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24 MAR 2003

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VERTICALLY ACTUATED BGA SOCKET

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This invention relates to a socket for retaining an integrated circuit (IC) for purposes of testing or application usage. While the type of IC shown and utilized in the following described embodiment is a ball grid array (BGA) type, it should be understood that other forms of ICs may be utilized.

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A constant demand for small and more compact integrated circuit packages has led to the growing use of ball grid array electrical leads on integrated circuits. BGA's significantly reduce the footprint of an integrated circuit; however, BGA's required the development of new and advanced sockets for testing and burn-in of the integrated circuits. Numerous sockets have been developed by various manufacturers to test integrated circuits with BGA's. Many of the sockets are of the clam shell design, where a hinged top opens to allow package entry and closing the top retains the package within the socket. As disclosed in U.S. Patent No. 5,646,447, a socket has been devised for testing integrated circuits with ball grid arrays that includes a base having contacts extending therethrough, a slidable plate disposed on top of the base, the slidable plate populated with through holes such that the elongated contacts extend upward into each hole. The socket includes a lid which is hingedly attached to the base. A cam is also mounted on the base having handles attached at either end. A torsion spring urges the cam handles and lid upward. At the same time, the cam rotates pushing the plate sideways thereby engaging the BGA leads with the elongated contacts. When the lid is pushed down, a spring returns the plate thereby releasing the electrical connection between BGA leads and elongated contacts.

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Another test socket is shown in U.S. Patent 4,407,555. That socket is designed for use with a dual in-line package (DIP). The socket includes a transport block receiving the DIP package. The rows of contact legs extend adjacent to the sides of the block. The socket housing includes a plurality of contacts having upwardly directed spring finger portions. The transport block is received between the spring finger portions of the contacts. The housing further include camming means for engaging the contact legs of the DIP package with the contact spring finger portion as the transport block is inserted toward the housing block.

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Another socket for an integrated circuit is shown in U.S. Patent 5,228,866. That device includes a base having a plurality of electrical contacts therein. The device further includes
5 latches for securing the integrated circuit in the socket. A movable top contacts cam actuation to operate the latches. A rotatable lever is housed in the base and connected to an actuating arm which moves in response to movement of the top. The levers cause the contacts to shift into a position in contact with or away from the leads of the integrated circuit in response to movement of the top.

10 It would be desirable to have a cam member that could urge the slidable plate causing contact between the BGA leads and the elongated contacts and also return the plate to its original position thereby eliminating the need for a return spring. It would also be desirable to have a latching mechanism for holding the integrated circuit on the slidable plate and further having the latching mechanism actuated with the same mechanism that activates the cam into rotation. It
15 would also be advantageous to have the slidable plate urged sideways at both ends to more evenly distribute the urging stress so as to reduce wear. Lastly, it would be desirable to have a

means of adjustably and precisely locating integrated circuits of various sizes and shapes on the slidable plate.

This invention relates to a chip carrier socket incorporating the above improvements for interconnecting a chip to a printed circuit board. The socket includes a base and at least one and preferably two cam shafts journaled or supported within the base in a spaced relationship for rotational movement relative to the base. A plate is supported upon the base and extends between the cam shafts. The plate has a plurality of openings formed in it which receive the leads of the IC. In a BGA type IC, these leads are semi-spherical balls which depend from the lower face of the IC. Conductors or pins adapted for connection to testing or operative circuitry are carried by the base and extend into proximity with the leads of the IC as it is supported upon the plate. Each cam shaft engages the plate so as to shift the plate relative to the base causing the conductors carried by the base to forcibly engage the leads of the IC when in one shifted position and causing the conductors to be released from such forcible engagement with the leads of the IC when in a second shifted position. A top located over the base movable between upper and lower positions relative to the base and the underlying plate is provided. The top engages each of the cam shafts to rotate the shafts causing the plate to be shifted between its previously mentioned positions as the top is moved between its upper and lower positions. In addition, adjustable locators which serve as a guide for the IC when it is placed upon the plate are provided and may be selectively positioned upon the plate depending upon the accommodating size of the IC and selected position of the IC upon the plate.

Accordingly it is an object of this invention to provide a socket device for an integrated circuit of reliable and simplified operation.

Another object of this invention is to provide a socket device for an integrated circuit which is of miniaturized design.

