Power Quality Improvement using Bridgeless Buck boost Converter fed BLDC Motor Drive

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Abstract: Power factor is an important performance parameter of a system. If the power factor of a system is low; it draws more current from the supply. So improving power factor is very much essential for better and economic performance of a system. One of the modern techniques employed for power factor correction is the use of Single-Ended primary-Inductor Converter (SEPIC). It can be used as preregulator operating in discontinuous conduction mode. But an important drawback of the SEPIC is the use of diode bridge rectifier which results in the conduction losses and low Power factor at the front end. Also Presence of harmonics decreases the system performance. For class-A equipment (< 600 W, 16 A per phase) which comprises household equipment, IEC 61000-3-2 limits the harmonic current of different order such that the total harmonic distortion (THD) of the supply current should be beneath 19%. So to overcome this drawback, a Bridgeless Buck Boost Converter is being proposed which ensures inherent PFC operation and reduces complexity in control. The present work is aimed at designing and fabricating a prototype of the bridgeless buck boost converter and thus improving the power factor on the utility side. The converter will also be modelled and simulated in MATLAB and the results analysed

Keywords: *BLDC motor, Power Factor Correction, THD.*

I. INTRODUCTION

Traditional AC rectification is very incompetent progression, which leads to waveform distortion of the current drawn from the mains. This produces a large range of harmonic signals that may meddle with supplementary utensils [1]. At superior power levels (200 to 500 watts and higher) rigorous intervention with other electronic utensils may become perceptible due to these harmonics introduce into the power utility line [2]. Another crisis is that the power utility line cabling, the installation and the distribution transformer is designed to withstand these peak current values resulting in higher electricity expenditure for any electricity utility company [2]. Conventional AC rectification has the following main disadvantages

(i) It injects harmonics and electromagnetic interference (EMI)

(ii) It has deprived power factor. (iii) It

induces high losses.

(iv) It requires over-dimensioning of parts.

(v) It reduces maximum power capability from the line.

In aforementioned years, single-phase switch-mode AC/DC power converters have been progressively more used in the commercial industrial, aerospace, residential, and military applications due to advantages of high smaller size, efficiency and weight. However, the propagation of the power converters draw pulsating input. current from the utility line, this not only diminish the input power factor of the converters but also interleave a substantive amount of harmonic current into the utility line To improve the power quality, various PFC schemes have been projected. There are harmonic norms such as IEC 1000-3-2 introduced for improving power quality [3]. By the introduction of harmonic norms now power supply manufacturers have to follow these norms strictly for the remedy of signal intervention problem .

The different methods of power factor correction can be classified as:

(i) Passive power factor correction techniques.

(ii) Active power factor correction techniques.

In passive power factor correction techniques, an LC filter is incorporate between the AC mains line and the input port of the diode rectifier of AC/DC converter.

This technique is rugged and uncomplicated but it has intense weight and immense size therefore power factor cannot be very high. Hence it is not valid for the recent trends of harmonic norms. Basically it is applicable for power rating of inferior than 25W [4]. For current power rating it will be bulky. In active power factor correction techniques approach, switched mode power supply (SMPS) method is used to shape the input current in phase with the input voltage. Thus, the power factor can reach upto unity. By the establishment of regulation standards IEC 1000-3-2 active power factor correction technique is used now a day. There are diverse topologies for implementing active power factor correction techniques. Fundamentally in this technique power factor correcting cell is used for tracking the input current in phase of input voltage such That input power factor come up to unity [5]. Comparing with the active PFC techniques, passive PFC techniques have many advantages such as abridged harmonics, high power factor, smaller size and light-weight.

