

DESCRIPTION

TITLE OF INVENTION: HANDLER FOR TESTING ELECTRONIC COMPONENTS, AND METHOD THEREOF FOR ALIGNING ELECTRONIC COMPONENTS

5 **Technical Field**

[1] The present invention relates to a handler for supporting the testing of electronic components by electrically connecting the electronic components and a tester to each other.

10 **Background Art**

[2] A handler for testing electronic components is the equipment that handles electronic components in order to electrically connect the electronic components to a tester.

[3] As the degree of integration of electronic components
15 such as semiconductor devices increases, there is a trend toward the line width of circuits becoming increasingly narrow. Accordingly, higher precision is required when electronic components are connected to testers.

[4] For example, although an error range of 20 μm was
20 previously sufficient to ensure the appropriate electrical connection between electronic components and testers, an error range of 10 μm or less, up to a few μm is required now.

[5] Meanwhile, among electronic components, there are dies that are separated into individual units from a wafer state.

[6] Dies may be completed as final products by undergoing a packaging task or by stacking them for High Bandwidth Memory (HBM) production and then undergoing a packaging task.

[7] The testing of dies is required to perform post-die tasks.

[8] Electronic components in a die state may be tested by electrically connecting the contact pads thereof to a tester.

[9] Dies have fine intervals between the contact pads thereof and are significantly thin, making them prone to breaking or cracking, so that no suitable test method capable of adequately supporting the testing of electronic components in a die or HBM state has been proposed until now. Accordingly, the applicant proposed Korean Patent Application Publication No. 10-2021-0088373 (hereinafter referred to as the 'conventional art').

[10] The conventional art proposes a technology for aligning the positions of electronic components by rearranging the electronic components before connecting them to a tester.

[11] The conventional art is configured to allow for the reduction of errors in the positions of electronic components by scanning the electronic components on a test table (named the 'chuck' in the conventional art) with a

camera to determine the current positions (arbitrary positions) of the electronic components and performing position adjustment to move the electronic components to correct positions.

5 [12] A handler to which the prior art is applied is provided with a picker that temporarily grips an electronic component at a current position.

[13] The picker may grip or release an electronic component.

10 [14] When the picker grips an electronic component, the test table moves the electronic component from an arbitrary position to a correct position through rotation, lifting/lowering, and/or horizontal movement, and then releases the electronic component from the picker.

15 [15] Meanwhile, as the demand for electronic components requiring precise contact with a tester increases, there is a need to expand the handling capacity of the handler according to the conventional art. However, the time taken in the rearrangement process of the handler according to the
20 conventional art acts as an obstacle to expanding the handling capacity.

[16] [Conventional Art Literature]

[17] [Patent Literature]

[18] (Patent Document 1) Korean Patent Application
25 Publication No. 10-2021-0088373

Disclosure

Technical Problem

[19] It is necessary to further reduce the time required to align and place electronic components on the test table in the handler according to the conventional art.

5 Technical Solution

[20] A handler for testing electronic components according to the present invention includes: a transport shuttle provided with a transport table capable of transporting electronic components by moving with the electronic components loaded thereonto; a first hand configured to load the electronic components onto the transport table that is placed in a first area by the operation of the transport shuttle; a second hand configured to unload the electronic components from the transport table that is moved from the first area to a second area by the operation of the transport shuttle; a test table configured such that the electronic components unloaded from the transport table by the second hand are loaded thereonto; a movement mechanism configured to move the test table between an alignment part, in which the electronic components are aligned on the test table by the second hand, and a connection part, in which the electronic components on the test table are electrically connected to a tester; a connector configured to enable the electronic components, loaded onto the test table, to be tested by electrically connecting the electronic components to a tester; and a controller configured to control the

transport shuttle, the first hand, the second hand, the movement mechanism, and the connector; the second hand includes: a plurality of second pickers capable of gripping the electronic components using vacuum pressure; a movable
5 installation body configured such that the plurality of second pickers are installed thereon; a mover configured to move the installation body in the horizontal directions; and a plurality of second elevators configured to independently lift or lower the plurality of respective second pickers;
10 and the controller controls the second hand to align the electronic components to regular zones of the test table.

[21] The second hand further may include a second camera configured to photograph an electronic component loaded into a temporary zone of the test table by the second hand; and
15 the controller may analyze an image captured by the second camera to calculate the temporary zone and may then control the second hand to align the electronic component in the temporary zone and rearrange it to a regular zone.

[22] The second hand may further include a plurality of
20 rotators configured to independently rotate the plurality of respective second pickers.

[23] The second hand may further include a plurality of buffers configured to buffer the pressure applied to the electronic components when the electronic components are
25 loaded onto the test table; and the plurality of buffers may independently buffer the electronic components gripped by the plurality of respective second pickers.

[24] The second pickers may be implemented to grip electronic components in a dead-bug state.

[25] The movement mechanism may include: a rotary mover configured to rotate the test table; and a horizontal mover configured to move the test table horizontally.

[26] A method of aligning electronic components for a handler for testing electronic components according to the present invention includes: an electronic component movement step of moving electronic components on a transport table to temporary zones of a test table with a second hand; a photographing step of photographing an electronic component placed in a temporary zone with a second camera installed in the second hand; an electronic component position calculation step of calculating a position of the electronic component placed in the temporary zone by analyzing an image captured in the photographing step; a movement distance calculation step of calculating, by a controller, the movement distance required to move the electronic component from the position calculated in the electronic component position calculation step to a regular zone of the test table; and an electronic component movement and seating step of gripping the electronic component in the temporary zone with the second hand, moving it by the movement distance calculated in the second calculation step, and then seating the electronic component into the regular zone.

