Description

Method and apparatus for orientation/position identification and/or coplanarity testing and/or separation testing of connections of components

The invention relates to a method and an apparatus for orientation/position identification and/or testing the coplanarity and/or separation of connections of components.

When SMD components (SMD = Surface Mounted Device) are being fitted automatically to printed circuit boards or ceramic substrates, the individual components are removed from a magazine or a feed device by means of a placement head, and are then positioned in a predetermined orientation/position on the printed circuit board or the ceramic substrate. Since the components in the magazine or in the pick-up position of a feed device are subject to an orientation/position tolerance of a few millimeters, but must be positioned with high accuracy on the printed circuit board or the ceramic substrate, automatic orientation/position identification and correction are required. Furthermore, particularly in the case of SMD components having a large number of poles, it is necessary to check the separation and the coplanarity, that is to say that the connections are at uniform height positions. Such a check must also be carried out, for example, as a quality control in the production of the SMD components.

Known arrangements for orientation/position identification and separation testing of the connections of components use an objective lens to image the component, or sections of the component, onto a large-area CCD camera, and use digital image processing to determine the orientation/position of the component connections, as well as the separation of the connections. Direct glare can in this case lead to the

CCD camera being over-exposed, as a result of which the resolution is reduced.

US 5 452 080 discloses a method which is used for coplanarity measurement of the connections of the components. In this case, the entire row of connections is imaged simultaneously onto a detection device by arranging a light source along one side wall of the component, and thus along a row of connections. In order that the investigation is carried out as quickly as possible, this patent provides for opposite rows of connections to be illuminated and imaged simultaneously. In order to suppress the mutual interference between the respective beam paths which image the opposite sides of the component, the two beam paths are separated from one another by being polarized at right angles to one another. If the connections are viewed using the front-illumination method, the polarization filters that are used must in this case be connected such that the direct glare of the connections is detected, which leads to the described overdriving of the detection device.

A triangulation method for coplanarity measurement is known from US 5 440 391, in which the height of a connection of an SMD component is determined by illuminating the connection with light from two directions, and by the two shadows cast by the connection being detected using CCD cameras. The heights of the connections is determined from this in an image evaluation unit connected downstream of the cameras. If the coplanarity discrepancy is unacceptable, and would lead to the connections not all making contact when placed on a printed circuit board, the faulty component can in this way be identified, and removed from the placement process. However, this method is not suitable for testing connections which are not illuminated by the light, for example connections located under the components, which are shadowed from the light by the component.

A method is furthermore known in which, in contrast to the described method, the diffuse

reflection of light on the connections is used instead of the shadow in order to determine the coplanarity and the separation of the connections. In this case, the connections are illuminated with vertically incident light and are imaged by an optical imaging device onto a position-resolving detector device. The imaging beam path in this case forms an angle that is not equal to zero degrees with the vertically incident light, in order that the height of the connections can be determined by triangulation. Furthermore, this reduces the influence of light beams reflected directly into the detector device. Any change in the height of the connections in this case results in a change in the imaging location on the detector device, which is identified by a downstream image evaluation unit. A scanning movement along the row of connections of the component ensures that all the connections are imaged. Owing to the different surface characteristics of the connections, direct reflections of relatively high intensity also reach the detector device, however, in addition to the diffuse reflections, as a result of which the detector device is partially overexposed. Furthermore, direct glare occurring well away from the actual radiation center can reduce the lateral resolution of the detector device. Both effects mean that it is no longer possible reliably to detect the spaces between the connections, for the separation test.

The object of the invention is thus to specify a method and an apparatus for orientation/position identification and/or coplanarity and/or separation testing of connections of components, which avoids the overdriving of detection devices.

The object is achieved according to the invention by a method as claimed in claim 1 and an apparatus having the characterizing features of patent claim 3.

The use of polarized light to illuminate the connections and the fitting of an optical analyzer in

the beam path can be achieved easily in terms of design. In the following text, the term optical analyzer - as is normal in optics - means an optical component whose transparency is dependent on the polarization. Polarization filters are used, for example, as optical analyzers. In contrast to polarizers which are in principle constructed in the same way and produce polarized light from unpolarized light, optical analyzers are used for analysis of light that is already polarized. Direct glare in this case has a fixed polarization direction, in contrast to the diffuse reflections, and can thus be suppressed by incorporating an optical analyzer in the beam path. This prevents the detector device from being overdriven by direct glare.

Advantageous refinements of the invention are described in the dependent claims.

It is particularly advantageous to use a laser as the light source, as claimed in patent claim 4, since laser light is already linear-polarized, and no further design complexity is thus required to produce polarized light.

