IMPLIMENTATION OF BUCK-BOOST CONVERTER FOR INDUCTION MOTOR AS MODULATOR

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***Abstract* – Induction Motors are the most commonly used motors in industries, There are various speed control methods for induction motor among them the v/f control method is popularly used method .The applications such as the uninterruptible power supplies(UPS), switch mode power supplies(SMPS) uses the Inverters to produce variable frequency and variable voltage. This paper proposes the topology for such loads controlling the frequency and voltage using Buck Boost converter and inverter respectively. The Buck Boost converter operates in buck and boost mode according to reference frequency to produce required frequency and generate modulated dc link for inverter . The inverter is used to control voltage by varying duty ratio of inverter switches. The output rms voltage varies linearly with duty ratio of inverter switches. The advantages of proposed method are it decrease the non linearity, and low order harmonics. The proposed system performance is verified using Simulink MATLAB 2014.**

***Index Terms* – Modulated DC Link, Buck Boost converter ,Inverter ,v/f drive.**

I.INTRODUCTION

Induction motors are widely used in industries because of its various advantages like simple in construction, less weight and it speed regulation is good[1]. The speed of IM is proportional to number of poles of stator ,frequency and source voltage .once number of poles are fixed then the speed of induction motor is controlled by varying frequency[2][3]. The stator voltage control method has some demerits such as %THD, reduced efficiency, to overcome these demerits the v/f control method is used. v/f control method which has some advantages such as good dynamic and steady state characteristics. The speed of induction motor is controlled using Z source inverter. This topology reduces stress across capacitors used in impedance network [2].There are other speed control method of induction motor are vector control, IFOC method etc. The vector control method is used to determine stability for motoring and regenerating modes of motor, but this method is complicated[4].For ups design a four quadrant inverter is analyzed using Buck Boost converter which is used when ac voltage lower/higher than dc required[6].

Induction motors always needs pure sine waves as its input. The PWM (Pulse width modulation) technique is used for(universal) inverter, by varying duty ratio of PWM the inverter is made shuffles between buck ,boost modes to produce pure sine waveforms[8]. . In conventional two stage conversion method consist of intermediate stiff dc link is used as input of inverter. If inveter needs different output it is supplied by same dc link,it will increase stress across switches. But present topology overcome this problem In present topology Modulated DC L ink is produced for inverter by Buck Boost converter.so that it will reduce the blocking voltage of switches this will leads to reduced switching losses.

II. INTRODUCTION TO PROPOSED TOPOLOGY

The proposed circuit consists of an uncontrolled diode rectifier, a buck-boost converter and an inverter connected as shown in fig1.the ac supply is given as input to the uncontrolled full bridge rectifier and the rectified output is given to the Buck Boost converter and output of buck boost converter is given to H- bridge inverter. In this topology buck boost converter is used for controlling frequency and inverter is used for controlling voltage.

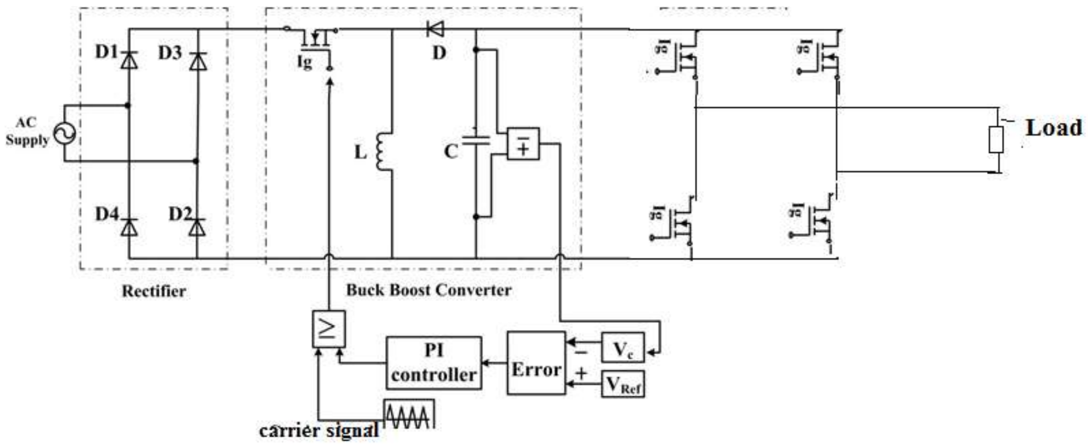

Fig1: circuit Diagram of proposed topology

III. WORKING OF PROPOSED TOPOLOGY

Frequency control

As shown in fig 2 the voltage across the capacitor of Buck Boost converter is compared with the reference voltage of particular frequency, after comparing the produced error is tuned by PI controller The output of PI controller is compared with high frequency triangular signal (5kHz) to produce gate pulse for MOSFET of Buck Boost converter. The input supply is 230v 50Hz and reference voltage is 110v, 20Hz. When input voltage is more than the reference voltage converter operates in Buck mode to reduce the voltage from 230V to 110V by giving pulses of less duty ratio to the MOSFET. During Boost operation the voltage is boosted from 0to 110V by giving pules of high duty ratio. In this way the frequency is varied from 0 to 50 Hz using buck boost converter.

