

**VREMIA – CH**  
**Joint Stock Company**

## **MICROSTEPPER COMBINER SYNTHESIZER**

**VCH-317**

**Operational Manual**

**411146.040OM**



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# 1 Description

## 1.1 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 signal compared with output signal.

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

- missing input signal;
- measured relative frequency difference of input signal exceeds limit;
- signal indicating input sine signals source error.

dT – 1 Hz output signal delay relatively external signal 1 Hz.

dt – programmed phase shift of output 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 signal source.

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

LCD – liquid crystal display.

PC – personal computer.

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

PLL – automatic phase lock loop.

PLL lock – the adjustment of output signal frequency to synchronizing group frequency and holding it.

Signals primary analysis mode – monitoring input signals quality after PLL lock. Input signals previously were included into synchronizing group.

Qualification – monitoring input signal quality before inclusion this signal into signal group (synchronizing group).

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

RFD – relative frequency difference between input and output signals.

RFDIG – relative frequency difference between one individual input signal and all other signals of signal group (synchronizing group).

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

Synchronizing group – the group of input signals, which forms output signal frequency.

Weight – weights ratio of input signal in synchronizing group.

## 1.2 Structure and principal of operation

Microstepper Combiner Synthesizer VCH-317 (hereinafter named as Combiner) produces an uninterrupted in frequency and phase precision signals on the base of some atomic clocks.

The external view of the Combiner is given in Fig. 1.1.



Fig. 1.1

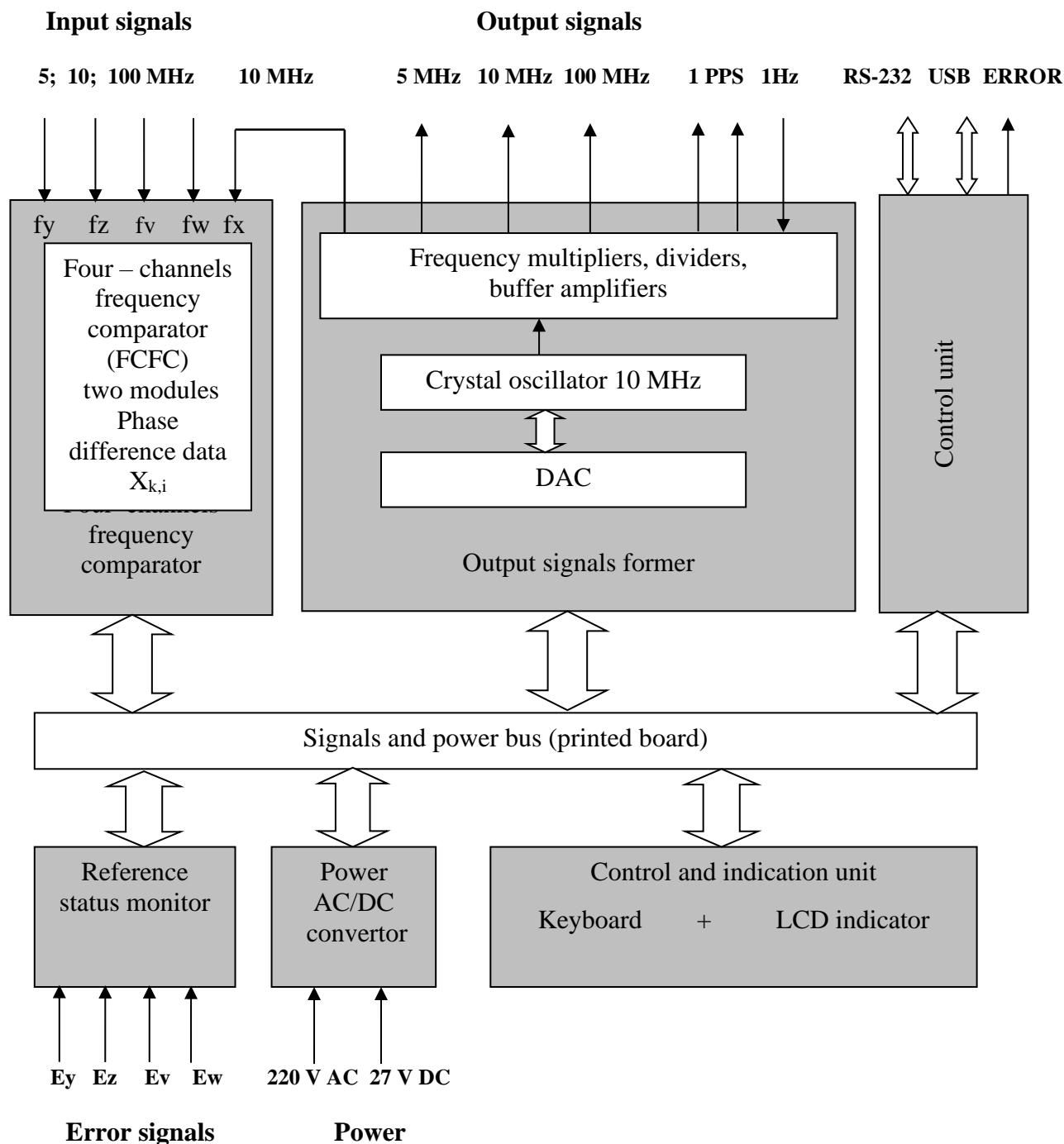
The Combiner can be used both independently, and in a structure of automated measuring systems. The remote control of the Combiner and diagnostics of its status by means of communication line is provided.

The main Combiner applications:

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

Fig.1.2 shows the simplified scheme of the Combiner.

Four input signals ( $f_y$ ,  $f_z$ ,  $f_v$ ,  $f_w$  connectors) feeds four-channels frequency comparator (FCFC).



**Fig. 1.2 – 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 PLL 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,

where:

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

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

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

Reference status monitor analyses Error signals from input signals source (parameters of this signal on p.7). When “low level” at one input occurs the Combiner automatically removes corresponding signal from signal group (synchronizing group).

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

Control and indication unit is devoted to change and monitor status of the Combiner. It is possible to control the Combiner manually or by external computer.

### 1.3 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 is optimal for the best reserving, because even if missing one of input signals all functions are available.



## 2 Safety and preparation for use

First carefully read instruction manual. 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.

### **Operating conditions of application**

Supply:

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

Environment conditions:

- ambient temperature: from +5 °C up to +40 °C;
- ambient temperature changes: not more than 1 °C/hour

### **Warning!**

High voltages are present in this Combiner, it is capable of causing injury or death.

The Combiner should be plugged to the power supply which has grounded terminal.

The use of the Combiner jointly with the other instruments requires grounding of all instruments.

### **Fuse**

A 3.15 Ampere 250 V slow-blow fuse is used for (220 – 240) VAC operation. Only replace fuses with the same type and specifications.

### **Line Cord**

The Combiner has a detachable, three wire power cord for connection to a grounded power source. The enclosure of the Combiner is directly connected to the outlet ground to protect against electrical shock. Always use an outlet with a protective ground and do not disable this safety mechanism.

### **Stationing of Combiner**

Place of setting the Combiner should be chosen in consideration of device overall dimension (483×133×370 mm). Also it should provide free access to vents.

Setting the Combiner close to electric motors, generators, transformers, and other equipment, which can create magnetic fields is impossible. The conformity of the device specifications are not guaranteed on such conditions.

