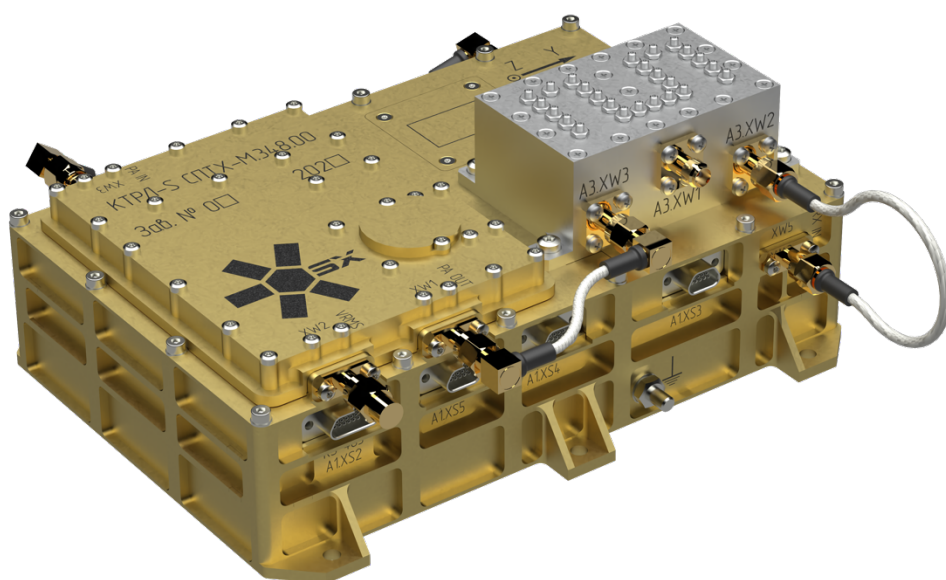


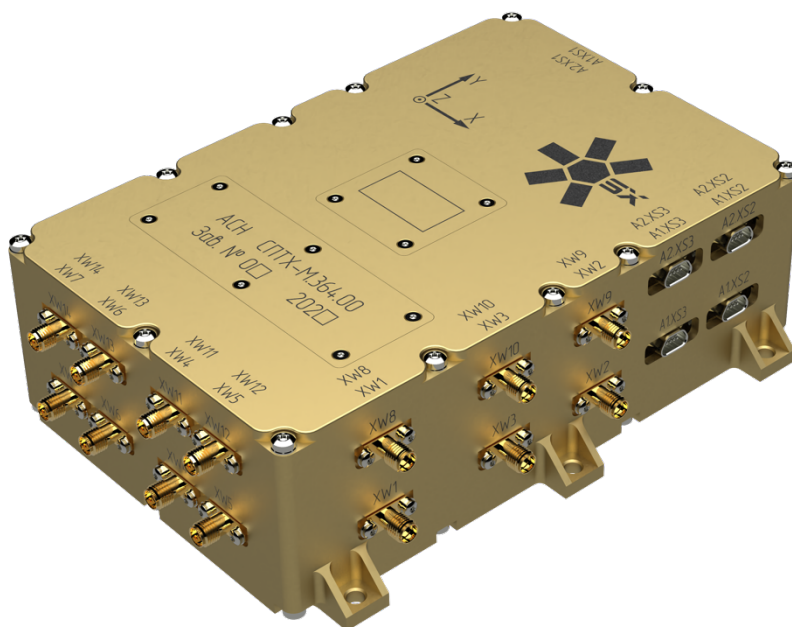


Line of microsatellite devices
SX-SBOX



Satellite navigation equipment

SX-SBOX-GNSS-01



Parameters	Value
Power consumption	2 W
Power voltage	22-34 , galvanic isolation 500 V
Mass	700 g
Dimensions	171 x 111 x 51 mm (without fasteners)
Duplicated interfaces	CAN2B, SpaceWire
Coordinate determination error	10 m (sigma)
Speed determination error,	0.01 m/s (sigma)
Time error	$\pm 10^{-8}$ s during the battery life of at least 48 hours.

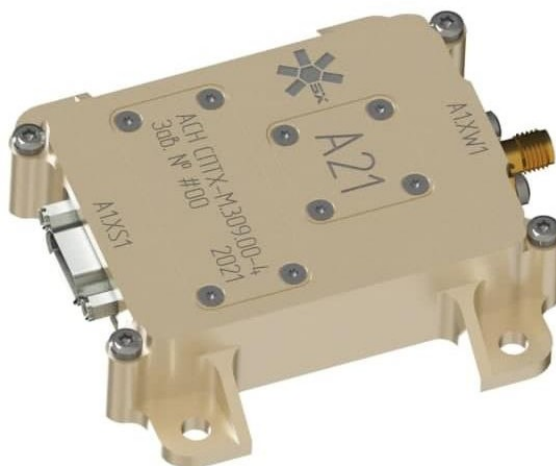
The task of the device is to adjust the output signal of 1 Hz bearing to the signal of 1 Hz of the navigation receiver in time so that the averaged position of the signal of 1 Hz CNE coincides with 1 Hz bearing, and to keep the signal of 1 Hz bearing in its current position in the absence of signal 1 Hz navigation receiver.

The device uses a highly stable (high short-term stability) crystal oscillator with a typical frequency of 10 MHz as its own source of time and frequency. The adjustment depending on the change in the control voltage is $\pm 3 \cdot 10^{-7}$, which is approximately 3 Hz. This change in frequency to the extreme positions relative to real 10 MHz creates a lead or, accordingly, a lag of the signal divided by 107 1 Hz relative to the divided real 10 MHz for a period of 1 s by 300 ns. As real 1 Hz, you can take the averaged position of 1 Hz of the navigation receiver.

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

Autonomous navigation system

SX-SBOX-NAV-03



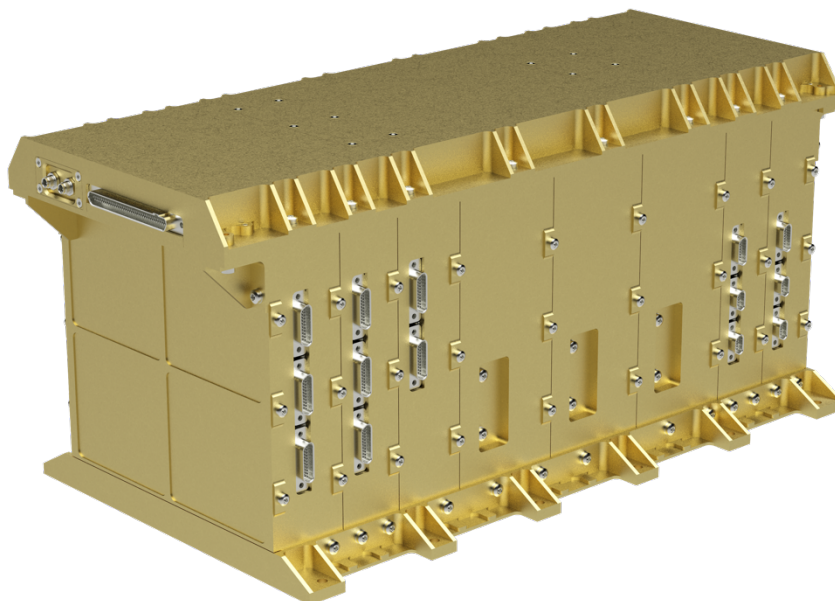
Parameters	Value
Dimensions	70 x 50 x 20 mm (without fasteners)
Mass	70 g
Power voltage	6 — 36 V (without galvanic isolation)
Power consumption	2 W
Duplicated interfaces	CAN2B
Coordinate determination error	10 m (sigma)
Speed determination error	0,01 m/s

The GPS / GLONASS receiver is used to determine the position and speed of the spacecraft in the inertial coordinate system and sets the time stamp.

