SMALL SPACE PLATFORM DEVELOPED BY JSC “MAKEYEV GRTs”

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Introduction

For fifty years OAO "Academician V.P. Makeyev State Rocket Centre" (OAO "Makeyev GRTs") as a leading developer has designed and commissioned three generations of rocket complexes to the Russian Navy. In total, eight base missiles and their sixteen modifications were commissioned.

The combination of improved power-and-mass characteristics, high reliability and safety of submarine-launched ballistic missiles (SLBM) allowed to use them as means to deliver payloads of different purposes to the near space.

Within 11 launches the RSM-25 SLBM (designated as ZYB LV), RSM-50 SLBM (designated as VOLNA LV) and RSM-54 SLBM (designated as SHTIL LV) have injected technological units and small spacecraft (SSC) along ballistic trajectories into elliptic and circular orbits.

A small space platform (SSP) is designed to accommodate an S/C in the SHTIL LV empty area. The S/C is placed into a special protective capsule to protect the S/C against thermal effects from the running engine of the SHTIL LV 3-rd stage, ensure cleanness in the S/C accommodation area and preserve S/C against loads during the separation of stages. The SSC based on the SSP can be launched by other LVs and also as a secondary payload.

The onboard instrumentation complex of the rocket takes telemetry measurements aboard the rocket during the S/C injection into the specified orbit. Existing facilities of the Northern range measuring stations without any additional equipment receive and record telemetry data at all working sections of the onboard instrumentation equipment, including that one at the end of the first turn of the rocket upper stage in the launch area. The telemetry data are processed in the GRTs telemetry processing center.

SSC purpose and composition

The SSP developed by GRTs is designed to create SSC.

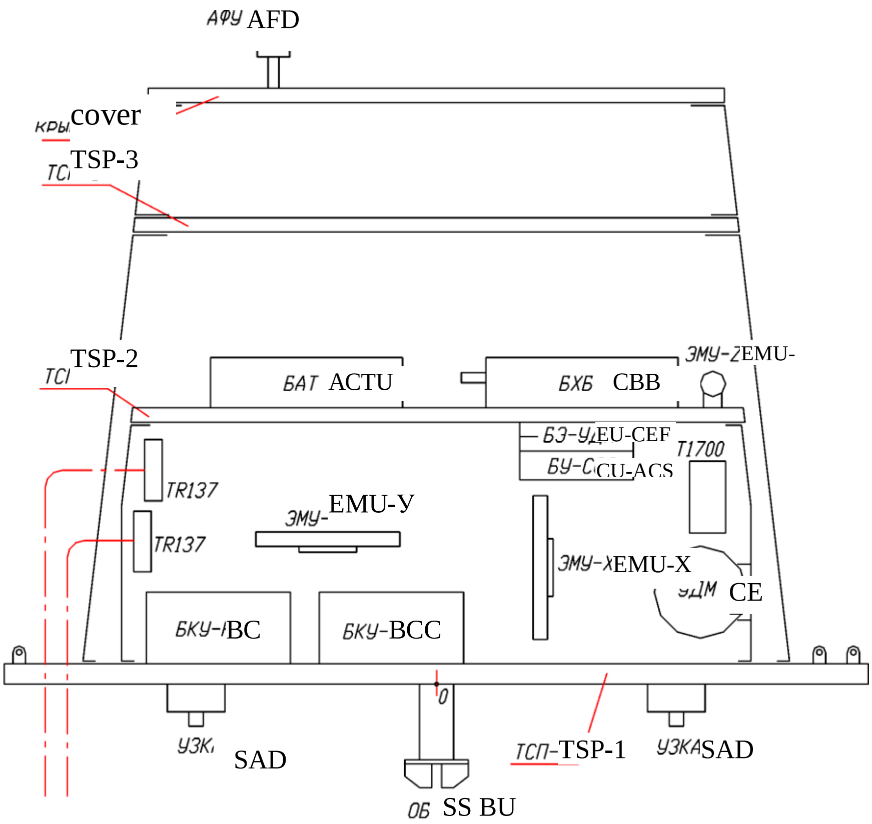
The SSP consists of a structure, onboard control complex and onboard complex of support systems.

The support systems comprise:

- telemetry transmitters and antennas;
- power supply system;
- thermal control system;
- attitude control system;
- mechanical systems.

All data from the SSP are recorded by a recorder and transmitted to the ground stations in the radio coverage zone.

Fig. 1 shows arrangement of the onboard control complex and support systems on the SSP.



where
ACS – attitude control system;
ACTU – automatic control and telemetry unit;
AFD – antenna-feeder device;
BCC – onboard control complex;
CBB – chemical buffer battery;
CEF – control engine-flywheel;
CU – control unit;
EMU – electromagnetic unit;
EU – electronics unit;
SAD – spacecraft activation device;
SS BU – solar sensor basic unit;
T1700 – telemetry transmitter;
TR137 – transceiver;
TSP – thermostabilized plate.

Fig. 1 - Arrangement of the onboard control complex and support systems on the SSP

SSP configuration

The SSP is a four-sided truncated pyramid equipped with photoelectric battery (PEB) elements, antenna devices for support equipment, rods for special-purpose equipment, if any. The four-sided truncated pyramid consists of a base, an Instrumentation Bay (IB) and two PEB flap panels.

In case the RSM-54 launcher is used as a carrier the SSP IB and flap panels are covered with a protective capsule in the launcher powered flight.

The SSP together with the special-purpose equipment forms a small spacecraft (SSC).

The base (thermostabilized plate TSP1) is made as an oval plate.

