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ELECTRONIC MODULE AND METHOD OF MANUFACTURING ELECTRONIC MODULE

Abstract

To provide an electronic module where a heat radiation surface is disposed on both up and lower surfaces thereof, and the radiation surfaces are mounted in a height direction with high mounting accuracy whereby the electronic module possesses an excellent heat radiation characteristic. The electronic module includes a first board, a first electronic element disposed on the first board, a second board, a second electronic element disposed on the second board, and an internal connection terminal that connects the first board and the second board to each other. The second board includes a protruding portion that protrudes more outside than an outer periphery of the first board as viewed in a plan view.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is based on, and claims priority from JP Application Serial Number 2024-020363, filed Feb. 14, 2024, the disclosure of which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to an electronic module and a method of manufacturing an electronic module.

BACKGROUND ART

[0003] Conventionally, there has been known an electronic module (semiconductor device) **900** where heat radiation members (back surface metal bodies) **923**, **933** are disposed on both surfaces of an electronic module (semiconductor device) **900** so as to radiate heat from both surfaces of the electronic module **900**. Patent Literature 1 discloses: a semiconductor element **910** that has electrodes on both surfaces; a pair of boards **920**, **930** that are disposed so as to sandwich the semiconductor element **910** therebetween; and an electrically conducive spacer **940** that is interposed between the board **930** and the semiconductor element **910**. The boards **920**, **930** include: insulation substrates **921**, **931**; surface metal bodies **922**, **932** that are connected to the corresponding electrodes of the semiconductor element **910**; heat radiation members **923**, **933**. Heat generated by the semiconductor element **910** is radiated from both surfaces of the electronic module **900** through the electrically conductive spacer **940**, surface metal bodies **922**, **932**, the heat radiation members **923**, **933**.

CITATION LIST

Patent Literature

[0004] [Japanese Patent Literature 1] JP-A-2022-181822

SUMMARY OF INVENTION

Technical Problem

[0005] However, in a case of an electronic module that radiates heat from both surfaces thereof, it is necessary to bring heat radiation surfaces disposed on both surface of the electronic module into contact with heat sinks (see FIG. **7**). Accordingly, a control that restricts a distance between the heat radiation surface and the heat radiation surface within a predetermined tolerance.

[0006] On the other hand, in an electronic module on which a plurality of boards are stacked, the electronic module is manufactured by stacking constitutional elements such as the boards, an internal connection terminal, an external connection terminal and the like in a height direction of the electronic module. In the conventional electronic module of a one side heat radiation type, a heat radiation surface is disposed only on one surface of the electronic module and hence, when the internal constitutional elements are stacked, it is not indispensable to perform a strict tolerance control. On the other hand, when the heat radiation surface is disposed on both surfaces of the electronic module, the positions of the heat radiation surfaces that are disposed in the height direction exert a large effect with respect to a heat radiation characteristic and hence, a highly accurate control of the positions of the heat radiation surfaces is requested.

[0007] 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 where a heat radiation surface is disposed on both surfaces thereof, wherein the heat radiation surface is mounted with high mounting accuracy in a height direction so that the electronic module possesses an excellent heat

radiation characteristic. It is another object of the present invention to provide a method of manufacturing an electronic module capable of manufacturing such an electronic module.

Solution to Problem

[0008] An electronic module according to the present invention includes: a first board; a first electronic element that is disposed on the first board; a second board; a second electronic element that is disposed on the second board; and an internal connection terminal that is disposed between the first board and the second board, wherein the second board includes a protruding portion that protrudes more outside than an outer periphery of the first board as viewed in a plan view.

