Single Power-Conversion Ac–Dc Converter with High Power Factor Based On ZVZCS for Dc Drive Applications

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Abstract--- Single power conversion AC to DC converter is proposed in this project. For output control and correction of power factor, novel control algorithm is used in proposed converter. Single power conversion is provided by this. In Continuous Conduction Mode (CCM) operation, non-minimum phase behavior is exhibited boost converter. With Proportional-Integral (PI) voltage controller, in a digitally current-mode controlled boost converter, non-linear tuning method is proposed in this paper. System performance is enhanced by combing zero current and voltage with proposed digital pulse with modulation. Soft witching is produced by zero current and voltage switching. Losses in switching is reduced by this and efficiency of system is enhanced by this. In MATLAB, simulated this boost converter. With maximum power factor, output is produced.

Keywords--- CCM, PI, PFC, ZVS, MATLAB.

I. INTRODUCTION

In DC-applications from the AC-framework with Low consonant substance of the information current, control factor Correction converters, comprising of an extension rectifier and an exchanging DC-DC converter, are utilized. For low power Applications, DC-DC converters like buck, help, buck-lift, SEPIC Or CUK converters are frequently worked in spasmodic Conduction mode. He most well known topology for high power applications is the lift converter, worked in consistent conduction mode shows the fundamental topology of the lift PFC converter. At the point when the switch S is directing, the information Current L Will rise, expanding the vitality put away in the inductor(L).

Through diode D, current will flow, if switch is in off condition. Towards output capacitor, inductor energy will be transferred. Until reaching zero value or next on-time, there will be decrease in current in switch's off time. Parameter of converter defines the converter's operating mode.

At high value of input current, converted can be operated in Continuous Conduction Mode and at low value of input current, it can be operated in Discontinuous conduction mode. For obtaining resistive input, input voltage should be proportional to input current waveform and also for PFC. There will be sinusoidal function of average input current. Both conduction mode can be operated simultaneously. This corresponds to mixed conduction mode.

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Lower power operation of Mixed Conduction Mode corresponds to Continuous Conduction Mode operation, if designed a boost Power Factor Corrector converters. In entire grid period, it can be operated in Discontinuous Conduction Mode. Waveform of input current will be distorted and there will be dramatic rise in input current harmonics.

Converter dynamic change, input current sampling errors, parasitic effects produce this harmonics. For various power levels, switching frequency is changed for avoiding mixed conduction mode operation. Solution is needed, if low switching frequencies are undesirable, and load changes quickly.

For a DC Led strip light, better power factor is produced by a proposed digital pulse-width-modulated (DPWM) boost converter which is operated by an AC source. For applications in high power, it can be used due to alternating current characteristics. In large distance transmission also, it can be used. High DC control is required in low power devices and appliances.

Requirements of supplies having less harmonic content is increased in recent years as indicated by extensive usage of DC power supplies. Power factor of this supplies must be close to unity. There is a need for energy gain control and conversion. Bridge rectifiers are included in many power electronic converters. In nature, they are non-linear. This results in system with low power factor and high harmonic distortion.

High frequency dc to dc converter, dc-link capacitor and full-bridge diode rectifier are there in ac to dc converter. If dc link voltage is less than rectified line voltage, from ac line energy is absorbed by converter.

There will be high distortion in input current of this converters. Low power factor and high harmonics is produced by this. Developed various power factor correction ac to dc converters for rectifying harmonic pollution produced by ac to dc converters. Two power-processing stages can be used for implementing PFC ac to dc converter.

High power factor can be computed using PFC input stage with constant dc-link voltage. Boost converter is used by many of the PFC circuits. Desired output is produced by a high frequency dc to dc converter in output stage.

Control circuit with gate drivers and controllers are need by two power processing stages. There are two types of PFC ac–dc converter. They are single stage ac–dc converter and two-stage ac to dc converter. Two power processing stages will be there in two-stage ac to dc converters. Control circuits are included in that.

