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Single - Phase VSI System Controlled by Suitable On - Board Microcontroller

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Abstract: In recent years, single-phase Voltage Source Inverter (VSI) is extensively used in various applications such as single phase uninterruptible power supply for the residential consumers, single phase micro-grid single-phase roof-top solar energy conversion system and single-phase Vehicle to Grid (V2G) system. This paper concentrates on the development of single-phase VSI system controlled by suitable on-board microcontroller. Nowadays, dedicated real time controllers such as ACE 1103, 1104 controllers, MICROLAB box, PXI platform etc. are developed as a general purpose controller panel/board. These controllers are mainly used in the laboratory for real time testing, research and development activities. But, in the applications mentioned above, the system with dedicated controller is required. Therefore, the development of the above said power electronics system plays an important role in the field of electrical power industry[1].

The VSI generates harmonics in its output voltage. The harmonics generation should be limited to avoid poor load performances. Lower order harmonics mainly contributes to the distortion effects in the system. On the other hand, the higher order harmonics effect less distortion in the system. Therefore, high switching frequency pulse width modulation techniques such as Sine-Triangle Pulse Width Modulation (SPWM) and Space Vector Pulse Width Modulation (SVPWM) are commercially used to remove the distortion effect created by the lower order harmonics. In this case, system efficiency is reduced due to higher switching losses by adopting these high frequency Pulse Width Modulation (PWM) techniques. Therefore, lower switching frequency Selective Harmonic Elimination PWM (SHEPWM) technique is considered in this paper to get the double benefits of lower switching losses and the removal of lower order selective harmonics.

Keywords: Sine-Triangle Pulse Width Modulation (SPWM) and Space Vector Pulse Width Modulation (SVPWM), Pulse Width Modulation (PWM)

I. INTRODUCTION

The implementation of SHEPWM involves in solution of non-linear transcendental equations to calculate different switching angles. The numbers of equations are dependent on the number of harmonics to be eliminated. So, the iterative algorithm such as Newton-Raphson method can be employed to compute switching instants of the PWM signals. But, the accuracy of this method depends on the initial guesses of the switching angles.

Hence, for improving accuracy, the optimization algorithms such as Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) technique an be employed to obtain lower Total Harmonic Distortion (THD) at any given Modulation Index (MI). These techniques are mainly discussed in the context of three-phase VSI. In this paper, single-phase VSI is considered and as a result, triple harmonics in addition to the other odd harmonics are to be eliminated. The parameters of PSO is adjusted to get more optimum solution (i.e. THD), for computing the switching angles. The plot of computed switching angles vs. MI is given in the result section.

The PIC16F676 is used as the embedded controller for the single-phase VSI. It is 14-pin, flash-based 8-bit CMOS microcontroller[2]. The main features are:0-20 MHz oscillator/clock input, 12 I/O pins, 10-bit ADC, one 8-bit and 16-bit timer each, one comparator, 1024 words program memory, 64 bytes SRAM and 128 bytes EEPROM as data memory, in-circuit serial programming via two pins.

