Hardware Implementation of a Single Phase Inverter

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*Abstract---*Three Phase Inverters find various applications in variable speed a.c Induction Motors. The PS21765 Inverter module reduces the complexity of the circuit. It is designed to incorporate the inverter circuit using IGBTs, drivers and Protection circuitry. It also reduces the overall Inverter size and design time for driving small Induction Motors. The application circuit is designed using EAGLE PCB software which further simplifies the complexity of the entire circuit. The Inverter is operated by using Arduino which generates PWM pulses. As Arduino does not accept negative signals, an offset circuit is designed to shift the Sine wave and is given as input to the Arduino kit. The use of Arduino makes the process of using electronics in multidisciplinary projects more accessible. It is well suited for processing control parameters such as speed of an Induction Motor.

Keywords- IPM Module, PCB, Arduino, Induction Motor

Introduction:

I.   PS21765

PS21765 has an inbuilt Voltage source Inverter with Driver circuit, gate drive protection, short circuit protection. The operating frequency of PS21765 is 20 kHz and is capable of withstanding 600V, 20Amp. The application circuit of this IC also consists of Voltage sensing circuit.

Use of 5th generation IGBTs, DIP packaging allow the designer to reduce inverter size and overall design time.

DIP-IPMs are intelligent power modules that integrate power devices, drivers, and protection circuitry in an ultra-compact dual-in-line transfer-mold package for use in driving small three phase motors.

These IC's are available in compact packages with single power supply. They can be directly connected to the CPU. They find applications in Refrigerators, Air Conditioners, Small Servo Motors and Small Motor Control. Power chips, drive and short circuit protection circuits are integrated in the module, which makes it easy for AC100-200V class low power motor inverter control. The application circuit of PS21765 IPM is designed using Eagle software.

II.   Arduino

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It is intended for designers and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling motors, lights and other actuators.Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, though new model has been designed around a 32-bit Atmel ARM.Arduino programs are written in C or C++.The Arduino IDE comes with a softwarelibrary called "Wiring" from the original Wiring project, which makes many common20input/output operations much easier. (PWM) can be implemented on The Arduino in several ways. The main aim of the program is to create PWM pulses without actual comparison of thereference sinusoidal wave and the triangular wave. The output is therefore obtained from thedigital pins instead of PWM pin. By changing the parameters in the program the duty cycle ofthe output wave form can be changed. The compliment waveform of the obtained PWMoutput is obtained by employing the NOT logic in The Arduino program. It is such that whena logical high is obtained on a pin a logical LOW is obtained on the other pin.
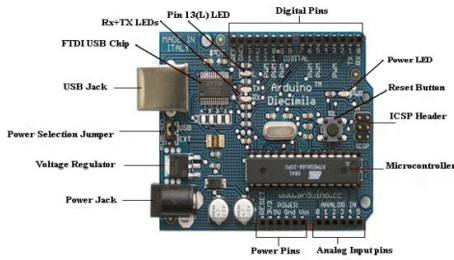

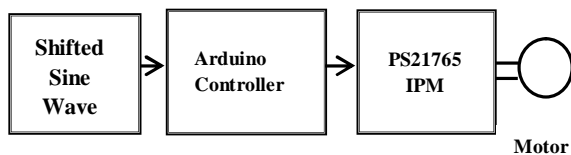Fig.1Arduino kit

III. Block Diagram

Fig.2Block Diagram

IV. Eagle PCB Designing

Printed Circuit Boards are designed using EAGLE (Easily Applicable Graphical User Interface) software. It is a graphical user interface wherein we arrange the components and connect them in a graphical method.Most of the components are readily available in the Eagle library. If any particular component is not available in the Eagle library, it has to be designed and added into the Eagle library. LM2574 – a Voltage Regulator and PS21765- Intelligent Power Module were designed using their datasheets and incorporated into the Eagle library.
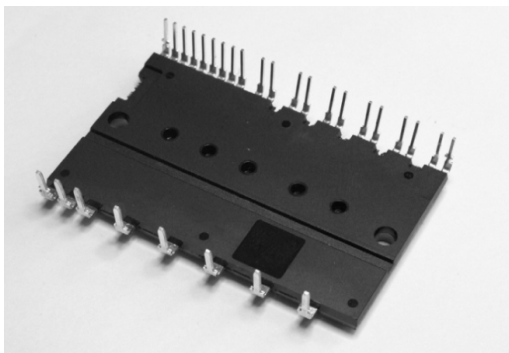

Fig.3 Device PS21765

A PCB is designed to obtain the Three Phase voltages which are given to the Induction motor to control the speed. Designing a PCB mainly consists of:

1) Schematic Diagram
2) Board

In the Schematic Diagram, the entire circuit is designed by placing the components and connecting them. Names and values are assigned to the individual components depending upon the circuit requirements. The Board can be obtained from the schematic diagram. Care is taken such that there are no overlaps during routing which may lead to short circuiting the components. This may damage the whole circuit. In case overlaps are unavoidable, then a double-layer routing is used. But this will increase the cost of the board. Later Gerber files are created for the PCB which are used for printing the board. This completes the design of the PCB.
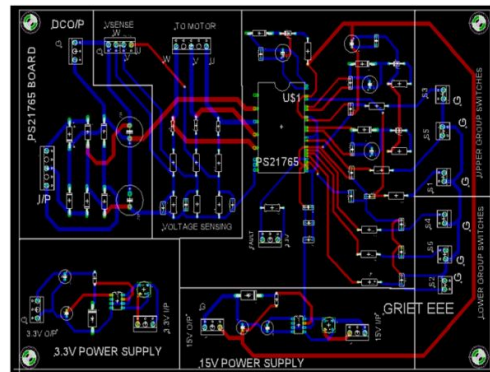

Fig: 4 PCB Layout of PS21765

The designed board is printed and components are soldered according to the circuit. It is then tested.

Hardware setup of PS21765:

Fig.5Printed PCB with Soldered components

V. Interfacing of Arduinowith PS21765 inverter module:

Arduino does not recognize negative voltage values. Offset circuit is designed to eliminate negative voltage in the analog signal. The reference sinusoidal signal is obtained from the grid and is stepped down to lower magnitude by using a suitable step-down transformer.The voltage levels are brought down to the range of Arduino working voltage and are given as the input to The Arduino kit.Output pulses of the drive circuit are given to the gates of IGBT's.

The output of the offset circuit is given as the input to the analogue input pin (A0) of Arduino. The program t is written and is dumped into the Arduino kit.The output of the offset circuit is given to the A0 (Analog input) of the kit. The Arduino is programmed such that the PWM pulses are obtained at the digital pins D12 and D13.

The main aim of the program is to create PWM pulses without actual comparison of the reference sinusoidal wave and the triangular wave. The output is therefore obtained from the digital pins instead of PWM pin. By changing the parameters in the program the duty cycle of the output wave form can be changed. The compliment waveform of the obtained PWM output is obtained by employing the NOT logic in The Arduino program. It is such that when a logical high is obtained on a pin a logical LOW is obtained on the other pin. This output is given to the gate terminals of the IGBTs present in the Inverter Module and the Inverter output is obtained as shown in the fig 9. To get sinusoidal output filter circuit is used as shown below.
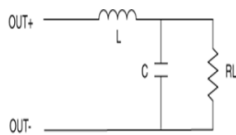

Fig.6 Filter connected at the Inverter output
L= 20mH, C= 470µf, R_l = 12KΩ

VI. Hardware setup showing interface of Arduinowith PS21765 Intelligent module

Fig.7Interfacing of Arduinowith PS21765 Intelligent Module

Interface of Arduino with the Inverter Module:
Table 1

S. No	Arduino Digital output	Connection to the IPM
1.	D12	S1, S6
2.	D13	S3, S2

VII. Outputs

The outputs are captured in the CRO and are as shown below for different frequencies.

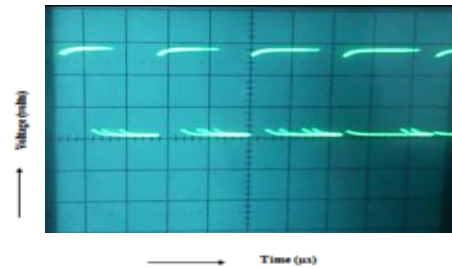**i) PWM pulses obtained from Arduino:**
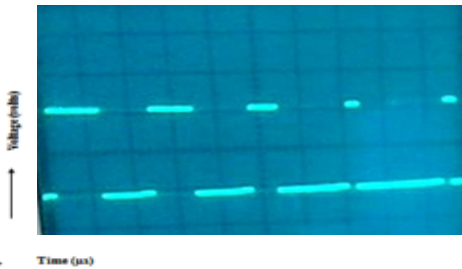

Fig.8PWM pulses

ii) Waveforms obtained from Inverter

Fig.9 Output at the inverter terminals

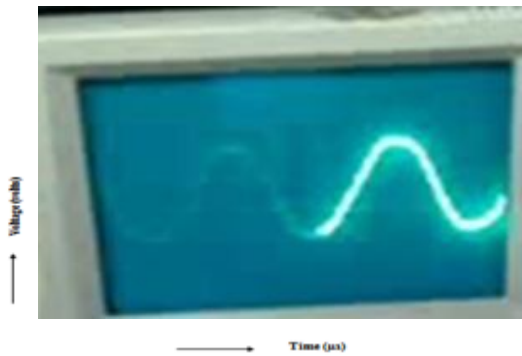**iii) 1Phase AC Output obtained after filter is Employed:**

Fig.10 Load current Waveforms

VIII. Conclusions

The PS21765 intelligent module reduced the complexity of the hardware by incorporatingdriver and protection circuitry. Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible. Arduino is used to generate the PWM pulses which are given to the intelligent module with proper protection circuitry.

This project can be further extended to work with a 230V supply and run a high rating Induction Motor. The designed PS21765 board can be used for different applications.

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