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(54) Mobile wireless communications device including a ground patch providing specific absorption rate (SAR) reduction and related methods

(57) A mobile wireless communications device may include a portable housing, a dielectric substrate carried by the portable housing having a front side facing toward a user and a back side opposite the front side, and a ground plane carried by the dielectric substrate. The device may further include at least one circuit carried by the dielectric substrate, and an antenna carried by the dielectric substrate adjacent an end thereof and electrically connected to the at least one circuit. A ground patch may be adjacent the front side of the dielectric substrate that is electrically connected to the ground plane and spaced apart from and at least partially overlapping the antenna.

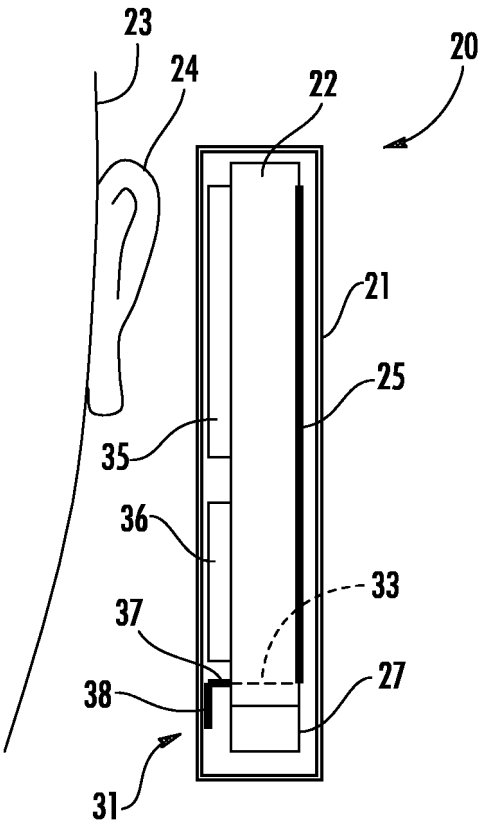


FIG. 1

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Description

Field of the Invention

[0001] The present invention relates to the field of communications devices, and, more particularly, to mobile wireless communications devices and related methods.

Background of the Invention

[0002] Cellular communications systems continue to grow in popularity and have become an integral part of both personal and business communications. Cellular telephones allow users to place and receive voice calls most anywhere they travel. Moreover, as cellular telephone technology has increased, so too has the functionality of cellular devices and the different types of devices available to users. For example, many cellular devices now incorporate personal digital assistant (PDA) features such as calendars, address books, task lists, etc. Moreover, such multi-function devices may also allow users to wirelessly send and receive electronic mail (email) messages and access the Internet via a cellular network and/or a wireless local area network (WLAN), for example.

[0003] Even so, as the functionality of cellular communications devices continues to increase, so too does the demand for smaller and thinner devices which are easier and more convenient for users to carry. One challenge this poses for cellular device manufacturers is designing antennas that provide desired operating characteristics within the relatively limited amount of space available for the antenna.

[0004] One approach for reducing phone size is to use flip phones having top and bottom housings connected with a hinge. The housings may be closed when the phone is not in use so that it is more compact and easier for a user to carry. One exemplary antenna system for a flip style cellular phone is described in U.S. Patent No. 6,765,536. In particular, the antenna system includes an external antenna element carried on the top of the lower housing, and a parasitic element carried by the top housing so that when the phone is flipped open the parasitic element is in close proximity to the antenna element. A tuning circuit carried by the lower housing is electrically coupled to the parasitic element. The tuning circuit is variable to adjust the parasitic load on the antenna element to provide variable operating frequencies and bandwidths for the phone.

[0005] External cell phone antennas are advantageous in that they are spaced apart from the user's head, which makes it easier for phone manufacturers to comply with applicable specific absorption rate (SAR) requirements, for example. This is because the farther the radiating element of the cell phone antenna system is from the user, the less intense the radiation exposure to the user. Yet, many users prefer internal antennas over external antennas, as external antennas are prone to catch on objects and become damaged, for example. However, with the ever increasing trend towards smaller cell phone sizes, for a relatively small phone having an internal antenna, this may place the antenna in relatively close proximity to the user's ear, which may make complying with applicable SAR and/or hearing aid compatibility (HAC) requirements potentially difficult for manufacturers. This is especially true for smaller and thinner "candy bar" style phones.

