(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 September 2004 (16.09.2004)

PCT

(10) International Publication Number
WO 2004/080140 A1

(51) International Patent Classification[7]: H05K 3/36

(21) International Application Number:
PCT/NZ2004/000037

(22) International Filing Date: 27 February 2004 (27.02.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
524595 6 March 2003 (06.03.2003) NZ

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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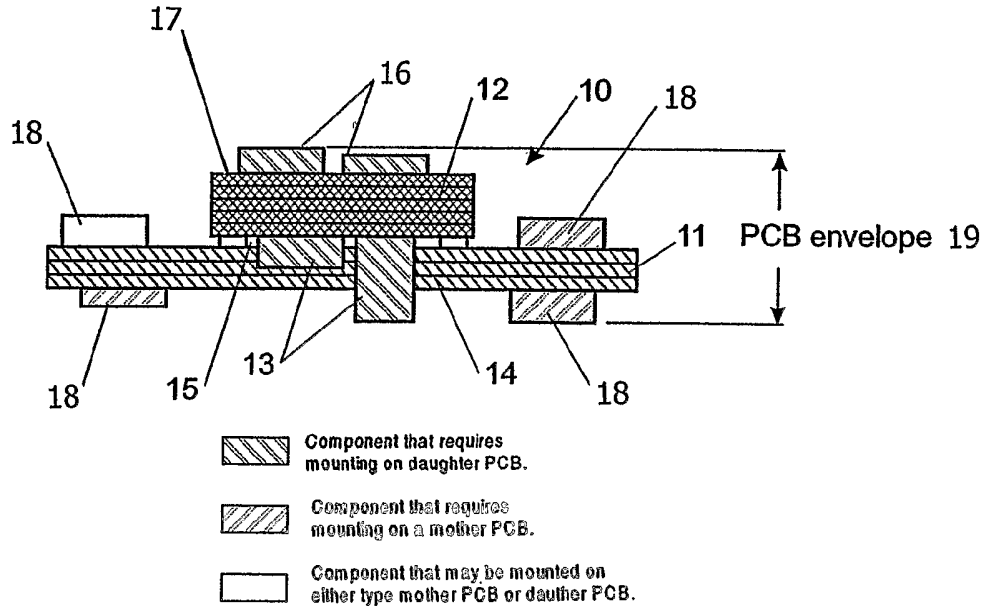
(54) Title: SURFACE MOUNTING DAUGHTER BOARD INTO AN APERTURE OF MOTHER BOARD



(57) Abstract: A PCB assembly 10 including a mother board 11 which has an aperture 14, surface mount terminals 20 located about the periphery of the aperture 14, and a daughter board 12 attached by the surface mount terminals 20 to the mother board 11 over the aperture 14. The board 11, 12 may be double sided and the PCB assembly 10 may be configured so that one or more of the components 13 on the daughter board 12 protrude into the aperture 14 of the mother board 11. The PCB assembly 10 may include a mother board with one or more additional apertures, additional surface mount terminals at the periphery of the additional apertures, and one or more additional daughter boards attached to the mother board by the additional terminals over the additional apertures.

WO 2004/080140 A1

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Surface mounting daughter board into an aperture of mother board

FIELD OF THE INVENTION

The present invention relates to a printed circuit board assembly comprising multiple interconnected printed circuit boards.

BACKGROUND TO THE INVENTION

Generally, the electronic componentry and circuitry within most products is mounted on a printed circuit board (PCB) of some type. PCBs provide a means to mount and interconnect electronic components via a network of tracks, vias and terminal pads which form an electronic circuit. Multiple layer PCBs are frequently required to enable complex circuitry to be formed.

Often portions of a PCB house more complex circuitry than the remainder of the PCB. For example, certain portions may have a higher component and track density, especially where microprocessors and the like are installed, which have a large number of pins. Such circuitry demands a higher specification board, for example one with more layers. Various other board specification requirements also result from portions of a circuit on a PCB such as different layer spacing or dielectric constant. Also, some portions of a circuit may demand special design constraints. For example, in RF applications where high frequencies and high track density cause EMC and other undesirable effects, measures are taken to reduce the effects. For example, a ground plane is often embedded in the board, and the tracks on the board are judiciously arranged.

