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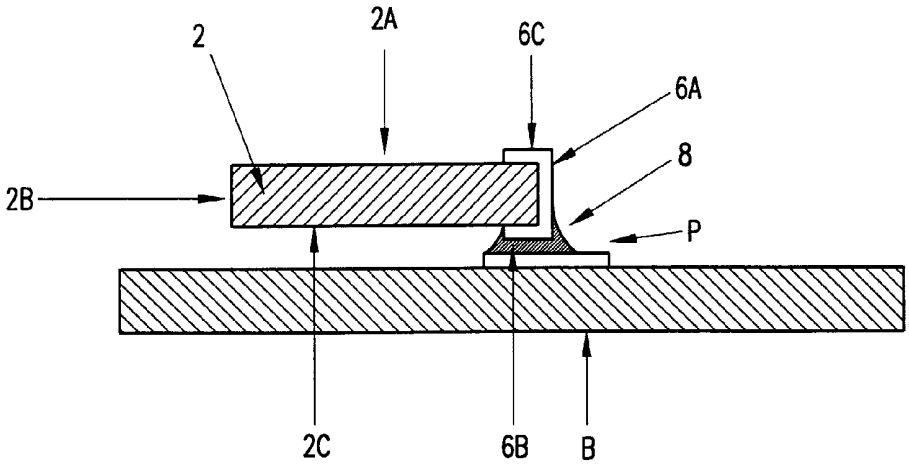
(54) Title: METHOD AND APPARATUS FOR SURFACE MOUNTING ELECTRICAL DEVICES



(57) Abstract: A method and device are disclosed for mounting a printed circuit board to another printed circuit board. The device (1) includes a first printed circuit board (2) having a plurality of electrical components (3) disposed thereon, the first printed circuit board (2) including a plurality of wire segments (4) electrically connecting the electrical components (3) together and a plurality of input-output wire segments (5) being routed to side surfaces (2B) of the first printed circuit board (2). The device further includes a plurality of plate members (6) of electrically conductive material disposed along the side surfaces (2B) of the first printed circuit board (2) and associated with the input-output wire segments (5) thereof. A solder bump (8) is disposed against each plate member (6). The first printed circuit board (2) is disposed on a second printed circuit board (B) and maintained thereon by the solder bumps (8), the second printed circuit board (B) providing electrical connectivity to each input-output wire segment (5) of the first printed circuit board (2). Because each solder bump (8)/plate member (6)/input-output segment (5) of the first printed circuit board (2) is located at the periphery thereof, the solder bumps (8)/plate members (6)/input-output segments (5) of the first printed circuit board (2) is easily inspected, reworked or removed.

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METHOD AND APPARATUS FOR SURFACE MOUNTING ELECTRICAL DEVICES

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to a method and apparatus for mounting devices to a printed circuit board, and particularly to a method and apparatus for surface mounting a printed circuit board to another printed circuit board.

Description of the Related Art

Printed circuit boards are frequently used to hold electrical circuit components in place and provide electrical connectivity thereto. Printed circuit boards pervade nearly every industry utilizing electronics. Printed circuit boards are typically populated with integrated circuit packages mounted thereto.

One problem with mounting or bonding circuit components and/or integrated circuit packages to the surface of printed circuit boards is with respect to board warpage. In particular, printed circuit boards may be warped during manufacture or even following installation of the board in a system. A warped or otherwise non-planar board has been seen to compromise the electrical connections between the board and their corresponding integrated circuit packages, thereby reducing system yield and reliability. Consequently, there is a need for a bonding technique that bonds a device to a printed circuit board while compensating for board warpage.

In addressing this need, various techniques have been attempted for mounting electrical devices to printed circuit boards. As is well known, ball grid arrays are used for mounting integrated circuits to the surface of printed circuit boards. In a ball grid array design, the underside of an integrated circuit package is commonly densely populated with high temperature solder balls. The location of each solder ball corresponds to the location of an input or output signal line of the integrated circuit. The solder balls of a ball grid

array are melted under application of relatively high heat so as to form a secure electrical connection between the integrated circuit package and the printed circuit board.

