# SIMULATION OF SINGLE PHASE UNIPOLAR INVERTER USING SLIDING MODE CONTROLLER

**Ms. Pooja T S[1], Ms. Pavithra P M[2], Prof. Nandish B.M[3], Prof. Praveena Anaji[4]**

[1, 2]UG Students, [3, 4]Assistant Professor
Department of EEE, JIT, DVG

***Abstract*: Obtaining the pure sine wave by employing the sliding mode controller by the simulation of single-phase unipolar pulse width modulation. The present model is implemented with the sim power system block set in the MATLAB. Here MOSFET is used as switching device. The design analysis and evaluation of single-phase inverter and its control is carried out using the MATLAB software and analyze the output waveforms for resistive load used in this circuit. The PWM is a technique used to control the operations of switches. Here the Dc input is converted into AC with the help of the inverter, where four MOSFET switches are used to act as inverter the robust controller Sliding mode controller is used here to reduce the harmonics. SMC is used because it is having a high stability in a wide range of operating conditions.**

## 1. INTRODUCTION

As the demand for electricity is increasing as the day passes. One of the best way to satisfy the demand by using renewable source of energy which can be converted into electrical energy for household applications. Most of the uninterrupted power supply (UPS) available in the market are designed as square or quasi wave the wave inverters, which is not suitable for the most of the electrical appliances. The output obtained with their solar inverter or with more harmonics and less efficient. If sinusoidal waveform is not provided to appliances the lifetime of the appliances with reduced day by day. The generated sinusoidal output waveform is to overcome this type of disadvantage. The sinusoidal output waveform can be obtained by implementation of sinusoidal pulse width modulation (SPWM) technique to the inverter circuit. The SPWM technique is used with the SMC. In UPS system, a 50 Hz sinusoidal output voltage is required.

In UPS systems, a 50Hz sinusoidal output voltage is required. It is well-known that sliding mode control (SMC) can give good tracking performance. However, one major disadvantage of sliding mode control in PWM inverters is that the varied change frequency of the switch. It will generate a lot of high frequency noise and give a high THD (total harmonic distortion). According to the IEEE standard 1547, the THD of the output voltage must be but five-hitter, especially for nonlinear load. For inverters with 50Hz output voltage frequency and its switching frequency above 2kHz, Low frequency harmonics (2nd to 13th) should be rejected by a closed loop controller perfectly. Moreover, the controller should perform a good regulation of output voltage against abrupt variations of the input voltage, output current and the reference voltage. These demands imply to use a quick controller with smart dynamic response for the electrical converter

In this project a better sliding mode controller with a more complete reaching condition is derived. In this, a discrete-time sliding mode controller (SMC) will be applied to control a Pulse Width Modulation Inverter It will be shown that this controller will offer sensible output response below linear and non-linear loads. An electrical converter may be a device that converts DC power into AC power at desired output voltage and frequency. In line commutated inverters Phase controlled converters are operated in the inverter. The line commutated inverters for their commutation at the output terminals an existing AC supply which is used. This means that line commutated inverters can't operate as an isolated AC voltage sources or as a variable frequency generator with DC power at the input. Therefore, frequency, voltage level and waveform on the AC side of the line commutated inverters can't be changed. On the other hand, force commutated inverters give an independent AC output voltage of adjustable voltage and adjustable. Based on their operation Inverters can be classified into two types: Voltage Source Inverters (VSI) Current Source Inverters (CSI) Voltage Source Inverters (VSI) is one in which the DC source has small or negligible impedance. A CSI is designed with adjustable current from a DC source of high impedance i.e., from a DC current source. In a Current Source Inverter designed with stiff current source, where output current waves are not affected by the load. Recently many control methods, hysteresis current mode control, multi loop feedback, like repetitive control, deadbeat control, have been introduced to achieve the demands. Recently, harmonic elimination techniques and nonlinear observer are employed to improve the transient response.

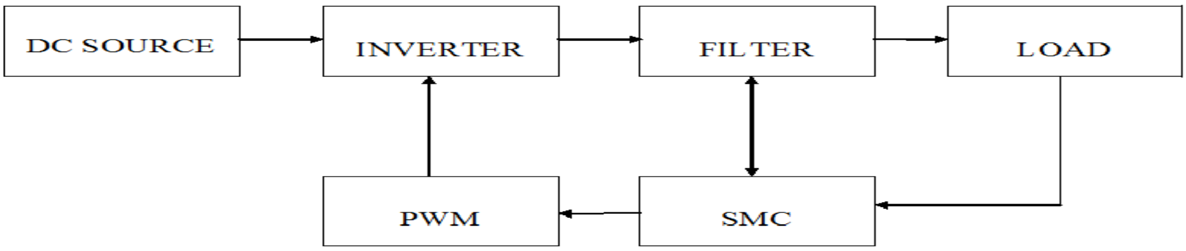


Figure 2.1: Block diagram of power electronic system

In this project the modelling and simulation of the SPWM inverter is done as shown in the above block diagram in the MATLAB software.

## 2. SLIDING MODE CONTROLLER:

Sliding mode controller (SMC) is a nonlinear technique featuring remarkable properties of accuracy robustness and easy tuning and implementation. The SMC is variable structure control method.

The Sliding mode supervisor (SMS) system are designed to drive the system states on to a particular surface in the state space i.e., the sliding surface. Once the sliding surface is reached, SMC keeps the states on the close neighborhood of the sliding surface hence the SMC is a two part controller design where the first part involves the design of sliding surf ace in order that sliding motion satisfies the design specification and therefore the second part is concerned with the choice of control law which can make the switching surface enticing to the system state.

There are two main advantage by using SMC in our project, Mainly the dynamic behavior of the system may be tailored by the particular choice of the sliding function. Further, the closed loop response becomes totally insensitive to some particular uncertainties. Thus, The SMC allows for controlling nonlinear process subject to external disturbances and heavy model uncertainties.

The SMC mainly operates in two phases:

1) Phase 1 sliding surface design
2) Phase 2 control input design

In phase 1, The switching surface are constructed so that the system is restricted to the switching surface which produces the desired behavior, for convenience only linear switching surfaces are produced.

In phase 2, The switched feedback gains is constructed which drive the plant state trajectory to the sliding surface and maintained it there.

## 3. SIMULINK MODEL:

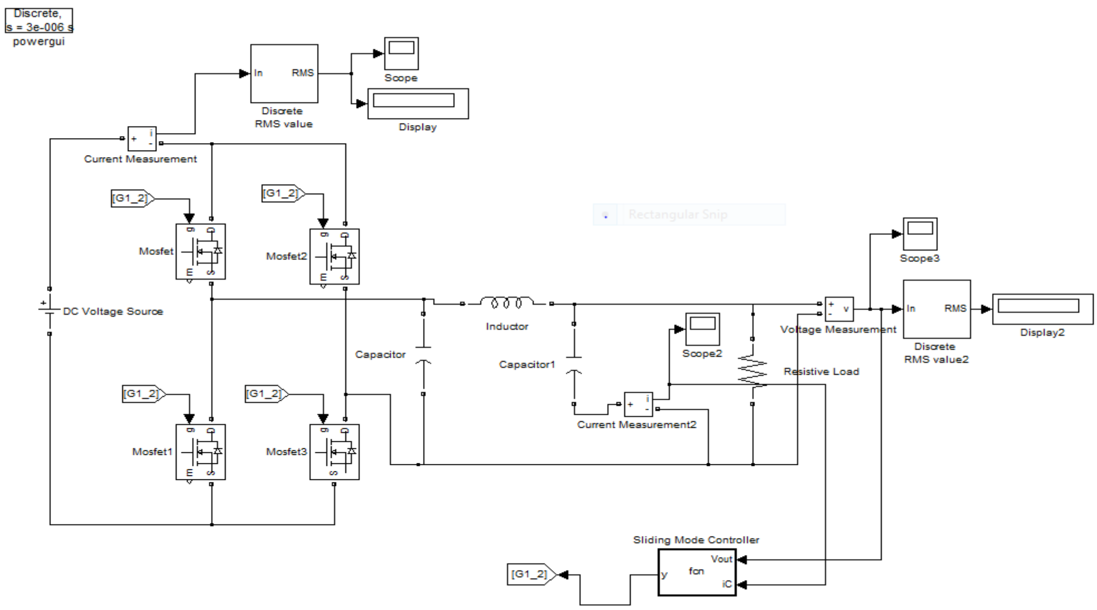


Figure 4.1: Simulink model

The Simulink model of the SPWM using SMC is shown in the above figure. It consists of four switching devices i.e. 4 MOSFET's which acts as the inverter. The DC supply which is given to the switching inverter is converted into AC provided with the RC filter to reduce harmonics. Here we are using resistive load, from the filter the SMC is connected to minimize the further harmonics or errors that are being produced. Thus, we can obtain a pure sinusoidal waveform with reduced errors.

