International Journal of Innovations in Engineering and Technology (IJIET)

http://dx.doi.org/10.21172/ijiet.83.033

Hardware Implementation of Speed Control Of Single Phase Induction Motor Fed From Solar Inverter By Using Microcontroller

R.Madhusudana Rao
Assistant Professor, Electrical and Electronics Department
V R Siddhartha Engineering College, Vijayawada, AP, India.

S. N. V. S. K. Chaitanya
Assistant Professor, Electrical and Electronics Department
V R Siddhartha Engineering College, Vijayawada, AP, India.

ABSTRACT:Induction motors are widely used in many industrial and home appliances because of their low cost and rugged construction. Most of the applications require variable speed drives. This paper presents the Speed Control of Induction Motor fed from solar inverter by using micro controller. In this paper Solar Inverter is designed and the output of the solar inverter is fed to the Induction Motor drive. A microcontroller is used to generate the required gate pulses for the operation of the solar inverter. Out of the several methods of speed control of an induction motor such as pole changing, frequency variation, variable rotor resistance, variable stator voltage, constant V/f control, slip recovery method etc, the controller gives accurate results. The supply voltage to induction motor is varied by varying the gate pulse width from microcontroller. Thus results in control over the speed of induction motor.

Keywords: Solar panel, Boost Converter, Inverter, Microcontroller and Induction motor.

I. INTRODUCTION

As the available of fossil fuel declines, there is need to find alternate energy sources, of the many sources, solar energy available in abundance and renewable is the ultimate source of all known forms of energy. It is clear, clean, safe, does not pollute the environment and thus will be an extremely viable alternative days to come. One way to utilize the solar energy is to generate electricity directly from the sunlight by photovoltaic conversion. Since photovoltaic modules have now become extensively available in the country.In this paper we designed the system to control the speed of the induction motor. For this purpose solar energy is used to drive the motor through 12V battery. Here the solar energy is used to charge the battery, and again the required 230V AC to drive the motor is generated from 12V DC source using pulse width modulation (PWM) inverter. Varying the supply voltage can vary the speed of the motor linearly from minimum to maximum. The effective operation of induction motor is based on the choice of suitable converter inverter system i.e., fed to induction motor. Converters like Buck, Boost and Buck-Boost converters are popularly used for photovoltaic systems.

II. BLOCK DIAGRAM

Whenever there is light radiation on the panel due to Photo voltaic effect the solar panels generate direct current which is then stored in rechargeable batteries. The battery set up in turn will serve as a source for the Inverter and the boost converter step up the voltage to the desired output by adjusting the duty cycle, which is fed to the inverter which in turn generates alternating current. And further increment of voltage is obtained by using Step up transformer to have required output voltage generation for driving an induction motor. Here we employed the stator voltage control by means of PWM technique for the Achievement of variable speed drive. Thus the voltage is varied by varying firing angle from the microcontroller according to speed requirement.

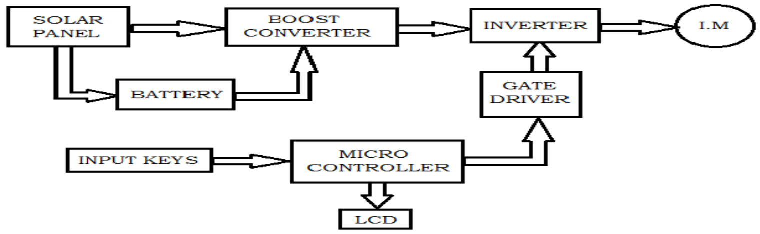


Fig 1 : Block Diagram.

http://dx.doi.org/10.21172/ijiet.83.033

III. BOOST CONVERTER:

Boost converter is a switch mode dc to dc converter in which output voltage is greater than the input voltage as shown in figure 2.It is also called as step up chopper.. During the off period switch opens and the inductor discharges across the load. 12dc voltage is stepped to 24v dc by using boost converter which is fed to inverter circuit for ac voltage generation for driving an induction motor.

