

# *Simulation of Transceiver RF Front End Based on ADS*

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**Abstract:** In this paper, the coupling mechanism and laws of the strong electromagnetic pulse on the RF front end are studied. The time domain characteristics and protection performance of the corresponding protective devices are simulated. The front door coupling simulation platform is built. The simulation of a certain type of UAV transceiver is subjected to high power microwave weapon attack, and the ADS simulation is used. The damage and interference caused by weak coupling pulse to the core link of the receiver.

## **1. Introduction**

Unmanned aerial vehicle (UAV), as an indispensable force in the modern war, has been paid more and more attention by various countries. The task is from battlefield investigation, information acquisition to electronic interference, antisubmarine warfare and ship (ground) attack, and in combination with other weapon systems, the “search and strike integration” campaign is realized in real sense Standard [1-2]. Electromagnetic pulse is a transient electromagnetic phenomenon, its time domain waveform usually has a steep front, and the pulse width is narrow, and the frequency domain covers a wide band, such as the electromagnetic pulse (NEMP) and the lightning electromagnetic pulse (LEMP), which are produced by the nuclear explosion, and have a strong interference and destructive effect on the electronic system [3]. The fast edge electromagnetic pulse (FREMP) is an electromagnetic pulse with a rising edge of several ns and a lasting time of dozens of NS. Its frequency bandwidth, high frequency distribution, high instantaneous power [4-5], more damage and destructive to the highly integrated electronic system, have become a hot spot at home and abroad.

Transceiver is an important part of UAV data link system, and plays a decisive role in the quality of communication between UAV and ground station. The transceiver can be divided into three parts: the local oscillator, the receiver and the transmitter. In the UAV data chain system, the receiver is a link sensitive to electromagnetic interference ([6-7]). Electromagnetic interference will cause nonlinear distortion of airborne receiver, which will lead to the interruption of data link communication and seriously threaten the battlefield survival of UAV. Experts and scholars at home and abroad have done a lot of research on electromagnetic pulse effect of UAV. At the same time, domestic personnel put forward many design schemes for electromagnetic pulse protection method of transceiver, which is of great significance for electromagnetic pulse protection of UAV.

The electrostatic discharge electromagnetic pulse, the lightning electromagnetic pulse, the nuclear power electromagnetic pulse and the electromagnetic pulse of the electromagnetic pulse weapon are listed as strong electromagnetic pulses. These strong electromagnetic pulses pose a great threat to radio frequency communication equipment. The damage process of strong electromagnetic pulse to electronic equipment is mainly divided into three processes: penetration, transmission and destruction, [9]. The strong electromagnetic pulse penetrates into the equipment through the antenna, the hole seam and so on, and acts on the electronic devices in the form of large current, large voltage or electromagnetic pulse, and destroys the weak parts of the electronic device, causing the damage of the coding disorder, the error of information and even the damage of the medium, the local melting and so on.

## 2. ADS Simulation

ADS software is the best in the field of RF circuit design and simulation. At the same time, Multisim and PSpice are excellent general circuit simulation software. All kinds of professional simulation software also have their good field and mature application. In terms of EMC, including front door coupling, making good use of them often results in twice the result with half the effort. The ADS simulation platform is used to build RF core link of the receiver, assuming that the device works in ideal non damage condition.

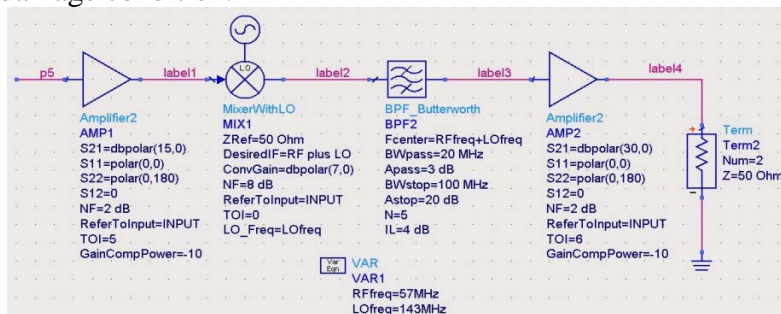


Fig .1 Receiver core circuit

Figure 2 is a waveform with a maximum of 0.1V of the induction electromotive force, which is added to figure 1 as a voltage source. After the time domain simulation, the voltage waveforms of the coupling path P5 point to label4 point are obtained, as shown in figures 3 to 7, which reflect the fast rising of the front door coupling interference rules of the electromagnetic pulse to the RF front end.

