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(54) Title: WEARABLE DEVICE WITH COMMUNICATION INTERFACE

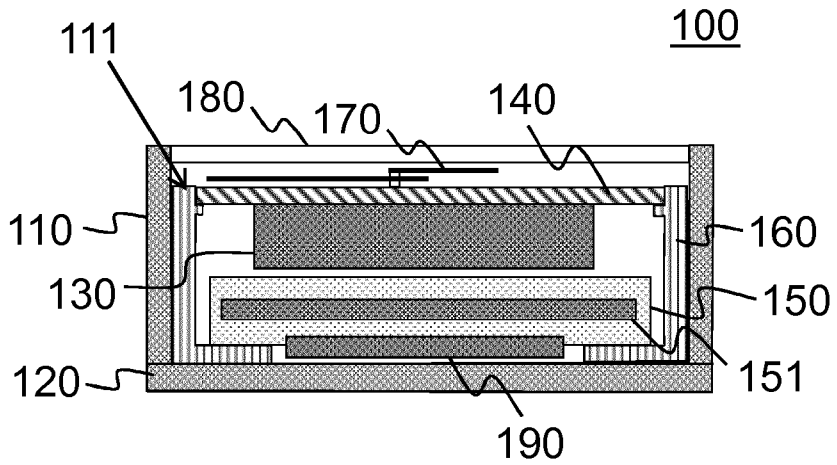

Fig. 1

(57) Abstract: A watch comprising a watch movement; a watch dial; and a communication interface for transceiving radio frequency signals; and a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface; wherein the watch dial comprising an antenna for the communication interface, the watch dial being isolated from the housing using an isolator, and the antenna together with the watch dial and the housing providing a radiator configured to resonate in at least one frequency band.

WEARABLE DEVICE WITH COMMUNICATION INTERFACE

TECHNICAL FIELD

The invention relates to apparatuses, such as wearable devices, with communication interfaces for wireless connections. More specifically, the invention relate to portable electronic devices, such as watches, that transfer data using Bluetooth Low Energy standard.

BACKGROUND ART

Portable apparatuses, such as mobile phones, tablets and personal computers have ever increasing demand for a high-speed data access. Furthermore, an antenna system of the apparatus may be arranged to operate in a plurality of different operational radio frequency bands and via a plurality of different protocols. For example, the different frequency bands and protocols may include (but are not limited to) Long Term Evolution (LTE) 700 (US) (698.0 - 716.0 MHz, 728.0 -746.0 MHz), LTE 1500 (Japan) (1427.9 - 1452.9 MHz, 1475.9 - 1500.9 MHz), LTE 2600 (Europe) (2500 - 2570 MHz, 2620 - 2690 MHz), amplitude modulation (AM) radio (0.535-1.705 MHz); frequency modulation (FM) radio (76-108 MHz); Bluetooth (2400-2483.5 MHz); wireless local area network (WLAN) (2400-2483.5 MHz); helical local area network (HLAN) (5150-5850 MHz); global positioning system (GPS) (1570.42-1580.42 MHz); US - Global system for mobile communications (US-GSM) 850 (824-894 MHz); European global system for mobile communications (EGSM) 900 (880-960 MHz); European wideband code division multiple access (EU-WCDMA) 900 (880-960 MHz); personal communications network (PCN/DCS) 1800 (1710-1880 MHz); US wideband code division multiple access (US-WCDMA) 1900 (1850-1990 MHz); wideband code division multiple access (WCDMA) 2100 (Tx: 1920-1980 MHz Rx: 2110-2180 MHz); personal communications service (PCS) 1900 (1850- 1990 MHz); ultra

wideband (UWB) Lower (3100-4900 MHz); UWB Upper (6000-10600 MHz); digital video broadcasting - handheld (DVB-H) (470-702 MHz); DVB-H US (1670-1675 MHz); digital radio mondiale (DRM) (0.15-30 MHz); worldwide interoperability for microwave access (WiMax) (2300-2400 MHz, 2305-2360 MHz, 2496-2690 MHz, 3300-3400 MHz, 3400-3800 MHz, 5250-5875 MHz); digital audio broadcasting (DAB) (174.928-239.2 MHz, 1452.96- 1490.62 MHz); radio frequency identification low frequency (RFID LF) (0.125-0.134 MHz); radio frequency identification high frequency (RFID HF) (13.56-13.56 MHz); radio frequency identification ultra-high frequency (RFID UHF) (433 MHz, 865-956 MHz, 2450 MHz).

