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(71) Applicant: **Research In Motion Limited**
Waterloo, ON N2L 3W8 (CA)

(72) Inventors:
- **Yang, Shing Lung Steven**
  Rolling Meadows, IL 60008 (US)
- **Badaruzzaman, Firass Mirza**
  Rolling Meadows, IL 60008 (US)
- **Rojas, Brian Francisco**
  Rolling Meadows, IL 60008 (US)

(74) Representative: **Roberts, Gwilym Vaughan et al**
Kilburn & Strode LLP
20 Red Lion Street
London WC1R 4PJ (GB)

(54) Mobile wireless communications device including antenna assembly having spaced apart parallel conductor arms and related methods

(57) A mobile wireless communications device may include a portable housing (31), at least one wireless transceiver (33) carried by the portable housing, and at least one satellite positioning signal receiver (34) carried by the portable housing. The mobile wireless communications device may also include an antenna assembly (35) carried by the portable housing. The antenna assembly may include a base electrical conductor (36) having a pair of antenna feed points (37a,b) defined therein and coupled to the at least one wireless transceiver and the at least one satellite signal positioning receiver. The antenna assembly may also include first and second conductor arms (43,44) being spaced apart, parallel, and extending outwardly from the base electrical conductor.

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Description

Technical Field

[0001] The present disclosure generally relates to the field of wireless 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 almost 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 top plan view of a mobile wireless communications device including an antenna assembly in accordance with one example embodiment.

[0005] FIG. 2 is a schematic block diagram of the device of FIG. 1.

[0006] FIG. 3 is a perspective view of a portion of the substrate of the device in FIG. 2 including the antenna.

[0007] FIG. 4a is a simulated current distribution graph for the antenna assembly of FIG. 2 for the common mode.

[0008] FIG. 4b is a simulated current distribution graph for the antenna assembly of FIG. 2 for the slot mode.

[0009] FIG. 5 is a graph of measured return loss and efficiency for an antenna assembly similar to FIG. 2.

[0010] FIG. 6 is a schematic diagram of a flexible substrate and an antenna assembly in accordance with another example embodiment.

[0011] FIG. 7a is a graph of measured efficiency in the global positioning system frequency band for an antenna assembly similar to FIG. 6.

[0012] FIG. 7b is a graph of measured efficiency in the wireless local area network frequency band for an antenna assembly similar to FIG. 6.

[0013] FIG. 7c is a graph of measured S parameters for an antenna assembly similar to FIG. 6.

[0014] FIG. 8 is a schematic block diagram illustrating additional components that may be included in the mobile wireless communications device of FIG. 1.

Detailed Description

[0015] The present description is made with reference to the accompanying drawings, in which various 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 notation is used to indicate similar elements or steps in alternative embodiments.

[0016] In accordance with one exemplary aspect, a mobile wireless communications device may include a portable housing, at least one wireless transceiver carried by the portable housing, and at least one satellite positioning signal receiver carried by the portable housing. The mobile wireless communications device may also include an antenna assembly carried by the portable housing, for example. The antenna assembly may include a base electrical conductor having a pair of antenna feed points defined therein and coupled to the at least one wireless transceiver and the at least one satellite signal positioning receiver. The antenna assembly may also include first and second conductor arms being spaced apart, parallel, and extending outwardly from the base electrical conductor, for example.

[0017] The antenna assembly may further include a dielectric substrate supporting the base electrical conductor and the first and second conductor arms. The dielectric substrate may include a flexible dielectric substrate, for example. The mobile wireless communications device may further include at least one electronic component carried by the dielectric substrate.

[0018] The first and second conductor arms each have a same length, for example. The first and second conductor arms may have a rectangular shape.

[0019] The pair of antenna feed points may include a pair of shorted antenna feed points, for example. The mobile wireless communications device may further include an impedance matching circuit carried by the housing and coupled to the antenna assembly. The antenna assembly may be configured to operate in at least one of a global positioning system (GPS) band, a wireless local area network (WLAN) band, and a personal area network (PAN) band.

[0020] Another example aspect is directed to a mobile wireless communications device that may include a portable housing, at least one wireless transceiver carried by the portable housing, and an antenna assembly carried by the portable housing, for example. The antenna assembly may include a base electrical conductor having

a slot therein defining pair of antenna feed points and coupled to the at least one wireless transceiver. The antenna assembly may further include first and second conductor arms being spaced apart, parallel, and extending outwardly from the base electrical conductor, the first and second conductor arms being angled with respect to the slot.

[0021] A method aspect is directed to a method of making an antenna assembly for a mobile wireless communications device that may include a portable housing, at least one wireless transceiver carried by the portable housing, and at least one satellite positioning signal receiver carried by the portable housing. The method may include forming a base electrical conductor having a pair of antenna feed points and to be coupled to the at least one wireless transceiver, and the at least one satellite positioning signal receiver. The method may also include forming first and second parallel conductor arms being spaced apart, parallel, and extending outwardly from the base electrical conductor.

