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MODIFIED AC/DC BI-DIRECTIONAL CONVERTER WITH POWER FACTOR CORRECTION AND HARMONICS REDUCTION

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Abstract - Most existing power semi converters and industrial motor drive systems draw non-sinusoidal currents from the supply. Non-sinusoidal currents contain harm harmonics that disturb the power supply, which is important serious concern for reliability. Other equipment that use the same power supply are adversely affected. This paper suggests the operation and performance of a new modified AC-DC converter that allows bi-directional power flow, provides improved power factor, and reduces harmonic magnitude and disturbance to the supply by system. The bi-directional feature allows recovery of regenerative energy of loads, back to the power supply and the converters. The proposed converter has high potential for industrial drives applications, such as electronically controlled traction system, lifts and general industrial motor drive systems can increase overall efficiency and reliability.

Key words - Pulse Width Modulation (PWM), inductor (L), Output Capacitor (C).

1. Introduction

In recent years, development of sophisticated static conversion techniques has gained increasing attention from many researchers because of the growing demand for industrial motor drives with power conditioning and power factor management. The classical AC/DC rectification approach of using a full wave bridge followed by a bulk capacitor is not suitable due to the undesirable input current harmonics **[2]-[4]**. These harmonics need to be controlled using passive filtering or active filtering with power factor correction. A bi-directional converter can be used so that regenerative energy can be fed to the supply instead of being stored in large capacitor. This project presents a modified thyristor based AC/DC power converter circuit with reduced harmonics and improved power factor. The inductor average current control method of the converter provides improved power factor in both power flow direction. The input current is

sinusoid ally shaped to follow the input voltage either in phase with the input voltage in motoring mode or 180 degree out of phase with the input voltage in the regenerating mode. Thus, the power factor approaches unity reduces harmonics and disturbance on the power supply. The design and performance of the converters is validated through the computer simulation using MAT-LAB SIMULINK. The design and performance of the converters is validated through the computer simulation using MAT-LAB SIMULINK.

2. System Configuration

Fig. 2.1 shows the circuit configuration of the proposed bi-directional AC/DC power converter. It consists of three main components. They are the power conversion stage, inductor average current controller and synchronization circuit for triggering the thyristors. The power conversion stage consists of four low cost, highly robust thyristors (T1-T4 uses TYN 616), two high frequency switches (S1and S2 uses IRF 460), two diodes (D1 and D2 uses MUR 8100), one inductor, one capacitor. The operation of the bi-directional AC/DC power converter consists of two modes, one is motoring mode and another one is regenerating mode. The operating mode of the converter either in motoring mode or in regenerating mode is controlled by conduction state of S2, which is determined by sensing the dc link voltage.

Now the multiplier output is summed with ramp function to form the reference current. This reference current is compared with feedback current, which gives PWM pulse to drive switch S1. By varying the duty cycle of the switch S1 to control the output voltage. In motoring mode supply voltage and supply current are in phase. During the regenerating mode S2 is turned on and D2 is reverse biased. In this mode T1-T4 are operated in anti-phase with the operation in motoring mode, which gives the reverse input voltage.
The converter now acts as a buck converter with voltage across the bulk capacitor as the input voltage. In regenerating mode when the switch S1 is closed the inductor current will rise and the current will flow from the load to supply through the thyristor. When the switch is open the inductor current will fall as the current flows through diode D1, so that power can fed back to the ac power supply. In regenerating mode supply voltage is 180 out of phase with supply current. The pulse generated by current mode controller to drive the switch S1. In both mode switch S1 is ON and OFF because the inductor is same for both mode **[5] – [8]**.

3. Synchronization network for triggering circuit

As in Fig. 3.1, switch on the ac supply to the circuit. Now, 50 V is applied to the input of the step down transformer and 50V is step down to 5V. This 5V is applied to input of the two half bridge which gives two rectified +ve sine waveforms (i.e. one for +ve half cycle and other for –ve half cycle).

4. Practical Implementation of Bidirectional Ac/Dc Power Converter

In this practical implementation of bi-directional AC/DC power converter, synchronization network for triggering circuit and some of the control circuit is discussed. The

control circuit consists of electronic PI controller, average current mode controller and low pass filter is designed and presented. TYN616 SCR (T1-T4) is used as front side AC/DC conversion which is operated at 50Hz. The use of SCR thyristors in the AC/DC front rectification power stage advantageous because;

- SCRs are low cost and robust
- They can be commuted naturally and making switching control simple.

5. Simulation and Hardware Results

In this motoring mode experimental results of a bi-directional ac-dc power converter are compared with simulated results and are validated.

6. CONCLUSION

The bi-directional ac-dc power converter is studied, implemented and the design performance is validated with simulated results. It has the advantages of the proposed converter can be operated with unity power factor for bi-directional power flow conditions and thus can reduce source side current harmonic content, the power factor corrected ac-dc converter uses a phase controlled thyristor rectifier. This converter is robust and low cost. Since the converter has bi-directional power flow capability, the energy storage requirement and the size of the dc link capacitor is reduced.The direction of the current flow in the inductor is same under both motoring and regenerating mode. This makes the current control simple.

7. REFERENCES

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