

Automatic Optical Inspection for Checking HF Printed Circuit Boards



Case Study

Quality assurance in the SMT process

Automatic optical inspection for checking HF printed circuit boards

In the series production of electronic assemblies, optimization of the manufacturing and inspection processes is desirable. The ever-increasing price pressure and heightened quality requirements in electronics manufacturing increase the demand for cost reduction, process optimization, short cycle times and traceability. For manufacturers of small to medium quantities in particular, cost is not the only primary criteria when it comes to selecting an AOI system. They also place special value in time-optimized product change, ease of programming and economy of operation. These reasons also played an important role when Sennheiser electronic GmbH & Co. KG made their AOI decision.

Sennheiser: Trendsetter in the electro-acoustics industry

First class products and tailor-made complete solutions in all areas of recording, transmission and reproduction of sound – something the name Sennheiser has stood for 60 years. The history of the company began in 1945 with the founding of the “Laboratium Wennebostel” by Professor Fritz Sennheiser. Today, Sennheiser products are firmly established amongst the world’s top names in audio technology. This medium-sized company has around 1,600 employees – of which 60 per cent work in Germany – and its headquarters are in the Wedemark, near Hanover. Sennheiser has four production facilities in Germany, Ireland and the USA. With a world-wide network of subsidiary sales companies and contract partners of many years standing, the company operates hand-in-hand with its customers and always has its “ear on the market“. This technological edge enables Sennheiser to maintain a major research and development division in Germany, as well as an R&D office in California. The on-going development of technologies in acoustics and electronics creates innovative products, with the help of which Sennheiser is able to further extend its position as a global player and unceasingly confirms its leading role as a trendsetter in the electro-acoustics industry. In 2004, the Sennheiser Group achieved a turn-over of 262 million Euros. Profit doubled to 13.6 million Euros.

The second German production facility in Burgdorf is the home of the greater part of Sennheiser’s HF production (High-Frequency manufacturing). It is here that the automatic assembly of printed circuit boards and the assembling of electronic equipment takes place. These are primarily wireless microphones and, as an additional pro-

duct range, conference and information systems. The characteristics of Sennheiser printed circuit boards can best be described as follows: They have a very high packing density, are manufactured in many different sizes and quantities and – an unusual feature, especially as regards the inspection task – they often have one or more HF shielding covers. Altogether, Sennheiser in Burgdorf produces approximately 270 different types of printed circuit boards, with about 330 different components, on two SMT production lines.



Inspection objects f.l.t.r.: Wireless hearing aid set 810, wireless microphone SK 5012, headset HMEC 300, conference system SDC 3000 D

AOI for process optimization

In its corporate philosophy, Sennheiser places a great deal of value in quality, since it is only in this way that it is possible to further improve its excellent position on the world market. In order to justify this claim even more, Sennheiser decided to have an AOI system installed on the electronic assembly production line.

In this particular case, the AOI system had to fulfil the following criteria:

- Reliable fault finding
- Early fault finding
- Reliable defect recognition even at high packing densities and ever smaller component sizes, such as 0402, or the forthcoming 0201 components
- Supply data for product and process optimization
- Reproducibility and repeatability of the inspection which, because of the small components is only possible to a limited degree by purely manual means

In order to properly fulfil these requirements, the following was required of the AOI system:

- Low (if possible, “zero”) missed defects with as low a pseudo defect rate as possible
- Inspection of HF printed circuit boards with shielding frame and associated mounting bracket
- Also capable of being used for future processing of 0201 components
- Supply data for statistical analysis and immediate process optimization



SMD manufacturing at Sennheiser in Burgdorf

The decision in Viscom's favour was arrived at during a series of trials conducted in the year 2002, during the course which AOI systems from different manufacturers were compared on the basis of the above-mentioned criteria. The evaluation was carried out on a selected assembly on a receiver. The special challenge for the AOI system on the one hand, was the HF frame for the subsequent assembling of the HF shield, which partially covered the orthogonal view of the components and their solder joints and, on the other hand, the high density packing. It is not possible to completely inspect these assemblies using a purely orthogonal view. Only the use of inclined sensor units resulted in an adequate inspection view of the printed circuit board. The outcome of the trials showed that the results of manual process control by three people differed widely, a situation which improved considerably with the AOI system.

On this basis, the AOI system was able to prove its worth very convincingly only a short time after it had been installed, and since it also proved to be of great help in process control, it was also quickly accepted in production. One of the most important things required of the AOI was rapid feedback for the line processes. This is possible due to the early detection of faults – especially with paste print and solders joint quality. It was thus easier to optimize the processes and defect rates were successfully reduced. Overall, this led to a considerable reduction in costs in the production cycle. To quote Dr. Petra Hildebrandt, Production Systems Test with Sennheiser: “Using the AOI system, we try to catch as many faults as possible, because every fault detected using the AOI system saves us a lot of money. This is because we no

longer have to look for these faults in the function test. And since we now locate the faults earlier, this means the rapid feedback to the line is secured.”

Today, around 80 per cent of the assembled printed circuit boards are being inspected by a Viscom S6055 system, and also a lot of internal customers – such as the production facilities in the USA and Ireland – in the meantime make an AOI inspection a pre-requisite. Sennheiser currently has series runs of about 40 product changes per week and line, which means the AOI system, has 16 product changes each day. Most batch sizes thereby are relatively small. In the meanwhile, there are roughly 430 AOI programs at Sennheiser, some of which are variations. According to Ulrich Anke, SMD Assembly at Sennheiser: “Whereas initially, due to the special inspection tasks, program creation took quite a lot of time, it now only takes about three to four hours (including specialized inspection tasks!). Because of statistical process control, the line defect rate is now less than 100 dpm.”

The AOI system is now so well integrated into the line that even printed circuit boards from the other production line can be manually fed in – this means that the system is capable of being utilized flexibly, resulting in optimum usage.

In addition to the orthogonal camera view, Sennheiser generally also inspects its products using the angled camera view. This is not only because the objects to be inspected are mostly HF assemblies with HF frames and shielding, but also because only in this way is it possible to inspect even the smallest chips reliably for tombstoning and co-planarity. The angled inspection technique is also of immense advantage when it comes to the inspection of QFP

and other fine-pitch components, as for instance in the detection of hair-fine bridges in the rear areas of the connection pins, and in cases of co-planarity, and thereby clearly increasing the inspection depth.

The Sennheiser Group has a total of three assembly lines – two of them are in Burgdorf, and one is



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in Albuquerque, New Mexico (USA). In each of these production facilities, automatic optical inspection is performed by a Viscom S6055 system. Following the installation of an S6055-II in the Albuquerque facility in the October of 2004, which at the same time was expanded and transformed into a mirror-image of the Burgdorf plant, it is now possible for these two locations to exchange information concerning inspections. At the present time, both the systems in Burgdorf and the USA are operating on the basis of a uniform inspection library. They have been accordingly calibrated, which also means that inspection programs can be transferred from one location to the other.

A glance at the future

Sennheiser has also set itself certain future goals. In the case of printed circuit board design for example, AOI inspection has been allowed for by making AOI data or their results available via a CAQ system. Since, in future, 0201 components are also to be utilized, the replacement or expansion of current AOI sensor units with a standard resolution of approximately 20µm/pixel with a high-resolution sensor system with a resolution of 10µm/pixel is planned. This makes it possible to reliably inspect 0201 components and their solder joints. But Dr. Petra Hildebrandt even looks forward to these changes with confidence.

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