



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.09.2010 Bulletin 2010/35

(51) Int Cl.:
H04R 3/00 (2006.01) **H04R 5/04 (2006.01)**

(21) Application number: **09153831.4**

(22) Date of filing: **26.02.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

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(54) **Audio jack for a portable electronic device**

(57) A portable electronic device includes a processor provided in a housing, a jack being sized for receiving a plug of an audio accessory and having electrical connectors for enabling communication between the audio accessory and the processor, the electrical connectors

for contacting corresponding electrical connectors of the plug and a switching circuit in communication with the processor and the electrical connectors, the switching circuit for determining a pin-out of the plug and routing signals between ungrounded ones of the corresponding electrical connectors of the plug and the processor.

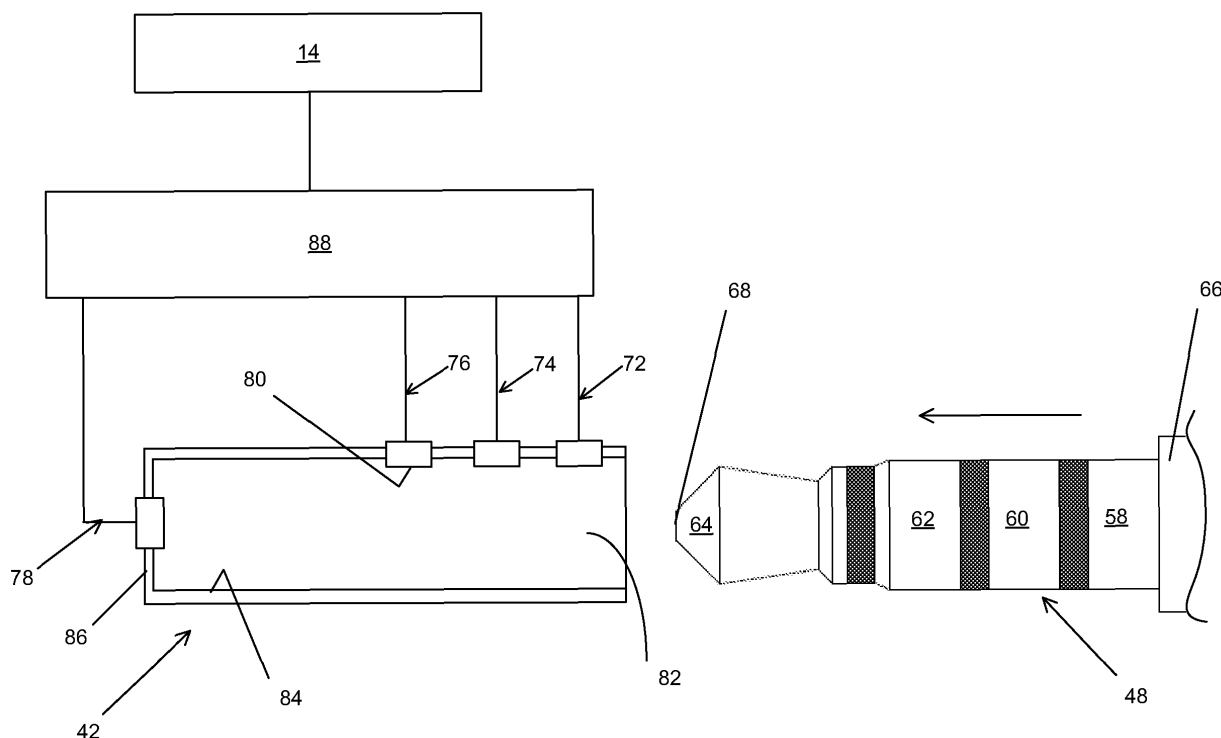


FIG. 3

Description

Technical Field

[0001] The present disclosure relates to audio jacks for portable electronic devices.

Background

[0002] In recent years, the accessibility and affordability of handheld technologies has made it commonplace for a single consumer to own several different portable electronic devices. Depending on the type of portable electronic device, accessories such as battery chargers and head phones, for example, may be provided in the packaging. Whether replacing a cell phone year after year or adding a portable music player, digital video camera or portable video game player to one's collection, duplication of accessories is very common.

[0003] Currently, there are no industry standards in place that dictate audio jack pin-out configuration for electronic devices having audio input and output capability. Therefore, the same headset, for example, will generally not work with portable electronic devices from different manufacturers. In order to avoid this problem, some electronic device vendors have begun to dictate the audio jack pin-out of the portable electronic devices that it will sell in order to ensure that the same accessories will work with the different devices. It is common for vendors in different countries to have different pin-out preferences, therefore, portable electronic device manufacturers who sell their devices to more than one vendor must incur additional costs to produce devices having different audio jack pin-outs.

[0004] One solution to this problem is to sell adapters that enable communication between incompatible accessories and portable electronic devices. This solution results in additional costs to the manufacturer and the consumer and also has the added inconvenience of requiring the consumer to keep track of adapters specific to each accessory. It is, therefore, desirable to provide an improved solution to the incompatibility of portable electronic devices and accessories.

Summary

[0005] In one embodiment, there is provided a portable electronic device including: a processor provided in a housing, a jack provided in the housing, the jack being sized for receiving a plug of an audio accessory, electrical connectors provided in the jack for enabling communication between the audio accessory and the processor, the electrical connectors for contacting corresponding electrical connectors of the plug and a switching circuit in communication with the processor and the electrical connectors, the switching circuit for determining a pin-out of the plug; wherein the switching circuit routes signals between ungrounded ones of the corresponding

electrical connectors of the plug and the processor.

[0006] In another embodiment, there is provided a portable electronic device including: a processor provided in a housing, a jack provided in the housing, the jack being sized for receiving a plug of an audio accessory, electrical connectors provided in the jack for enabling communication between the audio accessory and the processor, each of the electrical connectors for contacting a corresponding electrical connector of the plug and a switching circuit in communication with the processor and two of the electrical connectors, the switching circuit for selectively routing audio signals, such as microphone signals, for example, between a second one of the corresponding electrical connectors of the plug and the processor; wherein the switching circuit routes the audio signals between a second one of the corresponding electrical connectors of the plug and the processor when a first one of the corresponding electrical connectors of the plug is electrically grounded.

