

Two part hearing aid with databus connection

- The present invention relates to hearing aids. The invention further relates to a method for communication between two parts of a hearing aid. The invention
5 *more specifically concerns a two part hearing aid comprising power supply means and at least one microphone for transforming an acoustic signal in the surroundings of a hearing aid user into an electric signal. The hearing aid comprises a base part to be arranged outside the ear canal of a hearing aid user, said base part comprising signal processing means. The hearing aid also*
10 *comprises an ear plug part to be arranged in the ear canal of a hearing aid user, said ear plug part comprising acoustic output means for transmitting sound into the ear canal, said ear plug part comprising an ear canal microphone for transforming an acoustic signal in the ear canal into an electric signal, and the ear plug part further comprising an electronic module connected*
15 *to said ear canal microphone. The hearing aid further comprises an elongated member connecting said ear plug part with said base part. The elongated member comprises electrical wires adapted for providing power supply from the base part to the ear plug part, or, from the ear plug part to the base part.*
- 20 Hearing aids are often made as a two part device with one part, an ear plug, for being arranged in the ear canal of the hearing aid user, and another part, a base part, for being arranged outside the ear canal. Often the base part is arranged behind the ear, known as a behind-the-ear hearing aid. The base part will usually comprise signal processing means, one or two microphones and a
25 battery. Often a receiver is also arranged in the base part. A sound tube will then connect the base part with the ear plug part, and sounds from the receiver will be transmitted through this sound tube to the ear plug part transmitting the sound further to the ear drum of the hearing aid user.
- 30 In a known alternative the receiver is arranged in the ear plug part and connected with the signal processing means in the base part through e.g. two

wires. In this case the sound tube is replaced by electric leads, suitably encapsulated.

It has been suggested to arrange a microphone in the ear plug, at the side proximally to the tympanic membrane, for transforming sounds in the ear canal into electrical signals. Such a microphone may have many purposes during fitting and during daily use of the hearing aid. The electrical signal from such a microphone needs to be transferred to the signal processing means of the base part of the hearing aid, normally by an extra pair of wires. It has now been realized that one problem in having such a microphone is that the wires used for transferring the signal from the microphone to the base part will gather electrical noise. The electrical signal generated in the microphone is relatively weak, e.g. 5 - 10 μ V, and therefore rather sensitive to noise.

It has also now been realized that this problem is larger when a receiver is arranged in the ear plug, since the wires supplying the receiver signal, which may be 2 V at peak level, will be arranged close to the wires transferring the signal from the microphone. Therefore, it is likely that the receiver signal will induce noise into the wires carrying the microphone signal.

Another problem is that the number of wires preferably should be as low as possible in order to keep the diameter of the elongated member connecting the two parts as small as possible.

The above problems are solved by the present invention by providing a hearing aid where the signal from the ear canal microphone is transferred to the signal processing means in the base part through a serial databus connected through a data line arranged with said elongated member.

The invention is directed to a hearing aid comprising power supply means and at least one microphone for transforming an acoustic signal in the surroundings of a hearing aid user into an electric signal, said hearing aid further comprising a base part to be arranged outside the ear canal of a hearing aid user, said base part comprising signal processing means, an ear plug part to be arranged in the ear canal of a hearing aid user, said ear plug part comprising acoustic transmitting means for transmitting sound into the ear canal, said ear plug part comprising an ear canal microphone for transforming an acoustic signal in the ear canal into an electric signal, and the ear plug part further comprising an electronic module connected to said ear canal microphone, and an elongated member connecting said ear plug part with said base part, said elongated member comprising electrical wires adapted for providing power supply from the base part to the ear plug part, or, from the ear plug part to the base part, wherein the signal from the ear canal microphone is transferred to the signal processing means in said base part by a serial databus connected through a data line arranged in said elongated member, said databus being a one line bidirectional serial databus.

A serial databus is here understood to be a digital communication line which can be set up for communication between different units, suitable for carrying signals in more than one direction.

In an embodiment according to the invention the base part is adapted to be arranged behind the ear.

