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Plasma density sensor sensitivity estimation under the influence of sun-synchronous orbit heat fluxes on probes

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The paper for the first time analyzes the influence of the structural elements thermomechanical state of the plasma density sensor (DPS) on the parameters dynamics of the resonator under the influence of thermal fluxes of the circular SSO under operating conditions. By results analysis the temperature field and relative displacements of structural elements of DPP probes in the transverse and longitudinal directions as a result of thermoelastic deformations changes synchronously in time by quasi-periodic law during the nanosatellite orbit movement. Relative sensitivity (1.198×10^{-3}–2.115×10^{-3}) of the resonator is proportional to the resonant frequency shift, was determined based on the results of deformation calculation in the model approximation of a two-wire line. Based on the results of the analysis, it was found that t the resonant frequency shift similarly changes according to a quasi-periodic law towards lower –311.93 kHz and higher frequencies 550.597 kHz relative to the resonant frequency in the absence of heat fluxes during five orbits of the nanosatellite around the Earth. In this frequency range, the values of the permittivity and density of the electron plasma were calculated. The possibility of measuring the density of an electron plasma at times when the resonant shift is zero is investigated. The admissible 5 % region of plasma electron density is determined, in which the resonant shift insignificantly affects the possibility of accurate measurement of the plasma density. At other times, the shift in the resonant frequency leads to a change in the dielectric constant of the plasma, and as a result, the accuracy of plasma density measurements will decrease. The relative sensitivity of the DFS is an important characteristic in determining the possibility of measuring plasma density. To obtain reliable results of plasma density measurements, the required relative sensitivity of the sensor should be ~ (10^{-4}–10^{-5}).

Keywords: resonance, plasma density sensor, resonant RF probe, resonant frequency shift, relative sensitivity, resonator, temperature gradient, thermoelastic deformations, inhomogeneous ionosphere, plasma frequency, electron density.

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