[0007] In yet another embodiment, there is provided a method for connecting a plug of an audio accessory to a portable electronic device, the method including: receiving a plug of the audio accessory in a jack of the portable electronic device, the jack having electrical connectors for enabling communication between the audio accessory and a processor of the portable electronic device, the electrical connectors for contacting corresponding electrical connectors of the plug, determining a pin-out of the plug and routing signals between ungrounded ones of the corresponding electrical connectors of the plug and the processor.

[0008] In still another embodiment, there is provided a method for connecting a plug of an audio accessory to a portable electronic device, the method including: receiving a plug of the audio accessory in a jack of the portable electronic device, the jack having electrical connectors for enabling communication between the audio accessory and a processor of the portable electronic device, each of the electrical connectors for contacting a corresponding electrical connector of the plug, determining if a first one of the corresponding electrical connectors of the plug is electrically grounded and routing audio signals between a second one of the corresponding electrical connectors of the plug and the processor when the first one of the corresponding electrical connectors of the plug is electrically grounded.

[0009] The embodiments provided herein allow audio accessories having pin-outs that do not match a pin-out of the portable electronic device to be operated therewith. The inclusion of a switching circuit in the portable electronic device may reduce or eliminate the need for separate adapter components.

Drawings

[0010] The following figures set forth embodiments in which like reference numerals denote like parts. Embodiments are illustrated by way of example and not by way

of limitation in the accompanying figures.

[0011] Figure 1 is a block diagram of a portable electronic device according to an embodiment;

[0012] Figure 2 is a perspective view of the portable electronic device of Figure 1;

[0013] Figure 3 is a schematic side view of an audio jack of the portable electronic device of Figure 1 in section and a side view of a plug of an audio accessory for use with the audio jack;

[0014] Figure 4 is a circuit diagram of a switching circuit of the portable electronic device of Figure 1;

[0015] Figure 5 is a state diagram corresponding to the circuit diagram of Figure 4;

[0016] Figure 6 is a schematic side view of a plug and headset for use with the portable electronic device of Figure 1;

[0017] Figure 7 is a side view of a plug for use with the portable electronic device of Figure 1 ;

[0018] Figure 8 is a schematic side view of a plug and headset for use with the portable electronic device of Figure 1;

[0019] Figure 9 is a side view of a plug for use with the portable electronic device of Figure 1 ;

[0020] Figure 10 is a side view of a plug for use with the portable electronic device of Figure 1 ;

[0021] Figure 11 is a flowchart depicting a method for connecting a plug of an audio accessory to the portable electronic device of Figure 1 according to an embodiment; and

[0022] Figure 12 is a flowchart depicting a method for connecting a plug of an audio accessory to the portable electronic device of Figure 1 according to another embodiment.

Description of Preferred Embodiments

[0023] Referring now to Figure 1, components of a portable electronic device 10 according to an embodiment are generally shown. The portable electronic device 10 includes data communication capabilities and may communicate with other electronic devices directly or through a wireless network. The portable electronic device 10 is based on the computing environment and functionality of a handheld computer, such as a wireless personal digital assistant (PDA), for example. It will be understood, however, that the portable electronic device 10 is not limited to a wireless personal digital assistant. Other portable electronic devices are possible, such as cellular telephones, smart telephones, portable music players and laptop computers.

[0024] The portable electronic device 10 includes a number of components including processor 14, which controls the overall operation of the device 10. A communication subsystem 40 controls data and voice communication functions, such as email, PIN (Personal Identification Number) message functions, SMS (Short Message Service) message functions and cellular telephone functions, for example. The communication subsystem

40 is in communication with a wireless network 12, which may be a data-centric wireless network, a voice-centric wireless network or a dual-mode wireless network.

[0025] In Figure 1, the communication subsystem 40 is a dual-mode wireless network that supports both voice and data communications. The communication subsystem 40 is configured in accordance with the Global System for Mobile Communication (GSM) and General Packet Radio Services (GPRS) standards. The communication subsystem 40 may alternatively be configured in accordance with Enhanced Data GSM Environment (EDGE) or Universal Mobile Telecommunications Service (UMTS) standards. Other wireless networks may also be associated with the portable electronic device 10, including Code Division Multiple Access (CDMA) or CDMA2000 networks. Some other examples of data-centric networks include WiFi 802.11, Mobitex™ and DataTAC™ network communication systems. Examples of other voice-centric data networks include Personal Communication Systems (PCS) networks like GSM and Time Division Multiple Access (TDMA) systems.

[0026] The wireless network 12 includes base stations (not shown) that provide a wireless link to the portable electronic device 10. Each base station defines a coverage area, or cell, within which communications between the base station and the portable electronic device 10 can be effected. It will be appreciated that the portable electronic device 10 is movable within the cell and can be moved to coverage areas defined by other cells. Data is delivered to the portable electronic device 10 via wireless transmission from base station. Similarly, data is sent from the portable electronic device 10 via wireless transmission to the base station.

[0027] The communication subsystem 40 further includes a short range communications function, which enables the device 10 to communicate directly with other devices and computer systems without the use of the network 106 through infrared or Bluetooth™ technology, for example.

[0028] Prior to the portable electronic device 10 being able to send and receive communication signals over the wireless network 12, network registration or activation procedures must have been completed. In order to enable network communication, a SIM (Subscriber Identity Module) card 24 is inserted into a card interface 26. The SIM card, or Removable User Identity Module card, is used to identify the user of the mobile device, store personal device settings and enable access to network services, such as email and voice mail, for example, and is not bound to a particular portable electronic device 10.

[0029] The processor 14 is also connected to a Random Access Memory (RAM) 16 and a flash memory 18. An operating system and device software are typically stored in flash memory 18 and are executable by the processor 14. Some device software components may alternatively be stored in RAM 16. Software applications that control basic device operation, such as voice and data communication, are typically installed during man-

ufacture of the device 10. For devices that do not include a SIM card 24, user identification information may be programmed into the flash memory 18. The flash memory 18 may alternatively be a persistent storage, a Read-Only Memory (ROM) or other non-volatile storage.

