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Otsubo

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(45) **Date of Patent: Sep. 9, 2025**

(54) **CIRCUIT MODULE**

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H01L 23/367 (2006.01)
(Continued)

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CPC ***H05K 1/0203*** (2013.01); ***H01L 23/3675*** (2013.01); ***H01L 25/105*** (2013.01);
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(58) **Field of Classification Search**
CPC H01L 2225/1094; H01L 23/49816; H01L 2924/181; H01L 2225/1058; H01L 2225/1023; H01L 25/105; H01L 23/5385; H01L 23/5383; H01L 23/3121; H01L 23/367; H01L 21/486; H01L 2224/0401; H01L 2225/107; H01L 23/12; H01L 23/3135; H01L 23/36; H01L 23/49894; H01L 2224/1146; H01L 2224/11462; H01L 2224/33505; H01L 2224/32245; H01L 2224/29299; H01L 2224/214;
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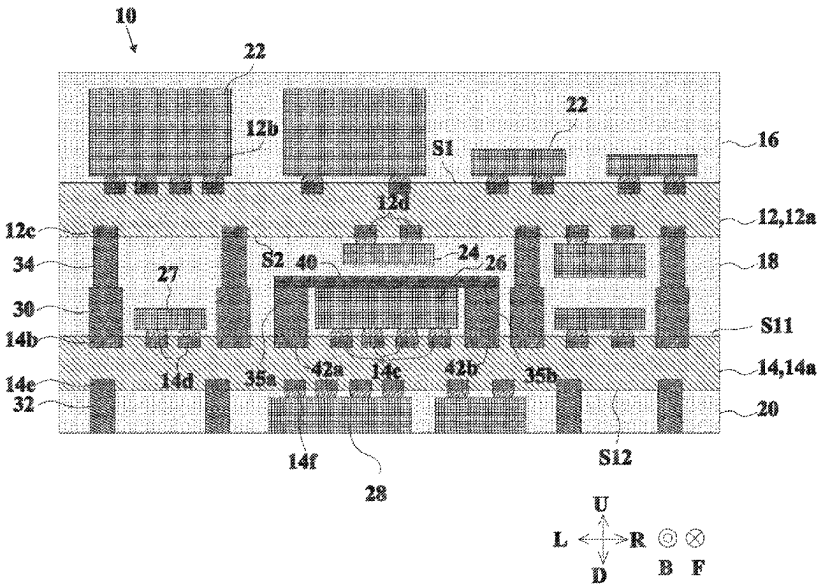
(57) **ABSTRACT**

A first sealing resin is disposed between a first lower main surface and a second upper main surface. An upper circuit board first mounting electrode is disposed on the first lower main surface. A lower circuit board first mounting electrode is disposed on the second upper main surface. A first component is mounted on the lower circuit board first mounting electrode and is disposed in the first sealing resin. A first conductor layer is disposed on an upper circuit board. As viewed in the downward direction, a heat conduction member overlaps the first component, is disposed in a space between the first lower main surface and the second upper main surface, and is coupled to the first conductor layer via a conductor. A part of a heat dissipation member is exposed from the first sealing resin in a direction orthogonal to an up-down axis.

15 Claims, 16 Drawing Sheets



(51) **Int. Cl.**

H01L 25/10	(2006.01)
H01L 25/16	(2023.01)
H05K 1/14	(2006.01)
H05K 1/18	(2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
CPC H01L 2224/33181; H01L 2224/81; H01L 2224/81191; H01L 2225/06589; H01L 2225/06586; H01L 2225/06548; H01L 2225/06541; H01L 23/49822; H01L 23/3675; H01L 25/162; H05K 1/144; H05K 1/181; H05K 2201/042; H05K 2201/10734; H05K 1/0203; H05K 1/11; H05K 3/46; H05K 1/0243; H05K 1/0298; H05K 1/115; H05K 1/18; H05K 1/141; H05K 1/186; H05K 2201/043; H05K 3/4007; H05K 3/3436; H05K 7/1438; H05K 2201/10015; H05K 2201/1003; H05K 2201/10522; H05K 2201/10545; H05K 2201/1056
See application file for complete search history.

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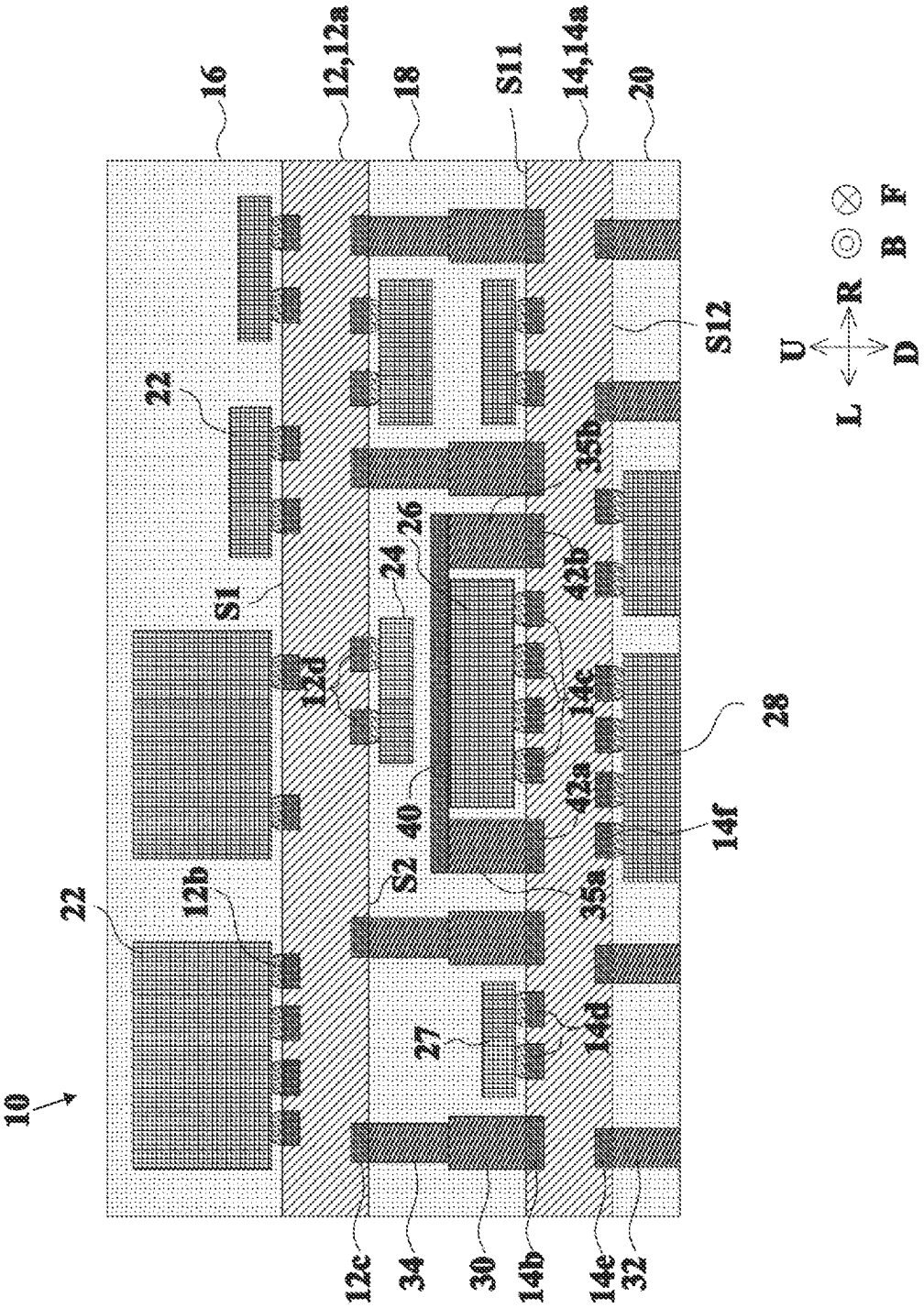
FIG. 1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S1
12d
24
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35b
42b
14c
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40
42a
14f
S2
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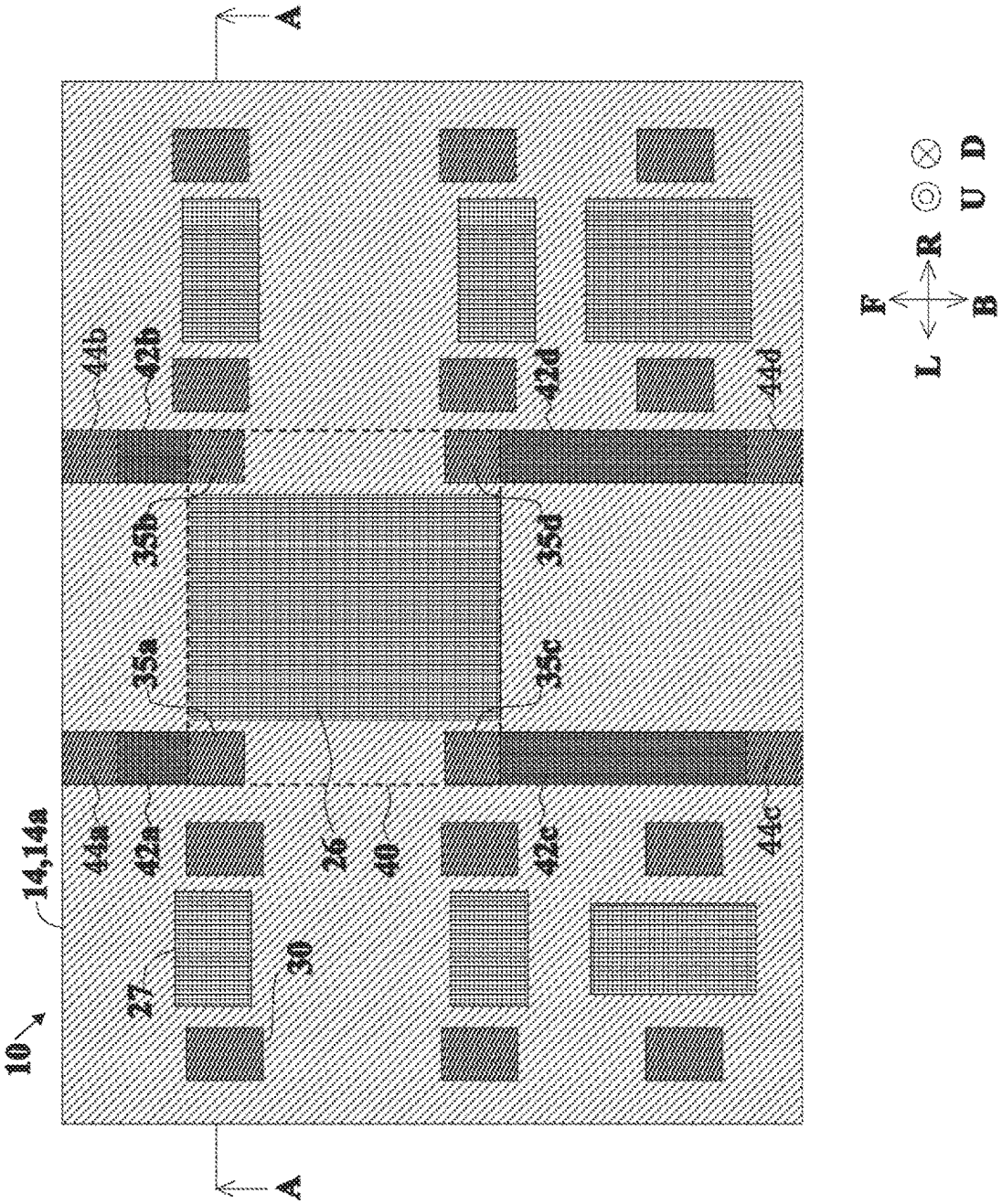
14e
32
U
D
L
R
B
F

FIG. 2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42c
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42d
44d
F
L
R
B
U
D