[0022] Another method aspect is direct to a method of forming a mobile wireless communications device including a portable housing, at least one wireless transceiver carried by the portable housing, and an antenna assembly carried by the portable housing. The method may include forming a base electrical conductor having a slot therein defining pair of antenna feed points and coupled to the at least one wireless transceiver, for example. The method may also include forming first and second conductor arms being spaced apart, parallel, and extending outwardly from the base electrical conductor, the first and second conductor arms being angled with respect to the slot.

[0023] Referring initially to FIGS. 1-3, a mobile wireless communications device **30** illustratively includes a portable housing **31** and a dielectric substrate **32,** for example, a printed circuit board (PCB), carried by the portable housing. The portable housing **31** has an upper portion and a lower portion. A wireless transceiver **33** is carried by the portable housing **31.** In some embodiments, not shown, the dielectric substrate **32** may be replaced by or used in conjunction with a metal chassis or other substrate. The dielectric substrate **32** may also include a conductive layer (not shown) defining a ground plane.

[0024] A satellite positioning signal receiver **34** is also carried by the portable housing **31.** The satellite positioning signal receiver **34** may be a Global Positioning System (GPS) satellite receiver, for example.

[0025] The exemplary device **30** further illustratively includes a display **60** and a plurality of control keys including an "off hook" (i.e., initiate phone call) key **61,** an "on hook" (i.e., discontinue phone call) key **62,** a menu key **63,** and a return or escape key **64.** Operation of the various device components and input keys, etc., will be described further below with reference to FIG. 8.

[0026] The device **30** further illustratively includes an antenna assembly **35** carried adjacent the upper portion of the portable housing **31**. The antenna assembly **35** is advantageously a two-arm planar inverted F-antenna (PIFA) that may be tuned to different frequency bands, for example. The antenna assembly **35** illustratively includes a base electrical conductor **36** supported by the dielectric substrate **32**. The base electrical conductor **36** has a pair of shorted antenna feed points **37a**, **37b** defined therein by a base electrical conductor slot **46**. The pair of shorted antenna feed points **37a**, **37b** may not be defined by the base electrical conductor slot **38**, for example. In other words, the base electrical conductor **37** may not include the base electrical conductor slot **46**. The base electrical conductor slot **46** advantageously tunes the impedance of the antenna assembly **35**. The shorted antenna feed points **37a**, **37b**, are coupled to the wireless transceiver **33** and the satellite positioning receiver **34.** In some embodiments, the antenna feed points **37a**, **37b** may not be shorted. The first and second conductive feeds **47a**, **47b** may be coupled between the shorted feed points **37a**, **37b** and the dielectric substrate **32** to space the antenna assembly above the dielectric substrate **32** (FIG. 3).

[0027] The antenna assembly **35** also includes first and second conductor arms **43**, **44** extending outwardly from the base electrical conductor **36** and supported by the dielectric substrate **32**. The first and second conductor arms **43**, **44** are illustratively rectangular in shape and spaced apart and parallel. In other words, the first and second conductor **43**, **44** arms may resemble a tuning fork. The first and second conductor arms **43**, **44** may be other shapes.

[0028] As will be appreciated by those skilled in the art, the length of the first and second conductor arms **43**, **44** may be tuned to excite the common mode. The first and second arms have an equal length so that they may be tuned to resonate at 1.575 GHz, which is advantageously in the GPS frequency band. Of course, the length of the first and second conductor arms **43**, **44** may be different and may be tuned to resonate at another frequency within another frequency band.

[0029] The length of the slot **41**, or space between the first and second conductor arms **43**, **44** advantageously may be tuned to excite the slot mode. For example, the length of the slot **41** may be tuned to resonate at 2.4 GHz, which is advantageously in the wireless local/personal area network (WLAN/PAN), Bluetooth, WiFi frequency band. Of course, the length of the slot **41** may be tuned to resonate at another frequency within another frequency band.

[0030] A matching circuit **45** may be carried by the housing **31** and/or dielectric substrate **32**, and coupled to the antenna assembly **35**. The matching circuit **45** may further improve impedance matching of the antenna assembly **35**, as will be appreciated by those skilled in the art. Other or additional circuitry or electric components may also be carried by the housing **31** and/or dielectric substrate **32.**

[0031] A controller **38** or processor may also be carried by the PCB **32**. The controller **38** may cooperate with the

other components, for example, the antenna assembly **35**, the satellite positioning signal receiver **34**, and the wireless transceiver **33** to coordinate and control operations of the mobile wireless communications device **30**. Operations may include mobile voice and data operations, including email and Internet data.

[0032] Referring now the graphs **48**, **49** in FIGS. 4a and 4b, respectively, the simulated surface currents for the antenna assembly **35** illustrated in FIGS. 2 and 3 are illustrated. More particularly, the graph **48** in FIG. 4a illustrates the surface current for the antenna assembly **35** operating in the common mode at 1.575 GHz. The graph **49** in FIG. 4b illustrates the surface current for the antenna assembly **35** operating in the slot mode at 2.45 GHz.

[0033] Referring now to the graph **50** FIG. 5, measured performance in free space for an antenna assembly similar to the antenna assembly **35** illustrated in FIGS. 2 and 3 and having a shorted trace with the matching circuit **45** is illustrated. The measured performance is illustratively measured by return loss in dB and efficiency at the given frequencies. The return loss **51** is illustratively reduced near the GPS and WiFi frequency bands, i.e. 1.575 GHz and 2.4 GHz, respectively. The efficiency at the GPS frequency band **52** illustratively about 24%. The efficiency at the WiFi frequency band **53** is illustratively between about 49-52%.

