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(54) A hearing aid and a method of operating a hearing aid

(57) A hearing aid comprising a housing with a connector enabling an external device to be connected thereto. The connector includes a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components. The hearing aid also comprises detecting means adapted for determining whether an external device is connected or unconnected to the hearing aid, and the hearing aid is adapted for keeping the set of closely spaced electrical terminals at a substantially equal electrical potential during at least a part of the time periods wherein an external device is unconnected.

The invention also relates to a hearing aid implemented method of operating a hearing aid and a program comprising code adapted for operating a hearing aid.

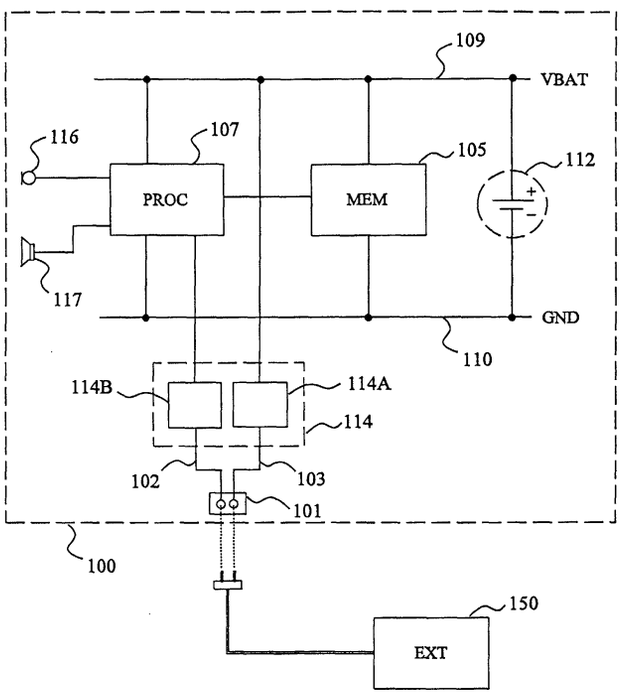

FIG. 1B

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Description

[0001] The present invention relates to a hearing aid comprising:

- a housing comprising a connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components, said set of electrical terminals being electrically connectable to an external device,

- detecting means adapted for determining whether an external device is connected or unconnected to the hearing aid.

[0002] Hearing aids often comprise a connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components. Such connectors normally form part of the housing of the hearing aid and may be located at the outer surface or at least near the outer surface thereof. This location enables an external device to be connected to the hearing aid. As a result an external device may be operatively connected to the hearing aid via the connector of the hearing aid; e.g. using a cable including a plug adapted to engage with the connector.

[0003] In some hearing aids the terminals may form an electrical programming interface for an external computer or programming device or the terminals may form part of such an interface. Therefore prior to programming a programmable hearing aid, the external programming device to be used may be electrically connected to the hearing aid via the connector. Hereby an external programming device may be operationally connected to one or more internal components of the hearing aid, such as a processor and/or a memory device, and the hearing aid may be programmed, if desired.

[0004] In order to program a hearing aid the connector includes at least one electrical terminal adapted to form a data communication path between the external device and one or more internal components of the hearing aid during programming. The hearing aid may be supplied with setting data from the external programming device connected thereto, or the hearing aid may exchange data with the programming device.

[0005] Normally, the connector in a hearing aid comprises two or more electrical terminals which are connected to internal hearing aid components. For example, the set of electrical terminals of the connector may include one or more electrical power terminals and one or more terminals for data communication.

[0006] The type of hearing aid initially mentioned also includes other types of hearing aids than programmable hearing aids having a programming interface. For example, the terminals may form an external audio interface adapted to receive audio signals from e.g. a miniature FM receiver or other audio sources.

[0007] A hearing aid of the above-mentioned type may include detecting means adapted to determine whether an external device is connected to the hearing aid or not. Hereby, the hearing aid may for example be operated in different modes depending on whether an external device is connected to the hearing aid or not. For example, a programming hearing aid may be brought into a programming mode when the external programming device is connected thereto. Likewise, the hearing aid may again be brought into a predetermined mode of operation, e.g. a mode of normal operation, when an external device, such as a programming device, is no longer operationally connected to the hearing aid. During programming mode, the hearing aid may for example receive programming data specifying the signal processing to be performed during one or more modes of operation.

[0008] The patent publication US 5,404,407 discloses a programmable hearing aid unit including electrical contacts for connecting a programming circuit of the hearing aid to an external programming unit via a programming socket at the housing.

[0009] Further, the German utility model publication DE 299 15 874 is an example of a programmable hearing aid having an electrical programming interface.

[0010] The terminals of a connector in a hearing aid are normally closely spaced as the terminals hereby may form part of a connector or socket as mentioned above. This is desirable as an interface having two or more closely spaced terminals enables the connection and disconnection of an external device to be performed easily, quickly and in a fail-safe manner. Furthermore, as hearing aids are unobtrusive, they are most often given miniature dimensions. Therefore, only a small amount of surface space is available for interfaces and the like on the surface of the hearing aid housing and the terminals must be closely spaced.

[0011] The drawback of placing the electrical terminals at or near the outer surface of the hearing aid has been found to be that the electrical terminals are unprotected from the external environment and as a result they are often subjected to corrosion. This is undesirable as corrosion makes connection to external devices unreliable and may at worst break the connection.

[0012] The object of the invention is to provide an improved hearing aid compared to the prior art.

[0013] According to the invention, the object is achieved by a hearing aid of the type initially mentioned characterized in that the detecting means is adapted for controlling said set of closely spaced electrical terminals so as to keep these at a substantially equal electrical potential during at least a part of the time periods wherein the external device is unconnected.

[0014] The wording closely spaced electrical terminals is to be read as electrical terminals located so that two neighbouring electrical terminals have an internal distance preferably between 0.1 mm and 2.0 mm, even more preferably between 0.1 mm and 0.5 mm and typically between 0.4 mm and 0.5 mm.

[0015] The invention is based on the fact that the electrical terminals of the hearing aid have been found to be subjected to corrosion as they are operated in an environment in which the terminals are often more or less covered by conducting fluids, e.g. due to the humidity or sweat from the user of the hearing aid. As the terminals in prior art hearing aids most often have different electrical potentials, an electro-chemical circuit is formed which results in a galvanic corrosion of the terminals. The metallic electrical terminals corrode due to the galvanic coupling created by the electrolyte and the voltage difference between the terminals. Therefore by detecting the presence of an external device connected to said terminals and by supplying the terminals substantially the same electrical potential during periods wherein no external devices are connected to said terminals, or at least a major part of said periods, the corrosion problem is solved or at least reduced significantly.

