Technical Design

Monitoring, Classification, RF Direction Finding and Jamming

CSL

Symlab GmbH
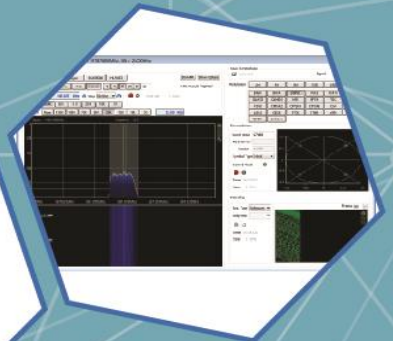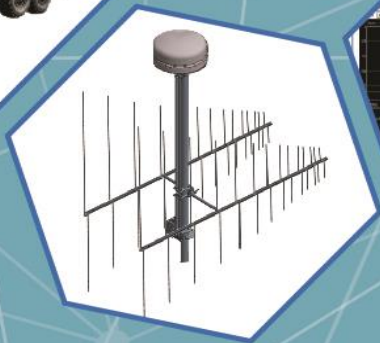
Introduction

One of the main concerns and challenges in critical infrastructure and military areas is the detection of unauthorized communications, as well as the disruption of such communications. Therefore, the use of spectrum monitoring systems, as well as disruptions of such signals, is key.

Detecting the type of communication in a radio spectrum is difficult and requires sophisticated specialized systems and knowledge. For this purpose, the system, will be able to identify the type of communication and extraction useful information. Another important issue is, to prevent unwanted communications.

The system uses the newest technical standards and application available in the market, such as direct digital sampling receivers/jammers, to be able, to jam signals as hoppers and CDMA signals. The system is installed in a shelter with air-condition, electric generator, mast and infrastructure for the operators. The whole system is mobile and fits on the most state of the art trucks.

The system is scalable; the drawing refers to the basic system Monitoring and classification up to 3GHz, DF and Jamming up to 1GHz. Optional and scalable as:

- Monitoring and Classification to 1GHz
- Monitoring and Classification to 3GHz
- Monitoring and Classification to 6GHz
- Monitoring and Classification to 8GHz
- Monitoring and Classification to 20GHz
- DF to 1GHz
- DF to 3GHz
- DF to 8GHz
- DF to 20GHz
- Jamming to 1GHz
- Jamming to 3GHz
- Jamming to 6GHz
- Jamming to 8GHz
- Jamming Output power 1kW
- Jamming Output power 2kW
- Jamming Output power 3kW
- One shelter, two or three different shelter, to separate monitoring unit from jamming unit

Basic system

Various measurements and jamming applications can be done in a basic system, such as:

- Spectrum monitoring in HF / VHF / UHF/ SHF bands (1.5 - 3000 MHz)
  - Search, detect and analyze signals and specify its main parameters
- Suppression
  - Preventing communication in the frequency band (20-3000) MHz
  - Suppressing satellite positioning systems
- Direction finding
  - Radio Signal Direction finding 20 to 3000 MHz
- Storage
  - Continuous cyclic recording of HF / VHF / UHF / SHF band signals
  - Analyzing offline the parameters of recorded signals

The main characteristics of the basic COMINT system:

PARAMETERS	SIGNIFICATIONS
RECONNAISSANCE SUBSYSTEM (MONITORING)	
Frequency Range	1.5-3000MHz
Simultaneous Review Bar (Monitoring Window)	1.5-30MHZ : 10MHz 30-3000MHZ : 80 MHZ 20-1000 :Up 120MHz
Frequency resolution	- for VHF jammer subsystem 10kHz - for HF receiver 1Hz - for VHF receiver 5kHz
Scanning speed	- for reconnaissance subsystem 20GHz/s(@RBW=10kHz) - for jammer subsystem 500GHz/s(@RBW=150kHz)
Frequency accuracy	100ppb
SUPRESSION SUBSYSTEM	
Frequency Range	20-3000MHz
Number of simultaneously suppressed channels	Channels are selected manually by the operator or reactive
Radiation power with VSWR 2:1 (ERP)	1000W
Frequency hopping suppression in the "Chase by frequency" mode	5000 Hops/s
Interference width	Max 250 MHz

