MES), for example—is relayed to the project partners, validated and verified. The X·Line 3D also plays its role in this. In addition to the full results of an inspection, machine statuses and operating times are also relayed. Among other things, this is intended to enable better planning and integration of future maintenance cycles.

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Fig. 4: Gerd Ohl, Director at Limtronik GmbH

At Limtronik, the aim of data mining is to discover factors which influence subsequent manufacturing results. For example, relationships can be established between solder paste application, the soldering process and any defects subsequently found in the X-ray system, so that the processes can then be adapted. In the long term, this leads to a reduction both in the pseudo fault rate and in the number of rejects due to faulty components. In addition to this vertical connectivity in the smart factory, Gerd Ohl also sees horizontal connectivity as a forward-looking concept. 'We want to involve our customers more and provide them with more data upstream.' In concrete terms, preprocessed data can be used to accelerate bid processes and the customer can be provided with a virtual simulation of the assembly in advance, for example. New product lines should be up and running even faster thanks to much more efficient creation of test programs. This is also supported by the AXI system from GÖPEL electronic, since it supports the latest ODB++ standard and loads panels which are already fully preconfigured into the programming software. 'In the EMS environment, the customer rents the factory for a period of time. Data mining allows operating costs to be reduced, and these cost savings are in turn passed on to the customer,' the price to the customer,' says Ohl, explaining the situation.

Summary and conclusion

GÖPEL electronic and Limtronik are together pushing two approaches: an inspection system as the X · Line 3D must be highly efficient when it comes to fault detection and speed and must at the same time be easy to operate. On the other hand, it must also be integrated in the interconnected factory like a link in a chain. 3D X-ray technology allows production-line inspection to be carried out within the cycle time. And even though Gerd Ohl admits 'we are data collectors', simply collecting data is not enough if you want to implement Industry 4.0 wisely. That's why Limtronik relies on data mining and

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works in close cooperation with its partners to allow it to offer its customers an advantage through smart manufacturing.

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