[0009] A method of manufacturing an electronic module according to the present invention is the method that uses an assembly jig includes a first mounting portion and a second mounting portion. The method includes: a first board mounting step of mounting a first board on the first mounting portion; an internal connection terminal mounting step of mounting one end of an internal connection terminal on the first board; and a second board mounting step of mounting the second board on an other end of the internal connection terminal and the second mounting portion. The second board has a protruding portion that protrudes more outside than an outer periphery of the first board as viewed in a plan view when the second board is assembled as a part of the electronic module, the second board is mounted on the second mounting portion in a state where the protruding portion is engaged with and is stopped by the second mounting portion, and the second mounting portion is disposed at a predetermined height position from the first mounting portion, and is disposed at a position where the protruding portion is engaged with and is stopped by the second mounting portion as viewed in a plan view.

Advantageous Effects of the Present Invention

[0010] The electronic module according to the present invention includes: the first board, the second board, and the internal connection terminal disposed between the first board and the second board. The second board includes the protruding portion that protrudes more outside than the outer periphery of the first board as viewed in a plan view. The electronic module according to the present invention can mount the first board and the second board in the height direction with high accuracy using the first heat radiation surface of the first board and the protruding portion of the second board. According to the present invention, in the electronic module where the heat radiation surface is disposed on both surfaces of the electronic module, the heat radiation surfaces can be mounted in the height direction with high mounting accuracy and hence, it is possible to provide the electronic module that possesses an excellent heat radiation characteristic.

[0011] The method of manufacturing an electronic module according to the present invention is performed using the assembly jig that includes the first mounting portion and the second mounting portion. The method includes: the first board mounting step of mounting the first board on the first mounting portion of the assembly jig; and the second board mounting step of mounting the second board on the second mounting portion. The second board has the protruding portion that protrudes more outside than the outer periphery of the first board as viewed in a plan view when the second board is assembled as the electronic module. The second board is mounted on the second mounting portion is disposed at a predetermined height position from the first mounting portion, and is disposed at a position where the protruding portion is engaged with and is stopped by the second mounting portion as viewed in a plan view. With such a configuration, the first board and the second board can be mounted in a height direction with high accuracy. According to the present invention, in the electronic module where a heat radiation surface is disposed on both surfaces of the electronic module, the heat radiation surfaces are mounted in the height direction with high mounting accuracy and hence, it is possible to realize the method of manufacturing an electronic module that possesses an excellent heat radiation characteristic.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. **1** is a perspective view of an electronic module **1** according to an embodiment. In FIG. **1**, among constitutional elements of the electronic module **1**, a mold resin **40** is not illustrated.

[0013] FIG. **2** is an external appearance view of the electronic module **1** according to the embodiment.

[0014] FIG. **3** is a side view illustrating the internal structure of the electronic module **1** according to the embodiment. In FIG. **3**, among the constitutional elements of the electronic module **1**, the mold resin **40** and some internal connection terminals **36** are not illustrated.

[0015] FIG. **4**A to FIG. **4**C are plan views illustrating variations of protruding portions **25** in the electronic module **1** according to the embodiment. In FIG. **4**A to FIG. **4**C, among the constitutional elements of the electronic module **1**, the mold resin **40**, a first external connection terminal **32** and a second external connection terminal **34** are not illustrated. Further, in FIG. **4**A to FIG. **4**C, a second board **20** is indicated by a solid line, a first board **10** is illustrated by a dotted line. In a portion where the solid line and the dotted line overlap with each other, the dotted line is omitted. FIG. **4**A is a view illustrating a mode of the protruding portion **25** in the electronic module **1** according to the embodiment illustrated in FIG. **1** to FIG. **3**. FIG. **4**B is a view illustrating a mode of the protruding portion **25** in the electronic module according to a first modification. FIG. **4**C is a view illustrating a mode of the protruding portion **25** in the electronic module according to a second modification.

[0016] FIG. **5** is a view illustrating an example of an assembly jig **50** that can be used for manufacturing the electronic module **1** according to the embodiment.

[0017] FIG. **6**A to FIG. **6**C are views illustrating a method of manufacturing the electronic module **1** according to the embodiment.

[0018] FIG. **7** is a view illustrating an electronic module **900** according to the prior art.

