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(54) **TELEMATICS CONTROL UNIT COMPRISING AN ANTENNA PRINTED ON A PLASTIC CARRIER**

(57) The invention relates to a telematics control unit (1) for a vehicle (3), said telematics control unit (1) comprising at least one antenna (10) connected to an electronic support (11), a first housing (12) and a second housing (13) that are configured to house said at least one antenna (10) and said electronic support (11), wherein it further comprises a plastic carrier (14) that is placed opposite to the electronic support (11), and wherein said at least one antenna (10) is printed on said plastic carrier (14).

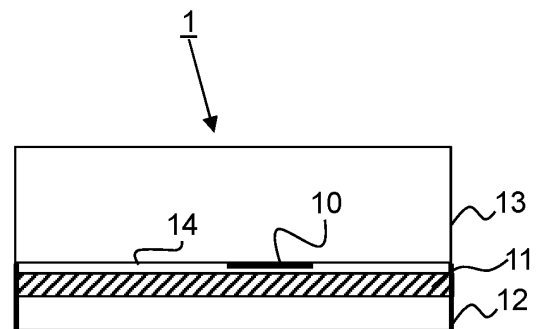


Fig. 1a

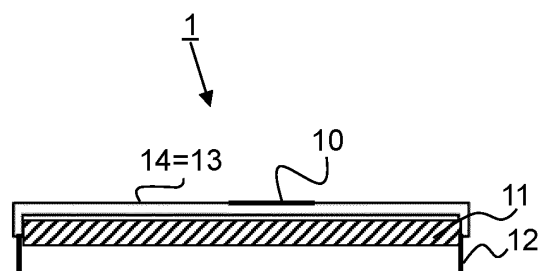


Fig. 1b

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a telematics control unit for a vehicle. Such telematics control unit may be used, but not exclusively, in the automotive domain.

BACKGROUND OF THE INVENTION

[0002] In the automotive domain, a telematics control unit for a vehicle, known by the man skilled in the art, comprises at least one antenna printed on an electronic support. The antenna is a cellular antenna.

[0003] The telematics control unit permits a connection to a base station to estimate the position of the vehicle via a triangulation. It also support voice and data connectivity within the 5G frequency band.

[0004] The telematics control unit is arranged under the roof of the vehicle inside the compartment of the vehicle. It comprises a housing that is configured to house the components of the telematics control unit. The telematics control unit also integrates a cellular communication module to be connected to the cellular antenna, and often other types of antennas and other types of communication modules. These components are all supported by the electronic support.

[0005] One problem of this prior art is that the telematics control unit has a housing that is limited in space and the integration of all the antennas and other components on the electronic support is complex as it must take into account not only the integration on a defined space which is the surface of the electronic support, but also the size of the compact housing of the telematics control unit.

[0006] It is an object of the invention to provide a telematics control unit for a vehicle, which resolves the problem above-stated.

SUMMARY OF THE INVENTION

[0007] To this end, it is provided a telematics control unit for a vehicle, said telematics control unit comprising at least one antenna connected to an electronic support, a first housing and a second housing that are configured to house said at least one antenna and said electronic support, wherein it further comprises a plastic carrier that is placed opposite to the electronic support, and wherein said at least one antenna is printed on said plastic carrier.

[0008] As we will see in details in the following, thanks to the plastic carrier, the antenna which is not anymore on the electronic support, allows to alleviate the number of components on the electronic support, and thus simplify the integration of the other components on the electronic support, while reducing its size so that it can fit in a compact housing of the telematics control unit.

[0009] According to non-limitative embodiments of the invention, the telematics control unit further comprises the following characteristics.

[0010] In a non-limitative embodiment, said at least one antenna is metal ink printed on said plastic carrier.

[0011] In a non-limitative embodiment, said plastic carrier is flat or has a curve shape.

[0012] In a non-limitative embodiment, said plastic carrier forms the second housing or is independent from the second housing.

[0013] In a non-limitative embodiment, said electronic support and said first housing provide ground to the at least one antenna.

[0014] In a non-limitative embodiment, said second housing is in plastic.

[0015] In a non-limitative embodiment, said at least one antenna is a full band cellular antenna.

[0016] In a non-limitative embodiment, said full band cellular antenna comprises :

- a body,
- a feeding pin that is configured to transmit and receive power for the full band antenna cellular, and
- a first loading pin that is connected to a first reactive component and that is configured to tune the full band cellular antenna to resonate according to a frequency within the first frequency band,
- a ground pin that is connected to a second reactive component to generate a resonance of the full band cellular antenna in a second frequency band,
- a second loading pin that is connected to a third reactive component and that is configured to tune the full band cellular antenna to resonate according to a frequency within the first frequency band.

[0017] In a non-limitative embodiment, the body of said at least one antenna comprises :

- a loop that goes from the feeding pin to the first loading pin and a first arm that is linked to said loop, said loop and said first arm being configured to create a resonance of said full band cellular antenna in said first frequency band.

[0018] In a non-limitative embodiment, said first reactive component, second reactive component and third reactive component are inductors or capacitors.

[0019] In a non-limitative embodiment, the feeding pin is connected to a matching network.

[0020] In a non-limitative embodiment, said first frequency band is a low frequency band that goes from 617Hz to 960MHz.

[0021] In a non-limitative embodiment, said second frequency band goes from 1.4GHz to 5GHz. In a non-limitative variant of embodiment, said second frequency band goes from 1.7GHz to 5GHz.

[0022] In a non-limitative embodiment, wherein said telematics control unit further comprises a NAD cellular module on the electronic support that is configured to be connected to said full-band cellular antenna.

[0023] In a non-limitative embodiment, said telematics

control unit comprises a plurality of antennas.

[0024] In a non-limitative embodiment, said telematics control unit comprises :

- a first full band cellular antenna printed on said plastic carrier,
- a second full band cellular antenna printed on said plastic carrier, and
- two middle/high band cellular antennas printed on said plastic carrier between the first cellular full band antenna and the second cellular full band antenna.

[0025] In a non-limitative embodiment, said telematics control unit is configured to be placed under the roof of the vehicle inside the compartment of the vehicle, or on the roof of the vehicle outside the compartment of the vehicle.