Power loss, cost of manufacturing are increased by a two-stage ac to dc converters. Efficiency and competitiveness of price of the system is reduced by this. Various single-stage ac to dc converters with less cost, size and components are presented.

Common switch can be shared by a high frequency dc to dc converter and PFC input stage, in order to simplify them. This eliminates, gate driver, PFC switch and PFC controller. In applications of low power, single-switch dc–dc converters like forward and flyback converters are used in single-stage ac to dc converters.

They are cost effective as well as simple. But, power switch's hard-switching operation produced high value of switching power losses. Asymmetrical pulse width modulation (APWM) half-bridge converter based single stage ac to dc converters are implemented for overcoming these drawbacks.

Power switches are operated in zero-voltage switching (ZVS) condition. So, their switching losses will below. When compared to two-stage ac to dc converter, low power factor or high voltage stresses is produced by conventional single-stage ac–dc converters. Dc-link electrolytic inductor and capacitor is required by single-stage ac to dc converter's PFC circuit.

Converter cost and size are increased by a dc-link electrolytic inductor and capacitor. From circuit, by removing dc-link electrolytic capacitor, this issue can be solved. But power factor is reduced.

Input current will be distorted by this. At input, there will be small amount of low-frequency power-ripple component. Instead of electrolytic capacitors, non-electrolytic capacitors like ceramic or film capacitor may be used.

Single-switch PFC ac–dc converters, commonly use this method. Converters with this method are having reduced cost and size, when compared with conventional single-stage ac to dc converters with the dc-link electrolytic capacitor. Due to hard-switching and discontinuous current mode (DCM) of operation, they exhibit a low efficiency and low power factor.

Inductor or capacitor's passive network can be used for doing linear load PFC. Reactive power with opposite sign in supplied by this network. Passive or active PFC is used for non-linear loads. Filters are used in passive PFC correction. This makes appearance of linear load of non-linear device. By using required inductors or capacitors, power factor can be made as unity.

II. LITERATURE SURVEY

Saijun Mao, et., al.,(2018), combined Zvs/Zcs Features with Active-Clamping Converter. In digitally controlled single-phase boost power factor correction rectifiers, minimization of input current harmonic distortion and enhancement of efficiency are explained in wide load range operation. In discontinuous conduction mode and continuous conduction mode, low harmonic operation is enabled by proposed predictive current control techniques.

Predictive current control law is facilitated by using a discontinuous conduction mode detection circuit. Transistor drain voltage is minimized by using adaptive switching. Current distortion is reduced and efficiency is enhanced by this method. At very light loads, efficiency is further increased by proposing adaptive switching frequency adjustment. Experimentation is conducted at 300 W digitally controlled boost Power Factor Correction rectifier.

Gabriel Chindris, et.,al., (2017) proposed a regulated output voltage, bus voltage, high power factor converter called Single-Stage Ac/Dc Converter. For digitally controlled boost power factor correction rectifiers, robust auto tuning method overview is presented. Digital perturbation signals are injected for perturbs voltage control loop and PFC current.

Filter capacitance and inductance values can be computed precisely by proposed method. This is an added advantage and detection of accurate boundary of discontinuous or continuous conduction mode is enabled by this. Transition effects are minimized by this, which in turn minimizes distortion in input current harmonics. With passive component tolerances typical range, stable system operation is guaranteed by plug-and-play-type auto tuner.

Sreevidya. E.V,et..al., (2016), presented an enhanced control method for Power Factor Correction in Ac/Dc Boost Converter. Power factor can be improved by this method. Controller has simple structure. Internal current loop and external voltage loop are there in conventional AC/DC PFC boost converter. DC bus voltage is regulated by a voltage loop and converter's input current is shaped by a current loop. Shape of rectified input voltage is followed by this. In current waveform distortion is produced due to low frequency ripples in output of PFC.

