VCH–314

Routine for Multi–Channel Measurement

of Frequency Instability

Software Operational Manual

Nizhny Novgorod

ATTENTION! **To prevent failure of the interface RS-232C, that provides the link between the comparator and the PC the connection of the PC to the hardware block should be carried out with the switched OFF PC, or with the switched OFF the comparator.**

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1 Introduction

This Operational Manual is the Supplement to the document "Frequency comparator VCH-314. Operational Manual", "VREMYA–CH" Joint Stock Company, Nizhny Novgorod, 2002.

The routine for the multi–channel measurement of the frequency instability (hereinafter – The Routine), described in this Manual, is intended for the management of the multi–channel frequency comparator VCH-314. The Routine provides the processing and recording of results of the frequency instability measurement.

The frequency comparator VCH-314 (further – Comparator) is intended for the improvement of the accuracy in the measurement of standard frequencies 5, 10 and 100 MHz. The use of the following methods is possible in the measurement:
– The comparison of two signals: f_{y1} and f_x (or f_{y2} and f_x);
– The treatment of three signals (method of three oscillators): f_x, f_{y1}, f_{y2};
– The comparison of two signals with the elimination of the noise added by Comparator.

The link between the computer of a type IBM/PC, on which the Routine is installed, and Comparator is carried out through the interface RS-232C.

The following functions are implemented in the Routine:
- Input via the screen interface of the mode of operations and managing parameters for the Comparator;
- Calculation of statistical functions describing:
  - The difference between frequencies of two signals,
  - The frequency instability for the separate signal (only in the method of three oscillators);
- The displaying of the measurement results (and calculated functions) as the tables (diagrams) on the screen interface;
- The printing of the tables and diagrams on the printer connected to the computer;
- The copying of fragments of the table (or complete table) containing the required data of measurements into the clipboard, and also pasting of the information from the clipboard, into the MS Word and Excel documents;
- The recording of tables and diagrams with results of the measurement (with addition of any comments) in the file;
- The displaying of the earlier recorded tables and diagrams on the screen interface.
    The following information is given in this Manual.
- The brief description of the Comparator operation principles;
- The description of the Routine, instructions on the use of the Routine and the adjustment of it.

2 Comparator VCH–314 operation principles

The block-diagram of the Comparator is shown in
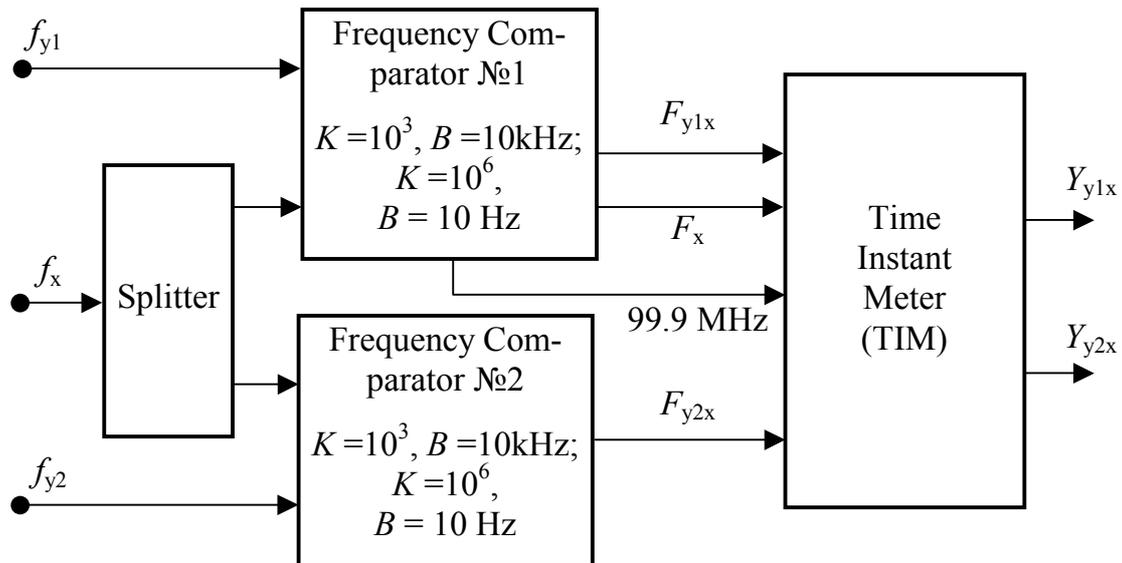
Fig. 2.1.

Fig. 2.1. The block-diagram of the Comparator VCH–314

The Comparator has three inputs: "f_x", "f_{y1}", and "f_{y2}".

- The input "f_x" is used at any method of the measurement.
- The input "f_{y1}" (or input "f_{y2}") is also used when two signals are compared.
- All three inputs of the Comparator are used in measurements on the method of three oscillators.
- The same signal is connected to inputs "f_{y1}" and "f_{y2}" for the elimination of the noise added by the Comparator.

The input signals in pairs are connected to two identical units "Frequency Comparator" (№ 1 and № 2). Each unit generates the impulse signal F which frequency (equal approximately 1Hz) is determined by the difference between frequencies of compared signals $-f_{y1}$ and f_x (or f_{y2} and f_x):

$$F_{y1x} \, [\text{Hz}] = 1 + K \cdot (f_{y1} - f_x)/f_x \qquad (2.1.1)$$

–for signals f_{y1} and f_x, or

$$F_{y2x} \, [\text{Hz}] = 1 + K \cdot (f_{y2} - f_x)/f_x \qquad (2.1.2)$$

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–for signals f_{y2} and f_x.

Here K is the multiplication factor for the frequency noise. This factor can take two meanings: 10^3, or 10^6. The meaning of the multiplication factor is set through the Routine, see Section **6.3.1. "Multiplication" – The setting of multiplication factor**.

The bandpass B for the frequency noise is also settled for units "Frequency Comparator" (№ 1 and № 2). The set of available meanings of the bandpass is determined by the chosen multiplication factor K for the frequency noise. If $K=10^6$, then this bandpass is equal 10Hz (3Hz after digital averaging of phase difference signals Y_{y1x} and Y_{y2x}). For $K=10^3$ the meaning $B=10$kHz is set automatically.

The meaning of the bandpass is set through the Routine, see Section **6.3.2 "Bandpass" – The setting of bandpass**.

The impulse signals having the frequency determined by relations **(2.1.1)** and/or **(2.1.2)** are supplied to the input of "Time Instant Meter two-channel" (TIM).

Two auxiliary signals (from the output of the block "Frequency Comparator" № 1) are supplied to additional inputs of the Meter:
–   Impulse signal F_x with frequency 1Hz,
–   Harmonic signal 99.9 MHz.
These auxiliary signals are necessary for the operation of TIM.

Two sampled (with the step equal approximately 10 nanosecond) signals are taken from the TIM output: Y_{y1x} and (or) Y_{y2x}. These signals contain the information on the difference of phases between impulse signals F_{y1} and F_x (or F_{y2} and F_x). The diagram of processes that illustrates the generation of the sampled phase difference signal Y_{y1x} is shown in
Fig.2.2.
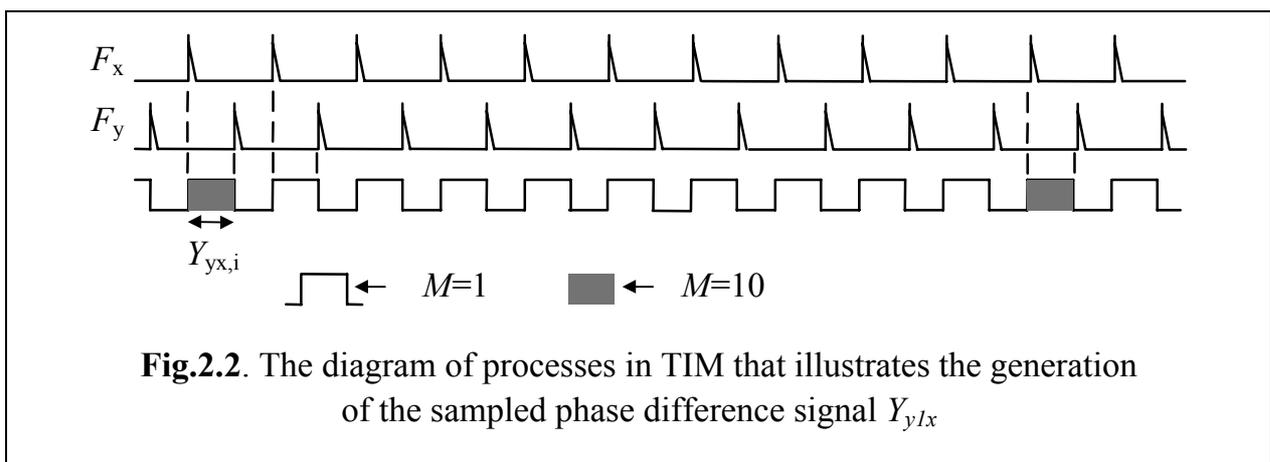
Fig.2.2. The diagram of processes in TIM that illustrates the generation
of the sampled phase difference signal Y_{y1x}

In the beginning of measurements the compared impulse signals are shifted from each other on a half of period (close to 0.5 seconds).

The maximum time of the single measurement of the phase difference ($\tau = M$ seconds) can get meanings from the series: 1, 10, 100, 1000, 3600, 10^4, 86400 (1day),10^5 and $5*10^5$ seconds. This time is set through the Routine, see Section **6.3.3 "Samples"** – **The setting of maximal time of measurement**.

One can see from

Fig.2.2, that for $M = 1$ ($\tau = 1$s) the delay between each pair of impulses F_{y1} and F_x is measured. If, for example, $M = 10$ ($\tau = 10$s), each 10-th pair of impulses is compared. In this case functions describing the frequency instability are calculated for $\tau = 1$s as well.

In the Routine the quantity of averages N is set. This value can get meanings from the series: 5, 10, 20, 50, 100, 200, 500, 1000. Thus, the full time of single measurement takes $M \cdot N$ seconds.

The required meaning N is set through the Routine, see Section **6.3.4 "Samples"** – **The setting of number of averaging**. The current number i is assigned to intermediate readouts, that is reflected in

Fig.2.2.

3 Calculated functions

3.1 Basic relations

The phase difference Y_{y1x} and (or) Y_{y2x}, generated in the block "Time Instant Meter two-channel " (TIM), is used as the basis for all calculated statistical functions of the analyzed signals, see Section **2 Comparator VCH–314 operation principles** .

The difference between phases of pairs of signals is calculated at first (with taking into account the meaning K – the multiplication factor for the frequency noise):

$$\Delta_{y1x,i} = \frac{1}{K} Y_{y1x,i} \, , \qquad\qquad\qquad (3.1.1a)$$

$$\Delta_{y2x,i} = \frac{1}{K} Y_{y2x,i} \, , \qquad\qquad\qquad (3.1.1b)$$

$$\Delta_{y2y1,i} = \Delta_{y2x,i} - \Delta_{y1x,i} \, . \qquad\qquad\qquad (3.1.1c)$$

Here i is the number of the intermediate readout (from N of the scheduled readouts).

Then the relative differences of frequencies measured on an interval $\tau = M$ seconds are calculated for pairs of signals:

$$y_{y1x,i}^{M} = \frac{1}{\tau} \left(\Delta_{y1x,M(i+1)} - \Delta_{y1x,Mi} \right), \qquad\qquad (3.1.2a)$$

$$y_{y2x,i}^{M} = \frac{1}{\tau} \left(\Delta_{y2x,M(i+1)} - \Delta_{y2x,Mi} \right), \qquad\qquad (3.1.2b)$$

$$y_{y2y1,i}^{M} = \frac{1}{\tau} \left(\Delta_{y2y1,M(i+1)} - \Delta_{y2y1,Mi} \right). \qquad\qquad (3.1.2c)$$

Relations **(3.1.2a)** – **(3.1.2c)** are used for the calculation of frequency differences of pairs of signals **(3.2.1a)** – **(3.2.1c)** averaged over the observation time $N\tau$. The superscript M is further omitted because everywhere it is meant that the frequency deviations are measured over the interval M seconds.

