

SEMICONDUCTOR COMPONENT TEST SOCKET

Field of the Invention

The present invention relates to a semiconductor component test socket that receives a semiconductor component and electrically connects the semiconductor component to a test apparatus for testing a semiconductor component that includes either a ball grid array (BGA) or a pin grid array (PGA), interconnection to the component test apparatus.

Background of the Invention

A semiconductor component, requiring performance and continuity testing before being mounted on a circuit board, is connected to a test socket attached to an inspection circuit to determine if the component passes the requirements of the testing scheme. During testing, the testing equipment and the semiconductor component may be heated. This procedure is called test and burn-in and the test socket, mentioned above, may also be referred to as a test and burn-in socket.

A semiconductor component including a ball grid array (BGA) has small solder balls arranged in regular rows and columns corresponding to a pattern of contact pads on a circuit board. The BGA component may be connected to the circuit board using solder reflow techniques.

Japanese application No. 10-513307 describes a test socket for inspecting a semiconductor component that includes a BGA of the type described above. The discussion, which follows, describes this prior art test socket 10 as illustrated in Figure 35 and Figure 36 of the present application. The test socket 10 includes a base 11 made of an electrically insulating material, a cover 12, an operating mechanism 13, positioned between the base 11 and the cover 12, and a plurality of contact terminals 14. The operating mechanism 13 has two brackets 15, 16, and coupled thereto, interposing members 17, 18, having comb-teeth-like rack sections 22, 23 extending from the interposing members 17, 18. The base 11 provides a support for the operating mechanism 13. Each of the brackets 15, 16 has a similar U-shaped structure including a pair of arms 19 and 20, arranged as illustrated, with the brackets 15, 16 in an opposing relationship so that the arms 19, 20 may adopt a crossed configuration. A support pin 21, passing through the arms 19, 20, at roughly their center point, allows one bracket 15 to pivot relative to the other bracket 16. Coupling of the interposing

members 17, 18 to the brackets 15, 16 produces an intermeshed condition of the rack sections 22, 23 extending from the interposing members 17, 18. Pivotal movement of the brackets 15, 16 causes sliding, rocking movement of the intermeshed rack sections 22, 23 about an axis substantially aligned with that of the support pin 21. Relative
5 positioning of the brackets 15, 16, interposing members 17, 18 and rack sections 22, 23 cause each of these parts to move as the arms 19, 20 pivot between a standby position and an open position.

The base 11 accommodates a plurality of contact terminals 14 placed in a pattern corresponding to the pattern of solder balls 41 of a BGA semiconductor component 40.
10 As illustrated, each of the contact terminals 14 is press-fit into holes formed in the base 11. One end portion of a contact terminal 14 has a pair of independent contact ends 24, 25 that separate to hold a solder ball 41. One contact end 24 moves in response to movement of one rack section 22, while the other contact end 25 moves under the influence of the other rack section 23. Depending upon the direction of
15 movement of the rack sections 22 and 23, as described above, the contact ends 24, 25 move between an open position in which the solder balls 41 can be received between the contact ends 24, 25 and a closed position in which the contact ends 24, 25 adopt a position adjacent to each other due to the shape memory of material used to fabricate the contact terminals 14.

20 The other end portion of each of the plurality of contact terminals 14 extends through the base 11 for interconnection to an inspection apparatus. This allows electrical connection of the inspection apparatus to a semiconductor component 40 mounted in a test socket 10. Electrical connection provided by the contact terminals 14 links a component to an inspection apparatus for testing.

25 During operation of the test socket 10, the cover 12 is depressed toward the base 11. As it moves downward, the cover 12 engages the arms 19 and 20 causing them to pivot from the standby position to the open position in the direction indicated by the arrow 46. As the arms 19, 20 move, the rack sections 22, 23 move in mutually opposite directions as indicated by the arrows 47, 48 in Fig. 36, and the contact ends
30 24, 25 separate during movement from the closed position to the open position. This allows the solder balls 41 of a BGA semiconductor component 40 to seat between the separated contact ends 24, 25 with the component 40, for testing, suitably inserted in the opening 26 of the cover 12. In this condition, the contact ends 24, 25 do not grip

the solder ball contacts 41. Such a gripping action occurs by releasing the downward pressure on the cover 12 to allow the contact ends 24, 25 of each contact terminal 14 to return towards their closed position in response to internal recovery forces.

As described above, the application of pressure to the cover 12 of the prior art test socket moves it towards the base 11 during pivotal movement of the arms 19, 20 and the interposing members 17, 18 to open the contact ends 24, 25 to receive the solder ball contacts 41 of a semiconductor component 40. The release of pressure allows separation between the cover 12 and the base 11 of the test socket 10 so that the contact ends 24, 25, of each contact terminal 14, close together to grip a solder ball 41 positioned between them. This connects the component under test to an inspection apparatus that is also connected to the test socket 10.

