About the Time Measurement of Radio-Waves Propagation in Atmosphere at Nanoseconds Accuracy

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Abstract - **Methods for measuring time of radio-waves propagation in troposphere are presented in article. The estimate of measurements is 1-10 nanoseconds for purpose of high-precision synchronization.**

Keywords – **time of propagation of radio-waves, synchronization of time scales.**

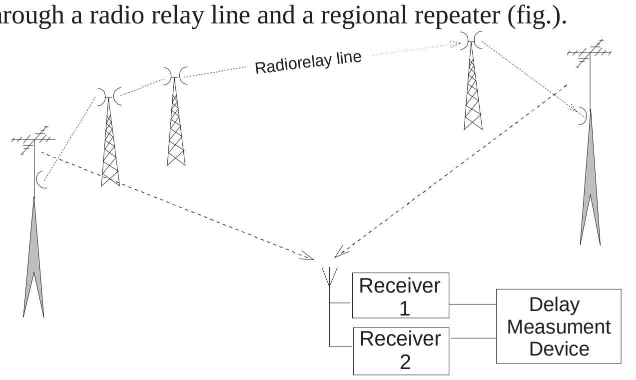
I. INTRODUCTION

Time of propagation of radio-waves in atmosphere is not equal to distance divided by the velocity of light in vacuum for the purpose of high-precision synchronization of standards of time and frequency in case of one-way algorithm [1]. The model analyzing the influence of conditions of atmosphere on the time of propagation has been created in [2]. Verification by the experiment will prove adequacy of the model and can specify some its parameters.

Verification can use active algorithms. Considerable technical and organizational difficulties will arise in this case. Passive algorithms of verification [1] should use standards of high stability. Time scales are required to be synchronized to these standards. The problem is solved by method of verification simple enough for the model in this research.

II. MEANS OF MEASUREMENTS

The method which is proposed, is based on measurement of time delay between two signals from the common source. However, these signals passed different ways in atmosphere. As the common source the regional television centre can be used. Its signal arrives to a place of reception both directly and through a radio relay line and a regional repeater (fig.).



Figure

This means has some disadvantages. The main disadvantage is indeterminancy of time delay in reception and transferring equipment of a radio relay line. The delay can be up to 20 nanoseconds for one repeater according to publication [3].

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However it does not interfere with measurement of relative time delay in case of change of atmosphere parameters. Stick-slip nature changes can be exactly identified, because they have obviously expressed hardware character.

As a reference-input element the line synchronizing impulse (LSI) of a television signal can be used. It enables to realize about 15000 measurements a second. As a reference-input element it is also possible to apply the 21st line of a television signal. This line has a package of measuring frequencies. In addition, it has sharp autocorrelation function.

The first method has been realized with the use of two high-quality television receivers, a special measuring device and a computer. The device is created on the basis of the single-crystal microprocessor.

III. RESULTS OF MEASUREMENTS

Measurements were made during November - December, 2009. The time of the common delay which is expected, makes 270 mcs. Variations of delay make 80-100 nanoseconds. These variations are possible to be explained by atmospheric factors according to model [2].The standard deviation of one measurement (using one LSI) is equal to 200 nanoseconds. The preprocessing makes possible to receive the estimate of measurement of a minute about 20 nanoseconds (it is realized on the single-crystal microprocessor.

The further numerical processing allowed to reveal both diurnal variations, and longer variations of a time delay. This data was compared to changes of weather and compliance between them was obtained for verification model [2].

IV. CONCLUSION

Consequently, a conclusion can be made that experimental verification confirmed the theoretical model. Experimental data specified the parameters of the model.

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