(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 742 449 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.05.2026 Bulletin 2026/20

(21) Application number: **24211565.7**

(22) Date of filing: **07.11.2024**

(51) International Patent Classification (IPC):
H01Q 5/357 *(2015.01)* ***H01Q 1/24*** *(2006.01)*
H01Q 1/32 *(2006.01)* ***H01Q 5/328*** *(2015.01)*
H01Q 5/335 *(2015.01)* ***H01Q 7/00*** *(2006.01)*
H01Q 9/42 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
H01Q 9/42; H01Q 1/241; H01Q 1/3233; H01Q 5/328; H01Q 5/335; H01Q 5/357; H01Q 7/00

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(71) Applicant: **Valeo Comfort and Driving Assistance**
94000 Créteil (FR)

(72) Inventors:
- **ATMATZAKIS, Georgios**
  94000 Créteil (FR)
- **JAFARI, Ahmadreza**
  94000 Créteil (FR)

(74) Representative: **Delaval, Guillaume Laurent**
Valeo Comfort and Driving Assistance
6 rue Daniel Costantini
94000 Créteil (FR)

(54) ANTENNA MODULE WITH A FULL BAND CELLULAR ANTENNA FOR A TELEMATICS CONTROL UNIT FOR A VEHICLE

(57) The invention relates to an antenna module (1) for a telematics control unit (2), said antenna module (1) comprising at least one full band cellular antenna (10) and an electronic support (11) configured to support said full band cellular antenna (10), wherein said full band cellular antenna (10) is metal stamped and 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 the 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).

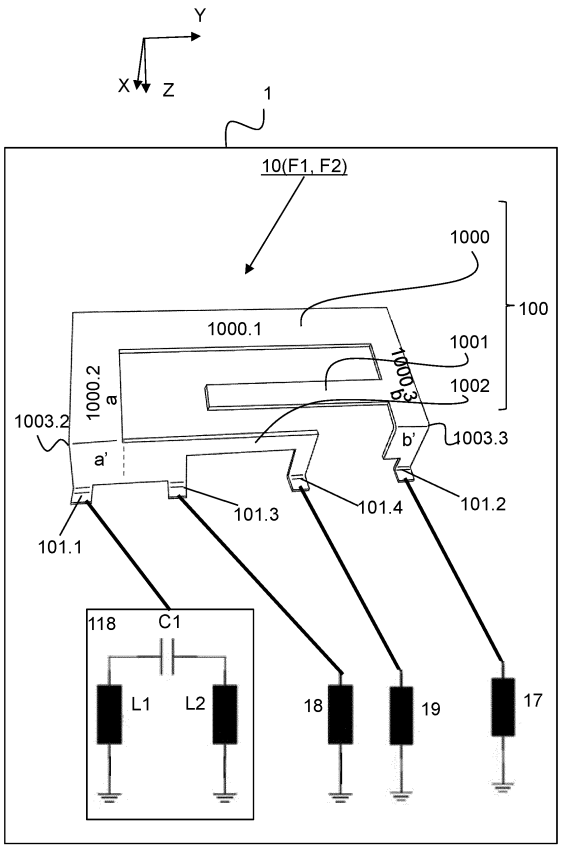

Fig. 2

Processed by Luminess, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an antenna module for a telematics control unit. Such antenna module may be used, but not exclusively, in the automotive domain. The invention also relates to a telematics control unit comprising such a full band cellular antenna.

BACKGROUND OF THE INVENTION

[0002] In the automotive domain, an antenna module for a telematics control unit, known by the man skilled in the art, comprises in particular a full band cellular antenna that is a combination of different mechanical separate elements : a table form antenna element, a strip line resonator beneath the table form antenna with a space in between that controls the coupling between the table form antenna element and the strip line resonator, and a ground plate. The space has to be adapted for the coupling.

[0003] The full-band cellular antenna is connected to a cellular module. It permits a connection to a base station to estimate the position of the vehicle via a triangulation. It also supports voice and data connectivity within the 5G frequency band.

[0004] This antenna module is arranged within a telematics control unit for a vehicle. The telematics control unit is arranged on the roof of a vehicle outside the compartment of the vehicle, or under the roof inside the compartment of the vehicle.

[0005] One problem of this prior art is that the manufacturing of the full band cellular antenna of the antenna module is expensive and complex to manufacture.

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

SUMMARY OF THE INVENTION

[0007] To this end, it is provided an antenna module for a telematics control unit, said antenna module comprising at least one full band cellular antenna and an electronic support configured to support said full band cellular antenna, wherein said full band cellular antenna is metal stamped and 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.

[0008] According to non-limitative embodiments of the invention, the antenna module further comprises the following characteristics.

[0009] In a non-limitative embodiment, said body 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.

[0010] In a non-limitative embodiment, said first reactive component, second reactive component and third reactive component are inductors or capacitors.

[0011] In a non-limitative embodiment, the feeding pin is connected to a matching network.

[0012] In a non-limitative embodiment, said first frequency band is a low frequency band that goes from 617Hz to 960MHz.

[0013] 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.

[0014] In a non-limitative embodiment, said antenna module is configured to be mounted inside the compartment of a vehicle under a roof of said vehicle, and that is configured to be connected to a telematics control unit that is arranged away from said antenna module.