Frequency variations for pairs of signals are also calculated in the Routine:

$$\sigma_{y1x,i} = y_{y1x,i+1} - y_{y1x,i} \, , \qquad\qquad\qquad (3.1.3a)$$

$$\sigma_{y2x,i} = y_{y2x,i+1} - y_{y2x,i} \, , \qquad\qquad\qquad (3.1.3b)$$

$$\sigma_{y2y1,i} = y_{y2y1,i+1} - y_{y2y1,i} \, , \quad i = 1,2,\ldots,N-1 \, . \qquad (3.1.3c)$$

These variations are used for the calculation of variances of the frequency noise.

3.2 Statistical functions

The frequency differences for pairs of signals averaged over the observation time $N\tau$ are calculated on the basis of relations **(3.1.2a)** – **(3.1.2c)**.

$$y_{y1x}^{N} = \frac{1}{N}\sum_{i=1}^{N} y_{y1x,i} \qquad (3.2.1a)$$

– for pairs of signals f_{y1} and f_x; identifier in the Routine: E{Fy1x}.

$$y_{y2x}^{N} = \frac{1}{N}\sum_{i=1}^{N} y_{y2x,i} \qquad (3.2.1b)$$

– for pairs of signals f_{y2} and f_x; identifier in the Routine: E{Fy2x}.

$$y_{y2y1}^{N} = \frac{1}{N}\sum_{i=1}^{N} y_{y2y1,i} \qquad (3.2.1c)$$

– for pairs of signals f_{y2} and f_{y1}; identifier in the Routine: E{Fy2y1}.

The N-sample variances (estimates of root mean square deviation for pairs of signals) are calculated on the basis of relations **(3.1.2a)** – **(3.1.2c)** and **(3.2.1a)** – **(3.2.1c)**.

$$\delta_{y1x}^{N} = \sqrt{\frac{1}{(N-1)}\sum_{i=1}^{N}\left(y_{y1x,i} - y_{y1x}^{N}\right)^2} \qquad (3.2.2a)$$

– for pairs of signals f_{y1} and f_x; identifier in the Routine: var{Fy1x}.

$$\delta_{y2x}^{N} = \sqrt{\frac{1}{(N-1)}\sum_{i=1}^{N}\left(y_{y2x,i} - y_{y2x}^{N}\right)^2} \qquad (3.\,2.2b)$$

–for pairs of signals f_{y2} and f_x; identifier in the Routine: var{Fy2x}.

$$\delta_{y2y1}^{N} = \sqrt{\frac{1}{(N-1)}\sum_{i=1}^{N}\left(y_{y2y1,i} - y_{y2y1}^{N}\right)^2} \qquad (3.2.2c)$$

–for pairs of signals f_{y2} and f_{y1}; identifier in the Routine: var{Fy2y1}.

The N-sample cross-variances (estimates of root mean square deviation for the separate signal) are calculated on the basis of the same relations **(3.1.2a)** – **(3.1.2c)** and **(3.2.1a)** – **(3.2.1c)** with the use of the correlation method yielding the extraction of the auto-correlation behavior of the separate signal.

$$\delta_x^N = \sqrt{\frac{1}{(N-1)} \left| \sum_{i=1}^{N} \left(y_{y1x,i} - y_{y1x}^N \right) \cdot \left(y_{y2x,i} - y_{y2x}^N \right) \right|} \qquad (3.2.3a)$$

– for signal f_x; identifier in the Routine: var{Fx}.

$$\delta_{y1}^N = \sqrt{\frac{1}{(N-1)} \left| \sum_{i=1}^{N} \left(y_{y1x,i} - y_{y1x}^N \right) \cdot \left(y_{y2y1,i} - y_{y2y1}^N \right) \right|} \qquad (3.2.3b)$$

– for signal f_{y1}; identifier in the Routine: var{Fy1}.

$$\delta_{y2}^N = \sqrt{\frac{1}{(N-1)} \left| \sum_{i=1}^{N} \left(y_{y2x,i} - y_{y2x}^N \right) \cdot \left(y_{y2y1,i} - y_{y2y1}^N \right) \right|} \qquad (3.2.3c)$$

– for signal f_{y2}; identifier in the Routine: var{Fy2}.

The Allan variances (two-sample estimates of root mean square for pair of signals) are calculated on the basis of relations **(3.1.3a)** – **(3.1.3c)**.

$$\sigma_{y1x}^N = \sqrt{\frac{1}{2(N-1)} \sum_{i=1}^{N-1} \left(\sigma_{y1x,i} \right)^2} \qquad (3.2.4a)$$

– for pair of signals f_{y1} and f_x; identifier in the Routine: var2{Fy1x}.

$$\sigma_{y2x}^N = \sqrt{\frac{1}{2(N-1)} \sum_{i=1}^{N-1} \left(\sigma_{y2x,i} \right)^2} \qquad (3.2.4b)$$

– for pair of signals f_{y2} and f_x; identifier in the Routine: var2{Fy2x}.

$$\sigma_{y2y1}^N = \sqrt{\frac{1}{2(N-1)} \sum_{i=1}^{N-1} \left(\sigma_{y2zy1,i} \right)^2} \qquad (3.2.4c)$$

– for pair of signals f_{y2} and f_{y1}; identifier in the Routine: var2{Fy2y1}.

The Allan cross-variances (two-sample estimates of root mean square for separate signals) are calculated with the use of the correlation method yielding the extraction of the auto-correlation behavior of the separate signal.

$$\sigma_x^N = \sqrt{\frac{1}{2(N-1)} \left| \sum_{i=1}^{N-1} \sigma_{y1x,i} \cdot \sigma_{y2x,i} \right|} \tag{3.2.5a}$$

– for signal f_x; identifier in the Routine: var2{Fx}.

$$\sigma_{y1}^N = \sqrt{\frac{1}{2(N-1)} \left| \sum_{i=1}^{N-1} \sigma_{y1x,i} \cdot \sigma_{y2y1,i} \right|} \tag{3.2.5b}$$

– for signal f_{y1}; identifier in the Routine: var2{Fy1}.

$$\sigma_{y2}^N = \sqrt{\frac{1}{2(N-1)} \left| \sum_{i=1}^{N-1} \sigma_{y2x,i} \cdot \sigma_{y2y1,i} \right|} \tag{3.2.5c}$$

– for signal f_{y2}; identifier in the Routine: var2{Fy2}.

The statistical functions for average times less than 100 s. are calculated using data from the circular buffer, containing last 4000 samples of phase from TIM output.

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4 Variants of the Routine operation

4.1 Single measurement over *N* data

The User sets the parameters. Then the Routine may be started by pressing of the button ▶ "Start" (see **Fig. 6.1** on page **14**). The start-up of the Routine can also be carried out by the activation of the item "Single" from menu "Run" (see Section **6.2**).

The Routine gives the command to start measurements, and begins the processing their results. The chosen parameters and the mode of measurement are displayed on the screen interface (see Section **6**).

After the termination of the ordered quantity **N** of measurements the Routine stops. The quantity of the executed measurements and meanings of functions calculated by the Routine are displayed in daughter windows of the screen interface.

The User can stop the measurements (before these are completed) by pressing the button ■ "Stop" (see **Fig. 6.1** on page **14**). The quantity of executed measurements, and the meanings of calculated functions are displayed in this case corresponding to the quantity of made measurements. The interruption of the measurements can also be carried out by activation of the item "Stop" from menu "Run" (see Section **6.2**).

4.2 Cyclic measurement over *N* data

The difference from the single measurement mode is in the follows. The Routine is started by the click of the button ◯ "Cycle" (see **Fig. 6.1** on page **14**). After the end of the single measurement the Routine is started again. The results are recorded after each measurement.

The cyclic start-up of the Routine can also be made by the activation of the item "Cyclic" from the menu "Run" (see Section **6.2**).

The interruption of the cyclic measurement is carried out by pressing the button ■ "Stop" or by activation of the item "Stop" from the menu "Run" (see Section **6.2**).

5 The restrictive admissions

To exclude gross blunders in calculations, caused, for example, by phase failure, or other technical handicapes, the User can use in the Routine the following limits, see Section **6.3 Menu "View" (Options, Tables)**:

− Maximal difference between frequencies of compared signals, see relations **(3.2.1a)** – **(3.2.1c)**;
− Maximal frequency variation of compared signals, see relations **(3.1.3a)** –**(3.1.3c)**.

1. If the single violation of limitation on the frequency difference occurs the Routine eliminates bad readouts from calculations. The Routine continues the measurements, but with calculation and indication of functions takes into account only really processed data.

The Routine stops measurements if during measurements the quantity of the rejected readouts reaches 50 percent. The information window "Difference of frequencies" is opened in this case on the screen interface, see **Fig. 5.1**.
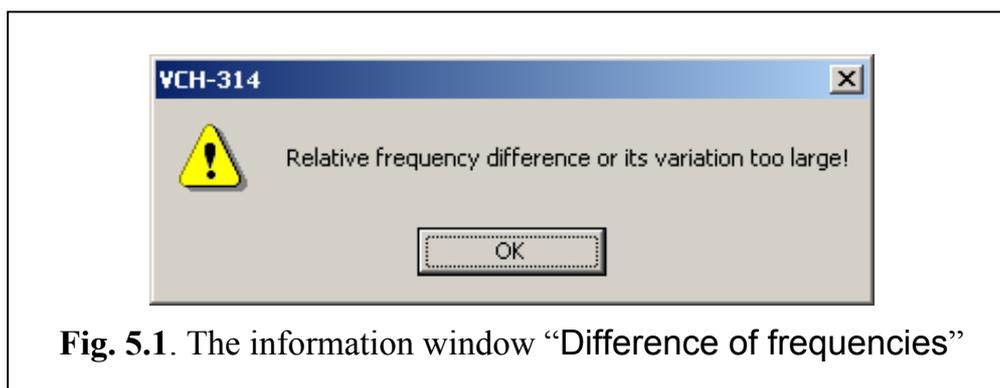
Fig. 5.1. The information window "Difference of frequencies"

2. If the violation of limitation on the frequency variation occurs then the discarding of defective values together with frequency differences forming them is made. The Routine continues the work up to the completing of the ordered quantity of measurements. The real quantity of the processed data and appropriate meanings of functions are indicated in this case.

The Routine stops measurements if during measurements the quantity of the rejected values reaches 50 percent. The same information window is opened in this case on the screen interface, see **Fig. 5.1**.

6 The Screen Interface, work with the Routine

The screen interface of the Routine is made as the standard Windows application. The extended interface covers the whole screen. That is why the top left (**Fig. 6.1**) and right (**Fig. 6.2**) parts of the interface are separately shown here.