The development of modern semiconductor components emphasizes design criteria for BGA devices that reduce the size of solder ball contacts and the space between them. Test sockets for such devices require more contact terminals corresponding to the increased number of solder balls. This requires the packing of more terminals into the same amount of space, or less space than was required previously. Moreover, there is a demand for reduction of the cost of test sockets due to intense competition among test socket manufacturers. As requirements change, the design of the previously described prior art test socket 10 fails to meet the testing needs of new semiconductor components. For example, any change of the external dimensions of a semiconductor component requires the replacement of the entire body 11, 12 of the prior art test socket 10. Another problem concerns the need to press-fit individual contact terminals 14 into openings in the base 11 of the test socket 10. Positioning of approximately one hundred contact terminals in limited space on the base 11 is an inefficient, time-consuming process that requires care to prevent damage to the relatively delicate structure of contact terminal receiving holes in the base 11.

Summary of the Invention

The present invention solves the aforementioned problems and provides a semiconductor component test socket that is smaller in size, less costly and more convenient to use.

One embodiment of the present invention provides a semiconductor component test socket to which a semiconductor component having an array of protruding

contacts, e.g. solder balls, may be detachably mounted, for electrical connection to an inspection circuit, the semiconductor component test socket comprising:

a plurality of contact members corresponding to the array of protruding contacts, wherein each of the plurality of contact members has a first contact tip and a second contact tip to receive a protruding contact therebetween to electrically connect the mounted semiconductor component with the inspection circuit; and

an interposing assembly for moving the first and second contact tips of each contact member to a contact preparation position wherein the first and second contact tips can receive a protruding contact therebetween,

said interposing assembly having a first interposing member, a second interposing member, and a biasing member,

the first interposing member having a plurality of first contact tip-supporting members arranged in a form of teeth of a comb, each of the first contact tip-supporting members engaging a first contact tip of the plurality of contact members,

the second interposing member having a plurality of second contact tip-supporting members arranged in a form of teeth of a comb adjacent to the plurality of first contact tip-supporting members, each of the second contact tip-supporting members engaging a second contact tip of the plurality of contact members, and

a frame body surrounding the first and second interposing members such that the plurality of first contact tip-supporting members and the plurality of second contact tip-supporting members slidably engage each other between a compact condition and an extended condition said frame body having a side wall extending in a thickness direction of a semiconductor component mounted to the semiconductor component test socket, the side wall including a biasing member to move at least one of the first and second interposing members to the compact condition to place the first and second contact tips in the contact preparation position.

A test socket according to the present invention may adopt a position wherein the first and second contact tips of each of the contact members has an elastic recovery force that produces a reduced separation between the first and second contact tips, the reduced separation being too narrow to receive a protruding contact when the biasing member moves to the extended position, also referred to herein as the standby position.

A test socket according to the present invention may further comprise a guide member inside the frame body, and over interposed first and second interposing members, for positioning the semiconductor component so that the protruding contacts of the semiconductor component become aligned with the contact members.

5 A test socket may include a base member having through holes to hold the plurality of contact members, the base member providing support for the first and second interposing members such that the first contact tip-supporting member and the second contact tip-supporting member adopt an interposed relationship for movement transmitted from the biasing member, and

10 a retention plate attached to the base member to prevent the contact members from falling out of the through holes in the base member.

The present invention may further comprise holding members mounted to the base member for operation between a release position and an engagement position corresponding to movement of the biasing member between the compact position and
15 the standby position as needed to enable a semiconductor component to be detachably mounted against the interposed first and second interposing members of the semiconductor component test socket.

Another aspect of the present invention, provides a semiconductor component-test apparatus comprising:

20 the semiconductor component test socket previously described;
an inspection board to hold the semiconductor component test socket for electrical connection thereto through the plurality of contact members; and
an inspection circuit for inspecting the semiconductor component mounted to the semiconductor component test socket, and electrically connected thereto through
25 the inspection board.

Brief Description of the Drawings

Fig. 1 is an exploded perspective view of a semiconductor component test socket according to the present invention.

Fig. 2 is a perspective view of a contact member of the semiconductor
30 component test socket shown in Fig. 1.

Fig. 3 is a partially exploded view indicating attachment of a contact member to a base member of a semiconductor component test socket according to Fig. 1.

Fig. 4 is a cross sectional view of a portion of the base member including contact members held by the base member of the test socket of Fig. 1.

Fig. 5 is a perspective view of a retention plate of the semiconductor component test socket shown in Fig. 1.

5 Fig. 6 is a perspective view of the base member of a semiconductor component test socket as shown in Fig. 1.

Fig. 7 is a perspective view of a first interposing member of the semiconductor component test socket shown in Fig. 1.

10 Fig. 8 is an exploded perspective view indicating a partially interposed relationship of first and second interposing members of the semiconductor component test socket shown in Fig. 1.

Fig. 9 is a perspective view of showing the relative positions of fully interposed first and second interposing members of the semiconductor component test socket shown in Fig. 1.

15 Fig. 10 is a perspective view showing the position of a portion of the first interposing member relative to contact members of the semiconductor component test socket shown in Fig. 1.

Fig. 11 is a cross sectional view showing an interposing member and a frame body of the semiconductor component test socket shown in Fig. 1.

20 Fig. 12 is a cross sectional view indicating displacement of an interposing member by the biasing member of a frame body according to the semiconductor component test socket shown in Fig. 1.

Fig. 13 is a cross sectional view showing the contact tips of a contact member in a position to receive the protruding contact of a semiconductor component.

