

Station of radiomonitoring, control and DF of HF frequency band «BERKUT-MP»



- Panoramic view of the frequency band 1.5-30 MHz with rate of up to 400 MHz/sec with unit RTBW = 800 kHz
- Detection and bearing taking of short-term signals $t_{\min} \geq 5$ ms
- Command-executive direction finding within HF band network of position finding by triangulation method (together with stations “Berkut”)

GENERAL INFORMATION

Station of radiomonitoring of HF frequency band “Berkut-MP” is designed for direction finding network operation control, automated detection, surveillance over operation and location of current radio communication sources in the frequency band of 1.5 – 30 MHz for obtaining up-to-date information about radio electronic environment of under controlled area.

Mobile direction finding station “Berkut-MP” provides high rate panoramic detection and following bearing taking of signals of short-term sources within frequency band 1.5–30 MHz. Station provides scanning of preset frequency band with a rate $V_{sc}=100-400$ MHz/s, spatial search and position location of the radio emission source (RES) by surface and gently falling radiowave of vertical polarization.

Panoramic detector of “Berkut-MP” station provides signal detection by change of spectral and statistic features together with direction assessment to the source of radio emitter.

Direction finder designed on the base of three-channel receiving and measuring device provides stable direction finding of signals by **Watson-Watt** method in real open waves and also provides bearing sampling fro short-term sources with signals duration of **5-200 ms** (including FH sources and electric interference).

Station “Berkut-MP” executes high-rate scanning of preset HF frequency band segment in panoramic mode using 1024, 2048, 4096, 8192, 16384 FFT point transformations, and providing resolution of spectral analysis 1000 Hz, 500 Hz, 250 Hz, 125 Hz and 62.5 Hz.

Panoramic scanning is provided by additional receiver of HF frequency band “**Philin-HF/P**”, on the figure from the right.



Station “Berkut-MP” is based on the vehicular platform provided by the Customer in which equipment of high-rate panoramic detector finder with additional audio HF receiving channel and also two operator WS are installed. Example of station layout on the vehicle “Ford Transit” is presented on figure 1.

Radio direction finding antenna-feeder system (AFS) is placed on roof of the vehicle.

Radio direction finding AFS of “Berkut-MP” station is an antenna consisting of two ferrite loop antennas and monopole with capacitance load and overall size 500×500×50 mm. Such arrangement of antenna on the roof of the vehicle allowed covering of entire HF frequency band from 1.5 MHz to 30 MHz without attracting attention of the people around

Navigation equipment and (GPS-receiver, electronic compass) together with communication channel provide possibility of simultaneous operation of station “Berkut-MP” within direction finding network consisting of more 2 stations “Berkut”. Display of coordinates of detected RES is provided on additional monitor against the background of the map of undercontrolled area.

Trunk communication channel for stations “Berkut-MP” of GSM (CDMA) 3G standard is provided by the Customer. Data transmission rate must be not less than 0.5 Mbit/s.

Station is powered from four accumulator cells 12 V (1 cell is main and 3 – reserve). Time of autonomous operation of station from accumulators is 8 hours. Accumulators are charged on stationary position from AC network 220 V, 50 Hz. It is possible to use generator Honda EU 20i from the composition of the product having carried it out of the vehicle.

Minimal composition of on-duty shift needed for servicing “Berkut-MP” station placed inside a vehicle) – 3 persons (two operators and one driver-mechanic).

“Berkut-MP” station operates both on stationary position and in motion. Readiness time of the station to operation is 5 minutes.

Software of the station is developed using cutting edge technologies and functions under control of OS Windows-7. Due to visual interfaces (virtual panels) operating with station equipment does not involve high qualification and special knowledge of operator, and built-in diagnostics system allows easy determination of equipment malfunction up to changeable unit.

Life support system provides a possibility for a crew to conduct autonomously radio surveillance and technical equipment maintenance of the station for a long period of time in the conditions of tropical climate.