Brief Description of the Drawings

[0006] FIG. 1 is a schematic cross-sectional diagram of a mobile wireless communications device including a ground patch in accordance with one exemplary embodiment adjacent a user's ear.

[0007] FIG. 2 is a schematic block diagram of the dielectric substrate and ground patch of FIG. 1.

[0008] FIG. 3 is a schematic block diagram of an alternative embodiment of the mobile wireless communications device of FIG. 1 in which the ground patch is carried on the exterior of the device housing.

[0009] FIG. 4 is a schematic block diagram illustrating further exemplary components that may be used in the mobile wireless communications device of FIG. 1.

Detailed Description of the Preferred Embodiments

[0010] The present description is made with reference to the accompanying drawings, in which preferred embodiments are shown. However, many different embodiments may be used, and thus the description should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete. Like numbers refer to like elements throughout, and prime number are used to indicate similar elements in different embodiments.

[0011] Generally speaking, a mobile wireless communications device is disclosed herein which may include a portable housing, a dielectric substrate carried by the portable housing having a front side facing toward a user and a back side opposite the front side, and a ground plane carried by the dielectric substrate. The device may further include at least one circuit carried by the dielectric substrate, and an antenna carried by the dielectric substrate adjacent an end thereof and electrically connected to the at least one circuit. Additionally, a ground patch may be adjacent the front side of the dielectric substrate that is electrically connected to the ground plane and spaced apart from and at least partially overlapping the antenna. The ground patch may advantageously reduce a specific absorption rate (SAR) associated with the device by shielding the user from electromagnetic (EM) radiation generated by the antenna in the direction of the user's head. Moreover, this may also advantageously provide desired hearing aid compatibility (HAC).

[0012] More particularly, the ground plane may be on

the back side of the dielectric substrate. In accordance with one embodiment, the ground patch may be carried by the dielectric substrate. By way of example, the ground patch may have an L-shape comprising a first member extending outwardly from the dielectric substrate, and a second member extending outwardly from the first member in a direction generally parallel to the dielectric substrate. More specifically, the second member may only partially overlap the antenna. In other embodiments, the ground patch may be carried by the portable housing, for example.

[0013] The ground patch may be connected to the ground plane at a plurality of spaced apart contact points. Also, the dielectric substrate may have a lower end and an upper end, and the antenna may be carried adjacent the lower end of the dielectric substrate. The at least one circuit may be a wireless transceiver, such as a cellular transceiver, for example. Additionally, the mobile wireless communications device may further include at least one of a display and a keypad carried by the dielectric substrate on the front surface thereof.

[0014] Referring now more particularly to FIGS. 1 and 2, a mobile wireless communications device **20,** such as a cellular communications device, for example, is first described. The device **20** illustratively includes a portable housing **21** and a dielectric substrate **22,** such as a printed circuit board (PCB), carried by the portable housing. The dielectric substrate **22** has a front side facing toward a user **23** when the device **20** is placed adjacent the user's ear **24** to engage in a telephone conversation, and a back side opposite the front side. In the illustrated example, the device **20** further illustratively includes a display **35** (e.g., a liquid crystal display (LCD)) and a keypad **36** carried by the dielectric substrate **22** on the front surface thereof.

[0015] A ground plane **25** is carried by the dielectric substrate **22,** which in the illustrated embodiment is on the back side thereof. The device **20** further illustratively includes a circuit(s) **26** carried by the dielectric substrate **22,** such a wireless cellular transceiver, for example. Of course, it will be appreciated that other circuitry may also be included, as will be discussed further below. An antenna **27** is also carried by the dielectric substrate **22** adjacent an end thereof and electrically connected to the circuit **26** at a contact point **30.** By way of example, the antenna **27** may include one or more conductive traces (e.g., printed circuit traces) on the dielectric substrate **22.** In some embodiments, additional risers or antenna retainer frames may be used to increase the surface area of the antenna, as well as wrapping of conductive traces around different sides/ends of the dielectric substrate **22,** as will be appreciated by those skilled in the art.

[0016] In the illustrated embodiment, the antenna **27** is adjacent the lower end of the substrate (i.e., where the microphone (not shown) of the cellular device would typically be located). However, in other embodiments, the antenna **27** could be positioned adjacent the upper end of the dielectric substrate **22.** Positioning the antenna **27** adjacent the bottom of the device **20** may advantageously help achieve a relatively wide bandwidth and relatively high antenna gain. However, this may also result in a more omni-directional antenna radiation pattern, which in turn can increase the SAR of the device **20** as more radiation is directed toward the user **23** than would be the case with a directional antenna having a boresight pointed away from the user, as will be appreciated by those skilled in the art.

