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(54) ELECTRONIC MODULE

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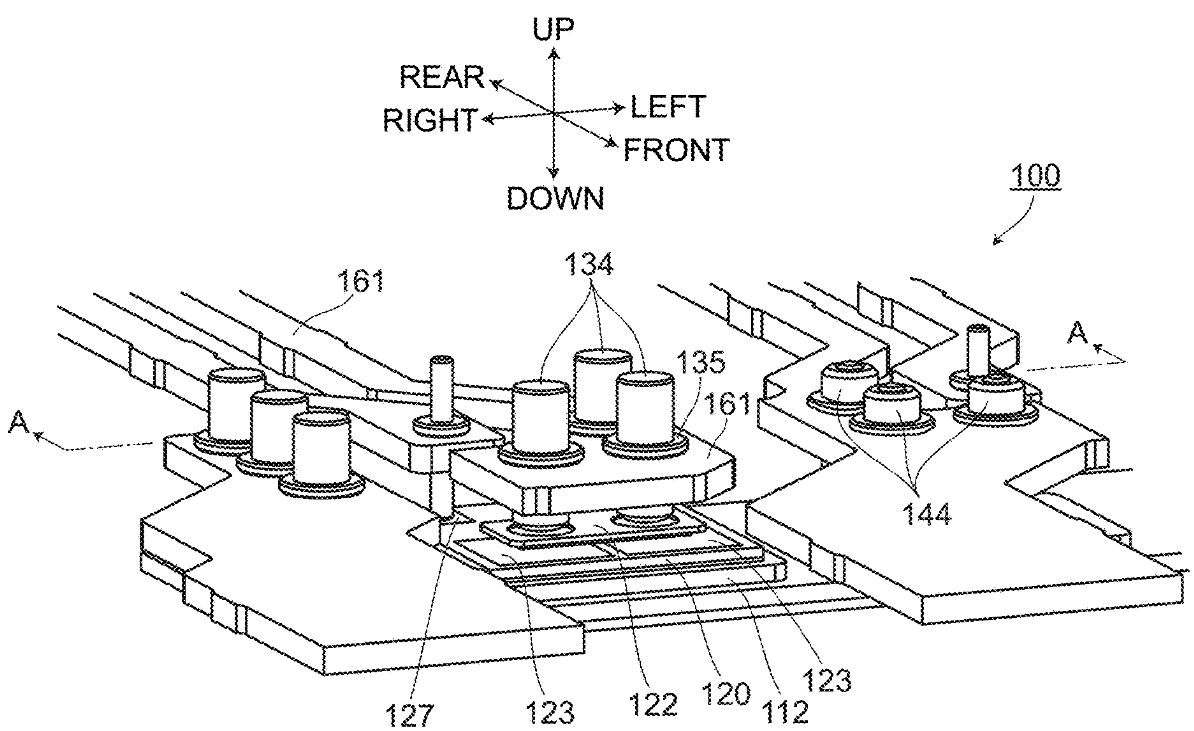
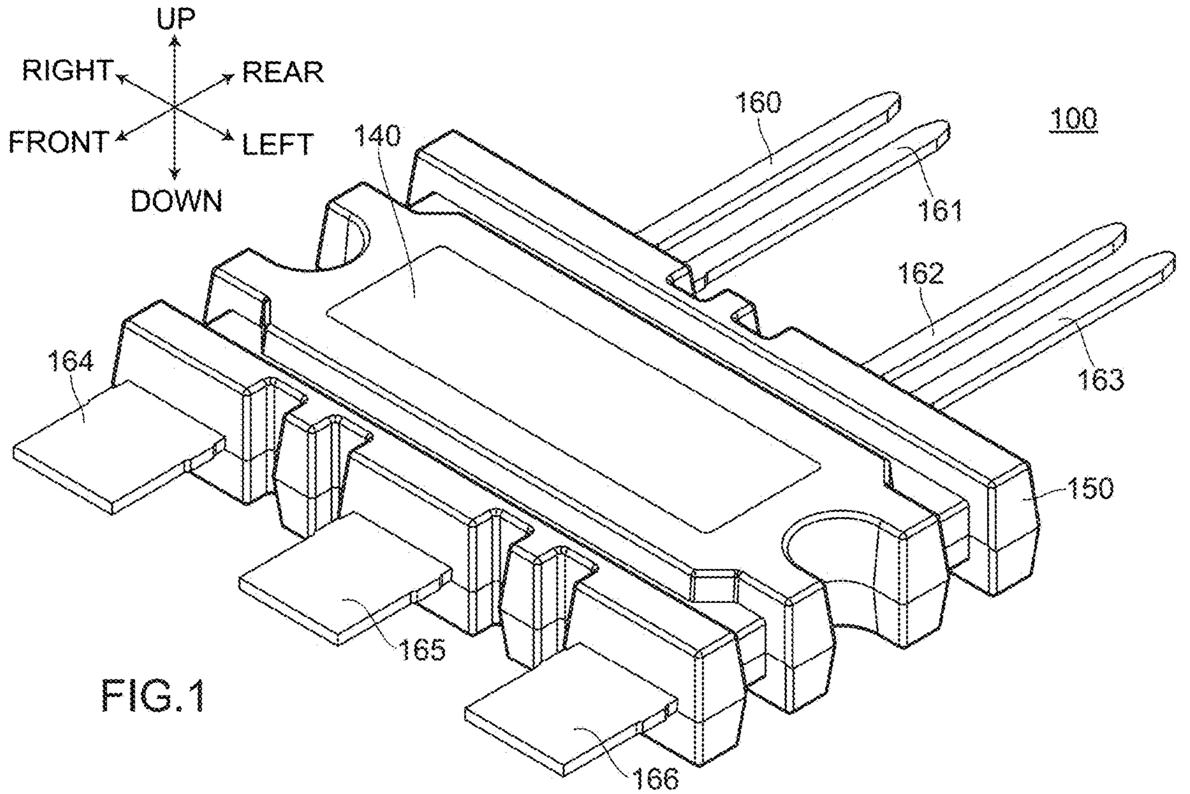
(57) **ABSTRACT**

