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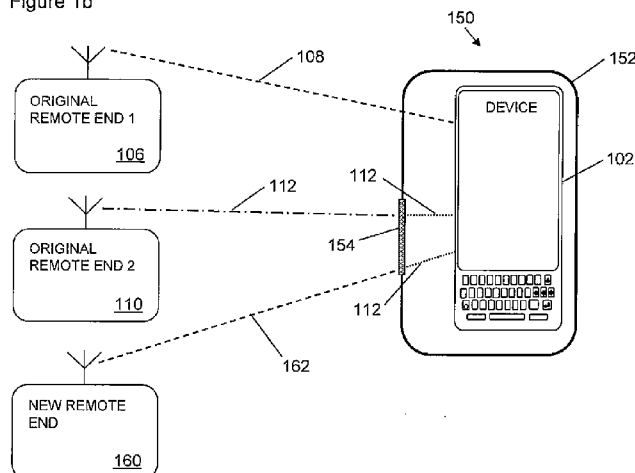
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(54) **Title:** AN APPARATUS AND ASSOCIATED METHODS

Figure 1b



(57) **Abstract:** A radio shield attachment for a portable radio communications device. The radio shield attachment is configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device. The radio shield attachment comprises an inwards wireless radio coupler, an outwards wireless radio antenna and a radio frequency converter. The inwards wireless radio coupler is configured to wirelessly communicate locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device. The outwards wireless radio antenna is configured to wirelessly communicate remotely at a second different radio frequency band. The radio frequency converter is configured to convert radio communications between the shielded radio frequency band and the second different radio frequency band to allow for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.



AN APPARATUS AND ASSOCIATED METHODS

Technical Field

5 The present disclosure relates to the field of radio communications, associated methods, computer programs and apparatus. Certain disclosed aspects/examples relate to portable electronic devices, in particular, so-called hand-portable electronic devices which may be hand-held in use (although they may be placed in a cradle in use). Such hand-portable electronic devices include so-called Personal Digital Assistants (PDAs), mobile telephones,
10 smartphones and other smart devices, and tablet PCs.

The portable electronic devices/apparatus according to one or more disclosed aspects/examples may provide one or more: audio/text/video communication functions such as tele-communication, video-communication, and/or text transmission (Short Message
15 Service (SMS) / Multimedia Message Service (MMS) / emailing functions); interactive/non-interactive viewing functions (such as web-browsing, navigation, TV/program viewing functions); music recording/playing functions such as MP3 or other format, FM/AM radio broadcast recording/playing; downloading/sending of data functions; image capture functions (for example, using a digital camera); and gaming functions.

20

Background

Many portable electronic devices are capable of radio communication. A device may be able to transmit and receive radio communications using one or more frequency bands.
25 Accordingly, the devices are specifically adapted for use in the one or more frequency bands.

The listing or discussion of a prior-published document or any background in this specification should not necessarily be taken as an acknowledgement that the document or background is part of the state of the art or is common general knowledge. One or more
30 aspects/examples of the present disclosure may or may not address one or more of the background issues.

Summary

In a first aspect there is provided a radio shield attachment for a portable radio communications device. The radio shield attachment is configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device. The radio shield attachment comprises an inwards wireless radio coupler, an outwards wireless radio antenna and a radio frequency converter:

the inwards wireless radio coupler configured to wirelessly communicate locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device,

the outwards wireless radio antenna configured to wirelessly communicate remotely at a second different radio frequency band, and

the radio frequency converter configured to convert radio communications between the shielded radio frequency band and the second different radio frequency band to allow for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.

It may not be possible to use a particular device in another different radio frequency band if that device is not configured/manufactured to use that particular different radio frequency band. There may be one or more frequency bands made available for use after a device has been manufactured to operate in other frequency bands. The device may not be able to use these newly available frequency bands if it was not originally manufactured to use them. For example, a new white space frequency band may be made available in a particular area, or may be available to a particular device if that device is moved from one location to another location.

There may exist restrictions on the public use of particular frequency bands for radio communications. For example, in a particular region, there may be one or more frequency bands reserved for use by emergency service communications (police, ambulance, fire service) which are not allowed for use by the general public. Particular frequency bands for

the public, and specific communication operators with operating licences, can also be specific to different countries or regions.

5 A radio shield attachment as disclosed herein allows a device to be readily converted for use with frequency bands which the device was not originally manufactured to be used with. The inwards wireless radio coupler allows a device to receive communications at a frequency which it was not originally designed for use with, by transmitting converted received signals from the radio frequency converter of the radio shield attachment to the device. The outwards wireless radio antenna allows the device to transmit communications at a
10 frequency which it was not originally designed for use with, by transmitting converted signals from the device to the air via the radio shield attachment at a frequency different to that which the device alone (without the radio shield attachment) can operate at.

15 The radio shield attachment can thus inhibit communication transmissions from the device at a locally forbidden frequency by shielding such transmissions and converting communications at that forbidden frequency to an allowed frequency for onward transmission. Thus the radio shield attachment allows ready conversion of an existing device for use with different frequency bands and may prevent illegal transmissions.

20 The second different radio frequency band may be different, at least partially, with respect to the shielded radio frequency band. For example, two different frequency bands may share some frequencies but also each band may include frequencies which the other band does not.

25 In a further aspect there is provided an apparatus comprising a radio shield attachment and a portable radio communications device.

The radio shield attachment may be one of:

- 30 a patch configured to attach to an external cover of the portable radio communications device,
- a replacement external cover of the portable radio communications device, and

an additional external cover configured to attach to and overlie an existing external cover of the portable radio communications device.

The radio shield attachment may be readily attachable/detachable to/from the device and may not require any modifications to the hardware/software of the device to be made. No physical wiring connections may need to be made between the attachment and device, as in certain embodiments, communication between the attachment and the device take place by wireless coupling. The attachment/patch may be attached by use of, for example, an adhesive (which may be a non-permanent adhesive to allow for removal of the patch/attachment if required).

The inwards wireless radio coupler and the outwards wireless radio antenna may share some or all of the same radio frequency transceiver to operate at the shielded radio frequency band and the second different radio frequency band. The inwards wireless radio coupler and the outwards wireless radio antenna may be comprised in the same transceiver configured to operate in both directions, in some examples. The inwards wireless radio coupler and the outwards wireless radio antenna may share at least one of: a processor, a modulator, circuitry and a power source. The inwards wireless radio coupler may be considered applicable for near field communications whereas the outwards wireless radio antenna may be considered applicable for far field wireless communications.

The radio shield attachment may be configured to shield the radio communications emanating from the portable radio communications device by comprising a first layer of electromagnetic shielding material configured to inhibit radio communications from the portable radio communications device at the shielded frequency band. The radio shield attachment may be configured to shield the radio communications emanating from the portable radio communications device by comprising a second layer of radio frequency absorbing material located over the layer of electromagnetic shielding material. The second layer of radio frequency absorbing material and the first layer of electromagnetic shielding together may be configured to inhibit radio communications from the portable radio communications device at the shielded frequency band. The first layer of electromagnetic shielding material may be located between the portable radio communications device and

the second layer of radio frequency absorbing material when the radio shield attachment is located operatively with the portable radio communications device.

The first layer of electromagnetic shielding material may have a thickness of between 0.01 mm and 2 mm. The first layer of electromagnetic shielding material may comprise one or more of: a metal foil, a flexible metal net/mesh, and metal powder distributed within rubber. Different metals, and/or metallic loaded compounds may be used. The electromagnetic shielding material may be flexible for ease of fitting/removal to/over/from the device while providing shielding properties.

The second layer of radio frequency absorbing material may have a thickness of between 0.1 mm and 10 mm. The second layer of radio frequency absorbing material may comprise an energy absorbent foam. The radio frequency absorbing material may be flexible to allow easy fitting and removal of the attachment to/from the device while providing radio frequency shielding properties.

The radio shield attachment may be configured to shield the radio communications emanating from the portable radio communications device by further comprising a low-loss material located proximal to at least one of the inwards wireless radio coupler and the outwards wireless radio antenna of the radio shield attachment to inhibit radio communications emanating from the portable radio communications device at the shielded frequency band. The low-loss material may have a thickness of between 0.5 mm and 5 mm.

The radio shield attachment may be configured to shield the radio communications emanating from the portable radio communications device by further comprising a transparent electromagnetic shielding material configured to be located over a display screen of the portable radio communications device to inhibit radio communications emanating from the portable radio communications device at the shielded frequency band. The transparent electromagnetic shielding material may comprise one or more of: a metal net, a silver net, and a transparent absorbing plastic.

The radio shield attachment may be configured to operate at the shielded radio frequency band and the second different radio frequency bands via one or more of the following categories of radio communication:

cellular network communications;
5 Bluetooth;
wireless local area network (WLAN);
global positioning system (GPS) communications;
global system for mobile communications (GSM);
white space (WS) communications;
10 wide band code division multiple access (WCDMA);
time-division synchronous code division multiple access (TD-SCDMA);
code division multiple access 2000 (CDMA2000);
frequency modulated (FM) radio communications;
near field communications (NFC);
15 digital video broadcasting – handheld (DVB-H);
long-term evolution (LTE) time division duplexing (TDD); and
long-term evolution (LTE) frequency division duplexing (FDD).

The radio shield attachment may be configured to operate at the shielded radio frequency
20 band and the second different radio frequency band within the same category of radio communication.

The radio shield attachment may comprise a battery configured to provide power to the radio shield attachment to power one or more of the transceivers, converter and shielding. This
25 may advantageously allow the radio shield attachment to be used without a battery of the device being drained by powering the attachment. The radio shield attachment may be configured to be powered by an internal power source for the portable radio communications device to provide power to the radio shield attachment to power one or more of the transceivers, converter and shielding. This may advantageously allow the radio shield
30 attachment to be manufactured without requiring a dedicated power supply/battery (but with appropriate wired/wireless connectors), which may allow a smaller, less complex, more flexible and/or cheaper attachment.

