MULTIPLE INPUT DC VOLTAGE SINGLE OUTPUT AC OUTPUT PWM DC/AC INVERTER USING A MICROCONTROLLER

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ABSTRACT

The multiple input DC voltage single output AC output PWM DC/AC inverter using a microcontroller is to achieve multiple voltage levels to improve square wave signal to improve power quality of output device. The principle of inverter the device which converts DC power to AC power at required output voltage and frequency level is known as inverter. Here multiple sources are connected to the different levels of inverter loads. Multilevel inverter as compared to single level inverters have advantages to minimize harmonic distortion, in order to reduce EMI/RFI can operate on several voltage levels can be improve . A multi-level inverter is used for multipurpose applications, such as active power filters, un-interrupted power supply, power inverters. and machine drives for sinusoidal and trapezoidal current applications. The drawbacks are the isolated power supplies required for each one of the stages of the multi-converter and it's also lot harder to manufacture, more cost, harder control in software. This project aims at generation of carrier based PWM technique using POD strategy through it defines of an AT89C51 microcontroller. The features are: Firstly, Both the high frequency triangular wave and sinusoidal reference signal are being produced by microcontroller. The digital to analog converter(DAC0808)is then employed for converting them into their analog signal forms An op-amp based comparator then compares these two carrier & reference signals to give us the desired sinusoidal pulse width modulation signal as required final-output. The PWM signal thus generated is then used for the multilevel triggering pulse inverters.

INTRODUCTION

Ac loads require constant or adjustable voltages at their input terminals. When such loads are fed by inverters, it's essential that output voltage of the inverters is so controlled as to fulfill the requirements of AC loads. This involves coping with the variation of DC input voltage, for voltage regulation of inverters and for the constant volts/frequency control requirement. There are various techniques to vary the inverter gain. The most efficient method of controlling the gain (and output voltage) is to incorporate pulse-width modulation (PWM) control within the inverters. The carrier based PWM schemes used for multilevel inverters is one of the most straight forward methods of describing voltage source modulation realized by the intersection of a modulating signal (Duty Cycle) with triangular carrier wavefroms.The Alternative PWM strategies with differing phase relationships are:

- Alternate phase disposition (APOD): Every carrier wave form is in out of phase with its neighbor carrier by 180 degree.
- Phase Opposition Disposition (POD): All carrier waveforms above zero reference are in

phase and are 180 degree out of phase with those below zero reference.

- Phase Disposition (PD): All carrier waveforms are in phase

PROJECT OUTLINE

This project aims at generation of carrier based PWM scheme using POD strategy through the means of an AT89C51 microcontroller. The salient features are:

- Firstly, both the high-frequency triangular carrier wave & the sinusoidal reference signal are being generated in the microcontroller.
- A digital to analog converter (DAC 0808) is then employed for converting them into their analog signal forms.
- An opamp(KF351) based comparator then compares these two carrier & reference signals to give us the desired sinusoidal pulse width modulated signal as the required final output

INVERTERS

A device that converts DC power into AC power at desired output voltage and frequency is called an Inverter. Phase controlled converters when operated in the inverter mode are called line commutated inverters. But line commutated inverters require at the output terminals an existing AC supply which is used for their commutation. This means that line commutated inverters can't function as isolated AC voltage sources or as variable frequency generators with DC power at the input. Therefore, voltage level, frequency and waveform on the AC side of the line commutated inverters can't be changed. On the other hand, force commutated inverters provide an independent AC output voltage of adjustable voltage and adjustable frequency and have therefore much wider application.

Inverters can be broadly classified into two types based on their operation:

1 Voltage Source Inverters(VSI)

2 Current Source Inverters(CSI)

Voltage Source Inverters is one in which the DC source has small or negligible impedance. In other words VSI has stiff DC voltage source at its input terminals. A current source inverter is fed with adjustable current from a DC source of high impedance, i.e.; from a stiff DC current source. In a CSI fed with stiff current source, output current waves are not affected by the load. From view point of connections of semiconductor devices, inverters are classified as under

- Bridge Inverters
- Series Inverters
- Parallel Inverters

PAM the successive sample values of the analog signal $s(t)$ are used to effect the amplitudes of a corresponding sequence of pulses of constant duration occurring at the sampling rate. No quantization of the samples normally occurs (Fig. 1*a*, *b*). In principle the pulses may occupy the entire time between samples, but in most practical systems the pulse duration, known as the duty cycle, is limited to a fraction of the sampling interval. Such a restriction creates the possibility of interleaving during one sample interval one or more pulses derived from other PAM systems in a process known as time-division multiplexing (TDM).