The rotatable arrangement of the optical analyzer as claimed in patent claim 9 allows the attenuation of the direct glare to be adjusted in an advantageous manner.

The invention will be explained in more detail using an exemplary embodiment and with reference to the drawing, in which:

Figure 1 shows the schematic layout of the apparatus according to the invention, having a laser as the light source.

Figure 2 shows the recording process without an optical analyzer for the height position of sixteen connections of a component,

Figure 3 shows the recording process with an optical analyzer of the height position of sixteen connections of a component, and

Figure 4 shows the schematic layout of the apparatus according to the invention, with light emitting diodes as the light source.

Figure 1 shows how polarized light from a light source 1 illuminates a connection 2 of a component 3 with vertical incidence, and how the connection 2 is imaged by an optical imaging device 4 (for example a converging lens) onto a position-resolving detector device 5. Such imaging, with the detector device 5 being arranged on the same side of the connections 2 as the light source 1, is also referred to as front-illumination. An arrangement of photodetectors in the form of a row is suitable, for example, for use as the detector device 5, being aligned at right angles to the imaging beam path, such that connections 2 in different height positions are detected by different photodetectors. The imaging beam path is in this case shifted through an angle of about 30° with respect to the vertically incident light, in order to reduce the overexposure caused by direct glare. A downstream image evaluation unit 6 evaluates the position of the image, by which means the height of the connection 2 is determined. A polarization filter is arranged as an optical analyzer 7 in the beam path between the connection 2 and the detector device 5, and is aligned such that it is not transparent, or scarcely transparent, for light which is reflected directly from the connection 2. This avoids overdriving the detector device 5, as is shown by way of example in Figure 2 using the results of a measurement without an optical analyzer 6.

The sixteen connections 2 of a component 3 have been measured by scanning in the direction 8 of the arrangement of the connections 2, while at the same time recording the position H of the images at 1000 measurement points. A position H = 0 mm in this case means optimum alignment. The detector device 5 is in this case being overdriven by direct glare, so that not only the

images 10 of the connections, but also the images 11 of the spaces between the connections, simulate a position H, whose order of magnitude corresponds to the position H of the images 10 of the connection 2. It is thus not possible to resolve the images 10 of the connections 2, and no separation test, that is to say no measurement of the distance between the connections (2) is possible.

In contrast to this, Figure 3 shows the result of a corresponding measurement with an optical analyzer 7 in the beam path between the connections 2 of the detector device 5. By suppressing the direct glare, the detector device 5 is not overdriven, while diffuse reflections reach the detector device 5, in order to produce the image on the basis of the different polarization direction through the optical analyzer 7, and are used for evaluation. The images 10 of the connections 2 are clearly separated from one another by the images 11 of the spaces between the connections, thus allowing a separation test. Figure 3 also shows more clearly than Figure 2 the lack of coplanarity in the eighth and ninth connections (in the vicinity of measurement points 400 to 450), so that the coplanarity testing is also simplified.

Lasers are particularly suitable for use as the light source 1, since they already transmit linear-polarized light, so that no additional polarization filter need be arranged as a polarizer in the beam path between the light source 1 and the connection 2. Otherwise, the polarized light can also be produced by a light-emitting diode and a polarizer.

The optical analyzer 7 is in this case mounted such that it can rotate about an axis parallel to the optical axis of the image, thus allowing the optimum attenuation of the direct glare to be set.

Figure 4 shows an apparatus for orientation/position identification. Using a light source comprising light-emitting diodes (LEDs) 12, whose emitted light is linear-polarized by a polarizer 13 in the beam path between the light-emitting diodes 12 and the component 3, the component 3, or at least a section of the component 3, is illuminated, and is imaged via an optical imaging device 4 onto a large-area CCD camera 14 as the detector device. An image evaluation unit 6 is connected downstream of the CCD camera 14, for evaluation of the orientation/position identification. In order to suppress direct glare, which would overdrive the CCD camera 14, an optical analyzer 7 is arranged in the imaging beam path.

Patent Claims

1. A method for orientation/position identification and/or coplanarity testing and/or separation testing of connections (2) of components (3), in which

the connections are illuminated with linear-polarized light using the front-illumination method,

the diffuse reflection of the connections is used for imaging the connections,

the direct reflection of the connections is suppressed by a polarization filter as an optical analyzer for the imaging, and

the orientation/position identification and/or the coplanarity test and/or the separation test are/is carried out using the image of the connections.

2. The method for orientation/position identification and/or coplanarity testing and/or separation testing of connections (2) of components (3) as claimed in claim 1,

characterized

in that a row of connections (2) is recorded by a successive row of images of individual connections (2).

