

SOLDER BALL LOADING MECHANISM

FIELD OF THE INVENTION

5 The present invention relates generally to the field of semiconductor packaging, and particularly to a solder ball loading mechanism used during a BGA packaging process.

BACKGROUND OF THE INVENTION

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BGAs (Ball Grid Arrays) are relatively new semiconductor devices where the contact points are solder balls arranged in an array formation. When creating a BGA device, the solder balls must be placed precisely on the BGA substrate in an array formation. Currently, all of the balls for a BGA
15 device are placed at one time using a suction pick & place device which picks up the balls in an array formation and places them onto the BGA substrate. But before the suction device can pick up the balls, the balls must first be loaded onto a template in an array formation. This can be a relatively time-consuming step during a BGA packaging process as the
20 balls tend to be very small and there are relatively large number of balls per array. Even a single missing ball will require a repeat of the loading process. Clearly, there is need for a mechanism for effectively and reliably loading the solder balls into an array formation with the minimum number of repeats.

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OBJECT OF THE INVENTION

It is therefore the object of the present invention to provide a mechanism for efficiently loading solder balls onto a template in an array
5 formation.

SUMMARY OF THE INVENTION

The present ball loading mechanism includes a movable plate.
10 Resting on top of the plate is a ball container adapted for holding relatively large quantities of solder balls. The container does not have a bottom, that is, the bottom of the container is essentially the plate itself. The container should be lightly resting on the plate so that the plate can easily slide underneath the container. To ensure that the container lightly rests on the
15 plate without any gaps, spring buffer may be provided between the container and the plate. Pressurized air is provided from two sides of the container via an air supply tube in an alternating fashion where only one of the tubes is providing air at any given time such that the air pressure causes the solder balls to move from side to side inside the container

20 The plate has at least one array template, and in this preferred embodiment, six templates. The templates are situated on the plate such that all six templates can be positioned underneath the container by sliding the plate towards the container. The template basically comprises step holes which are arranged in an array formation identical to that of the
25 pattern formed by the balls on the eventual BGA device. Each hole is only big enough to hold a single solder ball. Each of the holes extends through

the entire thickness of the plate but the diameter of the hole at the bottom is smaller than the diameter of the ball so that the solder ball does not fall through the hole. In the resting position, the solder ball should be just below or essentially even with the plane of the plate.

5 A pair of sensor devices , a detector and an emitter, is provided for detecting a missing ball in the templates. The emitter is located immediately below the templates, and the detector is attached to the side of the container. The emitter shines a light through the templates so that any hole which is not occupied by a solder ball will allow the light to be shined onto
10 the detector when the templates are positioned below the detector .

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective diagram of the present ball loading
15 mechanism shown in conjunction with solder ball suction pick & place device.

FIG. 2 is a cross-sectional view of the hole in the array template with a
20 solder ball resting inside the hole.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates the preferred embodiment of the present invention. For illustration purposes, the ball loading mechanism 1, the present
25 invention, is here shown in conjunction with a ball suction pick & place device 2. The ball suction pick & place device 2 works in conjunction with

the ball loading mechanism 1 during a BGA packaging process, but it is not part of the ball loading mechanism 1. It should be appreciated by those skilled in the art that the present ball loading mechanism 1 may work with other types of pick & place mechanisms other than the one shown herein.

5 The ball loading mechanism 1 includes a movable plate 5. Resting on top of the plate 5 is a ball container 15 adapted for holding relatively large quantities of solder balls 20. The container 15 does not have a bottom, that is, the bottom of the container is essentially the plate 5 itself. The container 15 should be lightly resting on the plate so that the plate 5 can
10 easily slide underneath the container 15. To ensure that the container 15 lightly rests on the plate 5 without any gaps, spring buffer may be provided between the container 15 and the plate 5.

Pressurized air is provided from two sides of the container 15 via air supply tube 25 (only one shown) in an alternating fashion where only one of
15 the tubes is providing air at any given time such that the air pressure causes the solder balls to move from side to side inside the container (hence the container preferably should have a cover though it is not shown here in the figure). It should be understood by those skilled in the art that while the air supply helps in the fill-in process and is highly desirable, it is possible that
20 the ball loading mechanism may operate without such air supply, or in the alternative, with other means for perturbing the balls inside the container.