- 5 In an embodiment according to the invention the base part comprises the at least one microphone for receiving sound signals from the surroundings. Alternatively, as disclosed in DE 102005006404 and in DE 102005013833, a microphone for receiving sound signals from the surroundings may also be arranged in the ear plug part.

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In an embodiment according to the invention the base part will preferably also comprise either or both of the signal processing means and a battery for power supply.

- 15 In an embodiment according to the invention the elongated member comprises three electrical wires, where two would typically be for power supply, and one for the data line. In further embodiments the elongated member comprises more than three electrical wires, and more than one wire is applied for the data line. The data line could also comprise an optical medium such as an optical
20 wave guide e.g. an optical fiber.

- In an embodiment according to the invention, the elongated member comprises a sound tube for transferring an acoustic signal from said base part to said ear plug part. Such a sound tube facilitates the application of two different receiver
25 units, where at least one receiver could be arranged in the base part of the hearing aid. This could be the low frequency receiver, for which the loss in the sound tube is smaller than for higher frequencies. Then the high frequency receiver unit could be arranged in the ear plug part.

- 30 In an embodiment according to the invention where the ear plug part comprises at least one receiver unit, the electric signal for said receiver unit is transmitted

as digital communication through the serial databus arranged in the elongated member. Thereby, acoustic loss in a sound tube is avoided.

In an embodiment according to the invention the receiver unit in the ear plug
5 part is for transmitting the high frequency part of the acoustic signal and the low frequency part of the acoustic signal is transmitted through said sound tube from a low frequency receiver unit arranged in the base part.

In an embodiment according to the invention the ear plug part comprises an
10 electronic chip connected with the ear canal microphone, said chip further being connected with electrical wires of the elongated member. This chip preferably comprises circuits for handling the digital communication through the dataline. Preferably, the electronic chip comprises a voltage regulator for the power supply of the ear canal microphone. Preferably, the electronic chip
15 comprises an analogue to digital converter for converting an analogue signal from the ear canal microphone into a digital signal. The electronic chip may also comprise a sigma-delta converter for converting the microphone signal.

In an embodiment according to the invention the base part of the hearing aid is
20 arranged to apply a first clock frequency for the signal processing means, and the ear plug part is arranged to apply a second clock frequency for the electronic module. Preferably, these two clock frequencies are synchronized. This may be done by arranging a clock frequency generator in either the base part or in the ear plug part of the hearing aid, and regenerate a clock frequency
25 in the part of the hearing aid without clock frequency generator.

In a further embodiment the regenerated clock frequency is being synchronized with the clock frequency of said clock frequency generator. Often the clock frequency generator is arranged in said base part of the hearing aid, where
30 there is usually more space available.

In a further embodiment the synchronization between the first and the second clock frequency is performed by a phase-locked loop.

In an embodiment according to the invention the ear plug part is connected with a transducer for measuring a physical or physiological parameter. Such a transducer could be adapted for measuring temperature, blood pressure, movement e.g. acceleration, orientation, i.e. is the person lying down, electrical signals of the body, e.g. EEG or ECG. Preferably such transducer is connected to the electronic module of the ear plug part and is prepared for transferring data to the signal processing means in said base part through the serial databus.

The invention is also directed to a method for communicating between two parts of a hearing aid comprising power supply means and at least one microphone for transforming an acoustic signal in the surroundings of a hearing aid user into an electric signal, said two parts of the hearing aid being connected through at least two wires, which method comprises arranging a base part outside the ear canal of a hearing aid user said base part comprising signal processing means. The method also comprises arranging an ear plug part in the ear canal of a hearing aid user, said ear plug part comprising acoustic transmitting means for transmitting sound into the ear canal, said ear plug part comprising an ear canal microphone for transforming an acoustic signal in the ear canal into an electric signal, and the ear plug part further comprising an electronic module connected to said ear canal microphone. The method further comprises connecting said ear plug part with said base part by an elongated member, said elongated member comprising electrical wires prepared for providing power supply from the base part to the ear plug part, or, from the ear plug part to the base part, wherein the signal from the ear canal microphone is transferred to the signal processing means in said base part through a serial databus connected through a data line arranged with said elongated member, said database being a one line bidirectional series databus.

