Research on the Design of Quasi Resonant Flyback Switching Power Supply Based on Electronic Information

Feng Zheng¹,*
¹Xi'an Jiaotong University, Xi'an, Shaanxi, China

*Corresponding author e-mail: zhengfeng@stu.xjtu.edu.cn

Abstract. With the popularization and in-depth development of electrification and electronization, the demand for switching power supply in all walks of life is also constantly strengthened, especially for the key indicators and parameters of switching power supply, such as performance, efficiency and reliability. Based on this, this paper first analyses the connotation and components of flyback switching power supply, then studies the design of quasi resonant flyback power supply, and finally gives the realization path and strategy of quasi resonant flyback switching power supply.

Keywords: Quasi Resonant, Flyback Switching Power Supply, Electronic Information

1. Introduction

With the iterative progress and maturity of modern science and tech represented by electronic information tech, electronic info and computer tech have been widely and deeply studied and popularized in many fields, especially in the field of switching power supply, which incalculable promotes the improvement of switching power supply design level and technical level. On the other hand, with the popularization and in-depth development of electrification and electronization, the demand for switching power supply in all walks of life is also constantly strengthened, especially for the key indicators and parameters of switching power supply, such as performance, efficiency and reliability [1]. With the rapid development of power electronics tech, the demand of various industries for stable power supply is deepening, and the utilization of electronic power is inseparable from intelligent equipment. Because of its typical advantages in efficiency and volume, switching power supply has become one of the most popular power supply forms.

Through energy processing, switching power supply can produce stable output voltage which is not affected by input voltage or load current. The energy efficiency of switching power supply has a significant impact on the size of energy transfer loss. With the improvement of the working frequency of switching power supply, its high-frequency loss is more and more serious. Therefore, the design of switching power supply needs to adopt soft switching tech to achieve quasi resonant or resonant methods to further reduce the energy consumption of switching power supply. Quasi resonant soft switching tech based on electronic info can effectively reduce the loss of switching power supply and further improve its efficiency, which has been gradually promoted and popularized in the power supply design of consumer products.
In addition, flyback switching power supply has the typical characteristics and advantages of simple structure, compact volume and multi output. The common feedback methods of flyback switching power supply mainly include primary side feedback and secondary side feedback. Among them, the former introduces the auxiliary winding, which saves part of the working devices, so as to further compress the cost and volume of the system, and improve the reliability at the same time. Compared with the traditional flyback switching power supply, it has high efficiency and stronger electromagnetic compatibility [2]. Due to the variety of utilization scenarios of switching power supply, its reliability requirements in harsh environment and working conditions are also very high. As a relatively mature tech, quasi resonant conversion has been widely used in the power design of consumer products.

In short, as a key component of electronic equipment, power supply in the context of social requirements for energy efficiency and environmental protection continues to improve, the need to improve efficiency and reduce switching loss is more and more urgent. As the key equipment of power conversion and energy transmission, switching power supply has the typical advantages of low cost, high efficiency and simple structure. It has been widely used in various industrial utilization scenarios and consumer level products [3]. With the development of digital info, its utilization scenarios and potential are further strengthened. Therefore, the research on the design of quasi resonant flyback switching power supply based on electronic info has important practical value.

2. Connotation and components of flyback switching power supply

2.1. Characteristics and composition of flyback switching power supply
Flyback switching power supply is simple in structure and cheap in price. It is usually suitable for small power supply, but the flyback power supply has small power, large ripple and low voltage load regulation rate [4]. The key of flyback power supply design is the design of transformer, especially the transformer with wide input voltage and multiple output. The core part of flyback switching power supply is power conversion. Its basic composition mainly includes rectifier, filter unit, input overvoltage and undervoltage protection unit, PFC unit, power change module, PFM control system, voltage stabilizing loop, current limiting and short circuit protection module and unit.

2.2. Principle of flyback converter
The basic working principle of flyback converter is that the transformer stores energy when the switch is turned on, and releases the stored energy when the switch is turned off. Its basic composition circuit is shown in Figure 1 below.

![Figure 1. Basic composition circuit of flyback converter](image)

According to the number of switches, flyback switching power supply can be divided into double ended and single ended flyback [5]. According to the working mode of flyback transformer, flyback switching power supply can be divided into CCM and DCM mode. According to the control mode, it can be divided into PFM and PWM flyback power supply [6]. According to the generation mode of driving duty cycle, it can be divided into voltage type and current type flyback switching power supply.
According to the volt second balance of the transformer, there are:

\[ Vin \times DT = nVo \times (1 - D)T \]

(1)

\[ Vds = Vin + nVo = \frac{Vin}{1 - D} \]

(2)

The input-output relationship of flyback converter is as follows:

\[ Vo = \frac{Vin \times D}{n \times (1 - D)} \]

(3)

2.3. Principle of flyback converter

First of all, at the loss level of the switch in the power supply circuit, the common losses mainly include the off-state loss caused by leakage current, the on-state loss caused by the on resistance of the switch, and the switching loss caused by the overlap of the voltage and current at both ends of the switch in the switching process [7]. The switching loss of MOS transistor is shown in Figure 1 below. Secondly, for flyback switching power supply, the loss of power switches has a great adverse impact on the efficiency of the power supply. In order to ensure the stability of the power supply, it is necessary to reduce the switching loss of power switches to improve the energy efficiency of the switching power supply.

![Figure 2. Waveform of voltage and current overlapping of switch tube](image)

In addition, in the power circuit design of switching power supply, the design of capacitors and inductors in switching power supply should follow the following principles: the design principles of capacitors and inductors in switching power supply: the voltage at both ends of the capacitor cannot be mutated, the current in the inductor cannot be mutated, the average current through the capacitor is zero in a switching cycle, and the volt second product of transformer and inductor must be balanced [8].

