V R E M Y A – C H
Joint Stock Company

MICROSTEPPER COMBINER SYNTHESIZER

VCH-317M

Operational Manual

411146.044OM

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This Operational Manual is intended to study structure and principal of operation, the rules of operation and maintenance of the Microstepper Combiner Synthesizer VCH-317M (hereinafter referred to as the Combiner).

The Operational Manual contains a description, product specifications and information necessary for using the Combiner.

The appearance of the Combiner is shown in Figure 1.

Figure 1 – The appearance of the Microstepper Combiner Synthesizer VCH-317M

1 List of abbreviations and determination

DAC 1 (2) – code of “coarse” (“fine”) digital to analog converter.

Dev.(1s) – frequency instability (two sample Allan variance for averaging time 1 s) of input sine-form signal compared with output sine-form signal.

Disqualification – automatic exclusion the signal from Signal Group by one of following reasons:

- missing input sine-form signal;
- measured relative frequency difference of input sine-form signal exceeds limit;
- signal indicating input sine-form signals source error (see ERROR signal).

Frequency offset – relative frequency difference between output signal frequency and synchronizing group mean frequency.

ERROR signal – input signal indicating the status (failure or normal operation) of the input sine-form signal source.

Frequency trend – programmed linear changing of output signals frequency (calculated to one day).

PC – personal computer.

PID factors – FLL tuning parameters, such as Proportional gain, Integral gain, Derivative gain.

FLL – automatic frequency lock loop.

FLL lock – the adjustment of output signal frequency to Synchronizing group frequency and holding it.

Signals primary analysis mode – monitoring input sine-form signals quality after FLL lock. Input signals sine-form previously were included into synchronizing group.

Qualification – monitoring input sine-form signal quality before inclusion this signal into Signal Group (Synchronizing Group).

Reserve group – the group of input sine-form signals which passed qualification and is waiting inclusion into synchronizing group.

RFD – relative frequency difference between input and output signals.

RFDEG – relative frequency difference between one individual input signal and all other signals of Signal Group (Synchronizing Group).

Signal Group – the group of input sine-form signals which passed qualification, and is ready to adjust of output signal frequency.

Synchronizing Group – the group of input sine-form signals, which forms output signal frequency.

2 Safety requirements

2.1 Accessible conductive parts of the Combiner are protected by basic insulation and electrically connected to the protective grounding.

2.2 The Combiner must be grounded before use via protective conductor in the power cable and protective earth terminal marked ⏚ on the rear panel.

ATTENTION! Grounding failure makes the Combiner unsafe. Operation of the ungrounded Combiner is prohibited.

2.3 The Combiner is connected to the AC via three-wire power cable (two poles and ground) included in the Combiner composition.

ATTENTION! Usage of any other power plugs is STRICTLY PROHIBITED.

Operation of the Combiner must comply with the electrical safety regulations in force at the operating facility.

3 Description

3.1 Key applications

Microstepper Combiner Synthesizer VCH-317M produces an uninterrupted in frequency and phase precision signals on the base of some atomic clocks.

The Combiner can be used both independently, and in a structure of automated measuring systems. The remote control of the Combiner and diagnostics of its status by means of communication line is provided.

Key Combiner applications:

- time and frequency keeping service;
- radionavigation;
- radioastronomy;
- scientific researches.

3.2 Operating conditions

Working operating conditions (in Use):

- ambient temperature: from +5 °C up to +40 °C;
- ambient temperature changes: not more than 1 °C/hour;
- Atmospheric pressure: 60 kPa – 106 kPa (450 mm Hg to 795 mm Hg);
- Power supply voltage:
    - (198 – 242) V AC and a line frequency of 50 to 60 Hz;
    - (22 – 32) V DC.

Utmost operating conditions (Storage and Transportation):

- Air temperature: –50 °C to +50 °C;
- Relative humidity: up to 95 % (non-condensing).

The Combiner should be kept under operating conditions for 8 hours after staying in utmost conditions.

3.3 Product set composition and the information

The Combiner composition is given in the table 3.1.

Table 3.1

№	Model and designation	Quantity	Note
1.	Microstepper Combiner Synthesizer VCH-317M	1	Desk variant
2.	Power connecting cord SCZ-1	1	
3.	RS-232 interface cable 685670.026	1	
4.	Interface cable USB 2.0 AM/BM-1.8M	1	
5.	Microstepper Combiner Synthesizer VCH-317M Operational Manual 411146.044OM	1	
6.	Program “Monitor317”. User guide RU.ЯКУР.00144-02 34 02	1	
7.	Program “Monitor 317” RU.ЯКУР.00144-02 Installation disc	1	
8.	DC power connector 2РМТ14КПН4Г1В1	1	2PM14-4TKQB2
9.	Fuse ВП2Б-1В 3,15 А 250 В	6	T3.15AL250V

3.4 Product specifications

3.4.1 Input signals:

- sine-form of 5 or 10 or 100 MHz nominal frequency;
- (0.8 – 1.2) V on 50 Ohm load;
- maximal frequency deviation from nominal value $\pm 1.0 \times 10^{-11}$;
- number of input signals: up to 4.

3.4.2 Output signals

3.4.2.1 Sine-form output signals:

- 5 MHz nominal frequency (1 output, SMA connectors);
- 10 MHz nominal frequency (1 output, SMA connectors);
- 100 MHz nominal frequency (1 output, SMA connector);
- (0.8 – 1.2) V on 50 Ohm load;
- harmonics level for output signals 5 and 10 MHz nominal frequency: not more minus 35 dB;
- phase noise spectral density (L(f)) for output signal 5 MHz nominal frequency: not more the values, given in the tables 3.2.

Table 3.2

f, Hz	10	100	1 000	10 000
L(*f*), dBc	–137	–155	–160	–160

- phase noise spectral density (L(f)) for output signal 10 MHz nominal frequency: not more the values, given in the tables 3.3.

Table 3.3

f, Hz	10	100	1 000	10 000
L(*f*), dBc	–131	–150	–155	–155

3.4.2.2 Pulse-form 1 PPS output signals (2 outputs, BNC connectors):

- nominal frequency: 1 Hz;
- polarity: positive;
- pulse amplitude: in the range from 2.5 V up to 5.0 V on 50 Ohm load;
- pulse duration: (10.2±0.1) μs;
- rise-time: not more 10 ns.

3.4.2.3 ERROR signal – Output signal “Wrong output signal” (BNC connector)

Output signal “Wrong output signal” parameters:

- voltage from 2.4 up to 5.0 V (perfect output signal);
- voltage less 0.4 V (output signal in disrepair).

3.4.3 Current output signals frequency corresponds to the formula:

$$f_{out} = f_{nom}(1 + s + y^*),$$

where:

f_{nom} – nominal frequency of output signal (5; 10; 100 MHz),

y^* – mean relative frequency difference,

$s = e + \nu \cdot t$ – current value of frequency offset,

where:

e – initial frequency offset value (range $\pm 1.0\times10^{-8}$, minimal step 1.0×10^{-18});

ν – programmed frequency trend per day value (range $\pm 8.64\times10^{-12}$, minimal step 1.0×10^{-18});

t – time (in days) after last frequency trend setting.

3.4.4 The Combiner operating modes:

- "Averaging";
- "Switching".

Synchronizing group can contain from one to four input signals in the "Averaging" mode, and the Combiner output signal frequency is adjusted to averaging frequency of all the synchronizing group signals. If one of the synchronizing group signal is disqualified, the Combiner will automatically exclude it from the synchronizing group. In this case, the output frequency does not change, but the frequency offset value of the output signal relative to the synchronizing group is recalculated.

Signals group can contain from one to four input signals in the "Switching" mode, and the Combiner output signal frequency is adjusted to one input signal (called as Master input signal). Thus only one signal – Master input signal enters the synchronizing group in the "Switching" mode. If this Master input signal is disqualified, the Combiner output signal frequency automatically is adjusted to the next highest priority input signal, which is included in the signal (reserve) group. In this case, the output frequency does not change, but the frequency offset value of the output signal relative to the synchronizing group signal is recalculated.

3.4.5 The Combiner indicates time delay of 1 PPS output signal relative to external 1 PPS signal and allows to synchronize output signal by edge of external 1PPS signal.

External 1 PPS signal parameters on 50 Ohm load:

- polarity: positive;
- amplitude: from 2.5 V up to 5.0 V;
- pulse duration: not less 1 μs;
- rise-time: not more 50 ns.

Synchronization error is not more than ±20 ns.

3.4.6 Frequency instability introduced by the Combiner (two-samples Allan variance at 5 MHz signal) not more than (maximal RFD of input and output signals not more than $\pm 1.0 \times 10^{-12}$):

- for averaging time 1 s: 1.0×10^{-13};
- for averaging time 3 600 s: 1.0×10^{-15},

when temperature changing is not more than ±1 °C/hour.

3.4.7 The Combiner allows to shift output signals phase:

- single shift range: ±999 999 ps;
- minimal step: 1 ps.

3.4.8 The Combiner allows to include any input signal into signal (synchronizing) group and exclude them from group by command.

In this case:

- phase shift isn't more than $\pm 1.0 \times 10^{-10}$ s;
- frequency shift isn't more than 2.0×10^{-15} (RMS).

3.4.9 The Combiner automatically excludes input signal from Signal (Synchronizing) Group when:

- corresponding signal physically disappears;
- input signals frequency difference exceeds programmed limit (when there are three or four signals in group);
- ERROR signal occurs on input signal source.

ERROR signal parameters:

- voltage from 2.4 up to 5.0 V (perfect source);
- voltage less 0.4 V (source in disrepair).

In this case phase shift isn't more than $\pm 1.0 \times 10^{-10}$ s.

3.4.10 Warm-up time: 4 h.

3.4.11 The Combiner is managed using a PC and special software that came with the Combiner (see the document “Program “Monitor317”. User guide” RU.ЯКУР.00144-02 34 02). Transfer of monitored data and receiving of control commands produces via RS-232 or USB interfaces.

System requirements: Intel Pentium-IV, 2 GHz, 512 Mb RAM, Windows XP/Vista/7/8, USB 1.1 or higher or COM port.

3.4.12 Power supply voltage:

- AC power supply: (198 – 242) V, 50 or 60 Hz;
- DC power supply: (22 – 32) V.

3.4.13 When AC power supply disappears the Combiner automatically use DC power supply, and when AC power supply appears again the Combiner automatically use AC voltage for power supply.

3.4.14 Power consumption:

- not more than 50 V·A from AC power supply;
- not more than 40 W from DC power supply.

3.4.15 Ambient temperature: from +5 ^{o}C up to +40 ^{o}C.

3.4.16 Weight: not more than 8 kg.

3.4.17 Dimensions (W×H×D): 483×133×370 mm.

3.5 Basic configuration and operation

Figure 3.1 shows the simplified scheme of the Combiner. Four input signals (fy, fz, fv, fw connectors) feeds four-channels frequency comparator (FCFC).

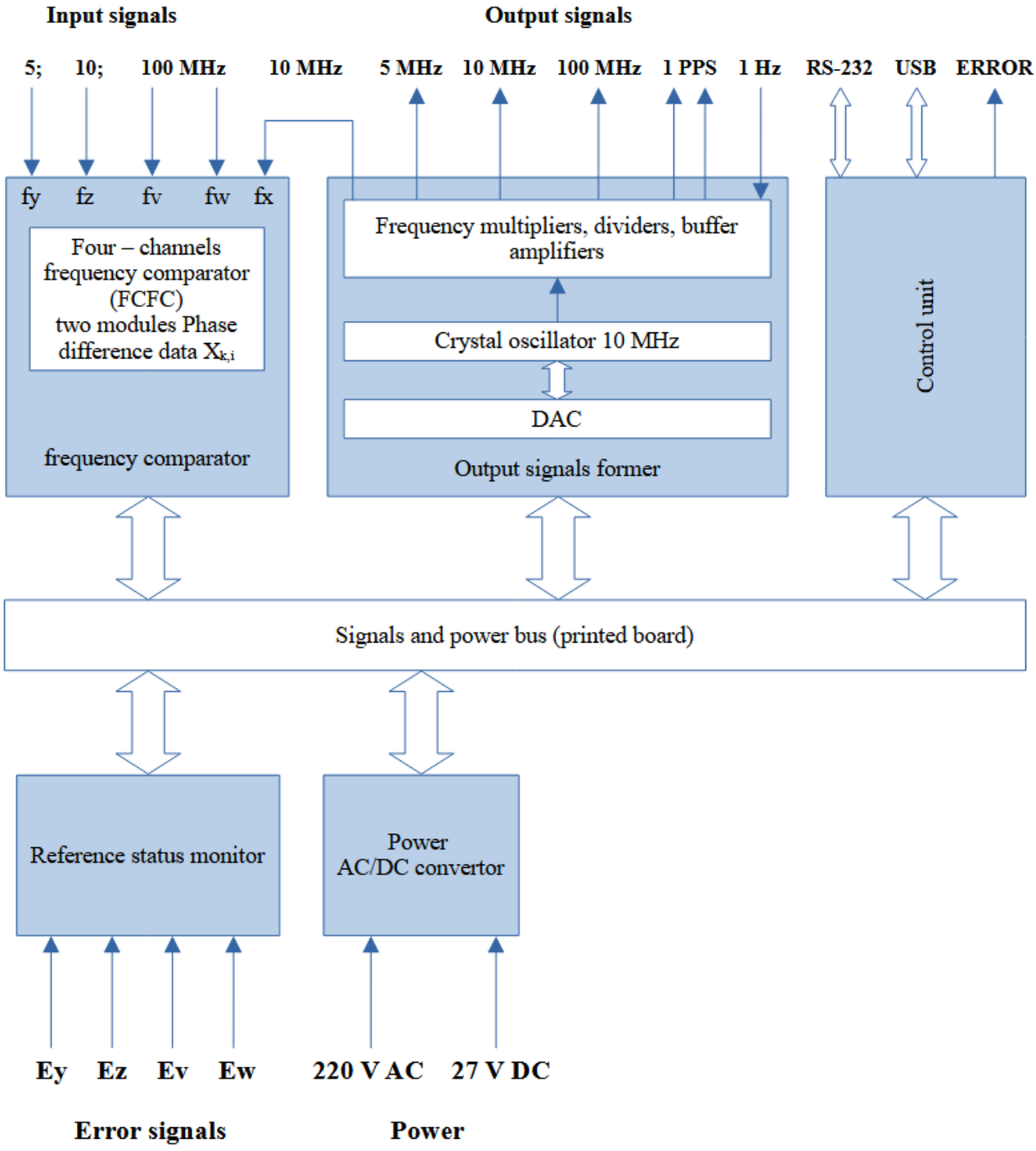

Figure 3.1 – The simplified scheme of the Combiner

To the reference input of FCFC (connector X) signal 10 MHz of local crystal oscillator is supplied. Each 10 ms the FCFC measures phase difference between input signals and reference $X_{k,i}$. Using this data processor change DAC code and oscillator's signal frequency. As a result we

have digital FLL providing output signal, synchronized in frequency by group of input signals. The output signal's frequency corresponds to the formula:

$$f_{out} = f_{nom}(1 + s + y^*)$$

where:

f_{nom} – nominal frequency of output signal (5; 10; 100 MHz),

y^* – mean relative frequency difference,

$s = e + \nu \cdot t$ – current frequency offset value,

where:

e – initial frequency offset value (range $\pm 1.0\times10^{-8}$, minimal step 1.0×10^{-18});

ν – programmed frequency trend per day value (range $\pm 8.64\times10^{-12}$, minimal step 1.0×10^{-18});

t – time (in days) after last frequency trend setting.

Reference status monitor analyses Error signals from input signals source (parameters of this signal on item 3.4.9). When "low level" at one input occurs the Combiner automatically removes corresponding signal from Signal Group (synchronizing group).

The Combiner automatically excludes signal from Signal Group (synchronizing group) if frequency difference between this signal mean frequency of another signals activated in group exceeds programmed limit.

A special program monitors the Combiner status and controls the Combiner.

3.6 Recommendation for use

The Combiner can work in two modes:

- the "Switching" mode;
- the "Averaging" mode.

Signals group can contain from one to four input signals in the "Switching" mode, and the Combiner output signal frequency is adjusted to one input signal (called as Master input signal).

If this Master input signal is disqualified, the Combiner output signal frequency automatically is adjusted to the highest priority input signal, which is included in the Signal Group (reserve group). In this case, the output frequency does not change, but the frequency offset value of the output signal relative to the synchronizing group signal is recalculated.

Synchronizing group can contain from one to four input signals in the "Averaging" mode, and the Combiner output signal frequency is adjusted to averaging frequency of all the synchronizing group signals.

If one of the synchronizing group signal is disqualified, the Combiner will automatically exclude it from the synchronizing group. In this case, the output frequency does not change, but the frequency offset value of the output signal relative to the synchronizing group is recalculated.

When there is no input signals, output signal is not synchronized.

If there is one input signal in Signal Group (Synchronizing Group), the Combiner offers:

1) Input signal disqualification by following reasons:

- missing input signal;
- ERROR signal appears.

2) Frequency locking of quartz oscillator by the signals of synchronizing group, which includes one input signal, without reserving frequency by input signal.

3) Frequency offset of input signal relative to mean group frequency.

4) Forming linear frequency trend of output signal.

If there are two input signals in Signal Group (Synchronizing Group), the Combiner offers:

1) Input signal disqualification by following reasons:

- missing input signal;
- ERROR signal appears.

2) Frequency locking of quartz oscillator by the signals of synchronizing group, which includes one or two input signals, with reserving frequency by input signal.

3) Frequency offset of input signal relative to mean synchronizing group frequency.

4) Forming linear frequency trend of output signal.

If there are three input signals in Signal Group (Synchronizing Group), the Combiner offers:

1) Input signal disqualification by following reasons:

- missing input signal;
- measured relative frequency difference of input signal exceeds limit;
- ERROR signal appears.

2) Frequency locking of quartz oscillator by the signals of synchronizing group, which includes from one up to three input signals, with reserving frequency by input signal.

3) Frequency offset of input signal relative to mean synchronizing group frequency.

4) Forming linear frequency trend of output signal.

If there are four input signals in Signal Group (Synchronizing Group), the Combiner offers:

1) Input signal disqualification by following reasons:

- missing input signal;
- measured relative frequency difference of input signal exceeds limit;
- ERROR signal appears.

2) Frequency locking of quartz oscillator by the signals of Synchronizing Group, which includes from one up to four input signals, with reserving frequency by input signal.

