

High-frequency dual-induction antenna and manufacturing method thereof

FIELD OF THE INVENTION

5 The present invention relates to the technical field of antennas operating in the high frequency band of 3-30 Mhz, in particular to a high-frequency dual induction antenna and a method of making the same.

BACKGROUND

10 International standards for contactless smart cards/tags include ISO14443, ISO15693, ISO 18000-3, etc. The antenna design band for cards and tags employing these standards is 13.56 MHz in high frequencies. Practical antenna products in this band are mostly made from multi-coil copper wire or metal PCB antennas. For example, bank and transport cards currently on the market are mostly made from smart card SE chip soldered copper wire wound antennas. Almost all copper wire wound
15 antennas in this band are designed as closed coils with various sizes and shapes.

 High frequency antenna designs for financial or transportation smart cards in practical use today mostly adopt high frequency coil antenna designs in cards, the high frequency antenna has the two functions of taking the corresponding operating voltage and current from the card reader and supplying it to the smart SE module and completing the communication interaction between card and
20 card reader by receiving and transmitting the corresponding electromagnetic modulated waveform signal. The unconnected high frequency coil has 2 to 10 turns (typically, the smaller the size, the higher the number of turns) of the closed copper winding coil (or PCB metal coil). One part of the coil is connected to the antenna interface 1 a of the smart card SE module and the other end of the coil is connected to the antenna interface 1 b of the smart card SE module (there is a corresponding
25 matching circuit when the PCB coil antenna is connected to the chip).

 In some practical application environments such as users with high standard requirements, cards or tags of existing design patterns require higher read and write distances (greater than 8 cm), while some items using standard readers designed from M1 cards require the use of CPU cards (some RF indices for M1 card readers are only 1/10 of CPU smart card readers), or applications requiring

communication with a poor radio frequency index reader using a smaller gauge coil, while some smart SE chips with poor radio frequency performance metrics are expected to gain good application experience, in the above application context, existing conventional high-frequency closed antenna designs cannot meet the requirements and even some engineering cannot achieve normal
5 communication between cards and card readers, so it is necessary to design a high-frequency dual induction antenna to address the above-mentioned problems.

SUMMARY OF THE INVENTION

Against the deficiencies present in the prior art, it is an object of the present invention to provide
10 a high-frequency dual induction antenna and a method of making the same, employing a dual high-frequency induction coil antenna design that greatly improves the radio frequency performance of cards.

In order to achieve the above objects, the technical solutions adopted by the present invention are as follows:

15 A high-frequency dual induction antenna comprising a main high-frequency antenna and an auxiliary high-frequency antenna wound around each other but not connected to each other, wherein the main high-frequency antenna is a large coil antenna in the periphery and the auxiliary high-frequency antenna is a small coil antenna in the primary high-frequency antenna; the main high-frequency antenna and the auxiliary high-frequency antenna are wound in the same direction from
20 the outer coil to the inner coil; one end of the main high-frequency antenna is connected to a first unconnected signal contact of a smart card chip; and one end of the auxiliary high-frequency antenna is connected to a second unconnected signal contact of the smart card chip .

Further, in the high-frequency dual induction antenna, the main high-frequency antenna and the auxiliary high-frequency antenna are wound clockwise or counterclockwise from outer loop to inner
25 loop.

Furthermore, before high-frequency dual induction antenna operates, the main and auxiliary high-frequency antennas need to be debugged such that the main and auxiliary high-frequency antennas are mutually inductively coupled to produce positive feedback and achieve positive superposition of various radio frequency parameters, a debug circuit of the high-frequency dual

induction antenna includes a coil inductor, a coil resistor, a coil capacitor, the first unconnected signal contact, the second unconnected signal contact, a chip capacitor, and a chip resistor, wherein one end of the coil inductor is connected with one end of the coil resistor, and the other end of the coil inductor is connected with one end of the coil capacitor and the second unconnected signal contact, the other
5 end of the coil resistor is connected with the other end of the coil capacitor and the first unconnected signal contact, the one end of the chip capacitor is connected with one end of the chip resistor and the first unconnected signal contact, and the other end of the chip capacitor is connected with the other end of the chip resistor and the second unconnected signal contact.

Further, above-described high-frequency dual induction antenna has various radio frequency
10 parameters including coil inductance, coil resistance, and coil capacitance of the main high-frequency antenna and the auxiliary high-frequency antenna.

