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UTILIZATION OF SELF-PROTECT SYSTEMS ON RECENT HELICOPTERS USED BY CZECH AIR FORCE

INTRODUCTION

Systems of self protection have the important case in the armed services on the world. With the continual advances in radar technology and the increasing complexity of aerial combat, the effectiveness systems of self protection must increasing too. But systems of self protection used by Czech Air Force (CAF) are behind the times by their technology and their concept. That equipment was developed mostly based upon the experiences from the Soviet war in Afghanistan and now with respect to interoperability in frame of NATO and character of probable treats in assumed missions are applicable with really extensive limitation.

Analyze of current state gives requests to apply modern self-protect systems only to two types of helicopters used by CAF. First of them is the multi-role helicopter Mi-17 that is mainly intended for transport of persons or cargo. Second one is Mi-24, the combat helicopter that is proposed for missions including direct air support, antitank attack, armed escort, air to air combat and reconnaissance as well as to transport troops or serving for SAR tasks.

Recent equipment of both of these types of helicopters for self protection is not sufficient enough to be used under current conditions (requests are to be equipped by autonomous RWR and CMDS). Hardware realization of most of the used warning receivers does not give us the possibility to modernize them or to extend their data library. They have not a capability to record data from mission and after the end of the mission a possibility to evaluate these data by specialists. Next serious shortcoming of those warning receivers is missing direct connection between them and CMDS.

THE TASK OF RWR IN FRAME OF INTEGRATED SELF PROTECTION SYSTEM

The modern self protection system is fully autonomous and achieves the protection against infra-red and/or radar guided missiles. The self protection equipment is

completely integrated into the avionics system, operates in the automatic, semiautomatic and manual modes and is able to launch highly effective RF passive countermeasure CHAFF and IF decoys FLARE in any combination. System is continually monitoring data from the sensors and when threat appears is activating appropriate countermeasure according to preprogrammed sequence.
The system is controlled by keypad and proper switches on the control display unit (CDU) and on the system HOCAS (Hands On Collective And Stick). Visual indication of the system activity is displayed by CDU. There is also possibility to generate voice messages for crew.

The radar warning receiver

Most of the recent NATO's aircraft are equipped by radar warning receivers (RWR). RWR is a part of the self protection system, which immediately informs crew about radar threats, about that fact the aircraft was illuminated by enemy radar. Of course the information about character and type of the enemy radar is available. RWR makes possible to react on the threat and to provide countermeasures by maneuvering or by using of self-protection equipment. Modern digital RWRs are able to detect also composite signal and its source. Acquired parameters and spectral characteristics of the signal are compared to stored patterns from the database. Usually only parts of seconds are necessary to recognize and identify the threat.
The development is oriented to improve sensitivity and angle accuracy as well as the speed of processing. About only two pulses are enough to detect pulse composite signal. There is possibility to detect CW signal too. Most of the RWRs uses VHSIC (Very High Speed Integrated Circuits) or MIMIC (Microwave/Millimeter Wave Monolithic Integrated Circuit) technologies. Extra attention is dedicated to detect signals with low probability of detection LPI (Low Probability of Intercept).
RWRs cover entire frequency band used by main type of radars and are characterized by the huge capacity of data processing in the environment of high density of signals (the ability to process more several millions of pulses per second) and short time of reaction. There are several requests those RWR has to fit:

- to process each radar pulse,
- to adapt itself according to the environment, large number of radar types and to their modes of operation,
- to measure carriage and repetition frequencies of the received signals and to identify their sources by using the receiver IFM (Instantaneous Frequency Measurement),

— the reaction time has to be extremely short in relation to the tactical situation.

The oldest type of RWR is the wideband crystal video receiver (CVR) which does not measure the frequency. They separate signals according to the approximate direction there are coming from and by comparing of the amplitude. The radar type identification is provided based upon the measuring of the pulse duration and repetition rate or PRI (Pulse Repetition Interval). These parameters can be distorted by the environment influence. That is why this method of identification gives ambiguous results.

