International Journal of Power Control and Computation(IJPCSC)
Vol 7. No.2 – 2015 Pp.54-60
©gopalax Journals, Singapore
available at : www.ijcns.com
ISSN: 0976-268X

A DOUBLE INPUT BUCK BOOST CONVERTER FOR WIND ENERGY SYSTEM WITH POWER SHARING CONTROL

S.Kamalakkannan,
Assoc.Prof.,Dept of EEE.,
Karpaga Vinayaga College of Engineering and Technology, Chennai-603 308.
mypkg194@gmail.com

R.Arunkumar,
PG Student, M.E Power Electronics and Drives,
Karpaga Vinayaga College of Engineering and Technology, Chennai-603 308.
arun2009ragu@gmail.com

Abstract--The simulation of a nonlinear controller with power sharing control capabilities for a wind energy system double input buck boost–buck boost converter is presented. A multiple-input DC–DC converter is useful to obtain the regulated output voltage from input power source such as a wind array. Double input DC-DC buck boost converter principle of operation and the equations describing the converter circuit are reviewed. Wind energy system combining two Photo Voltaic (PV) panels based double input buck boost – buck boost converter is simulated. Finally, various simulation results for a buck boost– buck boost converter operating under the proposed controller are reported to verify the operation of the designed controller.

Index Terms—Buck boost–buck boost converter, wind energy System, double-input converter, power sharing.

I. INTRODUCTION:

The double-input DC–DC converter is useful to get regulated output voltage for the desired load[1]. From the wind array power supply system, the maximum power point of a wind array can be easily tracked.

Advantages of utilizing a double input DC-DC converter [4] are reduced component count, potential weight reduction, source integration flexibility and power sharing management capability [5]. This double input DC-DC buck boost converter is a circuit which converts of direct current from one voltage to another which is a class of power converter. This double input DC-DC buck boost converter is used for renewable energy applications. Power sharing management is the ability of the double-input converter to vary the ratio of the power drawn from the two input sources while keeping the total output power as constant.

A basic block diagram of a system with wind source connected to a double-input withload arrangement is shown in fig. 1

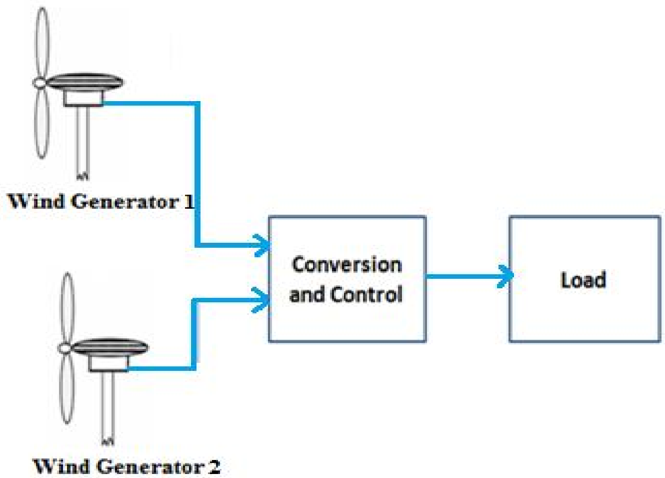

Fig. 1 Basic block diagram of Hybrid System

II.SYSTEM BLOCK DIAGRAM

The block diagram shown in fig.2 consists of PV cell, double input DC-DC buck boost converter, controlled rectifier, voltage source inverter, micro controller, driver circuit, power supply circuits and load. The description of various blocks is as follows.

Wind Generator: A wind generator is a device that converts kinetic energy from the wind into electrical energy. Thus electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives a generator to produce electricity. The windmill in this case is usually called a wind turbine. This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical power. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system (WECS).

