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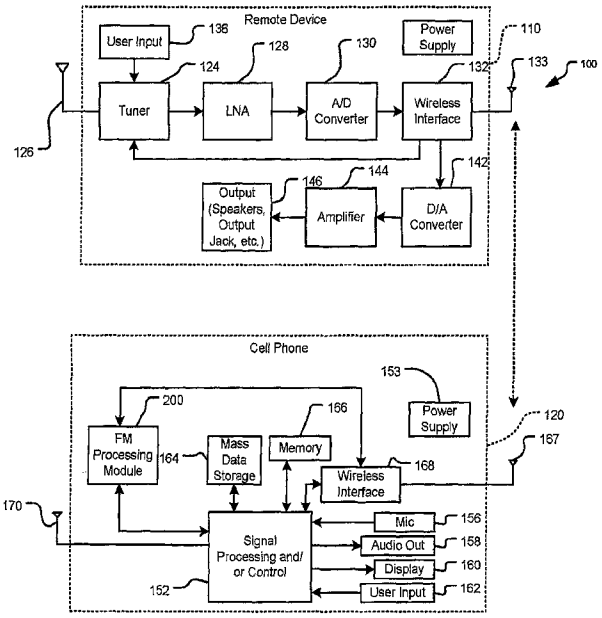
(54) **Title:** CELLULAR PHONE WITH INTEGRATED FM RADIO



(57) **Abstract:** A cellular phone includes a first wireless transceiver that receives intermediate frequency (IF) signals. The IF signals are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to an IF by a remote device. An FM processing module that receives the IF signals, that converts the IF signals to baseband signals, and that generates processed FM signals.

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AMENDED CLAIMS

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original claims 1-11 replaced by new claims 1-11 (2pages)

1. A cellular phone comprising:

a first wireless transceiver that receives intermediate frequency (IF) signals, which are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to an IF by a remote device and transmitted to the cellular phone; and

an FM processing module that receives said IF signals, that converts said IF signals to baseband signals and that generates processed FM signals.

2. The cellular phone of claim 1 further comprising a cellular phone processing module that performs cellular phone signal processing, wherein at least one of said first wireless transceiver and said FM processing module is integrated with said cellular phone processing module in an integrated circuit.

3. The cellular phone of claim 1 wherein said first wireless transceiver transmits said processed FM signals to said remote device.

4. The cellular phone of claim 1 further comprising a user interface that generates FM station selection data, wherein said first wireless transceiver transmits said FM station selection data to said remote device.

5. A system comprising the cellular phone of claim 1 and further comprising said remote device, wherein said remote device generates an audio signal based on said processed FM signals.

6. A system comprising the cellular phone of claim 1 and further comprising said remote device, wherein said remote device further comprises:

an antenna; and

a tuner that communicates with said antenna and that tunes an RF frequency.

7. The system of claim 6 wherein said remote device further comprises an amplifier that amplifies RF signals at said RF frequency.

8. The system of claim 7 wherein said remote device further comprises a mixer that mixes said RF signals to generate said IF signals.

9. The system of claim 8 wherein said remote device further comprises a second wireless transceiver that transmits said IF signals to said cellular phone.

10. The system of claim 6 wherein said remote device includes a user interface that communicates with said tuner to select an FM station.

11. A cellular phone, comprising:

a first wireless transceiver that receives radio frequency (RF) signals, which include frequency modulated (FM) signals that have been tuned by a remote device via a user input to a selected frequency associated with said FM signals; and

an FM processing module that receives said RF signals at said selected frequency, that converts said RF signals to baseband signals and that generates processed FM signals.

12. The cellular phone of claim 11 further comprising a cellular phone processing module that performs cellular phone signal processing, wherein at least one of said first wireless transceiver and said FM processing module is integrated with said cellular phone processing module in an integrated circuit.

13. The cellular phone of claim 11 wherein said first wireless transceiver transmits said processed signals to said remote device.

14. The cellular phone of claim 11 further comprising a user interface that generates FM station selection data, wherein said first wireless transceiver transmits said FM station selection data to said remote device.

15. A system comprising the cellular phone of claim 11 and further comprising said remote device, wherein said remote device generates an audio signal based on said processed FM signals.

16. A system comprising the cellular phone of claim 11 and further comprising said remote device, wherein said remote device further comprises:

an antenna; and

a tuner that communicates with said antenna and that tunes an RF frequency.

17. The system of claim 16 wherein said remote device further comprises an amplifier that amplifies signals at said tuned RF frequency.

18. The system of claim 17 wherein said remote device further comprises a second wireless transceiver that transmits said IF signals to said cellular phone.

19. The cellular phone of claim 11 wherein said first wireless transceiver and said FM processing module are implemented as an integrated circuit.

20. The cellular phone of claim 11 wherein said FM processing module comprises:

an intermediate frequency (IF) mixer that converts said RF signals to IF signals; and

a BB mixer that converts said IF signals to BB signals.

21. A cellular phone, comprising:

a first wireless transceiver that receives baseband (BB) signals, which are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to said BB by a remote device; and

an FM processing module that receives said BB signals and that generates processed FM signals based on said BB signals.

22. The cellular phone of claim 21 further comprising a cellular phone processing module that performs cellular phone signal processing, wherein at least one of said first wireless transceiver and said FM processing module is integrated with said cellular phone processing module in an integrated circuit.

23. The cellular phone of claim 21 wherein said first wireless transceiver transmits said processed FM signals to said remote device.

24. The cellular phone of claim 21 further comprising a user interface that generates FM station selection data, wherein said first wireless transceiver transmits said FM station selection data to said remote device.

25. A system comprising the cellular phone of claim 21 and further comprising said remote device, wherein said remote device further generates an audio signal based on said processed FM signals.

26. A system comprising the cellular phone of claim 21 and further comprising said remote device, wherein said remote device further comprises:

an antenna; and

a tuner that communicates with said antenna and that tunes an RF frequency.

27. The system of claim 26 wherein said remote device further comprises an amplifier that amplifies RF signals at said tuned RF frequency.

28. The system of claim 27 wherein said remote device further comprises an intermediate frequency (IF) mixer that mixes said RF signals to IF signals.

29. The system of claim 28 wherein said remote device further comprises a BB mixer that mixes said IF signals to BB signals.

30. The system of claim 29 wherein said remote device further comprises a second wireless transceiver that transmits said BB signals to said cellular phone.

31. The cellular phone of claim 21 wherein said first wireless transceiver and said FM processing module is implemented as an integrated circuit.

32. A remote device comprising:

a frequency modulated (FM) tuner that communicates with an antenna and that tunes an FM frequency; and

a wireless transceiver that transmits wireless signals to a remote cellular phone based on FM signals received at said FM frequency.

33. The remote device of claim 32 wherein said first wireless transceiver receives FM tuning data from said remote cellular phone and adjusts said FM tuner based on said FM tuning data.

34. The remote device of claim 32 further comprising:

a first antenna that communicates with said FM tuner and receives said RF signals; and

a second antenna that communicates with said first wireless transceiver and transmits said wireless signals.

35. The remote device of claim 32 wherein said first wireless transceiver includes a Bluetooth interface.

36. The remote device of claim 32 further comprising:

an amplifier that amplifies signals at said tuned RF frequency;

a mixer that mixes said signals to said IF signals, wherein said first wireless transceiver transmits said IF signals to said remote cellular phone and receives processed FM signals from said remote cellular phone; and

an amplifier that generates amplified audio signals based on said processed FM signals.

37. The remote device of claim 32 further comprising:

a first amplifier that amplifies RF signals at said tuned RF frequency;

an intermediate frequency (IF) mixer that mixes said RF signals to IF signals;

a BB mixer that mixes said IF signals to BB signals,

wherein said wireless transceiver transmits said BB signals to said remote cellular phone and receives processed FM signals from said remote cellular phone; and

a second amplifier that generates amplified audio signals based on said processed FM signals.

38. The remote device of claim 32 further comprising:

a tuner that tunes an RF frequency;

a first amplifier that amplifies signals at said tuned RF frequency,

wherein said wireless transceiver transmits said RF signals to said remote cellular phone and receives processed FM signals from said remote cellular phone; and

a second amplifier that generates amplified audio signals based on said processed FM signals.

39. A headset comprising the remote device of claim 36 and further comprising speakers that output said amplified audio signals.

40. The headset of claim 39 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

41. A headset comprising the remote device of claim 37 and further comprising speakers that output said amplified audio signals.

AMENDED SHEET (ARTICLE 19)

42. The headset of claim 41 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

43. A headset comprising the remote device of claim 38 and further comprising speakers that output said amplified audio signals.

44. The headset of claim 43 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

45. An article of clothing comprising the remote device of claim 36 and further comprising a speaker that outputs said amplified audio signals.

46. An article of clothing comprising the remote device of claim 37 and further comprising a speaker that outputs said amplified audio signals.

47. An article of clothing comprising the remote device of claim 38 and further comprising a speaker that outputs said amplified audio signals.

48. A system comprising the remote device of claim 36 and further comprising speakers that output said amplified audio signals.