DESCRIPTION OF EMBODIMENTS

[0019] Hereinafter, an electronic module and a method of manufacturing an electronic module according to the present invention are described based on embodiments illustrated in the drawings. It is not always the case that all of various constitutional elements described in the embodiments and the combinations thereof are indispensable as means to solve the problems of the present invention.

Embodiment

1. Electronic Module

[0020] As illustrated in FIG. **1** to FIG. **3**, the electronic module **1** according to an embodiment includes: a first board **10**; a first heat radiation member **12**; a first electronic element **13**; a second board **20**; a second heat radiation member **22**; a second electronic element **23**; a first external connection terminal **32**; a second external connection terminal **34**; and internal connection terminals **36**: The electronic module **1** may include constitutional elements other than the above-mentioned constitutional elements. Hereinafter, the respective constitutional elements are described.

[0021] The first board **10** is a board where the first heat radiation member **12** is disposed on one surface and the first electronic element **13** is disposed on another surface (see FIG. **3**). As the first board **10**, a ceramic board can be used. It is preferred that a board having a structure where a copper plate is disposed on both surfaces of a ceramic plate (for example, DCB board) can be used as the first board **10**. When a DCB board is used as the first board **10**, the copper plate disposed on one surface can be used as a first heat radiation member **12**. The first heat radiation member **12** is exposed to the outside of a mold resin **40**. The first board **10** has a wiring **11** (see FIG. **3**) and the wiring **11** is electrically connected to an electrode of the first electronic element **13**.

[0022] In this specification, “electrically connected” includes not only a case where electricity supply portions of constitutional elements are directly in contact with each other but also a case

where the constitutional elements are in contact with each other via an additional conductive constitutional element (for example, solder or a spacer).

[0023] The first electronic element **13** is an electronic element that is disposed on the first board **10**. The first electronic element **13** is disposed on a second board **20** side of the first board **10**, and is sealed by the mold resin **40**. The first electronic element **13** has an electrode not illustrated in the drawing, and is electrically connected to the wiring **11** mounted on the first board **10** and the internal connection terminals **36**. As the first electronic element **13**, for example, a vertical type MOSFET can be exemplified.

[0024] The second board **20** is a board disposed on a side where the first electronic element **13** of the first board **10** is disposed in a state where the second board **20** is spaced apart from the first board **10** and the first electronic element **13**. With respect to the second board **20**, "a state where the first board **10** and the first electronic element **13** are spaced apart from the second board **20**" means that the second board **20** is not in direct contact with the first board **10** and the first electronic element **13**.

[0025] The second board **20** is a board where a second heat radiation member **22** is disposed on one surface and the second electronic element **23** is disposed on another surface. As the second board **20**, a ceramic board can be used. It is preferred that a board having a structure where a copper plate is disposed on both surfaces of a ceramic plate (for example, DCB board) can be used as the second board **20**. When a DCB board is used as the second board **20**, the copper plate disposed on one surface can be used as a second heat radiation member **22**. The second heat radiation member **22** is exposed to the outside of the mold resin **40** (see FIG. **2**). The second board **20** has a wiring **21** (see FIG. **3**) and the wiring **21** is electrically connected to an electrode of the second electronic element **23**.

[0026] The second board **20** has, as viewed in a plan view, a protruding portion **25** that protrudes towards the outside from the outer periphery of the first board **10**. In this embodiment, the protruding portion **25** means a portion where the second board **20** protrudes from the outer periphery of the first board **10** when the electronic module **1** is viewed in a plan view. It is preferred that the protruding portion **25** is formed of a ceramic board.

[0027] The shape of the protruding portion **25** and the number of the protruding portions **25** that the second board **20** includes can be suitably decided so long as the second board **20** can be supported in a stable manner during assembling of the electronic module **1**. In such a configuration, "to support the second board **20** in a stable manner" includes not only a case where the second board **20** is supported by the protruding portions **25** but also a case where the second board **20** is supported by the protruding portions **25** and an internal connection terminal **35**.