FIG. 3

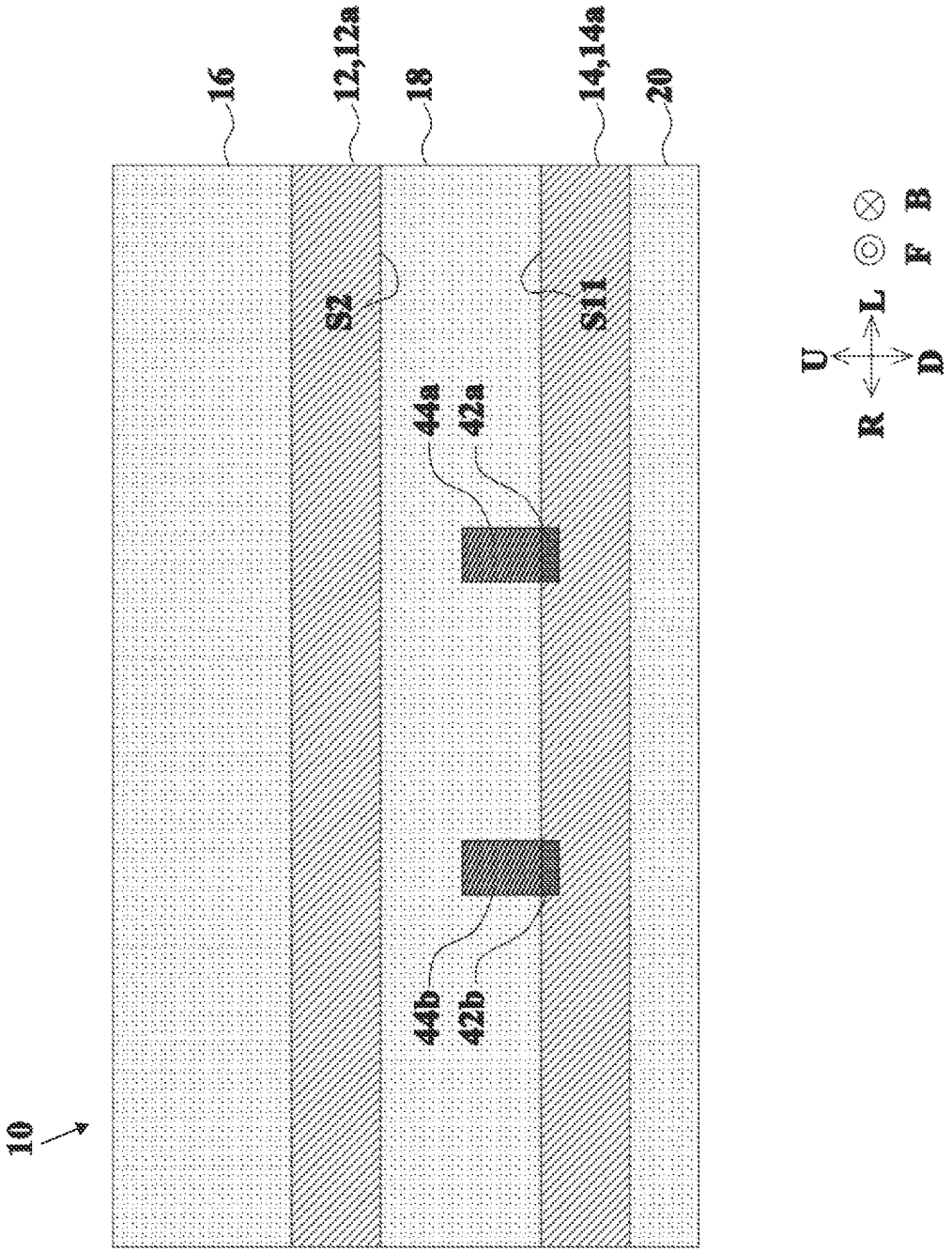


FIG. 4

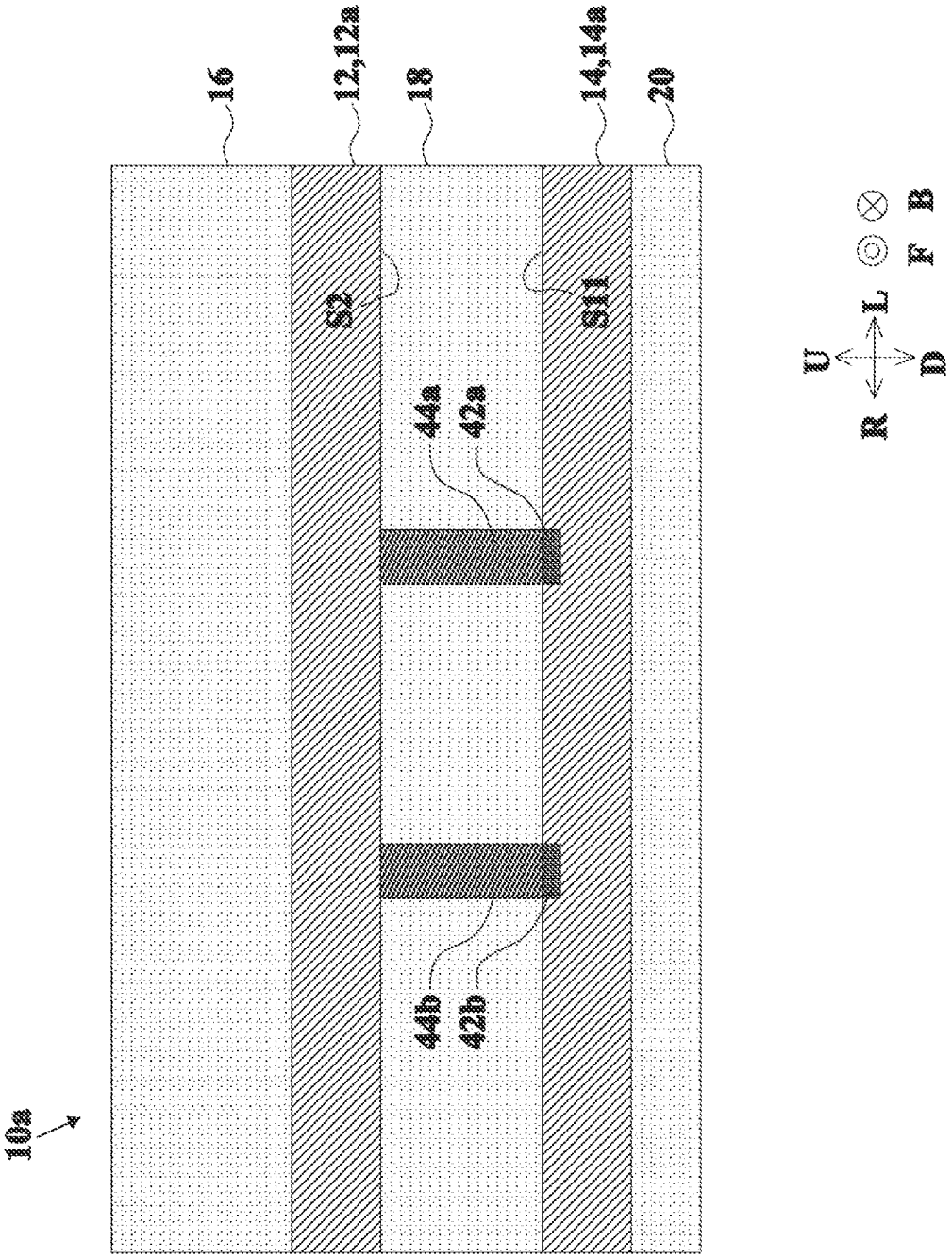
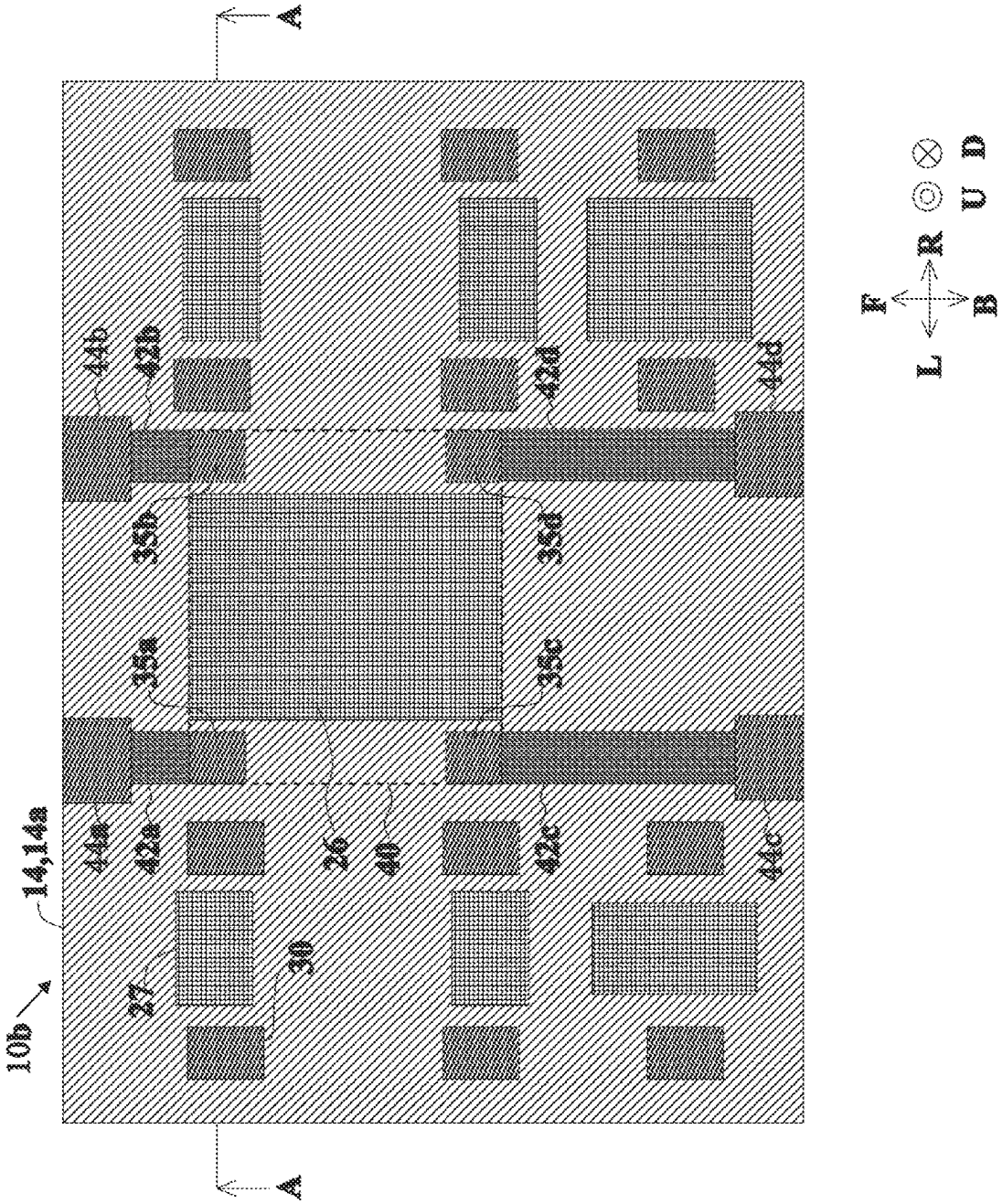


FIG. 5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44d
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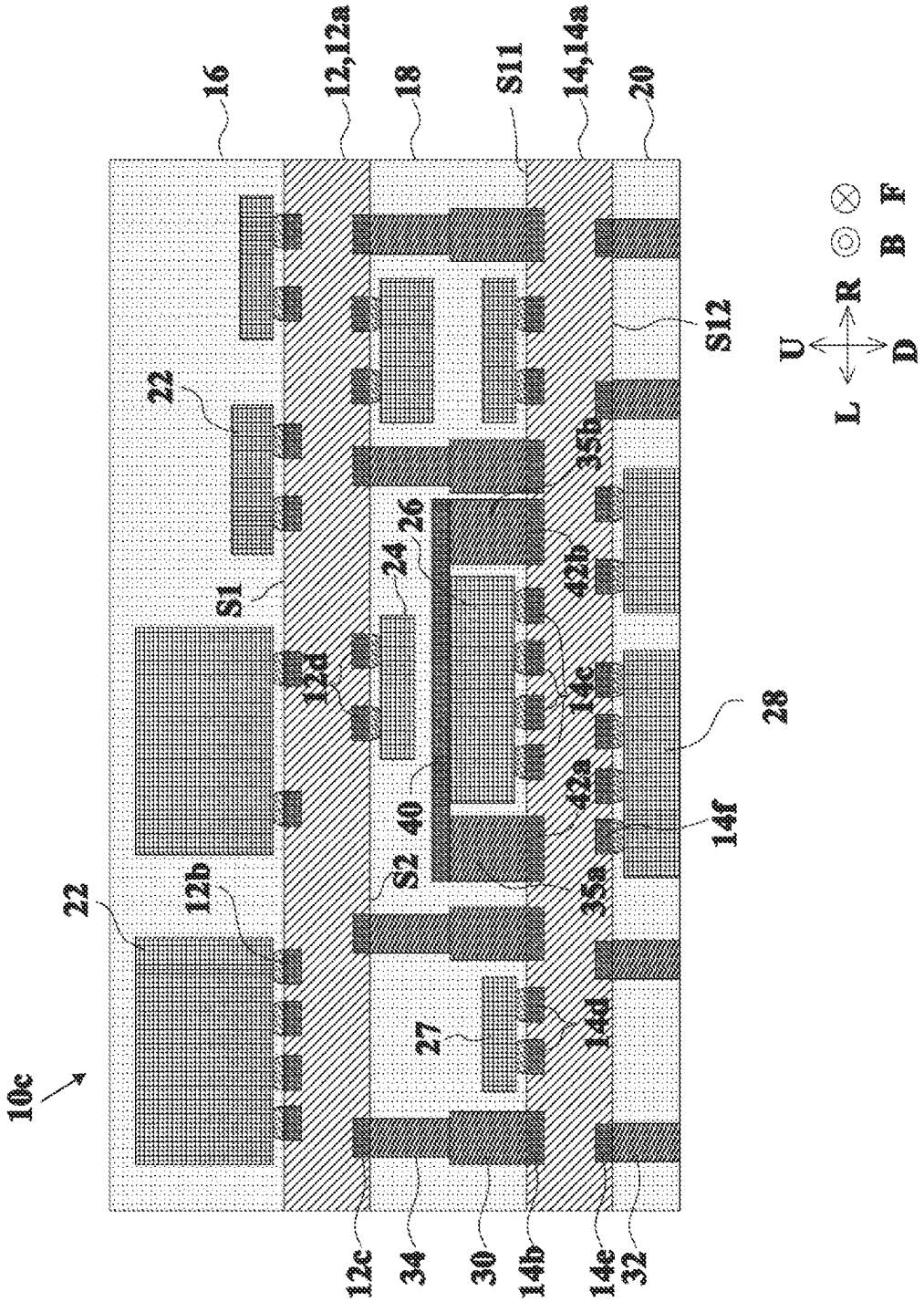
L
R
B
U
D