[0030] The processor 14 receives input from various input devices including a keypad 38 and other input devices 36. The other input devices 36 typically complement the keypad 38 to facilitate input and may include devices such as: single or multi-function buttons, a touch screen, a mouse, a trackball, a capacitive touch sensor or a roller wheel with dynamic button pressing capability.

[0031] The processor 14 outputs to various output devices including an LCD display screen 20. A microphone 32 and speaker 22 are connected to the processor 14 for cellular telephone functions. A data port 34 is connected to the processor 14 for enabling data communication between the portable electronic device 10 and another computing device. The data port 34 may include data lines for data transfer and a supply line for charging a battery 30 of the portable device 10. Battery interface 28 is provided for receiving one or more rechargeable batteries 30. Jack 42 is provided for receiving an audio accessory such as headphones, a headset, amplified speakers or amplified headphones, for example. Jack 42 may also receive other accessories such as a multi-media accessory including play, pause, stop and rewind buttons or a TV-out accessory that allows for connection of the portable electronic device to a TV, for example.

[0032] Only a limited number of device subsystems have been described. It will be appreciated by a person skilled in the art that additional subsystems corresponding to additional device features may also be connected to the processor 14.

[0033] Referring also to Figure 2, the portable electronic device 10 includes a housing 44 in which the display 20 and keypad 38 are mounted. The jack 42 is provided in an opening 43 in a side surface 46 of the housing 44. It will be appreciated by a person skilled in the art that the arrangement of Figure 2 is provided by way of example. The display 20, the keypad 38, the jack 42 and also other input devices 36 may be provided in any arrangement that allows the user to interact with the portable electronic device 10.

[0034] As shown in Figure 3, the jack 42 includes a sleeve 70 having a closed end 86 and four electrical connectors 72, 74, 76 and 78. A plug-receiving cavity 82 of the jack 42 is generally defined by an inner surface 84 of the sleeve 70 and is sized to receive a plug 48 of a headset (not shown). The electrical connectors 72, 74, 76, 78 each include a conductive surface 80 that extends into the plug-receiving cavity 82. When the plug 48 of the headset is received in the jack 42, the conductive elements 80 of the electrical connectors 72, 74, 76, 78 mate with corresponding conductive surfaces of electrical connectors 58, 60, 62 and 64 of the plug 48, respectively, to provide an electrical path between headset components, which include a microphone, a left speaker and a right

speaker, and matching ports of the processor 14.

[0035] It will be appreciated by a person skilled in the art that rather than including the sleeve 70, the plug-receiving cavity 82 may be defined by the housing 44 or one or more other components of the portable electronic device 10.

[0036] Electrical connectors 58, 60, 62 and 64 are provided in order between a base 66 and a tip 68 of the plug 48. Therefore, when the plug 48 is received in the jack 42, electrical connector 72 of the jack 42 mates with electrical connector 58 of the plug 48, electrical connector 74 of the jack 42 mates with electrical connector 60 of the plug 48, electrical connector 76 of the jack 42 mates with electrical connector 62 of the plug 48 and electrical connector 78 of the jack 42 mates with electrical connector 64 of the plug 48.

[0037] In order for the left speaker, the right speaker, the microphone and a ground of the headset to operate as expected, a pin-out of the plug 48 and a pin-out of the jack 42 should match. The term pin-out is well known in the art and describes the purpose of each connector, which is commonly referred to as a pin, in a connecting device, such as a jack or a plug, for example. The pin-out of the jack 42 of the portable electronic device 10 of Figure 1 is as follows:

Electrical connector 72	Microphone
Electrical connector 74	Ground
Electrical connector 76	Right Audio channel
Electrical connector 78	Left Audio Channel

[0038] As shown in Figure 3, the electrical connectors 72, 74, 76, 78 are electrically coupled to the processor 14 via a switching circuit 88, which is shown in Figure 4. In general, the switching circuit 88 is provided to determine the pin-out of the plug 48 and swap microphone and ground signals when the pin-out of the plug 48 does not match the pin-out of the jack 42. Specifically, the switching circuit 88 determines if electrical connector 58 is electrically grounded and, if so, routes audio signals from electrical connector 60 of the plug 48, if ungrounded, through electrical connector 72 of the jack 42 to the processor 14. The switching circuit 88 uses impedance testing to determine the pin-out of the plug 48.

[0039] Voltages are measured with respect to some sort of reference voltage, which is called the ground. In some cases, the voltage of the Earth itself serves as the reference, or ground. On a portable electronic device that is not electrically connected by a wire to the Earth, one electrical node is selected to be the "ground node," and it is with reference to the voltage of this node that other voltages are measured. To say that a connector is "electrically grounded" can be to mean that the connector is electrically coupled to, or is at substantially the same electric potential as, that ground node. As a practical mat-

ter, the voltage of a grounded connector has substantially zero difference in voltage with the ground node, and so would be measured as having a substantially constant voltage of about zero volts. Since typical electrical signals involve voltage changes, a connector that is electrically grounded typically is carrying no signal.

[0040] Referring to Figures 4 and 5, the switching circuit 88 includes a normally closed switch 98 between electrical connector 78 of the jack 42, which corresponds to the left audio channel, and an accessory detection circuitry 92. At state 100, the switching circuit 88 is in an idle mode when no plug 48 is received in the jack 42. When a plug 48 is received in the jack 42, the normally closed switch 98 opens and a signal interrupt is sent to the processor 14 to notify the processor 14 that an audio accessory has been inserted into the jack 42. When the audio accessory is detected, at state 102, the processor 14 performs a test to determine if the electrical connector 58 of the plug 48 is electrically grounded. The test is an impedance test that the processor 14 performs by: 1) applying a voltage to a microphone bias connector 94 to bias the electrical connector 72; 2) reading a direct current (dc) voltage at a microphone detection connector 96; and 3) comparing the dc voltage reading to a predetermined threshold value, V_{th} . At state 102, a switch 90 of the switching circuit is in a first position, which is the default position, to route audio signals from electrical connectors 58 and 60 of the plug 48 to mating electrical connectors 72 and 74 of the jack 42. A dc voltage reading that is high indicates that the electrical connector 58 is not electrically grounded. Therefore, it follows that the electrical connector 58 is connected to a microphone and the audio accessory is a headset, as indicated at state 104.