3. An apparatus for orientation/position identification and/or coplanarity testing and/or separation testing of connections (2) of components (3) using a light source (1) and a position-resolving detector device (5) on which the connections (2) are imaged, with the light source (1) and the detector device (5) being arranged such that the connections are illuminated and imaged using the front-illumination method, as well as an image evaluation unit (6), which is connected downstream of the detector device (5) and in which the image (10) of the connections (2) is used to determine a position of the connections (2) on the component (3),

characterized

in that the light with which the connections (2) are illuminated is linear-polarized, and

in that an optical analyzer (7) is arranged in the beam path between the connections (2) and the detector device (5) such that the polarization direction of the optical analyzer (7) and of the polarized light are at least approximately at right angles to one another.

4. The apparatus for orientation/position identification and/or coplanarity testing and/or separation testing as claimed in claim 3,

characterized by

a laser as the light source (1).

5. The apparatus for orientation/position identification and/or coplanarity testing and/or separation testing as claimed n claim 3,

characterized by

a polarizer in the beam path between the light source (1) and the connections (2).

6. The apparatus for orientation/position identification and/or coplanarity testing and/or separation testing as claimed in claim 5,

characterized by

at least one light-emitting diode as the light source (1).

7. The apparatus for orientation/position identification and/or coplanarity testing and/or separation testing as claimed in one of claims 3 to 6,

characterized by

an arrangement of photodetectors in a row as the detector device (5), which is arranged approximately at right angles to the beam path of the imaging, such that the images of connections (2) which are not correctly aligned, and the images of correctly aligned connections (2) are received by different photodetectors.

8. The apparatus for orientation/position identification and/or coplanarity testing and/or separation testing as claimed in one of claims 3 to 6,

characterized by

a large-area CCD camera (14) as the detector device.

9. The apparatus for orientation/position identification and/or coplanarity testing and/or separation testing as claimed in one of claims 3 to 7,

characterized

in that the optical analyzer (7) is arranged such that it can rotate about an axis parallel to the optical axis of the image.

Abstract

1.1 Method and apparatus for orientation/position identification and/or coplanarity and/or separation testing of connections (2) of components (3).

2.1 Before components (3) are fitted in automatic placement machines, it is necessary to check that the connections (2) are at the same height position (coplanarity) and/or are sufficiently far apart from one another (separation). In a known method, the connections (2) are imaged successively onto a position-resolving detector device (5), but in this case the detector device (5) is over-exposed by the direct glare of light source (1).

2.2 By using polarized light to illuminate the connections (2), and by using an optical analyzer (7) in the imaging beam path, the direct glare is suppressed, and only the diffuse glare leads to imaging.