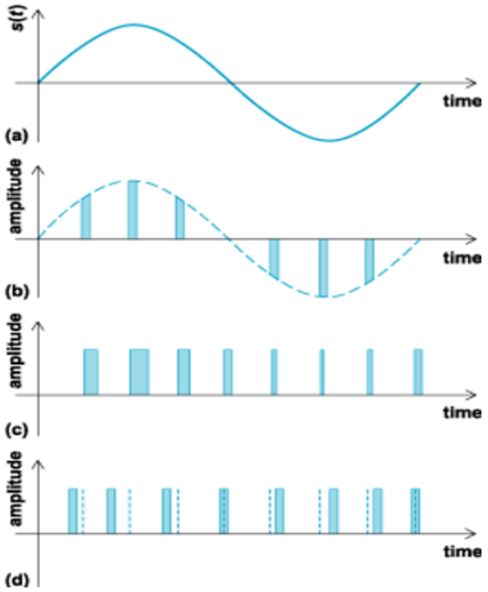

Fig 1 Pulse Width Modulation

There are many forms of modulation used for communicating information. When a high frequency signal has amplitude varied in response to a lower frequency signal we have AM (amplitude modulation). When the signal frequency is varied in response to the modulating signal we have FM (frequency modulation. These signals are used for radio modulation because the high frequency carrier signal is needs for efficient radiation of the signal. When communication by pulses was introduced, the amplitude, frequency and pulse width become possible modulation options. In many power electronic converters where the output voltage can be one of two values the only option is modulation of average conduction time.

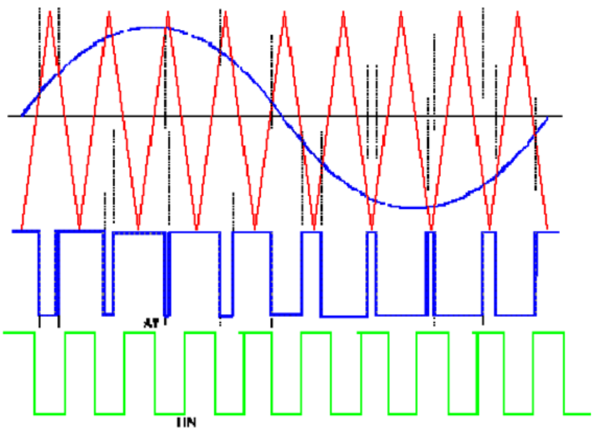

Fig 2 Sinusoidal PWM

LINEAR MODULATION

The simplest modulation to interpret is where the average ON time of the pulses varies proportionally with the modulating signal. The advantage of linear processing for this application lies in the ease of de-modulation. The modulating signal can be recovered from the PWM by low pass filtering. For a single low frequency sine wave as modulating signal modulating the width of a fixed frequency (fs) pulse train the spectra is as shown in Fig 2. Clearly a low pass filter can extract the modulating component fm.

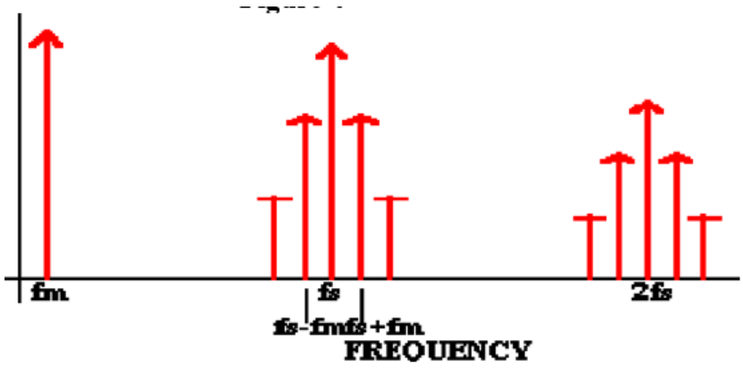

Fig 3 Linear modulation

SAW TOOTH PWM

The simplest analog form of generating fixed frequency PWM is by comparison with a linear slope waveform such as a saw tooth. As seen in Fig 2 the output signal goes high when the sine wave is higher than the saw tooth. This is implemented using a comparator whose output voltage goes to logic HIGH when ne input is greater than the other. Other signals with straight edges can be used for modulation a rising ramp carrier will generate

