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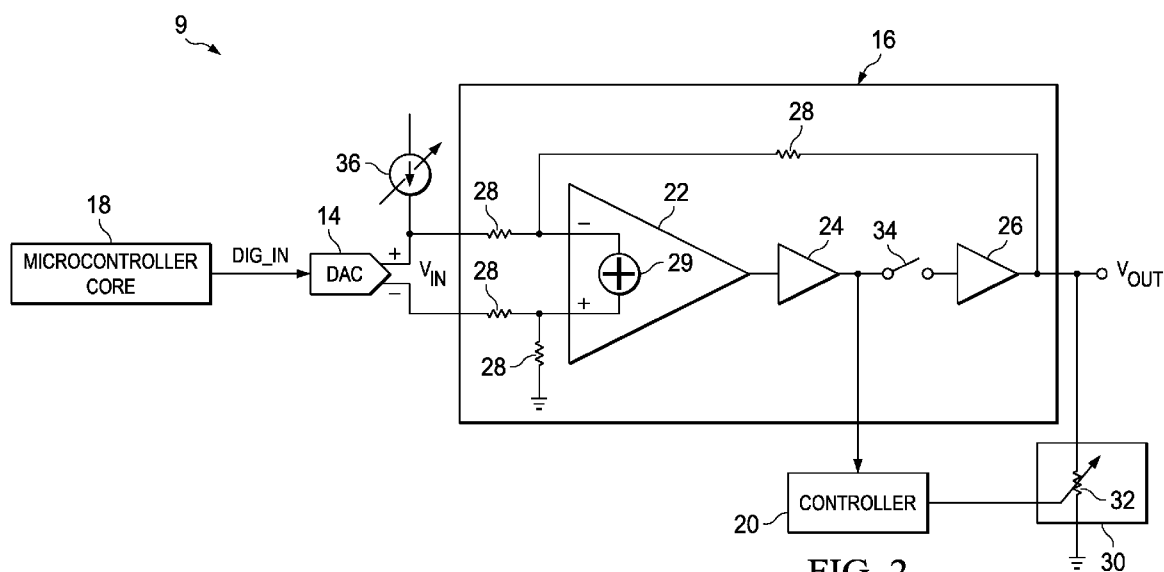


FIG. 2

(57) Abstract: A method may be provided for powering up or down a playback path (9) comprising a digital-to-analog converter (14) for generating a non- ground-centered analog intermediate voltage (VIN) centered at a common-mode voltage and coupled to a driver (16) for generating a ground-centered playback path output voltage (VOUT) at an output of the driver (16) wherein the output of the driver is clamped via a finite impedance (30) to a ground voltage. The method may include transitioning continuously or in a plurality of discrete steps the analog intermediate voltage (VIN) from an initial voltage to the common- mode voltage such that the transitioning is substantially inaudible at the output (VOUT) of the driver (16). A method for operating an output clamp (30) of an output driver stage of a playback path (9) may include transitioning continuously or in a plurality of discrete steps an impedance (32) of the output clamp (30) in order to match an output offset of the output driver stage in order to minimize audio artifacts appearing at an output (VOUT) of the output driver stage (16).

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MINIMIZING STARTUP TRANSIENTS IN AN AUDIO PLAYBACK PATH

FIELD OF DISCLOSURE

The present disclosure relates in general to circuits for audio devices, including
5 without limitation personal audio devices such as wireless telephones and media players,
and more specifically, to systems and methods for minimizing audible effects of electrical
transients during powering on or startup of an audio playback pack.

BACKGROUND

10 Personal audio devices, including wireless telephones, such as mobile/cellular
telephones, cordless telephones, mp3 players, and other consumer audio devices, are in
widespread use. Such personal audio devices may include circuitry for driving a pair of
headphones or one or more speakers. Such circuitry often includes a power amplifier for
driving an audio output signal to headphones or speakers.

15 Using existing approaches, during startup of an audio playback path of a personal
audio device, startup electrical transients of the audio playback path may lead to audible
artifacts (e.g., pops or clicks) perceptible to a listener of the personal audio device.

SUMMARY

20 In accordance with the teachings of the present disclosure, one or more
disadvantages and problems associated with existing audio signal paths may be reduced
or eliminated.

In accordance with embodiments of the present disclosure, a method may be
provided for powering up or down a playback path comprising a digital-to-analog
25 converter (DAC) for generating a non-ground-centered analog intermediate voltage
centered at a common-mode voltage and coupled to a driver for generating a ground-
centered playback path output voltage at an output of the driver wherein the output of the
driver is clamped via a finite impedance to a ground voltage. The method may include
transitioning continuously or in a plurality of discrete steps the analog intermediate
30 voltage from an initial voltage to the common-mode voltage such that the transitioning is
substantially inaudible at the output of the driver.