25 Fig. 14 is a cross sectional view indicating the operational relationship between the frame body and a holding member of the semiconductor component test socket shown in Fig. 1.

Fig. 15 is a perspective view of a guide member of the semiconductor component test socket shown in Fig. 1.

30 Fig. 16 is a cross sectional view indicating how the guide member assists positioning of a semiconductor component with contact members of the semiconductor component test socket shown in Fig. 1.

Fig. 17 is a perspective view of the frame body of the semiconductor component test socket shown in Fig. 1.

Fig. 18 is a partial cross sectional view to show an operational relationship between the frame body and the interposing member of the semiconductor component test socket shown in Fig. 1.

Fig. 19 is a cross section of an alternate embodiment of a frame body and an interposing assembly of the semiconductor component test socket shown in Fig. 1.

Fig. 20 is a cross sectional view showing another alternate embodiment of a frame body and an interposing assembly of the semiconductor component test socket shown in Fig. 1.

Fig. 21 is a cross section of another yet another embodiment of a frame body and an interposing assembly of the semiconductor component test socket of Fig. 1.

Fig. 22 is a cross sectional view showing one more embodiment of a frame body and an interposing assembly of the semiconductor component test socket shown in Fig. 1.

Fig. 23 is a perspective view of the underside of a base, of the semiconductor component test socket of Fig. 1, illustrating the placement of contact members.

Fig. 24 is an exploded perspective view showing a retention member positioned for attachment to a base of the semiconductor component test socket shown in Fig. 1.

Fig. 25 is a perspective view showing the contact tips of contact members extending from the base of the semiconductor component test socket shown in Fig. 1.

Fig. 26 is an exploded perspective view indicating positioning of a base and interposed first and second interposing members before assembly to provide a semiconductor component test socket of Fig. 1.

Fig. 27 is a partially exploded perspective view including holding members used to provide connection of a semiconductor component against an interposing assembly according to the semiconductor component test socket shown in Fig. 1.

Fig. 28 is an exploded perspective view indicating positioning of a guide member for attachment to a base included in a semiconductor component test socket according to Fig. 1.

Fig. 29 is a perspective view showing assembly of a frame body to a base included in a semiconductor component test socket of Fig. 1

Fig. 30 is an exploded, partial perspective view showing contact members, of a semiconductor component test socket of Fig. 1, having closed contact tips.

Fig. 31 is an exploded, partial perspective view showing contact members, of a semiconductor component test socket of Fig. 1, having open contact tips to receive
5 protruding contacts of a semiconductor component.

Fig. 32 is an exploded, partial perspective view showing protruding contacts of a semiconductor component inserted between open contact tips of contact members of a semiconductor component test socket of Fig. 1.

Fig. 33 is an exploded partial perspective view showing protruding contacts of a semiconductor component held by the gripping action of closed contact tips of
10 contact members of a semiconductor component test socket of Fig. 1.

Fig. 34 is a perspective view of a semiconductor component test apparatus including a semiconductor component test socket of Fig. 1.

Fig. 35 is a partially exploded perspective view of a conventional
15 semiconductor component test socket.

Fig. 36 is a partial cutaway perspective view of a bracket section provided for the semiconductor component test socket shown in Fig. 35.

Detailed Description of the Invention

A semiconductor component test socket and associated test apparatus
20 according to the present invention will be described below with reference to the drawings wherein like numerals denote like parts throughout the several views. It will be obvious to one skilled in the art that the disclosed embodiments are merely exemplary of the invention that may be embodied in various forms. The figures are not necessarily to scale, and some features may be exaggerated to show details of particular
25 components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

Reference to Fig. 30 shows an example of a semiconductor component 201
having a BGA including solder balls 202 to be mounted on a semiconductor
30 component test socket 101 for performance and continuity testing. A solder ball 202 is an example of a protruding contact of a semiconductor component 201. Other forms of protruding contact include a bump made of gold or the like. The design of

semiconductor component test sockets according to the present invention meets requirements for the testing of semiconductor components having a geometrical array of protruding contacts.

Fig. 1, shows the components of a semiconductor component test socket 101 according to the present invention including a frame body 110, a first interposing member 130-1, a second interposing member 130-2 and a contact member 170. The semiconductor component test socket 101 according to the present invention further includes a base member 150, a guide member 120, a holding member 140, and retention plate 160. It is to be noted that the first interposing member 130-1 and the second interposing member 130-2 are collectively referred to as an interposing assembly 130. These components 150, 120, 140, 160 may be assembled as indicated by Fig. 23 through Fig. 29, to form the semiconductor component test socket 101.

According to Fig. 23, each of a plurality of contact members 170 may be inserted from the underside of the base member 150 into each of a matrix of through holes 151 that penetrate the base member 150. Attachment of the retention plate 160 provides a cover for the underside 150a (see Fig. 3) of the base member 150. After attaching the retention plate 160, the base member 150 is turned over, as shown in Fig. 25, to receive the interposing assembly 130 comprising interposed structures of the first interposing member 130-1 and the second interposing member 130-2 (see Fig. 26). A holding member 140, attached to the base member 150 as shown in Fig. 27, provides releasable attachment of the interposing assembly 130 to the base member 150. Fig. 28 illustrates positioning of the guide member 120 for engagement with the base member 150 before enclosing the resulting structure in the frame body 110 to produce the semiconductor component test socket shown in Fig. 29.