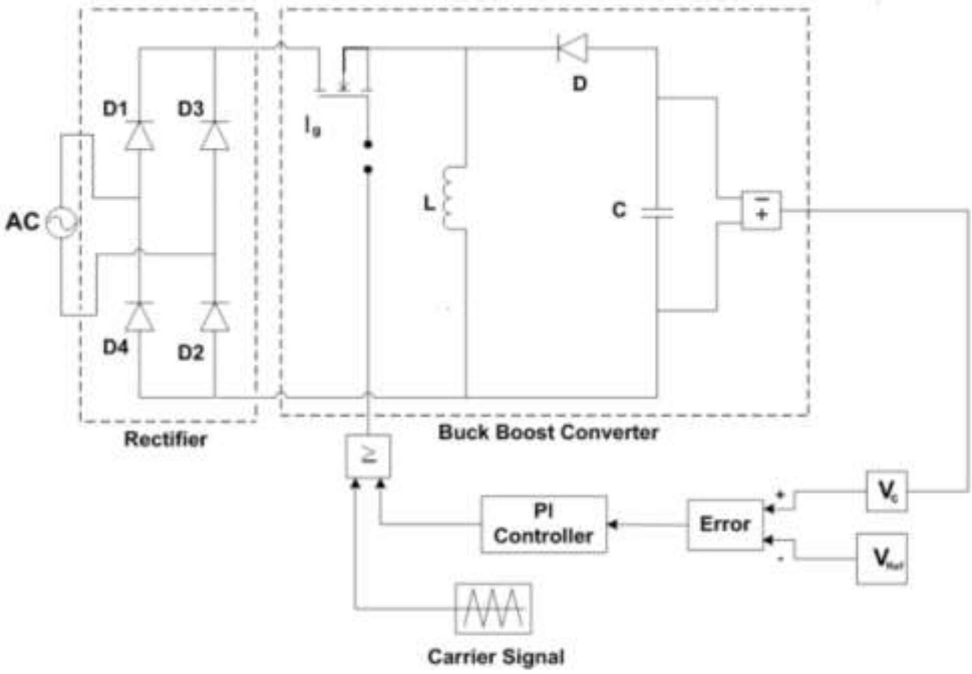

Fig2.Frequency control

Voltage control

The H bridge inverter is used to control the voltage. The H bridge inverter it consist of four switches MOSFET1, MOSFET2, MOSFET3, MOSFET4 . Switches1and 2 conduct for positive half cycle of inverter output switch 3 and 4 conducts for negative half cycle of inverter output. The speed is ranges from 0 to 800rpm, the rms output is varied from 0 to110v by varying duty ratio of inverter switches0 from 0 to1and frequency is varies from 0 to 50Hz.

IV. Buck Boost converter (DC Link Modulator)

Buck Boost converter is a converter which gives the output voltage more or less than the input voltage magnitude. The working principle of buck boost converter is that the inductor in input circuit resist sudden variation in input current. In this circuit MOSFET is used for connect and disconnect inductor from supply and diode is used for freewheeling purpose. It operates in two modes.

Mode I: Active mode

During mode I switch MOSFET is ON. When switch is ON the inductor stores energy in the form of magnetic field and diode D is reverse biased so input circuit is disconnected from output, during this period the capacitor supplies the load. For input voltage, $VS = L\, di/dt$

Mode II: Freewheeling mode

MOSFET is turned OFF, D is forward biased. Inductor will discharge the energy stored in it to the load through the path L-C-D.

For output voltage, $VO = L\, di/dt$ __________(1)

For the ON time of switch *TON*,
$ILMAX - ILMIN = TON\,(VS / L)$ _____________(2)
For the OFF time of switch *TOFF*,
$ILMAX - ILMIN = TOFF\,(VO / L)$ _____________(3)
On comparing (2) and (3),
$TON\,(VS / L) = TOFF\,(VO / L)$

Therefore; $VO = VS\,(TON / TOFF)$
$VO = Vs\, TON / T – TON$
$= VS\,(TON / T) / (1 – TON /T)$
$= Vs\,(k /1 - k)$ Where; $k = TON/T$
Hence; $VO /Vs = - D / (1 - D)$_____________ (4)

III. SIMULATION MODEL AND RESULTS

Refer fig -3 which shows the model created in Matlab/Simulink2014.The proposed topology which has input 230v single phase ac supply, which is given to the rectifier, the output of rectifier is given to Buck Boost converter. reference voltage of particular frequency is compared with capacitor of buck boost converter, the generated error tuned by PI controller. and gives pulses to MOSFET on comparing with carrier signal. The output voltage is chopped with 5KHz switching frequency . The output of Buck Boost converter follows reference closely. The below simulation results are shown for different reference frequency i.e 10Hz,20Hz,30Hz,40Hz,50Hz.