The device is made in the framework of the ideology of the unity of hardware and software solutions of the company's product line. As a result, it makes it possible to effectively use it both with onboard systems of third-party manufacturers and to ensure the fastest possible hardware and software integration into the spacecraft onboard with other onboard systems of SPUTNIX. It has flight qualifications.

Regulation and control equipment (RCE)

SX-SBOX-PRU-01



Parameters	Value
Power consumption	10 W
Power voltage	22-34 V
Mass	7 kg
Dimensions	306 x 161 x 140 mm (without fasteners)
Duplicated interfaces	CAN2B, RS485, SpaceWire
Redundant galvanically separated stabilized subscriber power bus	27 V, ECSS-E-ST-20-20C
Redundant unstabilized subscriber power bus	27 V, ECSS-E-ST-20-20C

RCE, when working in conjunction with solar batteries (SB) and storage batteries (SB), provides:

- 1) on-board equipment (BE) with stabilized constant voltage of 27 V;
- 2) BE with unstabilized constant voltage (24-33) V;
- 3) battery charge with limitation of the maximum charging current, maximum voltage depending on temperature;
- 4) battery discharge with limitation of the maximum discharge current, minimum voltage depending on temperature;

5) telemetric control of the parameters of power supply units, the formation and delivery of information arrays via wired circuits about the state of the parameters of power supply units during normal operation;

6) receiving and executing commands;

7) electrical tests from both ground and standard power sources.

The RCE includes:

- A set of chargers, consisting of several identical channels of chargers (CH);
- Power cross-module with power switching units (PSU) of unstabilized bus channels (BC) with load current limitation;
- Voltage stabilizer 27 V with a power switching unit (PSU) of stabilized bus channels (BS);
- RCE control system.

Structurally, the RCE is made in the form of a monoblock made of modules, the number of which varies depending on the average power consumed by the BE in the shade, the average power consumed by the BE in the illuminated area, and the peak power. From these parameters, the number and type of memory channels and discharge device channels, as well as the number of SB panels and AB configuration are selected. The upper peak power scaling limit for a regulated 27 V rail is 1,500 W.

The RCE control system is universal and consists of two microcontrollers operating in hot standby. The volume of peripheral devices for measuring analog parameters (multiplexers and ADCs) and issuing control commands (registers) corresponds to the most powerful EPS.

The power line of the memory is tied to the area of the SB based on three-stage GaAs PEC and has the form:

- 1) for the area of the SB panel up to 0.5 m² ZU200 (rated power 200 W);
- 2) for the area of the SB panel (0.5-0.75) m² ZU300 (rated power 300 W);
- 3) for the area of the SB panel (0.75-1) m² ZU400 (rated power 400 W);
- 4) for the area of the SB panel (1-1.5) m² ZU600 (rated power 600 W).

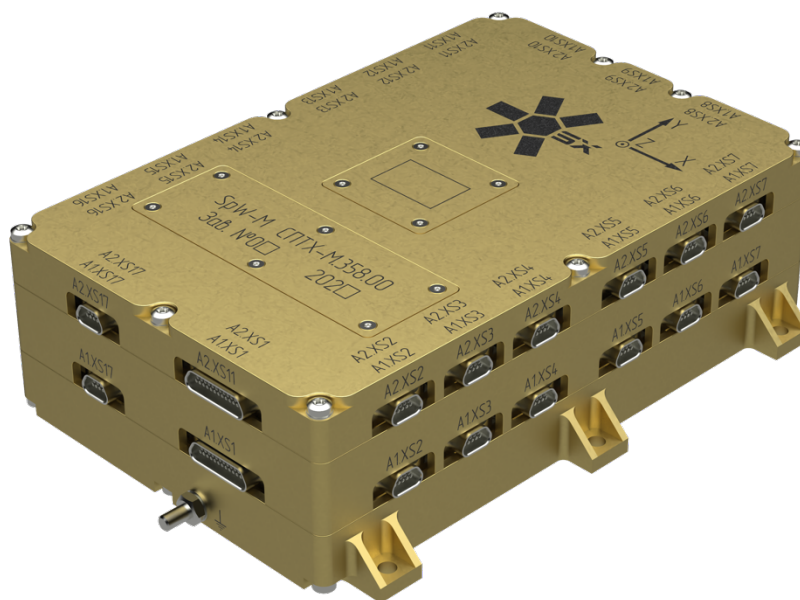
The storage battery used in the EPS must have a voltage range of (24-33) V, the accumulator capacity is increased by increasing the number of parallel connected strings. The capacity of the battery depends on the depth of the battery discharge, the duration of the shadow section of the orbit and the average power consumed by the battery in the shadow.

Non-stabilized bus channels are separate modules and can be expanded depending on the platform requirements.

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, modular scalable structure; availability of stabilized and unstabilized power rails 27V; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

SpaceWire-router and on-board storage device of the on-board computer complex

SX-SBOX-SPW-OBDAH-MEM-01



Parameters	Value
Power consumption	4 W
Power voltage	22-34 V, galvanic isolation 500 V
Mass	960 g
Dimensions	171 x 111 x 51 mm (without fasteners)
Duplicated interfaces	CAN2B, SpaceWire
Number of ports for connection	Up to 16
Exchange rate via SpaceWire	Up to 200 Mbps
RMAP support	ECSS-E-ST-50-52C
Built-in memory	8 MB

The router is used to organize the SpaceWire network in the system in terms of packet routing, communication of terminal devices with each other. One router is an assembly of 2 identical semi-sets that can work in both cold and hot standby.

One semi-set includes:

- Power supply system, consisting of a primary DC / DC isolated converter and secondary PDM converters to create the required voltage grid;
- 16-port SpaceWire routing switch with a built-in processor based on MIPS32 architecture, with exchange rates for each channel up to 200 Mbit / s, support for broadcast packets, adaptive multicast routing, both RMAP protocol over SpaceWire and UART debug port;
- EEPROM with a capacity of 1 Mbit for storing the image of the switch control software, which initializes the built-in processor, performs self-tests and configures the registers of the router;
- MRAM as non-volatile memory with a useful capacity of 8 MB for the organization of "cloud" storage in the SpaceWire network;

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; use of Russian electronic components; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

On-board computer

SX-SBOX-OBC-01



Parameters	Value
Power consumption	Up to 10 W
Power voltage	22-34 V, galvanic isolation 500 V
Dimensions	171 x 111 x 51 mm (without fasteners)
Mass	860 g

OC is an assembly of 2 identical semi-sets in a single body.

