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(54) **INTEGRATED ANTENNA AND METHOD FOR OPERATING INTEGRATED ANTENNA DEVICE**

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H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0457*** (2013.01); ***H01Q 9/285*** (2013.01)
USPC .... **343/700 MS**

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/0407; H01Q 9/0421
USPC .... 343/700 MS
See application file for complete search history.

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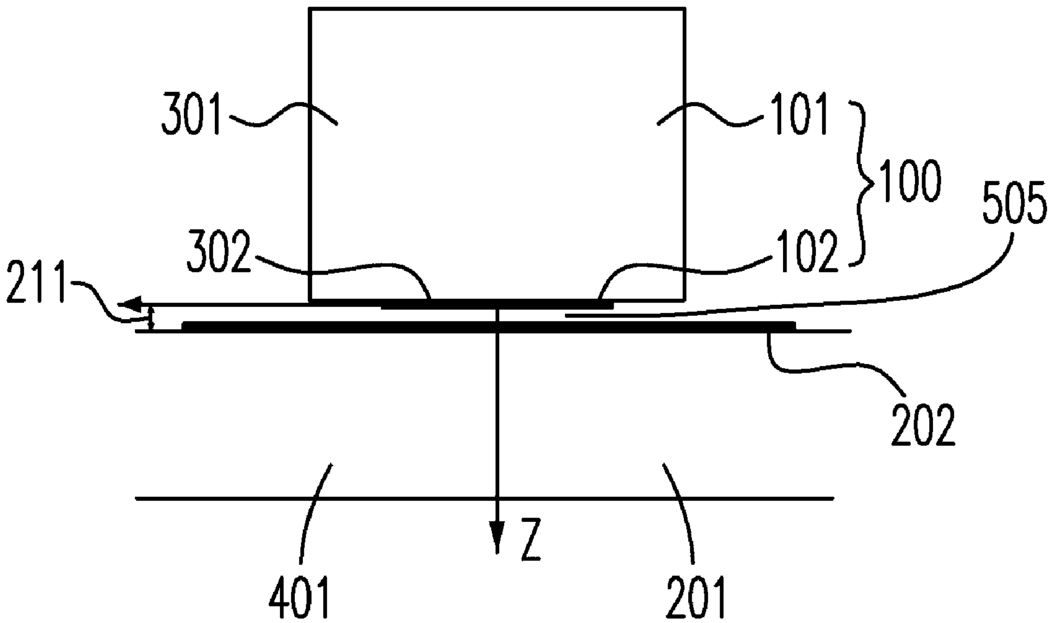
(57) **ABSTRACT**

An integrated antenna is provided. The integrated antenna includes a first resonant element disposed on a chip, and receiving a first signal having a frequency from the chip; and a second resonant element disposed on a substrate, wherein the chip is disposed on the substrate, and the first signal enables a non-contact resonant coupling to be established between the first resonant element and the second resonant element due to the frequency to cause the second resonant element to generate and radiate a second signal.

19 Claims, 7 Drawing Sheets



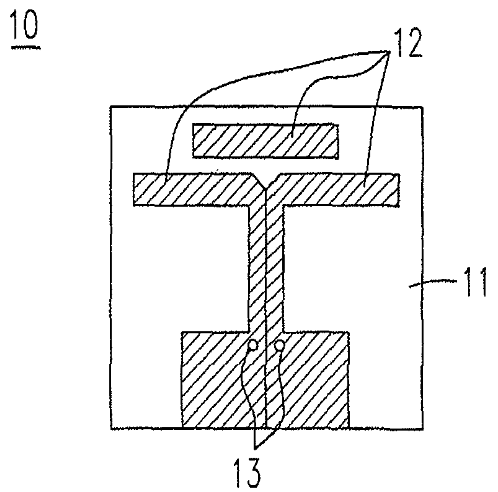


Fig. 1(a)(Prior Art)

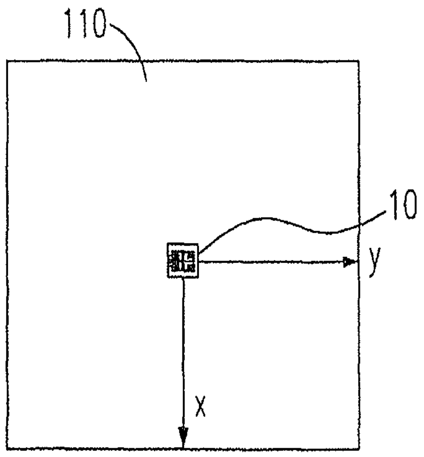


Fig. 1(b)(Prior Art)

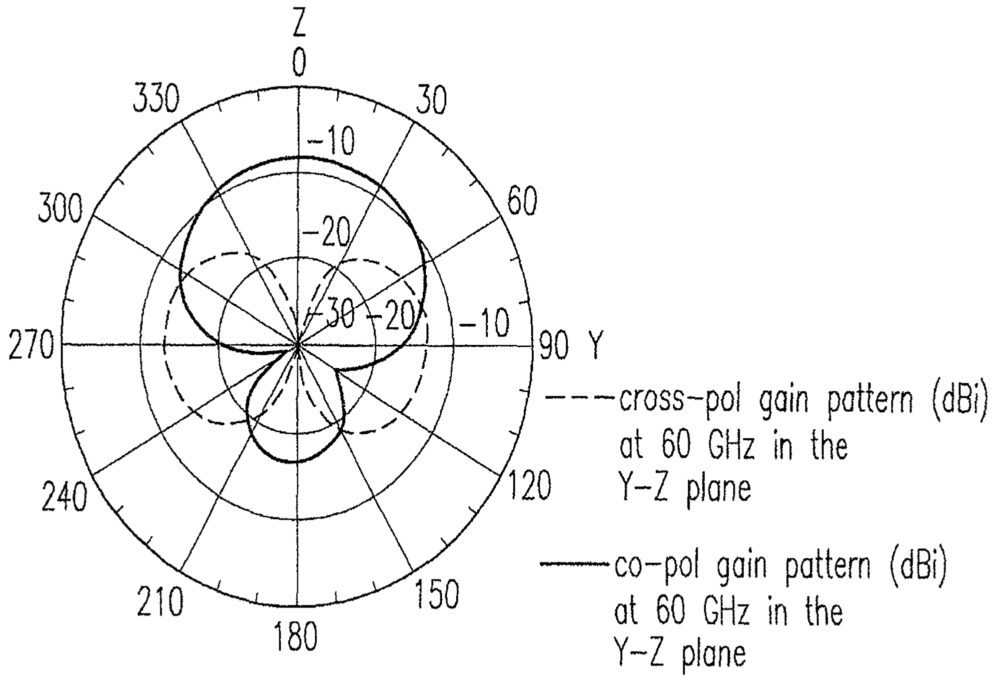


Fig. 1(c)(Prior Art)

