H-maser frequency and time standard

VCH-1006

Program "Monitor VCH-1006"

Operating manual

411141.012-0.14OM

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TABLE OF CONTENTS

1. General Information

Program "Monitor VCH-1006" is used to monitor passive hydrogen frequency and time standard VCH-1006 state, to print operated parameter value on the screen, in the main window of the program, and to save data to protocol files within selected periods of time. The program controls parameter value while working with hydrogen generator and prints them in different color (red – beyond tolerance limit, blue - below normal, green - normal).
See table 1 and 2 for description of operated parameters.

2. Installation

Put in compact disk from your delivery set and run "setup.exe" file, which is to be found in root directory. The installation program will request the name of the disk and working directory to copy working files in there. Put in requested data or keep default directory (C:\Program Files\Monitor VCH-1006). Press "OK". The program will copy the files and make a group of programs "Monitor VCH-1006" with an icon for the program run. Besides, a shortcut of the program "Monitor VCH-1006" will be added to folder "Startup" so that the program will run automatically every time computer is loaded. Corresponding message appears on the screen in case installation is completed correctly.

3. Program Operation

General view of the main window of the program is shown in figure 1. The window is divided into three parts for three groups of operated parameters: "Parameters", "Thermostats", "FLL system". Group "Parameters" shows parameters of different instrument units, measured by central processing unit. Group "Thermostats" shows parameters of the quantum hydrogen discriminator and resonator thermostating system under control. Group "FLL system" displays FLL system parameters. There are two status bars at the bottom of the window. The first one is used for printing current time and information about the number and type of the port through which the program is connected to the instrument, as well as the countdown of the time left till the next data receipt in seconds. The second status bar shows information about any operation completed by the program (data reading, user command execution, etc.), date and time of execution.

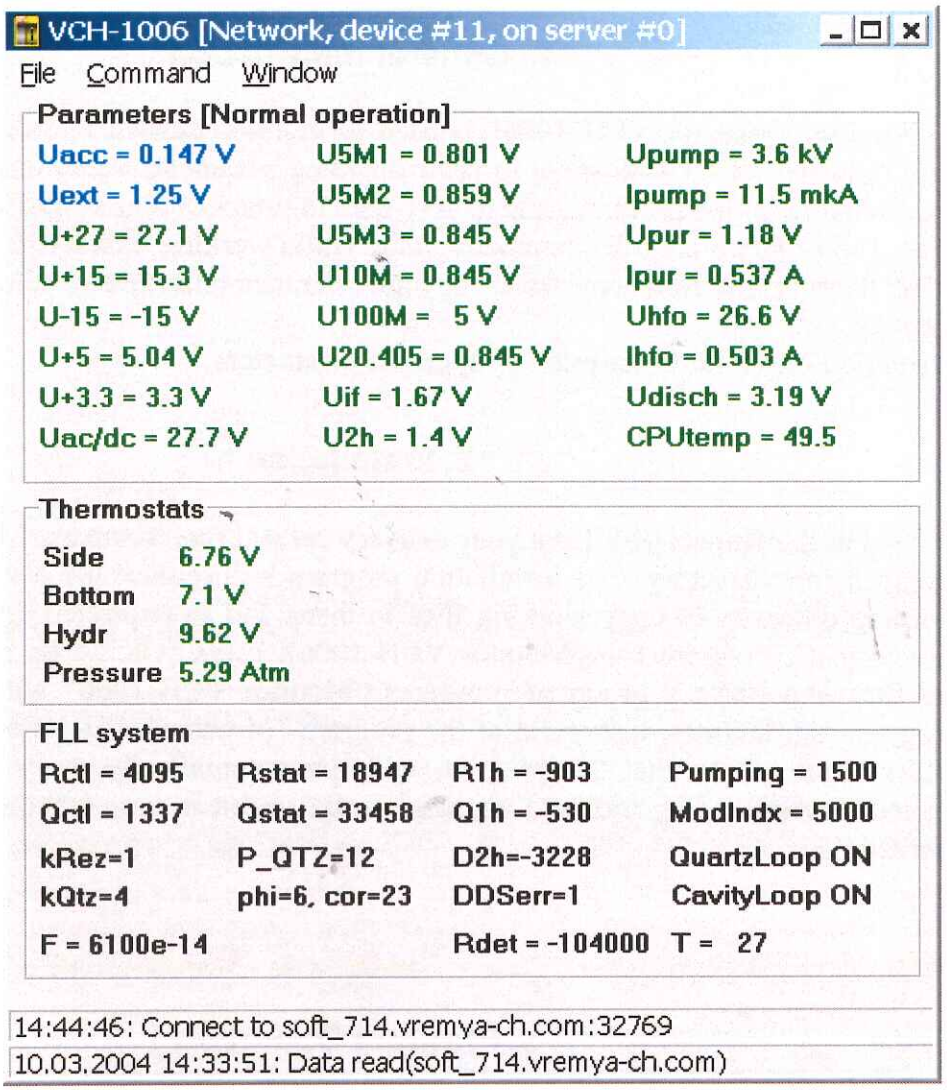


Figure 1

Parameter tolerance limits can be changed in case of individual setting of an instrument. Note that these limits in the program have nothing to do with the limits that are set in the monitor in VCH-1006 central processing unit, according to which error code for event log is formed (see p. 4.4 and 4.9). Tolerance limit modification in the program is used for different purposes not necessarily connected with malfunction diagnostics and presupposes that user, who performs it, is experienced enough.

Indication of limit overrun (red or blue color) does not mean that the unit is out of order, it only means that one of parameter value is higher or lower than a set one.

To change the limits bring mouse pointer to one of the parameters and press its left button. A corresponding dialog box appears on the screen (fig. 2). Put new data into the fields "min" and "max" and press "OK" for confirmation or "Cancel" for cancellation. To change the limits without a mouse, highlight parameter with the help of arrow keys (fig. 3) and press "blank".

