



VREMYA-CH

H-MASER FREQUENCY AND TIME STANDARD

VCH-1005

Brief description and maintenance instruction

Nizhny Novgorod 2004

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ATTENTION! To prevent failure of the interface **RS-232C**, that provides the link between separate blocks of the device (see Fig. 4.1 on page 9), it is necessary to be guided by the following rules.

1. The connection of the Control terminal **PC-1** to the block **Physical package** should be carried out with the switched **OFF** terminal **PC-1**, or with the switched **OFF** Standard.
2. The connection of the **Synchronization unit** to the block **Physical package** is admitted only with the switched **OFF** **Synchronization unit**, or with the switched **OFF** block **Physical package**.

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1. PURPOSE

H-maser Frequency and Time Standard VCH-1005 (hereinafter named as “Standard”) is intended for the use as the source of precision signals for time - frequency measurements, and for the use in the standard, reference and working instruments of measurements.

The Standard can be used both independently, and in a structure of automated measuring complexes.

The possibility of the remote control of the Standard and the diagnostics of its status by means the communication line and Internet is provided.

The main fields for the applications of the Standard:

- Time keeping service;
- Radionavigation;
- Radioastronomy;
- Scientific researches.



2. COMPLETE SET

The delivery complete set of H-maser Frequency and Time Standard VCH-1005 consists of the following items.

Item	Quantity
1. H-maser Frequency and Time Standard VCH-1005	1
2. Packing of the Standard	1
3. Installation CD	1
4. Brief Description and Maintenance Instruction	1
5. Brief Description of the Autonomous System of the Microwave Cavity Tuning in the H-Maser Frequency and Time Standard VCH-1005	1
6. H-maser Frequency and Time Standard VCH-1005 Circuitry Album	1



3. SPECIFICATIONS

In the H-maser Frequency and Time Standard VCH-1005 the quantum hydrogen generator (H-maser) as the active element is used.

Operational parameters of the Standard are as follows.

Voltage of the power supply, Volt	220 ± 22
Frequency of the power supply, Hertz	50; 60
Power consumption (max.): 220 V 50 Hz AC (VA) 21–30V DC (W)	< 250 < 200
Battery, Volt	21–30
Environment temperature, °C	+(5 ÷ 40)
Relative humidity of air (at the temperature +25 °C)	Up to 80%
Atmospheric pressure	84 - 106 kPa (630 - 795 mm of Hg)
H-maser thermostat warm-up time, days	9
Time of the setting of the working mode while the H-maser thermostat is warmed up, hours	24
Allowable storage time of the Standard with ion pumps switched OFF, days	< 30
Mean time before failure, hours	> 5000
Service life, years	> 12
Resource, hours	50 000
Weight of the Standard, kg – Without packing – In packing box	225 400
Overall dimensions of the Standard, mm – Without packing – In packing box	600×1585×900 1400×1000×1600

With the aim to spare the resource, and to shorten the time of preparation to work, the “Stand by” mode is realized in the Standard. This mode means that vacuum pumps are to be switched **ON**, and the system of the beam formation of hydrogen atoms is to be switched **OFF**.



ATTENTION!

1. For a short break (less than one month) in the operation the “Stand by” mode is admitted.
2. If the Standard is switched OFF for a long time it is recommended each month to use the “Stand by” mode for 2 days.

The Standard provides.

- 1) Generation of precision signals with frequencies 5 MHz and 100 MHz.
- 2) Time scale signal generation with the synchronization (in case of necessity) by the external time scale pulse.
- 3) Adjustment of the frequency of generated signals with the relative step 10^{-14} from the nominal value.

The signals generated by the Standard have the following guaranteed parameters.

1. Relative frequency instability (Allan variance)

Time of measurement	Allan variance (bandwidth 3 Hz)
1 sec	$3 \cdot 10^{-13}$
10 sec	$3 \cdot 10^{-14}$
100 sec	$8 \cdot 10^{-15}$
3600 sec	$3 \cdot 10^{-15}$
1 day	$3 \cdot 10^{-15}$

2. Spectral density of the phase noise of the output signal 5 MHz in the single side band (on the specified analyzing frequency), not more than

Analyzing frequency	Phase noise
10 Hz	-125 dB/Hz
100 Hz	-140 dB/Hz
1 kHz and more	-150 dB/Hz



3. Other parameters

Relative accuracy of the frequency (factory calibration)	$5 \cdot 10^{-13}$
Relative sensitivity of the frequency to an external magnetic field, Oersted ⁻¹	$< 2 \cdot 10^{-14}$
Temperature sensitivity factor of the frequency, °C ⁻¹	$< 1 \cdot 10^{-14}$
Relative drift in the frequency over 1 day	$< 5 \cdot 10^{-15}$
Effective voltage of output signals 5 MHz and 100 MHz on the load 50 Ohm, Volt	1 ± 0.2
Parameters of the time scale signal on the load 50 Ohm:	
a) Type of the signal	positive TTL pulses
b) Frequency of pulses, Hertz	1
c) Duration of the pulse, μs	20 ± 10
d) Time of the pulse rise, ns	10
e) Voltage, Volt	
– low level	< 0.2
– high level	> 2.5

The management of the Standard is executed through the screen interface of IBM compatible personal computer (**PC**). On the display the status of the following functions is indicated and set.

- The mode of the operation, and adjusting parameters of units of the Standard (“**Watches**”).
- The setting of the frequency corrector; the control tools of the Standard (“**Control**”).
- The record of the previous status of the Standard (“**History**”).
- Daily record of the status of the Standard (“**DayHistory**”).

Following elements are located on the forward wall of the Standard (from above downwards):

- The top panel (power supply for **PLL** – the **Synchronization unit**, see Fig. 4.1). LED indicators displaying the switching ON of:
 - the power supply voltage (**POWER**), is lighting when the power is supplied from the net 220 Volt;
 - the power supply from the battery, is lighting when there is a power of the battery, and flashes, when the power is supplied from the battery;
 - the Phase Locking Loop, is lighting in the locking mode.
- The bottom panel (power supply for **HG** – the **Physical package**, see Fig. 4.1). Similarly to described above.

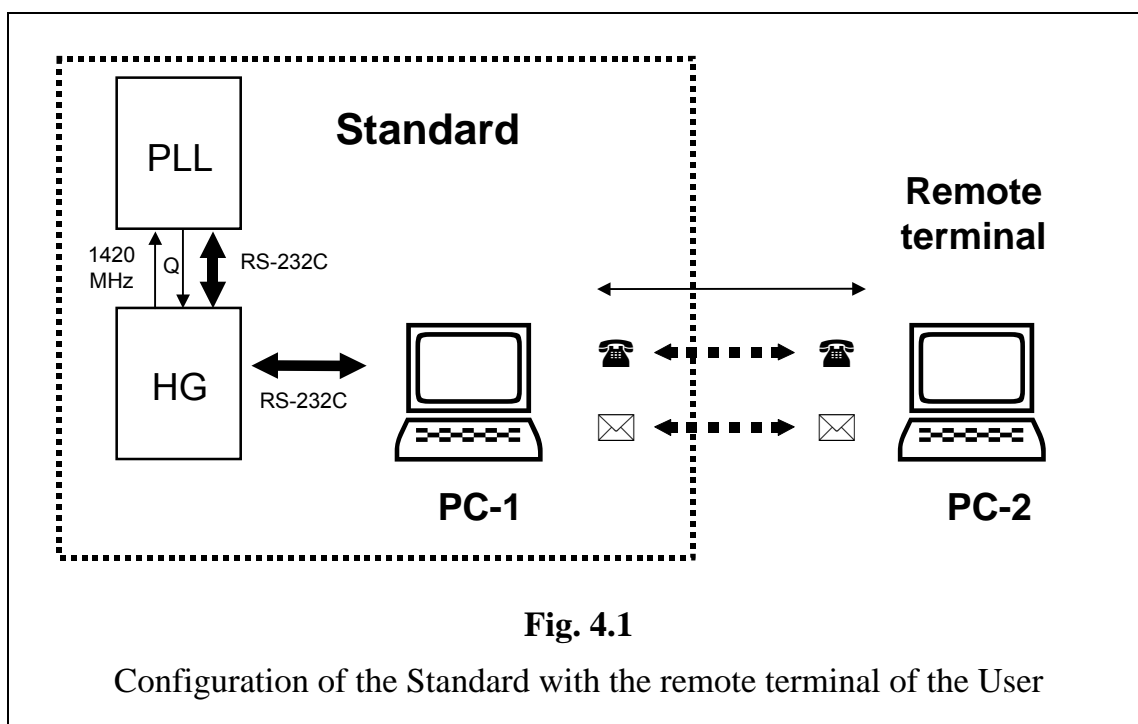
The external synchronizing signal 1Hz is to be connected through the appropriate socket on the back wall of the Synchronization unit.



4. BRIEF DESCRIPTION OF THE STANDARD

4.1. General structure

The complete configuration of the Standard has the structure shown in Fig. 4.1.



The following units are allocated here.

Standard – H-maser Frequency and Time Standard;

Remote terminal – the remote terminal of the User **PC-2**.

Standard consists of the following main blocks.

HG – H-maser plus the microprocessor for the management by maser
(**Physical package**);

PLL – radioelectronic system for the formation of reference signals of frequency and time (**Synchronization unit**);

PC-1 – the Control terminal containing the program-server,
and the program-manager.

The remote terminal **PC-2** of the User contains only the program-manager.



The terminals **PC-1** and **PC-2** provide:

- 1) The generation of commands for management by the Standard.
- 2) The processing of the data that characterize the operation mode of the Standard.
- 3) The tuning of the microwave cavity resonant frequency onto the top of the hydrogen emission line.
- 4) The dialogue mode of the management through the screen interface.

Three possible ways of the link between terminals, that provide the functions of the remote management by the Standard, are specified in Fig. 4.1.

↔ – Local network.

☎ – Telephone communication line.

✉ – Connection through Internet.

The management by the Standard, on the choice of the User, can be executed in four ways:

- 1) By the Control terminal **PC-1**.
- 2) Through the local network.
- 3) Through the telephone communication line.
- 4) Through Internet.

The choice of the way for the remote management by the Standard is executed with the help of the software installed on the remote terminal **PC-2** of the User.

4.2. Principle of the action of the Standard

The principle of the H-maser Frequency and Time Standard VCH-1005 action is based on the phase locking of the signal of the local crystal oscillator (**LCO**) by the hydrogen active maser signal (through the PLL – Phase Locking Loop).

The main source, that causes the frequency instability of the Standard on the long time intervals (more than 1 day), is the instability of the microwave cavity resonant frequency. Therefore, the system of the automatic tuning of this frequency onto the top of the hydrogen emission line is necessary to provide the stability at $3 \cdot 10^{-15}$ over the averaging time 1 day.

To maintain the requirements to the output signals (see Section 3) in the Standard the tuning system is realized. This one performs two main functions.

- 1) Automatic tuning of the output frequency of the Standard by H-maser signal.
- 2) Automatic tuning of the microwave cavity resonant frequency onto the top of the hydrogen emission line.

The main units and functions of the Standard are considered below in detail.



4.3. Physical package

The precision signal with the frequency 1 420.405... MHz and the power of the order 10^{-13} Watt is generated here. The schematic drawing of the **Physical package** is shown in Fig. 4.2.

The unit consists of the following main elements.

- The inner **microprocessor** and the control circuits.
- **Varactor**, to which the driven voltage formed by the **microprocessor** of the **Synchronization unit** and processed by the Control terminal **PC-1** (see Fig. 4.4) is supplied.
- The microwave cavity (**RF cavity**) with the **Storage bulb**. The cavity is being to be tuned by the **Varactor**, to which the driven voltage formed by the DAC of the **Physical package** is supplied. The control code for DAC is formed by the **microprocessor** of the same unit on the basis of codes generated in **PC-1**.
- The system that forms the beam of the excited hydrogen atoms irradiated the signal in the microwave cavity.