In accordance with these and other embodiments of the present disclosure, a method for operating an output clamp of an output driver stage of a playback path may include transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the output driver stage in order to minimize audio artifacts appearing at an output of the output driver stage.

In accordance with these and other embodiments of the present disclosure, a playback path may include a digital-to-analog converter (DAC) for generating a non-ground-centered analog intermediate voltage centered at a common-mode voltage, a driver coupled to the DAC for generating a ground-centered playback path output voltage at an output of the driver, an output clamp for clamping the output of the driver to a ground voltage via a finite impedance, and circuitry configured to transition continuously or in a plurality of discrete steps the analog intermediate voltage from an initial voltage to the common-mode voltage such that the transition is substantially inaudible at the output of the driver.

In accordance with these and other embodiments of the present disclosure, a playback path may include a driver for generating a ground-centered playback path output voltage at an output of the driver, an output clamp for clamping the output of the driver to a ground voltage via a finite impedance, and a controller for operating the output clamp by, each time the output clamp is activated or deactivated, transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the driver in order to minimize audio artifacts appearing at an output of the driver.

Technical advantages of the present disclosure may be readily apparent to one skilled in the art from the figures, description and claims included herein. The objects and advantages of the embodiments will be realized and achieved at least by the elements, features, and combinations particularly pointed out in the claims.

It is to be understood that both the foregoing general description and the following detailed description are examples and explanatory and are not restrictive of the claims set forth in this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present embodiments and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIGURE 1 is an illustration of an example personal audio device, in accordance with embodiments of the present disclosure; and

FIGURE 2 is a block diagram of selected components of an example audio integrated circuit of a personal audio device, in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

FIGURE 1 is an illustration of an example personal audio device 1, in accordance with embodiments of the present disclosure. FIGURE 1 depicts personal audio device 1 coupled to a headset 3 in the form of a pair of earbud speakers 8A and 8B. Headset 3 depicted in FIGURE 1 is merely an example, and it is understood that personal audio device 1 may be used in connection with a variety of audio transducers, including without limitation, headphones, earbuds, in-ear earphones, and external speakers. A plug 4 may provide for connection of headset 3 to an electrical terminal of personal audio device 1. Personal audio device 1 may provide a display to a user and receive user input using a touch screen 2, or alternatively, a standard liquid crystal display (LCD) may be combined with various buttons, sliders, and/or dials disposed on the face and/or sides of personal audio device 1. As also shown in FIGURE 1, personal audio device 1 may include an audio integrated circuit (IC) 9 for generating an analog audio signal for transmission to headset 3 and/or another audio transducer.

FIGURE 2 is a block diagram of selected components of an example audio IC 9 of a personal audio device, in accordance with embodiments of the present disclosure. As shown in FIGURE 2, a microcontroller core 18 may supply a digital audio input signal DIG_IN to a digital-to-analog converter (DAC) 14, which may convert the digital audio input signal to an intermediate analog signal V_{IN} .

DAC 14 may supply intermediate analog signal V_{IN} to an amplifier 16 which may amplify or attenuate audio input signal V_{IN} in conformity with a gain to provide an audio output signal V_{OUT} , which may operate a speaker, headphone transducer, a line level signal output, and/or other suitable output. Amplifier 16 may comprise multiple amplifier stages 22, 24, and 26 coupled in succession with one another and a plurality of resistors 28 such that the gain of amplifier 16 is set by the resistances of resistors 28. As shown in FIGURE 2, amplifier 16 may include, due to non-idealities of amplifier 16 (e.g., temperature variations, process tolerances, device mismatch, passive mismatch, etc.), a slight inherent offset 29 from a desired ground or common mode voltage associated with amplifier stage 16, which may affect signal output V_{OUT} . As also shown in FIGURE 2, amplifier 16 may include a switch 34 coupled between amplifier stage 24 and amplifier stage 26. Such switch 34 may be deactivated (e.g., open, off, disabled, etc.) when the playback path implemented by audio IC 9 is powered down, and activated (e.g., closed, on, enabled, etc.) when the playback path is powered on. In some instances, amplifier 16 may also be referred to as a “driver.”

