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Generation of Sine PWM Pulse in Three Phase Voltage Source Inverter

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ABSTRACT: This paper affords the improvement of 3Φ sinusoidal PWM inverter with the usage of Dspic Micro Controller. Generation of Dspic based totally PWM signal to govern the substantially assist the development of modern-day inverter that is required to work on different KVA ratings or distinct masses for numerous applications. Since experimentation of various KVA rankings inverter fashions on hardware being particularly highly-priced, the use of PWM allows to check the overall performance of those fashions and validate through the evaluation with the traditional strategies. It is feasible because the algorithm required to generate the PWM indicators is written in C language so it could be reused without problems and this liability presents in phases of converting the switching frequency for the favoured inverter output voltage. In this paper the set of rules improvement method and the experimental outcomes together with simulation version are presented which display the effectiveness of the proposed algorithm.

KEYWORDS: Dspic Micro Controller, photovoltaic, Modulation, pulse-width modulation, voltage source inverter.

I.INTRODUCTION

The recent traits in strength semiconductor devices and speedy digital signal processing hardware the inverters have become a major and commonplace gadgets which performs a critical role in various application together with information processing systems, domestic home equipment, affected person fitness care centres and vital telecommunication link. The advent of excessive strength voltage source inverter is exceedingly eased due to beneficial houses of IGBT such that high electricity managing functionality. Despite this gain of IGBT the switching losses are the important problem and it reasons the low modern distortion and harmonic losses.

One of the interesting answers that minimize the above trouble is locate of excessive performance pulse width modulation. The inverter is operated with a pulse-width modulation (PWM) strategy beneath the closed loop control to understand the desired output waveform with decreased harmonics. Control of the PWM inverter is realized with excessive-pace comments loops, where the real output waveform is compared with a sinusoidal reference [2]. Although the inverters has traditionally been designed as analogy circuitry, digital inverters are now desired. DSPic offer sophisticated manage algorithms with fairly bendy software program, the ability to add user interfaces, reduce additives, introduce testing methods, and growth reliability. The DSPic controlled inverter gadget employs software managed harmonic conditioners with the capacity to dynamically adapt to converting load situations for computerized repayment of the weight harmonics without manual intervention. Thus the application of advanced signal processing the use of a DSPic operates to provide sinusoidal load voltages even beneath varying nonlinear load situations, even as disposing of the need for big passive filters. This paper offers the hardware version of DSPic manipulate of 3 Φinverter systems supplying nonlinear load to continuously provide sinusoidal load voltages and DSPic-based algorithm to generate sine wave PWM signals is added.

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II.THREE PHASE INVERTER

Three Φ inverters are usually used for excessive strength packages. Inverters may be extensively categorized into two types. They are Voltage Source Inverter (VSI) & Current Source Inverter (CSI). The well-known configuration of a three section DC-AC inverter is proven in Figure1.

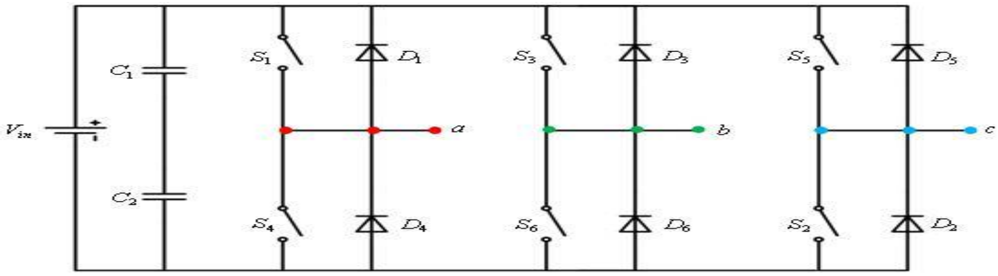

Figure 1 Configuration of a Three-Phase DC-AC Inverter

A. Voltage Source Inverter

A voltage source inverter (VSI) is fed by means of a stiff DC voltage, whereas a cutting-edge supply inverter is fed by a stiff cutting-edge supply. A voltage supply can be transformed to a current supply by way of connecting a chain inductance after which various the voltage to acquire the preferred cutting-edge. A VSI can also be operated in cutting-edge-controlled mode, and similarly a CSI can also be operated within the voltage control mode. The inverters are utilized in variable frequency AC motor drives, uninterrupted power elements, induction heating, static VAR compensators, etc which will be described at below figure 2.