[0034] Referring now to FIG. 6, in another example embodiment, the antenna assembly **35'** may be carried by a flexible dielectric substrate **39'.** The antenna assembly **35'** may be a printed pattern on the flexible dielectric substrate **39'**, or may be implemented thereon by other selective plating technologies, for example, laser direct structuring (LDS) or 2-shot molding.

[0035] The flexible dielectric substrate **39'** may be included with another PCB (not shown), for example, the device PCB, for carrying other components or circuitry, for example, the controller **38',** the display **60',** the wireless transceiver **33'**, and the satellite positioning signal receiver **34'**. The flexible dielectric substrate 39' may advantageously allow for conforming of the antenna assembly **35'** with the back of the portable housing **31'.** The flexible substrate **39'** may include an adhesive layer (not shown), for example, a pressure sensitive adhesive, on an underside thereof to mount with the mobile wireless communications device **30'.** A copper layer (not shown) may be carried on a front side of the flexible substrate **39'.**

[0036] Additional circuitry may be carried by the flexible substrate **39'.** For example, a microphone (not shown) may be carried by the flexible substrate **39'**. A camera flash **59'** may also be carried by the flexible substrate **39'** adjacent ends of the first and second conductor arms **43', 44'** opposite the base electrical conductor **36'**. A switch circuit **53**, may also be carried by the flexible substrate **39'.** Other or different electronic components may be carried by the flexible substrate **39'.**

[0037] The first and second conductor arms **43'**, **44'** are illustratively are spaced apart, parallel, and extend outwardly from the base electrical conductor **36'.** The first and second conductor arms **43', 44'** are angled with respect to the base electrical conductor slot **46'.** Illustratively, the first and second conductor arms **43'**, **44'** are at an angle greater than ninety degrees with respect to the base electrical conductor slot **46'.** In other words, the first and second conductor arms **43'**, **44'** define an L-shape, or more particularly, a lazy L-shape, with respect to the base electrical conductor slot **46'**. Of course, the first and second conductors **43', 44'** may be at any angle with respect to the base electrical conductor slot **46'** or may be at no angle at all, i.e. zero degrees.

[0038] Referring now to the graph in FIG. 7a, the measured GPS efficiency in free space of an antenna assembly similar to that illustrated in FIG. 6 is illustrated. The linear efficiency **81** is about 32% across the GPS frequency band.

[0039] Referring now to the graph in FIG. 7b, the measured WiFi efficiency in free space of the antenna assembly similar to that illustrated in FIG. 6 is illustrated. The linear efficiency **83** is about 40-49% across the WLAN frequency band.

[0040] Referring now to the graph in FIG. 7c, the measured S parameters in free space of the antenna assembly similar to that illustrated in FIG. 6 is illustrated. The return loss **85** in dB is reduced in the 1.49-1.59 GHz frequency band (i.e. GPS), and 2.37-2.5 GHz frequency band (i.e. WLAN).

[0041] The dual band functionality of the antenna assembly **35** may be particularly useful in the design of a mobile wireless communications device, for example, the mobile wireless communications device **30.** The antenna assembly 35 advantageously reduces space occupied in the housing **31** and cost as compared to using two individual antennas, for example. Indeed, while the size of the antenna assembly **35** may be reduced, the performance of the antenna assembly may be maintained, for example, to support requirements of different wireless service carriers.

[0042] A method aspect is directed to a method of making an antenna assembly **35** for a mobile wireless communications device **30** that includes a portable housing **31,** a wireless transceiver **33** carried by the portable housing, and a satellite positioning signal receiver **34** carried by the portable housing. The method includes forming a base electrical conductor **36** to have a pair of antenna feed points **37a**, **37b** and to be coupled to the wireless transceiver **33**, and the satellite positioning signal receiver **34**. The method also includes forming first and second parallel conductor arms **43**, **44** to be spaced apart, parallel, and extend outwardly from the base electrical conductor **36**.

[0043] Another method aspect is directed to a method of forming a mobile wireless communications device **30** including a portable housing **31**, a wireless transceiver **33** carried by the portable housing, and an antenna assembly **35** carried by the portable housing. The method includes forming a base electrical conductor **36** having

a slot **46** therein defining pair of antenna feed points **37a**, **37b** and coupled to the wireless transceiver **33**. The method also includes forming first and second conductor arms **43**, **44** being spaced apart, parallel, and extending outwardly from the base electrical conductor **36**. The first and second conductor arms **43**, **44** are angled with respect to the slot **46**.

[0044] Example components of a mobile wireless communications device **1000** that may be used in accordance with the above-described embodiments are further described below with reference to FIG. 8. The device **1000** illustratively includes a housing **1200**, a keyboard or keypad **1400** and an output device **1600**. The output device shown is a display **1600**, which may comprise 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**.

[0045] 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.

[0046] 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**, **110fl** 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 data and, optionally, voice communications capabilities. In addition, the mobile device **1000** may have the capability to communicate with other computer systems via the Internet.

