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(54) **Method for receiving radio frequency signals by the ground chassis of a mobile communications device**

(57) BLUESKY POSITIONING IPCo SARL

A coupling system between a ground chassis of a mobile communications device (30) used as an antenna and a radio frequency (RF) receiver housed on a printed circuit board (PCB) card of the mobile communications device (30) is described. The ground chassis can include the PCB ground. The coupling system comprises a main coupling leg (14) implemented as a galvanic connection between the PCB card (12) and the antenna. A reference capacitive coupling leg (16) is also formed between a ground plane of the PCB card (12) and the antenna. An auxiliary capacitive coupling leg (18) is further formed between a separate conductive area of the PCB card (12) and the antenna. The coupling system includes a delay line (4) arranged to introduce a phase shift of the signal captured through the auxiliary capacitive coupling leg (18). The system is arranged so that the RF receiver (20) is provided with the signal captured by the galvanic main coupling leg (14) and with the phase shifted signal delivered by the auxiliary coupling leg via the delay line (4).

The coupling system allows a RF receiver of a mobile communications device (30) system to receive the signals transmitted by the space vehicles of a global positioning system through an antenna of the mobile device, said antenna being for instance constituted by a chassis of the mobile communications device.

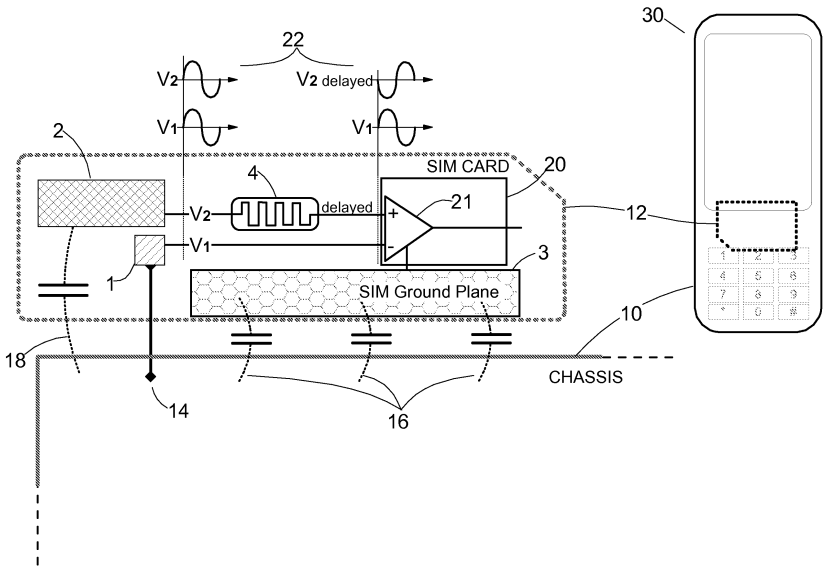

Figure 1

EP 2 182 580 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to mobile communications devices such as GSM (global system for mobile communications) and 3G (UMTS) portable telephone sets including a subscriber identity module (SIM), and more particularly to those subscriber identity modules that also embed a positioning system transceiver aimed at decoding the signals transmitted by space vehicles.

BACKGROUND OF THE INVENTION

[0002] The development by the wireless communications industry of location-based services relies on the actual capability of embedding a precise positioning system into all sorts of mobile communications devices. Such positioning systems are presently in practice based on the only world-wide operational system, i.e., the US military global positioning system or GPS which has also been made available for civil applications by the US government, but can be utilizing any other satellite based positioning systems. Other positioning systems under development and construction include the European Galileo system which is planned to be operational by 2013.

[0003] Indeed, the accurate location of mobile devices cannot be solely determined from the information gathered by a GSM or 3G network. This type of cellular networks can only pinpoint the position of a mobile device down to the size of the cell from which a communication is established, i.e., with an accuracy in a range of at best 50-100 meters in urban areas, and several kilometers in rural areas.