Next type is the RWR measuring frequency by narrow-band selectivity of input – frequency scanning super heterodyne receiver. The sequence of scanning entire frequency band is to long and reaction is than unacceptable slow particularly when radar is working in the scanning and tracking mode simultaneously (TWS – Track While Scan). Other shortcoming of this type is the dimensions and mass of those receivers.

During the 90’s was developed the new generation of RWRs – IFM (Instantaneous Frequency Measurement) designate to use on the planes and helicopters. They use both of the principles, the wideband tuning and coincidental accurate frequency measuring from pulse to pulse.

RWR USED BY CAF

According to the analysis above current systems used by the Mi-17 and Mi-24 helicopters are not sufficient enough to operate under the expected conditions. The helicopter Mi-17 is equipped by RWR SPO-10 and Mi-24 by SPO-15. Only the RWR Sky Guardian SG-217 which is the part of L-159 ALCA avionics meets the requests described in the previous chapter.

Receiver SPO-10

RWR SPO-10 is intended to warn pilot about the aircraft is illuminated by radar of another fighter. Signalization is by sound signal in the pilot’s headphones and optical by appropriate light.

Receiver SPO-15

RWR SPO-15 is intended to locate radars which illuminate the aircraft and to recognize type and mode of these radars. Power of received signals is measured

according to time of arrival into the illuminated area. When the aircraft is illuminated from more directions the indicator indicates only the strongest signal. When safety limits of illuminated signals are over then a red circle gradually lights up and warning tones comes into the pilots headphones. These warning lights and tones are used for pilots to signalize the aircraft illumination.
Signalization is activated after the radar localization. That is provided for an aircraft safety. SPO-15 determinates the bearing (accurately from frontal side and approximately from rear side), repetition frequency, carrier frequency (for CW signals) and pulse repetition interval. The main radar and velocity rate are selected by SPO-15. A pilot can choose correct maneuver to escape from territory of risk.

Receiver Sky Guardian 217

Sky Guardian 217 RWR (Fig. 1.) is primarily designed to identify hostile radars illuminating the aircraft in which the system is installed. It identifies threats originating from both CW and pulsed emitters and covers 360° of azimuth in the following bands of the Electronic Countermeasures (ECM) spectrum:

- E/H band – E, F, G and H threat bands, treated as a single band in the frequency range of 2.0 GHz to 7.5 GHz.
- I band – covers the frequencies 7.5 GHz to 11.5 GHz.
- J band – covers the frequencies 11.5 GHz to 18 GHz.

The RWR operating mode is controlled by the operator so that the aircrew is supplied with audio/visual information as follows:

- The bearing of emitters relative to the aircraft.
- The relative RF amplitude of the radar signal for pulse emitters.
- The threat identification of emitters if matched against the built-in emitter library.
- The PRF and band identify of detected unknown emitters.
- True PRF tones for pulse emitters.
- Alarm tones if one or more emitters are confirmed as a threat. There are separate tones for CW and pulse threats.

The system contains an extensive processing capability for analysis and identification of detected emitters. A threat identification library containing known radar signal details may be loaded into the system prior to flight. This is capable of holding data on over 330 emitters, with an average of four modes per emitter. Typical data would include details of frequency band, Pulse Repetition Interval (PRI), priority, stale-out time and a 3-character emitter identify code.

Emitters are presented on the Display using alpha-numeric identifiers superimposed on a pseudo plan view. The system can also initiate electronic counter measures and chaff/flare dispensing when a threat is detected.
The system can operate in 12 different modes selectable from the cockpit. Four of these deal with threat warning signals, five offer the use of built-in test (BIT) routines to ensure that equipment in the system is fully operational, and one operates to load data via the Program Loading Unit. The remaining two are reserved for future use. The operator can also select CW or pulse audio alarms, as well as true PRF tones. The operator can choose to view displayed information on all recognised emitters in tabular or polar formats on the display.

