SINGLE PHASE SINE WAVE PWM INVERTER

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ABSTRACT - This project thesis is about the brief overview of Single Phase Sine Wave PWM inverter. The main advantage of PWM is that power loss in the switching devices is very low. This project deals with studying the basic theory of a Sinusoidal Pulse Width Modulated Inverter (SPWM), it's simulink modelling, estimating various design parameters and the hardware implementation of the inverter and a transformer for its practical application. The project will be commenced by a basic understanding of the circuitry of the SPWM inverter, the components used in its design and the reason for choosing such components in this circuitry.

Keywords-SPWM, Inverter, Transformer

1. INTRODUCTION

The main objective of this project is to construct a prototype of practical inverter circuit. For that,first we have to design and implement the SPWM generator for control of Inverter and then to design and implement transformer for inverter. A survey of different PWM techniques is performed considering the efficiency,type of inverter used and the type of switch used in the inverter.Based on the survey Sine Wave PWM technique is chosen since it is more advantageous than other techniques(driver circuit is not required).The half bridge inverter is chosen

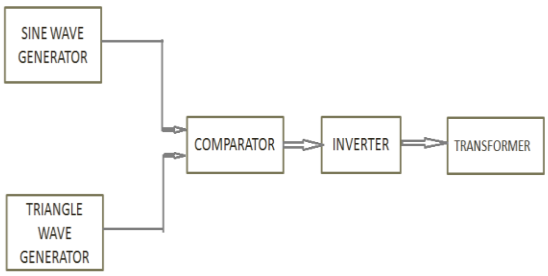


Fig 1. Block diagram of Sine Wave PWM Inverter

1.1 Sine Wave Generator:

The single phase sine wave is generated with the help of Wein Bridge oscillator. To get the desired frequency of 50Hz and peak-peak voltage of 12V it is assumed to take C=1uF and R2=2R1.The R value is calculated by using the formula,

f = 1 / (2*3.14*R*C)
R= 1 / (2*3.14*50*1x10^-6)
R= 3.3x10^3 ohmR2=2R1
R2=1.5x10^3 ohm, R1=860 ohm

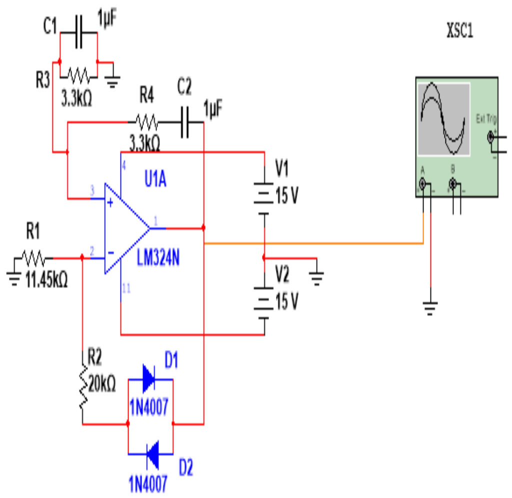


Fig 2. Sine Wave Generator

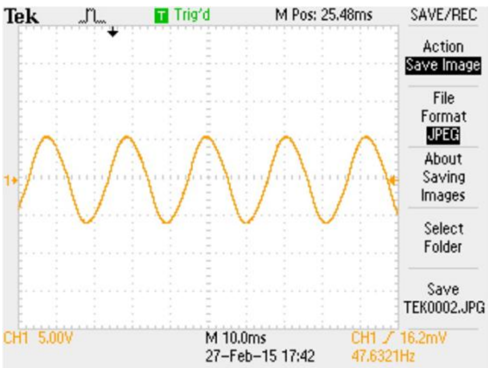


Fig 3. Sine Wave output

1.2 Triangle Wave Generator:

The triangular wave is generated using Triangular Wave generator circuit. Two LM324N ICs are used to generate the triangle wave with the frequency of 1 KHz and peak-peak voltage of 20V.

