High Speed Three-Dimension Inspection of Low Pin Count Integrated Circuit Packages

The present invention relates generally to a method of, and an apparatus for, inspecting features of low pin count integrated circuit packages, and in particular, the lead geometry of such packages.

Background of the Invention

High speed production of low pin count integrated circuit packages such as SOT23 (Small Outline Transistor) and SC59 are usually handled by rotary indexed machines. These integrated circuit devices usually have 3 to 8 leads distributed on two opposite sides of the package. The device is held from the top surface by a pick up head on the rotary indexed machine using vacuum suction. Each lead is indexed through different stations for different processes such as trimming, forming, electrical test and marking. The devices are then transferred to a tape and reel for bulk packaging; this is known as the taping process. It is usually required to inspect the geometry of these devices during the production process for process and quality control.

The prior art of inspecting low pin count integrated circuit packages handled by rotary indexed machines mainly adopts the implied measurement method in which only a single view of the device is acquired and analysed. The single view is most often taken from the top of the device at the taping station. The top viewing method infers defects such as curled leads and non-coplanar leads from the length of the leads. The implied measurement method, however, is grossly inaccurate due to poor sensitivity. Only when a particular lead is distorted by a very significant amount, is this implied measurement method effective. On the other hand, if strict tolerance is imposed, the method results in a very high false rejection rate.

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Summary of the Invention

In a first aspect, the present invention provides a method of inspecting the geometry of leads of a low pin count integrated circuit device, the method including the steps of:

obtaining first and second substantially orthogonal views of the integrated circuit device; and

evaluating the geometry of the integrated circuit device from said first and second views.

In a second aspect, the present invention provides an apparatus for inspecting the geometry of leads of a low pin count integrated circuit device, the apparatus including:

viewing means for obtaining first and second orthogonal views of the integrated circuit device; and

storage means for storing the first and second views to enable the evaluation of the geometry of the integrated circuit device from said first and second views.

In a preferred embodiment of this invention, the two orthogonal views are captured by a single camera, which is preferably a video, without obstructing the travel path of the devices. Preferably the views are obtained simultaneously and stored on a single image. Preferably the two orthogonal views consist of an end view and a bottom view of the low pin count integrated circuit package. The low pin count integrated circuit is hereinafter called the device. Preferably the image acquired by the single camera includes the end view and the bottom view, and the end view is preferably aligned above the bottom view in the image.

Preferably reflecting means are provided to enable the camera to obtain the first and second views simultaneously. Preferably, the first image is obtained directly by the camera whereas the second image is obtained via the reflective means. Preferably, the reflective means is in the form of a reflecting surface, such as a

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mirror, which is mounted below the device and at substantially 45 degrees to the top/bottom surface of the device. Preferably a substantially telecentric lens is attached to the video camera positioned substantially perpendicular to the pick up head. The viewing means views the end surface of the low pin count device directly and the bottom surface of the device indirectly from the reflecting surface. Due to the substantial telecentricity of the lens, the two orthogonal views appear in focus in the image acquired by the video source. Preferably the apparatus uses front lighting to illuminate the leads and the outline of the device under inspection.

The image which includes the two orthogonal views acquired by the video source is further sent to a image processing device such as frame grabber for image processing and computation. The processing device includes information which is compared to the image of the first and second views in evaluating the geometry of the circuit device. The end view of the image provides information on the height of the leads. Defects such as curled leads, non-coplanarity of leads, burrs and incomplete form can be inspected from the end view. The bottom view of the image provides information on pitch, width and length of the leads. Defects such as bent, smashed or broken leads can be inspected from the bottom view. The relative position between the lead and the package can also be computed from the bottom view. This embodiment of the present invention hence acquires and computes all the information required to measure and inspect the 3D geometry of a device mounted on a pickup head without obstructing its path of travel.

Brief Description of the Accompanying Drawings

Fig. 1 is a schematic illustration of the viewing means of the present invention.

Fig. 2 illustrates the placement of the invention in relation to the rotary indexed machine.

Fig. 3 shows two orthogonal views acquired by the present invention within a single image.

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Fig. 4 shows curled and burred leads as revealed by the end view.

Fig. 5 shows bent, broken and smashed leads as revealed by the bottom view.

Detailed Description of a Preferred Embodiment of the Invention

Referring to Fig. 1, the apparatus includes a reflecting surface 14 mounted below the device 17 and at substantially 45 degrees to the bottom surface of the device 17. A viewing means 9 includes a substantially telecentric lens 11 attached to a video source 10 positioned substantially perpendicular to the pick-up head 16. The viewing means 9 views the end of the low pin count device 17 directly along the line of sight 21 to form the end view 41. At the same time, the viewing means 9 views the bottom of the device 17 indirectly along the line of sight 22 via the reflecting surface 14 to form the bottom view 42. The end view 41 and the bottom view 42 form a pair of substantially orthogonal views. Due to the substantial telecentricity of the lens 11, the two orthogonal views 41 and 42 appear in focus in the image acquired by the video source 10. A CCD camera is typically employed as the video source 10. The apparatus uses front lighting sources 12 and 13 to illuminate the leads 18 and the package outline of the device 17. The viewing means 9, the reflecting surface 14 and the light sources 12 & 13 are desirably housed in a common casing 1.

