

BALL GRID ARRAY TYPE IC SOCKET

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to a ball grid array type IC socket for electrically connecting an LGA (land grid array) or a BGA (ball grid array) type IC package, which is mounted on an insulative housing of the IC socket, to electrical contacts provided in a matrix on the insulative housing in a pressurized
10 state, while also electrically connecting the electrical contacts to a printed circuit board (hereinafter, simply referred to as "circuit board"). The present invention relates in particular to a ball grid array type IC socket that performs the connection between the electrical contacts and the circuit board via solder
15 balls.

Description of the Related Art

A type of ball grid array type IC socket (hereinafter, simply referred to as "IC socket") is disclosed in U.S. Patent No. 6,132,222 (Figure 3). This IC socket comprises contacts for
20 contacting pin contacts of an IC package. The contacts comprise contact arms for contacting the pin contacts, fixing portions for fixing the contacts to the insulative housing of the IC socket, and solder ball connection portions to be connected to the circuit board. Generally, the IC sockets are provided to consumers with
25 solder balls soldered on to the solder ball connection portions.

In the known IC socket described above, the IC package is

of the pin contact type. In the case that the IC package is of the ball grid array or the land grid array type, the contacts of known IC sockets are modified as described below. That is, contact points of contact arms, which contact electrodes of the IC package, are horizontally offset after extending through an IC package mounting surface from the fixing portions, to reduce the height of the IC socket assembly having the IC package mounted thereon. The contacts of a ball grid array or a land grid array type IC package are connected to the contact arms in a pressurized state. This construction is adopted in response to the miniaturization of products to which IC sockets are mounted.

In the case that the contact pieces (contact arms) are offset in the manner described above, it is preferable that the positions of the solder balls on the opposite side of the housing therefrom, approach the positions of the contact points in the horizontal direction. That is, it is preferable that the solder ball connection portions are similarly offset from the fixing portions in the same direction as that of the contact arms. This offset is to balance the arrangement of the LGA or BGA of the IC package and the arrangement of the BGA of the IC socket.

Meanwhile, with the recent increases in the speed of transmitted signals, it is preferable that the signal paths of the contacts are as short as possible.

In view of the above, it is desirable that the solder ball connection portions are offset from the fixing portions, while providing the shortest possible signal paths from the IC package

to the circuit board.

In the IC socket disclosed in U.S. Patent No. 6,132,222, the solder ball connection portions are formed by bending the lower ends of the contacts, which extend downward from the fixing portions, at substantially a right angle. Therefore, in the case that the solder ball connection portions are to be offset, a problem arises in that the signal paths become elongated. In addition, solder fillets are formed between solder balls and the solder ball connection portions, during soldering of the solder balls onto the solder ball connection portions. There is a possibility that the solder balls are pulled toward the right, that is, the side of the fixing portions, due to the surface tension of the molten solder fillets. This leads to the problem that the solder balls being formed on the solder ball connection portion at positions that deviate from their predetermined positions, where they are to be soldered to the circuit board. As a result, there is a possibility that the positional accuracy of the solder balls is deteriorated, thereby reducing the reliability of electrical connections. In addition, there is a possibility that the spherical shapes of the solder balls will be altered due to the horizontal displacement thereof.

SUMMARY OF THE INVENTION

Embodiments of the present invention seek to provide a ball grid array type IC socket which is capable of

sufficiently offsetting solder balls from fixing portions in the horizontal direction and ensuring the positional accuracy thereof, while shortening the signal path.

In a first aspect of the present invention, there is provided a ball grid array IC socket comprising: an insulative housing having an IC package mounting surface on one face thereof and a circuit board mounting surface on a face opposite the IC package mounting surface and a plurality of contact housing apertures extending from the IC package mounting surface to the circuit board mounting surface and configured to receive a plurality of contacts; and a plurality of contacts, the contacts including contact arms that protrude from the first surface in a unidirectionally bent manner for contacting contact portions of an IC package mounted on the IC package mounting surface, fixing portions for engaging the interiors of the plurality of contact housing apertures, solder ball pads that protrude from the circuit board mounting surface for soldering solder balls thereto for connecting to a circuit board, and transition portions provided between the fixing portions and the solder ball pads for displacing the solder ball pads in substantially the same direction as the direction in which the contact arms are bent, wherein the transition portions further comprise fillet stops for preventing fillets from forming on the transition portions during soldering of the solder balls on the solder ball pads.

