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(54) **Integrated miniaturized RDS/DAB TMC antenna, communications device and method of integration**

Integrierte Miniatur-RDS/DAB-TMC-Antenne, Kommunikationsvorrichtung und Integrationsverfahren

Antenne RDS/DAB TMC miniaturisée intégrée, dispositif de communication et procédé d'intégration

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to communications and more specifically to a novel and improved antenna for automotive applications. The present invention also relates to a novel and improved communications device for vehicles for providing traffic information.

BACKGROUND OF THE INVENTION

[0002] Latest state of the art communication devices currently may have many different kinds of applications, as Personal Digital Assistants (PDA), as Smart Phones, or as Personal Navigation Devices (PND), especially when adapted to provide a variety of services and able to function using a plurality of technologies and protocols. For automotive applications the visualisation in real time of the current state of the traffic is becoming increasingly popular and necessary. Therefore PNDs with location determination capability are increasingly supplied with traffic information, in order to automatically update the traffic depending on where the vehicle is located.

[0003] Such services may be implemented over the traffic message channel TMC of the FM Radio Data System FM RDS, over the Digital Audio Broadcasting DAB standard or over a system resulting from the combination of both systems. When using this protocol, the traffic information frames are transported through electromagnetic waves at FM/VHF/DAB frequency and received by an antenna connected to a TMC chipset able to process the signals. Due to the wavelength of these FM/VHF/DAB radio waves, antennas which may be used for this traffic information system are quite large, bulky and inconvenient.

[0004] The current commercialised solutions are based on a wire antenna, ranging in length from 75mm to 150mm, including suction-cups for fixation on the windscreen or on the dashboard, and sometimes with the TMC chipset at one extremity. The wire antenna offers good performances of reception as its characteristics resemble closely those of a monopole.

[0005] However wire antennas are inherently not robust and stable devices. Even the ones which are placed in the interior of a vehicle are impractically long and, since they are fixed to the vehicle, reduce the mobility of the PND device they are attached to.

[0006] Publication WO-A-2006/061218 refers to the integration of antennas within vehicle components with the objective of solving problems related to aesthetics and aerodynamics.

[0007] DE 20 2007 010 033 U1 and DE 10 2004 051 286 A1 refer to systems known from the prior art, having TMC antennas mounted in the support of a PND. The connection of the wire antenna to an existing PND has certain inconveniences, such as, it has to be attached manually by the end-user (that is, by the car driver mainly), it occupies part of the visibility of the driver with the consequent increase in the risk of accidents due to lack of visibility, and it may vibrate when driving resulting in a less comfortable driving experience. Additionally, the installation of an external antenna by a non-trained driver results in reduction in antenna performance, either due to non-optimal positioning of the antenna in relation to the communication device or other electronic components or a faulty connection. The need of disconnecting the wire antenna from the PND each time the PND is stored, when leaving the car, to prevent robbery or the intention to steal the PND, adds to the general inconvenience of such a device.

SUMMARY OF THE INVENTION

[0008] It is therefore an object of the present invention to provide a solution to the above mentioned problems. The invention is defined by the independent claims. Optional features are set out in the dependent claims. The invention provides a method, apparatus and system elements that implement various aspects, embodiments, and features of the invention, as described in the following.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The features and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings, in which like reference characters identify correspondingly throughout.

Figure 1	depicts a miniature antenna according to the present invention.
Figure 2	shows examples of different fractal antenna patterns.
Figure 3	shows two different representations of a communications device not according to the present invention wherein the antenna is integrated in a back housing cover.
Figure 4	shows the antenna integrated in a cradle a according to the present invention.
Figure 5	shows the antenna integrated in a holder according to the present invention.
Figure 6	is a graphic representation of the interfering signals due to an inadequate integration.
Figure 7	is a graphic representation of a Smith Diagram for antennas with and without a matching network.
Figure 8	is a graphic representation of the power transfer between an antenna and a TMC receiver.
Figure 9	represents a LC lumped element configuration for optimum signal transfer according to the present invention.
Figure 10	depicts another miniature antenna accord-

ing to the present invention based on the Koch pattern.

Figure 11 depicts another miniature antenna according to the present invention based on Meander pattern.

DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

[0010] The Radio Data System (RDS) is a standard which enables information transmission via broadcast channels, and more specifically, using existing frequencies in the FM/VHF/DAB band. Since its inception, it has proved to be a very effective means of broadcasting data to vehicles, as most vehicles are equipped with standard radio receivers. The original data application was the transmission of the name of the radio channel being heard, as well as other information, such as the title or the author's name of the track being heard. Data transmission via FM RDS is performed using 57 kHz subcarriers to carry data at rates just over 1.1 kbit/s.

[0011] The analogue radio transmissions are currently being increasingly migrated to the digital standard. The Digital Audio Broadcasting DAB protocol will be the standard protocol for radio communications, as it offers a wide range of advantageous features, such as higher reuse factors, higher efficiency and lower interference, due to its use of Orthogonal Frequency Division Multiplexing OFDM, audio compression based on the MPEG standard, among others, thereby achieving data rates of approximately 192 kbit/s. Further advantages of the DAB system of audio broadcasting is its compatibility with information service providing technologies due to its digital format. As an advantageous example the application for the provision of traffic information to the mobile vehicle user could be implemented via DAB obtaining information from the Internet, either from a single page or a plurality of information providers. This option could be based on the availability of information depending on the geographical location of the user. This provision of information can also be implemented using the Traffic Message Channel TMC.

[0012] It is to be understood that the advantageous features of the preferred embodiments of the present invention are equally applicable to all variants of this technology, be it analogue, or digital, according to the DAB standard or analogue FM, within VHF band allocated for FM broadcasting or in other areas of the VHF band, using the RDS service or the DAB broadcasting service.

[0013] Personal navigation devices (PND) have also lately populated the vehicular and non-vehicular markets. Location based services, either for the mobile or fixed user, either pedestrian or motorised, are being developed rapidly and provide solutions encompassing a wide variety of factors and parameters as inputs. For the case of vehicles, a very useful application would be the provision of the latest traffic information to the user, especially when this information may be made dependent on the current location of the portable device.

[0014] In order to receive up to date traffic information for vehicles, traffic information providers use a number of existing solutions. One prior art solution for transmitting traffic information is using the GSM system for mobile communications. However, GSM-based services are expensive and complex to operate, incurring excessive service charges to the end-user by the mobile service operators. Additionally country-wide coverage is not guaranteed as GSM base stations are normally not completely deployed throughout the full road network where commercial vehicles transit. These disadvantages are solved by the provision of the traffic information over a Traffic Message Channel (TMC), which may be transmitted using the FM RDS system or the digital radio DAB system. The RDS/DAB TMC protocol has as an advantage that the use of the FM/VHF/DAB band of frequencies is not subject to paid licenses, and thereby provides a free service. Additionally country wide coverage has been achieved already by radio broadcasting stations, thereby reaching most transit roads. The common element in these systems is the transmission of the traffic information via signals in the FM/VHF/DAB band 30MHz to 300 MHz, and more specifically, most applications focus on using the FM band of frequencies, which for Europe lies in the range of 87.5 MHz to 108 MHz, or in the band of frequencies corresponding to the Digital Audio Broadcasting DAB standard.

[0015] In the RDS/DAB TMC system, traffic information is typically collected from police databases, cameras, or traffic reporting pools. Such data collection can be performed manually by people, such as policemen or emergency service personnel, which after witnessing incidents report them to a central location. Data collection may also be performed automatically, by continuously processing vehicle speeds, radar output data and the like, in order to extract information representing the traffic load at particular sections of a road network. Once collected, traffic data is coded into a format to be transmitted as a message. This traffic message may include, among others, an event code, a time code and a location code. However other systems and implementations exist which also aim at providing traffic information.

[0016] Typical TMC receivers designed in commercially available TMC chipsets aim at processing the received signals rapidly in order to provide the fastest response to urgent traffic problems, such as accidents, or on-road dangers. VHF/DAB band signal reception is maximised by typically comprising interference reduction, multipath compensation, redundant reception, diversity reception algorithms, or other signal quality enhancement algorithms commonly known to the skilled person in the art.

[0017] TMC messages may be transmitted in real-time or periodically. The real-time transmission assures the fastest traffic state updating, whereas periodic transmission assures a constant monitoring of the situation. Traffic messages comprise not only those informing of an incident, but equally importantly those informing of the cancellation of incidents, in order to render the most accurate picture possible.

