Implementation of SHEPWM in Single Phase Inverter

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Abstract— In this paper three-level single phase inverter by using SHEPWM system will be focused. The total harmonic distortion (THD) method is used to specify the quantity of harmonics contents in the output waveforms. Here we will check and prove the relationship between the line voltage THD and the number of switching angle.

Essentially in this, the harmonic components and the harmonic characteristics will be focused.

Index Terms— SHEPEM, THD, multilevel inverter

I.Introduction

(A) Multilevel inverter :

Now a day multilevel inverters have become more popular in electric high power application. By using multilevel inverter we get more advantage and fewer difficulties than ordinary two-level inverters in case of switching frequencies. I.e. two-level inverter generates more switching losses compared to the multilevel inverters. Multilevel inverters produce less THD voltage, it is in percentile.
In proposed system we are using three- level inverter.

(B) SHEPWM :

It is the selective harmonic elimination PWM technique used to eliminate the lower order harmonics. We knew that, harmonics are the biggest problem in the power quantity aspect in electrical systems. The presence of harmonics is major drawback faced with inverters. There are many advantages of SHEPWM over carrier-based sinusoidal PWM (SPWM) and space vector PWM (SVPWM).

In this, a three-level SHE PWM generated by a full-bridge inverter is considered. A full-bridge or H-bridge voltage source inverter, which comprises four switches and one dc source, is depicted in Fig.1. Three states of an output waveform such as positive, negative, and zero, can be obtained here. Fig.2 shows a generalized three-level SHE PWM waveform, which is synthesized by using the inverter circuit shown in Fig.1. The output waveform is chopped N times per quarter. As a result each switch switched N times per cycle to make such a waveform.

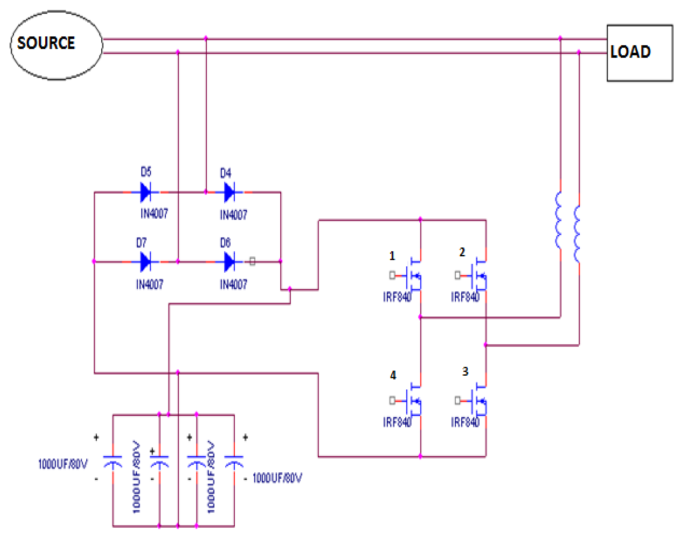


Fig.1. Three-level voltage source inverter.

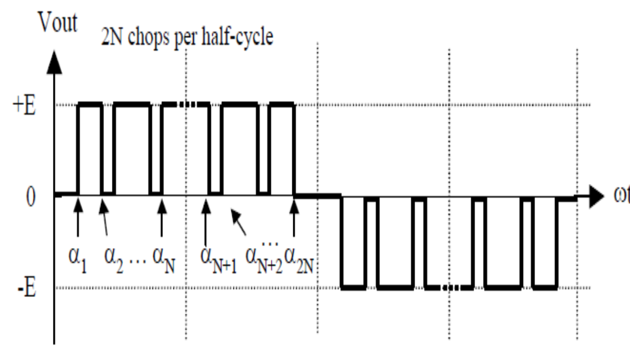


Fig.2. Generalized three-level SHE PWM waveform

II. The relationship between the line voltage THD and the number of switching angle.

In this, for the SHE PWM technique, for given modulation index, sets of switching angles of 2-, 3-, 4-, 5-, 6-, 7-, 8 switching angles of three-level waveform will be designed and voltage THD will be calculated.