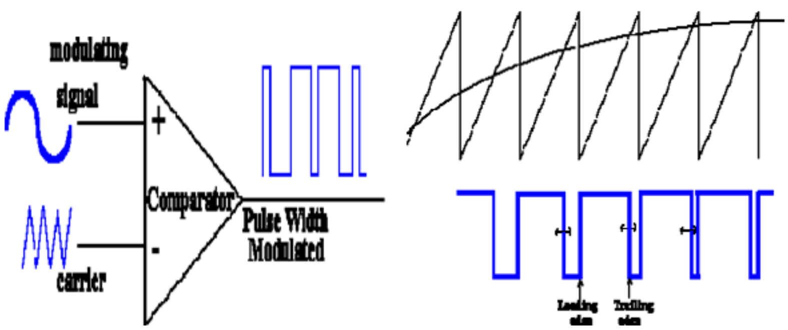

Fig 4 SAW TOOTH PWM

In many industrial applications, it's often required to control the output voltage of inverters for the following reasons To cope with the variations of DC input voltage For voltage regulation of inverters For the constant volts/frequency control requirement There are various techniques to vary the inverter gain. The most efficient method of controlling the gain (and output voltage) is to incorporate pulse width modulation (PWM) control within the inverters. The commonly used techniques are

- Single Pulse width Modulation

- Multiple Pulse width Modulation
- Sinusoidal Pulse width Modulation
- Trapezoidal Pulse width Modulation
- Stair case Pulse width Modulation

In PWM inverters, forced commutation is essential. The PWM techniques listed above differ from each other in the harmonic content in their respective output voltages.Thus,choice of a particular PWM technique depends upon the permissible harmonic content in the inverter output voltage. Industrial applications PWM inverter is supplied from a diode bridge rectifier and an LC filter. The inverter topology remains the same for a single phase inverter and for a three phase inverter. But now the devices are now switched ON and OFF several times within each half cycle to control the output voltage which has low harmonic content.

SINGLE PULSE WIDTH MODULATION

In this control, there's only one pulse per half cycle and the width of the pulse is varied to control the inverter output. The gating signals are generated by comparing a rectangular reference signal of the amplitude A_r with triangular carrier wave of amplitude A_c,the frequency of the carrier wave determines the fundamental frequency of output voltage. By varying A_r from 0 to A_c,the pulse width can be varied from 0 to 100 percent. The ratio of A_r to A_c is the control variable and defined as the modulation index.

MULTIPLE PULSE WIDTH MODULATION

The harmonic content can be reduced by using several pulses in each half cycle of output voltage. The generation of gating signals for turning ON and OFF transistors by comparing a reference signal with a triangular carrier wave. The frequency F_c, determines the number of pulses per half cycle. The modulation index controls the output voltage. This type of modulation is also known as uniform pulse width modulation (UPWM).

SINUSOIDAL PULSE WIDTH MODULATION

Instead of ,maintaining the width of all pulses of same as in case of multiple pulse width modulation, the width of each pulse is varied in proportion to the amplitude of a sine wave evaluated at the centre of the same pulse. The distortion factor and lower order harmonics are reduced significantly. The gating signals are generated by comparing a sinusoidal reference signal with a triangular carrier wave of frequency F_c.The frequency of reference signal F_r determines the inverter output frequency and its peak amplitude A_r,controls the modulation index M,and rms output voltage V_O.The number of pulses per half cycle depends on carrier .

