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# HARMONIC AND RIPPLE CONTROL USING ACTIVE RECTIFIER

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**Abstract**

This project proposes three-phase active rectifiers forhigh input power quality for adjustable speed drives. The proposed topology permits to reduce the harmonic distortion at the input supply side, and ripple content at the load. With the addition of bidirectional buck boost converter the total dc link capacitance is reduced than the conventional one. To improve the power density of a three-phase rectifier, it is essential to reduce the dc-link capacitor required for filtering the low-frequency ripple energy. The low frequency harmonic current is normally filtered using a bulk capacitor in the bus which results in low power density. This proposed an active ripple energy storage method that can effectively reduce the energy storage capacitance.PWM based switching technique is proposed to reduce the harmonics. This project presents the design and harmonic analysis of Three Phase PWM rectifier for DC motor drives and the scope of this paper is to reduce the current harmonics at the input side of the PWM rectifier

## 1. Introduction

Three phase active rectifiers, also known as pulse width-modulated (PWM) voltage-source converters (VSCs), or active front-end (AFE) rectifiers, are widely used in industrial and commercial applications. They represent a versatile solution for bidirectional power flow that is needed in applications, such as cranes, elevators, centrifuges, and wind turbines. With the introduction of recent standards on limiting harmonic pollution of electrical power distributionSystems, active rectifiers are being adopted more frequently in high-power electronic equipment to provide the interface to utility power lines. In addition, they are employed to minimize input voltage unbalances and reduce dc link capacitance values. This same power converter configuration is often chosen for use in active filters. Common nonlinear loads can produce a large amount of harmonic current and cause the source voltages to be distorted. The effects of harmonics can be overheating of transformers, cables, motors, generators and capacitors connected to the same power systems with the equipment generating the harmonics. In the proposed system a bidirectional buck-boost converter is connected at the output of the typical three phase PWM rectifier.

An auxiliary capacitor with dc capacitance is used as an energy storage element. We control the bidirectional converter as a buck mode when ripple energy needs to be stored in the Capacitor. It is controlled as a boost mode when ripple energy needs to be released back to the dc link. A dc link capacitor with capacitance is still needed at the output of the PWM rectifier. Dc capacitance can be considerably smaller than the capacitance required in the conventional method, since it needs only to filter the switching ripple energy and the harmonic ripple energy which not absorbed by the auxiliary capacitor. The switching ripple energy, results from both the PWM rectifier and the bidirectional buck boost converter.

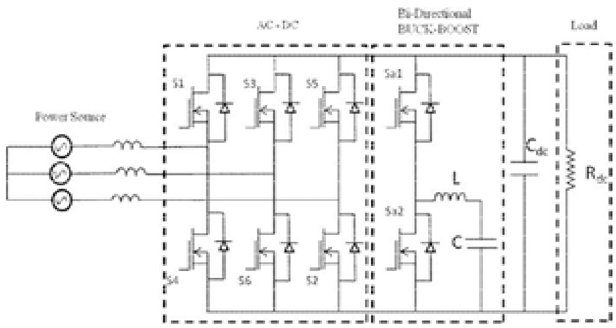



**Fig. 1. Proposed Active Rectifier**

**2. Control Analysis**

The low frequency ripples current and ripple voltage in the capacitor

At each switching period, the dc-link voltage and auxiliary capacitor voltage can be considered as quasi-static. This means the inductor charging slope and discharging slope can each be considered as a fixed value within each switching period.The output voltage is adjustable based on the duty cycle of the switching transistor. One possible drawback of this converter is that the switch does not have a terminal at ground, this complicates the driving circuitry.

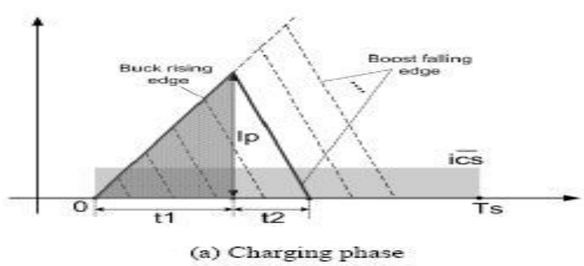



**Fig. 2. Boost mode during charging phase.**

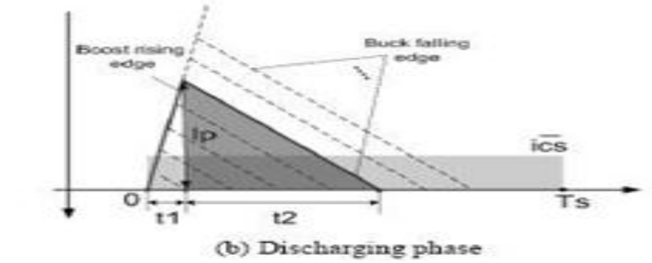



**Fig. 3. Buck mode during discharging phase**

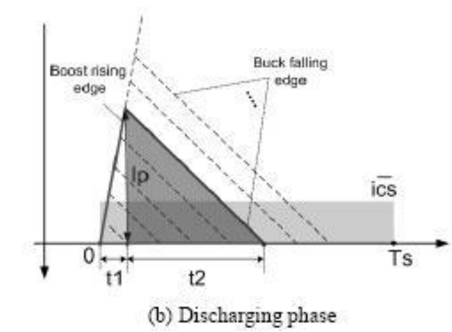
Also, the polarity of the output voltage is opposite the input voltage. Neither drawback is of any consequence if the power supply is isolated from the load circuit (if, for example, the supply is a battery) as the supply and diode polarity can simply be reversed. The switch can be on either the ground side or the supply side.