[0026] In a non-limitative embodiment, said telematics control unit is a telematics control unit of a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Some embodiments of methods and/or system in accordance with embodiments of the present invention are now described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1a illustrates a side view of a first non-limitative variant of embodiment of a first non-limitative embodiment of a telematics control unit according to the invention, said telematics control unit comprising one antenna, an electronic support, a first housing, a second housing, and a plastic carrier,

Figure 1b illustrates a side view of non-limitative variant of embodiment of a first non-limitative embodiment of a telematics control unit according to the invention, said telematics control unit comprising one antenna, an electronic support, a first housing, and a plastic carrier,

Figure 2 illustrates a side view of a second non-limitative embodiment of a telematics control unit according to the invention, said telematics control unit comprising one antenna, an electronic support, a first housing, a second housing, and a plastic carrier,

Figure 3 illustrates a top view of a first non-limitative embodiment of the plastic carrier of the telematics control unit of figure 1a or 1b, where said at least one antenna is printed on said plastic carrier and comprises a feeding pin, two loading pins, a ground pin, and a body with a first area, a loop, and a first arm,

Figure 4 illustrates the antenna of the telematics control unit of figures 1a, 1b, or 2, where said antenna is a full band cellular antenna and where the feeding pin is connected to a matching network,

the first loading pin is connected to a first reactive component, the ground pin is connected to a second reactive component, and the second loading pin is connected to a third reactive component,

Figure 5a is a schematic top view of the telematics control unit according to figure 1a, 1b or 2, where the antenna being a full band cellular antenna of figure 4, and said telematics control unit further comprising another full band cellular antenna of figure 4, and two high/middle cellular band antennas,

Figure 5b is a schematic top view of the telematics control unit according to figure 1a, 1b or 2, the antenna being a full band cellular antenna of figure 4, and said telematics control unit further comprising another full band cellular antenna of figure 4, two high/middle cellular band antennas, a GNSS antenna, a SDARS antenna, a V2X antenna, and a WIFI antenna,

Figure 6a illustrates a side view of the telematics control unit according to figure 5a, said telematics control unit further comprising a NAD cellular module,

Figure 6b illustrates a side view of the telematics control unit according to figure 5b, said telematics control unit further comprising a NAD cellular module, A GNSS module, a SDARS module, a V2X module, and a WIFI module,

Figure 7 is a schematic view of the antenna of figure 4, said antenna being connected to a NAD cellular module according to a non-limitative embodiment,

Figure 8 is a schematic view of the telematics control unit of figure 1a, 1b or 1c, said telematics control unit being arranged on the roof of a vehicle outside the compartment of the vehicle,

Figure 9 is a schematic view of the telematics control unit of figure 1a, 1b or 1c, said telematics control unit being arranged under the roof of a vehicle inside the compartment of the vehicle.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0028] In the following description, well-known functions or constructions by the person skilled in the art are not described in detail since they would obscure the invention in unnecessary detail.

[0029] The present invention relates to a telematics control unit 1 for a vehicle 3, said telematics control unit 1 being described in reference to figures 1a to 9. The telematics control unit 1 also referred to as TCU in the following. In a non-limitative embodiment, the vehicle 3 is

a motor vehicle. In non-limitative variants of embodiment, the motor vehicle has a combustion engine, has an electric engine, or a hybrid engine. The vehicle 3 has a roof 30 and a compartment 31 illustrated in figures 8 and 9.

[0030] The TCU permits wireless communication of the vehicle 3 with cloud services, other vehicles, base stations etc. to exchange information such as in non-limitative examples the position of the vehicle, the speed of the vehicle, engine data etc. In non-limitative examples, the TCU is used for the safety of the driver and passengers, to optimize the traffic flow and to make automatic emergency calls when an accident occurs.

[0031] In a first non-limitative embodiment illustrated in figure 8, the TCU is arranged on the roof 30 of the vehicle 3 outside the compartment 31 of the vehicle 3. In this case, in a non-limitative example, the telematics control unit 1 is arranged in a structure 32 in the form of a shark fin.

[0032] In a second non-limitative embodiment illustrated in figure 9, the TCU is arranged under the roof 30 of the vehicle 3 inside the compartment 31 of the vehicle 3.

[0033] As illustrated in figures 1a, 1b, and 2a, the TCU comprises :

- at least one antenna 10,
- an electronic support 11,
- a first housing 12,
- a second housing 13,
- a plastic carrier 14.

[0034] The electronic support 11 is configured to support the reactive components and the communication modules described later in the following. In a non-limitative embodiment, the electronic support 11 is a printed circuit board assembly also referred to as PCBA in the following. As illustrated in figure 3, in a non-limitative embodiment, the electronic support 11 has an elongated shape and extends along a plane X-Y. In another non-limitative embodiment illustrated in figure 2, the electronic support 11 is a flexible printed circuit. As illustrated in the non-limitative example of figure 2, it has a curve shape that fits the curve shape of the plastic carrier 14.

[0035] The electronic support 11 provides ground for the antenna(s) 10. In a non-limitative example, it is therefore grounded to the car body.

[0036] The first housing 12 is configured to close the second housing 13. Both of them allow housing of the antenna 10 and the electronic support 11 and the other communication module(s) described later in the following.

[0037] The first housing 12 provides ground for the electronic support 11. Hence, in a non-limitative embodiment, it is in metal so that it is grounded. In a non-limitative example, it is therefore grounded to the car body. Both the first housing 12 and the electronic support 11 serves as the ground for the antenna(s) 10.

[0038] In a non-limitative embodiment, the second housing 13 is in plastic so that it not disturbs the performance of the antenna 10.

[0039] The plastic carrier 14 is arranged opposite to the electronic support 11. In a non-limitative example, it is screwed on it.

[0040] In a first non-limitative embodiment illustrated in figures 1a, 1b and 3, the plastic carrier 14 is flat. It permits to obtain a height compact flat antenna 10 as this later is printed on the plastic carrier 14. It is especially interesting when the TCU is arranged inside the compartment 31 of the vehicle 3, under the roof 30 of the vehicle 3. It permits to lower the height of the TCU.

[0041] In a second non-limitative embodiment illustrated in figure 2, the plastic carrier 14 has a curved shape. It permits to have a flexible design so as to fit any desired surface in the vehicle.

[0042] In other non-limitative embodiments, the plastic carrier 14 have any other 3D shapes.

[0043] Said at least one antenna 10 is printed on the plastic carrier 14 on any side of it (bottom, top, etc.). In a non-limitative embodiment, it is metal ink printed on the plastic carrier 14. In a non-limitative embodiment, the ink printed is performed by a LDS ("Laser Direct Structuring") process. Hence, one obtains a laser direct structuring antenna. With one plastic carrier 14, one can place all the antennas of the TCU when it comprises a plurality of antennas. It also reduce the weight and the cost of the TCU as the electronic support 11 can be reduced in size as it doesn't support anymore the antenna 10.

[0044] In a non-limitative embodiment illustrated in figure 1a, the plastic carrier 14 is an element independent from the second housing 13. In another non-limitative embodiment illustrated in figure 1b, the plastic carrier 14 forms the second housing 13. It allows to reduce even more the height of the TCU leading to a more compact TCU.

[0045] In a non-limitative embodiment illustrated in figures 1a to 2, the TCU comprises one antenna 10.

[0046] In a non-limitative embodiment, said at least one antenna 10 is a full band cellular antenna 10. In the following, the full band cellular antenna 10 is also called FB cellular antenna 10 or FB antenna 10.

[0047] As illustrated in figures 3 and 4, the full band cellular antenna 10 comprises :

- a body 100,
- a feeding pin 101.1,
- a first loading pin 101.2,
- a ground pin 101.3,
- a second loading pin 101.4.

[0048] The FB cellular antenna 10 extends along a first direction X and a second direction Y perpendicular to the first direction X. The pins 101.1, 101.2, 101.3, 101.4 extend along the first direction X.

[0049] The FB cellular antenna 10 is grounded on the electronic support 11 by means of the ground pin 101.3.

Hence, the antenna module 1 doesn't need an extra ground plate, as the electronic support 11 serves as a ground.