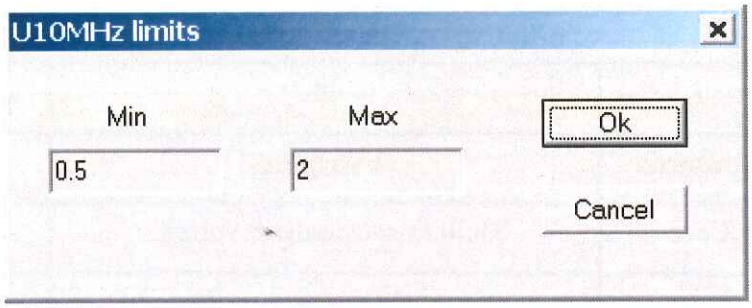


Figure 2

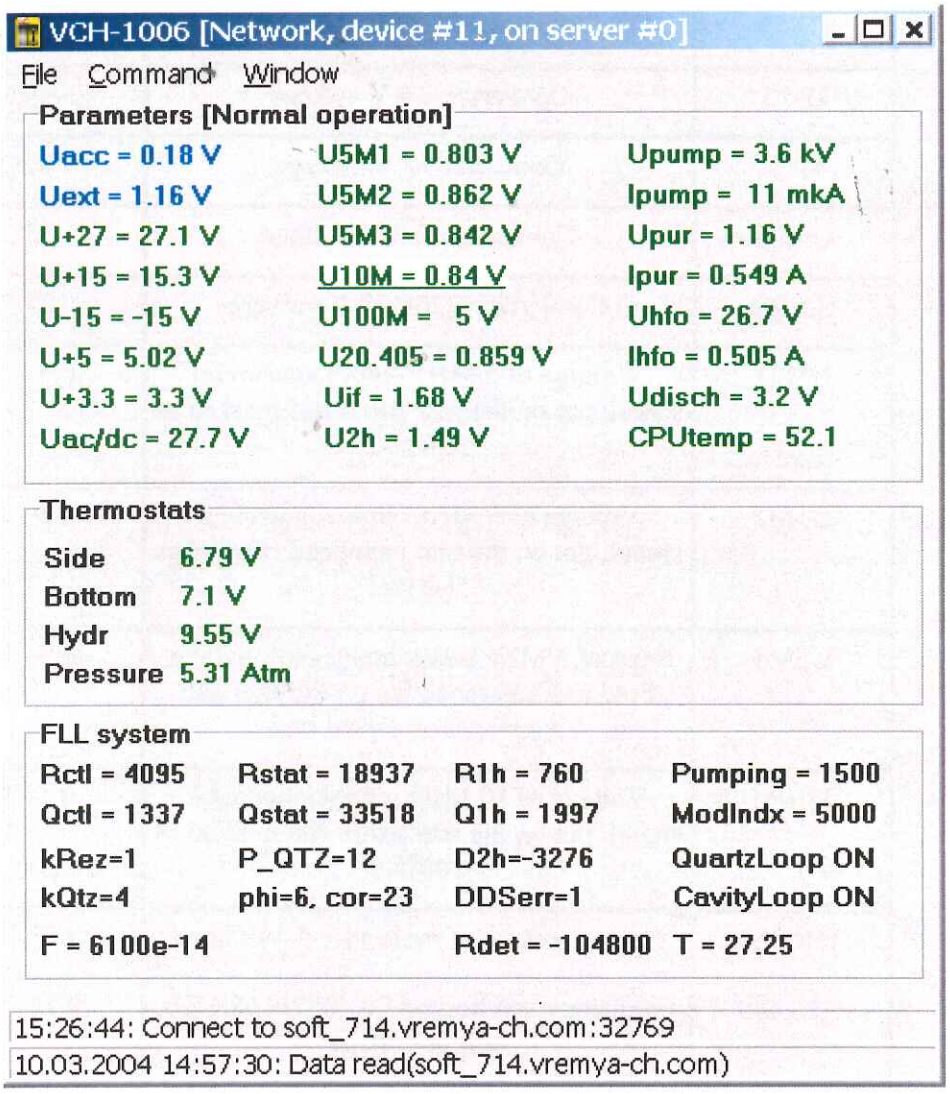


Figure 3

The program is also managed by means of menu commands (see p. 4).

Table 1. List of inspected parameters in groups "Parameters" and "Thermostats"

1	*2*	*3*
Parameter	***Description***	***Tolerance limits***
Uacc	Built in accumulator voltage	21.5 - 32V
Uext	External DC source voltage	22 - 32 V
U+27	Internal converter +27 V voltage	24 - 30 V
U+15	Converter +15 V voltage	13 - 18 V
U-15	Converter -15 V voltage	-13.5 - -18 V
U+5	Converter +5 V voltage	4.5 - 5.5 V
U+3.3	Converter +3.3 V voltage	3 - 3.5 V
Uac/dc	Converter ~220/+27 V voltage	23.5 - 30 V
U5M1	Voltage of 5 MHz output sinusoidal signal, put on the rear panel and marked as "5MHz-1"	0.5 - 2 V RMS
U5M2	Voltage of 5 MHz output sinusoidal signal, put on the rear panel and marked as "5MHz-2"	0.5 - 2 V RMS
U5M3	Internal 5 MHz sinusoidal signal voltage, used as a reference for synthesizer and interrogation signal unit	0.5 - 2 V RMS
U10M	Voltage of 10 MHz output sinusoidal signal, put on the rear panel and marked as "10MHz"	0.5 - 2 V RMS
U100M	Output voltage of multiplier 5-100 MHz	0.5 - 5 V RMS
U20.405	Frequency synthesizer 20.40575168 MHz output voltage	0.25 - 5 V RMS
Uif	Intermediate frequency output signal level	0.5 - 5 V RMS
U2h	Second harmonic signal level	0.5 - 5 V RMS
Upump	Ion pump supply voltage	2.5 - 4 kV
Ipump	Ion pump current	0 - 50 μA

1	*2*	*3*
Upur	Power voltage of molecular hydrogen purifier	0.5 - 2 V
Ipur	Purifier current	0.35 - 0.9 V
Uhfo	HFO power voltage	24.5 - 27 V
Ihfo	HFO current	0.3 - 0.7A
Udisch	Voltage on the output of discharge brightness sensor in discharge bulb	0.8 - 4.8 V
CPUtemp	Temperature of the central processor board	20°C - 60°C
Side	Voltage on the heater of discriminator cavity side surface	5 - 15 V
Bottom	Voltage on the heater of discriminator cavity bottom	5 - 15 V
Hydr	Voltage on the heater of molecular hydrogen source	5 - 15 V
Pressure	Molecular hydrogen pressure in the source	1.5 - 14 atm

Table 2. List of inspected parameters in group "FLL system"