[0018] Typically TMC transmissions are performed in an RDS/DAB sub-carrier, and transmitted at lower power than their counterpart audio transmissions. Therefore TMC receivers are designed to receive and decode the current traffic information even in rural regions with low signal strength reception due to low coverage. Many commercially available chipsets contain active components which amplify the weak signals received for further processing.

[0019] The advantages of receiving on-road latest traffic information, both for the benefit of the individual user as for the increase in road security for the general public, is normally enhanced by linking the specific information transmitted with the current location of the vehicle in question. Hence TMC messages typically contain a location code linked with the traffic information being broadcast, allowing receivers to filter out the relevant information depending on the current location of the receiver itself. Therefore communication devices for receiving traffic information are increasingly merged with location determination capability, providing for multifunctional devices, such as personal navigation devices, smart phones, portables personal digital assistants, fixed vehicle navigation modules, or the like.

[0020] Location determination protocols may be GSM-based, giving a rough approximation to the location of the device using algorithms such as triangulation. However the most exact location determination system is provided by satellite based systems. One such system is the Global Positioning System GPS, readily made for use for the general public, with world-wide coverage and free of charge. Other systems such as GLONASS, IRNSS or COMPASS also exist for different geographical regions in the world. In the case of Europe the satellite-based system being developed is the GALILEO satellite system.

[0021] A GPS receiver requires a highly stable clock and an antenna capable of receiving signals from a plurality of GPS satellites at frequencies ranging from 1176.45 MHz to 1575.42 MHz. Theoretically only 3 or 4 satellites are necessary for pinpointing the exact location of the receiver, but current satellite receivers typically track more than 20.

[0022] Prior art solutions have attempted to provide traffic information to mobile or fixed vehicles by fixing well known FM antennas to portable communication devices. Such well known antennas, known as wire antennas, are composed of a single long wire connected to the devices. For communications in the VHF/DAB band, these wires tend to range between 75 cm to 150 cm, which relative to the average size of portable devices, can be considered as long accessories. Due to this higher than average length they must be fixed to the vehicle via, for example, suction cups, and are prone to being caught somehow, torn down and pulled forcefully out of the device's connector.

[0023] Especially relevant to the end user, these long wires reduce the mobility of the portable device, as it is not a direct and swift task to carry the portable device with the metre long wire attached to it, in case updated traffic information is desired outside the vehicle. Additionally, long wires connected to state of the art navigation devices are not user-friendly, thereby reducing the commercialisation of such products, and preventing the proliferation of location based traffic information devices. The broadcasting of latest traffic information via FM RDS/DAB TMC service has as a principle objective the prevention of accidents and securing of road traffic. Therefore the use of long wires has a direct negative consequence in fulfilling this objective.

[0024] Additionally wire antennas are normally attached to the exterior of the vehicle, and as such are not robust and stable devices. Even the ones which may be used in the interior are impractically long and, since they are fixed to the vehicle, reduce the mobility of the communication device they are attached to.

[0025] Even the connection of the wire antenna to an existing communication device has certain inconveniences, such as, it has to be attached manually by the end-user (that is, by the car driver mainly), it occupies part of the visibility of the driver with the consequent increase in the risk of accidents due to lack of visibility, and it may vibrate when driving resulting in a less comfortable driving experience. The need of disconnecting the wire antenna from the communication device each time the device is stored, when leaving the car, to prevent robbery or the intention to steal the device, add to the general inconvenience of such a device.

[0026] Therefore it is proposed to solve the above mentioned inconveniences, disadvantages, and problems via the integration of the antenna with the communication device in a preferred embodiment of the invention. Such integration would enable a communications device to receive RDS/DAB TMC signals without the inconveniences of the prior art devices. In another embodiment a location determination module comprising at least an antenna is also integrated, in order to provide a self-contained location based traffic information service device. Such device could be a personal navigation device with integrated traffic information processing capabilities. In yet another embodiment the antenna may be integrated directly within the portable device, in a single housing, or may be integrated into a vehicular accessory of the portable device. In either case the TMC electronic sub-system for receiving and processing traffic information from the antenna may also be integrated within the same housing as the antenna, or may be located separately. The communications device is portable, for example, as part of an on-board navigation system, or as part of an vehicle accessory, or communications device accessory. Independently from the specific embodiments and implementation details, the integrated antenna solves the disadvantages of the prior art antennas as well as providing improved communication capabilities necessary for receiving traffic information in a communication device.

[0027] FIG. 1 illustrates a miniature antenna 100 object of the present invention. This miniature antenna may be integrated, for example, into a communications device. However it will be readily apparent to the skilled person in the art that following the teachings of the present invention, it may also be integrated into other devices, portable or not. Due to the advantageous characteristics of the miniature antenna, it is specially suited for devices which require portability. In fact the integration of such antenna within a normally fixed communication device may render it advantageously a mobile device due to the integration.

[0028] Antenna 100 is a fractal antenna in the form of a circuit board 101, with a printed pattern 102, the antenna 100 being embedded inside a support. The support may either be a fixed support or it may be a mobile support, such as within a portable device. Due to the pattern 102 fixing process, there is no constraint that the board be flat. The circuit board 102 may have many different shapes and forms, be flat or curved, spherical or conical, as long as it can contain the copper serigraphy which will form the antenna pattern. The high adaptability of the pattern design allows for the integration of the miniature antenna 100 into a wide variety of supports. As in most antennas, antenna 100 comprises a feeding point 103. No matter the shape or form of the antenna, its fractal pattern is designed in order to enable it to receive RDS/DAB TMC waves in the VHF band, therefore providing the consequent advantages over the prior art. Examples of different fractal antenna patterns 102 can be seen in FIG. 2, FIG. 10 and FIG. 11.

[0029] Fractal antennas are characterised by their self-similar repetitive designs, enabling to maximise their length, or increase their perimeter, to cover inside sections or outside structures, of the supporting material which can receive or transmit electromagnetic signals. The self-similar repetitive design is obtained via a multi-scalar repetition of a pattern, or motif, and results in the advantageous characteristics described, among which are its ability to operate simultaneously at a plurality of frequency bands, and frequency ranges, as well as providing the possibility of integration.

[0030] It is to be understood that the advantageous features of the preferred embodiments of the present invention are equally applicable to other types of antennas, be it fractal or otherwise, such PIFA, IFA, monopole, dipole, coupled monopole, or loop antennas.

[0031] Due to the specific frequency band of operation necessary in order to receive RDS/DAB TMC signals, the inconvenience of the long wire antennas of the prior art are solved by providing an antenna with a highly compact fractal pattern. This characteristic enables the fractal antenna to be implemented in an exceptionally small surface area, resulting in miniature VHF antennas adapted to receive RDS/DAB TMC radio signals.

[0032] The fractal pattern may be printed on a standard copper printed circuit board. An example of such a board would be the thin FR4 PCB (example dimensions: 35μm Cu, 0.2mm thick) as well as other supports which offer a good compromise between ease of assembling, flexibility, cost and dielectric properties. As supports for the copper either blended plastic films, cartons or flex-film may be used. Other materials which offer the advantageous feature during integration of flexibility are ceramic-based materials. The antenna may be integrated into the device by attaching it via clips or heatstaking it to the device.

[0033] Referring to FIG. 2, one example of how the antenna may be designed is following the Hilbert geometry of space-filling miniature antennas as it offers a very high degree of miniaturisation. Consequently, it also offers good integration characteristics inside the device. The Hilbert geometry allows for a variety of designs for the antenna pattern 102. As can be seen in FIG. 2a, FIG. 2b, FIG. 2c and FIG. 2d, the fractal patterns 201, 202, 203, 204 may vary in complexity, degree in which the space of the antenna is filled and therefore effective length.

[0034] However other fractal antenna geometries exist which offer the advantages of high degree of miniaturisation. Referring to FIG. 10, is another example antenna 1000 of how the antenna 100 may be designed by using the Koch geometry 1002. Referring to FIG. 11, is another example antenna 1100 of how the antenna 100 may be designed by using the Meander geometry 1102.

[0035] The various patterns 201, 202, 203, 204, 1002, 1102 are carefully designed in order to provide a good compromise between antenna performance and degree of integration. The correct choice while designing the geometry of the antenna will depend on a number of factors, as well as finally affect the performance of a number of parameters of the antenna 100. Among these factors and parameters are antenna size, its relative gain, electromagnetic radiation patterns, the impedance characteristics, degree of flatness or curvature, frequency range of operation, antenna efficiency, specific absorption rate and polarization.