3) Frequency offset of input signal relative to mean synchronizing group frequency.

4) Forming linear frequency trend of output signal.

5) Full reserving is kept in spite of exclusion one of input signals from Signal Group (synchronizing group).

Thus using four input signals in Signal Group (Synchronizing Group) is optimal for the best reserving, because even if missing one of input signals all functions are available.

The Combiner operating mode is selected and Signal Group (Synchronizing Group) is configured in program “Monitor317” using “**Mode, Synchronization**” tab (see section 3.3 of the document “Program “Monitor317”. User guide” RU.ЯКУР.00144-02 34 02).

Note

This document “Microstepper Combiner Synthesizer VCH-317M. Operational Manual” 411146.044OM hereinafter referred to as “this OM”.

The program “Monitor317” hereinafter referred to as “the Program”.

The document “Program “Monitor317”. User guide” RU.ЯКУР.00144-02 34 02 hereinafter referred to as “the UG”.

4 Preparation for use

4.1 Operational limitations

Power supply voltage (according to item 3.4.12 this OM):

- (198 – 242) V AC and a line frequency of 50 to 60 Hz;
- (22 – 32) V DC.

Environment conditions (according to item 3.4.15 of this OM):

- ambient temperature: from +5 ^{o}C up to +40 ^{o}C;
- ambient temperature changes: not more than 1 ^{o}C/hour.

The Combiner preserves its specifications after exposure to utmost conditions provided 4-hour warm-up time in normal operating conditions (according to item 3.4.10 this OM).

WARNING! RS-232 interface cable 685670.026 should be connected only when the Combiner is turned off. Failure to do so may result in damage to the Combiner's interface.

4.2 Installation procedure

4.2.1 Safety conditions

When working with the Combiner the safety conditions set out in section 2 this this OM must be observed.

4.2.2 Visual inspection

If the Combiner's storage or transportation conditions were different from those of operating conditions, it is necessary to keep the Combiner in operating conditions not less than 8 hours before starting the operation.

Unpack carefully and inspect the Combiner.

Check it for physical damage. If you observe physical damage, immediately contact Vremya-Ch JSC and the carrier. We recommend saving the shipping container for submitting any necessary claims to the carrier.

While inspecting the Combiner make sure that:

- there are no visible mechanical defects;
- the seals are intact;
- the external surfaces of the Combiner, connectors, terminals and sockets are clean;
- connecting cables are in good condition;
- all ventilation holes in the Combiner cover are open, not blocked by other objects.

4.2.3 Requirements for installation place of the Combiner

It is recommended to place the Combiner in a thermostabilized room with limited access to personnel. The place for the Combiner should be chosen taking into account the dimensions of the Combiner 483×133×370 mm and the need for free convection of air through the ventilation openings of the Combiner casing.

WARNING! Do not place the Combiner near any engines, generators, transformers, or other equipment that may create magnetic fields and acoustic vibrations. Placement near such equipment may impair the performance of the Combiner.

4.3 Preparing for usage

While the power is off, connect the Combiner to the PC in one of the following ways:

- "**RS-232**" socket of the Combiner with one of the COM ports of the PC using the RS-232 interface cable 685670.026;
- "**USB**" socket of the Combiner with one of the USB ports of the PC using the interface cable USB 2.0 AM/BM-1.8M.

ATTENTION! Connecting the Combiner to the COM port of the PC when the power of the Combiner is turned on can damage the RS-232 interface of the Combiner's processor.

Connect the power supply:

- from the AC power line (198 – 242) V, 50 or 60 Hz to socket "**5220 V 50 Hz 50 V·A**" with power connecting cord SCZ-1;
- from the DC power supply: (22 – 32) V to "**22 ... 32 V 40 W**" (backup power source) with power cable.

To connect an external power source use a power cable with a 2РМТ14КПН4Г1В1 (2PM14-4TKQB2) type connector. Pin 1 of the connector must be connected to the positive pole of the DC power supply, and pin 4 to the negative pole of the power supply (see Figure 4.1).

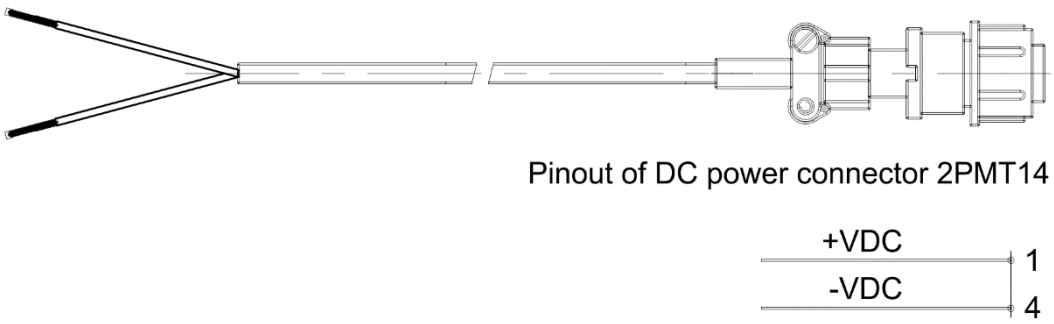

Figure 4.1 – DC power connecting cord

The input sine signals are connected to connectors “**1 fy**”, “**1 fz**”, “**1 fv**”, “**1 fw**“ respectively. The input sine signals are connected in accordance with the selected operating mode (see section 3.6 of this OM) during the operation of the Combiner. Connection is carried out by coaxial cables with wave resistance of 50 Ohm and SMA type connectors. The tightening torque of SMA connectors should be between 0.8 and 1.1 N·m.

The signals which indicates input sine signals source error (ERROR signals) are connected to the connectors “**1 Ey**”, “**1 Ez**”, “**1 Ev**”, “**1 Ew**“ respectively. The ERROR signals are connected in accordance with the selected operating mode (see section 3.6 this OM) during the operation of the Combiner. Connection is carried out by coaxial cables with wave resistance of 50 Ohm and BNC type connectors.

Input external synchronizing 1 PPS signal are connected to connector “**11 Hz**”. The external synchronizing 1 PPS signal is connected for synchronizing of 1 PPS output signals by edge of external 1 PPS signal (see section 6.3 this OM) during the operation of the Combiner. Connection is carried out by coaxial cable with wave resistance of 50 Ohm and BNC type connector.

Output sine-form signals are transmitted from the connectors “**2 5 MHz**”, “**2 100 MHz**”, “**2 10 MHz-1**” using coaxial cables with wave resistance of 50 Ohm and SMA type connectors. The tightening torque of SMA connectors should be between 0.8 and 1.1 N·m.

Output pulse-form 1PPS signals are transmitted from the connectors “**2 1 PPS-1**”, “**2 1 PPS-2**” using coaxial cables with wave resistance of 50 Ohm and BNC type connectors.

Output signal “Wrong output signal” is transmitted from the connector “**ERROR**” using coaxial cable with wave resistance of 50 Ohm and BNC type connector.

The Combiner will be ready for use after a warm-up period 4 h.

4.4 Program installation

Install the "Monitor VCH-317" program following the instructions given in the document “Program “Monitor317”. User guide” RU.ЯКУР.00144-02 34 02.

Before using the USB interface of the Combiner install a PC driver that creates a virtual serial port when connecting the Combiner via the USB interface, following the instructions in the document “Program “Monitor317”. User guide” RU.ЯКУР.00144-02 34 02.

5 Operating procedure

5.1 Location of control and connection systems

Connectors, indicators and control elements are located on front and rear panels of the Combiner (see Figure 5.1 and Table 5.1).

Table 5.1

Position (Fig. 5.1)	Designation	Destination
1	**POWER**	AC power indicator
2	**BATTERY**	DC power indicator
3	**LOCK**	Normal output signal indicator
4	**ERROR**	Wrong output signal indicator
5	**1 1 Hz**	External 1 PPS signal input
6	**21 PPS-1, 21 PPS-2**	1 PPS signal outputs
7	**25 MHz**	Sine-form 5 MHz signal output
8	**210 MHz-1**	Sine-form 10 MHz signal output
9	**2100 MHz**	Sine-form 100 MHz signal output
10, 11	**1 fy, 1 fz, 1 fv, 1 fw,**	Input signal’s ports
12	**1 Ey, 1 Ez, 1 Ev, 1 Ew**	ERROR signal’s ports
13	**RS-232**	Serial RS-232 port
14	**ERROR**	Output of wrong output signal notification
15	**USB**	USB interface port
16	**POWER**	AC power switch
17	**5 220 V 50 Hz 50 V·A**	AC power port
18	**SUPPLY**	Internal power indicator
19	**4 22…32 V 40 W**	DC power port
20	**F 3,15 A L 250 V**	Protection Fuse
21	**3**	Ground port

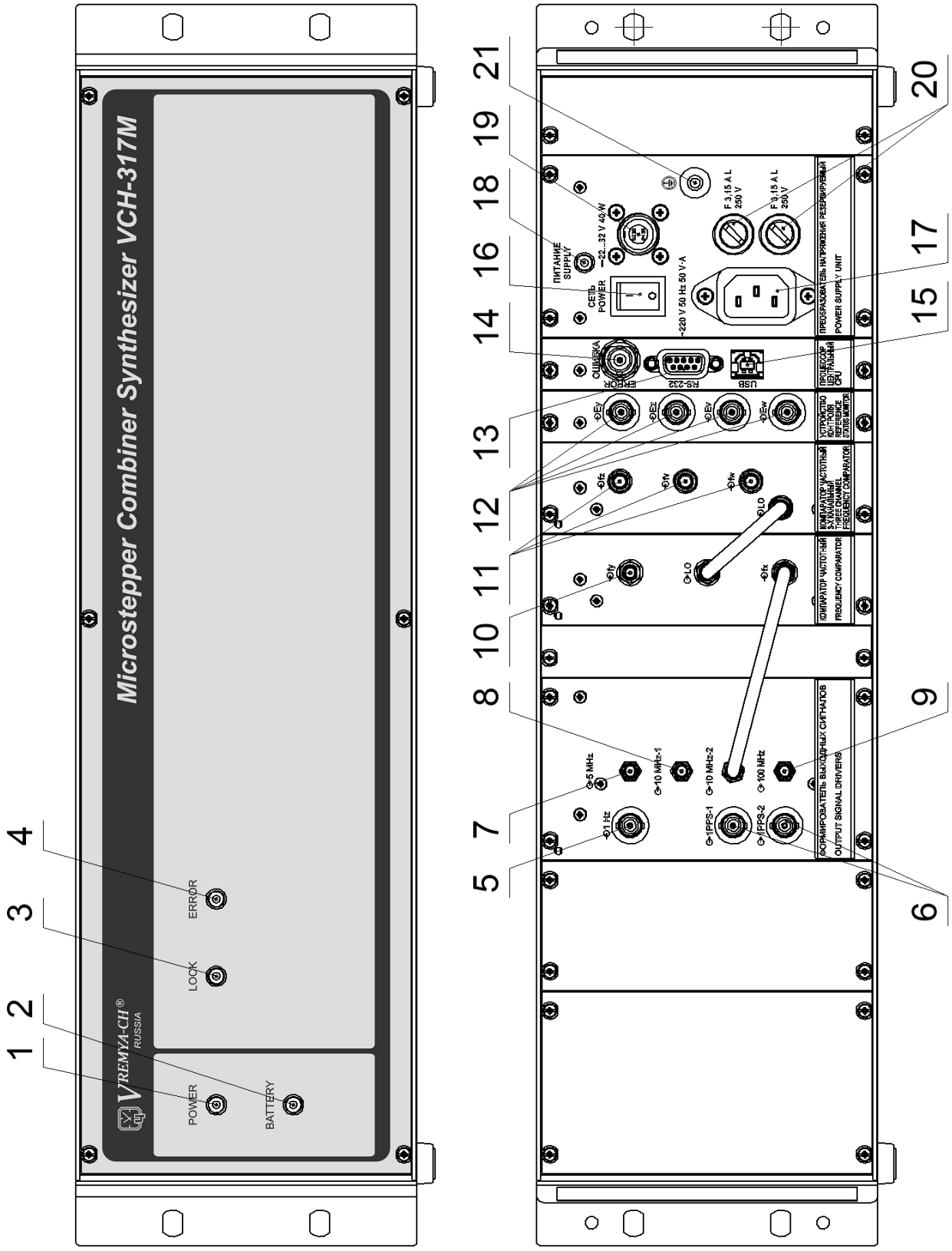

Figure 5.1 – Connectors, indicators and control elements of the Combiner

5.2 Instructions for turning on

Make the necessary connections to the Combiner in accordance with item 4.3 this OM.

The connection of input signals such as the input sine signals, input external synchronizing 1 PPS signal, the ERROR signals can be made during the Combiner operation, taking into account the instructions of section 6.1 this OM.

For example, the Figure 5.2 and Table 5.1 shows a connection variant in which the Signal Group (synchronizing group) of the Combiner is able to contain up to four input signals. In real measurements, the number of input sine-form signals can be from one to four. Recommendations for use for each of the cases are described in section 3.6 this OM.

It is not necessary to connect ERROR signals to the connectors marked "**1 Ey**", "**1 Ez**", "**1 Ev**", "**1 Ew**". However, the presence of error signals connected affects a disqualification quickness of the input sine-form signals.

Press "**Power**" switch on the rear panel, then green indicator located on the front panel, marked "**POWER**", should light up.

The "**BATTERY**" indicator on the power unit panel lights up when there is a DC voltage on the "**422 … 32 V 40 W**" connector.

The "**LOCK**" indicator must be extinguished, the "**ERROR**" indicator has to be flashing.

Perform the operation of the Combiner connecting to Program (previously installed on PC) in accordance with section 3.2 the UG.

ATTENTION! Before starting work with the device, keep the device switched on from the AC power line (198 – 242) V for four hours (warm-up time).

Table 5.1

Number of cable (Figure 5.2)	Model and designation	Note
1, 2, 3, 4	Coaxial cable with BNC type connector	see Section 4.3 this OM
5	Power connecting cord SCZ-1	see Section 3.3 this OM
6	RS-232 interface cable 685670.026	see Section 3.3 this OM
7	Interface cable USB 2.0 AM/BM-1.8M	see Section 3.3 this OM
8, 9, 10, 11	Coaxial cable with SMA type connector	see Section 4.3 this OM

Assign the name of every input sine-form signal in Program in accordance with section 3.1 the UG.

It should be remembered that for the Combiner:

- input "**1 fy**" corresponds to Channel 1;

- input "**1 fz**" corresponds to Channel 2;
- input "**1 fv**" corresponds to Channel 3;
- input "**1 fw**" corresponds to Channel 4.

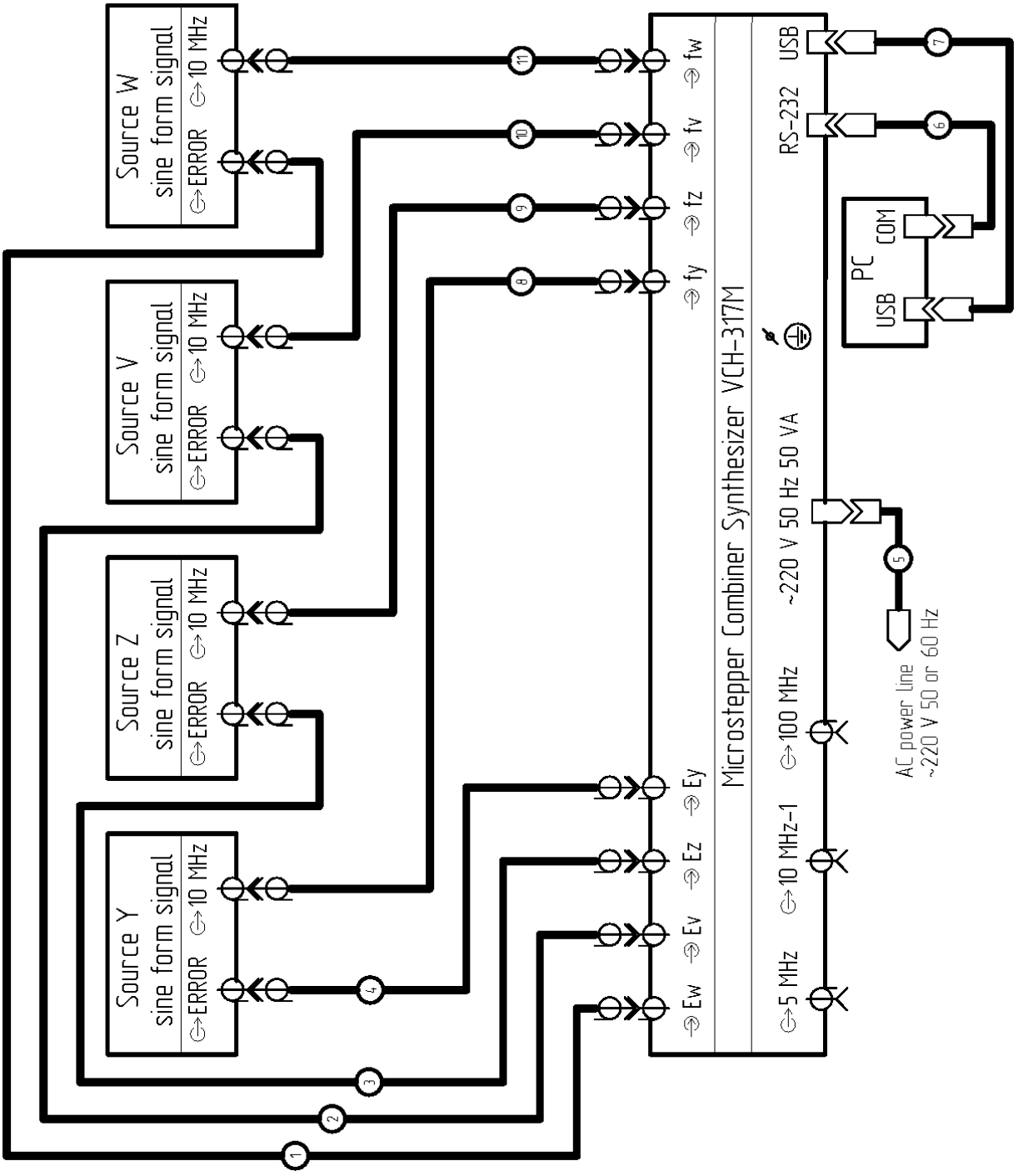

Figure 5.2

For example:

- the sine-form signal connected to input "**1 fy**" (Channel 1) has the name "Source Y";
- the sine-form signal connected to input "**1 fz**" (Channel 2) has the name "Source Z";
- the sine-form signal connected to input "**1 fv**" (Channel 3) has the name "Source V";
- the sine-form signal connected to input "**1 fw**" (Channel 4) has the name "Source W".

