



SYSTEM FOR GENERATING SIMULATED  
INTERFERENCE TO SATELLITE NAVIGATION SYSTEMS



Russian scientific research and production company. Part of the "Complex systems" group of companies.

For many years, it has been developing, producing, and implementing comprehensive solutions for monitoring and protecting site-based and linear objects.

#### Advantages of the company:

- own scientific, technological, and production facilities;
- proven quality and reliability of products through joint testing with the Ministry of Defense of Russia, the FSB of Russia, and the FSO of Russia;
- high scientific potential of employees at "BG-Optics", including professors, candidates, and doctors of physical-mathematical and technical sciences.

The scientific potential and practical experience of employees in the development and production of high-tech products allow for high-quality and timely solutions to a wide range of non-standard tasks.

## OUR PRODUCTS



### CHAMELEON L1/GPS

DYNAMIC SPOOFING



### CHAMELEON-X5 B1/BeiDou

DYNAMIC SPOOFING



### CHAMELEON-X6 E1/Galileo

DYNAMIC SPOOFING



### CHAMELEON-X7 L1/GLONASS

DYNAMIC SPOOFING



### ZOLOTOPRYAD

CENTRALIZED SIGNAL GENERATOR CONTROL



### CICADA

SIGNAL GENERATOR



### IBIS

BROADBAND  
SUPPRESSION UNIT



### SOUYONOK

EPHEMERIS SERVER



# Analysis of UAV Attacks

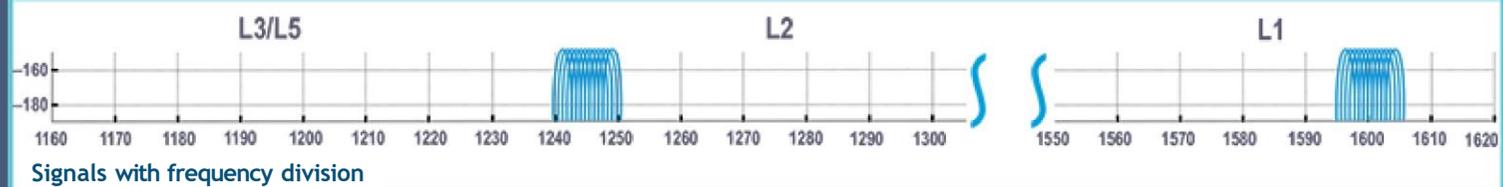
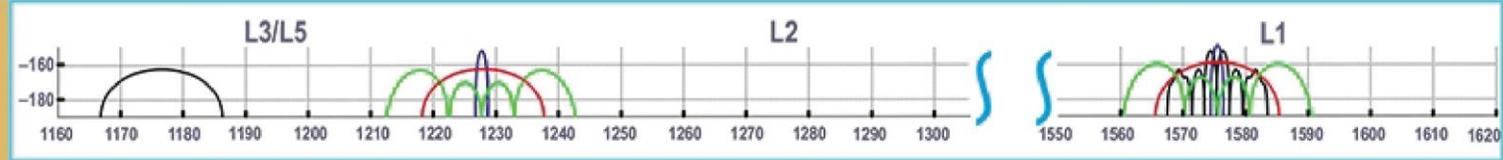
To provide data for developing threat models and intruder models, the company "BG-Optics" conducted an analysis of publications by the Ministry of Defense of the Russian Federation and the media.

Primarily, attacks are planned so that UAVs reach their targets during nighttime, making visual detection and counteraction by electronic weapons, optical detection tools, and firearms of security personnel more difficult.

