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(54) **Antenna device and portable radio communication device comprising such antenna device**

(57) The present invention relates to an antenna device for a portable radio communication device adapted for receiving and/or transmitting radio signals in at least a first and a second operating frequency band. The antenna device comprise a half-loop radiating element (2), comprising a first end and a second end, configured for receiving FM frequencies, wherein the antenna device comprises a band stop filter (6) and a capacitor (4) at the first end and an inductor (5) at said second end, the half-loop radiating element (2) is configured to also operate at DVB-H frequencies, the band stop filter (6) is arranged to block the DVB-H frequencies to provide an open-ended termination of the half-loop radiating element (2) for DVB-H frequencies, and the inductor (5) is arranged to short circuit the half-loop radiating element (2) to ground for FM frequencies.

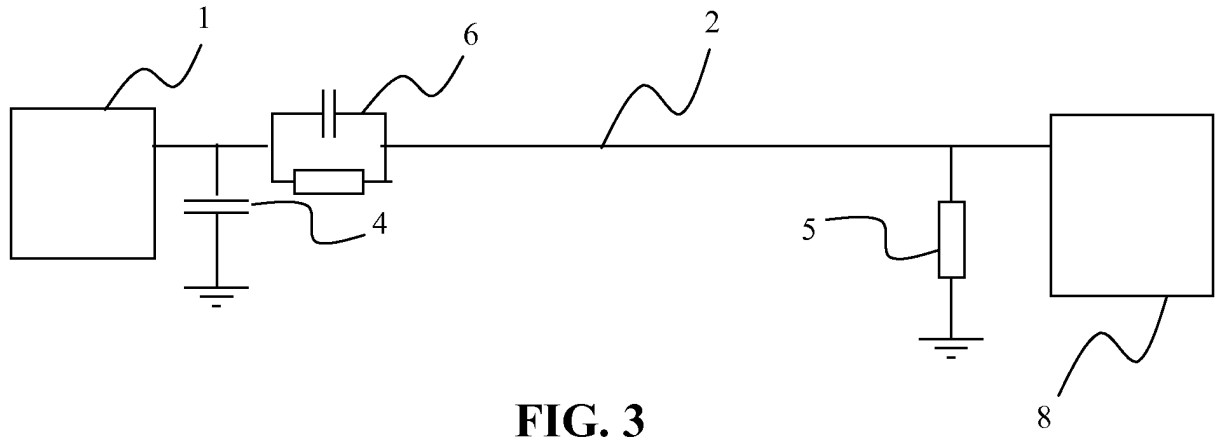

FIG. 3

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Description

FIELD OF INVENTION

[0001] The present invention relates generally to antenna devices and more particularly to an antenna device for use in a portable radio communication device, such as a mobile phone, which antenna device is adapted for receiving radio signals having a relatively low frequency, such as radio signals in the FM frequency band.

BACKGROUND

[0002] Internal antennas have been used for some time in portable radio communication devices. There are a number of advantages connected with using internal antennas, of which can be mentioned that they are small and light, making them suitable for applications wherein size and weight are of importance, such as in mobile phones, PDA, portable computer or similar devices.

[0003] However, the application of internal antennas in a mobile phone puts some constraints on the configuration of the antenna element. In particular, in a portable radio communication device the space for an internal antenna device is limited. These constraints may make it difficult to find a configuration of the antenna device that provides for desired use. This is especially true for antennas intended for use with radio signals of relatively low frequencies as the desired physical length of such antennas are large compared to antennas operating with relatively high frequencies.

[0004] One specific application operating in a relatively low frequency band is the FM radio application. The FM operating band is defined as frequencies between 88-108 MHz in most of the world and frequencies between 76-90 MHz in Japan. Prior art conventional antenna configurations, such as loop antennas or monopole antennas, fitted within the casing of a portable radio communication device will result in unsatisfactory operation in that the antenna either has too bad performance over a sufficiently wide frequency band or sufficient performance over a too narrow frequency band.

