

Analysis of Self Screening Jammer Parameters with RADAR Equation

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Abstract

RADARs are mainly used to detect and locate the position of objects. The power received at the radar depends on the radiating power, object size, target material, shape of the target and channel noises due to atmosphere and external induced devices. In the war fields it is very important that the target identity is masked so that the enemy attacks can be overcome. In order to mask the targets and create the false identity jammers are very useful. There are various types of jammers and self screening jammers are the most protecting jammers. Hence we have analysed all the parameters related to self screening jammers. By calculating the range between target and the radar and observing the power transmitted by the source station and power received at the radar we have estimated the Cross over range. The variation of this cross over range with respect to jammer peak power, RADAR peak power, attenuation are analysed using matlab in this paper.

Keywords: RADAR, Jammers, Self Screening Jammers, Cross Over/Burn through Range

I. Introduction

RADAR meant for Radio Detection and Ranging. Generally RADAR systems use the modulated waveform and directive antennas to transmit electromagnetic energy into specific volume in space for object. Targets which are kept in a limited volume reflects energy back to the RADAR. Then the processed echoes are received by RADAR to extract target information such as range, velocity, angular position, and other characteristics.

The equation of radar is given as

$$P_r = \frac{P_t G_t}{4\pi R^2} \frac{\sigma}{4\pi R^2} A_e \quad (1)$$

$$A_e = \frac{\lambda^2 G_r}{4\pi} \quad (2)$$

P_r = Received power

P_t = Transmitted power

G_t = Gain of transmitter

G_r = Gain of receive

σ = RADAR cross section

R = Distance between target and transmitter

A_e = Effective area of the receiving antenna.

There are different types of radars based on the radar systems as ground based, airborne, space borne, or ship based radar system. Based on the classification RADAR characteristics such as the frequency band, Antenna type, and waveforms are

utilized. The functionality of the radar also depends upon the weather, acquisition and search, tracking, track-while-scan, fire control, early warning, over the horizon, terrain following, and terrain avoidance radars. In antenna theory, a phased array is an array of antennas in which the relative phases of the respective signals feeding the antennas. A phased array is a composite antenna formed from two or more basic radiators.

II. ECM(Electronic counter Measure)

If we attempt to disturb the normal RADAR operation intentionally it is called as electronic counter measure (ECM). ECM accomplishes one or several objectives such as denying proper target detection, generate operator confusion, creating false tracks of targets. In the Gaussian form of noise, the jamming signal and noise power are dealt in the same way by the RADAR receiver. Hence detection and tracking of RADAR signal is no longer dependent on the SNR and in this case $S/(J+N)$ must be calculated.

A. Jammers

Jammers are categorized into two types mainly as barrage jammers and deceptive jammers. Self screening jammers are a class of ECM systems carried on the vehicle they are protecting. Since we are analysing the parameters of self screening jammers and SSJ exhibit the properties of barrage jammers SSJ come under barrage jammers.

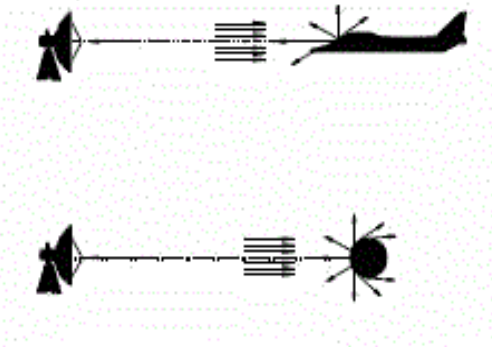


Fig1: Power received at the RADAR from the jammer

$$P_{SSJ} = \frac{P_j G_j AB}{4\pi R^2 P_j L_j} \quad (3)$$

P_{SSJ} = Power received at Radar from Jammer

P_j = Jammer's peak power

A = Effective area of RADAR

B_j = Operating Bandwidth of Jammer

R = Distance between Target and RADAR

B = Bandwidth of RADAR

L_j = Losses

Barrage jammers increase noise level across RADAR bandwidth. Consequently the receiver SNR is reduced which makes it difficult to detect the targets. So barrage jammers are also called as maskers. Barrage jammers can be deployed in the main beam or in the side lobes of the RADAR antenna. Main beam RADAR jammers use the maximum gain of antenna to amplify the broadcasted noise signal. They are used in either on-board attacking vehicle or in escorting the target. By contrast Side lobe jammers use more power or shorter range than main beam jammers. Side lobe jammers are deployed to interfere with specific target and since they do not stay close to the target, they have wide variety of deployment options.

Repeater jammers are used to confuse the RADAR by sending back the false target like signals. There are two types of repeater jammers. They are spot noise repeaters and deceptive repeaters. The spot noise repeaters jams only certain range of frequencies based on transmitted RADAR signal bandwidth. The deceptive repeaters send back the altered signals which make the target appear at false positions called ghosts with different angles and ranges. Repeater jammers make efficient use of jamming power as they jam only specific range of frequencies but not entire bandwidth.

