SINGLE PHASE PWM SINE WAVE INVERTER

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***Abstract*—An Inverter 'DC to AC converter' is used to run electrical or electrically driven electronic appliances during power failures or during all those situations where one is limited by a battery as the only source of power available around, hence emphasizing the need of a circuitry to efficiently produce AC voltage. This project focuses on a single phase PWM Sine wave inverter that can be used for minimalistic applications in general household scenario. This low cost design generates a sine wave by modulating the width of a square pulse at higher frequencies and a self programmed low cost microcontroller is used to produce this sine wave. A transformer is used to amplify the voltage output of this transistor based full bridge inverter circuit driven using gating signals supplemented from the PWM generating microcontroller. Such minimalistic design of an inverter producing waveforms similar to that of a true sinusoidal waveform finds its application in delicate electronic systems like a battery operated vehicle, or to run delicate hospital appliances.**

Keywords - Microcontroller, Pulse Width Modulation, Sinusoidal Wave, Full Bridge Inverter

I. INTRODUCTION

In today's world every single home is well equipped with electronic gadgets that run using AC voltage and a backup inverter or generator is always present for support during a power failure.

Sometimes, the power failure might last longer than usual and certain gadgets will fail to operate without AC supply. Under these conditions this low cost miniature inverter will help to successfully drive the less power consuming gadgets that run only using AC supply. A small, removable battery that could be charged elsewhere with much ease would aide the overall concept of this miniature inverter.

Furthermore, if electronic gadgets were to come pre-equipped with this miniature inverter then, it will prevent the sudden shut down of these gadgets in houses with no power backup.

II. EXISTING SYSTEM

Existing general purpose inverters and UPSs are costly, bigger in size and sometimes fail to achieve output that they claim of. These inverters hence end up making fans and other devices to produce huge amount of noise. This noise is bad as it hints that the output from such inverters are harmful for the devices.

III. PROPOSED SYSTEM

The proposed system is of low cost, is comparatively smaller in size and if manufactured in large quantities, it would reduce the overall cost of this inverter even further. In Figure 1, one could observe the circuit diagram of the proposed system.

This system aims to produce a sinusoidal wave as efficient as the pure sinusoidal wave, hence it will successfully drive other equipments without producing much noise and thus inflicting almost no harm to these devices.

IV. PROJECT DESCRIPTION

The system consists mostly of two main parts :

1. PWM producing Microcontroller

An Atmega32 microcontroller is used for the development of this project [2]. This 8bit microcontroller is programmed in Embedded C language using AVR Studio to produce a HEX file containing the program to produce a PWM Sinusoidal Wave [3], [1].

The program was optimized to its best to reduce as much size as possible thus reducing processing time and space consumed. This whole program hence produces a 9kb HEX file and produces sine values without depending upon additional look up tables. In Figure 2 to Figure 6 we can observe the oscilloscope output it produces.

A. PROGRAM :

```
#include<avr\io.h>
int main()
{
TCCR2=1<<WGM20|1<<WGM21|0<<CS22|0<<CS21|1<<CS20|1<<COM21;

TCCR0=1<<WGM00|1<<WGM01|0<<CS02|0<<CS01|1<<CS00|1<<COM01;
```

```
DDRB|=1<<PB3;DDRD|=1<<PD7;
int t=0,x=0;

while(1)
{
int a=255,b=0,d,e=0,z;

if(t==0){d=0;z=18;}else{d=90;z=-18;}

while(a>b){(t==0)?(e=b):(e=a);e=255*sin(0.0174533*(d+=
z));(x==0)?(OCR2=e):(OCR0=e);(t==0)?(b=e):(a=e);}++t;

switch(t){case 2:{t=0;++x;}}
switch(x){case 2:x=0;}
}
}
```

B. PROGRAM DESCRIPTION :

a) <u>io.h</u> : This header file includes the appropriate IO definitions for the device that has been specified by the compiler.

b) <u>TCCR2 and TCCR0</u> : 'Timer counter control registers, TCCR2 and TCCR0, control the functions of Timer 2 and Timer 0 by selecting the clock sources applied to Timer 2 and Timer 0. In this CS20 and CS00 have been used to set switch the clocks ON without any prescaler.

