

The study of Electronic measuring equipment Electromagnetic Protection

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Abstract: Electronic equipment is used more and more widely, but it is also to be interfered more and more vulnerable by external electromagnetic radiation interference. In this paper, a new method to enhance the anti-jamming capability of electronic devices is presented, named active electromagnetic protection technology. According the method, the first to measure the electromagnetic sensitivity characteristics, analyzes its operating principle, sensitive characteristics, and then again by theoretical analysis, simulation of electromagnetic protection plan worked out, the final practical test to verify the effect of the effective electromagnetic protection validity. It can be said that the active electromagnetic protection method has great engineering application prospects, provide an important reference for all types of electronic testing equipment of electromagnetic protection.

INTRODUCTION

With the development of information technology, Electronic measuring equipment is the applied more and more widely, the density is higher and higher, but the electromagnetic environment is increasingly complicated, formed a variety of electromagnetic hazard source. Not only constitute types, but the space crisscross, the continuous time domain and frequency domain intensive overlap, all of those constitute a serious threat to detection accuracy, safety, reliability and viability of electronic measurement equipment.

To further enhance the anti-jamming capability of electronic devices, lots of methods are given. In the thesis of Nanjing University of Technology and Engineering, it is given how to choose the nonlinear semiconductor overvoltage protection device for enhancing the EMC of initiating explosive device. In the paper[1],the results show that, after appropriate measures are applied to the signal processing circuit and the entire systems, the gain and bandwidth of the soft X-ray and XUV diagnostic systems are increased to 100 and 100 kHz, respectively, and their noise is reduced to about 10 mV. In the paper[2], the experimental results show that the DSP system using hardware shield and software reinforcement technology can work well near the EMP simulator, and that it is feasible and has strong anti—jamming capacity. And in the paper[3], the EMC and reinforce design of modified chassis were illuminated in detail. In the above articles, many effective electromagnetic protection program are given, but advance work of enhancing electromagnetic immunity of the equipment is not sufficient.

In this paper, a new method is shown, named proactive electromagnetic protection method. Firstly, Electromagnetic sensitivity characteristics of measuring equipment is tested. Secondly, calculate the magnitude of electromagnetic protection. Thirdly, study interference principle and

create a simulation. In the end, actual testing to verify the effectiveness of protective measures. The new proactive method is applied in a certain type of measuring equipment

Active electromagnetic protection design method provided by the article, has a good promotion prospects to enhance the anti-jamming capability of electronic devices.

APERTURES COUPLING THEORY

Theoretical basis of physical optics diffraction is Huygens' principle[4], which assumes that every point on the optical wave front can be seen as a secondary light source[5-7], which will produce sub-wave radiation. The wavelet transmission direction and at the front are superimposed to obtain the amount of the transmission direction of the field. Based on this principle, according to Green's theorem to derive Kirchhoff equation, it can be expressed for any field $y(r)$, at point P within a region V after coupling apertures.

$$y(r) = -\frac{1}{4p} \oint_s \frac{e^{jkR}}{R} \left[\nabla y + \left(jk - \frac{1}{R} \right) \frac{R}{K} y \right] dS \quad (1)$$

In the central apertures for Cartesian coordinate origin, apertures center field strength is y_0 , incident wave angle is q_0 , and angle q is between the radius vector for the field point to the center of apertures to the Normal vector direction of the conductive plate, so the expression can be gotten in the follow.

$$y(r) = j \frac{ke^{-jkR}}{4p} (q_0 + q) \int_{S_0} y_0 e^{jkr} dS \quad (2)$$

For example, the circular apertures S_0 , the radius of apertures a , When the incident field is constant $E_y = E_0$, coupling field can be expressed:

$$E_p = -\frac{jke^{jkR}}{4pR} E_0 S (1 + \cos q) \frac{2J_1(ksinq)}{ksinq} \quad (3)$$

In the expression, J_1 -an order Bessel, $s = pa^2$; In addition, the conductive plate thickness is thinner, and the wavelength of aperture size compared to hours, may also be used to solve electromagnetic duality principle apertures coupling approximation distribution.

STUDY OF A CERTAIN TYPE OF ELECTRIC MEASURING EQUIPMENT

Electromagnetic sensitivity characteristic measurement

According to relevant standards (RS103 electric field susceptibility test), first test Electromagnetic sensitivity characteristic of the electric measurement equipment in the Anechoic Chamber[8-10]. Its test composition shown in Figure 1.

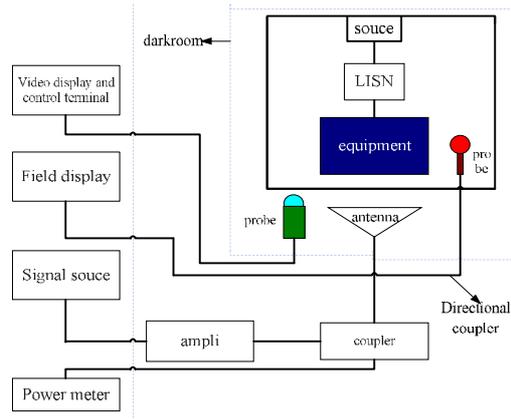


Fig 1 the testing composition

According to the practical test, the result of electromagnetism sensitivity curve is shown in the figure 2. By this, it is not difficult to find the electromagnetic sensitive limits, the electromagnetic sensitive frequency, which is very important.