[0041] A four pole stereo headset plug is shown in Figure 6 and a four pole mono headset plug is shown in Figure 7. When headset plugs of Figures 6 and 7 are inserted into the jack 42, the switching circuit 88 determines that the electrical connector 58 is not electrically grounded and the processor 14 operates the audio accessory with the adapter switch 90 in the first position.

[0042] A dc voltage reading from the impedance test that is low indicates that the electrical connector 58 is electrically grounded, and therefore, the accessory is either a headset or headphones. In response to the outcome of the test, at state 106, the switch 90 is changed to a second position in which the electrical connector 72 of the jack 42 is in communication with the electrical connector 60 of the plug 48. The processor 14 then performs a second test in order to determine if the electrical connector 60 of the plug 48 is electrically grounded. If the dc voltage reading of the second test is high, the electrical connector 60 is not electrically grounded. Therefore, it follows that the electrical connector 60 is connected to a microphone and the audio accessory is a headset, as indicated at state 108.

[0043] A stereo headset plug having the microphone and ground connectors reversed, when compared to the

jack 42, is shown in Figure 8. This pin-out configuration is often found in headphones and headsets that are manufactured in China. When the headset plug of Figures 8 is inserted into the jack 42, the switching circuit 88 allows the processor 14 to operate the audio accessory with the switch 90 in the second position.

[0044] A dc voltage reading from the second test that is low indicates that the electrical connector 60 is electrically grounded, and therefore, the accessory is a set of headphones, as indicated at state 110. Plugs for stereo headphones and mono headphones are shown in Figures 9 and 10, respectively.

[0045] Once the pin-out of two of the electrical connectors of the plug 48 has been determined, a further detection scheme may be performed in order to determine the entire pin-out of the plug 48, as indicated in Figure 5. Detection schemes for determining whether a headset or headphones is mono or stereo are known in the art and therefore will not be described further.

[0046] Referring to Figure 11, a method for connecting the plug 48 of an audio accessory to a portable electronic device is generally shown. At step 112, the plug 48 is received in the jack 42 of the portable electronic device. The pin-out of the plug 48 is then determined at step 114, as has been previously described, and audio signals from electrically ungrounded electrical connectors of the plug 48 are routed to matching ports of the processor 14 at step 116.

[0047] Referring to Figure 12, another method for connecting a plug of an audio accessory to a portable electronic device is generally shown. At step 118, the plug 48 is received in the jack 42 of the portable electronic device. At steps 120 and 122, it is determined if a first electrical connector of the plug 48 is electrically grounded and, if so, audio signals are routed between a second electrical connector of the plug 48 and the processor 14.

[0048] The jack 42 shown in Figure 3 is sized to receive a 3.5 mm plug, however, it will be appreciated by a person skilled in the art that the jack 42 may alternatively be sized to receive a 2.5 mm plug or another size of plug.

[0049] In another embodiment, the jack 42 includes a pin-out of:

Electrical connector 72	Ground
Electrical connector 74	Microphone
Electrical connector 76	Right Audio channel
Electrical connector 78	Left Audio Channel

In this embodiment, the switching circuit 88 is modified to first test if electrical connector 60 of the plug 48 is electrically grounded and, if not, change switch 90 to the second position and re-test.

[0050] The switching circuit 88 of the described embodiments is suitable for use with plugs having microphone and ground electrical connectors that are located

adjacent to one another at the base of the plug and in which at least one of the two connectors located adjacent to the tip of the plug are speaker electrical connectors. Plug pin-outs having this general configuration are shown in Figures 6-10 and are the most common pin-out configurations of headset and headphone accessories. It will, however, be appreciated by a person skilled in the art that a modified switching circuit including additional switches and further impedance testing could be provided to allow for pin-out determination of any pin-out configuration. The modified switching circuit would route audio signals between ungrounded ones of the electrical connectors of the plug and matching ports of the processor.

[0051] In another embodiment, the processor 14 executes software that is stored on the device 10 to allow a user to select different pin-out options via the keypad 38, display 20 or other input devices 36. In this embodiment, the processor 14 would not perform a test to determine the pin-out of the audio accessory. Instead, when the switching circuit 88 detects that an audio accessory has been inserted into the jack 42, the user would be prompted to select the type of audio accessory. The user would be able to select the type of audio accessory from a drop-down list, for example, which could include a list of pin-outs, product manufacturers, product serial numbers or a list of countries corresponding to where the accessory was manufactured.

[0052] Specific embodiments have been shown and described herein. However, modifications and variations may occur to those skilled in the art. All such modifications and variations are believed to be within the scope and sphere of the present embodiments.

Claims

1. A portable electronic device (10) comprising:

a processor (14) provided in a housing (44);
a jack (42) provided in said housing (44), said jack (42) being sized for receiving a plug (48) of an audio accessory;
electrical connectors (72, 74, 76, 78) provided in said jack (42) for enabling communication between said audio accessory and said processor (14), each of said electrical connectors (72, 74, 76, 78) for contacting a corresponding electrical connector (58, 60, 62, 64) of said plug (48);
a switching circuit (88) in communication with said processor (14) and two of said electrical connectors (72, 74, 76, 78), said switching circuit (88) for selectively routing audio signals between a second one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) and said processor (14);
wherein said switching circuit (88) routes said audio signals between a second one of said cor-

responding electrical connectors (58, 60, 62, 64) of said plug and said processor (14) when a first one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) is electrically grounded.

2. A portable electronic device (10) as claimed in claim 1, wherein no audio signals are routed to said processor (14) when both said first one of said corresponding electrical connectors (58, 60, 62, 64) of said plug and said second one of said corresponding electrical connectors (58, 60, 62, 64) of said plug are electrically grounded.