At least one of the inwards wireless radio coupler and the outwards wireless radio antenna of the radio shield attachment may comprise an antenna formed from at least one of a straight rod, a bent rod, a loop, and a plane. The transceiver/antenna of the attachment may be made in a suitable shape according to size and space restrictions while allowing coupling to an antenna of the device.

In a further aspect there is provided a computer readable medium comprising computer program code stored thereon for a radio shield attachment for a portable radio communications device. The radio shield attachment is configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device. The radio shield attachment comprises an inwards wireless radio coupler, an outwards wireless radio antenna and a radio frequency converter. The computer readable medium and computer program code for the radio shield attachment are configured to, when run on at least one processor, perform at least the following:

- wirelessly communicate locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device via the inwards wireless radio coupler;
- wirelessly communicate remotely at a second different radio frequency band via the outwards wireless radio antenna; and
- convert radio communications between the shielded radio frequency band and the second different radio frequency band via the radio frequency converter, to allow for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.

In a further aspect there is provided a method for operating a radio shield attachment for a portable radio communications device. The radio shield attachment is configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device. The radio shield attachment comprises an inwards wireless radio coupler, an outwards wireless radio antenna and a radio

frequency converter. The method for operating the radio shield attachment for a portable radio communications device comprises:

wirelessly communicating locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device via the inwards wireless radio coupler;

wirelessly communicating remotely at a second different radio frequency band via the outwards wireless radio antenna; and

converting radio communications between the shielded radio frequency band and the second different radio frequency band via the radio frequency converter, the radio frequency converter thereby allowing for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.

In a further aspect there is provided a radio shield attachment for a portable radio communications device, the radio shield attachment configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device, and comprising:

means for wirelessly communicating locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device,

means for wirelessly communicating remotely at a second different radio frequency band; and

means for converting radio communications between the shielded radio frequency band and the second different radio frequency band to allow for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.

The present disclosure includes one or more corresponding aspects, examples or features in isolation or in various combinations whether or not specifically stated (including claimed) in that combination or in isolation. Corresponding means and corresponding functional units (e.g. inwards coupler(s), outwards antenna(e), transceiver(s), radio frequency converters, shielding, communicators, circuitry, computer code and modules) for performing one or more of the discussed functions are also within the present disclosure.

Corresponding computer programs for implementing one or more of the methods disclosed are also within the present disclosure and encompassed by one or more of the described examples.

5

The above summary is intended to be merely exemplary and non-limiting.

Brief Description of the Figures

10 A description is now given, by way of example only, with reference to the accompanying drawings, in which:

figure 1a illustrates an example portable electronic device communicating with remote ends;

figure 1b illustrates an example radio shield attachment and portable electronic device
15 communicating with remote ends, according to the present disclosure;

figure 2 illustrates a schematic example radio shield attachment according to the present disclosure;

figures 3a-3b illustrate another example radio shield attachment and portable electronic device showing regions of the attachment according to the present disclosure;

20 figures 4a-4b illustrate another example radio shield attachment and portable electronic device showing transceivers of the attachment according to the present disclosure;

figures 5a-5b illustrate shielding elements of an example radio shield attachment according to the present disclosure;

figure 6 illustrates another example radio shield attachment and portable electronic device
25 showing a device transceiver and an attachment transceiver according to the present disclosure;

figure 7 illustrates an example TDD circuit for a radio shield attachment according to the present disclosure;

figure 8 illustrates an example FDD circuit for a radio shield attachment according to the
30 present disclosure;

figures 9a-9b illustrate other example radio shield attachments and portable electronic devices according to the present disclosure;

figure 10 illustrates a flowchart according to a method of the present disclosure; and figure 11 schematically illustrates a computer readable medium providing a program.

Description of Example Aspects

5

Many portable electronic devices are capable of radio communication. In recent years, the number of devices capable of radio communication has increased dramatically, and such devices are being used more and more widely. A radio communication device may be able to make and receive radio communications in one or more frequency bands. It may not be possible to use a particular device in another frequency band if that device is not configured/manufactured to use that particular frequency band. 4G communications devices are becoming more common, and they require LTE multiple slots (frequency bands) for reception and transmission. A 4G device may require access of up to 14 different slots (frequency bands) to be useable throughout the world, and different slots and bands are allowed in different locations.

There may be one or more frequency bands made available for use after a communication device has been manufactured to operate in different frequency bands. The communication device may not be able to use these newly available frequency bands if it was not originally manufactured to use them. "New" frequency bands which may be made available, for example, include spare TV bands, satellite bands, white space bands, or cognitive radio strategy bands. "New" frequency bands may be available to a particular communication device if that device is moved from one location to another location which has different frequency bands available, such as if a device is transferred to another country where that country's operators use different frequency bands to the original country. This may be the case, for example, when using white space frequencies for radio communications, where different frequency bands become available dependent on the location of the communications device and upon which white space bands are already in use.

It may be forbidden by local regulations to use particular frequency bands for communications, and thus there may exist restrictions on the public use of particular frequency bands for radio communications. For example, in a particular region, there may be

one or more frequency bands reserved for use by emergency service communications (police, ambulance, fire service), or by other services/industries such as railways, petroleum exploration, and traffic systems. These bands, used by particular services/industries, may not be allowed for use by the general public.

5

Also, it may be desirable for available communication equipment to be easily converted for use with particular frequency bands (for example, police radio communication frequency bands) even if the communication equipment was not originally designed/manufactured to do so. In this way, for example, a police officer may be able to use a mobile telephone which
10 was not originally configured to use police radio frequency bands, with those police radio frequency bands.

Further, in some emergency or remote sensor cases, it may be desirable to use communication equipment designed for high frequency band use (such as 2.4 GHz Wi-Fi,
15 2.4 GHz Bluetooth, 2.4 GHz Zigbee, and 1.8GHz GSM) in a lower frequency band (such as 700 MHz or 400MHz), which may allow the communication distance to be extended.

It may be advantageous to be able to use a communications device, which was made for operation in one or more particular frequency bands, to now operate in one or more other
20 frequency bands. Further, it may be advantageous to be able to prevent radio communications from being made by a device in one or more particular "forbidden" frequency bands.

It may be advantageous to be able to change which frequency band(s) a communications
25 device is able to operate at without significant or substantive changes or modifications to the RF elements, hardware and/or software of the device. It may further be advantageous if such changes to the operating frequency band(s) of the device are easily reversible. For example, it may be advantageous for existing or "legacy" devices to be converted for operation under new conditions (that is, using different frequency bands to those for which the device was
30 originally intended) without changes to the hardware or software of the device.

One or more of the following examples may be considered to provide a solution to problems described above.

Figure 1a shows a network 100 containing a portable radio communications device 102 and two remote ends 106, 110. In this example, the device 102 does not have a radio shield attachment. The device 102 can communicate with the first remote end 106 in a first frequency band 108, and with the second remote end 110 in a second frequency band 112. The first frequency band may be, for example, a GSM 800 band and the second frequency band may be, for example, a Wi-Fi 2.4 GHz band.

Figure 1b shows a different network 150 containing the same portable communications device 102 inside a radio shield attachment (e.g. cover) 152, and three remote ends 106, 110, 160. As in figure 1a, the device 102 can communicate in a first frequency band 108 with the first remote end 106.

In the network 150 of figure 1b, differently to network 100, the device 102 is forbidden from communicating with a remote end 110 using the second frequency band 112. The second frequency band 112 may be, for example, reserved for local police use, or it may be a white space band reserved for other users. In any case, the device 102 should not use the second frequency band 112 for outward remote communications, even though the device 102 is configured to operate using that second frequency band 112.

Further, in the network 150 of figure 1b, differently to network 100, there is a third remote end 160 available which may be communicated with using a third frequency band 162. However the device 102 alone is not configured to be able to use the third frequency band 162.

Therefore the device 102 in figure 1b is equipped with a radio shield attachment 152, which is shown schematically around the outside of the device 102. The radio shield attachment 152 for the portable radio communications device 102 is configured to shield radio communications emanating from the portable radio communications device 102 at a radio frequency band of the portable radio communications device, in this case at the forbidden second frequency band 112.

The radio shield attachment 152 comprises an inwards wireless radio coupler, an outwards wireless radio antenna s and a radio frequency converter, as discussed in more detail later. An element 154 of the attachment 152 is schematically shown to illustrate frequency band conversion and radio communication shielding.

Therefore, even though the device 102 alone cannot receive and transmit radio communications from and to the third remote end 160, because it is not configured itself to operate using the third frequency band 162 of the third remote end 160, the radio shield attachment 152 can allow the device 102 to effectively behave as if it can receive and transmit radio communications from and to the third remote end 160. The attachment 152 also acts as a radio shield preventing radio communications at the forbidden second radio frequency 112 from being remotely transmitted.

Due to the radio frequency converter and the inwards wireless radio coupler of the attachment 152, the attachment 152 can wirelessly communicate locally with the portable radio communications device 102 at the shielded second radio frequency band 112 of the portable radio communications device 102. Thus the attachment 152 can convert radio communications from the third remote end 160 between the received third frequency band 162 and the shielded second radio frequency band 112 of the device 102, and transmit them locally to the device. In this way the device 102 can receive communications from a remote end 160 using a frequency band 162 which alone (without the radio shield attachment 152) it cannot receive.

Due to the radio frequency converter and the outwards wireless radio antenna, the attachment 152 can allow the device 102 to wirelessly communicate remotely with the third remote end 160 using the third radio frequency band 162. Thus the attachment 152 can convert radio communications between the shielded second radio frequency band 112 and the third frequency band 162 and transmit them locally from the device 102 to the attachment 152 so that the attachment 152 can transmit radio communications to the third remote end 160 using the third radio frequency band 162. In this way the device 102 can transmit

communications to a remote end 160 using a frequency band which alone (without the radio shield attachment 152) it cannot use to transmit.

The radio shield attachment can also shield/inhibit radio communications emanating, or
5 which may emanate, from the portable radio communications device 102 at the shielded frequency band 112, thereby preventing forbidden/shielded transmissions at the second frequency band 112.

