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Amended claims in accordance with Rule 137(2) EPC.

(54) Mobile wireless communications device including wrap-around antenna assembly with feed arm extension and related methods

(57) A mobile wireless communications device may include a portable housing, at least one wireless communications circuit carried by the portable housing, and a wrap-around antenna assembly carried by the portable housing. The wrap-around antenna assembly may include a substrate comprising a first portion and a second portion extending outwardly therefrom defining an L-shape, and a wrap-around antenna element lying along adjacent contiguous exterior surfaces of the first and second substrate portions. The wrap-around antenna assembly may further include an antenna feed arm lying along an interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element, and a feed arm extension electrically coupled to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

EP 2 273 609 A1

Description

Technical Field

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

Background

[0002] Mobile wireless communications systems continue to grow in popularity and have become an integral part of both personal and business communications. For example, 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 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 antennas.

Brief Description of the Drawings

[0004] FIG. 1 is a schematic side view of a mobile wireless communications device in accordance with one exemplary embodiment.

[0005] FIG. 2 is an exterior surface view of a first substrate portion of an exemplary wrap-around antenna assembly for use with the mobile wireless communications device of FIG. 1.

[0006] FIG. 3 is an interior surface view of a second substrate portion of the wrap-around antenna assembly of FIG. 2.

[0007] FIG. 4 is an interior surface view of the first substrate portion of the wrap-around antenna assembly of FIG. 2.

[0008] FIG. 5 is an exterior surface view of the second substrate portion of the wrap-around antenna assembly of FIG. 2.

[0009] FIG. 6 is an exterior surface view of a first substrate portion of an alternative embodiment of the wrap-around antenna assembly shown in FIG. 2.

[0010] FIG. 7 is a flow diagram illustrating a method for making a wrap-around antenna assembly in accordance with an exemplary embodiment.

[0011] FIG. 8 is a schematic block diagram illustrating exemplary components of a mobile wireless communications device that may be used in accordance with exemplary embodiments.

Detailed Description

[0012] The present description is made with reference to the accompanying drawings, in which exemplary embodiments are shown. However, many different exemplary embodiments may be used, and thus the description should not be construed as limited to the exemplary embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure will be thorough and complete. Like numbers refer to like elements throughout, and prime notation is used to indicate similar elements or steps in different embodiments.

[0013] Generally speaking, a mobile wireless communications device is provided herein which may include a portable housing, at least one wireless communications circuit carried by the portable housing, and a wrap-around antenna assembly carried by the portable housing. The wrap-around antenna assembly may include a substrate comprising a first portion and a second portion extending outwardly therefrom defining an L-shape, and a wrap-around antenna element lying along adjacent contiguous exterior surfaces of the first and second substrate portions. The wrap-around antenna assembly may further include an antenna feed arm lying along an interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element, and a feed arm extension electrically coupled to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

[0014] In some embodiments, the feed arm extension may have a distal end defining a gap from adjacent portions of the wrap-around antenna element. By way of example, the gap may be not greater than 2 mm. In other embodiments, the feed arm extension may have a distal end electrically coupled to adjacent portions of the wrap-around antenna element.

[0015] The wrap-around antenna element and the feed arm extension may advantageously provide pentaband operation, for example. Additionally, the wrap-around antenna assembly may further include a floating, electrically conductive coupler element adjacent the feed arm extension. More particularly, the floating, electrically conductive coupler element may be spaced apart from and generally parallel to the feed arm extension.

[0016] Furthermore, the wrap-around antenna assembly may also include a monopole antenna element carried by the first portion of the substrate. In addition, the mobile wireless communications device may also include a printed circuit board (PCB) carried by the portable housing and carrying the at least one wireless RF circuit, and the substrate may be carried by the PCB. By way of example, the wrap-around antenna element may comprise an inverted-F antenna element, and the at least one wire-

less RF circuit may comprise at least one cellular transceiver.

[0017] A wrap-around antenna assembly for mobile wireless communications device, such as the one described briefly above, may include a substrate comprising a first portion and a second portion extending outwardly therefrom defining an L-shape, and a wrap-around antenna element lying along adjacent contiguous exterior surfaces of the first and second substrate portions. The assembly may further include an antenna feed arm lying along an interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element, and a feed arm extension electrically coupled to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

[0018] A related method for making a wrap-around antenna assembly may include forming a substrate comprising a first portion and a second portion extending outwardly therefrom defining an L-shape, and positioning a wrap-around antenna element along adjacent contiguous exterior surfaces of the first and second substrate portions. The method may further include positioning an antenna feed arm along an interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element, and electrically coupling a feed arm extension to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

[0019] Referring now to FIGS. 1-5, a mobile wireless communications device is provided herein which illustratively includes a portable housing **31**. By way of example, such mobile wireless communications devices (or "mobile devices") may include pagers, cellular phones, cellular smart-phones, wireless organizers, personal digital assistants, computers, laptops, handheld wireless communication devices, wirelessly enabled notebook computers, etc.

