

REDISTRIBUTION SYSTEM ✓**FIELD OF THE INVENTION**

The present invention is related to distribution systems. In particular, the
5 present invention is related to the transfer and distribution of integrated
circuit (IC) packages.

BACKGROUND OF THE INVENTION

The production of IC packages require numerous steps including
packaging, trimming and forming, and testing. Each step has its own
10 requirements, and sophisticated distribution and pick and place systems are
required to automate and streamline the transfer. In the test handler for
quality control, a fixed number of devices may be tested in one cycle. This
number differs according to the type of test site and the type of device. In
order to transfer the devices from the apparatus of the previous step to the
15 test site, various systems may be employed. These include the use of
sophisticated pick and place system which transfer the devices to
intermediate stacking trays or hot plates, before a second transfer system is
used to distribute the devices or trays into the test handler and test site.

The systems available in the art are not efficient, as they involve multiple
20 transferring steps or sophisticated software control. This is because of the
differences between the various apparatus, which result in different
arrangement of the array of devices. For example, the devices may be
arranged in a 5x3 matrix in the lead frame, with a fixed pitch or spacing

between the rows and columns of devices. The test site, however, may require a different arrangement and also different pitching. Therefore, either extensive rearrangement has to be made, or a sophisticated pick and place system is needed in the test handler to pick up the required number of devices, to spread them to the prerequisite pitch, and then to place them on a tray to be transferred into the test site for testing. Furthermore, a certain amount of soak time is required to bring the devices to the test temperature, further complicating equipment requirements. Sophisticated algorithms have to be developed to keep track of the complicated arrays resulting from the transfer of fixed numbers of devices during each testing cycle.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a redistribution system to overcome the shortcomings as stated above.

It is another object to provide a redistribution system which is simple and cost effective.

It is yet another object to provide an embodiment of a redistribution system which is adjustable according to the soak time requirement.

SUMMARY OF THE INVENTION

According to the objects of the invention, there is provided a redistribution system having a spatial redistribution ability which can transfer devices arranged in an array of columns and rows to a test handler having a test site
5 with a plurality of test sockets. According to one aspect of the invention, at least one receiving tray with a plurality of receiving sites is provided. The receiving sites are for receiving IC devices and are arranged into at least one receiving matrix having specific distance between the rows and columns. The pitch or distance between the columns is ideally the same as the
10 distance between the test sockets, which are normally arranged in a linear row. Pick and place instruments are provides to deliver columns of devices from the array to columns of receiving sites in the receiving tray. The number of columns to be placed in each matrix of the receiving tray is preferably the same as the number of test sockets. As a result, a simple linear delivering
15 system may be used to transfer a row of devices into the test site for testing.

In another aspect of the invention, the number of matrices in each tray, and the number and arrangements of the trays may be adjusted to increase the soak time needed for the devices under test to warm up to the test temperature, while maintaining the efficiency of the system. In yet another
20 aspect of the invention, the receiving tray is provided with a cover to provide small devices from being dislodged.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top plan view of a test handler system according to the present invention.

Figure 2 is a front view of the same system.

5 Figure 3 is a side view of the same system.

Figure 4 is a top plan view of a another test handler system according to the present invention.

Figure 5 is a cross-section view (Fig. 5A) and a top plan view (Fig. 5B) of a tray according to the present invention.

DESCRIPTION OF THE INVENTION

A redistribution system for an IC device test handler is described. In the following description, numerous specific details will be provided where they are necessary for the understanding and practice of the present invention. In
5 other instances, well known elements such as conveying systems, temperature control chambers and conventional pick and place apparatus are not described in details in order not to unnecessarily obscure the present invention.

Figure 1 shows a top plan view of a redistribution system in a test handler
10 according to the present invention. A conventional test site 20 in a temperature controlled chamber 22 is provided in the test handler. A first 24 and a second 26 tray having receiving sites (illustrated as dots in the trays) arranged in a plurality of matrices 28 are used to receive IC devices. The trays are preferably a hot plate made of heat-resistant and heat-conducting
15 material such as metal, as testing temperatures for IC devices may be quite high. The receiving sites may be just imaginary sites or actual sites such as individually raised mini-platforms adapted to receive, for example, gull wing QPF, SOIC, TSSOP, J bend and PLCC devices, or straight lead devices such as BGA and CSP. Each column of each matrix is separated from
20 another column by a distance which is ideally the same as the distance between the test sockets in the test site. The trays are movable by conventional means (not shown) between a receiving position 30 and an unloading position 32 as shown by the double-headed arrows. Conventional transferring means, such as pick and place mechanisms, for

example with a vacuum pick up mechanism, are also provided for transferring devices from one section to another. Figure 1 shows a first 34 and second 36 pick and place apparatus which are movable along ball screws 38 and 40 respectively. Shuttles 39 and 41 in this example is
 5 extended to the exterior of the temperature controlled chamber, such that the device may be transported away from the test site by pick and place apparatus after testing. Array 42 is provided in Figure 1 to illustrate an example of an array of devices at the lead frame which may be produced from a previous step, e.g. trim and form. Other types which can be used
 10 include Jedec trays or any other trays or arrays.

