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Harmonics and Stress Reduction by A 5 Level Dc Boost Converter Used For the Excitation System

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***Abstract*- This paper introduces new lift compose control factor corrector rectifiers that works in ceaseless conduction mode (CCM) and produces a multilevel voltage waveform at the information. Because of CCM activity, usually utilized air conditioning side capacitive channel and dc-side inductive channel are expelled from the proposed changed stuffed U-cell rectifier structure. The proposed transformer less, lessened channel, and multilevel rectifier topology has been examined tentatively to approve the great dynamic execution in producing and directing double 125-V dc yields terminals as media transmission board's feeders or mechanical battery chargers under different circumstance incorporating change in the heaps and change in the primary matrix voltage amplitude. High control factor or PFC support converter is utilized as a part of model which works in help mode. IGBT is utilized for exchanging activity and Model takes a shot at 50 Hz recurrence it utilizes Less no. of framework switches which decreases the framework stretch and Less number of switches lessens misfortune in influence and furthermore makes circuit basic and less expensive.**

Index Terms- Packed U-Cell, PUC5, HPUC, Buck PFC rectifier, multilevel converter, power quality.

1. INTRODUCTION

Ac–dc conversion of electric power is widely used in several applications such as adjustable-speed drives (ASDs), switch-mode power supplies (SMPSs), uninterrupted power supplies (UPSs), and battery energy storage. Conventionally ac–dc converters, also known as rectifiers, are developed using diodes and thyristors to provide uncontrolled and controlled dc power with unidirectional and bi directional power flow. Major drawbacks include poor power quality in terms of injected current harmonics; resulting voltage distortion, poor power factor at input ac mains, and slow varying rippled dc output at load end; low efficiency and large size of ac and dc filters.

Reduction of harmonic content with the consequent increase of power factor (PF) can be obtained by using either passive or active power factor correction (PFC) techniques. Passive methods include the use of tuned LC filters, what represents a robust solution. However, increased size, weight, and volume result. Besides, the passive filter may not respond adequately if the load power factor comes to vary. On the other hand, active methods come as a more efficient solution by using controlled solid-state switches in association with passive elements such as resistors, inductors, and capacitors.

In fact, the closed-loop operation of the static power converter dedicated to PFC assures satisfactory performance with high input PF and regulated dc output voltage over a wide operating range. Increased complexity and reduced robustness are distinct characteristics of this practice though.

In order to meet the requirements in the proposed standards such as IEC 61000-3-2 and IEEE Std 519 on the quality of the input current that can be drawn by low-power equipment, a PFC circuit is typically added as a front end stage. The boost PFC circuit operating in continuous conduction mode (CCM) is by far the popular choice for medium and high power (400 W to a few kilowatts) application. This is because the continuous nature of the boost converter's input current results in low conducted electromagnetic interference (EMI) compared to other active PFC topologies such as buck–boost and buck converters.

2. PFC BOOST CONTROL CONVERTER

Presently a day there are numerous machines that requires DC control supply. So to obtain this DC control, an interface must be given between AC line and the DC stack. By and large this change procedure is finished by single stage diode rectifiers. These converters redress the information AC line voltage to get DC yield voltage, yet this DC voltage sways between zero to top. To diminish this yield swell a channel capacitor is utilized, and that is the place the issue of energy factor and THD emerges. The capacitor keeps up the DC voltage at a steady esteem yet it draws non sinusoidal current from the supply. The capacitor draws current from the supply just at the line voltage crests. So the info current progresses toward becoming throbbing which brings about poor power factor and high THD.

PFC is utilized as a positive technique for enhancing the power quality. Basically PFC can kill symphonious wellspring of rectifier gadgets, through information current waveform consequently with input voltage waveform of the matrix, and get the previous waveform as sine waveform and have a similar waveform with voltage waveform on stage.

In this part we talk about the power factor remedy procedure and furthermore traditional control plot utilized as a part of lift PFC.

3. POWER FACTOR CORRECTION

Power factor is a measurement of the degree of utilization of the power from grid. It is define as the ration of the real power to the apparent power and the range of 0 to 1.

$$PF = \frac{Real\ power}{Apparent\ Power} = \cos\phi$$

For non-linear loads i.e. for sinusoidal line voltage and non-sinusoidal line current waveform the *PF* can be:

$$PF = \frac{V_v I_{1v} \cos\phi}{V_v I_v}$$

$$= \frac{I_{1v}}{I_v} \cos\phi$$

$$= K_p \cos\phi$$

Where,

$$K_p = \frac{I_{1v}}{I_v} = \frac{I_{1v}}{\sqrt{I_{1v}^2 + I_{2v}^2 + \ldots\ldots\ldots\ldots\ldots + I_{nv}^2}} \in [0,1]$$

is purity factor and represent harmonic content of the current associated to the fundamental; hence PF is proportional to both harmonic component and displacement factor.

