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Implementation OF Three Phase Variable Frequency Drive

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ABSTRACT:-
This paper is intended to provide a novel and simpler way of speed control three phase induction motor using simultaneous .The wide range control technique of three speed of induction motor has presented. With this technique the speed control is obtained by changing speed using simultaneous control of frequency and the three voltages which are spaced by 120o with respect to each other at all frequency. The variable frequency drive works principle, it's the electronic controller specifically designed to change the frequency and control signal voltage supplied to the controller and thereby the stator of three phase induction motor.

Keywords- Variable Frequency Drive (VFD), Inverter,Induction Motor, Rectifier

I. INTRODUCTION

Variable frequency drives (VFD) can control the speed of an induction motor by converting fixed frequency and fixed voltage magnitude to variable frequency and variable voltage magnitude at motor terminals, and thus, provide significantly improved process control, energy saving, and soft motor starting. The common VFD structure comprises of an AC/DC rectifier, a dc link, inverter, additional control and protection circuits. The dominant type of VFDs is the pulse-width-modulation (PWM)-controlled voltage source inverter type [1].The wide variety of settings, operating modes, and operating conditions of a VFD compound the challenges involved in characterizing motor-VFD systems. One area of interest in terms of application is operation of VFDs under voltage unbalance. VFDs, like other power equipment, are often subjected to voltage quality issues that are inherent in industrial power supply systems. Unbalanced voltage operation has been well covered in literature for sinusoidal powered induction machines.

II. IGBT

In the low power field where the MOSFET plays the major role, the switching frequency is normally subject to system efficiency and/or magnetic considerations instead of device limitations. In the medium power field, where the IGBT plays the major role, the situation changes. At the lower end, the limitation of the device does not dominate since the lower-rating IGBT is normally fast enough. However, when the power rating is higher, the IGBT switching speed decreases and the switching losses increase significantly. The practical switching frequency is thus subject to the limitation of the device.

III. POWER CIRCUIT

The block diagram below contains three separate sections to indicate the basic working principle of a VFD:

- The Rectifier
- The Filter

The switching section that uses regular transistors, or insulated gate bipolar transistors (IGBT) to invert the DC voltage back to AC voltage with the proper frequency

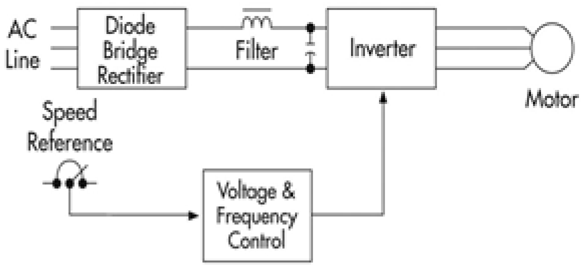


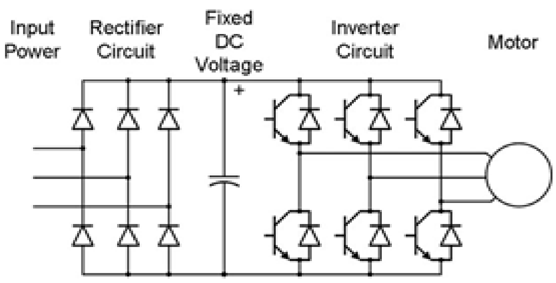
Fig. Block Diagram Of An Ac Motor

The VFD shown as three separate sections:

a) Rectifier stage: A full-wave, solid-state rectifier converts three-phase 60 Hz power from a standard or higher utility supply to either fixed or adjustable DC voltage. The system may include transformers if higher supply voltages are used.

b) Inverter stage: Electronic switches power transistors or thyristors - switch the rectified DC on and off, and produce a current or voltage waveform at the desired new frequency. The amount of distortion depends on the design of the inverter and filter.

c) Control system: An electronic circuit receives feedback information from the driven motor and adjusts the output voltage or frequency to the selected values. Usually the output voltage is regulated to produce a constant ratio of voltage to frequency(V/Hz).