FIG. 6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S2
35a
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S12
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D
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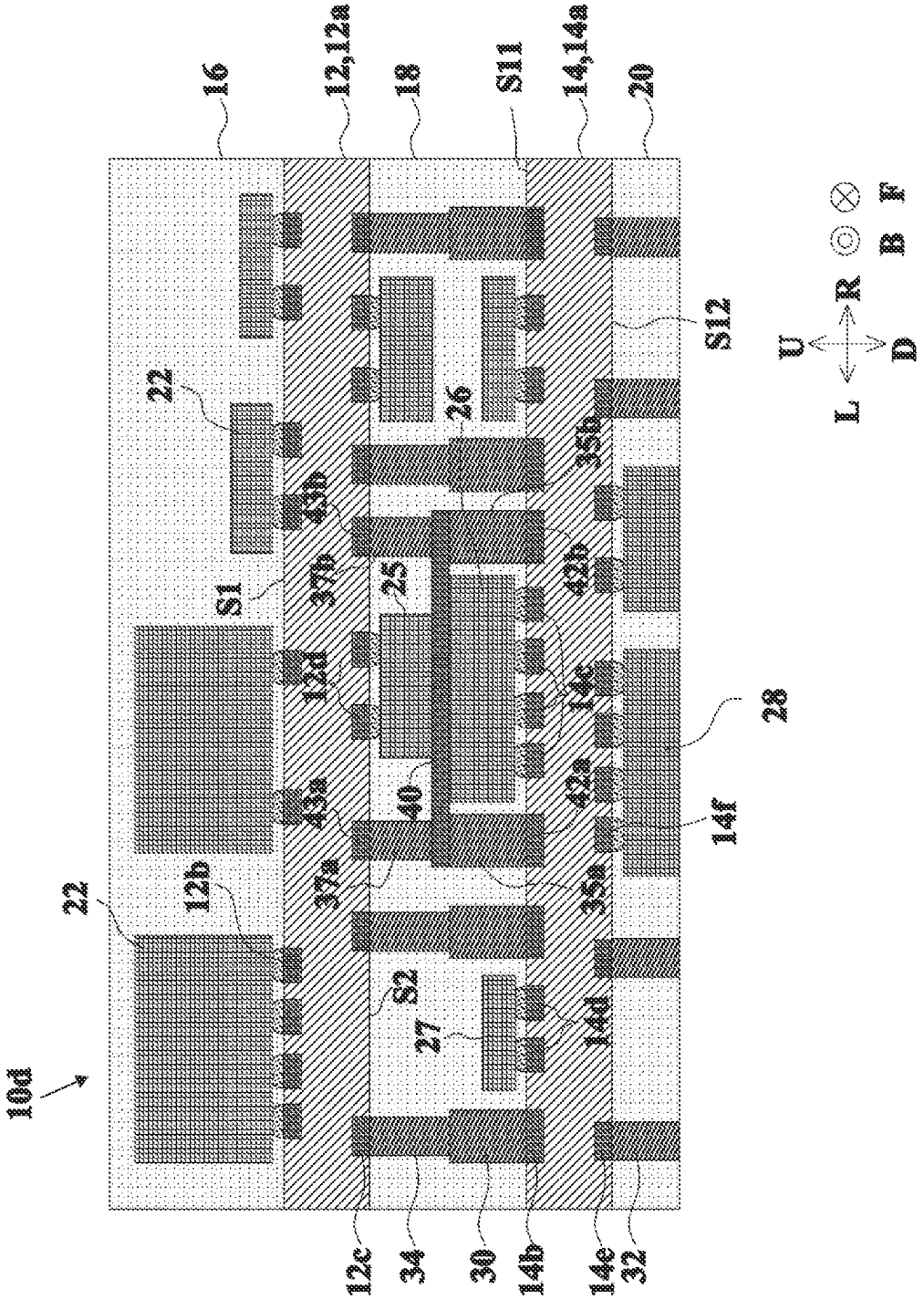
FIG. 7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S2
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14b
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14c
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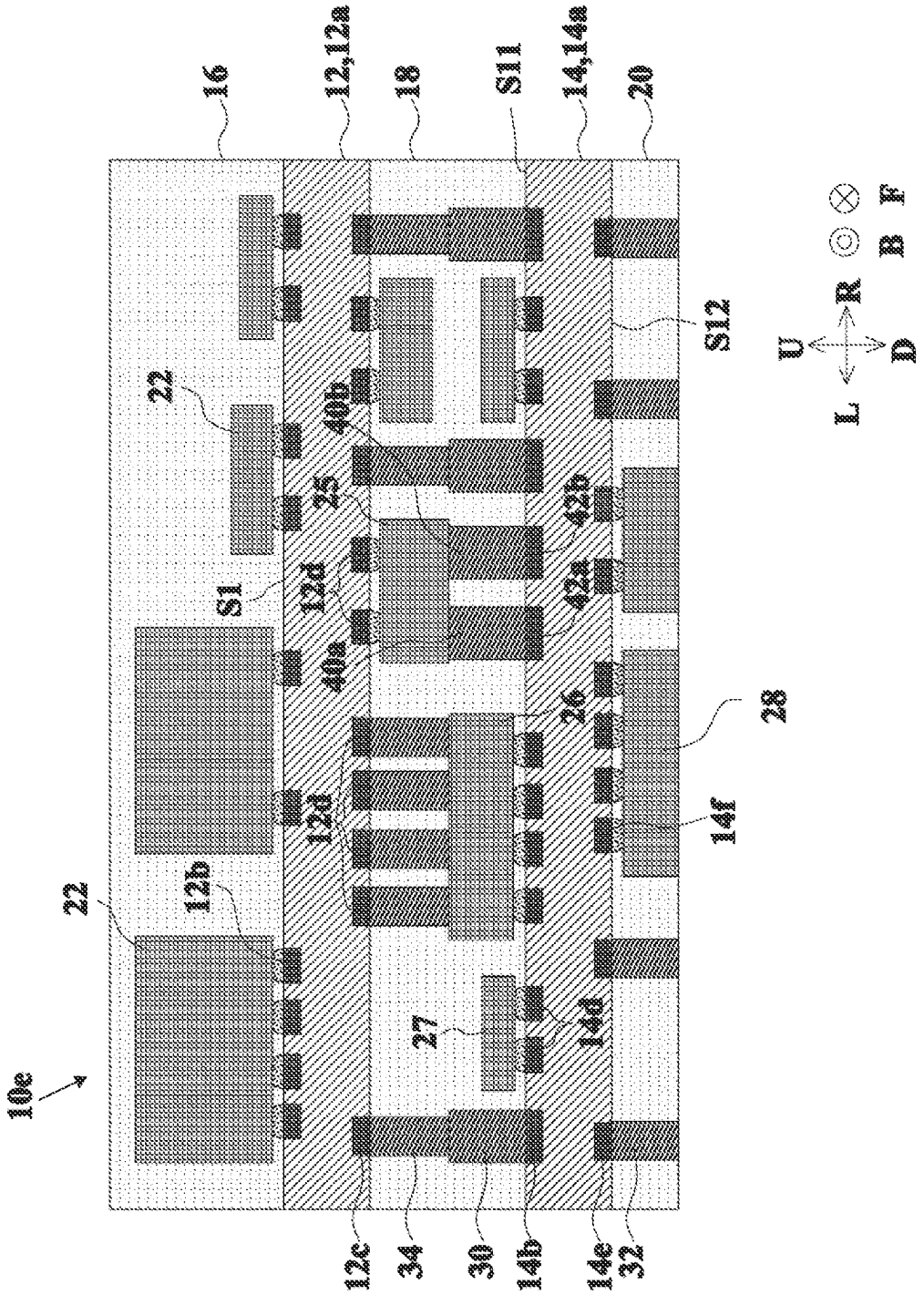
F

FIG. 8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S12
42a
42b
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27
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D
L
R
B
F

FIG. 9

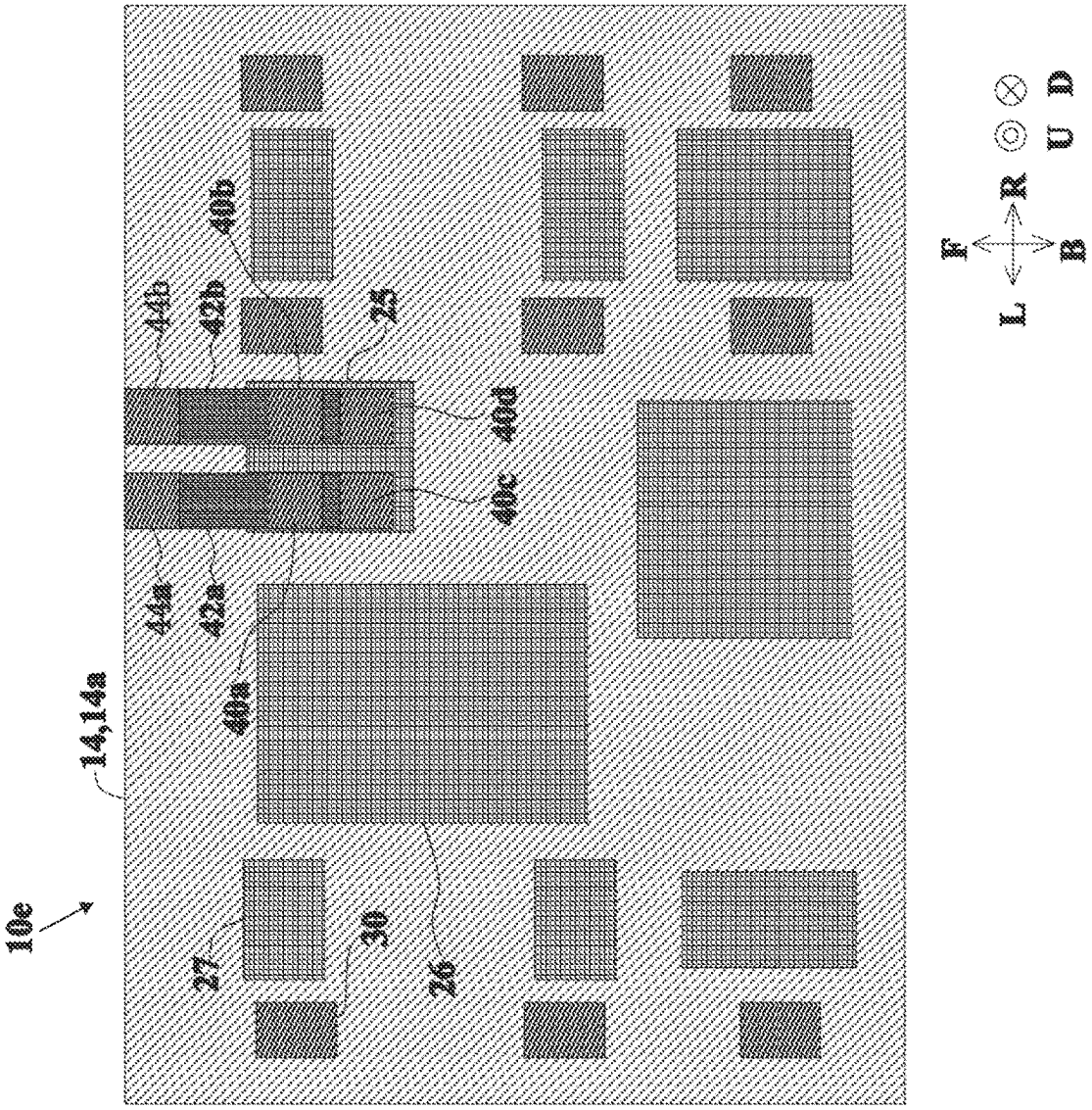
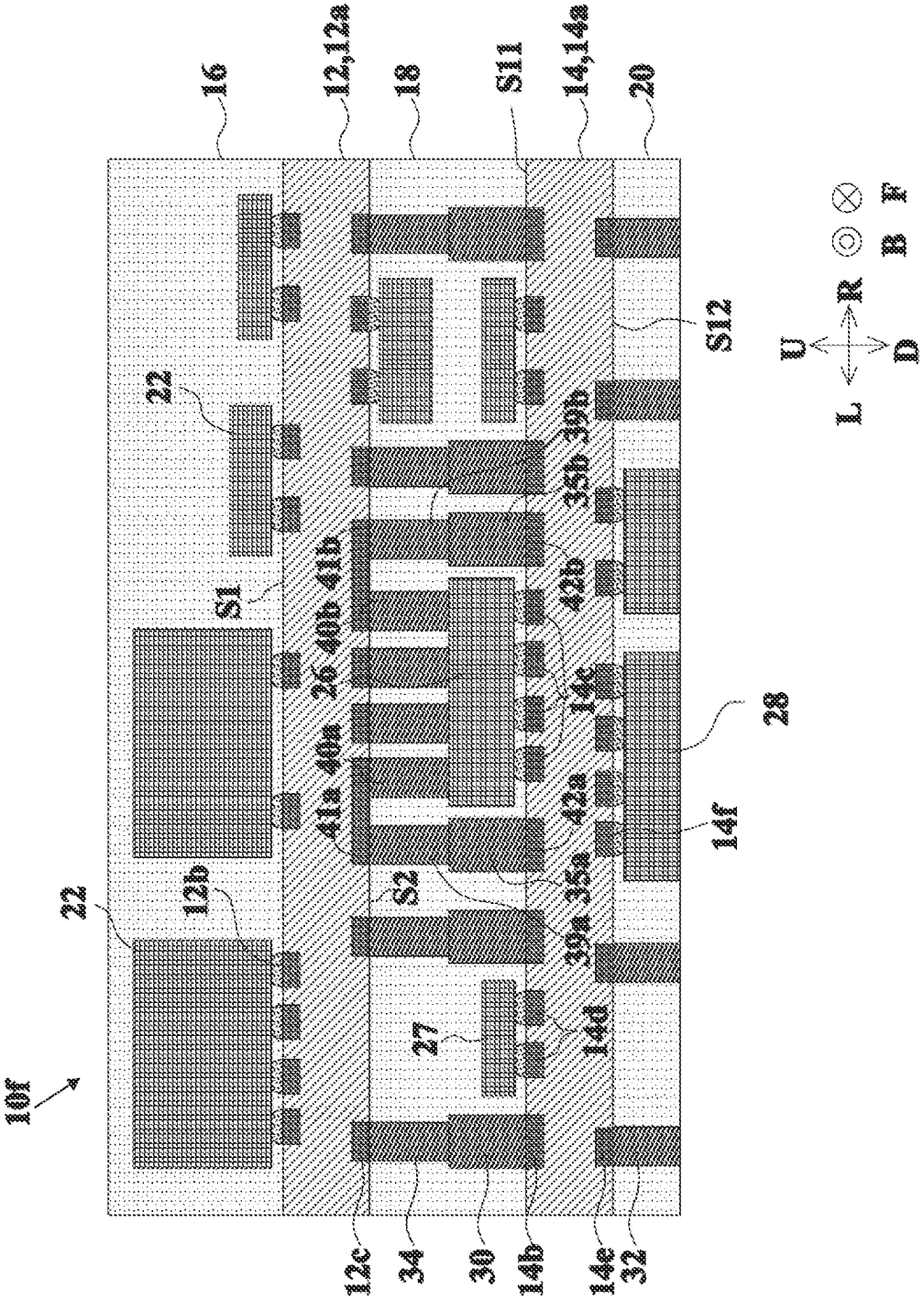