The radio shield attachment may effectively act as a shield bubble around a portable radio
10 communication device. Radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device are shielded by the attachment by virtue of the bubble created by the shielding (the radio frequency band of the device can be considered to be the shielded frequency which the bubble inhibits). However, the device is still able to send and receive radio communications
15 using the radio frequency band of the device, even though it is shielded, by use of radio frequency conversion. This is because the inwards wireless radio coupler allows wireless communications received from the air, which are not at the device frequency, to reach the device through the "bubble", via radio frequency conversion to the device frequency (this conversion being performed by the converter of the radio shield attachment).
20 Advantageously near field wireless communication can be used. The outwards wireless radio antenna allows wireless radio communications from the device, at the device frequency which is otherwise shielded, to reach the air, through the "bubble", again using the radio frequency converter, but this time from the shielded device frequency to a different frequency. The outwards wireless radio antenna advantageously allows for wireless far field
25 communications.

Generally, the inwards wireless radio coupler should be placed towards an inner side of the radio shield attachment, so that it may couple inwards with an appropriate antenna of the device being used with the attachment. The inwards wireless radio coupler need not
30 necessarily be located on the inside of the radio shield attachment. The inwards coupler is concerned with communications from the attachment inwards to the device.

Transmissions from the outwards wireless radio antenna should not be shielded by the radio shield attachment and the outwards antenna may thus be positioned in an un-shielded location, for example towards an outer side of the radio shield attachment. Similarly, it will be appreciated that the outwards wireless radio antenna need not necessarily be located on the outside of the radio shield attachment. The outwards antenna is concerned with communications from the attachment outwards to the air away from the device.

The inwards coupler and/or the outwards antenna may be formed from a surface layer or track, but for optimum prolonged use would best be constructed within a layer or sub layer of the attachment material, in order to minimise deterioration of performance of the coupler/antenna from material corrosion and/or handling by users.

The radio shield attachment can convert to and from different frequency bands on-the-fly (that is, in real time). In addition, frequency bands which are allowed and which the device is itself configured to operate using, can still be used, such as the first frequency band used to communicate with the first remote end.

Additionally, since the radio shield attachment is converting the frequency bands and preventing forbidden transmissions through wireless coupling to the device, no substantive amendments or changes are required to be made to the device itself. If the user of the device does not wish to convert any frequency bands or prevent transmissions at particular frequency band(s), the radio shield attachment may simply be removed from the device, or may simply be switched off (for example, in the case where minimal shielding cover materials are used and signal suppression is used to prevent transmissions in a shielded frequency band).

Also, it may be envisaged that different radio shield attachments may be suitable for use under different conditions (for example, in different locations). Therefore the ability to readily convert which frequencies a device can use can be achieved by simply changing the radio shield attachment for the device according to a particular condition. Using different radio shield attachments for different frequency conversion/shielding requirements may be an option, wherein each radio shield attachment may be relatively easy and/or

cheaper to manufacture than a single radio shield attachment which can perform all conversions/shielding (although a radio shield attachment which can perform all conversions/shielding could be provided). Examples described herein allow for the flexibility of different/all frequency conversion/shielding options depending on the user requirements.

5

Figure 2 illustrates schematically an example radio shield attachment 200 designed to overlie an existing cover of a communications device, comprising a flexible coat 202, hardware circuits 204 (which could include software components, a processor, and/or memory, for example), a battery 206 connected to 208 the hardware circuits, an inwards wireless radio
10 coupler 210 and an outwards wireless radio antenna 212. The flexible coat 202 allows a user to pull the attachment 200 over their device easily for a snug fit. The coat 202 may comprise non-flexible parts, such as, for example, metal shielding components and/or the battery 206. In some examples, all elements of the attachment 200 including the coat 202, hardware circuits 204 and battery 206 may be flexible.

15

The radio shield attachment 200 may, in other examples, be a patch configured to attach to an external cover of the portable radio communications device, or may be a replacement external cover of the portable radio communications device.

20 In the example of figure 2, the radio shield attachment 200 comprises a battery 206 configured to provide power to the radio shield attachment 200 to power one or more of the transceivers, converter and shielding. In other examples, the radio shield attachment may be configured to be powered by an internal power source for the portable radio communications device (rather than, or as well as, a battery of the attachment itself) to provide power to the
25 radio shield attachment to power one or more of the transceivers, converter and shielding. It may be advantageous for the attachment to comprise a battery so that the battery/power source of the device is not used/required to power the attachment.

In other cases it may be advantageous for the attachment to be powered by a battery/power
30 source of the device; for example the attachment may be easier and cheaper to manufacture without a dedicated battery/power source (but with an appropriate wired/wireless coupling possible to the device battery/power source).

Figures 3a – 3b illustrate a radio shield attachment cover 302 over a communications device 304 from the front (in figure 3a) and from the side (in figure 3b).

- 5 Typical locations for inwards and outwards radio transceivers of the attachment are shown at the top area 306, left and right side areas 308, 310, and bottom area 312 of the radio shield attachment 302. Such transceivers should be located so as to obtain good radiation communication reception from the air, allow good radiation communication transmission to the device, and minimise the specific absorption rate (SAR).

10

Figures 4a – 4b illustrates a radio shield attachment cover 402 over a communications device 404 from the front (in figure 4a) and from the side (in figure 4b) showing five antennae/transceivers of the radio shield attachment 402.

- 15 In Figure 4a, the top area 406 shows a top (front) antenna 416, the left and right side areas 408, 410 each show a left and right antenna respectively 418, 420, and the bottom area 412 shows a bottom antenna 422. From the side view in figure 4b, a back antenna 430 and the top front antenna 416 are shown in the top area 406 of the radio shield attachment 402.

- 20 In some examples, the inwards radio frequency coupler and the outwards radio frequency antenna may share some or all of the same radio frequency transceiver to operate at the shielded radio frequency band and the second different radio frequency band. That is, the inwards radio frequency coupler may be the same element, or share some element(s) with, the outwards radio frequency antenna. In some examples, the inwards radio frequency
25 coupler and the outwards radio frequency antenna may be the same transceiver. As shown in figures 4a – 4b, there may be more than one antenna/transceiver 416, 418, 420, 422, 430, present in the radio shield attachment 402.

- Radio shield attachments as described herein may be configured to operate at the shielded
30 radio frequency band and the second different radio frequency band within the same category of radio communication. For example, the device may be configured itself to operate at white space bands f_1 , f_2 and f_3 , but in a particular situation, white space band f_4

may be available and white space band f_1 may be forbidden for the device. In this example, all four frequency bands f_1 , f_2 , f_3 and f_4 are white space frequencies. In other examples, different categories of communication frequency bands may be accessible and/or forbidden.

- 5 Figures 5a and 5b illustrate schematically different layers which may be present in cover portions/shielding portions of the radio shield attachment of the present disclosure, and which may act as radiation shields/absorbers.

Figure 5a shows a two-layer cover portion which may be used as at least a portion of a shield in a radio shield attachment as disclosed herein. Layer 502 is a first layer of
10 electromagnetic shielding material, and layer 504 is a second layer of radio frequency absorbing material. In other examples only one layer, either a first layer of electromagnetic shielding material 502 or a second layer of radio frequency absorbing material 504 may be used in a radio shield attachment. If only one layer type is used, then it should be thicker
15 than the combination of a first and a second layer, to achieve the same shielding performance. In one example, the first layer of electromagnetic shielding material may comprise magnalium, and the second radio frequency absorbing material may comprise a micro-powder of metals. One or both these layers can be considered to provide the shielding functionality of the radio shield attachment.

20

Each layer 502, 504 comprised in a radio shield attachment may contribute to shielding radio communications emanating from a portable radio communications device within/attached to the radio shield attachment. The first layer of electromagnetic shielding material 502 may be configured to shield/inhibit radio communications from the portable radio communications
25 device at a shielded frequency band (that is, to block the signal from reaching the air). The second layer of radio frequency absorbing material 504 may be configured to inhibit radio communications from the portable radio communications device at a shielded frequency band. The radio shield attachment may be configured as a wideband shield, to shield a wide frequency range of radio communications. Both the first layer of electromagnetic shielding
30 material 502 and the second layer of radio frequency absorbing material 504 may reduce, and ideally prevent, the radio communications from travelling through the radio shield attachment from the portable radio communications device to the air.

In a two-layer cover portion, the second layer of radio frequency absorbing material 504 may be located over the first layer of electromagnetic shielding material 502. The second layer of radio frequency absorbing material 504 and the first layer of electromagnetic shielding together 502 may be together configured to inhibit radio communications from the portable radio communications device at the shielded frequency band. The layer of electromagnetic shielding material 502 may be located between the portable radio communications device and the layer of radio frequency absorbing material 504 when the radio shield attachment is located operatively with the portable radio communications device.

In a two-layer cover portion as shown in figure 5a, the first layer of electromagnetic shielding material 502 may have a thickness of between 0.1 mm and 0.5 mm; typically it may have a thickness of 0.25 mm. The first layer of electromagnetic shielding material 502 may comprise one or more of: a metal, a flexible metal net, and metal powder distributed within rubber. The first layer of electromagnetic shielding material may be flexible to allow ease of attachment of the radio shield attachment to a device (e.g., over the device).

In a two-layer cover portion as shown in figure 5a, the second layer of radio frequency absorbing material 504 may have a thickness of between 0.5 mm and 5 mm; typically it may have a thickness of 2 mm. The second layer of radio frequency absorbing material 504 may comprise an energy absorbent foam. As for the first layer of electromagnetic shielding, the second layer of radio-frequency absorbing material may be flexible to allow ease of attachment of the radio shield attachment to/over a device. There are several roles for the radio frequency absorbing material 504. One is improved electromagnetic shielding to prevent radiation emissions emanating from the communications device. Another is for absorbing the power output from the power amplifier of the communications device within the radio shield attachment in order to reduce any large power amplifier output mismatch, which may otherwise cause damage at the last stage of the power amplifier. The radio frequency absorbing material 504 may also reduce electromagnetic compatibility (EMC) interference (such as electromagnetic interference with other nearby communications devices).