The beam of hydrogen atoms is formed as follows.

The intermetallic compound $(\text{LaNi}_5\text{H})_x$ is used as **H2 supply**. While the compound is heated the molecular hydrogen is desorbed. The gaseous hydrogen goes into the purifier.

The hydrogen purifier (**Nickel purifier**, see Fig. 4.2) represents by itself the thin-walled nickel tube rolled - up in a spiral. The change of the tube penetrability is provided by the electrical heating by the current up to 1 Ampere (the purifier current) at the voltage up to 1 Volt.

The molecular hydrogen after the purifier is subjected to the dissociation and is excited in the **Discharge bulb**. The electrical glow discharge in the bulb is excited by the high-frequency oscillator (**HF Oscillator**). This oscillator provides the electrical field with the frequency 100-120 MHz and the strength of the order 1000 Volt/cm. The intensity of the glow discharge is monitored by the photo-resistor sensor.

Hydrogen atoms from the **Discharge bulb** (through the collimator) fall into the field of the quadrupole magnet (**4-pole state selector**). This magnet sorts the excited atoms.

The atoms of the excited hydrogen, that have been sorted out, are injected into the **Storage bulb** located in the center of the microwave cavity. The weak longitudinal magnetic field (C-field) is imposed onto the bulb. This field splits the hyperthin structure of the hydrogen main state arisen as the result of the interaction between the electron spin and the nucleus spin.

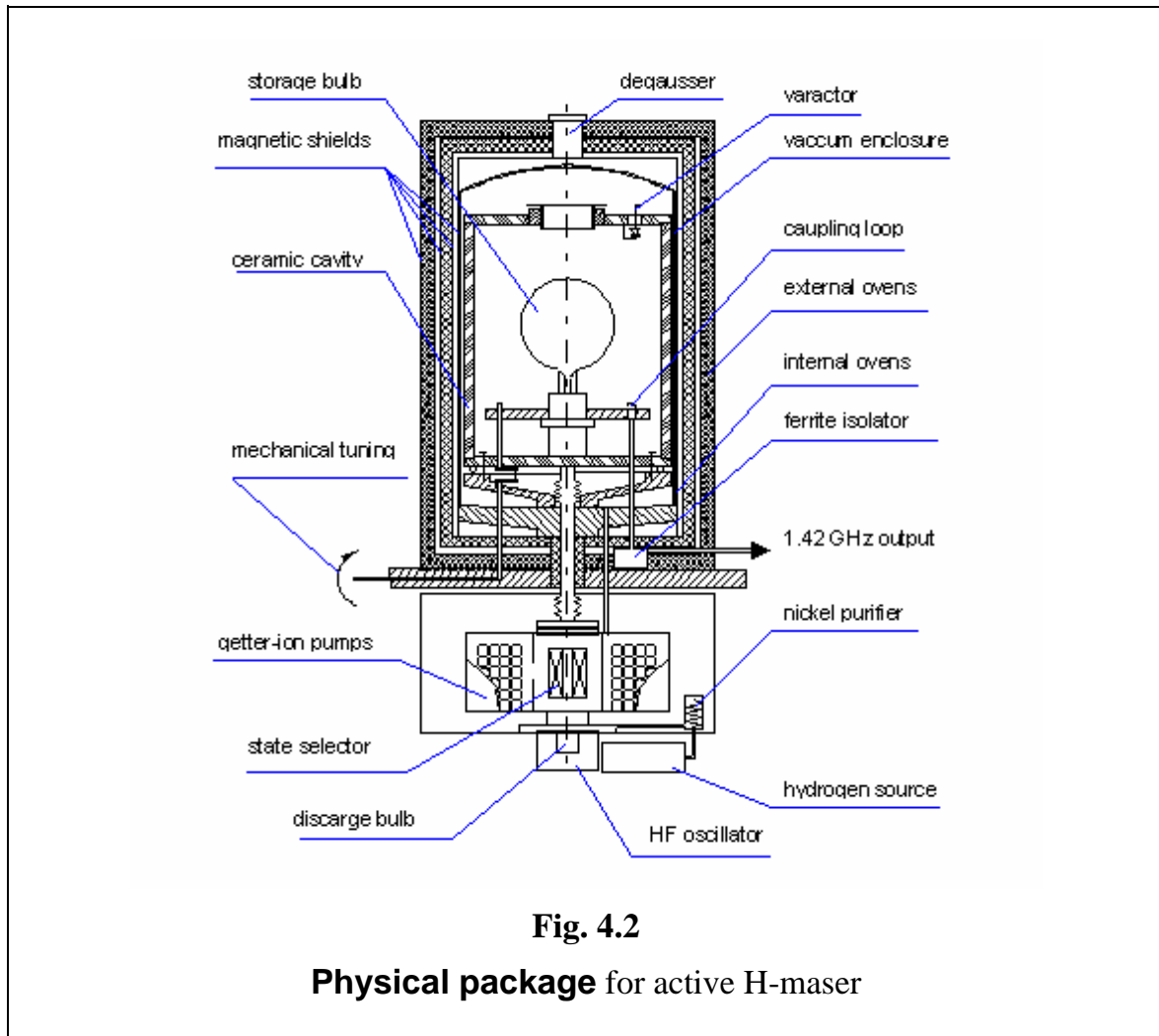


Fig. 4.2

Physical package for active H-maser

The induced radiation of the hydrogen atoms occurs in the storage bulb. The received signal, through the **Receiving loop**, the **Ferrite isolator**, and coaxial plug is transferred to the low-noise preamplifier of the **Synchronization unit** (see Section 4.4.1).

To stabilize the beam of the hydrogen atoms the system of the registration of the change in the hydrogen flow (**Beam stabilizer**) is used. The change in the hydrogen pressure yields the change in the temperature of the flow. The last one is checked by the thermoresistor Pirani-gauge.

To eliminate the dependence of the irradiated signal frequency on the external magnetic fields and the temperature there the systems of the **thermostats** and magnetic shields are used, inside of which the microwave cavity of the maser is placed.

The system of magnetic screening contains of 4 screens. The factor of the screening equals approximately 10^5 .



Two-step multi-zone thermostabilization system provides the keeping of the microwave cavity temperature with the accuracy $0.001\text{ }^{\circ}\text{C}$. The measurement of the temperature is executed by gauges placed in different points of the system.

The additional (and variable on the strength) inhomogeneous magnetic field, intended for the change of the quality factor of the hydrogen emission line, is created in the storage bulb of the microwave cavity.

Two independent vacuum systems provided by the **Getter pump** and two **Ion pumps** are used in the maser.

The getter pump, in the combination with the first ion pump, makes and supports the vacuum in the system of the atomic hydrogen beam formation. The second ion pump provides the vacuum in the **RF cavity**, and the third one is a spare.

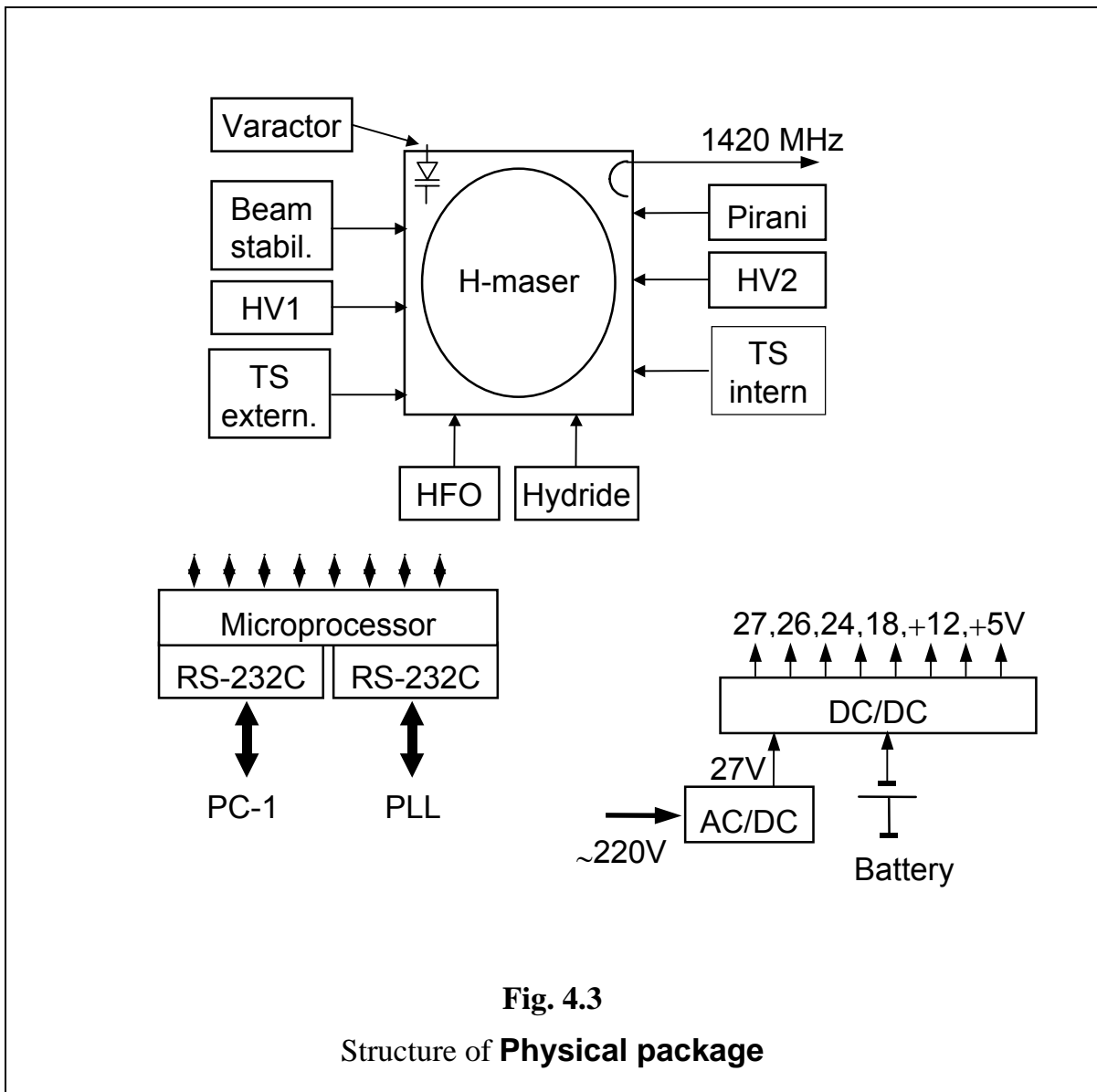
The activation of an absorber in the getter pump is carried out on the factory-manufacturer by the electrical heating up to temperature $800\text{ }^{\circ}\text{C}$. The switching ON of ion pumps is to be carried out in conditions of high vacuum with pressure of residual gases not more $1\cdot 10^{-7}$ mm of Hg.

The quality of the vacuum is checked by the current of ion pumps and by the thermo resistor Pirani-gauge installed in the system of the hydrogen beam formation.

Structure of the **Physical package** is shown in Fig. 4.3.

The following basic elements are shown in this figure.

- **TS extern. / intern** – external and internal thermostats supplied with voltages +24V and +18V.
- **HV1 / 2** – high voltage sources having the power supply + 24V.
- **Beam stabil.** – hydrogen beam stabilizer having the power supply + 24V.
- **HFO** – high frequency oscillator having the power supply + 26V.
- **Hydride** – source of molecular hydrogen.
- **AC/DC, DC/DC** – converters of power supply voltages.
- **Microprocessor** – the internal microprocessor that provides the management by the **Physical package**, and the link between the **Synchronization unit** and the Control terminal **PC-1** through the interface **RS-232C**.
- **Battery** –battery 21–30V.