The OC board includes:

- Power system, consisting of a primary DC / DC isolated converter, and secondary PDM converters to create the required voltage grid;
- Radiation-resistant 32-bit microprocessor based on the SPARC v8 architecture of the Leon4FT core, operating at 80 MHz as the main computing device. It includes 2 cores (hot standby), as well as CAN interface controllers with an exchange rate of up to 1 Mbit / s and 4

cores of the SpaceWire interface controller with built-in physical layer drivers with an exchange rate of up to 100 Mbit / s, for information exchange with system devices;

- EEPROM with a capacity of 1 Mbit for storing the image of the bootloader of the microprocessor, which performs the initial initialization of the periphery, performs self-testing, loads and transfers control to the main executable program, provides algorithms for updating the software without the participation of the main program;

- MRAM as non-volatile memory with a useful capacity of 16 MB for storing the image of the main program and other data;

- 16 MB RAM for standard memory during operation;

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; use of Russian electronic components; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

High-power distribution and control unit

SX-SBOX-PDU-HI-01



Parameters	Value
Power consumption	5 W
Power voltage	22-34 V
Dimensions	244 x 171 x 45 mm (without fasteners)
Mass	1100 g
Duplicated interfaces	CAN2B
Number of ports	Up to 8
Reservation	cold redundancy

The high-power supply switching unit (PSU-h) is used to organize power distribution between onboard devices, providing switching of the main and backup power lines of onboard equipment according to commands from the onboard computer, organizing redundant CAN data lines, organizing redundant second timestamp lines. Suitable for integrating powerful devices into one power supply network and data exchange. The use of PSU-h makes it possible to reduce the volume of the cable network and increase the reliability of the connection of onboard devices as part of the spacecraft. Each of the 8 PSU-h channels, to which the devices are connected, has:

SPUTNIX LLC is a Russian private company manufacturing high-tech satellite components and platforms, as well as ground equipment for sat testing, ground-based satellite stations, and equipment for aerospace education.

- independent control of switching on and off;
- adjustable overcurrent protection;
- support for information exchange and power switching.

If there are more than 8 on-board devices, you can use several PSU-h, switching them with each other. Moreover, each PSU-h has the ability to independently connect to the power supply system.

The PSU-h switch is designed in accordance with the ECSS-E-ST-20-20C standard.

Consumer power supply is routed through two independent channels through different connector contacts. The currents flowing are monitored and can be transferred to an external control device. One of the channels is considered the main one, the other is the backup one. The channels themselves are identical in their set of keys with switched current meters and control circuits.

The arbitration scheme implemented in the device monitors the health of the active control node and, when it stops, activates the backup one, shutting down the main one.

The board of power switching channels consists of 16 switching channels for powering 8 terminal devices (separate switching on the main and backup bus), which generate control commands for switching on for the switching channels, collect telemetry. The onboard equipment, including payloads, are connected to the PSU-h via a 25-pin Micro-D connector, which implements the following lines:

- Power line: 2 pcs
- Common bus of data exchange: 2 pcs
- Line of the second time mark: 2 pcs.

The pinout of the standard PSU-h connector is shown in the figure.

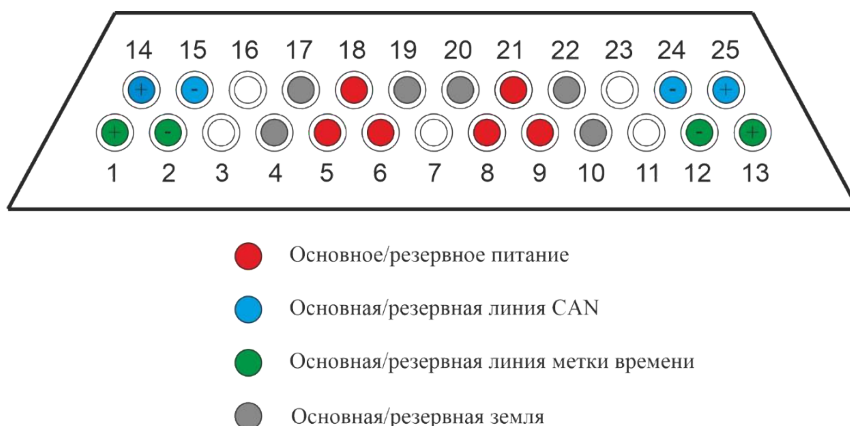
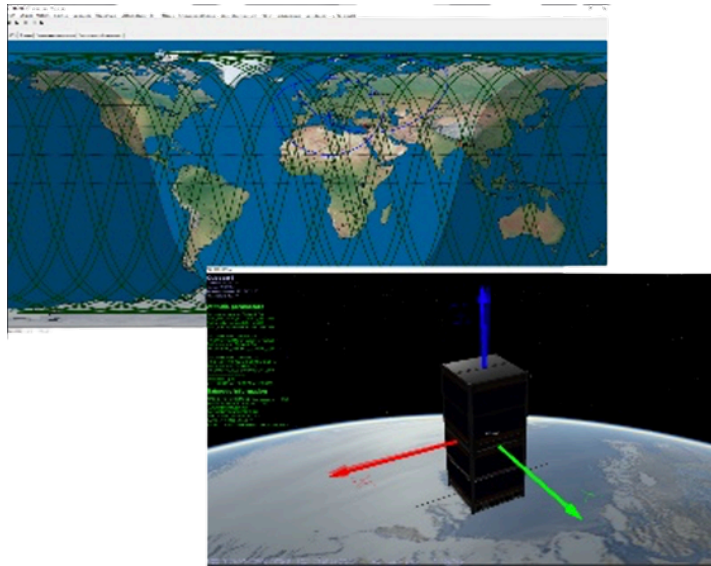


Figure - Pinout of the standard PSU-h connector

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

Onboard software

SX-SBOX-KINOSOFT



The on-board software for the on-board computer complex (BCC) was developed for the on-board computer (BC) of the space platform (CP) of the Pallada CP and uses the backlog created by the company during the implementation of the Tabletsat KP and cubsat projects. The architectural solution of the OSS under RTEMS OS is based on the ECSS-E-ST-70-41C Telemetry and telecommand packet utilization standard, as well as the company's developments in attitude control and stabilization systems algorithms, tested in flight aboard the Tabletsat-Aurora, Zorkiy "And other devices and systems developed by SPUTNIX.

The SxPA module (Sputnix PnP Architecture) is a key component of the OS, which is important for organizing a distributed computing network. This component as part of the BC system power supply unit is responsible for automatic configuration recognition and preparation (initialization) of onboard equipment on the SpaceWire bus when devices and systems are connected.