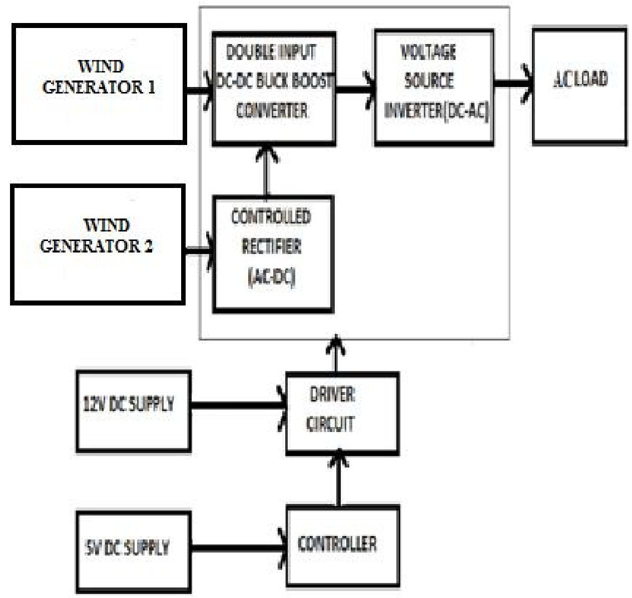

Fig. 2 System Block Diagram

Buck Boost-Buck Boost Converter: The buckboost–buckboost converter is a multiport (multi-input, single-output) converter with two input sources and one output port.Regulated output voltage that drives inverter is obtained with this converter.

Power Converter: Electrical power converter has both inverter and controlled rectifier thatconvert direct current to alternating current and alternating current to direct current respectively. Inverters are commonly used to supply AC power from DC sources such as wind panels or batteries.

Controller: Less instruction and low cost Peripheral Interface Controller (PIC)is used as power controller. It performs the function of controlling the input voltage and produces the gate pulse for the power electronic switches of converter.

III.WIND ENERGY SYSTEM

A wind turbine is a rotating machine which converts the kinetic energy into mechanical energy. If the mechanical energy is converted to electricity, the machine is called a wind generator, wind power unit (WPU), wind energy converter (WEC), or aero generator. Wind is the continuous movement of atmospheric air masses and is determined by its speed and its orientation [14]. This movement derives from the changes and the different values of the atmospheric pressure while these values are the result of the solar heating of different parts of the earth's surface. Despite the fact that the atmospheric air moves horizontally and vertically as well, only its horizontal movement is actually considered as wind. The wind energy is derived from the air as a result of its movement. Wind energy is the conversion of a small percentage, about 0.2%, of the solar radiation that reaches the surface of the earth.

Wind Power is energy extracted from the wind, passing through a machine known as the windmill. Electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives a generator to produce electricity. The windmill in this case is usually called a wind turbine. This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical energy. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system (WECS).

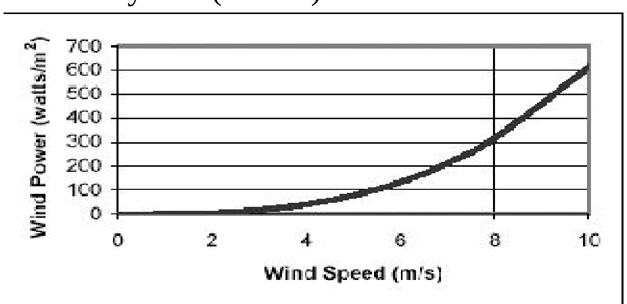

Fig. 5 Power Vs speed characteristic

The wind power Vs wind speed characteristic is shown in fig.5. Power is directly proportional to wind speed, as the wind speed increases the power delivered by a wind turbine also increases. If wind speed is between the rated wind speed and the furling speed of the wind turbine, the power output will be equal to the rated power of the turbine. Finally, if the wind speed is less than the cut-in speed or greater than the furling speed there will be no output power from the turbine.

IV.DOUBLE-INPUT BUCKBOOST–BUCKBOOST CONVERTER

The main purpose of these topologies is to provide a three phase voltage source, where the amplitude, phase, and frequency of the voltages should always be controllable. The buck boost–buck boost converter is a multiport (double-input, single-output) converter with two input sources$V_1$and V_2,three controllable switchesS_1, S_2 and $S_3$and one output port. Two of the controllable switches$S_1$and S_2can be turned ON and OFF independently, while the conduction status of S_3depend on that of $S_1$and S_2. Switch S_3should be turned ON only when $S_1$is ON and $S_2$is OFF.