General block diagram of the basic system

The diagram of **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the main components of the COMINT System which can vary depending on the options chosen:
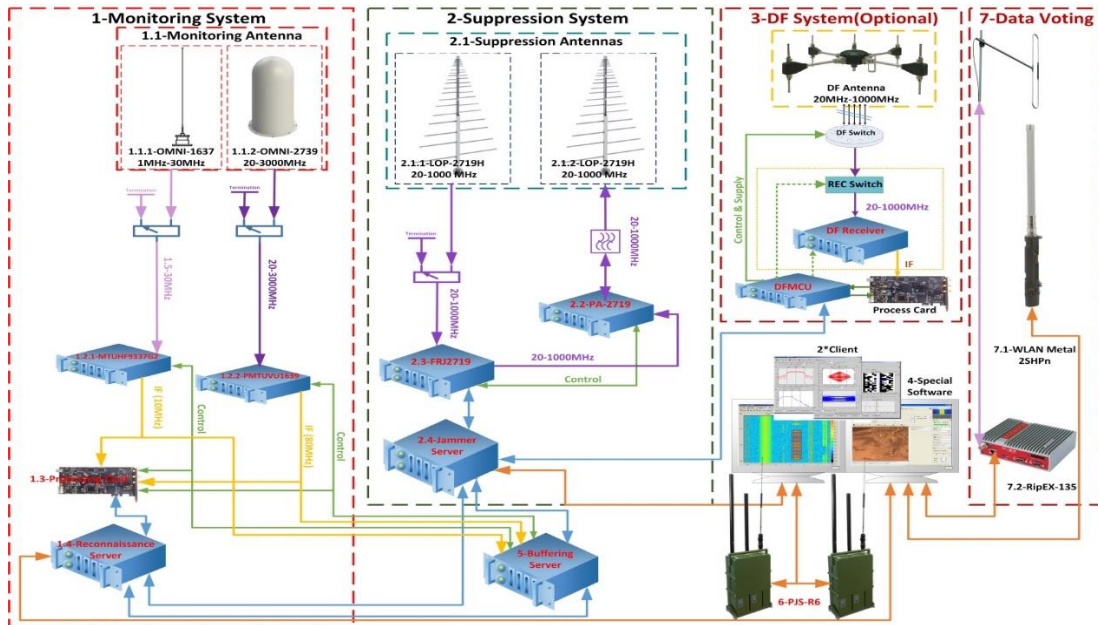
The system includes the following parts:

1. Monitoring System
    1.1. Monitoring Antenna
        1.1.1. HF Band: Omnidirectional (1-30MHz)
        1.1.2. VHF/UHF Band: Omnidirectional (20-3000MHz)
    1.2. Monitoring Receivers
        1.2.1. HF Band
        1.2.2. VHF/UHF Band
    1.3. Processing Card
    1.4. Reconnaissance Server
2. Jamming System
    2.1. RER/RES Antenna
        2.1.1. RER Antenna (20-3000MHz)
        2.1.2. RES Antenna (20-3000MHz)
    2.2. Power Amplifier
    2.3. RER/RES Subsystem (20-3000MHz)
    2.4. RER/RES Server
3. DF system
4. Monitoring Software
5. Buffering Server
6. Portable Jammers
7. Data Voting System
    7.1. WLAN
    7.2. VHF

System Structure:

The monitoring part of the jamming system can be used to detect, tune in and analyze signals in the frequency band of 1-3000 MHz. After detection of a signal of interest by the monitoring system, the direction of the signal is detected by the direction-finding system. By adjusting the angle of the LPDA antenna in the operational horizons, certain targeted communication channels in the frequency range of 1-3000 MHz can be suppressed.

Moreover, the jamming system has the ability automatically and separately receive all signals in the frequency of 1-3000, based on predefined instruction, jamming all the targeted signals can be achieved.

In the only monitoring mode, this system can be used for detecting, listening, and analyzing signals in the frequency band of 1-3000 MHz both online and offline.

System Functions

The system can be used quickly in different scenarios. The system can share the results and information among multiple COMINT systems, but each system can operate individually if necessary. There are multiple modes that allows users to monitor and suppress signals in different ways.