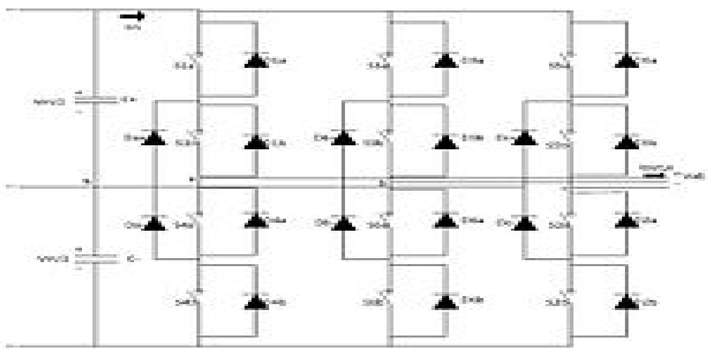

Figure 2 Three-Phase VSI Circuit Schematic

C. Proposed Method

A 3-Φ inverter converts a DC input right into a 3-phase AC output. Its 3 palms are usually not on time via an perspective of a hundred and twenty degree so that you can generate a 3-Φ AC deliver. The inverter switches each has a ratio of fifty percentages and switching happens after each T/6 of the time T (60 ° periods). The switches S1 and S4, the switches S2 and S5 and switches S3 and S6 complement every different. The parent beneath suggests a circuit for a three section inverter. It is not anything however 3 single Φ inverters put throughout the same DC supply. The pole voltages in a 3 phase inverter are equal to the pole voltages in unmarried section 1/2 bridge inverter.

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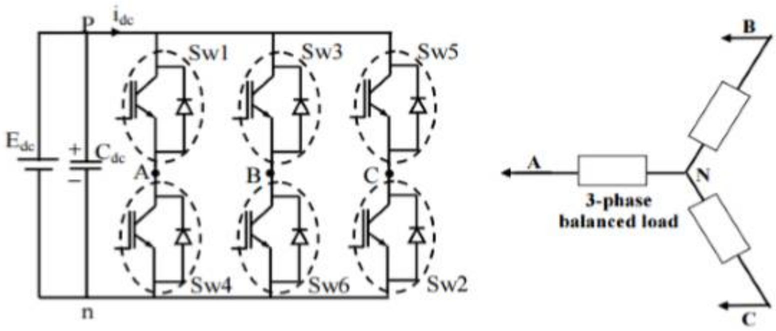

Figure 3 Three-Phase Voltage Source Inverter with balanced load

III.OPERATION OF THREE PHASE VSI

A. Three Phase VSI Modes of Operation

The inverters have two branches or modes of conduction

1) 180° conduction modes.
2) 120° conduction modes.

1. 180° conduction mode

In this mode of conduction, every device is in conduction nation for one hundred eighty degree in which they are switched ON at 60° durations. The terminals A, B and C are the output terminals of the bridge that are connected to the three-Φ delta or star connection of the load. The operation of a balanced big name linked load is defined within the diagram underneath. For the length 0° − 60° the factors S1, S5 and S6 are in conduction mode. The terminals A and C of the load are connected to the supply at its nice point. The terminal B is hooked up to the source at its poor point. In addition, resistances R/2 is among the neutral and the fine cease at the same time as resistance R is between the impartial and the negative terminal.

