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ELECTRONIC MODULE

Abstract

An electronic module includes: a flat-shaped power terminal; and an internal connection frame supporting the power terminal and electrically connecting electronic elements to the power terminal. The power terminal includes: an insertion portion which extends in a direction toward a board from the internal connection frame; and a large width portion which extends in a direction opposite to the board from the internal connection frame. The insertion portion is press-fitted into an elongated hole formed in the internal connection frame and a distal end of the insertion portion is brought into contact with the board, and a portion which protrudes in a thickness direction of the power terminal from one side surface and a portion which protrudes in a thickness direction of the power terminal from the other side surface of the power terminal are formed on a boundary portion between the insertion portion and the large width portion.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Japanese Patent Application No. 2024-20365, filed on Feb. 14, 2024, which is expressly incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to an electronic module.

BACKGROUND ART

[0003] Conventionally, there has been known an electronic module (semiconductor module) that includes: a board on which a semiconductor chip is mounted; a pin terminal which is connected to a wiring pattern disposed on the board; and a lead frame that supports a pin terminal and electrically connects an electrode of the semiconductor chip and the pin terminal to each other (see patent literature 1 described below). The pin terminal is press-fitted into a hole formed in the lead frame. The pin terminal can be made self-standing by supporting the pin terminal by a flange portion formed at an intermediate position, and the flange portion allows wetting and spreading of solder on the pin terminal.

[0004] In the conventional module, an electrode is taken out to the outside using a pin terminal. However, it is difficult to largely increase a cross-sectional area of a current path and hence, it is difficult to supply a large current to the electronic module. In view of the above-mentioned circumstance, the use of a plate-shaped power terminal is proposed for reducing inductance and a wiring resistance (see FIG. **4**).

[0005] As illustrated in FIG. **4**, an electronic module **300** includes two semiconductor elements **320**A, **320**B formed on one surface of an insulation board **312**. A first terminal **330** is disposed in front of the electronic module **300** in the longitudinal direction. A first connection frame **332** is electrically connected to the first terminal **330**, and is integrally formed with the first terminal **330**. A second connection frame **342** is electrically connected to a second terminal **340**. The electronic module **300** further includes a third terminal **360** having a plate shape as a power terminal. The third terminal **360** is formed in an elongated shape, and is disposed such that a front-and-back direction is taken in a plate thickness direction, and a vertical direction is set as a longitudinal direction.

PRIOR ART LITERATURE

Patent Literature

[0006] [Japanese Patent Literature 1] Japanese patent 6850938

SUMMARY OF INVENTION

Technical Problem

[0007] However, it is difficult to form a flange portion to a power terminal having a flat plate shape. Accordingly, unlike the pin terminal on which the flange portion is formed, problems still remain such that it is difficult to make the power terminal self-standing in a stable manner, and it is also difficult to enable stable wetting and spreading of solder (a conductive bonding material) between the power terminal and the lead frame.

[0008] The present invention has been made in view of the above-mentioned drawbacks, and it is an object of the present invention to provide an electronic module which enables the stable self-standing of a power terminal and enables the stable wetting and spreading of solder (a conductive bonding material) between the power terminal and a lead frame.

Solution to Problem

[0009] An electronic module according to the present invention includes: a board on which an electronic element is mounted; a power terminal having a flat plate shape which is connected to a wiring pattern on the board; and an internal connection frame which supports the power terminal

and electrically connects the electronic element and the power terminal to each other, wherein the internal connection frame is a member having a flat plate shape that has an elongated hole, the power terminal includes: an insertion portion which extends in a direction toward the board from the internal connection frame; and a large width portion which extends in a direction opposite to the board from the internal connection frame, the power terminal is electrically connected to the internal connection frame, the insertion portion is press-fitted into the elongated hole formed in the internal connection frame and a distal end portion of the insertion portion is brought into contact with the board, and a protruding portion which protrudes in a thickness direction of the power terminal from one side surface of the power terminal and a protruding portion which protrudes in a thickness direction of the power terminal from the other side surface of the power terminal are formed on a boundary portion between the insertion portion and the large width portion.

Advantageous Effects of the Present Invention

[0010] According to the electronic module of the present invention, the protruding portion which protrudes in a thickness direction of the power terminal from one side surface and the protruding portion which protrudes in a thickness direction of the power terminal from the other side surface of the power terminal are formed on the boundary portion between the insertion portion and the large width portion and hence, it is possible to enable the stable self-standing of the power terminal and, at the same time, it is also possible to enable the stable wetting and spreading of solder (a conductive bonding material) between the power terminal and a lead frame.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. **1** is a perspective view illustrating an external appearance of an electronic module **100** according to an embodiment 1.