[0005] Instead, a conventional FM antenna for portable radio communication devices is usually provided in the headset wire connected to the communication device. This configuration with a relatively long wire permits an antenna length that is sufficient also for low frequency applications. However, if no external antenna is permitted this solution is obviously not feasible.

[0006] Further, a portable radio communication device is today many times provided with frequency operational coverage for other frequency bands then FM, such as GSM900, GSM1800, GPS, Bluetooth, WLAN, WCDMA and DVB-H. A portable radio communication device has limited space and it is thus desirable to, if possible, add multiple functionality to an antenna device.

[0007] A known active FM rx antenna device for a mobile phone is illustrated in Fig. 1. A FM receiver 1 is connected to one end of a half-loop radiating element 2, which radiating element is short-circuited in the other end to reduce the size of the antenna device.

[0008] A combination antenna device comprising an active FM rx antenna and a BT/WLAN antenna for a mobile phone is illustrated in Fig. 2. A FM receiver 1 is connected to a first end of a half-loop radiating element 2, which is for FM rx frequencies short-circuited in a second end by a 5 nH inductor 5. A BT/WLAN receiver/transmitter 3 is connected to the second end of the radiating element 2, which is for BT/WLAN frequencies short-circuited in the first end by a 30 pF capacitor to reduce the size of the antenna device.

SUMMARY OF THE INVENTION

[0009] An object of the present invention is to provide an antenna device for use in a portable radio communication device, which efficiently utilizes available space of the portable radio communication device and provides for at least FM frequency band operation.

[0010] This object, among others, is according to the present invention attained by an antenna device and a portable radio communication device, respectively, as defined by the appended claims.

[0011] By providing an antenna device for a portable radio communication device adapted for receiving and/or transmitting radio signals in at least a first and a second operating frequency band, the antenna device comprising a half-loop radiating element, comprising a first end and a second end, configured for receiving FM frequencies, wherein the antenna device comprises a band stop filter at the first end and an inductor at the second end, and the half-loop radiating element is configured to also operate at DVB-H frequencies, the band stop filter is arranged to block said DVB-H frequencies to provide an open-ended termination of the half-loop radiating element for DVB-H frequencies and the inductor is arranged to short circuit the half-loop radiating element to ground for FM frequencies, efficient use of available space of a portable radio communication device is achieved since a half-loop antenna device provides reception of FM frequencies as well as DVB-H frequencies. The half-loop radiating element is short-circuited for FM frequencies to reduce size, and is open-ended for DVB-H frequencies to provide broad band.

[0012] By providing an antenna device for a portable radio communication device adapted for receiving and/or transmitting radio signals in at least a first, a second and a third operating frequency band, the antenna device comprising a half-loop radiating element, comprising a first end and a second end, configured for receiving FM frequencies, wherein the antenna device comprises a capacitor at the first end, an inductor at the second end, and a band stop filter at one end of the first and second ends, the half-loop radiating element is configured to also operate at frequencies at least ten times higher than FM frequencies, the capacitor is arranged to short circuit the

half-loop radiating element to ground for frequencies at least ten times higher than FM frequencies and the inductor is arranged to short circuit the half-loop radiating element to ground for FM frequencies, and the band stop filter is configured to block DVB-H frequencies to provide an open-ended termination of the half-loop radiating element for the DVB-H frequencies, efficient use of available space of a portable radio communication device is achieved since a half-loop antenna device provides reception of FM frequencies, DVB-H frequencies and operation at frequencies at least ten times higher than FM frequencies. The half-loop radiating element is short-circuited for FM frequencies to reduce size, is open-ended for DVB-H frequencies to provide broad band, and is short-circuited for frequencies at least ten times higher than FM frequencies.

[0013] The frequencies at least ten times higher than FM frequencies preferably comprise one or more of the following frequency bands: GPS, Bluetooth, WLAN and WCDMA diversity. Particularly Bluetooth is today often desired in a portable radio communication device.

