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BALL GRID ARRAY CONNECTOR

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to electrical connectors, and particularly to ball grid array connectors having a plurality of solder balls for surface mounting, to be connected to electronic (electric) parts having pin grid arrays.

Description of the Related Art

10 The IC package socket disclosed in Japanese Unexamined Patent Publication No. 2000-357572 is a known example of a ball grid array connector. This socket comprises a base housing having a plurality of contacts arranged in a matrix, and a sliding cover housing having openings corresponding to the
15 contacts. The contacts are connected to a printed circuit board (hereinafter, simply referred to as circuit board) via solder balls or tines. An IC package having a pin grid array is mounted on the cover housing, to be connected with the contacts on the base housing. Because the IC package has an
20 extremely large number of electrodes, the connection resistance between the pins and the contacts is great. Therefore, after the pins, which serve as the electrodes of the IC package, are inserted within the openings of the cover housing with no resistance, the cover housing with the IC
25 package mounted thereon is slid by a power assist mechanism to perform electrical connection between the contacts and the

pins.

As the mechanism for sliding the cover housing, a drive mechanism utilizing the lever principle is provided at an end portion of the socket. With regard to this drive mechanism, 5 a large amount of force is required in order to slide the cover housing to connect the pins and the contacts. Therefore, the drive mechanism is operated by a tool such as a screwdriver. In such a manner, a large force is exerted on the lever operating portion within the drive mechanism. Therefore, metal parts 10 are utilized for the operating parts of the drive mechanism, from the viewpoint of durability.

With regard to the aforementioned conventional technology, the center of gravity of the socket becomes biased, due to the existence of the drive mechanism, which utilizes 15 heavy metal parts, at the end portion of the socket. In other words, the center of gravity of the socket is at a position biased towards the drive mechanism side, as opposed to the center of the region of the contacts, which are soldered to the circuit board to fix the socket thereto, or the solder ball 20 region (soldering region).

Due to the positional misalignment between the center of the soldering region and the center of gravity of the socket, there is a possibility that the following problem will occur during the process of reflow soldering of the socket to the 25 circuit board. That is, during reflow soldering, a rotational moment is generated that causes the heavier drive mechanism

side to approach the circuit board, and the lighter socket end portion on the opposite side to separate from the circuit board. As a result, there is a possibility that the socket is mounted on to the circuit board inclined with respect thereto, and that
5 an electrical connection failure occurs. In addition, there are cases in which a heat sink is mounted onto the IC package after mounting thereof, to dissipate heat. In the case that the heat sink is the circuit board mounted type, which is mounted onto the circuit board positioned parallel thereto,
10 a problem arises that the heat sink does not appropriately contact the inclined surface of the IC package, mounted on the inclined socket, and a sufficient heat dissipation effect is not obtained. In particular, recent computer CPU's operate at high speeds and the amount of heat generated by the CPU's
15 have increased a great deal. However, in the case that the heat dissipation effect is insufficient, there is a possibility that it will have a catastrophic effect on the operation of the CPU.

In addition, there are cases in which the circuit board
20 undergoes another reflow soldering process in order to mount electronic (electric) parts on the other side thereof. In this process, the aforementioned socket, which has already been soldered to the circuit board, is on the underside thereof, that is, suspended therefrom, while the electronic parts are
25 mounted on the upper surface of the circuit board. During this subsequent reflow soldering process, as the atmospheric

temperature in the vicinity of the circuit board rises, the soldering portions of the socket (the soldering portions of the tines of the contacts, or the solder ball portions) soften and melt. In general, soldered connection portions that melt
5 maintain a mounted state to the circuit board, due to surface tension. However, if the center of gravity of the aforementioned socket is positionally misaligned from the center of the soldering region, a rotational moment is generated by the heavy drive mechanism so that the end portion
10 on the drive mechanism side separates from the circuit board. Therefore, the socket becomes inclined with respect to the circuit board, and there is a possibility that the socket will become fixed to the circuit board in this state. Depending on the case, there is a possibility that electrical connection
15 failures will occur, or that the socket itself will detach from the circuit board.

SUMMARY OF THE INVENTION

The present invention has been developed in view of the above points. It is an object of the present invention to
20 provide a ball grid array connector that enables reflow soldering of the connector parallel to a circuit board, even in the case that the center of gravity of a housing assembly is positionally misaligned with the center of the region where solder balls are arranged (soldering region).

25 It is another object of the present invention to provide a ball grid array connector to which a circuit board mounted

type heat sink is attachable to obtain a sufficient heat dissipation effect.