The plate 5 has at least one array template 10, and in this preferred embodiment, six templates. The templates 10 are situated on the plate 5 such that all six templates 10 can be positioned underneath the container 5
25 by sliding the plate 5 towards the container 15. The template 10 basically comprises step holes which are arranged in an array formation identical to

that of the pattern formed by the balls on the eventual BGA device. As can be seen in FIG. 2, each hole 39 is only big enough to hold a single solder ball 35. Each of the holes 39 extends through the entire thickness of the plate 5 but the diameter of the hole 37 at the bottom is smaller than the diameter of the ball so that the solder ball does not fall through the hole. In the resting position, the solder ball 35 should be just below or essentially even with the top plane of the plate 5.

A pair of sensor devices, a detector 30 and an emitter 35, is provided for detecting a missing ball in the templates 10. The emitter 35 (shown in phantom lines) is located immediately below the templates 10, and the detector 30 is attached to the side of the container 15. The emitter 35 shines a light through the templates 10 so that any hole which is not occupied by a solder ball will allow the light to be shined onto the detector 30 when the templates 10 are positioned below the detector 30.

The solder ball loading process begins by filling the container 15 with sufficient amount of solder balls. To optimize the process, it is preferred that the container only be partially filled or there will not be sufficient room for the solder balls to move about inside the container. Sufficient movement is desirable as it helps to move the solder balls into place. On the other hand, having too few solder balls is also not desirable because a sufficient number of balls are needed to optimize the random fill-in process.

Once the container is filled with the solder balls 20, the air supply is activated so that the solder balls move from side to side inside the container 5. The plate 5 then slides towards the container 15 to place the templates 10 underneath the container 15. Once underneath the container 15, the plate 5 remains in position for a short duration to allow the balls 20 to fill the holes

of the templates 10. After such a predetermined period has elapsed, the plate 5 slides away from the container 15 so that the templates 10 are no longer underneath the container 15. As the templates 10 move below the upper sensor 30, it is determined whether any of the holes are missing a solder ball. If any missing solder ball is detected, the plate 5 slides back towards the container 15 and the fill-in process is repeated. When all of the holes in the templates 10 are filled with solder balls, no light shines through the template holes and the solder ball loading process is deemed to be completed.

10 Once the loading process has been completed, the ball suction pick & place device 2 picks up the solder balls from the templates maintaining the array formation, and places the solder balls onto BGA substrates. Further processing is required to permanently attach the solder balls onto the substrates.

15 The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are, therefore, to be
20 embraced therein.

CLAIMS**We Claim:**

- 1 1. A solder ball loading mechanism comprising:
2 a plate;
3 at least one array template disposed on said plate;
4 a container for holding solder balls disposed on said plate, a bottom
5 of said container being a top surface of said plate;
6 a mechanism for detecting whether said array template is completely
7 filled with solder balls;
8 whereby said plate slides towards said container to place the
9 template underneath the container to fill the array template with said solder
10 balls.
1 2. The solder ball loading mechanism as recited in claim 1 further
2 comprising an air supply for moving said solder balls inside said container.
1 3. The solder ball loading mechanism as recited in claim 1 wherein said
2 array template comprises an array of step holes, each of said holes being
3 large enough to accommodate a single solder ball, said hole having a
4 bottom hole which has a diameter smaller than said solder ball.
1 4. The solder ball loading mechanism as recited in claim 2 wherein said
2 array template comprises an array of step holes, each of said holes being
3 large enough to accommodate a single solder ball, said hole having a
4 bottom hole which has a diameter smaller than said solder ball.
1 5. The solder ball loading mechanism as recited in claim 1 wherein said
2 detecting mechanism comprises a detector and an emitter.



1 6. The solder ball loading mechanism as recited in claim 2 wherein said
2 detecting mechanism comprises a detector and an emitter

1 7. The solder ball loading mechanism as recited in claim 3 wherein said
2 detecting mechanism comprises a detector and an emitter, said emitter
3 located below said template, said detector located above said plate,
4 wherein said emitter shines a light through said holes, said light being
5 detected by said detector, whereby a detection of said light is indicative of a
6 missing solder ball.

1 8. The solder ball loading mechanism as recited in claim 2 wherein said
2 air supply is located on two sides of said container to supply air to said
3 container in an alternating fashion to move said solder balls from side to
4 side.

1 9. The solder ball loading mechanism as recited in claim 4 wherein said
2 air supply is located on two sides of said container to supply air to said
3 container in an alternating fashion to move said solder balls from side to
4 side.

1 10. The solder ball loading mechanism as recited in claim 1 further
2 comprising a spring buffer between said container and said plate.