[0047] Operating system software executed by the processing device **1800** is 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**.

[0048] 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 corresponding data items stored or associated with a host computer system.

[0049] 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, 4G, etc.

[0050] 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 typically involves use of a subscriber identity module, commonly referred to as a SIM card, in order to operate on a GPRS network.

[0051] 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**.

[0052] 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**.

[0053] 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 may also be used to 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**.

[0054] 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 audit I/0 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.

[0055] 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, a Bluetaoth™ communications module to provide for communication with similarly-enabled systems and devices, or a near field communications (NFC) sensor for communicating with a NFC device or NFC tag via NFC communications.

[0056] Many modifications and other embodiments of the invention 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 the invention is not to be limited to the specific embodiments disclosed, and that modifications and embodiments are intended to be included within the scope of the appended claims.

Claims

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

a portable housing (31);
at least one wireless transceiver (33) carried by said portable housing (31);
at least one satellite positioning signal receiver (34) carried by said portable housing (31); and
an antenna assembly (35) carried by said portable housing (31) and comprising
a base electrical conductor (36) having a pair of antenna feed points (37a, 37b) defined therein and coupled to said at least one wireless transceiver (33) and said at least one satellite signal positioning receiver (34), and
first and second conductor arms (47a, 47b) being spaced apart, parallel, and extending outwardly from said base electrical conductor (36).

2. The mobile wireless communications device (30) according.to Claim 1, wherein said antenna assembly (35) further comprises a dielectric substrate (32) supporting said base electrical conductor (36) and said first and second conductor arms (47a, 47b). ..

3. The mobile wireless communications device (30) according to Claim 2, wherein said dielectric substrate (32) comprises a flexible dielectric substrate (39) .

4. The mobile wireless communications device (30) according to Claim 2, further comprising at least one electronic component carried by said dielectric substrate (32).

5. The mobile wireless communications device (30) according to Claim 1, wherein said first and second conductor arms (47a, 47b) each has a same length.

6. The mobile wireless communications device (30) according to Claim 1, wherein said first and second conductor arms (47a, 47b) have a rectangular shape.

7. The mobile wireless communications device (30) according to Claim 1, wherein the pair of antenna feed points (37a, 37b) comprises a pair of shorted antenna feed points (37a, 37b).

8. The mobile wireless communications device (30) according to Claim 1, further comprising an impedance matching circuit (45) carried by said housing (31) and coupled to said antenna assembly (35) .

9. The mobile wireless communications device (30) according to Claim 1, wherein said antenna assembly (35) is configured to operate in at least one of a global positioning system (GPS) band, a wireless local area network (WLAN) band, and a personal area network (PAN) band.

10. A method of making an antenna assembly (35) for a mobile wireless communications device (30) comprising a portable housing (31), at least one wireless transceiver (33) carried by the portable housing (31), and at least one satellite positioning signal receiver (34) carried by the portable housing (31), the method comprising:

forming a base electrical conductor (36) having a pair of antenna feed points (37a, 37b) and to be coupled to the at least one wireless transceiver (33), and the at least one satellite positioning signal receiver (34); and
forming first and second parallel conductor arms (43, 44) being spaced apart, parallel, and extending outwardly from the base electrical conductor (36).

11. The method according to Claim 10, further comprising forming the base electrical conductor (36) and the first and second conductor arms (43, 44) on a dielectric substrate (32).

12. The method according to Claim 11, wherein the dielectric substrate (32) comprises a flexible dielectric substrate (39).

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 transceiver (33) carried by said portable housing (31);
at least one satellite positioning signal receiver (34) carried by said portable housing (31); and
an antenna assembly (35) carried by said portable housing (31) and comprising

a base electrical conductor (36) having a pair of antenna feed points (37a, 37b) defined therein and coupled to said at least one wireless transceiver (33) and said at least one satellite signal positioning receiver (34), and
first and second conductor arms (47a, 47b) having a same length, being spaced apart, parallel, and extending outwardly from said base electrical conductor (36),
the same length of said first and second conductor arms defining a common mode tuned to an operating frequency of said at least one satellite positioning signal receiver,
space between said first and second conductor arms defining a slot mode tuned to an operating frequency of said at least one wireless transceiver.

2. The mobile wireless communications device (30) according to Claim 1, wherein said antenna assembly (35) further comprises a dielectric substrate (32) supporting said base electrical conductor (36) and said first and second conductor arms (47a, 47b).

3. The mobile wireless communications device (30) according to Claim 2, wherein said dielectric substrate (32) comprises a flexible dielectric substrate (39).

4. The mobile wireless communications device (30) according to Claim 2, further comprising at least one electronic component carried by said dielectric substrate (32).

5. The mobile wireless communications device (30) according to Claim 1, wherein said first and second conductor arms (47a, 47b) have a rectangular shape.

6. The mobile wireless communications device (30) according to Claim 1, wherein the pair of antenna feed points (37a, 37b) comprises a pair of shorted antenna feed points (37a, 37b).

7. The mobile wireless communications device (30) according to Claim 1, further comprising an impedance matching circuit (45) carried by said housing (31) and coupled to said antenna assembly (35).

