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Natsumeda et al.

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(54) **WIRELESSLY-COMMUNICABLE MEMORY CARD**

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May 19, 2016 (JP) 2016-100705

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H04B 5/00	(2006.01)
H01Q 1/48	(2006.01)

(52) **U.S. Cl.**

CPC ***H01Q 1/2275*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 1/48*** (2013.01); ***H04B 5/0031*** (2013.01); ***H04B 5/0037*** (2013.01)

(58) **Field of Classification Search**

CPC ... H01Q 1/2275; H01Q 1/2291; H04B 5/0037
See application file for complete search history.

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(57) **ABSTRACT**

A memory card includes a substrate, a nonvolatile memory on the substrate, a memory controller on the substrate and configured to control access to the nonvolatile memory, an interface terminal for external wired connection, on the substrate, an antenna, a plain region surrounded by the antenna including a first region that overlaps with the substrate and a second region that does not overlap with the substrate, and a communication controller disposed on the substrate, electrically connected to the antenna, and configured to wirelessly communicate with an external device through the antenna, using power generated at the antenna by an electromagnetic induction caused by the external device.

20 Claims, 20 Drawing Sheets

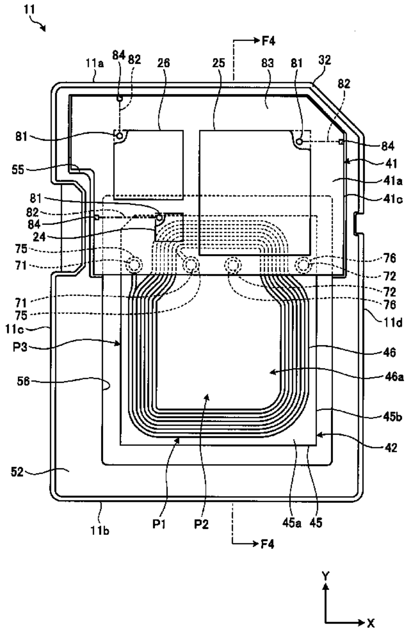


FIG. 1

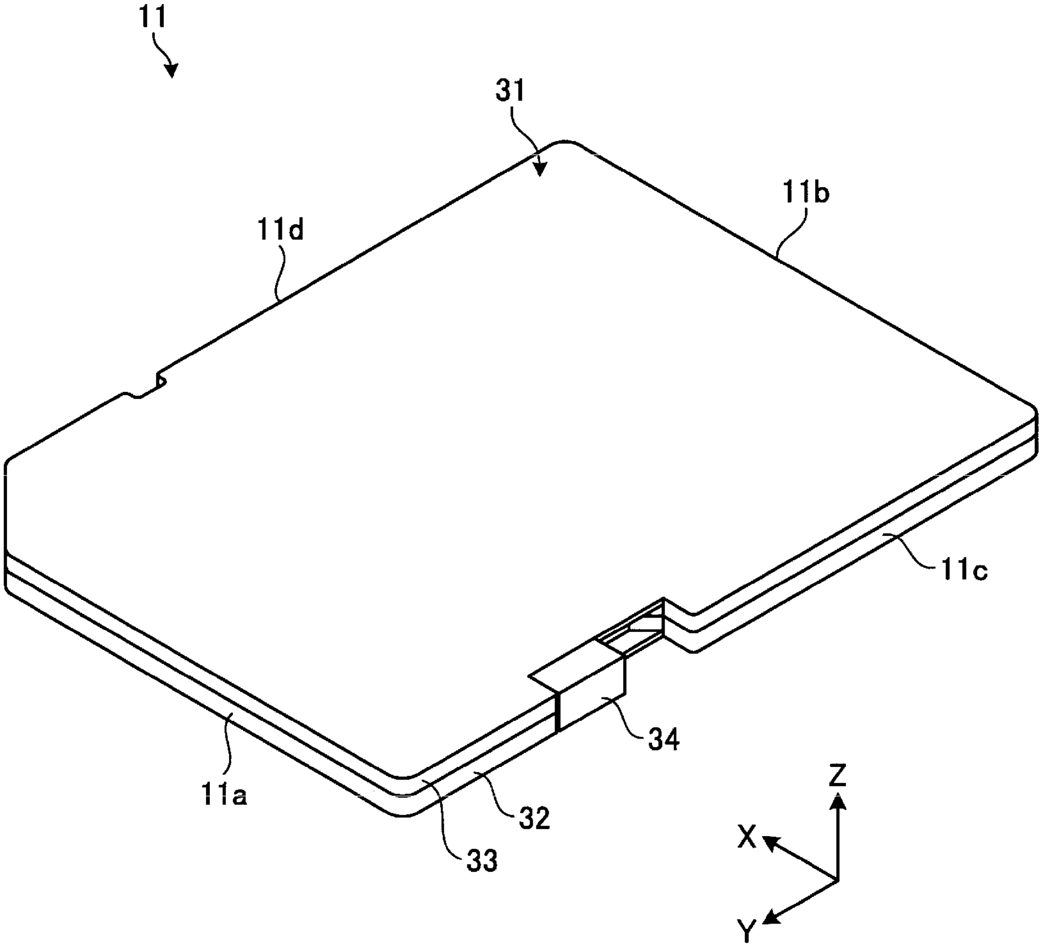


FIG. 2

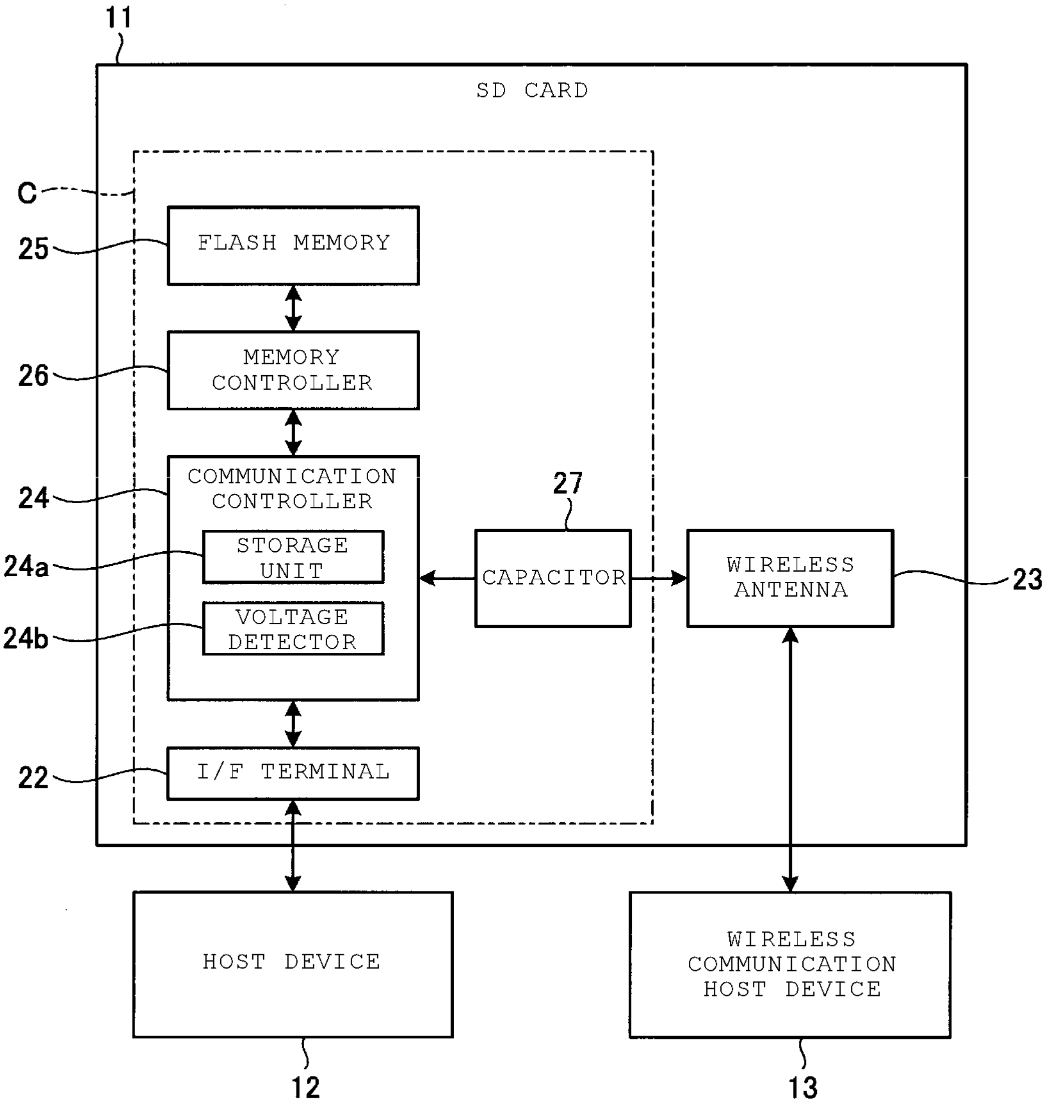

11
SD CARD
C
25
FLASH MEMORY
26
MEMORY CONTROLLER
24
COMMUNICATION CONTROLLER
24a
STORAGE UNIT
24b
VOLTAGE DETECTOR
27
CAPACITOR
WIRELESS ANTENNA
23
22
I/F TERMINAL
HOST DEVICE
12
WIRELESS COMMUNICATION HOST DEVICE
13

FIG. 3

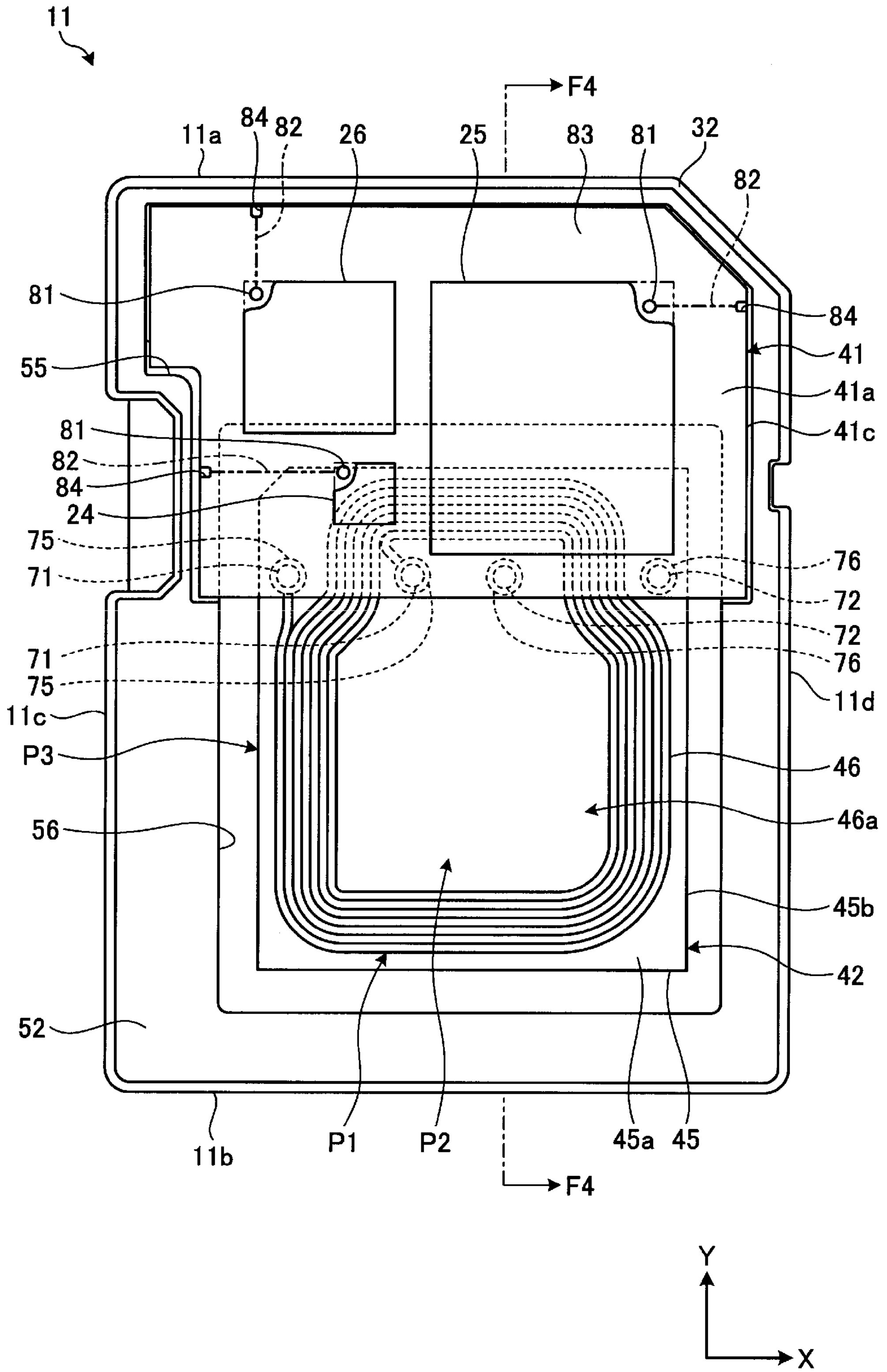
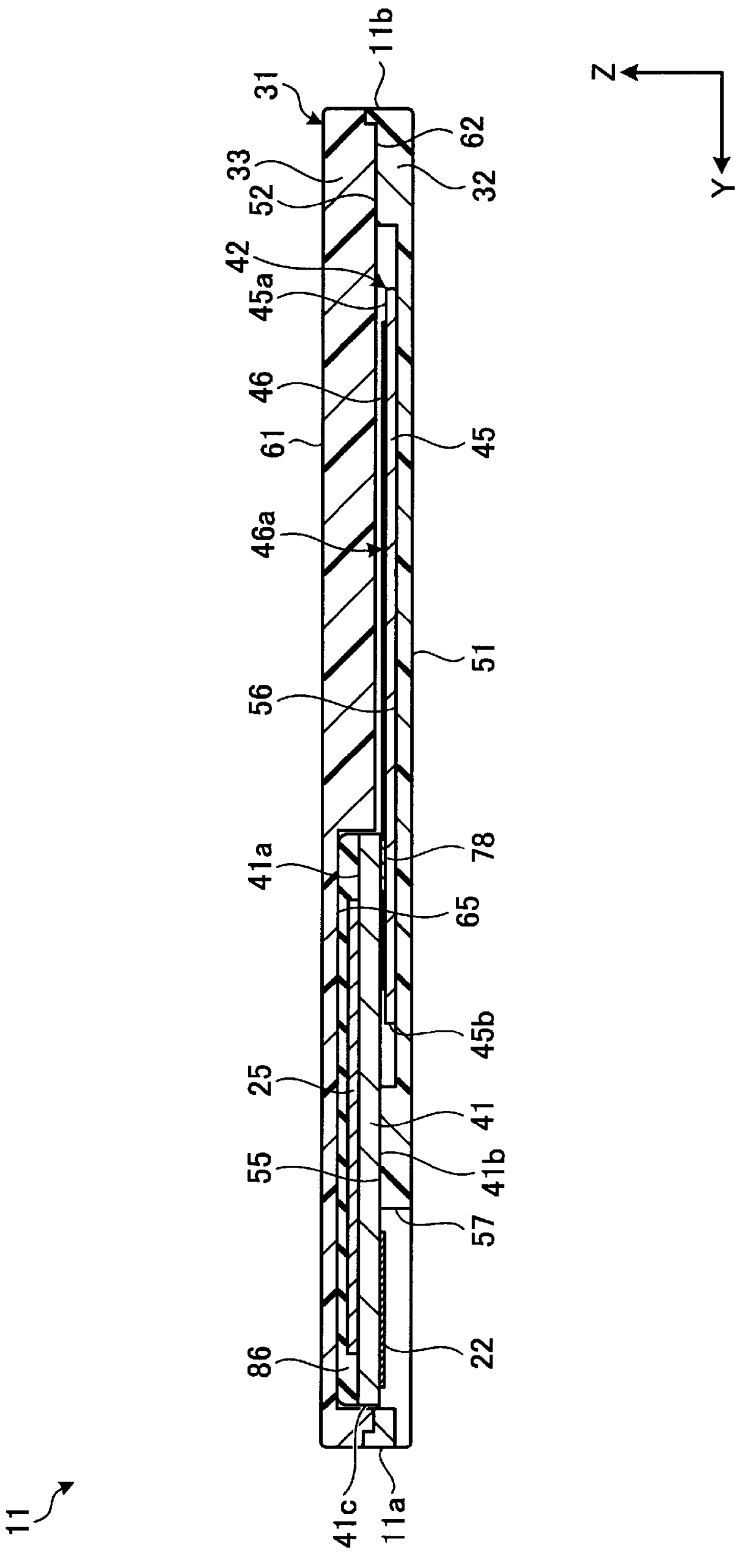

11
F4
11a
84
82
26
25
83
81
32
82
81
84
55
41
41a
41c
81
82
84
24
75
71
76
72
72
76
71
75
11c
11d
P3
46
56
46a
45b
42
52
11b
P1
P2
45a
45
F4
Y
X

FIG. 4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31
33
52
42
45a
46
61
46a
56
41a
25
55
86
41c
11a
11
62
32
45
51
78
65
45b
41
41b
57
22
Z
Y

FIG. 5

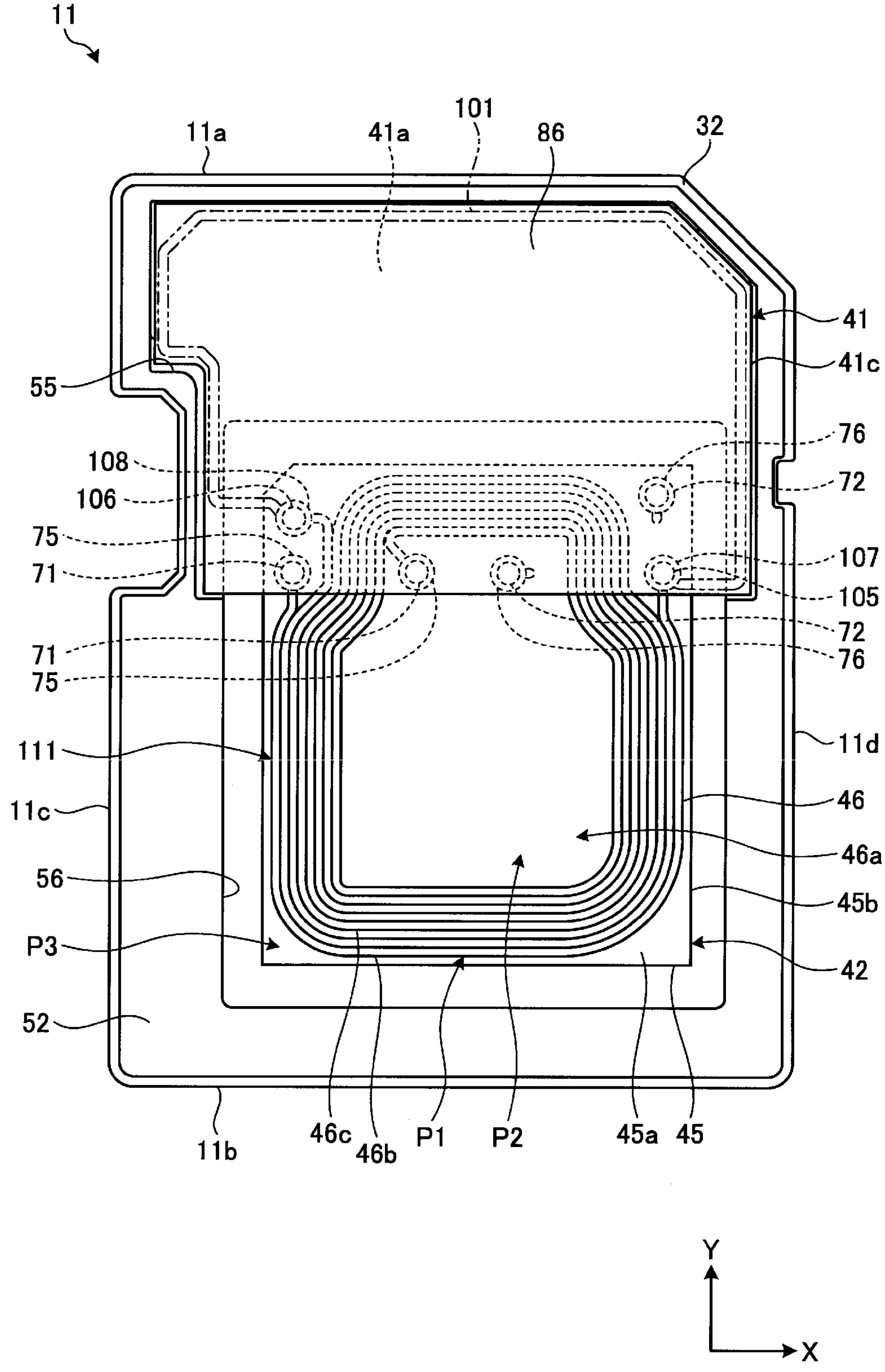

11
11a
41a
101
86
32
41
41c
55
76
108
72
106
75
107
71
105
72
71
76
75
111
11d
46
11c
46a
56
45b
P3
42
52
11b
46c
46b
P1
P2
45a
45
Y
X

