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(54) **TIMING AND FREQUENCY OFFSET ESTIMATION SCHEME FOR OFDM SYSTEMS BY USING AN ANALYTIC TONE**

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H04J 11/00   (2006.01)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,802,117	A *	9/1998	Ghosh	375/344
5,991,289	A *	11/1999	Huang et al.	370/350
6,021,110	A *	2/2000	McGibney	370/208
6,058,101	A *	5/2000	Huang et al.	370/208
6,198,782	B1 *	3/2001	De Courville et al.	375/341
6,285,654	B1 *	9/2001	Marchok et al.	370/208
6,332,008	B1 *	12/2001	Giallorenzi et al.	375/356
6,353,642	B1 *	3/2002	Asahara et al.	375/344
6,363,084	B1 *	3/2002	Dejonghe	370/480
6,373,861	B1 *	4/2002	Lee	370/503
6,393,073	B1 *	5/2002	Eilts	375/340
6,400,782	B1 *	6/2002	Tal et al.	375/350
6,418,158	B1 *	7/2002	Vishwanath et al.	375/139
6,470,030	B1 *	10/2002	Park et al.	370/480
6,487,252	B1 *	11/2002	Kleider et al.	375/260
6,538,986	B1 *	3/2003	Isaksson et al.	370/207
6,539,063	B1 *	3/2003	Peyla et al.	375/267
6,614,864	B1 *	9/2003	Raphaeli et al.	375/371
6,643,336	B1 *	11/2003	Hsieh et al.	375/343
6,647,066	B1 *	11/2003	Szajnowski	375/260
6,678,339	B1 *	1/2004	Lashkarian	375/341
6,714,511	B1 *	3/2004	Sudo et al.	370/208
6,765,969	B1 *	7/2004	Vook et al.	375/259
6,807,241	B1 *	10/2004	Milbar et al.	375/343
6,891,792	B1 *	5/2005	Cimini et al.	370/206
2002/0065047	A1 *	5/2002	Moose	455/63