Where a circuit portion demands a higher specification PCB and/or stricter design constraints, the entire circuit is usually designed within those constraints and formed on a PCB meeting those specifications, even portions of the circuit which could be formed on a lower specification board with lesser constraints. As higher specification boards are more expensive, this results in an unnecessary cost, as much of the board need only

be a cheaper lower specification type. Further, where a single board is used, stricter design constraints imposed on the more complex portion of the circuit (for example, to ensure low EMC), are also imposed on the less complex portion of the circuit which do not require such constraints. This results in unnecessary design costs.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a PCB assembly for an electronic circuit formed from multiple interconnected PCBs, and/or PCBs adapted for interconnection. This enables each PCB of the assembly to be selected to have specifications suitable for a portion of the electronic circuit.

In one aspect, the present invention broadly consists in a PCB assembly including a first PCB with an aperture through the PCB, surface mount terminals at the periphery of the aperture, and a second PCB attached by said surface mount terminals to the first PCB over the aperture.

In another aspect, the present invention broadly consists in a kit of parts including a first PCB with an aperture, surface mount terminals at the periphery of the aperture, and a second PCB adapted for attachment by the terminals to the first PCB, over the aperture.

In another aspect, the present invention broadly consists in a method for forming a PCB assembly including providing a first PCB including an aperture in the first PCB and providing surface mount terminals at the periphery of the aperture in the first PCB, providing a second PCB including terminals which when the second PCB is placed over the aperture in the first PCB can align with and contact the surface mount terminals on the first PCB, causing a pick and place machine to position the second PCB on the first PCB over the aperture, and heating the assembly to attach the second PCB to the first PCB at the surface mount terminals by reflow soldering.

In another aspect, the present invention broadly consists in a first PCB including an aperture and corresponding surface mount terminals for interconnection of a second PCB on the first PCB over the aperture.

In another aspect, the present invention broadly consists in a PCB assembly including a first PCB with an aperture and corresponding surface mount terminals, and a second PCB interconnected by the terminals to the first PCB over the aperture.

In another aspect, the present invention broadly consists in a kit of parts including a first PCB with an aperture and corresponding surface mount terminals, and a second PCB adapted for interconnection by the terminals to the PCB over the aperture.

The first and second PCB(s) may be have different specifications, such as a differing number of layers, and the circuitry fabricated on them may be designed within different design constraints. For example, the first PCB may have a lesser number of layers, and contain less complex circuitry, while the second PCB may have a greater number of layers and contain more complex circuitry designed to reduce EMC.

The invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described by way of example only and with reference to the drawings, of which:

Figure 1 is an elevation view of a preferred form PCB assembly, in which a second PCB is attached to a first PCB over an aperture;

Figures 2a and 2b are plan and elevation views showing detail of the interconnection of the first and second PCBs shown in Figure 1; and

Figures 3a and 3b are plan and elevation views showing detail of interconnection of the first and second PCBs in an alternative form of the PCB assembly.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows a preferred form PCB assembly 10 including a first PCB, referred to as a "mother board", 11 on which a second PCB, referred to as a "daughter board", 12 is surface mount installed or attached. It should be appreciated that the terms "mother board" and "daughter board" do not confer any restriction on the nature, size and specifications of the PCB, or associated circuitry on them. The mother board 11 has an aperture 14 through which one or more components 13 installed on the underside 15 of the daughter board 12 protrude. This enables double sided daughter boards 12 to be used that receive and secure components on both sides, and lowers the overall profile or envelope 19 of the PCB assembly 10. It will be appreciated that the daughter board 12 may also have a number of components 16 on its topside 17, and the mother board 11 may have one or more components 18 on both sides, however double sided boards are not a requirement of the PCB assembly.

The PCB assembly 10 contains circuitry such as tracks, vias, terminal pads, and (when installed) components 13, 16, 18 – all of which may span multiple layers. Certain portions of the circuitry may be more complex and/or have stricter design constraints than other portions. A PCB with higher specifications suitable for meeting those requirements can be selected, and fabricated with a more complex portion of the circuitry. A higher specification board may contain more layers, for example. A PCB with lower specifications can be selected and fabricated with the remainder of the circuitry with less complexity and/or lower design constraints. In this manner, rather than using a single expensive high specification PCB for the entire circuitry, including portions where such a PCB is not needed, a smaller separate high specification PCB is used just for the complex circuitry to reduce costs. Several higher specification boards

could be used where there are multiple portions of the circuitry that require a higher specification board.

