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13/413,920 7 March 2012 (07.03.2012) US(71) Applicant (for all designated States except US): **CIRRUS LOGIC, INC.** [US/US]; 800 W 6th St., Austin, TX 78701 (US).(72) Inventors: **HENDRIX, Jon, D.**; 1351 Thompson Ranch Rd., Wimberly, TX 78676 (US). **KAMATH, Gautham, Devendra**; 3004 Larsen Cove, Austin, TX 78748 (US). **KWATRA, Nitin**; 3014 William Cannon Dr., Apt 1435, Austin, TX 78745 (US). **ABDOLLAHZADEH MILANI, Ali**; 7901 Rialto Blvd, Apt 2314, Austin, TX 78735 (US). **ALDERSON, Jeffrey**; 7205 Twilight Mesa Dr, Austin, TX 78735 (US).(74) Agent: **HARRIS, Andrew, Mitchell**; Mitch Harris, Attorney At Law, L.L.C., P.O. Box 7998, Athens, GA 30604 (US).

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[Continued on next page])

(54) Title: AN ADAPTIVE NOISE CANCELING ARCHITECTURE FOR A PERSONAL AUDIO DEVICE

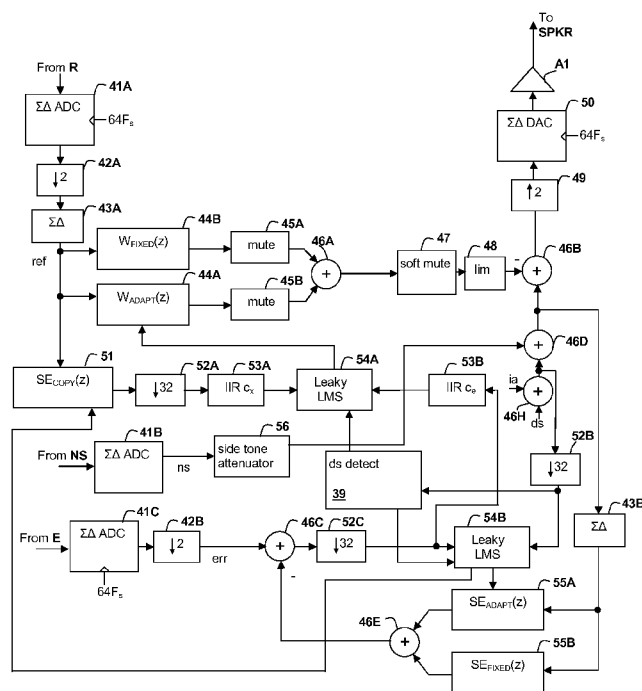


Fig. 4

(57) Abstract: A personal audio device, such as a wireless telephone, includes an adaptive noise canceling (ANC) circuit that adaptively generates an anti-noise signal from a reference microphone signal that measures the ambient audio and an error microphone signal that measures the output of an output transducer plus any ambient audio at that location and injects the anti-noise signal at the transducer output to cause cancellation of ambient audio sounds. A processing circuit uses the reference and error microphone to generate the anti-noise signal, which can be generated by an adaptive filter operating at a multiple of the ANC coefficient update rate. Downlink audio can be combined with the high data rate anti-noise signal by interpolation. High-pass filters in the control paths reduce DC offset in the ANC circuits, and ANC coefficient adaptation can be halted when downlink audio is not detected.



GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

19 September 2013

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/035815

A. CLASSIFICATION OF SUBJECT MATTER

INV. G10K11/178

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)

G10K

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.
Y	US 6 041 126 A (TERAI KENICHI [JP] ET AL) 21 March 2000 (2000-03-21) abstract; figure 1A column 5, lines 5-36	1
X	US 2011/007907 A1 (PARK HYUN JIN [US] ET AL) 13 January 2011 (2011-01-13)	1-12, 19, 20, 22, 23, 25, 26, 28, 29, 31, 32, 34, 35
Y	abstract; figures 14, 22A, 22C, 37A paragraphs [0006], [0095], [0123], [0132], [0133] - [0135] ----- -/-	21, 24, 27, 30, 33, 36



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

18 July 2013

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25/07/2013

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/035815

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.:
1-36
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.:

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: 1-12

Personal audio device with active noise control, wherein power consumption and processing speed requirements are reduced by lowering the adaptive filter update rate

2. claims: 13-18

Personal audio device with active noise control, wherein erroneous secondary-path filter estimation is prevented by adapting the secondary-path filter only when there is source audio

3. claims: 19-36

Personal audio device with active noise control, wherein loudspeaker dynamic range reduction is prevented by a high pass filter

4. claims: 37-42

Personal audio device with active noise control, wherein the required data width of ANC processing circuits is reduced by using a sigma-delta quantizer

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/035815

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2 455 828 A (WOLFSON MICROELECTRONICS PLC [GB]) 24 June 2009 (2009-06-24) abstract; figures 2,3 page 4, line 10 - page 5, line 7 page 8, lines 18-32 -----	1
A	US 2010/124336 A1 (SHRIDHAR VASANT [US] ET AL) 20 May 2010 (2010-05-20) abstract; figure 4 paragraphs [0021], [0022], [0032], [0036], [0038], [0040] -----	1,5,9
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X	US 2010/195844 A1 (CHRISTOPH MARKUS [DE] ET AL) 5 August 2010 (2010-08-05) abstract; figure 7A paragraphs [0007], [0044], [0045], [0049], [0050], [0053], [0061] - [0064] -----	13-18
Y	US 2009/046867 A1 (CLEMOW RICHARD [GB]) 19 February 2009 (2009-02-19) abstract; figures 8-10 paragraphs [0004], [0007], [0050] - [0056] -----	21,24, 27,30, 33,36

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Information on patent family members

International application No

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