INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 5 ISSUE 6 (2019) PAGES 4518 - 4525
RECEIVED : 15.06.2019 PUBLISHED : 19.12.2019
December 19,2019

DESIGN AND IMPLEMENTATION OF SINGLE PHASE INVERTER

M.MANICKAM,[1] V. GOPI [2]

[1]Lecturer, Department of Electrical and Electronics Engineering,IRT Polytechnic College, Bargur,Tamilnadu.
[2]Design Engineer,SKM Electronics,Thiruattur.

ABSTRACT

A microcontroller based progression technique of yield sine wave with lowest harmonics is designed and implemented in this paper. Design and implementation of a single phase inverter which can mortal DC voltage to AC voltage at high efficiency and low cost. Solar and wind powered electricity generation are being favored nowadays as the world increasingly focuses on environmental concerns. 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 the DC voltage is stepped up using a boost converter to a much higher voltage. This high voltage DC source is then transformed into an AC signal using pulse width modulation. Another method involves first transforming the DC source to AC at low voltage levels and then stepping up the AC signal using a transformer. A transformer however is less efficient and adds to the overall size and cost of a system. The former method is the one, used to implement this proposed method. To deliver such performance, the power inverters is driven by high-performance PIC 16F877A microcontroller units (MCUs) that can achieve high-level inverter control, and therefor this microcontroller is the heart of the system and controls entire system. The microcontroller is programmed using embedded c compiler and in specific mikroC pro to generate sine pulse width modulated (SPWM) pulses which are used to drive H-bridge. By alternate switching switches of two legs of H-bridge alternating 340V DC voltage is converted into 240V Ac voltage. The design is essentially focused upon low power electronic appliances such as personal computers, chargers, television sets. To build the design it is first mathematically modeled then is simulated in Proteus and finally the results are practically verified. The main objective of our proposed technique is to design a low cost, low harmonics voltage source inverter. In our project we used microcontroller to generate 4 KHz pwm switching signal. The design is essentially focused upon low power electronic appliances such as light, fan, chargers, etc. For driving the MOSFET we used as a MOSFET driver. The inverter input is 12VDC and its output is 220VAC across a transformer. The complete design is modeled in embedded software and its output is verified practically.

1. INTRODUCTION

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. Hence a need for power rating inverter to smoothly operate electrical and electronic appliances. Most of the commercially available inverters are actually square wave or quasi square wave inverters. Electronic devices run by this inverter will damage due to harmonic contents [1]. 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 [2]. 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, among others replacing dedicated analog components for each specified tasks, greatly reducing number of component in circuit and thus, lowering component production cost. Flexibility in the design has also been introduced by using microcontroller with capability of flash programming/reprogramming of tasks [3].
This project builds upon the work of another project which mandated to build the DC to DC boost. In this report, it is detailed how the inverter's controls are implemented with a digital approach using a microprocessor for the control system and how effective and efficient a 3-level PWM inverter can be. The inverter device will be able to run more sensitive devices that a modified sine wave may cause damage to such as: laser printers, laptop computers, power tools, digital clocks and medical equipment [1]. This form of AC power also reduces audible noise in devices such as fluorescent lights and runs inductive loads, like motors, faster and quieter due to the low harmonic distortion

2. LITERATURE REVIEW

DIRECT VERSUS ALTERNATING CURRENT

In the world today, there are currently two forms of electrical transmission, Direct Current (DC) and Alternating Current (AC) systems, each with their own advantages and disadvantages. DC power is simply the application of a constant voltage across a load resulting in a constant current [6]. A battery is the most common power source for DC along with several forms of power generation. This is widely used in digital circuitry as it provides constant high and low values which represent the basic 1 and 0 bits used by computers. Thomas Edison, inventor of the light bulb, was the first to transmit electricity commercially using DC power lines. It was not capable of transmission over long distances because the technology did not exist to step-up the voltage along the transmission path over which the power would dissipate. The equation below demonstrates how high voltage is necessary to decrease power loss. $V=IR$
$P=I2*R=V2R$
When the voltage is increased, the current decreases and concurrently the power loss decrease exponentially. Therefore, high voltage transmission decreases power loss. AC power was found to be much more efficient at transmitting power as it alternates between two voltages at a specific frequency, making it easier to either step up or down using a transformer [6]. Today, electrical transmission is based mostly of AC power, supplying homes and businesses with 240V AC power at 50Hz.While DC power is used in many digital applications, AC power also used in many other applications such as in power tools, televisions, radios, medical devices, and lighting. Therefore, it is necessary to have an efficient means of