FIG. 10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41b
S2
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S11
14,14a
20
S12
39b
35b
42b
14c
42a
35a
39a
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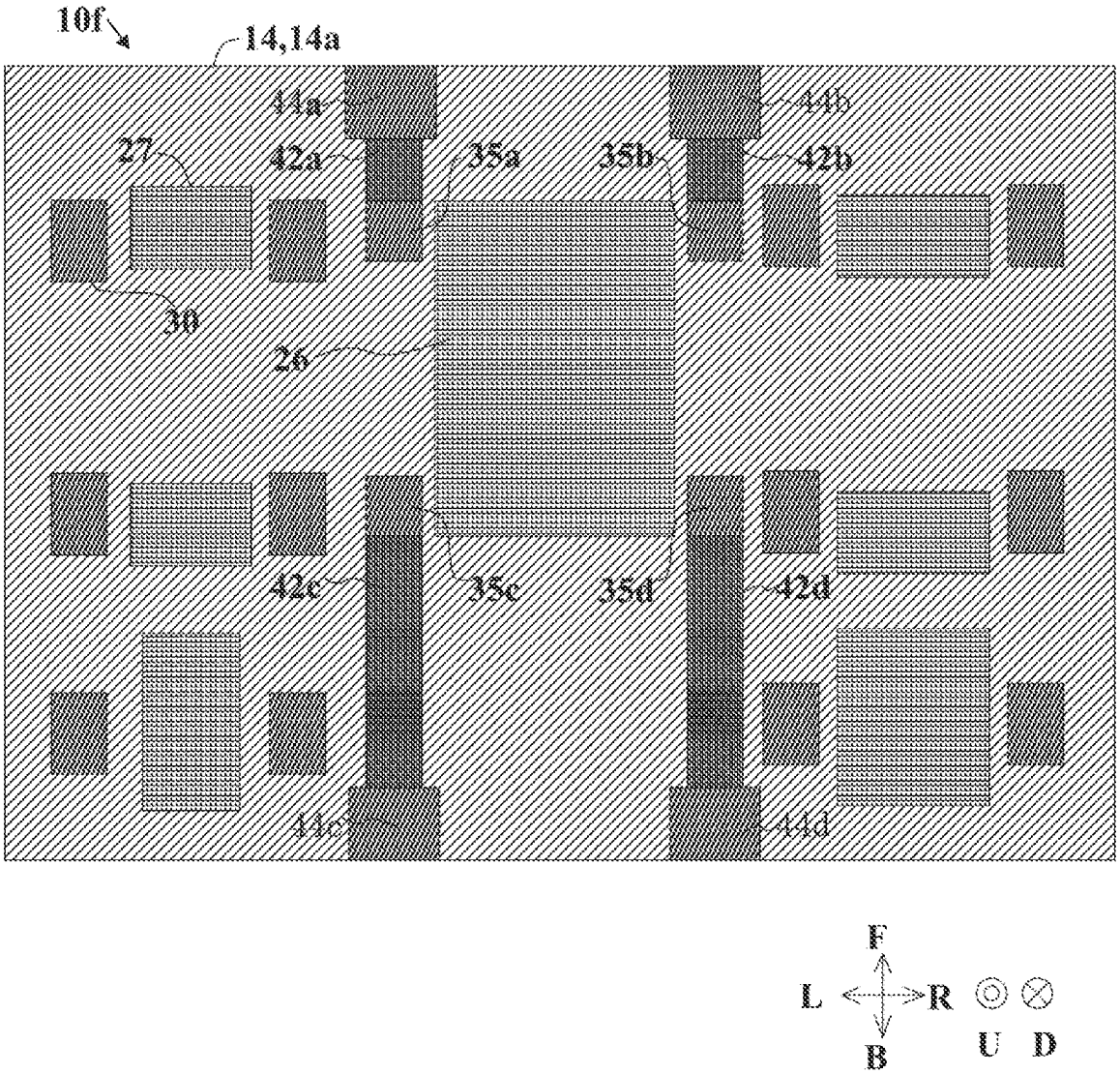
B

FIG. 11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42a
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35b
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35c
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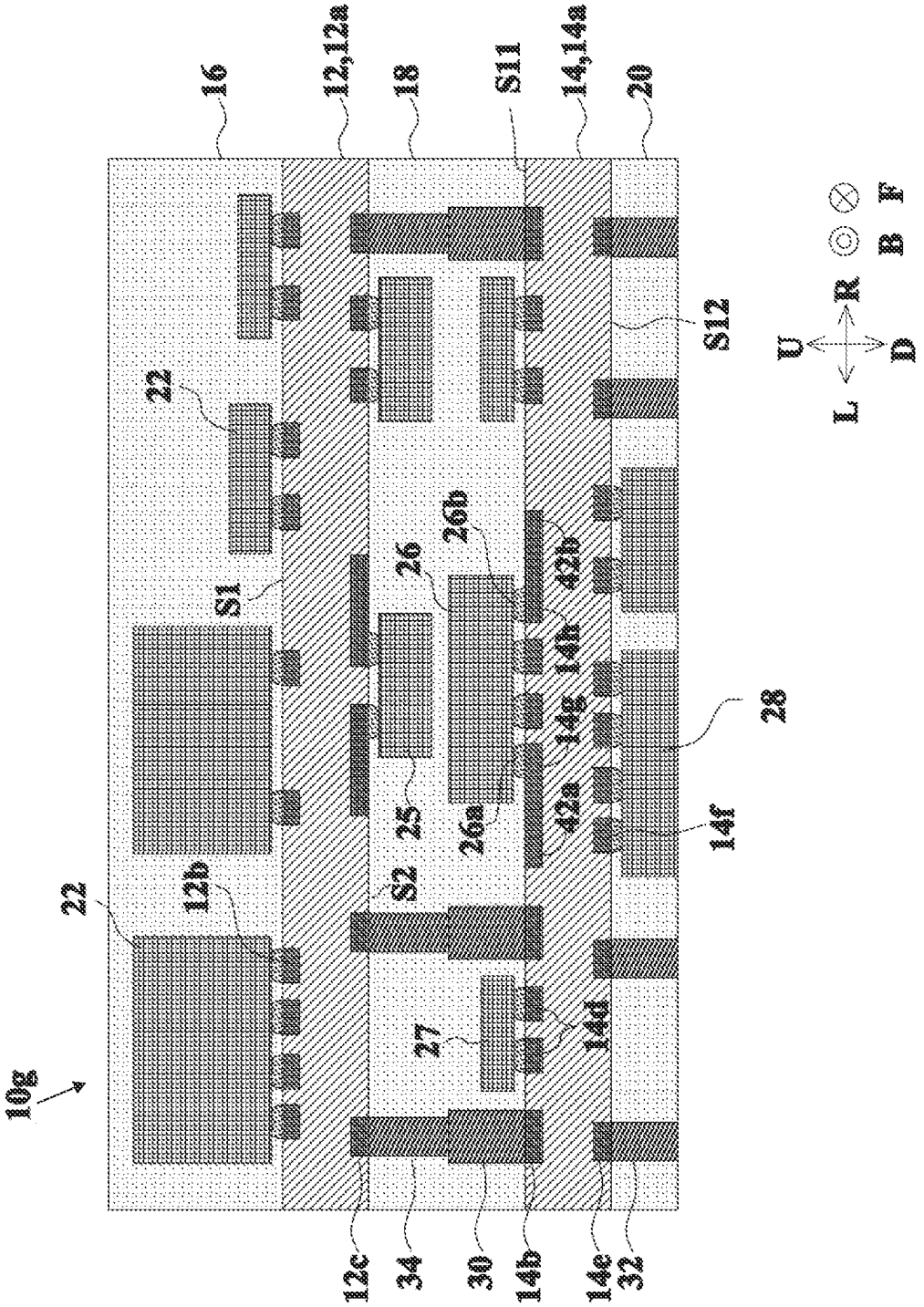
42d
44c
44d
F
L
R
B
U
D

FIG. 12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12b
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S1
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18
S11
14,14a
20
S12
26b
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42b
14h
14g
42a
26a
25
S2
27
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14f
12c
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30
14b
14e
32
U
D
L
R
B
F