An electronic module includes an internal connection terminal having conductivity that is electrically connected to an electronic element, and a spacer is disposed between a lower end surface of the internal connection terminal and the electronic element. Solder BM1 is disposed between the electronic element and the spacer, and a stepped portion is formed along an outer peripheral portion of the spacer.




UP
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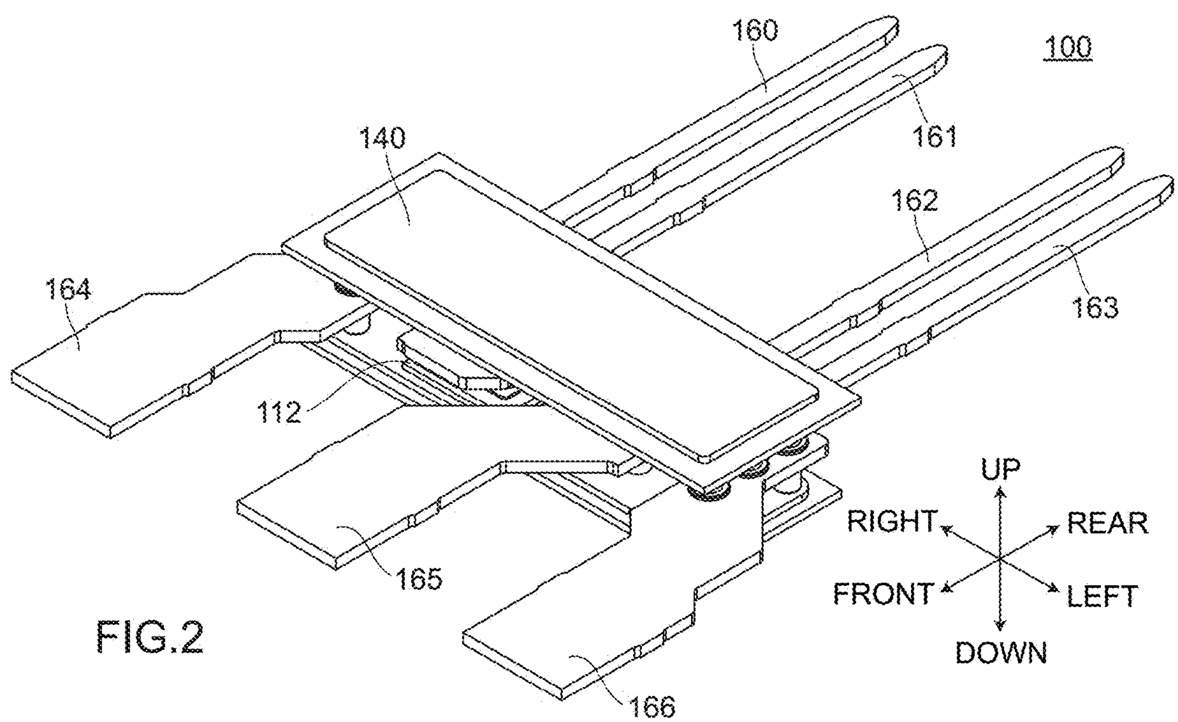
REAR
FRONT
LEFT
DOWN
160
100
140
161
162
164
163
150
165
166