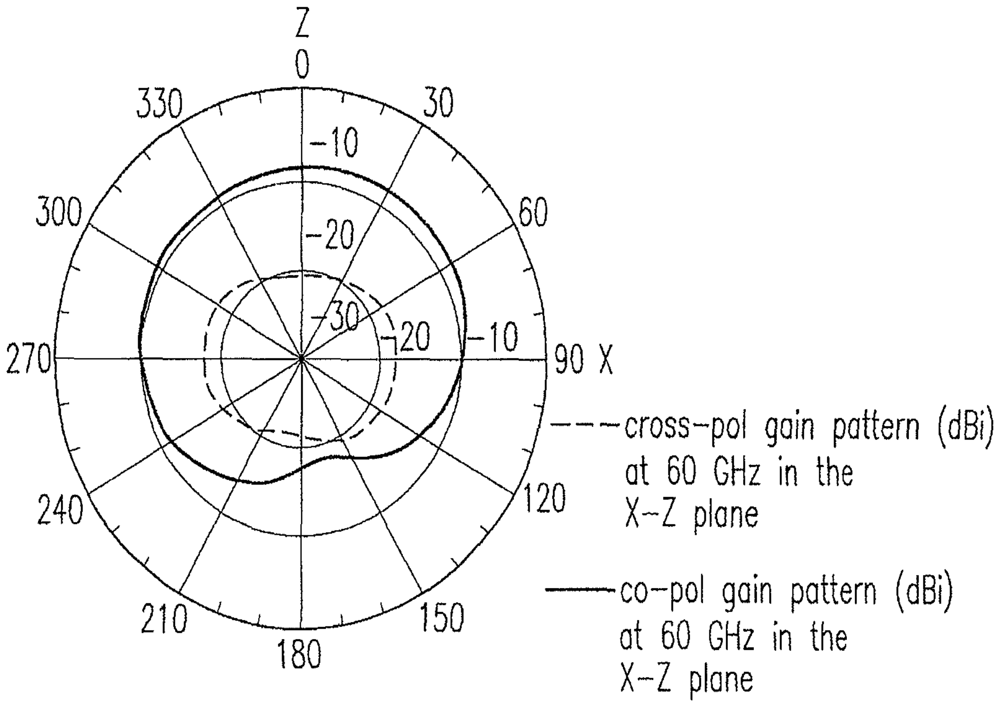


Fig. 1(d)(Prior Art)

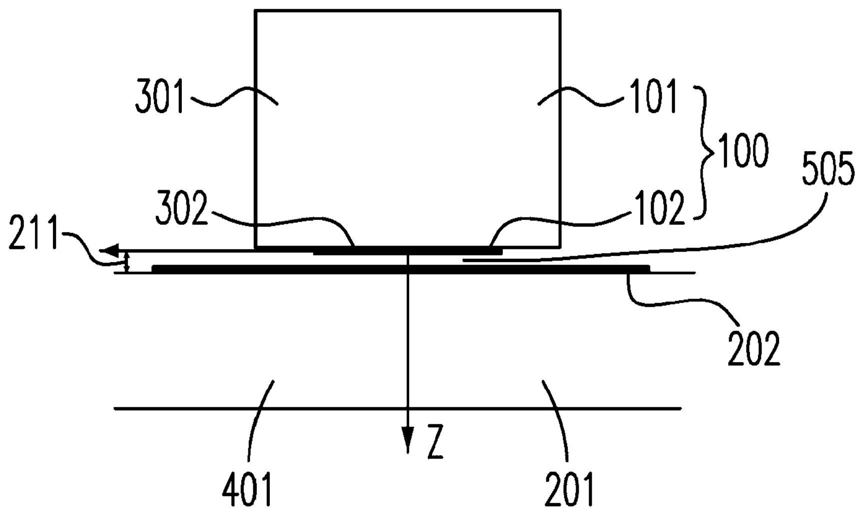
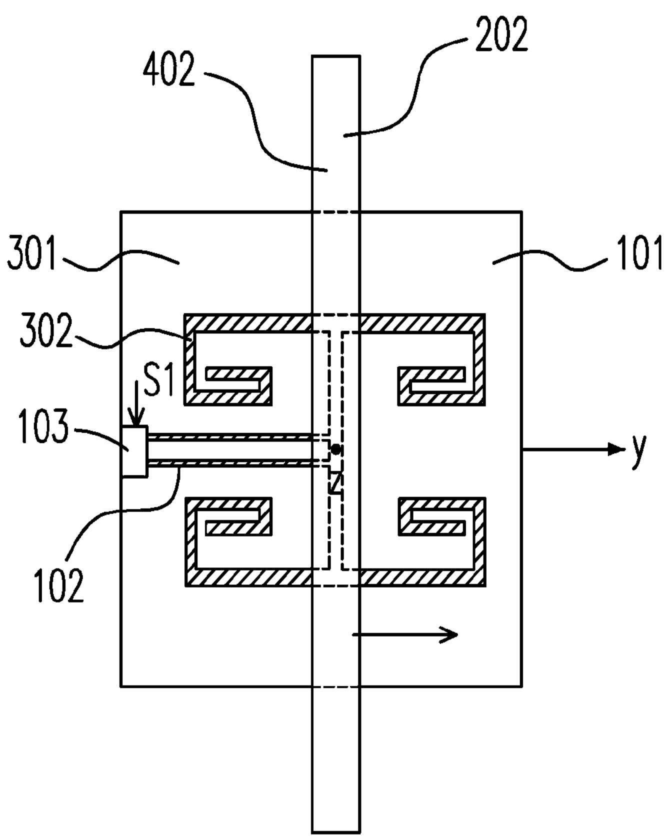

