## СЕКЦІЯ 11
## НАПРЯМИ РОЗВИТКУ ОЗБРОЄННЯ ТА ВІЙСЬКОВОЇ ТЕХНІКИ ПОВІТРЯНИХ СИЛ ЗБРОЙНИХ СИЛ УКРАЇНИ

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### DEVELOPMENT OF THE METHOD OF CONSTRUCTION OF THE COMBAT ORDER OF THE ANTI-AIRCRAFT MISSILE ARTILLERY DIVISION OF A SEPARATE MECHANIZED BRIGADE IN DEFENSE IN CONDITIONS OF AGGRESSION OF THE RUSSIAN FEDERATION USING DIGITAL TERRAIN MAPS

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By experience, the anti-terrorist operation in the modern battle has greatly increased the volumes and variety of data used in planning, organizing and conducting operations and battles.

In resolving the contradictions between growing volumes of information and reducing the time for decision-making, assistance to commanders and management bodies can provide the use of mathematical models and information and calculation systems implemented on personal computers, the use of perfect calculation methods and the assessment of the effectiveness of the use of air defense forces, based on modern scientific methods. The actual state of affairs in the field of information provision of combat operations and command and control of troops is increasingly affecting the implementation of the combat capabilities of the troops and the effectiveness of their actions. These issues are of particular relevance to the Army Air Defense Forces, in which the problems of automation of units' preparation for combat operations and their management during the battle are not resolved in full. The task of calculating the distance between the positions of anti-aircraft means (subdivisions) in the covered of troops and objects is solved by choosing positions of the positions of forces and means of the Army Air Defense Forces in 2 stages. At the first stage, proposals are made on the location of air defense forces and means using the developed mathematical apparatus and the practice of organizing the covered of troops and objects without taking into account the terrain. At the second stage, the correction of the coordinates of the location of the air defense facilities is made taking into account the terrain and the nature of the area, the location of local objects that affect the effectiveness of the use of anti-aircraft means, using the capabilities of digital terrain maps.

Therefore, using this method, we obtain the increase in the estimation of the effectiveness of the combat actions of the anti-aircraft missile artillery division with the chosen construction of the combat order.

## DEVELOPMENT OF THE ALGORITHM FOR INFORMATION INTEGRATION IN THE ORGANIZATION OF A MOBILE SYSTEM OF PASSIVE RADAR DETECTION OF NEAR-FIELD ANTI-AIRCRAFT SYSTEMS FOR DETERMINING THE COORDINATES OF AIR TARGETS

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The experience of military conflicts in recent 10 years pays our attention to the problem of increasing the importance of air defense. In modern war the successful usage of AD can be provided by applying the wide range of radar in AD. If we use AD properly it helps to decrease the level of destroying aircraft during the combat flight from 20-25% to 2-3%. That is why, in our opinion, it is important to develop means of passive processing data from passive radars.

The main result of our research can be divided into three steps.

The first step is developing algorithm of filtration which gives opportunity to proceed non continuous and no periodical data about position of targets which is optimal from the accuracy point of view.

The next step is the development of algorithm of complex for radar data from passive and active radars which allows to increase protection from interferences and to decrease the level of radar visibility.

The last step is developing the algorithm of functioning which allows to detect position of air targets with the help of data received from the unit radar with the help of algorithm of complex.

The presented algorithm gives opportunity to detect position of air targets in the conditions of radar determined functions to provide the accuracy in launching air targets.

## ARGUMENTYYA PROPOSALS FOR THE DEVELOPMENT OF THE OPTOELECTRONIC CHANNEL OF DETECTION AND ESCORT OF TARGET ANTI-AIRCRAFT REMEDY

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The analysis of the tactical and technical characteristics of airborne aerodynamic instruments shows that different types of goals and peculiarities of their combat use have significant differences, which are informative features in the process of their detection, recognition and tracking.

According to the results of the analysis it is possible to determine the following requirements for the modernization of the instruments of reconnaissance of the air enemy: increasing the range of optical detection of air targets, increasing the plausibility of detection, ensuring the mass-size characteristics of the optoelectronic device, using in the device circuitry solutions based on a modern element base, manufactured (available) in Ukraine, the use of a specialized digital information processing device (special processor), ensuring reliability and durability of work pr ranks in various conditions of combat. Ensuring the fulfillment of these requirements will generally improve the overall effectiveness of the anti-aircraft vehicle. Based on the demands made to the

optoelectronic intelligence device, proposals were made for its technical implementation on the basis of the television channel and its structural scheme was developed. The main elements of such a channel should be: digital television camera, video controller, special processor, connection board in the device input / output information. In order to realize the task of automatic maintenance of the air target in real time, it is proposed to develop a group of image processing algorithms.

Using this device, we solve the following tasks: automatic observation of visually observing the target, reducing the mistakes of guiding the anti-aircraft guided missile by the operator, reducing sighting mistakes during shooting by maneuvering targets, reducing errors in the process of guiding an anti-aircraft guided missile and, accordingly, reducing the dynamic missile missile sinking, reducing the follower`s inertia of the optical sight, the reduction of the influence of the subjective factor such as the level of training of the operator to the quality workcontrol of aiming anti-aircraft missiles.

## THE RELEVANCE OF LASER LOCATION USAGE IN AIR DEFENSE TROOPS

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Nowadays, the main instruments of detecting the ARC DB (MD) are radar equipment, and the auxiliary for them are optical. Because of the development of optoelectronics, we will have the technical ability to supplement the instruments of detecting laser devices for searching, guiding and maintaining the whole.