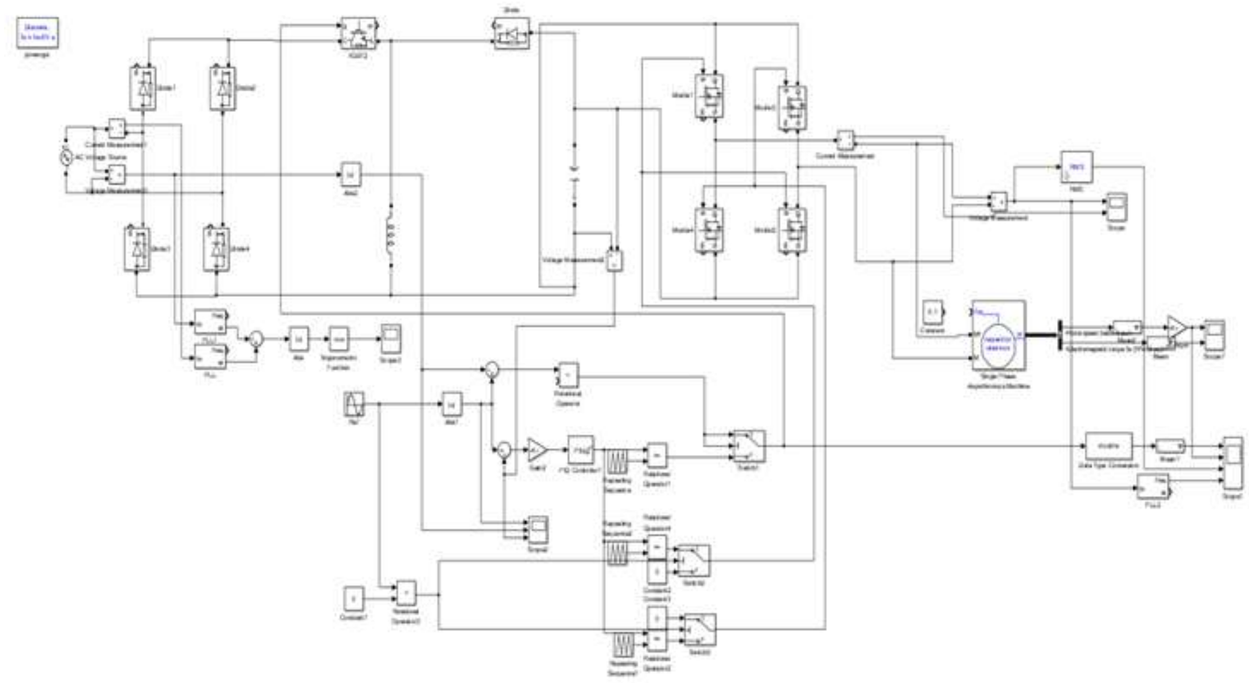

Fig 3: Simulink model

10Hz operation

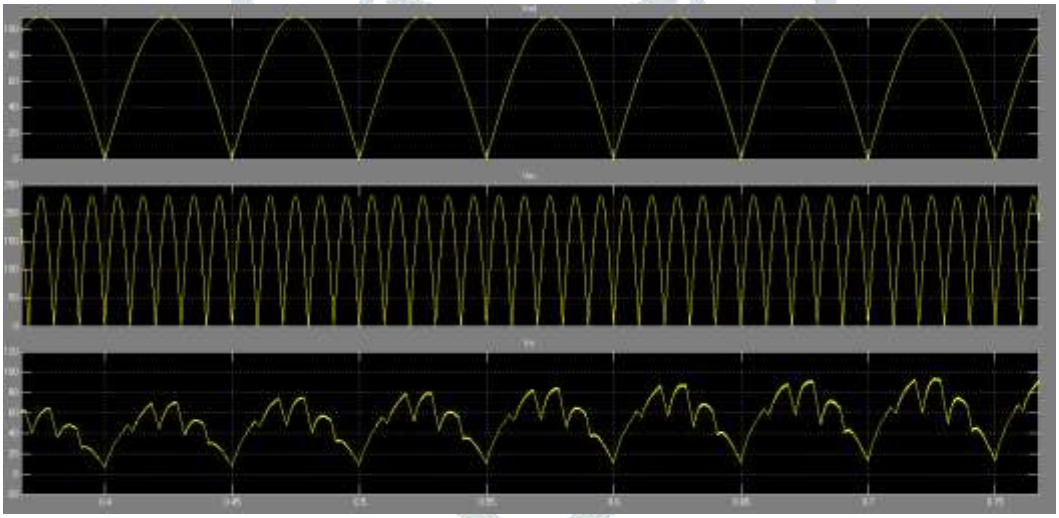

Fig4:(a)reference frequency(b)Input voltage of Buck Boost converter(c)actual capacitor voltage

