

AUTOMATED DETECTOR-DIRECTION FINDER OF SIGNALS IN HF-FREQUENCY BAND “VOSTOK-OPK1”



Automated detector-direction finder of HF-band signals “Vostok-OPK1” is designed for automated reception of data about new radio emitters within preset frequency bands from 0.5 Hz to 30 MHz against the background of real air by station interference and provides the *following*:

- Search and detection of radio sources within preset frequency bands (0.5 MHz – 30 MHz) at the background of their real loading;
- Bearing measurement of radio signal by 3D antenna pattern while panoramic frequency searching and while processing requests flow of detected radio sources;
- «self-training» of detector on real electromagnetic environment for optimizing detection thresholds with average noise level displaying in corresponding subbands;
- Distribution of requests to the posts of signal processing of detected radio sources;
- Operation monitoring of detected and put for control sources;
- Reception and continuous digital recording of initial signal shape from outputs of monitoring and direction finding receivers (including 3-D gain pattern and automatic sector scan);
- Indication of amplitude-frequency, frequency-time and frequency-bearing panorama of air loading;
- Signal shape observation of detected radio emission source (amplitude spectrum, autocorrelation function and automatic sector scan) in real time;
- Issuing of commands «ANALYSIS» into external system of technical analysis when detecting radio emissions with new transmission types;
- Digital recording into database of detected signals synchronously with panoramic HF band signal recorder “Barhan-PRSK”;
- Disclosure of radiation modes and composition of networks operating on fixed frequencies selecting separate sources by frequency-bearing panorama;
- Operating within direction finding network as Slave or Master station;
- Control over parameters and operation modes, collecting information from slave stations of direction finding network;
- Informational interaction with stations from direction finding network via LAN and FOCL;
- Source position estimation from one point (method SSL);
- Command issuing for bearing taking to the equipment of radio data processing of receiving radiocenter “Vostok-ORD”.

Operation of detector-direction finder of “Vostok-OPK1” is based on the algorithm of spectral and statistical signal detection together with direction estimation to the source of radio emission using correlation-interferometer method of bearing computing.

Navigation equipment (GPS-receiver) with communication equipment provides a possibility of synchronous operation of “Vostok-OPK1” products within direction finding network both in

slave and Master modes, and synchronous operation with panoramic HF band signal recorder “Barhan-PRSK”.

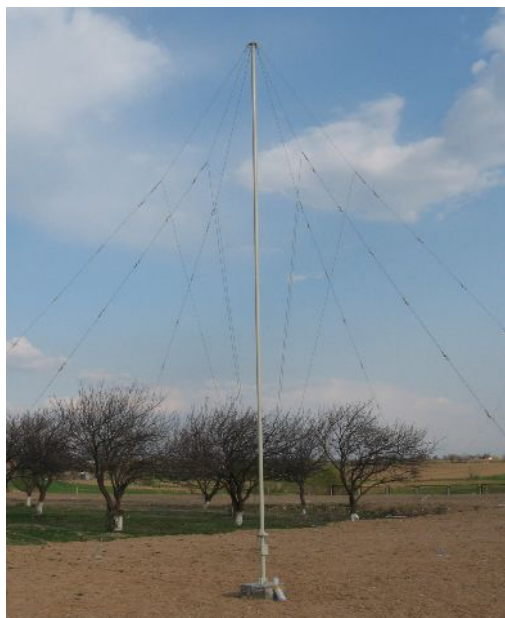
Software functions under control of OS Windows. Due to visual graphical interfaces (virtual panel boards) operation is easy and doesn't involve special knowledge of operator, built-in diagnostics system allows prompt defining equipment malfunction up to faulty unit.