Fig. 6.1. Part of the interface with management tools

Fig. 6.2. The right part of interface with management tools
and panels of indication
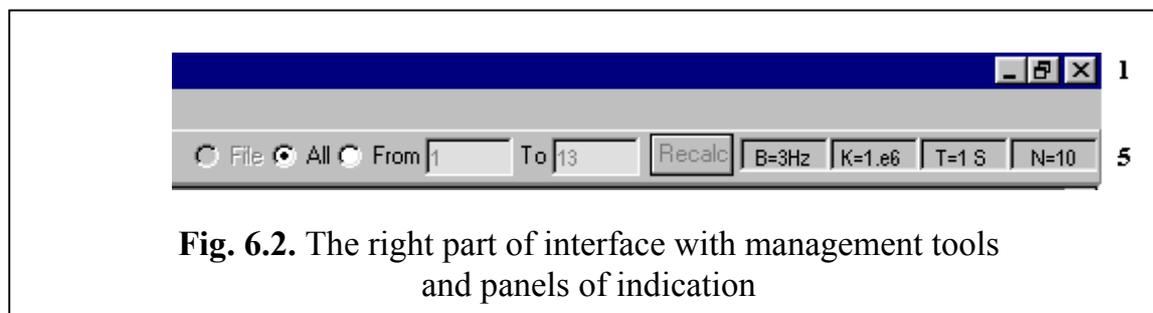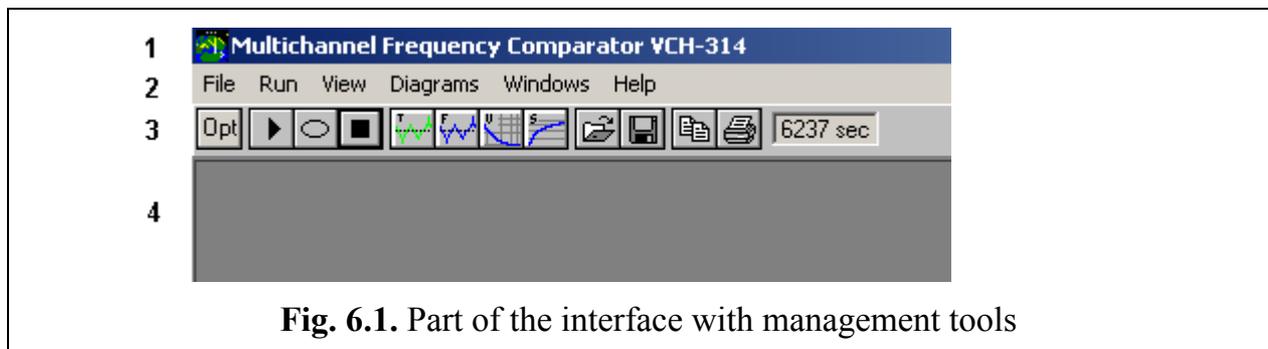
The interface contains the following main elements.
1. Heading line (item 1 in **Fig. 6.1** and **Fig. 6.2**).
2. Menu (line 2 in **Fig. 6.1**).
3. Panels of management and indication tools (line 3 in **Fig. 6.1**, and line 5 in **Fig. 6.2**).
4. Working region (item 4 in **Fig. 6.1** and **Fig. 6.2**).

The purpose of elements of the screen interface and functions, provided with them, are described below.

6.1 Menu "File"

This menu contains the following items:

- "Open" – The watching of files with results of measurements,
- "Save" – The recording of results of the executed measurements into a file,
- "Copy" – The copying of the tables of the data into the clipboard,
- "Print" – The printing of the tables of the data and diagrams,
- "Exit" – Cancellation of the Routine execution.

6.1.1 "Open" – The watching of files

The watching of written down files containing the data of the previous measurements is carried out by the item "Open" (Menu "File").

The functions of this item are duplicated by activation of the button 🖻 "Open" placed on the panel of management and indication tools (see **Fig. 6.1** on page **14**).

The activation of item "Open" yields the opening of the dialogue window "Select file to be watched". The folder "\data" is opened by default, however files of the data can be stored and in other place.

An example of the dialogue window "Select file to be watched" is shown in **Fig. 6.3**.
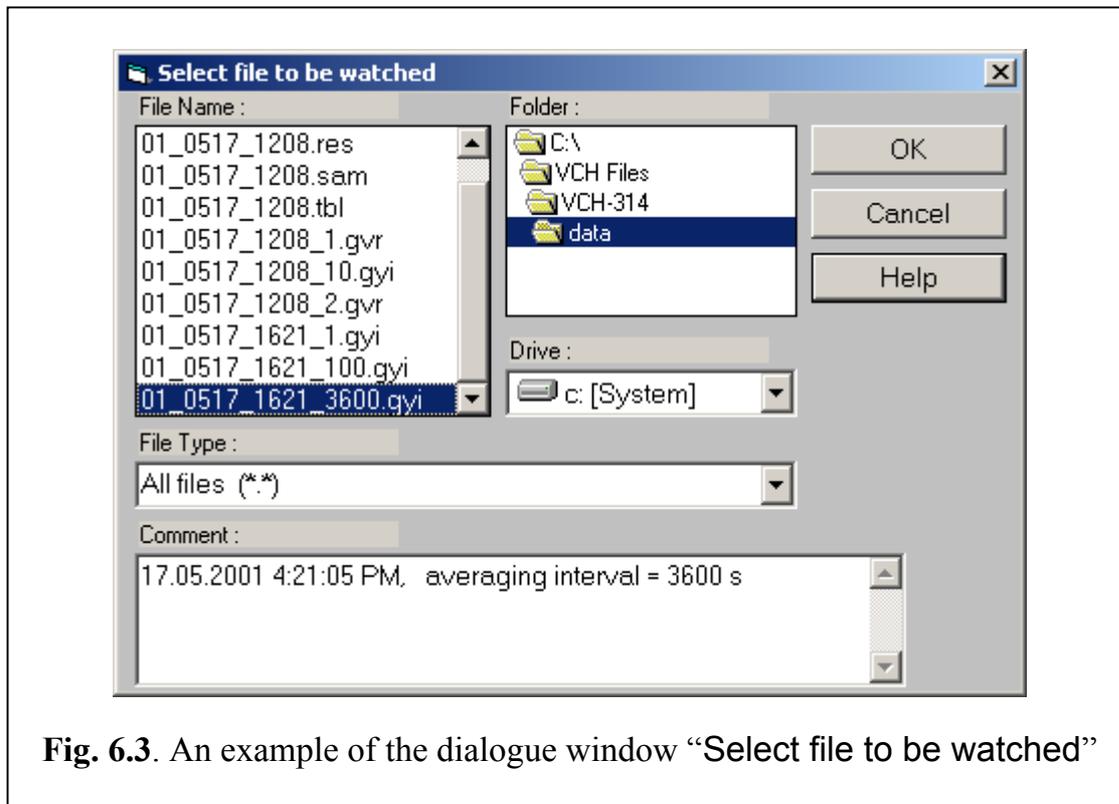
Fig. 6.3. An example of the dialogue window "Select file to be watched"

Windows "File Name", "Folder", "File Type" are made in the format of the standard Windows application. The additional window "Comment" giving an opportunity of viewing of the comments, made with record of the file, is entered.

The names of written down files look like "YY_MMDD_hhmm.ext". Here YY is two-digit designation of year; MM, DD, hh and mm are two-digit designations accordingly of month, day, hour and minute of the measurement.

The extension "ext" of the file name may be as follows:

res – Single results files, "Results" files

tbl – "Multiple results" files

sam – Files with the record of the sampled phase difference generated by TIM (see **Fig.2.2**), "Time Samples" files

gsp – Files with spectra of the relative frequency difference, and also with spectra of the frequency noise in separate signals (only for the method of three oscillators), "Relative frequency difference spectrum diagram" files.

Two types of files having the extension "gvr" and "gyi" are the exception of the rule.

gyi – These files contain diagrams of the relative frequency difference, "Relative freq. difference diagram (S sec)" files. These files have the format "YY_MMDD_hhmm_S.gyi", where S is the time of the single measurement (in seconds)

gvr – These files contain diagrams of variances, "Variance diagram" files. These files have the format "YY_MMDD_hhmm_M.gvr", where M is the modifier of the displayed statistical function. For M = 1 the relative mean square frequency difference is mapped. If M = 2 then the two-sample relative frequency deviation (Allan variance) is displayed.

6.1.2 "Save" – The recording of results into file

The recording of results of the executed measurements into the file is executed by the activation of the item "Save" (Menu "File").

Functions of this item are duplicated by activation of the button 🔲 "Save" placed on the panel of management and indication tools (see **Fig. 6.1** on page **14**).

The activation of item "Save" yields the opening of the dialogue window "Save As". The folder "\data" is opened by default, however files of the data can be stored and in other place.

An example of the dialogue window "Save As" is shown in **Fig. 6.4**.

This window is made in the format of the standard Windows application. The rule
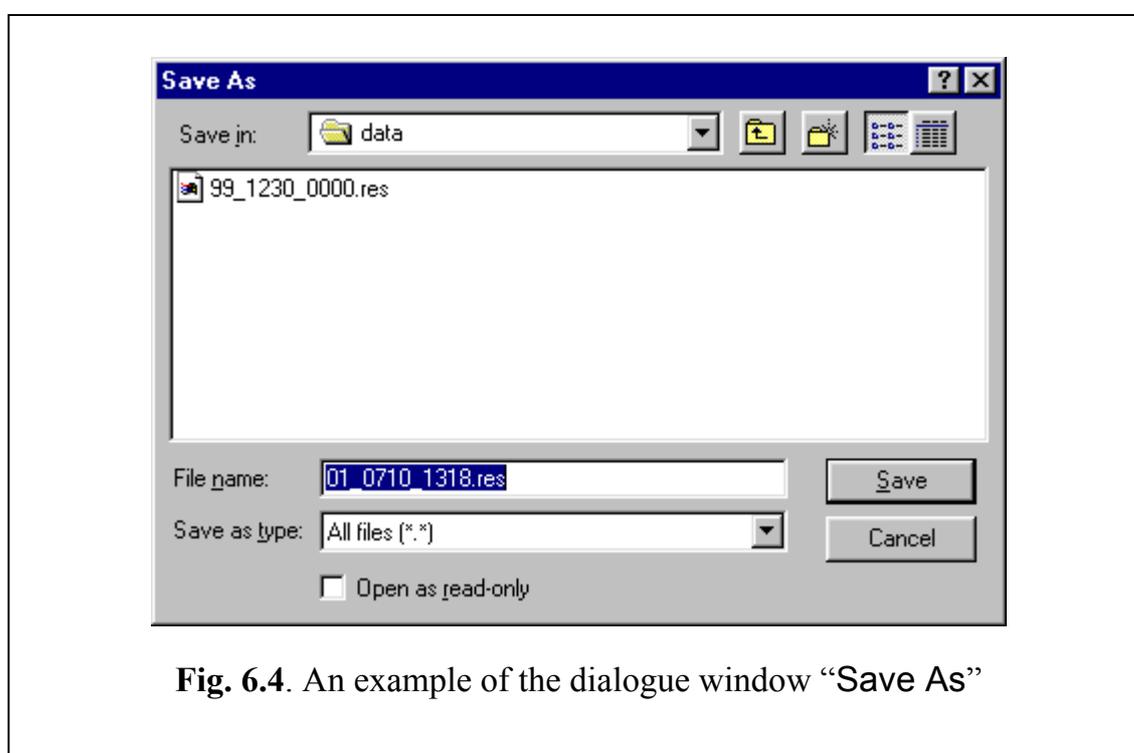
Fig. 6.4. An example of the dialogue window "Save As"

of the assignment of file names is described in Section **6.1.1 "Open" – The watching of files** (see page **15**).

The specificity of the item "Save" consists that the activation of this item yields the saving of the data only of one (activated) daughter window containing results of data processing of measurements. The extension of the file to be written down is determined by the type of the table to be saved or by the type of the function calculated, see Section **6.1.1**.

6.1.3 **"Copy"** – **Copying of the data tables**

The copying of protocols with results of measurement into the clipboard is provided by item "<u>C</u>opy" (Menu "<u>F</u>ile"). The same function is executed by the "Copy" button placed on the panel of management and indication tools (line 3 in **Fig. 6.1**, page **14**).

The function "Copy" is realized only for the tables of the data:

– "Multiple Results"
– "Single Results".

