Design of Temperature Frequency Drift Compensation for Hydrogen Maser

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I. INTRODUCTION

Due to the high stability and accuracy of quantum time frequency standards, as well as the fact that modern electronic technology can provide highly precise and reliable accumulation counting methods, the accuracy and precision of time frequency measurements are very high. In modern science and technology, the application of time and frequency measurement is very extensive, and almost all departments will use it. This greatly expands the application range of quantum frequency standards. The main performance of quantum frequency standards is the stability and accuracy of their standard frequencies.

At present, under ideal conditions, the maser will self oscillate at a highly stable frequency. In practical use, there are various environmental factors that affect the state and frequency stability of self oscillation. The temperature environment inside the hydrogen maser is one of the main factors limiting the frequency stability of the hydrogen atomic clock. In order to reduce the impact of changes in cavity resonant frequency on the frequency stability of hydrogen atomic clocks, it is necessary to compensate for the frequency drift value caused by temperature changes.

II. METHODS

This project aims to compensate for drift by constructing testing environments such as temperature measurement units, frequency measurement units, and frequency adjustment units. Firstly, the temperature measurement unit and frequency measurement unit are used to measure the data and establish a temperature characteristic (temperature coefficient) model of the atomic frequency standard. Subsequently, the temperature drift caused by temperature changes (compensation value) is calculated using this model, and the compensation value is quasi real-time feedback to the frequency adjustment unit. The original frequency signal is processed by the frequency adjustment unit and the output time signal is the time signal of the atomic frequency standard after temperature drift compensation. (Fig.1)

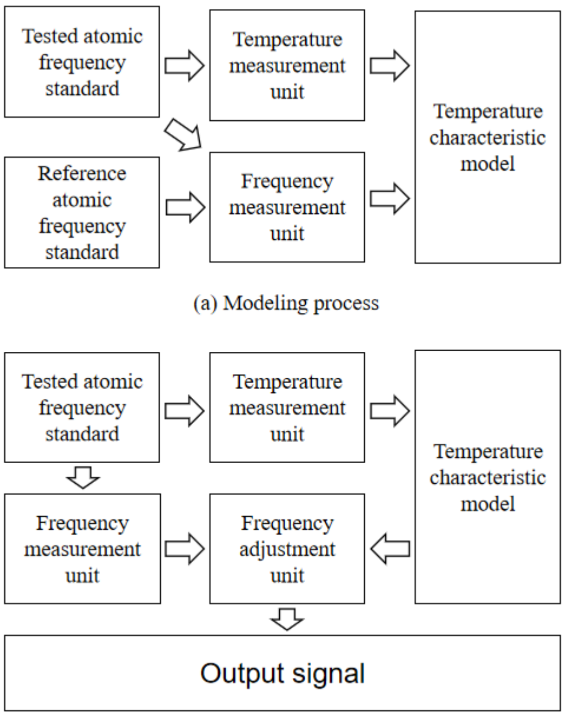

Fig.1 system structure diagram

III. CONCLUSIONS

Due to the fact that the temperature inside the cavity is one of the main factors affecting the frequency stability of the resonant cavity, real-time compensation for temperature frequency drift will improve the stability and accuracy of the atomic frequency standard. Moreover, after successfully designing a temperature compensation testing environment, this experimental environment can be used to model the temperature coefficients of different atomic frequency standards, which will help optimize the performance of different atomic frequency standards in the future.

Keywords—hydrogen maser, frequency drift, frequency compensation