[27] The second movement step may include: a rotational movement step of rotating the electronic component gripped

by the second hand; and a horizontal movement step of moving the electronic component, gripped by the second hand, in a horizontal direction.

Advantageous Effects

5 [28] According to the present invention, the horizontal positions and Θ -axis positions of electronic components gripped by the second hand having the plurality of second pickers may be corrected and aligned, thereby reducing the time required to place the electronic components on the test
10 table and thus improving the handling capacity of the handler.

Description of Drawings

[29] FIG. 1 is a conceptual plan view of a handler for testing electronic components according to a first
15 embodiment of the present invention;

[30] FIG. 2 is a schematic plan view of a transport table applied to the handler for testing electronic components of FIG. 1;

[31] FIG. 3 is a schematic perspective view of a first hand applied to the handler for testing electronic components of
20 FIG. 1;

[32] FIG. 4 is a reference view illustrating the first hand of FIG. 3;

[33] FIG. 5 is a conceptual perspective view of a second hand applied to the handler for testing electronic components of FIG. 1;

5 [34] FIG. 6 is a reference view illustrating a photographing area for an electronic component by a second camera in the second hand of FIG. 2;

[35] FIGS. 7 and 8 are reference views comparing the conventional art with the present invention;

10 [36] FIGS. 9 to 12 are reference views illustrating various examples of a photographing area for an electronic component by the second camera in the second hand of FIG. 2;

[37] FIG. 13 is a schematic perspective view of a test table applied to the handler for testing electronic components of FIG. 1;

15 [38] FIG. 14 is a schematic plan view of a test board coupled to the handler for testing electronic components of FIG. 1;

20 [39] FIG. 15 is a reference view illustrating the electrical connection relationship between the test board of FIG. 14 and an electronic component;

[40] FIG. 16 is a reference view illustrating temporary zones placed in the test table of FIG. 13;

[41] FIG. 17 is a reference view illustrating regular zones generated in the test table of FIG. 13;

25 [42] FIG. 18 is a reference view illustrating a movement mechanism applied to the handler for testing electronic components of FIG. 1;

[43] FIG. 19 is a flowchart illustrating a first operation method for the handler for testing electronic components of FIG. 1; and

[44] FIG. 20 is a flowchart illustrating a second operation method for the handler for testing electronic components of FIG. 1.

Mode for Invention

[45] Preferred embodiments according to the present invention will be described with reference to the accompanying drawings. For the sake of brevity, descriptions of well-known or redundant components are omitted or abridged as much as possible.

[46] <Description of Configuration of Handler>

[47] FIG. 1 is a conceptual plan view of a handler TH for testing electronic components (hereinafter abbreviated as the 'handler TH') according to the present invention.

[48] The handler TH for testing electronic components according to the present invention may be divided into a movement part MP, an unloading part LU, alignment parts AP, and a connection part CP. The handler TH for testing electronic components includes a transport shuttle 100, a first hand 210, second hands 220, test tables 300, vacuum devices 400, movement mechanisms 600, connectors 700, and a controller 800.

[49] In the movement part MF, electronic components may be moved such that the electronic components are handed over

between the unloading part LU and the rearrangement part RP.
To this end, the transport shuttle 100 for transporting electronic components is installed in the movement part MP.

[50] The transport shuttle 100 is provided to transport
5 electronic components between the unloading part LU and the rearrangement part RP.

[51] The transport shuttle 100 has a movable transport table 110.

[52] The transport shuttle 100 may have at least one
10 transport table 110.

[53] The transport table 110 is capable of reciprocating in one direction. According to a preferred example, the transport table 110 is capable of reciprocating in the X-axis direction.

[54] In the case where the transport table 100 includes a
15 plurality of transport tables 100, the plurality of transport tables 110 may be provided in parallel with each other in the Y-axis direction.

[55] Furthermore, the plurality of transport tables 110
20 need to be implemented to reciprocate in the X-axis direction independently of each other.

[56] The transport table 110 may move back and forth between a first area A1 located on an unloading part LU side and a second area A2 located on a rearrangement part RP
25 side.

[57] Electronic components may be loaded onto the transport table 110.

[58] The transport table 110 does not have a pocket structure having depressions into which electronic components can be seated, but has rather a vacuum structure which secures electronic components seated on a flat surface
5 by using vacuum pressure.

[59] As shown in the schematic plan view of FIG. 2, vacuum holes VH and vacuum depressions VG for vacuum-sucking electronic components are formed in the transport table 110.

[60] One vacuum hole VH and one vacuum depression VG form a
10 pair.

[61] The vacuum pressure coming via the vacuum hole VH acts on an electronic component while being evenly distributed within the vacuum depression VG.

[62] Since electronic components may be fixed to the
15 transport table 110 by vacuum pressure, the movement of the electronic components does not occur during the process of moving on the transport table 110 in the X-axis direction. Accordingly, as long as the electronic components are placed precisely on the transport table 110, the tolerance for the
20 positional misalignment of the electronic components, which has been a problem in the past, may be minimized.

[63] The vacuum holes VH and the vacuum depressions VG may be arranged in a 2×8 matrix, but the loading capacity of the transport table 110 may be increased or decreased as
25 needed.

[64] In the unloading part LU, electronic components are fed to the handler TH or recovered from the handler TH.

That is, electronic components to be tested are fed to the handler TH through the unloading part LU, and tested electronic components are recovered from the handler TH through the unloading part. Electronic components may be
5 loaded onto a carrier such as a JEDEC tray, a ring frame, or some other customer tray and may then be fed to the handler TH or recovered from the handler TH.