49. The system of claim 48 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

50. A system comprising the remote device of claim 37 and further comprising earbuds that output said amplified audio signals.

51. The system of claim 50 further comprising a conductor that connects said remote device to said earbuds, wherein said antenna extends adjacent to said conductor.

52. A system comprising the remote device of claim 38 and further comprising earbuds that output said amplified audio signals.

53. The system of claim 52 further comprising a conductor that connects said remote device to said earbuds, wherein said antenna extends adjacent to said conductor.

feature, the communication method further includes communicating with an antenna and tuning an RF frequency. In still another feature, the communication method further includes amplifying signals at the tuned RF frequency. In another feature, the communication method further includes transmitting the IF signals to the cellular phone.

[0040] In an additional feature, the communication method further includes converting the RF signals to IF signals. The IF signals are converted to BB signals.

[0041] In another feature, a cellular phone is provided and includes first wireless transceiver means for receiving radio frequency (RF) signals. The RF signals include frequency modulated (FM) signals that have been tuned by a remote device. FM processing means for receiving the RF signals is included. The FM processing means converts the RF signals to baseband signals and generates processed FM signals.

[0042] In a further feature, the cellular phone further includes cellular phone processing means for performing cellular phone signal processing. One or more of the first wireless transceiver means and the FM processing means are integrated with the cellular phone processing means in an integrated circuit.

[0043] In another feature, the first wireless transceiver means transmits the processed signals to the remote device.

[0044] In yet another feature, the cellular phone further includes user interface means for generating FM station selection data. The first wireless transceiver means transmits the FM station selection data to the remote device.

[0045] In another feature, a system includes the cellular phone and further includes the remote device. The remote device generates an audio signal based on the processed FM signals.

[0046] In still another feature, a system includes the cellular phone and further includes the remote device. The remote device further includes antenna means and tuner means for communicating with the antenna means and for tuning an RF frequency. In another feature, the remote device further includes an amplifier means for amplifying signals at the tuned RF frequency. In another

feature, the remote device further includes a second wireless transceiver means that transmits the IF signals to the cellular phone.

[0047] In another feature, the first wireless transceiver means and the FM processing means are implemented as an integrated circuit.

[0048] In a further feature, the FM processing means includes intermediate frequency (IF) mixer means for converting the RF signals to IF signals. BB mixer means for converting the IF signals to BB signals is also included.

[0049] In another feature, a cellular phone is provided and includes a first wireless transceiver that receives baseband (BB) signals. The BB signals are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to the BB by a remote device. An FM processing module receives the BB signals and generates processed FM signals based on the BB signals.

[0050] In still another feature, the cellular phone further includes a cellular phone processing module that performs cellular phone signal processing. One or more of the first wireless transceiver and the FM processing module are integrated with the cellular phone processing module in an integrated circuit.

[0051] In another feature, the first wireless transceiver transmits the processed FM signals to the remote device.

[0052] In yet another feature, the cellular phone further includes a user interface that generates FM station selection data. The first wireless transceiver transmits the FM station selection data to the remote device.

[0053] In another feature, a system includes the cellular phone and further includes the remote device. The remote device further generates an audio signal based on the processed FM signals.

[0054] In an additional feature, a system includes the cellular phone and further includes the remote device. The remote device further includes an antenna and a tuner that communicates with the antenna and that tunes an RF frequency. In another feature, the remote device further includes an amplifier that amplifies RF signals at the tuned RF frequency. In another feature, the

remote device further includes an intermediate frequency (IF) mixer that mixes the RF signals to IF signals. In yet another feature, the remote device further includes a BB mixer that mixes the IF signals to BB signals. In another feature, the remote device further includes a second wireless transceiver that transmits the BB signals to the cellular phone.

[0055] In another feature, the first wireless transceiver and the FM processing module is implemented as an integrated circuit.

[0056] In a further feature, a communication method is provided and includes receiving baseband (BB) signals, which are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to the BB by a remote device via a first wireless transceiver. The BB signals are received via an FM processing module. Processed FM signals are generated based on the BB signals.

[0057] In another feature, the communication method further includes transmitting the processed FM signals to the remote device.

[0058] In still another feature, the communication method further includes generating FM station selection data and transmitting the FM station selection data to the remote device.

[0059] In another feature, the communication method further includes generating an audio signal based on the processed FM signals.

[0060] In an additional feature, the communication method further includes communicating with an antenna via a tuner and tunings an RF frequency. In another feature, the communication method further includes amplifying RF signals at the tuned RF frequency. In yet another feature, the communication method further includes mixing the RF signals to generate IF signals. In another feature, the communication method further includes mixing the IF signals to generate BB signals. In another feature, the communication method further includes transmitting the BB signals to a cellular phone.

[0061] In still another feature, a cellular phone is provided and includes first wireless transceiver means for receiving baseband (BB) signals. The BB signals are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to the BB by a remote device.

FM processing means for receiving the BB signals is also included. The FM processing means generates processed FM signals based on the BB signals.

[0062] In another feature, the cellular phone further includes cellular phone processing means for performing cellular phone signal processing. One or more of the first wireless transceiver means and the FM processing means is integrated with the cellular phone processing means in an integrated circuit.

[0063] In a further feature, the first wireless transceiver means transmits the processed FM signals to the remote device.

[0064] In another feature, the cellular phone further includes user interface means for generating FM station selection data. The first wireless transceiver means transmits the FM station selection data to the remote device.

[0065] In still another feature, a system includes the cellular phone and further includes the remote device. The remote device further generates an audio signal based on the processed FM signals.

[0066] In another feature, a system includes the cellular phone and further includes the remote device. The remote device further includes an antenna and tuner means for communicating with the antenna and for tuning an RF frequency. In another feature, the remote device further includes amplifier means for amplifying RF signals at the tuned RF frequency. In a further feature, the remote device further includes intermediate frequency (IF) mixer means for mixing the RF signals to generate IF signals. In another feature, the remote device further includes a BB mixer means for mixing the IF signals to generate BB signals. In yet another feature, the remote device further includes a second wireless transceiver means for transmitting the BB signals to the cellular phone.

[0067] In another feature, the first wireless transceiver means and the FM processing means are implemented as an integrated circuit.

[0068] In still another feature, a remote device is provided and includes a frequency modulated (FM) tuner that communicates with an antenna and that tunes an FM frequency. A wireless transceiver transmits wireless signals to a remote cellular phone based on FM signals received at the FM frequency.

[0069] In another feature, the first wireless transceiver receives FM tuning data from the remote cellular phone and adjusts the FM tuner based on the FM tuning data.

[0070] In another feature, the remote device further includes a first antenna that communicates with the FM tuner and receives the RF signals. A second antenna communicates with the first wireless transceiver and transmits the wireless signals.

[0071] In an additional feature, the first wireless transceiver includes a Bluetooth interface.

[0072] In another feature, the remote device further includes an amplifier that amplifies signals at the tuned RF frequency. A mixer mixes the signals to the IF signals. The first wireless transceiver transmits the IF signals to the remote cellular phone and receives processed FM signals from the remote cellular phone. An amplifier generates amplified audio signals based on the processed FM signals.

[0073] In a further feature, a headset includes the remote device and further includes speakers that output the amplified audio signals. In another feature, the headset further includes a conductor that connects the remote device to the speakers. The antenna extends adjacent to the conductor.

[0074] In another feature, an article of clothing includes the remote device and further includes a speaker that outputs the amplified audio signals. In another feature, a system includes the remote device and further includes speakers that output the amplified audio signals. In another feature, the system further includes a conductor that connects the remote device to the speakers. The antenna extends adjacent to the conductor.

[0075] In yet another feature, the remote device further includes a first amplifier that amplifies RF signals at the tuned RF frequency. An intermediate frequency (IF) mixer mixes the RF signals to IF signals. A BB mixer mixes the IF signals to BB signals. The wireless transceiver transmits the BB signals to the remote cellular phone and receives processed FM signals from the remote cellular phone. A second amplifier generates amplified audio signals based on the processed FM signals.

[0076] In another feature, a headset includes the remote device and further includes speakers that output the amplified audio signals. In another feature, the headset further includes a conductor that connects the remote device to the speakers, wherein the antenna extends adjacent to the conductor.

[0077] In still another feature, an article of clothing includes the remote device and further includes a speaker that outputs the amplified audio signals.

[0078] In another feature, a system includes the remote device of claim 6 and further includes earbuds that output the amplified audio signals. In another feature, the system further includes a conductor that connects the remote device to the earbuds. The antenna extends adjacent to the conductor.

[0079] In another feature, the remote device further includes a tuner that tunes an RF frequency. A first amplifier amplifies signals at the tuned RF frequency. The wireless transceiver transmits the RF signals to the remote cellular phone and receives processed FM signals from the remote cellular phone. A second amplifier generates amplified audio signals based on the processed FM signals.

[0080] In yet another feature, a headset includes the remote device further includes speakers that output the amplified audio signals. In another feature, the headset further includes a conductor that connects the remote device to the speakers. The antenna extends adjacent to the conductor.