Figure 2 shows the front view of the relevant portions of the same test handler. This system is controlled by a computer with a display screen 48. Shuttles (not shown) are provided to transfer the tested devices away from the temperature control chamber 22 and test site 20 to the exterior.

15 Figure 3 is an enlarged side view of the same test handler showing the first 34 and second 36 pick up apparatus. Both are L-shaped, and have adjustable arms 35 and 37 which can be raised and lowered such that the pick-up mechanisms of both apparatus are along the same axis as the test sockets as shown by the dotted line. conventional vacuum suction
 20 mechanisms may be employed for the pick and place function.

During operation, a conventional pick and place arm (not shown) is used to pick up the first two columns 44 of the array 42 in Figure 1, and to transfer it to the first two columns 46 of the first matrix of the first tray 24. The number of receiving sites in each column of each matrix of each tray (e.g. column 46)

is ideally equal or more than the number of devices in each column of the incoming array 42 (e.g. column 44). In this way, every device from column 44 may be transferred over to column 46. Extra receiving sites in each column may be left empty. Although Figure 1 shows the transfer of two columns each time, it is understood that different numbers of columns may be transferred together, depending on the algorithm and apparatus available. For a simple pick and place system, one column may be transferred each time. The pick and place system continues to transfer additional columns from the incoming array 42 to the first matrix of tray 24. Once the first matrix is full, the computer control system would direct the pick and place system to start loading the first matrix of the second tray. Again, the ideal loading sequence is according to columns. In this way, the pitch between each column is automatically adjusted to correspond to the pitch required for testing. After the first matrix in the second tray is full, the system shifts the two trays one matrix higher, such that the second matrix of the first tray may be loaded, followed by the second matrix of the second tray. Subsequent matrices are then loaded in this alternate fashion. The matrices of the two trays are preferably fully loaded before testing commences. This is to allow sufficient soak time for the devices to reach the testing temperature.

For testing, the first tray is moved to the unloading position, and the first row of the IC devices are transferred by the first pick and place apparatus 34 to the testing sites in the test site. Once testing is complete, shuttle 41 transports the tested devices away from the test handler. This transporting step is performed simultaneously with another transferring step, in which the second pick and place apparatus 36 picks up the second row of devices

from the first matrix of the first tray, and transfers them to the testing sites for testing. Once testing is completed, the second row of devices is transported away from the test handler by shuttle 39, and this step is synchronized with the test transferring step of the third row of devices for testing by apparatus 5 34. This synchronized loading is continued until devices in the first matrix have been completely tested. Then the first tray is moved back to the receiving position while the second tray is moved to the unloading position for the synchronized testing and unloading of the devices in its first matrix. While testing is being performed on the devices of the first matrix in the 10 second tray, the empty matrix in the first tray is being re-loaded with incoming devices. When all the devices from the first matrix of the second tray has been unloaded, the second tray is moved back to the receiving position, for re-loading. The first tray is then moved to the unloading position where the second matrix is unloaded row by row for testing, followed by the second 15 matrix of the second tray. When devices in the last matrices has been unloaded, testing resumes in the first matrices. This alternative and synchronized loading sequence is preferred but not required, as it gives a seamless method which maximizes the efficiency of the test site, while also giving sufficient soak time for the devices.

20 Figure 4 shows the top plan view of another embodiment according to the present invention. The test site 56, temperature control chamber 58, the pick and place arms 60 and 62 and shuttles 64 and 66 are similar to the ones shown in Figure 1. An input arm (not shown) is used to transfer devices from the lead frame to the receiving sites on the trays as illustrated by the double- 25 sided arrow. In this embodiment, additional trays 68 are provided which

move in a continuous cyclic array as shown by the one-sided arrows. This arrangement increases the number of trays within the test handler and the temperature control chamber, and allow an increased soak time due to the longer cycle time. The receiving sites 70 in the trays in Figure 4 are also
5 shown to be larger to illustrate how the trays in the present invention may be adapted for retaining devices of different sizes and shapes.

Figure 5 shown another embodiment of the tray which includes a slidable cover 74 for smaller devices 76 which are prone to dislocation when the trays are shifted. The cover is attached to a spring loaded shoulder screw 80
10 containing long slots 78 wherethrough the small devices may be inserted or removed. During transfer or shifting, the shoulder screw slides the cover backwards a distance equivalent to the pitch, such that the devices are now protected by the cover in between the slots. The cover slides back to expose the devices when they are ready to be picked up.

15 While the present invention has been described particularly with references to Figs 1 to 5 with emphasis on an tray system for a test handler, it should be understood that the figures are for illustration only and should not be taken as limitation on the invention. In addition it is clear that the method and apparatus of the present invention has utility in many applications where
20 automatic transferring is required. It is contemplated that many changes and modifications may be made by one of ordinary skill in the art without departing from the spirit and the scope of the invention described. This modifications include the number of trays and matrices in each tray, and the sequences in which the steps are performed. A continuous holding
25 apparatus may also be used as equivalents instead of numerous separate

trays as depicted in the drawings shown. Although the system is described as operating in a temperature controlled environment, with the tray having the ability to withstand heat, it is clear that this invention may be practiced under numerous other environmental conditions and the tray made from

5 suitable materials.

