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BUSBAR ASSEMBLY AND METHOD OF MAKING

Abstract

A busbar assembly comprises a first busbar having a first surface and a second surface opposite the first surface and having a first lead aperture formed therein. The busbar assembly also comprises a second busbar positioned adjacently to the first busbar and having a third surface and a fourth surface opposite the third surface and having a second lead aperture formed therein. The first busbar comprises an extension element extending from the second surface. The first lead aperture is formed through the extension element. The extension element has a portion thereof extending through the second lead aperture.

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Background/Summary

TECHNICAL FIELD
[0001] Aspects of the disclosure relate to electronic component assembly, and more particularly to a busbar assembly and one or more methods for assembling the busbar assembly.
BACKGROUND
[0002] Electronics assembly processes incur time and cost elements to the fabrication of an end product. Some inefficient processes using manual labor can benefit from automation of construction and joining steps to reduce manufacturing time and cost.
SUMMARY
[0003] In accordance with one aspect of the present disclosure, a busbar assembly comprises a first busbar having a first surface and a second surface opposite the first surface and having a first lead aperture formed therein. The busbar assembly also comprises a second busbar positioned adjacently to the first busbar and having a third surface and a fourth surface opposite the third surface and having a second lead aperture formed therein. The first busbar comprises an extension element extending from the second surface. The first lead aperture is formed through the extension element. The extension element has a portion thereof extending through the second lead aperture.
[0004] In accordance with another aspect of the present disclosure, an electronic component assembly comprises an electronic component and a busbar assembly. The electronic component comprises a body, a first lead extending from the body, and a second lead extending from the body. The busbar assembly comprises a first busbar having first and second lead apertures extending therethrough and a second busbar having third and fourth lead apertures extending therethrough. The first lead extends through the first and third lead apertures. The second lead extends through the second and fourth lead apertures. The first lead aperture extends through the third lead aperture.
[0005] In accordance with another aspect of the present disclosure, a method of manufacturing a component assembly comprises aligning a first lead of an electronic component with a first aperture formed in a first busbar and with a second aperture formed in a second busbar, the first aperture extending through the second aperture. The method also comprises aligning a second lead of the electronic component with a third aperture formed in the first busbar and with a fourth aperture formed in the second busbar and inserting the first lead through the first and second apertures, the first lead having a portion thereof extending beyond the first and second apertures. The method further comprises inserting the second lead through the third and fourth apertures, the second lead having a portion thereof extending beyond the third and fourth apertures. The method also comprises electronically coupling the portion of the first lead with the first busbar and electronically coupling the portion of the second lead with the second busbar. The first lead is electronically isolated from the second lead.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0006] The drawings illustrate embodiments presently contemplated for carrying out the invention.
[0007] In the drawings:
[0008] FIG. **1** is an exploded isometric view of a busbar assembly according to one or more embodiments.
[0009] FIG. **2** is a side plan view of the busbar assembly of FIG. **1** according to one or more embodiments.
[0010] FIG. **3** illustrates a method of manufacturing the busbar assembly of FIGS. **1** and **2** according to one or more embodiments.
[0011] FIGS. **4-13** graphically illustrate portions of the method of FIG. **3** according to one or more embodiments.
[0012] FIGS. **14-16** graphically illustrate an alternate soldering method according to one or more