Embodiments of the invention will now be explained in further detail with reference to the figures.

Figure 1 illustrates an embodiment where a hearing aid is provided with a
5 sound tube between the base part and the ear plug part.

Figure 2 illustrates an embodiment of the hearing aid, similar to figure 1, but without a sound tube.

10 Figure 3 illustrates the bidirectional digital communication through a single wire databus, panes (a) through (k) signifying respective signals.

Figure 4 illustrates different states for controlling the bidirectional digital communication, panes (a) through (e) signifying respective signals.

15 Figure 5 illustrates a phase locked loop circuit applied in an embodiment of the invention.

Figure 6 illustrates a cross sectional view of an elongated member with a sound
20 tube and three wires.

Figure 1 shows the principles of a hearing aid according to an embodiment. The base part 1, often arranged behind the ear, comprises two microphones 3, 4, an electronic module 6, a receiver 9 and a battery 8. The electronic module 6
25 comprises signal processing means 23, a clock generator 20 and a controller 24 for controlling the communication on the data line 16. The ear plug part 2 comprises an electronic module or electronic chip 7 and a microphone 11. The ear plug part 2 also comprises a receiver 10. This receiver 10 is intended for the relatively high frequencies, e.g. 3 kHz – 15 kHz, while the lower
30 frequencies, e.g. 20 Hz – 3 kHz, are generated in the receiver 9 arranged in the base part. The sound from this low frequency receiver 9 is transmitted to the ear plug part 2 through the sound tube 5. The loss when transmitting low

frequency sound through the sound tube 5 is lower than the loss when transmitting higher frequencies through the sound tube. Since there may not always be sufficient space for two receiver units in the ear plug part it may be advantageous to have the low frequency unit in the base portion. This will,
5 however, make the application of a sound tube between the base part and the ear plug part necessary.

The electronic module 7 of the ear plug part 2 comprises a digital to analogue converter 22 for driving the high frequency receiver 10, and an analogue to
10 digital converter 21 for digitizing the signal from the microphone 11 near the tympanic membrane. Both converters may be in the form of sigma delta converters, known from US 5,878,146.

The sound tube will also be necessary in the situation where there is no
15 receiver unit in the ear plug part. In that situation one or two receiver units will be arranged in the base part. Such an embodiment may be preferred for high power hearing aids where large receiver units are necessary in order to obtain sufficient sound pressure.

20 Figure 2 shows an embodiment of a hearing aid where there is no sound tube because the two receiver units 9, 10 are arranged in the ear plug part 2. The two receiver units 9, 10 shown could as well be one combined unit.

Three wires or lines are connecting the base part with the ear plug part in the
25 embodiment illustrated in figure 1 and 2. Two electrical wires 15, 17, are for the power supply and one wire or line 16 is for the digital communication line, i.e. the serial databus. In principle the digital communication could also have been performed via a power supply wire, thereby reducing the necessary number of wires to two. This could cause some noise problems, and would imply further
30 signal processing of the communication line. Another option is to have four, or more, wires connecting the base part with the ear plug part, thereby enabling

one wire for communication from the base part to the ear plug part and one wire for communication from the ear plug part to the base part.

5 The data line or serial databus 16 may have the form of one or more electrical wires or it could be an optical wave guide such as one or more optical fibers. In the case of optical fibers an LED or semi conductor Laser and an appropriate detector should be arranged in both hearing aid parts. US 2008/0107292 A1 discloses a hearing aid where an optical wave guide is connecting an optical microphone in the ear canal with a behind-the-ear base part.

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The data line signal may also be sent as a balanced signal on a pair of wires. This will also reduce the risk of noise influencing the data line communication. A balanced pair of wires could be twisted in order to further reduce noise influence.

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In order to obtain both a thin combined wire and a stable communication between the base part and the ear plug part, three wires are often preferred for the connection. This means that one wire is to be applied for the digital communication in both directions. Different types of protocols may be applied
20 for controlling this communication.

