

Find every error, layer by layer: inspecting BGA and QFN packages using 3D X-ray

Abaco Manufacturing Services (AMS) – formerly known as Foundation Technology, and part of the embedded systems business of GE Intelligent Platforms - is a British EMS provider and part of Abaco Systems, whose business is the development of rugged embedded computing subsystems for deployment in the harshest environments. As well as manufacturing for its parent company, AMS has long served external organisations looking to leverage its expertise – customers, for example, from the world of Formula 1 motor racing or from the NASA space program have joined over time. Since the start of production in 1990, AMS has focused on highly complex products in the low-volume/high-mix field. Batch sizes ranging from 1 to 500 pieces are developed and produced, primarily for customers in the industrial, military, avionics, and automotive industries. Applications in these areas often require complicated layouts on the smallest surfaces. For example, BGAs are populated congruently on the top and underside of the assemblies (known as face-to-face assembly). Package-on-package components and incredibly small component sizes such as 01005 can also be found. Since the EMS provider supplies the ultimate in quality and reliability according to customer requirements, the standards it exacts of its own quality assurance are correspondingly high. An in-line 3D X-ray inspection system from GÖPEL electronic was ultimately chosen for the inspection of complex assemblies.

Facilities in manufacturing

At the economically strategically located headquarters in Milton Keynes, assemblies are produced on a total of four production lines. The high component complexity of some assemblies requires up to five pick-and-place machines on each production line, because the feeders must supply a large number of different components. There are numerous soldering systems available for various tasks, with reflow ovens in different temperature zones and selective soldering units. Dry storage ensures large solder joints are dried, especially when processing ICs. Extensive and continuous investments ensure technical equipment in electronics manufacturing that is always completely up to date, whilst complying with all environmental standards.

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The importance of quality assurance

The focus on the highest quality standards has made AMS a preferred EMS supplier in high-performance applications. The high levels of quality are achieved through continuous development and the involvement of all employees. These high standards are implemented throughout the entire production and support cycle. "As a result of the standards relating to the high quality of our products, we fundamentally have a marginal error rate," explains Iain Small, Engineering Manager at Abaco Manufacturing Services. "Our processes are subject to continuous optimisation in order to achieve the best possible level of quality and consistent reliability on a long-term basis." This involves using all visual inspection technologies and electrical tests. With solder paste inspection, AOI, boundary scanning, and flying probe tests, virtually every imaginable error has to date been scrutinised. However, the biggest challenge—posed by a particularly complex assembly—called for deeper insights.

Automatic 3D X-ray inspection

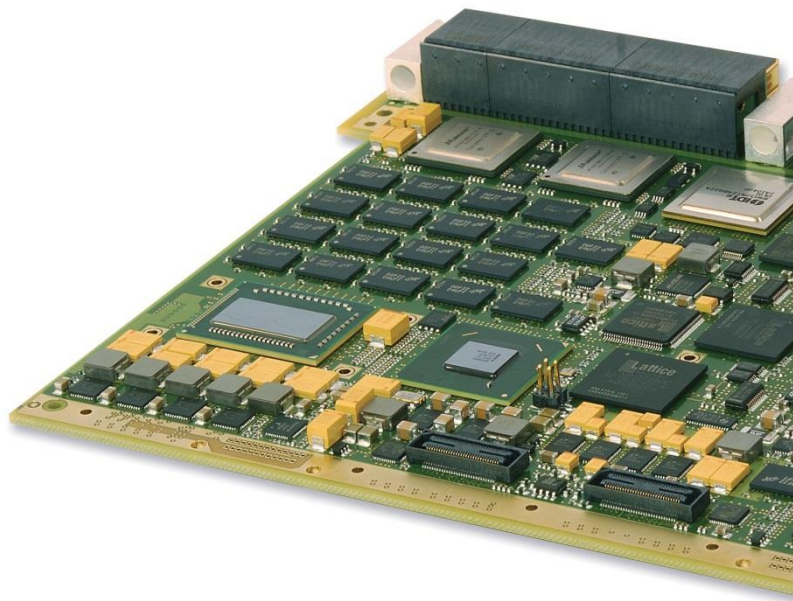


Figure 1 – An example of an assembly with numerous BGAs

A highly complex 28-multilayer assembly has a module positioned on its top side, which is in turn populated on both sides with BGAs. On the underside of the assembly there are a total of 10 BGAs, some of which are provided with a shield plate. A purely visual inspection is not productive here. "Previously, we used a manual 2.5D X-ray system for special cases. The many superimposed BGAs and the 5-mm-thick PCB pushed this system to its limits when it

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came to the quality assessment of concealed solder joints. Only a true 3D X-ray inspection was therefore an option for solving the problem.” The market for automatic in-line 3D X-ray systems is small. In the selection process, the X-Line 3D from GÖPEL electronic ultimately came out on top when pitted against the competition, because it was able to deliver steady, consistent and reliable results.



Figure 2 – X Line 3D X-ray inspection system in production (source: Foundation Technology)

At AMS, the line system is used as a standalone solution and as such fits perfectly into the production process. The main function of the X-ray inspection is that of checking QFN and BGA components. The solder joints of BGAs stacked on top of one another can be inspected for air pockets based on digital tomosynthesis and planarGT. For some assemblies, AMS sets a maximum air pocket content of 5%—far less than stipulated by the IPC-A-610 standard.