[0017] To help reduce the increased SAR resulting from the omni-directional EM radiation of the antenna **27,** a ground patch **31** may advantageously be positioned adjacent the front side of the dielectric substrate **22** and spaced apart from and at least partially overlapping the antenna **27.** The ground patch **31** is electrically connected to the ground plane **25.** More particularly, in the illustrated embodiment electrical contact occurs at a plurality of spaced-apart contact points **32** on the dielectric substrate **22,** which are connected to the ground plane **25** by respective vias **33.** It should be noted, however, that different electrical connection arrangements may be used in different embodiments, including one or more contact points and wrap-around connections instead of vias passing through the dielectric substrate **22,** for example. Moreover, in some embodiments the ground plane **25** may be located on the same side of the dielectric substrate **22** as the ground patch **31.** It should be noted that the ground patch **31** is shown with hatching in FIG. 2 for clarity of illustration, although this element is not being shown in section.

[0018] The ground patch **31** advantageously reduces a specific absorption rate (SAR) associated with the device **20** by shielding the user from electromagnetic (EM) radiation generated by the antenna in the direction of the user's head. Moreover, this may also advantageously provide desired hearing aid compatibility (HAC), as will be appreciated by those skilled in the art.

[0019] In the present example, the ground patch **31** is illustratively carried by the dielectric substrate **22** and has an L-shape comprising a first member **37** extending outwardly from the dielectric substrate, and a second member **38** extending outwardly from the first member in a direction generally parallel to the dielectric substrate (see FIG. 1). More specifically, the second member **38** may only partially overlap the antenna, as shown in FIGS. 1 and 2. By way of example, a height of the antenna **27** may preferably be about 15 mm or less, and a length of the second member **38** may be from about 1 to 15 mm. Moreover, the height of the first member **37** may typically be about 1 to 5 mm, although other dimensions may also be used.

[0020] Turning now to FIG. 3, an alternative embodiment of the device **20'** is shown in which the ground patch **31'** is carried by the portable housing **21'.** More particularly, in the illustrated embodiment the ground patch **31'** is carried on the outside or exterior of the housing **21'.** In this embodiment, the ground patch **31'** could have a stylistic appearance. For example, the ground patch **31'**

could be a piece of metal with a trade name or logo of the device manufacturer or network provider printed or engraved thereon. In other embodiments, the ground patch **31'** could be carried on the inside or interior of the housing **21',** e.g., carried on an interior surface of the housing.

[0021] Exemplary components of a hand-held mobile wireless communications device **1000** that may be included in the above-described devices **20, 20'** is further described in the example below with reference to FIG. 4. The device **1000** illustratively includes a housing **1200,** a keypad **1400** and an output device **1600.** The output device shown is a display **1600,** which is preferably a full graphic LCD. Other types of output devices may alternatively be utilized. A processing device **1800** is contained within the housing **1200** and is coupled between the keypad **1400** and the display **1600.** The processing device **1800** controls the operation of the display **1600,** as well as the overall operation of the mobile device **1000,** in response to actuation of keys on the keypad **1400** by the user.

[0022] The housing **1200** may be elongated vertically, or may take on other sizes and shapes (including clamshell housing structures). The keypad may include a mode selection key, or other hardware or software for switching between text entry and telephony entry.

[0023] In addition to the processing device **1800,** other parts of the mobile device **1000** are shown schematically in FIG. 4. These include a communications subsystem **1001;** a short-range communications subsystem **1020;** the keypad **1400** and the display **1600,** along with other input/output devices **1060, 1080, 1100** and **1120;** as well as memory devices **1160, 1180** and various other device subsystems **1201.** The mobile device **1000** is preferably a two-way RF communications device having voice and data communications capabilities. In addition, the mobile device **1000** preferably has the capability to communicate with other computer systems via the Internet.

