

DESCRIPTION

Title of the invention: ELECTRONIC MODULE FOR A CARD CONTAINING AT LEAST ONE ANTENNA AND MANUFACTURING METHOD THEREOF

[0001] The invention relates to an electronic module for a card containing at least one antenna and the method for manufacturing same. The electronic module can be incorporated in a contactless transaction card, a card with hybrid operation or “dual card” having a contact function and a contactless function.

[0002] The invention is applicable, regardless of the material used to make the connections, gold wires, aluminum wires or wires made of any other material capable of making the requisite connections between an integrated circuit (chip) and an antenna or between an integrated circuit and one or more “bonding” wells.

[0003] The electronic module according to the invention can be used in any handheld device, such as a card, in the identity field, in transportation, in the banking field, in access control, in health and also in the telecommunications field.

[0004] The electronic module incorporated in a chip card generally comprises a printed circuit provided with a chip or integrated circuit, and communication means allowing the transmission of data from the chip to a card reader device. The data transmission means consist, for example, of one or more antennas and/or a connector.

[0005] A contact chip card will comprise a connector for a suitable reader to be able to read the information on the card, the connector comprising contacts electrically connected to the chip. These contacts are composed of conductive metal tracks on the surface of the support to make a connection by electrical contact with the card reader device.

[0006] A contactless chip card comprises one or more antennas, connected directly, or via an antenna called “booster” antenna, to a card reader device.

[0007] A dual chip card comprises both functions for exchanging data and both of the abovementioned connection types.

[0008] One of the problems encountered in manufacturing electronic modules intended to be inserted in cards, or in any other equivalent support, is notably the

height of the bonding wires linking the antenna buried in the card and the chip contained therein.

[0009] Another difficulty that is encountered results from the connection of one or more pads of the chip with bonding wells. The bonding pads of the chip or of the integrated circuit having a determined layout, as well as the layout of the bonding wells with respect to the contacts on the surface of the support, can lead to crossed bonding wires or to the presence of excessively long wires.

[0010] The documents EP2892012, US2013/062419, US2015/269471 and EP3059698 disclose an electronic module comprising an intermediate bonding pad.

[0011] As is illustrated in figure 1, in some configurations, wires used for the connection between an antenna and an integrated circuit will "intersect".

[0012] An electronic module 1 is known comprising a substrate on which are deposited one or more conductive tracks forming an antenna. The conductive tracks comprise a first end forming the inner end of the antenna and a second end forming the outer end of the antenna. A chip is linked via bonding pads 12p, to the inner end of the antenna, to the outer end of the antenna and to bonding wells. The technique used is a bonding wire cabling technique better known by the expression "wire bond". In the prior art, the bonding wires 14 cross.

[0013] The idea behind the present invention rests on a novel approach for the manufacturing of an electronic module and the structure of the module resulting therefrom, which consists notably in using one or more intermediate bonding pads disposed "within the antenna" and which make it possible to make the necessary electrical connections. The presence of these intermediate bonding pads makes it possible to minimize the length of the bonding wires and/or avoid having the bonding wires cross.

[0014] The expression "disposed within" the antenna means, in the present invention, that a so-called "intermediate" pad will be disposed on the antenna support within an antenna loop (or a perimeter) formed by the wires or the turns of which the antenna is composed.

[0015] The expressions "intermediate bonding pad" or "intermediate pad" designate the same element.

[0016] The invention relates to an electronic module comprising a substrate on which are disposed one or more electrically conductive tracks, at least one integrated circuit comprising several bonding pads, characterized in that it comprises:

5 [0017] at least one intermediate bonding pad situated on at least one face of said substrate,

[0018] said intermediate bonding pad is connected at least:

[0019] at a first point, to said electrically conductive tracks or to a bonding well on the substrate, by means of a first bonding wire, and

10 [0020] at a second point, to at least one pad of the integrated circuit, by means of a second bonding wire.

[0021] Said electrically conductive track or tracks form at least one antenna, and

[0022] said intermediate bonding pad is situated on a face of said substrate bearing said electrically conductive wires,

15 [0023] said intermediate bonding pad is connected to at least one outer end of the antenna via a first bonding wire and to at least one bonding pad of the integrated circuit via a second bonding wire.

20 [0024] The electrically conductive tracks take, for example, the form of several loops deposited on a face of the substrate and at least one intermediate bonding pad extends over at least a part of the inner periphery formed by said electrically conductive tracks.