[0004] The location-based services considered by the wireless communications industry typically include the E-112 emergency services legislation in European Union and E-911 in the USA, with strict requirements for the accuracy of the caller's location. Network operators are required to identify the location of the callers with an accuracy level of just a few tens of meters in rural areas, i.e. between one and two order of magnitude better than what a GSM network is able to achieve. Similar to the E-911 legislation in the US, the new law is designed to improve emergency services reaction and response time to provide assistance to persons in danger. Because emergency calls are more and more frequently originated from mobile phone devices it will be eventually mandatory to include a very precise positioning system in all wireless communications devices carried by individuals.

[0005] Key to the practical achievement of this objective is the capability of embedding in mobile handsets a true precise self-positioning system in spite of the tight packaging in which they are built and despite the fact that the prime function of such device is to establish a versatile communication channel (voice, video, data etc.) through a terrestrial wireless network like the GSM network. The challenge is thus to be able to receive and interpret at the same time weak, and sometimes very weak, signals from space vehicles (at least three of them must be simultaneously viewable to obtain a valid position). This should be accomplished even though the reception conditions can be particularly difficult like being inside a building with no or few windows or outside in a so-called urban canyon, i.e. between tall buildings that block and/or reflect the signals. Hence, to rise to this challenge the front-end part of the reception system, i.e. the antenna and its coupling to the receiver must be particularly efficient to obtain signal to noise ratios that are exploitable in spite of all the physical constraints induced by a tight packaging while supplementary constraints like power consumption and cost of fabrication are also critical for mobile devices that are powered from a small battery and are produced for a large and extremely competitive market place.

SUMMARY OF THE INVENTION

[0006] It is therefore the object of the invention to meet the above challenges by providing a coupling system between a mobile communications device chassis acting as an antenna, as presented in prior art European patent application EP 1 777 781, and a radio frequency (RF) receiver housed in a printed circuit board (PCB) card of the SIM card. The coupling system comprises a main coupling leg implemented as a galvanic connection between the PCB card and the antenna. A reference capacitive coupling leg is also formed between a ground plane of the PCB card and the antenna. An auxiliary capacitive coupling leg is further formed between a conductive area of the PCB card and the antenna. The coupling system includes a delay line arranged to introduce a phase shift of the signal captured through the auxiliary capacitive coupling leg. The system is arranged so that the RF receiver is provided with the signal captured by the galvanic main coupling leg and with the phase shifted signal delivered by the delay line.

[0007] The coupling system allows a RF receiver in the subscriber identity module of a mobile communications device system to receive the signals transmitted for instance by the space vehicles of a global positioning system through the mobile device used as an antenna.

[0008] The coupling system of the invention may optionally comprise any one of the following features:

- the chassis comprises any electrically conductive part that has a galvanic connection to the phone ground such as the PCB ground, a battery, an embedded accessory or a phone body part;
- the RF receiver is equipped with a differential amplifier electrically connected to the ground plane of its PCB card;
- the system is arranged so that the signal captured by the galvanic main coupling leg is applied on a first input of the differential amplifier and the phase shift-

ed signal delivered by the delay line is applied on a second input of the differential amplifier;

- the auxiliary capacitive coupling leg includes a compensating inductor;
- the antenna is integrally formed of the chassis of the mobile communications device;
- the delay line is adjusted so that, for the received RF waves, the signals between the first and the second input of the RF differential amplifier are in opposite phase to maximize signal amplitude;
- the PCB card houses the complete coupling system;
- the delay line can be implemented as a conductive trace of the PCB card;
- the length of the conductive trace is adjusted so that the propagation delay creates a phase opposition of the signals applied on the differential amplifier;
- the delay line can also be a combination of active or passive components ensuring the right time delay to the signal path.
- the delay line is adjusted so that, for the received RF waves, the signal power loss is minimized to the amplifier input;
- the PCB card can be a removable subscriber identification module (SIM) card for the mobile communications device;
- the galvanic connection is achieved through a connecting pad of the removable SIM card and a connector pin of the card socket electrically connected to the mobile device chassis. The invention also provides a printed circuit board (PCB) card housing a radio frequency (RF) receiver and comprising a coupling system according to any one of the preceding features.

[0009] The invention further provides a mobile communications device comprising the coupling system according to any one of the preceding features.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Figure 1 shows the overall structure and principle of the coupling system between the chassis of a portable handset used as an antenna and the GPS receiver situated on the SIM card.

Figure 2 depicts an exemplary implementation on the SIM card of a coupling system according to the invention.