1	*2*	*3*
Parameter	***Description***	***Inspected parameters, comments***
Rctl	Cavity rough tuning DAC code (control)	between 0 and 4095; 4095 - if normal operation
Qctl	Crystal oscillator rough tuning DAC code (control)	between 0 and 4095; is set in the process of working point search
Rstat	Cavity fine tuning DAC code	between 0 and 65535; normal operation tolerance value - between 1000 and 65000
Qstat	Crystal oscillator fine tuning DAC code	between 0 and 65535, normal operation tolerance value - between 1000 and 65000

1	*2*	*3*
R1h	Cavity detuning	between -8191 and +8191, if normal operation - between -3000 and +3000
Q1h	Crystal oscillator detuning	between -8191 and +8191, if normal operation - between -3000 and +3000
F	Frequency synthesizer code	Tolerance values between 0 and 99999e-15
D2h	Output of second harmonic detector of FLL processor	between -8191 and +8191, while normal operation – between -8191 and –1000
Pumping	Synthesizer DAC code, determining signal 20.40575168 MHz output voltage	Tolerance value – between 20 and 4095, is set in the process of tuning
ModIndx	Synthesizer phase modulation index code	Tolerance value – between 3500 and 5500, is set in the process of tuning
kRez	Relative gain of cavity loop, defined as 2^{kRez}	Tolerance value – between 0 and 15, is set in the process of adjustment
kQtz	Relative gain of crystal oscillator loop, defined as 2^{kQtz}	Tolerance value – between 0 and 15, is set in the process of adjustment
P_QTZ	Number of points on synthesizer phase modulation period	Constant value - 12
Phi	Relative phase shift code of synchronous detector	Is set automatically in the process of adjustment, tolerance value is between 0 and P_QTZ-1
Cor	Correction code of synchronous detector reference signal	Is set automatically in the process of adjustment, tolerance value is between -49 and +49
DDSerr	Synthesizer error counter	Has a permanent value by normal operation, is incremented after synthesizer reset

1	*2*	*3*
Rdet	Current code of cavity loop additional tuning	Tolerance values are between -300000 and +300000
T	Temperature measured by FLL system, °C	Temperature probe is set not on all instruments
QuartzLoop ON	Indicator of quartz loop normal operation	
CavityLoop ON	Indicator of cavity loop normal operation	
OP searching	Indicator of H-line searching	
CavityLoop OFF	Indicator of cavity loop switching off	
QuartzLoop OFF	Indicator of crystal oscillator loop switching off	
Init FLL	Indicator of the FLL system initialization	
Ref.phi search.	Indication of synchronous detector reference phase searching	

4. Main Menu Commands

4.1. COM-port setting - menu item "Command\Set COM-port"

Use this command to set a port through which the program is connected to the instrument. Choose the corresponding menu item and there appears a dialog box "COM-port list"(fig.4).

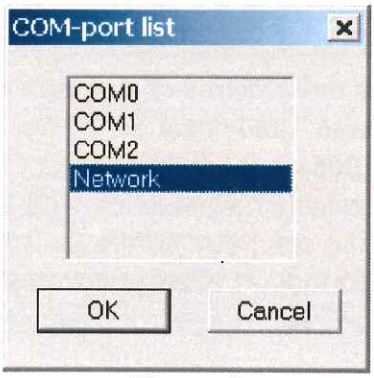


Figure 4

Choose one of the ports in the list and the program will try to get data from the instrument. In case connection is a success a corresponding message appears in the second status bar (fig.5).

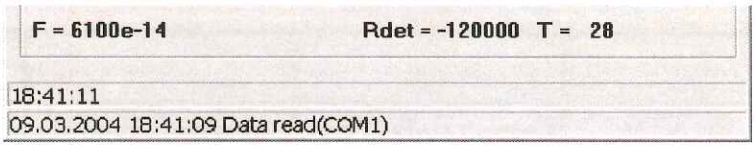


Figure 5

If connection is impossible an error message appears in the second status bar (fig. 6).

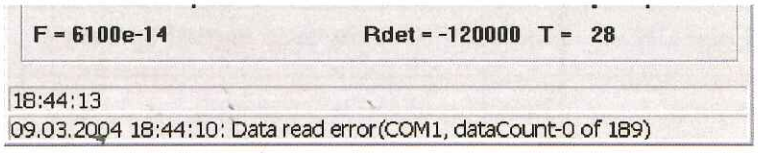


Figure 6

Program can be connected to another copy of the program (that is connected to the instrument through COM-port) through local net. Thereto choose point "Network" in "COM-port list" (fig.4) and a dialog box "SetServerParam" appears on the screen (fig. 7)

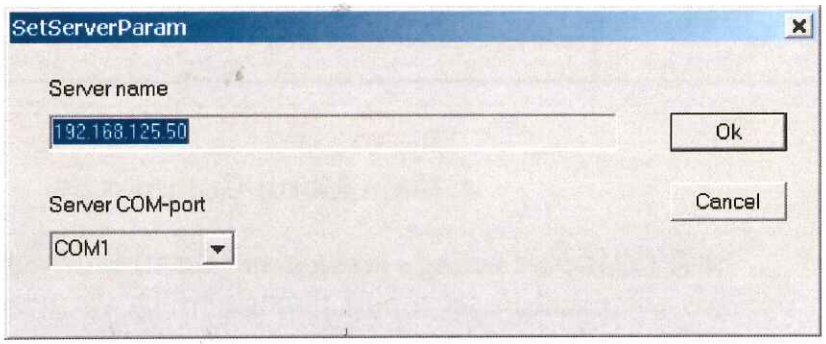
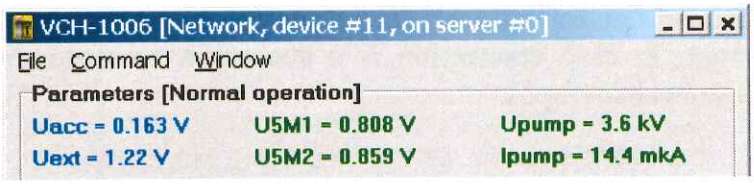


Figure 7

Print IP-address or net name of a computer, where the other program is installed, in the field "Server name" and local COM-port number, through which the program is connected to VCH-1006, in the field "Server COM-port". After certain parameters are set the program tries to establish connection with the server-program. In case connection is a success, address of the computer where the server-program in installed is printed in the heading line and information about a successful connection – in the second status bar (fig.8).