The total harmonic factor is defines as:

$$THD_i = \frac{\sqrt{I_{2v}^2 + I_{3v}^2 + \ldots\ldots\ldots I_{nv}^2}}{I_{1v}} = \frac{\sqrt{\sum_{n=2}^{\infty} I_{nv}^2}}{I_{1v}}$$

Hence, $$K_p = \frac{1}{\sqrt{1 + THD_i^2}} \quad 3.5$$

Therefore with a substantial harmonic content a achieving of high power factor can be possible. The power factor PF isn’t much affected by harmonics, unless their amplitude is quite large (low, very large). Also small harmonic content doesn’t assure high power factor (Kp close to unity, but low cosΦ).

Hence in simple, the power factor correction is referred as the minimization of the line current harmonic. The main objective of the thesis is the power factor correction i.e.; maintaining a least phase angle between the input voltage and current with improved THD level i.e. keeping the harmonic content to a minimum level. The effect of harmonic and its problems on power system is observed as significant and hence Electricity regulatory commissions and utilities, all over the world are penalizing the users for harmonic dumping into the supply lines. Central Electricity Regulatory Commission of India has given guide line to Institute of Electrical and Electronics Engineers (IEEE) Standard 519-92 on permissible limits for harmonics in the electrical system [8] both the utility and users should know and understand.

4. CONVENTIONAL PFC TECHNIQUE

It is a technique of counteracting the undesirable effects of electric loads that create a power factor less than 1.When an electric load has a PF lower than 1, the apparent power delivered to the load is greater than the real power which the load consumes .Only the real power is capable of doing work, but the apparent power determines the amount of power that flows into the load, combining both active and reactive components.

Advantage of Peak Current control Method

- Fixed Switching Frequency
- In this method only switch current is sensed so it accomplished by a current transformer, thus it avoid the loss due to sensing resister.

- In this method we use current error amplifier so compensation network is not required.

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5. NON-LINEAR BOOST CONVERTER CONTROL

The Boost converter always needs extensive operating conditions and fast response, which is satisfactorily impossible by conventional PWM current mode controller. The non linear controllers offer control backing in this regards. In comparison to the conventional current mode controllers the nonlinear controller is able to provide:

- Fast dynamic responses
- Inherent robust features with fixed operating frequency
- Stable for large operating range
- Least deviation of settling time over wide operating range
- Low overshoots voltage relatively over wide operating range

WORKINGPRINCIPLE OF A BOOST CONVERTER

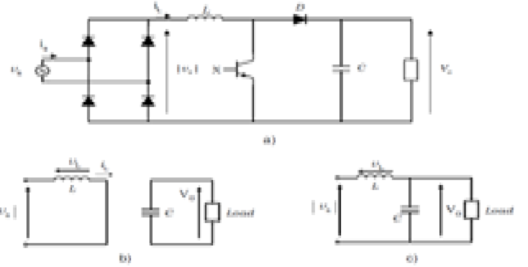


Fig 5.1 Boost converter

The input current is(t) is controlled by changing the conduction state of transistor. By switching the transistor with appropriate firing pulse sequence, the waveform of the input current can be controlled to follow a sinusoidal reference ,as can be observed in the positive half wave in Fig.5.2(a,b).This figure shows the reference inductor current iL ref, the inductor current iL, and the gate drive signal x for transistor. Transistor is ON when x=1and it is OFF when x=0.The ON and OFF state of the transistor produces an increase and decrease in the inductor current

5.1 Proposed methodology & results

High power factor or PFC boost converters are one of the mostly used equipment in the industries. The main concerns of such converters are the unity power factor operation and low harmonic distortion of the input AC waveforms that can be ensured by generating a DC voltage higher than the grid peak voltage amplitude, which makes use of switching devices inevitable. Conventional two-level rectifiers known as full bridge converters have been working for many decades satisfactorily, however they are being replaced by emerging multilevel converter technologies. The multilevel converters produce more voltage levels decreasing the voltage and current harmonics significantly while operating at lower switching frequency. Multilevel converters are comprehensively investigated as DC-AC energy conversion mode and now they have found many applications in AC-DC power conversion systems called rectifier