Voltage loop with very low bandwidth is used for avoiding this. During load transients, in DC bus voltage, PFC converter may have high overshoots due to this. Controllers based on CLF (control Lyapunov function) can be used for minimizing these issues. Load's specific profile forms base for those control laws. This is not available always. Boost converter's discrete energy error minimization based control law are computed to avoid these issues.

Wei Jiang, et.,al.,(2015) designed a Single-Stage Power Factor Correction Converter With A Feedback Winding and analyzed it. In this paper, for a digitally controlled SMPS, average inductor current sensor is described. Expansive Analog to Digital converter are not required for measuring average inductor current accurately. It also analysed stability conditions and dynamic performances. In a closed loop structure, this converter operates. High bandwidth can be produced by this.

Sensor concept feasibility is demonstrated by results of simulation. Digitally controlled current-mode Switch Mode Power supply is also implemented in hardware. For digitally controlled Power Factor Correction applications, it can be used because of its effective hardware realization and simple structure.

Bhim Singh, Brij N. Singh, et..al.,(2013) implemented a Single-Phase Improved Power Quality Ac–Dc Converters. Component selection, feature design, control methods, improved power quality converters (IPQCs) configurations are considered while implementing it for specific application with its selection and suitability.

For ac–dc conversion, with low radio frequency interference (RFI) at input ac mains, electromagnetic interference (EMI), high power factor, minimized harmonic currents and highly regulated dc output with high quality is produced by IPQC method. Due its enhanced reliability, low cost, high efficiency, small size, IPQCs is most commonly used for power quality improvement.
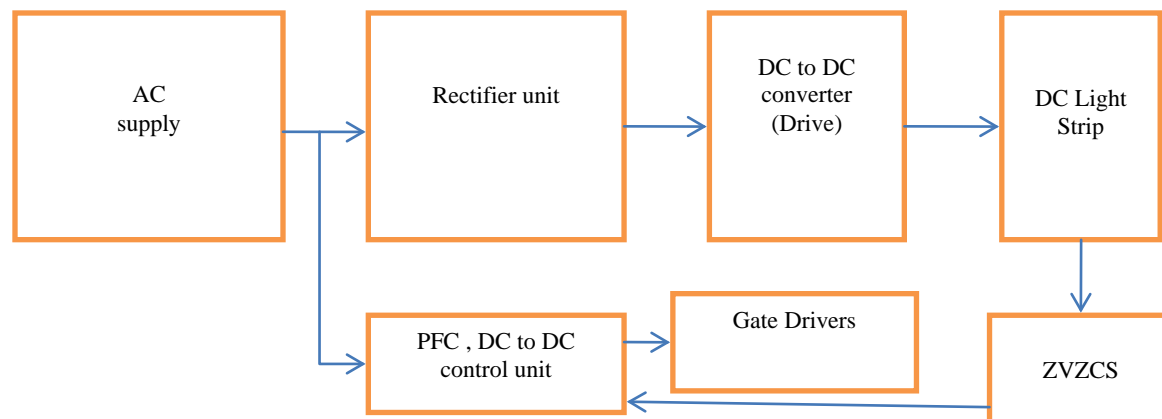
III. PROPOSED METHODOLOGY

Figure 3.1: Proposed System's block diagram

Converter's switching loss reduction is the major objective of soft switching converter. Figure 3.1 shows the proposed system's block diagram. For ripples in input current and output voltage, it has an advantage. Switching losses are reduced by this converter when compared with conventional boost converter. With high efficiency, solar cell's output voltage is boosted. Which is called the PFC is to reduce by using this mixed conduction mode and digital discontinuous mode this should be controlled by using the micro controller by the PWM pulse generation.

There are two single phase boost converters in boost converter. In parallel, they are connected. There will be a 180 degree difference between two PWM signals. Interleaving method is used for controlling switch. Magnitude of current in every inductor is decreased by factor 1/phase. During current flow in two boost inductor, inductance and size of inductor can be reduced. Input current corresponds to inductor L_1 and L_2's sum. This decreases, current ripple of input.