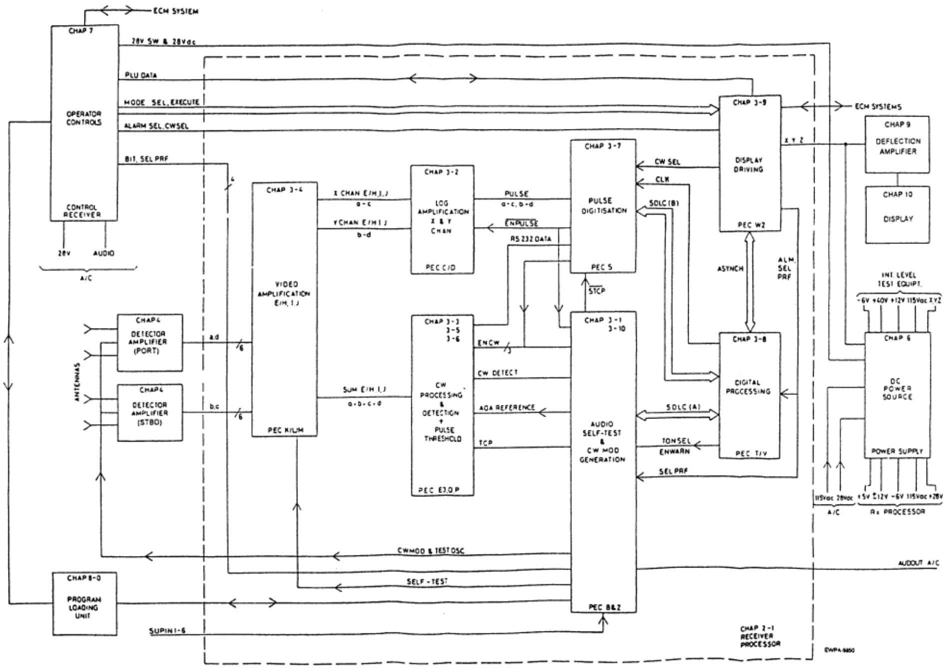

Fig. 1. Sky Guardian 217 (RWR): system block diagram

THE PERSPECTIVE EVALUATION OF RWR SYSTEMS

The concept of the current RWRs allows them to receive and process signals of the stable source. What is the stable source? That is the source with the constant carriage frequency as well as the constant PRI during the pulse to pulse interval. Recent trend is characterized by coming from the analysis of stable source to the ability to analyze agile sources, which are changing their pulse parameters continuously. For instance as an agile transmitter can be seen radars specialized for moving target indication (MTI). They use the method of PRF (Pulse Repetition Frequency) jittering. Other examples of agile source are pulse – Doppler radars which are changing carriage frequency and PRF from burst of pulses to burst of pulses or some of adaptive radars with transmitted frequency modulated by given algorithm. Next step of this evolution are the really agile radars which change their carriage frequency and PRF from pulse to pulse randomly. Specific issue in that evolution is that pulse – Doppler radar has to keep constant frequency at least for two adjacent pulses.

Perspective agile radar systems will except of changing carriage frequency and PRF (will be from the range of high PRF) also use pulse compression, adaptive lobe, LPI techniques or continuous wave principle with signal level on the level of noise.

This conglomeration of radar types will cause high density of signals which has to be separated into the effectible data flows in regard of RWR signal processing by both the frequency and spatial filtration. The carriage frequency and PRF are parameters suitable for classification of current sources. For future sources with adaptive and agile character are these parameters completely improper or inapplicable. Generally the incident angle is highly apposite as a classification parameter, since it is impossible to change it by transmitter from pulse to pulse.

REFERENCES

[1] ANDRLE Milos, GRECMAN Pavel, NAIDER Jiri: Approach to the research project, Self-Protection System for Helicopters, 2001. (in Czech).

[2] CECHAK Jaroslav, ZAJONC Jaromir: Electronic Warfare, Electronic Support Measures, 2000. (in Czech).

[3] GEC-Marconi: Sky Guardian 217 Radar Warning Receiver for The L-159 Light Multi-role Combat Aircraft, 1998.

[4] Janes' Radar and Electronic Warfare Systems, 2000 – 2001.