FIG. 13

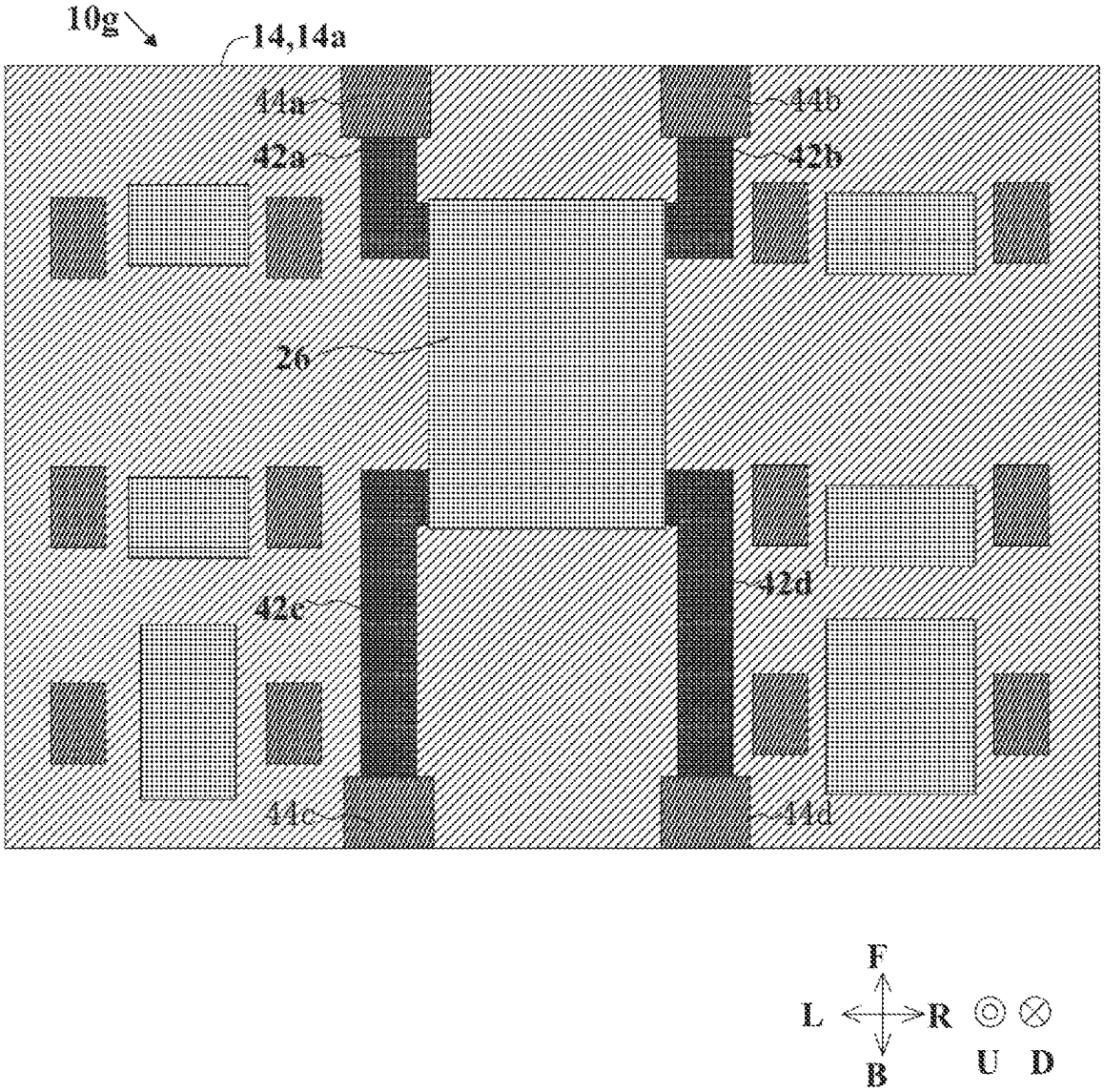


FIG. 14

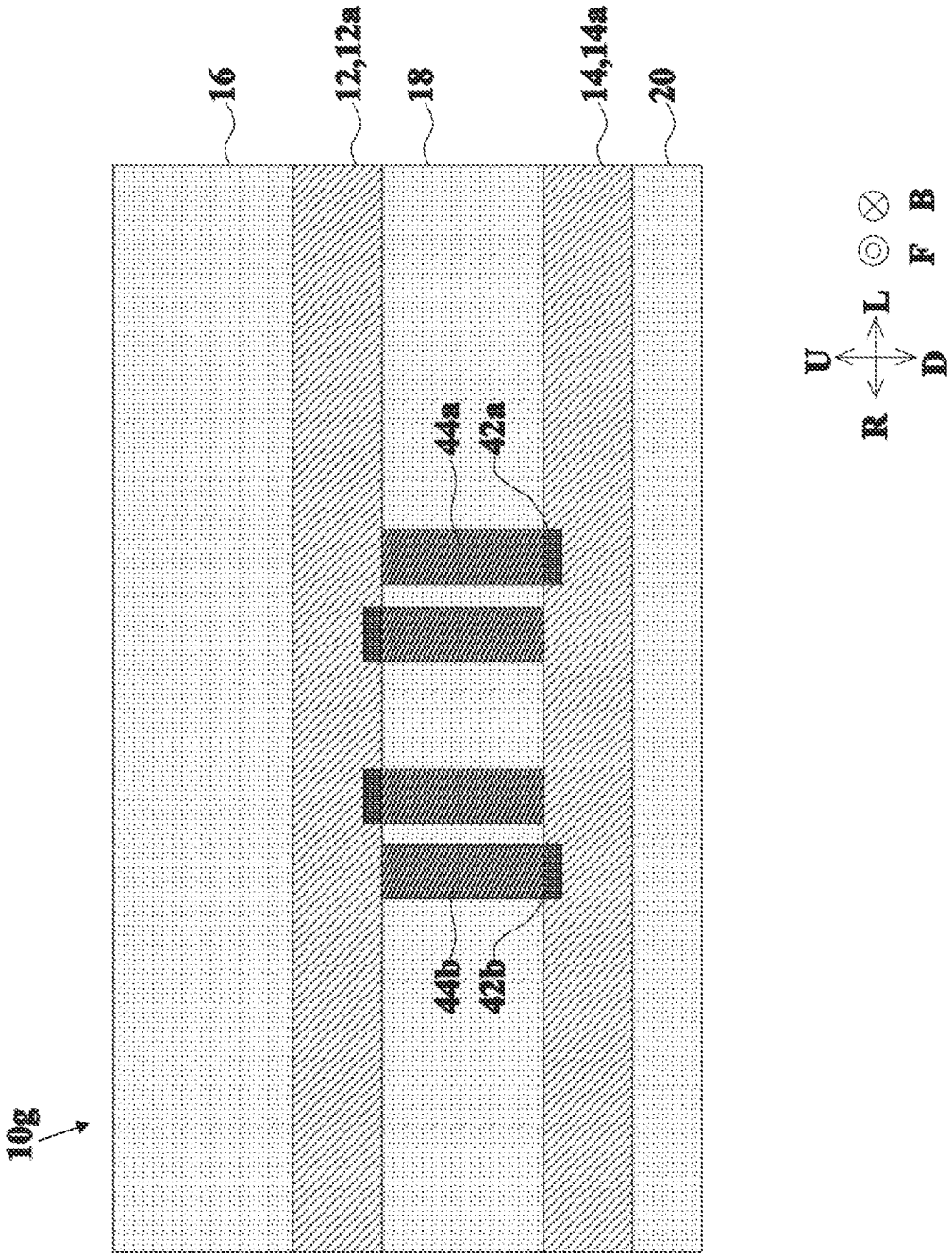
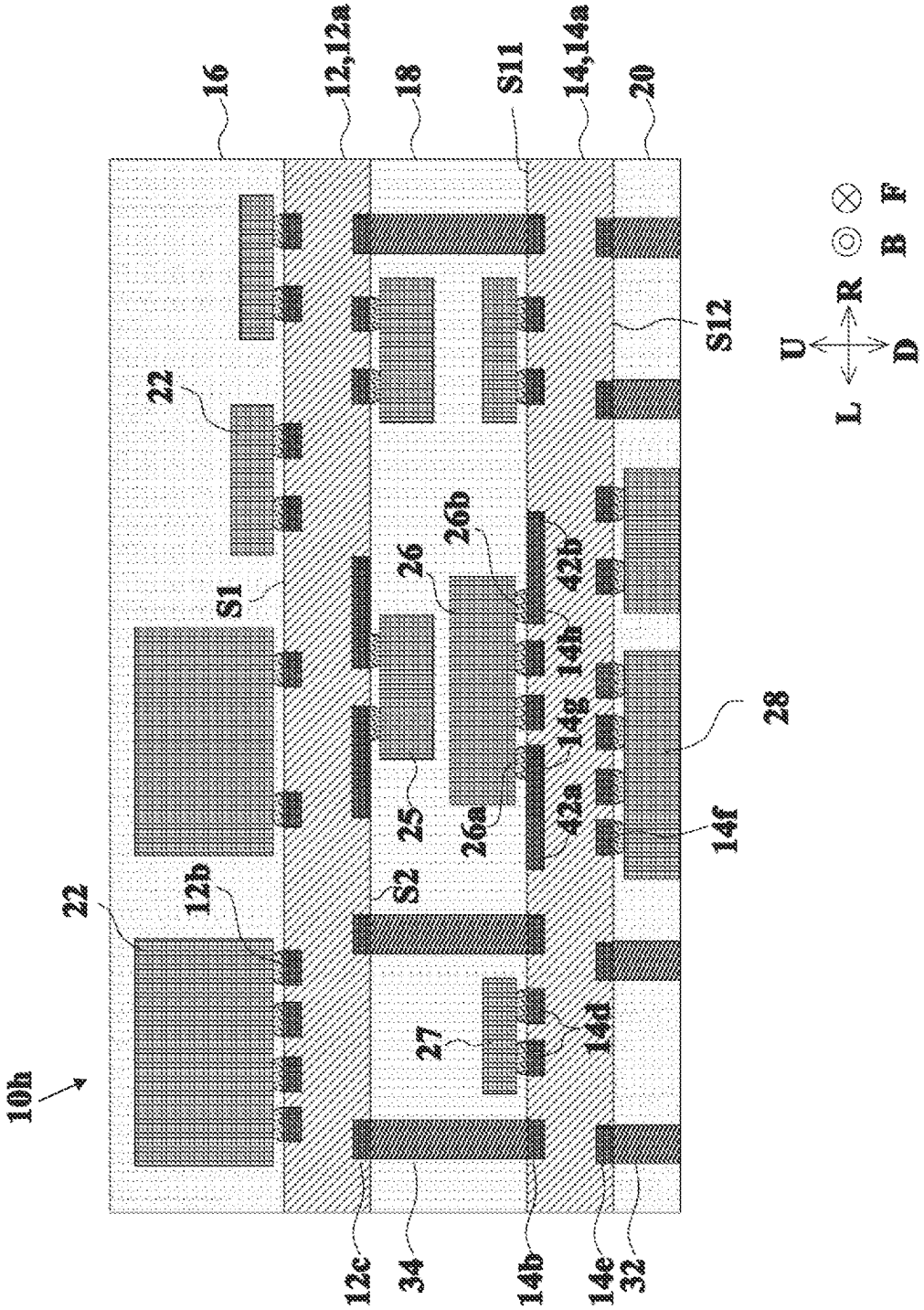


FIG. 15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25
26a
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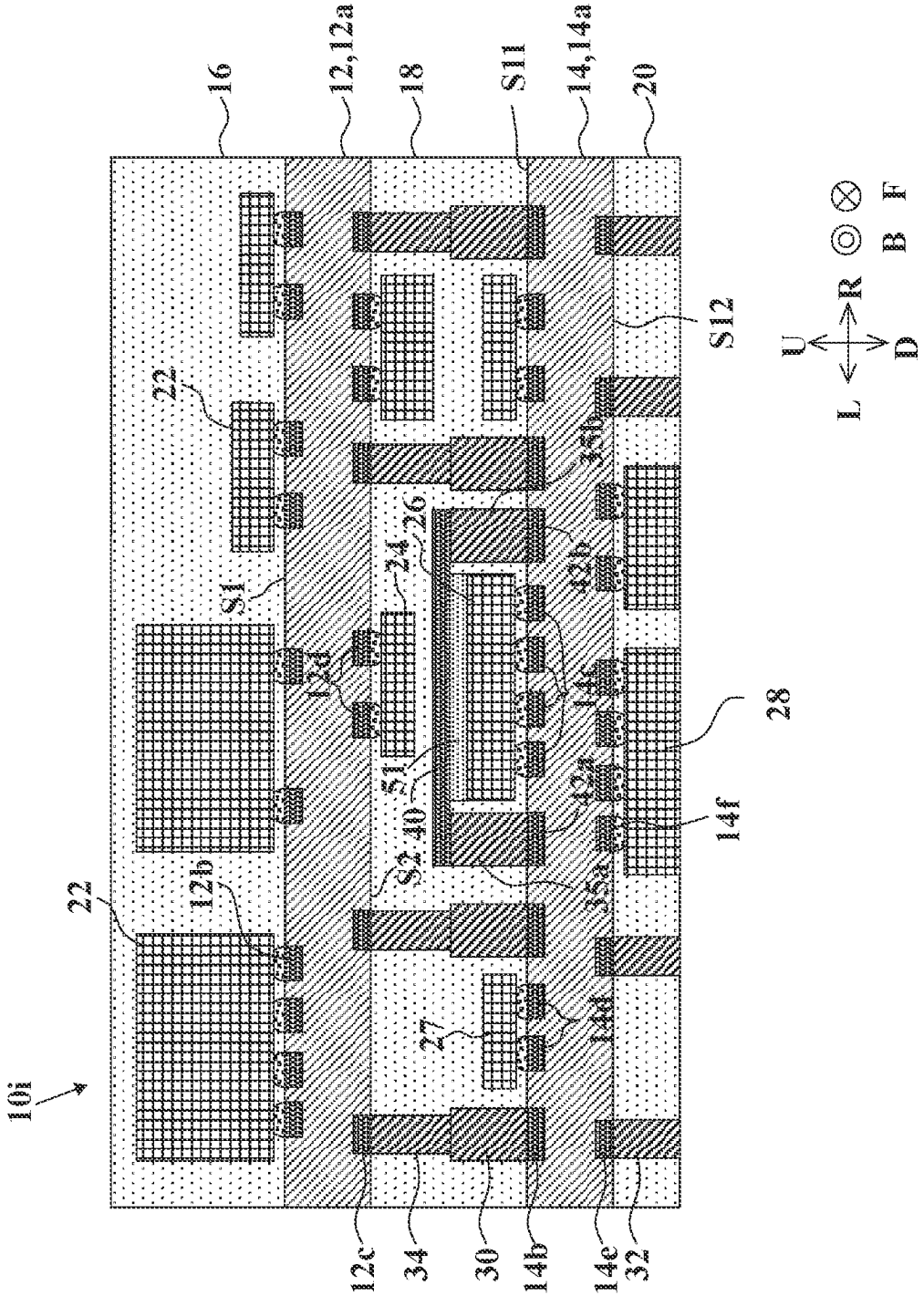
FIG. 16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S12
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24
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14e
28
S1
40
42a
14f
S2
35a
27
14d
12c
34
30
14b
14e
32
U
R
D
L
B
F

CIRCUIT MODULE

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2022-167403 filed on Oct. 19, 2022. The content of this application is incorporated herein by reference in its entirety.

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

The present disclosure relates to an electronic device including an upper circuit board and a lower circuit board.

2. Description of the Related Art

As a disclosure related to a conventional circuit module, for example, a semiconductor device package described in U.S. Pat. No. 11,133,244 is known. This composite substrate includes a first substrate, a second substrate, and a conductive structure. The first substrate is disposed on the second substrate. The conductive structure is a pin extending along an up-down axis. The conductive structure is mounted on a lower main surface of the first substrate and an upper main surface of the second substrate. Due to this, the conductive structure electrically connects the first substrate and the second substrate.

BRIEF SUMMARY OF THE DISCLOSURE

Regarding the semiconductor device package described in U.S. Pat. No. 11,133,244, there is a demand for releasing heat generated by a component disposed between the first substrate and the second substrate to the outside of the semiconductor device package.

A possible benefit of the present disclosure is to provide a circuit module capable of releasing heat generated by a component disposed between an upper circuit board and a lower circuit board to the outside of the circuit module.