### 3 Operating controls and connectors

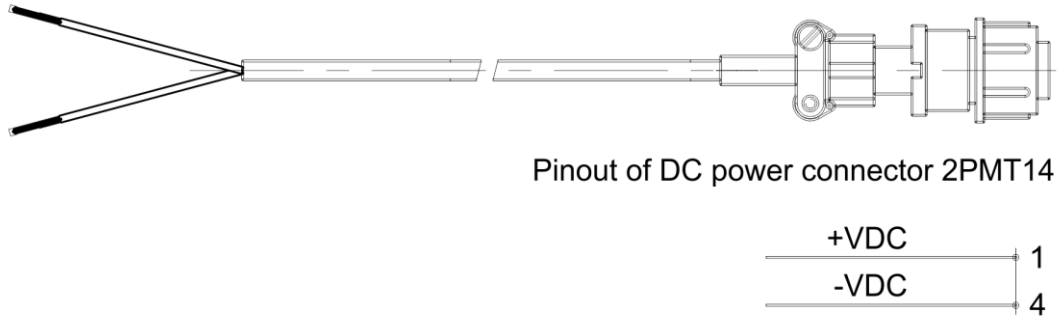
Connectors, indicators and control elements located on front and rear panels (see Fig. 3.1 and Table 3.1).

**Table 3.1**

Position (Fig.3.1)	Designation	Destination
1	NORM	Normal output signal indicator
2	ERROR	Wrong output signal indicator
3		LCD indicator to show information about working modes and parameters
4		Keyboard to set working modes and parameters
5	220 V	AC power indicator
6	27 V	DC power indicator
7	⊖ 1 Hz	External 1 PPS signal input
8	⊕ 1 PPS-1, ⊕ 1 PPSz-2	1 PPS signal outputs
9	⊕ 5 MHz	Sine-form 5 MHz signal output
10	⊕ 10 MHz-1	Sine-form 10 MHz signal output
11	⊕ 100 MHz	Sine-form 100 MHz signal output
12	⊖ fy, ⊖ fz, ⊖ fv, ⊖ fw,	Input signal's ports
13	⊖ Ey, ⊖ Ez, ⊖ Ev, ⊖ Ew	ERROR signal's ports
14	RS-232	Serial RS-232C port
15	USB	USB interface port
16	POWER	AC power switch
17	~ 220 V 50 Hz 50 V·A	AC power port
18	SUPPLY	Internal power indicator
19	== 22...32V	DC power port
20	F 3,15 A L 250 V	Protection Fuse
21	⊕	Ground port
22	ERROR	Output of wrong output signal notification
23	685670.176	Cable jumper (connects ⊖ fx and ⊕ 10 MHz-2)
24	685670.247	Cable jumper (connects ⊕ LO and ⊖ LO)

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To provide the Combiner with DC power supply you should make DC power connecting cord using DC power connector 2PMT14 in Combiner set composition (see Fig. 3.2).



**Fig 3.2** – DC power connecting cord

## 4 Operation

### 4.1 Turning on

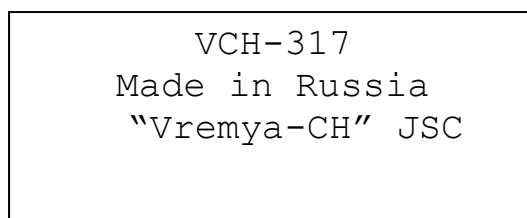
Supply (220 – 240) V AC, 50/60 Hz power by power connecting cord.

Ensure that this power supply cord is connected to a properly grounded mains receptacle.

If you need to supply DC power use DC power connecting cord, see Chapter 3, Fig. 3.2.

Press “Power” switch on the rear panel, then green LED located on the front panel, labeled “220 V”, should light up. When DC voltage source is switched on indicator “27 V” should light.

After that message according to Fig. 4.1 appears on LCD for 5 seconds. Indicator “NORM” doesn’t light, indicator “ERROR” is flashing.



**Fig. 4.1**

Then next “Channels status” window appears (Fig. 4.2). The window indicates that the Combiner is in warm-up mode now. The first line shows the time remaining to the end of warm-up mode. Total warming up time (warm-up time) is 4 hours. The second line indicates current time.

Warming up 03:57:59				
08:53:38				
Chan.	1	2	3	4
Status	*	*	*	*

**Fig. 4.2**

Symbol “\*” in “Channels status” line shows that there is no signal at the input.

Supply input signals (for example to the connectors “⊖fy”, “⊖fz”, “⊖fv”). Symbol “\*” in line “Status” for channels “1”, “2” and “3” changes to sign “–” (Fig. 4.3). It means that there are signals at the inputs but they are not used in signal group (synchronizing group) and output signal is not synchronized.

You should remember that:

- input “⊖fy” corresponds to channel 1;
- input “⊖fz” corresponds to channel 2;
- input “⊖fv” corresponds to channel 3;

- input “ $\ominus$ fw” corresponds to channel 4.

Warming up 03:57:59				
08:53:38				
Chan.	1	2	3	4
Status	-	-	-	*

**Fig. 4.3**

After warm up time has been finished “Channels status” window corresponds to Fig. 4.4.

PPL is off				
12:59:41				
Chan.	1	2	3	4
Status	-	-	-	*

**Fig. 4.4**

Then you should set output signal’s parameters. And lock PLL according Section 4.2.

All specifications are guaranteed after four-hours warm-up time.

## 4.2 Output signal synchronization

Go to the main menu (see Fig. 4.5).

### Note

If the “Channels status” window (see Fig. 4.4) is displayed on the LCD, press the "ENTER" key to go to the main menu.

VCH-317	
1.Monitoring	
2.Control	
3.Information	

**Fig. 4.5**

Press key “2” in main menu to display “Control” menu (see Fig. 4.6).

Control	
1.PLL	4.Data/Time
2.Phase	5.Settings
3.1PPS	6.Journal

**Fig. 4.6**

Press key “1” in “Control” menu to display “PLL control” menu (see Fig. 4.7).

PLL control (A)				PLL control (S)			
1.Mode		4.Offset		1.Mode		4.Offset	
2.Group		5.Trend		2.Group		5.Trend	
3.Priority		6.Lock		3.Priority		6.Lock	

**Menu in the "Averaging" mode**                      **Menu in the "Switching" mode**

**Fig. 4.7**

Press key “1” in “PLL control” menu to display the “Mode setting” window (see Fig. 4.8) and set operating mode (see Section 5.3.1.1).

Mode setting	
* 1. Averaging	
2. Switching	

**Fig. 4.8**

Combiner's control in the "Switching" mode is described in p. 4.2.1.  
Combiner's control in the "Averaging" mode is described in p. 4.2.2.

#### 4.2.1 Output signal synchronization in the "Switching" mode.

Press key “2” and “ENTER” in “Mode set” window to select "Switching" mode. To return to “PLL control” menu press key “SHIFT” or press key “ENTER”.

Press key “2” in “PLL control” menu to open the “Group control” window (see Fig. 4.9.1 – 4.9.4) and include input signals into signal group (see Section 5.3.1.2).

Group control (S)				
Channel	1	2	3	4
Status	–	–	–	*
Command	■	.	.	×

**Fig. 4.9.1**

Group control (S)				
Channel	1	2	3	4
Status	–	–	–	*
Command	+	–	+	×

**Fig. 4.9.2**

Group control (S)				
Channel	1	2	3	4
Status	Q	–	Q	*
Command	■	.	.	×

**Fig. 4.9.3**

Group control (S)				
Channel	1	2	3	4
Status	+	–	B1	*
Command	■	.	.	×

**Fig. 4.9.4**

**Note**

The example of output signal synchronization is described for the condition of supplying three input signals (channels 1, 2 and 3)

In this example channel 1 and channel 3 should be included into signal group.

Press key “3” in “PLL control” menu to open the “Priority setting” window (see Fig. 4.10) and set priority for every channel (see Section 5.3.1.3).

Priority setting				
Channel	1	2	3	4
Priority	1	2	3	4
	.	.	.	.