Some devices may have strict power consumption requirements. For example, low-power electronic devices such as wrist watches, heart rate monitors and other such devices can require that power consumption of the device should be kept at minimum to save battery resources. Many of the currently-available standards for wirelessly communicating between devices consume too much power and the standards often cannot be used when communicating with these low-power devices.

The Bluetooth Specification describes a Bluetooth Low Energy standard (BTLE) that enables data transfer using significantly less power than traditional Bluetooth. The BTLE standard can be used to communicate with some of these lower-power devices without consuming too much power.

With the ever increasing demand on different radio accesses, also the look and design of the mobile apparatus is of greater importance. Consumers may desire personalized and high-class design for their apparatuses. However, many of the materials suitable for high-class design are conductive. If such materials are used for a cover of the mobile apparatus comprising radio communication interface, the performance of the radio may be heavily affected. The conductive material may be radio frequency non-transparent and block the radio signals. Furthermore, if the mobile apparatus comprises a watch, for example, further conductive materials are comprised by the mechanical movement or the dial of the watch, for example.

These components provide a high value object and allow intricate decoration, however they also result in a faraday cage, preventing the antenna from working.

The radio performance degrades and may not meet design requirements. Thus, an apparatus is needed to provide low-power non-cellular radio frequency functionality for a communication interface that is operable as an internal antenna of a mobile apparatus with an improved performance and outer design.

SUMMARY

According to a first example aspect of the invention there is provided a watch comprising:

a watch movement;

a watch dial; and

a communication interface for transceiving radio frequency signals; and

a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface; wherein the watch dial comprising an antenna for the communication interface, the watch dial being isolated from the housing using an isolator, and the antenna together with the watch dial and the housing providing a radiator configured to resonate in at least one frequency band.

In an embodiment, the conductive material comprising at least one of the following:

solid metal;

stainless steel;

titanium;

aluminium;

gold;

plated metal; and

electroplated plastic.

In an embodiment, the watch dial is connected to the watch movement and the watch dial and the watch movement being isolated from the housing using an isolator.

In an embodiment, the isolator comprises a plastic isolator.

In an embodiment, the communication interface comprises Bluetooth Low Energy interface.

In an embodiment, the watch further comprising a transparent window made of sapphire on top of the watch dial and attached to a top of the housing.

In an embodiment, the watch further comprising a battery for providing drive power of the watch movement and the communication interface.

In an embodiment, the watch further comprising a back plate attached to a bottom of the housing.

In an embodiment, the watch dial is connected to the watch movement and the battery; and the watch dial, the watch movement and the battery being isolated from the housing and the back plate using an isolator.

In an embodiment, the isolator comprising the communication interface.

In an embodiment, the isolator is arranged between the watch dial and the housing, and between the back plate and at least one of the following:

the battery; and

the communication interface.

In an embodiment, the watch movement comprising mechanical movement.

In an embodiment, a gap is arranged between the watch dial and the housing by the isolating.

In an embodiment, the communication interface being tuned by adjusting the gap between the watch dial and the housing.

In an embodiment, a watch movement, a watch dial, a housing, and a back plate are formed from metal, and the antenna is comprised by the watch dial, wherein the watch dial overlapping with the watch movement in a planar manner.

According to a second example aspect of the invention there is provided a method for providing a low energy antenna system for a watch comprising a watch movement; a watch dial; a communication interface for transceiving radio frequency signals; and a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface, the method comprising:

connecting an antenna of the communication interface to the watch dial;

isolating the watch dial from the housing using an isolator; and

providing a radiator using the antenna together with the watch dial and the housing configured to resonate in at least one frequency band.

According to a third example aspect of the invention there is provided a wearable device comprising:

a face part;

a communication interface for transceiving radio frequency signals; and

a housing made of conductive material for accommodating the face part and the communication interface; wherein the face part comprising an antenna for the communication interface, the face part being isolated from the housing using an isolator, and the antenna together with the face part and the housing providing a radiator configured to resonate in at least one frequency band.