c) <u>DDRB and DDRD</u> : Here, these data direction registers have been used to specify PORT B3 and D7 as output ports.

d) <u>while(1)</u> : This is that infinite loop that never terminates, hence enable PWM signals to be generated when microcontroller is switched ON and PWM signals to stop only when microcontroller is switched OFF.

e) <u>PWM Signal generation</u> : This is that part of the program that deals with PWM signal generation :

if(t==0){d=0;z=18;}else{d=90;z=-18;}

while(a>b){(t==0)?(e=b):(e=a);e=255*sin(0.0174533*(d+=z));(x==0)?(OCR2=e):(OCR0=e);(t==0)?(b=e)
: ***(a=e);}++t;***

switch(t){case 2:{t=0;++x;}}
switch(x){case 2:x=0;}

Here, using while(a>b), if-else and switch cases, sine PWM is getting generated in four stages :

i. STAGE 1 :

while(a>b) = while(255>0) , t=0 , x=0

In this stage, on time width of PWM signal keeps incrementing using sinusoidal values from 0 to 255. This creates the rising half of the positive half of the sinusoidal signal.

ii. STAGE 2 :

while(a>b) = while(255>0) , t=1 , x=0

In this stage, on time width of PWM signal keeps decrementing using sinusoidal values from 255 to 0. This creates the falling half of the positive half of the sinusoidal signal.

iii. STAGE 3 :

while(a>b) = while(255>0) , t=0 , x=1

In this stage, on time width of PWM signal keeps incrementing using sinusoidal values from 0 to 255. This creates the rising half of the negative half of the sinusoidal signal.

iv. STAGE 4 :

while(a>b) = while(255>0) , t=1 , x=1

In this stage, on time width of PWM signal keeps decrementing using sinusoidal values from 255 to 0. This creates the falling half of the negative half of the sinusoidal signal.

2. Full Bridge Inverter Circuit

This full bridge inverter circuit helps to drive the load by alternating the polarity at the ends of the load using the two PWM signals of which one is used to create the positive half of the sinusoidal wave and the other is used to create the negative half of the sinusoidal wave.

A full bridge inverter circuit consists of four field effect transistors arranged in a certain combination with the load. In this circuit the following components have been used :

a. <u>IR2101</u> : This Mosfet driver helps to amplify the current and the voltage that is taken as the input from the output of the microcontroller for successfully driving each mosfet individually without inhibiting the performance of the mosfet.

b. <u>IRFZ44N</u> : It is a N-Channel Power Mosfet. Power Mosfets have the ability to perform faster switching when compared with the normal ones, and their tolerance to high voltage is also higher than the others though dependant on its specifications.

c. <u>Logic AND gate</u> : It is used to control the drain input to mosfets based on the gate input provided to the mosfets.

d. <u>Diodes, Capacitors and Resistors</u> : Usage of these components in this circuit has been done as per the pre-requisites specified by other components or for supporting the waveform.

e. Transformer : A step up transformer has been used to boost a 12V sinusoidal wave to a 240V sinusoidal wave. Here, the transformer also plays the role of an isolator and protects microcontroller and other ICs from getting damaged due to voltage spiking.

f. Clamper Circuits : These have been used at the output of the microcontroller ports to increase the DC value of the PWM signal for better results.

V. CIRCUIT DIAGRAM AND GRAPHS

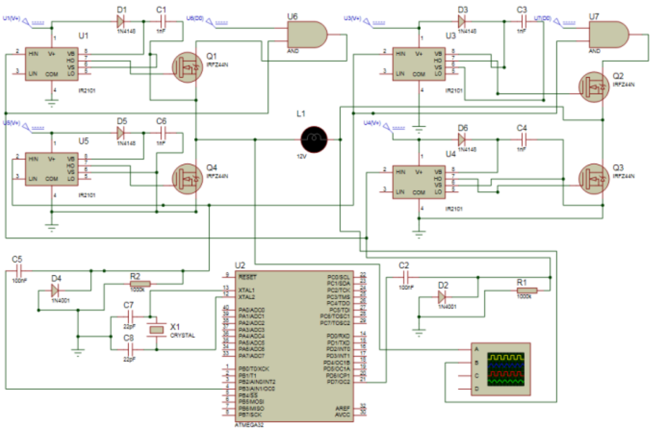

Fig 1: This is the circuit diagram of the inverter and consists of Full Bridge Inverter Circuit and Atmega32 microcontroller