8. The mobile wireless communications device (30) according to Claim 1, wherein said antenna assembly (35) is configured to operate in at least one of a global positioning system (GPS) band, a wireless local area network (WLAN) band, and a personal area network (PAN) band.

9. A method of making a mobile wireless communications device (30) comprising a portable housing (31), at least one wireless transceiver (33) carried by the portable housing (31), and at least one satellite positioning signal receiver (34) carried by the portable housing (31), the method comprising:

forming an antenna assembly by at least
forming a base electrical conductor (36) having a pair of antenna feed points (37a, 37b) and to be coupled to the at least one wireless transceiver (33), and the at least one satellite positioning signal receiver (34), and
forming first and second parallel conductor arms (43, 44) having a same length, being spaced apart, parallel, and extending outwardly from the

base electrical conductor (36),
the same length of said first and second conductor arms defining a common mode tuned to an operating frequency of the at least one satellite positioning signal receiver,
space between said first and second conductor arms defining a slot mode tuned to an operating frequency of the at least one wireless transceiver.

10. The method according to Claim 9, further comprising forming the base electrical conductor (36) and the first and second conductor arms (43, 44) on a dielectric substrate (32).

11. The method according to Claim 10, wherein the dielectric substrate (32) comprises a flexible dielectric substrate (39).

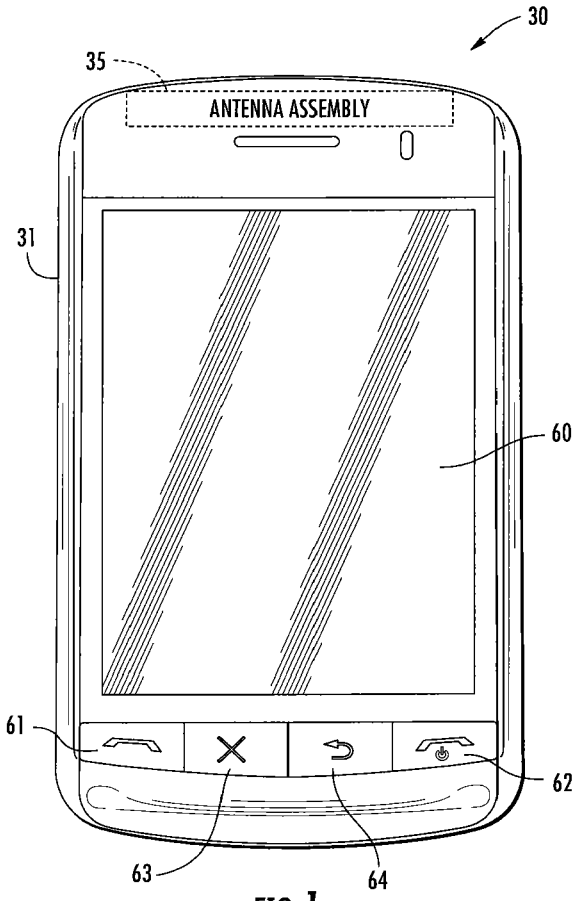
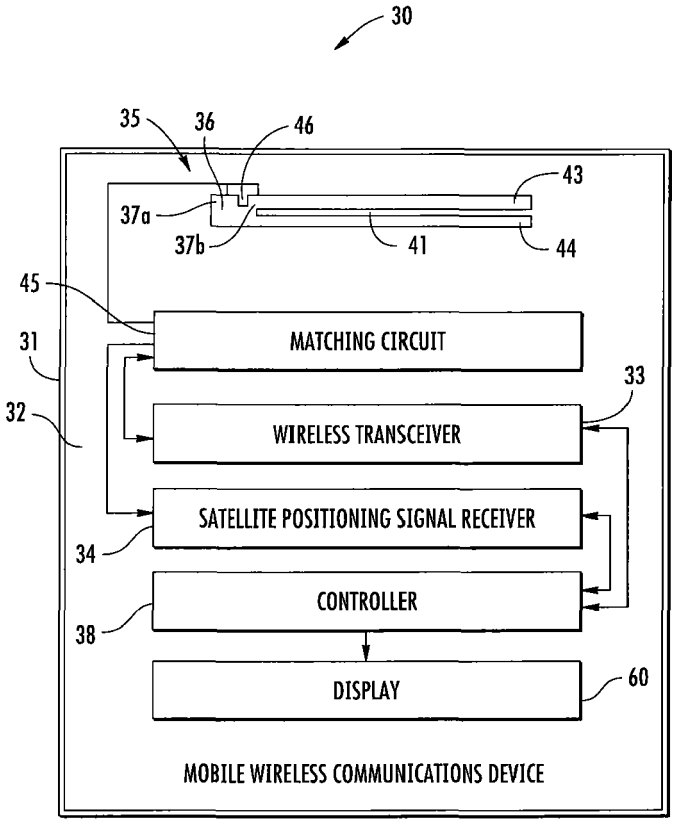


FIG. 1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33
MATCHING CIRCUIT
WIRELESS TRANSCEIVER
SATELLITE POSITIONING SIGNAL RECEIVER
34
CONTROLLER
38
DISPLAY
60
MOBILE WIRELESS COMMUNICATIONS DEVICE