According to a fourth example aspect of the invention there is provided an apparatus comprising the watch of the first aspect.

Different non-binding example aspects and embodiments of the present invention have been illustrated in the foregoing. The above embodiments are used merely to explain selected aspects or steps that may be utilized in implementations of the present invention. Some embodiments may be presented only with reference to certain example aspects of the invention. It should be appreciated that corresponding embodiments may apply to other example aspects as well.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows some details of a watch in which various embodiments of the invention may be applied;

Fig. 2 presents a schematic view of a watch in which various embodiments of the invention may be applied;

Fig. 3 presents an example block diagram of an apparatus in which various embodiments of the invention may be applied; and

Fig.4 shows operations in an apparatus in accordance with an example embodiment of the invention.

DETAILED DESCRIPTION

In the following description, like numbers denote like elements.

Fig. 1 shows some details of a watch 100 in which various embodiments of the invention may be applied.

In an embodiment, a watch 100 comprises a housing 110 made of conductive material. Such material may comprise, for example, solid metal; stainless steel; titanium; aluminium; gold; plated metal; or electroplated plastic. The housing may

comprise one or more housing parts, such as a back plate 120. The watch 100 further comprises a watch movement 130. The movement 130 may be mechanical, quartz or automatic movement. The back plate 120 may be made of glass as well.

Furthermore, the watch 100 comprises a face or a dial 140. The dial 140 may be made of conductive material, such as metal or brass and the dial may be plated or painted. The watch also comprises a communication interface 150 for transceiving radio frequency signals. The housing 110, 120 is configured to accommodate the watch movement, the watch dial and the communication interface. The watch dial 140 may comprise an antenna for the communication interface 150 and the watch dial 140 may be isolated from the housing 110, 120 using an isolator 160.

At least one pointer 170 may be operationally connected to the movement 130 to present watch related information to the user of the watch 100. The watch 100 may further comprise a transparent window 180 made of sapphire on top of the watch dial 140 and attached to a top of the housing 110.

In an embodiment, the watch dial 140 is connected to the watch movement 130 and both the watch dial 140 and the watch movement 130 are isolated from the housing 110, 120 using an isolator 160. As shown in Fig. 1, the isolator 160 may extend around the dial 140 and the movement 150 in horizontal and vertical directions. The isolator 160 may also extend around the communication interface 150 and between the communication interface 150 and the back plate 120. The isolator may comprise, for example, a plastic isolator.

In an embodiment, the transparent window 180 is made of sapphire on top of the watch dial and attached to a top of the housing. Alternatively, the window may be made of glass or plastic, for example.

Sapphire is a single crystal material, i.e. it is grown as a continuous large single crystal without grain boundaries. Such a single crystal may be grown before cutting to a desired size and shape for an optical element.

The sapphire single crystal, i.e., Al2O3, is used for usage of wider range, because it has higher hardness and toughness. The single crystal of sapphire may be pulled, growing a seed crystal in contact with the surface of the molten alumina to produce the single crystal into a larger single crystal, so as to generally work the single crystal into the desired shape.

In an embodiment, the sapphire crystal is either cut or grown so that a specific plane within the crystal is parallel to the sheet orientation of the sapphire. Hence sapphire may be referred to as A-plane or C-plane sapphire, for example. Thus for A-plane sapphire the A-plane is parallel to a screen direction of the optical element.

Sapphire single crystal is an anisotropic material. This means that the material has different mechanical properties (strength, hardness, optical properties etc.) depending on the direction of the crystal. In simplest terms, A-plane sapphire is generally the strongest plane whilst C-plane has the best optical properties.

In an embodiment, the communication interface 150 of the watch 100comprises Bluetooth Low Energy (BTLE) interface.

BTLE is a low energy communications protocol which allows efficient communication between electronic devices. This technology has not been implemented earlier in a watch with a mechanical movement, metal or composite case and a dial.

BTLE technology allows a watch with a mechanical movement, metal, ceramic, or composite case and a dial, to communicate, receive notifications and control a smartphone. However, luxury watches comprise traditionally metal movements housed in metal or composite casings and dials. Such components provide a high value object and allow decoration. However they also result in a faraday cage, preventing the internal antenna from working. Because of that, no mechanical

movement, metal or composite case and dial watches can be integrated with BTLE.