FIG. 6

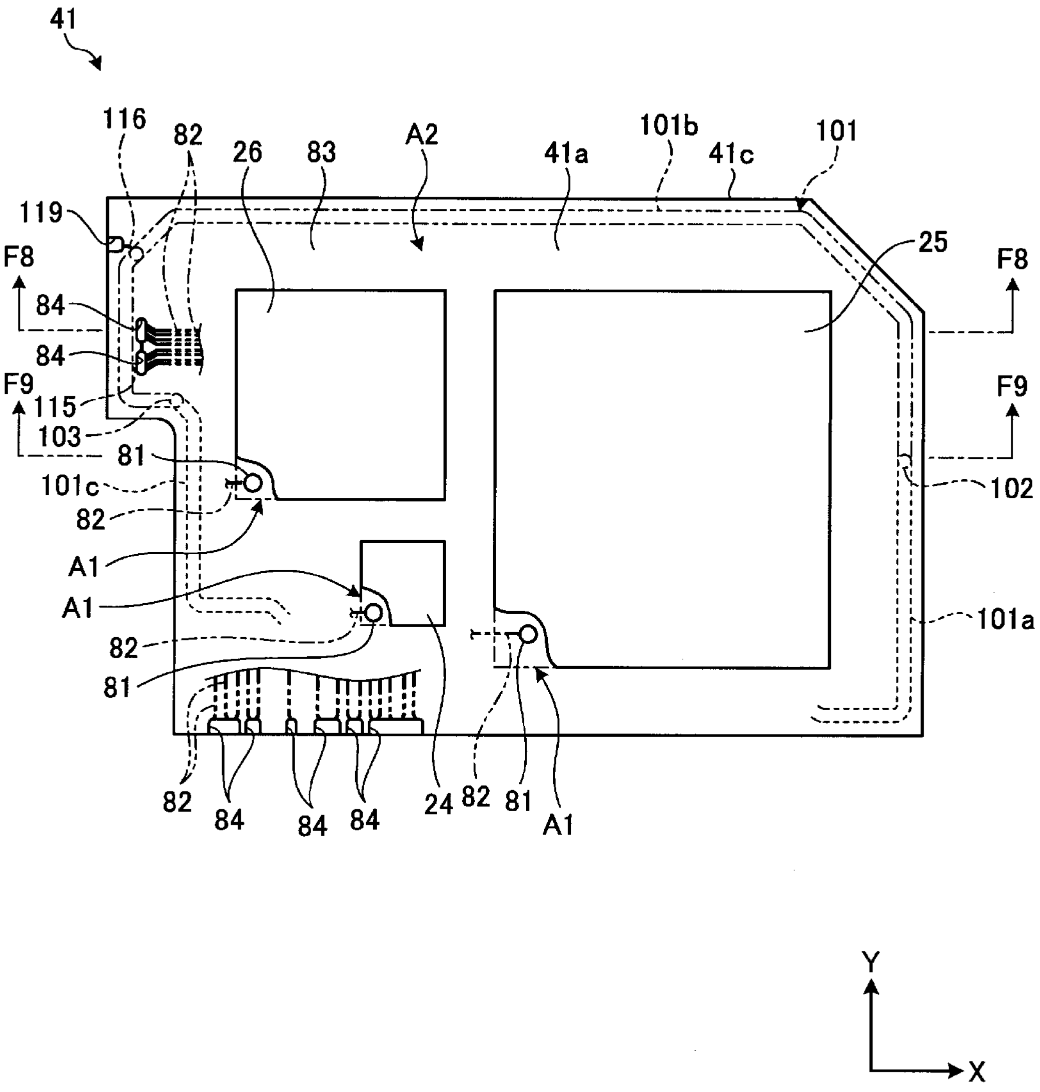

41
116
82
26
83
A2
41a
101b
41c
101
119
F8
25
F8
84
84
F9
115
103
F9
81
101c
82
102
A1
A1
82
101a
81
82
84
84
84
24
82
81
A1
Y
X

FIG. 7

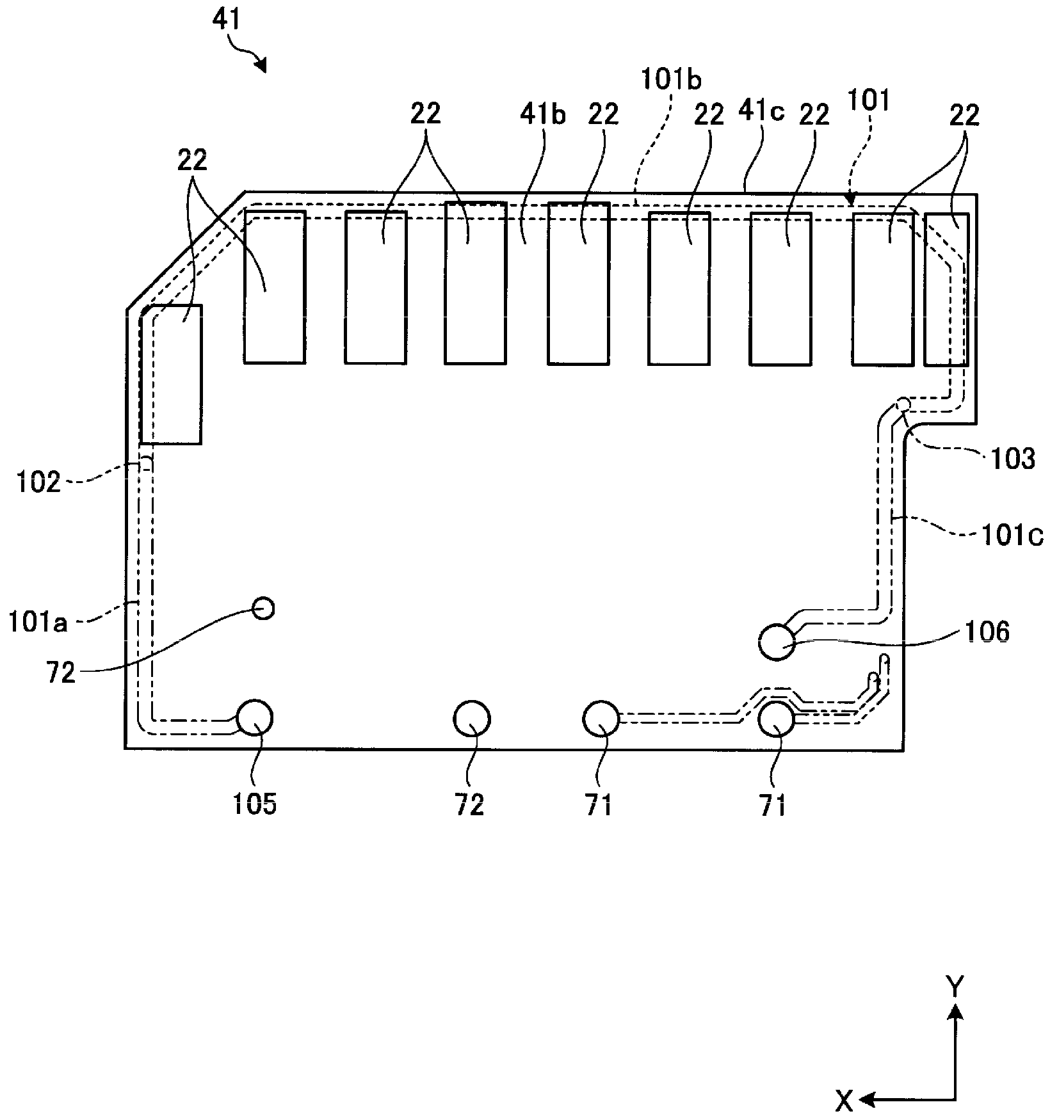

41
101b
22
41b
22
22
41c
22
101
22
22
102
103
101c
101a
72
106
105
72
71
71
Y
X

FIG. 8

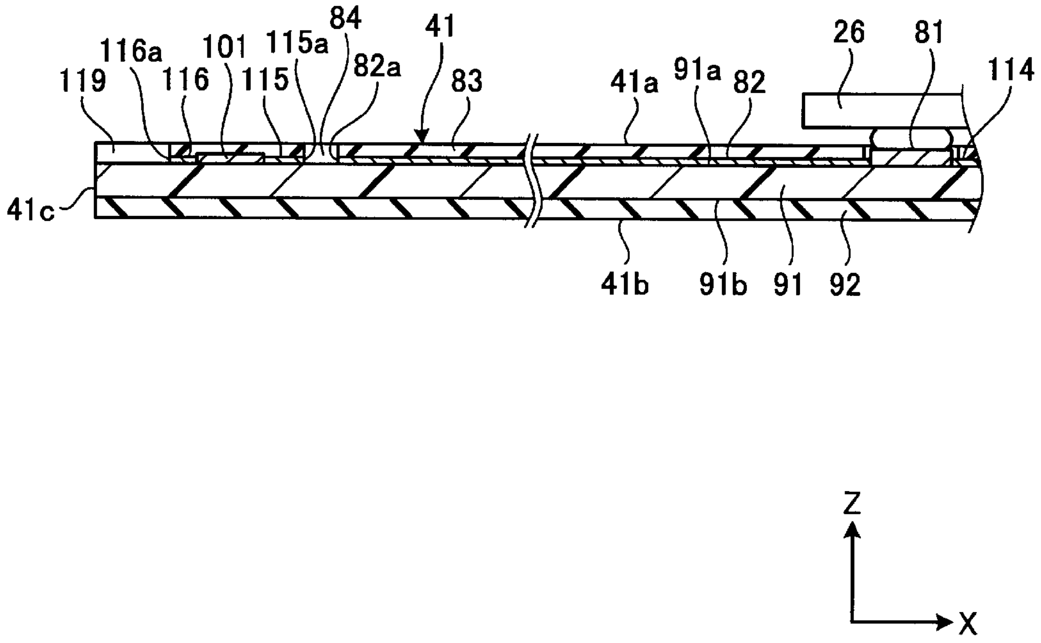

84
41
116a
101
115a
82a
119
116
115
83
41a
91a
82
26
81
114
41c
41b
91b
91
92
Z
X

FIG. 9

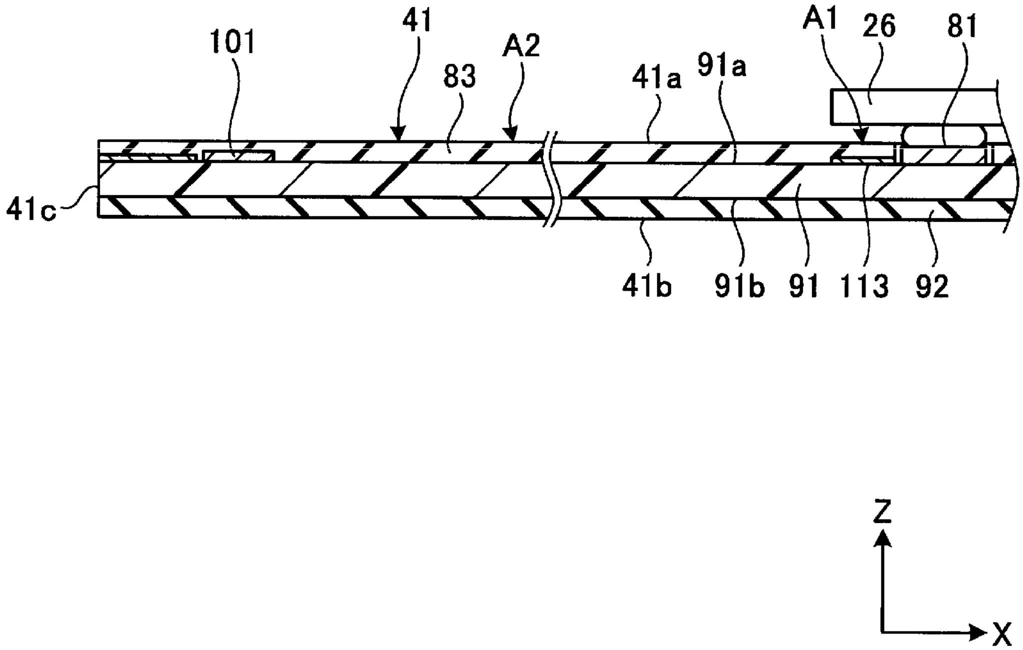

101
41
83
A2
41a
91a
A1
26
81
41c
41b
91b
91
113
92
Z
X

FIG. 10

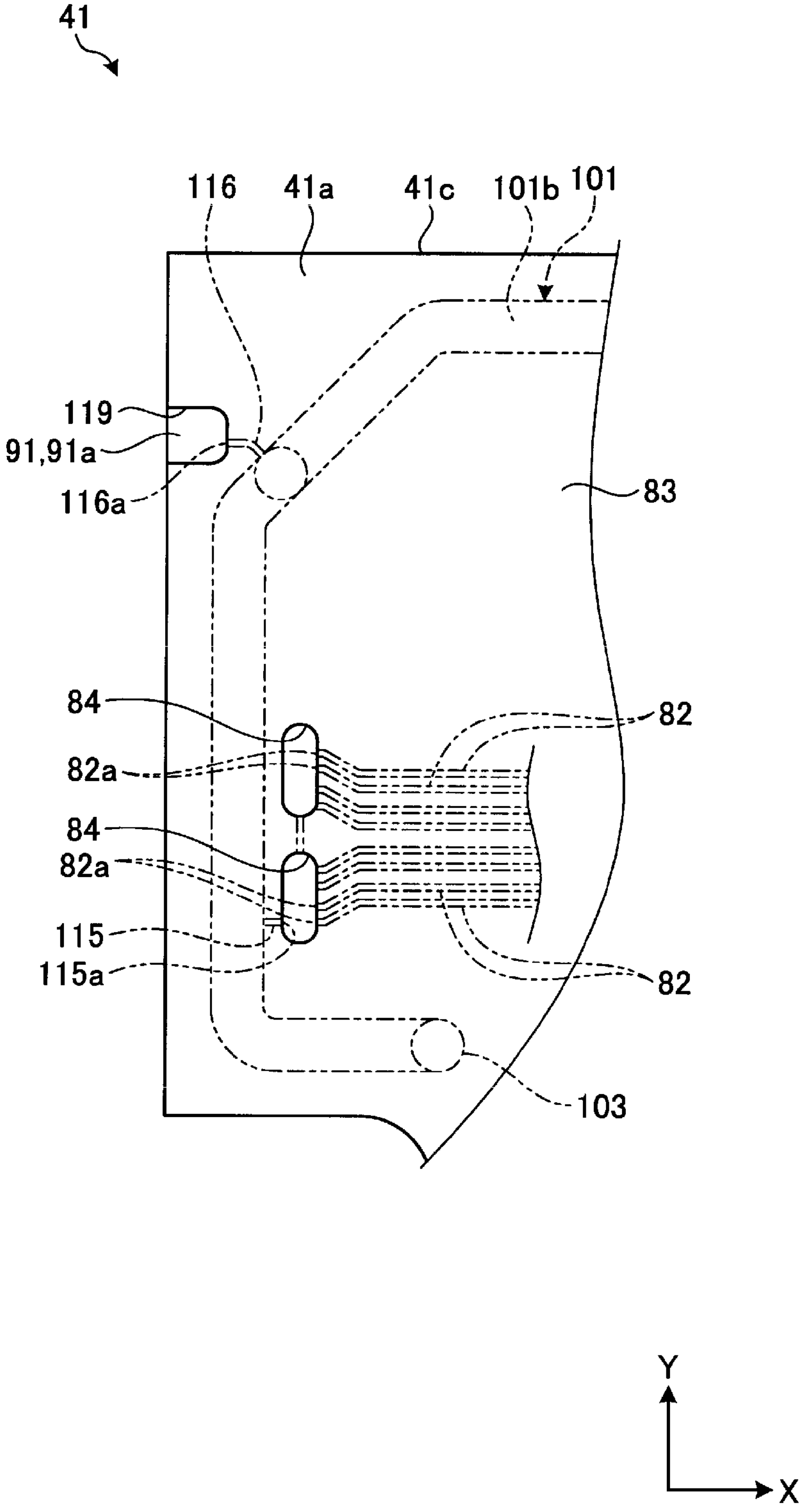

41
116
41a
41c
101b
101
119
91,91a
116a
83
84
82a
84
82a
115
115a
82
82
103
Y
X

FIG. 11

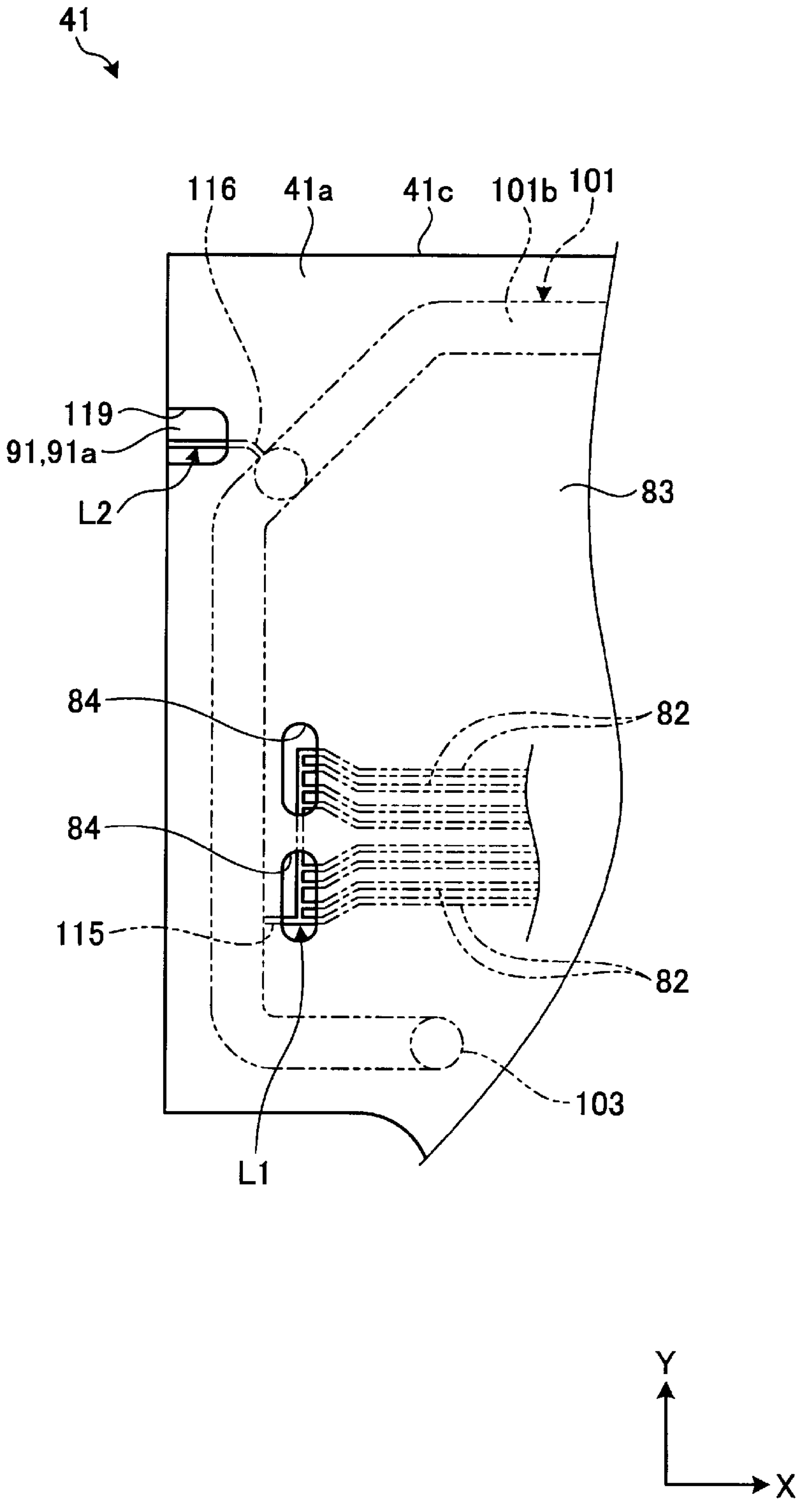
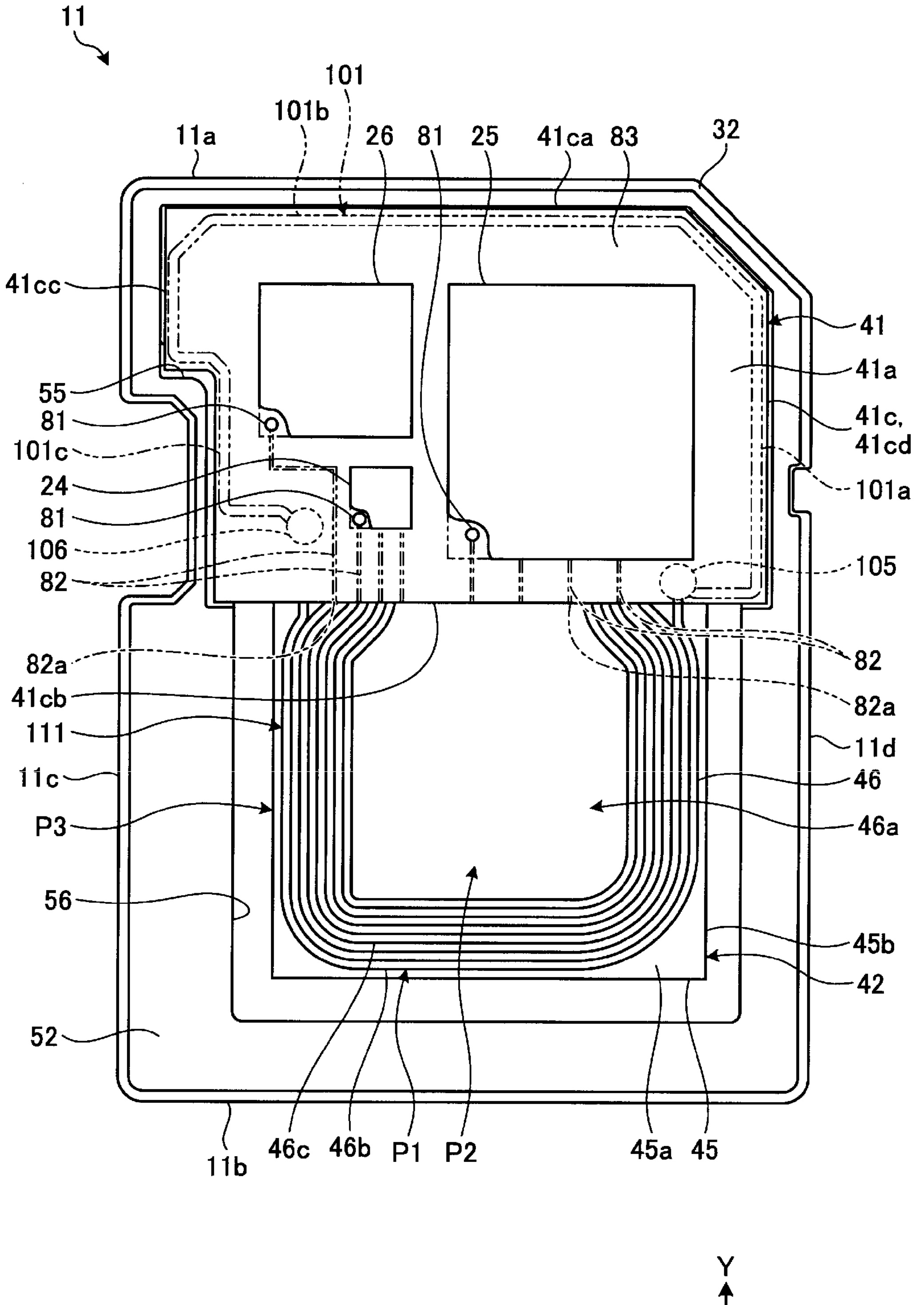