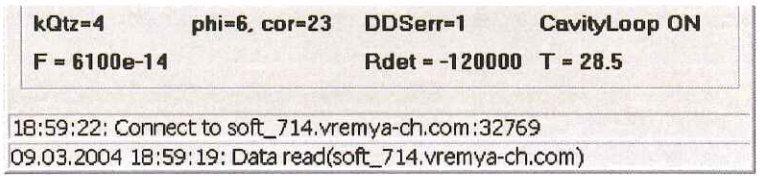


Figure 8

4.2 Data reading interval setting - menu item "Command\Set timer"

Use this command to set reading interval for VCH-1006 parametrical data, that are saved into history file "history.dat". After choosing this menu item a dialog box "Timer setup" appears on the screen (fig.9). Print the new value of the interval in seconds in the field "Timer interval" and press "OK". After that current file history.dat is renamed in file in format YYYY_MM_DD_hh_mm_ss.dat, where YYYY is a year, MM - month, DD – date, hh – hour, mm – minute, ss - second when data is received for the last time before the interval is changed. After that a new history file is being formed. Press "Cancel' if you want to cancel new value then the interval and file history.dat remains the same. If data reading is not initialized with the help of "Set timer" or "Start data input" (p. 4.5), canceling the new timer value will prevent initialization of the periodical data reception.

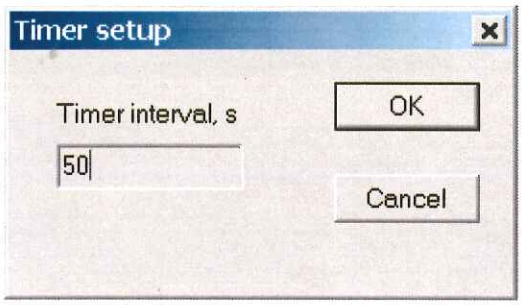


Figure 9

4.3 Single data reading – menu item "Command\Single read"

Use this command to receive data from VCH-1006 any moment for on-line inspection. In this case data are not saved into history file. If this command is initialized, after data reception, there appears a message about successful operation in the second status bar (fig. 10).

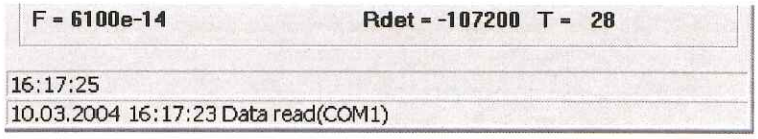


Figure 10

If computer is not connected to the instrument or due to other error in data reception there appears an error message in the second status bar (fig.11).

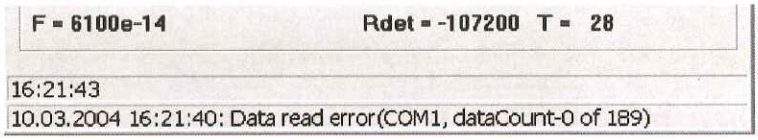


Figure 11

4.4 Event log reception - menu item "Command\Get log data"

Use this command to review event log, which is saved in nonvolatile memory of the instrument. Event log description can be found in "Hydrogen maser frequency and time standard VCH-1006. User guide. 411141.012UG". Event log is used to trace changes of instrument state in the process of switching it on/off and its control as well as in case of malfunction identification.

After command initialization, event log reception starts and information about the number of record, which is being received at the moment, appears in the second status bar (fig.12). If the operation is a success, a corresponding message appears in the second status bar (fig. 13). Event log is saved into binary file vch1006log.dat and window "View VCH-1006 log" appears on the screen (fig.14).