[0036] FIG. 3a and FIG. 3b depict the portable device 300 object not according to the present invention, and how the miniature antenna 100 may be integrated therein. As can be seen in FIG. 3a, the antenna 100 may be either integrated on the exterior of the back cover 301 of the portable device or it may be integrated between the back cover 301 and the front cover 303, inside the portable device. When integrated inside the back cover as in FIG. 3b, a pad 304 is attached to the feeding point 103 as an electrical connector. In this configuration the shape of the board 101 is chosen to fit in with the rest of the components of the portable device.

[0037] The advantages of integrating the miniature antenna within the same housing as the remaining components are readily apparent, as the fractal pattern 102 may be also designed to optimise its fit in relation to the remaining components, following the constraints of the printed circuit board size, area and forms. When integrated within the housing the antenna pattern 102 is designed to be located substantially along the outer perimeter of the communications device or of the antenna's PCB, in order to maximise its irradiating characteristics and minimise the interference and electromagnetic coupling of other electronic modules. The antenna may also be designed to be integrated either in parallel to the PCB or perpendicular to it. Either way the advantages of flexibility while designing the fractal pattern exist in order to achieve the advantages of highest integration and lowest interference reception.

[0038] The fact that the board my require holes for fixation, gaps to allow the introduction of other components does not prevent the antenna's integration, as it would be a matter of designing the correct fractal pattern for each specific fit, taking into account not only the physical constraints as mentioned, but also the electrical and electromagnetic requirements of the miniature antenna, in particular referring to RDS/DAB TMC antennas operating in the VHF band. Therefore antenna 100 has at least one feeding point, however optionally the antenna 100 could have more than one feeding point, or more than one grounding points connected to the main PCB of the communications device.

[0039] FIG. 4 depicts the integration of the miniature antenna within the cradle 401 of the portable device. Such a cradle is typically used in vehicles, and serves to host the device, be it either a personal navigation device or any other communication device. The cradle comprises a connector 402 as an electrical connection point with the portable device and a suction mount 403. The cradle may host the integrated antenna alone, or optionally, also the TMC receiver chipset.

[0040] The portable device is not enabled to receive traffic information when not connected to the cradle unless an additional wireless communication module were also integrated within the cradle. This integration would also conform to the objective of the present invention, as the wireless antenna for communication would also be designed as a miniature antenna 100, and could also be hosted within the cradle, together with the corresponding wireless transceiver and processing elements. As an example, it is common to find Bluetooth modules within almost every commercially available portable device. Hence the integration process for receiving traffic information, when hosted by an element not part of the device itself, could include apart from a TMC module also a Bluetooth module. This integration would include two miniature antennas, one for TMC and the other for Bluetooth, with the corresponding transceivers and processing elements coupled either within the same housing, or separately.

[0041] In FIG. 5 the antenna 100 is integrated within the holder 500 of the portable device. The advantages of this embodiment are readily apparent, as the antenna is integrated into an otherwise unused space, therefore saving on space within the portable device 300 itself. Similar to the embodiment of FIG. 4, when the TMC module is integrated within such separate elements from the portable device, many different applications exist when integrated in addition with a wireless communication module.

[0042] In one example the wireless communication module could conform to the Bluetooth standard. As an example, this TMC/Bluetooth module would enable a portable device within the area of the whole vehicle to receive the latest traffic information, and even in a radius around the vehicle. In one embodiment different, for very large vehicles, such as trains or lorries, the latest traffic information could even be received and displayed in areas far away from the vehicle's cockpit, or sitting area. In another embodiment, even within the sitting area, for example of a bus, there could be several seat displays, in order to inform the passengers of the latest traffic conditions, for example, in the case of an accident.

[0043] In an embodiment where the portable device includes also a location determination module for navigation purposes, this would enable the device to be used even outside the vehicle in order to update the route according to the current location and the latest traffic information.

[0044] Traffic information sharing is also possible, as this combined traffic/communication module broadcasts the latest traffic information to all neighbouring moving, or stationary, vehicles. This enables the neighbouring vehicles having portable navigation devices without traffic information receiving capabilities to receive such information via a wireless communications module, such as a Bluetooth module, and therefore update their routes via a recalculation process. This kind of application could require these neighbouring vehicles to enable an option in their portable navigation devices to receive broadcast traffic information sent via a wireless communication protocol, as an example, Bluetooth or WLAN.

[0045] The antenna pattern 102 is directly printed onto the printed circuit board 101 of a communication device 300. In situations where the amount of space to integrate the antenna is highly limited, and not even a miniature antenna according to an aspect of the present invention may be fit into the available space, the RDS/DAB TMC antenna pattern 102 printed directly onto a pre-existent board 101 would provide such communication device with traffic information receiving capabilities. As an example of such scenario, latest generation media players, which play, as an example, MP3 music tracks, are being designed in very small dimensions, and in order to display the details of the track being heard, contain also a small display panel. Such small devices may be integrated with the RDS/DAB TMC antenna of the present invention, however, due to the close proximity of the device's ground plane to the antenna, careful attention has to be paid during the integration process in order to minimise capacitative effects, electromagnetic coupling, or other types of interference due to the antenna fractal pattern being printed or etched on the same board as the portable device's main board.

[0046] These integration problems are not limited to the embodiment as just described. Decrease in the antenna and/or receiver's performance, due to undesired capacitative effects, electromagnetic coupling, or interference from other electronic components, are issues that have to be dealt with while producing the miniature RDS/DAB TMC antenna object of the present invention and in the process of integrating the miniature antenna into communication devices resulting in the communication devices object of the present invention.

[0047] The extremely small dimensions in which the FM/VHF/DAB band antenna is implemented increases the design and manufacturing constraints to be fulfilled in order to provide a well performing product which solves the problems of the antennas of the prior art. Such a design process, either for producing the miniature antenna itself, or the portable device object of the present invention, is a complex iterative process requiring not only careful conceptual design, but also extended Electromagnetic Compatibility simulations. As a general guideline, in order to maximise the correct performance of the antenna 100 and the communication device 300, at least one or more of the following conditions have to be fulfilled, either alone or in combination:

- The antenna's feeding point 103 should be placed as far away as possible from the device's battery. A minimum of approximately 18mm to 22mm is recommended.
- The antenna's feeding point 103 should be placed as close as possible to the TMC chipset input RF receiver. The copper track between them should not exceed approximately 33mm to 37mm.
- In the embodiment where an additional module exists, for example, a location determination module with a GPS antenna, the miniature RDS/DAB TMC antenna's feeding point 103 should be placed as far away as possible from the GPS antenna's groundplane. A minimum of approximately 28 to 32mm is recommended.
- Any device shielding components should be placed no more than 1.5mm from the antenna.
- Due to the limited size available, maximising this usable surface area for antenna integration is an important factor taken into account in this process. Fractal antennas due to the flexibility in layout they offer are particularly suited for this purpose. The layout of the antenna also plays a role. The highest integration is achieved with an antenna integrated in parallel to the ground plane of the device. However if the antenna is placed perpendicular to the PCB, it is subjected to less interference from other neighbouring electronic modules, such as the location determination navigations module. Therefore it also conforms to the iterative integration process to find the optimum placement for maximising integration and minimising the effect of interference on the antenna.

[0048] The optimisation of these general parameters is a complex iterative procedure, for which an electromagnetic compatibility EMC simulation is necessary. The non-desirable signals, such as noisy and spurious transmission within the FM/VHF/DAB band, emitted by all the electronic components installed inside the portable device degrade the antenna's performance as such, as well as the overall system's functionality.

[0049] The resulting miniature antenna may have dimensions ranging as low as 68mm x 68mm in its largest surface area. As can be realised, when compared to prior art RDS/DAB TMC antennas, the antenna 100 is very compact. It is also completely passive, in the sense that there are no additional active systems to improve the overall performance by, as an example, amplifying the signal or filtering it.

[0050] Optionally it is possible to include a matching network as another passive element without affecting the antenna's performance. The impedance matching network, which may be implemented as an LC circuit, to be placed between the antenna feeding point 103 and the TMC chipset receiver, has the function of preventing any further losses in the interface between these two components due to variations in impedances, resulting in a maximum signal transfer from the antenna 100 to the receiver.

[0051] FIG. 6 is a graphic representation of the problem being confronted with, and the improvement obtained, via the iterative process described. The top line 601 depicts the level of interference measured for the case of a conventional FM antenna directly integrated within a portable device. The bottom line 602 depicts the level of the interfering signals of an integrated miniature antenna conforming to EMC restrictions for adequate performance.