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II. PROPOSED SYSTEM FOR MULTILEVEL INVERTER

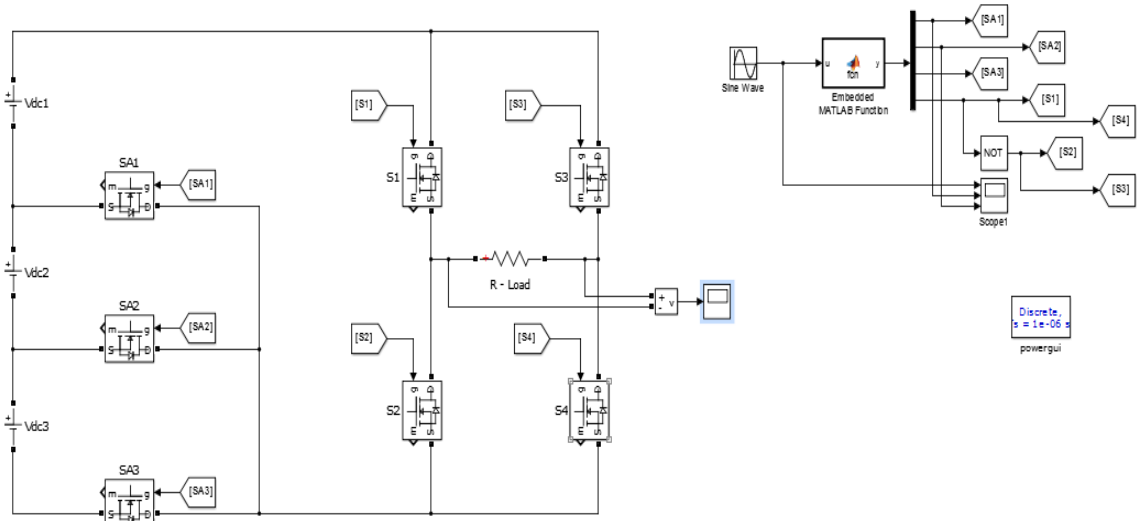

Fig.1 Circuit diagram for multilevel inverter

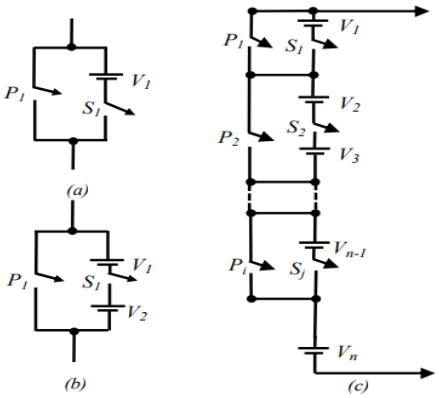

Fig.2 Proposed system for multilevel inverter

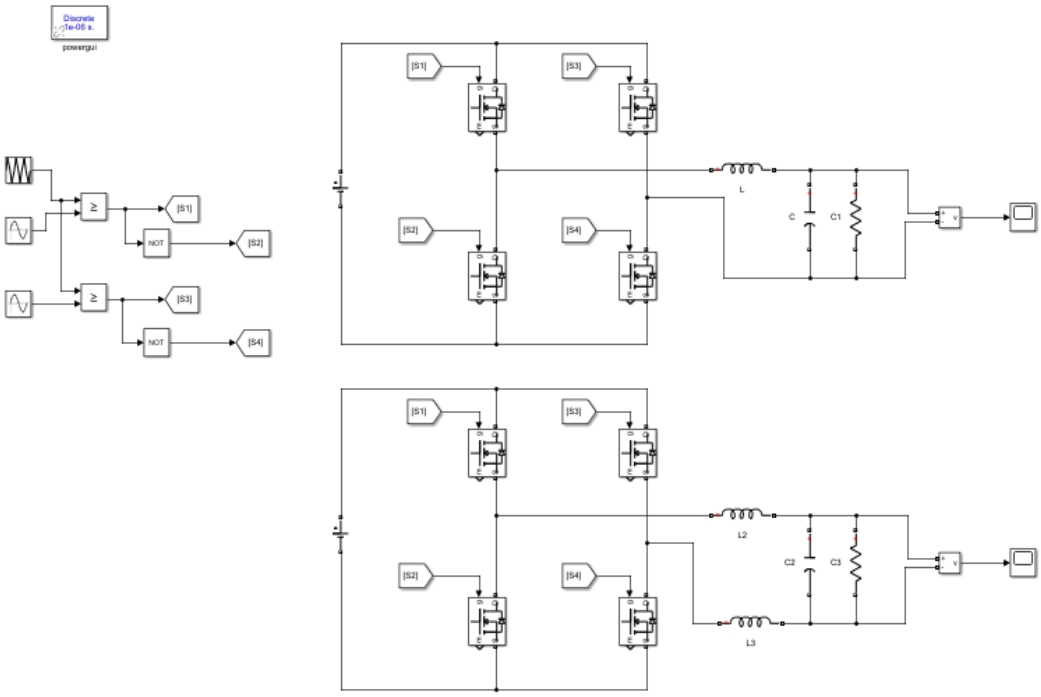

Fig.3 Circuit diagram for first and second order harmonics

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III. RESULTS AND DISCUSSION

Output for Multilevel Inverter

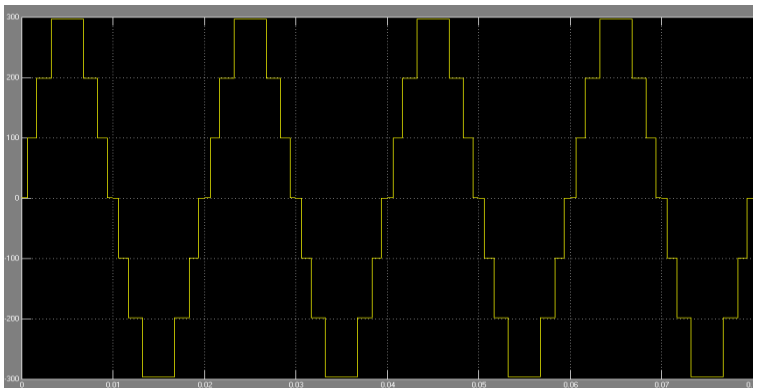

Fig.4 Output for seven level multi inverter