Functions of this OS:

- Management and performance monitoring of devices from the CP and payload:
 - Switching power lines for devices and payloads;
 - Interrogation of telemetric information from functioning devices;
 - Switching backup devices or sets as part of a device;
 - Switching between operating modes of devices;
- Performing the functions of a telemetry system:
 - Saving telemetry information from devices;
 - Formation of own telemetry BCC;
 - Formation of telemetry packets and sending them to the service radio channel for

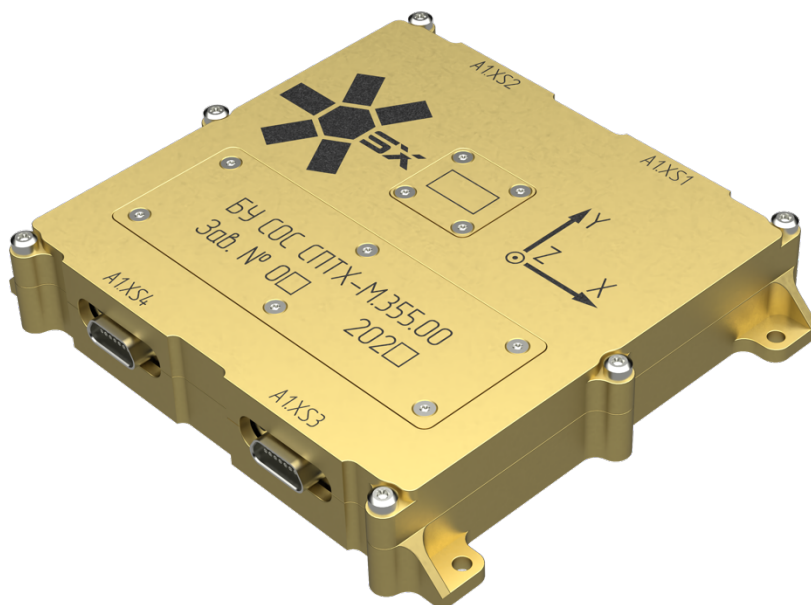
subsequent transmission to the Earth in the following modes:

- Direct transfer;
- Reproduction of previously recorded information;
- Execution of command and program information (CPI):
 - Reception of CPI from the onboard service radio channel;
 - Processing and execution of the adopted CRPD;
 - Formation and execution of the flight task (FT) on the basis of the adopted CPI;
- Automatic control of the gearbox outside the radio visibility zones:
 - Execution of the flight task formed on the basis of the accepted CPI;
 - Performing switching between standard modes of gearbox functioning;
 - Switching between backup devices and sets available for the current operating mode of the CP;
 - Implementation of cyclograms of commands as a reaction to an identified contingency situation (CS);
- Execution of algorithms for the orientation and stabilization system:
 - Interrogation of data from measuring devices of the attitude and stabilization system (ASS);
 - Issuance of commands to the ASS actuators;
 - Execution of ASS mathematical algorithms;
- Formation of the SpaceWire information network for the transfer of service information between the CP devices and the payload;
- Formation of an exchange via the CAN information network for the transfer of service information between on-board equipment devices;
- Organization of the uniform time service (UTS):
 - By transmitting the PPS signal from satellite navigation equipment (SNE) via a duplicated CAN line;
 - By means of transmission of synchro-signals over the SpaceWire line;
- Provision of storage of service information in the non-volatile storage device BCC, accessible from the SpaceWire network via the RMAP protocol;
- Management of means of the thermal control system:
 - Interrogation of temperature sensors;
 - Commutation of electric heaters.

Own development of the company according to the company's standards, compatible with the recommendations of ECSS / CCSDS; adaptation to customer requirements; support for distributed networks based on CAN buses, SpaceWire.

ADCS control unit

SX-SBOX-ADCU-01



Parameters	Value
Dimensions	101 x 100 x 20 mm (without fasteners)
Mass	220 g
Power voltage	6 — 36 V, (without galvanic isolation)
Power consumption	No more 5 W, (the average 2)
Duplicated interfaces	CAN2B, RS422/485
Reservation	Hot redundancy
Processor	160 MHz, ARM Cortex-M4
Storage	32 Mb ROM (Flash), 4 Mb ROM (MRAM), 16 Mb RAM
Operating system	RTOS

The attitude control and stabilization system control unit (OSSCU) carries out:

- collection and processing of information from on-board devices and payload
- implementation of orientation and stabilization algorithms
- formation of telemetry

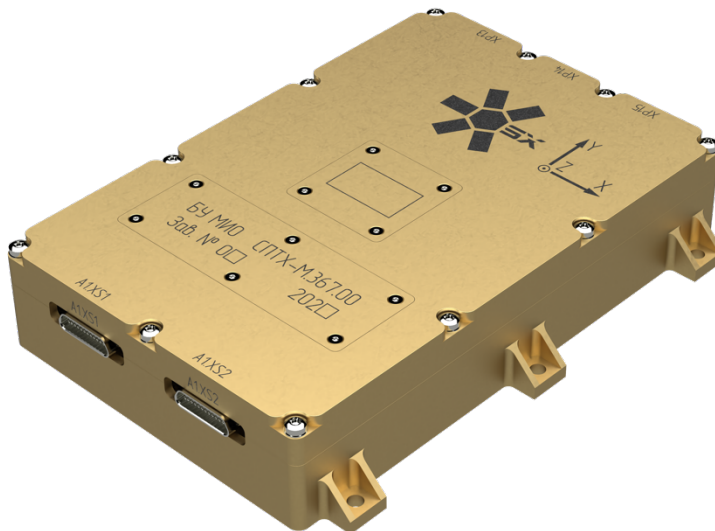
SPUTNIX LLC is a Russian private company manufacturing high-tech satellite components and platforms, as well as ground equipment for sat testing, ground-based satellite stations, and equipment for aerospace education.

OSSCU consists of two semi-sets, each of which is controlled by a separate microcontroller, the purpose of which can be redefined during the operation of the system. The hardware of the two semi-sets is identical. OSSCU can use a SPUTNIX-developed on-board software that has flight qualifications in various missions.

OSSCU is made in the framework of the ideology of the unity of hardware and software solutions of the company's product line. As a result, it makes it possible to effectively use it both with onboard systems of third-party manufacturers and to ensure the fastest possible hardware and software integration into the spacecraft onboard with other onboard systems of SPUTNIX.

Magnetic torquers control unit

SX-SBOX-MTQU-0



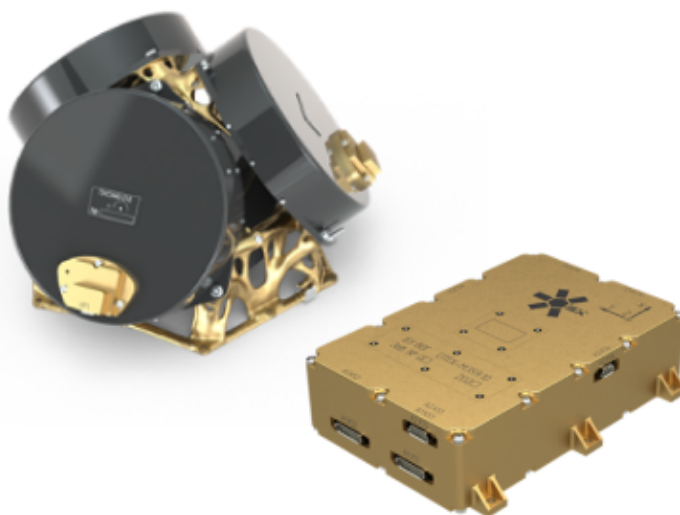
Parameters	Value
Power consumption	0,8 W
Power voltage	6 — 36 V, without galvanic isolation
Dimensions	54x48x20 mm (without fasteners)
Mass	85 g
Duplicated interfaces	CAN2B
Control channels of MT	3
Method of managing channels of MT	PDM
Maximum power for each control channel of the MT	Up to 2 W

Magnetic torquers control unit (MTCU) is used in the ADCS circuit to unload the flywheels, realizing the law of damping of the angular velocity using measurements of a magnetometer or an inertial measuring module.

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces. Separately, it should be noted that the device can independently implement the algorithms of the stabilization system, it allows connecting up to three magnetic actuators from the SX-MT line to it. All MA channels are independently controlled.