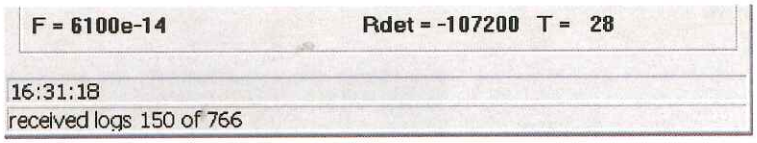


Figure 12

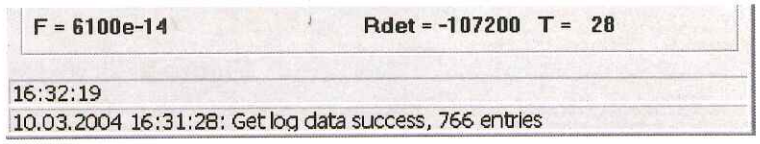


Figure 13

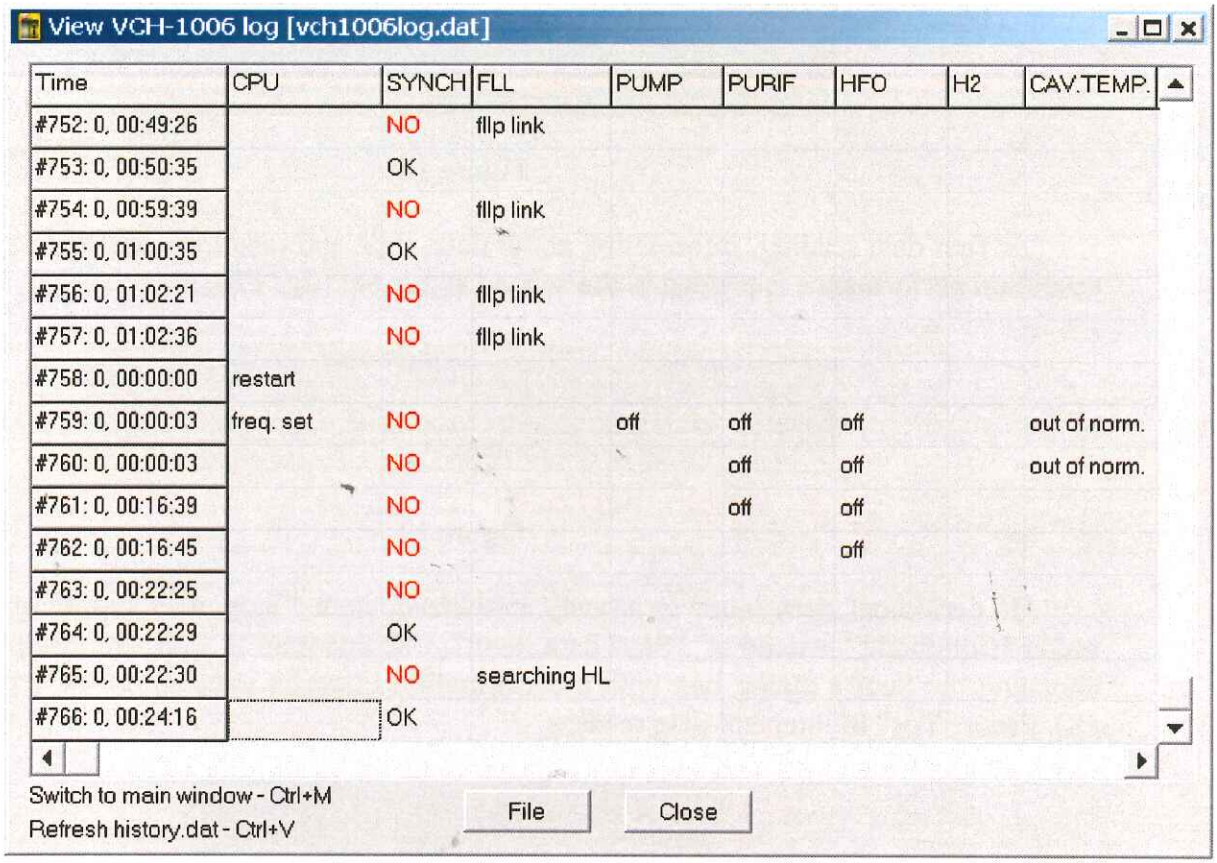


Figure 14

If event log reception is impossible, an error message appears in the second status bar (fig. 15).

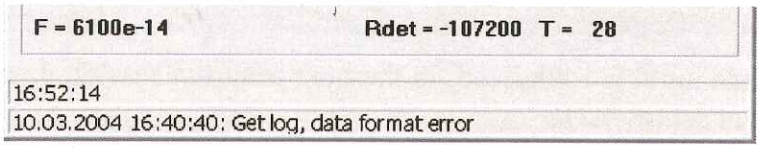


Figure 15

4.5 Data input initialization – menu item "Command\Start data input" and data input interruption – menu item "Command\Stop data input"

If periodical data input is not initialized, item "Start data input" in menu "Command" is active. After its initialization the program starts to read data and save them into history file history.dat at previously determined by command "Set timer" (p. 4.2). At that a corresponding message appears in the second status bar (fig.16). At the same time information about type of connection of the program to the instrument and time in seconds left till the next data input appears in the first status bar.

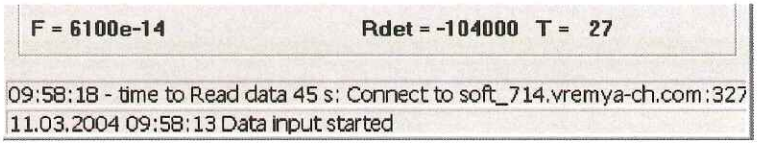


Figure 16

At first data reading, information about date, time and result of current data reading operation performance is printed in the second status bar (fig. 17).

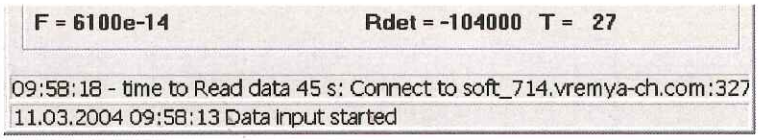


Figure 17

If periodical data input is already initialized, item "Stop data input" appears in menu "Command" instead of "Start data input". Use this item to stop data reading. After choosing the item a dialog box with a confirmation question appears on the screen (fig. 18). Press "Yes" to interrupt data reading.

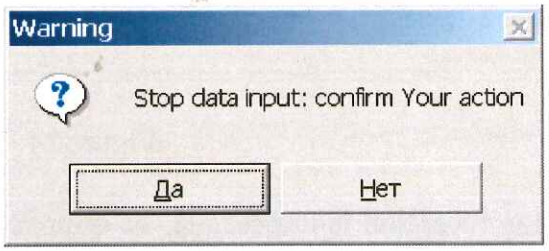


Figure 18

If data input is initialized, in the next program session data reading is resumed with the interval set (p. 4.2).

4.6 History file review – menu items **"Command\Show history"** *and* **"Command\Open data file(log/history)"**

Use command "show history" to review parametrical data, saved in file history.dat. Choose this menu item and a window with information from file history.dat appears on the screen (if it has been generated already) (fig. 19).