301
101
100
505
302
102
211
202
Z
401
201

Fig. 2(a)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Z
102

Fig. 2(b)

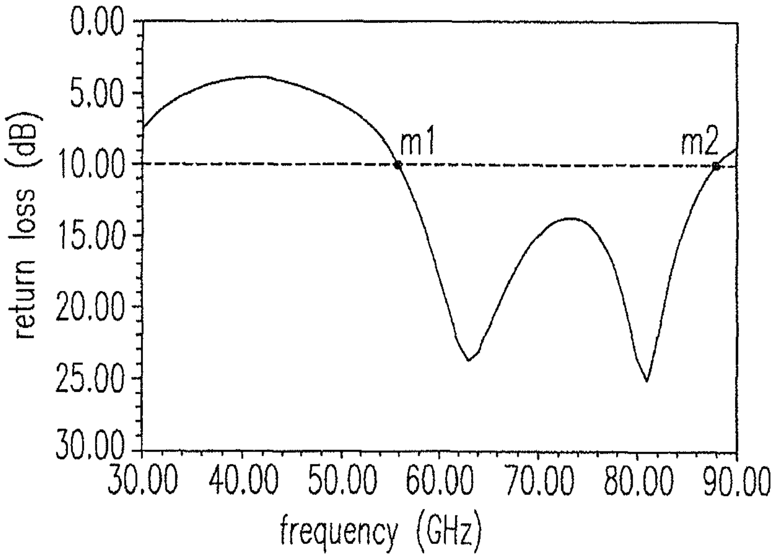
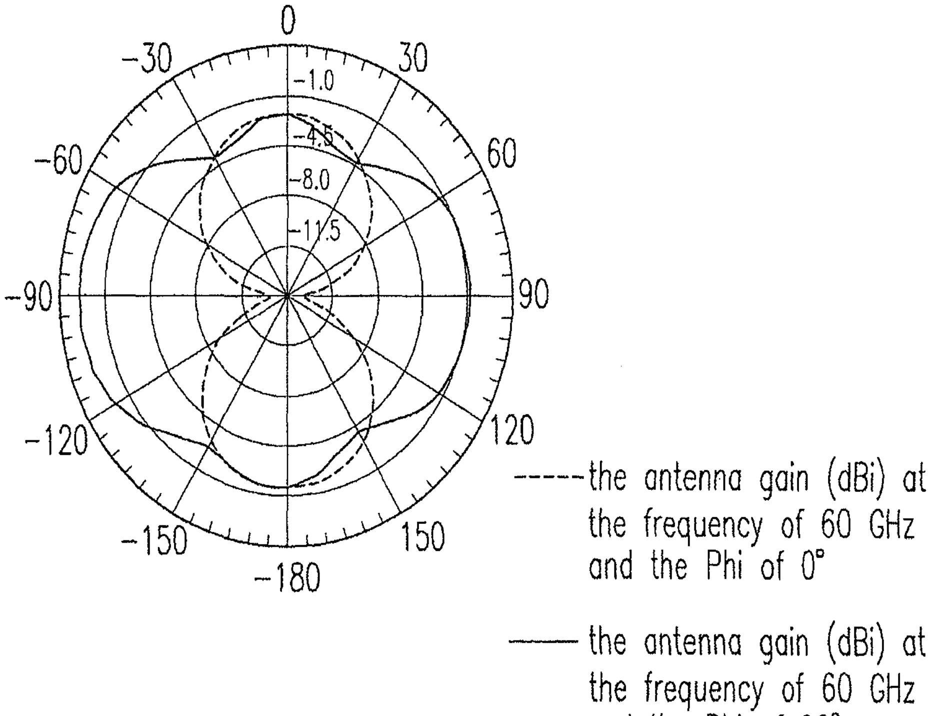

0.00
5.00
10.00
15.00
20.00
25.00
30.00
return loss (dB)
m1
m2
30.00
40.00
50.00
60.00
70.00
80.00
90.00
frequency (GHz)

Fig. 3(a)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30
60
90
120
150
-180
-150
-120
-90
-60
-30
-1.0
-4.5
-8.0
-11.5
the antenna gain (dBi) at the frequency of 60 GHz and the Phi of 0°
the antenna gain (dBi) at the frequency of 60 GHz and the Phi of 90°

Fig. 3(b)

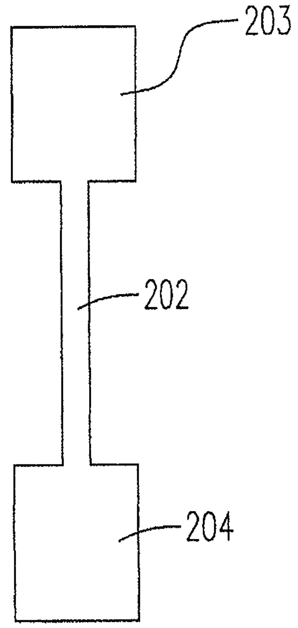
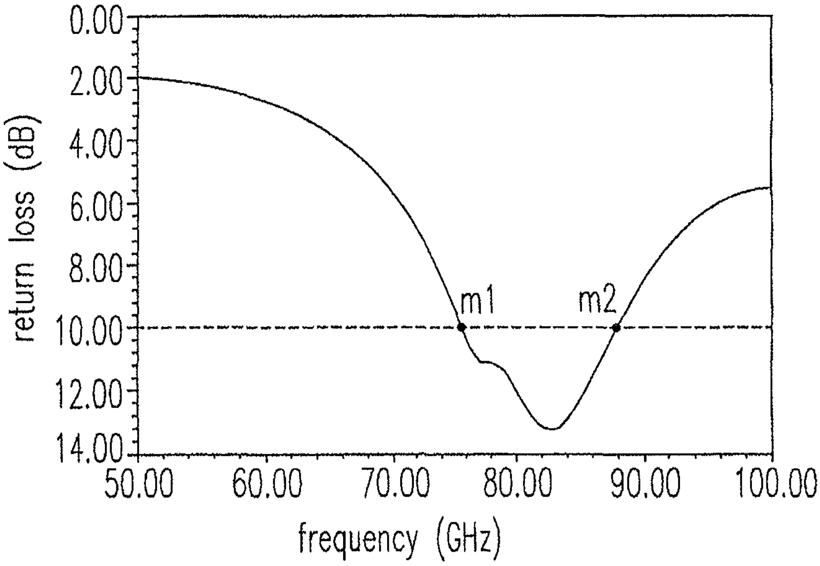