The load voltages are gives as follows;
$V_{an} = V/3$, $V_{bn} = -2V/3$, $V_{cn} = V/3$

The line voltages are given as follows;
$V_{ab} = V_{an} - V_{bn} = V$, $V_{bc} = V_{bn} - V_{cn} = -V$,
$V_{ca} = V_{cn} - V_{an} = 0$

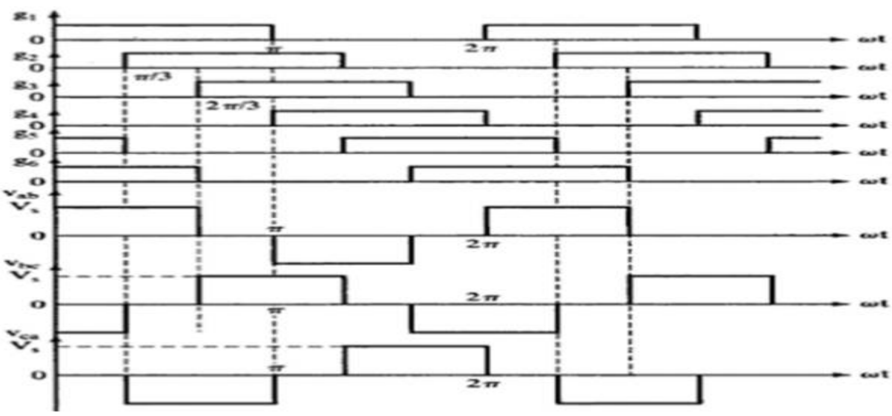

Figure 4 Waveforms for 180° mode of conduction

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2. 120° conduction mode

In this mode of conduction, each digital tool is in a conduction state for one hundred twenty degree. It is most suitable for a delta connection in a load because it effects in a six-step kind of waveform throughout any of its stages. Therefore, at any instantaneous most effective devices are undertaking due to the fact each device conducts at handiest 120°. The terminal A at the load is hooked up to the tremendous give up at the same time as the terminal B is attached to the bad stop of the source. The terminal C at the load is in a circumstance referred to as floating country. Furthermore, the phase voltages are identical to the load voltages as shown under. In this conduction mode every transfer conducts for 120° term or 2π/3 radians. Here switches will conduct concurrently at any instant of time. After every 60° or π/three radians, one of the undertaking switches is grew to become off and different switch will begin engaging in. In this conduction mode there may be a delay of π/6 between turning on and turning off of switches of equal leg. So there is no possibility of quick circuit. Phase voltages = Line voltages

$V_{ab} = VV_{bc} = -V/2V_{ca} = -V/2$

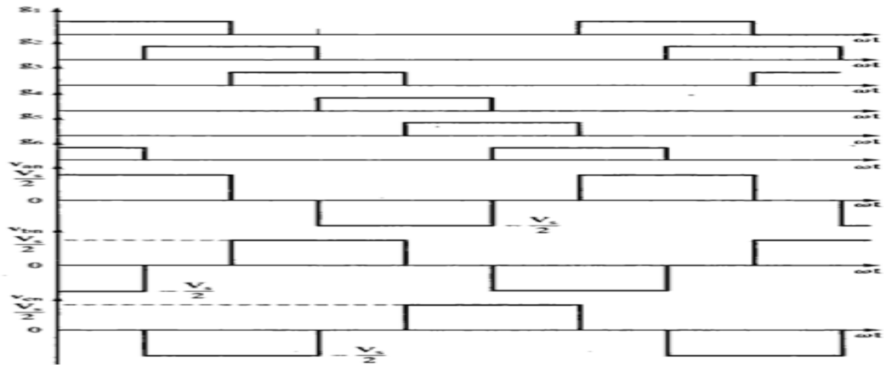

Figure 5 Waveforms for 120° mode of conduction

B. Pulse Generation Method

Sinusoidal Pulse Width Modulation

In sinusoidal PWM, additionally called sine-PWM, the resulting pulse widths are numerous in the course of the half cycle in this kind of manner that they're proportional to the immediate value of the reference sine wave at the center of the pulses. The distance among the centers of the pulses is saved consistent as in multi-PWM. Voltage manipulate is accomplished via various the widths of all pulses without stressful the sinusoidal courting. The technology of the gating indicators for sinusoidal PWM and the output voltage and currents is shown in Figure 6.