[0028] Hereinafter, the variations of the protruding portions **25** in the electronic module **1** are described with reference to FIG. **4**A to FIG. **4**C.

[0029] In the electronic module **1** according to the embodiment, the second board **20** is larger than the first board **10** in the longitudinal direction (vertical direction in the drawing) and in the lateral direction (in the left-and-right direction in the drawing) (see FIG. **4**A). With such a configuration, when the first board **10** and the second board **20** are stacked such that the position of the center of gravity of the first board **10** and the position of the center of gravity of the second board **20** are aligned with each other, an outer periphery of the second board **20** is disposed outside an outer periphery of the first board **10** in all portions thus forming the protruding portion **25**.

[0030] In a first modification, the second board **20** is formed such that a length in the lateral direction (the left-and-right direction in the drawing) is set longer than the first board **10** in the corresponding direction, and is formed with the same length as the first board **10** in the longitudinal direction (the vertical direction in the drawing) (see FIG. **4**B). Accordingly, when the first board **10** and the second board **20** are stacked in the height direction such that the positions of the centers of gravity of the respective boards **10**, **20** are aligned, the protruding portions **25** that protrude toward the outside from the outer periphery of the first board **10** are formed on the left side and the right

side of the second board **20** in the drawing.
[0031] An outer shape of the first board **10** and an outer shape of the second board **20** are not limited to a rectangular shape. Either one or both of the first board **10** and the second board **20** may have shapes that differ from the rectangular shape. For example, in a second modification illustrated in FIG. **4**C, as viewed in a plan view, an outer periphery of the second board **20** partially protrudes with respect to an outer periphery of the first board thus forming the protruding portions **25**. In the second modification, in FIG. **4**C, the protruding portions **25** are formed at five positions on sides of the second board **20**. That is, two protruding portions **25** are formed at two positions on a left side of the second board **20**, at one position from an upper side to a right side, at one position on the right side, and at one position from the right side to a lower side.
[0032] The above-mentioned shapes of the protruding portions **25** and the above-mentioned positions where the protruding portions **25** are formed are described in an exemplifying purpose, and are not limited to the above-mentioned shapes and positions. By providing the protruding portion **25** or the protruding portions **25** that are formed in a protruding manner toward the outside from the outer periphery of the first board **10** to the second board **20**, this embodiment can acquire an advantageous effect that the first board **10** and the second board **20** can be mounted with high accuracy in a height direction.
[0033] The second electronic element **23** is an electronic element that is disposed on the second board **20**. The second electronic element **23** is disposed on the second board **20** on a first board **10** side, and is sealed by the mold resin **40**. The second electronic element **23** has an electrode, and is electrically connected to the wiring **21** disposed on the second board **20** and the internal connection terminals **36**. As the second electronic element **23**, for example, a vertical MOSFET can be exemplified.
[0034] The internal connection terminals **36** are disposed between the first board **10** and the second board **20**. The internal connection terminal **36** is s formed as a columnar member, and functions as a member that adjusts a height of the second board **20** with respect to the first board **10**. One end of the internal connection terminal **36** is disposed on the first board **10** or the first electronic element **13** disposed on the first board **10** via a bonding material (for example, solder). Further, the other end of the internal connection terminal **36** is disposed on the second board **20** or the second electronic element **23** disposed on the second board **20** via a bonding material (for example, solder).
[0035] The internal connection terminal **36** is a member that is used for electrical transaction in the electronic module **1** simultaneously. One end of the internal connection terminal **36** is electrically connected to the wiring **11** of the first board **10** or an electrode of the first electronic element **13**. The other end of the internal connection terminal **36** is electrically connected with the wiring **21** of the second board **20** or an electrode of the second electronic element **23**. Further, the internal connection terminal **36** is electrically connected with the first external connection terminal **32** or the second external connection terminal **34**. By taking into account an amount of current that flows into the internal connection terminal **36**, it is preferred that a cross-sectional area and a material of the internal connection terminal **36** is selected, and the number of the internal connection terminals **36** to be used is selected.
[0036] The first external connection terminal **32** is a terminal that connects the wiring **11** of the first board **10**, the electrode of the first electronic element **13**, the wiring **21** of the second board **20** or the electrode of the second electronic element **23** with the outside of the electronic module **1** via the internal connection terminal **36**. The first external connection terminal **32** is a power terminal corresponding to a large current. The first external connection terminal **32** is configured such that at least one end of the first external connection terminal **32** is exposed to the outside of the mold resin **40**, and is capable of being connected with an external terminal not illustrated in the drawing.
[0037] The second external connection terminal **34** is a terminal that connects the wiring **11** of the first board **10**, the electrode of the first electronic element **13**, the wiring **21** of the second board **20**

