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A REVIEW ON OPTIMIZATION OF ENERGY BY USING PWM INVERTER

Mr. Ravindra Patil.
E & TC Department.
Govt. College of Engg.
Jalgaon, India

Prof. M.H. Nerkar
E & TC Department.
Govt. College of Engg.
Jalgaon, India

Mr. Prashant Chaudhari
E & TC Department.
Govt. College of Engg.
Jalgaon, India

Abstract: **An important part of uninterruptable power supply is the DC to AC inverter which converts the DC voltage from a battery to an AC voltage that is required to operate electronic circuits. These inverters are bulky in nature & consume most of the power. Therefore power available at the output of inverter is less. So it is the goal of this paper to develop a DC/AC inverter capable of producing a pure sine wave which will consume less power. In this paper, we detail how the inverter's controls were implemented with a digital approach using a microcontroller for the control system and how effective and energy efficient a PWM (Pulse Width Modulation) inverter can be.**

Index Terms **- Dead time, Inverter, PIC controller, PWM, sine wave, VFD, VSI.**

I. INTRODUCTION

A lot of techniques have been developed to control Alternating Current (AC) power. In this paper a novel technique to design and implement a single phase PWM inverter using PIC microcontroller instead of using Digital Signal Processor (DSP) controllers.

Duty cycle of the PWM signal is altered to make a DC voltage source to look like an AC signal across a load. Digital microcontroller is used to generate the pattern at which the duty cycle of the PWM signal varies. PWM is used to powering AC devices with a DC power source. To control the power flowing through the load feedback is used. The changes in load can cause changes in the supplied current and voltage this problem can be overcome by the microcontroller. The microcontroller will allow easy feedback to circuit so; it is possible to "look" at the power output and change the duty cycle accordingly based on whether or not the load requires additional power or is being oversupplied [1].

This paper focuses on development of PWM inverter which will save energy. The main aim of static power converters is to produce an AC output waveform from a DC power supply. These types of waveforms are required in uninterruptible power supplies (UPS), adjustable speed drives (ASDs), flexible ac transmission systems (FACTS), static variable compensators, voltage compensators, and active filters which are only a few applications. For sinusoidal ac outputs, the magnitude, frequency, and phase should be controllable. We will use IC's instead of using discrete component which will reduce energy consumption & hence this technique will optimize energy.

II. LITERATURE SURVEY

Power conversion from DC to AC was accomplished using rotary converters since the nineteenth century up to the middle of the twentieth century after that in the twentieth century, vacuum tubes and gas filled tubes began to be used as switches in inverter circuits. The most widely used tube at that time was thyratron. In 1947 after the invention of transistor by Walter Brattain they were used as switches in inverters. Since early transistors have very low voltage & current ratings, so in 1957 thyristor make transition to solid state inverter circuits. These inverters can be used for high voltage & current ratings. For designing thyristor or silicon controlled rectifiers (SCR) circuits. It was find that it needs to consider the commutation requirements. SCRs do not turn off or *commutate* automatically when the gate control signal is shut off. They only turn off when the forward current is reduced below the minimum holding current. For an AC power source, commutation occurs naturally because at every time the polarity of the source voltage also reverses. This is natural commutation. However this not happens for SCRs connected to a DC power source and hence it usually requires a means of forced commutation that forces the current to zero when commutation is required [2].

A. Voltage Source Inverters

Figure (I) shows the power topology of a full-bridge VSI. However, a second leg provides the neutral point to the load. As expected, both switches S_{1+} and S_{1-} cannot be ON simultaneously because a short circuit across the dc link voltage source V_i would be produced. There are four defined (states 1, 2, 3, and 4) and one undefined (state 5) switch states. The undefined condition should be avoided so as to be always capable of defining the ac output voltage. In order to avoid the short circuit across the dc bus and the undefined ac output voltage condition, the modulating technique should ensure that either the top or the bottom switch of each leg is on at any instant. It can be observed that the ac output voltage can take values up to the dc link value V_i, which twice that are obtained with half-bridge VSI topologies.

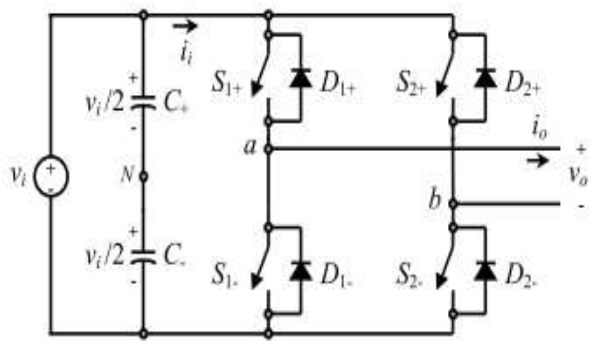

Fig. I: Voltage Source Inverter.

