Abstract: An integrated DC power delivery system for PCBs is disclosed. In one embodiment, the system includes a compliant mechanical coupling assembly. The system further includes a power distribution interface having power planes configured to receive the DC power via the compliant mechanical coupling assembly upon securing the compliant mechanical coupling to the power distribution interface to provide the needed mechanical support.
Declarations under Rule 4.17: Published:

— as to the identity of the inventor (Rule 4.17(i))
— with international search report (Art. 21(3))
INTEGRATED POWER DELIVERY SYSTEM FOR PRINTED CIRCUIT BOARDS

CROSS-REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to printed circuit boards and more particularly to delivering power to the printed circuit boards.

Brief Description of Related Art

[0003] Typically, a top surface of a printed circuit board (PCB) assembly covered with integrated circuits are mounted on another assembly that delivers DC power and extract heat away from the PCB. Generally, such PCB assembly requires a large amount of DC power and also dissipates a large amount of power and further requires mechanically attaching in a removable way.

[0004] Typically, delivering DC power to PCBs is accomplished via large connectors. However, these connectors may not be able to be used as secure mechanical attachment mechanism. Instead, another approach bonds a large conductive area of the PCB with a conductive epoxy to the power source. Such bonding to provide the power and
mechanical attachment may not be easily detachable, since the top surface of the PCB cannot be penetrated as they are, generally, covered with integrated circuits, and there would be no way to mechanically couple the assembly down to the top surface of the PCB.
SUMMARY OF THE INVENTION

[0005] An integrated DC power delivery system for PCB is disclosed. According to one aspect of the present subject matter, the system includes a compliant mechanical coupling assembly. The system further includes a power distribution interface having power planes configured to receive the DC power via the compliant mechanical coupling assembly upon securing the compliant mechanical coupling to the power distribution interface to provide the needed mechanical support. The system may further include a PCB including at least one integrated circuit that is disposed on top of the power distribution interface and electrically coupled to the power distribution interface to receive the DC power via the power planes in the power distribution interface.
BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The advantages and features of the present disclosure will become better understood with reference to the following detailed description and claims taken in conjunction with the accompanying drawings, wherein like elements are identified with like symbols, and in which:

[0007] FIG. 1 is an exploded view of major components of an integrated DC power delivery system to PCBs, according to an example embodiment of the present subject matter.

[0008] FIG. 2 is a cross-sectional view of the integrated DC power delivery system showing interconnectivity of the transfer lugs to the power distribution interface for providing the DC power to the power planes in the power distribution interface, such as those shown in FIG. 1, according to an example embodiment of the present subject matter.

[0009] FIG. 3 is a cross-sectional view of the integrated DC power delivery system to the PCB, such as those shown in FIGS. 1-2, showing the mechanical force distribution along with power flow paths, according to an example embodiment of the present subject matter.

[00010] FIG. 4 is a cross-sectional view of a helical spring connector used in securing the transfer lugs to the power distribution interface, such as those shown in FIGS. 1 and 2, according to an example embodiment of the present subject matter.
DETAILED DESCRIPTION OF THE INVENTION

[0001] The exemplary embodiments described herein in detail for illustrative purposes are subject to many variations in structure and design. The present technique provides an integrated DC power delivery system for PCBs via a compliant mechanical coupling mechanism and electrical connection that provides both the needed mechanical support and the needed DC power to the PCBs via the power planes of the power distribution board with substantially reduced structural stress. The present technique allows for the conservation of space on a PCB by allowing the mechanical coupling mechanism, such as the transfer lugs and the helical spring connectors to perform two functions, one being DC power delivery to the power planes of the power distribution interface and the other being mechanical fastening function.

[0002] The terms "mechanical coupling mechanism" and "mechanical coupling assembly" are being used interchangeably throughout the document. Further the terms, "power planes" and "power distribution planes" are used interchangeably throughout the document. Furthermore, the terms "power", "current", "DC power" and "DC current" are being used interchangeably throughout the document. Moreover, the term "power" refers to, high or low AC or DC power.

