

Semi-mobile complex for radio monitoring and radio emission source location in VHF-UHF frequency bands «Barvinok»

Purpose

"Barvinok" semi-mobile complex is designed for detecting and location the sources of radio emissions (SRE), estimating their operational value, and performing radio monitoring of the known and newly appearing SRE operation.

Functions

"Barvinok" complex provides detection and processing of signals received in the frequency band from 25 MHz to 3000 MHz within 30 km × 30 km region in order to ensure the following functions:

- Automated search, detection, direction finding, and location of SRE;
- On air operation monitoring of SRE that are already known and put under observation;
- Transmission mode classification (impulse, continuous, modulation kind) and disclosure of radio networks operating at fixed and hopping frequencies;
- Radio network classification and parameter measurement for the SRE detected;
- Visual and audible check of the signals being received;
- Radio electronic environment data collection, processing, and display at a digital map;
- Control of the parameters and operation modes of slave stations "Barvinok-OP" that work in the same direction finding network;
- Automated processing of the signals being registered and SRE databases being formed.

Composition

"Barvinok" complex includes the following elements:

- "Barvinok-OP" mobile station for signal detection and direction finding in VHF-UHF frequency bands (25 MHz – 3000 MHz) based on fast detector&radio direction finder with computerized control and equipment for signal spectrum density measurement in frequency band from 25 MHz to 3000 GHz – 3 sets;
- The group kit of spare parts and accessories for the products of "Barvinok" complex – 1 set;
- The complete set of operation and maintenance documents.

«BARVINOK»

Sketch diagram of the complex for radio monitoring and location of radio emission sources in VHF-UHF frequency bands

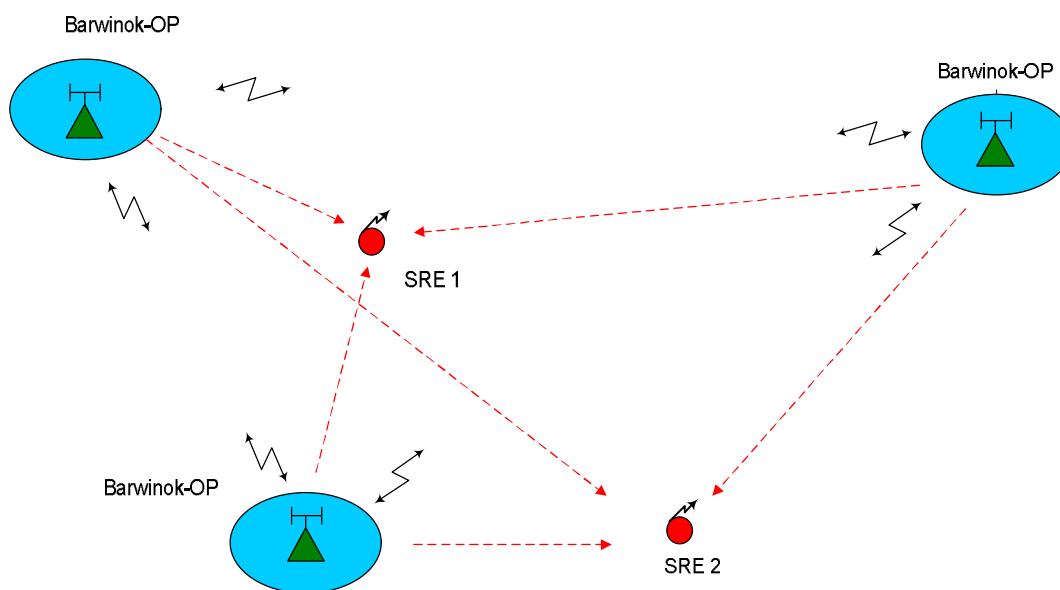


Fig. 1

Peculiarities of the complex

- Detection&direction finding stations with wide base antenna systems provide high performance when detecting live signals and finding direction to their sources in VHF/UHF frequency bands in conditions of multipath signal propagation through urban areas, high-rise objects, and local re-emitters (power transmission lines, antenna masts, etc.).
- Use of spatial-spectrum FFT algorithms for signal processing in the complex provides effective measurement of carrier frequencies for short time radio emissions and provides automatic tuning of the network for synchronous direction finding.
- Bearings to the SREs measured by the detection&direction finding stations are automatically time-tagged, which provides unambiguous location of SREs operating in the same radio network.
- Automatic direction finding and coordinate computation for SREs provide their tracking in real time (1 to 2 s delay).
- Open system architecture makes it possible to increase the number of detectors&direction finders or radio direction finders.
- Registration and storage of signal records are done in digital format.
- Documenting and information processing is done in form of databases on emissions, sources, etc.