One or more semiconductor component test sockets 101, as described above, may be attached to an inspection board 251 (see Fig. 34) to receive a semiconductor component 201 for performance and continuity testing using an inspection circuit 252 that is electrically connected to the inspection board 251.

A semiconductor component test socket 101 uses contact members 170 to provide electrical connection with protruding contacts of a semiconductor component. Contact members 170 according to the present invention may be made as an elongate contact of a conductive material such as gold, copper, aluminum or the like. Fig. 2, shows that the contact member 170 has a central connecting portion 173 having a

U-shaped cross-section. A first contact tip 171 and a second contact tip 172 extend from one end of the connecting portion 173. An inspection board connecting portion 174 extends from the other end of the connecting portion 173. A positioning protrusion 175 lies between the inspection board connecting portion 174 and the central connecting portion 173. The first contact tip 171 and the second contact tip 172 are positioned close together in a position of reduced separation 176. Elastic forces within materials used to fabricate contact members 170 normally cause the contact tips 171, 172 to return to the position of reduced separation 176 following deflection. Application of deflection forces causes contact tips 171, 172 to separate to receive a protruding contact 202 of a semiconductor component 201. Release of the deflecting forces allows the contact tips 171, 172 to recover towards their original configuration to grip either side of the protruding contact 202, thereby making a conductive connection.

Fig. 23 shows several contact members 170 inserted into through holes 151 formed as a matrix in the base member 150. Inserted from the bottom surface 150a of the base member 150, the orientation of a contact member 170 places the contact tips 171, 172 as the leading parts of a contact member 170 to enter a through hole 151 in the base member 150, as shown in Fig. 3.

The array of the through holes 151 corresponds to an array of the protruding contacts (e.g. solder balls of a BGA) 202 of the semiconductor component 201 to be mounted on the semiconductor component test socket 101. Approximately one hundred protruding contacts 202, are arranged in matrix form, require a corresponding matrix of holes to provide contact members to accurately connect a semiconductor component 201 to a test apparatus. The semiconductor component 201 has a roughly rectangular shape with sides of 5 to 15 mm and a thickness of 1 mm. The size of each through hole 151 allows passage of the closed contact tips 171, 172 and the connecting portion 173, but blocks entry of the positioning protrusion 175. There is, however, a recess 1511 connected to each through hole 151 that can house only the positioning protrusion 175 adjacent to the underside 150a of the base member 150, as shown in Fig. 4. Accordingly, movement of the contact member 170 into the through hole 151 stops when the positioning protrusion 175 resides in the recess 1511 and the first and second contact tips 171, 172 extend from the front surface 150b of the base member 150.

The plastic retention plate 160, in contact with positioning protrusions 175, prevents inadvertent withdrawal or removal of contact members 170 from the base member 150. Fig. 5 shows a matrix of openings 161 formed in the retention member 160. These openings 161 correspond to the through holes 151 of the base member 150 providing points of exit for the inspection board connecting portion 174 of each contact member 170. Latch arms 162 adjacent to each corner of the retention plate 160 include hooked ends 1621 for attaching the retention plate 160 to the bottom surface 150a of the base member 150 by inserting the latch arms 162 into insertion holes 152 included in the base member 150. After attaching the retention plate 160 to the base member 150, the inspection board connecting portions 174 of each contact member 170 protrude from the retention plate 160 as shown in Fig. 4.

A semiconductor component test socket 101 according to the present invention uses the retention plate 160 to confine a contact member 170 to a through hole 151 by preventing movement of the positioning protrusion 175 after installation of a contact member 170. The dimensions of the through hole 151 allow a contact member 170 relative freedom of movement, in contrast to the force required to press-fit a contact terminal 14 into the base 11 of a conventional semiconductor component test socket 10. This facilitates the insertion of contact members 170 according to the present invention by eliminating the need for a separate press-fitting jig, thereby improving efficiency and reducing the possibility of damage during test socket assembly. Ease of insertion of contact members 170 aids the construction of test sockets 101 for semiconductor components having narrowly pitched arrays of protruding contacts.

Fig. 6 shows a base member 150 molded from an insulating resin. As illustrated, the base member 150 includes positioning posts 153, interposing member latch arm insertion holes 154, holding member fastening portions 155, guide member latch arm insertion holes 156, frame body latch arm insertion grooves 157, and frame body guide grooves 158 in addition to the through holes 151 and the insertion holes 152 for the latch arms 162 of a retention plate 160.

The positioning posts 153, at the corners of the underside 150a of a base member 150, assist with positioning of the base member 150 on an inspection board 251. Portions denoted by the reference numerals 154 through 158 are guides for attaching other parts of a test socket to the base member 150. The following

description provides additional detail of the assembly of a test socket according to the present.

Fig. 1 shows an interposing assembly 130 comprising a first interposing member 130-1 and a second interposing member 130-2 with each part molded from an insulating resin. Sliding engagement of interposed first and second interposing members 130-1, 130-2 causes deflection of the first contact tip 171 and the second contact tip 172 of a contact member 170 to produce a contact preparation position 177. The first interposing member 130-1 and the second interposing member 130-2 have essentially the same shape and function, and therefore, description of one interposing member clarifies the structure and function of both.