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 5 ISSUE 6 (2019) PAGES 4518 - 4525
RECEIVED : 15.06.2019 PUBLISHED : 19.12.2019

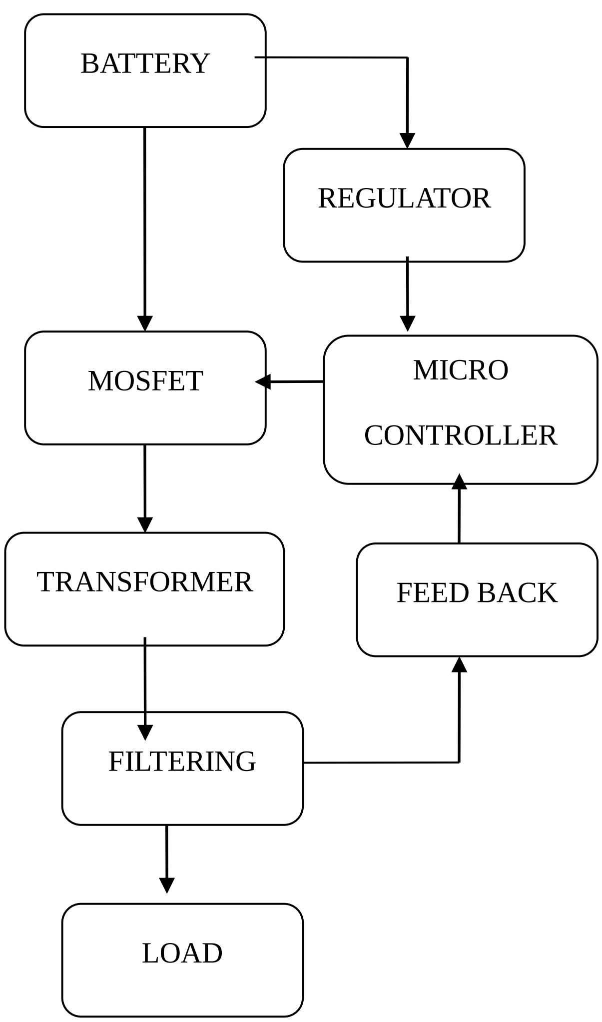
transforming DC to AC and vice versa. Without this ability, people would be restricted to using devices that only works on the power that is supplied to them.

CHOP AND TRANSFORM TECHNIQUE

This type converts the low voltage DC into a low voltage AC first and then converts the low-voltage AC into the wanted AC voltage. The advantages are the low-voltage (=safe) operation, the insulation from the grid after the inverter, the ease with which it makes sine-wave which feeds into the transformer and the most important in many aspects: reliability due

to the low number of semiconductors in the power path. Disadvantage is the slightly lower efficiency of the inverter, typically 92%. Also some hum can be generated by the transformer under load [13, 5].

BLOCK DIAGRAM



3. BLOCK DESCRIPTION

BATTERY

Battery (electricity), an array of electrochemical cells for electricity storage

MICROCONTROLLER

The main component of this inverter is a microcontroller as it is used to generate control signals. The theory of encoding a sine wave with a PWM signal is relatively simple. A sine wave is needed for the reference that will dictate the output, and a triangle wave of higher frequency is needed to sample the reference and actuate the switches.

TRANSFORMER

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils

MOSFET

Operating as switches, each of these components can sustain a blocking voltage of 120 volts in the OFF state, and can conduct a continuous current of 30 amperes in the ON state

FILTER

Filter circuits are used to remove unwanted or undesired frequencies from a signal.