FIG.1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100
140
161
162
164
163
112
UP
RIGHT
REAR
FRONT
LEFT
165
DOWN
166

FIG.2

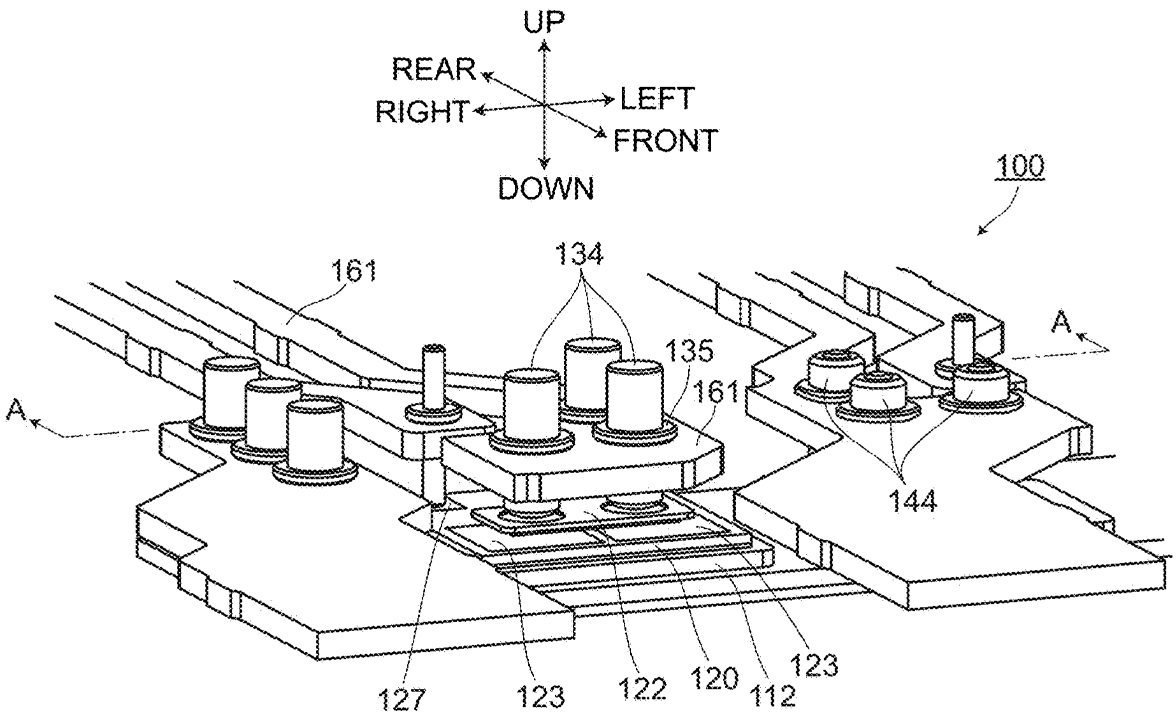
UP
REAR
LEFT
RIGHT
FRONT
DOWN
100
161
134
135
161
A
A
144
127
123
122
120
112
123