**Fig. 4.10**

In this example channel 1 should have priority value “1”, channel 2 should have priority value “2”, channel 3 should have priority value “3” and channel 4 should have priority value “4”.

If necessary to change frequency offset, press key “4” in “PLL control” menu to open the “Frequency offset” window (see Fig. 4.11) and set new value of Frequency offset (see Section 5.3.1.4).

Frequency offset	
0.0	
+	_____e-____
Set value & ENTER	

**Fig. 4.11**

If necessary to change frequency trend, press key “5” in “PLL control” menu to open the “Frequency trend” window (see Fig. 4.12) and set new value of Frequency trend (see Section 5.3.1.5).

Frequency trend	
0.0 /day	
+	_____e-____/day
Set value & ENTER	

**Fig. 4.12**



Press key “6” in “PLL control” menu to open the “Lock” window (see Fig. 4.13.1, 4.13.2) and turn on PLL lock (see Section 5.3.1.6).

```

Lock (A)
      -
      .
For lock incl.signal

```

Window “Lock” in the "Averaging" mode

**Fig. 4.13.1**

```

Lock (S)
Master 1      -
      .
For lock incl.signal

```

Window “Lock” in the "Switching" mode

**Fig. 4.13.2**

Return to “Channels status” window (press key “SHIFT” four times).

“Channels status” window, for this example, is shown on Fig. 4.14.1.

In the first line on the right it is shown time in seconds remaining to the end of primary signal analysis mode (see Fig. 4.14.1). When “NORM” indicates, the Combiner produces output signal of high quality. However error of signal including/excluding is not guaranteed up to the end of primary signal analysis (see item 7.8)

```

Signals analysis498s
      13:40:58
Chan.  1  2  3  4
Status +  -  B1 *

```

**Fig. 4.14.1**

```

Switching
      13:53:38
Chan.  1  2  3  4
Status +  -  B1  *

```

**Fig. 4.14.2**

Symbols “+” and “B1” in corresponding positions of line “Status” (see Fig. 4.14.1, 4.14.2) display that channels 1, 3 are included in signal group and channel 1 is Master input signal and channel 3 is backup.

After the finish of primary signal analysis “Channels status” window looks like on Fig. 4.14.2. In this state all of characteristics and functions are guaranteed when not less than three input signals are in signal group.

#### 4.2.2 Output signal synchronization in the "Averaging" mode.

Press key “1” in “PLL control” menu to display the “Mode setting” window (see Fig. 4.15) and set operating mode (see Section 5.3.1.1).

```

Mode setting
1. Averaging
* 2. Switching

```

**Fig. 4.15**

Press key “1” and “ENTER” in “Mode set” window to select "Averaging" mode. To return to “PLL control” menu press key “SHIFT” or press key “ENTER”.

Press key “2” in “PLL control” menu to open the “Group control” window (see Fig. 4.16.1) and include input signals into signal group (see Section 5.3.1.2). In this example, after channel 1 and channel 3 are included in the synchronization group, the "Group control" window will look like the one shown in Figure 4.16.2.

Group control (A)				
Channel	1	2	3	4
Status	–	–	–	*
Command	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	×

**Fig. 4.16.1**

Group control (A)				
Channel	1	2	3	4
Status	+	–	+	*
Command	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	×

**Fig. 4.16.2**

If necessary to change frequency offset, press key “4” in “PLL control” menu to open the “Frequency offset” window (see Fig. 4.11) and set new value of Frequency offset (see Section 5.3.1.4).

If necessary to change frequency trend, press key “5” in “PLL control” menu to open the “Frequency trend” window (see Fig. 4.12) and set new value of Frequency trend (see Section 5.3.1.5).

Press key “6” in “PLL control” menu to open the “Lock” window (see Fig. 4.17) and turn on PLL lock (see Section 5.3.1.6).

Lock (A) <div style="text-align: center;">– <input checked="" type="checkbox"/></div> For lock incl.signal
---

**Window “Lock” in the "Averaging" mode**

**Fig. 4.17**

Return to “Channels status” window (press key “SHIFT” four times).

“Channels status” window, for this example, is shown on Fig. 4.18.1, 4.18.2.

In the first line on the right it is shown time in seconds remaining to the end of signal primary analysis mode (see Fig. 4.18.1). When “NORM” indicates, the Combiner produces output signal of high quality. However signal including/excluding error is guaranteed after finish of primary signal analysis (see item 7.8)

Signals analysis 498s				
13:40:58				
Chan.	1	2	3	4
Status	+	-	+	*

**Fig. 4.18.1**

Averaging				
13:53:38				
Chan.	1	2	3	4
Status	+	-	+	*

**Fig. 4.18.2**

Symbols “+” in corresponding positions of line “Status” (see Fig. 4.18.1, 4.18.2) display that channels 1, 3 are included in synchronizing group.

After the finish of primary signal analysis “Channels status” window looks like on Fig. 4.18.2.

**Note**

All of characteristics and functions are guaranteed when not less than three input signals are in synchronizing group.

**4.3 Synchronizing group configuration**

User can connect new signals on free Combiner’s inputs (“ $\ominus$ fy”, “ $\ominus$ fz”, “ $\ominus$ fv”, “ $\ominus$ fw”) during operation.

After connecting the signal to input the Combiner starts measuring:

- RFD at measuring time 600 s;
- frequency instability – two sample Allan variance for averaging time 1 s and measuring time 30 s.

User can include corresponding channel into synchronizing group after estimating of measured input signal parameters and RFDIG limit (see Section 5.3.6 and 5.2.5).

If synchronizing group contains only one signal then new input signal is included into synchronizing group with any RFDIG value of new signal.

If synchronizing group contains two or three signals then new input signal is included into synchronizing group in condition that new signal RFDIG value doesn’t exceed RFDIG limit.

Command for including input signal into synchronizing group is introduced in Section 5.3.1.1. After command has been entered, window “Channels status” displays countdown to including input signal into synchronizing group – qualification process (see Fig. 4.20.1, Fig.4.20.2).

During qualification process the Combiner is measuring RFD of new signal. And after input signals qualification, in the moment of including of signals into new synchronizing group, the Combiner calculates weight ratio for all input signals in new synchronizing group and Frequency offset to save the same output signal frequency.

**Attention!** Disconnecting input signals from inputs “ $\ominus$ fy”, “ $\ominus$ fz”, “ $\ominus$ fv”, “ $\ominus$ 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.

If the signal connected to the input has a large frequency difference relative to the output signal, then a negative effect of this signal on the output signal due to the PFM is possible, even if this signal is not included in the qualification or in the group.

**Including channel 2 into synchronizing group** (as example).

Open “Group control” window (follow instruction of section 5.3.1.2).

Line “Status” in the "Averaging" mode displays that (see Fig. 4.19.1):

- channels 1 and 3 are included in synchronizing group (symbols “+” in corresponding positions of this line);
- channel 2 isn’t included in synchronizing group (symbols “–” in corresponding position of this line).

Line “Status” in the "Switching" mode displays that (see Fig. 4.19.2):

- channels 1 and 3 are included in signal group (symbols “+” and “B1” in corresponding positions of this line); Channel 3 is in reserve and is not involved in adjusting the output signal.
- channel 1 is Master input signal (symbols “+” in corresponding position of this line);
- channel 2 isn’t included in signal group (symbols “–” in corresponding position of this line).

Group control (A)				
Channel	1	2	3	4
Status	+	–	+	*
Command	█	.	.	×

**Fig. 4.19.1**

Group control (S)				
Channel	1	2	3	4
Status	+	–	B1	*
Command	█	.	.	×

**Fig. 4.19.2**

To include channel 2 into synchronizing (signal) group (see Fig. 4.19.1, 4.19.2):

- move cursor to second position (by pressing “2” or “→”, “←”) in line “Command” (this position corresponds channel 2);
- press key “+” and key “ENTER”.