Fig. 4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2.00
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6.00
8.00
10.00
12.00
14.00
return loss (dB)
m1
m2
50.00
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70.00
80.00
90.00
100.00
frequency (GHz)

Fig. 5

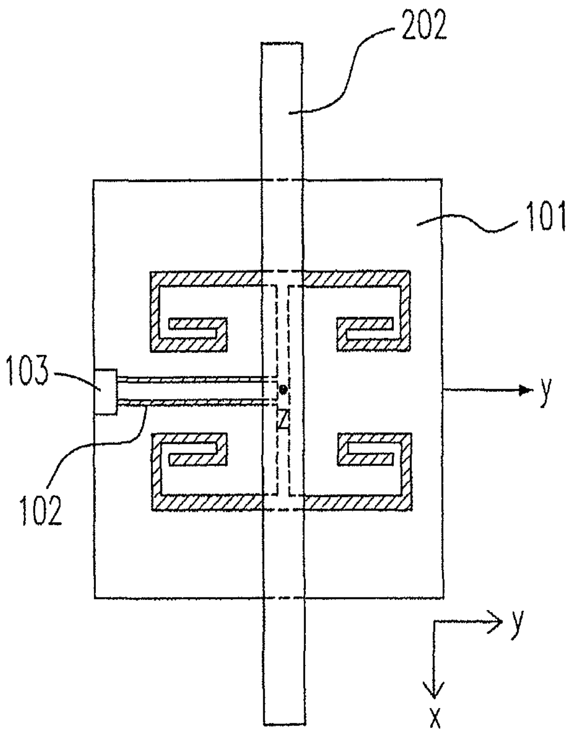
202
101
103
y
Z
102
y
x

Fig. 6

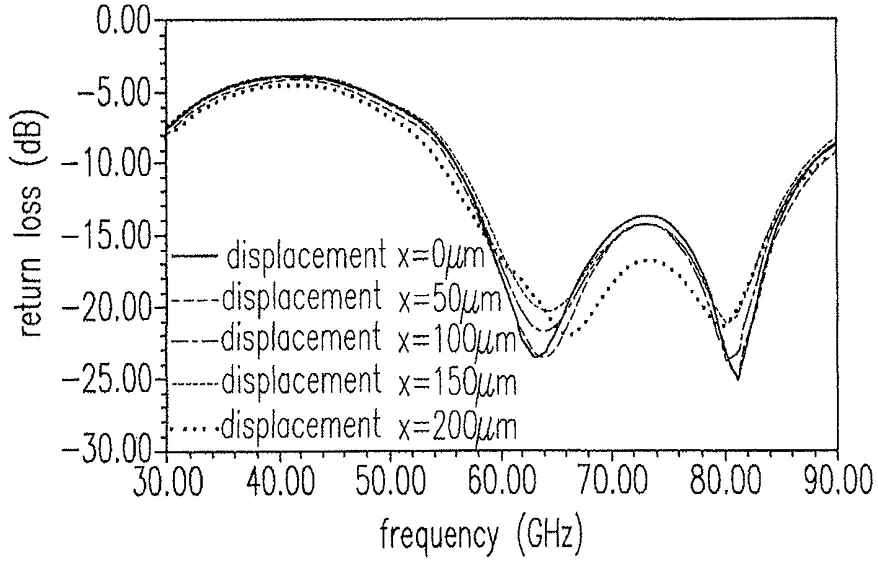
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
return loss (dB)
displacement x=0μm
displacement x=50μm
displacement x=100μm
displacement x=150μm
displacement x=200μm
30.00
40.00
50.00
60.00
70.00
80.00
90.00
frequency (GHz)

Fig. 7(a)

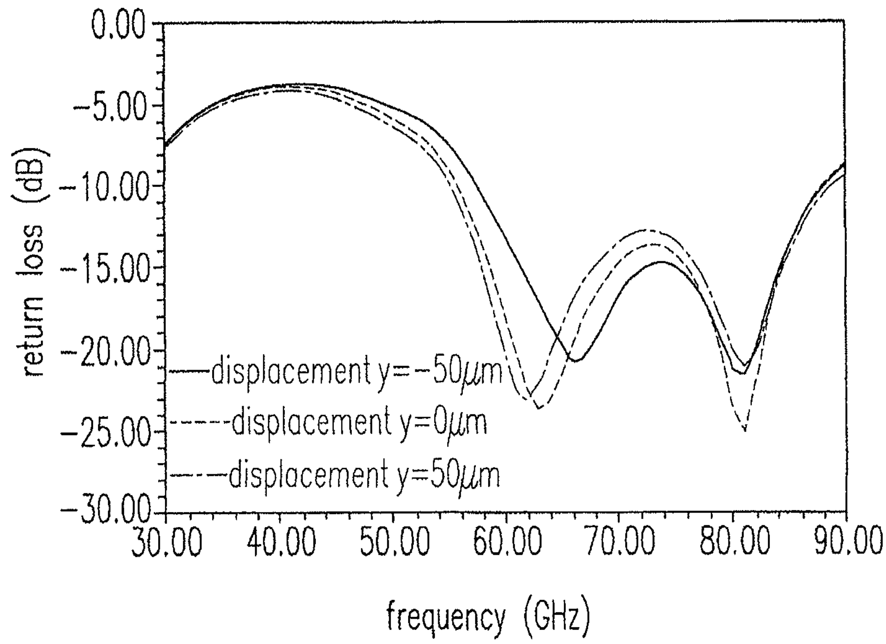
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
return loss (dB)
displacement y=-50μm
displacement y=0μm
displacement y=50μm
30.00
40.00
50.00
60.00
70.00
80.00
90.00
frequency (GHz)

Fig. 7(b)

INTEGRATED ANTENNA AND METHOD FOR OPERATING INTEGRATED ANTENNA DEVICE

FIELD OF INVENTION

The present invention relates to an integrated antenna and a method for manufacturing the same, and more particularly to an integrated antenna and a method for manufacturing the same via non-contact resonant coupling.

