Power Factor Improvement Using Dc-Dc Converter In Bldc Motor Drives

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***Abstract*—This paper deals about the Power Factor Correction (PFC) in Brushless motor drives by comparing various DC-DC converter. Power factor corrected converter is essential to improve the Power quality (PQ). Speed control is done by Voltage Source inverter(VSI). In order to reduce conduction loss and number of components, diode bridge rectifier is eliminated. It is used to operate in DICM mode. The BrushlessDC motor is fed by bridge rectifier with a elevated rate of DC-link capacitor. It consequences in extremely pulled supply current and a poor power factor.To achieve power factor near to unity is used to new bidirectional bridgeless isolated cuk converter.when compared to conventional Converters Circuit efficiency is further improved.**

***Keywords*— Power Quality (PQ), Power Factor Correction (PFC), Bridgeless converters, cuk Converter, Bridgeless isolated cuk converter, Brushless dc motor(BLDC) .**

I. INTRODUCTION

Brushless DC motors are recommended for an many applications due to the absence of mechanical commutator. It causes less need maintenance and low EMI problem. BrushlessDC motor is more energy efficient than brushed DC-motors. The Brushless DC motor is smaller because its body has less heat to dissipate. It is applicable in many household appliances. Some of theadvantages such as reduced size,higher efficiency, no voltage drop across brushes, low electric noise [3].

BLDC motor consists no of brushesandcommutator. Rotor consists of Permanent Magnet, where stator consists of number of windings.So the current direction of the conductor on the stator controlled electronically. Hall sensor is used to determine the position during commutation. Rotor position depends on the accurate position with stator. It has semiconductor switches to turn the stator winding on and off at appropriate time. Switches current from winding to winding forcing the rotor to turn by varying pulse motor is rotated [16].

Electronically commutated motors are different from other motors like brushless DC motors.In brush-type motors, commutation is done with a commutator and brushes. In brushless motor with an electronically commutated, it is achieved by switching electronics. It obtains information on the position of the rotor by means of sensors with the help of microprocessor.Electronic commutation is achieved by using an three phase voltage source inverter (VSI) [10].

BLDC motor is connected after the diode bridge rectifier (DBR) and DC link capacitor. When DC link voltage is higher than the supply voltage .It draws current only for a small duration.Therefore, peaky current is strained from the ACsupply, it has elevated rate of harmonics which lead todeprived power factor (PF) [14].Power factor correction(PFC) converters are used to improve power factor.Therequirement of sensor plays major role in determiningoverall cost of the system. There are two mode ofoperation such as Continuous inductor current mode(CICM) and discontinuous inductor current mode (DICM)[4]. In the entire switching period the current in inductanceremains continuous. In CICM, or continuous conductionmode (CCM), whereas the current becomes discontinuousin DICM or DCM mode. 2-Voltage and 1-Current sensorsare required in CCM mode and it has lower current stress.In DICM single voltage sensor is required.It has lowvoltage stress and cost is low [7].In conventional method cuk converter is used for powerquality improvement at AC supply. It maintains constant DClink voltage.High switching loss is occurred so thebridgeless configuration is introduced.

II. BRIDGELESS CONVERTER

A. Types of Bridgeless converter

Bridgeless means Diode Bridge is eliminated at frontend. It reduces the number of semiconductor components.Switching loss and power losses is reduced. It usuallyoccurs in a diode bridge and as a result overall systemefficiency is improved. The occurrence of twosemiconductors switches in the

current path throughoutinterval it consequence in a smaller amount conductionlosses [19].

B. Bridgeless Boost converter

Figure 1 shows the Bridgeless Boost Converters. Abridgeless boost converter with low common mode noise ispresented in this paper. The numbers of components arecondensed by the magnetic components such as transformerand inductor on same core.Bridgeless power factor correction (PFC) circuittopologies are used to maximize the power supply efficiencyand conduction loss is reduced and the number ofsemiconductor components in the current path iscondensed. By replace a couple of bridge rectifiers andemploy an boost inductor is implemented.In bridgeless type, one rectifier is get rid of from thecontour path reduce the conduction loss.The further type works mutually in continuous conduction mode (CCM) anddiscontinuous conduction mode (DCM). This figure 1 utilizes the totem-pole collection in the reverse recoveryperformance of the anti-parallel diode.It can work only inDCM mode .It makes CCM operation impractical. Highcommon-mode noise produced in realistic application isvulnerable by a lofty frequency switching. Thisimplementations does not bear from the lofty noiseproblem [19].Bridgeless boost rectifier has several realistic problems.It has elevated output voltage than the crest input voltage,deficient in galvanic isolation and elevated initiate andinrush currents. An extra converter or isolation transformeris necessary for small output voltage purpose, for instancetelecommunication or computer to step-down the voltage.Three semiconductors in current transmission paththroughout all switching cycle is still suffers [1].