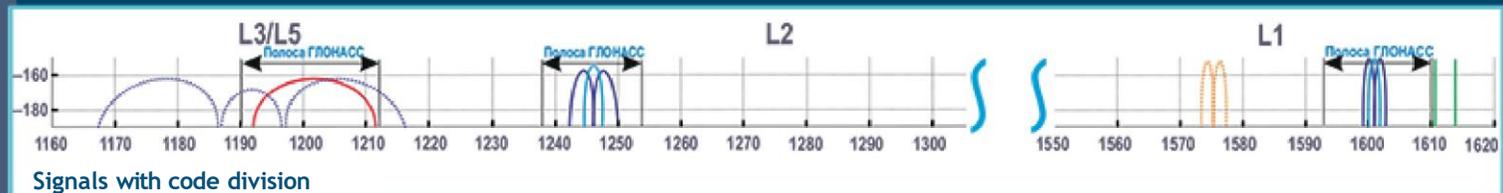
## Several methods of UAV control can be identified:

- 1. Global Navigation Satellite System (GNSS):** The study of UAV debris and attack videos suggests the launch of UAVs over distances of tens or hundreds of kilometers. These are typically fixed-wing UAVs. In 98% of cases, flights are carried out automatically using satellite radio navigation systems (1164 –1610 MHz) without transmitting information back to the ground.
- 2. Inertial Navigation Systems (INS):** This navigation system lacks the necessary accuracy for carrying out attacks. Additional disadvantages include the cost of navigation equipment when aiming for increased precision.
- 3. Manual Control:** There is no evidence of the use of FPV drones (first-person view) for diversionary activities at enterprises. Most attacks with their help occur near the front line of combat contact, at a distance of no more than 5-7 km. Control is carried out at frequencies of 700 –1200 MHz.

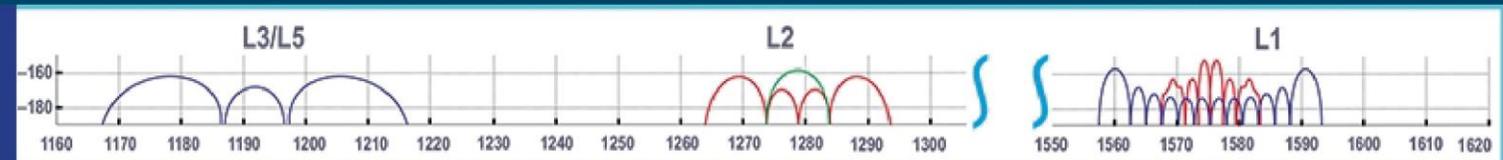
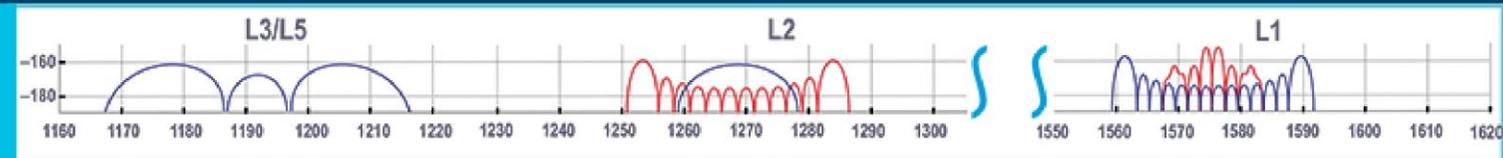
Regarding suppression, considering that fixed-wing UAVs can reach targets via inertia, the most relevant methods for combating detected UAVs are jamming, deceptive trajectory changes, and the use of systems that mimic a false target, redirecting UAVs to a fake location.



