

United States Patent [19]
McGibney

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[54] **OFDM TIMING AND FREQUENCY RECOVERY SYSTEM**

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Related U.S. Application Data

[62] Division of application No. 08/696,315, Aug. 13, 1996, Pat. No. 5,889,759.

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[52] **U.S. Cl.** 370/208; 370/210; 370/207; 370/203; 370/206; 375/326; 375/344; 375/260

[58] **Field of Search** 370/208, 210, 370/207, 203, 206, 18, 19, 20; 375/326, 344, 260, 97, 98, 118, 119, 80, 84

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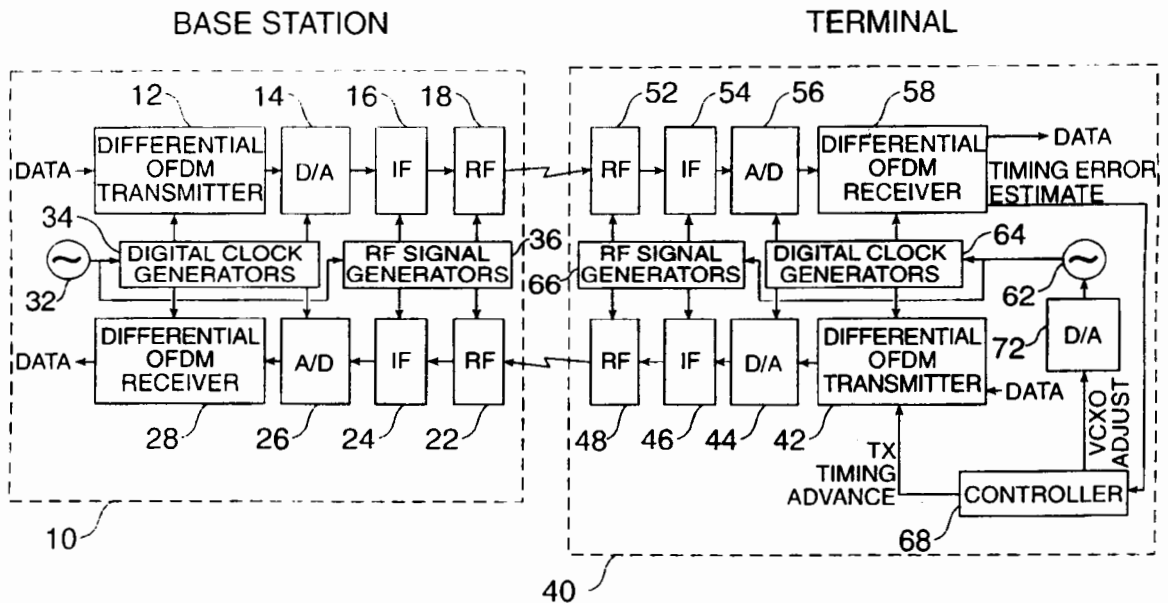
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[57] **ABSTRACT**

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.

10 Claims, 5 Drawing Sheets



United States Patent [19]

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Davies et al.

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[54] **HYBRID SINGLE SIDEBAND OPTICAL MODULATOR**

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[52] **U.S. Cl.** 359/183; 359/181; 359/188; 359/279; 385/2; 385/3

[58] **Field of Search** 359/183, 181, 359/188, 276, 279; 385/2, 3

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[57] **ABSTRACT**

Bandwidth reduction methods and apparatus that offset the effects of dispersion on a signal transmitted through an optical fiber. The apparatus and methods employ a generator of modulated optical signals in cascade with a modulator. One of the generator and the modulator may be an optical intensity or amplitude modulator and the other a phase (or frequency) modulator. With the application of specific signals, the cascaded generator and modulator produce an optical signal with reduced energy in one half of the transmission bandwidth. One important benefit in the method is the fact that by exploiting the less obvious spectral characteristics of single sideband signals, a simple modulator design is achieved. All of the designs exploit a method of generating analytic signals via hybrid modulation.

26 Claims, 8 Drawing Sheets