Laser location devices allow you to solve the problem of tracking the target and directing the missile to the target by automating it. Also, this add-on gives us the opportunity to apply large streams of radiated power, it is very important that the given flows are monochromatic in frequency. This significantly facilitates the reception and processing of a useful signal. As well as changing the carrier frequency (approximately 1000 times compared with traditional radar), it is possible to obtain very narrow diagrams of laser station orientation. This value is especially important for the SSC. It is known that the directional patterns are directly proportional to the wavelength, therefore, with a significant reduction in the wavelength of the carrier compared with the traditional radar, the need for overall reception and transmitting devices disappears, with a preserved nude directional pattern. These changes lead to increased resolution and accuracy. SDC day-type will have more noise immunity. Since apart from the selection of a useful signal by frequency, it is possible to provide ideal spatial selection, since the directional diagram of the laser locator has almost no lateral petals. And since the optical range is more frequent in comparison with the radar range, this allows broadband modulation to allow more accurate measurement of the speed of low-speed targets. This system also solves the problem of the anticode of the goal. But there are disadvantages in this system, one of these is the transition of the global flow through various environments that adhere the light flux, and are natural obstacles for the laser location system. This shortcoming does not allow the complete replacement of the radar system with laser location systems.

## SPATIALLY DIVERSE BI-STATIC RADIOMETRIC SYSTEM FOR THE MAPPING OF VARIOUS OBJECTS

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The variant of improvement of both the sensitivity and the time difference of arrival resolution of a bi-static radiometric system (BRS) is proposed.

Brightness temperatures of atmospheric emission in the 3 mm wavelength band are given under different conditions.

The new range equation is obtained taking into account interfering brightness temperatures at the Earth surface mapping by the BRS.

This allows simulating the BRS depending on its technical parameters at the mapping of small-sized objects.

The advantage of the BRS is shown for the case in which the Doppler frequency shift is present in the system carriage-target.

The variant of the range equation is substantiated at space objects monitoring by orbiting BRS.

The Wiener-distributed radiometric signal detection rule is obtained based on the maximum plausibility estimation method.

The obtainment of the detection rules is presented for the non-stationary signal against non-stationary interfering background signals and the noise of radiometer.

Physically existing minor simplifications have been introduced.

The technically feasible block diagrams are given for these detection rules of radiometric signal accounting the threshold level.

## DETECTING THREATS TO THE INFORMATION AND PSYCHOLOGICAL SECURITY OF UKRAINIAN ARMED FORCES PERSONNEL IN CYBERSPACE

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Analysis of the conduct of local wars and armed conflicts over the last decade has shown that the confrontation in the military sphere is increasingly moving into virtual-informational (cybernetic) – space. This is due to the fact that modern information technologies enable them to realize their own interests without the use of military force, to weaken or significantly damage the security of a rival state making use of its lack of an effective system of protection against negative informational and psychological influence. Such influence is directed towards the consciousness and subconsciousness of a person in order to make changes in his/her behavior and outlook. Therefore, ensuring the information and psychological security of a person is a vital interest of the state in cybernetic warfare.

The destructive influence on the control systems is also achieved through information and psychological operations directed against the personnel and decision makers and affect their moral stability, emotions and motives for making decisions, implementation of measures for operational security, disinformation and physical destruction of the '

infrastructure objects. Information counteraction in cyberspace is just one of the components of information security. One of the important directions of ensuring the country's defense capability is the maintenance of a sufficiently high level of information security of the Armed Forces of Ukraine.

A number of approaches and methods implemented on the basis of analytical tools and linguistic processing of information resources are developed and continued to be developed for the analysis of information.

Therefore, the development of information and telecommunication technologies leads to an increase in the level of information security in cyberspace.

## INFORMATION PROTECTION ALGORITHMS IN THE TELECOMMUNICATION NETWORKS OF THE AIR FORCES

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Every year the relevance of the information security problem is increasing, especially in military telecommunication networks during the ATO.

The main functions that are subject to priority automation are:

- alert;
- mapping and entering the operational environment using digital map data;
- collection, processing, storage of information;
- control over the execution of tasks and instructions;
- Information and analytical support of the leadership of the Ministry of Defense (MO) and the Armed Forces of Ukraine;
- secure exchange of electronic documents (text and graphic) in an automated mode with a stamp not lower than "secret"

To provide the last item, it is necessary to use modern algorithms of cryptographic protection, which include block-symmetric ciphers.

The main task of code command system is to keep mission, reports and information in secret. The solution of the task is achieved by a series of measures conducted by the commanders andheadquarters.

For the construction of information security mechanisms, traditional methods of cryptographic information processing are traditionally used. These are, first of all, the methods of symmetric and asymmetric cryptography. To provide the last item, it is necessary to use modern algorithms of cryptographic protection, which include block-symmetric code.

The main requirements for the BSCare: the cryptographic resistance to possible modern crypto-attack, the possibility of using different lengths of keys and effective hardware and software implementation.

The results of the ATO show that the block-symmetric codeis still usedin the telecommunication systems of the special (military) purpose. Therefore, the development of modern block-symmetric code is an urgent issue.

## ANALYSIS OF THE POSSIBILITY OF TRANSMITTING TELEPHONE MESSAGES WITH A GIVEN PROBABILITY ON THE DECAMETER RANGE DIGITAL RADIO CHANNELS, TAKING INTO ACCOUNT THE EXPERIENCE OF ATO

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Radio communication in aviation is the main form of communication between the ground command posts, headquarters, control points and aerodromes.

