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A New Kind of Fuze Anti Jamming Technology

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Abstract. All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper. Please keep a second copy of your manuscript in your office.When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. Should authors use tables or figures from other Publications, they must ask the corresponding publishers to grant them the right to publish this material in their paper.

1. Introduction

With the development of electronic countermeasures, there are more and more Fuze interference and anti-jamming technologies, and the common pseudo-random code modulation Fuze detection sensitivity is high, but the anti-jamming ability is weak. Pulse Doppler Fuze has strong resistance to distributed interference, good distance cut-off characteristics, but the detection sensitivity of ranging receiver is low, easy to produce distance blur.

In view of the disadvantages of the weak anti-distributed jamming capability of Pseudo Random Code Phase Control Fuse, the initial phase of Pseudo Random Code(Pseudo Random Code) on pulse Doppler Fuse can be modulated to give it a sharp distance cut-off feature, greatly improve the distance blur, and improve its anti-jamming capability [1, 2].

2. Working Principle of Pseudo Pulse Doppler Fuse

Pseudo code pulse Doppler Fuze main modules are: time series generation module, transmission module, receiving circuit module, signal processing circuit module, Fuze execution module and power supply module, etc. [3]. Its basic composition is shown in Figure1.

3. Performance analysis and Preferinces

The Fuze not only receives the target echo signal, but also receives various kinds of jamming signal, which includes artificial active jamming signal. The pseudo-code pulse Fuze link includes nonlinear devices such as antenna, mixer, filter and correlator, all of which have certain working bandwidth [4, 5].

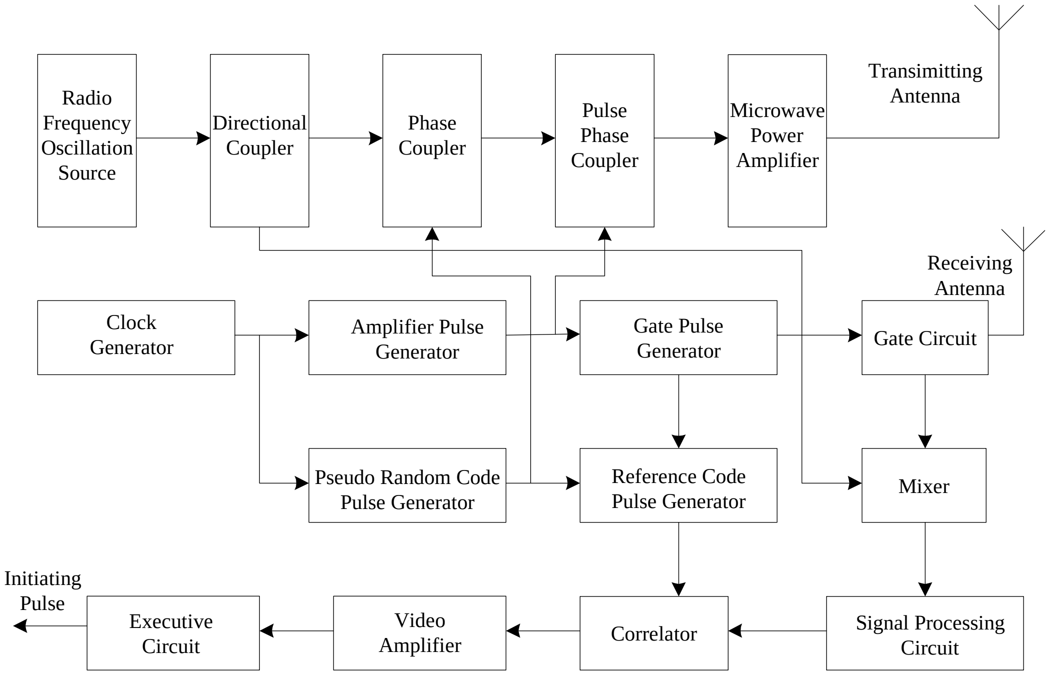

Figure 1. Frames of Pseudo Code Pulse Doppler Fuse Principle

When the Fuze receives the broadband noise interference signal, most of the disturbance energy will be filtered out due to the bandwidth restriction. The relevant processing gain will not be obtained after the unrelated noise signal passes through the correlator, while the relevant target echo signal will be obtained. For example, the correlation processing gain of $10lg10P$ =11.76dB, for pseudo-code sequences with a code length of 15 is decreasing in signal processing. Therefore, the pseudo-code pulse Fuze has a strong anti-noise capability [6]. For the time domain narrowband jamming signal, the frequency domain is the convolution of the frequency spectrum and the spread spectrum when it is related to the local fixed delay signal of the fuse. The useful signals of the mixed jamming signal are then filtered out by the narrowband filter, thus suppressing the narrowband jamming signal [7, 8].