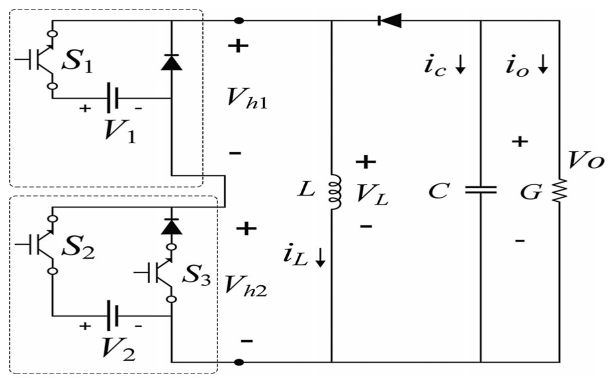

Fig. 6 Circuit of Double-Input Buck -Boost Converter

As per the power sharing management principle involved in the converter for constant load and constant power output, the double input converter can alternate the amount of power drawn from the energy source (V_1 and V_2) when needed and hold the voltage as constant.

V.MODES OF OPERATION

The principles of operation for double input buck boost–buck boost converter [2] are reviewed here to provide deeper insight into the proposed control method. The switching operation of three different switches is shown below in table-1.

Table-1 Switching Operation of S_1,$S_2$and S_3

S_1	S_2	S_2	S_3
OFF	OFF	ON	OFF
OFF	ON	OFF	OFF
ON	OFF	ON	ON
ON	ON	OFF	OFF

Two of the controllable switches S_1 and S_2 can be turned ON and OFF independently, while the conduction status of S_3 depend on that of S_1 and S_2. Switch S_3 should be turned ON only when S_1 is ON and S_2 is OFF ***($S_3 = S_1 \times \hat{S}_2$)***; thus, the modes of operation of this converter depend only on the status of conduction of S_1 and S_2 resulting in totally four modes of operation. The waveform of switches S1 and S2 are shown below in Fig.8.

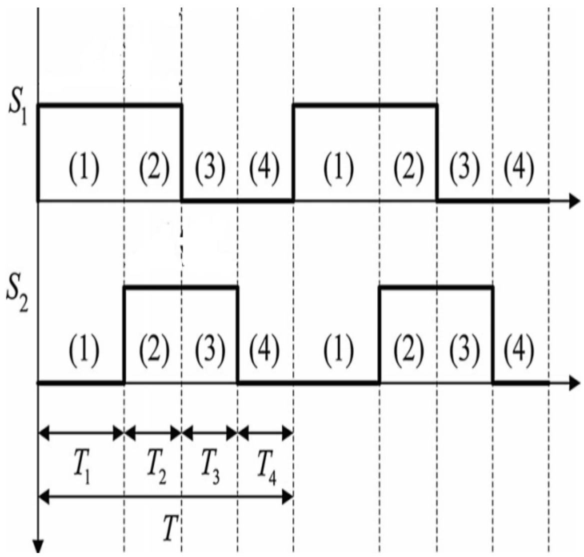

Fig.7 Waveform of switch S_1,S_2

Mode 1 Operation:In mode 1, S_1 and S_3 are ON and S_2 is OFF V_1 energizes the inductor L.

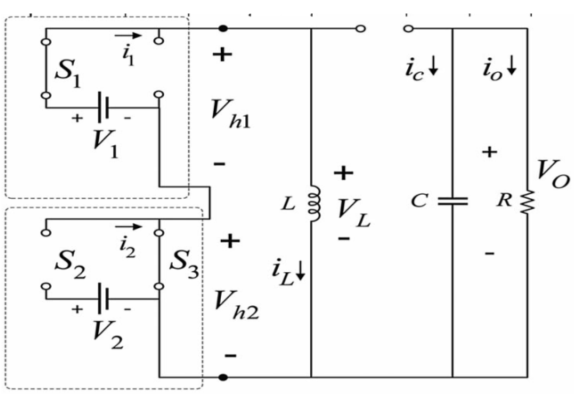

Fig. 8 Circuit of Mode 1 Operation

Mode 2 Operation:In mode 2, both S_1 and S_2 are ON, and S_3 is OFF and both sources energize the inductor L.