FOREIGN PATENT DOCUMENTS

WO   WO 00/77961 A1   12/2000

* cited by examiner

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(57) **ABSTRACT**

A timing and frequency offset estimation method for OFDM use an analytic tone in calculating timing offset estimation and a frequency offset estimation. An analytic tone includes a signal that contains only one subcarrier and has characteristics of a uniform magnitude and a uniform phase rotation. The estimation algorithm with an analytic tone is based correlation function. By changing the interval between two samples in correlation, the maximum estimation range for the frequency offset can be extended to ±N/2 subcarrier spacing, where N is the number of total subcarriers. Thus, the frequency synchronization scheme for OFDM systems has a wider range and a more simple complexity than traditional ones requiring separate fine and coarse synchronization.
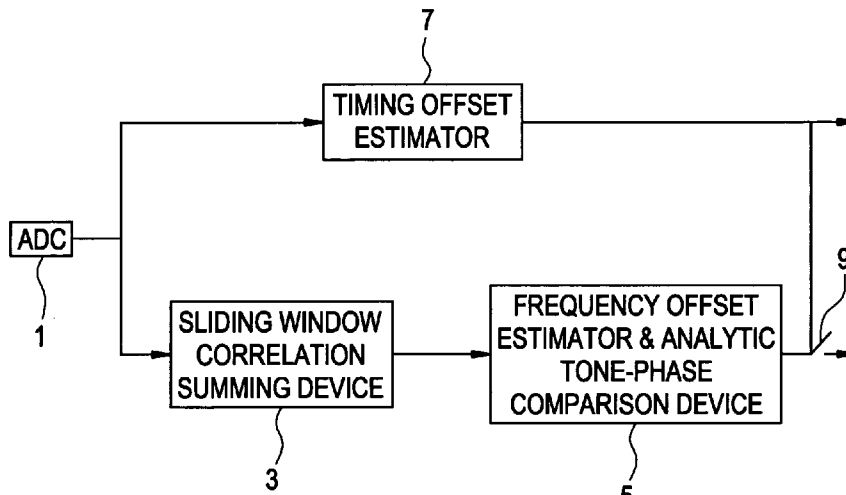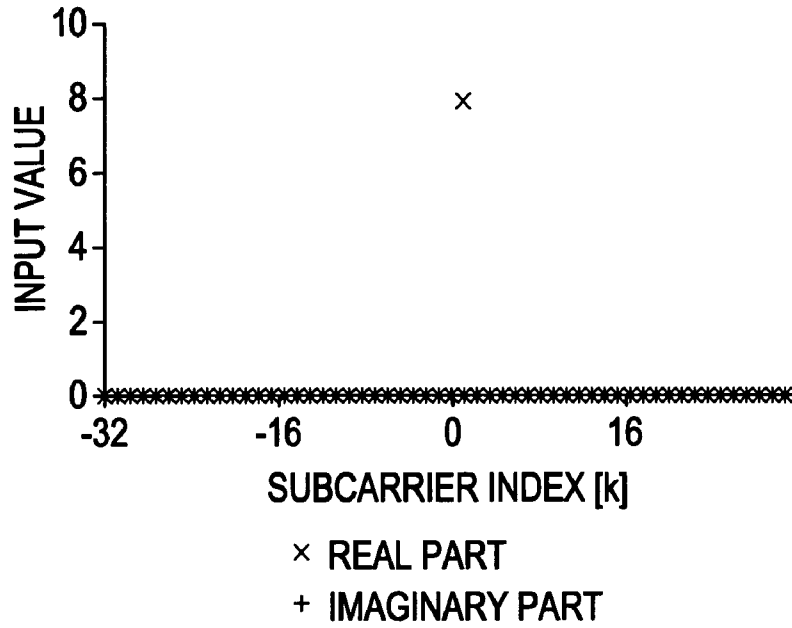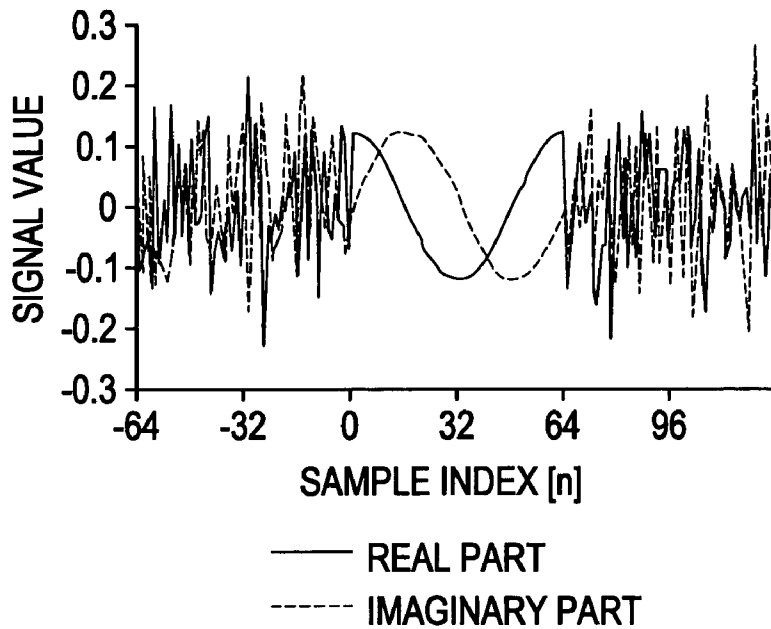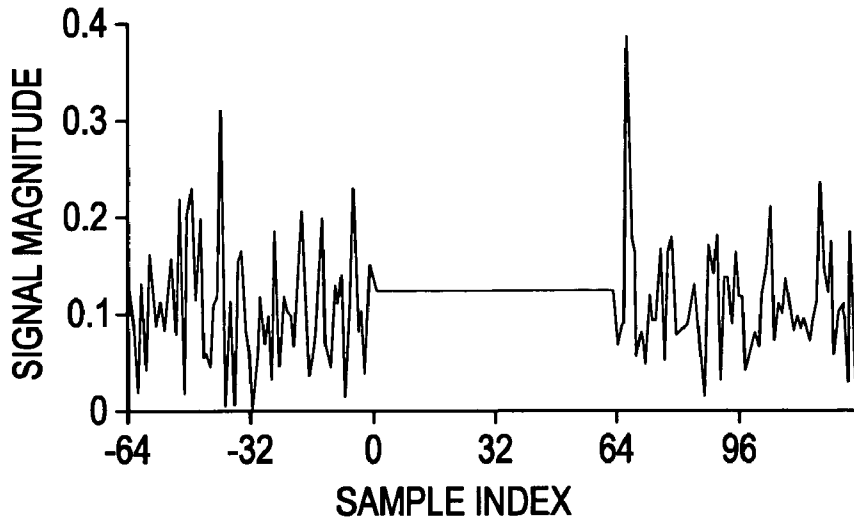
40 Claims, 12 Drawing Sheets

