Glenbrook Technologies Inc.
X-RAY TECHNOLOGY LIKE NO OTHER

X-ray Inspection Verifies Quality of Complex PCBs

By Kathryn Cramer

"Some of our high-end customers use AQC for the most complex boards," says Harold de Gruyter, operations manager of AQC B.V., a PCB supplier located in Helmond, The Netherlands. The firm, founded in 2014, specializes in helping assemblers around the world develop the increasingly complex boards needed for today's advanced products. From two-layer up to multi-layer boards with as many as 80 layers, hybrid boards using different base materials, high-density interconnect (HDI) boards, flex and flex-rigid PCBs without cable assemblies, as well as boards with blind, buried or stacked vias.

As the industry-wide drive towards miniaturization, coupled with the need to pack more functionality into a smaller footprint, has grown, so has the need for these more complex types of PCBs, "but designers need education to design them. It requires a new way of thinking," explains Erwin Lemmens, one of AQC's owners. With more than thirty years of experience in PCB development among its senior staff, the company welcomes customers looking for new solutions to complex issues.

Figure 1. From its base in Helmond, The Netherlands, AQC B.V. provides highly complex PCBs to customers worldwide, relying on a Jewel Box T100 real-time X-ray inspection system provided by Glenbrook Technologies of Randolph, New Jersey, USA, to ensure quality.

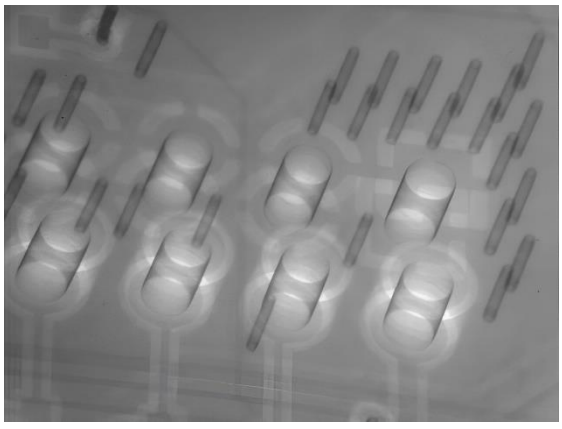


Figure 2. PTH and via integrity is inspected under real-time X-ray for the presence of barrel crack, plating voids and plating. Also, with operator experience, plating thickness can be determined to a certain degree.

"They always come with challenging questions or items never made before," Lemmens states. Among the solutions that AQC provides are multi-layer boards of at least three and sometimes as many as 80 copper layers, which provide increased functionality in a more compact space, reduce trace width and support dense micro-BGA assembly. Multi-layer boards that include different base materials, known as hybrid boards, are also available, as are aluminum boards that dissipate heat away from certain sensitive areas or components. HDI boards allow more components to be placed on both sides of the PCB, reducing power consumption

and improving signal transmission within a smaller package. In all these types of advanced boards, the vias may be blind, buried or stacked, adding to the complexity of manufacturing them.

One of the fastest-growing segments of challenging, advanced PCBs are flex and flex-rigid boards. “Not many companies are making them,” Lemmens notes, “but more and more companies are asking for them. We can provide the education, recommend materials and thicknesses.”

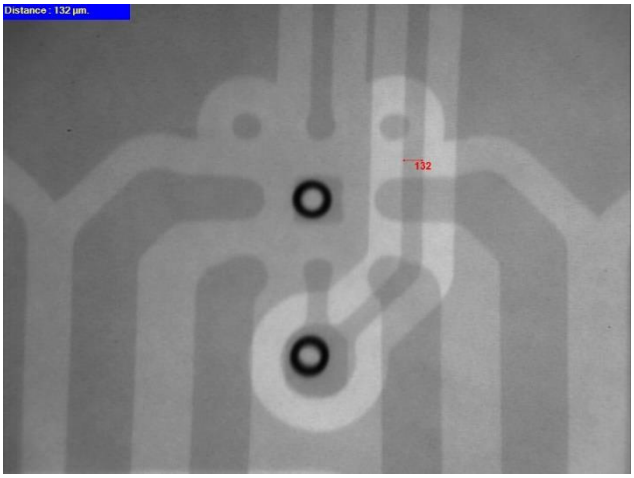


Figure 3. Conductors on an inner layer can be measured with an accuracy of +-10 µm with a minimum of 75 µm. Inner layer conductors are analyzed on average width and local reductions.

