Scope International Journal of Science, Humanities, Management and Technology. ISSN : 2455-068X
Vol.2 Issue 1 (2016) 64-70. Submitted 12/03/2016. Published 29/03/2016

Reduction of Power Electronic Switches for Three Phase Multi Level Inverter Fed Drive Applications

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Abstract

This paper provides the simulation of cascaded multilevel inverter fed induction motor drive. The terrible excellent of voltage and present day of a traditional inverter fed induction machine is due to the presence of harmonics and hence there is substantial degree of energy losses. To attain high satisfactory sinusoidal output voltage with decreased harmonics, multi carrier based totally Sinusoidal pulse width modulation (MSPWM) manage scheme is proposed for cascaded H bridge multilevel inverter. The subject orientation manage strategies used to manipulate the velocity of induction motor through controlling the quadrature axis modern the use of PI velocity regulator. The proposed gadget is an wonderful substitute for the conventional technique which produces excessive switching losses results in negative pressure performance. The simulation outcomes expose that the proposed circuit successfully controls the motor pace and enhances the pressure overall performance via reduction in whole harmonic distortion (THD). The effectiveness of the machine is validated via simulation the use of PSIM Simulink software.
Keywords: Cascaded multilevel inverter(CMLI), discipline orientation control (FOC), PSIM simulink, Total harmonic distortion(THD), Voltage source multi degree inverter(VSI), etc.

Introduction

Majority of industrial drives use ac induction motor because these motors are rugged, reliable, and extraordinarily inexpensive. Induction motors are more often than not used for regular velocity functions because of unavailability of the variable frequency supply voltage however many purposes want variable pace operations. Historically, mechanical equipment structures have been used to reap variable speed. Recently, power electronics and manipulate systems have matured to allow these components to be used for motor manage in area of mechanical gears. Present day force types are the Induction motor drives with voltage supply inverters. Also the voltage waveforms of traditional two level inverter fed Induction motor indicates that the voltage across the motor carries not solely the required “fundamental” sinusoidal components, however additionally pulses of voltage i.e. “ripple “voltage. Adjustable velocity drives commonly rent a front-end rectifier to convertibility ac voltage to dc voltage and an inverter to convert the dc voltage to variable frequency and variable voltage for motor control. Motor harm and failure has been mentioned through enterprise as a result of adjustable pace pressure inverters’ excessive frequency PWM switching. The important issues stated have been “motor bearing failure” and “motor winding insulation breakdown” because of internally caused circulating currents. The purpose of these currents is related to the capacitive factors between the winding conductor and motor shaft and additionally the insulation between distinct winding layers being subjected to excessive voltage transients.

The troubles associated with traditional adjustable velocity power inverters are as follows:

1. High-frequency switching requires great de ranking of switching devices and generates giant switching losses.
2. High dV/dt because of switching reasons motor bearing failure and stator winding insulation breakdown.
3. High-frequency switching generates two broadband (10 kHz to 30 Mhz) electromagnetic interference (EMI) to nearby conversation or other electronic equipment.

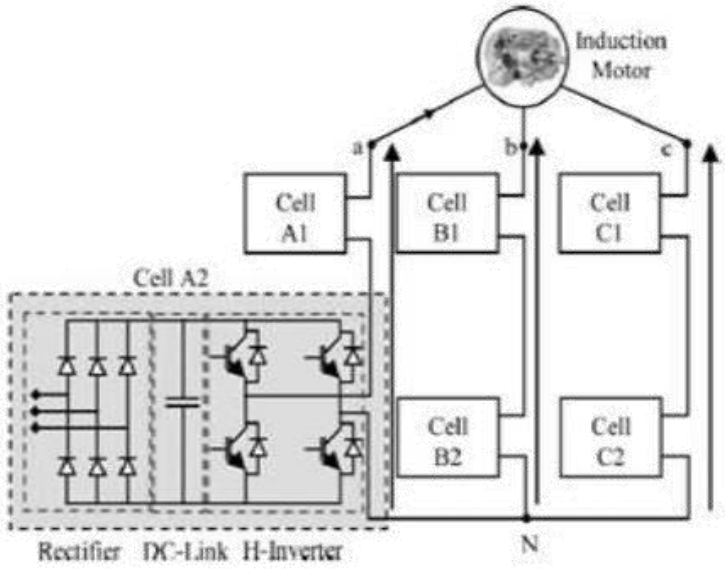
The recent development in strength electronics has initiated to enhance the degree of inverter as a substitute increasing the size of filter. The entire harmonic distortion of the standard inverter is very high. The overall performance of the multilevel inverter is higher than classical inverter. In different words the total harmonic distortion for multilevel inverter is low. The total harmonic distortion is analyzed between multilevel inverter and different classical inverter.