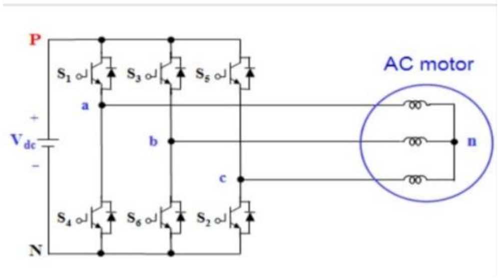


The first stage of a Variable Frequency AC Drive, or VFD, is the Converter . The converter is comprised of six diodes, which are similar to check valves used in plumbing systems. They allow current to flow in only one direction; the direction shown by the arrow in the diode The supply voltage is firstly pass through a rectifier unit where in gets converted into AC to DC supply, the three phase supply is fed with three phase full wave diode where it gets converts into DC supply. The DC bus comprises with a filter section where the harmonics generated during the AC to DC conversion are filtered out. The last section consists of a inverter section which comprises with six IGBT (Insulated Gate Bipolar Transistor) where the filtered DC supply is being converted to quasi sinusoidal wave of AC supply which is supply to the induction motor connected to it. A set of IGBT switches are used to convert the DC to three phase AC power to drive induction motor. The filter supplies a DC voltage to the inverter that is largely independent of load current due to filter capacitor. The inverter tends to keep the current constant. The AC to DC converter output may be fixed or variable depending on the type of inverter and the filter used. As we know that the synchronous speed of motor is directly proportional to the supply frequency, therefore synchronous speed of the motor can easily vary by changing the value of the frequency.

AC motor characteristics require the applied voltage to be proportionally adjusted by the VFD whenever the frequency is changed .Thus the ratio of volts per hertz must be regulated to a constant value . The most common method used for adjusting the motor voltage is called pulse width modulation (PWM). With PWM voltage control, the inverter switches are used to divide the simulated sine-wave output waveform into a series of narrow voltage pulses and modulate the width of the pulses.With a standard AC across-the-line motor starter, line voltage and frequency are applied to the motor and the speed is solely dependent on the number of motor stator poles. In comparison, a VFD delivers a varying voltage and frequency to the motor, which determines its speed. The higher the frequency supplied to the motor, the faster it will run.

IV. A THREE PHASE 120 DEGREE MODE BRIDGE INVERTER

A three-phase inverter converts a DC input into a three-phase AC output. Its three arms are normally delayed by an angle of 120° so as to generate a three-phase AC supply.



The inverter switches each has a ratio of 50% and switching occurs after every T/6 of the time T 60°angleinterval 60°angle interval. The switches S1 and S4, the switches S2 and S5 and switches S3 and S6 complement each other.

The figure below shows a circuit for a three phase inverter. It is nothing but three single phase inverters put across the same DC source. The pole voltages in a three phase inverter are equal to the pole voltages in single phase half bridge inverter.

The two types of inverters above have two modes of conduction − 120° mode of conduction.

120° mode of conduction

In this mode of conduction, each electronic device is in a conduction state for 120°. It is most suitable for a delta connection in a load because it results in a six-step type of waveform across any of its phases. Therefore, at any instant only two devices are conducting because each device conducts at only 120°.The terminal A on the load is connected to the positive end while the terminal B is connected to the negative end of the source. The terminal C on the load is in a condition called floating state. Furthermore, the phase voltages are equal to the load voltages as shown below.

Phase voltages = Line voltages

VAB = V
VBC = −V/2
VCA = −V/2

By following this symmetrical switching we can achieve the desired three-phase voltage represented in the graph.It can be seen in the output graphs of both 120º switching cases that we have achieved an alternating three-phase voltage at the three output terminals. Although the output waveform is not a pure sine wave, it did resemble the three-phase voltage waveform. This is a simple ideal circuit and approximated waveform for understanding 3 phase inverter working.