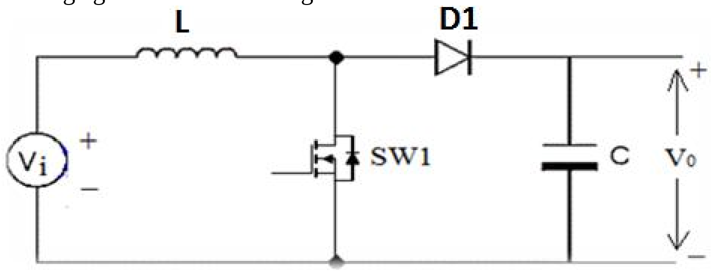


Fig 2 : Connection Diagram Of Boost Converter.

IV. SPEED CONTROL FROM STATOR SIDE:

Controlling supply voltage:

The torque produced by running three phase induction motor is given by

$$T \propto \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2}$$

In low slip region $(sX)^2$ is very small as compared to R_2.So, it can be neglected. Then torque becomes

$$T \propto \frac{sE_2^2}{R_2}$$

Since rotor resistance, R_2 is constant so the equation of torque further reduces to

$$T \propto sE_2^2$$

We know that rotor induced EMF $E_2 \propto$ V. So, T $\propto$ sV_2.

From the equation it is clear that if we decrease supply voltage torque will also decrease. But for supplying the same load, the torque must remain the same and it is possible only if we increase the slip and if slip increases the motor will run at reduced speed. This method of speed control is rarely used because small change in speed requires large reduction in voltage, and hence the current drawn by the motor increases, which cause over heating of induction motor.

V. GATE DRIVE FOR MOSFETs

OPTO COUPLER:

An opto-coupler is a component that transfers electrical signals between two isolated circuits by using light. It transforms useful input signal into light, sends it across the dielectric channel, captures light on the output side and transforms it back into electric signal. Unlike transformers, which pass energy in both directions with very low losses, opto-couplers are unidirectional and they cannot transmit power.

The opto-coupler applications in the circuit are:

1. Monitor high voltage.
2. Output voltage sampling for regulation.
3. Ground isolation.

The opto-coupler used in this circuit is TLP250.

http://dx.doi.org/10.21172/ijiet.83.033

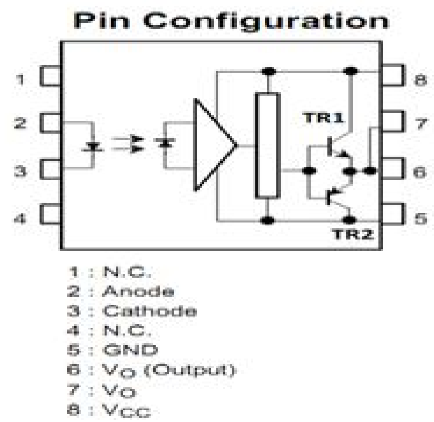


Fig 3: Opto-Coupler and It's Internal Circuit

VI. H-BRIDGE INVERTER:

The device pair A_+-B_- and B_+-A_- is switched alternatively. Only two MOSFET are able to switch ON and OFF at the same time. The driver circuit fed to the triggering pulses for four MOSFET's it will turn ON and OFF continuously. By controlling different switches in the bridge, a positive, negative, or zero potential voltage can be placed across a load. The H-Bridge configuration implemented using four MOSFET IRF840 N channel.

The Pulse Width Modulation (PWM) is a technique which is characterized by the generation of constant amplitude pulse by modulating the pulse duration by modulating the duty cycle. Analog PWM control requires the generation of both reference and carrier signals that are feed into the comparator and based on some logical output, the final output is generated.

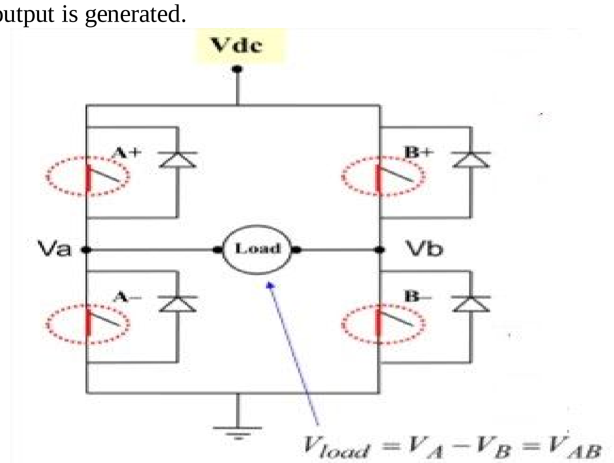


Fig 4 : Circuit Operation.