Multilevel inverters also clear up issues with current high-frequency PWM adjustable pace drives (ASD). A multilevel converter has countless blessings over a conventional two-level converter that uses high switching frequency pulse width modulation (PWM) like Staircase waveform nice which can generate the output voltages with very low distortion but additionally can decrease the dv/dt stresses therefore electromagnetic compatibility (EMC) troubles can be decreased also Multilevel converters produce smaller CM voltage consequently the stress in the bearings of a motor linked to a multilevel motor force can be reduced. Multilevel converters can draw enter current with low distortion and operates at low the switching frequency. It should be referred to that decrease switching frequency generally skill decrease switching loss and higher efficiency.

Multilevel converters do have some disadvantages. One precise disadvantage is the larger wide variety of energy semiconductor switches needed. Although decrease voltage rated switches can be utilized in a multilevel converter, every swap requires a associated gate force circuit. This may also motive the standard system to be more pricey and complex.

Cascaded Multi Level Inverter

Cascaded H-Bridge (CHB) configuration has currently end up very famous in high-power AC resources and adjustable-speed power applications. A cascade multilevel inverter consists of a collection of H-bridge (single-phase full bridge) inverter units in every of its three phases. Each H-bridge unit has its very own dc source, which for an induction motor would be a battery unit, gasoline cell or solar cell. Each SDC (separate D.C. source) is associated with a single-phase full-bridge inverter. The ac terminal voltages of special level inverters are connected in series. Through one of a kind combos of the 4 switches, S1-S4, every converter level can generate three different voltage outputs, +Vdc, -Vdcand zero. The AC outputs of exclusive full-bridge converters in the same section are related in series such that the synthesized voltage waveform is the sum of the individual converter outputs. In this topology, the number of output-phase voltage degrees is described by way of m= 2N+1, where N is the range of DC sources.



A. five-level cascaded converter for instance consists of two DC sources and two full bridge converters. Minimum harmonic distortion can be got by using controlling the conducting angles at distinctive converter levels. Each H- bridge unit generates a quasi-square waveform with the aid of phase shifting its high quality and poor phase legs‟ switching timings. Each switching gadget always conducts for 180° (or 1/2 cycle) regardless of the pulse width of the quasi-square wave. This switching approach makes all of the switching units' contemporary stress equal. In the motoring mode, energy flows from the batteries thru the cascade inverters to the motor. In the charging mode the cascade converters works as rectifiers and power flows from the charger (ac source) to the batteries. The cascade converters can additionally act as rectifiers to help get better the kinetic energy of the vehicle if regenerative braking is used. The cascade inverter can also be utilized in the parallel HEV configurations. This new converter can keep away from greater clamping diodes or voltage balancing capacitors. The combination of the 180° conducting method and the pattern-swapping scheme make the cascade inverters voltage and present day stresses the equal and battery voltage balanced. Identical H-bridge inverter units can be utilized, therefore improving modularity and manufacturability and appreciably decreasing production costs. Battery-fed cascade inverter prototype driving an induction motor at 50%and 80% rated speed each the voltage and cutting-edge are almost sinusoidal. The important advantages of using the cascade inverter in an induction motor that it makes induction motor greater accessible/safer and open wiring feasible for most of an induction motor power system. Traditional 230 V or 460 V motors can be used, as a result higher affectivity is anticipated as compared to low voltage motors. No EMI problem or common-mode voltage/current trouble exists. Low voltage switching gadgets can be used. No cost unbalance trouble exists in each cost mode and pressure mode.

Control Techniques

Many applications, such as robotics and manufacturing unit automation, require precise manipulate of speed and position. Speed Control Systems permit one to easily set and adjust the speed of a motor. The control machine consists of a speed feedback system, a motor, an inverter, a controller and a speed placing device. A right designed comments controller makes the system

senseless to disturbance and modifications of the parameters. The purpose of a motor pace controller is to take a signal representing the demanded speed, and to pressure a motor at that speed. Closed Loop speed manipulate structures have fastresponse, however end up luxurious due to the need of feedback elements such as pace sensors.

Implementation of the Speed Control Loop

For a PM motor force device with a full velocity vary the machine will consist of a motor, an inverter, a controller (constant torque and flux weakening operation, generation of reference currents and PI controller) as proven in figure.