Figure 5b shows a three-layer cover portion with an inwards wireless radio coupler 510, which may be used as at least a portion of a shield in a radio shield attachment as disclosed herein. Layer 520 is a first layer of electromagnetic shielding material, layer 518 is a second layer of radio frequency absorbing material, and layer 516 is a layer of low-loss material.

5 Foamed plastic may be used as a low-loss material. The low-loss material is configured to insulate the inwards wireless radio coupler 510 from the outwards wireless radio antenna. One or more of these layers can be considered to provide the shielding functionality of the radio shield attachment.

10 The coupler 510 may be metal, and when the radio shield attachment is located operatively with a communications device, may be located close to the internal antenna/transceiver of the device in order to set up near field energy coupling with the device's internal antenna/transceiver. The coupler 510 may be shaped as a straight rod, a bent rod, a loop, or a plane antenna. Of course, the coupler 510 may have another shape depending on the
15 particular radio shield attachment and any space/shape restrictions.

The low-loss material 516 may be located proximal to at least one of the inwards wireless radio coupler and the outwards wireless radio antenna of the radio shield attachment. The low-loss material contributes to the inhibition of radio communications emanating from a
20 portable radio communications device at the shielded frequency band.

In a radio shield attachment having three-layer 516, 518, 520 plus inwards wireless radio coupler 510 portion of the cover as shown in figure 5b, the first layer of electromagnetic shielding material 520 may have a thickness of between 0.1 mm and 0.5 mm; typically it may
25 have a thickness of 0.25 mm. The second layer of radio frequency absorbing material 518 may have a thickness of between 0.5 mm and 5 mm; typically it may have a thickness of 3 mm. The layer of low-loss material 516 may have a thickness of between 0.5 mm and 5 mm; typically it may have a thickness of 2 mm. In a three-layer plus coupler cover portion, the
30 coupler 510 may be located as far as possible from any metallic elements present in the cover portion to mitigate the generation/production of high frequency bow waves. The coupler 510 may be mounted on the three layers as shown in figure 5b, or in other examples, on the low-loss material 516, or on the electromagnetic shielding material 518.

The cover portions shown in figures 5a and 5b may be used to construct in a radio shield attachment in different ways. One example is to form a radio shield attachment which covers all of the portable radio communications device. The three-layer cover portion may be used
5 proximal any internal antenna of the device. The two-layer cover portion may be used elsewhere over the device. An electromagnetic shielding material may be located over a display screen(s) of the device. In this example, a transparent electromagnetic shielding material of the attachment may be located over the display screen(s) of the portable radio communications device, to inhibit radio communications emanating from the portable radio
10 communications device at the shielded frequency band. The transparent electromagnetic shielding material located over the display screen(s) of the device may comprise one or more of: a metal net, a silver net, and a transparent absorbing plastic.

Another example is to form a radio shield attachment which covers all of the portable radio
15 communications device except a display screen of the device. The three-layer cover portion may be used proximal any internal antenna of the device. The two-layer cover portion may be used elsewhere over the device, except over the display screen. Any display screen of the device may be left without any cover portions/shielding. In this case, the display screen is not electromagnetically shielded as the other areas of the device are, but the radio shield
20 attachment may still operate. Reduced levels of radio communications may emanate from the display screen in any case.

Another example is to form a radio shield attachment which covers the regions of the device containing antennae/transceivers. In this case, the three-layer cover portion may be used to
25 cover any internal antenna of the device, and the other regions of the device not housing antennae/transceivers may remain without a radio shield attachment cover.

Another example is to form a radio shield attachment which does not include the electromagnetic shielding layer but includes a radio frequency absorbing material layer. Such
30 a radio shield attachment may be located, for example, over all of a device, all of a device except a display screen, or over regions of a device housing antennae/transceivers. In the case where no electromagnetic shielding layer is used, the radio shield attachment inwards

wireless radio coupler should be configured to output a stronger signal locally to the device than any signal received from a remote base station or access point.

Through the above examples, the extent to which the device is covered by the radio shield attachment is reduced. There is a signal overlap effect between the signals transmitted from the radio shield attachment to the device, and from any remote base station or access point transmitting signals to the device. These two types of signals may be at a common frequency, but are from different sources. Thus, the signals may interfere with each other, which is undesirable. As the extent to which the device is covered by the radio shield attachment reduces, the level of overlap between the signals from the two sources increases, which in turn decreases the performance of the radio shield attachment. Also, the power consumption by the radio shield attachment increases and there is an increased requirement to suppress signals. In the examples where less shielding material is present, the radio communication signal from the radio shield attachment should be stronger than any "leakage" signal from an original remote end, then the device should be "forced" to communicate with the attachment.

Figure 6 illustrates a portable radio communications device 604 with a display screen 606 housed within a radio shield attachment cover 602. The device 604 has an internal antenna/transceiver 608. This is shown coupled to a coupler 610 of the radio shield attachment 602. Similarly to figure 5b the layers of the radio shield attachment cover 602 are shown. Close to the antenna 608 of the device 604, and proximal the coupler 610 is a low-loss material layer 616. A radio frequency absorbing material layer 618 is shown next to the low loss layer 616. An electromagnetic shielding layer 620 is located next to the radio frequency absorbing layer 618 at the outside of the attachment 602. Located through the layers 616, 618, 620 from the coupler 610 to the exterior surface of the cover 602 and located in a small hole 614 is a feeding element 612 coupled to the coupler 610 of the cover 602. The small hole 614 may be filled with a low-loss insulation material (which may be similar to the material used for the low-loss material layer 616).

Figure 7 schematically illustrates a circuit which may be used for frequency conversion using frequency division duplexing (FDD) according to examples described herein of a radio shield attachment. For frequency conversion via FDD, the radio shield attachment may comprise

two antennae/transceivers 702, 728 and a frequency conversion circuit, as shown in figure 7. The antenna 702 may be considered an outwards wireless radio antenna, the coupler 728 may be considered an inwards wireless radio coupler/"antenna" (in some examples, comprising elements such as the feeder 612 and the coupler 610 of figure 6), and the
5 circuitry in-between may be considered a radio frequency converter.

In figure 7, an antenna 702 is coupled to a first duplexer 704, which in turn, on the receiver side, is coupled to a low-noise amplifier (LNA) 706, a first automatic gain control (AGC) 708, a first mixer 710, an adjustable amplifier 712, then to a second duplexer 726. This second
10 duplexer 726 is coupled to a coupler 728 for transmission to the device, and to an adjustable attenuator 724 on the transmitter side. The adjustable attenuator 724 is in turn connected to a second AGC 722, second mixer 720, third AGC 718 and a power amplifier 716 which is in turn coupled to the first duplexer 704. A synthesizer 714 is coupled to both the first and second mixers 710, 720 between the receiver and transmitter sides of the circuit.

15 A wireless energy coupling 736 is present between a) the circuit connection between the second duplexer 726 and b) the adjustable attenuator 724. The wireless energy coupling 736 is coupled to an energy detector 730, which in turn is coupled to a controller 732 coupled to an on-off power control 734.

20 The main purpose of the energy detector 730 and controller 732 circuit branch is to reduce power consumption and prolong the life of a battery powering the circuit in the radio shield attachment. The transmitter branch of the circuit need only be switched on when the energy detector 730 detects that the circuit is transmitting a signal. The purpose of the adjustable
25 amplifier 712 at the receiver side is to suppress the signal received from the remote end. The adjustable attenuator 724 and AGC 722 on the transmitter side are to protect the transmission circuitry from damage or saturation from strong power from the portable radio communications device located within/proximal the radio shield attachment.

30 Figure 8 schematically illustrates a circuit which may be used for frequency conversion using time division duplexing (TDD) according to examples described herein of a radio shield attachment. The antenna 802 may be considered an outwards wireless radio antenna, the

coupler 828 may be considered an inwards wireless radio coupler/"antenna" (in some examples, comprising elements such as the feeder 612 and the coupler 610 of figure 6), and the circuitry in-between may be considered a radio frequency converter.

5 In figure 8, an antenna 802 is coupled to a first switch 804, which in turn on the receiver side is coupled to a low-noise amplifier (LNA) 806, a first AGC 808, a first mixer 810, an adjustable amplifier 812, then to a second switch 824. This second switch 824 is coupled to a coupler 828 via an adjustable attenuator 826 for transmission to the device. The second switch 824 is also coupled to a second AGC 822 on the transmitter side. The second AGC
10 822 is in turn connected to a second mixer 820, third AGC 818 and a power amplifier 816 which is coupled to the first switch 804. A synthesizer 814 is coupled to both the first and second mixers 810, 820 between the receiver and transmitter sides of the circuit.

A wireless energy coupling 836 is present between the circuit connection between the adjustable attenuator 826 and the coupler 828. The wireless energy coupling 836 is coupled
15 to an energy detector 830, which in turn is coupled to a controller 832 coupled to an on-off power control 834. The controller 832 is also coupled to the first and second switches 804, 824.

20 When the energy detector 830 detects that the circuit is transmitting a signal, the transmitter circuit branch is switched on and the receiver circuit branch is switched off. Otherwise, the transmitter circuit branch is switched off and the receiver circuit branch is switched on. The purpose of the adjustable amplifier 812 at the receiver side is to suppress the signal received from the remote end. The adjustable attenuator 826 and AGC 822 on the transmitter side are
25 to protect the transmission circuitry from damage or saturation from strong power from the portable radio communications device located within/proximal the radio shield attachment.

As a general trend, portable radio communication devices such as mobile telephones support a wide range of communication standards. Radio shield attachments as described
30 herein may be configured to operate at a shielded radio frequency band and a second, different, radio frequency bands, via one or more of the following categories of radio communication standard: cellular network communications; Bluetooth; wireless local area

network (WLAN); global positioning system (GPS) communications; global system for mobile communications (GSM); white space (WS) communications; wide band code division multiple access (WCDMA); time-division synchronous code division multiple access (TD-SCDMA); code division multiple access 2000 (CDMA2000); frequency modulated (FM) radio communications; near field communications (NFC); digital video broadcasting - handheld (DVB-H); long-term evolution (LTE) time division duplexing (TDD); and long-term evolution (LTE) frequency division duplexing (FDD).