Shortwave system radio communication is widely used in aviation in order to provide long-range air and land-based communications.

Advantages of SW radio communication:

– efficiency of establishing direct communication over long distances;
– easy organization of radio communication with moving objects;
– ability to provide communication through inaccessible spaces (zone of high infection, difficult water and mountainous areas, forest arrays, etc.);
– high mobility of SW radio communication;
– simple restoration of communication in case of communications failure (the influence of both random and intentional obstacles);
– low cost of one channel per kilometer of communication distance.

The Counter-Terrorist Operation (ATO) shows that a reliable communication is one of the main factors or a condition for ensuring the effectiveness of troop control in the course of their practical application.

Today, among combat units and units that perform tasks in the ATO zone, information exchange is carried out by usage of modern secured digital means. Thus, on the basis of analysis of existing and perspective methods of processing signals, a structural scheme of the SW range radio station is developed with digital conversion of voice signal parameters and their transfer at the rate of 1200 bps.

So, the usage of digital signal processing can increase the reliability and authenticity of the transmission of information with the errors probability of $10^{-5}$.

## PROPOSALS FOR COUNTERACTION TO ULTRA LIGHT UNMANNED AERIAL VEHICLES IN PROTECTION OF MILITARY OBJECTS BY THE DEVELOPMENT OF JAMMERS

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At this stage it is relevant to create such jammers which would be effective for counteraction to ultra light unmanned aerial vehicles for the protection of military objects.

Analysis of realization of combat operations in the zone of ATO showed that the opponent has quite a significant number of unmanned aerial vehicles, which causes the necessity to create the newest specialized jammers.

In the zone of ATO small-sized and low noise unmanned aerial vehicles are used for air attack which apply incendiary and high-explosive munitions.

The objects of combat action are usually selected among unprepared for such a scenario objects on the second and third lines of defense (up to 20 km), for example, ammunition depots.

Based on the analysis of the principles and methods of constructing jammers, a jammer circuit was proposed and substantiated, that would provide a suppression of control channel of the UAV at a frequency of 2.4 GHz and a higher reliability of military objects.

As a result of calculations, taking into account the distance to the operator of the control panel of the UAV of 50-200 meters, the conclusion is that the zone of suppression meets the requirements for the protection of strategic objects, for example warehouses, so it is advisable to use the proposed device to complete this task.

The usage of the proposed device will allow to protect military objects, while placing the UAV control panel at distances of 50 m or more from the jammer device.

So, the usage of the proposed device will improve the reliability of object protection and warehouse protection by approximately 8...10%.

## DEVELOPMENT OF PROPOSALS FOR THE COVERAGE OF ORDNANCE DUMPS FROM TERRORIST AIR ATTACKS ARM "OSA-AKM"

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Specialists state that the most dangerous terrorist acts are those that aimed at ordnance dumps because they become uncontrollable in case of fire or explosion, making it difficult to curb such an accident.

That is why, it is necessary to ensure in safety of people's lives and the generalization of a number of important and complex events in international life that involves the cover of important state facilities and the country's defence capability. It is necessary to spend a lot of time preparing proposals of combat organization construction of air defense anti-aircraft weapons for ordnance dumps screening. The commander should take into account a large number of conditions and restrictions and be sure in a high probability of preservating the object of cover. Such mythology includes 8 blocks:

- Formation (or correction) of initial data
- Calculation of the dropsite of the aircraft fragments and borders of the fire task settings
- Calculation of the spatial zone of possible anti-aircraft means placement
- Calculation of the required number of target channels for the i-type anti-aircraft means
- Construction of the combat order of anti-aircraft vehicles taking into account terrain features
- The calculation of the effectiveness of the terrorist attack reflection on the object of cover
- This block compares the received effectiveness of the air defense with the required one.
- Formation of recommendations for covering important state facilities from the air.

## DEVELOPMENT OF PROPOSALS FOR THE PROTECTION OF RADAR SYSTEMS FROM ACTIVE INTERFERENCE WITH THE USAGE OF A POWER STRUGGLE METHOD IN THE ATO ZONE CONDITIONS

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According to the current military situation, it is necessary to study the features of using different duration manipulation codes, their influence on the change of radar detection range at different noise conditions in the radar survival zone.

The research was carried out to ensure the protection of radar from active interference by the way of using adaptive changes of signal. The analysis shows that there are several options that can lead to the counteraction against active noise interferences. They provide requirements for combat work in conditions of difficult interference. The choice must be made taking into account technical characteristics of the radar and conditions of saving the quality of radar data. Absolute advantages in the way of radar protection are present in the method of power struggle with suppliers of active interferences.

Calculations of the quality indicators of signal detection under the influence of active interference with the use of the power struggle method show that under the influence of a single active interferences supplier on the centimeter band radar, the sounding signals are modulated by 7-13 elementary codes of Barker. In case of the joint influence of several active interference suppliers, it is advisable to use longer signals, namely M-sequences with length of 16 and more elements. In this case, the minimum detection range for airborne objects will be 5 km. In case of using the M-sequence of longer duration, it is necessary to use the integration of two or more radars to provide the specified parameters of the radar field.

That is why, the developed methodology makes it possible to improve the level of radar systems protection.

## ANALYSIS OF METROLOGICAL CHARACTERISTICS OF DIGITAL MULTIMETERS USED TO CONTROL THE PARAMETERS OF WEAPONS IN THE ATO ZONE

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This work considers ways of use of digital multimeters (DM) of the mobile metrological laboratories, utilized during the verification of the armament and military equipment samples in the ATO zone, describing metrological and operational characteristics of these digital multimeters, and providing their accuracy.