3. A portable electronic device (10) as claimed in claim 1 or claim 2, wherein said audio accessory comprises any of: stereo headsets, stereo headphones, mono headsets and mono headphones.

4. A portable electronic device (10) as claimed in any one of claims 1 to 3, wherein said first one of said corresponding electrical connectors (58, 60, 62, 64) and said second one of said corresponding electrical connectors (58, 60, 62, 64) are located adjacent to one another at a base (66) of said plug (48).

5. A portable electronic device (10) as claimed in any one of the preceding claims, wherein said switching circuit (88) comprises a switch (90) having a default position and a second position, said audio signals being routed between said first one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) and said processor (14) when said switch (90) is in said default position.

6. A portable electronic device (10) as claimed in claim 5, wherein said switch (90) is changed from said default position to said second position based on an outcome of an impedance test.

7. A portable electronic device as claimed in any one of the preceding claims 1, wherein said plug is one of a 2.5 mm plug and a 3.5 mm plug.

8. A method for connecting a plug (48) of an audio accessory to a portable electronic device (10), said method comprising:

receiving a plug (48) of said audio accessory in a jack (42) of said portable electronic device (10), said jack (42) having electrical connectors (72, 74, 76, 78) for enabling communication between said audio accessory and a processor (14) of said portable electronic device (10), each of said electrical connectors (72, 74, 76, 78) for contacting a corresponding electrical connector (58, 60, 62, 64) of said plug (48);
determining if a first one of said corresponding

electrical connectors (58, 60, 62, 64) of said plug (48) is electrically grounded; and routing audio signals between a second one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) and said processor (14) (58, 60, 62, 64) when said first one of said corresponding electrical connectors of said plug is electrically grounded. 5

9. A method as claimed in claim 8, wherein no audio signals are routed to said processor (14) when both said first one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) and said second one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) are electrically grounded. 10 15
10. A method as claimed in claim 8 or claim 9, wherein said audio accessory is any of: stereo headsets, stereo headphones, mono headsets and mono headphones. 20
11. A method as claimed in any one of claims 8 to 10, wherein said first one of said corresponding electrical connectors (58, 60, 62, 64) and said second one of said corresponding electrical connectors (58, 60, 62, 64) are located adjacent to one another at a base (66) of said plug (48). 25
12. A method as claimed in any one of claims 8 to 11, wherein said audio signals are routed by a switching circuit (88). 30
13. A method as claimed in claim 11, wherein said switching circuit (88) has a switch (90) having a default position and a second position, said audio signals being routed between said first one of said corresponding electrical connectors (58, 60, 62, 64) of said plug (48) and said processor (14) when said switch (90) is in said default position. 35 40
14. A method as claimed in any one of claims 8 to 13, further comprising performing a test to determine if said first one of said corresponding electrical connectors (58, 60, 62, 64) in contact with said first one of said electrical connectors (72, 74, 76, 78) of said jack (42) is electrically grounded. 45
15. A method as claimed in claim 13, wherein said test is an impedance test. 50
16. A method as claimed in claim 15, wherein said impedance test comprises applying a voltage to a microphone bias connector (94), reading a voltage at a microphone detection connector (96) and comparing the voltage reading to a predetermined threshold value. 55

