Simulation of Single Phase PWM Inverter Using Solar Input
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Abstract—This paper is about new technique of Pulse Width Modulation (PWM) inverter for solar applications. The model is being implemented using MATLAB/Simulink. The Insulated Gate Bipolar Transistor (IGBT) device is used for switching. This project purpose to use MATLAB/Simulink software to design, analysis and evaluation of power electronic inverter and their controllers. For modeling, Simulink provides a graphical user interface (GUI) for building model as block diagram, using click-and-drag mouse operation. The PWM signal is used to control ON/OFF switching state of the IGBTs will functions in driver model that created the switching scheme. Then, the simulation is made from the inverter model in Simulink. The output voltage is obtained from Simulink. The input to this PWM inverter is given through the solar power. The solar is the one of the world’s largest available renewable source of energy. The way we generate the solar power is the DC but we need the power in the AC so we are using the PWM inverter among all the available inverter PWM inverter is the more effective one which will be generate less losses to the system and high voltage control.

Key words: Solar Generation, Pulse Width Modulation(PWM)

I. INTRODUCTION

The sources of the energy we are classified according to the way they are available they are Renewable and Nonrenewable resources they way they are utilized and we can say like no harm to the nature. and others cause so many changes to the nature by this global warming will occur and to eliminate this we need to utilize the Renewable resources effectively and need to be update according to the modern world and we can see how they are classified and how do they work and coming to working of the solar and how they are changes according to need.

One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. Demand has increased for renewable sources of energy to be utilized along with conventional systems to meet the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard. The continuous use of fossil fuels has caused the fossil fuel deposit to be reduced and has drastically affected the environment depleting the biosphere and cumulatively adding to global warming.

Solar energy is abundantly available that has made it possible to harvest it and utilize it properly. Solar energy can be a standalone generating unit or can be a grid connected generating unit depending on the availability of a grid nearby. Thus it can be used to power rural areas where the availability of grids is very low. Another advantage of using solar energy is the portable operation whenever wherever necessary.

In order to tackle the present energy crisis one has to develop an efficient manner in which power has to be extracted from the incoming solar radiation. The power conversion mechanisms have been greatly reduced in size in the past few years. The development in power electronics and material science has helped engineers to come up very small but powerful systems to withstand the high power demand. But the disadvantage of these systems is the increased power density. Trend has set in for the use of multi-input converter units that can effectively handle the voltage fluctuations. But due to high production cost and the low efficiency of these systems they can hardly compete in the competitive markets as a prime power generation source. The constant increase in the development of the solar cells manufacturing technology would definitely make the use of these technologies possible on a wider basis.

II. MATLAB REPRESENTATION OF PWM

The simple representation of the single phase PWM using solar input and here the we are using the four IGBT’s in the antiparallel with the each other by this we can control the DC in the both cycles by this full control of the system can be obtained. Here the gate pulses are generated using the pulses box which is available in the MATLAB easily and here four gate pules for IG BT’s are used and this pulses can be easily control by the carrier frequency and also by modulation index and by this width of the pules are controlled. The IGBT’s the internal snubbear resistance this is used in practical case because it will help the IGBT in the protection from over currents and over voltages and these snubber are of two types turn ON and turn OFF snubber and coming to the load if we are using R-L load we need to use the diode in anti-parallel with the IGBT and by this the revers current which is generated in load due to inductor the diode will provide the free circulating path of the current so that current can be nullified.

III. SOLAR POWER

Solar energy is radiant light and heat from the Sun harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture and artificial photosynthesis.

It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on the way they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable...
thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

Fig. 2.0: shows the MATLAB / Simulink diagram

A. Solar Energy coming to earth

The Earth receives 174,000 terawatts (TW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth’s surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet. Most people around the world live in areas with insolation levels of 150 to 300 watts per square meter or 3.5 to 7.0 kWh/m2 per day.

Fig. 3.1: shows the amount of solar coming to the earth

B. Solar Cell Modelling

A solar cell is the building block of a solar panel. A photovoltaic module is form connecting many solar cells in series and parallel[3]. Considering only a single solar cell; it is modeled by utilizing a current source, a diode and two resistors. [1-2]This model is known as a Single diode model of solar cell. Two diode models are also available but only single diode is used here.

Fig. 3.2: Single diode model of a solar cell

The characteristic equation for a photovoltaic cell is given by

\[ I = I_{oc} - I_{os} \left[ \exp \left( \frac{q \left( V + I \cdot R_s \right)}{A \cdot k \cdot T} \right) - 1 \right] - \frac{V + I \cdot R_s}{R_s} \]  

(1)

Where

\[ I_{os} = I_{oc} \cdot \left( \frac{T}{T_r} \right)^3 \cdot \left[ \exp \left( \frac{1}{A \cdot k} \right) - \frac{1}{T - T_r} \right] \]  

(2)

\[ I_{lg} = \left( I_{sc} + K_i \cdot (T - 25) \right) \cdot I \cdot \lambda \cdot d \cdot a \]  

(3)

I & V : Cell output current and voltage;
Ios : Cell reverse saturation current;
T : Cell temperature in Celsius;
Ki : Boltzmann's constant, 1.38 * 10-19 J/K;
Q : Electron charge, 1.6 * 10^-19 C;
K : Short circuit current temperature coefficient atIscr;
\lambda : Solar irradiation in W/m²;
Iscre : Short circuit current at 25 degree Celsius;
Ilg : Light-generated current;
Ego : Band gap for silicon;
A : Ideality factor;
T : Reference temperature;
Ior : Cell saturation current at Tr;
Rsh : Shunt resistance;
Rs : Series resistance;

C. Pulse Width Modulation:

Pulse – width modulation or pulse – duration modulation is a modulation technique that conforms the width of the pulse, formally the pulse duration. Based on modulation signal information. Although this modulation technique can be used to encode information for transmission, its main use to allow the control of the power supplied to electrical devices, especially to inertial loads like motors

The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and loads on and off at a fast pace[4-6]. The longer the switch is on compared to the off periods, the higher the power supplied to the load.

The PWM switching frequency has to be much faster than what would affect the load, which is to say the device that user the power. Typically switching have to be done several times a minute in an electric stove, 120 Hz in a lamp dimmer, from few kilohertz to tens of kHz for a motor drive and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies[7].

The term duty cycle describes the proportion of the ‘on’ time to the regular interval or ‘period’ of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on. The following PWM techniques are used for controlling the output ac rms voltage and frequency in an inverter[9]:

- Single-Pulse-Width-Modulation
- Multiple-Pulse-Width-Modulation
- Sinusoidal-Pulse-Width-Modulation (SPWM)

D. Single-Pulse-Width-Modulation

In single pulse width modulation control, there is only one pulse per half cycle and the output rms voltage is changed
by varying the width of the pulse. The gating signals are generated by comparing the rectangular control signal of amplitude \( V_c \) with triangular carrier signal \( V_{car} \). The frequency of the control signal determines the fundamental frequency of ac output voltage. The amplitude modulation index is defined as:

\[
m_a = \frac{V_c}{V_{car}}
\]  

The rms ac output voltage

\[
V_o = \sqrt{\frac{2}{T} \int_{0}^{T/2} (\frac{T}{2} - \frac{T}{4} - \frac{T}{4} + \frac{t_{on}}{2}) V_c^2 dt} = V_c \sqrt{\frac{2t_{on}}{T}} = V_s \sqrt{2 \delta}
\]

Where \( \delta = \text{duty ratio} = \frac{t_{on}}{T} \) 

By varying the control signal amplitude \( V_c \) from 0 to \( V_{car} \) the pulse width \( t_{on} \) can be modified from 0 secs to \( T/2 \) secs and the rms output voltage \( V_o \) from 0 to \( V_s \).[8]

In multiple PWM control, instead of having a single pulse per half cycle, there will be multiple number of pulses per half cycle, all of them being of equal width.

**IV. RESULT AND DISCUSSION**

The overall voltage which is generated from the Solar may not need the requirements of the demand so we need to step up the voltage and improve the voltage with no of solar panels connected in series are parallel according to requirement we are considering the output of the about connected MATLAB model and voltage wave forms are seen below.

The above output wave form is the simulated circuit and by this we are able to get the required current and voltage wave that is sinusoidal wave form if we consider the output at the particular cycle then the wave form will be seen below. This PWM is an important thing to extract as much as pure sin wave is obtained from the DC input and we need to see that the out should not get more no of ripples and also by this number of harmonics are reduced in the output wave by this we can make the instrument work properly with out and loss in the system and we need to consider the so many parameters before we supply to the load the load should be near to the inverter but not far.

**V. CONCLUSION**

We all know that the solar is the world’s largest renewable source we are not able to absorb this power effectively so we need to utilize this solar power by this we will be free from the polluted world up to some extent. Among all the inverters to convert DC to Ac PWM is most effective one so we need so many changes even in this Inverter so that we can reach the load. Now all over the world the main priority is being given to the renewable that to solar energy and buy this we conclude that there is very vast technology coming in further in this field.

**REFERENCES**