Monitoring mode

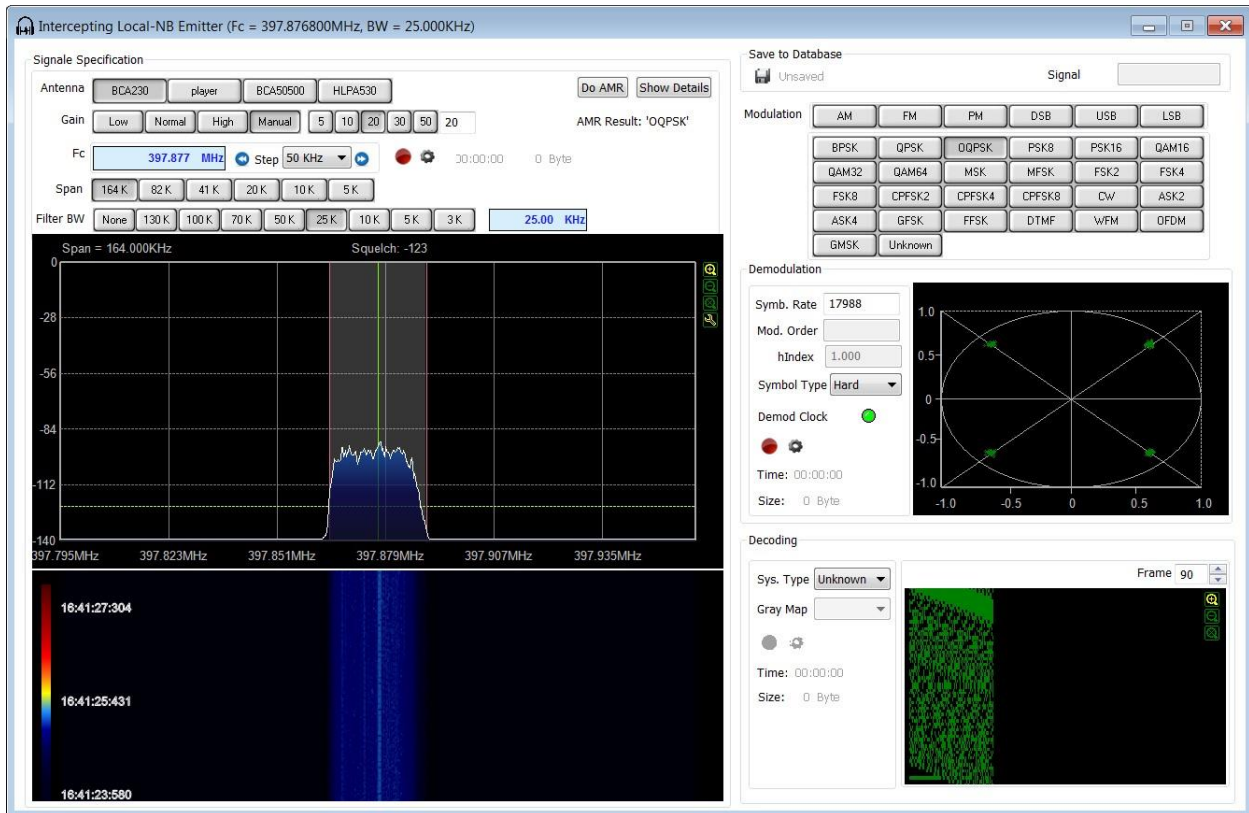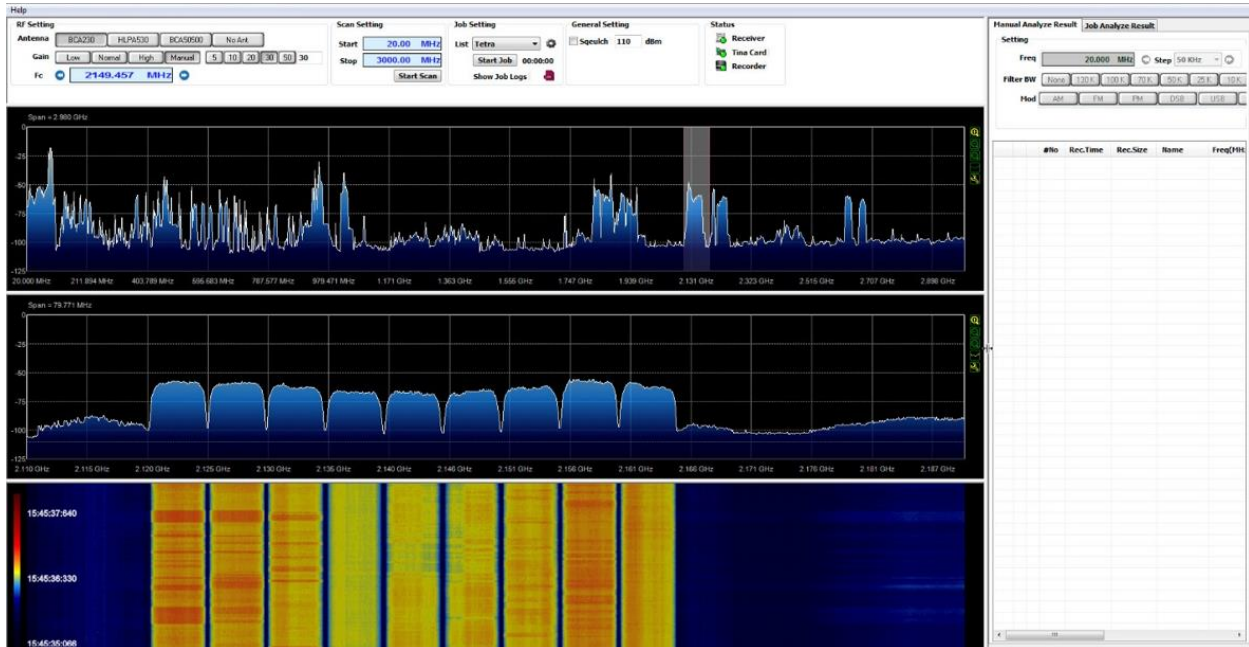In monitoring mode, the system has the capabilities as mentioned below:

1. Two twin monitors simultaneously display the spectrum in time-frequency and frequency-domain formats. Also displayed on the location map.
2. Technical analysis of signals in the band and extraction of parameters such as modulation type, bandwidth, carrier frequency, signal level, etc.
3. Storage of technical analysis results in the database.
4. Automatic detection of modulation type
5. Detecting the protocols and modulations
6. COMINT system positioning function using GPS automatically and in manual mode by entering latitude and longitude.
7. Synchronization of different systems with the GPS or GLONASS clock, automatically and manually.
8. Automatic signal direction detection compared to north by electronic compass.
9. Listening to 256 channels (as presented in a list periodically, and only six channels simultaneously); narrow band (up to 100 kHz for the VHF band and up to 20 kHz for the HF band); Designated with predetermined parameters such as modulation type, bandwidth, listening time, and so on.
10. The ability to store received signals and use them for processing and technical analysis.
11. Save results.
12. Ability to report work results to send and communicate with other COMINT systems
13. Software that provides BCCH channel information for various mobile network generations, such as LTE / UMTS / GSM.

The monitoring system consists of two radio receivers and two antennas that provide rapid monitoring of the HF band (1.5 - 30 MHz) and the VHF / UHF band (20-3000 MHz).

The receiver system provides very high-speed data analysis to detect and track the signal (in Frequency hopping mode), detection and analysis are performed on a buffer, the detection of hopping is not real-time. It can store 10 MHz bandwidth in the HF band and 80 MHz bandwidth in the VHF / UHF band into the buffering system for at least one hour (can be customized).

The system can simultaneously process 6 narrowband processing channels for detecting and analyzing the content (scalable). The monitoring includes the following main sections:

- HF band antenna
- VHF / UHF band antenna
- HF Band Receiver
- VHF / UHF Band Receiver
- Processing card
- Monitoring server

File Setting Help

| Clear | Search |

Filter type | Values
Frequency (MHz) | (300.0,400.0)
Bandwidth (KHz) | (20.0,35.0)

Status: **Request executed.**

Recor...	No.	ID	Start Time	Frequency(M...	BandWidth(K...	Modulation	BaudR...	Hopping Freq L...	Hop...
No	970	2815	2018/02/03 10:14:43	396.9481	30.75		0.0		0.0
No	971	2817	2018/02/03 10:14:50	395.2466	20.50		0.0		0.0
No	972	2820	2018/02/03 10:14:50	397.8219	23.06		0.0		0.0
No	973	2823	2018/02/03 10:14:55	397.7219	30.75		0.0		0.0
No	974	2825	2018/02/03 10:14:59	398.3472	20.50		0.0		0.0
No	975	2831	2018/02/03 10:15:06	397.7219	30.75		0.0		0.0
No	976	2832	2018/02/03 10:15:10	395.2491	23.06		0.0		0.0
No	977	2833	2018/02/03 10:15:10	397.8219	23.06		0.0		0.0
No	978	2838	2018/02/03 10:15:23	392.9736	23.06		0.0		0.0
No	979	2839	2018/02/03 10:15:23	396.6483	30.75		0.0		0.0
No	980	2841	2018/02/03 10:15:23	397.7219	30.75		0.0		0.0
No	981	2843	2018/02/03 10:15:26	392.7481	23.06		0.0		0.0
No	982	2844	2018/02/03 10:15:26	395.4618	33.31		0.0		0.0
No	983	2848	2018/02/03 10:15:30	398.3498	23.06		0.0		0.0
No	984	2850	2018/02/03 10:15:38	396.6483	30.75		0.0		0.0
No	985	2851	2018/02/03 10:15:38	397.8219	23.06		0.0		0.0
No	986	2852	2018/02/03 10:15:42	396.4996	28.19		0.0		0.0
No	987	2856	2018/02/03 10:15:51	397.7219	30.75		0.0		0.0
No	988	2857	2018/02/03 10:15:55	397.8219	25.63		0.0		0.0
No	989	2861	2018/02/03 10:15:59	396.3715	30.75		0.0		0.0
No	990	2865	2018/02/03 10:16:07	396.4996	28.19		0.0		0.0
No	991	2868	2018/02/03 10:16:12	397.8219	23.06		0.0		0.0
No	992	2873	2018/02/03 10:16:15	397.7219	30.75		0.0		0.0
No	993	2878	2018/02/03 10:16:23	397.8219	23.06		0.0		0.0
No	994	2881	2018/02/03 10:16:32	398.3498	23.06		0.0		0.0
No	995	2882	2018/02/03 10:16:36	397.7219	30.75		0.0		0.0
No	996	2886	2018/02/03 10:16:40	397.8219	23.06		0.0		0.0
No	997	2890	2018/02/03 10:16:44	396.4996	28.19		0.0		0.0
No	998	2897	2018/02/03 10:16:48	398.3472	20.50		0.0		0.0
No	999	2900	2018/02/03 10:16:57	395.1979	20.50		0.0		0.0
No	1000	2901	2018/02/03 10:16:57	396.4996	28.19		0.0		0.0