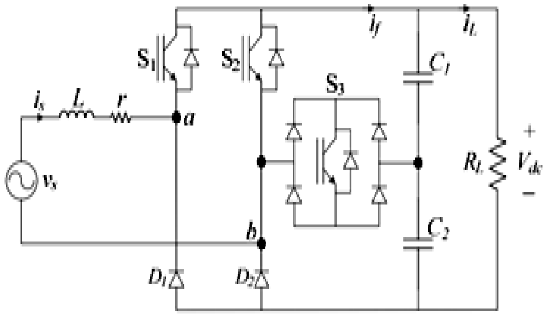


Fig 5.2 Proposed Boost Converter for Power Factor Improvement

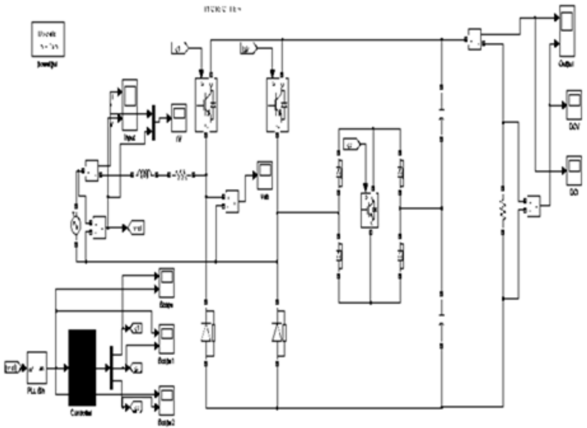
5.2 Simulation Model

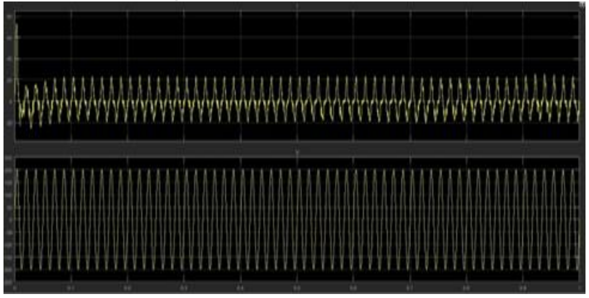
For showing the dynamic behavior of the proposed work is implemented in the MATLAB software. Here for simulation use sim power system tool box. The simulation mode is use variable step discrete with simulation time of 50µs.

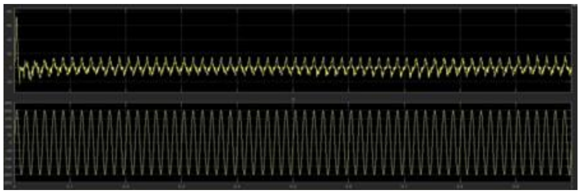
Table 5.1 Parameter used in proposed work

System Parameter	
AC Supply Voltage Peak Value	120 V
AC frequency	50Hz
Inductor size	2.5mH
DC Voltage	220 V
DC Capacitor (C_1& C_2)	47000µF
DC Load (R_L)	100Ω
Switching Frequency	5kHz

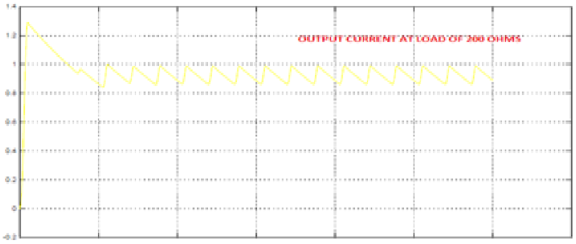
This section deals the result obtained from the simulation of proposed work. The following results are obtained with the simulation of the 5 level PFC boost converter which is proposed in previous chapter.

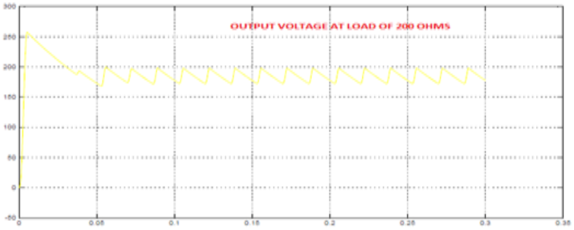






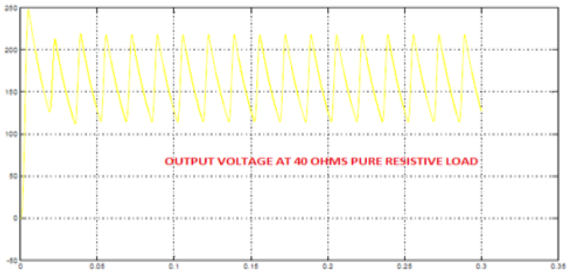
Input supply from grid for load 200 omhs