[0020] In the illustrated example, the at least one wireless communications circuit **32** is carried by the portable housing **31**. More particularly, the wireless communications circuit(s) **32** is mounted on a printed circuit board (PCB) **33**, and the circuit may be a wireless transceiver, such as a cellular transceiver, for example. However, other wireless communications formats may also be used, such as wireless local area network (WLAN) formats, Bluetooth, etc., as will be discussed further below.

[0021] The device **30** further illustratively includes a wrap-around antenna assembly **34** carried by the portable housing **31**. The wrap-around antenna assembly **34** illustratively includes a substrate **35** comprising a first portion **36** and a second portion **37** extending outwardly therefrom defining an L-shape, as seen in FIG. 1. More particularly, in the exemplary implementation, the longer portion of the L is the first portion **36**, and the second portion **37** is the shorter portion which is orthogonal to the first portion.

[0022] The wrap-around antenna assembly **34** further illustratively includes a wrap-around antenna element **40** lying along adjacent contiguous exterior surfaces of the first and second substrate portions **36**, **37**, as perhaps best seen in FIGS. 2 and 5. In the illustrated example, the wrap-around antenna element **40** is an inverted-F antenna comprising a plurality of conductive traces which are printed on the exterior surfaces of the first and second portions **36**, **37**, as will be appreciated by those skilled in the art. The wrap-around antenna assembly **34** further illustratively includes an antenna feed arm **41** lying along an interior surface of the first substrate portion **36** (FIG. 4) and electrically coupled to the wrap-around antenna element **40,** and a ground arm **53** also lying along the interior surface of the first substrate portion. By way of example, the antenna feed arm **41** and ground arm **53** may respectively be connected to the circuit **32** and a ground plane (not shown) on the PCB **33** by conductive spring clips, flex connector, etc., as will be appreciated by those skilled in the art.

[0023] As a result of the L-shaped substrate **35,** the wrap-around antenna assembly **34** advantageously provides a relatively compact form factor that can be secured to an end or side of the PCB **33,** which advantageously frees up surface area of the PCB for other components, in that the conductive traces **40** need not be printed on a surface of the PCB itself. Further, due to the three-dimensional (3D) or non-planar nature of the wrap-around antenna element **40,** which wraps around multiple surfaces of the substrate **35,** this allows the antenna element to have a longer electrical length within the relatively small surface area occupied by the substrate **37.**

[0024] The wrap-around antenna assembly **34** also illustratively includes a feed arm extension **42** electrically coupled to the antenna feed arm **41** on the inner surface of the first substrate portion **42** (see FIG. 4), and extending around to the exterior surface of the first substrate portion (see FIG. 2). In the illustrated embodiment, the feed arm extension has a distal end electrically coupled to adjacent portions of the wrap-around antenna element **40** at a point **43,** as shown in FIG. 2.

[0025] In an alternative embodiment illustrated in FIG. 6, the distal end of the feed arm extension **42'** defines a gap **44'** from adjacent portions of the wrap-around antenna element **40'.** By way of example, an exemplary width of the gap **44'** may be 2 mm or less, such as 0.5 to 2 mm, although other gap distances may be used in various embodiments.

[0026] The wrap-around antenna element **40** or **40',** with the addition of the feed arm extension **42** or **42',** advantageously provides pentaband operation across the CDMA, WCDMA, and GSM high/low frequency bands in the illustrated examples, as will be appreciated by those skilled in the art. However, without the addition of the feed arm extension **42** or **42',** the wrap-around antenna elements **40** or **40'** alone would otherwise provide quad-band operation.

[0027] In addition to providing operation across a greater frequency range, the feed arm extensions **42, 42'**

advantageously provide enhanced gain and matching for the antenna element **40, 40'.** The choice of whether to use the antenna assembly **34** (FIG. 2) or **34'** (FIG. 6), i.e., whether to have the gap **44'** or directly couple the feed arm extension **42** to the antenna **40,** will generally depend upon the desired operating characteristics, and whether a greater enhancement in antenna gain or matching is desired. That is, the antenna assembly **34** generally provides greater gain enhancement, while the antenna assembly **34'** generally provides greater matching and tuning characteristics.