MAIN PECULIARITIES

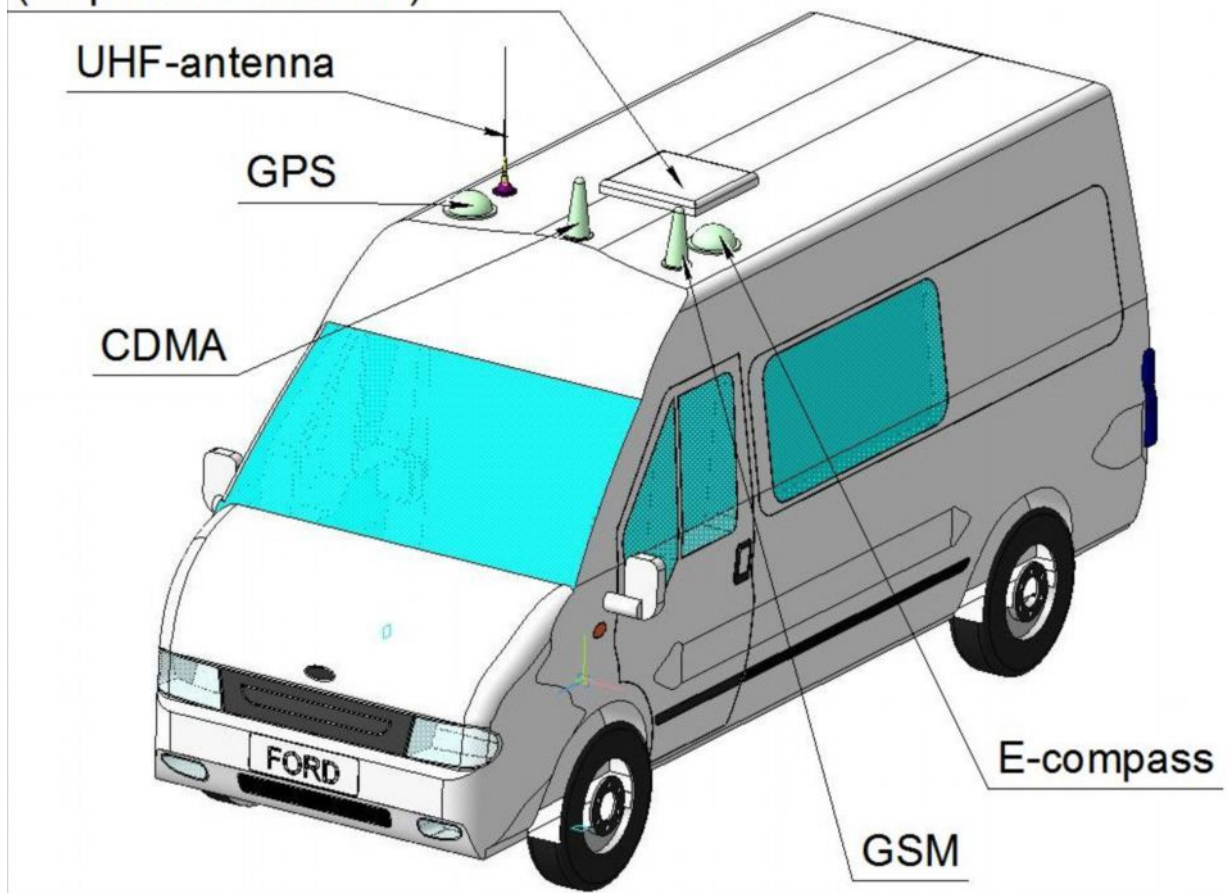
- Maximal frequency scanning rate **400 MHz/sec** with **RTBW = 800 kHz**;
- Panoramic Detector providing detection of **pulse and FH signals** with duration of **5 ms**;
- Simultaneous operation of detection and command-executive direction finding systems;
- Automatic position fix (implementing **triangulation methods**) when operating within direction finding network with additional 2 stations “Berkut”.