FIG. 2

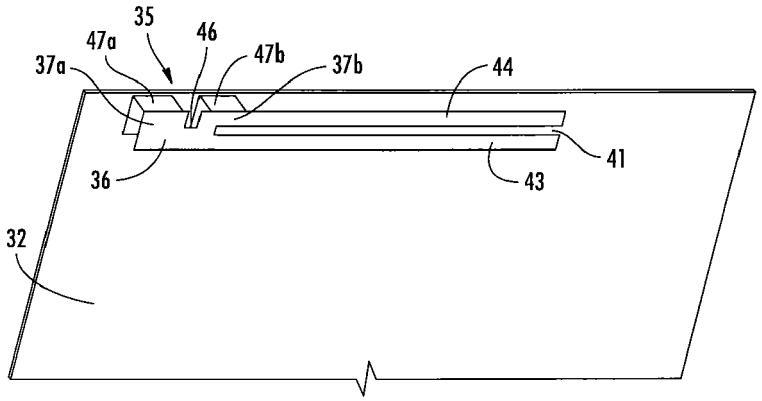

FIG. 3

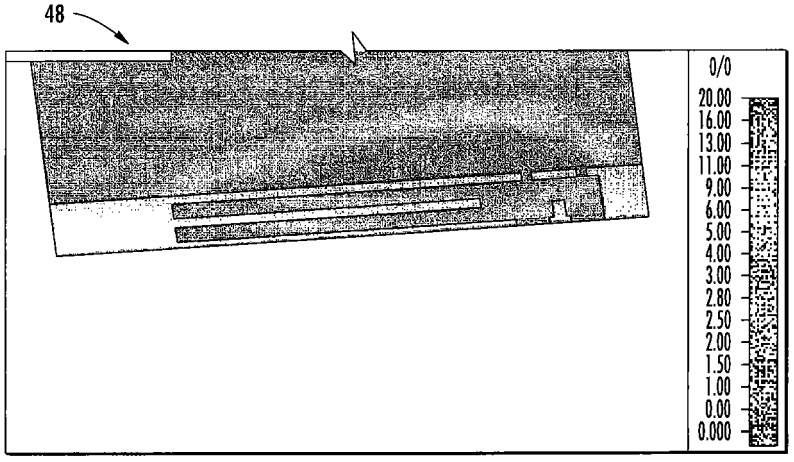
48
0/0
20.00
16.00
13.00
11.00
9.00
6.00
5.00
4.00
3.00
2.80
2.50
2.00
1.50
1.00
0.00
0.000

FIG. 4A

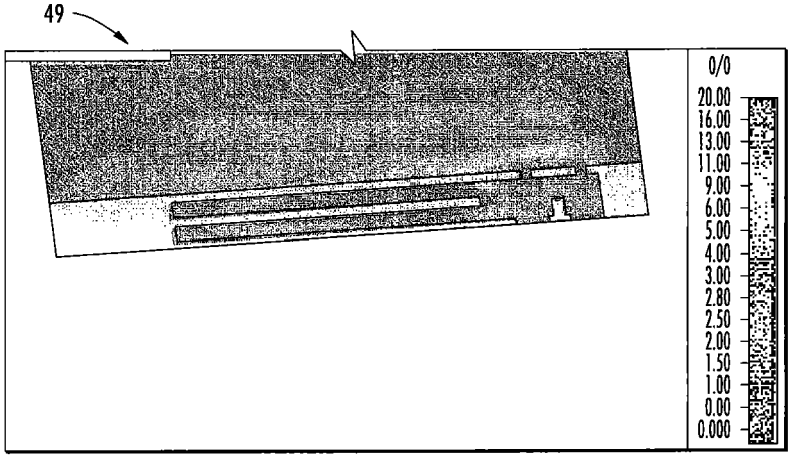
49
0/0
20.00
16.00
13.00
11.00
9.00
6.00
5.00
4.00
3.00
2.80
2.50
2.00
1.50
1.00
0.00
0.000

FIG. 4B

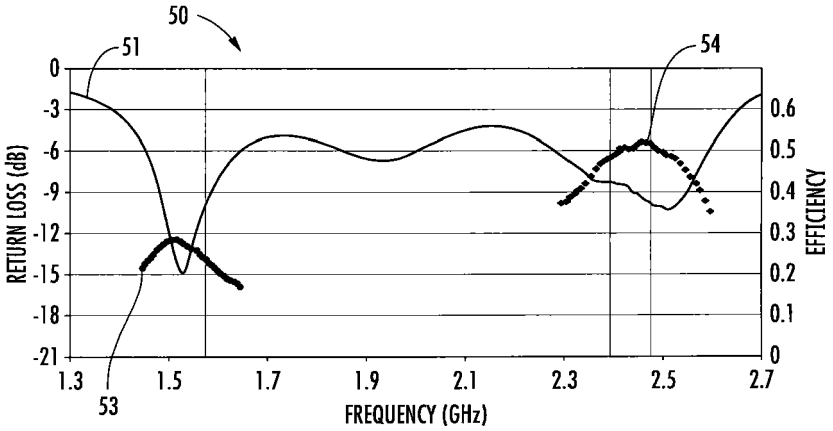
50
51
54
53
0
-3
-6
-9
-12
-15
-18
-21
RETURN LOSS (dB)
0.6
0.5
0.4
0.3
0.2
0.1
0
EFFICIENCY
1.3
1.5
1.7
1.9
2.1
2.3
2.5
2.7
FREQUENCY (GHz)