In an embodiment, the dial 140 and the movement 130 are isolated from the case 110, 120 and the antenna of the communication interface is integrated to the dial 140. The antenna may be tuned to allow the system to resonate at the correct frequency.

The mechanical watch movement 130 is cradled in a non-conductive material 160 isolating it from the watch case 110, 120. The dial 140 is mounted onto the movement 130. Between the dial and the housing 110 there is a gap 111. The gap 111 may be filled with an isolating material corresponding to the isolator 160 as in Fig. 1. The antenna system for the communication interface may be tuned by adjusting the gap 111 between the dial 140 and the case 110, 120.

In an embodiment, the dial 140 and the mechanical movement 130 are electrically connected. The dial 140 is not connected to the metal case 110.

In an embodiment, the watch dial 140 is isolated from the housing 110, 120 over a gap 111 with an isolator 160, and the antenna together with the watch dial 140 and the housing 110, 120 providing a radiator configured to resonate in at least one frequency band.

In an embodiment, the communication interface 150 is not electrically connected to the movement 130 and the dial 140. A battery 190 may be placed between the communication interface 150 and the back plate 120. The battery 190 may provide drive power of the watch movement and the communication interface or just of the communication interface.

In an embodiment, the isolator 160 comprises the communication interface 150. The communication interface 150 may thus be integral to the isolator 160.

There may also be a gap between the movement 130 and the battery 190 so that they are not connected. The communication interface 150 may comprise a printed circuit board (PCB) 151. The PCB 151 and the battery 190 may be isolated in antenna sense. For other operation they are of course connected.

In an embodiment, the antenna of the communication interface can be tuned in different ways. The most important parameter is the distance or gap 111 between the edge of the dial 140 and the watch case or housing 110, 120. The antenna of the communication interface can also be tuned by impedance matching of the system. Another gap may be arranged between the battery 190 and the back plate 120. Such gap may be used for tuning as well.

Thus, BTLE can be integrated into a metal or composite watch housing, with metal mechanical movement and metal or composite dial. Thus the watch design is improved and decoration techniques enhanced. Also the strength of the watch may be improved, compared to using plastic housing, for example.

In an embodiment, the watch movement 130, the watch dial 140, the housing 110 and the back plate 120 are formed from metal, and the antenna is comprised by the watch dial 140, wherein the watch dial 140 overlaps with the watch movement 130 in a planar manner.

In an embodiment, an apparatus may comprise a wearable device such as a watch, or a jewellery. The apparatus may comprise, for example, a watch comprising a watch movement; a watch dial; a communication interface for transceiving radio frequency signals; and a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface; wherein the watch dial comprising an antenna for the communication interface, the watch dial being isolated from the housing using an isolator, and the antenna together with the watch dial and the housing providing a radiator configured to resonate in at least one frequency band.

Fig. 2 presents a schematic view of a watch 100, in which various embodiments of the invention may be applied.

The watch 100 is presented from above and illustrates the watch 100 from outside. The watch 100 comprises a housing 110 made of metal, for example. A watch dial 140 comprises an antenna for a communication interface of the watch 100. The antenna may be a ceramic monopole, for example.

In an embodiment, the dial 140 is isolated from housing 110 by a gap 111 from each four sides of the dial 140, as illustrated in Fig. 2. Performance of the antenna may be improved by increasing the gap 111 width. In an embodiment, a 0.3mm gap may be used.

Antenna performance is dependent on the overall mechanical structure of the watch 100. Not only the antenna of the dial 140 radiates but radiation also comes from the watch body 110 via coupling between the dial 140 and the body 110.

In an embodiment, the antenna may be a ceramic C-coupled antenna.

In an embodiment, the gap 111 between the metal dial 140 and the housing 110 affects the antenna performance. Increasing the gap 111 results better performance. Improved performance is achieved if gap width of minimum 0.5 mm is utilized. The gap 111 needs to go around the dial 140. That is, there must not be any contact between dial 140 and the housing 110.

In an embodiment, the gap 111 may be filled with different materials, for example with plastics. Material of the gap 111 affects antenna tuning and thus must be known. There must also be a gap in z-direction so that the housing 110 is not supporting the dial 140 from below.