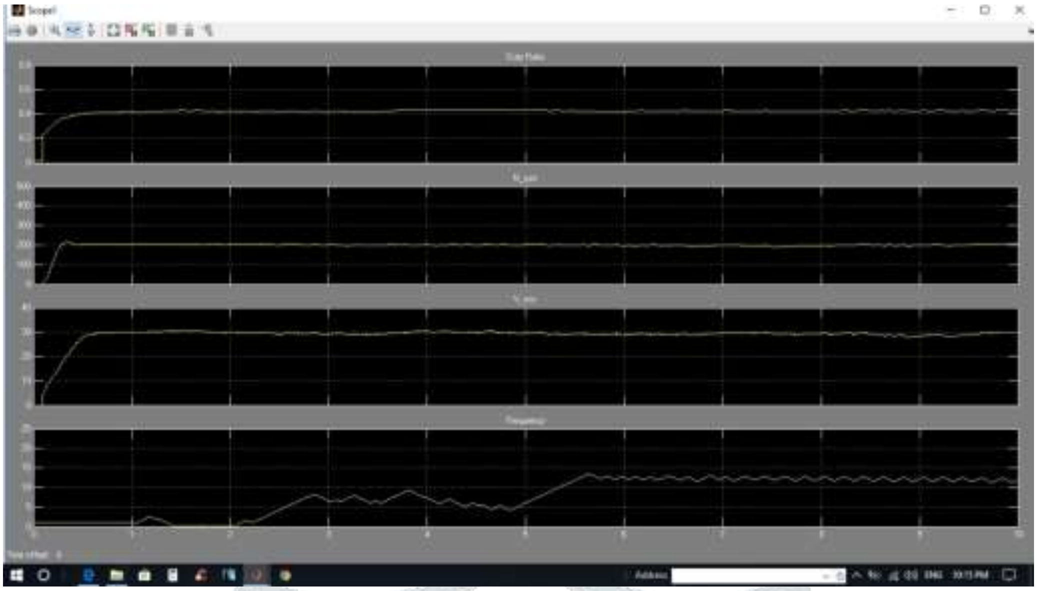
Fig5: (a)inverter duty ratio (b)speed (c)rms voltage of inverter (d)frequency

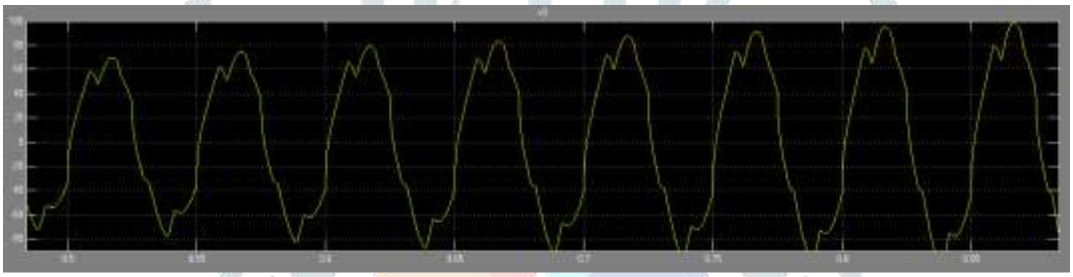
Fig6:Invereter output

20Hz operation

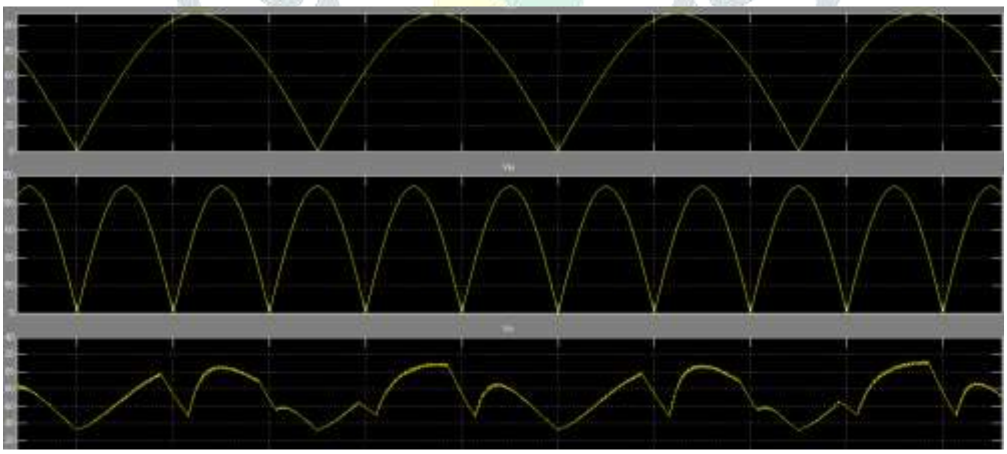
Fig7:(a)reference frequency(b)Input voltage of Buck Boost converter(c)actual capacitor voltage