[0014] To provide three band operation for the half-loop antenna device, the antenna device preferably comprises a switching arrangement at said first end and the filter device is arranged at the second end, wherein the switching arrangement is configured to switch between FM operation and DVB-H operation. Alternatively, the antenna device comprises a switching arrangement at the second end and the filter device is arranged at the first end, wherein the switching arrangement is configured to switch between operation at frequencies at least ten times higher than FM frequencies and DVB-H operation.

[0015] The antenna device is preferably adapted for also transmitting radio signals for FM frequencies, to provide e.g. the possibility to send information from the portable radio communication device to a FM receiver in a car.

[0016] The half-loop radiating element of the antenna device is preferably arranged over a ground plane device of a portable radio communication device, to provide a desired virtual loop.

[0017] By utilization of very distinct operating frequency bands, e.g. FM and DVB-H or FM and BT can operate simultaneously on the radiating element, without use of any switches.

[0018] Further preferred embodiments are defined in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

[0019] The present invention will become more fully understood from the detailed description of embodiments given below and the accompanying figures, which are given by way of illustration only, and thus, are not limitative of the present invention, wherein:

FIG. 1 is a schematic diagram showing a previously known half-loop FM antenna.

FIG. 2 is a schematic diagram showing a half-loop FM antenna also usable as BT/WLAN antenna.

FIG. 3 is a schematic diagram showing a first embodiment of an antenna device according to the present invention.

FIG. 4 is a schematic diagram showing a second embodiment of an antenna device according to the present invention.

FIG. 5 is a schematic diagram showing a third embodiment of an antenna device according to the present invention.

FIG. 6 illustrates an antenna device according to the present invention positioned in a portable radio communication device with partly cut-away portions.

DETAILED DESCRIPTION OF THE INVENTION

[0020] In the following description, for purpose of explanation and not limitation, specific details are set forth, such as particular techniques and applications in order to provide a thorough understanding of the present invention. However, it will be apparent for a person skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed description of well-known methods and apparatuses are omitted so as not to obscure the description of the present invention with unnecessary details.

[0021] In the following description and claims, the term radiating element is used. It is to be understood that this term is intended to cover electrically conductive elements arranged for receiving and/or transmitting radio signals.

[0022] With reference to Figs. 3 and 6 a first embodiment of an antenna device according to the present invention is described. The antenna device comprises a half-loop radiating element 2, having a first end and a second end, configured for receiving FM frequencies. A half-loop antenna is a virtual loop antenna, by being provided over a ground plane device. The antenna device further comprises a capacitor 4 at the first end for fine tuning or setting the half-loop radiating element 2 to e.g. either Japan or other country FM receiving frequencies and an inductor 5 at the second end to short-circuit the half-loop radiating element 2 for FM receiving frequencies.

[0023] The antenna device is further configured to simultaneously with FM frequencies operate at DVB-H frequencies. The antenna device further comprises a filter device 6 at the first end of the half-loop radiating element 2, which filter device 6 is configured to block DVB-H frequencies. In this way a FM receiver 1 connected to the first end of the half-loop radiating element 2 experiences

a short-circuited half-loop antenna device configured for FM frequencies, whereas a DVB-H receiver 8 connected to the second end of the half-loop radiating element 2 experiences an open-ended half-loop antenna device configured for DVB-H frequencies.

[0024] The capacitor 4 is configured fine tune the half-loop radiating element 2 for FM frequencies. A capacitance of about 30 pF is appropriate to fine tune the half-loop radiating element 2 for FM frequencies.

[0025] The inductor 5 is configured to short circuit the half-loop radiating element 2 to ground for FM frequencies. An inductance of about 5 nH is appropriate to provide a short circuit for FM frequencies, at the same time preventing short circuit for DVB-H frequencies.

[0026] The filter device 6 is configured to block DVB-H frequencies. The filter device is e.g. made up by a capacitor in parallel with an inductor. A capacitance of about 6 pF and an inductance of about 11 nH is appropriate to provide a block for DVB-H frequencies, at the same time allowing FM frequencies to pass through.