In comparison with standard cables, flex boards provide a thin and lightweight, but highly reliable, heat-resistant, strong connection in a limited space. With no cable assembly required, the chance of connection errors is eliminated. When weight is a critical issue, a flex board can be the right solution, as in one project that Henk Mathijssen, AQC’s quality manager, explains. In this case the flex PCB was installed in a bird tracker, a device that monitors bird migration. The entire product could not weigh more than 10 grams, hence the need for a lightweight flex board.

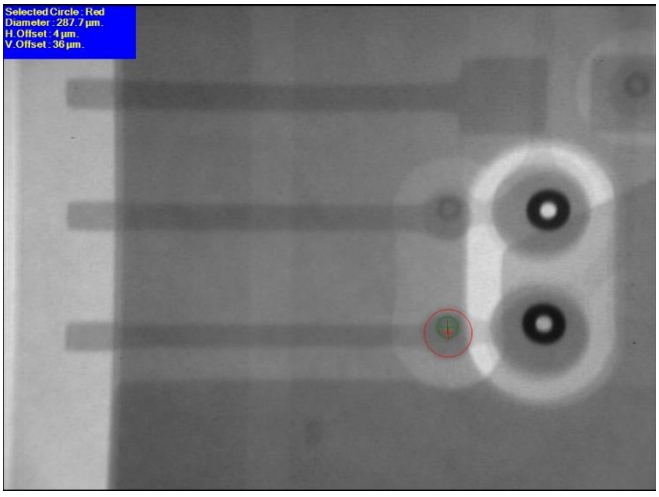


Figure 4. Micro via laser drilling is analyzed on the registration toward the landing area of the inner layer and possible break-out.

When flex PCBs are combined with rigid PCBs, the result is known as a flex-rigid or FR board, “the most reliable connection you can have,” says Lemmens. In the highly complex products used in medical, military, electronic assembly or aerospace applications, “If you have multiple wires and connections, each point is an assembly that can break. With FR, everything is pressed and laminated, so you have a really strong and reliable product.” One AQC customer using FR boards is a manufacturer of electronic assembly machines that cost more than €100 million each and are expected to run 24/7. Because any breakdown costs “tens of thousands per hour, they cannot take any risk on reliability,” he states.

Among other applications for which AQC has supplied flex-rigid boards are an impedance control being used in a Dutch university project at CERN, the world’s largest particle physics laboratory, in Switzerland. “They wanted the right figures to start with, the right materials from the beginning,” Mathijssen says. “They didn’t want to have to discard

boards; that costs money. For us, it was normal work" to meet this customers' specifications. A satellite for the European aerospace consortium also carries AQC-supplied flex-rigid boards as it orbits the earth. And sometimes, he admits, "we don't know where the end use is."

Producing FR boards is challenging, de Gruyter notes. "You are working with two totally different materials," he explains. The flex part may be polyamide and the rigid part FR4. Registration, or stretch, can present a problem. This is a lamination process, so you put all the layers on top of each other and put them in a press, but the different types of materials behave differently, which means they will shift, they can stretch or shrink, and registration can be difficult to predict." Boards must also adhere to different standards: IPC-6012 for rigid boards and IPC-6013 for flex-rigid boards.

To ensure the quality of all these complex PCBs, AQC relies on real-time x-ray inspection. "We can see that the inner layers meet both customer and IPC specifications, that registration is correct, that there is no breakout. We can verify it all with X-ray," de Gruyter says. "The only other option is cross-section, but that destroys the board and it takes two to three hours, which costs money. With X-ray, you put the product in the machine and see it immediately. You can easily check many boards. And customers get a good feeling when they know all their boards are checked."

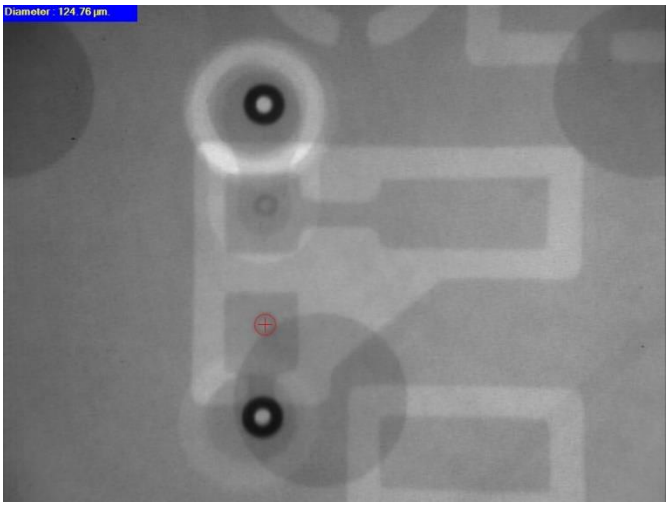
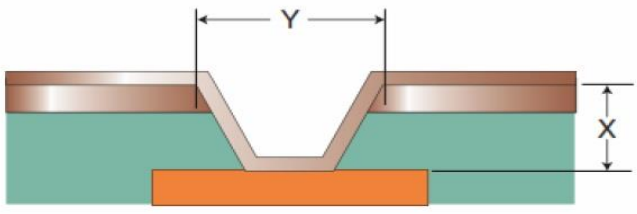