Still another object of this invention is to provide a socket device for a BGA type integrated circuit which is of economical design.

Other objects of this invention will become apparent upon a reading of the following description.

DESCRIPTION OF THE DRAWINGS

A preferred embodiment has been chosen for illustrations and description wherein:

Figure 1 is a perspective view of the component parts of the socket device shown in separated or exploded form for illustrative purposes.

Figure 2 is a side view of the socket with top depressed or in its lowered position.

Figure 3 is a side view of the socket with top in its raised or spring biased position.

Figure 4 is a cross-sectional side view of the socket through the driving cam lobes with the top in the lowered position.

Figure 5 is cross-sectional side view of the socket through the driving cam lobes with the top in the raised position.

Figure 6 is cross-sectional side view of the socket taken through the return cam lobes with the top in the lowered position.

Figure 7 is a cross-sectional side view of the socket taken through the return cam lobes with the top in the raised position.

Figure 8 is a perspective view of the cam shaft utilized in the socket.

Figure 9 is the top view of the shiftable plate of this invention showing the grid pattern openings and movable locating tabs.

Figure 10 is a perspective view of a movable locating tab showing the mounting feet.

Figure 11 is cross-sectional view of a mounting tab inserted into the shiftable plate.

Figure 12 is a perspective view of the base to the socket showing cross sections of the cams journaled therein.

Figure 13 is a perspective view of the socket device in partial form showing a vertical cross-sectional view taken through the center of one of the cam shafts and with the top in its raised position.

Figure 14 is a perspective view of the upper portion of the base and cam shafts shown in separative or exploded form for illustrative purposes.

Figure 15 is longitudinal cross-sectional view of the socket taken through the IC hold down latches with the top in a raised position.

Figure 16 is a longitudinal cross-sectional view of the socket taken through the IC hold down latches with the top in a lowered position showing the latches raised to free the IC from the socket device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment illustrated is not intended to be exhaustive or to limit the invention to the precise form disclosed. It is chosen and described in order best to explain the principles of the invention and its application and use.

Referring first to Figure 1 in which the separated component parts of the socket device 10 are shown, there is a base 12 consisting of an upper part 14 and a lower part 16 which is snap-fitted onto part 14. Base part 14 carries a center grid having a plurality of closely spaced openings 18, a plurality of conductors or pins 20 (see Figures 2-7, 12, 15 and 16) are anchored within base part 14 and extend upwardly through openings 18. Conductors or contacts 20 extend downwardly through base part 16. In Figure 12, for simplification of illustration, the multiplicity of openings 18 in selected rows are not shown. For purposes of description, it is assumed that base part 14 has a conductor 20 extending through each of its openings 18. Each of the conductors or pins 20 may be connected to an appropriate testing or operational circuit.

Continuing to refer to Figure 1, device 10 also includes two cam shafts 22 which are supported upon and journaled within base part 14 for rotational movement relative to base 12. A plate 24 is supported upon base part 14 overlying and flanked by cam shafts 22. Plate 24 is snap fitted at snaps 25 (Figure 14, only two of four shown) to the base part so as to become a part of

the base and to prevent its vertical separation while permitting horizontal movement of the plate relative to the base part. Plate 24 includes a center grid having a plurality of openings 26 (not shown in multiple form in Figure 13 for simplification of illustration) which can be brought into alignment or registry with the openings 18 in base part 14. The upper distal end of each conductor or pin 20 extends upwardly into a registering opening 26 in plate 24. Conductor 20 extends preferably just to or slightly below the upper surface of plate 24. The shiftability of the plate and the general location of the conductor relative to the plate are shown in U.S. patent 5,646,447 incorporated herein by reference. Attached to or molded integrally with plate 24 are wall like sections 27 and 29, which reduce the cross section of the cam shaft journal area in plate 24. A metal tab 31 is provided to fit over wall like portion 29 for providing a bearing surface thereon.

Journalled about each of the cam shafts 22 is a latch 28. Each latch 28 is normally urged or biased by a helical spring 30 into a lower position adjacently overlying plate 24. Latches 28 are held in position by circling a sufficient portion of its accommodating cam shaft 22 so as to prevent lateral separation of the latch from the cam shaft. A coil spring 32 extends about each of the protruding ends 34 of each cam shaft 22 and is secured between base 12 and the cam shaft so as to normally urge or bias the cam shaft into a first position in which arms 36 located at the end portions of the cam shaft are elevated as best seen in Figure 3.