FIGURE 2 also depicts an output clamp 30 having a finite variable resistor 32 coupled between the output of amplifier 16 and ground. When the playback path implemented by audio IC 9 is powered down, a controller (e.g., controller 20) may cause variable resistor 32 to have a low impedance, such that audio output voltage V_{OUT} is forced to approximately ground voltage. When the playback path implemented by audio IC 9 is powered on, a controller (e.g., controller 20) may cause variable resistor 32 to have a high impedance (ideally infinite), such that audio output voltage V_{OUT} may be driven by amplifier 16. In some embodiments, variable resistor 32 may be implemented using a plurality of parallel switches each having a finite impedance, such that an impedance of variable resistor 32 is controlled by selectively activating and deactivating individual switches. Controller 20 may comprise any system, device, or apparatus for controlling clamp 30 and the resistance of variable resistor 32.

In operation, in order to reduce audio artifacts caused by electrical transients occurring at startup of the playback path implemented by audio IC 9, one or more components of audio IC 9 may cause analog intermediate voltage V_{IN} to transition continuously or in a plurality of discrete steps from an initial voltage (e.g., ground

voltage) to a common-mode voltage of DAC 14 such that the transition is substantially inaudible at the output of amplifier 16. When the analog intermediate voltage V_{IN} is transitioned to any non-zero value, a level-shifting current may flow from the output of DAC 14 to the output node of amplifier 36 (e.g., via the network of resistors 28) and through clamp 30. If clamp 30 was an ideal clamp with zero impedance, such current would cause no change in voltage V_{OUT} at the output node of amplifier 16. However, clamp 30, no matter how well constructed or engineered, may have a finite impedance associated with it and when the level-shifting current flows through such impedance, a voltage step in output voltage V_{OUT} may be created at the output. However, in the present disclosure, analog intermediate voltage V_{IN} may be transitioned in a manner in which a sequence of voltage steps created at the output node of amplifier are sufficient to minimize or eliminate audible artifacts. For example, in some embodiments, such transition may be performed by microcontroller core 18 or another component of audio IC 9 forcing digital input signal DIG_IN to DAC 14 to a maximum (e.g., maximum positive or maximum negative value) such that analog intermediate voltage V_{IN} is initially set to the ground voltage when DAC 14 is powered on due to start-up of the playback path, and then microcontroller core 18 may transition digital input signal DIG_IN continuously or in a plurality of discrete steps such that analog intermediate voltage V_{IN} transitions from the initial voltage (e.g., ground voltage) to the common-mode voltage such that the transitioning is substantially inaudible at the output of amplifier 16. In other embodiments, a variable current source 36 (or a plurality of current sources in parallel with each other and DAC 14) may be coupled to the output of DAC 14 and may be configured to increase the current output by such variable current source 36 continuously or in a plurality of discrete steps such that analog intermediate voltage V_{IN} transitions from the initial voltage (e.g., ground voltage) to the common-mode voltage such that the transitioning is substantially inaudible at the output of amplifier 16.

In addition or alternatively, in operation, controller 20 may operate output clamp 30 by, each time the output clamp 30 is activated (e.g., impedance decreased to low impedance upon powering off of playback path) or deactivated (e.g., impedance decreased to low impedance upon powering on of playback path), transitioning continuously or in a plurality of discrete steps variable resistance 32 of output clamp 30 in

order to match voltage offset 29 of amplifier 16 to the audio output signal V_{OUT} in order to minimize audio artifacts appearing at the output of the amplifier 16. In some embodiments, one of stages 22 or 24 of amplifier 16 (shown in FIGURE 2 as stage 24) may in effect be configured as a comparator to compare analog output signal V_{OUT} to voltage offset 29. In other words, by sensing an output of one of the stages of amplifier 16 other than the final output stage 26, the output of such stage 22 or 24 may indicate whether transitioning of the impedance of output clamp 30 has caused audio output signal V_{OUT} to reach a voltage approximately equal to voltage offset 29, and controller 20 may cease the transitioning upon occurrence of audio output signal V_{OUT} reaching a voltage approximately equal to voltage offset 29. In these and other embodiments, controller 20 may be configured to transition variable resistance 32 of output clamp 30 in order to match voltage offset 29 of amplifier 16 to the audio output signal V_{OUT} such that when output clamp 30 is activated or deactivated, audio output signal V_{OUT} experiences no substantial change.

Although the various systems and methods described herein contemplate reduction of audio artifacts in audio paths of personal audio devices, the systems and methods herein may also apply to any other audio systems, including, without limitation, home audio systems, theaters, automotive audio systems, live performances, etc.

