G00002

Description

Method and device for checking electric components in a pick-and-place device for substrates

The invention relates to a method and a device for checking electric components in a pick-and-place device for substrates,
the components being handled by a pick-and-place head of the pick-and-place device which is made to travel in a working plane,
a pick-up for the components being displaced in the pick-and-place head perpendicularly in relation to the working plane by means of a lift drive between a transporting position and a functioning position,
the component being sucked against an underside of the pick-up,
the component being raised by the pick-up from a pick-up position into the transporting position and, after the pick-and-place head has been made to travel into a placement position, is lowered onto the substrate into the functioning position, and
the positional relationship between the component and the pick-up being checked by an optical scanning means of the pick-and-place head. The positional relationship is to be understood here as meaning not only the relative position of the components on the pick-up, but also the presence or absence of the component on the pick-up.

A device of this type is disclosed by US 5 660 519. According to the latter, the scanning means of the pick-and-place head in each case comprises a row of transmitting and receiving diodes, which form a scanning plane perpendicular to the lifting direction at the height of the component located in the transporting position. While the pick-and-place head is traveling to the placement location on the

substrate, the side contours of the component can be scanned by rotating the suction pick-up about the lifting axis, which allows the positional deviation of the center of the component from the pick-up axis to be ascertained. The presence or absence of the

component on the pick-up is detected during the picking-up or placing of the component by sensing the suction pressure at the pipette. It goes without saying that the presence or absence of the component can also be established by optical measurement.

Furthermore, JP 11-154797 A discloses a pick-and-place device with a fixed turntable rotating step by step, under which a printed circuit board can be made to travel in two coordinate directions. The turret-like turntable is equipped with a multiplicity of pick-ups for the components, which run step by step through different stations and which transport the components from a pick-up position to an opposite placement position. Before the picking-up, the free end of the pick-up runs through a control station with a perpendicular row of optical transmitting and receiving diodes in the manner of light barriers, whereby the position in height of the underside of the pick-up can be ascertained. After the picking-up of the component, the end of the pick-up with the component runs through a further optical control station with a perpendicular row of diodes, whereby the position in height of the underside of the component, and consequently its overall height, can be ascertained. In the case of a pick-and-place head which can be made to travel in two coordinate directions, the pick-up would have to run through the fixed control station before and after picking up the component to allow a corresponding measurement to be carried out, which would generally involve an unacceptable detour between the pick-up position and the and the placement position, and vice versa.

Furthermore, it is known, for example from US 4 875 285, to design the pick-and-place head in the manner of a turret with a multiplicity of suction pick-ups arranged in a circular manner on a rotor, a stator

having with processing stations for the components arranged along the circulatory path of the pick-ups, which components are centered, contacted and electrically, optically or mechanically measured in these stations, for example according to column 2, line 65 et seq. It is currently generally customary to carry out the positional determination of the

components on the pick-up by means of a CCT camera, which measures the placement side of the components, in particular the position of the contact areas, in reflected light. The angular position of the component can be corrected in a downstream rotating station. The x-y offset is taken into account by corresponding correction of the target coordinates of the pick-and-place head.

The current trend toward ever smaller components, of for example an edge length of 0.25 mm, requires a very narrow suction channel in the pick-up, which makes it difficult for the vacuum to be sensed, in particular when there is soiling. Furthermore, inaccuracies of the pick-up position may occur if the component does not completely cover the suction channel and, as a result of this leakage, the result of the vacuum scanning is unreliable. For example, in the case of a turret head, under some circumstances the absence of a component is consequently only noticed in the optics station during the placement phase. The picking up of a replacement component requires a considerable additional amount of time to be expended.

The invention is based on the object of achieving a higher level of reliability in the checking of the components.