Fibre-Optic Gyroscope

SX-SBOX-AVS-FOG-01



Parameters	Value
Power consumption	Up to 33 W
Power voltage	22-34 V, galvanic isolation 500 V
Dimensions of the sensor unit	275 x 275 x 160 mm (without fasteners)
Dimensions of the control unit	171 x 111 x 44 mm (without fasteners)
Weight of the control unit with sensor unit	1700 g
Duplicated interfaces	CAN2B
The random component of the zero signal drift at a constant temperature (100 sec-averaging, 1 σ) along each of the axes	$\leq 0,005$ °/h
The random component of the zero signal drift when the temperature changes from -40	$\leq 0,02$ °/h

°C to +60 °C (100 sec-averaging, 1σ) along each of the axes	
The spectral density of the noise power (according to the Allan variation) along each of the axes	$\leq 0,0007^{\circ}/\sqrt{h}$

Fibre-Optic Gyroscope (FOG) is designed for use in the contour of the orientation determination system of small satellites. Angular velocity measurements are based on the sensitive elements of a third-party Russian manufacturer. FOG consists of a control unit and an assembly of 4 sensitive elements (three main and one backup).

The company's own development according to the company's standards compatible with ECSS recommendations, relatively low cost, low weight and energy consumption; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

Angular velocity sensor (AVS)

SX-SBOX-AVS-MEMS-01



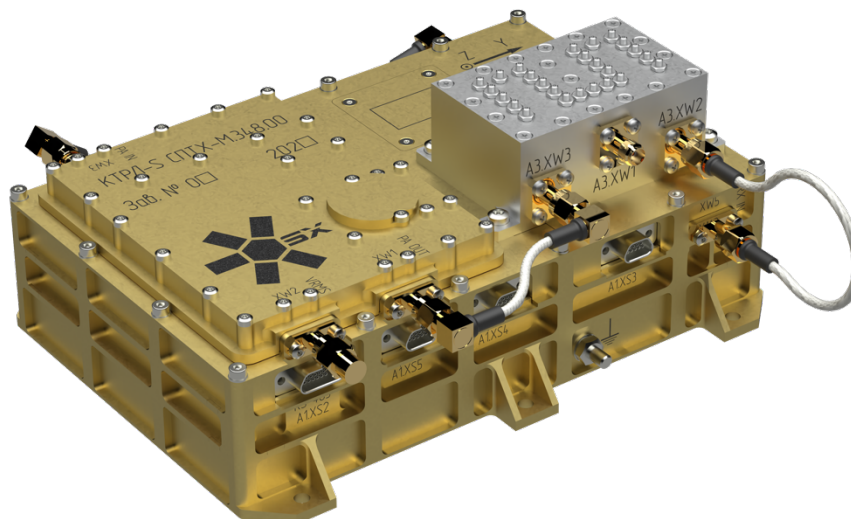
Parameters	Value
Power consumption	0,6 W
Power voltage	6 — 36 V, galvanic isolation
Dimensions	54 x 52 x 20 mm (without fasteners)
Mass	75 g
Duplicated interfaces	CAN2B
The random component of the zero signal drift at constant temperature, 1σ	2 °/h

The triaxial angular velocity sensor (AVS) is intended for use in the loop of the system for determining the orientation of small satellites. The angular velocity measurements are based on a sensitive MEMS element.

Own development of the company based on the experience of creating sensors for the orientation and stabilization system of spacecraft TabletSat-Aurora, OrbiCaft-Pro. This device is made in the framework of the ideology of the unity of hardware and software solutions of the company's product line. As a result, it makes it possible to effectively use it both with onboard systems of third-party manufacturers and to provide the fastest possible hardware and software integration into the spacecraft onboard with the rest of the company's onboard systems.

S-band TM/TC radio link

SX-SBOX-TRX-S-01



Parameters	Value
Power consumption	22 W (reception + transmission), 3 W(reception)
Power voltage, V	22-34 V galvanic isolation 500 V
Dimensions	171 x 111 x 48 mm (without fasteners and diplexer)
Mass	850 g (without diplexer)
Operating mode	Full duplex
Operating frequency range reception	2025 – 2110, MHz
Operating frequency range transmission	2200 – 2290, MHz
Output power level	5 W
Symbol data transfer rate	0,1 – 10 Mbps
Coding	LDPC NASA C2 (7/8)
Modulation	BPSK, QPSK, 8-PSK

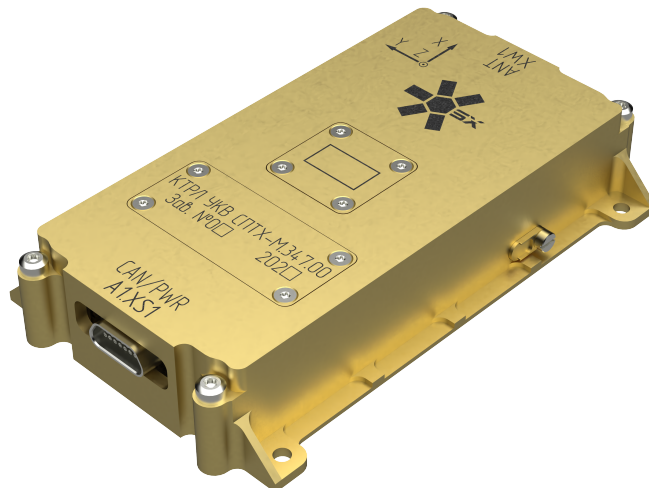
Protocols	CCSDS 732.1-B-1, 131.0-B-3, 232.1-B-2
Duplicated interfaces	SpaceWire, CAN2B, RS-485, Ethernet
Crypto protection	AES-128/256
Built-in ROM	64 MB

The S-band command-telemetry radio link is intended for the implementation of a full-duplex high-speed communication channel of small spacecraft with a ground control station, as well as for the formation of inter-satellite information exchange lines.

1. Full compliance with CCSDS standards
2. Using high efficiency LDPC encoder / decoder
3. Built-in hardware data encryption AES-128/256
4. Flexible ability to change modulation, data rate and encoder directly in orbit
5. Wide range of available interfaces: SpaceWire, CAN, RS-485, Ethernet

UHF TM/TC radio link

SX-SBOX-TRX-UHF-01



Parameters	Value
Power consumption	20 W (transmission), 1 W (reception)
Power voltage	6 — 36 V, without galvanic isolation
Dimensions	115 x 66 x 19 mm(without fasteners)
Mass	135 g
Duplicated interfaces	CAN2B
Operating mode	Half duplex
Channel data transfer rate	Up to 19200 bit / sec
Data transfer protocol	AX.25, USP
Operating frequency range	435 – 438 MHz
Output power level	5 W
Receiving path sensitivity	minus 109 dBm

The UHF transceiver makes it possible to organize communication between the ground control complex and the spacecraft in the VHF range of radio waves for control tasks and receiving telemetry. Suitable for use in low orbit as a primary or backup transceiver.

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; availability of flight qualifications; compatibility with a network of VHF receiving stations around the world through the use of open communication protocols.

