Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 3, June 2021:1011- 1016

Research Article

A Single Stage Bridgeless Sepic Power Factor Correction Rectifier

A.Andrews[1], Dr.N.Anbu Selvan[2]

Abstract

A power factor correction rectifier (pfc) named bridgeless single ended primary inductor converter (SEPIC) pfc with less number of active and passive components under less conduction loss is proposed in this paper. The novel technology tends to maintain the power factor become unity. Apart from SEPIC pfc, achievement of high efficiency & reduction of harmonics also incorporates with a specified control logic. In this paper a peak current mode control (PCMC) topology is executed. Among various control logic, this topology has concurred more attention due to its rapid development and accessibility respectively. Having switch also corrects the degraded performance of diode under variable operating conditions. Absolutely this novel method can improve the output voltage and satisfies the load requirement and boost the power factor nearer to unity. An input voltage of 120 volt is applied and simulated. Further simulation study experimentally proven the efficiency and power factor of the system.

Keywords: Power Factor Correction (PFC); Single Ended Primary Inductor Converter (SEPIC); Efficiency; Harmonics; Peak Current Mode Control (PCMC)

I.INTRODUCTION

In industry and household appliances the consumption of power depends upon the quality of power factor associated with it. The power factor is considered as predominant; especially during power transmission this being major one. The power factor ranges from 0 to 1. Depending upon the availability of power factor the power requirement for electrical devices should vary. As power factor said to be low the appliances need additional power to compensate it. It increases the economical rate. More than 0.85 is acceptable and at this condition there is no need for additional power insertion to compensate the loss. The Non linear loads utilize the sinusoidal input voltage; but its impedance is same not at all.

[1]UG Scholar,Department of Electrical and Electronics Engineering, Saveetha School of Engineering, Saveetha Institute of Medical And Technical Science, Chennai. andrewsjaguar009@gmail.com
[2]Assistant Professor, Department of Electrical and Electronics Engineering, Saveetha School of Engineering, Saveetha Institute of Medical And Technical Science, Chennai. anbu.1324@gmail.com

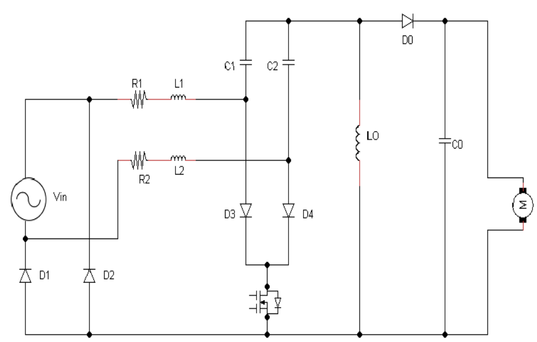
It varies continuously. It changes the input current even though the input voltage is said to be sinusoidal. The appearance of harmonics and organization can be pointed out at this condition. It overlaps with fundamental frequency causing variation in current. At this situation the need of power factor correction has been necessary. Power factor alone can compensate power inconvenience. The lossless power can be attained with unity power factor.

The possibility of power factor correction is listed below: active pfc and passive pfc. The passive pfc dealt with capacitor to correct power factor. Some of the disadvantages are bulky capacitor, wide range of voltage regulation capability, etc. hence this method is inapplicable for power factor correction. The overall cost is said to be high. In power correction using passive power factor correction has been attained less. The active power factor correction associated with semiconducting switches. It replaces diodes. The diode performs rectification and the output voltage is sinusoidal not yet. This action may vulnerable the appliances associated with. So it needs a capacitor to correct it. To resolve this problem diodes are replaced by switches. It needs only certain control logic. Because the switches are controllable one and its controllability interconnected with the pulse given to it. Thus move upon with active power factor correction.