Typically, although not necessarily, the majority of circuitry will require a lower specification board. In this case, the mother board 11 may be a larger, lower specification board than the daughter board 12 and contain a larger portion of the overall circuitry. The daughter board 12 may be a smaller, higher specification board containing more complex circuitry or may have a higher density of circuitry and/or components per unit area than the mother board 11. For example, as shown in Figure 1, the mother board 11 is a four layer double sided board and the daughter board 12 is a six layer double sided board. There may also be other differences in the board specifications e.g. layer spacing, dielectric constant or temperature rating. It will be appreciated that the daughter PCB(s) need not necessarily be higher specification boards, nor necessarily smaller. Any configuration and number of higher/lower specification PCBs of any size could be used to form the mother board and daughter board assembly 10, according to the specific circuitry requirements. It will be appreciated that the size of the PCBs may be represented by their surface areas or other dimensions.

Figures 2a and 2b show interconnection of the PCBs 11, 12 in more detail. The mother board 11 has a cut-out or aperture 14 formed at a suitable position. Around the perimeter of the aperture 14, surface mount terminal pads 20 are arranged on either the top or bottom surface for interconnection with corresponding surface mount terminal pads 21 on the daughter board 12. These terminals 20, 21 are connected with tracks 23, 24 on each respective PCB 11, 12 (for example, as shown in Figure 2b) to enable interconnection between the circuitry fabricated on both PCBs 11, 12. Connection between the terminals 21 and components on the mother board 11 may be via an internal layer in the mother board. The tracks 23, 24, vias 25, 26, and terminals 20, 21 shown in Figures 2a and 2b are by way of example only. It will be appreciated both boards 11, 12 can be fabricated with the required circuitry, and include a suitable number of terminals positioned correctly to enable interconnection as required. The

size, shape and spacing of the terminals are not restricted to those shown, but can be designed to the required specifications for a particular application.

Figures 3a and 3b show an alternative embodiment in which a rebate 30 is formed around the aperture 14 to provide a shelf. The terminals 31 on the mother board 11 are arranged on the shelf.

Preferably, the assembly 10 is manufactured using surface mount techniques. For example, for the assembly 10 shown in Figures 2a and 2b, the daughter board 12 is first populated with components, soldered and then removed from its PCB panel or frame. There may be more than one daughter board 12 in a panel for installation on one or more mother boards 11. Solder paste is then dispensed onto the terminals 20 on the mother board 11. The populated daughter board 11 is presented to the surface mount placement machine in a suitable form. For example, it may be on a tray or reel. A flat area larger than the pick up nozzle of the placement machine is provided near the centre of the daughter board 12 to facilitate machine pick up and place. Machine vision markings may also be provided. The daughter board 12 is placed on the terminals 20 and soldered, or heated, using a standard surface mount reflow technique. When installed, the daughter board 12 is positioned over the aperture 14 so that components 13 on the underside can protrude through the aperture 14.

The procedure for the assembly shown in Figures 3a and 3b is substantially the same, although an alternative solder paste dispensation process may be required to deposit solder paste on the terminals 31 in the rebate 30. For example, robotic dispensation could be used. The daughter board terminals 21 are positioned on the mother board terminals 30 and soldered using a standard surface mount reflow technique. When installed, the daughter board 12 is partially countersunk within the mother board 11, thus lowering the overall profile 17 of the PCB assembly. Variations on the assembly process described will be apparent to those skilled in the art.

In an alternative embodiment, the daughter board part may be detachable from the mother board part. Further, a range of daughter board parts, with different circuitry,

could be interchangeable to perform different circuit functions. The entire assembly could be supplied or produced as a kit including one or more mother boards and one or more daughter boards for interconnection and/or interchange.

It will be appreciated that the printed circuit board is scalable in all aspects. The size of the separate boards may be re-sized to suit circuit design requirements. Further, the number and thickness of the layers in each board part may be modified to suit requirements.

It will be appreciated that the printed circuit board can be adapted to include more board parts with different numbers of layers. For example, the mother board may have one or more additional apertures, with surface mount terminals at the periphery of the additional apertures, and one or more additional daughter boards attached to the mother board by the terminals over the additional aperture(s).

The foregoing description includes various forms of the invention. It will be appreciated that other variations within the scope of the invention could be envisaged by those skilled in the art.

What We Claim Is:

1. A PCB assembly including a first PCB with an aperture through the PCB, surface mount terminals at the periphery of the aperture, and a second PCB attached by said surface mount terminals to the first PCB over the aperture.

2. A PCB assembly according to claim 1, wherein the second PCB has components mounted on both sides of the second PCB.

3. A PCB assembly according to claim 2, wherein one or more components on the second PCB protrude into the aperture in the first PCB.

