

SOLDER BALL PLACEMENT WITH FLUX, TEMPLATE AND LASER TAG

FIELD OF THE INVENTION

5 The present invention relates to the use of soldering in the electrical connection between an IC device and a printed circuit board. In particular, the present invention relates to the exact placement of solder balls on a ball grid array (BGA) device in the manufacturing process.

10 BACKGROUND OF THE INVENTION

Ball grid array (BGA) packaging of integrated circuit (IC) devices is gaining increasing importance in IC device production. In BGA packaging, the IC chip is commonly mounted on a copper substrate with pads, whereon flux is applied followed by the placement of solder balls. The solder balls are then
15 soldered onto the pads in a reflow oven.

The conventional method of ball placement is to use a vacuum suction head with the appropriate array of suction holes to pick up the soldering balls. The balls sucked up in the proper array onto the head are then lowered onto a substrate with pre-applied flux. This BGA assembly can then
20 be conveyed to the reflow oven for soldering of the solder balls.

Current trend in IC chip production is for greater IC density per chip. The higher the IC density, the greater the number of interconnects required on the same chip size. Therefore, there has been a demand for BGA packages with higher density pads and solder balls. In these high density BGA

packages, the number of interconnecting pads per chip can be as high as 1,000 to 2,000, compared to a low density BGA package of below 400 pads per chip for the same surface area. For high density packages above 400 pads per chip, the pitch (distance between solder balls) and solder ball size
5 have to be reduced accordingly. For example, a low density BGA configuration of below 400 pads per chip with a pad diameter of 25 mil. and pitch of 50 mil. can use solder balls of 30 mil. diameter. In the case of high density BGA configurations for example with pads diameter of 10 mil. and pitch of 20 mil., solder balls of 12 mil. diameter have to be used instead.

10 This reduced pitch and ball size poses a problem for the soldering process. The first problem is placement problem. Due to the very small size and light weight of the solder balls, even a minute air turbulence or a minor warpage of the substrate might result in a displacement of the ball position. Because of the fine pitch required in high density arrays, even a slight
15 displacement may result in bridging, which is the mixing of two soldering balls to form a connection during the process of soldering in a reflow oven. Once bridging occurs, the entire package has to be rejected. Consequently, conventional method of ball placement using the vacuum suction head results in high rejection rates due to bridging. The second problem is in the
20 transfer of the packaging from the ball placement site to the reflow oven. Even if the solder balls were placed accurately, the movement necessary to transfer the packaging to the reflow oven would cause the balls to be displaced. There is therefore a need to improve the packaging process by designing new concepts of ball placement which would prevent
25 displacement of the solder balls and bridging.

OBJECT OF THE INVENTION

It is an object of the present invention to provide a method of small solder ball placement in the packaging of BGA devices.

It is another object to reduce the occurrence of solder ball bridging in the
5 BGA assembly process.

SUMMARY OF THE INVENTION

The present invention is a system for solder ball placement on pads of substrates of BGA packaging comprising means for template alignment,
10 means for solder ball placement and a laser head. A template is aligned with connection pads located on the surface of the substrate with pre-applied flux. The aligned template allows accurate guiding of the balls onto the pads by the ball placement means. One ball is dropped into each hole in the template directly onto a pad. The balls positioned on the pads are then
15 exposed for a short time to a laser via the laser head to cause partial melting of the balls. This short exposure to laser results in a gentle attachment or tagging of the balls onto the pad of the substrate. Once the balls are tagged, they can be transferred to the reflow oven without being easily displaced.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of template-guided ball placement step according to the present invention.

5 Figure 2 is a schematic illustration of the laser tagging step according to the present invention.

Figure 3 is a schematic diagram to show the positioning of a laser head for tagging of the solder ball.

Figure 4 is a flow diagram to illustrate the steps involved in the laser tagging system according to the present invention.

DESCRIPTION OF THE INVENTION

The present invention utilizes a combination of two separate techniques to the packaging of high density BGA devices. Applying either technique alone gives unsatisfactory results, but the combination of the two techniques in the proper sequence gives results that are synergistically superior to their expected additive benefits. The first technique involves the use of a template to guide the release and placement of the ball from a conventional ball sucking head. Once the balls are properly placed above the substrate and within the template, the second technique of laser tagging is used, which causes localized melting of the solder balls. This results in the balls being gently attached or tagged to the substrate below. The template can then be removed and the device transferred onto the reflow oven for proper soldering. The result is BGA packaging with high quality soldering of the solder balls. Rejection due to bridging of solder balls is also minimized.

