

Multilayer electronic module, in particular for a contactless chip card

The invention relates to an electronic module for portable communicating
5 objects, in particular for chip cards that are able to communicate via radiofrequency
with a remote reader, or for electronic passports, or for other portable
communicating objects.

The invention will be described, only for the sake of simplicity and without
limiting the scope thereof, in the context of an application to contactless chip cards,
10 it being understood that the invention applies to other portable communicating
objects and to other shape factors.

Prior art

Electronic modules without an antenna are known in the field of chip cards. In
15 order to provide the chip card that receives the electronic module with an RF
communication function, these modules are provided with a microelectronic chip
connected to what is termed an "ID-1" antenna that is external to the module and
situated in the body of the chip card. This architecture exhibits drawbacks that are
linked in particular to the fragility of the connection between the electronic module
20 and the ID-1 antenna.

To mitigate this, first of all electronic modules provided with a miniature
antenna situated directly on the module were conceived, this antenna being coupled
electromagnetically with a "booster" formed of a concentrator antenna in series or in
parallel with the ID-1 antenna and situated on the card body. This architecture, using
25 inductive coupling between the booster and the antenna of the module, solves the
problem outlined above of the mechanical and electrical connection between the
module and the card body. However, this architecture requires a total of 3 antennae
on the chip card, including one large antenna of ID-1 format, and the method for
manufacturing and integrating the insert carrying this antenna remains relatively
30 complex and expensive.

Now, an increasing need is emerging to integrate the entire radiofrequency
stage of a chip card or other portable communicating product into the electronic

module itself in order to avoid having a portion of the radiofrequency circuit, in particular a large ID-1 antenna or an ID-1 antenna connected to a concentrator, in the card body. Specifically, by integrating the radiofrequency stage into the electronic module, it would be possible to manufacture contactless chip cards, or
5 dual cards, or electronic passports, using the very economic and very well-understood method consisting simply in introducing an independent radiofrequency electronic module into the product (card, passport, etc.), as is done for contact chip cards in the ISO 7816-2 format. In other words, what is targeted is a card body without electronics and without an antenna, and an electronic module incorporating
10 all of the electronic and radiofrequency (RF) components that are required for communication with an external RF reader. This requires a more extensive miniaturization and a change in structure of the module.

Aims of the invention

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The main aim of the invention is therefore to propose a novel type of electronic module, of standard size and thickness, but that is able to solve the abovementioned problems and drawbacks.

Another aim of the invention is to improve the reliability and to reduce the
20 manufacturing cost of the final product incorporating the module according to the invention.

Another aim of the invention is also to ensure a large degree of functional flexibility of the final product, simply through variants of the novel electronic module according to the invention.

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Principle of the solution

The basic principle of the invention provides for superimposing two antennae on the same electronic module, each antenna being produced on its own substrate.
30 The lower substrate also carries the chip. The upper substrate includes a recess allowing the chip to pass through the height thereof, such that said recess is situated

at a height that is substantially equal to that of the upper face of the chip in order to facilitate wiring of the latter.

The module according to the invention will therefore have a thickness similar to that of a standard module. The sum of the thicknesses of the upper and lower
5 substrates is smaller than the thickness of the module according to the invention.

Resistive, capacitive or inductive connections are formed between the antennae of the 2 substrates in order to obtain a plurality of equivalent circuit diagrams of resonant circuits, depending on the applications targeted.

One subject of the invention is therefore an electronic module for a chip card
10 with contactless operation, including a first substrate S2 to which a microelectronic chip is attached, and a first antenna L3 connected to said chip and formed by a plurality of turns wound around said microelectronic chip, the electronic module including a second substrate S1 superimposed on the first substrate S2 and provided with a recess positioned in such a way that said microelectronic chip is positioned in
15 said recess, characterized in that said second substrate includes a second antenna L2 and a third antenna L1 that are connected in series, and in that the turns of said second antenna L2 and of said third antenna L1 are distributed on either side of the second substrate S1.

Thus, by virtue of superimposing two substrates each provided with antennae
20 and being able to form capacitances between them, it is possible, without modifying the geometry of the electronic module or the antenna production technology, to obtain a multitude of circuit diagrams with a broader range of impedances, and hence a greater choice of resonant frequencies depending on the applications targeted.

25 According to one advantageous embodiment, at least some of the turns of the second and third antennae (L2, L1) situated on either side of the second substrate (S1) are positioned facing one another, so as to create a capacitance between the two planes of turns.

According to one embodiment, the first antenna (L3) is electrically insulated
30 from the second and third antennae (L2, L1) by interposition of an insulating film.

Alternatively, the second and third antennae (L2, L1) may be electrically connected to the first antenna (L3) by way of a conductive adhesive.

According to one embodiment, an insulating foil is interposed between the first and second substrates (S2, S1) and the third antenna (L1) is electrically connected to the first antenna (L3) by way of a connecting wire.

