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Radar protection system against anti-radar missiles with integrated detection channel

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Abstract

Developed and justified the appearance of the system of protection of radar observation station from anti-radar missiles. In order to detect homing high-precision weapons, it was proposed to include in the radar a channel for detecting signs of the trajectory of an anti-radar missile, taking into account its distinctive features.

Introduction

In air defense systems, modern surveillance radar stations (radars) are the most important sources of information about the air environment. According to their purpose, the surveillance radars are the first to come into contact with the air enemy, and at present, due to the rapid development of high-precision weapons, radars have become priority targets for destruction [1-6]. A particular threat to surveillance radars are such high-precision weapons as anti-radiation missiles (ARM).

a *b*

Figure 1. Examples of radar fire: a) destroyed radar equipment during the armed conflicts in Nagorno-Karabakh; b) in Ukraine

Timely detection of anti-radar missiles contributes to an increase in missile homing missiles on the radar (due to the implementation of special measures) and leads to an increase in the probability of radar protection from missiles. However, detection of anti-radar missiles is complicated by the fact that it is conducted in a complex signal-interference environment with a low signal-to-interference ratio, which necessitates adaptation and correction of algorithms for primary and secondary radar information processing. Thus, the selection of anti-radar missiles is not possible in a single contact (review) and requires the use of algorithms for combining multiscan information - i.e., multiscan selection of moving targets.

Material and Method

At the moment the following systems of multiscan selection of anti-radar missiles are known [1-5]: according to external targeting data and with the detection channel built into the radar, which have high enough efficiency and at the same time serious drawbacks: low mobility, high cost of production and operation, low probability of correct detection.

A distinctive feature of the first selection systems is the coupling with the external radar detector, which detects dangerous (similar to anti-radar missiles) targets flying at the radar, determines their speed and time of approach [1]. Such systems have a sufficiently high efficiency, but their use leads to deterioration of radar mobility, reliability of its operation and increase the cost of production and operation. Therefore, as an alternative, some radars use built-in anti-radar missile detection channel.

When building a defense system, one should also keep in mind the promising, priority directions of development of counter radar missiles [1-5]: increasing the launch range by using more efficient fuel mixtures, reducing the weight of the ramjet and using direct-flow air-jet engines; expanding the operating frequency range of the passive radar homing head from 0.5 to 40 GHz, increasing the sensitivity and immunity of the homing head receiver; equipping the anti-radar missiles with a combined guidance system that includes an autonomous inertial navigation system, corrected via a GPS receiver, and one of the homing systems at the end of the anti-radar missile's flight path: passive radar, active radar, or passive optoelectronic; redirection of anti-radar missiles in flight to another radar; targeting of anti-radar missiles to mobile radars, including when they are moving by using the proportional guidance method; eliminating the danger of hitting their radar. The key features of the ARMs as radar observation objects are as follows: launch range of 100 to 180 km; average flight speed of 660 to 1200 m/s; effective scattering surface (in cm-dm ranges) of 0.06 to 0.2 m^2 [1].

Results and Discussion

Taking into account the advantages and disadvantages of the existing defense systems, the design of an advanced comprehensive system of radar protection from high-precision weapons was developed (Figure 2). This defense system is based on methods that help reduce information about the homing object (radar), as well as shifting the point of aim of the missile defense from the location of the radar.

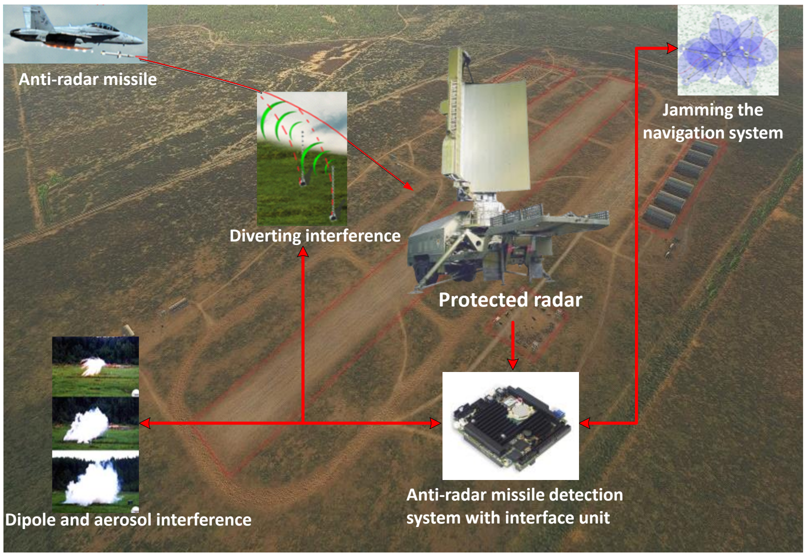

Figure 2. Integrated system of radar protection against anti-radar missiles

The radar protection system includes: control unit (interface); set of diversion devices (radar and infrared emitters); set of launchers for dipole and aerosol interference; set of cables; system of detection of SRBs; built-in channel for detection of anti-radar missiles. Diversion devices are a diversion chain consisting of additional radio emission sources. The main purpose of creating such a chain is to divert a booster away from the radar by successive activation of additional radiation sources. Dipole deflector launchers create passive interference for the radar homing head, contributing to premature triggering of the fuse and detonation of the warhead long before it reaches the radar. Aerosol jamming launchers reduce the transparency of the atmosphere in the optical and radio bands, provide absorption of radio waves and increase radar stealth.

A number of additional special technical measures have been adopted in the counter radar missile detection channel [7-10]: adaptive inter-period accumulation, an adaptive decision-making device with a reduced detection threshold, a one-time estimation device, and a trajectory processing device implemented according to the TBD (Track-before-detect). These approaches together will provide the necessary probability of detection of a ballistic missile (usually selected at least 0.5) over virtually the entire range of its flight to timely activate sets of diversion devices (radar and infrared emitters) and launchers for dipole and aerosol interference.

In the proposed trajectory-processing device of the radar defense system, the central place is taken by the dangerous trajectory detector, a DRD aimed at the radar. For its operation it uses the a priori information about the possible ranges of parameters of known SLBMs (HARM (USA), Martel (France), Tacit Rainbow (USA), ALARM (UK), Delilah (Israel), etc.): launch range, flight speed, effective dispersion area value. These parameters are evaluated, after which a probabilistic decision on the detection of a dangerous trajectory is made based on the obtained trajectory and signal indications, which is given to the operator, who, based on the emerging situation, activates protective means and changes the operation modes of the radar.

Conclusion

The appearance of complex system of radar protection from high-precision weapons on the example of the dispatcher radar, which is part of the system of radio technical support of aviation flights is proposed. The key difference of the proposed solution is the refusal of an external missile detector in favor of an additional channel of processing and separation of the missile radar, working on the received signal of the radar. This allows to reduce the cost of the specified protection system and is possible due to the high energy potential of the protected dispatcher radar. In addition, in the specified channel it is proposed to take a number of special technical measures to improve the efficiency of detection and tracking objects with a small value of the effective scattering surface: adaptive accumulation and decision-making with a reduced detection threshold and trajectory processing device.

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