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A New Method of EMI Estimation among Low Altitude Aircrafts on Sea Surface

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Abstract

There is a certain amount of RF facilities on the low altitude aircrafts that could cause electromagnetic interference within the platform, the electromagnetic interference between platforms is the key to influence the electromagnetic compatibility of aircraft platform. In this paper, the theoretical model of aircraft trajectory dynamics is seamlessly transformed into the electromagnetic collision field of low-altitude aircraft. Based on the dynamic evaluation method of electromagnetic interference level, the risk analysis of electromagnetic collision probability of aircraft is carried out, which can provide powerful technical support for solving electromagnetic interference problem of aircraft, which has important reference value for design, test and maintenance of aircraft RF system.

Basic theoretical model

Aircraft trajectory and interference power calculation

$$\begin{cases} \ddot{x} - 2\omega\dot{y} - 3\omega^2 x = 0 \\ \ddot{y} + 2\omega\dot{x} = 0 \\ \ddot{z} + \omega^2 z = 0 \end{cases}$$

where ω is the trajectory angular velocity of the aircraft

Given the transmitting power P_t, the receive power is

$$P_r = P_t G_t G_r \lambda^2 / (4\pi d)^2$$

G_t is the gain of receiving antenna, G_r is the wavelength of electromagnetic wave, and d is the distance between transmitter and receiver.

Maintaining the Integrity of the Specifications

$$P_{cEM} = \Pr[Z < R_{tEM}] = \int_{-\infty}^{R_{tEM}} f_z(z)dz$$

$$Z = Y / \sqrt{X_\sigma^*}, \quad X_\sigma^* = 10^{(X_\sigma/10)}$$

f is GHz, and * is shown as a random variable.

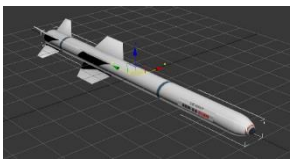
The collision probability matrix P_{cEM} can be obtained based on the interference matrix T:

$$\mathbf{P_{cEM}} = \begin{bmatrix} P_{cEM\,11} & \cdots & P_{cEM\,1j} & \cdots & P_{cEM\,1m} \\ \vdots & \ddots & & & \vdots \\ P_{cEM\,i1} & & P_{cEM\,ij} & & \vdots \\ \vdots & & & \ddots & \vdots \\ P_{cEM\,n1} & & & & P_{cEM\,nm} \end{bmatrix}$$

Simulation and data analysis

The simulation results show:

- The antenna radiation power:0.49W;
- The maximum antenna gain:2.436dBi;
- The resonant frequency:142.9MHz;



According to Friis formula:

- The receive power: -49.69 dBm;
- Safety margin between transmitter and receiver: 60.30 dB;

According to the regulations of space systems electromagnetic compatibility requirements GJB3590-99, the safety margin of this analysis should be set as 20dB.

- safety margin>20dB: it is considered to be compatible;
- 20dB>safety margin>0dB: it is considered compatible with the work;
- 0dB>safety margin: the transmitter may interfere with the receiver.

Conclusion

According to the dynamics equation of the aircraft, the three-dimensional position, attitude, velocity and acceleration of the aircraft system at any time are obtained. Combined with the electromagnetic emission antenna model, the electromagnetic radiation range of the aircraft system is determined. Based on the gain and mode parameters of receiving antenna, the influence degree of electromagnetic radiation hazard is evaluated. The theoretical model of trajectory dynamics is transferred seamlessly into the field of electromagnetic collision, that is, the electromagnetic interference between systems, which provides a strong technical support for solving the problem of electromagnetic interference between aircraft.