Embodiments of the present invention also provide a method of manufacturing a high-frequency dual induction antenna, comprising the steps of:

(S100) Connecting a connection end of the main high-frequency antenna with the first
15 unconnected signal contact of the smart card chip and connecting a connection end of the auxiliary high-frequency antenna with the second unconnected signal contact of the smart card chip, and winding the main high-frequency antenna and the auxiliary high-frequency antenna in series;

(S200) When the main high-frequency antenna and the auxiliary high frequency antenna are soldered with the smart card chip, connection line between the first unconnected signal contact and
20 the second unconnected signal contact is cut by production stamping blade to obtain the main high-frequency antenna and the auxiliary high-frequency antenna which are intertwined but not connected.

Further, manufacturing method of above-described high-frequency dual induction antenna Step (S100) includes winding a copper wire in one direction from free end of the main high-frequency antenna by winding machine, sequentially passing through the first unconnected signal contact and
25 the second unconnected signal contact, and then winding in opposite direction, and finally ending winding from free end of the auxiliary high-frequency antenna.

Further, the method of manufacturing a high-frequency dual induction antenna described above step (S100) includes:

Winding, by a winding machine, a copper wire counterclockwise from the free end of the main

high-frequency antenna, sequentially through the first unconnected signal contact and the second unconnected signal contact, then clockwise, and finally ending from the free end of the auxiliary high-frequency antenna; or

A copper wire is wound clockwise from free end of the main high-frequency antenna by winding machine, sequentially through the first unconnected signal contact and the second unconnected signal contact, then wound counterclockwise, and finally wound ending from free end of the auxiliary high frequency antenna.

An advantage of the present invention is that the RF performance of the card is greatly improved by employing a dual high frequency induction coil antenna design; cards employing dual induction antenna designs greatly increase the range of applications for CPU cards, with greater read and write compatibility for cards; the design of dual sensing antennas when using SE chips with poorer radio frequency performance can overcome the shortcomings of the chip to ensure that the radio frequency performance of the entire card is improved so that the user feels better two coil antennas in series design winding machine is convenient to wind fingers at once during production increases production efficiency and reduces cost.

DESCRIPTION OF THE FIGURES

FIG. 1 is a structural schematic diagram of an existing high frequency antenna provided in an embodiment of the present invention;

Fig. 2 is a schematic structural diagram of a high frequency dual induction antenna provided in an embodiment of the present invention;

Fig. 3 is a schematic design view of a high frequency dual induction antenna provided in an embodiment of the present invention;

Fig. 4 is a flow chart of a method of manufacturing a high frequency dual induction antenna provided in embodiments of the present invention;

Fig. 5 is a winding diagram of a high frequency dual induction antenna provided in an embodiment of the present invention.

Detailed Description of Invention

The present invention is described in further detail below with reference to the accompanying drawings and detailed description.

The present invention changes the conventional design of a smart card where one SE chip is connected to only one high frequency antenna, the developed dual induction high frequency antenna sampling card greatly improves contactless radio frequency parameters with the design of one SE chip connected with two high frequency antennas at the same time, which design technique is also applicable to various scenarios (cards, card readers, tags, etc.) for this band antenna design and application.

As shown in Figure 2, the high-frequency dual induction antenna comprises a primary high-frequency antenna and a secondary high-frequency antenna that are intertwined but not connected to each other, wherein the primary high-frequency antenna is a large peripheral coil antenna, the secondary high frequency antenna is a small coil antenna inside a primary high frequency antenna, the primary high frequency antenna and the secondary high frequency antenna being wound in the same direction from an outer coil to an inner coil, one end of the primary high frequency antenna being connected to a first unconnected signal contact of the chip, and one end of the secondary high frequency antenna being connected to a second unconnected signal contact of the chip.

Preferably, chip is SE chip, one end of main high frequency antenna is connected with LA contact of SE chip, and one end of auxiliary high frequency antenna is connected with LB contact of SE chip.

Preferably, primary and secondary high-frequency antennas are wound clockwise or counterclockwise from outer coil to inner coil.

Preferably, design of dual induction antenna includes following implementation modes: copper wire winding mode, PCB antenna, and antenna design and production mode such as copper or aluminum etching.

Key to the present invention is that the WIN mode of the dual high frequency induction antenna needs to be designed considering electromagnetic compatibility. Considering that both antennas are designed in the high frequency band, and both antennas are located in the card, and the fact that both antennas passively obtain the operating voltage and current from the high frequency reader, the EMC design is very important. The electromagnetic induced magnetic fields of both antennas should be

guaranteed to be in the same direction. The primary high frequency antenna of the outer coil is wound clockwise from the outer coil to the inner coil, the secondary high frequency antenna is wound clockwise from the outer coil to the inner coil. According to electromagnetic principles, when both coils produce clockwise current, the primary coil and the auxiliary coil generating a magnetic field in the auxiliary coil from outside to inside, the energy gained by the auxiliary coil is thereby increased. By using dual induction antennas, the current and voltage induced by the card is increased by 30% over a conventional card, again, the modulated signal produced by the main coil antenna and the modulated signal produced by the auxiliary coil antenna will have a positive additive effect, with actual product test data showing that the signal modulation amplitude of the card is almost doubled.