BACKGROUND

The application of the wireless communication has already become the mainstream technology of the consumer electronic products. In recent years, with the development of millimeter-wave frequency technology, the applications of high-speed data rate transmission of the wireless personal area network (WPAN) and general vehicular radar system both use the frequency up to tens of Giga Hertz. Because the wireless communication apparatus operating at millimeter-wave frequency can carry large number of data for transmission, it is quite suitable for applications of WPAN and the vehicular radar system. In millimeter-wave circuit technology, the design of system on chip (SoC) provides a small circuit size and facilitates mass production. In fact, the transmitter or receiver currently used in wireless communication apparatus has already been designed as a chip, and the antenna needs to be disposed at the front end of the transmitter or receiver to perform the signal transmission and reception.

In millimeter-wave communication applications, there are two methods to dispose the antenna. The first is to dispose the antenna on chip with the transmitter or receiver, which is called chip antenna. The second is to manufacture the antenna on the printed circuit board (PCB), and then integrate the antenna with the transmitter or receiver on chip by electrical connecting methods. Generally, the electrical connecting methods can be wire bonding, flip-chip, etc.

Please refer to FIG. **1**(*a*), which shows an antenna **10** disposed on a chip in the prior art. The antenna **10** is the so-called Yagi chip antenna. As shown in FIG. **1**(*a*), a resonant element **12** is disposed on the silicon substrate **11** of the chip. The resonant element **12** is connected to the feed-in point **13** for the antenna signal. Generally, the transmitter or receiver feeds the signal into the resonant element **12** via the feed-in point **13**. The antenna signal can be resonated in the resonant element **12**. Besides, the resonant element **12** also serves as the radiation element of the antenna **10** for transmitting the antenna signal. Please refer to FIG. **1**(*b*), which shows the antenna **10** disposed on a printed circuit board **110**. The advantage of the chip antenna is that the circuit of the resonant element **12** is integrated with the chip, which avoids the issues of the energy loss and impedance mismatching resulting from the substantial electrical connecting path such as the wire bonding or flip-chip. However, the material of the substrate **11** of the chip usually causes the energy loss, thereby deteriorating the radiation efficiency and radiation gain of the antenna. Please refer to FIGS. **1**(*c*)-**1**(*d*), which show the radiation gain patterns of the antenna **10** of FIG. **1**(*a*). FIG. **1**(*c*) shows the radiation pattern of the signal of 60 GHz in the y-z plane, and FIG. **1**(*d*) shows the radiation pattern of the signal of 60 GHz in the x-z plane. Generally, the radiation gain usually can reach 7~9 dBi by using the Yagi antenna. However, by using this highly-directional Yagi antenna, the radiation gain and efficiency of the antenna in the chip still are only −10 dBi and about 10% respectively. This fully proves that the high-loss silicon substrate for manufacturing the chip greatly affects the efficiency of the antenna, which is a disadvantage of the chip antenna.

Compared to chip antenna, the method for manufacturing the antenna on the PCB has a lower cost and a lower energy loss of the signal, and the efficiency of the antenna usually can be above 80~90%, which far surpasses the chip antenna with the efficiency of about 10%. However, for transmitting the signal from the chip to the antenna on the PCB, when applied in the millimeter-wave frequency band (e.g. 77 GHz), the conventional wire bonding or flip-chip technologies cause the issues of energy loss. Also the length of wire bonding causes radiation and the parasitic effects coming from capacitor and inductor due to the substantial circuit structure. When designing the antenna, these parasitic effects have to be considered in advance, and the compensation circuit shall be made with a more complex circuit design. Besides, the request for the process management of the wire bonding or flip-chip is relatively complicated, which increases lots of extra costs and the difficulty in manufacturing the antenna.

In order to overcome the drawbacks in the prior art, an integrated antenna and a method for operating an integrated antenna device are provided. The particular design in the present invention not only solves the problems described above, but also is easy to be implemented. Thus, the present invention has the utility for the industry.

SUMMARY

In accordance with an aspect of the present invention, an integrated antenna and a method for operating an integrated antenna device are provided, which not only have the advantages of lower cost and higher antenna efficiency but also prevent the issues resulting from the substantial circuit connection between the chip and PCB. The present invention uses the non-contact resonant coupling method to replace the conventionally substantial circuit connection between the chip and PCB, e.g. the wire bonding or flip-chip.

In accordance with another aspect of the present invention, an integrated antenna is provided. The integrated antenna includes a first resonant element disposed on a chip, and receiving a first signal having a frequency from the chip; and a second resonant element disposed on a substrate, wherein the chip is disposed on the substrate, and the first signal enables a non-contact resonant coupling to be established between the first resonant element and the second resonant element due to the frequency to cause the second resonant element to generate and radiate a second signal.

In accordance with a further aspect of the present invention, an integrated antenna is provided. The integrated antenna is disposed at a first substrate and a second substrate, and includes a first coupling element disposed at the first substrate, and receiving a feed-in signal; and a second coupling element disposed at the second substrate, wherein the feed-in signal enables a non-contact resonant coupling to be established between the first coupling element and the second coupling element.

In accordance with a further aspect of the present invention, a method for operating an integrated antenna device is provided. The method includes steps of disposing a first resonant element at a first substrate; feeding a signal into the first resonant element, wherein the first resonant element is resonated in response to the signal; and disposing a second resonant element at a second substrate, wherein the signal enables a non-contact resonant coupling to be established between the first resonant element and the second resonant element.