A top or actuator 38 is mounted by guide pins 40 to base part 14 and is shiftable between upper and lower positions relative to base 12. Pins 40 each include an enlarged head 42 which abuts a shoulder within bore 44 at each corner of top 38 thereby preventing separation of the top from the base with the lower end of each guide 40 anchored within base 12. Top 38 abuts and is always in contact with arms 36 of cam shafts 22 with the arms serving to urge the top normally into the upper position as seen in Figures 3 and 15. When top 38 is depressed or moved towards base 12, it causes each of the cam shafts 22 to pivot within the base. Each cam shaft 22 includes a pair of drive lobes 46, 47 and a pair of return lobes 48. (Figure 8)

The operation of socket 10 is as follows: top 38 is depressed into its lowered position as shown in Figure 2. In this position, plate 24 is centered with its openings 26 aligned with openings 18 in base part 14. Drive lobes 46 of the cam shafts 22 are positioned in a non-driving

essentially diagonal position under plate 24 as seen in Figure 4. The cam shafts are supported by circular shaped bearing parts 50 upon base part 14. While top 38 is in its lowered position an IC 52 or chip is deposited through a center opening 54 in the top and guidably positioned upon plate 24 by locating tabs 56 (Figure 9 and 13). Locating tabs 56 are positioned at each of the four corners of the opening grid in plate 24 and have beveled inside faces 58 which serve to guide the corners of the IC as it is lowered into position over the plate. Each locating tab 56 includes depending feet 60 (Figure 10 and 11) which are inserted into selected openings 26 in the plate depending upon the overall dimensions of the IC being accommodated by socket 10. Feet 60 of each tab 56 form snaps which, when the feet are inserted into openings 26, are snap fitted about a bottom surface of the plate so as to lock the tabs in position. The manner in which tabs 56 are removably secured to the plate in openings 26 can vary.

Located on the bottom surface of IC 52 are ball grid array leads 51. With IC 52 so located upon plate 24, leads 51 will seat themselves within openings 26 in the plate. During the locating of IC 52, latches 28 are in their raised position. As top 38 is permitted to rise under the spring biased upward movement of arms 36 of cam shafts 22, latches 28 which had been held in their raised position by the lid as shown in Figure 16 are allowed to pivot inwardly under the influence of springs 30 to overly and retain the IC within socket 10 against plate 24. Upon the continued upward movement of top 38, cam shafts 22 rotate with their driving lobes 46 and 47 drivingly contacting plate 24 to urge the plate laterally or horizontally across plate 24 as best observed in Figure 5. As moving from Figure 4 to Figure 5, the rotational movement of the left located cam shaft 22 is counter-clockwise causing lobe 47 to urge plate 24 laterally to the left and the rotational movement of the right located cam shaft is clockwise causing lobe 46 to also urge plate 24 laterally to the left. The combined effort of both cam shafts through their drive lobes 46 and 47 apply a shear force to the plate to shift plate 24 relative to base 12. As plate 24 and its carried IC 52 are shifted slightly laterally relative to base 12, the pins or conductors 20 extending into openings 26 in the plate adjacent the leads 51 of the IC are moved forcibly into engagement with the IC leads in a manner known in the prior art and as particularly described in U.S. patent 5,646,447, which is incorporated herein by reference. With IC 52 now so located

within socket 10, the testing of the IC may proceed or the IC, when appropriately secured to a mounting board, can perform its operational function.

To remove IC 52 from socket 10, top 38 is depressed or located in its lowered position as shown in Figure 2, 4, 6 and 16. As lid 38 is being depressed, cam shafts 22 due to their engagement through arms 36 with the lid are rotated causing their driving lobes 46, 47 to release their hold upon plate 24. To relocate plate 24 relative to base 12, as the lid is being lowered, the eccentrically positioned return lobes 48 are each rotated from the position illustrated in Figure 7 into the position shown in Figure 6. In viewing the return lobes in Figures 6 and 7, the lobes located to the left, designated 48(a), rotate clockwise contacting bearing tab 31 on wall like structure 29 thereby driving plate 24 to the right relative to base part 14 and to its original centered position seen in Figure 6. As plate 24 is moved into its original or centered position relative to the socket, the latches 28 still initially overlap the IC allowing the IC to be shifted with the plate which causes conductors or pins 20 to be released from forcible engagement with the leads of the IC. Further downward movement of the top toward the base causes the top to engage latches 28 to rotate the latches into a raised position so as to release the IC for removal from socket 10 as seen in Figure 16. Return lobes 48(b) as seen in Figures 6 and 7 freely rotate within plate 24 and produce no driving engagement with the plate. Driving lobes 48(b) exist only because cam shafts 22, for simplicity of manufacture, are of like construction and may be interchangeable. With top 38 fully depressed or in its lowered position relative to base 12, IC 52 may now be removed and another IC placed and centered upon plate 24.