This disclosure encompasses all changes, substitutions, variations, alterations, and modifications to the exemplary embodiments herein that a person having ordinary skill in the art would comprehend. Similarly, where appropriate, the appended claims encompass all changes, substitutions, variations, alterations, and modifications to the exemplary embodiments herein that a person having ordinary skill in the art would comprehend. Moreover, reference in the appended claims to an apparatus or system or a component of an apparatus or system being adapted to, arranged to, capable of, configured to, enabled to, operable to, or operative to perform a particular function encompasses that apparatus, system, or component, whether or not it or that particular function is activated, turned on, or unlocked, as long as that apparatus, system, or component is so adapted, arranged, capable, configured, enabled, operable, or operative.

All examples and conditional language recited herein are intended for pedagogical objects to aid the reader in understanding the invention and the concepts contributed by

the inventor to furthering the art, and are construed as being without limitation to such specifically recited examples and conditions. Although embodiments of the present inventions have been described in detail, it should be understood that various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the disclosure.

5

WHAT IS CLAIMED IS:

1. A method for powering up or down a playback path comprising a digital-to-analog converter (DAC) for generating a non-ground-centered analog intermediate voltage centered at a common-mode voltage and coupled to a driver for generating a
5 ground-centered playback path output voltage at an output of the driver wherein the output of the driver is clamped via a finite impedance to a ground voltage, the method comprising:

transitioning continuously or in a plurality of discrete steps the analog intermediate voltage from an initial voltage to the common-mode voltage such that the
10 transitioning is substantially inaudible at the output of the driver.

2. The method of Claim 1, further comprising:

forcing an input signal of the DAC to a maximum such that the analog intermediate voltage is set to the ground voltage; and

15 wherein transitioning comprises transitioning continuously or in a plurality of discrete steps the input signal such that the analog intermediate voltage transitions from an initial voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.

20 3. The method of Claim 1, wherein transitioning comprises transitioning continuously or in a plurality of discrete steps the analog intermediate voltage from the ground voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.

25 4. The method of Claim 1, further comprising operating an output clamp of the driver for clamping the output of the driver via the finite impedance to the ground voltage by, each time the output clamp is activated or deactivated, transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the driver in order to minimize audio artifacts appearing at an
30 output of the driver.

5. The method of Claim 4, wherein the output clamp impedance is matched to the output offset of the driver such that when the output clamp is activated or deactivated, no substantial change occurs in the playback path output voltage.

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6. The method of Claim 4, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, and the method further comprises measuring the output offset by comparing, using one of the plurality of stages other than the output stage, the ground-centered analog output signal to an inherent voltage offset of the driver.

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7. The method of Claim 1, further comprising varying continuously or in a plurality of discrete steps an output offset of the driver to match the output offset of the driver to the playback path output voltage when an output clamp for clamping the output of the driver via the finite impedance to the ground voltage is activated in order to minimize audio artifacts appearing at an output of the driver during such varying, and such that when the output clamp is deactivated, the playback path output voltage is substantially unchanged.

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8. A method for operating an output clamp of an output driver stage of a playback path comprising:

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transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the output driver stage in order to minimize audio artifacts appearing at an output of the output driver stage.

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9. The method of Claim 8, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, the method further comprising measuring the output offset by comparing, using one of the plurality of stages other than the output stage, the clamped ground-centered analog output signal to an inherent voltage offset of the driver.

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10. The method of Claim 8, wherein the output clamp impedance is matched to the output offset of the driver such that when the output clamp is activated or deactivated, no substantial change occurs in the playback path output voltage.

5 11. A playback path comprising:
a digital-to-analog converter (DAC) for generating a non-ground-centered analog intermediate voltage centered at a common-mode voltage;
a driver coupled to the DAC for generating a ground-centered playback path output voltage at an output of the driver;
10 an output clamp for clamping the output of the driver to a ground voltage via a finite impedance; and
circuitry configured to transition continuously or in a plurality of discrete steps the analog intermediate voltage from an initial voltage to the common-mode voltage such that the transition is substantially inaudible at the output of the driver.

15 12. The playback path of Claim 11, wherein the circuitry is configured to:
force an input signal of the DAC to a maximum such that the analog intermediate voltage is set to the ground voltage; and
transition continuously or in a plurality of discrete steps the input signal such that
20 the analog intermediate voltage transitions from an initial voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.

13. The playback path of Claim 11, wherein the circuitry is configured to transition continuously or in a plurality of discrete steps the analog intermediate voltage
25 from the ground voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.

14. The playback path of Claim 11, further comprising a controller for operating the output clamp by, each time the output clamp is activated or deactivated,
30 transitioning continuously or in a plurality of discrete steps an impedance of the output

clamp in order to match an output offset of the driver in order to minimize audio artifacts appearing at an output of the driver.