[65] Electronic components to be tested in the unloading part LU are loaded onto the transport table 110 in the first
10 area A1, and tested electronic components loaded onto the transport table 110 in the first area A1 are unloaded from the transport table 110. To this end, the first hand 210 is provided in the unloading part LU.

[66] The first hand 210 is provided to load electronic
15 components onto the transport table 110 or unload electronic components from the transport table 110.

[67] For unloading operations by the first hand 210, the transport table 110 has to be moved toward the unloading part LU and be placed in the first area A1.

20 [68] The first hand 210 loads electronic components to be tested onto the transport table 110 in the first area A1, or unloads tested electronic components from the transport table 110 in the first area A1.

[69] The first hand 210 may have one or more first pickers
25 capable of gripping or releasing electronic components.

[70] The first pickers may grip electronic components by vacuum pressure.

[71] The first hand 210 may be provided with a plurality of first pickers to increase the working capacity in a single operation. For example, as shown in the schematic diagram of FIG. 3, the first hand 210 may have four first pickers P1
5 arranged in a 2×2 matrix. The number of first pickers P1 provided in the first hand 210 may be increased or decreased depending on the implementation.

[72] The first hand 210 has first elevators E1 for independently lifting/lowering the first pickers P1. By the
10 first elevators E1, the first pickers P1 may selectively grip or release electronic components. Accordingly, the electronic components moved to the transport table 110 by the first hand 210 may be individually seated on the transport table 110 while their positions are being
15 individually and precisely adjusted. Furthermore, the electronic components unloaded from the transport table 110 by the first hand 210 may be classified while being divided and loaded at respective positions according to the test grade.

[73] The first hand 210 may further include a first camera C1.
20

[74] The controller 800 may control the first hand 210 to grip an electronic component with the first picker P1 after accurately calculating the position of the electronic
25 component before gripping by analyzing an image captured by the first camera C1 before the first hand 210 grips the electronic component. Accordingly, the first picker P1 may

grip the electronic component more precisely, and, accordingly, can place the electronic component at a correct position on the transport table 110.

[75] The first picker P1 may be implemented to grip
5 electronic components of various heights.

[76] For example, an implementation may be made in such a manner as to determine the lifting height of the first picker P1 according to the height of an electronic component preset by an administrator. In this case, when the
10 specifications of an electronic component to be tested change, it entails the inconvenience in which an administrator has to re-enter the height of the electronic component.

[77] For example, an implementation may be made in such a manner as to determine the lifting height of the first
15 picker P1 required for gripping or releasing an electronic component by calculating the height of the electronic component from an image captured by the first camera C1. In this case, operational convenience is improved because the
20 handler TH automatically recognizes the height of the electronic component and then operates the first picker P1.

[78] The first hand 210 may further include first rotators R1.

[79] The first rotators R1 each rotate an electronic
25 component ED in the Θ -axis direction by using a vertical line in the Z-axis direction as the axis of rotation, as shown in FIG. 4.

[80] The first rotators R1 may rotate the respective first pickers P1 individually. Accordingly, the first hand 210 may not only move the electronic component ED in the X-, Y-, and Z-axis directions, but may also rotate the electronic component ED in the Θ -axis direction. That is, the first hand 210 may correct the misalignment of the electronic component ED having an angular position rotated in the Θ -axis direction and photographed by the first camera C1 before gripping, and may then seat it on the transport table 110. The position of the electronic component ED seated at a precise position on the transport table 110 by the first hand 210 is fixed by vacuum pressure. Accordingly, during the process of moving the electronic component ED by the first hand 210, the positions of the electronic component ED in the X-, Y-, Z-, and Θ -axis directions may be precisely adjusted.

[81] However, it may also be possible to provide a rotation means for the electronic component ED separately from the first hand 210.

[82] For example, an implementation may be made such that, when the first hand 210 grips the electronic component ED from a JEDEC tray or ring frame and feeds it to the rotation means, the rotation means may correct the misalignment of the electronic component ED by fixing the electronic component ED with vacuum pressure and then rotating it. The electronic component ED, the misalignment of which has been

corrected by the rotation means, may be gripped again by the first hand 210 and then moved to the transport table 110.

[83] In the example of FIG. 3, the first hand 210 is provided with four first pickers P1. When a plurality of
5 first pickers P1 are provided in this manner, the targets to be gripped may be different for the respective first pickers P1.

[84] For example, some first pickers P1 may be implemented to grip electronic components ED in a live-bug state (in the
10 state in which terminals face downward), and the remaining first pickers P1 may be implemented to grip electronic components ED in a dead-bug state (in the state in which terminals face upward). In this case, all the electronic components ED fed to the handler TH via a JEDEC tray or ring
15 frame may be handled regardless of their loading state, thereby increasing the usability of the handler TH.

[85] In the alignment parts RP, electronic components ED to be tested are unloaded from the transport table 110, and the unloaded electronic components ED are aligned.

[86] According to the present embodiment, two alignment
20 parts AP are symmetrically arranged on both sides with the connection part CP disposed therebetween. By having the two alignment parts AP in this manner, the handling capacities of the handler TH and a tester are improved.

[87] The second hands 220 are provided in respective
25 alignment parts AP.

[88] The second hands 220 unload electronic components ED to be tested from the transport table 110 in the second area A2.

[89] The second hands 200 load the electronic components ED, unloaded from the transport table 110, onto the test table 300 that has been moved to the alignment part AP. In this process, the second hands 220 may align the electronic components ED that the second hands 220 are gripping, and may load them into the regular zones of the test table 300. In this case, the regular zones refer to the zones in which electronic components ED can be electrically connected with the tester accurately.

[90] The second hands 220 unload tested electronic components ED from the test table 300 and load them onto the transport table 110 in the second area A2.

