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AN INTERLEAVE ISOLATED BOOST CONVERTER CONNECTED IN THREE PHASE INDUCTION MOTOR (ASD) CONTROL WITH SINE PWM TECHNIQUE IN MATLAB

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ABSTRACT

Renewable energy source such as Solar power or fuel cell produce a low D.C. voltage, Hence conversion of this resource power into useful AC power to operate a three phase induction motor is a great challenge, Since solar power or fuel cell produce a very low output voltage, Hence we need to boost up voltage with high efficient converter. Here an isolated interleaved boost converter is used as front end converter in order to obtain a desired input voltage and current to operate the three phase induction motor it also have many advantage such as it overcome back emf problem that occur due to the motor, This converter is able to control the high input current with help of two inductor connected in parallel at input side to share the input current and high output voltage with help of capacitor are connected in series at output side in interleaved manner, Since two boost converter cell produce demagnetizing effect by helping each other, therefore transformer structure is simplified. As interleaved operation is being used current ripple is reduced therefore capacitor and inductor size is reduced both at input and output side, All the above feature interleaved isolated boost converter desirable for low D.C supply to required high D.C supply for the motor. D.C. supply obtain from boost converter is converted to A.C. input supply for the motor with the help voltage source inverter which control by Sinusoidal pulse width modulation technique is used to obtain variable voltage and supply frequency. Nowadays, Pulse Width Modulation with adjustable speed drives are increasingly applied in Three phase Induction motor to obtain superior performance in it.This paper discuss on step by step development of interleaved isolated Sine PWM technique which is implemented on an three phase Induction motor. Here 150V D.C. voltage are given as input for Three phase Induction motor Simulation results are obtained using MATLAB/Simulink environment successfully.

Keywords—*Interleaved Isolated boost converter,Voltage Source Inverter, SinePulseWidth Modulation Technique, Adjustable Speed Drive(ASD), Voltage Source Inverter, PI Controller, MATLAB.*

I. INTRODUCTION

In modern day worldwide there is increase in demand for electricity. Therefore there is scarcity of power especially in rural area Even though in this area large place used for agriculture they mostly need power to operate motor for irrigation purpose. As we depend 70% on non-renewable energy source which has many problem such as increase in fuel cost, depletion of fuel, increase in concern for climatic changes such as Greenhouse gas effect etc. To overcome this problem Renewable energy source such as Solar power or fuel cell, but this resource produce a very low output voltage which is not sufficient to operate a three phase induction motor, Renewable Energy source such as Fuel/PV cell need power converter (dc/dc) to convert the variable low voltage Fuel cell/PV cell stack voltage to High DC voltage required for the input of VSI Inverter to converter that into AC voltage for motor. Power converter help to process the variable DC power to either produce a high-voltage dc or a high voltage AC. However, power converter design is also influenced by source behavior like input current ripple in order to meet reliability requirement of FUEL/PV cell. Also, researchers have proposed a non-isolated high efficiency high step-up interleave DC/DC converter is proposed for PV/FUEL CELL can be connected to motor. This converter must handle high current at the input and high voltage at the output, with low cost, high efficient & high power density Here the fuel cell the DC power is converted into utility AC power for motor. The front DC-DC boost converter is part of the system, required to step-up the low fuel cell stack voltage to peak of the utility line voltage at the intermediate DC link. The boost ratio is very high that cannot be achieved by a conventional non-isolated boost converter.

Therefore the use transformer is necessary and also, it isolates the Fuel cell from motor line plus ensure safety of personnel. In order to design a compact, low cost and low weight converter, high frequency [HF] operation is desired because HF operation reduce size of transformer, filter and other reactive components.. Nowadays the Interleaved Isolated converter got interest over researcher. This converter is used to boost voltage from 40V D.C. to

600V D.C. for 300W circuit. Hence from this circuit we can obtain 350V D.C with 1.5 A current. Hence this D.C. voltage can be converted to A.C with help of three phase Voltage Source Inverter that is become popular in industrial drive application because it can share large voltage between series device and improvement of harmonic quality at output is given to the motor. Motor speed can be controlled with help of Adjustable Speed Driver[ASD].ASD is used for continuous range of speed control in motor. ASD adjust the speed and torque of an Induction motor with help of a PI controller which produce a error signal given to sinusoidal pulse width modulator which produce sine pulse that control entire system as shown in Figure1.