Metrological characteristics are the characteristics of the DM, which are being normalized to determine the measurement result and its errors. Based on the analysis of digital multimeters used by mobile metrological laboratories, it was found that depending on the tasks, performed in the zone, it is necessary to choose a multimeter with corresponding metrological characteristics. Also, a general approach to the metrological

characteristics of the means of measuring equipment is standardized, implying that nominal functions and nominal values, as well as the limits of their permissible deviations for the normalized functions, and individual values of the normalized metrological characteristics are established, simplifying the selection of an instrument for a specific task. In order to increase nose immunity of a certain device, some aspects digital multimeters are also analyzed in this work.

Thus, thework contains a basic analysis of metrological characteristics of digital multimeters, ways to increase them, and to reduce the errors affecting the metrological characteristics. The methods of selection of digital multimeters with the necessary metrological characteristics to fulfill certain tasks are proposed.

## THE ANALYSIS OF DIGITAL METHODS OF CALIBRATION OF DEFORMATION MANOMETERS BY MEANS OF MEASURING EQUIPMENT FOR MILITARY PURPOSES

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Verification of military devices significantly affects on the increase of combat readiness of certain types of armament (forces), especially in the context of the antiterrorist operation. Pressure measurement in the military metrological authorities of the Armed Forces of Ukraine is determined by the constant increase in the quality requirements of the Armed Forces of Ukraine. Methods and means of measuring pressure, the further determination of their advantages and disadvantages significantly affect on the metrological provision of armament of forces carried out by the forces of outgoing metrological repair and restoration groups in the composition of the mobile laboratory of the measuring equipment.

One of the main parameters is pressure. The following instruments are used for pressure measurement: atmospheric barometers, pressure gauges – excess; vacuum gauges – vacuum metric. It is known, that to determine the metrological utility of devices measuring devices are to be calibrated and verified, without the exception of pressure measuring devices. Working standards are used as working standards, cargo piston gauges and pressure sensors. The aim is to analyze the digital methods of calibration and calibration of deformation manometers by means of military equipment, principles of construction of such pressure gauges and in determining the ways of their further application to the UMG. The need for pressure gauges is growing rapidly due to the rapid development of automated control and control systems, the introduction of new technological processes, the transition to flexible automated productions. In addition to high metrological characteristics, pressure gauges should have high reliability, durability, stability, small dimensions, mass, compatibility with microelectronic devices for processing information at low labor costs and low cost. On the basis of analysis was considered methods and means of measuring the pressure and measuring devices of the pressure by means of outgoing metrological repair and restoration groups of armaments of the Armed Forces of Ukraine.

## ANALYSIS OF EXISTING SEMIACTIVE RADAR SYSTEMS

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This work analyses main problems caused the development of an effective system of organization airspace control such as creation and support of fully automated radar space over Ukraine on extremely low altitudes. This research is considering usage of semi active radar systems (radars) working with signal waveforms from nonradar sources as well as radio broadcasting, analog and digital television, cellular communication systems, etc.

Existing semi active radar systems that receive direct signal waveforms from an outside source and calculates cross-correlation function of direct and mirrored signal waveforms from the target are analyzed in this work. Next systems are reviewed:

- Silent Sentry of Lockheed-Martin using the television radiated emission, DVB-T and FM-transmitters;
- Celldar of Roke Manor using cellular radiated emissions in GSM 900, 1800 and2700 MHz frequencies;
- Home Alerter 100 of Thales using intensity signal of FM-transmitters (DAB and DVB-T systems could be used as well);
- SINBAD of Thales using ground-based digital television signals with DVB-T technology;
- "Pole" using analog television signals;

Analyzed causes of aviation accidents proves that precise and up-to-date information about meteorological situation in the airspace is a substantial part of the way how to predict and prevent this kind of accidents. At the moment the significant attention is payed to perform metrological control with use meteo locators which are providing meteorological information in the airspace in smart and timely manner. However manufacturing and maintaining this kind of radars is quite expensive. So implementation of a meteorological channel into a radar used for military purposes expands their self-descriptiveness and options how these radars can be utilized.

## RADAR SIGNAL SIMULATORS

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Radar signal simulation as a branch of the radar systemsis rapidly developingduring the recent years. More modern methods of signal generation are based on digital signal processing and transmission. Currently broadband radar signal simulation can be achieved mainly in three ways:

I. DDS ASIC Using this way of programming is simplier and easier. And it is allowed to operate the frequency of waveform that could be generated in a high level. However the waveforms are simple relatively to the reference waveforms that are used as chip to keep data.

II. FPGA and Direct Digital Control IC. Complicatedwaveforms could be produced using this way of software technology but it has some disadvantages as a narrow bandwidth and high level of a chip power consumption.

III. FPGA and dual high-speed DA with analog modulator and the mixer. FPGA controls the output of the waveform data including waveform conversion cycle and frequency.

Radar signal imitators are known to be widely used to develop, manufacture, utilize and to provide end-user support. With usage of these simulators radar manufacturers are able to:

- model radar signals and different working scenarios;
- perform a full control over different scenarios while taking different testing, providing qualitative results;
- simulate iterative movement of radars by the same path with the same configuration.

