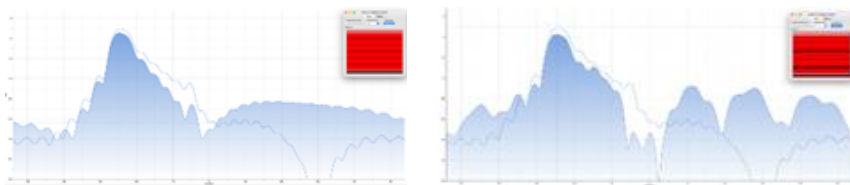


ANTENNA WITH COSECANT PATTERN

Modern active phased antenna array consists of either several active elements or several thousands. There is a possibility of failure of one or more radiating elements during the operation. Antenna pattern can be significantly damaged. The level of damage depends on the percentage of affected elements and their location on the surface of the antenna aperture. We consider one-dimensional transmitting antenna array used in surface radars, such as radar 80K6T/90K6E. Element damage leads to significant distortion of the detection zone of the radar in the elevation plane. The scientific novelty of the work lies in using of synthesis method for complex coefficients of field distribution for the levelling of one or more broken elements. The method will allow to restore zone of detection of the radar targets and the accuracy detection of coordinates at the elevation plane. The goal is to improve the reliability and stability of the tactical and technical characteristics of the radar, which is very important for the advancement of the defense development. Radar 80K6T has one-dimensional array, which is built of open type radiating waveguides (W-lines). The use of a one-dimensional phased array makes the radar vulnerable to the failure of one or more elements. The simulation results and the effect on the shape of the pattern for several cases of failure of individual elements can be seen in Fig. 1. It shows that different elements have different degrees of influence on the formation of the pattern. Failure of the second element in general caused a decrease in the main lobe by 2 dB, which is equivalent to a decrease in the range of the radar in the main direction by $\sim 12\%$. This is equivalent to a decrease in the detection range of the target by 48 km. In this case of failure we notice that these effects are summing up. The compensation for the impact of defective element is an urgent problem that needs solving. The introduction of the method of adjusting the phase distribution of the field in the aperture of the transmission grid will allow to restore the detection zones of the radar in the angular plane without interrupting the operation of the radar.

The algorithm of damaged pattern correction consists of uniform search for complex coefficients of distribution along a lattice which give the greatest correlation coefficient between the calculated and pattern at all undamaged elements. It should be noted that it makes sense to assess the degree of correlation not for all values of the spatial angle of view θ , but only in the interval of the main lobe - because the priority is the restoring of the level and shape of the main lobe.



a – 2nd broken element; b – 2nd, 7th, 18th elements.

Figure 1 – Antenna pattern.

Mathematical modeling of antenna array and pattern correction was developed using the IDE Xcode. To speed up calculations, some of them were implemented on the GPU using the low-level API Metal.

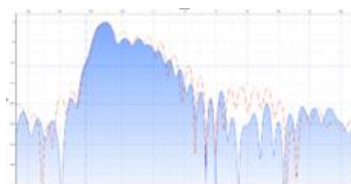


Figure 2 – Comparison of patterns without correction algorithm (red line) and with algorithm (blue line).

As can be seen from Figure 2, the correction method allows to reduce the level of oscillations of the pattern within the main lobe and level the gap of 5 dB in the direction of $\sim 3^\circ$, as well as reduce the level of side petals as a whole. As was shown by mathematical modeling of the algorithm for the correction of defects in the amplitude-phase distribution of the antenna array, the proposed method allows to improve the antenna performance in the presence of defective elements. It is appropriate to establish different limits for estimating the correlation in the algorithm to obtain the greatest efficiency.

If you set the correlation limits only in the range of the main petal of the pattern, it allows you to get the best correction for the main lobe but will inevitably lead to some increase in the level of the lateral petal. An indisputable advantage of the proposed method of adjusting the phase distribution of the field in the grating aperture is the ability to restore the detection zone of the radar in the angular plane directly on the combat duty.