[0050] The FB cellular antenna 10 is configured to resonate according to a wide range of frequency bands : from 617 MHz to 4.2GHz according to the North American standard, and from 703MHz to 5GHz according to the European standard. More standards can be supported, for example China and Rest of the World (ROW). Moreover, the FB cellular antenna 10 is configured to be fine-tuned to resonate within the range 617MHz to 960MHz at low frequencies.

[0051] The FB cellular antenna 10 is therefore multi-resonant : it has different resonant frequencies. The FB cellular antenna 10 complies with the 5G spectrum standard which goes from 617MHz to 5GHz and has the following range of band frequencies:

- 617MHz to 960MHz,
- 1.71GHz to 2.69GHz,
- 1.432GHz to 1.517GHz,
- 3.3GHz to 4.2GHz,
- 4.4GHz to 5GHz.

[0052] The FB cellular antenna 10 is responsible for the transmission and reception of cellular signals S_c (illustrated in figure 5) for wireless communication. It is configured to receive and transmit cellular signals S_c from and to a cellular base station (not illustrated). In order to simplify figure 5, the FB cellular antenna 10 has been illustrated schematically.

[0053] The different elements of the FB cellular antenna 10 are described in detail hereinafter.

Feeding pin 101.1.

[0054] The feeding pin 101.1 permits to transmit and receive the power needed for the FB cellular antenna 10.

[0055] As illustrated in figures 4 and 7, in a non-limitative embodiment, the feeding pin 101.1 is connected to a matching network 118. In a non-limitative embodiment, the matching network 118 comprises two inductors L1, L2 and one capacitor C1. The matching network 118 improves the impedance of the FB cellular antenna 10. It permits maximizing the power transferred from the NAD cellular module NADm (described later) to the FB cellular antenna 10 when the FB cellular antenna 10 is in a transmitting mode and the power transmitted from the FB cellular antenna 10 to the NAD cellular module NADm when the FB cellular antenna 10 is in a receiving mode.

First loading pin 101.2.

[0056] As illustrated in figures 4 and 7, the first loading pin 101.2 is connected to a first reactive component 17, so as to tune the FB antenna 10 to resonate according to a frequency within the first frequency band F1.

[0057] In a non-limitative embodiment, the first frequency band F1 is a low frequency band. In a non-limitative embodiment, the first frequency band F1 is between 617Hz to 960MHz.

[0058] The first loading pin 101.2 is configured to tune the loop 1000 of the body 100 (described later) of the FB cellular antenna 10. By tuning the loop 1000, one means that it changes its electrical length. By electrical length, one means the length of the loop 1000 in terms of wavelength. The FB cellular antenna physical length is not changing, only the effective electrical length is by changing the value of the corresponding reactive component 17. Hence, the first loading pin 101.2 is also called first tuning pin 101.2.

[0059] By adjusting the electrical length of the loop 1000, one fine-tunes the antenna 10 within the first frequency band F1.

[0060] The first reactive component 17 changes the electrical length of the loop 1000 of the body 100 of the FB antenna 10. With the value of the first reactive component 17, one adjusts the electrical length of the loop 1000 and therefore the antenna resonant frequency within the first frequency band F1.

[0061] In a non-limitative embodiment, the first reactive component 17 is an inductor or a capacitor. It permits to easily increase the electrical length of the loop 1000 and this with no extra cost.

[0062] With the first reactive component 17 coupled with the loop 1000, one ensures that the antenna 10 resonates either within a first frequency band F1 between 617MHz to 900MHz for the Northern American standard at low frequencies, or within a first frequency band F1 between 703MHz to 960MHz for the European standard at low frequencies.

[0063] In a non-limitative embodiment, the first reactive component 17 is welded on the electronic support 11.

[0064] By loading the FB cellular antenna 10 with reactive components, one means that we force the FB cellular antenna 10 to resonate higher or lower from its natural resonance by the use of the reactive components.

[0065] In a non-limitative embodiment, the first loading pin 101.2 is arranged away from the feeding pin 101.1. It permits loading the FB cellular antenna 10 with reactive components away from the feeding pin 101.1, that is to say with reactive components that are not connected to the feeding pin 101.1.

[0066] The ground pin 101.3 matches the impedance of the FB cellular antenna 10 in a second frequency band F2. It permits the connection of the FB cellular antenna 10 to the ground. It provides some inductance to the FB cellular antenna 10.

[0067] As illustrated in figures 4 and 7, in a non-limitative embodiment, the ground pin 101.3 is connected to a second reactive component 18 to generate a resonance of the full band cellular antenna 10 in the second frequency band F2.

Ground pin 101.3.

[0066] The ground pin 101.3 matches the impedance of the FB cellular antenna 10 in a second frequency band F2. It permits the connection of the FB cellular antenna 10 to the ground. It provides some inductance to the FB cellular antenna 10.

[0067] As illustrated in figures 4 and 7, in a non-limitative embodiment, the ground pin 101.3 is connected to a second reactive component 18 to generate a resonance of the full band cellular antenna 10 in the second frequency band F2.

[0068] The second reactive component 18 with the ground pin 101.3 is to match the FB cellular antenna 10 in the second frequency band F2. The matching is when one achieves low reflection of a signal received by the FB cellular antenna 10.

[0069] In a non-limitative embodiment, the second frequency band F2 is between 1.4GHz and 5GHz.

[0070] In a non-limitative embodiment, the second reactive component 18 is welded on the electronic support 11.

[0071] In a non-limitative embodiment, the second reactive component 18 is an inductor or a capacitor. It is a cheap electronic component.

Second loading pin 101.4.

[0072] As illustrated in figures 4 and 7, the second loading pin 101.4 is connected to a third reactive component 19, so as to tune the FB antenna 10 to resonate according to a frequency within the first frequency band F1. Hence, the second loading pin 101.4 is also called second tuning pin 101.4.

[0073] By using both 101.2, 101.4 the tuning is refined and it increases the tuning range (to have a higher or lower frequencies within the first frequency band F1).

[0074] In a non-limitative embodiment, the first frequency band F1 is a low frequency band. In a non-limitative embodiment, the first frequency band F1 is between 617Hz to 960MHz.

[0075] As illustrated in figures 4 and 7, in a non-limitative embodiment, the second loading pin 101.4 is connected to a third reactive component 19 to generate a resonance of the full band cellular antenna 10 in the first frequency band F1.

[0076] The third reactive component 19 with the second loading pin 101.4 is to match the antenna 10 in the first frequency band F1. The matching is when one achieves low reflection of a signal received by the FB cellular antenna 10.

[0077] In a non-limitative embodiment, the third reactive component 19 is welded on the electronic support 11.

[0078] In a non-limitative embodiment, the third reactive component 19 is an inductor or a capacitor. It is a cheap component.

[0079] In a non-limitative embodiment, the second loading pin 101.4 is arranged away from the feeding pin 101.1. It permits loading the FB cellular antenna 10 with reactive components away from the feeding pin 101.1, that is to say with reactive components that are not connected to the feeding pin 101.1.

[0080] It is to be noted that the FB cellular antenna 10 resonates only at a sub part of a band frequency at a time.

