

## **The Design And Analysis of Automotive Electronic PCB**

Mengrong Xiong<sup>1</sup>, Wenjing Li<sup>2</sup>

<sup>1</sup>(College Of Automotive Engineering, Shanghai University Of Engineering Science, Shanghai 201620, China)

<sup>2</sup>(College Of Automotive Engineering, Shanghai University Of Engineering Science, Shanghai 201620, China)

**Abstract:** At present, PCB is more and more widely used in automotive electronics. With the promotion of energy saving and emission reduction, the proportion of PCB in the car is more and more. Based on more and more automotive electronic components inside the car, at the same time, there will inevitably be mutual interference, if not timely taking measures, it is likely to endanger the normal driving of the car. Therefore, in this paper, based on the car with the PCB environment, proposed in the drawing PCB, to take certain measures such as wiring to reduce the interference

**Keyword:** Automotive electronics ; PCB ; wiring

### **I. INTRODUCTION**

At present, electronic equipment for all kinds of electronic devices and systems are still printed circuit boards (hereinafter referred to as "PCB") as the main mode of assembly. If PCB in entertainment products goes wrong, people's lives are not threatened; but if the PCB in the car goes wrong, people's lives are in danger. Therefore, it is necessary to take the reliability design of automotive electronic components into consideration in the design process. With the increasing of the proportion of automotive electronic configuration of a vehicle, the printed circuit board as the key parts of automobile electronic products is very essential, and it has become the focus of automotive OEMs and automotive components suppliers, both supply and demand sides can hope to reduce the prime cost through a series of optimization design. However, due to the high demand for safety, reliability and durability of automotive products, PCB design standards and quality standards in automotive industry are higher than in the general electronics industry. Based on the design of automotive electronic PCB, this paper puts forward some matters needing attention in drawing printed circuit board.

### **II. CHARACTERISTICS OF PRINTED CIRCUIT BOARD FOR VEHICLE**

#### **2.1 dissipating heat**

In order to achieve the flow of high power, there is a lot of power semiconductor switching device (such as MOSFET) to control the power flow inside the automobile ECU controller, the power devices in the work will consume electric energy, the electric energy consumed can be converted into heat and the operating temperature of the device is increased, the higher temperature will make weaken the reliability of power devices, shorten the working life. Nowadays, the thermal design of the automobile controller mostly uses the heat conduction, natural convection and radiation and so on, at the same time, in order to meet the requirement of waterproof and dustproof ISO20653 prescribed, vehicle controller has been sealed, due to poor air convection which caused by sealing in the narrow space, the printed circuit board more emphasis on the difficulty of heat dissipation.

Electrical energy consumed during the operation of electronic equipment, in addition to useful work, most of the energy turn into heat. The heat generated by electronic equipment will make the internal temperature rise rapidly during the period. Surface mount technology (SMT) makes the installation density of electronic devices increase, the effective heat dissipation area decreases. General SOP package cooling performance is very poor, mainly because the SOP package itself has a high heat transfer resistance, hinder the heat conduction. Heat transfer thermal resistance mainly is related to the shell material of the electronic components, and the contact area of the PCB board, PCB board material and so on. As the process, cost and other aspects, the heat transfer resistance is difficult to achieve very good. In order to increase the vehicle interior space, the future trend of PCB is miniaturization and integration. With the improvement of the degree of electronic vehicles, a car used more and more PCB, so that the heat source is further increased. All of the above will make cooling difficulty.

#### **2.2 electromagnetic interference**

The conventional car equipped with PCB in approximately 20 blocks and luxury cars is equipped with PCB in approximately 40 blocks. Automotive electronic devices working environment is very bad, usually work in the temperature change dramatically, alternating high and low temperature, road uneven pavement, mechanical

vibration, shock, humidity environment. At the same time, because of the sealing design, the sealing area is small and tight, integrated a large number of small and ultra-small components, the connection line is sophisticated and complex. Thus, it has become such a complex environment of high voltage, strong power, high frequency signal interaction in the unit space. In such an environment, a large number of electronic devices at the same time work, the electromagnetic waves generated will interfere with each other, so that some devices lose their role, even if the situation is serious that damage to the device. In order to ensure the safe and stable operation of the automobile product in the working state, it is necessary to analyze the cause of the interference, and then take the measures to solve it.

The common interference of PCB includes three types, namely, conducted interference, radiation interference and common mode interference. (1) conduction interference. Conducted interference is produced by the coupling of the conductor. In addition, the impedance coupling also affects the circuit conduction. Due to a larger number of loop circuit, when the current flow to a public impedance, separate circuit loop current in the common impedance voltage changes, which impact to other circuits, and it produce coupling impedance. Normally, the conduction interference coupling in PCB is generated by the direct connected circuit. At the same time, the interference signal generated by the interference source will be transmitted to the sensing element through the channel. (2) crosstalk. Crosstalk is reduced mainly because of interference from a signal line to the adjacent signal path, common in the loop or conductor. In general, it is mainly expressed that by means of mutual capacitance and mutual inductance between conductor and conductor or conductor and circuit. In a piece of PCB, a two printed lines are more close, which will lead to electromagnetic crosstalk, making the component can not play a normal utility. For example, there is a signal on the PCB on a certain area along the line, when the parallel wiring length of more than 10cm or the distance between the two lines is less than  $3W$  ( $W$  for the printed line width), it will produce crosstalk. (3) radiation interference. A certain scale of electromagnetic field is generated around the electronic device, and there is an energy conversion process. By the action of the electromagnetic field, the energy can be transferred from one circuit to another, that is, the radiation coupling.