MICROCONTROLLER BASED WAVE GENERATION SCHEME

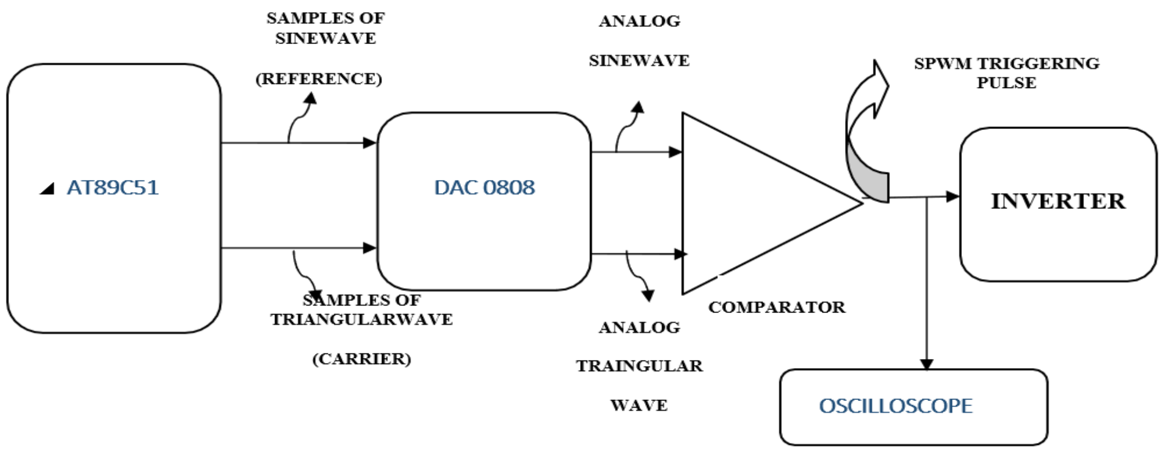

Fig 5 Block Diagram Representation of Wave Generation Scheme

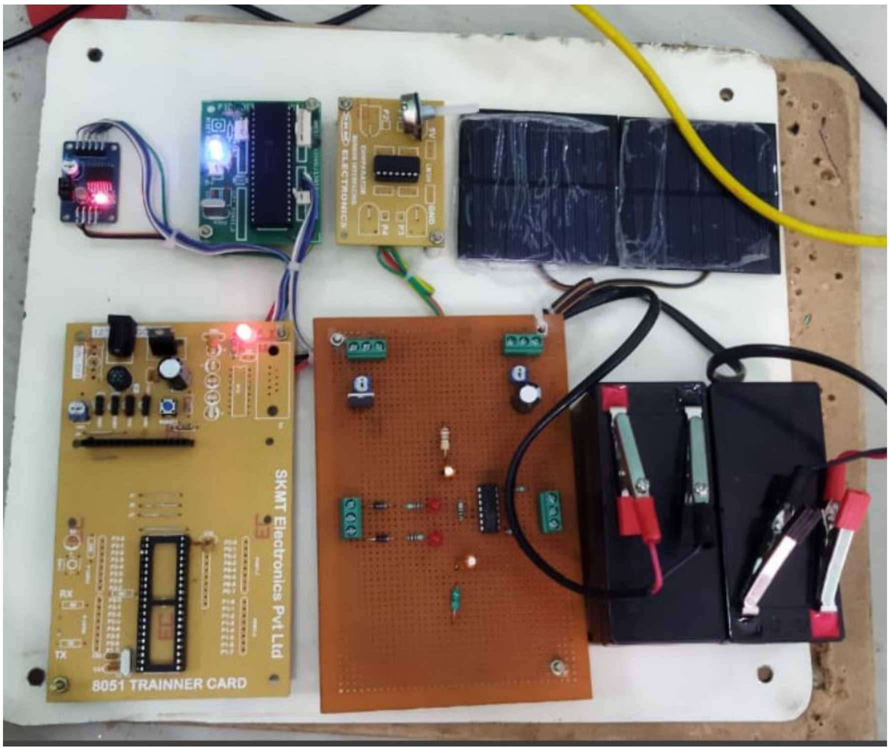

Fig 6 Experimental prototype

ALGORITHM FOR PWM WAVE GENERATION:

- Compilation and Simulation of Assembly language program for AT89C51 using "Top view simulator(4.1)"
- Burning the Program through the "BeeProg universal(48pin Driver) Programmer" into the flash memory of AT89C51
- Generation of Digital Sample of Sinusoidal and Triangular waves from microcontroller, which is fed into the DAC 0808
- Analog output from the DAC 0808 is fed into the comparator KF351
- Generation of SPWM triggering pulses from KF351 (which is observed through the Oscilloscope) fed to the inverter

INTERFACING AT89C51 WITH DAC 0808 DAC0808 8-BIT D/A CONVERTER

The Digital to Analog converter is a device widely used to convert digital pulses to analog signal. There are two methods of making the DAC namely, Binary weighted and R/2R ladder. The vast majority of integrated circuit DACs, use the R/2R method. Since, it can achieve much higher degree of precision. The first criterion for judging a DAC is its resolution, which is a function of the number of binary inputs. The common ones are 8,10 and 12 bits. The number of data bit inputs decides the resolution of the DAC since the number of analog output levels is equal to 2^n ,where n is the number of data bit inputs. There are also 16 bit DACs but they are expensive.

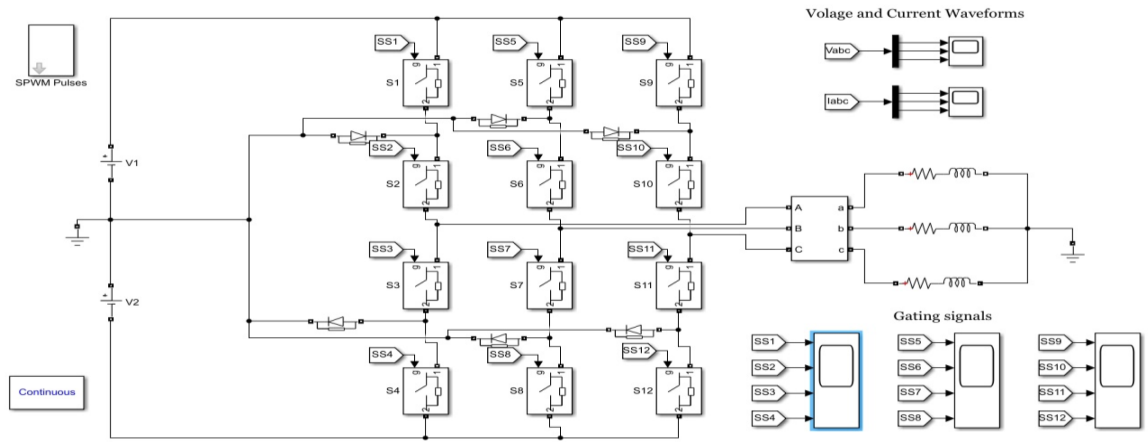

Fig 7 Proposed system simulation

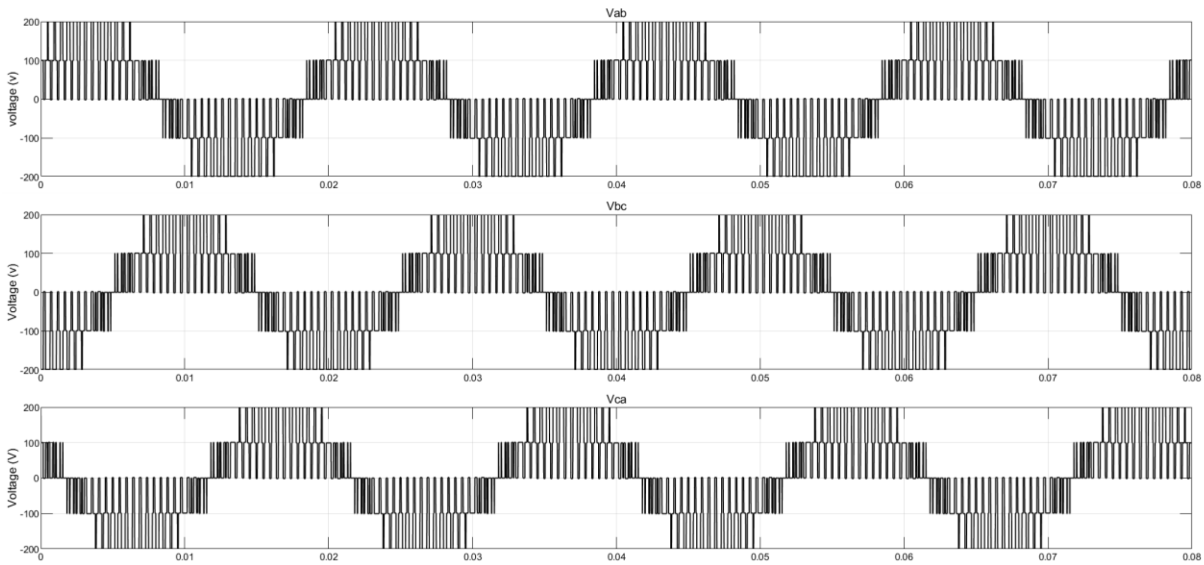

Fig 8 OUTPUT VOLTAGE WAVEFORM

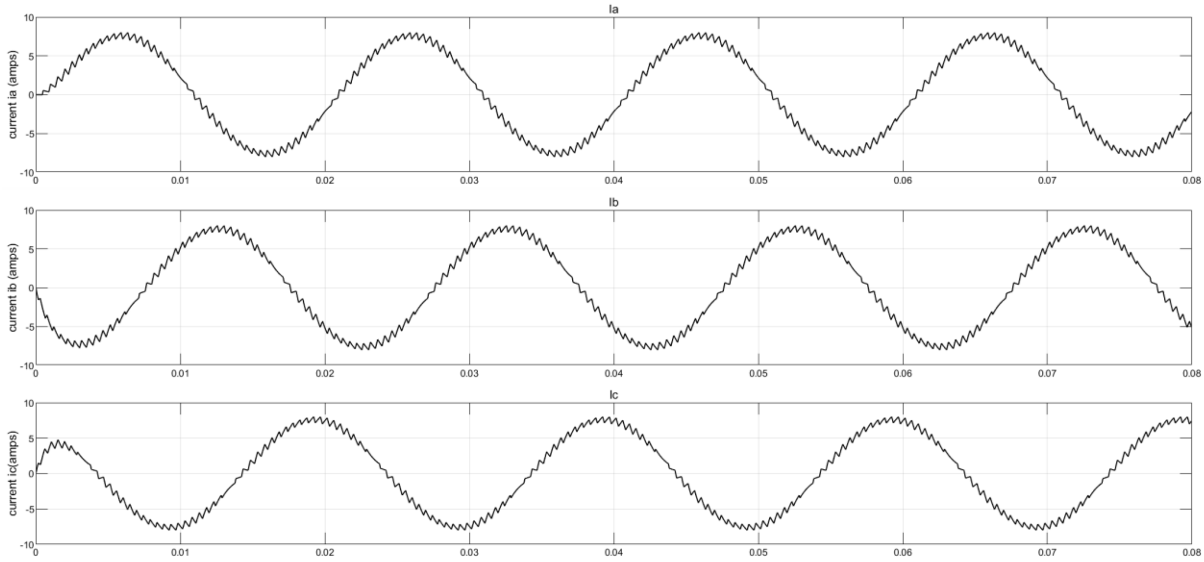

Fig 9 OUTPUT CURRENT WAVEFORM

CONCLUSION

The background study regarding the various aspects of the PWM firing scheme was studied. The carrier based PWM scheme using the POD strategy based on AT89C51 was simulated with the help of "TOP VIEW SIMULATOR (1.2H)". Hardware involving the power circuit of AT89C51 was fabricated. Power circuit of AT89C51 was interfaced with DAC0808 for the generation of analog signal. The analog signals (sinusoidal and triangular) so generated were compared using a comparator (KF351) thereby generating PWM waves which is fed as triggering pulses to the inverters. It's to be noted that in this entire experiment DAC 0808, an 8 bit D/A converter is used. Thus the resolution of the waves generated is not impeccable. Thus, it's recommended to use 12 or 16 bit D/A converter to get better wave forms.

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