Improvement of H-maser performance due to increase of power radiated by atomic beam

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Extended Abstract

There are several well known methods to increase a power radiated by atoms in H-maser's storage bulb [1]. In the paper few main results of complete series of works dedicated to creation and research of a special hydrogen maser with increased output power based on the methods are represented. Experimental results show that actual achievement of a signal to noise ratio (*S*/*N*) in bandwidth 1 Hz at the H-maser's output is close to 87 dB level, what is greater about 20 dB than typical value of *S/N* for industrial masers.

The special hydrogen maser, firstly, according to theory prediction and experimental results has an extreme low phase noise level near carrier due to large signal to noise ratio. This parameter is highly important in microwave frequency standards operated in pulse mode when a period of one cycle is equal to T_c. So, in fountain atomic frequency standards a usage of the special H-maser as a reference source for a microwave synthesizer can significantly suppress the phase noise of the interrogation signal at the offsets n/T_c from clock transition frequency (where T_c = 1.5 s, n = 1…10), i. e. decrease the Dick effect because these harmonics cause a dominant contribution in a value of the effect [2]. Secondly, the large level of the signal to noise ratio also allows to get a high short and medium term stability of the hydrogen frequency standard. In figure 1 the frequency Allan deviation (ADEV) at 1 second average versus signal to noise ratio of the special H-maser is represented, the measurements were performed at precision frequency comparator *VCH*-314 ("Vremya-Ch" JSC, Russia) in bandwidth 3 Hz. Thus, the key benefit of such hydrogen maser application in microwave atomic frequency standards is the significant reduction of metrological requirements, such as phase noise and limit frequency stability, of the local oscillator – quartz oscillator or dielectric resonator oscillator (DRO).

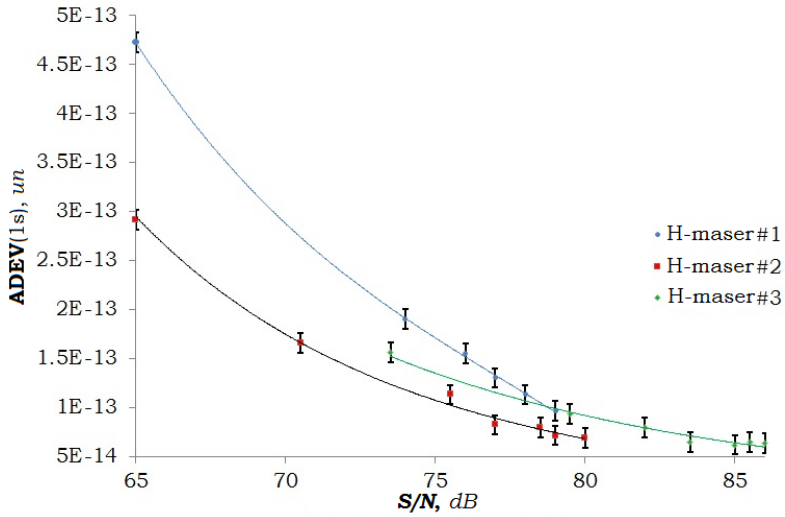

Figure 1. The measured Allan deviation at 1 s of three special hydrogen standards versus signal to noise value at the maser's output. The used inner quartz oscillator 5 MHz has the stability about $6.5 \cdot 10^{-13}$ at 1 s in free running mode.

References

1. Boyko A. I., Yolkin G. A., Ghestkova N. D., Kurnikov G. P., and Paramzin V. A., "Hydrogen maser with improved short-term frequency stability", *Proceedings EFTF*, Neuchatel, 2001, pp. 406-408.

2. Aleynikov M. S., Boyko A. I., "On the single-state selection for H-maser and its signal application for fountain atomic standard", *Proceedings EFTF*, Neuchatel, 2014, pp. 169-172.