[0003] FIG. 1 is an exploded view of major components of an integrated DC power delivery system 100 to PCBs, according to an example embodiment of the present subject matter. FIG. 1 shows a power distribution interface 210 (shown in FIG. 2) including a top surface/interposer 110 and a power distribution board 120 of the power distribution
Further, FIG. 1 shows a compliant mechanical coupling provided by a plurality of transfer lugs 130 and an associated plurality of helical spring connectors 140 used for transferring DC power to the power planes disposed on the power distribution board 120 of the power distribution interface 210. In these embodiments, the plurality of transfer lugs 130 are configured to carry DC current and, as shown in FIG. 1, the plurality of transfer lugs 130 are disposed through the power distribution board 120 and then into the plurality of associated helical spring connectors 140.

FIG. 2 is a cross-sectional view 200 of the integrated DC power delivery system showing interconnectivity of the plurality of transfer lugs 130 via the associated plurality of helical spring connectors 140 to the power distribution board 120 of the power distribution interface 210, such as those shown in FIG. 1, according to an example embodiment of the present subject matter. Further, FIG. 2 shows an established mechanical and electrical interconnectivity between the plurality of transfer lugs 130, plurality of associated helical spring connectors 140 and the power planes 330 (shown in FIG. 3) of the power distribution interface 210 for delivering the needed DC power to the power planes 330 (shown in FIG. 3) upon securing the plurality of transfer lugs 130 to the power distribution interface 210 via the associated plurality of helical spring connectors 140.

FIG. 3 is a schematic diagram of a cutaway view 300 showing mechanical and electrical interconnectivity established between the plurality of transfer lugs 130, plurality of associated helical spring connectors 140 and the power planes 330 (shown in FIG. 3) of the power distribution interface 210 for delivering the needed DC power to the
power planes 330 (shown in FIG. 3) upon securing the plurality of transfer lugs 130 to the power distribution interface 210 via the associated plurality of helical spring connectors 140. Further FIG. 3 shows mechanical force distribution 310 along with power flow paths 320 upon securing the plurality of transfer lugs 130 to the power distribution interface 210 via the associated plurality of helical spring connectors 140 and during operation. It can be seen in FIG. 3 the distribution of mechanical and locking forces 310 between the plurality of transfer lugs 130, plurality of associated helical spring connectors 140 and the power distribution interface 210 (shown in FIG. 2). It can also be seen in FIGS. 2 and 3 that the power planes 330 (shown in FIG. 3) are configured to receive the DC power via each transfer lug 130, helical spring contact 410, helical spring barrel housing 420 and helical spring connector flange 430. Further it can be seen in FIG. 3 that the helical spring connectors 140 provide the needed compliant mechanical coupling between the plurality of transfer lugs 130 and the power distribution interface 210 upon securing the plurality of transfer lugs 130 to the power distribution interface 210 via the plurality of helical spring connectors 140. In some embodiments, as shown in FIG. 3, the power distribution interface 210 is configured with a plurality of recesses 220 to receive the heads of the plurality of transfer lugs 130 such that the heads of the plurality of transfer lugs 130 are flush with the top surface of the power distribution interface 210. In these embodiments, the helical spring connectors 140 are conductive and mechanically compliant.

[00016] As shown in FIG. 3, each of the plurality of transfer lugs 130 is disposed through the power distribution board 120 and an associated helical spring connector 140. Further as shown in FIG. 3, the helical spring connector flange 430 is affixed to the power
distribution board 120 such that the helical spring connector flange 430 does not bear any
substantial structural stress, while the flanged end of the plurality of transfer lugs 130 provides the needed mechanical clamping force. This compliant mechanical
coupling/electrical connection enables proper functioning of the embedded fasteners,
such as the plurality of transfer lugs 130 and the associated plurality of helical spring
connectors 140. In these embodiments, the power distribution interface 210 including the
power distribution board 120 and the plurality of transfer lugs 130 is topped by an
mierposer 110 and at least one PCB including at least one integrated circuit (not shown
for simplicity). Also in these embodiments, the DC power to the integrated circuits is
delivered via the power planes disposed in the power distribution interface 210.

[00017] FIG. 4 is a cross-sectional view of a helical spring connector 140 used in securing
the plurality of transfer lugs 130 to the power distribution interface 210, such as those
shown in FIGS. 1 and 2, according to an example embodiment of the present subject
matter. It can be seen in FIG. 4 that the helical spring connector 140 includes a helical
spring contact 410. Further as shown in FIG. 4, the helical spring connector 140 includes
a helical spring barrel housing 420 that is configured to receive the helical spring contact
410 concentrically inside the helical spring baixel housing 420. Furthermore as shown in
FIG. 4, the helical spring connector 140 includes a helical spring connector flange 430
that is configured to receive the helical spring barrel housing 420 along with the helical
spring contact 410 concentrically inside the helical spring connector flange 430.
Exemplary helical spring barrel housing 420 is copper barrel housing/copper sheath. In
some embodiments, the helical spring connector flange 430 is affixed to the power
distribution interface 210 using joining techniques, such as soldering, brazing, pressing,
and the like. Further in some embodiments, the helical spring barrel housing 420 is affixed to the helical spring contact 410 via joining techniques, such as soldering, brazing, pressing, and so on. In these embodiments, the helical spring connector flange 430 is made of high conductivity metal flange.