FIG.3

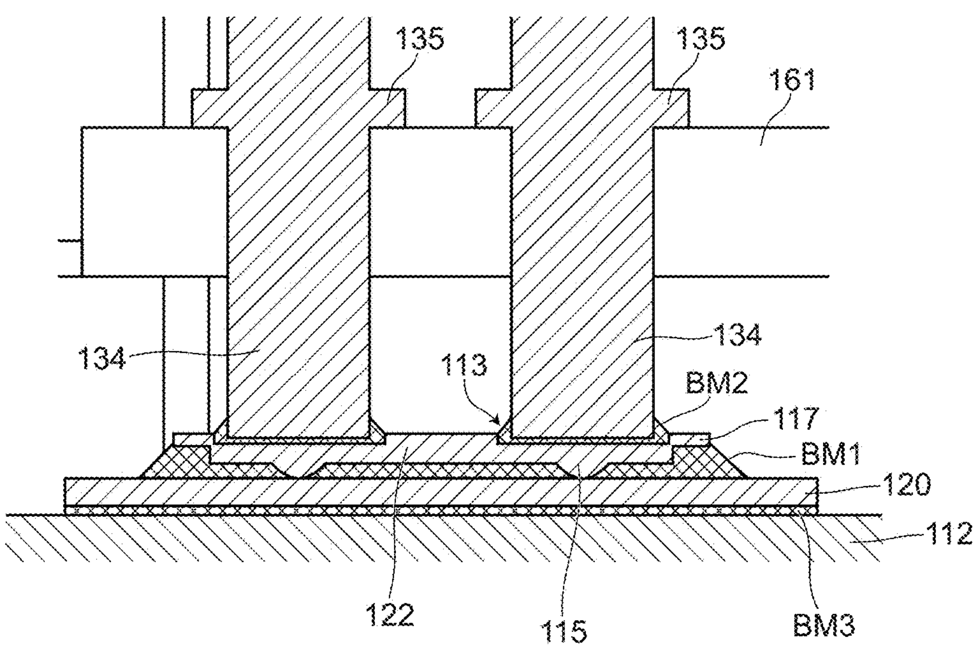
135
135
161
134
134
113
BM2
117
BM1
120
112
122
115
BM3