Because solder balls are typically adjacent center portions of the underside of the integrated circuit package, such solder balls are difficult to inspect. Existing inspection techniques include use of x-rays and fiber optic vision rays. However, these inspection techniques are complicated, time consuming and expensive to perform. Another problem with ball grid arrays is that the high temperatures used to melt the solder balls increase the likelihood of damaging printed circuit boards constructed of FR-4 material or other non-ceramic compositions.

Based upon the foregoing, there is a need for a technique for bonding devices to printed circuit boards that allows for post-bonding inspection and does not adversely effect the printed circuit boards being bonded.

SUMMARY OF THE INVENTION

The present invention overcomes the shortcomings in prior systems and thereby satisfies a significant need for efficiently mounting a printed circuit board onto the surface of another printed circuit board. An embodiment of the present invention includes a first substrate onto which a plurality of electrical components are mounted along a first surface thereof. The first substrate, which may be a printed circuit board, has wire segments electrically connecting the electrical components together. At least one plate member of electrically conductive material is disposed against the first substrate, including a first portion adjacent a side surface of the first substrate and a second portion adjacent a second surface of the first substrate. The plate member is electrically connected to at least one of the electrical components. A bump of solder material is disposed adjacent the plate member and is electrically connected thereto and the at least one of the electrical components. The first substrate is capable of being connected to a second substrate in part by bonding the solder bump to a surface mount pad disposed along a surface of the second substrate, thereby creating an electrical connection with the surface mount pad.

By locating the solder bump along the side surface of the printed circuit board, the solder bump may be easily inspected, reworked or removed.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the system and method of the present invention may be obtained by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1 is a top plan view of a printed circuit board assembly according to an embodiment of the present invention;

FIGURE 2 is a perspective view of the printed circuit board assembly of Figure 1; and

FIGURE 3 is a side elevational view of the printed circuit board assembly of Figure 1 in association with a printed circuit board.

DETAILED DESCRIPTION OF THE PREFERRED EXEMPLARY EMBODIMENTS

The present invention will now be described more fully hereinafter with reference to the accompanying drawings in which a preferred embodiment of the invention is shown. The embodiment is provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Referring to Figures 1-3, there is disclosed a surface mount board assembly 1 according to an embodiment of the present invention. Surface mount board assembly (hereinafter "board assembly") 1 is adapted to mount to the surface of a printed circuit board. Board assembly 1 is shown in Figure 1 as a printed circuit board 2 having a number of electrical components 3, such as discrete and/or integrated electrical components, disposed thereon and interconnected so that board assembly 1 provides at least one function or operation. It is understood, however, that printed circuit board 2 may be any substrate which maintains electrical components 3 in a fixed position along a surface thereof and provides electrical interconnectivity therebetween.

Printed circuit board 2 is substantially planar having a first surface 2A on which electrical components 2 are disposed. Printed circuit board 2 may be formed of one or more layers of material, such as FR-4, another fiberglass composition or a ceramic. The electrical interconnectivity between electrical components 2 may be provided by electrical wire segments 4 disposed along first surface 1 and/or between adjacent layers of the material forming printed circuit board 2. As shown in Figures 1 and 2, the wire segments 4 associated with the input and output signals and with the power supply lines (hereinafter "I/O lines") 5 of board assembly 1 are routed to edges of first surface 2A of printed circuit board 2 at spaced locations therealong.

Board assembly 1 further includes plate members 6 disposed along the sides of printed circuit board 1 at each location to which a wire segment 4 associated with an I/O line 5 is routed. As shown in Figure 3, each plate member 6 may include a first plate portion 6A adjacent a side surface 2B of printed circuit board 2, a second plate portion 6B adjacent a second surface 2C of printed circuit board 2, and a third plate portion 6C adjacent the first surface 2A of printed circuit board 2. Plate member 6 may form a substantially C-shape to substantially conform around side surface 2B of printed circuit board 2.

Plate members 6 are constructed from an electrically conductive material to provide an electrical connection to the associated input/output line segments 5. By way of one example, plate members 6 are a gold composition. Plate members 6 may be formed to printed circuit board 2 using an electroplating process and/or a selective edge plating process. The process utilized forms plate members 6 that are spaced apart from each other along the side surfaces 2B of printed circuit board 2. An etching process applied to the edges and corners of printed circuit board 2 is utilized to permit a greater attraction and deposition of the plating material. It is understood that plate members 6 may be formed against printed circuit board 2 using other techniques as well.