FIG. 1A

FIG. 1B

FIG. 1C

FIG. 1D

FIG. 2

FIG. 3

DOCKET ALARM
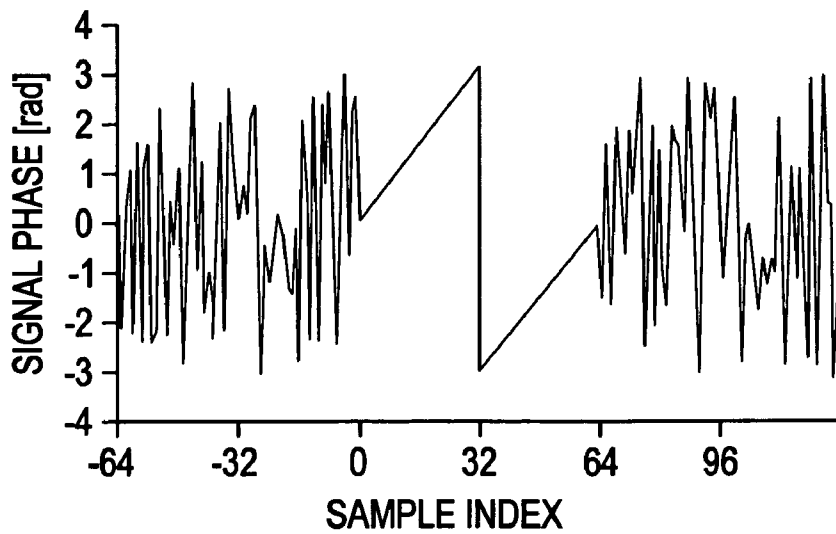