In an embodiment, a bracelet or jewelry comprises an integral full metal housing. The housing comprises a communication interface for transceiving radio frequency signals. The housing is made of conductive material for accommodating also the

bracelet and/or jewelry comprising a face or a side. The face or the side comprises an antenna for the communication interface, the face of the side being isolated over a gap from the housing using an isolator, and the antenna together with the face or side and the housing providing a radiator configured to resonate in at least one frequency band.

In an embodiment, a wearable device comprises a face part, such as a cover part that faces to an external direction other than towards the user of the device. The device comprises a communication interface for transceiving radio frequency signals; and a housing made of conductive material for accommodating the face part and the communication interface; wherein the face part comprising an antenna for the communication interface, the face part being isolated from the housing using an isolator, and the antenna together with the face part and the housing providing a radiator configured to resonate in at least one frequency band.

Fig. 3 presents an example block diagram of an apparatus 300 in which various embodiments of the invention may be applied. The apparatus 300 may be a watch, a personal training device, a wrist attached navigation device or such with wireless communication capabilities.

The general structure of the apparatus 300 comprises a housing 340, a communication interface 350 including with at least one antenna 370, a processor 310, and a memory 320 coupled to the processor 310. The apparatus 300 further comprises software 330 stored in the memory 320 and operable to be loaded into and executed in the processor 310. The software 330 may comprise one or more software modules and can be in the form of a computer program product. The apparatus 300 further comprises a dial 360 comprising the antenna 370, wherein the dial being isolated from the housing 340 over a gap.

The processor 310 may be, e.g. a central processing unit (CPU), a microprocessor, a digital signal processor (DSP), a graphics processing unit, or the like. Fig. 3 shows one processor 310, but the apparatus 300 may comprise a plurality of processors.

The memory 320 may be for example a non-volatile or a volatile memory, such as a read-only memory (ROM), a programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), a random-access memory (RAM), a flash memory, a data disk, an optical storage, a magnetic storage, a smart card, or the like. The apparatus 300 may comprise a plurality of memories. The memory 320 may be constructed as a part of the apparatus 300 or it may be inserted into a slot, port, or the like of the apparatus 300 by a user. The memory 320 may serve the sole purpose of storing data, or it may be constructed as a part of an apparatus serving other purposes, such as processing data.

The apparatus 300 may further comprise a user interface 380 with circuitry for receiving input from a user of the apparatus 300, e.g., via a key, or a knob, graphical user interface shown on the display of the user apparatus 300, speech recognition circuitry, or an accessory device, such as a headset, and for providing output to the user via, e.g., a graphical user interface or a loudspeaker. The display of the user interface 380 may comprise a touch-sensitive display.

The communication interface module 350 implements at least part of radio transmission. The communication interface module 350 may comprise, e.g., a wireless interface module. The wireless interface may comprise such as near field communication (NFC), Bluetooth, Bluetooth Low Energy (BTLE), or radio frequency identification (RF ID) radio module. The communication interface module 350 may be integrated into the user apparatus 300, or into an adapter, card or the like that may be inserted into a suitable slot or port of the apparatus 300. The communication interface module 350 may support one radio interface technology or a plurality of technologies. The apparatus 300 may comprise a plurality of communication interface modules 350.

A skilled person appreciates that in addition to the elements shown in Fig. 3, the apparatus 300 may comprise other elements, such as microphones, displays, as well as additional circuitry such as input/output (I/O) circuitry, memory chips, application-specific integrated circuits (ASIC), processing circuitry for specific

purposes such as source coding/decoding circuitry, channel coding/decoding circuitry, ciphering/deciphering circuitry, and the like. Additionally, the apparatus 300 may comprise a disposable or rechargeable battery (not shown) for powering.

In an embodiment, the antenna 370 does not physically feed into the dial 360, but the antenna 370 may be located on a printed circuit board (PCB). At least one of the dial 360 and the movement 130 may be tuned and resonated with the antenna 370. Such tuning may be done by adjusting the gap 111.

In an embodiment, grounding of a radiator, such as the antenna 370, the movement 130 or the dial 360 may depend on the design and geometry of a particular watch. For example, the dial/movement radiator may be grounded in to the housing 110, 120 in selected positions.