[0012] FIG. **2** is a perspective view illustrating a structure of a power terminal.

[0013] FIG. **3**A and FIG. **3**B are views illustrating a protruding portion of the power terminal. FIG. **3**A is a cross-sectional view taken along a line X-X in FIG. **2**, and FIG. **3**B is a view illustrating wetting and spreading of solder formed in the vicinity of the protruding portion of the power terminal.

[0014] FIG. **4** is a view illustrating an electronic module **300** according to a prior art.

DESCRIPTION OF EMBODIMENTS

[0015] Hereinafter, the electronic module according to one embodiment of the present invention is described. The embodiment described hereinafter is not intended to limit the present invention called for in claims. Further, it is not always the case that all of various elements described in the embodiment and combinations of these elements are indispensable in the present invention.

[0016] In the description made hereinafter, as illustrated in FIG. **1**, the description is made by setting a longitudinal direction of an electronic module **100** as a front-rear direction, and a lateral direction of the electronic module **100** as a left-right direction. Further, a height direction of the electronic module **100** is described as up-down direction. In the direction hereinafter, “front”, “rear”, “left”, “right”, “up”, and “down” are used for the sake of convenience of the description, and do not specify the direction that the electronic module **100** is mounted when the electronic module **100** is used.

[0017] The electronic module **100** includes an insulation board **112**, electronic elements **120**A, **120**B, a first terminal **130**, a second terminal **140**, a third terminal **160**, a first connection frame (internal connection frame) **132**, a second connection frame (internal connection frame) **142**, and a third connection frame (internal connection frame) **152**.

[0018] As the electronic elements **120**A, **120**B, for example, a power metal-oxide-semiconductor field-effect transistor (MOSFET) can be used. As the electronic element, besides the MOSFET, a

suitable semiconductor element such as an IGBT, a triac, a diode or the like can be also used. The electronic elements **120**A, **120**B may be disposed on one surface of the insulation board **112**. The electronic elements **120**A, **120**B are respectively formed as a semiconductor element, for example, and each of the electronic elements **120**A, **120**B includes an electrode not illustrated in the drawing which is formed on one surface or both surfaces of the insulation board **112**. The electronic elements **120**A, **120**B may be other electronic elements (capacitors, for example) besides the semiconductor elements.

[0019] The insulation board **112** on which the electronic elements are mounted is a direct copper bonding board (DCB) where a metal plate for heat radiation is formed on a lower surface (back surface) of the insulation board **112**. A wiring is disposed on the insulation board **112**, and the electronic elements **120**A, **120**B are mounted on the wiring. The insulation board **112** may be a printed circuit board or the like. The insulation board **112** is formed in a rectangular flat shape, and it is preferred that the insulation board **112** is disposed at a center portion of the electronic module **100** in the front-rear direction which is the longitudinal direction.

[0020] As illustrated in FIG. **1**, the first terminal **130** is disposed on a front side of the electronic module **100** in the front-rear direction. The first terminal **130** is a flat plate member having conductivity, for example, a member having a plate shape and formed of a copper plate. The first terminal **130** includes a through hole **131** which penetrates the first terminal **130** in the vertical direction. The through hole **131** has a circular shape, for example, as viewed in the vertical direction.

[0021] The first connection frame **132** is electrically connected with the first terminal **130**. The first connection frame **132** is embedded in a sealing resin (not illustrated in the drawing). In the electronic module **100**, the first connection frame **132** is formed integrally with the first terminal **130** using the same plate material.

[0022] The first connection frame **132** includes a through hole (symbol being omitted) which penetrates the first connection frame **132** in the vertical direction. The through hole is formed in a circular shape as viewed in the vertical direction. An upper end portion of the internal connection terminal (symbol being omitted) is fitted in the through hole. The first connection frame **132** and an electrode (not illustrated in the drawing) of the electronic element **120**A are connected to each other by the internal connection terminal. The internal connection terminal is fixed to the first connection frame **132** by press-fitting, for example.

[0023] As illustrated in FIG. **1**, the second terminal **140** is disposed on a rear side of the electronic module **100** in the front-rear direction. The second terminal **140** is a flat plate material having conductivity, for example, a member having a plate shape formed of a copper plate. The second terminal **140** includes a through hole **141** which penetrates the second terminal **140** in the vertical direction. The through hole **141** has a circular shape, for example, as viewed in the vertical direction.

[0024] The second connection frame **142** is electrically connect with the second terminal **140**. The second connection frame **142** is embedded in a sealing resin (not illustrated in the drawing). In the electronic module **100**, the second connection frame **142** is formed integrally with the second terminal **140** using the same plate material.

