고속 스위칭에 의한 만능 전력변화기 구성

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Universal power converter using High-Speed Switching

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Abstract

Combination the several type of single phase power conversion utilized simply topology are proposed in this paper. Totally four kind of converter are investigated, they are Boost AC/AC Converter, Buck AC/AC Converter, Boost AC/DC Converter, and Buck DC/AC Converter. Two types action mode are presented to determine the functional of circuit. First is AC chopper action mode, representation of the AC/AC converter. AC chopper action mode offered the sinusoidal current waveform, better power factor, faster dynamics, and smaller input/output filter. They present high robustness, offer safe commutation and have high efficiency. The second is full bridge action mode, determined the transformation AC to DC power and otherwise. Four switching devices and one magnetic contactor will establish the mode operation of circuit and manage the flow of power proceed in proper. The correction and advance of the kind of converter are verified by simulation.

Keywords: AC Chopper, Inverter, voltage regulator.

1. Introduction

AC and DC voltage regulators had been widely used in industrial application such as line conditioner, lighting dimmer, and speed control motor. In our daily life, both of them can be encountered in photovoltaic system, battery charger etc. Generally, the voltage regulator only has one function of energy conversion in each application, so the energy consumers are limited to utilize the type of energy. With this limitation, we have to provide several of energy sources base on the necessity.

This paper proposed the solution to optimize of the energy sources by unify them into one system. The system provided the energy regulation as increasing (boost) either decreasing (buck) base on the PWM switching technique. PWM switching technique serve the nearly sinusoidal input-output currents/voltages waveforms, improved power factor reduced harmonics current, a fast response speed and a smaller input filter size [1],[2]. It can protect sensitive tools such as a computer or communication equipment, it can also be used to solve power quality problems caused by line voltage sags and swells [3].

2. The Proposed Universal Power Converter

The proposed of universal power converter is shown in fig. 1. The circuit topology has the succeeding attributes: it can be configured as AC chopper and full bridge mode operation. The input filter consisting of inductor L_i and capacitor C_i, absorbs the harmonic currents. There are also four switching devices (MOSFET) S_{1A}, S_{1B}, S_{2A} and S_{2B} to warranty the power will flowing in proper. MOSFET has the inner anti-parallel diode which provide freewheeling currents path when the reserve voltage is encountered. The inductor L is used to store and transfer the energy to the output side. The output filter capacitor C_o reduces the output voltage ripple.

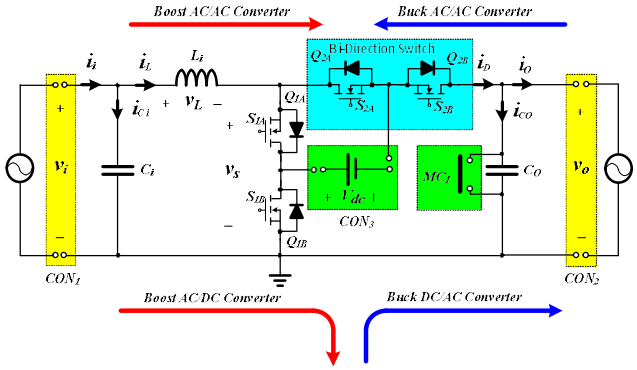


Fig. 1 The proposed of universal power converter.

AC chopper mode operation can be obtained by turn off the magnetic contactor (MC) on the output side. Thus, we may derive the boost AC/AC converter (forward) and buck AC/AC converter (backward), determine by the direction of view.

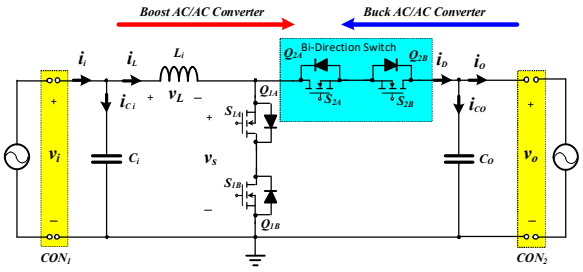


Fig 2. AC chopper action mode.

Both converters have the same control, depending on the voltage source V_i sign. In this way, if V_i is positif, S_{1A} and S_{1B} switches are PWM controlled with a constant duty ratio D, while S_{2A} and S_{2B} are fully turn off. When the sign of the voltage source is changed, the switching pattern is reversed, S_{2A} and S_{2B} being complementary PWM controlled with a constant duty ratio, and S_{1A} and S_{1B} are fully turn off. In these switching patterns, the current path always exits whatever the inductor current direction. In the buck converter topology, the output voltage can be determined by:

$$Vo = V_i * D \tag{1}$$

While in boost converter topology, the output voltage is proportional with the duty ratio:

$$Vo = \frac{V_i}{1-D} \tag{2}$$

The circuit topology and type of power converter base on the full bridge configuration is shown in fig. 3. The magnetic contactor is holding the significant role to convert the function of circuit.

