THT production – old principle, new quality!

THT production and the search for the optimum production and inspection strategy

Foreword

If one considers the diversity of all electronic assemblies, one thing is clear: Despite constant miniaturisation and increasing integration density, THT components are still present on a significant number of assemblies. The answer to the question of ensuring the manufacturing quality of these components seems all the more strange, however. Traditionally, visual inspections are carried out either manually or not at all. Both approaches are no longer acceptable in today's quality standards. This fact is all the more serious because THT assemblies are still used in sensitive areas – particularly in the area of power electronics.

The use of THT in the solar industry

These assemblies are indispensable in many fields, including the solar industry. Here, for example, inverters are produced using THT technology. Put simply, these inverters convert the direct current coming from the solar modules into alternating current that can be fed into the grid. Because such inverters are in some cases used in very remote areas and replacement is time-consuming and expensive, smooth operation must be ensured.
At SMA Solar Technology AG, the world's leading manufacturers of inverters, a very high value is placed on the quality of the assemblies even at the assembly and soldering stage, which is why the automatic optical inspection (AOI) test method is used. In principle, there are two different approaches to the AOI of THT assemblies:
In the first approach, the fully pre-fabricated assembly is inspected after the soldering process. Both the solder joints and the components are checked to ensure they are present and in the correct location. It is extremely important for the manufacturing process that the assemblies can be inspected on both sides without extra handling. Faulty assemblies are removed and reworked at a separate workstation.

The second option is to test in two steps. The components are first of all inspected immediately after manual assembly, i.e. before soldering. Any faults that may arise, such as missing or incorrect components or components with reverse polarity, can be corrected immediately without the need for any tools. Only after this check are the assemblies fed to the soldering process and their solder joints inspected subsequently.

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As a rule, the THT boards are assembled at several manual workstations, which results in various options for organising the visual inspection. The most obvious is a central check of the components immediately before soldering.

Image 1: Cellular manufacturing with THT-Line AOI system

All assemblies from the manual assembly stations are brought together on the main conveyor belt and inspected there immediately upstream of the wave soldering unit. All faulty assemblies are discharged at this point and reworked. A major advantage of this strategy is that only one visual inspection system is necessary for all assembly workstations. Disadvantages are, firstly, that an additional repair workstation must be set up and staffed for the necessary reworking and, secondly, that there is no direct feedback between detected faults and their originator. Although any moments of inattention during assembly can be safely identified and eliminated, they occur repeatedly since the originator of these faults is not responsible for eliminating them.

After soldering, the solder joints of the assemblies are inspected and the abnormalities identified are classified at another station. There is no time for direct repair at this point, because the buffer size is limited and the workpiece carriers are required to further assembly.

The assemblies are removed from the workpiece carriers following classification and fed to the next stage in the process. The faulty assemblies are repaired at one or more separate stations.

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AOI for THT – what are the advantages?

To significantly shorten this control loop, which exists only to a limited extent, a visual inspection system can be installed after each manual assembly station. The advantages are obvious: Immediately after assembly, the assemblies are fed manually into the AOI system and checked accordingly. Faulty assemblies do not make it to the central conveyor belt but are instead removed from the process and reworked immediately at the relevant workstation. Only once the AOI system indicates that there are no more abnormalities is the assembly taken out of the device and fed to the main conveyor belt.