[0015] In a non-limitative embodiment, said at least one full band cellular antenna is grounded on the electronic support by means of the ground pin.

[0016] In a non-limitative embodiment, said module antenna comprises :

- a first full band cellular antenna metal stamped and mounted over a first extremity of the electronic support,
- a second full band cellular antenna metal stamped and mounted over a second extremity of the electronic support, and
- two middle/high band cellular antennas metal stamped and mounted between the first cellular full band antenna and the second cellular full band antenna.

[0017] There is also provided a telematics control unit for a vehicle, said telematics control unit comprising a NAD cellular module and a module antenna according to any of the preceding characteristics that is connected to said NAD cellular module.

[0018] In a non-limitative embodiment, the telematics control unit is a telematics control unit of a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] 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 1 illustrates a non-limitative embodiment of an antenna module comprising a full band cellular antenna according to the invention, said full band cellular antenna comprising a feeding pin, two loading pins, a ground pin, and a body with a first area, a loop, and a first arm,

Figure 2 is a view of the full band cellular antenna of figure 1, 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 3a is a schematic top view of a first non-limitative embodiment of an antenna module with two full band cellular antennas of figure 1 or 2, and two high/middle cellular band antennas,

Figure 3b is a schematic top view of a second non-limitative embodiment of an antenna module with two full band cellular antennas of figure 1 or 2, two high/middle cellular band antennas, a GNSS antenna, a SDARS antenna, a V2X antenna, and a WIFI antenna,

Figure 4a is a schematic side view of a first non-limitative embodiment of a telematics control unit for vehicle, said telematics control unit comprising an antenna module of figure 3a and a NAD cellular module,

Figure 4b is a schematic side view of a second non-limitative embodiment of a telematics control unit for vehicle, said telematics control unit comprising an antenna module of figure 3b and a NAD cellular module, A GNSS module, a SDARS module, a V2X module, and a WIFI module,

Figure 5 is a view of the antenna module of figure 2, said antenna module being connected to a NAD cellular module according to a non-limitative embodiment,

Figure 6 is a schematic top view of a non-limitative embodiment of the telematics control unit of figure 4a or 4b, said telematics control unit being arranged on the roof of a vehicle, outside the compartment of the vehicle,

Figure 7 is a schematic top view of a non-limitative embodiment of a telematics control unit that is configured to be connected to the module antenna of figures 3a or 3b, said telematics control unit being arranged in the compartment of a vehicle, away from said antenna module.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0020] 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.

[0021] The present invention relates to an antenna module 1 for a telematics control unit 2 for a vehicle, said antenna module 1 being described in reference to figures 1 to 7. The telematics control unit 2 also referred to as TCU in the following.

[0022] The antenna module 1 comprises :

- at least one full band cellular antenna 10, and
- an electronic support 11.

[0023] The electronic support 11 is configured to support said at least one full band cellular antenna 10. 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 figures 3a or 3b, in a non-limitative embodiment, the electronic support 11 has an elongated shape with a first extremity 11.1 and a second extremity 11.2.

[0024] In the following, the full band cellular antenna 10 is also called FB cellular antenna 10 or FB antenna 10.

[0025] In a non-limitative embodiment, the full band cellular antenna 10 is an antenna for a vehicle 3 illustrated in figure 6 and 7. 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.

[0026] The full band cellular antenna 10 is metal stamped. It is in one piece which eases its manufacture.

[0027] As illustrated in figures 1 and 2, 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.

[0028] The FB cellular antenna 10 extends along a first direction X, a second direction Y perpendicular to the first direction X, and a vertical direction Z perpendicular to the first direction X and to the second direction Y. In non-limitative embodiment, the pins 101.1, 101.2, 101.3, 101.4 are soldered, press fitted, connected via spring, connected via gasket on the electronic support 11.

[0029] The FB cellular antenna 10 is mounted on the electronic support 11 illustrated in figure 1.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] The different elements of the FB cellular antenna 10 are described in detail hereinafter.

Feeding pin 101.1.

[0035] The feeding pin 101.1 permits to transmit and receive the power needed for the FB cellular antenna 10.

[0036] As illustrated in figures 2 and 5, 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.

[0037] As illustrated in figures 2 and 5, 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.

[0038] 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.

[0039] 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.

[0040] By adjusting the electrical length of the loop 1000, one fine-tunes the antenna 10 within the first frequency band F1.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] In a non-limitative embodiment, the first reactive component 17 is welded on the electronic support 11.

[0045] 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.

[0046] 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.

Ground pin 101.3.

[0047] 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.

[0048] As illustrated in figures 2 and 5, in a non-limita-

tive 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.

[0049] 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.

[0050] In a non-limitative embodiment, the second frequency band F2 is between 1.4GHz and 5GHz.

[0051] In a non-limitative embodiment, the second reactive component 18 is welded on the electronic support 11.

[0052] 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.

[0053] As illustrated in figures 2 and 5, 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.

[0054] 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).

[0055] 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.

[0056] As illustrated in figures 2 and 5, 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.

[0057] 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.

[0058] In a non-limitative embodiment, the third reactive component 19 is welded on the electronic support 11.

[0059] In a non-limitative embodiment, the third reactive component 19 is an inductor or a capacitor. It is a cheap component.

[0060] 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.