FIG.4

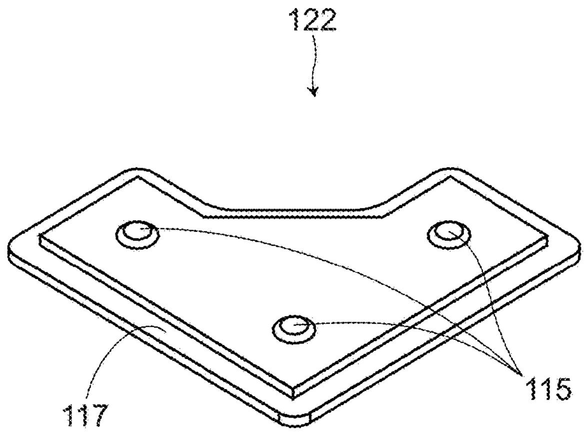

FIG.5

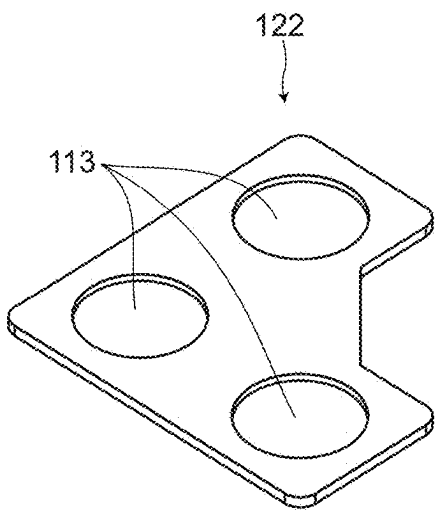

FIG.6

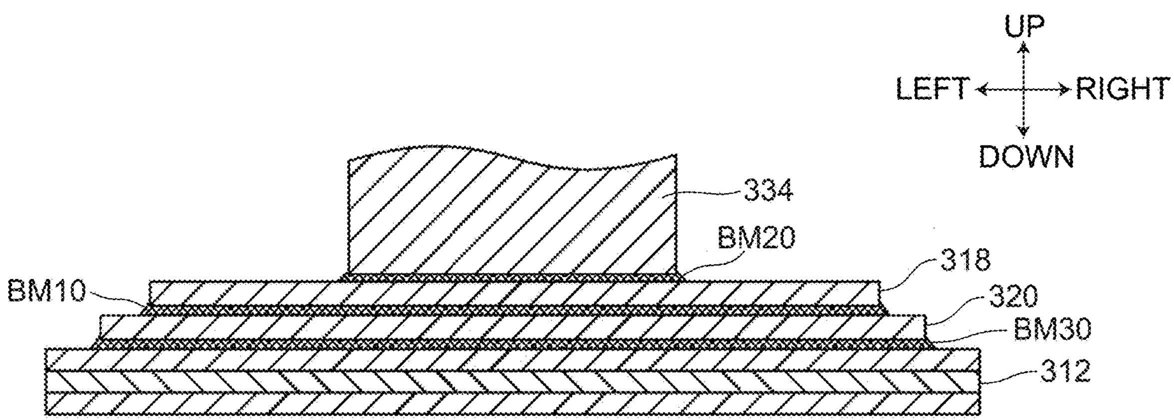

FIG.7

ELECTRONIC MODULE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Japanese Patent Application No. 2024-20366, 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 that includes: an electronic element (for example, a chip); a board on which the electronic element is mounted; and a pin terminal that forms an internal connection terminal which is connected to a wiring pattern on the board (hereinafter, referred to patent literature 1). Among electronic modules of this type, there has been known an electronic module where the internal connection terminal is connected to an electrode of an electronic element in place of a wiring pattern. As such an electronic module, there exists an electronic module where an internal connection terminal is connected to an electrode of an electronic element via a spacer having a flat plate shape (for example, a chip spacer). In this case, the spacer and the electrode of the electronic element are bonded to each other by solder.

[0004] To be more specific, as illustrated in FIG. **7**, an electronic element **320** is disposed on a board **312**, and is bonded to the board **312** by solder BM30. A chip spacer **318** us disposed on the electronic element **320**, and is bonded to the electronic element **320** via solder BM10. A lower end of an inner connection terminal **334** is disposed on the chip spacer **318**, and the inner connection terminal **334** is bonded to the chip spacer **318** by solder BM20.

PRIOR ART LITERATURE

Patent Literature

[0005] [Japanese Patent Literature 1] Japanese Patent No. 6850938

SUMMARY OF INVENTION

Technical Problem

[0006] The spacer is used for alleviating a thermal stress that acts in solder between an electronic element and an internal connection terminal. In a case where a large electronic element is mounted or a highly reliable withstand strength is necessary, it is further necessary to alleviate a thermal stress. Accordingly, it is necessary to secure solder having a predetermined thickness on an outer peripheral portion of a spacer which is a thermal stress concentrating portion in a bonding portion between the spacer and an electronic element.

[0007] On the other hand, an amount of solder which can be applied by coating to electrodes of an electronic element for preventing a solder bridge between electrodes having different polarities on the electronic element is restricted. Accordingly, in the above-mentioned conventional structure, it is difficult to secure a sufficient solder thickness on the outer peripheral portion.

[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 that can secure a predetermined solder thickness on an outer peripheral portion of a spacer which is a thermal stress concentrating portion in a bonding portion between a spacer and an electronic element, and can alleviate a thermal stress generated in the outer peripheral portion of the spacer.