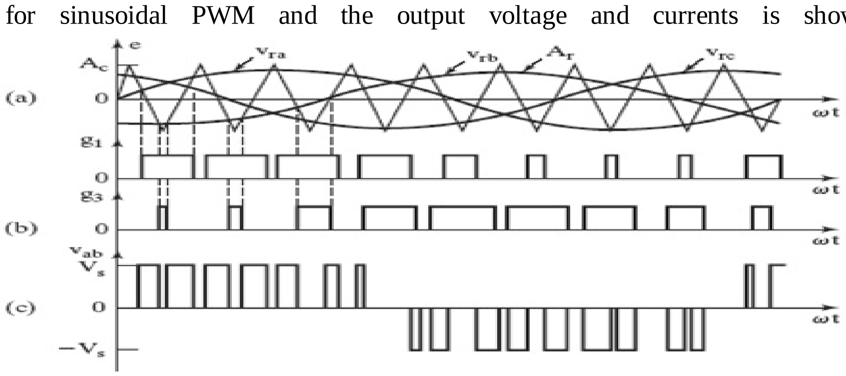

Figure 6 Waveforms for Sine PWM method

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In this software Event Manager Module (EVB) and General Purpose Timers 3 and four (GP timers 3 and four) of the DSPic were used to generate asymmetrical PWM waves. GP timer 3 is configured as follows:

* The timer period sign in T3PR is set to 2500 (favoured 10 kHz PWM frequency).
* The timer manipulate register T3CON is set to 0x1042 (counting mode, clock source).

A continuous up-counting mode is typically used to generate asynchronous PWM. The timer length value is calculated as follows:

Timer 3 period = $\frac{SYSCLOCKOUT}{2*CLOCKPRESCALER*PWM\ FREQUENCY}$

Where: *SYSCLKOUT is* the CPU clock frequency

Timer 3 period = $\frac{150MHZ}{2*3*10KHZ}$

For a brand new PWM frequency, the duration value for GP timer 3 is recalculated and the new cost is written to the duration check in in the course of this system run. It is also feasible to regulate the switching frequency by way of a virtual enter. GP timer four is used to adjust periodically the compare sign in a good way to gain the desired frequency of the inverter output. In this utility the compare registers have been updated each timer interrupt to attain the 50 Hz inverter output voltage. The interrupt is generated upon duration fit. The period price for this timer is calculated as follows:

Timer 4 period = $\frac{SYSCLOCKOUT}{2*CLOCKPRESCALER*OUTPUT\ FREQUENCY*NO\ OF\ SINE\ WAVES}$ Timer 4 period = $\frac{150MHZ}{2x3x50x751}$. = 555

Timer four length checks in fee represent the step required to load the subsequent value from the sine desk. Modifying this period register price outcome in converting the inverter output frequency without the need to exchange the frequency of the modulating sign as in the traditional sine PWM generation.

IV.SIMULATION RESULTS

A. SIMULATION OF 180 DEGREE MODE

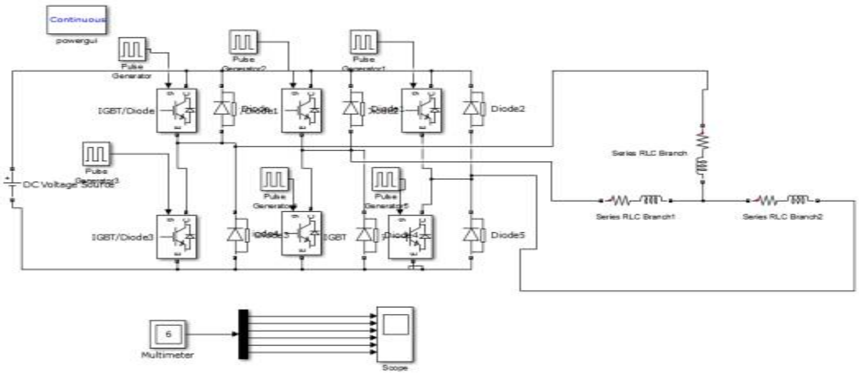

Figure 7 a Simulink diagram of 180 degree mode

The above figure 7 (a) a shows the simulink model of three phase inverter in 180 degree conduction mode with a RL load and the output of the 180 degree mode is shown in figure 7 (b).