[0024] Operating system software executed by the processing device **1800** is preferably stored in a persistent store, such as the flash memory **1160,** but may be stored in other types of memory devices, such as a read only memory (ROM) or similar storage element. In addition, system software, specific device applications, or parts thereof, may be temporarily loaded into a volatile store, such as the random access memory (RAM) **1180.** Communications signals received by the mobile device may also be stored in the RAM **1180.**

[0025] The processing device **1800,** in addition to its operating system functions, enables execution of software applications **1300A-1300N** on the device **1000.** A predetermined set of applications that control basic device operations, such as data and voice communications **1300A** and **1300B,** may be installed on the device **1000** during manufacture. In addition, a personal information manager (PIM) application may be installed during manufacture. The PIM is preferably capable of organizing and managing data items, such as e-mail, calendar events, voice mails, appointments, and task items. The PIM application is also preferably capable of sending and receiving data items via a wireless network **1401.** Preferably, the PIM data items are seamlessly integrated, synchronized and updated via the wireless network **1401** with the device user's corresponding data items stored or associated with a host computer system.

[0026] Communication functions, including data and voice communications, are performed through the communications subsystem **1001,** and possibly through the short-range communications subsystem. The communications subsystem **1001** includes a receiver **1500,** a transmitter **1520,** and one or more antennas **1540** and **1560.** In addition, the communications subsystem **1001** also includes a processing module, such as a digital signal processor (DSP) **1580,** and local oscillators (LOs) **1601.** The specific design and implementation of the communications subsystem **1001** is dependent upon the communications network in which the mobile device **1000** is intended to operate. For example, a mobile device **1000** may include a communications subsystem **1001** designed to operate with the Mobitex™, Data TAC™ or General Packet Radio Service (GPRS) mobile data communications networks, and also designed to operate with any of a variety of voice communications networks, such as AMPS, TDMA, CDMA, WCDMA, PCS, GSM, EDGE, etc. Other types of data and voice networks, both separate and integrated, may also be utilized with the mobile device **1000.** The mobile device **1000** may also be compliant with other communications standards such as 3GSM, 3GPP, UMTS, etc.

[0027] Network access requirements vary depending upon the type of communication system. For example, in the Mobitex and DataTAC networks, mobile devices are registered on the network using a unique personal identification number or PIN associated with each device. In GPRS networks, however, network access is associated with a subscriber or user of a device. A GPRS device therefore requires a subscriber identity module, commonly referred to as a SIM card, in order to operate on a GPRS network.

[0028] When required network registration or activation procedures have been completed, the mobile device **1000** may send and receive communications signals over the communication network **1401.** Signals received from the communications network **1401** by the antenna **1540** are routed to the receiver **1500,** which provides for signal amplification, frequency down conversion, filtering, channel selection, etc., and may also provide analog to digital conversion. Analog-to-digital conversion of the received signal allows the DSP **1580** to perform more complex communications functions, such as demodulation and decoding. In a similar manner, signals to be transmitted to the network **1401** are processed (e.g. modulated and encoded) by the DSP **1580** and are then provided to the transmitter **1520** for digital to analog conversion, frequency up conversion, filtering, amplification and transmission to the communication network **1401** (or net-

works) via the antenna **1560.**

[0029] In addition to processing communications signals, the DSP **1580** provides for control of the receiver **1500** and the transmitter **1520.** For example, gains applied to communications signals in the receiver **1500** and transmitter **1520** may be adaptively controlled through automatic gain control algorithms implemented in the DSP **1580.**

[0030] In a data communications mode, a received signal, such as a text message or web page download, is processed by the communications subsystem **1001** and is input to the processing device **1800.** The received signal is then further processed by the processing device **1800** for an output to the display **1600,** or alternatively to some other auxiliary I/O device **1060.** A device user may also compose data items, such as e-mail messages, using the keypad **1400** and/or some other auxiliary I/O device **1060,** such as a touchpad, a rocker switch, a thumb-wheel, or some other type of input device. The composed data items may then be transmitted over the communications network **1401** via the communications subsystem **1001.**

[0031] In a voice communications mode, overall operation of the device is substantially similar to the data communications mode, except that received signals are output to a speaker **1100,** and signals for transmission are generated by a microphone **1120.** Alternative voice or audio I/O subsystems, such as a voice message recording subsystem, may also be implemented on the device **1000.** In addition, the display **1600** may also be utilized in voice communications mode, for example to display the identity of a calling party, the duration of a voice call, or other voice call related information.

[0032] The short-range communications subsystem enables communication between the mobile device **1000** and other proximate systems or devices, which need not necessarily be similar devices. For example, the short-range communications subsystem may include an infrared device and associated circuits and components, or a Bluetooth™ communications module to provide for communication with similarly-enabled systems and devices.