Solution to Problem

[0009] An electronic module according to the present invention includes: an electronic element; an internal connection terminal having conductivity that is electrically connected to the electronic element; and a spacer disposed between a lower end surface of the internal connection terminal and the electronic element, wherein a conductive bonding material is disposed between the electronic element and the spacer, and a stepped portion is formed along an outer peripheral portion of the spacer.

Advantageous Effects of the Present Invention

[0010] The electronic module according to the embodiment includes: the electronic element; the internal connection terminals having conductivity that are electrically connected to the electronic element; and the spacer disposed between the lower end surfaces of the internal connection terminals and the electronic element, wherein the conductive bonding material is disposed between the electronic element and the spacer, and the stepped portion is formed along the outer peripheral portion of the spacer. With such a configuration, a space for securing a proper solder thickness can be formed between the stepped portion formed on the outer peripheral portion of the spacer and the electronic element. Accordingly, it is possible to secure a predetermined solder thickness on the outer peripheral portion of the spacer that forms a thermal stress concentrating portion. As a result, it is possible to alleviate a thermal stress that is generated on the outer peripheral portion of the spacer at the bonding portion between the spacer and the electronic element.

BRIEF DESCRIPTION OF DRAWINGS

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

[0012] FIG. **2** is a perspective view illustrating the internal structure of the electronical module **100** according to the embodiment.

[0013] FIG. **3** is a perspective view illustrating a peripheral structure of a spacer **122** in the embodiment. In FIG. **3**, symbol **135** indicates a flange portion, and symbol **144** indicates an internal connection terminal.

[0014] FIG. **4** is a cross-sectional view taken along A-A in FIG. **3**.

[0015] FIG. **5** is a perspective view illustrating the structure of a lower surface of the spacer **122** in the embodiment.

[0016] FIG. **6** is a perspective view illustrating the structure of an upper surface of the spacer **122** in the embodiment.

[0017] FIG. **7** is a view illustrating an electronic module according to a prior art.

DESCRIPTION OF EMBODIMENTS

[0018] Hereinafter, the electronic module according to the present invention is described based on an embodiment illustrated in the drawings. 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 as means to solve the problem of the present invention.

EMBODIMENT

[0019] As illustrated in FIG. **1** to FIG. **3**, an electronic module **100** according to the embodiment includes: a board (first board) **112**; an electronic element **120**; a spacer (chip spacer) **122**; an internal connection terminal **134**; a board (second board) **140**; and a lead frame (constituting external connection terminals, hereinafter, referred to as "external connection terminals") **160**, **161**, **162**, **163**, **164**, **165**, **166**; and a mold resin **150**. The external connection terminal **161** is connected to the internal connection terminal **134** at an intermediate position of the internal connection terminal **134**. The electronic element (semiconductor element) **120** is bonded to an upper surface of the board **112** by solder BM3 (see FIG. **4**), and an electronic element (semiconductor element: not illustrated in the drawing) is bonded to a lower surface of the board **140** via solder.

[0020] In the embodiment, the electronic module **100** is provided for constituting a half bridge circuit. For example, the electronic element **120** is used on a high side, and the electronic element bonded to the lower surface of the board **140** is used on a low side. There also may be a case where the electronic element **120** is used on the low side, and the electronic element bonded to the lower surface of the board **140** is used on the high side. The electronic module **100** may include constitutional elements other than the above-mentioned constitutional elements. Hereinafter, for the sake of convenience, the constitutional elements in the electronic element **120** of the electronic module **100** are described, and the detailed description of the constitutional elements of the electronic element bonded to the lower surface of the board **140** is omitted. In the present specification, the phrase "electrically connected" means not only the case where electricity supply portions of constitutional elements are directly brought into contact with each other but also a case where the electricity supply portions of the constitutional elements are bonded to each other via an additional constitutional element having conductivity (for example, solder or a spacer).

[0021] The board **112** is a board having the structure where a copper plate is disposed on both surfaces of a ceramic plate (for example, DCB board). The board **112** is electrically connected to a drain electrode (not illustrated in the drawing) of the electronic element **120**. The board **112** is not limited to the DCB board, and may be a printed board or the like, for example.

