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(54) **SPUR REDUCTION TECHNIQUE FOR SAMPLING PLL'S**

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(58) **Field of Classification Search** **327/149, 327/158, 159**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,055,286	A	4/2000	Wu et al.	
6,081,572	A	6/2000	Filip	
7,737,743	B1 *	6/2010	Gao et al.	327/158
7,990,194	B2 *	8/2011	Shim	327/158
8,253,455	B2 *	8/2012	Hyun et al.	327/147
2006/0222134	A1 *	10/2006	Eldredge et al.	375/371

2007/0285177	A1 *	12/2007	Werker	331/16
2008/0218274	A1 *	9/2008	Clementi	331/16
2009/0074126	A1 *	3/2009	Song	375/376
2010/0295621	A1 *	11/2010	Mar	331/18
2012/0062292	A1 *	3/2012	Sai	327/157
2012/0154003	A1 *	6/2012	Gao et al.	327/159

OTHER PUBLICATIONS

Anand et al., "A CMOS Clock Recovery Circuit for 2.5-Gb/s NRZ Data" IEEE Journal of Solid-State Circuits, vol. 36, No. 3, Mar. 2001, pp. 432-439.

Maulik et al., "A 150 MHz-400MHz DLL-Based Programmable Clock Multiplier with -70dBc Reference Spur in 0.18um CMOS", IEEE 2006, CICC, pp. 757-760.

Desgrez et al., "A New MMIC Sampling Phase Detector Design for Space Applications", IEEE Journal of Solid State-Circuits, vol. 38, No. 9, Sep. 2003, pp. 1438-1442.

Gao et al., "A 2.2GHz 7.6mW Sub-Sampling PLL with -126dBc/Hz In-band Phase Noise and 0.15ps RMS Jitter in 0.18um CMOS", IEEE Int. Solid-State Circuits Conf.(ISSCC), pp. 392-393.

Gao et al., "Sampling Phase Detector and Charge Pump with Pulse Width Control", US Patent pending, filed as IDF P07120 in Mar. 2008.

Gao et al., "Spur Reduction Technique for Sampling PLLs", summary of invention submitted Mar. 2009.

U.S. Appl. No. 12/973,323 for Low Power and Low Spur Sampling PLL, 15 pages.

* cited by examiner

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(57) **ABSTRACT**

Control circuitry and method of controlling for a sampling phase lock loop (PLL). By controlling the duty cycle of a sampling control signal, in accordance with the PLL reference and output signals, spurious output signals from the sampling PLL being controlled can be reduced.

20 Claims, 6 Drawing Sheets