[0016] Furthermore the solution according to the invention may be implemented without rearranging the terminals, i.e. the close-spacing of the terminals does not have to be changed compared to the terminal locations in hearing aids of the prior art, if desired. Hereby the advantages of the close-spacing location of the terminals according to the prior art may still be found in the hearing aids according to the invention. In addition the solution may easily be implemented in both existing and newly developed hearing aids.

[0017] In a preferred embodiment of a hearing aid according to the invention, the detecting means is responsive to an electrical signal, such as a DC or AC voltage, supplied by the external device. Based on the electrical signal supplied to the hearing aid the detecting means may be adapted to sense whether an external device is connected to the hearing aid or not. This is a space saving solution as it does not require additional electrical terminals or mechanical detecting means at the outer surface of the hearing aid. In addition, the operation does not require any special action from a user due to the automatical detection, and hereby a fail safe operation is ensured.

[0018] In a preferred embodiment of a hearing aid according to the invention, the detecting means comprises a comparator responsive to said electrical signal. Preferably, the comparator includes a MOS transistor to which gate terminal said electrical signal is supplied. These embodiment is advantageous due to the simplicity and due to the fact that it may form a compact, space saving implementation in a hearing aid.

[0019] In an alternative embodiment the detecting means includes mechanical detecting means. This solution may be advantageous in some hearing aids.

[0020] Preferably the set of closely spaced electrical terminals is kept at a substantially equal electrical potential during substantially entire time periods wherein the external device is unconnected. Hereby, a maximal suppression of the undesired corrosion of the terminal is obtained.

[0021] According to a preferred embodiment said set of closely spaced electrical terminals forms part of a programming interface or an audio connector between the external device and the hearing aid.

[0022] The invention also relates to a hearing aid comprising:

a housing comprising a programming interface connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components, said set of electrical terminals being electrically connectable to an external device,

characterised by including voltage setting means adapted for keeping said set of closely spaced electrical terminals at a substantially equal DC-voltage.

[0023] Hereby, the above-mentioned corrosion problem is solved or at least reduced significantly. Further the solution according to the invention may be implemented in hearings aids at a relatively low cost.

[0024] Preferred embodiments according to the invention are defined by claims 9 and 10.

[0025] Furthermore, the invention relates to a method of operating a hearing aid comprising a connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components and electrically connectable to an external device, said method comprising:

- detecting whether the external device is connected or unconnected to the hearing aid, and
- keeping said set of closely spaced electrical terminals at a substantially equal electrical potential during at least a part of the time periods wherein an external device is unconnected.

[0026] Hereby the same advantages are achieved as mentioned in relation to the independent hearing aid claim above.

[0027] Other features and advantages of the hearing aid of the present invention will become apparent from the following description of preferred embodiments, taken in conjunction with the accompanying figures wherein:

Figure 1A is a first example of a hearing aid according to the invention,

Figure 1B is a second example of a hearing aid according to the invention,

Figure 2A is an electrical detecting means,

Figure 2B is another electrical detecting means,

Figure 3 is a controllable switch,

Figure 4 is a third example of a hearing aid according to the invention, and

Figure 5 is a mechanical detecting means.

[0028] Figure 1A is an example of a hearing aid according to the invention. The hearing aid 100 shown includes an acoustic-electro transducer 116, a processor 107, a memory 105, and a speaker 117. As shown in the figure the acoustic-electro transducer or microphone 116 is normally connected to the speaker 117 via the processor 107. During normal operation an acoustic signal is received via the microphone 116 and an electrical signal representing the received signal is supplied to the processor 107. The processor 107, e.g. a digital signal processor or DSP, is adapted for processing the signal received from the microphone 116 and to generate a signal which is supplied to a user of the hearing aid 100 via the speaker 117. The processor 107 is normally connected to the memory 105 which may include information to be used by the processor 107 in order to perform the desired data processing. Therefore the memory 105 may include both general and user-related processing information as well as other data.

[0029] The hearing aid 100 comprises a housing (not shown) and a number of internal hearing aid components which are located within the hearing aid housing. In the example shown, the internal components include the memory 105, and the processor 107 and a battery 112. In the example shown, the battery 112 is connected to the processor 107 and the memory 105 via electrical connections 109, 110. Furthermore the hearing aid 100 comprises a connector 101 with a number of electrical terminals adapted for being electrically connected to an external device 150. In the example shown the connector 101 includes two electrical terminals 102, 103.

[0030] In order to form a connector 101, the set of electrical terminals 102, 103 is closely spaced, i.e. the terminals 102, 103 have a relative small internal distance. The distance between the two neighbouring electrical terminals 102, 103 in a hearing aid connector 101 may vary from hearing aid to hearing aid but it is preferably between 0.1 mm and 2.0 mm, even more preferably between 0.1 mm and 0.5 mm, and typically between 0.4 mm and 0.5 mm. In the embodiment shown, the distance between two neighbouring electrical terminals is 0.2 mm. The electrical terminals 102, 103 of the connector 101 form a set of terminals as they are operatively connected to one or more co-operating internal hearing aid components. The connector 101 is adapted for enabling an external device 150 to be electrically connected to the electrical terminals 102, 103. Hereby an external devise 150, such as a programming unit, may be connected to one or more internal components of the hearing aid 100, such as the processor 107 and the battery 112, and may for example perform a programming of the hearing aid 100.

[0031] Normally a hearing aid includes two or more connector terminals each being connected to one or more internal electrical components. A programming interface may for example use a serial data transmission using two or more electrical connections or terminals. In the example shown, the first electrical terminal 102 and the second electrical terminal 103 are both connected to the processor 107. For example, the first and the second electrical terminal may be used as a data terminal and a clock terminal, or as a data terminal and a ground potential terminal. In other embodiments of hearing aids according to the invention, the first electrical terminal 102 and/or the second electrical terminal 103 could be connected to other internal hearing aid components, such as the memory 105.

[0032] In hearing aids according to the prior art one or more internal hearing aid components have been connected to the connector terminals and therefore both DC and AC voltage was supplied to the connector terminals during use. For example, a data communication line between a processor or a memory device, may be connected to a connector terminal.