For copying the data it is necessary to select by the mouse (with the pressed left button of the mouse) the required fragment of the table, or the whole table. For entering the data into the clipboard it is necessary to click on the button "Copy", or use the corresponding item of "File".

In the Routine the opportunity of copying earlier written down tables, displayed with the help of item "<u>O</u>pen", is stipulated also, see Section **6.1.1**.

It is possible to place the data brought into the clipboard, into the document Word, or Excel. Example of representation of the data, received from the table "Single Results", is shown in **Table 6.1**.

Table 6.1. Example of representation of the data, received from the table "Single Results", as the worksheet Excel

Frequency comparator VCH-314				
Measurement time [s] ->	1	10	100	1000
Mean Relative Freq. Diff. (E{Fy1x})	4.77E-15			
Mean Relative Freq. Diff. (E{Fy2x})	1.80E-15			
Mean Relative Freq. Diff. (E{Fy2y1})	-2.97E-15			
RMS Relative Freq. Diff. (var{Fy1x})	1.00E-12	3.17E-13	9.75E-14	3.14E-14
RMS Relative Freq. Diff. (var{Fy2x})	1.41E-12	4.45E-13	1.39E-13	4.34E-14
RMS Relative Freq. Diff. (var{Fy2y1})	1.01E-12	3.18E-13	1.00E-13	2.92E-14
RMS Relative Freq. Diff. (var{Fx})	9.98E-13	3.14E-13	9.69E-14	3.17E-14
RMS Relative Freq. Diff. (var{Fy1})	1.05E-13	4.59E-14	1.02E-14	4.72E-15
RMS Relative Freq. Diff. (var{Fy2})	1.00E-12	3.15E-13	9.97E-14	2.96E-14
RMS Two-sample Freq. Diff.(var2{Fy1x})	1.00E-12	3.16E-13	9.74E-14	2.92E-14
RMS Two-sample Freq. Diff.(var2{Fy2x})	1.41E-12	4.42E-13	1.43E-13	3.93E-14
RMS Two-sample Freq. Diff.(var2{Fy2y1})	1.01E-12	3.18E-13	1.02E-13	3.09E-14
RMS Two-sample Freq. Diff.(var2{Fx})	9.95E-13	3.12E-13	9.89E-14	2.69E-14
RMS Two-sample Freq. Diff.(var2{Fy1})	1.12E-13	5.13E-14	1.67E-14	1.15E-14
RMS Two-sample Freq. Diff.(var2{Fy2})	1.00E-12	3.14E-13	1.03E-13	2.87E-14
Real number of averages N	3999	399	1009	100

It is necessary to mean the following specificity of copying of data.

When the group of cells containing results of measurement is selected, two strings are automatically added into the clipboard. These strings contain the title of the used comparator (VCH-314) and available meanings of the measurement time.

In addition, the (first) column containing the names of measured functions is recorded into the clipboard.

6.1.4 "**Print**" – Printing of Tables and Diagrams

In the Routine the opportunity of the printing of the tables of the data, and diagrams through the printer connected to the computer is stipulated.

For the printing of the protocol it is necessary to execute the following actions:
– To activate the required table (diagram) by click of the mouse.
– To click on the button 🖨 "Print", located on the panel of management and indication tools (line 3 in **Fig. 6.1**, page **14**), or activate item "Print" (Menu "File").

It is assumed that the printer is connected and is filled.

The printout of the data table is supplemented by the header containing the title of the comparator used. Besides, the additional string is printed. This string contains data on the installed bandpass **B**, multiplying factor **K**, time of measurement **T**, and number of averaging **N**.

The printing of the table "Multiple Results" is carried out via the Editor of worksheets Excel, which should be beforehand installed on the used computer. This software is used as the OLE-server. That is caused by the necessity to adjust the sizes of the large tables to the sizes of the paper used for printing.

It is recommended to format the table "Multiple Results" before the printing. For this purpose it must be saved (with the help of item "Copy" 📋) as the worksheet Excel. Then, by making necessary formatting of the worksheet, it is possible to print the document.

If the diagram is printed, the type of the used comparator (VCH-314) in addition is shown.

6.1.5 Item "**Exit**"

The execution of item "Exit" (Menu "File") results in cessation of work of the Routine and closing of the screen interface VCH–314. If results of measurements are present, that were not saved, the preliminary inquiry about their saving is asked.

6.2 Menu "Run"

Menu "Run" provides start-up of the Routine in modes of single and cyclic measurements over **N** data (see Section **4 Variants of the Routine operation**). This menu contains the following items duplicated by managing buttons (buttons are shown in **Fig. 6.1**, page **14**).

– "Single", single measurements over **N** data, managing button ▶ .
– "Cyclic", cyclic measurements over **N** data, managing button ◯ .
– "Stop", pre-scheduled interruption of measurement, managing button ■
– "Recalc", recalculation of the tables and diagrams for the changed range of data, managing button Recalc

View of the opened Menu "Run" is shown in **Fig. 6.5**.

Fig. 6.5. View of the opened Menu "Run"
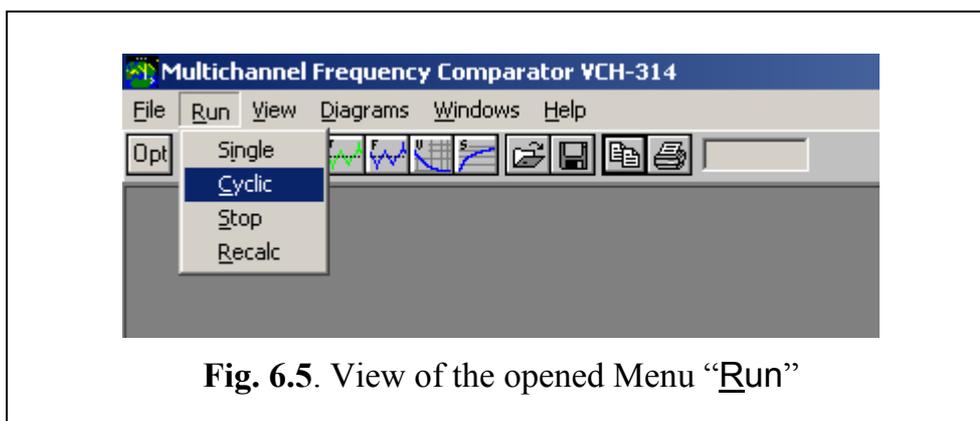
6.3 Menu "View" (Options, Tables)

Menu "View" contains items for the management by the Comparator, and displaying of tables with results of calculation of statistical functions describing the frequency instability. View of the opened Menu is shown in **Fig. 6.6**.
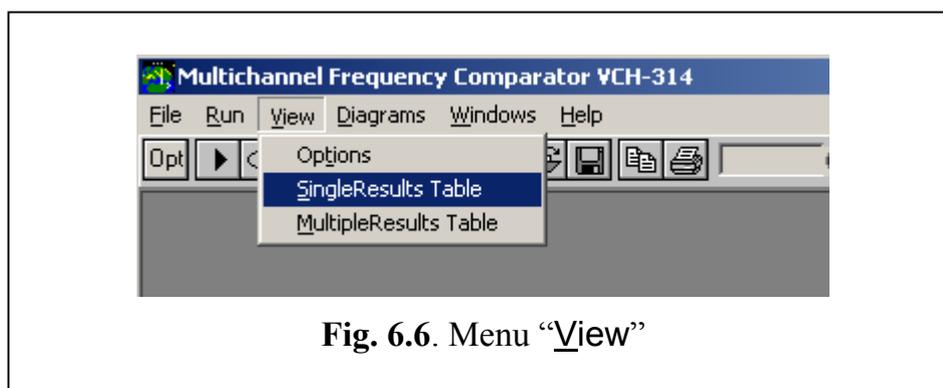
Fig. 6.6. Menu "View"

The last two items of Menu "View":
– "SingleResults Table",
– "MultipleResults Table",
provide the displaying of the tables containing data of the last measurement, and of all executed measurements, accordingly.

The setting of parameters of the Routine is carried out by the item "Options". The functions of this item are duplicated by activation of the button Opt "Options" placed on the panel of management and indication tools (see **Fig. 6.1** on page **14**).

The execution of this item yields the opening of the dialogue window "Options". An example of the dialogue window "Options" is shown in **Fig. 6.7**.

The dialogue window "Options" contains the following panels: "Multiplication", "Bandpass", "Samples", "Serial interface", "Limits", "Inputs in use", and "Common commentary".

The purpose of these panels, and provided by these the settings are described below.

6.3.1 "Multiplication" – The setting of multiplication factor

The multiplication factor **K** for the frequency noise (the variable K, see Section **2**) is set from the "Multiplication" panel of the dialogue window "Options". This factor can take two meanings: 10^3 and 10^6 for input frequencies 5,10,100 MHz, or 778 and 5.96e5 for input frequency 10.0028 MHz.

The choice of a required meaning is carried out from the opened list "Multiplication factor".

The chosen meaning of the multiplication factor **K** is displayed on the indication panel (line 5 in **Fig. 6.2**).

6.3.2 "Bandpass" – The setting of bandpass

The set of available meanings of the bandpass **B** for measured frequency noise (the variable *B*, see Section **2**) is determined by the chosen multiplication factor **K** (see previous Section).

If $K=10^6$ (5.96e5), then this bandpass can take two meanings: 3Hz, or 10Hz. The choice of the required meaning is carried out by the activation of the appropriate button on the panel "Bandpass" of the dialogue window "Options".

For $K=10^3$ (778) the meaning $B=10$kHz is set automatically.

The width of the bandpass is displayed on the indication panel (line 5 in **Fig. 6.2**).
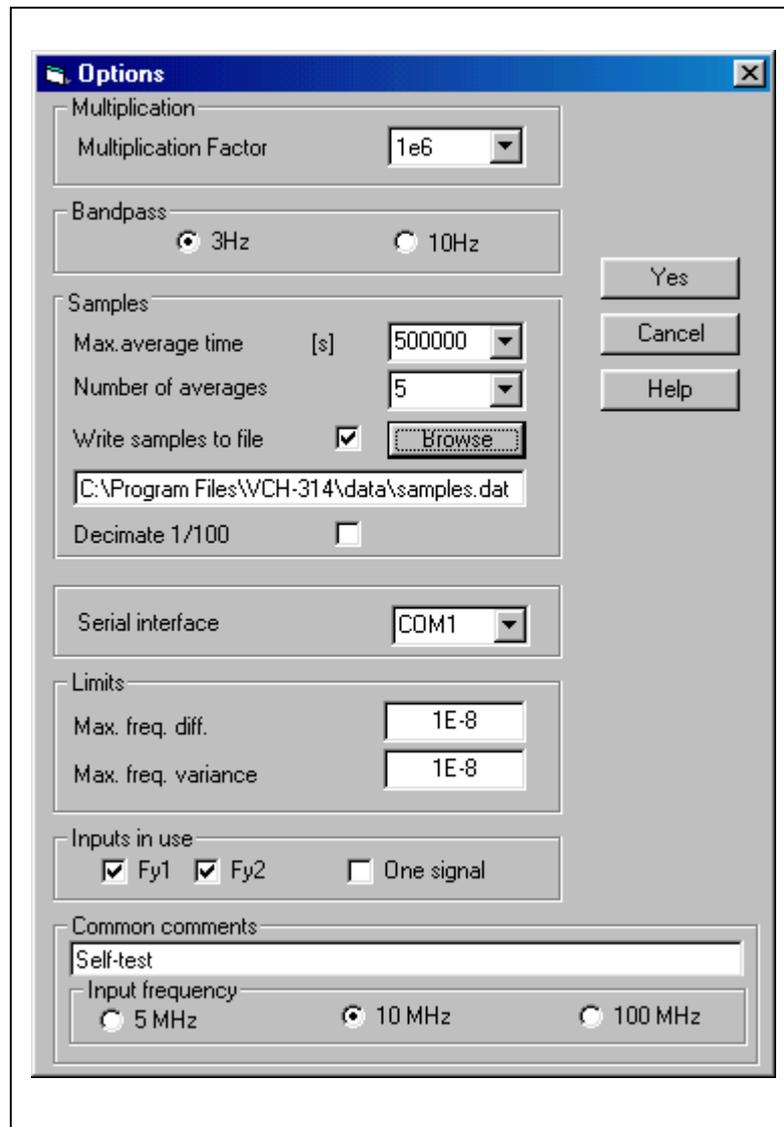
Fig. 6.7. Window "Options"

6.3.3 **"Samples"** – **The setting of maximal time of measurement**

The setting of the maximal time **T** for the single measurement (the variable τ, see Section **2**) is carried out from the opened list "Max. Measurement time" (the "Samples" panel of the dialogue window "Options").

