ISSN : 0974 - 7435 Volume 10 Issue 23

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(23), 2014 [14174-14178]

Research and design of AC stabilized voltage supply based on PWM

Yang Zhaohui[1]*, Chen Hongjuan[2], Chi Yun-Fei[1]

[1]*School of Electrical and Control EngineeringChang'an University Xi'an, Shaanxi, (CHINA)

[2]PLA Third twenty-three hospitals, disinfection and supply roomXi'an, Shaanxi, (CHINA)

E-mail: zhhyang@chd.edu.cn

ABSTRACT

With improvement of the intelligent traffic control systems, the requirements of signal control system are more complex. The traffic signal control circuit are designed and simulated by using hardware description VHDL language in this paper. Considering the traffic flow and intersection signal characteristics, in order to minimize delays in the vehicle at the intersection of control objectives, the implementation of the optimal control signal is introduced in the traffic signal control systems. A method of top-down hierarchical design was used in the system designing, the design of unit circuit was created a module from the bottom to up. Analyses of simulation results using this approach show significant improvement over traditional full-actuated control, especially for the case of accident and over-saturated traffic demand.

KEYWORDS

Traffic engineering; VHDL; Traffic signal systems; Hardware description language; Hierarchical design method.

INTRODUCTION

Nowadays, the demand of the stabilized voltage supply is increasingly expanding. The research about AC stabilized voltage supply becomes extremely popular. AC stabilized voltage supply includes linear resonant AC stabilized voltage supply and switching AC stabilized voltage supply[1, 2, 3]. Linear resonant AC stabilized voltage supply (Sine energy distributor) is able to adjust the output of AC voltage by changing the LC resonant parametric. But it holds the shortcomings of the narrower range of input voltage, unloaded and unwanted current in source port, large harmonic currents, prone to oscillation, and so on. Switching AC voltage supply adopts advanced high-frequency switching power supply technology. Therefore it holds the advantages of small power consummation, high efficiency, fast respond, etc. This paper designs and develops a high-performance PWM control chip. It adopts the new type of AC stabilized power supply circuit which uses the method of adjusting the inductance to the high-performance PWM chopper. And this circuit has the advantages of small harmonic, strong ability of against electromagnetic interference, high accuracy of stable voltage, fast dynamic response, etc[4, 5].

Basic components and principles of working

The main functions of AC stabilized voltage supply are providing the AC excitation signal for the sensors in avionics system. The requirements are stable performance, small volume, light weight, high efficiency and high reliability. The core of this AC stabilized voltage supply is unidirectional 36V, 400Hz AC/DC circuit[6]. It adopts the new type of AC stabilized power supply circuit which uses the method of adjusting the inductance to the high-performance PWM chopper, mainly including chopper circuit, soft turn on or off network, closed-loop feedback circuit, voltage compensation circuit, etc. The principle of this circuit is shown in Figure 1.

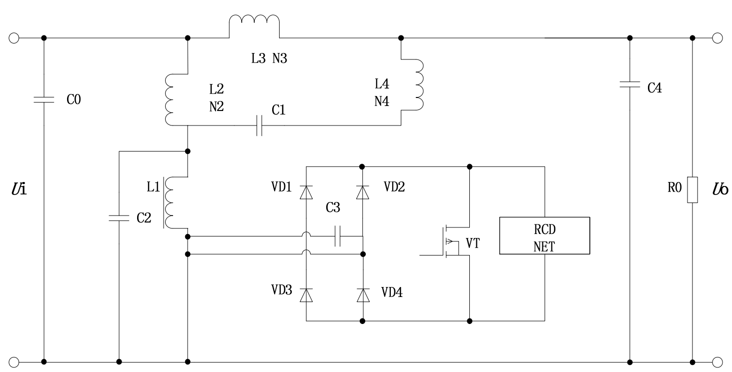


Figure 1 : AC stabilized voltage supply based on high-frequency PWM chopper

As shown in Figure 1, the high-frequency PWM chopper is composed by the L1, VD1~VD4, C3, VT, etc. In order to reduce the switching consummation of CMOS, we can add the soft turn on and off network (RCD NET) which is composed by resistance, capacitance and inductance. In the Figure 1, the inductor L1 and the branch of high-frequency PWM chopper can be represented by an equivalent inductor LX. LX is the function of on-duty of power FET VT in the high-frequency PWM chopper. It can be derived:

$$L_x = {}^{L_1}/_{D} \quad \textbf{(1)}$$

In the formula: D------On-duty of VT.

Similarly, impedance Z which is the parallel circuit of LX and C2 is also the function of D:

$$\mathrm{Z} = \mathrm{J}L_x\omega(1-\omega^2 C_2 L_x) \quad \textbf{(2)}$$

In the formula: ω------Angular frequency of u_i which is the input power.

When the output voltage drops caused by the reduced input voltage or heavy loaders. D will increase in this time, and the branch of L2, C2 is inductive. The drop of voltage produced by the branch current acting on the linear inductance coil N2 has the same phase with ui. The sum of UN3 coupled to the coil N3 and ui. will compensate the shortage of input power[7, 8].