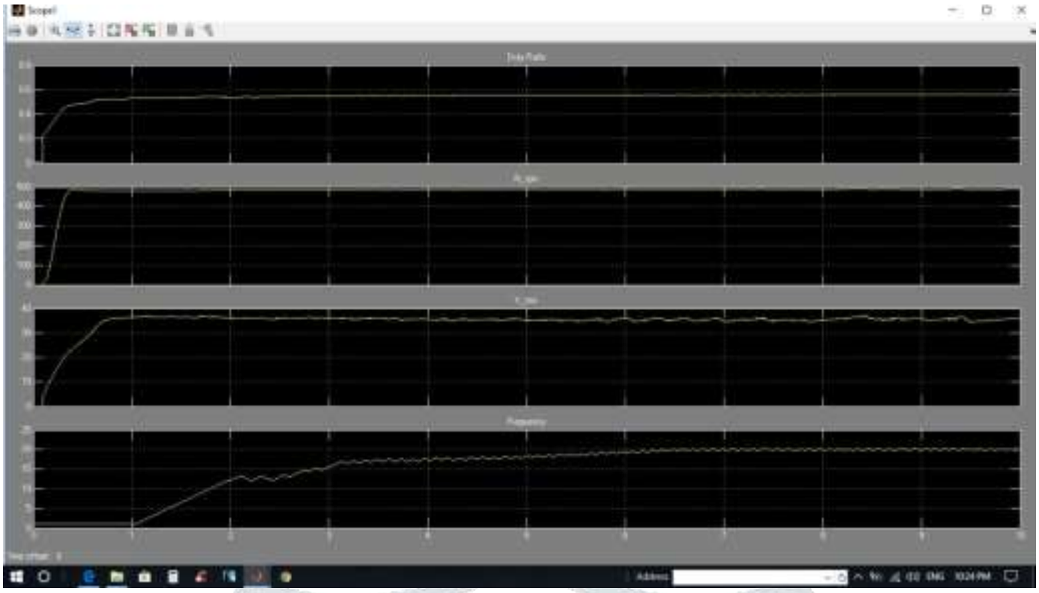

Fig8: (a)inverter duty ratio (b)speed (c)rms voltage of inverter (d)frequency

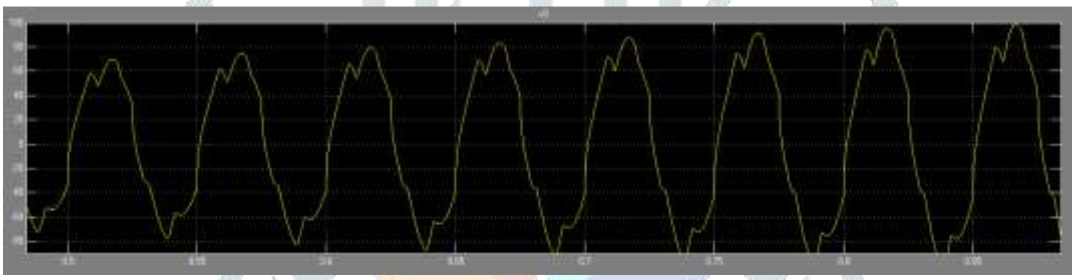

Fig9:inverter output

30Hz operation

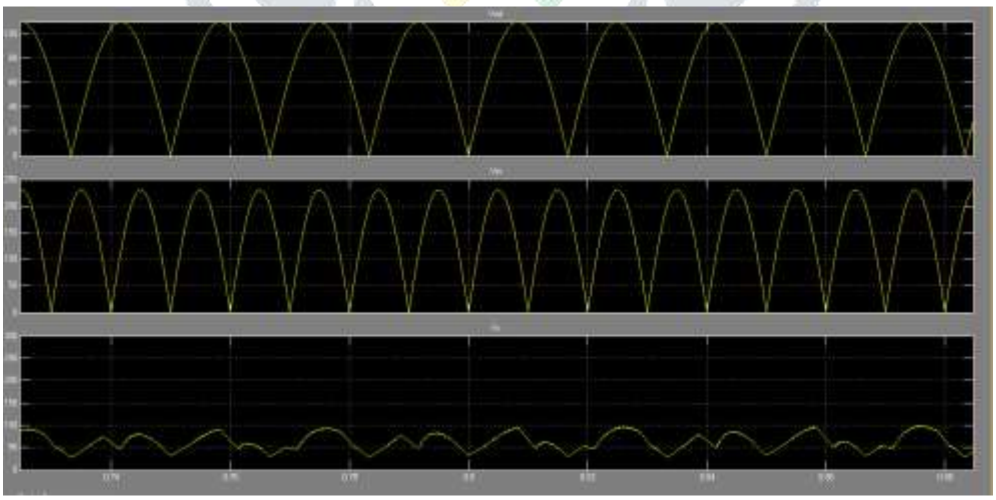

Fig10:(a)reference voltage(b)Input voltage(c)voltage across capacitor

