ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org

A Comparative Analysis of MPWM & SPWM Techniques to Reduce Harmonic Distortion in H-Bridge Inverter

[1]Anjana Thakur, [2]Dr. A.K.Sharma

[1]M.E. Student (Control system Engg), Deptt of Electrical Engineering, JEC, Jabalpur, M.P. India
[2]Professor, Deptt of Electrical Engineering, JEC, Jabalpur, M.P. India

Abstract: **In the modern world, the demand of electricity is increasing day by day. The main reasons of increasing demand are the population, the economy growth and rapid depletion of fossil based energy reserve. Then it must research for an alternative source of power generation. One of the sources is a renewable energy which is not possibly harmful on environment. The need of power rating inverter is required to operate electrical and electronics appliances smoothly. Static UPS are virtually perfect electric generators. They are highly reliable and, by nature, ensure the uninterrupted availability of electric power. As regards electrical characteristics, the inverter (which constitutes the UPS generator) possesses from the point of view of frequency stability as well as voltage stability, performances superior to those of the mains. The only doubtful characteristic is, in the opinion of any engineer, its ability to deliver a sinusoidal voltage regardless of the shape of the current drawn by the load. Most of the available commercial uninterruptible power supplies (UPSs) are actually square wave inverter or quasi square wave inverters. Electronic devices, managed by these inverters will be damaged due to content of harmonics.In this paper a comparative harmonic distortion analysis is presented between and square wave and sine wave i.e. (MSPWM & SPWM) inverters.**

Keywords: **Pulse width modulation, H-bridge inverter, Total harmonic distortion, Harmonic factor, modulation index.**

I. INTRODUCTION

The output voltage of an inverter has in general non-sinusoidal shape. The required AC output quantity – frequency and voltage – is created by a sequence of "segments" properly cut out from the input variable quantity, which is a DC voltage. The required output quantities, AC voltage amplitude and frequency, are created either from rectangular pulses or by the pulse-width-modulation (PWM).

Power source with a non-sinusoidal voltage supplied to an electrical equipment brings some undesirable effects. It can cause additional losses in the windings and ferromagnetic circuits of transformers. In AC motors the additional losses are higher and operating characteristic of motors are worse.

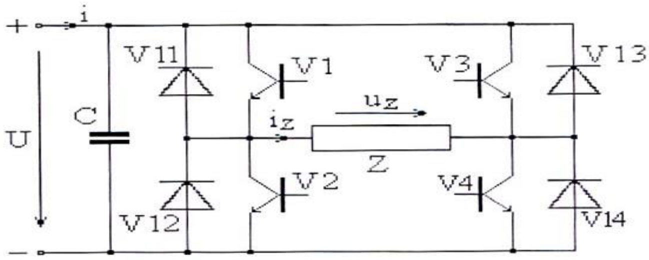


Fig 1: Single phase Full Bridge Inverter

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org

In case of single phase full bridge inverter the output voltage oscillates between +ve and –ve polarity of the source DC voltage. The zero voltage at the load occurs when all four switches are turned off. For inductive loads, the current inertia of inductance is looped through the anti-parallel diodes.

Individual semiconductor switches can lead the current maximally for a half of the period. It means that for a fundamental output frequency f = 50 Hz (T = 2π) the maximum value of the conduction angle of switches is π. This kind of inverter is called "an inverter with 180 degrees conduction angle". The conduction angle of switches may be reduced. The inverter can have a 150 degrees conduction angle or 120 degrees conduction angle or even less.

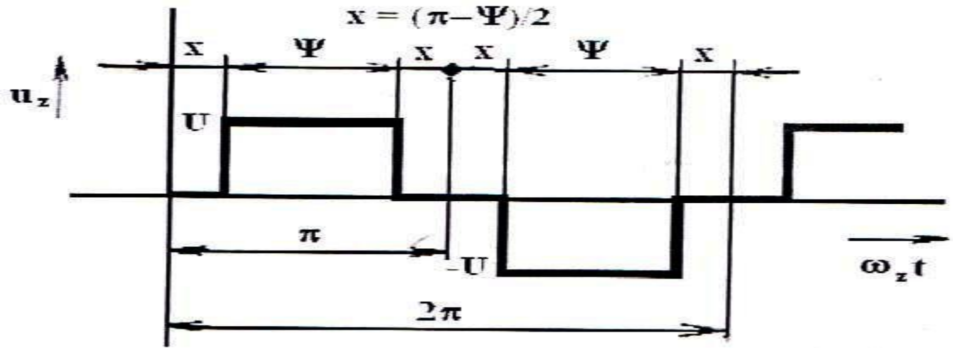


Fig 2: Output Voltage As a Function of Conduction Angle φ

The content of harmonics in the output voltage depends highly on the conduction angle φ. The harmonic spectrum of the voltage at load in dependence on the conduction angle φ (shown in fig 3.7 and fig. 3.8) can also be described by the following equation.