We can know from the above analysis, we can control the bigness of D by sampling the output and closed-loop feedback. Thus the bigness and phase of the voltage in the coil N3 can be changed automatically. Through this method, the stability of output can be realized.

Mechanical strength and heat dissipation need to be considered in the process of structural design. Three-phase AC power supply is the box structure, and the transformer and inductance are installed on the box in order to increase the mechanical strength and improve the cooling effect. The control circuit is a plug-in which can improve the interchangeability and maintainability of the circuit[9, 10]. Electrical connection connects with mother-board via plug-in, and electrical connection of port connects with each other via the aircraft on front panel. Thus, the inner and outer of the box can be connected. The connection between the box and the plug-in is via the locking device.

Because high-frequency PWM chopper circuit of voltage stability has the features of adjusting the bigness of all phase. Therefore, it's easy to make three-phase and balanced power supply. And we actually develop the three-phase and balanced power supply whose power is 150VA based on the above circuit. Switching MOS FET applies aerospace-grade devices. And the controller of PWM applies military 883 devices. At the same time, linear inductance applies new materials of annular band gap and specular crafts. When the three-phase and balanced power supply is tested, each main technology specifications is shown below:

Voltage stability: $\leq 1\%$

Load stability: $\leq 1\%$

Efficiency: $\geq 88\%$ (full output)

Phase difference of three-phase output: 120°

Output waveforms distortion: $\leq 3\%$ (supply voltage without distortion)

Choices of circuit parameters

Since L1 and the branch of high-frequency chopper are equivalent to Lx, then the circuit shown as Figure 1 is a linear circuit. When the coupled inductor of L1, L2 is decoupled equivalent and neglects the filtering branch composed by L4 and C1. We can column equations to the equivalent circuit based on Kirchhoff's law. The solution is:

$$U_0 = \frac{R_0 U_i}{(L_2+L_m)\times\frac{R_0+j\omega(L_2+L_3+2M+L_m)}{L_2+M+L_m} - j\omega(L_2+M+L_m)} \quad \textbf{(3)}$$

In the formula: $L_m = \frac{L_x}{(1-\omega^2 C_2 L_x)}$.

Because Ui and U0 have the almost same phase, so we can neglect the difference between them. It can be got:

$$|U_0| = \sqrt{\frac{R_0^2(L_2+M+L_m)^2}{R_0^2(L_2+L_m)^2+\omega^2 L_2^3 L_m^2}} \cdot |U_i| \quad \textbf{(4)}$$

In the formula: $\mathrm{M} = \sqrt{L_2 L_3}$

The mutual inductance of L2 and L3.

Based on the relationship between the inputs and the outputs which are shown in the formula (3). We can determine L1, L2and L3 based on the system requirements. Besides, we also can design the main circuit meeting the performance requirements.

In the actually circuit parameters selection, in order to speed up the design speed and improve the quality of design, people generally will adopt the method of engineering estimation combined with simulation software to optimize the design..

According to the following principles to estimate the parameters of L1, L2,L3, etc.

A. The sinusoidal energy distribution network is composed by the inductance, such as L1,L2and C2. Its natural resonant frequency should be located in between 1.3 ~ 2 times of the frequency of the input source. Thus we can make sure the source frequency changes have less effect on the network. In this design, because the source frequency is 400Hz, so resonant frequency of the network should be taken as 520Hz ~ 800Hz.

B. N3/N2 is the main parameters to determine the input voltage range. When N3/N2 is too small, the input voltage range is not wide enough; on the contrary, when N3/N2 is too large, this will lead to the system transient response characteristics getting bad the lowering ability to mount loads. The actually N3/N2 can adopt between 0.2~0.4. At this time, it can obtain good transient response performance and load characteristic, etc.

C. Due to the limits of the harmonic distortion in the circuit, L1 can't be too small. In the actual control of the switch, because of adopting the method of high-frequency PWM chopper, so the output leave harmonic can be removed by a small capacity C3. So, when the source frequency is 400Hz,the PWM switching frequency adopts 80 KHz. In the main circuit, when the L1 = 20mh and theC3 = 0.1 u F, the circuit can filter the higher harmonic in the high-frequency PWM chopper.

D. In the main circuit, the branch circuit composed by N4 and C1 has the function of the filter and reducing the current waveform distortion. The value of capacitor C1 should not be too large. When the value of C1 increases too much, the adjusting polarity of circuit will be reversal, and it no longer has the voltage stabilized function.

Computer Simulation of circuit

After estimating a set of parameters according to the above principles, under the condition of the output of AC36V, 400Hz, 50VA, the main circuit can be simulated using the "ISSPICE4" analog and digital mixed circuit simulation software. The simulation circuit is shown in Figure 2.