[0081] In another feature, an article of clothing includes the remote device and further includes a speaker that outputs the amplified audio signals. In another feature, a system includes the remote device and further includes earbuds that output the amplified audio signals. In another feature, the system further includes a conductor that connects the remote device to the earbuds. The antenna extends adjacent to the conductor.

[0082] In another feature, a communication method is provided and includes communicating with an antenna and tuning an FM frequency via a frequency modulated (FM) tuner. Wireless signals are transmitted to a remote cellular phone based on FM signals received at the FM frequency via a wireless transceiver.

[0083] In another feature, the communication method includes receiving FM tuning data from the remote cellular phone and adjusting the FM tuner based on the FM tuning data.

[0084] In still another feature, the communication method further includes communicating with the FM tuner and receiving the RF signals via a first antenna. The first wireless transceiver is communicated with and the wireless signals are transmitted via a second antenna.

[0085] In another feature, the communication method further includes amplifying signals at the tuned RF frequency. The amplified signals are mixed to generate the IF signals. The IF signals are transmitted to the remote cellular phone. Processed FM signals are received from the remote cellular phone. The amplified audio signals are generated based on the processed FM signals.

[0086] In a further feature, the communication method further includes amplifying RF signals at the tuned RF frequency. The RF signals are mixed to generate IF signals. The IF signals are mixed to generate BB signals. The BB signals are transmitted to the remote cellular phone. Processed FM signals are received from the remote cellular phone. Amplified audio signals are generated based on the processed FM signals.

[0087] In another feature, the communication method further includes tuning an RF frequency. Amplifying signals are tuned at the RF frequency. The RF signals are transmitted to the remote cellular phone. Processed FM signals are received from the remote cellular phone. Amplified audio signals are generated based on the processed FM signals.

[0088] In another feature, the communication method further includes outputting the amplified audio signals. In another feature, the communication method further includes outputting the amplified audio signals. In another feature, the communication method further includes outputting the amplified audio signals.

[0089] In an additional feature, a remote device is provided and includes frequency modulated (FM) tuner means for communicating with an antenna and for tuning an FM frequency. Wireless transceiver means for

transmitting wireless signals to a remote cellular phone based on FM signals received at the FM frequency is also included.

[0090] In another feature, the first wireless transceiver means receives FM tuning data from the remote cellular phone and adjusts the FM tuner based on the FM tuning data.

[0091] In another feature, the remote device further includes first antenna means for communicating with the FM tuner and receiving the RF signals. Second antenna means for communicating with the first wireless transceiver means and transmitting the wireless signals is included.

[0092] In another feature, the first wireless transceiver means includes a Bluetooth interface means.

[0093] In yet another feature, the remote device further includes amplifier means for amplifying signals at the tuned RF frequency. Mixer means for mixing the signals to generate the IF signals. First wireless transceiver means for transmitting the IF signals to the remote cellular phone and for receiving processed FM signals from the remote cellular phone is included. Amplifier means for generating amplified audio signals based on the processed FM signals is also included.

[0094] In another feature, a headset includes the remote device and further includes audio means for outputting the amplified audio signals. In another feature, the headset further includes a conductor means for connecting the remote means to the audio means. The antenna extends adjacent to the conductor means.

[0095] In still another feature, an article of clothing includes the remote device and further includes audio means for outputting the amplified audio signals. In another feature, a system includes the remote device and further includes audio means for outputting the amplified audio signals. In another feature, the system further includes conductor means for connecting the remote means to the audio means. The antenna extends adjacent to the conductor means.

[0096] In another feature, the remote device further includes first amplifier means for amplifying RF signals at the tuned RF frequency.

Intermediate frequency (IF) mixer means for mixing the RF signals to generate IF signals is included. BB mixer means for mixing the IF signals to generate BB signals is also included. The wireless transceiver means transmits the BB signals to the remote cellular phone and receives processed FM signals from the remote cellular phone. Second amplifier means for generating amplified audio signals based on the processed FM signals is further included.

[0097] In another feature, a headset includes the remote device and further includes audio means for outputting the amplified audio signals. In another feature, the headset further includes conductor means for connecting the remote means to the audio means. The antenna extends adjacent to the conductor means.

[0098] In a further feature, an article of clothing includes the remote means and further includes audio means for outputting the amplified audio signals. In another feature, a system includes the remote means and further includes audio means for outputting the amplified audio signals. In another feature, the system further includes conductor means for connecting the remote means to the audio means. The antenna extends adjacent to the conductor means.

[0100] In another feature, the remote device further includes tuner means for tuning an RF frequency. First amplifier means for amplifying signals at the tuned RF frequency is included. The wireless transceiver means transmits the RF signals to the remote cellular phone and receives processed FM signals from the remote cellular phone. Second amplifier means for generating amplified audio signals based on the processed FM signals is further included.

[0101] In another feature, a headset includes the remote device and further includes audio means for outputting the amplified audio signals. In another feature, the headset further includes conductor means for connecting the remote device to the audio means. The antenna extends adjacent to the conductor means.

[0102] In an additional feature, an article of clothing includes the remote device and further includes audio means for outputting the amplified audio signals. In another feature, a system includes the remote device and

further includes audio means for outputting the amplified audio signals. In another feature, the system further includes conductor means for connecting the remote device to the audio means. The antenna extends adjacent to the conductor means.

[0103] In still other features, the systems and methods described above are implemented by a computer program executed by one or more processors. The computer program can reside on a computer readable medium such as but not limited to memory, non-volatile data storage and/or other suitable tangible storage mediums.

[0104] Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the disclosure, are intended for purposes of illustration only and are not intended to limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0105] The present disclosure will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0106] FIG. 1A is a functional block diagram of an exemplary FM receiver according to the prior art;

[0107] FIG. 1B is a functional block diagram of a second exemplary FM receiver according to the prior art;

[0108] FIG. 2 is a functional block diagram of a cellular phone system including an exemplary remote device and an exemplary cellular phone according to the present disclosure;

[0109] FIG. 3A is a functional block diagram of a headset according to the present disclosure;

[0110] FIG. 3B is a functional block diagram of earbuds according to the present disclosure;

[0111] FIGs. 4A and 4B illustrate articles of clothing that incorporate the remote device according to the present disclosure;

[0112] FIG. 5 is a more detailed functional block diagram of the cellular phone system of FIG. 2;

[0113] FIG. 6 is a functional block diagram of an alternate cellular phone system;

[0114] FIG. 7 is a functional block diagram of another alternate cellular phone system; and

[0115] FIG. 8 is a logic flow diagram illustrating a method of operating a cellular phone system.

DETAILED DESCRIPTION

[0116] The following description is merely exemplary in nature and is in no way intended to limit the disclosure, its application, or uses. For purposes of clarity, the same reference numbers will be used in the drawings to identify similar elements. As used herein, the term module refers to an Application Specific Integrated Circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group) and memory that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable components that provide the described functionality. As used herein, the phrase at least one of A, B, and C should be construed to mean a logical (A or B or C), using a non-exclusive logical or. It should be understood that steps within a method may be executed sequentially, simultaneously or in different order without altering the principles of the present disclosure.

[0117] A cellular phone FM receiver typically has multiple associated components, such as tuners, low noise amplifiers (LNAs), oscillators, amplifiers, filters, converters, etc.. The cellular phone system according to the present invention separates one or more of such components from a cellular phone. As a result, a potion of the FM signal processing is performed remotely from the cellular phone. The cellular phone continues and completes the FM signal processing as described in further detail below.

[0118] Referring now to FIG. 2, a cellular phone system 100 is shown and includes a remote device 110 and a cellular phone 120. The cellular phone system 100, the remote device 110, and the cellular phone 120 are shown as and each considered a cellular phone circuit. The remote device 110 includes a tuning module 124 that tunes to one or more selected frequencies, such as one or more FM radio stations. The tuning module 124 communicates

with one or more FM antennas 126 that receive FM signals as input signals. A low noise amplifier (LNA) module 128 amplifies the selected FM signals and outputs amplified signals to an analog to digital (A/D) converter module 130. The A/D converter 130 outputs digital signals to a wireless interface module 132 of the remote device 110. The wireless interface module 132 transmits wireless signals to the cellular phone 120 via an antenna 133. One or more components of the remote device 110 can be integrated into a system on a chip (SOC).

[0119] The user may select a particular FM station using inputs on the cellular phone 120 and/or on the remote device 110. If the user employs inputs of the cellular phone 120 to select an FM station, the wireless interface 132 also may receive tuning data such as frequency data from the cellular phone 120, which is output to the tuner 124. Alternately, the remote device 110 may include a user input 136 that allows a user to select a station, adjust volume, and/or perform other radio-based functions such as selecting preset stations, setting preset stations, scanning, etc.. The user input of the cellular phone 120 may also allow the user to adjust volume, and/or perform other radio-based functions such as selecting preset stations, setting preset stations, scanning, etc..

[0120] The wireless interface 132 also receives the processed FM radio signal from the cellular phone 120. The received signal is output to a digital to analog (D/A) converter 142, which outputs analog audio signals. The D/A converter 142 outputs the audio signal to an amplifier 144, which amplifies the audio signal and outputs the signal to an output 146, such as an output jack, speakers, etc.