The simulation of the proposed system is carried out by using MATLAB⁄Simulink. The simulation diagram of the proposed system is shown in fig.3.

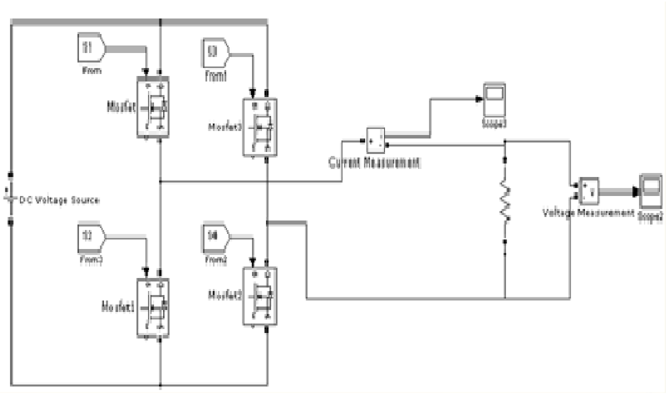


Fig.3. Simulation diagram of proposed system.

From fig.3, a full bridge topology is has been formed by using four MOSFETs. The switching angles are resulting from the switching subsystems. The switching subsystem acknowledges the modulation index and gives solution for the switching angles. In our proposed system we kept modulation index as 0.8 and vary the no. of switching angles(2 to 8).

In this we will take different values of switching angles and check the output voltage waveform and THD values .