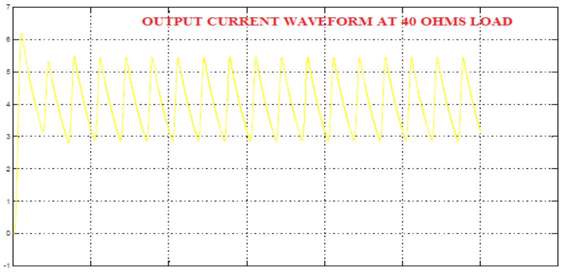


6. TEST RESULTS FROM THE BOOST CONVERTOR MODEL

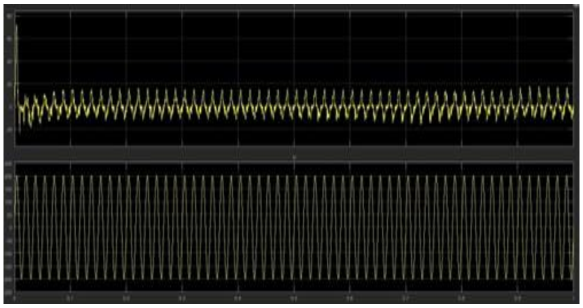
Input supply from grid for load 40 ohms



Output from boost converter load at 40 ohms



Output from boost convertor for load at 200 ohms



Test results from base paper

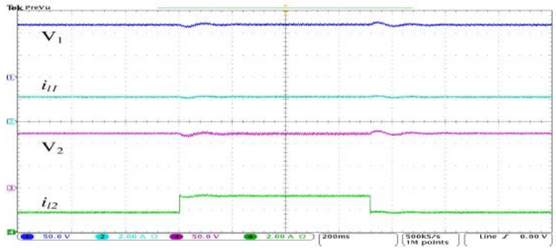


Fig. 11. Test results during 50% decrease in load$_2$ from 80 to 40 Ω.

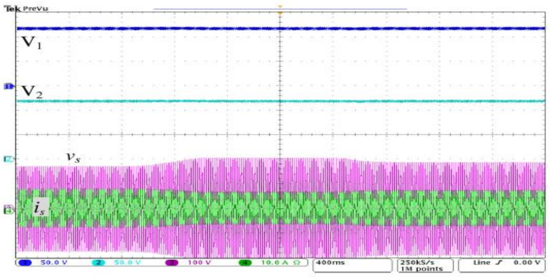
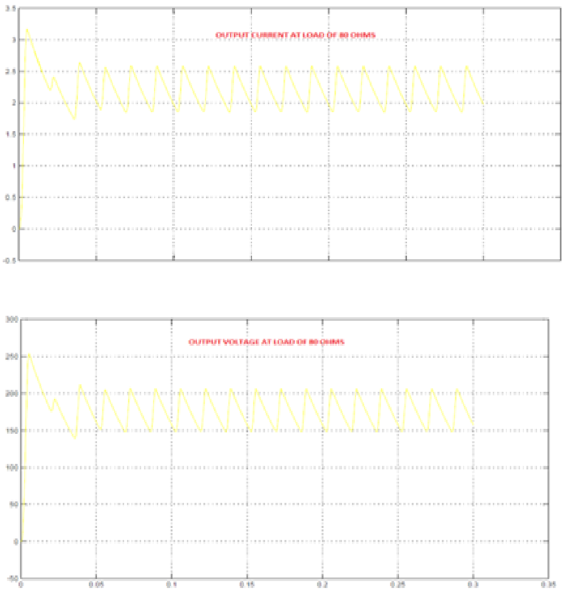


Fig. 12. Supply voltage variation while the output dc voltages are regulated at 125 V as buck mode of operation.

Input supply from grid for load 80 ohms



Output from boost convertor for load at 80 ohms

7. CONCLUSION

AC-DC conversion is now widely used in many applications like SMPS, ASD's battery charging unit etc. Multilevel converter is now use for producing low harmonics. This thesis based on the new topology for AC-DC conversion with reduces number of switch.

For completing of thesis firstly survey the literature of given in chapter 2. In chapter 3 discuss the various approach for control methodology of the converter. On the basis of this here proposed new topology for power factor correction. Here in thesis a reduce number of switch is used for generation of 5 level boost converter. For conversion of AC-DC here required three switches.

To validation of the system, the system is simulated in MATLAB software. MATLAB software is powerful software for simulation of the work. Results show the proposed system produce unity power factor shown in result section. Also produce DC output for rectification.

7.1 Future Work

Every work has some drawback. This drawback is used for advancement in future work. Some of important future work as:

- The proposed system is based on single phase supply system. In future this system is applicable in 3-pgase system to.
- In this proposed work harmonics related topic is not consider so in future harmonic related work is consider.
- In future increasing level is considered for more advancement or reduction in harmonics.

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