[0121] An exemplary embodiment of the cellular phone 120 is shown in FIG. 2. Still other types of cellular phones may be used. The cellular phone 120 includes a modified FM receiver or FM processing module 200, which communicates with a wireless interface module 168 of the cellular phone 120. The FM module 200 continues processing of the FM signals as will be described further below. When the processing is completed, the FM module 200 outputs the processed FM signals to the signal processing and/or control module 152 and/or to the wireless interface module 168. From the control module 152, the

processed FM signals may be sent to the wireless interface 168 and/or to an audio out 158. The wireless interface module 168, in turn, transmits the wireless signals to the wireless interface module 132 via an antenna 167. The remote device 110 receives the wireless signals and outputs the signals as described above.

[0122] The cellular phone 120 in addition to the audio output 158, which may be a speaker and/or audio output jack, may include a microphone 156, a display 160 and/or an input device 162 such as a keypad, pointing device, voice actuation and/or other input device. The control module 152 and/or other circuits (not shown) in the cellular phone 120 may process data, perform coding and/or encryption, perform calculations, format data and/or perform other cellular phone functions. The cellular phone in addition to the antenna 167 may have a cellular designated antenna 170.

[0123] The cellular phone 120 may communicate with mass data storage 164 that stores data in a nonvolatile manner such as optical and/or magnetic storage devices for example hard disk drives HDD. The HDD may be a mini HDD that includes one or more platters having a diameter that is smaller than approximately 1.8".

[0124] The cellular phone 120 may be connected to memory 166 such as RAM, ROM, low latency nonvolatile memory such as flash memory and/or other suitable electronic data storage. The cellular phone 120 also may support connections with a WLAN via the wireless interface 168 and/or via an additional wireless interface (not shown). The wireless interfaces may be compliant with one or more of the following IEEE standards 802.11, 802.11a, 802.11b, 802.11g, 802.11h, 802.11n, 802.16, 802.20, and/or Bluetooth. The control module 152 may be integrated with the FM module 200, the memory 166 into a system on-chip (SOC).

[0125] Referring now to FIG. 3A, the remote device 110 may be packaged with a headset 220, that includes first and second housings 224 and 226. The first and second housings 224 and 226 enclose speakers 230 and 232, respectively. The remote device 110 may be packaged with the first and/or second housings 224 and 226. The housings 224 and 226 may be connected by

a "C"-shaped portion 230, which supports the headset 220 on a user's head. The antenna 126 may be routed through the "C"-shaped portion 230. The housings 224 and/or 226 may also house batteries 240, which power the remote device 110.

[0126] Referring now to FIG. 3B, the remote device 110 may be integrated with a headset 250, which is shown to include first and second earbuds 244 and 246, respectively. The first and second earbuds 244 and 246 include speakers 230 and 232, respectively. The earbuds244 and 246 may include a device (not shown) that physically attaches to attach the earbuds 244 and 246 to the user's ears. The remote device 110 may be integrated with one or both of the earbuds 244 and/or 246. The earbuds 244 and 246 may be connected by wire 260. The antenna 126 may be integrated with and/or routed adjacent to the wire 260. The earbuds 244 and/or 246 may also house batteries 240, which power the remote device 110.

[0127] Referring now to FIGs. 4A and 4B, the remote device 110 may be attached to and/or inserted in an article of clothing 260. In FIG. 4A, the article of clothing 260 also includes a speaker 270 and a battery 272. In FIG. 4B, the earbuds 244 and 246 are connected by wire 260 to the remote device 110 via an output jack thereof. The antenna 126 may be located adjacent to the wire 260. Still other variations are contemplated.

[0128] Referring now to FIGs. 5-7, several variations relating to the relative arrangement and location of FM receiver components associated with the remote device 110 and/or the cellular phone 120 are shown. In FIG. 5, a more detailed drawing of the remote device 110 of FIG. 2 is shown. The LNA is located in the remote device 110. In FIG. 6, an intermediate frequency (IF) mixer is also located in the remote device 110 in addition to the LNA. In FIG. 7, the IF mixer and a baseband (BB) mixer are located in the remote device 110 in addition to the LNA.

[0129] In FIG. 5, the antenna 126 receives a RF signal including FM signals. The LNA 128 amplifies the signals and outputs the signals to the A/D converter 130. Optional filters 300 may be used at the input and/or output of the LNA 128. The digital signal output by the A/D converter 130 is output to the

wireless network interface 132, which transmits the digital signal to the wireless network interface 168. The wireless network interface 168 outputs the signal to intermediate frequency (IF) mixers 304-1 and 304-2, which also receive a reference signal outputs from an oscillator 308. Intermediate signal outputs of the IF mixers 304-1 and 304-2 are optionally filtered by filters 310 and 312 and input to BB mixers 312-1 and 312-2, respectively. The BB mixers 312-1 and 312-2 also receive reference signal outputs from an oscillator 316. Baseband signal outputs of the BB mixers 312-1 and 312-2 are optionally filtered by filters 320 and 322 and input to a signal processor 330, which processes the baseband FM signals.

[0130] The processed FM signals are output by the signal processor 330 to the wireless network interface 168. The wireless network interface 168 transmits the processed signal to the wireless network interface 132. The wireless network interface 132 outputs the received processed signal to a digital to analog (D/A) converter 142. The D/A converter 142 outputs the analog signals to an amplifier 144 as described above.

[0131] In FIG. 6, an analog IF mixer 400 is integrated with the remote device 110. The mixer 400 includes first and second mixers 410-1 and 410-2. An analog oscillator 414 outputs oscillator signals to the mixers 410-1 and 410-2. Outputs of the mixers 410-1 and 410-2 are optionally filtered by filters 414 and 416, respectively and output to the A/D converter 130.

[0132] In FIG. 7, the analog IF mixer 400 is integrated with the remote device 110. In addition, an analog BB mixer 430 is integrated with the remote device 110. The mixer 430 includes first and second mixers 432-1 and 432-2. An analog oscillator 434 outputs oscillator signals to the mixers 432-1 and 432-2. Outputs of the mixers 432-1 and 432-2 are optionally filtered (not shown) and output to the A/D converter 130. As can be appreciated, one or both of the mixers 400, 430 can be implemented in the digital domain by adjusting the location of the A/D converter 130 in the remote device 110.

[0133] Referring to FIG. 8, a logic flow diagram illustrating a method of operating a cellular phone system is shown. Although the following steps are primarily described with respect to the embodiment of FIG. 2, the steps

may be easily modified to encompass other embodiments of the present invention, some of which are described above.

[0134] In step 500, a remote device receives FM station data. The FM station data may be received from a user input of the remote device or may be wirelessly received from a cellular phone using wireless interfaces, such as the interfaces 132, 168. In step 502, a tuner of the remote device tunes to a FM station based on the FM station data. In step 504, FM radio signals are received via a first antenna, such as the antenna 126. In step 506, the FM signals are amplified to generate amplified signals. The FM signals may be amplified by a LNA, such the LNA 128.

[0135] In step 508, the amplified signals are converted into digital signals or preprocessed FM signals. The amplified signals may be converter using an A/D converter, such as the A/D converter 130. In step 510, the preprocessed FM signals are wirelessly transmitted as wireless signals to the cellular phone via a second antenna, such as the antenna 133.

[0136] Note that additional steps may be incorporated in between steps 504-510 to perform addition FM signal processing as described above and below. For example, additional steps may be incorporated to include the generation of intermediate frequency signals and baseband signals, as well the filtration of such signals.

[0137] In step 512, the preprocessed FM signals are received by the cellular phone as input signals via an antenna, such as the antenna 167. In step 514, the preprocessed FM signals are passed through a wireless interface to a FM processing module, such as the FM processing module 200. In step 516, the FM processing module or some other cellular phone processor or control module completes the processing of the originally received FM signals. The preprocessed FM signals are converted into processed FM signals.

[0138] In step 518, the processed FM signals from step 116 are transmitted to the remote device for audio output thereof or to an audio output of the cellular phone. Of course, the processed FM signals or data related thereto may be stored in a memory of the cellular phone or in a memory of the remote device.

[0139] The above-described method eliminates some of the disadvantages that are associated with the need for a long FM antenna to be directly connected to a cellular phone.

[0140] Those skilled in the art can now appreciate from the foregoing description that the broad teachings of the disclosure can be implemented in a variety of forms. Therefore, while this disclosure includes particular examples, the true scope of the disclosure should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, the specification and the following claims.

CLAIMS

What is claimed is:

1. A cellular phone comprising:

a first wireless transceiver that receives intermediate frequency (IF) signals, which are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to an IF by a remote device; and

an FM processing module that receives said IF signals, that converts said IF signals to baseband signals and that generates processed FM signals.

2. The cellular phone of claim 1 further comprising a cellular phone processing module that performs cellular phone signal processing, wherein at least one of said first wireless transceiver and said FM processing module is integrated with said cellular phone processing module in an integrated circuit.