embodiments.
[0013] While the present disclosure is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the present disclosure to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present disclosure. Note that corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.
DETAILED DESCRIPTION
[0014] Examples of the present disclosure will now be described more fully with reference to the accompanying drawings. The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses.
[0015] Example embodiments are provided so that this disclosure will be thorough and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.
[0016] Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structures. While the preferred embodiment has been described, the details may be changed without departing from the invention, which is defined by the claims.
[0017] FIG. **1** illustrates an exploded isometric view of a busbar assembly **100** according to one or more embodiments. FIG. **2** illustrates a side plan view of the busbar assembly **100** according to one or more embodiments. Referring to FIGS. **1** and **2**, the busbar assembly **100** includes a first busbar **101**, a second busbar **102**, and an insulation layer **103** positioned between the first and second busbars **101**, **102**. The first busbar **101** has a first surface **104** and a second surface **105** opposite the first surface **104**. A pair of lead apertures **106**, **107** are formed therein to allow passage therethrough of respective component leads as described hereinbelow. An extension element, projection, protuberant member, or protuberance **108** is formed in the first busbar **101** and extends from the second surface **105** in a direction normal to the second surface **105**. FIG. **2** illustrates deviations of the first and second surfaces **104**, **105** to form the protuberance **108** that surrounds the lead aperture **106**. The lead aperture **107** includes passage openings flush with the first and second surfaces **105**, **106** in the illustrated embodiment. However, it is contemplated that the lead aperture **107** may be surrounded by an additional protuberance (not shown) extending from the second surface **105** in a similar manner as the protuberance **108**.
[0018] As shown, on opposite ends of the first busbar **101**, leg assemblies **109**, **110** formed in the first busbar **101** are bent to extend away from the second surface **105** in a direction substantially parallel to the normal direction of the second surface **105**. Each leg assembly **109**, **110** has one or more legs **111**, **112** useful for attaching and electrically coupling the first busbar **101** to a printed circuit board (PCB) as described hereinbelow.
[0019] The second busbar **102** has a first surface **113** and a second surface **114** opposite the first surface **113**. A first lead aperture **115** is formed in the second busbar **102** and is aligned with the lead aperture **106** of the first busbar **101** during the assembly and joining process described herein. The protuberance **108** of the first busbar **101** is designed to extend into and through the lead aperture **115** of the second busbar **102** as illustrated in FIG. **2**. To eliminate or substantially reduce electrical conductivity between the busbars **101**, **102**, a diameter of the lead aperture **115** is greater

than a diameter of the portion of the protuberance **108** extending through the lead aperture **115**. Further, the busbars **101**, **102** are separated by the insulation layer **103**, which is electrically insulative. While illustrated in FIG. **2** as extending beyond the second surface **114** of the second busbar **102**, the protuberance **108** may be flush with the second surface **114** and may even be partially extending into the lead aperture **115** so as to end short of the second surface **114**. A second lead aperture **116** is also formed in the second busbar **102** and is aligned with the lead aperture **107** of the first busbar **101** during the assembly and joining process. Two leg assemblies **117**, **118** are formed in the second busbar **102** on opposite ends thereof, and each has one or more legs **119**, **120** extending in a direction substantially parallel with a normal direction of the second surface **114**.

[0020] The insulation layer **103** has a first surface **121** and a second busbar **122** opposite the first surface **121**. A first lead aperture **123** and a second lead aperture **124** are formed in the insulation layer **103** and are respectively aligned with the lead apertures **106**, **115** and **107**, **116** during the assembly and joining process.

[0021] An electronic component **125** having a pair of component leads **126**, **127** extending from a body **128** thereof are aligned with and extend through the lead apertures **106**, **107**, **115**, **116**, **123**, **124** during the assembly and joining process. As illustrated, the component leads **126**, **127** extend from a can-style body **128** in a same direction. However, other types of component bodies and constructions are substitutable within the scope of this disclosure. For example, a radial style body where two leads extend in opposite directions from opposite ends of the body may also be coupled with the busbars **101**, **102** with appropriate guidance of the leads into and through the lead apertures **106**, **107**, **115**, **116**, **123**, **124**.

[0022] FIG. **3** illustrates an assembly method or process **300** of manufacturing the busbar assembly **100** of FIGS. **1** and **2** according to one or more embodiments. In a first method step **301**, the first and second busbars **101**, **102** are formed. As shown in FIG. **4**, the step **301** may include forming the busbars **101**, **102** from sheets of electrically conductive material such as copper. The first busbar **101** has the leg assembly **109** and the leg assembly **110** formed by bending opposite ends thereof. The leg assembly bending may also simultaneously create individual legs **111**, **112**. The lead aperture **106** is formed by creating a via in the copper sheet and bending the first and second surfaces **104**, **105** to form the protuberant member **108**. The lead aperture **107** may be formed by creating a via in the copper sheet without additional bending of the first and second surfaces **104**, **105**.

[0023] Similarly, the leg assembies **117**, **118** of the second busbar **102** may be formed by bending opposite ends thereof and forming the individual legs **119**, **120** thereafter or simultaneously therewith. The lead apertures **115**, **116** may be formed by creating vias in the second busbar **102** via drilling or punching, for example. In one embodiment, one or more of the forming steps disclosed above for the first and second busbars **101**, **102** may be simultaneously created via a punch.