25 [0025] The bonding wire linking the outer end of the antenna and a pad of the integrated circuit is composed, for example, of a first part which links the outer end of the antenna to a first zone of the intermediate bonding pad and of a second part which links a second zone of the intermediate bonding pad to said pad of the integrated circuit.

[0026] The connection between a bonding pad of the integrated circuit and at least one of the electrically conductive tracks or at least one of the bonding wells is produced with an aluminum wire or with a gold wire.

[0027] The integrated circuit can be an electronic chip.

[0028] The invention relates also to a method for manufacturing an electronic module according to the invention comprising at least the following steps:

[0029] – at least one or more electrically conductive tracks are disposed on at least one face of a substrate,

5 [0030] – at least one integrated circuit comprising one or more bonding pads is deposited on the substrate.

[0031] The method is characterized in that:

[0032] – one or more intermediate bonding pads are produced, configured to ensure a connection between at least one of the bonding pads of at least one integrated
10 circuit and an electrically conductive track or a bonding well, of the substrate,

[0033] – the intermediate bonding pad or pads are electrically dissociated from the electrically conductive track or tracks or from a bonding well,

[0034] – the connection is made between at least one of the intermediate bonding pads and at least the electrically conductive track or tracks or at least one bonding
15 well with a first bonding wire, and between at least one of the intermediate bonding pads and one of the pads of at least one integrated circuit with a second bonding wire. At least one intermediate bonding pad 35 extends over at least a part of the inner periphery 36 formed by said electrically conductive tracks.

[0035] According to a variant embodiment, said electrically conductive tracks are
20 deposited to form at least one antenna comprising a first end and a second end, and a connection is made between said intermediate bonding pad with at least one outer end of the antenna via a first bonding wire and to at least one bonding pad of the integrated circuit via a second bonding wire.

[0036] It is also possible to electrically deposit the intermediate bonding pad or pads
25 upon the creation of a central aperture in the substrate, said central aperture having dimensions chosen to accommodate an integrated circuit.

[0037] The connection between at least one electrically conductive track or one bonding well and at least one of the intermediate bonding pads and between at least one of the intermediate bonding pads and one of the pads of at least one integrated
30 circuit can be made by using a gold wire or an aluminum wire.

[0038] The method can further comprise a step of encapsulation of the electrically conductive wires, of the intermediate bonding pads and of the integrated circuit using a protective resin.

[0039] Other features, details and advantages of the invention will emerge on reading the description given with reference to the attached drawings, which are given as nonlimiting examples and which represent, respectively:

[0040] [Fig.1] figure 1 is an illustration of a first exemplary embodiment of the electronic module according to the invention,

[0041] [Fig.2] figure 2 is an enlarged view of the first exemplary embodiment of figure 1;

[0042] [Fig.3] figure 3 is a variant of figures 1 and 2 with an intermediate pad making it possible to connect the chip to a contact on the surface of the support, avoiding the crossing of bonding wires;

[0043] [Fig. 4] figure 4 is a variant embodiment for the form of an intermediate bonding pad;

[0044] [Fig.5] figure 5 is a succession of steps implemented for an exemplary method for manufacturing the electronic module according to the invention.

[0045] Figure 1 illustrates an electronic module 2 according to the invention comprising a substrate 20 on which are deposited one or more conductive tracks 21 forming an antenna. The conductive tracks comprise a first end 21i forming the inner end of the antenna 21 and a second end 21e forming the outer end of the antenna 21. A chip 22 is linked via several bonding pads 22p, on the one hand to the inner end 21i of the antenna 21 and to the outer end 21e of the antenna 21 via an intermediate bonding pad 25 on at least one face 21 of the substrate 20 as will be detailed hereinbelow, and, on the other hand, to bonding wells 23j. The technique used for the connection is a bonding wire 24 cabling technique, better known as "wire bond". The bonding wires can be made of aluminum, of gold or any other electrically conductive material that makes it possible to connect the chip with the antenna and the contacts on the surface of the support.

