

Analysis On Electrostatic Discharge Protection of Electronics Dictionary

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Abstract: The ESD protection for an electronic dictionary was studied, and detailed countermeasures are presented. By the presented steps against the ESD, the electronic dictionary can satisfy the requirement of 4 kV ESD in the mode of contact discharge, 8 kV ESD in the mode of air discharge.

Key words: electrostatic discharge; electronic dictionary; protection; filter; electrostatic interference

1. INTRODUCTION

Electronic dictionary sometimes is reset by electrostatic interference. It's more and more important to degrade electrostatic interference for electronic product. This paper based on experiment analysis, presented how to settle the problem of electrostatic interference for an electronic dictionary. By the characteristic of electronic dictionary, a model of the product is put forward.

2. ELECTROSTATIC INTERFERENCE MODEL

Electrostatic interference model, as an analysis tool for electrostatic interference, can help us to optimize production design. The factors, such as the distance of parts, the distance of apertures, the structure and dimension can affect the ESD immunity. From interference source to core circuit, the parameters of conducting circuit and coupling circuit are different. So only the key factors are shown in the electrostatic model.

Generally, the sensitive zones of electronic dictionary are the LCD screen, power zone, loudhailer, keystroke zone and crust. By the national regulation, an eligible electronic dictionary works well under the ESD interference of 4-kV contact discharge and 8-kV air discharge. By this standard, we checked the whole product and exposed product by ESD in the mode of air discharge, contact discharge, HCP air discharge and VCP air discharge. Checked zones include the LCD screen, power zone, loudhailer,

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keystroke zone and crust.

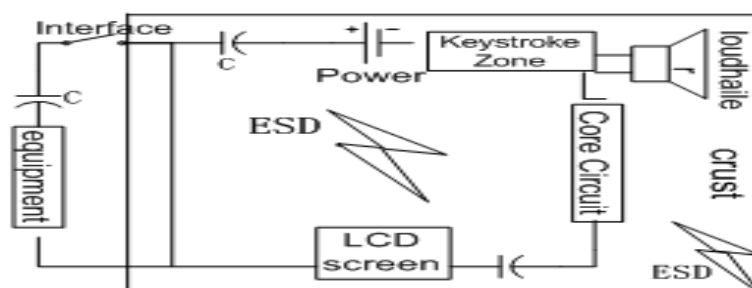


Fig.1. General circuit analysis model of the electronic dictionary

Experiment was executed in a platform which accords to IEC standard. EST902 ESD immunity diagnosis and debugging system, which was use as the electrostatic generator, can produce waveform according to the requirement of IEC61000-4-2. Contact discharge, air discharge, HCP air discharge and VCP air discharge was executed at the temperature and humidity in the defined scope of IEC61000-4-2.

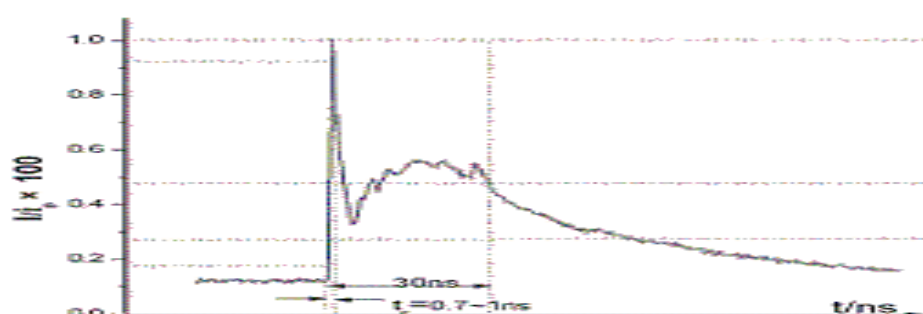


Fig. 2. Actual ESD interfere

3. THE MEASURES FOR ESD PROTECTION

The immunity of sample product is low. When checking the product by the ESD interference of 2-kV, 4-kV, 6-kV in the mode of contact discharge, keystroke zone and LCD screen would be invalidation or flicker at the level of 2 kV ESD, when the discharge voltage exceeds 2 kV, the electronic dictionary would be reset, as shown in Table 1.

Table 1. Experimental results of contact discharge to the whole product

	Screen	Keystroke	Power	loudhailer
2 kV	flicker	invalidation	Reset	Work
4 kV	Dark	invalidation	Reset	invalidation
6 kV	invalidation	invalidation	Reset	invalidation
8 kV	invalidation	invalidation	Reset	invalidation
10kV	invalidation	invalidation	Reset	invalidation

When checking the electronic dictionary by air discharge of 2 kV, 4 kV 6 kV, 8 kV and 10 kV, LCD screen would show dark point at the level of 2 kV ESD. When checked by the ESD interference of 4kv, 6kv, function is unstable, screen is dark. Keystroke zone is interfered by 8kv ESD, the product works well, when the ESD is above 10 kV, it would be reset, as shown in Table 2.