Signals with frequency division



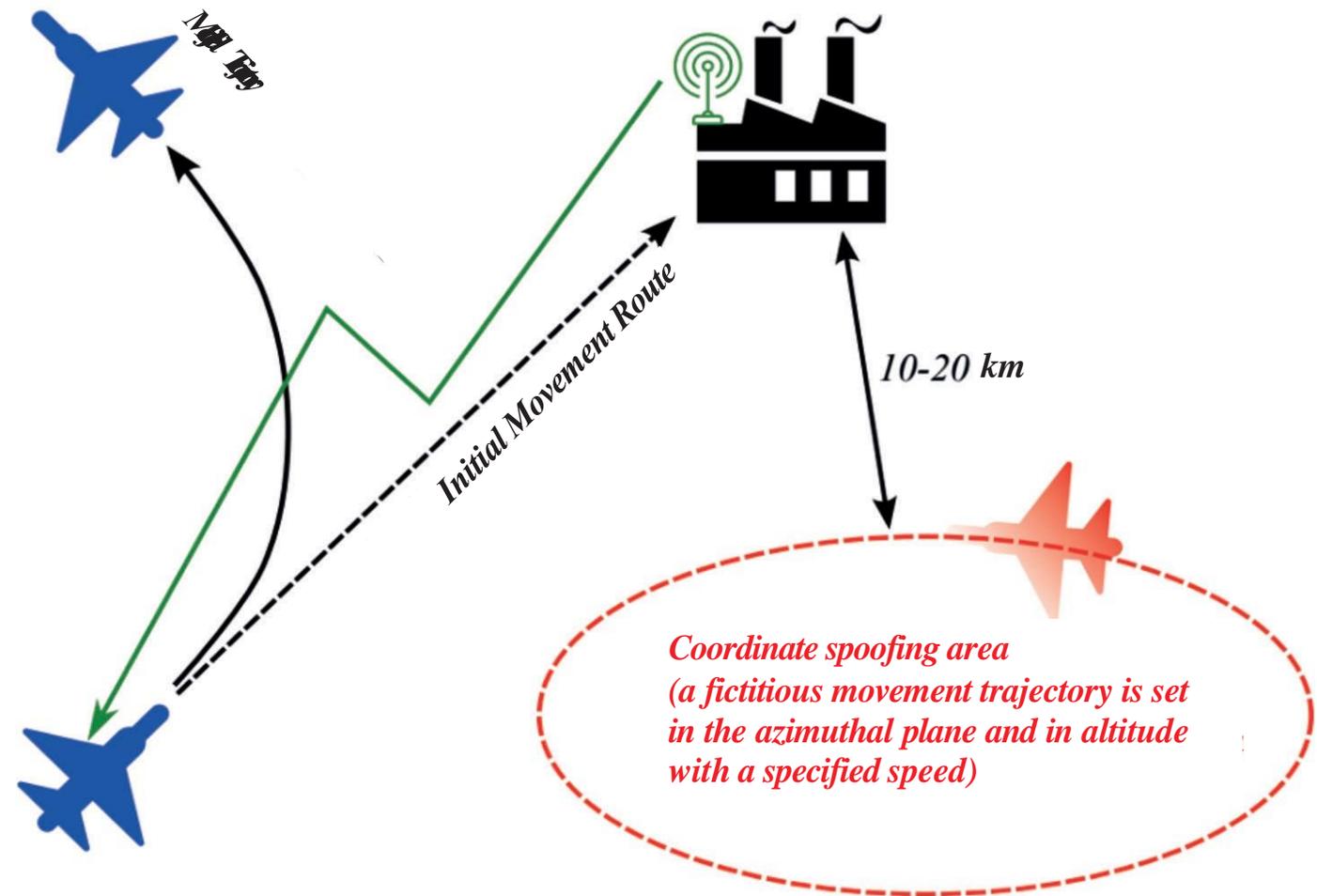
Signals with code division



\* based on materials from the website: <https://glonass-iac.ru>

## FREQUENCY IMPACT PLAN:

- L1 band (GPS) - coordinate spoofing;
- B1 band (BeiDou) – coordinate spoofing;
- E1 band (Galileo) – coordinate spoofing;
- L1 band (GLONASS) – coordinate spoofing;
- L2 + L5 bands (all GNSS) – barrage (wideband noise) jamming.



## Basic dynamic spoofer "CHAMELEON" L1/GPS. Stationary

Uses a spoofing attack method where the false signal source is synchronized in phase, code, and Doppler frequency with the authentic GNSS signal (Overlapped attack). Ephemeris data is obtained from the proprietary "SOVENOK" server network.



## Principle of operation

The "CHAMELEON" spoofer performs navigation field spoofing by transmitting false satellite navigation signals. Due to the higher power of the false signal, any GNSS receiver within the coverage area prioritizes this signal and switches to it, receiving false coordinates. These false coordinates simulate movement along a predefined trajectory with specified radius, altitude, and speed.