Status for each input sine-form signal (Channel) is indicated in the "Status" field in the main window of the Program (see sections 3.1, 3.3 the UG). The possible statuses are depend on selected operating mode of the Combiner.

A possible view of main window of the Program is shown in Figure 5.3. The main state of the Combiner indicated as "**No synchronization!**" (on red field) informs that the Combiner local quartz oscillator is free running, not synchronized with input signals.

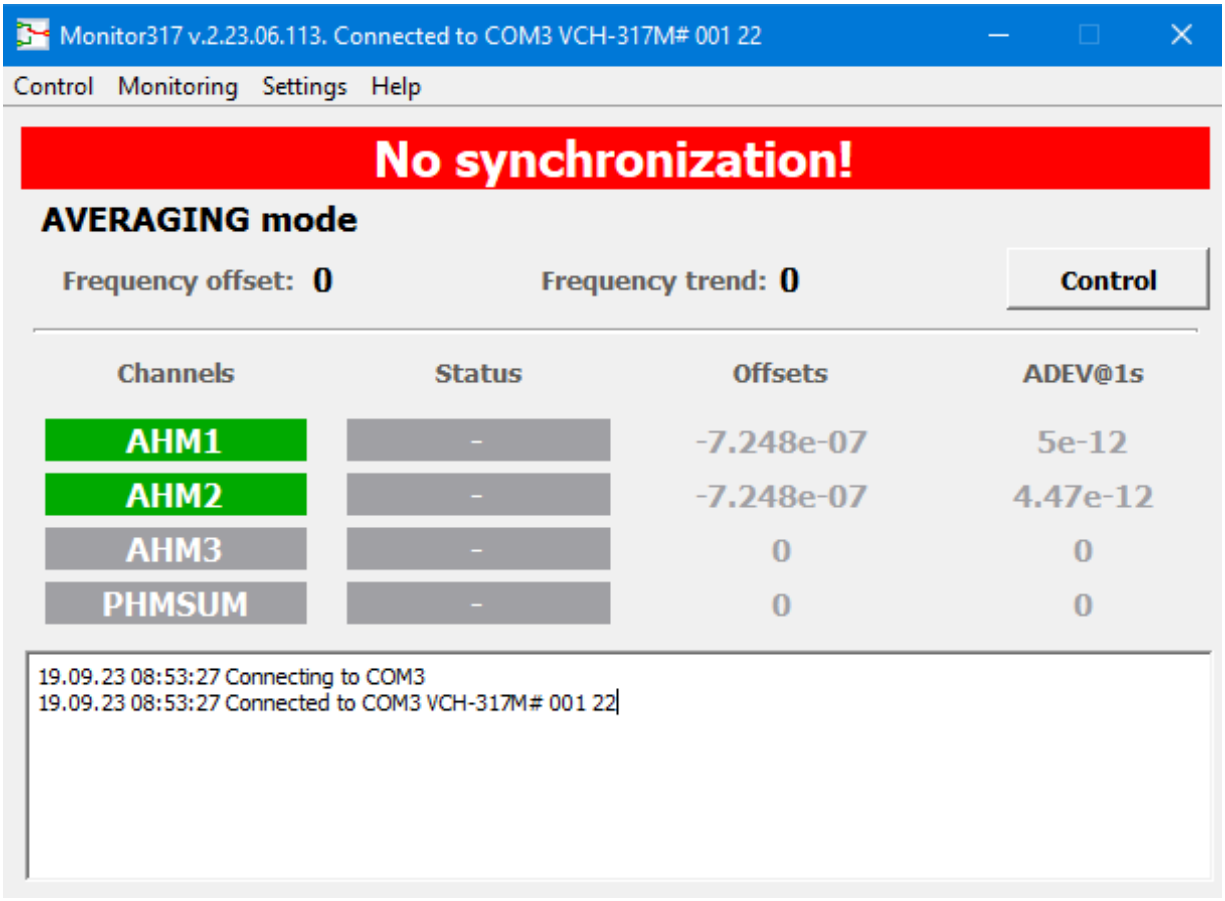

Figure 5.3

For further operation of the Combiner it's necessary to select the operational mode ("**SWITCHING**" or "**AVERAGING**"), to configure the signals group and to turn synchronization on of the Combiner local quartz oscillator in accordance with section 6.1 this OM.

6 Control operations

Control operations allow:

- to change output signal parameters;
- to synchronize the Combiner local quartz oscillator (Combiner output signal);
- to synchronize 1 PPS signal by edge of external 1 PPS signal;
- to set date and time in the Combiner;
- to change RFDEG limit;
- to select the Program interface language.

6.1 Output signal frequency synchronization

The operation described in this section 6.1 this OM are performed in accordance with section 3.3 the UG.

Open "**Control**" window in the Program. This window is available after pressing the button "**Control**" on the main window of the Program or selecting the "**Control**" item of menu bar.

Open "**Mode, Synchronization**" tab to select the operational mode ("**SWITCHING mode**" or "**AVERAGING mode**") and to configure the signals group. The appearance of this tab depends on selected operational mode.

Combiner's control in the "Switching" mode is described in item 6.1.1 this OM.

Combiner's control in the "Averaging" mode is described in item 6.1.2 this OM.

6.1.1 Output signal frequency synchronization in the "Switching" mode

Select radio button "**SWITCHING mode**" in "**Mode, Synchronization**" tab to set "Switching" mode.

To synchronize the Combiner local quartz oscillator (Combiner output signal) with frequency one of input sine-form signals (Channels) it's necessary to form a Signal Group (see section 3.6 this OM) in "**Mode, Synchronization**" tab in accordance with section 3.3 the UG.

The formation of a Signal Group is the choice some input sine-form signals (Channels):

- the input sine-form signal (Channel) by which the Combiner local quartz oscillator is primary synchronized;
- the input sine-form signals (Channels) by which will synchronize the Combiner local quartz oscillator after current synchronizing sine-form input signal is disqualified.

NOTE

The input sine-form signal by which the Combiner local quartz oscillator is synchronized hereinafter referred to as "Master input signal".

Click on the checkbox “In Group” in “**Mode, Synchronization**” tab to activate Channels planned to be included in the Signal Group, as shown in the Figure 6.1.

Channels that are not supplied with input sine-form signals are blocked in the "**Mode, Synchronization**" tab and the selection of such channels is not possible.

To select the input sine-form signal (Channel) by which the Combiner local quartz oscillator is primary synchronized it’s necessary to set the priority "1" in the corresponding drop-down menu. For example (see Figure 6.1), to synchronize the Combiner local quartz oscillator by Channel 1 is selected priority "1" in the corresponding drop-down menu for Channel 1.

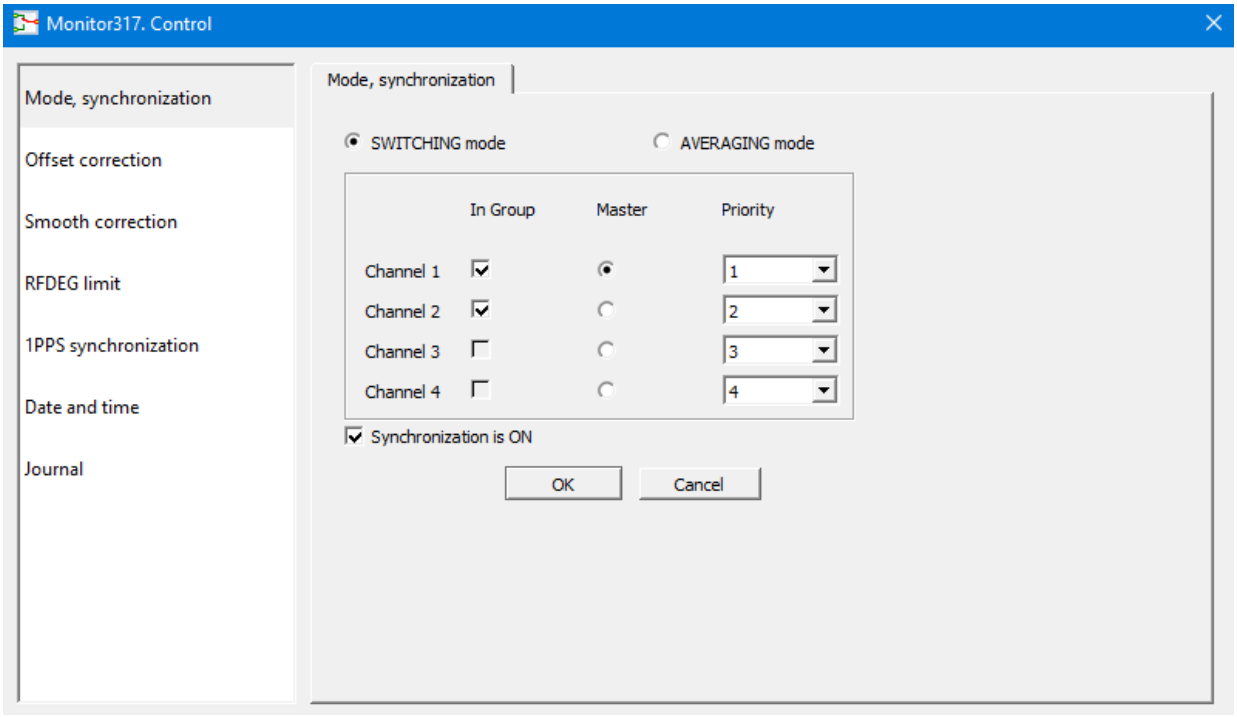

Figure 6.1

To select the input sine-form signals (Channels) by which will synchronize the Combiner local quartz oscillator after current synchronizing sine-form input signal (Channel) is disqualified it’s necessary to set the Priorities “2”, “3”, “4” in the corresponding drop-down menus. When Master input signal is disqualified, the Combiner local quartz oscillator automatically is adjusted to the highest priority input sine-form signal, which is included in the Signal Group.

For example (see Figure 6.1), Channel 2 has set Priority “2” and if Master input signal (Channel 1) is disqualified, then Channel 2 becomes new Master input signal for the Combiner local quartz oscillator. And further, if Channel 2 that has become the Master input signal is disqualified, then Channel 3, which has Priority “3”, becomes new Master input signal for the Combiner local quartz oscillator. And finally, if Channel 3 that has become the Master input signal is disqualified, then Channel 4, which has Priority “4”, becomes new Master input signal for the Combiner local quartz oscillator.

To enable synchronization of the Combiner local quartz oscillator (Combiner output signal) it's necessary to click on the checkbox "**Synchronization is ON**" in "**Mode, Synchronization**" tab.

To begin synchronization procedure of the Combiner local quartz oscillator (Combiner output signal) it's necessary to click "**OK**" button (see Figure 6.1).

Synchronization procedure of the Combiner local quartz oscillator begins with the initial analysis of the signals of the Signal Group. Process of initial analysis takes 10 minutes.

ATTENTION! Do not disable the input sine-form signals connected to the connectors marked "**1 fy**", "**1 fz**", "**1 fv**", "**1 fw**" included in Signal Group during the initial analysis of the signals.

A possible view of main window of the Program is shown in Figure 6.2. The main state of the Combiner indicated as "**Initial signal estimation, ___ s**" (on blue field) informs that the Combiner local quartz oscillator is synchronized with Master input signal however all input sine-form signals (Channels) included in Signal Group are in the testing state. The countdown in seconds shows the time remaining until the normal state of the Combiner is turned on.

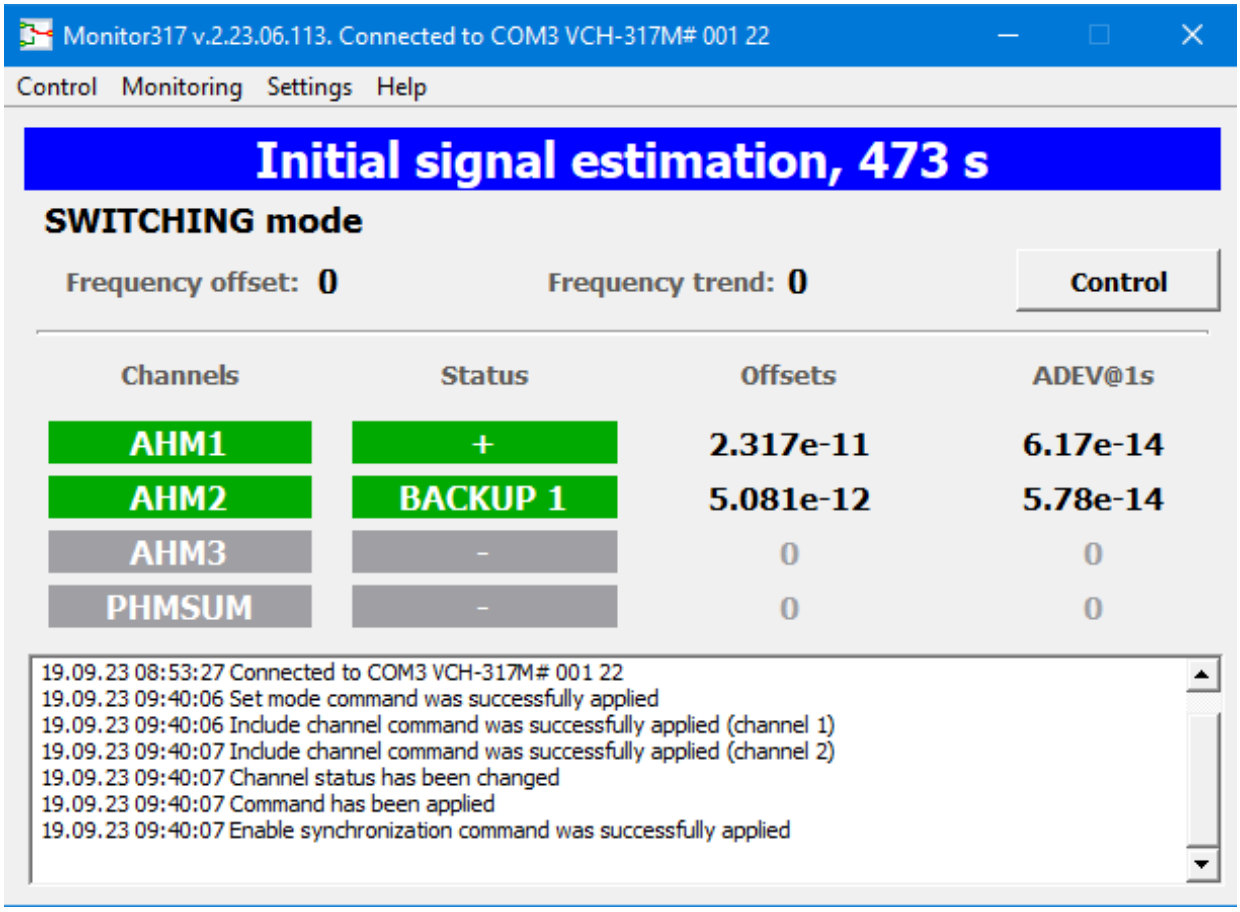

Figure 6.2

In normal state the output signals of the Combiner are synchronized with input sine-form signal included in Signal Group (with Master input signal) and the "**ERROR**" indicator on the Combiner front panel is off, the "**LOCK**" indicator on the Combiner front panel is lit (or blinks in the case when the Signal Group consists of only one input sine-form signal). A possible view of main window of the Program for the normal state of the Combiner is shown in Figure 6.3. In this cause the main state of the Combiner indicated as "**Synchronization OK**". Such view of main window of the Program shows that:

- the Channel named "Source Y" (corresponds to input "**1 fy**") has been assigned the status "+" (has Priority "1",the output signals of the Combiner are synchronized with this Master input signal);
- the Channel named "Source Z" (corresponds to input "**1 fz**") has been assigned the channel status "**BACKUP 1**" (has Priority "2", becomes new Master input signal for the Combiner local quartz oscillator if the Channel named "Source Y" is disqualified);
- the Channel named "Source V" (corresponds to input "**1 fv**") has been assigned the channel status "**BACKUP 2**" (has Priority "3", becomes new Master input signal for the Combiner local quartz oscillator if the Channels named "Source Y", "Source Z" are disqualified);
- the Channel named "Source W" (corresponds to input "**1 fw**") has been assigned the channel status "**BACKUP 3**" (has Priority "4", becomes new Master input signal for the Combiner local quartz oscillator if the Channels named "Source Y", "Source Z" "Source V" are disqualified).

To synchronize the Combiner local quartz oscillator with other of input sine-form signal (Channel) it's necessary to select radio button "**Master**" for the corresponding channel in "**Mode, Synchronization**" tab in accordance with section 3.3 the UG. Input sine-form signal planned to be used as a Master input signal must be included in the Signal Group.

To include input sine-form signal in the Signal Group it's necessary to click on the corresponding checkbox "**In Group**" in "**Mode, Synchronization**" tab (see Figure 6.1 as an example). Input sine-form signal goes through a process of qualification before being included in the Signal Group. Process of the qualification takes 10 minutes.

To exclude input sine-form signal out of the Signal Group it's necessary to click off the corresponding checkbox "**In Group**" in "**Mode, Synchronization**" tab (see Figure 6.1 as an example) and then to click "**OK**" button.

The Combiner response to the procedure for excluding a channel from the Signal Group depends on the status of the excluded Channel.