3. The cellular phone of claim 1 wherein said first wireless transceiver transmits said processed FM signals to said remote device.

4. The cellular phone of claim 1 further comprising a user interface that generates FM station selection data, wherein said first wireless transceiver transmits said FM station selection data to said remote device.

5. A system comprising the cellular phone of claim 1 and further comprising said remote device, wherein said remote device generates an audio signal based on said processed FM signals.

6. A system comprising the cellular phone of claim 1 and further comprising said remote device, wherein said remote device further comprises:

an antenna; and

a tuner that communicates with said antenna and that tunes an RF frequency.

7. The system of claim 6 wherein said remote device further comprises an amplifier that amplifies RF signals at said RF frequency.

8. The system of claim 7 wherein said remote device further comprises a mixer that mixes said RF signals to generate said IF signals.

9. The system of claim 8 wherein said remote device further comprises a second wireless transceiver that transmits said IF signals to said cellular phone.

10. The system of claim 6 wherein said remote device includes a user interface that communicates with said tuner to select an FM station.

11. A cellular phone, comprising:

a first wireless transceiver that receives radio frequency (RF) signals, which include frequency modulated (FM) signals that have been tuned by a remote device; and

an FM processing module that receives said RF signals, that converts said RF signals to baseband signals and that generates processed FM signals.

12. The cellular phone of claim 11 further comprising a cellular phone processing module that performs cellular phone signal processing, wherein at least one of said first wireless transceiver and said FM processing module is integrated with said cellular phone processing module in an integrated circuit.

13. The cellular phone of claim 11 wherein said first wireless transceiver transmits said processed signals to said remote device.

14. The cellular phone of claim 11 further comprising a user interface that generates FM station selection data, wherein said first wireless transceiver transmits said FM station selection data to said remote device.

15. A system comprising the cellular phone of claim 11 and further comprising said remote device, wherein said remote device generates an audio signal based on said processed FM signals.

16. A system comprising the cellular phone of claim 11 and further comprising said remote device, wherein said remote device further comprises:

an antenna; and

a tuner that communicates with said antenna and that tunes an RF frequency.

17. The system of claim 16 wherein said remote device further comprises an amplifier that amplifies signals at said tuned RF frequency.

18. The system of claim 17 wherein said remote device further comprises a second wireless transceiver that transmits said IF signals to said cellular phone.

19. The cellular phone of claim 11 wherein said first wireless transceiver and said FM processing module are implemented as an integrated circuit.

20. The cellular phone of claim 11 wherein said FM processing module comprises:

an intermediate frequency (IF) mixer that converts said RF signals to IF signals; and

a BB mixer that converts said IF signals to BB signals.

21. A cellular phone, comprising:

a first wireless transceiver that receives baseband (BB) signals, which are based on frequency modulated (FM) signals that have been tuned and down-converted from a radio frequency (RF) to said BB by a remote device; and

an FM processing module that receives said BB signals and that generates processed FM signals based on said BB signals.

22. The cellular phone of claim 21 further comprising a cellular phone processing module that performs cellular phone signal processing, wherein at least one of said first wireless transceiver and said FM processing module is integrated with said cellular phone processing module in an integrated circuit.

23. The cellular phone of claim 21 wherein said first wireless transceiver transmits said processed FM signals to said remote device.

24. The cellular phone of claim 21 further comprising a user interface that generates FM station selection data, wherein said first wireless transceiver transmits said FM station selection data to said remote device.

25. A system comprising the cellular phone of claim 21 and further comprising said remote device, wherein said remote device further generates an audio signal based on said processed FM signals.

26. A system comprising the cellular phone of claim 21 and further comprising said remote device, wherein said remote device further comprises:

an antenna; and

a tuner that communicates with said antenna and that tunes an RF frequency.

27. The system of claim 26 wherein said remote device further comprises an amplifier that amplifies RF signals at said tuned RF frequency.

28. The system of claim 27 wherein said remote device further comprises an intermediate frequency (IF) mixer that mixes said RF signals to IF signals.

29. The system of claim 28 wherein said remote device further comprises a BB mixer that mixes said IF signals to BB signals.

30. The system of claim 29 wherein said remote device further comprises a second wireless transceiver that transmits said BB signals to said cellular phone.

31. The cellular phone of claim 21 wherein said first wireless transceiver and said FM processing module is implemented as an integrated circuit.

32. A remote device comprising:

a frequency modulated (FM) tuner that communicates with an antenna and that tunes an FM frequency; and

a wireless transceiver that transmits wireless signals to a remote cellular phone based on FM signals received at said FM frequency.

33. The remote device of claim 32 wherein said first wireless transceiver receives FM tuning data from said remote cellular phone and adjusts said FM tuner based on said FM tuning data.

34. The remote device of claim 32 further comprising:

a first antenna that communicates with said FM tuner and receives said RF signals; and

a second antenna that communicates with said first wireless transceiver and transmits said wireless signals.

35. The remote device of claim 32 wherein said first wireless transceiver includes a Bluetooth interface.

36. The remote device of claim 32 further comprising:

an amplifier that amplifies signals at said tuned RF frequency;

a mixer that mixes said signals to said IF signals, wherein said first wireless transceiver transmits said IF signals to said remote cellular phone and receives processed FM signals from said remote cellular phone; and

an amplifier that generates amplified audio signals based on said processed FM signals.

37. The remote device of claim 32 further comprising:

A first amplifier that amplifies RF signals at said tuned RF frequency;

an intermediate frequency (IF) mixer that mixes said RF signals to IF signals;

a BB mixer that mixes said IF signals to BB signals,

wherein said wireless transceiver transmits said BB signals to said remote cellular phone and receives processed FM signals from said remote cellular phone; and

a second amplifier that generates amplified audio signals based on said processed FM signals.

38. The remote device of claim 32 further comprising:

a tuner that tunes an RF frequency;

a first amplifier that amplifies signals at said tuned RF frequency,

wherein said wireless transceiver transmits said RF signals to said remote cellular phone and receives processed FM signals from said remote cellular phone; and

a second amplifier that generates amplified audio signals based on said processed FM signals.

39. A headset comprising the remote device of claim 36 and further comprising speakers that output said amplified audio signals.

40. The headset of claim 39 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

41. A headset comprising the remote device of claim 37 and further comprising speakers that output said amplified audio signals.

42. The headset of claim 41 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

43. A headset comprising the remote device of claim 38 and further comprising speakers that output said amplified audio signals.

44. The headset of claim 43 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

45. An article of clothing comprising the remote device of claim 36 and further comprising a speaker that outputs said amplified audio signals.

46. An article of clothing comprising the remote device of claim 37 and further comprising a speaker that outputs said amplified audio signals.

47. An article of clothing comprising the remote device of claim 38 and further comprising a speaker that outputs said amplified audio signals.

48. A system comprising the remote device of claim 36 and further comprising speakers that output said amplified audio signals.

49. The system of claim 48 further comprising a conductor that connects said remote device to said speakers, wherein said antenna extends adjacent to said conductor.

50. A system comprising the remote device of claim 37 and further comprising earbuds that output said amplified audio signals.

51. The system of claim 50 further comprising a conductor that connects said remote device to said earbuds, wherein said antenna extends adjacent to said conductor.

52. A system comprising the remote device of claim 38 and further comprising earbuds that output said amplified audio signals.

53. The system of claim 52 further comprising a conductor that connects said remote device to said earbuds, wherein said antenna extends adjacent to said conductor.

FIG. 1A
Prior Art

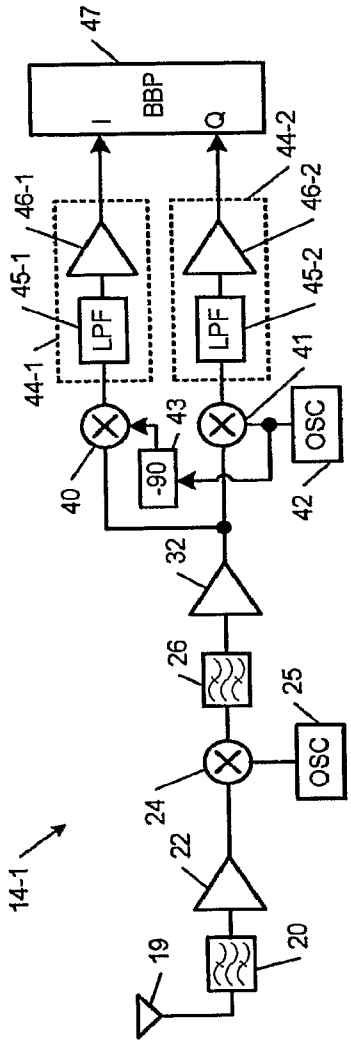
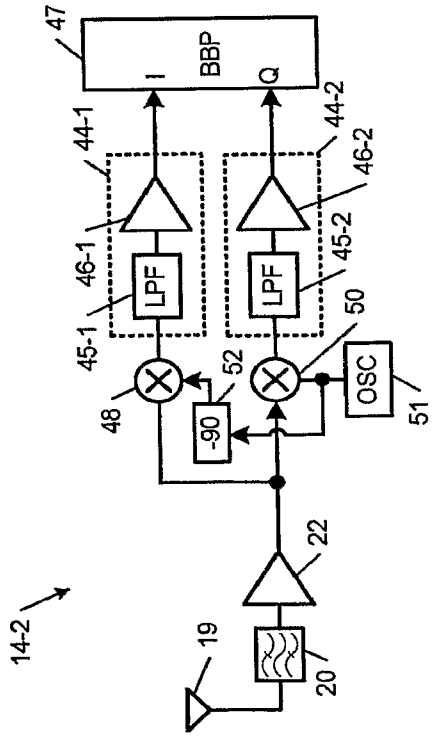