This object is achieved by the invention as claimed in claim 1. For example, the scanning beam may be arranged just underneath the underside of the pick-up in the raised state. This makes it possible to check the underside of the pick-up before it is lowered onto the component to be picked up. Normally, the path of rays of the light barrier is not interrupted. After that, the pick-up is lowered onto the component to be picked up. The latter is then sucked onto said pick-up and raised. Directly after that, it can be reliably

established by a renewed scanning pulse whether the component has been picked up by the pick-up. The components are supplied in the customary way in belt pockets. When the belt is advanced, it may happen that vibrations cause the component to come out of the pocket or change its position, but it is also possible on account of the tolerances mentioned

for the pick-up not to pick up the component. The directly following scanning can immediately initiate a new picking-up operation, in which the belt is advanced by a further pocket spacing, so that the pick-up can pick up another component. This takes place without any further traveling movement of the pick-and-place head and consequently with little time delay. Directly before the component is placed onto the substrate, scanning may be carried out once again, in order to establish whether the component is still present on the pick-up. This is advantageous if the component is lost before it is placed, for example as a result of vibrations, accelerations or decelerations of the pick-and-place head. In this case, the setting down of the pick-up is not performed. This is of significance to the extent that otherwise the underside of the pick-up would be set down onto the soldering paste present on the printed circuit board, with the effect of contaminating the underside so much that the suction opening is considerably narrowed or even closed. If the component is present, it is placed onto the substrate and released from the underside by means of a pulse of compressed air. In the case of very small components, however, the adhesive action of a contaminated underside may be to so great that the component sticks to the pick-up. This is established by scanning directly after the raising of the pick-up, so that the pick-up can once again attempt to place the component onto the substrate before the pick-and-place head leaves the placement position. In this way, a high degree of picking and placing reliability is achieved.

Complete monitoring of the underside of the pipettes in all operating phases is achieved by an advantageous development of the invention as claimed in claim 2.

It is possible by the development as claimed in claim 3 not only to check the presence of a component but also to ascertain the height of the component, allowing additional information to be obtained concerning the type of component. For example, it may happen that the component lying in the belt pocket

is sucked against the pick-up one-sidedly, so that it is picked up on edge by the pick-up. This can consequently already be detected during picking-up as a pick-up error. Such a component is discarded in a specific position and consequently does not get onto the substrate in an undefined way. The device as claimed in claim 4 achieves the object on which the invention is based in a way similar to the method according to figure 1. Here, too, the conditions on the underside of the pick-up can be completely monitored, so that the level of pick-and-place reliability is correspondingly increased.

In a way similar to the method as claimed in claim 3, the device as claimed in claim 5 permits more accurate checking of the component height in the lifting direction, from which more accurate conclusions can be drawn concerning the type or the installation position of the component.

It is possible by the device as claimed in claim 6 for the scanning means to be combined in a structure, whereby an exact geometrical relationship between the functional parts can be established. The deflecting means near the underside can be formed for example by a prism which deflects the scanning beam obliquely upward to a transmitting diode.

The turret pick-and-place head as claimed in claim 7 has, for example, 12 suction pick-ups, which are arranged in a star-shaped manner along a circular circulatory path. The rotor is driven step by step, so that the suction pick-ups can be rotated one after the other into the pick-up station, in order to be able to pick up the components in a direct sequence. However, this means that, before they can be optically inspected, the components run through at least several stations, until they reach an optics station. In this

period of time, it is not possible without the scanning means according to the invention for the components to be optically checked. Some of the components are only taken past the optics station and checked in the placement phase. As a result, pick-up errors which cannot be detected by the vacuum sensing

are only detected in a later phase, and consequently entail a corresponding time loss. The invention makes it possible to monitor all the suction pick-ups directly in connection with the picking-up operation, so that, in the event of a pick-up error, the pick-up can undertake a new pick-up attempt, without it being possible in the meantime for the rotor to be turned further. It is customary to arrange the optical station for measuring the component position several stations upstream of the placement station and to turn the pick-up into the desired installation position in a downstream station. During the turning of the rotor and the pick-up, it is still possible after the optical measurement for a component to be lost, which without the scanning means in the placement station could no longer be detected. The optical scanning during placement therefore increases the level of monitoring reliability to a considerable degree.

It is possible by the development as claimed in claim 8 to make the cable light barrier engage in one piece from the stator side into the traveling path of the components.

