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A New Power Factor Correction Technique Using PFC Boost Converter

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Abstract— *In this planned project a replacement economical bridgeless Cuk rectifier is employed for Power Factor correction (PFC). It's solely 2 semiconductor switches within the current flowing path. Throughout every interval of the switch cycle it end in less conductivity losses Associate in an improved thermal management compared to the standard Cuk greenhouse emission rectifier. to realize nearly unity power issue and low total harmonic distortion of input current, the topologies area unit designed to figure in discontinuous conductivity mode (DCM). The DCM has extra advantage like zero-current stimulation within the power switches, zero current turn off within the output diode. The issues of improvement of power quality area unit reduction in total harmonic distortion and improvement in power factor at input ac, and tight output dc regulation. This work presents a bridgeless AC DC boost convertor operational in CCM. The implementation of input current and output voltage controller is additionally mentioned. Then a comparative analysis supported simulation results of bridgeless and bridge boost rectifier is given. Bridgeless boost AC-DC convertor has outperformed the standard techniques owing to lower conductivity losses, lower ThD of input current and improved input power issue.*

Keywords—Bridge boost ac-dc converter, Continuous Conduction Mode, Power Factor Correction (PFC), Bridgeless boost ac-dc converter, Total Harmonic Distortion (THD)

I. INTRODUCTION

Rectification is a process in which electric power is converted from AC to DC. It is widely used in many applications as most of electronics appliances nowadays require DC power. Conventional AC-DC converters, such as Bridge rectifiers, have been developed for this purpose but there are few factors to be controlled in this regard. The No sinusoidal current drawn at the input side results in lower distortion as well displacement factors. Commanding the line current to follow the line voltage in a sinusoidal manner cangives higher efficiency with improved power factor and lowerTHD. AC side power factor (PF) is needed to be improved along with lowering of Total Harmonic Distortion of input line current. Tight regulation of the output voltage even in the case of dynamic loads is also a stringent requirement of DC-DC converters. A controller that simultaneously controls both the input as well as the output parameters is the choice. .To gain a high power factor, different power factor correction (PFC) techniques have been introduced which can be divided into two parts, passive and active. Passive techniques consist of passive components such as inductors and capacitors that are used as input filter to reduce line currentharmonics. However, improvements are not significant andanother drawback is the relatively large size of these passive elements. Moreover, these techniques may not be able to handle dynamic loads. On the other hand, active PFC techniques more efficient solution, having a combination of switches and passive elements. Due to presence of switches, controllers can be implemented on active techniques of PFC. At the cost of complexity, the controlled active techniques can increase Power factor and reduce THD in the input AC current. Along with it active techniques can also bring precise DC regulation for variable loads. The active PFC technique uses a diode bridge rectifier followed by a dc–dc converter and the bulk capacitor. By controlling the dc–dc converter, the input line current is commanded to follow the input line voltage and in this way Power Factor approaches to unity. For medium and high power applications boost dc-dc converter works better for power factor correction than other dc-dc converters such as buckboostand buck converters because of lower electromagnetic interference. Moreover, in case of boost PFC converter there islow requirement of filtering because of continuous line current, whereas other dc-dc converters such as buck, buck-boost, andflyback have higher requirement of filtering because of pulsating line current. As boost converter is capable of handling much higher power levels as compared to its other counterparts, much

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research has been carried out on many different PFCtechniques of this topology[1]-[6]. Among all these techniques of improvement of robustness, power efficiency and cost the bridgeless topology has outperformed almost all thetechniques. A brief performance evaluation of bridgeless boostPFC is presented in [7], [8]. Different new topologies ofbridgeless boost DC-DC converter topology have also beendiscussed in some recent research [9]-[11].In this paper a new topology of bridgeless boost PFCconverter has been analyzed. Its performance has beenanalyzed by applying a simple controller on it. To avoid complexity and get maximum advantage of the controller wehave applied Proportional Integral (PI) controller by usingdouble stage Pulse Width Modulation (PWM). This controllerworks for both ac and dc side. The control technique iscapable of improving Power Factor and reducing THD at acside along with regulating DC voltage at the output tightly. Toget best performance for variable loads, a resistor observer has been applied. Moreover a comparison has been made between bridgeless boost PFC and conventionally used diode bridgeboost PFC. The comparison clearly shows that the proposed topology and controller is giving a simimplementable solution to all the discussed issThe paper is organized as follow; Section 2over view of Bridge Type Boost PFC Cosystem and load observer is presented in Secpresents over view of Bridgeless Boost PFCwith its working principle. Comparison of Siare presented in section 5, followed by conclusion.