4.4. Synchronization unit

The **Synchronization unit**, as the basic functions, provides:

- Formation of output signals of the Standard,
- Generation of signals for the management by systems of the frequency automatic tuning.

The **Synchronization unit** provides the operation of two systems.

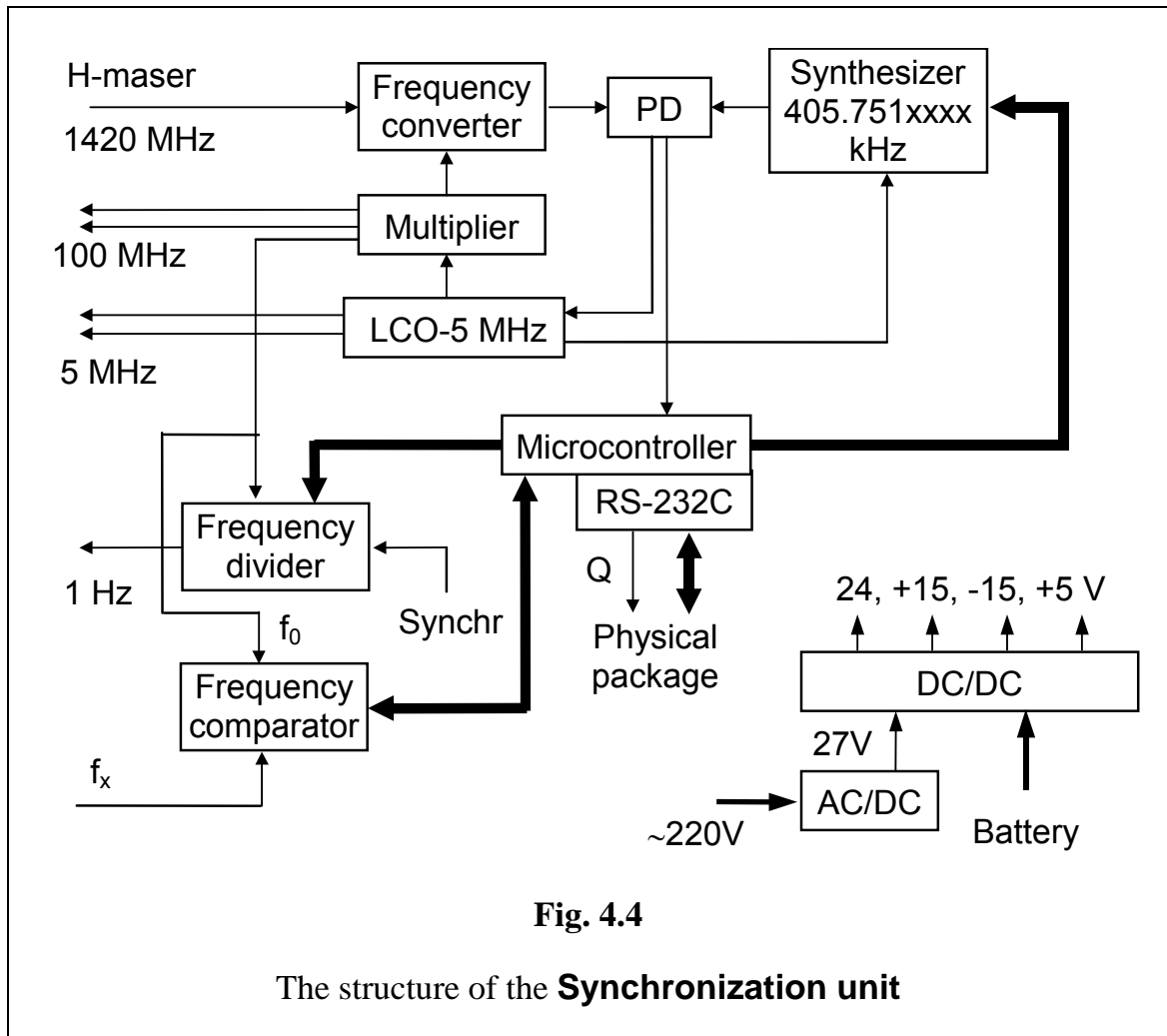
- 1) The phase-auto-tuning system of the frequency of the local crystal oscillator 5 MHz to the signal of H-maser (further – system **LCO-PLL**);
- 2) System for the auto tuning of the frequency of the microwave cavity.



The structure of the **Synchronization unit** is shown in Fig. 4.4.

The power supply unit consisting of the converters **AC/DC** and **DC/DC** is separately shown here. The power supply (**~220V** and **Battery 21–30V**) for this unit is taken from the **Physical package**. The output voltages have the following purpose.

- **24V** – the power supply for the local crystal oscillator (**LCO-5MHz**).
- **+15V, -15V, +5V** – the power supply for electronic circuits of the **Synchronization unit**.





4.4.1. System LCO-PLL

The main elements of the system are shown in Fig. 4.4.

The system for the phase locking of the local crystal oscillator 5 MHz (**LCO-5 MHz**) by the signal of the hydrogen maser (**Physical package**) contains the following elements:

- The low-noise **Frequency converter**;
- The frequency **Multiplier**;
- The phase detector (**PD**);
- The tunable frequency synthesizer 405.751xxxx kHz (**Synthesizer**).

The **Frequency converter** provides the conversion of frequency 1.420... GHz (of the signal generated by the maser) to the frequency of the phase detector 405 ... kHz. The signal of the local crystal oscillator 5 MHz, transformed in the **Multiplier**, is used as the reference signal for the converter.

The tunable frequency **Synthesizer** is used for the formation of the reference signal for the phase detector. The synthesizer provides the discrete electronic tuning of output frequencies with the relative step 10^{-14} from their nominal values.

The signal from the phase detector (**PD**) output is subjected to the low-frequency filtering, and is used for the tuning of the local crystal oscillator 5 MHz.

4.4.2. System of the microwave cavity tuning

The tuning of the microwave cavity resonant frequency onto the top of the hydrogen emission line is executed as follows.

Actually, the maser is the auto-oscillating system with two resonators. It contains the microwave cavity, the second resonator is presented by the hydrogen emission line.

While the resonators are detuned, the effect of the dragging of the oscillation frequency takes place. This effect is described by following approximate relation:

$$f_0 = f_H + \frac{Q_C}{Q_H}(f_C - f_H).$$

Here

f_0 is the maser oscillation frequency;

$f_H = 1\,420.4057517$ MHz is the frequency of the hydrogen radiation spectral line top;

f_C is the resonant frequency of the microwave cavity;

$Q_H \approx 2 \cdot 10^9$ is the quality factor of the hydrogen radiation spectral line;

$Q_C \approx 4 \cdot 10^4$ is the quality factor of the microwave cavity.

Thus, the change of the quality factor of one resonator results in the shift of the maser oscillation frequency. This shift is proportional to the detuning of the resona-



tors. If the detuning is equal to zero then the change of the quality factor does not affect the frequency of the output signal.

To tune the microwave cavity in the maser VCH-1005 the cyclic modulation of the quality factor of the hydrogen emission line is performed. The modulation of the quality factor is made in two following ways.

- By the change of the beam intensity of excited hydrogen atoms injected into the microwave cavity;
- By the imposing of the inhomogeneous magnetic field on the storage bulb located inside the microwave cavity.

The change of the beam intensity of excited hydrogen atoms, in turn, is realized also in two ways:

- Through the modulation of the molecular hydrogen flow by the change of the penetrability of walls of the nickel tube used as the purifier (see Section 4.3);
- By the modulation of the output power of the high-frequency oscillator used for the dissociation and excitation of hydrogen.

The modulation of the nickel purifier penetrability is characterized by large inertia because this mechanism is realized by the change of the temperature of the purifier pipe. The use of this way excludes the modulation of the inhomogeneous magnetic field and the high-frequency oscillator output power.

The ways mentioned above permit to modulate the quality factor of the hydrogen emission line by the depth up to 50 percents.

The Standard VCH-1005 may operate in different tuning modes: autonomous and non-autonomous that requires reference signal from another maser. Autonomous mode is described in the document “The Brief Description of the Autonomous System of the Microwave Cavity Tuning in the H-Maser Frequency and Time Standard VCH-1005”. Autonomous mode is available when non-autonomous mode is not activated (see Section 6.3.7.c).

As it was mentioned above, the non-autonomous mode requires reference signal from another maser. There are different regimes of non-autonomous tuning depending on variables determined in the file *h_server.ini* (see page 23). The structure of managing links is shown in Fig. 4.5.

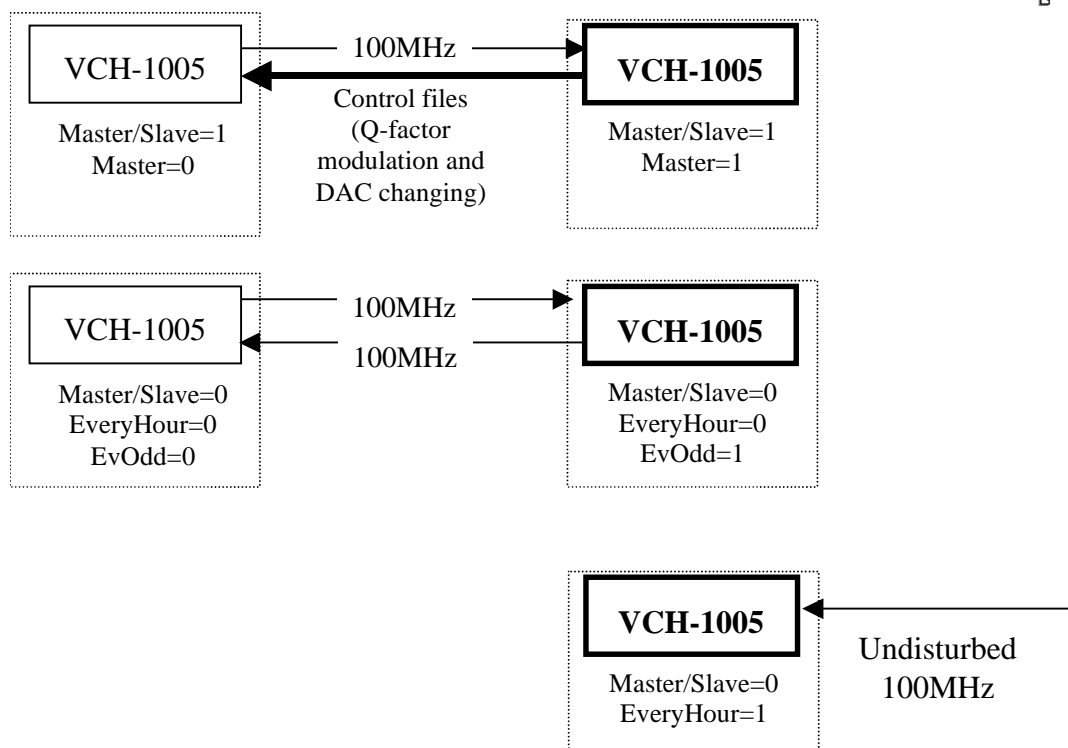


Fig. 4.5. Structure of links for the non-autonomous tuning of Standards

The built-in Frequency comparator with the Time Interval Meter is used for the measurement of the relative frequency difference $df=(f_x-f_0)/f_0$ in this case. The discrepancy signal is calculated without accumulation of results.

The period (in seconds) of the modulation of the quality factor is to be predetermined through the keyboard into the field **Period** of the window **Control** (see Section 6.3.7.c). The detected difference between frequencies of the Standard at high and low meanings of the quality factor expressed in terms of 10^{-15} is displayed in the field **dF*1e15**.

