JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DESIGN AND IMPLEMENTATION OF FUZZY BASED PFC USING INTERLEAVED BUCK BOOST CONVERTER

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ABSTRACT:

The technology for developing power factor correction is increasingly being discussed because of the increasing number of nonlinear loads that exist. This is related to power quality which can affect load system performance because nonlinear loads cause low power factor and the appearance of harmonic currents. However, it takes a power factor corrector converter that has a simple construction and reliable performance. Interleaved buck Boost Converter is often applied as a power factor corrector converter because it has these advantages. Combined with a fuzzy controller it is a proposed system to achieve a near unity power factor. The discontinuous Conduction Mode (DCM) technique is used because it has an efficient inductor design. The results of the proposed system design were proven by simulation and hardware implementation which resulted in significant power factor improvements.

Keywords: Interleaved buck Boost Converter, Conduction Mode (DCM) & Interleaved buck Boost Converter (IBC)

1. INTRODUCTION

Interleaved buck Boost Converter (IBC) is commonly used for power factor correction (PFC) due to its advantages of low current ripple, small filtering volume and high power density, etc. Power-density is a key factor that limits application of IBC PFC, where requires small volume and light weight, such as on-board charger (OBC), laptop adapter and aircraft power supply. Heat sink, which is used to transfer heat generated by power loss to maintain working temperature of devices at the proper range, occupies a lot of volume in PFC. Therefore, it is necessary to reduce heat sink volume through increasing efficiency. If efficiency can be increased without adding any hardware cost and software cost, then total loss and heat can be decreased, heat sink volume can be reduced and power-density of IBC PFC can be increased. Many researchers have been conducted on improving efficiency of PFC by modifying topology to create soft switching condition for reducing switching loss.

2.LITERATURE REVIEW

A New Current Phasor-Controlled ZVS Twin Half-Bridge High-Frequency Resonant Inverter for Induction Heating Tomokazu Mishima (2013): A novel soft-switching high-frequency (HF) resonant (HF-R) inverter for induction heating (IH) applications is presented in this paper. By adopting the current phasor control of changing a phase shift (PS) angle between two half-bridge inverter units, the IH load resonant current can be regulated continuously under the condition of wide range soft-switching operations. In addition to this, the dual mode power regulation scheme based PS angle control & asymmetrical pulse-width modulation (PWM) in one inverter unit is proposed for improving the efficiency in low output power settings. The essential performances on the output power regulation and soft-switching operations are demonstrated in an experiment using its 1kW- 60 kHz HF-R inverter prototype, then the topological validity is evaluated from a practical point of view.

High Power Density Series Resonant Inverter using an Auxiliary Switched Capacitor Cell for Induction Heating Applications

Bishwajit Saha, Rae-Young Kim (2013)- This project proposes a unique topology of voltage fed high frequency series load resonant inverter with a lossless snubber capacitor and an auxiliary switched cell for induction heating appliances. The main objective of this paper is to demonstrate how high power density can be achieved by including a switched capacitor cell with the capacitor-clamped half-bridge ZVS high frequency inverter circuit using the PWM control scheme. The operation principle of the proposed inverter circuit is based upon an asymmetrical duty cycle PWM control scheme. The operating performances of high frequency AC regulation and power conversion efficiency characteristics are shown through experiments with their soft-switching operating ranges.

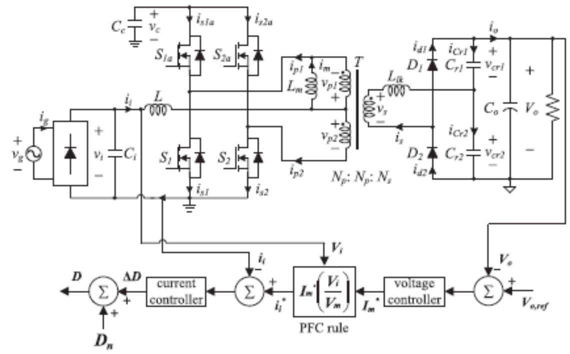
PV STRING PER-MODULE MAXIMUM POWER POINT ENABLING CONVERTERS

G.R. Walker (2011): Many grid connected PV installations consist of a single series string of PV modules and a single DCAC inverter. This efficiency of this topology can be enhanced with additional low power, low cost per panel converter modules. Most current flows directly in the series string which ensures high efficiency. However parallel Cuk or buck-boost DC-DC converters connected across each adjacent pair of modules now support any desired current difference between series connected PV modules. Each converter "shuffles" the desired difference in PV module currents between two modules and so on up the string. Spice simulations show that even with poor efficiency, these modules can make a significant improvement to the overall power which can be recovered from partially shaded PV strings.