4. CIRCUIT DIAGRAM

MOSFETs turn OFF more slowly than they turn ON. If you attempt to turn on a high side MOSFET at the same time you're turning OFF a low-side MOSFET (or vice versa), you will wind up having both of them turned on at the same time, causing the dreaded "shoot-through" condition, which will lead to damage of the components [5]. For this reason one of the major factor in inverter device is its ability to protect itself from surges that could damage the circuitry. The IR2110 used in this design does not have built-in optoisolators hence it does not provide for "dead time" which is much needed in order to avoid short circuiting of the rail voltage.
Another protection of the circuit needed is MOSFET gate protection, which employed a resistor between “gate” and “source”. It prevents accidental turn on of the MOSFET by external noise usually at startup when the gate is floating. The MOSFET may sometimes turn on with a floating gate because of the internal drain to gate "Miller" capacitance. A gate to source resistor acts as a pull-down to ensure a low level for the MOSFET. The principle of operation is that when the parasitic capacitance of the circuit comes into play. The resistor creates an RC circuit complete with its time constant. And this RC delays the time the circuit switches ON just enough to allow the complementary part of the bridge circuit to switch OFF. typical values of this resistor a 1 kΩ, 10 kΩ, or 100 kΩ depending on the rail voltage of the h bridge.

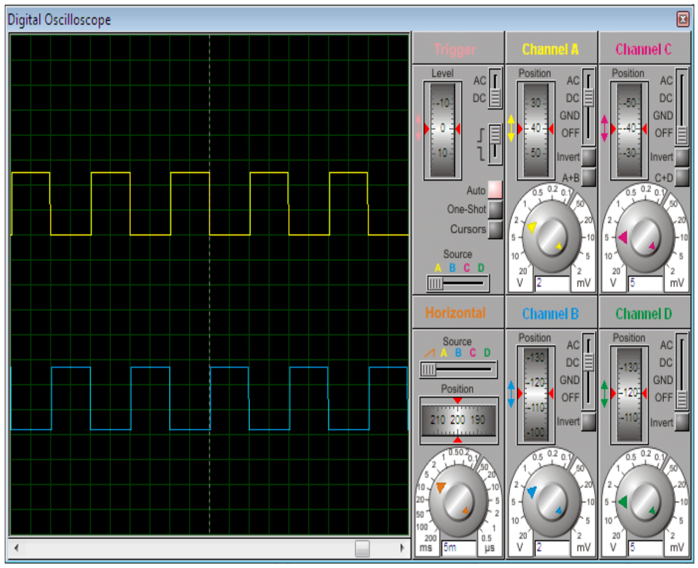
INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 5 ISSUE 6 (2019) PAGES 4518 - 4525
RECEIVED : 15.06.2019 PUBLISHED : 19.12.2019