Modes of operation

- Tasking and configuration of the complex's direction finding network.
- Automatic search, detection, and registration of signals from SRE.
- Direction finding, coordinate computation and display for the SRE being detected.
- Monitoring (direction finding and radio intercept) of the SRE operation at fixed frequencies.
- Guiding assault teams onto the position of operationally valuable sources.
- Measurement of the radio signal spectrum density.
- Registration and collection of information about radio electronic environment.
- Formation of reports and intelligence on the region radio environment.
- Automatic testing of subsystems.

Basic characteristics

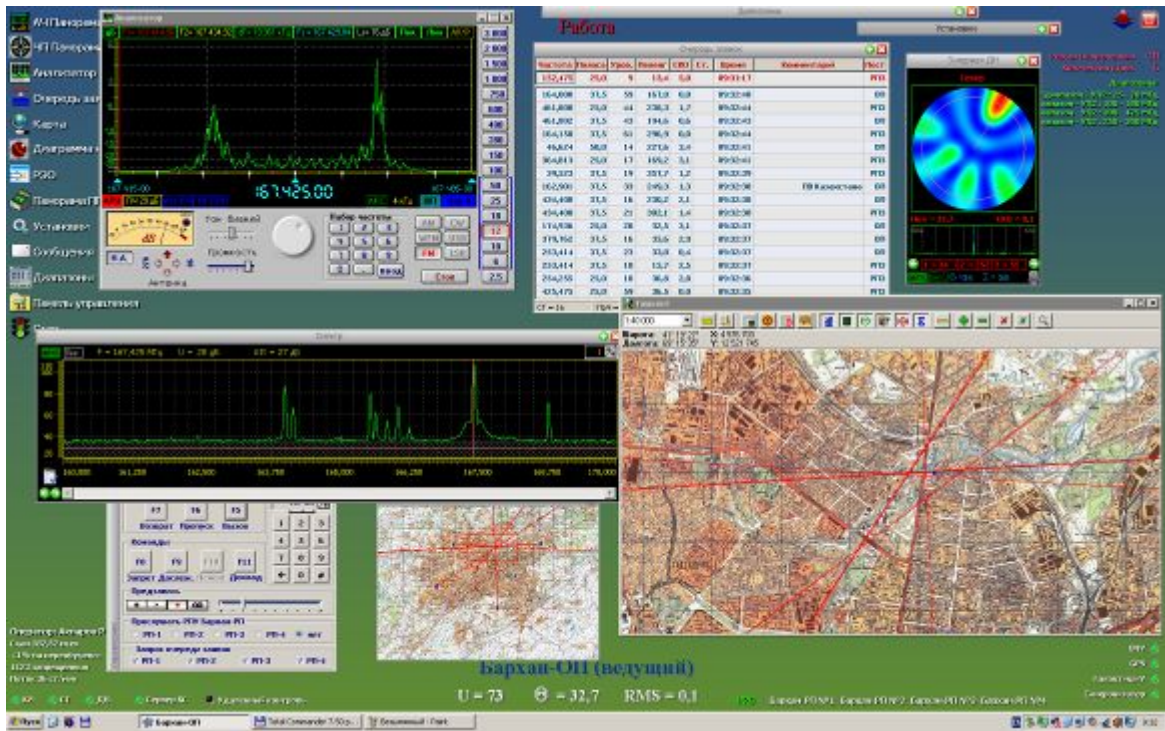
Panoramic analysis	
Frequency band	25 – 3000 MHz
Panoramic frequency scan rate	up to 10 000 MHz/sec
Direction finding and SRE location	
Frequency band	25 – 3000 MHz
Frequency scan rate at direction finding	up to 10 000 MHz/sec
SRE location accuracy	3% of the range
Throughput of the SRE location system	not less than 10000 emissions/hour with coordinate data recorded and information on SRE added to the database

Coverage of the region larger than 30 km by 30 km is done by increased number of detection&direction finding stations "Barvinok-OP" (from 3 to 5) combined together via telecommunication channel or GSM channel to form a direction finding network.

Stations of the "Barvinok" complex are powered through uninterruptible power supply (UPS) from AC 220 V, 50 Hz industrial supply line; or from onboard power generator installed at the vehicle's chassis. UPS protects the circuits from voltage surges and voltage deviation from rated value, allowed deviation being within $\pm 15\%$.