[0033] Many modifications and other embodiments will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is understood that various modifications and embodiments are intended to be included within the scope of the appended claims.

Claims

1. A mobile wireless communications device comprising:

a portable housing;
a dielectric substrate carried by said portable housing having a front side facing toward a user and a back side opposite the front side;
a ground plane carried by said dielectric substrate;
at least one circuit carried by said dielectric substrate;
an antenna carried by said dielectric substrate adjacent an end thereof and electrically connected to said at least one circuit; and
a ground patch adjacent the front side of said dielectric substrate being electrically connected to said ground plane and being spaced apart from and at least partially overlapping said antenna.

2. The mobile wireless communications device of Claim 1 wherein said ground plane is on the back side of said dielectric substrate.

3. The mobile wireless communications device of Claim 1 wherein said ground patch is carried by said dielectric substrate.

4. The mobile wireless communications device of Claim 3 wherein said ground patch has an L-shape comprising a first member extending outwardly from said dielectric substrate, and a second member extending outwardly from said first member in a direction generally parallel to said dielectric substrate.

5. The mobile wireless communications device of Claim 4 wherein said second member only partially overlaps said antenna.

6. The mobile wireless communications device of Claim 1 wherein said ground patch is carried by said portable housing.

7. The mobile wireless communications device of Claim 1 wherein said ground patch is connected to said ground plane at a plurality of spaced apart contact points.

8. The mobile wireless communications device of Claim 1 wherein said dielectric substrate has a lower end and an upper end, and wherein said antenna is carried adjacent the lower end of said dielectric substrate.

9. The mobile wireless communications device of Claim 1 wherein said at least one circuit comprises a wireless transceiver.

10. The mobile wireless communications device of Claim 9 wherein said wireless transceiver comprises a cellular transceiver.

11. The mobile wireless communications device of

Claim 1 further comprising at least one of a display and a keypad carried by said dielectric substrate on the front surface thereof.

12. A method for reducing a specific absorption rate (SAR) of a mobile wireless communications device comprising a portable housing, a dielectric substrate carried by the portable housing having a front side facing toward a user and a back side opposite the front side, a ground plane carried by the dielectric substrate, at least one circuit carried by the dielectric substrate, and an antenna carried by the dielectric substrate adjacent an end thereof and electrically connected to the at least one circuit, the method comprising:

positioning a ground patch adjacent the front side of the dielectric substrate spaced apart from and at least partially overlapping the antenna and electrically connecting the ground patch to the ground plane.

13. The method of Claim 12 wherein the ground plane is on the back side of the dielectric substrate.

14. The method of Claim 12 wherein positioning the ground patch comprises mounting the ground patch on the dielectric substrate.

15. The method of Claim 14 wherein the ground patch has an L-shape comprising a first member extending outwardly from the dielectric substrate, and a second member extending outwardly from the first member in a direction generally parallel to the dielectric substrate.

16. The method of Claim 15 wherein the second member only partially overlaps the antenna.

17. The method of Claim 12 wherein positioning the ground patch comprises mounting the ground patch on the portable housing.

18. The method of Claim 12 wherein electrically connecting the ground patch to the ground plane comprises electrically connecting the ground patch to the ground plane at a plurality of spaced apart contact points.

19. The method of Claim 12 wherein the dielectric substrate has a lower end and an upper end, and wherein the antenna is carried adjacent the lower end of the dielectric substrate.