Figure 7 illustrates an interposing member 130-1 including an L-shaped frame member 131-1 obtained by integrally forming a first frame member 1311-1 with a second frame member 1312-1. The interposing member 130-1 further includes first contact tip-supporting members 132 arranged in a comb-teeth-like shape extended from the first frame member 1311-1 parallel to the second frame member 1312-1. Latch arms 133 extend below each end of the first frame member 1311-1 to mate with insertion holes 154 of the base member 150. These components 131-1, 132 and 133 are integrally formed.

Fig. 10 shows that each of the first contact tip-supporting members 132 includes first contact tip-engagement portions 1321. The distance separating the first contact tip-engagement portions 1321 from each other corresponds to the pitch of the contact members 170. Each of the contact tip-engagement portions 1321 has a recess to hold one of a plurality of first contact tips 171 to move the contact tip 171 during movement of a first contact tip-supporting member 132. Although each contact member 170 includes a first contact tip 171 and a second contact tip 172 Figure 10 omits illustration of the second contact tip 172 to avoid confusion.

Fig. 11 and Fig 12 show that an interposing assembly 130 moves in the directions of arrows 135-1 and 135-2 due to the movement of a biasing member 1112 included as a part of a frame body 110. The interposing assembly 130 moves in response to the downward movement of the frame body according to direction 119-1. During this movement the biasing member 1112 contacts a movement engagement portion 1313 of the interposing assembly 130. Figure 7 shows that the movement engagement portion 1313 has a shoulder portion 1314 chamfered for smooth contact

with the with the moving frame body 110. Grooves 1315 formed in the movement engagement portion 1313-1 prevent deformation of the frame member 131-1 while it is being molded. They are not functional parts of a semiconductor component test socket according to the present invention.

5 The second interposing member 130-2 includes a frame member 131-2, second contact tip-supporting members 134, and latch arms 133. The frame member 131-2 is a member corresponding to the frame member 131-1 and is a member obtained by integrally forming a first frame member 1311-2 corresponding to the first frame member 1311-1 with a second frame member 1312-2 corresponding to the
10 second frame member 1312-1. The first frame member 1311-2 also has a movement engagement portion 1313-2 that has a chamfered shoulder portion 1314 and further includes groove portions 1315 to prevent deformation during molding.

 The second contact tip-supporting members 134 are members corresponding to the first contact tip-supporting members 132 and are similarly arranged in a comb-
15 teeth-like shape extending from the first frame member 1311-2 parallel to the second frame member 1312-2 and placed in interposed relationship with the first contact tip-supporting members 132. Each of the second contact tip-supporting members 134 as described above has second contact tip-engagement portions 1341 (see Fig. 8). Each of the second contact tip-engagement portions 1341 includes a recess arranged at
20 intervals corresponding to the pitch of the contact members 170. Each recess holds a second contact tip 172 of the contact members 170.

 The first interposing member 130-1 and the second interposing member 130-2 form the interposing assembly 130 as shown by reference to Fig. 8 and Fig. 9. by interposing the first contact tip-supporting members 132 between the second contact
25 tip-supporting members 134. When formed as described above the interposing assembly 130 allows the first contact tip-supporting members 132 and the second contact tip-supporting members 134 to slide back and forth, with a reciprocating motion, to vary the separation of the first and second interposing members 130-1, 130-2 as indicated by the direction of an arrow 135 in Fig. 9.

30 The interposing assembly 130 includes four latch arms 133 (see Fig. 9) to be inserted into corresponding latch arm insertion holes 154 formed through the base member 150 with the first interposing member 130-1 and the second interposing member 130-2 in an extended or standby position 136. Then, the tip portion 1331 of

each latch arm 133 engages the base member 150 to attach the interposing assembly thereto. Attachment of the interposing assembly 130 to the base member 150 does not prevent sliding of the first interposing member 130-1 relative to the second interposing member 130-2 in the directions of the arrow 135. Also, attachment of the interposing assembly 130 to the base member 150, as shown in Fig. 10, places the first contact tips 171 in the recesses formed between the first contact tip-engagement portions 1321 of the respective first contact tip-supporting members 132. The second contact tips 172 are similarly positioned in the recesses formed between the second contact tip-engagement portions 1341 of the respective second contact tip-supporting members 134.

The interposing assembly 130 exists in a standby position wherein there is maximum separation between the first interposing member 130-1 and the second interposing member 130-2 inside the frame body 110. In the standby position, the first contact tip 171 and the second contact tip 172 of each contact member 170 occupy a position 176 of reduced or minimum separation under the influence of internal elastic recovery forces. Fig. 30 shows the positions of a pair of first contact tips 171 and second contact tips 172 when the interposing assembly 130 adopts the standby position. In Fig. 30 and Fig. 31, the pair of contact members 170 is only representative of the plurality of contact members included in a semiconductor component test socket 101 according to the present invention.