After that symbol “Q” changes symbol “–” in second position of line “Status”. It means start of qualification for channel 2 (see Fig. 4.19.3, 4.19.4).

Group control (A)				
Channel	1	2	3	4
Status	+	Q	+	*
Command	█	.	.	×

**Fig. 4.19.3**

Group control (S)				
Channel	1	2	3	4
Status	+	Q	B1	*
Command	█	.	.	×

**Fig. 4.19.4**

**Note**

If you go to window “Channels status” during qualification process, second line of this window displays countdown of qualification for this channel instead current time (see Fig. 4.20.1, 4.20.2).

Averaging				
382				
Chan.	1	2	3	4
Status	+	Q	+	*

**Fig. 4.20.1**

Switching				
382				
Chan.	1	2	3	4
Status	+	Q	B1	*

**Fig. 4.20.2**

The length of the qualification time is 600 s. When qualification in the "Averaging" mode has been finished, symbol “Q” (second position of line “Status”) is changed by symbol “+”, it means channel 2 was included into synchronizing group (see Fig. 4.20.3).

When qualification in the "Switching" mode has been finished, symbol “Q” (position corresponds channel 2 of line “Status”) is changed by symbol “B1”, “B2”, “B3” (depends on channel priorities), it means channel 2 is included into signal group и будет в резерве (see Fig. 4.20.4).

Channel priorities can be changed if necessary (see p. 5.3.1.3).

Averaging				
13:53:38				
Chan.	1	2	3	4
Status	+	+	+	*

**Fig. 4.20.3**

Switching				
13:53:38				
Chan.	1	2	3	4
Status	+	B1	B2	*

**Fig. 4.20.4****Exclusion signal out of synchronizing group**

Exclusion signal out of synchronizing group can be made by user or automatically.

Command of signal exclusion performs immediately after setting in window “Group control”.

Input signal is excluded automatically out of synchronizing group if:

- input signal disappears;
- RFDIG limit of input signal is exceeded (for three or four signals in signal group and if the end of primary signals analysis is finished);
- signal “ERROR” from the input source of the RF signal atomic clock appears.

With “ERROR” signal on inputs “ $\ominus E_y$ ”, “ $\ominus E_z$ ”, “ $\ominus E_v$ ”, “ $\ominus E_w$ ” corresponding channel is excluded out of synchronizing group (see Fig. 4.21.1, 4.21.2). Look for “ERROR” signal parameters in Section 7.9.

Averaging				
13:53:38				
Chan.	1	2	3	4
Status	+	E	+	*

**Fig. 4.21.1**

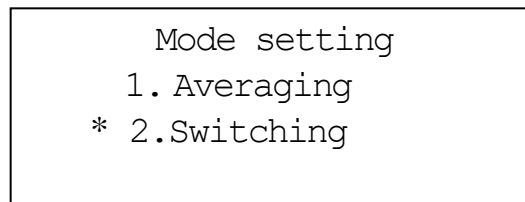
Switching				
13:53:38				
Chan.	1	2	3	4
Status	+	E	B1	*

**Fig. 4.21.2**

#### 4.4 Operating mode change

Operating mode can be changed when PLL lock on and when PLL lock off.

Press key “1” in “PLL control” menu to display the “Mode setting” window (see Fig. 4.22) and change operating mode (see Section 5.3.1.1).



**Fig. 4.22**

If PLL lock on, the changing will occur "on the fly" with the necessary frequency offset correction, while the output signal frequency will change no more than the error in measuring the frequency of the input signals.

**Note**

Mode changing "on the fly" is possible only after completion of primary analysis mode.

When switching from "Averaging" mode to "Switching" mode, the Combiner works with previously set priorities.

#### 4.5 Remote control and monitoring

Connect the Combiner to PC with RS-232 interface cable 685670.026 or Interface cable USB 2.0 AM/BM-1.8M.

Run the program “Monitor VCH-317” on PC.

For information about the program “Monitor VCH-317” read Microstepper Combiner Synthesizer VCH-317 Remote Control Operational Manual RU.ЯКУР.00144-01 34 01-2.

## 5 Local control and monitoring description

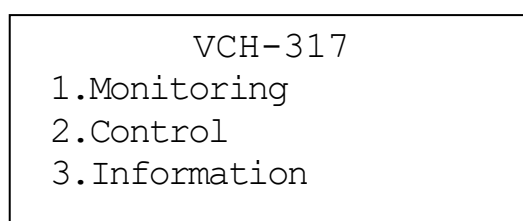
### 5.1 Main menu

In order to go to the main menu of the Combiner from “Channels status” window (Fig. 5.1) press “ENTER” key.

**Note**

In order to go to the “Channels status” window from any window press “SHIFT” key several times.

View of the main menu is shown in Fig. 5.1.



**Fig. 5.1**

**General note**

Key “SHIFT”:

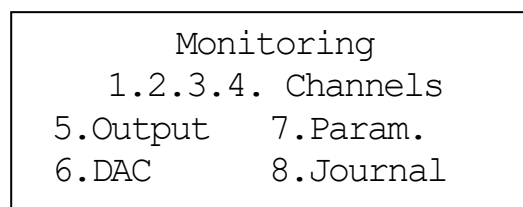
- cancels execution of incomplete command;
- causes transfer to previous menu;
- causes transfer to previous window.

Key “ENTER”:

- causes execution of command;
- causes transfer to next window.

### 5.2 “Monitoring” menu

“Monitoring” menu allows to monitor current state of the Combiner. Press key “1” in main menu to display “Monitoring” menu (Fig. 5.2).



**Fig. 5.2**

**Note**

Examples of the “Monitoring” menu written below are explained for the following input signals configuration:



- signals are supplied to Combiner inputs “ $\ominus fy$ ”, “ $\ominus fz$ ”, “ $\ominus fv$ ” (channels 1, 2, 3 accordingly);
- signal (synchronizing) group includes input signals “ $\ominus fy$ ”, “ $\ominus fv$ ” (channels 1, 3 accordingly), see Section 4.2 .

### 5.2.1 Channels monitoring

Press key “1” in “Monitoring” menu to display “Channel 1 (Y)” window (Fig. 5.3, 5.4 ).

Press keys “2” in “Monitoring” menu to display “Channel 2 (Z)” window (Fig. 5.3, 5.4).

Press keys “3” in “Monitoring” menu to display “Channel 3 (V)” window (Fig. 5.3, 5.4).

Press keys “4” in “Monitoring” menu to display “Channel 4 (W)” window (Fig. 5.3, 5.4).

These windows display channel parameters: Status, Priority, Weight, RFD, Dev.(1s), RFDIG.

The Figures 5.3, 5.5 show the examples of “Channels monitoring” menu in the "Averaging" mode.

“Channel 1 (Y)” and “Channel 3 (V)” windows ( Fig. 5.3) display that input signals are connected to inputs “ $\ominus fy$ ”, “ $\ominus fv$ ” and channels 1, 3 are included in synchronizing group. Output signal synchronization is realized with these channels (weights for channels 1 and 3 are 0.5 both).

“Channel 2 (Z)” window (Fig. 5.3) displays that channel 2 is in qualification. Countdown in first line displays time remaining for channel 2 (input signal “ $\ominus fz$ ”) to be included into synchronizing group.

“Channel 4 (W)” window (Fig. 5.3) displays that there is no signal at input “ $\ominus fw$ ”.

Press key “↓” to view values of RFD, Dev.(1s), RFDIG for corresponding channel.

As for example – Fig. 5.5 shows values of RFD, Dev.(1s), RFDIG for channels 1 and 3 in the "Averaging" mode.