B. Stand-off jamming

The jamming platform maintains an orbit at a longer range from the target.

C. Stand-in jamming

In this a remotely piloted vehicle orbits very close to the victim RADAR Jamming power required for SOJ is much greater than that of SIJ to screen the same target.

III. SSJ(Self screening jammer Parameters)

A. Burn through range

Bistatic J/S crossover range is the radar-to-target range when the power received (S) from the radar skin return from the target equals the power received (J) from the jamming signal transmitted from the target.

When the ratio of radar power to jammer power is unity the range is known as cross over or burn through range (R_{co})

$$(R_{co})_{SSJ} = \left(\frac{P_T G \sigma B_j L_j}{4\pi P_j G_j B L} \right)^{1/2} \quad (4)$$

B. Radar cross-section

The ability of target to reflect the RADAR signals in the direction of RADAR receiver is known as RADAR cross section. It is ratio of backscatter power per steradian in the direction of the RADAR from target to the power density that is intercepted by the target.

IV. Results

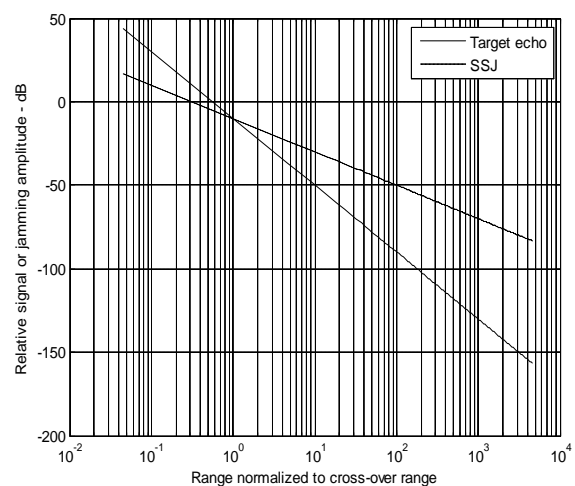


Fig2: Cross Over Range to signal attenuation

The normalised range of the RADAR signal coinciding with the jammer signal is called range cross over. As the range cross over increases, the signal attenuation increases.

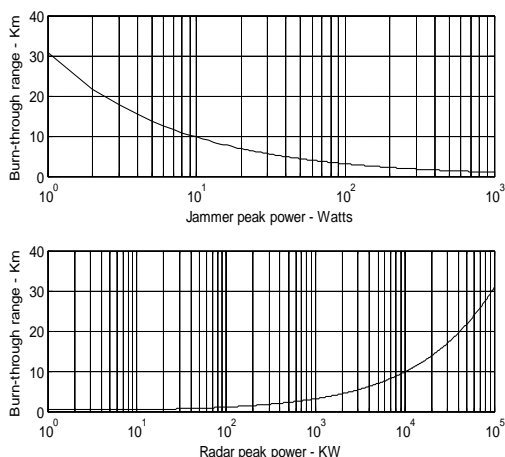


Fig3:Jammer Peak Power and Radar Peak Power to Cross Over Range

If we consider cross over range on y axis and jammer peak power on x axis, as cross over range increases the peak power of jammer decreases logarithmically. Similarly if we consider RADAR peak power on x axis and cross over range on y axis, with the increase in cross over range, RADAR peak power increases logarithmically.

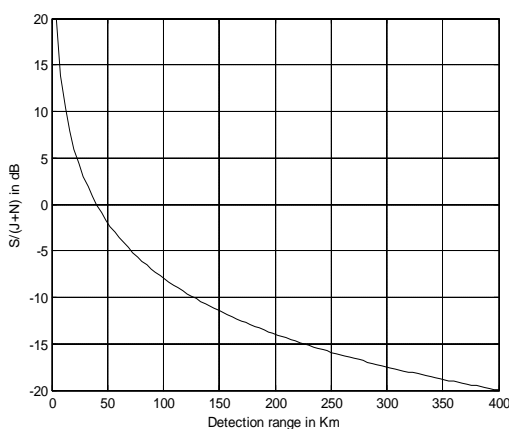


Fig4:Detection Range and signal to jammer power

This proves that with the raise in the detecting range of the target, the $S/(J+N)$ i.e cross over range decreases.

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VI. Conclusion

RADAR transmission is a two-way transmission. It has to be emerged from the RADAR and hit the target where the signal is dispersed in all the directions and some part of the signal is echoed towards the RADAR which is a weak signal compared to the original signal that is transmitted. In other hand transmission through jammer is one-way, where it has to travel from target to the RADAR which is a direct signal from the jammer possessing high signal strength which can dominate the original RADAR signal. As the cross over range increases the signal attenuation increases, so the signal weakens.

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