PERFORMANCE AND ANALYSIS OF DC-AC PURE SINE WAVE INVERTER

A Thesis
Submitted to the Department of Computer Science and Engineering
of
BRAC University
by

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In Partial Fulfillment of the Requirements for the degree of Bachelor of Science in Electronics and Communication Engineering, Dec 2010

FALL 2010

BRAC University, Dhaka

DECLARATION

I hereby declare that this thesis is based on the results I found in my thesis work. Contents of work found by other researcher are mentioned by reference. This thesis has never been previously submitted for any degree neither in whole nor in part.

Signature of Supervisor	Signature of Author
.... 8/12/10	....

ACKNOWLEDGEMENT

Firstly, I would like to thank my supervisor Dr. AKM Abdul Malek Azad for giving us the opportunity to work on this project under his supervision and also for his invaluable support and guidance throughout the period of pre-thesis and thesis semesters. Through his supervision, I have learned a lot.

Lastly, I would like to thank our Lab Technical Officers for their support and guidance in my project.

ABASTRACT

Energy crisis are of special attention in today's world. The unending usage of non-renewable energy sources will bring an end to the limited resources in near future. In order to preserve the resources, several alternative renewable sources have been in use these days. The power generated from the renewable sources, like solar energy, produces is a DC power which can be stored in batteries. This DC power needs to be converted to AC power as most of the appliances used in our daily life are dependent on AC power. To overcome this obstacle, DC-AC Inverter took birth.

Inverter s can be categorized into three groups: Square wave, modified sine wave and pure sine wave. Considering power wattage, efficiency and harmonic content, pure sine wave inverters has proved to have the best quality among the three types. The control circuit for pure sine wave inverter produces sinusoidal pulse width modulation. There are two basic topologies to generate pulse width modulation-Topology 1: Analog Control circuit and Topology 2: Microcontroller based control circuit.

In this thesis project, performance of both topologies used in inverters has been analyzed and a DC-AC pure sine wave Inverter using the Analog control circuit (Topology 1) has been implemented.

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CHAPTER I

1.1 Motivation:

Bangladesh is suffering from shortage of electricity and to overcome this crisis, alternative source of energy is expanding, especially in rural areas of Bangladesh. The Solar Home System is one of the alternative sources that can mitigate the demand of electricity especially in rural areas where electricity has not reached yet.

Solar energy is a renewable energy without causing pollution to the environment. The maximum electricity that a solar panel can produce is 130 Watt (130 wup). By this panel, 11 CFL (compact florescent lamp) of 6 watt power and a 17-20 inches back and white TV can run. Fan conducted on DC current can also be run by this solar energy. BRAC Solar Home System, Grameen Sakti and few other companies are working to provide solar energy to the villages in Bangladesh. Their main objective is to provide electricity all over Bangladesh.

After some research, we found that most of the companies, including BRAC Solar Home System are dependent on DC appliances. Due to lack of proper inverters, companies provide usages of DC appliances only and not AC appliances. That is because, the existing inverters produces modified sine wave (square waves) which causes a power loss and harms the AC appliances. It is learnt that the amount of investment in this energy sector in rural area per year is more than 2500 corer. 60% of this invested in solar panel, total of which requires being imported from outside. 25% is invested in battery and the rest 15% in small mechanical parts. The companies are interested to extend the service to the city dwellers.

In near future, the demand of pure sin wave inverter will be sky-rocketing, since most of the appliances around us are dependent on AC power. Thus, this has motivated us to create a pure sine wave inverter which can be implemented in Solar Home Systems, at an affordable cost so the rural people can be benefited besides others. Our goal is to produces pure sine wave, and not modified. If we can successfully implement the analog circuit, then we can digitize our pure sine wave inverter circuitry using micro-controller applications.

1.2 INTRODUCTION

The output of battery source is a 12 volt DC and the required AC volt for AC appliances is a 220V AC (50 Hz). The function of inverter is to convert 12 DC to 220V AC which should have pure sine wave oscillation at 50 hertz like the ordinary household electrical outlet. The method that we are applying in our experiment is, converting the low voltage DC power to AC, and then using a transformer to boost the voltage to 220V AC.

In today's market, there are two different types of inverters, modified sine wave and pure sine wave inverter. The modified sine wave is similar to a square wave which is less efficient in power consumption. It produces high number of harmonics which affects the devices, hence, reducing its life time. Whereas, a pure sin wave inverter reduces the harmonics to minimum, thus increasing the efficiency of power consumption and life time of AC appliances. It also reduces the audible and electrical noise in audible equipment, TV's, Fluorescent lights and allows inductive load, like fan to run faster and quieter. The basic differences between the three waves are shown in the figure: 1, below. It can be noted that the square wave has the minimum amplitude, that is, maximum distortion. The modified sin wave is quite similar to square, but it rests at zero for moment then rises or falls, it's less distorted then the square. Whereas, the pure sin wave shown, have zero distortion (maximum amplitude) compared to the rest two with pure oscillation of sine wave.

1.3 Types of Inverter:

1. Square wave Inverter:

   Square wave inverters were the first invented inverter. Square wave inverter has had odd number of harmonics and can hardly be used to AC appliances except some lights and fans which eventually reduce their life time. This is cheapest inverter. The green colored line shown in figure:1 illustrates the out put of the square wave inverter.

2. Modified sine wave Inverter:

   Modified sine wave is more like the square wave which has less harmonic distortion compared to square wave. The harsh corners from the square wave were eliminated to transform it to a modified sine wave. This type of inverter mostly exits in today's market. Although it is less harmful to devises compared to the square wave, it still heats up the coil in filter due to large amount of harmonic distortion and dissipates power. The blue color line in figure (1) shows the modified sine wave.

3. Pure sine wave inverter:

   Unlike square wave and modified sine wave, pure sine wave inverters maintain the best quality due to the least number of harmonic distortions present in it. Usually sine wave inverter are more expensive but it allows to us use all AC appliances and reduces the humming noise of inductive loads. The red colored line represents the sine wave with respect to the other two, in figure (1)

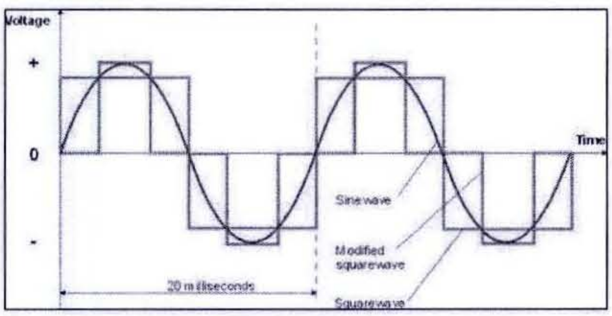

Figure: 1 Pure sine wave

1.4 Topologies of Pure Sine Wave Inverter:

Pulse width modulation is widely used as a source of powering alternating current (AC) devices with available direct current (DC) source. Variation of duty cycle of the PWM signal to provide dc voltages across the load in a specific pattern will appear to the load as ac signal. The pattern at which the duty cycle of a PWM Signal varies can be implemented using simple analog components or a digital microcontroller. There are two basic topologies to generate sinusoidal PWM that controls that output of the inverter. The two topologies are,

1.4.1 TOPOLOGY 1: Analog Control Circuit

In this type of control circuit, the SPWM is generated by comparing a sine wave with a high carrier frequency (Triangular wave or saw tooth wave) with sine wave as the reference voltage. Figure () shows how SPWM is produced by comparing sine wave with triangular wave. This type of topology, analog components is used to generate the sine wave and carrier wave and compare them with analog comparator.

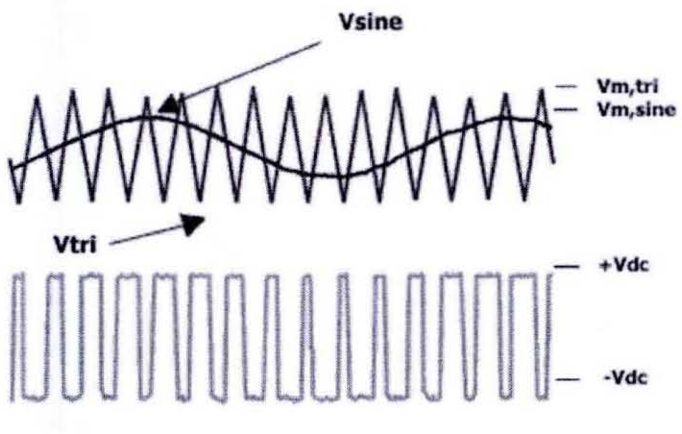

Figure2: Pulse width modulation

1.4.2 TOPOLOGY 2 : Microcontroller Based Control Circuit

In this type of topology, the SPWM is directly achieved using microcontroller that will control the final sine wave at the final output. Using this type of topology reduces the cost and the size of the control circuit. The low cost micro controller like ATmega32 or Pic18F4431 has built in PWM modules which require some command to generate the necessary PWM wave form.