The rough tuning of the oscillation frequency is stipulated in the system. The additional two-digit DAC (**DACaux**) is used for this purpose. The code of the additional DAC is to be set in file **h_server.ini**. The resulting driven voltage is the sum of output voltages of both DACs.

It's necessary to change DACaux value when the code of main DAC come near lower or upper limits, i.e. 1000 and 32000 respectively.

4.5. The output signals

The output signals 5 MHz, 100 MHz and the signal of the time scale 1 Hz are formed in the Standard (see Fig. 4.4).

1. The signals 5 MHz are taken from the outputs of the local crystal oscillator (2 outputs).
2. The signal 100 MHz is formed in the frequency multiplier, and through buffer amplifiers is put to outputs of the Standard (2 outputs).



3. The time scale 1 Hz is formed by the **Frequency divider**. Following to the command from the Control terminal **PC-1**, acting through the **Interface RS-232C**, the time scale signal formed by the Standard can be synchronized by the external time scale pulse submitted to the input **Synchr**.



5. INSTALLATION INSTRUCTIONS

To install the software of the Standard the certain requirements to the configuration and software of personal computers must be fulfilled.

5.1. Requirements to personal computers

5.1.1. Host computer **PC-1**

For the functioning of the Standard the use of the host computer with the type not lower than Pentium, RAM 128 Mb, hard disk 500 Mb and RS-232C port are necessary.

The host computer **PC-1** executes the functions of the Control terminal. The operational system Windows 95,98,2000,XP should be installed on this computer.

To provide the function of the remote management through the phone it is necessary to connect a modem to the computer, and to install the software Dial up server.

To provide the function of the remote management through Internet the computer should be continually connected to Internet, and have the fixed IP address. Besides, it is necessary to put the program of the FTP-server into the Start Up folder of the host computer.

5.1.2. Remote computer **PC-2**

The remote computer **PC-2** provides the functions of the User terminal. It is possible to use a computer of the type IBM PC/AT with the following minimal configuration: the processor Pentium, RAM 128 Mb, hard disk 500 Mb.

The operational system Windows 95 (or higher) should be installed on the remote computer.

To provide the function of the remote management through the phone it is necessary to connect a modem to the computer.



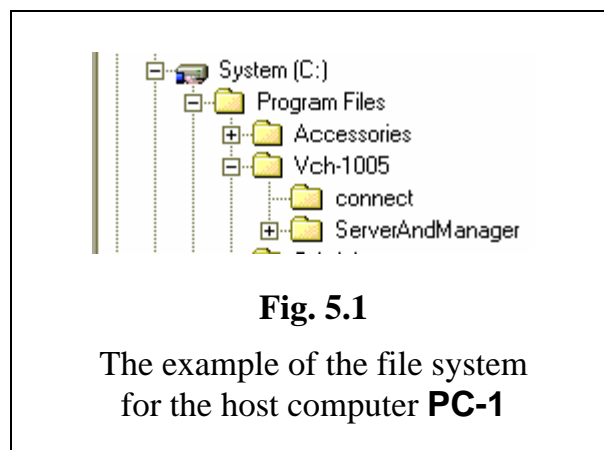
5.2. Installation of the software

The installation of the software is to be executed from the CD. The CD contains two folders: *Server And Manager Software* and *Manager Software*.

The installation of the software on the host computer **PC-1** is executed from the folder *Server And Manager Software* of the CD. The installation of the program-manager on the remote computer **PC-2** is executed from the folder *Manager Software*. To install the software it is necessary to run the file *setup.exe* from appropriate folder.

An example of the file system for the host computer **PC-1** is presented in Fig. 5.1. The folder **VCH-1005** with two subfolders that have the identical level is shown here.

- **connect** – the folder containing files for the providing of the data exchange between the program-server and the program-manager (this folder is created automatically by the program Server);
- **ServerAndManager** – the folder containing the program-server and the program-manager.



The arrangement on disks of the computer and the names of all catalogues, except the folder **Connect**, can be arbitrary.

The folder **Connect** should be announced as **home** for the remote users. The appropriate declaration is to be made when the FTP server is set. This folder should be announced as the **shared resource** (to provide the management through the remote terminal).

For the system security the folder **ServerAndManager** should be closed for the external users. All higher level catalogues are also recommended to close for the external users.

While the software is being installed on the host computer **PC-1** it is necessary to place the program-server into the **Start Up** folder.



5.3. File hmanager.ini

The installation of the software results in occurrence of the file *hmanager.ini* in the folder **Server**.

The example of this file (with the brief comments) is shown below.

[Server]

ServerPath=C:\Connect – The complete way to the folder **Connect**
Local=-1 – The type of the connection with the program **Server**
LAN=0
DialUp=0
TCP/IP=0

[TCP/IP]

Host=127.0.0.1 – **IP** address of the Control terminal
User=abcd – The name of the User
Passv=2222 – The password for the connection through Internet

[GaugeAdj]

Adjust=0 – The key to change the set “Limits” of the Standard

[Common]

Passv=>:45 – The encrypted password of the program-manager



5.4. File `h_server.ini`

The installation of the software results in occurrence of the file `h_server.ini` in the folder **Server** with the software.

As an example, the part of this file (with brief comments) is shown below.

[Tune] – Group of parameters, responsible for the tuning of the cavity
 **** Group of parameters, responsible for the autonomous tuning
 (see “The Brief Description of the Autonomous System of the Microwave Cavity Tuning in the H-Maser Frequency and Time Standard VCH-1005”)

NCycl=0 – number of cycles elapsed since beginning of tuning

AutoTuneNAver=999

– number of averagings

AutoTuneELimit=550

– the detuning threshold. If the relative detuning exceeds this limit, the proportional tuning of the microwave cavity is executed using next parameter **AutoTuneSlope**

AutoTuneSlope=30

**** Group of parameters, responsible for non-autonomous tuning

Pause=30 – Pause in seconds after the switching of Q-factor before the first measurement of the difference between phases (if the beam intensity of excited hydrogen atoms is modulated by the change of the nickel purifier current then set **Pause=300**)

LogFile=1 – The protocol of the tuning is allowed to be written to the file (the protocol is not saved if **LogFile=0**)

Prop=1 – Mode of the proportional tuning the microwave cavity. That is the correction of the DAC code is proportional to the detuning if the detuning exceeds **dFLimit \times 1.e-15**

EvOdd=0 – If **Master/Slave=0** then the Standard is tuned every even hour (1:00-1:59, 3:00-3:59,...),
 for **EvOdd=1** – every odd hour

In these modes the Period of quality factor modulation (see 6.3.7.c) should be less than 1 hour, for example, 1000 - 3500 sec.

EveryHour=1 – The Standard is tuned continuously without taking into account the meaning of **EvOdd**, the external reference signal is necessary. This mode requires to set **Master/Slave=0**

Master/Slave=1 – The Standard tunes itself and the External Standard VCH-1005. If **Master/Slave=0** then the mode “Even/Odd Hour” or “Every Hour” is used for the Standard VCH-1005

Slope=55 – The relative change (in units of the 17th digit) of the frequency of the Standard corresponding to 1 ADC step. This parameter is used at



- large detuning (more than **dFLimit**×**1.e-15**) and **Prop=1**, and in the mode “Even/Odd Hour” for the selftuning of the Standard
- SlaveSlope=55** – The same as **Slope** but is used for the tuning of the External Standard. This parameter is used by the Standard VCH-1005 for the calculation of the correction to the ADC code of the External Standard
- dFLimit=50** – The detuning threshold. If the relative detuning exceeds **dFLimit**×**1.e-15** then the change of the ADC code is made by large steps $10 \times \mathbf{Step}$ (for **Prop=0**) or proportionally (for **Prop=1**)
- Step=8** – The meaning of the small step. It is adapted if **AdapStep=1** but can not exceed the meaning 40
- SlaveStep=5** – The same as **Step** but is used for the tuning of the External Standard. This parameter is used by the Standard VCH-1005 for the calculation of the correction to the ADC code of the External Standard
- Step0=10** – The starting meaning for the small step. This parameter is used when the detuning exceeds **dFLimit**×**1.e-15**.
- AdapStep=1** – This parameter allows the adaptive choice of **Step** depending on the process of the tuning:
- If the quantity of steps in one direction exceeds these in the opposite direction on **Ndir1** steps (over **Cdir** cycles) then the meaning of **Step** is increased twice
- If the quantity of steps in one direction is less than in the opposite direction on **Ndir2** steps (over **Cdir** cycles) then the meaning of **Step** is decreased twice
- CDir=21**
- Ndir1=13**
- Ndir2=6**
- TCounter=100** – The counting interval [seconds] for the determination of the difference between frequencies
- [Mode]**
- BigWindow=1** – In the window of the program the current debug information is displayed
- CalibrMode=1** – The HFO and the Beam are not switched OFF if the current of ion pumps is too high, the erroneous measurements of parameters are not discarded. If **CalibrMode=0** then the HFO and the beam are switched OFF if the current of ion pumps is too high, and erroneous measurements are discarded.
- WriteErrs=1** - The program writes the file "Errs.dat" containing error codes.

[DAC]



-
- DACcode=18908** – The code of the main ADC (see Section 4.4.2. System of the microwave cavity tuning)
- DACaux=1** – The code of the auxiliary ADC. This code is used for the setting of the region of the driven voltage
- [COMM]**
- HG=COM1** – The serial port, to which is connected the block HG
- PLLU=COM1.2** – The serial port, to which is connected the block PLL. The name of this port must always be ended by “.2”



6. TERMINALS AND SCREEN INTERFACES

6.1. Control terminal PC-1

While the host computer **PC-1** (that provides the functions of the Control terminal) is switched ON, the automatic loading of the system **Windows** and the activation of the program-server occur.

The open window **Server** is displayed on the desktop of the computer. This window has no control tools (except system functions of the window management). It can be turned into the icon (see Fig. 6.1).

On the desktop of the Control terminal **PC-1** the icon **H-manager** is also displayed (see Fig. 6.2).

To provide the management by the Standard the program **H-manager** installed on the Control terminal is to be activated. It is necessary to execute actions specified in Item “b” of Section 6.2 for this purpose.

6.2. The management from the User terminal PC-2

The User terminal **PC-2** provides the functions of the remote management by the Standard. To switch the User terminal ON it is necessary to execute the following actions.

- a) To switch the computer ON, and to load the system **Windows**;
- b) To start the software by clicking the icon **H-manager** (see Fig. 6.2).

The inquiry of the password appears on the display after the activation of the program **H-manager** (see Fig. 6.3).

It is necessary to enter the password into this box (from the keyboard). Then the button **OK** is to be clicked by the mouse.



H-server

Fig. 6.1

The icon of the program **H-server**



H-manager

Fig. 6.2

The icon of the program **H-manager**

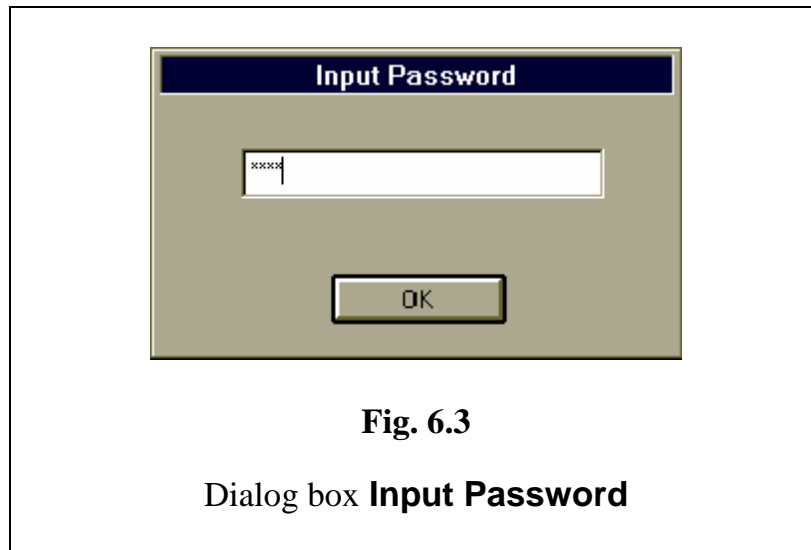


Fig. 6.3

Dialog box **Input Password**

6.3. Screen interface of the program “Manager”

When the terminal is switched ON, the screen interface **VCH-1005** appears on the computer display (the example of the interface with windows turned to icons is given in Fig. 6.4).