Single phase VSIs cover low-range power applications and three-phase VSIs cover the medium to high power applications.

B. Current Source Inverter

Another type of SCR inverter circuit is the current source input (CSI) inverter. A CSI inverter is the dual of a six-step voltage source inverter. With a current source inverter, the DC power supply is configured as a current source rather than a voltage source. The inverters SCRs are switched in a six-step sequence to direct the current to a three-phase AC load as a stepped current waveform. CSI inverter commutation methods include load commutation and parallel capacitor commutation. With both methods, the input current regulation assists the commutation. With load commutation, the load is a synchronous motor operated at a leading power factor. As they have become available in higher voltage and current ratings, semiconductors such as transistors or MOSFETs that can be turned off by means of control signals have become the preferred switching components for use in inverter circuits [3], [4].

C. PWM Technique

In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the ON and OFF periods of the inverter components. This is the most popular method of controlling the output voltage and this method is termed as Pulse Width Modulation (PWM) Control. Bipolar PWM techniques have only two values in its output which are V_{i+} & V_{i-}. Unipolar PWM techniques have three values in its output which are V_{i+}, V_{i-} & 0. The advantages possessed by PWM techniques over previous methods are: (i) the output voltage control with this method can be obtained without any additional components. (ii) With the method, lower order harmonics can be eliminated or minimized along with its output voltage control. As higher order harmonics can be filtered easily, the filtering requirements are minimized. (iii) Excellent dynamic response.

III. SYSTEM DEVELOPMENT

The figure (II) shows proposed system of PWM inverter.

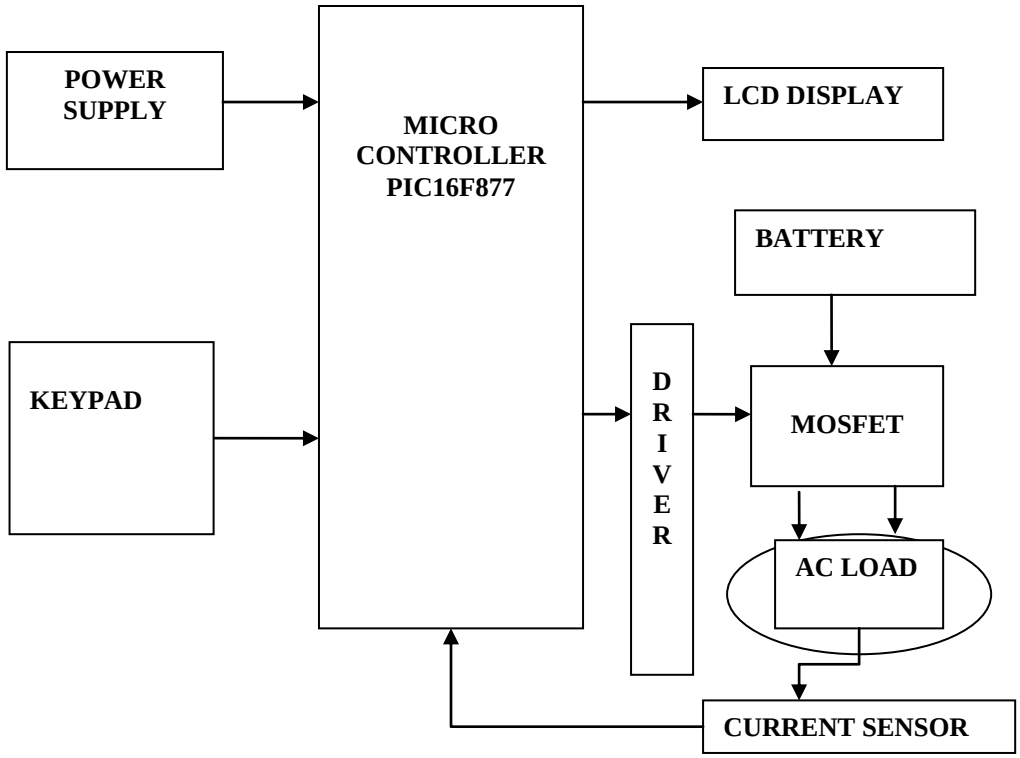

Fig. II: Proposed System of PWM inverter

A. Hardware Development

The MOSFET is a device that is voltage and not current controlled. MOSFETs have a positive temperature coefficient, stopping thermal runaway. The on-state-resistance has no theoretical limit; hence on-state losses can be far lower. The MOSFET also has a body-drain diode, which is particularly useful in dealing with limited freewheeling currents [5], [6].