## Technical specifications. Stationary model

<b>Coverage radius</b>	up to 20 km	<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Device weight</b>	No more than 15 kg	<b>Protection level</b>	GOST 14254-96 – IP – 66
<b>Dimensions (WxHxD)</b>	metal cabinet 400x210x400 mm	<b>Spoofing modes</b>	Static, Dynamic
<b>Operating time</b>	24/7	<b>Parameters of simulated motion dynamics in the navigation field</b>	Altitude range: 0-10,000 m Speed range: 0-1,000 km/h
<b>Power consumption</b>	up to 500 W	<b>Object motion model parameter</b>	Constant preset speed Zero speed Movement along a predefined trajectory
<b>Power supply</b>	from 90 to 264 V AC (47 to 63 Hz)	<b>Switching of GNSS output signal power level</b>	Discrete
<b>Operating temperature range</b>	-40°C to +55°C	<b>Emitter configuration</b>	Omnidirectional Directional Sectoral
<b>Control interface</b>	Ethernet (LAN) - 10/100 Base-T (TCP/IP and DHCP)		



AMELEO

# Basic dynamic spoofer "CHAMELEON-X5" L1/BeiDou



## Basic dynamic spoofer "CHAMELEON-X5" L1/BeiDou

Designed to simulate the code signals of GNSS spacecraft in the BeiDou B1 band elements of the BAS (BVS and SVP) and to provide protection of guarded objects from adversarial BVS intrusion.

Ephemeris data is obtained from the proprietary "SOVENOK" server network.

### Principle of operation

The "CHAMELEON" spoofer performs navigation field spoofing by transmitting false satellite navigation signals. Due to the higher power of the false signal, any GNSS receiver within the coverage area prioritizes this signal and switches to it, receiving false coordinates. These false coordinates simulate movement along a predefined trajectory with specified radius, altitude, and speed.

- ✓ Emission range, MHz – from 1559 to 1563
- ✓ Emission class: BPSK;
- ✓ Emission power: up to 15 dBW.

### Technical specifications. Stationary model

Coverage radius	up to 20 km
Device weight	No more than 15 kg
Dimensions (WxHxD)	metal cabinet 400x210x400 mm
Operating time	24/7
Power consumption	up to 500 W
Power supply	220±20 V AC (from 47 to 63 Hz)
Operating temperature range	-40°C to +50°C
Control interface	Ethernet (LAN) - 10/100 Base-T (TCP/IP and DHCP)

Operating system	Embedded real-time operating system from the Linux family
Protection level	GOST 14254-96 – IP – 54
Spoofing modes	Static, Dynamic
Parameters of simulated motion dynamics in the navigation field	Altitude range: 0-10,000 m Speed range: 0-1,000 km/h
Object motion model parameter	Constant preset speed Zero speed Movement along a predefined trajectory
Switching of GNSS output signal power level	Discrete
Emitter configuration	Omnidirectional Directional Sectoral



- ✓ Emission range, MHz – from 1559 to 1591
- ✓ Emission class: BPSK;
- ✓ Emission power: up to 15 dBW.

## Basic dynamic spoofer "CHAMELEON-X6" E1/Galileo

Designed to simulate GNSS satellite code signals in the E1/Galileo band elements of the BAS (BVS and SVP) and to provide protection of guarded objects from adversarial BVS intrusion.

Ephemeris data is obtained from the proprietary "SOVENOK" server network.

### Principle of operation

The "CHAMELEON" spoofer performs navigation field spoofing by transmitting false satellite navigation signals. Due to the higher power of the false signal, any GNSS receiver within the coverage area prioritizes this signal and switches to it, receiving false coordinates. These false coordinates simulate movement along a predefined trajectory with specified radius, altitude, and speed.

