3상 변압기를 이용한 단방향 DC-DC 컨버터

곡중직, 레동부, 박진욱, 황정구, 박성준
전남대학교

The One Direction 3-phase DC-DC Converter

Qu Zhongzhi, Tuan Vu Le, Jin Wook Park, Jung Goo Hwang, Sung Jun Park
Chonnam national University

ABSTRACT

This paper presents the one direction 3 phase DC DC converter. The converter employs DC AC inverter, 3 phase 1:N transformer and 3 phase full wave rectification circuit make low voltage direct current to high voltage direct current. By computer simulation and experiment, the theoretical results can be verified or modified. Finally, the simulation and experiment results are presented. Compared with the general DC converter, has anti interference ability, high reliability, high output power, range and other characteristics, widely used, fully isolated input and output, the output of the multiplexer is not limited, polar optional.

1. Introduction

In recent years, with the rapid development of electric vehicles, distributed generation systems, wind power and other green energy, three phase DC/DC converters widely used, it not only can be used as a bridge to connect between two different voltage levels of electrical systems, but also for energy regulation and management. Three phase DC/DC converters because of its high power density, high efficiency while has research value. Meanwhile, the power supply is also being developed to intelligent. With the development of applications, on different occasions, intelligent power devices should also accept different types of monitoring client control.

2. Description of the Converter

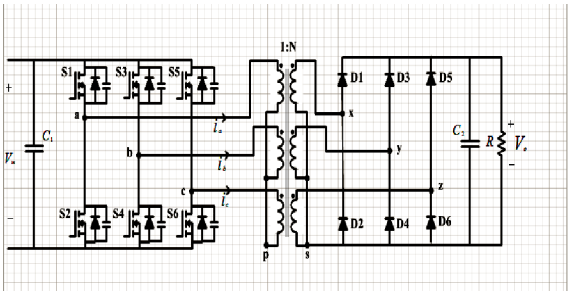

Fig.1 The converter general circuit

As we can see in Fig 1, the circuit is the general circuit, the direct current from the current source and flow six switching which used the PWM technology control the switching on/off as shown in Fig.2, make the direct current become to a/b/c three phase rectangular wave. With the top switches of the converter operating at a duty cycle of d=1/2, all the top switches conduct for a phase interval of π while the bottom ones conduct for the rest of a cycle, a phase interval of π. Moreover, there is a phase shift of 2π/3 between the turn on of any two of the top or bottom switches.

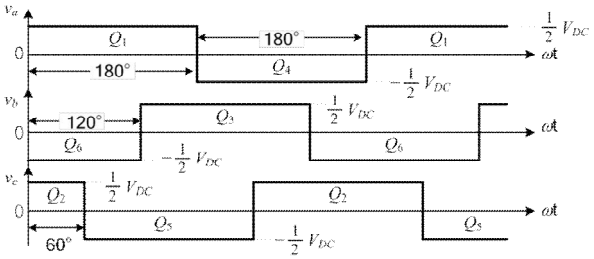

Fig.2 The switching action mode

The calculate the value of voltage equation is:

$$v_{an} = v_a - v_n = S_{an} V_{DC} \qquad S_a = \frac{1}{2}(S_1 - S_4) = S_1 - \frac{1}{2}$$

$$v_{bn} = v_b - v_n = S_{bn} V_{DC} \qquad S_b = \frac{1}{2}(S_3 - S_6) = S_3 - \frac{1}{2}$$

$$v_{cn} = v_a - v_c = S_{cn} V_{DC} \qquad S_c = \frac{1}{2}(S_5 - S_2) = S_5 - \frac{1}{2}$$

The 3 phase transformer setting is listed in table I. In this paper, we set the Np:Ns=2:1.

Table 1 The 3-phase transformer setting

Rp(primary)	0.01
Rs(secondary)	0.01
Lp(pri. leakage)	2u
Ls(sec. leakage)	2u
Lm(magnetizing)	200u
Np(primary)	2
Ns(secondary)	1

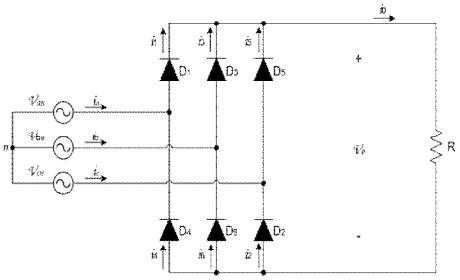

Fig.3 The 3-phase full wave rectification circuit

From the Fig.3 circuit, the 3 phase alternating current from transformer flow out, through the 3 phase full wave rectification circuit that made up by 6 pulse rectifier diodes, become the positive current alternating current. As Fig.1 circuit, we use filtering capacitor just keep the positive current alternating current wave crest pass. So, finally, we get the smooth direct current.