The above output shows that the seven level inverter can reduced the total harmonic distortion from higher level to lower level and without giving the equal efficiency from input to output[4].The input given to the multilevel inverter through the scope is lower comparing to the output.

Output for First Order Harmonics using a Single Phase Voltage Inverter

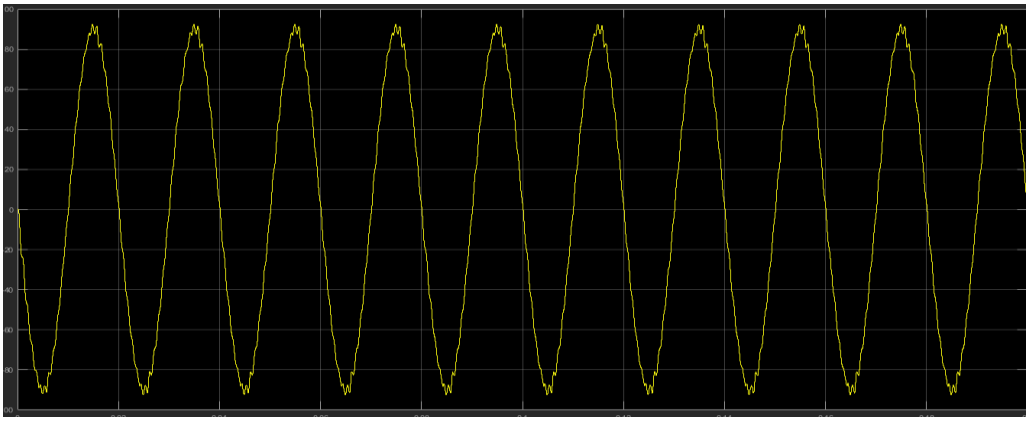

Fig.5 Output for first order harmonics

This output shows that the first order harmonic for the singlephase voltage source inverter.Comparingly first order harmonics THD is higher than the second order harmonics.