In an embodiment, an antenna 370 is located on a PCB 151. The antenna 370 may comprise, for example, a ceramic monopole. At least one of the movement 130 and the dial 360 may resonate with the antenna 370. The resonance may be tuned by adjusting the gap 111 between the dial 360 and the housing 110, 120.

Fig. 4 shows operations in an apparatus in accordance with an example embodiment of the invention.

In step 400, a method for providing a low energy antenna system for a watch comprising a watch movement; a watch dial; a communication interface for transceiving radio frequency signals; and a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface is started. In step 410, an antenna of the communication interface is connected to the watch dial. In step 420, the watch dial is isolated from the housing using an isolator. In step 430, a radiator is provided using the antenna together with the watch dial and the housing to resonate in at least one frequency band. In step 440, the method ends.

Various embodiments have been presented. It should be appreciated that in this document, words comprise, include and contain are each used as open-ended expressions with no intended exclusivity.

The foregoing description has provided by way of non-limiting examples of particular implementations and embodiments of the invention a full and informative description of the best mode presently contemplated by the inventors for carrying out the invention. It is however clear to a person skilled in the art that the invention is not restricted to details of the embodiments presented above, but that it can be implemented in other embodiments using equivalent means or in different combinations of embodiments without deviating from the characteristics of the invention.

Furthermore, some of the features of the above-disclosed embodiments of this invention may be used to advantage without the corresponding use of other features. As such, the foregoing description shall be considered as merely illustrative of the principles of the present invention, and not in limitation thereof. Hence, the scope of the invention is only restricted by the appended patent claims.

Claims:

1. A wearable device comprising:

a face part;

a communication interface for transceiving radio frequency signals; and

a housing made of conductive material for accommodating the face part and the communication interface; wherein the face part comprising an antenna for the communication interface, the face part being isolated from the housing using an isolator, and the antenna together with the face part and the housing providing a radiator configured to resonate in at least one frequency band.

2. A watch comprising:

a watch movement;

a watch dial;

a communication interface for transceiving radio frequency signals; and

a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface; wherein the watch dial comprising an antenna for the communication interface, the watch dial being isolated from the housing using an isolator, and the antenna together with the watch dial and the housing providing a radiator configured to resonate in at least one frequency band.

3. The watch of claim 2, wherein the conductive material comprising at least one of the following:

solid metal;

stainless steel;

titanium;

aluminium;

gold;

plated metal; and

electroplated plastic.

4. The watch of claim 2 or 3, wherein the watch dial is connected to the watch movement, and the watch dial and the watch movement being isolated from the housing using an isolator.

5. The watch of any of claims 2 to 4, wherein the isolator comprising a plastic isolator.

6. The watch of any of claims 2 to 5, wherein the communication interface comprises Bluetooth Low Energy interface.

7. The watch of any of claims 2 to 6, further comprising a transparent window made of sapphire on top of the watch dial and attached to a top of the housing.

8. The watch of any of claims 2 to 7, further comprising a battery for providing drive power of the watch movement and the communication interface.

9. The watch of any of claims 2 to 8, further comprising a back plate attached to a bottom of the housing.

10. The watch of any of claims 2 to 9, wherein the watch dial is connected to the watch movement and the battery; and the watch dial, the watch movement and the battery being isolated from the housing and the back plate using an isolator.

11. The watch of any of claims 2 to 10, wherein the isolator comprising the communication interface.

12. The watch of any of claims 2 to 10, wherein the isolator is arranged between the watch dial and the housing and between the back plate and at least one of the following:

the battery; and

the communication interface.

13. The watch of any of claims 2 to 12, wherein the watch movement comprising mechanical movement.

14. The watch of any of claims 2 to 13, wherein a gap is arranged between the watch dial and the housing by the isolating.

15. The watch of claim 14, wherein the communication interface being tuned by adjusting the gap between the watch dial and the housing.

16. The watch of any of claims 2 to 15, wherein a watch movement, a watch dial, a housing, and a back plate are formed from metal, and the antenna is comprised by the watch dial, wherein the watch dial overlapping with the watch movement in a planar manner.

