

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶: H04H 1/00, H04L 5/02, 27/26</p>	<p>A3</p>	<p>(11) International Publication Number: WO 99/50980</p> <p>(43) International Publication Date: 7 October 1999 (07.10.99)</p>
<p>(21) International Application Number: PCT/US99/04328</p> <p>(22) International Filing Date: 24 February 1999 (24.02.99)</p> <p>(30) Priority Data: 09/049,210 27 March 1998 (27.03.98) US</p> <p>(71) Applicant: USA DIGITAL RADIO, INC. [US/US]; 8865 Stanford Boulevard, Columbia, MD 21045 (US).</p> <p>(72) Inventors: KROEGER, William; 12813 Amberwoods Way, Sykesville, MD 21784 (US). CAMMARATA, Denise, Maureen; 12087 Long Lake Drive, Owings Mill, MD 21117 (US). MARTINSON, Richard, Edward; 906 High Stepper Trail, Sykesville, MD 21784 (US). BAIRD, Jeffrey, Scott; 19882 Olde Woods Way, Columbia, MD 21044 (US). PEYLA, Paul, James; 6528 Meadowfield Court, Elkridge, MD 21075 (US). WALDEN, E., Glynn; 14 Landings Drive, Marlton, NJ 08053 (US).</p> <p>(74) Agent: LENART, Robert, L.; CBS Corporation, 11 Stanwix Street, Pittsburgh, PA 15222 (US).</p>	<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW. ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW). Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM). European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p>(88) Date of publication of the international search report: 18 November 1999 (18.11.99)</p>	
<p>(54) Title: HYBRID AND ALL DIGITAL FM IN-BAND-ON-CHANNEL DIGITAL AUDIO BROADCASTING METHOD AND SYSTEM</p>		
<p>(57) Abstract</p> <p>This invention provides a method of broadcasting including the steps of providing a broadcast signal in a central frequency band of an FM radio channel; providing a first plurality of sub-carriers in an upper sideband of the FM radio channel; providing a second plurality of sub-carriers in a lower sideband of the FM radio channel; modulating a first group of the first plurality of sub-carriers with a complementary punctured convolution coded version of program material; modulating a first group of the second plurality of sub-carriers with the complementary punctured convolution coded version of the program material; and transmitting the broadcast signal, the first group of the first plurality of sub-carriers and the first group of the second plurality of sub-carriers. In an all-digital version of the invention, the central frequency band may include a plurality of sub-carriers transmitted at a lower power level than that of the sub-carriers in the upper and lower sidebands. These additional sub-carriers can be used to transmit additional data. Transmitters and receivers which utilized the method are also included.</p>		

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INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 99/04328

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04H1/00 H04L5/02 H04L27/26

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)

IPC 6 H04H H04L

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BRIAN KROEGER, DENISE CAMMARATA: "Robust modem and coding techniques for FM hybrid IBOC DAB" IEEE TRANSACTIONS ON BROADCASTING, vol. 43, no. 4, December 1997 (1997-12), pages 412-420, XP002104794 the whole document	1-13, 19, 21
A	—	14, 20, 22
X	BRIAN W. KROEGER, PAUL J. PEYLA: "Compatibility of FM Hybrid in-band on-channel (IBOC) system for digital audio broadcasting" IEEE TRANSACTIONS ON BROADCASTING, vol. 43, no. 4, December 1997 (1997-12), pages 421-430, XP002104795 the whole document	1-13, 19, 21
	— -/-	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

1 September 1999

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/04328

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	W0 97 49207 A (KUMAR DEREK D) 24 December 1997 (1997-12-24) abstract page 61, line 7 - line 23 page 66, line 17 - page 67, line 26 page 106, line 17 - page 108, line 25 claims 1,2,6,7,11,13,15-17 figures 4,9	1-13, 19, 21
A	— BRIAN W. KROEGER AND D.SC. PAUL J. PEYLA : "Robust IBOC DAB AM and FM Technology for digital audio broadcasting" 51ST ANNUAL BROADCAST ENGINEERING CONFERENCE (NAB), April 1997 (1997-04), XP002104796 Las Vegas, Nevada the whole document	14,20,22
X	— US 5 315 583 A (MURPHY JOHN L ET AL) 24 May 1994 (1994-05-24) cited in the application abstract column 1, line 56 - column 2, line 10 column 3, line 37 - column 4, line 30 column 7, line 44 - line 60 figure 3	1,19,21
X	— R.L. CUPO, M. SARRAF, M. SHARIAT, M. ZARRABIZADEH: "An OFDM all digital in-band on-channel (IBOC) AM and FM radio solution using the PAC encoder" IEEE TRANSACTIONS ON BROADCASTING, vol. 44, no. 1, March 1998 (1998-03), pages 22-27, XP002113456 abstract paragraph '0004! figures 7-9	14,20,22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/04328

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 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 fee, this Authority did not invite payment of any additional fee.
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.
- ☒ 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: 1-13 19 21

Hybrid analog/digital in-band on-channel digital audio broadcast

2. Claims: 14-18 20 22

All digital in-band on-channel digital audio broadcast

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/04328

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9749207 A	24-12-1997	AU 3307197 A	07-01-1998
US 5315583 A	24-05-1994	NONE	