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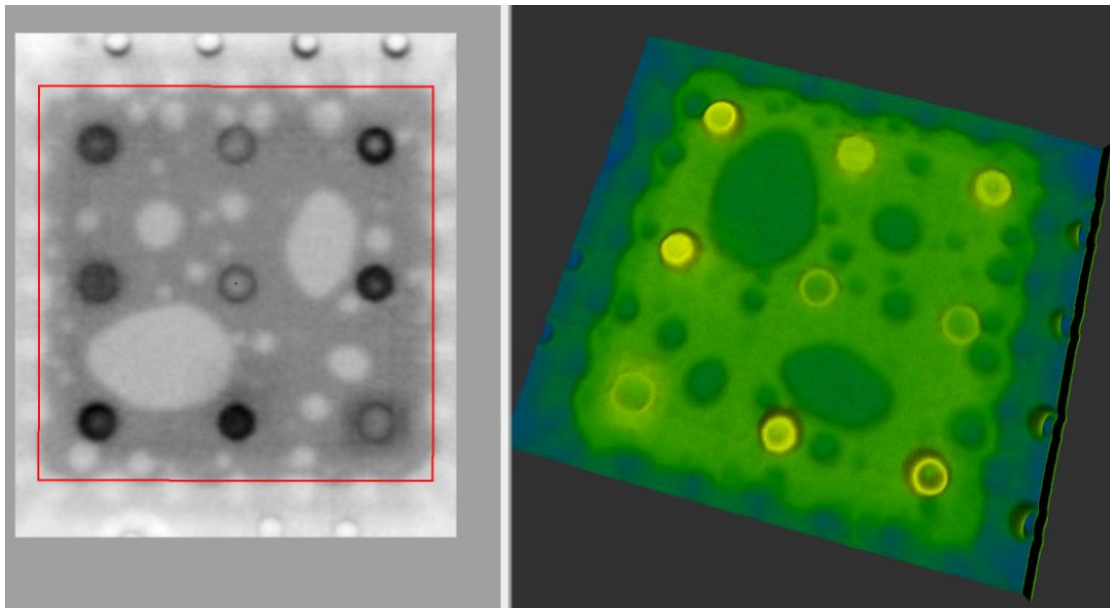


Figure 3: Automatic detection of air pockets – Foundation technology allows just 5%

These guidelines are intended to ensure maximum quality. The X-Line 3D X-ray detector allows full 3D-recording of both sides of the assembly in a very short time. The integrated reconstruction method, combined with clear visualisation in 3D or in individual layers, provides optimum error detection. The layered reconstruction of components and solder joints in an assembly is carried out in the production cycle. Special attention in the selection of an X-ray system was given to operability. "With small batch sizes and product variants which change frequently, it is important to keep programming complexity to a minimum. The X-Line 3D allows us to use simple and reproducible test programs and is therefore both cost-effective and time-efficient. The systems supplied by other providers required too much time for programming and test-program debugging for our purposes," reveals Iain Small.

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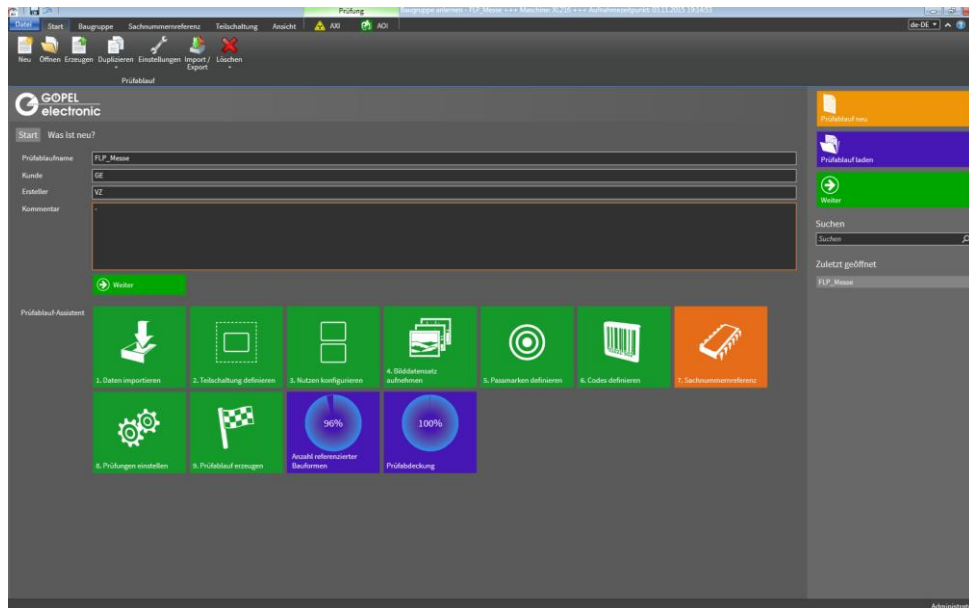


Figure 4: Home screen of PILOT AXI with inspection process wizard

The system software PILOT AXI supports the rapid creation of test programs based on CAD data using a library that includes predefined test algorithms and classifiers for all common designs. The library can be augmented as desired and can therefore be adapted to the changeable production requirements and to future designs.

The right choice

Abaco Manufacturing Services is very pleased with the technical performance of X-Line 3D, as Iain Small observes. What is more, however, there are no regrets about choosing GÖPEL electronic as the supplier because the package as a whole is right: "The technical expertise of GÖPEL electronic staff was impressive. First and foremost, it was important to us that we have a direct point of contact here in England. Our requests are processed quickly by the staff in the UK branch, without having to go through a distributor. Unfortunately, these days that's not something that comes as standard. So we're all the more satisfied with our choice."

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