PURPOSE

Radio monitoring system “Berkut-MP” solves the following tasks:

- Control over radio electronic environment at the distance of up to 30-50 km (reception of surface waves);
- Search, detection of newly appeared radio emitters within preset HF frequency band segments (1.5–30 MHz);
- Command-executive direction finding of newly detected signals by own direction finder and together with direction finding network consisting of 2 stations “Berkut”;
- Signal recording to digital form: I/Q-components of complex envelope and in WAV-format;
- Position fix of RE location with their display on the map of the area;
- Control over parameters and operation modes by transmitting commands to stations of direction finding network “Berkut”;
- Automated processing and logging of radio electronic environment data

Radiomonitoring & DF AΦC (loop ferrite antenna)



Deployed station "Berkut-MP" on position

STATION COMPOSITION

- 1) Omnidirectional AFS of radiomonitoring and direction finding (DF) with a size 500×500×50 mm, consisting of two active loop ferrite antennas and single wideband monopole with capacitance load;
- 2) Receiving and measuring device on the base of three-channel DSP-receiver with tunable preselector and with single additional audio HF receiving channel for co-operation with panoramic receiver;
- 3) High rate panoramic receiver of HF frequency band "Philin-HF/P";
- 4) Operator's WS of RF search of newly detected RES on the base of industrial computer Panasonic (with OS Windows 7.0);
- 5) Operator's WS of position finding system with industrial computer Panasonic (with OS Windows 7.0) and additional monitor Dell 23" for map display;
- 6) LAN-equipment – 1 set;
- 7) Electronic compass – 1 pcs.;
- 8) GPS-receiver with antenna – 1 pcs.;
- 9) Communication channel equipment GSM 3G – 1 set;
- 10) Communication channel equipment CDMA 3G – 1 set;
- 11) UHF radio station with antenna – 1 pcs.;
- 12) Generator Honda EU 20i with fuel tank 10 L;
- 13) Powering system (including: power input board, automatic protection board, distribution board, four accumulator cells);
- 14) Complete set of mounting parts and connecting cables (including: tables, chairs, chairs of ARM operators);
- 15) Complete set parts for fastening AFS on the roof of the vehicle;
- 16) Complete set of calibration accessories (field heterodyne unit, set of vibrators) – 1 set;

17) Operational and maintenance documentation (User Guide, operating instruction, technical data sheet).

Notes:

1. Equipment according to paragraphs 4) – 6), 9) – 12), batteries (traction) – 4 pcs. from 13), tables and chairs Operator's WS from 14) too is provided by the Customer;
2. Functional software for this equipment is installed by the Executer.