COMPOSITION

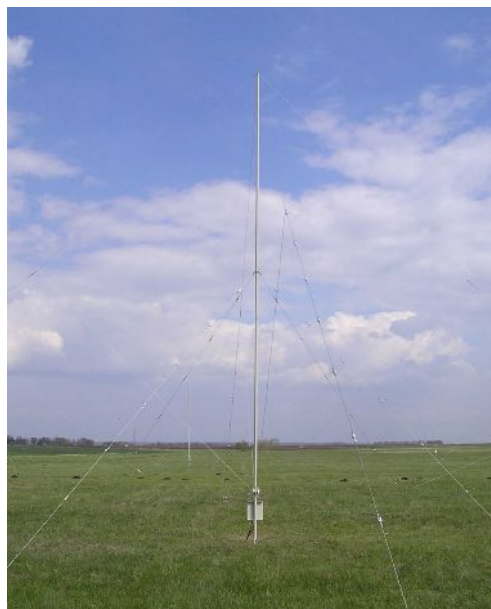
- Antenna feeder system consisting of two antenna arrays with diameter 120 m and 50 m, provides signals receiving within two subbands 0.5-12 MHz and 12-30 MHz.
- Antenna-feeder system of sector beam reception (directional sector reception) on the base of four V-shaped antennas.
- Antenna switch unit of antenna-feeder system of sector beam reception.
- Unit of wideband input devices.
- Multichannel digital radio receiving device of HF frequency band (9 channels are used and one is reserve) with the unit of digital signal processing and control on the basis of industrial computer Intel Core i7 produced by ADLINK – rack of detector-direction finder.
- Remote control board of detector-direction finder and indication of its information on computer base.
- Two operator workstations each consisting of:
 - two receivers (product “Galaktika-M”);
 - unit of control and visualization of information about detected signals (on the base of computer Intel Core i7);
 - button operative control board.
- Uninterruptible power supply units (for every station computer).
- Complete set of connecting cables.
- Complete set of accessories (including field heterodyne).
- Operational and maintenance documentation (Operating Instruction and Special Instruction. User Guide).
- Special software (two copies of installation CD).

Note. Product “Vostok-OPK1” is supplied in two versions: with circular antenna array or without it, when direction finding antenna-feeder system from the composition of receiving and measuring radio direction finder “Vostok-RP1” can be used.

Monopole antenna element



Loop antenna element of the first subband



Unit of wideband input devices



Rack of detector-direction finder



Receiver
(product "Galaktika-M»)



Workstation of operator



MODES OF OPERATION

Initialization: equipment serviceability check after switching in, setting of initial parameters (scan rate, detection levels, lists of prohibited subbands and fixed frequencies, list of priority frequencies, frequency resolution and averaging parameters), task for searching (operating frequency subbands).

Autonomous control: automatic searching, detection and radio emission sources bearing taking; display of radio electronic environment on observing/survey panorama and frequency bearing panorama, spectral panorama and queue of requests panel; servicing by operator of detector requests flow; signal processing (audio control, surveillance, direction finding, classification and recording); generating of queue of requests and radio emissions database, providing of access to database of external system.

Remote control: automatic control of operator actions, tracking over requests flow and change of signal-interference environment, reading of signal fragments for conducting detailed technical analysis via local network Ethernet.

Testing: complex serviceability check and automated search of faulty element by the system of built-in control.

Main control functions:

- Setting of operating frequency subbands, search sector and list of priority frequencies;
- Entering and editing of lists of prohibited segments and fixed frequencies;
- Selecting of frequency resolution and parameters of averaging (look frame duration);
- Entry of parameters of requests flow decimation;
- Distribution of requests among tracking posts according to frequency subbands, bearings and elevation angles;
- Requests flow processing (RESET/CALL, BACK, COMMAND, STATUS);
- Prompt analysis of signal with display of signal shape and autocorrelation function of analyzed signal;
- Azimuth measuring by visual ASL-indicator or polyphase raster;
- Display of registered signal in coordinates amplitude-frequency, time-amplitude-frequency (“waterfall”) and bearing frequency in real time scale, and also observe panorama of group signal in real time bandwidth of 2.4 MHz;
- Display of direction finding results against the background of electronic map;
- Generating of databases by detected and registered signals of sources with fixed frequencies and FH;
- Control over component elements of the station via control panels.