17. An apparatus comprising the watch of any of claims 2 to 16.

18. A method for providing a low energy antenna system for a watch comprising a watch movement; a watch dial; a communication interface for transceiving radio frequency signals; and a housing made of conductive material for accommodating the watch movement, the watch dial and the communication interface, the method comprising:

connecting an antenna of the communication interface to the watch dial;

isolating the watch dial from the housing using an isolator; and

providing a radiator using the antenna together with the watch dial and the housing configured to resonate in at least one frequency band.

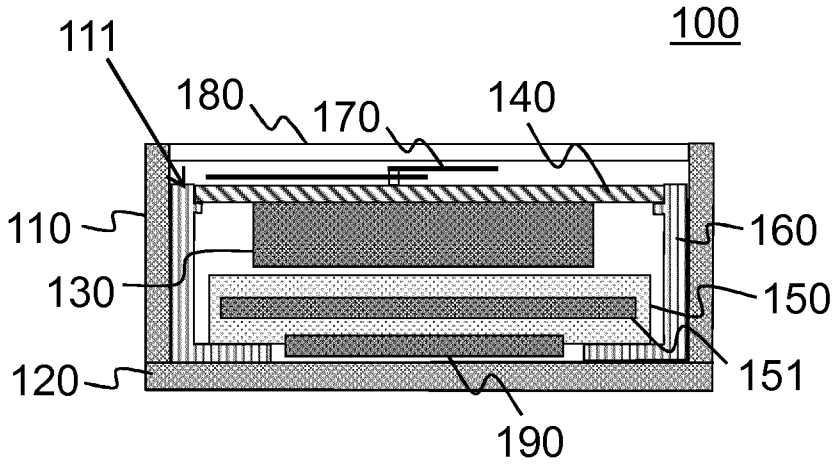

Fig. 1

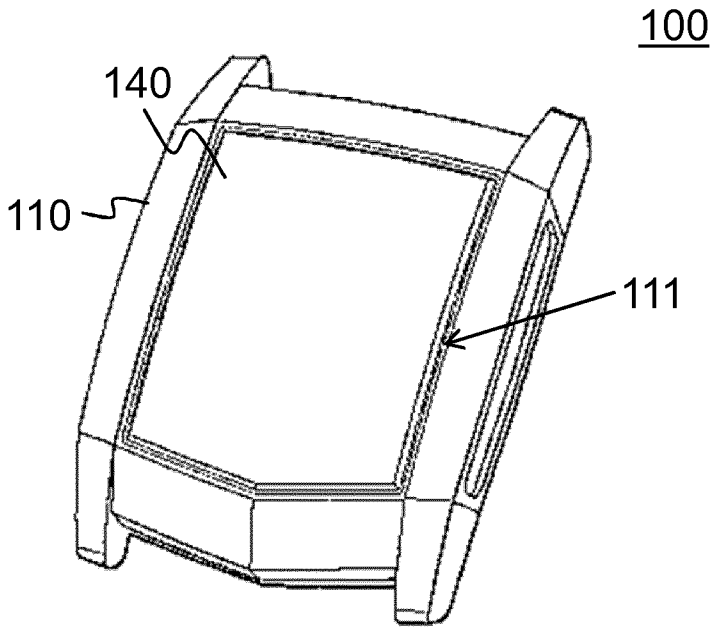

Fig. 2

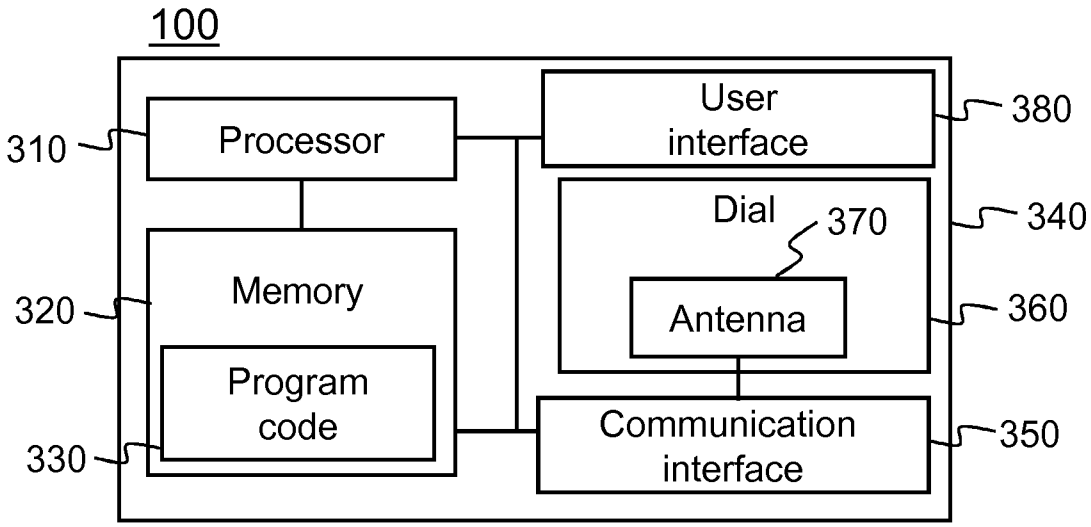
100
Processor
310
User interface
380
Dial
370
340
Memory
320
Antenna
360
Program code
330
Communication interface
350

Fig. 3

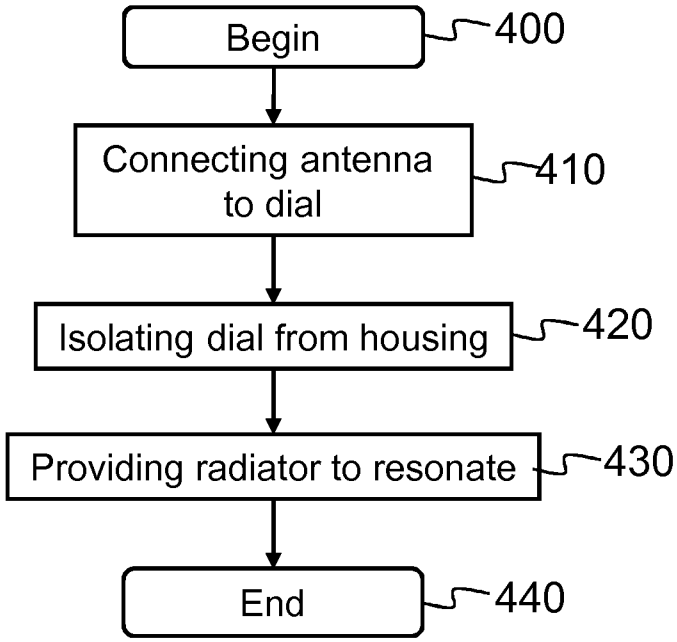
Begin
400
Connecting antenna to dial
410
Isolating dial from housing
420
Providing radiator to resonate
430
End
440

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052232

A. CLASSIFICATION OF SUBJECT MATTER
INV. G04R60/10 G04R20/28 H01Q1/27
