

United States Patent [19]

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McGibney

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- [54] **OFDM TIMING AND FREQUENCY RECOVERY SYSTEM**
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- [52] **U.S. Cl.** **370/207; 375/261; 375/331; 375/344; 455/208; 455/517**
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5,506,836 4/1996 Ikeda et al. 370/203

FOREIGN PATENT DOCUMENTS

653 858 A2 11/1994 European Pat. Off. H04L 5/06
 656 706 A2 11/1994 European Pat. Off. H04L 5/06

OTHER PUBLICATIONS

Implementation of a High Performance Wireless LAN, Grant McGibney, Abu Sesay, John McRory, Brad Morris, TR Labs, Calgary, Alberta, Canada, conference proceedings of "Wireless 94", Jul. 11-13, 1994, Calgary, pp. 645-650.

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[57] **ABSTRACT**

A synchronizing apparatus for a differential OFDM receiver that simultaneously adjust the radio frequency and sample clock frequency using a voltage controlled crystal oscillator to generate a common reference frequency. Timing errors are found by constellation rotation. Subcarrier signals are weighted by using complex multiplication to find the phase differentials and then the timing errors. The reference oscillator is adjusted using the timing errors. Slow frequency drift may be compensated using an integral of the timing error. Frequency offset is found using the time required for the timing offset to drift from one value to another.

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,679,227	7/1987	Hughes-Hartogs	.....	379/93.31
5,206,886	4/1993	Bingham	.....	375/344
5,345,440	9/1994	Gledhill et al.	.....	370/210
5,369,670	11/1994	Zagloul et al.	.....	370/210
5,406,551	4/1995	Saito et al.	.....	370/203
5,444,697	8/1995	Leung et al.	.....	370/207

16 Claims, 5 Drawing Sheets