With reference to Fig. 2, the present invention is mainly used in conjunction with a rotary indexed machine 30 in which the devices 17 are transported in a circular path 5 by pick-up heads 16. The rotary indexed machine 30 has some number N of pick-up heads 16 and some number M of processing stations 19 for the purpose of, for example, forming, marking and testing. N is generally larger than M. Each of the pick up heads 16 will pick up one device 17 at a time from the different stations surrounding the rotary indexed machine 30. All the pick-up heads 16 will be moved in a synchronous motion. In other words, all the pick-up heads 16 will be indexed by a certain degree and then stop for a certain time for

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processing. The indexing and stopping for processing will enable a device 17 to be processed by all the stations associated with the rotary indexed machine 30. The present invention may therefore be positioned as one of the stations of the rotary indexed machine 30. The present invention does not come into contact with the device 17 and hence, the path 5 of the device 17 attached to the pick-up head 16 will not be obstructed during operation.

Referring now to Figs. 3, 4 and 5 of the drawings, when a device 17 is indexed to the apparatus of the present invention, orthogonal views 41 and 42 of the device can be acquired by the video source 10. The end view 41 acquired by the apparatus of the present invention allows defects such as burred 51, non-coplanar 52, curled 53 and under-formed 54 leads to be detected with ease. These defects may not be detected by viewing the device 17 from the top or the bottom. On the other hand, defects such as bent 61, smashed 62, broken/shortened 63 and oversized 64 leads may only be detected by viewing the device 17 from either the bottom or from the top. In this embodiment of the present invention, these defects are detected by the bottom view 42. The combination of viewing the device 17 from both the end 21 and the bottom 22 therefore enables almost all defects to be inspected. The present invention is most effective when dealing with integrated circuits having less than 8 leads.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the construction and arrangements of the parts previously described without departing from the spirit or ambit of this invention.

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Claim set 1 (Singapore, Malaysia and Switzerland)

The claims:

1. A method of inspecting the geometry of leads of a low pin count integrated circuit device, the method including the steps of:

obtaining first and second substantially orthogonal views of the integrated circuit device; and

evaluating the geometry of the integrated circuit device from said first and second views.

2. A method as claimed in claim 1 wherein the first and second views are obtained substantially simultaneously.

3. A method as claimed in either claim 1 or 2, wherein the first and second views comprise a view of an end of the integrated circuit device and a view of the bottom of the integrated circuit device respectively.

4. A method as claimed in any one of the preceding claims, further including the steps of:

transmitting said first and second views to image processing means having a memory containing information; and wherein said evaluating step includes said processing means comparing said information with said first and second views.

5. A method as claimed in any preceding claim, wherein the first and second views are stored in a single image, and wherein in said evaluating step, the geometry of the integrated circuit is evaluated from said image.

6. A method as claimed in claim 5, wherein the first and second views are arranged adjacent one another in said image.

7. A method as claimed in any one of the preceding claims further including using a camera to obtain the first and second views.

8. A method as claimed in claim 7, further including using reflecting means to enable said camera to obtain said first and second views simultaneously, the camera including a telecentric lens and being arranged to obtain the first view directly and to obtain the second view via the reflective means.

9. A method as claimed in any one of the preceding claims further including the step of illuminating the integrated circuit device whilst obtaining said first and second views.

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10. A method as claimed in any one of the preceding claims wherein the first and second views are obtained in a process station of a high speed rotary index machine, and wherein the first and second views are obtained without obstructing the path of travel of the machine or the integrated circuit device.

11. An apparatus for inspecting the geometry of leads of a low pin count integrated circuit device, the apparatus including:

viewing means for obtaining first and second orthogonal views of the integrated circuit device; and

storage means for storing the first and second views to enable the evaluation of the geometry of the integrated circuit device from said first and second views.

12. An apparatus as claimed in claim 11 wherein the first and second views comprise a view of an end of the integrated circuit device and a view of the bottom of the integrated circuit device respectively.

13. An apparatus as claimed in either claim 11 or 12, wherein the storage means is operable to store the first and second views in a single image.

14. An apparatus as claimed in claim 13 wherein the first and second views are adjacent one another in said image.

15. An apparatus as claimed in any one of claims 11 to 14, wherein the viewing means is adapted to obtain the first and second views simultaneously.

16. An apparatus as claimed in any one of claims 11 to 15 wherein the first and second views stored by the storage means are adapted to be transmitted to image processing means having a memory containing said information, and wherein the geometry of the circuit device is evaluated by comparing said information with said first and second views.

17. An apparatus as claimed in any one of claims 11 to 16 wherein the storage means forms part of a camera operable to store said first and second views.

18. An apparatus as claimed in claim 17 wherein the viewing means includes reflective means operable with said camera to obtain and store said first and second views simultaneously whereby said camera includes a telecentric lens and which is adapted to receive and store the first view directly and is adapted to receive and store the second view via the reflective means.

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19. An apparatus as claimed in any one of claims 11 to 18 further including illumination means operable to illuminate the integrated circuit device whilst said viewing means obtains said first and second views.

20. An apparatus as claimed in any one of claims 11 to 19, wherein the apparatus is adapted to form a process station of a high speed rotary index machine producing low pin count integrated circuit devices.

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