The IB casing, PEB flap panels, SSP support systems and the second thermostabilized plate (TSP2) placed on heat-conducting rods are mounted on one side of the base.

One of two solar sensors (SS), two SSP activation command transmitters, Onboard Control Complex (BCC) antennas, elements to jettison the protective casing are placed on the base exterior side with seats to fix the SSP to the launcher.

The IB looks like a four-sided truncated pyramid and is not sealed. The IB casing has a two-layer casing and a rectangular cover. The IB casing sections are joint with studs. The shield-vacuum thermal covering (SVTC) blankets are placed on the interior surfaces of the casing sections and cover. Photovoltaic converters are glued onto the exterior surfaces of the IB section.

The IB casing is mounted on heat insulating blankets. The exterior side of the base and all the instruments on it are shielded with SVTC. The exposed base surfaces from the IB side earth-directed in orbital flight are heat radiators of the thermal conditions support system (TCS). The surfaces are covered with a thermoregulating coating.

The second thermostabilized plate (TSP2) is intended for accommodation of special-purpose and support equipment. From TSP2 heat is removed to the SSP base (TSP1) through aluminum-alloy heat-conducting struts.

Inside TCP2 a TCS heat accumulator is mounted as a hermetic container filled with a heat-retaining material.

On the end of the large IP section the third thermostabilized plate (TSP3) is mounted for SE installation. The side plate surface covered with a thermoregulating coating is a heat exchanger. Inside the plate there is an SVTC heat accumulator made as a sealed container filled with a heat-retaining material.

The support system components are mounted on the IB casing cover.

The trapezoidal flap panels are mounted on the SSP base and in transportation are kept with a binding band against the supports on the IB cover. Each panel is made as an aluminum-alloy frame with a net-like cloth. Photovoltaic converters are glued onto both sides of the cloth.

Figure 2 illustrates the KOMPAS-2 SSC as an SSP equipped with the special-purpose equipment to broadcast earthquakes that was designed by the Institute of Earth Magnetism, Ionosphere and Radio-Wave Propagation of the Russian Academy of Sciences (IZMIRAN), Space Research Centre, Polish Academy of Sciences, and Budapest Space Institute.

Fig. 2 - KOMPAS-2 SSC

Table 1 summarizes the KOMPAS-2 SSC basic characteristics.

Table 1 – KOMPAS-2 SSC basic characteristics

Customer	Federal Space Agency
SSC orbit	Elliptical, 400/500…600 km high, inclined at 79°
SSC purpose	Intended to conduct space experiments for research on possible detection of the earthquake premonitory symptoms and trace radioactive impurities with the purpose to create a space system for monitoring of natural and technogenic catastrophs (VULKAN)
SSC basic characteristics	SSC is a space platform carrying a set of support and mechanical systems and scientific equipment. SSC mass in orbit is ~ 86 kg (including scientific equipment 14.5 kg in mass, BCC 6 kg in mass) Average daily power is no less than 25 W. SSC is oriented in three axes, accuracy of steering control in pitch direction is 2-3° and in yaw and roll directions – 1 ° The active lifetime period is no less than 1 year.
SSC Launcher	Submarine-launched SHTIL Space Rocket and other launchers, can be launched as a piggyback
Scientific equipment	Satellite navigation equipment; RBE 150/400 MAYAK tone intermittent; RF analyzer (made in cooperation with Poland); VLF/ELF wave complex (made in cooperation with Ukraine, Hungary); DRF scientific equipment.
Satellite navigation equipment	High-frequency measuring of the distributed electron density
MAYAK tone intermittent characteristics	High-frequency measuring of space-and-time distribution of regular, wave and stochastic structure of the electron density 1^{st} channel actual frequency - 400±1MHz. 2^{nd} channel actual frequency - 150±1MHz. Power output of the 1^{st} and 2^{nd} channels, no less than 27 dBm.
RF analyzer characteristics	Measurement of the electromagnetic field oscillation spectrum within the frequency range 100kHz-20MHz
VLF/ELF wave complex characteristics	Measurement of the wave shape of electromagnetic oscillations in electric and magnetic components within the frequency range 0.1 Hz – 15 kHz. Measurement of the electromagnetic oscillation spectrum within the frequency range 1Hz - 15kHz
DRF scientific equipment	Recording of corpuscular radiation, UV airglow
Mission Control Centre (MCC)	MCC – TsNIImash (Korolyov)
Command and Tracking Stations (CTS)	MCC-K – receipt and processing of telemetry data; IZMIRAN (Zapadny CTS) - receipt and processing of scientific data; GRTs (Vostochny CTS) - receipt and processing of telemetry and scientific data.
SSC launches	On December 10^{th}, 2001 KOMPAS SSC was ridden as a piggyback by the ZENIT Launcher from Baykonur cosmodrome. On May 26^{th}, 2006 KOMPAS-2 SSC was put into orbit by the SHTIL Launcher from the Delfin SLBM.

From November 2006 till March 2007 the IZMIRAN command and tracking station had nearly 945 communication sessions and the OAO "Makeyev GRTs" post had nearly 1,117 sessions.

Roughly 4000 MB of data were received and processed.

The key parameters of the scientific equipment were validated. The ionosphere background behavior was measured, phenomena of the powerful thunderstorm activity in the upper atmosphere were recorded in the near-earth space.

In December 2006, during the severe geomagnetic storm, streams of accelerated protons and electrons caused by the solar activity were registered.

Trial operation of the KOMPAS SSC designed on the basis of a space platform under the OAO "Makeyev GRTs" development proved that it could be used in future projects and space missions.