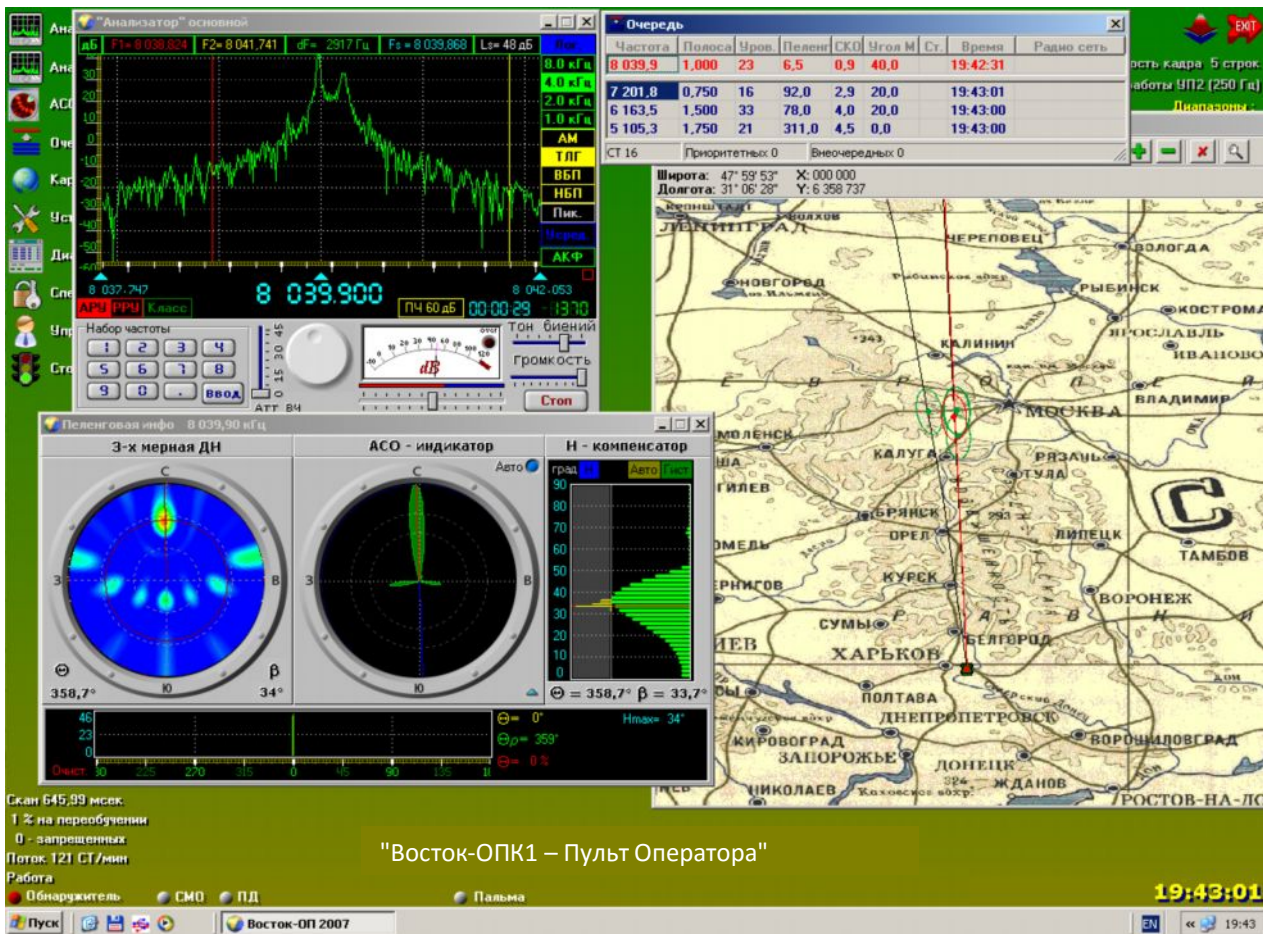
Product “Vostok-OPK1” by the composition of equipment is similar to product “Vostok-RP1”. Transfer of functional software provides a possibility to start software of “Vostok-RP1” and conduct tasks of executive direction finding on “Vostok-OPK1” equipment.

