IMPROVING METROLOGICAL CHARACTERISTICS OF A FREQUENCY STANDARD BASED ON CESIUM ATOMS

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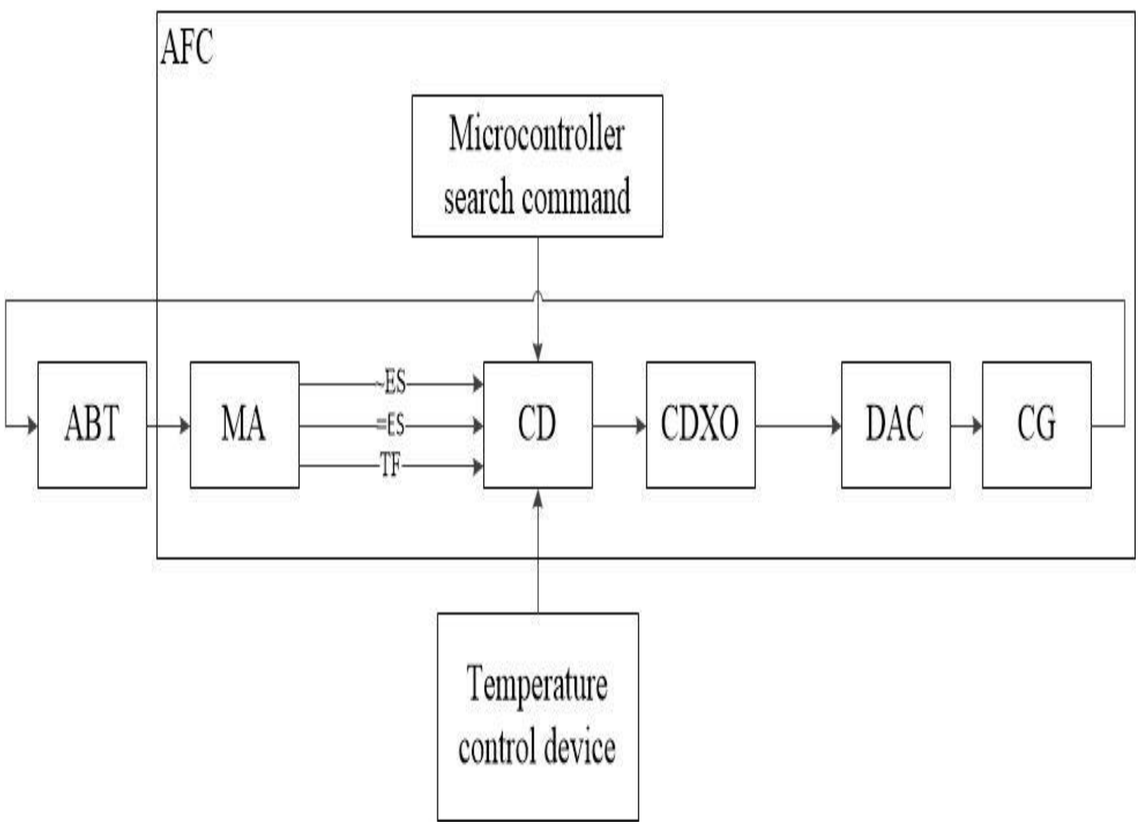
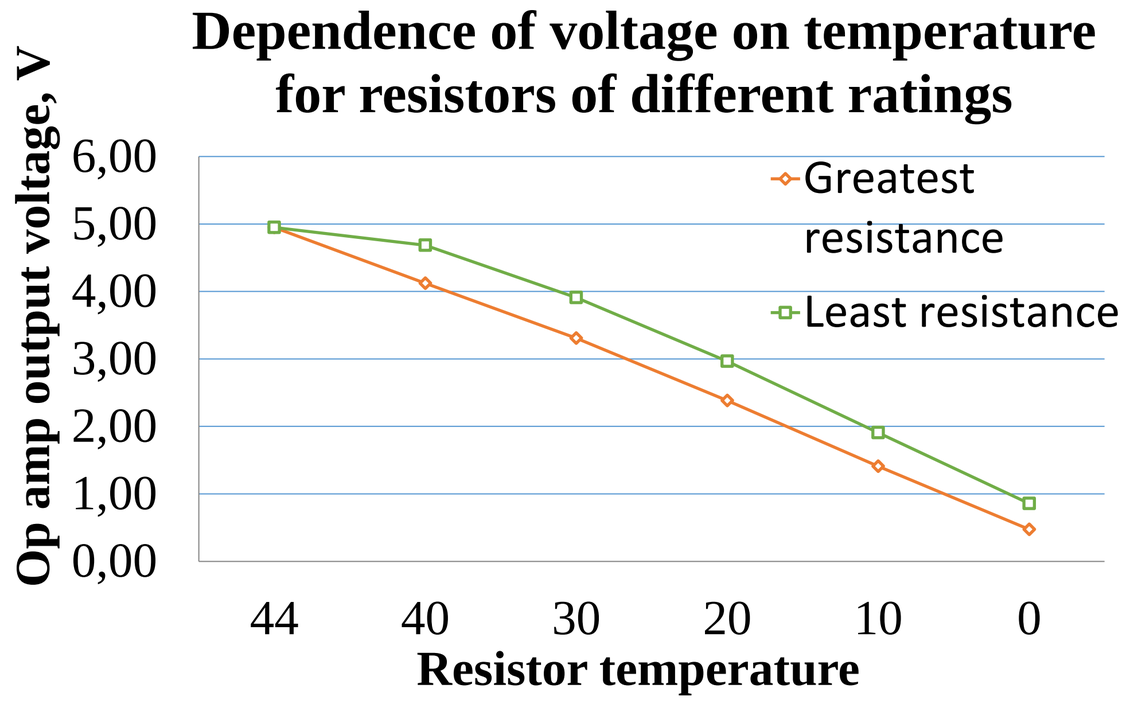
Abstract. The necessity of constant modernization of quantum frequency standards (QFS) - atomic clocks, which are used in satellite navigation and telecommunication systems to solve new problems of the speed of transmission of large amounts of information, etc., is substantiated. It is noted that among all atomic clocks, cesium QFSs occupy a special place. These standards are the primary frequency reference upon which the international time scale is based. The main goal of all QFS upgrades is to improve the metrological characteristics. In the case of its use on moving objects, its dimensions, weight and power consumption also become important characteristics. The article presents one of the options for reducing the influence of negative factors on the stability of the QFS. The problem of modernizing the cesium frequency standard by including a device for monitoring and stabilizing the temperature regime of its operation is considered.