$$U_Z = \frac{4\,U}{\pi} \sum_{k=1}^{\omega} \frac{1}{2k-1} \left[(2k-1) \frac{\pi-\varphi}{2} \right] \sin[(2k-1)\omega t]$$

Where U - Value of DC voltage , $\omega = 2\pi f$, Harmonic order n = 2k – 1

II. PULSE WIDTH MODULATION (PWM)

The pulse width modulation (PWM) is a technique which is characterized by the generation of constant amplitude pulse by modulating the pulse duration by modulating the duty cycle.

PWM control requires the generation of two signals:

- Reference signal
- Carrier or Modulating signal

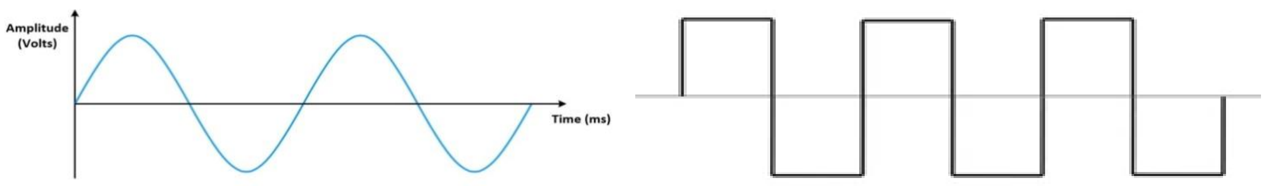


Fig 3: Reference Signals

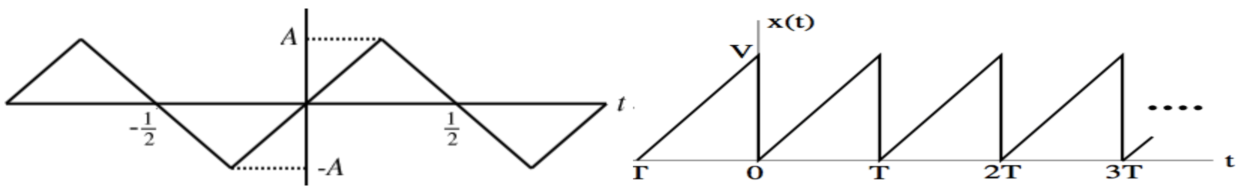


Fig 4: Carrier Signals

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org

The reference signal is the desired signal output, may be sinusoidal or square wave , while the carrier signal is either a saw-tooth or triangular wave(shown in fig 4.2) at a frequency significantly greater than the reference signal frequency. The frequency of the output signal frequency is same as the reference signal frequency. To generate the switching pulses both the signals are feed into the comparator and based on some logical output, the final output is generated. The width of these pulses is, however, modulated to obtain inverter output voltage control and to reduce its harmonic content.

Different PWM techniques are as under:

- Linear modulation
- Saw tooth PWM
- Single-pulse modulation
- Multiple-pulse modulation
- Sinusoidal-pulse modulation

In PWM inverters, forced commutation is essential. The PWM techniques listed above differ from each other in the harmonic content in their respective output voltages. Thus, choice of a particular PWM technique depends upon the permissible harmonic content in the inverter output voltage.

In industrial applications, PWM inverter is supplied from a diode bridge rectifier and an LC filter. The inverter topology remains same as in the conventional inverter but now the devices are switched on and off several times within each half cycle to control the output voltage which has low harmonic content.