Output for second order harmonics using a single phase voltage inverter

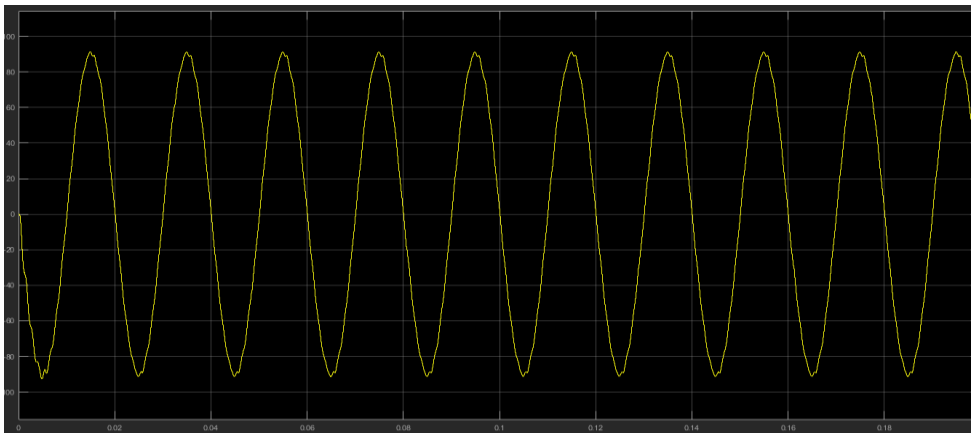

Fig.6 Output for second order harmonics

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This output shows that the second order harmonic for the single phase voltage source inverter. Comparingly second order harmonics[5] THD is lower than the first order harmonics.

Finding of MI by FFT analysis: MI for SCOPE Data1

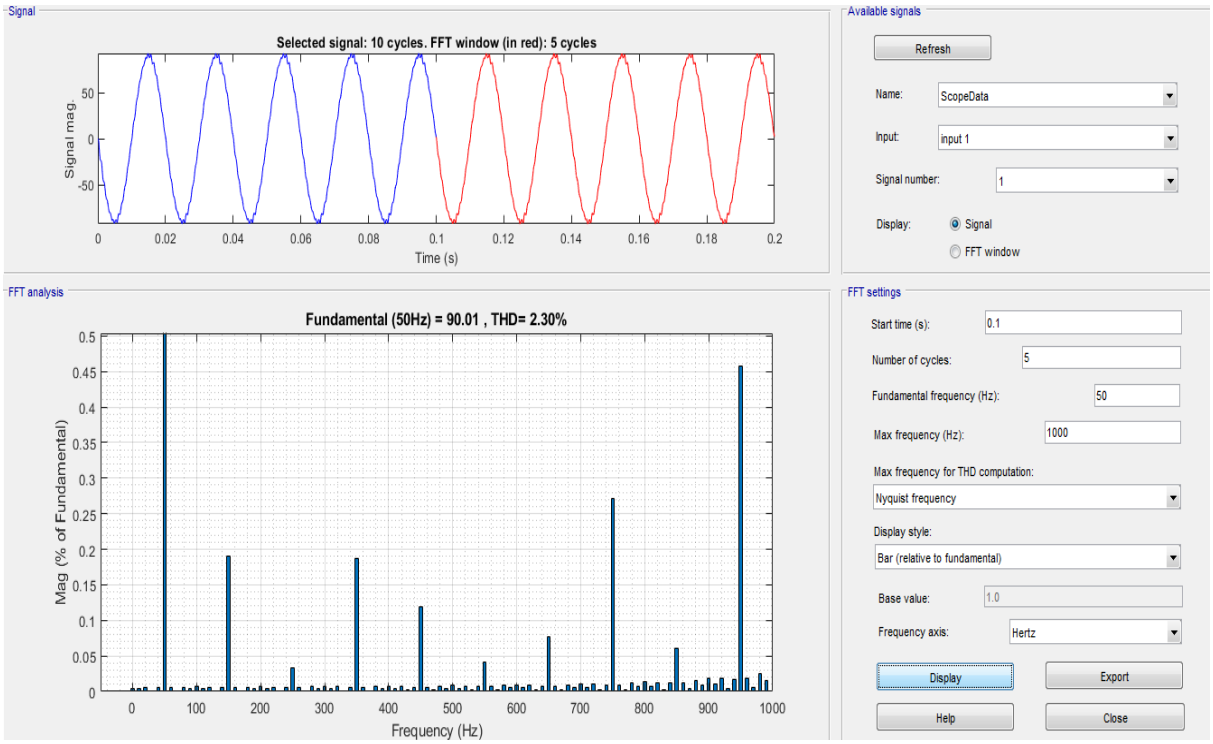

Fig.7 MI for Scope Data1

Modulation Index for the scope data1 is 2.30% by using of FFT analysis, the first order harmonic shows that the time period and frequency for both fundamental and single phase voltage.