[0061] It is to be noted that the FB cellular antenna 10 resonates only at a sub part of a band frequency at a time.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] As the FB antenna 10 is in only one piece, and metal stamped, it is easy to manufacture.

Body 100:

[0067] 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.

[0068] The elongated part 1002 extends along the vertical direction Z and longitudinally along the second direction Y.

[0069] 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:

- 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.

[0070] 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 (parts illustrated respectively a and b in figures 1 and 2) longitudinally along the first direction X, and another part of them (illustrated respectively a' and b' in figures 1 and 2) extends along the vertical direction Z. The two parts a and a' of the second sub-part 1000.2 are linked by a fold 1003.2, and the two parts b and b' of the third sub-part 1000.3 are linked by a fold 1003.3.

[0071] Parts a and b of the second sub-part 1000.2 and

of the third sub-part 1000.3 are substantially parallel to each other and perpendicular to the first sub-part 1000.1. All three a, b and 1000.3 are on the same plane X-Y.

[0072] The first arm 1001 extends longitudinally along the second direction Y. It extends from the first part b of the third sub-part 1000.3. The first arm 1001 is substantially parallel to the first sub-part 1000.1 of the loop 1000.

[0073] The ground pin 101.3 and the second loading pin 101.4 extends from the elongated part 1002.

[0074] 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.

[0075] In a non-limitative embodiment illustrated in figure 3a, the antenna module 1 comprises :

- the electronic support 11,
- a first full band (FB) cellular antenna 10_1,
- a second full band (FB) cellular antenna 10_2,
- two middle (MD)/high band (HB) cellular antennas 12_1, 12_2.

[0076] This non-limitative embodiment is interesting for the MIMO ("Multiple Input-Multiple Output") cellular technology to be fully covered.

[0077] In a non-limitative embodiment, each of the first cellular full band antenna 10_1 and the second cellular full band antenna 10_2 covers cellular dedicated bands from 0.6GHz (617MHz) to 5GHz;

[0078] In a non-limitative embodiment, each of the first cellular middle/high band antenna $12_1$and the second cellular middle/high band antenna 12_2 covers cellular dedicated bands from 1.4GHz to 5GHz.

[0079] In a non-limitative embodiment, the first full band cellular antenna 10_1 is mounted over the first extremity 11.1 of the PCBA and the second full band cellular antenna 10_2 is mounted over the second extremity 11.2 of the PCBA.

[0080] In a non-limitative embodiment, the two middle/high cellular band antennas 11_1, 11_2 are mounted over the PCBA between the first full band cellular antenna 10_1 and the second full band cellular antenna 10_2.

[0081] In a non-limitative embodiment, the first cellular full band antenna 10_1 and the second cellular full band antenna 10_2 have an effective height 15mm. In a non-limitative variant of embodiment, it is less than 13mm.

[0082] In a non-limitative embodiment, the first cellular middle/high band antenna 11_1 and the second cellular middle/high band antenna 11_2 have an effective height less than 15mm. In a non-limitative variant of embodiment, it is less than 13mm.

[0083] In a non-limitative embodiment illustrated in figure 3b, the antenna module 1 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 antenna module 1 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.

[0084] In a non-limitative embodiment, the electronic support 11 is configured to support the other antennas 13 to 16 of the antenna module 1. They can be also metal stamped and connected to the electronic support 11. It is to be noted that the GNSS dual band antenna 13 is often a ceramic antenna. In this case, it is not metal stamped.

[0085] In a first non-limitative embodiment illustrated in figures 4a and 4b, the antenna module 1 is part of an telematics control unit 2. In this case, in a non-limitative embodiment illustrated in figure 6, the TCU is arranged on the roof 30 of the vehicle 3. In this case, in a non-limitative example, the telematics control unit 2 is arranged in a structure 32 in the form of a shark fin. As illustrated in figures 4a or 4b, the TCU comprises a housing 20 within which the module antenna 1 can be placed. In a non-limitative embodiment, in this case, the antenna module 1 is of about this size : 70mm*240mm*20mm.

[0086] In a second non-limitative embodiment illustrated in figure 7, the antenna module 1 is independent from the telematics control unit 2. In a non-limitative variant of embodiment, it is mounted inside the compartment 31 of the vehicle 3. In a non-limitative example, it is mounted under the roof 30 of the vehicle 3. It permits to arrange the TCU in any locations in the vehicle 3 independently from the location of the antenna module 1, and therefore from the FB cellular antenna(s) 10. In this case, in a non-limitative embodiment, the telematics control unit 2 is arranged inside the compartment 31 of the vehicle 3. In a non-limitative example illustrated in figure 7, it is arranged away from the antenna module 1, here in the back of the vehicle 3. In this example, the antenna module 1 comprises coaxial connectors (not illustrated) for connecting via different external cables to the TCU.

[0087] It is to be noted that 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.

[0088] To this end, as illustrated in figures 4a and 4b, the TCU comprises all the electronics for these wireless communication. As illustrated in figure 4a, in a non-limitative embodiment, it comprises a NAD (Network Access Device) cellular module NADm to be connected to the FB cellular antenna(s) 10. In non-limitative embodiments illustrated in figure 4b, it also comprises a GNSS module referenced GNSSm, and/or a SDARS module refer-

enced SDARSm, and/or a V2X module referenced V2Xm, and/or a WIFI module referenced WIFIm.