Board assembly 1 may further include a via 7 associated with each plate member 6. Via 7 is defined from first surface 2A to second surface 2C of printed circuit board 2. Via 7 is formed during the electroplating process that forms plate members 6. Vias 7

provide greater integrity of the electrical connection between plate members 6, and particularly first plate portion 6A and second plate portion 6B, and the input/output line segments 5 associated therewith.

Because plate members 6 form a C-shape and thereby substantially conforms around side surfaces 2B of printed circuit board 2, plate members 6 substantially tightly adhere thereto. It is understood, however, that third plate portion 6C of plate members 6 may be unnecessary so long as first and second plate portions 6A and 6B can adhere to printed circuit board 2.

Board assembly 1 further includes a solder bump 8 disposed against at least the second surface 6B of each plate member 6. Solder bumps 8 are electrically connected to plate members 6 and the input/output line segments 5 associated therewith. Solder bumps 8 are of a relatively low temperature solder so that, in the event printed circuit board 2 is formed from FR-4 material, printed circuit board 2 is less likely to be damaged when solder bumps 8 are heated. Solder bumps 8 may be formed to plate members 6 using a paste or other material.

Solder bumps 8 allow board assembly 1 to be surface mounted to a printed circuit board B, such as a motherboard, and electrically connected thereto. Each solder bump 8 of board assembly 1 is positioned adjacent a surface mount pad P disposed on a surface of printed circuit board B. When sufficiently heated, each solder bump 8 becomes flowable and spreads between corresponding surface mount pad P and plate member 6. When cooled, each solder bump 8 forms a secure connection between printed circuit board 2 and printed circuit board B, and an electrical connection between the surface mount pad P and first plate portion 6A and second plate portion 6B of plate member 6. Because of the flowable characteristic of solder bumps 8, solder bumps 8 compensate for warpage or other non-linear effects of either printed circuit board 2 or printed circuit board B. Because solder bumps 8 are disposed along the side surfaces 2A of printed circuit board 2, solder bumps 8 may be quickly and easily inspected. Solder bumps 8 may also be easily reworked or removed.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

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WHAT IS CLAIMED IS:

1. An electrical device, comprising:

a plurality of electrical components; and

a first substrate onto which the electrical components are mounted along a first surface thereof, the first substrate having wire segments electrically connecting the electrical components together, and including a second surface and a plurality of side surfaces;

at least one plate member of electrically conductive material disposed against the first substrate, including a first portion adjacent a side surface of the first substrate and a second portion adjacent the second surface of the first substrate, the at least one plate member being electrically connected to at least one of the electrical components; and

at least one bump of solder material, each at least one bump of solder material being disposed adjacent a distinct at least one plate member.

2. The electrical device of claim 1, further comprising:

a plurality of plate members, each plate member disposed against the first substrate and including a first portion adjacent a side surface of the first substrate and a second portion adjacent the second surface of the first substrate, the plate members being electrically connected to at least one of the electrical components and isolated from the other plate members.

3. The electrical device of claim 2, further comprising:

a plurality of bumps of solder material, each bump of solder material being disposed adjacent a distinct plate member.

4. The electrical device of claim 1, further comprising:

a second substrate having at least one bond pad disposed along a first surface of the second substrate, the at least one bump of solder material being disposed against and

attached to the at least one bond pad so as to provide an electrical connection between the at least one plate member and the at least one bond pad.

5. The electrical device of claim 1, wherein:

the at least one plate member is substantially C-shaped.

6. The electrical device of claim 1, wherein:

the first substrate includes at least one via defined between the first and second surfaces of the first substrate adjacent and electrically connected to the at least one plate member.

7. An electronic device, comprising:

a first substrate having a plurality of electrical components disposed thereon, the first substrate including a plurality of wire segments electrically connecting the electrical components together and a plurality of input-output wire segments being routed to side surfaces of the first substrate;

a plurality of plate members of electrically conductive material disposed along the side surfaces of the first substrate and associated with the input-output wire segments thereof; and

a second substrate on which the first substrate is disposed, the second substrate providing electrical connectivity to each input-output wire segment of the first substrate.

8. The electronic device of claim 7, further comprising:

a plurality of solder bumps, each solder bump disposed between a plate member and the second substrate.