CHAPTER II

2.1 Design Method of pure sine wave inverter (Topology 1)

The implementation of pure sine wave inverter can be complex when thought of as a whole but when broken into smaller projects and implementing them individually, it becomes easier. the following sections describes how the individual blocks like Oscillator section, carrier wave generator and switching circuit was implemented and how the blocks were joined together.

2.2 Block Diagram:

Our project consists of analog circuitry (resistors, capacitor, diode, variable resistors) as well as discrete components (Integrated circuits-LM348, TL084, MC3302), MOSFET driver (IR-2101), MOSFETs and step up transformer. That is all required to construct a sin wave to generate 220V AC sine wave across a load. The block diagram (Figure 1) illustrates the various parts or blocks of the project. The three basic blocks to control the circuit are the Six volt reference, sine wave generator and triangle wave generator. When these blocks are implemented with comparator, and other small circuitry, they control the pulse width modulated (PWM) signals that are fed into two MOSFET drivers. The comparator circuit also produces square waves that are fed into other MOSFET drivers which determine the polarity of the final output sin wave. The PWM signals fed into the MOSFET Driver performs the level translation to drive four N-Channel MOSFETs in an H-Bridge configuration. From here, the signals from the N-Channel MOSFETs are passed through a low pass filter so that the output is a pure sin wave of 12V P-P with 50 hertz frequency. Then the signal will be boosted up to 220 V AC using a step-up transformer.

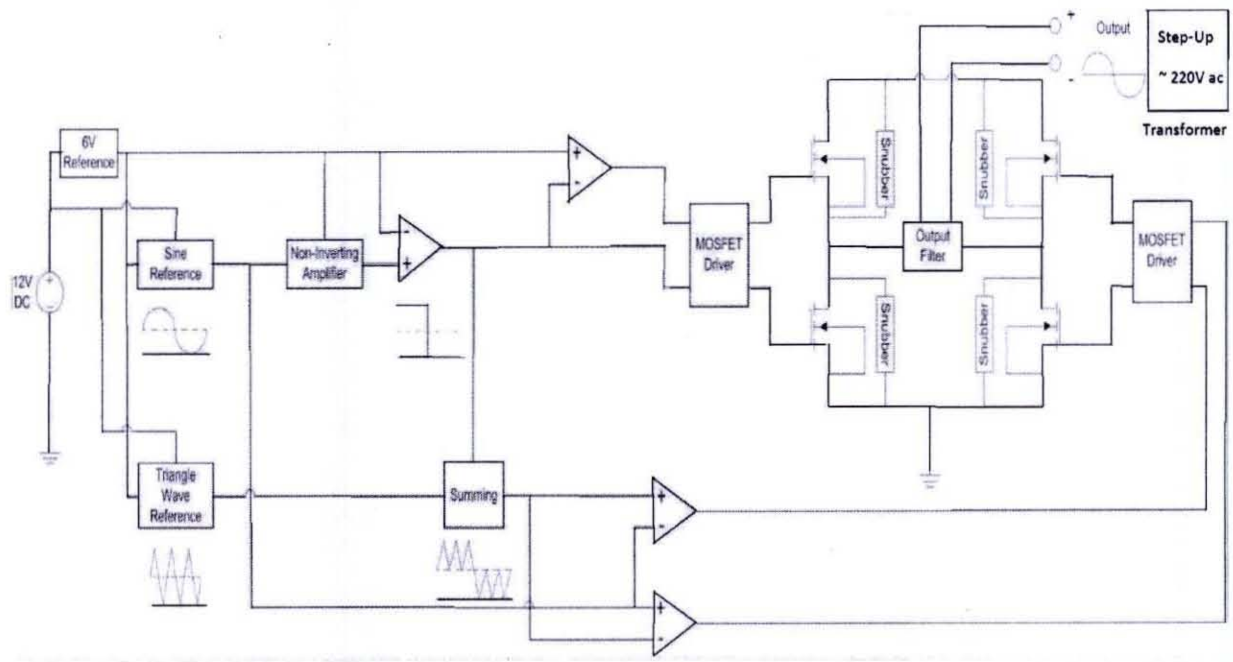

Figure 3: Block diagram of the system

2.3 SOFTWARE Simulations

In order to understand the circuit, we had to design the circuit in Pspice software and note the outputs at some specific nodes. The IC used in the hardware implementation of comparator circuit was MC3302 which has 4 comparator OP-AMPS inside it. But, due to unavailability of MC3302 in Pspice library, we used LM 139 which is the same series of MC3302. The control circuit (sine wave generator, carrier triangular wave generator, and 6V reference) was artificially created using VSIN, VPULSE and VDC from the library. Then the signals were fed into the comparator circuit.

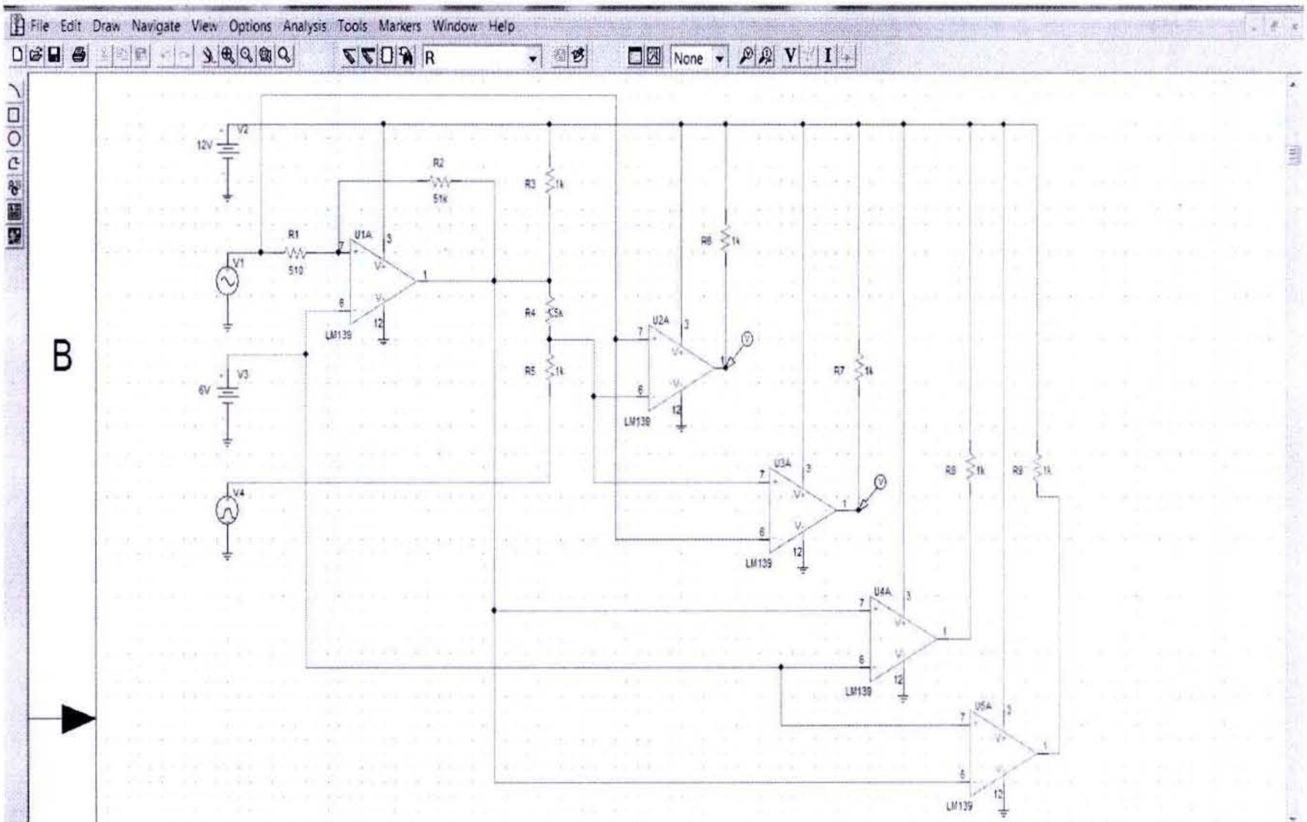

Figure 4: Software implementation of the circuit.