[0046] The substrate 20 comprises one or more bonding pads, called "intermediate bonding pads" 25. For the purposes of simplification, figure 1 illustrates the case

where an intermediate pad 25 is used to connect the outer end 21e of the antenna 21 to a bonding pad 22p of the chip. The bonding wire 24, usually composed of a single part to connect the chip and the outer end of the antenna, is divided into two, a first part 241 which links the outer end 21e of the antenna to a first zone 252 of the intermediate pad 25 and a second part 242 which links a second zone 251 of the intermediate pad 25 to a pad 22e of the chip 22. In this way, the length of the part of the bonding wire is less than the length of the wire directly linking the outer end of the antenna to the chip according to the prior art techniques. That advantageously makes it possible to reduce the height of the loop of the wire thus formed. A third part of the bonding wire 243 links the inner end 21i of the antenna 21 to a pad 22i of the chip 22.

[0047] An aperture 26 can be produced in the substrate for passage of the integrated circuit, for example. Its dimensions are chosen accordingly. Without departing from the context of the invention, the architecture according to the invention can also be implemented for a substrate without aperture, in which the integrated circuit is placed on one of the faces of the substrate.

[0048] In figure 1, a single intermediate bonding pad has been illustrated. This intermediate bonding pad can be divided into several pads, taking different forms and which are distributed at different points of the substrate in order to allow the connection of the wires, to reduce the dimension of these wires and avoid having them cross. The number of intermediate bonding pads is notably chosen as a function of the number and the disposition of integrated circuits disposed on the substrate.

[0049] In the case of a connection wire made of aluminum, the arrangement illustrated in figure 1 facilitates the placement of the wires and their connections, by notably making it possible to dispose several bonding wires in parallel.

[0050] In the case of a bonding wire made of gold, this structure offers more flexibility in the wiring, notably in the case of an electronic module comprising several integrated circuits or chips.

[0051] The intermediate bonding pad or pads are metalized pads. Since the antenna is generally made of copper, the metallization of the pad will be composed, in

addition to copper, of nickel and of gold or of any other material making it possible to make an electrical connection.

[0052] In order to keep the bonding wires in parallel, notably in the case of aluminum wires, the intermediate bonding pad will be able to contain at least two bonding pads disposed in such a way that the bonding wire between the outer end of the antenna with the intermediate pad, the bonding wire between the intermediate pad, and the bonding wire between the inner end of the antenna and the chip are disposed substantially parallel to one another. Figure 2 illustrates three bonding wires 241, 242, 243 that are substantially parallel to one another.

[0053] The geometry and the dimensions of an intermediate bonding pad will be chosen, notably, as a function of the potential direction of arrival of the bonding wire. For example, the form of the intermediate bonding pad can take an oblong form in the direction parallel to the arrival of the bonding wire. The dimensions of this intermediate bonding pad are chosen according to a trade-off between the cost of the metallization of the pad and the size, which must be sufficient to accommodate a bonding wire. The technique for the connection made with a gold wire is known as “ball-wedge bonding”, which consists in placing a ball of gold on the chip and a fixing pad or “wedge” on the substrate. For the connection made with an aluminum wire, the technique is known as “wedge-wedge bonding” with two fixing pads. In the case of a metallization produced with precious metals it will be sought to reduce the cost resulting from the metallization and to optimize the cost/size trade-off. The deposition of these precious metals can be performed for example by selective electrodeposition (or “selective plating”).

[0054] When the antenna is being manufactured on the substrate, the intermediate bonding pad or pads are linked. Thus, during the step of deposition of the materials allowing the wire connection (generally nickel and gold), and requiring the input of a current, the intermediate pad or pads are supplied in the same way as the antenna itself. The electrical insulation of these intermediate pads is produced, for example, in the internal cutting of the substrate, allowing access to the contact on the surface of the substrate and the finalization of the electronic module. The electrical insulation can also be produced by the punching technique better known in the abbreviated form “punch”, during de-short-circuiting or testing.

[0055] The assembly of chip and antenna will for example be protected by a resin, not represented for the purposes of simplification of the figures, according to techniques known from the prior art. For example, the resin will be deposited via the encapsulation technique known as “dam and fill”, or else by transfer molding. The resin will be able to be an encapsulation resin of coating or “potting” type. It is also possible to use epoxy-based resins known by the term “glob top”.

[0056] The chip will be held in place on the antenna support (substrate), for example by means of an adhesive or any other technique known to the person skilled in the art.

[0057] Figure 3 illustrates a variant embodiment for a bonding well (connection to an ISO contact, on the contact face) which is within the bundle of wires forming an antenna to avoid wire crossings in the wiring, and render a substrate or tape “design” universal, to shorten the wires. In this example, a bonding well 234 is connected to a pad 221 of the chip 22 via a first bonding wire 41 in a first zone of an intermediate bonding pad 42 and a second bonding wire 44 in a second zone of the same intermediate bonding pad.