9. The electronic device of claim 8, wherein:

the solder bumps are relatively low temperate solder bumps.

10. The electronic device of claim 7, wherein:

each plate member is substantially C-shaped.

11. The electronic device of claim 7, wherein:

the electrical components are disposed along a first surface of the first substrate; and

each plate member includes a first portion disposed adjacent the side surface of the first substrate and a second portion disposed adjacent a second surface of the first substrate.

12. The electronic device of claim 11, wherein:

each plate member includes a third portion disposed adjacent the first surface of the first substrate.

13. The electronic device of claim 12, wherein:

the first substrate and each plate member includes a via defined from the first surface of the first substrate to the second surface thereof.

14. The electronic device of claim 7, wherein:

the first and second substrates are printed circuit boards.

15. An electronic assembly, comprising:

a plurality of electrical components;

a substrate on which the electrical components are disposed along the first surface thereof, the substrate including wire segments electrically interconnecting the electrical components so as to form at least one function block, wire segments associated with input/output signals of the at least one function block being routed to side surfaces of the substrate; and

a plurality of plate members of electrically conductive material disposed along the side surfaces of the substrate adjacent the wire segments associated with the input/output signals of the at least one function block; and

a plurality of bumps of solder material, each bump being disposed adjacent a plate member.

16. The electronic assembly of claim 15, wherein:

each plate member includes a first portion disposed adjacent a side surface of the substrate and a second portion disposed adjacent a second surface thereof.

17. The electronic assembly of claim 16, wherein:

each bump is disposed adjacent at least one of the first portion and the second portion of a plate member.

18. The electronic assembly of claim 15, further comprising:

a plurality of vias defined from the first surface of the substrate to a second surface opposite the first surface, each via being disposed adjacent a distinct plate member.

19. The electronic assembly of claim 18, wherein:

each via includes an electrically conductive material electrically connected to the corresponding plate member.

20. The electronic assembly of claim 15, wherein:

the substrate comprises a printed circuit board.