Equipment of the "Barvinok-OP" stations as well as their control boards are installed inside containers mounted on a truck, all the equipment operates under ambient temperature from $-10\text{ }^{\circ}\text{C}$ through $+50\text{ }^{\circ}\text{C}$.

Antenna systems of the complex mounted outside operate under ambient temperature from $-30\text{ }^{\circ}\text{C}$ through $+55\text{ }^{\circ}\text{C}$.



Windows desktop view at the "Barvinok-OP" operator's computer screen



Variants of installing the "Barvinok-OP" at the trucks

Mobile station for signal detection and direction finding «Barvinok-OP»

Purpose

«Barvinok-OP» station is designed for detecting signals and finding directions to their sources in order to obtain information on the known and newly appearing sources of radio emissions in the station responsibility zone.

Composition

- **Direction finding antenna-feeder system (AFS-OP)** consisting of three seven-element circular antenna arrays (AFS-OP1 – frequency band 25 MHz through 300 MHz, AFS-OP2 – frequency band 300 MHz through 1000 MHz, AFS-OP3 – frequency band 1000 MHz through 3000 MHz). AFS-OP3 includes the four channel converter for down converting frequency band of 1000 MHz – 3000 MHz into the frequency band from 300 MHz through 800 MHz.
- **OPP unit** – four channel analog-digital signal detector&direction finder that provides reception and digital processing of signals.
- **«Galactika-U» receiver** – single channel analog-digital receiver for audible signal check and selection of the low and intermediate frequency signal fragments for the record.
- Operator's workplace equipment designed for controlling the elements of the complex, performing signal processing, recording and technical analysis, as well as for SRE location computation.
- **Communications equipment** - digital radio relay station of 500 MHz – 700MHz frequency band with data transfer rate of 1.5 MBit/sec, data transfer system using GSM communications channel.
- **Power supply unit** provides the product elements with rated AC voltage. In case of supply line AC 220 V voltage is lost to the system, backup power unit provides stable operation of the product during 10 minutes.

Note: The carrier truck with container, and life support system for the station are provided by the system integrator in the country of customer.

Functions

When performing radio monitoring in frequency band from 25 MHz through 3000 MHz, the product provides signal reception and processing in order to implement the following functions:

- Monitoring of radioelectronic environment (REE) in coordination with other stations "Barvinok-OP";
- Signal search, detection, and direction finding to the newly appearing sources of radio emissions at the background of actual radio spectrum occupation;
- Automated parameter measurement for the signals detected from SRE, results being displayed in a separate panel of the program window;
- Generation of commands together with instructions as to direction finding to be sent to the slave stations "Barvinok-OP", as well as automatic transmission of these commands when specific SREs are detected (tagged as primary, priority);
- Determination of number of stations operating in the same radio network (that use both fixed and hopping frequencies);
- Digital recording of signal fragment at low (LF) and intermediate (IF) frequencies at the output of "Galactika-U" receiver;
- Direction finding to the SRE, with all the bearing taken to the SRE being displayed at a digital

- map;
- Performance according to the direction finding instructions coming from leading (master) station "Barvinok-OP";
- Playback of the signals recorded at LF and IF in the database, their express analysis with simultaneous display of bearings;
- Automated REE data processing (statistics collected by the time of operation including number of SREs detected and their operation intensity);
- Automatic synchronization of bearing taking for all the stations working in the same direction finding network;
- Detection, direction finding, and audible check of a wide class of signals with AM, SSB, FSK, FM, PM, wideband transmissions, as well as signals with frequency hopping;
- Automatic equipment testing of the station's subsystems.