II. BRIDGE TYPE BOOST PFC CONVERTER

For the active Power Factor Correction in we mostly use dc-dc converter. Among all converters, the boost converter is more effectiPFC applications. Mostly we use dc-dc boost he output of ac-dc converter to get power faunity. This process also has simplicity, inefficiency and lower harmonic distortion as other converters. The dc-dc converter which voltage is known as boost dc-dc convert converters requires some energy storage inductors, along with switching elementransistors.Most of the times the boost PFC type acnot require much filtering because it gets cofrom the ac source. Only a simple filter capacitor can fulfill the requirement of converter. However, higher level of filtering iother converters such as buck and buck-boost their input current is pulsating type. So the Bused for PFC is our main focus in this paper. Will analyze different operating modes and topology to obtain the best possible results. We will also do some modifications inconventional boost PFC and its control. In this PFC technique bridge rectifier I Boost converter. We can control the output DC power factor by controlling this boost convert can operate in different regions that are define inductors current behavior. The regions in converter can operate are the continuous c(CCM) and discontinuous conduction mode (the inductor current ripples are very high due losses are high so the DCM operation restrict applications [13]. At the other end in Current ripples are very small due to which plow, which makes it optimal for medium applications. Moreover in case of DCM we voltage control loop but in case of CCM of Simple and easilyues.presents a briefonverter. Contraction 3. Section 4Converter alongimulation Resultssion.CONVERTERac-dc converters the basic dc-drive than others converter withactor approachingigher conversion compared to the each steps up theer. This type of element such as; diodes and dc-dc converter continuouscurrent consisting of altering for suchis required for allt. This is because BOOSTconverter In this paper decontrolling of this topology. The structure ofs followed by ac voltage and theer. This converted on the basis ofan which a boost conduction modeDCM). In DCM,e to which powers it to low power, the inductor power losses areand high power have to use theperation of boostPFC converter, we have to use both control loops. The current control input line current to follow the involtage control loop is used to regular DCM operation offers a numb inherited power factor correction an electronic switches. Moreover itrecovery losses of the diode due to diode. On the other hand, in CCrequired to control voltage and current inductor current ripples are very low complex control strategy the sizeWhereas, DCM requires a high-extremely high current ripples. The control of this system is the output voltage control loop and theFig. 1 shows the block diagram of loop calculates the voltagecalculates the current error. Both ofPI controllers.

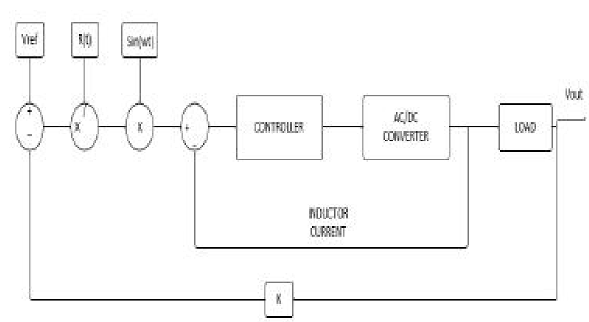

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Fig:1 Block diagram of the control methodology of Boost PFC Converter

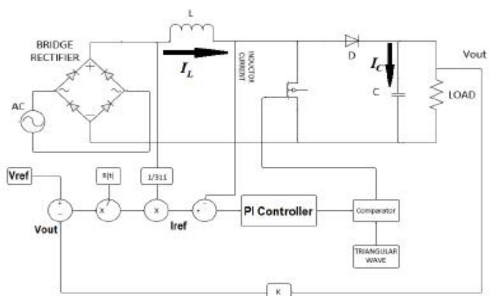

Fig:2 Schematic diagram of Boost PFC converter with control diagram

As discussed earlier, there are two states capacitor voltage and inductor current. Insystem both of these states need to be control only one control input available for controllinthis is an under actuated electric system.