[0081] The selection happens with the tuning, by a reactive component which tunes the FB cellular antenna 10 to resonate to one sub-part of a frequency band at a time or by the length of a ground pin 101.3 or a length of a loading pin 101.2, 101.4.

[0082] Hence, in a non-limitative embodiment, in order

to tune the resonance within the second frequency band F2, one changes the length of the ground pin 101.3 and/or the value of the second reactive component 18.

[0083] Hence, in a non-limitative embodiment, in order to tune the resonance within the first frequency band F1, one changes the length of the first loading pin 101.2 and the length of the second loading pin 101.4, and/or the value of the first reactive component 17 and the third reactive component 19.

[0084] Hence, the FB cellular antenna 10 is able to operate at the same time at a first frequency within the first frequency band F1 and at a second frequency within the second frequency band F2.

[0085] The FB cellular antenna 10 is printed on the plastic carrier 14. Hence, it is more compact in height compared to a metal stamped solution. Moreover, it is easy to manufacture.

Body 100:

[0086] As illustrated in figures 1 and 2, the body 100 of the antenna 10 comprises :

- a loop 1000 that goes from the feeding pin 101.1 to the first loading pin 101.2,
- a first arm 1001 that is connected to the loop 1000,
- an elongated part 1002 that extends from the loop 1000.

[0087] The loop 1000, the first arm 1001 and the elongated part 1002 are on the same plane X-Y.

[0088] The loop 1000 extends along the first direction X and along the second direction Y. The first arm 1001 and the elongated part 1002 extend along the second direction Y.

[0089] The loop 1000 is the continuous path from the feeding pin 101.1 all the way around to the first loading pin 101.2. The loop 1000 is composed of three sub-parts on the same plane X-Y:

- a first sub-part 1000.1 attached to a second sub-part 1000.2 and to a third sub-part 1000.3,
- the second sub-part 1000.2 from which the feeding pin 101.1 extends, and that is linked to the elongated part 1002 of the body 100, and
- the third sub-part 1000.3 from which the first arm 1001 extends and from which the first loading pin 101.2 extends.

[0090] The first sub-part 1000.1 extends longitudinally along the second direction Y. The second sub-part 1000.2 and third sub-part 1000.3 extend longitudinally along the first direction X. Hence, the second sub-part 1000.2 and the third sub-part 1000.3 are substantially parallel to each other and perpendicular to the first sub-part 1000.1.

[0091] The first arm 1001 is substantially parallel to the first sub-part 1000.1 of the loop 1000 and to the elongated

part 1002 of the body 100.

[0092] The ground pin 101.3 and the second loading pin 101.4 extends from the elongated part 1002.

[0093] The loop 1000 and the first arm 1001 are configured to cover the first frequency band F1 for the FB cellular antenna 10 to resonate according to low frequencies. Hence, they allow the FB cellular antenna 10 to resonate within this first frequency band F1. It can be called the main mode of the FB cellular antenna 10.

[0094] The pins 101.1, 101.2, 101.3, and 101.4 are on the same plane X-Y than the body 100 of the FB antenna 10.

[0095] In a non-limitative embodiment, the TCU comprises a plurality of antennas printed on the plastic carrier 14.

[0096] In a first non-limitative variant of embodiment illustrated in figure 5a, the TCU comprises :

- a first full band (FB) cellular antenna 10₁,
- a second full band (FB) cellular antenna 10₂,
- two middle (MD)/high band (HB) cellular antennas 12₁, 12₂.

[0097] This non-limitative variant of embodiment is interesting for the MIMO ("Multiple Input-Multiple Output") cellular technology to be fully covered.

[0098] Each of the first cellular full band antenna 10₁ and the second cellular full band antenna 10₂ covers cellular dedicated bands from 0.6GHz (617MHz) to 5GHz.

[0099] Each of the first cellular middle/high band antenna 12₁ and the second cellular middle/high band antenna 12₂ covers cellular dedicated bands from 1.4GHz to 5GHz.

[0100] In a non-limitative embodiment, the two middle/high cellular band antennas 11₁, 11₂ are printed on the plastic carrier 14 between the first full band cellular antenna 10₁ and the second full band cellular antenna 10₂.

[0101] In a second non-limitative variant of embodiment illustrated in figure 5b, the TCU further comprises other different types of antennas in order to wirelessly connect the vehicle to different systems such as cloud services, other vehicles, base stations etc. Hence, in a non-limitative embodiment, the TCU further comprises :

- GNSS dual band antenna 13, and/or
- an SDARS antenna 14, and/or
- a V2X antenna 15, and/or
- a WIFI antenna 16.

[0102] In a non-limitative embodiment, the plastic carrier 14 is also configured to support the other antennas 13 to 16 of the TCU. They can be also printed on the plastic carrier 14. It is to be noted that the GNSS dual band antenna 13 is often a ceramic antenna. In this case, it is not printed on the plastic carrier 14.

[0103] As the TCU permits wireless communication, to

this end, as illustrated in figure 6a to 6c, the TCU comprises all the electronics for this wireless communication. As illustrated in figure 6a, in a non-limitative embodiment, it comprises a NAD (Network Access Device) cellular module NADm to be connected to the cellular antenna(s), here to the FB cellular antennas 10₁, 10₂ and HB cellular antennas 12₁, 12₂ in the non-limitative example illustrated. In non-limitative embodiments illustrated in figure 6b, it also comprises a GNSS module referenced GNSSm, and/or a SDARS module referenced SDARSm, and/or a V2X module referenced V2Xm, and/or a WIFI module referenced WIFIm.

[0104] The NAD cellular module NADm are arranged on and connected to the electronic support 11. The GNSS module GNSSm, SDARS module SDARSm, and/or a V2X module V2Xm, and/or a WIFI module referenced WIFIm are arranged on and connected to the electronic support 11.

[0105] The feeding pin 101.2 of the FB cellular antenna 10 is configured to transmit the signals received by the FB cellular antenna(s) 10 to the NAD cellular module NADm. As illustrated in figure 7, the feeding pin 101.1 is connected to the NAD cellular module NADm through its matching network 118 via a transmission line 230 that allows cellular signals Sc received by the FB cellular antenna 10 to be transmitted to the NAD cellular module NADm.

NAD cellular module

[0106] The NAD cellular module NADm is illustrated in figure 6a to 7.

[0107] The NAD cellular module NADm is configured to receive the cellular signals S_c from the FB cellular antenna 10. It is configured to be connected to the FB cellular antenna 10, in particular to the feeding pin 101.1 via the matching network 118.

[0108] As known by the man skilled in the art, the cellular signals S_c are then analyzed and used for the estimation of the position of the vehicle 3.

[0109] In a non-limitative embodiment, the TCU comprises only one NAD cellular module NADm for all the cellular antennas illustrated in figures 5a and 5b.

[0110] It is to be understood that the present invention is not limited to the aforementioned application, embodiments and variations and modifications may be made without departing from the scope of the invention. All statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass equivalents thereof. In this respect, the following remarks are made. Hence, in a non-limitative embodiments, the TCU further comprises other types of antennas such as Bluetooth™. It is to be noted that the non-limitative embodiment of cellular antenna 10 that is printed on the plastic carrier 14 can be applied to other types of antenna.

