

STUDY OF SINGLE PHASE H-BRIDGE INVERTER USING VARIOUS SINUSOIDAL PWM TECHNIQUES

Dhambi Raj P¹, Murali Ganesh E²
School of Electrical Engineering
VIT University
Vellore, India

[1dhambiraj@gmail.com](mailto:dhambiraj@gmail.com)
[2emuralig24@gmail.com](mailto:emuralig24@gmail.com)

Abstract— We know that, inverters are nowadays in huge demand and there various types of inverters are already available. The major drawbacks of inverter are the harmonics and the high output voltage that is caused in output; there are many ways to eliminate the harmonics and the output voltage. In this paper we are studying the in-depth analysis of single phase H-Bridge inverter and their harmonic elimination, finally we will get a pure sinusoidal waveform and the proper output voltage. The result of the analysis is shown as a graph.

Index Terms— single Phase inverter, arduino mega 2560.

I. INTRODUCTION

Nowadays the requirement of low power electronic devices has been increased. People prefer devices which have low power consumption with good efficiency. When the level of inverter is increased the output voltage waveform will be ripple free and harmonics will be reduced. The harmonics is mainly caused due to low switching losses and low EMC's. This results in high output voltage with the harmonics, there are many modulation techniques can be done to analyze the harmonics and to get a pure sinusoidal waveform. In our project we are studying the in-depth analysis of single phase H-Bridge inverter with various sinusoidal pulse width modulation techniques. The harmonics has been decreased up to a certain level and the output waveform has been measured in a digital oscilloscope. The details of the analysis are presented in the form graph and tabular column. The pulses can be given to the circuit in the form of analog design, this increases the complexity of circuit. In our thesis, we are using a Arduino Mega 2560 microcontroller for generating the pulses. The pulses have been generated using MATLAB Simulink for our purpose and it is dumped in to the microcontroller. This reduces the complexity of circuit and easy to use.

II. PROPOSED STUDY AND METHODOLOGY

A. BACKGROUND

Devices that convert dc power to ac power are called inverters. The purpose of an inverter is to change a dc input voltage to ac output voltage which will be symmetric and harmonic less. The output voltage can be varied by varying the

input dc voltage and keeping the inverter gain constant, however, if the dc voltage is fixed and cannot be controlled the gain of the inverter has to be varied to obtain the variable output voltage. Varying the gain is mainly done by using different pulse width modulation techniques. The different types of modulation techniques are:

1. Single-pulse modulation
2. Multiple-pulse modulation
3. Sinusoidal pulse modulation

Our project deals with the Sinusoidal pulse modulation techniques and its types.

B. METHODOLOGY

In this proposed model we are doing the in-depth analysis of a single phase H-Bridge inverter using various types of sinusoidal pulse width modulation. **Fig.1.** shows the general circuit diagram of the inverter. Sinusoidal modulation has two types namely,

1. Unipolar modulation
2. Bipolar modulation

In our project we are experimenting the results only on bipolar modulation. If the half cycle sine wave modulation, triangular carrier in continuous change between positive and negative polarity, the SPWM wave is between positive and negative changes known as bipolar modulation. The bipolar modulations are shown in **fig.2.**

The input pulses to the switches can be given by designing an analog circuit but it will increase the complexity of the circuit, so we are introducing a new method for generating a pulse by using Arduino Mega 2560 Microcontroller. The major advantages of using this microcontroller is it will reduce the complexity of the circuit and the energy consumption is less. The Arduino Mega 2560 can be powered via the USB cable or with an external power supply through an adaptor. The microcontroller can operate on an external supply of 6 to 20 volts. If supplied with less than 7V the 5V pin may supply less than five volts and microcontroller may be unstable. If it is operated more than 12V the voltage will be heated up and the device will get damaged. The recommended voltage range for the microcontroller is 7 to 10 volts. The input pulses to the circuit are generated through the MATLAB Simulink software and the generated pulses are dumped into the arduino microcontroller.

The pulses that are dumped can be changed according to our needs. We can overwrite the old pulses with the new generated pulses with the reset option.