The ball grid array connector of the present invention comprises:

- 5 a plurality of contacts for contacting another connector;
- an insulative housing for housing the contacts;
- solder balls arranged corresponding to the contacts on the bottom surface of the insulative housing so that they are
- 10 conductively connected to the contacts;
- a housing assembly which is soldered to a circuit board by the solder balls, the center of gravity of the housing assembly being biased from the center of the region in which the solder balls are arranged; wherein
- 15 a positional compensation member is provided to prevent an inclination of the housing assembly which causes the solder balls to separate from the circuit board, due to the rotational moment generated by the biased center of gravity during reflow soldering of the housing assembly to the circuit board.
- 20 The positional compensation member may be, for example, a metallic solder peg soldered onto a surface of the circuit board, protruding towards the circuit board from the end portion of the housing assembly on the side of the center of gravity thereof.
- 25 Further, a construction may be adopted wherein the housing assembly comprises:

a base housing;

a cover housing slidably mounted on the base housing for mounting an IC package thereon;

a cam member at a front end portion of the housing assembly for sliding the cover housing; and

a base plate fixed on the base housing for supporting the cam member; wherein

the solder peg is integrally formed with the base plate.

In addition, the positional compensation member may be constructed to be positioned on a bottom surface of the housing assembly on the side of the center of gravity thereof.

In the ball grid array connector of the present invention, the center of gravity of the housing assembly is biased away from the center of the region in which the solder balls are arranged. However, positional compensation member is provided on the housing assembly for preventing an inclination of the housing assembly which causes the solder balls to separate from the circuit board, due to the rotational moment generated by said biased center of gravity. This structure provides the following advantageous effects.

That is, even in a case that the center of the soldering region and the center of gravity of the housing assembly are positionally misaligned, the connector can be reflow soldered parallel to the circuit board, and an electrical connection between the connector and the circuit board are positively made. This effect is particularly significant in the case that other

electronic parts are reflow soldered onto the surface of the circuit board. That is, the positional compensation member maintains the parallel mounting position with respect to the circuit board, and there is no possibility that the connector
5 will become detached therefrom.

In addition, in the case that the positional compensation member is constructed as a solder peg soldered onto a surface of the circuit board, protruding towards the circuit board from the end portion of the housing assembly on the side of the center
10 of gravity thereof, the tendency of the housing assembly to incline with respect to the circuit board due to the rotational moment which causes the solder balls to separate from the circuit board is stopped by this solder peg, which protrudes towards the circuit board, abutting the circuit board.
15 Therefore, the positional compensation member may be constructed of simple parts.

Further, in the case that the housing assembly comprises:

a base housing;

a cover housing slidably mounted on the base housing for
20 mounting an IC package thereon;

a cam member at a front end portion of the housing assembly for sliding the cover housing; and

a base plate fixed on the base housing for supporting the cam member; wherein

25 the solder peg is integrally formed with the base plate, the number of parts can be reduced by adopting a structure

wherein components are commonly used. In addition, a circuit board mounted type heat sink may be mounted, parallel to the circuit board having appropriate surface contact with the IC package, to obtain a sufficient heat dissipation effect.

5 In addition, in the case that the positional compensation member is constructed to be positioned on a bottom surface of the housing assembly on the side of the center of gravity thereof, the positional compensation member does not protrude outside of the periphery of the connector. Therefore, the area
10 occupied by the connector can be minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a connector of the present invention.

Figure 2 is a vertical sectional view of the connector
15 shown in Figure 1 taken along the line 2-2 of Figure 1.

Figure 3 is a side view that shows the position of the connector shown in Figure 1 during a first reflow soldering operation.

Figure 4 is a side view that shows the position of the
20 connector shown in Figure 1 during a second reflow soldering operation.

Figures 5A and 5B are side views that show the connector, with an IC package and a heat sink mounted thereon, mounted to a circuit board, wherein Figure 5A shows a state in which
25 the connector is not appropriately mounted on the circuit board, and Figure 5B shows a state in which the connector is

appropriately mounted on the circuit board.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a preferred embodiment of the ball grid array connector (hereinafter referred to simply as connector) of the present invention will be described with reference to the attached drawings. Figure 1 is a plan view of a connector of the present invention. Figure 2 is a vertical sectional view of the connector shown in Figure 1 taken along the line 2-2 of Figure 1. Figure 3 is a side view that shows the position of the connector shown in Figure 1 during a first reflow soldering operation. Figure 4 is a side view that shows the position of the connector shown in Figure 1 during a second reflow soldering operation. Figures 5A and 5B are side views that show the connector, with an IC package and a heat sink mounted thereon, mounted to a circuit board, wherein Figure 5A shows a state in which the connector is not appropriately mounted on the circuit board, and Figure 5B shows a state in which the connector is appropriately mounted on the circuit board.