[0089] 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.

[0090] The feeding pin 101.1 of the FB cellular antenna 10 is configured to transmit the cellular signals S_c received by the FB cellular antenna(s) 10 to the NAD cellular module NADm. As illustrated in figure 5, 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

[0091] The NAD cellular module NADm is illustrated in figure 4a to 5.

[0092] 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.

[0093] As known by the man skilled in the art, when the NAD cellular module NADm receives the cellular signals S_c, the cellular signals S_c are then analyzed and used for the estimation of the position of the vehicle 3.

[0094] In a non-limitative embodiment, the TCU comprises only one NAD cellular module NADm for all the cellular antennas illustrated in figures 3a and 3b.

[0095] 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 embodiment, the TCU further comprises other types of antennas such as Bluetooth™.

[0096] Hence, some embodiments of the invention may comprise one or a plurality of the following advantages:

- it provides an antenna module 1 that that allows to have a TCU withs a low profile flat,
- it provides an antenna module 1 with a one piece FB cellular antenna(s) 10 that is not expensive, and that is easy to manufacture and with a lower time process compared to the cited prior art which needs a more complex assembly line and more time process,
- it provides an antenna module 1 with an electronic support 11 that serves as the ground for the FB cellular antenna(s) 10 ; there is no need of an additional ground plate,
- it provides an antenna module 1 with a FB cellular antennas(s) 10 that is tunable to have a multiband antenna,
- it provides an antenna module 1 with a FB cellular antennas(s) 10 that is tunable to have a multiband antenna,
- it permits to have a TCU that is compact in height as it comprises a module antenna 1 that is shorter in height compared to the cited prior art,
- it provides an antenna module 1 with good performance on low band frequency using tuning.

Claims

1. Antenna module (1) for a telematics control unit (2), said antenna module (1) comprising at least one full band cellular antenna (10) and an electronic support (11) configured to support said full band cellular antenna (10), wherein said full band cellular antenna (10) is metal stamped and 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 the 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).

2. Antenna module (1) according to claim 1, wherein said body (100) comprises :
   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).

3. Antenna module (1) according to any of the preceding claims, wherein said first reactive component (17), second reactive component (18) and third reactive component (19) are inductors or capacitor.

4. Antenna module (1) according to any of the preceding claims, wherein the feeding pin (100.1) is connected to a matching network (118).

5. Antenna module (1) according to any of the preceding claims, wherein said first frequency band (F1) is a low frequency band that goes from 617Hz to 960MHz

6. Antenna module (1) according to any of the preceding claims, wherein said second frequency band (F2) goes from 1.4GHz to 5GHz.

7. Antenna module (1) according to any of the preceding claims, wherein said antenna module (1) is configured to be mounted inside the compartment (31) of a vehicle (3) under a roof (30) of said vehicle (3), and that is configured to be connected to a telematics control unit (2) that is arranged away from said antenna module (1).

8. Antenna module (1) according to any of the preceding claims, wherein said at least one full band cellular antenna (10) is grounded on the electronic support (11) by means of the ground pin (101.3).

9. Antenna module (1) according to any of the preceding claims, wherein said module antenna (1) comprises :

- a first full band cellular antenna (10_1) metal stamped and mounted over a first extremity (11.1) of the electronic support (11),
- a second full band cellular antenna (10_2) metal stamped and mounted over a second extremity (11.2) of the electronic support (11), and
- two middle/high band cellular antennas (12_1, 12_2) metal stamped and mounted between the first cellular full band antenna (10_1) and the second cellular full band antenna (10_2)

10. Telematics control unit (2) for a vehicle (3), said telematics control unit (2) comprising a NAD cellular module (NADm) and a module antenna (1) according to any of the preceding claims that is connected to said NAD cellular module (NADm).