A circuit module according to an embodiment of the present disclosure includes: an upper circuit board, a lower circuit board, a first component, a first sealing resin, a heat conduction member, a first conductor layer, and a heat dissipation member, in which the upper circuit board includes an upper circuit board body and one or more upper circuit board first mounting electrodes, the lower circuit board includes a lower circuit board body and one or more lower circuit board first mounting electrodes, and is disposed below the upper circuit board, the upper circuit board body has a first upper main surface and a first lower main surface, the lower circuit board body has a second upper main surface and a second lower main surface, the first sealing resin is disposed between the first lower main surface and the second upper main surface, the one or more upper circuit board first mounting electrodes are disposed on the first lower main surface, the one or more lower circuit board first mounting electrodes are disposed on the second upper main surface, the first component is mounted on the one or more upper circuit board first mounting electrodes or the one or more lower circuit board first mounting electrodes, and is disposed in the first sealing resin, the first conductor layer is disposed on the upper circuit board or the lower circuit board, the heat conduction member overlaps the first component as viewed in a downward direction, is disposed on the first lower main surface, on the second upper main surface, or in a space between the first lower main surface and the second upper main surface, and is directly coupled to the first conductor layer or is coupled to the first conductor layer via a conductor, a part of the heat dissipation member is exposed from the first sealing resin in a direction orthogonal to an up-down axis, and the heat dissipation member is directly coupled to the first conductor layer or is coupled to the first conductor layer via a conductor.

According to the circuit module according to the present disclosure, more components can be mounted between the upper circuit board and the lower circuit board.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a cross-sectional view of a circuit module **10**;
FIG. **2** is a top view of the circuit module **10**;
FIG. **3** is a front view of the circuit module **10**;
FIG. **4** is a front view of a circuit module **10***a;*
FIG. **5** is a top view of a circuit module **10***b;*
FIG. **6** is a cross-sectional view of a circuit module **10***c;*
FIG. **7** is a cross-sectional view of a circuit module **10***d;*
FIG. **8** is a cross-sectional view of a circuit module **10***e;*
FIG. **9** is a top view of the circuit module **10***e;*
FIG. **10** is a cross-sectional view of a circuit module **10***f;*
FIG. **11** is a top view of the circuit module **10***f;*
FIG. **12** is a cross-sectional view of a circuit module log;
FIG. **13** is a top view of the circuit module log;
FIG. **14** is a front view of the circuit module **10***g;*
FIG. **15** is a cross-sectional view of a circuit module **10***h*; and
FIG. **16** is a cross-sectional view of a circuit module **10***i*.

DETAILED DESCRIPTION OF THE DISCLOSURE

Embodiments

[Structure of Circuit Module **10**]

The structure of the circuit module **10** according to a first embodiment of the present disclosure will be described below with reference to the drawings. FIG. **1** is a cross-sectional view of the circuit module **10**. FIG. **2** is a top view of the circuit module **10**. FIG. **3** is a front view of the circuit module **10**.

Hereinafter, as illustrated in FIG. **1**, a direction from an upper circuit board **12** toward a lower circuit board **14** is defined as a downward direction of an up-down axis that coincides with an up-down direction. Axes orthogonal to the up-down axis are defined as a front-back axis and a left-right axis. The up-down axis, the front-back axis, and the left-right axis are orthogonal to one another. The front-back axis coincides with an axis extending along an axis perpendicular to the drawing sheet surface of FIG. **1**. The left-right axis coincides with the left-right axis of the drawing sheet surface of FIG. **1**. However, the up-down axis, the left-right axis, and the front-back axis in the present specification are directions defined for convenience of description, and need not coincide with the up-down axis, the left-right axis, and the front-back axis in use of the circuit module **10**. In each drawing, the upward direction and the downward direction may be interchanged, the left direction and the right direction may be interchanged, and the front direction and the back direction may be interchanged.

The circuit module **10** is used for a wireless communication terminal such as a smartphone. The circuit module **10**

includes, for example, an integrated circuit (IC) such as a power amplifier (PA) or a low noise amplifier (LNA), and a coil, a capacitor, and the like. The coil, the capacitor, and the like are impedance matching circuit elements for each IC. The circuit module **10** has a cuboid shape. As illustrated in FIG. **1**, the circuit module **10** includes the upper circuit board **12**, the lower circuit board **14**, a sealing resin **16**, a first sealing resin **18**, a sealing resin **20**, a plurality of components **22**, a plurality of components **24**, a first component **26**, a plurality of components **27**, a plurality of components **28**, a plurality of conductor members **34**, a plurality of conductor members **30**, a plurality of conductor members **32**, conductor members **35***a* to **35***d*, a heat conduction member **40**, first conductor layers **42***a* to **42***d*, and heat dissipation members **44***a* to **44***d*.

The upper circuit board **12** includes an upper circuit board body **12***a*, a plurality of upper circuit board mounting electrodes **12***b*, a plurality of upper circuit board mounting electrodes **12***c*, and a plurality of upper circuit board first mounting electrodes **12***d*. The upper circuit board body **12***a* has a plate shape having a first upper main surface S**1** and a first lower main surface S**2**. The upper circuit board body **12***a* has a rectangular shape having two sides along the front-back axis and two sides extending along the left-right axis as viewed in the downward direction. The upper circuit board body **12***a* has a multilayer structure. An electric circuit not illustrated is provided inside the upper circuit board body **12***a*. The material of the upper circuit board body **12***a* is, for example, a glass epoxy or a low temperature co-fired ceramics (LTCC) board, or the like.

As illustrated in FIG. **1**, the plurality of upper circuit board mounting electrodes **12***b* are disposed on the first upper main surface S**1**. The plurality of upper circuit board mounting electrodes **12***c* and the plurality of upper circuit board first mounting electrodes **12***d* are disposed on the first lower main surface S**2**. The plurality of upper circuit board mounting electrodes **12***b*, the plurality of upper circuit board mounting electrodes **12***c*, and the plurality of upper circuit board first mounting electrodes **12***d* have a rectangular shape or a circular shape as viewed in the downward direction. The plurality of upper circuit board mounting electrodes **12***b*, the plurality of upper circuit board mounting electrodes **12***c*, and the plurality of upper circuit board first mounting electrodes **12***d* have a structure in which, for example, Ni plating and Au plating are applied to the surface of a copper-thick film electrode.

The lower circuit board **14** includes a lower circuit board body **14***a*, a plurality of lower circuit board mounting electrodes **14***b*, a plurality of lower circuit board first mounting electrodes **14***c*, a plurality of lower circuit board mounting electrodes **14***d*, a plurality of lower circuit board mounting electrodes **14***e*, and a plurality of lower circuit board mounting electrodes **14***f*. The lower circuit board body **14***a* has a plate shape having a second upper main surface S**11** and a second lower main surface S**12**. The lower circuit board body **14***a* has a rectangular shape having two sides extending along the front-back axis and two sides extending along the left-right axis as viewed in the downward direction. The lower circuit board body **14***a* has a multilayer structure. An electric circuit not illustrated is provided inside the lower circuit board body **14***a*. The material of the lower circuit board body **14***a* is, for example, a glass epoxy or an LTCC board, or the like.

As illustrated in FIG. **1**, the plurality of lower circuit board mounting electrodes **14***b*, the plurality of lower circuit board first mounting electrodes **14***c*, and the plurality of lower circuit board mounting electrodes **14***d* are disposed on the second upper main surface S**11**. The plurality of lower circuit board mounting electrodes **14***e* and the plurality of lower circuit board mounting electrodes **14***f* are disposed on the lower main surface of the lower circuit board body **14***a*. The plurality of lower circuit board mounting electrodes **14***b*, the plurality of lower circuit board first mounting electrodes **14***c*, the plurality of lower circuit board mounting electrodes **14***d*, the plurality of lower circuit board mounting electrodes **14***e*, and the plurality of lower circuit board mounting electrodes **14***f* have a rectangular shape or a circular shape as viewed in the downward direction. The plurality of lower circuit board mounting electrodes **14***b*, the plurality of lower circuit board first mounting electrodes **14***c*, the plurality of lower circuit board mounting electrodes **14***d*, the plurality of lower circuit board mounting electrodes **14***e*, and the plurality of lower circuit board mounting electrodes **14***f* have a structure in which, for example, Ni plating and Au plating are applied to the surface of a copper thin film.

As illustrated in FIG. **1**, the lower circuit board **14** as described above is disposed below the upper circuit board **12**. The lower circuit board **14** overlaps the upper circuit board **12** as viewed in the downward direction. As viewed in the downward direction, the entire outer edge of the lower circuit board **14** overlaps the entire outer edge of the upper circuit board **12**.

The plurality of conductor members **30** and **34** electrically connect the upper circuit board **12** and the lower circuit board **14**. The plurality of conductor members **34** are metal members or conductive members. The plurality of conductor members **34** are, for example, metal pins. The plurality of conductor members **34** have a rod shape extending along the up-down axis. The length of the plurality of conductor members **34** in the up-down direction is longer than the maximum value of the length of the plurality of conductor members **34** in the orthogonal direction orthogonal to the up-down direction. Each of the upper ends of the plurality of conductor members **34** is fixed to the plurality of upper circuit board mounting electrodes **12***c* by soldering. The material of the plurality of conductor members **34** is, for example, copper.

The plurality of conductor members **30** are metal members or conductive members. The plurality of conductor members **30** re, for example, metal pins. The plurality of conductor members **30** have a rod shape extending along the up-down axis. Therefore, the length of the plurality of conductor members **30** in the up-down direction is longer than the maximum value of the length of the plurality of conductor members **30** in the orthogonal direction orthogonal to the up-down direction. Furthermore, the plurality of conductor members **30** are thicker than the plurality of conductor members **34**. That is, the maximum value of the length of the plurality of conductor members **30** in the orthogonal direction orthogonal to the up-down direction is larger than the maximum value of the length of the plurality of conductor members **34** in the orthogonal direction orthogonal to the up-down direction. In the present embodiment, the area of the upper ends of the plurality of conductor members **30** is larger than the area of the lower ends of the plurality of conductor members **34**. Each of the lower ends of the plurality of conductor members **30** is fixed to the plurality of lower circuit board mounting electrodes **14***b* by soldering.

Furthermore, the plurality of conductor members **30** are disposed below the plurality of conductor members **34**. The upper ends of the plurality of conductor members **30** are in contact with the lower ends of the plurality of conductor

members **34**. Due to this, the plurality of conductor members **30** are electrically connected to the plurality of conductor members **34**. The material of the plurality of conductor members **30** is, for example, copper. The plurality of conductor members **34** and the plurality of conductor members **30** having the above structure electrically connect the upper circuit board **12** and the lower circuit board **14**.

The plurality of conductor members **32** are metal pins. The plurality of conductor members **32** have a rod shape extending along the up-down axis. The length of the plurality of conductor members **32** in the up-down direction is longer than the maximum value of the length of the plurality of conductor members **32** in the orthogonal direction orthogonal to the up-down direction. The plurality of conductor members **32** are connected to the second lower main surface S**12**. Specifically, each of the upper ends of the plurality of conductor members **32** is fixed to the lower circuit board mounting electrode **14***e* of the lower circuit board **14** by soldering. The plurality of conductor members **32** come into contact with a mounting electrode of a motherboard when the circuit module **10** is mounted on the motherboard. The material of the plurality of conductor members **32** is, for example, copper.

The plurality of components **22** are mounted on the plurality of upper circuit board mounting electrodes **12***b*. The plurality of components **22** are electronic components such as chip coils, chip capacitors, and semiconductor integrated circuits.

The plurality of components **24** are mounted on the plurality of upper circuit board first mounting electrodes **12***d*. The plurality of components **24** are electronic components such as chip coils, chip capacitors, and semiconductor integrated circuits.

The plurality of components **27** are mounted on the plurality of lower circuit board mounting electrodes **14***d*. The plurality of components **27** are electronic components such as chip coils, chip capacitors, and semiconductor integrated circuits.

The plurality of components **28** are mounted on the plurality of lower circuit board mounting electrodes **14***f*. The plurality of components **28** are electronic components such as chip coils, chip capacitors, and semiconductor integrated circuits.

The first component **26** is mounted on the plurality of lower circuit board first mounting electrodes **14***c*. The first component **26** is an electronic component that generates heat during driving. Such an electronic component is, for example, low noise amplification (LNA), power amplification (PA), a switch integrated circuit (IC), or an inductor.

The first conductor layers **42***a* to **42***d* are disposed on the lower circuit board. In the present embodiment, the first conductor layers **42***a* to **42***d* are disposed on the second upper main surface S**11**. The first conductor layers **42***a* to **42***d* extend along the front-back axis. As viewed in the downward direction, the first conductor layers **42***a* to **42***d* have a linear shape. The first conductor layer **42***a* is disposed at the left front of the first component **26** as viewed in the downward direction. The first conductor layer **42***b* is disposed on the right front of the first component **26** as viewed in the downward direction. The first conductor layer **42***c* is disposed on the left back of the first component **26** as viewed in the downward direction. The first conductor layer **42***d* is disposed on the right back of the first component **26** as viewed in the downward direction.

The heat conduction member **40** is disposed in a space between the first lower main surface S**2** and the second upper main surface S**11**. The heat conduction member **40** is disposed on the first component **26**. Due to this, the heat conduction member **40** overlaps the first component **26** as viewed in the downward direction. In the present embodiment, the heat conduction member **40** overlaps the entire first component **26** as viewed in the downward direction. Furthermore, the heat conduction member **40** is in contact with the upper surface of the first component **26**. The heat conduction member **40** is, for example, a metal plate made of copper or the like. Therefore, the thermal conductivity of the heat conduction member **40** is higher than the thermal conductivity of the upper circuit board body **12***a*.

The conductor members **35***a* to **35***d* are metal pins. The conductor members **35***a* to **35***d* have a rod shape extending along the up-down axis. As illustrated in FIG. **2**, the conductor member **35***a* is disposed at the left front of the first component **26** as viewed in the downward direction. The conductor member **35***b* is disposed on the right front of the first component **26** as viewed in the downward direction. The conductor member **35***c* is disposed on the left back of the first component **26** as viewed in the downward direction. The conductor member **35***d* is disposed on the right back of the first component **26** as viewed in the downward direction.

