AC Load Control By SPWM Technique

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Abstract - Induction motors are being used in greater numbers throughout a wide variety of industrial and commercial applications because it provides many benefits and reliable device to convert the electrical energy into mechanical motion. In some applications, it’s desired to control the speed of the induction motor. Because of the physics of the induction motor the preferred method of controlling its speed is to vary the frequency of the AC voltage driving the motor. In recent years, with the microcontroller incorporated into an appliance, it becomes possible to use it to generate the variable frequency AC voltage to control the speed of the induction motor. This study investigates the variable frequency power inverter. The variable frequency pulse width modulation (PWM) signal that controls the applied voltage on the gate drive, which provides the required PWM frequency with less harmonics at the output of the power inverter. The fully controlled bridge voltage source inverter has been implemented with semiconductors power devices isolated gate bipolar transistor (IGBT), and the PWM technique has been employed in this inverter to supply the motor with AC voltage. The proposed drive system for three & single phase power inverter is simulated using Matlab/Simulink. The Matlab simulation results of the proposed system were achieved with different PWM. From the result, a stable variable frequency inverter over wide range has been obtained and a good agreement has been found between the simulation and hardware of a microcontroller based single phase inverter.

Index Terms —Microcontroller, Induction motor, three phase power inverter, SPWM technique.

I. INTRODUCTION

The variable frequency inverters are used in wide applications. three phase induction motor drive traction and it is popular in many high power industrial applications, such as speed and torque control. Single phase induction motor, which has a common using in residential applications domestic such as dishwashers, cloths dryers, fans, pumps, etc. ,when the SPIMs are preferred due to the greater availability of single phase power supply..
developed the software for the control system, which confirmed the high quality of the control based on microcontroller techniques and to provide additional real time processing through put in an inverter operation, microcontrollers and DSP features minimize the CPU's overhead in an interrupt intensive application [4]. microcontroller has been chosen for this implementation because it is easy to develop, instantly response, high performance, high speed, and low-power chip with multiplexed capable of running at up to 2 MHZ. Traditionally, variable speed operation of a single phase induction motor suffers from large harmonic and limited speed, therefore the system has been built using voltage control method with semiconductors power devices IGBT and SPWM techniques have been implemented to avoid the large harmonics. Simulation of a single phase and three phase variable frequency inverter, which has been constructed on Matlab software to check its capability to achieve sinusoidal waveform with variable frequency to use as single phase and three phase variable frequency power supply.

The Matlab simulation results achieved with different PWM frequencies. this system can be considered as high power variable frequency voltage source inverter.

II. CIRCUIT OPERATION

![Figure 2: 3phase Inverter ckt](image)

The ckt operation is shown in the fig. three phase inverter input is rectifier. As shown in fig there are six IGBT based inverter the output is not pure Ac, so we connect LC filter at output of inverter. So we can get sinusoidal waveform. In three phase inverter three phase line connected to the ckt so high power supply passes from the ckt. Three phase inverter has two conduction mode: 120 Degree and 180 Degree. The IGBT triggered as per delay time. The triggering wave form of the both conduction mode is as shown in figure.

![Figure 3: 180 Degree conduction](image)

In three phase inverter of fig.2&3, each IGBT conducts 180 degree of a cycle. IGBT pair in each arm, i.e. S1,s4;S3,s6 and S5,s2 are turn on with a time interval of 180 degree. S1 conducts for 180 and S4 for next 180 of cycle. IGBT in upper group, i.e. S1,S3,S5 conduct at an interval of 120 Degree. It means that S1 is fired at wt=0, and S3 must be at wt=120 and S5 at wt=240. same procedure for S4,S6,S2 lower group of IGBTs. The fig.3 shows that S5,S6,S1 should be gated for step1;S6,S1,S2 for step2;S1,S2,S3 for step 3;S2,S3,S4 for step4 and so on. From this procedure every step of 60 degree duration, only three IGBTs are conducting. One from upper group and two from the lower group or two from the upper group and one from lower group.

![Figure 4: 120 conduction mode](image)
In three phase inverter of fig.2&4, each IGBT conducts 120 degree of a cycle. IGBT. from the first row shows that s1 conducts 120 degree and for next 60 degree, neither s1 and s4 conducts. s4 is turned on at 180 degree and further conduct as 120 to 180, series connected IGBTs s1, s4 do not conduct. At wt=360, s4 is turned off, then 60 interval elapses before s1 is turned on again wt=360 degree. in second row s3 is conducts for 120, then 60 interval elapses during which neither s3 nor s6 conducts. At wt=300 degree, s3 is on, it conducts for 120 and then 60 interval elapses after which s3 is turned on again. thired row is also complete similarly, s6, s1 on for step1: s1, s2 for step2: s2, s3 for step3 and so on. the sequence of firing six IGBTs are same as for 180 degree mode inverter. During each step, only two IGBTs conducts for this inverter, one from upper group and one from lower group.

III. EXPERIMENTAL SETUP.

In this study, the full bridge rectifier has been used to convert the AC supply to a DC voltage. A capacitor and an inductor are connected to form a smoothing filter. The output of the rectifier is the input to the inverter, which receives the smooth DC voltage and converts it to AC power to get the variable frequency power source. The microcontroller-based control system hardware has been programmed to vary the frequency of the SPWM signal that controls the frequency of the power inverter. The SPWM module gets two inputs “duty cycle and frequency” the duty cycle can be ranged from 0% to 100%. In order to use the output compare function as PWM generator, the frequency is converted from Hz to counts according to the following equation.

\[ \text{FREQ}_{\text{HZ}} \times \text{FREQ}_{\text{CNT}} = 0.5 \]

Where, 0.5μs is the one cycle period of microcontroller. The PWM signals of the MCU are applied to the gate of IGBT through gate drive; the gate driver provides isolation, low impedance and high current supply to drive the IGBT’s.

IV. RESULT ANALYSIS

Simulation is carried out in the MATLAB/SIMULINK environment as shown in. Load is assumed resistive. Voltage 230v to rectifier and 330v to inverter, switching frequency is set 50 KHz.
V. CONCLUSION

Three phase variable frequency inverter is simulated using Matlab/Simulink software. The stable AC power source with variable amplitude and variable frequency over wide range has been obtained. The microcontroller based Three phase variable frequency power inverter has been introduced. Results of the experiment have been obtained for the microcontroller, which offers reliable and low-cost solutions for Three phase variable frequency inverter and good agreement was found between simulation and hardware results. In general, the AC-DC-AC conversion was successful, on the other side, some overshoot were found due to suspected causes such as the control algorithm used in the microcontroller and harmonic content at the inverter output.

VI. REFERENCES


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