4. A PCB assembly according to any one of claims 1 to 3, wherein the second PCB carries a higher density of circuitry and/or components per unit area than the first PCB.

5. A PCB assembly according to any one of claims 1 to 4, wherein the second PCB has more layers than the first PCB.

6. A PCB assembly according to any one of claims 1 to 5, wherein the second PCB has a smaller surface area than the first PCB.

7. A PCB assembly according to any one of claims 1 to 6, wherein said surface mount terminals enable attachment of the second PCB to the first PCB by reflow soldering.

8. A PCB assembly according to any one of claims 1 to 7, wherein the first PCB further includes one or more additional apertures, additional surface mount terminals at the periphery of the additional apertures, and one or more additional second PCBs attached by said additional terminals to the first PCB over the additional aperture(s).

9. A kit of parts including a first PCB with an aperture, surface mount terminals at the periphery of the aperture, and a second PCB adapted for attachment by the terminals to the first PCB, over the aperture.

10. A method for forming a PCB assembly including providing a first PCB including an aperture in the first PCB and providing surface mount terminals at the periphery of the aperture in the first PCB, providing a second PCB including terminals which when the second PCB is placed over the aperture in the first PCB can align with and contact the surface mount terminals on the first PCB, causing a pick and place machine to position the second PCB on the first PCB over the aperture, and heating the assembly to attach the second PCB to the first PCB at the surface mount terminals by reflow soldering.

11. A method according to claim 10, wherein the second PCB has components mounted on both sides of the second PCB.

12. A method according to claim 11, wherein one or more components on the second PCB protrude into the aperture in the first PCB.

13. A method according to any one of claims 10 to 12, wherein the second PCB carries a higher density of circuitry and/or components per unit area than the first PCB.

14. A method according to any one of claims 10 to 13, wherein the second PCB has a higher number of layers than the first PCB.

15. A method according to any one of claims 10 to 14, wherein the second PCB has a smaller surface area than the first PCB.

16. A method according to any one of claims 10 to 15, wherein the first PCB further includes one or more additional apertures and additional surface mount terminals at the periphery of the or each additional aperture(s), and including the step of attaching one

or more additional second PCBs by said additional terminals to the first PCB over the additional aperture.

17. A first PCB including an aperture and corresponding surface mount terminals for interconnection of a second PCB on the first PCB over the aperture.

18. A first PCB according to claim 17, wherein the second PCB is double sided, and the aperture is adapted to enable components on one side of the second PCB, when installed, to protrude through the aperture.

19. A first PCB according to claim 17, further including one or more additional apertures with corresponding terminals for interconnection of one or more additional PCBs on the first PCB over the aperture.

20. A PCB assembly including a first PCB with an aperture and corresponding surface mount terminals, and a second PCB interconnected by the terminals to the first PCB over the aperture.

21. A kit of parts including a first PCB with an aperture and corresponding surface mount terminals, and a second PCB adapted for interconnection by the terminals to the PCB over the aperture.