[0111] Hence, some embodiments of the invention may comprise one or a plurality of the following advan-

tages:

- it provides a TCU that has a reduced size (in particular width and length) as the electronic support 11 can be reduced in size : this latter doesn't support the antenna(s) anymore, 5
- it provides a TCU that has a low profile flat (small dimensions on all X, Y and Z directions) when the plastic carrier 14 is flat or slightly curved, 10
- compared to a TCU with metal stamped antenna(s), it permits flexibility for antenna design and ability to create more complex shapes, 15
- compared to a TCU with metal stamped antenna(s), it reduced the weight, the number of elements in the TCU and therefore the cost, as the antenna(s) are all printed on the plastic carrier 14, 20
- thanks to the plastic carrier 14, the antenna(s) is easily integrated in the TCU, leading to a more efficient and less complex integration of the antenna(s) in a confined space, 25
- it provides a TCU that has a lower time process and lower time assembly, 30
- it reduce the complexity of organizing all the elements (antenna(s) and communication module(s)) within the housing of the TCU : it facilitates the integration of all these elements within the TCU, 35
- it provides a FB cellular antennas(s) 10 that is tunable to have a multiband antenna, 40
- it provides an antenna module 1 with good performance on low band frequency using tuning. when the electronic support is located too low under the roof, the performances of the antenna decrease, 45
- when the electronic support 11 is located too low under the roof of the vehicle, it allows the antenna(s) to be placed higher thanks to the plastic carrier 14 which enhanced their performances. 50

Claims

1. Telematics control unit (1) for a vehicle (3), said telematics control unit (1) comprising at least one antenna (10) connected to an electronic support (11), a first housing (12) and a second housing (13) that are configure to house said at least one antenna (10) and said electronic support (11), wherein it further comprises a plastic carrier (14) that is placed opposite to the electronic support (11), and wherein said at least one antenna (10) is printed on said plastic carrier (14). 50
2. Telematics control unit (1) according to claim 1, wherein said at least one antenna (10) is metal ink printed on said plastic carrier (14). 55
3. Telematics control unit (1) according to claim 1 or claim 2, wherein said plastic carrier (14) is flat or has a curve shape.

4. Telematics control unit (1) according to any of the preceding claims, wherein said plastic carrier (14) forms the second housing (13) or is independent from the second housing (13).

5. Telematics control unit (1) according to any of the preceding claims, wherein said electronic support (11) and said first housing (12) provide ground to the at least one antenna (10).

6. Telematics control unit (1) according to any of the preceding claims, wherein said second housing (13) is in plastic.

7. Telematics control unit (1) according to any of the preceding claims, wherein said at least one antenna (10) is a full band cellular antenna.

8. Telematics control unit (1) according to the preceding claim, wherein said full band cellular antenna (10) comprises :

- a body (100),
- a feeding pin (101.1) that is configured to transmit and receive power for the full band antenna cellular (10), and
- a first loading pin (101.2) that is connected to a first reactive component (17) and that is configured to tune the full band cellular antenna (10) to resonate according to a frequency within a first frequency band (F1),
- a ground pin (101.3) that is connected to a second reactive component (18) to generate a resonance of the full band cellular antenna (10) in a second frequency band (F2),
- a second loading pin (101.4) that is connected to a third reactive component (19) and that is configured to tune the full band cellular antenna (10) to resonate according to a frequency within the first frequency band (F1).

9. Telematics control unit (1) according to the preceding claim, wherein said body (100) comprises :

- a loop (1000) that goes from the feeding pin (101.1) to the first loading pin (101.2) and a first arm (1001) that is linked to said loop (1000), said loop (1000) and said first arm (1001) being configured to create a resonance of said full band cellular antenna (10) in said first frequency band (F1).

10. Telematics control unit (1) according to the preceding claims 8 or 9, wherein said first frequency band (F1) is a low frequency band that goes from 617Hz to 960MHz.

11. Telematics control unit (1) according to any of the

preceding claims 8 to 10, wherein said second frequency band (F2) goes from 1.4GHz to 5GHz.

12. Telematics control unit (1) according to any of the preceding claims 7 to 11, wherein said telematics control unit (1) further comprises a NAD cellular module (NADm) on the electronic support (11) that is configured to be connected to said full-band cellular antenna (10). 5 10
13. Telematics control unit (1) according to any of the preceding claims, wherein said telematics control unit (1) comprises a plurality of antennas (10).
14. Telematics control unit (1) according to any of the preceding claims, wherein said telematics control unit (1) comprises : 15
 - a first full band cellular antenna (10₁) printed on the plastic carrier (22), 20
 - a second full band cellular antenna (10₂) printed on the plastic carrier (22), and
 - two middle/high band cellular antennas (12₁, 12₂) printed on the plastic carrier (22) between the first cellular full band antenna (10₁) and the 25 second cellular full band antenna (10₂).
15. Telematics control unit (1) according to any of the preceding claims, wherein the telematics control unit (1) is configured to be placed under the roof (30) of the vehicle (3) inside the compartment (31) of the vehicle (3), or on the roof (30) of the vehicle (3) outside the compartment (31) of the vehicle (3). 30 35 40 45 50 55