Distance resolution is the ability of guidance letter to distinguish the minimum distance between targets. It is recorded as R_{min}. In the pseudo-random code pulse Doppler Fuze interference study letter, the distance resolution is the corresponding distance of a pulse width, that is $R_{min}=c\tau_A/2$. Distance resolution is determined by the width of the code element. Reducing the width of the code element can improve distance resolution [8, 9].

If τ_A = 100ns, R_{min} =$3.0\times10^8\times100\times10^{-9}\times0.5$=15m.

The distance cut-off characteristics of pseudo-code pulse fuzes are expressed by the slope of the primary peak of the correlator output waveform, $k= (p+1)/p\tau_A$. As can be seen, this feature is mainly determined by the width of high frequency Pulse, the smaller A, the better distance cut-off characteristics.

The maximum fuzzy distance is the maximum measuring distance of the fuse. Because of the periodicity of the correlation function, each blast distance corresponds to multiple target distances. The maximum non-fuzzy distance of the pseudo-code pulse fuse is defined as the distance between the target of electromagnetic wave from the transmitter to the receiver when the delay is exactly one pseudo-code period, and is recorded as $R_{max}= cRT_c/2$.

It can be seen that increasing the width of code element or pseudo code length can increase the absence of fuzzy distance. In order to ensure the reliability of Fuze operation, no fuzzy distance is always greater than the actual distance of Fuze.

In pseudo-code pulse Fuze, the narrower the pulse width, the steeper the distance cut-off characteristic and the higher the distance resolution. However, the pulse width can not be too small due to the restriction of switching devices and the consideration of increasing average emission power. Therefore, the pulse width should be considered in a comprehensive, eclectic way.

Pseudo-code length determines the ratio of the main side valve of the correlator output peak, and the greater the ratio, the stronger the ability of the system to restrain the clutter and interference signal. Assuming the required ability of the fuse to suppress jamming signals at the distance cut-off zone is J (dB), the value of P is

$$P = 10^{\left[\frac{J}{20}\log U_{com}\right]} \tag{1}$$

In the formula, U is the threshold level, also called the comparative level. The code length also affects the correlation function. When the code frequency (the penultimate of the code period) is 4 times higher than the Doppler frequency, the Doppler frequency has little effect on the correlation function, i.e.

$$P \leq 1/4 f_d T_c \tag{2}$$

Therefore, the pseudo-code length should be considered comprehensively.

The width of the code element determines the duration of the correlation function and the slope of the correlation coefficient. The narrower the width of the code element, the greater the slope of the correlation function, the better the distance cut-off characteristic of the Fuze.

4. System Simulation

Simulink is an important part of Matlab and provides an integrated environment for dynamic system modeling, simulation and integrated analysis [9, 10]. The simulation of Pseudo-code pulse Doppler Fuze is built by Simulink platform [10, 11].