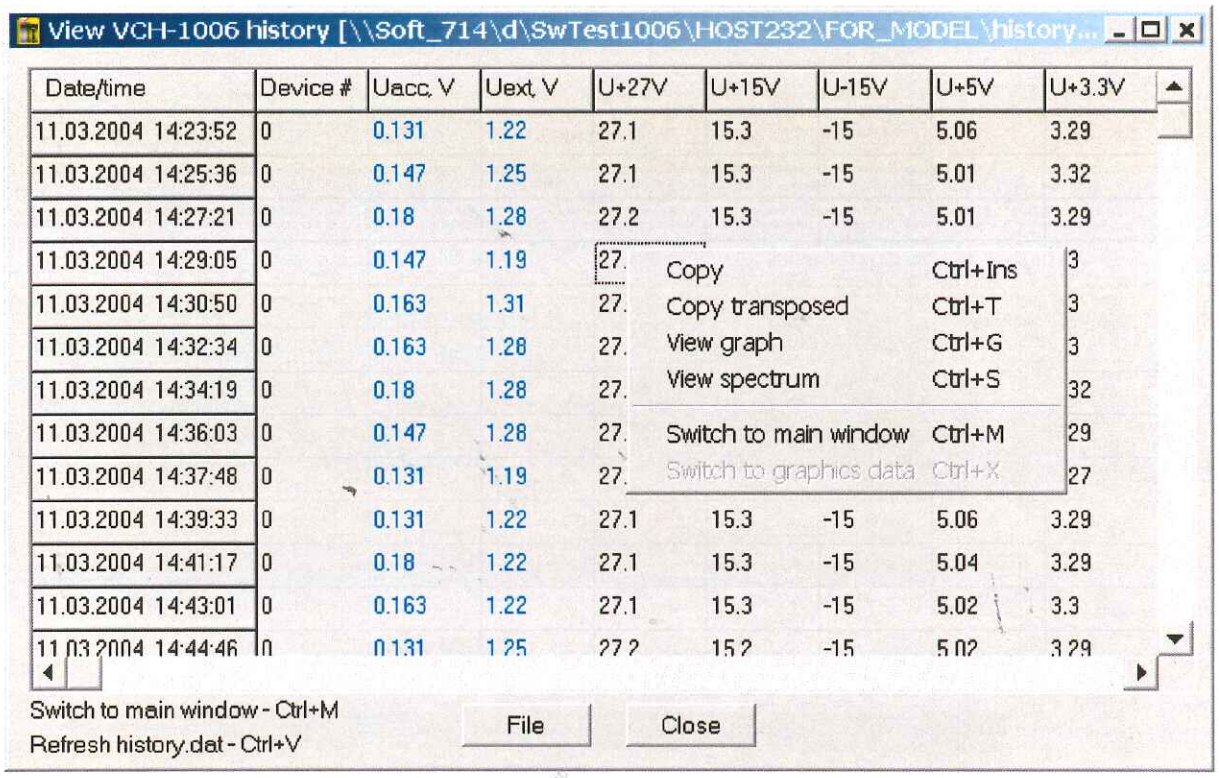


Figure 19

If file history.dat has not been generated due to data input interruption, dialog box with error message appears on the screen (fig. 20). Press "OK" to close the box and an empty table appears on the screen (fig. 21), if history file is opened for the first time in current program session, or table with data from file, which was opened for the last time. To open any other file in format YYYY_MM_DD_hh_ss.dat generated before, press button "File" and choose a file in the box that appears on the screen (fig. 22).

Figure 20

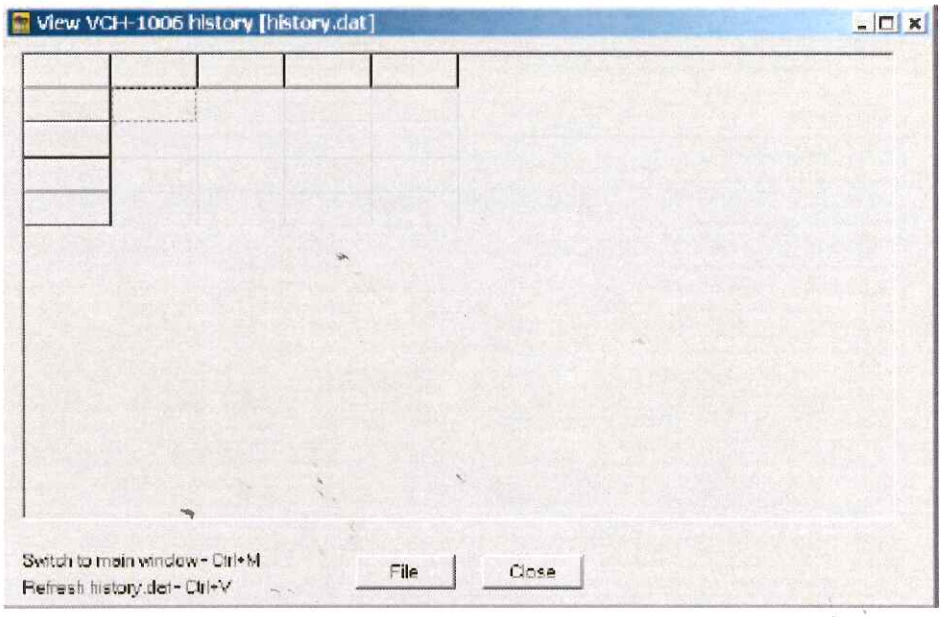


Figure 21

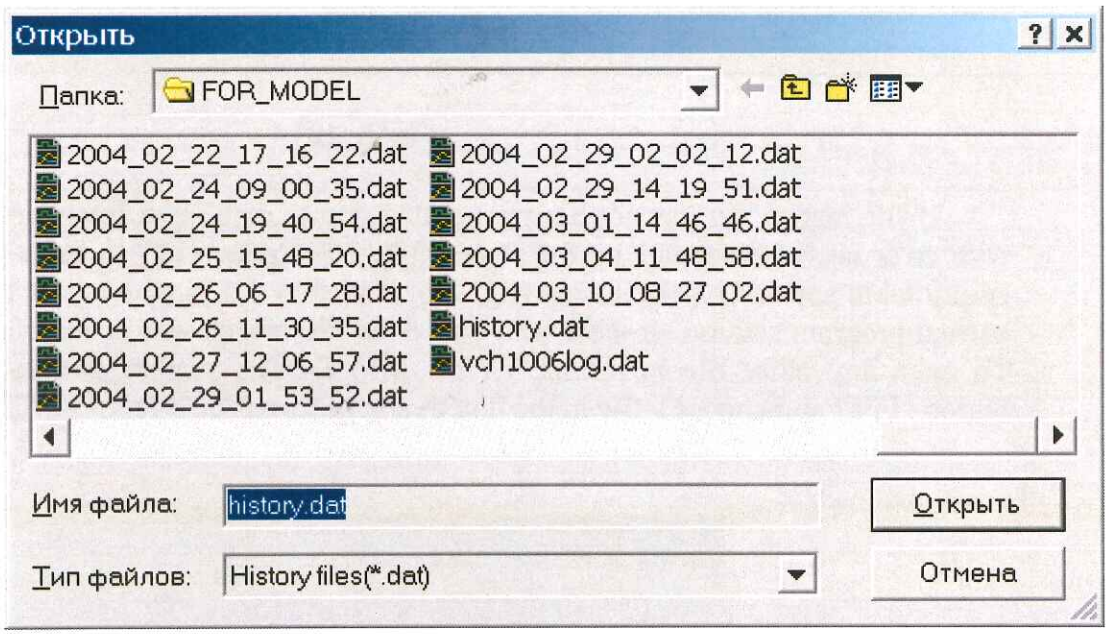


Figure 22

The same dialog box appears on the screen when menu item "Command\Open data file (log/history)" is chosen. Use this item to review any file with parametrical data or event log file vch1006log.dat.