Fig.6.4

Fragment of the screen interface **VCH-1005** with icons **Control, History, Server Link Monitor, Watches, and DayHistory**

- **Watches** – is open by default;
- **Control** – icon by default;
- **History** – icon by default;
- **Server Link Monitor** – is open by default;
- **DayHistory** – icon by default.



On the remote terminal of the User **PC-2**, in case of the connection through Internet, the item **C**onnection appears in the main menu (see, for example, Fig. 6.11).

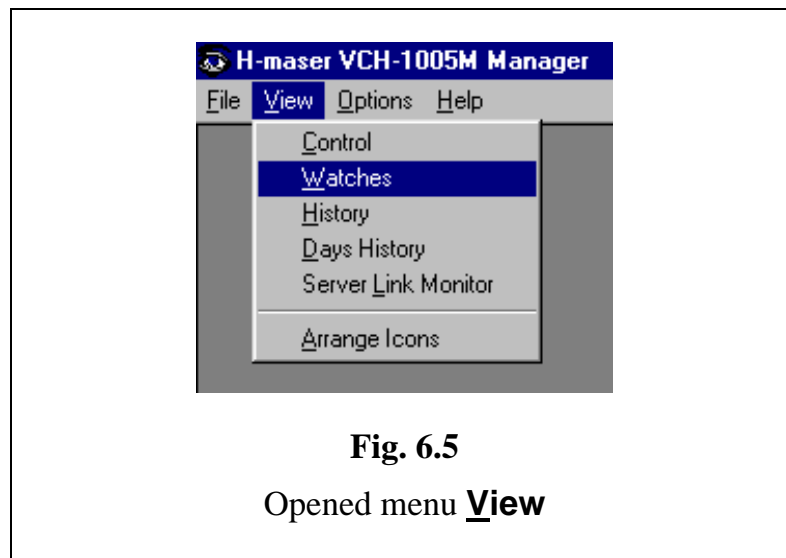
The contents of the main menu and windows of the interface are considered below.

6.3.1. Menu **F**ile

This menu contains the unique command **E**xit intended for the switching the screen interface OFF.

6.3.2. Menu **V**iew

This menu contains the following commands (see Fig. 6.5).



- **C**ontrol, **W**atches, **H**istory, **D**ayHistory, **S**erver Link **M**onitor
– Expanding of icons to the complete images.
- **A**rrange Icons – The arrangement of icons.

When the command **S**erver Link **M**onitor is activated the message box is opened (see Fig. 6.6).

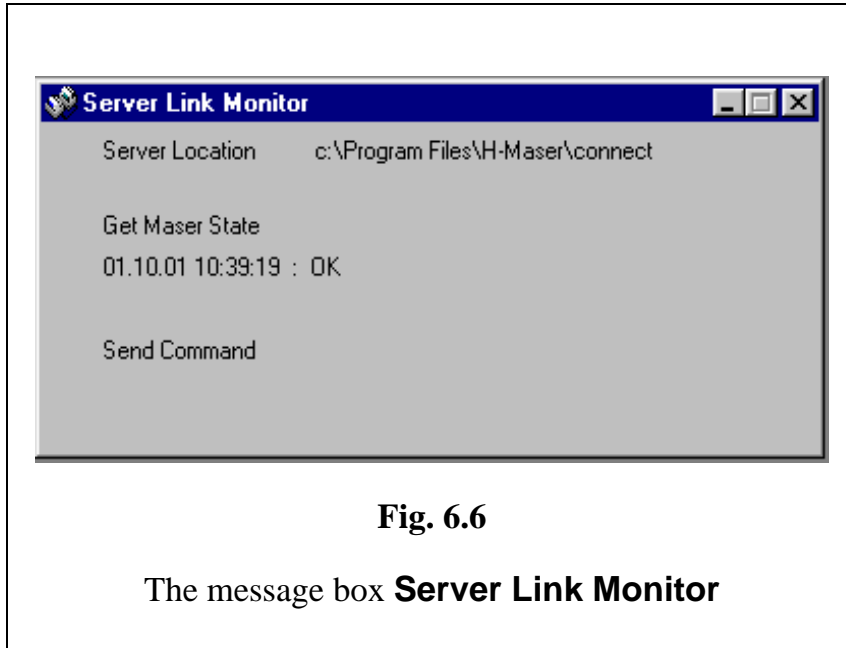


Fig. 6.6

The message box **Server Link Monitor**

The current status of the connection with the program-server is displayed in this box.

6.3.3. Menu Options

This menu contains two following commands (see Fig. 6.7).

- **H-maser server Location;**
- **Change Password.**

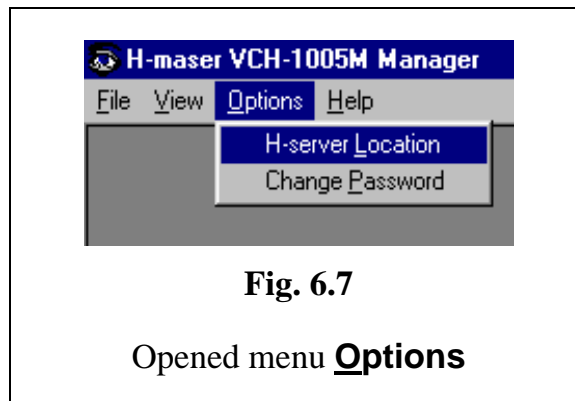


Fig. 6.7

Opened menu **Options**

6.3.3.a. *Command H-maser server Location*

The command **H-maser server Location** determines the way of the management (from control or remote terminal), as well as the choice of the folder **Connect**, in which the programs ensuring exchange by the data are placed. The activation of this command yields the opening of the dialog box **H-maser server location** represented in Fig. 6.8. This box contains three panels.



- **Location/Connection.**
- **Directory.**
- **TCP/IP.**

The following settings are executed from these panels.

- The type of the connection (work from the Control terminal, through the local network, telephone communication line, **Internet**) is set.
- The disk drive and the complete way to the folder **Connect** on the host computer **PC-1** (performing functions of the Control terminal) are specified.
- The data necessary for the maintenance of the remote connection (through the User terminal **PC-2**) are entered.

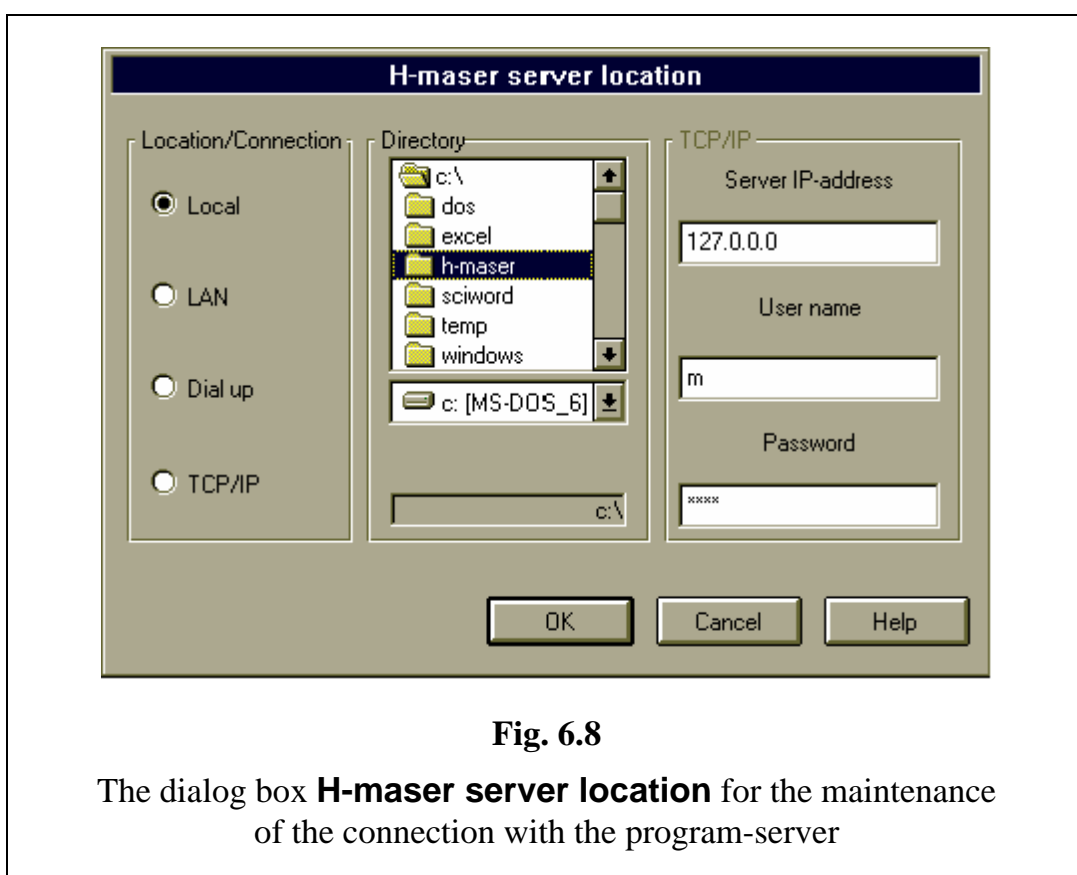


Fig. 6.8

The dialog box **H-maser server location** for the maintenance of the connection with the program-server

The panel **Location/Connection** is intended for the choice of the way of the connection. It contains the following buttons that ensure the management by the Standard.

- **Local** – Work from the Control terminal;
- **LAN** – Through the local network;
- **Dial up** – Through the telephone communication line;
- **TCP/IP** – Connection through Internet.



The panel **Directory** is intended for the indication of the disk drive and the way to the folder **Connect**. This panel becomes inaccessible when the button **TCP/IP** is activated, that is the work through **Internet**.

The choice of the disk drive is executed by the opening of the dialog box of the disk drives (the second window from the top).

The selection of the way to the folder **Connect** is executed by the double click by the mouse on the name of the required folder directory in the dialog box **Directory** (the first box).

The complete way to the chosen folder is displayed in the bottom (the third) box of the panel.

The panel **TCP/IP** is intended for the data input, necessary for the maintenance of the remote connection through **Internet**. This panel contains three dialog boxes.

- **Server IP-address;**
- **User name;**
- **Password.**

Into the dialog box **Server IP-address** the IP address of the host computer **PC-1** (performing function of the Control terminal, which contains the program-server) is entered (from the keyboard of the remote terminal **PC-2** of the User).

The dialog boxes **User name** and **Password** are intended for the identification of the User, possessing the right of the management by the Standard.

While working from the Control terminal **PC-1**, through the local network, or telephone communication line, the panel **Directory** becomes accessible.

The information, confirming correctness of the choice of the folder, appears in the case of the correct selection of the way to the folder **Connect** on this panel (between the box of the disk drive and the box of the complete way to the folder, see Fig. 6.9).