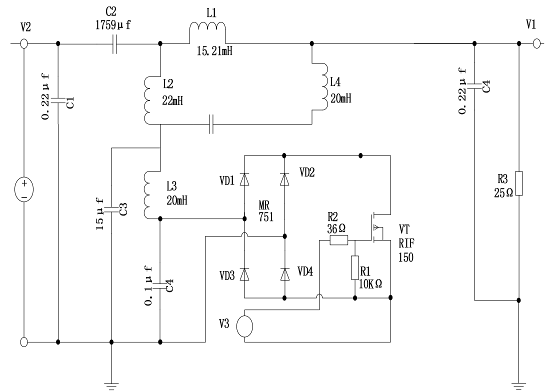
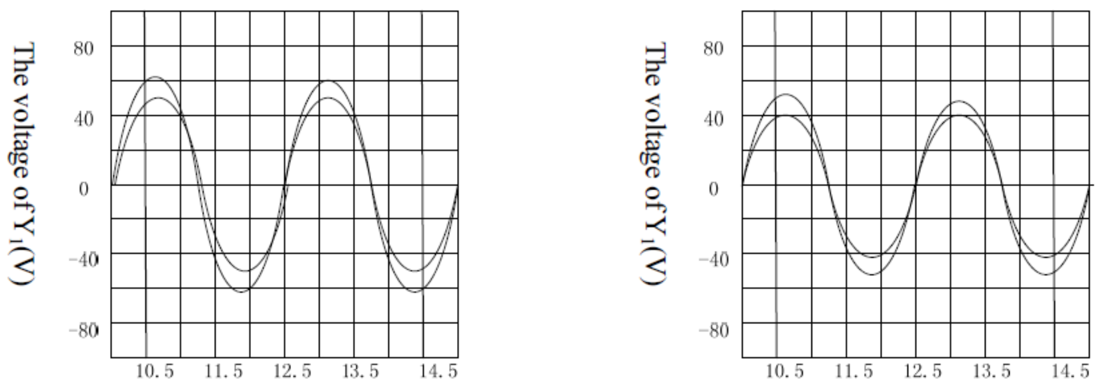


Figure 2 : Simulation of the main circuit

In the simulation circuit, the voltage source V2 and V1 represent respectively the input source and PWM high-frequency pulse source, and a pure resistance represents the output load. In the conditions of input AC 29V/400Hzor AC 45 V/400Hz, the simulation waveform of input and output of this circuit is shown in Figure 3.



(a)Simulation waveforms(AC45V/400Hz) (b)simulationwaveforms (AC29V/400Hz)

Figure 3 : The simulation aveforms of the input and output voltage

From the above simulation results, it can be seen that when the input source changes between AC 29 ~ 45V/400Hz, the output is always stable at AC 36V/400Hz.

CONCLUSIONS

Airborne three-phase AC regulated power supply requires stable performance, small size, light weight, high efficiency and high reliability. Circuit adopts the high-frequency PWM chopper adjusting inductance to form a new airborne AC regulated power supply. It can control the bigness of D, which is the on-duty, through the closed loop feedback from studying the sampling of the output voltage. By doing this, the stability of the output voltage can be realized. The no-load current of improved linear harmonic stabilized AC power supply and harmonic current is smaller than traditional thyristor sense of power (in fact, the power can be idle for a long time). Although voltage range is relatively narrow, it can completely satisfy the actual requirements. The circuit has the advantage of little harmonics, strong electromagnetic interference resistance, voltage regulation precision, fast dynamic response, etc.

REFERENCES

[1] Dallas semiconductou; DS1820 1-WireTM Digital Thermometer, Maxim Integrated Products, Inc., **(2012)**.

[2] J.A.Hendler; Interlligent agents：Where AI meets information technology[J], In IEEE EXPERT, **11(6)**, P20-23 **(2006)**.

[3] L.V.Jun, Feng Bo-Qin, Li Bo; Genetic algorithm based features reduction[J], Microelectronics & Computer, **23(7)**, P151-154 (Ch) **(2006)**.

[4] First advanced encryption standard candidate conference[Z], SAFER+) Cylink Corporation, s Submission for the Advanced Encryption Standar d Ventura, CA: August, P20- 22 **(2008)**.

[5] B.Chatschik; An overview of the bluetooth wireless technology[J], IEEE Communications Magazine, **39(12)**, P86-94 **(2011)**.

[6] Joakim Persson, Ben Sweets; Bluetooth security_an overview[J], Information Security Technical Report, **5(3)**, P32- 43 **(2010)**.

[7] J.Weston, S.Mukherjee, O.Chapelle et al.; Feature selection for SVMS[J], Advances in Neural Information Processing Systems, P668-674 **(2010)**.

[8] M.B.Tümer, M.C.Demir; A genetic approach to data dimensionality reduction using a special initial population[A] international Work Conference on the Interplay between natural and artificial computation[C], Las Palmas, Canary Islands, Spain, P310-316 **(2005)**.

[9] Hao Yang, Nan Zhang, Ming Jia Ye; Power to passive network VSC-HVDC discrete model and its control strategy[J], Power System Protection and control, **40(4)**, 37-42 **(2012)**.

[10] Sheng Li Qi, Hai Gang Zhang, Feng Qian; 500 kV series compensation capacitor bank wiring and protection[J], Power System Protection and control, **38(4)**, 63-67 **(2010)**.