In a second aspect of the present invention, there is provided a ball grid array IC socket comprising: an insulative housing having an IC package mounting surface on one face thereof and a circuit board mounting surface on a face opposite the IC package mounting surface and a plurality of contact housing apertures extending from the IC package mounting surface to the circuit board mounting surface and configured to receive a plurality of contacts; and a plurality of contacts, the contacts including arms that protrude from

the first surface in a unidirectionally bent manner for contacting contact portions of an IC package mounted on the IC package mounting surface, fixing portions for engaging the interiors of the plurality of contact housing apertures, solder ball pads that protrude from the circuit board mounting surface for soldering solder balls thereto for connecting to a circuit board, and transition portions provided between the fixing portions and the solder ball pads for displacing the solder ball pads in substantially the same direction as the direction in which the contact arms are bent, wherein the housing further comprises protrusions that extend from the circuit board mounting surface to the ends of the solder ball pads for preventing fillets from forming on the transition portions during soldering of the solder balls on the solder ball pads.

In a third aspect of the present invention, there is provided a ball grid array IC socket comprising: an inclusive housing having an IC package mounting surface on one face thereof and a circuit board mounting surface on a face opposite the IC package mounting surface and a plurality of contact housing apertures extending from the IC package mounting surface to the circuit board mounting surface and configured to receive a plurality of contacts; and a plurality of contacts, the contacts including contact arms that protrude from the first surface in a unidirectionally bent manner for contacting contact portions of an IC package mounted on the IC package mounting surface, fixing portions for engaging the interiors of the plurality of contact housing apertures, solder ball pads that protrude from the circuit board mounting surface for soldering balls thereto for connecting to a circuit board, and transition portions provided between the fixing portions and the solder ball pads for displacing the solder ball pads in substantially the same direction in which the contact arms are bent, wherein the solder ball pad is of a

discoid shape having a diameter slightly smaller than that of the solder ball.

The protrusive portions may be of a shape that copies that of the transition portions of the contacts.

The contacts of the ball grid array type IC socket may comprise solder ball connection portions, which are to be connected to a circuit board. The contacts may further comprise transition portions for offsetting the solder ball connection portions in substantially the same direction as that of the contact arms. The transition portions may be provided between the fixing portions, which are fixed within the contact housing apertures, and the solder ball contact portions, which are to be connected to the circuit board. Therefore, the following effects are exhibited.

That is, the positions of the solder balls are sufficiently offset by the transition portions, so that they are aligned with the contact points of the contact arms.

A construction may be adopted wherein: the transition
5 portions further comprise fillet formation preventing portions,
for preventing fillets from forming on the transition portions
during soldering of the solder balls on the solder ball connection
portions. In this case, molten solder is prevented from moving
to the transition portion. Because the solder balls are not
10 pulled toward the transition portion by surface tension of the
molten solder, there is no possibility that positional
displacement or deformation of the solder balls will occur.
Accordingly, the reliability of the electrical connections is
ensured.

15 The fillet formation preventing portions may comprise
vertical portions, which are formed on the solder ball connection
portions substantially at right angles from the circuit board
mounting surface. In this case, the possibility that solder
fillets are formed on the vertical portions from the solder ball
20 connection portions is extremely small. Therefore, the effect
that the positional displacement or deformation of the solder
balls is prevented is positively obtained.

Further, a construction may be adopted wherein: the housing
further comprises protrusive portions that extend from the
25 circuit board mounting surface to the ends of the solder ball
connection portions, for preventing fillets from forming on the

transition portions during soldering of the solder balls on the solder ball connection portions. In this case, movement of the solder fillets to the transition portions can be even more positively prevented due to the combined effects of the fillet
5 formation preventing portions and the protrusive portions.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross sectional view of a ball grid array type IC
10 socket of the present invention.

Figure 2 is a magnified view of a portion indicated by an arrow in Figure 1, showing only a housing and contacts.

15 Figure 3A is a left side view, Figure 3B is a front view, and Figure 3C is a right side view of the contact, which is utilized in the ball grid array type IC socket of the present invention.

Figure 4A is a plan view, and Figure 4B is a bottom view of the
20 contact shown in Figures 3A, 3B, and 3C.

Figure 5 is a partial magnified view of a tine of the contact shown in Figures 3A, 3B, and 3C.

25 Figure 6 is a partial magnified view of a modified contact having an inclined transition portion.

Figure 7 is a partial magnified view of the contact shown in Figures 3A, 3B, and 3C with a housing according to a second embodiment of the present invention.