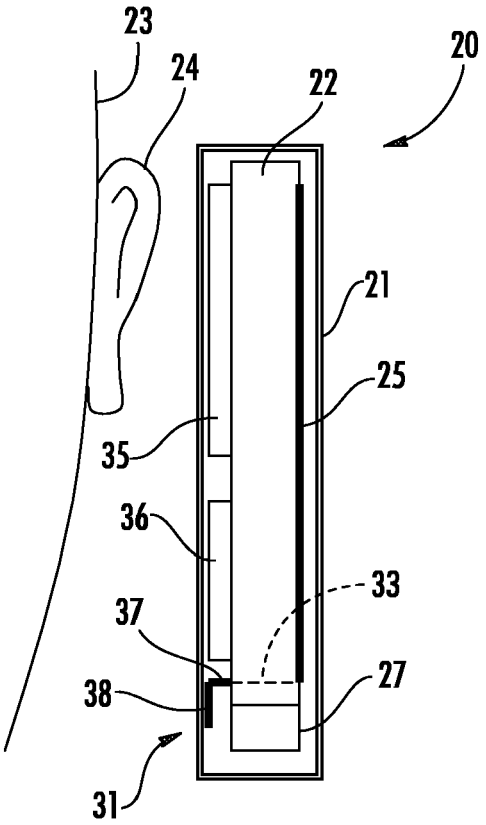

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38
27
31

FIG. 1

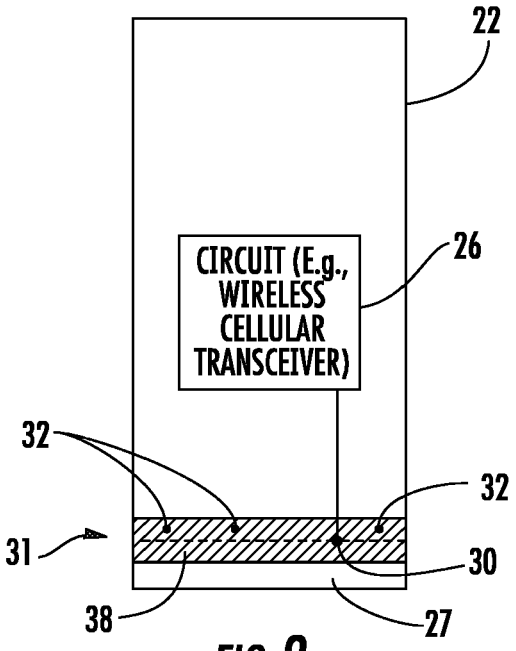

22
CIRCUIT (E.g., WIRELESS CELLULAR TRANSCEIVER)
26
32
32
31
30
38
27

FIG. 2

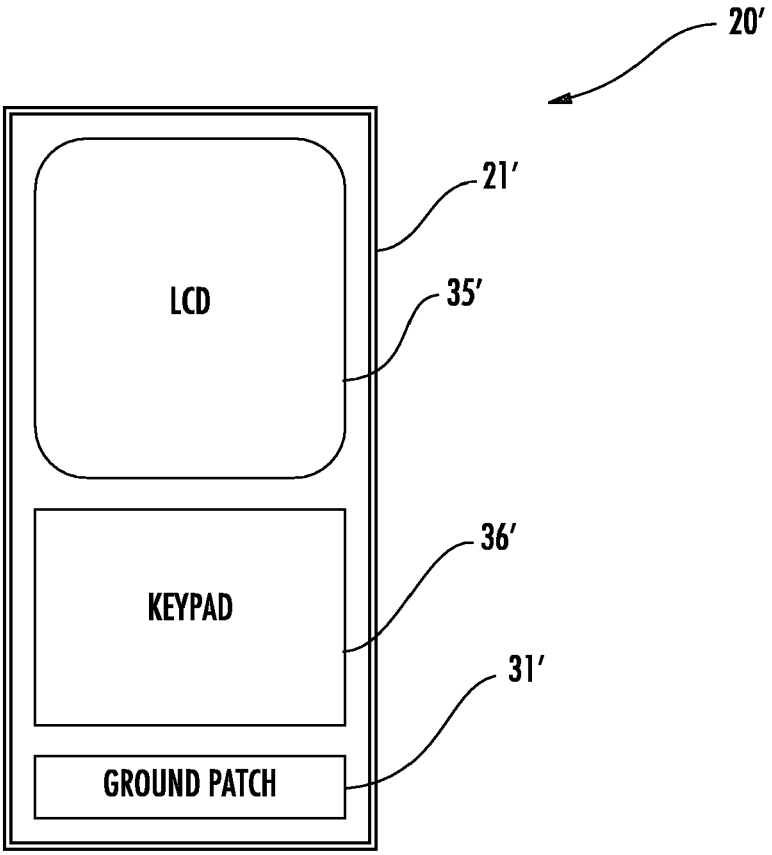


FIG. 3

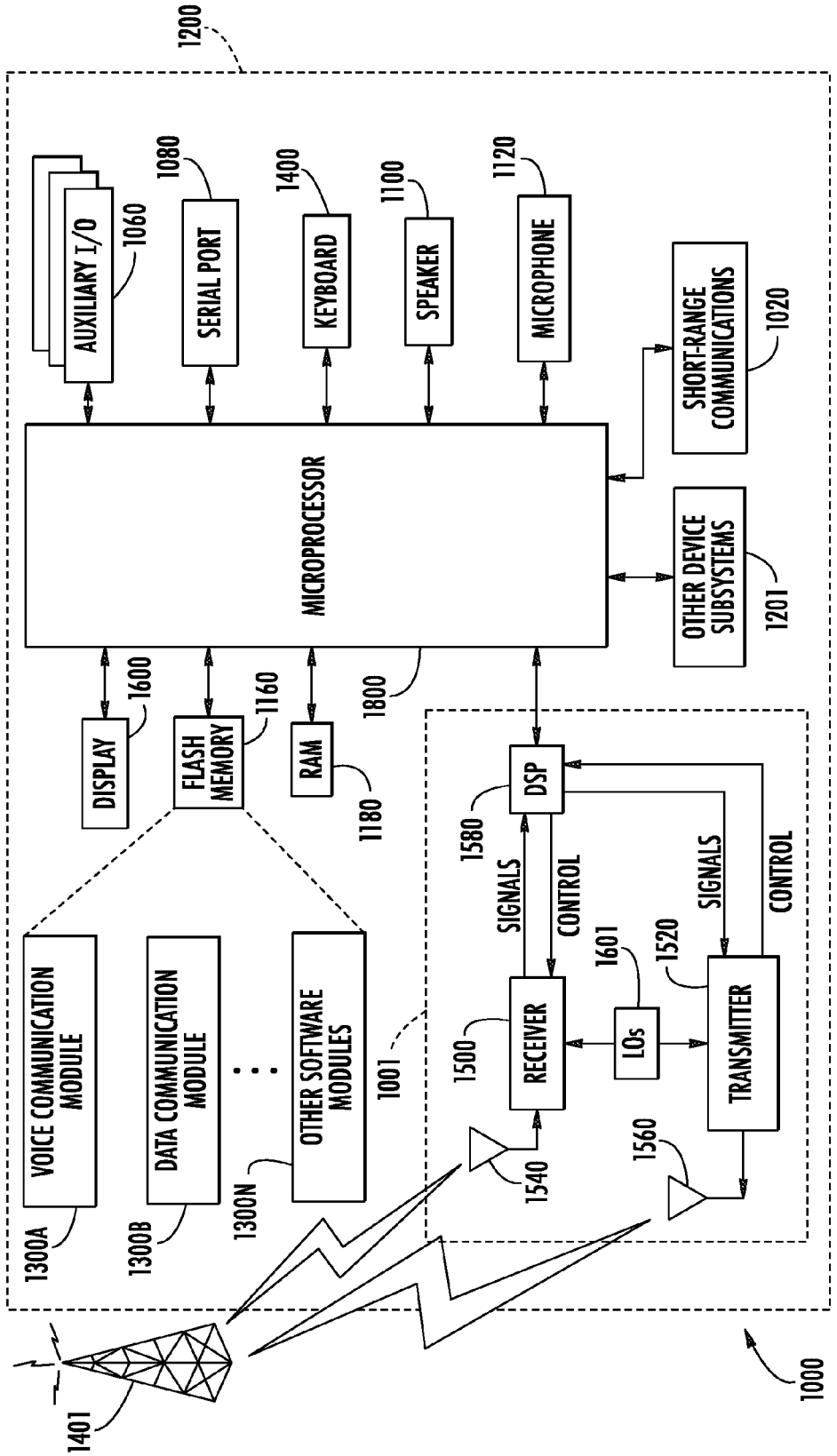

1200
AUXILIARY I/O
1060
SERIAL PORT
1080
KEYBOARD
1400
SPEAKER
1100
MICROPHONE
1120
SHORT-RANGE COMMUNICATIONS
1020
MICROPROCESSOR
OTHER DEVICE SUBSYSTEMS
1201
1800
DISPLAY
1600
FLASH MEMORY
1160
RAM
1180
DSP
1580
SIGNALS
CONTROL
SIGNALS
CONTROL
1601
1520
1500
RECEIVER
LOs
TRANSMITTER
1560
1540
VOICE COMMUNICATION MODULE
1300A
DATA COMMUNICATION MODULE
1300B
OTHER SOFTWARE MODULES
1300N
1001
1401
1000

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 5873

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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
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CATEGORY OF CITED DOCUMENTS

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