According to one preferred variant of the electronic module according to the invention, the overall thickness of the two substrates is smaller than the thickness of the module, but it is possible for the upper face of the second substrate to be substantially at the same level as the upper face of the chip.

Another subject of the invention is a chip card including an electronic module such as defined above.

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Detailed description

The invention will be better understood in the light of the detailed description and of the drawings, in which:

- figure 1 shows a functional diagram of the principle of a chip card according to the prior art, including a module with an antenna, and a card body antenna with a booster for communicating with a radiofrequency reader;
- figure 2 shows a plan view of the electronic module of the chip card of figure 1;
- figure 3 shows a cross-sectional view of the electronic module of figure 2;
- figure 4 shows a cross-sectional view of the electronic module according to the invention;
- figure 5 shows a top view of the electronic module of figure 4;
- figure 6 shows the equivalent circuit diagram of the electronic module of figures 4 and 5;
- figures 7A and 7B show a sectional view of a first variant of the electronic module according to the invention and the corresponding equivalent circuit diagram, respectively;
- figures 8A and 8B show a sectional view of a second variant of the electronic module according to the invention and the corresponding equivalent circuit diagram, respectively;

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- figures 9A and 9B show a sectional view of a third variant of the electronic module according to the invention and the corresponding equivalent circuit diagram, respectively;
- figures 10A and 10B show a sectional view of a fourth variant of the electronic module according to the invention and the corresponding equivalent circuit diagram, respectively;
- figures 11A and 11B show a sectional view of a fifth implementation variant of the electronic module according to the invention and its corresponding equivalent circuit diagram, respectively.

Detailed description of the figures

Reference is made to figure 1, corresponding to the system according to the prior art. This figure shows the typical circuit diagram of a microelectronic module 1 for a chip card, including a chip 2 provided, as is conventional, with a processor, with a memory and with a radiofrequency communication stage, these not being shown in detail. The main output terminals L_a , L_b of the communication stage of the chip 2 are connected to a miniature antenna 3 produced on the module 1.

The chip card includes, in addition to the module, a system of antennae, also called "booster", that are integrated into the body of the chip card, said system being formed of an antenna 4 of ID-1 format that is connected in series with a concentrator antenna 5. The antenna 4 makes it possible to recover the electromagnetic flux of the antenna 6 of the external reader, and the concentrator antenna 5 makes it possible to concentrate the electromagnetic coupling flux between the card body and the module.

The antenna 6 of the reader generates an electromagnetic field. The booster, through the large antenna 4 termed ID-1 antenna of the card body, uses this field as a power source to activate and electrically power the microelectronic component 1 of the module.

The power and the data recovered by the ID-1 antenna of the booster are transmitted to the antenna 3 of the module via the concentrator 5. The chip 2 includes two main connection pads L_a , L_b used for the radiofrequency communication

of the chip and linked to the intrinsic capacitor of the chip (not shown), and to the antenna 3 of the module 1.

Figures 2 and 3 show an example of a known electronic module 1, in a plan view and in a sectional view. As is seen, the module 1 includes a single antenna 3 formed of conductive turns that are produced on the substrate 10. The other face of the substrate carries metal contacts 11 that are used as resistive contacts with the equivalent contacts of a chip card reader. In a known manner, the output pads of the radiofrequency interface of the chip 2 are connected to connection pads of the antenna 3 by way of metal wires 12.

Figure 4 shows a partial section of an electronic module 1 according to the invention. As is seen, this module includes a dual substrate S1 (upper substrate), S2 (lower substrate), in the form of two superimposed substrates S1, S2. On the upper face of the upper substrate S1 are formed the turns of a first antenna of inductance L1, denoted by the reference L1 for simplicity. On the lower face of the upper substrate S1 are formed the turns of a second antenna of inductance L2, denoted L2. On the lower substrate S2 are formed the turns of a third antenna of inductance L3, denoted by L3. In the example shown, the turns of the second antenna L2 are produced facing the turns of the 3rd antenna L3. In order to electrically insulate the turns of the antenna L2 and the turns of the antenna L3, an electrical insulator 14 has been interposed between them. The turns of the antennae L1, L2 of the upper substrate S1 are placed in series by way of a conductive via 15.

In addition, metal stubs 16, situated facing one another on either side of the upper substrate S1, form a capacitor of capacitance C.

Thus, as shown in the equivalent circuit diagram of figure 6, an electronic module is obtained that includes a microelectronic chip connected in series with an antenna L3, coupled electromagnetically with two antennae L1, L2 in series and with a value of $L1 + L2$, in series with a capacitor of capacitance C.

Thus, by way of the suitable choice of values for the inductances L1, L2, L3 and C, a multilayer resonant circuit is obtained that offers more modes of operation than known electronic modules for chip cards.

In particular, superimposing the two substrates S1, S2 makes it possible to obtain an inductance $L1 + L2$ that is far higher than the inductance $L1$ of known single-substrate modules, without changing the antenna production technology.