Table 2. Immunity of the whole product checking in HCP air discharge

	Screen	Keystroke	Power	loudhailer
2 kV	Dark Point	Work	Reset	Work
4 kV	Flicker	Work	Reset	Invalidation
6 kV	Dark	Work	Reset	Invalidation
8 kV	Invalidation	Work	Reset	Invalidation
10kV	Invalidation	Invalidation	Reset	Invalidation

By China national regulation, eligible electronic dictionary works well under the ESD interference of 4 kV contact discharge and 8 kV air discharge. We can see that the electronic dictionary can not satisfy the national standards and should be forbidden sold in market. Generally, sensitive zone of electronic dictionary exists on the LCD screen, power zone, loudhailer, keystroke zone and crust. By this standard, we checked the whole product and exposed product by ESD in the mode of air discharge, contact discharge, HCP air discharge and VCP air discharge.

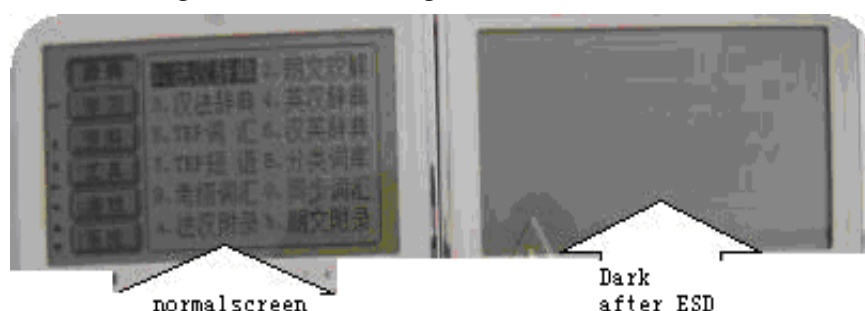


Fig. 3. Comparative diagram of the electronic dictionary by ESD interference

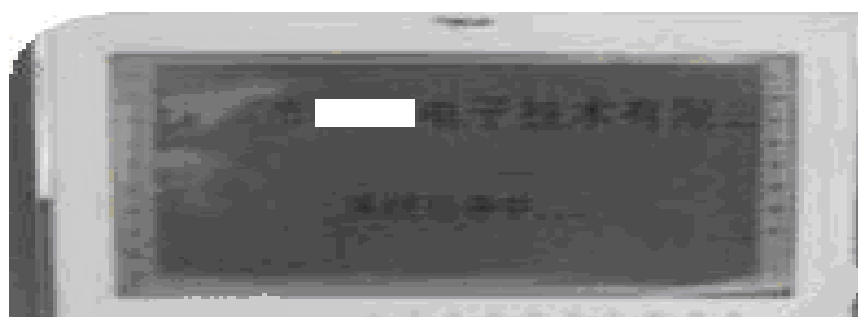


Fig.4. Reset by the ESD interfere of 2kV contact discharge

3.1 Adding filter rightly

Filter circuit design on interface, power switch and key access of ESD interference can improve the ESD immunity. When selecting filter, we should make sure that the main function will not be affected by the filter, at the same time, the characteristic of the circuit function and work environment cannot be ignored.⁴

Table 3. Immunity of the whole product in mode of air discharge after add filter

	Screen	Keystroke	Power	Loudhailer
2 kV	Work	Work	Work	Work
4 kV	Flicker	Work	Work	Work
6 kV	Dark	Work	Reset	Invalidation
8 kV	Invalidation	Work	Reset	Invalidation
10kV	Invalidation	Invalidation	Reset	Invalidation

3.2 Separating Signal Grounding Rightly

The voltage of grounding in electronic dictionary is not on the same level. So for making sure the work status of signal circuit, separation and shield for signal grounding, power zone and the interface of accessorial parts are necessary. Separation and shield for grounding, power zone and the interface of accessorial parts can protect the inner circuit from the ESD interference. This step can improve the immunity of electronic dictionary greatly. The ESD interference reduced greatly in the keystroke and power zone after separation of signal grounding, as shown in Table 4.