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G04R H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 564 236 A2 (CITIZEN WATCH CO LTD [JP] CITIZEN WATCH CO LTD [DE]) 6 October 1993 (1993-10-06)	1-14, 16-18
A	column 4, lines 31-42; figures 1,5 column 6, lines 15,35-37 column 9, line 26 column 11, lines 17-28	15
X	EP 2 093 634 A2 (SEIKO EPSON CORP [JP]) 26 August 2009 (2009-08-26) paragraphs [0086] - [0095]; figure 3	1-13,17, 18
X	US 2012/213039 A1 (AIZAWA TADASHI [JP] ET AL) 23 August 2012 (2012-08-23) paragraphs [0041] - [0050]; figures 2,3	1-3,5-8, 11,13,17

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 October 2014	05/11/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Mérimèche, Habib

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052232

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP 2 495 621 A1 (WINWATCH IP LTD [CH]) 5 September 2012 (2012-09-05) column 12, line 50 - column 13, line 13; figures 6-8 column 15, lines 16-31 column 16, lines 14-21 -----	1-3,6,7, 17,18
X	EP 2 474 872 A2 (SEIKO EPSON CORP [JP]) 11 July 2012 (2012-07-11) paragraphs [0071], [0150] - [0151], [0165], [0175], [0183]; figure 6 -----	1-3,5-9, 11-14, 16-18

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/052232

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