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Figure 8 is a partial magnified view of the contact shown in Figures 3A, 3B, and 3C with a modified housing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

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Hereinafter, embodiments of the IC socket according to the present invention will be described in detail with reference to the attached drawings. Figure 1 is a sectional view of an IC socket 1 of a first embodiment. The IC socket 1 comprises an
15 insulative housing 2; a metal plate 20; and a loading plate 19. The metal plate 20 supports the housing 2 from the side of a circuit board mounting surface 10 thereof. The loading plate presses an IC package 30 onto the housing 2. The metal plate 20 and the loading plate 19 are formed by punching and bending metal plates.

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The housing 2 of the IC socket 1 is rectangular. An IC package mounting surface 6 is provided on a first side thereof, and the circuit board mounting surface 10 is provided on the other side. The IC package mounting surface 6 is surrounded by walls 4. The circuit board mounting surface 10 is to be mounted on a
25 circuit board 8. Contact housing apertures 12, which will be described later (refer to Figure 2), are formed through the

housing 2 from the first side, which is the upper surface, to the other side, on the side of the circuit board 8. The contact housing apertures 12 are arranged in a matrix. Contacts 14 are press fit and fixed within each of the contact housing apertures
5 12.

A rectangular step portion 16 is formed along the entire periphery of the lower surface of the housing 2. An opening 18 for housing the lower portions of the housing 2, formed by the step portion 16, is formed in the metal plate 20. When the metal plate
10 20 and the housing 2 are assembled together, the vicinity of the opening 18 abuts the step portion 16. A support portion 28, for holding a rotating axis 26 of a lever 22 that operates the loading plate 19, is formed at one end of the metal plate 20 by bending. A crank shaped operating portion 24, for urging the loading plate
15 19, is formed on the rotating axis 26.

A bearing 32 is formed at the end of the loading plate 19 opposite from the end of the lever 22. The metal plate 20 is provided with claws 34 for rotatably engaging an aperture 32a formed through the bearing 32. This structure enables the loading
20 plate 19 to rotate in the direction indicated by arrow 36 of Figure 1. A tongue piece 38, which is to be pressed by the operating portion 24, is formed at the end of the loading plate 19 opposite the end of the bearing 32. In addition, a curved portion 40, which curves downward in Figure 1, is formed at the central portion of
25 the loading plate 19. When the loading plate 19 is closed by rotating the lever 22 and is in the position shown in Figure 1,

the curved portion 40 presses the IC package 30 (shown by broken lines in Figure 1) toward the housing 2. Thereby, electrodes 31 (connecting portions) of the IC package 30, that is, the LGA or the BGA, electrically connect with contact arms 46 of the contacts 14.

Next, the shape and the mounting structure of the contacts 14 will be described with reference to Figures 2 through Figure 4B. Figure 2 is a magnified view of the portion indicated by arrow 42 of Figure 1, showing only the housing 2 and the contacts 14. Figures 3A, 3B, and 3C show the contact 14, which is utilized in the IC socket of the present invention. Figure 3A is a left side view, Figure 3B is a front view, and Figure 3C is a right side view of the contact 14 of Figure 2. Figure 4A is a plan view, and Figure 4B is a bottom view of the contact 14.

First, with reference to Figure 2, it is clearly illustrated that the contacts 14 are engaged within the contact housing apertures 12 from the IC package mounting surface 6 to the circuit board mounting surface 10 of the housing 2. Each of the contacts 14, as more clearly shown in Figures 3A, 3B, 3C, 4A, and 4B, is constructed by punching and bending a single metal plate. Each of the contacts 14 comprises a base portion 44 (fixing portion) that extends in the vertical direction of Figures 3A, 3B, and 3C; a contact arm 46 that extends from the side of the base portion 44, is bent to overlap the base portion 44, and further extends upward; and a tine 48 that extends from the lower end of the base portion 44 toward the circuit board 8. Note that the expressions

up, down, left, and right will be employed for each figure, to facilitate the description.

The shapes of each portion of the contact 14 will be described in further detail. As most clearly shown in Figure 3C, engagement protrusions 56 (56a, 56b, 56c, and 56d), for frictionally engaging inner walls 54 of the contact housing apertures 12, are formed above and below the base portion 44 on both side edges 50 and 52 thereof. The contact arm 46 is bent from the side edge 52 of the base portion 44 at a bend 58. The contact arm 46 extends further upward from the bend 58, and is bent toward the left of Figure 3B. A contact point 60, which has an arcuate upper surface for connecting with the connecting portions of the IC package 30, are provided at the distal ends of the contact arms 46.