or the electrode of the second electronic element **23** with the outside of the electronic module **1** via the internal connection terminal **36**. The second external connection terminal **34** is electrically connected with the internal connection terminal **36** between the first board **10** and the second board **20**. The second external connection terminal **34** is configured such that at least one end of the second external connection terminal **34** is exposed to the outside of the mold resin **40**, and is capable of being connected with an external terminal not illustrated in the drawing.

[0038] The mold resin **40** seals a surface of the first board **10** on a side where the first electronic element **13** is disposed and the first electronic element **13** (see FIG. **2**). Further, the mold resin **40** seals a surface of the second board **20** on a side where the second electronic element **23** is disposed and the second electronic element **23**.

2. Method of Manufacturing Electronic Module

[0039] The method of manufacturing the electronic module **1** according to the embodiment is described.

2.1. Assembly Jig

[0040] The electronic module **1** according to the embodiment manufactures by arranging the first board **10**, the internal connection terminal **36**, the first external connection terminal **32**, the second connection terminal **34** and the second board **20** in a height direction using an assembly jig **50**.

[0041] The assembly jig **50** that can be used in the manufacture of the electronic module **1** includes, as illustrated in FIG. **5**, a first mounting portion **52**, raised portions **53**, second mounting portions **54**, and walls **55**.

[0042] The first mounting portion **52** is a flat surface formed on the assembly jig **50** is formed, and is a mounting portion on which the first board **10** is mounted. In FIG. **5**, the first mounting portion **52** is indicated as a region that is surrounded by a solid line and a dotted line. By mounting the first board **10** on the first mounting portion **52**, a height of the first board **10** can be adjusted using the surface on which the first mounting portion **52** is formed as a reference surface.

[0043] The raised portions **53** are arranged around the first mounting portion **52**. In the assembly jig **50** illustrated in FIG. **5**, five raised portions **53** are disposed. Further, as viewed in a plan view, each raised portion **53** is arranged to be in contact with a boundary between the first mounting portion **52** and a region outside the first mounting portion **52**. With such a configuration, when the first board **10** is mounted on the first mounting portion **52**, the free movement of the first board **10** in-plane direction is restricted and hence, the positioning of the first board **10** in the in-plane direction can be performed.

[0044] In the electronic module **1**, the raised portions **53** are disposed while avoiding the positions at which the first external connection terminals **32** and the second external connection terminals **34** are arranged.

[0045] The raised portion **53** includes the second mounting portion **54**. The second mounting portion **54** is a mounting portion that engages with and stopes the protruding portion **25** of the second board **20** at the time of deciding the height of the second board **20**. The second mounting portion **54** is formed on a surface of the raised portion **53** that faces the first mounting portion **52**. When the second board **20** is mounted on the assembly jig **50**, the second mounting portion **54** is disposed at the position that corresponds to the protruding portion **25** of the second board **20**. The second mounting portion **54** is disposed at the position having a predetermined height using the first mounting portion **52** as a reference. In arranging the the second board **20** on the second mounting portion **54**, by allowing the protruding portion **25** to be engaged with and to be stopped by the second mounting portion **54**, the second board **20** can be implemented in the height direction with high accuracy with respect to the reference surface of the first mounting portion **52**.