[0028] It should also be noted that in some embodiments the gap **44'** need not be directly adjacent to the antenna element **40'** (i.e., adjacent the point **43** in FIG. 2). That is, the gap **44'** may be located elsewhere along the length of the feed arm extension **42,** if desired. Generally speaking, the length of the feed arm extension **42, 42'** on the interior surface of the substrate **35** and its distance to the antenna element **40, 40'** on the outer surface of the substrate controls the antenna matching (i.e., S11 bandwidth), and this is why the location and size of the gap **44'** is advantageously beneficial for matching and tuning adjustment.

[0029] In the illustrated example, the wrap-around antenna assembly **34** further illustratively includes a floating, electrically conductive coupler element **50** adjacent the feed arm extension **42.** More particularly, the floating, electrically conductive parasitic coupler element **50** is spaced apart from and generally parallel to the feed arm extension **42** in the illustrated example, although other orientations or configurations may be used in different embodiments, as will be appreciated by those skilled in the art. By "spaced apart" it is meant that the coupler element **50** is not in contact with the feed arm extension **42** (or the antenna element **40**), and the spacing may vary in different embodiments. The coupler element **50** advantageously may be used to further enhance antenna gain and matching across all of the operating bands. In addition, the length of the coupler element **50** and its spacing from the antenna element **40** and feed arm extension may advantageously be selected to further control frequency band operation, as will also be appreciated by those skilled in the art.

[0030] Furthermore, the wrap-around antenna assembly **34** also illustratively includes a monopole antenna element **51** carried by the first portion of the substrate **35** (FIG. 2), and also connected to the circuit **32** (or different wireless communications circuitry). The monopole antenna element 51 may optionally provide operation in one of the above-noted frequency bands, or in a separate frequency band, if desired, but it is not necessary in all embodiments. In embodiments where the monopole antenna element **51** is not present, the coupler element **50** may be located in its place (or elsewhere) to provide closer coupling to the feed arm extension **42** or antenna element **40,** as will be appreciated by those skilled in the art.

[0031] Referring additionally to FIG. 7, a related method for making a wrap-around antenna assembly **34** is now described. Beginning at Block **70,** the method includes forming a substrate **35** comprising a first portion and a second portion extending outwardly therefrom defining an L-shape, and positioning a wrap-around antenna element **40** along adjacent contiguous exterior surfaces of the first and second substrate portions, at Blocks **71-72.** The method further illustratively includes positioning an antenna feed arm **41** along an interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element **40,** at Block **73,** and electrically coupling a feed arm extension **42** to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof, at Block **74,** thus concluding the method illustrated in FIG. 7 (Block **75**).

[0032] Exemplary components of a mobile wireless communications device **1000** that may be used in accordance with the systems **30, 31',** such as for determining traffic rate or density, or both, are further described in the example below with reference to FIG. 8. 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 may comprise a full graphic LCD. In some embodiments, display **1600** may comprise a touch-sensitive input and output device. 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. In some embodiments, keypad **1400** may comprise a physical keypad or a virtual keypad (e.g., using a touch-sensitive interface) or both.

[0033] The housing **1200** may be elongated vertically, or may take on other sizes and shapes (including clamshell housing structures). The keypad **1400** may include a mode selection key, or other hardware or software for switching between text entry and telephony entry.

[0034] In addition to the processing device **1800,** other parts of the mobile device **1000** are shown schematically in FIG. 8. 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** may comprise a two-way RF communications device having voice and data communications capabilities. In addition, the mobile device **1000** may have the capability to communicate with other computer systems via the Internet.

[0035] Operating system software executed by the processing device **1800** may be 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.**

[0036] 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 may be capable of organizing and managing data items, such as e-mail, calendar events, voice mails, appointments, and task items. The PIM application may also be capable of sending and receiving data items via a wireless network **1401.** The PIM data items may be 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.

[0037] 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, 3G, UMTS, 4G, etc.

[0038] 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 utilizes a subscriber identity module, commonly referred to as a SIM card, in order to operate on a GPRS network.

[0039] 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 networks) via the antenna **1560.**

[0040] 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.**

[0041] 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, track ball, 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.**

[0042] 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.

[0043] 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.

[0044] Many modifications and other embodiments will come to the mind of one skilled in the art having the ben-

efit 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;
   at least one wireless communications circuit carried by said portable housing; and
   a wrap-around antenna assembly carried by said portable housing and comprising
   a substrate comprising a first portion and a second portion extending outwardly therefrom defining an L-shape,
   a wrap-around antenna element lying along adjacent contiguous exterior surfaces of said first and second substrate portions,
   an antenna feed arm lying along an interior surface of the first substrate portion and electrically coupled to said wrap-around antenna element, and
   a feed arm extension electrically coupled to said antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

2. The mobile wireless communications device of Claim 1 wherein said feed arm extension has a distal end defining a gap from adjacent portions of said wrap-around antenna element.