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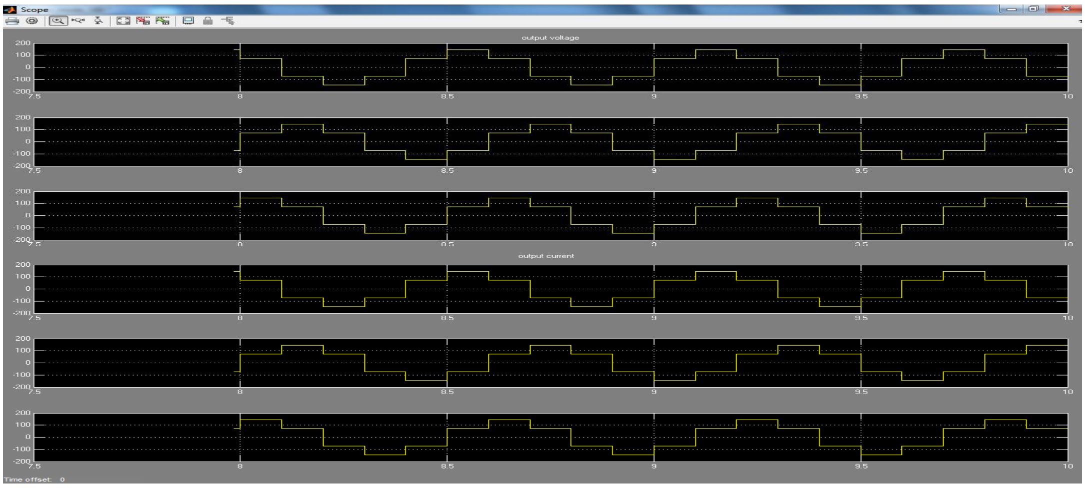