Magnetometer

SX-SBOX-MAG-01



Parameters	Value
Power consumption	0,8 W
Power voltage	6 — 36 V without galvanic isolation
Dimensions	54x52x16 mm (without fasteners)
Mass	70 g
Measurement range	$\pm 100\,000$ nT
Measurement noise (σ)	100 nT

The magnetometer is designed to measure the magnetic induction vector. It is a three-axis measuring device and is intended for use in the loop of the system for determining the orientation of the spacecraft. As a rule, it is used in conjunction with electromagnetic coils for damping the spacecraft rotation, as well as for unloading the control flywheel motors.

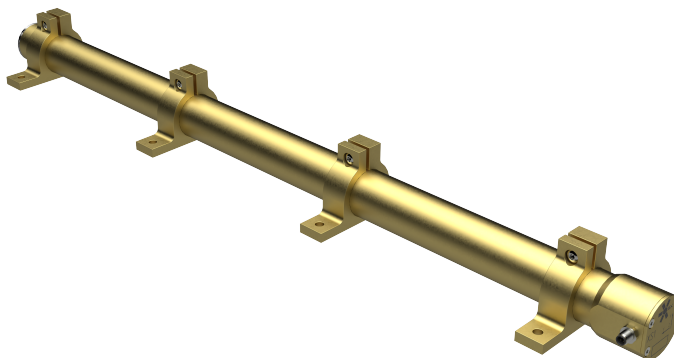
Magnetic field measurements are carried out using anisotropic magnetoresistive sensors, which provide the necessary accuracy to operate in the spacecraft attitude control and stabilization system loop with small dimensions, weight and power consumption.

Own development of the company based on the experience of creating sensors for the orientation and stabilization system of spacecraft TabletSat-Aurora, OrbiCafT-Pro. This device

is made in the framework of the ideology of the unity of hardware and software solutions of the company's product line. As a result, it makes it possible to effectively use it both with onboard systems of third-party manufacturers and to ensure the fastest possible hardware and software integration into the spacecraft onboard with the rest of the company's onboard systems.

Magnetic torquers

SX-SBOX-MTQ



Magnetic torquers (MT) are used in conjunction with a magnetic torquers control unit (MTCU) to provide satellite orientation and stabilization modes that do not require high accuracy and speed. As a rule, these are modes that provide damping of the angular velocity of rotation of the spacecraft and unloading of the control flywheel motors. The minimum number of MT for installation in a spacecraft is 3 pcs.

Code	Maximum moment, A·m ²	Consumption, Wt	Mass, g	Diameter, mm	Dimensions, mm
SX-MT-1	1	0,4	200	16	140x30x30
SX-MT-5	5	0,6	350	20	220x50x35
SX-MT-10	10	0,7	550	20	320x50x35
SX-MT-15	15	0,8	650	20	400x50x35
SX-MT-20	20	1,0	800	20	470x50x35
SX-MT-25	25	1,2	1000	22	470x50x35
SX-MT-30	30	1,8	1200	25	440x50x40

Dimensions without fasteners.

Each device developed by SPUTNIX uses proprietary magnetic actuators. These are the most reliable attitude control devices due to their simple design and low energy consumption.

It is also important that in the manufacture of devices, they are subject to careful control during winding and assembly of the device as a whole. The production uses its own specialized equipment and proven materials, as well as proven technological processes.

Numerical simulation software

«Sputnix satellite modeler»

SX-SBOX-MODELER-3.0.X

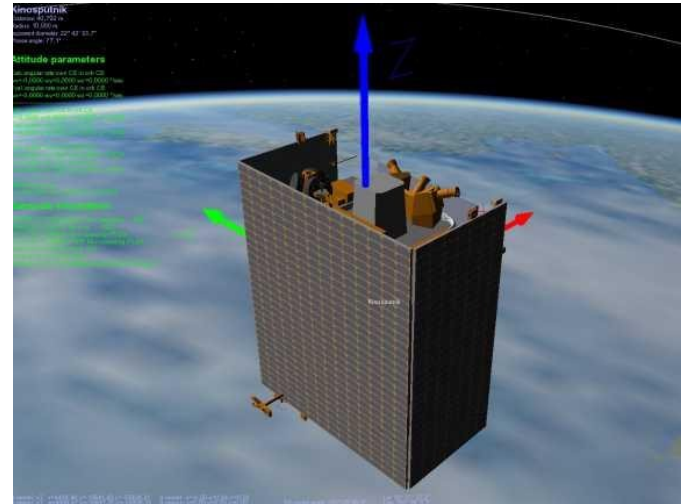
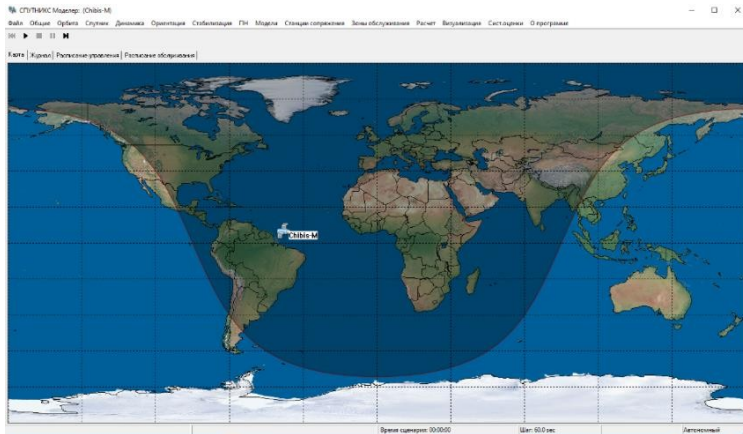


Fig. 1 Main window Fig. 2 General view of the application

The Microsatellite Simulator software package is designed to simulate satellite movement in orbit, as well as various attitude control modes, including the ability to simulate in the "hardware-in-the-loop" mode. The complex implements the following features:

- calculation of the spacecraft motion in near-earth orbit and space parameters along the flight path,
 - integration of the equations of the dynamics of rotation of the vehicle around the center of mass,
 - implementation of various algorithms for stabilization and determination of the orientation of the vehicle,
 - calculation of the energy balance on board,
 - analysis of spacecraft operating modes and transitions between them;
- and some others.

The main window looks like Figure 1. It consists of:

- title, which displays the name of the application, state and name of the current project;

- main menu;
- toolbars;
- windows for displaying a rectangular projection of the world map (Map tab) and Event Log (Log tab);
- status bars.

The visualization of the spacecraft movement around the center of mass is carried out using the dialog boxes of the graphical user interface.

The results of the calculation of orientation, orbital position can be displayed graphically in real time. Information about the state of the system is also recorded in ASCII text data files, which can later be analyzed by other programs such as MatLab / SciLab / Excel.

The company's own development, which has a 20-year history, was verified during the Chibis-M and TabletSat-Aurora missions.

Solar sensor

SX-SBOX-SUNS-01



Parameters	Value
Power consumption	0.4 W
Power voltage	6 — 36 V, with galvanic isolation
Dimensions	43 x 43 x 16 mm (without fasteners)
Mass	45 g
Duplicated interfaces	CAN2B
line of sight	half-angle cone 45°
Accuracy (sigma)	0,15°

The solar sensor (SS) is intended for use in the attitude control loop to determine the ort of the direction to the Sun.

Information from the sensor is presented in the form of unit vector projections on the axis of the coordinate system associated with the sensor. The work is based on the transformation of information about the exposure of the matrix photodetector to sunlight.