The analysis of the SPWM techniques is done for,

1. Bipolar trailing edge
2. Bipolar leading edge
3. Bipolar double edge

The modulation index place an important role in the harmonic elimination. As the value of modulation index increases the total harmonic distortion will decrease. This is analyzed and the tabular column is shown in **fig.3.** and the output voltage is also analyzed, as the modulation index increases the output voltage also increases. This is shown in **fig.4.**

Modulation index	Trailing edge	Leading edge	Double edge
	V0	V0	V0
0.6	12.39	12.31	12.30
0.7	13.38	13.29	13.36
0.8	14.3	14.21	14.20
0.9	15.17	15.07	15.14
1.0	15.99	15.88	15.96

Fig.4. Analysis of output voltage

The block diagram of the circuit is shown in **fig.5.** It explains that the DC input voltage is directly given to the single phase inverter circuit and the pulses is generated through Arduino Mega 2560 microcontroller and is given to the driver circuit and it is connected to the load.

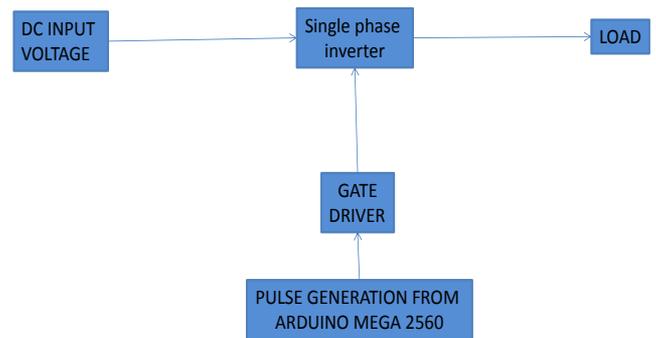


Fig.5. Block diagram for hardware implementation

IV. RESULTS AND DISCUSSIONS

The results of the inverter are analyzed and are shown in **fig.7.** from the graph we can see that as the value of the modulation index increases the total harmonic distortion decreases. The voltage is also analyzed and is shown in **fig.6.** from the graph it is clear that as the modulation index increases the output voltage increases.

The dumping method for Arduino microcontroller using MATLAB Simulink is shown in **fig.8.** the pulses are dumped for the single phase sinusoidal pulse width modulation technique.

Above tabulation shows the analysis of total harmonic distortion and the obtained output voltage

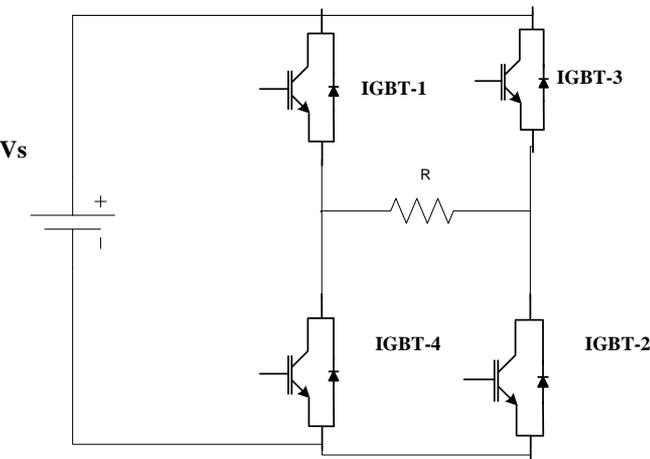


Fig. 1. Circuit diagram - single phase inverter

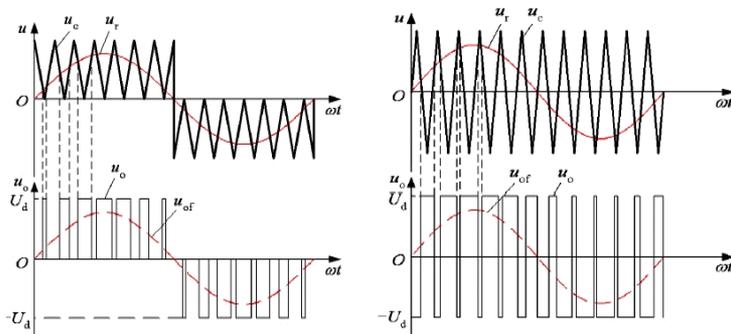


Fig.2. Unipolar and Bipolar modulation

III. TABULATION OF SIMULATION OUTPUT

Modulation Index	Trailing edge	Leading edge	Double edge
	THD	THD	THD
0.6	106.3	105.1	106
0.7	90.91	89.62	90.6
0.8	77.34	76	77.02
0.9	64.86	63.41	64.51
1.0	52.79	51.15	52.4