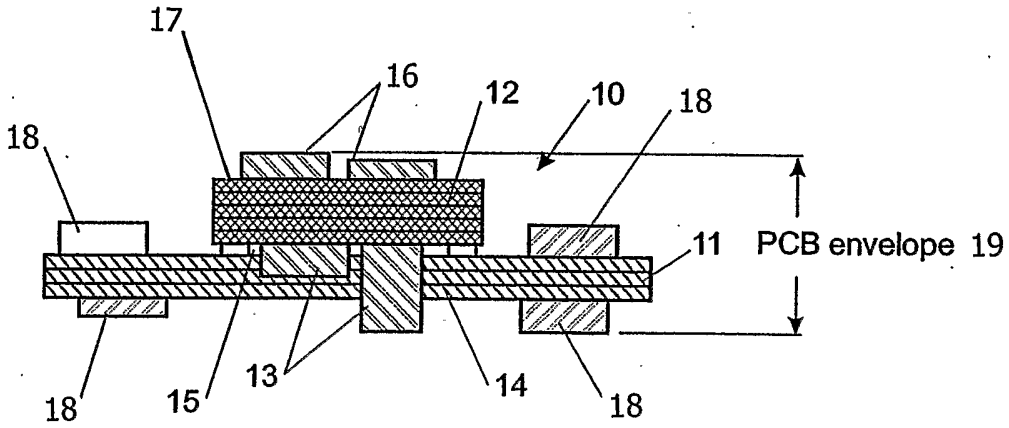


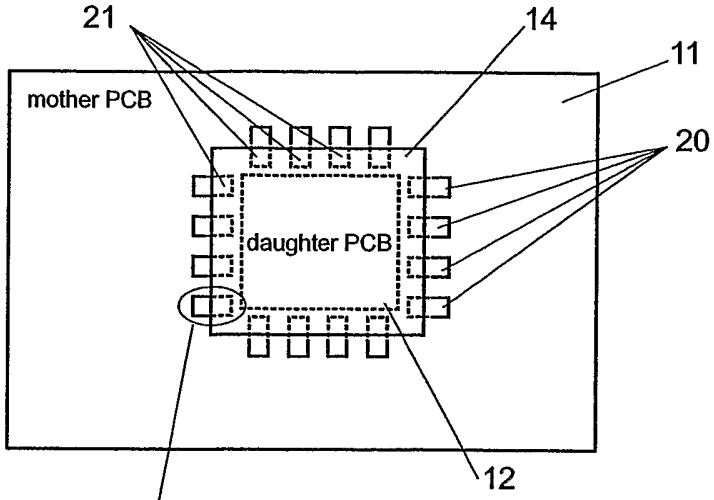
FIGURE 1

Component that requires mounting on daughter PCB.

Component that requires mounting on a mother PCB.

Component that may be mounted on either type mother PCB or dauther PCB.