[91] For unloading operations by the second hands 220, the transport table 110 needs to be moved toward the alignment part AP and placed in the second area A2.

[92] The second hands 220 each have one or more second pickers capable of gripping or releasing electronic components ED.

[93] The second pickers may grip electronic components by vacuum pressure.

[94] The second pickers are provided to grip electronic components in a dead-bug state.

[95] To increase working capacity in a single operation of the second hand 220, the second hand 220 may be provided

with a plurality of second pickers. For example, as shown in the schematic diagram of FIG. 5, the second hand 220 may have four second pickers P2 arranged in a 2×2 matrix. The number of second pickers P2 provided in the second hand 220 may be increased or decreased depending on the implementation.

[96] The second pickers P2 are installed on an installation body 221 such that the positions thereof in the X-and Y-axis directions are fixed relative to each other.

10 [97] The installation body 221 is installed to be movable.

[98] The installation body 221 may be moved in the horizontal directions (the X- and Y-axis directions) by a mover 222.

[99] The second hand 220 has second elevators E2 configured to lift/lower the second pickers P1 independently. By the second elevators E2, the second pickers P2 may selectively grip or release electronic components. Accordingly, electronic components ED unloaded from the transport table 110 by the second hand 220 may be gripped individually, and electronic components E loaded onto the test table 300 by the second hand 220 may be loaded individually.

[100] The second hand 210 may further include a second camera C2.

[101] According to one example, the controller 800 may control the second hand 220 to grip an electronic component ED with the second picker P2 after accurately calculating the position of the electronic component ED before gripping

by analyzing an image captured by the second camera C2 before the second hand 210 grips the electronic component. Accordingly, the second picker P2 may grip the electronic component ED more precisely, and thus, may seat the electronic component ED in a correct position on the test table 300.

[102] According to one example, the controller 800 may accurately calculate the position of an electronic component ED by analyzing an image acquired by photographing the electronic component ED, loaded in the temporary area of the test table 300, with the second camera C2. Accordingly, the controller 800 may control the second hand 220 to precisely move the electronic component ED, placed in a temporary zone, to a regular zone. In this case, the temporary zone refers to the position where an electronic component ED is temporarily loaded before being moved to a regular zone.

[103] As shown in the example of FIG. 6, the second camera C2 is provided to photograph a first corner D1 or a second corner D2 among the four corners of the electronic component ED. In this case, the first and second corners D1 and D2 face each other in a diagonal direction.

[104] According to a preferred example of the present invention, the interval between the second camera C2 and the electronic component ED is kept closer than in the conventional art. Accordingly, as shown in the example of FIG. 7, assuming that the second camera C2 captures an image by using the center O of the electronic component ED as the

center of the image, all or at least a portion of the edge of the electronic component ED exceeds the field of view. That is, according to the present embodiment, the second camera C2 is installed such that the overall electronic component ED cannot be fully placed within an image I captured by the second camera C2. The focal length of the second camera C2 is set as the distance between the lens of the second camera C2 and the electronic component ED. Therefore, in the image captured by the second camera C2, the first and second edges D1 and D2 of the electronic component ED may be distinguished more clearly.

[105] (a) of FIG. 8 shows an image I1 captured by a camera according to the conventional art, and (b) and (c) of FIG. 8 show images I2 and I3 captured by the second camera C2 according to the present embodiment. (b) of FIG. 8 is an image I2 acquired by photographing a first corner D1 of an electronic component ED, and (c) of FIG. 8 is an image I3 acquired by photographing a second corner D2 of the electronic component ED.

[106] When the numbers of pixels of the images I1, I2 and I3 in (a), (b) and (c) of FIG. 8 are the same, the corners D1 and D2 and edge of the electronic component ED may be distinguished more clearly in the images I2 and I3 in (b) and (c) of FIG. 8 than in the image I1 in (a) of FIG. 8. According to the present embodiment, the processing and analysis of the images I2 and I3 may be made easier to reduce the time required, and the processing and analysis of

the images I2 and I3 may be performed more precisely. Accordingly, the current position of the electronic component ED (the coordinates on the X-Y plane and the angular position) may be determined more precisely.

5 [107] The positions of the corners D1 and D2 may be calculated by comparison with other specific points, or by comparison with the position of the second hand 220 or the positions of other components that are tracked in real time.

10 [108] However, the embodiment of FIG. 8 is implemented such that photographing is performed twice for a single electronic component ED, but it may also be implemented such that both the corners D1 and D2 are photographed together in a single act of photographing.

15 [109] For reference, the corners D1 and D2 that are the targets photographed by the second camera C2 may be replaced with special identification patterns, pads, terminals, marks, or the like depending on the implementation.

20 [110] FIG. 9 shows the case where the photographing targets of the second camera C2 are identification patterns D3 and D4. The identification patterns D3 and D4 may be partial patterns in specific areas of a circuit pattern in an electronic component ED.

25 [111] FIG. 10 shows the case where the photographing targets of the second camera C2 are identification pads D5 and D6. The identification pads D5 and D6 may be some pads placed in specific areas among a plurality of pads in an electronic component ED.

[112] FIG. 11 shows the case where the photographing targets of the second camera C2 are identification terminals D7 and D8. The identification terminals D7 and D8 may be some terminals in specific areas among a plurality of terminals in an electronic component ED.

[113] FIG. 12 shows the case where the photographing targets of the second camera C2 are identification marks M1 and M2. The identification marks M1 and M2 may be identifiers of specific shapes generated separately from a circuit pattern at a manufacturing plant during the manufacture of an electronic component ED.

[114] The relative positions of the second pickers P2 and the second camera C2 are fixed.

[115] Like the first pickers P1, the second pickers P2 may also be implemented to grip electronic components ED of various heights.

