See what you've been missing

Automatic Optical Inspection, the Cost of Ownership From DCB Automation

Introduction

Manual Inspection
Manual inspection is both slow and unreliable and becomes more unreliable through the working day and progressively more difficult the smaller the component and the higher the density of components placed. Experience also suggests that estimates of manual inspection times are usually very much underestimated and vary markedly between inspectors. Interruptions during manual inspection may also result in either missing faults or repeating the inspection process from the beginning. When a change of boards occurs new documentation may be required and the inspectors will have to familiarise themselves with the requirements for that new board.

Solder quality introduces an additional area of uncertainty as acceptance or otherwise of the soldered joints are very subjective; one inspector's perception of a good soldered joint may differ markedly from that of another inspector.

Automatic Inspection
Automatic optical inspection will overcome the problems associated with manual inspection. The system should give repeatable performance with similar inspection times for similar boards from "switch on" to the end of the working day without the need for breaks during that period and un-affected by interruptions.

There are several aspects to be taken into account when working out the costings associated with automatic optical inspection including the type of inspection, programming, 1st off inspection and production inspection.

The software developed by DCB Automation offers alternative methods of inspection dependant on the number of boards to be inspected, the frequency of inspection and the type of inspection required.

General Automatic Inspection

We will consider inspection of those boards that already have inspection programs developed. To perform inspection on a batch of boards it will be necessary to adjust the board supports to the required position for the boards and select the necessary inspection program. Inspection can now be carried out. At the end of each inspection a fault report is generated. The faults can be either reviewed at the inspection machine, printed out on a local printer and rework carried out later or down loaded to a remote work station using off line software. We provide as standard an Off-Line package

with security dongle. By performing rework at an off line station, the inspection machine is then available for further inspection.

Where boards are assembled in panel format the inspection program can be set to inspect the complete panel or omit circuits on that panel that have not been loaded. By inspecting in panels the overall unit inspection time will be reduced at least by the saving of only loading one panel as opposed to loading several boards.
There are also alternative options in the inspection of double sided boards, by inspecting all of one side and then inspecting the second side or by inspecting both sides of the board with the system automatically changing inspection programs as required.

Boards can either be identified by manually entering a batch and board number or by the use of bar codes. Both one and two dimensional bar codes can be automatically read, (this is an extra on EasyVision). This technique is particularly useful for cartridge fed systems.

In-Line Operation (only available on UltraVision)
UltraVision can be supplied on a conveyor that can be incorporated into a surface mount assembly line, or retro fitted on site from a bench top system into an in-line facility. This illuminates the need for an inspector to perform these duties.

Cartridge Feeding (only available on Ultravision)
Ultravision can be mounted on a Cartridge Feeder which will allow up to 50 boards to be automatically inspected. This will allow the person responsible for inspection to perform other duties.

Timings
Automatic inspection is a fast process that offers reliability and repeatability. Typically a board fitted with 300 components would take 10 to 20 seconds. Loading and unloading the board into the inspection system may take a further 15 seconds.

Program Generation

Both placement and component data is required for the production of an inspection program. We would normally recommend the use of prime data, which is produced when the printed circuit board is initially designed. As an alternative, loading data from a placement machine can be used but one must be aware that if an error is made when loading the component placer this will be transferred to the inspection machine.

It is difficult to give definitive timings on program generation. This is largely dependent on the type of board, the number of different components on the board and the inspector's knowledge of the system. Library functions are available which will significantly reduce programming time. Libraries can be either customer specific or global or a combination of both so that as components are added

from previous boards, they can be used when required on new boards. If the majority of the components used on a board are available from a library, programming can be completed quickly by using an auto-programming facility within the software package.

Facilities are also included to import Gerber data, enabling pad sizes to be automatically set for solder inspection (this is an extra on EasyVision).

For the majority of those components that are not currently available from a library there are a set of programming icons that facilitate the rapid building of inspection routines for those components.

A further consideration when programming is the use of the laser (this is an extra on EasyVision).There are 2 modes of operation, a simple co-planarity surface check to ensure IC's (for example BGA's) are flat to the board, and an IC leg check ensuring there are no lifted leads that have not been identified with certainty by vision inspection. The later facility can either be forced by the programmer to inspect all leads on an IC or allow the software to determine the need for inspection

1st off Inspection

There are two types of first off inspection, the first 1st off inspection and subsequent 1st off inspections for each new batch of boards manufactured. A considerable amount of time can be saved when completing the first 1st of inspection. The board to be verified is imaged. A parts list and layout data is then loaded and aligned with the board layout. After imaging the board, the 1st off inspection can be carried out off-line thus leaving the inspection system available for other work, (an off line package is included as a standard feature on both EasyVision and UltraVision).