The upper ends of the conductor members **35***a* to **35***d* are mounted on the heat conduction member **40**. The lower end of the conductor member **35***a* is mounted on the back end of the first conductor layer **42***a*. The lower end of the conductor member **35***b* is mounted on the back end of the first conductor layer **42***b*. The lower end of the conductor member **35***c* is mounted on the front end of the first conductor layer **42***c*. The lower end of the conductor member **35***d* is mounted on the front end of the first conductor layer **42***d*. Due to this, the heat conduction member **40** is coupled to the first conductor layers **42***a* to **42***d* via a conductor.

The heat dissipation members **44***a* to **44***d* are metal members or conductive members. The heat dissipation members **44***a* to **44***d* re, for example, metal pins. As illustrated in FIG. **3**, the heat dissipation members **44***a* to **44***d* have a rod shape extending along the up-down axis. The thickness of the heat dissipation members **44***a* to **44***d* in the up-down direction is larger than the thickness of the first conductor layers **42***a* to **42***d* in the up-down direction. The lower end of the heat dissipation member **44***a* is mounted on the front end of the first conductor layer **42***a*. The lower end of the heat dissipation member **44***b* is mounted on the front end of the first conductor layer **42***b*. The lower end of the heat dissipation member **44***c* is mounted on the back end of the first conductor layer **42***c*. The lower end of the heat dissipation member **44***d* is mounted on the back end of the first conductor layer **42***d*. Due to this, the heat dissipation members **44***a* to **44***d* are directly coupled to the first conductor layers **42***a* to **42***d*.

As illustrated in FIG. **1**, the first sealing resin **18** is disposed between the first lower main surface S**2** and the second upper main surface S**11**. The first sealing resin **18** covers the first lower main surface S**2** and the second upper main surface S**11**. The first sealing resin **18** covers the plurality of components **24**, the first component **26**, the plurality of components **27**, the plurality of conductor members **34**, the plurality of conductor members **30**, the conductor members **35***a* to **35***d*, the heat conduction member **40**, the first conductor layers **42***a* to **42***d*, and the heat dissipation members **44***a* to **44***d*. As a result, the plurality of components **24**, the first component **26**, the plurality of components **27**, the plurality of conductor members **34**, the plurality of conductor members **30**, the conductor members **35***a* to **35***d*, the heat conduction member **40**, and the first conductor layers **42***a* to **42***d* are disposed in the first sealing resin **18**.

However, the heat dissipation members **44***a* and **44***b* are exposed from the first sealing resin **18** on the front surface of the first sealing resin **18**. The heat dissipation members **44***c* and **44***d* are exposed from the first sealing resin **18** on the back surface of the first sealing resin **18**. Due to this, parts of the heat dissipation members **44***a* to **44***d* are exposed from the first sealing resin **18** in a direction orthogonal to the up-down axis. The first sealing resin **18** has a cuboid shape. As viewed in the downward direction, the entire outer edge of the first sealing resin **18** overlaps the entire outer edge of the upper circuit board **12** and the entire outer edge of the lower circuit board **14**.

As illustrated in FIG. **1**, the sealing resin **16** covers the first upper main surface S**1**. The sealing resin **16** covers the plurality of components **22**. The sealing resin **16** has a cuboid shape. As viewed in the downward direction, the entire outer edge of the sealing resin **16** overlaps the entire outer edge of the upper circuit board **12** and the entire outer edge of the lower circuit board **14**.

As illustrated in FIG. **1**, the sealing resin **20** covers the second lower main surface S**12**. The sealing resin **20** covers the plurality of conductor members **32** and the plurality of components **28**. However, the lower ends of the plurality of conductor members **32** and the lower surfaces of the plurality of components **28** are exposed from the sealing resin **20**. The sealing resin **20** has a cuboid shape. As viewed in the downward direction, the entire outer edge of the sealing resin **20** overlaps the entire outer edge of the upper circuit board **12** and the entire outer edge of the lower circuit board **14**. The materials of the first sealing resin **18**, the sealing resin **16**, and the sealing resin **20** as described above are, for example, epoxy resins.

Effects

According to the circuit module **10**, heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be released to the outside of the circuit module **10**. More specifically, the heat conduction member **40** is disposed in a space between the first lower main surface S**2** and the second upper main surface S**11**. Furthermore, the heat conduction member **40** overlaps the first component **26** as viewed in the downward direction. Due to this, the heat generated by the first component **26** is transferred to the heat conduction member **40**. The heat conduction member **40** is coupled to the first conductor layers **42***a* to **42***d* via the conductor members **35***a* to **35***d*. The heat dissipation members **44***a* to **44***d* are directly coupled to the respective first conductor layers **42***a* to **42***d*. Due to this, the heat transferred to the heat conduction member **40** is transferred to the heat dissipation members **44***a* to **44***d* via the first conductor layers **42***a* to **42***d*. Here, parts of the heat dissipation members **44***a* to **44***d* are exposed from the first sealing resin **18** in the direction orthogonal to the up-down axis. Due to this, the heat transferred to the heat dissipation members **44***a* to **44***d* is released to the outside of the circuit module **10**. In this case, for example, when the housing is close to the circuit module **10**, heat is effectively released from the side surface of the housing. As described above, according to the circuit module **10**, heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be released to the outside of the circuit module **10**.

The thickness of heat dissipation members **44***a* to **44***d* in the up-down direction is larger than the thickness of first conductor layers **42***a* to **42***d* in the up-down direction. That is, the heat dissipation members **44***a* to **44***d* are exposed from the first sealing resin **18** in a large area. Due to this, the heat transferred to the heat dissipation members **44***a* to **44***d* is more efficiently released to the outside of the circuit module **10**.

In the circuit module **10**, the heat conduction member **40** is in contact with the upper surface of the first component **26**. Due to this, the heat generated by the first component **26** is efficiently transferred to the heat conduction member **40**. As a result, the heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be efficiently released to the outside of the circuit module **10**.

First Modification

Hereinafter, the circuit module **10***a* according to a first modification will be described with reference to the drawings. FIG. **4** is a front view of a circuit module **10***a*.

The circuit module **10***a* is different from the circuit module **10** in the length in a direction along the up-down axis of the heat dissipation members **44***a* to **44***d*. More specifically, in the circuit module **10**, the upper ends of the heat dissipation members **44***a* to **44***d* are not in contact with the first lower main surface S**2**. On the other hand, in the circuit module **10***a*, the upper ends of the heat dissipation members **44***a* to **44***d* are in contact with the first lower main surface S**2**. Therefore, the length of the heat dissipation members **44***a* to **44***d* in the up-down direction is equal to an interval between the upper circuit board **12** and the lower circuit board **14**. Due to this, the area where the heat dissipation members **44***a* to **44***d* are exposed from the first sealing resin **18** is increased. As a result, the heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be efficiently released to the outside of the circuit module **10***a*. The other structures of the circuit module **10***a* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***a* has the same functions and effects as those of the circuit module **10**.

Second Modification

Hereinafter, the circuit module **10***b* according to a second modification will be described with reference to the drawings. FIG. **5** is a top view of a circuit module **10***b*.

The circuit module **10***b* is different from the circuit module **10** in the area of the heat dissipation members **44***a* to **44***d* as viewed in the downward direction. More specifically, the area of the heat dissipation members **44***a* to **44***d* as viewed in the downward direction is larger than the area of the conductor members **30**, **34**, and **35***a* to **35***d* as viewed in the downward direction. Due to this, the area where the heat dissipation members **44***a* to **44***d* are exposed from the first sealing resin **18** is increased. As a result, the heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be efficiently released to the outside of the circuit module **10***b*. The other structures of the circuit module **10***b* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***b* has the same functions and effects as those of the circuit module **10**.

Third Modification

Hereinafter, the circuit module **10***c* according to a third modification will be described with reference to the drawings. FIG. **6** is a cross-sectional view of a circuit module **10***c*.

The circuit module **10***c* is different from the circuit module **10** in the area of the conductor members **35***a* to **35***d* as viewed in the downward direction. More specifically, the area of the conductor members **35***a* to **35***d* as viewed in the downward direction is larger than the area of the plurality of conductor members **30** as viewed in the downward direction. Due to this, the heat generated by the first component **26** is efficiently transferred to the heat dissipation members **44***a* to **44***d* by the conductor members **35***a* to **35***d*. As a result, the heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be efficiently released to the outside of the circuit module **10***c*. The other structures of the circuit module **10***c* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***c* has the same functions and effects as those of the circuit module **10**.

Fourth Modification

Hereinafter, the circuit module **10***d* according to a fourth modification will be described with reference to the drawings. FIG. **7** is a cross-sectional view of a circuit module **10***d*.

The circuit module **10***d* is different from the circuit module **10** in the following point. The circuit module **10***d* further includes conductor members **37***a* to **37***d* (the conductor members **37***c* and **37***d* are not illustrated) and first conductor layers **43***a* to **43***d* (the first conductor layers **43***c* and **43***d* are not illustrated). The circuit module **10***d* includes a first component **25** instead of the component **24**.

The first component **25** is mounted on the plurality of upper circuit board first mounting electrodes **12***d*. The first conductor layers **43***a* to **43***d* are disposed on the upper circuit board **12**. The first conductor layers **43***a* to **43***d* are coupled to the respective heat dissipation members **44***a* to **44***d* not illustrated in FIG. **7**.

The conductor members **37***a* to **37***d* are metal pins. The conductor members **37***a* to **37***d* extend along the up-down axis. The lower ends of the conductor members **37***a* to **37***d* are mounted on the heat conduction member **40**. The upper end of the conductor member **37***a* is mounted on the back end of the first conductor layer **43***a*. The upper end of the conductor member **37***b* is mounted on the back end of the first conductor layer **43***b*. The upper end of the conductor member **37***c* is mounted on the front end of the first conductor layer **43***c*. The upper end of the conductor member **37***d* is mounted on the front end of the first conductor layer **43***d*.

Due to this, the heat generated by the first component **25** is released to the outside of the circuit module **10***d* via the heat conduction member **40**, the conductor members **37***a* to **37***d*, and the heat dissipation members **44***a* to **44***d*. The other structures of the circuit module **10***d* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***d* has the same functions and effects as those of the circuit module **10**.

(Fifth Modification)

Hereinafter, the circuit module **10***e* according to a fifth modification will be described with reference to the drawings. FIG. **8** is a cross-sectional view of a circuit module **10***e*. FIG. **9** is a top view of the circuit module **10***e*.

The circuit module **10***e* is different from the circuit module **10***d* in including heat conduction members **40***a* to **40***d* instead of the heat conduction member **40**. The heat conduction members **40***a* to **40***d* are metal pins extending along the up-down axis. The upper ends of the heat conduction members **40***a* to **40***d* are in contact with the lower surface of the first component **25**. The lower end of the heat conduction member **40***a* is mounted on the back portion of the first conductor layer **42***a*. The lower end of the heat conduction member **40***b* is mounted on the back portion of the first conductor layer **42***b*. The lower end of the heat conduction member **40***c* is mounted on the back end of the first conductor layer **42***a*. The lower end of the heat conduction member **40***d* is mounted on the back end of the first conductor layer **42***b*. Due to this, the heat generated by the first component **25** is released to the outside of the circuit module **10***e* via the heat conduction members **40***a* to **40***d*, the first conductor layers **42***a* and **42***b*, and the heat dissipation members **44***a* and **44***b*. The other structures of the circuit module **10***e* are the same as those of the circuit module **10***d*, and thus description will be omitted. The circuit module **10***e* has the same functions and effects as those of the circuit module **10***d*.

Sixth Modification

Hereinafter, the circuit module **10***f* according to a sixth modification will be described with reference to the drawings. FIG. **10** is a cross-sectional view of a circuit module **10***f*. FIG. **11** is a top view of the circuit module **10***f*.

The circuit module **10***f* is different from the circuit module **10** in further including the heat conduction members **40***a* to **40***d* and **41***a* to **41***d* and conductor members **39***a* to **39***d*. More specifically, the heat conduction members **41***a* to **41***d* are disposed on the first lower main surface S**2**. The heat conduction members **41***a* to **41***d* extend in the left-right direction. The heat conduction members **41***a* to **41***d* are conductor layers.

The heat conduction members **40***a* to **40***d* are metal pins extending along the up-down axis. The lower ends of the heat conduction members **40***a* to **40***d* are in contact with the upper surface of the first component **26**. The upper end of the heat conduction member **40***a* is mounted on the right end of the heat conduction member **41***a*. The upper end of the heat conduction member **40***b* is mounted on the left end of the heat conduction member **41***b*. The upper end of the heat conduction member **40***c* is mounted on the right end of the heat conduction member **41***c*. The upper end of the heat conduction member **40***d* is mounted on the left end of the heat conduction member **41***d*.

The heat conduction member **41***a* is coupled to the first conductor layer **42***a* via the conductor members **35***a* and **39***a*. The heat conduction member **41***b* is coupled to the first conductor layer **42***b* via the conductor members **35***b* and **39***b*. The heat conduction member **41***c* is coupled to the first conductor layer **42***c* via the conductor members **35***c* and **39***c*. The heat conduction member **41***d* is coupled to the first conductor layer **42***d* via the conductor members **35***d* and **39***d*. Due to this, the heat generated by the first component **26** is released to the outside of the circuit module **10***f* via the heat conduction members **40***a* to **40***d* and **41***a* to **41***d*, the conductor members **39***a* to **39***d* and **35***a* to **35***d*, the first conductor layers **42***a* to **42***d*, and the heat dissipation members **44***a* to **44***d*. The other structures of the circuit module **10***f* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***f* has the same functions and effects as those of the circuit module **10**.