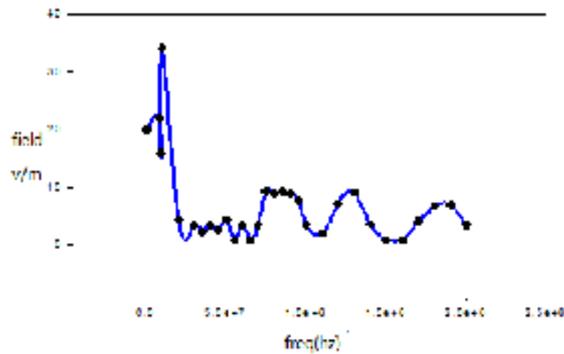


Fig 2 electromagnetic sensitivity curve of the equipment

Electromagnetic sensitive principles and Protection

The composition of the electronic measuring equipment is shown in Figure 3

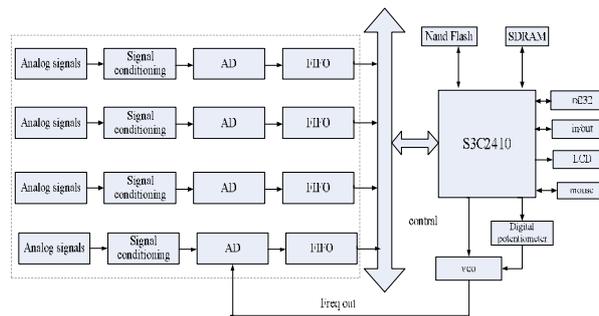


Fig 3 the composition of the electronic measuring equipment

External electromagnetic radiation interference does not have electromagnetic protection, because body shell of the measurement device is non-metallic materials. The internal electronic components of the equipment, signal transmission cable, analog signal acquisition and transmission line can be interrupted very easily. Therefore, when conducting electromagnetic protective measures, it should proceed to a comprehensive system of electromagnetic protection of this type of measuring device.

According to the test by the standard curve (10KHz ~ 2MHz, 20v / m; 2MHz ~ 40GHz, 50v / m) comparison, not difficult to find the value of shielding effectiveness of the shell as long as no less than 40dB, to meet shielding requirements.

According sensitive frequency range and its own characteristics, designed to shield shown in the fig 4. The display is partly due to the larger aperture size (relative to the sensitive frequency range) in the shell, so a strong electromagnetic coupling will be occurred at the range of 7MHz ~ 400MHz. It is necessary to take protective measures to prevent the coupling of external electromagnetic interference. At the same time, it does not affect the normal observation, so to take the installation of translucent shielding glass or something.

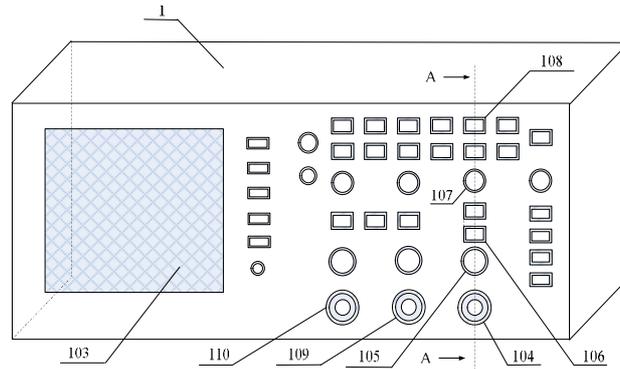


Fig 4 shielding shell structure

Using numerical simulation, external vertical polarization interference source at the frequency of 7MHz, 300MHz and 400MHz is applied respectively, and the resultant field distribution inside and outside the box is shown in the fig 5-fig 7.

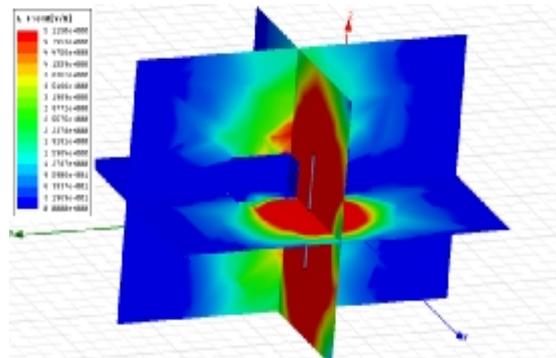


Figure 5 field distribution inside and outside of the shell(7MHz)

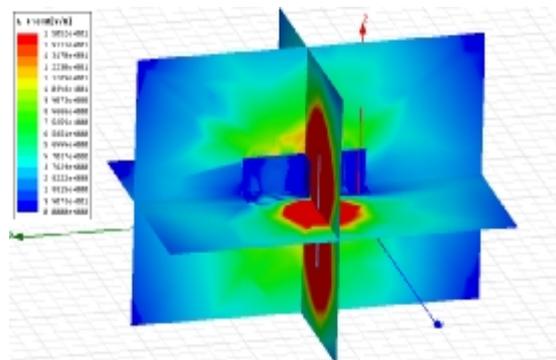


Figure 6 field distribution inside and outside of the shell(300MHz)