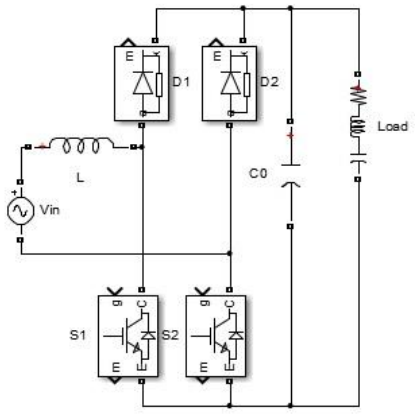

Fig 1. Bridgeless Boost Converter

C. Bridgeless Buck-Boost Converter

Figure 2 shows the Bridgeless Buck-Boost Converter.This converter is considered to work in DICM to offernatural PFC at AC supply. Rate of BLDC motor isprohibited by singlevoltage sensor. The commutation of motor provides a compact switching losses and frequencyswitching is specified by means of this commutation.In BLconfiguration eradication of the diode bridge rectifierdiminish the conduction losses related in it.Figure 2. Bridgeless Buck Boost ConverterDue to the usage of a smaller amount of apparatus anda single switch single stage PFC converter has higheffectiveness when evaluate to two stage converters. Theranking of the apparatus used in the converter create aserious concern since it straight affects the modes ofconverter. Two modes are continuous conduction mode(CCM) and discontinuous conduction mode (DCM) .Thecurrent or the voltage in the inductor remains uninterruptedin CCM mode [2] .It Sense dc linkage voltage and supply voltage. Singlevoltage sensor is needed for DCM. Hence, for low-powerapplications DCM mode is preferred. Bridgeless Buck –Boost converter has pulsed input current and hence itrequire input filter. It has peak input current in powercomponent. Power transient response make it less efficient [15].

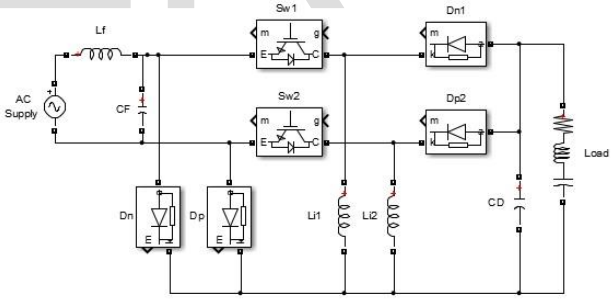

Fig 2. Bridgeless Buck – Boost Converter

D. Bridgeless SEPIC Converter

Figure 3 shows the Bridgeless SEPIC Converter.Inbridgeless sepic converter extraordinary intend of dc sideinductor is required to bear dc current and elevated rate ofwrinkle current. It requires three additional passive element.It adds the amount and mass of converter.It twice the outputvoltage and amount of output filter is increased.While working in Continuous conduction mode Voltageand current loop is necessary for usual PFC converters.When the converter function in discontinuous conductionmode the power circuit is easy and

current loop is notnecessary for the proposed converter.In Buck converteroffline small voltage power provisions is chosen to haveworse output than the input voltage.On the other hand, the buck converter has irregularinput current and a further passive filter is used to filter thecurrent.To determine this trouble, single ended primaryinductor converter (SEPIC) and Cuk converters is used.Control circuit is necessary in CCM mode,but in DCM,converter can work at permanent duty cycle to accurate theinput power factor (PF) [11] .In the power flow path three semiconductor devices isalready exist. To bear the dc current and high-frequencywrinkle current a unique design of dc-side inductor isessential. The bridgeless rectifier is projected to conquerthese problems. Therefore to contour input current towardsthe sinusoidal waveform additional passive filter isneeded.The converter is working in DCM due to thecontinuous input current.Three additional passive elements of this converter haveadd the mass and volume of converter. It twice the outputvoltage and volume of output filter is increased. BridgelessSEPIC converter is establishing to conquer these limits whilecompared to conservative SEPIC PFC.However theconverter has no supplementary elements.