[0027] A portable radio communication device 10 comprising an antenna device as described above comprises a ground plane device below the half-loop radiating element 2 to provide a virtual loop antenna device. The ground plane device is e.g. provided as a printed wiring board of the portable radio communication device 10. The portable radio communication device 10 is further provided with a matching network or matching filter for the FM receiver 1, and a matching network or matching filter for the DVB-H receiver 8. The matching network or matching filter for the FM receiver 1 is connected to the first end of the half-loop radiating element 2. The matching network or matching filter for the DVB-H receiver 8 is connected to the second end of the half-loop radiating element 2.

[0028] A second embodiment of the present invention will now be described with reference to Figs. 4 and 6.

[0029] The antenna device comprises a half-loop radiating element 2, having a first end and a second end, configured for receiving FM frequencies. The antenna device further comprises a capacitor 4 at the first end for fine tuning the half-loop radiating element 2 to FM receiving frequencies and an inductor 5 at the second end to short-circuit the half-loop radiating element 2 for FM receiving frequencies.

[0030] The antenna device is further configured to operate at DVB-H frequencies and at frequencies at least ten times higher than FM frequencies, such as at least one of GPS, Bluetooth, WLAN and WCDMA diversity. Preferably, the antenna device is arranged to operate with FM frequencies, DVB-H frequencies and Bluetooth frequencies, which all provide much desired functions.

[0031] The capacitor 4 is configured to also short circuit the half-loop radiating element 2 to ground for frequencies at least ten times higher than FM frequencies. A capacitance of about 30 pF is appropriate to provide a short circuit for frequencies at least ten times higher than FM frequencies and to simultaneously tune the half-loop radiating element 2 for FM frequencies.

[0032] The inductor 5 is configured to short circuit the half-loop radiating element 2 to ground for FM frequencies. An inductance of about 5 nH is appropriate to provide a short circuit for FM frequencies, at the same time preventing short circuit for frequencies at least ten times higher than FM frequencies. The inductor 5 is further preferably used for tuning of the half-loop radiating element 2 for frequencies at least ten times higher than FM frequencies.

[0033] The filter device 6 is configured to block DVB-H frequencies. The filter device is e.g. made up by a capacitor in parallel with an inductor. A capacitance of about 6 pF and an inductance of about 11 nH is appropriate to provide a block for DVB-H frequencies, at the same time allowing FM frequencies as well as frequencies at least ten times FM frequencies to pass through.

[0034] The antenna device further comprises a filter device 6 at the second end of the half-loop radiating element 2, which filter device 6 is configured to block only DVB-H frequencies. The antenna device also comprises a switching arrangement 7 at the first end, wherein the switching arrangement is configured to switch between FM operation and DVB-H operation.

[0035] In this way a FM receiver 1 switchable to the first end of the half-loop radiating element 2 experiences a short-circuited half-loop antenna device configured for FM frequencies, a DVB-H receiver 8 switchable to the first end of the half-loop radiating element 2 experiences an open-ended half-loop antenna device configured for DVB-H frequencies, and a BT transceiver 3 connected to the second end experiences a short-circuited half-loop antenna device configured for BT frequencies.

[0036] Tuning of the DVB-H receiver 8 is e.g. performed by a tuning device connected thereto, which tuning device has tuning properties corresponding to that of a Peregrine DTC device, modified with a lower cap.

[0037] A portable radio communication device 10 comprising an antenna device as described above comprises a ground plane device below the half-loop radiating element 2 to provide a virtual loop antenna. The ground plane device is e.g. provided as a printed wiring board of the portable radio communication device. The portable radio communication device 10 is further provided with a matching network or matching filter for a FM receiver 1, a matching network or matching filter for e.g. a Bluetooth transceiver 3, and a matching network or matching filter for a DVB-H receiver 8. The matching network or matching filter for the FM receiver 1 is connected to the first end of the half-loop radiating element 2 via the switching arrangement 7. The matching network or matching filter for the Bluetooth transceiver 3 is connected to the second end of the half-loop radiating element 2. The matching network or matching filter for the DVB-H receiver 8 is connected to the first end of the half-loop radiating element 2 via the switching arrangement 7.