[0024] At step **302**, the busbars **101**, **102** are assembled. FIG. **5** illustrates aligning the first and second busbars **101**, **102** to align the lead aperture **106** with the lead aperture **115** and to align the lead aperture **107** with the lead aperture **116**. The insulation layer **103** is also aligned with the lead apertures, and adhesive layers **500**, **501** may be positioned between the first busbar **101** and the insulation layer **103** and between the insulation layer **103** and the second busbar **102**. In this manner, the second surface **105** of the first busbar **101** is adhesively coupled with the first surface **121** of the insulation layer **103**, and the second busbar **122** of the insulation layer **103** is adhesively coupled with the first surface **113** of the second busbar **102**. Alternatively, the first and second busbars **101**, **102** and the insulation layer **103** may be abutted adjacently to each other without adhesive. FIG. **6** illustrates the coupled busbar assembly **600** of the first and second busbars **101**, **102** and the insulation layer **103**. While FIGS. **6-13** illustrate the busbar assembly without illustrating the adhesive layers **500**, **501** for clarity, it is understood that the adhesive layers **500**, **501** may be present.

[0025] Returning to FIG. **3**, assembly of the busbar assembly continues at step **303** with the alignment of the component leads with the respective lead apertures in the busbar assembly. For example, FIG. **7** illustrates aligning the component lead **126** of the electronic component **125** with the lead aperture **106** of the first busbar **101**. Since the lead aperture **106** is aligned with the lead aperture **115** of the second busbar **102**, the component lead **126** is aligned with both. The component lead **127** is also aligned with the lead apertures **107**, **116** of the first and second busbars **101**, **102**. If the component leads are not of the correct length, they may additionally be cut to size in step **303**. At step **304** and as illustrated in FIG. **8**, the gap between the electronic component **125** and the first busbar **101** is reduced by inserting the component leads **126**, **127** into the lead apertures **106**, **107**, **116**.

[0026] The assembly method **300** proceeds at step **305** with the alignment of a lead solder guide **900** with the coupled busbar assembly **600**. FIG. **9** illustrates the lead solder guide **900** having a plurality of leg cavities **901**, **902**, **903**, **904** in a top surface **905** thereof. The leg cavities **901-904** extend toward a bottom surface **906** of the lead solder guide **900** and are aligned with the one or more legs extending from the edge portions of the first and second busbars **101**, **102** of the coupled busbar assembly **600**. The depth of the leg cavities **901-904** from the top surface **905** is less than the depth of the lead solder guide **900** between the top and bottom surfaces **905**, **906**. In this manner, the bottom surface **906** of the lead solder guide **900** is unbroken in the area of each leg cavity **901-904** so that solder flowing along the bottom surface **906** does not flow into the leg cavities **901-904**.

[0027] The lead solder guide **900** includes a pair of solder vias **907**, **908** formed through the lead solder guide **900** from the top surface **905** to the bottom surface **906** to allow solder flowing along the bottom surface **906** to flow therein. As shown, the openings of the solder vias **907**, **908** in the bottom surface **906** may be larger than the openings of the solder vias **907**, **908** in the top surface **905**. Thus, the solder vias **907**, **908** may be formed in a filter-type shape. The shapes of the solder vias **907**, **908** promote the flow of solder into the solder vias **907**, **908** for coupling the coupled busbar assembly **600** to the component leads **126**, **127**.

[0028] At step **306** of the assembly method **300** of FIG. **3**, the component leads **126**, **127** of the electronic component **125** are electrically coupled with the coupled busbar assembly **600**. In one embodiment illustrated in FIG. **10**, liquid solder **1000** is introduced to the bottom of the lead solder guide **900** and is allowed to flow along the bottom surface **906**. In one embodiment, the liquid solder **1000** is introduced via a wave soldering process. For example, the coupled busbar assembly **600** and the lead solder guide **900** may be brought adjacent to and passed along a pan of molten solder. As the solder **1000** flows past the solder vias **907**, **908**, a portion thereof flows into the solder via cavities **907**, **908**. In the solder via **907**, the solder portion contacts the protuberance **108** of the first busbar **101** and the first component lead **126** of the electronic component **125**. In the solder via **908**, the solder portion contacts the component lead **127** and a portion of the second busbar **102** adjacent to the lead aperture **116**. In this manner (as illustrated in FIG. **11**), a first solder connection **1100** electrically coupling the component lead **126** to the first busbar **101** via the protuberance **108** is formed, and a second solder connection **1101** electrically coupling the component lead **127** to the second busbar **102** is formed. Thus, in a single soldering process, the component leads **126**, **127** are electrically coupled to their respective busbars **101**, **102**, and manufacturing efficiency over a manual process of separately coupling the component leads **126**, **127** to their respective busbars **101**, **102** is gained.