The above objects and advantages of the present invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed descriptions and accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**(*a*) shows an antenna disposed on a chip in the prior art;

FIG. **1**(*b*) shows the chip antenna disposed on a printed circuit board;

FIGS. **1**(*c*)-**1**(*d*) show the radiation gain patterns of the chip antenna of FIG. **1**(*a*);

FIG. **2**(*a*) is a cross-sectional view of an integrated antenna via non-contact resonant coupling according to an embodiment of the present invention;

FIG. **2**(*b*) is a top view of the integrated antenna via non-contact coupling of FIG. **2**(*a*);

FIG. **3**(*a*) shows a simulation result of the embodiment of FIG. **2**(*a*);

FIG. **3**(*b*) shows the radiation gain pattern of the integrated antenna of FIG. **2**(*a*);

FIG. **4** shows an antenna element disposed on the printed circuit board according to another embodiment of the present invention;

FIG. **5** shows a simulation result of the embodiment of FIG. **4**;

FIG. **6** shows the relative positions of the two resonant elements of the present invention;

FIG. **7**(*a*) shows the antenna effects of the first and the second resonant elements of the present invention, wherein the relative positions thereof are changed along the x direction; and

FIG. **7**(*b*) shows the antenna effects of the first and the second resonant elements of the present invention, wherein the relative positions thereof are changed along the y direction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described more specifically with reference to the following embodiments. It is to be noted that the following descriptions of preferred embodiments of this invention are presented herein for the purposes of illustration and description only; it is not intended to be exhaustive or to be limited to the precise form disclosed.

According to the basic idea of the present invention, the antenna signal is transmitted from the integrated antenna device which is composed of a resonant element on chip and another resonant element on PCB via non-contact resonant coupling. This not only has the advantages of lower cost and higher antenna efficiency but also prevents the issues resulting from the substantial circuit connection between the chip and PCB.

Please refer to FIG. **2**(*a*), which is a cross-sectional view of an integrated antenna via a non-contact resonant coupling **505** according to an embodiment of the present invention. As shown in FIG. **2**(*a*), a chip **100** is disposed above a PCB substrate **201**, and a first resonant element **102** is disposed at the lower side of a silicon substrate **101** of the chip **100**. A second resonant element **202** is disposed on the PCB substrate **201** near the position of the chip **100**. There is a gap **211** between the first resonant element **102** and the second resonant element **202**, e.g. about 60 microns, so that the first resonant element **102** does not contact the second resonant element **202**. As shown in FIG. **2**(*a*), a preferred structure of the first resonant element **102** is obtained by manufacturing the antenna as a planar shape. For receiving and transmitting the antenna signal with a specific frequency more efficiently, preferably the conducting path (open circuit or short circuit) of the first resonant element **102** has a length being one-fourth, a half or a multiple of the wavelength of the signal of the first resonant element **102**. In addition, the first resonant element **102** can be an inductive or capacitive element, which uses the inductive or capacitive resonant coupling to enable the received feed-in signal S1 to be resonated in the first resonant element **102** and coupled to the second resonant element **202**, thereby transmitting the antenna signal. Similarly, the function of the second resonant element **202** disposed on the PCB substrate **201** is also for transmitting or receiving the antenna signal with the specific frequency. Hence, preferably the conducting path of the resonant element **202** also has a length being one-fourth, a half or a multiple of the wavelength of the transmitted or received signal, so that the second resonant element **202** is also resonated due to the transmitted or received signal. Theoretically, signals of the first resonant element **102** of the chip **100** can be all coupled to the second resonant element **202** of the PCB substrate **201** by using the principle of resonant element coupling. The second resonant element **202** of FIG. **2**(*a*) is also a radiation unit so that it can be a resonant antenna such as a general dipole antenna, microstrip antenna, Yagi antenna, etc.

Please refer to FIG. **2**(*b*), which is a top view of the integrated antenna via the non-contact coupling of FIG. **2**(*a*). FIG. **2**(*b*) shows the respective positions of the first resonant element **102** and the second resonant element **202**. The first resonant element **102** can receive a first signal (not shown) from a chip with transmission circuit (not shown) via a feed-in point **103**. Specifically, the first signal has a specific frequency. Since the first signal passes through the silicon substrate **101** and has a first wavelength, the first wavelength depends on the dielectric constant of the silicon substrate **101**. Because the specific frequency is the resonant frequency of the first resonant element **102** and that of the second resonant element **202** simultaneously, according to the configuration of FIG. **2**(*b*), when the first signal is transmitted to the first resonant element **102**, the resonant coupling between the first resonant element **102** and the second resonant element **202** will be induced. This enables the second resonant element **202** to generate a second signal (not shown) having the specific frequency. Then, the second signal is transmitted by the second resonant element **202**. At this time, the second resonant element **202** of the PCB substrate **201** (not shown in FIG. **2** (*b*)) simultaneously has the function of an antenna radiation element. The conducting path of the first resonant element **102** of FIG. **2**(*b*) is curved to a small size, which utilizes the area occupied on the silicon substrate **101** of the chip **100** more efficiently, thereby saving the production cost.

As described above, preferably the conducting path of the second resonant element **202** has a length being one-fourth, a half or a multiple of the wavelength of the second signal transmitted (not shown) so that the second resonant element **202** is resonated due to the second signal transmitted. The conducting path can be an open circuit structure or a short circuit structure; in this embodiment, the conducting path is an open circuit structure. The wavelength of the second signal depends on the dielectric constant of the PCB substrate **201**. Therefore, the antenna designer can decide the sizes of the first and second resonant elements **102**, **202** based on the respective dielectric constants of the silicon substrate **101** and the PCB substrate **201** as well as the appropriate operation frequency band of the antenna. Basically, the first signal and the second signal described above simultaneously have the specific frequency. Under this condition, the first signal passing through the chip **100** can enable the second resonant element **202** of the PCB substrate **201** to generate the second signal via non-contact resonant coupling **505** between the first and the second resonant elements **102**, **202**. Contrarily, since the second resonant element **202** itself also has the function of an antenna radiation element, the antenna signal received by the second resonant element **202** from the outside can also be coupled to the circuit on the chip **100** via the first and the second resonant elements **102**, **202**. Basically, the non-contact resonant coupling of the present invention is the coupling between the first and the second resonant elements **102**, **202**. In other words, the first and the second resonant elements **102**, **202** can be respectively referred to as a first coupling element **302** and a second coupling element **402**; and the silicon substrate **101** and the PBC substrate **201** can be respectively referred to as a first substrate **301** and a second substrate **401**.