### Technical specifications. Stationary model

<b>Coverage radius</b>	up to 20 km
<b>Device weight</b>	No more than 15 kg
<b>Dimensions (WxHxD)</b>	metal cabinet 400x210x400 mm
<b>Operating time</b>	24/7
<b>Power consumption</b>	up to 500 W
<b>Power supply</b>	220±20 V AC (from 47 to 63 Hz)
<b>Operating temperature range</b>	-40°C to +55°C
<b>Control interface</b>	Ethernet (LAN) - 10/100 Base-T (TCP/IP and DHCP)

<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Protection level</b>	GOST 14254-96 – IP – 54
<b>Spoofing modes</b>	Static, Dynamic
<b>Parameters of simulated motion dynamics in the navigation field</b>	Altitude range: 0-10,000 m Speed range: 0-1,000 km/h
<b>Object motion model parameter</b>	Constant preset speed Zero speed Movement along a predefined trajectory
<b>Switching of GNSS output signal power level</b>	Discrete
<b>Emitter configuration</b>	Omnidirectional Directional Sectoral



- ✓ Emission range, MHz – from 1598 to 1605;
- ✓ Emission class: BPSK;
- ✓ Emission power: up to 15 dBW.

## Basic dynamic spoofer "CHAMELEON-X7" L1/GLONASS

Designed to simulate GNSS satellite code signals in the L1/GLONASS band elements of the BAS (BVS and SVP) and to provide protection of guarded objects from adversarial BVS intrusion.

Ephemeris data is obtained from the proprietary "SOVENOK" server network.

### Principle of operation

The "CHAMELEON" spoofer performs navigation field spoofing by transmitting false satellite navigation signals. Due to the higher power of the false signal, any GNSS receiver within the coverage area prioritizes this signal and switches to it, receiving false coordinates. These false coordinates simulate movement along a predefined trajectory with specified radius, altitude, and speed.

### Technical specifications. Stationary model

<b>Coverage radius</b>	up to 20 km
<b>Device weight</b>	No more than 15 kg
<b>Dimensions (WxHxD)</b>	metal cabinet 400x210x400 mm
<b>Operating time</b>	24/7
<b>Power consumption</b>	up to 500 W
<b>Power supply</b>	220±20 V AC (from 47 to 63 Hz)
<b>Operating temperature range</b>	-40°C to +55°C
<b>Control interface</b>	Ethernet (LAN) - 10/100 Base-T (TCP/IP and DHCP)

<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Protection level</b>	GOST 14254-96 – IP – 54
<b>Spoofing modes</b>	Static, Dynamic
<b>Parameters of simulated motion dynamics in the navigation field</b>	Altitude range: 0-10,000 m Speed range: 0-1,000 km/h
<b>Object motion model parameter</b>	Constant preset speed Zero speed Movement along a predefined trajectory
<b>Switching of GNSS output signal power level</b>	Discrete
<b>Emitter configuration</b>	Omnidirectional Directional Sectoral

# Basic dynamic spoofer "CHAMELEON" L1/GPS. Stationary. High-power version



## Basic dynamic spoofer "CHAMELEON" L1/GPS. Stationary. High-power version

Uses a spoofing attack method where the false signal source is synchronized in phase, code, and Doppler frequency with the authentic GNSS signal (Overlapped attack). Ephemeris data is obtained from the proprietary "SOVENOK" server network.

### Principle of operation

The "CHAMELEON" spoofer performs navigation field spoofing by transmitting false satellite navigation signals. Due to the higher power of the false signal, any GNSS receiver within the coverage area prioritizes this signal and switches to it, receiving false coordinates. These false coordinates simulate movement along a predefined trajectory with specified radius, altitude, and speed.