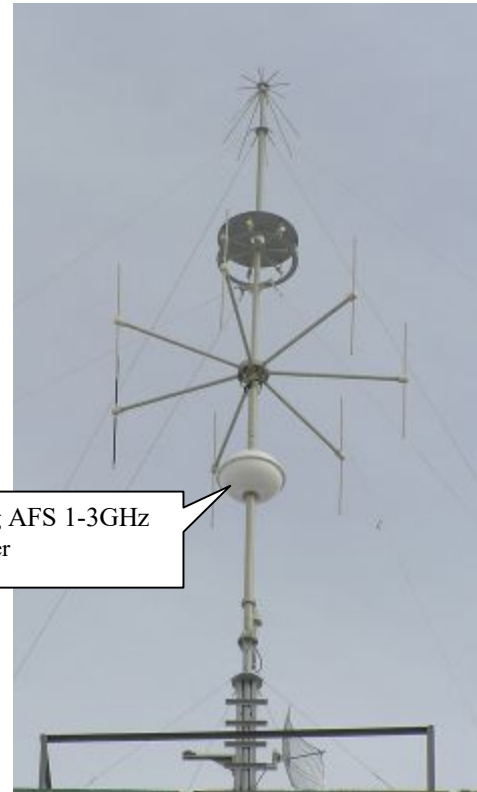
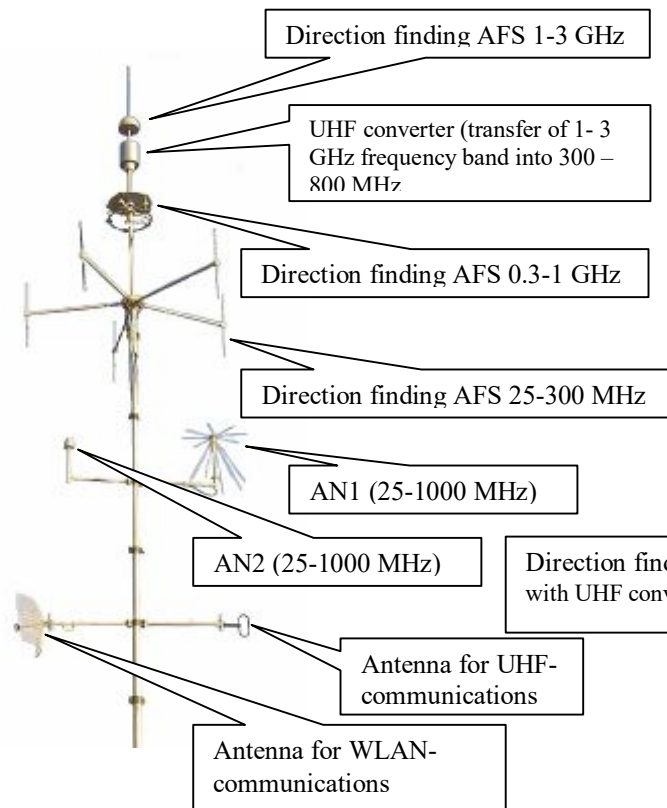
Basic characteristics of the «Barvinok-OP» station

- Working frequency range **25 MHz - 3000 MHz**
- Frequency scan rate (including spatial-spectrum processing time in the unit frequency swath of 10 MHz):

Scan rate, GHz/sec	2	5	10
Frequency resolution, kHz	6.25	12.5	25

- Instrumental error of direction finding:
 - in frequency band 25-100 MHz **2.0° (RMS)**
 - in frequency band 100-1000 MHz **1.0° (RMS)**
 - in frequency band 1000-3000 MHz **2.0° (RMS)**
- Sensitivity to EM field (by RMS bearing $\pm 2^\circ$, BW=12.5 kHz):
 - in frequency band 30-50 МГц **15 - 30 μ V/m**
 - in frequency band 50-1000 МГц **3 - 15 μ V/m**
 - in frequency band 1000-3000 МГц **10 - 30 μ V/m**
- Frequency swath (Real time BW) **2.5 / 10 MHz**
- Probability of detection and direction finding for the 100 ms signal when scanning within frequency band of 200 MHz **> 0.9**
- Probability of detection and direction finding for the frequency hopping signals **> 0.9**
- Minimum duration of the signal that can be detected and bearing to its source can be taken **1 ms**
- Receiver channels sensitivity (SNR=10 dB, BW=12.5 kHz) **0.7-1.0 μ V**
- Dynamic range with respect to the intermodulation of the 3d order **> 80 dB**
- Dynamic range **120 dB**
- Spurious channel suppression **> 80 dB**
- Relative frequency instability **$2 \cdot 10^{-7}$**
- Tuning on the frequency time for the receiver frequency synthesizer **200 μ s**
- Frequency tuning increment **2.5 MHz/10 MHz**
- Noise spectrum density of heterodyne (tune out is 25 kHz) **-100 dBc/Hz**
- Estimate of the signal reception and direction finding quality **RMS Θ/U dB μ V**

AFS and workplaces of the "Barvinok" stations and station modifications



Direction finding AFS of VHF-UHF frequency band (Variant 1)

Direction finding AFS of VHF-UHF frequency band (Variant 2)

Automated workplace of the mobile station operator



Operators' workplace in the truck mounted container



"Barvinok-OP" station mounted on the «KRAZ» truck



"Barvinok-OP" station mounted on the APC



Operators' workplace in the APC



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