[0052] For such an improvement over prior art solutions to be possible, the antenna itself should have as much as possible an isotropic behaviour in reception. This omni-directional characteristic is obtained by an iterative optimisation process to find the global best performance provided by the following parameters:

- the fractal pattern 102 design;
- the position of the antenna 100 with respect to the device's ground plane and other components. This positioning is critical when other modules, such as location determination modules, such as according to standard GPS satellite location determination protocols, or wireless communication modules, such as Bluetooth, GSM, or WLAN, as well as a number of shielding components are included within the same housing;
- the design and parameter choice for the impedance matching network.

[0053] FIG. 7a depicts a Smith Diagram of an antenna without a matching network and FIG. 7b depicts an antenna with a matching network attached. It is clear from the comparison of these two charts how the antenna impedance when better matched to the TMC chipset input impedance results in a minimum loss of signal strength between the two components. Such advantage is again readily apparent from the signal transfer graphical representation of FIG. 8, where the top curve 801 represents the signal strength with a matching network and the bottom curve 802 represents the signal strength without a matching network. As can be seen curve 802 depicts heavy losses when compared to curve 801, especially in the lower regions of the spectrum.

[0054] An example of a matching network may be an LC lumped circuit as depicted in FIG. 9. This circuit is composed of a set of capacitors 902, 903 and 905 connected partially in series and partially in parallel, and further connected to an inductor 906. Connectors 901 and 904 serve as connection points to the antenna's feeding point 103 on one hand and to the input of the TMC receiver on the other.

[0055] It is to be understood that the advantageous features of the preferred embodiments of the present invention are equally applicable to all variants of the radio broadcasting technology, be it analogue, or digital, according to the DAB standard or analogue FM, within VHF band allocated for FM broadcasting or in other areas of the VHF band. The common element is the broad range of frequencies commonly known as the FM/VHF/DAB band, normally comprising frequency modulated FM signals, which define a specific wavelength, and therefore antenna dimensions and characteristics, object of the present invention.

[0056] When the iterative integration and optimisation process is performed correctly, the improvement in antenna performance allows it to receive a wide range of signal strengths, from weak to strong signals. In scenarios where the electromagnetic field is very weak, such as when the portable device finds itself in a region of low coverage, or is situated in a geographical area very far from the emitter, or if certain obstacles block the correct reception of radio waves, the antenna object of the present invention has proven to be able to achieve still 80% to 90% of the performance level of a conventional 75cm long wire antenna. Considering the relative miniaturisation combined with the complex integration into the portable device, this translates to an even considerably larger overall improvement.

[0057] It is to be understood to the skilled person in the art that the disclosure of the various embodiments of the invention is intended as non-limitative preferred examples and realisations of the inventions, and therefore features of different embodiments may be readily combined within the scope of the general inventive concept described.

[0058] The various logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented of performed with a general purpose processor, a digital signal processor (DSP), and application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine.

[0059] The methods or algorithms described may be embodied directly in hardware, in a software module executed by a processor, or a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art.

[0060] Those skilled in the art should appreciate that the foregoing discussion of one or more embodiments does not limit the present invention, nor do the accompanying figures. Rather, the present invention is limited only by the following claims.

Claims

1. A portable communications device (300) for vehicles, the device (300) adapted to receive traffic information, via a traffic information service broadcasting in the VHF/DAB band, and adapted to provide traffic information services by transmitting the received traffic information to other communication devices not able to receive traffic information in the VHF/DAB band, comprising:

   a support (401, 500) for mounting the portable communications device (300) inside the vehicle;
   a traffic information module comprising at least one traffic information antenna (100, 1000, 1100) in the VHF/DAB band with a self-similar repetitive pattern (102) printed on a printed circuit board (101), and a signal receiver for traffic information reception;
   a wireless communication module comprising at least one wireless antenna (100, 1000, 1100) with a self-similar repetitive pattern (102) printed on a printed circuit board (101), and a signal transceiver and processor configured to transmit the received traffic information;
   wherein the at least one traffic information and wireless antenna (100, 100, 1100) are integrated within said support (401, 500) of the device (300).

2. The communications device of claim 1, wherein the VHF/DAB band of frequencies comprises analogue frequency modulated FM band as well as the digital audio broadcasting DAB band.

3. The communications device of any of the preceding claims further comprising at least one antenna for

location determination and a processor for location determination, wherein at least the location determination antenna is also integrated within the device (300).

4. The communications device of claim 1, wherein the support (401, 500) is a cradle (401), or a holder (500) for attaching the cradle (401) to the vehicle.

5. The communications device of any of the preceding claims, wherein the at least one antenna (100, 1000, 1100) has the self-similar repetitive pattern (102) following the Hilbert geometry, Koch geometry (1002), or Meander geometry (1102), or a combination of any geometry conforming to its integration, such as a combination with a PIFA antenna, or IFA antenna, or monopole antenna, or dipole antenna, or coupled monopole antenna, or a loop antenna.

6. The communications device of any of the preceding claims wherein the at least one antenna (100, 1000, 1100) has the self-similar repetitive pattern (102) located substantially along the outer perimeter of the communication device (300).

7. The communications device of any of the preceding claims, wherein the at least one antenna (100, 1000, 1100) is connectable directly to the signal receiver, or via a matched network.

8. The communications device of claim 7, wherein the matched network is an LC lumped circuit.

9. The communications device of any of the preceding claims, wherein the traffic information is broadcast through the Radio Data System, RDS, or via the Digital Audio Broadcasting DAB system, or a combination of both, using the Traffic Message Channel, TMC, or another channel adapted for traffic information transmission.

10. A method of integrating an antenna (100, 1000, 1100) system into a portable communications device (300) for vehicles, the method comprising the steps of:

providing a support (401, 500) for mounting the portable communications device (300) inside the vehicle;
forming at least one VHF/DAB antenna (100, 1000, 1100) as a printed circuit board (101) with at least one self-similar repetitive pattern (102);
providing a traffic information module comprising the at least one VHF/DAB antenna (100, 1000, 1100) and a signal receiver for traffic information reception;
forming at least one wireless antenna (100, 1000, 1100) as a printed circuit board (101) with at least one self-similar repetitive pattern (102);
providing a wireless communication module comprising the at least one wireless antenna (100, 1000, 1100) and a signal transceiver and processor configured to transmit the received traffic information;
integrating the at least one VHF/DAB and wireless antenna (100, 1000, 1100) within said support (401, 500) of the communications device (300).

11. The method of claim 10, wherein the VHF/DAB band of frequencies comprises analogue frequency modulated FM band as well as the digital audio broadcasting DAB band.

Patentansprüche

1. Eine tragbare Kommunikationsvorrichtung (300) für Fahrzeuge, wobei die Vorrichtung (300) dazu geeignet ist, Verkehrsinformation zu empfangen, durch einen Verkehrsinformationsservicerundfunk in dem VHF/DAB-Band, und dazu geeignet ist, Verkehrsinformationsservice durch Übertragen der empfangenen Verkehrsinformation zu anderen Kommunikationsvorrichtungen bereitzustellen, welche keine Verkehrsinformation in dem VHF/DAB-Band empfangen können, umfassend:

eine Unterstützung (401, 500) zum Befestigen der tragbaren Kommunikationsvorrichtung (300) innerhalb des Fahrzeugs;
ein Verkehrsinformationsmodul umfassend zumindest eine Verkehrsinformationsantenne (100, 1000, 1100) in dem VHF-/DAB-Band mit einem selbstähnlichen wiederkehrenden Muster (102), welches auf einer Leiterplatine (101) gedruckt ist, und einen Signalempfänger für den Empfang von Verkehrsinformation;
ein drahtloses Kommunikationsmodul umfassend zumindest eine drahtlose Antenne (100, 1000, 1100) mit einem selbstähnlichen wiederkehrenden Muster (102), welches auf eine Leiterplatine (101) gedruckt ist, und einen Signalsender-Empfänger und Prozessor dazu eingerichtet, um die empfangen Verkehrsinformation zu übertragen;
wobei die zumindest eine Verkehrsinformations- und drahtlose Antenne (100, 100, 1100) innerhalb der Unterstützung (401, 500) der Vorrichtung (300) integriert sind.

2. Die Kommunikationsvorrichtung nach Anspruch 1, wobei das VHF/DAB-Band von Frequenzen das analoge Frequenzmodulation, FM, -Band sowie das digitale Autorundfunk-DAB-Band umfasst.