Figure 3 shows an alternative embodiment of the overall structure and principle of the coupling system depicted at Figure 1.

DETAILED DESCRIPTION

[0011] The following detailed description of the invention refers to the accompanying drawings where like elements are designated by the same reference numerals in all the drawings and throughout the description. While the description includes exemplary embodiments, other embodiments are possible, and changes may be made to the embodiments described without departing from the spirit and scope of the invention.

[0012] In order to achieve the here above objectives, i.e., the implementation of a precise positioning system that fits in the packaging of a SIM card of mobile portable handset, e.g.: 30, the invention preferably re-uses and adapts existing standard components for housing the circuitry needed.

[0013] Hence, the invention manages to use the standard removable subscriber identification module (SIM) card or equivalent identification card 12, which equips many mobile portable handsets, to also house the receiver circuitry along with the processing and computational resources needed to receive and decode the signals transmitted by the space vehicles of the global positioning system. The SIM or equivalent card is then a small printed circuit board (PCB) card used to hold specialized electronic components with their wiring and connecting lands.

[0014] The invention considers that the conductive chassis 10 of the handset can be used as an antenna for receiving the signals provided an appropriate coupling between the chassis and the receiver located on the SIM card can be achieved as described hereafter.

[0015] In the following description of the invention what is broadly referred to as the chassis comprises any electrically conductive part, usually metallic, that has a galvanic connection to the phone ground. Thus the chassis of the invention may, additionally to the chassis frame of the handset, notably includes the main printed circuit board, battery, embedded accessory or phone body part In particular, the PCB ground can be used as an antenna.

[0016] Figure 1 shows the overall structure and principle of the coupling between the ground chassis 10 of a portable handset 30 used as an antenna and the GPS receiver 20 situated on the SIM card 12.

[0017] The applicant found out that a number of factors tend to hinder an appropriate coupling between the chassis 10 and the receiver 20. Indeed due to the limited surface available on the SIM card (i.e.: 25 x15 mm^2) compared with the chassis of a typical mobile device (e.g.: 100 x 40mm^2), the possibility to place large coupling elements is limited, and consequently the possibilities to tune the antenna characteristics are also limited. The receiver ground of the SIM card 3 is also coupled with the mobile device chassis 10, making it difficult to extract the signal to the transceiver input. Furthermore, because of the limited room available, couplers necessarily lay very close one to each other, typically within few millimeters. The signals fed by the couplers are then very similar in terms of phase or time difference.

[0018] Hence, to overcome the above problems while enabling to keep the coupling structure all enclosed on the SIM card, i.e., on a small PCB card also housing the GPS receiver the invention uses three coupling ele-

ments:

- a main coupler 1 that establish a galvanic connection 14 between the SIM card 12 and the chassis 10 through at least one connector ground contact of the PCB card;
- a reference coupler which results of the capacitive coupling 16 between the SIM ground plane 3 and the chassis 10;
- an auxiliary capacitive coupler 2 on which a phase shifter 4 is connected.

[0019] Highly sensitive digital receivers often make use of a differential amplifier 21 as a part of the radio frequency (RF) front end circuitry of the receiver 20 which, if connected directly to the main and auxiliary couplers 1, 2, would however provide a very low output, due to the lack of phase difference existing between the physically close coupling points. Because there is no space available to move farther away the two couplers so that the resulting phase difference would become higher (ideally the phases should be exactly opposite) the invention introduces instead an electrical phase shift (or delay) between the coupling points. Thus, to overcome the problems posed by the limited physical space available, the invention manages to use the phase shifter 4 to create a virtual distance between the main galvanic coupler 1 and the auxiliary coupler 2.

[0020] Figure 2 depicts an exemplary implementation of a coupling system according the invention between the chassis antenna of a portable handset and the GPS receiving circuitry situated on the SIM card 12.

[0021] The main galvanic connection 1 is done here through one of the six or eight standardized connecting pads of the SIM card, for example contact 5 of ISO 7816 standard. The auxiliary capacitive coupler 2 is a conductive area which is shown in the middle of the standard contacts. The delay line is implemented in the form of a transmission line 4 which connects the auxiliary coupler to one of the input of the differential amplifier 21 of the receiver circuitry 20 while the other one is tied to the galvanic connection 1.