2.4 GRAPHICAL OUTPUTS OF SOFTWARE simulation

The outputs of the four comparator OP-AMPS were carefully noted by varying the transient time and other parameters. Finally the expected results were crystal clear, that our system will work, that is, we can generate PWM and Square waveif we go for hardware implimentation. Figure – 4.1, shows the both the square wave and inverted square wave of 12 V p-p and frquency is dependent on the frequency of the Sine wave generator. In this case, the frequency was 60HZ. And Figure 4.2: shows the PWM and inverted PWM (12V p-p). Both of the outputs are shown in the same axis in order to understand the inversion of respective waves.

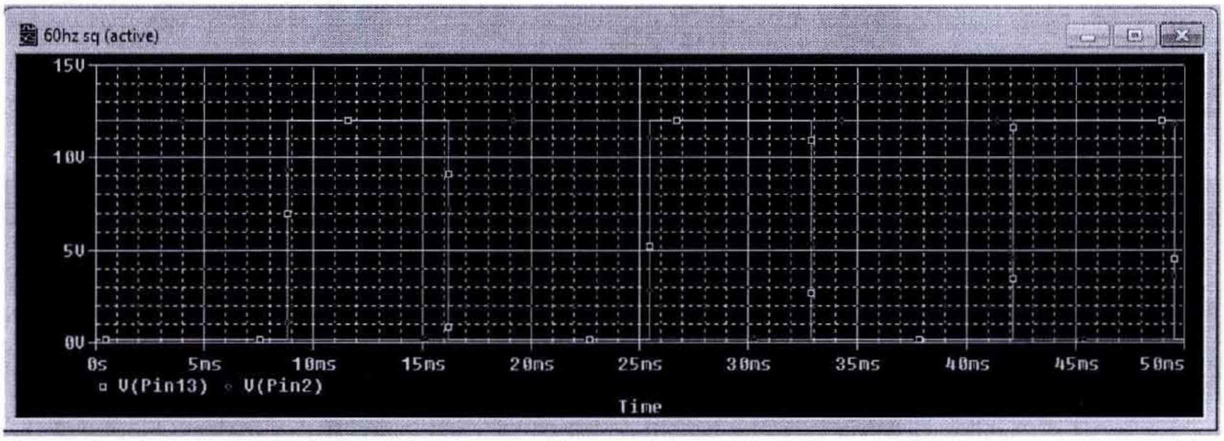

Figure - 4.1: Square wave fed to left MOSFET driver which controls the polarity of output sine wave.

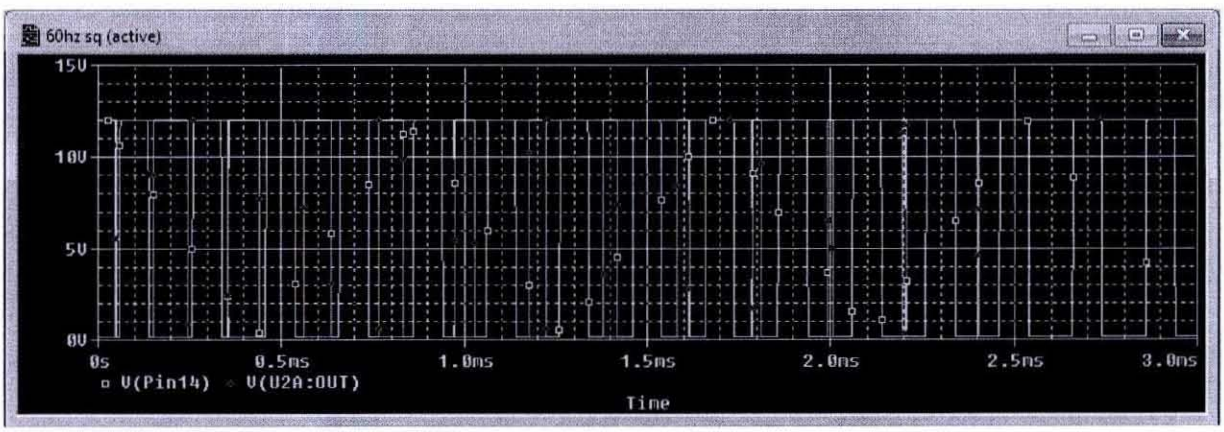

Figure - 4.2: PWM fed in to right side mosfet driver which controls the amplitude of output sine wave.

2.5 Sine Wave generator:

For sine wave generator block, we have used **Bubba Oscillator.** The Bubba Oscillator is a circuit that provides a filtered sin wave of any frequency based on the configuration of resistors and capacitors. The Bubba oscillator is a phase-shift circuit which requires a 45 degree phase-shift in order to function. The four OP-AMP when placed in series, produces a total 180 degree phase-shift. The biggest advantage of Bubba Oscillator is that that frequency stability holds while still giving a low distortion output. The RC filter used after each OP-Amp provides clear and stable signals. The four identical RC filters phase-shifts the signal to 45 degree each. This causes a 180 degree phase shit which is then returned to a zero phase shift with the inverting amplifier across the first OP-AMPS.

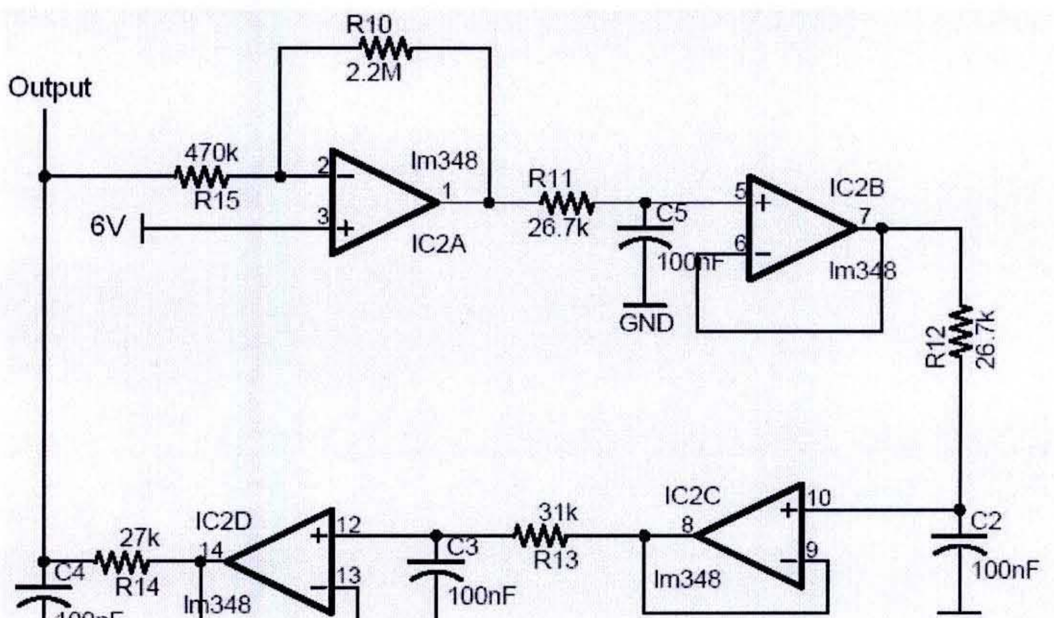

Figure 5: Circuit diagram of the Bubba Oscillator

OUTPUTS OF THE BUBBA OSCILLATOR:

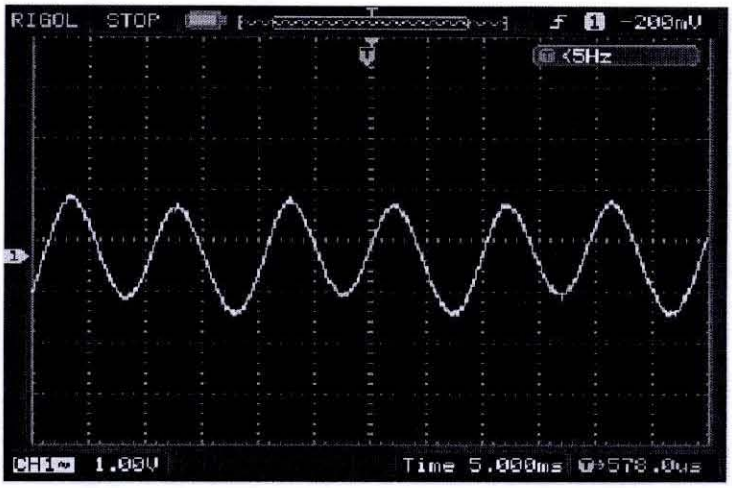

Figure 6: Output of the Bubba Oscillator taken from the Digital Oscilloscope.