3. Die Kommunikationsvorrichtung nach einem der vorhergehenden Ansprüche, weiter umfassend zumindest eine Antenne für Standortbestimmung und einen Prozessor für Standortbestimmung, wobei zumindest die Standortbestimmungsantenne auch innerhalb der Vorrichtung (300) integriert ist.

4. Die Kommunikationsvorrichtung nach Anspruch 1, wobei die Unterstützung (401, 500) eine Bündeltasche (401) oder eine Halterung (500) zum Befestigen der Bündeltasche (401) an das Fahrzeug ist.

5. Die Kommunikationsvorrichtung nach einem der vorhergehenden Ansprüche, wobei die zumindest eine Antenne (100, 1000, 1100) das selbstähnliche wiederkehrende Muster (102) hat, welches der Hilbert-Geometrie, Koch-Geometrie (1002) oder Mäandergeometrie (1102) oder eine Kombination jeglicher Geometrie, welche zu seiner Integration entspricht, besitzt, wie etwa eine Kombination mit einer PIFA-Antenne oder IFA-Antenne oder Monopolantenne oder Dipolantenne oder gekoppelte Monopolantenne oder eine Rahmenantenne.

6. Die Kommunikationsvorrichtung nach einem der vorhergehenden Ansprüche, wobei die zumindest eine Antenne (100, 1000, 1100) das selbstähnliche wiederkehrende Muster (102) hat, welches sich im Wesentlichen entlang des äußeren Umrisses der Kommunikationsvorrichtung (300) befindet.

7. Die Kommunikationsvorrichtung nach einem der vorhergehenden Ansprüche, wobei die zumindest eine Antenne (100, 1000, 1100) direkt verbindbar zu dem Signalempfänger ist oder durch ein abgestimmtes Netzwerk.

8. Die Kommunikationsvorrichtung nach Anspruch 7, wobei das abgestimmte Netzwerk ein LC-lumped-Schaltkreis (LC lumped circuit) ist.

9. Die Kommunikationsvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Verkehrsinformation durch das Radiodatensystem, RDS, oder durch das digitale Audio Broadcasting, DAB, System oder eine Kombination von beidem gesendet wird durch Verwenden des Verkehrsnachrichtenkanals, TMC, oder einem Kanal, welcher dazu geeignet ist, für die Übertragung von Verkehrsinformation.

10. Ein Verfahren zum Integrieren eines Antennensystems (100, 1000, 1100) in einer tragbaren Kommunikationsvorrichtung (300) für Fahrzeuge, wobei das Verfahren folgende Schritte umfasst:

Bereitstellen einer Unterstützung (401, 500) zum Befestigen der tragbaren Kommunikationsvorrichtung (300) innerhalb des Fahrzeugs;
Formen von zumindest einer VHF/DAB-Antenne (100, 1000, 1100) als eine Leiterplatine (101) mit zumindest einem selbstähnlichen wiederkehrenden Muster (102);
Bereitstellen eines Verkehrsinformationsmoduls umfassend die zumindest eine VHF/DAB-Antenne (100, 1000, 1100) und einen Signalempfänger für den Empfang von Verkehrsinformation;
Formen von zumindest einer drahtlosen Antenne (100, 1000, 1100) als eine Leiterplatine (101) mit zumindest einem selbstähnlichen wiederkehrenden Muster (102);
Bereitstellen eines drahtlosen Kommunikationsmoduls umfassend die zumindest eine drahtlose Antenne (100, 1000, 1100) und einen Signalsender-Empfänger und einen Prozessor dazu eingerichtet, um die empfangene Verkehrsinformation zu übertragen;
Integrieren der zumindest einen VHF/DAB- und drahtlosen Antenne (100, 1000, 1100) innerhalb der Unterstützung (401, 500) der Kommunikationsvorrichtung (300).

11. Das Verfahren nach Anspruch 10, wobei das VHF/DAB-Band von Frequenzen ein analoges frequenzmoduliertes FM-Band sowie das digitale Audio Rundfunk DAB-Band umfasst.

Revendications

1. Un dispositif de communication portable (300) pour véhicules, le dispositif (300) étant apte à recevoir des informations de trafic, via un service d'informations de trafic diffusant en broadcast dans la bande VHF/DAB, et apte à délivrer des services d'informations de trafic par émission des informations de trafic reçues vers d'autres dispositifs de communication qui ne sont pas capables de recevoir les informations de trafic dans la bande VHF/DAB, comprenant :

un support (401, 500) pour le montage du dispositif de communication portable (300) à l'intérieur du véhicule ;
un module d'informations de trafic comprenant au moins une antenne d'informations de trafic (100, 1000, 1100) dans la bande VHF/DAB avec un motif répétitif autosemblable (102) imprimé sur une carte de circuit imprimé (101), et un récepteur de signal pour la réception d'informations de trafic ;
un module de communication sans fil comprenant au moins une antenne sans fil (100, 1000, 1100) avec un motif répétitif autosemblable (102) imprimé sur une carte de circuit imprimé (101), et un émetteur/récepteur de signal et processeur configuré pour émettre les informations

de trafic reçues ;
dans lequel la au moins une antenne d'informations de trafic et l'antenne sans fil (100, 1000, 1100) sont intégrées à l'intérieur dudit support (401, 500) du dispositif (300).

2. Le dispositif de communication de la revendication 1, dans lequel la bande de fréquence VHF/DAB comprend à la fois une bande FM analogique modulée en fréquence et la bande DAB de diffusion en broadcast audionumérique.

3. Le dispositif de communication de l'une des revendications précédentes, comprenant en outre au moins une antenne pour une détermination d'un emplacement et un processeur pour la détermination de l'emplacement, la au moins une antenne de détermination d'un emplacement étant également intégrée au sein du dispositif (300).

4. Le dispositif de communication de la revendication 1, dans lequel le support (401, 500) est un berceau (401), ou un socle (500) pour solidariser le berceau (401) au véhicule.

5. Le dispositif de communication de l'une des revendications précédentes, dans lequel le motif répétitif autosemblable (102) de la au moins une antenne (100, 1000, 1100) suit la géométrie de Hilbert, la géométrie de Koch (1002), ou une géométrie en méandres (1102), ou une combinaison de toutes géométries se conformant à son intégration, telle qu'une combinaison avec une antenne PIFA, ou une antenne IFA, ou une antenne monopôle, ou une antenne dipôle, ou une antenne monopôle couplée, ou une antenne boucle.

6. Le dispositif de communication de l'une des revendications précédentes, dans lequel le motif répétitif autosemblable (102) de la au moins une antenne (100, 1000, 1100) est situé substantiellement le long du périmètre extérieur du dispositif de communication (300).

7. Le dispositif de communication de l'une des revendications précédentes, dans lequel la au moins une antenne (100, 1000, 1100) peut être connectée directement au récepteur de signal, ou via un réseau accordé.

8. Le dispositif de communication de la revendication 7, dans lequel le réseau accordé est un réseau LC à constantes localisées.

9. Le dispositif de communication de l'une des revendications précédentes, dans lequel les informations de trafic sont diffusées en broadcast par l'intermédiaire du Système de Données Radio, RDS, ou via le système de Diffusion en broadcast Audio Numérique DAB, ou une combinaison des deux, en utilisant le Canal de Messages de Trafic, TMC, ou tout autre canal adapté à une transmission d'informations de trafic.

10. Un procédé d'intégration d'un système d'antenne (100, 1000, 1100) dans un dispositif de communication portable (300) pour des véhicules, le procédé comprenant les étapes suivantes :

l'obtention d'un support (401, 500) pour le montage du dispositif de communication portable (300) à l'intérieur du véhicule ;
la formation d'au moins une antenne VHF/DAB (100, 1000, 1100) sous forme d'une carte de circuit imprimé (101) avec au moins un motif répétitif autosemblable (102) ;
l'obtention d'un module d'informations de trafic comprenant la au moins une antenne VHF/DAB (100, 1000, 1100) et un récepteur de signal pour la réception d'informations de trafic ;
la formation d'au moins une antenne sans fil (100, 1000, 1100) sous forme d'une carte de circuit imprimé (101) avec au moins un motif répétitif autosemblable (102) ; l'obtention d'un module de communication sans fil comprenant la au moins une antenne sans fil (100, 1000, 1100) et un émetteur/récepteur et un processeur configurés pour émettre les informations de trafic reçues ;
l'intégration de la au moins une antenne VHF/DAB et de l'antenne sans fil (100, 1000, 1100) à l'intérieur dudit support (401, 500) du dispositif de communication (300).

