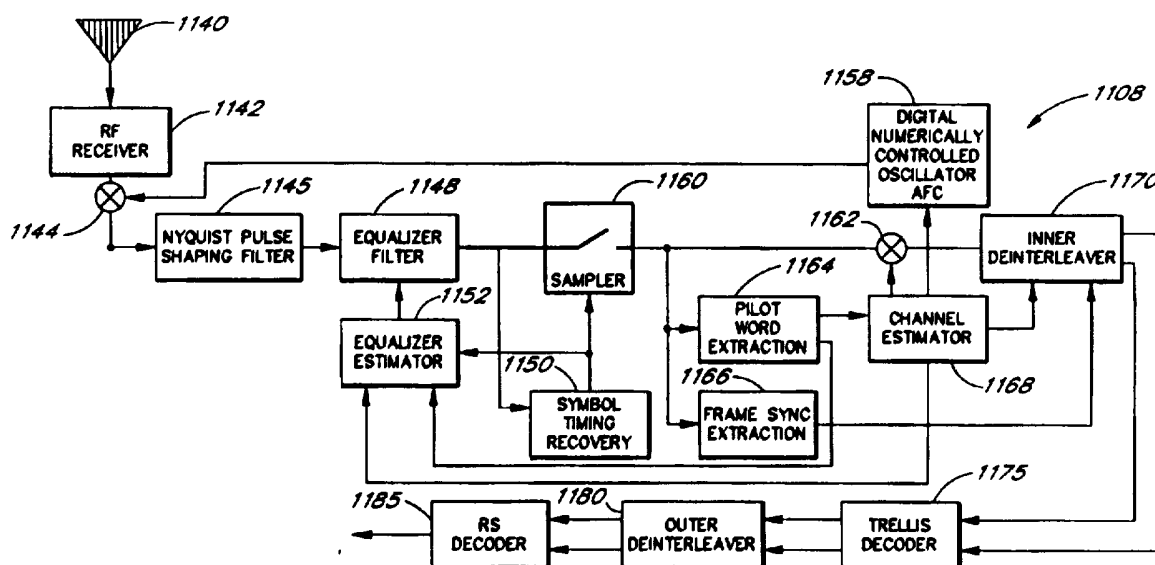




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/US95/15368 (22) International Filing Date: 22 November 1995 (22.11.95) (30) Priority Data: 08/344,156 23 November 1994 (23.11.94) US (71) Applicant: AT & T WIRELESS SERVICES, INC. [US/US]; 5000 Carillon Point, Kirkland, WA 98033-9760 (US). (72) Inventors: ALAMOUTI, Siavash, M.; Suite D-325, 8935 160th Avenue NE, Redmond, WA 98052 (US). WRIGHT, S., Andrew; Suite 310, 1432 W. 10th Avenue, Vancouver, British Columbia V6H 1J9 (CA). HAYMOND, William, D.; 17673 24th Avenue, Surrey, British Columbia V4P 1MP (CA). (74) Agent: SEWELL, Jerry, T.; Knobbe, Martens, Olson and Bear, Suite 1600, 620 Newport Center Drive, Newport Beach, CA 92660 (US).		(81) Designated States: AL, AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, LS, MW, SD, SZ, UG). 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: 8 August 1996 (08.08.96)

(54) Title: TRELLIS CODED 16 STAR QAM WITH REED-SOLOMON CODING



(57) Abstract

A cellular communication system provides for trellis encoding/decoding of a 16 Star QAM signal. The system includes a transmitter circuit and a receiver circuit. The transmitter circuit has a Reed-Solomon encoder, an outer interleaver circuit for spreading burst errors, a cyclic trellis encoder, an inner interleaver circuit for reducing channel memory, a 16 Star QAM mapper and a radio frequency transmitter. The receiver circuit has a radio frequency receiver, equalization and filtering circuitry and timing and synchronization recovery circuitry. The receiver also has an inner deinterleaver, a trellis decoder, an outer deinterleaver, and a Reed-Solomon decoder.