[0025] The electronic module **100** includes a third terminal (hereinafter referred to as “power terminal”) **160** which functions as a power terminal. As illustrated in FIG. **1**, the power terminal **160** is formed of a flat plate member having conductivity, for example, a copper plate. The power terminal **160** is formed in an elongated shape where the left and right direction of the power terminal **160** becomes a plate thickness direction, and the vertical direction of the power terminal **160** becomes a longitudinal direction. The detail of the power terminal **160** is described later.

[0026] The electronic module **100** includes a third connection frame **152**. The third connection frame **152** is electrically connected to the power terminal **160**. The third connection frame **152** may be disposed on the same plane as the first connection frame **132** and the second connection frame

142 (on the same plane as illustrated in FIG. **1**).

[0027] The third connection frame **152** includes a through hole (symbol being omitted) which penetrates the third connection frame **152** in the vertical direction. The through hole is formed in a circular shape as viewed in the vertical direction. An upper end portion of the internal connection terminal **154** is fitted in the through hole. Electrodes (not illustrate in the drawing) of the third connection frame **152** and the electronic element **120**A are connected with each other by the internal connection terminal **154**. The internal connection terminal **154** is fixed to the third connection frame **152** by press-fitting, for example.

Structure of Power Terminal

[0028] Hereinafter, the structure of the power terminal **160** is described with reference to FIG. **2**. The power terminal **160** includes: an insertion portion **166** which extends in a direction (a downward direction) directed from the third connection frame **152** to the insulation board **112**; and a large width portion **164** extending in a direction (an upward direction) opposite to the insulation board **112** from the third connection frame **152**. The power terminal **160** is electrically connected to the third connection frame **152**, the insertion portion **166** is press-fitted into the elongated hole **156** formed in the third connection frame **152** (see FIG. **1** and FIG. **3**A and FIG. **3**B), a distal end portion of the insertion portion **166** is brought contact with the insulation board **112**, and protruding portions (convex portions) **162** which protrude in a thickness direction of the power terminal **160** from one surface **165**A and the other surface of the power terminal **160** are formed at a boundary portion between the insertion portion **166** and the large width portion **164**. Cross sections of the elongated hole **156** and the insertion portion **166** as viewed in the vertical direction are formed in a longitudinal direction where the front-rear direction is set as the longitudinal direction.

[0029] As illustrated in FIG. **3**A, a first protruding portion **162***a* is formed on one surface **165**A of the power terminal **160**, and a second protruding portion **163***a* is formed on the other surface **165**B of the power terminal **160**. The first protruding portion **162***a* and the second protruding portion **163***a* are formed with a predetermined distance therebetween in a state that the protruding portions are directed in the opposite directions. The first protruding portion **162***a* is formed by pressing (half-punching) the e other surface **165**B of the insertion portion **166** such that a first pressed portion (recessed portion) **162***b* is formed. The second protruding portion **163***a* is formed by pressing (half-punching) one surface **165**A of the insertion portion **166** such that a second pressed portion (recessed portion) **163***b* is formed.

[0030] Further, a protruding height of the first protruding portion **162***a* and a protruding height of the second protruding portion **163***a* are the same. Assuming such a height as A and a plate thickness of the power terminal **160** as B, it is preferred that a relationship of $A \leq B/2$ is satisfied. The reason that the satisfying of the relationship $A \leq B/2$ is preferred is that, in a case where the relationship of $A > B/2$ is set between the height A of the protruding portion and the plate thickness B of the power terminal **160**, there is a concern that a strength of the first protruding portion **162***a* and a strength of the second protruding portion **163***a* become weak. In this embodiment, the height A means, using a surface of the power terminal **160** as a reference, a length from the surface to a peak head portion of the protruding portion (see FIG. **3**A).

[0031] Accordingly, in the above-mentioned configuration, the first protruding portion **162***a* and the second protruding portion **163***a* are made to protrude perpendicular to the surface of the power terminal **160** and in the opposite directions and hence, the power terminal **160** can be supported by the first protruding portion **162***a* and the second protruding portion **163***a* whereby it enables stable self-standing of the power terminal **160**.