In our proposed system the number of diodes in conventional methodology is replaced by switches. The bridgeless sepic power factor correction rectifier is evolved within it. Bridgeless reduce (or) replace the requirement of more diodes. The bridgeless sepic can boost the voltage with high power factor correction. The peak current mode control logic analyze the output voltage from bridgeless sepic pfc by feedback it to the control topology; then it generates pulse depends upon the availability of output before feedback to it.

In section II the proposed bridgeless sepic pfc rectifier and its operation is explained. The section III visualize the PCMC contol strategy and it overviews how to inject PWM signal to the AC-DC portion. In section IV topology of proposed system is analyzed. SIMULATION Result and discussion are overviewed in section V and the system is concluded within section VI.

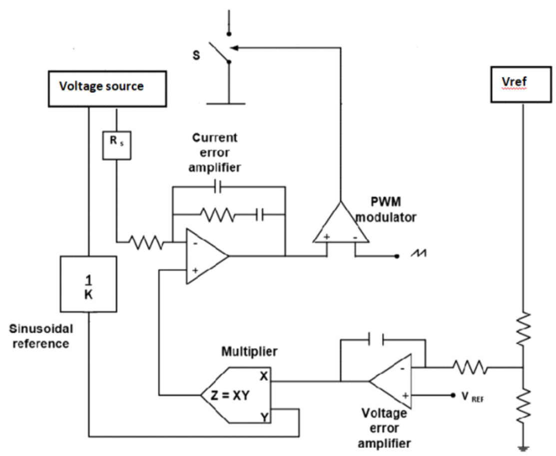
II.BRIDGELESS SEPIC POWER FACTOR CORRECTION RECTIFIER



The above diagram represents bridgeless SEPIC PFC converter. It replaces diodes by capacitor and switch. The capacitor acts as a filter and the switching combination respond both positive and negative cycle. The power rectification process is demonstrated into four ways. In path 1, Vin energies L1 through D3, switch and D2 respectively. In second path the energy stored in L0 is utilized by C1. In third path the energy storage elements namely C1, C2, L2 completely energized. Apart from this C1 charges with discharge in C2. Further the motor is accelerated by the charge from C0 in final path. Now switch is turned off and D0 conducts with D1, D2, and D3 are in reverse biased condition. All the energy storage elements transfer their energy to the load side (i.e.) L1, L2, C1, C2, L0, C0 to motor. A pure dc output voltage with higher power factor is supplied to the load.

III.PEAK CURRENT MODE CONTROL

The switch present in bridgeless sepic pfc is turned on and off by a specified control technique known as peak current mode control (PCMC). A clock signal holds the switch is to be in on condition with fixed switching frequency. The sum of switch current and compensating ramp turn off the switch. The reference signal can be attained by expand the voltage error amplifier with line voltage at rectifier. The current reference amplitude has been set with this expansion. Thus the switching current may increases above zero, the switch conducts or else it tend to rise above reference current it makes the switch off.



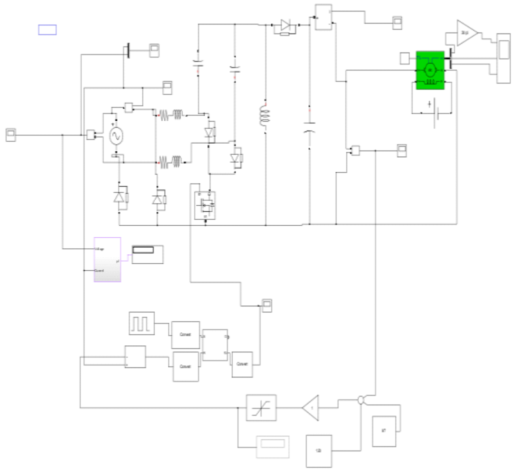
The above diagram explained about "what's the process undergoing in peak current mode control technique.