The time **T** can accept the following discrete meanings (in seconds): 1, 10, 100, 1000, 3600, 10000, 86400, 100000, 500000.

If **T** >1 (that is **T** =10, 100, 1000, 3600,…) the calculation of the characteristics of the frequency instability not only for the chosen meaning of **T**, but also for intermediate meanings is carried out. For this reason the value **T** is determined as the maximal time. The set of intermediate meanings is determined by the selected kind of the data represented.

For example, if **T** =1000 (sec) the calculation of all available characteristics is performed:

– for **T** =1, 10, 100, 1000, with the recording of appropriate quantities of readouts **N**, if the data are recorded as the table;
– for **T** =1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, with the calculation of appropriate statistical functions, if the data are recorded as the diagram.

The chosen meaning of the maximal time **T** for the single measurement is displayed on the indication panel (line 5 in **Fig. 6.2**).

6.3.4 **"Samples"** – **The setting of number of averaging**

The setting of the quantity **N** of consecutively averaged values of the relative frequency deviations (the variable N, see Section **2**) is carried out from the opened list "Number of samples" (the "Samples" panel of the dialogue window "Options").

This list contains possible meanings of the quantity **N** = 10, 20, 50, 100, 200, 500, 1000. However, with the activation of the list the User can enter any required meaning from the keyboard of the computer, for example, **N** = 99.

The quantity of readouts can be less due to the rejection of bad data (see Section **5 The restrictive admissions**).

If the duration of the ordered measurement is inadmissible (for example, **N** = 100 for the maximal time of the single measurement **T** = 100000 sec) then the information window "Samples" suggesting to decrease the maximal time, or number of averages, is displayed (see **Fig. 6.8**).

6.3.5 **"Samples"** – **Write samples to file**

On completion of measurements the user can analyze any part of the measured data. To do this at any time later it is necessary to save samples of data in a file. Use button "Browse" to find a file or type the file name in the field below the button.

6.3.6 **"Serial interface"** – The setting of the serial port number

The setting of the computer serial port number (COM 1,2,3,4), through
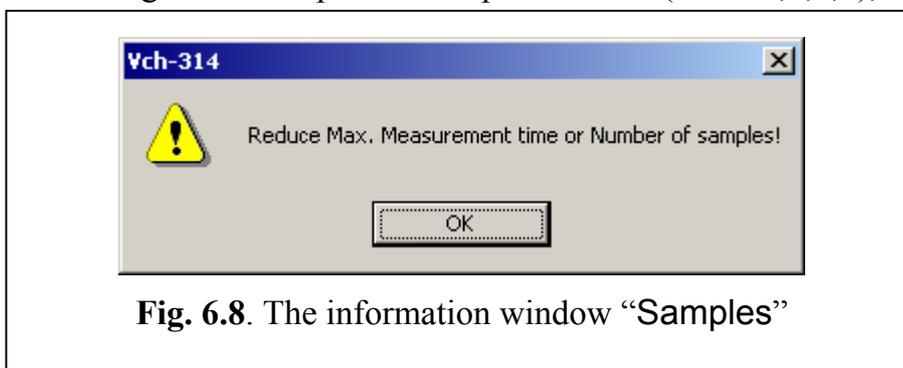
Fig. 6.8. The information window "Samples"

which the Routine is linked with the Comparator, is carried out from the opened list "Serial interface" (of the dialogue window "Options", see **Fig. 6.7**).

Setting port COM0 switches the program into the demo-mode (the software uses random data instead of TIM output.

6.3.7 **"Limits"** – The setting of restrictions on allowable parameters

The setting of restrictions on allowable parameters (see also Section **5 The restrictive admissions**) is carried out from the "Limits" panel of the dialogue window "Options". This panel contains two windows:
– max freq. difference,
– max freq. variance.

If measured parameters exceed limits of allowable meanings, the information window "Difference of frequencies" (represented in **Fig. 5.1**) is opened on the screen interface. The interruption of data processing happens in this case.

The data entry is continued if the intermediate stage of processing takes place. The excursion of measured parameters through allowable limit results in the termination of data entry only after the processing of the last ordered number **N** of averaged values.

6.3.8 **"Inputs in use"** – The choice of the method of measurement

The method of measurement of the frequency noise is to be chosen with the help of this panel.

If only one field is activated, **Fy1**, or **Fy2**, frequencies of two oscillators are compared. In other words, the treatment of two signals, f_{y1} and f_x, or f_{y2} and f_x, is being made.

If both fields are activated, **Fy1** and **Fy2**, the measurements are being made by the method of three oscillators. The measurement of the frequency instability for each from three processed signals is possible in this case.

For the treatment of two signals with the elimination of the inner noise of the Comparator it is necessary to activate the field "The same signals".

6.3.9 "Common commentary" – The entering of the common commentary

This panel contains two elements: the field for the entering of any commentary (for example, with the indication of the used instruments), and three managing buttons for the indication of frequency of signals – 5 MHz, 10 MHz (10.0028 MHz) and 100 MHz.

The information introduced with the help of the panel "Common commentary", will be recorded together with all saved (as the file) tables and diagrams.

6.4 Menu "Diagrams"

Menu "Diagrams" allows choosing the types of diagrams to be displayed, and their parameters. Here the opportunity of viewing of the power spectral density of the relative frequency deviation is stipulated. The open Menu "Diagrams" is shown in **Fig. 6.9**.
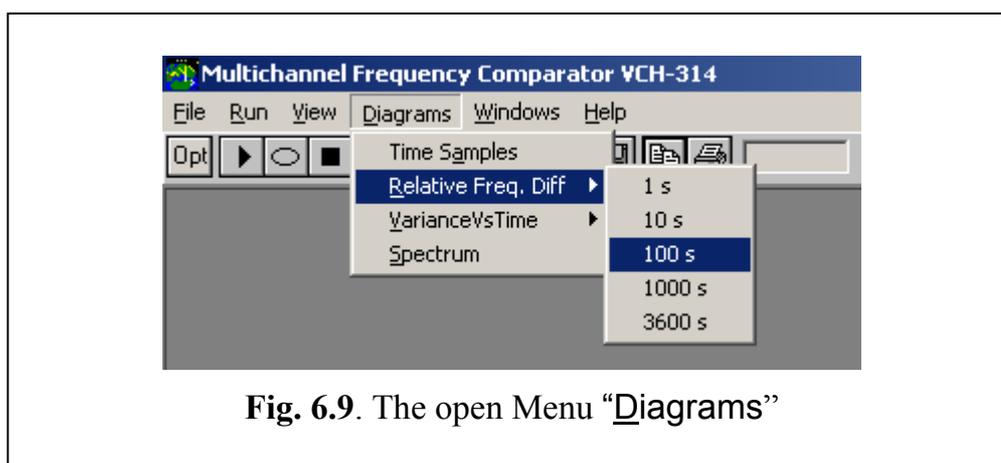
Fig. 6.9. The open Menu "Diagrams"

Menu "Diagrams" contains the following items:
– "Time Samples",
– "Relative Freq. Diff",
– "VarianceVs Time",
– "Spectrum".

6.4.1 Item "Time Samples"

This item of Menu "Diagrams" is duplicated by button , placed on the panel of management and indication tools (line 3 in **Fig. 6.1**).

The execution of the item yields the opening of the diagram "Time Samples" that shows the dependence of signals Y_{y1x}, Y_{y2x} and Y_{y2y1} (formed by TIM, see

Fig.2.2), on the readout current number i.

An example of the diagram "Time Samples" is shown in **Fig. 7.3**.

6.4.2 Item "Relative Freq. Diff"

This item of Menu "Diagrams" is duplicated by button [icon], placed on the panel of management and indication tools (line 3 in **Fig. 6.1**). The execution of the item "Relative Freq. Diff." yields the opening of the additional list. This list contains the set of possible meanings of the measurement time **T**: 1, 10, 100, 1000, 3600, 10000 seconds, 1 day or 1e5, 5e5 seconds. The accessible meanings of the measurement interval are determined by the maximal time of measurement **T** and chosen quantity **N** of averaged consecutive values of relative frequency deviations.

The change of the chosen earlier meaning **T** yields respective change in the displaying of the diagram "Relative Frequency Difference" (provided that this diagram is already opened). For instance, the increase of the measurement interval yields the smoothing of the chart displayed in the diagram.

The opening of the diagram by managing button [icon] results in the choice of the measurement interval used for this diagram earlier. By default the interval equal to 1 second is selected. An example of the diagram "Relative Frequency Difference" is shown in Ошибка! Источник ссылки не найден..

6.4.3 Items "VarianceVs Time", "Spectrum"

With activation of item "Variance Versus Time" another additional list is opened (appropriate example is shown in **Fig. 6.10**). This list contains the set of statistical functions describing the frequency instability:

- var{y,t} – root mean square relative frequency difference,
- var2{y,t} – root mean square two-sample relative frequency deviation (Allan variance).
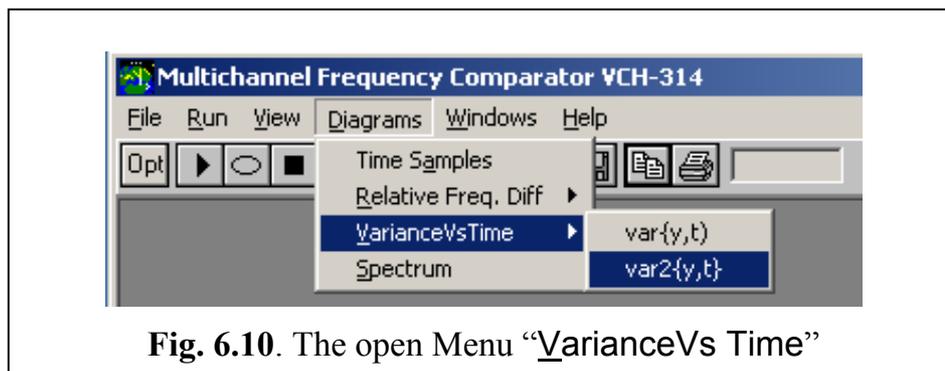
Fig. 6.10. The open Menu "VarianceVs Time"

The call of the item is duplicated by button [icon] "Variance", placed on the panel of management and indication tools (line 3 in **Fig. 6.1**).

The clicking (by the mouse) on this button yields the displaying of the diagram called earlier. By default the call of the diagram var{y,t} takes place.

When the item "Spectrum" is executed, the power spectral density of relative frequency deviations is calculated and displayed. The call of this item is duplicated by button [icon], placed on the panel of management and indication tools (line 3 in **Fig. 6.1**).

If the method of three oscillators is used, the appropriate data not only for the difference between frequencies of any two signals, but also for the frequency noise of anyone from three signals can be displayed on diagrams "Variance Versus Time" and "Spectrum".