[116] The second hand 220 may further include second rotators R2.

[117] The second rotators R2 may each rotate an electronic component ED forward or rearward in the Θ -axis direction by using a vertical line V1 in the Z-axis direction as the axis of rotation.

[118] The second rotators R2 may rotate respective second pickers P2 individually. Due to the rotation of the second pickers P2, electronic components ED gripped by the second pickers P2 are also rotated. Accordingly, the second hand 220 may not only move the electronic components ED in the X-

, Y-, and Z-axis directions, but also rotate them in the Θ -axis direction. That is, the second hand 220 may correct the misalignment of electronic components ED analyzed via images captured by the second camera C2 and then seat them
5 onto the test table 300. Furthermore, the positions of the electronic components ED seated into the regular zones of the test table 300 by the second hand 220 are fixed by vacuum pressure. Therefore, during the process in which the electronic components ED are moved by the second hand 220,
10 the positions of the electronic components ED in the X-, Y-, Z-, and Θ -axis directions may be precisely adjusted by the second hand 220.

[119] The second hand 220 may further include buffers SA.

[120] The buffers SA each buffer the pressure applied to the
15 electronic component ED that the second picker P2 is gripping or needs to grip.

[121] The buffers SA may be provided as springs, pneumatic cylinders, or the like.

[122] Each of the buffers SA corresponds to each of the
20 second pickers P2. Accordingly, the electronic components ED gripped by the respective second pickers P2 may be buffered individually.

[123] The test table 300 is provided to be loaded with the electronic components ED that are unloaded from the
25 transport table 110 by the second hand 220.

[124] As shown in the schematic excerpt of FIG. 13, the test table 300 is provided to have a flat top surface.

Accordingly, electronic components ED are loaded onto the test table 300 in such a manner that the electronic components ED are placed on the flat top surface of the test table 300.

5 [125] When viewed in a plan view, the test table 300 may be formed in the shape of a disk as in (a) of FIG. 13 or in the shape of a square plate as in (b) of FIG. 13.

[126] According to the present invention, the test table 300 may be moved in the X- and Y-axis directions, or may be
10 rotated in the Θ -axis direction by using a vertical line V2, passing through the center of the test table 300 in the Z-axis direction, as the axis of rotation.

[127] Furthermore, the test table 300 may be lifted/lowered in the Z-axis direction by the connector 700 to be described
15 later.

[128] The vacuum holes h are formed in the areas where electronic components ED are loaded on the test table 300. Furthermore, when vacuum pressure is applied through the vacuum holes h, the electronic components ED may be fixed to
20 the test table 300. That is, when the electronic component ED is placed on the test table 300 by the second hand 220, the electronic component ED may be seated at the position, where it was placed, without change by the vacuum pressure.

[129] According to a preferred example, a third camera C3
25 may be installed at the center of the test table 300. In this case, the third camera C3 is used to identify the angular position (the position in the Θ -axis direction) of a

test board to be described later. However, any position where the angular position of the test board TB can be identified may preferably be considered as a position for the installation of the third camera C3.

5 [130] The vacuum device 400 provides vacuum pressure to the vacuum holes h in the test table 300 via a vacuum circuit (not shown). The vacuum pressure provided by the vacuum device 400 is transmitted to the electronic components ED through the vacuum holes h. Accordingly, the positions of
10 the electronic components ED loaded onto the test table 300 may be fixed by the vacuum pressure.

[131] The vacuum holes h may be implemented to be selectively opened or closed depending on the control of the vacuum circuit (not shown). Accordingly, the electronic
15 components ED may be fixedly loaded onto the test table 300, or may be separated from the test table 300.

[132] According to the present invention, the electronic components ED loaded onto the test table 300 and to be tested are precisely aligned in the alignment part RP. This
20 will be described in detail later.

[133] In the connection part CP, the electrical connection is set up between the electronic components ED, loaded onto the test table 300 that is moved to the connection part CP, and the tester.

25 [134] The test board TB is provided in the tester for electrical connection between the electronic components ED and the tester. The test board TB is coupled to the handler

TH. More specifically, the test board TB is coupled to the connection part CP.

[135] The electronic components ED loaded onto the test table 300 are electrically connected to the test board TB.

5 The electronic components ED may ultimately be electrically connected to the tester via the test board TB.

[136] In this case, the test board TB will be described in brief.

10 [137] FIG. 14 is a bottom view showing the bottom surface of the test board TB.

[138] Although the test board TB is formed in the shape of a disk in the example of FIG. 14, the test board TB may also be provided in the shape of a square plate.

15 [139] As in FIG. 14, test zones TZ corresponding to respective electronic components ED are arranged on the test board TB. The test zones TZ correspond to the electronic components ED, loaded onto the test table 300, in a one-to-one correspondence.

20 [140] Each of the test zones TZ is provided with test pins t for electrically connecting to one electronic component ED.

[141] The test pins t in each test zone TZ form a single set to form the test zone TZ, and are electrically connected to an electronic component ED. Accordingly, the test zone TZ and the electronic component ED have to be aligned with each other. When the coordinates of the electronic component ED on the test table 300 do not match the coordinates of the test zone TZ on the X-Y plane, a failure occurs in the

25

electrical connection between the electronic component ED and the tester.

[142] In particular, as shown in the conceptual example of FIG. 15, when the electronic component ED on the test table 300 is placed at an angular position rotated by a rotation angle Θ_1 in the Θ -axis direction relative to the test zone TZ, a failure occurs in the electrical connection between the electronic component ED and the tester. Accordingly, all the test zones TZ of the test board TB and all electronic components ED on the test table 300 have to be aligned with each other.

