PJSC “Chernigovskiy plant of radio equipment”

Optoelectronic systems for shooting control for armored vehicles

TRACK-M
PANORAMA-2P
TANDEM-2
TRIADA

The product “TRACK-M”

AAVF.201219.004-01

1. The product “Track-M” is the optoelectronic shooting control system (OES) intended for observation and detection of the ground targets (armored vehicles, manpower) and “hovered” helicopters, targeting and control of arming of combat module of armoured personnel carrier, consisting of:

- automatic 30-mm gun ZTM-1;
- automatic grenade launcher AGS-17;
- machinegun of caliber of 7.62 mm, PKT type;
- antitank rocket system 212;
- means for smokescreens making.

The product “Track-M” provides:

- detection of targets by panoramic overview device “PANORAMA-2M” and imaging of detected targets and environment on the video monitor of commander;
- observation of targets and environment in daytime and poor natural light;
- detection of targets by NTC and WTC TV cameras of optoelectronic module (OEM) and imaging of detected targets and environment of the monitors of commander and operator;
- measurement of distance to a target by laser rangefinder (LR);
- displaying of images of targets and environment on the monitors of commander and operator;
- formation and imaging of target aiming marks on the monitors of commander and operator;
- determination of the target range by indirect method;
- automatic determination of angle of sight for selected weapon;
- control of shooting of the chosen weapon type;
- formation and imaging of aiming marks for chosen type of weapon depending on target range on the monitors of commander and operator;
- formation and imaging of performance alphanumeric information on monitors;
- imaging of numerical value of the angle of sight on monitor at using of grenade launcher for invisible target depending on the entered value of the target range;
- switching of circuit voltage +27 V into blocks of product and devices of armoured personnel carrier;
- control of the gun mechanisms at loading;
- selecting of the type of gun projectile (armor-piercing and tracing or high-explosive fragmentation) and shooting mode (single shooting or bursting) for gun and grenade launcher;
- storage of selected amount of ammunition of gun and grenade launcher and automatic counting of remained ammunition at shooting;
- control of six smokescreen facilities;
- automated control of product outfit.

Main parameters and specification of the product:

- range of detection and identification of ground targets in daytime at meteorological range of visibility >10 km, the light of not more than 10^5 lux and contrast ratio of 0.4, is shown in the Table 1.

Table 1

Type of camera	Type of target	Range, not less than, km	
		detection	identification
NTC	tank	6	5
	manpower	3	2
WTC	tank	3	-
	manpower	2	-

- detection range of ground target like tank in natural nightlight $5x10^{-3}$ in environment with meteorological range of visibility> 10 km and contrast rate of 0.5 for ETC is at least 1 km;

- the range of measured distances to observed targets:

minimal -160 m

maximal - 7 km (not less);

- maximum error of measurement of the target range is not more than 5 m;

- the error of ranging by indirect method for typical targets at a distance of up to 2500 m is not more than 10%;

- angle of the field of view (azimuth x tilt angle)

(2 ° 20' x 1 ° 50') ± 5% - for NTC,

(8 ° 40' x 6 ° 30') ± 5% - for WTC.

- angular resolution corresponding to playback of one television line on video monitor is not less than 40 seconds of arc for NTC and 3 seconds of arc for WTC;

- the time of product availability to perform fighting tasks is not more than 2 minutes after start, and at decrease of ambient temperatures to minus 40° C is 5 minutes (video monitors - 12 min);

- continuous operation time of the product is not less than 6 hours following by 1 hour break before the next start;

- power supply of the product is implemented from the board voltage (27^{+2}_{-5}) V

- total current consumption is not more than 15 A (excluding the current consumed by mechanisms of weapon);

- the total weight of the product is not more than 70 kg (without weight of bundles included in the product kit);

- MTBF is 1,000 hours;

- lifetime is 15 years;

- assigned resource during entire lifetime is not less than 15,000 hours.

By the nature of use and operation the product is classified as “A” - equipment of repeated use.

Climatic version of the product is “O” under the GOST 15150.

2. Composition of the product

The composition of the product “Track-M” and weight and size of its components are represented in the table 2.

