



US007411465B2

(12) **United States Patent**
Watson

(10) **Patent No.:** **US 7,411,465 B2**
(45) **Date of Patent:** **Aug. 12, 2008**

(54) **AGC CIRCUIT FOR THE REDUCTION OF HARMONICS IN THE DRIVE SIGNAL**

(75) **Inventor:** **William S. Watson, Eau Claire, WI (US)**

(73) **Assignee:** **Watson Industries, Inc., Eau Claire, WI (US)**

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 391 days.

5,272,922 A	12/1993	Watson
5,329,269 A	7/1994	Watson
5,430,342 A	7/1995	Watson
5,440,817 A	8/1995	Watson et al.
5,469,414 A	11/1995	Okamura
5,802,728 A	9/1998	Karnick et al.

(Continued)

(21) **Appl. No.:** **11/182,619**

(22) **Filed:** **Jul. 15, 2005**

(65) **Prior Publication Data**

US 2007/0052456 A1 Mar. 8, 2007

(51) **Int. Cl.**
H03B 5/30 (2006.01)
H01L 41/00 (2006.01)

(52) **U.S. Cl.** **331/154; 73/504.12; 310/318**

(58) **Field of Classification Search** **331/154; 73/504.12; 310/318**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,659,175 A *	4/1972	Sordello	318/696
3,979,715 A	9/1976	Hufstedler et al.	
3,988,659 A	10/1976	Ambrosini	
3,994,016 A *	11/1976	Moghadam	360/77.02
4,157,041 A	6/1979	Loper, Jr. et al.	
4,479,098 A	10/1984	Watson	
4,511,848 A	4/1985	Watson	
4,578,650 A	3/1986	Watson	
4,595,960 A *	6/1986	Hamalainen et al.	360/77.17
4,628,734 A	12/1986	Watson	
4,655,081 A	4/1987	Burdess	
4,674,331 A	6/1987	Watson	
4,700,056 A *	10/1987	Silvy et al.	369/44.28
5,226,321 A	7/1993	Varnham et al.	
5,270,648 A	12/1993	Watson	

OTHER PUBLICATIONS

Gao, Z., et al. A Vibratory Wheel Micromachined Gyroscope, Symposium Gyro Technology, pp. 9.0-9.10 (1998).

(Continued)

Primary Examiner—Robert J. Pascal
Assistant Examiner—Levi Gannon

(74) *Attorney, Agent, or Firm*—Patterson, Thuente, Skaar & Christensen, P.A.

(57) **ABSTRACT**

A drive circuit apparatus for use in generating a drive signal for energizing an actuator about a natural resonant frequency is disclosed. The circuit has a counter that generates a count sequence derived from a drive sense signal. Additionally, a demodulator is further coupled to the counter and generates a voltage level signal from the drive sense signal based on the count sequence. A digital to analog (D/A) converter is coupled to both the counter and demodulator. The D/A converter generates the drive signal in a substantially constant phase relationship with respect to the drive sense signal as derived from the voltage level signal and based on the count sequence. In addition, a method of generating a drive signal for energizing an actuator about a natural resonant frequency is provided.

17 Claims, 3 Drawing Sheets