## SUGGESTIONS ON HOW TO USE MODERN ADS-B TECHNOLOGIES IN THE ARMED FORCES OF UKRAINE

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ADS-B( Automatic dependent surveillance-broadcast) Technologies is an Anchorage, Alaska engineering and technical corporation that offers consultations on specialized air traffic management and air traffic control services. Specifically, it provides support in the deployment of Automatic Dependent Surveillance - Broadcast (ADS-B) related to Communication, Navigation, and Surveillance (CNS) technologies throughout the World. Our airspace-based on ADS-B is also issued with the dual link (both 1090ES and UAT) system only and is capable of tracking aircraft in the real-time through the accuracy and security of air traffic control that ispractically used anywhere in the world.

ADS-B Technologies' approach to Air Traffic Management (ATM) is based on our strong belief that we are currently entering a new era of theGlobal Satellite Navigation Age in aviation. Its universal application as well as use Automatic Dependent Surveillance - Broadcast (ADS-B) will trigger changes in the global air traffic management . Their usage has been surpassed the introduction of Radar more than sixty years ago.

Although we use the both 1090 MHz "Extended Squitter" and 978 MHz "UAT" ADS-B, we direct our attention on the providing and development of 978 MHz UAT product cause of its high level of ADS-B datalink standards, its capability and flexibility. It is displayed as the nextgen product and it is the first Cooperative Dependent Surveillance (CDS) technology that was fully certified by the FAA and ICAO for critical "radar-like" air traffic control services (2002).

ADS-B is radically new technology that is redefining the paradigm of COMMUNICATIONS – NAVIGATION – SURVEILLANCE in Air Traffic Management today. It has been already proven and certified the benefits of replacement a conventional radar with ADS-B that allows pilots and air traffic controllers to "see" and to control aircraft simultaneously with the earth's surface supervising comprising the higher percentage of accuracy than has ever been possible before.

## CAPABILITIES OF EXISTING RADAR SYSTEMS USED IN RADAR TROOPS TO DETECT UNMANNED AERIAL VEHICLES

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In the modern conditions the constant task of radar troops and its infrastructure has being continuously become complicated with the appearance of sufficient amount of small-sized unmanned aerial devices (UAVs). UAVs have specific flying and tactical characteristics.First of allthere are their capabilities of effective small scattering surface and wide speed range as well as their capability to fly on low and extremely low altitudes using terrain benefits. This research considers the developmenttrends and application of UAVsduring the recent local and armed conflicts. Using the military forces in local wars and conflicts was practically proved the fact that the implementation of active warfare with UAVs ( their capability of antiaircraft defeats) is a very complicated task, and it becomes effective in defined circumstances only. The quite well effectiveness of anti-UAVs warfare with using anti- aircraft artillery system, air defense missile system and anti-aircraft weapons could be achieved in case of early UAVs detection and attacking(with relatively large dimensions). In the modern driving conditions of network-centered and hybrid wars, UAVs are considered to be used as a main reconnaissance unit (along with space reconnaissance). Thus, countries involved in modern hybrid warfare have actively being developed existing ways of UAVs exploitation. So, for example, the Russian Armyis widely issued with UAVs.Realizing the UAVs underutilization in Georgian and Chechen campaigns, the Ministry of Defense of Russian Federation has started an active work from 2009 in this direction. UAVsareanactiveassetsinthe zone ofanti-terrorist operation, especially in the areas close to the borders of the Russian Federation. Nowadays, the Russian Federation army is equipped with following models of UAVs such as "Orlan-10", "Zastava", "Granat", "Leyer", "Forpost", "Tachikon", "ZALA" etc.

Based on analysis of the development trends and the recent wide UAVs usage, it becomes clear thatthere is still a need in implementation of specialized radar means with their relevant specifications and reconnaissance capabilities of working with small objectsin present and future military conflicts.

## ANALYSIS OF WAYS OF REDUCTION OF ASCINE CURRENTS OF ASYNCHRONAL MOTORS OF DISTRIBUTION-CONVERTING SETTINGS OF ZENITICAL ROCKET COMPLEXES IN THE CONDITIONS OF ATO

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The conducted analysis of the application of electrical systems of weapons complexes and military equipment in the ATO zone showed a certain number of omissions regarding the organization and planning of the supply of military facilities. The most characteristic is the case when consumers are equipped with asynchronous motors of more than 10 kW power (drives, antennas, crane equipment, converters) at the time of start-up, fuses are fired at substations or there is a reset of diesel generator loads.

These phenomena are associated with power constraints over power lines, transformers and diesel generators for starting currents of asynchronous motors since the multiplicity of the starting current is within the limits of (4-7) multiplicities from the nominal. Ultimately, this leads to a failure in the combat task.

When conducting operations in the ATO zone, there were cases when a specialized electric motor with a 10 kW power was not able to overload a product weighing 3 tons due to voltage failures at the moment of switching, which compromised the execution of combat mission. The analysis showed that at the moment of activation of the asynchronous motor due to the voltage drop in the supplying transformer and in the 80-meter cable, the voltage dropped and the engine developing at an under voltage of 340 V instead of 380 V was not sufficient. Anyone from the considered methods of launch could correct the situation. Taking into account the rapid development of digital technology, it becomes apparent to use soft start devices on terrorists, and thinking about the prospect of solving simultaneously the question of start-up and the issue of changing the speed affecting both the frequency and the amplitude of the supply voltage, it should be preferred inverter start-up.

## ANALYSIS OF METHODS AND MEANS FOR DETERMINING THE TECHNICAL STATE OF ASYNCHRONOUS MOTORS OF ELECTROMECHANICAL FREQUENCY CONVERTERS IN POWER SUPPLY SYSTEMS OF ANTI-AIRCRAFT MISSILE SYSTEMS USED DURING ATO

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The experience of using forces in the ATO suggests that the anti-aircraft missile systems S-300PT, C-300PS and Buk-M1 in the area of the anti-terrorist operation constitute the main firepower in the air defense system and are used to protect the most important industrial and military objects.