The tine 48 comprises: a solder ball connection portion 62, to which a solder ball 64 is soldered; and a transition portion 66, for linking the base portion 44 with the solder ball connection portion 62. The solder ball connection portion 62 is of a discoid shape having a diameter slightly smaller than that of the solder ball 64, and extends substantially parallel to the circuit board mounting surface 10. The transition portion 66 offsets the solder ball connection portion in substantially the same direction as that in which the contact point 60 is offset. The transition portion 66 will be described with reference to Figure 5.

Figure 5 is a partial magnified view that shows the tine 48 of the contact 14 of Figures 3A, 3B, and 3C. The transition

portion 66 comprises: a horizontal portion 66a that extends substantially parallel to the circuit board mounting surface 10; and a vertical portion 66b, which is continuous with the horizontal portion 66a and substantially perpendicular to the
5 solder ball connection portion 62.

Next, the operation of the transition portion 66 will be described in further detail. A solder fillet 64a is formed, by partially molten solder, between the solder ball connection portion 62 and the solder ball 64 around the entire periphery
10 thereof, during soldering of the solder ball 64 onto the solder ball connection portion 62. Because the vertical portion 66b, which is continuous with the solder ball connection portion 62, is formed perpendicular thereto, the solder fillet 64a does not flow toward the vertical portion 66b. Accordingly, the vertical
15 portion 66b functions as a solder fillet formation preventing portion.

Now consider a case in which the transition portion 66 extends rightward from the solder ball connection portion 62 then upward, as shown by the broken lines of Figure 5. In this case,
20 the solder fillet 64a would flow toward the right from the solder ball connection portion 62. Then, the surface tension of the molten solder would cause the solder ball 64 to move to the right, and cause it to be fixed in a positionally misaligned state. As a result, the solder balls 64 and conductive pads of the circuit
25 board (not shown) become misaligned, reducing the reliability of electrical connections therebetween.

Regarding the IC socket of the present invention, however, the solder balls 64 are always formed at their predetermined positions. Therefore, there is no possibility that positional misalignment will occur. In addition to the transition portion 5 66, the size of the solder ball connection portion 62 (slightly smaller than the solder ball 64) also works to achieve this characteristic. That is, the size of the solder ball connection portion 62 eliminates the possibility of horizontal movement of the solder ball 64, thereby contributing to accurate positioning 10 thereof.

The transition portion 66 is not limited to being of the shape shown in Figure 5. Various shapes may be considered, as long as they prevent the flow of the solder fillet 64a. For example, a modified contact 14, having a differently shaped 15 transition portion, is shown in Figure 6.

Figure 6 is a partial magnified view of a modified contact 14a having a transition portion 68 with an inclined portion 68a. Note that of the parts illustrated in Figure 6, those in common with the parts illustrated in Figures 3A through 5 will be denoted 20 with the same reference numerals in the following description. The transition portion 68 is inclined. Therefore, it is difficult for the solder fillet 64a to flow upward along the inclined portion 68a. That is, it is difficult for the solder ball 64 to be pulled upward toward the transition portion 68. In addition, the incline 25 portion 68a links the base portion 44 and the solder ball connection portion 62 with a shorter distance, thereby shortening

the electrical path.

The transition portion may be of a variety of shapes that discourage movement of the solder fillet 64a toward the transition portion. For example, the shape of the transition portion may be a combination of the aforementioned vertical portion 66b and the inclined portion 68a. Alternatively, the transition portion may be formed as an arcuate shape that curves diagonally upward.

Next, a second embodiment of the present invention will be described with reference to Figure 7. Figure 7 is a partial magnified view showing the tine 48 of the contact 14 of Figures 3A, 3B, and 3C, with an alternate housing 2a. In the second embodiment, a protrusion 70 (protrusive portion) having a triangular cross section is additionally provided on the circuit board mounting surface 10 of the housing 2a. The protrusion 70 is provided to discourage movement of the solder fillet 64a toward the transition portion 66 of the contact 14. The protrusion 70 extends from the fixing portion of the circuit board mounting surface 10, that is, the base portion 44 of the contact 14, to the solder ball connection portion 62. Therefore, the distal end 70a of the protrusion 70 prevents upward movement of the solder fillet 64a when it attempts to flow along the transition portion 66. Accordingly, movement and deformation of the solder ball 64 is further prevented.