III. GATE SIGNALS FOR DIFFERENT PWM TECHNIQUES

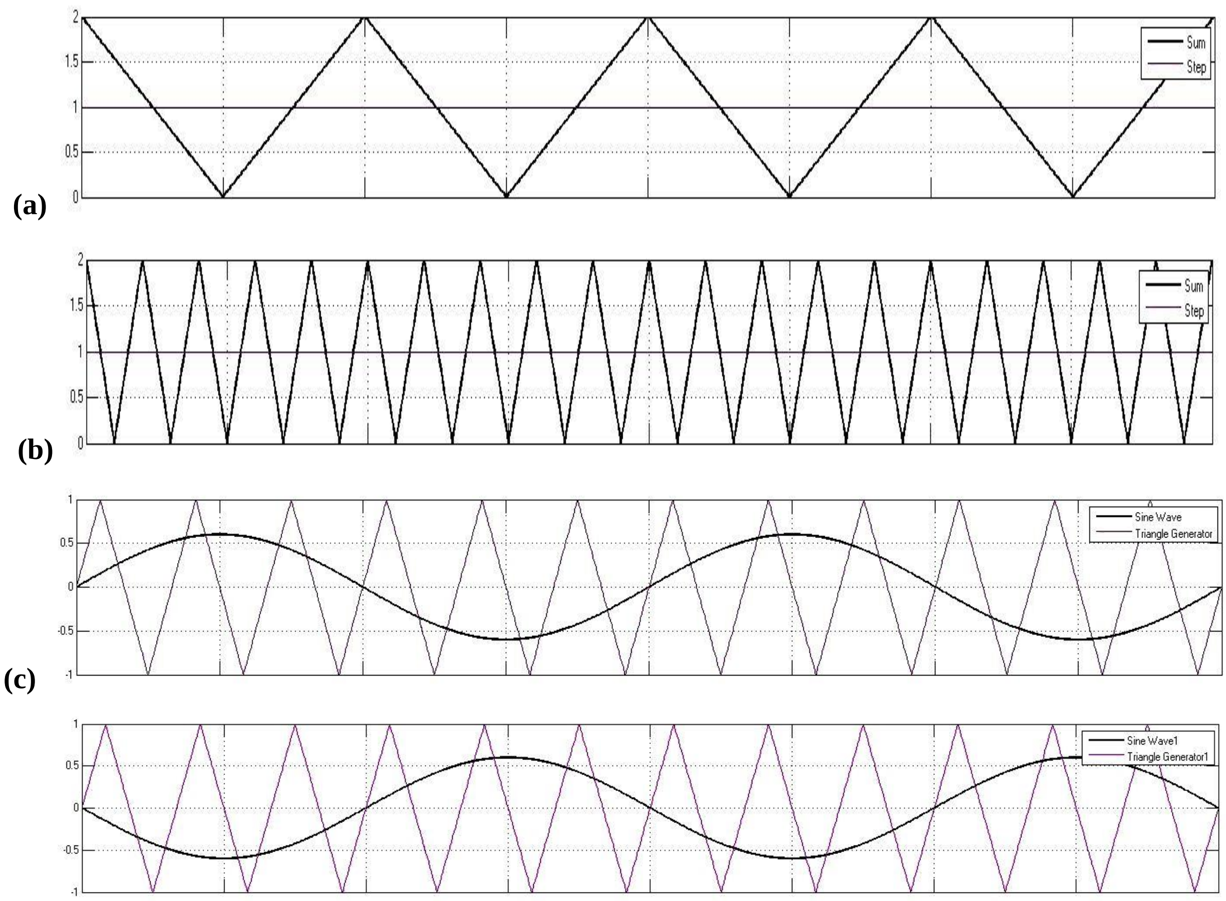


Fig. 5: Pulse Generation

(a) SINGLE PULSE MODULATION (b) MULTIPLE PULSE MODULATION (c) SPWM

ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org