3. EXISTING SYSTEM

The existing converter consists of a full-bridge diode rectifier, an isolated resonant dc–dc converter, and only one controller. The existing converter provides the PWM technique for all components operating at low frequency, allowing for an improvement in power density without a cost of power-conversion. Furthermore, by using a controls power factor and output power, the converter performs ac–dc power conversion in only a single-power processing step.

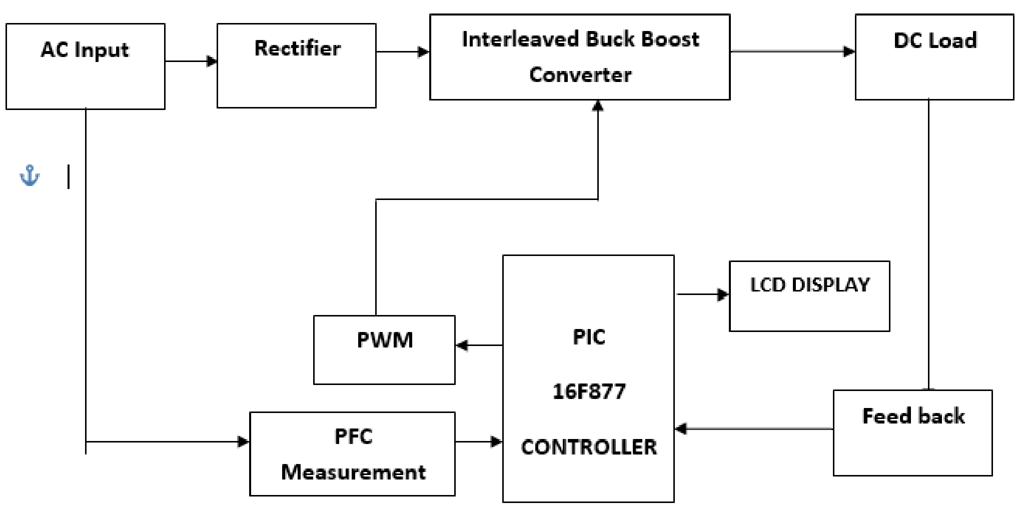
4. EXISTING BLOCK DIAGRAM



5.PROPOSED SYSTEM

The development of new families of Interleaved Buck Boost Converter topologies used in the design of dc–dc converters with active power factor corrections (PFC's). The goal is to design high-efficiency and high-power density converters with improved power factor and low electromagnetic interference. In recent years, as the new standards became compulsory regarding limiting the total harmonic distortion and input power factor in power electronic circuits. Active PFC circuits that use pulse width modulation (PWM) switch-mode topologies such as the boost, buck–boost, and their derived ones have been used dominantly.

5.1. BLOCK DIAGRAM OF PROPOSED SYSTEM



6. RESULT AND DESCUSION

6.1 SOFTWARE SIMULATOR

MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Typical uses include:

Math and computation

Algorithm development

Modeling, simulation, and prototyping

Data analysis, exploration, and visualization
Scientific and engineering graphics
Application development, including Graphical User Interface building
MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or FORTRAN.

Modeling and Simulation

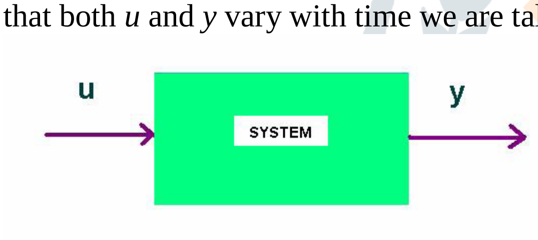
Matlab has several auxiliary Toolboxes distributed by Math works, Inc., which are useful in constructing models and simulating dynamical systems. These include the System Identification Toolbox, the Optimization Toolbox, and the Control System Toolbox. These toolboxes are collections of m-files that have been developed for specialized applications. There is also a specialized application, Simulink, which is useful in modular construction and real time simulation of dynamical systems.

