Single Phase Inverter using PIC Controller

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ABSTRACT

The aim of this project is to design and implement a single phase inverter which can convert DC voltage to AC voltage at high efficiency and low cost. Power inverters, which convert solar-cell DC into domestic-use AC, are one of the key technologies for delivering efficient AC power. A low voltage DC source is inverted into a high voltage AC source in a two-step process. First transforming the DC source to AC at low voltage levels and then stepping up the AC signal using a transformer. To deliver such performance, the power inverters are driven by high-performance PIC 16F877 microcontroller unit that can achieve high-level inverter control, and therefore this microcontroller is the heart of the system and controls entire system. The PIC microcontroller is programmed using embedded c compiler and it generate sine pulse width modulated (SPWM) pulses which are used to drive H-bridge. The design is essentially focused upon low power electronic appliances. To build the design it is first mathematically modeled then is simulated in MATLAB and finally the results are practically verified.

Keywords: - *PIC controller, Transformer, H-Bridge etc.*

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1. INTRODUCTION

1.1 Problem Definition:

Nowadays, the world needs the electricity to be increased. The power rating inverter is required to operate electrical and electronic appliances smoothly. Most of the available commercially uninterruptible power supplies (UPSs) are actually square wave inverters or quasi sine wave inverters. Electronic devices, managed by these inverters will be damaged due to the contents of the harmonics. For getting a pure sine wave, the SPWM switching technique is applied. This method involves a certain pattern of switching used in the DC-to-AC inverter bridges Electronic devices run on AC power, however, batteries and some forms of power generation produce a DC voltage so it is necessary to convert the voltage into a source that devices can use.

1.2 Solution and Effect

Electronic devices run by this inverter will damage due to harmonic contents. Available sine wave inverters are expensive and their output is not so good. For getting pure sine wave we've to apply sinusoidal pulse width modulation (SPWM) technique. This technique has been the main choice in power electronics because of its simplicity and it is the mostly used method in inverter application. To generate this signal, triangular wave is used as a carrier signal is compared with sinusoidal wave at desired frequency. Advances in microcontroller technology have made it possible to perform functions that were previously done by analog electronic components. With multitasking capability, microcontrollers today are able to perform functions like comparator, analog to digital conversion (ADC), setting input/output (I/O), counters/timer.

1.3 Proposed Work

The proposed approach is to replace the conventional method with the use of microcontroller. In this project PIC16F877 microcontroller is used. It has low cost and reduces the complexity of the circuit for the single phase full bridge inverter .The focus of this report is on the design and prototype testing of a DC to AC inverter which efficiently transforms a DC voltage source to a high voltage AC source similar to the power delivered through an electrical outlet (230V, 50Hz) with a power rating of approximately 40W.

The block diagram for "single Phase Inverter using PIC controller" is given in fig (1). The 12V battery supply is given to regulator 7805.This regulator maintains 5V constant DC supply which is further given to the PIC16F877A controller. The PIC controller gives the gate pulses to the bridge circuit i.e. H-Bridge. When Ac supply is available then it is given to the bridge rectifier through the transformer. The rectifier converts the AC supply came from transformer into the DC supply. The output of rectifier is stepped down to 12V with the help of step down transformer. This 12V is utilized for battery storage as well as for regulator supply. The H-Bridge inverter gives AC voltage. The output of H-Bridge is then stepped up to 230V with the help of step up transformer.

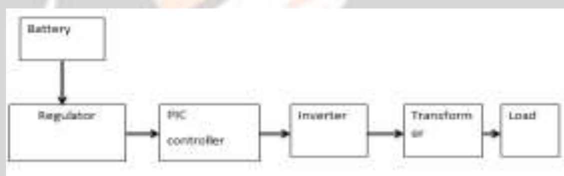


Fig 1. Block diagram

2. System Development

2.1 Hardware Implementation

Hardware model is as shown in below figure. A stable 5 volts to power the microcontroller is provided from the output of 7805 IC voltage regulator. The LED connected will light Red to indicate when the inverter is on and switch off when it's not working. The pulse width modulated signal is used to drive the other side of H-bridge. During simulation IR Driver (L2930) is used. The input from the PIC controller is taken to drive high side and low side IGBT respectively.

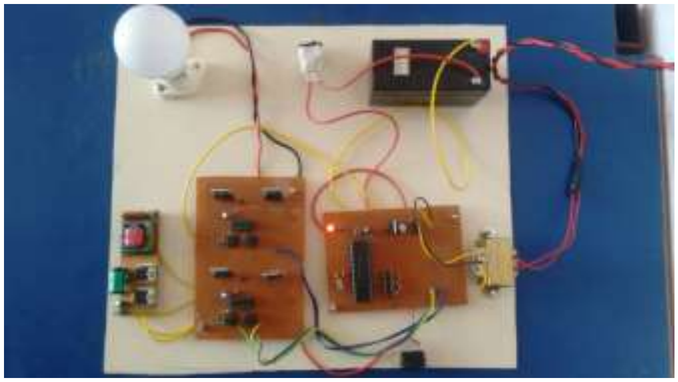
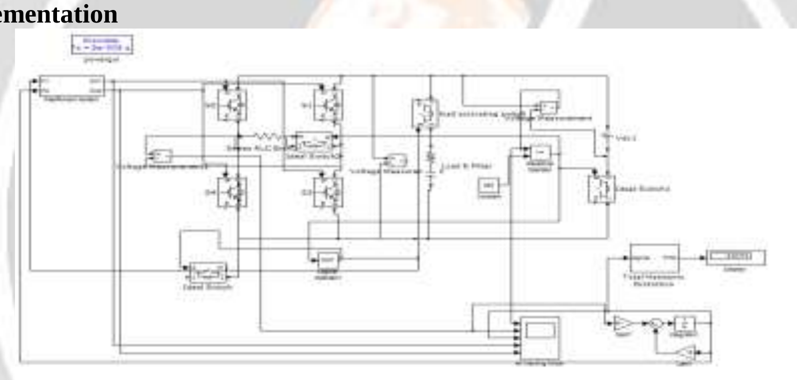