In an embodiment of the present invention, shown in Fig. 11 and Fig. 12, during downward movement of the frame body 110, shown by arrow 119-1, the first interposing member 130-1 moves in the direction of the arrow 135-1, the second interposing member 130-2 moves in the direction of the arrow 135-2, to convert the interposing assembly from the standby position to a compact position wherein the contact tips 171, 172 separate to receive the protruding contacts of a semiconductor BGA component. Upward movement of the frame body 110, as expected returns the interposing assembly 130 to the standby position driven by the recovery forces associated with the springy contact members 170. A return spring, such as a coil-shaped spring 116, may also be used to urge the frame body 110 upward and away from the base member 150.

The compact position of an interposing assembly 130 corresponds to the contact preparation position that places the first contact tips 171 and the second

contact tips 172 in an open condition with sufficient separation to receive a protruding contact 202 between them, as shown in Fig. 13. Preferably the first contact tips 171 have a gap 178 of 0.5 to 1.0 mm from the second contact tips 172 to accommodate a solder ball 202 having a diameter of 0.3 mm to 0.7 mm.

5 Movement of the first interposing member 130-1 relative to the second interposing member 130-2 is limited to a range indicated by a reference numeral 138 in Fig. 9. Preferably the distance is 0.2 to 1.0 mm. The restricted movement of the first interposing member 130-1 and the second interposing member 130-2 to the movable range 138 prevents the first contact tips 171 and the second contact tips 172
10 from separating beyond the contact preparation position 177. Each interposing member 130-1, 130-2 moves half the movable range, i.e. 0.1 to 0.5 mm between the standby position 136 and the compact position 137.

Fig. 1 shows fastening portions 155 in two places of the base member 150. Holding members 140, as shown in Fig. 1 and Fig. 14, become seated in the fastening
15 portions 155. Each holding member is made of a resin and integrally formed into a roughly L-shaped shape that includes a clamping portion 141 and an arm portion 142 having an opening with a pin 143 pivotally mounted therein. When the semiconductor component 201 is mounted on the semiconductor component test socket 101, each holding member 140 releasably secures the semiconductor
20 component 201 on both the right-hand and left-hand sides respectively by contact with each clamping portion 141 to hold the component against the interposing assembly 130. Each holding member fastening portion 155 includes a coil-shaped spring 1551 for biasing a tongue portion 1421 of the arm portion 142. Therefore, each holding member 140 is usually positioned against a semiconductor component in
25 an engagement position 144 as indicated by the solid lines in Fig. 14. Movement of the frame body 110 towards the base 150, produces contact between the tongue portions 1421 and the frame body 110, whereby each holding member 140 pivots around the pin 143 against the urging force of the spring 1551 to a release position 145 as indicated by dotted lines in Fig. 14. This allows removal of the semiconductor
30 component 201 from the interposing assembly 130.

A guide member 120, shown in Fig. 1, Fig. 15 and Fig. 16, may be made from a resin to provide a frame having an opening 124 formed therein. The guide member 120 aligns the semiconductor component 201 to connect the protruding contacts 202

of the semiconductor component 201 to the contact members 170 positioned in the interposing assembly 130. The guide member 120 has guide portions 121, guide member latch arms 122, and mounting use guide pins 123. The guide member 120 is positioned on the interposing assembly 130 and detachably joined to the base member 150 by placing the mounting use guide pins 123 along engagement portions of the base member 150 and inserting the guide member latch arms 122 into the respective guide member latch arm insertion holes 156. When the mounting is completed, engagement portions 1221 formed at the tips of the guide member latch arms 122 engage guide member latch arm insertion holes 156 (see Fig. 6) to join the guide member 120 to the base member 150.

Figure 15 shows the guide member 120 having internal surfaces 125-1 through 125-4 that include guide portions 121 having sloped portions 1211 and positioning portions 1212. The sloped portions 1211 provide guide surfaces for contacting the edges 203 of a semiconductor component 201, inserted in the guide opening 124, to move the component 201 into alignment with the interposing assembly 130. The positioning portion 1212 extends from the slope portion 1211 as a plane parallel to an outer edge of a semiconductor component 201. When the semiconductor component 201 is positioned correctly in a test socket according to the present invention, there is a slight gap 126 between the positioning portion 1212 and the edge 203 of the semiconductor component 201. The gap 126 allows some movement of the semiconductor component for reliable connection of each protruding contact 202 with a first contact tip 171 and a second contact tip 172. Also, the gap is narrow enough to prevent displacement of the semiconductor component 201 by vibration or impact after connection of the component 201 to the semiconductor component test socket 101. Preferably the gap is approximately 0.1 to 0.3 mm considering the tolerances of semiconductor components 201 and test sockets 101.

A semiconductor component test socket 101 according to the present invention may be readily modified for use with semiconductor components 201 of differing size. The modification changes the angle of the slope portion 1211 and this controls how far the positioning portion 1212 extends into the guide opening 124. In this way the internal surfaces of the guide member 120 may be changed without changing the other dimensions of the guide member 120. Therefore, a variety of interchangeable guide

members 120 provides a versatile test socket 101 that can handle different sizes of semiconductor components 201 at lower overall cost.

Referring now to Fig. 1, Fig. 11, Fig. 12 and Fig. 17, the frame body 110 is a molded resin frame having an opening 113 that communicates with the opening 124 of the guide member 120 and surrounds the interposing assembly 130 and the guide member 120. The frame body 110 further includes a pair of opposing biasing members formed in sidewalls 111 to engage and move the interposing members 130-1, 130-2 of the interposing assembly 130. Other parts of the frame body 110 include four moving member latch arms 112, and pushing portions 117 that apply pressure to the tongue portions 1421 to release the holding members 140.