To move cursor from one cell to another in data table use mouse or arrow keys, having put focus to any sell of the table by clicking the left mouse button on it or pressing "Tab" key several times. To highlight several neighboring cells use arrow keys holding down "Shift" or hold down the left mouse button and move it. Highlighted cells can be copied to clipboard by pressing combination of keys "Ctrl"+"Ins" or choosing command "copy" in contextual menu. To call contextual menu press mouse left button or

combination of keys "Shift"+"F10" (fig. 19). To copy cells to clipboard with simultaneous row and column replacement use contextual menu item "Copy transported".

Use contextual menu item "View graph" to review highlighted cells in a form of a graph. Data from one or two neighboring columns can be reviewed at once. If columns are not neighboring move one column to another pressing the left mouse button on the column heading and moving the mouse holding in down.

An additional window opens for graph review (fig. 23). To return to history review window press combination of keys "Ctrl"+"H". To get back to graph window press "Ctrl"+"X".

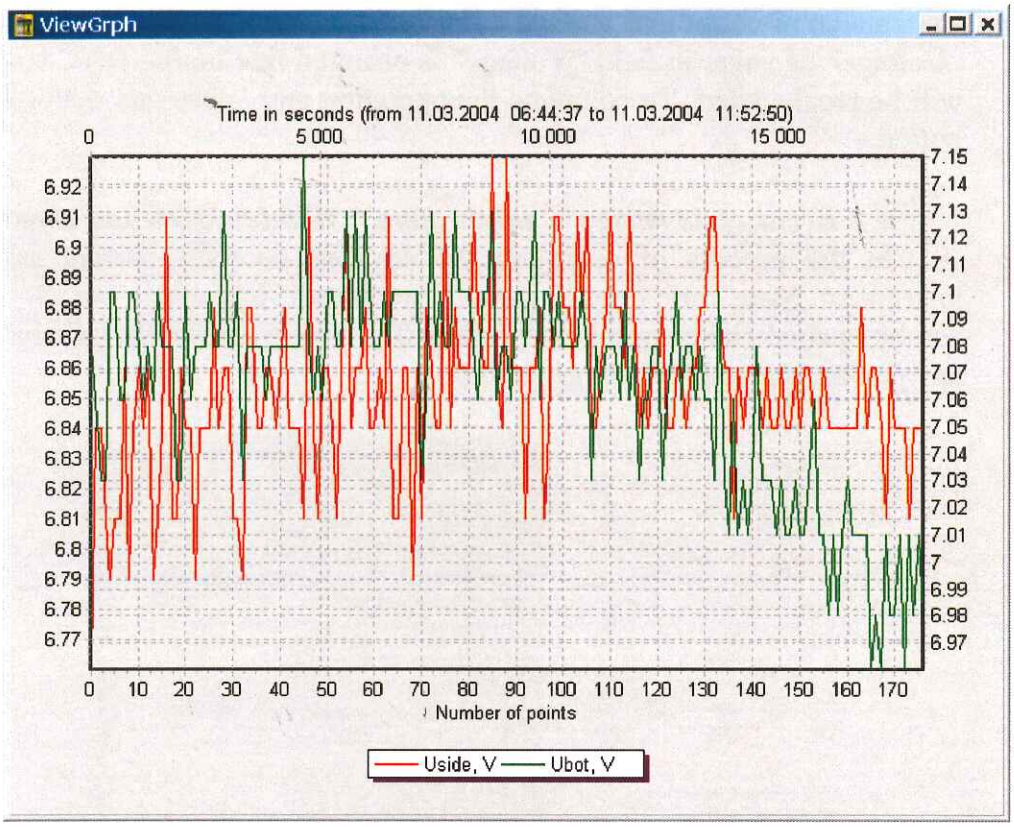


Figure 23

4.7 Cavity control DAC codes conversion into voltage – menu item "Command\Rdac conversion"

Menu item "Command\Rdac conversion" is used to convert cavity control DAC codes (fine and rough tuning) into voltage on cavity varactor. A corresponding dialog box appears on the screen in case this menu item is chosen (fig. 24)

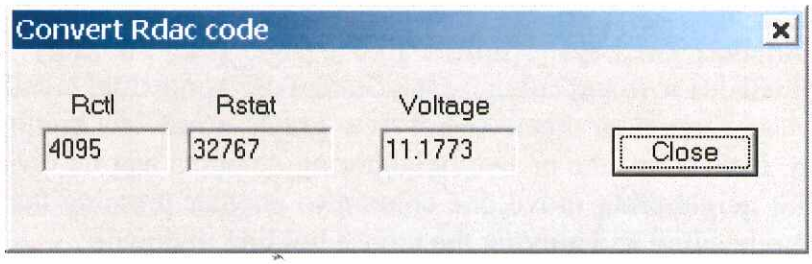


Figure 24

Print DAC code values into fields "Rctl" (rough tuning) and "Rstat" (fine tuning). Conversion of codes into voltage is carried out automatically and result is printed in field "Voltage". If value in field "Voltage" is changed fine tuning DAC codes in field "Rstat" will be recalculated. To complete the operation and close this dialog box, press "Close" button.

4.8 Error code review - menu item " Window\view log error list"

In the process of operation the program receives current state code from the instrument. State code decoding can be reviewed in window "VCH –1006 error" which can be opened choosing this menu item (fig. 25). If error code cannot be received due to any reason, this menu item is inactive.

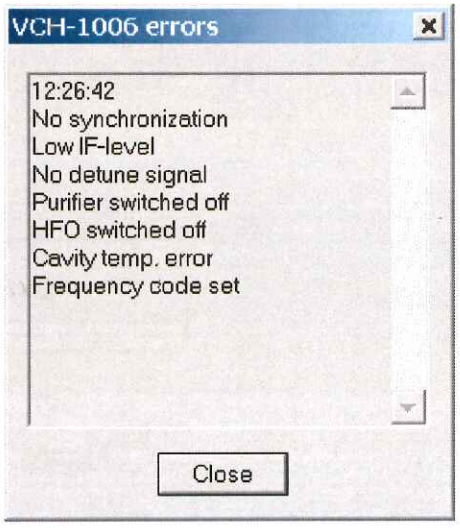


Figure 25

Time when the latest data reception was accomplished is printed in the first line of the error code window. Then all current errors are printed. In case of normal operation of the instrument, message "Normal operation" appears in the screen (fig.26).

