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#### Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

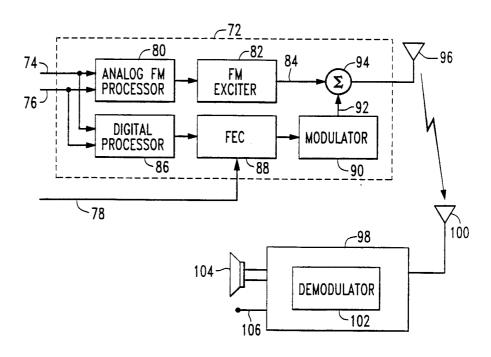
(88) Date of publication of the international search report:

18 November 1999 (18.11.99)

# (54) Title: HYBRID AND ALL DIGITAL FM IN-BAND-ON-CHANNEL DIGITAL AUDIO BROADCASTING METHOD AND SYSTEM

### (57) Abstract

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 encoded 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.

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A CLASS IPC 6	SIFICATION OF SUBJECT MATTER H04H1/00 H04L5/02 H04L27	//26	
According	to international Patent Classification (IPC) or to both national class	ification and IPC	
	8 SEARCHED		
Minimum of IPC 6	documentation searched (classification system followed by classifi HO4H HO4L	cation symbols)	
Document	ation searched other than minimum documentation to the extent th	at such documents are included	in the fields searched
Electronic	data base consulted during the international search (name of data	base and, where practical, sean	ch terms used)
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X	BRIAN KROEGER, DENISE CAMMARATA modem and coding techniques for IBOC DAB" IEEE TRANSACTIONS ON BROADCASTI	1-13,19, 21	
	vol. 43, no. 4, December 1997 ( pages 412-420, XP002104794		
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X Funt	ther documents are listed in the continuation of box C.	X Patent family member	ers are listed in annex.
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	actual completion of the international search	Date of mailing of the inte	•
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Inter onal Application No PCT/US 99/04328

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	ntion) DOCUMENTS CONSIDERED TO BE RELEVANT	•
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 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	1-13,19, 21
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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

In....ational 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:
Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
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
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.  X  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

information on patent family members

Inter mal Application No PCT/US 99/04328

Patent document cited in search report		Publication date	Patent family member(s)		Publication date	
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US 5315583	A	24-05-1994	NONE			