The equivalent circuit of the resonator usually includes an inductor and a capacitor. The present invention uses the structural design to enable the first resonant element **102** to have the strongest current distribution at a specific position. Then, the current is coupled to the second resonant element **202** having the function of an antenna radiation element via inductive coupling. The first and the second resonant elements **102**, **202** are not limited to the way of inductive coupling; the way of capacitive coupling or the way of a combination of inductive coupling with capacitive coupling can also be used for the first and the second resonant elements **102**, **202**. Compared to the conventional way of connecting the chip and PCB by using the substantial circuit, the integrated antenna of the present invention greatly enhances the radiation gain and efficiency of the antenna. FIG. **3**(*a*) shows a simulation result of the embodiment of FIG. **2**(*a*), wherein the central frequency is 60 GHz, and the portion between m**1** and m**2** is regarded as the range of the available bandwidth (about 56~88 GHz), which is suitable for use in WPAN radar or vehicular radar. However, the present invention is not limited to the application of this frequency band, but can be widely applied to the application of integrating the chip circuit with the PCB substrate.

FIG. **3**(*b*) shows the radiation gain patterns of the integrated antenna of FIG. **2**(*a*), wherein the radiation gain patterns of the 60 GHz signal in the x-z and y-z planes are shown, which are consistent with those of the dipole antenna. This represents that the integrated antenna of the present invention can successfully excite the dipole antenna. Besides, the gain of the integrated antenna of the present invention can be maintained at about 1 dB. Moreover, the radiation gain pattern of the integrated antenna of the present invention is an omni- directional radiation gain pattern. And the gain of the integrated antenna of the present invention is far larger than that of the general chip antenna.

The second resonant element **202** of FIG. **2**(*b*) is bar-shaped. However, the skilled person can change the structure of the antenna and select different types of antennas according to actual needs. For example, the type of the antenna can be either of the resonant antennas such as the microstrip antenna, the Yagi antenna, etc. Please refer to FIG. **4**, which shows an antenna element disposed on the printed circuit board according to another embodiment of the present invention. As shown in FIG. **4**, the radiation elements **203**, **204** are disposed at two ends of the second resonant element **202**. Please refer to FIG. **5**, which shows a simulation result of the embodiment of FIG. **4**. The range of the available bandwidth of this embodiment is about 75~88 GHz, which is suitable for use in a vehicular antenna. The skilled person can know from this embodiment that the antenna element disposed on the PCB substrate can use the second resonant element **202** to cooperate with the appropriate radiation element for different specific operating frequency bandwidths, so as to obtain the technical scheme of the integrated antenna of the present invention.

Please refer to FIG. **6**, which shows the relative positions of the first and the second resonant elements **102**, **202** of the present invention. The present invention transmits the antenna signal between different substrates (the silicon substrate of the IC chip and the PCB substrate) via non-contact resonant coupling **505** between the first and the second resonant elements **102**, **202**. Because the IC chip is assembled on the PCB substrate during the practical manufacturing process, a slight deviation on the xy plane due to the mechanical assembly is unavoidable. To understand the influence of the deviation of the assembly position on the coupling effect, the second resonant element **202** is moved, from the position facing the center of the first resonant element **102**, along the x direction by 200 microns and along the y direction back and forth by 50 microns. Please refer to FIGS. **7**(*a*) and **7**(*b*). FIG. **7**(*a*) shows the antenna effects of the first and the second resonant elements **102**, **202** of the present invention wherein the relative positions thereof are changed along the x direction, and FIG. **7**(*b*) shows the antenna effects of the first and the second resonant elements **102**, **202** of the present invention wherein the relative positions thereof are changed along the y direction. As shown in FIGS. **7**(*a*) and **7**(*b*), no matter what direction the second resonant element **202** is moved along, a little relative displacement does not cause a notable change in the frequency response of the antenna. Accordingly, the method and device for transmitting the antenna signal between different substrates via the non-contact resonant coupling **505** of the present invention can provide a sufficient deviation-allowable space, whose function is not affected by the position deviation of the xy plane due to the manufacturing process and which is easy to mass produce.

EMBODIMENTS

1. An integrated antenna, comprising:
   a first resonant element **102** disposed on a chip, and receiving a first signal having a frequency from the chip; and
   a second resonant element **202** disposed on a substrate, wherein the chip is disposed onthe substrate, and the first signal enables a non-contact resonant coupling **505** to be established between the first resonant element **102** and the second resonant element **202** due to the frequency to cause the second resonant element **202** to generate and radiate a second signal.

2. The integrated antenna of Embodiment 1, wherein the first signal has a first wavelength, and the first resonant element **102** has a first conducting path.

3. The integrated antenna of any one of Embodiments 1-2, wherein the first conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the first wavelength.

4. The integrated antenna of any one of Embodiments 1-3, wherein the second signal has a second wavelength, and the second resonant element **202** has a second conducting path.

5. The integrated antenna of any one of Embodiments 1-4, wherein the second conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the second wavelength.

6. The integrated antenna of any one of Embodiments 1-5, further comprising a radiation element, wherein the second

resonant element **202** is connected to the radiation element, and sends the second signal to the radiation element.

7. An integrated antenna disposed at a first substrate **301** and a second substrate **401**, and comprising:

a first coupling element **302** disposed at the first substrate **301**, and receiving a feed-in signal S**1**; and

a second coupling element **402** disposed at the second substrate **401**, wherein the feed-in signal S**1** enables a non-contact resonant coupling **505** to be established between the first coupling element **302** and the second coupling element **402**.

8. The integrated antenna of Embodiment 7, wherein the feed-in signal S**1** has a first wavelength in the first substrate **301**, and the first coupling element **302** has a first conducting path.

9. The integrated antenna of any one of Embodiments 7-8, wherein the first conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the first wavelength.

