The 5^{th} IVS General Meeting Proceedings, 2008, p. 77–81

Automatic System for Monitoring Hydrogen Masers in QUASAR VLBI Network

Dmitriy Ivanov, Aleksandr Vytnov

Institute of Applied Astronomy, Russian Academy of Sciences, Russia

Abstract. The observatories of the QUASAR VLBI network are equipped with a set of hydrogen masers. For remote monitoring and testing of hydrogen masers a software and hardware system is developed at IAA.

1. Introduction

The accuracy of a VLBI network is substantially defined by the characteristics of hydrogen masers which provide the function of independent local oscillators to spatially separated radiotelescopes as a phase measurement radiosystem [1].

All observatories of the QUASAR VLBI network are equipped with a set of three active hydrogen masers CH1-80 (Fig. 1), manufactured at IEM “Kvartz” (Nizhniy Novgorod, Russia) [2–4].

The masers are widely spaced. The problem of definition of parameters of the separated masers will traditionally be solved in several stages: measurement of parameters, entering of data in a computer, data transmission, processing, and providing access to data. The delay of data acquisition can be several days, besides, mistakes of operators are added. Additional mistakes arise because of non-simultaneous registration of measurements on standards.

For VLBI network reliable functioning creation of the system, allowing to receive parameters hydrogen masers in real time without participation of operators is necessary.

2. The Automatic System

For remote monitoring and testing of hydrogen masers a software and hardware system is developed at IAA (Fig. 2).

This automatic system provides internal comparisons between hydrogen masers and external comparison of the basic standard by GPS/GLONASS signals. The data measured are transmitted in quasi-real time mode to the IAA

Figure 1. The set of active hydrogen standards CH1-80, observatory “Zelenchukskaya”

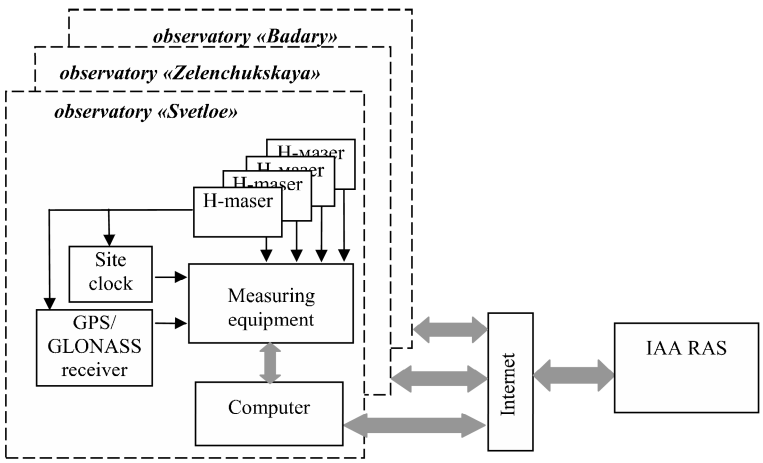

Figure 2. The automatic system for monitoring parameters of the removed standards of time and frequency

for processing and analysis. The adjustment of the frequency standards is made by the results of processing.

The block diagram of measuring equipment is presented in Fig. 3.

The commutation unit (Fig. 4) allows to switch inputs with a time delay of 0.1 nanoseconds. The special interface board for management of the commutation unit by a computer is developed.

The special software for automation of process of measurements is developed in “LabView” development software system [5]. This software allows to realize

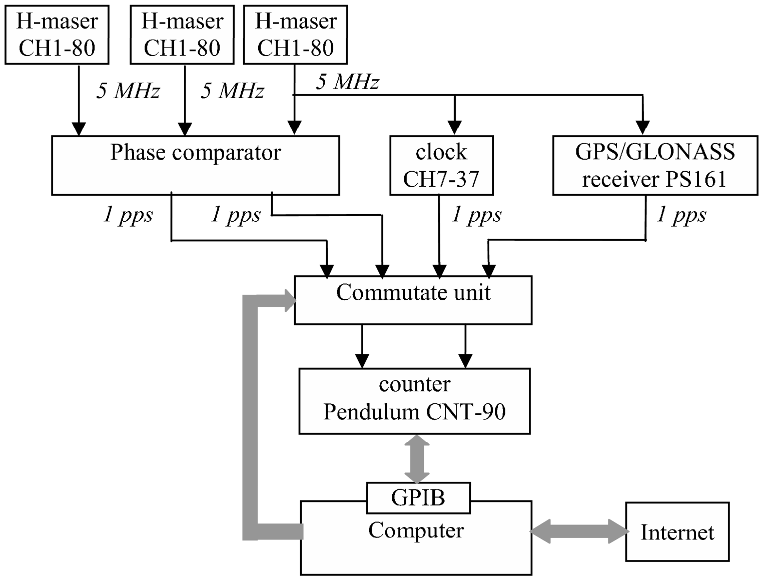

Figure 3. The block diagram of measuring equipment for internal and external comparisons