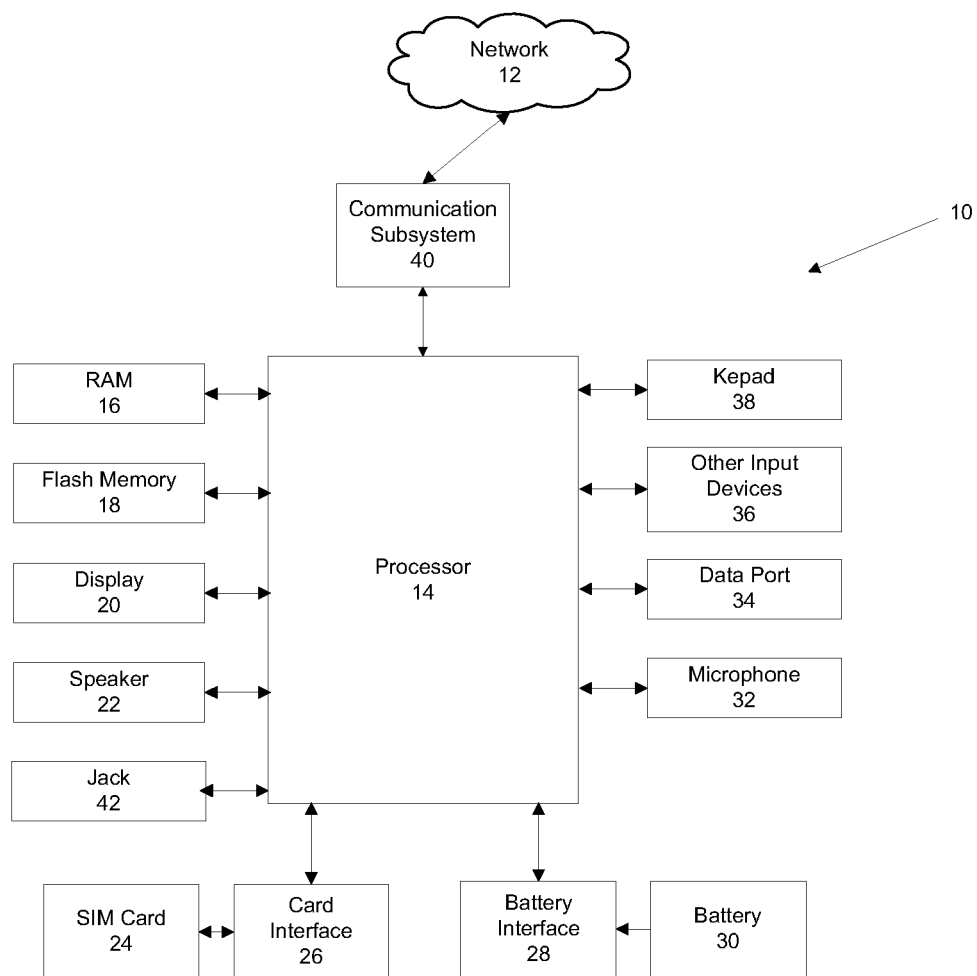


FIG. 1

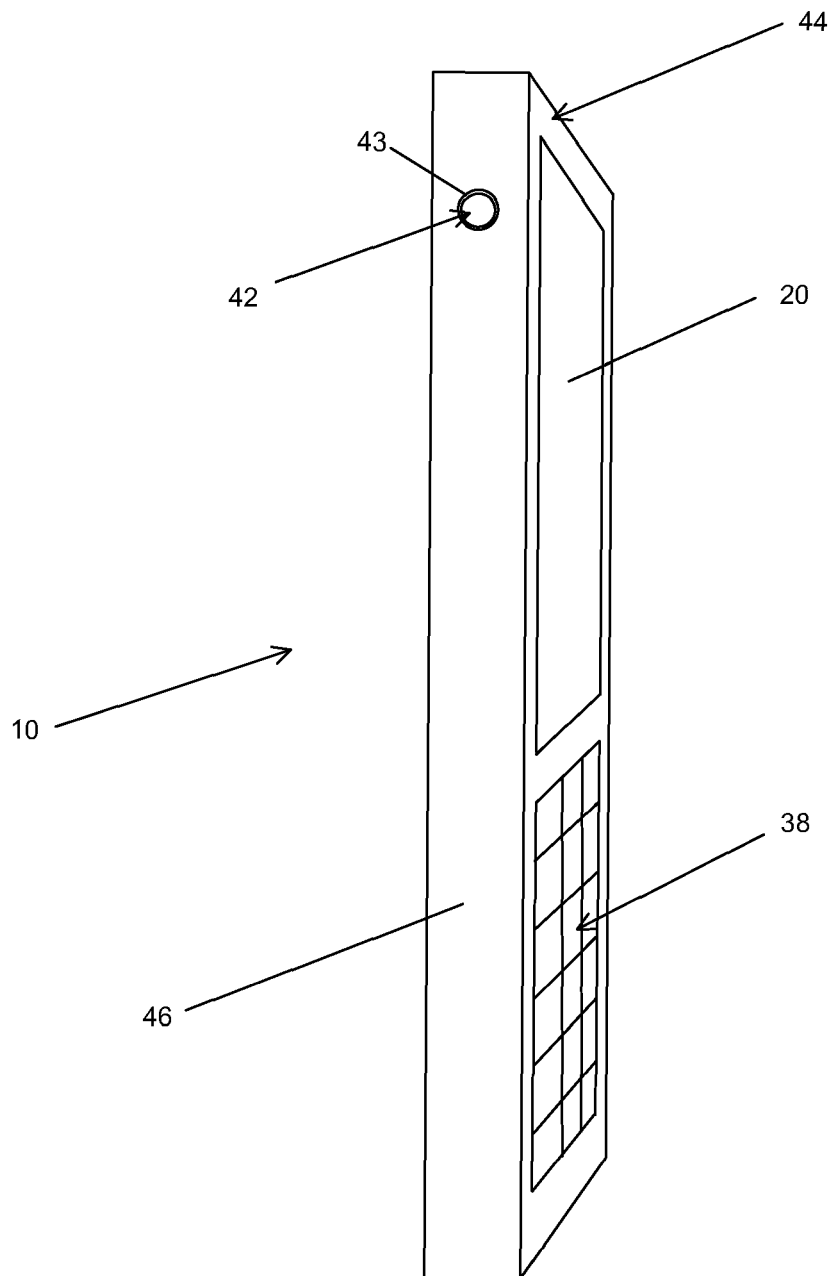


FIG. 2

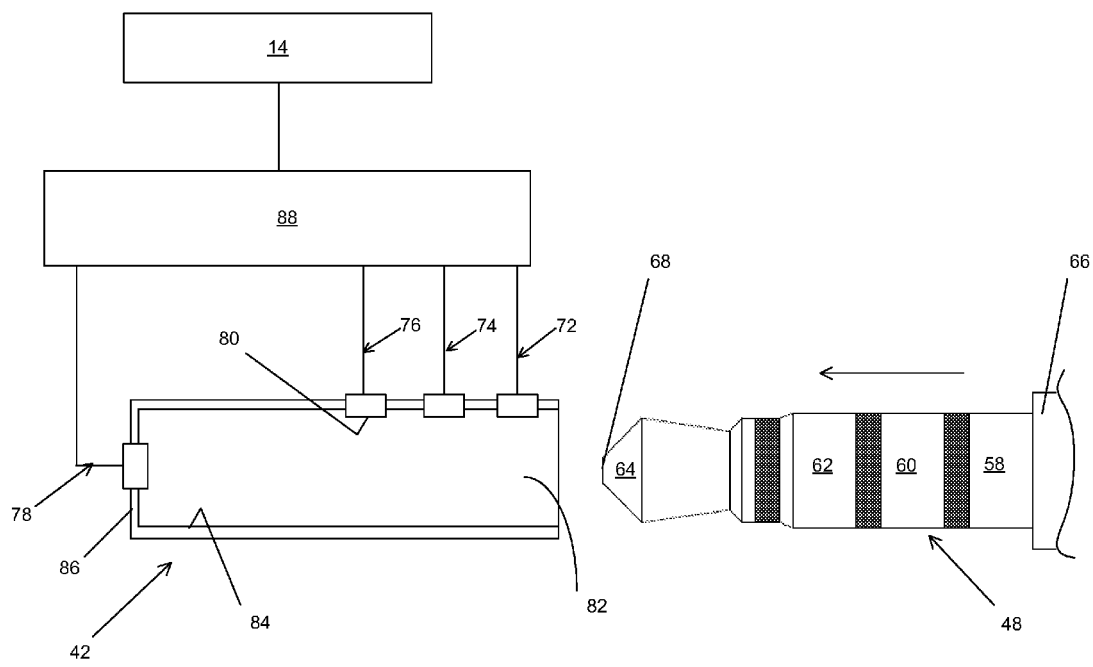


FIG. 3

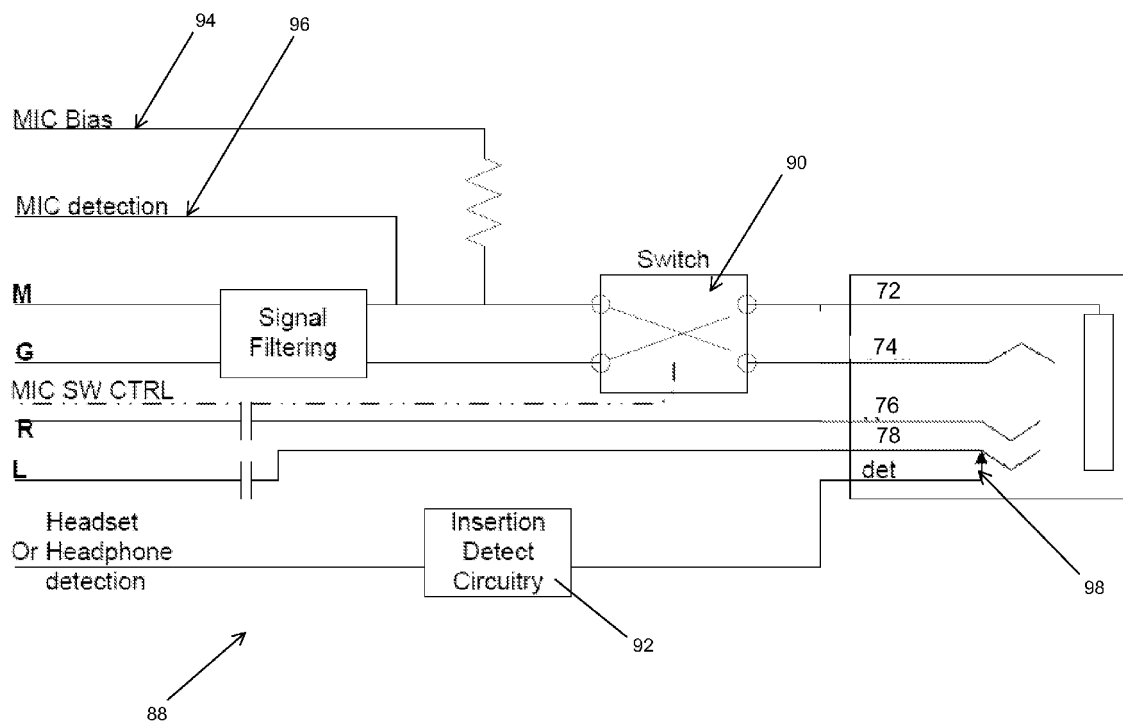


FIG. 4

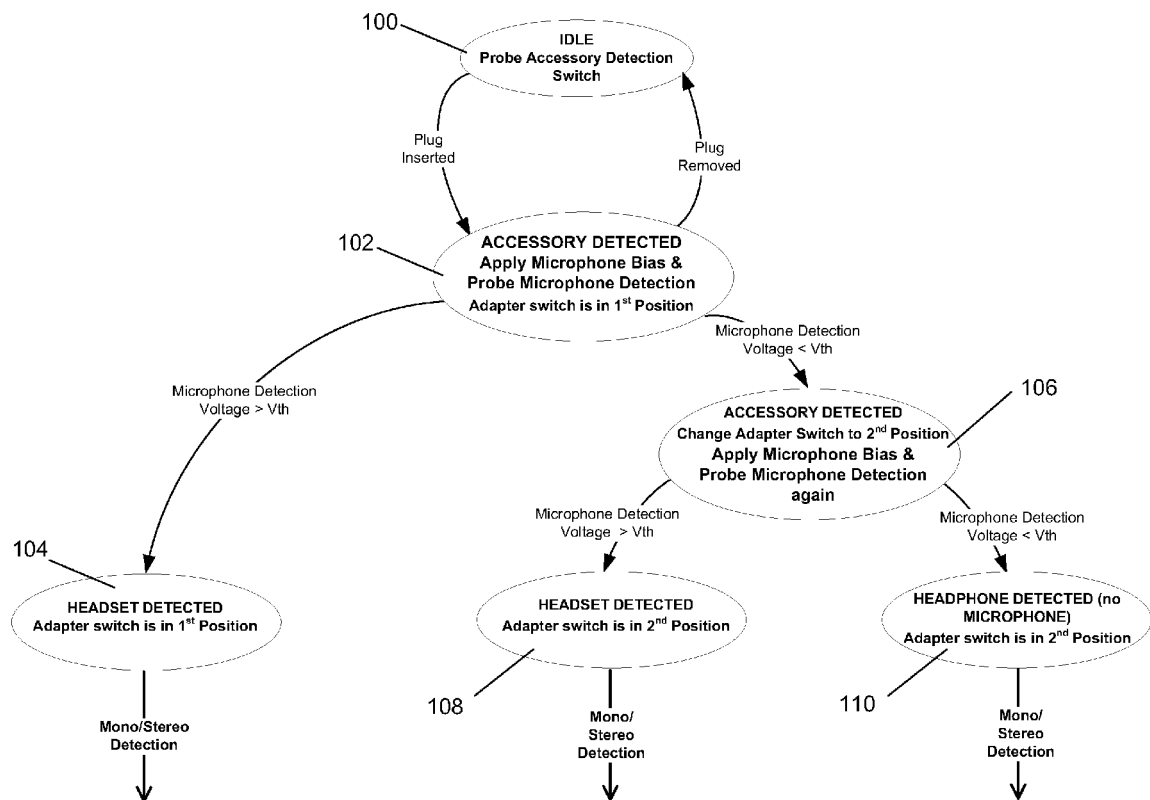


FIG. 5

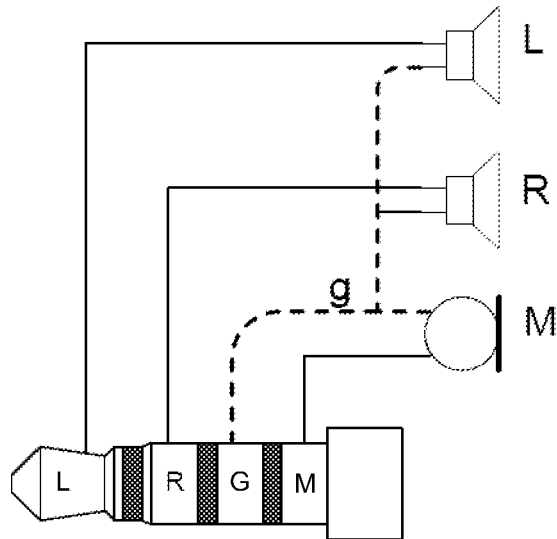


FIG. 6

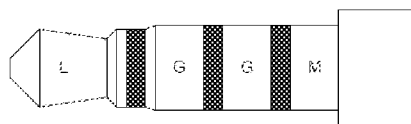


FIG. 7

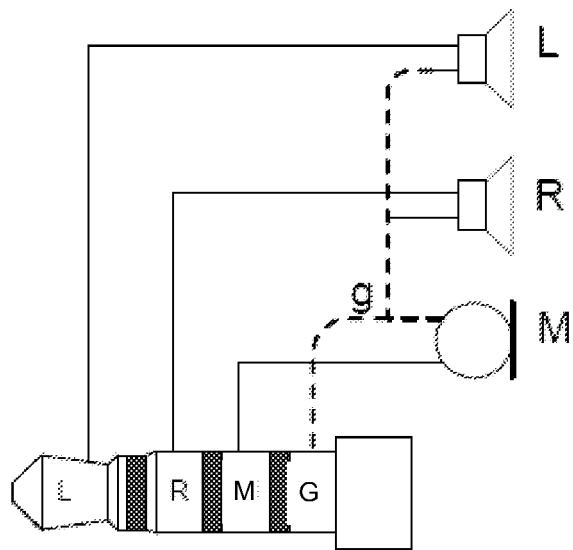


FIG. 8

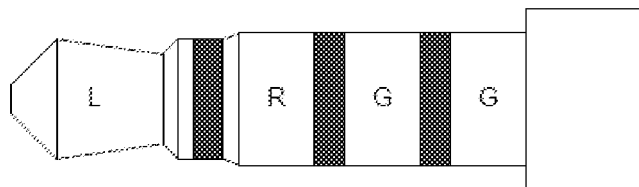


FIG. 9

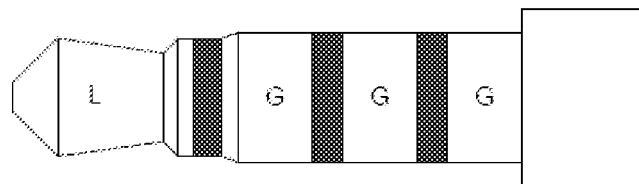


FIG. 10