1 Record Per Page 1000

Records' List

Type	Start Record Time	Duration(s)	Files Count	Antenna	Gain Mode	Gain V...

Files' List

| Filename	Size	Status

Direction finding mode

In DF mode, the system has the following capabilities:

- Ability to locate burst, frequency hopping and chirp signals in addition to conventional CW telecommunication signals with analog or digital modulation.
- Ability to follow animated targets
- Categorizing transmitters based on the type of signal received from them
- Ability to filter known transmitters based on their frequency and location
- Simple user interface in both online and offline
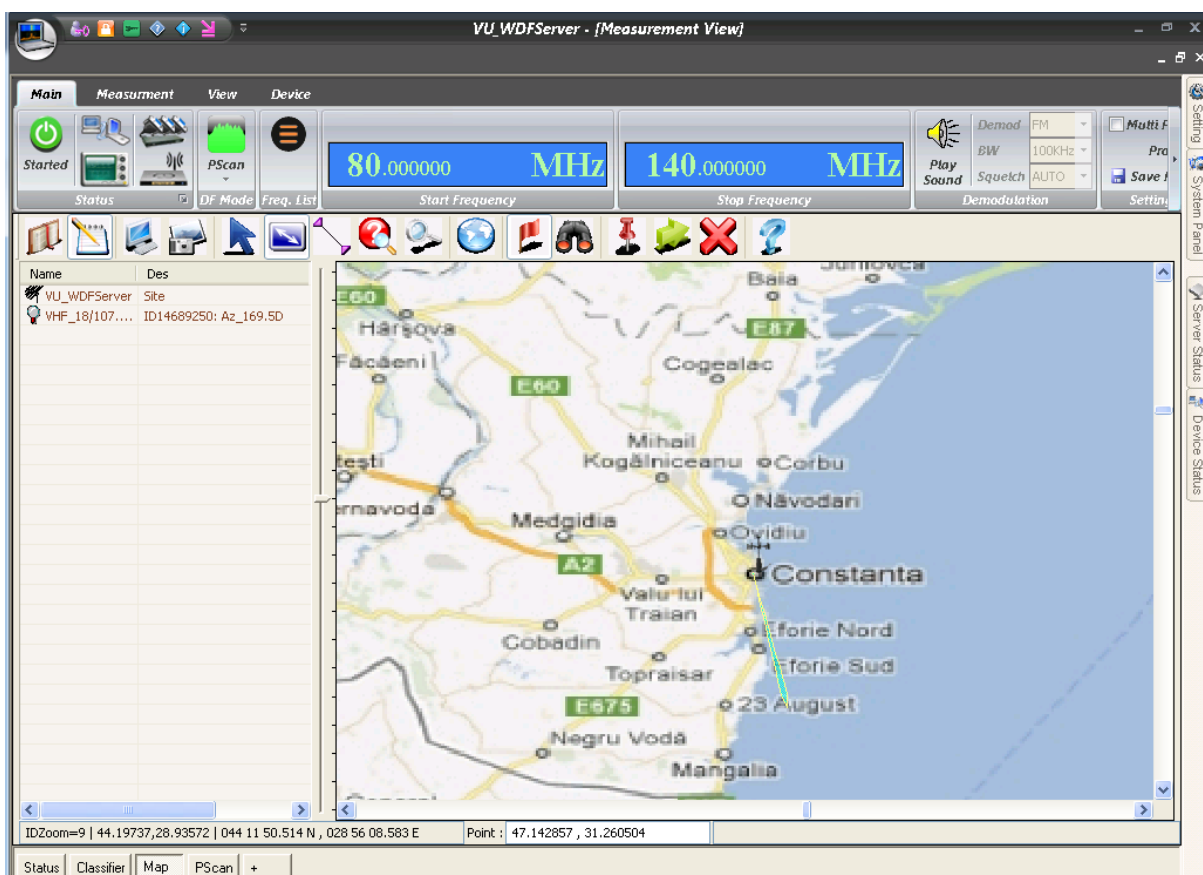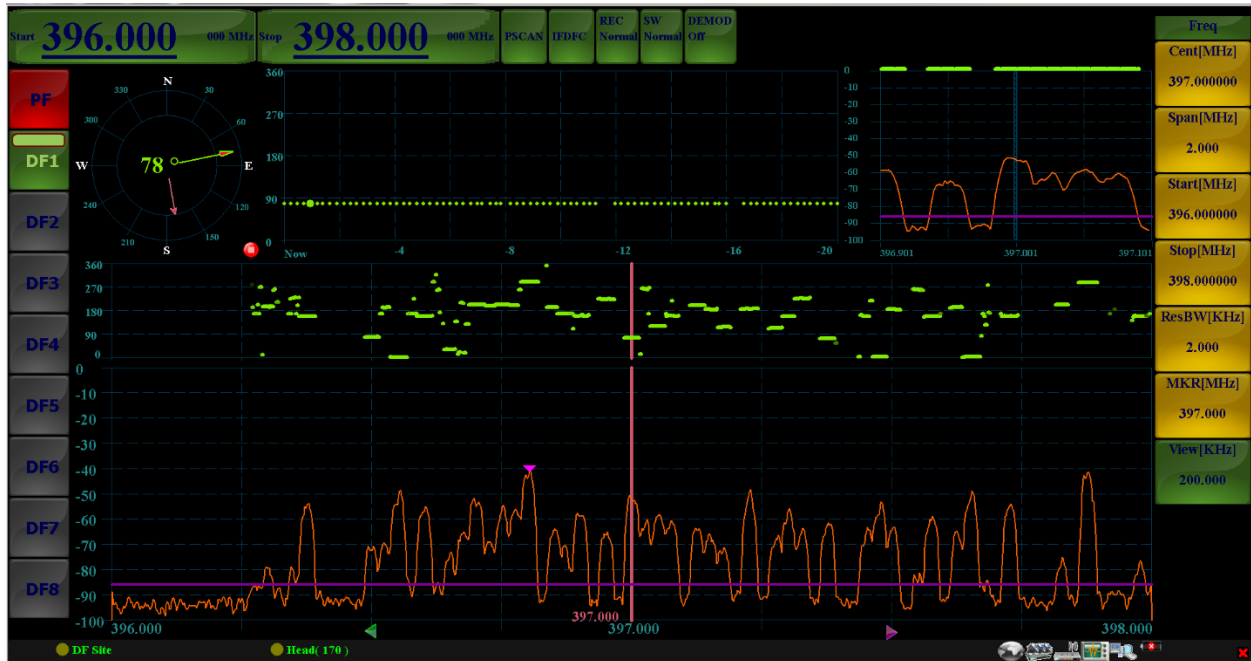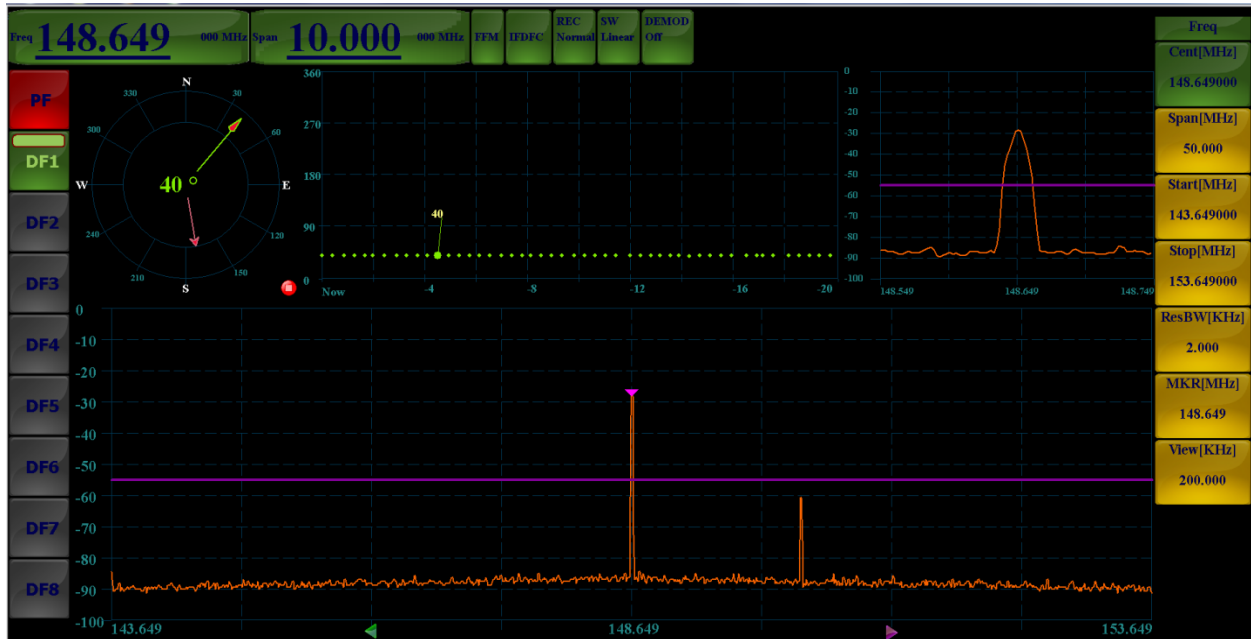
Jamming mode