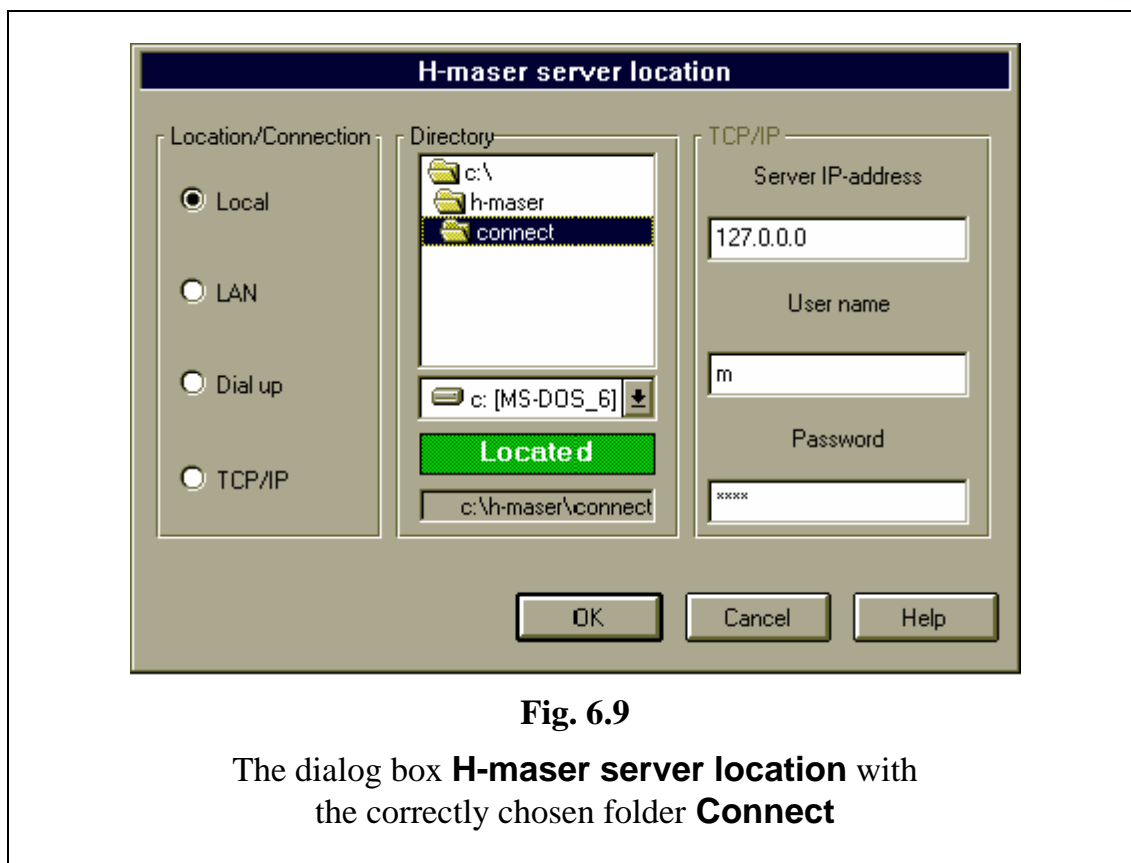


Fig. 6.9

The dialog box **H-maser server location** with the correctly chosen folder **Connect**

6.3.3.b. *Command **Change Password***

The command **Change Password** is intended for the change of the password that ensures the access of the program-manager.

When the program is installed the following fixed password is set.

vremyach

To change this (or entered earlier) password it is necessary to activate the command **Change Password**. As the result the dialog box, represented in Fig. 6.10, appears. After the dialog box **Change Password** is opened it is necessary to execute the following actions.

1. To type (from the keyboard) the old password into the box **Old Password**.
2. To type (from the keyboard) the new password into the box **New Password**.
3. To type again the new password into the box **Confirm New Password**.
4. To click the button **OK** by the mouse.

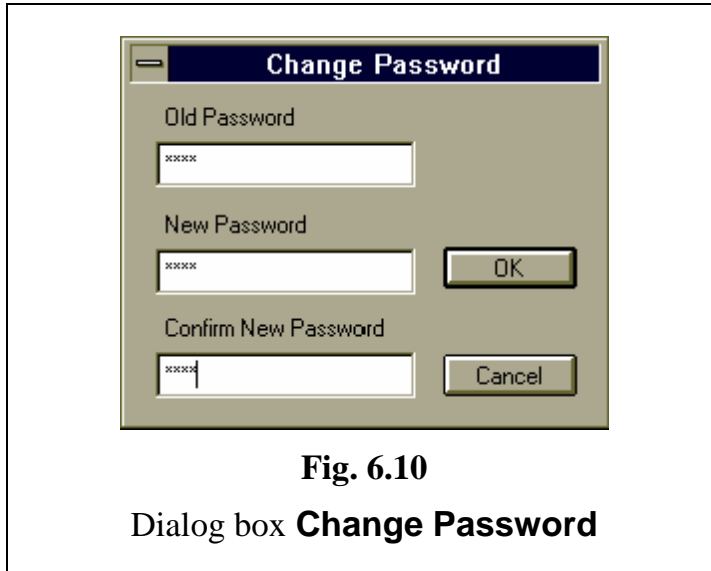


Fig. 6.10

Dialog box **Change Password**

6.3.4. Menu Connection

If the management from the remote computer **PC-2** through Internet is chosen (the dialog box **H-maser server location** of menu **O**ptions, see Fig. 6.8) then the menu **C**onnection becomes accessible. The content of this menu is represented in Fig. 6.11. The menu provides three commands.

- **C**onnect.
- **D**isconnect.
- **A**uto connect / disconnect.

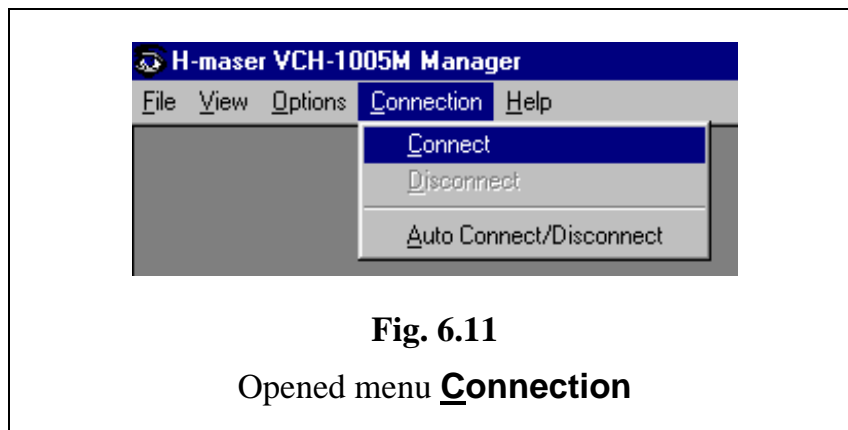


Fig. 6.11

Opened menu **C**onnection

The activation of the first two commands provides, accordingly, the switch ON and OFF of the connection with the program-server.

If the third command is activated then the connection takes place. It is automatically closed at the completion of data transfer.



6.3.5. Menu Help

Menu **H**elp is executed in the format accepted for the system Windows. It provides the call of the help system, and gives the information on the license agreement.

The help system supports the contextual information. This information can be asked from dialog boxes, and by the key F1 after the click by the mouse on any control tool in any window.

6.3.6. Window **W**atches

The fragment of the screen interface **VCH-1005** containing the expanded image of the child window **Watches** is represented in Fig. 6.12.

The date and time of the last record are displayed in the heading of this window (in brackets).

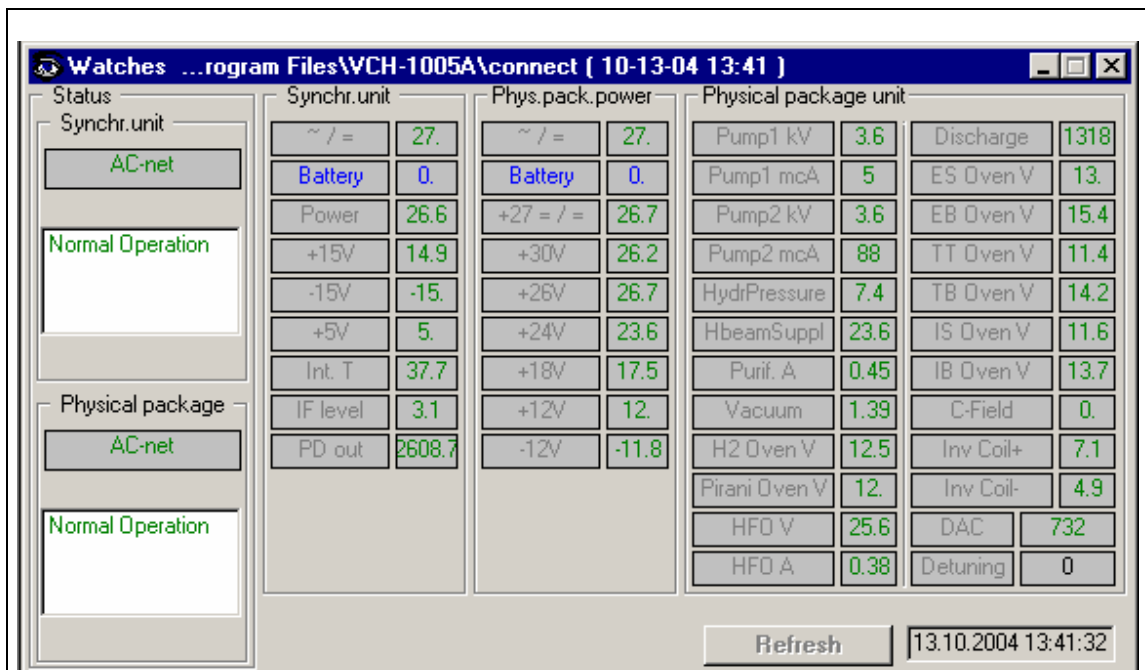


Fig. 6.12

Fragment of the screen interface **VCH-1005** with the expanded image of the child window **Watches**

The window **Watches** contains the following four panels.

- **Status;**
- **Synchr. unit;**
- **Phys. pack power;**
- **Physical package unit.**



The panel **Status** contains the following fields.

- 1) **Synchr. unit**
 - indication of the power supply used:
 - **AC net** – net supply 220V,
 - **Battery** – external battery;
 - the status of the **Synchronization unit**.
- 2) **Physical package**
 - indication of the power supply used;
 - the status of the **Physical package**.

In the field “the status of the **Synchronization unit**” one of the following messages is displayed:

Normal operation (in green color) – code 0000

Not connected (in red color) – code 4000

No synchronism (in red color) – code 0100

No 1 pps (in red color) – code 0200

1 Hz synchr. fail (in red color) – code 0400

The field “the status of the **Physical package**” may contain one of the following messages:

Normal operation (in green color) – code 0000

Not connected (in red color) – code 0040

All codes are summed and displayed in the column **SynErr** of the window **History**. For example, the code 0300 means, that no malfunctions is revealed in the **Physical package** (see two low-order digits of the code), but the synchronization is broken in the **Synchronization unit**, and there is no output signal 1 Hz.

The following indication is displayed on the panel **Synchr. unit**.

- 1) **Power** – the net voltage supplied through **Physical package**.
- 2) **AC/DC** – the voltage at the converter **AC/DC** output.
- 3) **Battery** – the battery voltage supplied through **Physical package**.
- 4) **+15V** – the voltage of the source **+15V**.
- 5) **-15V** – the voltage of the source **-15V**.
- 6) **+5V** – the voltage of the source **+5V**.
- 7) **Det 100 #1, Det 100 #2, Det 100 #3** – indication of the voltage in control points of the system that forms the signal 100MHz.
- 8) **Det 1420** – the check of the signal 1420MHz.
- 9) **Int T** – temperature of the block of the management by internal thermostats.
- 10) **IF level** – the voltage of the H-maser signal that is supplied to the system **LCO-PLL**.
- 11) **PD out** – the voltage at the phase detector output.