[0033] The hearing aid 100 according to the invention includes voltage setting means 106A, 106B adapted for controlling the DC-voltages on the electrical terminals 102, 103. In the embodiment shown the voltage setting means 106A is implemented as a pull-down resistor 111A connected between the terminal 103 and a predefined potential, such as ground potential. Likewise, the voltage setting means 106B is implemented as a pull-down resistor 111B connecting the terminal 102 to the ground potential. Hereby, the closely spaced electrical terminals are kept at a substantially equal DC-voltage during most of the time in which the hearing aid is operated. Other voltage setting means may be used as well. The use of pull-up resistors is another example of a simple implementation of a voltage setting means to be used.

[0034] Figure 1B is another example of a hearing aid according to the invention. As some parts of the hearing aid in Figure 1B are similar or identical to the corresponding parts of the hearing aid illustrated in Figure 1A, these parts are given the same reference numbers as used in Figure 1A. The hearing aid illustrated in figure 1B includes a microphone 116, a processor 107, a loudspeaker 117, a memory 105, a battery 112, and a connector 101 having two electrical terminals 102, 103. The electrical terminals are connected to internal hearing aid components and is connectable to an external device 150 via the connector 101.

[0035] In the example shown the first electrical terminal 102 and the second terminal 103 are connected to the processor 107 and to the electrical connection 109, respectively. Hereby an external power source may provide the hearing aid with electrical power during a programming session and ensures that a sufficient power level is present in the hearing aid. As a result a desired power level is ensured to be present in the hearing aid. Further, the hearing aid may be operated both with and

without a battery.

[0036] As described below, the hearing aid shown includes detecting means 114 adapted for detecting whether an external device 150 is connected or unconnected to the hearing aid 100, and the hearing aid 100 is adapted for keeping the closely spaced electrical terminals 102, 103 at a substantially equal electrical potential during at least a part of the time periods wherein the external device 150 is not connected to the hearing aid 100. For example, this solution is advantageous over the use of voltage setting means in the form of a pull-down or pull-up resistor when one or more of the electrical terminals 102, 103 of the connector 101 are connected to an internal power source 112.

[0037] When the hearing aid 100 detects that an external device 150 has been connected thereto via the electrical terminals 102, 103, the hearing aid 100 may change the mode of operation from a mode of normal operation to another mode. For example, when an external programming device is connected to a programmable hearing aid, the hearing aid mode may change to a programming mode wherein the hearing aid is supplied with programming data from the external programming device 150 connected thereto, or the hearing aid 100 may exchange data with the programming device 150. In other words, in the programming mode data may be transmitted between a hearing aid 100 and an external device 150 via a communication path established between the external device and one or more internal hearing aid components via the connector 101.

[0038] Likewise the detecting means 114 of the hearing aid 100 is also adapted to determine when the external device 150 is disconnected from the hearing aid 100. Hereby, the mode of operation of the hearing aid 100 may automatically be changed from a programming mode to the mode of normal operation in which all the connector terminals are supplied with substantially the same electrical potential. This will be described more fully below. As illustrated in the figure a hearing aid 100 may include a plurality of detecting means 114A, 114B or only a single detecting means 114. Further the detecting means may not be located in a single component but may as well be located in a number of co-operating parts of the hearing aid, e.g. the processor may perform some of the described detecting means functions or operations, whereas other operations may be performed by other parts of the hearing aid.

[0039] The detecting means 114 may be implemented in a number of different ways and some examples are given below.

[0040] Figure 2A is a first example of a detecting means 114 adapted for detecting whether an external electrical signal is supplied thereto and which is further adapted for keeping an electrical terminal at a substantially equal electrical potential during the time periods wherein an electrical signal is not supplied thereto, i.e. during the time periods wherein an external device is not connected to the hearing aid. It should be noted that keeping the electrical terminals of the connector at a substantially equal electrical potential also includes the embodiment wherein the connector terminals are disconnected from the internal devices of the hearing aid, i.e. disconnected from electrical signal or electrical power supplying devices.

[0041] The detecting means shown may for example be adapted for detecting whether an electrical power signal is supplied on an electrical terminal such as the terminal 102 of the connector 101 shown in Figure 1B. Therefore the detecting means shown is supplied with the reference number 114A as in Figure 1B.

[0042] As indicated in Figure 2A, the detecting means 114A may include a first electrical terminal 102 which is connected to a second electrical terminal 109, such as an electrical power terminal 109, via a first transistor 201. The detecting means 114A includes a first and a second transistor 201, 202. The first transistor 201 is a p-type MOS transistor having the source terminal (S1) and the drain terminal (D1) connected to the first terminal 102 and the second terminal 109, respectively. The second terminal 109 is adapted for supplying a high electrical potential (VBAT) of a power source, such as a battery 112 as described in Figure 1B, for example. The gate terminal (G1) of the first transistor 201 is connected to the second electrical terminal or electrical power terminal 109 via a first resistor 203. In the example shown the gate terminal (G1) of the first transistor 201 is connected to a predefined ground potential (GND) via a second transistor 202. In the example shown, the second transistor 202 is an n-type MOS transistor having the drain (D2) terminal and the source terminal (S2) connected to the gate terminal (G1) of the first transistor 201 and GND, respectively. The gate terminal (G2) of the second transistor 202 is connected to the electrical terminal 102. Further the gate terminal (G2) of the second transistor 202 is connected to GND via a second resistor 204. Finally, as illustrated in the figure, the detecting means 114A may include a decoupling capacitor 206. It is noted that the use of MOS transistors is a specific embodiment of the use of comparators. In other words other comparators may also be used according to the invention.

[0043] The function of the detecting means 114A may be described as follows. When a voltage lower than the gate-to-source voltage threshold voltage of the second transistor 202 is supplied to the first terminal 102, e.g. when no external electrical device is connected thereto, the second transistor 202 is off disconnecting source terminal (S2) and the drain terminal (D2). As a consequence the potential VBAT may be found at the drain terminal (D2) of the second transistor 202, as substantially no current will flow through the resistor 203. In this situation the first transistor 201 will be off. On the other hand, when a voltage higher than the gate-to-source voltage threshold of the second transistor 202 is supplied to the first terminal 102, i.e. when a sufficient high electrical potential is present at the terminal 102, the

second transistor 202 is on. As a consequence a potential substantially equal to GND may be found at the drain terminal (D2) of the second transistor 202. In this situation the first transistor 201 will act as a connected switch between the source terminal (S1) and the drain terminal (D1) thereof. D2 acts as a comparator with a threshold voltage of 0.5 - 0.8 V, for example. Other voltage levels are also possible.