Table 2

Name	Designation	Quantity	Overall dimensions, mm	Weight, kg
Control of commander of CC	468324.004-01	1	280x191x211	4.5
Control of operator of OC	468324.005-01	1	280x191x211	4
Control block of mechanisms	468364.029-01	1	272x247x138	6,5
Optoelectronic module OEM-V	201219.075-12PS	1	490x368x214	32,5
Video monitor	467846.003-02	2	310x360x103	8,0
Kit of bundles*	468939.004	1		
Kit of bundles*	468939.005	1		

* The kit of bundles, included in supply of the product is specified in the contract for supply of the product "Track-M".

Optoelectronic module (hereinafter OEM) is placed on the outer surface from the left side of the axis of arming unit of the armoured personnel carrier, control block of mechanisms is placed in the tower, the console of commander and operator and two video monitors (of commander and operator) are located in internal compartment of armoured personnel carrier.

Structure and operation of the product

General information of operation principles

Control can be realized from commander place (from CC) and operator console (OC), depending on position of the switch SELECT on the control of commander. Starting position of switch is SELECT - OPERATOR.

Commander and operator can make adjustment of television sighting channel (TCE), LD channel and channel of control of ARS to the arming of the combat module.

In the field conditions the commander carries out observation of fight situation, searching for targets and information of targeting to operator or independently hit detected targets while the

operator passively watching the actions of the commander on his video monitor. The commander applies smokescreen if necessary.

The operator in combat conditions carries out or independent observation of fight situation, finding and hitting of detected targets or performs the target designation from the commander. Meanwhile commander watches the environment using the panoramic camera and has possibility to give automatic target designation to operator or sees the image similar to that on video monitor of operator.

Console of commander (CC) is designed to work with panoramic device, interaction with operator and the execution of tasks of shooting and adjustment control.

The organizational tasks include:

- control of voltage supply to the product + 27 V;
- observation of environment using panoramic view device;
- giving of target destination command to match the tower with panoramic device;

- selection of shooting controller (commander or operator)

1.3.1.3 The tasks of shooting control and adjustment are:

- selection of informational channel to display its information on video monitor;
- displaying of targets and environment formed by NTC and WTC and TV camera of aiming device of the complex 212;
- displaying of target aiming mark and sighting mark for gun, grenade launcher and machine gun, the scale grid for indirect ranging, service alphanumeric information including information about the target range and remained ammunition of selected weapon;
- formation of the value of target range in accordance with the output signals of laser rangefinder, image on a video monitor, target range and the quantity of targets and the target number to which the range is measured;
- selection of the type of weapon, the projectile for shooting with gun, the mode of shooting (bursts or single) for gun and grenade launcher, number of rocket for the complex 212;
- determination of angles of sight and control of position of the aiming mark on the video monitor, depending on the type of weapon the target range;
- control of closing of shooting;
- control of brightness of the aiming mark of the complex 212 and the mark of OEM collimator;
- converting of voltage of angular sensors of horizontal and vertical aiming into binary code with displaying of obtained angles of aiming on the video monitor;
- control of smokescreens;
- adjustment of the mark of LR and shooting marks.

1.3.1.4 During operation of panoramic device the communication with CC is carried out using the video monitor through serial link R5422.

The operator console (OC) is designed to control the voltage supply to the product +27 V, the tasks of control of shooting and adjustment (paragraph 1,3.1.3) when appointing him to control the shooting and to implement the gun loading, to set the quantity of ammunition of gun and grenade launcher and to bring the combat module in stowed position.

The product Tandem-2” AAVF.201219.003

1.1 Purpose and specification

1.1.1 The product “Tandem-2” that is the optoelectronic system of surveillance, aiming and shooting control (ECO) is intended for observation and detection of ground targets (armored vehicles, manpower) and "hovered" helicopters, aiming and control of arming of the shooting unit of armoured personnel carrier:

- automatic gun 30 mm ZTM-1;
- automatic grenade launcher AGC-17;
- machine gun of caliber 7.62 mm PT type;
- antitank rocket system 212;
- means of smokescreens making.