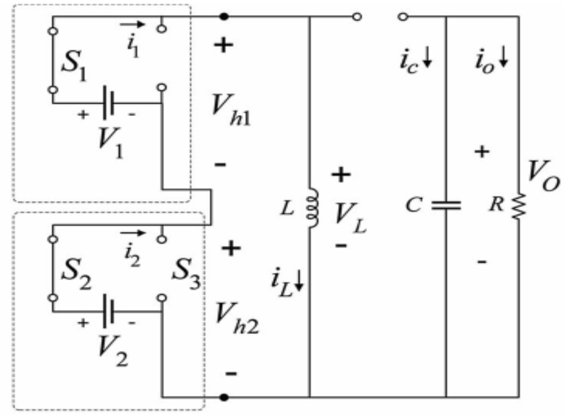

Fig. 9 Circuit of Mode 2 Operation

Mode 3 Operation:In mode 3 only S_2 is ON and S_3 is OFF, and V_2 energizes the inductor L.

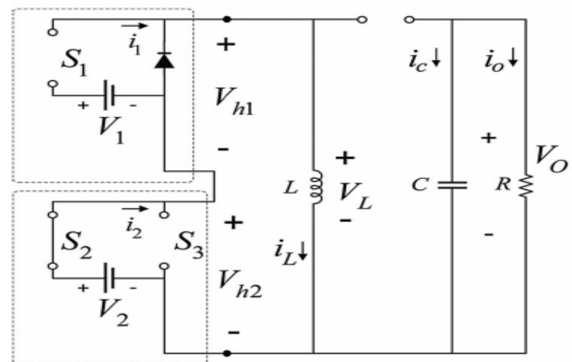

Fig. 10Circuit of Mode 3 Operation

Mode4 Operation:In mode 4, S_1,S_2 and S_3 are OFF, and the inductor L starts to discharge.

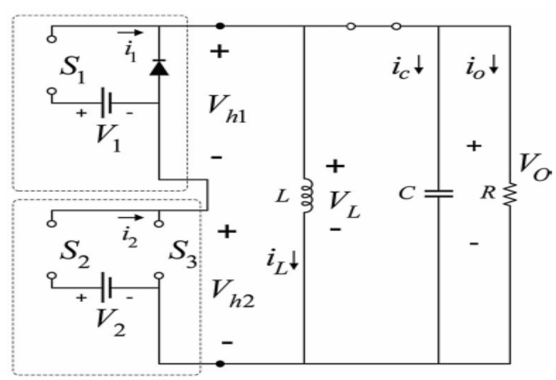

Fig. 11Circuit of Mode 4 Operation

VI. SIMULATION RESULTS

The simulink circuit of Wind Panels 1 and 2 circuit is shown in Fig 13.Fig 14 and Fig 15 showsthe Output voltage of Wind panels 1 and 2 respectively. Thesimulink circuit of double input Buck – boost converter is shown in fig.16. Fig.17 shows output voltage and current ofdouble input Buck – boost converter and fig.18 shows the output voltage of single-phase inverter circuit that feeds an AC load.The various parameters involved in the design are tabulated in table-2

PARAMETERS	VALUES
Wind Input Voltage 1 (V_{w1})	12V
Wind Input Voltage 2 (V_{w2})	24V
Double Input Buck-boost converter Output Voltage DC (V_O)	100V
Inverter Output Voltage AC (V_O)	100V