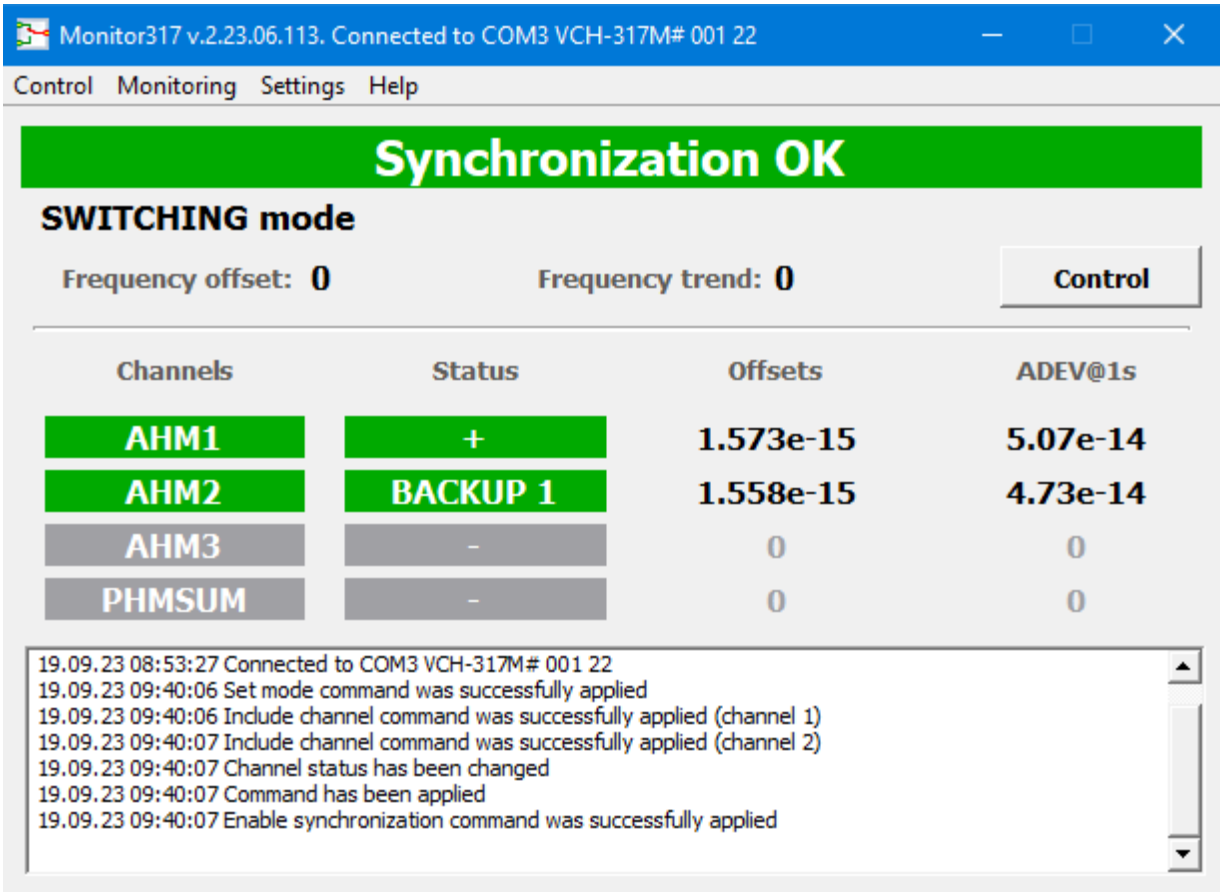

Figure 6.3

If the Channel to be excluded from the Signal Group has the status “+” (Master input signal) then after the finishing of the procedure for excluding the Master input signal from the Signal Group some input sine-form signal (Channel), with the highest priority (consisting into the Signal Group), becomes new Master input signal for the Combiner local quartz oscillator. For example, according to previously made settings (see Figure 6.1) Channel 2 has Priority "2" and after the Master input signal (Channel 1) has disqualified, Channel 2 becomes new Master input signal for the Combiner local quartz oscillator (see Figure 6.4).

In this case, after the finishing of the procedure for excluding the Master input signal from the Signal Group (see Figure 6.1):

- the Channel named “Source Y” (corresponds to input “**1 fy**”) has been assigned the status “–” (not included in Signal Group);

- the Channel named “Source Z” (corresponds to input “**1 fz**”) has been assigned the channel status “+” (has the highest priority in Signal Group – Priority "2", becomes new Master input signal for the Combiner local quartz oscillator instead of the Channel named “Source Y” which excluded from the Signal Group);

- the Channel named “Source V” (corresponds to input “**1 fv**”) has been assigned the channel status “**BACKUP 1**” (has Priority "3", receives the status “**BACKUP 1**” instead of the status “**BACKUP 2**”);

- the Channel named “Source W” (corresponds to input “**1 fw**”) has been assigned the channel status “**BACKUP 2**” (has Priority "4", receives the status “**BACKUP 2**” instead of the status “**BACKUP 3**”).

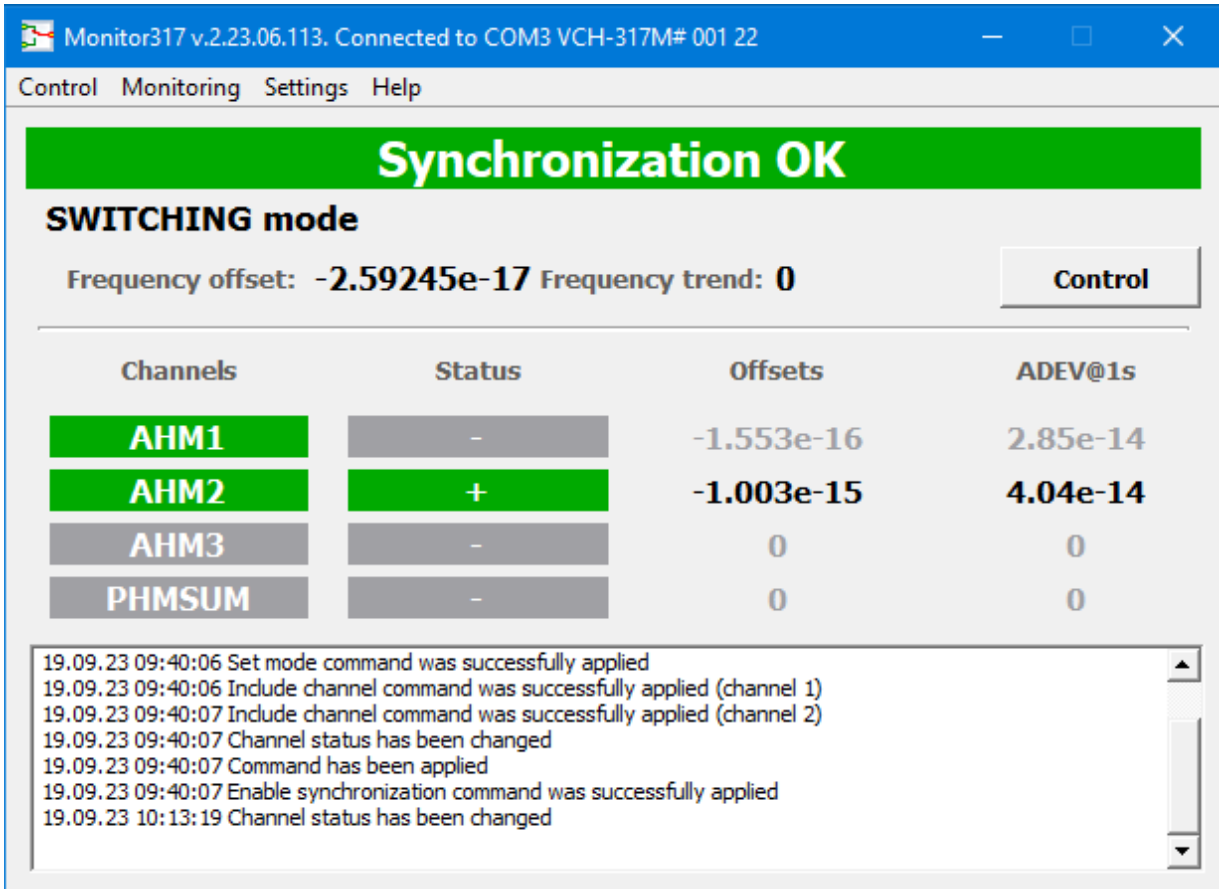

Figure 6.4

At the same time, the Combiner constantly monitors the frequency difference between the input and output sine-form signals and, after excluding the Master input signal from the Signal Group, the Combiner changes the value of the output signal frequency offset in such a way as to avoid a frequency jump in the output sine-form signal when the Master input signal changes (switching between Channels of the Signal Group). Thus after change of the Master input signal the Combiner output signal frequency will remain unchanged taking into account the switching error (the frequency shift of the output sine-form signal does not exceed value specified in item 3.4.8).

If the Channel to be excluded from the Signal Group has the status “**BACKUP 1**” or “**BACKUP 2**” or “**BACKUP 3**” then after the finishing of the procedure for excluding the input

signal from the Signal Group Master input signal will remain the same. Depending on the status of the excluded signal, the status of the "**BACKUP _"** signals may change.

6.1.2 Output signal frequency synchronization in the "Averaging" mode.

Select radio button "**AVERAGING mode**" in "**Mode, Synchronization**" tab to set "Averaging" mode.

To synchronize the Combiner local quartz oscillator (Combiner output signal) with averaging frequency of all the Synchronizing Group signals (Channels) it's necessary to form a Synchronizing Group (see section 3.6 this OM) in "**Mode, Synchronization**" tab in accordance with section 3.3 the UG.

Click on the checkbox "**In Group**" in "**Mode, Synchronization**" tab to activate Channels planned to be included in the Synchronizing Group, as shown in the Figure 6.5.

Channels that are not supplied with input sine-form signals are blocked in the "**Mode, Synchronization**" tab and the selection of such channels is not possible.

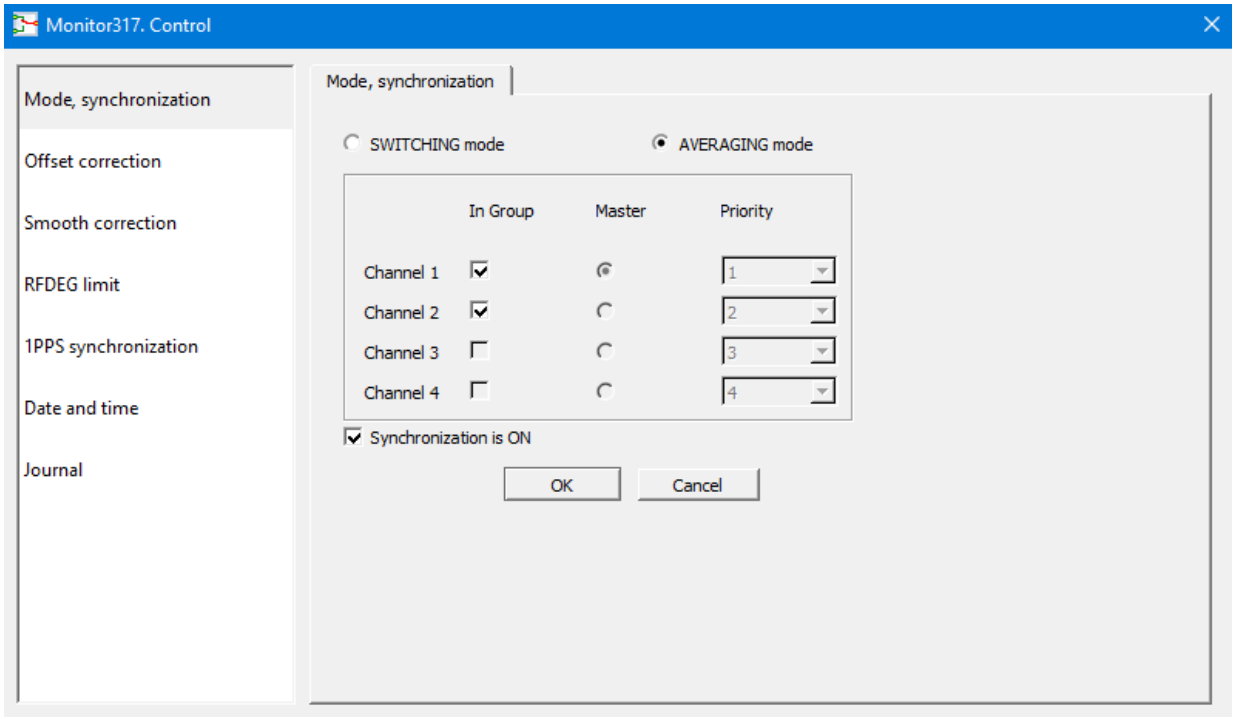

Figure 6.5

To enable synchronization of the Combiner local quartz oscillator (Combiner output signal) it's necessary to click on the checkbox "**Synchronization is ON**" in "**Mode, Synchronization**" tab.

To begin synchronization procedure of the Combiner local quartz oscillator (Combiner output signal) it's necessary to click "**OK**" button (see Figure 6.5).

Synchronization procedure of the Combiner local quartz oscillator begins with the initial analysis of the signals of the Synchronizing Group. Process of initial analysis takes 10 minutes.

ATTENTION! Do not disable the input sine-form signals connected to the connectors marked "**1 fy**", "**1 fz**", "**1 fv**", "**1 fw**" included in Synchronizing Group during the initial analysis of the signals.

ATTENTION! Disconnecting input sine-form signals connected to the connectors marked "**1 fy**", "**1 fz**", "**1 fv**", "**1 fw**" should be made only if corresponding channel is not included into Synchronizing Group. Otherwise, "bursts" in frequency may be present in the output signal.

A possible view of main window of the Program is shown in Figure 6.6.

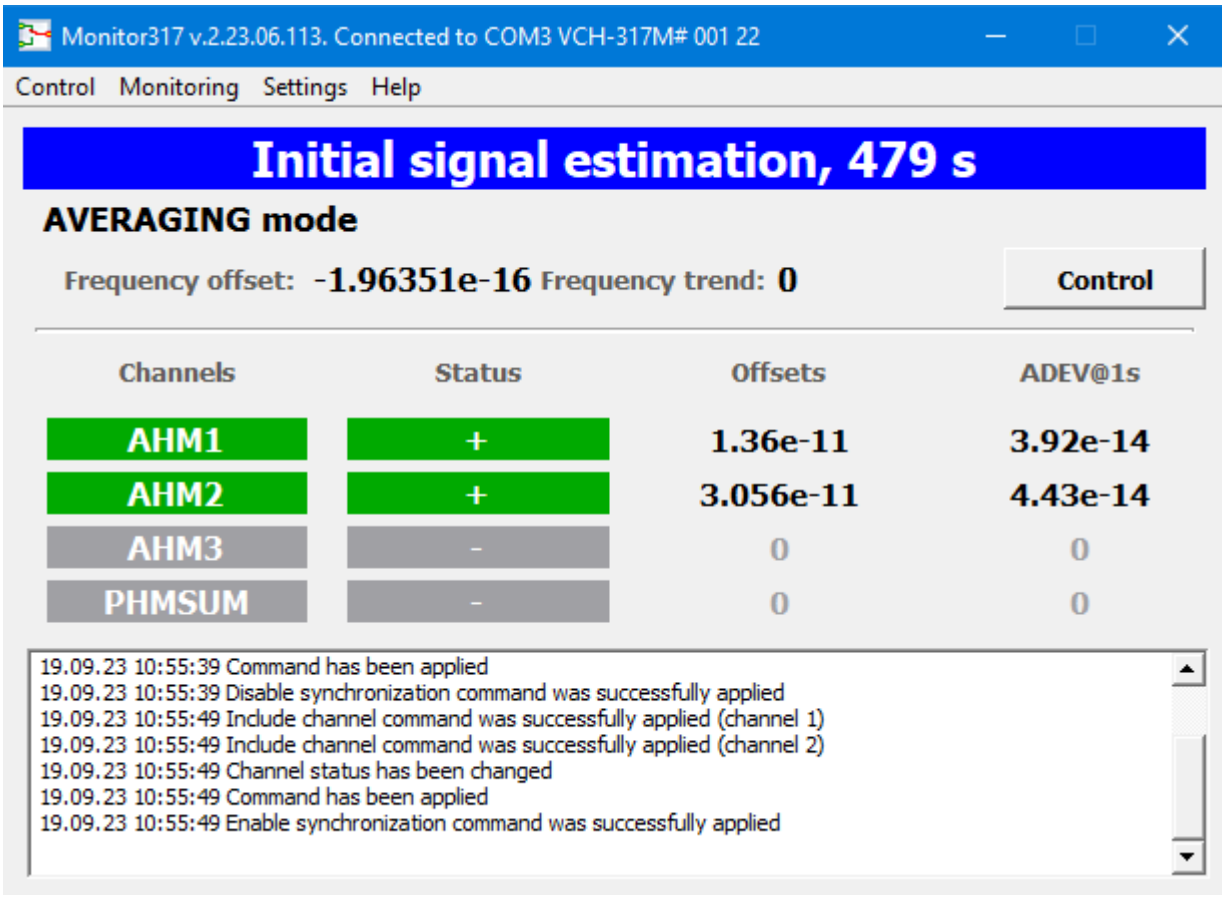

Figure 6.6

The main state of the Combiner indicated as "**Initial signal estimation, ___ s**" (on blue field) informs that the Combiner local quartz oscillator is synchronized with averaging frequency of all the Synchronizing Group signals (Channels) however all input sine-form signals (Channels) included in Synchronizing Group are in the testing state. The countdown in seconds shows the time remaining until the normal state of the Combiner is turned on.

In normal state the output signals of the Combiner are synchronized with averaging frequency of all the Synchronizing Group signals (Channels) and the "**ERROR**" indicator on the Combiner front panel is off, the "**LOCK**" indicator on the Combiner front panel is lit (or blinks in the case when the Synchronizing Group consists of only one input sine-form signal). A possible view of main window of the Program for the normal state of the Combiner is shown in Figure 6.7. In this cause the main state of the Combiner indicated as "**Synchronization OK**"**.** Such view of main window of the Program shows that:

- the Channel named "Source Y" (corresponds to input "**1 fy**") has been assigned the status "+" (input sine-form signal at this Channel is included in Synchronizing Group);

- the Channel named "Source Z" (corresponds to input "**1 fz**") has been assigned the channel status "+" (input sine-form signal at this Channel is included in Synchronizing Group);

- the Channel named "Source V" (corresponds to input "**1 fv**") has been assigned the channel status "+" (input sine-form signal at this Channel is included in Synchronizing Group);

- the Channel named "Source W" (corresponds to input "**1 fw**") has been assigned the channel status "+"(input sine-form signal at this Channel is included in Synchronizing Group).