System Identification

The System Identification Toolbox contains many features for processing experimental data and is used for testing the appropriateness of various models by optimizing values of model parameters. It is particularly useful in working with dynamical systems data and time series analyses. This toolbox is included in the Matlab installations on all the ITS servers. The identification process is a bit complex, but a guided tour through a simple example can be accessed with the iddemo command at a Command Window prompt.

Using Simulink

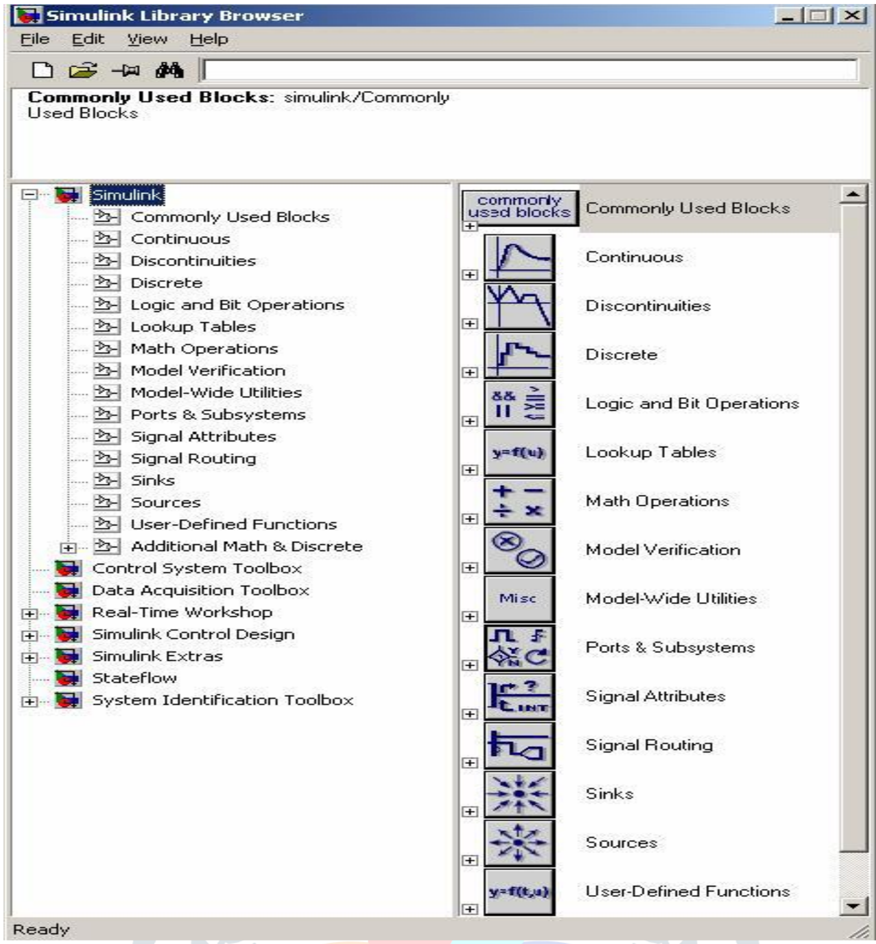
Simulink is a simulation tools library for dynamical systems. Any system in nature can roughly be thought of as a "black box" receiving an input vector *u* and eliciting a unique output vector *y*. In the case that both *u* and *y* vary with time we are talking about dynamic systems.



