

- [54] **TECHNIQUE FOR MITIGATING RAIN FADING IN A SATELLITE COMMUNICATIONS SYSTEM USING QUADRATURE PHASE SHIFT KEYING**
- [75] Inventors: **Itzhak Gurantz**, San Diego; **David A. Wright**, Solana Beach, both of Calif.
- [73] Assignee: **Comstream Corporation**, San Diego, Calif.
- [21] Appl. No.: **894,316**
- [22] Filed: **Aug. 7, 1986**
- [51] Int. Cl.⁴ **H04J 11/0; H04B 15/00**
- [52] U.S. Cl. **370/20; 375/1; 375/102; 375/38; 380/34**
- [58] **Field of Search** **375/67, 39, 38, 102, 375/1; 370/19, 20, 21, 110.1, 85; 380/34**

Sons, 1976, pp. 6-7, 128-131, 138-145, 177, 205-209, 265-272, 276-277, 283-285.
 Philipp Hartl, "Fernwirktechnik der Raumfahrt", (Telecontrol Technology in Astronautics), Springer-Verlag, 1977, pp. 155-161, (including translation from German to English).
 James Martin, "Communication Satellite Systems", Prentice Hall, Inc., 1978, pp. 22, 53, 142-147, 189, 358-359, 365-367.
 Report 708 of the comite Consultatif International des Radiocommunications (CCIR), Geneve, 1978, vol. IV, 4.2.4, p. 131.
 Tares, et al., "Systems for Telecommunications by Satellite", 1978, pp. 78-79, (including translation from French to English).

(List continued on next page.)

Primary Examiner—Robert L. Griffin
Assistant Examiner—Andrew J. Telesz, Jr.
Attorney, Agent, or Firm—Knobbe, Martens, Olson & Bear

[56] **References Cited**
U.S. PATENT DOCUMENTS

3,035,169	5/1962	Griffith	455/10
3,365,666	1/1968	Reynders et al.	455/10
3,652,802	3/1972	Schellenberg	370/84
3,676,778	7/1972	Mori	455/13
3,681,694	8/1972	Sarati	340/147 SC
3,896,382	7/1975	Magenheim	455/12
4,135,156	1/1979	Sanders, Jr. et al.	455/12
4,261,053	4/1981	Dostis et al.	375/67
4,287,598	9/1981	Langseth et al.	455/52
4,309,764	1/1982	Acampora	370/83
4,427,995	1/1984	Naito	455/3
4,455,651	6/1984	Baran	375/1
4,528,674	7/1985	Sweeney et al.	375/102
4,601,046	7/1986	Halpern et al.	375/102

OTHER PUBLICATIONS

Walter R. Braun and William C. Lindsey, "Carrier Synchronization Techniques for Unbalanced QPSK Signals—Part I", IEEE Transactions on Communications, vol. Com-26, No. 9, Sep. 1978, pp. 1325-1333.
 Walter R. Braun and William C. Lindsey, "Carrier Synchronization Techniques for Unbalanced QPSK Signals—Part II", IEEE Transactions on Communications, vol. Com-26, No. 9, Sep. 1978, pp. 1334-1341.
 R. C. Dixon, "Spread Spectrum Systems," John Wiley &

ABSTRACT

A system for data communication between ground stations using an orbiting satellite as a relay includes a technique for avoiding the loss of signals from the satellite during periods of heavy precipitation. Data is communicated from an orbiting satellite to a plurality of earth stations on a single transmission frequency. The data is communicated on two separate transmission channels on that one frequency by using orthogonal channels of a coherent phase quadrature transmission system. The overall data rate on one of the two transmission channels is much lower than the overall data rate on the other of the two channels. The data on the lower data rate channel is less likely to be affected by heavy precipitation occurring in the line of sight between the satellite and the ground station, and the lower data rate channel is thus used to communicate data to a ground station located in an area of heavy precipitation. The lower data rate channel is further used to maintain phase synchronization so that the probability of losing phase synchronization with the signal transmitted by the satellite is significantly reduced.

13 Claims, 10 Drawing Sheets