VII. INVERTER WITH GATE DRIVER CIRCUIT

http://dx.doi.org/10.21172/ijiet.83.033

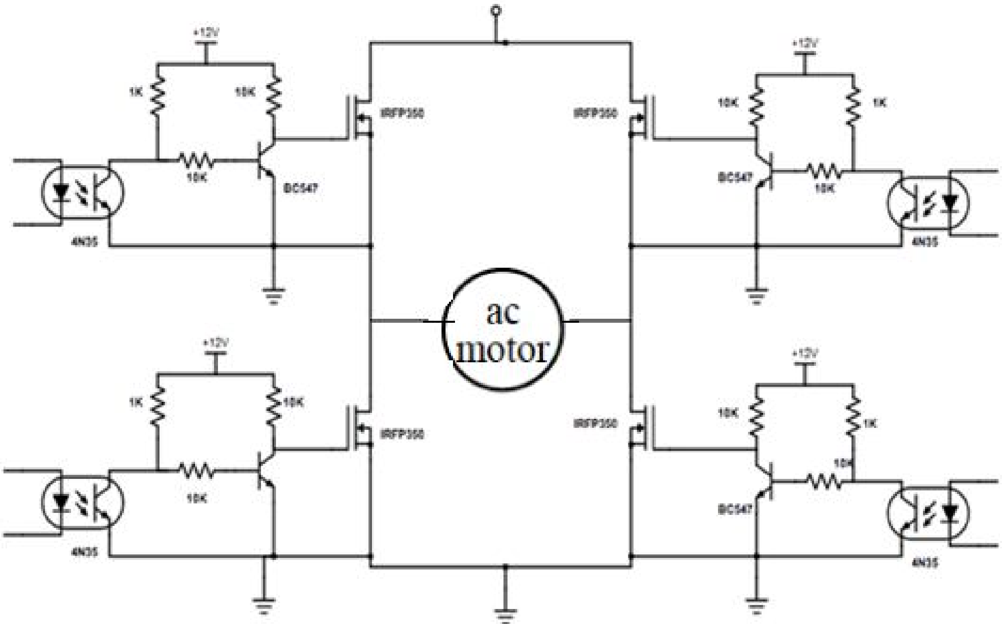


Fig 5: MOSFET H-Bridge.

VIII. COMPONENTS

S.NO:	COMPONENTS	RATINGS	QTY
I	SOLAR CIRCUIT		
1.	Solar panel	5W,12V	1
2.	Battery	7Ah,12V	1
3.	Boost converter	0-30V(INPUT), 0-55V(OUTPUT), 3A	1
II	INVERTER		
1.	MOSFET (IRF-350)	400V,3A	4
2.	Opto-coupler(TLP-250)	-	4
3.	Capacitors	16V,10uF	4
4.	Resistors	1k ohms	4
III	RECTIFIERS		
1.	Transformer	230/12-0-12V 500mA	4
2.	Bridge rectifier IC	-	4
3.	Capacitors	220uF	8
4.	Capacitors	2200uF	8
5.	Voltage regulators	7812,7912	8
6.	LED’s (red,green)	-	8

http://dx.doi.org/10.21172/ijiet.83.033

7.	Resistors	1k ohm	8
IV	STEP-UP TRANSFORMER	30/230V	1
V	INDUCTION MOTOR	220-240V,0.14A	1
VI	MC-8051(AT89S52)		
1.	Capacitors	33pF,60V	2
2.	Crystal oscillator	11.0592MHz	1
3.	Resistors		
4.	Capacitor		
5.	Push button		
IX	ADC (0804)		
1.	Variable resistor (POT)	10k ohms	2
2.	Resistor	10k ohm	1
3.	Capacitor	150pF	1
X	LCD 16x2	-	1

Table 1: Components.