Usually the battery is arranged in the base part and a voltage regulator is applied for supplying a stable voltage V_{DD} for the electronic modules. A voltage transferred through wires in the elongated member may be affected or
25 disturbed by e.g. an electrical data line or external devices. Therefore, it is often preferred to transfer the battery voltage directly and to provide a local voltage regulator 20 in the ear plug part.

Figure 3 and 4 shows one example on how the communication through a one
30 line bidirectional serial databus 16 could be handled. The example may apply for both an electrical wire and an optical fiber as data line. In figure 3a an 8 MHz clock frequency generated in the base part 1 is shown. A corresponding 8

MHz clock frequency is generated in the ear plug part 2 by application of a phase-locked loop (PLL) circuit 19 (see figure 5). The PLL 19 regenerates the 8 MHz clock frequency by application of the data line signal. The PLL continuously adjusts the synchronization between the two 8 MHz clock frequencies, by application of rising edges in the data line signal. When the clock generator 20 is arranged in the base part, as in this example, the PLL is arranged in the ear plug part. This synchronization is important for the proper functioning of the one or two sigma-delta converters driving the one or two receivers 9, 10. If the two clock frequencies get slightly out of phase, phase noise will be introduced in the at least one receiver. Clock jitter caused by an unstable clock frequency will reduce the quality and reliability of the data communication. This can be avoided when a crystal is applied for clock frequency generator, and this clock frequency is transferred to the other part of the hearing aid, e.g. by the method described above. Transferring the crystal based clock frequency results in a reliable communication.

A result of the application of the PLL circuit shown in figure 5 is that a 2 MHz clock frequency is also generated (see figure 3b). This 2 MHz clock frequency is generated by a divider 33 in the feedback loop of the PLL, and is applied for synchronizing with the frequency of the rising edges in the data line signal. Often a 2 MHz clock frequency is also necessary for the receiver.

Figure 3c and 3d shows an example on sending one bit from the base part to the ear plug part, where a "0" is sent in figure 3c and a "1" is sent in figure 3d. In both figure 3c and in figure 3d a "0" is sent out of the ear plug part.

Figure 3e and 3f shows an example on sending one bit from the ear plug part to the base part, where a "0" is sent in figure 3e and a "1" is sent in figure 3f. In both figure 3e and in figure 3f a "0" is sent out of the base part.

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Figure 3g shows the resulting signal on the bidirectional data communication line, where the dashed lines indicate that the signal can follow one of the two

possible routes, resulting in either a "0" or a "1" being sent. This resulting signal on the data line is a summation of signals from figure 3c or 3d, and figure 3e or 3f. In the example there will be a rising edge, indicated by arrows in figure 3g, in the data line signal for every fourth rising edge in the 8 MHz clock frequency.

5 This is equivalent to a rising edge in the data line signal for every rising edge in the 2 MHz frequency, also indicated with arrows in figure 3b. This means that the signal on the data line must go low before this rising edge, which is also the case in the data line signal shown in figure 3g. A change in the data line signal level only occurs on rising or falling edges of the 8 MHz clock frequency.

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The mentioned rising edges in the data line signal, indicated with arrows in figure 3g, are applied for the PLL to synchronize the clock signals between the base part and the ear plug part.

15 Figure 4a further illustrates the states of a phase counter. A phase counter is present in both the base part and in the ear plug part. The phase counter is part of a control means 18 of the ear plug part. These two phase counters are synchronized by the PLL via rising edges of the data line. The phase counter starts on 1 on a rising edge of the data line signal and increments by one for each rising edge on the 8 MHz clock until 4. After 4 the phase counter starts from 1 again. The phase counters can also be incremented by half by

20 identifying the falling edges on the 8 MHz clock.

The phase counters are applied for identifying which part, the base part or the ear plug part, is sending data out. For this purpose a line_phase is defined as shown in figure 4e. In the periods where line_phase equals "A", the base part is sending, and in the periods where line_phase equals "B", the ear plug part is sending. In the example the line_phase is set to "B", when the phase counter is between 1.5 and 3.5. In the rest of the cycle the line_phase is set to "A".

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Figure 4b repeats the 8 MHz clock frequency, and figure 4c repeats the data line signal, both for ease of comparison in figure 4.

