

Improvement in response speed of phase detection type impedance probe

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The impedance probe has been used for over 40 years, to obtain the absolute value of electron density in space plasma with high accuracy (Oya, 1966). In association with recent rocket campaigns, in-situ measurements of electron density by using impedance probe have been successfully carried out.

Recently, a phase detection type impedance probe has been developed to realize a continuous observation of the plasma density. In the previous instrumentation for the in-situ observations such as SEEK-2 in 2002 and DELTA in 2004 (namely, ordinary type impedance probe), the impedance probe showed an observation limit that it could not detect the fine structure of plasma irregularity due to the plasma instabilities. Detection of fine structure of the plasma density becomes very much important to understand the physical processes generated in the ionosphere. So, accurate observation of fine structure of plasma distribution with absolute value is essential to study the electro-dynamics in the ionosphere.

We tried to develop the phase detection type impedance probe by using PLL (Phase Locked Loop) method. The methodology of phase detection type was examined by numerical calculations and experiments in laboratory.

In the laboratory experiments, high time resolution of 6.25 ms was successfully obtained. However, response speed of the PLL circuit was too slow to track the steep gradient of electron density in the ionosphere. To improve the response speed, we provided two solutions. Firstly, we adopted crystal oscillator with 40MHz frequency for micro-controller. Secondly, we used the fast analog-to-digital converter IC (AD876) as a substitute for internal analog-to-digital converter of micro-controller. As a result, the response speed was improved obviously.

In the presentation, we will discuss about the property of present circuit and the application of rocket observations.