[0046] The raised portion **53** has the wall **55**. The wall **55** is disposed at the position at which the free movement of the second board **20** in the in-plane direction is restricted in a state where the protruding portion **25** is engaged with and is stopped by the second mounting portion **54**. With such a configuration, when the second board **20** is mounted on the second mounting portion **54**, it is

possible to perform the positioning of the second board **20** in the in-plane direction.

2.2 Method of Manufacturing Electronic Module

[0047] Next, the method of manufacturing an electronic module is described with reference to FIG. **6**A to FIG. **6**C.

[0048] The method of manufacturing the electronic module **1** includes: a first board mounting step of mounting the first board **10** on the first mounting portion **52** of the assembly jig **50**; an internal connection terminal mounting step of mounting one end of the internal connection terminal **36** on the first board **10**; and a second board mounting step of mounting the second board **20** on the other end of the internal connection terminal **36** and the second mounting portion **54**.

[0049] In the method of manufacturing the electronic module **1**, when the second board **20** is assembled as a part of the electronic module **1**, as viewed in a plan view, the second board **20** includes the protruding portion **25** that protrudes toward the outside from the outer periphery of the first board **10**. The second board **20** is mounted on the second mounting portion **54** in a state where the protruding portion **25** is engaged with and is stopped by the second mounting portion **54**.

[0050] Further, in the method of manufacturing the electronic module **1**, the second mounting portion **54** is disposed at the predetermined height position from the first mounting portion **52**. Further, the second mounting portion **54** is disposed at the position where the protruding portion **25** is engaged with and is stopped by the second mounting portion **54** as viewed in a plan view.

[0051] Hereinafter, the method of manufacturing the electronic module **1** is described in detail.

[0052] The assembly jig **50** is prepared. The assembly jig **50** that can be used in the method of manufacturing the electronic module **1** includes, as illustrated in FIG. **5** and FIG. **6**A to FIG. **6**C, the first mounting portion **52** on which the first board **10** is mounted, the raised portion **53**, and the second mounting portion **54** on which the second board **20** is mounted.

[0053] The raised portions **53** are disposed at positions that allow the first board **10** to pass between the raised portions **53** from above when the first board **10** is mounted on the first mounting portion **52**. The second mounting portion **54** is disposed on the raised portion **53**, and is disposed at a predetermined height position using the first mounting portion **52** as the reference. Further, the second mounting portion **54** is, as viewed in a plan view, disposed at the position where the protruding portion **25** is engaged with and is stopped by the second mounting portion **54**.

[0054] In the first board mounting step, as illustrated in FIG. **6**A, the first board **10** is mounted on the first mounting portion **52** on the assembly jig **50**. When the first board **10** is mounted on the first mounting portion **52**, the raised portions **53** that include the second mounting portions **54** are disposed at the positions that allow the first board **10** to pass between the raised portions **53** as viewed in a plan view. With such arrangement, it is possible to make the first board **10** to pass between the raised portions **53** and the first board **10** can be mounted on the first mounting portion **52**.

[0055] The first board **10** is mounted such that the surface on which the first heat radiation member **12** is disposed is brought into contact with the first mounting potion **52**. With such arrangement, it is possible to make the height of the surface that the first heat radiation member **12** of the first board **10** is disposed align with the height of the reference surface of the first mounting portion **52**. Further, the outer periphery of the first board **10** is brought into contact with the internal peripheries of the raised portions **53** of the assembly jig **50**. With such a configuration, it is possible to prevent free movement of the first board **10** in the in-plane direction. As a result, the positioning of the first board **10** in the in-plane direction can be performed.

[0056] As illustrated in FIG. **6**B, in the internal connection terminal mounting step, the internal connection terminals **36** are raised on the first board **10**. Subsequently, the first external connection terminal **32** and the second external connection terminal **34** are disposed. Alternatively, in place of the above-mentioned steps, the internal connection terminals **36** are made to pass through holes formed in the first external connection terminal **32** or the second external connection terminal **34**, and the structure where the internal connection terminal **36** and the first external connection

terminal **32** and/or the second external connection terminal **34** are assembled is prepared. Further, the structure where the internal connection terminal **36** and the first external connection terminal **32** and/or the second external connection terminal **34** are assembled may be disposed on the first board **10**.