Seventh Modification

Hereinafter, the circuit module **10***g* according to a seventh modification will be described with reference to the draw-

ings. FIG. **12** is a cross-sectional view of the circuit module **10***g*. FIG. **13** is a top view of the circuit module **10***g*. FIG. **14** is a front view of the circuit module **10***g*.

The circuit module **10***g* is different from the circuit module **10** in the following points. The first component **26** includes ground electrodes **26***a* to **26***d*. The lower circuit board **14** further includes ground mounting electrodes **14***g* to **14***j*.

The ground mounting electrodes **14***g* to **14***j* are disposed on the second upper main surface S**11**. The ground mounting electrodes **14***g* to **14***j* overlap the first component **26** as viewed in the downward direction. The ground electrodes **26***a* to **26***d* are mounted on the respective ground mounting electrodes **14***g* to **14***j*. Therefore, in the circuit module **10***g*, the heat conduction member is the ground mounting electrodes **14***g* to **14***j* disposed on the second upper main surface S**11**. The ground mounting electrodes **14***g* to **14***j* are directly coupled to the respective first conductor layers **42***a* to **42***d*. The other structures of the circuit module **10***g* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***g* has the same functions and effects as those of the circuit module **10**.

Eighth Modification

Hereinafter, the circuit module **10***h* according to an eighth modification will be described with reference to the drawings. FIG. **15** is a cross-sectional view of a circuit module **10***h*.

The circuit module **10***h* is different from the circuit module **10***g* in not including the plurality of conductor members **30**. The lower ends of the plurality of conductor members **34** are mounted on the plurality of lower circuit board mounting electrodes **14***b*. The other structures of the circuit module **10***h* are the same as those of the circuit module **10***g*, and thus description will be omitted. The circuit module **10***h* has the same functions and effects as those of the circuit module **10***g*.

Ninth Modification

Hereinafter, the circuit module **10***i* according to a ninth modification will be described with reference to the drawings. FIG. **16** is a cross-sectional view of the circuit module **10***i*.

The circuit module **10***i* is different from the circuit module **10** in further including a thermal interface material (TIM) layer **51**. More specifically, the TIM layer **51** is disposed between the first component **26** and the heat conduction member **40**. The lower surface of the TIM layer **51** is in contact with the upper surface of the first component **26**. The upper surface of the TIM layer **51** is in contact with the lower surface of the heat conduction member **40**.

The TIM layer **51** is a layer of a heat conduction material. That is, the TIM layer **51** is a layer of a material suitable for heat conduction. The material of the TIM layer **51** is non-conductive. The material of the TIM layer **51** may be, for example, an epoxy resin mixed with a metal. The metal to be mixed here may be, for example, gold, silver, or the like. The TIM layer **51** may be formed of thermal grease, white grease, or the like. The TIM layer **51** may be formed by combining two or more of thermal grease, white grease, and the like.

The material of the TIM layer **51** may be any of an epoxy resin, silicone, an inorganic material, and a matrix polymer. The material of the TIM layer **51** may be a polymer mixed with a heat conductive filler. The matrix polymer may contain any selected from the group consisting of ethylene propylene, a monomer of ethylene propylene diene, and hydrogenated polyisoprene, and may be a combination of two or more selected from this group. The TIM layer **51** may contain any selected from the group consisting of aluminum oxide, boron nitride, and aluminum nitride, and may be a combination of two or more selected from this group.

The TIM layer **51** may contain any selected from the group consisting of carbon nanotubes, graphite, graphene, a polyimide resin, polybenzoxazole, an epoxy-based polymer, a silica-based polymer, and an acryl-based polymer, and may be a combination of two or more selected from this group. The TIM layer **51** may contain a filler. The thermal conductivity of the material of the TIM layer **51** may be equal to or greater than 5 W/(m·K) and equal to or less than 100 W/(m·K). Furthermore, the thermal conductivity of the material of the TIM layer **51** is preferably equal to or greater than 10 W/(m·K) and equal to or less than 90 W/(m·K). Furthermore, the thermal conductivity of the material of the TIM layer **51** is preferably equal to or greater than 20 W/(m·K) and equal to or less than 80 W/(m·K). The material of the TIM layer **51** may have a structure in which a polymer is bonded to a liquid metal by an organometallic bond, a coordinate bond, or a covalent bond.

The heat generated by the first component **26** is efficiently transferred to the heat conduction member **40** by the TIM layer **51**. As a result, the heat generated by the first component **26** disposed between the upper circuit board **12** and the lower circuit board **14** can be efficiently released to the outside of the circuit module **10***i*.

The other structures of the circuit module **10***i* are the same as those of the circuit module **10**, and thus description will be omitted. The circuit module **10***i* has the same functions and effects as those of the circuit module **10**.

Other Embodiments

The circuit module according to the present disclosure is not limited to the circuit modules **10** and **10***a* to **10***i*, and can be changed within the scope of the gist thereof. The structures of the circuit modules **10** and **10***a* to **10***i* may be arbitrarily combined.

The circuit modules **10** and **10***a* to **10***i* include the plurality of components **22**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more components **22**.

The circuit modules **10** and **10***a* to **10***i* include the plurality of components **24**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more components **24**.

The circuit modules **10** and **10***a* to **10***i* include the plurality of components **27**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more components **27**.

The circuit modules **10** and **10***a* to **10***i* include the plurality of components **28**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more components **28**.

The circuit modules **10** and **10***a* to **10***i* include the plurality of conductor members **34**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more conductor members **34**.

The circuit modules **10** and **10***a* to **10***i* include the plurality of conductor members **30**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more conductor members **30**.

The circuit modules **10** and **10***a* to **10***i* include the plurality of conductor members **32**. However, the circuit modules **10** and **10***a* to **10***i* only need to include one or more conductor members **32**.

A shield member covering the front surface, the back surface, the left surface, the right surface, and the upper surface of the circuit modules **10** and **10***a* to **10***i* may be provided.

The plurality of components **22**, the plurality of components **24**, the plurality of components **27**, and the plurality of components **28** are not essential components.

The sealing resins **16** and **20** are not essential components.

The upper circuit board **12** only needs to include one or more upper circuit board first mounting electrodes.

The lower circuit board **14** only needs to include one or more lower circuit board first mounting electrodes.

The heat conduction member may be disposed on the second upper main surface S**11**.

The heat dissipation member may be coupled to the first conductor layer via a conductor.

The heat conduction member may be in contact with the first component lower surface.

The heat conduction member may be a ground mounting electrode disposed on the first lower main surface.

The first conductor layer may be disposed in the upper circuit board body or the lower circuit board body.

The plurality of conductor members **30** and **34** and the heat dissipation members **44***a* to **44***d* may be electrodes formed by plating. When the upper circuit board body **12***a* and the lower circuit board body **14***a* are LTCC boards, the plurality of conductor members **30** and **34** and the heat dissipation members **44***a* to **44***d* may be sintered metals.

The present disclosure includes the following structure.

(1) A circuit module including: an upper circuit board; a lower circuit board; a first component; a first sealing resin; a heat conduction member; a first conductor layer; and a heat dissipation member; in which the upper circuit board includes an upper circuit board body and one or more upper circuit board first mounting electrodes, the lower circuit board includes a lower circuit board body and one or more lower circuit board first mounting electrodes, and is disposed below the upper circuit board, the upper circuit board body has a first upper main surface and a first lower main surface, the lower circuit board body has a second upper main surface and a second lower main surface, the first sealing resin is disposed between the first lower main surface and the second upper main surface, the one or more upper circuit board first mounting electrodes are disposed on the first lower main surface, the one or more lower circuit board first mounting electrodes are disposed on the second upper main surface, the first component is mounted on the one or more upper circuit board first mounting electrodes or the one or more lower circuit board first mounting electrodes, and is disposed in the first sealing resin, the first conductor layer is disposed on the upper circuit board or the lower circuit board, the heat conduction member overlaps the first component as viewed in a downward direction of an up-down axis, is disposed on the first lower main surface, on the second upper main surface, or in a space between the first lower main surface and the second upper main surface, and is directly coupled to the first conductor layer or is coupled to the first conductor layer via a conductor, a part of the heat dissipation member is exposed from the first sealing resin in a direction orthogonal to an up-down axis, and the heat dissipation member is directly coupled to the first conductor layer or is coupled to the first conductor layer via a conductor.

(2) The circuit module according to (1), in which a thickness of the heat dissipation member in an up-down direction is larger than a thickness of the first conductor layer in the up-down direction, the up-down direction extending along the up-down axis.

(3) The circuit module according to (1) or (2), in which the heat conduction member is in contact with an upper surface or a lower surface of the first component.

(4) The circuit module according to (3), in which the heat conduction member is a metal pin extending along an up-down axis.

(5) The circuit module according to any of (1) to (3), in which the first component includes a ground electrode, the heat conduction member is a ground mounting electrode disposed on the first lower main surface or the second upper main surface, and the ground electrode is mounted on the ground mounting electrode.

(6) The circuit module according to any of (1) to (5), in which a length of the heat dissipation member in an up-down direction is equal to an interval between the upper circuit board and the lower circuit board, the up-down direction extending along the up-down axis.

(7) The circuit module according to any of (1) to (6) further including a conductor member, in which the conductor member electrically connects the upper circuit board and the lower circuit board, and an area of the heat dissipation member as viewed in a downward direction is larger than an area of the conductor member as viewed in a downward direction.

(8) The circuit module according to any of (1) to (7), in which the first conductor layer has a linear shape as viewed in a downward direction.

(9) The circuit module according to any of (1) to (4) and (6) to (8) further including a thermal interface material (TIM) layer, in which the TIM layer is disposed between the first component and the heat conduction member and is in contact with the first component and the heat conduction member.

What is claimed is:

1. A circuit module comprising:

an upper circuit board;

a lower circuit board;

a first component;

a first sealing resin;

a heat conduction member;

a first conductor layer; and

a heat dissipation member,

wherein

the upper circuit board includes an upper circuit board body and one or more upper circuit board first mounting electrodes,

the lower circuit board includes a lower circuit board body and one or more lower circuit board first mounting electrodes, and is disposed below the upper circuit board,

the upper circuit board body has a first upper main surface and a first lower main surface,

the lower circuit board body has a second upper main surface and a second lower main surface,

the first sealing resin is disposed between the first lower main surface and the second upper main surface,

the one or more upper circuit board first mounting electrodes are disposed on the first lower main surface,

the one or more lower circuit board first mounting electrodes are disposed on the second upper main surface,

the first component is mounted on the one or more upper circuit board first mounting electrodes or the one or

more lower circuit board first mounting electrodes, and is disposed in the first sealing resin,

the first conductor layer is disposed on the upper circuit board or the lower circuit board,

the heat conduction member overlaps the first component as viewed in a downward direction of an up-down axis, is disposed on the first lower main surface, on the second upper main surface, or in a space between the first lower main surface and the second upper main surface, and is directly coupled to the first conductor layer or is coupled to the first conductor layer via a first conductor,

a part of the heat dissipation member is exposed from the first sealing resin in a direction orthogonal to the up-down axis, and

the heat dissipation member is directly coupled to the first conductor layer or is coupled to the first conductor layer via a second conductor.

2. The circuit module according to claim **1**, wherein a thickness of the heat dissipation member in an up-down direction is more than a thickness of the first conductor layer in the up-down direction, the up-down direction extending along the up-down axis.

3. The circuit module according to claim **1**, wherein the heat conduction member is in contact with an upper surface or a lower surface of the first component.

4. The circuit module according to claim **3**, wherein the heat conduction member is a metal pin extending along the up-down axis.

5. The circuit module according to claim **1**, wherein

the first component includes a ground electrode,

the heat conduction member is a ground mounting electrode disposed on the first lower main surface or the second upper main surface, and

the ground electrode is mounted on the ground mounting electrode.

6. The circuit module according to claim **1**, wherein a length of the heat dissipation member in an up-down direction is equal to an interval between the upper circuit board and the lower circuit board, the up-down direction extending along the up-down axis.

7. The circuit module according to claim **1**, further comprising a conductor member,

wherein

the conductor member electrically connects the upper circuit board and the lower circuit board, and

an area of the heat dissipation member as viewed in the downward direction is larger than an area of the conductor member as viewed in the downward direction.

8. The circuit module according to claim **1**, wherein the first conductor layer has a linear shape as viewed in the downward direction.

9. The circuit module according to claim **1**, further comprising a thermal interface material layer,

wherein the thermal interface material layer is disposed between the first component and the heat conduction member, and is in contact with the first component and the heat conduction member.

10. The circuit module according to claim **2**, wherein the heat conduction member is in contact with an upper surface or a lower surface of the first component.

11. The circuit module according to claim **2**, wherein

the first component includes a ground electrode,

the heat conduction member is a ground mounting electrode disposed on the first lower main surface or the second upper main surface, and

the ground electrode is mounted on the ground mounting electrode.

12. The circuit module according to claim **2**, wherein a length of the heat dissipation member in the up-down direction is equal to an interval between the upper circuit board and the lower circuit board.

13. The circuit module according to claim **2**, further comprising a conductor member,

wherein

the conductor member electrically connects the upper circuit board and the lower circuit board, and

an area of the heat dissipation member as viewed in the downward direction is larger than an area of the conductor member as viewed in the downward direction.

14. The circuit module according to claim **2**, wherein the first conductor layer has a linear shape as viewed in the downward direction.

15. The circuit module according to claim **2**, further comprising a thermal interface material layer,

wherein the thermal interface material layer is disposed between the first component and the heat conduction member, and is in contact with the first component and the heat conduction member.

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