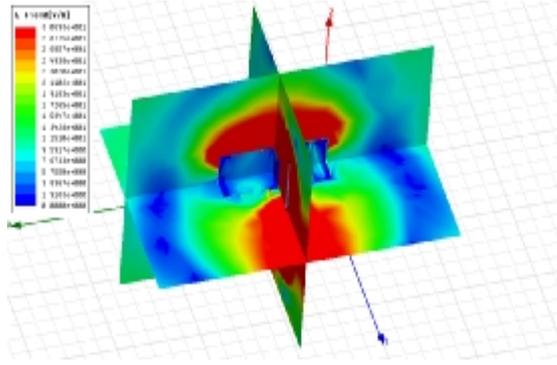


Figure 7 field distribution inside and outside of the shell(400MHz)

According to the numerical simulation results, it can be seen that external electromagnetic interference is shielded better by using the installation.

With simulation results, not difficult to find holes in the front panel joints, electromagnetic coupling enhanced disclosure. The structure can be regarded as the key hole at the cutoff waveguide structure.

For a circular waveguide structure, its cutoff frequency calculated by the following expression: $f_c = \frac{17.5}{d}$, and for rectangular waveguide structure, its cutoff frequency calculated by the following expression: $f_c = \frac{15}{d}$.

After the cut-off frequency is obtained, as in (6), shielding effectiveness can be simple estimated, which can be judged whether the shield is designed to meet the actual needs of the shield. If the shielding effectiveness in a more accurate numerical algorithm should be used to solve it.

$$SE = 1.832 \times f_{cmn} \times L \times 10^{-9} \sqrt{1 - \left(\frac{f}{f_{cmn}}\right)^2} \quad (6)$$

Further to enhance the electromagnetic shielding effectiveness, as in (6), the thickness may be increased. That increase cutoff length of the waveguide to achieve better shielding effectiveness, the structure shown in Figure 8 at the keys.

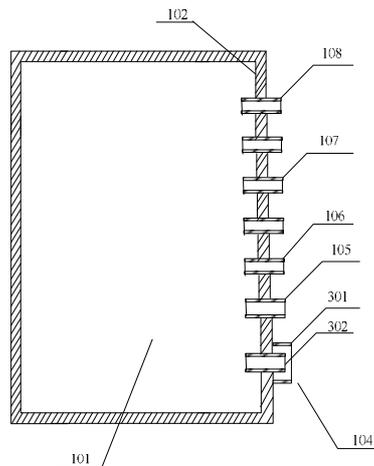


Fig 8 Shielding means internal structure

The actual test results

Through theoretical analysis, simulation, and electromagnetic protection project is worked out , but it must be tested to verify the validity at the EMC anechoic chamber, testing site at the EMC anechoic chamber in the fig 9.



Fig 9 testing site at the EMC anechoic chamber

After the electromagnetic reinforcement, electromagnetic sensitivity character is tested in the Fig 10-11.

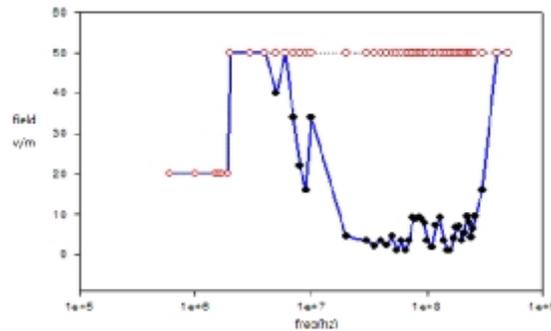


Fig 10 vertical polarization test curve

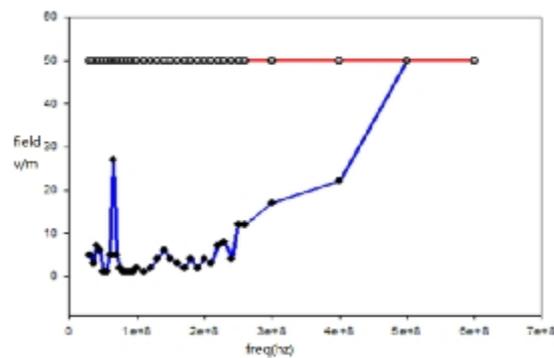


Fig 11 horizontal polarization test curve

The practical curve indicated that the electromagnetic sensitivity greatly is enhanced by the design, which can be to meet the standard limits.

CONCLUSION

In this paper, a new method to enhance the anti-jamming capability of electronic devices is presented, named active electromagnetic protection technology. According the method, The important work is followed: the first to measure the electromagnetic sensitivity characteristics,

analyzes its operating principle, sensitive characteristics, and then again by theoretical analysis, simulation of electromagnetic protection plan worked out, the final practical test to verify the effect of the effective electromagnetic protection validity. It can be said that the active electromagnetic protection method has great engineering application prospects, providing an important reference for all types of electronic testing equipment of electromagnetic protection.

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