15 15. The playback path of Claim 14, wherein the controller is configured to transition the impedance to match to the output offset of the driver such that when the output clamp is activated or deactivated, the playback path output voltage experiences no substantial change.

10 16. The playback path of Claim 14, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, and one of the plurality of stages other than the output stage is configured to compare the analog output signal to an inherent voltage offset of the driver.

15 17. The playback path of Claim 11, further comprising a controller for varying continuously or in a plurality of discrete steps an output offset of the driver to match the output offset of the driver to the playback path output voltage when an output clamp for clamping the output of the driver via the finite impedance to the ground voltage is activated in order to minimize audio artifacts appearing at an output of the driver during such varying, and such that when the output clamp is deactivated, the playback path output voltage is substantially unchanged.

18. A playback path comprising:
a driver for generating a ground-centered playback path output voltage at an output of the driver;
25 an output clamp for clamping the output of the driver to a ground voltage via a finite impedance; and
a controller for operating the output clamp by, each time the output clamp is activated or deactivated, transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the driver in order to
30 minimize audio artifacts appearing at an output of the driver.

19. The playback path of Claim 18, wherein the controller is configured to transition the impedance to match to the output offset of the driver such that when the output clamp is activated or deactivated, the playback path output voltage experiences no substantial change.

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20. The playback path of Claim 18, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, and one of the plurality of stages other than the output stage is configured to compare the analog output signal to an inherent voltage offset of the driver.

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AMENDED CLAIMS
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WHAT IS CLAIMED IS:

1. A method for powering up or down a playback path comprising a digital-to-analog converter (DAC) for generating a non-ground-centered analog intermediate
5 voltage centered at a common-mode voltage and coupled to a driver for generating a ground-centered playback path output voltage at an output of the driver, the method comprising:
while the output of the driver is clamped via a finite impedance to a ground
voltage, transitioning continuously or in a plurality of discrete steps the analog
10 intermediate voltage from an initial voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.
2. The method of Claim 1, further comprising:
forcing an input signal of the DAC to a maximum such that the analog
15 intermediate voltage is set to the ground voltage; and
wherein transitioning comprises transitioning continuously or in a plurality of
discrete steps the input signal such that the analog intermediate voltage transitions from
an initial voltage to the common-mode voltage such that the transitioning is substantially
inaudible at the output of the driver.
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3. The method of Claim 1, wherein transitioning comprises transitioning
continuously or in a plurality of discrete steps the analog intermediate voltage from the
ground voltage to the common-mode voltage such that the transitioning is substantially
inaudible at the output of the driver.
25
4. The method of Claim 1, further comprising operating an output clamp of
the driver for clamping the output of the driver via the finite impedance to the ground
voltage by, each time the output clamp is activated or deactivated, transitioning
continuously or in a plurality of discrete steps an impedance of the output clamp in order
30 to match an output offset of the driver in order to minimize audio artifacts appearing at an
output of the driver.

5. The method of Claim 4, wherein the output clamp impedance is matched to the output offset of the driver such that when the output clamp is activated or deactivated, no substantial change occurs in the playback path output voltage.

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6. The method of Claim 4, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, and the method further comprises measuring the output offset by comparing, using one of the plurality of stages other than the output stage, the ground-centered analog output signal to an inherent voltage offset of the driver.

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7. The method of Claim 1, further comprising varying continuously or in a plurality of discrete steps an output offset of the driver to match the output offset of the driver to the playback path output voltage when an output clamp for clamping the output of the driver via the finite impedance to the ground voltage is activated in order to minimize audio artifacts appearing at an output of the driver during such varying, and such that when the output clamp is deactivated, the playback path output voltage is substantially unchanged.

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8. A method for operating an output clamp of an output driver stage of a playback path comprising:

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transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the output driver stage in order to minimize audio artifacts appearing at an output of the output driver stage.

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9. The method of Claim 8, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, the method further comprising measuring the output offset by comparing, using one of the plurality of stages other than the output stage, the clamped ground-centered analog output signal to an inherent voltage offset of the driver.

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10. The method of Claim 8, wherein the output clamp impedance is matched to the output offset of the driver such that when the output clamp is activated or deactivated, no substantial change occurs in the playback path output voltage.

5 11. A playback path comprising:
a digital-to-analog converter (DAC) for generating a non-ground-centered analog intermediate voltage centered at a common-mode voltage;
a driver coupled to the DAC for generating a ground-centered playback path output voltage at an output of the driver;
10 an output clamp for clamping the output of the driver to a ground voltage via a finite impedance; and
circuitry configured to, while the output clamp is activated to clamp the output of the driver to the ground voltage, transition continuously or in a plurality of discrete steps the analog intermediate voltage from an initial voltage to the common-mode voltage such
15 that the transition is substantially inaudible at the output of the driver.