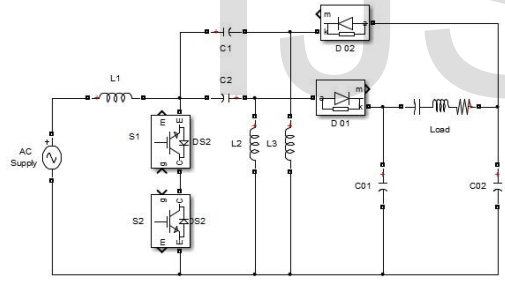

Fig 3. Bridgeless SEPIC Converter

E. Bridgeless ZETA Converter

Figure 4 shows the Bridgeless ZETA Converter. Singlevoltage sensor is used for devious voltage. PWM (PulseWidth Modulation) is the method used conventionally.VSIis novel scheme for calculating the speed and voltage. InBL-Zeta converter voltage follower technique is used infavour of voltage control which is operating in DCM(Discontinuous Conduction Mode).The concert of projected drive for a various choice of speed andvoltage is satisfactory.Switches stresses and heat sink design are also analysedfor their selection. To progress the power quality of BLDCit cannot be used for feeding. Boost converter with twostages is mostly chosen to work in DCM mode and forvoltage control a buck-boost converter has been generallyused. Two independent controls is essential or two stages.Owing to multiple stages losses is increased.Figure 4. Bridgeless ZETA Converterto overcome these disadvantages PFC converters with single stage is utilized for voltage control. Stresses involtage and current is take place across the switch. Stressesacross the switch is low in CCM mode but currentmultiplier approach is complex and two-voltage sensor andone-current sensor totally three sensors are required.Voltage follower approach for DCM mode is simple.Single voltage sensor is required but higher stressesoccur across the switch. For a low power rating DCMmode is preferred.It limits stresses across the switch, whereas for high power ratings CCM mode is used.Generally two switches are accomplished alternatively forpositive and negative half cycle. Power Factor Correctionof Zeta converter is extensively used for diverseapplications. For the improvement of BLDC motorBridgeless configuration in Zeta converter is stillunexplored in low cost.BL-Zeta converter with reduced sensor is offered. Highefficiency is achieved by reduced switching and conductionlosses. In the front end converter suitable rating ofMOSFET (Metal Oxide Semiconductor Field EffectTransistors) is used. Whereas for low frequency operationIGBT (Insulated Gate Bipolar Transistors) are used inVSI.Therefore switches and heat sink are selected.Commutation of BLDC motor electronically is achievedwith fundamental frequency switching. Due to ringing highvoltage stress is caused by the resonance [17].

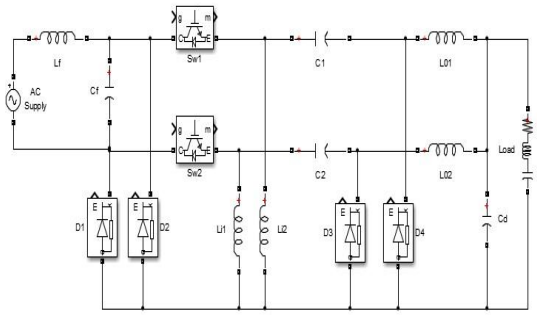

Fig 4. Bridgeless ZETA Converter

F. Bridgeless CUK Converter

Figure 5 shows the Bridgeless CUK Converter. CUKconverter in fact is a grouping of buck and boostconverter. The process during each sub-interval isdiscussed. Current Injected Equivalent Circuit Approach(CIECA) is a new technique that represents the minute andbulky indicator.Power factor correction (PFC) circuitproduces more

unusual concern for the earlier period.Due to its capacity switch-mode power supply (SMPS) draws energy from the mains efficiently. Two dioderectifiers are conduct repeatedly in usual converter but inbridgeless converter one diode rectifier is conduct,particularly in trigger state. Efficiency of the converter isenhanced by soft-switching technique and reducing theenergy loss in all component. Though, in Boost converter output voltage intensity iselevated for all time than the input voltage. The voltageintensity is about 50V or additional for a general PFCconverter, whereas the majority of the electronicapplications control at 5V to 50V DC for all time.Todecrease intensity of voltage another cuk converter isintroduce. Thus the converter is proficient to offer inferiorvoltage at output[8].A latest bridgeless Cuk converter is projected. Foremostcompensation of Cuk converter has prominent feature ofinput and output current. The main cause to validate theposition of inductance at the input and output of converteris that these two currents would never be turned OFFsuddenly. During each phase the amount of input diode isfewer compare to usual Cuk Converter. For instance in anycase two diode is perform for normal bridgeless PFC.In this converter one diode is conduct at all instance.The amount of apparatus used to extend the converter isfurther when compare to the other Cuk converter types. It isbecause of two Cuk converters are subsisting throughoutthe half-line period. Advantages of this converter such ascontinuous input and output current. For voltage controlvoltage follower approach is used. Output voltage can beeither superior or fewer than input voltage.It defends against the inrush current taking place atinitial or surplus current. It has worse current ripple .Fewerrange of heat sink is used for the witch. Non isolatedconverter cannot withstand high voltage. It create unwantedcurrent loop problem. It suppresses electrical noise [8].

