

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
5 June 2008 (05.06.2008)

PCT

(10) International Publication Number  
WO 2008/067149 A3

(51) International Patent Classification:  
H03M 13/27 (2006.01) H03M 13/29 (2006.01)

(21) International Application Number:  
PCT/US2007/084390

(22) International Filing Date:  
12 November 2007 (12.11.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/867,899 30 November 2006 (30.11.2006) US  
11/683,024 7 March 2007 (07.03.2007) US

(71) Applicant (for all designated States except US): **MO-TOROLA, INC.** [US/US]; 1303 East Algonquin Road, Schaumburg, Illinois 60196 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **NIMBALKER, Ajit** [IN/US]; 1120 E. Algonquin Road, Apt. 3E, Schaumburg, Illinois 60173 (US). **BLANKENSHIP, Yufei, W.** [CN/US]; 21910 Pine Lake Circle, Kildeer, Illinois 60047 (US). **CLASSON, Brian, K.** [US/US]; 756 Bloomfield Court, Palatine, Illinois 60067 (US).

(74) Agents: **HAAS, Kenneth, A.** et al.; 1303 East Algonquin Road, Schaumburg, Illinois 60196 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:  
28 August 2008

(54) Title: TURBO-ENCODING WITH CONTENTION-FREE INTERLEAVERS

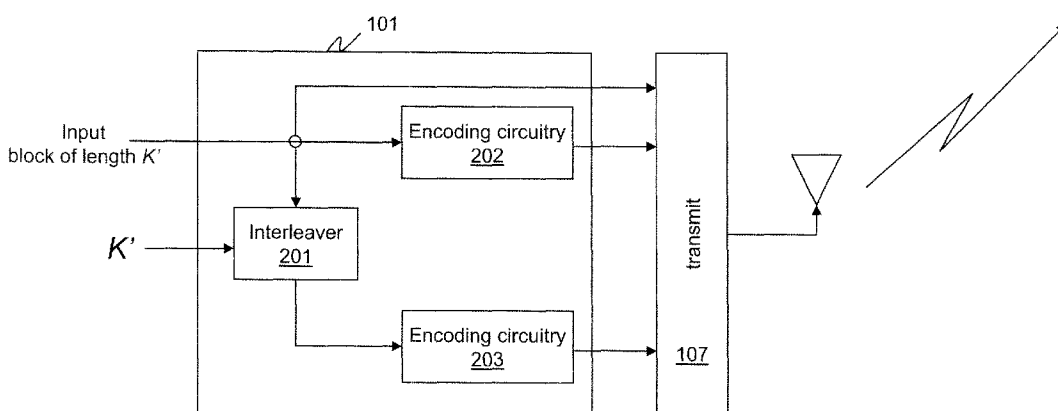


FIG. 2

(57) Abstract: Methods and apparatus for turbo encoding are provided herein. During operation of the turbo encoder (101) the size of the turbo interleaver (201) is determined in dependence on the information block size and the appropriate interleaving parameters are selected. These parameters configure the turbo interleaver, which is a contention-free interleaver and which is based on either a quadratic permutation polynomial QPP interleaver or an almost regular permutation ARP interleaver. If the information block size does not match a supported interleaver size, then the information block is padded by means of filler bits insertion.

WO 2008/067149 A3

# INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/084390

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. H03M13/27 H03M13/29

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 practical, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ERICSSON: "Quadratic Permutation Polynomial Interleavers for LTE Turbo Coding" TDOC R1-063137 OF 3GPP TSG RAN WG 1 MEETING #47, [Online] 10 November 2006 (2006-11-10), pages 1-5, XP002473949 Riga, Latvia Retrieved from the Internet: URL: <a href="http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_47/Docs/">http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_47/Docs/</a> [retrieved on 2008-03-26]	1,5
A	page 1 - page 2 ----- -/--	2,4,6,8

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 document 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.
- \*8\* document member of the same patent family

Date of the actual completion of the international search

27 March 2008

Date of mailing of the international search report

11/07/2008

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
 Fax: (+31-70) 340-3016

Authorized officer

Burkert, Frank

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/084390

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>MOTOROLA: "Code Block Segmentation for Contention-Free Turbo Interleavers"  TDOC R1-063062 OF TSG RAN WG 1 MEETING #47, [Online]  10 November 2006 (2006-11-10), pages 1-4, XP002473950  Riga, Latvia  Retrieved from the Internet:  URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_47/Docs/&gt;  [retrieved on 2008-03-26]  page 1 - page 2</p>	1,5
P,X	<p>MOTOROLA: "Contention-Free Interleaver Designs for LTE Turbo Codes"  TDOC R1-070054 OF 3GPP TSG RAN WG 1 MEETING #47BIS, [Online]  19 January 2007 (2007-01-19), pages 1-9, XP002473951  Sorrento, Italy  Retrieved from the Internet:  URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_47bis/Docs/&gt;  [retrieved on 2008-03-26]  pages 1,2,5,7,  table 3</p>	1,2,4-6, 8
A	<p>ROSNES E ET AL: "Optimum distance quadratic permutation polynomial-based interleavers for turbo codes"  PROC. 2006 IEEE INTERNATIONAL SYMPOSIUM ON INFORMATION THEORY,  9 July 2006 (2006-07-09), - 14 July 2006 (2006-07-14) pages 1988-1992, XP002473952  Seattle, USA  ISBN: 1-4244-0504-1  page 1988 - page 1990  tables 1,2</p>	1,2,4-6, 8
A	<p>TAKESHITA O Y: "On maximum contention-free interleavers and permutation polynomials over integer rings"  IEEE TRANSACTIONS ON INFORMATION THEORY  IEEE USA,  vol. 52, no. 3, March 2006 (2006-03),  pages 1249-1253, XP002473953  ISSN: 0018-9448  the whole document</p>	1,2,4-6, 8

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2007/084390

## 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 allsearchable 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, 4, 5, 8 (and 2, 6)

### 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: 1,4,5,8 (and 2,6)

Independent claims 1, 4, 5 and 8 and the claims dependent thereon effectively relate to turbo encoding using a so-called quadratic permutation polynomial (QPP) interleaver, wherein the interleaving rule is determined by a polynomial over an integer ring. Said claims define the parameters of such an interleaver.

---

2. claims: 3,7

Independent claims 3 and 7 effectively relate to turbo-encoding using a so-called almost regular permutation (ARP) interleaver, which is based on a circular permutation based on congruence properties. Said claims define parameters of such an interleaver.

---