Fig. 6: Gate Pulse

(a) SINGLE PULSE MODULATION (b) MULTIPLE PULSE MODULATION (c) SPWM

IV. SIMULATION RESULTS

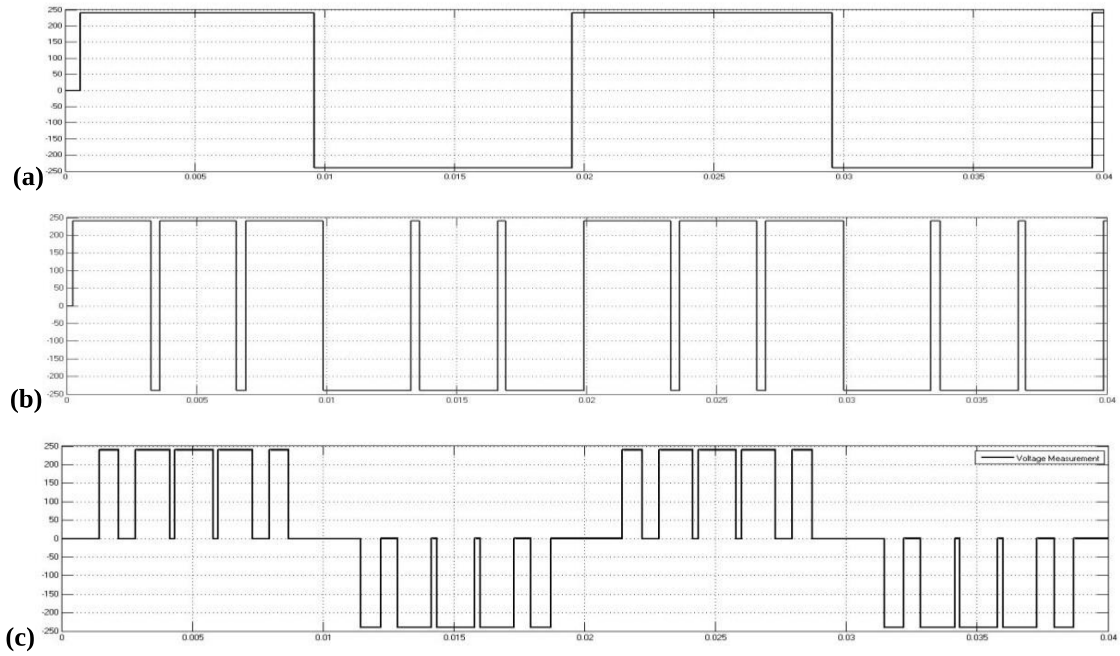
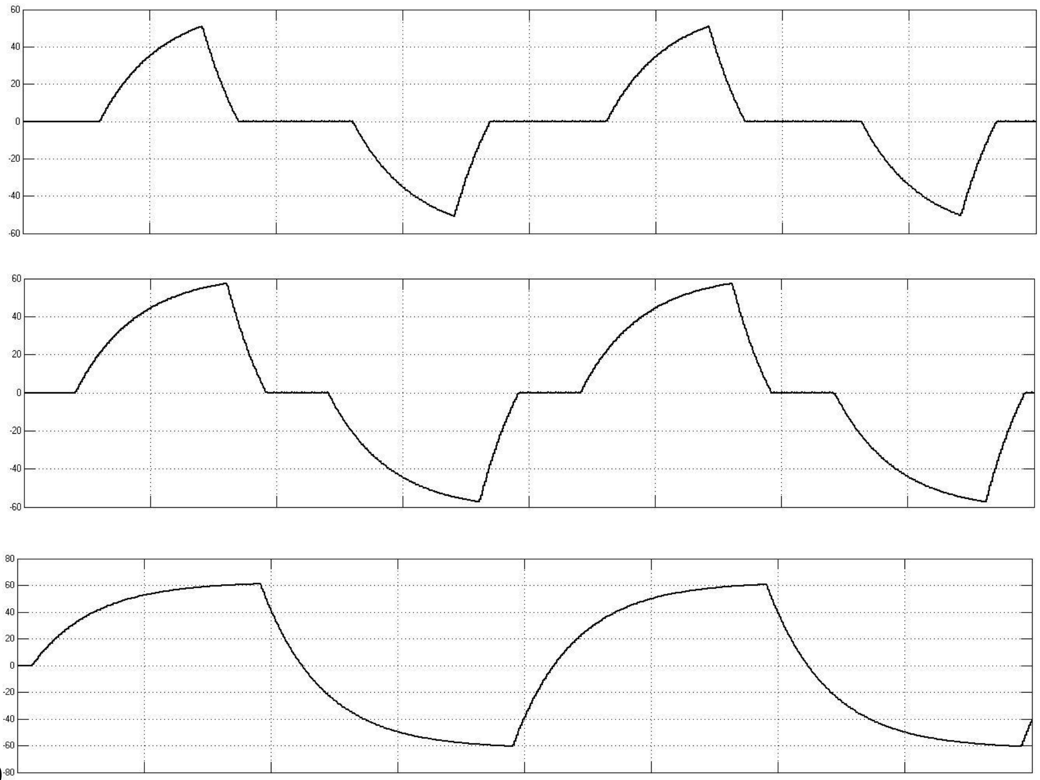