IX. HARDWARE CIRCUIT:

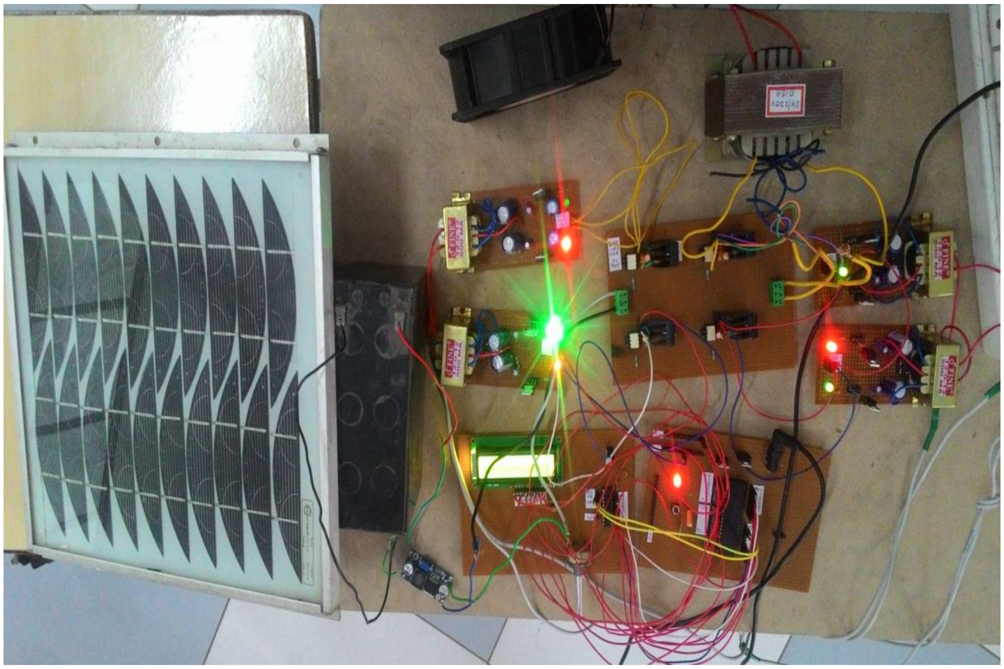


Fig 6: Hardware.

X. SOFTWARE CODE

ORG 0000H

http://dx.doi.org/10.21172/ijiet.83.033

```
                    JMP MAIN
                    ORG 000BH
                    SJMP INTRRUPT

      INTRRUPT:      PUSH 0D0H
                     CLR PSW.3
                    JB P3.0,POSITIVE_CYCLE
                    SJMP NEGATIVE_CYCLE

  POSITIVE_CYCLE:   JB P3.1 ,T1OFF_DELAY
                    LJMP T1ON_DELAY
  NEGATIVE_CYCLE:   JB P3.1,T2OFF_DELAY
                    LJMP T2ON_DELAY

  T1OFF_DELAY:      CLR TR0
                    SETB P3.6                 ; OFF B+
                    MOV R1,#60
        BACK12:     DJNZ R1,BACK12
                    SETB P3.3                 ; OFF A+
                    MOV R1,#60
         BACK13:    DJNZ R1,BACK13
                    MOV TL0,R4
                    MOV TH0,R5
                    SETB P3.0
                    CLR P3.1
                    SETB TR0
                    POP 0D0H

                    RETI
T1ON_DELAY:         CLR TR0
                    CLR P3.3                  ; ON A+
                    MOV R1,#60
         BACK14:    DJNZ R1,BACK14
                    MOV TL0,R6
                    MOV TH0,R7
                    CLR P3.0
                    SETB P3.1
                    SETB TR0
                    POP 0D0H
                    RETI
T2OFF_DELAY:        CLR TR0
                    SETB P3.3                 ; OFF A+
                    MOV R1,#60
         BACK15:    DJNZ R1, BACK15
                    SETB P3.6                 ;OFF B+
                    MOV TL0,R4
                    MOV TH0,R5
                    CLR P3.0
                    CLR P3.1
                    SETB TR0
                    POP 0D0H
                    RETI
T2ON_DELAY:         CLR TR0
                    MOV R1,#60
         BACK16:    DJNZ R1,BACK16
                    CLR P3.6                  ;ON B+
                    MOV TL0,R6
                    MOV TH0,R7
                    SETB P3.0
```