FIGURE 2a



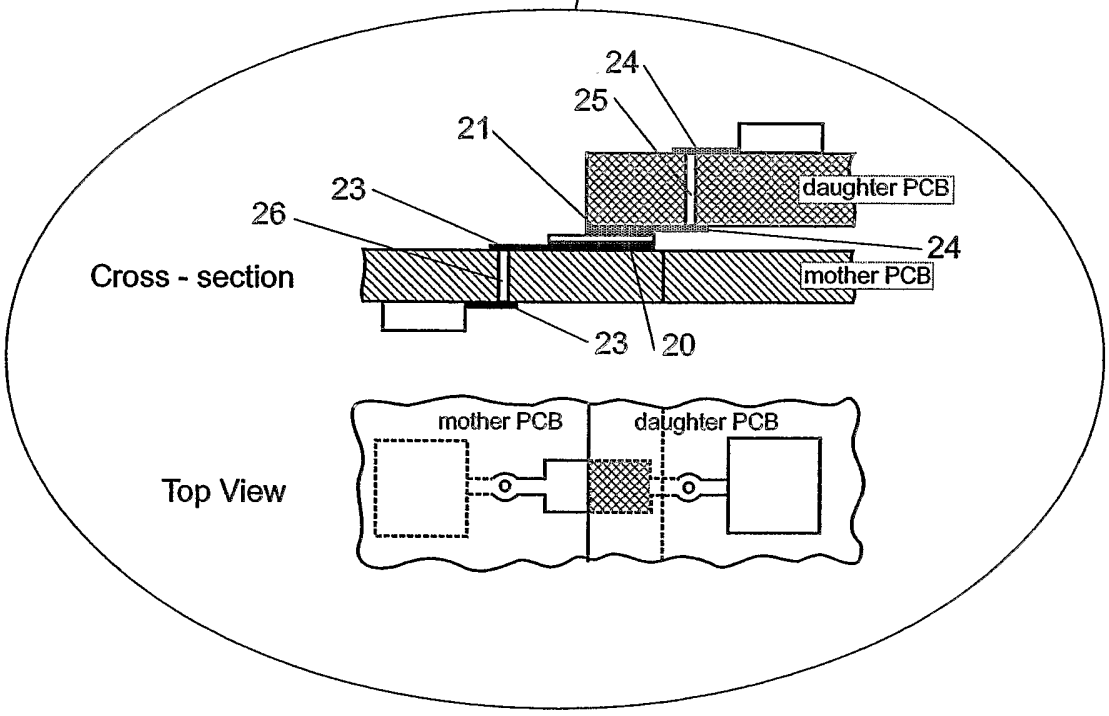


FIGURE 2b

FIGURE 3a

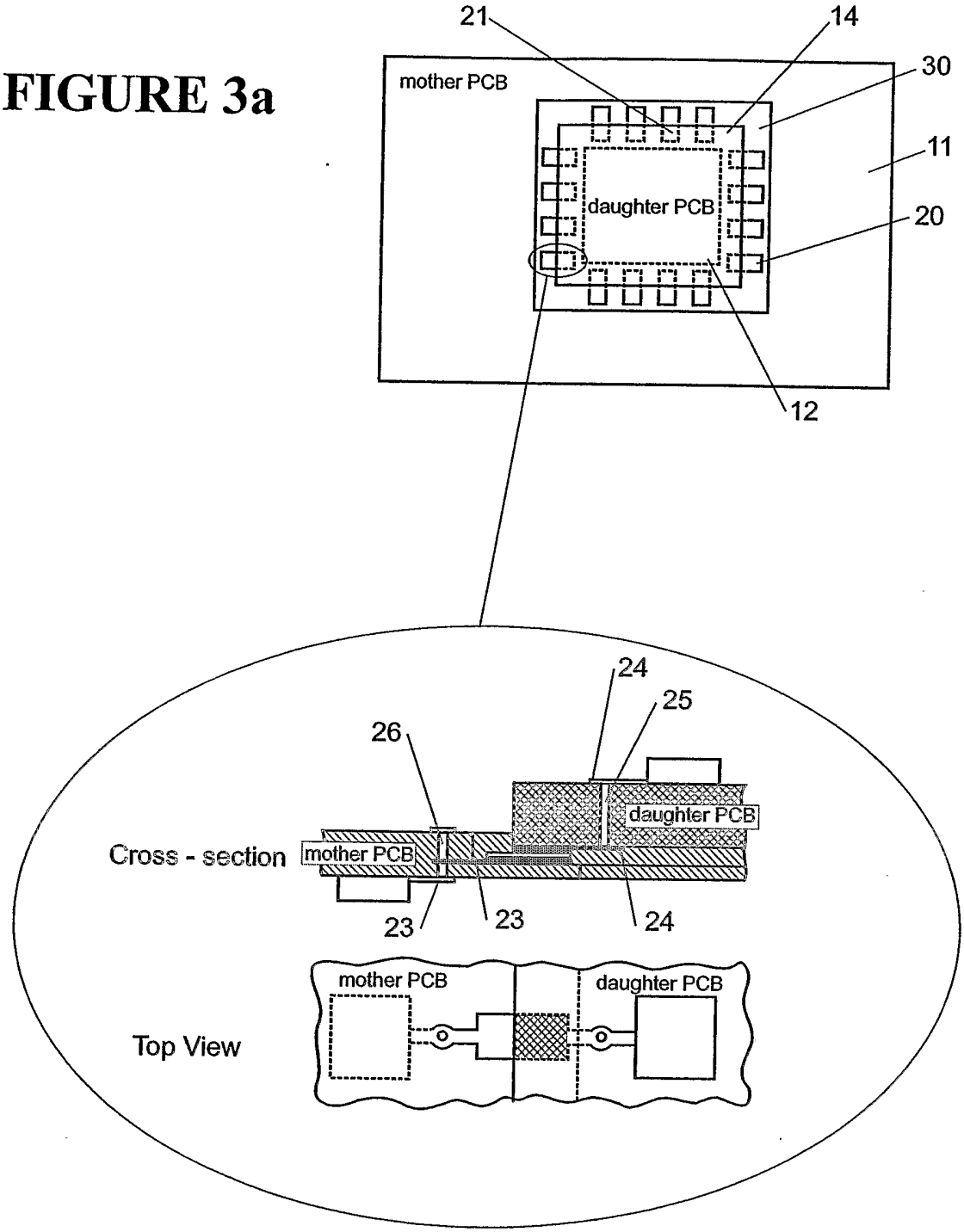


FIGURE 3b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2004/000037

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: H05K 3/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Please see electronic data base consulted given below

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI: IPC H05K/-, PCB, stack, aperture, surface mount, terminals, periphery and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 06-334298 A (FUJITSU LTD) 2 December 1994 See JPO machine translation of the entire document	1-21
X	US 5053853 A (HAJ-ALI-AHMADI et al) 1 October 1991 entire document	1-21
A	EP 0586069 A2 (SAMSUNG ELECTRONICS CO LTD) 9 March 1994 Entire document	
P,X	WO 2003067656 A1 (IBIDEN CO LTD) 14 August 2003 abstract	1-21

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 June 2004	05 JUL 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **MANO RAMACHANDRAN** Telephone No : (02) 6283 2166

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/NZ2004/000037

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
JP	6334298				
US	5053853	EP	0461753	JP	4229645
EP	0586069	JP	6177501		
WO	2003067656				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX