International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Design of SPWM Unipolar (Single Phase) Inverter

Sachin Maheshri[1], Prabodh Khampariya[2]

[1, 2]S. S. S. I. S &T, Sehore M.P., India

Abstract: ***In this paper, a design and development unipolar SPWM switching strategy is presented for single phase full bridge inverter. The main advantage of this strategy is that it does not required additional circuit. To obtain the unipolar SPWM switching pulses generated with carrier frequency of 2 kHz and the modulation ratio change from 0.5 to 0.7 by varying amplitude of modulating signal. In the unipolar single phase SPWM microcontroller-based 300VA inverter is designed and tested for fixed modulation index with unipolar voltage switching. The gate pulses waveforms are observed on DSO, The outputs voltage and current %THD waveforms for variable AC voltages and modulation index are observed on DSO, and also see the THD. The pulse width modulation inverter has been the main choice in power electronic for decades, because of its circuit simplicity and rugged control scheme SPWM switching technique is commonly used in industrial applications.***

Keywords*:* Sinusoidal Pulse Width Modulation (SPWM), Unipolar, Total Harmonic distortion (THD). Pulse Width Modulation (PWM), Digital Storage Oscilloscope (DSO).

1. Introduction

An inverter is a device that converts electrical energy of DC to AC. The purpose of DC-AC inverter is to take DC power from a battery source and converts it to AC. The inverter receives DC supply from 12V battery and then inverter converts it to 230V AC with a desirable frequency of 50Hz. These DC-AC inverters have been widely used for industrial applications such as uninterruptible power supply (UPS), AC motor drives. In addition to this, the control strategies used in the inverters are also similar to those in DC-DC converters. Both current-mode control and voltage-mode control are hired in practical applications.

A voltage source inverter employing thyristor as switches, some type of forced commutation is required, while the VSI made up of using GTOs, power transistors, power MOSFETs. A single-phase voltage or current source inverter can be in the half-bridge or full-bridge configuration. Some industrial applications of inverters are for adjustable-speed ac drives, UPS (uninterruptible power supplies) for computers, HVDC transmission lines, induction heating, standby aircraft power supplies etc.

2. Hardware System Development

The hardware design for the inverter including PIC microcontroller circuit, H-bridge Inverter circuit and MOSFET driver in Fig.1.3. The system consists of microcontroller circuit for generating SPWM pulses, opto isolator or isolation circuit, gate drivers, inverter circuit or full bridge circuit, filter circuit and step up transformer. SPWM signal generated by microcontroller needs to be isolated for protection and safety between a safe and a potentially hazardous environment. The outputs are then fed to gate drivers which contains four independent electrically-isolated MOSFET drivers. The outputs of the gate drivers are then distributed to power switches in full bridge arrangement. The output of the inverter has square waveform due to the switching pattern. In order to get a sine wave signal the LC filter was used to reduce harmonic content. The output then fed to step up transformer to get the required output level.

Block Diagram of Hardware System

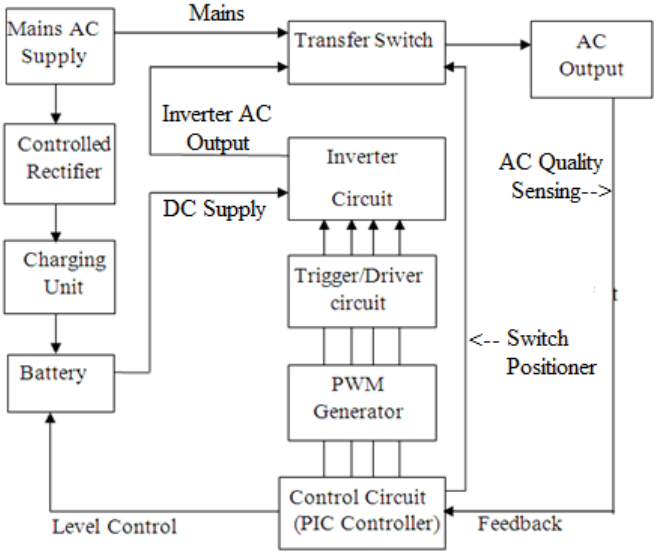

Figure 1.1: Block Diagram of the SPWM Inverter

a) Mains AC Supply: The AC Line block represents an AC input. This input will be a 230V, 50 Hz AC signal, just like the signal from a wall outlet

b) Chargering Unit: The battery charger is an AC-DC converter that will supply the battery with a DC voltage so it remains charged. While the AC line is powered the charge will complete this conversion.If power to the AC line is lost the charger will remain idle until power is restored, and it will continue charging the battery.

c) Battery: The battery will be a 12V battery. The battery will supply power. The DC power will be converted to AC to support the electrical devices.