III. CONTROLLER AND RESISTOR OBS

The control strategy of Boost PFC AC-Designed in such a way that, first it calculates tothe reference and the output voltage and then converted to the reference current that follows by multiplying it with the rectified sinus dividing it with the load resistance. Now thisis then subtracted from the actual inductor error, which is then fed to the controller to attacking. Fig. 2 is the schematic diagram ofDiode Bridge and controller. In equation (1)shown which is applied on the error obtained reference current $i_{ref}$from inductor current $i_L$the reference current i_{ref}waveform is generate output DC voltage, connected load andwaveform of AC voltage. $V_{ref}$is the desired othe converter and Vo is the actual output Volta resistive load is denoted by R(t) and k_1,$k_2$are the

$$u = K_p(i_{ref} - i_L) + K_i \int (i_{ref} - i_L)dt \quad (1)$$

$$i_{ref} = \frac{(V_{ref} - k_1 V_o)}{k_2 R(t)} |\sin(\omega t)| \quad (2)$$

$$R(t) = \frac{V_{ref}}{I_o} \quad (3)$$

$$I_o = (i_L - i_C)\bar{u} \quad (4)$$

$$i_C = C\frac{dV_C}{dt} \quad (5)$$

As output of the controller has to switch the power electronic switch of boost converter so we have to convert into PWM. In this paper, fixed frequency Sinusoidal PWM (SPWM) is used. As this converter is designed for variable Switching load sowe have to observe the value of load. As the equation of controller totally depend upon the generation of reference signal and reference signal depends upon co value of load must be known. The load described as:

IV. BRIDGELESS BOOST PFC CONVERTER

As the requirement of high power quality is always there so it is an active research area. Therefore, efforts are always made to get higher power factor and lower total harmonics distortionPreviously, boost power factor correction converter has beenwidely used because of its simplicity, inherent PFC Capability and high output power. But this g topology has harmonic distortions and low efficiency due to number of semiconductor switches in the line. To lower the losses and to increase theefficiency single phase bridgeless boost PFC Converter introduced [12]-[13]. In the literature bridge less boost AC-DC converter is also called as dual-boost converter .IN this converter the conduction losses are reduced due to reduction in the semiconductor switches in the path of current .Bridge less topology boost PFC converter is highly efficient topology because topology bridge-rectifier is omitted and there are only nonlinear switches in any given conduction path This bridgeless topology consists of two boost converters circuits .The control strategy is same as Boost PFC Converter ,but only difference is during positive half cycle is then used and during negative half cycle is converted in to positive half cycle by using bridge rectifier and then fed to the boost converter

A. Working principle of Bridgeless

This bridgeless topology is actually made from twoconverters that's why it is also know as dual converters .In conventional boost converter DC is fed to the inductor but in bridge less topology AC is directly fed between the

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inductors bridgeless topology AC is directly fed two DC converters.

There are four modes of operation of bridgeless power factor correction converter. Positive voltage consists of Modes I and II ac line voltage consists of modes III.