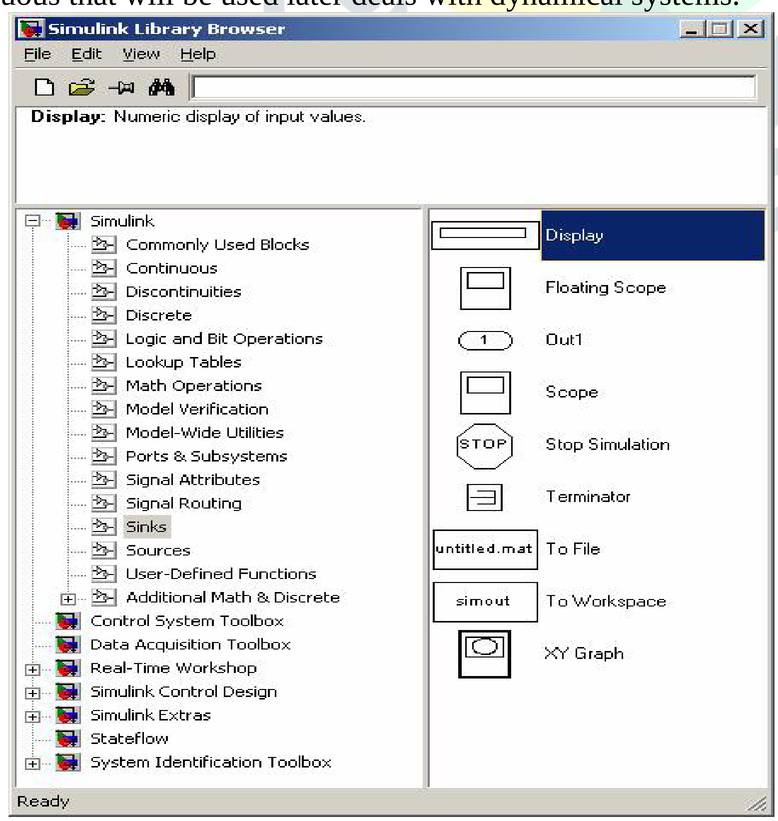
Associated with a system is the so-called state vector which loosely speaking contains the required information at time that together with knowledge of the input for time greater than, uniquely determines the output for. A general continuous dynamical system can be modeled by using the following set of ordinary differential and algebraic equations.

Simulink Library Browser:

Simulink can be launched by typing
>> Simulink
in the Simulink icon in the Command window of the default Matlab desktop.



The library's functionalities are divided into eight groups (click on any of the category icons for both the UNIX or Windows versions). For example, the categories Sources and Sinks contain various kinds of inputs and ways to handle or display the output respectively. Also, it contains the group Continuous that will be used later deals with dynamical systems.



Simulink Subsystems

In Matlab programming, functions are used to encapsulate a computation so that it can be used repeatedly without having to duplicate code wherever it is needed. In addition, a function can insulate its calling script from having to worry about its implementation details. In Simulink, subsystems play a similar role. Using subsystems in Simulink has these advantages:

It helps reduce the number of blocks displayed in the model window.

Functionally related blocks can be kept together.

It permits the establishment of a hierarchical block diagram, wherein a Subsystem block is on one layer and the blocks that make up that subsystem are on another.

In Simulink, a subsystem can be created in two ways:

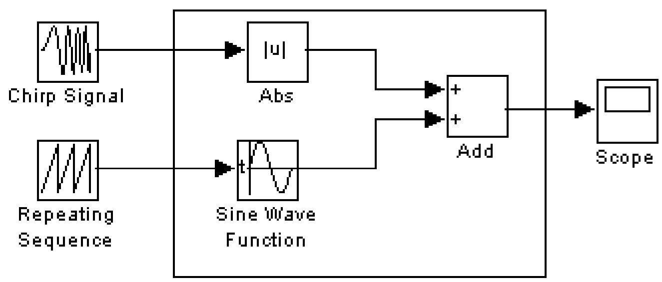
One way is to add the blocks that make up the subsystem to the model, then group those blocks into a subsystem.

The other way is to first add a Subsystem block to the model, then open that block and install the component blocks of the Subsystem to the subsystem window.

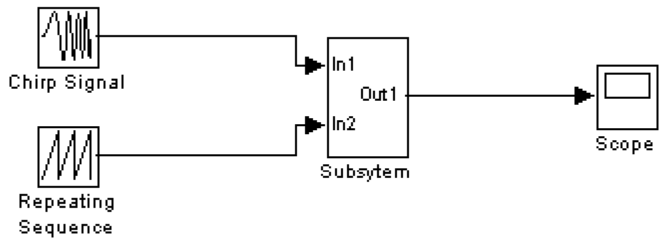
Grouping existing blocks into a Subsystem

If a model already contains the blocks needed for a desired subsystem, you can create the subsystem by grouping those blocks:

Enclose the blocks and connecting lines that you want to include in the subsystem within a bounding box. For example, the figure below shows a model that does signal processing. The Abs, Sine Wave Function and Add blocks that do the signal conversions are selected within a bounding box. The box illustrated can be selected by clicking the mouse at the upper left position, and then while depressing the right mouse button drag to the lower right position.