Output Voltage Vo= (2R3/R2) Vsat
Where Vsat=15 V, Vo=20 V 20=2(15)(R3/R2)
2R3=R2

To get the desired frequency of 1 KHz,
Let us assume, C1=1uF, R3=10x10^3 ohm fo=4 / (R1*C1*R3) 1KHz=16x10^3 / (4*R1*1x10^-6*10x10^3) R1=400 ohm

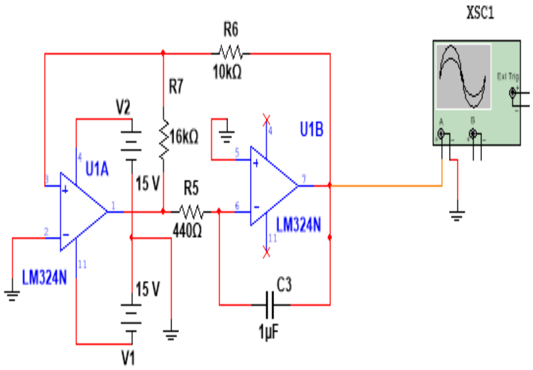


Fig 4. Triangle Wave Generator

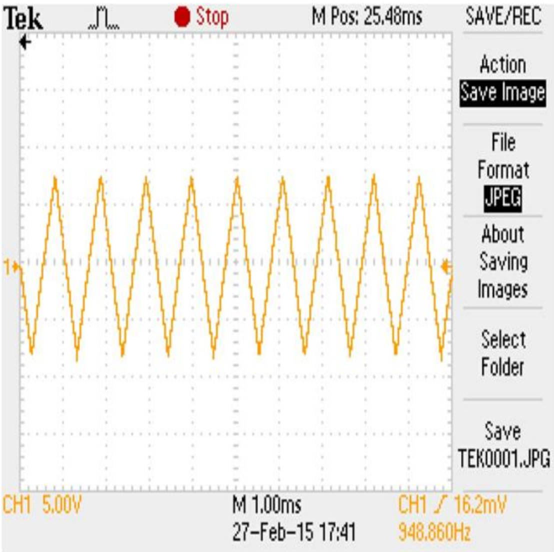


Fig 5. Triangle Wave Output

1.3 PWM generation:

The gating pulses required for turning ON the MOSFET switch is generated by comparing the Sine Wave with the Triangular wave. Depending upon the Modulation Index chosen the width of the pulse is varied. The LM324N IC is used as comparator. To turn ON the switches alternatively it is necessary to produce two gating pulses. The gate pulses generated for the first switch is inverted and it is given to the second switch.

Inverter Overview:

A single phase half bridge inverter with two MOSFET switches are used to convert the 12V DC into 230V AC.Two switches S1 and S2 are used to chop the DC supply and a transformer converts this pulsating 12V DC into 230V AC. The inverter output power 500W is given to a resistive load. Sine wave PWM signals are given to the gates of the MOSFET switches.

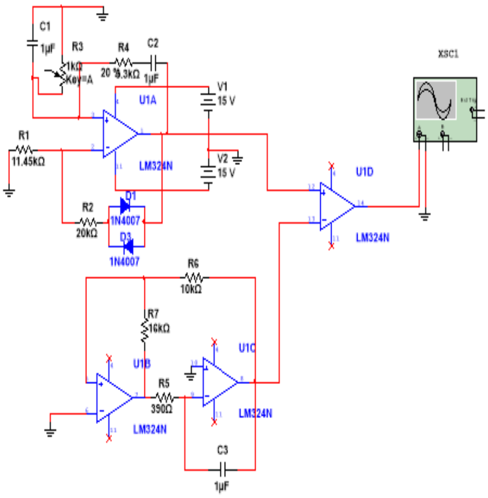


Fig 6. Comparator circuit

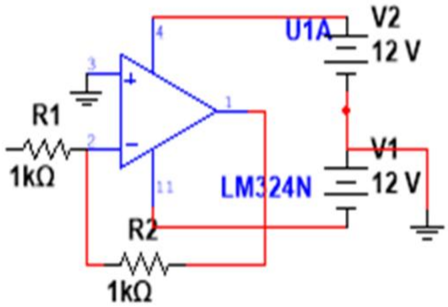


Fig 7. Inversion of gate pulses

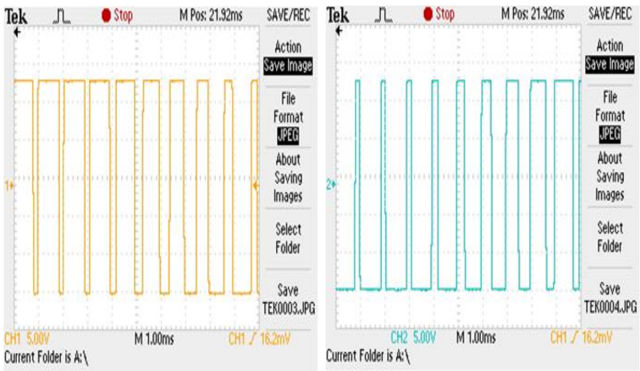


Fig 8. Gate pulses

The MOSFET turns ON and OFF depending upon the Gate pulse and the duration of ON and OFF are determined by the width of SPWM.