In order to discriminate between the rising edges of the data line signal intended for synchronization, illustrated with arrows in figure 3g, and the rising edges, which will occur every time a "1" is sent from the ear plug part to the base part, the control unit 18 of the electronic module 7 of the ear plug part 2 is arranged for generating a signal to be applied for this discrimination. This signal is called trig_on and is illustrated in figure 4d.

The trig_on signal is set to "1" (or high), when the line_phase equals "A". The trig_on signal is set to "0" (or low), when the line _phase equals "B".

Figure 5 shows an example of the phase locked loop (PLL) circuit 19 applied for synchronizing the 8 MHz clock frequency by application of rising edges marked with arrows in figure 3g and 4c. The data line signal goes to an AND operator 30 together with the trig_on signal. The output of the AND operator 30 will thus only go high for the rising edges of the data line signal, marked with an arrow, and not for the rising edge when the ear plug part is sending a "1", where the trig_on signal is low (see figure 4c and 4d).

The signal from the AND operator 30 is the reference input (A) to the phase frequency detector (PFD) 31. The other input (B) to the PFD 31 is the feedback from the voltage controlled oscillator (VCO) 32 through a divider 33. The two outputs Q_A and Q_B of the PFD 31 control a first switch 34 and a second switch 35 through a train of pulses. A first constant current generator 36 and a second constant current generator 37 will either charge or discharge a capacitor 38, thereby determining the input voltage to the VCO 32. The two current generators 36, 37 generate the same current. A pulse on Q_A will close the first switch 34 connected with Q_A , whereby the first constant current generator 36 will be charging the capacitor 38. A pulse on Q_B will close the second switch 35 connected with Q_B , whereby the second constant current generator 37 will be discharging the capacitor 38.

When the two signals on input A and B of the PFD 31 are synchronized or locked, the length of the pulses Q_A and Q_B are the same and the voltage on the VCO 32 input remains unchanged. If the two signals on input A and B of the PFD 31 are out of synchronization, the pulses on one of the outputs Q_A and Q_B of the PFD 31 become longer than the pulses on the other output, thereby either charging or discharging the capacitor 38. This will adjust the input voltage on the VCO 32 to a level where the output frequency of the VCO is synchronized with the data line signal.

10 When starting up the bidirectional digital communication line, e.g. when turning on the hearing aid, or when resetting the communication line, the controller 18 should wait for the PLL to lock, i.e. for the two 8 MHz frequencies to become synchronized. This is the case when the length of the pulses Q_A and Q_B are the same or approximately the same. When this happens, the line_phase is set to
15 A. The ear plug part will now be waiting for a rising edge on the data line. When the controller 18 detects a rising edge on the data line, the phase counter is set to 1. From this point in time the phase counter and the line_phase will continue as shown in figure 4a and 4e, and as described above. In order for this start up procedure to function properly, no data should be transmitted from the ear
20 plug part. This means that the data line signal initially has to look like the signal in figure 3h or 3i, i.e. sending "0" only from the ear plug part to the base part.

Resetting the communication line, and subsequent application of the above start-up procedure, can be initialized if the connection at one or more lines or
25 wires is temporary lost. Such a temporarily loss of connection can be detected by the control circuit 18 of the ear plug electronic module 7. This could be done by checking the voltage over the capacitor 38 in the PLL 19 (see figure 5). The rising edges of the dataline signal stops, this voltage will fall towards zero, and when the control circuit 18 detects this, the ear plug part should stop sending
30 data on the dataline and at the same time the above start-up procedure should be initialized. The control circuit 18 may also be set up for detecting any temporary loss of connection on the power supply wires.

A specific code may be applied for confirming that the clock frequencies are properly synchronized. This code, or a different code, could also be sent with specific time intervals to confirm that the communication is functioning as scheduled. If this code stops, or the time intervals are not properly followed, a reset procedure could also be initialized.