A radio shield attachment as described herein may be used according to one or more such standards, to perform frequency conversion to and from another frequency band, within the same standard or to/from a different standard, or to/from a frequency band in a different range to the standards noted above and/or any other standards. Also, a radio shield attachment may operate to allow radio communications without frequency conversion/shielding also according to one or more such standards (which may be the same standards, partially the same standards, or different standards to those within which frequency conversion/shielding takes place). The example of figures 9a and 9b illustrate radio shield attachments configured for frequency conversion of one standard while allowing other standards to be used without frequency conversion/shielding.

Figure 9a shows an example device 902 with a display screen 904. The device is shown with four antennae 906, 908, 910 and 912 each at one edge of the device 902. The antennae 906, 908, 910, 912 for different standards are separated. Often, a portable radio communication device will have more than one antenna (such as diversity or multiple input-multiple output, MIMO) for each standard. A radio shield attachment 914 is located proximal the top antenna 906 of the device 902. The radio shield attachment 914 comprises a transceiver 916. It may be envisaged that in figure 9a, the top antenna 906 is the main antenna and supports quad-band GSM. The other three antennae of the device 908, 910, 912, are not the main antennae, and support other standards (for example, GPS, Bluetooth/Wi-Fi and WCDMA).

If it is desired that no frequency conversion/shielding is required for transmissions over GPS, Bluetooth/Wi-Fi and WCDMA, then the radio shield attachment is not required to operate in relation to the corresponding GPS, Bluetooth/Wi-Fi and WCDMA antennae 908, 910, 912.

For frequency conversion and shielding of quad-band GSM communications, the radio shield attachment 914 may be located on the device 902 such that the radio shield attachment antenna/transceiver 916 is located proximal the quad-band GSM antenna 906 of the device 902 for coupling, and the radio shield attachment 916 is located for quad-band GSM communication shielding without affecting communications from the other antennae 908, 910, 912.

In other examples, the antennae for different standards may be combined, or may be located very close to each other, as the space within such as device may be limited. Figure 9b shows an example device 952 with a display screen 954. The device is shown with one combined antenna 956. A radio shield attachment 958 is located proximal the antenna 956 of the device 902, and the radio shield attachment 958 comprises a transceiver 960. It may be envisaged that in figure 9b, the combined antenna 956 supports penta-band communications such as quad-band GSM as well as WCDMA 2100, for example.

The radio shield attachment 958 may be configured such that frequency conversion and shielding of quad-band GSM communications is possible while leaving any other communications, such as WCDMA 2100, communications unaffected. In other examples other antennae, such as Bluetooth / Wi-Fi antennae may be located in the same bottom region of the device 952. In other examples, the same antenna 956 may support multiple communications including quad-band GSM, WCDMA 2100, Bluetooth / Wi-Fi, and possibly others.

The skilled person will appreciate from the disclosure how to combine circuits such as those illustrated in figures 7 and 8 to allow a radio shield attachment to operate according to the schemes discussed, for example in relation to figures 9a and 9b. For example, for a radio shield attachment having separate but proximal antennae for GSM communications and for WCDMA and Bluetooth / Wi-Fi communications, a circuit may be constructed for example, by including:

a circuit similar to that of figure 8 for GSM communications to allow for frequency conversion/shielding; and

simplified circuits (removing the synthesiser component) similar to those of figure 7 for WCDMA 2100 and of figure 8 for Bluetooth / Wi-Fi communications such that these communications remain unaffected.

5 As another example, for a radio shield attachment having separate but proximal antennae for GSM communications and for WCDMA and Bluetooth / Wi-Fi communications, a circuit may be constructed including a circuit similar to that of figure 8 for GSM communications, but without shielding any communications. In this case, a filter may be included between the adjustable amplifier on the transmitter side and the second switch to help ensure the inwards
10 GSM signal is limited to its own frequency band, and reduce any interference of the inwards GSM signal with the original WCDMA in the near-band range. A narrow band strong signal may be used to suppress the original GSM signal and thereby keep WCDMA (Bluetooth / Wi-Fi) communications unaffected. The filter may be used to limit the strong suppression signal to the narrow band.

15 As a further example, for a radio shield attachment having one antenna configured for multiple communication standards (for example, both Bluetooth and Wi-Fi) a circuit may be constructed including a circuit similar to that of figure 8 each for the Bluetooth and Wi-Fi communication standards. Both Bluetooth and Wi-Fi work in the 2.4 GHz ISM band and can
20 share the same antenna. However, due to the different specifications for each communication standard, each will use a different frequency band. There are around 80 continuous frequency points with 1MHz spacing in the 2.4 GHz ISM band, of which Wi-Fi occupied about 20 continuous frequencies and Bluetooth requires more than 21 frequencies. Thus Wi-Fi and Bluetooth can operate in separate frequency groups within the 2.4 GHz ISM
25 band. If a single antenna is used for both Wi-Fi and Bluetooth communications, and it is required that the frequency band of Bluetooth is changed to a new frequency band while the frequency band of Wi-Fi remains unchanged, then this is possible with the apparatus disclosed herein. In this case, local oscillators (LOs) may be included in each Wi-Fi and Bluetooth circuit between mixers in the transmitter and receiver circuit branches in order to
30 tune the frequency band and convert the frequency of, for example, Bluetooth communications to a new frequency band while the Wi-Fi frequency band remains unchanged.

In other examples, if it is required to change the frequency band of more than one antenna of a portable radio communications device, then this may be achieved by having a radio shield attachment with inwards and outwards transceivers located proximal to each antenna of the device for which communications are to be frequency shifted. Also shielding components may be located for each device antenna for communication inhibition at forbidden shielded frequency bands. For example, a device may have at least two antennae: one diversity/MIMO antenna and another main antenna for CDMA or LTE communications. A radio shield attachment may have two regions with inwards and outwards transceivers located proximal the device antennae and suitable shielding to inhibit radio communications from the device antennae at shielded frequency bands.

Figure 10 shows a flow diagram illustrating the method steps of wirelessly communicating locally with a portable radio communications device at a shielded radio frequency band of the portable radio communications device via the inwards wireless radio coupler 1002, wirelessly communicating remotely at a second different radio frequency band via the outwards wireless radio antenna 1004, and converting radio communications between the shielded radio frequency band and the second different radio frequency band via the radio frequency converter, thereby allowing for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band 1006.

Figure 11 illustrates schematically a computer/processor readable medium 1100 providing a program according to an example. In this example, the computer/processor readable medium is a disc such as a digital versatile disc (DVD) or a compact disc (CD). In other examples, the computer readable medium may be any medium that has been programmed in such a way as to carry out an inventive function. The computer program code may be distributed between the multiple memories of the same type, or multiple memories of a different type, such as ROM, RAM, flash, hard disk, solid state, etc.

30

The portable radio communication apparatus shown in the above examples for use with the radio shield attachment may be a portable electronic device, a mobile phone, a Smartphone,

a personal digital assistant, a tablet computer, a laptop computer, a radio, a portable communicator, or a module/circuitry for one or more of the same.

Any mentioned apparatus/device and/or other features of particular mentioned apparatus/
5 device may be provided by apparatus arranged such that they become configured to carry out the desired operations only when enabled, e.g. switched on, or the like. In such cases, they may not necessarily have the appropriate software loaded into the active memory in the non-enabled (switched off state) and only load the appropriate software in the enabled (on state). The apparatus may comprise hardware circuitry and/or firmware. The apparatus may
10 comprise software loaded onto memory. Such software may be recorded on the same memory/processor/functional units and/or on one or more memories/processors/ functional units.

In some examples, a particular mentioned apparatus/device may be pre-programmed with
15 the appropriate software to carry out desired operations, and wherein the appropriate software can be enabled for use by a user downloading a "key", for example, to unlock/enable the software and its associated functionality. Advantages associated with such examples can include a reduced requirement to download data when further functionality is required for a device, and this can be useful in examples where a device is perceived to have
20 sufficient capacity to store such pre-programmed software for functionality that may not be enabled by a user.

Any mentioned apparatus/circuitry/elements/processor may have other functions in addition to the mentioned functions, and that these functions may be performed by the same
25 apparatus/circuitry/elements/processor. One or more disclosed aspects may encompass the electronic distribution of associated computer programs and computer programs (which may be source/transport encoded) recorded on an appropriate carrier (e.g. memory, signal).

Any "computer" described herein may comprise a collection of one or more individual
30 processors/processing elements that may or may not be located on the same circuit board, or the same region/position of a circuit board or even the same device. In some examples one or more of any mentioned processors may be distributed over a plurality of devices. The

same or different processor/processing elements may perform one or more functions described herein.

The term "signalling" may refer to one or more signals transmitted as a series of transmitted
5 and/or received electrical/optical/electromagnetic signals. The series of signals may comprise one or more individual signal components or distinct signals to make up said signalling. Some or all of these individual signals may be transmitted/received by wireless or wired communication simultaneously, in sequence, and/or such that they temporally overlap one another.

10 With reference to any discussion of any mentioned computer and/or processor and memory (including ROM, CD-ROM etc), these may comprise a computer processor, Application Specific Integrated Circuit (ASIC), field-programmable gate array (FPGA), and/or other hardware components that have been programmed in such a way to carry out the inventive
15 function.

The applicant hereby discloses in isolation each individual feature described herein and any combination of two or more such features, to the extent that such features or combinations are capable of being carried out based on the present specification as a whole, in the light of
20 the common general knowledge of a person skilled in the art, irrespective of whether such features or combinations of features solve any problems disclosed herein, and without limitation to the scope of the claims. The applicant indicates that the disclosed aspects/examples may consist of any such individual feature or combination of features. In view of the foregoing description it will be evident to a person skilled in the art that various
25 modifications may be made within the scope of the disclosure.