http://dx.doi.org/10.21172/ijiet.83.033

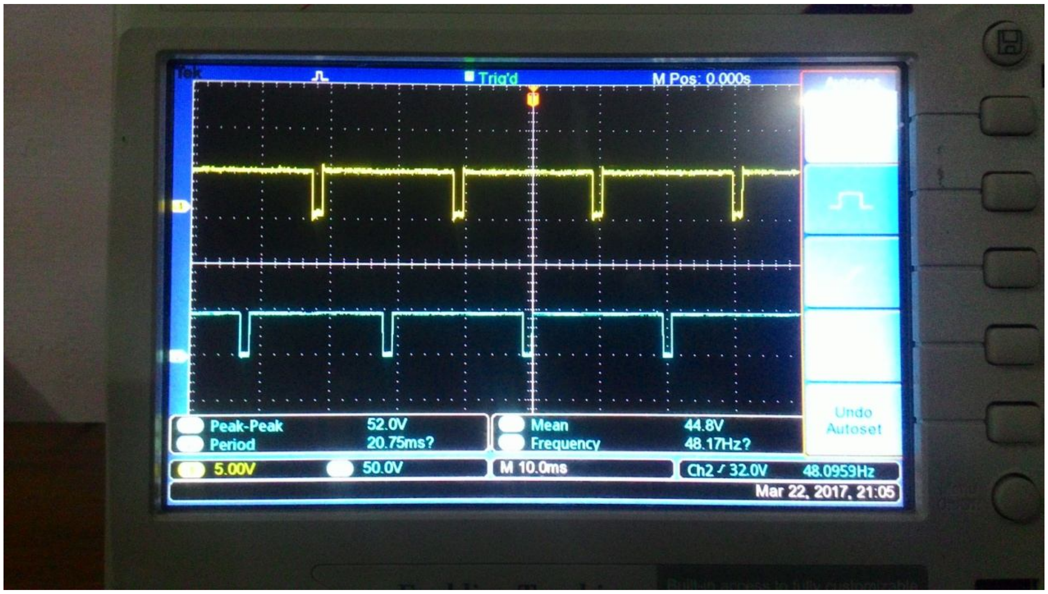
```
                        SETB P3.1
                        ACALL OFF_ONDELAYCAL
                        SETB TR0
                        POP 0D0H
                        RETI

    ORG     0100H
            MAIN:       MOV SP,#30H
                        MOV R4,#00
                        MOV R5,#0DCH
                        MOV R6,#00
                        MOV R7,#0DCH
                        MOV IE,#10000010B
                        MOV TMOD,#11H       ;timer 0,1 both are selected in mode 1
                        MOV TL0,#00H
                        MOV TH0,#0DCH
                        SETB P3.0
                        SETB P3.1
                        SETB TR0
                        MOV  P0,#0FFH   ;make P1 = input to read digital data
                        MOV DPTR,#MYCOM
            C1:         CLR A
                        MOVC A,@A+DPTR
                        ACALL COMNWRT
                        ACALL DELAY
                        JZ ADC               ;jump if accumulator zero
                        INC DPTR
                        SJMP C1
     ADC:               CLR  P2.6            ;WR=0
                        SETB P2.6           ; WR=1 L-to-H to start conversion
    HERE1:              JB   P2.7,HERE1      ; wait for end of conversion
                        CLR  P2.5           ;conversion finished, enable  RD
                        MOV  A,P0           ;read the data
                        SETB P2.5           ;make RD=1 for next round
                        SJMP ADC
OFF_ONDELAYCAL:         MOV A,P0
                        MOV B,#36
                        MUL AB
                        MOV R2,A
                        MOV R3,B
                        CLR C
                        MOV A,#0FFH
                        SUBB A,R2
                        MOV R4,A
                        MOV A,#0FFH
                        SUBB A,R3
                        MOV R5,A
                        CLR C
                        MOV A,#00
                        ADD A,R2
                        MOV R6,A
                        MOV A,#0DCH
                        ADDC A,R3
                        MOV R7,A
                        RET
    END
```