[0058] In the particular embodiment of figure 3, the antenna formed by the electrically conductive tracks 21 has a bypass zone Z_c . This bypass zone Z_c is intended to bypass the outer end 21e of the antenna. This bypass zone Z_c extends toward the interior of said antenna. The intermediate bonding pad here partially follows the inner periphery formed by the antenna. This bonding pad then has a form 351 complementing the bypass zone Z_c and thus partly surrounding it. More particularly, the complementary form 351 is, here, partially incurved. In other words, this complementary form 351 has a bean form.

[0059] Figure 4 illustrates a variant embodiment of figure 3, in which the form of the intermediate pad 25 “follows” all of the inner periphery 36 formed by the innermost tracks constituting the antenna. The intermediate pad 25 has a first part that has the complementary form 351 or a bean form and a second part 352 in the form of an electrically conductive track. This second part 352 extends over the entire inner periphery 36 to entirely surround the integrated circuit 22. Preferably, this second part 352 takes the form of a thick tape which follows the inner periphery of the wires forming the antenna. Such an arrangement notably makes it possible to more easily

connect the various pads of the chip, which can be distributed over the perimeter of the chip, to one or more bonding wells 231, 232, 233, 234, 235 (fig. 4), connected for example to an outer terminal such as a communication interface of ISO type, by avoiding a crossing of the bonding wires.

- 5 [0060] Without departing from the context of the invention, the electronic module can comprise a substrate with a double antenna, deposited on each of the faces of the substrate.

[0061] Figure 5 illustrates an example of successions of steps for the manufacturing of an electronic module according to the invention which will be able to comprise, for
10 example, the following steps:

[0062] 501 – a substrate is available on which are deposited, according to a technique known to the person skilled in the art, a set of metal tracks on at least one face of the substrate to form, for example, one or more antennas,

[0063] As an example, to produce an electrically conductive contact, a sheet of
15 material will be dipped in an electrolyte solution and said electrically conductive sheet will be secured to the substrate,

[0064] 502 – at least one chip or integrated circuit is deposited at the center of the substrate,

[0065] 503 – one or more bonding wells are produced, this step being optional,

20 [0066] 504 – one or more intermediate bonding pads are deposited, the dimensions and the position or positions of which are chosen such that the wire connections between the pads of the chip and the two ends of the antenna do not cross, and

[0067] an intermediate pad is electrically dissociated from the antenna before its connection by the bonding wires. For example, the electrical dissociation (isolation) is
25 carried out after the substrate finishing steps, such that the intermediate bonding pad has layers of electrolyte deposition necessary to the wire soldering. This electrical dissociation 505 is for example carried out upon the creation of a central aperture (26, figure 1) intended to accommodate the integrated circuit at a lower altitude on the finished product,

[0068] the connection is made between at least one of the intermediate pads and one end of the antenna 21 and between at least one of the intermediate pads with one of the pads 22p of the integrated circuit 22, and/or with a bonding well, 506,

5 [0069] 507 – an encapsulation resin is deposited to protect the antenna and the integrated circuit.

[0070] The dielectric substrate is, for example, made of epoxy glass, of polyethylene terephthalate, of polyethylene naphthalate, of polyimide, etc.

[0071] The electronic module thus obtained can be positioned in a cavity of the card body by using a hot melt glue.

10 [0072] The module according to the invention and the method for manufacturing same make it possible to offer a module in which the height of the loops formed by the bonding wires is less than the heights found in the electronic modules of the prior art. That makes it possible to make the module more compact, to reduce the thickness of this module. Such a structure makes it possible to facilitate the wiring
15 with aluminum wires. The presence of an intermediate pad avoids the crossing of the bonding wires.

CLAIMS

1- An electronic module (2) comprising:

- a substrate (20) on which are disposed several electrically conductive tracks (21), said electrically conductive tracks taking the form of several loops deposited on a face of said substrate (20), forming at least one antenna;
- at least one integrated circuit (22) comprising several bonding pads (22p);
- at least one intermediate bonding pad (25) situated on a face (201) of said substrate (20), said intermediate bonding pad (25) being connected at a first point to said electrically conductive tracks (21) or to a bonding well (231, 232, 233) on the substrate (20), by means of a first bonding wire (241), and, at a second point, to at least one pad of the integrated circuit (22), by means of a second bonding wire (242), said intermediate bonding pad (25) being situated on a face (201) of said substrate (20) bearing said electrically conductive wires (21), and said intermediate bonding pad (25) being connected to at least one outer end (21e) of the antenna (21) via the first bonding wire (241) and to at least one bonding pad (22p) of the integrated circuit (22) via the second bonding wire (242);

characterized in that the intermediate bonding pad (25) extends over at least a part of the inner periphery (36) formed by said electrically conductive tracks (21).