First, a description will be given with reference to Figure 1 and Figure 2. As most clearly shown in Figure 2, the connector 1 comprises an insulative base housing (insulative housing) 2, and a cover housing 4, which is slidably arranged on this base housing 2. A plurality of contacts (not shown), which act as electrodes, is arranged in a matrix on the base housing 2. Each of these contacts is in electrical connection

with a solder ball 6, to be soldered onto a circuit board 100 (Figure 2). That is, the solder balls 6 are arranged in a matrix on the base housing 2, corresponding to the contacts. A standoff 54, which protrudes slightly from a bottom surface 8 of the base housing 2, is integrally formed with the base housing 2 at an end portion 50 thereof. The solder balls 6 protrude from the bottom surface 8 of the base housing 2 towards the circuit board 100 slightly more than the standoff 54.

In addition, a drive mechanism 14 for sliding the cover housing 4 along an upper surface of the base housing 2 is provided at the end portion 50, which is away from the ball grid array of the connector 1, that is, the region 10 where the plurality of solder balls 6 are arranged (soldering region). The drive mechanism 14 is similar to that which utilizes a metallic eccentric cam member disclosed in Japanese Unexamined Patent Publication No. 2000-173735.

The basic structure of the drive mechanism 14 will be described hereinbelow. A recess 16 is formed in the bottom surface 8 of the base housing 2, at the end portion 50 where the standoff 54 is formed. A depression 18, in which a base plate having a solder peg 20 (to be described later) is to be arranged, is formed in the upper surface 12 of the base housing corresponding to the recess 16. The recess 16 and the depression 18 are in communication with each other via an aperture 26. An indentation 22 is formed in the cover housing 4 at a portion that corresponds to the depression 18. A metal

plate 24 having an aperture 24a formed therethrough is fixed within the indentation 22.

A metallic cam member 28 is inserted through the aperture 24a and the aperture 26 and mounted to construct a housing assembly 42. The cam member 28 has a flange portion 32 with a tool engaging groove 30 (Figure 1) on its upper surface, and a trunk portion 34 extending downward from the approximate center of the lower surface of the flange portion 32. The trunk portion 34 is inserted through the aperture 24a of the metal plate 24, the aperture 20a of the base plate 19, and the aperture 26 of the base housing. The trunk portion 34 protrudes within the recess 16 and a washer 38 is fixed at its tip 36 to prevent extraction thereof. The cam member 28 is rotatably supported by the aperture 20a of the base plate 19.

The base plate 19 reinforces the thin portion of the base housing, due to the formation of the recess 16, while serving also to support the cam member 28. As it is necessary to positively support the cam member 28 with respect to the base housing 2, the base plate 19, although not shown in the figure, is of a rectangular shape extending to the vicinity of both edges of the connector at one end thereof on both sides of the solder peg 20. Therefore, the base plate 19 is structured to support the force imparted by the cam member 28 across a large area of the base housing 2. A cam 40 is formed at the outer periphery of the trunk portion 34 at a portion corresponding to the metal plate 24. This structure causes the cam 40 to

cam engage with and drive the metal plate 24 when the cam member 28 is rotated. The metal plate 24 slides the cover housing 4.

The solder peg 20, which acts as the positional compensation member, comprises a flat portion 48 arranged in the recess 18 of the base housing 2, that is, the portion of the base plate 19; and a tine portion 52 that extends outwardly from the end portion 50 of the base housing, is bent towards the circuit board 100, and then extends substantially parallel to the circuit board 100. The tine portion 52 has a cutout 52a. The cutout 52a serves to increase the length of the solder fillet formed when the tine portion 52 is soldered to the circuit board. That is, the length of the periphery of the tine portion 52 is increased. This structure is adopted to increase the surface tension of the melted solder. The tine portion 52 protrudes slightly further than the aforementioned standoff 54 towards the circuit board 100.