[0044] Therefore the detecting means 114A illustrated in Figure 2A is adapted for connecting and disconnecting a first terminal 102 and a second terminal 109 in accordance with the voltage occurring on the first terminal 102. In other words, the detecting means 114A is adapted for detecting the absence of a sufficiently high voltage on the terminal 102 and as a result the terminal 102 and the terminal 109 will be kept disconnected. Further the detecting means 114A will detect the presence of a sufficiently high voltage on the terminal 102, and as a result the first terminal 102 and the second terminal 109 will be kept connected. Therefore the detecting means 114A may act as a switch connecting and disconnecting a terminal located at the outer surface of a hearing aid to and from an internal component of the hearing aid, e.g. a battery power terminal. Further the detecting means may be responsive to an AC and DC voltage supplied thereto by an external device.

[0045] In practice the terminal 102 may advantageously be connected to GND via a pull-down resistor (not shown) as the terminal voltage hereby may be kept at a well-defined level during periods wherein no external voltage is supplied thereto, e.g. when no external signal or power supplying devices are connected thereto. For example, the pull-down resistor may have a resistance in the interval of 100-200 kQ but other values may also be selected. Further, in some embodiments a pull-up resistor may be used instead of the above-mentioned pull-down resistor.

[0046] Figure 2B is a second example of a detecting means adapted for detecting whether an external electrical signal is supplied thereto and which is further adapted for keeping an electrical terminal at a substantially equal electrical potential during at least a part of time periods wherein an electrical signal is not supplied thereto.

[0047] In addition to the components described in relation to Figure 2A, the detecting means shown in Figure 2B includes a third transistor 213. The third transistor 213 shown is a MOS transistor having the source terminal (S3) and the drain terminal (D3) connected to the first terminal 102 and the second terminal 109, respectively. The gate terminal (G3) of the third transistor 213 is connected to a control terminal 208. Hereby the connection and disconnection of the first and the second terminal 102, 109 may also be controlled by use of a control signal supplied by the control terminal 208. As shown in the figure the detecting means may for example be supplied to the transistor from a register (REG) 210 which may be located in the processor 107 of the hearing aid 100, for example.

[0048] As described the detecting means 114 may perform the operation of supplying a terminal with a predefined potential when no external devices are connected to the hearing aid. Alternatively this operation may also be performed by other components of the hearing aid. For example, one or more component adapted for receiving information from the detecting means about external devices connected or disconnected to the hearing aid may operate as a switch connecting or disconnecting the connector terminals and the internal components of the hearing aid. Further the detecting means 114 and/or the means adapted for keeping the closely spaced electrical terminals 102, 103 at a substantially equal electrical potential may form part of other components of the hearing aid, e.g. the processor 107.

[0049] Figure 3 is another example of a circuit adapted for keeping the set of closely spaced electrical terminals at a substantially equal electrical potential during the time periods wherein an external device is not connected to the hearing aid 100.

[0050] The circuit 300 is a well-known transmission gate adapted for connecting or disconnecting a first terminal 301 and a second terminal 302 depending on a control signal supplied thereto via a control terminal 303; i.e. the circuit 300 is adapted for operating as a controllable switch.

[0051] As in Figures 2A and 2B, the terminal 301 may advantageously be connected to a well-defined potential, e.g. a ground potential, via a pull-down resistor as the terminal voltage hereby may be kept at a well-defined level during periods wherein no external voltage is supplied thereto. Hereby the switch 300 may form part of a hearing aid according to the invention. For example, the switch 300 may form part of the detecting means denoted 114B and the detecting means described in Figure 2A or Figure 2B may be used as the detecting means 114B in Figure 1B. The control signal supplied to control terminal 303 of the switch 300 may for example be controlled by a signal level detector which is activated when the signal level on the electrical terminal 103 exceeds a predefined level. Hereby, when a signal such as a data signal or a power input is present on a connector terminal, such as the terminal 102 or the terminal 103, the switch is activated, i.e. a connector terminal may be connected to one or more internal hearing aid components. Alternatively the control terminal 103 may form part of the connector 101 whereby the operation thereof may be controlled externally. Hereby, the switch 300 may connect an connector terminal, such as terminal 103 to the processor 107, when the connection is requested by an external device 150, only. The request may for example be performed by applying a control signal to the control terminal 103. The detecting means may be responsive to a DC or an AC voltage supplied by the external device.

[0052] Figure 4 is a second example of a hearing aid according to the invention. The hearing aid 400 includes

a connector 401 having four electrical terminals 421, 422, 423 and 424. The first terminal 421 and the third terminal 423 is connected to the processor 107 and to the electrical power terminal 109 via a detecting means 414, and therefore these terminals may correspond to the first terminal 102 and the second terminal 103 of Figure 1B, respectively. In addition to these terminals the hearing aid 400 includes a second terminal 422 and a fourth terminal 424. The second terminal 422 is also connected to the processor 107 via the detecting means 414 and may for example be adapted for supplying an external clock signal to the processor 107. The fourth terminal 424 is connected to the power terminal 110. For example, the four electrical terminals may be used as a data terminal, a clock terminal, and a first and a second electrical potential terminal e.g. supplying GND and VBAT to the hearing aid. The figure illustrates that a connector of a hearing aid according to the invention may include more than two terminals. In fact the connector of a hearing aid according to the invention may include an arbitrary number of terminals.

[0053] The detecting means 414 may be implemented in different ways for example as illustrated in Figure 2A and Figure 2B where the connection or disconnection are controlled on basis of the signal sensed on one or more connector terminals, or as in Figure 3 wherein the connection or disconnection is controlled by use of a control signal supplied thereto via a control terminal 303. For example, the control terminal 303 may be connected to the processor 107 whereby the controlling of the switch 300 may be performed by the processor, e. g. depending on which state the processor 107 is operated. For example, if the processor 107 and the memory 105 are connected to each other and to a terminal of the connector 401, as shown in Figure 4, the switch 300 may be instructed to disconnect when internal data are transmitted between the processor 107 and the memory 105, whereas it may be instructed to connect when data are to be transmitted to or from an external device via the connector 401. The instruction of the switch may also be derived from the presence of signals on one or more connector terminals or in other ways, e.g. when an external mechanical switch indicating a programming mode is activated externally.

[0054] Figure 5 is an example of a mechanical detecting means 501 adapted for detecting whether an external electrical device is connected to a hearing aid, and which is further adapted for keeping an electrical terminal at a predefined electrical potential during the time periods wherein an external device is not connected to the hearing aid.