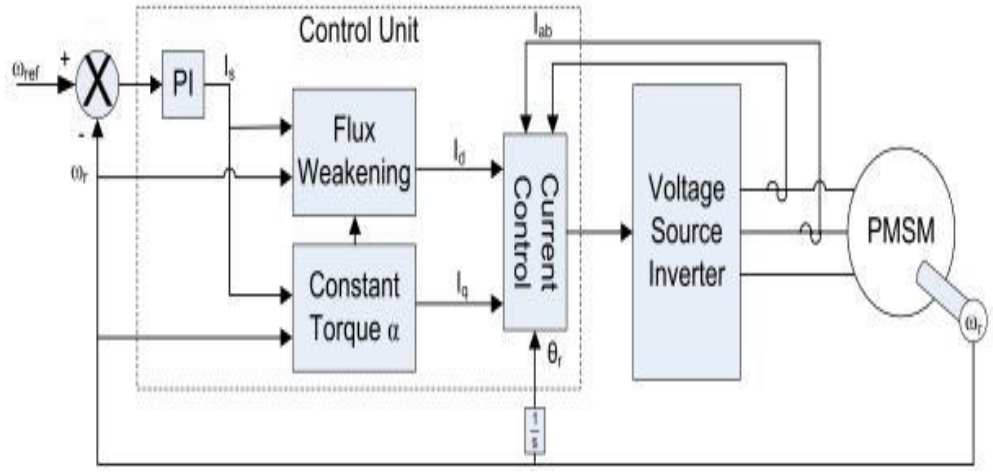


Fig. 2.Block Diagram

The operation of the controller ought to be in accordance to the pace range. For operation up to rated pace it will operate in steady torque region and for speeds above rated velocity it will operate in flux-weakening region. In this vicinity the d-axis flux and the developed torque are reduced. Speed controller calculates the distinction between the reference pace and the true velocity producing an error, which is fed to the PI controller. PI controllers are used extensively formation manage systems. They consist of a proportional attain that produces an output proportional to the enter error and an integration to make the constant state error zero for a step alternate in the input.

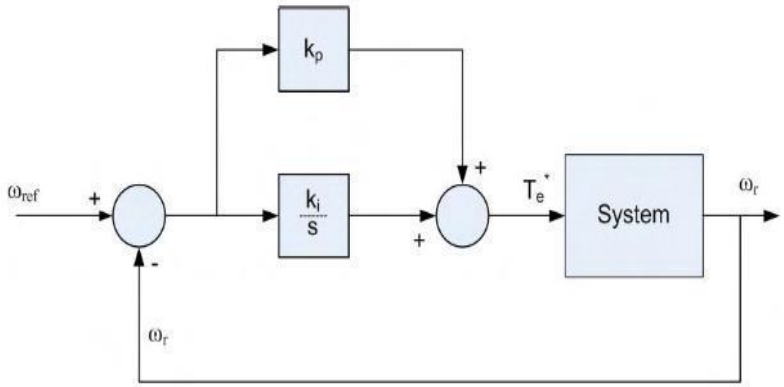


Fig. 3. PI Controller

Speed manipulate of motors mostly consist of two loops the internal loop for modern-day and the outer loop for speed. The order of the loops is due to their response, how quick they can be changed. This requires a present day loop at least 10 instances faster than the speed loop.

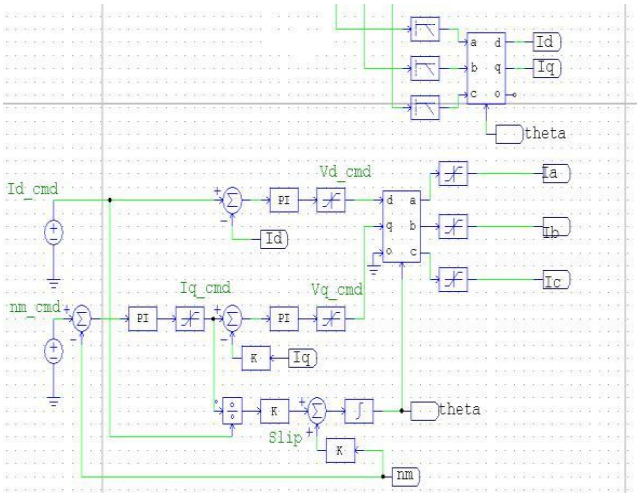


Fig4. Control Circuit

Modulation Topologies For Multilevel Inverters

Mainly the energy electronic converters are operated in the "switched mode". Which capacity the switches inside the converter are usually in both one of the two states - grew to become off when no cutting-edge flows or became on? To manage the waft of strength in the converter, the switches alternate between these two states. This occurs swiftly ample that the inductors and capacitors at the input and output nodes of the converter average or filter the switched signal. The switched issue is attenuated and the favored DC or low frequencyAC component is retained. This manner is known as Pulse Width Modulation (PWM), because the desired average fee iscontrolled through modulating the width of the pulses. To achieve the greatest possible attenuation of the switching component,it is usually suited that the switch frequency f is excessive — many instances the frequency of the preferred necessary Component f1c viewed at the enter or output terminals. No frequency aspects beneath the necessary frequency will exist. This is important seeing that an undesired harmonic component near zero frequency, even if small in amplitude, can reason largecurrents to flow in inductive loads. Beyond these primary requirements, there are many distinctive methods of generating PWMswitching edges. Any approach can possibly be placed into one of the following three categories: 1)Off-line or pre-calculated PWM technique, 2) Hysteresis manipulate PWM, 3) Carrier based PWM.