FIG. 1B
Prior Art



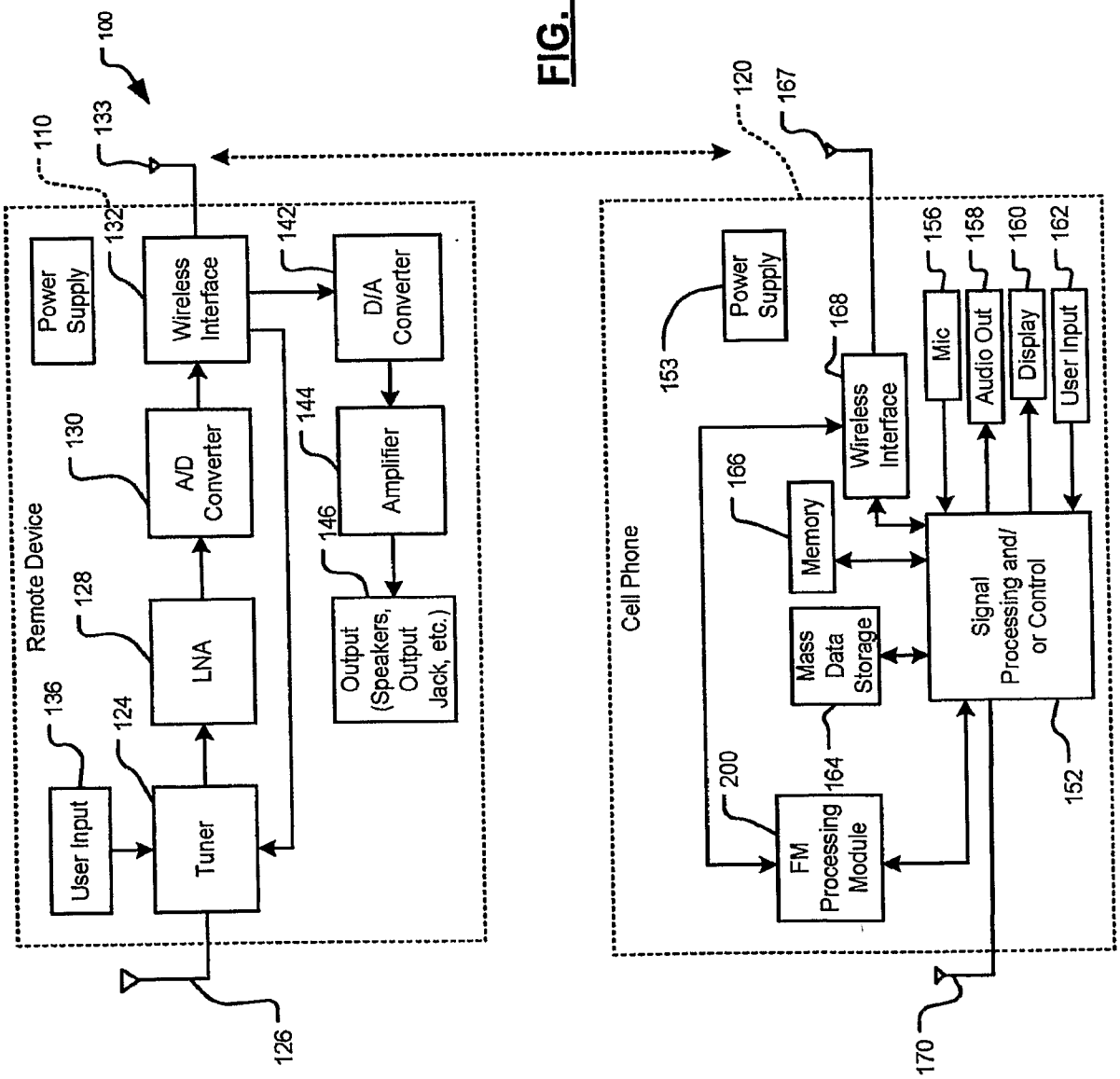

100
110
133
120
167
Remote Device
Power Supply
132
Wireless Interface
142
D/A Converter
130
A/D Converter
144
Amplifier
128
LNA
146
Output (Speakers, Output Jack, etc.)
136
User Input
124
Tuner
126
Cell Phone
153
Power Supply
168
Wireless Interface
156
Mic
158
Audio Out
160
Display
162
User Input
166
Memory
Mass Data Storage
164
Signal Processing and/ or Control
152
200
FM Processing Module
170