2. The electronic module as claimed in claim 1, characterized in that the bonding wire linking the outer end (21e) of the antenna (21) and a pad (22e) of the integrated circuit (22) is composed of a first part (241) which links the outer end (21e) of the antenna to a first zone (251) of the intermediate bonding pad (25) and of a second part (242) which links a second zone (252) of the intermediate bonding pad (25) to the pad (22e) of the integrated circuit (22).

3. The electronic module as claimed in one of the preceding claims, characterized in that the connection between a bonding pad (22p) of the integrated circuit (22) and at least one of the electrically conductive tracks (21) or at least one of the bonding wells is produced with an aluminum wire.

4. The electronic module as claimed in one of claims 1 and 2, characterized in that the connection between a bonding pad (22p) of the integrated circuit (22) and at

least one of the electrically conductive tracks (21) or at least one of the bonding wells is produced with a gold wire.

5 5. The electronic module as claimed in one of claims 1 to 4, characterized in that the integrated circuit (22) is an electronic chip.

6. The electronic module as claimed in any one of claims 1 to 5, characterized in that the antenna formed by the electrically conductive tracks (21) has a bypass zone (Zc) intended to bypass the outer end (21e) of the antenna, said bypass zone (Zc) extending toward the interior of said antenna and in that the intermediate bonding pad (25) has a form (351) complementing said bypass zone (Zc).

7. The electronic module as claimed in claim 6, wherein the complementing form (351) is partially incurved.

15 8. The electronic module as claimed in either one of claims 6 and 7, wherein the intermediate bonding pad (25) comprises an electrically conductive track (352) extending over the inner periphery (36) to entirely surround the integrated circuit (22).

20 9. A method for manufacturing an electronic module as claimed in any one of claims 1 to 8, comprising at least the following steps:

- at least one or several electrically conductive tracks (21) are disposed on at least one face of a substrate (20),
- at least one integrated circuit (22) comprising one or more bonding pads (22p), is deposited on the substrate (20), (502),

25 characterized in that:

- one or more intermediate bonding pads (25) are produced, configured to ensure a connection between at least one of the bonding pads (22p) of at least one integrated circuit (22) and an electrically conductive track (21) or a bonding well (231, 232, 233) of the substrate, (504), at least one intermediate bonding pad (35) extends over at least a part of the inner periphery (36) formed by said electrically conductive tracks,
- the intermediate bonding pad or pads (25) of the electrically conductive track or tracks or of a bonding well are electrically disassociated, (505),

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- the connection is made between at least one of the intermediate bonding pads (25) and at least the electrically conductive track or tracks or at least one bonding well (231, 232, 233) with a first bonding wire and between at least one of the intermediate bonding pads (25) and one of the pads (22p) of at least one integrated circuit (22) with a second bonding wire.

10. The method as claimed in claim 9, characterized in that said electrically conductive tracks are deposited to form at least one antenna (21) comprising a first end (21i) and a second end (21e) and a connection is made between said intermediate bonding pad (25) with at least one outer end (21e) of the antenna (21) via a first bonding wire (241) and to at least one bonding pad (22p) of the integrated circuit (22) via a second bonding wire (242).

11. The method as claimed in one of claims 9 and 10, characterized in that the intermediate bonding pad or pads (25) are electrically dissociated upon the creation of a central aperture (26) in the substrate (20), said central aperture being intended to accommodate an integrated circuit (22).

12. The method as claimed in one of claims 9 to 11, characterized in that the connection is made between at least one electrically conductive track (21) or a bonding well and at least one of the intermediate bonding pads (25) and between at least one of the intermediate bonding pads (25) and one of the pads (22p) of at least one integrated circuit (22) by using a gold wire or an aluminum wire.

13. The method as claimed in one of claims 9 to 12, characterized in that it further comprises a step of encapsulation of the electrically conductive wires, of the intermediate bonding pads and of the integrated circuit using a protective resin.