

## Design and Implementation of Arduino Based Three Phase Inverter

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**Abstract:** This paper describes the design and implementation of an Arduino based three-phase inverter and a passive filter (RC filter) for the reduction of harmonics in the three phase line voltages. Generally, inverters are used in high power applications such as industrial based induction motor etc. The demand for inverters in low power applications is also increasing rapidly, particularly for micro grid, UPS etc. Here the Three-phase Inverter is formed by three legs; each leg consists of two switches. So there are total of six switches. This Three-phase Inverter circuit consists of MOSFETs/IGBTs as switching devices for which the gate pulses are given using a Microcontroller. The microcontroller used here is ARDUINO-UNOR3 through which pulses are generated and given to the switches. In this paper, the MATLAB/Simulink simulation results and experimental results of a three phase inverter (120° conduction mode) with and without RC Filter.

**Keywords:** FFT (Fast Fourier Transform), UPS (Uninterrupted Power Supply), THD (Total Harmonic Distortion).

### I. INTRODUCTION

Solar energy is the most emerging technology in the generation of grid connected electric power, because of its free availability, environment friendly and little maintenance. Now a day's solar power plants are synchronizing with the grid to generate bulk (M.W) amount of power. For the generation of three phase AC supply from the PV module, the inverter plays a key role. In this paper, the proposed method will make solar power generation simple and cost effective. In case of a micro grid, every smart house will act as a power generating plant using green energy. By strengthening the micro grid, the burden on the main grid can be reduced.

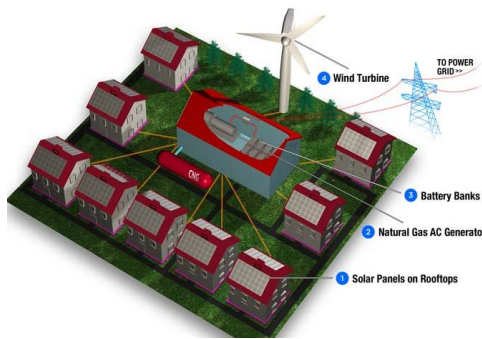


Fig. 1.1 Micro Grid System

Even though the individual smart house can generate only a small amount of power by interconnecting all using

micro grid, it gives a big benefit to the power system. The main advantages are: can reduce the installed generation capacity; reduce the power grid failures by reducing the burden on the main grid.

### II. PROPOSED METHOD

After introducing the Arduino which has an inbuilt microprocessor, the fabrication of power electronic devices becomes very easy. In this paper, the inverter was designed, fabricated, and tested by considering a resistive load as shown in Fig. 2.1. The required triggering pulse to the inverter was taken from the Arduino. The triggering pulse is generated in such a way that each IGBT conducts 120 degree conduction period. A high pass filter was designed for the reduction of harmonics in the three phase line voltages. It is a simple method for the generation of three phase power supply from the battery.

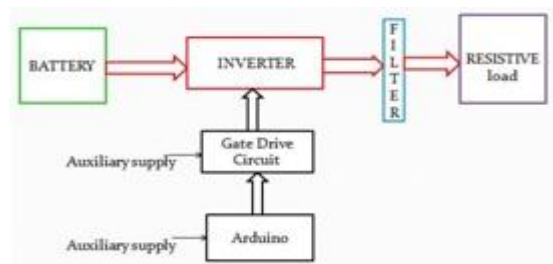


Fig. 2.1 Block Diagram of Arduino Based Three Phase Inverter

Instead of giving the gate triggering pulse directly to the inverter from the Arduino, it is better to isolate the power circuit and controlling circuit using an opto coupler or gate drive circuit to avoid the reverse current flow problems.

### III. MATLAB, SIMULINK RESULTS

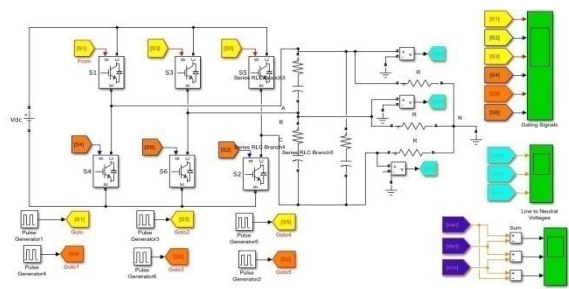


Fig. 3.1 MATLAB Simulink Model of Three Phase Inverter (120 Degree Conduction Mode) with RC Filter

A three phase inverter (120 degree conduction mode) with and without RC filter was simulated. Fig. 3.1.