11. Le procédé de la revendication 10, dans lequel la bande de fréquence VHF/DAB comprend à la fois une bande FM analogique modulée en fréquence et la bande DAB de diffusion en broadcast audionumérique.

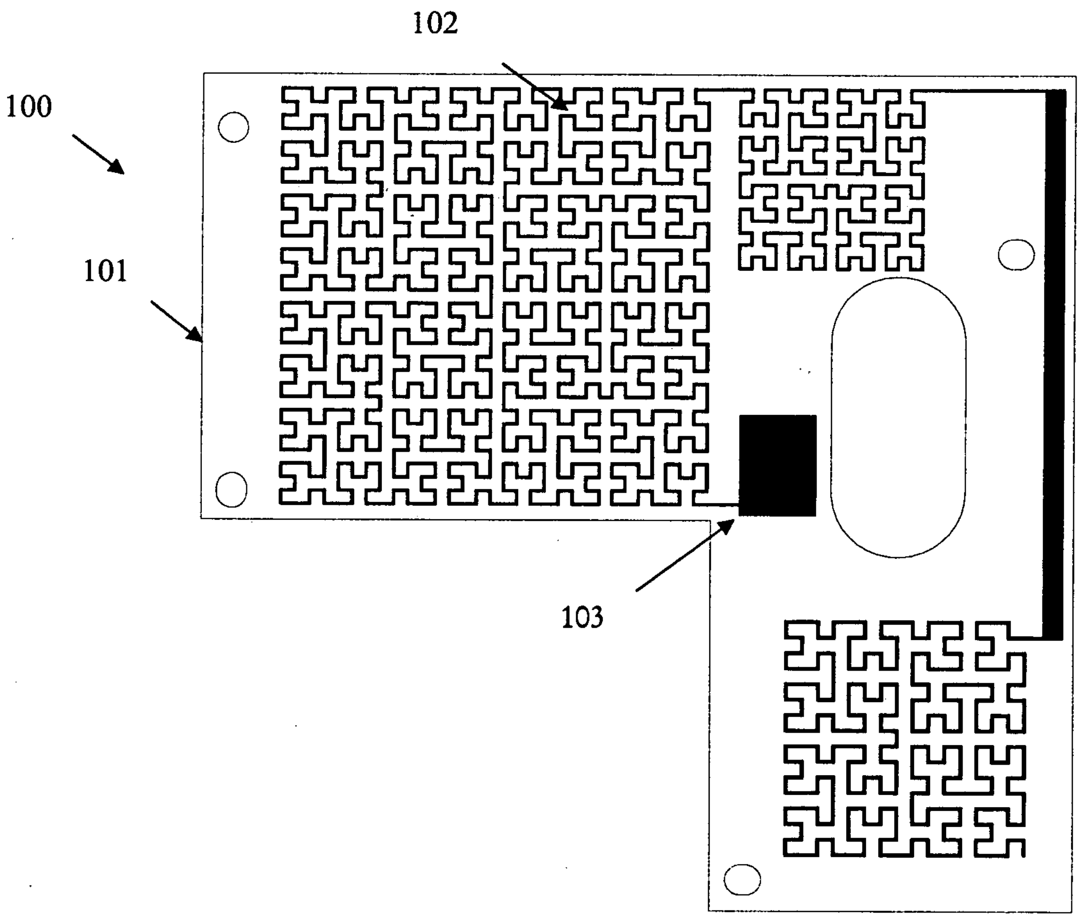

FIG. 1

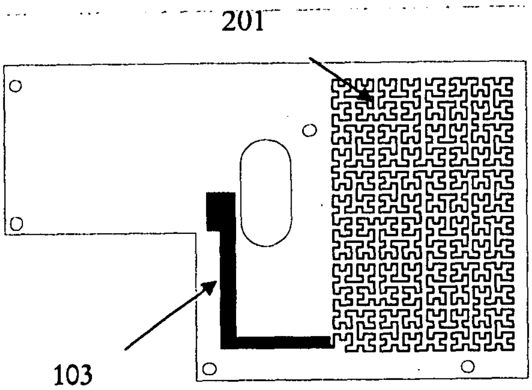

FIG. 2a

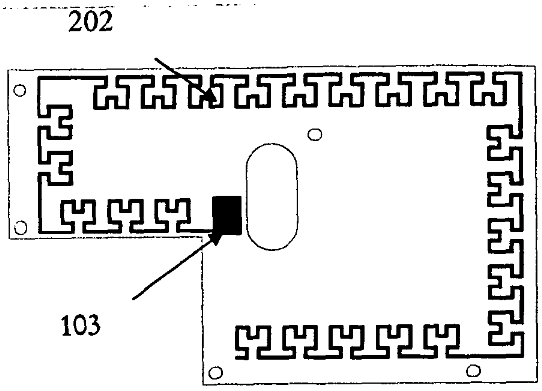

FIG. 2b

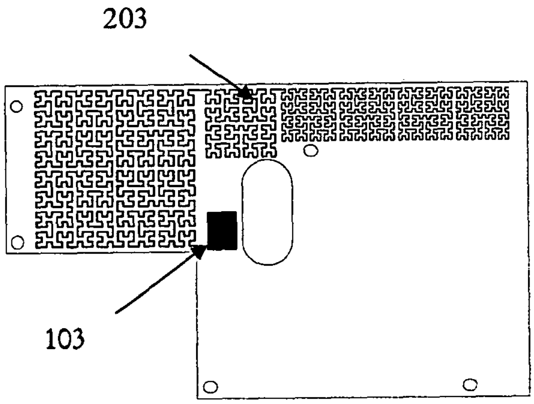

FIG. 2c