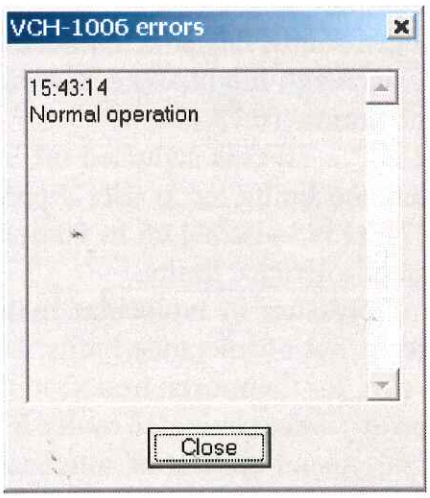


Figure 26

List of messages that can appear in the window:

1. "CPU restart" – central processor cleaning after power-up of the instrument.
2. "Quartz locked" - crystal oscillator is tuned in the hydrogen spectral line, but there are minor malfunctions.
3. "No synchronization" – there is no synchronization, crystal oscillator is not tuned in the line.
4. "H-line searching" – H-line searching is carried out in automatic turn-on mode or in manual control mode, with additional message " User's control" in the latter case.
5. "Multiplier 100MHz error" – signal output 100 MHz (U100M parameter) is below 0,5 V RMS level.
6. "DDS error" – synthesizer output 20.40575168 MHz (U20.405 parameter) is below 0,1 V RMS level.
7. "Low IF-level" – IF receiver level (Uif parameter) is below 0,5 V RMS.
8. "FLLP link error" – connection error with FLL processor.
9. "DDS restart" – synthesizer rerun, DDSerr counter is changed.
10. "No detune signal" – quadrature detector, output value of which is a tuning criterion for crystal oscillator, is implemented in the program of automatic frequency control, which is carried out in the FLL processor. Central processor monitor program is constantly verifying this value. If D2h value is less than –1000, crystal oscillator is considered to be tuned in hydrogen spectral line frequency. If D2h value is between –200 and +200, central processor monitor program considers that there is no tuning signal on ADC output of FLL processor and generates a corresponding message.
11. "Pump alarm" - ion pump current is beyond normal or voltage is below normal. Voltage limit is 2 kV, current limit – 500 microamperes during turn-on procedure and 100 microamperes after warm-up.
12. "Pump switched off" – ion pump is switched off due to tolerance limits overrun or at user's command in the manual control mode.
13. "Purifier alarm' – purifier current is out of tolerance limits. Minimum value – 0,15 A, maximum – 1,2 A.
14. "Purifier switched off" – purifier is switched off because instrument is in warm-up mode or due to out of tolerance limits, or at user's command in the manual control mode. In warm-up mode purifier is switched on only after discriminator cavity is

warmed up, pressure in molecular hydrogen source is normal and voltage on molecular hydrogen source heater is not out of tolerance limits.

15. "HFO alarm" - discharge brightness sensor voltage is below normal (0,5 V) or HFO current is beyond normal (0,7A).
16. "HFO switched off" – HFO is switched off because instrument is in warm-up mode, or is out of tolerance limits, or at user's command in the manual control mode. In warm-up mode HFO is switched on in 5 minutes after purifier power is on if purifier current is not out of tolerance limits.
17. "H2 src error" – pressure in molecular hydrogen source or voltage on the source thermostat heater is out of tolerance limits. Limits for pressure: minimum – 1,5 atm, maximum – 14 atm, for thermostat heater: minimum – 1 V, maximum – 21 V.
18. "Cavity temp. error" – discriminator cavity is not warmed up: voltages on the heaters of bottom and side panel are out of tolerance limits or are changing at high speed. VCH-1006 central processor monitor program compares voltages on discriminator heater with their previous values and in case the difference exceeds 0,5 V as absolute value, resonator is considered to be not warmed up. The lower heater voltage limit is - 1.0 V, upper – 21V.
19. "5/10 MHz output error" – output voltage of one of the signals 5/10 MHz is below 0.3 V RMS level.
20. "1PPS#1 output error" – 1 Hz impulse signal marked as "1 PPS-1" on the rear panel is missing on the output.
21. "1PPS#2 output error" – 1 Hz impulse signal marked as "1 PPS-2" on the rear panel is missing on the output.
22. "2.048 MHz output error" – 2.048 MHz impulse signal is missing on the output.
23. "Internal 1PPS error" – 1 Hz internal signal, with the help of which time counting is managed, is missing. Time is indicated on the 7-segment LED indicator on the front panel.
24. "27acdc error" – converter ~220/+27 V output voltage is out of tolerance limits: minimum +23.5 V, maximum +30.5 V.
25. "internal 27V error" – internal converter 27/27 V voltage is out of tolerance limits: minimum +24 V, maximum +30 V.
26. "DC power error" – voltages of one or several DC converter +15V/-15V/+5V/+3.3V are out of tolerance limits:

    +15 V: minimum +13.5V, maximum +18 V;
    -15 V: minimum -13.5V, maximum -18 V;
    +5 V: minimum +4.5V, maximum +5.5 V;
    +3.3V: minimum +3.0V, maximum +3.5 V.

27. "Accumulator discharged" – accumulator is discharged, voltage on the clamps are below 21.5 V.
28. "Accumulator engaged" - battery operation, external power ~220 V and +27 V are missing.
29. "DAC overflow" –there are two loops in automatic frequency control system: the first one - for tuning cavity to the crystal oscillator frequency, the second one - for tuning crystal oscillator in the hydrogen spectral line frequency. Digital-to-analog converter (DAC) is used to form control voltages of the fine tuning loops. In both loops 16-bits fine tuning DACs are used, full scale of which is between 0 and 65535. If fine tuning

DAC code of one of the loops crosses the line of 1000 or 64500, central processor control program prints this message on the screen. Note that in case this message appears and it is DAC code of crystal oscillator that crosses the line but its value has not reached 65450 or 100, at the moment the instrument is considered to be in a normal mode of operation, but it is advisable to set new working parameters of crystal oscillator with the help of VCH-1006 menu item "Control\search line" in the nearest future. This operation is described in "Hydrogen maser frequency and time standard VCH-1006.User guide." 411141.012 UG.

30. "Frequency code set" – synthesizer frequency code is changed by user.
31. " User's control" – user controls switching on/off of discriminator power unit or started searching of crystal oscillator working parameter.