[00018] In operation, the plurality of transfer lugs 130 after inserting via the power distribution board 120 it contacts associated plurality of helical spring contacts 410 within the helical spring connector 140. When a DC current is passed through the plurality of transfer lugs 130 it transfers the DC power to the helical spring contacts 410, then to the helical spring barrel housing 420 and the helical spring connector flange 430 and then to the distribution power planes 330 as shown in FIG. 3. In some embodiments, the helical spring barrel housing 420 is a copper sheath and in these embodiments, the copper sheath contacts the distribution power planes 330 via plated through hole disposed on the power distribution board 120. This configuration allows for a large DC current to be passed from the plurality of transfer lugs 130 to the helical spring connector 140 and then to the distribution power planes 330 disposed on the power distribution board 120.

[00019] Even though the above idea is described with reference to DC power, one skilled in the art can envision that the idea works, similarly, for AC power as well.

[00020] The foregoing descriptions of specific embodiments of the present disclosure have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the present disclosure to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the
present disclosure and its practical application, to thereby enable others skilled in the art to best utilize the present disclosure and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omission and substitutions of equivalents are contemplated as circumstance may suggest or render expedient, but such are intended to cover the application or implementation without departing from the spirit or scope of the claims of the present disclosure.
CLAIMS

What is claimed is:

1. An integrated DC power delivery system for a printed circuit board (PCB), comprising:
   a compliant mechanical coupling assembly; and
   a power distribution interface having power planes configured to receive the DC power via the compliant mechanical coupling assembly upon securing the compliant mechanical coupling to the power distribution interface to provide the needed mechanical support.

2. The system of claim 1, further comprising:
   a PCB disposed on the top surface of the power distribution board and electrically coupled to the power distribution board for receiving the delivered DC power, wherein the PCB includes at least one integrated circuit.

3. The system of claim 1, wherein the compliant mechanical coupling assembly comprises:
   a plurality of transfer lugs; and
   associated plurality of helical spring connectors, wherein the helical spring connectors are configured to receive the transfer lugs such that the helical spring connectors provide the needed compliance when secured to the power distribution board.

4. The system of claim 3, wherein the each helical spring connector comprises:
   a helical spring contact;
   a helical spring barrel housing configured to receive the helical spring contact concentrically inside the helical spring barrel housing; and
   a helical spring connector flange configured to receive the helical spring barrel housing along with the helical spring contact concentrically inside the helical spring connector flange.

5. The system of claim 4, wherein the helical spring bairel housing is copper bairel housing.
6. The system of claim 4, wherein the power distribution interlace is configured with plurality of recesses to receive the heads of the plurality of transfer lugs such that the heads of the plurality of transfer lugs are flush with the top surface of the power distribution interface.

7. The system of claim 4, wherein the helical spring connector flange is affixed to the power distribution interface using joining techniques selected from the group consisting of soldering, brazing and pressing.

8. The system of claim 4, wherein the helical spring barrel housing is affixed to the helical spring contact via joining techniques selected from the group consisting of soldering, brazing and pressing.

9. The system of claim 4, wherein the power planes configured to receive the DC power via each transfer lug, helical spring contact, helical spring barrel housing and helical spring connector flange.
INTERNATIONAL SEARCH REPORT

PCT/US2014/046777

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01 R 12/52 (2014.01)
CPC - H01 R 12/52 (2014.09)

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)
IPC(8) - H01 R 12/52, 13/621 (2014.01)
USPC - 361/748, 752, 787, 796; 439/359, 361, 362, 363, 364, 926

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - H01 R 12/52, 523, 526, 13/621, 6215 (2014.09)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>X</td>
<td>US 2001/0036066 A1 (DIBENE et al) 01 November 2001 (01.11.2001) entire document</td>
<td>1</td>
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Further documents are listed in the continuation of Box C.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
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