2.6 CARRIER WAVE GENERATOR

Carrier waves can be either saw tooth or triangular signals; in our experiment, a triangular wave will is used. This wave is set to 50 KHz to determined optimal power loss. The generation of the triangular carrier wave will be done with analog components. The circuit for the construction of the triangle wave generator consists of a square wave generator and integrator, as shown in Figure 16. The above circuit will oscillate at a frequency of 1/4RtC, and the amplitude can be controlled by the ratio of R1 and R2.

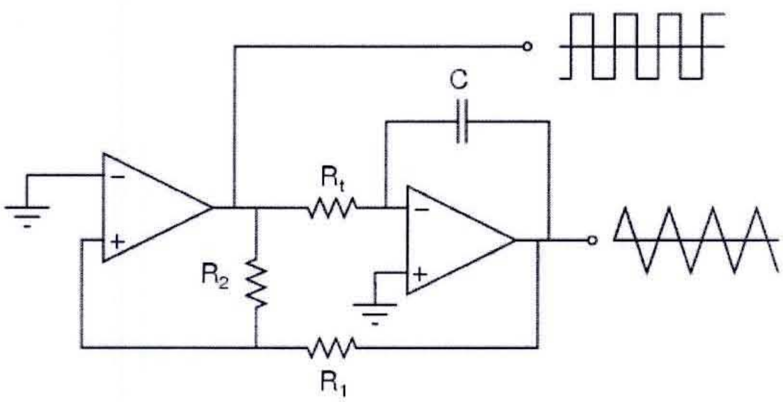

Figure 7: Triangle Wave Generator

OUTPUT OF THE TRIANGLE WAVW GENERATOR:

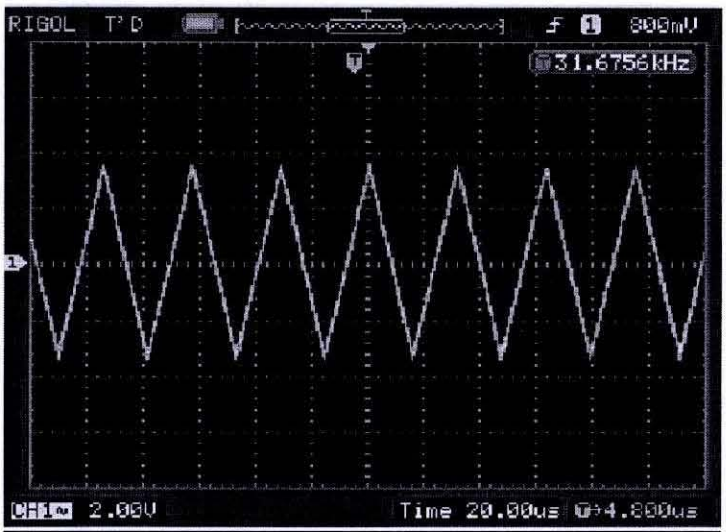

Figure 6: Output of the Triangle wave generator taken from the Digital Oscilloscope.

2.7 Pulse Width Modulation:

In this project a Trilevel PWM is produced by comparing a modified triangular wave with the reference sine wave.

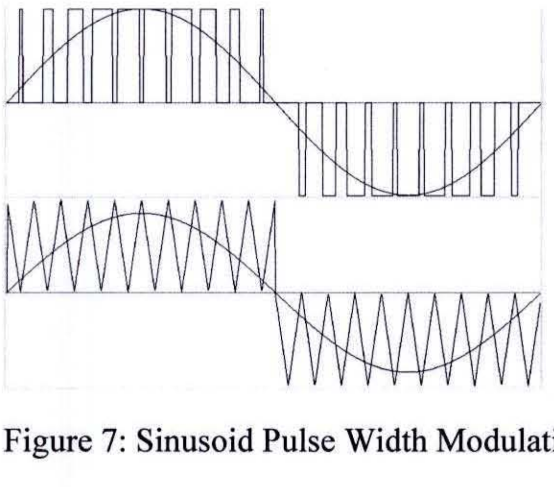

Figure 7: Sinusoid Pulse Width Modulation

In figure () the top picture shows the input referenwave form and the generated PWM signal. The bottom picture shows the signals which are passed into comparator to achieve the PWM wave form. The triangular wave must be modified such that it switchs between a mid-to-high triangular wave mid-to-low. Figure () shows the modified triangular wave that was achieved in the experiment.

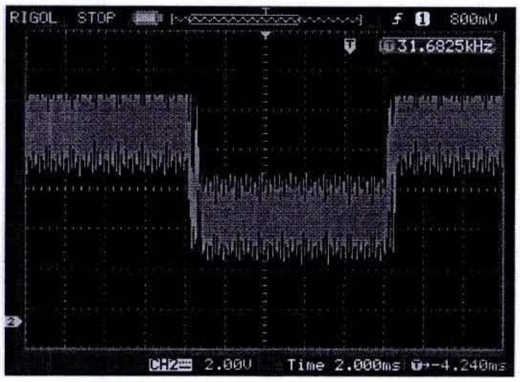

Figure 8: Modified Triangular wave

Now with this modified Triangular wave, a sine wave is compared using comparators and the PWM achieved in the experiment is shown in figure ():

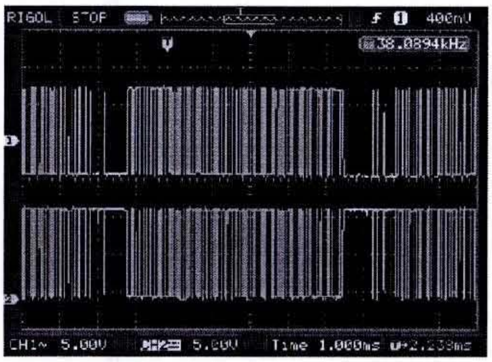

Figure 9: Output of comparator

2.8 H-Bridge:

An **H-bridge** is an electronic circuit which enables a voltage to be applied across a load in either directionThe term "H-bridge" is derived from the typical graphical representation of such a circuit. An H-bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor.

By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor.

Using the nomenclature above, the switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source. The same applies to the switches S3 and S4. This condition is known as shoot-through.

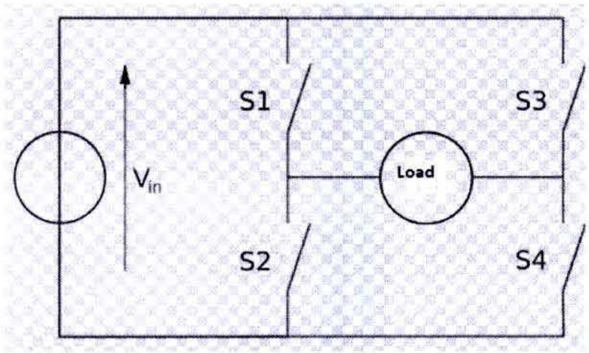

Figure 10: H-Bridge Configuration

Generating a sine wave centered on zero volts require a positive and negative voltage across the load, for the positive and negative parts of the wave, respectively. This can b implemented from a single source through the use of MOSFET switches arranged in an H-Bridge configuration. To minimize power loss and utilize higher switching speeds, N-channel MOSFETS were chosen as switches in the bridge. To drive the HIGH side of the of H-Bridge, MOSFET Drivers were used. Figure () shows the connections of the mosfet driver to the H-Bridge.