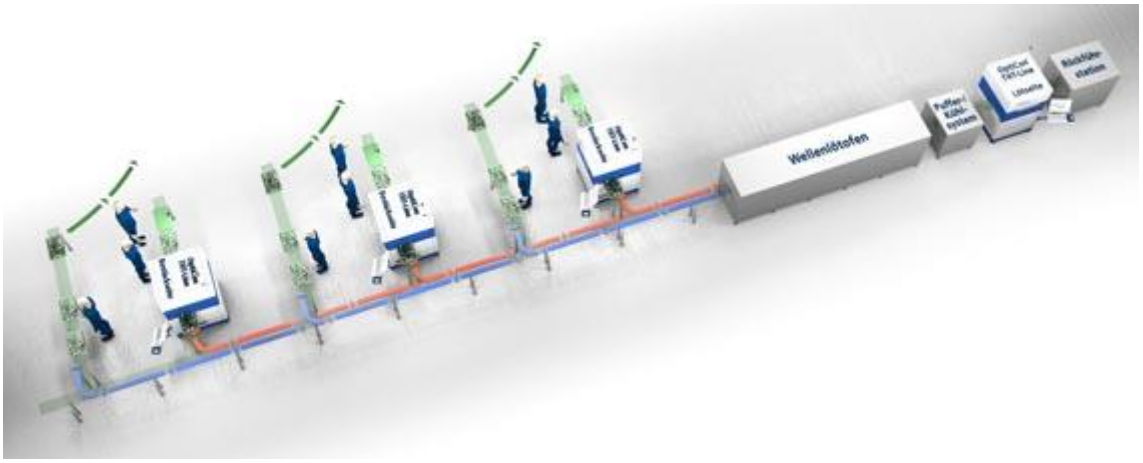

Image 2: Diagram showing cellular manufacturing at SMA Technology

This ensures an extremely short control loop during assembly. The member of staff at the manual assembly station therefore has the option of being notified of any faulty assembly. This results in a significant perspective reduction in the fault rate and thus the necessary – if also short – time for reworking. This makes it impossible for series faults to creep in.

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Image 3: Diagram of assembly and reworking station

After the soldering process and subsequent solder joint inspection, the workpiece carriers together with assemblies are transported back beneath the production line and are assigned to the manual assembly stations with the help of RFIDs (radio frequency identification) on the workpiece carriers. At the classification/repair stations located there, the serial numbers of the assemblies are scanned and the corresponding data records from the fault database are displayed. This allows classification and, where appropriate, immediate repair of the faults.

Classification of fault data using serial numbers

How is fault data assigned to the serial numbers in the last two variants then? One option is to integrate a barcode reader in each optical inspection device. A more elegant solution is to use the camera which is already in the system. However, since labels and application of labels to the assemblies on this scale is expensive, they are normal affixed to only one side – on the assembly side.

So how can an AOI system detect the correct serial numbers? The option of using an external scanner has the disadvantage that reading multiple serial numbers on one assembly is impossible without immense effort (moving the scanner in the x- and y-direction).

The solution to the problem is to cache all the serial numbers between the assembly-side AOIs and the solder-joint AOIs.

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In the majority of cases, THT assemblies are transported in workpiece carriers. These carriers are furnished with unique numbers on RFID tags or separate barcodes. These small, increasingly widely-used "radio helpers" are used in THT production to adjust the soldering systems to different solder profiles according to the assembly. This is necessary because THT production usually does not produce items accurately sorted, as in an SMD line. The individual assemblies can sometimes vary greatly, meaning that a different soldering profile can also be required to ensure the highest possible soldering quality.
The serial number is read with the camera, which checks the assembly sides (upper side of the assemblies) and the RFID is read using a reader. The workpiece carrier ID is then stored in a database, together with the read serial numbers for the assembly. The camera for inspecting the solder-joint side (underside of the assemblies) likewise reads the RFID and retrieves the corresponding serial numbers from the database. Optionally, the workpiece carrier can of course also be identified using a barcode label affixed to it.

Furnished with the correct serial numbers, the data records can be accessed at the relevant classification and repair stations. To ensure full traceability of the assemblies, at each station the inspection data of an assembly – furnished with the correct serial number – is sent to a higher-level MES-system.

Everyday practice

AOI systems by GÖPEL electronic have been used successfully for a number of years in production at SMA Solar Technology for the quality control variants in the THT production process which are illustrated here. Due to the various configuration variants in this system family, they have been optimally adapted to the relevant production process. It can therefore be concluded that the use of AOI systems in the THT process on the one hand represents an important component in the quality control of products, but on the other hand requires flexible integration of these systems with the specific manufacturing conditions. AOI systems from GÖPEL electronic guarantee both.

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