Channel 1 (Y) Status = Include Priority= 1 Weight = 0.5	Channel 3 (V) Status = Include Priority= 3 Weight = 0.5
Channel 2 (Z) 568s Status = Qualific. Priority= 2 Weight = 0	Channel 4 (W)  No signal

**Fig. 5.3**

The Figure 5.4 shows the examples of “Channels monitoring” menu in the "Switching" mode.

“Channel 1 (Y)” and “Channel 3 (V)” windows (Fig. 5.4) display that input signals are connected to inputs “ $\ominus$ fy”, “ $\ominus$ fv” and channels 1, 3 are included in signal group. Output signal synchronization is realized with channel 1 (weight for channel 1 is “1” and weight for channel 3 is “0”).

“Channel 2 (Z)” window (Fig. 5.4) displays that channel 2 is in qualification. Countdown in first line displays time remaining for channel 2 (input signal “ $\ominus$ fz”) to be included into signal group (reserve group).

“Channel 4 (W)” window (Fig. 5.4) displays that there is no signal at input “ $\ominus$ fw”.

Channel 1 (Y) Status = Include Priority= 1 Weight = 1	Channel 3 (V) Status = Reserve 1 Priority= 3 Weight = 0
Channel 2 (Z) 568s Status = Qualific. Priority= 2 Weight = 0	Channel 4 (W)  No signal

**Fig. 5.4**

Channel 1 (Y) RFD = + 1.123e-13 Dev.(1s)= 2.34e-13 RFDIG = + 1.123e-13	Channel 3 (V) RFD = + 1.523e-13 Dev.(1s)= 2.58e-13 RFDIG = + 3.425e-13
---	---

**Fig. 5.5**

### 5.2.2 Output signal monitoring

Press key “5” in “Monitoring” menu to display “Output signal” window (Fig. 5.6).

Output signal Lock + 518 s Offset=+1.23455e-13 Trend=+1.23455e-14
--

**Fig. 5.6**

Countdown in second line displays time remaining to the end of signals primary analysis mode. Symbol “+” displays PLL lock.

**Note**

If programmed linear frequency trend of output signal ("Trend") is not equal to zero, then frequency offset ("Offset") changes in proportion to trend.

**5.2.3 DAC monitoring**

Press key "6" in "Monitoring" menu to display "DAC" window (Fig. 5.7).

"DAC" window shows code of "coarse" ("DAC 1") and "fine" ("DAC 2") digital to analog convertors. DAC codes ranges from 0 up to 65535.

**Note**

If DAC 2 in PLL lock mode is near 0 or 65535 then DAC 2 correction takes place. In this case DAC 1 changes its code a slowly to set DAC 2 in the middle of range (code 32766).

DAC	
DAC 1 =	43897
DAC 2 =	23567

**Fig. 5.7****5.2.4 Parameters monitoring**

Press key "7" in "Monitoring" menu to display "Params monitoring" window (Fig. 5.8).

Params monitoring	
1.1PPS	4.Voltmeter
2.Time	5.PID fact.
3.RFDIG	limit

**Fig. 5.8**

Press key "1" in "Params monitoring" menu to display "Monitoring 1PPS" window.

If there is an external 1 PPS signal on the input connector "⊖ 1 Hz", the "Monitoring 1PPS" window displays the time delay of 1 PPS output signal relative to the external 1 PPS signal (Fig. 5.9).

Monitoring 1PPS	
dT =	-20 ns

**Fig. 5.9**

If there is no an external 1 PPS signal on the input connector "⊖ 1 Hz", then "Monitoring 1PPS" window displays message "No synchronizing signal" (Fig. 5.10).

```
Monitoring 1PPS

No synchronizing
  signal
```

**Fig. 5.10**

Press key "2" in "Params monitoring" menu to display "Monitoring Date/Time" window. "Monitoring Date/Time" window displays the current date and time set in the Combiner (Fig. 5.11).

```
Monitoring Date/Time
      06/03/19
      11:14:35
```

**Fig. 5.11**

Press key "3" in "Params monitoring" menu to display "RFDEG limit" window. RFDIG limit is shown in this window. If RFDIG value of input signal exceeds RFDIG limit then input signal is excluded from synchronizing group. In this case, three or four input signals should be included in synchronizing group (Fig. 5.12).

```
RFDEG limit

1.000000e-11
```

**Fig. 5.12**

Press key "4" in "Params monitoring" menu to display "Voltmeter" window. Temperature inside Combiner and value of DC supply voltage are shown in this window (Fig. 5.13).

```
Voltmeter
Temper. = +38.7 °C
Ureserv = -0.0 V
```

**Fig. 5.13**

Press key “5” in “Params monitoring” menu to display “PID fact.” window. PID factors (Proportional, Integral, Derivative) are shown in this window (Fig. 5.14).

```

          PID factors
Prop.      2.00000e-01
Integr.    2.00000e-01
Deriv.     0.0

```

**Fig. 5.14**

### 5.2.5 Journal

Press key “8” in “Monitoring” menu to display “Journal” window (Fig. 5.15.1).

“Journal ” window displays (see Fig. 5.15.1):

- second line – total amount of events (on the left), number of last viewed event (on the right);
- third line – date and time of the first event;
- fourth line – date and time of the last event.

```

          Journal
all 7 # 6
beg10/07/17 15:48:56
end19/07/17 13:46:16

```

**Fig. 5.15.1**

Press key “↓” or “↑” to choose event number, here it is shown general event information – date, time, name, reason (see Fig. 5.15.2).

```

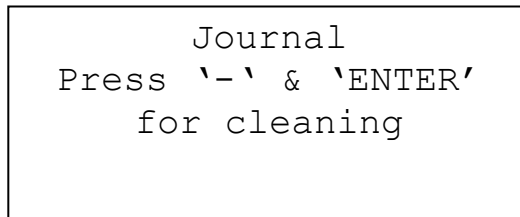
Event #    7
      10/07/17 15:48:56
Unit switching on

```

**Fig. 5.15.2**

All information about event is divided into four windows – “Data 1”, “Data 2”, “Data 3”, “Data 4”. Press key “ENTER” or keys “→”, “←” to read more information about this event.

**Journal cleaning** – press key “6” in “Control” menu to display “Journal” window (Fig. 5.16).



```
Journal
Press \-\' & \'ENTER\'
for cleaning
```

**Fig. 5.16**

Then press key “—” and “ENTER” for Journal cleaning as written in the window.

### 5.3 “Control” menu

Press key “2” in main menu to display “Control” menu (Fig. 5.17).

“Control” menu allows:

- to change output signal parameters;
- to adjust output signal phase;
- to synchronize 1 PPS signal by external signal;
- to set date and time in the Combiner;
- to change RFDIG limit;
- to choose menu language;
- Journal cleaning

Control	
1.PLL	4.Data/Time
2.Phase	5.Settings
3.1PPS	6.Journal

**Fig. 5.17**

#### 5.3.1 “PLL control” menu

Press key “1” in “Control” menu to display “PLL control” menu (Fig. 5.18).

“PLL” menu allows:

- to set work mode;
- to change configuration of signal group;
- to adjust output signal frequency relative to synchronizing group mean frequency;
- to set linear frequency trend of output signal;
- to switch on PLL lock under synchronizing group frequency.

PLL control (A)		PLL control (S)	
1.Mode	4.Offset	1.Mode	4.Offset
2.Group	5.Trend	2.Group	5.Trend
3.Priority	6.Lock	3.Priority	6.Lock

**Menu in the "Averaging" mode**

**Menu in the "Switching" mode**

**Fig. 5.18**

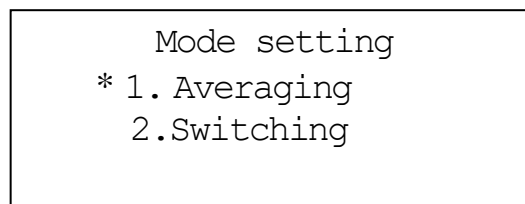
First line of “PLL control” menu displays (see Fig. 5.18):

- menu name – “PLL control”;
- mode indicator – (A) "Averaging" mode or (S) "Switching" mode.