When S1 is ON:

When switch S1 is ON the current flows through the upper half of the centre tapped transformer. Hence flux linkage is established at the secondary. During this switch S2 is maintained in OFF state.

When S2 is ON:

When the switch S2 is ON the current flows through the lower half of the centre tapped transformer. Hence flux linkage is established at the secondary. During this switch S1 is maintained in OFF state.

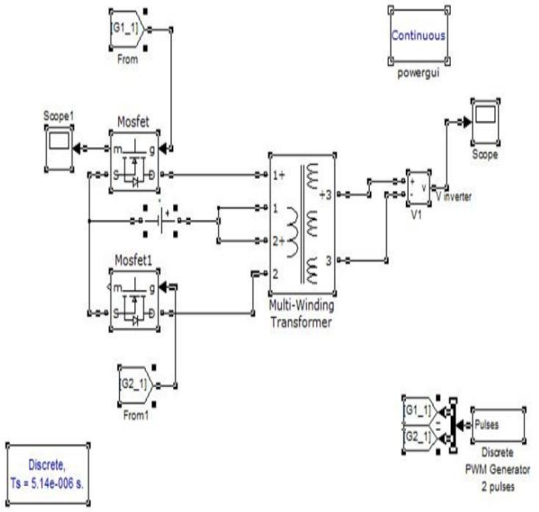


Fig 9. Schematic of Inverter

1.4 Transformer design:

Assume the worst case efficiency of transformer is 80%

Po = 500Wtransformer efficiency Ƞ = Po / Pin

Pin = 500 / 0.8

Pin = 625W

Secondary current,

I rms-s = output power/output voltage

I rms-s = 500 / 230

I rms-s = 2.17 A

Primary current,

I m = Pin / Vin = 625/12 = 52.08 A I rms-p = Im / √2 = 36.82 A

1.5 Wire gauge:

It is chosen based on the value of current density. Usually 500 to 1000 circular mils/Amp. Now multiply this with current to get circular mil.

Circular mil for primary = 52.08 X 700

= 36456 circular mill

$\pi r^2 = 36456$ A = d^2

d = √A = 160.54 mils

1 inch = 1000 mils 1 mil = 1/1000 inch

160.54 mils = 160.54/1000 = 0.16inch

SWG = 8

Circular mil for secondary = 2.17 X 700 = 1519 circular mils

d = √A = 38.97 mils

38.97 mils = 38.97/1000 = 0.038 inch

SWG = 20

Core geometry:

Selected core is ETD44 so Ae = 175 mm^2 taken from core data book. Assume Bmax = 1500 G

E = 4.44fΦmN = 4fBmAeN

N1/2 = E/ (4fBmAe) = E/ (4fBmAeX10^-8)

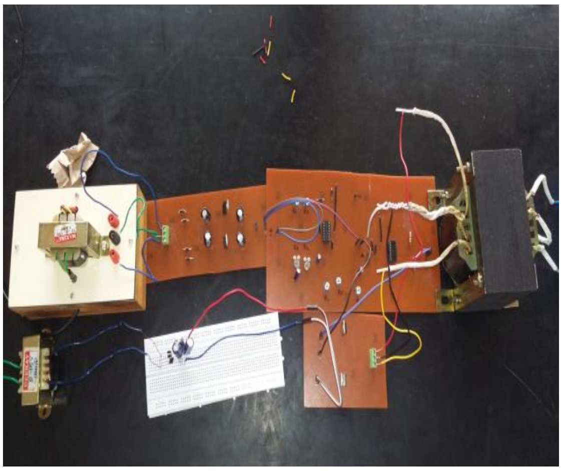
N1/2 = 12X10^8/ (4X1000X1500X1.75)

= 114.286 = 115

N1= 230 turns

N2= 3120 turns

1.5 Hardware Setup:



Conclusion:

Thus the single phase sine wave PWM inverter has been simulated in Multisim software and implemented practically. In future a LC filter circuit can be added to reduce the harmonics at the output side.

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