All the switches are Off Solar Power directly passes through load through the inductor and diode. And Zero current the switch SW1 is ON Acts like Short Circuit and increases the inductor current Minimum amount of current flows load through inductor and diode.

When current in diode becomes zero. Then the resonance operation starts as shown in diagram. Switch Sw1 is turned off at zero voltage condition. If resonant capacitor voltage becomes (Cr1) zero Then D1 and D2 are turned ON.

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Operation of the PFC

In this approach, a shunt is used to sense the total current. An average-current mode control is employed for forcing input current to track input voltage. Pulse-width modulation (PWM) controller generates two signals, each with the same duty ratio but shifted by 180° to drive the two boost stages. A current transformer (CT) is put right above the MOSFET in each phase to sense the switching current.

Method 1: Cycle-by-Cycle Duty-Ratio Adjustment

In this approach, a shunt is used to sense the total current. An average-current mode control is employed for forcing input current to track input voltage. Pulse-width modulation (PWM) controller generates two signals, each with the same duty ratio but shifted by 180° to drive the two boost stages.

Method 2: Half-AC-Cycle Duty-Ratio Adjustment

Since adjusting the duty ratio on each switching cycle brings high-frequency noise to the total input current, it seems reasonable to try adjusting the duty ratio only once in each half AC cycle. Either average or peak inductor current in each half AC cycle can be used for current balancing.

Method 3: Dual Current-Control Loops

In the preceding approaches, there is only one current control loop. The total current is used for current-loop control, and the two phases get the same duty ratio from the same control loop. If two current-control loops with the same current reference are used, with each controlling one phase individually, the closed-loop control will force the current to be balanced automatically, making duty ratio adjustments unnecessary. For analog controllers, adding one more loop means adding another compensation network and another feedback pin.

However, the loop bandwidth suffers due to the reduced control-loop speed, and a reduced bandwidth deteriorates PFC performance. Integrated control solution a second-generation digital controller such as the offers a different solution.

Power Factor Correction

For complying with standard, it requires a line current harmonics reduction. It is termed as Power Factor Correction (PFC). It may mislead. So, it requires a clarification. Ratio between active power P and apparent power S defines, power factor PF.

$$PF = \frac{P}{S}.$$
(1)

Classical definition for PF of pure sinusoidal current and voltage is given by:

$$PF = \cos \varphi,$$
(2)

Sinusoidal signal is assumed as a line voltage. So there will be a less value of total harmonic voltage distortion. Line voltage's total harmonic distortion includes this. $THDv \cong 2\%$. If there is a non-linear load, current will not be a sinusoidal one. So, it is not possible to apply power factor's classical definition. For voltage of sinusoidal and current of non-sinusoidal, following gives the value of PF,

$$PF = \frac{V_{rms}I_{1,rms} \cos \varphi}{V_{rms}I_{rms}} = \frac{I_{1,rms}}{I_{rms}} \cos \varphi = K_p \cos \varphi.$$
(3)

The factor

$$K_p = I_{1,rms}/I_{rms}, \ K_p \in [0,1],$$
(4)

Where, current and voltage's displacement factor is given by $\cos\varphi$. Displacement factor compensation corresponds to PCF.

$$THD_i = \frac{\sqrt{\sum_{n=2}^{\infty} I_{n,rms}^2}}{I_{1,rms}}.$$
(5)

It is straightforward to show that relation among THDi and Kp is:

$$K_p = \frac{1}{\sqrt{1 + THD_i^2}}.$$

(6)

On current's harmonic content, limits are defined by IEC 1000-3-2 standard. Line current THDi's total harmonic distortion or purity factor Kp are not regulate by this. Based on level of power and with compliance of IEC 1000-3-2, THDi and Kp values are defined. With standard, at low level of power, it is possible to comply line current with distortion.