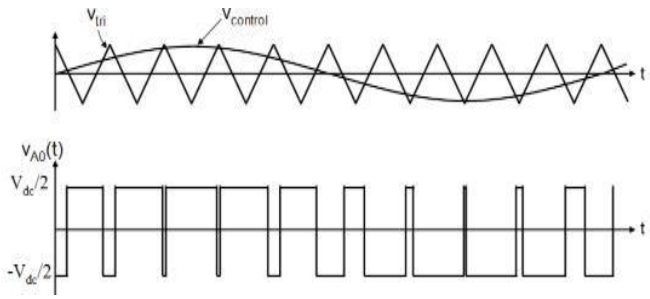


Fig5. Pulse width modulation

Results

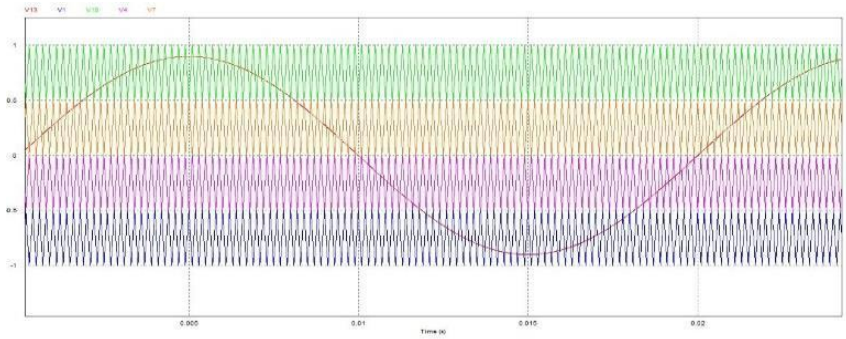


Fig 7. Multicarrier sinusoidal PWM waveform

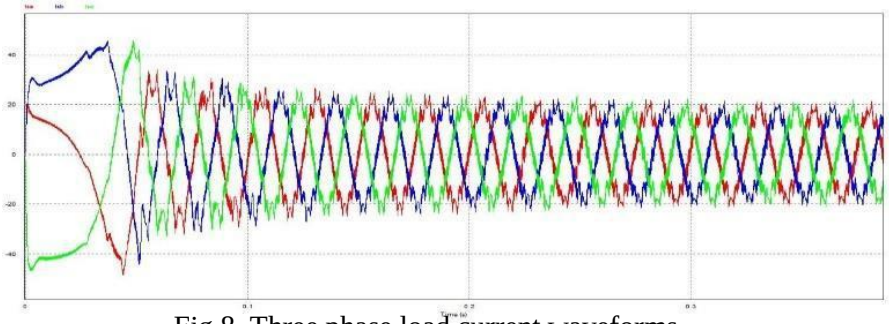


Fig 8. Three phase load current waveforms

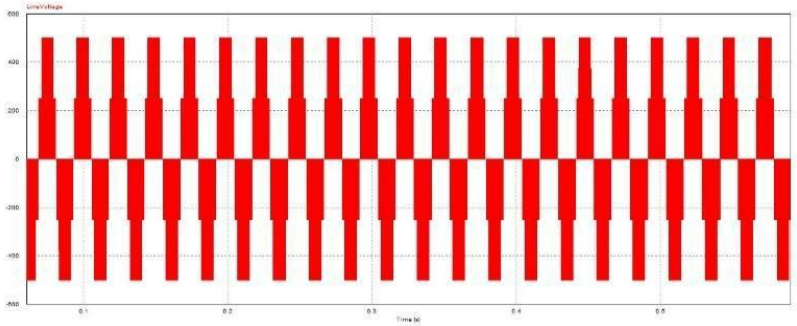


Fig 9. Three phase line voltage

Conclusion

The proposed multicarrier based totally multilevel inverter fed induction motor force the use of area orientation control approach is supply excessive first-rate output signal with decrease total harmonics distortion which is much less than 5% as compare with normal inverter topology and also it furnish higher pace and torque regulation.

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