FIG. 2

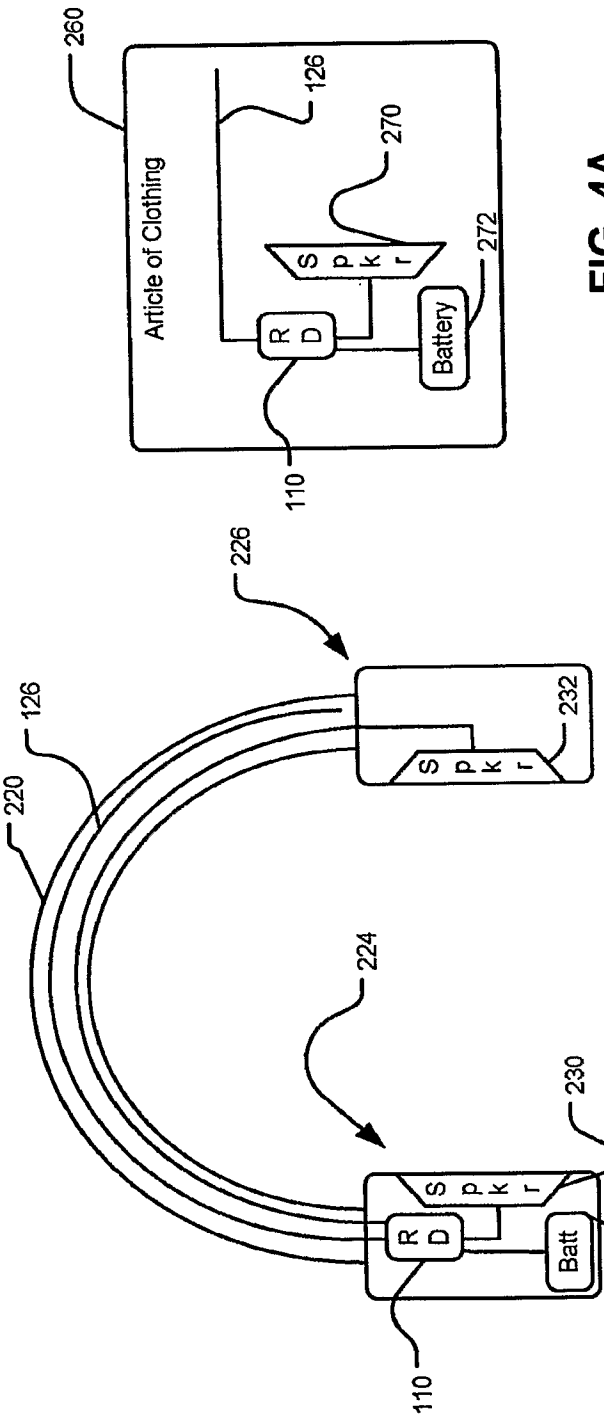


FIG. 3A

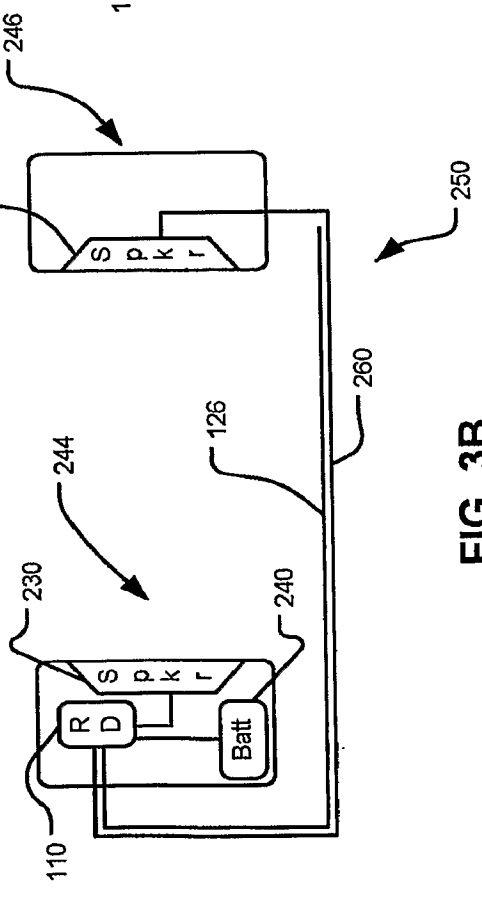


FIG. 3B

FIG. 4A

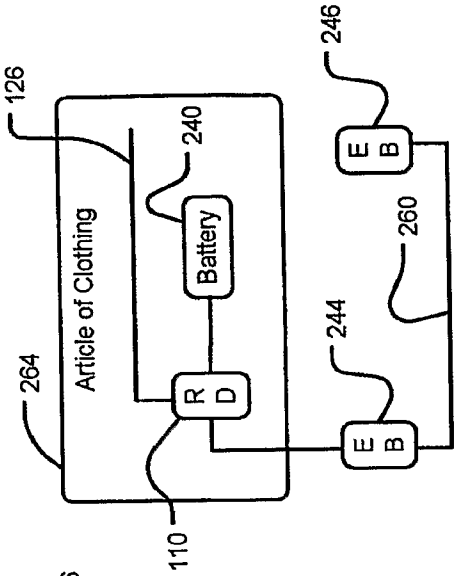


FIG. 4B

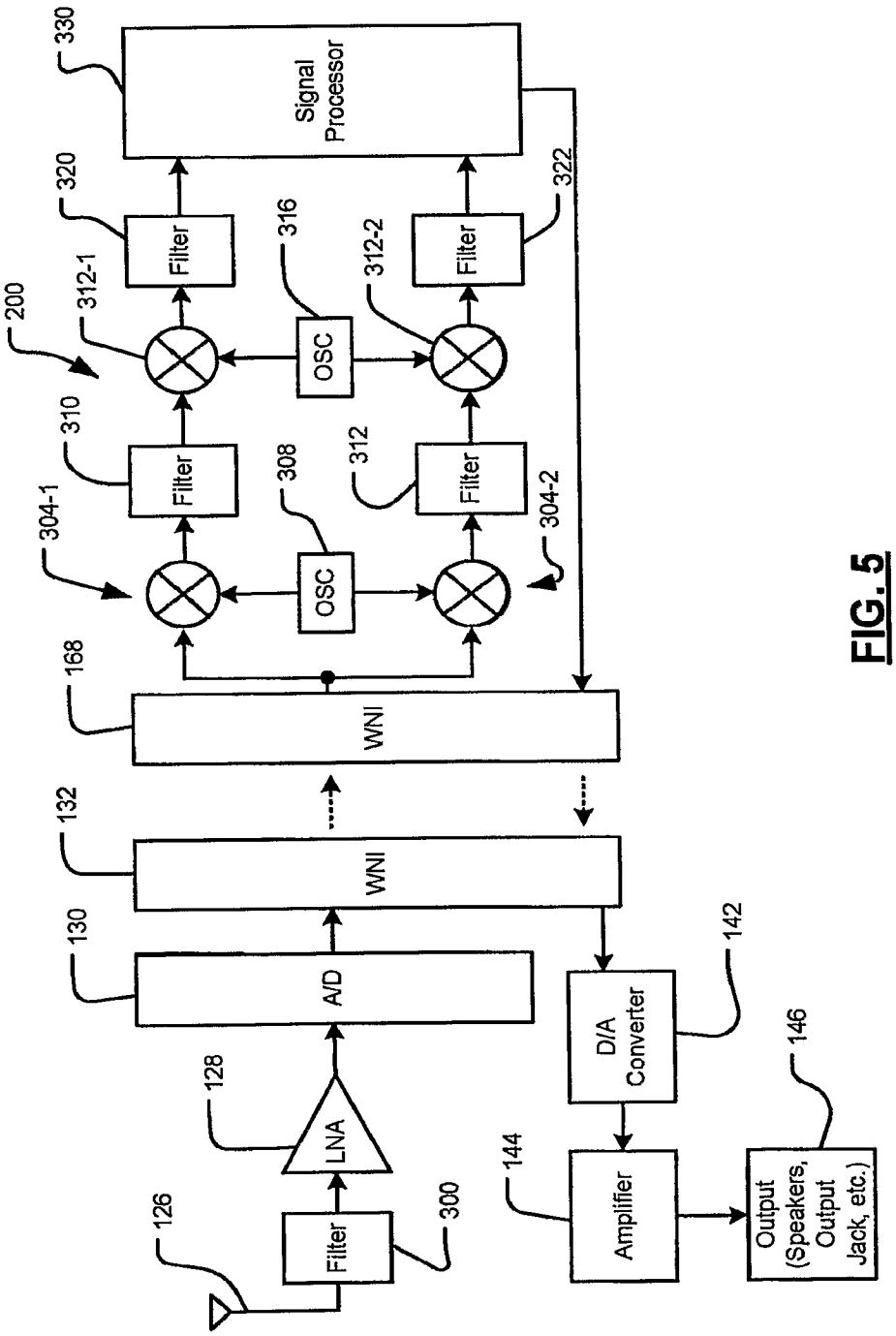

126
Filter
300
128
LNA
130
A/D
132
WNI
168
WNI
304-1
304-2
308
OSC
310
Filter
312
Filter
200
312-1
312-2
316
OSC
320
Filter
322
Filter
330
Signal Processor
142
D/A Converter
144
Amplifier
146
Output (Speakers, Output Jack, etc.)

FIG. 5

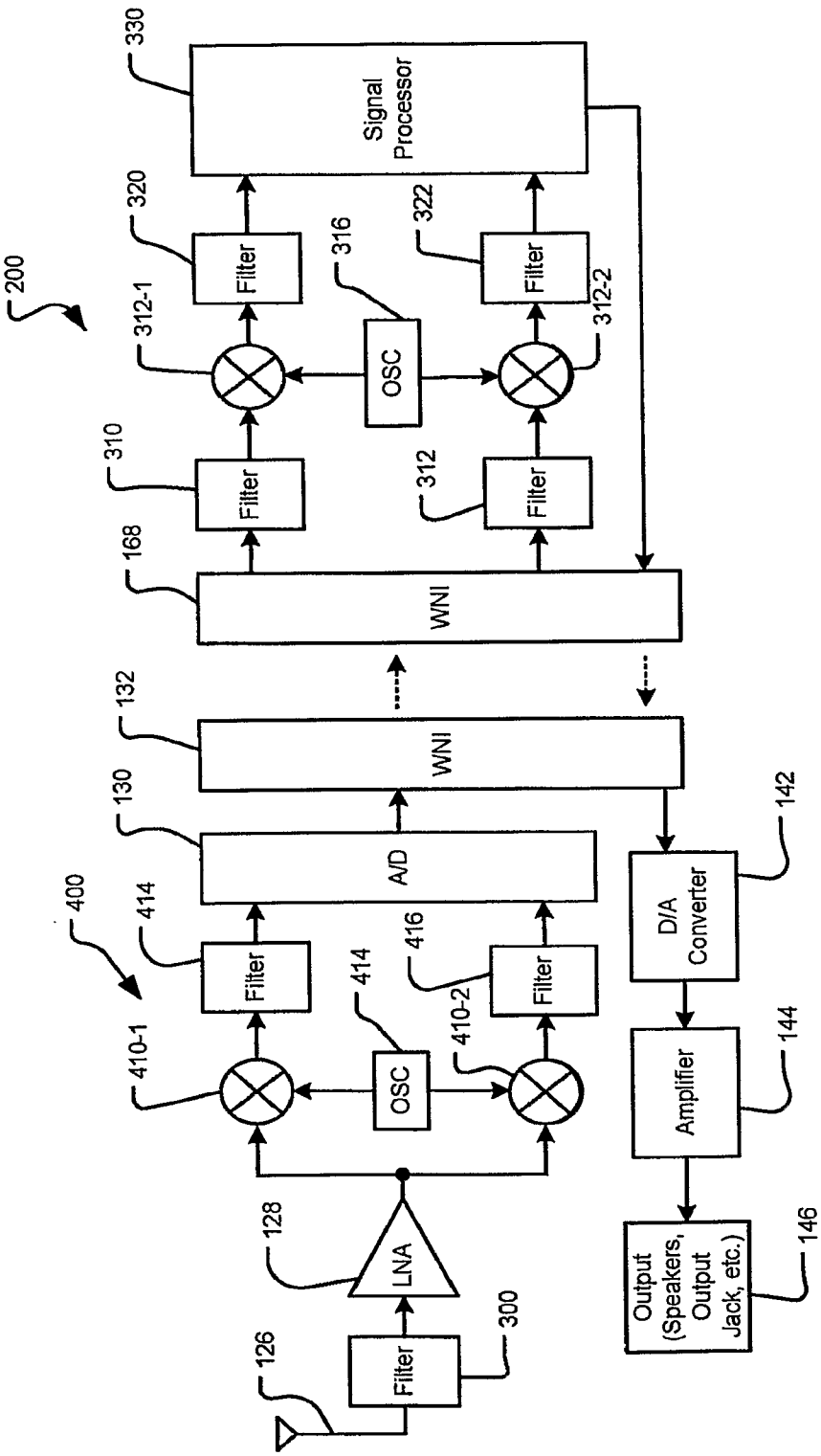

200
330
Signal Processor
320
Filter
322
Filter
316
312-1
OSC
312-2
310
Filter
312
Filter
168
WNI
132
WNI
130
A/D
400
414
Filter
414
416
Filter
410-1
OSC
410-2
128
LNA
126
Filter
300
142
D/A Converter
144
Amplifier
146
Output (Speakers, Output Jack, etc.)