The components within the box will be selected when the mouse button is released. Choose *Create Subsystem* from the *Edit* menu. Simulink replaces the selected blocks with a Subsystem block. The figure below shows the model after the *Create Subsystem* command has been chosen. If necessary, the Subsystem block can be resized so that the port labels are readable).



Creating a Subsystem by adding a Subsystem block

The process of creating a subsystem before adding its component blocks usually consists of three major steps:

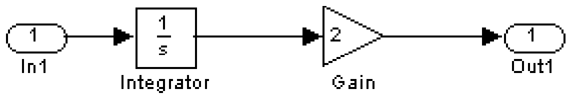
1. Copy the Subsystem block from the Ports & Subsystems library into your model.

2 Open the Subsystem block by double-clicking it. Simulink opens the subsystem in the current or a new model window, depending on the model window reuse mode that you selected.

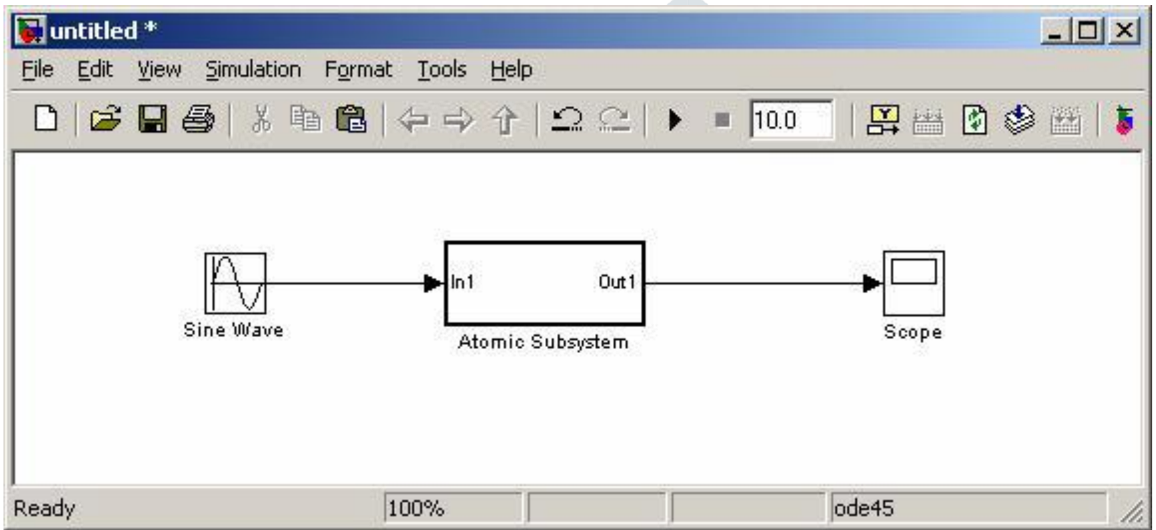
3. In the empty Subsystem window, create the subsystem. Use Inport blocks to represent input from outside the subsystem and Outport blocks to represent external output.

Here is an example which models an integrator system.

1. From the Simulink Library Browser, go to the Ports & Subsystems subdirectory. Click-drag the Atomic Subsystem block into the Model window.
2. Open the subsystem block by double-clicking the subsystem block.
3. Delete the line connecting In1 block and Out1 block.
4. Insert blocks into this subsystem window as prescribed in the figure below and then fix the block layout and connections between blocks.