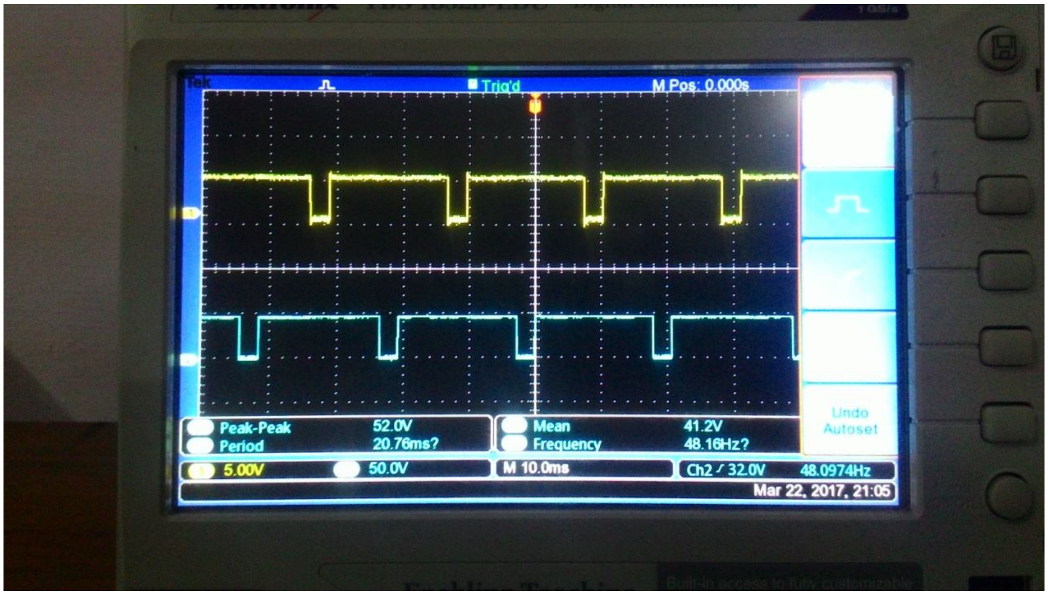
http://dx.doi.org/10.21172/ijiet.83.033

XI. RESULT

The Supply Voltage drive for a single phase induction motor is successfully developed and tested and the photograph of the complete project setup is shown in fig 6 . For different loads and set speeds, voltage of the gate pulses are observed. Digital Storage Oscilloscope (DSO) is used to store gate pulses and inverter output voltage waveforms.The gate pulses are observed for different RPM's and they are shown in figure. The inverter output voltage waveform is observed using DSO and it is shown in below figure.

GATE PULSES AT DIFFERENT FIRING ANGLES :





http://dx.doi.org/10.21172/ijiet.83.033

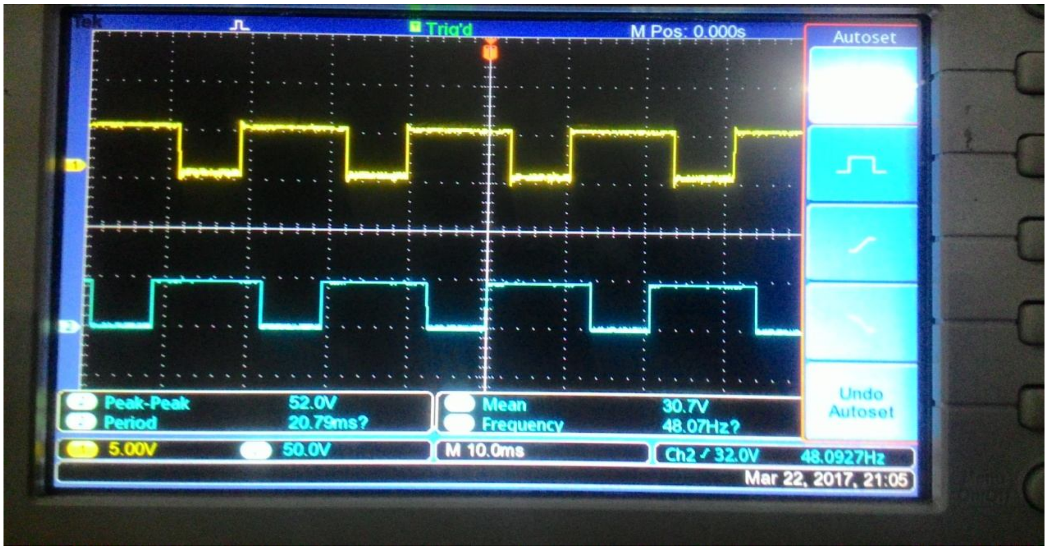


Fig 7 : Gate Pulses.