Each component loaded on the board is identified by cross hairs on the monitor screen, by moving the mouse pointer towards the cross hairs a component identifier and description is shown. The identified component is either accepted or reject. At the end of the verification process a report is generated detailing any faults.

If an inspection program is then generated for this series of boards then it will never be necessary to perform a 1st off inspection again, the first board of a new batch can be inspected in the normal manner. Both the reduction in the time for 1st off inspection and later batch manufacturing can have significant effects on production line utilisation.

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Timings

From information supplied by users of our inspection systems one can expect to reduce 1st off inspection of a new board by at least 2/3rd. The 1st off inspection of a new batch of similar boards will only take a few seconds. This will ensure there is a minimum delay if other equipment within the manufacturing process is being held for confirmation of the 1st off.

Hand Assembled Prototypes and Small Build Assemblies

A useful spin off from 1st off inspection is the ability to use the inspection machine to assist in the assembly of prototypes and low volume board manufacture where hand placement techniques are being employed. By imaging a bare board and aligning the component data to the board, the inspection machine can be used to locate the positions of components quickly and confirm their value. This means that time is not wasted in locating the positions of components and looking up parts lists to determine their value. Facilities are included in the software to order the components by value so that all similar components can be laid down together. This process can also be performed off line after the board is imaged leaving the inspection machine available for other work

Comparator Mode

This is an ideal solution for the inspection of small quantities of boards that are infrequently manufactured. A known good board “golden board” is required and all other boards are compared to it. The golden board is first imaged by the inspection system and stored as the master board. This master will always be available for future production runs of this board. If placement data is available this can be loaded and aligned with the components on the board. Alternatively, component identification can be entered manually.

A matrix of images will now be created from the golden board, which is used for comparison between this board and the board under inspection. The board under inspection is loaded into the inspection machine and the inspection process can begin. Individual images from the master board are compared with a similar image from the board under test by switching between the images. The switching rate can be adjusted to a frequency that best suits the operator. Any discrepancies between the images will show as a flickering effect, which can be tagged with a description of the fault. If component data has not been added then a dimensioned position will be stored against that particular fault. Each individual image is processed sequentially under the control of the systems computer. Should there be a break in the inspection process, on resuming; the last image inspected will be presented to the operator. Areas not requiring inspection can be masked and areas requiring special attention can be highlighted.

While this type of inspection is essentially a manual function, by controlling the inspection sequence, presenting small areas for viewing and a simple reporting facility, there will be significant reductions in inspection times and the detecting of faults compared with conventional manual inspection processes. At the end of the inspection process a printout is available for later reworking. This can either be in the form of a file that could be accessed by an off line work station or a printer built in to the inspection machine; (This is an extra on EasyVision).

Timings

The time to inspect each frame will be dependent on its complexity. For an experienced inspector a frame showing mainly conventional components would take between 2 to 3 seconds. A frame heavily

loaded with surface mount components may take between 5 to 6 seconds. Inspection speeds can be increased by ensuring all components have the same orientation. The only other timing to take into account is the loading and unloading of the board from the inspection machine.

Manufacturing Data and Inspection Data Retrieval

One major advantage in using automatic inspection is that all information and data associated with a particular board is available from 1 source and can be instantly retrieved. Likewise a complete history of inspection data can be generated and is always available. However backup procedures must be considered at an early stage as board programming and inspection generate large files of information.

Timing Reviews

The information given below is a guide to the likely times based on our knowledge and experiences of customers.

Automatic Inspection
We have run a board of dimensions 130mm X 170mm with in excess of 600 components of approximately 40 different types in 29 seconds excluding loading and unloading time. A reasonably competent person should be able to program this board in under 2 hours.

1st off Inspection
To perform a 1st off inspection it is necessary to compare a parts list against the loaded components. This can be a very slow manual process particularly for more complex boards where there can often an issue in manually locating the component on the board. Using the inspection machine and combining both the parts list with placement information the time involved is significantly reduced. We performed a 1st off inspection on a board of approximately 300 components in 25 minutes. Once a 1st off has been performed on a new range of boards there will never be a need to repeat the procedure again. When that particular board is again manufactured, the first board built can be inspected using the inspection program, thus ensuring a minimum of down time for the manufacturing line.

Comparator Inspection
For a mixed technology board with approximately 200 components, and size 160mm X 165mm the time for manual inspection would be approximately 5 to 6 minutes. Using comparator inspection this

would be reduced to approximately 3 minutes. If all the components had the same orientation this would be further reduced.

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