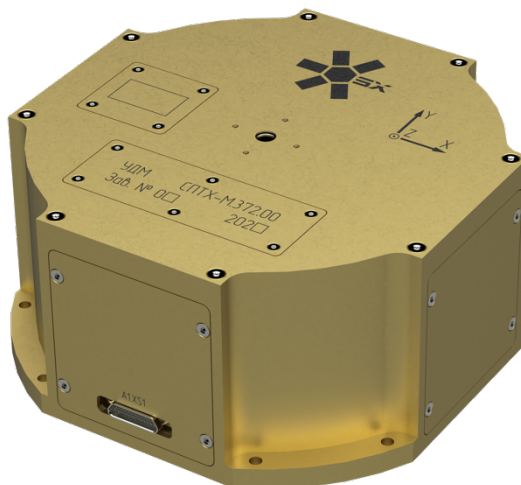
A known problem with solar sensors operating in low orbits is the glare of reflected light from the Earth. This device includes algorithms that allow you to combat such flares and provide the required accuracy.

The minimization of the dimensions and weight of this device made it possible to use it in spacecraft such as Cubesat. At the same time, it can be used in any other small spacecraft.

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; availability of flight qualifications for analogue products; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

Reaction wheel

SX-SBOX-RWH-50-2.0-01

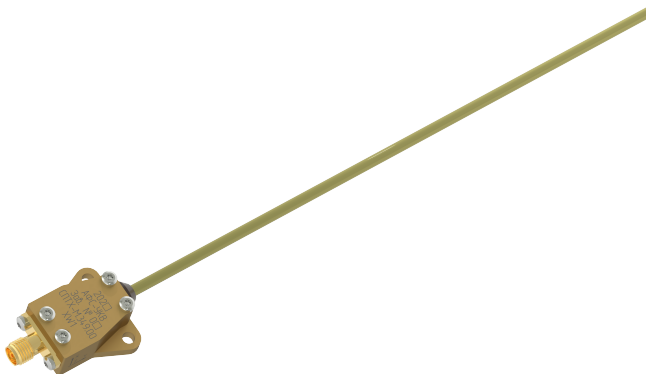


Parameters	Value
Power consumption	43 W (without galvanic isolation)
Peak power consumption	10 W
Power voltage	22-34 V
Mass	3200 g
Dimensions	160x160x80 mm (without fasteners)
Duplicated interfaces	CAN2B
Maximum control torque, Nmax	0,05 Nm
Maximum kinetic moment, hmax	2 Nms

The control flywheel motor (CFM) is designed to create a control mechanical torque due to acceleration and deceleration of the rotor speed.

Own development of the company according to company standards, compatible with ECSS recommendations, relatively low cost, light weight and energy consumption; adaptation to customer requirements; use of unified electrical, information and mechanical interfaces; the GEM cycle has been successfully completed.

Antenna-feeder system of the UHF band *SX-SBOX-UHF_ANT_01*



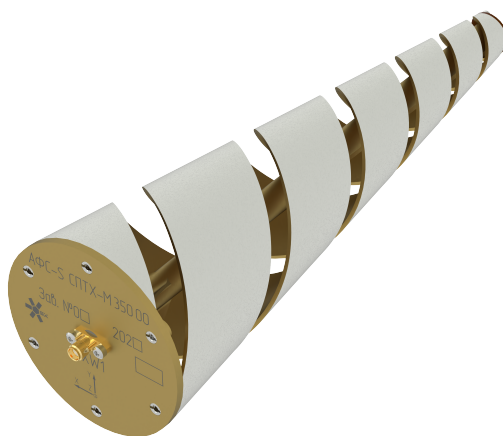
Parameters	Value
Antenna Type	monopole
Gain	at least 4 dB
Operating frequency range	400 - 403 MHz
Standing wave voltage coefficient	no more than 2
Mass	21 g
Dimensions	12.4 x 25 x 205 mm
Type of polarization	linear

AFS-UHF It is a monopole antenna that converts electrical signals into electromagnetic vibrations and radiates them into free space.

The antenna has successfully passed the GEM cycle.

S band antenna-feeder system

SX-SBOX-SBAND_ANT_01

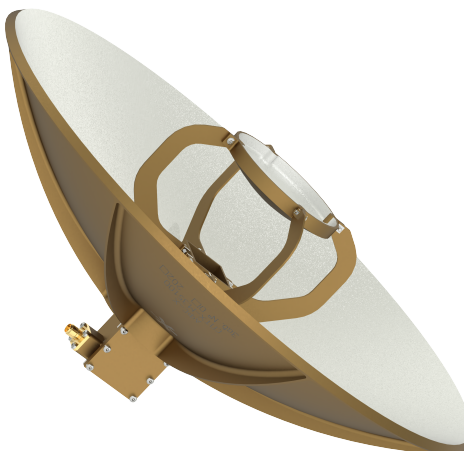


Parameters	Value
Antenna Type	Two-way spiral
Gain	at least 4 dB
Operating frequency range	2000 - 2290 MHz
Standing wave voltage coefficient	no more than 1.65
The width of the radiation pattern at the level of minus 3 dB	at least 155 degrees
Ellipticity coefficient	no more than 4 dB
Mass	190 g
Dimensions	80 x 80 x 235 mm
Type of polarization	Circular, RHCP

AFS-SBand It is a two-way spiral antenna made using 3D metal printing technology, designed for the organization of command and telemetry radio lines of the spacecraft. The antenna is characterized by a wide directional pattern close to the hemisphere and low mass. The antenna has successfully passed the GEM cycle.

X band antenna-feeder system

SX-SBOX-XBAND_ANT_01



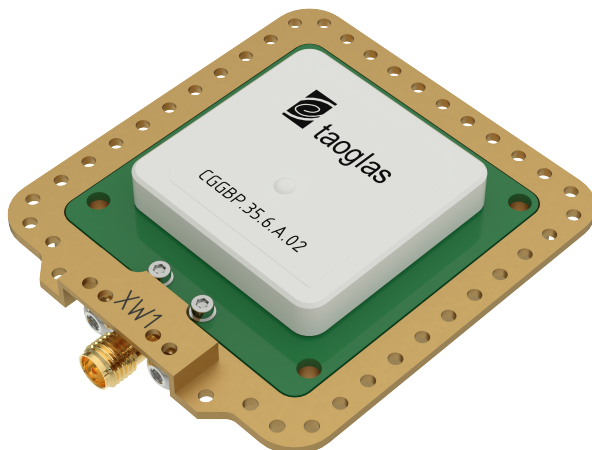
Parameters	Value
Antenna Type	Mirror
Gain	at least 22.5 dB
Operating frequency range	8000 - 8400 MHz
Standing wave voltage coefficient	no more than 1.5
The width of the radiation pattern at the level of minus 3 dB	at least 7 degrees
Normal ellipticity coefficient	no more than 1 dB
Side lobe level	no more than minus 12 dB
Mass	570 g
Dimensions	138 x 317 x 317 mm
Type of polarization	Circular, RHCP

AFS-XBand It is a two-mirror Cassegrain antenna designed for the organization of high-speed spacecraft radio lines. The antenna is characterized by low mass and the possibility of using a second input to organize simultaneous two-polarization data transmission (RHCP/LHCP).

The antenna has successfully passed the GEM cycle.