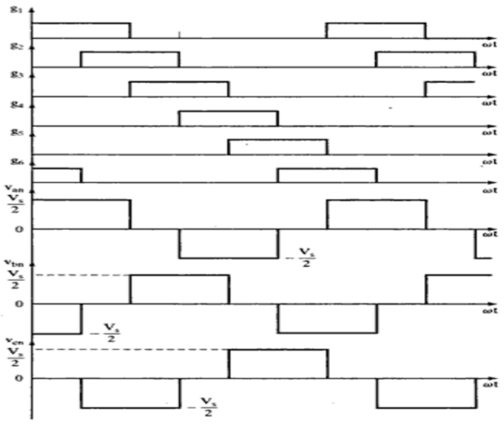


FIG : Waveforms For 120° Mode Of Conduction

V. PROPOSED TOPOLOGY

PULSE WIDTH MODULATION

Pulse Width Modulation (PWM) VFDs provide a more sinusoidal current output to control frequency and voltage supplied to an AC motor. PWM VFDs are more efficient and typically provide higher levels of performance. A basic PWM VFD consists of a converter, DC link, control logic, and an inverter.In pulse width modulation technique , the thyristor switches are turned on and turned off several times during a half cycle and the output voltage is controlled by changing the width of pulses. For turning on and off the gate pulses are generated by comparing a triangular wave with a dc signal.

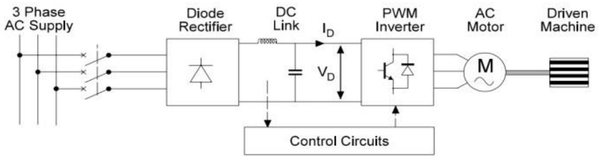


FIG overall circuit

System Design

The system block diagram is shown in Fig.1,the input voltage signal is input to the error amplifier circuit, and then the input to the comparator, and its negative feedback to the error amplifier circuit, to improve the accuracy of the input signal. The triangular wave circuit generates a triangular wave and input to the comparator, and the input voltage of the triangular wave voltage and the error amplification circuit is compared by comparing the circuit, and the output of the PWM wave is generated. Change the input voltage signal, will produce different PWM waveform. By reasonable selection of high performance devices, the frequency and driving ability of wave can be improve

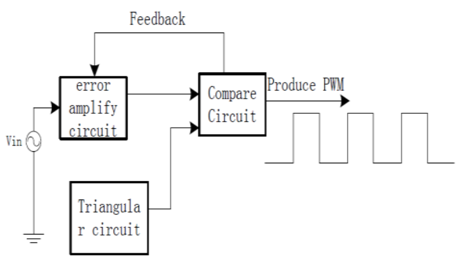
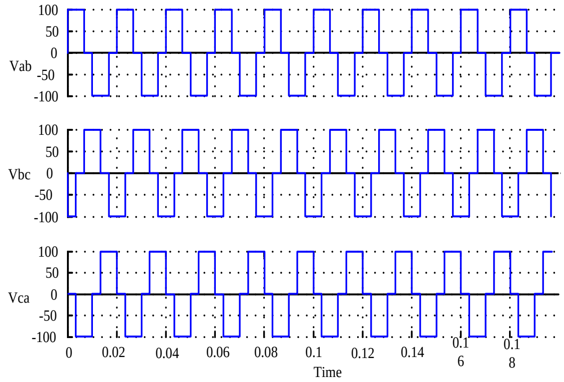
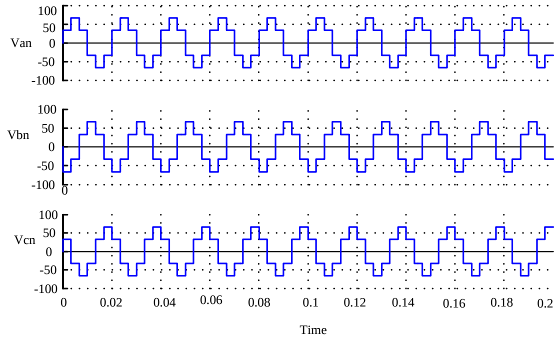


Fig .system design diagram





VII. Conclusion

The technique presented in this paper wide range control of three phase induction motor which is not easily possible by voltage control .The v/f ratio is maintained for below rated speed and speed varies from 10 % to 95 %of the rated speed and the speed for the range above the rated speed of the motor was varied from 95% to 120 % of the rated speed by keeping stator voltage constant

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