[0022] Alternatively, the delay can be obtained with a trimmable passive device made of discrete inductors and capacitors or with a specialized active component capable of providing an adjustable delay.

[0023] The length of the delay line 4 is adjusted to tune the signal phase shift taking into account the characteristics of the couplers for the input signal frequency (1.57542 GHz in the case of a GPS application) and to minimize the losses. Usually the objective is to have two signals with a relative phase shift as close to 180° as possible 22. The benefit is not only an increase in the antenna gain, but also a better shape in the radiation diagram due to a more homogeneous current distribution on the chassis.

[0024] The resulting system has a low sensitivity to capacity variations typically resulting from different SIM card distances over the chassis, or different materials in between the SIM card and the chassis. This is because of the capacity variation being partially compensated by the capacitive connection of the reference coupler (receiver ground plane in the SIM Card) to the mobile device chassis.

[0025] Figure 3 shows a variant of the coupling circuitry in which an inductor 25 is inserted between the auxiliary coupler 2 and the delay line 4 to improve the transmission of the signal captured by the coupler. The relatively large value of the coupling capacitor 18, which tends to attenuate the captured signal, can thus be compensated by the inductor in forming a LC circuit which is tuned to have minimum impedance at the operating frequency of the device. This embodiment improves therefore the performances of the system.

Claims

1. A coupling system between a ground chassis of a mobile communications device (30) used as an antenna, the antenna being arranged to receive RF waves and a radio frequency (RF) receiver (20) housed on a printed circuit board (PCB) card (12) intended to cooperate with the mobile communications device (30), **characterized in that** it comprises:

   a main coupling leg (14) implemented as a galvanic connection (1) between the PCB card and the antenna;
   a reference capacitive coupling leg (16) formed between a ground plane (3) of the PCB card and the antenna;
   an auxiliary capacitive coupling leg (18) formed between a conductive land of the PCB card (2) and the antenna;
   a delay line (4) arranged to introduce a phase shift of the signal captured through the auxiliary capacitive coupling leg;

   and **in that** it is arranged so that the RF receiver (20) is provided with the signal captured by the galvanic main coupling leg (14) and with the phase shifted signal delivered by the delay line (4).

2. The system of claim 1 wherein the auxiliary capacitive coupling leg includes a compensating inductor (25).

3. The system according to any one of claims 1 to 2 wherein the chassis comprises any electrically conductive part that has a galvanic connection to the phone ground such as the PCB ground plane (3), a battery, an embedded accessory or a phone body part.

4. The system according to any one of claims 1 to 3 wherein the RF receiver is equipped with a differential amplifier (21) electrically connected to the ground plane (3) of the PCB card (12) and wherein the system is arranged so that the signal captured by the galvanic main coupling leg (14) is applied on a first input of the differential amplifier (21) and the signal captured through the auxiliary capacitive coupling leg (2) is applied on a second input of the differential amplifier (21) via the delay line (4).

5. The system according to the preceding claim wherein the delay line (4) is adjusted so that, for the received RF waves, the signals between the first and the second input of the RF differential amplifier (21) are in phase opposition (22).

6. The system according to any one of claims 1 to 5 wherein the PCB card (12) houses the complete coupling system.

7. The system according to any one of claims 1 to 6 wherein the delay line (4) is implemented as a conductive trace of the PCB card (12).

8. The system according to any one of claims 1 to 6 wherein the delay line (4) is implemented by a trimmable passive device.

9. The system according to any one of claims 1 to 6 wherein the delay line (4) is implemented by an adjustable active delay line.

10. The system according to any one of the previous claims wherein the PCB card (12) is a removable subscriber identification module (SIM) card for the mobile communications device (30).

11. The system of claim 10 wherein the galvanic connection is achieved through a connecting tab of the removable SIM card and a connector pin of the card socket electrically connected to the antenna.

12. The system according to any one of the previous claims wherein the antenna and the RF receiver (20) are adapted to receive the signals transmitted by the space vehicles of a global positioning system.

13. A printed circuit board (PCB) card (12) housing a radio frequency (RF) receiver (12) and comprising the coupling system according to any one of claims 1 to 12.