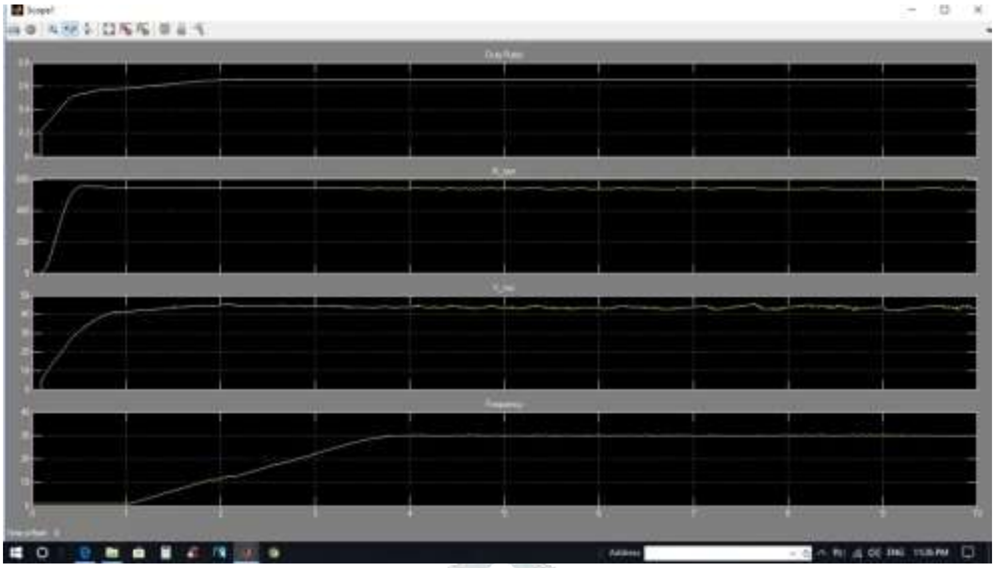

Fig11: (a)inverter duty ratio (b)speed (c)rms voltage of inverter (d)frequency

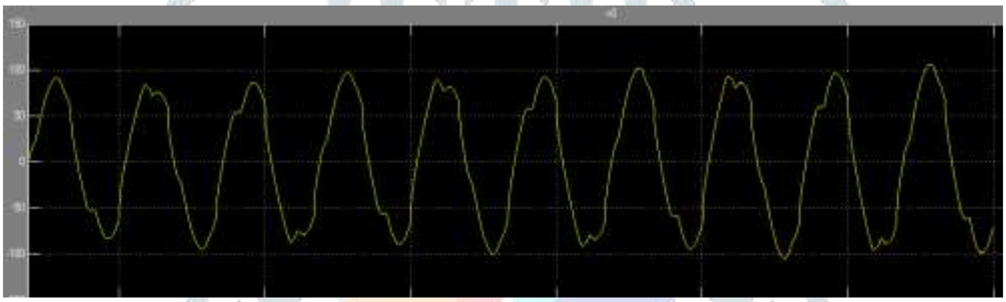

Fig12: output of inverter

40Hz operation

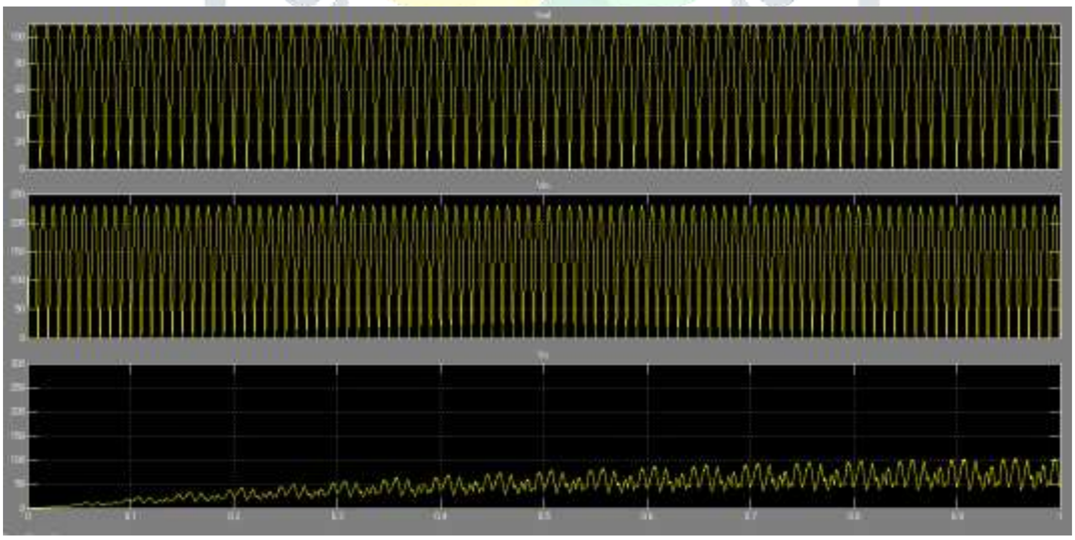

Fig13:(a)reference frequency(b)Input voltage of Buck Boost converter(c)actual capacitor voltage

