Research Paper Engineering

"Implementation On Three Phase Voltage Source Inverter With 1500 Conduction Mode"

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ABSTRACT

This paper presents a new modification and implementation for the most common, simple and well-known three-phase six insulated gate bipolar transistors (IGBTs) switch voltage source inverter (VSI). Via this strategy, each one of the six IGBTs conducts for 150o instead of the known 180o or 120o conduction modes and this 1500 conduction was get through using a PIC16F72 Microcontroller, resulting in a wye connected load, the output phase voltage becomes a seven-level, 12 steps waveform. So the using the new controlling strategy, this result a 50% reduction of the total harmonic distortion is obtained and simplicity of hardware compare to 1800 and 1200 conduction modes. Simulation and experimental results show the contribution of the proposed strategy. Simulation is done Mat-Lab and proutius simulator.

Keywords : Three phase voltage source inverter, Conduction Modes, PIC16F72 Microcontroller, IGBTs

I Introduction

Inverters are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. For an inverter selection, various power topologies are there like VSI and CSI.[1] Also they are distinguishing like single phase, three phase, multilevel etc. Three phase inverter with different conduction mode (1800 mode, 1200 mode and 1500 mode) is discussed. From this discussion comparison topics are achieved. Base on it, 1500 conduction mode is selected for further work.[2]

The harmonic contents generated by power electronic devices have significant and detrimental effect on circuit output.[1] So, THD should be minimum for reliable operation of any circuit. THD is an important figure of merit for representing the characteristic of any circuit.[2] The comparative results of total harmonic distortion generated at the output for conduction period of switches in 120º conduction, 150º conduction and 180º conduction are present at the last with some another comparative issues.[2]

As shown connection diagram, DC supply for inverter is given by bridge module 35MT60 whose ac supply is taken through auto transformer (Variac) and required filter component. The auto transformer is used to apply variable ac voltage to rectifier unit for obtaining variable DC supply. This variable DC supply is used for open loop observation of three phase inverter. Three FGA-25N120ANTD IGBTs is the main part of hex bridge. Three resistors of 1k1 connected in star is used as a load of three phase inverter.

II. EXPERIMENTAL RESULTS

Control Circuit Testing

The required 150 degree PWM gate pulses are generated by PIC16F72.This IC gives six PWM pulses. Using ADC channel of controller frequency of pulse will be varying to 50Hz to 1kHz. On 50 Hz switching frequency satisfactory results are achieved.

Driver Circuit Testing

Driver circuit and isolated power supply for each gate pulse are shown in show the generated gate pulse with 60 degree phase shifted. Driver circuit input and output waveform.

The output pulse of dead band circuit is given to the driver circuit having IC 6N137.There is a need for electrical isolation between the logic level control signal and driver circuit. This isolation is provided by optocoupler inside the driver IC. Different driver ICs for top and bottom IGBT are supplied with isolated power supply. The output of driver circuit is given to gate of IGBT through 10 ohm gate current limiting resistor, Test results shows the input and output of driver IC. We can observe the delay time and propagation time from the results. The test results prove that the delay time and propagation time of driver IC are same as given in its datasheet. The total response time given in datasheet is maximum 20 nsec. The result also gives 20 nsec response times which is less than maximum, Fig. 9 show the response time of Gate driver IC.

Line Voltage Output

Here twelve switching patterns are presented per cycle; with each pattern duration is 300. Three switches are conducting in one interval- as in 1800 mode, while only two switch conduct in the next one as in 1200 mode. Show simulated output voltage waveforms for wye-connected load.

The line-to-neutral voltage, show in (2) Van, is expressed in Fourier series, as:

$$V_{a\_150^0} = \sum_{n=1,3,5.}^{\infty} \frac{V_d}{6n\times\pi}\left[\begin{array}{l} 4+Cos\frac{n\pi}{6}+Cos\frac{n\pi}{3}-Cos\frac{2n\pi}{3}-2Cos\frac{5n\pi}{6} \\ -Cos\frac{7n\pi}{6}-Cos\frac{4n\pi}{3}+Cos\frac{5n\pi}{3}+2Cos\frac{1}{6}\frac{n\pi}{} \end{array}\right] Sin\left(\omega t+\frac{\pi}{3}\right) \quad (2)$$

Figure 1. Line Voltage with 120 degree shifted waveform

Phase Voltage Output

Figure 2. Phase Voltage with 120 degree shifted waveform

So the when 1.1kΩ star connected load used for three phase voltage source inverter applied a 1500 conduction mode pulse than the phase voltage was made as, Three phase voltage source inverter in 1500 conduction mode with a star-connected load, the output phase voltage becomes a seven-level, 12 steps waveform, compared to the known only four or three levels in 180o and 1200 conduction modes, respectively.

III. CONCLUSION

Three phase voltage source inverter in 1500 conduction mode using PIC16F72 Microcontroller controlling circuit with a star-connected load, the output phase voltage becomes a seven-level, 12 steps waveform, compared to the known only four or three levels in 180o and 1200 conduction modes, respectively. This result in a reduction of the total harmonic distortion, reduction of voltage distortion factor, and the lowest harmonic order becomes 11 rather than 5. So, on the basis of simplicity, economy, easy to implement and less personates of total harmonics distortion at output side 1500 is suitable topology.

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