Table 4. Immunity of the whole product checked in the mode of HCP air discharge after separation of signal grounding

	Screen	Keystroke	Power	Loudhailer
2 kV	Work	Work	Work	Work
4 kV	Work	Work	Work	Work
6 kV	Dark Point	Work	Work	Work
8 kV	Flicker	Work	Work	Work
10kV	Invalidation	Work	Work	Invalidation
12kV	Invalidation	Invalidation	Reset	Invalidation

3.3 Applying Appropriate Crust

If the problem of low ESD immunity was caused by circuit, there should show similar results when we test the whole product and exposed product. In fact, the ESD immunity of exposed product is higher than the whole product. The material of crust contributes to the low ESD immunity.

The crust of the electronic dictionary is aluminum crust, inboard direction of aluminum crust is

⁴ John Wettroth, ESD Protect Circuit Maxim Company.

protecting pellicle, and the side of product is plastic pellicle. The operation of the product halts because of the electrostatic discharging of human body discharged by fingers, and of environment discharged by interface. In experiment, the whole product resets continually in different level of voltage, the screen has dark points.

Appropriate crust can shield inner circuit from the electrostatic interference effectively. For making use of its shielding function sufficiently, we check the electronic dictionary enwrapped by isolating crust instead of mental crust.

Table 5. Immunity of exposed product in the mode of air discharge

	Screen	Keystroke	Power	Loudhailer
2 kV	Work	Work	Work	Work
4 kV	On Work	Work	Work	Work
6 kV	Dark Point	Work	Work	Work
8 kV	Flicker	Work	Work	Work
10kV	Invalidation	Work	Work	Work
12kV	Invalidation	Work	Work	Invalidation
-6kV	Flicker	Work	Work	Work
-8kV	Invalidation	Work	Work	Work

So the selection of crust must consider the environment factors into design. Making use of the shielding function of crust sufficiently, we separated the inner circuit from outer ESD interference.

3.4 Improvement on LCD screen

LCD screen, as an important part of electronic dictionary, is subject to ESD interference. When interfered by 4 kV ESD, LCD screen showed dark point, sometimes showed flicker. When interfered by 6 kV, 8 kV ESD, malfunction would be shown.

Table 6. Immunity of the whole product in the mode of HCP air discharge

	Screen	Keystroke	Power	Loudhailer
2 kV	Work	Work	Work	Work
4 kV	Work	Work	Work	Work
6 kV	Work	Work	Work	Work
8 kV	Work	Work	Work	Work
10kV	Work	Work	Work	Work
12kV	Flicker	Work	Work	Invalidation
-6kV	Work	Work	Work	Work
-8kV	Dark Point	Work	Work	Work

The copper foil behind the LCD screen has the function of capacitance,⁵ the electrostatic charge on it would discharge in some condition and interrupt its work, even destroy the electronic dictionary. So changing the copper foil appropriately can adjust the capacitance. The copper foil is disposed in the steps as follow:

- 1st. Deepening protection layer behind the LCD Screen;
- 2nd. Reducing the distance between protecting copper foil and LCD screen, by this way, the distance of copper foil and electron circuit is increased, the charges on this capacitance is lessened, and there would lower the interference;
- 3rd. Adding some measures to release charges on copper foil.

By steps above, the immunity of the electronic dictionary was improved greatly, as shown in Table 6 and Table 7.

Table 7. Immunity of the whole product checked in the mode of contacting discharge

	Screen	Keystroke	Power	Loudhailer
2 kV	Work	Work	Work	Work
4 kV	Work	Work	Work	Work
6 kV	Work	Work	Work	Work
8 kV	Work	Work	Work	Work
10kV	flicker	Work	Work	Invalidation
12kV	Dark	Invalidation	Invalidation	Invalidation
-6kV	Work	Work	Work	Work
-8kV	Invalidation	invalidation	Work	Work

4. CONCLUSIONS

The ESD protection is very important for the electronic dictionary. Crust design rightly shields the electrostatic interference, but can not erase the ESD interference in key circuit. Adding filter on inner circuit can restrain ESD interference effectively. The copper foil behind the LCD has the function of capacitance, the electrostatic charge on it would discharge and make damage under certain condition, so how to treat with protecting copper foil plays important role for all electronic product with the LCD. Separation and shield for signal and other grounding, interface of accessorial parts can hold inner circuit off the ESD interference effectively.

By the presented steps against the ESD, the electronic dictionary can satisfy the national requirement of ESD with 4 kV in the mode of contact discharge, ESD with 8 kV in the mode of air discharge. If some improvement is considered in the design, the immunity would be improved higher.

⁵ LUO Laijun. Capacitance in ESD protecting. *Electrical Times*, Vol. 10, 2004.