Fig.3. Analysis of THD

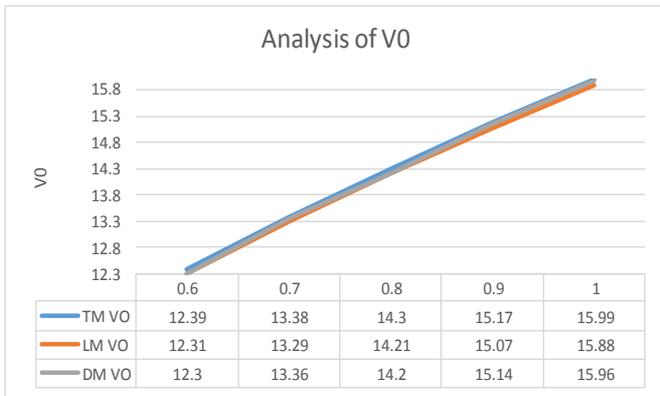


Fig.6. Analysis of V0

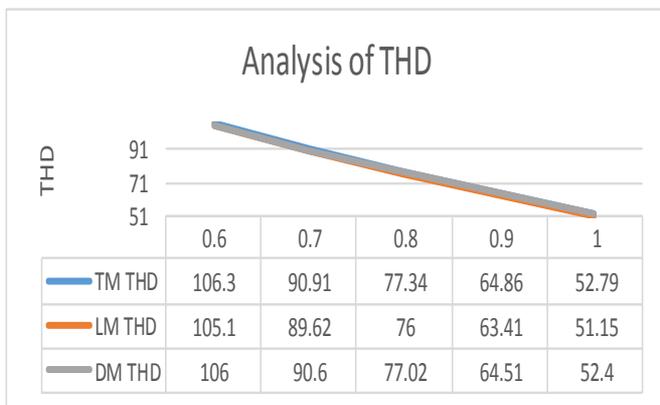


Fig.7. Analysis of THD

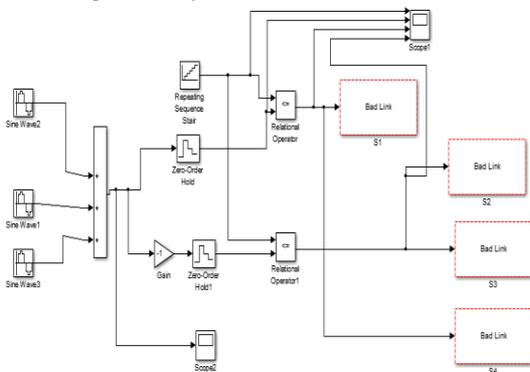


Fig.8. Dumping pulses to the arduino

V. CONCLUSION

A study of single phase H-Bridge inverter for various sinusoidal pulse width modulation techniques has been analyzed and discussed. From **fig.6.and fig.7.** at the modulation index of 0.8 we are getting an optimum voltage and the total harmonic distortion respectively. This PWM inverter is preferred choice for its simplicity and low cost. The

switching frequency is significantly lower. This results in low switching losses.

REFERENCES

[1] Hasmukh S. Patel and Richard G. Hoft“**General Techniques of Harmonic Elimination and Voltage Control in Thyristor Inverters,**” (IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS VOL. 1A-9, NO. 3, MAY/JUNE. 1973

[2]“**Power Electronics: Circuits, Devices, and Applications**” by Muhammed H. Rashid chapter-6 pg.no: 237-247 and chapter-7 pg.no:406-412.

[3]Arduino MegaReference – “arduino.cc”.

[4] John N. Chiasson, Leon M. Tolbert, et.al.,“**Control of a Multilevel Converter using Resultant theory,**” (IEEE TRANSACTIONS ON CONTROL SYSTEM TECHNOLOGY, VOL. 11, NO. 3, MAY 2003)