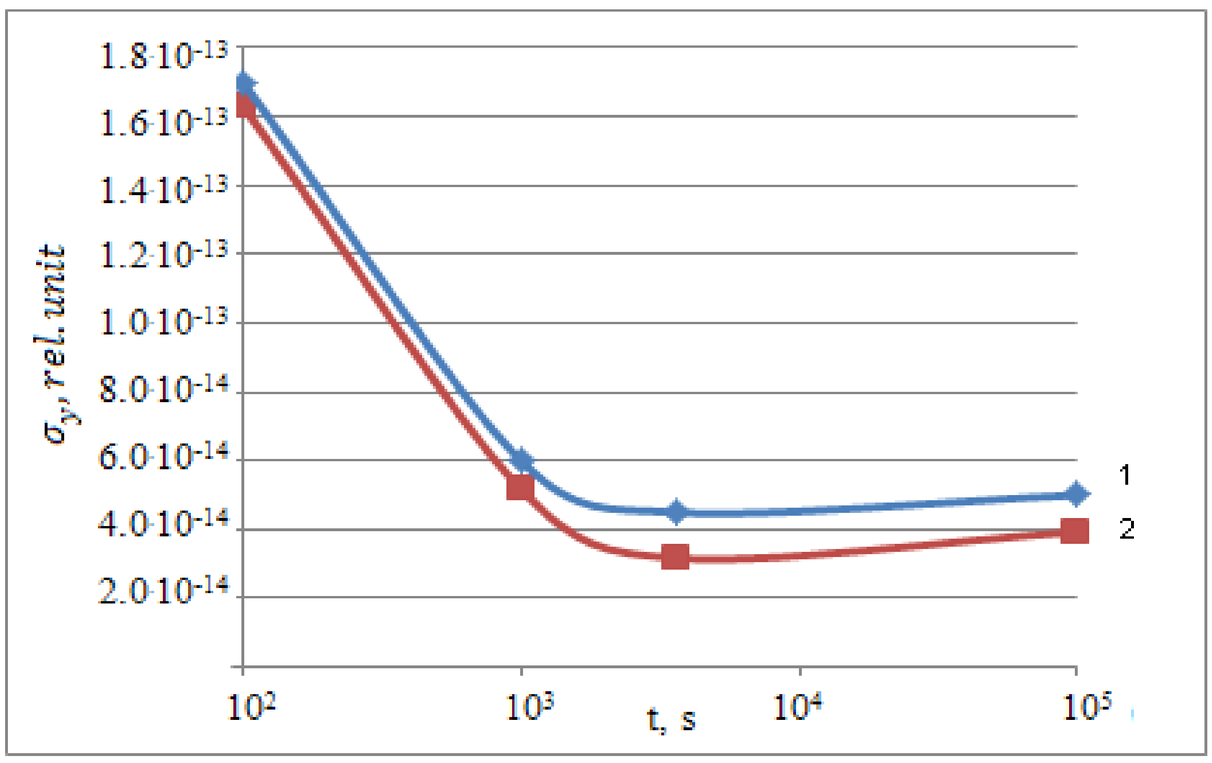


Scheme of the AFC of the quantum frequency standard: ABT - atomic beam tube, MA - matching amplifier, CD - control device, QO - quartz oscillator, ES - error signal

The result obtained shows that if the U(T) dependence becomes non-linear, an additional error appears. In the developed new AFC system, this error is eliminated. On fig. Figure 4 shows the dependence of the change in the values of the Allan variance $\sigma_{y(\tau)}$ on time τ for the modernized and previous QFS designs.



Dependence of voltage on temperature for resistors of different ratings.



Plot of the Allan variance σy versus time t. Graphs 1 and 2 correspond to the previously used AFC system in the QSC and developed by us.

The results obtained show an improvement in the Allan variance $\sigma(\tau)$ by 5%. Studies of the operation of the QFS were carried out for 12 days in a temperature chamber. As a result of the research, it was found that the temperature coefficient of the frequency of the standard decreased by 1.35 times.

Conclusion The conducted experiments have shown the efficiency of using automatic frequency control systems with the thermal compensation device developed by us. As a result of using the device for compensating the temperature coefficient of frequency, the temperature sensitivity of the AFC system decreased by a factor of 1.3, which improves the synchronization of satellite time scales for spacecraft with Earth remote sensing systems.