[0029] Referring to FIGS. **3** and **12**, a PCB **1200** and a leg solder guide **1201** are positioned adjacently to the coupled busbar assembly **600** and aligned with the legs **111**, **112**, **119**, **120** at step **307** of the assembly process **300**. The leg solder guide **1201** has a plurality of lead cavities **1202**, **1203** in a top surface **1204** thereof that are respectively aligned with the component leads **126**, **127** of the electronic component **125**. The lead cavities **1202**, **1203** extend toward the bottom surface **1205** of the leg solder guide **1201** but do not open out to the bottom surface **1205**. In this manner, the bottom surface **1205** of the leg solder guide **1201** is unbroken so that additional solder does not

flow about the component leads **126**, **127**.
[0030] A plurality of solder vias **1206**, **1207**, **1208**, **1209** formed through the leg solder guide **1201** from the top surface **1204** to the bottom surface **1205** to allow solder flowing along the bottom surface **1205** to flow therein. The openings of the solder vias **1206-1209** in the bottom surface **1205** are larger than the openings in the top surface **1204**. Thus, filter-shaped vias solder vias **1206-1209** may be formed.
[0031] At step **308**, liquid solder **1210** is introduced to the bottom of the leg solder guide **1201** and is allowed to flow along the bottom surface **1205** in a wave soldering process as described hereinabove. In this manner (as illustrated in FIG. **13**), PCB solder connections **1300**, **1301**, **1302**, **1303** are formed that electrically couple the legs **111**, **112**, **119**, **120** and the busbars **101**, **102** to the PCB **1200**.
[0032] FIGS. **14-16** graphically illustrate an alternate soldering method according to one or more embodiments. As discussed above, separate soldering steps are used for the component leads **126**, **127** and for the legs **111**, **112**, **119**, **120** (see, for example, FIGS. **10** and **12**). FIG. **14** illustrates a solder guide **1400** used to simultaneously solder the component leads **126**, **127** to the respective first and second busbars **101**, **102** and the legs **111**, **112**, **119**, **120** to the PCB **1200**. The solder guide **1400** has a plurality of solder cavities **1401**, **1402**, **1403**, **1404**, **1405**, **1406** aligned with the first and second busbars **101**, **102** and the legs **111**, **112**, **119**, **120** together with their respective openings in the PCB **1200**. The solder cavities **1401-1406** form a funnel shape.
[0033] As shown in FIG. **15**, solder **1500** is introduced to the bottom of the solder guide **1400** and is allowed to flow along a bottom surface **1407** thereof in a wave soldering process, for example. Similar to that described hereinabove, PCB solder connections **1600-1605** as illustrated in FIG. **16**. The method steps illustrated in FIGS. **14-16** thus allow for simultaneous wave soldering connections to be made. In this manner, further efficiencies may be achieved.
[0034] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the present disclosure. Additionally, while various embodiments of the present disclosure have been described, it is to be understood that aspects of the present disclosure may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description but is only limited by the scope of the appended claims.

Claims

1. A busbar assembly comprising: a first busbar having a first surface and a second surface opposite the first surface and having a first lead aperture formed therein; and a second busbar positioned adjacently to the first busbar and having a third surface and a fourth surface opposite the third surface and having a second lead aperture formed therein; wherein the first busbar comprises an extension element extending from the second surface; wherein the first lead aperture is formed through the extension element; and wherein the extension element has a portion thereof extending through the second lead aperture.
2. The busbar assembly of claim 1, wherein a diameter of the second lead aperture is greater than a diameter of the portion of the extension element extending therethrough.
3. The busbar assembly of claim 1, wherein the first and second busbars are electrically conductive.
4. The busbar assembly of claim 3 further comprising an insulation member positioned between the first and second busbars.
5. The busbar assembly of claim 4 further comprising: a first adhesive layer adhesively joining the second surface of the first busbar and the insulation member; and a second adhesive layer

adhesively joining the third surface of the second busbar and the insulation member.