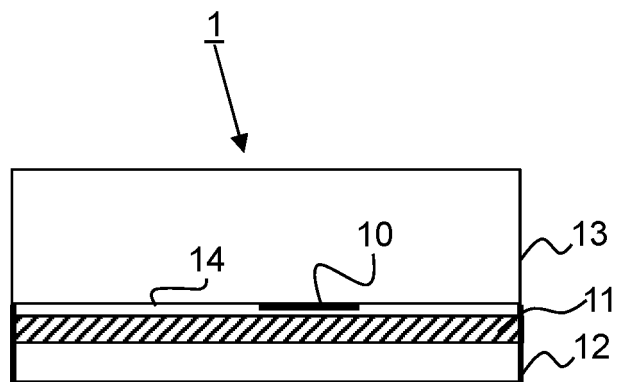


Fig. 1a

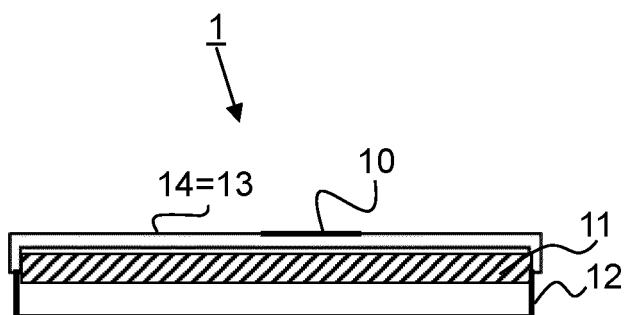


Fig. 1b

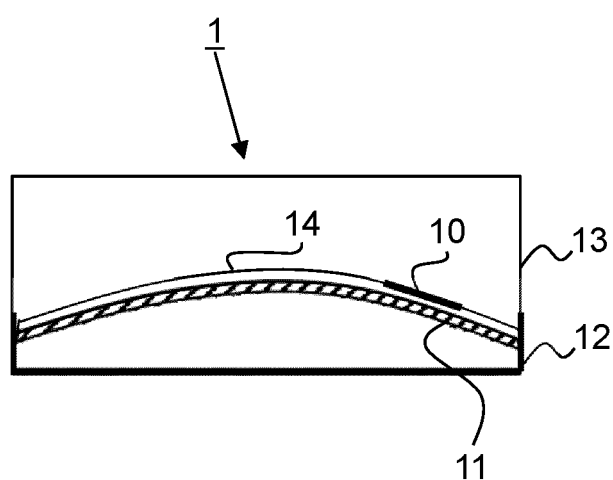


Fig. 2

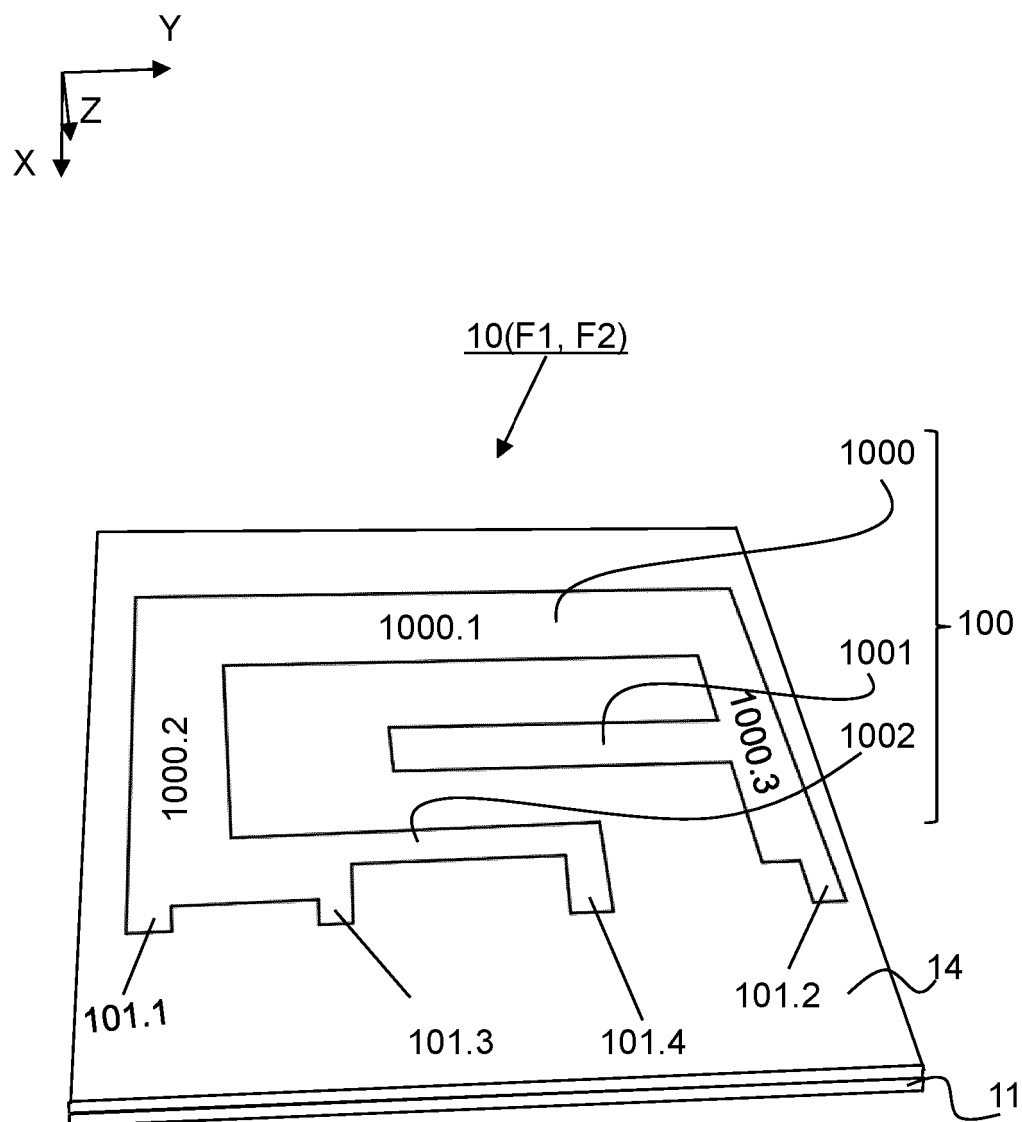


Fig. 3

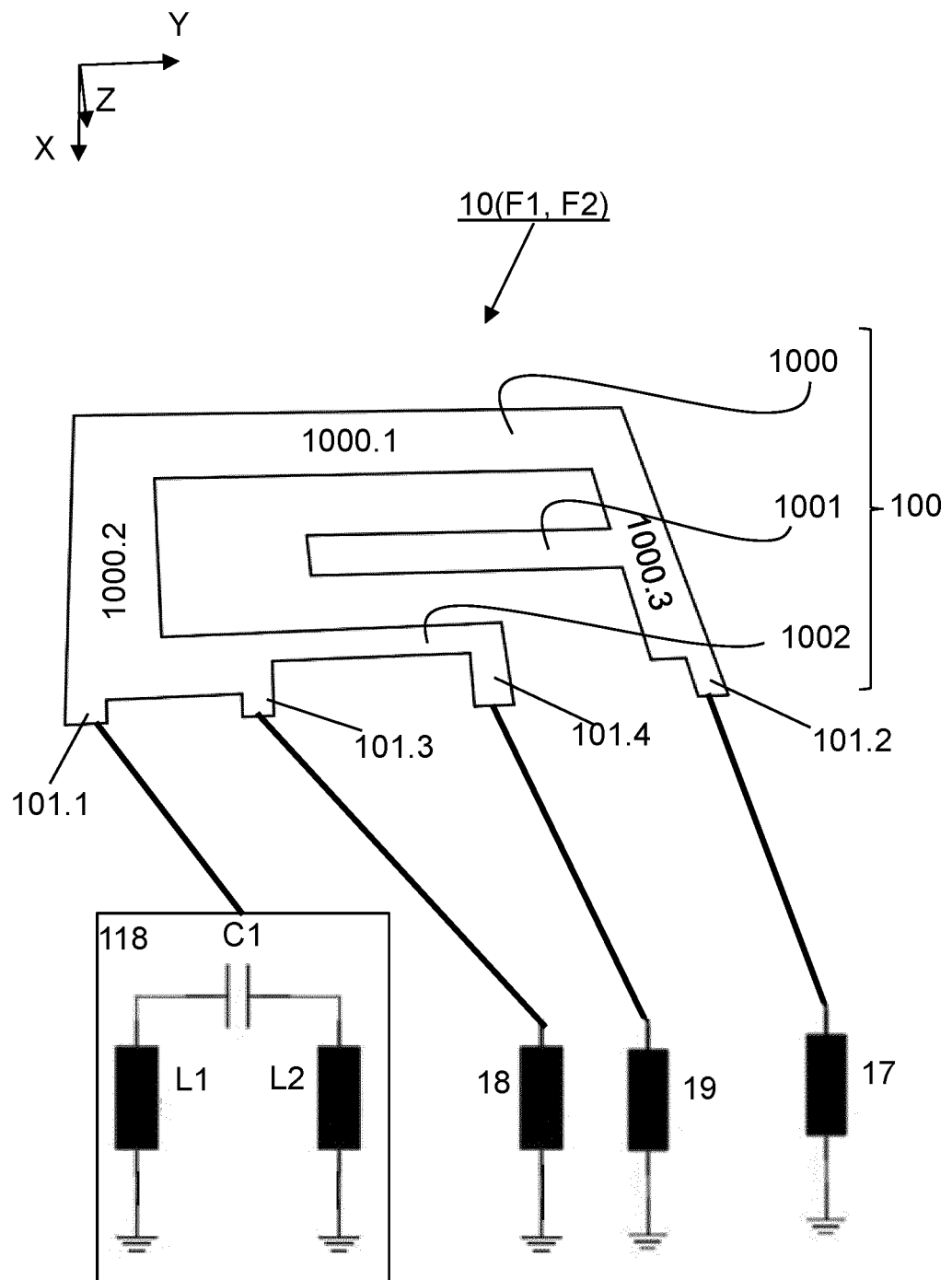


Fig. 4

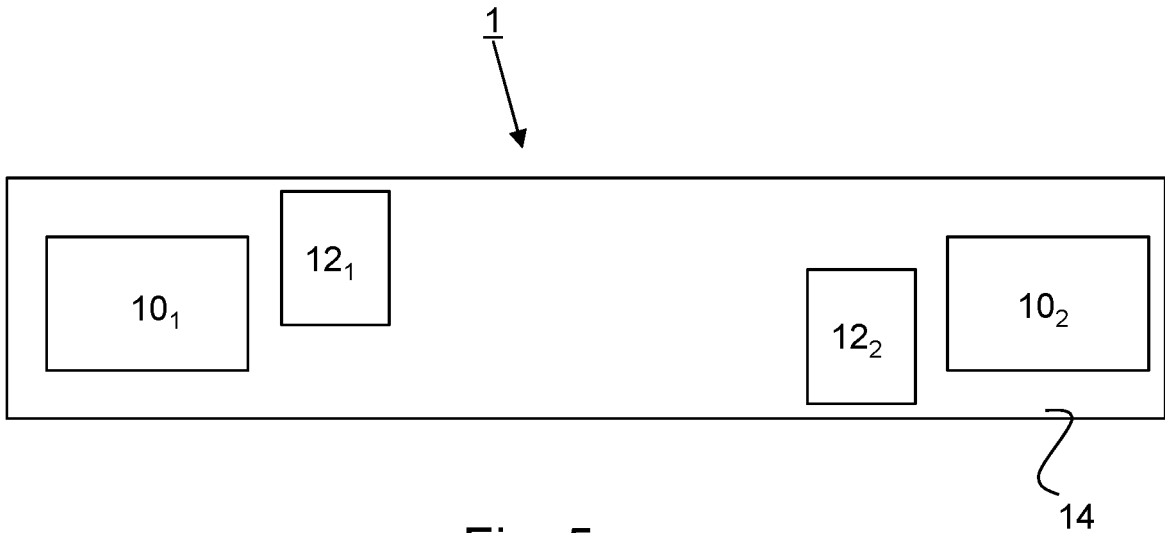


Fig. 5a

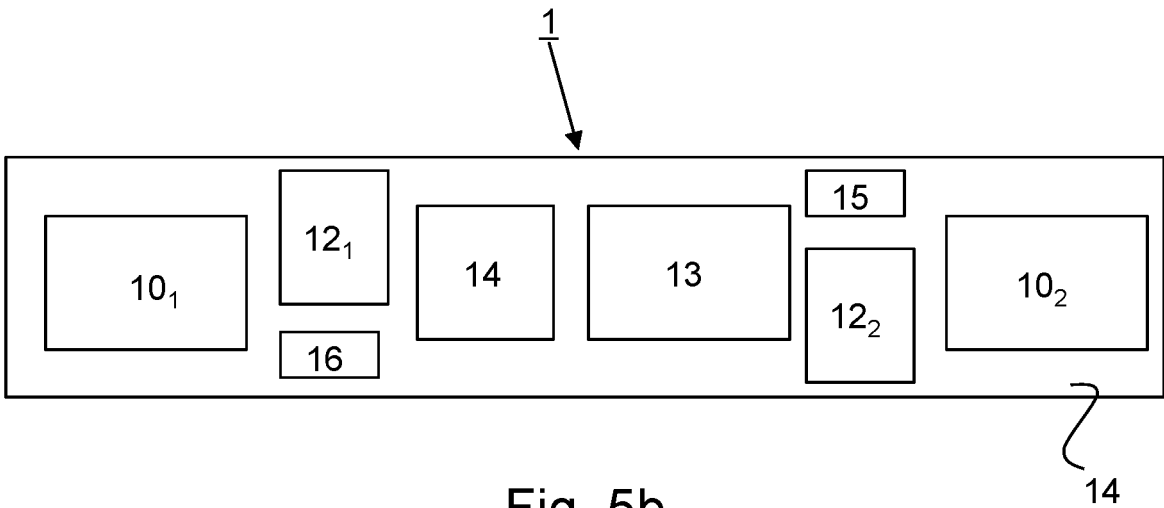