1. K=2

α1= 30.12, α2=90.25

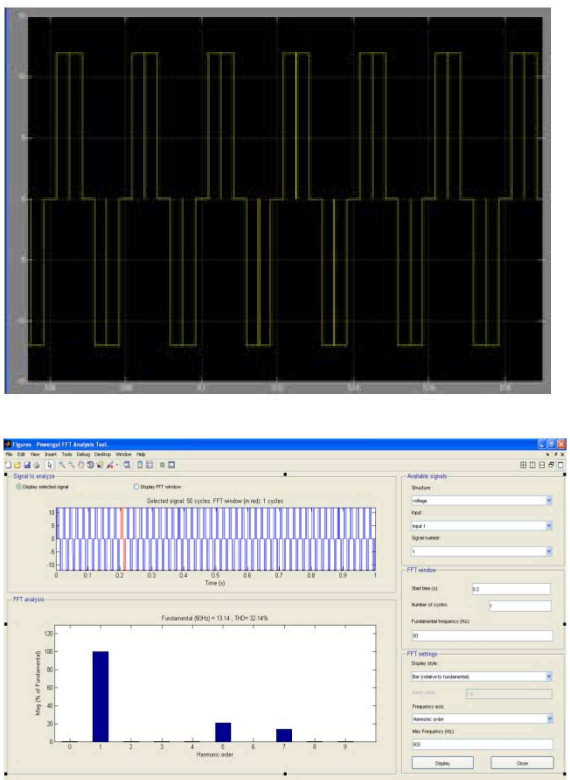


Fig.4. Inverter output voltage waveform and FFT modulation index 0.8 with K=2

2. K=3

α1= 22.23, α2=35.20, α3=45.75

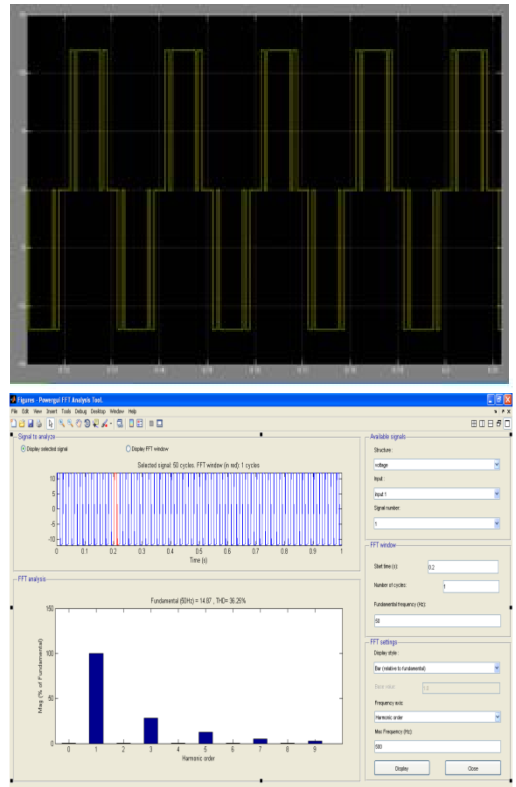


Fig.5. Inverter output voltage waveform and FFT modulation index 0.8 with K=3

3. K=4

α1= 21.82, α2=39.34, α3= 46.61, α4=90.11,

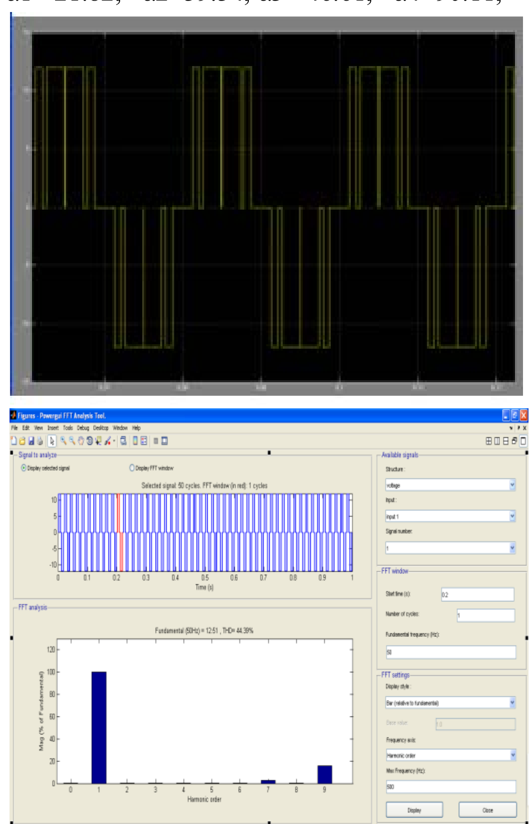


Fig.6. Inverter output voltage waveform and FFT modulation index 0.8 with K=4

4. K=5

α1= 19.14, α2=27.29, α3=38.17, α4=55.01, α5=60.13

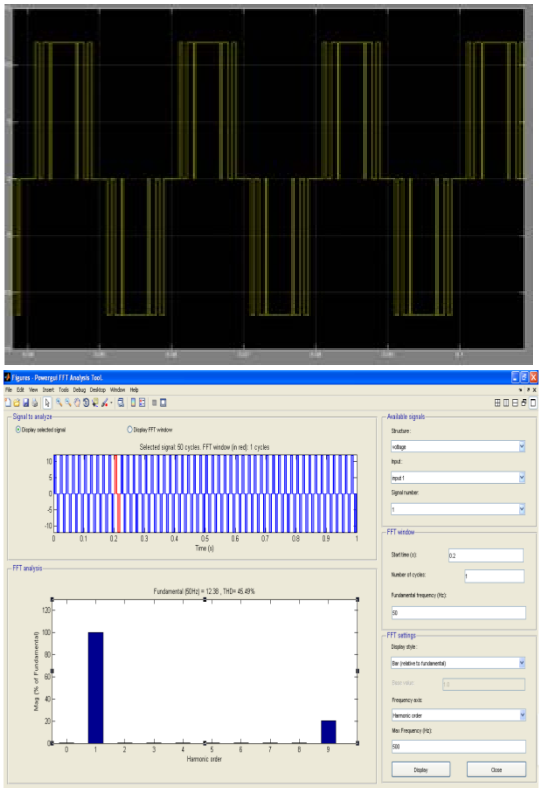
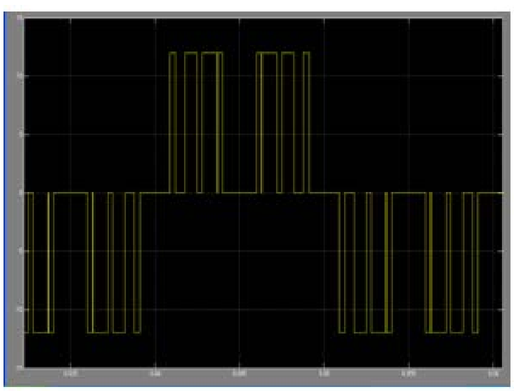