6.5 Menu "Windows"

This menu provides the management by the displaying of earlier opened windows containing results of the analysis of various characteristics of the frequency instability.

The activation of Menu "Windows" yields the opening of the dialogue window "Windows" (see **Fig. 6.11**).

This Menu contains two items
– "Cascade",
– "Arrange icons",
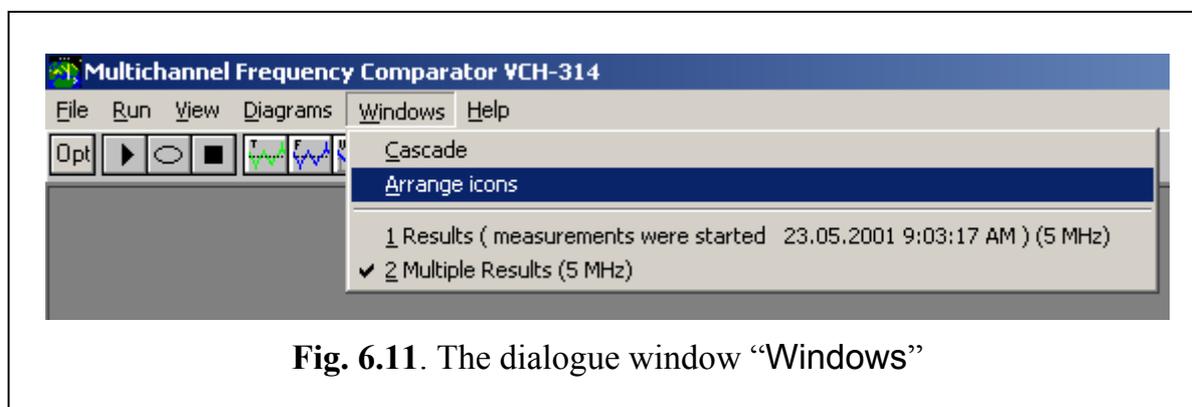
Fig. 6.11. The dialogue window "Windows"

and the list of opened windows (which can be turned to icons) as well. The symbol "∨" marks the window, to which the management is transferred.

After item "Cascade" is executed all windows are opened as the cascade, and item "Arrange icons" provides the arrangement of icons on the screen interface.

6.6 Menu "Help"

Menu "Help" provides the call of help system, and also the displaying of the information about the Manufacturer of the present Routine. The opened window "Help" is shown in **Fig. 6.12**.
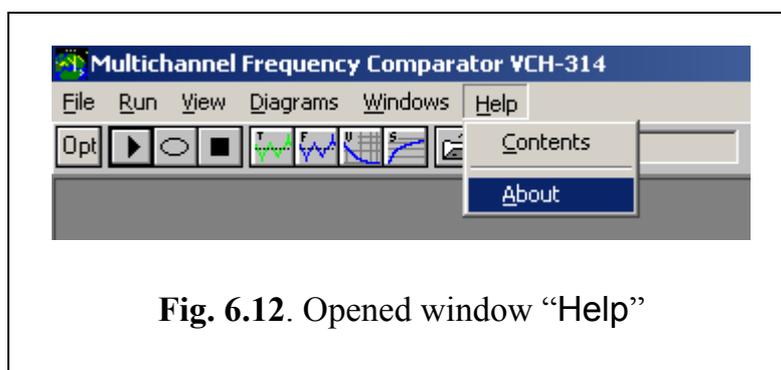
Fig. 6.12. Opened window "Help"

The contextual - dependent help is stipulated in the Routine. Pressing of key F1 from the keyboard carries out the call of the appropriate section of the help system.

6.7 Panel of management and indication tools

Panel of management and indication tools is shown by line 3 in **Fig. 6.1**, and line 5 in **Fig. 6.2**, see page **14**. The assignment of all buttons located on the first part of the panel (line 3) was described above. It is necessary only to add that after the "Print" button ⌸ the information window is located, in which the time (in seconds) necessary for the completing of the measurement is displayed.

The management and indication tools, shown in line 5, are to be discussed now.

Here four information windows, located on the right, display the parameters accepted for measurements by appropriate settings in the window "Options", see Section **6.3 Menu "View" (Options, Tables)**, **Fig. 6.7**.

Other five tools of the panel have the following assignment.

6.7.1 The button "File"

The button "File" is accessible if the user switched ON writing of samples to file (see Section 6.3.5). It means, that the data from file named in the corresponding field on window "Options" will be used for calculations after pressing the button "Recalc".

6.7.2 The button "All"

The button "All" is activated at the beginning of any measurement. It means, that the result of all measurements will be displayed in tables and diagrams.

In the analysis of results of measurements the necessity can arise to display only part of obtained data (for example, for the exception of artifacts). The special tools are stipulated for such processing.

6.7.3 Analysis of the part of data

For the analysis of the part of the measured data it is necessary to execute the following operations.

1. To activate the button "From" (or button "File").
2. To print (from the keyboard) the number of the readout, from which it is necessary to begin the analysis of data, into the field with the same name.
3. To print (from the keyboard) the number of final readout to be analyzed into the field "To".
4. To click by mouse on the button ⌷Recalc⌷, or to call the appropriate item from Menu "Run", see Section **6.2** on page **20**.
5. To call again the required table, or diagram, through the menu, or by clicking the appropriate button.

Note.

1.   If inadmissible narrow range for recalculation of some table (or diagram) was chosen, the attempt of call of badly defined function is finished by indication of the information window "Not enough data" (see **Fig. 6.13**).

2.   Using button "From" allows to calculate statistical functions in accor-

Fig. 6.13. Opened window "Not enough data"
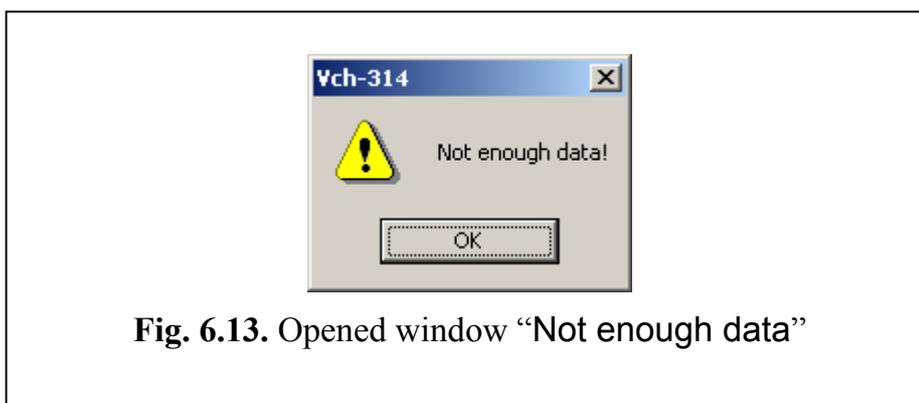
dance with the chosen range of sample numbers only for average times equal or more than 100 seconds. The statistical functions for average times less than 100 s. are calculated using data from the circular buffer, containing last 4000 samples of phase from TIM output got during measurements.

3.   To calculate statistical functions in accordance with the chosen range of sample numbers for all average times use writing samples to the file and button "File" accordingly.

7 Tables and Diagrams

The results of the Routine execution are always displayed in two tables, see Section **6.3 Menu "View" (Options, Tables)**:
– "Multiple Results",
– "Single Results".

Table "Multiple Results", by default, is contained on the screen interface as an icon. Table "Single Results" is displayed in the full size.

At the request of the User the various diagrams with characteristic of the frequency instability, may be calculated and displayed (see Section **6.3 Menu "View" (Options, Tables)** and Section **6.4 Menu "Diagrams"**).

The description of the tables and diagrams is given below.

7.1 Table "Single Results"

The results of last measurement are presented in this table. The possible view of the table is shown in **Fig. 7.1**.

Single Results Table (measurements were started 30.06.2001 10:24:28 AM) (5 MHz)				
Comment : 30.06.2001 10:24:28 AM (5 MHz)	☑ Fyx ☑ Fzx ☑ Fzy ☑ Fx ☑ Fy ☑ Fz				
Measurement time [s] ->	1	10	100	1000	3600
Mean Relative Freq. Diff. (E{Fyx})	-1.00e-12				
Mean Relative Freq. Diff. (E{Fzx})	-1.00e-12				
Mean Relative Freq. Diff. (E{Fzy})	5.28e-17				
RMS Relative Freq. Diff. (var{Fyx})	1.43e-12	1.59e-13	1.87e-14	1.29e-15	4.35e-16
RMS Relative Freq. Diff. (var{Fzx})	1.42e-12	1.57e-13	2.09e-14	1.42e-15	6.48e-16
RMS Relative Freq. Diff. (var{Fzy})	2.02e-12	2.02e-13	2.13e-14	1.90e-15	6.04e-16
RMS Relative Freq. Diff. (var{Fx})	1.35e-13	6.66e-14	1.29e-14	1.80e-16	3.49e-16
RMS Relative Freq. Diff. (var{Fy})	1.43e-12	1.44e-13	1.35e-14	1.28e-15	2.59e-16
RMS Relative Freq. Diff. (var{Fz})	1.43e-12	1.42e-13	1.65e-14	1.41e-15	5.45e-16
RMS Two-sample Freq. Diff.(var2{Fyx})	1.75e-12	1.82e-13	2.40e-14	1.50e-15	5.07e-16
RMS Two-sample Freq. Diff.(var2{Fzx})	1.74e-12	1.79e-13	2.70e-14	1.65e-15	7.59e-16
RMS Two-sample Freq. Diff.(var2{Fzy})	2.48e-12	2.49e-13	2.63e-14	2.37e-15	7.32e-16
RMS Two-sample Freq. Diff.(var2{Fx})	1.86e-13	4.07e-14	1.75e-14	5.58e-16	3.86e-16
RMS Two-sample Freq. Diff.(var2{Fy})	1.76e-12	1.77e-13	1.64e-14	1.60e-15	3.29e-16
RMS Two-sample Freq. Diff.(var2{Fz})	1.75e-12	1.75e-13	2.05e-14	1.75e-15	6.54e-16
Real number of averages N	39600	3959	395	38	10

Fig. 7.1. Possible view of table "Single Results"

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The table contains the following fields.
- "Heading". Date and time of the executed measurement are displayed here. The managing buttons typical for the standard Windows application are put into this field.
- "Commentary". The date and time of the executed measurement are displayed in this field by default. Any textual information desired by the User can be inserted here. While table "Single Results" is recorded into the file the comment is recorded as well.
- Field of the order of signals to be analyzed. Check box in the appropriate window of the field is used for the choice of signals (and their combinations). In case, when only two signals are connected to inputs of the Comparator, only one window for the difference of frequencies is available: "Fy1–Fx", or "Fy2–Fx". The kind of the frequency difference available for the analysis is determined by the used input of the Comparator: "Fy1", or "Fy2", see Section **6.3 Menu "View" (Options, Tables)**.
- "Table with results of measurements" (see also **Table 6.1**). Its content is discussed below.

The first line "Measurement time" in "Table with results of measurements" displays the interval **T** for the frequency instability measurement. If **T** >1, then the indication of results for intermediate meanings of the measurement interval takes place. Note that value **T** has dimension "second".

The content of other lines is determined by the selected method of the measurement (two, or three oscillators). The main part of displayed functions is available only for the method of three oscillators.

The lines of displayed functions are formed in blocks. Each block can contain up to three lines (depending on number of processed signals or their combinations).

In the first block of lines "Mean Relative Freq. Diff. (E{Fy1x})" the averaged frequency difference is displayed.

The second block "RMS Relative Freq. Diff. (var{Fy1x})" contains meanings of the standard of the frequency difference for pair of signals.

The third block "RMS Relative Freq. Diff. (var{Fx})" contains meanings of relative instability of frequency for any from three analyzed signals. This block is available only for the method of three oscillators.

