EFFICIENT POWR FACTOR CORRECTION FOR MULTIPULSE BRIDGELESS ACTIVE BOOST CONVERTER 3 PHASE AC-DC CONVERTER

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Abstract - In our daily life, we find various application of the power supplies, regulators etc. All the electrical and electronic appliances require high QoS power supplies. The Power factor is an important measure of the power quality being provided to the user end. Thus, this parameter needs to be controlled and losses are to be minimized. In this work, we have presented a modified PFC Boost converter with bridgeless AC to DC converter for Multi-Pulse systems. We have designed, implemented and simulated the results for the 24-Pulse converter topology for Three phase AC to DC rectifier systems. We have shown using our proposed technique and topology, the power factor has been increased from 0.715 to 0.982 as compared to the conventional 24-Pulse rectifier model. We have implemented the design and all the simulation through MATLAB-SIMULINK model and design verified by SIMPOWERSYSTEM toolbox of SIMULINK.

Key Words: Rectifier, 24-pulse converter, Power Factor, Boost Converter, Multi-pulse systems

1. INTRODUCTION

In AC Transmission lines, the power factor is very important parameter of Quality of Service. The major power losses are due to low power factor. Thus, it needs to be controlled in a very efficient manner. Thus, the need for a very efficient power factor correction models needs to be developed. Thus, maintaining the power factor for the (90-400V) is very difficult. The utilities will always demand for high power factor and low THD. Several topologies have been introduced conventionally in this area.

The rectifier circuits find a lot of applications in the electronics and electrical loads. We need to use it as power supply for various critical DC loads like DC Motor, Electronics appliances etc.

Thus, we need to develop the circuitry that can improve the power factor of the supply. Power factor of the supply lower in presence of the various non-linear loads, reactive loads and losses in the systems due to this. Thus, Power factor correction is a very important technique used for controlling the power factor of the input AC Supply and thus maintaining the good Quality of service in the transmission systems.

The main reasons for the power losses in AC-DC converter is due to high switching losses, their non-linearity and simultaneous switching losses and noises arising due to it. To reduce the harmonic distortions, the various multi-pulse topologies have been utilized. The various pulse converters like 6-pulse, 12-pulse, 24-pulse converters are been applied to the various power supplies. These techniques are found to very efficient for the converter design.

In our proposed design, we introduce a bridgeless AC-DC boost converter for boosting the PFC of the 24-pulse rectifier systems. We have implemented the design on the MATLAB-SIMULINK.

Here, the bridgeless topology has been presented. It based on the three phase 220V /50 Hz supply. The diode based 24-pulse bridgeless active boost converter has been presented here. Thus, EMI inductor has also been added. Our design is compared with the conventional 24-pulse AC to DC converter (bridge-based). It is proved by the results , that the method proposed by us for the proposed load has improved the power factor of the power supply systems.

2. Bridgeless PFC Boost Converter

In the previous boost topology, current flows through two of the bridge diodes in series, whereas, in the bridgeless power factor correction configuration, current flows through only one diode and the return path is provided by Power MOSFET. When S2 switches off, energy stored in inductor is released and the current flows through D2, through the load and back to the mains through the body diode of switch S1.Thus, in each half line cycle, one of the MOSFET operates as an active switch and the other one operates as a diode. The difference between the bridgeless PFC and conventional PFC is that in bridgeless PFC converter the inductor current flows through only two semiconductor devices, but in conventional PFC circuit the inductor current flows through three semiconductor devices.

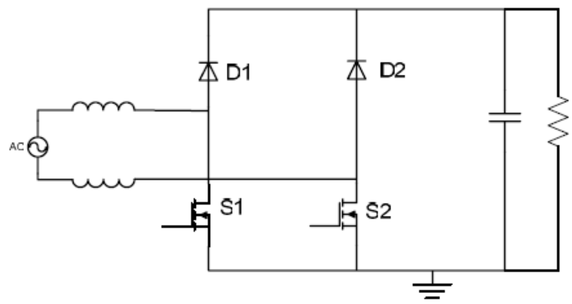

Fig.1. Bridgeless boost converter topology for single phase

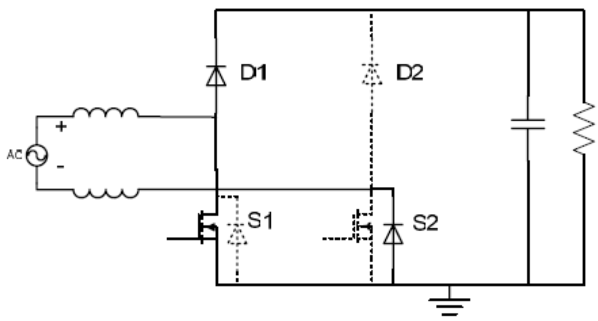

Fig.2. Switching cycle of Bridgeless boost converter topology for single phase.