### **III. SOLUTION**

#### **3.1 dissipating heat**

About 20% of the heat by components produced is through components shell convection and radiation heat emitted to the outside and 80% of the heat is emitted by way of heat conduction that heat reached PCB through the pin components, in printed circuit board, the internal heat is conducted along the plane direction and the thickness direction. For heat energy efficient and rapid transmission, for high power devices, it is helpful to choose a large package of devices. Printed boards are generally made of insulating materials, such as FR4 and metal copper, which are heated and pressed through layers, copper has a conductive effect on PCB, is also a good conductor of heat, the heat can be extended to a larger extent. Increasing the content of copper in PCB can significantly enhance the heat dissipating capacity of the printed board. Only continuous copper skin can play the role of heat transfer, we should pay attention to the partition of copper skin. For smaller PCB printed boards, hole for heat dissipation around high power device help to dissipating heat, increasing the thickness of copper skin also can work. Aperture is 10-12mil, center distance is 30-40mil, the number of holes depends on the level of device consumption and temperature control requirements.

#### **3.2 Interference Suppression**

When it to wiring, it is essential to reducing the loop area. The common mode radiation is mainly determined by the radiation performance of the product. As far as PCB is concerned, it should be possible to reduce the source voltage of this antenna, the high - mode impedance of the cable is connected to the cable. At the same time, the common mode current can be bypassed to ground. We should try to reduce the printed line length, and widen the area of the line.

### **IV. ANTI INTERFERENCE MEASURES OF PCB DESIGN**

The use of equal walk line can reduce the inductance of the wire, but the mutual inductance and distributed capacitance between the wires is increased. If layout allows, The specific approach is the lateral wiring of the printed board, the other side of the vertical wiring, and then there are used the hole metal at the intersection. In order to suppress crosstalk between printed wiring boards, design of wiring should try to avoid the long distance of the equal walk line, distance between the line and the line is as far as possible, signal line and ground line and power line do not cross as far as possible. You can effectively suppress crosstalk by setting of a ground of the printed line between the signal lines that are very sensitive to interference.

Grounding is an important method to control the interference in electronic equipment. If the grounding

and shielding can be properly combined, most of the interference problem can be solved. In the low frequency circuit, the working frequency of the signal is less than 1MHz, the inductance between the wiring and the device is less affected, and the circulation of the grounding circuit has a great influence on the interference, one point grounding should be used. When the working frequency of the signal is greater than 10MHz, the impedance of the ground wire becomes very large. At this time, the ground resistance should be reduced as far as possible. Multi point grounding should be adopted. When the operating frequency is 1 ~ 10MHz, if the ground is used, the ground wire length should not exceed the wavelength of 1/20. There is not only high logic circuit, but also linear circuit, we should try to separate them, and both of ground do not mix, respectively connected with the power supply end ground wire. As far as possible to increase the grounding area of the linear circuit, the line of ground is bold as far as possible.

The so-called bonding copper, that is, the idle space on the PCB as a reference surface, what is filled with solid copper. The significance of bonding copper is to reduce the ground resistance, improve the anti-interference ability, reduce the voltage drop, improve the power efficiency, and is connected with the ground, reduce the loop area. A large scale of the bonding copper has play the role of increasing current and shielding. Simple copper cladding is only used for shielding, less used for increasing the current. With the grid can be prevented and relieved when welding gas produced copper foil adhesive made of copper foil blister. Grid can prevent the copper foil bubble produced when welding of copper foil adhesive. So, it pays attention to a few slots, alleviate the copper foam while a large area of copper. High frequency circuit and circuit that high demand for interference need use copper clad, low frequency circuit and circuit that large current need use solid copper clad.

## V. CONCLUSION

This paper introduces the harsh environment of the printed circuit board on the car, and the factors that can affect the normal operation of the circuit. The corresponding measures are put forward in order to reduce the cost of research and development, and to reduce the cost of research and development. However, due to the complexity of the working environment on the circuit board, all kinds of factors affect each other. The designer must proceed from the actual situation, choose the best.

## REFERENCE

- [1]. Ma Xinbing, Feng Jiali, Yao Changqing, Cai Hua. Research on automotive electronics [J]. *technology PCB Automotive Practical Technology*. 2014 (10):11-13.
- [2]. Ren Guofeng, Tian Feng, Zhang Shumei, Yang Lin. Research on thermal design of automobile controller [J]. *automotive technology*. 2014 (10):1-3, 21
- [3]. Chen Rongzhang, Yin Yue. Through the design optimization to reduce the cost of automobile printed circuit board [J]. *automobile and accessories*:68-70. (28).2014
- [4]. dry Jun. PCB digital technology and application. 2016 (1):198. *digital technology and application* [J].
- [5]. even Long Gang, Xu Wenkuan, Wang Baocheng. Study on the EMI problem of high speed PCB design [J]. *electronic technology application*. 2015 (3):17-19.
- [6]. Ma Xiaoyu, Guan Dandan. Design of [J]. *printed circuit information*. 2009 *electromagnetic compatibility of automotive PCB* (5):23-26.