3. Design of quasi resonant flyback power supply

3.1. Selection of primary power circuit devices

In the selection of switch MOS transistor and its driver design, the selection of NMOS withstand voltage value should consider the heat dissipation capacity of the radiator to select the current margin. The switching speed will affect the loss of the switch and the conducted radiation. The resistance can be selected by measuring the waveform of the switch. Secondly, the absorption circuit is designed to absorb the primary leakage inductance of the transformer, and the MOS transistor voltage spike is suppressed through the absorption circuit to reduce the EMI and EMC of the power supply. Fast
recovery diode is selected for diode, RC is selected for capacitance and resistance, and VRCD voltage meets efficiency requirement.

3.2. Feedback loop and transformer design
It is relatively simple to design feedback loop for current mode switching power supply. Because the current mode is double loop, the inner loop counteracts the inductance effect of the transformer, reduces the order of the system transfer function and increases the phase shift margin. As the key of flyback switching power supply, the energy of transformer is stored in the air gap of magnetic core during the primary turn-on period, and the stored energy is transmitted to the output during the turn off period. The current in the primary stage does not flow at the same time. Therefore, it is more considered as an inductor with secondary winding [9]. Calculate the total output power, including all secondary output power, auxiliary output power and output diode voltage drop. In addition, for multi-channel output power supply, it is necessary to calculate repeatedly to find out the best transformation ratio and output voltage to ensure that the number of turns adjusted is an integer.

4. Realization of quasi resonant flyback switching power supply

4.1. Principle of quasi resonant flyback switching power supply
The principle of quasi resonant flyback switching power supply is shown in Figure 3 below. The quasi resonant flyback switching power supply works in DCM or CRCM state [10]. When the current of the secondary diode drops to zero, the capacitor, the primary inductor and the resistance constitute a resonant circuit, and the voltage at both ends of the main switch will oscillate. In addition, the quasi resonant flyback switching power supply always controls the main switch to turn on when it detects the bottom of VDS waveform oscillation, so as to reduce the turn-on loss of the main switch and minimize the energy loss of the output capacitor, and the regulation process is not affected by the load.

Figure 3. The principle of quasi resonant flyback switching power supply

4.2. Realization of quasi resonant mode
It has many advantages to use quasi resonant switch in flyback power supply design. First of all, the quasi-resonant switching scheme can significantly reduce the conduction loss, which is due to the reduction of the conduction current peak, which reduces the temperature of the device. Secondly, the quasi-resonant switching scheme helps to reduce the reverse recovery loss of the output diode and improve the overall efficiency of the power supply. In addition, the quasi-resonant switching scheme helps to reduce EMI noise, thus reducing the cost of power supply.

The quasi-resonant power supply circuit is mainly composed of fuse, input filter, quasi resonant control circuit, output filter circuit and feedback circuit. Among them, the protection circuit is composed of fuse tube, thermistor, varistor and other components, so as to protect the circuit. EMI filter is a low-pass filter composed of common mode inductor and capacitor, and the bridge rectifier is selected as the rectifier. The high frequency transformer is determined by comprehensively considering the conversion efficiency, power frequency, circuit topology, output voltage and winding
mode. Through the determination of the above circuit and the corresponding device parameters, the quasi-resonant flyback switching power supply is constructed.

5. Conclusion
In summary, Flyback switching power supply not only has high efficiency, but also has stronger electromagnetic compatibility. As a mature tech, quasi resonant conversion has been widely used in power supply design of consumer products. This paper analyzes the principle of flyback converter by studying the connotation and components of flyback switching power supply. By analyzing the design of quasi resonant flyback power supply, the selection of primary power circuit devices is studied. Through the research on the realization of quasi resonant flyback switching power supply, the design strategy and implementation path are analyzed.

References
[1] Cao Haiyang, Shen Jianhui, Wang Hongzhen, et al. EMI suppression of explosion proof variable frequency speed regulation system based on EMI filter [J]. Electric drive, 2015, 45 (5): 51-55.
[2] Chen Biao, Li Wenguo, Li Zhiping, et al. Design and implementation of high-power factor power supply [J]. Digital tech and utilization, 2015,7:165-166.
[3] Chen Xi, He Zhijie. Research on transformer design of flyback DC/DC converter [J]. Electromechanical tech, 2015, 4:98-99.
[4] Feng Yongping. Discussion on Design of average current mode PWM switching power supply [J]. Electronic world, 2016 (2): 80-82.
[5] Han Weiqing. Comparison and analysis of two control models of switching power supply [J]. Digital tech and utilization, 2015,2:11-11.
[6] Hu Xibao, Xi Liang, Tan Zhiyong, et al. Study on optimal design method of high frequency, high voltage and high-power transformer [J]. Journal of electrical engineering, 2016, 11 (6): 40-47.
[7] Lu Fangchao, Li Yuren, Lan Genlong. Reliability analysis of switching power supply [J]. Power supply tech, 2014, 38 (6): 1127-1129.
[8] Su Tong, Zhang Fanghua, Ma Chao, et al. Leakage inductance energy recovery method based on flyback converter[J]. New electrical energy tech, 2016, 35 (6): 13-17.
[9] Yang Lihua, Ding Li, Wang Xuxiang, et al. Design and research of low power consumption single phase smart meter based on switching power supply [J]. Hubei electric power, 2016, 40 (3): 57-60.
[10] Zhao Shaomin, Han Yuheng, Zhang Guojun, et al. Design of error amplifier based on Buck DC converter [J]. Utilization of electronic tech, 2014,40 (10): 43-45.