[0055] The mechanical detecting means shown is a switch 501 which may be activated when an external device is connected to a hearing aid 500 via a connector 503 having two or more electrical terminals 504, 505. For example, the switch 501 positioned in such a way that it is activated automatically when a plug or the like is engaged with a connector 503 of the hearing aid, and hereby the switches of a switching means 508 are connected, i.e. the connector terminals 504, 505 are connected to one or more internal hearing aid components. Likewise the connector terminals 504, 505 may be disconnected from the internal hearing aid components when switch 501 is deactivated.

[0056] In another embodiment the switch 501 may be activated by a user prior to the desired use of the connector 503. In another embodiment the switch 501 may be connected to the processor of the hearing aid 500 and hereby the processor may use the input therefrom to select the mode of operation as mentioned above. Alternatively the switch 501 may be connected as a control signal to a connection/disconnection device, e.g. the circuit 300 shown in Figure 3. Other mechanical detecting means 501 may be used in connection with a hearing aid according to the invention, if desired.

[0057] The invention also relates to a method of operating a hearing aid comprising a connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components and electrically connectable to an external device. The method comprises the step of detecting whether an external device is connected or unconnected to the hearing aid. The detection may be performed in different ways, e.g. as described above in relation to a hearing aid according to the invention. The method further includes keeping said set of closely spaced electrical terminals at a substantially equal electrical potential during at least a part of time periods wherein an external device is unconnected; i.e. when no external devices are connected to the hearing aid. When, on the other hand, an external device is operatively connected to one or more internal hearing aid components via the connector, the hearing aid may for example receive and/or transit data via the electrical terminals of the connector. The method or at least a part thereof may be executed by the processor of the hearing aid; i.e. the hearing aid includes processor executable program code adapted for performing at least a part of the above-mentioned method when run by a processor in a digital hearing aid. For example, when it is determined that an external device has been connected to the hearing aid, an interrupt request may be supplied to the processor of the hearing aid indicating that the hearing aid is to be operated in a first predefined mode of operation, e.g. at programming mode. Likewise when it is determined that an external device has been disconnected from the hearing aid, another interrupt request may be supplied to the processor indicating that the hearing aid is to be operated in a second predefined mode of operation, e.g. at mode of normal hearing aid operation, and the connector may for example be instructed to disconnect by supplying a control signal thereto.

[0058] Due to the fact that a preferred embodiment of the invention has been illustrated and described herein it will be apparent to those skilled in the art that modifications and improvements may be made to forms herein

specifically disclosed. For example, the type of interface formed by the electrical terminals of the connector is of minor interest, as the problem according to the invention occurs in a variety of prior art hearing aids including electrical connector terminals. Further the hearing aids shown include a connector forming part of a programming interface but the connector may also be used for other purposes, if desired. The connector may for example be adapted for transmitting and/or receiving other signals such as audio signals to and/or from an external device when such a device is connected thereto, e. g. via an audio shoe connected to the hearing aid via the connector terminals. Further a hearing aid may include one or more detecting means, and one or more electrical and/or mechanical means adapted for keeping the connector terminals of the hearing aid at substantially the same potential. Further, in some embodiments the hearing aid according to the invention may act as a master when determining whether an external devise is connected thereto or not. For example, the detecting means may output a low duty-cycle pulse signal to one or more of the electrical terminals 102, 103 and sensing impedance changes, e.g. by measuring amplitude changes in the pulse signal. In other embodiments the hearing aid may act as a slave, e.g. being instructed in which time periods the electrical terminals of the connector are to be kept at the same or approximately the same electrical potential. For example an AC signal, a DC signal, an optical signal my be supplied to the hearing aid as an instruction signal. Accordingly the scope of the present invention is defined by the appended claims rather than the forgoing described embodiments.

Claims

1. A hearing aid comprising:

a housing comprising a connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components, said set of electrical terminals being electrically connectable to an external device,

detecting means adapted to determine whether an external device is connected or unconnected to the hearing aid, **characterised in that**

the detecting means is adapted for controlling said set of closely spaced electrical terminals so as to keep these at a substantially equal electrical potential during at least a part of the time periods wherein the external device is unconnected.

2. A hearing aid according to claim 1, **characterised in that** the detecting means is responsive to an electrical signal, such as a DC or an AC voltage, supplied by the external device.

3. A hearing aid according to claim 2, **characterised in that**, the detecting means comprises a comparator responsive to said electrical signal.

4. A hearing aid according to claim 3, **characterised in that**, said comparator includes a MOS transistor to which gate terminal said electrical signal is supplied.

5. A hearing aid according to claim 1, **characterised in that** the detecting means includes mechanical detecting means.

6. A hearing aid according to one or more of the preceding claims, **characteri sed** in that the set of closely spaced electrical terminals is kept at a substantially equal electrical potential during substantially the entire time periods wherein the external device is unconnected.

7. A hearing aid according to one or more of the preceding claims, **characterised in that** said set of closely spaced electrical terminals forms part of a programming interface or an audio connector between the external device and the hearing aid.

8. A hearing aid comprising:

a housing comprising a programming interface connector with a set of closely spaced electrical terminals operatively connected to one or more internal hearing aid components, said set of electrical terminals being electrically connectable to an external device, **characterised by** including voltage setting means adapted for keeping said set of closely spaced electrical terminals at a substantially equal DC-voltage.

9. A hearing aid according to claim 8, **characterised in that**, pull-up or pull-down resistors form said voltage setting means.

10. A hearing aid according to claim 8, **characterised by** including detecting means adapted to determine whether an external device is connected or unconnected to the hearing aid and said detecting means being adapted for controlling said voltage setting means so as to keep said set of closely spaced electrical terminals at a substantially equal electrical potential during at least a part of the time periods wherein the external device is unconnected.

11. A method of operating a hearing aid comprising a connector with a set of closely spaced electrical terminals operatively connected to one or more inter-

nal hearing aid components and electrically connectable to an external device, said method comprising:

- detecting whether the external device is connected or unconnected to the hearing aid, and
- keeping said set of closely spaced electrical terminals at a substantially equal electrical potential during at least a part of the time periods wherein an external device is unconnected.

