ABSTRACT

Title：Effects of amplitude, frequency and reference harmonics of excitation current on the responsivity of fluxgate magnetometer

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Time：July, 2012 Degree：Master

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Keywords ： miniature fluxgate, harmonic, giant magnetoresistive (GMR), sensitivity

The noise level of miniature fluxgate is obviously enhanced because it's sensitivity dramatically decreases with the reducing size of core and coil. Numerical simulation shows that the harmonic spectrum of the fluxgate induced voltage waveform consists of high-order even harmonics of excitation frequency. Therefore, in addition to use the traditional 2nd harmonic detection, we can also detect several other important higher-order even harmonic responses. In this work, a homemade miniature wire-wound Förster-type fluxgate and multiple-harmonic detection circuits were fabricated to measure the first four even harmonics with various excitation amplitudes at the frequency of 15.6 kHz. With an optimum excitation current of 80 mA, the responses of four even harmonics were added up by using a mixer with a reference signal consisting of multiple even-harmonic square waves. Experimental result shows that the sensitivity of multiple harmonics is

approximately the summation of all even harmonics. The sensitivity is enhanced from 384 V/T of the 2nd harmonic to 1081.5 V/T of the multiple harmonics. The corresponding 1-Hz field noise is reduced from 2 nT/√Hz of 2nd harmonic to 0.6 nT/√Hz of multiple harmonics. The multiple-harmonics detection technique can be applied to improve the sensitivity and field noise for miniature fluxgates, in particular the chip-level miniature fluxgate. In this study, the multiple-harmonic detection was also successfully used to enhance the sensitivity and to decrease the field noise of a chip-level miniature fluxgate. Furthermore, we also analyzed the linearity and linear range for each harmonic response of wire-wound and chip-level fluxgates.

The harmonic spectrum of giant magnetoresistance voltage shows that only the odd harmonics of excitation frequency are sensitive to the external field. Therefore, just change the reference frequency to odd harmonics, the similar signal processing method for fluxgate can be applied to the giant magnetoresistance sensor to transform the non-linear response into linear output voltage. Therefore, we designed and fabricated a multiple excitation frequency circuit which can be used to detect the responses of 2nd harmonic in a fluxgate and 1st harmonic in a giant magnetoresistance sensor under several excitation frequencies. The typical results were analyzed and discussed.