The frame body 110 may be attached to the base member using latch arms 112 to engage grooves 157 in the base 150. This produces alignment of the sidewalls 111 with frame member guide grooves 158. A coil spring 116 at each upper corner of the base 150 assists with the separation of the frame body 110 from the base 150 during opening and closing of a test socket according to the present invention. Hooked tip engagement portions 1121 of the latch arms 112 engage projection portions 1571 to maintain releasable connection between the frame body 110 and the base 150. Thus attached to the base 150, the frame body 110 may move downwards, towards the base, or upwards away from the base. Downwards movement of the frame body 110 brings a sloped surface biasing member 1112 into contact with the sides 1313-1, 1313-2 of the first interposing member 130-1 and the second interposing member 130-2 to move them closer together.

The angle of the slope of the biasing member 1112 affects the extent of movement of the first interposing member 130-1 and the second interposing member 130-2. Movement of the interposing members 130-1, 130-2 also affects the amount of separation between the contact tips 171, 172 of the contact members 170. As the interposing members move towards each other the contact tip support members 132, 134 press against first contact tips 171 and second contact tips 172 increasing the distance of separation between the contact tips 171, 172. At maximum separation the contact tips 171, 172 are in a contact preparation position to receive protruding contacts 202, such as the solder balls of a BGA, attached to a semiconductor component 201.

The use of a biasing member 112, to move the interposing members 130-1, 130-2 of the interposing assembly 130, eliminates the need for the brackets 15, 16 and the metal arms 19, 20 typically found in a conventional, prior art test socket, as previously described. Interposing members 130-1, 130-2 according to the present invention move with a reciprocating motion for opening and closing the contact tips 171, 172 of the contact members 170. This is different to the rocking motion of test sockets 10 of the prior art design discussed previously. A reciprocating structure requires fewer moving parts and less space for operation than a rocking structure. This represents an advantage for semiconductor component test sockets 101 according to the present invention, which preferably have a size of 15×30 mm and a weight of 5 to 10 g. A conventional test socket is two to three times larger and about twice the weight of this. The present invention includes a method for using a semiconductor component test socket 101, assembled as indicated in Fig. 23 through Fig. 29, for inspecting a semiconductor component 201.

While Fig. 34 shows only one test socket 101 mounted to an inspection board 251, it will be appreciated that a number of such sockets 101 could be arranged in a suitable pattern on the board 251. The use of multiple sockets 101 on an inspection board 251 facilitates the simultaneous test and burn-in of multiple semiconductor components 201.

The inspection board 251 is provided with insertion holes into which the positioning posts 153 can be press-fit. Press fitting the positioning posts 153 into the insertion holes in pre-selected positions, secures the test socket 101 to the inspection board. After attaching a semiconductor component test socket 101 to an inspection board 251, connection of the inspection board connecting portions 174, of the contact members 170, to inspection board 251 contacts provides electrical continuity between a test socket 101 and the board 251.

Downward movement of the frame body 110 moves the interposing assembly 130 to place the contact tips 171, 172 of the contact members 170 in the contact preparation position to receive the protruding contacts 202 of a semiconductor component 201. At the same time the holding members 140 pivot from the engagement position 144 to the release position 145 against the elastic forces of the springs 1551.

Placement of a semiconductor component 201 into the opening 113 of the frame body 110 and the opening 124 of the guide member 120 is the first step towards mounting and electrically connecting a semiconductor component 201 to a test socket according to the present invention. Subsequently, the protruding contacts 202 of a semiconductor component 201 becomes aligned to the contact members 170 of a test socket 101 using the guide portion 121 of the guide member 120. When correctly positioned, each protruding contact 202 lies approximately at the center point of the distance separating each first contact tip 171 from each second contact tip 172, in the contact preparation position. In other words, when a semiconductor component 201 settles against an interposing assembly 130, each protruding contact 202 is received between a pair of contact tips 171, 172.

Removal of the downward pressure on the frame body 110 allows it to lift away from the base 150. This action reverses the movement that opened the contact tips 171, 172 of the contact members 170, as previously described. As intended, the semiconductor component test socket 101 begins to recover towards the original standby position under the influence of the springs 116 and recovery forces exerted by the contact members 170. During this process the contact tips 171, 172 apply gripping force to the protruding contacts 202. At the same time, the hooked ends 144 of each holding member 140 engage the top of the semiconductor component 201 to retain it against the interposing assembly 130 for the duration of component testing. During this process the semiconductor component 201 becomes electrically connected to the inspection circuit 252 to facilitate testing by the inspection circuit 252. Following inspection, the application of downward pressure to the frame body 110 causes the various parts of the test socket 101 to move so that the holding members 140 release the semiconductor component body and the contact tips 171, 172 release their grip on the protruding contacts 202. This re-establishes the contact preparation position in which the semiconductor component 201 may be lifted out of the semiconductor component test socket 101 according to the present invention.