The development of modern methods and means for determining the technical state of asynchronous motors of electromechanical frequency converters is an urgent task.

Electric frequency carriers provide combat operations by anti-aircraft missile units, and failure of the drive induction motor can lead to non-fulfillment of the combat mission and the destruction of important industrial and military units in the country.

Due to the fact that the reliable operation of the asynchronous motor of the frequency converter depends on the performance of combat tasks by anti-aircraft missile systems, information about the actual technical state of the engine is very important.

Existing methods and means of diagnosing asynchronous motors used in the Armed Forces of Ukraine do not allow to fully assess their actual technical condition and thus prevent possible malfunctions and accidents.

For the efficient and reliable diagnosis of asynchronous motors of electromechanical frequency converters, it is most appropriate to use a method that is fundamentally based on the method of analyzing the spectra of current and voltage.

## INVESTIGATION OF THE AUTOMATIC COMMUNICATION SYSTEM. EVALUATION OF THE COMPULSORY PROPERTIES OF SMALL-DIMENSIONAL OBJECTIVES

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Air defense is an important element of the security of any country. It is aimed at protecting military and administrative centers, groups of troops and population from air strikes and protecting the country's borders in the airspace. One of the components of the combat readiness of the air defense system is the ability to destroy all types of targets at maximum distances.

One of the directions of increasing the combat capabilities of ZRV is to improve the combat capabilities of the MRK "Buk M1", which proved to be most effective in combat operations in the ATO zone. As a result of combat operations in the ATO zone, which account for more than 19 destroyed unmanned aerial vehicles (UAVs). One of the main directions of improvement of combat vehicles of the "Buk-M1" MRK is the improvement of the 9C35M1 radar.

Means of detection and escorting can be of various types and relate to the optical or radar range, as well as performed as a single multifunctional station that solves both the problem of detection and the objectives of tracking purposes.

Calculation of the main technical characteristics of the radar is based on the principles of the system approach, which consists in the task of the criteria of efficiency (target function), the solution of optimization tasks and comparisons of the implementation of systems. The application of computer systems of automated design allows "the method of successive approximations" to design a system with close to optimal technical and operational characteristics, which is achieved by the possibility of multiple recounting options when varying the parameters of the system.

## THE EFFICIENCY INVESTIGATION OF FUNCTIONING OF A SEMI-ACTIVE PHASE-DOPPLER RADIO FUSE OF SURFACE-TO-AIR GUIDED MISSILE WITH COMBINED CONTROL UNDER ABSENCE OF OBSTACLES AND UNDER THE INFLUENCE OF ACTIVE AND PASSIVE OBSTACLES ON ITS WORK

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The analysis of the current state and prospects of advanced states armament shows that the greatest attention is paid to the means of air attack.It became obvious in the wars in Yugoslavia, Iraq, Libya, Yemen and Syria, and it is possible that this will manifest itself in Ukraine in the area of an anti-terrorist operation. Anti-aircraft missile systems and complexes in Ukraine need improving.

It is known that the probability of a target's destruction by surface-to-air guided missile depends on the effectiveness of its combat equipment, especially, on the

coordination degree of the radio fuse operation area with the damage area of the combat unit.

A semi-active phase-Doppler radio fuse is used as a rule in modern surface-to-air guided missile.

The problem of removing the influence of radio fuse early operation on the effectiveness of the combat equipment of an surface-to-air guided missile is of great importance.

It is reasonable to measure the time of the radio fuse early operation by introducing an additional frequency channel with a detachment relative to the second frequency channel by a value similar to that of the first frequency channel, but towards the lower frequencies.

The analysis of the radio fuse work with the correction device was also carried out. It is obvious that the radio fuse operates in a regular mode in the absence of obstacles, and the correction device does not affect its operation.

Thus, the implementation of the proposed method of correction activation moment will increase the probability of destruction target under the influence of passive obstacles.

## REDUCING THE LEVEL OF THE LATERAL AND BACK LOBES OF THE ANTENNA DIRECTION DIAGRAM OF THE RADAR STATION 35D6

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Successful solution of air defense tasks on destroying an air enemy, protecting of administrative and political centers and population is largely determined by the effectiveness of the air intelligence system over the territory of Ukraine and neighboring countries.

Radio absorbing materials can be used not only to reduce the radar sensitivity of aircraft by reducing the electromagnetic energy emitted by enemy radar stations, but also to absorb the radiation of the antenna of its own radar, for example, the radiation generated by the lateral lobes of the antenna direction diagram.

With the help of the technique used in my work, some ratios were obtained and they allowed to estimate the radiation field both in the distant antenna area and near it, with the radio-absorbing coating applied to the edge of the antenna. In order to verify the adequacy of the results obtained by the developed method, an experiment with the use of a radar measuring complex was carried out on the real processes of scattering of a plain electromagnetic wave on an antenna mirror.

The data obtained from the writing of the thesis showed that indeed, when applying radiation absorbing materials on the elements of the antenna system, the level of the lateral lobes of the direction diagram is reduced, while other antenna characteristics do not worsen.

## CALCULATION OF THE RADAR TRANSMITTER EFFICIENCY AND ESTIMATIONOF POWER LOSS OF THE PROBING SIGNALUSING A PHASED ANTENNA ARRAY WITH OPTICAL EXCITATION

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The tasks assigned to the reconnaissance and guidance radar of SAM-complexesrequire high power of the probing signal and high resolution at angles and range. In addition, the solution of the tasks of fire control and missile guidance at the target requires the possibility of instantaneous retuning the parameters of the direction pattern antenna in time and space.

