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PWM TECHNIQUES FOR THREE PHASE RECTIFIERS

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Abstract— **The proposed topology of different pulse width modulation techniques for three phase rectifiers features such as improved waveform quality, lower switching losses, reduced ac side passive component size when compared to the conventional continuous pulsewidth modulation. These features allow higher power density and/or efficiency to be achieved and are important targets for next generation of power rectifiers. The proposed topology will be simulated using MATLAB simulink.**

I. INTRODUCTION

VIENNA RECTIFIER

The Vienna rectifier was introduced in 1993 by Prof. Johann W. Kolar. It is a three phase, three levels and three switch rectifier, it is kind of PWM (Pulse Width Modulation) rectifier with controlled output voltage. The topology of the Vienna Rectifier is a combination of a boost DC\DC converter with a three-phase diode bridge rectifier. Fig.1. illustrates this rectifier circuit. The input current for each phase is defined by the voltage applied across the corresponding inductor LN; the input voltage of the rectifier is determined by the switching state and the input current direction. The input inductors (LN) charge when the switch is on and the current increase in the inductor, and when the switch is off the inductors discharge through the positive or negative diode depending on the current flow direction. The existence of an input inductor creates a current source at the input while the capacitors create output voltages. In other words, the Vienna rectifier may be considered as a diode–transistor matrix connecting the input current sources with output voltages.

The Vienna rectifier with constant switching frequency dual-boost type controller was chosen as the suitable rectifier for converting a generator type input, due to following grounds:

- The Vienna rectifier offers the same or less input current harmonic distortion than the other topologies.
- The Vienna rectifier, with its three-level output, allows any DC-DC converter to be used at the rectifier output (half-bridge, full-bridge or any other topology) and, with co`nstant switching frequency control, no additional circuitry is required to balance the two output capacitors. The high boost voltage of 2.45VLL might be a disadvantage, but the three-level output allows the designer some flexibility in his design.
- The vienna rectifier has only three switches, which are significantly fewer than other active rectifiers with the same performance (in terms of harmonic distortion).
- The vienna rectifier requires less control effort (in terms of the number of isolated gate drives required) than other active rectifier topologies with comparable performance (in terms of harmonic distortion).
- With constant switching frequency dual-boost control sufficient sensing effort is provided to implement dual-boost control or unified one-cycle control if needed but not *vice versa*.
- Implementation of the vienna rectifier is eased by the availability of single bridge leg modules; And, Dual-boost constant frequency control is not dependant on a fixed line frequency, making it ideal for variable frequency type inputs.

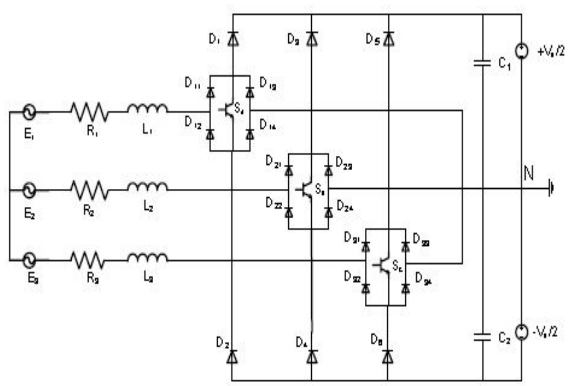

Fig.1. Vienna rectifier

II. OPERATION OF VIENNA RECTIFIER

Vienna Rectifier as shown in Figure.1 was originally developed at the Technical University Vienna. It comprises a semiconductor switch, say, a MOSFET in each phase leg of a 1-Phase diode bridge. By adjusting the width of the pulse that turns ON the MOSFET, corresponding line current is forced to be sinusoidal and in phase with the Voltage. When the MOSFET is turned ON the corresponding phase is connected, via the line inductor, to the center point between the output capacitors. The phase current rises, through the MOSFET, during that pulse period, charging the capacitor. When the MOSFET is turned off, current tapers through the diode half bridge (upper or lower depending on direction of the current flow)

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III. SIMULATION OF VIENNA RECTIFIER

Vienna rectifier is a combination of a boost DC/DC converter series with a single-phase rectifier provides a new topology. It's a single-phase; single-switch rectifier. It can be seen as a diode bridge rectifier with an integrated boost converter. The Vienna rectifier is useful wherever six switch converters are used for achieving sinusoidal mains current and controlled output voltage, when no energy feedback from load into the mains is required. The Vienna rectifier comprises a semiconductor switch in each phase leg of 1- phase Diode Bridge. It is a highly efficient method of high current, single-phase AC/DC conversion and is very useful for achieving unity power factor correction.

Vienna rectifier gives various advantage application and limitation they are

A. Advantages of Vienna Rectifier-

1. Its a boost type PFC with continuous sinusoidal input current and unidirectional power flow.
2. It needs only active switches, i.e. MOSFETS.
3. It is Operational even in presence of unbalanced mains or only two phases.
4. Total switching losses are reduced by a factor of six, assuming switching Frequency below 50 KHz.
5. Any malfunction in control circuit does not manifest itself in short circuit of output or PFC front end.
6. Sinusoidal input currents with Power Factor = 0.997, THD<5% and overall efficiency > 97% are obtainable with current designs.