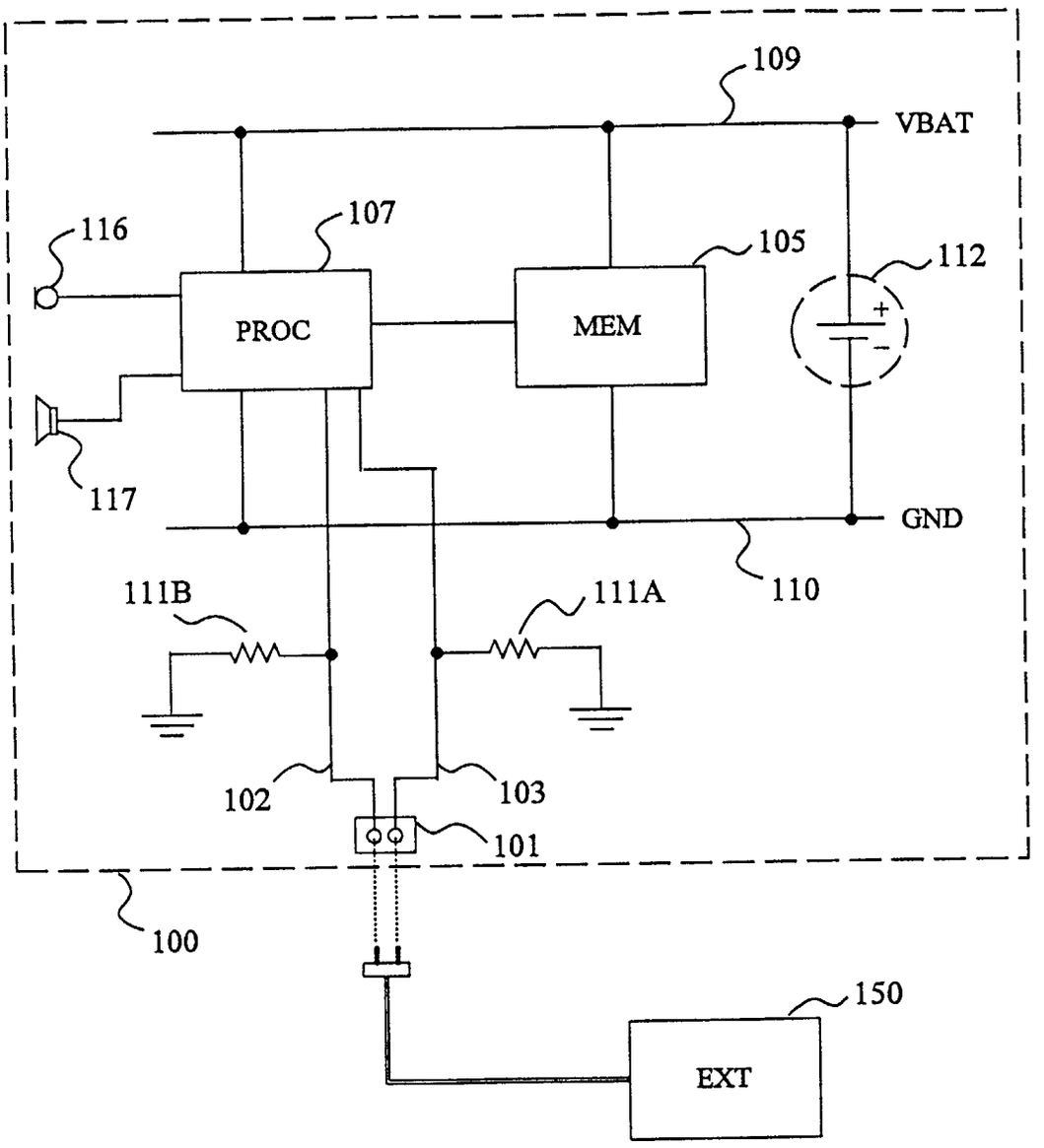

109
VBAT
116
107
105
112
PROC
MEM
+
−
117
GND
110
111B
111A
102
103
101
100
150
EXT

FIG. 1A

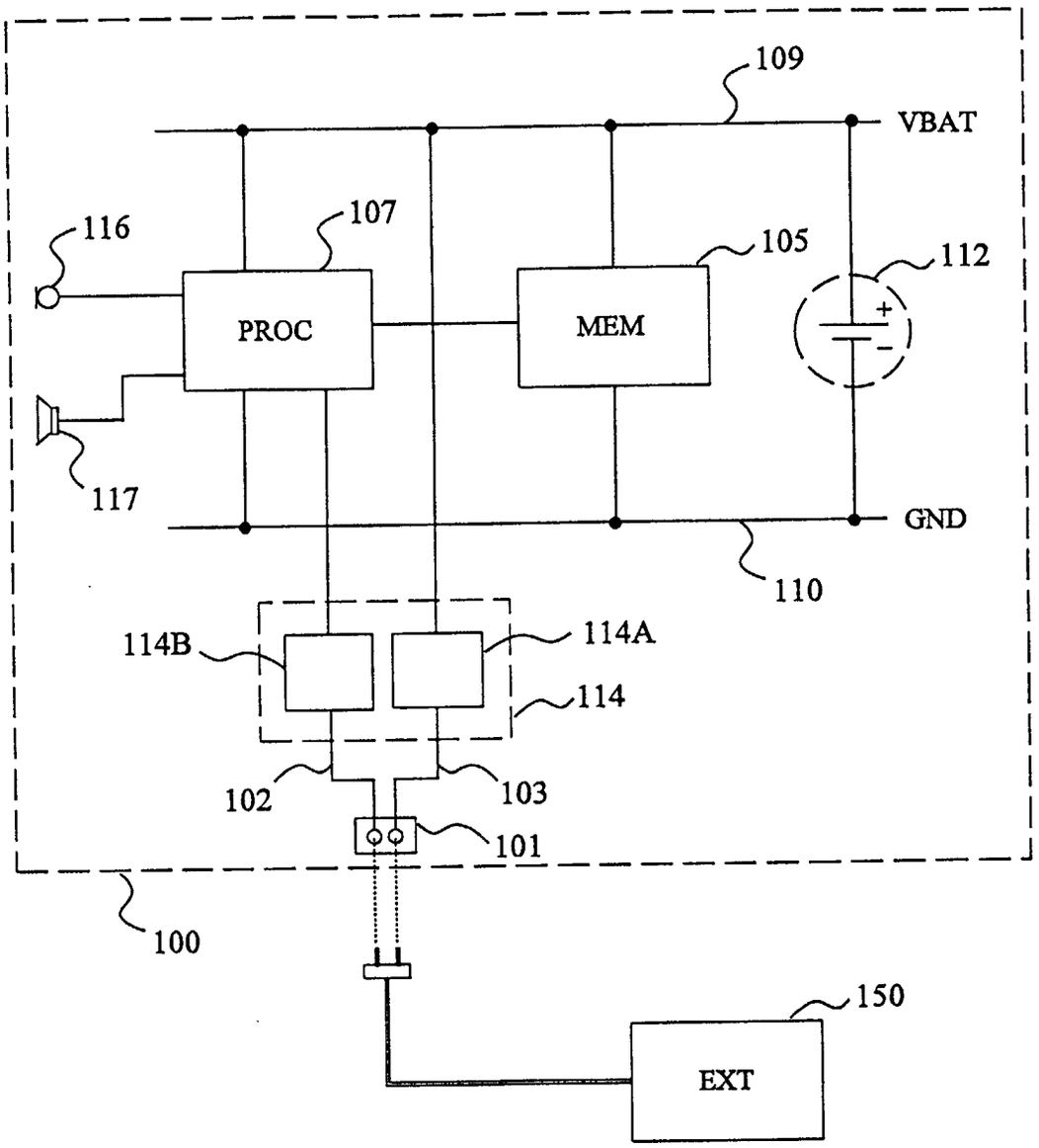

109
VBAT
116
107
105
112
PROC
MEM
+
-
117
GND
110
114B