12. The playback path of Claim 11, wherein the circuitry is configured to:
force an input signal of the DAC to a maximum such that the analog intermediate voltage is set to the ground voltage; and
20 transition continuously or in a plurality of discrete steps the input signal such that the analog intermediate voltage transitions from an initial voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.

13. The playback path of Claim 11, wherein the circuitry is configured to
25 transition continuously or in a plurality of discrete steps the analog intermediate voltage from the ground voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver.

14. The playback path of Claim 11, further comprising a controller for
30 operating the output clamp by, each time the output clamp is activated or deactivated, transitioning continuously or in a plurality of discrete steps an impedance of the output

clamp in order to match an output offset of the driver in order to minimize audio artifacts appearing at an output of the driver.

15 15. The playback path of Claim 14, wherein the controller is configured to transition the impedance to match to the output offset of the driver such that when the output clamp is activated or deactivated, the playback path output voltage experiences no substantial change.

10 16. The playback path of Claim 14, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, and one of the plurality of stages other than the output stage is configured to compare the analog output signal to an inherent voltage offset of the driver.

15 17. The playback path of Claim 11, further comprising a controller for varying continuously or in a plurality of discrete steps an output offset of the driver to match the output offset of the driver to the playback path output voltage when an output clamp for clamping the output of the driver via the finite impedance to the ground voltage is activated in order to minimize audio artifacts appearing at an output of the driver during such varying, and such that when the output clamp is deactivated, the playback path output voltage is substantially unchanged.

18. A playback path comprising:
a driver for generating a ground-centered playback path output voltage at an output of the driver;
25 an output clamp for clamping the output of the driver to a ground voltage via a finite impedance; and
a controller for operating the output clamp by, each time the output clamp is activated or deactivated, transitioning continuously or in a plurality of discrete steps an impedance of the output clamp in order to match an output offset of the driver in order to
30 minimize audio artifacts appearing at an output of the driver.

19. The playback path of Claim 18, wherein the controller is configured to transition the impedance to match to the output offset of the driver such that when the output clamp is activated or deactivated, the playback path output voltage experiences no substantial change.

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20. The playback path of Claim 18, wherein the driver comprises a plurality of stages including an output stage for driving the output of the driver, and one of the plurality of stages other than the output stage is configured to compare the analog output signal to an inherent voltage offset of the driver.

STATEMENT UNDER ARTICLE 19(1)**No Waiver**

All of Applicant's arguments herein are without prejudice or disclaimer. Thus, by not responding specifically to specific allegations or statements of the Authority in the International Search Report/Written Opinion, Applicant does not acquiesce to any such allegations or statements, and reserves the right to refute such allegations or statements in response to correspondence received from any patent office or similar authority of any country in which the Applicant may file a corresponding application. Also, Applicant does not acquiesce to any determination by the Authority of the status of any reference as "prior art" that may be cited against the claims of the present application in one or more particular countries in which the Applicant may file a corresponding application.

Claims 1-3, 11-13

In the International Search Report/Written Opinion, at Re Item V 1-2, the Authority asserts that the subject matter of Claims 1 and 11 is not new and novel over each of reference D1, U.S. Pat. App. Pub. 2005/0025322 by Henson *et al.* (hereinafter "D1"), reference D2, U.S. Pat. App. Pub. 2006/0066363 by Ho (hereinafter "D2"), and reference D3, U.S. Pat. App. Pub. 2005/0195991 by Wang *et al.* (hereinafter "D3"). Applicant respectfully traverses these findings, and submits that Claims 1 and 11 are new and novel over D1, D2, and D3 (collectively, "the references"), at least because the references fail to teach "while the output of the driver is clamped via a finite impedance to a ground voltage, transitioning continuously or in a plurality of discrete steps the analog intermediate voltage from an initial voltage to the common-mode voltage such that the transitioning is substantially inaudible at the output of the driver" as recited in Claim 1 and as similarly recited in Claim 11.

For at least these reasons, Claims 1 and 11 are new and novel. Given that Claims 2 and 3 depend from Claim 1 and Claims 12 and 13 depend from Claim 11, Applicant submits that Claims 2, 3, 12, and 13 are also new and novel.