FIG. 12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101
101b
11a
26
81
25
41ca
83
32
41cc
41
41a
55
81
41c,
41cd
101c
101a
24
81
106
105
82
82
82a
41cb
82a
111
11d
11c
46
P3
46a
56
45b
42
52
11b
46c
46b
P1
P2
45a
45
Y
X

FIG. 13

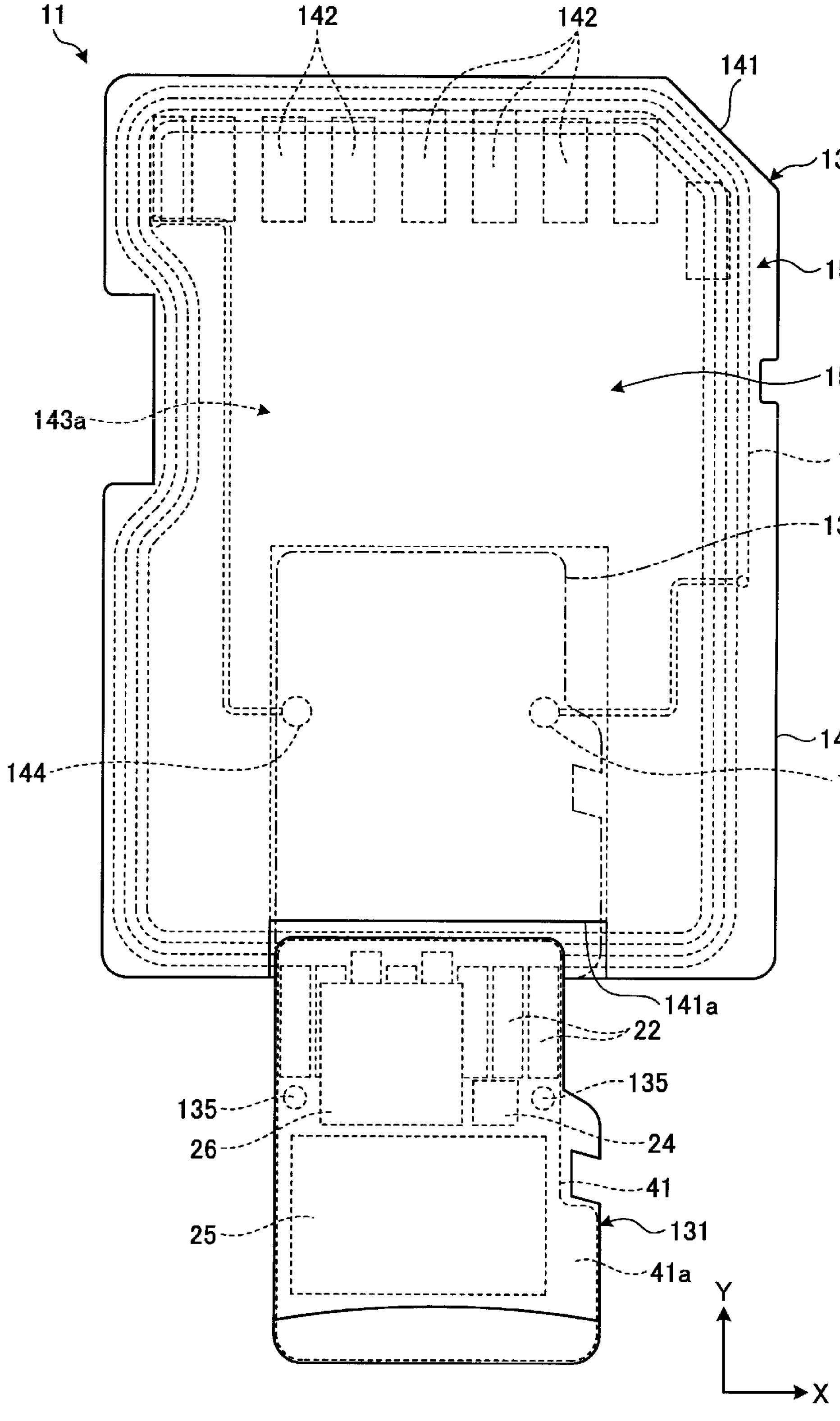

11
142
142
141
132
151
143a
152
143
131
144
141b
144
141a
22
135
135
24
26
41
25
131
41a
Y
X

FIG. 14

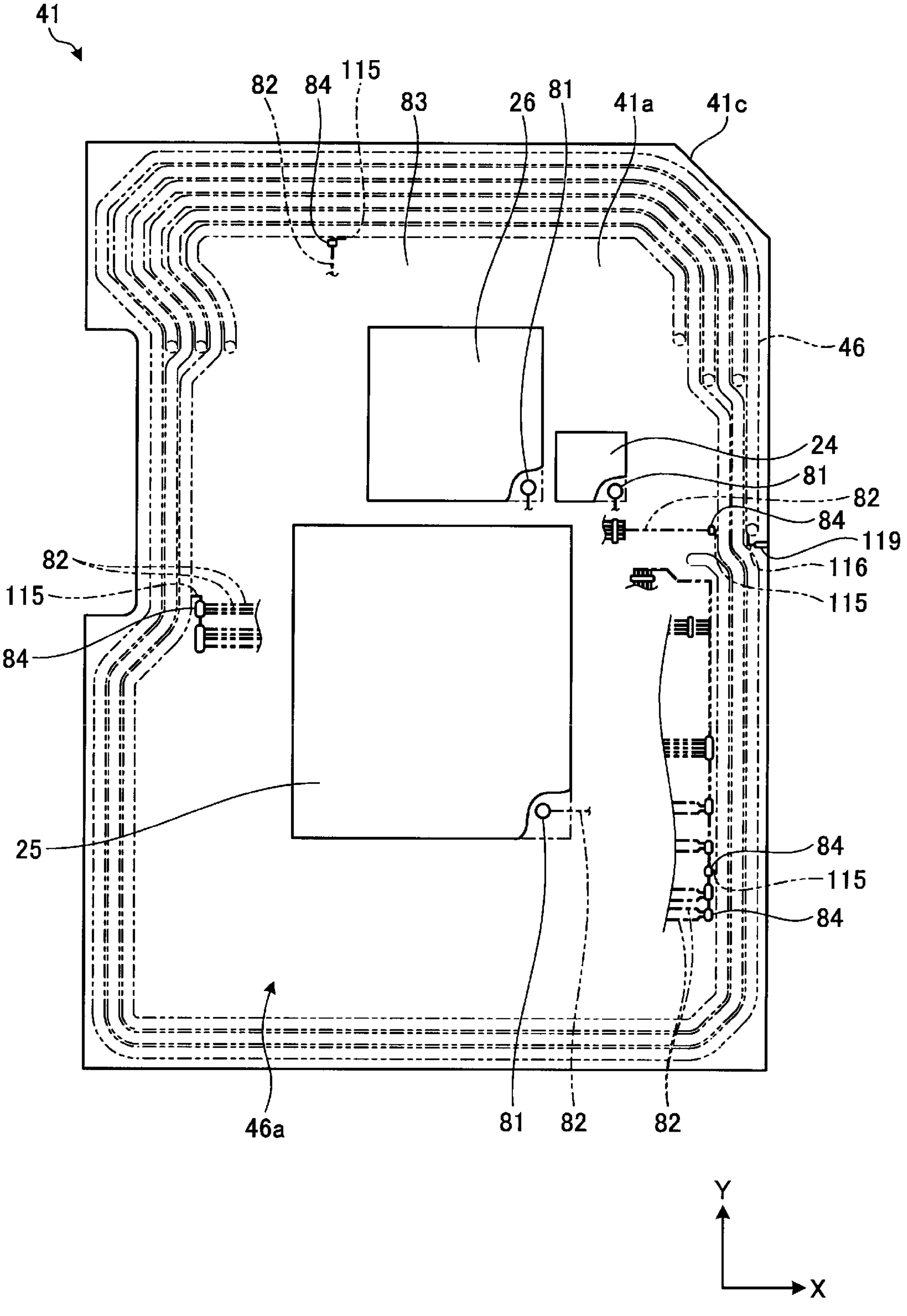

41
82
84
115
83
26
81
41a
41c
46
24
81
82
84
119
116
115
82
115
84
25
84
115
84
46a
81
82
82
Y
X

FIG. 15

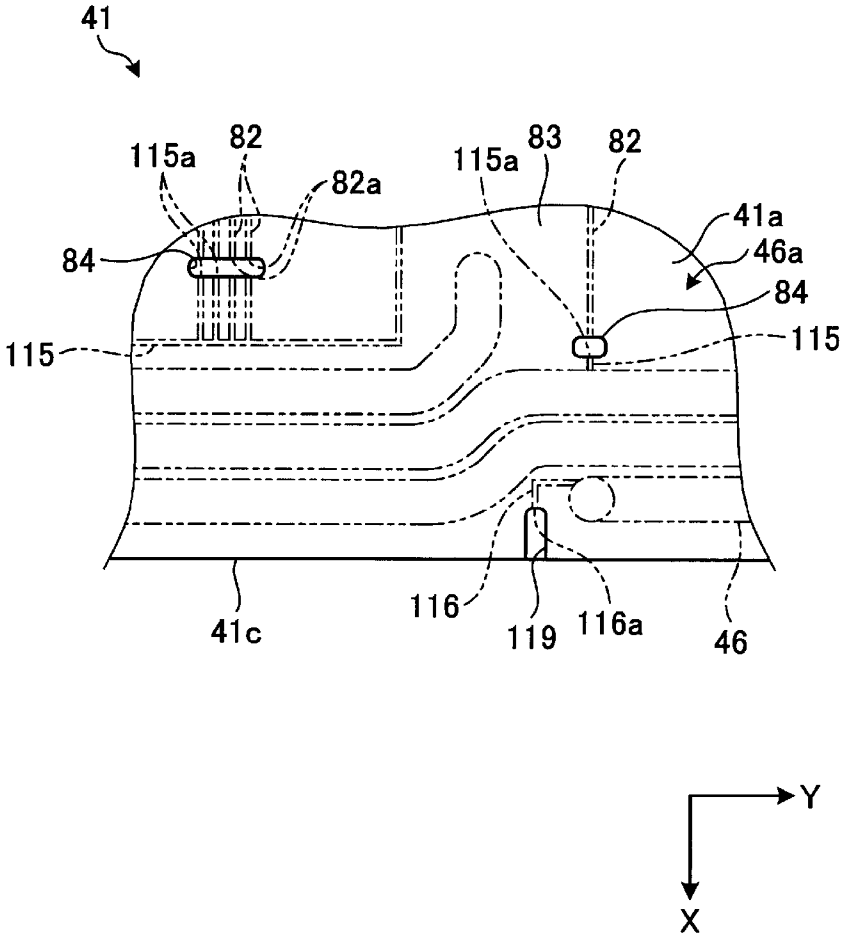

41
115a
82
82a
115a
83
82
41a
46a
84
84
115
115
41c
116
119
116a
46
Y
X

FIG. 16

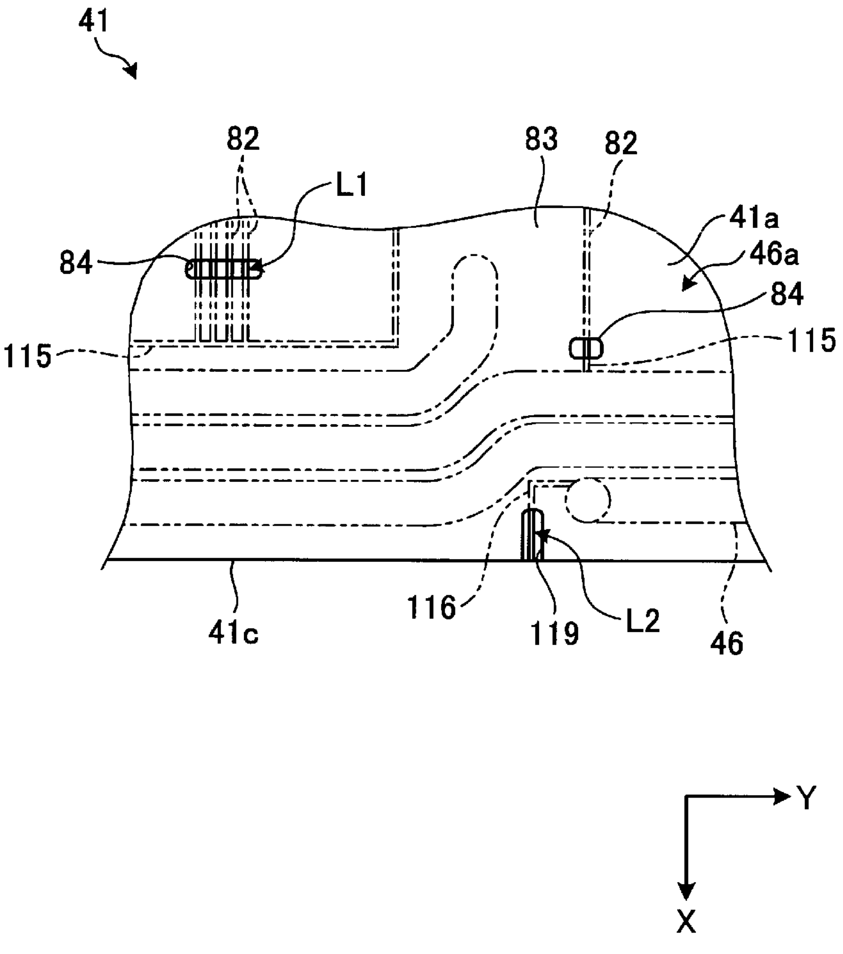
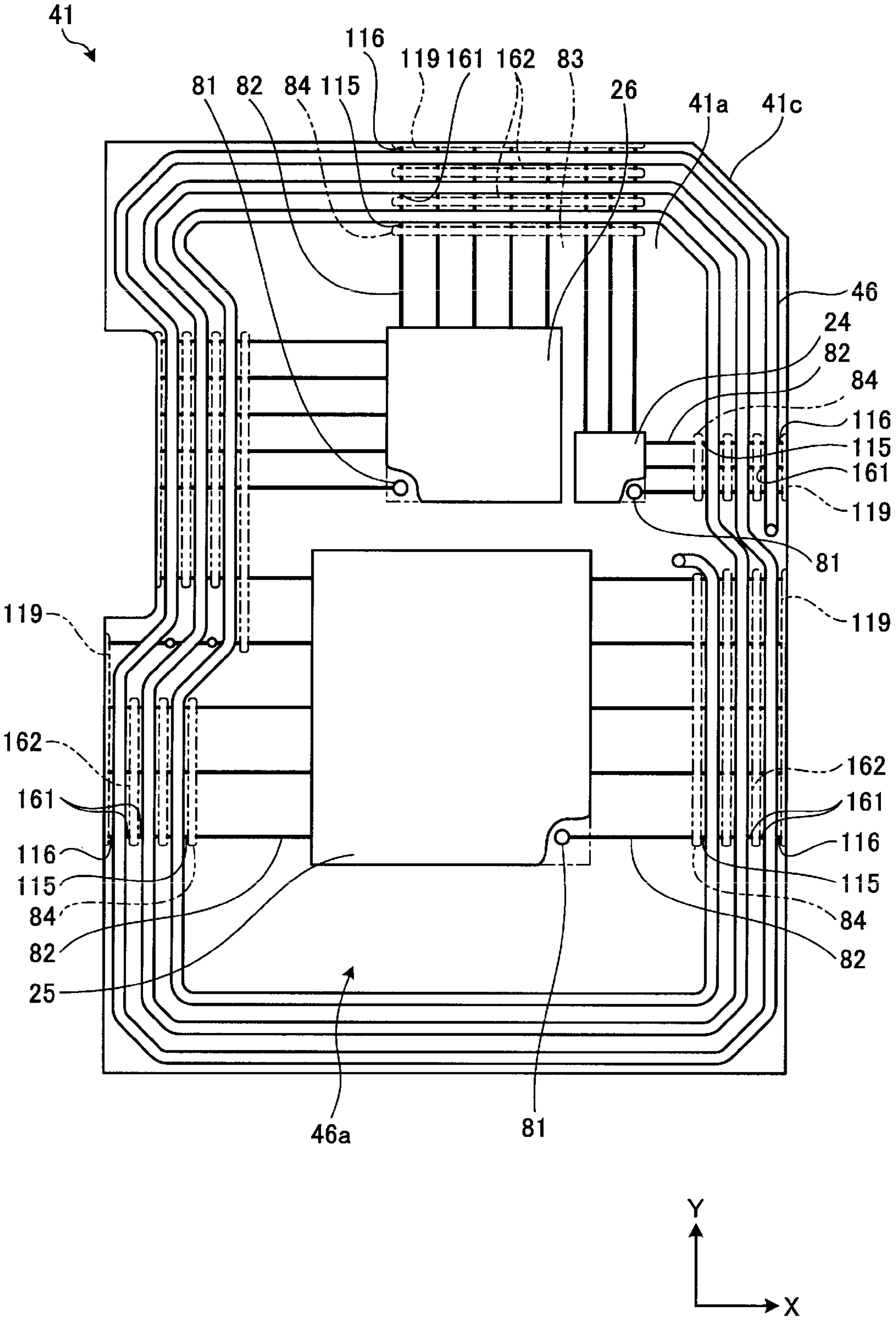