The bridgeless PFC circuit is shown in Figure 1. The boost inductor is split and located at the AC side to construct the boost structure. The equivalent circuit of positive half line cycle is show in Figure 2. In this half line cycle, MOSFET S1 and boost diode D1, together with the boost inductor construct a boost DC/DC converter. Meanwhile, MOSFET S2 is operating as a simple diode. The input current is controlled by the boost converter and following the input voltage.

During the other half line cycle, circuit operation as the same way. Thus, in each half line cycle, one of the MOSFET operates as active switch and the other one operates as a diode: both the MOSFETs can be driven by the same signal

3. Multi-Pulse Converter

Multi-pulse rectifiers use various pulse multiplication schemes to produce the desired pulse number in the input currents and the output voltages [3], [4]. The electromagnetic device needed to create the different phase shifts can be multi-winding transformer or auto-transformer or a combination of three-phase and single phase transformers. The windings are then connected together following particular configuration to obtain the desired configuration.

The three-phase output voltages provided by four secondary winding have the same amplitude and 15º phase shift between them. The required phase shifts are obtained by connecting the primary windings in zigzag configuration. Fig. 3 shows the 24-pulse transformer windings connection and a phasor diagram representing the twelve-phase voltage system at the transformer output.

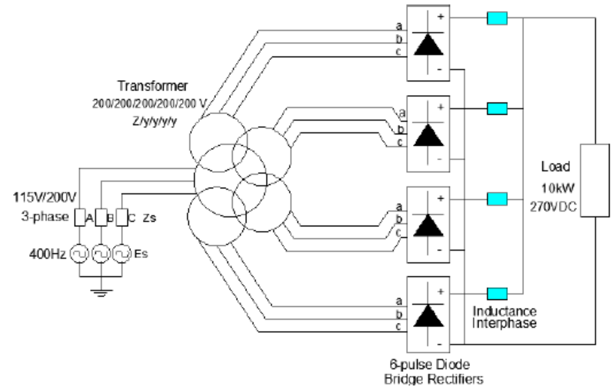

Fig.3 24-Pulse AC to DC converter systems

Four six-pulse diode bridges are used to convert three phase output voltages to four dc voltages with 2400 Hz ripple. The four dc outputs are connected in parallel to the load, through inter phase inductors, to provide a dc voltage having 9600 Hz ripple. The inter phase inductors are used to limit the circulating current between secondary and to reduce the output ripple.

4. Proposed Design

4.1 Conventional 24-pulse rectifier system (3-Phase)

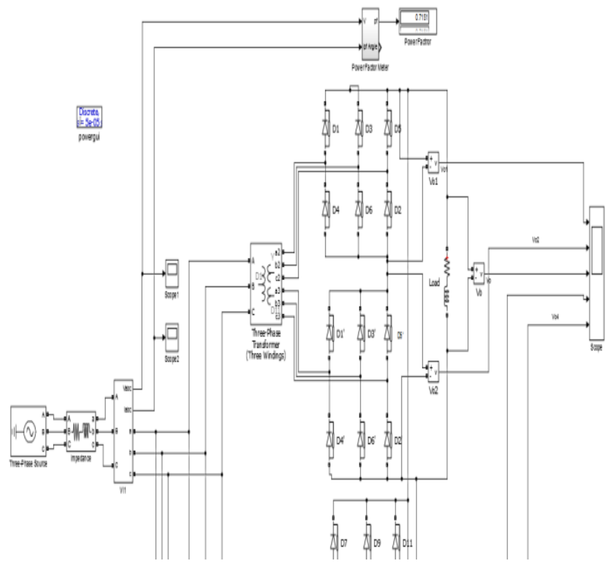

Fig.4 Conventional 24-pulse rectifier systems

Fig.4 shows the conventional model of the 24-pulse rectifier systems. The system has been designed for 220V/50 Hz system. Three phase source has been used for the conversion.Four six-pulse diode bridges are used to convert three phase output voltages to four dc voltages .The inter phase inductors are used to limit the circulating current between secondary and to reduce the output ripple.