### 5.3.1.1 “Mode setting” window

Press key “1” in “PLL control” menu to display “Mode setting” window (Fig. 5.19).

Press key “1” and “ENTER” in “Mode setting” window to set "Averaging" mode or press key “2” and “ENTER” in “Mode set” window to select "Switching" mode.



**Fig. 5.19**

Combiner's mode is indicated by the symbol "\*" opposite the corresponding line.

#### Note

The selected, but not set, mode is indicated by the "+" symbol opposite the corresponding line. To set the selected mode, press “ENTER”.

To return to “PLL control” menu press key “SHIFT” or press key “ENTER” again.

### 5.3.1.2 “Group control” window

Press key “2” in “PLL control” menu to display “Group control” window (Fig. 5.20.1 – 5.20.8).

First line of “Group control” window displays:

- menu name – “Group control”;
- mode indicator – (A) "Averaging" mode or (S) "Switching" mode.

The Fig. 5.20.1 – 5.20.4 show the examples of “Group control” window in the "Averaging" mode.

Second line (“Status”) of “Group control” window (see Fig. 5.20.1) displays:

- symbol “–” in cells corresponding channels 1, 2, 3 – it means input signals are connected to inputs “ $\ominus_{fy}$ ”, “ $\ominus_{fz}$ ”, “ $\ominus_{fv}$ ” and channels 1, 2, 3 are not included in synchronizing group;
- symbol “\*” in cell corresponding channel 4 – it means input signal is not connected to input “ $\ominus_{fw}$ ” and channel 4 is not included in synchronizing group.

To change channel status set cursor near channel number by pressing corresponding digit or using “←”, “→” keys.

Press key “+” in “Command” line for channels you are going to use in synchronizing group. Press key “–” in “Command” line for channels you are going to exclude from synchronizing group (Fig. 5.20.2).

Enter the command by pressing “ENTER”. And several seconds later symbol “Q” for channels programmed to include appears (see Fig. 5.20.3).



In the examples shown in the Fig. 5.20.2 and 5.20.3, channels 1, 3 are intended to be included in the synchronizing group.

Third line ("Status") of "Group control" window (see Fig. 5.20.3) displays:

- symbol "Q" in cells corresponding channels 1, 3 – it means input signals are connected to inputs "⊖fy", "⊖fv" and channels 1, 3 are in the state of qualification and is not included yet in synchronizing group;
- symbol "–" in cell corresponding channels 2 – it means input signals is connected to input "⊖fz" and channel 2 is not included in synchronizing group;
- symbol "\*" in cell corresponding channel 4 – it means input signal is not connected to input "⊖fw" and channel 4 is not included in synchronizing group.

Group control (A)				
Channel	1	2	3	4
Status	–	–	–	*
Command	■	.	.	×

**Fig. 5.20.1**

Group control (A)				
Channel	1	2	3	4
Status	–	–	–	*
Command	+	–	+	×

**Fig. 5.20.2**

Group control (A)				
Channel	1	2	3	4
Status	Q	–	Q	*
Command	■	.	.	×

**Fig. 5.20.3**

Group control (A)				
Channel	1	2	3	4
Status	+	–	+	*
Command	■	.	.	×

**Fig. 5.20.4**

When the auto-loop is closed, the "Group control" window will look like the one shown in Figure 5.20.4.

#### Note

To include channels in synchronizing group it's necessary do PLL lock on (see p.5.3.1.6).

Third line ("Status") of "Group control" window displays:

- symbol "+" in cells corresponding channels 1, 3 – it means input signals are connected to inputs "⊖fy", "⊖fv" and channels 1, 3 are included in synchronizing group;
- symbol "–" in cell corresponding channel 2 – it means input signals is connected to input "⊖fz" and channel 2 is not included in synchronizing group;
- symbol "\*" in cell corresponding channel 4 – it means input signal is not connected to input "⊖fw" and channel 4 is not included in synchronizing group.

The Fig. 5.20.5 – 5.20.8 show the examples of "Group control" window in the "Switching" mode.

Third line ("Status") of "Group control" window ( see Fig. 5.20.5) displays:

- symbol “-” in cells corresponding channels 1, 2, 3 – it means input signals are connected to inputs “ $\ominus fy$ ”, “ $\ominus fz$ ”, “ $\ominus fv$ ” and channels 1, 2, 3 are not included in signal group;
- symbol “\*” in cell corresponding channel 4 – it means input signal is not connected to input “ $\ominus fw$ ” and channel 4 is not included in signal group.

To change channel status set cursor near channel number by pressing corresponding digit or using “←”, “→” keys.

Press key “+” in “Command” line for channels you are going to use in signal group. Press key “-” in “Command” line for channels you are going to exclude from signal group (Fig. 5.20.6).

Enter the command by pressing “ENTER”. And several seconds later symbol “Q” for channels programmed to include appears (see Fig. 5.20.7).

In the examples shown in the Fig. 5.20.6 and 5.20.7, channels 1, 3 are intended to be included in the signal group.

Third line (“Status”) of “Group control” window ( see Fig. 5.20.7) displays:

- symbol “Q” in cells corresponding channels 1, 3 – it means input signals are connected to inputs “ $\ominus fy$ ”, “ $\ominus fv$ ” and channels 1, 3 are in the state of qualification and is not included yet in signal group;
- symbol “-” in cell corresponding channels 2 – it means input signals is connected to input “ $\ominus fz$ ” and channel 2 is not included in signal group;
- symbol “\*” in cell corresponding channel 4 – it means input signal is not connected to input “ $\ominus fw$ ” and channel 4 is not included in signal group.

Group control (S)				
Channel	1	2	3	4
Status	-	-	-	*
Command	.	.	.	x

**Fig. 5.20.5**

Group control (S)				
Channel	1	2	3	4
Status	-	-	-	*
Command	+	-	+	x

**Fig. 5.20.6**

Group control (S)				
Channel	1	2	3	4
Status	Q	-	Q	*
Command	.	.	.	x

**Fig. 5.20.7**

Group control (S)				
Channel	1	2	3	4
Status	+	-	B1	*
Command	.	.	.	x

**Fig. 5.20.8**

When the auto-loop is closed, the "Group control" window will look like the one shown in Figure 5.20.8.

Third line (третья) (“Status”) of “Group control” displays:

- symbol “+” in cell corresponding channel 1 – it means input signal is connected to inputs “ $\ominus fy$ ” and channel 1 is included in synchronizing group;

- symbol “–“ in cell corresponding channel 2 – it means input signals is connected to input “ $\ominus fz$ ” and channel 2 is not included in synchronizing group;
- symbol “B1“ in cell corresponding channel 3 – it means input signal is connected to input “ $\ominus fv$ ” and input signal in channel 3 is in reserve and is not involved in adjusting the output signal and is the next highest priority input signal;
- symbol “\*“ in cell corresponding channel 4 – it means input signal is not connected to input “ $\ominus fw$ ” and channel 4 is not included in synchronizing group.

**Note**

To include channels in signal group it's necessary do PLL lock on (see p.5.3.1.6).

Before including channels in signal group it's necessary pay attention priority for each channel (see p.5.3.1.3).

**Note**

In "Averaging" mode press key “ENTER” to display “Frequency offset” window.

In "Switching" mode press key “ENTER” to display “Priority setting” window.

To return to menu “PLL control” press key “SHIFT”.