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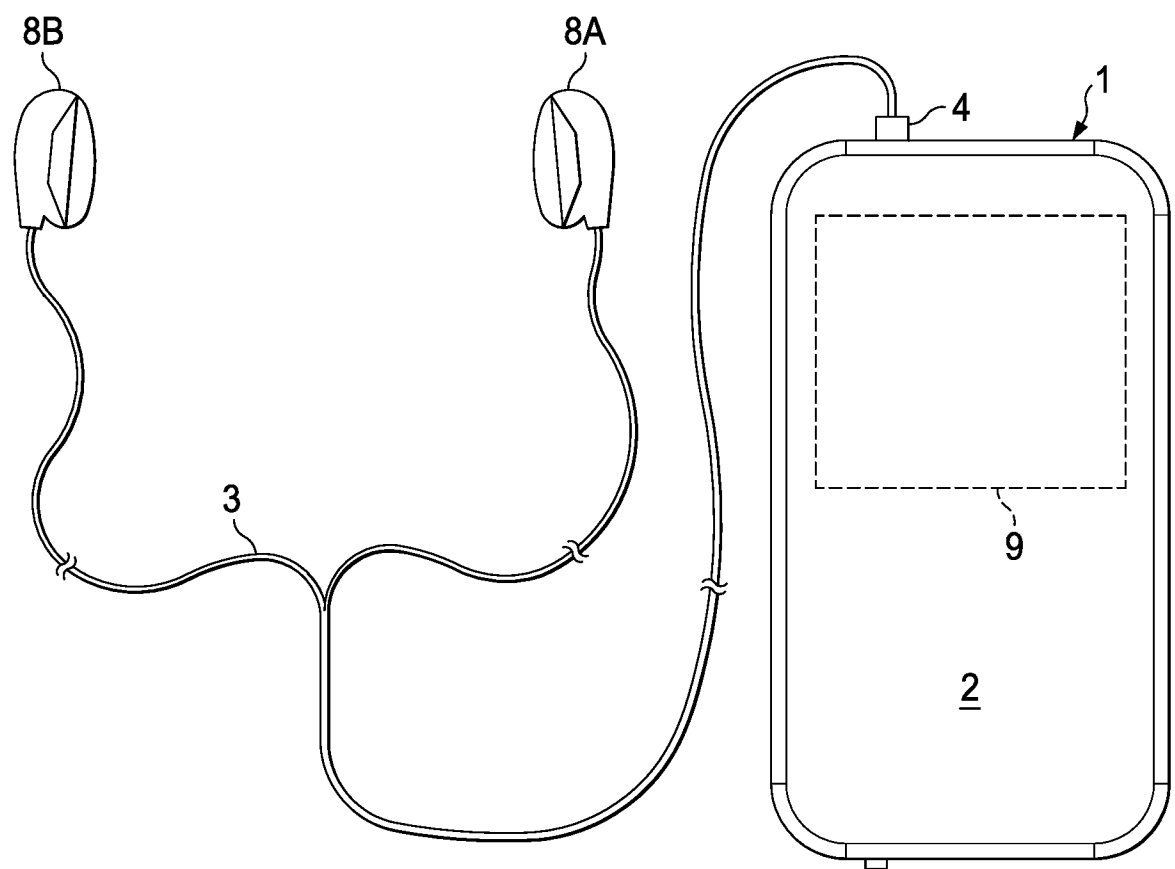
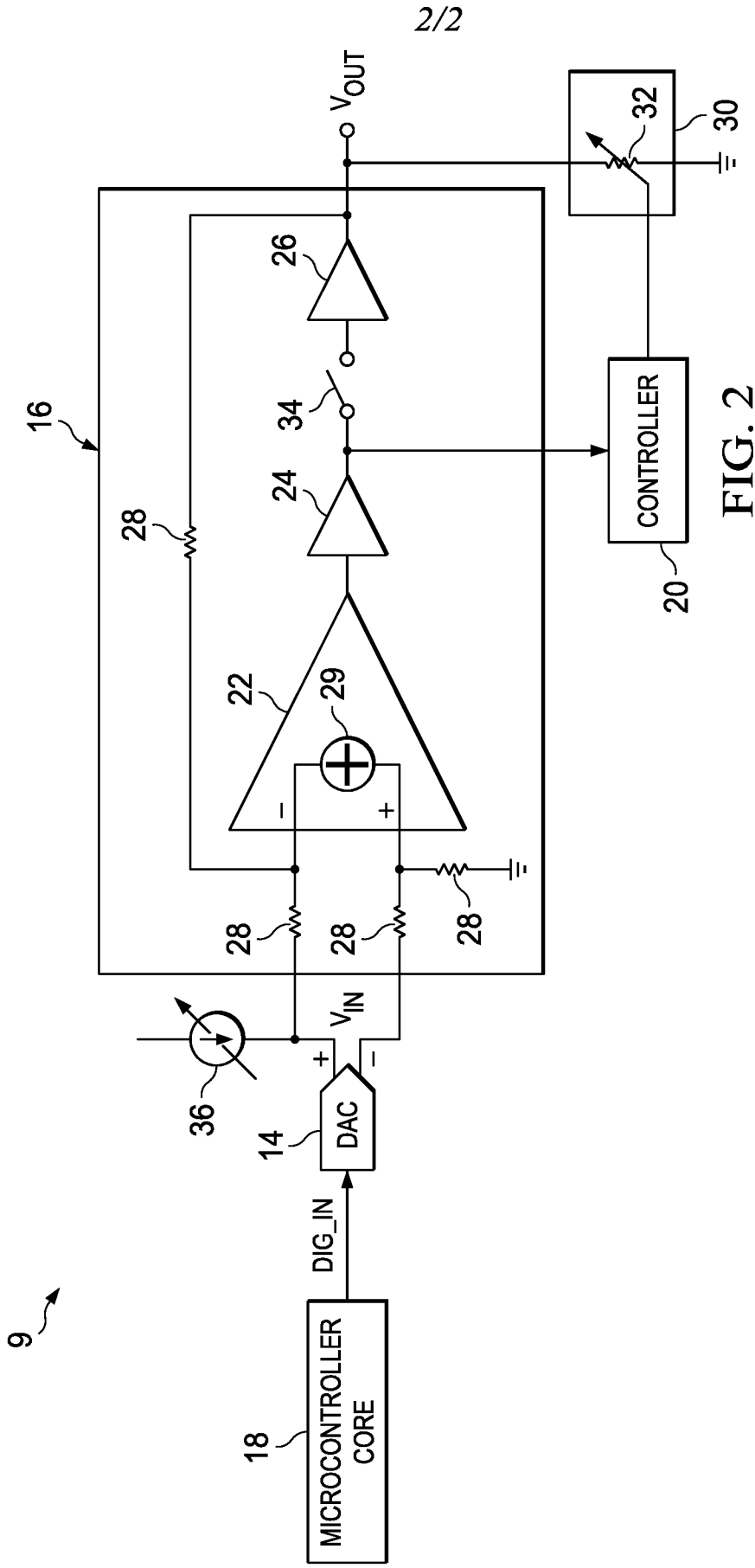


