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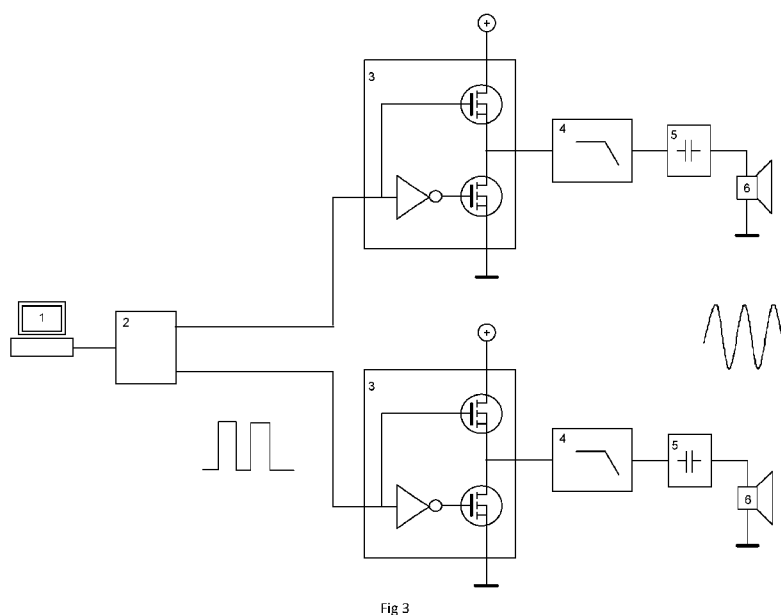
(54) Title: DIGITAL AUDIO AMPLIFICATION SYSTEM

Fig 3

(57) Abstract: The digital audio amplification system described herein uses a pulse density modulation (PDM) encoded 1-bit digital audio signal as the input signal, which is, for example, encoded based on the DSD (Direct Stream Digital) standard or another analogue method, and reproduces it for an acoustic system in an analogue shape, using low-pass filtering, voltage and/or current amplification of digital signals, and, if necessary, conversion of the frequency and/or specification of the time offset of the input signal. The audio amplification system includes a DSD/PDM signal receiving system and a circuit for correcting the time offset of that signal, which can also work as a frequency converter. The achieved PDM signal is directed to a switching circuit, which copies the shape of the input signal with a bigger output current and a voltage amplitude selected by the user. The signal exiting the switch is suitable as an input signal for acoustic systems (speaker, headphones) after low-pass filtering, and the mechanical or electrical parts of the acoustic system it-

self can serve as low-pass filters. The audio amplification system may be an autonomous component or form an integrated whole with an acoustic system (speaker).

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2016/050050

A. CLASSIFICATION OF SUBJECT MATTER

INV. H03F3/181 H03F3/217
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

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	HAWKSFORD MALCOLM J ET AL: "Digital Audio Power Amplifier for DSD Data Streams", AES CONVENTION 117; OCTOBER 2004, AES, 60 EAST 42ND STREET, ROOM 2520 NEW YORK 10165-2520, USA, 1 October 2004 (2004-10-01), XP040507052, the whole document	1,2
X	US 7 061 415 B2 (MAGRATH ANTHONY J [GB]) 13 June 2006 (2006-06-13) column 7, line 16 - line 23; figures 6,7,8 column 10, line 27 - line 32	1,2
X	US 7 479 829 B2 (INOUE TAKAHIRO [JP]) 20 January 2009 (2009-01-20)	1
A	column 6, line 27 - line 39; figure 1	2
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☒ 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

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/237060 A1 (CHO JAE-YONG [KR] ET AL) 20 September 2012 (2012-09-20)	1
A	the whole document	2

X	US 2011/148677 A1 (IHS HASSAN [FR] ET AL) 23 June 2011 (2011-06-23)	1
A	paragraph [0006] - paragraph [0008]; figure 1A	2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/050050

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1, 2

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2

A digital audio amplification system for controlling a speaker system which comprises a DSD signal receiving circuit, a switching stage and an electrical filter, wherein the DSD-encoded signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage.

2. claim: 3

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein the electrical filter is part of the speaker system.

3. claim: 4

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein the audio amplification system is integrated with the speaker system.

4. claim: 5

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein an electrical filter is formed through the electroacoustic and mechanical properties of the speaker system.

5. claim: 6

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein the timing of

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

single bits of the digital input signal has been corrected.

6. claim: 7

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein the bit rate of the digital input signal has been altered.

7. claim: 8

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein it includes a receiving circuit for digital audio signals that are not in the PDM format and a conversion circuit for converting digital audio signals that are not in the PDM format into a PDM format for steering the switching stage, without converting it into an analog signal beforehand.

8. claim: 9

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein it contains a receiving circuit for analogue audio signals, which is connected to a conversion circuit used to convert analog audio signals into a PDM signal that it necessary for steering the switching stage.

9. claim: 10

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein it contains a receiving circuit for receiving audio input signals in a digital format via a data communication channel.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

10. claim: 11

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein the supply voltage circuit of the switching stage comprises a tuned filter.

11. claim: 12

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein the supply voltage is controllable to change the level of analog signals reproduced in the acoustic system.

12. claims: 13, 14

A digital audio amplification system for controlling a speaker system which comprises a pulse density modulated (PDM) signal receiving circuit, a switching stage and an electrical filter, wherein the PDM signal received via the receiving circuit is, in its unprocessed form, used for controlling the switching stage, wherein separately located amplification systems are interconnected by means of a low latency communication channel to improve the timing bits of the modulation signal of such amplification systems.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2016/050050

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			EP 2308171 A2	13-04-2011
			US 2011148677 A1	23-06-2011
			WO 2009153449 A2	23-12-2009
			WO 2009153450 A2	23-12-2009
