



[54] MULTIPLE ACCESS CODING FOR RADIO COMMUNICATIONS

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[58] Field of Search 375/1; 380/34, 37, 36, 380/49, 50

[56] References Cited

U.S. PATENT DOCUMENTS

- 4,052,565 10/1977 Baxter et al.
4,134,071 1/1979 Ohnsorge
4,293,953 10/1981 Gutleber
4,455,662 6/1984 Gutleber
4,470,138 9/1984 Gutleber
4,568,915 2/1986 Gutleber
4,644,560 2/1987 Torre et al.
4,901,307 2/1990 Gilhousen et al.
4,930,140 5/1990 Cripps et al.
4,933,952 6/1990 Albrieux et al.
4,984,247 1/1991 Kaufmann et al.
5,022,049 6/1991 Abrahamson et al.
5,048,057 9/1991 Saleh et al.
5,048,059 9/1991 Dent
5,056,109 10/1991 Gilhousen et al.
5,060,266 10/1991 Dent
5,091,942 2/1992 Dent
5,101,501 3/1992 Gilhousen et al.
5,103,459 4/1992 Gilhousen et al.
5,109,390 4/1992 Gilhousen et al.
5,136,612 8/1992 Bi
5,151,919 9/1992 Dent
5,159,608 10/1992 Falconer et al.

FOREIGN PATENT DOCUMENTS

- 336832 10/1989 European Pat. Off.
2172777 9/1986 United Kingdom

OTHER PUBLICATIONS

Tzannes, N. S., Communication and Radar Systems, N.J.: Prentice-Hall, Inc., 1985, pp. 227-239.
Stremmer, F. G., Introduction to Communication Systems, Mass.: Addison-Wesley Publishing Co., 1982, pp. 406-418.
'Introduction to Spread-Spectrum Antimultipath Techniques and Their Application to Urban Digital Radio', G. Turin, Proceedings of the IEEE, vol. 68, No. 3, Mar. 1980.

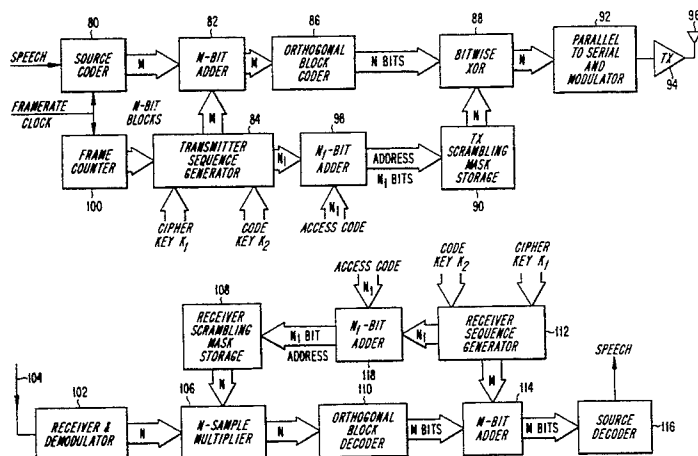
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[57] ABSTRACT

Individual information signals encoded with a common block error-correction code are assigned a unique scrambling mask, or signature sequence, taken from a set of scrambling masks having selected correlation properties. The set of scrambling masks is selected such that the correlation between the modulo-2 sum of two masks with any codeword in the block code is a constant magnitude, independent of the mask set and the individual masks being compared. In one embodiment, when any two masks are summed using modulo-2 arithmetic, the Walsh transformation of that sum results in a maximally flat Walsh spectrum. For cellular radio telephone systems using subtractive CDMA demodulation techniques, a two-tier ciphering system ensures security at the cellular system level by using a pseudorandomly generated code key to select one of the scrambling masks common to all of the mobile stations in a particular cell. Also, privacy at the individual mobile subscriber level is ensured by using a pseudorandomly generated ciphering key to encipher individual information signals before the scrambling operation.

67 Claims, 9 Drawing Sheets



OTHER PUBLICATIONS

"A Communication Technique for Multipath Channels", R. Price et al., *Proceedings of the IRE*, Mar. 1958, pp. 555-570.

"Fading Channel Communications", P. Monsen, *IEEE Communications Magazine*, Jan. 1980, pp. 16-25.

Proakis, J. G., *Digital Communications*, N.Y.: McGraw-Hill 1989, pp. 728-739.

"Origins of Spread-Spectrum Communications", Scholtz, *IEEE Transactions on Communications*, vol. COM-30, No. 5, May 1982, pp. 18-21.

"Very Low Rate Convolutional Codes for Maximum Theoretical Performance of Spread-Spectrum Multiple-Access Channels" A Viterbi, *IEEE Journal on Selected Areas in Communications*, vol. 8, No. 4, May 1990.