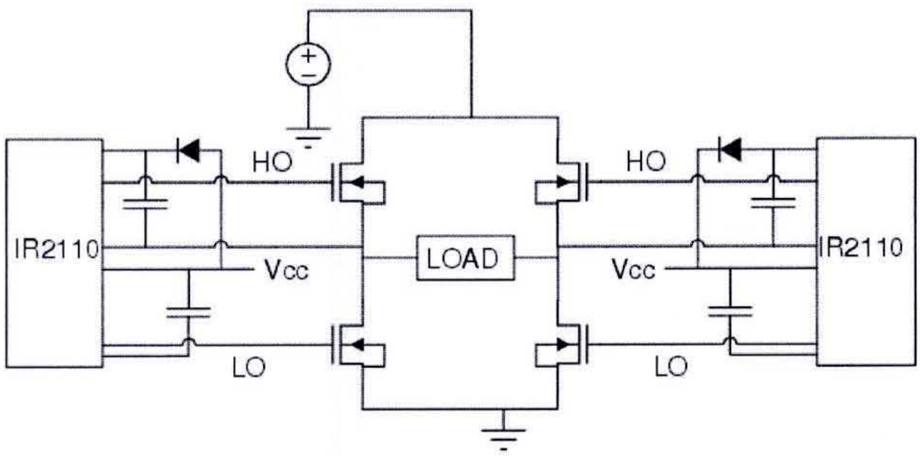

Figure 11: Connection of MOSFET Driver to MOSFET

The inputs to the MOSFET Drivers are shown in Figure () and figure ()

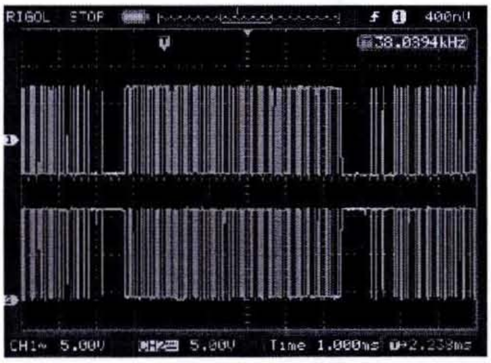

Figure 12: Input to Mosfet Driver

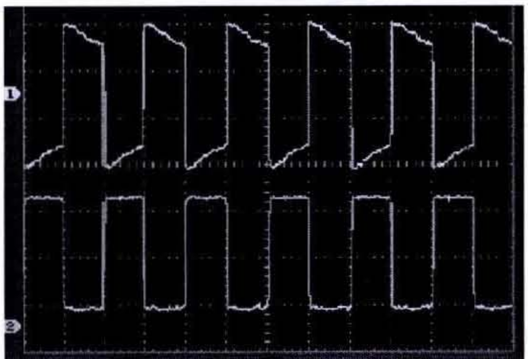

Figure 13: Input to Mosfet Driver

2.9 Filter:

A low-pass filter is a filter that passes low-frequency signals but attenuates of signals with frequencies higher than the cutoff frequency. The actual amount of attenuation for each frequency varies from filter to filter. It is sometimes called a high-cut filter, or treble cut filter when used in audio applications. A low-pass filter is the opposite of a high-pass filter, and a band-pass filter is a combination of a low-pass and a high-pass.

In this experiment, a LC low pass filter was used which extracts the high frequency carrier wave from the original signal.

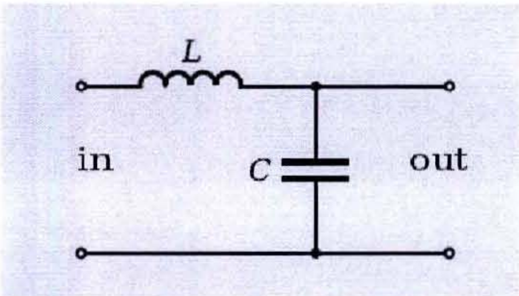

Figure 14: LC Low pass filter

The signals entering the the LC filter is shown in Figure() below,

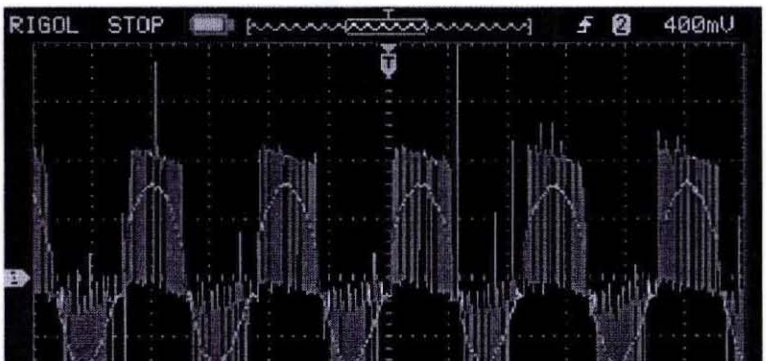

Figure 15: Output of Mosfet switching circuit

CHAPTER III

3.1 Implementation of Design:

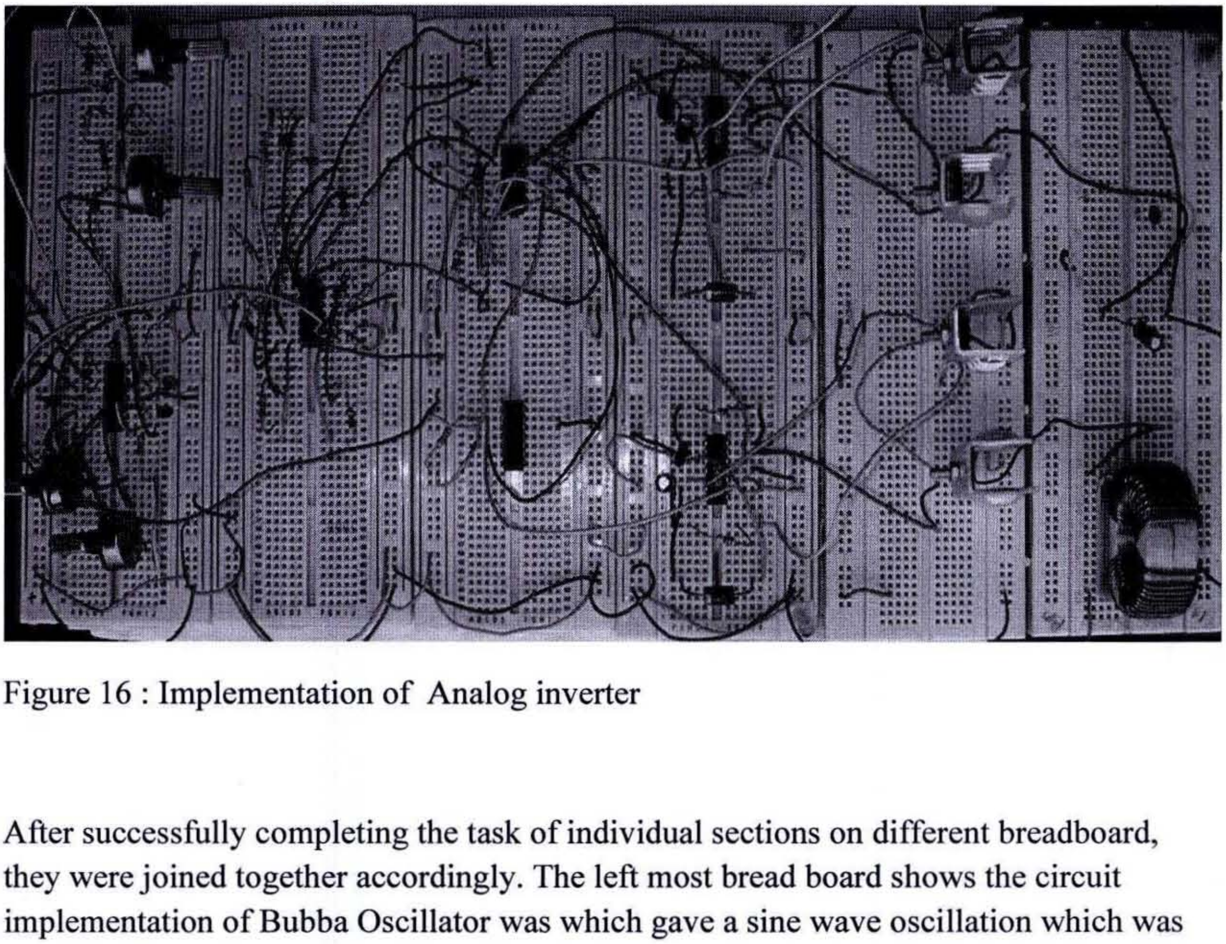

Figure 16 : Implementation of Analog inverter

After successfully completing the task of individual sections on different breadboard, they were joined together accordingly. The left most bread board shows the circuit implementation of Bubba Oscillator was which gave a sine wave oscillation which was amplified later. On the second breadboard, the carrier wave generator was implemented which produced triangular wave. The third section is the comparator circuit which produced a SPWM and Square wave. These signals were fed to the MOSFET Drivers implemented on the fourth breadboard. The Mosfet Driver Drives the High side N-channel Mosfets in H-Bridge Switching circuit that was constructed on the fifth breadboard which produced a bipolar SPWM that was filtered using LC filter on the 5^{th} breadboard. Finally the output of the filater circuit was the result and goal of implementing the desing.