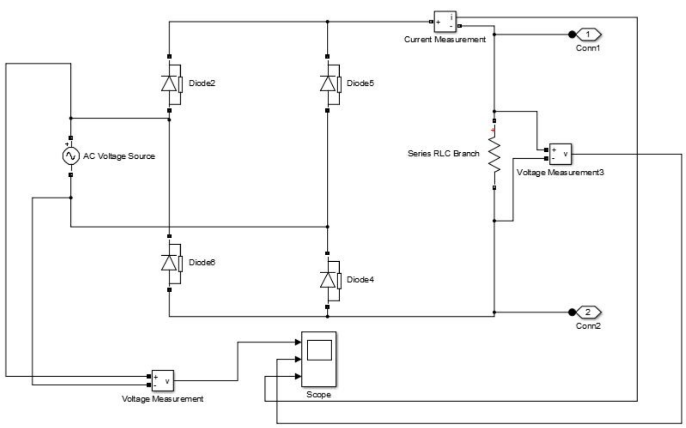

Fig. 12 Simulation of Rectifier Circuit

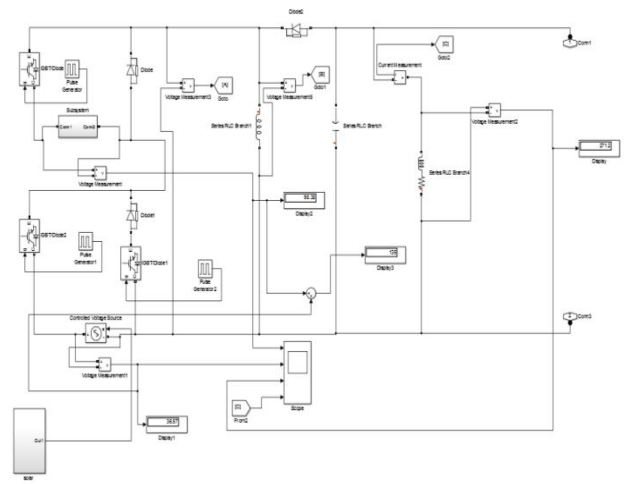

Fig. 13 Simulation of Double Buck-Boost Converter

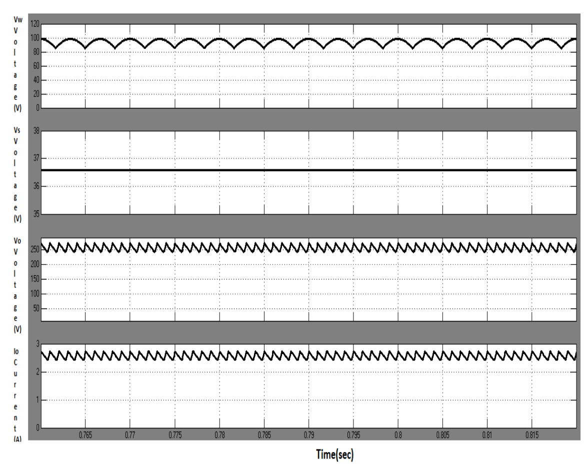

Fig. 14 Double Buck-Boost Converter Output

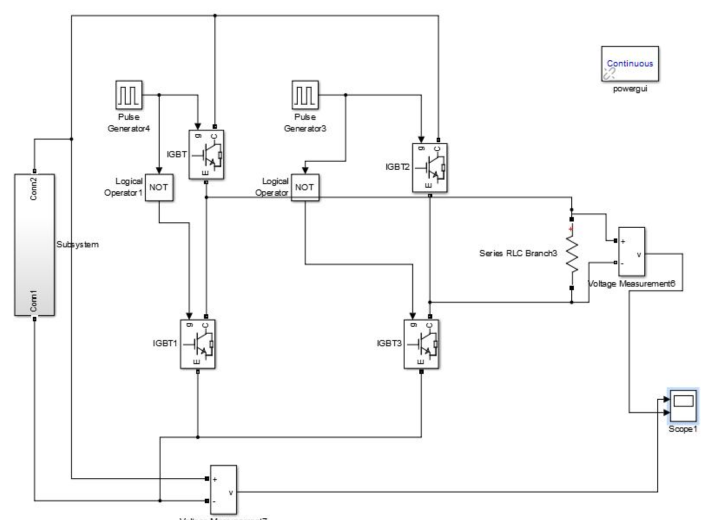

Fig. 15 Simulation of Inverter circuit

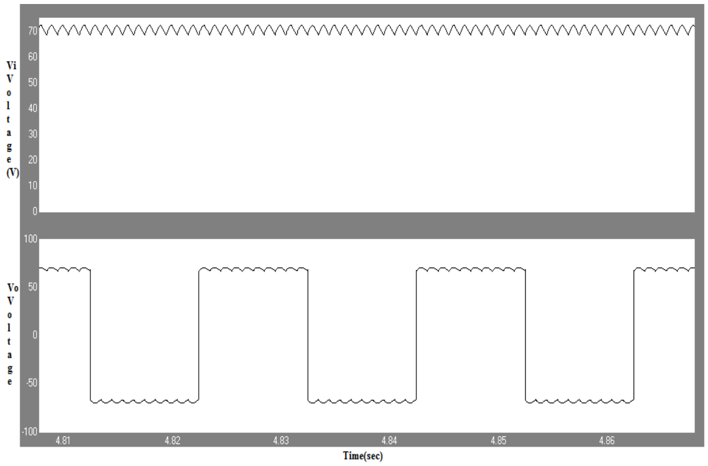

Fig. 16 Inverter Output Voltage

VII.CONCLUSION

Wind energy system using double input Buck Boost – Buck Boost converter is simulated. The output voltage from wind is regulated using double input DC – DC buck boost–buck boost converter. In addition to regulation of output voltage, the converter also provides non-linear control with power sharing capability. The simulation is done with help of MATLAB software and the results are obtained. In future the same circuit can be extended for more than two sources.

REFERENCES:

[1] H. Matsuo,W. Lin, F. Kurokawa, T. Shigemizu, and N.Watanabe, "Characteristics of the multiple-input DC-DC converter," IEEE Trans. Ind. Electron., vol. 51, no. 3, pp. 625–631, Jun. 2004.

[2] K. P. Yalamanchili and M. Ferdowsi, "Review of multiple input dc-dc converters for electric and hybrid vehicles," in Proc IEEE Vehicle PowerPropulsion Conf., Sep. 2005, pp. 160–163.

[3] N. D. Benavides and P. L. Chapman, "Power budgeting of a multiple input buck-boost converter," IEEE Trans. Power Electron., vol. 20, no. 6, pp. 1303–1309, Nov. 2005.

[4] R. Ahmadi and M. Ferdowsi, "Double-input converters based on h-bridge cells: Derivation, small-signal modeling, and power sharing analysis," IEEE Trans. Circuits Syst. I, Reg. Papers, vol. 59, no. 4, pp. 875–888, Apr. 2012.

[5] D. Somayajula and M. Ferdowsi, "Power sharing in a double-input buckboostconverter using offset time control," in Proc. IEEE Appl. Power Electron. Conf., Feb. 2009, pp. 1091–1096.