The panel **Phys. pack. power** displays the voltages of the **Physical package** power supply.

The panel **Physical package unit** (that contains two columns) displays the mode of the **Physical package** operation.

The digital gauges, that are located on these panels, display the meaning of checked parameters. The exit of the meaning out of the allowable limits is displayed by color of the gauge.

The green color means the normal mode.

Red color – excess of the allowable meaning.

Dark blue color – very low meaning.

The button **Refresh** and the box for the indication of the current date and time are placed at the bottom right corner of the window **Watches**.

The button **Refresh** is accessible only if the management of the Standard through the telephone communication line, or through **Internet** is provided. If this button is activated then the connection between the remote terminal of the User and the Control terminal is made.

In the case of the use of the telephone line, the connection is closed automatically (at the absence of transmitted data) after the expiration of the maximum allowable time.

At the connection through **Internet** the connection is closed at once after the completion of the data transfer.

The button **Refresh** provides the call of the server and refreshes the data of the gauges. This button duplicates the functions executed at the activation of the command **Auto connect / disconnect** from the menu **Connection**.

6.3.7. Window Control

The expanded child window **Control** is shown in Fig. 6.13. This window is intended both for the management of processes of switching ON/OFF and the adjusting of the Standard, and for the displaying of the status of separate units of the Standard.

The indicators of the control tools of the window **Control** provide two following functions.

- 1) The displaying of the commands entered through this window.
- 2) The displaying of the current status of the Standard (in the view of external commands entered, for example, from another terminal).

If the command is sent through the remote terminal of the User **PC-2** then its execution is confirmed by the Control terminal **PC-1** after some delay determined by the type of the chosen connection with the program-server.



This window contains the following panels.

- **On/Off;**
- **Method of Cavity Tuning;**
- **Cavity Tuning;**
- **Output frequency;**
- **Synchronization.**

The main part of the control tools of these panels is mutually dependent. These will be considered in a sequence.

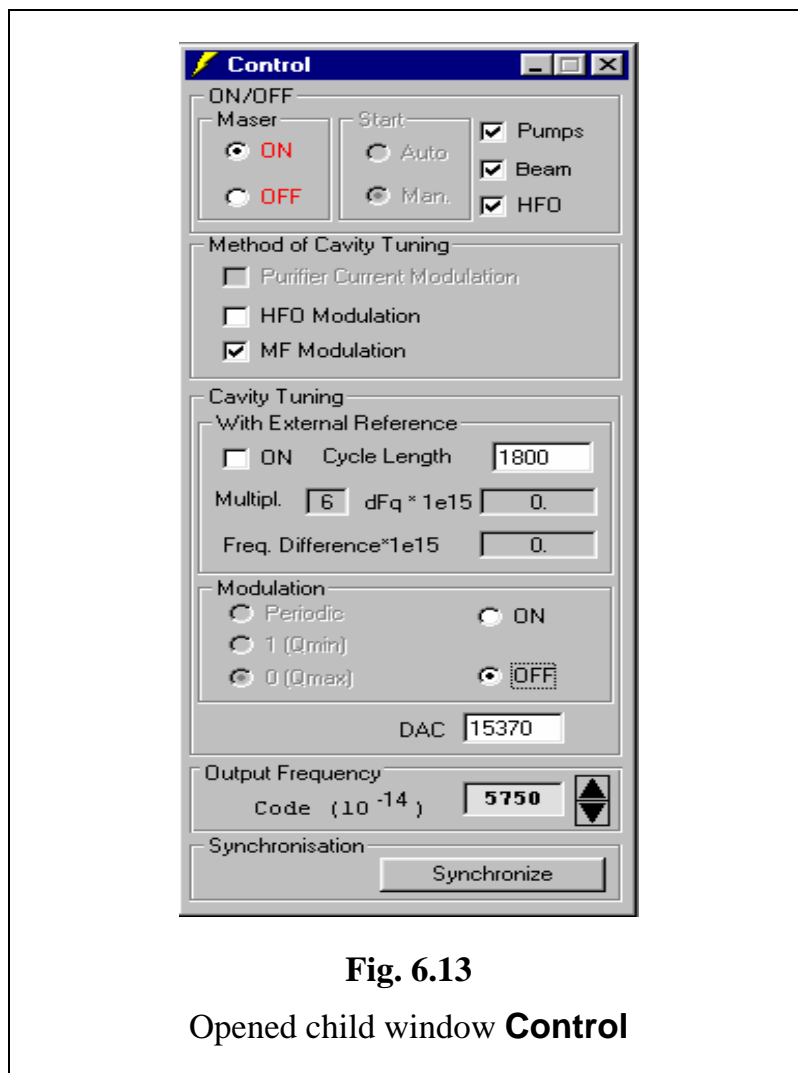


Fig. 6.13

Opened child window **Control**



6.3.7.a. Panel On/Off

The panel **On/Off** is intended for the switching ON and OFF of the maser. This panel contains three groups of managing tools.

The first group **Maser** has two trigger buttons: **ON** and **OFF**. The initial status before the switching ON of the maser is **OFF**, thus the tools of the third group (see below) are inaccessible.

The second group **Start** has also two trigger buttons: **Auto** and **Manual**. They are intended for the choice of the way of the switching ON of the maser - automatic or hand-operated. This group is accessible only at the activated button **OFF** in the group **Maser**.

The third group contains the managing buttons **Pumps**, **H-beam** and **HFO**. This group becomes accessible after the switching ON of the maser by the button **ON** located in the group **Maser**, provided that the hand-operated way of the switching ON by the button **Manual** of the group **Start** is chosen.

At first the button **Pumps** for the switching ON of ion pumps becomes accessible.

After the switching ON of the pumps by the button **Pumps** the button **H-beam** becomes accessible, with the use of which the beam of the hydrogen is switched ON.

The switching ON of the hydrogen beam by the button **H-beam** makes the last button **HFO** of the third group of the control tools to be accessible. The high-frequency oscillator that ensures the dissociation and excitation of molecular hydrogen, is switched ON by this button.

6.3.7.b. Panel Method of Cavity Tuning

The panel **Method of Cavity Tuning** is intended for the choice of the method of the tuning of the microwave cavity resonant frequency. The generation of the driven signal, that ensures the tuning, is executed by the modulation of the quality factor of the hydrogen emission line (see Section 4.4.2). The panel contains three buttons.

Purifier Current Modulation – The change of the current of the molecular hydrogen purifier.

HFO Modulation – The change of the high-frequency oscillator power.

MF Modulation – The change of the magnetic field in the storage bulb.

Two mutually exclusive methods of the tuning are possible.

The first method has large inertia. That is the modulation of the electrical current used for the heating of the nickel purifier of the molecular hydrogen.

To choice this method it is necessary to activate the button **Purifier Current Modulation**. Two other buttons become inaccessible in this case. This method is used in the hand-operated mode of the cavity tuning only when the device is been installing.



The second method has less inertia, it provides the tuning of the microwave cavity resonant frequency by two complementary ways.

- 1) Modulation of the output power of the high-frequency oscillator (button **HFO Modulation** is unavailable for delivered model of Standard).
- 2) Modulation of the additional inhomogeneous magnetic field imposed onto the storage bulb inside the microwave cavity (button **MF Modulation**).

Only second method is usable in the case of autonomous tuning of the microwave cavity. The button **Purifier Current Modulation** becomes inaccessible in this case.

6.3.7.c. *Panel Cavity Tuning*

The panel **Cavity Tuning** is intended for the switching ON and OFF of the tuning mode of the maser microwave cavity. It contains two groups of control tools.

The first group **With External Reference** contains the check-box **ON**, which activation turns the Standard to the non-autonomous mode of the tuning of the frequency (by the reference signal from other standard). Thus, the control tools of the autonomous and hand-operated tuning become inaccessible.

Into the field **Period** the period of quality factor modulation (in seconds) is entered from the keyboard. Usually the period 1800s is to be set.

Fields **K comp**, **dFq*1e15** and **Freq.Difference*1e15** become informative when the button **On** is activated. The field **K comp** shows the multiplication factor of the difference in the frequency (it is equal to 6 for this model of the built-in comparator). In the field **dFq*1e15** the difference between frequencies of the Standard at high and low meanings of the quality factor expressed in terms of 10^{-15} is displayed. In the field **Freq.Difference*1e15** the difference between frequencies of the Standard and an external reference in terms of 10^{-15} is displayed.

The second group **Modulation** becomes accessible when **Tuning with External Reference** is switched OFF.

Periodic – Periodic modulation. This button switches ON autonomous tuning.

1(Qmin) – Setting of logic unit (decreased quality factor).

0(Qmax) – Setting of the logic zero (maximum quality factor).

The buttons **Periodic**, **1** and **0** become accessible when the button **ON** is activated in the group **Modulation**.

6.3.7.d. *Panel Output frequency*

The panel **Output frequency** is intended for the correction of the frequency relative value of the Standard with the accuracy up to 14th digit after the decimal



point. The correction is necessary for the putting of the frequency standard value (for example, the standard frequency 1 Hz for the time scale signal). The correction can be made in two ways:

- by the typing of the required value (from the keyboard) after the activation by the mouse of the box containing the meaning of the frequency correction factor;
- by the mouse click on the appropriate control button located on the right side of the box (with the step 10^{-14}).

6.3.7.e. *Panel Synchronization*

The panel **Synchronization** contains the unique button **Synchr** for the synchronization of the time scale signal of the Standard by the external time scale pulse.

Attention!

The status of the window **Control** is saved at any way (scheduled, emergency) switching OFF of the host computer **PC-1** (that performs the functions of the Control terminal). The repeated switching ON of the computer results in the resumption of settings made before its switching OFF.

6.3.8. **Window History**

The child window **History** is intended for the display of the record of the Standard status. The record is displayed as the table, in which the date and time of the adjustment and the status of all controllable parameters, that were reflected by the windows **Watches** and **Control**, are displayed (see Fig. 6.14).

To get the recorded information on the status of the Standard it is necessary to activate the button **Refresh**.

The table of the record contains 100 rows. The separate row reflects the status of the Standard in the moment of the record. The record is being made each hour, at the occurrence of the failure, and at the change of the Standard operation mode by the User. The updating of the table is made by the displacement of the old records.

To view various parts of the table it is possible to use the scroll bars.

The width of each column may be changed with the purpose of viewing of its full contents. To change the column width its right border is to be seized by the mouse pointer. Then, at the pressed left-hand button of the mouse, it is necessary to move the border into the new position.

The contents of the group of the cells can be copied to the **Clipboard** for further copying into the worksheet **Excel**. For this purpose the following actions are to be executed.

1. To select by the mouse (at the pressed left-hand button) the required group of cells.
2. To click the button **Copy**.



As a result the data contained in the selected group of cells are copied into the Clipboard. These data may be copied into the new worksheet **Excel** with the help of command **Paste** from the menu **Edit**.

In the addition to the current record, another record is made daily into the file **dayhist.dat**, this one is intended for the check of the status of the Standard by the manufacturer. New records are appended to the file, without displacement of the previous records. To view the file it is necessary to open the icon **DayHistory** of the screen interface VCH-1005 (see Section 6.3).

Date & Time	ON	Pumps	Beam	HF0	PurMod	HF0Mod	MFieldMod	AutoTuning	Tuning
4-13-00 18:09	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 18:09	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 18:10	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 18:10	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 18:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 19:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 20:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 21:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 22:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-13-00 23:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-14-00 0:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-14-00 1:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-14-00 2:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
4-14-00 3:30	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No

Fig. 6.14

Child window **History** with selected group of cells



7. USER'S GUIDE

7.1. Switching of the Standard ON

The switching of the power supply of the Standard ON is executed by the switching ON of two blocks, that have independent power supply systems: the hydrogen maser, and the host computer (executing the functions of the control terminal **PC-1**).

