Failure Analysis of Computer Backplane Burning Down

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Abstract: The bottom plate burned out during the computer power-on detection process. This was analyzed. Firstly, the fault tree of the bottom plate was built and analyzed. Then a fault tree is established for the problem of capacitor short-circuit failure, and finally the possibility of capacitor problem is eliminated. After analysis, it is concluded that the cause of the burning of the bottom plate is the presence of foreign objects in the chassis. In the process of random vibration, foreign objects may be short-circuited to the power supply, resulting in a short circuit of the bottom plate, which may cause burnout. The power supply has an overcurrent protection mechanism, but the protection mechanism is that the power supply reduces the voltage output in the event of an overcurrent, so even if a short circuit occurs, the power supply will still output current, resulting in a burnout failure.

1 Introduction

It is inevitable that various problems will not occur in the process of production debugging of computer products. The phenomenon of circuit board burnout is very common. Many scholars have studied the problem of circuit burnout or failure [1-4]. It has reference significance for our analysis.

Check the power on the computer[5-9]. After the power is on for about 20 minutes, the chassis smells burnt. Open the chassis and find that the chassis slots XA0, XA3, XA4 have been burned. The burning situation is shown in Figure 1.

![Figure 1 After the bottom plate is burnt](image)

It can be seen from the photo that the completely burnt capacitor is C63, and the suspected burned capacitors are C61 and C69. The capacitors C61 and C69 are sent to professional organizations for analysis and the results are obtained: C61 fails, and C69 is normal.

2 Problem location

The failed capacitor (C61) was sent to a professional organization for analysis and the conclusion was reached: "The failed capacitor is short-circuited due to a crack in the internal ceramic capacitor medium. The generation of cracks in the capacitor's internal medium is related to the external mechanical stress on the capacitor" The stress should be generated during the burning of the PCB."
It can be seen from the burned pictures that C63 has been completely burned and burned for a long time. It can be speculated that during the burning process of the capacitor C63, the heat is mainly transferred along the copper plating connected to the capacitor C63. The connected capacitors are C62 and C61. During the heat transfer process, the capacitors C62 and C61 are overheated. Due to the differences in the capacitors themselves, the capacitor C61 undergoes mechanical stress of thermal expansion and contraction under the impact of overheating, resulting in internal cracks and short circuit failure. Establish the following fault tree on how to burn the chassis floor.

2.1 Fault tree analysis
According to the principle that the chassis bottom is burnt out, a fault tree is established, as shown in Figure 2.

2.1.1 Foreign body short circuit
Disassemble the front panel of the chassis, unplug all the modules inside the chassis, no foreign objects are found, disassemble the rear panel of the chassis, and check the inside of the chassis, no foreign objects are found. If there is a foreign object in the gap between the chassis bottom and the back cover, after random vibration, the foreign object may fall to the lower part of the chassis. If it is just connected between +12V and GND, it will cause an electrical ground short circuit. Although the power supply will perform short-circuit protection after a short circuit, the mechanism of the short-circuit protection of the power supply is to reduce the output voltage instead of disconnecting the output current. Therefore, if a foreign object is short-circuited, the power supply will continue to increase the current, resulting in a large-scale chassis bottom burnout.

When the chassis is short-circuited due to foreign objects in the chassis, when the fault occurs, the foreign objects will be burned in a short time because of the excessive current. At the same time, the layers of the printed circuit board will be short-circuited during the burning process, resulting in a large area of burnout. Long, the bottom plate is burned more seriously, there may be situations where the excess has been burned and cannot be found. In addition, check the production records of the batch of reinforcement machines. During the assembly process, there are multiple repair records, so it is not ruled out that the excess is not cleaned up during the repair process.

2.1.2 Board short circuit
The slots on both sides of the failed capacitor (C61) are XA3 and XA4. The above two slots are empty slots and no modules are inserted. At the same time, check all the modules inside the chassis. Except for the data loading module whose CPCI connector is damaged due to the high temperature of the backplane (after the connector is replaced, it can still be used normally), the other modules are all in good appearance and function normally. According to the above analysis, the short circuit factor of the board can be eliminated.

2.1.3 Short circuit of looper
The CPCI pin condition of the short-circuit slot was detected, and no short-circuit condition of the bent pin was found. At the same time, the other slots of the chassis were detected, and no bending pins were found. From the above analysis, it can be seen that the looper short circuit factor can be eliminated.
2.1.4 Abnormal output voltage of power module +12V

Use drawing software to view the PCB routing, as shown in Figure 3. It is found that the netlist connected by the short-circuit capacitors C61 and C63 is +12V. At the same time, check the burned bottom plate and find that the burned position is consistent with the copper laying position of the trace. Therefore, the +12V power supply of the power supply is checked.