FIG. 17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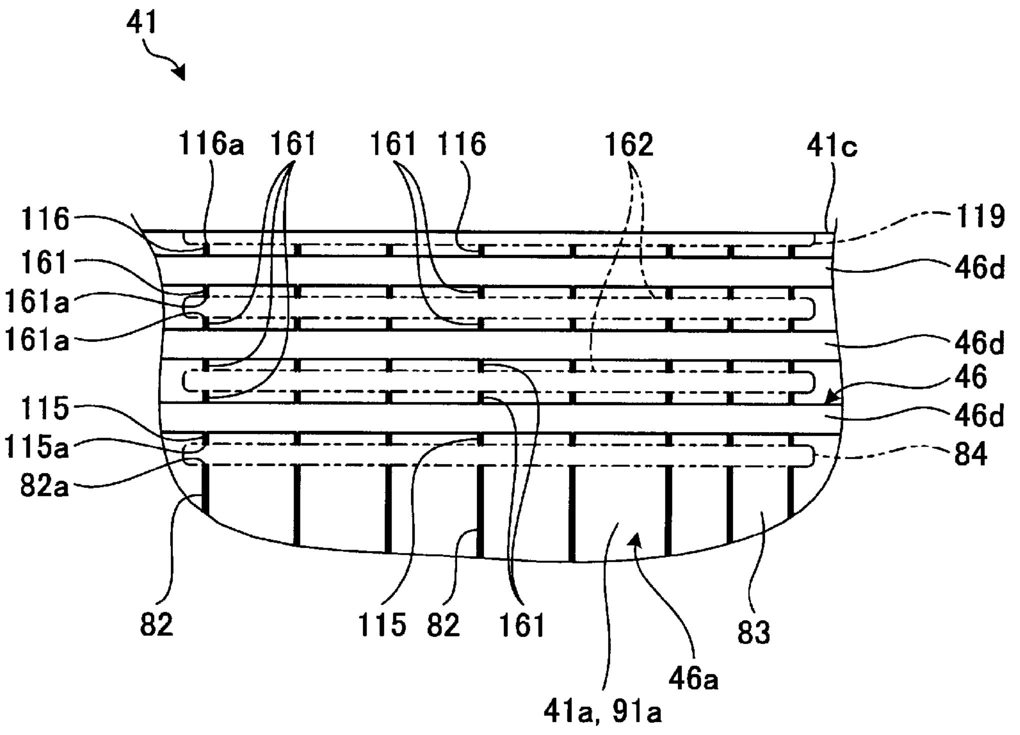
116
119
161
162
83
81
82
84
115
26
41a
41c
46
24
82
84
116
115
161
119
81
119
119
162
161
116
115
84
82
25
162
161
116
115
84
82
46a
81
Y
X

FIG. 18


41
116a
161
161
116
162
41c
116
161
161a
161a
115
115a
82a
119
46d
46d
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46d
84
82
115
82
161
83
46a
41a, 91a

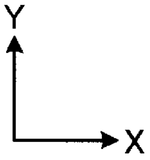

Y
X

FIG. 19

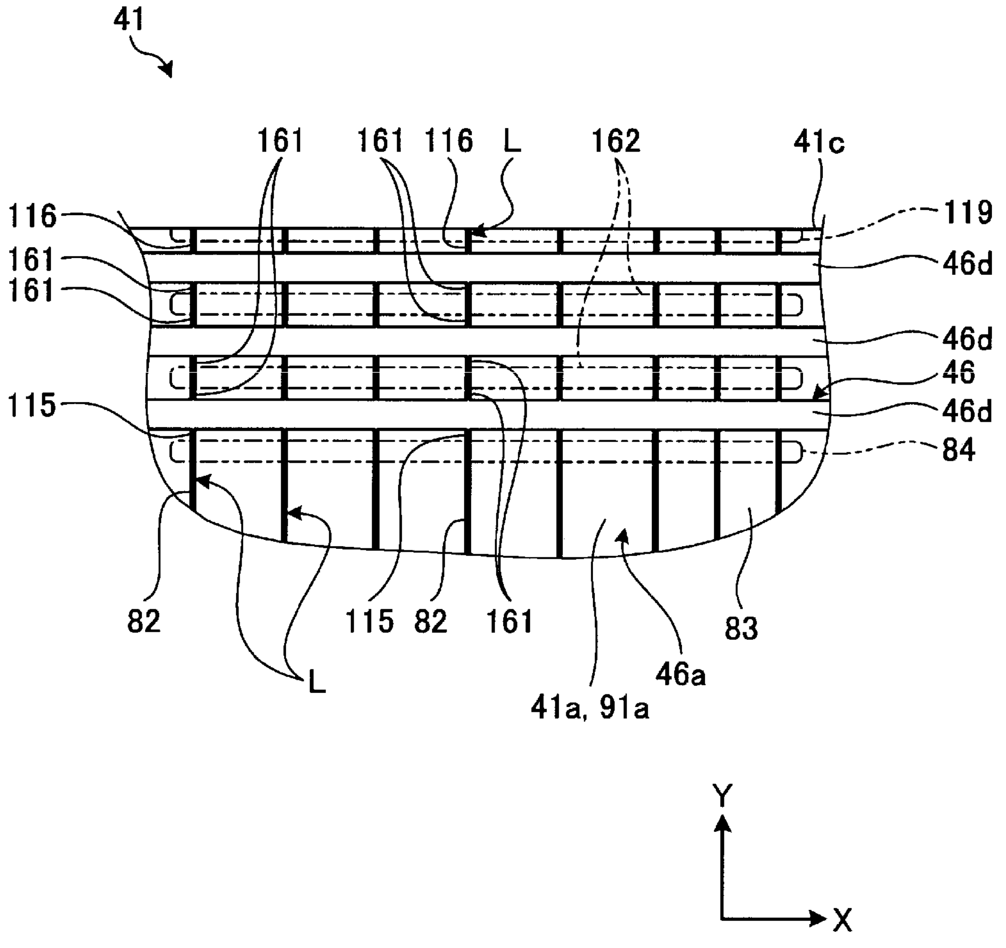

41
161
161
116
L
162
41c
116
119
161
46d
161
46d
46
115
46d
84
82
115
82
161
83
L
46a
41a, 91a
Y
X

FIG. 20

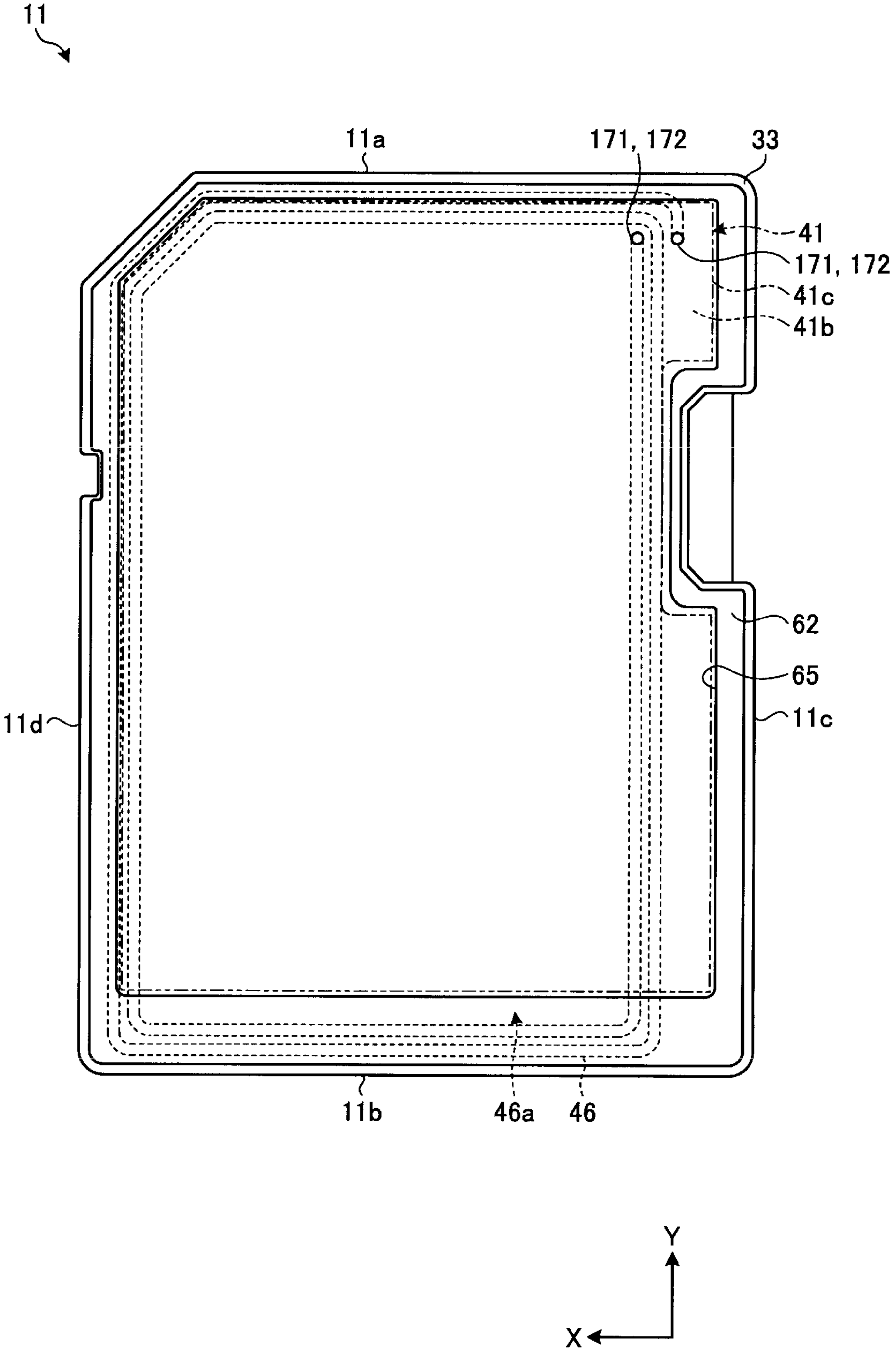
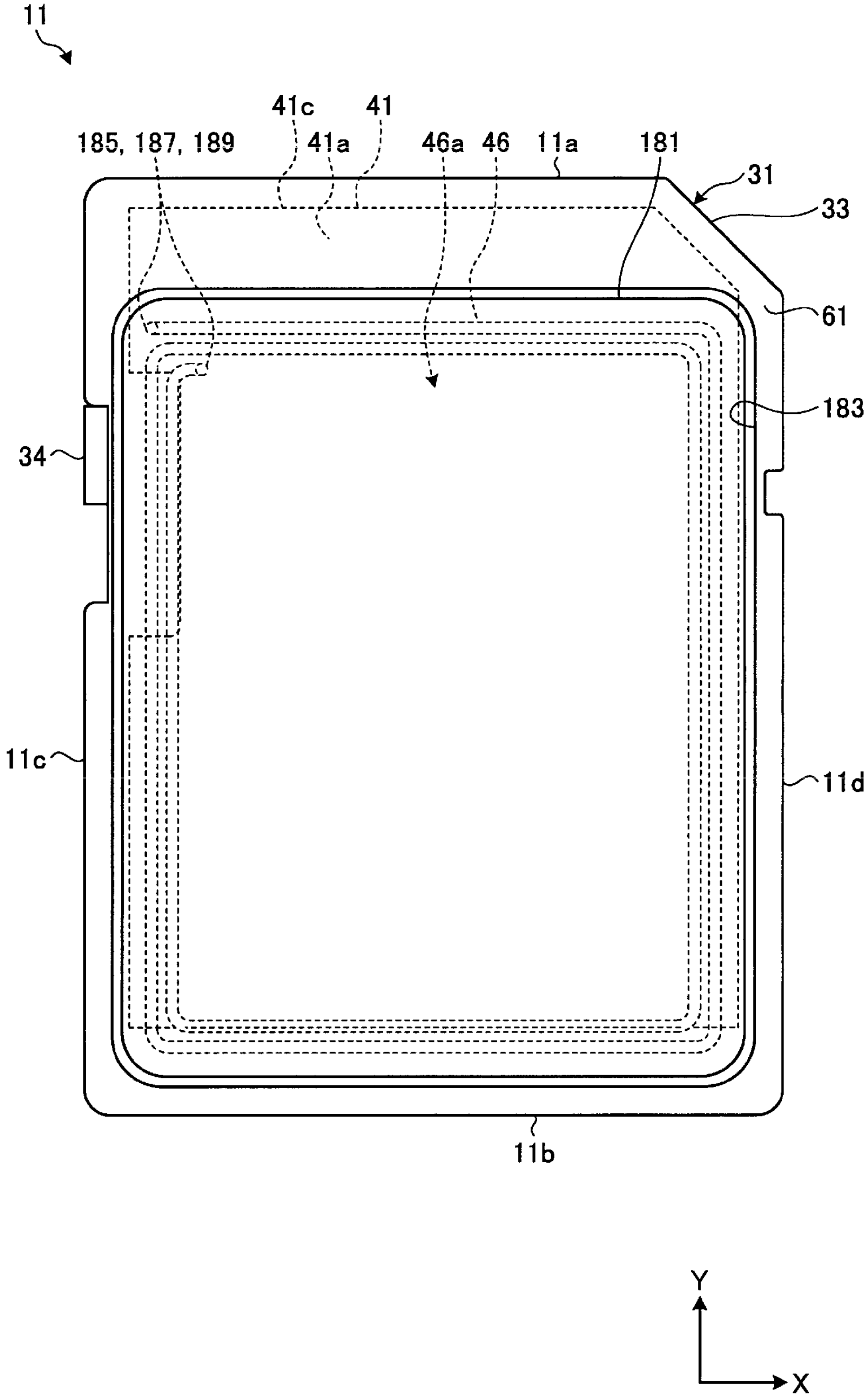


FIG. 21


11
41c
41
185, 187, 189
41a
46a
46
11a
181
31
33
61
183
34
11c
11d
11b
Y
X

WIRELESSLY-COMMUNICABLE MEMORY CARD

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2015-233522, filed Nov. 30, 2015 and Japanese Patent Application No. 2016-100705, filed May 19, 2016; the entire contents of both applications are incorporated herein by reference.

FIELD

Embodiments described herein relate generally to a semiconductor memory device, in particular, a wirelessly-communicable memory card.

BACKGROUND

Antennas for communication with external devices may be mounted in various devices. For example, an antenna such as a dipole antenna, a loop antenna, or a dielectric antenna is mounted in a device.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an SD card according to a first embodiment.

FIG. **2** is a block diagram of a system that includes the SD card according to the first embodiment.

FIG. **3** is a plan view of the SD card according to the first embodiment, from which a top cover is removed.

FIG. **4** is a cross-sectional view of the SD card according to the first embodiment taken along a line F**4**-F**4** in FIG. **3**.

FIG. **5** is a plan view of an SD card according to a second embodiment, from which a top cover is removed.

FIG. **6** is a plan view of a first substrate of the SD card according to the second embodiment, from which a seal resin is removed.

FIG. **7** is a bottom view of the first substrate according to the second embodiment.

FIG. **8** is a cross-sectional view of a part of the first substrate according to the second embodiment taken along a line F**8**-F**8** in FIG. **6**.

FIG. **9** is a cross-sectional view of a part of the first substrate according to the second embodiment taken along a line F**9**-F**9** in FIG. **6**.

FIG. **10** is a plan view of a part of the first substrate according to the second embodiment.

FIG. **11** is a plan view of a part of the first substrate during a process of manufacturing processes according to the second embodiment.

FIG. **12** is a plan view of an SD card according to a modification example of the second embodiment, from which a top cover is removed.

FIG. **13** is a plan view of an SD card according to a third embodiment.

FIG. **14** is a plan view of a first substrate of an SD card according to a fourth embodiment.

FIG. **15** is a plan view of a part of the first substrate according to the fourth embodiment.

FIG. **16** is a plan view of a part of the first substrate during a process of manufacturing processes according to the fourth embodiment.

FIG. **17** is a plan view of a first substrate of an SD card according to a modification example of the fourth embodiment.

FIG. **18** is a plan view of a part of the first substrate according to the modification example of the fourth embodiment.

FIG. **19** is a plan view of a part of the first substrate during a process of manufacturing processes according to the modification example of the fourth embodiment.

FIG. **20** is a bottom view of an SD card according to a fifth embodiment, from which a bottom cover is removed.

FIG. **21** is a plan view of an SD card according to a sixth embodiment.

DETAILED DESCRIPTION

Generally, mounting an antenna in a device may increase the manufacturing cost of the device.

An embodiment provides a semiconductor memory device and an adapter including a wireless antenna, that can be manufactured at a lower manufacturing cost, while maintaining sufficient communication ability.

In general, according to an embodiment, a memory card includes a substrate, a nonvolatile memory on the substrate, a memory controller on the substrate and configured to control access to the nonvolatile memory, an interface terminal for external wired connection, on the substrate, an antenna, a plain region surrounded by the antenna including a first region that overlaps with the substrate and a second region that does not overlap with the substrate, and a communication controller disposed on the substrate, electrically connected to the antenna, and configured to wirelessly communicate with an external device through the antenna, using power generated at the antenna by an electromagnetic induction caused by the external device.

Hereinafter, a semiconductor memory device and an adapter according to embodiments will be described in detail with reference to the appended drawings. These embodiments do not limit the present disclosure.

An element according to embodiments and the description thereof may be represented in a plurality of manners in the following description. The element and the description thereof may also be represented in other unrepresented manners. Furthermore, an element and the description thereof that are not represented in a plurality of manners may also be represented in other manners.

First Embodiment

Hereinafter, a first embodiment will be described with reference to FIG. **1** to FIG. **4**. FIG. **1** is a perspective view of an SD card **11** according to the first embodiment. The SD card **11** is one example of a semiconductor memory device. The semiconductor memory device may be another device such as a MultiMediaCard or a USB flash memory. The semiconductor memory device is a device or a system having a semiconductor chip and may be a wireless communication device such as a mobile phone.

An X axis, a Y axis, and a Z axis are defined in the present disclosure as illustrated in each drawing. The X axis, the Y axis, and the Z axis are orthogonal to one another. The X axis is defined along a width direction of the SD card **11**. The Y axis is defined along a length direction of the SD card **11**. The Z axis is defined along a thickness direction of the SD card **11**.

A wireless communication technology is applicable to the SD card **11** of the present embodiment. For example, near field communication (NFC) that uses a frequency of 13.56 MHz is applicable to the SD card **11**. Other wireless communication technologies may be applied to the SD card **11**.

The SD card **11** that employs NFC generates an induction current with a wireless antenna by the electromagnetic induction. Thus, as described below, the SD card **11** includes a wireless antenna formed in a shape that may be referred to as, for example, a coil shape, a spiral shape, or a swirling shape.

FIG. **2** is a block diagram of a system that includes the SD card **11** according to the first embodiment. As illustrated in FIG. **2**, the SD card **11** is electrically (and physically) connected to a host device **12**. Furthermore, the SD card **11** wirelessly communicates with a wireless communication host device **13**. The host device **12** is one example of a first external device. The wireless communication host device **13** is one example of a second external device. Each of the host device **12** and the wireless communication host device **13** is, for example, a personal computer, a portable computer, a smartphone, a mobile phone, a server, a smart card, or another device.

The SD card **11** includes an interface (I/F) terminal **22**, a wireless antenna **23**, a communication controller **24**, a flash memory **25**, a memory controller **26**, and a capacitor **27**. The I/F terminal **22** is one example of a first interface terminal. The flash memory **25** is one example of a nonvolatile memory.

The communication controller **24** controls communication between the SD card **11** and the host device **12** and communication between the SD card **11** and the wireless communication host device **13**. The communication controller **24** includes a storage unit **24***a* and a voltage detector **24***b*. The storage unit **24***a* may be an electronic component that is independent of the communication controller **24**. In that case, the communication controller **24** is connected to the storage unit **24***a*.

The communication controller **24** and the memory controller **26** maybe included in one electronic component. In addition, a plurality of electronic components, wiring, and a program may configure the communication controller **24** and the memory controller **26**. That is, each of the communication controller **24** and the memory controller **26** may include one electric element, a plurality of electric elements, or one or more electric elements and programs.

When the SD card **11** is electrically (and physically) connected to the host device **12**, the SD card **11** is operated by power supplied from the host device **12**. For example, the host device **12** writes data into the SD card **11** or reads data from the SD card **11**.

The SD card **11** can send data to and receive data from the wireless communication host device **13** in a state where the SD card **11** is not physically connected to an external device such as the host device **12** and the wireless communication host device **13** and power is not supplied from the external device. For example, the SD card **11** can send data to and receive data from the wireless communication host device **13** using power generated (induced) by the electromagnetic induction caused at the wireless antenna **23**. The SD card **11**, for example, performs NFC communication at a frequency of approximately 13.56 MHz and sends data to and receives data from the wireless communication host device **13**. That is, the SD card **11** can be operated without supply of power from the host device **12**.

The SD card **11** according to the present embodiment sends data to and receives data from the host device **12** in accordance with an SD interface. The SD card **11** may send data to and receive data from the host device **12** using the other interfaces. The SD card **11** sends data to and receives data from the wireless communication host device **13** in accordance with an NFC interface. The SD card **11** may send data to and receive data from the wireless communication host device **13** using the other wireless communication interfaces. The host device **12** and the wireless communication host device **13** may be the same device.

As illustrated in FIG. **1**, the SD card **11** further includes a casing **31**. The casing **31** is formed of, for example, synthetic resin that has non-magnetic and insulating properties. The casing **31** may be formed of the other materials.

The casing **31** is formed in an approximately quadrangular box shape. The casing **31** may be formed in the other shapes. The casing **31** includes a bottom cover **32**, a top cover **33**, and a lock switch **34**. The bottom cover **32** is one example of a first cover. The top cover **33** is one example of a second cover.

FIG. **3** is a plan view of an internal structure of the SD card **11** according to the first embodiment, from which the top cover **33** is removed. Further, a part of each of the communication controller **24**, the flash memory **25**, and the memory controller **26** is omitted in FIG. **3**. FIG. **3** illustrates contour lines of the omitted parts of the communication controller **24**, the flash memory **25**, and the memory controller **26** with double-dot chain lines.