3. The mobile wireless communications device of Claim 2 wherein the gap is not greater than 2 mm.

4. The mobile wireless communications device of Claim 1 wherein said feed arm extension has a distal end electrically coupled to adjacent portions of said wrap-around antenna element.

5. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna element and said feed arm extension provide pentaband operation.

6. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna assembly further comprises a floating, electrically conductive coupler element adjacent said feed arm extension.

7. The mobile wireless communications device of Claim 6 wherein said floating, electrically conductive coupler element is spaced apart from and generally parallel to said feed arm extension.

8. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna assembly further comprises a monopole antenna element carried by said first portion of said substrate.

9. The mobile wireless communications device of Claim 1 further comprising a printed circuit board (PCB) carried by said portable housing and carrying said at least one wireless RF circuit; and wherein said substrate is carried by said PCB.

10. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna element comprises an inverted-F antenna element.

11. The mobile wireless communications device of Claim 1 wherein said at least one wireless RF circuit comprises at least one cellular transceiver.

12. A method for making a wrap-around antenna assembly for a mobile wireless communications device comprising a portable housing and at least one wireless communications circuit carried by the portable housing, the wrap-around antenna assembly comprising:

    forming a substrate comprising a first portion and a second portion extending outwardly therefrom defining an L-shape;
    positioning a wrap-around antenna element along adjacent contiguous exterior surfaces of the first and second substrate portions;
    positioning an antenna feed arm along an interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element; and
    electrically coupling a feed arm extension to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

13. The method of Claim 12 wherein the feed arm extension has a distal end defining a gap from adjacent portions of the wrap-around antenna element.

14. The method of Claim 13 wherein the gap is not greater than 2 mm.

15. The method of Claim 12 wherein the feed arm extension has a distal end electrically coupled to adjacent portions of the wrap-around antenna element.

Amended claims in accordance with Rule 137(2) EPC.

1. A mobile wireless communications device (30) comprising:

a portable housing (31);
at least one wireless communications circuit (32) carried by said portable housing; and
a wrap-around antenna assembly (34) carried by said portable housing and comprising
a substrate (35) comprising a first portion (36) and a second portion (37) extending outwardly therefrom defining an L-shape, each of the first and second substrate portions having respective interior surfaces and respective exterior surfaces relative to said portable housing,
a wrap-around antenna element (40) lying along adjacent exterior surfaces of said first and second substrate portions,
an antenna feed arm (41) lying along the interior surface of the first substrate portion and electrically coupled to said wrap-around antenna element, and
a feed arm extension (42) electrically coupled to said antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

2. The mobile wireless communications device of Claim 1 wherein said feed arm extension has a distal end adjacent portions of said wrap-around antenna element defining a gap (44') from the adjacent portions of said wrap-around antenna element.

3. The mobile wireless communications device of Claim 2 wherein the gap is not greater than 2 mm.

4. The mobile wireless communications device of Claim 1 wherein said feed arm extension has a distal end electrically coupled to adjacent portions of said wrap-around antenna element.

5. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna element and said feed arm extension are arranged to provide pentaband operation.

6. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna assembly further comprises an electrically floating, electrically conductive coupler element (50) adjacent said feed arm extension.

7. The mobile wireless communications device of Claim 6 wherein said electrically floating, electrically conductive coupler element is spaced apart from and generally parallel to said feed arm extension.

8. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna assembly further comprises a monopole antenna element (51) carried by said first portion of said substrate.

9. The mobile wireless communications device of Claim 1 further comprising a printed circuit board (PCB) (33) carried by said portable housing and carrying said at least one wireless RF circuit; and wherein said substrate is carried by said PCB.

10. The mobile wireless communications device of Claim 1 wherein said wrap-around antenna element comprises an inverted-F antenna element.

11. The mobile wireless communications device of Claim 1 wherein said at least one wireless RF circuit comprises at least one cellular transceiver.

12. A method for making a wrap-around antenna assembly (34) for a mobile wireless communications device (30) comprising a portable housing (31) and at least one wireless communications circuit (32) carried by the portable housing, the wrap-around antenna assembly comprising:

forming a substrate (35) comprising a first portion (36) and a second portion (37) extending outwardly therefrom defining an L-shape, each of the first and second substrate portions having respective interior surfaces and respective exterior surfaces relative to the portable housing;
positioning a wrap-around antenna element (40) along adjacent exterior surfaces of the first and second substrate portions;
positioning an antenna feed arm (41) along the interior surface of the first substrate portion and electrically coupled to the wrap-around antenna element; and
electrically coupling a feed arm extension (42) to the antenna feed arm and extending from the interior surface of the first substrate portion around to the exterior surface thereof.