Fig. 7: Out Put Voltage for Lagging Pf Load

(a) SINGLE PULSE MODULATION (b) MULTIPLE PULSE MODULATION (c) SPWM

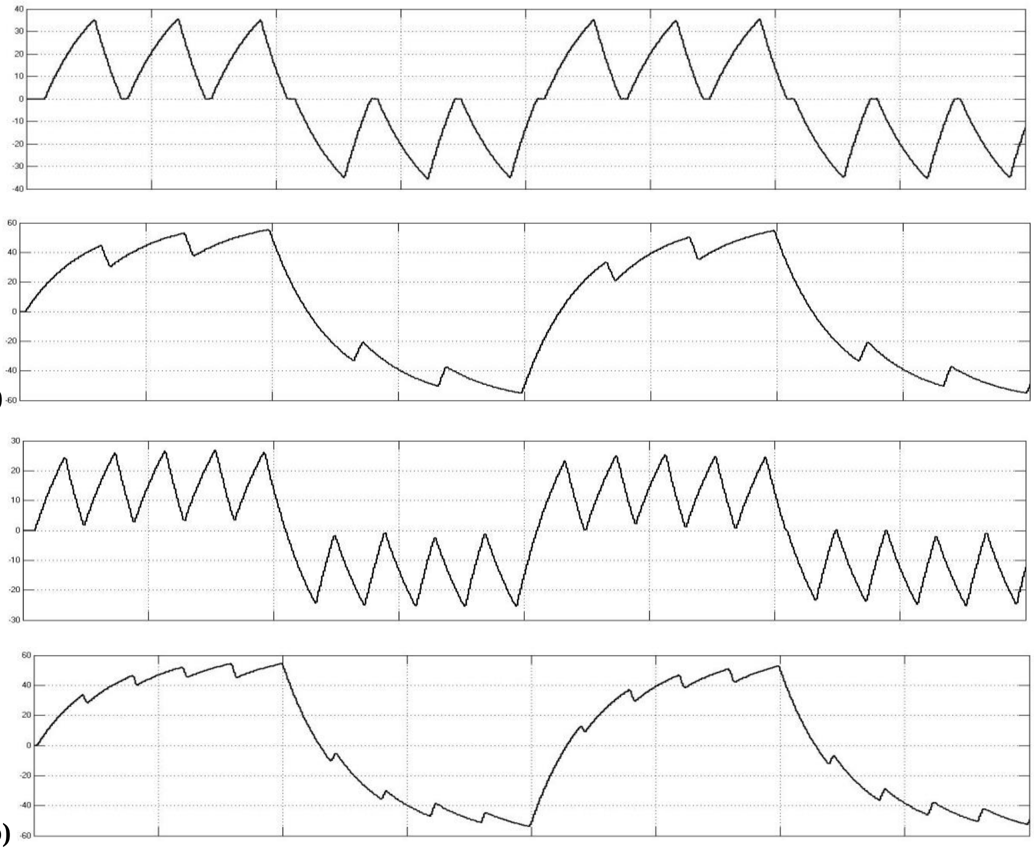
ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org



(a) (b) (c)

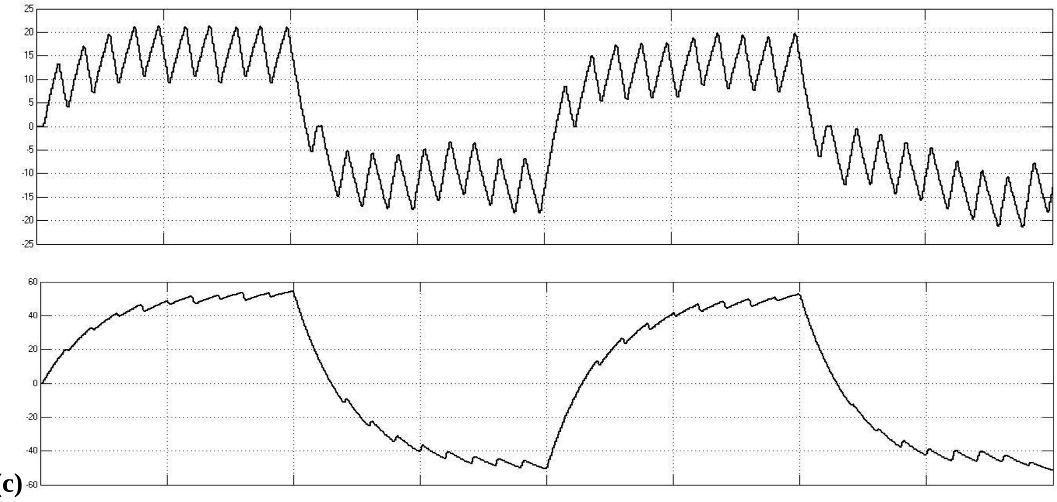
Fig. 8: Effect of Modulation Index on WAVESHAPE of Load Current in Single Pulse Inverter (A) MI = 0.4 (B) MI = 0.6 (C) MI = 0.9



