



STATIONARY RADIO DIRECTION FINDING STATION OF HF FREQUENCY BAND «KRUG-M-A»

Stationary radio direction finder “Krug-M-A” is based on product R-300 antenna-feeder system (code «Krug») and is purposed for destination designation to radio emission sources operating in the frequency band 1 – 25 MHz at the distance of up to 2000 km and more. Radio direction finder “Krug-M-A” operates autonomously and in command-executive mode and provides measuring of azimuth and elevation angle of signal radio wave arrival; also it can be used for position of source by SSL method (Single Station Location) with ionosphere radio waves propagation.

Radio direction finding post of station “Krug-M-A” that is currently in production comparing to similar posts of the previous generation due to exclusion of crystal filters in receiving and measuring device provides frequency dynamic (when switching antenna elements) selectivity by adjacent channel 93...100 dB and at detuning far zone 110...115 dB instead of 40...50 dB and 68...70 dB (previous generation).

COMPOSITION

- Direction finding antenna feeder system (AFS) of product R-300 consisting of single circular antenna array (CAA) with diameter 120 m provides signal reception in two subbands 1.0...12 MHz and 12...25 MHz. CAA contains 40 antenna elements (wideband monopoles) with 7 m height enclosed by parasitic reflector;
- Wideband branching signal amplifiers (8 outputs, able to be switched off) ^{*} – 40 pcs.;
- Unit of matrix switch for 40 inputs and 3 outputs;
- Four-channel HF band receiver with digital signal processing unit;
- Control and indication board on the base of computer with two LCD-monitors;
- Operation control panel;
- Omni directional receiving antenna;
- System of time synchronization based on navigation receiver GPS-18;
- Equipment of data transceiving (supplied by Customer),
- Unit of discrete heterodyne generating discrete frequency grid (0.5 and 1 MHz) of control signal necessary for measuring instrumental accuracy of direction finder;
- Power supply system (distribution board, UPS),
- Complete set of connecting cables and accessories;
- Complete set of operational and maintenance documentation.

Note. * - option, is supplied on the Customer's request.

MAIN PECULIARITIES

- Widebase antenna system of direction finder provides its high performance in conditions of interference signal fading.
- Simultaneous measurement of azimuth and elevation angle of radio wave arrival provides a possibility of estimating source position from single point (SSL method) with indication on the map.
- Ranging by SSL with implementation of ionosphere (ranging error $\Delta D \leq 20\%$).
- High dynamic frequency selectivity of receiving system comparing to similar products.
- Interaction with transceiving channel of positioning system of the Customer.
- Quick learning process and ease-of-operation by attending personnel.
- Modular structure of system equipment.
- Built-in system of control and failure diagnostics.
- Computer control of station using interface of virtual control panels.
- Continuous signal record of spatial channels to HDD of computer provides possibility of scrolling and postponed direction finding in cases of receiving short term signals and signals with low quality of reception.

General view of equipment arrangement of RDF station "Krug-M-A"



WS of station operator



General view of antenna elements of direction finding AFS of "Krug-M-A" product



Additional HF-sections with antenna amplifier and dividing devices, to those can be connected additional receiving and measuring devices able to provide independent control of antenna system, are provided in equipment of radio direction finding station for increasing throughput of processing of commands on bearing taking.