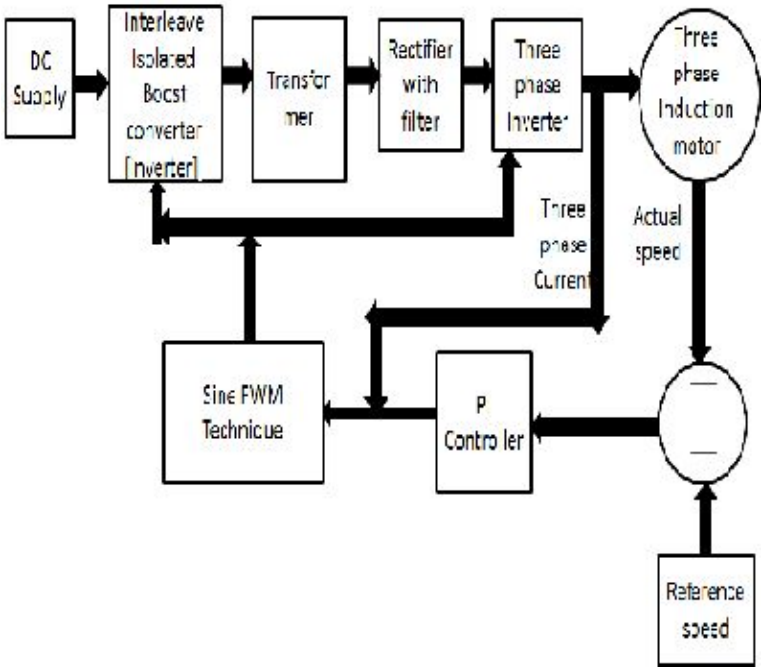


Figure1:Block diagram of interleave isolated boost converter connected in three phase induction motor adjustable speed drive control with sine PWM technique

II. CIRCUIT OPERATION PRINCIPLE AND CHARACTERISTICS

In Medium to High power applications two or more boost converter are paralleled in an interleaved manner to increase the output current and reduce the input current ripple. However, current sharing among the parallel path is a major design problem. Here however voltage Doubler circuit is used that is more advantageous than Full bridge rectifier circuit Two Boost converter are paralleled to achieve the required output voltage as to reduce the input current ripple is operated with two converter with 180 degree phase shift.

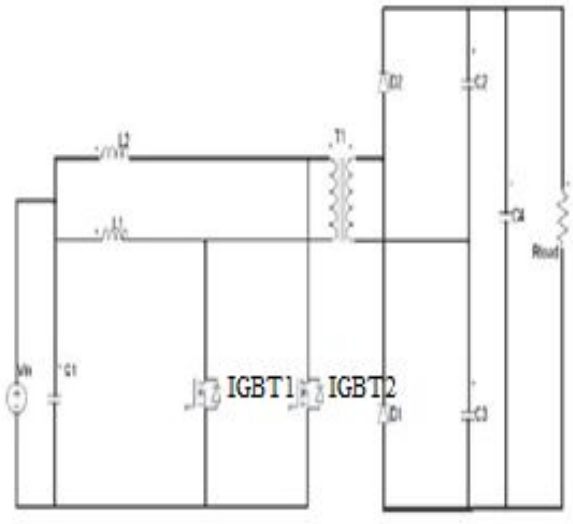


Figure 2:Circuit Diagram of Interleaved Isolated Boost Converter

The converter circuit as shown Figure 2. consist of an input capacitor C1, two boost inductor L1& L2, two ground referenced IGBT such IGBT1& IGBT2, a high frequency Transformer T1, two rectifier diodes, D1 &D2 and three output capacitors C2, C3 and C4.Two rectifier diodes with Two output capacitor C2 &C3 form a voltage doubler which is used to further boost the HF transformer output voltage . The two gate driving signal are used to command the two BOOST IGBT gates 180 degree phase shift have duty cycle less than 0.5 As duty cycle is less than 0.5 there is problem of controlling DC-DC Converter Two way can be used to overcome the problem.