3.2 Results:

The final result was a sine wave of 60 HZ with an amplitude of 10-14V p-p depending on the frequency of the desire output with little distortion but pure indeed for most of the time.

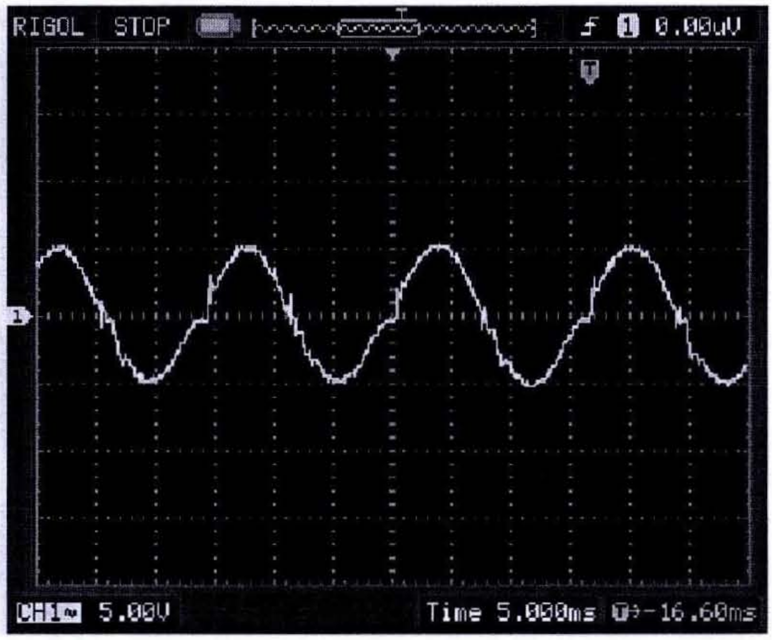

Figure 17: Output of filter circuit

3.3 Difficulties:

The most difficult part was to design the LC filter since the type Inductor used is not available. So whenever the circuit was turned on with wrong filter load, huge current flowed through the circuit causing damages to ICs.

CHAPTER IV

4.1 Microcontroller Based Inverter : (Topology 2)

The control circuit in a pure sine wave inverter is designed using Microcontroller. The advantages of this inverter are the use of a low cost microcontroller that has built in PWM modules. In this experiment, ATmega32 was used that was able to store required commands to generate the necessary PWM waveforms. In Atmega32, PORT D has four output that produces PWM. In this experiment, only the control part was discussed and implemented and not the entire inverter.

4.2 General Description of Sinusoidal PWM

The Method used for creating the pure sine wave in Microcontroller is done through manipulation of mathematical representation of the original sine wave. It is done by dividing halh of the sine wave into "m" number of segments (even number), where area under the first quarter of the sine wave (0- $\pi/2$) resembles series of the form [2n-1] where n=1,2.....m/2, while areareas of the next quarter from $\pi/2$-π will resemble series of the form [2n-1] where n=m/2....1.

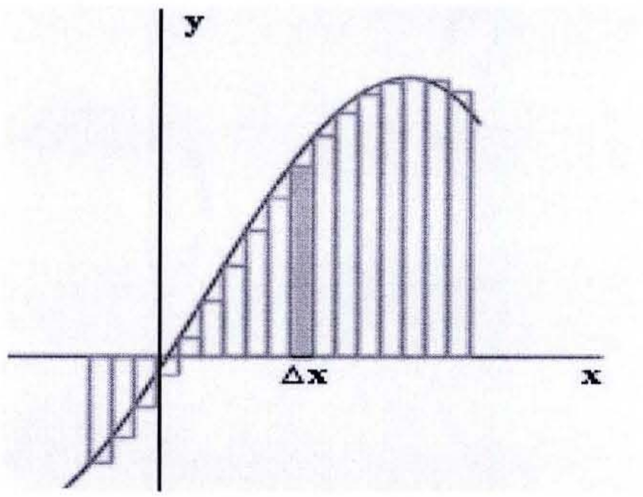

Figure 18: Segmentation of sine wave

4.3 Basic Design Of Microcontroller Based Inverter:

In the Microcontroller based inverter, the control circuit has to produced two types of SPWM. SPMW remains on for half of the cycle of the sine wave and for rest half of the cycle off, and the other SPWM is the vise versa. These two signals are faded to two sides of the MOSFETS in the H-bridge switching circuit which changes the polarity at the output. The basic design of the microcontroller based inverter is shown in figure().

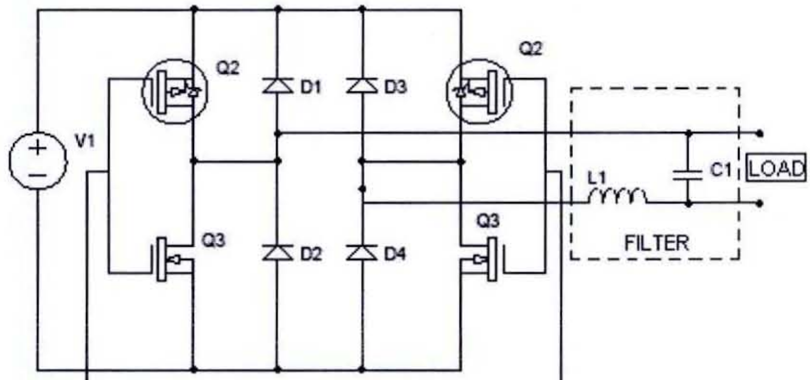

Figure 19: Output of filter circuit

4.4 Methodology:

A simple method has been applied to the two types of SPWM required in microcontroller based inverter. For a 50 Hz sine wave, the total time period is 0.02s. so one of the SPWM should represent half of the sin for the first(0.00- 0.01)sec and the other SPWM should produce SPWM of half of the sin for rest (0.01-0.02) sec. The clock pulses produced in microcontroller can be controlled. Figure (20) showsthe PWM of the first half cycle of a sine wave. And Figure (21) shows the two types of SPWM that has to be generate to controm the microcontroller based inverter. The final desired output is shown in figure(23) after the H-Bridge switching circuit.