MAIN INDICATION MODES

It is possible to display:

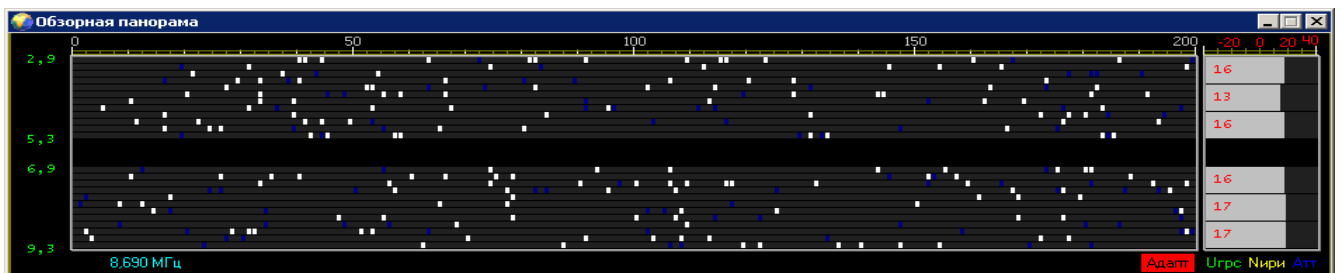
- Survey panorama of group signal in real time bandwidth of 2.4 MHz;
- Digital indication of requests flow of detected radio emission sources;
- Results of automated signals classification and measurement of their parameters;
- Envelope of antenna pattern of radio direction finder in polar coordinates;
- Lists of nets with fixed frequencies;
- Lists of nets with FH;
- Results of DB viewing.

Operator's desktop

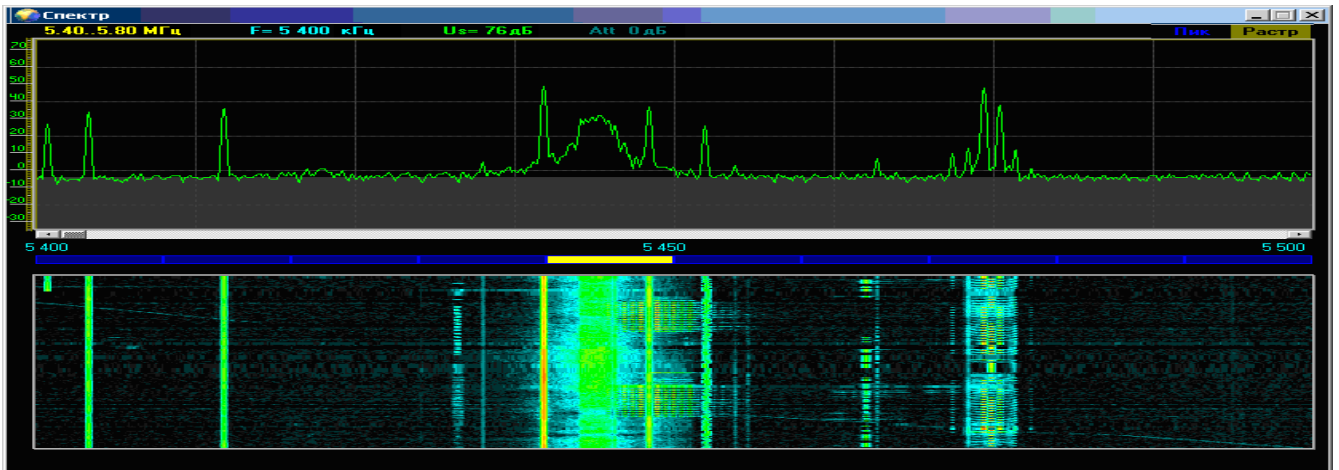


"Восток-ОПК1 – Пульт Оператора"