### Technical specifications. Stationary version. High-power version

<b>Coverage radius</b>	up to 40 km
<b>Device weight</b>	25 kg
<b>Dimensions (WxHxD)</b>	metal cabinet 450x230x700 mm
<b>Operating time</b>	24/7
<b>Power consumption</b>	up to 1 kW
<b>Power supply</b>	from 90 to 264 V AC (from 47 to 63 Hz)
<b>Operating temperature range</b>	-40°C to +55°C
<b>Control interface</b>	Ethernet (LAN) - 10/100 Base-T. (TCP/IP и DHCP)

<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Protection level</b>	GOST 14254-96 – IP – 54
<b>Spoofing modes</b>	Static, Dynamic
<b>Parameters of simulated motion dynamics in the navigation field</b>	Altitude range: 0-10,000 m Speed range: 0-1,000 km/h
<b>Object motion model parameter</b>	Constant preset speed Zero speed Movement along a predefined trajectory
<b>Switching of GNSS output signal power level</b>	Discrete
<b>Emitter configuration</b>	Omnidirectional Directional, Sectoral

## Basic dynamic spoofer "CHAMELEON" L1/GPS. Mobile

Uses a spoofing attack method where the false signal source is synchronized in phase, code, and Doppler frequency with the authentic GNSS signal (Overlapped attack)



## Principle of operation

The "CHAMELEON" spoofer performs navigation field spoofing by transmitting false satellite navigation signals. Due to the higher power of the false signal, any GNSS receiver within the coverage area prioritizes this signal and switches to it, receiving false coordinates. These false coordinates simulate movement along a predefined trajectory with specified radius, altitude, and speed.

## Technical specifications. Mobile model

<b>Coverage radius</b>	up to 5 km
<b>Device weight</b>	7 kg
<b>Dimensions (WxHxD)</b>	Impact-resistant case, 340×300×160 mm
<b>Operating time</b>	Autonomous operation at ambient temperature from 0°C to +30°C – at least 4 hours / autonomous operation at ambient temperature from +16°C to +30°C – 6 hours
<b>Power consumption</b>	up to 75 W
<b>Power supply</b>	Built-in rechargeable battery, external power supply/charger
<b>Operating temperature range</b>	-20°C to +30°C
<b>Control interface</b>	Ethernet (LAN) - 10/100 Base-T. (TCP/IP и DHCP), WIFI

<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Protection level</b>	GOST 14254-96 – IP – 54
<b>Spoofing modes</b>	Static, Dynamic
<b>Parameters of simulated motion dynamics in the navigation field</b>	Altitude range: 0-10,000 m Speed range: 0-1,000 km/h
<b>Object motion model parameter</b>	Constant preset speed Zero speed Movement along a predefined trajectory
<b>Switching of GNSS output signal power level</b>	Discrete
<b>Emitter configuration</b>	Omnidirectional Directional, Sectoral



**CICADA**

# Signal generator "CIKADA"

## Signal generator "CIKADA" – intelligent jammer for L1/GLONASS frequencies

Designed for generating a range-finding radio frequency signal with the required signal-to-noise ratio for testing and determining the technical characteristics of radionavigation system channels, simulating the operation of satellite radio links.



### Principle of operation

The operating principle is based on generating a noise signal with binary phase-shift keying (BPSK) modulation at the output in two channels, simulating the operation of satellite radio links while maintaining the required signal-to-noise ratio.

### Technical specifications. Stationary model

- ✓ Type of generated interference – signal with binary phase-shift keying (BPSK);
- ✓ number of transmission channels – 2;
- ✓ emission range of Channel 1, MHz – from 1558 to 1564;
- ✓ emission Range of Channel 2, MHz – from 1590 to 1610.

<b>Coverage radius</b>	up to 20 km
<b>Device weight</b>	No more than 15 kg
<b>Dimensions (WxHxD)</b>	metal cabinet 400x210x400 mm
<b>Operating time</b>	24/7

<b>Power consumption</b>	up to 500 W
<b>Power supply</b>	from 90 to 264 V AC (47 to 63 Hz)
<b>Operating temperature range</b>	-40°C t+55°C
<b>Control interface</b>	Ethernet (LAN) -10/100 Base-T. (TCP/IP and DHCP)
<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Protection level</b>	GOST 14254-96 – IP – 54



# Wideband frequency jamming unit "IBIS" L2+L5



## Wideband frequency jamming unit "IBIS" L2+L5

The generator is designed to produce radio frequency chirp signals with a required signal-to-noise ratio for suppressing communication and control channels of radionavigation systems used by unmanned aerial vehicles (UAVs) operating with radio signals from global navigation satellite systems (GPS (L5), (L2), GLONASS (L5), (L2), Galileo (E5), (E6), BeiDou (B2), (B3)).