[0038] A third embodiment of an antenna device according to the present invention is schematically shown

in Figs. 5 and 6. This third embodiment of the antenna device is identical with the second embodiment of the antenna device described above apart from the following.

[0039] The antenna device is configured to connect the DVB-H receiver 8 to the second end of the half-loop radiating element 2, instead of the first end thereof. The filter device 6 and switching arrangement 7 are therefore also arranged at opposite ends, respectively, of the half-loop antenna device, compared to the second embodiment describe above.

[0040] The antenna device according to any of the embodiments above may further be adapted for also transmitting radio signals for FM frequencies. The portable radio communication device comprises in such a case comprises a FM transmitter switchable to the first end of the half-loop radiating element 2. The matching networks or matching filters for the FM transmitter and FM receiver are preferably a common matching network or matching filter for the FM receiver and the FM transmitter. Since the FM receiver and FM transmitter will not operate simultaneously, a switching arrangement is needed at the first end of the half-loop radiating element, which advantageously in the embodiment of Fig. 4 is a three state switch, since FM and DVB-H will not operate simultaneously in this embodiment.

[0041] It will be obvious that the present invention may be varied in a plurality of ways. Such variations are not to be regarded as departure from the scope of the present invention as defined by the appended claims. All such variations as would be obvious for a person skilled in the art are intended to be included within the scope of the present invention as defined by the appended claims.

Claims

1. An antenna device for a portable radio communication device (10) adapted for receiving and/or transmitting radio signals in at least a first and a second operating frequency band, said antenna device comprising
a half-loop radiating element (2), comprising a first end and a second end, configured for receiving FM frequencies,
characterized in that
said antenna device comprises a capacitor (4) at said first end, an inductor (5) at said second end, and a band stop filter (6) at said first end, and
said half-loop radiating element (2) is configured to also operate at DVB-H frequencies, wherein said band stop filter (6) is arranged to block said DVB-H frequencies to provide an open-ended termination of said half-loop radiating element (2) for DVB-H frequencies and said inductor (5) is arranged to short circuit said half-loop radiating element (2) to ground for FM frequencies.

2. An antenna device for a portable radio communication device (10) adapted for receiving and/or transmitting radio signals in at least a first, a second and a third operating frequency band, said antenna device comprising
a half-loop radiating element (2), comprising a first end and a second end, configured for receiving FM frequencies,
characterized in that
said antenna device comprises a capacitor (4) at said first end, an inductor (5) at said second end, and a band stop filter (6) at said first end or at said second end, and
said half-loop radiating element (2) is configured to also operate at frequencies at least ten times higher than FM frequencies, wherein said capacitor (4) is arranged to short circuit said half-loop radiating element (2) to ground for frequencies at least ten times higher than FM frequencies and said inductor (5) is arranged to short circuit said half-loop radiating element (2) to ground for FM frequencies, and said band stop filter (6) is configured to block DVB-H frequencies to provide an open-ended termination of said half-loop radiating element (2) for said DVB-H frequencies.

3. The antenna device according to claim 2, wherein said frequencies at least ten times higher than FM frequencies comprises one or more of the following frequency bands: GPS, Bluetooth, WLAN and WCDMA diversity.

4. The antenna device according to claim 2 or 3, comprising a switching arrangement at said first end and said filter device is arranged at said second end, wherein said switching arrangement is configured to switch said antenna device between FM operation and DVB-H operation.

5. The antenna device according to claim 2 or 3, comprising a switching arrangement at said second end and said filter device is arranged at said first end, wherein said switching arrangement is configured to switch said antenna device between operation at said frequencies at least ten times higher than FM frequencies and DVB-H operation.

6. The antenna device according to any of claims 1-5, wherein said antenna device is further adapted for transmitting radio signals for FM frequencies.