[143] The electronic components ED to be tested and loaded onto the transport table 110 may have misaligned positions in the horizontal and Θ -axis directions. Accordingly, when the electronic components ED on the transport table 110 are moved to the test table 300 without change, the positions of the electronic components ED, loaded onto the test table 300 by the second hand 220, on the X-Y plane or the angular positions thereof may be misaligned. That is, the electronic components ED loaded onto the test table 300 and the test zones TZ of the test board TB may not be aligned with each other.

[144] It does not matter when the range of error tolerances between the electronic components ED and the test zones TZ is wide. However, the reality is that a precision within 30 μm is required for the packaged semiconductor device and a precision within 5 μm is required for the die or HBM. To

overcome this problem, in the present invention, the handler TH may be operated by two methods.

[145] One operation method is for the second hand 220 to align the positions of the electronic components ED in the horizontal and Θ -axis directions in the process of moving the electronic components ED from the transport table 110 to the test table 300.

[146] Another operation method is for the second hand 220 to first load the electronic components ED into temporary zones of the test table 300, correct the positions of the electronic components ED by the second hand 220 and then rearrange them to the regular zones of the test table 300. In this case, the planar shape and area of the temporary and regular zones may be the same as the planar shape and area of the electronic components ED. These temporary and regular zones will be described further.

[147] The temporary zones are not set positions, but are any positions where electronic components ED are placed on the test table 300 by the second hand 220. That is, the temporary zones are not set by the controller 800 or are not fixed, but are the positions determined by the second hand 220 as desired. For example, when the second hand 220 seats electronic components ED onto the test table 300, the zones where the electronic components ED are seated become the temporary zones BZ. The exaggerated FIG. 16 shows an example of the temporary zones BZ on the test table 300.

[148] The regular zones RZ refer to the positions where the electronic components ED and the test zones TZ are aligned with each other. The exaggerated FIG. 17 shows the relationship between the temporary zones BZ and the regular zones RZ on the test table 300.

[149] Although the regular zones RZ may be preset, they may be set to match the positions and arrangement of the test zones TZ on the test board TB after the electronic components ED to be tested have been loaded onto the test table 300.

[150] For reference, when only a theoretical design that does not give consideration to machining errors is taken into consideration, the interval between the second pickers of the second hand 220 may be the same as the interval between the electronic components ED seated onto the transport table 110. In this case, the adjustment of the interval between the electronic components ED moved from the transport table 110 to the test table 300 or from the test table 300 to the transport table 110 by the second hand 220 may not be required. Accordingly, the manufacturing cost may be reduced accordingly. In the same manner, the interval between the second pickers of the second hand 220 may be the interval between the test zones TZ of the test board TB, and may be the same as the interval between the regular zones RZ on the test table 300.

[151] For reference, although FIG. 9 shows the misalignment between temporary zones BZ and regular zones RZ as

significant, the misalignment between temporary zones BZ and regular zones RZ may be various. In some cases, temporary zones BZ and regular zones RZ may have the same center but only slight differences in angle.

5 [152] The temporary zones may be named arbitrary positions, and the regular zones may be named regular positions.

[153] In the sense that an electronic component placed in a temporary position is rearranged to be placed at a regular position, the state where correction is required in either a horizontal direction or a twisted rotation angle is referred to as the temporary position, while the regular position refers to the position where the electronic component is aligned as the desired state. Furthermore, the situation in which an electronic component is seated at a temporary position does not always means that the electronic component is incorrectly aligned.

10

15

[154] The movement mechanism 600 is provided to move the test table 300.

[155] The movement mechanism 600 in the present embodiment may rotate the test table 300 in the Θ -axis direction.

20

[156] Furthermore, the movement mechanism 600 in the present embodiment may move the test table 300 horizontally.

[157] As shown in the schematic excerpt of FIG. 18, the movement mechanism 600 includes a rotary mover 610 and a horizontal mover 620.

25

[158] The rotary mover 610 may rotate the test table 300 forward and rearward in the Z-axis direction by using a

vertical line V2, passing through the center of the test table 300, as the axis of rotation. The reason why the rotation of the test table 300 is required is to align the test table 300 with the test board TB. When there is
5 another mechanical design for aligning the test table 300 with the test board TB, the rotary mover 610 may be omitted.
[159] The horizontal mover 620 moves the test table 300 horizontally on the X-Y plane.
[160] The horizontal mover 620 may be divided into and
10 provided as an X-axis mover 621 and a Y-axis mover 622.
[161] The X-axis mover 621 may move the test table 300 horizontally in the X-axis direction.
[162] The Y-axis mover 622 may move the test table 300 horizontally in the Y-axis direction.
15 [163] The movement mechanism 600 moves the test table 300 horizontally to selectively position the test table 300 in the rearrangement part RP and the connection part CP. That is, by the movement mechanism 600, the test table 300 may be moved back and forth between the rearrangement part RP and
20 the connection part CP.
[164] The connector 700 electrically connects the electronic components ED, loaded onto the test table 300 that is moved to the connection part CP, to the tester.
[165] The connector 700 may press the test table 300 toward
25 the test board TB placed above the test table 300. Accordingly, the electronic components ED loaded onto the test table 300 are electrically connected to the test board

TB, thereby ultimately electrically connecting the electronic components ED to the tester. The testing of the electronic components ED is performed in the state in which the electronic components ED have been electrically
5 connected to the tester by the connector 700. In this case, the electronic components ED loaded onto the test table 300 has to be in the state in which they have been precisely arranged to the regular zones RZ by an alignment operation performed in the alignment part AP.

10 [166] In the present embodiment, the test table 300 is positioned below the test board TB. Accordingly, the connector 700 is provided to lift/lower the test table 300.