IV.METHODOLOGY

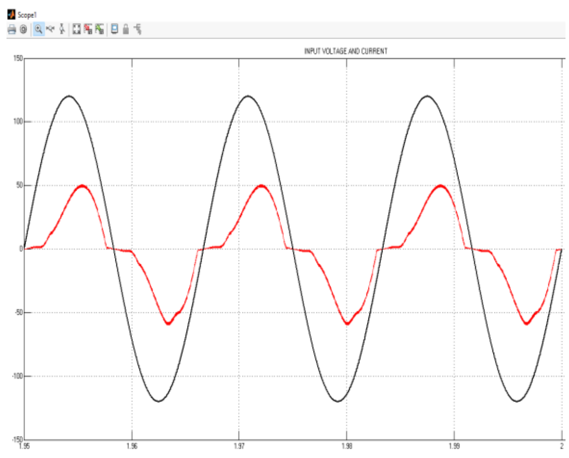
Bridgeless SEPIC PFC rectifier receives supply from AC mains; it performs AC-DC conversion. PWM generator draws attention from peak current control technique to generate pulses. The generated pulse holds the entire circuit operation. A voltage gain can be extended without extreme duty cycle operation. This utilizes the sinusoidal input voltage and delivers a pure dc voltage without any deterioration. The proposed bridgeless rectifier topology configuration results in high overall efficiency and power density. Finally, a lossless DC power is fed to the dc load. Literally the harmonics are stabilized and are removed by the specialized topology.

V.SIMULATION RESULT AND DISCUSSION

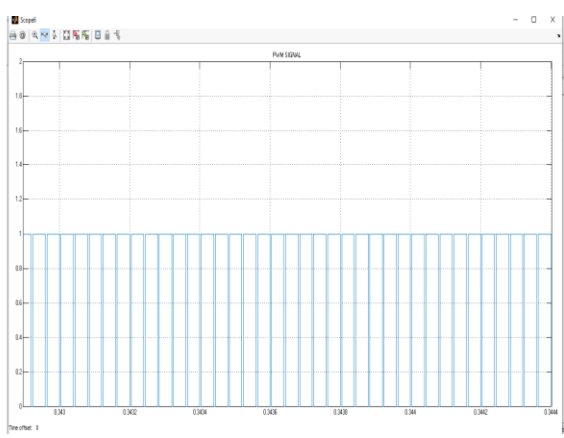
The simulation study dealt with bridgeless SEPIC power factor correction rectifier interfacing peak current mode current control technique. The performance and the output voltage is either associated with harmonics or not is established in this section. An input voltage of 120 volt, 50 Amps is applied to the power factor correction rectifier without ripple.



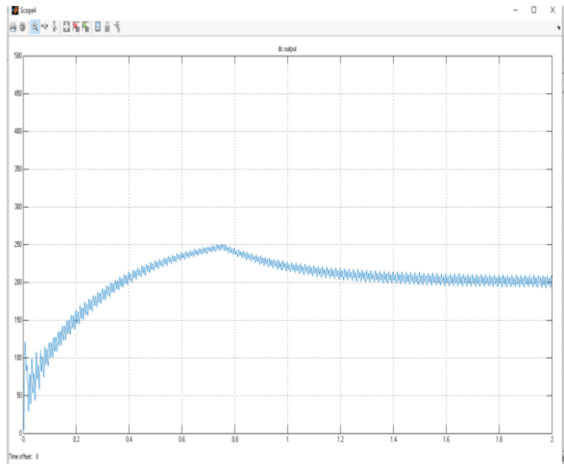
The sinusoidal input voltage with fundamental frequency is represented in the below waveform. There is no current ripple in input voltage and it is clarified with the waveform.