d) Inverter: The inverter will change the DC power from the battery to AC power. It will convert the DC voltage to an approximate 230V ,50Hz sinusoidal signal. The inverter will monitor what the sensors see to ensure that the signal is synchronized with the AC line. Once the two signals are synchronized the inverter will allow the switch to operate, so that switching between the two lines can occur.

e) **Positioner Switch:** The switch will take the information from the Controller and determine when it is possible to switch between the AC line and the back-up system.

f) **Load:**Our AC load is Resistive load (Incandescent lamps).

g) **PWM Generator Circuit:** The block diagram of single phase full bridge inverter shown in Figure 1.3,The control strategy is performed in such away a pair (S11 & S22) of switches is turn on during another pair (S12 & S21) is turn off. When a pair (S12 and S21) turn on the other pair (S11 and S22) is automatically turn off. The sequences of on and off of the switches occurred continuously and sequentially. This produces an alternating output voltage across the load.

Figure 1.2: Actual Hardware model set with load & battery

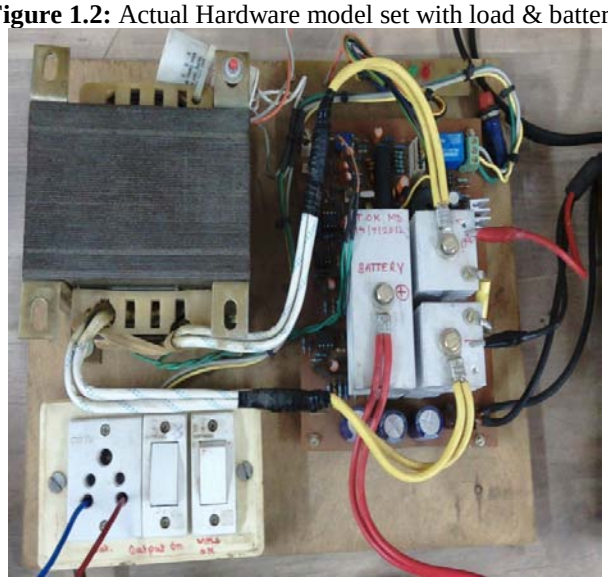

Figure 1.3: Hardware model

3. Algorithm

Hardware Algorithm for generating Unipolar SPWM.The above mentioned methods are analog designs of inverter. We also like mention digital implementation of inverter using microcontroller. The proposed alternative approach is to replace the conventional method with the use of microcontroller. The use of microcontroller brings the flexibility to change the real-time control algorithms without further changes in hardware. It is also low cost and has a small size of control circuit for the single phase full bridge inverter.For generating SPWM we have chosen microcontroller PIC 16F872A for unipolar.