1.1.2 The product “Tandem-2” provides:

- observation of targets and environment in daytime and in conditions of poor natural light;
- detection of targets using the TV cameras NTC and WTC of optoelectronic module (OEM) and imaging of detected targets and environment on the video monitor of operator;

- measurement of the target range using the laser rangefinder (LR);
- displaying on the video monitor of images of targets and environment;
- formation and imaging of target aiming mark on the video monitor;
- determination of the target range by indirect method;
- automatic determination of aiming angles for selected weapon;
- control of shooting using selected weapon type;
- formation and imaging of aiming mark for selected type of weapon on the video monitor of operator depending on the target range;
- formation and imaging of service alphanumeric information;
- imaging of numeric value of the aiming angle at shooting by grenade launcher on invisible target depending on set value of the target range;
- switching of the board power voltage +27 V on the product block and armoured personnel carrier device;
- control of the gun mechanisms at loading;
- selection of type of the gun projectile (armor-piercing or high-explosive) and the shooting mode (burst or single) for gun and grenade launcher;
- memorizing of selected quantity of ammunition of the gun and grenade launcher and automatic counting of remained ammunition at shooting;
- automated control of the product equipment.

1.1.3 Specification and parameters of the product:

- the range of detection and identification of the ground target in daytime at meteorological range of visibility >10 km and illumination of not more than 10^5 lux and the contrast rate of 0,5 is given in the table 1.

Table 1

Type of camera	Type of target	Range, not less, km	
		detection	identification
NTC	tank	6	5
	manpower	3	2
WTC	tank	3	-
	manpower	2	-

- detection range of the ground target of the tank type in conditions of natural night illumination $5x10^{-3}$ lux on locality at meteorological range of visibility >10 km and the contrast rate 0,5 for NTC is not less than 1 km;

- the range of measurable distances to the targets being observed:

minimal - 160 m;

maximal – 7 km (not less);

- maximal error of measurement of the target range is not more than 5 m;

- the error of determination of range by indirect method for typical target at the distance of up to 2500 m is not more than 10%;

- the angle of field of view (azimuth x angle of place)

(2° 20' x 1° 50') ±5% - for NTC

(8° 40' x 6° 30') ± 5% - for WTC.

- the angular resolution corresponding to representation of one television line on the video monitor is not less than 40 seconds of arc for NTC and 3 seconds of arc for WTC.

- the time of readiness of the product to implementation of combat task is not more than 2 minutes after start and at decrease of ambient temperature up to minus 40°C is 5 minutes (video monitors – 12 min);

- the time of continuous operation of the product is not less than 6 hours with following

break of 1 hour before next start;

- power supply of the product is carried out from the board voltage (27^{+2}_{-5}) V,

the total consumption current in not less than 12 A (without current consumed by weapon mechanisms);

- the total weight of the product is not more than 60 kg (without weight of bundles included in the product composition);

- MTBF is 1000 hours;

- designated lifetime is 15 years;

- designated resource during entire lifetime is not less than 15000 hours.

1.1.4 Under using and operation type the product is classified as “A” — equipment of repeated use.

Climatic version of the product is “O” under GOST I5150.

1.2 Composition of the product

The composition of the product “Tandem-2” and mass-dimensional parameters of its components are represented in the table 2.

Table 2

Name	Designation	Quantity	Overall dimensions, mm	Weight, kg
Control board	468324.005-01	1	280x191x211	4
Control block of mechanisms of CONTROL BLOCK OF MECHANISMS	468364.029-01	1	272x247x138	6,5
Optoelectronic module OEM-V	201219.075-12PS	1	490x368x214	32,5
Video monitor	467846.003-02	1	310x360x103	4,0
Power supply switch		1	280x191x211	3,0
Kit of bundles*		1		

* The kit of bundles that is included in the product supply is stipulated in supply agreement of the product “Tandem-2”.

Optoelectronic module (hereinafter OEM) is located on the outer surface and firmly attached to the axis of the arming block of the infantry vehicle or armoured personnel carrier, control block of mechanisms, operator console, video monitor, power supply switch are in the internal cabinet of infantry vehicle (armoured personnel carrier).

The general view of the product components is represented on the figure

Figure 1. General view of equipment of “Tandem-2”

1.3 Structure and operation of the product

1.3.1 General information about operation principles

1.3.1.1 Operation can be carried out from the operator.

Operator can realize adjustment of television aiming channel (TAC), channel of LD and the channel of control of antitank rocket system and ammunition of the combat module.