13. The method of Claim 12 wherein the feed arm extension has a distal end adjacent portions of the wrap-around antenna element defining a gap (44') from the adjacent portions of said wrap-around antenna element.

14. The method of Claim 13 wherein the gap is not greater than 2 mm.

15. The method of Claim 12 wherein the feed arm extension has a distal end electrically coupled to adjacent portions of the wrap-around antenna element.

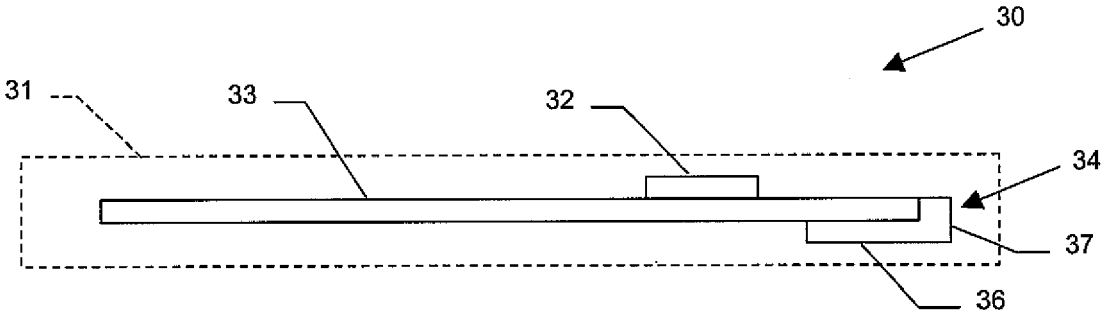

FIG. 1

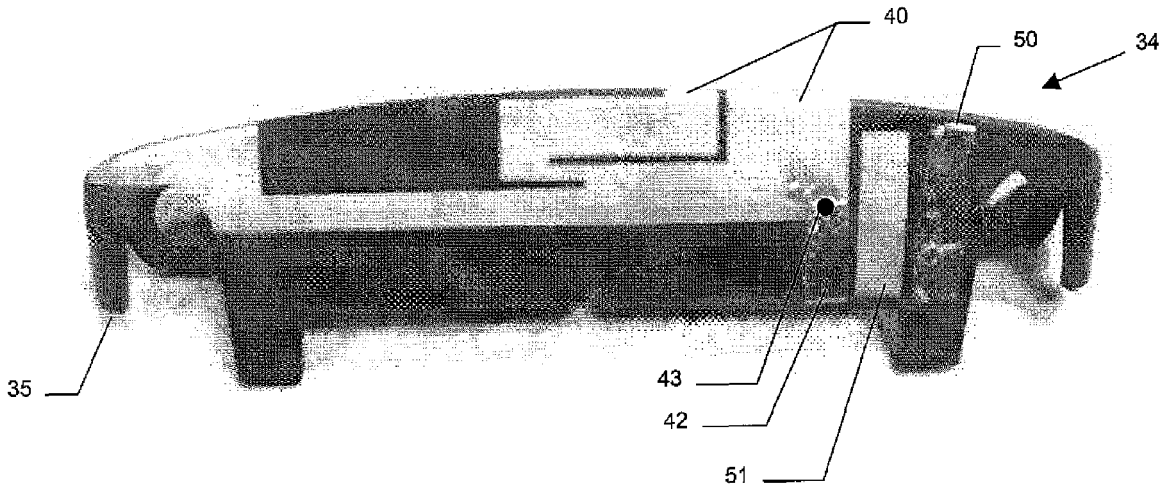

FIG. 2

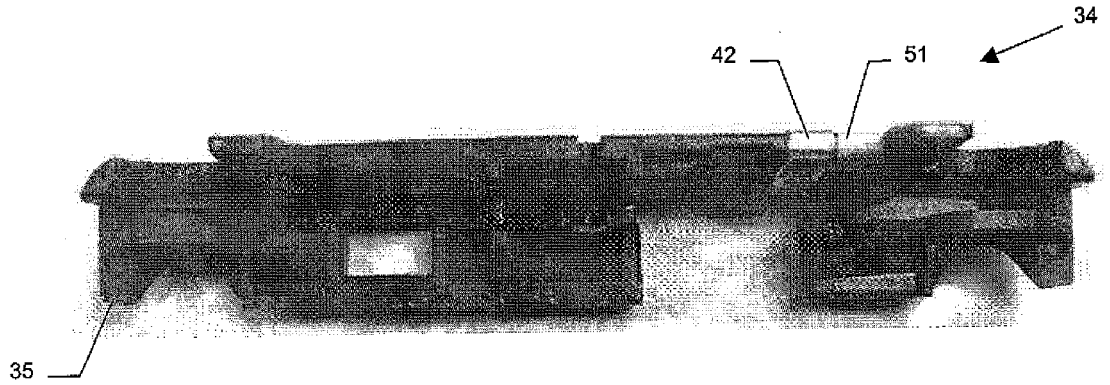

FIG. 3

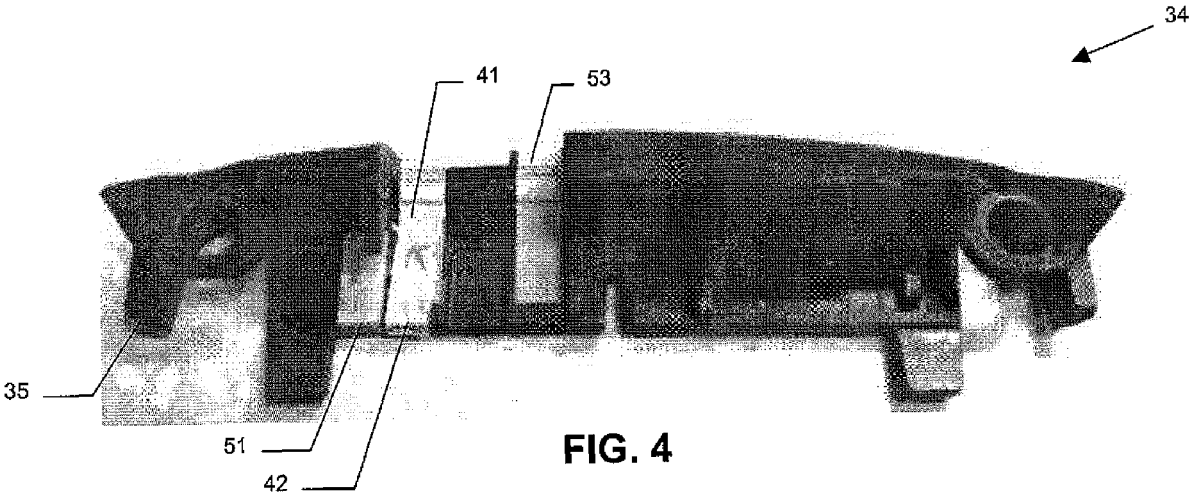

FIG. 4

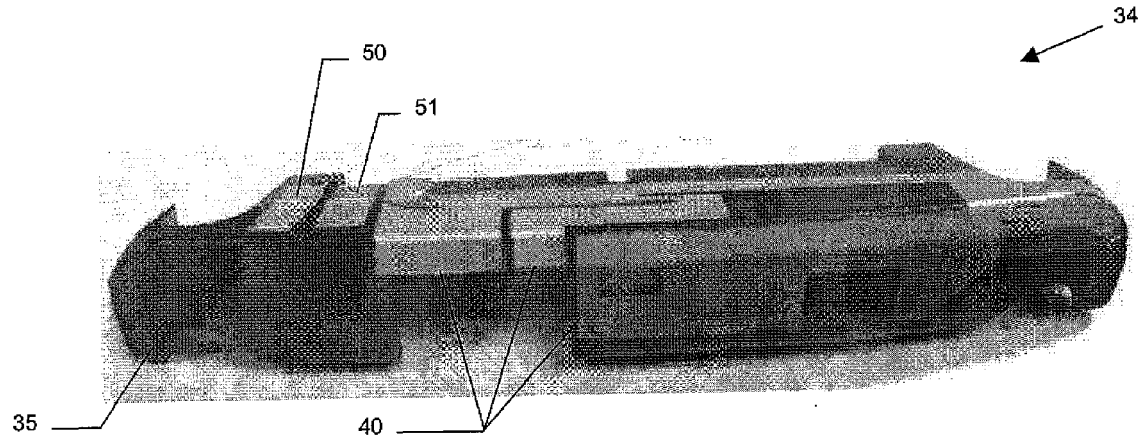

FIG. 5

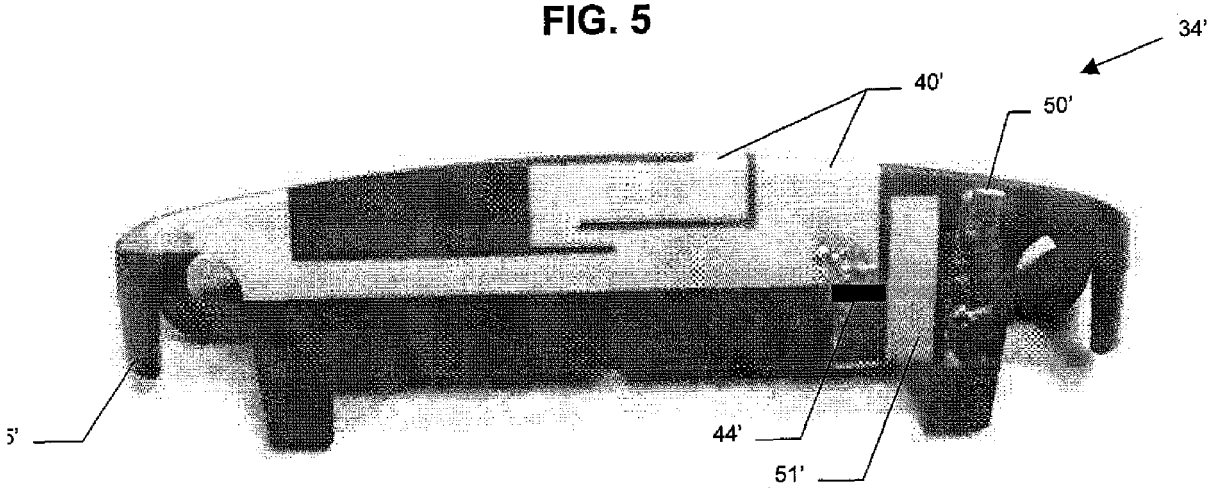

FIG. 6

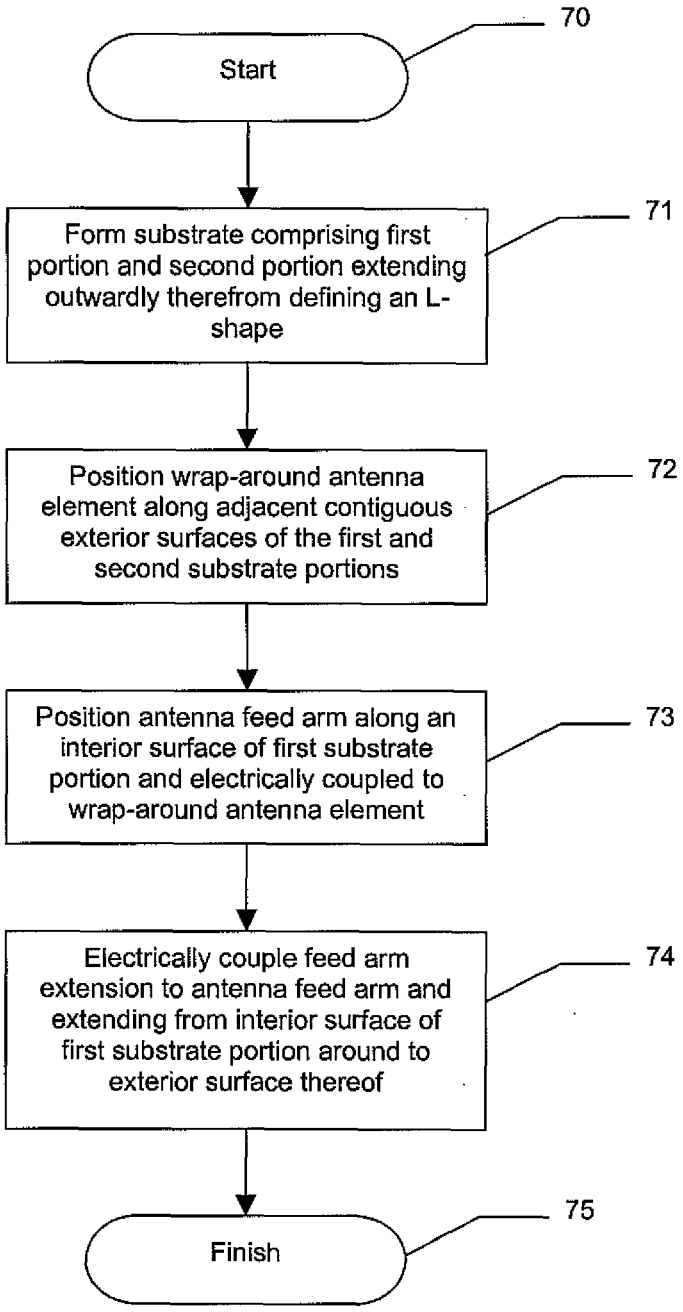
70
Start
71
Form substrate comprising first portion and second portion extending outwardly therefrom defining an L-shape
72
Position wrap-around antenna element along adjacent contiguous exterior surfaces of the first and second substrate portions
73
Position antenna feed arm along an interior surface of first substrate portion and electrically coupled to wrap-around antenna element
74
Electrically couple feed arm extension to antenna feed arm and extending from interior surface of first substrate portion around to exterior surface thereof
75
Finish