Matrix switch 40 inputs and 3 outputs 4-channel receiver CRPU-1k/4t



TECHNICAL PARAMETERS

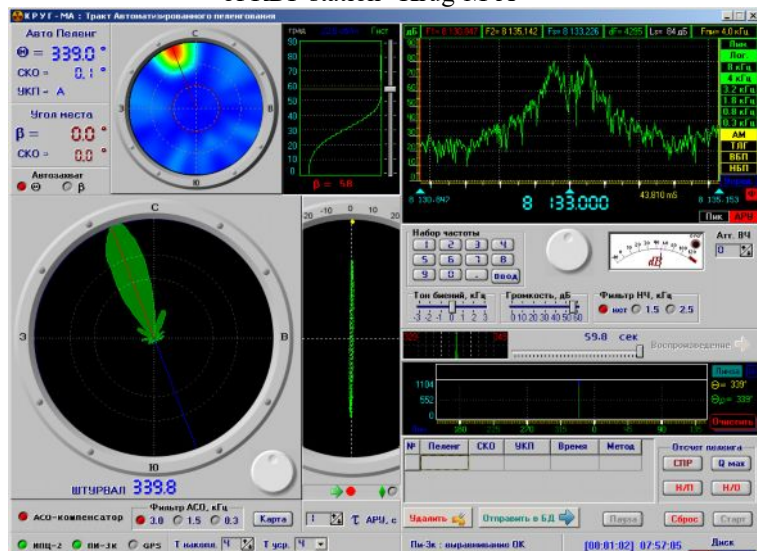
Frequency band	1.5–25 MHz
Polarization	Vertical
Method of automatic direction finding	Correlation interferometer
Methods of pattern indication (visual)	Amplitude sector scan
Bearing measurement error Θ within $0^\circ \dots 360^\circ$:	
in the frequency band 1-3 MHz	< 2° (RMS)
in the frequency band 3-30 MHz	< 1° (RMS)
Elevation angle of measurement error β within $20^\circ \dots 70^\circ$:	
in the frequency band 1-3 MHz	< 5° (RMS)
in the frequency band 3-30MHz	< 3° (RMS)
Error of position by SSL method (when $K_v = \sigma$)	20% from distance to RES
Sensitivity (depending on frequency)	0.5 - 3 μV/m
Spatial selectivity of interference stations	15...20 dB
Frequency resolution of signals	20 Hz
Minimal signal duration	50 ms
Dynamic range of signals	not less than 120 dB
Frequency bandwidth (set of six ranges)	0.3...8.0 kHz
Frequency dynamic selectivity of detuning $\geq \pm 500$ kHz	110...115 dB
Frequency dynamic selectivity in adjacent channel (± 1 kHz)	93...100 dB
Third order dynamic range (while antenna switching):	
in the frequency band 1-12 MHz	> 90 dB
in the frequency band 12-30 MHz	> 85 dB
ADC resolution of digital sections	16 bit
Relative frequency instability	$0.5 \cdot 10^{-7}$
Bearing pattern update rate	20-40 frames/s
Accuracy of bearing sample time binding	± 10 ms
Continuous signal record, disk space consumption	0.5 Mb/h
Throughput (depending of transmitting type)	2...5 RES/min
Visual bearings' indication y numbers of correspondents of radio net	available
Remote control:	LAN (FOCL channel)
	backbone HF-channel
Power consumption	not more than 500 VA
Operating temperature range of:	
Equipment of post and operator's board	+ 5 °C...+ 40 °C
HF-equipment	- 10 °C...+ 50 °C

Radio direction finding station “Krug-M-A” along with mode of automated bearing sampling implementing correlation processing of spatial receiving channels has traditional mode of ASL pattern indication that was used for bearing measurements at radio direction finding stations of previous generations.

Implementing of different methods of bearing taking (amplitude, correlation interferometer) and also combining of data collection methods (automatic with histogram accumulation, visual, audio) provides credibility of obtained bearing information about signal in complicated conditions of receiving in HF band.

In radio direction finding station “Krug-M-A” bearing samples taken by operator are tagged with time markers coming from second markers channel of GPS precise time system that significantly increases validity of bearing information and provides a possibility to automate RES coordinates computation belonging to the same radionet.