Antenna-feeder system of global navigation satellite systems

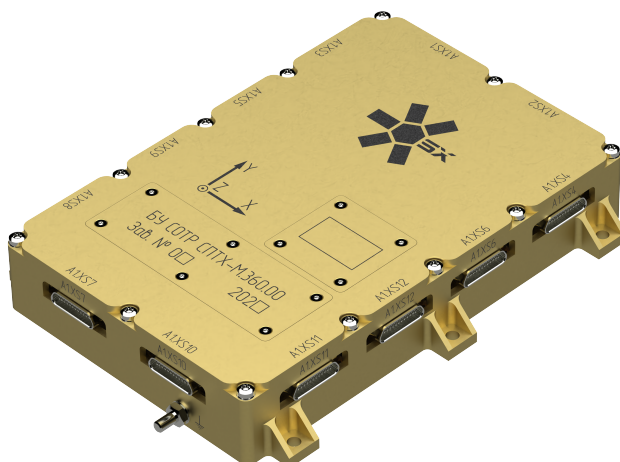
SX-SBOX-AGG-01



Parameters	Value
Antenna Type	Printed
Gain	at least 5.5 dB
Operating frequency range	1559 - 1607 MHz
Standing wave voltage coefficient	no more than 1.5
The width of the radiation pattern at the level of minus 3 dB	at least 84 degrees
Normal ellipticity coefficient	no more than 1.7 dB
Mass	61 g
Dimensions	68 x 68 x 15 mm
Type of polarization	Circular, RHCP

AFS-GNSS is a passive printed antenna for receiving GNSS signals of the L1 band.

Control unit of the thermal regime support system
SX-SBOX-THERMU-01



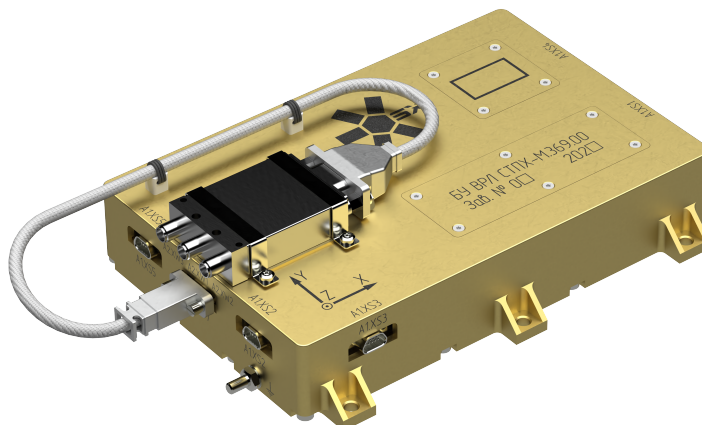
Parameters	Value
Power consumption without heaters included, no more	5 W
Supply voltage	22-33 V
Duplicated interface	CAN2B
The number of half-sets in the device	2 pcs
The number of electric heaters connected to the half-set	14 pcs
Power of a single heater, no more	60 W
The number of analog temperature sensors connected to the half-set	36 pcs
Type of connected analog temperature sensors	P1K0.232.6W.A.010
The number of digital temperature sensors connected to the half-set	14 pcs
Type of connected digital temperature sensors	DS18B20Z
Mass	600 g
Dimensions	200 x 130 x 30 mm

The control unit of the thermal regime support system is designed to ensure the thermal

regime of the service platform and the payload of the spacecraft.

The control unit provides control of the temperature regime of the spacecraft structural elements and payloads by measuring the temperature of the spacecraft structural elements and controlling the heating elements of the spacecraft.

High-speed radio line control unit *SX-SBOX-XBAND_CU_01*



Parameters	Value
Power supply	22...33 V, galvanic isolation 500 V
Control interface	CAN, duplicated
Output power parameters	+11...+16.5 V, 30 W
Parameters of the control output interface	x4 RS-422
Mass	750 g
Dimensions	171 x 120 x 46 mm

The control unit is designed to convert the input power supply and control interfaces in order to interact with high-speed transmitters of target information.

Options of devices delivery

- EM – engineering model
- FM – flight model

The differences between the EM and FM options are in the scope of the tests. Options are shown in the table.

№	Test	Model		Comment
		EM	FM	
1	Preliminary tests: - Checking power supply circuits; - Verification of information exchange (with the device and device nodes); - Calibration (if necessary)	+	+	Carried out in the laboratory of SPUTNIX LLC under normal climatic conditions.
2	Functional Acceptance Tests (FAT)	–*	+*	Checks for compliance of the device with the functional characteristics specified in the Operational Manual and compliance with the MS
3	Vibrodynamic Acceptance Tests	–	+*	Tests for resistance to mechanical external influences specified in Technical conditions (or Operational Manual)
4	Thermovacuum Acceptance Tests	–	+*	Checks for resistance to thermal and climatic external influences

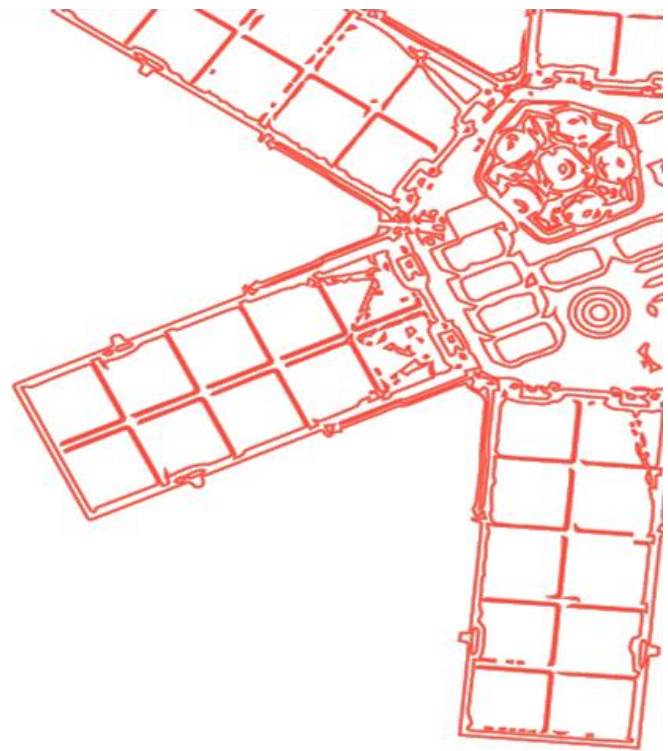
				specified in Technical conditions (or Operational Manual)
5	Electromagnetic Acceptance Tests	-	+	Tests for resistance to electrical external influences specified in Technical conditions (or Operational Manual)
Notes: *Inspection can be carried out, carried out partially or excluded as agreed with the Customer				

If the requested device intended for laboratory testing will not be installed in a real satellite, EM with test type 1 (minimum test scope) should be used.

If the requested device is intended for use as part of a specialized functional stand, EM should be used with preliminary and functional acceptance tests (1 and 2).

If the requested device is intended for installation on a satellite, or for use as part of a stand for ground experimental testing of a flight product, it is required to use a FM with a full scope of tests (1, 2, 3, 4, 5).

If the requested device is intended for installation on a satellite (flight model), but for some reason it is not possible to conduct a full scope of tests, it is allowed to exclude certain types of tests for external influences (3,4,5) in a combination and sequence discussed with the Supplier. In this case, the responsibility for carrying out the missing tests lies with the Customer.



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