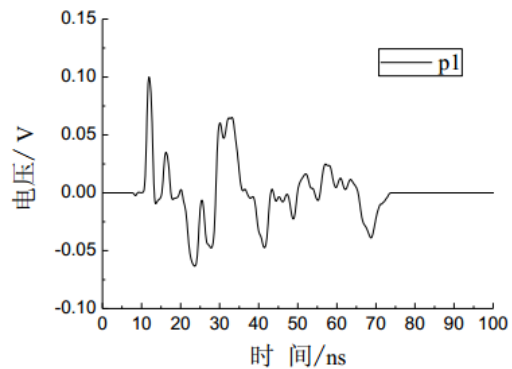
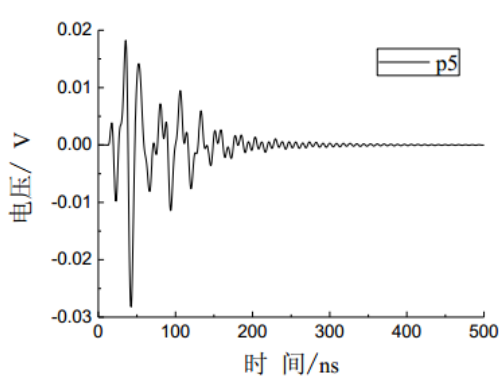