FIG. 6

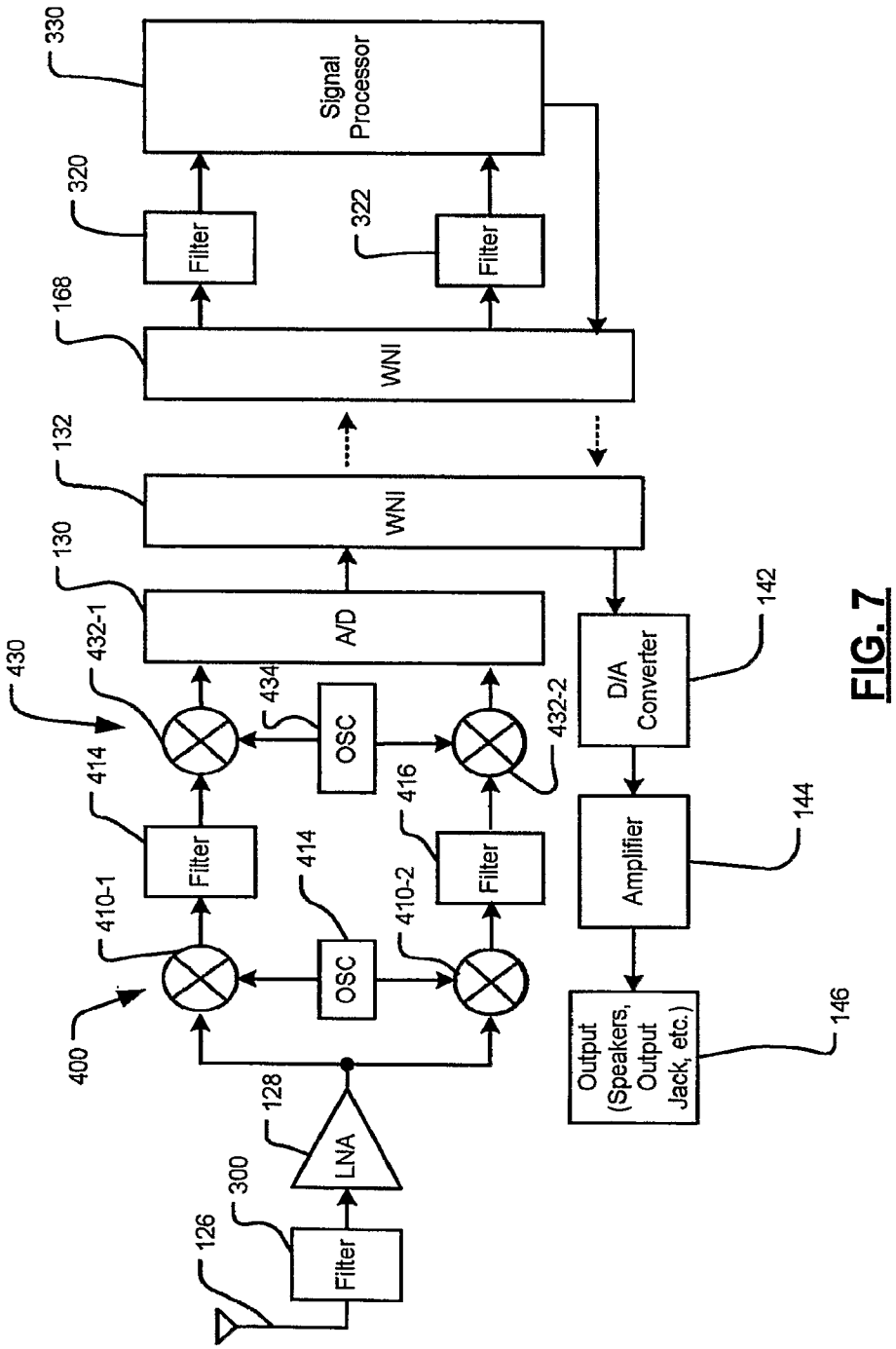

330
Signal Processor
320
Filter
322
Filter
168
WNI
132
WNI
130
A/D
142
D/A Converter
144
Amplifier
146
Output (Speakers, Output Jack, etc.)
430
432-1
434
OSC
432-2
414
Filter
410-1
414
OSC
416
Filter
410-2
400
128
LNA
300
Filter
126

FIG. 7

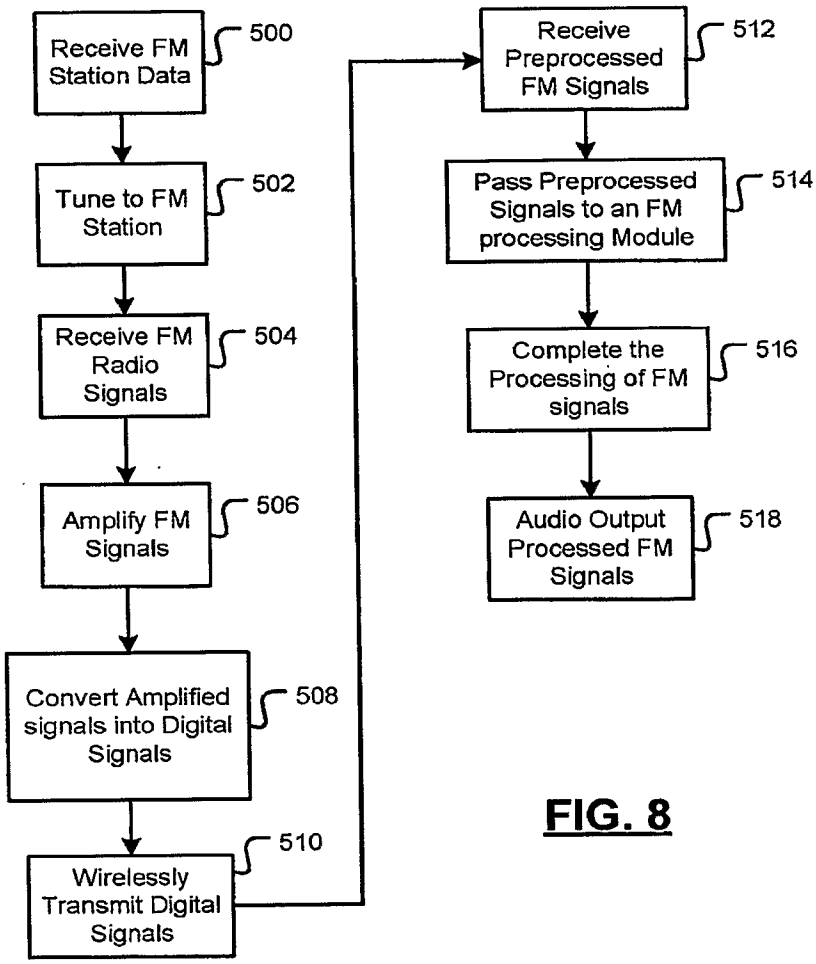

Receive FM Station Data
500
Tune to FM Station
502
Receive FM Radio Signals
504
Amplify FM Signals
506
Convert Amplified signals into Digital Signals
508
Wirelessly Transmit Digital Signals
510
Receive Preprocessed FM Signals
512
Pass Preprocessed Signals to an FM processing Module
514
Complete the Processing of FM signals
516
Audio Output Processed FM Signals
518

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/007160

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B1/38

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)
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 practical, 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	WO 01/63780 A (SONY ELECTRONICS INC [US]) 30 August 2001 (2001-08-30) abstract page 5, line 4 - page 13, line 30 figures 1-3	1-53
A	EP 1 610 546 A (SONY CORP [JP]) 28 December 2005 (2005-12-28) abstract paragraph [0030] - paragraph [0074] figures 1,4,5	1-53
A	US 5 991 637 A (MACK II GAWINS A [US] ET AL) 23 November 1999 (1999-11-23) abstract page 3, line 20 - page 10, line 54 figures 1-15	1-53

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"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

"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

"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

"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2007	06/08/2007
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Authorized officer TZIMEAS, K

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2007/007160

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0163780 A	30-08-2001	AU 4326101 A	03-09-2001
		TW 496042 B	21-07-2002
		US 6658267 B1	02-12-2003
		US 2004029541 A1	12-02-2004
EP 1610546 A	28-12-2005	CN 1713534 A	28-12-2005
		JP 2006013646 A	12-01-2006
		KR 20060046486 A	17-05-2006
		US 2005288059 A1	29-12-2005
US 5991637 A	23-11-1999	US 6510325 B1	21-01-2003