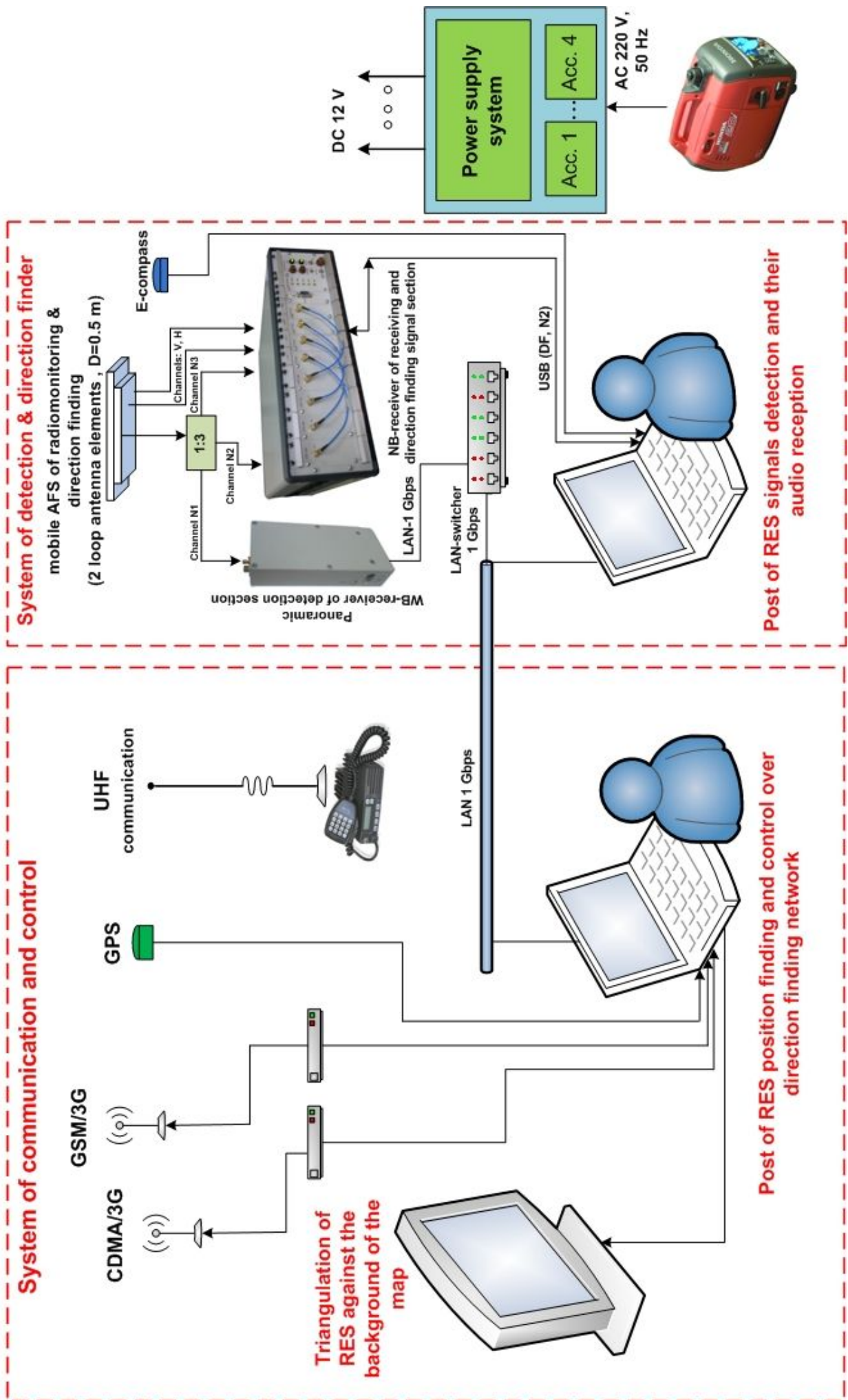
MAIN CONTROL FUNCTIONS:

- 1) Setting of operating frequency subbands, priority frequencies list;
- 2) Input and editing of prohibited frequency segments and fixed frequencies;
- 3) Selection of frequency resolution and averaging parameters (scanning frame duration);
- 4) Parameters input for decimation requests flow;
- 5) Servicing requests flow (SKIP/NEXT, RETURN, POSITION, RECORD);
- 6) Selection of preset frequency segments of a signal (interference) using F-cursors;
- 7) Transmitting of commands to slave radio direction finders "Berkut" during synchronous direction finding;
- 8) Control of component parts of the station via control board interfaces.

MAIN DISPLAY MODES

- 1) Indication of load panorama of monitored frequency band in coordinates "amplitude-frequency";
- 2) Indication of signal spectrum and autocorrelation function of analyzed signal;
- 3) Results display of automatic signal modulation classification and results of their parameters measurement;
- 4) Map display of under controlled area with indication of coordinates of detected RE and azimuth marks of RDF stations;
- 5) Indication of table of detected radio emitters.