7.1.1. Hand-operated mode

The hand-operated mode of the switching of the maser ON after the long (more than 10 days) break in the work is executed as follows.

1. To put the switch "Power" ON. It provides the switching of the following blocks ON.
 - a) **Physical package** and **Synchronization unit**.
 - b) Systems of the thermostabilization.

The time of the warm up of all thermostats takes 9 days.

2. To set the connection between the program-manager and program-server (only for the first, after the installation, execution of the software, see Section 7.4 on page 45).

All other switching are executed from the terminal by the activation of the control tools of the window **Control** (see Fig. 6.13 on page 37). The check of parameters, that describe the status of the Standard, is to be made via the gauges of the window **Watches** (see Fig. 6.12 on page 34).

3. Execute the following switching on the panel **On/Off**.
 - a) To activate the button **OFF** in the group **Maser**. As a result the group **Start** becomes accessible.
 - b) To activate the button **Manual** in the group **Start**.
 - c) To activate the button **ON** in the group **Maser**. As a result the buttons of switching ON of the maser units become accessible.



4. To switch the ion pumps ON by the button **Pumps**. The setting of the required vacuum is checked by the current of pumps.
5. After the current of pumps becomes lower than the installed limit (that is displayed by green color of the gauges **Pump1,2, mcA**), to switch ON the source of the molecular hydrogen, and purifier, by the button **H-beam**. The flow of the hydrogen from the purifier is checked by the gauge **Vacuum**.
6. While the required flow of the molecular hydrogen (indicated by green color of the gauge **Vacuum**) is reached, to switch ON the high-frequency oscillator for the initiation of the glow discharge, that ensures the dissociation and excitation of hydrogen (button **HFO**).
 - a) The operation of the high-frequency oscillator is to be tested by the voltage (**HFO Supply voltage**) and the current (**HFO Supply I**),
 - b) The presence of the discharge is to be tested by the photoresistor sensor (**Discharge brightness**).
7. After the glow discharge is appeared the setting of the synchronization in the **PLL-LCO** system occurs. The status of the system is tested by the following parameters.
 - a) By the voltage of the intermediate frequency signal in the system (**IF level**, this voltage is proportional to the H-maser signal).
 - b) By the voltage on the phase detector output (**PD out**).

The status of the **PLL-LCO** system is displayed in the field **Synchr. unit** of the panel **Status**.

8. After the setting of the synchronous mode it is necessary to switch ON the system of the automatic tuning of the microwave cavity. The following actions are to be executed for this purpose.

Method of the tuning of the cavity is to be chosen. It is recommended to activate the button **MF Modulation** or **Purifier Current Modulation** (но надо увеличить паузу в ini-файле) of the panel **Method of Cavity Tuning**. If the modulation of the purifier current is chosen it is necessary to increase in 10 times the parameter **Pause** in file **h_server.ini** (see page 23).
9. To synchronize the time scale signal of the Standard by the external time scale pulse it is necessary to click by the mouse on the button **Synchr** of the group **Synchronization**.

The Standard is ready for the operation after all parameters to be checked have the meanings located in the permitted limits. In this case in the fields **Synchr. unit**



and **Physical package** of the panel **Status** the message **Normal operation** is displayed, and all gauges have green color.

7.1.2. Automatic mode

It is recommended to use the method of the automatic switching of the maser ON by the button **ON** of the group **Maser** on the panel **On/Off**. Before the switching of the maser ON, it is necessary to make the following settings.

A) Panel On/Off , group Maser	OFF
B) Panel On/Off , group Start	Auto
C) Panel Method of Cavity Tuning	MF Modulation

The total time of the getting of the working mode of the Standard takes 10 days;
when thermostats are warmed up - not more than 1 day.

7.2. Temporary switching of the Standard OFF

If the Standard will not be used more than 10 days, it can temporarily be switched OFF. For this purpose it is necessary to activate the button **OFF** of the group **Maser** on the panel **On/Off**.

However, it is more preferable to switch the maser OFF without the switching OFF of the pumps. Such mode guarantees the preservation of the vacuum at the repeated switching of the maser ON after a long-duration break. To switch ON the pumps while the maser is switched OFF it is necessary to execute the following settings in the group **Maser** on the panel **On/Off**.

- 1) To activate the button **OFF**.
- 2) To activate the button **Manual**.
- 3) To switch OFF the button **H-beam**.
- 4) To activate the button **Pump**.

Attention!

At the temporary switching of the Standard OFF it is not recommended to switch OFF the power supply of the **Physical package**. Before the host computer **PC-1** is switched OFF it is necessary to close the software **H-server**.

7.3. Activation of the software

While the host computer **PC-1** is switched ON, the automatic loading of the program-server occurs.



The activation of the program-manager is to be executed pursuant to the instructions of Section 6.2 (see page 26).

The activation of the control tools of the Standard is to be executed pursuant to the instructions of Section 6.3 (see page 27).

7.4. Connection with the program-server

For the management by the Standard it is necessary to set the connection between the program-manager and the program-server (only for the first, after the installation, execution of the software). The command **H-maser server Location** from the menu **Options** is used for this purpose (see Fig. 6.7 on page 29). This command opens the dialog box **H-maser server location** represented in Fig. 6.8.

The sequence of further actions is determined by the chosen way of the connection.

7.4.1. Work from the Control terminal

While working on the host computer **PC-1** (that performs the functions of the Control terminal) it is necessary to execute following actions.

1. To activate the button **Local** on the panel **Location/Connection**.
2. To set the way to the folder **Connect** (through the panel **Directory**) intended for the organization of the data exchange.

The information, that confirms the correctness of the folder choice, is displayed on the panel **Directory** (between boxes of the disk drive and the indication of the complete way to the folder) in the case of the correct choice of the way to the folder **Connect** (see Fig. 6.9 on page 32).

The closing of the dialog box **H-maser server location** is to be made by the click on the button **OK**. The terminal is ready for the management by the Standard.

7.4.2. Work through the local network

While working on the remote computer **PC-2** of the User through the local network it is necessary to execute following actions.

1. To activate the button **LAN** on the panel **Location/Connection**.
2. To set the way to the folder **Connect** (through the panel **Directory**), intended for the organization of the data exchange.

The information, that confirms the correctness of the folder choice, is displayed on the panel **Directory** (between boxes of the disk drive and the indication of the complete way to the folder) in the case of the correct choice of the way to the folder **Connect**.

The closing of the dialog box **H-maser server location** is to be made by the click on the button **OK**. The terminal is ready for the management by the Standard.



7.4.3. Work through the telephone communication line

While working on the remote computer **PC-2** of the User through the telephone communication line it is necessary to execute following actions.

1. To set the parameters of the connection with the host computer **PC-1** (that provides the functions of the Control terminal) with the help of the software **Dial up networking**.
2. To connect the disk of the host computer **PC-1** (as the network disk) to the remote computer **PC-2** with the help of Windows Explorer.
3. To activate the button **Dial up** on the panel **Location/Connection**.
4. To set the way to the folder **Connect** (through the panel **Directory**), intended for the organization of the data exchange.

The information, that confirms the correctness of the folder choice, is displayed on the panel **Directory** (between boxes of the disk drive and the indication of the complete way to the folder) in the case of the correct choice of the way to the folder **Connect**.

The closing of the dialog box **H-maser server location** is to be made by the click on the button **OK**. The terminal is ready for the management by the Standard.

7.4.4. Connection through Internet

While working on the remote computer **PC-2** of the User through Internet it is necessary to execute following actions.

1. To activate the button **TCP/IP** on the panel **Location/Connection**.
2. Through the panel **TCP/IP** to set the address of the host computer **PC-1** (that contains the program-server), the User's name and password.
3. Close the dialog box **H-maser server location** by the click on the button **OK** after the setting of the connection.

The terminal is ready for the management by the Standard.

7.5. Correction of the frequency

The initial setting of the frequency of the Standard is made by the manufacturer. Nevertheless, the necessity may arise to make the correction.

To correct the frequency it is necessary to open the child window **Control** (see Fig. 6.13 on page 37). Then the correction of frequency of the Standard is to be made (through the dialog box on the panel **Output frequency**) with the relative accuracy up to the 14th digit after the point.



7.6. Manual tuning of the cavity

If the absolute value of the relative detuning of the frequency of the Standard (from the nominal value) exceeds 10^{-11} , then the rough tuning of the microwave cavity is to be made. It is necessary to change the code of auxiliary DAC (**DACaux**) by the correction of file **h_server.ini**.

The excess of the allowable detuning and its sign are determined on the gauges **DAC code** and **Cavity Detuning**, located at the bottom of the second column on the panel **Physical package unit** in the child window **Watches** of the screen interface **VCH-1005** (see Section 6.3.6).

The dark blue color on the gauges testifies the inadmissible low frequency, red color – the excess of allowable value.

7.7. Synchronization of the time scale signal

To synchronize the time scale signal of the Standard by the external time scale pulse it is necessary to execute the following actions.

1. Connect the cable from the receiver (that receives the time scale signal) with the coaxial plug of maser **Synchr**.
2. To click the button **Synchr** of the group **Synchronization**.

7.8. Closing of the connection

The actions, realized at the completion by the User of the work with the Standard, are determined by the used way of the connection between the program-manager and program-server.

1. The command **Exit** of the menu **File** may be used at any way of the connection (see Section 6.3.1 on page 28).
2. At the management by the Standard through **Internet** the completion of the connection can be executed by the command **Disconnect** from menu **Connection** of the main menu of the screen interface VCH-1005 (see Section 6.3.4 on page 33).
3. At the management by the Standard through the telephone line the connection is closed automatically after the expiration of the certain time of the absence of the exchange by commands and data between terminals.
4. At the management by the Standard through **Internet** the completion of the connection occurs automatically after the completion of the data transfer.



7.9. Change of the password

To change the password of the access to the program-manager the actions, described in Section 6.3.3.b (see page 32), are to be executed.

For the restoration of the fixed password it is necessary to modify the file *hmanager.ini* (see Section 5.3 on page 22). For this purpose in the block **[Common]** the text of the encrypted password, following after the equality sign in the line **Passv=**, is to be deleted.

7.10. Change of the admissions on parameters

Attention!

The procedures, described in this Section, are to be executed by the manufacturer of the Standard.

In the Standard the opportunity of the change of the allowable limits for parameters under the check is provided. In the mode, that is used at the installation of the software, this operation is not realized.

To get the opportunity of the change of allowable limits the file *hmanager.ini* (see Section 5.3 on page 22) is to be modified. For this purpose it is necessary to assign the value **1** to the variable **Adjust** (in the block **[GaugeAdj]**). This setting should be executed before the activation of the program-manager.

After the activation of the program-manager the contents of menu **Options** of the main menu is changed. Opened menu **Options** is represented in Fig. 7.1.



Fig. 7.1

Modified menu **Options**

To change the allowable limits the command **Tuning** in menu **Special** is to be activated. The change of limits is to be executed by the click of the right button of the mouse on the required gauge of panel **Watches**, that results the opening of the dialog box **Operation Limits** (see Fig. 7.2).

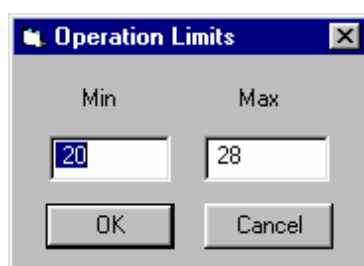


Fig. 7.2

Opened dialog box **Operation Limits** of the window **Watches**

The change of allowable limits is to be made by the typing of the required values (from the keyboard) into the boxes **Min** and **Max** been previously activated by the mouse.

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October 8, 2004