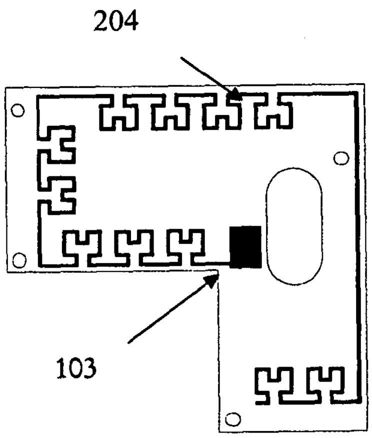

FIG. 2d

FIG. 2

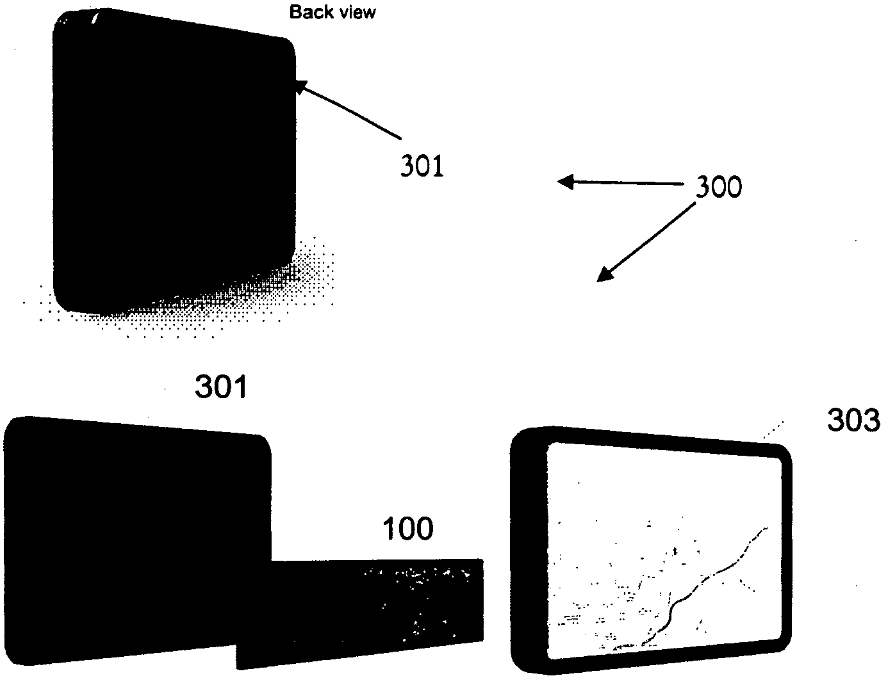

FIG. 3a

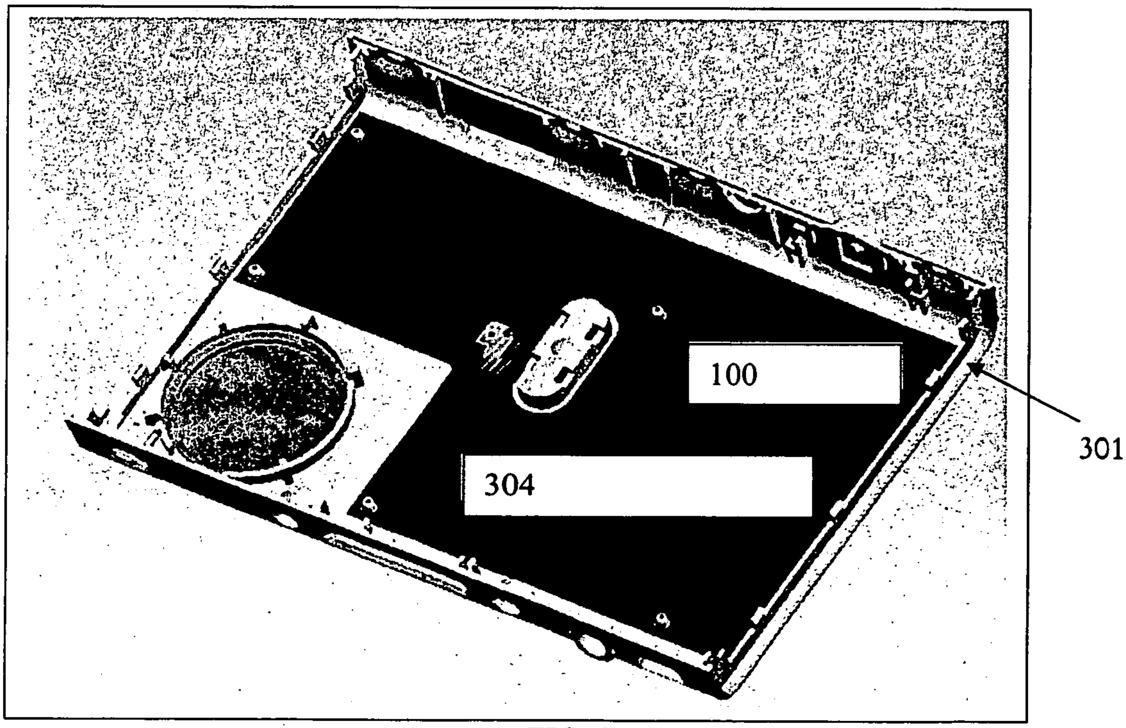

FIG. 3b

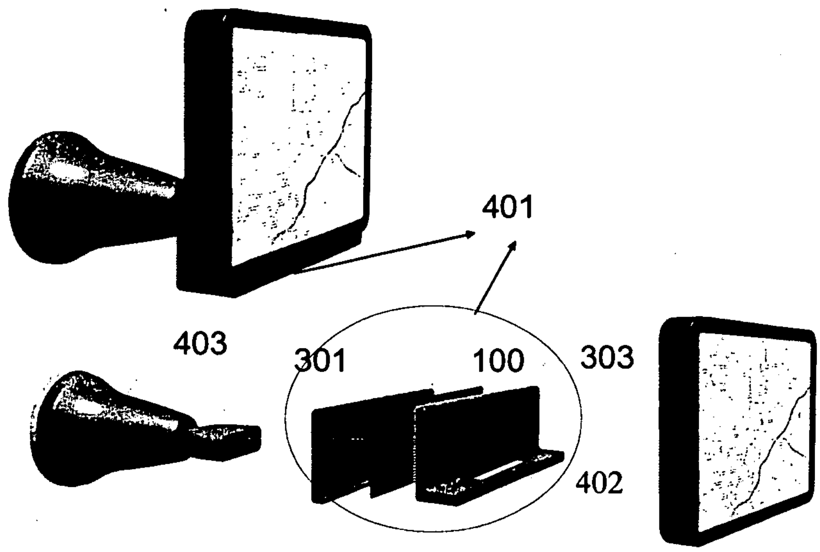

FIG. 4

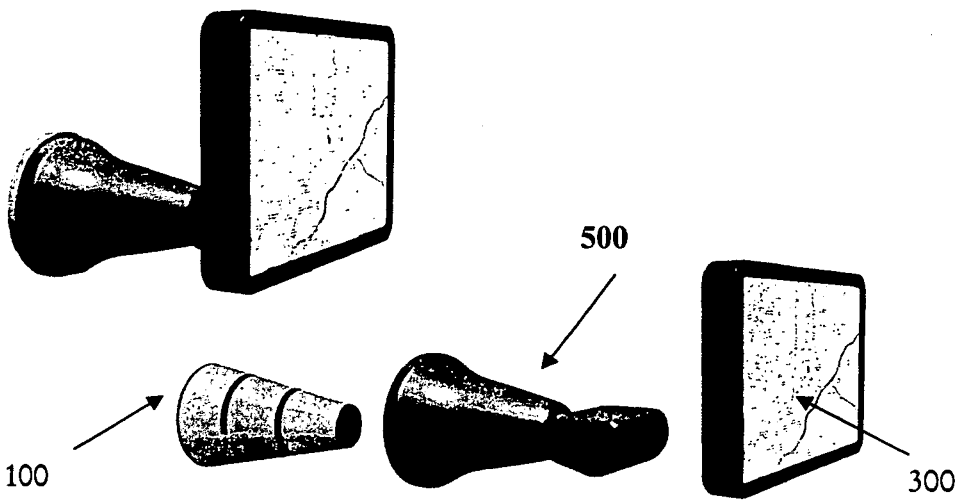

FIG. 5

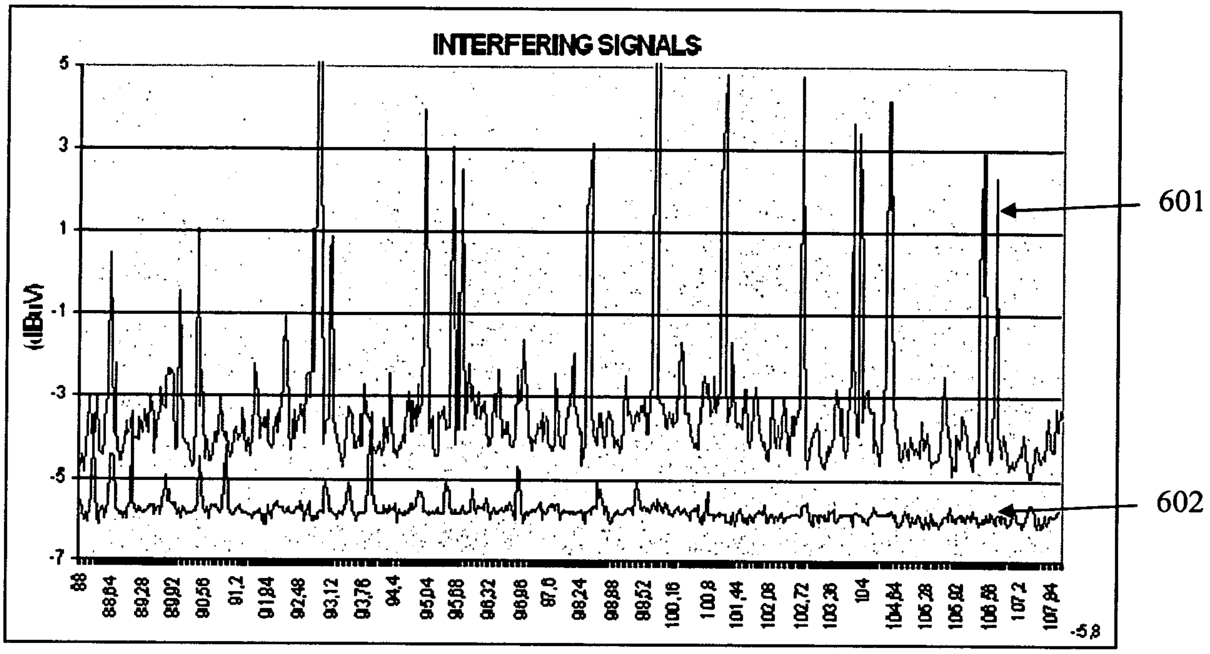

FIG. 6

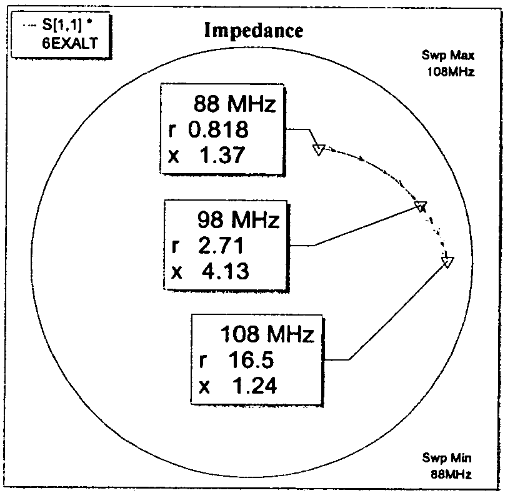

FIG. 7a

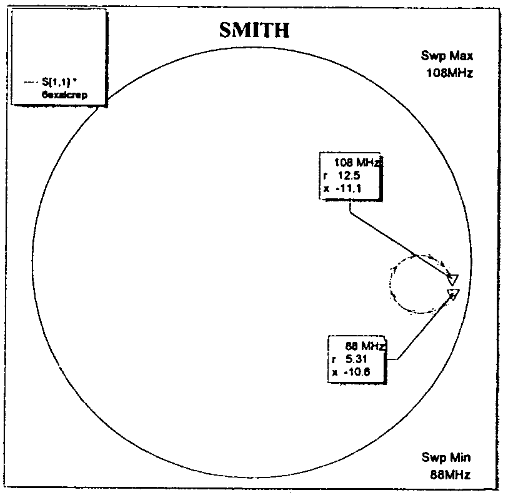

FIG. 7b