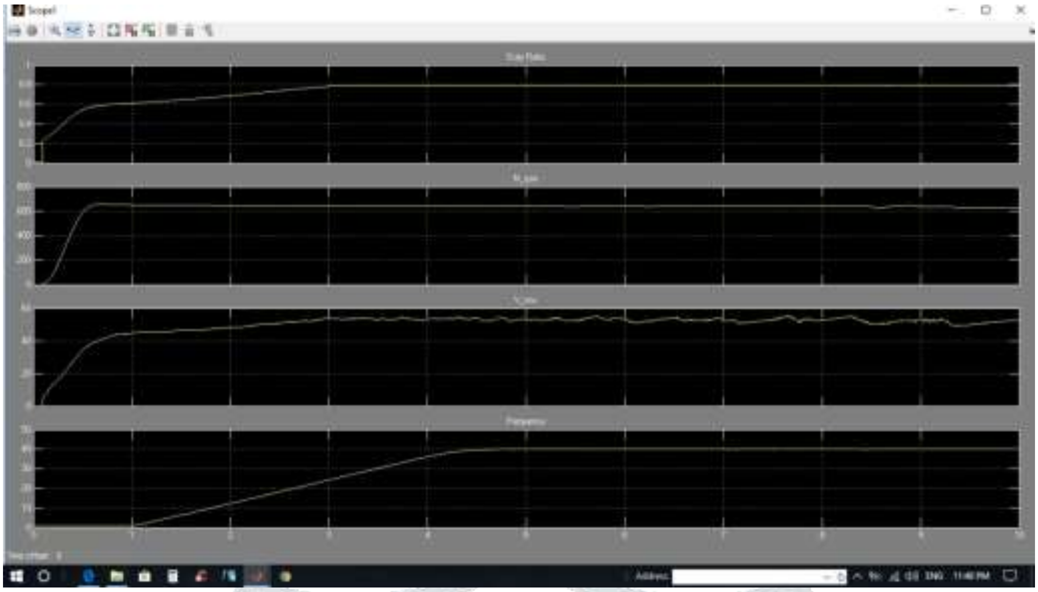

Fig14: (a)inverter duty ratio (b)speed (c)rms voltage of inverter (d)frequency

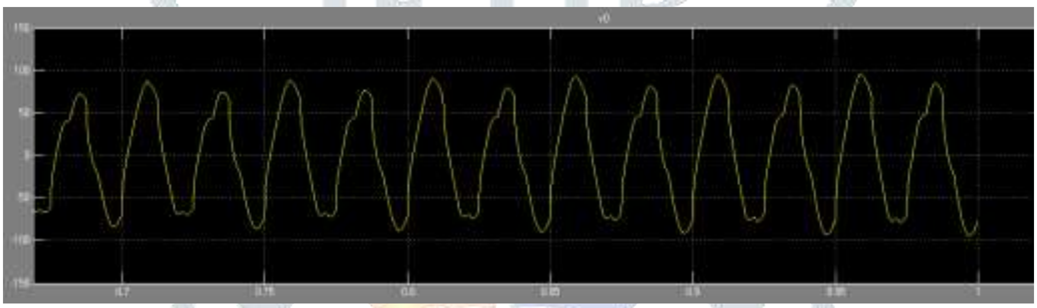

Fig15 :output of inverter

50Hz operation

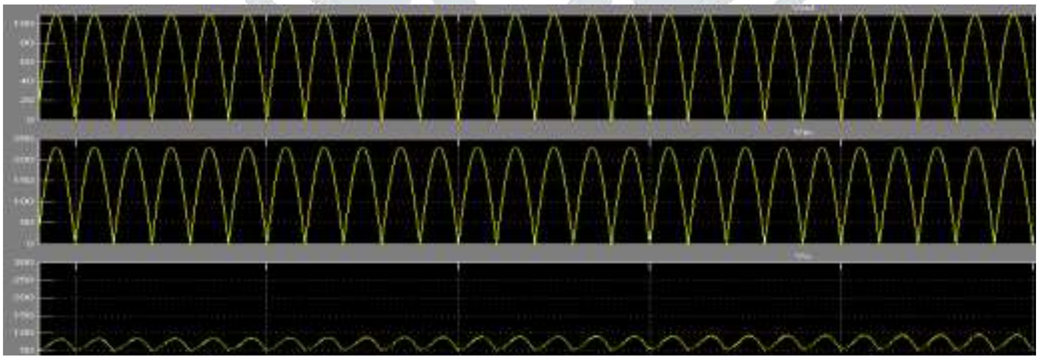

Fig16:(a)reference frequency(b)Input voltage of Buck Boost converter(c)actual capacitor voltage

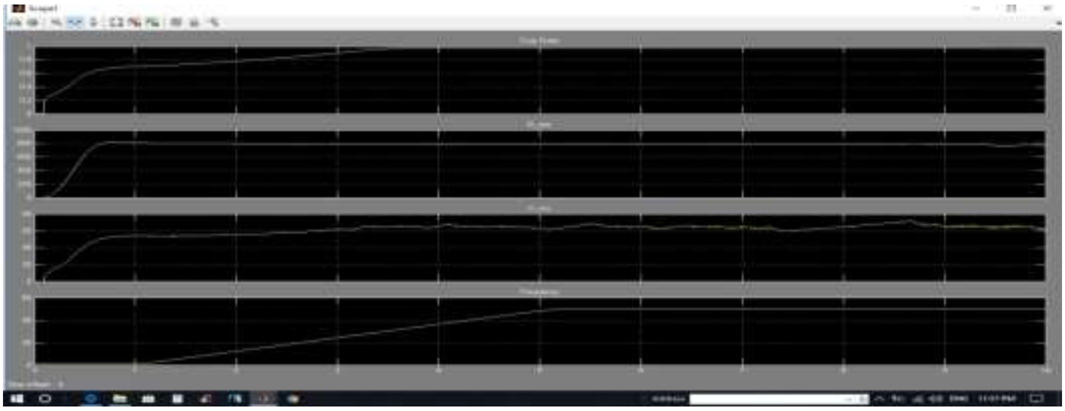

Fig17: (a)inverter duty ratio (b)speed (c)rms voltage of inverter (d)frequency

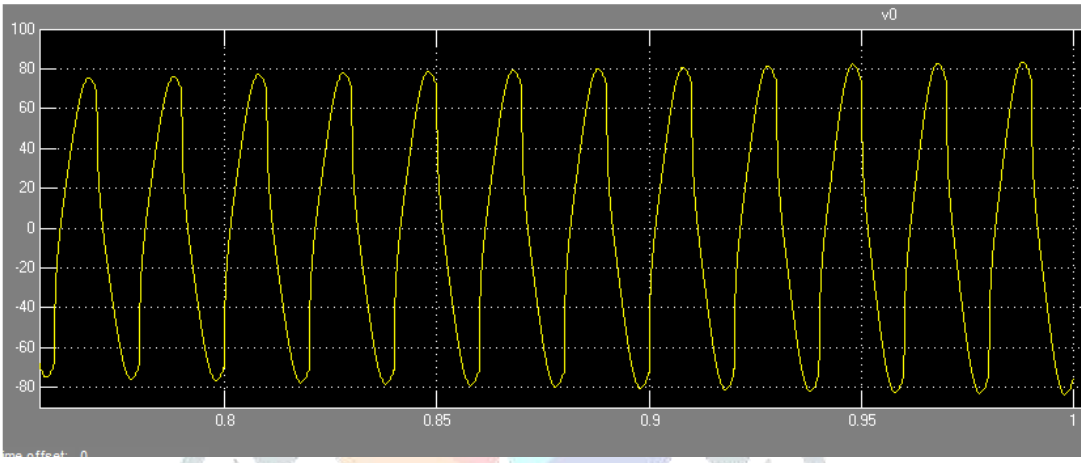

Fig18; output of inverter

Conclusion

In the work simulation of Buck Boost converter and Inverter has been developed using Matlab/Simulink2014. The simulation results were observed to confirm the predicted performance of proposed topology .The simulation results are observed for different reference frequencies. From the simulations results observed that as the speed ranges from 0 to rated speed the voltage and frequency varies linearly keeping v/f constant, the frequency ranges from 0 to 50Hz and Duty ratio varies from 0 to 1. In proposed topology the output rms voltage increases linearly with duty ratio of inverter. From the simulation results it predicts that to get inverter output voltage 100% there is no need to go in overmodulation, which removes the non linearity. The output voltage of inverter is sinusoidal because of the modulated dc link provided by the Buck Boost converter, this reduces harmonic distortion and stress across the switches.

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