In the above example of the data communication one cycle of the clock frequency is applied for sending one bit from the base part to the ear plug part and one bit from the ear plug part to the base part. The data communication could be arranged in many other ways. The base part could be sending in one clock cycle and the ear plug part could be sending in the next clock cycle, followed by the base part etc. Other options within the embodiments of the invention could be to send e.g. 8 or 16 bits from the base part followed by the same number of bits sent from the ear plug part, again followed by the base part and so on.

Further to sound signals, of which there will often be two, it is preferred also to include other types of information in the data communication. This could be control bits identifying the type of information being sent and identifying the transducer generating the signal. Transducer types other than microphones and receivers could be applied. This could be a thermometer or electrodes for measuring bioelectrical signals from the person wearing the hearing aid.

Also configuration data could be included in the data communication. This could be data identifying the type of ear plug part applied. This would be relevant in the case where different ear plug parts may be applied together with the same base part. A type number identifying the ear plug part could be stored in the control circuit 18 and communicated to the base part, e.g. upon request. Further to this, also status information can be sent via the data line. This could be the status on the clock synchronization.

Figure 6 shows a cross sectional view of an elongated member 40, where a sound tube 41 will take up a major part of the space. The material of which the elongated member 40 is formed is often a polyamide material. The polyamide is often modified by addition of other materials, such as a biocompatible
5 softener.

The wires 42, 43 for power supply lines 15, 17 are preferably fully incorporated in the material forming the elongated member 40 and the sound tube 41. Also the one or more lines 44 forming the data line 16 are preferably fully
10 incorporated in this material. As mentioned the line 44 forming the data line 16 may be one or more electrical wires or it may be one or more optical fibers. In order to keep the outer diameter of the elongated member 40 as small as possible, the number of lines for the data line should preferably be as low as possible, independently of whether electrical wires or optical fibers are applied.

15 A small outer diameter of the elongated member makes the elongated member easier to fit to the ears of most hearing aid users, and a small outer diameter is also preferred by many hearing aid users for cosmetic reasons. Embodiments without sound tube can be made with a considerably smaller outer diameter, or
20 there will be space for more lines for the data line, e.g. two electrical wires or two optical fibers, one line for communication in each direction. However, the plugs connecting the elongated member with the ear plug part and with the base part, respectively, will also take up more space with more wires needing termination.

25 When the data line is arranged as one electrical wire, this may be configured as a pair of twisted wires for a balanced signal. This will reduce the sensibility of the data line to electrical noise.

30 One way of keeping the number of lines for the data line low, preferably at one, is to increase the clock frequency of the two parts of the hearing aid, which will

increase the amount of information which can be submitted per line correspondingly.

5 A digitized sound signal often needs a bandwidth of 32 KHz at a resolution of 16 bit in order to provide a sufficiently high sound quality. This means that a signal of 512 KHz needs to be transferred in each direction when a receiver and a microphone are arranged in the ear plug part. So, with a clock frequency of 8 MHz there will be sufficient capacity for at least two sound signals and for signals of other transducers and for control bits, configuration data and status
10 information.

When adding further transducers to e.g. the ear plug part, where data needs to be transferred through the data line to the base part, further bandwidth of the data line is necessary. Depending on the type of these transducers the amount
15 of data to transfer may vary significantly. If the transducer is a thermometer or an accelerometer for detection of movements, the necessary amount of data for transfer may be relatively limited, whereas when the transducer is one or several EEG signals more data needs to be transferred, but still considerably less than is the case for a sound signal.

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When a number of transducers are comprised in or connected with the ear plug part, the data from these may be collected by the electronic module 7 of the ear plug part and packaged into a format suitable for sending via the data line 16 together with e.g. the digitized sound signal from a microphone 11.