In the fourth block "RMS Two-sample Freq. Diff. (var2{Fy1x})" the meanings of the two-sample relative variation (Allan variance) for the frequency difference of two signals are given.

The fifth block "RMS Two-sample Freq. Diff. (var2{Fx})" contains meanings of the two-sample relative frequency cross-variances (Allan cross-variance) for any from three analyzed signals. This block is available only for the method of three oscillators.

If the same signal is connected to inputs "f_{y1}" and "f_{y2}" (see Section **6.3.8 "Inputs in use"** – **The choice of the method of measurement**) the Allan variance describing the noise in the difference frequency $(f_{y1} - f_x)$ is displayed in this block. The noise added by Comparator is eliminated in this case.

Note that the setting of the option "The same signals" results in indication only of one line per block.

The last line contains true (for each possible interval of measurement **T**) quantity **N** of averaged relative deviations of frequency.

The User can change the width of each column of the table with results of measurements. To change the width of the column it is necessary (with pressed right mouse button) to capture the right boundary of the column in the field of its header. Then, moving the pointer of the mouse horizontally, it is possible to set the required width of the column.

In the cyclic mode of operation of the Routine the contents of the table is updated after each measurement. It allows to watch the process of measurements and, if necessary, to interrupt it.

7.2 Table "Multiple Results"

In the table the results of measurements executed from the moment of the setting of required parameters and start of the Routine execution are recorded. The possible view of the table is shown in **Fig. 7.2**.
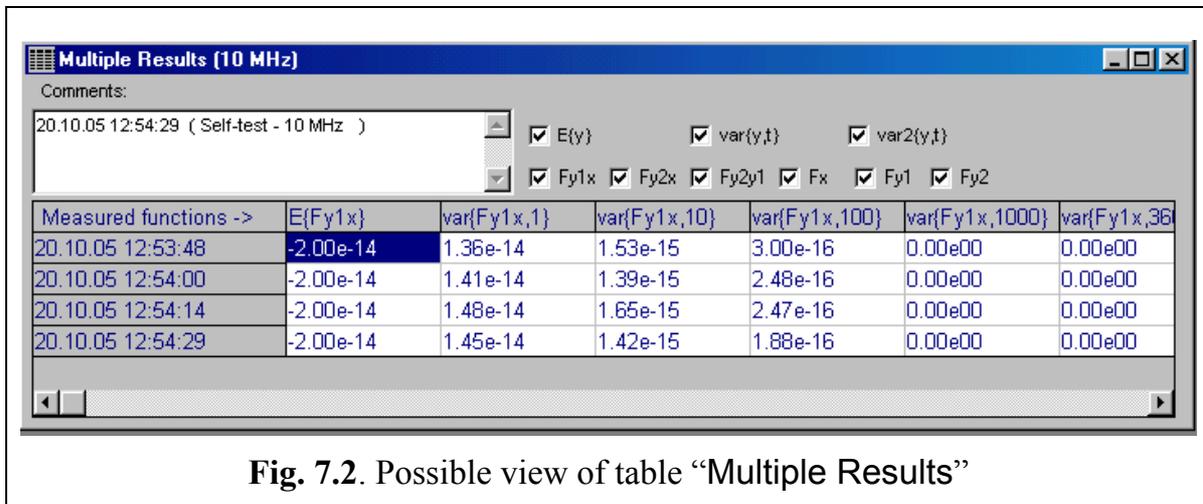
Fig. 7.2. Possible view of table "Multiple Results"

Fields of the table "Multiple Results" in many respects are similar to fields used in the table "Single Results" (see previous Section). There is the difference in two last fields.

"Field of the order of signals to be analyzed"
Here, in addition to the choice of signals (and their combinations), the possibility of the choice of displayed statistical functions is stipulated:
- E{y} – the mean relative difference between frequencies of two signals,
- var{y,t} – frequency relative variance,

- var2{y,t} – two-sample frequency relative variance (Allan variance).

"Table with results of measurements"

The field displaying results of measurements may contain not more 2000 lines. If the table is filled, the replacement of the oldest data by new data occurs.

The User can change the width of each column of the table with results of measurements. To change the width of the column it is necessary (with pressed right mouse button) to capture the right boundary of the column in the field of its header. Then, moving the pointer of the mouse horizontally, it is possible to set the required width of the column.

The first column in the table displays date and time of the executed measurement. Others contain meanings of the calculated functions. The quantity of columns with results for all functions (except function E{y} - relative mean difference between frequencies of two signals) depends on the chosen meaning of the measurement interval **T** of the frequency instability. If **T** >1 sec, then the columns are displayed with results for intermediate meanings of the measurement interval. In this case the meanings of **T** are specified as the additional argument of the function, for example, "var{Fx,10}".

7.3 Diagram "Time Samples"

The sampled difference of phases Y_{y1x}, Y_{y2x}, and Y_{y2y1}, formed by TIM (see **Fig.2.2**) are displayed on this diagram.

The imaging of the diagram for any signal (from three signals mentioned above) is possible only when the method of three oscillators is used.

The illustration of diagram "Time Samples" is shown in **Fig. 7.3**.

Here the vertical axis shows the magnitudes of sampled (with the accuracy equal approximately 10 nanoseconds) signals: Y_{y1x} and (or) Y_{y2x}, Y_{y2y1} (see Section **2 Comparator VCH–314 operation principles**), and the horizontal axis – the numbers of readouts.

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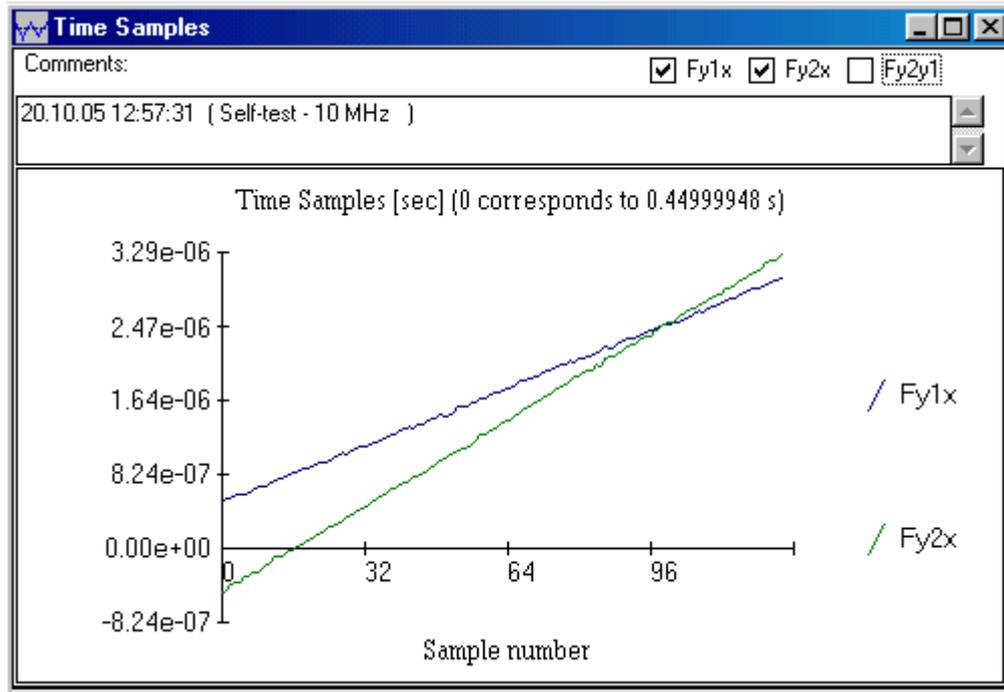
Fig. 7.3. The illustration of diagram "Time Samples"

In the header of the diagram the time of arrival of the first impulse 1Hz is shown. If during the construction of the diagram the Routine has made the decimation of data, the appropriate factor is mentioned as the variable **Kdec**.

The textual field "Comment" is displayed in the window of the diagram. It is possible to print any comments into this field. These comments will be saved while the diagram will be saved into the file (see Section **6.1.2 "Save" – The recording of results into file**, page **17)**. By default in the field "Comment" the date and time of executed measurement are shown.

7.4 Diagram "Relative frequency difference"

The oscillogram of the relative frequency deviation is displayed on the diagram. Parameter of the diagram is the maximal time of the single measurement of the phase difference **T**. The meaning of parameter **T** is shown in the heading of the diagram (in brackets).

Possible view of diagram "Relative frequency difference" is shown in Ошибка! Источник ссылки не найден..
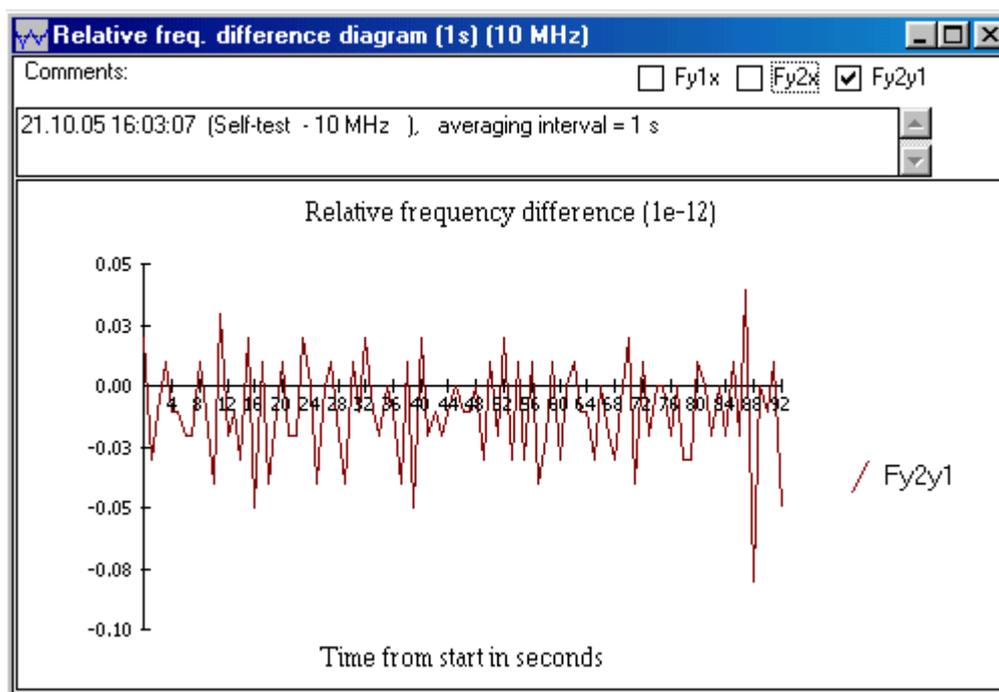
Fig. 7.4. Possible view of diagram "Relative Frequency Difference"

Here the vertical axis contains the relative frequency deviation, the horizontal axis - current time of the analysis.

The textual field "Comment" exists in the diagram window. It is possible to print any comments into this field. These comments will be saved while the diagram will be saved into the file (see Section **6.1.2 "Save" – The recording of results into file**, page **17)**.

By default the date and time of executed measurement, and the maximal time of the single measurement are shown in the field "Comment".

7.5 The management by the diagram display

The management by the display of diagrams "Time Samples" and "Relative Frequency Difference" (the scale change of the vertical axis, statistical processing, and so on) is stipulated in the Routine. To call this function it is necessary to click the right button of the mouse on the diagram field. Depending on the type of the diagram displayed, one of dialogue windows shown in **Fig. 7.5** is opened.

These windows contain the following fields and managing buttons.

– Field "**Centered diagram**" (only for the diagram "**Relative Frequency Difference**"). The activation of this field (accompanied by occurrence of the mark "×") yields the centering of displayed diagram.