14. A mobile communications device (30) comprising the coupling system according to any one of claims 1 to 12.

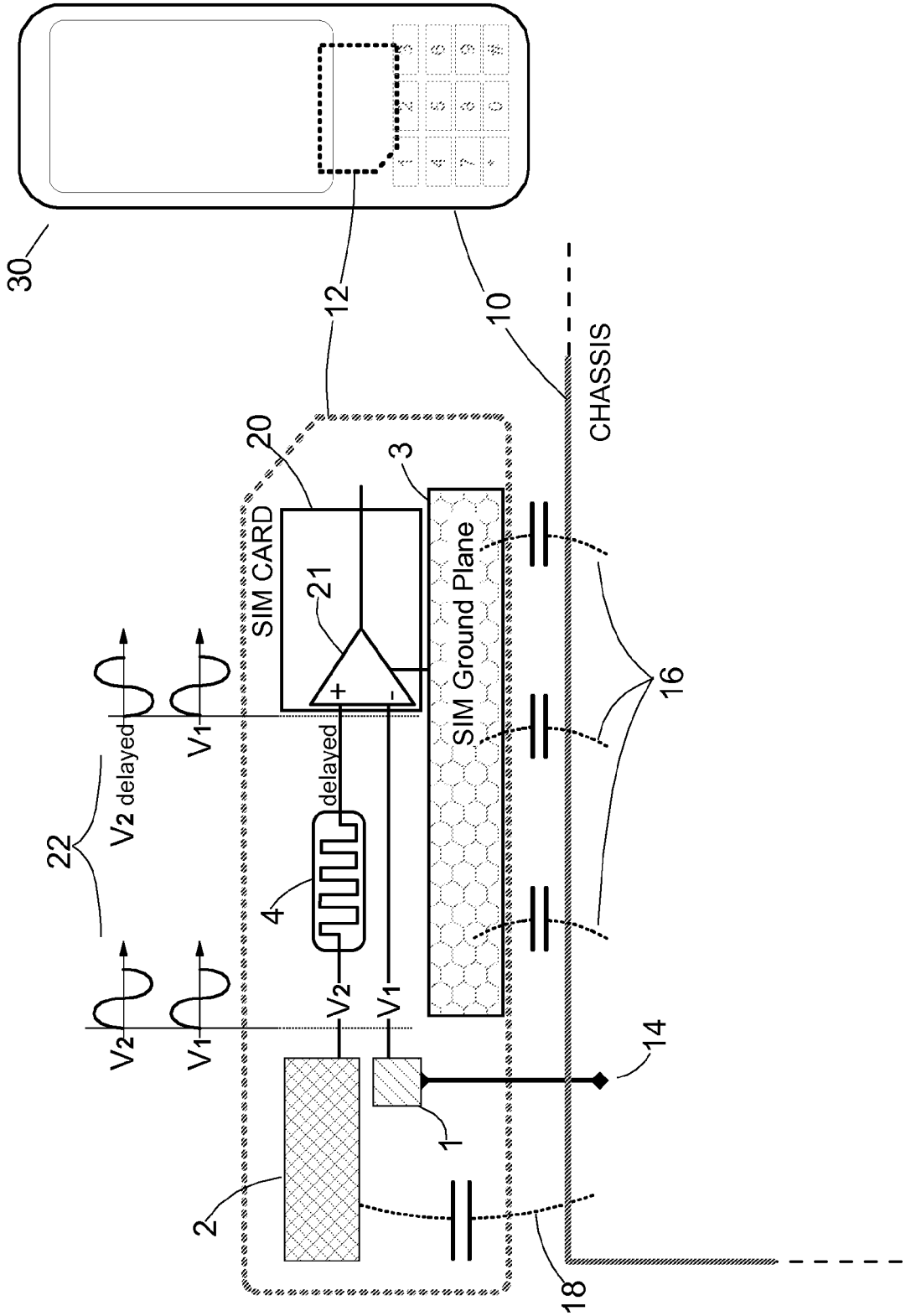
30
12
10
CHASSIS
20
3
SIM CARD
21
SIM Ground Plane
16
22
V2 delayed
V1
delayed
4
V2
V1
14
1
2
18