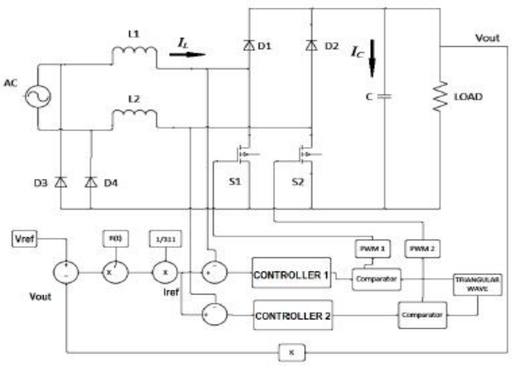

Fig. 3. Schematic diagram of Bridgeless Boost Converter

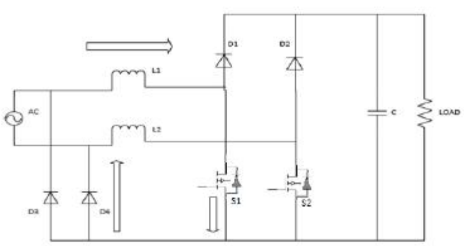

Fig. 4. Mode I positive half cycle

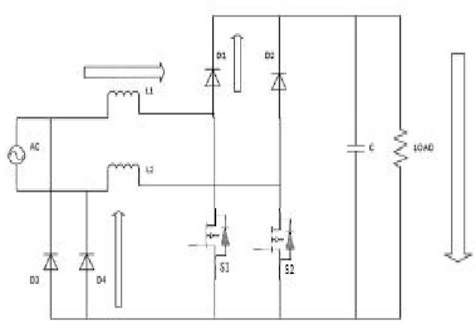

Fig. 5. Mode II positive half cycle

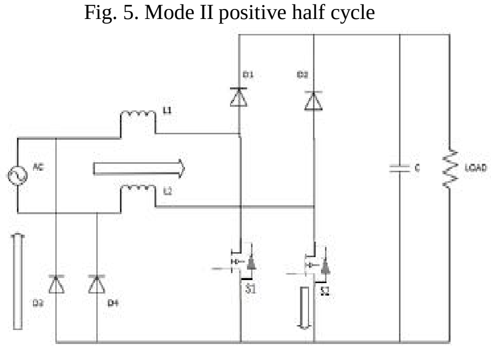

Fig. 6. Mode III negative half cycle

converter; L1-D1–S1-D4. Diode D4 completes the circuit without including the inductor L2 and connecting the output ground. Furthermore, there are two modes of operation of positive half cycle. Fig. 4 shows the working principle of mode I. The switchS1 is turned on to store the energy in inductor L1. The pathVin-L1-S1-D4 is followed in this mode. Fig. 5 shows the working principle of mode II in which switch S1 is in off state. As S1 is turned off so the current uses the path of diode D1 to pass through the load. In this mode the

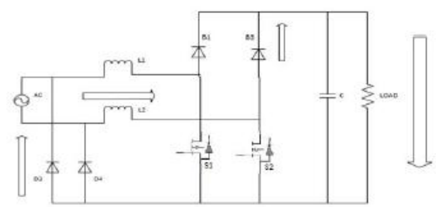

Fig. 7. Mode IV positive half cycle

charged inductor L1 of mode I gets discharged by using the path of diode D1, load and diode D4.

1) Negative half cycle

For the duration of the negative half cycle of the ac line voltage, the current follows the path of second dc/dc boost converter; L2-D2–S2-D3. Diode D3 completes the circuit without including the inductor L1. This diode also connects the ground with the diode D3. Same like positive half cycle there are two modes of operation of negative half cycle (Mode IIIand Mode IV).Fig. 6 shows the operation of mode III. The switch S2 is turned on to store the energy in inductor L2. The path followed during this operation mode, consists of Vin-L2-S2-D3.Fig. 7 show the mode IV of operation in which switch S2is turned off. As switch S2 is off so the current uses the path of diode D2 to pass through the load. In this mode the charged inductor is discharged through the path of diode D2, load and diode D3.

V. SIMULATION RESULTS

The projected power issue correction technique is simulated by mistreatment PSIM software package and also the results obtained square measure shown below. The values taken within the simulation circuit square measure given within the below table. the various results square measure shown & explained in brief.

TABLE I. PARAMETER TAKEN FOR SIMULATION

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Sl. No.	Name	Value
1.	Supply voltage	230V (P-P), 50Hz
2.	Source impedance	0.1mH
3.	Boost Inductor	2mH
4.	Output of Boost Converter	300V
5.	Non-linear Load	20mH, 500Ω, 1000μF
6.	Boost Converter	470μF, 100Ω, 10mH
7.	Hysteresis Band (h)	0.05

Fig. 9 shows totally different wave types of the system feeding to a non-linear load. Because the condenser is connected within the load facet to carry the DC output voltage, once the fast worth of