**5.3.1.3 “Priority setting” window**

Press key “3” in “PLL control” menu to display “Priority setting” window (Fig. 5.21.1, 5.21.2).

**Note**

Channel priorities are only used in "Switching" mode. Although channel priority setting can be performed both in "Averaging" mode and in "Switching" mode.

Window “Priority setting ” displays:

- second line (“Channel”) – channel numbers;
- third line (“Priority”) – previously set priority value.

To set the priority for every channel set the priority value in cell of corresponding channel (lower line of “Priority setting” window) and press key “ENTER”.

After the command is executed, the new priority values are displayed in the third line of “Priority setting” window.

Priority setting				
Channel	1	2	3	4
Priority	1	2	3	4
	•	•	•	•

**Fig. 5.21.1**

Priority setting				
Channel	1	2	3	4
Priority	1	2	2	3
Values duplicated				

**Fig. 5.21.2**

If entered priority value is the same for several channels, then message – “Value duplicated” appears in lower line of “Priority setting” window (see Fig. 5.21.2).

### Note

If the transition to the "Priority setting" window was made from the "PLL control" window, press key “ENTER” or “SHIFT” to return to the "PLL control" window.

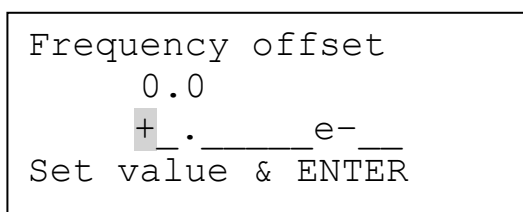
If the transition to the "Priority setting" window was made from the "Group control" window, press key “SHIFT” to return to the "Group control" window or press key “ENTER” to display “Frequency offset” window.

#### 5.3.1.4 “Frequency offset” window

Press key “4” in “PLL control” menu to display “Frequency offset” window (Fig. 5.22.1, 5.22.2).

Window “Frequency offset” displays:

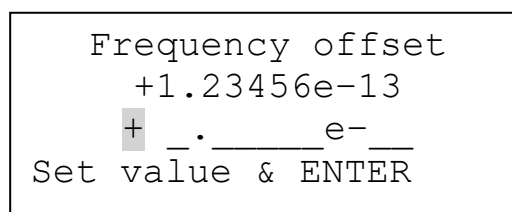
- second line – real value of Frequency offset (default value – 0);
- third line – for new value setting.



```

Frequency offset
  0.0
+ . . . e-
Set value & ENTER
  
```

**Fig. 5.22.1**



```

Frequency offset
+1.23456e-13
+ . . . e-
Set value & ENTER
  
```

**Fig. 5.22.2**

Frequency offset range:

- from  $+1.00000e-8$  up to  $+1.00000e-18$ ;
- number 0;
- from  $-1.00000e-18$  up to  $-1.00000e-8$ .

Write new value of Frequency offset in third line of “Frequency offset” window and press key “ENTER” (Fig. 5.22.1). After that new value of Frequency offset will be displayed in second line (Fig. 5.22.2).

If entered value is wrong, then message – “Value out of range” appears on “Frequency offset” window.

Press “SHIFT” for deleting incorrectly written new value.

### Note

If the transition to the "Frequency offset" window was made from the "PLL control" window, press key “ENTER” or “SHIFT” to return to the "PLL control" window.

If the transition to the "Frequency offset" window was made from the "Group control" window or “Priority setting” window, press key “SHIFT” to return to the previous window or press key “ENTER” to display "Frequency trend" window.

### 5.3.1.5 “Frequency trend” window

Press key “5” in “PLL control” menu to display “Frequency trend” window (Fig. 5.23.1, 5.23.2).

“Frequency trend” window:

- second line – real value of Frequency trend (default value – 0);
- third line – for new value setting.

Frequency trend range:

- from  $+8.64000\text{e-}12$  up to  $+1.00000\text{e-}18$ ;
- number 0;
- from  $-1.00000\text{e-}18$  up to  $-8.64000\text{e-}12$ .

Write new value of Frequency trend in third line of “Frequency trend” window and press key “ENTER” (Fig. 5.23.1). After that new value of Frequency trend will be displayed in second line (Fig. 5.23.2).

If entered value is wrong, then message – “Value out of range” appears on “Frequency trend” window.

Press “SHIFT” for deleting incorrectly written new value.

```

Frequency trend
0.0          /day
+ _ . _____ e- ____ /day
Set value & ENTER
  
```

**Fig. 5.23.1**

```

Frequency trend
+1.23456e-14/day
+ _ . _____ e- ____ /day
Set value & ENTER
  
```

**Fig. 5.23.2**

#### Note

If the transition to the "Frequency trend" window was made from the "PLL control" window, press key “ENTER” or “SHIFT” to return to the "PLL control" window.

If the transition to the "Frequency trend" window was made from the "Frequency offset" window or “Lock” window, press key “SHIFT” to return to the "Frequency offset" window or press key “ENTER” to display “Lock” window.

### 5.3.1.6 “Lock” window

This window function allows to switch on/off PLL lock and in the "Switching" mode, change the number of the Master input signal.

Press key “6” in “PLL control” menu to display “Lock” window (Fig. 5.24.1, 5.24.2).

Second line of “Lock” window (see Fig. 5.24.1, 5.24.2) can display:

- symbol “–” – it means synchronizing group not formed;
- symbol “+” – it means PLL lock ;
- symbols “Master “ – it means number of the Master input signal (only for "Switching" mode);

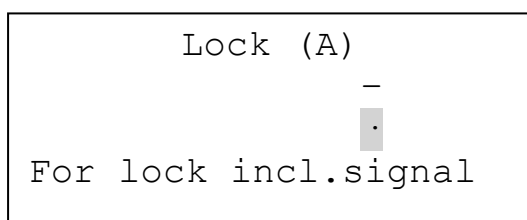
Countdown in second line displays time remaining to the end of signals primary analysis mode (see Fig. 5.24.3).

To PLL lock set symbol “+” in corresponding cell of third line and press key “ENTER”. After that symbol “+” changes symbol “-” in second line. After that green LED “NORM”, located on the front panel, should light up and Combiner operates in signals primary analysis mode (during 600 s) and countdown displays time remaining to the end of signals primary analysis mode (Fig. 5.24.3).

#### Note

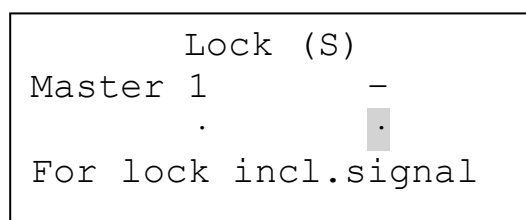
For PLL lock it is necessary to have one and more signals in state of qualification.

If synchronizing group contains only one input signal, then green LED “NORM”, should flash warning that input signal reserving is absent.



Window “Lock” in the "Averaging" mode

**Fig. 5.24.1**

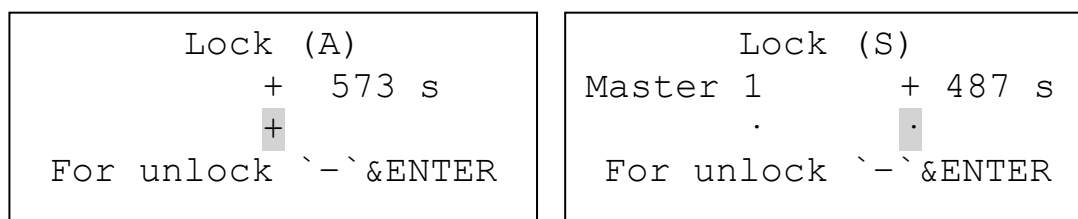


Window “Lock” in the "Switching" mode

**Fig. 5.24.2**

#### Attention!

During primary signals analysis mode: it's forbidden to exclude and include input signals till countdown has finished.