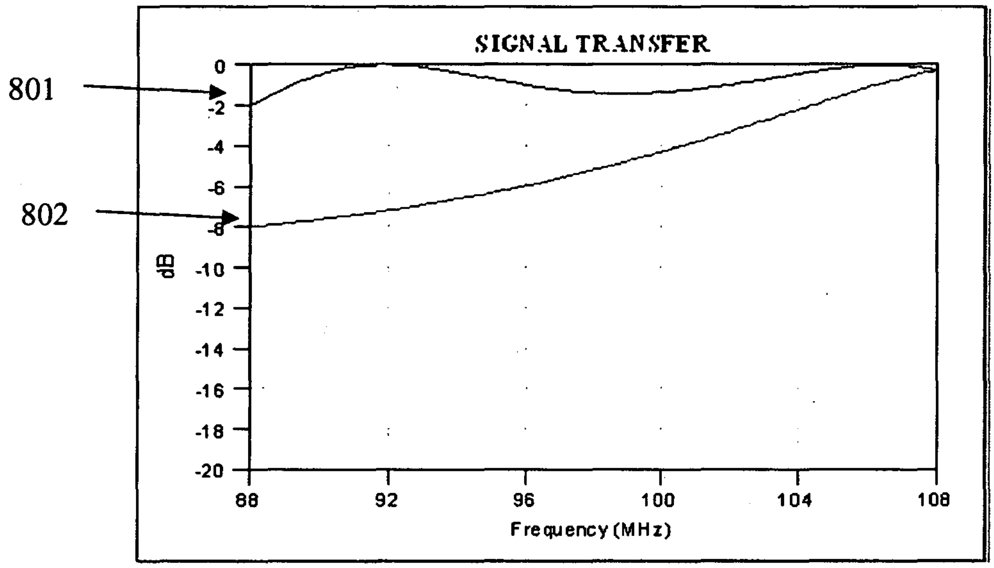
801
802
SIGNAL TRANSFER
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
dB
88
92
96
100
104
108
Frequency (MHz)

FIG. 8

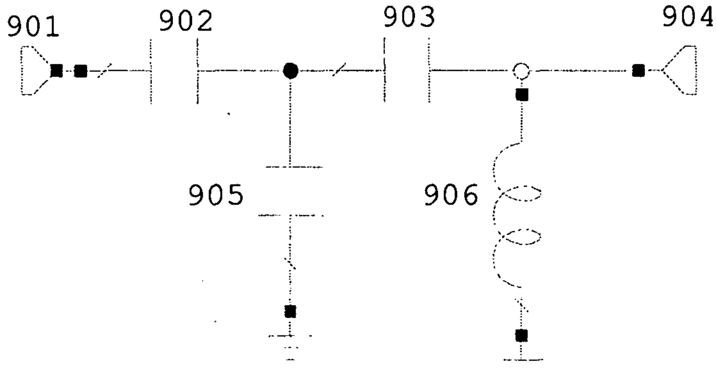
901
902
903
904
905
906

FIG. 9

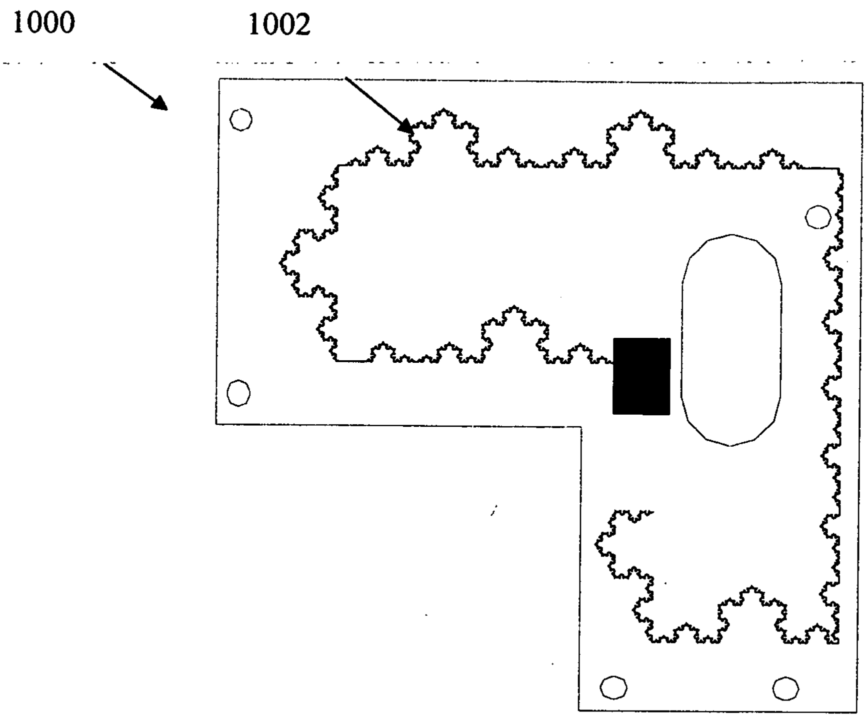

FIG. 10

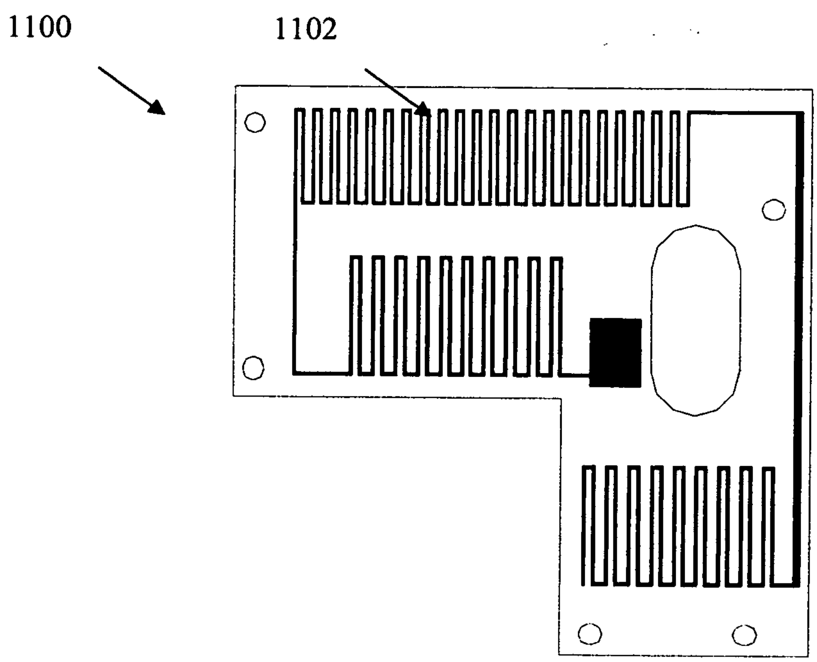

FIG. 11

REFERENCES CITED IN THE DESCRIPTION

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