Fig. 2 Volt-time curve at point p1 Fig .3 Volt-time curve at point p5

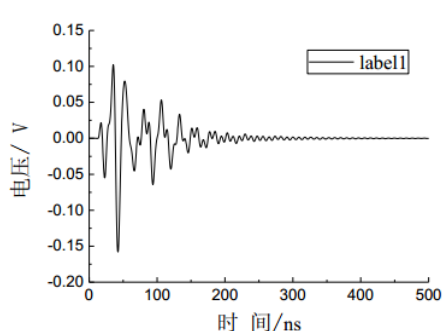


Fig 4. Volt-time curve at point label1

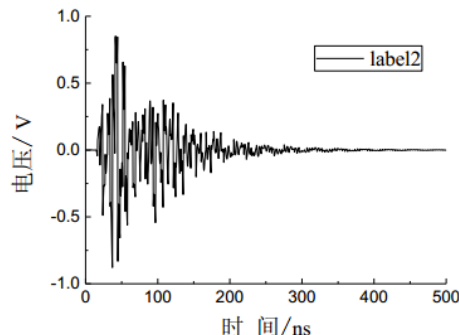


Fig5. Volt-time curve at point label2

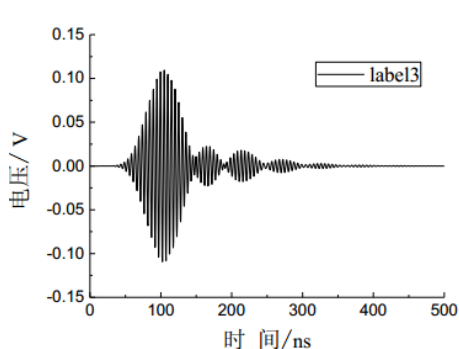


Fig6. Volt-time curve at point label3

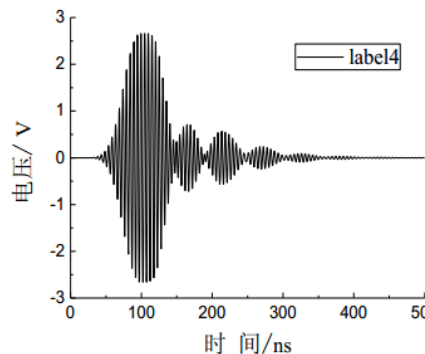


Fig 7. Volt-time curve at point label4

### 3. Electromagnetic Pulse Protection

The main idea of strong electromagnetic pulse protection is to implement a series of means such as reflection, absorption, isolation and release of pulse energy, aiming at the coupling path of the strong electromagnetic pulse to the sensitive equipment. The conventional protective devices are out of bounds for the front door front door coupling overvoltage protection. (1) the coupling pulse waveform is complex, the intensity is high, the rising edge is ns, and it is far less than the  $\mu s$  of the lightning surge. Conventional protective devices are often difficult to meet the requirements. There is a contradiction between the power and response time. (2) conventional protective devices often have some junction capacitance, small tens of pF, large ones hundreds of pF or even larger. This can not be ignored for high frequency electronic equipment, it is easy to cause signal distortion.

The transient suppressor diode ADS model is designed to simulate the avalanche effect of TVS diode and can be used in transient simulation of protection circuit.

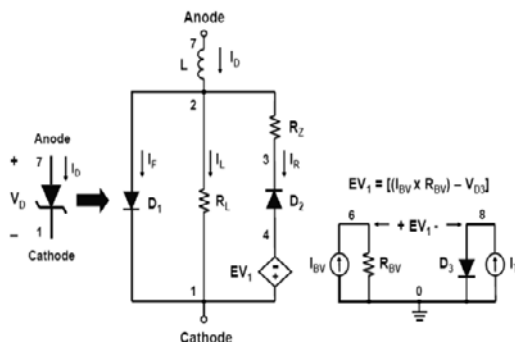


Fig8. TVS diode macro model

Test the protection of pulse wave by TVS. The following figure 9 shows the amplitude of the signal source 1V and 100V, the rising edge and the falling edge are 1 s, and the response of the pulse wave when the pulse width is 30 s.

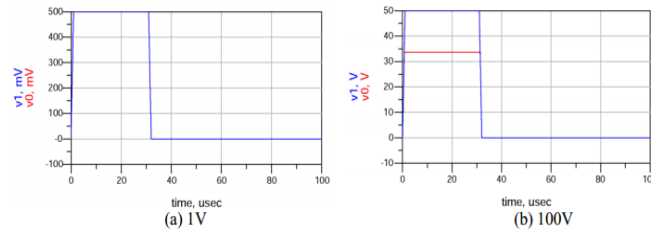


Fig9. Circuit response to pulse-wave with 1µs rise time

The following figure 10 shows the amplitude of the signal source 1V and 100V. The rising and falling edges are both 1ns, and the pulse response is 5ns when the pulse width is 5ns.

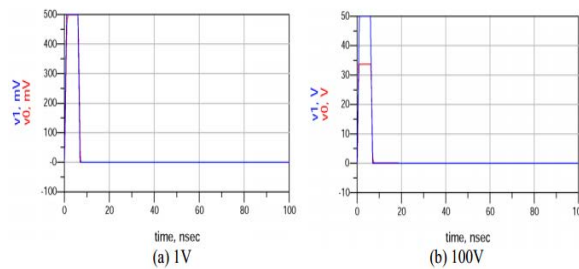


Fig10 Circuit response to pulse-wave with 1ns rise time

Figures 9 and 10 show that when the pulse amplitude exceeds the breakdown voltage 32.75V, TVS 1SMC28A can effectively clamp the S (NS) and rise (down) along the pulse.

This paper mainly establishes a simulation test circuit, which can compare the load response of the circuit with and without adding protective devices. At the same time, through the study of the protection line for pulse protection, it is better to protect the s level along the pulse, and the ns level rises (down) is slower than the pulse response.

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