MI for Scope Data2

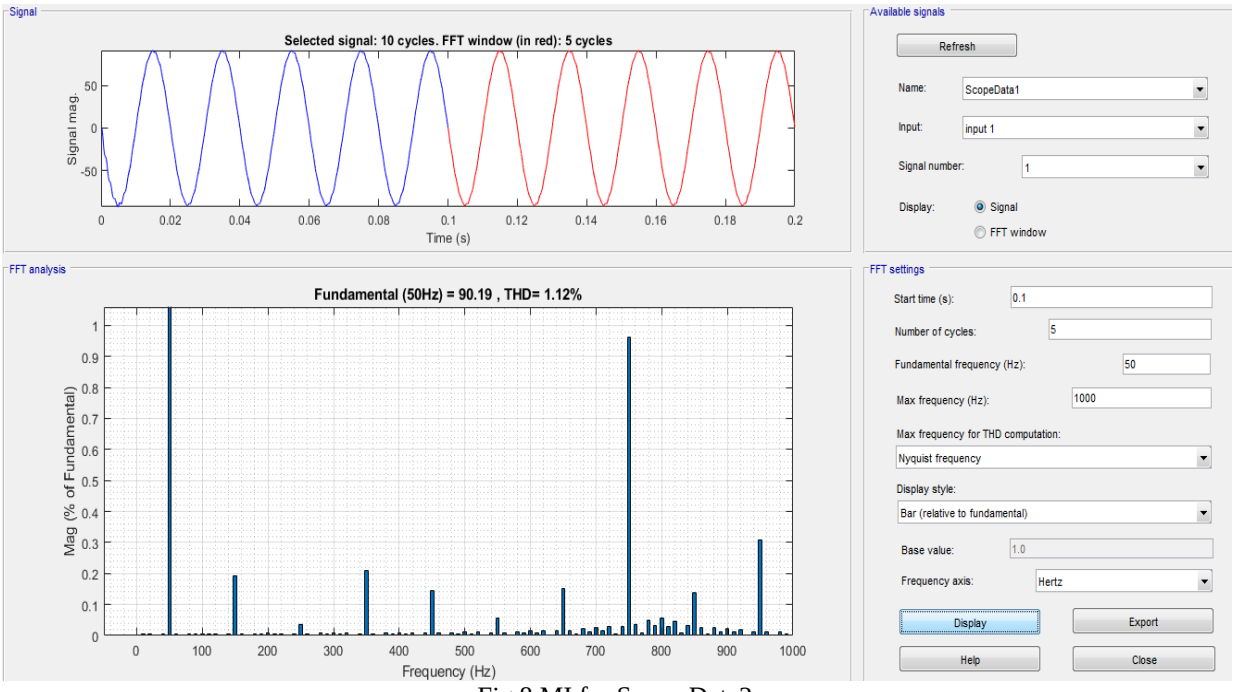

Fig.8 MI for Scope Data2

Modulation Index for the scope data1 is 1.12% by using of FFT analysis, the second order harmonic shows that the time period and frequency for both fundamental and single phase voltage[6].

IV. CONCLUSION

This paper presents development and fabrication of single- phase VSI for various power applications such as UPS, V2G, roof-top solar energy conversion system and micro-grid applications. The main features of this system are lower distortion in output voltage and lower switching operation. The on-board PIC microcontroller is used to generate SHEPWM signals for the single-phase VSI. The switching instants of the SHEPWM are computed using PSO technique at various values of modulation indices[7]. In this way, lower order predominant harmonics up to 21st are eliminated from the output of the inverter[8]. The performance of the built-up system shows the satisfactory results. In future by using the techniques of reducing THD by single phase voltage source inverter and seven level multi inverter lowering the noise occurrence level in the home applicants**.**

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