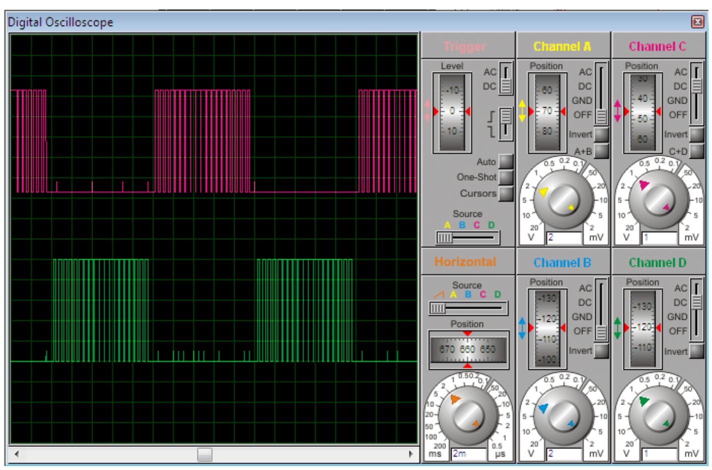
5. SIMULATION RESULTS

MICROCONTROLLER OUTPUTS

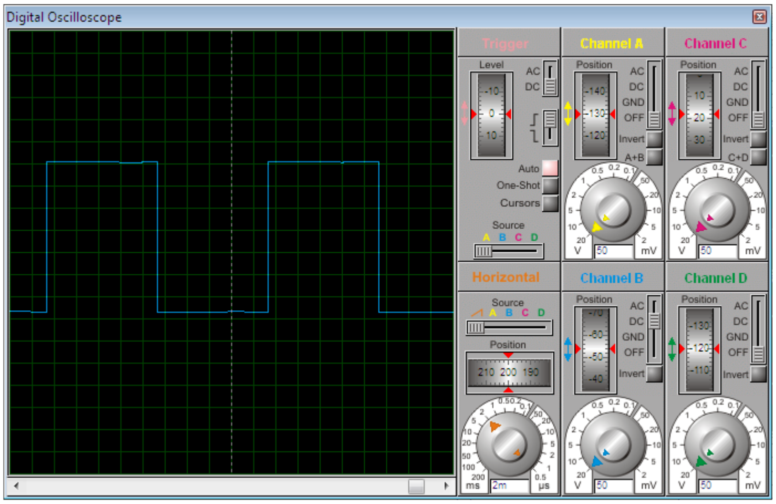
a) 50Hz square waves

As mentioned earlier the output of pin34 and 35 which are used to drive one side of H-bridge should be 180 degrees out of phase and they are as shown

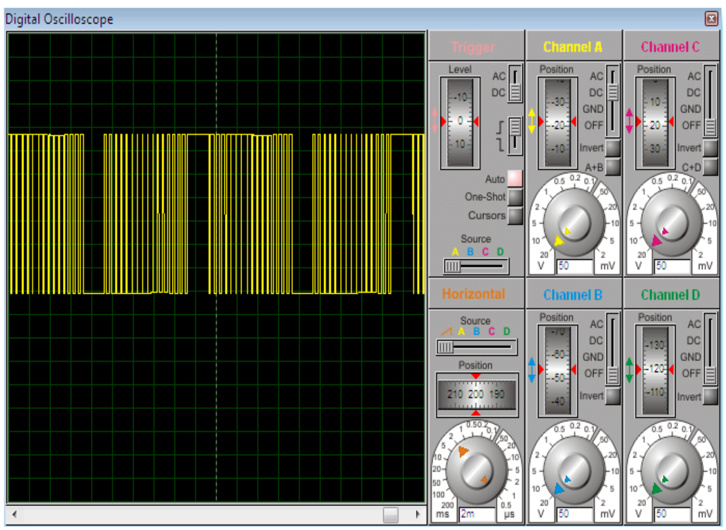




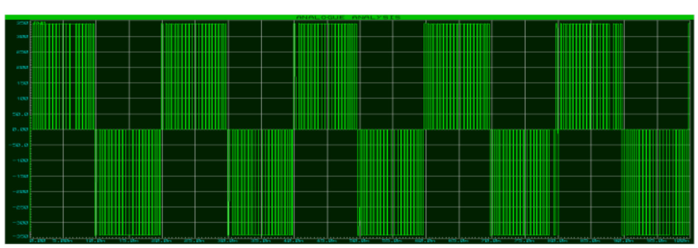
The next simulation step includes the Mosfet driver, IR2110 and the H-bridge. The driver's main purpose is to keep the gate voltage 10V above the source when the MOSFET is enabled. The expected response of the driver is approximately 100ns; meaning that after the MOSFET driver is enabled it will take 100ns to drive the gate voltage to 10V with respect to the source.