B. Applications of Vienna Rectifier-

A number of industrial, telecom and computing equipments are used Salient amongst them are

1. A.C. and D.C Drives.
2. Telecommunication Power Supplies.
3. Uninterruptible Power Supplies.
4. Air Conditioning Units.
5. Computer Installations.
6. Power supplies for all industrial uses such as welding, surface treating, motion .control, large appliances and process control.
7. R.F. Transmitters and Radar Transmitters and repeater stations.

C. Limitation of Vienna Rectifier

1. Unidirectional power flow.

IV. SIMULATION OF VIENNA RECTIFIER USING PWM

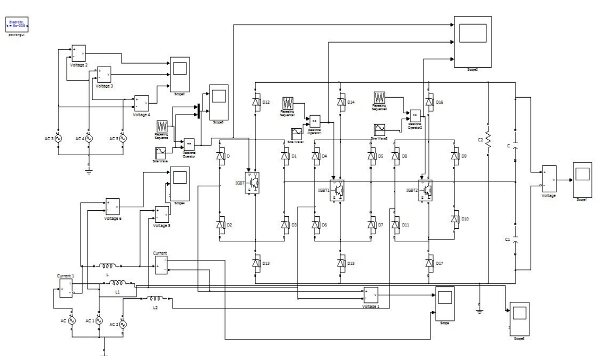

Fig.2. Vienna rectifier for PWM

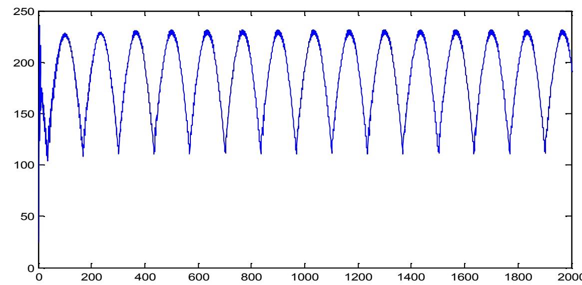

Fig.3. Output voltage waveform

V. SIMULATION OF VIENNA RECTIFIER USING SPWM

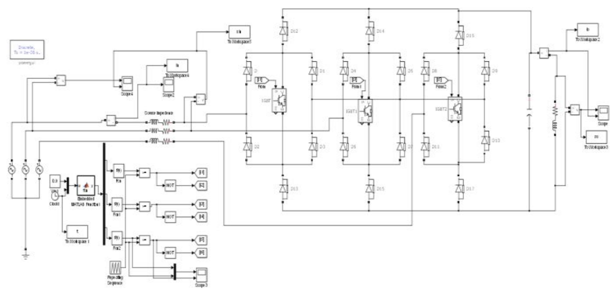

Fig.4. Vienna rectifier for SPWM

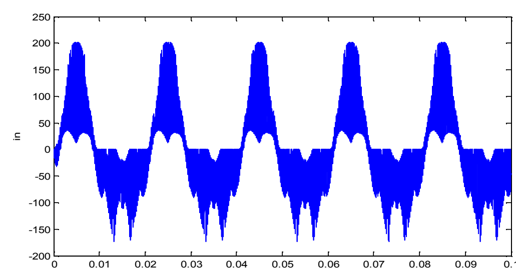

Fig.5. Input current

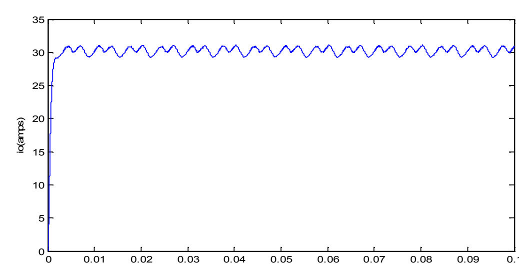

Fig.6. Output current

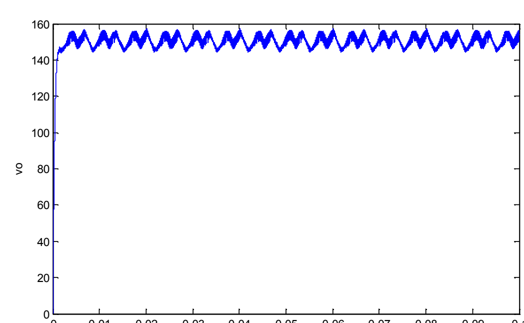

Fig.7. Output voltage

CONCLUSION

In this paper Vienna rectifier has been proposed and analysed for different PWM techniques. An LC filter based on a switched capacitor bank is utilized to obtain a wide speed operational range. The switching and conduction losses of the power semiconductors in the Vienna rectifier were obtained simulations and compared to losses incurred by a similar six-switch converter. The result show that the proposed system has potential to be more efficient and reliable.

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