Structure diagram of mobile HF station of radiomonitoring, control and DF «Berkut-MP»



TECHNICAL PARAMETERS

Panoramic HF signals detector finder:

- Operating frequency band: **1.5 - 30 MHz**
- Probability of signal detection ($T=1$ s, $\Delta F_{\text{view}}=10$ MHz, SNR=10 dB) **> 0.98**
- Scanning rate accounting for spectral and bearing processing of detected signals (is set by operator):

Scanning rate, MHz/sec	25	50	100	200	400
Frequency resolution, Hz	62,5	125	250	500	1000

Note. Scanning rate is presented with panoramic signal spectrum without averaging.

- Minimal signal duration of detected signal **5 ms**
- Sensitivity by EM-field (1.5-30 MHz) **10 - 35 μ V/m**
- Sensitivity of radio receiving section (SNR=10 dB, BW=1 kHz) **- 10 dB μ V**
- Real time BW **800 kHz**
- Dynamic range for 3rd order intermodulation **> 85 dB**
- ADC capacity of digital section **16 bit**
- Dynamic range of received signal levels **> 110 dB**
- Relative frequency instability **$\pm 1 \times 10^{-6}$**
- Quality assessment of bearing taking and signal receiving **U dB μ V**
- Number of detection sections **1 channel**

HF direction finder

- Operating frequency band: **1.5 - 30 MHz**
- Polarization **vertical**
- Dynamic range for 3rd order intermodulation **> 80 dB**
- Direction finding method **Watson-Watt**
- Modes of direction finding: **«instant» direction finding, histogram accumulation
frequency selection of RES, polarization selection**
- Instrumental bearing taking error accounting for RDC (RMS): **3°**
- Sensitivity by EM-field (RMS threshold = 5°) **5...25 μ V/m**
- Minimal duration of bearing taken signal **5 ms**
- Dynamic range of bearing taken signals (accounting for AGC) **not less than 110 dB**
- Assessment of signal bearing taking quality and level **RMS/dB μ V**
- Frequency bandwidth of DSP-radio direction finder **0.03 ...16 kHz**
- Frequency resolution of bearing samples **100 Hz**
- Bearing pattern update rate **15-20 frames/s**
- Number of direction finding channels **3 channels**

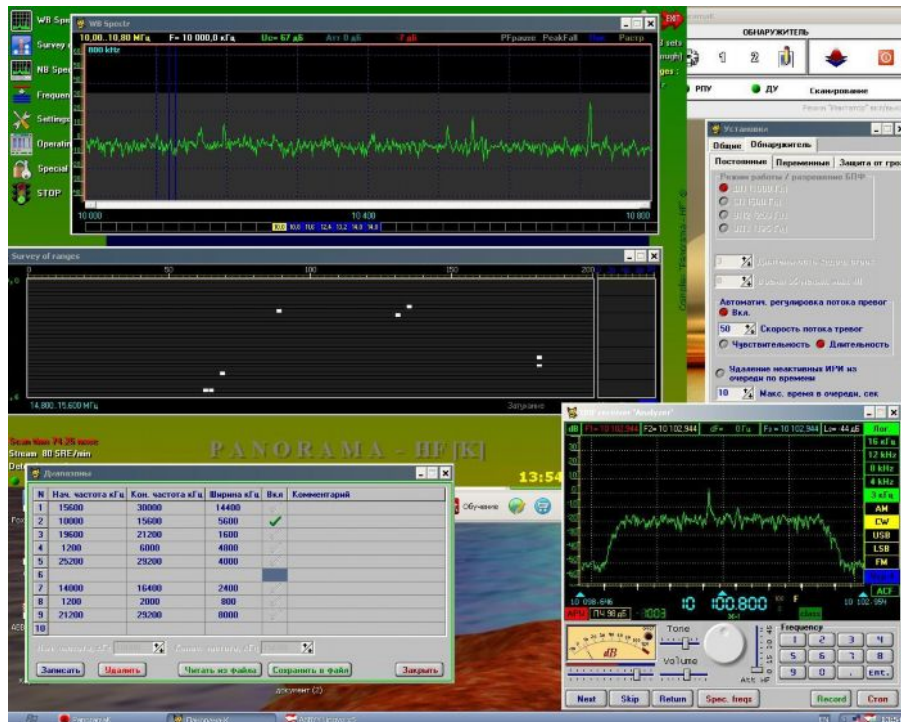
HF-equipment of tracking and signal recording:

- Operating frequency band **1.5 - 30 MHz**
- Sensitivity of tracking nad recording by EM-field (1,5-30 МГц) **10 - 35 μ V/m**
- Frequency bandwidth **0.03-16 kHz**
- Relative frequency instability **$\pm 2 \times 10^{-7}$**
- Dynamic range for 3rd order intermodulation **> 80 dB**
- Resolution of ADC section **16 bit**
- Dynamic range of received signals levels **> 110 dB**
- Frequency tuning step **1 Hz**
- Quality assessment of signal reception **U dB μ V**
- Number of channels of audio control and recording **1 channel**

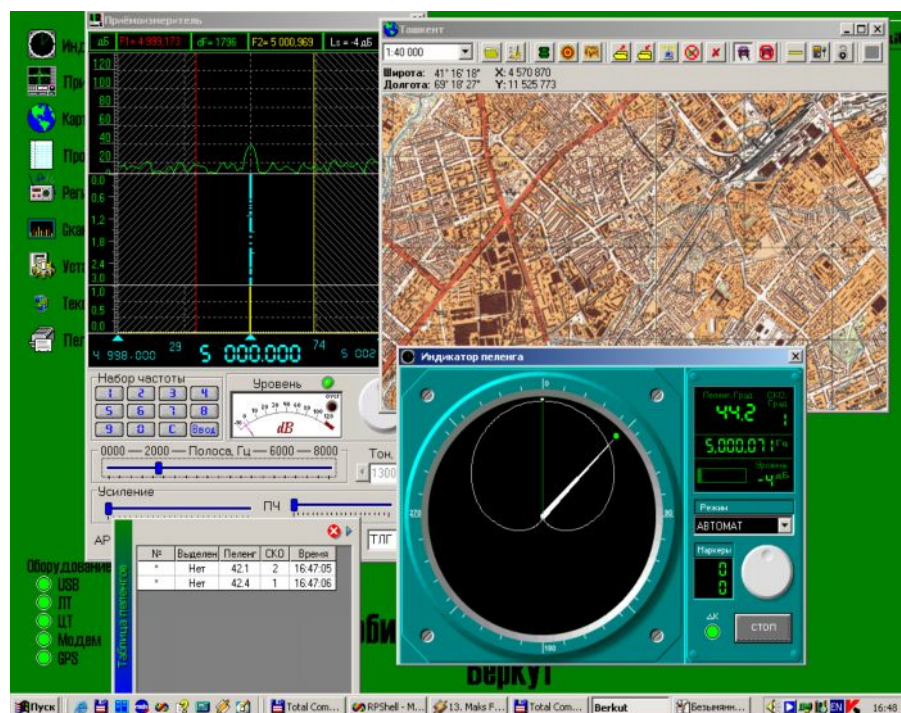
General requirements

- Remote control
- Power supply: accumulator cells
single phase
- Total power consumption of the station from AC 220 V
- Time of autonomous operation from accumulator cells
- Total weight of station equipment (with AFS)
- Operating frequency range:
Equipment of the station
Antenna-feeder system

GSM 3G
(≥ 500 kbit/s)
DC 12V, 20 A
220 V $\pm 15\%$, 50 Hz
not more than 300 VA
8 hours
not more than 300 kg
+ 5° C...+ 50° C
- 40° C...+ 60° C



Desktop of operator (searching mode)



Desktop of operator board (direction finding mode)

Structure diagram of integration of radiomonitoring and DF station "Berkut-MP" and direction finding stations "Berkut with handheld direction finders "Philin-K"

Triangulation method

(error of position finding 3-5 % from distance to RES)

Station of radiomonitoring, DF and control over radio direction finders "Berkut-MP"

