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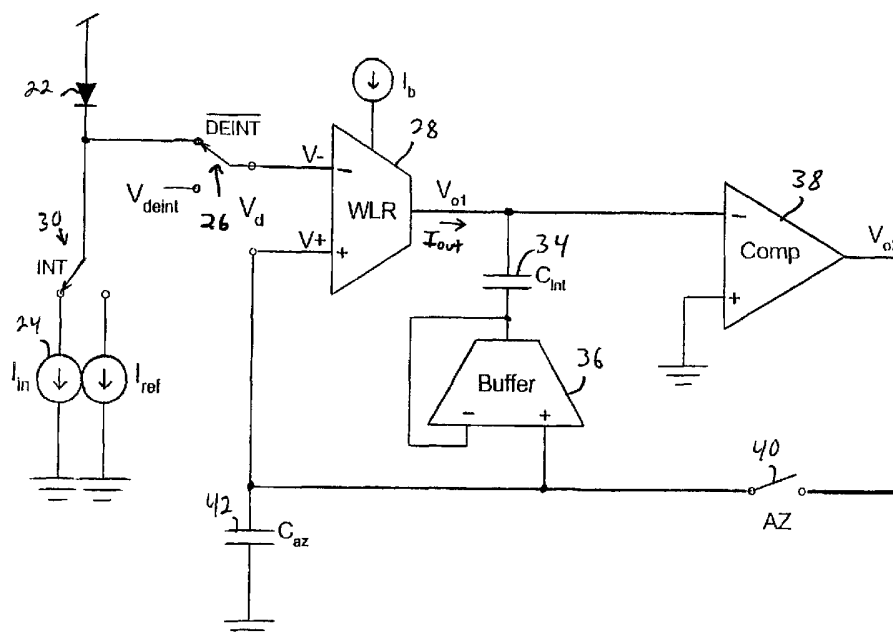
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[Continued on next page]

(54) Title: MICROPOWER LOGARITHMIC ANALOG TO DIGITAL CONVERSION SYSTEM AND METHOD WITH OFF-SET AND TEMPERATURE COMPENSATION



(57) Abstract: A logarithmic analog-to-digital converter system is disclosed. The system includes a transconductor for receiving an input signal and for producing a transconductor output signal at a transconductor output, a logarithmic circuit unit that is coupled to an input of the transconductor, a comparator amplifier for receiving the transconductor output signal and for producing a comparator amplifier output signal at a comparator amplifier output, and an integrating capacitor coupled to the transconductor output signal.



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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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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 practical, search terms used)

EPO-Internal, WPI Data, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	SIT J.J, SARPESHKAR R.: "A Micropower Logarithmic A/D with offset and Temperature Compensation" IEEE JOURNAL OF SOLID-STATE CIRCUITS, vol. 39, no. 2, February 2004 (2004-02), pages 308-319, XP002313182 the whole document	1-33
X	CANTARANO S ET AL: "LOGARITHMIC ANALOG-TO-DIGITAL CONVERTERS: A SURVEY" IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, IEEE INC. NEW YORK, US, vol. IM-22, no. 3, 1 September 1973 (1973-09-01), pages 201-213, XP000676103 ISSN: 0018-9456	1
Y	figure 3 ----- -/--	2-33

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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International Application No

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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	<p>JI_JON SIT: "A Low-power analog logarithmic map circuit with offset and temperature compensation for use in bionic ears"</p> <p>INTERNET ARTICLE, 'Online! September 2002 (2002-09), XP002313184</p> <p>Retrieved from the Internet: URL:/theses.mit.edu/Dienst/UI/2.0/Query/?boolean=and&author=ji-jon+sit&title=&abstract=&authority=0018.mit.etheses&authority=0018.mit.theses&name></p> <p>'retrieved on 2005-01-12!</p> <p>abstract; figures 17,23,66</p>	1,3-15, 17-22, 24-33
Y	<p>US 5 699 004 A (PICCIOTTO CARL E)</p> <p>16 December 1997 (1997-12-16)</p> <p>figure 5</p>	1-33
Y	<p>US 5 652 586 A (CHUH THOMAS Y ET AL)</p> <p>29 July 1997 (1997-07-29)</p> <p>figure 5</p>	1-33
Y	<p>ENZ C C ET AL: "CMOS low-power analog circuit design"</p> <p>CONFERENCE PROCEEDINGS ARTICLE, 1996, pages 79-133, XP010164710</p> <p>paragraph '1.2.2.1!</p>	1-33
Y	<p>ANONYMOUS: "The Integrated A/D Converters (ICL7135)"</p> <p>INTERNET ARTICLE, 'Online! 1999, XP002313185</p> <p>INTERSIL</p> <p>Retrieved from the Internet: URL:http://www.intersil.com/data/an/an017.pdf></p> <p>abstract; figures 3,5</p>	1-33
X	<p>SARPESHKAR R ET AL: "A LOW-POWER WIDE-DYNAMIC-RANGE ANALOG VLSI COCHLEA" ANALOG INTEGRATED CIRCUITS AND SIGNAL PROCESSING, DORDRECHT, NL, vol. 16, August 1998 (1998-08), pages 245-274, XP000864140</p> <p>paragraph '02.1!; figure 1</p>	12,13
Y	<p>TOUMAZOU C ET AL: "Micropower log-domain filter for electronic cochlea"</p> <p>ELECTRONICS LETTERS, IEE STEVENAGE, GB, vol. 30, no. 22, 27 October 1994 (1994-10-27), pages 1839-1841, XP006001275</p> <p>ISSN: 0013-5194</p> <p>figure 1</p>	1-33
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PCT/US2004/023313

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 936 466 A (ANDOH HAJIME ET AL) 10 August 1999 (1999-08-10) figure 10	1-33
A	----- US 6 392 582 B1 (NAKAMURA HIROYUKI) 21 May 2002 (2002-05-21) figure 1	1-33
A	----- SARPESHKAR R ET AL: "AN ANALOG VLSI COCHLEA WITH NEW TRANSCONDUCTANCE AMPLIFIERS AND NONLINEAR GAIN CONTROL" 1996 IEEE INTERNATIONAL SYMPOSIUM ON CIRCUITS AND SYSTEMS (ISCAS). CIRCUITS AND SYSTEMS CONNECTING THE WORLD. ATLANTA, MAY 12 - 15, 1996, IEEE INTERNATIONAL SYMPOSIUM ON CIRCUITS AND SYSTEMS (ISCAS), NEW YORK, IEEE, US, vol. VOL. 3, 12 May 1996 (1996-05-12), pages 292-295, XP000688857 ISBN: 0-7803-3074-9 figure 1	1-33
A	----- US 5 592 168 A (LIAO TSUOE-HSIANG) 7 January 1997 (1997-01-07) figure 5	1-33
A	----- US 6 396 430 B1 (LI QUNYING) 28 May 2002 (2002-05-28) figure 4 -----	1-33

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/023313

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5699004	A	16-12-1997	NONE	
US 5652586	A	29-07-1997	NONE	
US 5936466	A	10-08-1999	NONE	
US 6392582	B1	21-05-2002	JP 11214998 A EP 0932047 A1 US 6150967 A	06-08-1999 28-07-1999 21-11-2000
US 5592168	A	07-01-1997	NONE	
US 6396430	B1	28-05-2002	NONE	