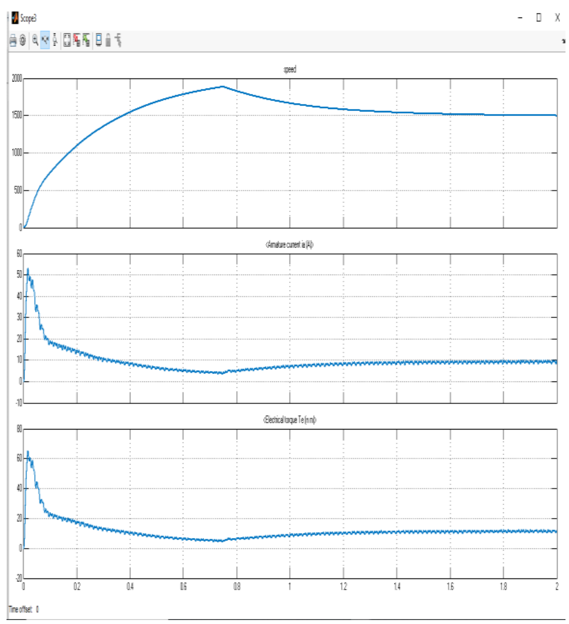
The amount of pulse given to bridgeless SEPIC pfc produced from peak current mode control technique is displayed in above graph. Normally duty cycle ranges from 0 to 1.



The above graph virtually explains about the output voltage of bridgeless SEPIC pfc rectifier without distortion is shown. The rectifier not only improves the power factor; also it boosts the voltage deliver to output. Having an input voltage of 120 volt AC supply is converted into 250 volt DC supply. The switching action responds well in accordance with peak current control topology. The power factor tends to be unity.



The below waveform shows the efficiency of an dc load with input voltage obtained from bridgeless SEPIC pfc rectifier.



VI.CONCLUSION

The simulation result reviews about how much power can be generated without the intrusion of harmonics within it. A sinusoidal input voltage controllability and availability of pure dc voltage with unity power factor is varied and proved using simulink diagram. An input voltage of 120 volt, 50A is converted into 250 volt dc supply without ripple. This is why we undergoes bridgeless sepic power factor correction rectifier instead of other pfc rectifiers. Moreover comparison with other rectifier's, it reduce the cost and avoids excessive power insertion when the power factor correction becoming more intensive.

REFERENCE

- N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications and Design. Hoboken, USA: Wiley, 2009.
- Marian K. Kazimierczuk, "Pulse-width Modulated DC-DC Power Converter", John Willey & Sons, USA, 2008.
- Limits for Harmonics Current Emissions (Equipment current ≤16A per Phase), International standards IEC 61000-3-2, 2000.
- SAE Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler, SAE Std. J1772, 2010.
- S. Dusmez and A. Khaligh, "A compact and integrated multifunctional power electronic interface for plug-in electric vehicles," IEEE Transactions Power Electronics, vol. 28, no. 12, pp. 5690-5701, Dec. 2013.
- F. Musavi, M. Edington, W. Eberle and W. G. Dunford, "Evaluation and efficiency comparison of front end AC-DC plug-in hybrid charger topologies," IEEE Transactions Smart Grid, vol. 3, no. 1, pp. 413-421, March 2012.
- D. H. Kim, M. J. Kim and B. K. Lee, "An integrated battery charger with high power density and efficiency for electric vehicles," IEEE Transactions Power Electronics, vol. 32, no. 6, pp. 4553-4565, June 2017.
- C. Y. Oh, D. H. Kim, D. G. Woo, W. Y. Sung, Y. S. Kim and B. K. Lee, "A high-efficient non isolated single-stage on-board battery charger for electric vehicles," IEEE Transactions Power Electronics, vol. 28, no. 12, pp. 5746-5757, Dec. 2013.
- S. Li, J. Deng and C. C. Mi, "Single-stage resonant battery charger with inherent power factor correction for electric vehicles," IEEE Transactions Vehicular Technology, vol. 62, no. 9, pp. 4336-4344, Nov. 2013.
- F. Musavi, W. Eberle and W. G. Dunford, "A high performance single-phase bridgeless interleaved PFC converter for plug-in hybrid electric vehicle battery chargers," IEEE Transactions Industry Applications, vol. 47, no. 4, pp. 1833- 1843, July-Aug. 2011.