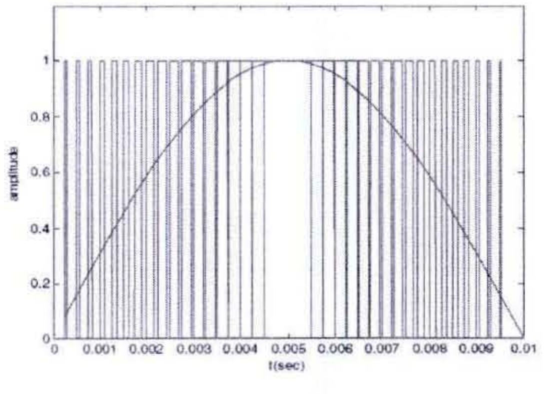

Figure 20: Half sine sefmentation

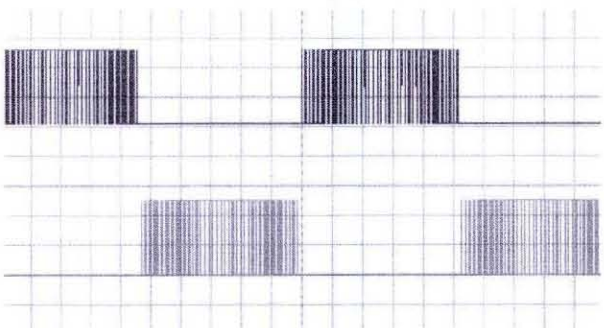

Figure 21: Two typs of Sinusoid PWM

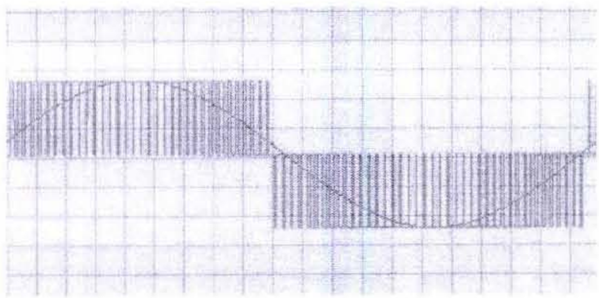

Figure 22: Output of filter circuit

4.5 Algorithm For Generating SPWM:

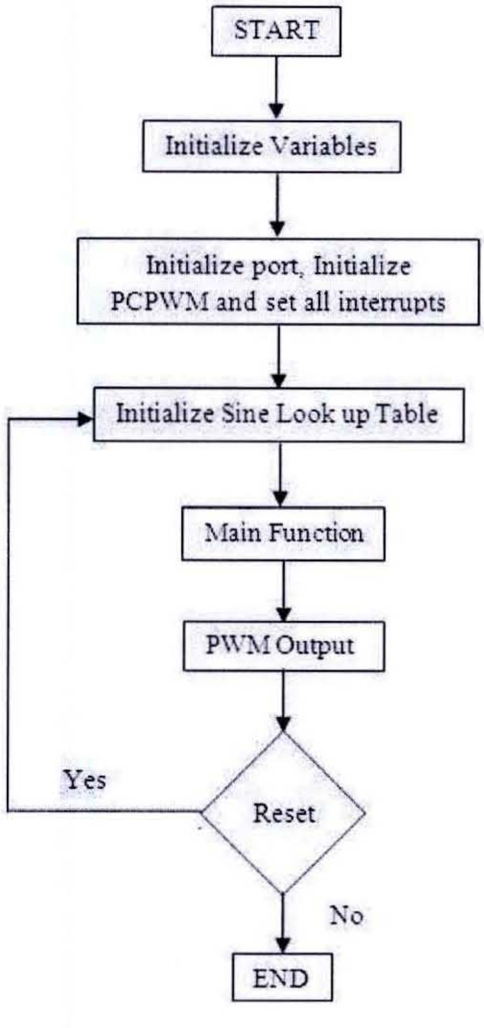

Figure 23: Algorithm

The Flow Chart shown in the above figure() is the algorithm for a single phase sinusoidal PWM signal. In this flow chart "initialize variables" means initialize the user defined memory cell, "initialize ports" means definifing the output ports. Then comes theInitialize Sine Look Up table which stores sampling value sine wave. The these values will be given to the main function and thus PMW output is achieved and then it checks the logic if the loop ihas finished or not. If yes, it goes to the sine look up table and daes the same functions, and orlse END .

4.6 Coding Of Sinusoid PWM

```
#include<avr/io.h>
#include<util/delay.h>
#include<avr/interrupt.h>

#define set_FORWARD TCCR1A = 0x81
#define set_REVERSE TCCR1A |= (1<<COM1B1)
#define F_CPU 8000000UL

#include <avr/pgmspace.h>

const uint8_t  sinewave1[] PROGMEM= //256 values
{
0x80,0x83,0x86,0x89,0x8c,0x8f,0x92,0x95,0x98,0x9c,0x9f,0xa2,0xa5,0xa8,0xab,0xae,
0xb0,0xb3,0xb6,0xb9,0xbc,0xbf,0xc1,0xc4,0xc7,0xc9,0xcc,0xce,0xd1,0xd3,0xd5,0xd8,
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0xff,0xff,0xff,0xff,0xfe,0xfe,0xfd,0xfc,0xfc,0xfb,0xfa,0xf9,0xf8,0xf7,0xf6,0xf5,0xf3,0xf
2,
0xf0,
0xef,0xed,0xec,0xea,0xe8,0xe6,0xe4,0xe2,0xe0,0xde,0xdc,0xda,0xd8,0xd5,0xd3,0xd1,
0xce,0xcc,0xc9,0xc7,0xc4,0xc1,0xbf,0xbc,0xb9,0xb6,0xb3,0xb0,0xae,0xab,0xa8,0xa5,0
xa2,
```

```
0x9f,0x9c,0x98,0x95,0x92,0x8f,0x8c,0x89,0x86,0x83,0x80,0x7c,0x79,0x76,0x73,0x70,0
x6d,

0x6a,0x67,0x63,0x60,0x5d,0x5a,0x57,0x54,0x51,0x4f,0x4c,0x49,0x46,0x43,0x40,0x3e,
0x3b,0x38,0x36,0x33,0x31,0x2e,0x2c,0x2a,0x27,0x25,0x23,0x21,0x1f,0x1d,0x1b,0x19,
0x17,0x15,0x13,0x12,0x10,0x0f,0x0d,0x0c,0x0a,0x09,0x08,0x07,0x06,0x05,0x04,0x03,
0x03,0x02,0x01,0x01,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x01,
0x01,0x02,0x03,0x03,0x04,0x05,0x06,0x07,0x08,0x09,0x0a,0x0c,0x0d,0x0f,0x10,0x12,
0x13,0x15,0x17,0x19,0x1b,0x1d,0x1f,0x21,0x23,0x25,0x27,0x2a,0x2c,0x2e,0x31,0x33,
0x36,0x38,0x3b,0x3e,0x40,0x43,0x46,0x49,

0x4c,0x4f,0x51,0x54,0x57,0x5a,0x5d,0x60,0x63,0x67,0x6a,0x6d,0x70,0x73,0x76,0x79,
0x7c


};


const uint8_t  sinewave[] PROGMEM=

{

0,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,

42,44,46,48,50,52,54,56,58,60,62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92,94,96,98
,

100,102,104,106,108,110,112,114,116,118,120,122,124,126,128,130,132,134,136,138,14
0,142,

144,146,148,150,152,154,156,158,160,162,164,166,168,170,172,174,176,178,180,182,18
4,186,

188,190,192,194,196,198,200,202,204,206,208,210,212,214,216,218,220,222,224,226,22
8,230,

232,234,236,238,240,242,244,246,248,250,252,254,255,254,252,250,248,246,244,242,24
0,238,
```

```
236,234,232,230,228,226,224,222,220,218,216,214,212,210,208,206,204,202,200,198,19
6,194,192,190,188,186,184,182,180,178,176,174,172,170,168,166,164,162,160,158,156,
154,152,150,148,146,144,142,140,138,136,134,132,130,

128,126,124,122,120,118,116,114,112,110,108,106,104,102,100,98,96,94,92,90,88,86,84
,82,

80,78,76,74,72,70,68,66,64,62,60,58,56,54,52,50,48,46,44,42,40,38,36,34,32,30,28,26,24
,

22,20,18,16,14,12,10,8,6,4,2,0

};



void delay_ms(unsigned int ms){


   while(ms){

       _delay_ms(1.000);

       ms--;

       }

}



void delay_us(unsigned int us){


   while(us){

       _delay_us(1.000);
```

```
us--;
}
}

int main()
{

DDRD |= (1<<PD5) | (1<<PD4) ;
    DDRB |= (1<<PB3);

unsigned int i=0;

TCCR1A |= (1<<COM1A1) |    (1<<COM1B1) | (1<<WGM10);// | (1<<WGM11) ;

TCCR1B |= (1<<CS10) ;//| (1<<WGM12) | (1<<WGM13) ;

    TCCR0  |=  (1<<WGM01) | (1<<WGM00) |   (1<<COM01) |   (1<<COM00) |
(1<<CS00) ;//|  (1<<COM00);

while(1){

  i=0;
```

```
// set_FORWARD;
 //  set_REVERSE;

  while(i<256)
  {
   OCR1A=pgm_read_byte(&sinewave[i]);
            OCR1B=0;

            i++;

   _delay_us(10);
  }
            i=0;
             while(i<256)
  {
```

```
    OCR1B=pgm_read_byte(&sinewave[i]);
            OCR1A=0;
            i++;

    _delay_us(10);
    }
  }

}
```

