5th International Conference on Nanotechnologies and Biomedical Engineering
Proceedings of ICNBME-2021, vol 87., November 3-5, 2021, Chisinau, Moldova,
Springer, Cham

Use of Fractional-Quadratic Approximation Invariant of Nonlinear Characteristic of Magnetoelectric Sensor

A. Penin, A. Sidorenko

https://doi.org/10.1007/978-3-030-92328-0_71

Abstract

An idea of a sensor of direct magnetic fields using the magnetoelectric effect in a planar ferromagnetic-piezoelectric composite structure is described. It is shown that introduction in the sensor circuit a negative feedback, which contains a current amplifier, a convenient approximation characteristic former, and a compensation coil, results in a widening of the sensor magnetic field region without of linearization of its characteristic. The approximation nonlinear characteristic is close in shape to the original sensor characteristic. Therefore, no deep negative feedback is required and thereby stability is ensured. As this convenient characteristic, a fractional-quadratic relationship is used, for which an invariant is performed between the output voltage value and the magnetic field strength. Such an invariant is a cross ratio (double proportion) for four values or samples of these values. The cross ratio contains the differences of these values and the ratios of these differences. Therefore, additive and multiplicative errors of the output voltage measurements due to the accuracy of the measuring instrument, the noise of the sensor itself and the electronic circuit are mutually reduced.

Keywords: magnetic field sensors, ferromagnetic-piezoelectric composite, additive errors, multiplicative errors

5th International Conference on Nanotechnologies and Biomedical Engineering
Proceedings of ICNBME-2021, vol 87., November 3-5, 2021, Chisinau, Moldova,
Springer, Cham

References

1. Gao, J., Jiang, Z., Zhang, S., et al.: Review of magnetoelectric sensors. Actuators **10**(6), 109–132 (2021)
   Google Scholar
2. Zuo, S., Schmalz, J., Özden, M., et al.: Ultrasensitive magnetoelectric sensing system for pico-tesla magnetomyography. IEEE Trans. Biomed. Circuits Syst. **14**(5), 971–984 (2020)
   Google Scholar
3. Li, M., Dong, C., Zhou, H., et al.: Highly sensitive DC magnetic field sensor based on nonlinear ME effect. IEEE Sensors Lett **1**(6), 1–4 (2017)
   Google Scholar
4. Srinivasan, G.: Magnetoelectric composites. Annu. Rev. Mater. Res. **40**, 153–178 (2010)
   Google Scholar
5. Serov, V., Chashin, D., Fetisov, L., et al.: Widening and linearization of dc magnetic field magnetoelectric sensor characteristic using a compensation scheme. IEEE Sens. J. **18**(20), 8256–8260 (2018)
   Google Scholar
6. Penin, A.: Analysis of Electrical Circuits with Variable Load Regime Parameters. Projective Geometry Method, 3rd edn. Springer International Publishing AG, Switzerland (2020)
   Google Scholar
7. Penin, A., Sidorenko, A.: Method for measurement of constant magnetic field strength by magnetoelectric sensor with initial nonlinear characteristic. MD Patent Application S20210009 (2021)
   Google Scholar