Analysis of Electronic Circuit Interference in Electrical Debugging Based on Computer-aided Software

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Abstract. In this paper, based on computer-aided software, the simulation method is used to explore the influence of the coupling voltage generated by the terminal load of the circuit board in the shielding body on the internal circuit from two aspects. When there is no through wire, the interference voltage is much smaller than that when there is no through wire. This shows that the anti-interference ability of the electronic circuit in the shield is reduced when there are through wires. When the vertical distance between the interference source and the line changes, the interference increases with the shortening of the distance; at the same time, affected by the working frequency of the interference source, the relative position symmetry interference is large at low frequency, and it increases with the relative position asymmetry at high frequency.

Keywords: Electronic Circuit, Interference, Simulation, Computer-aided Software

1. Introduction

At present, there is a rapid development of electrification in the world, and electrical equipment is widely used in industrial production and life. In order to achieve high efficiency of electrical equipment, its debugging work becomes particularly important. Among them, the interference of electronic circuit brings a great challenge, which is one of the problems of electrical debugging. For the interference of electronic circuit, the influence of electromagnetic wave is a very important content. In this paper, the simulation method is used to establish a simplified model of the circuit in the through conductor and shield case, and analyze the influence of the load voltage of the interference source transmitting electromagnetic pulse and the change of the length of the line on the load interference voltage of the terminal[1].

2. Modeling

Set the circuit connection diagram as shown in figure 1, assuming that the analog is infinite ground plate, and its distance from the plane height is k=5.6cm, wire radius is 0.3cm. The initial length h is
The head end resistance is shown as $50\,\Omega$, which end is connected to the metal belt. Metal belt shield body and circuit board, the width of the strip is $0.6\,c$. Center of the board terminal in the width direction of the cavity, which is $0.5\,c$ from the front. The simulated rubber table is the same size as the shielding cavity. The shield body is an automobile electronic control unit, and the circuit connected to the analog terminal of the internal circuit is $50\,\Omega$.

![Circuit connection diagram of through conductor and shield body(cm).](image)

**Figure 1.** Circuit connection diagram of through conductor and shield body(cm).

Set the interference source port as port 1, its initial position is located at the distance between the horizontal distance and the first end of the line, $y = 7.5\,c$, and the distance between the vertical direction and the line, $l$, the initial value is $10\,c$. When the distance $l$ between the interference source and the wire changes and the length $h$ of the wire changes, the ratio of the voltage between the feed point of the interference source and the $50\,\Omega$ resistance at the end of the circuit board, the interference to the terminal load of PCB was studied. The interference source intensity is $1\,V$ voltage source and the center frequency is $1.67\,GHz$.

3. Data simulation

Set the voltage of interference source port 1 as $U_1$, terminal load port 2 as $U_2$, and the voltage transmission relationship between the two voltage ratios $k_{21}$ and port voltage $S_{21}$ as:

$$k_{21} = \frac{U_2}{U_1}$$  \hspace{1cm} (1)

$$S_{21} = 20\log_{10}(k_{21})$$  \hspace{1cm} (2)

Set $S_{22}$ as the self reflection voltage transmission relation of terminal load plus excitation source.
of PCB

\[ S_{22} = 20 \log_{10}(k_{22}) \]  (3)

\[ k_{22} \] is the ratio of the reflected voltage to the initial voltage.

4. Result analysis

**Figure 2.** Voltage transmission relationship without wires.

It can be seen from figure 2 that the interference of electromagnetic pulse coupled into the shielding body through the opening on the terminal load increases with the increase of frequency. The maximum interference is at the resonant frequency of the model (near 2.65GHz in the figure). The fluctuation of the curve is small, and there is resonance and oscillation in the shielding body, but the interference voltage is small (\( S_{21} < 115 \text{dB} \)). Therefore, when the shield has only holes and is relatively small, the coupling voltage of external interference electromagnetic wave in the internal circuit is relatively small.

**Figure 3.** Voltage transmission relationship.

when line interference source distance \( l = 12 \text{cm} \)

It can be showed from figure 3 (a) that the interference voltage in the presence of conductor is far greater than that in the absence of conductor. According to the comparison of figure 3 (a) (b), the interference intensity of voltage ratio is large. Compared with no conductor, the terminal load coupling voltage is also large. When the model resonates at some frequencies (such as 2.5GHz), the greater the
interference will be. It is showed that the anti-interference ability of the through conductor to the electronic circuit system inside the shielding body is greatly weakened, which is easy to degrade the circuit performance and affect the normal operation of the equipment.

Change the distance $L$ to. Voltage transmission relationship $S_{21}$, as shown in figure 4 compared with figure 3 (a), the shorter the distance, the greater the interference. Because as the distance becomes shorter, the more interference wave energy the conductor absorbs, and the richer the spectrum $^{[4]}$.

![Figure 4. Voltage transmission relationship.](image)

when line interference source distance $L = 10cm$

5. Conclusion

In this paper, based on computer-aided software, the simulation method is used to explore the influence of the coupling voltage generated by the terminal load of the circuit board in the shielding body on the internal circuit. The effects of the presence or absence of wires and the variation of vertical distance of interference sources are studied. The results are as follows:

When there is no through conductor, the interference electromagnetic pulse enters the shield through the through-hole coupling, and resonance occurs in the shield due to the influence of the shield structure. However, when the size of the hole is very small, compared with the through conductor, the interference voltage is much smaller when there is no conductor. This shows that the anti-interference ability of the electronic circuit in the shield is reduced when there are through wires $^{[5]}$.

When the vertical distance $l$ between the interference source and the line changes, the interference increases with the shortening of the distance; at the same time, the interference is relatively large within the working frequency range of the interference source due to the influence of the working frequency of the interference source; due to the influence of the structure of the model itself, it has no anti-interference ability for some frequencies, so the interference is also large within these frequency ranges $^{[6]}$.

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