Manual Mode

In this mode, the jammer interferes with predetermined frequencies manually programmed to the jammer with information from the monitoring and DF part.

Automatic Mode

Auto mode provides two different methods of jamming:

1   Jamming radio communications at specified frequencies (Suppression of radio transmissions at fixed frequencies), parameters such as the number of intermittent simultaneously interrupted frequencies, bandwidth, signal detection threshold, jamming signal type, frequency shift between receiver frequency and transmitter (up to 50 MHz), and other necessary parameters can be preset by the operator. In case one preprogramed signal appears in the spectrum the jammer switches on.

2   Responsive jamming (reactive) of radio communication at specified frequencies allocated frequency band (reactive suppression of radio transmissions at fixed frequencies belonging to the allocated frequency band). In this jamming mode, the jamming system operates as follows:

   - At the time of monitoring (receiving time), active signals in the assigned bandwidth and frequencies will be detected

   - At jamming time (transmitting time), the active signals in the assigned bandwidth and frequencies detected during receiving time will be transmitted automatically.

Parameters such as frequencies to be interrupted, the number of simultaneously disrupted frequency bands, bandwidth, signal detection threshold, distortion signal type, frequency shift between receiver and transmit frequency (up to 50 MHz) And other parameters are set by the system automatically.

Other considerations: the jammer software includes to save, edit and convert various storage formats (mp3, wav, etc.) and sound files. It is possible to use the stored signals as a disturbing signal. This software could communicate with other COMINT systems, such that they can exchange files together and share instant messages and reports.

INFRASTRUCTURE

Telecommunication Racks

The main equipment is in telecommunication racks equipped with vibration isolation supports. Vibro-isolating supports are selected considering the mass of installed equipment and provide protection against shaking and vibration. The racks are also equipped with interface plates to ensure fastening to the shelters.

GPS/GLONASS Receiver

To determine the location of stations, and to synchronize all computers on a single time source, the stations use a GPS / GLONASS device with a remote antenna. This I done, to ensure that all actions will be registered according to a single source of time.