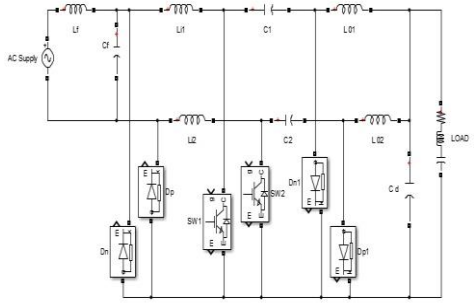

Fig 5. Bridgeless CUK Converter

G. Bridgeless ISOLATED CUK converter

Bridgeless isolated cuk converter means there is anelectrical isolation and no electron flow between two circuits.It withstands high voltage between windings. Itprevent unwanted current loop [5].Isolation betweenelectrical system prevent current flow.They do not conductdirectly. High frequency isolation is present in this isolationtransformer. It is bidirectional and it eliminates losses andcorono free operation.It withstands high vibration andvoltage [6].Energy can be exchanged between the section by means ofinductance, capacitance or electromagnetic waves.It isused for safety, preventing accidental current fromreaching ground through person body.Bridgeless isolatedcuk converter is used for wind,solar,fuel,hybrid vehicles,industrial drives andtransportation [12].

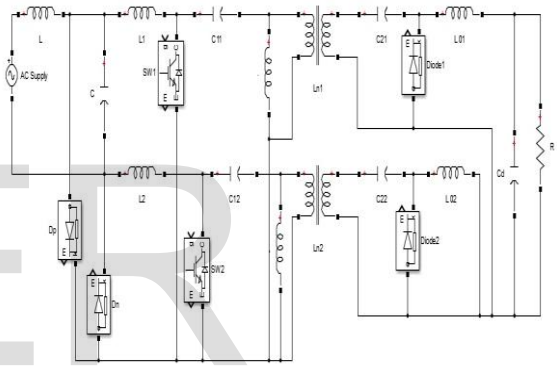

Fig 6. Bridgeless Isolated Cuk Converter

Comparative analysis of different types of Bridgelesstopologies for PFC in BLDC drives is shown in Table 1.

TABLE 1 COMPARATIVE ANALYSIS OF BRIDGELESS PFC CONVERTER TOPOLOGIES

Converter Topology	Component Count					Stability	Isolation
	SW	*D*	*L*	*C*	*Total*		
BL – BUCK	2	4	2	2	10	NO	NO
BL – BOOST	2	2	1	1	6	NO	NO
BL – BUCK	3	4	1	3	11	YES	NO

BOOST							
BL – CUK TYPE 1	2	3	3	3	11	YES	NO
BL – CUK TYPE 2	2	2	3	4	11	YES	NO
BL – CUK TYPE 3	2	3	3	2	10	YES	NO
BL – ISLOATED CUK	2	4	4	4	14	YES	YES

Bridgeless isolated Cuk converter has the followingadvantages:

1. There is an electrical isolation and no electronflow between two circuits.
2. It withstands high voltage between windings.
3. It prevent unwanted current loop.
4. Isolation between electrical systems preventscurrent flow. They do not conduct directly. Highfrequency isolation is present in this isolationtransformer. It is bidirectional and it eliminateslosses and corono freeoperation.
5. It withstands high vibration and voltage.
6. Energy can be exchanged between the sections bymeans of inductance, capacitance orelectromagnetic waves.
7. It is used for safety, preventing accidental currentfrom reaching ground through person body stability and isolation is more in Bridgeless isolated cukconverter when compare to other converter.

III. CONCLUSION

Comparative analysis of different types of Bridgelesstopologies for PFC in BLDC drives has been discussed.Bridgeless isolated cuk converter is most suitable. Itgives the high efficiency output, power factor near to unity,reduced torque ripples and good speed response for theBLDC drives while compare to the conventional PFCconverters.

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