4.7 Implementation of Sinusoidal PWM in Microcontroller:

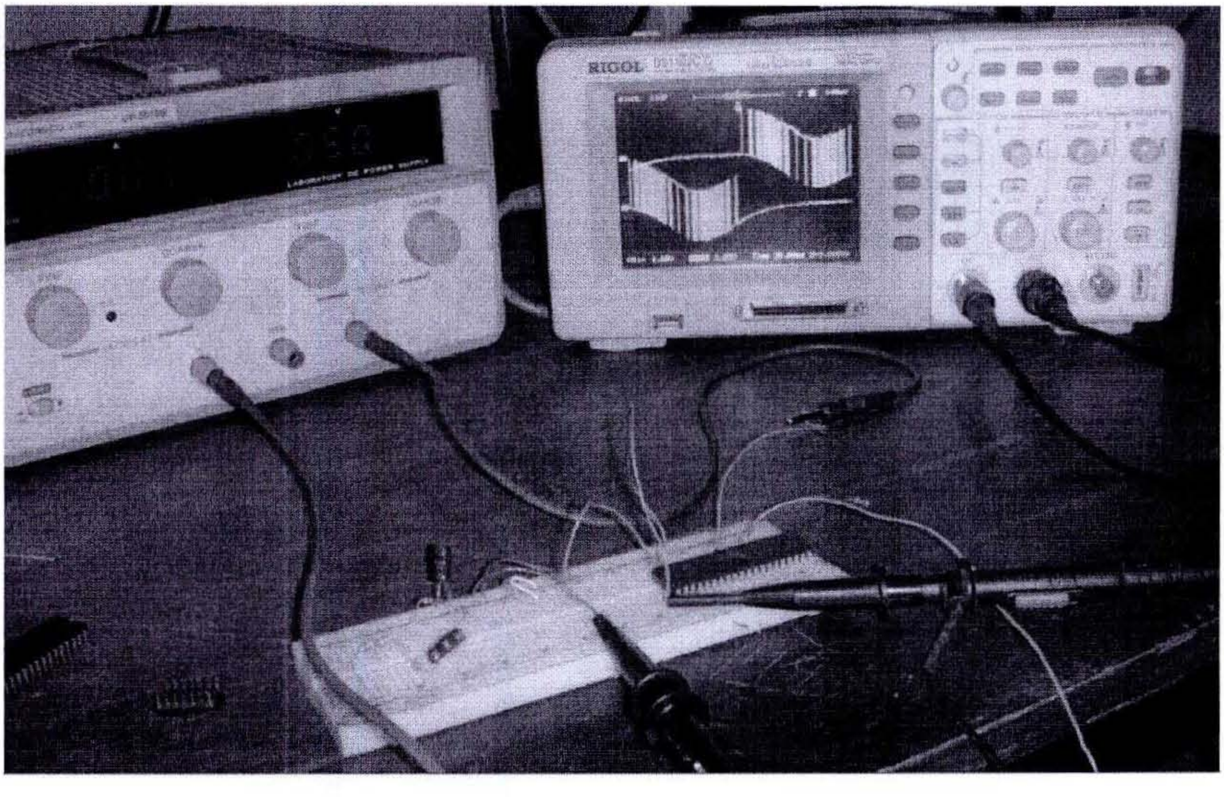

Figure 24: Implementation of Microcontroller Control circuit

The program was downloaded into the ATmega32 microcontroller using AVRstudio4.Then it was operated using 5V DC power supply at pin 10 and pin 11 was grounded . The outputs were taken from PIN 19 and PIN 18 which were connected to digital oscilloscope and the outputs were simultaneously taken using both channels.

4.8 Results:

The output of the Atmega32 microcontroller was observed using oscilloscope. Figure () shows the output of PIN18 in channel 2, and Output of PIN19 in Channel 1. Its observed that both the channel shows a half cycle sinusoidal PWM with a phase shit of π, that is when channel 2 is on channel 1 is off and vice versa.

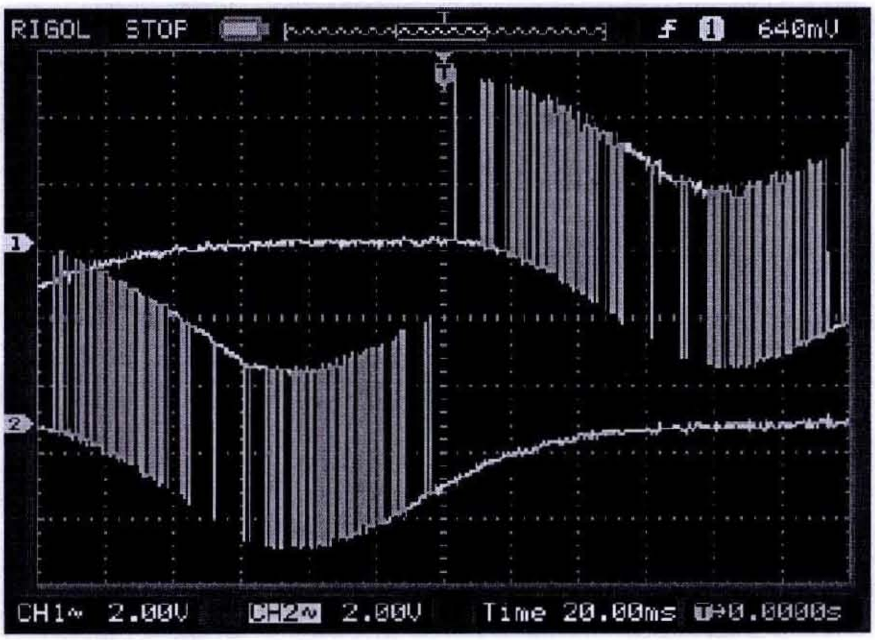

Figure 25: Output of Sinusoidal PWM

4.9 Difficulties:

There was a noise in the signal which led to a floating Signals as shown in Figure ()

4.10 Block Diagram Of Microcontrller Based Inverter:

The figure () shows the block diagram of a Microcontroller based pure sine wave inverter. Clock pulses are generated using crystall oscillator and is given to the microcontroller. Battery start/ stop reset button tells the microcontroller when to turn ON the inverter and when OFF. Two types of SPWM is produced shown in Figure() which are fed into switching Mosfets which switshes the polarity to the transformer. And then a a low pass filter is used to get a pure sine wave at the output.

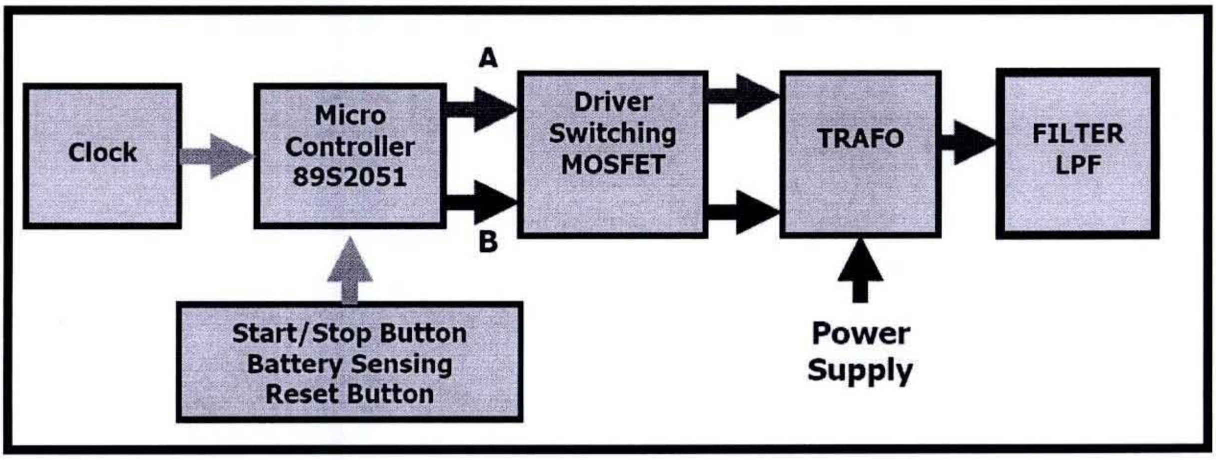

Figure 26: Block Diagram of Mocrocontroller based inverter

4.11 Future Works:

There are still loads of tasks left to impliment the microcontroller based inverter. The two Sinusoidal PWM signals shown in figure() will be fed to MOSFET switching and obser if the MOFTEF can switch its polarity so fast. If the bipolar PWM is achieved, then a LC filter will be designed to eliminate the higher carrier in SPWM to get pure sine wave. Then both type of Inverters using differter topology can be compared.

CHAPTER V

5.1 Conclusion

The basic goal of this thesis has been achieved, which is the conversion of DC voltage to 60 HZ AC voltage. Both Topologies, that is analog control circuit and microcontroller based controll circuit , were implemented and studied and thus the microcontroller based inverter will be implemented in future.

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