[6] R. Ahmadi, N. Yousefpoor, and M. Ferdowsi, "Power sharing analysis of double-input converters based on h-bridge cells," in Proc. Electric ShipTechnol. Symp., Apr. 2011, pp. 111–114.

[7] R. Ahmadi, H. Zargarzadeh, and M. Ferdowsi, "Nonlinear power sharing controller for double-input h-bridge based converters," in Proc. IEEEAppl. Power Electron. Conf., Feb. 2012, pp. 200–206.

[8] B. G. Dobbs and P. L. Chapman, "A multiple-input DC-DC converter topology," IEEE Trans. Power Electron. Lett., vol. 1, no. 1, pp. 6–9, Mar. 2003.

[9] H. Behjati and A. Davoudi, "A multi-port DC-DC converter with independent outputs for vehicular applications," in Proc. IEEE Vehicle Power Propulsion Conf., Sep. 2011, pp. 1–5.

[10] Y. M. Chen, Y. C. Liu, and F. Y.Wu, "Multi-input DC/DC converter based on the multiwinding transformer for renewable energy applications," IEEE Trans. Ind. Appl., vol. 38, no. 4, pp. 1096–1104, Aug. 2002.

[11] Y. M. Chen, Y. C. Liu, F. Y.Wu, and Y. E.Wu, "Multi-input converter with power factor correction and maximum power point tracking features," in Proc. IEEE Appl. Power Electron. Conf., Aug. 2002, vol. 1, pp. 490–496.

[12] A. Di Napoli, F. Crescimbini, S. Rodo, and L. Solero, "Multiple input DC-DC power converter for fuel-cell powered hybrid vehicles," in Proc.IEEE Power Electron. Spec. Conf., Nov. 2002, vol. 4, pp. 1685–1690.

[13] K. Gummi and M. Ferdowsi, "Synthesis of double-input DC-DC converters using a single-pole triple-throw

switch as a building block," in Proc. IEEEPower Electron. Spec. Conf., Jun. 2008, pp. 2819–2823.
[14] K. Gummi and M. Ferdowsi, "Derivation of new double-input DC-DC converters using h-bridge cells as building blocks," in Proc. IEEE Ind. Electron. Conf., Nov. 2008, pp. 2806–2811.
[15] The journal of CPRI vol.9 issues 3 sep-13 ISSN 0973-0338.