Operators Workplace

The operator's workplace comes with a system and is based on highly reliable computers with monitors. On the operator's workplace, certain software with a user interface will be installed, according to its role in the context of the work of the station. Headphones will be supplied to the operator's workplace, which will be used to listen to signals from receivers or to play back recorded signals.
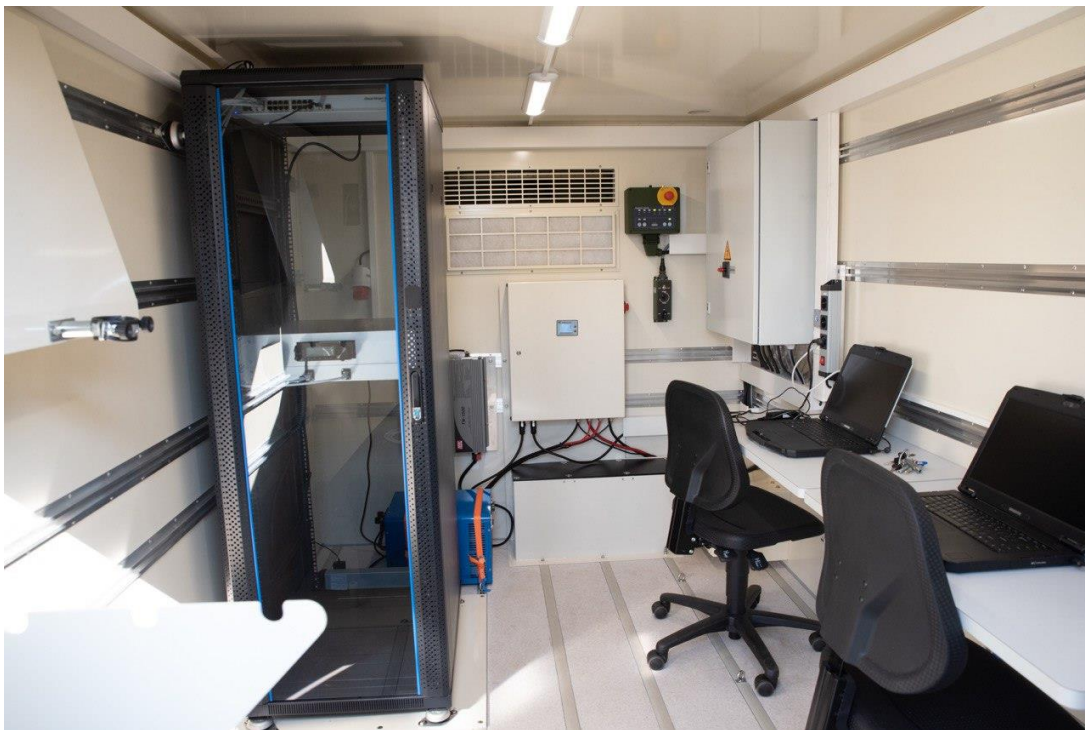
MAST Features

- Manual tilt mechanism
- Electric rotators
- Vertical load - 120 kg
- Height 8 m
- Electric / manual lift drive

Track and Trailor

The transport chassis is a cross-country vehicle with a wheel arrangement of 6x6. The chassis is equipped with a towing device and a spare wheel holder located behind the cab. The kit includes 4 sets of filter elements (for fuel, oil, air) and a special tool for simple repairs (hydraulic jack, hammer, chisel, special keys and pullers, screwdrivers, etc.). The customer can choose only on one truck or split between trach and a trailer.

Shelters

The shelters are designed for extreme mobile applications. This type of body provides a shielding efficiency of ≥60 dB. The shelter itself is already designed as a shielded casing, therefore only the appropriate HF shielding components for doors, windows and other openings are added. These technologies are many years of operational experience in armed forces of different countries in the world.

Key Features:

- Shielded shelter with beveled corners
- Shielding ≥60dB @ 100kHz ... 1GHz (MIL-STD 285 and VG 95370T15 distance to the antenna 0.6 m)
- C-profiles for easy installation of equipment
- Aluminum welded construction
- Interfaces for masts and other equipment
- ISO-angles for fixing on the platform
- Integrated heating and air-conditioning system
- Full harmonization for the possibility of installing a filter unit
- The level of acoustic high-frequency emissions within the operators' work area corresponds to international standards
- Dimensions correspond to ST RK 1555-2006 and provide transportation of railway stations with transport without dismantling it from the car frame.

Air Conditioning

The entire system is a compact module and is suitable for installation on mobile structures. The components of the air conditioning system are combined in the shelter.

Electric Generator

Diesel power generator is designed for mobile applications and work in harsh climatic conditions. Built-in preheating engine allows the generator to be operated in extremely cold temperatures.

The generator has a local and remote-control panel. The remote-control panel is located inside the shelter.

Main technical features:

- Output power: 15 - 30 kVA, 400 V ± 5%, 50 Hz
- Working time without refueling - 12 hours
- Retractable rails for maintenance
- Soundproof cover
- Easy access to the tank neck
- The oil drain hose is located under the housing
- Ability to operate at an ambient temperature of -40C to + 40C
- Possibility to provide power with variable load without time limit
- Permanent monitoring of insulation