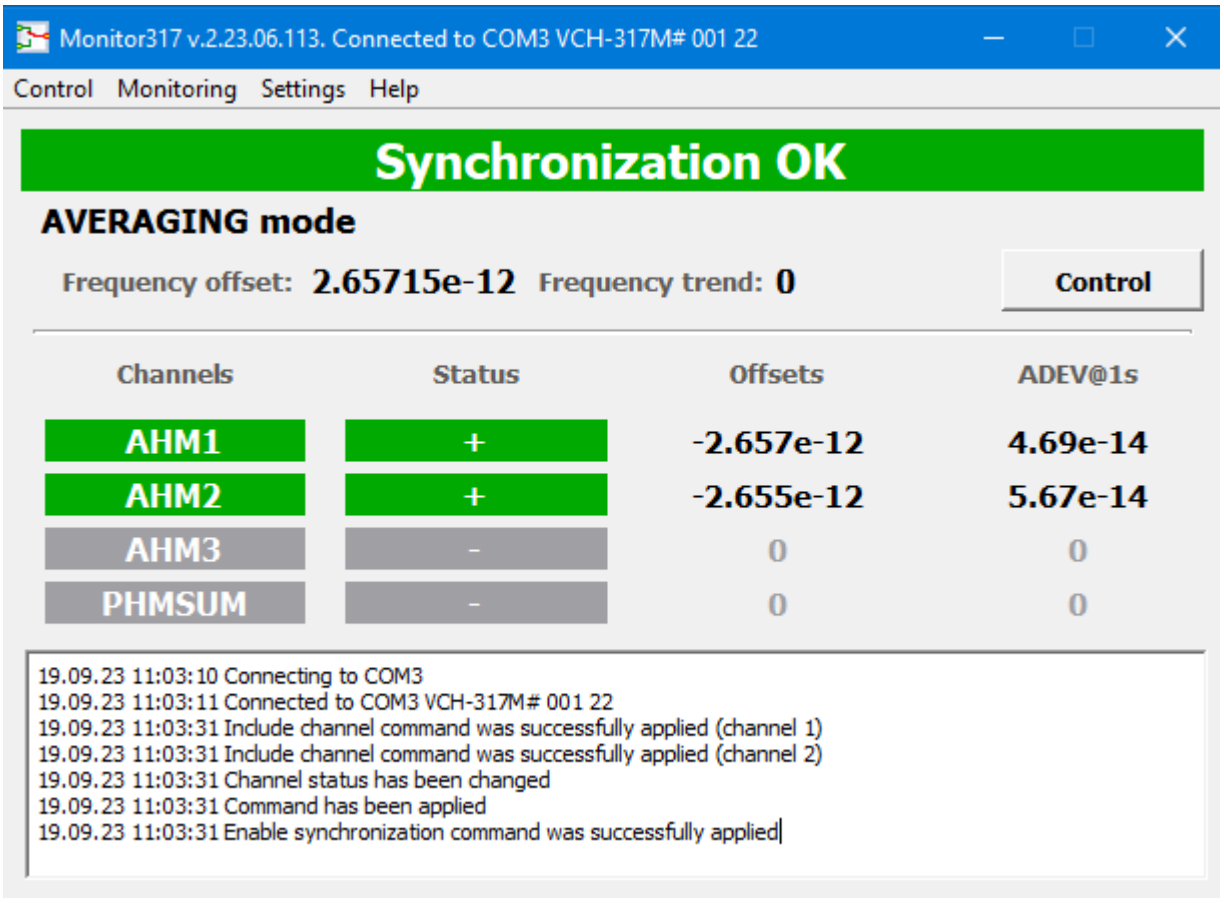

Figure 6.7

To include input sine-form signal in the Signal Group it's necessary to click on the corresponding checkbox "**In Group**" in "**Mode, Synchronization**" tab (see Figure 6.5 as an example). Input sine-form signal goes through a process of qualification before being included in the Synchronizing Group. Process of the qualification takes 10 minutes.

All characteristics and functions are guaranteed when not less than three input sine-form signals are in Synchronizing Group of the Combiner.

ATTENTION! If the sine-form signal connected to the Combiner input (on any of the connectors marked "**1 fy**", "**1 fz**", "**1 fv**", "**1 fw**") has a large frequency difference relative to the output signal, then a negative effect of this signal on the output signal due to a parasitic phase modulation is possible, even if this signal is not included in the qualification or in the group.

To exclude input sine-form signal out of the Synchronizing Group it's necessary to click off the corresponding checkbox "**In Group**" in "**Mode, Synchronization**" tab (see Figure 6.5 as an example) and then to click "**OK**" button.

After excluding the input sine-form signal from the Synchronizing Group, the Combiner changes the value of the output signal frequency offset in such a way as to avoid a frequency jump in the output sine-form signal when recalculation of the frequency of the output sine-form signal of the Combiner will be carried out according to the frequencies of the input sine-form signals remaining in the Synchronizing Group. Thus after excluding the input sine-form signal from the Synchronizing Group the Combiner output signal frequency will remain unchanged taking into account the switching error (the frequency shift of the output sine-form signal does not exceed value specified in item 3.4.8).

After excluding the input sine-form signal from the Synchronizing Group the status of corresponding Channel will be changed from the symbol "+" to the symbol "–".

6.1.3 Exclusion of the input sine-form signal out of the Signal Group/Synchronizing Group.

Exclusion of the input sine-form signal from the Signal Group/Synchronizing Group can be made by user or automatically.

The excluding of input sine-form signal out of Signal Group/Synchronizing Group by user is performed in accordance with Sections 6.1.1, 6.1.2 this OM.

Input sine-form signal (Channel) is excluded automatically out of Signal Group/Synchronizing Group if:

- input sine-form signal disappears;

- RFDEG limit of input sine-form signal is exceeded (for three or four input sine-form signals in Signal Group/Synchronizing Group and if the end of primary signals analysis is finished);
- signal ERROR from the input signal source appears.

With ERROR signal on inputs “**1 Ey**”, “**1 Ez**”, **“1 Ev**”, **“1 Ew**” corresponding channel is excluded out of Signal Group/Synchronizing Group. Look for “ERROR” signal parameters in item 3.4.9.

The main window of the Program (as the example) is shown in Figure 6.8. The example is given for the connection variant shown in Figure 5.2, the "Averaging" mode, and subject to the presence of ERROR signal from the signal with name “Source V” (connected to input “**1 fv**”). After excluding the input sine-form signal from the Synchronizing Group the status of corresponding Channel (see the Figure 6.8) will be changed from the symbol "**+**" to the symbol "**E**".

RFDEG measurement of input sine-form signal is performed for each input sine-form signal included in the Signal Group/Synchronizing Group and provided that the Signal Group/ Synchronizing Group contains at least three signals. To set RFDEG limit of input sine-form signal (Channel) use the instructions in section 3.3 of the UG. If the RFD value between one of input signals and output sine-form signal exceeds RFDEG limit for corresponding input sine-form signal, then the input sine-form signal is excluded from the Signal Group/Synchronizing Group.

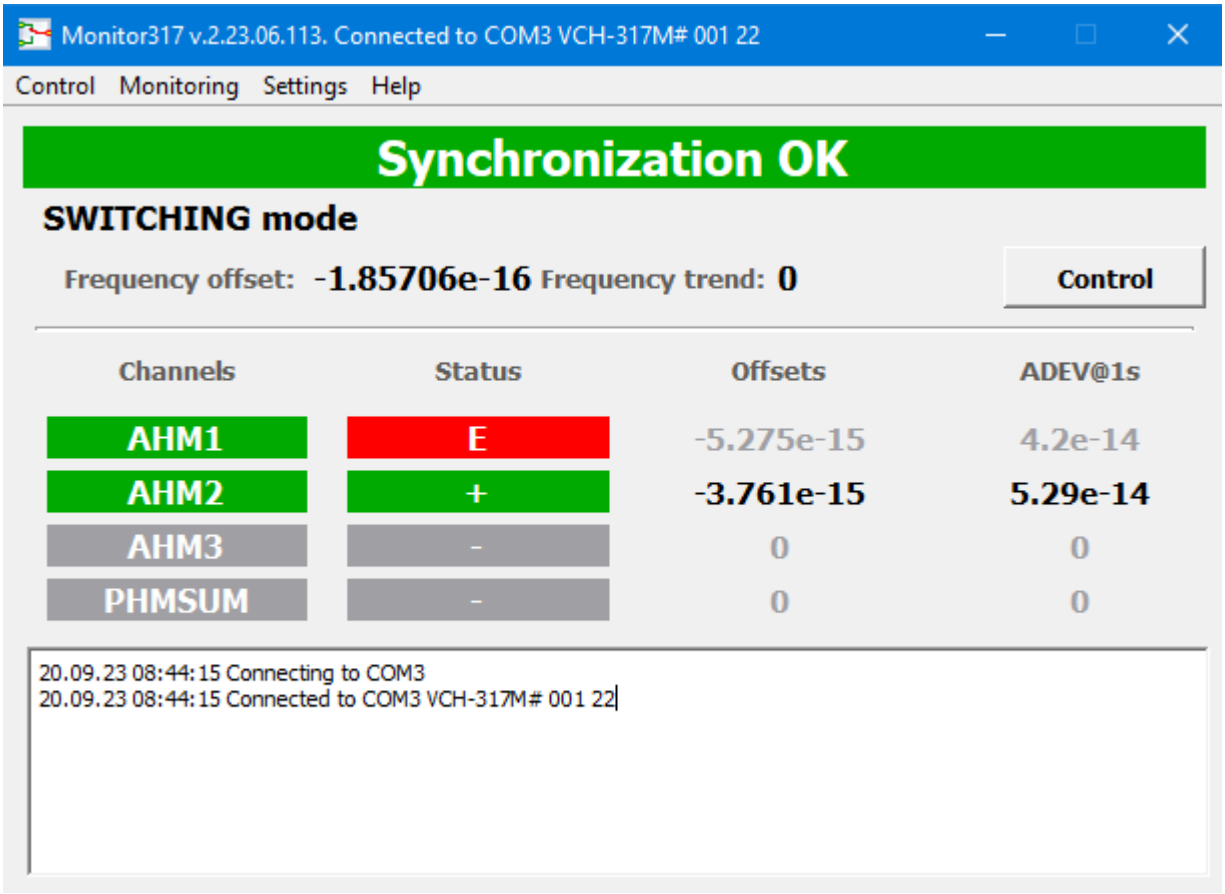

Figure 6.8

The RFDEG limit value recommended during the initial setting should not exceed the maximum value of the relative frequency difference between the input signals (otherwise some signals will be automatically excluded out of Signal Group/Synchronizing Group immediately after the initial analysis process is completed).

6.2 Output signal frequency correction

The operation described in section 6.2 this OM are performed in accordance with section 3.3 the UG.

Open "**Control**" window in the Program. This window is available after pressing the button "**Control**" on the main window of the Program or selecting the "**Control**" item of menu bar.

Open "**Offset correction**" item in "**Control**" window.

6.2.1 Phase offset correction

To correct the phase of the output signals of the Combiner, select the "Phase offset correction" tab in "**Offset correction**" item and follow the steps shown in Section 3.3 of the UG.

During the phase correction of output signals of the Combiner there is a rapid but short-lived change in the frequency of the output signals of the Combiner. There may be a short-term loss of

the normal state of the Combiner, in this case, the "**LOCK**" indicator on the Combiner front panel is off, the "**ERROR**" indicator on the Combiner front panel is blinks. If during the operation of the Combiner such frequency jumps are undesirable, then to correct the phase (frequency) it's possible to apply the Smooth Correction procedure as shown in Section 3.3 of the UG.

NOTE

When correcting the phase of the output sine-form signal, the phase of the output 1PPS pulse signals (formed on the connectors marked "**21 PPS-1**", "**21 PPS-2**") is shifted by the same value.

6.2.2 Frequency offset correction

To correct the output sine-form signal frequency of the Combiner, select the "**Frequency offset correction**" tab in "**Offset correction**" item and follow the steps shown in Section 3.3 of the UG.

NOTE

The planned value of "**New offset"** in the "**Frequency offset correction**" tab must be calculated relative to the average frequency of the input signals, included in the Synchronizing Group ("Averaging" mode) or the Master input signal ("Switching" mode).

The influence of the Frequency offset on the current output signals frequency is shown in the formula in item 3.4.3 this OM.

6.2.3 Frequency trend correction

To correct the output sine-form signal frequency of the Combiner, select the "**Frequency trend correction**" tab in "**Offset correction**" item and follow the steps shown in Section 3.3 of the UG.

The value of Frequency trend is entered in units of relative frequency difference change per day. The influence of the Frequency trend on the current output signals frequency is shown in the formula in item 3.4.3 this OM.

6.3 Synchronization of the pulse-form 1 PPS output signals

The operation described in section 6.3 this OM are performed in accordance with section 3.3 the UG.

To synchronize the pulse-form 1 PPS output signals of the Combiner by edge of external 1 PPS signal with parameters specified item 3.4.5 this OM it's necessary to apply external 1 PPS signal to the input of the Combiner marked "**1 1 Hz**".

For example, the Figure 6.9 and Table 6.1 show a connection where the external 1 PPS signal used for synchronization is supplied from the Source 1 PPS synchronizing signal (using cable number 5).

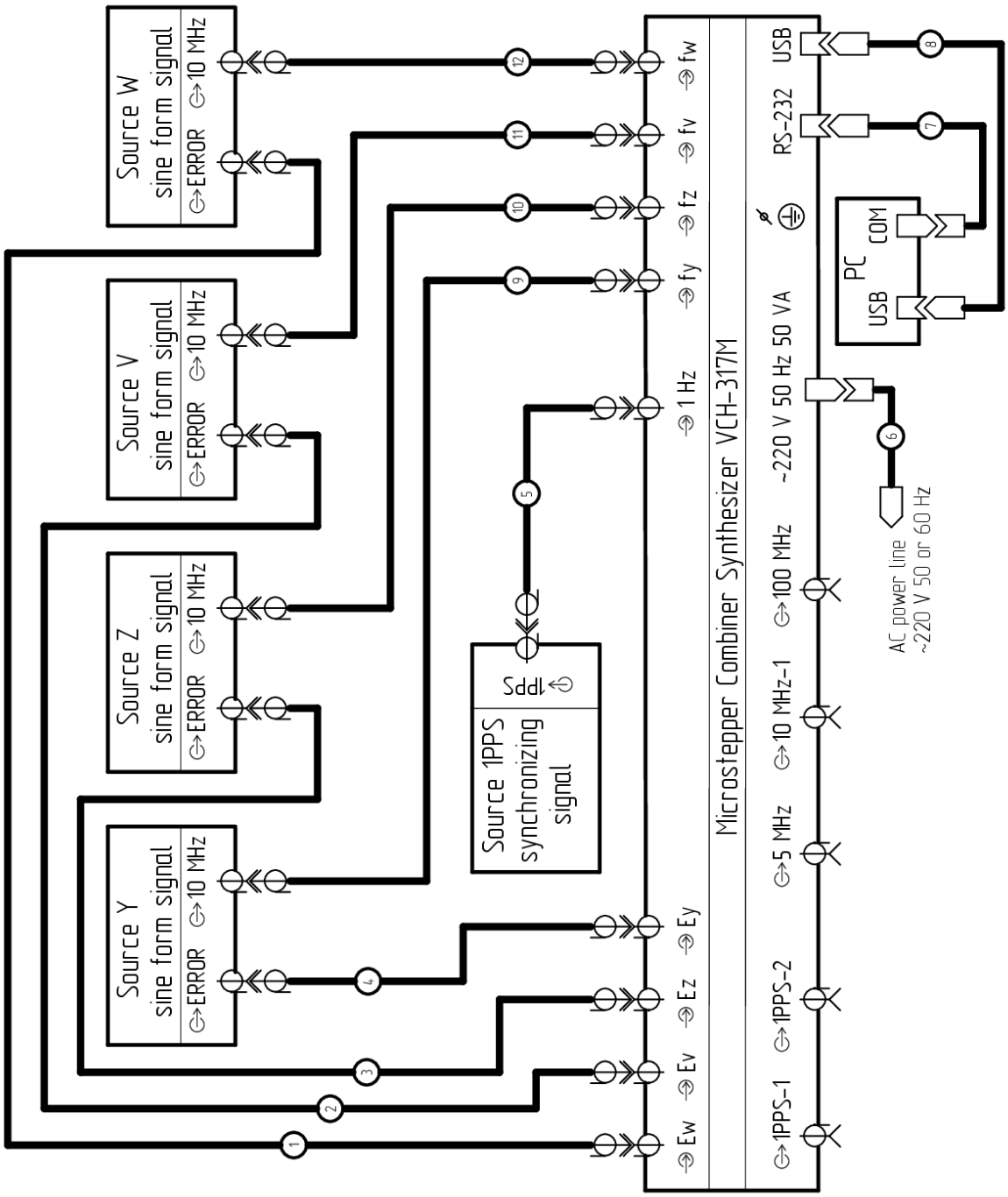

Figure 6.9

Table 6.1

Number of cable (Figure 6.9)	Model and designation	Note
1, 2, 3, 4, 5	Coaxial cable with BNC type connector	see Section 4.3 this OM
6	Power connecting cord SCZ-1	see Section 3.3 this OM
7	RS-232 interface cable 685670.026	see Section 3.3 this OM
8	Interface cable USB 2.0 AM/BM-1.8M	see Section 3.3 this OM
9, 10, 11, 12	Coaxial cable with SMA type connector	see Section 4.3 this OM

Open “**1 PPS synchronization**” tab in “**Control**” window.

When a synchronizing external 1 PPS signal is connected to the input of the Combiner marked “**1 1 Hz**” make sure the “**External 1 PPS status**” field is indicated as “**AVAILABLE**” and press the button “**Synchronize**” (see Figure 6.9 as an example).

After pressing the "Synchronize" button, the synchronization process of the pulse-form 1 PPS output signals has be executed and the new value of the time delay of 1 PPS output signal relative to external 1 PPS signal indicated on “**Current offset (ns)**” field. According to the item 3.4.5 this OM, after the end of the synchronization process, the “**Current offset (ns)**” value (see Figure 6.10 as an example) must be in the range from minus 20 ns to 20 ns.