[167] The connector 700 electrically connects the electronic components ED, placed on the test table 300, to the test
15 board TB by lifting the test table 300 toward the test board TB placed above the test table 300. In this case, the electronic components ED are electrically connected to the test board TB via respective corresponding test zones TZ.

[168] As described above, according to the present
20 embodiment, during the process of aligning an electronic component ED, the second hand 220 is moved horizontally, and the second picker P2 precisely aligns the electronic component ED with the regular zone RZ while rotating and moving vertically.

25 [169] The above-described handler TH is intended to align electronic components ED to be tested with the regular zones

RZ of the test table 300. In connection with this, there are two operation methods, which will be described further.

[170] **<First Operation Method>**

[171] According to a first operation method, the second hand
5 220 directly moves the electronic components ED, placed on the transport table 110, to regular zones RZ of the test table 300. This will be described with reference to the flowchart of FIG. 19.

[172] **1. Photographing of Electronic Components <S11>**

10 [173] The positions of the transport table 110 and the test table 300 are tracked in real time by the controller 800. The positions of the regular zones RZ may be accurately determined by the position of the test table 300.

[174] Before gripping the electronic components ED placed on
15 the transport table 110, the second hand first photographs the electronic components ED with the second camera C2.

[175] The photographing of the electronic components ED is performed based on the number of electronic components ED that can be gripped by the second hand 220 at once.

20 [176] **2. Calculation of Positions of Electronic Components <S12>**

[177] The controller 800 calculates the positions of the electronic components ED by analyzing an image captured by the second camera C2.

25 [178] The positions of the electronic components ED may be accurately calculated by relative comparison with specific points on the transport table 110.

[179] **3. Calculation of Movement Distances <S13>**

[180] The controller 800 calculates the movement distances of the electronic components ED by comparing the positions of the electronic components ED on the transport table 110 with the positions of the regular zones RZ of the test table 300. In this case, the movement distances include not only the movement distances in the horizontal directions but also the rotational movement distances in the Θ -axis direction intended to correct angular misalignment.

[181] **4. Gripping of Electronic Components <S14>**

[182] The second hand 220 grips the electronic components ED of the transport table 110. In this case, the electronic components ED may be gripped all at once by all the second pickers P1, or the electronic components ED may be gripped one by one sequentially while correcting the horizontal positional relationship between the electronic components ED.

[183] **5. Movement and Rotation of Electronic Components <S15>**

[184] The second hand 220 operates the mover 222 and the second rotators R2 to move the electronic components ED horizontally to the regular zones RZ of the test table 300 and rotate them ED in order to correct angular misalignment in the Θ -axis direction.

[185] **6. Seating of Electronic Components <S16>**

[186] Once the positions of the electronic components ED have been aligned, the second elevators E2 operate to seat

the electronic components ED, gripped by the second pickers P2, into the regular zones RZ of the test table 300.

[187] In this case, the electronic components ED may also be seated by two methods.

5 [188] When the relative positions of the electronic components ED have been corrected in the preceding step S14, the electronic components ED gripped by the second hand 220 may be seated onto the test table 300 all at once.

10 [189] When the relative positions of the electronic components ED have not been corrected in the preceding step S14, the electronic components ED gripped by the second hand 220 may be sequentially seated into the respective regular zones RZ.

15 [190] The electronic components ED are fixed in the regular zones RZ of the test table 300 by vacuum pressure upon seating.

[191] **<Second Operation Method>**

[192] According to a second operation method, the second hand 220 temporarily moves the electronic components ED, placed on the transport table 110, to temporary zones BZ of the test table 300 and then moves them to regular zones RZ. When the second operation method is applied, the degree of freedom of the transport table 110 is improved. This will be described with reference to the flowchart of FIG. 20.

25 [193] **1. Movement of Electronic Components <S21>**

[194] The second hand 220 rapidly moves all the electronic components ED, placed on the transport table 110, to the

temporary zones BZ of the test table 300. Accordingly, the transport table 110, which has been rapidly emptied, may move to the first zone A1 and be load with subsequent electronic components ED.

5 [195] **2. Photographing of Electronic Components <S22>**

[196] Once all the electronic components ED on the transport table 110 have been moved to the temporary zones BZ of the test table 300, the electronic components ED in the temporary zones BZ are photographed with the second camera
10 C2 of the second hand 220.

[197] The photographing of the electronic components ED is performed based on the number of electronic components ED that can be gripped by the second hand 220 at once.

15 [198] **3. Calculation of Positions of Electronic Components <S23>**

[199] The controller 800 calculates the positions of the electronic components ED by analyzing an image captured by the second camera C2. In this case, the positions of the electronic components ED are the same as the temporary zones
20 BZ.

[200] The position of the test table 300 is tracked in real time by the controller 800.

[201] The positions of the electronic components ED may be accurately calculated by relative comparison with specific
25 points on the test table 300, but may also be calculated by another method.

[202] **4. Calculation of Movement Distances <S24>**

[203] The controller 800 calculates the movement distances of the electronic components ED by comparing the positions of the electronic components ED in the temporary zones BZ of the test table 300 with the positions of the regular zones RZ of the test table 300. In this case, the movement distances include not only the movement distances in the horizontal directions but also the rotational movement distances in the Θ -axis direction intended to correct angular misalignment. In this case, the regular zones RZ may be precisely determined by the position of the test table 300.

[204] **5. Gripping of Electronic Components <S25>**

[205] The second hand 220 grips the electronic components ED placed in the temporary zones BZ. In this case, it may be possible to grip the electronic components ED all at once with all the second pickers P1. Alternatively, it may be possible to sequentially grip the electronic components ED one by one while correcting the horizontal positional relationship between the electronic components ED.