**CLAIMS**

- 1 1. A redistribution system for transferring devices arranged in an array of
2 columns and rows to a test handler having a test site with a row of test
3 sockets comprising :
- 4 at least one receiving tray with a plurality of receiving sites for
5 receiving devices, said receiving sites arranged into at least one
6 receiving matrix having predetermined numbers of rows and columns;
7 said columns set at a preset distances apart, said predetermined
8 number of columns corresponding to the number of test sockets in
9 said test site, and said preset distance corresponding to the distance
10 between said test sockets;
- 11 a pick and place apparatus adapted to pick up a plurality of devices
12 from at least one column of said array and to place said devices onto
13 a corresponding column of receiving sites in said receiving tray;
- 14 means for delivering a row of devices on said receiving tray into said
15 test site for testing, and transporting said tested devices away from
16 said test site after testing.
- 1 2. A redistribution system according to claim 1 wherein the receiving tray
2 and test site are disposed within a temperature controlled chamber.
- 1 3. A redistribution system according to claim 1 wherein said receiving
2 tray is movable between a receiving position and an unloading
3 position, said receiving position for receiving said devices from said
4 pick and place apparatus, said unloading position for pick up of



5 devices by said means for delivering; said redistribution system further
6 provided with means for transferring said receiving tray from said
7 receiving position to said unloading position.

1 4. A redistribution system according to claim 3 wherein two receiving
2 trays are provided, each receiving tray movable between a receiving
3 and an unloading position.

1 5. A redistribution system according to claim 1 wherein a plurality of
2 receiving trays are provided.

1 6. A redistribution system according to claim 5 wherein said receiving
2 trays are arranged and movable in a cyclic array, each tray having a
3 receiving and an unloading position within said cyclic array, said
4 receiving position for receiving said devices from said pick and place
5 apparatus, said unloading position for pick up of said device by said
6 means for delivering; said redistribution system further provided with
7 means for transferring said receiving trays from, said receiving
8 position to said unloading position.

1 7. A redistribution system according to claim 1 wherein said array of
2 columns and rows are disposed in a lead frame from a trim and form
3 machine.

1 8. A redistribution system according to claim 1 wherein said receiving
2 tray is provided with a cover for preventing dislocation of said devices
3 during transfer.



- 1 9. A redistribution system according to claim 8 wherein said cover is
2 slidably attached to said receiving tray, and comprises slots
3 wherethrough devices may be inserted or removed.
- 1 10. A method for redistribution of devices from an array of columns and
2 rows to a test handler with a test site with plurality of test sockets
3 comprising :
- 4 a) transferring one column of devices from said array to a
5 corresponding column in a receiving tray;
- 6 b) transferring a second column of devices from said array to a
7 corresponding second column in said receiving tray, said
8 second column being separated from said first column by a
9 distance equal to the distance between said test sockets;
- 10 c) repeating step (b) to form a matrix of devices in said receiving
11 tray having a number of columns equal the number of test
12 sockets in said test site; and
- 13 d) delivering the first row of devices of said matrix to said test site
14 for testing
- 15 e) transporting the first row of devices away from the test site
- 16 f) repeating steps (d) and (e) until all rows in said matrix have
17 been tested.



- 1 11. A method for redistribution according to claim 10 wherein steps (a) to
2 (c) are repeated to form additional matrices before steps (d) to (f) are
3 performed.
- 1 12. A method for redistribution according to claim 11 wherein at least one
2 additional tray is provided, and steps (a) to (c) are repeated on said
3 additional tray before steps (d) to (f) are performed.
- 1 13. A method for redistribution according to claim 12 wherein said trays
2 are movable between a receiving position and an unloading position,
3 said receiving position for receiving said devices from said pick and
4 place apparatus, said unloading position for pick up of said device by
5 said means for delivering, said method further comprising the step of
6 moving said tray from said receiving position to said unloading
7 position before steps (d) to (f) are performed.
- 1 14. A method for redistribution of devices from an array of columns and
2 rows to a test handler with a test site with plurality of test sockets
3 comprising :
- 4 a) transferring a plurality of columns of devices from said array to
5 a corresponding plurality of columns in a receiving tray;
- 6 b) transferring a second plurality of columns of devices from said
7 array to a corresponding second plurality of columns in said
8 receiving tray, each of said columns in said receiving tray being
9 separated from neighboring columns by a distance equal to the
10 distance between said test sockets;



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- 11 c) repeating step (b) to form a matrix of devices in said receiving
12 tray having a number of columns equal the number of test
13 sockets in said test site; and
- 14 d) delivering the first row of devices of said matrix to said test site
15 for testing
- 16 e) transporting the first row of devices away from the test site
- 17 f) repeating steps (d) and (e) until all rows in said matrix have
18 been tested.

- 1 15. A method for redistribution according to claim 14 wherein steps (a)
2 and (c) are repeated to form additional matrices before steps (d) to (f)
3 are performed.