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INTERNATIONAL SEARCH REPORT

Inter- national Application No
PCT/US 95/15368

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L27/34

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 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.
	- / - -	

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

☐ Patent family members are listed in annex.

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- * & * document member of the same patent family

Date of the actual completion of the international search

31 May 1996

Date of mailing of the international search report

13. 06. 96

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 95/15368

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	IEE PROCEEDINGS I, vol. 138, no. 3, June 1991, STEVENAGE, GB, pages 169-175, XP000237261 WEBB ET AL.: "Bandwidth efficient QAM schemes for Rayleigh fading channels" see figures 1,4,5 see abstract see page 169, right-hand column, line 4 - page 170, left-hand column, line 1 see page 173, left-hand column, paragraph 3 - paragraph 4 see page 173, left-hand column, paragraph 5 - right-hand column, paragraph 1 see page 174, paragraph 3 see page 174, left-hand column, paragraph 4 - page 175, left-hand column, paragraph 1	1,2,4-6, 8,9,17, 18,23, 25-27, 29,30, 32,34
Y	---	3,7, 10-16, 19,28
X	IEEE TRANSACTIONS ON INFORMATION THEORY, vol. 36, no. 5, September 1990, pages 1101-1110, XP000141844 LIU ET AL.: "Error probability for digital transmission over nonlinear channels with application to TCM" see figure 3 see page 1105, right-hand column, paragraph 5 - page 1106, left-hand column, paragraph 1	1,4,5, 17,23, 25,26, 29,32,34
A	---	2,8,9,30
Y	ELECTRONICS LETTERS, vol. 29, no. 20, 30 September 1993, pages 1746-1748, XP002000431 ZEIN ET AL.: "Optimum erasure threshold in Reed-Solomon coded differential 16 star-QAM modulation" see abstract; figure 1	3,7, 10-16, 19,28
A	---	1,6,17, 18,23, 25,27, 29,32,34
A	EUROPEAN TRANSACTIONS ON TELECOMMUNICATIONS AND RELATED TECHNOLOGIES, vol. 4, no. 5, September 1993, MILANO IT, pages 495-510, XP000424081 HANZO ET AL.: "On QAM speech transmission schemes for microcellular mobile PCNs" see abstract; figure 2 ---	1-34
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INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/US 95/15368

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	IEE PROCEEDINGS I, vol. 140, no. 4, August 1993, STEVENAGE GB, pages 269-276, XP000389915 DIMAKIS ET AL.: "Performance evaluation of concatenated coding schemes on multilevel QAM signalling in non-Gaussian products environment" see figure 1 see page 270, left-hand column, paragraph 3 - right-hand column, paragraph 2 ---	1-34
A	EUROPEAN TRANSACTIONS ON TELECOMMUNICATIONS, vol. 4, no. 3, May 1993, MILAN, IT, pages 243-256, XP000385751 EYUBOGLU ET AL.: "Advanced modulation techniques for V.fast" see page 247, right-hand column, paragraph 2 - paragraph 6 ---	1-34
A	IEICE TRANSACTIONS, vol. E74, no. 8, August 1991, pages 2220-2229, XP000268457 SPENLER ET AL.: "Differentially coherent TC-PSK with subset dilation" see figures 3-5 see page 2222, left-hand column, paragraph 2 - paragraph 4 ---	1-34
A	41ST IEEE VEHICULAR TECHNOLOGY CONFERENCE, 19 - 22 May 1991, NEW YORK, US, pages 511-516, XP000260231 WEBB ET AL.: "Does 16-QAM provide an alternative to a half-rate GSM speech codec?" see abstract ---	1-34
A	IEEE COMMUNICATIONS MAGAZINE, vol. 30, no. 12, December 1992, NEW YORK, US, pages 90-95, XP000330093 WEBB: "Modulation methods for PCNs" see figure 1 -----	1-34

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 95/15368

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:

1. claims 1,4-7,10,17-29,31-34: use of Trellis coded modulation in systems with a star shaped signal constellation;
2. claims 2,8,9,30: transmission in a cellular radio network;
3. claims 3,11-16: various synchronisation aspects.

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.