
A Case Study of a Small Switching Power Supply Process: Based on the Module of Production

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Abstract: With the rapid development of electronic products, technology plays an important role in the management and production of electronic products. In the increasingly fierce market competition, excellent technological process is also one of the important bargaining chips for the success of an enterprise, and it is the embodiment of the level of enterprise management ability. As a product of modern power electronic technology, switching power supply represents the development direction of regulated power supply, and it is an industry pursued by many electronic companies. Switching power supply manufacturers should not only pay attention to the miniaturized power module technology, but also do a good job in the quality management of the production process. Only by doing a good job in the production process design, can better ensure the function and quality of the miniaturized switching power supply module, and help enterprises gain an advantage in the market competition. Using the method of case study, this article interviewed the small switching power supply design engineers and production workshop workers in Factory A. combined with literature analysis and on-site observation, it is proposed that the production process of switching power supply module should involve three stages: before production, during production, and after production, which include 8 links: production preparation, coil production, the device welding assembly, cleaning, inspection, potting, sealing and marking. In particular, the requirements and precautions of each step are described in detail.

Keywords: Switching Power Supply, Manufacturing, Technological Process

1. Introduction

Switching power supply is a product of modern power electronic technology, which maintains a stable output voltage by controlling the time ratio of switching on and off. With the development of power electronics technology, switching power supply technology is constantly innovating. It has the characteristics of high efficiency, low power consumption, small size, and light weight, which represents the development direction of regulated power supply. In addition to product design and development, production is also an important part of ensuring the quality of power modules. Only by adopting strict technological processes and standards, the finished power module can achieve the expected performance and effect. What kind of production process is designed has become the focus of attention of electronic product manufacturers. Therefore, the research mainly focuses on the processes that should be included in the production process of small switching power supplies, and the key aspects of each

process that should be paid attention to.

In this study, Scientific Management and Business Process Re-engineering theory are applied. According to Taylor's Scientific Management Theory, scientific technological process should be formulated to standardize machinery, equipment, technology, tools, materials and working environment. The theory of Business Process Re-engineering (BPR) proposed by Michael Hammer and James Champy aims to achieve significant improvement in cost, quality, service and speed, so that enterprises can adapt to the modern enterprise environment characterized by Customers, Competition and Change. These two theories provide a theoretical basis for researcher to analyze and discuss the production process of small switching power supply.

The research aims at the current production process flow of a company, proposes the small switching power supply production process that should be implemented and the key links that should be paid attention to in each process. The research results have great constructive significance for a

company to improve production management, increase production efficiency, reduce equipment and material loss, and enhance product safety. The researcher hopes that the research results can be used by A company to improve the production business process management, and also hope to provide reference for other companies of the same type.

2. Methodology

In this study, small switching power supply design engineers and workshop workers in a factory were selected as the research participants. Data collection was carried out by literature analysis, field observation and interview, and supported by the school-level scientific research fund project of Xijing University. Based on many years of work experience in the design of small switching power supply, the researcher mainly adopts the method of field observation, with the method of interview and literature as the auxiliary method for data collection and research. The interviews in this study are informal and casual. In their spare time, the researcher interviewed two engineers and individual production workers.

3. Result

As a small switching power supply manufacturer, Factory A needs to strengthen scientific management and reorganize business processes. It should improve the production process around the three stages before, during and after production. It must focus on the production preparation, coil production, device welding and assembly, cleaning, inspection, potting, sealing and marking, determine the stage objectives and set the inspection of all links, so as to ensure the product quality and obtain the market competitive advantage.

4. Discussion

The increasingly popular trend of portable electronic

products leads to the miniaturization of electronic components and the high difficulty of processing technology, enterprises have to improve reliability and reliability from the aspects of design and process flow [1]. With the rapid development of power module towards miniaturization and high efficiency, only strict process flow and standards can make the completed power module achieve the expected performance and effect [2, 3]. The optimization and quality of the production process determine whether the enterprise can produce high-quality and high availability products, the steps include managing the process flow and improving the production steps [4]. At present, the technological process of producing small switching power supply needs to be deeply discussed and studied by industry experts and scholars.

According to the collected data in Factory A, the researcher specifically answers two questions about the production process of switching power supply module, the requirements of each link and the key links that need to be paid attention to.

Problem 1: what process should be include in the production of small switching power supply?

Optimizing the whole production process is an effective way of product quality control, covering optimal design, control and inspection [5]. Production process and flow quality are the two most important links in the enterprise quality control and management system, the influencing factors include production environment, production technology, raw materials, mechanical equipment and human factors, enterprise must scientifically set the key points of quality control [6].