MacWilliams, F., *The Theory of Error-Correcting Codes, Part I and II*, N.Y.: North-Holland, 1988, pp. 93-124, 451-465.

"A Class of Low-Rate Nonlinear Binary Codes", A. Kerdock, *Information and Control*, vol. 20, pp. 182-187 (1972).

Tatsuro Masamura, "Spread Spectrum Multiple Access System with Intrasystem Interference Cancellation," *Transactions on the Institute of Electronics, Information & Communication Engineers*, vol. E 71, No. 3, Mar. 1988, pp. 224-231.

Mahesh K. Varanasi et al., "An Iterative Detector for Asynchronous Spread-Spectrum Multiple-Access Systems," *Proceedings of the IEEE Global Telecommunications Conference*, vol. 1, Nov. 28-Dec. 1, 1988, pp. 556-560.

Ryuji Kohno et al., "Adaptive Cancellation of Interference in Direct-Sequence Spread-Spectrum Multiple Access Systems," *Proceedings of the IEEE/IEICE Global Telecommunications Conference*, vol. 1, Nov. 15-18, 1987, pp. 630-634.

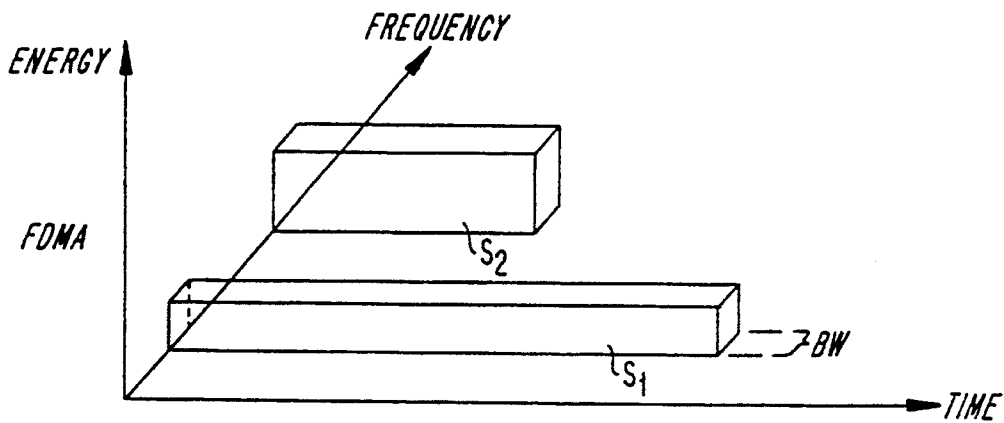


Fig. 1a

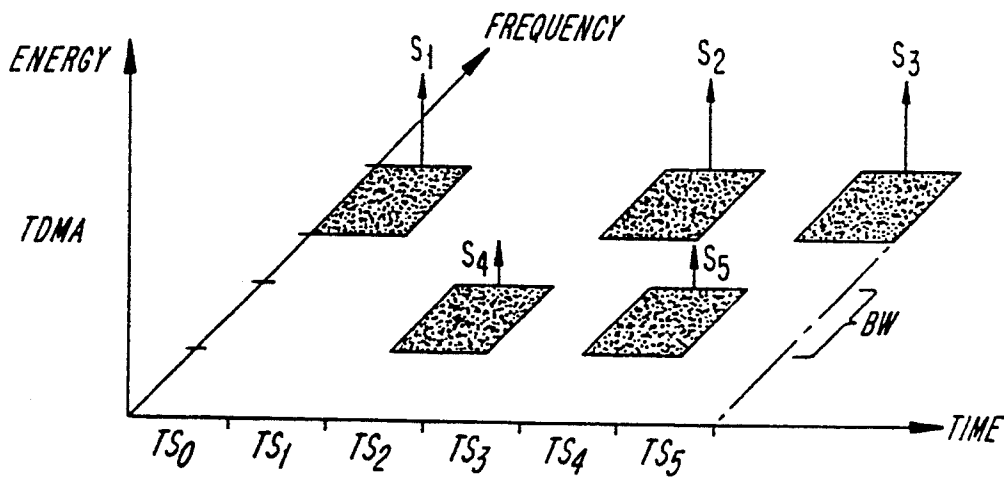


Fig. 1b

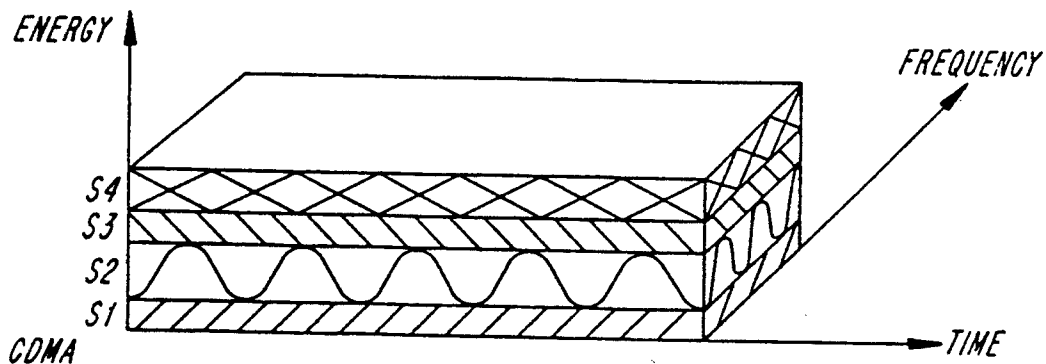


Fig. 1c

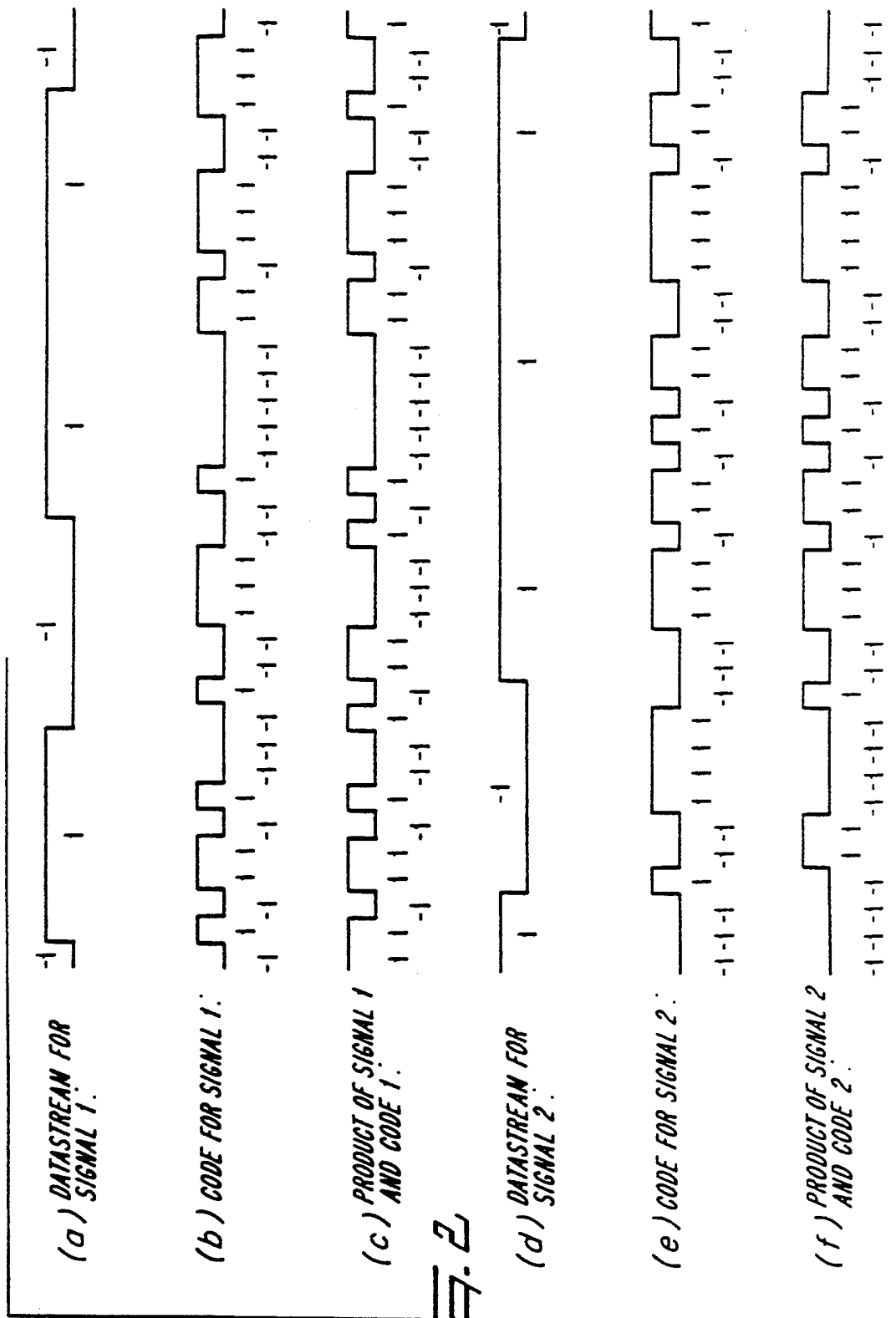


FIG. 2

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