The invention is explained in more detail below on the basis of exemplary embodiments represented in a schematized form in the drawing.

Figure 1 shows a section through a pick-and-place head with a suction pick-up and a control means,

figure 2 shows a plan view of part of the pick-and-place head according to figure 1,

figure 3 shows part of the pick-and-place head at the beginning of a pick-up phase with a component belt and electric components,

figure 4 shows the parts according to figure 3 in a subsequent phase,

figure 5 shows the parts according to figure 4 without the component belt in a subsequent phase,

figure 6 shows the parts according to figure 5 at the end of the pick-up phase,

figure 7 shows the parts according to figure 6 after the end of the pick-up phase,

figure 8 shows the parts according to figure 7 during a placement phase of the component onto a substrate,

figure 9 shows the parts according to figure 9 after the placement of the component,

figure 10 shows a side view of another, turret-like pick-and-place head with components and a substrate,

figure 11 shows a side view of the parts according to figure 10.

According to figure 1, a pick-and-place head 1 which can be made to travel in two coordinate directions X and Y of a horizontal working plane X-Y is provided with a pick-up 2, which is displaceable by means of its lift drive 3 perpendicularly in relation to the working plane. The pick-up 2 is provided on its downwardly pointing tip with a suction opening 4 for workpieces to be picked up. The lift drive 3 has a displacement-measuring means 5, with which the respective lifting position of the pick-up can be established and which is connected via a data line to a control means 6 of the pick-and-place device. In the region of the underside of the pick-up 2 there is fastened to the pick-and-place head 1 a scanning means 7 in the form of a forked light barrier, which is provided with a transmitting diode 8 and a receiving diode 9. The diodes are arranged and aligned with each other in such a way that a sharply focused scanning beam 22 running between them crosses the pick-up axis perpendicularly. The scanning means 7 is likewise connected to the control means 6 via a further data line.

In the transporting position shown, the pick-up 2 is in the uppermost lifting position, in which the underside of the pick-up 2 is located above the scanning height

defined by the diodes. The control means 6 receives the measured displacement values of the displacement-measuring means 5. The scanning means is activated during the lowering and lifting phases of the pick-up 2. The signals received by the receiving diode are likewise transmitted to the control means 6. At the moment at

which the received brightness value of the receiving diode 9 exceeds a threshold value, the lifting displacement just measured of the pick-up 2 is stored for further use.

Figure 2 shows a plan view of the scanning means 7, with the position of the tip of the pick-up 2 and an electric component 10 to be held on it being indicated by dashed lines.

In figures 3 to 9, the sequence of the phases of a picking-and-placing cycle with respect to the scanning means 7 is represented.

According to figure 3, the pick-and-place head is located with its pick-up 2 above a component 10 to be picked up and has already been lowered from its starting position, represented in figure 1, to the extent that its empty underside crosses the scanning beam 22 of the scanning means 7. The corresponding position of the pick-up is stored by the control means. It is possible to carry out such scanning after each change of pick-up and to compare the standard value ascertained in this way with the respective measured value when the empty pick-up is lowered. Significant deviations may then indicate an error at the tip of the pick-up, which for example suggests contaminants or a component sticking to it.

According to figure 4, the underside of the pick-up 2 is already resting on the component lying in a pocket 11 of a belt 12 and sucking this component onto it.

According to figure 5, the pick-up 2 has been raised to the extent that its underside is located above the scanning beam 22 and that the component 10 sucked onto it is interrupting the scanning beam 22. It is already possible at this moment to establish from the stored

value that the component to be picked up is present on the pick-up 2.

According to figure 6, the pick-up 2 with the component 10 sucked onto it has just been raised to the extent that the underside of the component 10 clears the scanning beam 22. This change in status is detected by the control means 6 (figure 1), stored with the associated scanning value of the displacement-measuring means 5. At this moment, the value stored earlier can already be compared with the current value, the difference in height in the lifting position representing a measure of the height of the component 10. If the two scanned values remain unchanged, this means that the component 10 has not being sufficiently sucked onto the pick-up and raised. The control means also knows the component data from a component library. A deviation in the height values may mean that an incorrect type of component has been provided or that the component was sucked onto the pick-up in an incorrect position. Such components can be removed over a discharge point. The unsuccessful attempt can trigger a renewed picking-up operation before the pick-up leaves the pick-up position.