[206] **6. Movement and Rotation of Electronic Components <S26>**

[207] The second hand 220 operates the mover 222 and the second rotors R2 to move the electronic components ED horizontally to the regular zones RZ of the test table 300 and rotate them in order to correct angular misalignment in the Θ -axis direction.

[208] **7. Seating of Electronic Components <S27>**

[209] Once the positions of the electronic components ED have been aligned, the second elevators E2 operate to seat the electronic components ED, gripped by the second pickers P2, into the regular zones RZ of the test table 300.

5 [210] In this case, the electronic components ED may also be seated by two methods.

[211] When the relative positions of the electronic components ED have been corrected in the preceding step S25, the electronic components ED gripped by the second hand 220
10 may be seated into the regular zones RZ all at once.

[212] When the relative positions of the electronic components ED have not been corrected in the preceding step S25, the electronic components ED gripped by the second hand 220 may sequentially be seated in the respective regular
15 zones RZ.

[213] The above steps S25 to S27 may be grouped into an electronic component movement and seating step, and there may be various detailed methods.

[214] **<Reference Notes>**

20 [215] According to the above embodiments, the alignment and lifting/lowering of electronic components ED in the alignment part AP are performed by the second hand 220.

[216] Meanwhile, an implementation may be made to provide the lifting/lowering of the test table 300 by the connector
25 700 instead of the lifting/lowering of the electronic components ED by the second elevators E2.

[217] Furthermore, an implementation may be made to provide the rotation of the test table 300 by the rotatory mover 610 instead of the rotation of electronic components ED by the second rotators R2.

5 [218] Furthermore, an implementation may be made to provide the movement of the test table 300 by the horizontal mover 620 instead of the movement of the electronic components ED by the mover 222.

[219] Moreover, to further reduce the time required to load
10 electronic components onto the test table 300, an implementation may also be made such that the horizontal movement, rotational movement, and lifting/lowering movement of electronic components ED by the second hand 220 and the horizontal movement, rotational movement, and
15 lifting/lowering movement of the test table are performed together.

[220] The above-described embodiments have been described using preferred examples of the present invention, and may have various forms of application. Therefore, the present
20 invention should not be understood as being limited only to the content described above. Instead, the scope of the present invention should be understood as the separately described claims and their equivalents.

CLAIMS

[Claim 1] A handler for testing electronic components,
the handler comprising:

5 a transport shuttle provided with a transport table
capable of transporting electronic components by moving with
the electronic components loaded thereonto;

a first hand configured to load the electronic
components onto the transport table that is placed in a
first area by an operation of the transport shuttle;

10 a second hand configured to unload the electronic
components from the transport table that is moved from the
first area to a second area by an operation of the transport
shuttle;

15 a test table configured such that the electronic
components unloaded from the transport table by the second
hand are loaded thereonto;

a movement mechanism configured to move the test table
between an alignment part, in which the electronic
components are aligned on the test table by the second hand,
20 and a connection part, in which the electronic components on
the test table are electrically connected to a tester;

a connector configured to enable the electronic
components, loaded onto the test table, to be tested by
electrically connecting the electronic components to a
25 tester; and

a controller configured to control the transport

shuttle, the first hand, the second hand, the movement mechanism, and the connector;

wherein the second hand comprises:

5 a plurality of second pickers capable of gripping the electronic components using vacuum pressure;

a movable installation body configured such that the plurality of second pickers are installed thereon;

10 a mover configured to move the installation body in horizontal directions; and

a plurality of second elevators configured to independently lift or lower the plurality of respective second pickers; and

15 wherein the controller controls the second hand to align the electronic components to regular zones of the test table.

[Claim 2] The handler of claim 1, wherein:

20 the second hand further comprises a second camera configured to photograph an electronic component loaded into a temporary zone of the test table by the second hand; and

the controller analyzes an image captured by the second camera to calculate the temporary zone, and then controls the second hand to align the electronic component in the temporary zone and rearrange the electronic component to a regular zone.

25

[Claim 3] The handler of claim 1, wherein the second hand further comprises a plurality of rotators configured to independently rotate the plurality of respective second pickers.

5 [Claim 4] The handler of claim 1, wherein:

the second hand further comprises a plurality of buffers configured to buffer pressure applied to the electronic components when the electronic components are loaded onto the test table; and

10 the plurality of buffers independently buffer the electronic components gripped by the plurality of respective second pickers.

[Claim 5] The handler of claim 1, wherein the second pickers grip electronic components in a dead-bug state.

15 [Claim 6] The handler of claim 1, wherein the movement mechanism comprises:

a rotary mover configured to rotate the test table;
and

a horizontal mover configured to move the test table
20 horizontally.

[Claim 7] A method of aligning electronic components for a handler for testing electronic components, the method

comprising:

an electronic component movement step of moving electronic components on a transport table to temporary zones of a test table with a second hand;

5 a photographing step of photographing an electronic components placed in a temporary zone with a second camera installed in the second hand;

10 an electronic component position calculation step of calculating a position of the electronic component placed in the temporary zones by analyzing an image captured in the photographing step;

15 a movement distance calculation step of calculating, by a controller, a movement distance required to move the electronic component from the position calculated in the electronic component position calculation step to a regular zone of the test table; and

20 an electronic component movement and seating step of gripping the electronic component in the temporary zone with the second hand, moving the electronic component by the movement distance calculated in the second calculation step, and then seating the electronic component into the regular zone.

[Claim 8] The method of claim 7, wherein the second movement step comprises:

25 a rotational movement step of rotating the electronic component gripped by the second hand; and

a horizontal movement step of moving the electronic component, gripped by the second hand, in a horizontal direction.