Fig. 5b

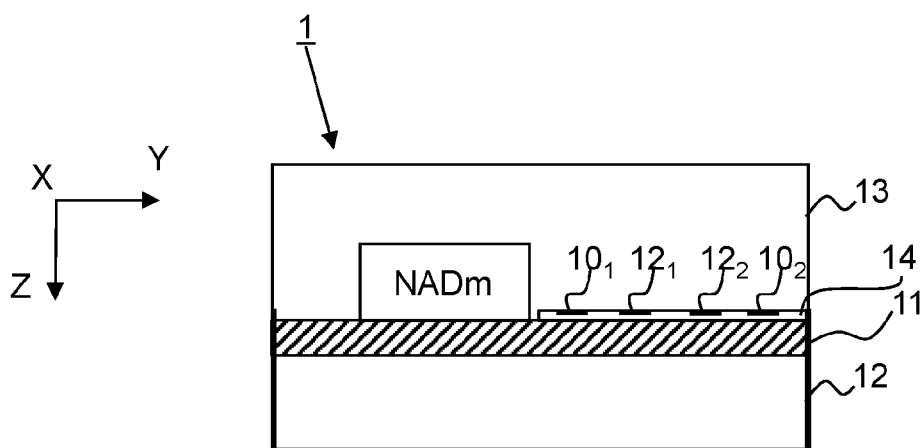


Fig. 6a

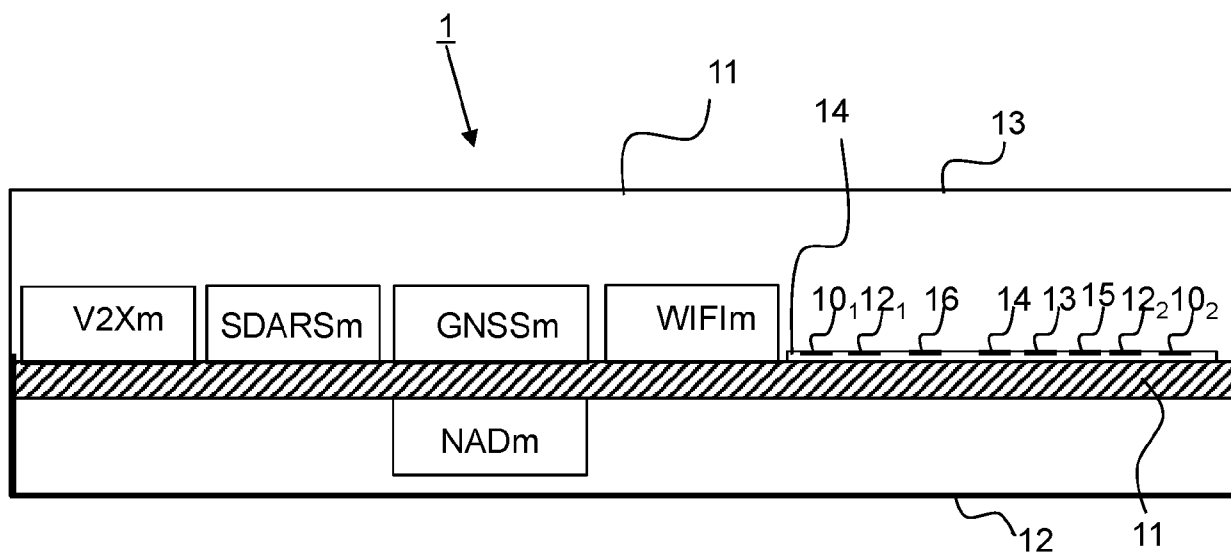


Fig. 6b

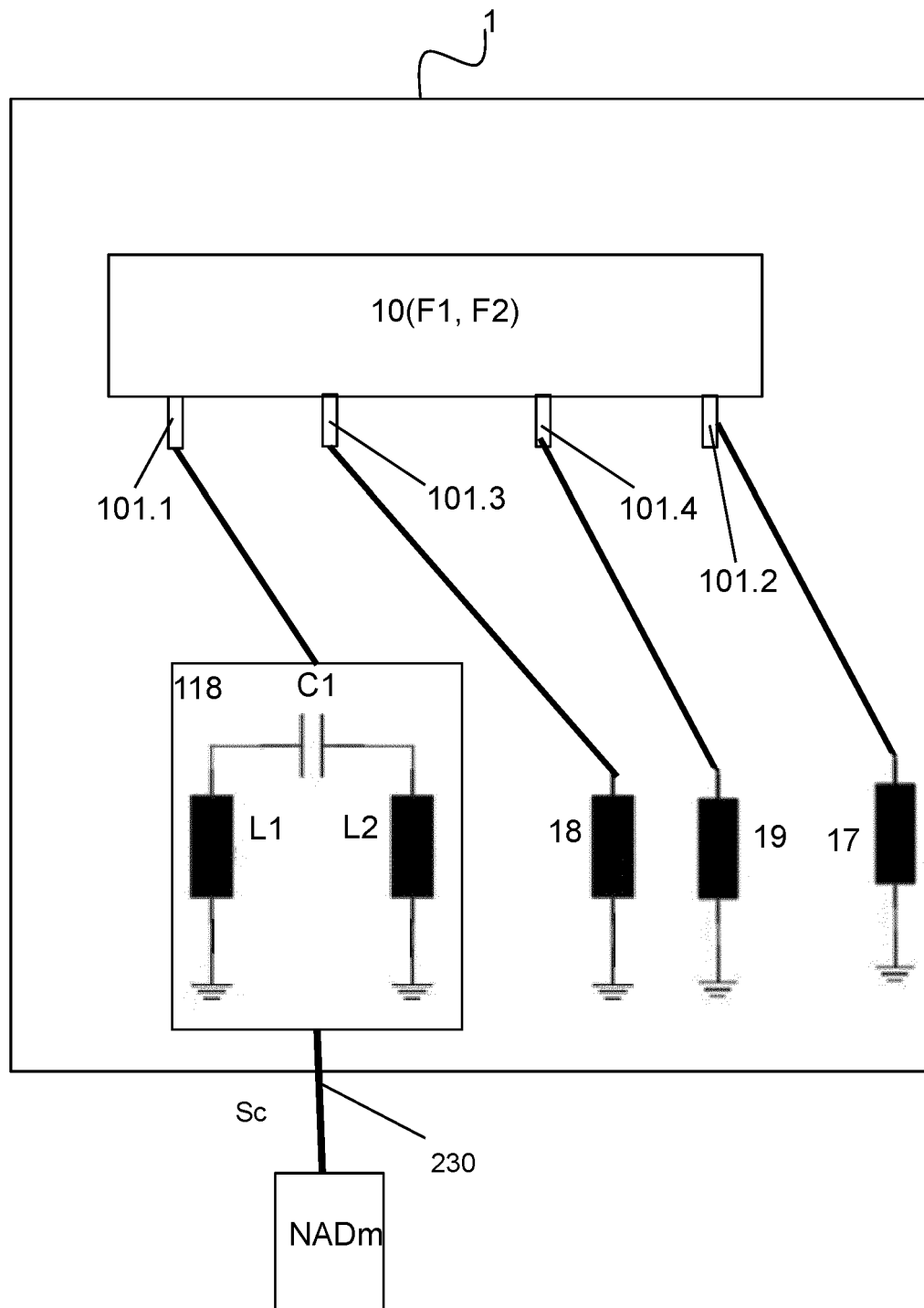


Fig. 7

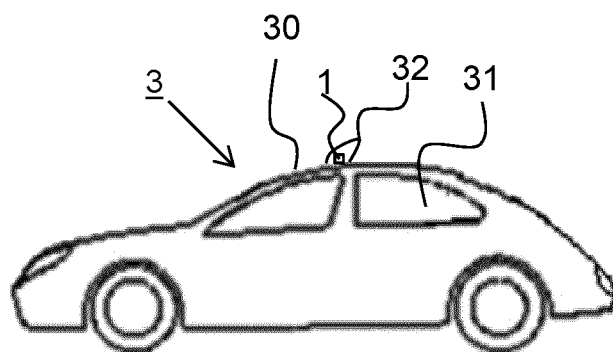


Fig. 8

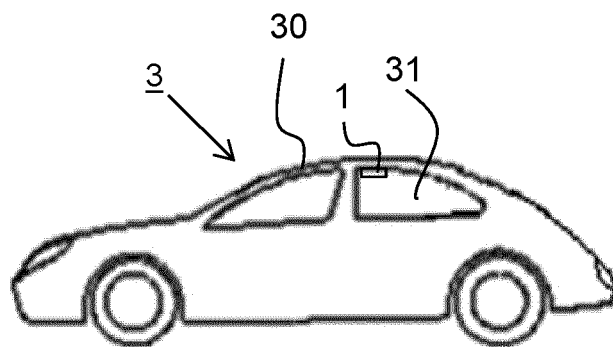


Fig. 9



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Application Number

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A	* paragraphs [0001] - [0083]; figures 1-7 *	8-11	H01Q5/328 H01Q5/335 H01Q5/371

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Place of search		Date of completion of the search	Examiner
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