114A
114
102
103
101
100
150
EXT

FIG. 1B

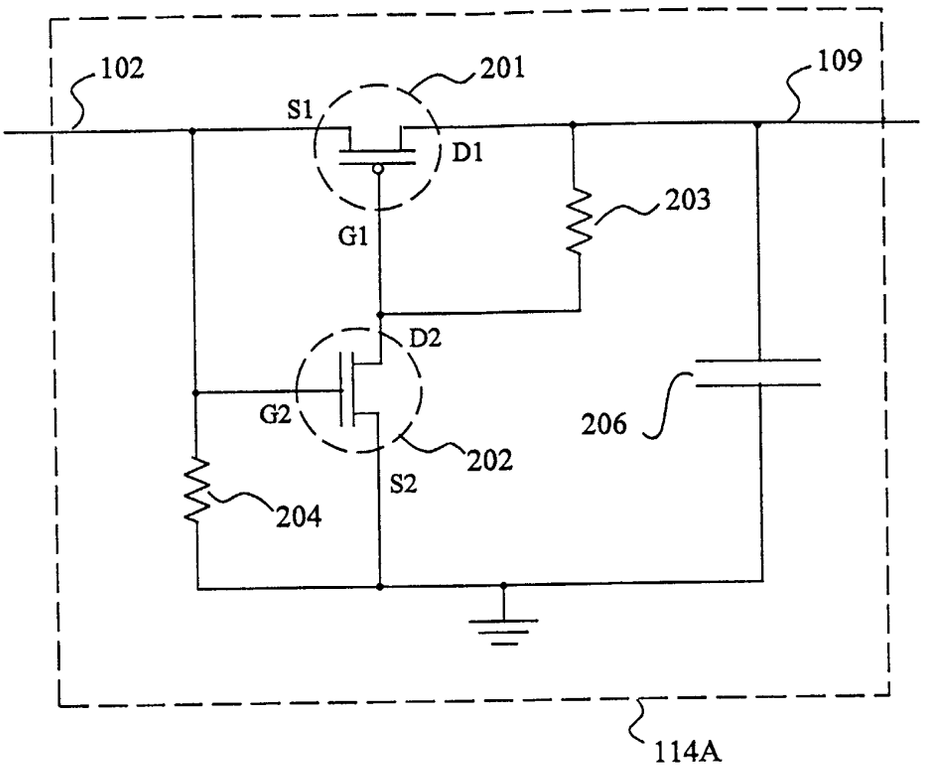

102
201
109
S1
D1
203
G1
D2
G2
206
202
S2
204
114A

FIG. 2A

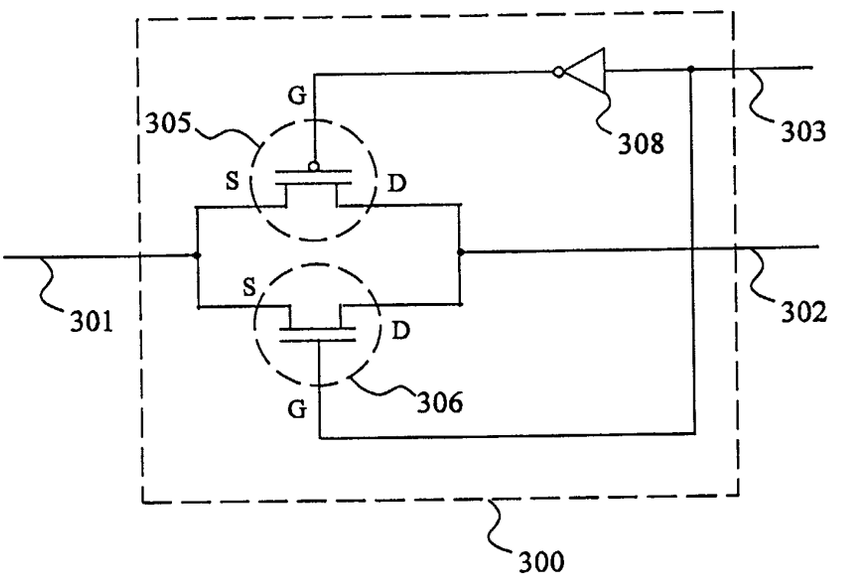
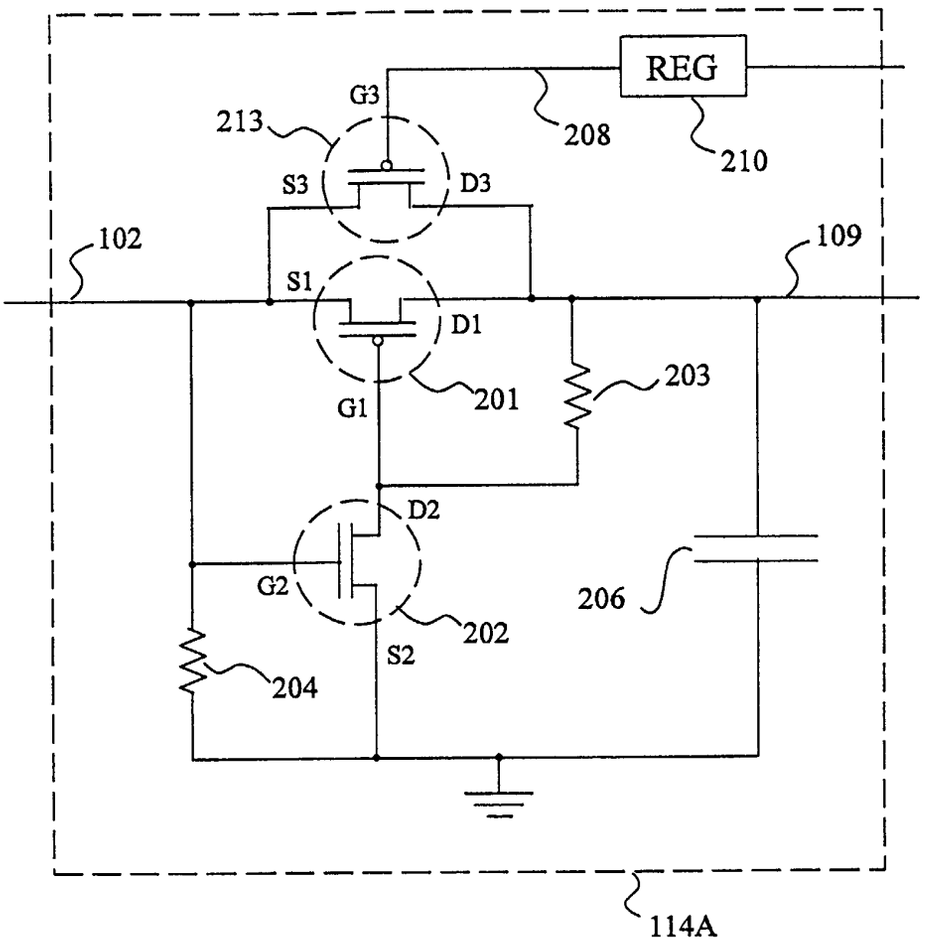