FIG. 1



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/040458

A. CLASSIFICATION OF SUBJECT MATTER INV. H03F1/30 H03F1/34 H03F3/187 H03F3/72 H03M1/66 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H03F H03M		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2005/025322 A1 (HENSON MATTHEW BRADY [US] ET AL) 3 February 2005 (2005-02-03) figures 1-3 abstract paragraphs [0002] - [0008] paragraphs [0019] - [0027] paragraphs [0028] - [0031] -----	1-3, 11-13 4-10, 14-20
X A	US 2006/066363 A1 (HO DANIEL [US]) 30 March 2006 (2006-03-30) figures 2-3 paragraphs [0001] - [0011] paragraphs [0018] - [0025] paragraphs [0027] - [0038] ----- -/-	1-3, 11-13 4-10, 14-20
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search	Date of mailing of the international search report	
13 February 2017	23/02/2017	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Jespers, Michaël	

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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X	US 2005/195991 A1 (WANG YUHE [US] ET AL) 8 September 2005 (2005-09-08)	1-3, 11-13
A	figures 1A, 1B, 2 paragraphs [0002] - [0024] paragraphs [0027] - [0031] -----	4-10, 14-20
A	Mark Ginsberg: "Introduction 2 What Causes Pop in the TPA1517? Pop Reduction for the TPA1517 Audio Power Amplifier", 1 August 2004 (2004-08-01), pages 1-9, XP55342384, Retrieved from the Internet: URL: http://www.ti.com/lit/an/sloa108/sloa108.pdf [retrieved on 2017-02-06] figure 5 page 4, line 1 - page 5, line 9 -----	1-20
A	On Semiconductor: "AN-6044 Pop Suppression Techniques Using Analog Switches Introduction", 18 June 2008 (2008-06-18), XP55342387, Retrieved from the Internet: URL: https://www.fairchildsemi.com/application-notes/AN/AN-6044.pdf [retrieved on 2017-02-06] page 3, lines 16-26 -----	1-20

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Information on patent family members

International application No

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			EP 1723738 A1 22-11-2006
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