Based on the analysis of the design documents, process documents, test methods and production operation rules and data of the power module, the researcher thinks that the production process of small switching power supply is mainly divided into three stages: before production, during and after production, and the objectives and requirements of each stage are different. As shown in the figure below:

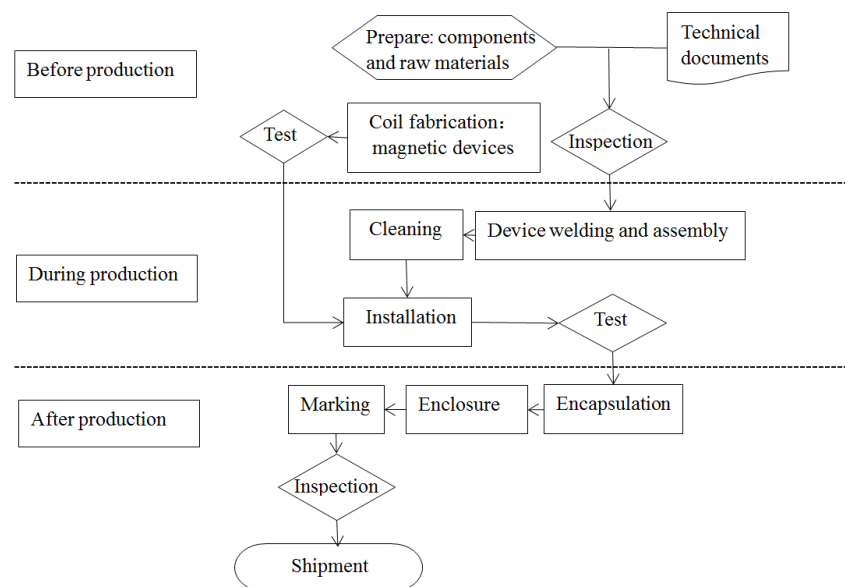


Figure 1. Production process flow chart of switching power supply module.

Before production. This stage is mainly to prepare components and raw materials that meet the relevant design indicators. At the same time, turning on the coil production refers to making magnetic devices.

During production. This stage focuses on solving the device welding assembly (referred to as welding), cleaning, installation, and testing.

After production. This stage is the follow-up link of production, which mainly realizes the potting, sealing and marking of the product. This stage directly affects the aesthetics of the product's appearance and the customer's aesthetics.

In addition, multi-step inspections must be set up throughout the production process. It not only inspects the production process of the previous process, but also provides guarantee for the production of the next process.

Problem 2: What are the key links in each stage of the production process?

If enterprises want to win the first opportunity in the market competition, they must establish and improve the standardized quality management system and supervise the process technology, product raw materials and production discipline [7, 8]. There are many reasons why switching power supply can not work normally, such as aging of components, poor performance, oxidation of circuit board, desoldering, false soldering, corrosion, moisture, etc. [9] Enterprises must strengthen research and continuously improve the level of technological development, including welding technology, synthesis technology, testing technology, application technology, etc. [10] Weld-ability is the key factor, which will affect the reliability of product quality [1, 10]. In the process of welding operation, it is necessary to build a reliable system, deeply study the substrate and chip packaging, and accurately grasp the welding law [11]. Power conversion circuit is the core link leading to the failure of miniaturized switching power supply [12, 13], and the manufacturer can improve the performance index of withstand voltage and rated capacity of power rectifier module and reduce or eliminate the failure [14, 15].

In view of this problem, the researcher interviewed engineers and front-line workers, and thought that in the three stages of the production process of small switching power supply, the enterprise should pay attention to production preparation, coil production, the device welding assembly, cleaning, inspection, potting, sealing and marking. The details are as follows:

Production preparation. In order to ensure the smooth progress of product production and complete the production operation with high efficiency and quality, it is necessary to prepare for production in strict accordance with relevant technical documents in advance. It mainly includes: preparation of components, raw materials and related equipment required; design documents, process documents, test methods, production and operation rules and data of relevant power modules; assembly of some components and

performance inspection of related components need to be completed in advance.

Coil fabrication. Strictly speaking, coil production is also a part of production preparation, but magnetic devices are very important for power supply module, which directly affects product performance. Therefore, this item is listed separately, and operators need to have magnetic device qualification certificate. Confirm the winding and parameters before winding, confirm the material list according to the requirements of magnetic devices, select enameled wire and skeleton according to the parameters of magnetic component winding, and cut the length of each winding wire.