(a) (b)

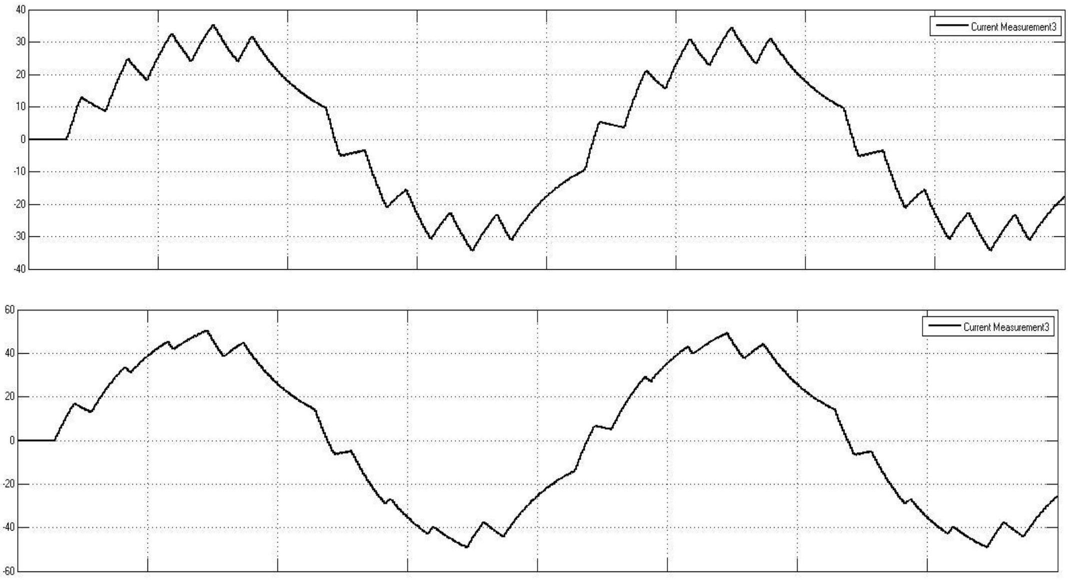
ISSN 2349-7815

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org

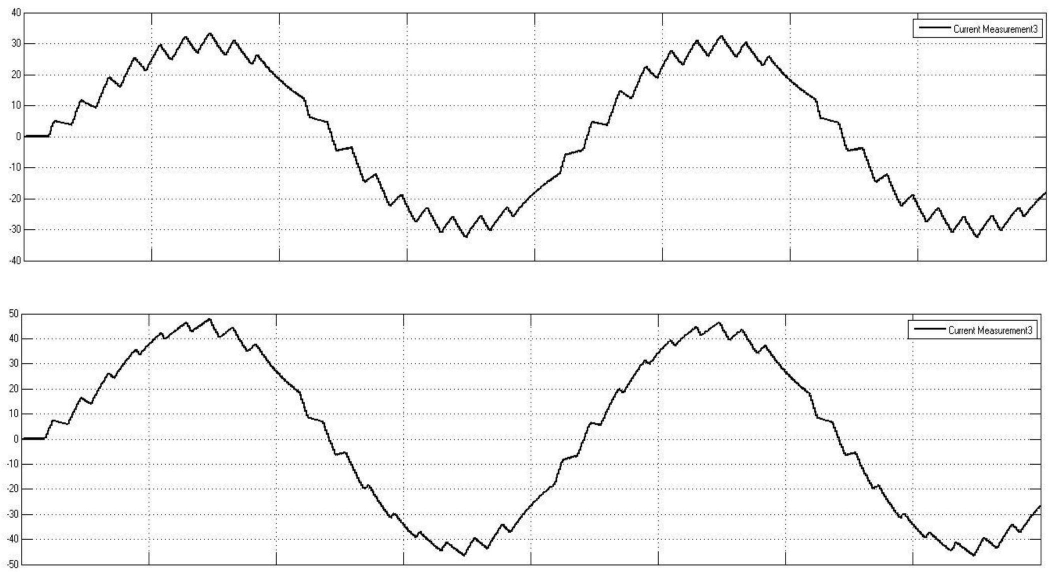


(c)