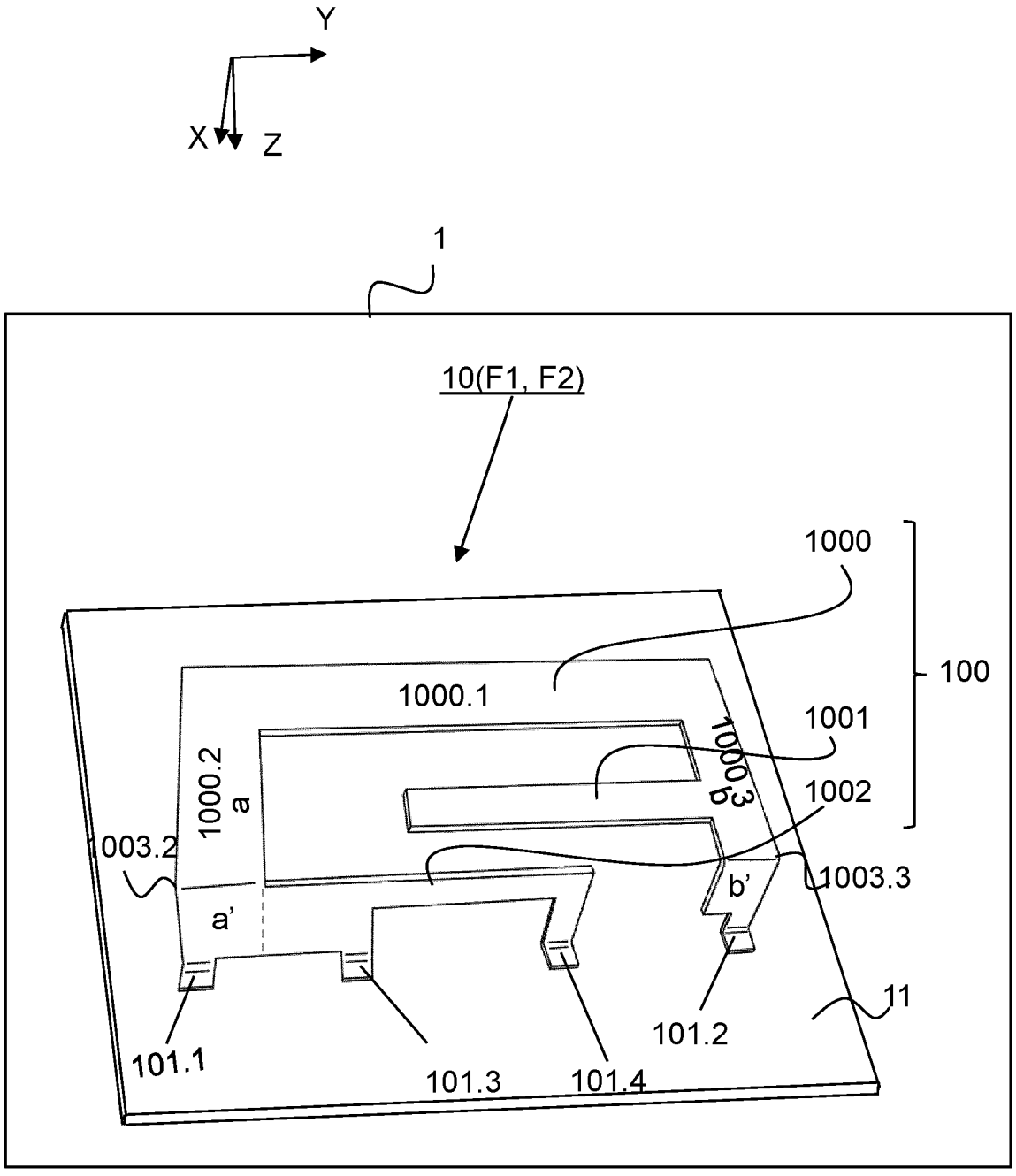
Y
X
Z
1
10(F1, F2)
1000
100
1000.1
1001
1000.3
b
1002
1000.2
a
1003.2
1003.3
b'
a'
11
101.1
101.3
101.4
101.2

Fig. 1

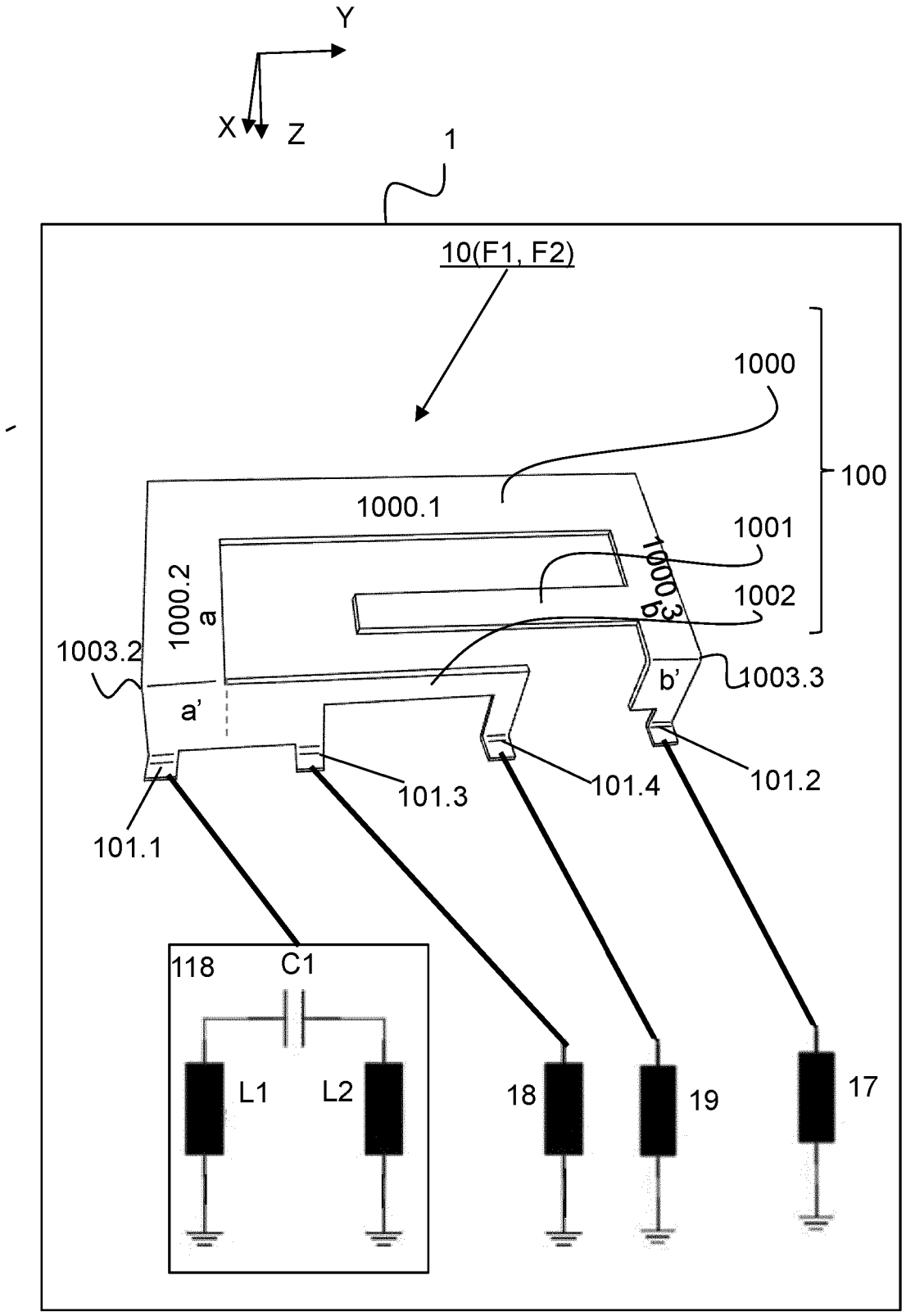
Y
X
Z
1
10(F1, F2)
1000
100
1000.1
1001
1000.3
1002
1000.2
a
1003.2
a'
b'
1003.3
101.1
101.3
101.4
101.2
118
C1
L1
L2
18
19
17