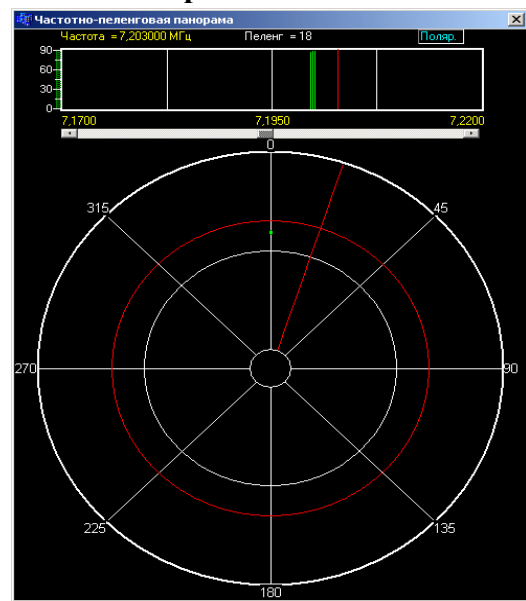
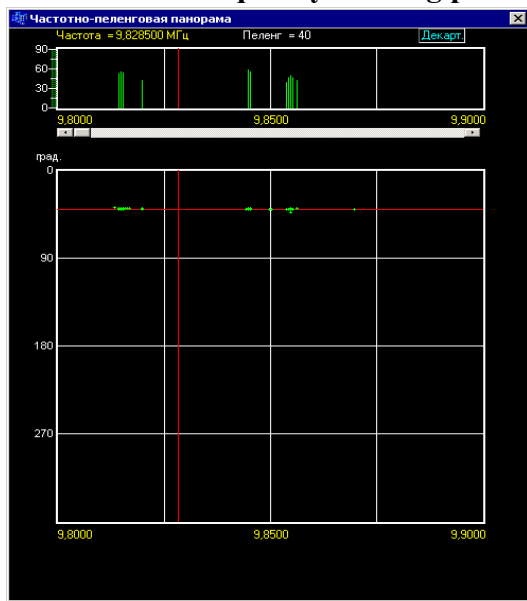
Survey panorama in frequency subbands 2.9-5.3 MHz and 6.9-9.3 MHz



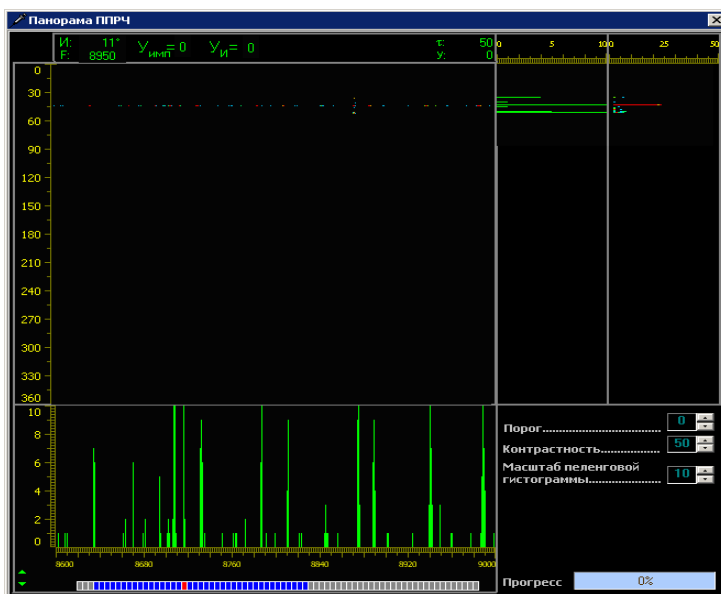
Panorama amplitude-frequency and frequency-time-amplitude (“waterfall”)