[0022] The electronic element **120** is disposed on the board **112**. The electronic element **120** is a vertical-type MOSFET having a source electrode **123** disposed on a side opposite to a board **112** side, a drain electrode (not illustrated in the drawing) disposed on a board **112** side, and a gate electrode **127** disposed on the same side as the source electrode **123** (see FIG. **3**). The electronic element **120** includes three source electrodes **123** as the source electrode.

[0023] The inner connection terminal **134** is a member having an approximately columnar shape and having conductive property (see FIG. **4**), and is connected to the spacer **122** having a flat plate shape which is made of a conductive material via a through hole (symbol being omitted) formed in the external connection terminal **161**. The inner connection terminal **134** is connected to the board **112** and the board **140**. The electronic module **100** includes three internal connection terminals **134** corresponding to the state that the electronic element **120** includes three source electrodes **123**. In the embodiment, the description has been made by taking the case where the inner connection terminal **134** has an approximately columnar shape as an example. However, the inner connection terminal **134** is not limited to the approximately columnar internal connection terminal, and may be an internal connection terminal having a flat shape, for example.

[0024] A lower surface of the spacer **122** is bonded to the source electrode **123** of the electronic element **120** via a conductive bonding member (for example, solder) BM1. An upper surface of the spacer **122** is bonded to a lower end surface of the internal connection electrode **134** via solder BM2.

[0025] The external connection terminal **161** is a member that is electrically connected to the internal connection terminal **134**, and at least one end the external connection terminal **161** protrudes toward the outside from the mold resin **150**. In the electronic module **100**. the external connection terminal **161** is a detection terminal for the source electrode **123** of the electronic element **120**.

(Structure of Spacer)

[0026] As illustrated in FIG. **5** and FIG. **6**, the spacer **122** is a thin flat member (a copper plate) having conductivity that is formed in a polygonal shape. On an upper surface of the spacer **122**, three annular indentations (recessed portions) **113** each having an outer diameter larger than a diameter of the inner connection terminal **134** are formed (see FIG. **6**). The spacer **122** is bonded to a lower surface of the inner connection terminals **134** by way of a conductive bonding material (for example, solder BM2) at indentations **113**. The indentations **113** are formed by applying a force in the vertical direction by pressing from above. An external appearance shape of the indentation **113** conforms to a cross-sectional shape of the internal connection terminal **134**, and an outer diameter and a depth of the indentation **113** can be changed corresponding to a shape of the internal connection terminal **134**. A lower surface of the spacer **122** is bonded to an upper surface (to be more specific, the source electrode **123**) of the electronic element **120** by way of a conductive bonding material (for example, solder BM1).

[0027] The annular indentations **113** each having an outer diameter larger than an outer diameter of the internal connection terminal **134** are formed on the spacer **122**. With the formation of such an indentation **113**, it is possible to prevent solder BM2 from flowing out from between an upper surface of the spacer **122** and a lower surface of the inner connection terminal **134** to the outside in a radial direction.

[0028] Further, as illustrated in FIG. **5**, a stepped portion (a depressed portion) **117** is formed along an outer peripheral portion of the spacer **122**. Accordingly, a space is formed between the stepped portion **117** formed on the outer peripheral portion of the spacer **122** and the electronic element **120**. Accordingly, compared to a conventional spacer on which a stepped portion is not formed, a thickness of solder between the lower surface of the spacer **122** and the electronic element **120** at the outer peripheral portion can be largely increased.

[0029] On a lower surface of the spacer **122**, protruding portions **115** that bring the internal connection terminals **134** and source electrodes **123** of the electronic elements **120** into a point contact with each other are formed via the spacer **122**. With the formation of the protruding portions **115**, a distance between portions of the bottom portion of the spacer **122** other than the protruding portions **115** and the electronic element **120** can be held at a fixed value. Accordingly, a solder thickness of solder BM1 disposed between the spacer **122** and the electronic element **120** can be held at a fixed value (see FIG. **4**).