Figure 1 shows a schematic illustration of the first step in the ball placement process according to the present invention. After flux is applied to the substrate 20 according to conventional methods, a template 22 of the high density array is placed over the substrate. A ball sucking head 24 with solder balls in position is aligned over the substrate, using the template as a guide. When the array in the ball sucking head is aligned with the array of the template, the vacuum on the ball sucking head is released, and the solder balls drop onto the substrate with flux. The ball sucking head may be a conventional one commonly used in BGA packaging, with the array adapted for high density devices. The template can be a wire mesh with the mesh size of the required density. The template may be made from any

material which is heat tolerant such as stainless steel or aluminium. A preferred material is stainless steel. The wire of the mesh should be thick enough to prevent a solder ball from rolling over the wire. For example, for a solder ball with diameter of 12 mil, the thickness of the wire of the mesh, as
5 indicated by reference numeral 26 of Figure 3, may be around 12 mil, to prevent the ball from rolling out of the cavity 27. In addition, the surface area of the cavity should preferably be slightly larger than the diameter of the solder ball for ease of placement by the ball sucking head, and prevention of a ball getting easily attached to the wire mesh. A preferred area is 15-
10 35% larger than the cross-sectional area of the solder ball.

Figure 2 illustrates how a matrix laser head is used to tag the solder balls. The ball sucking head is moved away from the substrate after ball placement, and a laser head 30 is placed over the template and solder balls. A short exposure of laser is given to the solder balls to cause localized
15 melting, resulting in the tagging of the solder balls onto the substrate. The laser head is preferably a gyroscope head or a matrix type head comprising of a series of optical fibers arranged in an identical array as the ball array. Lasers such as neodymium:yttrium-aluminum-garnet (Nd:YAG) laser is suitable for tagging. The exposure duration and intensity would depend on
20 the size of the solder ball.

Figure 3 shows the alignment of the optic fibers of the laser head with the solder balls 28 placed inside the cavities 27 of the template 29 above the layer of flux 32. The optical fibers are housed in a housing 34 which fixes the position of the optical fibers 36 to match the position of the pads and the

solder balls. The wire mesh of the template has a height 26 approximately the same as the diameter of the solder balls.

Figure 4 is a flow diagram to show process according to the present invention. After flux application 40, the template is aligned with the substrate
5 followed by ball placement with the ball sucking head 42. After step 42, a visual check 44 is preferably performed with a camera for example a CCD (capacitor charge device) camera to ensure that the balls are placed properly, followed by laser tagging 46. Steps 42-46 are preferably performed with the package stationary to minimize any disturbance to the
10 balls once they are placed onto the substrate. The last step 48 is the transfer of the package to the reflow oven for soldering of the balls.

While the present invention has been described particularly with references to Figs 1 and 4, it should be understood that the figures are for illustration only and should not be taken as limitation on the invention. It is
15 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.



CLAIMS

- 1 1. A system for solder ball placement for ball grid array packaging of an IC
2 chip with a substrate having an array of pads comprising :
3 means for template alignment;
4 a template with an array of cavities matching said array of pads,
5 means for solder ball placement and
6 a laser module with a laser head adapted to send at least one laser
7 beam onto said solder balls,
8 said system performing the sequential steps of :
9 aligning said cavities of said template with said array of pads having
10 pre-applied flux;
11 aligning said means for solder ball placement with said substrate
12 using said template as a guide so that an array of solder balls is aligned
13 with said array of pads;
14 discharging said aligned solder balls onto said pads with pre-applied
15 flux so that one solder ball is placed within each cavity of said template;
16 aligning said laser head with said substrate; and
17 discharging a laser beam directly onto said solder ball such that said
18 solder balls are lightly melted and tagged onto said pad.
- 1 2. A system for solder ball placement according to claim 1 wherein said
2 system further comprises a camera, and an additional step of visual
3 checking is performed after solder ball placement.



- 1 3. A system for solder ball placement of ball grid array packaging according
2 to claim 1 wherein said laser head is a matrix laser head.
- 1 4. A system for solder ball placement of ball grid array packaging according
2 to claim 1 wherein said laser head delivers a Nd:YAG laser beam.
- 1 5. An apparatus for solder ball placement of ball grid array packaging of an
2 IC chip with a substrate having an array of pads for interconnection
3 comprising :
4 means for template alignment;
5 means for solder ball placement onto said pads; and
6 a laser head adapted to send a laser beam onto said solder balls.