4.2 Bridgeless 24-pulse Boost converter systems

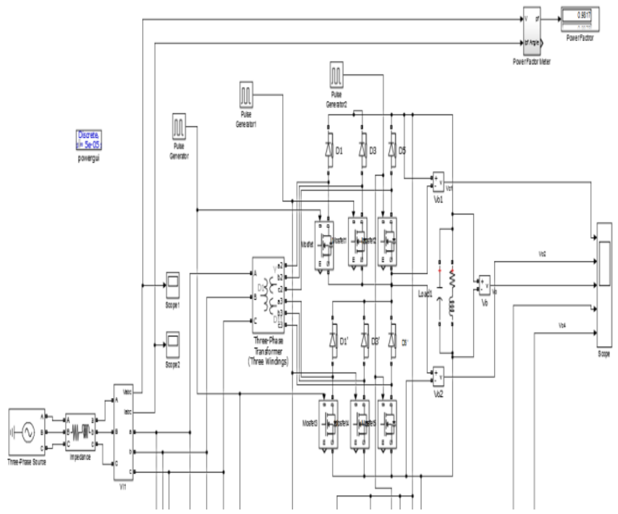

Fig. 5 Proposed design of bridgeless 24-pulse converter systems.

Figure 5 shows the propose model for the above bridgeless converter. The difference between the bridgeless PFC and conventional PFC is that in bridgeless PFC converter the inductor current flows through only two semiconductor devices, but in conventional PFC circuit the inductor current flows through three semiconductor devices. Thus, three phase bridgeless converter has been presented.

4.3 **Simulation Parameters**

Table 1. Simulation Parameters

Parameters	Values
Input Voltage	220V RMS
Frequency	50 Hz
Source Resistance	0.01 Ohm
Source Inductance	1 mH
Three phase Transformer Winding 1	Delta (D1)
Three phase Transformer Winding 2	Y
Three phase Transformer Winding 3	Delta (D11)
DC Capacitor	1000uF
Output Impedance	100 Ohm, 5mH

5. RESULTS & DISCUSSION

Figure 6 shows the input voltage waveform of the power supply. It shows 220V /50V RMS three phase supply. The Table 1 shows all the simulation parameters of the input supply. The input resistance is found to be 0.01 Ohm and inductance is 1mH.

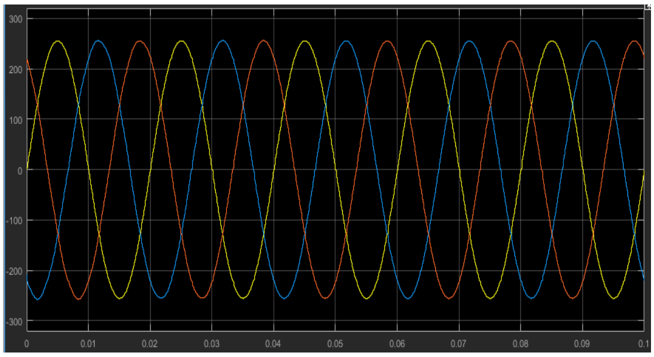

Fig.6 Input Source Waves

Similarly, Figure 7 shows the current waveform of the input power supply. The output is connected to the non-linear load and transformer is being used at the supply.

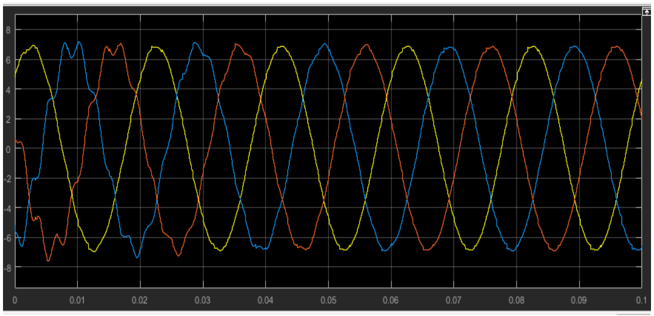

Fig.7. Current Input Waveform

Figure 8 represents the 24-pulse converter pulse output from the 24-pulse converter circuit. It represents four six-pulse diode bridges output combined used to convert three phase output voltages.