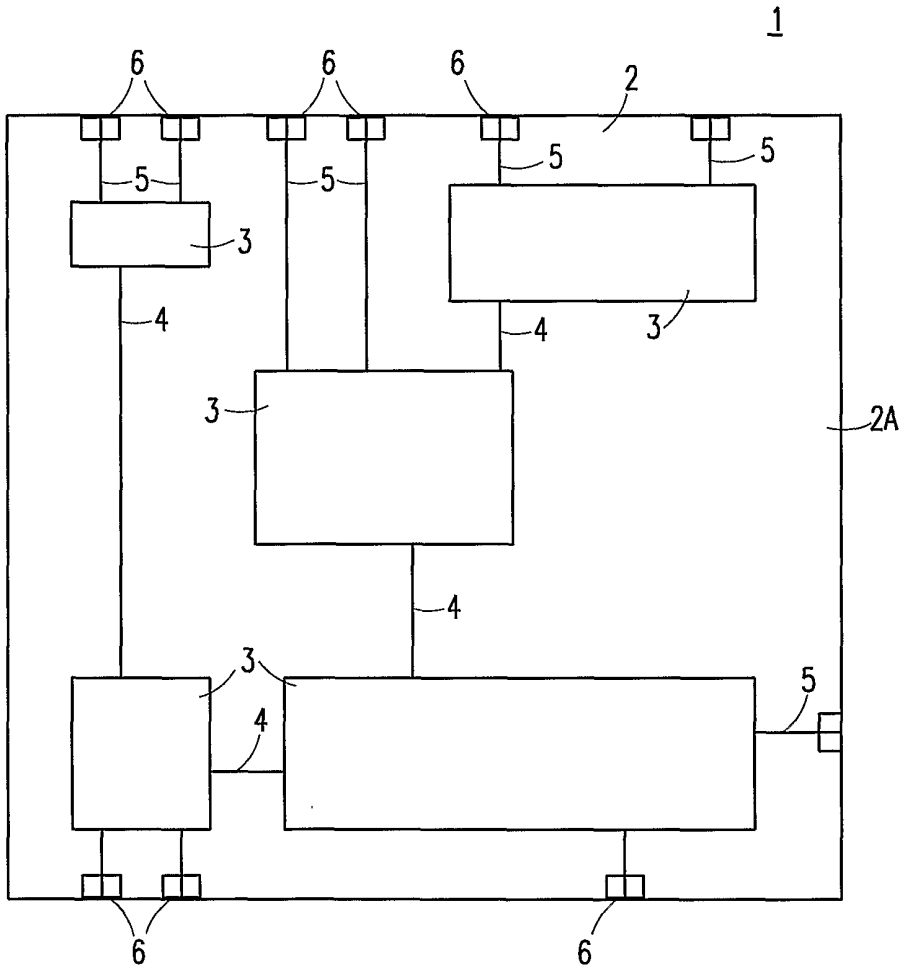

FIG. 1

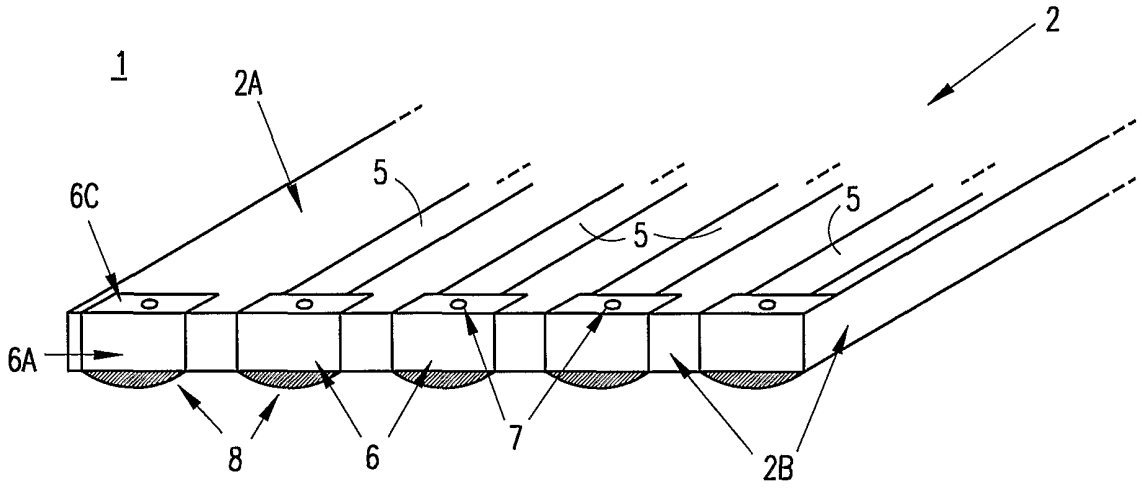

FIG. 2

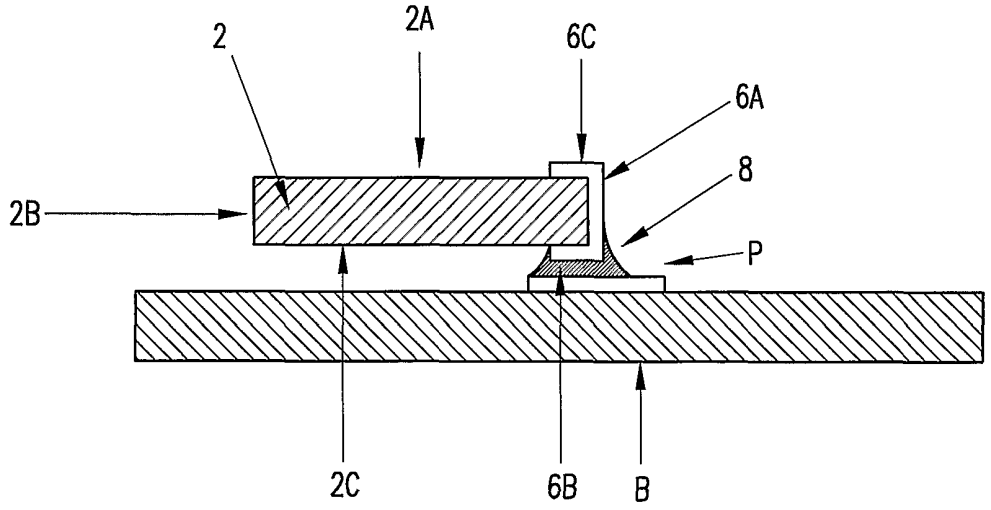

FIG. 3