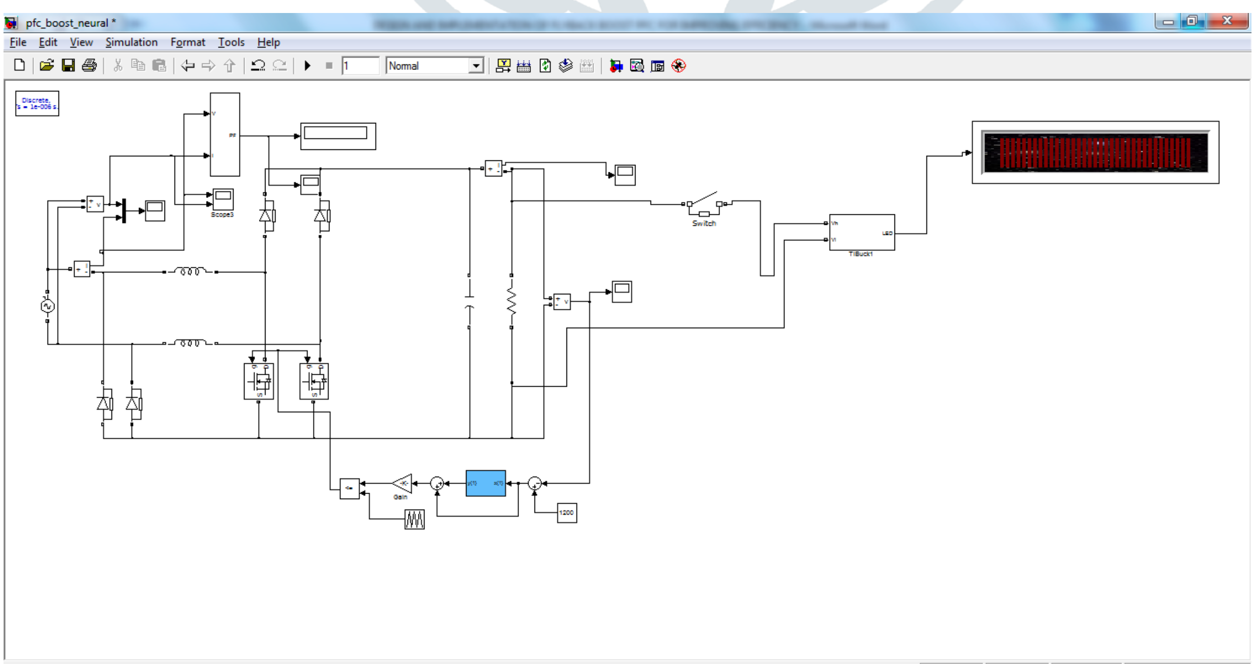


5. Click on the *Go to parent system* button or choose *View > Go to the Parent* from the navigation bar. This will send you back to the underlying Model window.
6. Go back to the Simulink Library Browser and add sine wave function and scope blocks into the Model window as described below.



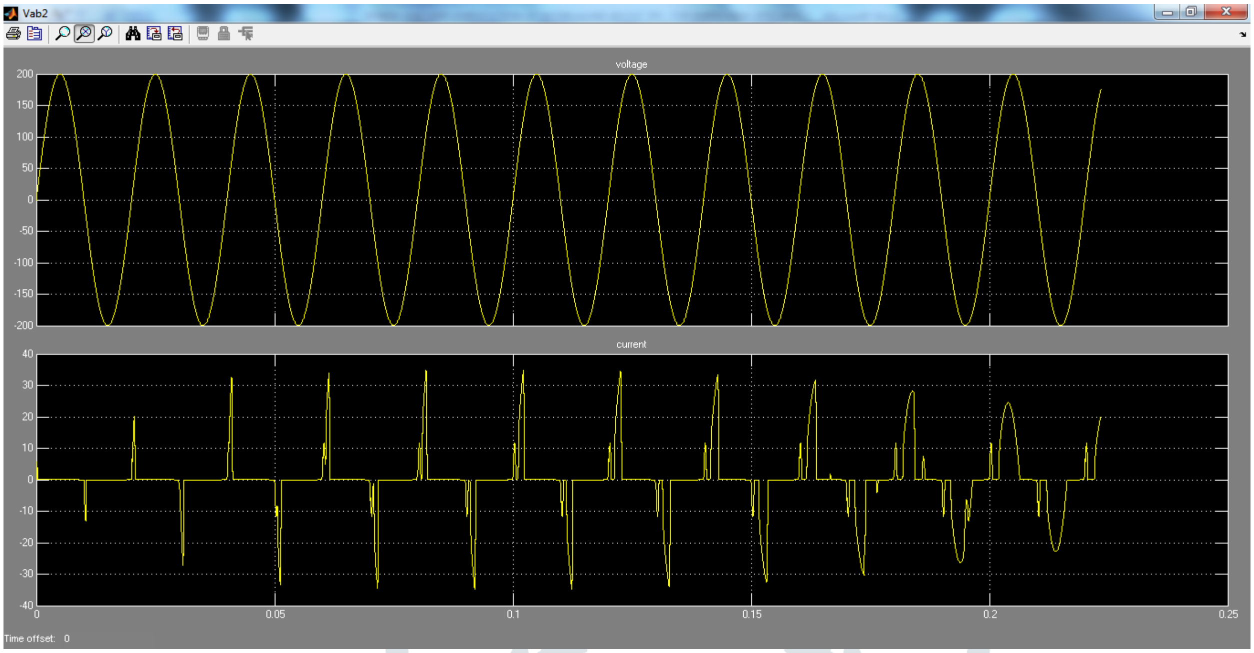
7. Run the simulation by clicking the *Start* button on the toolbar or by selecting *Simulation > Start* from the navigation bar. Results can be seen by double clicking on the scope block.