[0032] Further, as illustrated in FIG. **3**B, solder BM which is a conductive bonding material is disposed between an inner peripheral surface of the elongated hole **156** and the insertion portion **166**. The power terminal **160** and the third connection frame **152** are electrically connected with each other via the solder BM. This solder BM is obtained by heating the solder BM disposed on an upper surface of the third connection frame **152** corresponding to the insertion portion **166** by

printing or by using a dispenser, and by making the solder BM flow into a gap formed between the insertion portion **166** and the inner peripheral surface of the elongated hole **156**, and by solidifying the solder BM. The flow of the solder BM is guided using the first protruding portion **162***a* and the second protruding portion **163***a* as flow start points. Accordingly, by forming the first protruding portion **162***a* and the second protruding portion **163***a*, it enables stable wetting and spreading of the solder between the power terminal **160** and the third connection frame (lead frame) **152**.

Advantageous Effects Acquired by Electronic Module **100** According to Embodiment

[0033] The electronic module **100** according to the embodiment includes: the insulation board **112** on which the electronic elements **120**A, **120**B are mounted; the power terminal **160** having a flat plate shape which is connected to the wiring pattern on the insulation board **112**; and the internal connection frame **152** which supports the power terminal **160** and electrically connects the electronic elements **120**A, **120**B and the power terminal **160** to each other, wherein the internal connection frame **152** is a member having a flat plate shape which has the elongated hole **156**. The power terminal **160** includes: the insertion portion **166** which extends in a direction toward the insulation board **112** from the internal connection frame **152**; and the large width portion **164** which extends in a direction opposite to the insulation board **112** from the internal connection frame **152**. The power terminal **160** is electrically connected to the internal connection frame **152**, the insertion portion **166** is press-fitted into the elongated hole **156** formed in the internal connection frame **152**, and the distal end of the insertion portion **166** is brought into contact with the insulation board **112**, and the first protruding portion **162***a* and the second protruding portion **163***a* which protrude in the thickness direction of the power terminal **160** from one side surface **165**A and the other side surface **165**B of the power terminal **160** are formed on the boundary portion between the insertion portion **166** and the large width portion **164**. Accordingly, the power terminal **160** can be supported by the first protruding portion **162***a* and the second protruding portion **163***a* and hence, it enables stable self-standing of the power terminal **160** and, at the same time, it enables stable wetting and spreading of the solder BM between the power terminal **160** and the internal connection frame **152**.

[0034] Further, according to the electronic module of the embodiment, at least one protruding portion **162** is formed on one surface **165**A, and at least one protruding portion **162** is formed on the other surface **165**B. Accordingly, it enables stable self-standing of the power terminal **160** with certainty.

[0035] Further, according to the electronic module of the embodiment, assuming the protruding height of the protruding portion **162** as A and the plate thickness of the power terminal **160** as B, the relationship between the protruding height A and the plate thickness B is set to satisfy the relationship of $A \leq B/2$ and hence, the protruding portion **162** can maintain a strength of a fixed value or more.

Modification

[0036] In the above-mentioned example, the case where one protruding portion is formed on one surface of the power terminal and one protruding portion is formed on the other surface of the power terminal is exemplified. However, a case may be considered where two or more protruding portions are formed on one surface of the power terminal and two or more protruding portions are formed on the other surface of the power terminal. In this case, it is preferred that a distance between the protruding portions on one surface and a distance between the protruding portions on the other surface are equal. With such a configuration, the number of the protruding portions is increased and hence, it is possible to enhance self-standing of the power terminal **160** with more certainty.

[0037] The present invention is not limited to the above-mentioned embodiment, and various modifications are conceivable without departing from the gist of the present invention.

Claims

1. An electronic module comprising: a board on which an electronic element is mounted; a power terminal having a flat plate shape which is connected to a wiring pattern on the board; and an internal connection frame which supports the power terminal and electrically connects the electronic element and the power terminal to each other, wherein the internal connection frame is a member having a flat plate shape that has an elongated hole, the power terminal includes: i an insertion portion which extends in a direction toward the board from the internal connection frame; and a large width portion which extends in a direction opposite to the board from the internal connection frame, the power terminal is electrically connected to the internal connection frame, the insertion portion is press-fitted into the elongated hole formed in the internal connection frame and a distal end of the insertion portion is brought into contact with the board, and a protruding portion which protrudes in a thickness direction of the power terminal from one side surface and a protruding portion which protrudes in the thickness direction of the power terminal from the other side surface of the power terminal are formed on a boundary portion between the insertion portion and the large width portion.

2. The electronic module according to claim 1, wherein the at least one protruding portion is formed on the one surface and the at least one protruding portion is formed on the other surface.

3. The electronic module according to claim 1, wherein, assuming a height that the protruding portion protrudes as A and a plate thickness of the power terminal as B, a relationship of $A \leq B/2$ is satisfied.

4. The electronic module according to claim 2, wherein, assuming a height that the protruding portion protrudes as A and a plate thickness of the power terminal as B, a relationship of $A \leq B/2$ is satisfied.