## 4. RESULT:

As the main aim of the project is to obtain the pure sine wave with least harmonics. Finally, by using the concept of SMC theory the pure sine wave is obtained by simulation and modeling of the SPWM with SMC in MATLAB software and the output result obtained is as shown below.

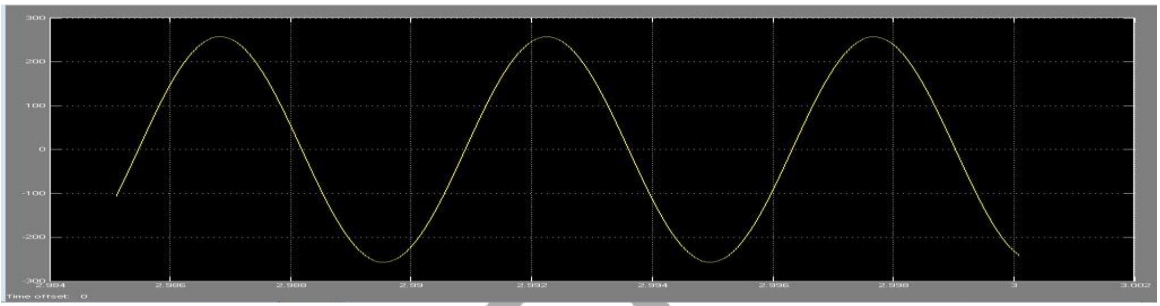

Figure 5.1 Output voltage waveform

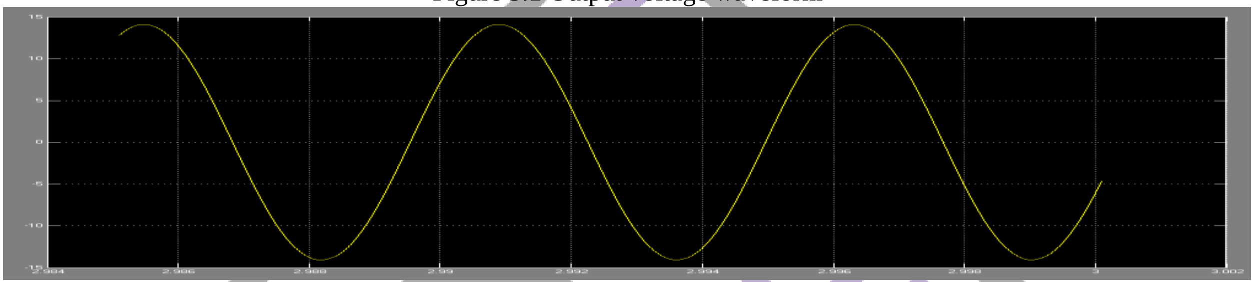

Figure 5.2 Output current waveform

## 5. CONCLUSION:

The switching scheme of the inverter is used here. There are two PWM switching scheme regular and natural sampling are used in which the regular sampling is widely used. We can infer that the output obtained by using SPWM technique with SMC is having better harmonic profile when compared with the bipolar voltage switching. A better performance can be observed by the use of sliding mode controller (SMC) which is proposed in this project.

## REFERENCES


1. Zhang, Kang, Xiong, and Chen , 1999 **"Deadbeat control of PWM inverter with repetitive disturbance prediction,"** in Proc. 14th Annu.Appl.Power Electron. Conf. Expo, pp. 1026–1031.

2. Abdel-Rahim and Quaicoe , 1996 **"Analysis and design of a multiple feedback loop control strategy for single-phase voltage-source ups inverters,"** IEEE Trans. Power Electron., vol. 11, no. 4, pp. 532– 541.

3. Wang, Liu, Zhang, Gong, and Ma, 2009 **"Modeling and analysis of hysteretic current mode control inverter,"** in Proc. 24th Annu. IEEE Appl.Power Electron. Conf. Expo, pp. 1338–1343.

4. Hu, Shang, He, and Zhu, 2011,**"Direct active and reactive power regulation of grid-connected DC/AC converters using sliding mode control approach,"** IEEE Trans. Power Electron., vol. 26, no. 1, pp. 210–222.

5. Adib Abrishamifar, Ahmad Ale Ahmad and Mustafa Mohamadian,,**"Fixed Switching Frequency Sliding Mode Control for Single-Phase Unipolar Inverters,"** IEEE transactions on power electronics, vol. 27, no.