The use of multi-cascade transmitters solves the problem of forming a powerful probingsignal, and the use of phased antenna arrays solves the problem of instantaneous retuning the parameters of the direction pattern antenna.

To achieve the specified radar parameters in terms of range and resolution, the transmitter power and antenna parameters must meet the requirements of the gain factor and the efficiency.

The quantitative estimation of power loss of the radar probing signal is made due to the use of a passive phased antenna array with optical excitation. The results of calculations of the radar transmitter efficiency are given.

Proposals have been made to increase the radar transmitter efficiency.

## DEVELOPMENT OF THE PROPOSALS FOR CREATION OF PROBING PATHS OF CYLINDRAL PHASED ARRAY AS PROMISING MEANS FOR FUNCTIONAL DESTRUCTION OF DRONES IN THE ATO AREA

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Destroying drones in the ATO area does not differ too much from the methods used in the past for destroying aircraft. Unfortunately, such kinds of fighting are low effective these days, because aircraft became smaller and more maneuverable and fly at the comparatively high altitudes which make them nearly invisible for human eyes and make it nearly impossible to destroy them using small arms. There are different kinds and types of drones which can be more noticeable because they are bigger in size and can have weapons. But in this research an attention is paid to drones of tactical level which are small and the radius of their action is 15-20 km. As technology and electronics develop, the new methods of destroying drones appear. For example, directed action electromagnetic weapons.

For destroying drones, probing paths of cylindrical phased array only in the direction of searching for drones can be used. It allows us to use less energy in comparison with usual antenna array and concentrate about 90 percent of energy in the main lobe.

Operation time of the best anti- electromagnetic protection devices is 10 us..

In this research one of the main tasks was evaluating spatiotemporal characteristics of multifrequent spacious-frequent signal which is emitted by cylindrical phased array with the usage of equally discreet single and multi V-shaped frequency distributions. So, if

single v-shaped frequency distribution is used, functional destruction of semiconductors can take place when we have 800..1000 impulses per the pack and the range of possible destructions is from 400 to 1400 meters. In the case, with the usage of multi V-shaped frequency distribution energy of a single signal is less and degradation starts when N is 1600…2000 impulses per pack and can be used for the range from 1400 to 5000m.

## DEVELOPMENT OF ALGORITHMS FOR IDENTIFYING VARIOUS DATA SOURCES OF INFORMATION SUPPORT TAKING INTO ACCOUNT THE EXPERIENCE OF PARTICIPATING IN THE ANTITERRORIST OPERATION

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To improve the information support of SAM (surface-to-air) units, in particular in the area of anti-terrorist operation, special software "Virage-tablet" is used. To link it to the command post of the medium range SAM system, it is proposed to use the method of identifying the information using the interpolation method.

The algorithms of data identification from the intelligence means of the command post of the medium range SAM system, the superior command post and the support unit of the radio troops are developed. They are designed to receive data of secondary processing of information from the radar stations. The basis of the identification algorithms is the interpolation procedure. The expediency of using the developed algorithms for data identification to increase the information support of the command post of the medium range SAM system has been proved.

## RESEARCH OF AUTOMATIC-FREQUENCY CONTROL SYSTEM OF THE RADAR OF A PERSPECTIVE SURFACE-TO-AIR MISSILE COMPLEX

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The principle of the digital automatic-frequency control system operation is considered. The mathematical models of functional units are obtained based on their operation principles. The mathematical model of the system is obtained by their combination. Transformation from discrete and continuous mathematical model to discrete mathematical model of the system is carried out.

The analysis of the system stability is carried out on the basis of Gurvits criterion. The stability conditions which define the stability area are obtained. The analysis of quality of the system operation in the transient is carried out by a direct method. By means of the Control System software of the MATLAB program on the basis of transfer operator of the open-loop system the family of rated transient response for different values of the signal-to-noise ratio is obtained. According to method of error coefficients the equation for calculation of systematic dynamic error is defined. According to spectral method the equation for calculation of fluctuation error variance is defined. The root-mean-square error of the system is obtained by their combination, The dependences of a systematic dynamic error, fluctuation error variance and root-mean-square error of the

automatic-frequency control system on the signal-to-noise ratio are obtained. The root-mean-square error of the automatic-frequency control system does not exceed of the amplitude frequency response bandwidth.

## ESTIMATION OF THE POSSIBILITIES OF USING REGULAR SATELLITE NAVIGATION EQUIPMENT FOR ORIENTATION OF THE MEANS OF MEDIUM RANGE SAM COMPLEXES TAKING INTO ACCOUNT THE EXPERIENCE OF ATO

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In order to increase combat capabilities of the Anti-aircraft missile troops unitssatellite navigation systems and special software productsare supplied to our armament.

Estimation of the possibilities of using regular satellite navigation equipment for orientation of MR SAM complexes is an actual task in modern conditions. The experience of the ATO, in local wars and armed conflicts shows that the units armed with MR SAM complexeswere successful in case of constant maneuvering by forces and means.

For the conduct of combat operations, the MR SAM complexes need to be topographically tied up and oriented.

The regular means of orientation of the MR SAM complexes allow you to carry out orientation with a given accuracy in peacetime. However, in combat situations, where quick change of positions is required, they cannot always be used. In units, regular means are SN-3003M.