As illustrated in FIG. **3**, the SD card **11** further includes a first substrate **41** and an antenna module **42**. The casing **31** accommodates the first substrate **41**, the antenna module **42**, the communication controller **24**, the flash memory **25**, and the memory controller **26**.

The communication controller **24**, the flash memory **25**, and the memory controller **26** are mounted on the first substrate **41**. The antenna module **42** includes a second substrate **45** and a first antenna pattern **46**. The wireless antenna **23** in FIG. **2** includes the first antenna pattern **46** in the first embodiment. The first antenna pattern **46** is one example of a first antenna.

The SD card **11** is formed in an approximately quadrangular card shape and includes four sides **11***a*, **11***b*, **11***c*, and **11***d*. For convenience of description, the four sides **11***a* to **11***d* of the SD card **11** will be respectively referred to as a front side **11***a*, a rear side **11***b*, a left side **11***c*, and a right side **11***d*. This naming of the front side **11***a*, the rear side **11***b*, the left end portion **11***c*, and the right side **11***d* is based on the position in FIG. **3** and does not limit the directions and other features of each of the sides **11***a*, **11***b*, **11***c*, and **11***d*.

The front side **11***a* is one side of the SD card **11** in the direction along the Y axis. The rear side **11***b* is the other side of the SD card **11** in the direction along the Y axis and opposite to the front side **11***a*. The front side **11***a* and the rear side **11***b* extend in the direction along the X axis.

The left side **11***c* is one end portion of the SD card **11** in the direction along the X axis. The right side **11***d* is the other end portion of the SD card **11** in the direction along the X axis and is positioned on the opposite side from the left side **11***c*. Each of the left side **11***c* and the right side **11***d* extends in the direction along the Y axis.

FIG. **4** is a cross-sectional view of the SD card **11** according to the first embodiment taken along a line F4-F4 in FIG. **3**. As illustrated in FIG. **4**, the bottom cover **32** includes a bottom surface **51** and a first inner surface **52**. The bottom surface **51** forms one surface of the casing **31** that is exposed to the outside. The first inner surface **52** is positioned opposite to the bottom surface **51**.

A first recess portion **55**, a second recess portion **56**, and a plurality of terminal holes **57** are provided in the bottom cover **32**. FIG. **4** illustrates one of the plurality of terminal holes **57**. Each of the first recess portion **55** and the second recess portion **56** maybe referred to as, for example, a recess, an accommodation region, or a fit portion. The first recess portion **55** and the second recess portion **56** are provided on the first inner surface **52**. In other words, the first and second recess portions **55** and **56** are regions recessed from the first inner surface **52**.

The first recess portion **55** and the second recess portion **56** are arranged to partially overlie each other in the direction along the Y direction. The first recess portion **55** is closer to the front side **11***a* than the second recess portion **56**. More specifically, an end portion of the first recess portion **55** in the positive direction along the Y axis (the direction to which the Y-axis arrow is directed) is closer to the front side **11***a* than an end portion of the second recess portion **56** in the positive direction along the Y axis.

The first recess portion **55** accommodates the first substrate **41**. A part of the first substrate **41** is positioned outside of the first recess portion **55** in the thickness direction of the first substrate **41** (in the direction along the Z axis). In other words, the depth of the first recess portion **55** is smaller than the thickness of the first substrate **41**. The depth of the first recess portion **55** may be greater than the thickness of the first substrate **41**. The second recess portion **56** accommodates the antenna module **42**. A part of the antenna module **42** may be positioned outside the second recess portion **56**.

The plurality of terminal holes **57** is provided in the first recess portion **55**. The plurality of terminal holes **57** is adjacent to the front side **11***a* and is lined up in the direction along the X axis. The plurality of terminal holes **57** passes through the bottom cover **32** between the bottom surface **51** and the first inner surface **52**. In other words, the plurality of terminal holes **57** is opened in the first recess portion **55**.

The top cover **33** is coupled with the bottom cover **32**. The top cover **33** covers the first substrate **41** accommodated in the first recess portion **55** and the antenna module **42** accommodated in the second recess portion **56**.

The top cover **33** includes an upper surface **61** and a second inner surface **62**. The upper surface **61** forms one surface of the casing **31** that is exposed to the outside. In terms of the casing **31**, the upper surface **61** is positioned opposite to the bottom surface **51**. In terms of the top cover **33**, the second inner surface **62** is positioned opposite to the upper surface **61**.

A third recess portion **65** is formed in the top cover **33**. The third recess portion **65** is formed on the second inner surface **62**. Coupling of the top cover **33** with the bottom cover **32** causes the third recess portion **65** to accommodate the part of the first substrate **41** that is positioned outside the first recess portion **55**. The first recess portion **55** and the third recess portion **65** hold the first substrate **41** and restrict movement of the first substrate **41**.

The first substrate **41** is, for example, a printed circuit board (PCB). The first substrate **41** may be another substrate such as a flexible printed circuit board (FPC). The first substrate **41** includes a first surface **41***a*, a second surface **41***b*, and a side surface **41***c*.

The first surface **41***a* is formed to be approximately flat and faces the top cover **33**. The second surface **41***b* is formed to be approximately flat and opposite to the first surface **41***a*. The second surface **41***b* faces the bottom cover **32**. The end surface **41***c* connects an end of the first surface **41***a* and an end of the second surface **41***b*.

As illustrated in FIG. **3**, the communication controller **24**, the flash memory **25**, and the memory controller **26** are mounted on the first surface **41***a* of the first substrate **41**. At least one of the communication controller **24**, the flash memory **25**, and the memory controller **26** may be mounted on another surface of the first substrate **41**. Furthermore, the communication controller **24** maybe disposed on another element such as the second substrate **45**.

The first substrate **41** is formed in an approximately quadrangular board shape. The first substrate **41** maybe formed in another shape. The length of the first substrate **41** in the direction along the Y axis is smaller than half of the length of the casing **31** in the direction along the Y axis. The dimensions of the first substrate **41** are not limited thereto. For example, the length of the first substrate **41** in the direction along the Y axis maybe greater than half of the length of the casing **31** in the direction along the Y axis.

As illustrated in FIG. **4**, a plurality of I/F terminals **22** is provided on the second surface **41***b* of the first substrate **41**. FIG. **4** illustrates one of the plurality of I/F terminals **22**. The plurality of I/F terminals **22** is adjacent to the front side **11***a* of the SD card **11** and is lined up in the direction along the X axis. The plurality of I/F terminals **22** is exposed to the outside of the casing **31** through the plurality of terminal holes **57** formed in the bottom cover **32**.

The I/F terminal **22** according to the present embodiment is an SD interface terminal and used for electrical connection to the host device **12**. In other words, the I/F terminal **22** can be electrically connected to the host device **12**.

The second substrate **45** of the antenna module **42** is an FPC. Thus, the second substrate **45** is thinner and more flexible than the first substrate **41**. The second substrate **45** may be another substrate such as a PCB.

The second substrate **45** includes a connection surface **45***a*. The connection surface **45***a* faces the top cover **33**. Apart of the connection surface **45***a* of the second substrate **45** faces a part of the second surface **41***b* of the first substrate **41**. That is, when the first surface **41***a* is viewed in a plan view as illustrated in FIG. **3**, a part of the first substrate **41** overlies a part of the second substrate **45**.

The second substrate **45** is formed in an approximately square shape. Thus, a greater number of second substrates **45** maybe obtained from one large substrate. The second substrate **45** may be formed in other shapes.

The length of the second substrate **45** in the direction along the Y axis is greater than the length of the first substrate **41** in the direction along the Y axis. The dimensions of the second substrate **45** are not limited thereto. For example, the length of the second substrate **45** in the direction along the Y axis maybe smaller than the length of the first substrate **41** in the direction along the Y axis. The length of the second substrate **45** in the direction along the X axis is smaller than the length of the first substrate **41** in the direction along the X axis. The dimensions of the second substrate **45** are not limited thereto. For example, the length of the second substrate **45** in the direction along the X axis may be greater than the length of the first substrate **41** in the direction along the X axis.

The first antenna pattern **46** is mounted on the second substrate **45**. The first antenna pattern **46** according to the present embodiment is a wiring pattern that is formed on the second substrate **45**. The first antenna pattern **46** maybe formed of another material such as an insulated copper wire. The first antenna pattern **46** of the wireless antenna **23** is a loop antenna that is formed in a coil shape. The first antenna pattern **46** is formed in an approximately quadrangular annular shape in the present embodiment. The first antenna pattern **46** may be formed in another shape such as a circular annular shape.

The first antenna pattern **46**, which is a loop antenna, is formed by using a conductor (wiring pattern) that extends to surround an inside region of the first antenna pattern **46**. Any conductor that surrounds the inside region of the first antenna pattern **46** may be used for the first antenna pattern **46**, and the conductor may be wound less than once. In other words, the inside region of the first antenna pattern **46** may be connected with the outside region of the first antenna pattern **46**. The conductor may be wound a plurality of times. Applying a voltage to the end portion of the conductor causes the first antenna pattern **46** to generate magnetic flux that passes through the inside of the first antenna pattern **46**. In addition, the magnetic flux passing through the inside of the first antenna pattern **46** generates a voltage in the conductor. The first antenna pattern **46** communicates with an external device using the electromagnetic induction.

The second substrate **45** includes a first part P**1**, a second part P**2**, and a third part P**3** (See FIG. **3**). Each of the first to third parts P**1** to P**3** may be referred to as, for example, a region or an area.

The first part P**1** is a part of the second substrate **45** in which the first antenna pattern **46** is mounted. More specifically, the first part P**1** is a part of the second substrate **45** that overlies the first antenna pattern **46** when the connection surface **45***a* of the second substrate **45** is viewed as illustrated in FIG. **3**.

The second part P**2** is a part of the second substrate **45** that is surrounded by the first part P**1**. The third part P**3** is a part of the second substrate **45** that surrounds the first part P**1**. In other words, the third part P**3** is positioned between the first part P**1** and side surfaces **45***b* of the second substrate **45**. The first part P**1** is positioned between the second part P**2** and the third part P**3**.

As illustrated by broken lines in FIG. **3**, two first pads **71** and two second pads **72** are formed on the second surface **41***b* of the first substrate **41**. The two first pads **71** are one example of a plurality of first pads and may be referred to as, for example, a pattern, a land, a conductor, or a metal portion. Each of the two second pads **72** is one example of a second pad and may be referred to as, for example, a pattern, a land, a conductor, or a metal portion.

As illustrated in FIG. **2**, a circuit C is disposed on the first substrate **41**. The circuit C includes the I/F terminal **22**, the communication controller **24**, the flash memory **25**, the memory controller **26**, the two first pads **71** in FIG. **3**. In addition, various wiring and electronic components are provided in the first substrate **41**. That is, the circuit C is formed on the first substrate **41**, and a current externally supplied or induced in the SD card **11** flows therein.

As described above, the two first pads **71** in FIG. **3** are included in the circuit C. Meanwhile, the two second pads **72** are electrically independent of the circuit C. That is, when a current flows in the circuit C, a current does not flow in the second pads **72**. The second pads **72** may be connected to ground.

The first antenna pattern **46** of the antenna module **42** includes two third pads **75**. Furthermore, the second substrate **45** includes two fourth pads **76**. The third and fourth pads **75** and **76** are illustrated by broken lines in FIG. **3**. The two third pads **75** are one example of a plurality of third pads and may be referred to as, for example, a pattern, a land, a conductor, or a metal portion. Each of the two fourth pads **76** is one example of a fourth pad and may be referred to as, for example, a pattern, a land, a conductor, or a metal portion.

The two third pads **75** are two terminals of the first antenna pattern **46**. In other words, one third pad **75** is provided in one end portion of the first antenna pattern **46**. The other third pad **75** is provided in the other end portion of the first antenna pattern **46**.

The two fourth pads **76** are electrically independent of the first antenna pattern **46**. For example, when a current flows in the first antenna pattern **46**, a current does not flow in the fourth pads **76**. The fourth pads **76** may be connected to ground.

One third pad **75** and one fourth pad **76** are provided in the second part P**2** of the second substrate **45**. The other third pad **75** and the other fourth pad **76** are provided in the third part P**3** of the second substrate **45**. At least one of the two third pads **75** and at least one of the two fourth pads **76** are provided in the second part P**2**, and at least one of the two third pads **75** and at least one of the two fourth pads **76** are provided in the third part P**3**. Alternatively, all of the two third pads **75** and the two fourth pads **76** may be provided in the second part P**2** or the third part P**3**.

The third pads **75** and the fourth pads **76** are provided on the connection surface **45***a* of the second substrate **45**. The two third pads **75** are soldered to the corresponding first pads **71** of the first substrate **41** using a solder **78** illustrated in FIG. **4**. The two fourth pads **76** are soldered to the corresponding second pads **72** of the first substrate **41** using the solder **78**.

Soldering the third pads **75** to the first pads **71** causes the first antenna pattern **46** to be electrically connected to the circuit C of the first substrate **41**. The first antenna pattern **46** is electrically connected to, for example, the communication controller **24**. Meanwhile, the second pads **72** and the fourth pads **76** that are soldered to each other are electrically independent of the circuit C and the first antenna pattern **46**.

Soldering the third pads **75** to the first pads **71** and the fourth pads **76** to the second pads **72** causes the antenna module **42** to be attached to the first substrate **41**. The third pads **75** are fixed to the corresponding first pads **71** using the solder **78**. Furthermore, the fourth pads **76** are fixed to the corresponding second pads **72** using the solder **78**.

Apart of the first antenna pattern **46** overlies the first substrate **41** when the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **3**. Furthermore, a part of the first part P**1**, a part of the second part P**2**, and a part of the third part P**3** of the second substrate **45** overlie the first substrate **41**.

Furthermore, when the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **3**, a part of an inside **46***a* of the first antenna pattern **46** is positioned outside of the first substrate **41**. In other words, apart of the inside **46***a* of the first antenna pattern **46** does not overlie the first substrate **41**. The inside **46***a* of the first antenna pattern **46** is a region surrounded by the annular first antenna pattern **46**. The inside **46***a* maybe empty. In addition, a component may be disposed in the inside **46***a*. When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **3**, a part of the first antenna pattern **46** as well is positioned outside of the first substrate **41**.

In other words, when the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **3**, a part of the second part P**2** of the second substrate **45** is positioned outside of the first substrate **41**. When the first surface **41***a* is viewed as illustrated in FIG. **3**, the inside **46***a* of the first antenna pattern **46** substantially matches the second part P**2**. The inside **46***a* of the first antenna pattern **46** may be different from the second part P**2**.

As illustrated in FIG. **4**, a part of the inside **46***a* of the first antenna pattern **46** that is positioned outside of the first substrate **41** faces the bottom cover **32** and the top cover **33** in the direction along the Z axis. In other words, a part of the inside **46***a* of the first antenna pattern **46** that is positioned outside of the first substrate **41** overlies, in the direction along the Z axis, the bottom cover **32** and the top cover **33** that are formed by using resin.

As illustrated in FIG. **3**, a plurality of connection pads **81** is provided on the first surface **41***a* of the first substrate **41**. Each of the plurality of connection pads **81** is one example of a connection pad and may be referred to as, for example, a pattern, a land, a conductor, or a metal portion. Each of the plurality of connection pads **81** is electrically connected to the corresponding terminal of the communication controller **24**, the flash memory **25**, or the memory controller **26** by, for example, soldering. The connection pads **81** may be provided on the second surface **41***b*.

A first lead **82** extends from each of the plurality of connection pads **81**. The first lead **82** is covered with, for example, a first solder resist **83** of the first substrate **41**. The first solder resist **83** forms at least a part of the first surface **41***a* of the first substrate **41**. FIG. **3** illustrates the first lead **82** with a double-dot chain line for description.

The first lead **82** extends from the corresponding connection pad **81** to the end surface **41***c* of the first substrate **41**. In other words, the first lead **82** extends to the end of the first surface **41***a* of the first substrate **41**. The first lead **82** may include a plurality of curved parts. The end portion of the first lead **82** is apart from the end of the first surface **41***a*.

A plurality of first openings **84** is provided in the first solder resist **83**. The first opening **84** is, for example, a notch that extends from the end of the first surface **41***a* of the first substrate **41**. The first opening **84** may be a hole.

When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **3**, the end portion of the first lead **82** substantially overlies the edge of the first solder resist **83** that forms the first opening **84**. The end portion of the first lead **82** may be arranged in other positions. The first opening **84** is used when etchback is performed on the first lead **82**.

As illustrated in FIG. **4**, a seal resin **86** covers the first surface **41***a* of the first substrate **41**, the communication controller **24**, the flash memory **25**, and the memory controller **26**. The seal resin **86** is, for example, synthetic resin and closely adheres to the first surface **41***a* of the first substrate **41**, the communication controller **24**, the flash memory **25**, and the memory controller **26**. The seal resin **86** covers the first opening **84** of the first solder resist **83**. FIG. **3** illustrates the first substrate **41** without the seal resin **86**.

The wireless antenna **23** (first antenna pattern **46**) in FIG. **2** generates a current or a voltage by the electromagnetic induction in the SD card **11** described above when the wireless antenna **23** receives an electromagnetic wave emitted from the wireless communication host device **13**. The wireless antenna **23** supplies generated power to the communication controller **24**.

The wireless antenna **23** according to the present embodiment is set to conform to a predetermined frequency or a frequency bandwidth corresponding to NFC. Since a part of the first antenna pattern **46** and a part of the inside **46***a* of the wireless antenna **23** overlie the first substrate **41** in the direction along the Z axis, the frequency or the frequency bandwidth of the electromagnetic wave received by the first antenna pattern **46** may be shifted. The frequency or the frequency bandwidth of the electromagnetic wave is adjusted by, for example, the capacitor **27**.

The wireless antenna **23** sends data received from the wireless communication host device **13** to the communication controller **24**. Furthermore, the wireless antenna **23** sends data received from the communication controller **24** to the wireless communication host device **13**.

That is, the communication controller **24** can communicate with the wireless communication host device **13** through the wireless antenna **23**. The communication controller **24** controls NFC with the wireless communication host device **13** using the wireless antenna **23**.

The communication controller **24** can be operated with power that is generated by the wireless antenna **23** by the electromagnetic induction. The communication controller **24** receives a signal or data that is represented by a current or a voltage generated by the wireless antenna **23** based on the electromagnetic wave from the wireless communication host device **13**, and is operated in accordance with the signal or data. For example, the communication controller **24**, when operated, receives data from the wireless communication host device **13** through the wireless antenna **23** at a predetermined frequency corresponding to NFC and writes the data into the storage unit **24***a*. In addition, the communication controller **24**, when operated, reads data written in the storage unit **24***a* and sends the data to the wireless communication host device **13** through the wireless antenna **23**. More specifically, the communication controller **24** can perform NFC when the communication controller **24** receives a signal of a predetermined frequency corresponding to NFC through the wireless antenna **23**.

The communication controller **24**, when performing data writing in the flash memory **25**, sends data received from the host device **12** through the I/F terminal **22** to the memory controller **26**. The communication controller **24**, when performing data reading from the flash memory **25**, sends data received from the memory controller **26** to the host device **12** through the I/F terminal **22**.

A sufficient amount of power should be supplied to the communication controller **24** when, for example, the SD card **11** is electrically connected to the host device **12**. In this case, the communication controller **24** may write, into the flash memory **25** through the memory controller **26**, data that is received by NFC from the wireless communication host device **13** through the wireless antenna **23**.

When a sufficient amount of power is supplied to the communication controller **24**, the communication controller **24** may read data written in the flash memory **25** through the memory controller **26** and may write the data into the storage unit **24***a*.

Also, when a sufficient amount of power is supplied to the communication controller **24**, the communication controller **24** may read a part or the entirety of data written in the flash memory **25** through the memory controller **26** and may send the read data to the wireless communication host device **13** through the wireless antenna **23**.

The storage unit **24***a* is a low-power-consuming memory that can be operated by power generated by the wireless antenna **23**. The storage unit **24***a* is, for example, a nonvolatile memory. The storage unit **24***a* stores data based on control of the communication controller **24** or the memory controller **26**. The storage unit **24***a* may be a (volatile) memory that temporarily stores data. The storage unit **24***a* is, for example, an electrically erasable programmable read-only memory (EEPROM). The storage unit **24***a* may be other types of memory.

As described above, the communication controller **24** and the storage unit **24***a* can be operated with power that is generated in the wireless antenna **23** by the electromagnetic wave from the wireless communication host device **13**. The communication controller **24** and the storage unit **24***a* may be operated with power supplied from the host device **12** when the SD card **11** is supplied with power from the host device **12**.

The voltage detector **24***b* monitors a level of voltage supplied from the wireless antenna **23** to the communication controller **24** and continues to output a reset signal for NFC communication until the voltage reaches a predetermined value. As a result, a faulty start and faulty operation of NFC communication can be prevented.

The flash memory **25** is, for example, a NAND-type flash memory. A nonvolatile memory is not limited to a NAND-type flash memory and may be another nonvolatile memory such as a NOR-type flash memory, a magnetoresistive random access memory (MRAM), a phase change random access memory (PRAM), a resistive random access memory (ReRAM), or a ferroelectric random access memory (FeRAM).