G
305
308
303
S
D
S
301
302
D
G
306
300

FIG. 3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G3
213
208
210
S3
D3
102
109
S1
D1
203
201
G1
D2
G2
206
202
S2
204
114A

FIG. 2B

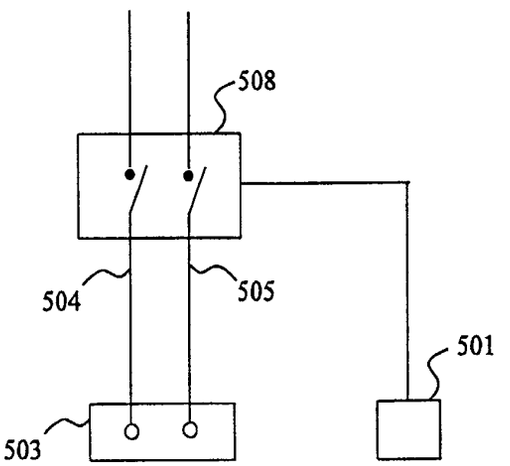
508
504
505
501
503

FIG. 5

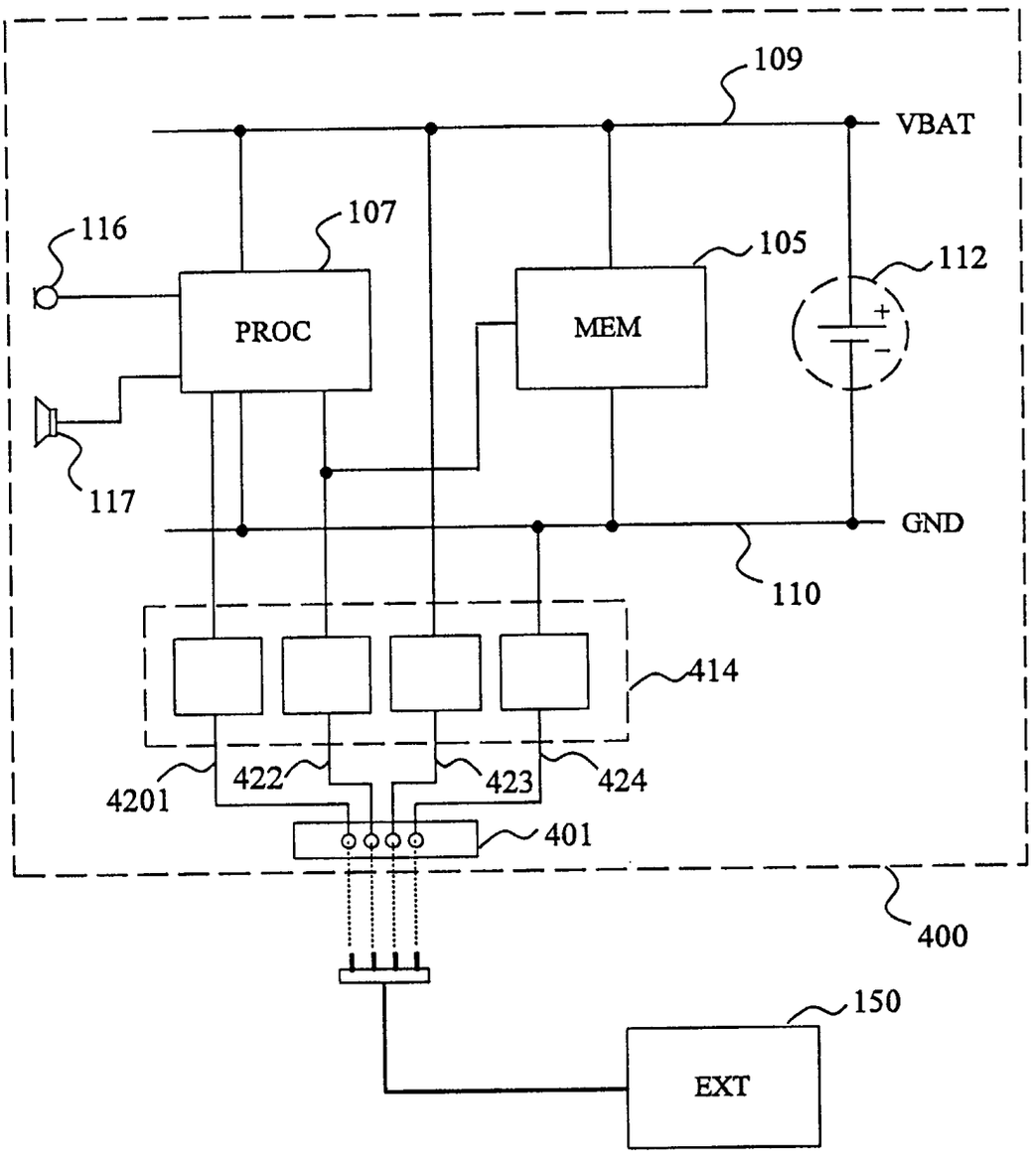
109
VBAT
116
107
105
112
PROC
MEM
+
-
117
GND
110
414
4201
422
423
424
401
400
150
EXT

FIG. 4