Figure 7 b Output Voltage & Current Waveforms of 180 degree mode

B. SIMULATIONOF 120 DEGREE MODE

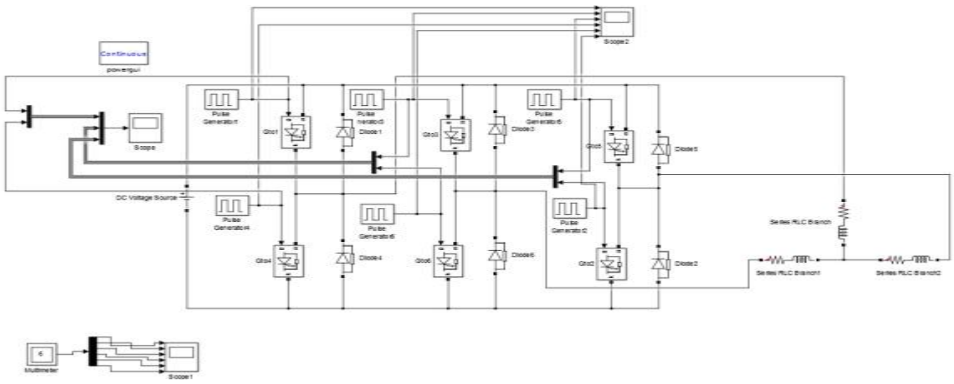

Figure 8 a Simulink diagram of 120 degree mode

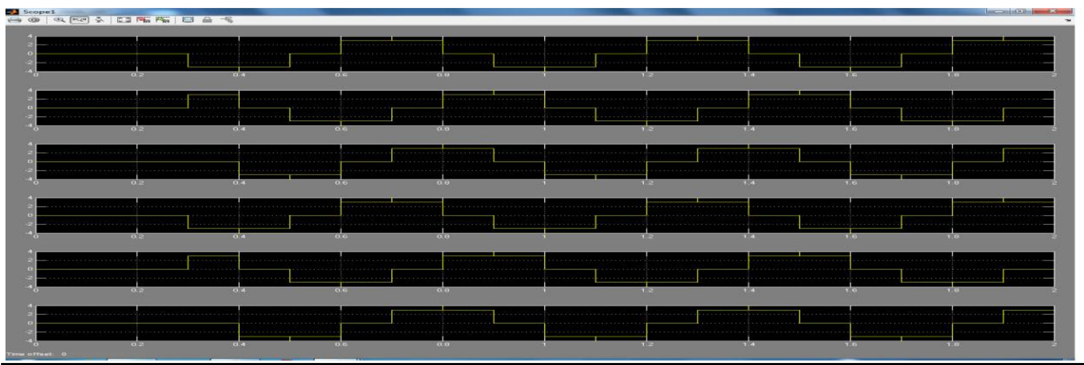

Figure 8 b Output voltage & current waveforms of 120 degree mode

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The above figure 8 (a) a shows the simulink model of three phase inverter in 120 degree conduction mode with a RL load and the output of the 120 degree mode is shown in figure 8 (b) with the both phase – phase and phase – neutral voltage.

V. HARDWARE RESULTS

A. Components used in driver circuit

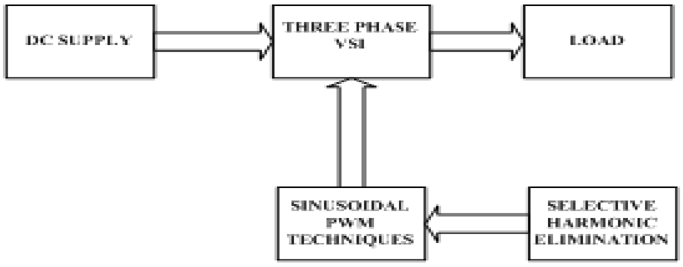

Figure 9 Block diagram of Dspic Micro Controller

A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. In modern terminology, it is similar to, but less sophisticated than, a system on a chip or SoC; an SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input /output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.

This power module is designed by using IGBT based Inverter for AC/DC Motor control application. This power module can be used for AC, DC, BLDC and PMSM Motor application by proper external PWM controller interfacing (like Dspic, FPGA & DSP). This PWM/Firing pulse controller is designed based on Dspic30f4011 controller chip from “MICROCHIP” company and this controller can be used to generate PWM Signals for SCR, IGBT based power electronics application like DC-AC Inverter, DC-DC Chopper & SCR converter based AC/DC/BLDC Switched Reluctance Motor (SRM) control application. PWM output of this controller can be directly interfaced with Power Module through External cable connection.

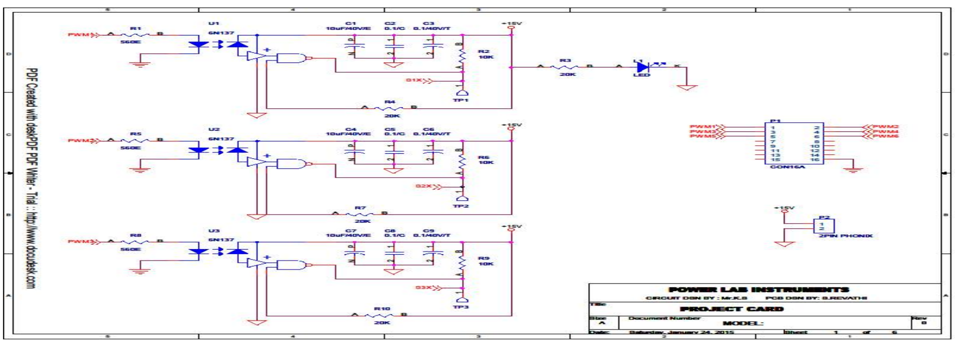

Figure 10 Circuit diagram of Hardware model

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Hardware Parameters:

- Includes High-Performance Microchip dsPIC30F4011 Microcontroller with 48kb Internal Flash Program Memory
- 6 Numbers of PWM Outputs up to 15KHZ of switching frequency
- Internal EEPROM &Five 16-bit Timers
- Power, Programming and Test LED's
- 2MB PROM & 24 MHZ clock speed
- QEP Sensor /Hall sensor/Speed sensor(Proximity)Interface connector on front panel
- PWM increment & decrement key &Reset switch is provided
- 20 X 4 LCD screen &PWM outputs are terminated by Front panel Connector
- 230VA INPUT with Power ON/OFF switch

B. HARDWARE OUTPUT

The below shown figure 11 describes the hardware model of the 3 phase PWM inverter with and with V/f control. The hardware results were tested on Digital Oscilloscope at various test points. The snapshots of these results were shown in fig (11 a & b).