The SN-3003M provides the possibility of automatic continuous data acquisition of points of finding of objects, their recount into a rectangular coordinate system of the SC-42, as well as obtaining linear coordinates in the map of Gauss.

Thus, in the course of combat operations by the units of Anti-Aircraft missile troops, the use of standard means of satellite navigation, special software expands their ability to carry out orientation during maneuver. They can be used:

a) to determine the preliminary orientation data:

- during position changes after each switch-on of the TR using the reserve position network;
- at the maneuver of the TR between launcher units at topographically prepared positions;

b) to determine the basic orienteering data:

- during tasks performed by fire groups;
- during demonstrative actions;
- in the case of lack of or failure of standard means of orientation;
- during stops, during the march.

## DEVELOPMENT OF AN OPTIMAL TGT-DISTRIBUTION ALGORITHM FOR THE COMMAND POSTS OF THE AA DEFENSE FORCES IN CONDITIONS OF ARMED AGGRESSION OF THE RUSSIAN FEDERATION

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Target distribution is one of the most important tasks that are solved in C4l system (automated command and control system) under fire control of Army. Target distribution is at the top of the control process because precisely at that stage decisions are made, the correctness of which largely affects the effectiveness of the use of fire capabilities of group alignment and, consistently, the quality of the implementation of its combat missions.

Under the conditions of target distribution the activity of the control agency is aimed at obtaining the greatest effect of the use of firing equipment under determined costs of resources (ready to shoot handling channels), which control agency has. So from the formal point of view, the goal of the target distribution can be attributed to the class of tasks of optimal resource distribution (effort distribution). Under conditions of open Russian aggression, the number of aircraft in air thrust will lie within the range of 40-60 resources of the air attack, and group alignments of troops of AA defense will have hundreds of handling channels. In these conditions the optimal task solution of the target distribution will be of paramount importance.

Thus, as a result of the attestation work, the scientific task of developing an optimal target distribution algorithm for the command posts of the Air Defense Forces of the Army was solved, which allowed to achieve the goal of work - to develop an optimal method and algorithm for automation of the target distribution for a promising command post of the Air Defense Forces of the Army.

## DEVELOPMENT OF PROPOSALS FOR PROVIDING P-18 RADAR STATION ELECTROMAGNETIC COMPATIBILITY

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The purpose of the research is to develop a program for assessment of radio electronic systems (RES) and devices electromagnetic compatibility (EMC) in the area of air defense radar unit location.

The analysis of the electromagnetic environment in the area of radar unit location was carried out. There were evaluated the causes of unintentional interferences, as the main reasons for the RES mutual influence in their joint work. The utilization of the meter wave band in the area of the location of the radar unit was analyzed.

Some radars from the Army Air defense radar unit were considered as sources and receivers of unintentional interferences. It was shown that when several radio-technic devices work together, there arises a problem of equipment normal functioning. The analysis of experimental data of transmitting devices of various radar types shows, that practically all of them emit signals not only in the working band, but also far beyond its limits.

The estimating method of radar mutual influence zones was presented. A typical "dual situation" is considered. There the potentially incompatible radio-electronic systems and devices (RECES) are detected on the basis of time, frequency and energy criteria.

An analysis of the electromagnetic environment in the area of the air defense radar unit location was carried out. Radar means, which operate under conditions of different nature electromagnetic interference influence, are determined. The analysis of electromagnetic compatibility estimation methods was carried out. With the help of the mutual influence zones evaluation method, the minimal-permissible mutual compatibility distance between two radio electronic means is determined.

The analytical expressions for each wavelength attenuation coefficient are obtained. It was made in accordance with the considered method for evaluating the electromagnetic compatibility of radio-electronic systems and devices.

These programs are of special significance in time of redeployment of radar unit to a new position and deployment it in combat order.

## RESEARCH OF DIGITAL ANGULAR AUTOMATIC TRACKING SYSTEM OF THE RADAR OF A SURFACE-TO-AIR MISSILE COMPLEX, WHICH IS USED IN THE ANTITEROSRIST OPERARION AREA

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Work is performed with the aim of creation of mathematical model and the analysis of quality of the system operation.

- To achieve this aim the following tasks are solved:
- The principle of the system operation is considered;
- The mathematical model of the system is obtained.

The analysis of the system stability and quality of the system operation in the transient and steady state is carried out.

The digital angular automatic tracking system is intended for spatial selection of signals which come to the radar input and estimation of angular object coordinates.

The directional finder provides formation of the reference direction and signals of angular errors between this reference direction and the object direction in two mutually perpendicular planes. The direction finder comprises the antenna- fider system and elements of receiver unit. In monopulse direction finder the antenna feeder system forms two couples of partial directional pattens in two mutually perpendicular planes which turned one to other on angular of $2\theta$ .In antenna-feeder system of monopulse angular devices there is a device of summary and difference processing. It provides forming the summary directional pattern equal to the sum of all partial directional patterns and one difference directional patterns. The executive unit is intended for transformation of angular error signals to the control acts which are given on the antenna and provide such change of the reference direction. The mathematical models of functional units are obtained based on their operation principles. The mathematical model of the system is obtained by their combination .

The analysis of the system stability is carried out on the basis of Gurvits criterion.The analysis of quality of the system operation in the transient condition is carried out by a direct method.

According to the method of error coefficients the equation for calculation of systematic dynamic error is defined. Substituting a systematic error and fluctuation error variance, we obtain the dependence of a root-mean-square error on the signal –to-noise ratio which coincides with the systematic dynamic error. This error doesn't exceed of half of the directional pattern of 0.8 degrees.