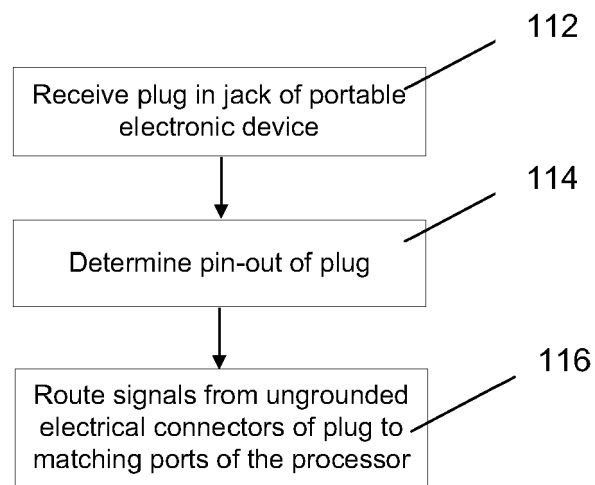


FIG. 11

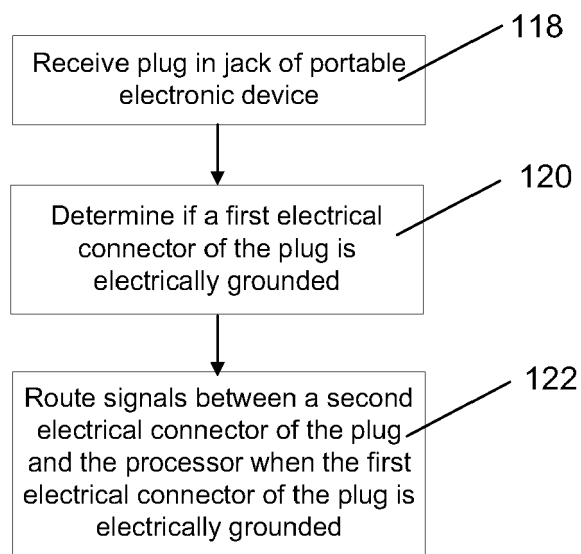


FIG. 12



EUROPEAN SEARCH REPORT

Application Number
EP 09 15 3831

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2007/047745 A1 (LAI CHENG-SHING [TW] ET AL) 1 March 2007 (2007-03-01) * paragraph [0001] - paragraph [0008] * * paragraph [0014] - paragraph [0023] * -----	1-16	INV. H04R3/00 ADD. H04R5/04
Y	US 2007/104332 A1 (CLEMENS ROBERT P [US] ET AL) 10 May 2007 (2007-05-10) * paragraph [0003] - paragraph [0030] * * paragraph [0192] - paragraph [0194] * -----	1-16	
A	US 2008/137896 A1 (TSEN KUO-TING [TW]) 12 June 2008 (2008-06-12) * paragraph [0002] - paragraph [0010] * * paragraph [0018] - paragraph [0023] * -----	1-16	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04R H01R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 July 2009	Examiner Peirs, Karel
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 09 15 3831

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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