In the field conditions the operator carries out observation of combat environment, searching of target and by the command of commander hits detected targets independently.

1.3.1.2 Control board (CB) is intended for implementation of tasks for control of shooting and adjustment and for gun loading, setting of quantity of ammunition of gun and grenade launcher and positioning of combat module into field mode.

Organizational tasks include:

- control of power supply to the product +27 V;

1.3.1.3 The tasks of control of shooting and adjustment include:

- selection of informational channel for displaying of its information on the video monitor;

- imaging of targets and environment on the video monitor formed by NTC and WTC and television camera of aiming device of the complex 212;

- displaying of aiming marks for gun, grenade launcher and machinegun and scale grid for indirect measurement of range, service alphanumeric information, including information about the target range and remained ammunition of selected weapon;

- formation of the value of the target range according to the output signals of the laser rangefinder, displaying of the target range and quantity of targets and number of the target being measured on the video monitor;

- selection of type of weapon, type of projectile for shooting with gun, shooting mode (burst or single) for gun and grenade launcher, number of rocket for the complex 212;

- determination of aiming angles and control of aiming mark position on the video monitor depending on selected type of weapon and the target range;

- control of brightness of the aiming mark of the complex 212 and mark of collimator of OEM;

- converting of voltages of sensors of horizontal and vertical aiming into binary code with displaying of obtained aiming angles on the video monitor;

- adjustment of the mark of LR and shooting marks.

1.3.1.6 Video monitor is intended for displaying of:

- environment from OEM in narrow and wide field of view;
- environment from panoramic camera;
- aiming and viewing marks;
- target and aiming mark, formed by TV camera of antitank rocket system;
- scale grid for indirect method of the target range measurement;

- service information.

1.3.1.7 Control block of mechanisms is intended for:

- power supply +27 V to the product equipment by the command from CC (OC);

- receipt of control information by serial link (RxD) through video monitor from CC;

- formation of voltages for control of electric triggers of gun, grenade launcher and machinegun by control signals from CC, impulses of rockets launching, voltages of power supply of electric motors of gun mechanisms;

- transmitting of information about condition of weapon mechanisms by serial link (TxD) through video monitor.

1.3.1.8 Optoelectronic module (OEM) is intended for:

- formation of television signals of image of ground targets and environment in narrow and wide field of view;

- formation of start-stop signals of the laser rangefinder;

- control of angular position of axis of the laser rangefinder in narrow and wide field of view;

OEM is designed as sole construct that includes two television cameras, with narrow field of view (NTC) and wide field of view (WTC), switcher of signals of TV cameras (SS), laser rangefinder (LR), unit of heating of input protective glass (UNZS) and built-in optical collimator (OC).

NTC and WTC convert the light flux from target into video signal and process it to obtain the image of target at different levels of illumination. The lenses of NTC and WTC cameras are fit with diaphragm control unit. Video signals from outputs of NTC and WTC cameras are transmitted to television channel commutator input that connects the signal of selected camera with the output of OEM through control signal of switching of fields of view.

LR provides formation of start-stop signals by the command of starting from control block of mechanisms for calculation of the target range and counting of their quantity within the beam range.

The built-in optical collimator forms radiation of cross that is transmitted to the inputs of NTC and WTC using optical prism systems to obtain the image of direction of optical axis of LR on the video monitor.

Universal protection system provides heating of protective glass at decreased ambient temperature.

The product “TRIADA” AAVF. 201219.007

1. Purpose and specification

1.1.1 The product “Triada” is the universal complex of shooting control (OES) for light-armored vehicles and is intended for observation and detection of ground targets (armored vehicles, manpower) and “hovered” helicopters, aiming and control of weapon of the combat module of armoured personnel carrier:

- automatic gun 30 mm ZTM-1;

- automatic grenade launcher AGS-17;

- machinegun of caliber 1,62 mm of type PKT;

- antitank rocket system 212;

- means for making of smokescreens.