### Technical specifications. Stationary version

- ✓ Type of generated interference - signal with linear frequency modulation;
- ✓ number of emission channels - 2;
- ✓ emission range of Channel 1: GPS (L2), GLONASS (L2); Galileo (E5), BeiDou (B2);
- ✓ emission range of Channel 2: GPS (L5), GLONASS (L5); Galileo (E6), BeiDou (B3).

<b>Coverage radius</b>	up to 20 km
<b>Device weight</b>	No more than 15 kg
<b>Dimensions (WxHxD)</b>	metal cabinet 400x210x400 mm
<b>Operating time</b>	24/7

<b>Power consumption</b>	up to 500 W
<b>Power supply</b>	from 90 to 264 V AC (47 to 63 Hz)
<b>Operating temperature range</b>	-40°C t+55°C
<b>Control interface</b>	Ethernet (LAN) -10/100 Base-T. (TCP/IP and DHCP)
<b>Operating system</b>	Embedded real-time operating system from the Linux family
<b>Protection level</b>	GOST 14254-96 – IP – 54



ZOLOTOPRYAD

# Centralized control system for signal generators

## "ZOLOTOPRYAD" - centralized control system for signal generators

Allows real-time monitoring of the operating status of "CHAMELEON" and "CIKADA" signal generators at secured facilities, as well as control of their emission power via control relays.

### The system includes:

- ✓ monitoring the operating status of "CHAMELEON" and "CIKADA" signal generators;
- ✓ monitoring the status of emission power control relays;
- ✓ emission power control via relays (on/off)
- ✓ viewing the history of relay status changes (user, date, and time of status changes);
- ✓ user registration functionality for accessing devices at secured facilities;
- ✓ personalized access rights management for device monitoring and control;
- ✓ 24/7 automatic notifications about device status changes via email and/or Telegram.

Additionally, technical support services may be provided by specialists with on-site visits to secured facilities.

The "ZOLOTOPRYAD" system complies with anti-terrorism protection requirements and provides access for monitoring and control involving authorized specialized security services (Rosgvardiya, Ministry of Internal Affairs, and others).

№	SERIAL NUMBER	INSTALLATION LOCATION	DATA IN THE DEVICE MONITORING SYSTEM	SIGNAL GENERATOR	POWER GENERATOR	CONTRACT	TRANSFER DATE
5	Stationary Prime		The production site Operating	Enabled			According to the contract Actual
6	Stationary Prime		Operating	Disabled			According to the contract Actual

"Chameleon" Signal Generators / Serial number

ID: [redacted] creation date: [redacted] user: [redacted] // Object settings

### General information

SERIAL NUMBER: [redacted] TYPE: Stationary Prime

INSTALLATION ADDRESS: [redacted]

CONTRACT: [redacted]

TRANSFER DATE UNDER THE CONTRACT: [redacted] ACTUAL TRANSFER DATE: [redacted]

CONTACTS: [redacted]

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### Data in the device monitoring system

CODE: [redacted] NAME: [redacted] IP: [redacted]

CURRENT DEVICE STATUS: Not monitored

### Emission power control

Control relay: [redacted]

CURRENT STATUS: Disabled Enabled

Last status change: [redacted] user: [redacted]

Device status change history: [redacted] Upload...

The server downloads current ephemeris and high-precision time data directly from satellites, ensuring highly accurate trajectory measurements for higher quality signal generation while bypassing UAV protection systems.

Expands the functional capabilities of the frequency generator "CHAMELEON".

*Note: **Ephemeris** refers to the coordinates of artificial Earth satellites used for navigation, such as in the NAVSTAR (GPS), GLONASS, and Galileo systems.*

The ephemeris server module is integrated into an already installed "CHAMELEON" generator, with an additional satellite navigation antenna connected to the module.