10. The integrated antenna of any one of Embodiments 7-9, wherein the first substrate **301** has a first dielectric constant, and the first conducting path has a first length.

11. The integrated antenna of any one of Embodiments 7-10, wherein the first length is based on the first dielectric constant.

12. The integrated antenna of any one of Embodiments 7-11, wherein the feed-in signal S**1** has a second wavelength in the second substrate **401**, and the second coupling element **402** has a second conducting path.

13. The integrated antenna of any one of Embodiments 7-12, wherein the second conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the second wavelength.

14. The integrated antenna of any one of Embodiments 7-13, wherein the second substrate **401** has a second dielectric constant, and the second conducting path has a second length.

15. The integrated antenna of any one of Embodiments 7-14, wherein the second length is based on the second dielectric constant.

16. A method for operating an integrated antenna device, comprising steps of: disposing a first resonant element **102** at a first substrate **301**;

feeding a signal into the first resonant element **102**, wherein the first resonant element **102** is resonated in response to the signal; and

disposing a second resonant element **202** at a second substrate **401**, wherein the signal enables a non-contact resonant coupling **505** to be established between the first resonant element **102** and the second resonant element **202**.

17. The method of Embodiment 16, wherein the signal has a frequency, and the non-contact resonant coupling **505** is established between the first resonant element **102** and the second resonant element **202** due to the frequency.

18. The method of any one of Embodiments 16-17, wherein the first substrate **301** has a first dielectric constant, the second substrate **401** has a second dielectric constant, the first resonant element **102** has a first conducting path having a first length, and the second resonant element **202** has a second conducting path having a second length.

19. The method of any one of Embodiments 16-18, wherein the first length is based on the first dielectric constant.

20. The method of any one of Embodiments 16-19, wherein the second length is based on the second dielectric constant.

While the invention has been described in terms of what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention needs not be limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims which are to be accorded with the broadest interpretation so as to encompass all such modifications and similar structures.

What is claimed is:

1. An integrated antenna, comprising:

a chip having a silicon substrate, and disposed above a printed circuit board (PCB) substrate;

a first resonant element disposed on the silicon substrate; and

a second resonant element disposed on the PCB substrate, and being a radiation unit, wherein:

the chip sends a first signal having a specific frequency to the first resonant element;

the first signal enables a non-contact resonant coupling to be established between the first resonant element and the second resonant element due to the specific frequency to cause the second resonant element to generate and radiate a second signal; and

the first and the second signals are entirely coupled through the non-contact resonant coupling and the first and the second resonant elements, and the non-contact resonant coupling enables the second resonant element to wirelessly transmit the second signal having the specific frequency.

2. An integrated antenna as claimed in claim **1**, wherein the first signal has a first wavelength, and the first resonant element has a first conducting path configured as an open circuit structure and curved to a small size.

3. An integrated antenna as claimed in claim **2**, wherein the first conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the first wavelength.

4. An integrated antenna as claimed in claim **1**, wherein the second signal has a second wavelength, and the second resonant element has a second conducting path configured as an open circuit structure.

5. An integrated antenna as claimed in claim **4**, wherein the second conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the second wavelength.

6. An integrated antenna disposed at a first substrate and a second substrate, and comprising:

a chip including the first substrate;

a first coupling element disposed at the first substrate, and receiving from the chip a feed-in signal having a specific frequency; and

a second coupling element disposed at the second substrate, and being a radiation unit, wherein:

the first and the second substrates are a silicon substrate and a PCB substrate, respectively;

the feed-in signal enables a non-contact resonant coupling to be established between the first coupling element and the second coupling element to cause the second resonant element to generate an antenna signal; and

the feed-in and the antenna signals are entirely coupled through the non-contact resonant coupling and the first and the second coupling elements, and the non-contact resonant coupling enables the second coupling element to wirelessly transmit the antenna signal having the specific frequency.

7. An integrated antenna as claimed in claim 6, wherein the feed-in signal has a first wavelength in the first substrate, and the first coupling element has a first conducting path.

8. An integrated antenna as claimed in claim 7, wherein the first conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the first wavelength.

9. An integrated antenna as claimed in claim 7, wherein the first substrate has a first dielectric constant, and the first conducting path has a first length.

10. An integrated antenna as claimed in claim 9, wherein the first length is based on the first dielectric constant.

11. An integrated antenna as claimed in claim 6, wherein the feed-in signal has a second wavelength in the second substrate, and the second coupling element has a second conducting path.

12. An integrated antenna as claimed in claim 11, wherein the second conducting path has a length being one selected from a group consisting of one-fourth, a half and a multiple of the second wavelength.

13. An integrated antenna as claimed in claim 11, wherein the second substrate has a second dielectric constant, and the second conducting path has a second length.

14. An integrated antenna as claimed in claim 13, wherein the second length is based on the second dielectric constant.

15. A method for operating an integrated antenna device, comprising steps of:

providing a chip including a first substrate;

disposing a first resonant element at the first substrate;

feeding from the chip a first signal having a specific frequency into the first resonant element, wherein the first resonant element is resonated in response to the first signal; and

disposing a second resonant element at a second substrate, wherein:

the second resonant element is a radiation unit;

the first and the second substrates are a silicon substrate and a PCB substrate, respectively;

the first signal enables a non-contact resonant coupling to be established between the first resonant element and the second resonant element to cause the second resonant element to generate a second signal; and

the first and the second signals are entirely coupled through the non-contact resonant coupling and the first and the second resonant elements, and the non-contact resonant coupling enables the second resonant element to wirelessly transmit the second signal having the specific frequency.

16. A method as claimed in claim 15, wherein the non-contact coupling is established between the first resonant element and the second resonant element due to the specific frequency.

17. A method as claimed in claim 15, wherein the first substrate has a first dielectric constant, the second substrate has a second dielectric constant, the first resonant element has a first conducting path having a first length, and the second resonant element has a second conducting path having a second length.

18. A method as claimed in claim 17, wherein the first length is based on the first dielectric constant.

19. A method as claimed in claim 17, wherein the second length is based on the second dielectric constant.

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