1. By keeping Duty Cycle almost constant value and switching frequency as control variable.

2. Constant switching frequency and enables burst mode operation.

In this paper 2nd solution is preferred for control at low power In this sine pulse modulated gate signal is given as triggering pulse for the IGBT1 and IGBT 2 switches this pulse are given and operation of circuit can be explain each interval as mode of operation as given below.

Mode 1

As a control strategy two gate signal are overlapped during part of switching period therefore both IGBT are ON. Therefore both inductor LI AND L2 store energy during this period input current is equally divided in two IGBT. No current flow in secondary Transformer and Diode so no current is supplied by output capacitor.

Mode 2

During second switching interval IGBT1 is still ON while IGBT2 is turned off. The energy stored in L2 is now transferred to secondary winding and capacitor C2 is charged Since Diode D2 is in conduction.

Mode 3

During interval both IGBT conduct again .it similar mode1 operation.

Mode 4

During fourth interval IGBT1 is OFF and IGBT2 is kept OFF. Then energy stored in L1 is discharged on C3 with Transformer secondary winding flowing through D1.Thus Interleaved Isolated Boost Converter operation is explained.

III. IMPLEMENTATION OF CONTROLLERS

Sine pulse width modulator produce a sine pulse signal with help of feedback obtain from PI controller. Sine pulse signal is used to control Interleaved Isolated Boost Converter where required D.C. voltage is obtained and it also control Voltage Source Inverter that used to converter a D.C. voltage into A.C. voltage which is connected to three phase Induction motor.

IV. SINUSOIDAL PULSE WIDTH MODULATOR

The output A.C. voltage ***vo = vaN*** is obtain from sinusoidal waveform on a continuous basis by proper switching the IGBT gate valve. The carrier-based PWM technique fulfills such a requirement as it defines the on and off states of the IGBT switches of VSI and Interleaved Isolated Boost Converter by comparing a modulating signal V^C(desired ac output voltage) and a triangular waveform V^Δ(carrier signal). In practice, when V^C> V^Δ the switch S+ is on and the switch S- is off; similarly, V^C< V^Δ when the switch S+ is off and the switch S- is on.

A special case is when the modulating signal V^C is a sinusoidal at frequency Fc and amplitude V^C, and the triangular signal *V^Δ*is at frequency FΔand amplitude *V^Δ*. This is the sinusoidal PWM (SPWM) scheme. In this case, the modulation index Ma (also known as the amplitude-modulation ratio) is defined as

$$M_a = V^{\wedge}C / V^{\wedge}\Delta \quad (1)$$

and the normalized carrier frequency ***Mf*** (also known as the frequency-modulation ratio) is

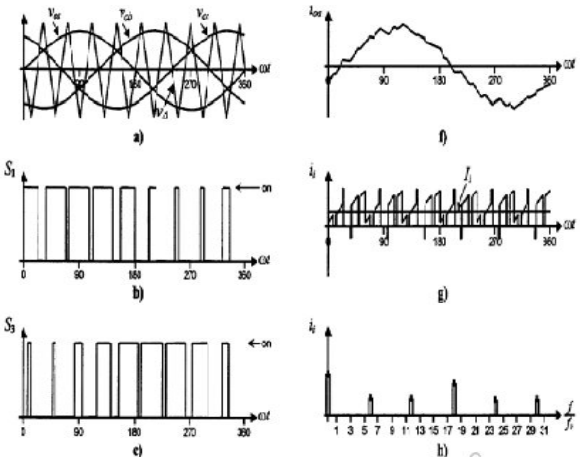
$$Mf = F\Delta / Fc \quad (2)$$

For small values of ***M f***that isif ***Mf*** is less than 21obtain from equation 2, then the carrier signal ***V^Δ*** and the modulating signal V^C should be synchronized with each other , which is required to hold the previous features; if this is not the case, sub harmonics will be present in the A.C. output voltage

For large values of ***Mf*** that is if ***Mf*** is more than 21obtain from equation 2, the sub harmonics are negligible if an asynchronous PWM technique is used, however, due to potential very low-order sub harmonics, its use should be avoided.