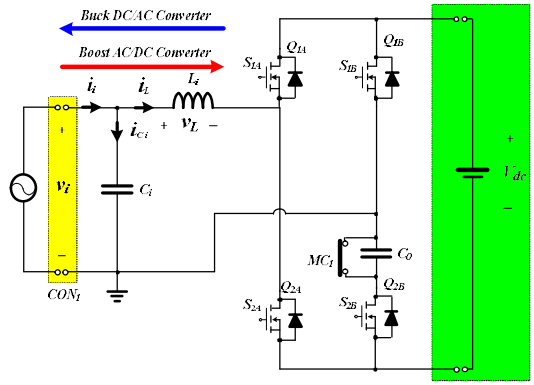
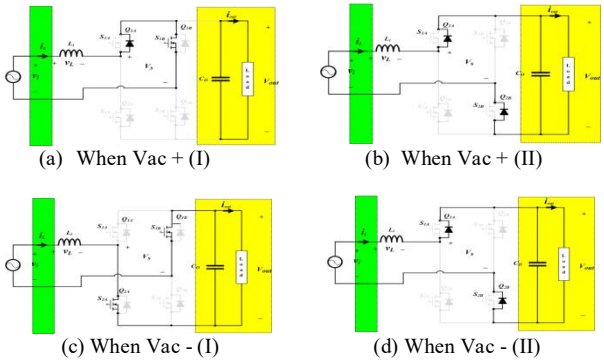


Fig. 3 Full bridge action mode.

Based on the picture above, from the forward direction we obtain the boost AC/DC converter and the buck DC/AC converter by opposite side.



(a) When Vac + (I) (b) When Vac + (II)

(c) When Vac - (I) (d) When Vac - (II)

Fig. 4 Boost AC/DC converter mode operation

Table 1. Control strategy for buck DC/AC converter

S_A	S_B	V_o
P	N	V_{DC}
N	P	$-V_{DC}$
P	N	0
N	P	0

3. Simulation Results

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 base of frequency switching is 10 [kHz]. The simulation results show in fig.5~8. It is mean that the universal power converter have capability to serve the energy sources as boost either buck.

4. Conclusions

High speed switching minimized the loss energy that occur during the power conversion by convert the power source in input side into output power, thus system has high efficiency. To verify the validity of the proposed converter, we carry out a computer aided simulation.

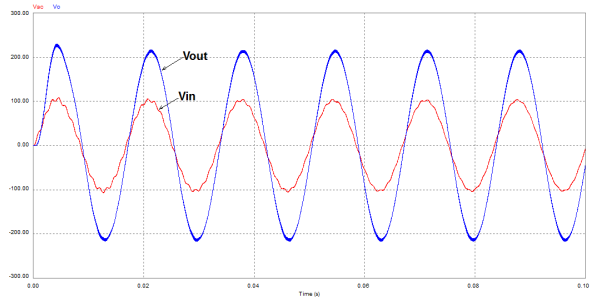


Fig. 5 Boost AC/AC converter voltage input and output with D = 0.5.

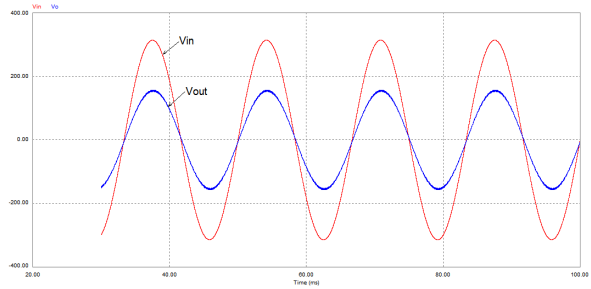


Fig. 6 Buck AC/AC converter voltage input and output with D = 0.5.

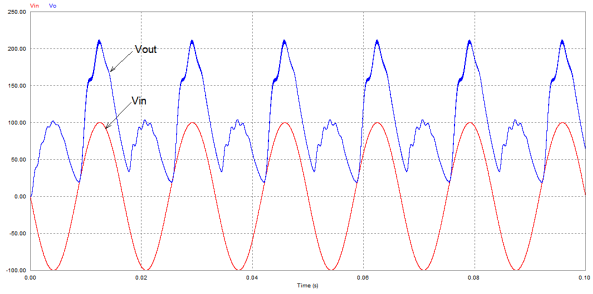


Fig. 7 Boost AC/DC converter voltage input and output.

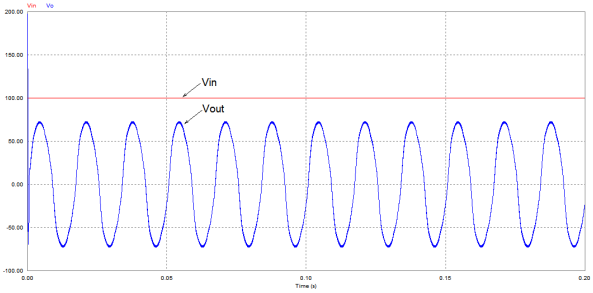


Fig.8 Buck DC/AC converter voltage input and output.

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