**3. Simulation Circuit**

Simulations were performed by using MATLAB-Simulink to verify that the proposed circuit with reduced THD. In this circuit, the voltage and current waveforms for open loop and closed loop are measured with voltage and current measurement block.THD is measured for input current using FFT analysis.

**For open loop**

The three phase input voltage 440 Volt is given to the proposed active rectifier and the switches are triggered by the gate pulses which are generated using PWM technique. The bidirectional buck boost converter is triggered using pulse generator, which trigger both the switches in the buck boost converter sequentially with the help of the NOT gate.



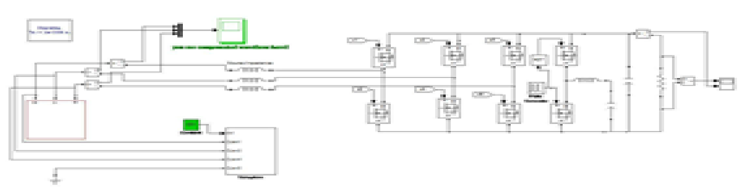



**Fig. 4. Open loop circuit for the proposed active rectifier.**

Pulse generated by the PWM technique was done using the comparator which compares the input error signal with the ramp signal, the error signal was generated by scaling the input signal with the constant.

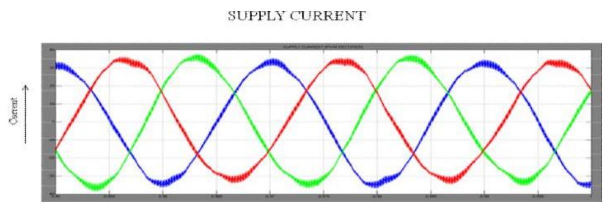



**Fig. 5. Open loop supply current for the proposed active rectifier**

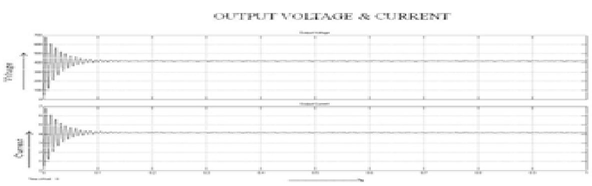



**Fig. 6. Open loop output voltage and current for the proposed active rectifier**

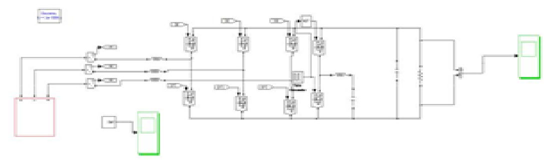


**Fig. 7. Closed loop circuit for the proposed active rectifier**

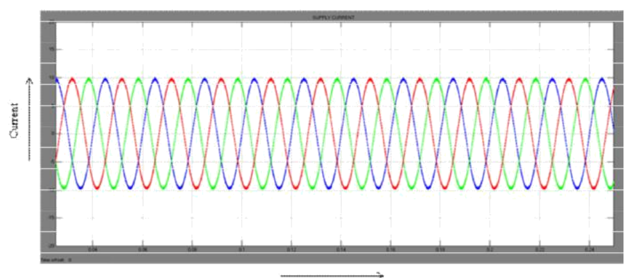



**Fig. 8. Harmonic analysis for open loop.**

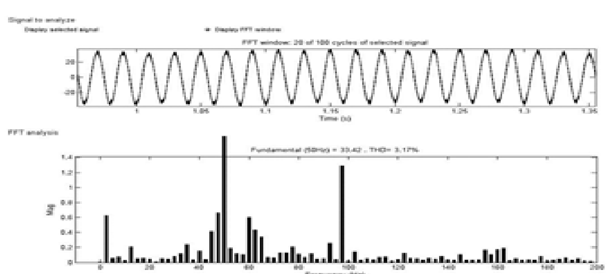


**Fig. 9. PWM generation for the closed loop.**

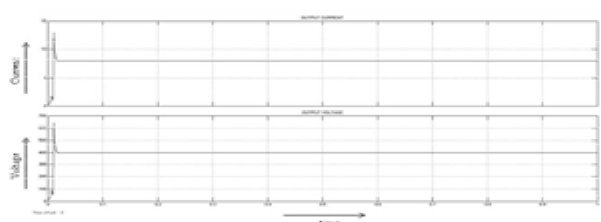


**Fig. 10. Closed loop output voltage and current for the proposed active rectifier**

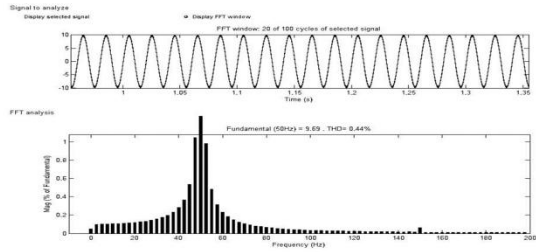


**Fig. 13. Harmonic analysis for closed loop.**

## 4. Conclusion

The use of PWM control in rectifiers eliminates the problems caused by using phase controlled rectifiers. Thus the PWM rectifiers can perform well in many applications such as battery charger, UPS system, regulated DC voltage source. The PWM rectifier can assert itself for its good behavior in many applications, for example as an active filter. The thyristor rectifiers due to their phase control load supply grid with higher harmonics and consume reactive power.

Proposed PWM rectifiers were tested using MATLAB and the simulated results have shown that total harmonic distortion has greatly reduced. These effects of phase control cannot be ignored and must be suppressed or compensated. The modern way is to apply the rectifier with pulse width modulation instead of the thyristor rectifier. The high switching frequency required in the control scheme has made the input filtering of the ac current harmonics easier. The size of the smoothing capacitor at the dc side can also be reduced due to buck boost converter at the output.

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