There will be a close to unity value of waveforms distortion factor Kp which may have moderate THDi. With substantial harmonic content, it is possible to have high power factor. Harmonics with high amplitude will have huge effect of power factor PF. If not, the effect is not significant (large value of THD and low value of Kp). High power factor is not guaranteed by low harmonic content (low value of cosϕ and close to unity Kp value).

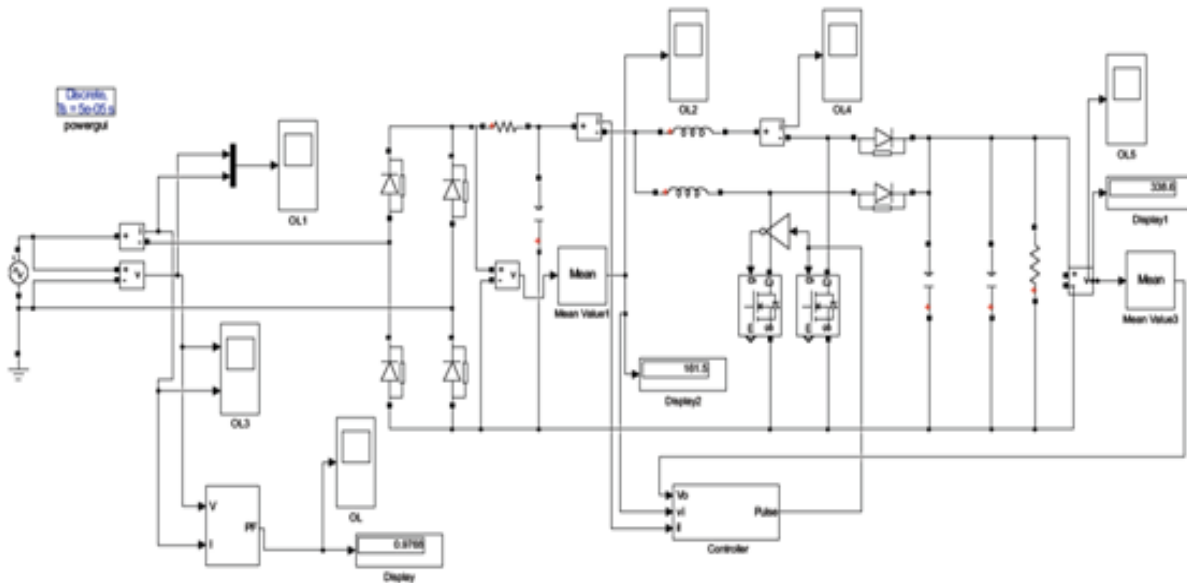## IV. SIMULATION MODEL AND OUTPUT WAVEFORMS

Figure 4.1: Proposed System Simulation Model

V. SIMULATION MODEL DESCRIPTION

The Proposed System Simulation Model Figure 4.1 given above is to design boost converter to produce output in continuous conduction mode. Full bridge rectifier circuit is used for rectifying AC input, which is derived from supply in first stage. Value of CL1 and CL2 defines the value of voltage and current from rectifier circuit.

There are some power factor minimization in rectified DC. Boost converter is used for this minimization. Conduction mode of boost rectifier is changed between discontinuous to continuous vice versa simultaneously.

This is termed as mixed conduction mode. Mean value is calculated by rectified DC supply and PWM generator is given with this. In circuit, current is enhanced by giving inductor with dc positive voltage. MOSFET drain is also given with this value. Current is made to flow gradually by connecting freewheeling diode. Converter output corresponds to an output voltage of booster.

Here, connected an additional boost converter. Pulse width modulated signal is used for controlling it. Generator produces this PWM signal. In circuit, power factor variation defines the dc supply. Input ac voltage based output current and voltage which are power factor corrected are plotted.