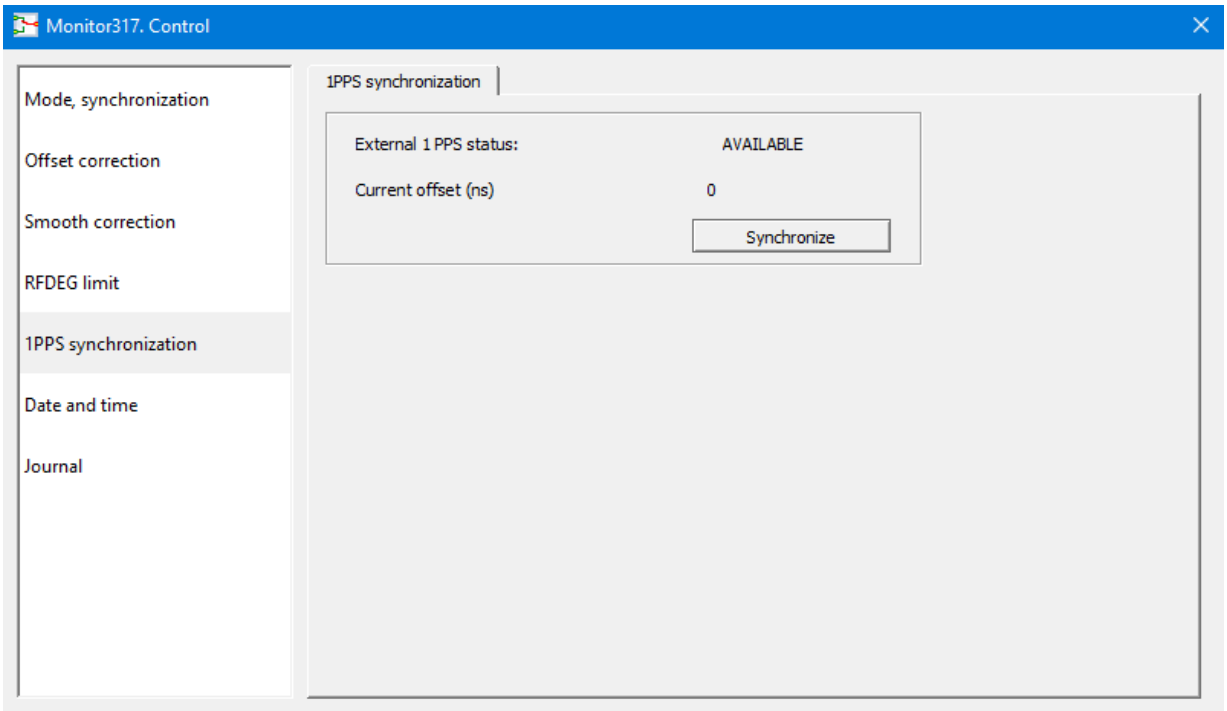

Figure 6.10

6.4 Date and time setting

The operation described in section 6.4 this OM are performed in accordance with section 3.3 the UG.

To set date and time on the Combiner it's necessary to open "**Date and time**" tab in "**Control**" window ("**Control**" window is available after pressing the button "**Control**" on the main window of the Program or selecting the "**Control**" item of menu bar).

To click the "Change time (date) on device" button on "**Date and time**" tab.

Next, the Program sets the time and date of the Combiner in one of two ways.

The first way to set the time and date of the Combiner – select radio button "**Enter a date**" in "**Date and time**" tab and enter the new date and time on the Combiner (see Figure 6.11a as an example).

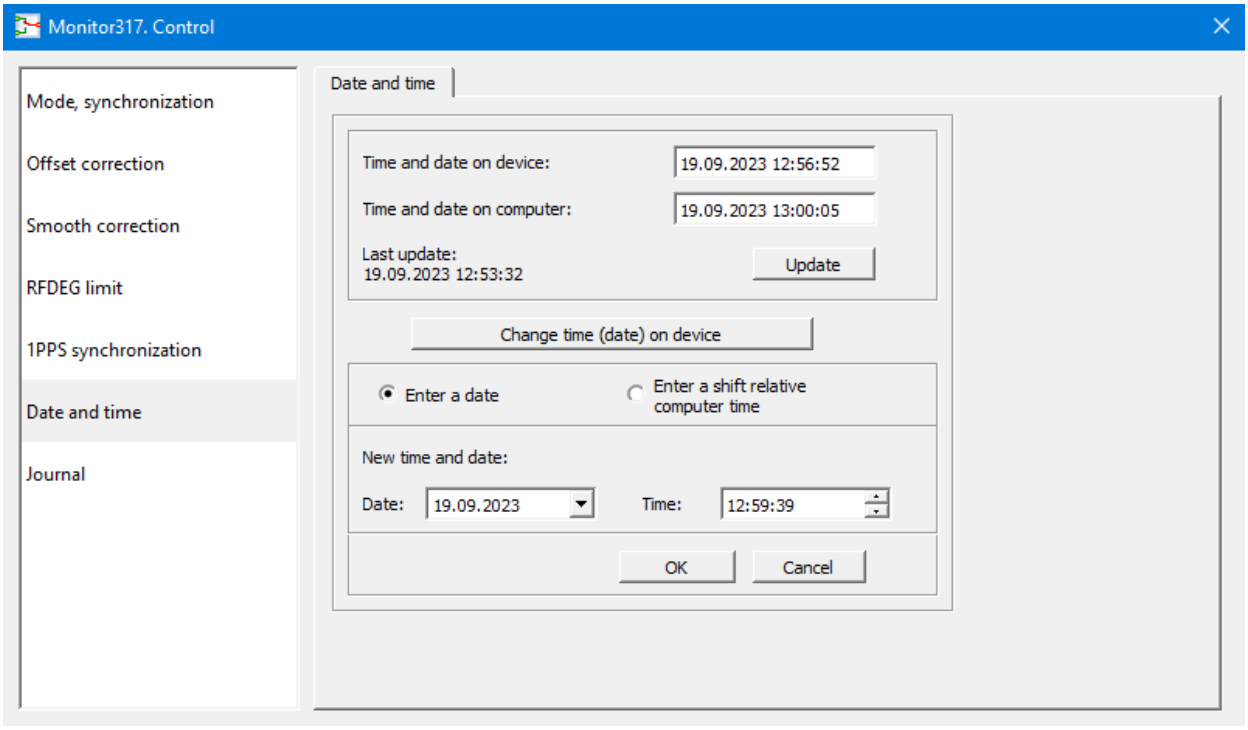

Figure 6.11a

The second way to set the time and date of the Combiner – select radio button "**Enter a shift relative computer time**" in "**Date and time**" tab and enter the shift values relative to the system time on the computer and click the "OK" button (see Figure 6.11b as an example).

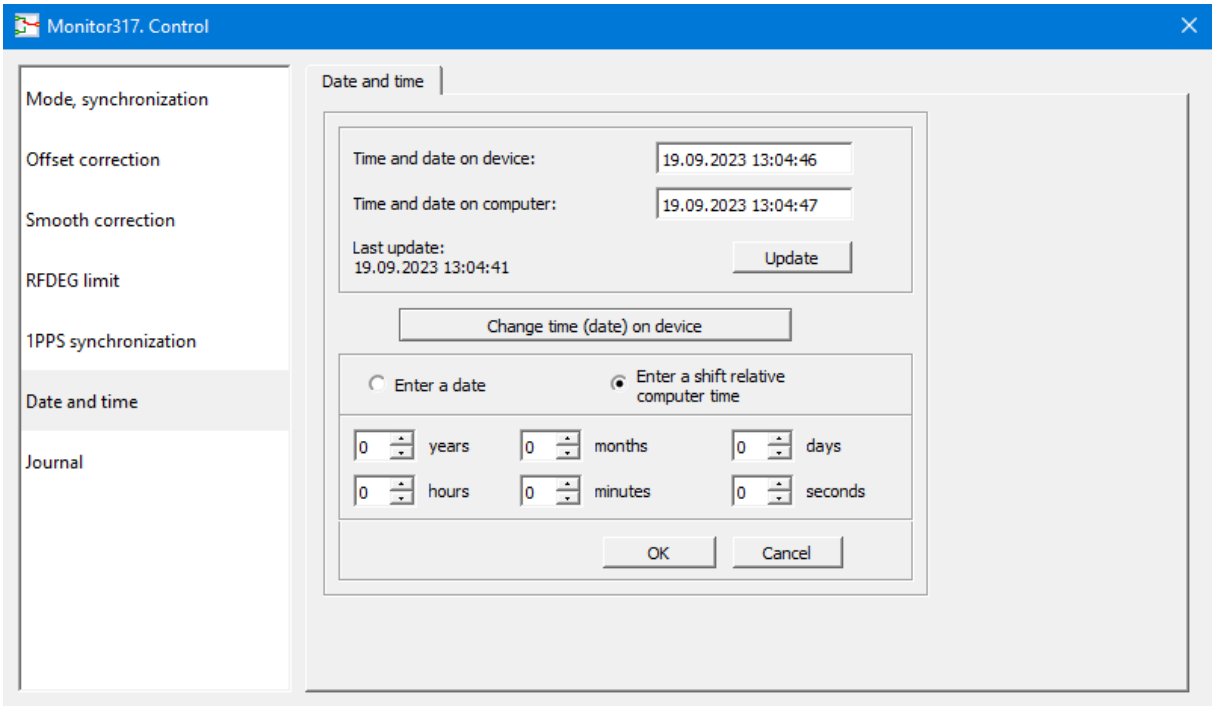
Monitor317. Control
Mode, synchronization
Offset correction
Smooth correction
RFDEG limit
1PPS synchronization
Date and time
Journal
Date and time
Time and date on device:
19.09.2023 13:04:46
Time and date on computer:
19.09.2023 13:04:47
Last update:
19.09.2023 13:04:41
Update
Change time (date) on device
Enter a date
Enter a shift relative computer time
0
years
0
months
0
days
0
hours
0
minutes
0
seconds
OK
Cancel

Figure 6.11b

6.5 PID factors

The information described in section 6.5 this OM are performed in accordance with section 4.2 the UG.

The "**PID factors**" tab is selected by choosing the "**PID factors**" item in the left part of the "**Control**" window (see Figure 6.12).

NOTE

The "**PID factors**" tab of the "**Control**" window becomes available in developer mode of the Program only. To access this tab, select "**Developer mode**" item from the "**Control**" item of the menu bar in the main window of the Program and authenticate in the window that opens.

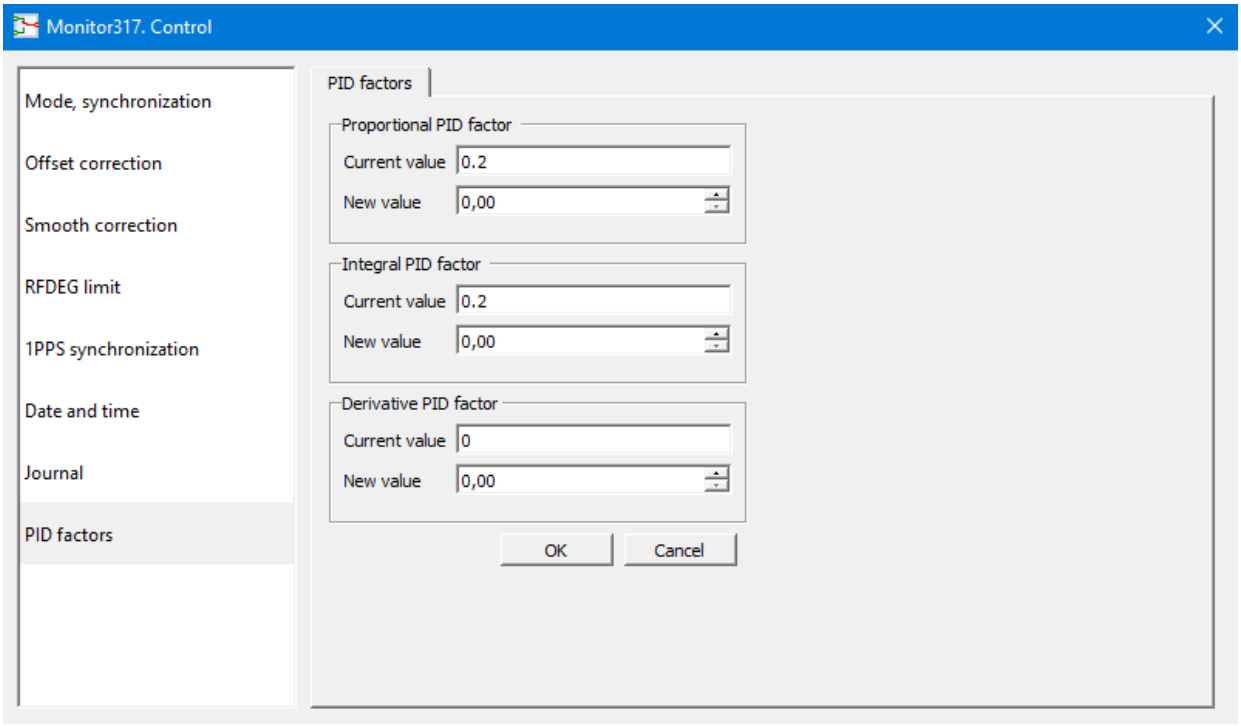

Figure 6.12

ATTENTION! Due to changes in the PID factors, there will be a change in operating mode and parameters of the Combiner's FLL system, which may lead to change in some technical characteristics of the Combiner (frequency instability of the Combiner sine-form output signals, process stability of FLL lock).

To change the PID factor, enter the new value in corresponding "**New value**" field. After entering the new value of the PID factor, click the "**OK**" button.

The PID factors set in the "**PID factors**" tab are used for frequency adjustment in normal operation when the Combiner local quartz oscillator is synchronized with input sine-form signal (with the Synchronizing Group). At the beginning of the FLL lock (frequency lock-in process) the

Combiner's CPU automatically sets other values for the PID factors. These values of PID factors are specially selected by the Combiner manufacturer and are used only for the frequency lock-in process.

After the Combiner was manufactured, the manufacturer set the following values of the PID factors:

- Proportional PID factor – 0,2;
- Integral PID factor – 0,2;
- Derivative PID factor – 0.

The default combination of the PID factors is the most adapted for the Combiner operation with high quality input sine-form signals (e.g. sine-form signals of Active Hydrogen Maser).

6.6 Selecting the language of the Program interface

To select the language of the Program interface it's necessary to open "**Language**" item in "**Settings**" item of menu bar (on the top part of main window). There is a choice of one of two languages: English or Russian.

7 Monitoring functions

Monitoring functions allow to monitor current state of the Combiner.

7.1 Main window of the Program

Main window of the Program displays the following main parameters of the Combiner.

The information described in section 7.1 this OM are performed in accordance with section 3.1 the UG.

The field below the menu bar of the main window (see Figures 7.1a, 7.1b) shows one of the Combiners main state:

- **Synchronization OK**
- **Initial signal estimation, ___ s**
- **No synchronization!**
- **No connection**

The Combiners main states "**Synchronization OK**" and "**Initial signal estimation, ___ s**" inform that the Combiner local quartz oscillator is synchronized with averaging frequency of all the Synchronizing Group signals (Channels) or with frequency of Master input sine-form signal.

The Combiner main state "**No synchronization!**" informs that the Combiner local quartz oscillator is not synchronized, this is not the normal the Combiner state.

The Combiner main state "**No connection**" informs that the Combiner is not connected to the Program.

Under the field showing the main state of the Combiner (see Figures 7.2a, 7.2b) is situated field indicates the Combiner operating mode (**"Switching mode / Averaging mode"**). The operational mode selecting and output signal frequency synchronization in the above modes is described in section 6.1 this OM and section 3.3 the UG.

Under the field showing the Combiner operating mode (see Figures 7.2a, 7.2b) is situated field indicates some parameters of the output sine-form signal frequency ("**Frequency offset**", "**Frequency trend**"). Frequency offset correction is described in item 6.2.2 this OM and section 3.3 the UG. Frequency offset correction is described in item 6.2.3 this OM and section 3.3 the UG. The influence of the Frequency offset and Frequency trend on the current output signals frequency is shown in the formula in item 3.4.3 this OM.

Under the field showing frequency offset and frequency trend is situated a column of four fields labeled "**Channels**".