1.1.2 Integrated system of detection, aiming, stabilization and shooting control (the product “Triada”) is designed based on technical solutions practiced in shooting control systems “Tandem”, “Tandem-2”, “Track-M” and in stabilizer “CS-2P” and the products “Katran” and “Katran-M”.

The aim of design is decrease of labor intensiveness for manufacturing, quantity of device interconnections, increase of operation reliability, and application of modern component base, introduction of stabilization mode and decrease of total value of the product comparing with the total value of replaceable systems.

Equipment of the product is developed so as to provide both autonomous control of operator from the combat module and remote control of the combat module from the consoles of commander and operator located in the chassis of combat machine.

Design of the product provides receipt of the command from commander at autonomous control (device of commander console) and from the panoramic view system at remote controlling (the product “Panorama”).

1.1.3 Main technical parameters and specification of the product:

- the range of target detection of the tank type in daytime at meteorological range of visibility >10 km, illumination of terrain within the range $100..10^5$ lux and the contrast rate of 0,4 must be not less than 7 000 m, 5 000 m, 3 000 m, 1700 m for the shooting channel of controlled rocket, NTC, WTC respectively.

- the detection range of NTC of the ground target of tank type in conditions of natural night illumination $5x10^{-3}$ on the terrain at meteorological range of visibility >10 km and the contrast rate of 0,5 for NTC is not less than 800 m;

- the range of detection of ground target of tank type at heat contrast =2K is not less than 2 000 m;

- the range of measurable distances to the targets being observed:

minimal – 160 m;

maximal – 7 km (not less);

- the readiness time of the product to implementation of combat task is not more than 3 minutes after start and at the ambient temperature of minus 20°C and minus 40 °C the readiness time is 5 minutes and 12 minutes respectively.

- continuous operation time of the product in not less than 8 hours with following break of 1 hour before next start;

- the power supply of the product is carried out from the board voltage 27^{+2}_{-5} V,

the total consumption current is not more than 15 A (without current consumed by the weapon mechanisms);

- the total weight of the product is not more than 70 kg (without weight of bundles included in product composition);

- MTBF is 1 000 hours;

- the average resource during entire lifetime is not less than 1 0000 hours;

- the average operation period is 10, 5 years;

1.1.4 Under the character of use and operation the product is classified as category “A” – equipment of repeated use.

Climatic version of the product is “O” under GOST15150.

2. Product composition

Composition of the product “Triada”:

1) optoelectronic module (OEM) included in NTC (narrow-field television channel), MTC (middle-field television channel), WTC (wide-field television channel), LR (laser rangefinder) and equipment included in composition of aiming device of the complex 212:

2) Control console of commander (CC)

3) Control console of operator (OC)

4) Video monitors of operator and commander:

5) Aiming consoles (AC) of commander and operator

6) controlling device;

7) control block of mechanisms;

8) amplifier;

9) turning drive;

10) lifting drive;

11) meter of inclination angles;

12) kit of bundles.

Equipment p.p. 1, 5, 7…10 is always located in the combat module and the meter of inclination angle in chassis. The rest of equipment is located in the combat module at autonomous control and at remote control in chassis.

3. Survivability and external action resistance

Under resistance, durability and stability to external action the complex corresponds to GOST V20.39.304-76 of the group 1.11.

PANORAMA-2P

all-round looking device\Panorama-2P

is intended for searching and detection of movable and immovable targets of tank and manpower type by combat vehicle commander, giving of video signal for imaging of detected targets and environment on the video monitor of combat vehicle commander and angular coordinates of direction of optical axis in horizontal plane relative to the tower of combat module.

Main technical parameters and specification of the product:

Overview within the range of angles, degrees: 360

Field of view (8°40'x6°30')±5%

Angular resolution, °/c:

- at searching and detection: 3

- at changeover: 36

The height of lift of optoelectronic module, millimeters: 117±2

The readiness time for implementation of combat task in normal climatic conditions, not more, seconds: 10

The readiness time of the product for implementation of combat task at the temperature of minus 40° C and in the absence of hoarfrost or ice of up to 1 mm or snow on the external surface, not more, minutes: 2

Continuous operation period with following break of 1 hour before the next start, not less, hours: 6