Output Waveforms

Figure 4.2 shows simulation results of input current and voltage w supply. Figure 4.3 shows simulation results of output voltage.
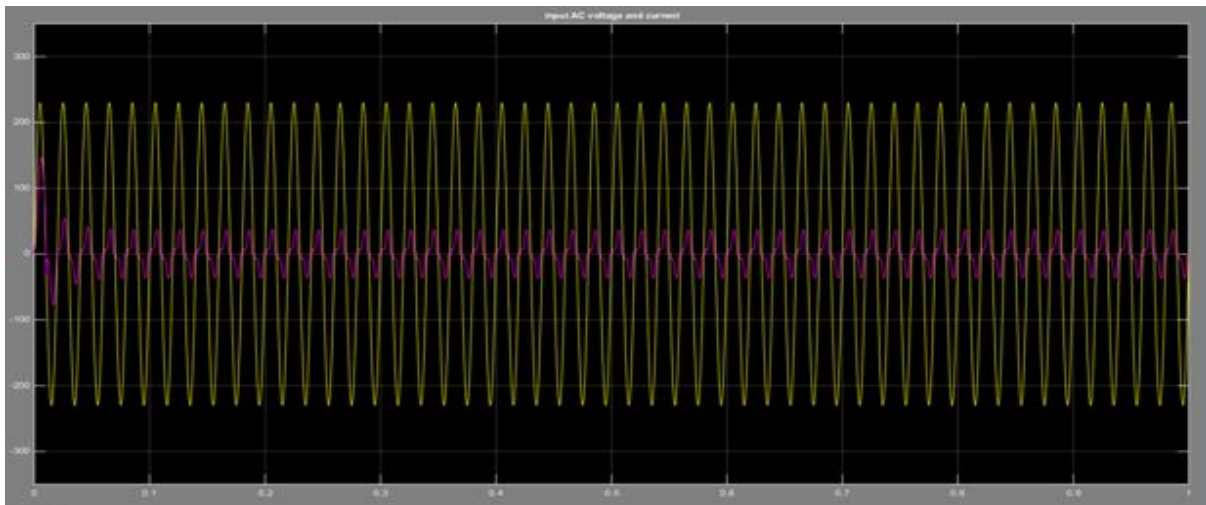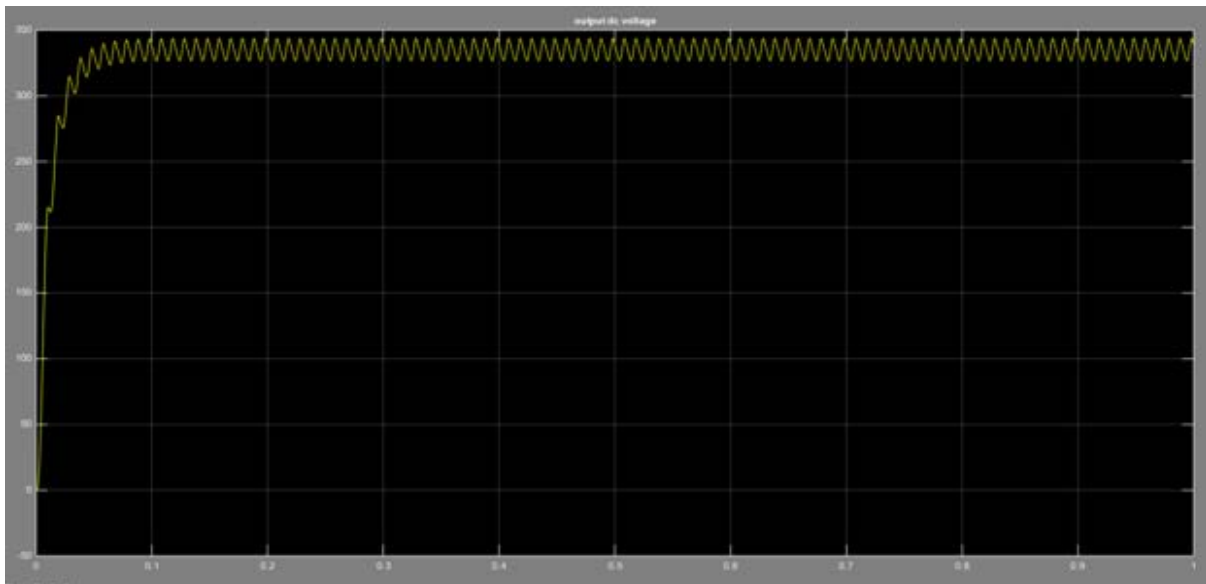