As most clearly shown in Figure 1, a plurality of openings 44 for receiving the pins (electrodes) of an IC package 90 (Figure 5) are arranged in a matrix on an upper surface of the cover housing 4 which corresponds to the soldering region 10. In Figure 1, only the outermost and innermost of the openings 44 are shown, and the intermediate portion is omitted. If the center of the soldering region 10 is designated as C, the center of gravity G of the housing assembly 42 is at a position biased towards the drive mechanism 14 from the center C. This is

because the drive mechanism 14 is provided with the metal plate 24 and the cam member 28, which contribute to its weight. If this position is designated as G, it is a position biased away from the center C as shown in Figure 1 and Figure 2.

5 Next, the process of soldering the housing assembly 42 onto the circuit board 100 will be described with reference to Figure 3 and Figure 4. During reflow soldering, the housing assembly 42 is in a state in which it is simply placed on the circuit board 100 with no support, as shown in Figure 3. When
10 the atmospheric temperature reaches the melting temperature of the solder balls 6, the solder balls 6 begin to melt, and the solder balls 6 become fused with conductive pads at predetermined positions on the circuit board. At this time, because the center of gravity G is biased away from the center
15 C of the soldering region, a rotational moment is generated at the end portion 50 of the base housing 2 in the direction indicated by arrow M1. There is a possibility that the end portion 50 will sink with respect to the circuit board 100. In other words, there is a possibility that the right side of
20 the housing assembly 42 as shown in Figure 3 will become lower, and the left side will become higher.

 However, the tine portion 52 of the aforementioned solder peg 20 protrudes toward the circuit board 100 and is soldered thereto. Thereby, the tine portion 52 prevents the sinking
25 of the end portion 50, and the upper surface 46 of the housing assembly 42 is maintained parallel with respect to the circuit

board. Then, when the reflow soldering process is completed, the melted solder balls 6 harden, and the housing assembly 42 is fixed to the circuit board 100. In this process, the solder peg 20 serves a purpose similar to that of the standoff, but
5 differs therefrom in the point that it is soldered and fixed to the circuit board. The importance of the function of the solder peg 20 will be further clarified in the following description of the second reflow soldering process.

Next, the state of the connector 1 during a second reflow
10 soldering process will be described with reference to Figure 4. The second reflow soldering process is for mounting another electronic part 104 on a surface 102 of the circuit board 100 reverse from that on which the connector 1 has been mounted. The electronic part 104 is placed on the circuit board 100 and
15 is surface mounted thereon in a high temperature atmosphere in the same manner as described above. However, at this time, the soldered portions of the connector 1 are also exposed to high temperature, and therefore soften. Because the center of gravity G is biased away from the center C of the soldering
20 region, a rotational moment is generated in the direction indicated by arrow M2, opposite that of arrow M1, causing the left side of the connector 1 as shown in Figure 4 to become lower. Therefore, the solder ball 6a close to the end portion
50 of the base housing 2 is at risk of separating from the
25 circuit board 100, making the connection therebetween unstable. If the reflow soldering process is completed in this state,

the connector 1 will be fixed to the circuit board 100 in a state in which it is inclined with respect thereto. In the worst case, the soldered portions starting with the solder ball 6a may separate sequentially and the connector 1 may drop from the circuit board 100 during reflow soldering.

However, because the tine portion 52, which is of a relatively large area, of the aforementioned solder peg 20 is positively soldered to the circuit board 100, even if the rotational moment M_2 is generated, the connector 1 does not change its position, due to the surface tension at the tine portion 52. Therefore, the upper surface 46 maintains a parallel relationship with the circuit board 100. In this manner, the solder peg 20 performs an important function, that of controlling the position of the connector 1 during reflow soldering. In this point, the solder peg 20 has a completely different function from conventional solder pegs, which are generally utilized to simply mount electronic parts and the like to a circuit board.

Next, states in which an IC package 90 and a heat sink 92 are mounted on the connector 1 will be described, with reference to Figure 5A and Figure 5B. As shown in Figure 5A, in a state in which the connector 1 is not appropriately mounted on the circuit board 100, the electrical connection between the solder balls 6 of the connector 1 and the circuit board 100 become unstable, while at the same time, an upper surface 90a of the IC package 90 also becomes inclined with respect

to the circuit board 100. Therefore, a bottom surface 94 of the heat sink 92, which is mounted parallel to the circuit board 100, is not in surface contact with the upper surface 90a of the IC package 90, and it should be understood that a sufficient
5 heat dissipation effect is not obtained.