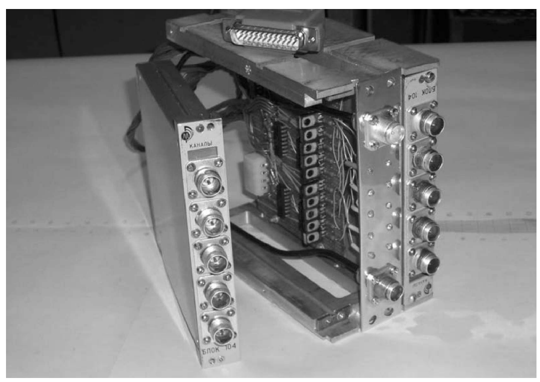

Figure 4. The commutation unit

internal and external comparisons of hydrogen standards of frequency. The key feature of the software, application of the components, allows to work with measuring devices in real time.

A synchronization of processes is carried out using an internal clock of a computer using protocol SNTP. Measuring installation carries out a full cycle of measurements under the schedule before data transmission. In a complex it is used two reports of an exchange: through a mail server and the link protocol “Data Socket” allowing to transmit data in real time.

The software has a user interface allowing the operator to control the measurement process.

3. Some Results

The results of internal comparison of three hydrogen masers at Badary observatory after carrying out of a complex of works as agreed target frequencies of masers are presented below. In Fig. 5 the relative differences of frequencies

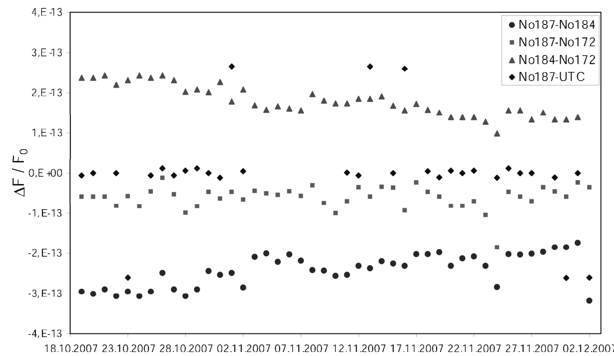

Figure 5. The relative differences of frequencies of pairs of hydrogen masers and UTC

of pairs of hydrogen masers with numbers 187, 184, and 172 are shown. The frequency of the maser N187 (basic maser) is coordinated with scale UTC. From the presented results it is visible that masers are coordinated on frequency at a level $10^{-13} - 10^{-14}$, that allows to keep value of frequency in case of the leading maser failure.

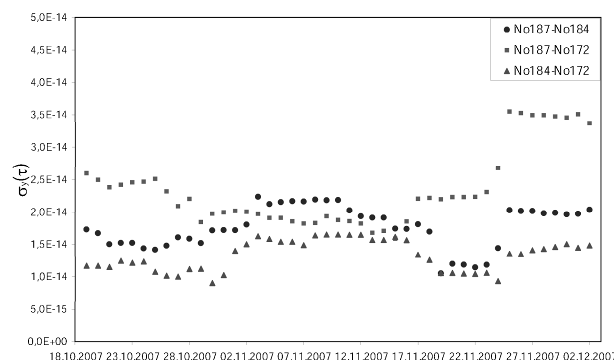

Figure 6. Alan dispersion of maser pairs ($\tau = 1$ day)

In Fig. 6 the results of Alan dispersion calculation of maser pairs on a daily interval of time are presented. As there are three pairs of masers independent comparison, it is possible to calculate Alan dispersion for each maser separately

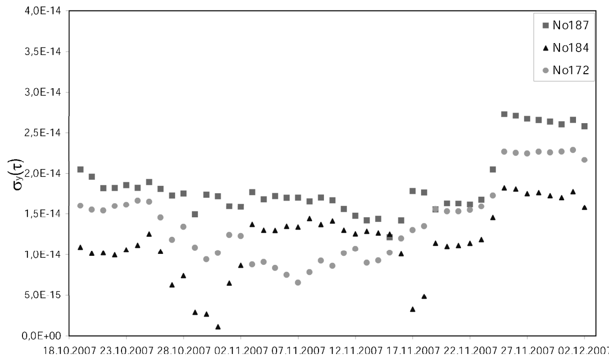

Figure 7. Alan dispersion of masers ($\tau = 1$ day)

(Fig. 7). From the presented data it is visible that stability of masers does not exceed 3×10^{-14}, that completely corresponds to passport data.

4. Conclusion

The developed automatic system provides internal comparisons between hydrogen masers with accuracy of 10^{-14} and transmits results in quasi-real time mode to IAA. It also allows external comparisons of the basic maser with GPS/GLONASS.

The automatic system also allows to supervise stability of the basic maser during a VLBI session. The stability data can be used while processing observations.

References

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