Figure 4.2: Input Voltage and Current waveform

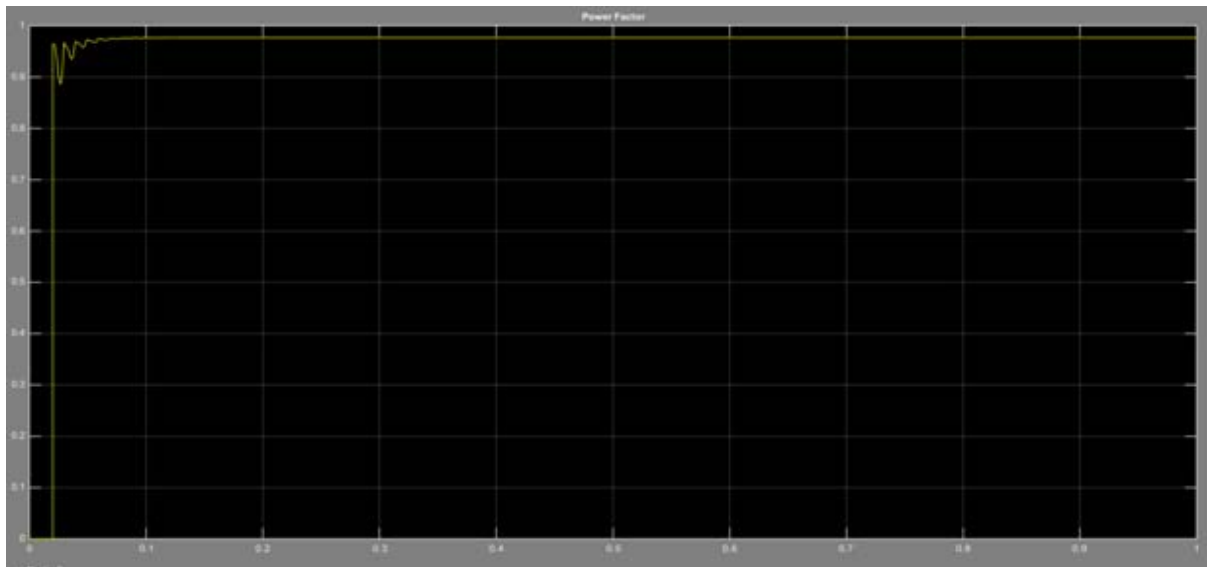Figure 4.3: Output DC Voltage waveform

Figure 4.4: Power Factor's Output Waveform

VI. CONCLUSION

Designed a high power efficiency and high power factor single power processing ac to dc converter. Proposed converter is analysed and presented its results of simulation. DC to DC converter and full-bridge diode rectifier is combined in the proposed converter. Fly back converter forms base for the series-resonant active-clamp dc to dc converter. At primary side of transformer, active clamp is applied and at secondary side, voltage doubler is applied in this method for reducing losses in switches. Leakage inductance of transformer effects the main switch's voltage stress. Single power conversion in proposed converter makes its structure as a simple one with low value of voltage stress and low cost. PFC circuit is not used in this. For application requiring low-power, proposed converter can be used. In MATLAB, analysed the results and simulated waveforms are used for verification.

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