Fig. 2

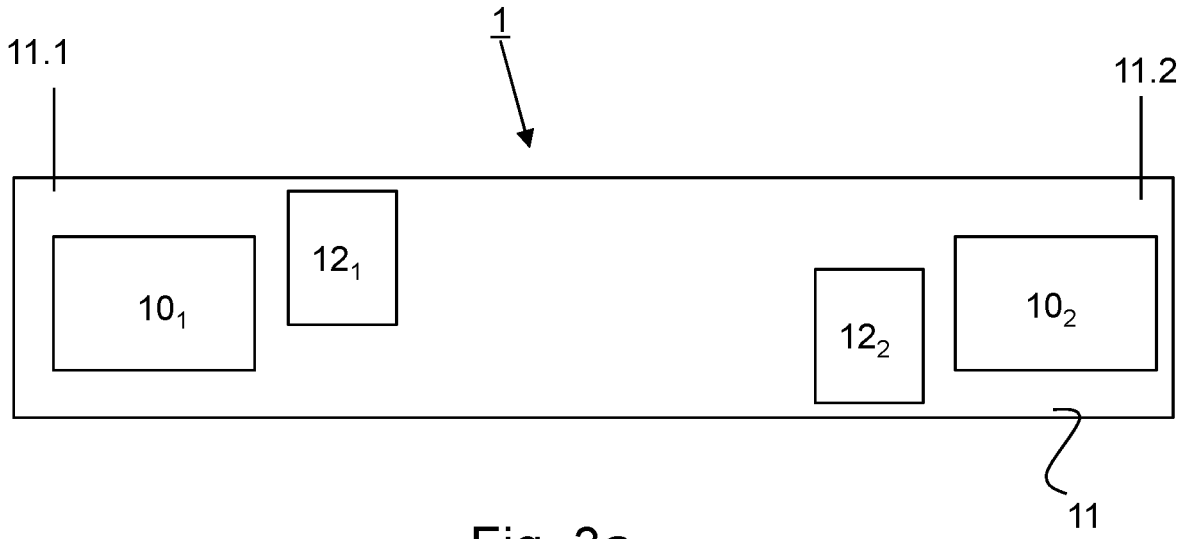
1
11.1
11.2
10_1
12_1
12_2
10_2
11

Fig. 3a

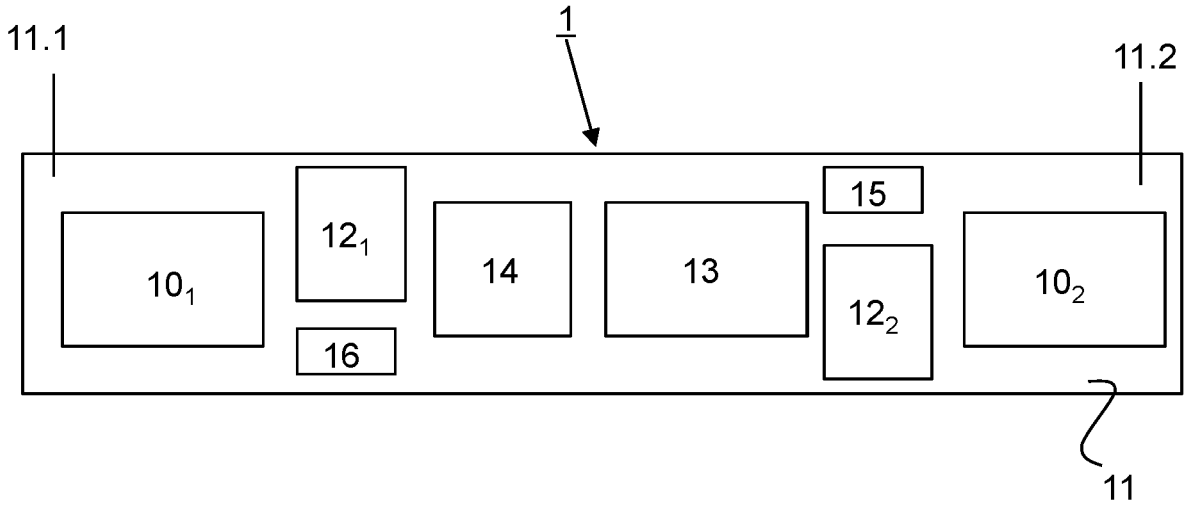
1
11.1
11.2
10_1
12_1
16
14
13
15
12_2
10_2
11