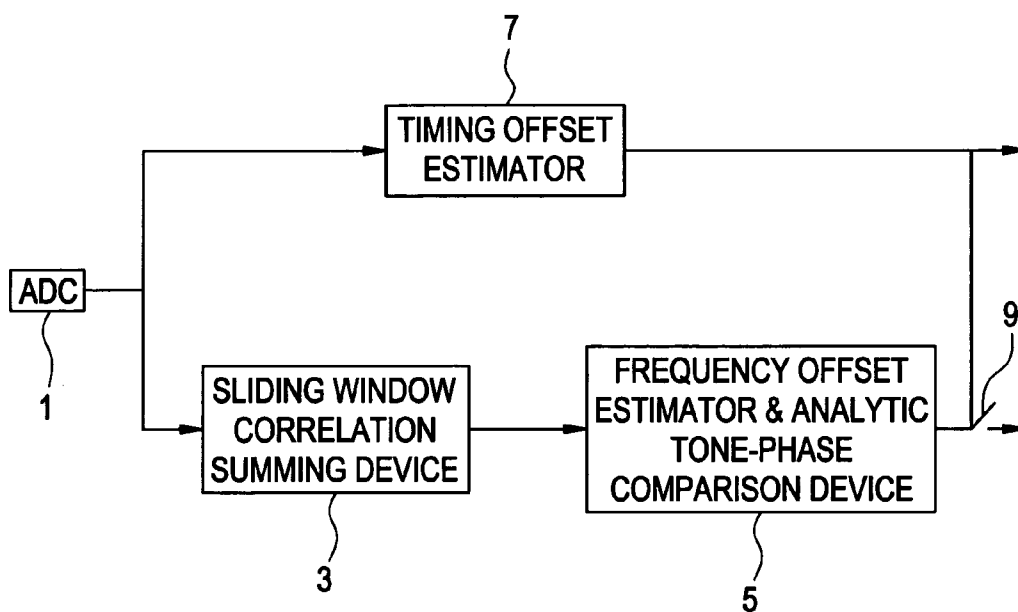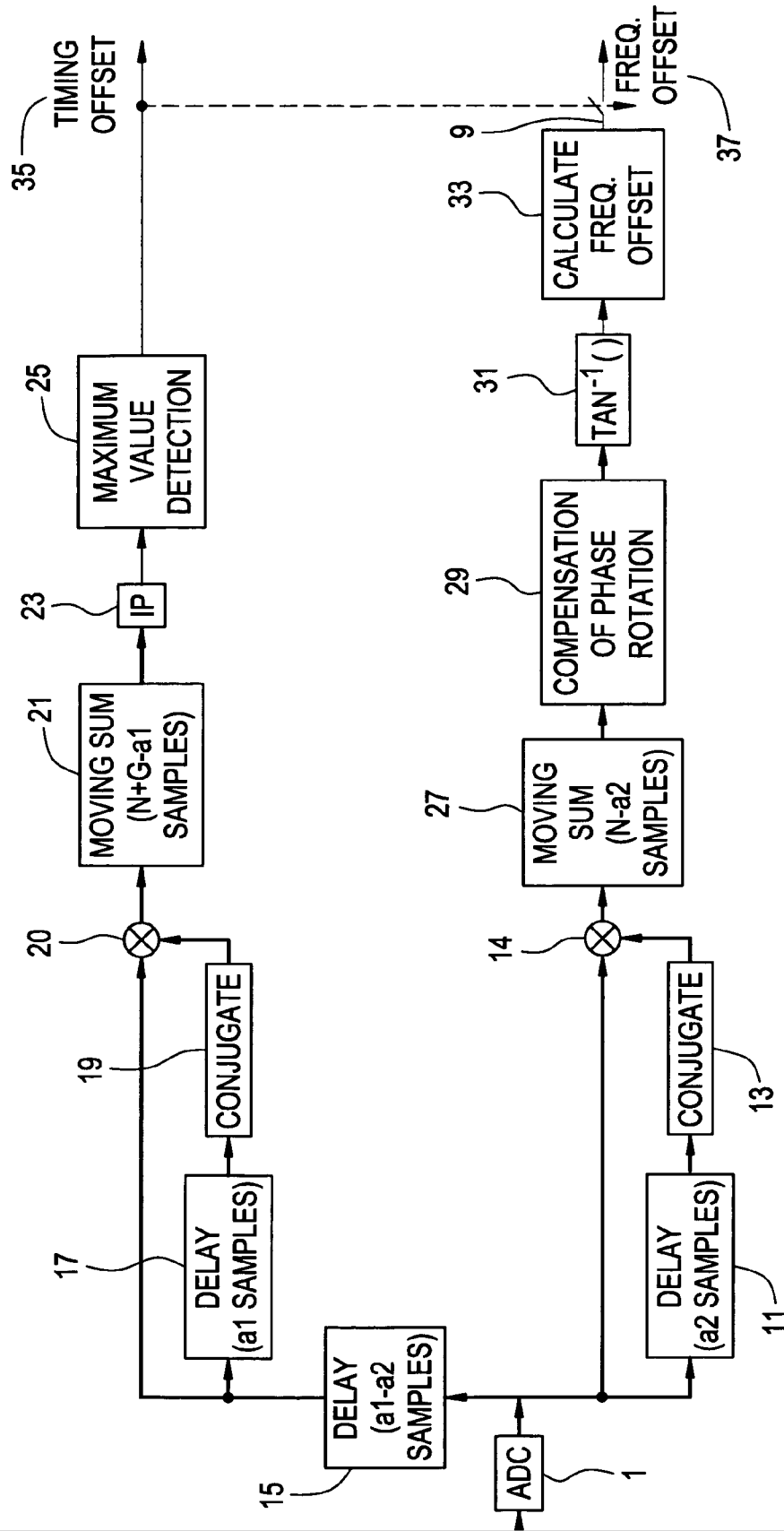
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