[0030] Further, it is preferred that the positions where the indentations **113** and the protruding portions **115** are formed correspond to the positions where the inner connection terminals **134** are formed, and are formed inside an outer periphery of the spacer **122**. It is preferred that the number of indentations **113** and the number of protruding portions **115** are respectively at least three, for example. The reason is that such arrangement and the numbers enable the self-standing of the spacer **122**. That is, to enable the self-standing of the spacer **122**, it is necessary that the protruding portions **115** at three points or more are not disposed on one straight line.

Advantageous Effects Acquired by Embodiment

[0031] The electronic module **100** according to the embodiment includes: the electronic element **120**; the internal connection terminals **134** having conductivity that are electrically connected to the electronic element **120**; and the spacer **122** disposed between the lower end surfaces of the internal connection terminals **134** and the electronic element **120**, wherein solder BM1 is disposed between the electronic element **120** and the spacer **122**, and the stepped portion **117** is formed along the outer peripheral portion of the spacer **122**. With such a configuration, the space for securing a proper solder thickness can be formed between the stepped portion **117** formed on the outer peripheral portion of the spacer **122** and the electronic element **120**.

[0032] Accordingly, it is possible to secure a predetermined solder thickness on the outer peripheral portion of the spacer **122** that forms a thermal stress concentrating portion. As a result, it is possible to alleviate a thermal stress that is generated on the outer peripheral portion of the spacer **122** at the bonding portion between the spacer **122** and the electronic element **120**.

[0033] Further, in the electronic module **100** according to the embodiment, the protruding portions **115** provided for electrically connecting the internal connection terminals **134** and the electronic element **120** are formed on the lower surface of the spacer **122**. Due to the formation of the protruding portions **115**, the distance between portions of the bottom portion of the spacer **122** other than the protruding portions **115** and the electronic element **120** can be held at a fixed value. As the result, a solder thickness of solder BM1 disposed between the portions of the bottom portion of the spacer **122** other than the protruding portions **115** and the electronic element **120** can be held at a fixed value. Further, due to the formation of the protruding portions **115**, it is possible to generate the self-alignment of solder BM1 at the time of coagulation toward the axes of the internal connection terminals **134**.

[0034] Further, according to the electronic module **100** of the embodiment, at least three protruding portions **115** are formed and hence, it is possible to make the spacer **122** stand upright.

[0035] Further, according to the electronic module **100** of the embodiment, the annular indentations **113** each having outer diameter larger than the diameter of the internal connection terminal **134** are formed on the upper surface of the spacer **122**, and the positions where the indentations **113** are formed are set at positions corresponding to the positions of the internal connection terminals **134**. Accordingly, it is possible to provide a self-alignment effect to the internal connection terminals **134** inserted into the lead frame **161** and hence, it is possible to prevent the positional displacement of the spacer **122**.

REFERENCE SIGNS LIST

[0036] **100**: electronic module
[0037] **113**: indentation (recessed portion)
[0038] **115**: protruding portion
[0039] **117**: stepped portion
[0040] **120**: electronic element
[0041] **122**: spacer
[0042] **134**: internal connection terminal

1. An electronic module comprising:
an electronic element;
an internal connection terminal having conductivity that is electrically connected to the electronic element; and
a spacer disposed between a lower end surface of the internal connection terminal and the electronic element, wherein
a conductive bonding material is disposed between the electronic element and the spacer, and
a stepped portion is formed along an outer peripheral portion of the spacer.

2. The electronic module according to claim **1**, wherein a protruding portion is formed on a surface of the spacer on an electronic element side.

3. The electronic module according to claim **1**, wherein, the protruding portion is formed of at least three protruding portions.

4. The electronic module according to claim **2**, wherein, the protruding portion is formed of at least three protruding portions.

5. The electronic module according to claim **1**, wherein, an annular indentation having an outer diameter larger than a diameter of the internal connection terminal is formed on an upper surface of the spacer, and the indentation is formed at positions corresponding to a position where the internal connection terminal is positioned.

6. The electronic module according to claim **2**, wherein, an annular indentation having an outer diameter larger than a diameter of the internal connection terminal is formed on an upper surface of the spacer, and the indentation is formed at positions corresponding to a position where the internal connection terminal is positioned.

* * * * *