(ii) level pulse width modulated voltage from second half of bridge



(iii) Output of the H-bridge without the filter

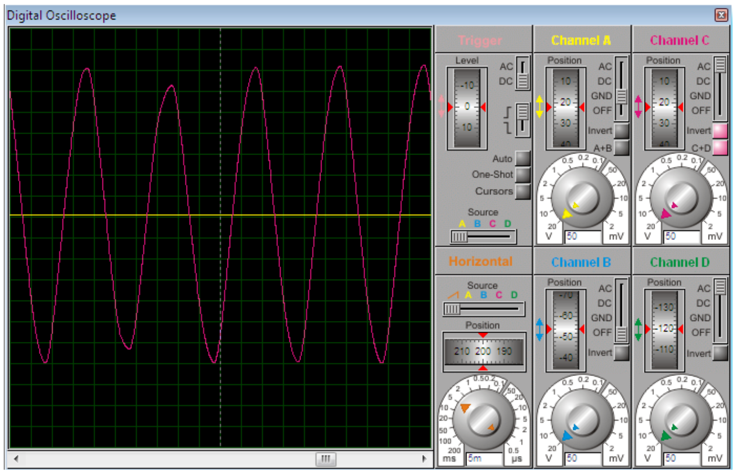


INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 5 ISSUE 6 (2019) PAGES 4518 - 4525
RECEIVED : 15.06.2019 PUBLISHED : 19.12.2019
December 19,2019

FILTER OUTPUT

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 below at no load.

(i) Output at no load



6. EXPERIMENTAL RESULT

After simulation and determination of specifications of the overall design, a prototype is built of the final circuit as shown below in fig 4.8. First a preliminary prototype was constructed on a breadboard to test the components before being soldered permanent on a PCB, however due the high voltage rail of the H-bridge the testing on the breadboard was limited to No load condition which makes the current to be zero. MOSFETs are attached to heat-sinks due to their nature of generating heat especially at high switching frequency. Due to inability to get a high voltage of 340Vdc a voltage of 50V was used as the rail voltage which was the maximum a laboratory power supply can output. Also a second power supply was used to supply 24V equivalent to what 24V battery would have supplied before dc to dc step up.

CONCLUSION

The objective of the circuit was to invert power from high voltage DC sources or an output voltage of DC to DC boost into AC power similar to one available in our wall sockets for any load and of which was partially met. This inverter power output is usable for any load although not practically tested. Almost 90% of the project was completed within time line given and by the time this report was being submitted. The fact that I was able to integrate the whole system and achieve a desired output of both the frequency and voltage with reverence to rail voltage supplied shows that much of key parts of this project is practically achievable and with required DC voltage a complete working inverter can be achieved.
Some of the important conclusion that can be drawn from this work are;

REFERENCE

[1] A.Ali Qazalbash, Awais Amin, Abdul Manan and Mahveen Khalid "Design and Implementation of Microcontroller based PWM technique for Sine wave Inverter", International Conference on Power Engineering, Energy and Electrical Drives, POWERENG '09. 2009 pp.163-167, IEEE.

[2] S. M. Mohaiminul Islam, Gazi Mohammad Sharif "Microcontroller Based Sinusoidal PWM Inverter for Photovoltaic Application", First International Conference Developments in Renewable Energy Technology (ICDRET), December, 2009 pp. 1-4, IEEE.

[3] B. Ismail, S. T. "Development of a Single Phase SPWM Microcontroller-Based Inverter", First International Power and Energy Conference PEC, November 28-29, 2006, pp. 437, Putrajaya, Malaysia: IEEE.

[4] MICROCHIP. (2003). PIC18F2331/2431/4331/4431 Data Sheet, Michrochip Techonology Inc.

[5] Mohaiminul Islam, S. M. " Generation of 3 Phase Sinusoidal PWM Signal with Variable Frequency By using Low Cost Microcontroller", Senior Project Report Published by Independent University, 2009, Bangladesh.

[6] Salim, K. M. "Development of Power Conditioner Unit (PCU) For Fuel Cell", Master's Thesis, June, 1999.

[7]http://www.wvshare.com/datasheet_html/PIC16F73- PDF.html (23 Nov, 2012)

[8] http://dsp-book.narod.ru/CPMicro.pdf (24 Nov, 2012)