The memory controller **26** controls writing and reading of data with respect to the flash memory **25**. More specifically, when the memory controller **26** receives a write instruction and data from the host device **12** through the I/F terminal **22** and the communication controller **24**, the memory controller **26** writes the data into the flash memory **25**. When the memory controller **26** receives a read instruction from the host device **12** through the I/F terminal **22** and the communication controller **24**, the memory controller **26** reads data from the flash memory **25** and sends the data to the host device **12** through the communication controller **24** and the I/F terminal **22**.

A sufficient amount of power should be supplied to the memory controller **26** when, for example, the SD card **11** is electrically connected to the host device **12**. In this case, the memory controller **26** may write, into the flash memory **25**, data that is received from the wireless communication host device **13** through the wireless antenna **23** and the communication controller **24**. When a sufficient amount of power is supplied to the memory controller **26**, the memory controller **26** may send data read from the flash memory **25** to the wireless communication host device **13** through the communication controller **24** and the wireless antenna **23**.

The flash memory **25** and the memory controller **26** are operated with power supplied from the host device **12**.

The capacitor **27** includes, for example, two terminals. One terminal is electrically connected to one end of the wireless antenna **23**. The other terminal is electrically connected to the other end of the wireless antenna **23**.

The capacitor **27** adjusts the frequency of a current or a voltage generated in the wireless antenna **23**. More specifically, the capacitor **27** adjusts a shift in the frequency of NFC that is caused by a part of the first antenna pattern **46** and a part of the inside **46***a* of the wireless antenna **23** overlying the first substrate **41** in the direction along the Y axis.

The above data may be, for example, data that is sent and received between the wireless communication host device **13** and the SD card **11** in accordance with the NFC interface, feature data of data written in the flash memory **25**, feature data that is received by the communication controller **24** from the wireless communication host device **13** through the wireless antenna **23**, feature data that is related to the flash memory **25**, or feature data that is related to the SD card **11**. More specifically, the data may be, for example, a partial (for example, initial or last) data of image data written in the flash memory **25**, thumbnail data, management information for data written in the flash memory **25**, the memory capacity of the flash memory **25**, the remaining capacity of the flash memory **25**, the name of a file written in the flash memory **25**, the time when the data was generated, data of image captured time when the data is image data, or the number of files written in the flash memory **25**.

The write instruction and the data from the host device **12** are first received by the communication controller **24** and are then received by the memory controller **26** in the present embodiment. The reason is that a determination of whether the communication controller **24** receives the write instruction and the data from the host device **12** or from the wireless communication host device **13** is first performed, and the following operation is differentiated according to the determination result.

As described above, the SD card **11** sends data to and receives data from the wireless communication host device **13** using power that is generated by the electromagnetic induction at the wireless antenna **23**. Specifically, magnetic flux passing through the inside **46***a* of the first antenna pattern **46** of the wireless antenna **23** during the NFC causes the first antenna pattern **46** to generate power and causes the communication controller **24** to receive a signal or data that is represented by a current or a voltage generated by the first antenna pattern **46**. Furthermore, the communication controller **24** generates magnetic flux that passes through the inside **46***a* of the first antenna pattern **46** of the wireless antenna **23**, thereby sending data to the wireless communication host device **13**.

When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **3**, a part of the inside **46***a* of the first antenna pattern **46** is positioned outside of the first substrate **41**. Thus, magnetic flux that passes through the inside **46***a* of the first antenna pattern **46** is less likely to be interfered by the first substrate **41** and the communication controller **24**, the flash memory **25**, and the memory controller **26** mounted on the first substrate **41**.

The first antenna pattern **46** of the antenna module **42** is connected to the first substrate **41** in the SD card **11** according to the first embodiment. Generally, a loop antenna such as the first antenna pattern **46** is less expensive than a chip antenna. Thus, an increase in the manufacturing cost of the SD card **11** is prevented, compared with when a chip antenna instead of the first antenna pattern **46** is mounted on the first substrate **41**. Furthermore, the area in which the first antenna pattern **46**, which is a loop antenna, generates magnetic flux is wider than an area in which a chip antenna generates magnetic flux. As a result, a NFC communication range can become wider. Furthermore, when the first surface **41***a* is viewed as illustrated in FIG. **3**, at least a part of the first antenna pattern **46** is positioned outside of the first substrate **41**. For that reason, magnetic flux that is generated by the first antenna pattern **46** is less likely to be interfered by the pattern of the first substrate **41** and electronic components such as the flash memory **25** mounted on the first substrate **41**. Furthermore, the first substrate **41** which is a PCB can have a small size, and an increase in the manufacturing cost of the SD card **11** can be prevented.

When the first surface **41***a* is viewed as illustrated in FIG. **3**, at least a part of the first antenna pattern **46** is positioned outside of the first substrate **41**. For that reason, magnetic flux that passes through the inside **46***a* of the first antenna pattern **46** is less likely to be interfered by the pattern of the first substrate **41** and electronic components such as the flash memory **25** mounted on the first substrate **41**.

The SD card **11** includes the second substrate **45** in which the first antenna pattern **46** is mounted and that is different from the first substrate **41**. Thus, the antenna module **42** that includes the first antenna pattern **46** mounted on the second substrate **45** may be manufactured in advance independently of the first substrate **41**. Coupling the antenna module **42** with the first substrate **41** causes the first antenna pattern **46** to be connected to the first substrate **41**.

The first antenna pattern **46** is electrically connected to the circuit C by soldering the plurality of third pads **75** to the plurality of first pads **71**. Furthermore, the fourth pad **76** of the second substrate **45** is soldered to the second pad **72** provided in the first substrate **41**. Accordingly, the antenna module **42** is securely attached to the first substrate **41**, compared with when, for example, only the third pad **75** is soldered to the first pad **71**. Furthermore, electrical connection between the first substrate **41** and the first antenna pattern **46** can be retained even if accuracy of the dimensions of the first and second recess portions **55** and **56**, which determines the positions of the first substrate **41** and the antenna module **42**, is low.

At least one of the plurality of third pads **75** and the fourth pads **76** is provided in the second part P2, and at least another one of the plurality of third pads **75** and the fourth pads **76** is provided in the third part P3. Accordingly, the second substrate **45** is less likely to be separated from the first substrate **41**, and the plurality of first pads **71** is less likely to be separated from the plurality of third pads **75**.

The second substrate **45** is thinner than the first substrate **41**. Accordingly, the SD card **11** would not become thick even though the first antenna pattern **46** mounted on the second substrate **45** overlies the first substrate **41**.

Generally, influence on the magnetic flux of the first antenna pattern **46** by the overlap of the first antenna pattern **46** with the first substrate **41** is less than influence on the magnetic flux of the first antenna pattern **46** by the overlap of the inside **46***a* of the first antenna pattern **46** with the first substrate **41**. When the first surface **41***a* is viewed as illustrated in FIG. **3**, at least a part of the first antenna pattern **46** overlies the first substrate **41** (is positioned in the first substrate **41**) in the present embodiment. Thus, the magnetic flux of the first antenna pattern **46** is less likely to be interfered by the first substrate **41** when the first antenna pattern **46** and the inside **46***a* of the first antenna pattern **46** are formed large.

The first recess portion **55** accommodating the first substrate **41** and the second recess portion **56** accommodating the antenna module **42** and the first antenna pattern **46** of the antenna module **42** are provided in the bottom cover **32**. Since the first substrate **41** and the first antenna pattern **46** are contained in the first and second recess portions **55** and **56**, the positions of the first substrate **41** and the first antenna pattern **46** can be determined in the casing **31**.

Second Embodiment

Hereinafter, a second embodiment will be described with reference to FIG. **5** to FIG. **11**. In the description of a plurality of embodiments below, elements having the same or similar function as previously-described elements will be designated by the same reference signs as the previously-described elements and may not be described further. The plurality of elements designated by the same reference signs may not necessarily have the same functions and properties and may have different functions and properties according to each embodiment.

FIG. **5** is a plan view of the SD card **11** according to the second embodiment, from which the top cover **33** is removed. The first surface **41***a* of the first substrate **41**, the communication controller **24**, the flash memory **25**, the memory controller **26**, the first solder resist **83**, and the first opening **84** are covered with the seal resin **86** in the same manner as the first embodiment. The seal resin **86** of the second embodiment is one example of a covering member.

FIG. **6** is a plan view of the first substrate **41** according to the second embodiment, from which the seal resin **86** is removed. FIG. **7** is a bottom view of the first substrate **41** according to the second embodiment. FIG. **8** is a cross-sectional view of a part of the first substrate **41** according to the second embodiment taken along a line F**8**-F**8** in FIG. **6**.

As illustrated in FIG. **8**, the first substrate **41** includes the first solder resist **83**, a base substrate **91**, and a second solder resist **92**. The base substrate **91** may be referred to as, for example, a base. The first substrate **41** may include more layers than the one illustrated in FIG. **8**.

The base substrate **91** is, for example, an insulating board that is formed of paper or glass fabric covered with synthetic resin. The base substrate **91** may be formed of other materials. The base substrate **91** includes a first surface **91***a* and a second surface **91***b*. The first surface **91***a* is one example of a forming surface.

The first surface **91***a* is an approximately flat surface that faces the top cover **33**. The first surface **91***a* forms a part of the first surface **41***a* of the first substrate **41**. The first surface **91***a* is covered with the first solder resist **83**. The first solder resist **83** according to the second embodiment is one example of a solder resist. The first solder resist **83** forms a part of the first surface **41***a* of the first substrate **41**.

The second surface **91***b* is an approximately flat surface that faces the bottom cover **32**. The second surface **91***b* is opposite to the first surface **91***a*. The second surface **91***b* forms a part of the second surface **41***b* of the first substrate **41**. The second surface **91***b* is covered with the second solder resist **92**. The second solder resist **92** forms a part of the second surface **41***b* of the first substrate **41**.

As illustrated in FIG. **6**, the first substrate **41** according to the second embodiment includes a second antenna pattern **101**. The second antenna pattern **101** is one example of a second antenna. The second antenna pattern **101** includes a first pattern portion **101***a*, a second pattern portion **101***b*, and a third pattern portion **101***c*. The second pattern portion **101***b* is one example of first wiring. Each of the first pattern portion **101***a* and the third pattern portion **101***c* is one example of second wiring.

The first pattern portion **101***a* and the third pattern portion **101***c* illustrated in FIG. **7** are formed on the second surface **91***b* of the base substrate **91**. In other words, the first pattern portion **101***a* and the third pattern portion **101***c* are mounted on the second surface **41***b* of the first substrate **41**.

The second pattern portion **101***b* illustrated in FIG. **6** is provided on the first surface **91***a* of the base substrate **91**. In other words, the second pattern portion **101***b* is mounted on the first surface **41***a* of the first substrate **41**.

As illustrated in FIG. **7**, one end of the first pattern portion **101***a* is electrically connected to one end of the second pattern portion **101***b* through a first via **102**. One end of the third pattern portion **101***c* is electrically connected to the other end of the second pattern portion **101***b* by a second via **103**. The first to third pattern portions **101***a*, **101***b*, and **101***c* form one continuous second antenna pattern **101**. The second antenna pattern **101** extends adjacent to the end surface **41***c* of the first substrate **41**. The second antenna pattern **101** extends adjacent to, for example, the right side **11***d*, the front side **11***a*, and the left side **11***c* of the SD card **11**.

When the second surface **41***b* of the first substrate **41** is viewed as illustrated in FIG. **7**, at least apart of the second pattern portion **101***b* overlies the plurality of I/F terminals **22**. Also, at least a part of the second pattern portion **101***b* also overlies the plurality of I/F terminals **22**.

A fifth pad **105** is formed in the other end of the first pattern portion **101***a*. A sixth pad **106** is formed in the other end of the third pattern portion **101***c*. In other words, the fifth and sixth pads **105** and **106** are formed in both ends of the second antenna pattern **101**. The fifth and sixth pads **105** and **106** are provided on the second surface **41***b* of the first substrate **41**.

As illustrated in FIG. **5**, the first antenna pattern **46** of the antenna module **42** includes a first wound portion **46***b* and a second wound portion **46***c*. Each of the first wound portion **46***b* and the second wound portion **46***c* is a part of the first antenna pattern **46** that is formed in a coil shape.

The first antenna pattern **46** further includes a seventh pad **107** and an eighth pad **108**. The seventh pad **107** and the eighth pad **108** are provided on the connection surface **45***a* of the second substrate **45**.

The seventh pad **107** is provided in one end of the first wound portion **46***b* of the first antenna pattern **46**. One third pad **75** is provided in the other end of the first wound portion **46***b*. The eighth pad **108** is provided in one end of the second wound portion **46***c* of the first antenna pattern **46**. The other third pad **75** is provided in the other end of the second wound portion **46***c*.

As described above, the first antenna pattern **46** is formed in a coil shape. The pattern of the first antenna pattern **46** includes the first wound portion **46***b* and the second wound portion **46***c* in the second embodiment.

The seventh pad **107** and the eighth pad **108** are provided in the third part P**3** of the second substrate **45**. At least one of the seventh pad **107** and the eighth pad **108** may be provided in the second part P**2**.

The seventh pad **107** of the second substrate **45** is soldered to the fifth pad **105** of the first substrate **41**. Furthermore, the eighth pad **108** of the second substrate **45** is soldered to the sixth pad **106** of the first substrate **41**.

By soldering the seventh pad **107** to the fifth pad **105**, the first wound portion **46***b* of the first antenna pattern **46** is electrically connected to the first pattern portion **101***a* of the second antenna pattern **101**. Furthermore, by soldering the eighth pad **108** to the sixth pad **106**, the second wound portion **46***c* of the first antenna pattern **46** is electrically connected to the third pattern portion **101***c* of the second antenna pattern **101**. In other words, the first antenna pattern **46** is electrically connected to the second antenna pattern **101**.

The second antenna pattern **101** is connected to the first antenna pattern **46** and forms a loop antenna **111** along with the first antenna pattern **46**. That is, the loop antenna **111** includes one third pad **75**, the first wound portion **46***b*, the seventh pad **107**, the fifth pad **105**, the first pattern portion **101***a*, the first via **102**, the second pattern portion **101***b*, the second via **103**, the third pattern portion **101***c*, the sixth pad **106**, the eighth pad **108**, the second wound portion **46***c*, and the other third pad **75** that are electrically connected to one another. The wireless antenna **23** in FIG. **2** includes the loop antenna **111** in the second embodiment.

The loop antenna **111** is formed by using a conductor (the first antenna pattern **46** and the second antenna pattern **101**) that surrounds the inside region of the loop antenna **111**. Any conductor that surrounds the inside region of the loop antenna **111** may be used for the loop antenna **111**, and the conductor maybe wound less than once. In other words, the inside region of the loop antenna **111** may be connected with the outside region of the loop antenna **111**. The conductor maybe wound a plurality of times. Applying a voltage to an end of the conductor causes the loop antenna **111** to generate magnetic flux that passes through the inside of the loop antenna **111**. In addition, the magnetic flux passing through the inside of the loop antenna **111** generates a voltage in the conductor. The loop antenna **111** communicates with an external device by the electromagnetic induction.

As illustrated in FIG. **6**, the first substrate **41** includes a plurality of first regions A**1** and a second region A**2**. Each of the plurality of first regions A**1** and the second region A**2** may be referred to as, for example, a part or an area. The plurality of first regions A**1** and the second region A**2** are surrounded by the loop antenna **111**.

Each of the plurality of first regions A**1** is a part of the first substrate **41** that overlies at least one of the communication controller **24**, the flash memory **25**, and the memory controller **26**, when the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **6**.

Each of the first regions A**1** is surrounded by the second region A**2** and is separated from the loop antenna **111**. In other words, the communication controller **24**, the flash memory **25**, and the memory controller **26** are separated from the loop antenna **111**. At least one of the communication controller **24**, the flash memory **25**, and the memory controller **26** may be adjacent to the loop antenna **111**.

The second region A**2** is a part of the first substrate **41** that is surrounded by the loop antenna **111** and is different from the plurality of first regions A**1** when the first surface **41***a* is viewed as illustrated in FIG. **6**. That is, the part of the first substrate **41** surrounded by the loop antenna **111** includes the plurality of first regions A**1** and the second region A**2**. Another region different from the first and second regions A**1** and A**2** may be provided in the part of the first substrate **41** surrounded by the loop antenna **111**.

FIG. **9** is a cross-sectional view of a part of the first substrate **41** according to the second embodiment taken along a line F**9**-F**9** in FIG. **6**. As illustrated in FIG. **9**, a ground terminal **113** is provided in the first substrate **41**. The ground terminal **113** may be referred to as, for example, a ground pattern, a ground layer, or a conductor. The ground terminal **113**, for example, is provided on the first surface **91***a* of the base substrate **91**. The ground terminal **113** may be provided on the second surface **91***b*.

The ground terminal **113** is provided in each of the plurality of first regions A**1**. In other words, the ground terminal **113** is provided outside of the second region A**2**. A part of the ground terminal **113** may be provided in the second region A**2**. Furthermore, the ground terminal **113** may be provided in the part of the first substrate **41** surrounded by the loop antenna **111**.

As illustrated in FIG. **6**, the first lead **82** extends from each of the plurality of connection pads **81**. The first lead **82** that extends from the connection pad **81** is partially illustrated in FIG. **6**. Furthermore, FIG. **6** illustrates a part of first leads **82** that extend from the connection pads **81** and is hidden below the communication controller **24**, the flash memory **25**, and the memory controller **26**.

The plurality of first leads **82** is formed on the first surface **91***a*. That is, the first solder resist **83** covers the first lead **82**. FIG. **6** illustrates the first lead **82** with a double-dot chain line for description.

Some first leads **82** extend from the corresponding connection pads **81** to the second antenna pattern **101**. Some other first leads **82** extend to the end of the first surface **41***a* of the first substrate **41**. Each of the plurality of first leads **82** may include a plurality of curved portions.

FIG. **10** is a plan view of a part of the first substrate **41** according to the second embodiment. As illustrated in FIG. **10**, each of the plurality of first leads **82** includes a first end portion **82***a*. The first end portion **82***a* is an end portion of the first lead **82** that extends from the connection pad **81**. In other words, the first end portion **82***a* is positioned on the opposite end of the connection pad **81**.

The first end portion **82***a* is apart from other conductors including the second antenna pattern **101**. Specifically, the first end portion **82***a* of the first lead **82** is apart from a conductive part of a member or a component that is different from the first lead **82**. Thus, the first lead **82** is electrically separated from other conductors that are different from the connection pad **81**.

When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **10**, the first end portion **82***a* substantially overlies the edge of the first solder resist **83** that forms the first opening **84**. The first end portion **82***a* may be arranged in other positions. The first opening **84** is a hole in the second embodiment. The first opening **84** may be a notch.

As illustrated in FIG. **8**, wiring **114** is formed on the first substrate **41**. The wiring **114** is one example of a first conductive pattern. The wiring **114**, for example, is formed on the first surface **91***a* of the base substrate **91** and extends from the connection pad **81**. In other words, the wiring **114** is connected to the connection pad **81**.

The wiring **114** is electrically connected to the connection pad **81** and other conductors that are different from the connection pad **81**. For example, the wiring **114** that extends from the connection pad **81** in which the communication controller **24** is mounted is electrically connected to the connection pad **81** and the first pad **71**. The wiring **114** that extends from the connection pad **81** in which the flash memory **25** is mounted is electrically connected to the connection pad **81** and the connection pad **81** in which the memory controller **26** is mounted. The wiring **114** may connect the connection pad **81** with another conductor such as the I/F terminal **22**, the capacitor **27**, another electronic component, or another terminal.

A second lead **115** extends from the second antenna pattern **101**. The second lead **115** is formed on the first surface **91***a*. For that reason, the first solder resist **83** covers the second lead **115**. FIG. **10** illustrates the second lead **115** with a double-dot chain line for description.

The second lead **115** includes a second end portion **115***a*. The second end portion **115***a* is an end portion of the second lead **115** that extends from the second antenna pattern **101**. In other words, the second end portion **115***a* is positioned opposite to the second antenna pattern **101**.

The second end portion **115***a* is separated from other conductors including the first end portion **82***a* of the first lead **82**. Thus, the second lead **115** is electrically separated from other conductors that are different from the second antenna pattern **101**. When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **10**, the second end portion **115***a* substantially overlies the edge of the first solder resist **83** that forms the first opening **84**. The second end portion **115***a* may be arranged in other positions.

The number of first leads **82** is greater than the number of second leads **115**. The first end portions **82***a* of the plurality of first leads **82** substantially overlie the second end portion **115***a* of one second lead **115** on the edge of the first solder resist **83** that forms one first opening **84**. The first opening **84** overlies the region between the first end portion **82***a* of the first lead **82** and the second end portion **115***a* of the second lead **115** when the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **10**.

A third lead **116** extends from the second antenna pattern **101**. The third lead **116** is formed on the first surface **91***a*. For that reason, the first solder resist **83** covers the third lead **116**. FIG. **10** illustrates the third lead **116** with a double-dot chain line for description.