FIG. 5

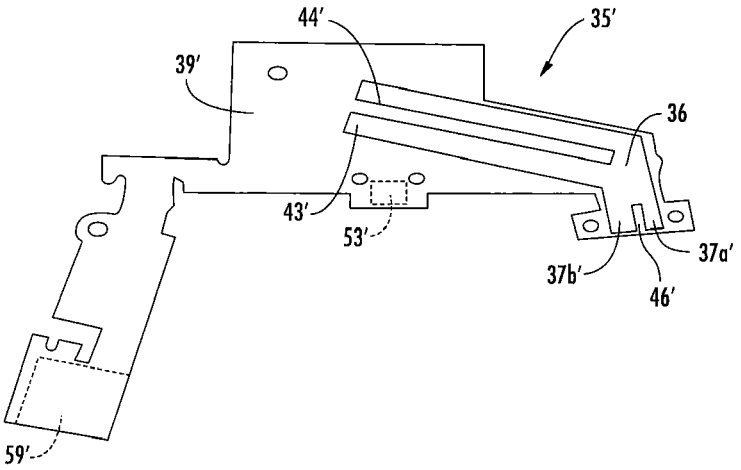

FIG. 6

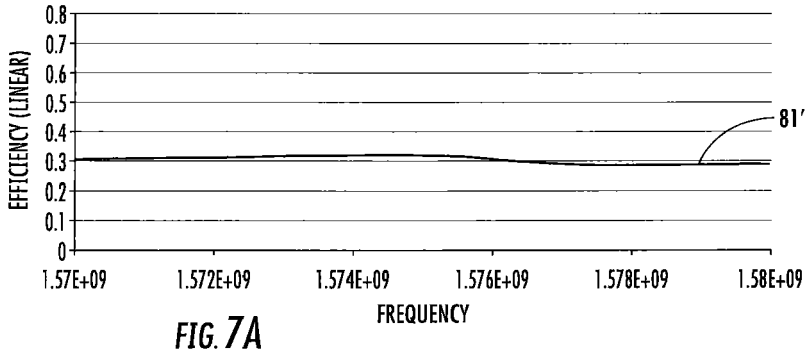

FIG. 7A

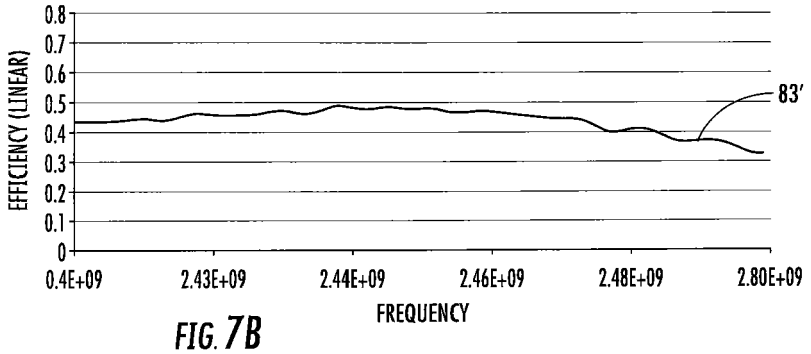

FIG. 7B

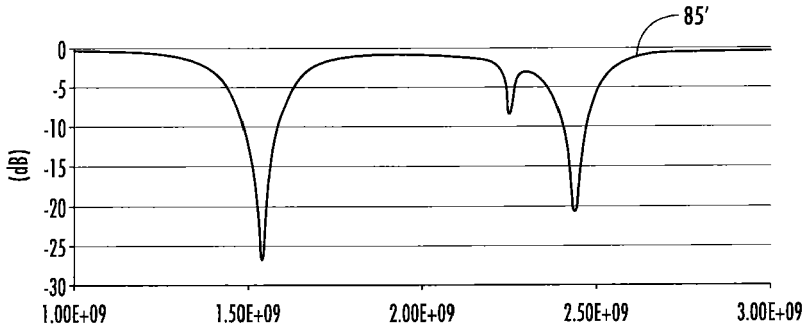

FIG. 7C

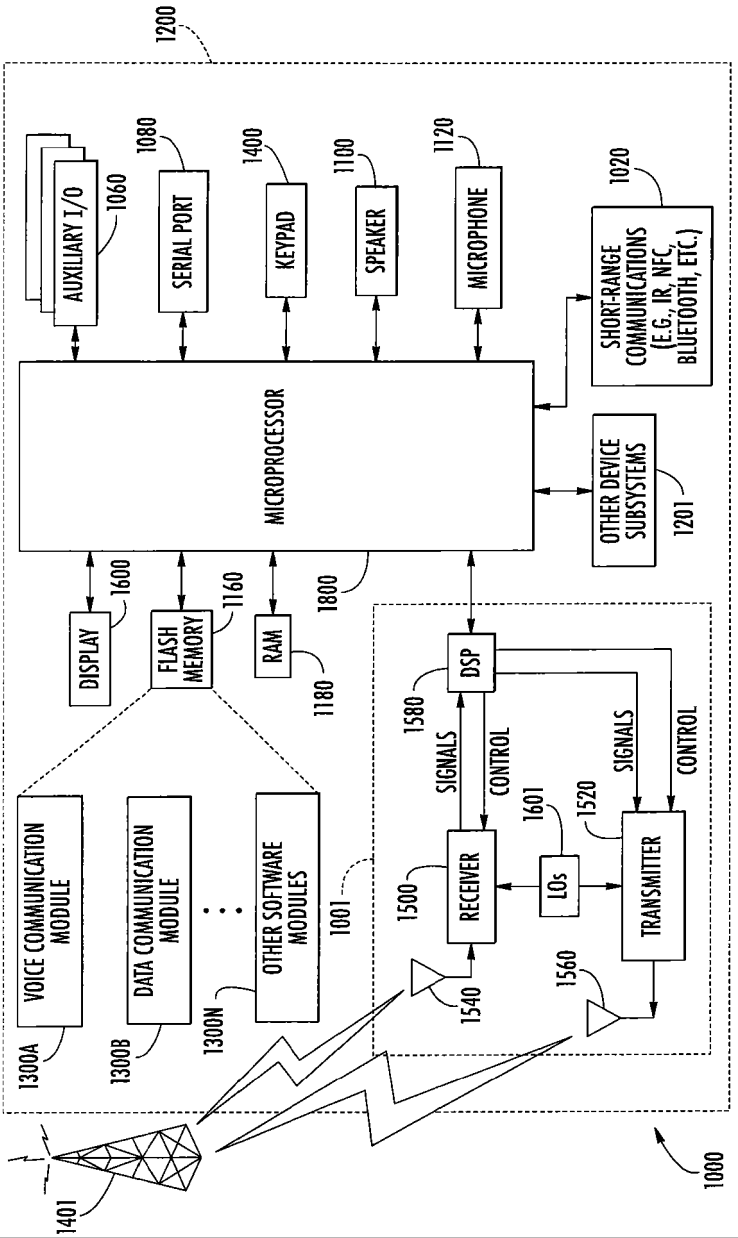
1200
AUXILIARY I/O
1060
SERIAL PORT
1080
KEYPAD
1400
SPEAKER
1100
MICROPHONE
1120
SHORT-RANGE COMMUNICATIONS (E.G., IR, NFC, BLUETOOTH, ETC.)
1020
MICROPROCESSOR
OTHER DEVICE SUBSYSTEMS
1201
1800
DISPLAY
1600
FLASH MEMORY
1160
RAM
1180
DSP
1580
SIGNALS
CONTROL
SIGNALS
CONTROL
1601
1520
RECEIVER
1500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

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 6999

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 00/36700 A1 (ERICSSON TELEFON AB L M [SE]) 22 June 2000 (2000-06-22) * page 8, line 13 - line 29; figure 4 *	1-12	INV. H01Q1/24 H01Q9/04 H01Q13/10
X	JP 2008 160319 A (NISSEI ELECTRIC CO LTD) 10 July 2008 (2008-07-10) * abstract *	1-3,6-12	H01Q5/00
X	US 2007/152881 A1 (CHAN YIU K [US]) 5 July 2007 (2007-07-05) * paragraph [0059] - paragraph [0060]; figure 8 *	1-4,6-12	
X	WO 2008/009391 A2 (FRACTUS SA [ES]; MUMBRU JOSEPH [ES]; PUENTE BALIARDES CARLES [ES]; ILA) 24 January 2008 (2008-01-24) * paragraph [0087]; figure 17h * * paragraph [0108] *	1-3,6,7, 9-12	
