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H03M 1/16 (2006.01)

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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

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GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, 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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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))

(54) Title: ALIAS REJECTION IN ANALOG-TO-DIGITAL CONVERTERS (ADCs)

(57) Abstract: Techniques and apparatus for alias rejection in analog-to-digital converters (ADCs), in which only a portion of the ADC is operated at a higher sampling rate than other portions of the ADC, thereby preventing aliasing, but saving power. One example ADC circuit generally includes a first circuit portion configured to operate at a first clock rate equal to a sampling rate of the ADC circuit; and a second circuit portion configured to operate at a second clock rate higher than the sampling rate of the ADC circuit.

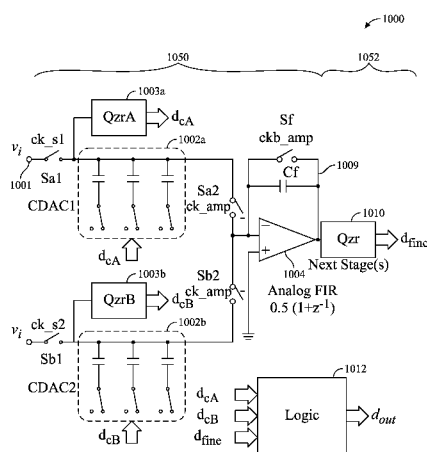


FIG. 10

(88) Date of publication of the international search report:
10 May 2024 (10.05.2024)

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. H03M1/06 ADD. H03M1/16 H03M1/46				
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) 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, COMPENDEX, INSPEC, IBM-TDB, 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	DONG LIRAN ET AL: "A 2-GS/s 200-MHz BW Oversampling Continuous-Time Pipeline ADC with Adaptive Digital Filter in 28nm", 2021 IEEE INTERNATIONAL CONFERENCE ON INTEGRATED CIRCUITS, TECHNOLOGIES AND APPLICATIONS (ICTA), IEEE, 24 November 2021 (2021-11-24), pages 245-246, XP033996982, DOI: 10.1109/ICTA53157.2021.9661855 ISBN: 978-1-6654-1745-7 [retrieved on 2021-12-22] Section I, Section II; figures 1,3 ----- -/-	1-12, 22-32, 42		
<table><tr><td>☒ Further documents are listed in the continuation of Box C.</td><td>☒ See patent family annex.</td></tr></table>			☒ Further documents are listed in the continuation of Box C.	☒ See patent family annex.
☒ Further documents are listed in the continuation of Box C.	☒ See patent family annex.			
<table><tr><td>* 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</td><td>"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</td></tr></table>			* 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
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Date of the actual completion of the international search 28 March 2024		Date of mailing of the international search report 12/04/2024		
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 Jesus, Paulo		

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2023/073998

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MANIVANNAN SARAVANA KUMAR ET AL: "Improved Multistage Continuous-Time Pipelined Analog-to-Digital Converters and the Implicit Decimation Property", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS I: REGULAR PAPERS, IEEE, US, vol. 69, no. 8, 1 August 2022 (2022-08-01) , pages 3102-3113, XP011915388, ISSN: 1549-8328, DOI: 10.1109/TCSI.2022.3173563 [retrieved on 2022-05-27] figure 10 -----	1, 23
X	EP 2 744 112 A2 (DUST NETWORKS INC) 18 June 2014 (2014-06-18) paragraphs [0016], [0025] - [0031]; figures 5A, 5B, 6C -----	1, 13-21, 23, 33-41
X	WHITCOMBE AMV ET AL: "A Dual-Mode Configurable RF-to-Digital Receiver in 16NM FinFET", 2018 IEEE SYMPOSIUM ON VLSI CIRCUITS, IEEE, 18 June 2018 (2018-06-18), pages 23-24, XP033427755, DOI: 10.1109/VLSIC.2018.8502392 [retrieved on 2018-10-22] page 23; figures 1-3 -----	1, 13-21, 23, 33-41
A	EP 3 720 002 A1 (NXP BV [NL]) 7 October 2020 (2020-10-07) paragraphs [0038] - [0040]; figure 5 -----	1-42
A	PARK SHINWOONG ET AL: "A Low-Power, High-Linearity Wideband 3.25 GS/s Fourth-Order Programmable Analog FIR Filter Using Split-CDAC Coefficient Multipliers", IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, IEEE, USA, vol. 68, no. 4, 1 April 2020 (2020-04-01), pages 1576-1590, XP011781464, ISSN: 0018-9480, DOI: 10.1109/TMTT.2020.2967388 [retrieved on 2020-04-02] figures 2, 3 ----- -/--	1-42

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2023/073998

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	OH SEIN ET AL: "A 80dB DR 6MHz Bandwidth Pipelined Noise-Shaping SAR ADC with 1-2 MASH structure", 2020 IEEE CUSTOM INTEGRATED CIRCUITS CONFERENCE (CICC), IEEE, 22 March 2020 (2020-03-22), pages 1-4, XP033762138, DOI: 10.1109/CICC48029.2020.9075929 [retrieved on 2020-04-21] Section II; figure 3 -----	1-42

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/073998

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.:

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, 22-32, 42

Implementation of inter-stage and digital signal reconstruction features of a pipelined ADC.

2. claims: 13-21, 33-41

Implementation of an anti-aliasing filter.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2023/073998

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
EP 2744112	A2	18-06-2014	CN	103873058 A		18-06-2014
			EP	2744112 A2		18-06-2014
			TW	201436471 A		16-09-2014
			US	2014168000 A1		19-06-2014

EP 3720002	A1	07-10-2020	CN	111800132 A		20-10-2020
			EP	3720002 A1		07-10-2020
			US	10630304 B1		21-04-2020