Next, a modification of the protrusion will be described with reference to Figure 8. Figure 8 is a partial magnified view showing the tine 48 of the contact 14 with a modified housing 2b.

Figure 8 shows a state in which the shape of a protrusion 72 (protrusive portion) copies that of the transition portion 66. That is, the protrusion 72 has a shape that is complementary to the right side of the transition portion 66 of the contact 14.

5 In this case as well, the distal end 72a of the protrusion 72 prevents movement of the solder fillet 64a toward the transition portion 66.

In addition, a protrusion may be formed in the housing 2, in combination with the contact 14a having the transition portion 10 68 (refer to Figure 6). It goes without saying that upward movement of the solder fillet 64a along the transition portion 68 can be prevented in this case, also.

In this manner, the transition portions 66 and 68 of the contacts 14 and 14a may construct solder fillet formation 15 preventing portions by themselves, without depending on the shape of the housing 2. However, by additionally providing the aforementioned protrusions 70 and 72 to the housings 2a and 2b, the solder balls 64 are enabled to be offset while more effectively preventing positional misalignment. In this manner, the 20 protrusions 70 and 72 of the housings 2a and 2b also function as solder fillet formation preventing portions.

Claims

1. A ball grid array IC socket comprising:

an insulative housing having an IC package mounting surface on one face thereof and a circuit board mounting surface on a face opposite the IC package mounting surface and a plurality of contact housing apertures extending from the IC package mounting surface to the circuit board mounting surface and configured to receive a plurality of contacts; and

a plurality of contacts, the contacts including contact arms that protrude from the first surface in a unidirectionally bent manner for contacting contact portions of an IC package mounted on the IC package mounting surface, fixing portions for engaging the interiors of the plurality of contact housing apertures, solder ball pads that protrude from the circuit board mounting surface for soldering solder balls thereto for connecting to a circuit board, and transition portions provided between the fixing portions and the solder ball pads for displacing the solder ball pads in substantially the same direction as the direction in which the contact arms are bent,

wherein the transition portions further comprise fillet stops for preventing fillets from forming on the transition portions during soldering of the solder balls on the solder ball pads.

2. A ball grid array IC socket as defined in claim 1, wherein the fillet stops comprise vertical portions of the transition portions substantially perpendicular to the circuit board mounting surface.

3. A ball grid array IC socket as defined in claim 1, wherein the fillet stops comprise inclined transition portions.

4. A ball grid array IC socket as defined in claim 1, wherein the contact arms are bent from a side edge of the fixing portions at a bend and extend upward from the bend.

5. A ball grid array IC socket as defined in claim 4, wherein the contact arms have an arcuate upper surface for connecting with the contacts of the IC package at the distal ends of the contact arms.

6. A ball grid array IC socket comprising:

an insulative housing having an IC package mounting surface on one face thereof and a circuit board mounting surface on a face opposite the IC package mounting surface and a plurality of contact housing apertures extending from the IC package mounting surface to the circuit board mounting surface and configured to receive a plurality of contacts; and

a plurality of contacts, the contacts including arms that protrude from the first surface in a unidirectionally bent manner for contacting contact portions of an IC package mounted on the IC package mounting surface, fixing portions for engaging the interiors of the plurality of contact housing apertures, solder ball pads that protrude from the circuit board mounting surface for soldering solder balls thereto for connecting to a circuit board, and transition portions provided between the fixing portions and the solder ball pads

for displacing the solder ball pads in substantially the same direction as the direction in which the contact arms are bent,

wherein the housing further comprises protrusions that extend from the circuit board mounting surface to the ends of the solder ball pads for preventing fillets from forming on the transition portions during soldering of the solder balls on the solder ball pads.

7. A ball grid array IC socket comprising:

an inclusive housing having an IC package mounting surface on one face thereof and a circuit board mounting surface on a face opposite the IC package mounting surface and a plurality of contact housing apertures extending from the IC package mounting surface to the circuit board mounting surface and configured to receive a plurality of contacts; and

a plurality of contacts, the contacts including contact arms that protrude from the first surface in a unidirectionally bent manner for contacting contact portions of an IC package mounted on the IC package mounting surface, fixing portions for engaging the interiors of the plurality of contact housing apertures, solder ball pads that protrude from the circuit board mounting surface for soldering balls thereto for connecting to a circuit board, and transition portions provided between the fixing portions and the solder ball pads for displacing the solder ball pads in substantially the same direction in which the contact arms are bent,

wherein the solder ball pad is of a discoid shape having a diameter slightly smaller than that of the solder ball.