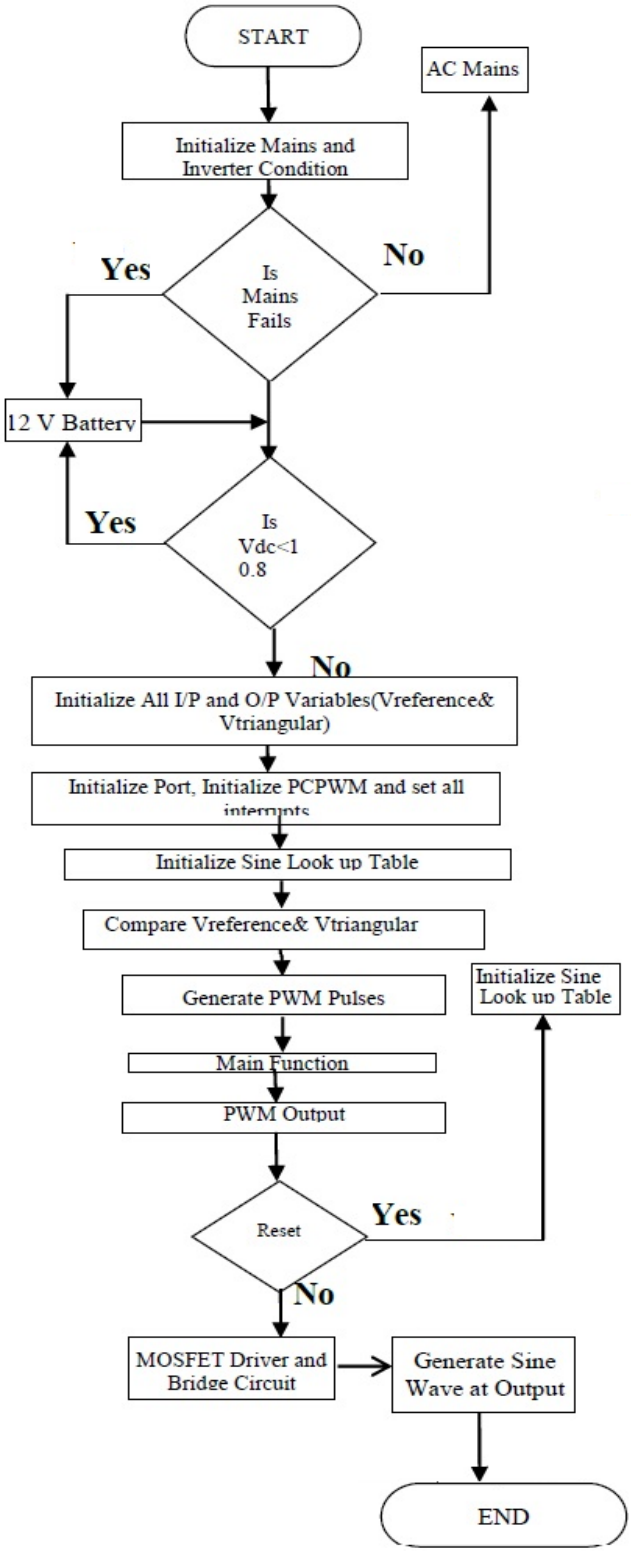

Figure 1.4: Algorithm of Unipolar SPWM

Fig.1.4 shows the Algorithm for generating of single phase sinusoidal PWM signal. In this ware by which the ports work

as output ports. It Generate PWM. Here first Initialize Mains and Inverter Condition (Mode).Then It check availability of mains, if Mains fail then it goes to 12V battery and then start inverter mode. In next it check battery voltage(Vdc),if it is less than 10.8V it again goes to 12V battery. If it is greater than 10.8V goes to next and Initialize All input and output Variables (Vreference & Vtriangular)"initialize variables" means initialize the user defined memory cell, "initialize port" initializes the ports in software by which the ports work as output ports. Those sampling value will go in PDC(Peripheral DMA Controller) Register, and the PTMR register will generate the Triangular wave. after comparison of these signals will generate sinusoidal PWM signal with dead time. The microcontroller checks whether the generation is completed or not, if yes, take another sampling of the sine wave table, if not, it waits until completion.

4. Result

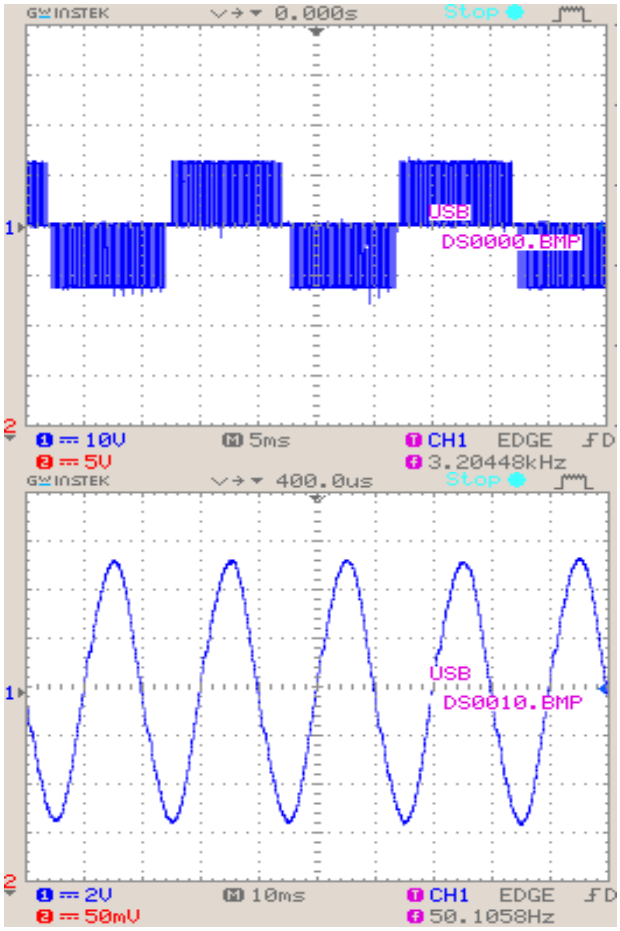

Figure 1.5: PWM output Waveforms

5. Conclusion

The electronic devices is smaller, therefore the efficiency of power supply used in electronic devices should be improved from time to time. The different switching techniques and switching elements were used in single phase inverter also considered when inverters become the best power supply for converting DC power to AC power. Based on studied, SPWM techniques is a common method used in single phase inverter circuit are Unipolar voltage Switching. For 300 VA the voltage and current is noted on different sets of resistive load. It is observed that it results maximum efficiency for 302W load upto 65 to 70% in hardware.

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