![Figure 3 Case bottom +12V copper laying](image)

The two power modules used in the faulty chassis are tested according to the connection method of the chassis bottom plate (only 12V current sharing signal is connected, 5V and 3.3V current sharing signal is not connected), and the power-on time is 24 hours. Set the oscilloscope trigger level 13V and 11V, no abnormality was found. And the two power modules have been re-used in the newly put into production chassis, and the relevant screening tests have been completed and delivered, and no abnormalities have been found. Through the above analysis, it can be seen that the power failure factor can be eliminated.

2.2. Failure analysis of capacitor short circuit

Detecting the case where the chassis bottom plate burns the capacitor, C63 is completely burned out. If the failure mode of the capacitor is open, the impedance is infinite and the current is zero. According to the formula $E = i^2 \times R \times t$, the heat value of the capacitor is zero. It cannot be burned, so it can be judged that the capacitor (C63) has failed, and the failure mode is short circuit. After the capacitor is short-circuited, the current flowing through the capacitor becomes larger, resulting in greater heat generation, and the generated heat is conducted along the path with a smaller thermal resistance, resulting in more serious heating of the +12V copper laying and the area around the capacitor C63. The specific burned photos are shown in Figure 1.

![Figure 4 Fault tree of capacitor short-circuit failure](image)

According to the failure mechanism of the capacitor, a fault tree is established, as shown in Figure 4.

![Figure 4 Fault tree of capacitor short-circuit failure](image)

The capacitors of this type in this batch are only used for this project, but not for other projects. The unit's testing center tested the purchased capacitors and found no abnormalities, and all other capacitors have been screened and delivered through debugging tests. So far, no abnormalities have been found. From the above analysis, it can be seen that the failure factors caused during the manufacturing process can be eliminated.

Chassis bottom burned capacitors are conventional surface mount capacitors, which are widely used in computer backplanes. For many years, our unit has carried out corresponding welding temperature, welding time and other process parameters according to different devices to ensure
welding quality. The past quality cases of printed board assembly products were traced back, and there were no problems such as component welding process and illegal operation, which caused damage to the device and scorched the quality of the printed board. In addition, our unit regularly carries out process discipline inspection work, and supervises and inspects the drawings, processes, systems, etc. of the entire process of product manufacturing, to ensure that the process specifications and rules and regulations are effective and standardized implementation, improve the professional quality of employees, and ensure product quality. Judging from the process discipline inspection records, no violations of the welding process parameters of printed board components were found. Through the above analysis, it can be ruled out that the capacitor failure caused by the welding process can be ruled out.

There are many forms of raw material failure, and from the perspective of the phenomenon, the capacitor is a breakdown short circuit failure, the main factors that cause this failure are:

1) Arc flashes between the surface poles: This fault is likely to occur in the case of low pressure or high humidity. The production debugging test process of all parts of the equipment is in the new area, the atmospheric pressure is 101kPa, and no low pressure related tests have been carried out. Therefore, it is ruled out that the flashover between the poles of the surface occurs under low pressure. Considering the high humidity situation, the low-pressure test (1.5MPa, 30min) of the liquid-cooled parts of the chassis was not leaked. At the same time, when the chassis failed, the device had not been tested at the unit level. (The humidity is lower than 80%).

According to the above analysis, it can be ruled out that the flashover between the surface poles leads to the failure of the capacitor.

2) Dielectric breakdown: The withstand voltage of this capacitor is 25V, the use of this device is 12V, and the power supply is tested, and no abnormality is found. From the above analysis, it can be ruled out that the dielectric breakdown causes the capacitor to fail. To sum up the above two points, the failure of raw materials can be ruled out and cause the failure of the capacitor.

3 Conclusion
If there are foreign objects in the chassis, during the random vibration process, the foreign objects may be short-circuited to the power supply, resulting in a short circuit of the bottom plate, which may cause burnout. The power supply has an overcurrent protection mechanism, but the protection mechanism is that the power supply reduces the voltage output in the event of an overcurrent, so even if a short circuit occurs, the power supply will still output current, resulting in a burnout failure.

The problem of burning down the bottom plate is caused by the entry of foreign matter (excess) into the bottom plate. Follow-up relevant links should be strengthened to prevent similar situations from recurring. During product assembly and commissioning, foreign objects may enter the bottom plate. Therefore, it is necessary to carry out redundant material control in each link and educate assembly, commissioning, and testing personnel on this quality case to strengthen education on redundant material control and prevent similar situations from recurring.

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