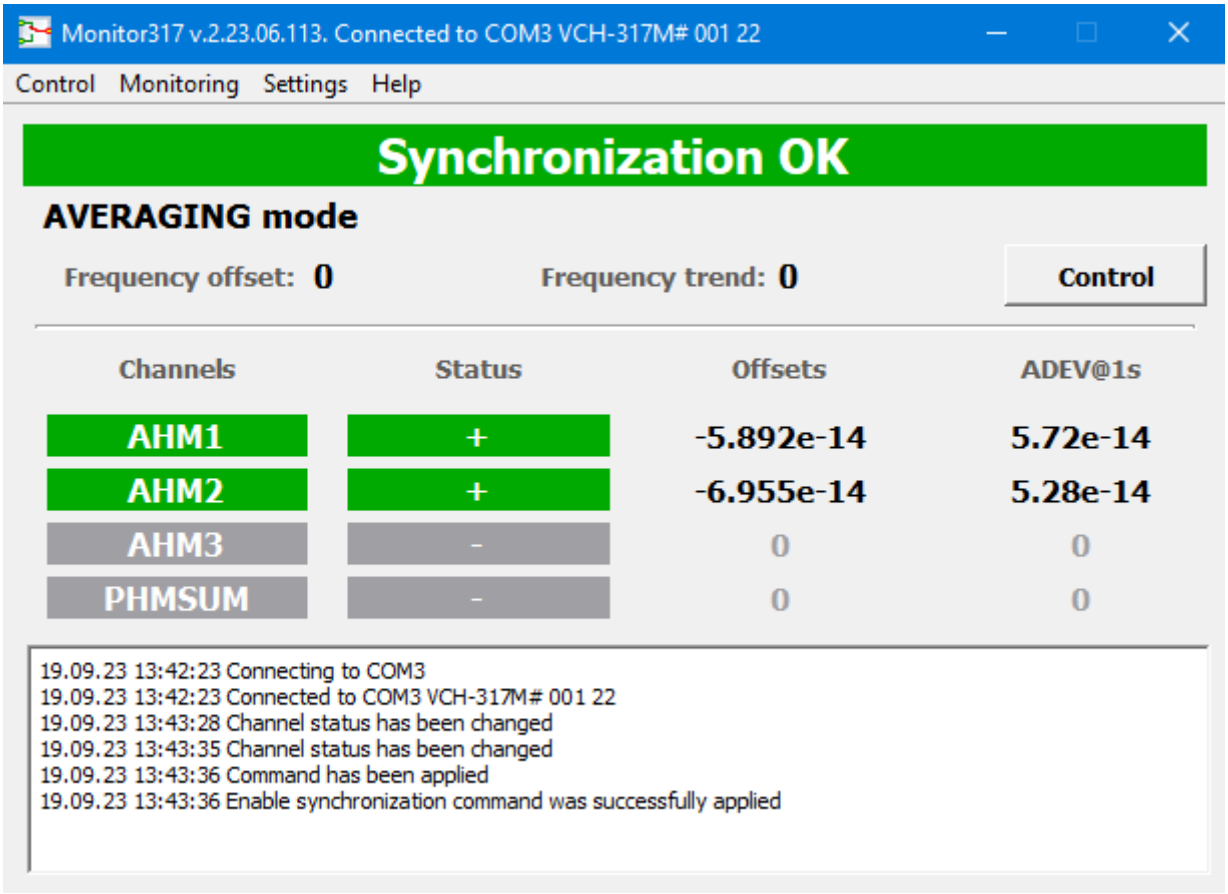

Figure 7.1a

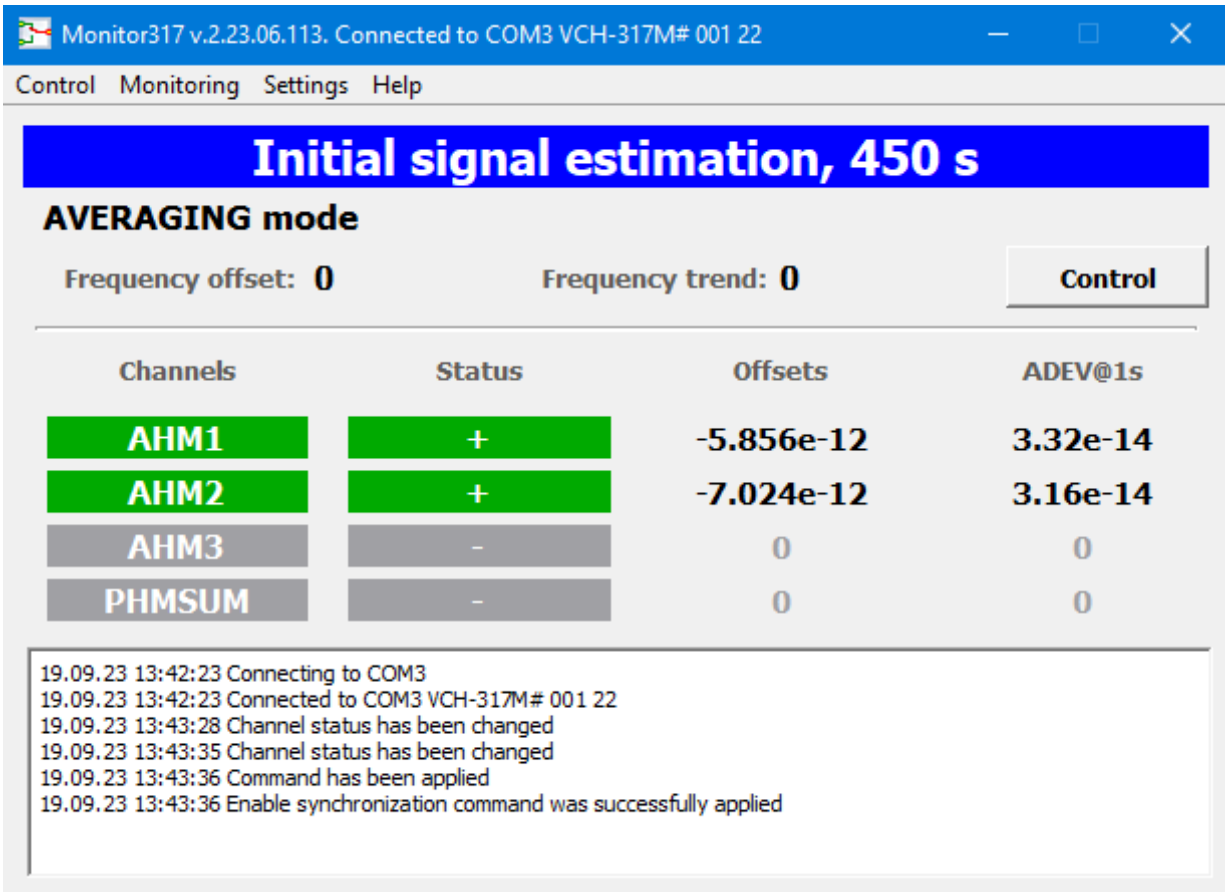

Figure 7.1b

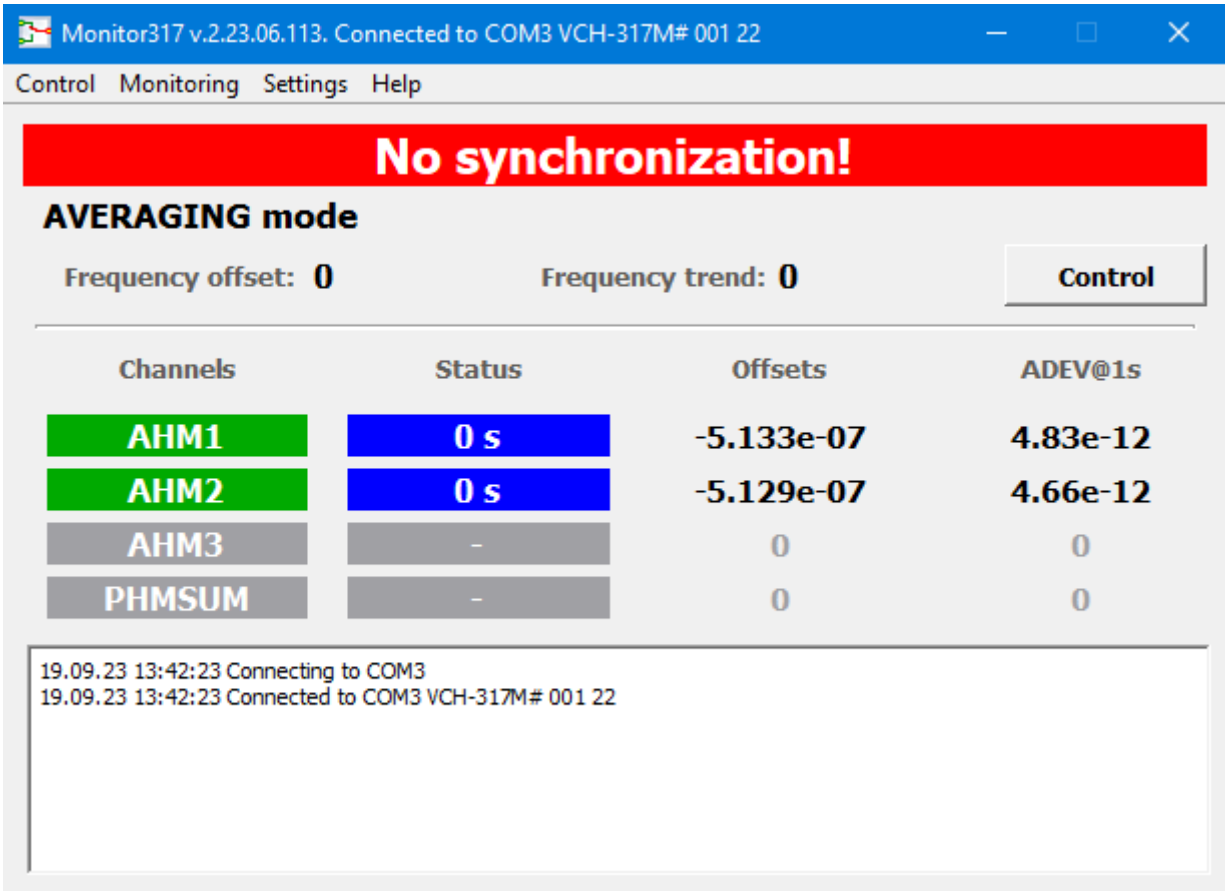

Figure 7.1c

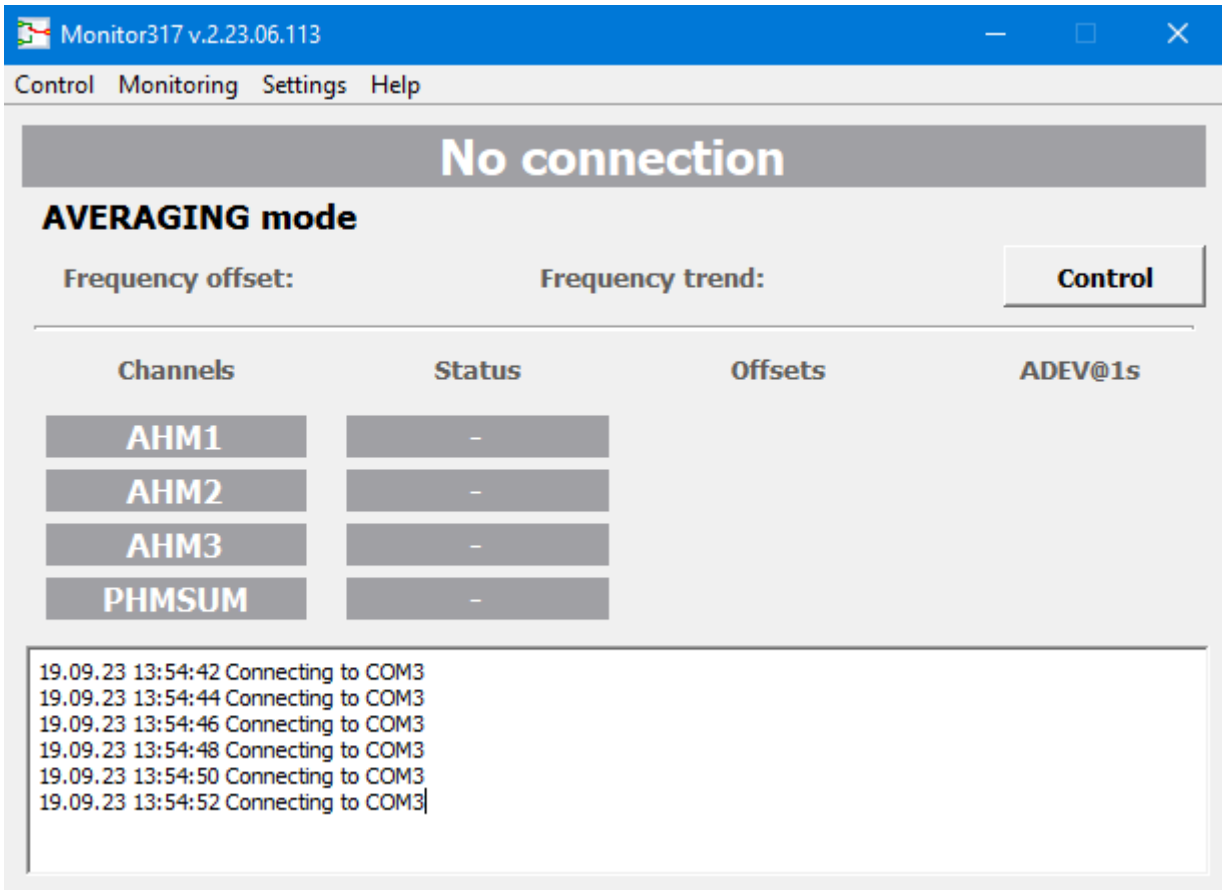

Figure 7.1d

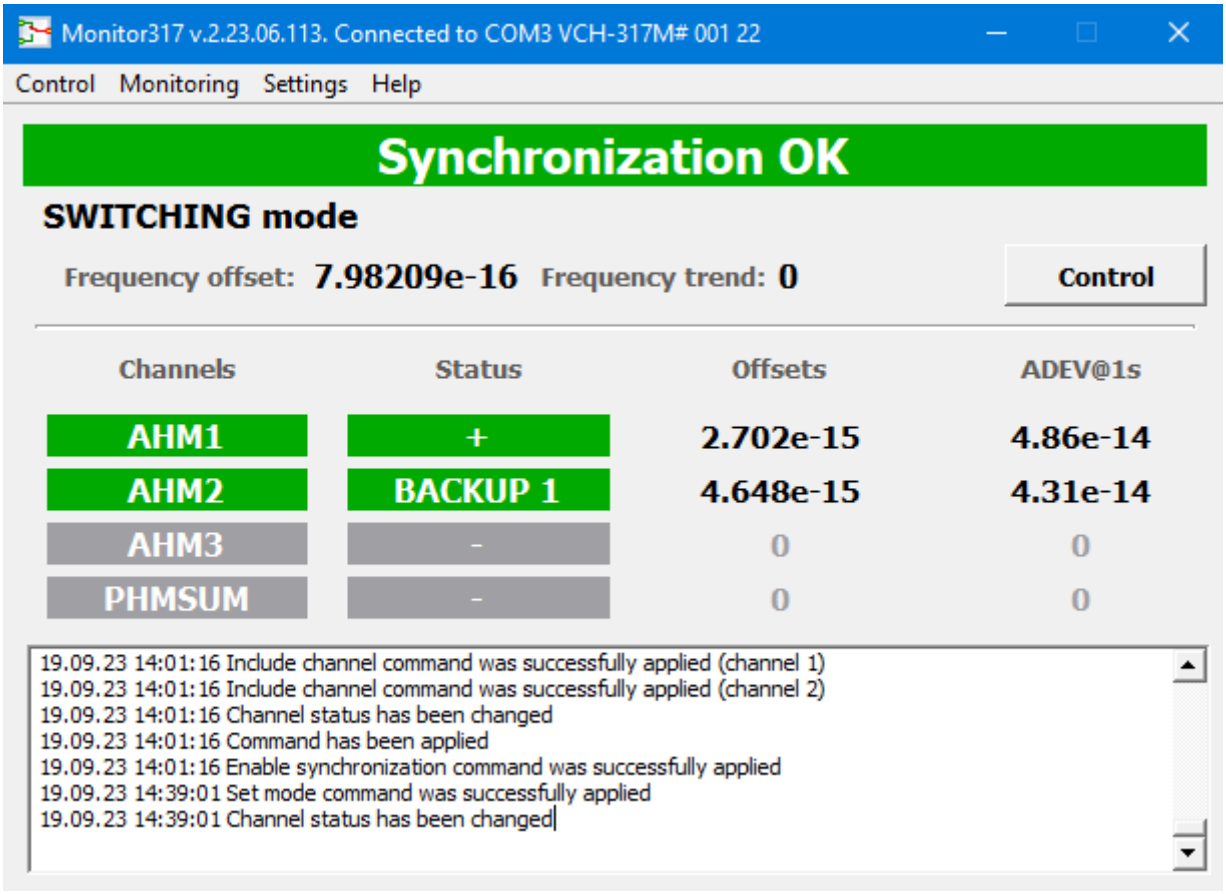

Figure 7.2a

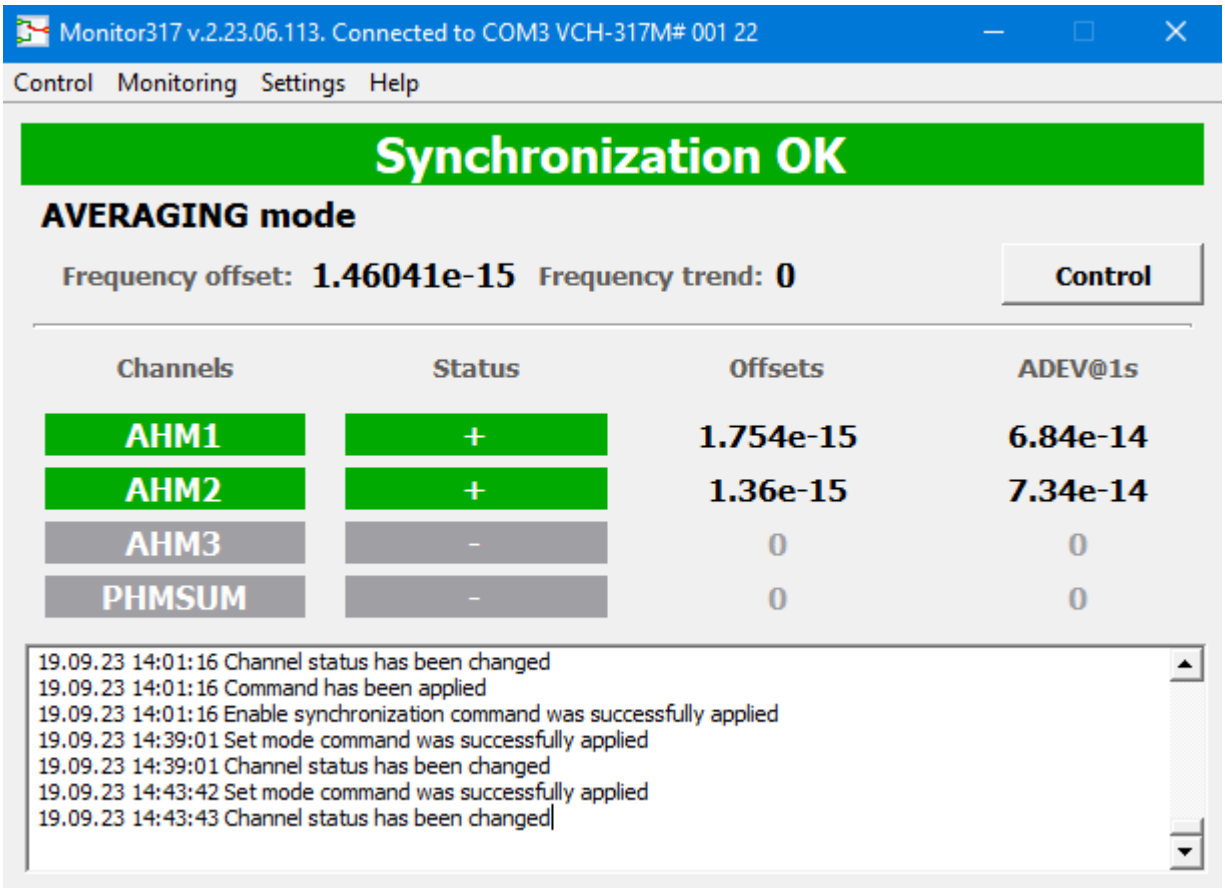

Figure 7.2b

Each of the four fields corresponds to one of the four input sine-form signals (Channels). The name of the input sine-form signal (Channel) is displayed in the field. To assign the name of every input sine-form signal in main window of the Program it's necessary to click the left mouse button on corresponding field of input sine-form signal. A green field means that the input sine form signal is applied to the corresponding input of the Combiner (connected to the connectors marked "**1 fy**", "**1 fz**", "**1 fv**", "**1 fw**"). A grey field means that there is no input sine-form signal in corresponding channel.

To the right of the column of four fields labeled "**Channels**" is situated the column of four fields labeled "**Status**". These fields indicate status for each input sine-form signal (Channel).