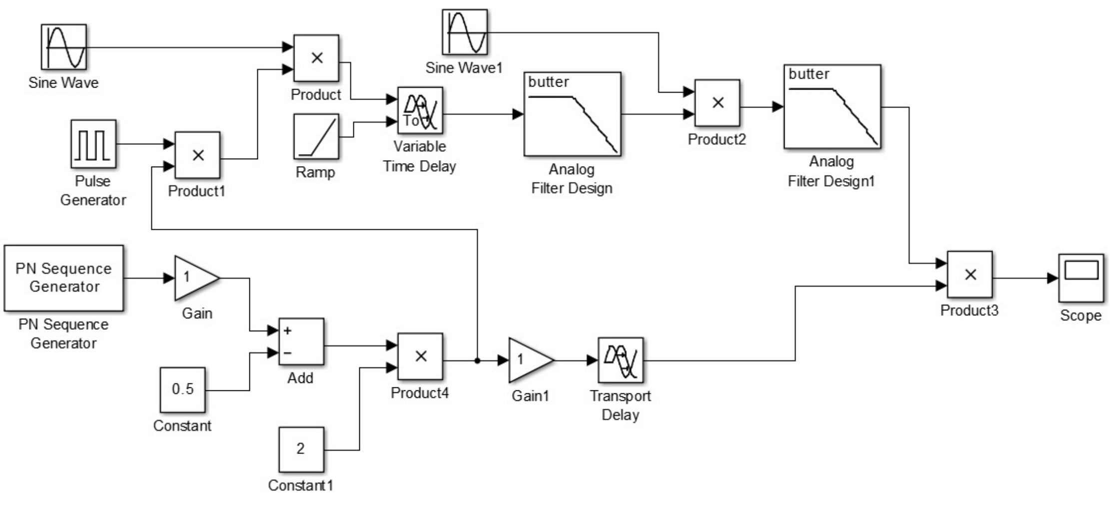

Figure 2. Frames of Pseudo Code Pulse Doppler Fuse SimulationPrinciple

In the model of pseudo-code pulse composite Fuze system, the peak gain is 10lg31=14.9dB. Pulse cycle T_R = 6100 ns, pulse width τ_A= 3000 ns, fuse default explosion radius is 60m. In simulation, because of the memory requirements of the system, the carrier frequency f_0=100MHz, the target frequency f_d=4500Hz, the relative velocity of the target 5000m/s, is established in order to balance the Doppler frequency and Fuze carrier frequency. The model is shown in Figure 2.

As shown in Figure 3, the output waveform and spectrum of the fuse correlator show significant correlation peaks, but because the filters do not match satisfactorily, the main side valve ratio is slightly less than 14.9dB, and the correlation peaks appear at 346ns instead of the theoretical 400ns. The above system error will not have a substantial effect on the interference effect analysis of the Fuze.

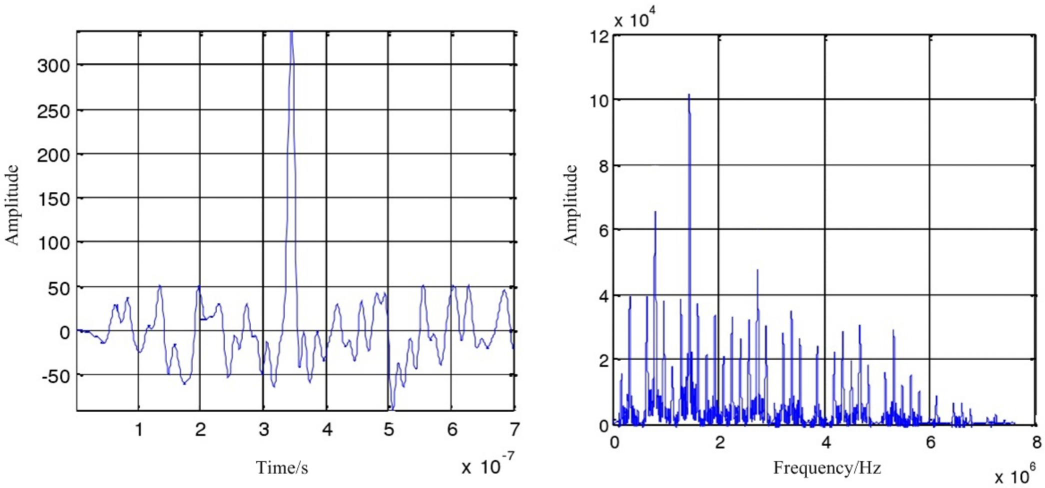

Figure 3. Frames of Pseudo Code Pulse Doppler Fuse Waveform

5. Conclusion

In this paper, the working principle of pseudo-code phase modulation Fuze and pulse Doppler Fuze are analyzed. On this basis, the working principle of pseudo-random code phase modulation pulse Doppler Fuze is analyzed. This paper introduces the anti-jamming mechanism of Fuze, chooses the system parameters, simulates the Fuze model of ideal environment, and prepares for the analysis of the effect of subsequent interference.

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