In order to obtain good non-RF performance of dual high-frequency induction antenna, it is necessary to commission two high-frequency antennas such that two high-frequency antennas are precisely matched and two high-frequency antennas are induced and coupled to each other, thereby creating positive feedback effect and various RF parameters form positive superposition.

Preferably, prior to operation of high-frequency dual induction antenna, primary high-frequency antenna and secondary high-frequency antenna must be debugged such that primary high-frequency antenna and secondary high-frequency antenna mutually induce and couple to produce positive feedback to achieve positive superposition of various radio frequency parameters.

Preferably, various radio frequency parameters include coil inductance, coil resistance, and coil capacitance of primary and secondary high frequency antennas.

The debug circuit of the high-frequency dual induction antenna of the present invention comprises a coil inductor, a coil resistor, a coil capacitor, an La contact, an Lb contact, a chip capacitor and a chip resistor, wherein one end of the coil inductor is connected with one end of the coil resistor, the other end of the coil inductor is connected with one end of the coil capacitor and the Lb contact, the other end of the coil resistor is connected with the other end of the coil capacitor and the La contact, the one end of the chip capacitor is connected with one end of the chip resistor and the La contact, the other end of the chip capacitor is connected with the other end of the chip resistor and the Lb contact.

As shown in Figure 3, a debug circuit diagram of the high-frequency dual induction antenna of the present invention, the radio frequency performance of this antenna depends mainly on three

parameters of coil inductance L_{coil} /coil resistance R_{coil} /coil capacitance C_{coil} . L_{coil} values for normal single frequency closed coils are 2 to 3 microhenries, and its R_{coil} is about 5 ohms, thus its Q value is typically between 30 and 50. For the dual high frequency induction antenna of the present invention, the L_{coil} value of the primary high frequency antenna is about 1.5 to 2 microhenries. Since the LA/LB contacts of the SE chip are soldered at one end of the primary and secondary high frequency antenna coils, respectively, and the equivalent L_{coil} value of both antennas is 1.5 to 2 microhenries, and an equivalent R_{coil} of about 10 to 15 ohms, therefore, the L_{coil} value of the auxiliary high frequency antenna is about 7 to 9 microhenries, and the R_{coil} value of the auxiliary high frequency antenna is about 12 ohms, so that the Q value of the auxiliary high frequency antenna is about 60 to 70. Thus, the Q value of these two antennas is greatly reduced to 10 to 15. Thus, the dual frequency induction antenna of the present invention solves the contradiction between high Q value and narrow bandwidth, and is more efficient than the conventional single frequency closed antenna.

As shown in FIG. 4, a method of manufacturing a dual high frequency induction antenna includes:

Connecting a connection end of the main high frequency antenna with an La contact of the SE chip, connecting a connection end of the auxiliary high frequency antenna with an Lb contact of the SE chip together, and connecting the main high frequency antenna and the auxiliary high frequency antenna in series S100;

S100 comprises:

The copper wire is wound by winding machine from free end of primary high frequency antenna in one direction, then wound in opposite direction after passing through LA contact and LB contact in sequence, and finally wound on free end of secondary high frequency antenna.

Specifically, the copper wire is wound by the winding machine counterclockwise from the free end of the primary high frequency antenna, then clockwise after passing through the LA contact and the LB contact in sequence, and finally completing the winding from the free end of the secondary high frequency antenna; or

Copper wire is wound clockwise from free end of primary high frequency antenna by winding machine, sequentially through LA contact and LB contact, then wound counterclockwise, and finally wound ending from free end of secondary high frequency antenna.

S200. When primary high frequency antenna and secondary high frequency antenna are soldered

with SE chip, severing connecting line between LA contact and LB contact by manufacturing stamping blade to obtain primary high frequency antenna and secondary high frequency antenna wound around but not connected to each other.

5 In manufacture of dual high frequency induction antenna described above, two high frequency coil antennas can be wound in its entirety, i.e., both antennas are wound in its entirety by copper wire depending on mode of operation of current winding machine. When one enters and one exits, winding machine is first wound from bottom thick arrow line and finally ends with middle thick arrow line.

The antenna integrated winding first connects connection end of primary antenna and LA contact of SE chip and connection end of secondary antenna and LB contact of SE chip, so that two high
10 frequency antennas are connected in series. When two antenna coils are soldered with SE chip, top thin arrow in Fig. 4 can be cut into two separate antenna coils by producing stamping blade.