MTBF, not less, hours: 1000

Lifetime, years: 15

Resource during entire lifetime, not less, hours: 15000

Device is resistant and durable to external action according to GOST V10.39.304-76 for the group 1.11 of the version “O” under GOST15150 considering following amendments:

sinusoidal vibration – with acceleration 6g within the range of frequency 5-60 Hz;

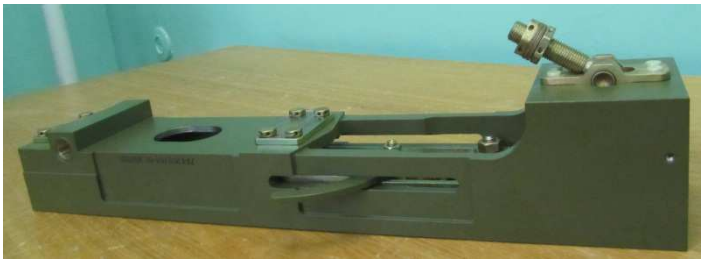
multiple-acting mechanical shock with peak acceleration 4g and interval of action of shock acceleration 5-10 milliseconds;

the operating temperature range is determined by agreement with the client.

Under the character of use and operation the product is referred to the category “A” – equipment of repeated use.

Climatic version of the product is “O” under GOST15150.

GUIDE



It is used for installation of launching transporting container TPK-2 on the combat vehicle.

The launching transporting container is firmly inserted in slots of the guide up to automatic actuation of hooks.

After shoot the spring reduces the nuclear recoil. Depending on the power of charge there are provided two variants of constructive versions.

After shot the lever releases the launching transporting container.

Comparative parameters of the products “Track-M” and “Triada”

№	Parameter	Existing “Track-M”	Foreseen “Triada”
1	Type of stabilization system	High-speed. It is provided by gyroscopic speed sensors with following integration for obtaining of values of the angles.	Angular. Direct obtaining of values of angles from sensors System stability is increased.
2	Availability of horizontal and vertical movement of weapon	Periodical adjustment is required.	Absent. Operation is simplified. Maintenance cost is decreased and combat readiness is increased respectively.
3	Maximal speed of tower turning	40 °/c	40 °/c
4	Minimal speed of tower turning	0,02 °/c (by TZ), real 0,1..0,3 °/c	0,01 °/c Accuracy of weapon aiming on target is improved and probability of hitting of target by the “first” shot is increased.
5	Modes of weapon aiming	Semiautomatic, automatic, aiming of antitank rocket system.	semiautomatic, automatic, aiming of antitank rocket system aiming
6	Automatic following of targets	Absent.	Provided. Allows automatic observation of selected target, probability of hitting of movable targets and hit accuracy at marching shooting is increased.
7	Compensation of friction and imbalance torques in drives of weapon control system	Absent.	Provided. Target aiming accuracy is increased.

8	Automatic adjustment of target aiming angle	Absent.	Provided. Operator work is simplified. The probability of target hitting by the first shot is increased.
9	Generation of ballistic corrections	Absent.	Provided. Operator work is simplified. The probability of target hitting by the first shot is increased.
10	Introduction of ballistic corrections	Absent.	Provided. Operator work is simplified.
11*	Quantity of the fields of view of OEM	2	3 Visual observation of the battlefield is improved.
12*	Maximal measurable target range	5000 meters.	7000 meters. Fire aiming range is increased.
13	Range strobing	Absent.	Provided. Selection of targets is improved and stability of following by range is increased.
14*	Operation of laser rangefinder with automatic (amplitude choice of target selection)	Absent.	Provided. It increases the accuracy and reliability of targeting and decreases the shooting preparation time, probability of target hitting is increased.
15	Continuous operation time	6 hours	8 hours. Time of combat use is increased.
16	Correction of image quality	Absent.	Provided. Visual observation of the battlefield is improved.

Selection of type of weapon for shooting, mode of shooting, control of electric triggers condition, counting of remained ammunition of gun and grenade launcher, displaying of angular position of tower and tube, displaying of aiming angle of grenade launcher, indirect measurement of range and resolution of television channels of the product “Triada” correspond to parameters of the product “Track-M”.

*-Parameters are provided if OEM corresponds to technical terms and requirements of performance specification for the product “Triada”.