**Fig. 5.24.3**

If you need to turn off PLL press key “-” and then “ENTER”.

#### Note

If the transition to the "Lock" window was made from the "PLL control" window, press key “ENTER” or “SHIFT” to return to the "PLL control" window.

If the transition to the "Lock" window was made from the "Frequency trend" window, press key “SHIFT” to return to the "Frequency trend" window or press key “ENTER” to display “PLL control” window.

### 5.3.2 Output signal phase correction

Press key “2” in “Control” menu to display “Phase correction” window (Fig. 5.25.1 – 5.25.3).

```

Phase correction

dt=+_ _ _ _ _ ps
Set dt & press ENTER

```

**Fig. 5.25.1**

When programmed phase shift of output signals (dt) has been entered, output signals phase correction goes and the “Phase correction” window looks like shown on Fig. 5.25.2.

```

Phase correction

25s
dt=+028 018ps
Wait!

```

**Fig. 5.25.2**

Second line (see Fig. 5.25.2) displays countdown remaining to the end of output signal phase correction. When output signal phase correction is finished the last line of window shows “Correct. has finished” message. Then last message changes to “Set dt & press ENTER” (see Fig. 5.25.3) and you will be able to set new “dt” value.

```

Phase correction

dt=+028 018ps
Set dt & press ENTER

```

**Fig. 5.25.3****Note**

Phase correction of output sine-form signals causes synchronous shift of output pulse signal “ $\odot$  1 Hz” to the same value.

**5.3.3 Synchronization of 1 PPS signal by external signal**

Supply the Combiner input “ $\odot$  1 Hz” with synchronizing signal from atomic clock.

Press key “3” in “Control” menu to display menu “1 PPS” (Fig. 5.26.1).

```

1 PPS
dT= 267 567 230 ns
.
For synch.'+' & ENTER

```

**Fig. 5.26.1**

Second line of “1 PPS” window displays current value of output signals “⊙1 PPS-1”, “⊙1 PPS-2” delay relative to input signal “⊙1 Hz”.

Press key “+” and “ENTER” for synchronization of output signals “⊙1 PPS-1”, “⊙1 PPS-2” as written in window. After this value “dT” must be in one of the ranges: from -20 ns to 20 ns;(-20...+20)

If synchronizing signal is absent on input “⊙1 Hz” then “1 PPS” window looks like Fig. 5.26.2.

```

1 PPS

No synchronizing
signal

```

**Fig. 5.26.2**

### 5.3.4 Date and time correction

Press key “4” in “Control” menu to display “Date/Time” window (Fig. 5.27).

“Date/Time” window (see Fig. 5.27):

- second line displays set current date and time;
- third line allows to set new date and time.

If date or time has been written incorrectly then press “SHIFT” and repeat setting again.

```

Date/Time
12/08/10 13:24:56
__/_/_/__ __:__:__
Set value & ENTER

```

**Fig. 5.27**

### 5.3.5 Settings changing

Press key “5” in “Control” menu to display menu “Settings” (Fig. 5.28).



```

      Settings
1.RFDIG  limit
2.Language
3.Reset parameters

```

**Fig. 5.28**

Press key “1” in “Settings” menu to display “RFDIG limit” window and set RFDIG limit (Fig. 5.29).

**Note**

If RFDIG value of input signal exceeds RFDIG limit then input signal will be excluded from signal group.

RFDIG limit is from  $1.00000e-13$  up to  $1.00000e-8$

```

      RFDIG limit
      5.00000e-12
      + _ . _____ e-__
      Set value & ENTER

```

**Fig. 5.29**

Press key “2” in “Settings” menu (Fig. 5.28) to display “Language” window. Menu “Language” (Russian or English) is set in this window.

Press key “3” in “Settings” menu (Fig. 5.28) to display “Reset parameters” window. Choose this option to make default settings.

**5.3.6 Journal cleaning**

Press key “6” in “Control” menu to display “Journal” window (Fig. 5.30).

```

      Journal
      Press '-' & 'ENTER'
      for cleaning

```

**Fig. 5.30**

After this press key “-” and “ENTER” for Journal cleaning as written in “Journal” window.

## 5.4 “Information” window

To open “Information” window press key “3” in main menu.

“Information” window (see Fig. 5.31.1) contains:

- in second line – serial number of the Combiner;
- in third line – control unit software version;
- in fourth line – control and indication unit software version.

Press key “↓” to see next part of “Information” window (see Fig. 5.31.2)

Next part of “Information” window (see Fig. 5.31.2) contains:

- in second line – serial number of the Combiner;
- in third line – frequency comparator and three channel frequency comparator firmware version;
- in fourth line – CPLD and output signal drivers firmware version.

```

Information
VCH-317 # 000 12
CP 00.00.00/29Feb12
FP 00.00.00/29Feb12

```

**Fig. 5.31.1**

```

Information
VCH-317 # 000 12
COMP 17 COMP3 09
CPLD 20 FVS 03.05

```

**Fig. 5.31.2**

## 6 Instrument set composition and the Combiner information

6.1 Instrument set composition is given in the table 6.1.

**Table 6.1**

<b>№</b>	<b>Model and designation</b>	<b>Quantity</b>	<b>Note</b>
1.	Microstepper Combiner Synthesizer VCH-317	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-317 Operational Manual 411146.040OM	1	
6.	Microstepper Combiner Synthesizer VCH-317 Remote Control Operational Manual RU.ЯKYP.00144-01 34 01-2	1	
7.	Microstepper Combiner Synthesizer VCH-317 The program “Monitor VCH-317” Installation disc	1	
8.	DC power connector 2PMT14KIIH4Г1B1	1	2PM14-4TKQB2

### 6.2 The Combiner information

Serial number of the Microstepper Synthesizer VCH-317

---

Control unit software version \_\_\_\_\_.

Control and indication unit software version \_\_\_\_\_.

## 7 Technical specifications

### 7.1 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.

### 7.2 Output signals

#### 7.2.1 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 7.1 .

**Table 7.1**

$f$ , Hz	10	100	1000	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 7.2 .

**Table 7.2**

$f$ , Hz	10	100	1000	10000
$L(f)$ , dBc	-131	-150	-155	-155

#### 7.2.2 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 :  $(10.2 \pm 0.1) \mu\text{s}$ ;
- rise-time: not more 10 ns.

#### 7.2.3 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).

### 7.3 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 frequency offset,

where:

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

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

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

#### 7.4 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.

7.5 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: positiv;
- amplitude: from 2.5 V up to 5.0 V;
- pulse duration: not less 1  $\mu$ s;
- rise-time: not more 50 ns.

Synchronization error is not more than  $\pm 20$  ns.

7.6 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:  $1.0 \times 10^{-13}$ ;
- for averaging time 3600 s:  $1.0 \times 10^{-15}$ ,

when temperature changing is not more than  $\pm 1$  °C/hour.

7.7 The Combiner allows to shift output signals phase:

- single shift range:  $\pm 999999$  ps;

- minimal step: 1 ps.

7.8 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  $2.0 \times 10^{-15}$  s (RMS).

7.9 The Combiner automatically removes 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.

7.10 Warm-up time: 4 h.

7.11 The Combiner can be managed using a PC and special software. Monitored parameters and control commands are transferred via RS-232 or USB interfaces.

7.12 Power supply voltage:

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

7.13 When AC power disappears the Combiner automatically use DC voltage, and when AC appears again the device automatically use AC voltage.

7.14 Power consumption: not more than 50 V·A.

7.15 Ambient temperature: from +5 °C up to +40 °C.

7.16 Weight: not more than 8 kg.

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

## **8 Warranty**

According the Contract.