As shown in figure 5, which shows the upper substrate S1 of the novel electronic module in a top view, this substrate S1 includes a recess or through-aperture 17 of a size sufficient to allow the upper part of the chip 2 and all or some of the connecting wires 12 to pass through.

Figures 7 to 11 show implementation variants of the principle employed in figure 4.

Figure 7A differs from figure 4 in that the antennae L1, L2 are connected in series by way of the via 15 and are connected to a capacitance that is available on the chip by virtue of the connecting wire 12a between Lc and LD, and are coupled to an antenna L3 that is itself connected to the chip via the connecting wire 12b between LA and LB, in accordance with the equivalent circuit diagram of figure 7B.

Figure 8A differs from figure 7A through the mode of interconnection of the antennae L1, L2 and L3. Specifically, while the antennae L1 and L2 are connected in series by virtue of a via 15, they are also connected in series with the antenna L3 by virtue of a connection 18 that is formed by a local flattened area of an anisotropic adhesive that makes this flattened area conductive. The insulating foil 14 of figures 4 and 7A is therefore replaced with an anisotropic conductive adhesive.

By contrast, as shown in figure 9A, it is possible to arrive at the same equivalent circuit diagram (figure 9B identical to figure 8B) while keeping an insulating foil 14 between the lower and upper substrates, but while directly connecting the antenna L1 (in series with the antenna L2 by virtue of the via 15) to the antenna L3 by virtue of the connecting wire 19.

In another embodiment shown in figure 10A, the antennae L1 and L2, connected in series through the via 15, are connected to the antenna L3 and to the chip 2 through capacitive coupling by way of metal plates 20 and 21 that are positioned facing one another under the upper substrate and on the lower substrate. The diagram of a resonant circuit in accordance with figure 10B is thus obtained.

In the variant of figure 11A, the respective upper and lower substrates S1 and S2 include antennae L1, L3 that are arranged head-to-tail and separated by an

anisotropic material that makes it possible to electrically interconnect them at the location of a local pinched area or flattened area 18. A module whose upper substrate S1 has a single face in accordance with the circuit diagram of figure 11B is thus obtained, said circuit diagram being identical to the one of figures 7B and 9B, but by another means.

Ultimately, by virtue of superimposing two substrates each provided with antennae and being able to form capacitances between them, there is a possibility, without modifying the geometry of the electronic module or the antenna production technology, for a multitude of circuit diagrams with a broader range of impedances, and hence a greater choice of resonant frequencies depending on the applications targeted.

Advantages of the invention

The electronic module according to the invention achieves the aims that are set. It makes it possible to keep a standard thickness for the range of products targeted, for example the standard thickness of a chip card module, while increasing the number and the value of the inductances on board the module, thereby making it possible to enhance the functionalities of the module and of the products, in particular chip cards, on which it will be fitted.

Furthermore, the electronic module according to the invention has a reduced cost and a simplified manufacturing and integration method.

CLAIMS

1. An electronic module for a chip card with contactless operation, said module
5 including a first substrate (S2) to which a microelectronic chip (2) is attached, and a first
antenna (L3) connected to said chip and formed by a plurality of turns wound around said
microelectronic chip, and said electronic module including a second substrate (S1)
superimposed on the first substrate (S2) and provided with a recess (17) positioned in such a
way that said microelectronic chip (2) is positioned in said recess, wherein said second
10 substrate of the electronic module includes a second antenna (L2) and a third antenna (L1)
that are connected in series, and wherein the turns of said second antenna (L2) and of said
third antenna (L1) of the electronic module are distributed on either side of the second
substrate (S1) of the electronic module, and wherein at least some of the turns of the second
and third antennas (L2, L1) situated on either side of the second substrate (S1) of the
15 electronic module are positioned facing one another, so as to create a capacitance between
the two planes of turns of the second and third antennas of the electronic module.

2. The electronic module as claimed in claim 1, characterized in that the first
antenna (L3) is electrically insulated from the second and third antennae (L2, L1) by
20 interposition of an insulating film (14).

3. The electronic module as claimed in any one of claims 1 or 2, characterized in
that the second and third antennae (L2, L1) are electrically connected to the first antenna
(L3) by way of a conductive adhesive (18).

25 4. The electronic module as claimed in either one of claims 1 and 2,
characterized in that an insulating foil (14) is interposed between the first and second
substrates (S2, S1) and in that the third antenna (L1) is electrically connected to the first
antenna (L3) by way of a connecting wire (19).

30 5. The electronic module as claimed in any one of the preceding claims,
characterized in that the overall thickness of the two substrates (S1, S2) is smaller than the
thickness of the module.

35 6. The electronic module as claimed in any one of the preceding claims,
characterized in that the upper face of the second substrate (S1) is substantially at the same
level as the upper face of the chip (2).

7. A chip card, characterized in that it includes an electronic module as claimed in any one of claims 1 to 6.