Cam shafts 22 operate independently so as to produce even wear upon both cam shafts. To further reduce wear, bearing tabs such as tab 31 may be placed on all bearing surfaces. The cam shafts are identical so as to reduce manufacturing costs. In utilizing both cam shafts to initially shift plate 24, the applying load is distributed to both the fore and aft of the plate, thus reducing wear. Plate 24 is returned to its initial, loading position relative to base 12 by a single cam shaft with the load or pressure required to return the plate being reduced through the assistance of the flexed conductors or pins 20 which are in engagement with the leads of the IC.

It is to be understood that the invention is not to be limited to the details above given but may be modified within the scope of the appended claims. For example, in the preferred

embodiment, locating tabs 56 are identical and interchangeable for manufacturing and assembly efficiency; however, non-uniform tabs or sized IC template could be used with the disclosed socket.

CLAIMS

What I claim is:

1. A chip carrier socket (10) for interconnecting a chip (52) having leads (51) to a printed circuit board, the chip carrier socket comprising a base (12), a plurality of contacts (20) extending from the base, a plate (24) movable in a direction parallel to the base between first and second positions, the first position allowing entry of the leads adjacent the contacts and the second position urging the leads into engagement with the contacts, an actuator (38), and an urging means (22) which urges the plate to both the first and second positions, characterized by a latch (28) independent of the plate for releasably holding the chip in the socket and wherein the actuator operates the urging means and the latch.
2. The chip carrier socket of claim 1, characterized in that the plate (24) has a plurality of openings (26) therethrough aligned with the contacts.
3. The chip carrier socket of claim 2, characterized in that the urging means includes two cam shafts.
4. The chip carrier socket of claim 3, characterized in that the cam shafts flank the plate.
5. The chip carrier socket of either of claims 3 or 4, characterized in that the cam shafts are identical.
6. The chip carrier socket of either of claims 3 or 4, characterized in that both the cam shafts urge the plate into the second position and only one of the cam shafts urges the plate into the first position.
7. The chip carrier socket of any of claims 3 or 4-6, characterized in that the cam shafts rotate in directions opposite from one another when actuated by the actuator.
8. The chip carrier socket of any of the preceding claims characterized in that the actuator is partly defined by a top (38) of the socket.
9. The chip carrier socket of claim 8, characterized in that the top is movable between upper and lower positions relative to the base such that when the top is moved to the upper position the leads are urged against the contacts and when the top is moved to the lower position the leads are disengaged from the contacts.

10. The chip carrier socket of either of claims 8 or 9, characterized by a biasing means (32) for biasing the top in the upper position.
11. The chip carrier socket of any of claims 3-10, characterized in that the latch is journaled about one of the cam shafts.
12. The chip carrier socket of any of claims 3-10, characterized by a biasing mechanism (30) for biasing the latching mechanism to hold the chip.
13. The chip carrier socket of any of claims 3-12, characterized by bearing tabs (31) on the plate for supporting bearing stress when the plate is being urged between the first and second positions.
14. The chip carrier socket of any of the preceding claims, characterized by adjustable locating tabs (56) for locating the chip in the socket.
15. The chip carrier socket of claim 14, characterized in that the locating tabs can be adjusted to accommodate integrated circuits of varying size and shape.
16. The chip carrier socket either of claims 14 or 15, characterized in that each locating tab is identical to all other locating tabs.
17. The chip carrier socket of any of claims 14-16, characterized in that the locating tabs have chamfered surfaces to facilitate placement of the chip upon the plate.
18. The chip carrier socket of any of claims 14-17, characterized in that the locating tabs are attached to the plate.
19. The chip carrier socket of any of the preceding claims, characterized in that the chip leads are in the form of a ball grid array.