2.3 Automatic placement machines

3. FIG. 1

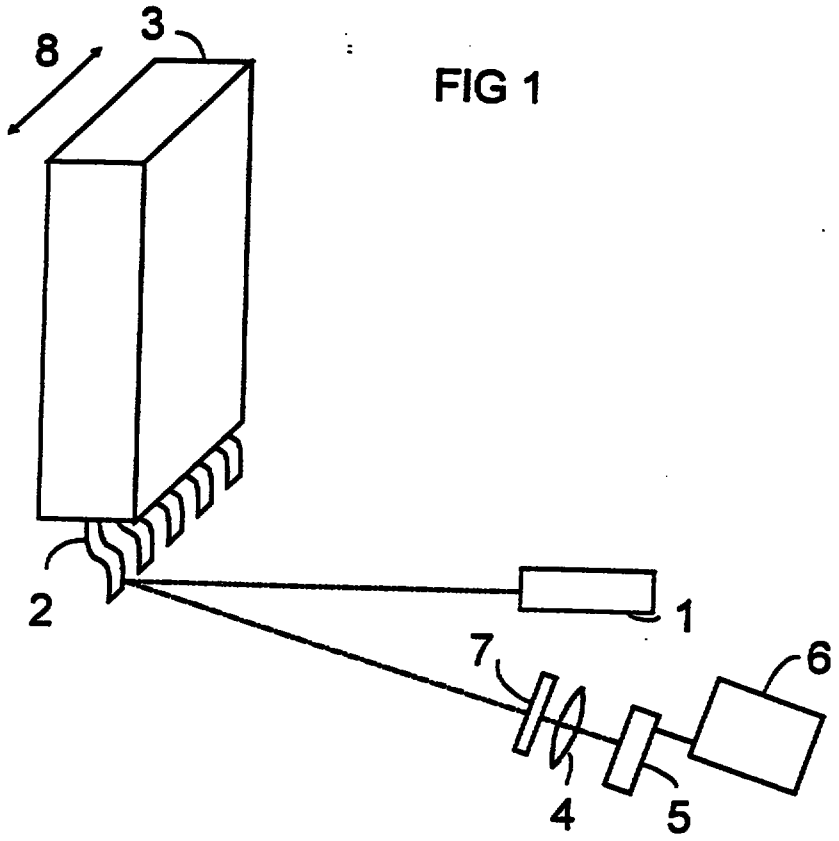

FIG 1

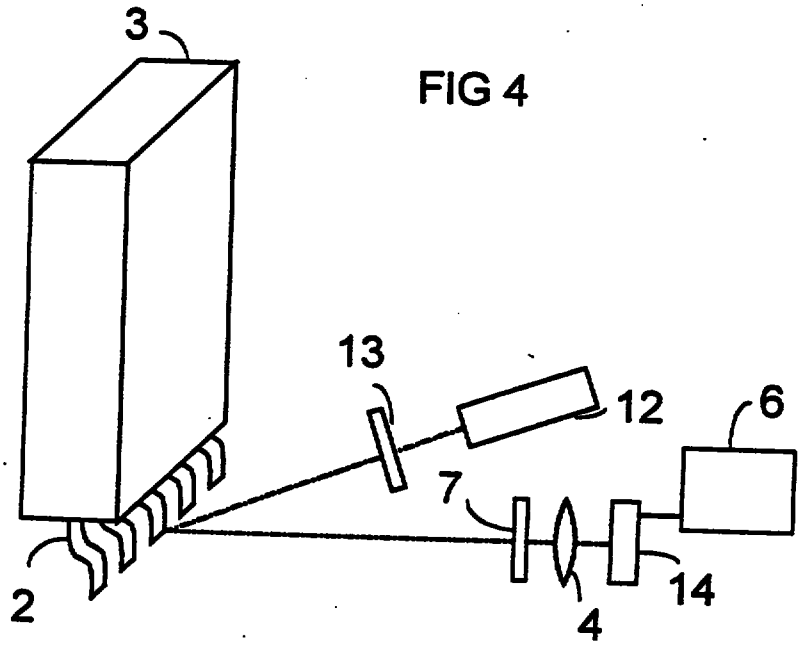

FIG 4

FIG 2

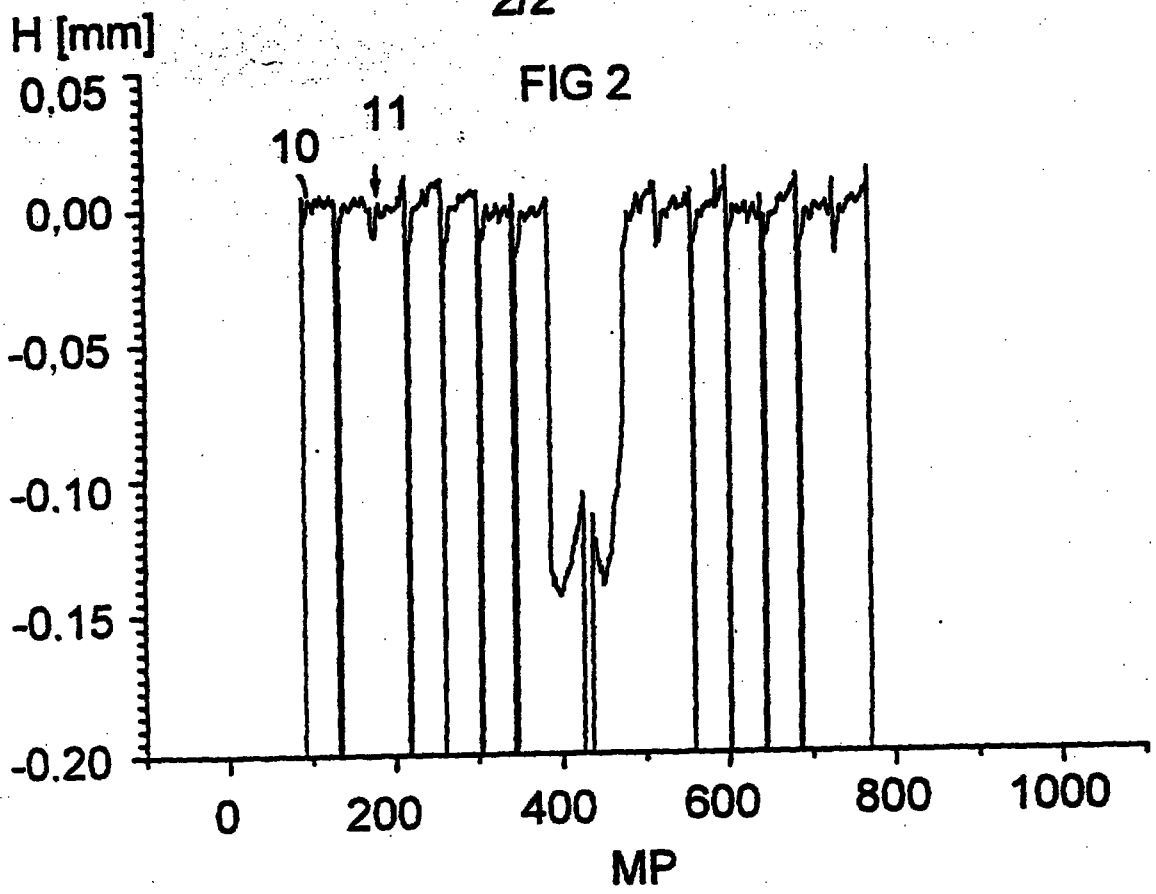