Figure 1

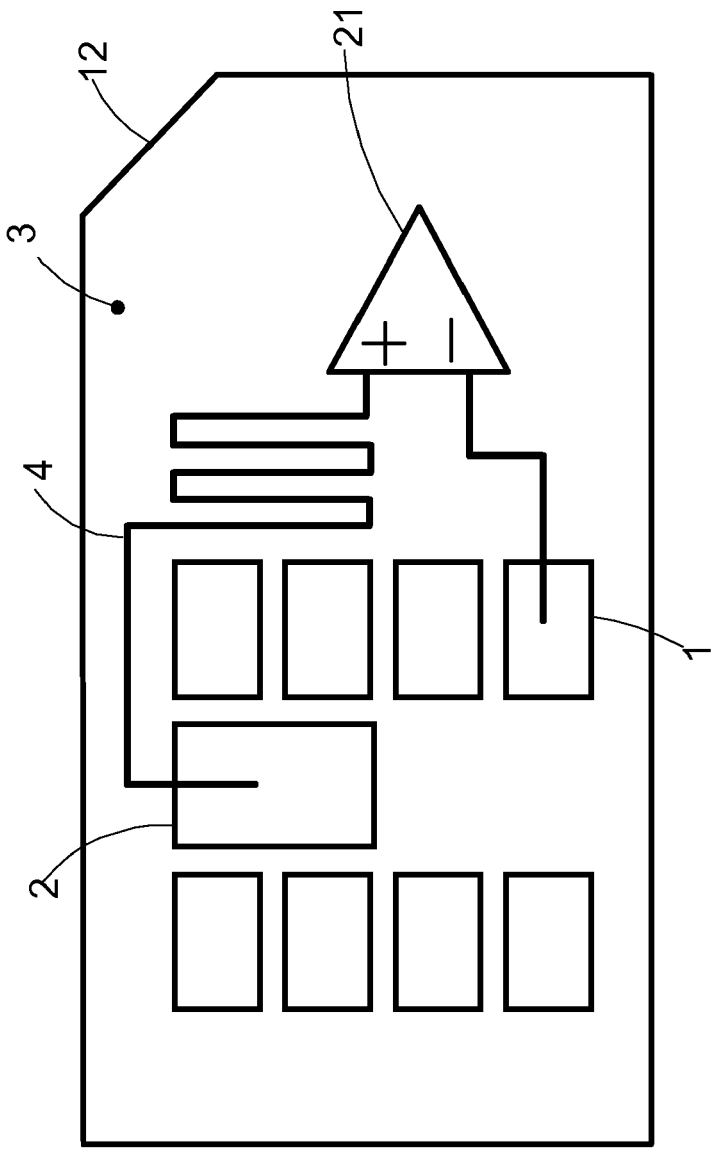

Figure 2

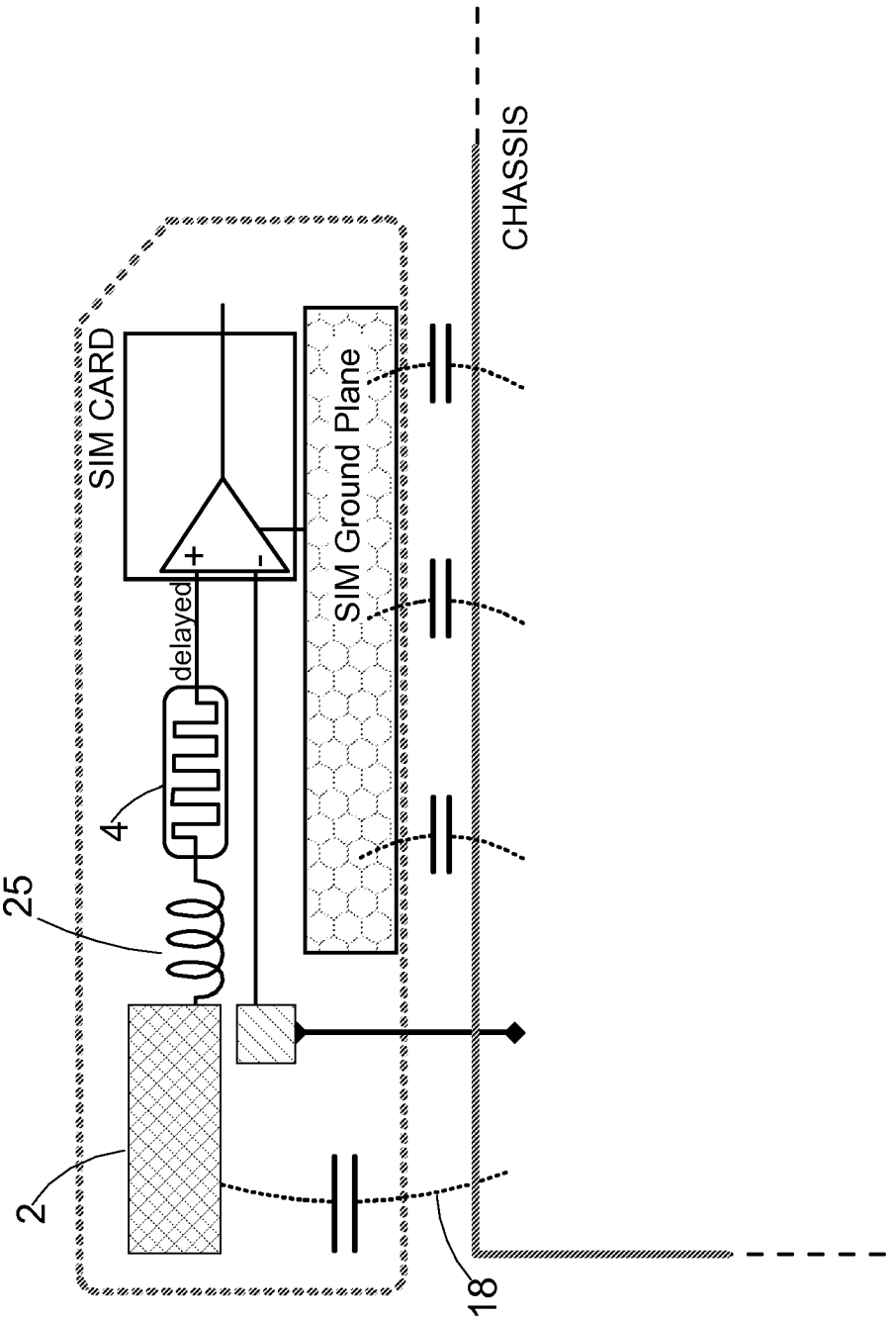

Figure 3

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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 8223

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	EP 1 777 781 A (SAVOLAINEN RISTO KALEVI [FR]) 25 April 2007 (2007-04-25) * paragraph [0042] - paragraph [0045]; figure 6b *	1-14	INV. H01Q1/44 ADD. H01Q1/24
A	US 2007/252764 A1 (KESKI-OPAS PETRI [FI]) 1 November 2007 (2007-11-01) * abstract; figures 1,2 *	1-14	
A	EP 1 267 441 A (HITACHI METALS LTD [JP]) 18 December 2002 (2002-12-18) * paragraph [0037]; figures 1,2 *	1-14	
A	US 5 940 045 A (BELCHER DONALD K [US] ET AL) 17 August 1999 (1999-08-17) * abstract; figure 2 *	1-14	

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
Munich	16 March 2009	Marot-Lassauzaie, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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16-03-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1777781 A	25-04-2007	AU 2006303180 A1	26-04-2007
		CA 2626582 A1	26-04-2007
		CN 101331645 A	24-12-2008
		WO 2007045725 A1	26-04-2007
		KR 20080064868 A	09-07-2008
		US 2008316109 A1	25-12-2008
US 2007252764 A1	01-11-2007	EP 2011187 A2	07-01-2009
		WO 2007125417 A2	08-11-2007
EP 1267441 A	18-12-2002	AT 352109 T	15-02-2007
		CN 1407832 A	02-04-2003
		DE 60217580 T2	08-11-2007
		ES 2278836 T3	16-08-2007
		JP 2003069330 A	07-03-2003
		KR 20020096016 A	28-12-2002
		US 2003006936 A1	09-01-2003
US 5940045 A	17-08-1999	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1777781 A **[0006]**