Fig 2: Hardware model

At the H-bridge voltage is provided equivalent to V max of the output RMS voltage needed. For this inverter a 230Vrms is the required. Output of the H-bridge is a pulse width modulated signal and with maximum voltage equal to voltage of H-bridge. This voltage is fed to a low pass passive filter made of inductor, capacitor and resistor. The inductor must be able to pass maximum current rated for the IGBT and capacitor be able to handle the maximum voltage which is equal to the voltage of H-bridge. Across the output terminals of the filter is where we are now supposed to connect load.

2.2 Software Implementation



(Fig 3. simulation diagram)

Simulation of the inverter circuit is carried out using MATLAB R2010.Various blocks of the circuit are interconnected and virtual instruments of the simulator used to observe and analyze results. As shown in fig a solid state h-bridge is built using four switches. When switch S1 and S2 are closed (according to fig 3) and switches S3 and S4 are open a positive voltage will be applied across the load. By closing S3 and S4 switches and opening S1 and S2 switches a reverse voltage will be applied to the load. Using nomenclature above switches S1 and S4 should never be closed at the same time as this will cause a short circuit on between the power supply and ground, potentially damaging the devices or draining the power supply. The same applies to switches S2 and S3. This condition is known as shoot-through. The table below outlines the positions. Note that shoot-through switch positions are omitted. The switches used to implement an H-Bridge can be mechanical or built from solid state transistors. Selection of the proper switches varies greatly.

S1	S2	S3	S4	Vo
ON	ON	OFF	OFF	+Ve
OFF	OFF	ON	ON	-Ve
ON	OFF	ON	OFF	ZERO
OFF	ON	OFF	ON	ZERO

Fig 4: Switching modes

2.3 Hardware Result

The fig shows the output of H-bridge without filter. The output of the inverter is tapped across filter terminals and if proper values of the capacitor and inductor are set the output should be a pure sine wave of 50Hz which is as shown in fig.

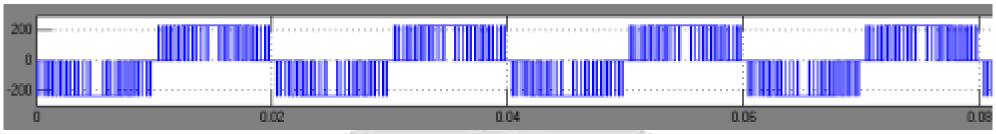


Fig 5

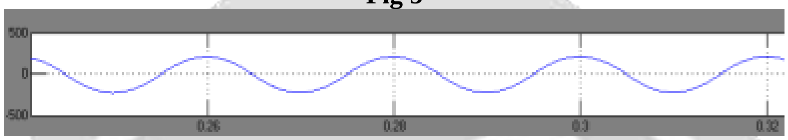


Fig 6

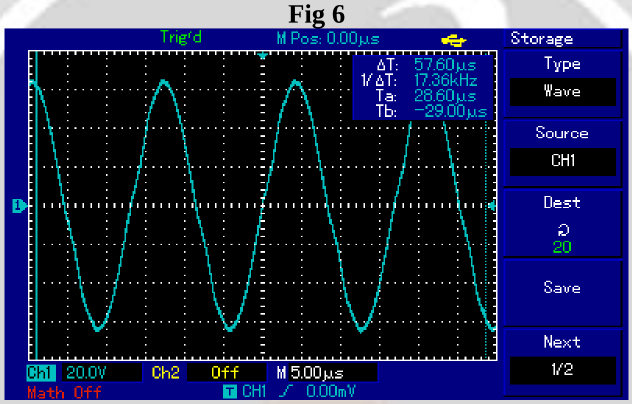


Fig 7: DSO output

Figure (7) shows the output waveform of single Phase inverter.

3. CONCLUSIONS

The objective of the circuit was to invert power from high voltage DC sources. This inverter power output is usable for any load. The fact that we were able to integrate the whole system and achieve a desired output of both the frequency and voltage supplied shows that much of key parts of this project are practically achievable and with required DC voltage a complete working inverter can be achieved.

Some of the important conclusions that can be drawn from this work are:

- Output waveform frequency was found to be satisfactory at 50Hz equivalent of standard Frequency.
- Sine pulse with modulation circuit is much simplified by the use PIC16F877A microcontroller

4. REFERENCES

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