Fig. 3b

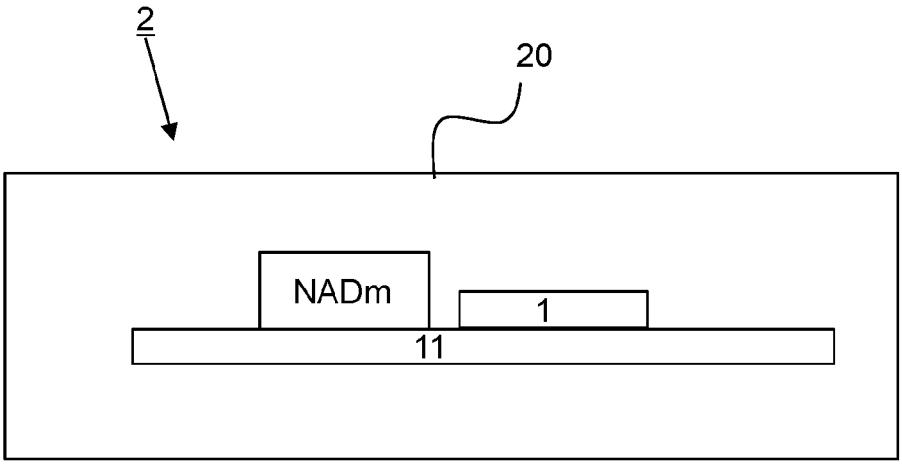

Fig. 4a

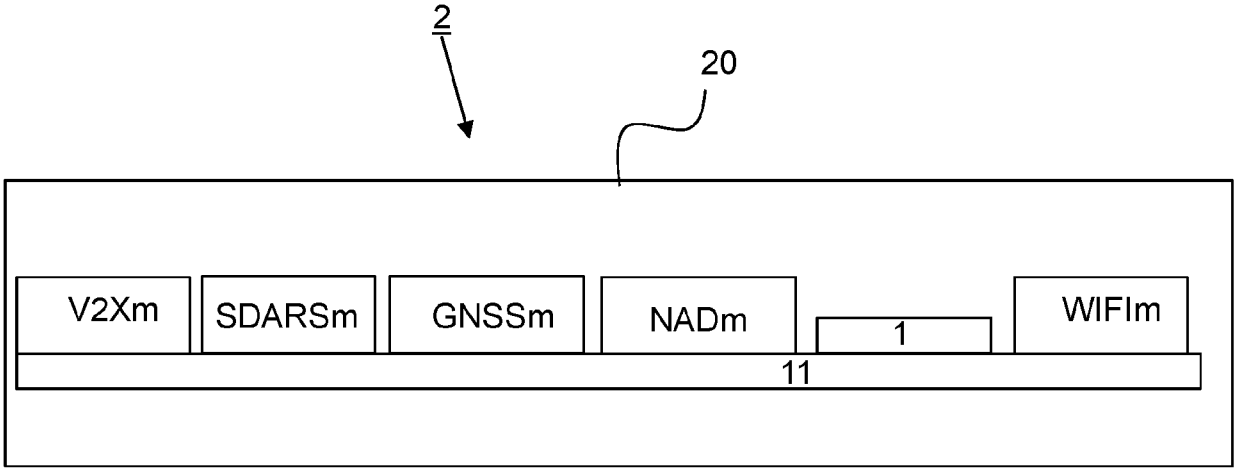

Fig. 4b

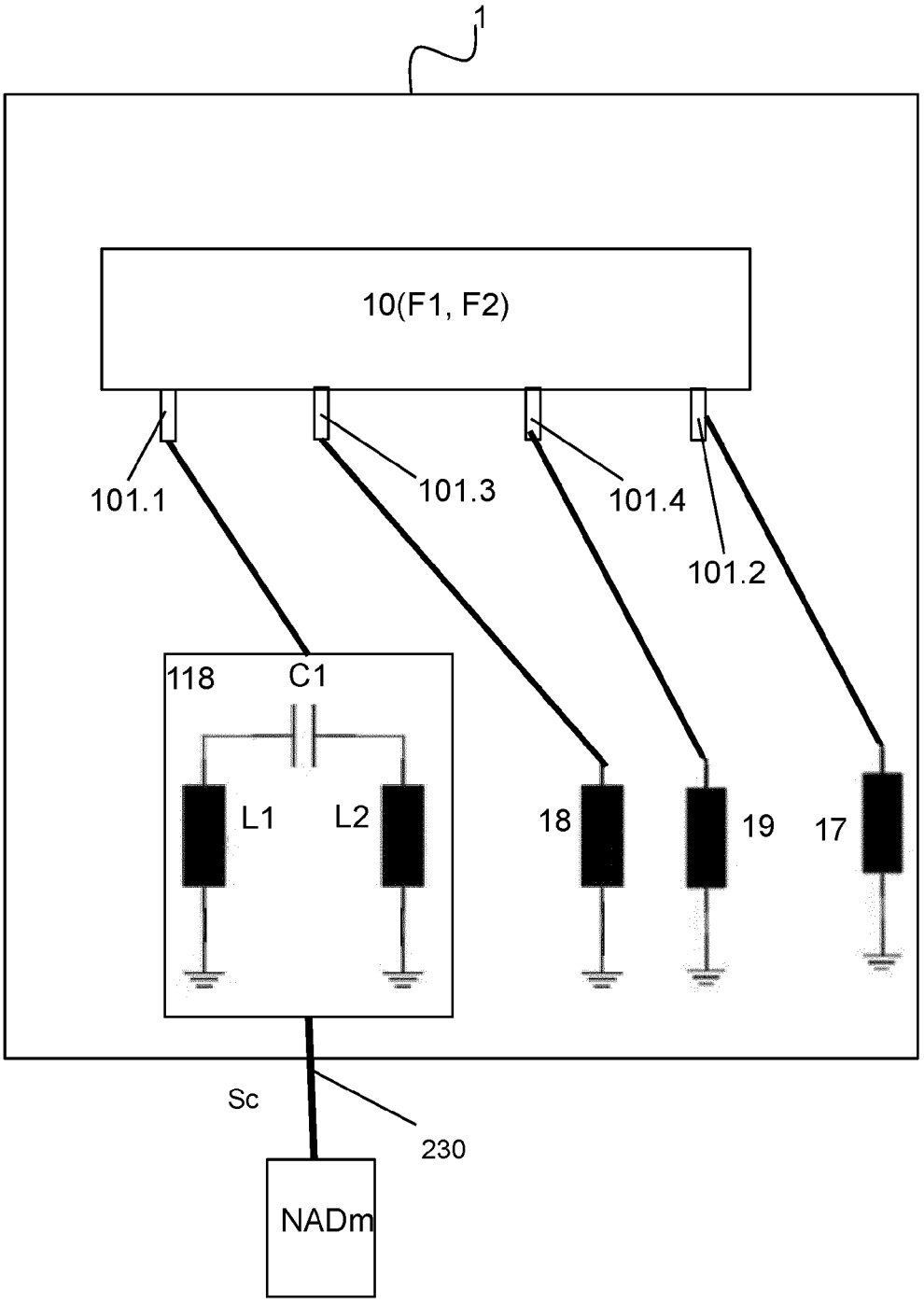

Fig. 5

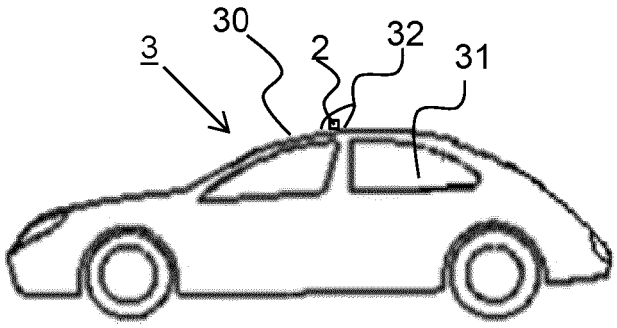

Fig. 6

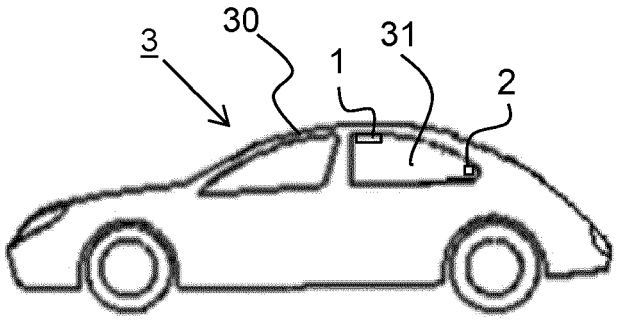

Fig. 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 21 1565

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2012/146865 A1 (HAYASHI KENJI [JP] ET AL) 14 June 2012 (2012-06-14)	1-8	INV. H01Q5/357
Y	* figure 29 * * paragraph [0130] - paragraph [0137]; figures 30-32 *	9,10	H01Q1/24 H01Q1/32 H01Q5/328 H01Q5/335
Y	US 2023/066184 A1 (KIM YONGKON [KR]) 2 March 2023 (2023-03-02) * figures 6A-7C *	9,10	H01Q7/00 H01Q9/42

TECHNICAL FIELDS SEARCHED (IPC)

H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 April 2025	Blech, Marcel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 21 1565

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-04-2025

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012146865 A1	14-06-2012	CN 102696149 A	26-09-2012
		EP 2458681 A1	30-05-2012
		JP 5692086 B2	01-04-2015
		JP 5939322 B2	22-06-2016
		JP 2015084604 A	30-04-2015
		JP WO2011059088 A1	04-04-2013
		KR 20120092663 A	21-08-2012
		US 2012146865 A1	14-06-2012
		WO 2011059088 A1	19-05-2011
US 2023066184 A1	02-03-2023	KR 20220084396 A	21-06-2022
		US 2023066184 A1	02-03-2023
		WO 2021145463 A1	22-07-2021

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82