[0057] As illustrated in FIG. **6**C, in the second board mounting step, the second board **20** on which the second electronic element **23** (see FIG. **3**) is mounted on the other end of the internal connection terminal **36** and the second mounting portion **54**. The second board **20** includes the protruding portion **25**. By allowing the protruding portion **25** to be engaged with and to be stopped by the second mounting portion **54**, the second board **20** can be mounted on the second mounting portion **54**. Accordingly, the height of the second board **20** can be adjusted using the height of the first mounting portion **52** as the reference.

[0058] Further, the outer periphery of the second board **20** is brought into contact with the wall **55**. Accordingly, it is possible to restrict the free movement of the second board **20** in the in-plane direction when the second board **20** is mounted on the second mounting portion **54**. As a result, it is possible to perform the positioning of the second board **20** in the in-plane direction.

[0059] After the second board **20** is mounted, the assembled structure is sealed by a mold resin **40** thus completing the electronic module **1**. The resin sealing is performed as follows. The surface of the first board **10** on a side where the first electronic element **13** is disposed and the first electronic element **13** are sealed by the mold resin **40**. Further, the surface of the second board **20** on a side where the second electronic element **23** is disposed and the second electronic element **23** are sealed by the mold resin **40**.

[0060] Hereinafter, advantageous effects acquired by the electronic module **1** according to the embodiment are described.

[0061] The electronic module **1** according to the embodiment includes the first board **10**, the second board **20**, and the internal connection terminal **36** that connects the first board **10** and the second board **20** to each other. The second board **20** has, as viewed in a plan view, the protruding portion **25** that protrudes more toward the outside than the outer periphery of the first board **10**. According to the electronic module **1**, due to the provision of the heat radiation surface of the first board **10** and the protruding portion **25** of the second board **20**, the first board **10** and the second board **20** can be mounted with high accuracy in the height direction. Accordingly, it is possible to provide the electronic module **1** that possesses an excellent heat radiation characteristic.

[0062] In the electronic module **1** according to the embodiment, the second board **20** includes the ceramic board and the second heat radiation member **22** formed on one surface of the ceramic board, and the protruding portion **25** is formed of a ceramic board. By adopting a ceramic board as the second board **20**, the first board **10** and the second board **20** can be mounted with high accuracy in the height direction and, at the same time, a heat radiation characteristic from the second board **20** side can be enhanced. Further, by forming the second heat radiation member **22** on the surface of the second board **20**, a heat radiation characteristic can be further enhanced. Accordingly, it is possible to provide the electronic module **1** that possesses an excellent heat radiation characteristic.

[0063] In the electronic module **1** according to the embodiment, the first board **10** includes the ceramic board and the first heat radiation member **12** that is formed on one surface of the ceramic board. By adopting the ceramic board as the first board **10**, the first board **10** and the second board **20** can be mounted with high accuracy in the height direction and, at the same time, a heat radiation characteristic from the first board **10** side can be enhanced. Further, by forming the first heart radiation member **12** on one surface of the first board **10**, the heat radiation characteristic can be further enhanced. Accordingly, it is possible to provide the electronic module **1** that possesses the excellent heat radiation characteristic.

[0064] The electronic module **1** according to the embodiment further includes the first external connection terminal **32** and/or the second external connection terminal **34**, and the internal connection terminal **36** is made to pass through the first external connection terminal **32** and/or the

second external connection terminal **34**. By accurately controlling a length of the internal connection terminal **36**, the first board **10** and the second board **20** can be mounted with high accuracy in the height direction. Further, the first electronic element **13** or the second electronic element **23** can be electrically connected to the first external connection terminal **32** or the second external connection terminal **34**.