*a. Without RC Filter:*

The simulated output, three phase line to line voltage waveform which having a 120 degree phase displacement from phase to phase with a frequency of 50Hz, has a Rms value 16.16v(Line Voltage), By considering the input battery voltage as a 24v, shown in Fig 3.2 . And its FFT analysis observed that the lower order harmonics are dominant compare to higher order harmonics and the total harmonic distortion with respect to fundamental is 31.27%. Fig 3.3.

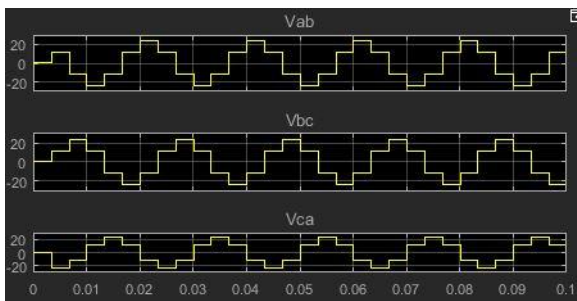


Fig. 3.2 Simulink Results Of Output Three Phase Live Voltages Without RC Filter.

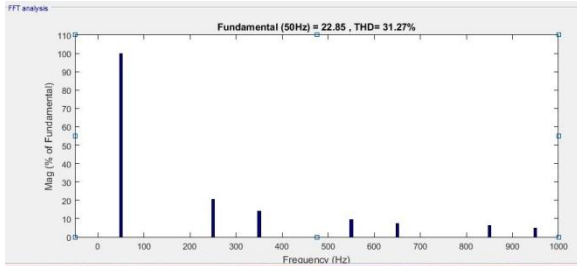


Fig. 3.3 FFT Analysis of Simulated Line Voltage Without RC Filter

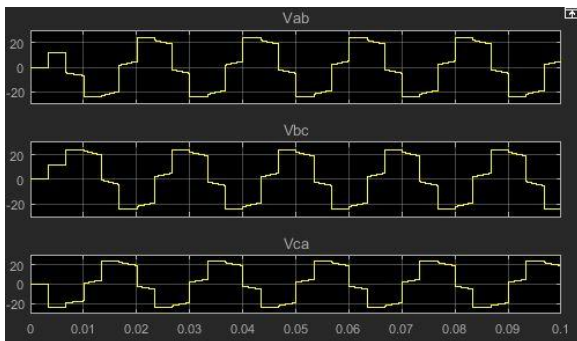


Fig. 3.4 Simulink Results of Output Three Phase Live Voltages With RC Filter.

*b. With RC Filter:*

The simulated output, three phase line to line voltage waveform which having a 120 degree phase displacement

from phase to phase with a frequency of 50Hz, has a Rms value 17.7v(Line Voltage), By considering the input battery voltage as a 24v, shown in Fig 3.4 . And its FFT analysis observed that the total harmonic distortion with respect to fundamental is reduced to 27.29%. Fig 3.5.

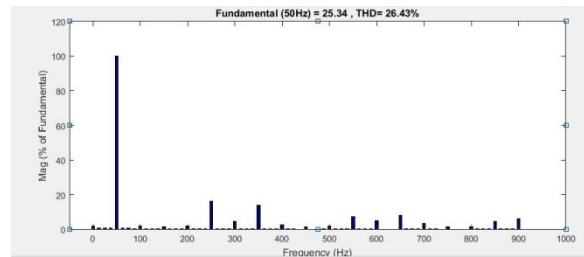


Fig. 3.5 FFT Analysis of Simulated Line Voltage With RC Filter

**IV. EXPERIMENTAL RESULTS**



Fig. 4.1 Experimental Setup of Arduino Base Three Phase Inverter With RC Filter

A three phase inverter was fabricated using the IGBT's having a modal number FGA25N120ANTD. input dc voltage to the inverter was taken from a battery Fig4.2, by connecting two 12v batteries in series. To operate the inverter in 120 degree conduction mode, the required triggering pulse was taken from the Arduino (UNOR3). An opt coupler (TLP250) was used for keeping an electrical isolation in between the controlling circuit and power circuit. Fig4.3 is the evidence that how the upper and lower switch in the same leg is operating, from the figure it is clear that each switch is conducting 6.66 ms, and 3.33ms time delay between upper and lower switch conduction. The three phase inverter Output line voltage was measured by using the digital storage oscilloscope(TPS2000B), which having a power analysis application.