In the embodiment previously described the first contact tips 171 and the second contact tips 172 moved to the contact preparation position 177 in response to the movement of biasing members 1112 on the side walls 111 of the frame body 110. Other forms of biasing member 1112 may be used. For example, Fig. 19, shows biasing portions 5313-1 and 5313-2 formed as sloped edges of an alternate first

interposing member 530-1 and a second interposing member 530-2 of a interposing assembly 530 corresponding to the interposing assembly 130. Use of the alternate interposing assembly requires a modified frame body 510.

5 A further modification of the biasing structure of Fig. 19 appears in Fig. 20 wherein a different frame body 5100 includes a protruding portion 51121 for contact with the movement engagement portions 5313-1 and 5313-2 of the interposing assembly 530. The movement engagement portions 5313-1 urge movement of the first interposing member 530-1 and the second interposing member 530-2 resulting in increased separation between contact tips 171, 172 during application of downward
10 pressure to the frame body 5100.

Other biasing schemes may be used for opening and closing contact tips 171, 172 of semiconductor component test sockets 101 according to the present invention. Fig. 21 provides illustration of optional structures. Such structures allow opening of contact tips 171, 172 by lifting a frame body 610 up rather than pushing it down.

15 Fig. 22, shows that an interposing assembly 130 need only be moved from one side to open the contact tips 171, 172 to the contact preparation position. In this case the frame body 710 includes a sloped biasing member 7112 that pushes the first interposing member 130-1 towards the second interposing member 130-2 with application of downward pressure to the frame body 710. Those skilled in the art will
20 appreciate other possibilities for biasing members that fall within the scope of the present invention.

A semiconductor component test socket has been described, comprising a first interposing member, a second interposing member, and a frame body. The frame body moves downward to displace the first interposing member and the second
25 interposing member from a standby position to a compact position in which the tips of contact members have their widest separation. A biasing member formed in the wall of the frame body replaces the metallic biasing arms of a conventional test socket to reduce the size, weight, cost and number of parts required for a semiconductor component test socket according to the present invention.

30 Further improvement is found in the use of a retention plate to hold contact members in the through holes of the base member of the test socket rather than press fit the contact members with a special jig. This provides improved efficiency and

reduction in the cost and time required to manufacture a test socket according to the present invention.

5 The improvements provided by semiconductor component test sockets according to the present invention lead to the manufacture of smaller sockets, compared to the conventional socket previously described. More of the smaller sockets may be arranged on an inspection board. This increases the number of semiconductor components that may be included in a batch of components for simultaneous testing.

What is claimed is :

1. A semiconductor component test socket, for a semiconductor component having an array of protruding contacts for electrically connecting the mounted semiconductor component to an inspection circuit, the semiconductor component test socket comprising:
 - a plurality of contact members corresponding to the array of protruding contacts for contact therewith between a first contact tip and a second contact tip of each contact member so as to electrically connect a mounted semiconductor component with an inspection circuit;
 - an interposing assembly for moving the first and second contact tips of each contact member to a contact preparation position wherein a pair of first and second contact tips receive one of the array of protruding contacts therebetween, the interposing assembly having a first interposing member having a plurality of first contact tip-supporting members arranged as the teeth of a comb, each of the first contact tip-supporting members engaging with the first contact tips of the contact members, the interposing assembly further including a second interposing member having a plurality of second contact tip-supporting members arranged as the teeth of a comb, each of the second contact tip-supporting members engaging with the second contact tips of the contact members, the first and second interposing members arranged in interposed relationship to slide side by side with a reciprocating motion; and
 - a frame body surrounding the interposing assembly, the frame body further including a side wall having a biasing member formed therein to push against at least one of the first and second interposing members to move the interposing assembly from a standby position to a compact position, wherein the first and second contact tips assume the contact preparation position.
2. The semiconductor component test socket of claim 1, wherein each contact member has an elastic recovery force such that the first and second contact tips occupy a reduced separation position preventing entry of a protruding contact therebetween, when the relative positioning of the interposing assembly and the frame body produces the standby position.

3. The semiconductor component test socket of claim 1 further comprising a guide member, installed inside the frame body in contact with the interposing assembly, for positioning a semiconductor component so that the protruding contacts align with the contact members.

5 4. The semiconductor component test socket of claim 1, further comprising a base member having through holes allowing passage of first and second contact tips of the contact members therethrough for positioning between first and second contact tip-supporting members arranged in interposed relationship, the semiconductor component test socket having a retention plate releasably connected to
10 the base member to hold the contact members inside the base member.

5. The semiconductor component test socket of claim 1, further comprising a plurality of holding members, mounted to the base member, such that the holding members move from a release position to an engagement position so that a semiconductor component, inserted in the semiconductor component test socket in
15 the compact position, becomes clamped to the interposing assembly, by the holding members, when the semiconductor component test socket moves towards the standby position.

6. The semiconductor component test socket of claim 1, wherein the biasing member at the side wall of the frame body is a sloped portion of the side wall.

20 7. A semiconductor component testing apparatus comprising:
the semiconductor component test socket of claim 1;
an inspection board for holding the semiconductor component test socket with electrical connection to the contact members thereof; and
an inspection circuit connected to the inspection board to inspect a
25 semiconductor component mounted to the semiconductor component test socket.