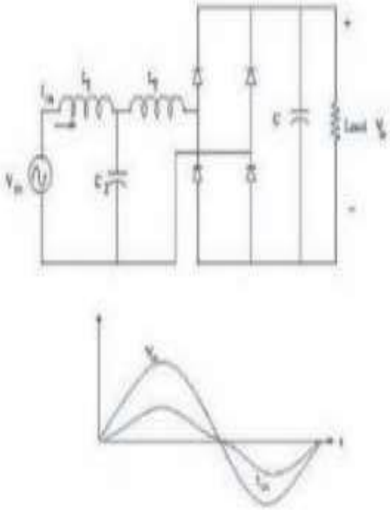

Fig 1: Passive PFC Technique Circuit Diagram

II. BENEFITS OF PF IMPROVEMENT

Power Factor is the ratio of active current to total current. It is also the ratio of active power expressed in (kW) to apparent power expressed in (kva). Power Factor is usually expressed as a decimal or as a percentage. The following are the possible reimbursement that can be achieved by correcting consumer's PF value The contract demand is the demand that the supplier of electric service agrees to have available for delivery. According to the Egyptian tariff structure escalation of PF may result in reduction of the consumer contracted power. Low PF cuts down distribution system capacity [7]. Similar capacity improvements are possible with cables, circuit breakers, and other electrical utensils. The capacity of all this equipment to provide useful power is reduced by low PF. In effect, improving PF will result in increased capacity in existing electrical distribution systems. This can help offset or reduce expenses for additional system capacity. While not a reason in itself for installing PF improvement equipment, better voltage stability is usually an additional benefit of PFC [8].

III. EXISTING SYSTEM

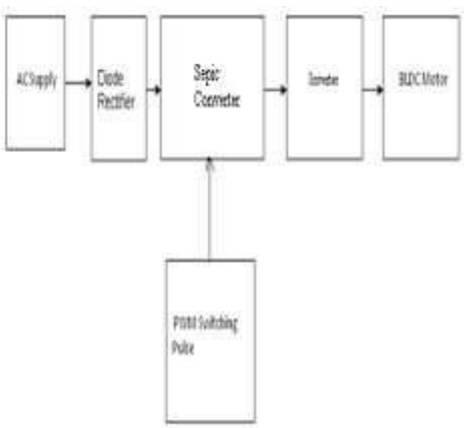

Fig 2: Block Diagram of Existing System

In existing system SEPIC converter is used as a power factor correction circuit [6]. Ac supply is converted into DC supply by using diode bridge rectifier. Output of diode rectifier is given as an input to the cuk converter. Output of cuk converter is given as an input to the inverter. Inverter converts DC supply into AC supply which drives the BLDC motor. Pulse width modulation technique is used to trigger the switches the switches used in the cuk converter and inverter circuit. The main drawback of existing system is usage of diode bridge rectifier introduces power loss in the circuit and reduces the efficiency of the system.

IV. PROPOSED SYSTEM

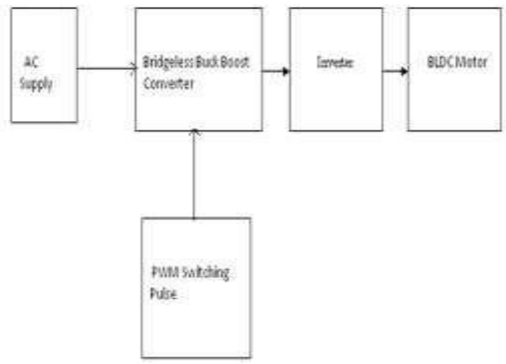

Fig 3: Block Diagram of Proposed System.

In proposed system bridgeless buck boost converter is used as a power factor correction circuit. AC supply is given as an input to the bridgeless buck boost converter. Output of the converter is given as a input to the inverter and inverter output is used to drive the BLDC motor. Depend on the signal sense in the hall sensor of BLDC motor inverter switches are turned on.

V. SIMULATION MODEL

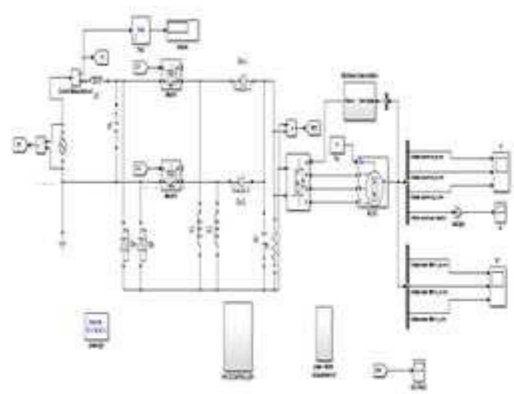

Fig 4: Simulation Model of Proposed System

Figure4 shows the simulation model of proposed system. Solver used in simulation model is discrete. BLDC Motor is used as a load and bridgeless buck boost converter is used as a power factor correction circuit.