Fig. 4.2 Input Voltage to the Inverter Take from the Battery

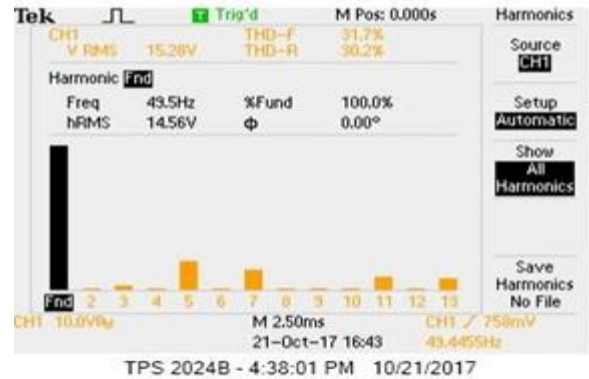


Fig. 4.5 FFT Analysis of a Live Voltage without RC Filter  
 b. With RC Filter:

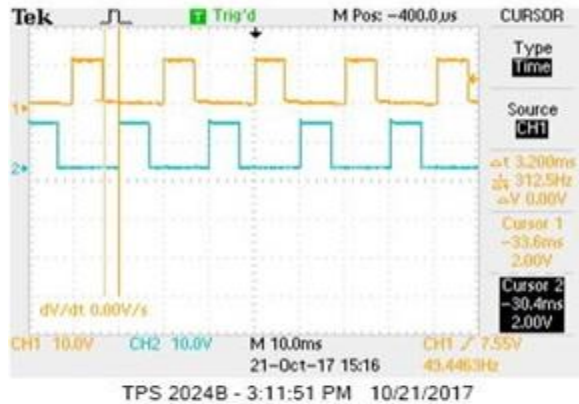


Fig. 4.3 Time Delay Between Upper and Lower Switch  
 a. Without RC Filter:

In the experimental setup, line voltage waveform of the inverter is measured a value of 15.4v, which is having a frequency 49.99Hz. Fig. 4.4. and its FFT Analysis observed that even harmonics are almost zero, The THD value with respect to fundamental component is 31.7%. Fig. 4.5.

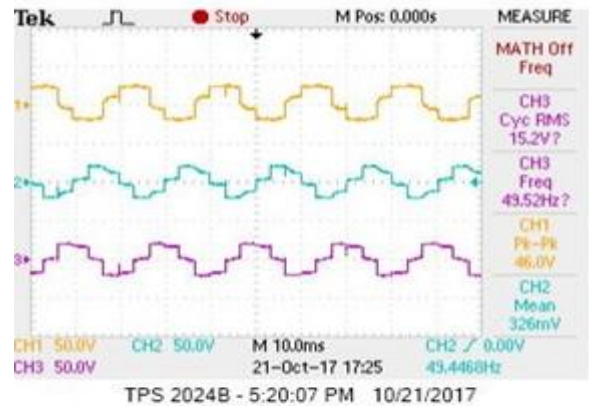


Fig. 4.6 Three Phase Line Voltages of the Inverter with RC Filter

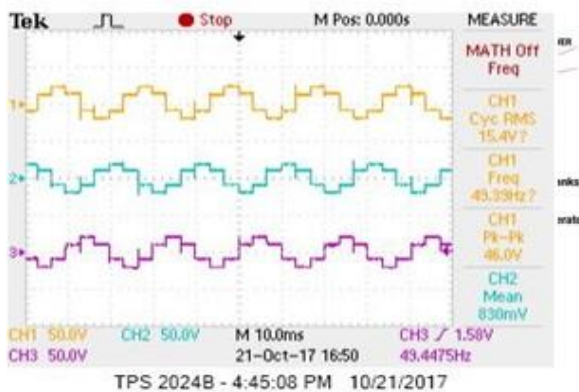


Fig. 4.4 Three Phase Line Voltages of the Inverter without RC Filter

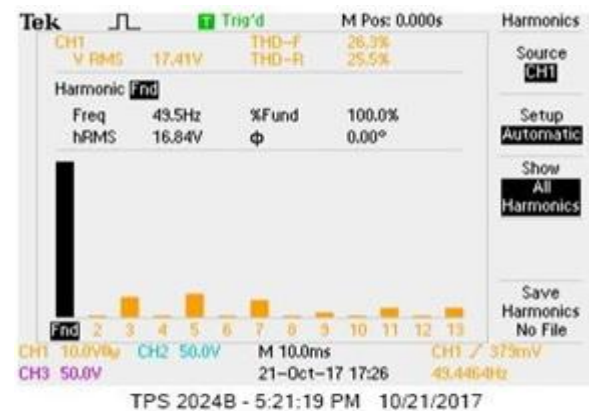


Fig. 4.5 FFT Analysis of a Live Voltage with RC Filter



## V. CONCLUSION

In this paper compared a MATLAB/simulink results and hardware results of a three phase inverter with and without RC filter. By using the passive filter (RC filter), reduction of THD value of certain frequency is observed. In hardware results observed that the value of THD is reduced from 31.7% to 26.3% by using RC filter. Since the triggering pulse is generated easily by using Arduino, design and implementation is very simple. It is helpful to the house hold applications like UPS, Micro Grid system.

## VI. REFERENCES

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