This is the basic principle for obtain a sine pulse from a sinusoidal pulse width modulatornow let us discuss about sinusoidal pulse width modulator given to three phase voltage source inverter.

SPWM for Three Phase VSI must produce 120 out-of-phase load voltages, three modulating signals that are 120 out of phase are produced. Figure.3 shows the ideal waveforms of three-phase VSI SPWM. In order to use a single carrier signal and preserve the features of the PWM technique, the normalized carrier frequency ***Mf*** should be an odd multiple of 3. Thus, all phase voltages (***vaN***,***vbN***, and ***vcN***) are identical but 120 out of phase without even harmonics; moreover, harmonics at frequencies a multiple of 3 are identical in amplitude and phase in all phases.



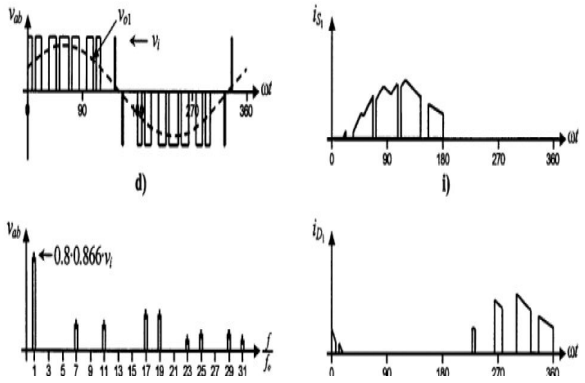


Figure 3:The three-phase VSI. Ideal waveforms for the SPWM (ma = 0.8, mf = 0.9)

(a) **carrier and modulating signals; (b) switch S1 state; (c)switch S3 state; (d) ac output voltage; (e) ac output voltage spectrum; (f) ac output current; (g) dc current; (h) dc current spectrum; (i) switch S1 current; (j) diode D1 current multiple of 3 are identical in amplitude and phase in all phases.**

V. PI CONTROLLER

PI controller are used to control speed and torque of three phase Induction motor, it used to get feedback of input current, torque and speed of the motor it compare with reference speed, current based on requirement and produce a error signal as shown in Figure 4.Basedon this signal the sine pulse is produced to control the Interleaved Isolated Boost Converter and Three Phase Voltage Source Inverter.

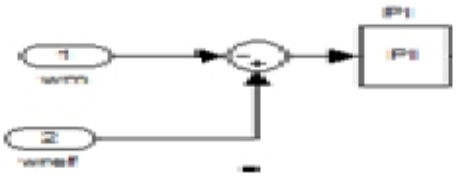


Figure 4: PI controller used in circuit

SIMULATION AND EXPERIMENTAL VERIFICATION

To verify the Theoretical analysis in the section II and III simulation result is carried out .In this section we can clearly understand the concept with experimental result.