The third lead **116** is positioned between the second antenna pattern **101** and the end surface **41***c* of the first substrate **41**. The third lead **116** extends from the second antenna pattern **101** to the end surface **41***c* of the first substrate **41**. In other words, the third lead **116** extends from the second antenna pattern **101** to the end of the first surface **41***a* of the first substrate **41**.

The third lead **116** includes a third end portion **116***a*. The third end portion **116***a* is an end portion of the third lead **116** that extends from the second antenna pattern **101**. In other words, the third end portion **116***a* is positioned opposite to the second antenna pattern **101**.

A second opening **119** is formed in the first solder resist **83**. The second opening **119** is, for example, a notch that extends from the end of the first surface **41***a* of the first substrate **41**. The second opening **119** may be a hole.

When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **10**, the third end portion **116***a* of the third lead **116** substantially overlies the edge of the first solder resist **83** that forms the second opening **119**. The third end portion **116***a* is separated from other conductors. Thus, the third lead **116** is electrically separated from other conductors that are different from the second antenna pattern **101**. The third end portion **116***a* may be arranged in other positions. The second opening **119** is covered with the seal resin **86** in the same manner as the first opening **84**.

As described above, the first to third leads **82**, **115**, and **116** are mounted on the first surface **91***a* of the first substrate **41** in the present embodiment. The first to third leads **82**, **115**, and **116** may be mounted on another location such as the second surface **91***b*.

As described above, the fifth pad **105** and the sixth pad **106** are formed in both end portions of the second antenna pattern **101**. In other words, the fifth and sixth pads **105** and **106** are connected to the second antenna pattern **101**.

The fifth pad **105** electrically connects the second antenna pattern **101** with the seventh pad **107**. The sixth pad **106** electrically connects the second antenna pattern **101** with the eighth pad **108**. Each of the fifth and sixth pads **105** and **106** is one example of a second conductive pattern that electrically connects the second antenna pattern **101** with other conductors different from the second antenna pattern **101**. The second conductive pattern is not limited to the fifth and sixth pads **105** and **106** and may be other conductive patterns.

Hereinafter, a part of a method for manufacturing the first substrate **41** of the second embodiment will be illustrated. A method for manufacturing the first substrate **41** is not limited to the method below and may use other methods.

FIG. **11** is a plan view of a part of the first substrate **41** at a process of manufacturing processes according to the second embodiment. A first plated lead L**1** and a second plated lead L**2** illustrated in FIG. **11** are provided on the first surface **91***a* of the base substrate **91** before the plurality of connection pads **81** is formed in the first substrate **41**.

The plurality of connection pads **81** and a plurality of other pads are formed by electroplating on the base substrate **91** in which the first and second plated leads L**1** and L**2** are provided. The first and second plated leads L**1** and L**2** are provided in order to form the plurality of connection pads **81** and the plurality of other pads by, for example, electroplating.

The first plated lead L**1** includes the plurality of first leads **82** and the second lead **115**. In other words, the plurality of first leads **82** and the second lead **115** that are connected to each other form the first plated lead L**1**.

The first plated lead L**1** extends from the second antenna pattern **101**, includes a plurality of branching parts, and is connected to the plurality of connection pads **81**. In other words, the connection pad **81** is formed in a plurality of end portions of the first plated lead L**1** by electroplating.

The second plated lead L**2** includes the third lead **116**. The second plated lead L**2** extends from the second antenna pattern **101** to the end surface **41***c* of the first substrate **41**. The second plated lead L**2** is electrically connected to the plurality of connection pads **81** through the second antenna pattern **101** and the first plated lead L**1**. In other words, the second plated lead L**2**, the second antenna pattern **101**, the first plated lead L**1**, and the plurality of connection pads **81** have the same electrical potential. The second plated lead L**2**, the second antenna pattern **101**, the first plated lead L**1**, and the plurality of connection pads **81** may have different electrical potentials.

The second plated lead L**2** is connected to a power source when the connection pad **81** is formed by electroplating. For example, before a plurality of first substrates **41** is cut out of one aggregate substrate, a lead that is connected to the second plated lead L**2** of each of the first substrates **41** is formed on the aggregate substrate that includes the plurality of first substrates **41**. Clamping the aggregate substrate to a jig connected to a power source causes a voltage to be applied to the second plated lead L**2** through the lead. Applying a voltage to the first plated lead L**1** through the second plated lead L**2** and the second antenna pattern **101** forms the connection pad **81** by electroplating. The aggregate substrate may be referred to as a frame, a strip, a sheet, or an aggregate.

A part of the first plated lead L**1** is exposed at the plurality of first openings **84**. The first opening **84** exposes, for example, a connection portion at which the plurality of first leads **82** is connected with the second lead **115** (branching part). A part of the second plated lead L**2** is exposed at the second opening **119**.

When the plurality of connection pads **81** is formed, a part of the first plated lead L**1** and a part of the second plated lead L**2** are removed by, for example, etchback. The first plated lead L**1** is etched back through the first opening **84**, thereby being formed into the plurality of first leads **82** and the second lead **115**. The second plated lead L**2** is etched back through the second opening **119** and thereby forms the third lead **116**. As a result, the plurality of connection pads **81** is electrically separated from the second antenna pattern **101**.

Next, the communication controller **24**, the flash memory **25**, and the memory controller **26** are electrically connected to the formed plurality of connection pads **81** by soldering. Then, the seal resin **86** is formed to cover the first surface **41***a* of the first substrate **41**, the communication controller **24**, the flash memory **25**, the memory controller **26**, the first solder resist **83**, the first opening **84**, and the second opening **119**. The first substrate **41** is manufactured as described above.

The second antenna pattern **101** that forms one loop antenna **111** along with the first antenna pattern **46** is formed on the first substrate **41** in the SD card **11** of the second embodiment. For that reason, the area in which magnetic flux is generated from the first antenna pattern **46** and the second antenna pattern **101** is enlarged in the direction along the X axis and the direction along the Y axis, and a communicable range using the magnetic flux is enlarged, compared with when the SD card **11** includes only the first antenna pattern **46**. Furthermore, the amount of magnetic flux that may be captured by the loop antenna **111** is greater than the amount of magnetic flux that may be captured by the first antenna pattern **46**, and thus the communicable range using the magnetic flux is enlarged in the direction along the Z axis. Since the communicable range is enlarged, and the communication characteristic of the SD card **11** can be improved.

The second antenna pattern **101** includes the second pattern portion **101***b* formed on the first surface **91***a* and the first and third pattern portions **101***a* and **101***c* formed on the second surface **91***b*. Since a part of the second antenna pattern **101** is formed on the second surface **91***b*, the area in which various electronic components such as the flash memory **25** can be formed on the first surface **41***a* would not be compromised.

The first substrate **41** includes the first region A**1** in which an electronic component such as the flash memory **25** is mounted and in which the ground terminal **113** is provided, and the second region A**2** that is different from the first region A**1**. By providing the second region A**2**, influence of the communication controller **24**, the flash memory **25**, the memory controller **26**, and the ground terminal **113** on the magnetic flux at the loop antenna **111** that is formed with the first antenna pattern **46** and the second antenna pattern **101** can be reduced.

The first lead **82** extends from the connection pad **81** to which an electronic component such as the flash memory **25** is connected. The first lead **82** is electrically separated from other conductors. Meanwhile, the second lead **115** extends from the second antenna pattern **101**. The second lead **115** is electrically separated from other conductors. The first and second leads **82** and **115**, for example, are connected during the manufacturing processes of the SD card **11** and form the first plated lead L**1**. In this case, by applying a voltage to the first and second leads **82** and **115** through the second antenna pattern **101**, the connection pad **81** is formed in the end portion of the first lead **82** by electroplating. The first lead **82** and the second lead **115** are split after the connection pad **81** is formed. The connection pad **81** can be formed by electroplating using the first and second leads **82** and **115** on the first substrate **41** in which the second antenna pattern **101** is formed.

The first opening **84** that overlies the region between the first end portion **82***a* of the first lead **82** and the second end portion **115***a* of the second lead **115** is provided in the first solder resist **83**. As a result, the first lead **82** and the second lead **115** that are connected to each other can be split by, for example, etchback through the first opening **84** in the manufacturing processes of the SD card **11**.

The seal resin **86** covers the flash memory **25**, the memory controller **26**, and the first opening **84** of the first solder resist **83**. For that reason, the seal resin **86** protects the flash memory **25**, the memory controller **26**, and the first surface **91***a*, and the flash memory **25**, the memory controller **26**, and the first surface **91***a* are less likely to be damaged.

The third lead **116** extends from the second antenna pattern **101** between the second antenna pattern **101** and the end surface **41***c* of the first substrate **41**. The third lead **116** is electrically separated from other conductors. The third lead **116**, for example, can be connected to a power source during the manufacturing processes of the SD card **11**. Then, by applying a voltage to the first lead **82** through the third lead **116**, the second antenna pattern **101**, and the second lead **115**, the connection pad **81** is formed by electroplating. The third lead **116** is split from the lead of the aggregate substrate after the connection pad **81** is formed. The connection pad **81** can be formed by electroplating using the first and second leads **82** and **115** on the first substrate **41** in which the second antenna pattern **101** is formed.

The number of the plurality of first leads **82** is greater than the number of the plurality of second leads **115**. The plurality of first leads **82**, for example, is connected to corresponding one of the second leads **115** during the manufacturing processes of the SD card **11**. By removing the part in which the plurality of first leads **82** is connected with the second lead **115** by, for example, etchback, the plurality of first leads **82** each of which includes the first end portion **82***a* separated from other conductors, and the second lead **115** that includes the second end portion **115***a* separated from other conductors are formed. As the number of the second leads **115** does not need to correspond to the number of first leads **82**, an increase in the number of second leads **115** can be prevented. Therefore, a region of conductors existing inside of the second antenna pattern **101** is decreased, and influence on the magnetic flux at the loop antenna **111** that is formed with the first antenna pattern **46** and the second antenna pattern **101** can be minimized.

Hereinafter, a modification example of the second embodiment will be described with reference to FIG. **12**. FIG. **12** is a plan view of the SD card **11** according to the modification example of the second embodiment, from which the top cover **33** is removed.

As illustrated in FIG. **12**, the side surfaces **41***c* of the first substrate **41** include a front side surface **41***ca*, a rear side surface **41***cb*, a left side surface **41***cc*, and a right side surface **41***cd*. The naming of the front side surface **41***ca*, the rear side surface **41***cb*, the left side surface **41***cc*, and the right side surface **41***cd* are based on the position in FIG. **12** and do not limit the directions and other features of the side surfaces **41***ca*, **41***cb*, **41***cc*, and **41***cd*.

The front side surface **41***ca* is one side surface of the first substrate **41** in the direction along the Y axis. The I/F terminal **22** is adjacent to the front side surface **41***ca*. The rear side surface **41***cb* is the other side surface of the first substrate **41** in the direction along the Y axis and is positioned opposite to the front side surface **41***ca*. The front side surface **41***ca* and the rear side surface **41***cb* extend in the direction along the X axis.

The left side surface **41***cc* is one side surface of the first substrate **41** in the direction along the X axis. The right side surface **41***cd* is the other side surface of the first substrate **41** in the direction along the X axis and positioned opposite to the left side surface **41***cc*. The left side surface **41***cc* and the right side surface **41***cd* extend in the direction along the Y axis.

The second antenna pattern **101** extends adjacent to the front side surface **41***ca*, a part of the rear side surface **41***cb*, the left side surface **41***cc*, and the right end surface **41***cd* of the first substrate **41**. The second antenna pattern **101** is open in the part of the end surface **41***c* adjacent to the rear side surface **41***cb*. In other words, the inside region of the second antenna pattern **101** is connected with the outside region of the second antenna pattern **101** in the part of the end surface **41***c* adjacent to the rear side surface **41***cb*. The shape of the second antenna pattern **101** is not limited thereto.

Each of the plurality of first leads **82** extends from the connection pad **81** to the rear side surface **41***cb* of the first substrate **41** according to the modification example of the second embodiment. In other words, the first lead **82** extends in the direction apart from the front side surface **41***ca* to which the I/F terminal **22** is adjacent.

When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **12**, the first end portion **82***a* of the first lead **82** substantially overlies the rear side surface **41***cb*. That is, the first lead **82** extends from the connection pad **81** to the rear side surface **41***cb*. The first end portion **82***a* is separated from other conductors including the second antenna pattern **101**.

The second antenna pattern **101** may exist on the extension lines of some first leads **82** that extend from the connection pads **81**. In this case, the first lead **82** includes at least one curved part and extends along a path that does not intersect with the second antenna pattern **101**. In other words, the first lead **82** extends away from the second antenna pattern **101** and is apart from the second antenna pattern **101**.

All of the first leads **82** do not intersect with the second antenna pattern **101** and extend from the connection pads **81** to the rear side surface **41***cb* in the modification example of the second embodiment. The first lead **82** is electrically separated from other conductors that are different from the connection pad **81**.

At least one connection pad **81** is closer to one of the front side surface **41***ca*, the left side surface **41***cc*, and the right end surface **41***cd* than to the rear side surface **41***cb*. That is, the first lead **82** extends from the connection pad **81** to the rear side surface **41***cb* and not to the front side surface **41***ca*, the left side surface **41***cc*, or the right end surface **41***cd* which is the closest end surface **41***c*.

The first opening **84** is not provided in the first solder resist **83** in the modification example of the second embodiment. The first opening **84** may be provided in the first solder resist **83**, though the first end portion **82***a* of the first lead **82** overlies the rear side surface **41***cb* as described above.

The rear side surface **41***cb* of the first substrate **41** faces the antenna module **42** that includes the first antenna pattern **46**. Furthermore, at least a part of the rear side surface **41***cb* overlies the antenna module **42**.

The second antenna pattern **101** is connected to the first antenna pattern **46**. In order to increase the inside region of the second antenna pattern **101**, the second antenna pattern **101** extends adjacent to the front side surface **41***ca*, the left side surface **41***cc*, or the right end surface **41***cd* that is separated from the first antenna pattern **46**. As the first lead **82** extends from the connection pad **81** to the rear side surface **41***cb*, the first lead **82** can be easily arranged on a path separated from the second antenna pattern **101**. The first lead **82** may extend from the connection pad **81** to the front side surface **41***ca*, the left side surface **41***cc*, or the right side surface **41***cd*.

A part of the first lead **82** overlies the inside **46***a* of the first antenna pattern **46**. The first lead **82** is narrower than the conductor forming the first antenna pattern **46**. For that reason, the first lead **82** is less likely to influence on the magnetic flux of the first antenna pattern **46**.

All of the first leads **82** are separated from the second antenna pattern **101** and extend from the connection pads **81** to the end surface **41***c* of the first substrate **41** in the SD card according to the modification example of the second embodiment. Since there is no need to electrically separate the first lead **82** and the second antenna pattern **101** by etchback, the number of manufacturing processes and the manufacturing cost for the SD card **11** would not increase.

Third Embodiment

Hereinafter, a third embodiment will be described with reference to FIG. **13**. FIG. **13** is a plan view of the SD card **11** according to the third embodiment. As illustrated in FIG. **13**, the SD card **11** according to the third embodiment includes a microSD card **131** and an adapter **132**. The microSD card **131** that is attached to the adapter **132** is used as a full-size SD card **11**.

The microSD card **131** is one example of a semiconductor device and may be referred to as, for example, a device, a module, a unit, a medium, and a component. The semiconductor device maybe another device such as a miniSD card or a USB flash memory.

The microSD card **131** includes the first substrate **41**, the plurality of I/F terminals **22**, the communication controller **24**, the flash memory **25**, and the memory controller **26**. The I/F terminal **22** in the third embodiment is a microSD interface terminal.

The microSD card **131** can be electrically connected to the host device **12** independently. In the microSD card **131**, data can be written by the host device **12**, or data can be read by the host device **12**.

The microSD card **131** includes two first connection terminals **135**. The first connection terminal **135** is provided on the second surface **41***b* of the first substrate **41** in the same manner as the I/F terminal **22**. The two first connection terminals **135** are adjacent to, for example, the plurality of I/F terminals **22**. The first connection terminal **135** may be provided in other locations.

The two first connection terminals **135** are electrically connected to, for example, the communication controller **24**. The two first connection terminals **135** are exposed to the outside through, for example, openings. The first connection terminal **135** may be included in the I/F terminal **22**.

The adapter **132** is an adapter to insert a microSD card into a full-size SD card reader/writer. The adapter may be other adapters such as an adapter for using a miniSD card with a full-size SD card reader/writer, an adapter for using an SD card, a miniSD card, or a microSD card with a USB connector, and an adapter for using a USB A terminal with connectors of other USB standards such as Type-C.

The adapter **132** includes a case **141**, a plurality of full-size I/F terminals **142**, a loop antenna **143**, and two second connection terminals **144**. The full-size I/F terminal **142** is one example of a second interface terminal. The loop antenna **143** is one example of the first antenna and an antenna.

The case **141** is formed of, for example, synthetic resin that has non-magnetic and insulating properties. The case **141** may be formed of other materials. The case **141** is formed in an approximately quadrangular box shape.

The full-size I/F terminal **142** is an SD interface terminal. The full-size I/F terminal **142** is provided in one end portion of the case **141** in the direction along the Y axis. The plurality of full-size I/F terminals **142** is lined up in the direction along the X axis. The full-size I/F terminal **142** is exposed to the outside of the case **141**.

An insertion port **141***a* is provided in the case **141**. The insertion port **141***a* is open in the other end portion of the case **141** in the direction along the Y axis. The microSD card **131** is inserted into the insertion port **141***a*, thereby being detachably attached to the adapter **132**.

Inserting the microSD card **131** into the insertion port **141***a* causes the plurality of I/F terminals **22** of the microSD card **131** to be electrically connected to the corresponding full-size I/F terminals **142**. The I/F terminal **22** can be electrically connected with the host device **12** through the full-size I/F terminal **142**.

The loop antenna **143** is disposed in the case **141**. The loop antenna **143** is formed in a shape that may be referred to as, for example, a coil shape, a spiral shape, or a swirling shape. The loop antenna **143** in the present embodiment is formed of a copper wire wound in a coil shape. The copper wire wound in a coil shape is one example of a wound conductor. The loop antenna **143** may be, for example, a pattern that is formed in a substrate.

The case **141** includes an outer frame region **151** and an inner region **152**. The outer frame region **151** is a frame-shaped part that is adjacent to a peripheral end portion **141***b* of the case **141**. The inner region **152** is surrounded by the outer frame region **151**.

The loop antenna **143** is arranged in the outer frame region **151** of the case **141**. In other words, the loop antenna **143** extends along the peripheral end portion **141***b* of the case **141**. The arrangement of the loop antenna **143** is not limited thereto.

The two second connection terminals **144** are provided in the insertion port **141***a*. The two second connection terminals **144** are two terminals of the loop antenna **143**. One second connection terminal **144** is electrically connected to one end portion of the loop antenna **143**. The other second connection terminal **144** is electrically connected to the other end portion of the loop antenna **143**.

By inserting the microSD card **131** into the insertion port **141***a*, the two first connection terminals **135** of the microSD card **131** are electrically connected to the corresponding second connection terminals **144**. Accordingly, the communication controller **24** is electrically connected to the loop antenna **143** through the first and second connection terminals **135** and **144**.

The communication controller **24** of the third embodiment communicates with the wireless communication host device **13** through the loop antenna **143** instead of the first antenna pattern **46** according to the first embodiment. That is, the wireless antenna **23** in FIG. **2** includes the loop antenna **143** in the third embodiment.

The first antenna pattern **46** of the adapter **132** sends data received from the wireless communication host device **13** to the communication controller **24** of the microSD card **131**. Furthermore, the first antenna pattern **46** of the adapter **132** sends data received from the communication controller **24** of the microSD card **131** to the wireless communication host device **13**.

FIG. **13** illustrates the microSD card **131** that is inserted in the insertion port **141***a* with a double-dot chain line. When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **13**, a part of an inside **143***a* of the loop antenna **143** is positioned outside of the microSD card **131**. The inside **143***a* of the loop antenna **143** is a region surrounded by the annular loop antenna **143**. In addition, when the first surface **41***a* is viewed as illustrated in FIG. **13**, a part of the loop antenna **143** is positioned outside of the first substrate **41**.

The microSD card **131** that includes the first substrate **41** is attached to the adapter **132** that includes the loop antenna **143**, in the SD card **11** according to the third embodiment. As a result, the microSD card **131** can communicate with the wireless communication host device **13** through the loop antenna **143** of the adapter **132**.

The loop antenna **143** is formed of a wound copper wire. For that reason, the manufacturing cost of the SD card **11** can be suppressed, compared with when, for example, the loop antenna **143** is formed of a pattern on a substrate.

Fourth Embodiment

Hereinafter, a fourth embodiment will be described with reference to FIG. **14** to FIG. **16**. FIG. **14** is a plan view of the first substrate **41** according to the fourth embodiment. As illustrated in FIG. **14**, the first antenna pattern **46** is formed on the first substrate **41** in the fourth embodiment. The wireless antenna **23** in FIG. **2** includes the first antenna pattern **46** in the fourth embodiment.