The status of input sine-form signal (Channel) depends on selected operational mode. The Combiner's control in the "Switching" mode is described in item 6.1.1 this OM and the Combiner's control in the "Averaging" mode is described in item 6.1.2 this OM.

Also the status of input sine-form signal (Channel) depends on the corresponding input sine-form signal (Channel) is included (excluded) in the Signal Group/Synchronizing Group. Inclusion and exclusion of the input sine-form signal out of the Signal Group/Synchronizing Group is described in items 6.1.1 – 6.1.3 this OM.

For example, different statuses of input sine-form signals (Channels) depending on the operating mode and composition of the Synchronizing group are shown in Figures 6.2 – 6.4, 6.6 – 6.8.

The Figure 6.2 show examples of the Combiner operation in the "Switching" mode. The inscription "**Initial signal estimation, ___ s**" in the field below the menu bar of the main window (see Figures 6.2) indicates that the initial analysis of the input sine-form signals of the Signal Group is in progress. The countdown in seconds shows the time remaining until the "**Synchronization OK**" mode is turned on. The Channel named "Source Y" (corresponds to input "**1 fy**") has the status "**+**" and the output signals of the Combiner are synchronized with this Master input signal. The Channel named "Source Z" (corresponds to input "**1 fz**") has the status "**BACKUP 1**" and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named "Source Y" is disqualified. The Channel named "Source V" (corresponds to input "**1 fv**") has the status "**BACKUP 2**" and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named "Source Z" is disqualified. The Channel named "Source W" (corresponds to input **"1 fw**") has the status "**BACKUP 3**" and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named "Source V" is disqualified.

The Figure 6.3 show examples of the Combiner operation in the “Switching” mode. The inscription “**Synchronization OK**” in the field below the menu bar of the main window (see Figures 6.3) indicates the normal state of the Combiner in which, the output signals of the Combiner are synchronized with input sine-form signal included in Signal Group (with Master input signal). The Channel named “Source Y” (corresponds to input “**1 fy**”) has the status “+” and the output signals of the Combiner are synchronized with this Master input signal. The Channel named “Source Z” (corresponds to input “**1 fz**”) has the status “**BACKUP 1**” and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named “Source Y” is disqualified. The Channel named “Source V” (corresponds to input “**1 fv**”) has the status “**BACKUP 2**” and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named “Source Z” is disqualified. The Channel named “Source W” (corresponds to input “**1 fw**”) has the status “**BACKUP 3**” and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named “Source V” is disqualified.

The Figure 6.4 show examples of the Combiner operation in the “Switching” mode. The inscription “**Synchronization OK**” in the field below the menu bar of the main window (see Figures 6.4) indicates the normal state of the Combiner in which, the output signals of the Combiner are synchronized with input sine-form signal included in Signal Group (with Master input signal). The Channel named “Source Y” (corresponds to input “**1 fy**”) has the status “**–**” and not included (or excluded) in Signal Group. The Channel named “Source Z” (corresponds to input “**1 fz**”) has the status “+” and the output signals of the Combiner are synchronized with this Master input signal. The Channel named “Source V” (corresponds to input “**1 fv**”) has the status “**BACKUP 1**” and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named “Source Z” is disqualified. The Channel named “Source W” (corresponds to input “**1 fw**”) has the status “**BACKUP 2**” and this input sine-form signal becomes new Master input signal for the Combiner local quartz oscillator if the Channel named “Source V” is disqualified.

The Figure 6.6 show examples of the Combiner operation in the “Averaging” mode. The inscription “**Initial signal estimation, ___ s**” in the field below the menu bar of the main window (see Figures 6.6) indicates that the initial analysis of the input sine-form signals of the Signal Group is in progress. The output signals of the Combiner are synchronized with averaging frequency of all the Synchronizing Group signals (Channels) however all input sine-form signals (Channels) included in Synchronizing Group are in the testing state. The countdown in seconds shows the time remaining until the “**Synchronization OK**” mode is turned on. The Channel named “Source Y” (corresponds to input “**1 fy**”) has the status “+” and input sine-form signal at

this Channel is included in Synchronizing Group. The Channel named "Source Z" (corresponds to input "**1 fz**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source V" (corresponds to input "**1 fv**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source W" (corresponds to input "**1 fw**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group.

The Figure 6.7 show examples of the Combiner operation in the "Averaging" mode. The inscription "**Synchronization OK**" in the field below the menu bar of the main window (see Figures 6.7) indicates the normal state of the Combiner in which, the output signals of the Combiner are synchronized with averaging frequency of all the Synchronizing Group signals (Channels). The Channel named "Source Y" (corresponds to input "**1 fy**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source Z" (corresponds to input "**1 fz**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source V" (corresponds to input "**1 fv**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source W" (corresponds to input "**1 fw**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group.

The Figure 6.8 show examples of the Combiner operation in the "Averaging" mode. The inscription "**Synchronization OK**" in the field below the menu bar of the main window (see Figures 6.8) indicates the normal state of the Combiner in which, the output signals of the Combiner are synchronized with averaging frequency of all the Synchronizing Group signals (Channels). The Channel named "Source Y" (corresponds to input "**1 fy**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source Z" (corresponds to input "**1 fz**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. The Channel named "Source V" (corresponds to input "**1 fv**") has the status "**E**" and input sine-form signal at this Channel is automatically excluded out of Synchronizing Group since signal ERROR on input "**1 Ev**", from the "Source V" sine-form signal (see Figures 5.2) appears. The Channel named "Source W" (corresponds to input "**1 fw**") has the status "+" and input sine-form signal at this Channel is included in Synchronizing Group. Thus, in the case shown in Figure 6.8, only three input sine-form signals ("Source Y", "Source Z", "Source W") are included in the Synchronization Group.

7.2 The event log

The information described in section 7.2 this OM are performed in accordance with section 3.3 the UG.

The "**Journal**" tab is selected by choosing the "**Journal**" item from the "**Monitoring**" item of the menu bar of the main window and selecting the "**Journal**" item in the left part of the "**Control**" window (see Figure 7.3).

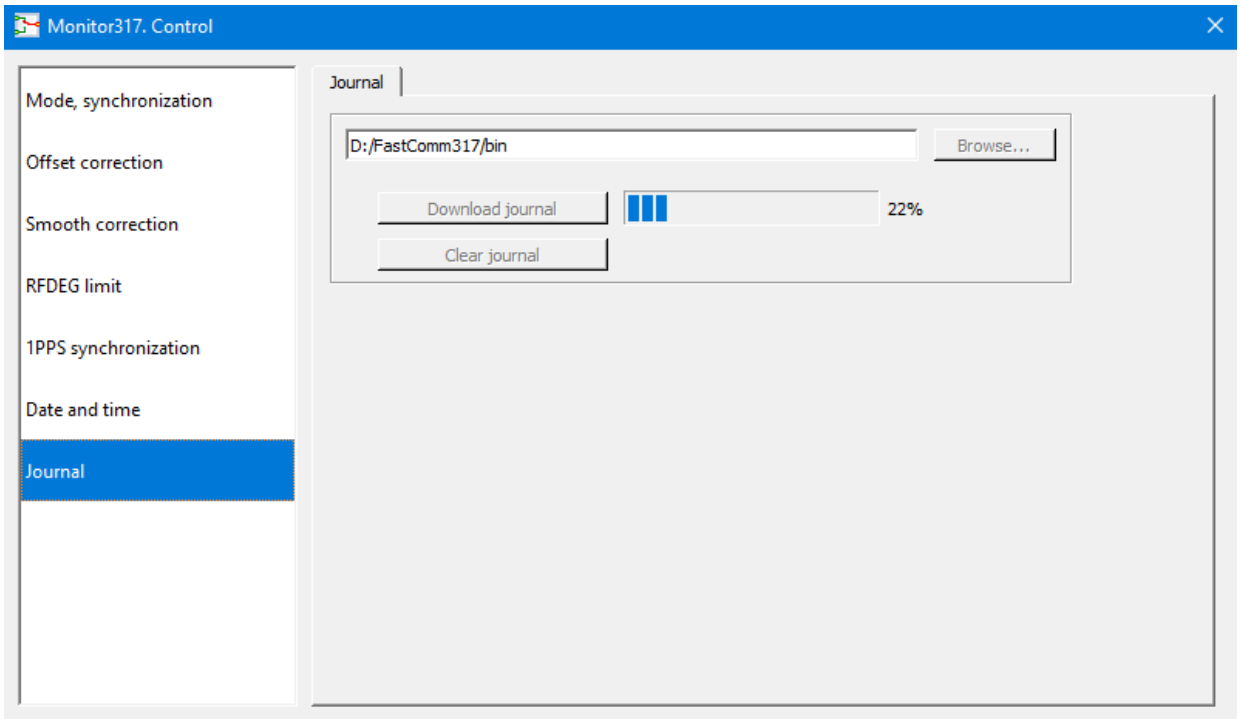

Figure 7.3

7.3 “FLL state” window

The information described in section 7.3 this OM are performed in accordance with section 3.4 the UG.

The “**FLL state**” window is selected by choosing the “**FLL state**” item from the “**Monitoring**” item of the menu bar of the main window (see Figure 7.4).

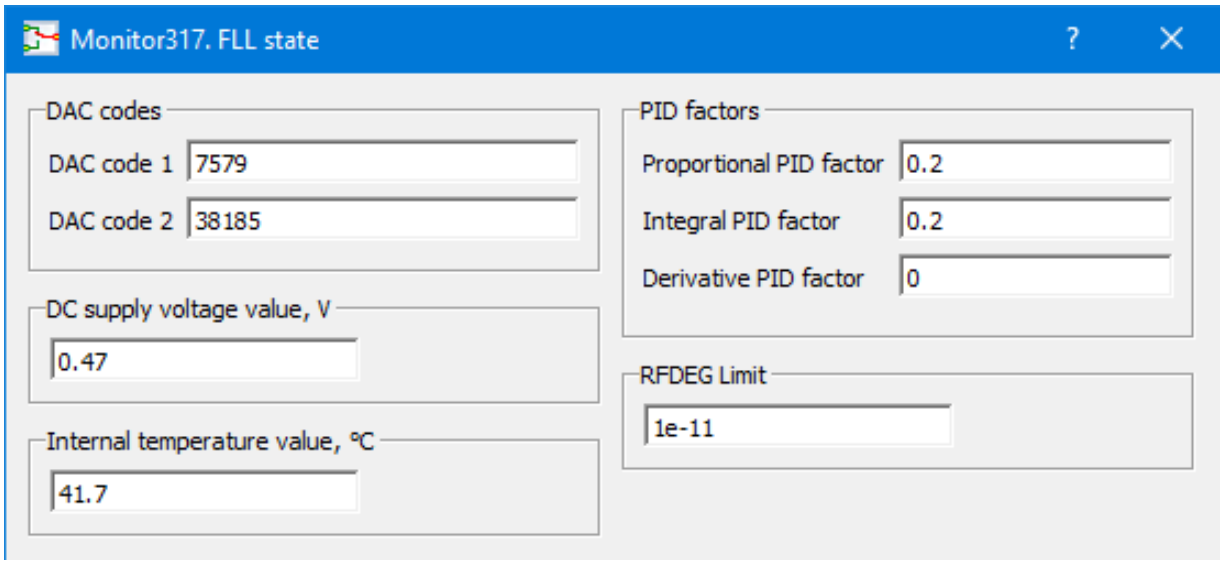

Figure 7.4

The “**FLL state**” window displays information about the following parameters of the Combiner:

- DAC codes:
- voltage value of the external DC power supply;
- internal temperature value;
- PID factors;
- RFDEG limit value.

The panel “**DAC codes**” displays the current DAC codes, which are used to synchronize (frequency adjust) the Combiner local quartz oscillator.

“**DAC code 1**” field in the panel “**DAC codes**” displays the current code of “coarse” digital to analog converter. The code of “coarse” digital to analog converter adjusts frequency of the Combiner local quartz oscillator with an accuracy sufficient to get the intermediate frequency into the lock-in band of the “fine” channel where frequency adjustment is carried out using the "fine" DAC. As well the code of “coarse” digital to analog converter compensates for the frequency drift of the Combiner local quartz oscillator from the operating point when the Combiner local quartz oscillator ages or when the temperature inside the Combiner changes significantly. Therefore, the current code of “coarse” digital to analog converter does not change, or it changes slightly when

the Combiner local quartz oscillator is synchronized with input sine-form signal (Synchronizing Group).

"**DAC code 2**" field in the panel "**DAC codes**" displays the current code of "fine" digital to analog converter. The code of "fine" digital to analog converter adjusts frequency of the Combiner local quartz oscillator in normal operation when the Combiner local quartz oscillator is synchronized with input sine-form signal (with the Synchronizing Group) and the ambient temperature is stable and suitable for working operating conditions. Therefore, the current code of "fine" digital to analog converter changes significantly synchronizing the Combiner local quartz oscillator.

The panel "**PID factors**" displays the control coefficients of the auto-tuning system that form the dynamic behavior of the Combiner's FLL system. To set PID factors for the Combiner's FLL system use the instructions in section 6.5 this OM and section 4.2 of the UG.

The panel "**DC supply voltage value, V**" displays the current value of a DC power supply voltage on the connector marked "**422 … 32 V 40 W**". This value of a DC power supply voltage is a description parameter and has no metrological significance. For normal operation of the Combiner from DC power supply, the value of the DC power supply voltage must be in the range from 22 V to 32 V (see item 3.4.12 this OM).

NOTE

If there is no DC supply voltage at the Combiner connector marked "**422 … 32 V 40 W**", a small voltage may be displayed on the panel "**DC supply voltage value, V**". This appearance is due to the error of the DC power supply voltage measurement circuit.

The panel "**Internal temperature value, ºC**" displays the current value of the Combiner Internal temperature. The value of the Combiner internal temperature is measured with the temperature sensor in the CPU. This value of the Combiner internal temperature is a description parameter and has no metrological significance.

The panel "**RFDEG Limit**" displays the current value of the RFDEG limit. The RFDEG limit of input sine-form signal (Channel) is used in process of automatically Exclusion of the input sine-form signal out of the Signal Group/Synchronizing Group (see item 6.1.3 this OM). To set RFDEG limit of input sine-form signal (Channel) use the instructions in section 3.3 of the UG.

7.4 “Graphs” window

The information described in section 7.3 this OM are performed in accordance with section 3.5 the UG.

The “**Graphs**” window is selected by choosing the “**Graphs**” item from the “**Monitoring**” item of the menu bar of the main window (see Figure 7.5).

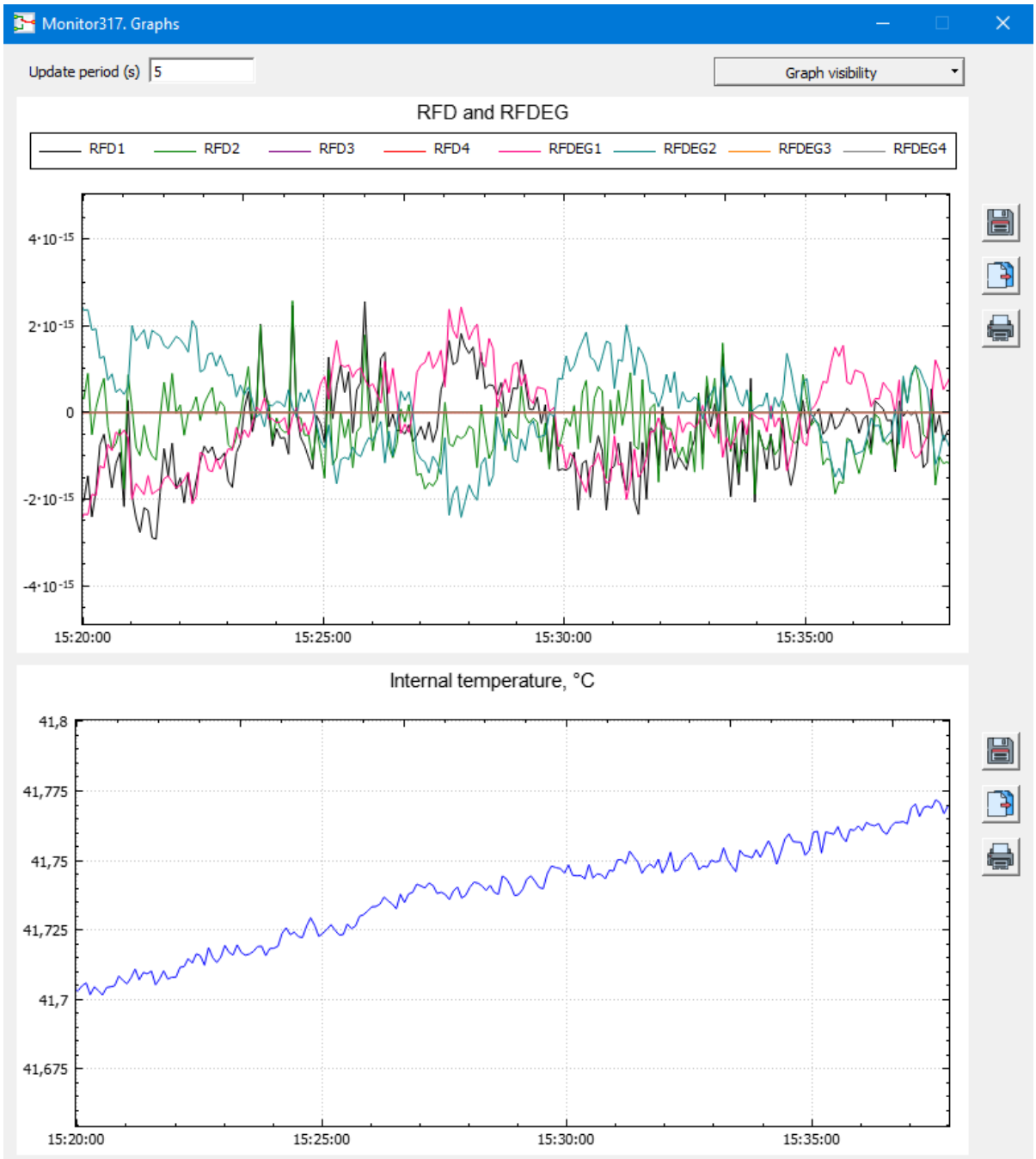

Figure 7.5

RFD and RFDEG charts and the internal temperature chart of the Combiner presented in the "**Graphs**" window give a visual representation of the behavior of these parameters.

8 Warranty

According the Contract.