According to figure 7, the pick-up 2 has been raised into its upper transporting position, in which the component 10 is located above the scanning height. The pick-and-place head 1 can now be made to travel into the placement position for the component 10.

According to figure 8, the pick-up 2 with the component 10 is located precisely in this placement position above a substrate 13 in the lowering phase. In this case, it can be checked in a way corresponding to figure 5 whether the component 10 is still on the pick-up. This check, which may also be combined with a renewed height measurement, permits a reliable statement concerning the presence of the component 10. If the latter has been lost during transport, the pick-up 2 is not lowered any further, so that its tip cannot

be contaminated with soldering paste present on the substrate 13.

According to figure 9, the component 10 has already been placed onto the substrate 13 and the empty underside of the pick-up 2 has been raised

above the scanning level. During this operation, the status of the receiving diode 9 is continuously monitored, so that it can be established whether the component has actually been released from the pick-up 2.

According to figures 9 and 10, another pick-and-place head 14 is designed in the manner of a turret and can be made to travel in the working plane in both coordinate directions x and y. It has a stator 15, on which a rotor 16 can be mounted such that it can rotate step by step. On the rotor, modified pick-ups 17 are arranged such that they protrude in a star-shaped manner and run around in a circular manner. During a picking cycle, in this way all the pick-ups 17 can be loaded with components one after the other in turn before the pick-and-place head travels over the substrate 13. Along the circulatory path of the pick-ups 17 there is an optical scanning unit 18, with which the underside of the components 10 can be accurately measured. This means that, without a scanning means, the presence and type of the component 10 can only be reliably checked in this phase. Consequently, an incorrect pick-up can only be corrected during the next picking cycle.

Another lift drive 19 with the displacement-measuring means 5 is assigned to a lifting station 20 and is in temporary engagement with the associated pick-up 17. Another scanning means 21 is fastened to the stator 15 in such a way that the scanning beam 22 is directed just above and tangentially in relation to the circulatory path of the components 10. By this arrangement it is possible to form the scanning means likewise as a forked light barrier with a one-piece bow-like carrier, the base of which is fastened to the stator 15 on one side of the circulatory path. It is also possible in the case of this pick-and-place head

14 for scanning steps corresponding to figures 3 to 9 to be carried out.

Patent claims

A method for checking electric components (10) in a pick-and-place device for substrates (13),
the components (10) being handled by a pick-and-place head (1) of the pick-and-place device which is made to travel in a working plane (x-y),
a pick-up (2) for the components (10) being displaced in the pick-and-place head (1) perpendicularly in relation to the working plane (x-y) by means of a lift drive (3) between a transporting position and a functioning position,
the component (10) being sucked against an underside of the pick-up (2),
the component (10) being raised by the pick-up (2) from a pick-up position into the transporting position and, after the pick-and-place head (1) has been made to travel into a placement position, is lowered onto the substrate (13) into the functioning position,
the positional relationship between the component (10) and the pick-up (2) being checked by an optical scanning means (7) of the pick-and-place head (1),
the component (10) being brought by the lifting movement of the pick-up (2) into the active range of at least one scanning beam (22) of the scanning means (7) oriented transversely in relation to the lifting direction,
in the transporting position, the underside of the pick-up (2) being located above the scanning beam (22), and
the the pick-and-place head (1) having a control means (6), which checks the lifting position of the pick-up (2),
characterized
in that the scanning means (7) is coupled to the control means (6),

in that the scanning means (7) is activated in a phase before and a phase after the suction attachment of the component (10),

in that the control means (6) detects the presence or absence of the component (10) on the pick-up (2) from the scanning values of the scanning means (7),

and in that the control means (6) assesses scanning values remaining the same between the two phases as operating errors.

2. The method as claimed in claim 1, characterized in that the scanning means (7) is activated during the picking-up and during the placing of the component (10).