Figure 5. The micro via drill diameter is measured to verify the aspect ratio between drilling diameter and drilling depth (the laser depth is a known factor which must agree with the specified stack-up, as shown in the diagram below).

In addition to verifying production, real-time X-ray inspection is a valuable troubleshooting tool. "If a customer has developed a product and issues arise," Mathijssen explains, "we can use X-ray to find out the real root cause, where there may be weak points in the design." He adds that "customers often point to the PCB first as causing a problem. X-ray can help us prove that it may actually be the process or the component that is the problem." Interpreting an X-ray image and analyzing the issue at hand requires experience, since several factors and phenomena must be taken in account.

The real-time X-ray inspection system that AQC uses is a JewelBox-100T provided by Glenbrook Technologies of Randolph, New Jersey USA. Mathijssen has used Glenbrook



Note: X/Y = Microvia Aspect Ratio, with X=Y 1:1

systems extensively, first at another PCB manufacturer, then at a solder paste manufacturer, before joining the company recently. “I knew what the machine was capable of, and its footprint and flexibility,” he says. “I knew it would be a nice tool for us to upgrade our lab.” Since the system’s installation on October 9, 2023, he adds, it has been in use almost every day.

The JewelBox-100T features a high-voltage, 100 KV X-ray tube and a five- to seven-micron focal spot, giving it the capability to penetrate more dense metal packages. Normal copper boards weigh up to 75 µm, but heavy copper boards used in electronic and automobile applications can weigh as much as or more than 500 µm, requiring higher voltage penetration to inspect. “We’re investing in the future,” says Lemmens, “since we need more power to inspect products such as aluminum boards with BGA components. We also expect to provide AQC customers with the service of inspecting their assembled boards, checking the solder joints.”

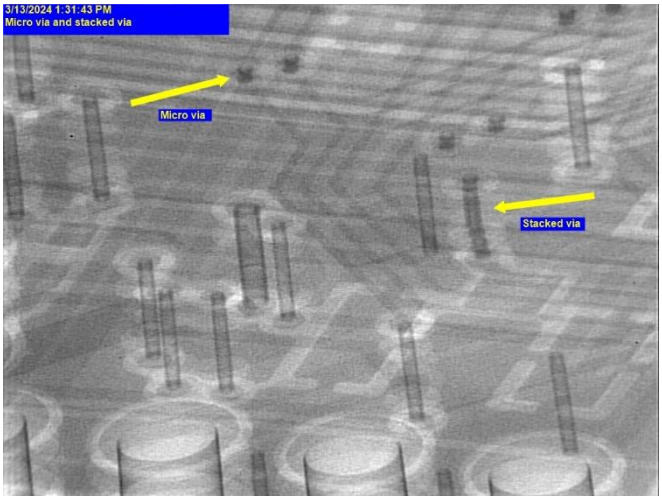


Figure 6. Real-time X-ray inspection verifies the specified stack-up regarding buried and stacked vias.

Delivering services from initial design consultation through all stages of production is a hallmark of AQC’s business philosophy. From its base in The Netherlands, and with a team of highly skilled engineers, AQC draws on tec partners located around the globe. Qualifying and then continually auditing those production partners is another area where real-time X-ray inspection is proving to be a valuable tool for maintaining the high quality of AQC’s output. Although the company is relatively small, it has a strong, dedicated team, enabling it to “behave as a multi-national,” Lemmens says.

Contacts:
AQC B.V., Zuiddijk 5, 5705 CS Helmond, The Netherlands; T: +31 088-0045500; info@aqcbv.com.

Glenbrook Technologies, Inc., 11 Emery Avenue, Randolph, NJ 07869; T: 973-361-8866; fax: 973-361-9286; www.glenbrooktech.com.