X	US 2005/162321 A1 (COLBURN JOSEPH S [US] ET AL) 28 July 2005 (2005-07-28) * paragraph [0025] - paragraph [0032]; figures 1,2 * * paragraph [0002] *	1-3,5-12	TECHNICAL FIELDS SEARCHED (IPC) H01Q
A	US 2004/090372 A1 (NALLO CARLO DI [US] ET AL) 13 May 2004 (2004-05-13) * paragraph [0059] - paragraph [0061]; figures 5-7 *	1-12	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 October 2011	Kaleve, Abraham

CATEGORY OF CITED DOCUMENTS

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18-10-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0036700 A1	22-06-2000	AU 3092500 A	03-07-2000
		CN 1357163 A	03-07-2002
		DE 19983824 T1	07-03-2002
		GB 2363911 A	09-01-2002
		JP 4409773 B2	03-02-2010
		JP 2002533001 A	02-10-2002
		TW 461140 B	21-10-2001
		US 6343208 B1	29-01-2002
JP 2008160319 A	10-07-2008	NONE	
US 2007152881 A1	05-07-2007	WO 2007079107 A2	12-07-2007
WO 2008009391 A2	24-01-2008	EP 2041834 A2	01-04-2009
		US 2009243943 A1	01-10-2009
		US 2008018543 A1	24-01-2008
US 2005162321 A1	28-07-2005	NONE	
US 2004090372 A1	13-05-2004	NONE	

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