The dual high frequency induction antenna of the present invention and the manufacturing method thereof have the following advantages:

(1) The RF performance of card, such as read and write distance and transaction speed, is greatly
15 improved with dual high frequency induction coil antenna design and passes tighter standard tests.

(2) Cards employing dual induction antenna design greatly expand range of applications for CPU cards, with greater read and write compatibility for cards.

(3) When SE chip with poor RF performance is employed, dual sensor antenna design can overcome shortcomings of chip, ensure RF performance of entire card is improved, and make
20 customer feel better.

(4) Two coil antennas are designed in series, and winder facilitates winding fingers at once during production, which increases production efficiency and reduces costs.

It will be apparent to those skilled in the art that various changes and modifications may be made
25 to the present invention without departing from the spirit and scope of the invention and, therefore, it is intended that the present invention also include such modifications and variations as come within the scope of the appended claims and their equivalents.

Claims

1. A high-frequency dual induction antenna comprising: a main high-frequency antenna and an auxiliary high-frequency antenna that are wound around each other but are not connected to each other, wherein, the main high-frequency antenna is a large peripheral coil antenna, the auxiliary high-frequency antenna is a small coil antenna, and the main high-frequency antenna and the auxiliary high-frequency antenna are wound in the same direction from an outer coil to an inner coil; one end of the main high-frequency antenna is connected to a first unconnected signal contact of a smart card chip; and one end of the auxiliary high-frequency antenna is connected to a second unconnected signal contact of the smart card chip.

2. The high-frequency dual induction antenna according to claim 1, wherein both the main high-frequency antenna and the auxiliary high-frequency antenna are wound clockwise or counterclockwise from outer coil to inner coil.

3. The high-frequency dual induction antenna according to claim 1, wherein prior to operation of the high-frequency dual induction antenna, the main high-frequency antenna and the auxiliary high-frequency antenna must be debugged such that they mutually induce and couple to generate positive feedback to achieve a positive superposition of various radio frequency parameters, a debug circuit of the high-frequency dual induction antenna includes a coil inductor, a coil resistor, a coil capacitor, the first unconnected signal contact, the second unconnected signal contact, a chip capacitor, and a chip resistor, wherein one end of the coil inductor is connected with one end of the coil resistor, and the other end of the coil inductor is connected with one end of the coil capacitor and the second unconnected signal contact, the other end of the coil resistor is connected with the other end of the coil capacitor and the first unconnected signal contact, the one end of the chip capacitor is connected with one end of the chip resistor and the first unconnected signal contact, and the other end of the chip capacitor is connected with the other end of the chip resistor and the second unconnected signal contact.

4. The high-frequency dual induction antenna according to claim 3, wherein various radio frequency parameters include coil inductance, coil resistance and coil capacitance of the main high-frequency antenna and the auxiliary high-frequency antenna.

5. A manufacturing method of a high-frequency dual induction antenna applied to the high-frequency dual induction antenna according to any one of claims 1-4, wherein the manufacturing method comprises:

(S100) Connecting a connection end of the main high-frequency antenna with the first unconnected signal contact of the smart card chip and connecting a connection end of the auxiliary high-frequency antenna with the second unconnected signal contact of the smart card chip, and winding the main high-frequency antenna and the auxiliary high-frequency antenna in series;

(S200) When the main high-frequency antenna and the auxiliary high-frequency antenna are soldered with the smart card chip, connection line between the first unconnected signal contact and the second unconnected signal contact is cut by production stamping blade to obtain the main high-frequency antenna and the auxiliary high-frequency antenna which are intertwined but not connected.

6. The manufacturing method of a high-frequency dual induction antenna according to claim 5, wherein the step (S100) includes:

A copper wire is wound by winding machine from free end of the main high-frequency antenna in one direction, sequentially through the first unconnected signal contact and the second unconnected signal contact, then wound in opposite direction, and finally wound from free end of the auxiliary high-frequency antenna.

7. The manufacturing method of a high-frequency dual induction antenna according to claim 6, wherein the step (S100) includes:

A copper wire is wound counterclockwise from the free end of the main high frequency antenna by a winding machine, sequentially through the first unconnected signal contact and the second unconnected signal contact, then wound clockwise, and finally ending from the free end of the

auxiliary high-frequency antenna; or

A copper wire is wound clockwise from the free end of the main high-frequency antenna by a winding machine, sequentially through the first unconnected signal contact and the second unconnected signal contact, then wound counterclockwise, and finally ending from the free end of the auxiliary high-frequency antenna.

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