The "SOVYONOK" ephemeris server includes a built-in NTP server.



## Use of the embedded "SOVYONOK" ephemeris server module ensures:

- ✓ uninterrupted reception of current ephemeris directly from navigation satellites;
- ✓ high-precision synchronization of internal clocks for "CHAMELEON" signal generators with GNSS timing: accuracy **no worse than 1.5 microseconds** (typical value < 500 nanoseconds);
- ✓ minimal deviation from current broadcast GNSS ephemeris values: no more than 4 minutes (for satellite agency server updates, the delay is no less than 30 minutes).

## Key Points:

1. The operation of the frequency generator is not affected by internet disruptions or outages, nor does it depend on the availability of ephemeris servers from space agencies, including foreign servers (igs.bkg.bund.de, garner.ucsd.edu, cddis.nasa.gov), which may be blocked.
2. The ephemeris channel remains available even in cases of intentional jamming of GNSS receivers, thanks to the software and hardware integration of the embedded server module.
3. Reduces the time of a successful attack on a receiver installed on a UAV threefold, increasing the operating range of the "CHAMELEON" signal generator.

## PRIME

### Basic configuration

- Basic dynamic frequency generator "CHAMELEON" L1/GPS
- Wideband frequency jamming unit "IBIS" L2+L5
- Remote control and monitoring gateway



## SPECTR

### Extended configuration

- Basic dynamic frequency generator "CHAMELEON" L1/GPS
- "CIKADA" L1 frequency jammer
- Wideband frequency jamming unit "IBIS" L2+L5
- Centralized control system for signal generators "ZOLOTOPRYAD"
- Integration gateway with detection devices (radar detectors, etc.)
- Remote control and monitoring gateway



## STRAZH

### Extended configuration

- Basic dynamic frequency generator "CHAMELEON" L1/GPS
- "CHAMELEON-X5" dynamic frequency generator L1/BeiDou
- "CIKADA" L1 frequency jammer
- Wideband frequency jamming unit "IBIS" L2+L5
- Centralized control system for signal generators "ZOLOTOPRYAD"
- Integration gateway with detection devices (radar detectors, etc.)
- Remote control and monitoring gateway



## LIKTOR

### Maximum configuration

- Basic dynamic frequency generator "CHAMELEON" L1/GPS
- "CHAMELEON-X5" dynamic frequency generator L1/BeiDou
- "CHAMELEON-X6" dynamic frequency generator E1/Galileo
- "CHAMELEON-X7" dynamic frequency generator L1/GLONASS
- Wideband frequency jamming unit "IBIS" L2+L5
- Centralized control system for signal generators "ZOLOTOPRYAD"
- Integration gateway with detection devices (radar detectors, etc.)
- Remote control and monitoring gateway



1. For the purpose of improved synchronization of devices, the manufacturer allows the integration of Chameleon modules into a single enclosure with combined device functionality..

2. The manufacturer may, at its discretion, replace the equipment with a more advanced functional version.

TITLE	PRIME	SPECTR	STRAZH	LIKTOR
1 Basic dynamic spoofer "CHAMELEON" L1/GPS	✓	✓	✓	✓
2 "CHAMELEON-X5" dynamic spoofer L1/BeiDou	✗	✗	✓	✓
3 "CHAMELEON-X6" dynamic spoofer E1/Galileo	✗	✗	✗	✓
4 "CHAMELEON-X7" dynamic spoofer L1/GLONASS	✗	✗	✗	✓
5 "CIKADA" intelligent frequency jammer L1/GLONASS	✗	✓	✓	✗
6 "IBIS" wideband frequency jamming unit L2+L5. Signals: GPS, Galileo, BeiDou, GLONASS	✓	✓	✓	✓
7 "ZOLOTOPRYAD" centralized signal generator management system	✗	✓	✓	✓
8 Integration gateway with detection devices (radar detectors, etc.)	✗	✓	✓	✓
9 Remote control and monitoring gateway	✓	✓	✓	✓