FIG. **15** is a plan view of a part of the first substrate **41** according to the fourth embodiment. As illustrated in FIG. **14** and FIG. **15**, the plurality of connection pads **81**, the plurality of first leads **82**, the first solder resist **83**, the second lead **115**, and the third lead **116** are formed on the first substrate **41** according to the fourth embodiment in the same manner as the second embodiment. The plurality of first openings **84** and the second opening **119** are formed in the first solder resist **83**.

The second lead **115** extends from the first antenna pattern **46** instead of the second antenna pattern **101** according to the second embodiment. The third lead **116** as well extends from the first antenna pattern **46**.

FIG. **16** is a plan view of a part of the first substrate **41** during a process of manufacturing processes according to the fourth embodiment. As illustrated in FIG. **16**, the first plated lead L**1** and the second plated lead L**2** are formed on the first surface **91***a* of the base substrate **91** before the plurality of connection pads **81** is formed in the first substrate **41**.

The first plated lead L**1** includes the plurality of first leads **82** and the second lead **115**. The first plated lead L**1** extends from the first antenna pattern **46**, includes a plurality of branching parts, and is connected to the plurality of connection pads **81**. In other words, the connection pad **81** is formed in the end portion of the first plated lead L**1** by electroplating.

The second plated lead L**2** includes the third lead **116**. The second plated lead L**2** extends from the first antenna pattern **46** to the end surface **41***c* of the first substrate **41**. The second plated lead L**2** is electrically connected to the plurality of connection pads **81** through the first antenna pattern **46** and the first plated lead L**1**.

The second plated lead L**2** is connected to a power source when the connection pad **81** is formed by electroplating. When the plurality of connection pads **81** is formed, a part of the first plated lead L**1** and a part of the second plated lead L**2** are removed by, for example, etchback. The first plated lead L**1** is etched back through the first opening **84**, thereby being split into the plurality of first leads **82** and the second lead **115**. The second plated lead L**2** is etched back through the second opening **119**, thereby forming the third lead **116**. As a result, the plurality of connection pads **81** is electrically separated from the first antenna pattern **46**.

The first lead **82** in the SD card **11** according to the fourth embodiment extends from the connection pad **81** to which an electronic component such as the flash memory **25** is connected. The first lead **82** is electrically separated from other conductors. Meanwhile, the second lead **115** extends from the first antenna pattern **46**. The second lead **115** is electrically separated from other conductors. The first and second leads **82** and **115**, for example, are connected during the manufacturing processes of the SD card **11** and form the first plated lead L**1**. In this case, by applying a voltage to the first and second leads **82** and **115** through the first antenna pattern **46**, the connection pad **81** in the end portion of the first lead **82** can be formed by electroplating. The first lead **82** and the second lead **115** are split after the connection pad **81** is formed. The connection pad **81** can be formed by electroplating using the first and second leads **82** and **115** in the first substrate **41** in which the first antenna pattern **46** is formed. For that reason, the first antenna pattern **46** which is a loop antenna and not a chip antenna can be provided in the first substrate **41**, and the manufacturing cost of the SD card **11** can be suppressed.

Hereinafter, a modification example of the fourth embodiment will be described with reference to FIG. **17** to FIG. **19**. FIG. **17** is a plan view of the first substrate **41** according to the modification example of the fourth embodiment. As illustrated in FIG. **17**, the plurality of connection pads **81**, the plurality of first leads **82**, the first solder resist **83**, the plurality of second leads **115**, a plurality of third leads **116**, and a plurality of fourth leads **161** are formed on the first substrate **41** according to the modification example of the fourth embodiment. The plurality of first openings **84**, a plurality of second openings **119**, and a plurality of third openings **162** are formed in the first solder resist **83**.

FIG. **17** illustrates the plurality of first leads **82**, the plurality of second leads **115**, the plurality of third leads **116**, and the plurality of fourth leads **161** with solid lines and illustrates the plurality of first openings **84**, the plurality of second openings **119**, and the plurality of third openings **162** with double-dot chain lines for description.

FIG. **18** is a plan view of a part of the first substrate according to the modification example of the fourth embodiment. The first antenna pattern **46** is wound a plurality of times in the modification example of the fourth embodiment. For that reason, as illustrated in FIG. **18**, an extending portion **46***d* and another extending portion **46***d* of the first antenna pattern **46** extend substantially parallel to each other at an interval in a region that is adjacent to the end surface **41***c* of the first substrate **41**. The extending portion **46***d* of the first antenna pattern **46** is a part of the first antenna pattern **46** that extends along the adjacent end surface **41***c*.

The fourth lead **161** is formed on the first surface **91***a*. Thus, the first solder resist **83** covers the fourth lead **161**. The plurality of fourth leads **161** extends from the extending portion **46***d* of the first antenna pattern **46** to another adjacent extending portion **46***d*. For example, one fourth lead **161** extends from one extending portion **46***d* to another extending portion **46***d* that is adjacent to the one extending portion **46***d* and is separated farther from the flash memory **25** than the one extending portion **46***d*. That is, the fourth lead **161** is positioned between two adjacent extending portions **46***d* and **46***d* of the first antenna pattern **46**.

Each of the plurality of fourth leads **161** includes a fourth end portion **161***a*. The fourth end portion **161***a* is the end portion of the fourth lead **161** that extends from the first antenna pattern **46**. In other words, the fourth end portion **161***a* is positioned opposite to the first antenna pattern **46**.

The fourth end portion **161***a* is separated from other conductors including other extending portions **46***d* of the first antenna pattern **46**. Thus, the fourth lead **161** is electrically separated from other conductors that are different from the extending portion **46***d* of the first antenna pattern **46**. In other words, the fourth lead **161** does not connect one extending portion **46***d* of the first antenna pattern **46** with another extending portion **46***d* in the midst of the first antenna pattern **46** that is wound a plurality of times.

The third opening **162** is a hole formed in the first solder resist **83**. The third opening **162** is positioned between two adjacent extending portions **46***d* and **46***d* of the first antenna pattern **46** in a region that is adjacent to the end surface **41***c* of the first substrate **41**. The third opening **162** is separated from two adjacent extending portions **46***d* and **46***d* of the first antenna pattern **46**.

When the first surface **41***a* of the first substrate **41** is viewed as illustrated in FIG. **17**, the fourth end portion **161***a* of the fourth lead **161** substantially overlies the edge of the first solder resist **83** that forms the third opening **162**. The fourth end portion **161***a* may be arranged in other positions.

The fourth end portions **161***a* of the plurality of fourth leads **161** that extends from one extending portion **46***d* of the first antenna pattern **46** substantially overlie the edge of the first solder resist **83** that forms one third opening **162**. Furthermore, the fourth end portions **161***a* of the plurality of fourth leads **161** that extends from another extending portion **46***d* of the first antenna pattern **46** substantially overlie the edge of the first solder resist **83** that forms one third opening **162**.

The fourth end portion **161***a* of the fourth lead **161** that extends from one extending portion **46***d* of the first antenna pattern **46** faces the fourth end portion **161***a* of the fourth lead **161** that extends from another extending portion **46***d* of the first antenna pattern **46**. The fourth lead **161** that extends from one extending portion **46***d* of the first antenna pattern **46** is positioned on the extension line of the fourth lead **161** that extends from another extending portion **46***d* of the first antenna pattern **46**.

The first lead **82**, the second lead **115**, the third lead **116**, and the plurality of fourth leads **161** that correspond to each other are positioned on the extension lines of each other. The arrangement of the first lead **82**, the second lead **115**, the third lead **116**, and the fourth lead **161** is not limited thereto.

FIG. **19** is a plan view of a part of the first substrate **41** during a process of manufacturing processes according to the modification example of the fourth embodiment. As illustrated in FIG. **19**, a plurality of plated leads L is formed on the first surface **91***a* of the base substrate **91** before the plurality of connection pads **81** is formed in the first substrate **41**. The plated lead L is provided in order to form the plurality of connection pads **81** and a plurality of other pads by, for example, electroplating.

Each of the plurality of plated leads L includes the first lead **82**, the second lead **115**, the third lead **116**, and the plurality of fourth leads **161**. The plated lead L extends from the connection pad **81** to the end surface **41***c* of the first substrate **41**. In other words, the connection pad **81** is formed in the end portion of the plated lead L by electroplating.

Each of the plurality of plated leads L extends straight from one connection pad **81** to the end surface **41***c* of the first substrate **41**. The plurality of plated leads L may be curved or may be joined (or branch).

The plurality of plated leads L intersects with a plurality of extending portions **46***d* of the first antenna pattern **46**. In other words, the plurality of plated leads L electrically connects one extending portion **46***d* of the first antenna pattern **46** with another extending portion **46***d*. When, for example, the flash memory **25** or the memory controller **26** is wired using a wire bonding technology, a part of the first antenna pattern **46** may be formed of a bonding wire and be separated from the plated lead L.

The plurality of plated leads L, before the plurality of first substrates **41** is cut out of an aggregate substrate, is connected to the lead of the aggregate substrate that includes the plurality of first substrates **41**. That is, the plurality of plated leads L connects the lead of the aggregate substrate with the inside **46***a* of the first antenna pattern **46**. When the connection pad **81** is formed by electroplating, the plated lead L is connected to a power source.

When the plurality of connection pads **81** is formed, a part of the plated lead L is removed by, for example, etchback. The plated lead L is etched back through the first opening **84**, the second opening **119**, and the plurality of third openings **162** and is thereby split into the first lead **82**, the second lead **115**, the third lead **116**, and the plurality of fourth leads **161**.

By etching back the plated lead L, the plurality of connection pads **81** is electrically separated from the first antenna pattern **46**. Furthermore, one extending portion **46***d* of the first antenna pattern **46** is electrically separated from another extending portion **46***d*.

The first lead **82** extends from the connection pad **81** and the second lead **115** extends from the first antenna pattern **46** in the SD card **11** according to the modification example of the fourth embodiment. Furthermore, the third lead **116** extends from the first antenna pattern **46** to the end surface **41***c* of the first substrate **41**, and the fourth lead **161** extends from one extending portion **46***d* of the first antenna pattern **46** to another extending portion **46***d*. The first to fourth leads **82**, **115**, **116**, and **161** are electrically separated from other conductors. The first to fourth leads **82**, **115**, **116**, and **161**, for example, are connected during the manufacturing processes of the SD card **11** and form the plated lead L. In this case, by applying a voltage to the plated lead L that intersects with the first antenna pattern **46**, the connection pad **81** is formed in the end portion of the first lead **82** by electroplating. The first to fourth leads **82**, **115**, **116**, and **161** are split after the connection pad **81** is formed. The connection pad **81** can be formed by electroplating using the first to fourth leads **82**, **115**, **116**, and **161** in the first substrate **41** in which the first antenna pattern **46** is formed.

A voltage is applied to the plurality of plated leads L, each of which extends in a straight linear shape, during the above process of forming the connection pad **81**. For that reason, the distance from a power supply to the end portion of the first lead **82** of each plated lead L is likely to become uniform. In addition, the distance from the end surface **41***c* of the first substrate **41** to the end portion of the first lead **82** of each plated lead L is likely to become uniform. As a result, power supply can be stabilized, and the plurality of connection pads **81** is likely to be uniformly formed by electroplating.

Fifth Embodiment

Hereinafter, a fifth embodiment will be described with reference to FIG. **20**. FIG. **20** is a bottom plan view of the SD card **11** according to the fifth embodiment without the bottom cover **32**. The first substrate **41** is illustrated by a double-dot chain line in FIG. **20**.

As illustrated in FIG. **20**, the first antenna pattern **46** is mounted in the top cover **33** in the fifth embodiment. The wireless antenna **23** in FIG. **2** includes the first antenna pattern **46** in the fifth embodiment.

The first antenna pattern **46** is embedded in the top cover **33** in the fifth embodiment. In other words, the first antenna pattern **46** is positioned between the upper surface **61** and the second inner surface **62** of the top cover **33**. The first antenna pattern **46**, for example, may be provided on the second inner surface **62** of the top cover **33** or may be provided in the bottom cover **32**. The first antenna pattern **46** may be a conductive pattern formed using various methods such as printing or may be a conductor such as a copper line.

A first terminal **171** is provided in both end portions of the first antenna pattern **46**. The first terminal **171**, for example, protrudes from the third recess portion **65** on the second inner surface **62** of the top cover **33**. The first terminal **171** overlies the first substrate **41** when the second surface **41***b* of the first substrate **41** is viewed as illustrated in FIG. **20**.

Two second terminals **172** are provided on the first surface **41***a* of the first substrate **41**. The second terminal **172** faces the first terminal **171**. The second terminal **172**, for example, is electrically connected to the first terminal **171** through a conductive spring. The second terminal **172** may be in direct contact with the first terminal **171** or may be connected thereto by solder. As a result, the circuit C of the first substrate **41** and the first antenna pattern **46** are electrically connected.

The first antenna pattern **46** is formed in the top cover **33** of the casing **31** in the SD card **11** according to the fifth embodiment. For that reason, flexibility of location of wiring in the first substrate **41** can be improved. Furthermore, by providing the first antenna pattern **46** in the casing **31** of the SD card **11**, the number of components of the SD card **11** and the manufacturing cost of the SD card **11** can be suppressed.

The first terminal **171** of the first antenna pattern **46** is electrically connected with the second terminal **172** of the first substrate **41** by, for example, a spring. As a result, even if the first antenna pattern **46** and the first substrate **41** are relatively moved, a connected portion between the first antenna pattern **46** and the first substrate **41** is prevented from being damaged.

Sixth Embodiment

Hereinafter, a sixth embodiment will be described with reference to FIG. **21**. FIG. **21** is a plan view of the SD card **11** according to the sixth embodiment. As illustrated in FIG. **21**, a label **181** is bonded to the upper surface **61** of the top cover **33**.

The label **181** is a sheet bonded to the casing **31**. For example, the specifications, the storage capacity, the direction of insertion, and the description of the SD card **11** are represented on the label **181**. The label **181** is not limited thereto. The label **181**, for example, is bonded to a recess **183** that is formed on the upper surface **61**. Apart of the label **181** may be located outside of the recess **183**.

The first antenna pattern **46** is mounted in the label **181** in the sixth embodiment. The wireless antenna **23** in FIG. **2** includes the first antenna pattern **46** in the sixth embodiment.

The first antenna pattern **46** is embedded in the label **181** in the sixth embodiment. The first antenna pattern **46**, for example, may be provided on an adhesive surface of the label **181** bonded to the top cover **33**. The adhesive surface is a surface of the label **181** on which an adhesive is applied. The first antenna pattern **46** may be a conductive pattern formed using various methods such as printing or may be a conductor such as a copper line.

A third terminal **185** is provided in both end portions of the first antenna pattern **46**. The third terminal **185**, for example, is provided on the adhesive surface of the label **181**. The third terminal **185** overlies the first substrate **41** when the upper surface **61** of the top cover **33** is viewed in a plan view as in FIG. **21**.

Two through electrodes **187** are provided in the top cover **33**. The through electrode **187** is formed of a conductor and passes through the top cover **33**. The through electrode **187** protrudes from the upper surface **61** and from the second inner surface **62**. The third terminal **185** of the first antenna pattern **46** faces the through electrode **187**. The third terminal **185** is in contact with the through electrode **187** and is electrically connected to the through electrode **187**.

By bonding the label **181** to the recess **183** of the top cover **33**, the third terminal **185** is in contact with the through electrode **187**. That is, the recess **183** is used for aligning the positions of the third terminal **185** and the through electrode **187**.

Two fourth terminals **189** are provided on the first surface **41***a* of the first substrate **41**. The fourth terminal **189** faces the through electrode **187**. The fourth terminal **189**, for example, is electrically connected to the through electrode **187** through a conductive spring. The fourth terminal **189** may be indirect contact with the through electrode **187** or connected thereto by solder.

The through electrode **187** is disposed between the third terminal **185** of the first antenna pattern **46** and the fourth terminal **189** of the first substrate **41**. As a result, the third terminal **185** is electrically connected to the fourth terminal **189** through the through electrode **187**, and the circuit C of the first substrate **41** is electrically connected with the first antenna pattern **46**.

The first antenna pattern **46** is provided in the label **181** of the SD card **11** according to the sixth embodiment. As a result, flexibility of location of wiring in the first substrate **41** can be improved. Furthermore, by providing the first antenna pattern **46** in the label **181** of the SD card **11**, the number of components of the SD card **11** and the manufacturing cost of the SD card **11** can be suppressed.

The adhesive surface of the label **181** adheres to the upper surface **61** of the top cover **33** from which the through electrode **187** protrudes. As a result, the label **181** in which the first antenna pattern **46** is mounted and the through electrode **187** are prevented from relatively moving, and a connected portion between the first antenna pattern **46** and the first substrate **41** is prevented from being damaged.

The position to which the label **181** is bonded is not limited to the upper surface **61** of the top cover **33** and may be other parts of the casing **31**. For example, the label **181** may be bonded to the second inner surface **62** of the top cover **33**. In this case, the third terminal **185** and the fourth terminal **189** are electrically connected not through the through electrode **187**.

Furthermore, the position in which the first antenna pattern **46** is mounted is not limited to the label **181** and may be a sheet that does not include an adhesive surface. In this case, for example, the sheet is disposed between the top cover **33** and the label **181** that does not include the first antenna pattern **46**. Accordingly, the sheet that does not include an adhesive surface can be bonded to the casing **31**.

According to at least one embodiment described above, at least a part of the first antenna is positioned outside of the first substrate, and at least a part of the remaining part is positioned in the first substrate. As a result, the manufacturing cost of a semiconductor memory device can be suppressed.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein maybe made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

What is claimed is:

1. A memory card, comprising:

a substrate;

a nonvolatile memory on the substrate;

a memory controller on the substrate and configured to control access to the nonvolatile memory;

an interface terminal for external wired connection, on the substrate;

an antenna, a region surrounded by the antenna including a first region that overlaps with the substrate and a second region that does not overlap with the substrate; and

a communication controller on the substrate, electrically connected to the antenna, and configured to wirelessly communicate with an external device through the antenna, using power generated at the antenna by an electromagnetic induction caused by the external device.

2. The memory card according to claim **1**, further comprising:

a second substrate on which the antenna is formed.

3. The memory card according to claim **2**, wherein

the substrate includes a first pad that is electrically connected to the communication controller and a second pad that is electrically separated from the nonvolatile memory, the memory controller, the interface terminal, and the communication controller, and

the second substrate includes a third pad that is soldered with the first pad and a fourth pad that is soldered with the second pad, the communication controller and the antenna being electrically connected through an electrical connection of the first pad and the third pad.

4. The memory card according to claim **3**, wherein

one of the third and fourth pads is located on the second substrate within the region, and the other of the third and fourth pads is located outside the region.

5. The memory card according to claim **2**, wherein

a thickness of the second substrate is less than a thickness of the substrate.

6. The memory card according to claim **1**, wherein

at least one of the nonvolatile memory, the memory controller, and the communication controller is located outside the region.

7. The memory card according to claim **1**, wherein

the substrate includes an antenna portion that is electrically connected to the antenna and serves as a single antenna together with the antenna.

8. The memory card according to claim **7**, wherein

the antenna portion is disposed along a periphery of the substrate.

9. The memory card according to claim **7**, wherein

the antenna portion includes a first sub-portion formed on a first surface of the substrate and a second sub-portion formed on a second surface of the substrate opposite to the first surface.

10. The memory card according to claim **9**, wherein

the interface terminal is formed on the second surface of the substrate, and the first sub-portion of the antenna portion overlaps with the interface terminal.

11. The memory card according to claim **1**, wherein

the substrate includes a ground terminal in a region on which the nonvolatile memory or the memory controller is disposed.

12. The memory card according to claim **1**, further comprising:

a sealing resin layer formed on the substrate and covering the nonvolatile memory, the memory controller, and the communication controller.

13. The memory card according to claim **1**, further comprising:

a housing including a first member and a second member, the substrate and the antenna being disposed in a space formed by the first and second members.

14. The memory card according to claim **13**, wherein

the first member includes a first recessed portion in which the antenna is disposed, and

the second member includes a second recessed portion in which at least part of the substrate is disposed.

15. The memory card according to claim **13**, wherein

the antenna is embedded in one of the first and second members.

16. The memory card according to claim **13**, further comprising:

a label fixed to one of the first and second members, the antenna being embedded in the label.

17. A memory card, comprising:

a substrate;

a nonvolatile memory on the substrate;

a memory controller on the substrate and configured to control access to the nonvolatile memory;

an interface terminal for external wired connection on the substrate;

an antenna; and

a communication controller disposed on the substrate, electrically connected to the antenna, and configured to wirelessly communicate with an external device through the antenna, using power generated at the antenna by an electromagnetic induction caused by the external device, wherein

a region surrounded by the antenna, that includes a first region that overlaps with at least one of the nonvolatile memory and the communication controller, and a second region that does not overlap with the substrate.

18. The memory card according to claim **17**, further comprising:

a second substrate on which the antenna is formed.

19. The memory card according to claim **18**, wherein

a thickness of the second substrate is less than a thickness of the substrate.

20. The memory card according to claim **17**, wherein

at least one of the nonvolatile memory, the memory controller, and the communication controller is located outside the region.

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