FIG. 7

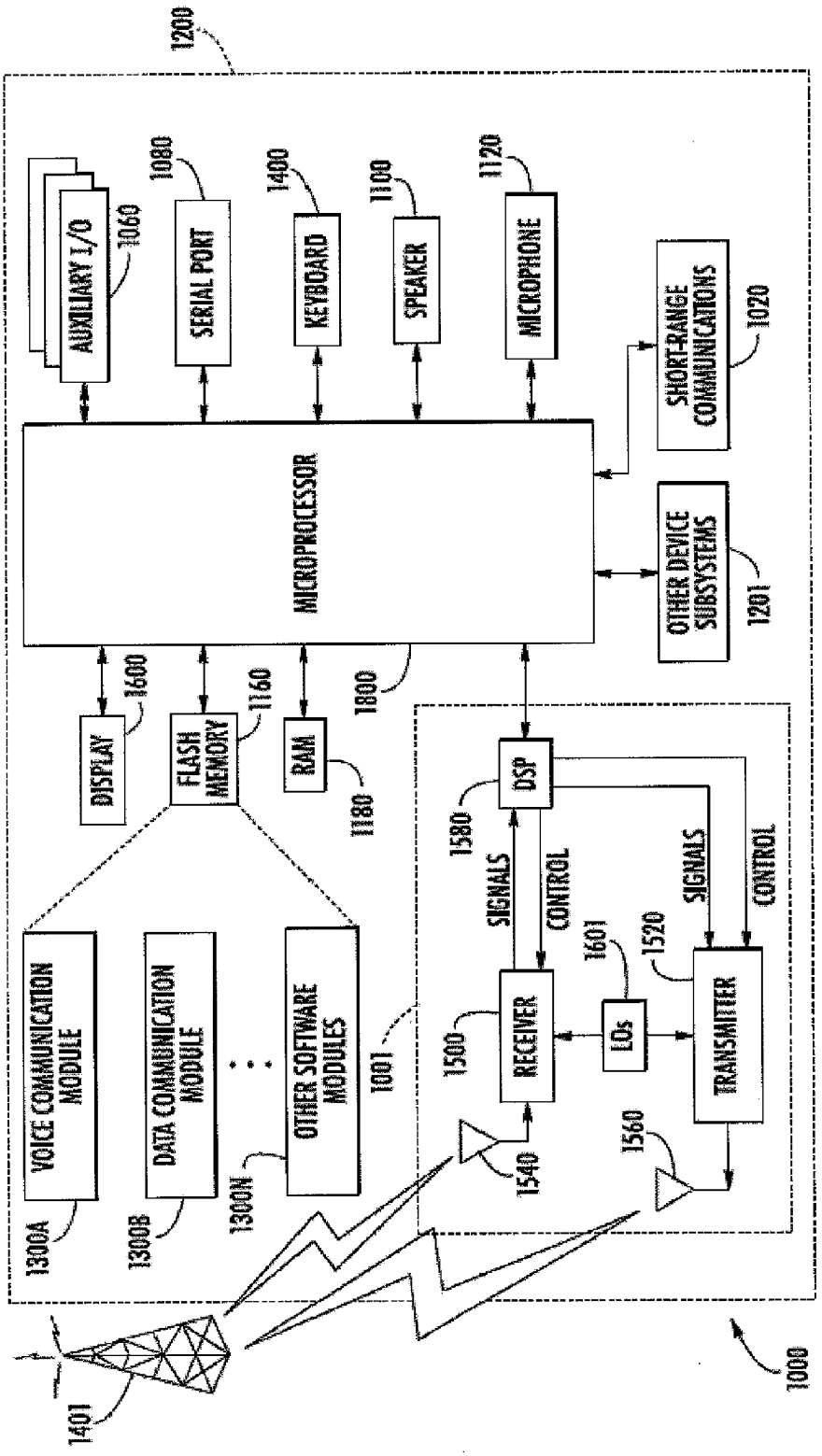
1200
AUXILIARY I/O
1060
SERIAL PORT
1080
KEYBOARD
1400
SPEAKER
1100
MICROPHONE
1120
SHORT-RANGE COMMUNICATIONS
1020
MICROPROCESSOR
OTHER DEVICE SUBSYSTEMS
1201
1800
DISPLAY
1600
FLASH MEMORY
1160
RAM
1180
DSP
1580
SIGNALS
CONTROL
SIGNALS
CONTROL
1601
1520
VOICE COMMUNICATION MODULE
DATA COMMUNICATION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

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 4926

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 October 2009	Wattiaux, Véronique

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