Oscilloscope Output of the PWM Sinusoidal Wave's positive half cycle using Proteus simulations:

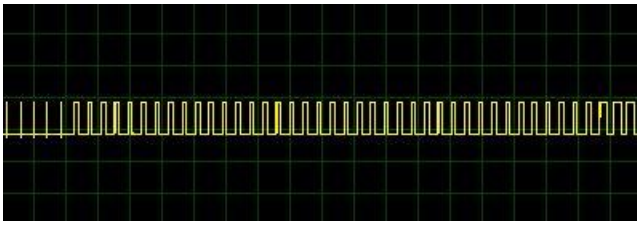

Fig 2: First quarter of the rising half of the signal.

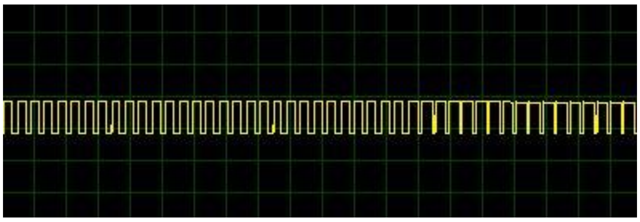

Fig 3: Second quarter of the rising half of the signal.

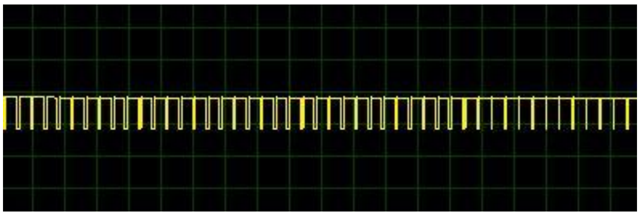

Fig 4: Peak of the PWM signal.

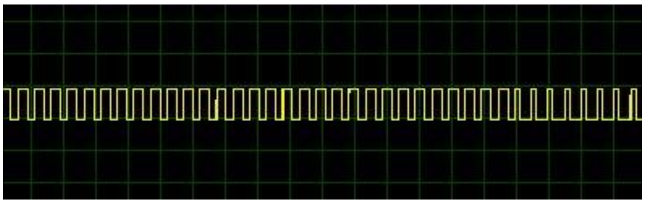

Fig 5: First quarter of the falling half of the signal.

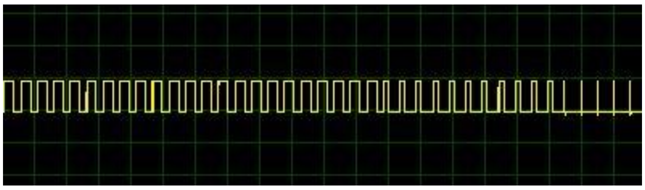

Fig 6: Second quarter of the falling half of the signal.

VI. SOFTWARE SUPPORT

This project was successfully simulated with the help of following language and software :

1. Embedded C : The program was coded using this language. Embedded C is an extension for the existing C programming language by the C Standards Committee to help program different embedded systems.

2. AVR Studio : It is a software development environment developed by Atmel. Here, it has been used to compile codes and to produce HEX files with the help of MinGW package.

3. Proteus : This software helps to build and simulate complex circuits using a personal computer.

VII. CONCLUSION AND FUTURE WORK

A framework for building a cost effective inverter is proposed. The system meets all the basic requirements to efficiently produce a sine wave as its output.

This project could further be improved by increasing the power handling capability of the inverter.

ACKNOWLEDGMENT

Authors would like to express their sincere gratitude towards SRM Institute of Science and Technology for providing the necessary facilities for carrying out the project.

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