Fig.7. Inverter output voltage waveform and FFT modulation index 0.8 with K=5

5. K=6

α1= 18.22, α2=25.11, α3= 37.07, α4=54.98, α5= 57.10, α6=90.05



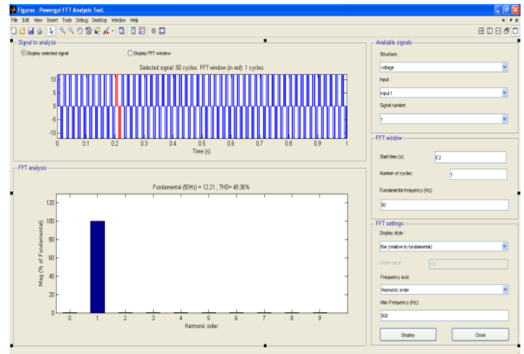


Fig.8. Inverter output voltage waveform and FFT modulation index 0.8 with K=6

6. K=7

α1= 16.99, α2=21.91, α3= 34.98, α4=50.06, α5= 55.63, α6=62.80, α7=68.72

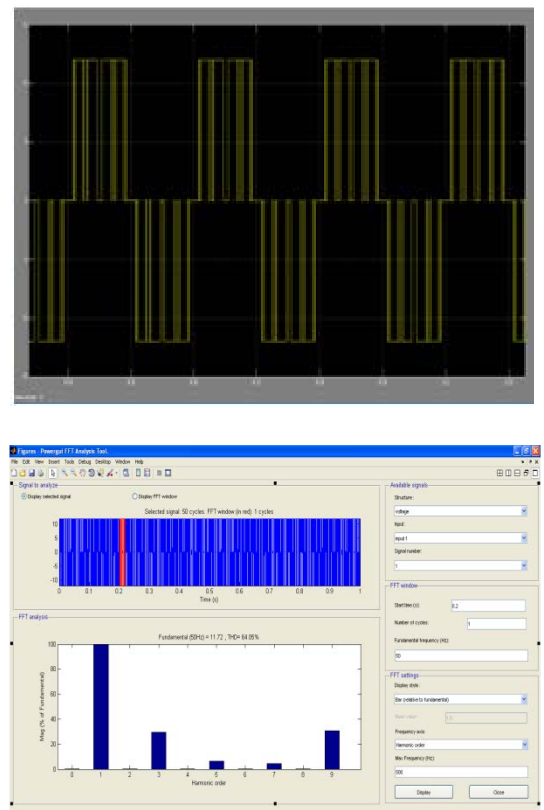


Fig.9. Inverter output voltage waveform and FFT modulation index 0.8 with K=7

7. K=8
   α1= 16.32, α2=21.25, α3= 34.16, α4=51.38,
   α5= 54.35, α6=61.29, α7= 67.94, α8=75.87

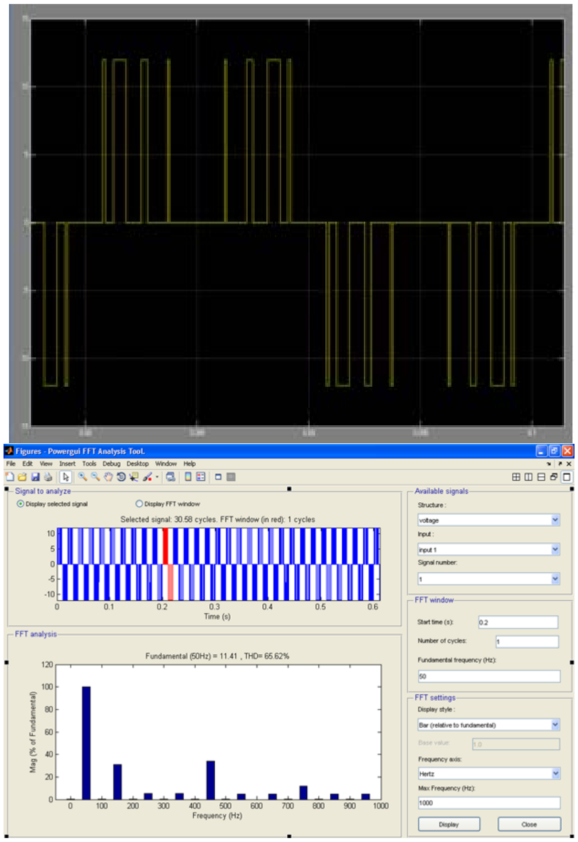


Fig.10. Inverter output voltage waveform and FFT modulation index 0.8 with K=8

III SIMULATION AND RESULT

MATLAB was used to generate plots of switching angles and THD .

Table-1 Analysis of Switching angles and THD

Switching NO.(K)		2	3	4	5	6	7	8
α (Degree)	α1	30.12	22.23	21.82	19.14	18.22	16.99	16.32
	α2	90.25	35.20	39.34	27.29	25.11	21.91	21.25
	α3		45.75	46.61	38.17	37.07	34.98	34.16
	α4			90.11	55.01	54.98	50.06	51.38
	α5				60.13	57.10	55.63	54.35
	α6					90.05	62.80	61.29
	α7						68.72	67.94
	α8							75.87
TDH(%)		32.16	36.25	44.39	45.49	48.36	64.06	66.62

From table.1, with increase in the no. of switching angles (2 to 8) causes the THD value of the system goes on increases. In short, increasing the no. of angles increases the motor impedance with frequency (2πfL).

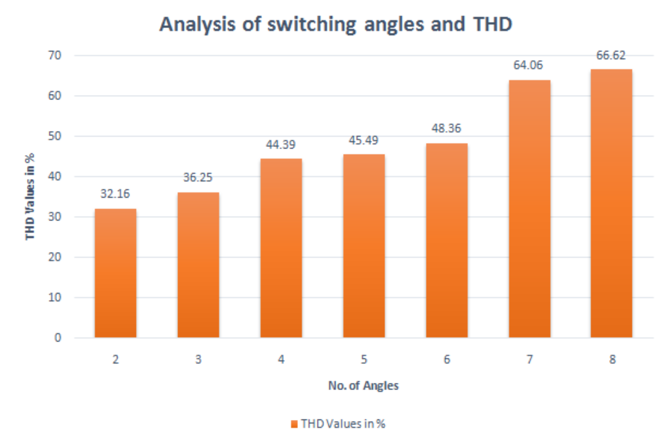


Fig. 11. Graph of Analysis of switching angles and THD

IV CONCLUSION:

In the system, an implementation of SHEPWM to minimize the lower order harmonics in the output voltage waveform of the single-phase three-level inverter presented. Evaluation of the inverter performance can be calculated from the performance factor THD. The voltage THD changes slightly, when the number of switching angles per quarter, N, is changed.

REFERENCES

[1] M. Balasubramonian and V. Rajamani "Design and Real-Time Implementation of SHEPWM in Single-Phase Inverter Using Generalized Hopfield Neural Network“, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 61, NO. 11, NOVEMBER 2014 6327

[2] "Novel Multilevel Inverter Carrier-Based PWM Methods“ by Leon M. Tolbert Thomas G. Habetler Oak Ridge National Laboratory Georgia Institute of Technology Electrical and Computer Engineering Oak Ridge.

[3] Dr. Jamal A. Mohammed "Optimum Solving SHEPWM Equations for Single Phase Inverter Using Resultant Method Optimum Solving SHEPWM Equations for Single Phase Inverter Using Resultant Method“Engineering Technology, Vol. 26, No.6, 2008

[4] L. Li D. Czarkowski Y. Liu P. Pillay," Multilevel Selective Harmonic Elimination PWM Technique in Series-Connected Voltage Inverters“, Dept. of Electrical Engineering Dept. of Electrical and Computer Engg. Polytechnic University Clarkson University

[5] K. Imarazene1, H. Chekireb2 and E.M. Berkouk," Selective Harmonics Elimination PWM with Self-Balancing DC-link Capacitors in Five-Level Inverter“, Laboratoire des SystÃ´lmes Electriques et industriels, U.S.T.H.B University, Algeria.