Fig. 9: Load current in Multi pulse Single phase Inverter at different carrier frequency and modulation index MI (a) f_c = 300 Hz MI = 0.6 & 0.9 (b) f_c = 500 Hz MI = 0.6 & 0.9 (c) f_c = 1000 Hz MI = 0.6 & 0.9

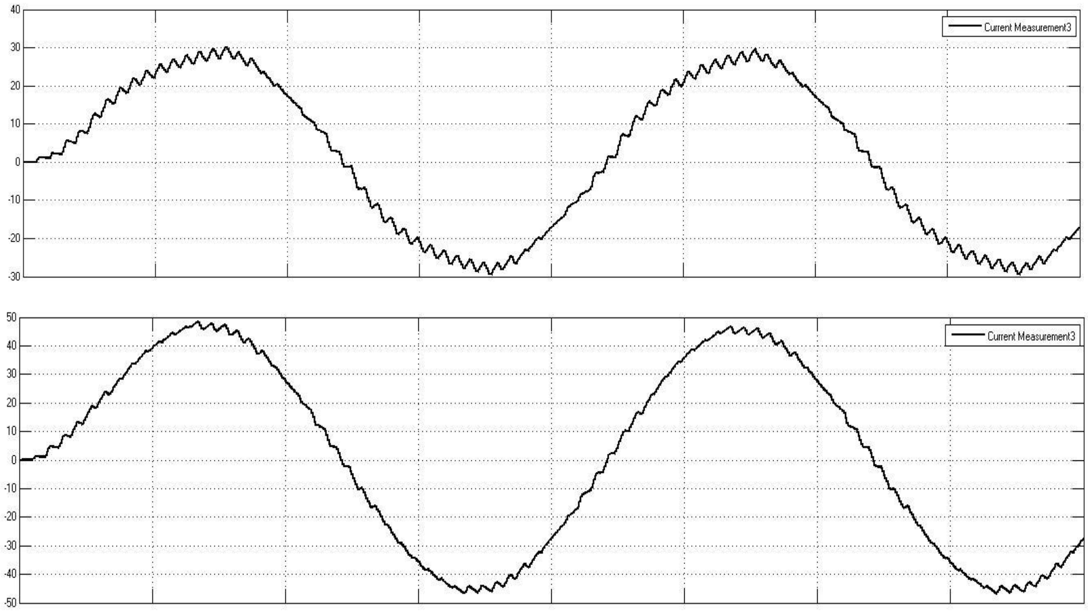


(a)



(b)

International Journal of Recent Research in Electrical and Electronics Engineering (IJRREEE)
Vol. 3, Issue 2, pp: (70-76), Month: April 2016 - June 2016, Available at: www.paperpublications.org



(c)

Fig. 10: Load current in SPWM Single phase Inverter at different carrier frequency and modulation index MI (a) f_c = 300 Hz MI = 0.6 & 0.9 (b) f_c = 500 Hz MI = 0.6 & 0.9 (c) f_c = 1000 Hz MI = 0.6 & 0.9

V. CONCLUSION

It is clear from fig.8, 9 and 10 , that on a constant carrier frequency, change in the modulation index changes the wave-shape of load current. By comparing the wave-shape of load currents for same carrier frequency and modulation index, it is clear that load current is comparatively much smoother and nearer to the sine wave shape in sinusoidal pulse width modulation technique. Total harmonic distortion of load current is lesser in SPWM as compared to MPWM.

REFERENCES

[1] Muhammad H.Rashid, Third edition, “Power electronics circuits, devices and applications” ,Practice Hall of India.

[2] Bimbhra Dr. P.S., “Power Electronics”, 5th Edition, Khanna Publishers, New Delhi, 2012.