[0065] The method of manufacturing the electronic module **1** according to the embodiment includes: a first board mounting step of mounting the first board **10** on the first mounting portion **52** of the assembly jig **50** that includes the first mounting portion **52** on which the first board **10** is mounted and the second mounting portion **54** on which the second board **20** is mounted; and the second board mounting step of mounting the second board **20** on the second mounting portion **54**. The second board **20**, when the second board **20** is assembled as a part of the electronic module **1**, includes the protruding portion **25** that protrudes more outside than the outer periphery of the first board **10** as viewed in a plan view. The second mounting portion **54** is disposed at the predetermined height position from the first mounting portion **52**, and is disposed at the position where the protruding portion **25** is engaged with and is stopped by the second mounting portion **54** as viewed in a plan view. With such a configuration, the first board **10** and the second board **20** can be mounted in the height direction with high accuracy. According to the present invention, in the electronic module **1** where a heat radiation surface is formed on both surfaces of the electronic module **1**, the heat radiation surface can be mounted in the height direction with high mounting accuracy and hence, it is possible to provide the method of manufacturing the electronic module **1** which possesses excellent heat radiation characteristic.

[0066] The present invention has been described based on the above-mentioned embodiments heretofore, the present invention is not limited to the above-mentioned embodiment. The present invention can be carried out in various modes without departing from the gist of the present invention. For example, the following modifications are also conceivable. [0067] (1) The shape, the numbers, the sizes, the positions and the like of the constitutional elements according to the present invention are not limited to the values illustrated in the above-mentioned description and the respective drawings, and the values can be suitably changed so long as the technical feature of the present invention are not impaired.

[0068] To exemplify one example, in the above-mentioned embodiment, although the number of the first electronic elements **13** and the number of the second electronic elements **23** are respectively one, the present invention is not limited to such a case. The number of the first electronic elements **13** and the number of the second electronic elements **23** may be plural. [0069] (2) The electronic module according to the present invention may further include electronic elements, structures and the like besides the first electronic element **13** on the first board **10**. Further, the electronic module according to the present invention may further include electronic elements, structures and the like besides the second electronic element **23** on the second board **20**.

[0070] (3) As the first electronic element **13** in the electronic module according to the present invention, electronic elements other than a MOSFET (for example, various types of diodes, transistors other than a vertical MOSFET, a thyristor) can be also used. The same goes for the second electronic element **23**.

Claims

1. An electronic module comprising: a first board; a first electronic element that is disposed on the first board; a second board; a second electronic element that is disposed on the second board; and an internal connection terminal that is disposed between the first board and the second board, wherein the second board includes a protruding portion that protrudes more outside than an outer periphery of the first board as viewed in a plan view.

2. The electronic module according to claim 1, wherein the second board has a ceramic board and a

heat radiation member that is formed on one surface of the ceramic board, and the protruding portion is formed of a part of the ceramic board.

3. The electronic module according to claim 2, wherein the first board includes a ceramic board member and a heat radiation member that is formed on one surface of the ceramic board.

4. The electronic module according to claim 1, further comprising an external connection terminal, wherein the internal connection terminal is configured to pass through the external connection terminal.

5. A method of manufacturing an electronic module using an assembly jig that includes a first mounting portion and a second mounting portion, the method comprising: a first board mounting step of mounting a first board on the first mounting portion; an internal connection terminal mounting step of mounting one end of an internal connection terminal on the first board; and a second board mounting step of mounting the second board on an other end of the internal connection terminal and the second mounting portion, wherein the second board has a protruding portion that protrudes more outside than an outer periphery of the first board as viewed in a plan view when the second board is assembled as a part of the electronic module, the second board is mounted on the second mounting portion in a state where the protruding portion is engaged with and is stopped by the second mounting portion, and the second mounting portion is disposed at a predetermined height position from the first mounting portion, and is disposed at a position where the protruding portion is engaged with and is stopped by the second mounting portion as viewed in a plan view.