PIC16F8XX family is a general purpose, low-cost, highly reliable, and highly expandable microcontroller system. This microcontroller features, 8 K x 14 words of In-System Reprogrammable Downloadable Flash Memory, 368 bytes of RAM, 256 bytes of EEPROM data memory,15 Interrupt Sources, Two 8-bit Timers/ counters with prescalers, One 16-bit timer/counter, Two 16-bit compare/capture PWM modules, 10-bit, 8 channel ADC which will be used to convert analog signal of current sensor in digital signal, Two analog comparators which can be used to generate PWM signal, Programmable UART Serial Channel, SPI and Master I2C Serial Interfaces Programmable Watchdog Timer , Brown out detector, 33 general purpose I/O pins, this microcontroller possess two purposes one is to generate PWM signals and second is to control the overall system [7].

MOSFET's are voltage controlled devices & it needs some gate voltage to turn ON. The output signal of microcontroller is unable to turn ON MOSFET's. We will use driver stage which will enhance the signal of microcontroller up to the level so that it can drive the MOSFET's.

A current sensor is a device that detects electrical current (AC or DC) in a wire, and generates a signal proportional to it. The generated signal could be analog voltage or current or even digital output. It can be then utilized to compare with reference voltage to vary the pulse width of PWM.

B. Software Development

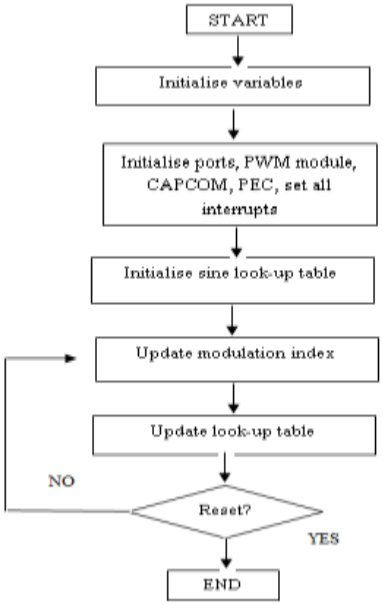

Figure 3. Flow-Chart for the PWM generation

The flowchart of the PWM generation program is shown in Figure III. First, initialization of all variables and peripheral ports take place. These include the setting of the switching frequency, configuring the CAPCOM compare values, initialising the PEC channels and setting all the interrupt priority levels. Next, the look-up table is prepared. Once the main program is executed, the system goes into an infinite interrupt driven loop. In this loop, the pulse width registers are updated. This is achieved by multiplying the basic data in the sine wave table with the current modulation index. The loop can be terminated by resetting the reset switch of the hardware boar.

C. Working

Using microcontroller ports, the digital data is accepted and is compared with required currents digital data. Proportional Algorithm is used to adjust the duty cycle of the PWM signal in accordance with the error. The generated PWM signal is used to generate two gate signals using interrupts required for bridge inverter circuit [8].

Gate signals are passed through gate driver circuit to boost up the gate signal so that it can drive the MOSFET switches of bridge inverter to the ON state. There are two switches in one leg of inverter, therefore only one switch is ON at a time however another switch is OFF. To accomplish this we will generate two signals which will be inverted of each other. If the switch is going to turn ON before another switch in that leg turns OFF, then DC bus becomes short circuit. To avoid this short circuiting we will develop an algorithm which will introduce some dead-time so that one switch will be ON only when another switch becomes OFF. A sensor is used to sense the current at output. This current is compared with reference which will decide the pulse width of PWM signal. In this way we can control the output voltage. Many additional features can be further added like sensing the temperature of room and automatically controlling either the speed of the fan or the level of air conditioning required.

IV. CONCLUSIONS

The main task of our work is to develop an inverter which will optimize energy. This can be achieved by PWM technique. PWM technique reduces the harmonics present in output. Previous work is based on analog control however Microcontroller introduces digital control which introduces flexibility in the circuit also it is used to introduce dead time through programming. Because of this microcontroller hardware circuit will reduce & hence power required for that hardware will also reduced. Pulse width of PWM will be adjusted by using feedback from output to microcontroller.

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