OUTPUT VOLTAGE OF INVERTER :

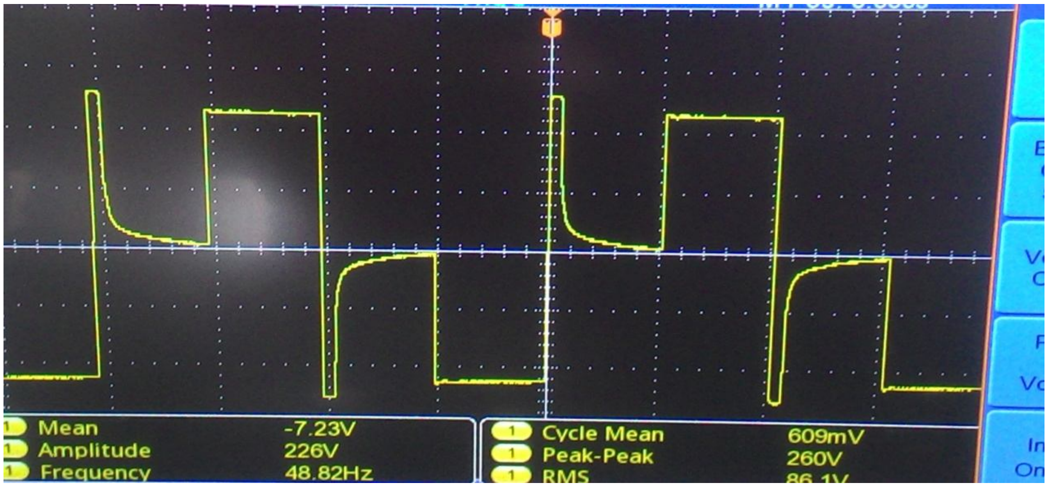


Fig : Output Waveform.

XII. CONCLUSIONS

Supply voltage control provides a simple and cost efficient method for open-loop speed control of 1-phase induction motors. A low-cost supply voltage solution can be implemented using Micro Controller. Additional on-chip resources, like multiple timers and AD0C, allow users to easily implement safety and control features, such as current and voltage protection and configurable acceleration and deceleration time.

1. The main task of this work is to develop and improve the control circuit for a single phase inverter which has been implemented using microcontroller.
2. The used method to control the inverter switch is the SPWM technique. This method is superior to other methods because it improves the quality of the output waveform.

REFERENCES

[1]. Hardware Implementation of a Single Phase Inverter, International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 8- August 2013 by G. Swapnn, V.HimaBindu, M.Chakravarthy, P.M.Sarma.

http://dx.doi.org/10.21172/ijiet.83.033

[2]. Roberto Gonzalez, Jesus Lopez, Pablo Sanchis and Luis Marroyo, Transformerless Inverter for Single-Phase Photovoltaic Systems, IEEE TRANSACTONS ON POWER ELECTRONICS, VOL.22 NO.2, MARCH 2007

[3]. Soeren Baekhoej Kjaer, John K. Pedersen,Frede Blaabjerg, A Review of Single-Phase Grid-Connected Inverters for Photovoltaic Modules, IEEE TRANSECTIONS ON INDUSTRY APPLICATION VOL. 41 NO.5 SEPTEMBER/OCTOBER2005

[4]. Joanne Hui, Alireza Bakhshai, and Praveen K. Jain, “A Hybrid Wind-Solar Energy System: A New Rectifier Stage Topology “, in Applied Power Electronics Conference and Exposition (APEC), 2010 Twenty-Fifth Annual IEEE, pp 156-161, 21-25 Feb. 2010

[5]. J.-P. Lee, B.-D. Min, T.-J. Kim, D.-W. Yoo, and J.-Y. Yoo, “Design and control of novel topology for photovoltaic dc/dc converter with high efficiency under wide load ranges,” Journel of Power Electron. ,Vol. 9,No. 2,pp. 300–307, Mar. 2009