Frequency-bearing panoramas in Cartesian and polar coordinates



FH signals panorama



FH network table

РЭО

СФЧ - 11 ППРЧ - 1

Количество обнаруженных сетей ППРЧ -

N	Г нач.	Г кон.	Шаг	ИРИ	Т раб.	Вых.	Т ср.	N п.	Т посл.
1	7009	8998	1	1	00:00:02	1	00:00:00	1	10:05:53
2									
3									
4									
5									

Номер сети ППРЧ - 1

N	Уров.	Пеленг	СКО	Т имп.	Т раб.	Вых.	Инт	P
1	1	43	0	3	00:00:00	1	0	*
2								
3								
4								
5								

Панорама ППРЧ

Очистить РЭО

MAIN TECHNICAL CHARACTERISTICS

Panoramic signal detector-direction finder:

- Operating frequency band **0.5 – 30 MHz**
- Probability of signal detection ($t=1$ s, $\Delta f_{BW}=10$ MHz, SNR=10 dB) **> 0.98**
- Scanning rate accounting for spectral-statistical and spatial processing of detected signals (is set by operator):

Scanning rate, MHz/sec	500	200	100	50	12
Frequency resolution, Hz	1000	500	250	125	62.5
Number of averaging	1	2	2	2	2

- Minimal signal duration ($\Delta f_{BW}= 2400$ kHz) **3 ms**
- Instrumental probability of detection and direction finding of FH signal with duration of 3 ms in the frequency band 1 MHz with communication session duration of controlled source 5 s and more is not more **>0.95**
- Instrumental error of signal bearing taking **1.5° (RMS)**
- Sensitivity by EM-field **1..3 μ V/m**
- Sensitivity of radio circuit, SNR=10 dB **0.5 μ V**
- RTBW (real time bandwidth) **2400 kHz**
- Dynamic range by third order intermodulation **> 90 dB**
- ADC resolution of digital circuits **16 bit**
- Dynamic range of received signal levels accounting for input attenuators **> 120 dB**
- Suppression of spurious receiving channels **> 90 dB**
- Relative frequency instability **$2 \cdot 10^{-7}$**
- Tuning time of receiver frequency synthesizer **0.2 ms**
- Spectral density of heterodyne noise (1 kHz tuning) **-115 dB/Hz**
- Quality assessment of bearing taking and signal receiving **RMS Θ /U dB μ V**
- Remote control **LAN Ethernet**

Operator's WS (workstation):

- Operating frequency band **1 - 30 MHz**
- Number of tracking and register channels **2**
- Sensitivity, (SNR=10 dB) **0.5 μ V**
- Dynamic range by third order intermodulation **> 90 dB**
- ADC resolution of digital circuits **16 bit**
- Dynamic range of received signal levels **> 120 dB**
- Tuning time of receiver frequency synthesizer **5 ms**
- Frequency tuning interval **1 Hz**
- Frequency analysis bandwidth (is set with 1 Hz interval) **0.3 ... 12 kHz**
- Error of signal parameters measurement:
 - in automatic mode **3–10 %**
 - in manual mode **0.5–2 %**
- Automatic measurement of technical parameters (central frequency, spectrum bandwidth, frequency deviation FM/FSK, manipulation rate).

GENERAL REQUIREMENTS

- Total consumed power of the complex (with single WS) not more **1200 VA**
- Total weight not more **170 kg**
- Operating temperature range:
 - Operating board **+ 10 °C ... + 40 °C**
 - Receiving equipment **- 10 °C ... + 50 °C**
 - Antenna system **- 40 °C...+ 65 °C**

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