When the skeleton is fixed on the winding machine for winding, the matters needing attention are as follows: the wound coil shall be tight and flat; the incoming wire shall be short and the outgoing line shall be long; the primary winding shall be followed by the secondary winding; if the secondary winding has two, the same number of turns shall be wound at the same time, and when the number of turns is different, the winding shall be conducted separately. Finally, the incoming and outgoing wires of each winding are respectively twisted for 3-5 turns to prevent loosening. Then, the skeleton is removed from the winding machine, and the enameled wire is cleaned, the wire is scraped and tin is applied.

Device welding and assembly. Standard component welding is the basic guarantee of product quality. It requires that the components should be free of solder leakage, each solder joint should be firmly welded, with good contact and no wrong parts. In the welding process, the following shall be done:

- 1) confirm the accuracy of materials;
- 2) the electric soldering iron should be fully preheated, holding the soldering iron in one hand, tweezers or wire in the other hand;
- 3) welding should be in order, such as from large to small, from left to right;
- 4) every device should be checked to see whether it is firm and in good contact, there should be no deviation, desoldering, false soldering, the solder joints should be smooth, round, and there should be no burrs and other undesirable phenomena; free of burr;
- 5) also need to check for missing soldering and device short circuits caused by solder flow;
- 6) chips, capacitors, and resistors should be close to the surface of the substrate.

Cleaning. It refers to cleaning the base plate with ultrasonic cleaning machine to ensure that there is no excess solder paste and debris in the product. It is better to clean twice. During operation, ensure that the cleaning machine is installed smoothly, and inject water and washing water respectively according to the standard process, and clean for 1 minute. After cleaning, air dry at room temperature or dry in high-temperature drying oven. Check the cleaned base plate to see if there is any false welding, empty welding,

short circuit, etc.

Inspection. Any process inspection is an indispensable process, and it is also the last quality assurance before product shipment. Power module inspection includes regular appearance inspection, performance test and high and low temperature test.

The routine test is to check the package and appearance of the power module, which should be free from damage, scratch, dirt, pin skew and other adverse phenomena; put the power module under a 1.5-10 times microscope to ensure that the coating is free from peeling, blistering, lead wire breaking and corrosion; use vernier caliper to detect the physical size. According to the requirements of the customer agreement, check the input and output parameters, load transient, input voltage transient, check whether the output meets the requirements.

The temperature test is divided in high temperature test and low temperature test. The high temperature test is to place the power module in a high temperature drying oven for more than 2 hours, and then quickly take out the product for performance testing; the low temperature test is to place the power module in a low temperature storage box for more than 2 hours, and then quickly take out the product for performance testing.

Encapsulation. It is to slowly pour the refrigerated colloid into the body. The colloid should cover the components and the surface should be smooth and flat. The glued products are placed in parallel in the tray and cured for more than 48 hours at room temperature. After the colloid is completely cured, the next link can be performed. After the product is potted into a whole, the anti-vibration performance is improved and the product quality is guaranteed.

Enclosure. Parallel seam welding machine is used for sealing shell. First place the base of the product in the fixture of the parallel seam welding machine, and then take the cover plate and put it on the product base to confirm the direction of the cover plate. According to the size of the shell to be welded, input the corresponding length and width of the shell and the height of the left and right electrodes in the welding parameter interface. After setting all the parameters, carry out spot welding operation. After the spot welding operation is completed, check whether the cover plate and the base are spot welded together, and then carry out the seam welding operation. After the welding operation is completed, the welding surface shall be inspected under a microscope of 20-40 times. The welding shall meet the following requirements: the welding surface shall be well welded, and there shall be no air hole, crack, unsealed, cover plate deviation and other adverse phenomena; the welding surface shall be flat without unevenness and wheel mark; the welding surface shall not be burnt or scratched.

Marking. It is the last link before the product leaves the factory. The product is marked to make the product model and pin function easy to identify, and to prevent wrong connection and misuse.

5. Conclusions

With the development of small switching power supply equipment in the direction of high integration, high efficiency, and low power consumption, the technical requirements of its manufacturers are getting higher and higher. Through the above analysis, it can be seen that not just A company, all small switching power supply manufacturers should improve the production process before, during, and after production. On the basis of the above process, it is also necessary to set up different inspection links after the key links to ensure the product quality of each step. Strict technological process and production standards are strictly observed by every employee. It is also an important guarantee for product quality and a guarantee for enterprise reputation.

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