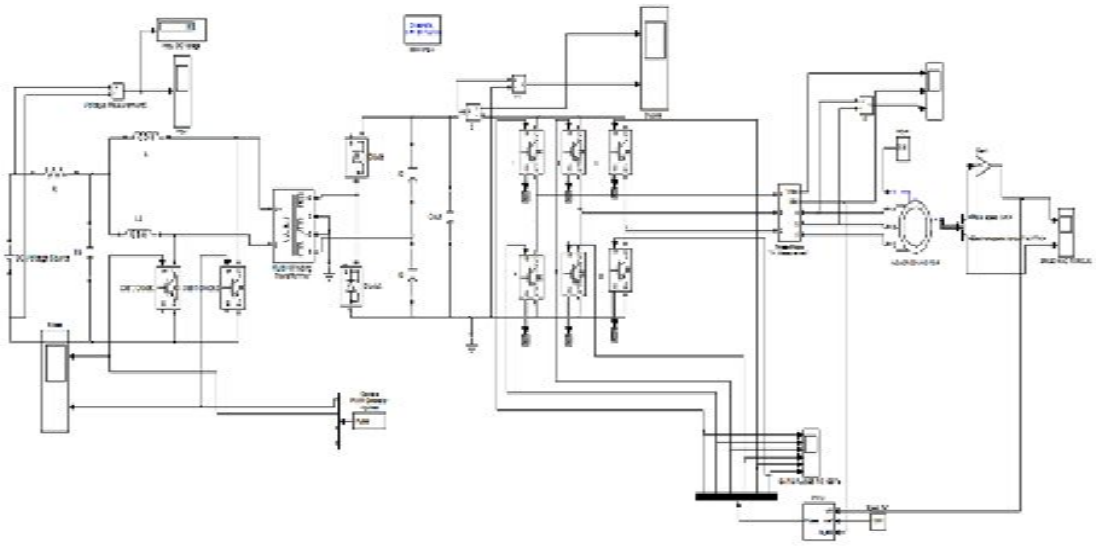


Figure 5: MATLAB simulation of interleave isolated boost converter connected in three phase induction motor adjustable speed drive control with sine PWM technique