Desktop of operators board
of RDF station “Krug-M-A”

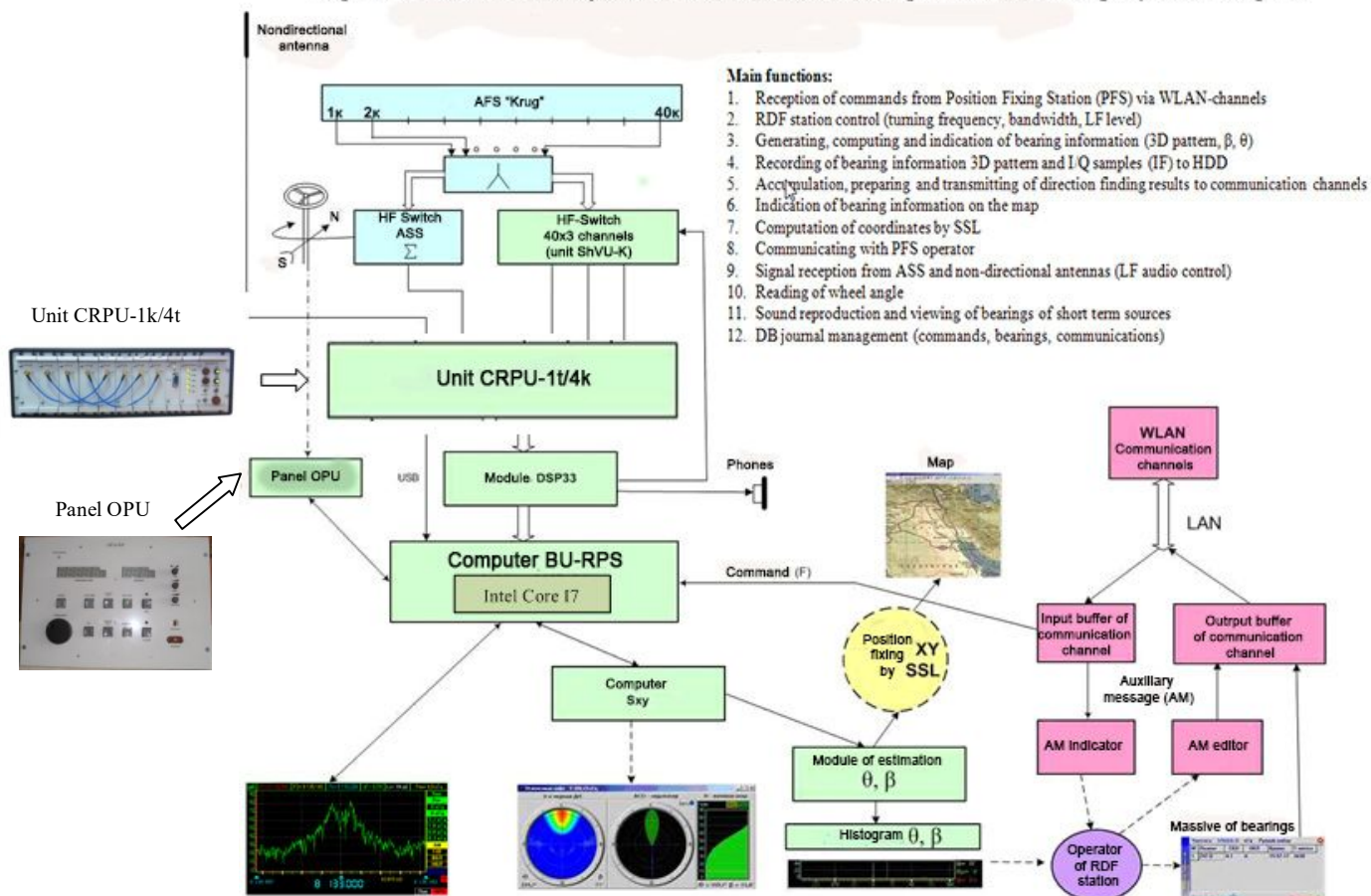


Modes of indication:

- Amplitude signal spectrum
- ASL-pattern (2 dimensional)
- 3D ASL-pattern (3 dimensional)
- H-histogram (directional pattern in elevation plane)
- Histogram of bearing samples («coarse»: -180°...+180° «fine»: -15°...+15°)
- Map with bears of bearings to RES and results of its position fixing by SSL method with ionosphere forecast

Equipment of station “Krug-M-A” on Customer’s request can be attached to the equipment of station R-300 as presented on the diagram below:

Diagram of interaction of subsystems of visual and automated signals direction finding in product "Krug-M-A"



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