7. SIMULATION DIAGRAM

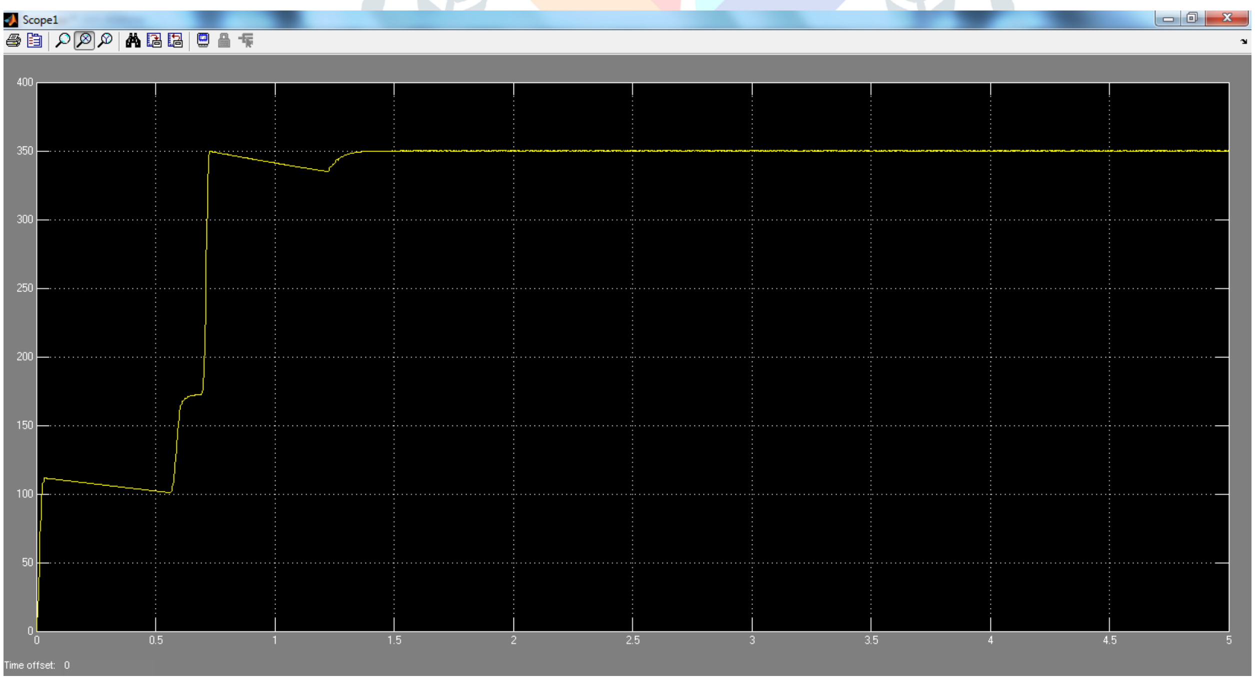


8. SIMULATION RESULT

8.1 INPUT VOLTAGE AND CURRENT



8.2 OUTPUT VOLTAGE AND CURRENT:



9. CONCLUSION

To improve the power factor under the light load, we propose a duty-ratio feed-forward controller for the Interleaved Buck Boost PFC converter. The interleaved PFC converter features step-up/down ability, low cost, and high efficiency. However, it suffers from low power factor and total harmonic distortion under the light load due to the input capacitor effect. The proposed feed-forward controller aims at compensating the phase leaded current caused by the input capacitor. We describe the implementation of the controller, the required compensated current, and the controller structure in detail. We conducted experiments with a prototype to verify the operation of the proposed feed-forward controller. The proposed feed forward controller significantly increased the power factor of the converter. Meanwhile, the output voltage of the PFC converter is well regulated.

10. REFERENCES

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