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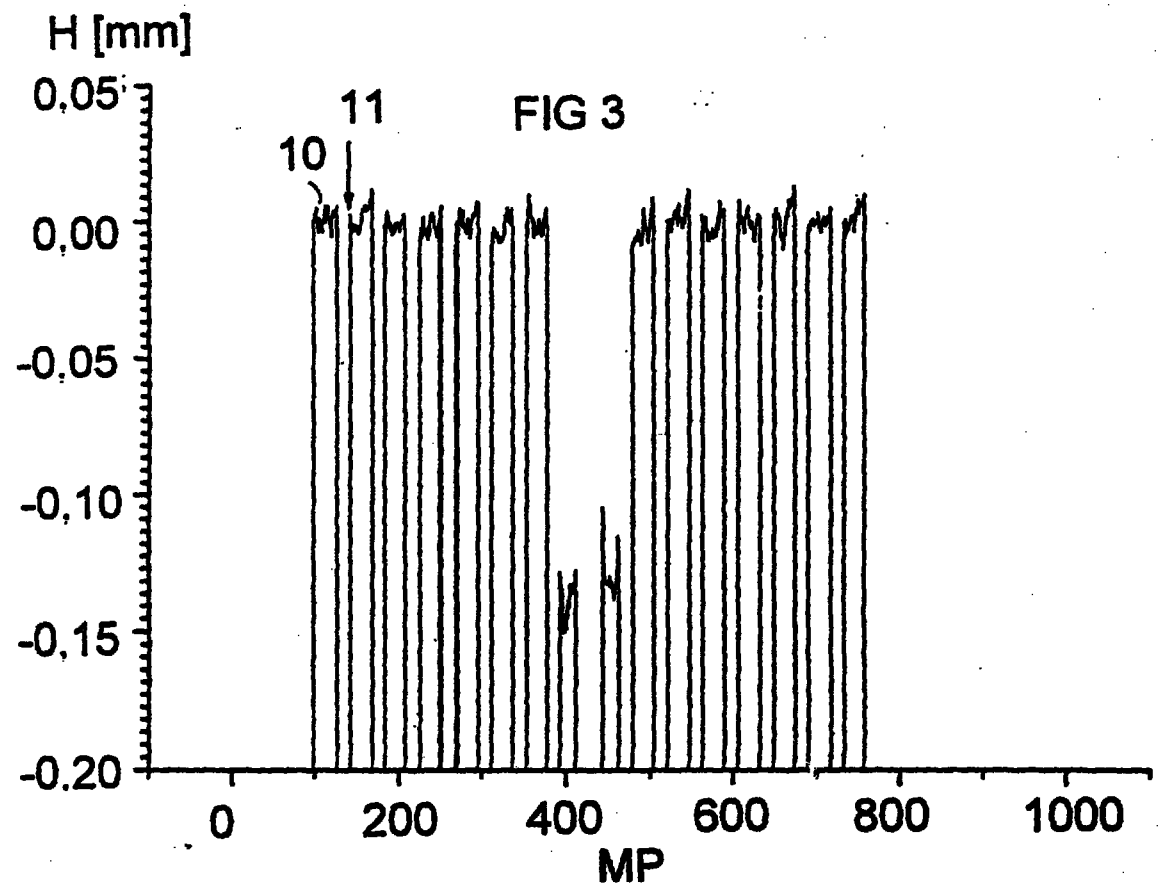
FIG 3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