As shown in Figure 5B, in a state in which the connector 1 is appropriately mounted on the circuit board 100, the position of the connector 1 is properly maintained. In this state, the upper surface 46 of the housing assembly 42, the
10 upper surface 90a of the IC package 90, and the bottom surface 94 of the heat sink 92 are parallel with respect to the circuit board 100. Therefore, a highly reliable electrical connection is obtained. In addition, due to the surface contact between the upper surface 90a of the IC package 90 and the bottom surface
15 94 of the heat sink 92, a sufficient heat dissipation effect is obtained.

Next, the embodiments of the present invention will be described.

Embodiments

20 To obtain satisfactory performance, it is required that the angle of inclination of the connector 1 is within the range of $\pm 0.2^\circ$. With regard to the connector of the present invention, different heights were set for the solder peg 20, and 13 experiments were performed for each of the heights. The
25 results were as follows in Table 1:

Table 1

Measured Values of the Angle of Inclination of the Connector

Height between standoff and solder peg	0.1mm	0.2mm	0.3mm
After first reflow soldering	-0.18°~-0.07°	-0.16°~-0.02°	-0.11°~+0.05°
After second reflow soldering	-0.05°~+0.16°	-0.15°~0°	-0.08°~+0.13°

Note: the direction in which the drive mechanism side separates
5 from the circuit board was designated as positive (+), and the
direction in which the drive mechanism side approaches the
circuit board was designated as negative (-). In addition,
the protrusive height of the standoff 54 from the bottom surface
8 of the base housing 2 is 0.1mm, and the protrusive height
10 of the solder balls 6 from the standoff 54 is 0.25mm.

From the above experimental results, it was proven that
in cases in which the height of the solder peg 20 from the
standoff 54 is 0.1mm, 0.2mm, and 0.3mm, the angle of inclination
of the connector 1 was well within the range of $\pm 0.2^\circ$.

15 A preferred embodiment of the present invention has been
described in detail above. However, the present invention is
not limited to the embodiment described above. For example,

the drive mechanism may be other than that operated by a flat head screwdriver, and may alternatively be of a known construction that employs a lever. In addition, the embodiment described above concerned a socket for an IC package.

5 However, it goes without saying that the present invention may be applied to an electrical connector which utilizes a surface mounted ball grid array having a plurality of electrodes, for connection with another connector.

The solder peg 20 is not limited to that having a single
10 cutout 52a. A plurality of cutouts may be provided. In addition, the position of the drive mechanism need not be on the central axis of the connector 1. The drive mechanism may be positioned, for example, at any desired position spanning from the upper right portion to the lower right portion of
15 Figure 1.

With regard to the embodiment of the present invention described above, a case has been described in which the solder peg 20, which acts as the positional compensation member, was provided at the end portion 50 of the base housing 2.
20 Alternatively, the solder peg 20 may be provided at the end portion opposite the end portion 50. In addition, a relatively heavy attachment may be mounted on the end portion opposite that at which the drive mechanism is mounted. Alternatively, a relatively heavy portion may be integrally formed with the
25 base housing 2 and/or the cover housing 4.

CLAIMS:

1. A ball grid array connector comprising:
a plurality of contacts for contacting another
connector;
5 an insulative housing for housing said contacts;
solder balls arranged corresponding to said contacts on
the bottom surface of said insulative housing so that they are
conductively connected to said contacts;
a housing assembly which is soldered to a circuit board
10 by said solder balls, the center of gravity of said housing
assembly being biased from the center of the region in which
said solder balls are arranged; wherein
a positional compensation member is provided on the
housing assembly for preventing an inclination of the housing
15 assembly which causes said solder balls to separate from said
circuit board, due to the rotational moment generated by said
biased center of gravity during reflow soldering of said
housing assembly to said circuit board.
2. A ball grid array connector as defined in Claim 1,
20 wherein:
said positional compensation member is a metallic solder
peg soldered onto a surface of said circuit board, protruding
towards said circuit board from the end portion of said housing
assembly on the side of said center of gravity thereof.
- 25 3. A ball grid array connector as defined in Claim 2,
wherein:

said housing assembly comprises:

a base housing;

a cover housing slidably mounted on said base housing
for mounting an IC package thereon;

5 a cam member at a front end portion of said housing
assembly for sliding said cover housing; and

a base plate fixed on said base housing for supporting
said cam member; wherein

said solder peg is integrally formed with said base plate.

10 4. A ball grid array connector as defined in any one of the preceding claims,
wherein:

said positional compensation member is positioned on a
bottom surface of said housing assembly on the side of said
center of gravity thereof.

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