Synchronization optimization providing for MT stations at grid survey

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SUMMARY

Magnetotelluric (MT) survey is a leading electromagnetic method to probe the electrical conductivity structure of the Earth at depths ranging from few tens of meters to several hundreds of kilometers. As passive exploration technique, MT involves measuring fluctuations of the natural electric and magnetic fields in wide frequency range in two orthogonal directions at the Earth' surface. Recent application of multiple MT stations survey – remote reference or grid stations location – together with the modern computational technology allows significantly improve the quality of the results by eliminating noise and improving the signal-to-noise ratio and, as a consequence, to determine the parameters of Earth' geoelectric cross-section with a high degree of reliability.

It has to be stressed that the successful application of MT method greatly depends on the used instrumentation parameters. For grid survey, especially important is the precise synchronization of measurements simultaneously in every location. To organize the synchronous operation of all instruments, the systems for global positioning and time reference - GPS receivers - are widely used. However, despite GPS availability, the normally obtained synchronization precision is not enough because of the instability of the GPS synchronization signal, especially in the moments of the GPS signals loss.

To raise the synchronization accuracy, a new structure of the synchronization circuit has been developed. A linearized model of the circuit was constructed and its computer simulation was carried out. The stochastic model of a set of synchronization circuits is developed what allowed us to derive the equation of the evolution of cumulates of the random process of the clock. The computational experiments made it possible to identify the necessary parameters of the model and then the verification of the results was carried out using the structure of the broadband MT station LEMI-423. The experimental results confirmed a significant reduction of the obtained error from the instability of the GPS synchronization signal. As a result, we achieved sampling timing accuracy better than ± 60 ns, without phase jumps and distortion. To this, what is important for an autonomous field instrument, the obtained power consumption of the synchronization circuit was very low, what allowed us to reach the total power consumption of the LEMI-423 MT station below 1.7 W.

In conclusion, the short description of LEMI-423 MT station and its parameters are given.

Keywords: GPS synchronization, MT station, stochastic model.