6. The busbar assembly of claim 1, wherein the first busbar has a third lead aperture formed therein; wherein the second busbar has a fourth lead aperture formed therein; and wherein the third and fourth lead apertures are aligned.

7. The busbar assembly of claim 1, wherein the extension element extends beyond the fourth surface of the second busbar.

8. The busbar assembly of claim 1, wherein an outer surface of the extension element comprises an extension of the second surface punched in a direction normal to the second surface.

9. An electronic component assembly comprising: an electronic component comprising: a body; a first lead extending from the body; and a second lead extending from the body; a busbar assembly comprising: a first busbar having first and second lead apertures extending therethrough; and a second busbar having third and fourth lead apertures extending therethrough; wherein the first lead extends through the first and third lead apertures; wherein the second lead extends through the second and fourth lead apertures; and wherein the first lead aperture extends through the third lead aperture.

10. The electronic component assembly of claim 9 further comprising a projection extending from a bottom surface of the first busbar; wherein the projection forms the first lead aperture and extends through the third lead aperture.

11. The electronic component assembly of claim 9, wherein the first lead is electronically coupled with the first busbar; wherein the second lead is electronically coupled with the second busbar; and wherein the first busbar is electronically isolated from the second busbar.

12. The electronic component assembly of claim 11, wherein the first lead is electronically coupled with the first busbar via a first solder connection; wherein the second lead is electronically coupled with the second busbar via a second solder connection; and wherein the first and second solder connections are formed via a wave soldering process.

13. The electronic component assembly of claim 11 further comprising an electrical insulation layer positioned between the first and second busbars.

14. The electronic component assembly of claim 9, wherein the electronic component comprises a capacitor.

15. A method of manufacturing a component assembly comprising: aligning a first lead of an electronic component with a first aperture formed in a first busbar and with a second aperture formed in a second busbar, the first aperture extending through the second aperture; aligning a second lead of the electronic component with a third aperture formed in the first busbar and with a fourth aperture formed in the second busbar; inserting the first lead through the first and second apertures, the first lead having a portion thereof extending beyond the first and second apertures; inserting the second lead through the third and fourth apertures, the second lead having a portion thereof extending beyond the third and fourth apertures; electronically coupling the portion of the first lead with the first busbar; and electronically coupling the portion of the second lead with the second busbar; wherein the first lead is electronically isolated from the second lead.

16. The method of claim 15 further comprising forming a protuberant member in the first busbar; wherein the first aperture extends through the protuberant member.

17. The method of claim 16, wherein electronically coupling the portion of the first lead with the first busbar comprises soldering the portion of the first lead with the protuberant member via a wave soldering process; and wherein electronically coupling the portion of the second lead with the second busbar comprises soldering the portion of the second lead with a portion of the second busbar surrounding the second aperture via the wave soldering process.

18. The method of claim 17, further comprising: forming one or more legs extending from an edge portion of the first busbar; and forming one or more legs extending from an edge portion of the second busbar.

19. The method of claim 18 further comprising: soldering the one or more legs extending from the edge portion of the first busbar to a printed circuit board; and soldering the one or more legs extending from the edge portion of the second busbar to the printed circuit board.

20. The method of claim 16 further comprising positioning a first solder guide adjacently to the second busbar prior to soldering the portions of the first and second leads; wherein the first solder guide comprises: a first surface; a second surface opposite the first surface; a first solder via formed therethrough from the first surface to the second surface and aligned with the protuberant member; a second solder via formed therethrough from the first surface to the second surface and aligned with the second lead; one or more first leg cavities formed in the first surface and extending toward the second surface and aligned with the one or more legs extending from the edge portion of the first busbar; and one or more second leg cavities formed in the first surface and extending toward the second surface and aligned with the one or more legs extending from the edge portion of the second busbar; wherein a depth of the first and second leg cavities is less than a distance between the first and second surfaces of the first solder guide.