– Field "**Mean**". The activation of this field (accompanied by occurrence of the mark "∨") yields the display of the horizontal line appropriate to the average relative frequency deviations.
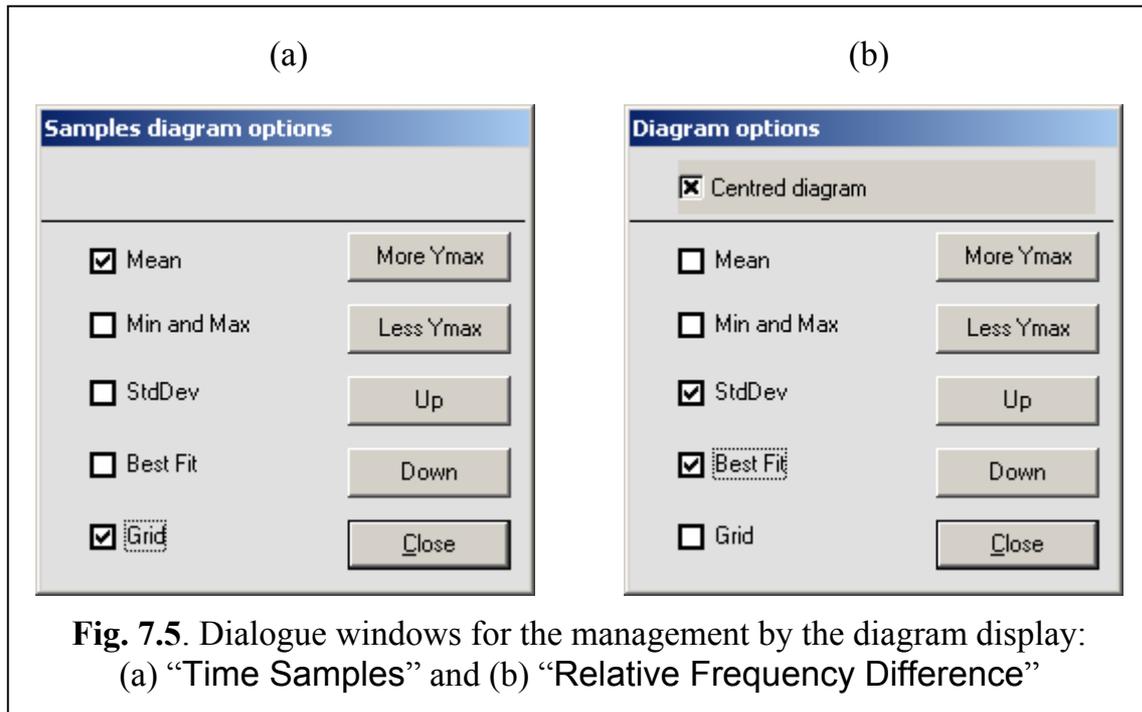
Fig. 7.5. Dialogue windows for the management by the diagram display:
(a) "**Time Samples**" and (b) "**Relative Frequency Difference**"

– Field "**Min and Max**". The activation of this field (accompanied by occurrence of the mark "∨") yields the drawing of two horizontal lines corresponding to the minimal and maximal meanings of the relative frequency deviations.

– Field "**StdDev**". The activation of this field (accompanied by occurrence of the mark "∨") yields the displaying on the diagram of two horizontal lines appropriate to the deviation downwards and upwards (relatively to the average) on the root mean square relative frequency deviation.

– Field "**Best Fit**". The activation of this field (accompanied by occurrence of the mark "∨") yields the displaying on the diagram of the line showing the trend of the relative frequency deviations.

– Field "**Grid**". The activation of this field (accompanied by occurrence of the mark "∨") yields the displaying of the coordinate grid on the diagram.

– Managing button "**More Ymax**". The click by the mouse on this button results in expansion of the range of meanings displayed on the vertical axis, and, thus, to reduction of the diagram scope.

– Managing button "**Less Ymax**". Its assignment is controversial to the assignment of the previous button.

– Managing button "Up". The click by the mouse on this button results in displacement of the diagram upwards.
– Managing button "Down". The click by the mouse on this button results in displacement of the diagram downwards.
– Managing button "Close" provides the closing of the dialogue window.

7.6 Diagrams "Variance versus time"

According to the preliminary settings, the displaying of one of the below listed diagrams is carried out:
- var{y,t} – root mean square frequency deviation,
- var2{y,t} – two-sample root mean square frequency deviation (Allan variance).

The set of analyzed signals is determined by the selected method of the measurement (two, or three oscillators). In the case of the analysis of two input signals the diagrams for the difference frequency ("Fy1–Fx", or "Fy2–Fx") are available only.

These diagrams are calculated only for the maximal time of the measurement $T > 1$, that is for $T = 10, 100, 1000, 3600, 10000$ …. The calculations are carried out not only for the given meaning T, but also for intermediate meanings. For example, if $T = 100$ then the calculation and displaying of the chosen functions for $T = 1, 2, 5, 10, 20, 50, 100$ with linear interpolation of functions between the calculated points is executed.

The windows of all diagrams have the identical structure. They contain the following fields.
– "Heading". The managing buttons typical for the standard Windows application are placed here, the type of the diagram is displayed as well.
– "Comment". The date and time of the executed measurement are displayed in this field by default. Any comments may be entered into this field, these are recorded while the diagram is saved as the file (see Section **6.1.2 "Save" – The recording of results into file**, page **17)**.
– The set of fields for the order of combinations of signals to be analyzed is placed between fields "Heading" and "Comment".
– "Field for the chart". The charts of the chosen function in double logarithmic scale are displayed here. The set of displayed charts is set by activation of appropriate fields of the order of combinations of analyzed signals.

As an example, the possible view of the diagram var2{*y,t*} is given in Ошибка! Источник ссылки не найден..
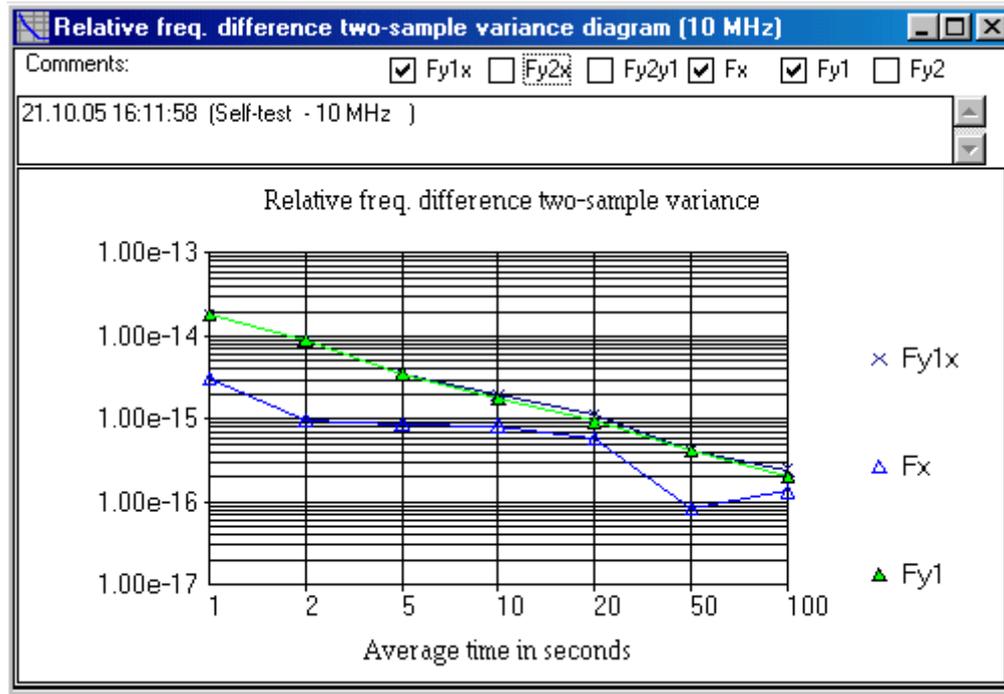
Fig. 7.6. The possible view of the diagram "var{*y,t*}"

7.7 Diagram "Spectrum"

The call of the diagram is carried out through the item "Spectrum" from Menu "Diagrams" (see Section **6.4.3 Items "VarianceVs Time", "Spectrum"**, on page **26**), or by the button [icon] on the panel of management and indication tools (line 3 in **Fig. 6.1**, page **14**).

The possible view of the diagram is represented in **Fig. 7.7**.

The window of the diagram "Spectrum" has the same structure, as for previous diagrams.

The power spectral density of the relative frequency deviations in semi-logarithmic scale is displayed in this field. The set of displayed spectra is set by activation of appropriate fields of the order of combinations of analyzed signals. The horizontal (linear) axis shows the analyzing frequency *F*. This frequency has the dimension [milliHz].

Fig. 7.7. Possible view of the diagram "Spectrum"
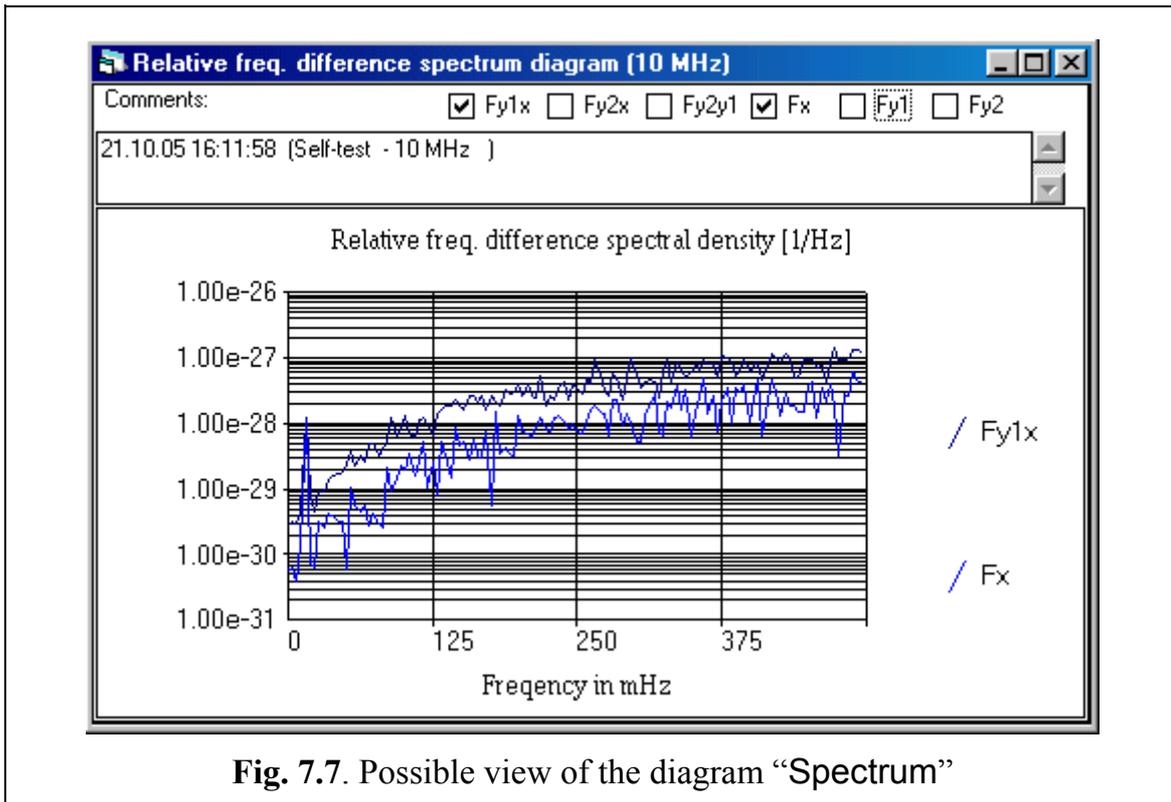
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