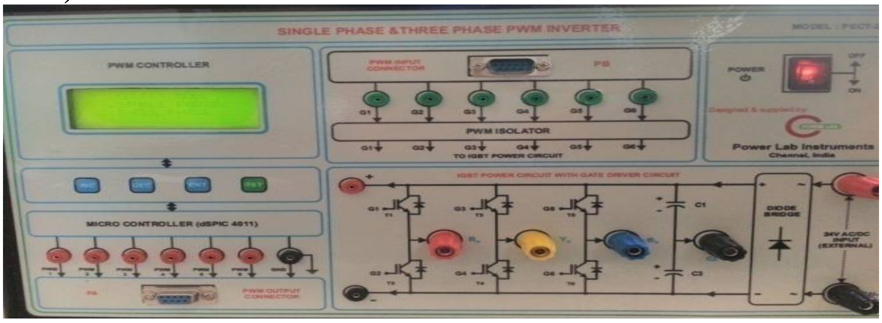

Figure 11 Hardware model of three phase PWM inverter

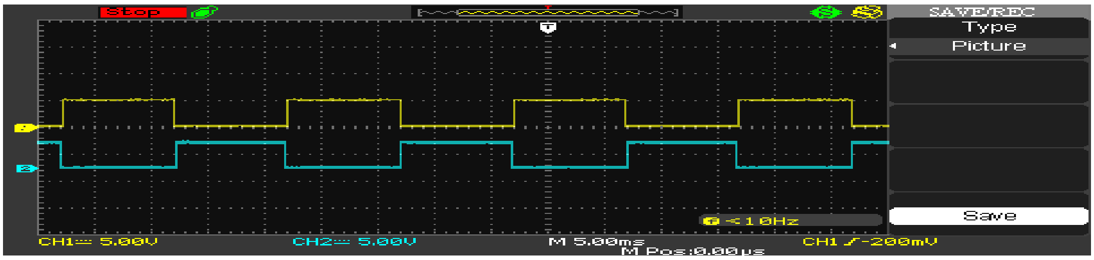

Figure 11 (a) Pulse waveform of three phase PWM inverter in 180º mode

The above shown waveform figure 11 (a) & (b) describes the output of the three phase inverter in 180 degree and 120 degree mode with the triggering pulse with the respective data

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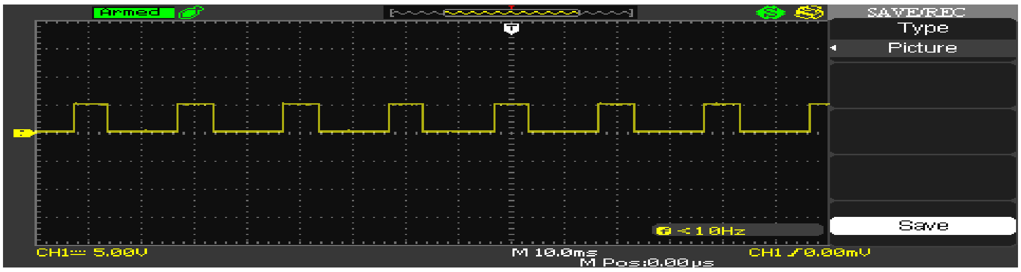

Figure 11 (b) Pulse waveform of three phase PWM inverter in 120º mode

VI.CONCLUSION

Thus, the generation of pure sinusoidal signals, SPWM is the most popular technique. In SPWM a digital waveform is generated and the duty cycle is modulated such that the average voltage of the waveform is corresponds to the higher frequencies. The SPWM technique treats each modulating voltages as a separate signals and compared to the common carrier triangular waveform

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