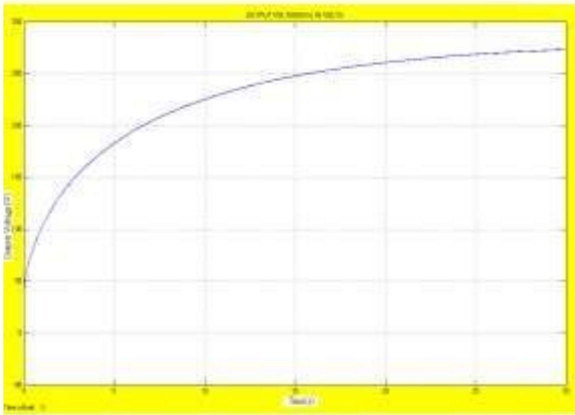

Fig 5: Bridgeless Buck Boost Converter Output for 230v input AC Supply

Above figure shows the bridgeless converter output waveform for the 230V input AC supply. For 230v AC input supply voltage, output voltage is boosted to 250v DC.

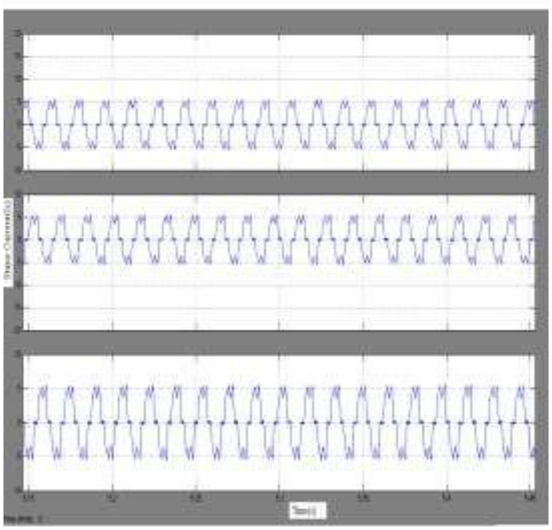

Fig 6: Stator Current Waveform of BLDC Motor for 230v AC supply

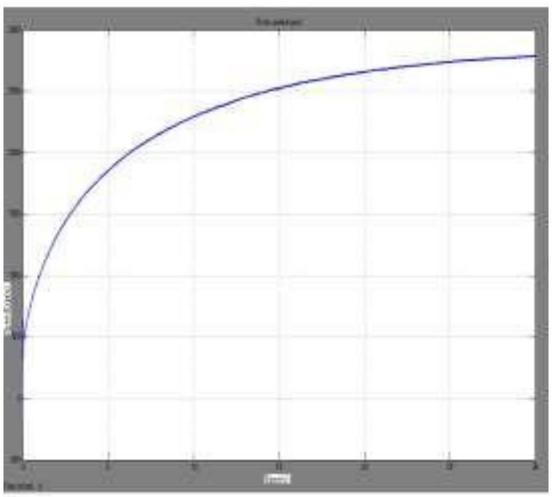

Fig 7: Speed Output waveform for 230v input supply

Above figure shows the speed output waveform for 230v input AC Supply. For 230V AC supply the speed value gets settle down at 2500 rpm.

Table I: Performance tabulation of Proposed System

I/P Voltage(Vac)	POWER FACTOR(PF)	THD	SPEED (RPM)
70	0.99	7%	250
150	0.99	7%	1250
170	0.99	7%	1550
200	0.99	7%	2250
230	0.99	7%	2600

Table1 shows the performance tabulation for variable input supply voltage. From the comparison table it is clear that for variation in input supply voltage Power factor is maintained at 0.99 and THD of the system is maintained at 7%.

CONCLUSION

From the simulation waveform and performance table it is clear that even if there is any variation in the input supply, the power factor of the system is and the total harmonic distortion of the system is maintained within their standard limit. When compared with the existing system, the performance of the motor was improved in the proposed system. In future, using a suitable optimization technique we can improve the system performance further.

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