While there have been described fundamental novel features as applied to examples, it will be understood that various omissions, substitutions and changes in the form and details of the devices and methods described may be made by those skilled in the art without
30 departing from the scope of the disclosure. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the

disclosure. Moreover, it should be recognized that structures, elements and/or method steps shown and/or described in connection with any disclosed form or examples may be incorporated in any other disclosed, described or suggested form or example as a general matter of design choice. Furthermore, in the claims, means-plus-function clauses are
5 intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Thus although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures.

What is claimed is:

1. A radio shield attachment for a portable radio communications device, the radio shield attachment configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device, the radio shield attachment comprising an inwards wireless coupler, an outwards wireless antenna and a radio frequency converter,

the inwards wireless radio coupler configured to wirelessly communicate locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device,

the outwards wireless radio antenna configured to wirelessly communicate remotely at a second different radio frequency band, and

the radio frequency converter configured to convert radio communications between the shielded radio frequency band and the second different radio frequency band to allow for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.

2. An apparatus comprising the radio shield attachment of claim 1 and the portable radio communications device of claim 1.

3. The radio shield attachment of claim 1, wherein the radio shield attachment is one of: a patch configured to attach to an external cover of the portable radio communications device,

a replacement external cover of the portable radio communications device, and

an additional external cover configured to attach to and overlie an existing external cover of the portable radio communications device.

4. The radio shield attachment of claim 1, wherein the inwards wireless radio coupler and the outwards wireless radio antenna share some or all of the same radio frequency transceiver to operate at the shielded radio frequency band and the second different radio frequency band.

5. The radio shield attachment of claim 1, wherein the radio shield attachment is configured to shield the radio communications emanating from the portable radio communications device by comprising:

a first layer of electromagnetic shielding material configured to inhibit radio communications from the portable radio communications device at the shielded frequency band.

6. The radio shield attachment of claim 5, wherein the radio shield attachment is configured to shield the radio communications emanating from the portable radio communications device by further comprising:

a second layer of radio frequency absorbing material located over the layer of electromagnetic shielding material;

the second layer of radio frequency absorbing material and the first layer of electromagnetic shielding together configured to inhibit radio communications from the portable radio communications device at the shielded frequency band.

7. The radio shield attachment of claim 6, wherein the layer of electromagnetic shielding material is located between the portable radio communications device and the layer of radio frequency absorbing material when the radio shield attachment is located operatively with the portable radio communications device.

8. The radio shield attachment of claim 5, wherein the first layer of electromagnetic shielding material comprises one or more of: a metal foil, a flexible metal net, and metal powder distributed within rubber.

9. The radio shield attachment of claim 6, wherein the second layer of radio frequency absorbing material comprises an energy absorbent foam.

10. The radio shield attachment of claim 1, wherein the radio shield attachment is configured to shield the radio communications emanating from the portable radio communications device by comprising:

a low-loss material located proximal to at least one of the inwards wireless radio coupler and the outwards wireless radio antenna of the radio shield attachment to inhibit radio communications emanating from the portable radio communications device at the shielded frequency band.

5

11. The radio shield attachment of claim 1, wherein the radio shield attachment is configured to shield the radio communications emanating from the portable radio communications device by comprising:

10 a transparent electromagnetic shielding material configured to be located over a display screen of the portable radio communications device to inhibit radio communications emanating from the portable radio communications device at the shielded frequency band.

12. The radio shield attachment of claim 11, wherein the transparent electromagnetic shielding material comprises one or more of: a metal net, a silver net, and a transparent
15 absorbing plastic.

13. The radio shield attachment of claim 1, wherein the radio shield attachment is configured to operate at the shielded radio frequency band and the second different radio frequency bands via one or more of the following categories of radio communication:

20 cellular network communications;
Bluetooth;
wireless local area network (WLAN);
global positioning system (GPS) communications;
global system for mobile communications (GSM);
25 white space (WS) communications;
wide band code division multiple access (WCDMA);
time-division synchronous code division multiple access (TD-SCDMA);
code division multiple access 2000 (CDMA2000);
frequency modulated (FM) radio communications;
30 near field communications (NFC);
digital video broadcasting – handheld (DVB-H);
long-term evolution (LTE) time division duplexing (TDD); and

long-term evolution (LTE) frequency division duplexing (FDD).

14. The radio shield attachment of claim 13, wherein the radio shield attachment is configured to operate at the shielded radio frequency band and the second different radio frequency band within the same category of radio communication.

15. The radio shield attachment of claim 1, wherein the radio shield attachment comprises a battery configured to provide power to the radio shield attachment to power one or more of the transceivers, converter and shielding.

16. The radio shield attachment of claim 1, wherein the radio shield attachment is configured to be powered by an internal power source for the portable radio communications device to provide power to the radio shield attachment to power one or more of the transceivers, converter and shielding.

17. A computer program product for a radio shield attachment for a portable radio communications device, the radio shield attachment configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device, the radio shield attachment comprising an inwards wireless radio coupler, an outwards wireless radio antenna. and a radio frequency converter, the computer program product comprising:

computer code configured to wirelessly communicate locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device via the coupler;

computer code configured to wirelessly communicate remotely at a second different radio frequency band via the outwards wireless radio antenna; and

computer code configured to convert radio communications between the shielded radio frequency band and the second different radio frequency band via the radio frequency converter, to allow for remote radio communications to and from the portable radio communications device to be received and transmitted at the second different radio frequency band.

18. A method for operating a radio shield attachment for a portable radio communications device, the radio shield attachment configured to shield radio communications emanating from the portable radio communications device at a radio frequency band of the portable radio communications device, the radio shield attachment comprising an inwards wireless
5 radio coupler, an outwards wireless radio antenna and a radio frequency converter, the method comprising:

wirelessly communicating locally with the portable radio communications device at the shielded radio frequency band of the portable radio communications device via the inwards wireless radio coupler;

10 wirelessly communicating remotely at a second different radio frequency band via the outwards wireless radio antenna; and

converting radio communications between the shielded radio frequency band and the second different radio frequency band via the radio frequency converter, the radio frequency converter thereby allowing for remote radio communications to and from the portable radio
15 communications device to be received and transmitted at the second different radio frequency band.