7. A portable radio communication device, **characterized in that** it comprises an antenna device according to any of the preceding claims arranged over a ground plane device of said portable radio communication device.

8. The portable radio communication device according to claim 7, comprising a FM receiver (1) connected

to said antenna device at said first end and a DVB-H receiver (8) connected to said antenna device at said second end.

9. The portable radio communication device according to claim 7, comprising a FM receiver (1) connected to said antenna device at said first end via a switching arrangement (7) and a DVB-H receiver (8) connected to said antenna device at said first end via said switching arrangement (7).

10. The portable radio communication device according to any of claims 7-9, comprising a receiver (3) for said frequencies at least ten times higher than FM frequencies connected to said antenna device at said second end.

11. The portable radio communication device according to any of claims 7-10, comprising a FM transmitter connected to said antenna device via a switching arrangement (7) at said first end.

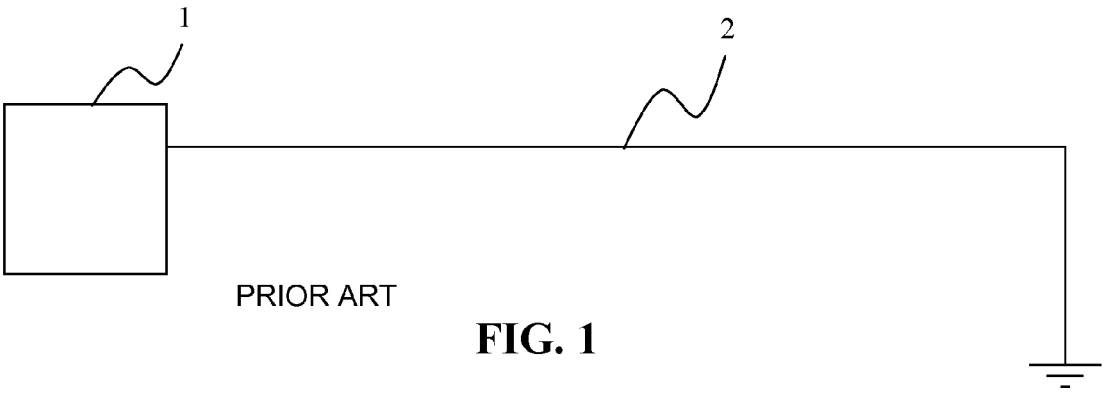

FIG. 1

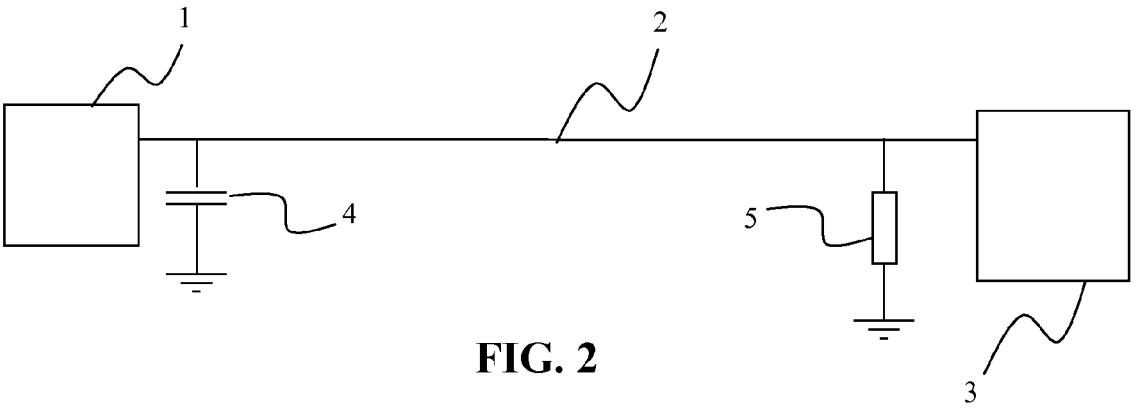

FIG. 2

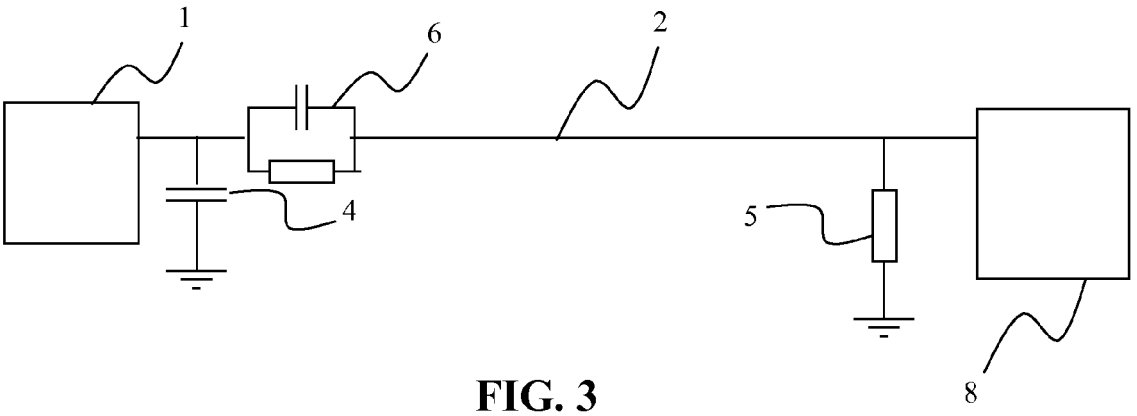

FIG. 3

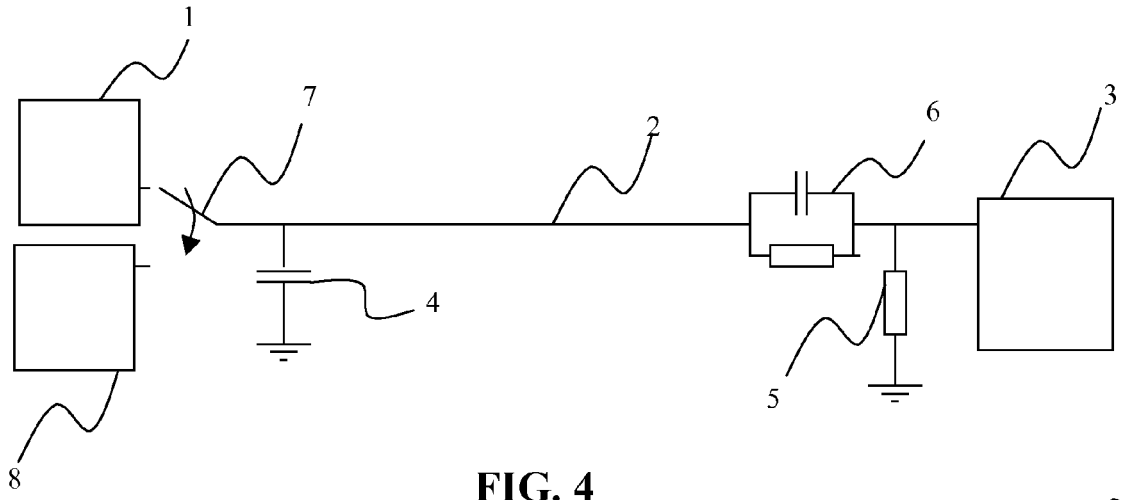

FIG. 4

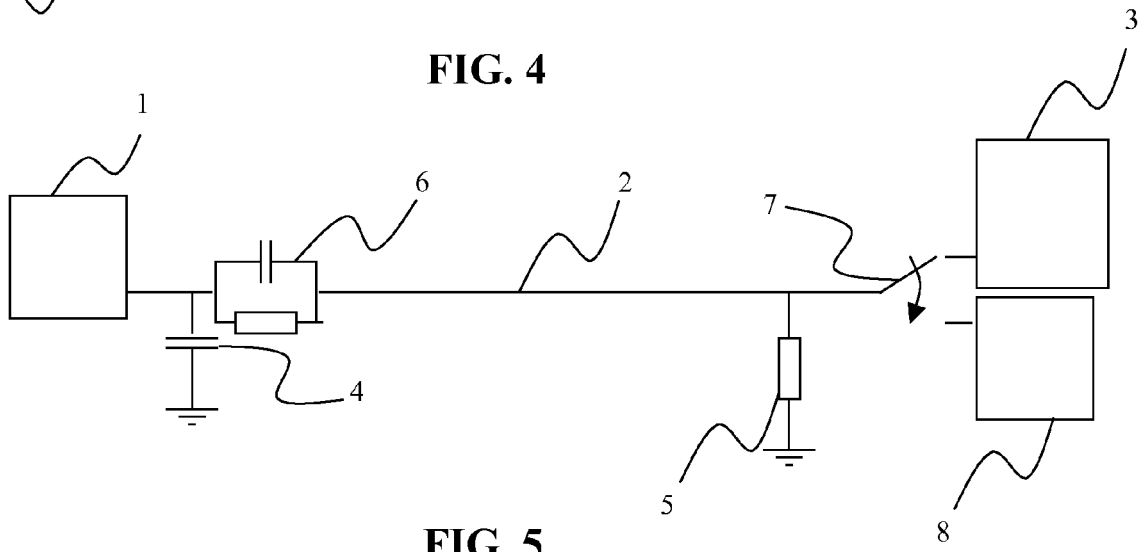

FIG. 5

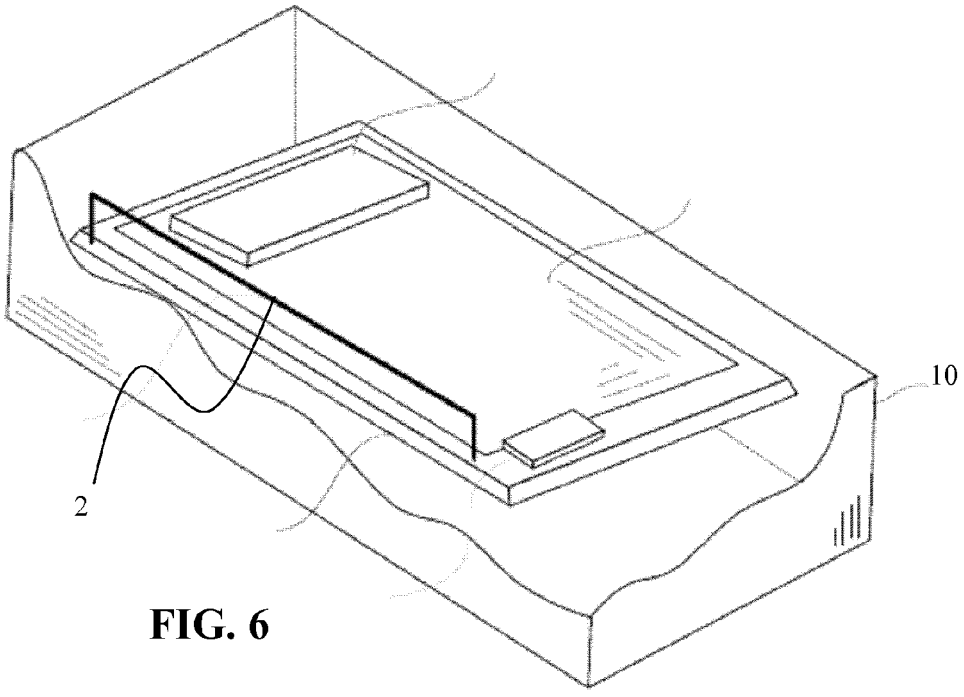

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 08 15 9354

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 December 2008	von Walter, Sven-Uwe

CATEGORY OF CITED DOCUMENTS

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