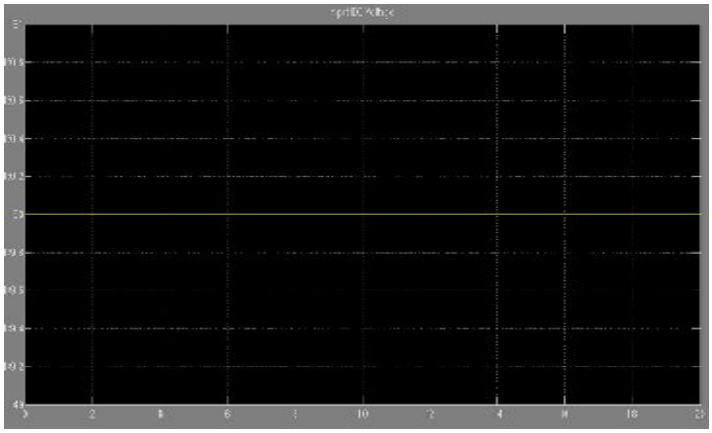


Figure 6: Input DC voltage

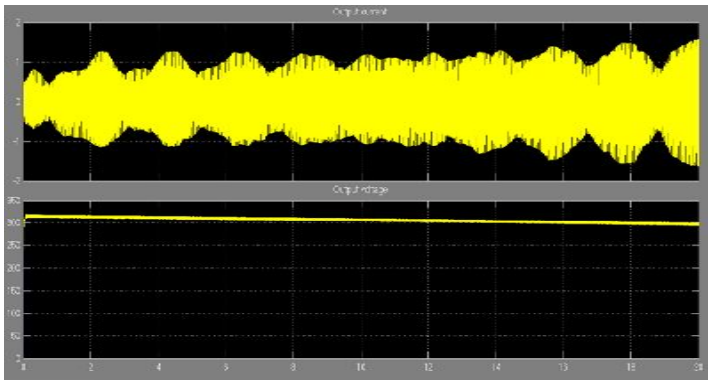


Figure 7:Output of Interleaved Isolated Boost Converter

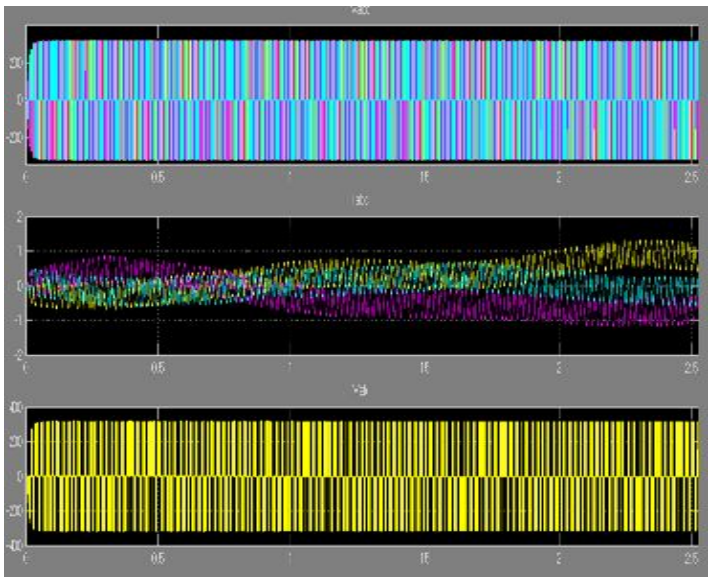


Figure 8:Output of voltage&current of three phase induction motor

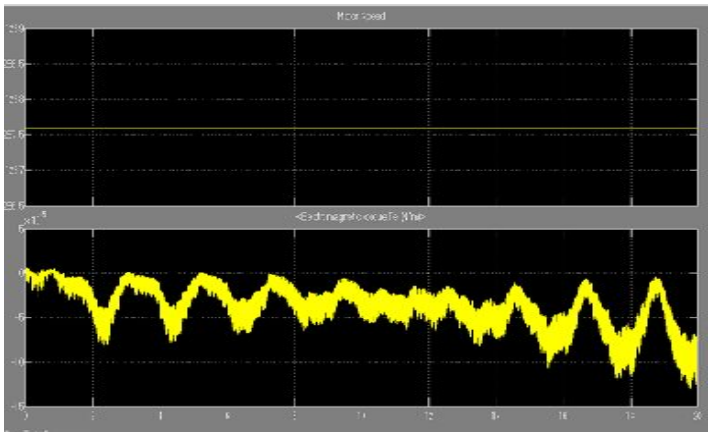


Figure 9: Output of speed& Torque three phase induction motor

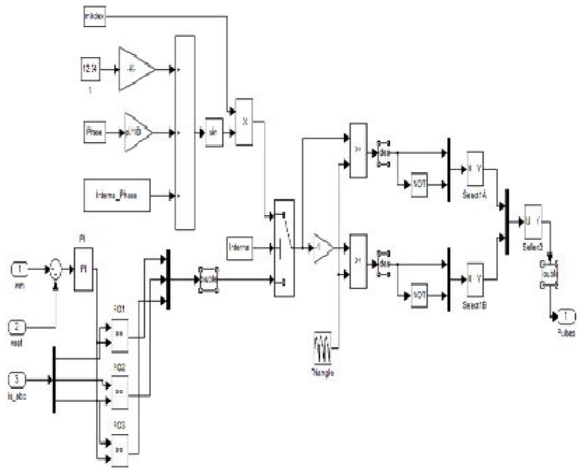


Figure 10: MATLAB simulation of Sinusoidal Pulse Width Modulator

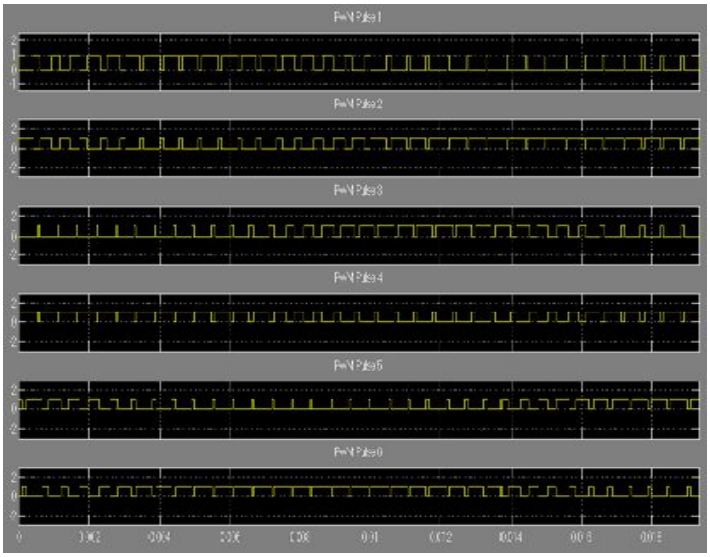


Figure 11: MATLAB simulation of Sinusoidal Pulse

VI. CONCLUSION

This work presented a advantage of Interleaved Isolated Boost Converter as front converter as it share input current equally and lower current ripple also output voltage is equally shared. Sine PWM VSIprovides the additional advantage of superior harmonic quality and larger under-modulation range about 78.5Thus interleave isolated boost converter with sine PWM technique connected to three phase induction motor to obtain superior performance is achieved and it verified with MATLAB simulation.

VII. ACKNOWLEDGMENT

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