Figure 1a

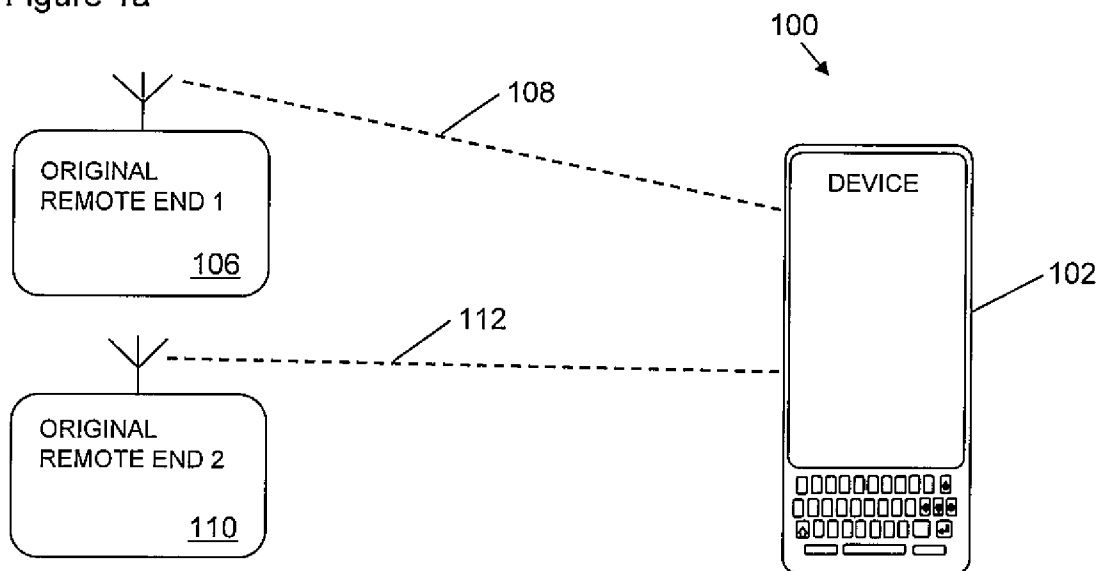


Figure 1b

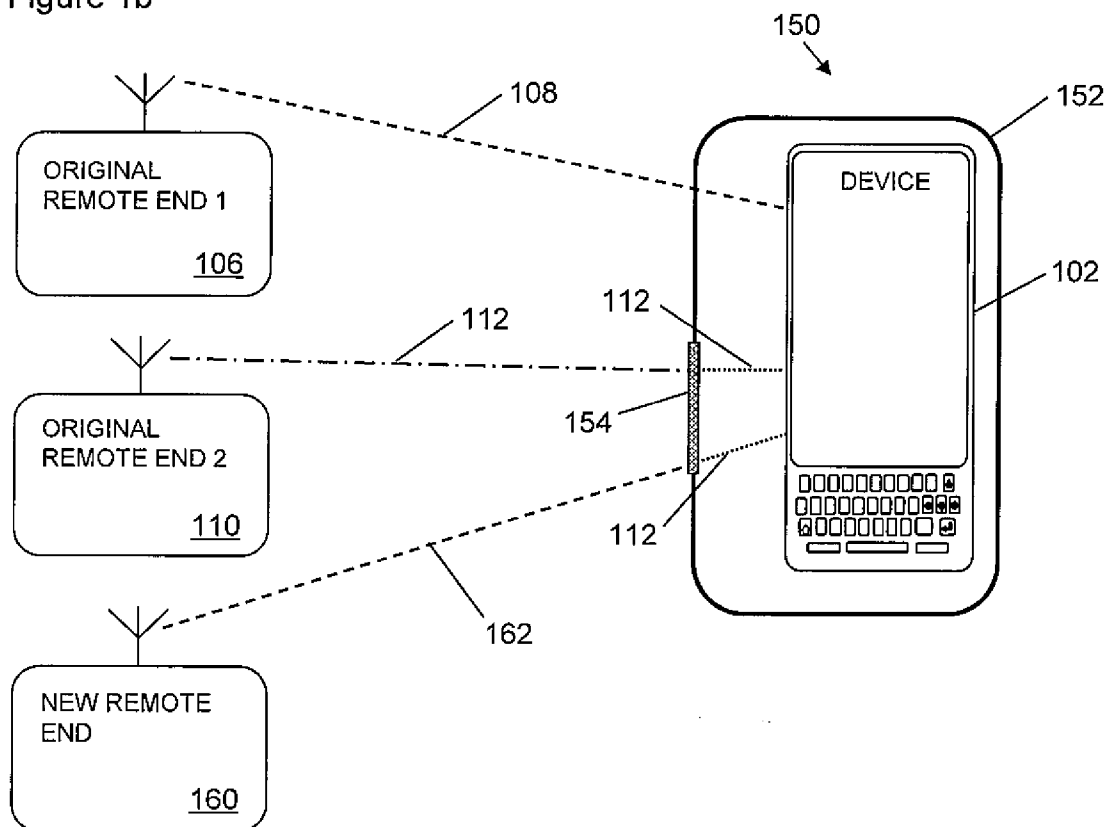


Figure 2

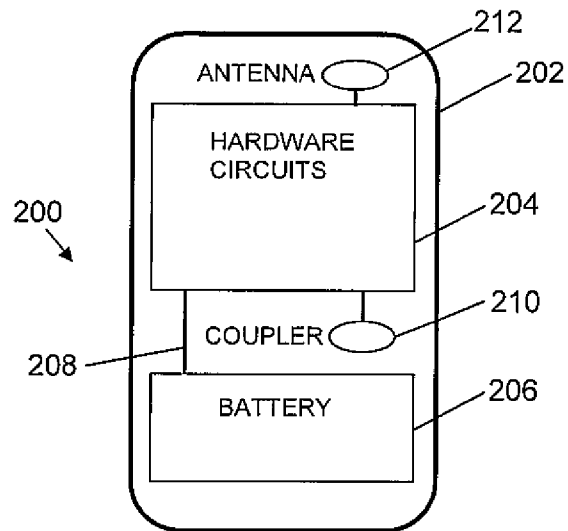


Figure 3a

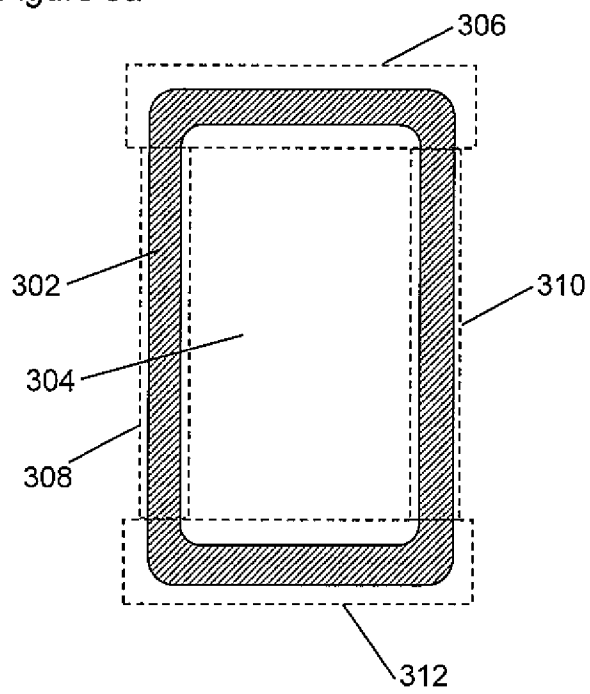


Figure 3b

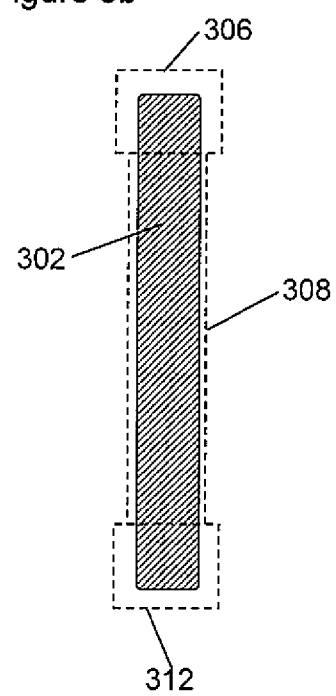


Figure 4a

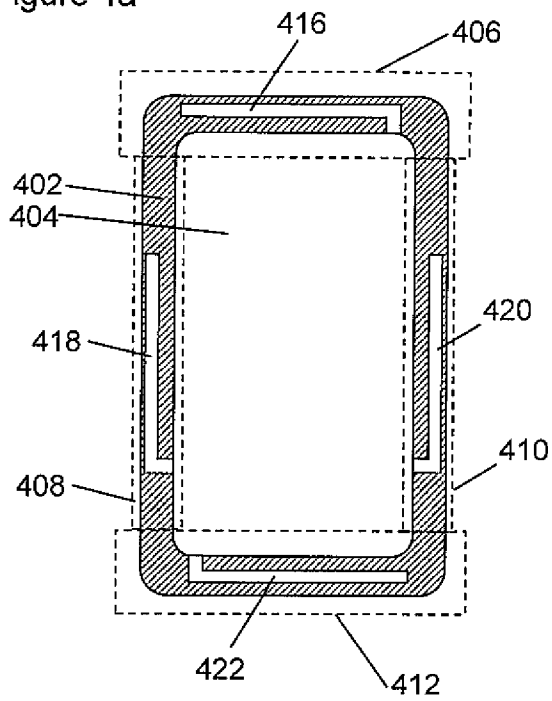


Figure 4b

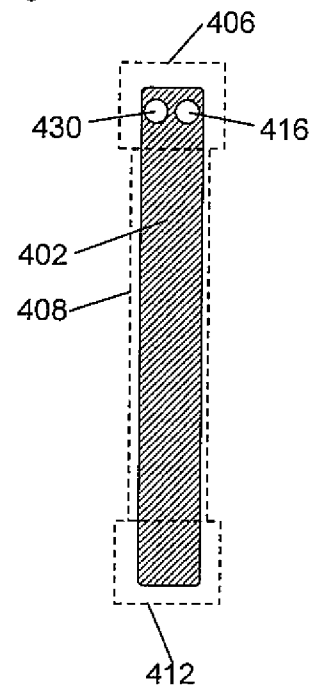


Figure 5a

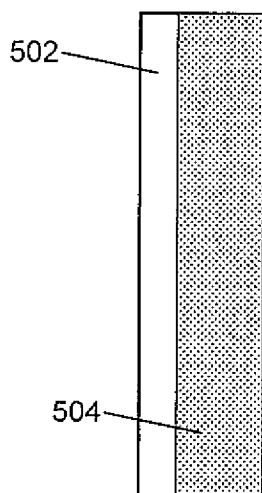


Figure 5b

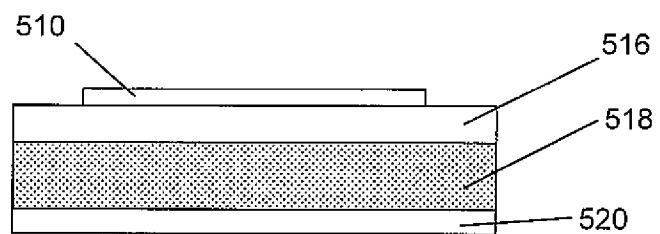


Figure 6

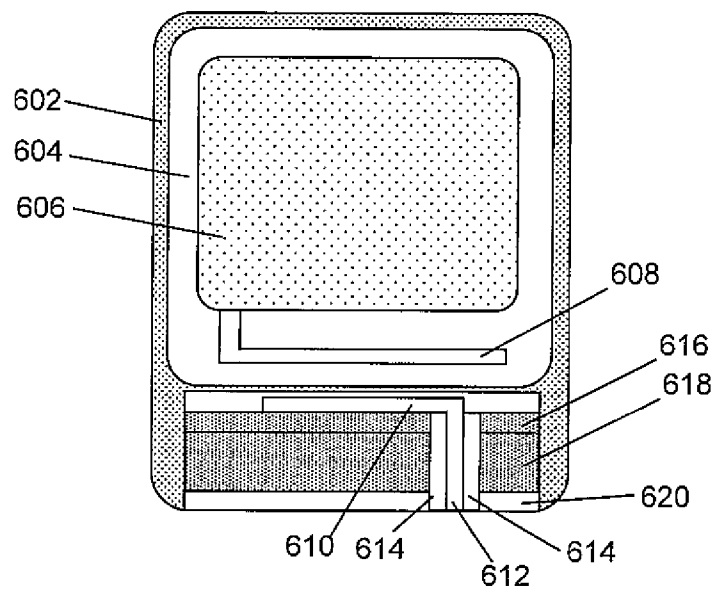


Figure 7

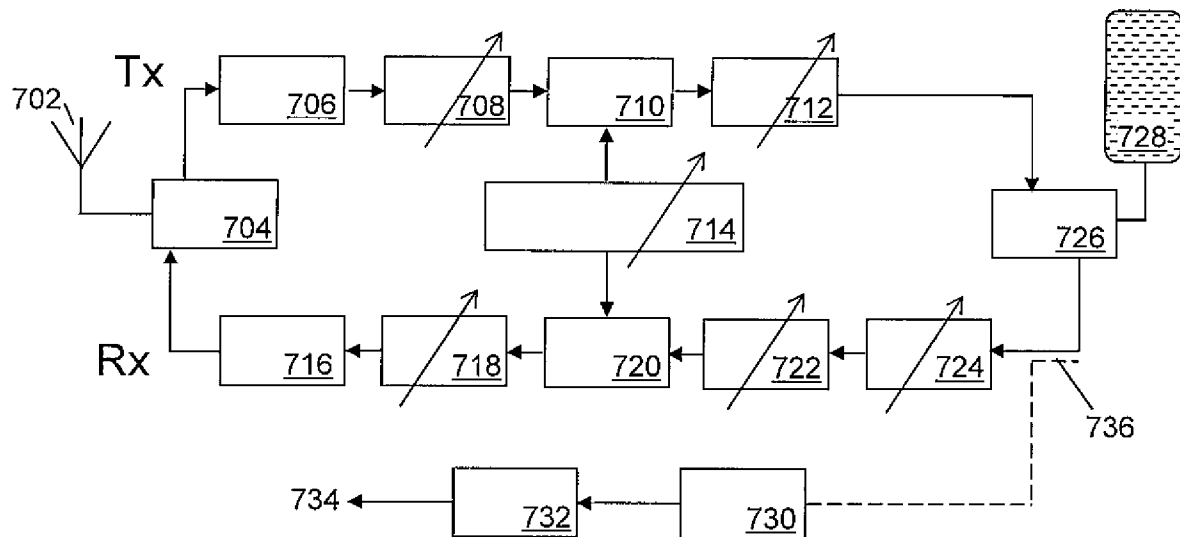


Figure 8

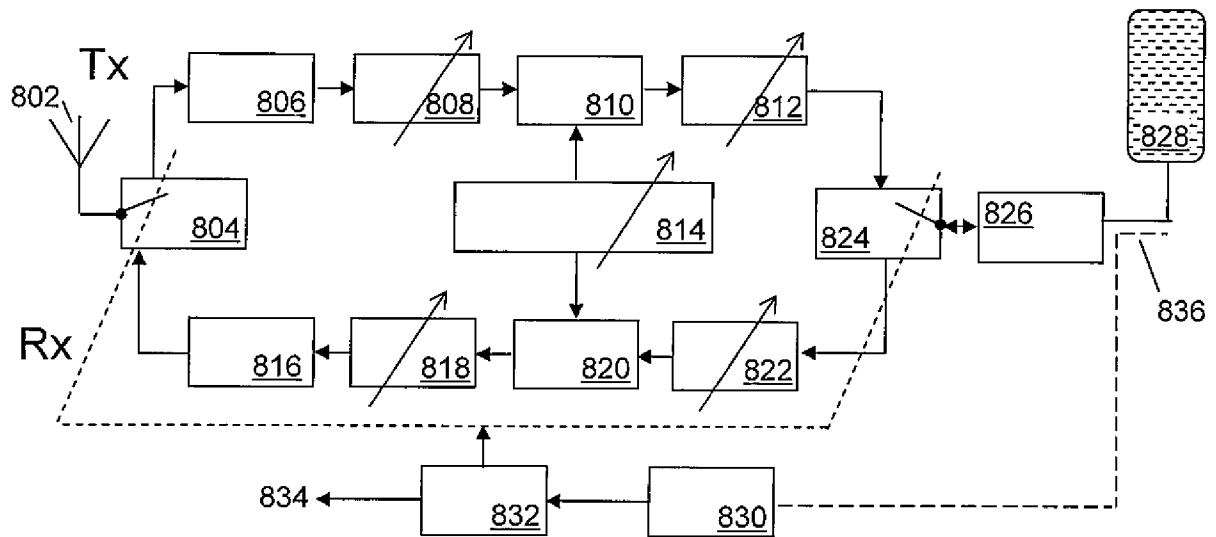


Figure 9a

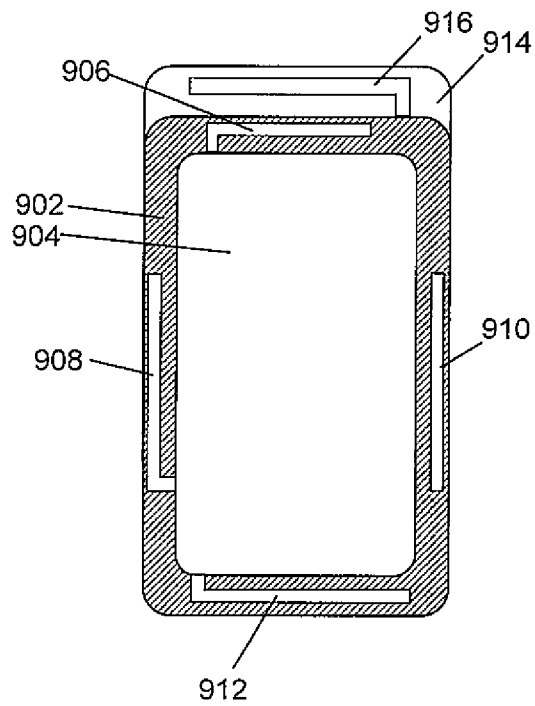


Figure 9b

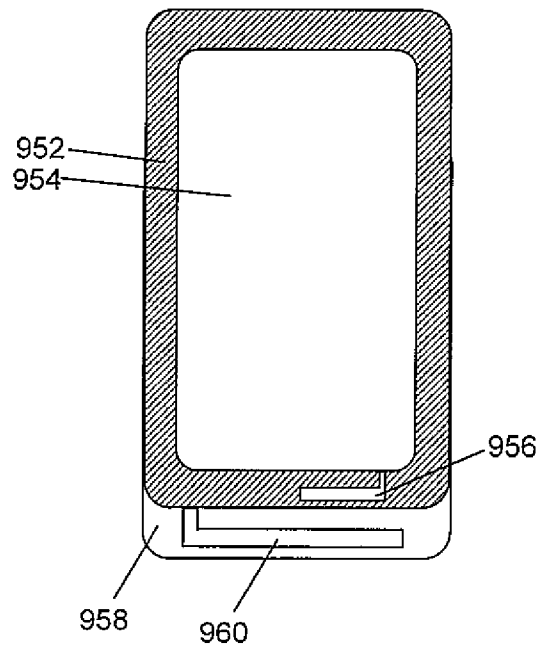


Figure 10

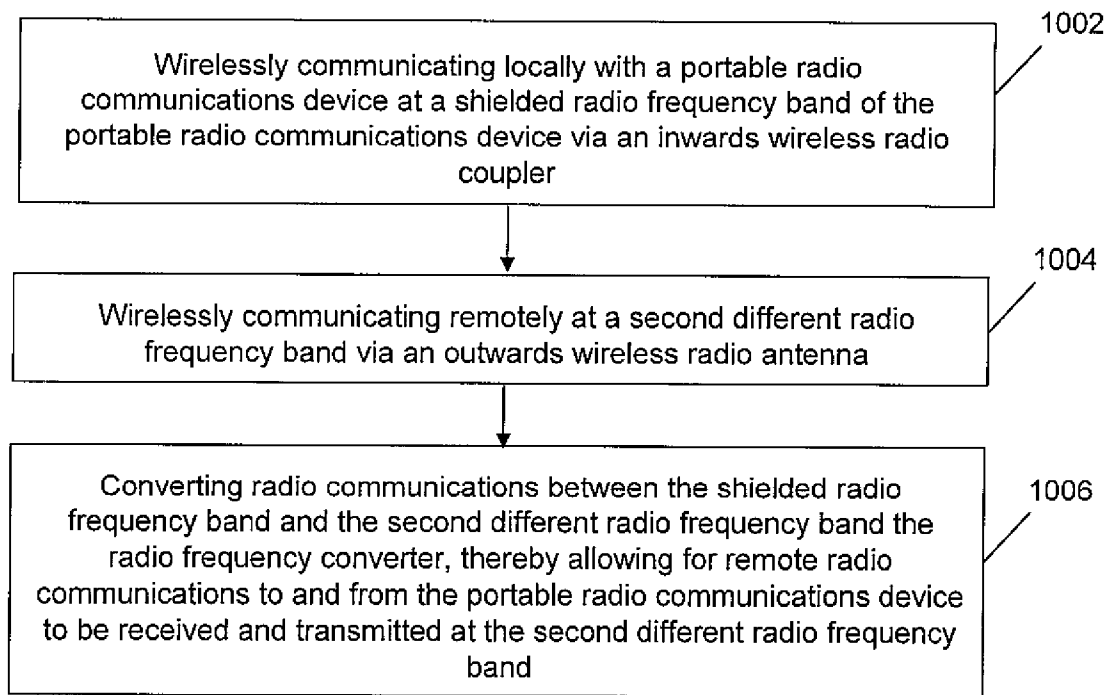
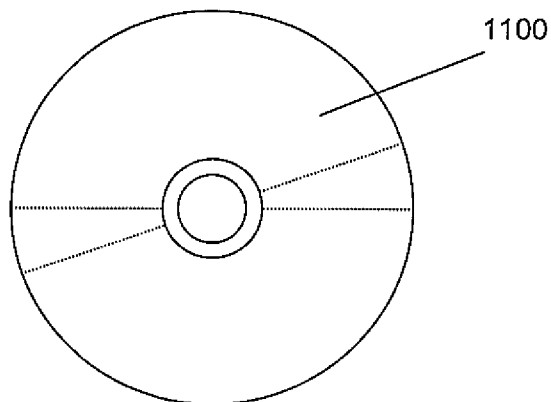


Figure 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/079350

A. CLASSIFICATION OF SUBJECT MATTER

see the extra sheet

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)

IPC: H04B; H04M

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)

CNABS; CNTXT; CNKI; VEN: shield+, cover?, patch, case, casing, shell, housing, device?, terminal?, +phone?, antenna?, frequency, converter?, switch+, couple+, dual w mode, multi w mode

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP2216917 A1 (RESEARCH IN MOTION LTD.) 11 Aug. 2010 (11.08.2010) description, paragraphs [0022]-[0026], and figure 1	1-18
A	CN101296017 A (ALCATEL LUCENT) 29 Oct. 2008 (29.10.2008) the whole document	1-18
A	CN101595598 A (PULSE FINLAND OY.) 02 Dec. 2009 (02.12.2009) the whole document	1-18

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 25 Apr. 2013 (25.04.2013)	Date of mailing of the international search report 16 May 2013 (16.05.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer HU, Shaoqin Telephone No. (86-10)62412000

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/079350

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EP2216917 A1	11.08.2010	AT505856 T	15.04.2011
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		FI20065728A0	15.11.2006
		EP2092598A4	16.12.2009

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/079350

A. CLASSIFICATION OF SUBJECT MATTER

H04W 88/06 (2009.01) i

H04M 1/02 (2006.01) i