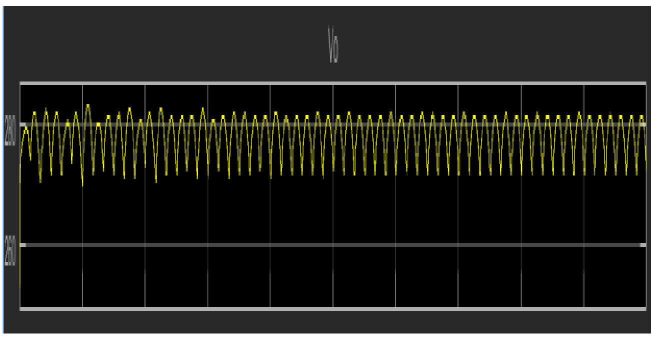

Fig.8. 24-pulse conversion output

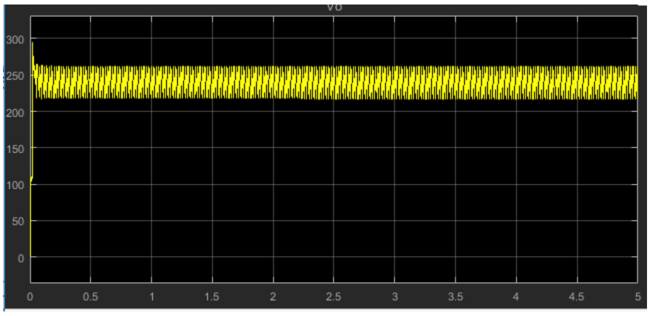

Fig.9 DC Output from the 24-Pulse converter output

Simulation Results:

Comparison	Power Factor
Conventional 24-Pulse Converter	0.717
Proposed Bridgeless Boost 24-Pulse Converter	0.982

CONCLUSION

In this work, we have presented a modified PFC Boost converter with bridgeless AC to DC converter for Multi-Pulse systems. We have designed, implemented and simulated the results for the 24-Pulse converter topology for Three phase AC to DC rectifier systems. We have shown using our proposed technique and topology, the power factor has been increased from 0.715 to 0.982 as compared to the conventional 24-Pulse rectifier model. We have implemented the design and all the simulation through MATLAB-SIMULINK model and design verified by SIMPOWERSYSTEM toolbox of SIMULINK.

REFERENCES

[1]. D. M. Mitchell, "AC - DC converter having an Improved Power Factor," U.S. Patent 4 412 277, Oct. 25, 1983.
[2]. D. Tollik and B. Pietkiewicz, "Comparative Analysis of 1-ф active Power Factor correction Topologies," in Proc. Int. Telecommunication Energy Conf., Oct.
1992, pp. 517–523.
[3]. W.-Y. Choi, J.-M. Kwon, E.-H. Kim, J.-J. Lee, and B.-H. Kwon, "Bridgeless boost rectifier with low conduction losses and reduced diode reverse-recovery
problems," IEEE Trans. Ind. Electron., vol. 54, no. 2, pp. 769–780, Apr. 2007.
[4]. H. Ye, Z. Yang, J. Dai, C. Yan, X. Xin, and J. Ying, ―Common mode noise modelling and analysis of dual PFC circuit,‖ International Telecommunication
Energy Conf. (INTELEC) Proc., pp. 575-582, Sep.2004.
[5]. Suja C Rajappan , K. Sarabose , Neetha John"
An Efficient AC/DC Converter with Power Factor Correction" ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 3, March 2013.
[6]. S.M.AshrafulAlam Mohon1,GolamSarowar2, Dr. Md. Ashraful Hoque3,
M. Bazlur Rashid4, TaniaAnnur" A Novel High Performance Bridgeless Ac-Dc Boost Converter" e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-5, Issue-8, pp-70-75(2016)
[7]. ChongmingQiao and Keyue M. Smedley, "A Topology Survey of Single-Stage Power Factor Corrector with a Boost type Input-
Current-shaper", 0-7803-5864-3/00/$10.00 02 000 IEEE, Pg: 460-467.
[8]. SumanDwari, and Leila Parsa, "An Efficient AC–DC Step-Up Converter for Low-Voltage Energy Harvesting," IEEE transactions
on power electronics, vol. 25, no. 8, august 2010
[9]. S. Dwari, R. Dayal, and L. Parsa, "A novel direct AC/DC converter for efficient low voltage energy harvesting," inProc. IEEE Ind.
Electron. Soc. Annu. Conf., Nov. 2008, pp. 484–488.
[10]. B. Su and Z. Lu, "An interleaved totem-pole boost bridgeless rectifier with reduced reverse-recovery problems for power factor
correction," IEEE Trans. Power Electron., vol. 25, no. 6, pp.769-780, June 2010.

BIOGRAPHIES

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