3. Simulation

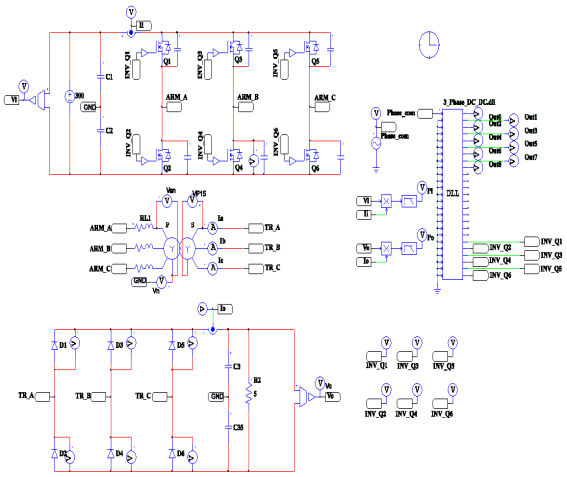

Fig.4 Simulation circuit

To show the feasibility of the proposed analysis method and control strategy, the simulation model of the proposed universal power converter is setup using by PSIM and Microsoft Visual C. The simulation results show in fig.5~8.

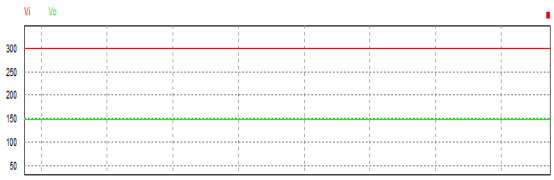

Fig.5 The voltage input and output with transformer ratio 2:1

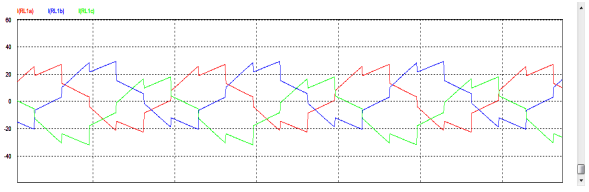

Fig.6 wave of 3-phase transformer current

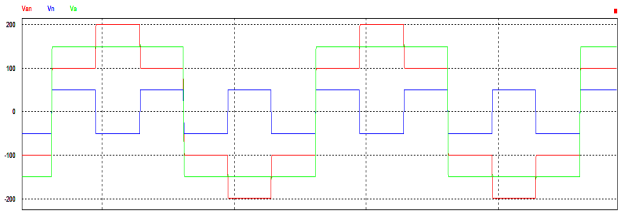

Fig.7 wave of transformer voltage Va, Vn, Van

MODE	Van	Q1	Q3	Q5	Vn	Va
1	(1/3)Vin	1	0	1	(1/6)Vin	(1/2)Vin
2	(2/3)Vin	1	0	0	(-1/6)Vin	(1/2)Vin
3	(1/3)Vin	1	1	0	(1/6)Vin	(1/2)Vin
4	(-1/3)Vin	0	1	0	(-1/6)Vin	(-1/2)Vin
5	(-2/3)Vin	0	1	1	(1/6)Vin	(-1/2)Vin
6	(-1/3)Vin	0	0	1	(-1/6)Vin	(-1/2)Vin

Table.2 The control mode of switching and voltage

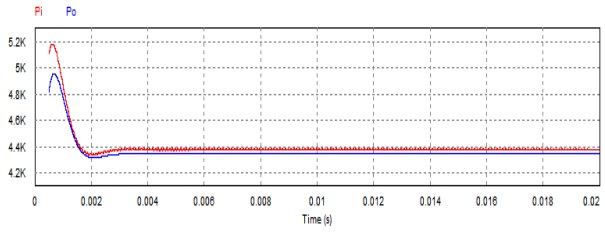

Fig.8 The power flow of the input and output

4. Conclusion

This paper of the one direction 3 phase dc dc converter. Make the voltage conversion ratio 1:N, between the primary and secondary winding. The leakage inductance is very important to the realization phase shift control and zero voltage switching technology. The converter minimized the loss energy, thus system has high efficiency. To verify the validity of the proposed converter, we carry out a computer aided simulation.

Reference

[1] Fang Z Peng, Hui Li, Gui jia Su, Jack S.Lawler, "A New ZVS Bidirectional dc dc Converter for Fuel Cell and Battery Applications," in IEEE Transactions on Power Electronics, Vol.19, No.1, Jan, 2004, pp.54 65

[2] R. W.A.A.A. DeDoncker, D.M. Divan, M.H. Kheraluwla, "A three phase soft switched high power density dc/dc converter for high power applications," in IEEE Transactions on Industry applications, Vol.27, No.1, Jan/Feb, 1991, pp.63 73

[3] C.Liu, A.Johnson, J.Lai, "A nover three phase high power soft switched DC/DC converter for low voltage fuel cell applications," in IEEE Transactions on Industry Applications, Vol.41, Nov, 2005, pp.1691 1697