3. The method as claimed in claim 1 or 2, characterized
in that, in the transporting position, the underside of the component (10) is raised above the height level of the narrowly focused scanning beam (22),
in that, in its functioning position, the underside of the pick-up (2) is displaced under the height level of the scanning beam (22),
in that the lift drive (3) has a displacement-measuring means (5) for determining the lifting position of the pick-up (2),
in that the displacement-measuring means (5) is coupled to the control means (6),
in that the lifting means is activated during the raising and/or lowering of the component (10), and
in that the control means (6) ascertains the position in height of the underside of the component (10) or of the pick-up (2) from the changes in the scanning values during the crossing of the undersides and from the respective lifting position of the pick-up (2).

4. A device for checking electric components (10) in a pick-and-place device for substrates (13), in particular as claimed in one of claims 1 to 3,
the pick-and-place device having a pick-and-place head (1) which can be made to travel in a working

plane (x-y) and is intended for handling the components (10),

a pick-up (2) for the components (10) being mounted in the pick-and-place head (1) such that it can be displaced perpendicularly in relation to the working plane (x-y) by means of a lift drive (3) between a transporting position and a functioning position,

it being possible for the component (10) to be sucked against the underside of the pick-up (2),
it being possible for the component (10) to be raised by the pick-up (2) from a pick-up position into the transporting position and, after the pick-and-place head (1) has been made to travel into a placement position, it being possible for it to be lowered onto the substrate (13) into the functioning position,
the pick-and-place head (1) having an optical scanning means (7) for checking the component (10) on the pick-up (2) and
the scanning means (7) receiving at least one scanning beam (22) which is oriented transversely in relation to the lifting direction and is narrow in the lifting direction, and
in the transporting position, the underside of the pick-up (2) being located above the scanning beam (22),
the pick-and-place head (1) having a control means (6) for keeping a control check on the lifting movement of the pick-up (2),
characterized
in that the scanning means (7) is coupled to the control means (6),
in that the scanning means (7) can be activated in a phase before and a phase after the suction attachment of the component (10),
in that the control means (6) can detect the presence or absence of the component (10) on the pick-up (2) from the scanning values of the scanning means (7),
in that the control means (6) assesses scanning values remaining the same between the two phases as operating errors.

5. The device as claimed in claim 4, characterized

in that, in the transporting port position of the component (10), the scanning beam (22) is arranged under the underside of said component,
in that, in its functioning position, the underside of the pick-up (2) is located underneath the sharply focused scanning beam (22),
in that the lift drive (3) has a displacement-measuring means (5) for determining the lifting position of the pick-up (2),
in that the displacement-measuring means (5) is coupled to the control means (6),

in that the lifting means can be activated during the raising and/or lowering of the component (10), and

in that the control means (6) can ascertain the position in height of the underside of the component (10) or of the pick-up (2) from the changes in the scanning values during the crossing of the undersides and from the respective lifting position of the pick-up (2), and from this can calculate the height of the component (10).

6. The device as claimed in claim 5, characterized in that the scanning means (7) is formed as a forked light barrier with a bow-shaped carrier for the optical functional parts (for example 8, 9), and

in that the scanning beam (22) is arranged by deflecting means near the underside of the scanning means (7) facing the substrate (13).

7. The device as claimed in claim 4, 5 or 6, characterized

in that the pick-and-place head (14) designed in the manner of a turret has a stator (15), on which a rotor (16) is mounted such that it can rotate step by step,

in that the rotor (16) is provided with a multiplicity of pick-ups (17) distributed in a circular manner,

in that the pick-up (17) can be lowered and raised by the lift drive (19) in a lifting station (20) of the pick-and-place head (14),

in that the scanning means (31) fastened to the stator (15) is assigned to the lifting station (20), and

in that the stator (15) of the pick-and-place head (1) is provided outside the lifting station (20) in addition to the scanning means (7) with an optics

station (18) for ascertaining the position of the component (10) on the pick-up (2).

8. The device as claimed in claim 7, characterized

in that the scanning beam (22) is oriented in the direction of rotation of the components (10).