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Claims

1. A hearing aid comprising power supply means and at least one
microphone for transforming an acoustic signal in the surroundings of a
hearing aid user into an electric signal, said hearing aid further
comprising
- a base part to be arranged outside the ear canal of a hearing aid
user, said base part comprising signal processing means,
 - an ear plug part to be arranged in the ear canal of a hearing aid
user, said ear plug part comprising acoustic transmitting means for
transmitting sound into the ear canal, said ear plug part comprising
an ear canal microphone for transforming an acoustic signal in the
ear canal into an electric signal, and the ear plug part further
comprising an electronic module connected to said ear canal
microphone, and
 - an elongated member connecting said ear plug part with said base
part, said elongated member comprising electrical wires adapted
for providing power supply from the base part to the ear plug part,
or, from the ear plug part to the base part,
- wherein the signal from the ear canal microphone is transferred to the
signal processing means in said base part by a serial databus connected
through a data line arranged in said elongated member, said databus
being a one line bidirectional serial databus.
2. A hearing aid according to claim 1, wherein said base part is adapted to
be arranged behind the ear.
3. A hearing aid according to claim 1 or 2, wherein said elongated member
comprises three electrical wires.
4. A hearing aid according to claim 1 or 2, wherein said data line
comprises an optical wave guide.

5. A hearing aid according to any one of the previous claims, wherein said elongated member comprises a sound tube for transferring an acoustic signal from said base part to said ear plug part.
- 5 6. A hearing aid according to any one of the previous claims, wherein said ear plug part comprise at least one receiver unit, where the electric signal for said receiver unit is transmitted as digital communication through said serial databus.
- 10 7. A hearing aid according to claim 6, wherein said receiver unit is adapted for transmitting the high frequency part of the acoustic signal, and a low frequency receiver unit is arranged in the base part and adapted for transmitting the low frequency part of the acoustic signal through a sound tube.
- 15 8. A hearing aid according to any one of the previous claims, wherein said ear plug part comprises an electronic chip connected with the ear canal microphone, said chip being connected with electrical wires of the elongated member.
- 20 9. A hearing aid according to claim 8, wherein said electronic chip comprises a voltage regulator for the power supply of the ear canal microphone.
- 25 10. A hearing aid according to claim 8 or 9, wherein said electronic chip comprises an analogue to digital converter for converting an analogue signal from the ear canal microphone into a digital signal.
- 30 11. A hearing aid according to any one of the claims 10, wherein said analogue to digital converter is a sigma-delta converter.
12. A hearing aid according to any one of the previous claims, wherein a clock frequency generator is arranged in either the base part or in the ear plug part of the hearing aid, and wherein a clock frequency is

regenerated in the part of the hearing aid without clock frequency generator.

13. A hearing aid according to claim 12, wherein said regenerated clock
5 frequency is synchronized with the clock frequency of said clock frequency generator.

14. A hearing aid according to claim 12 or 13, wherein said clock frequency
10 generator is arranged in said base part of the hearing aid.

15. A hearing aid according to claim 13 or 14, wherein said synchronization
is performed by a phase-locked loop.

16. A hearing aid according to any one of the previous claims, wherein said
15 ear plug part is connected with a transducer for measuring a physical or physiological parameter.

17. A hearing aid according to claim 16, wherein said transducer is
20 connected to said electronic module of the ear plug part and is adapted for transferring data to the signal processing means in said base part through the serial databus.

18. A hearing aid according to any one of the previous claims, wherein said
25 one line bidirectional serial databus is applied for data transfer between the base part and the ear plug part and for synchronization of the clock frequency in the two parts.

19. A method for communicating between two parts of a hearing aid
30 comprising power supply means and at least one microphone for transforming an acoustic signal in the surroundings of a hearing aid user into an electric signal, said two parts being connected through at least two wires, said method comprising

- arranging a base part outside the ear canal of a hearing aid user,
said base part comprising signal processing means,
 - arranging an ear plug part in the ear canal of a hearing aid user,
said ear plug part comprising acoustic transmitting means for
transmitting sound into the ear canal, said ear plug part comprising
an ear canal microphone for transforming an acoustic signal in the
ear canal into an electric signal, and the ear plug part further
comprising an electronic module connected to said ear canal
microphone, and
 - connecting said ear plug part with said base part by an elongated
member, said elongated member comprising electrical wires
adapted for providing power supply from the base part to the ear
plug part, or, from the ear plug part to the base part,
- wherein the signal from the ear canal microphone is transferred to the
signal processing means in said base part through a serial databus
connected through a data line arranged in said elongated member, said
databus being a one line bidirectional serial databus.