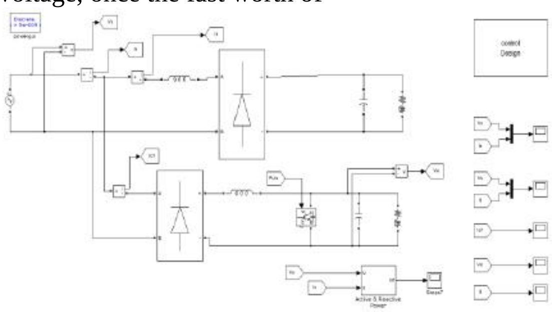


Fig 8 Simulink Model for Proposed PFC AC to DC Converter

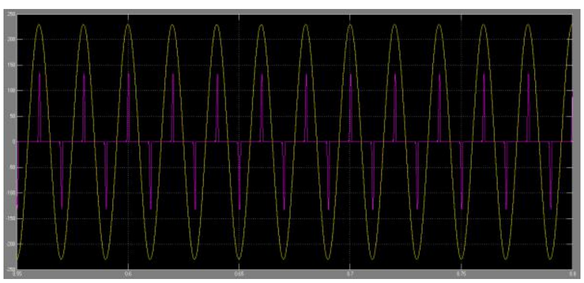
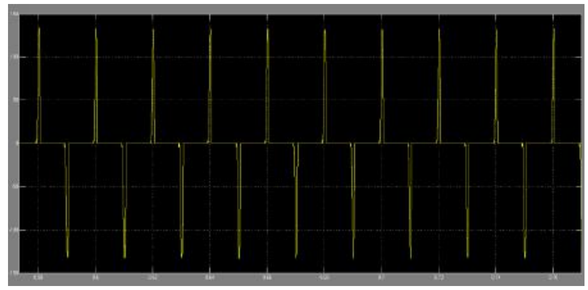


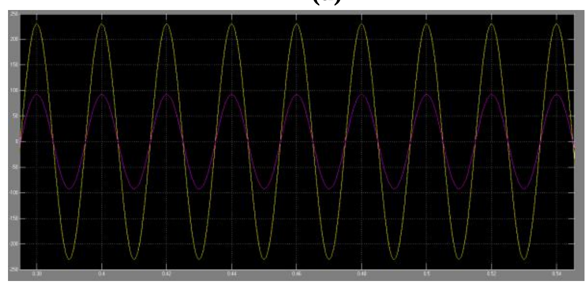
Fig.9. (a) Supply voltage & Non-linear load current

Fig.9 shows completely different waveforms of the system once Compensation mistreatment fluorocarbon boost device. As we know, the a lot of harmonics content within the offer current will increase the full harmonic distortion (THD) of the system thus the general power issue of the system decreases. This harmonic current ought to be removed at the purpose of generation. Therefore to get rid of the harmonic current generated by the non-linear load, a fluorocarbon boost device is connected in shunt with the non-linear load & the compensating current is formed in such some way that the full current drawn by the full arrangement becomes curving.

The supply feels the full arrangement to be resistive load and provide nearly curving current with nearly unity power issue. This drawn by the non-linear load is shown in Fig. 10 (a) and also the compensating current wave kind is



(a)



(b)

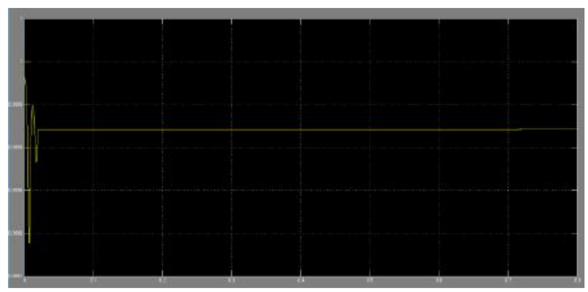


Fig.10. (a) Non-linear load current, (b) Compensating current, (c) Supply voltage and supply current (d)System Power Factor

Shown in the Fig. 10 (b) resulting supply current to be nearly sinusoidal shown in Fig. 10 (c). Using FFT analysis, we can see the harmonic content in the supply current with proposed technique is almost neglected. The lower order harmonics content in the load current almost removed and only fundamental current drawn from the supply shown in Fig. 10 (d), resulting supply current to reduce to 13% and improve the supply power factor to 0.993.

VI. CONCLUSION

This paper has presented one new and interesting AC/DC boost-type converters for PFC applications. Without using any dedicated converter, one converter can be used to eliminate the harmonic current generated by the other non-linear load. With the help of simulation study, it can be concluded that, this configuration removes almost all lower order harmonics, hence with this configuration we can achieve power factor nearer to unity, THD less than 15%. However, this technique can be limited to application

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where the non-linear load (pulsating) current is less and fixed. Besides, the literature review has been developed to explore a perspective of various configurations of for power factor correction techniques.

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