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Single Phase to Three Phase Converter

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ABSTRACT: This paper presents a single phase to three phase converter topology using power electronic devices. Different converter section is used for the conversion. This idea will reduce the switching current and harmonic distortion of input side converter. The input to the converter is a single phase supply and the output taken is a balanced three phase. With the help of IGBTs which is used for six leg inverter. The sinusoidal waveform is remain constant even though the load is increased. Simulation and experimental results are provided to illustrate and compare the operation of the system.

KEYWORDS: AC to DC converter, DC to AC converter, IGBTs, drive system, inverter, Boost converter, PWM, H, CRO.

I.INTRODUCTION

In the past single phase to three phase converter is complicated due to the use of capacitors and reactors with autotransformer converters[1]. Such kind of system was expensive and less efficient, so to overcome this power electronics components are used. At the beginning of solid state power electronics devices, these were normally used as switches and were the major technology used for power processor[2]. Beyond the power switches different circuit topology were invented with the help of power electronics devices such as three-phase to three-phase, single phase to single phase and three-phase to single phase conversion systems. There are some rural areas in which the single phase supply is only available, so it is very difficult to get a three phase supply for industrial purpose therefore it is better to convert single phase to three phase converter. This paper proposes an alternative solution for phase conversion with very low overall cost, moderate performance during start up and high steady-state performance at line frequency. This system fits the requirements in rural areas where only a single-phase supply is available.

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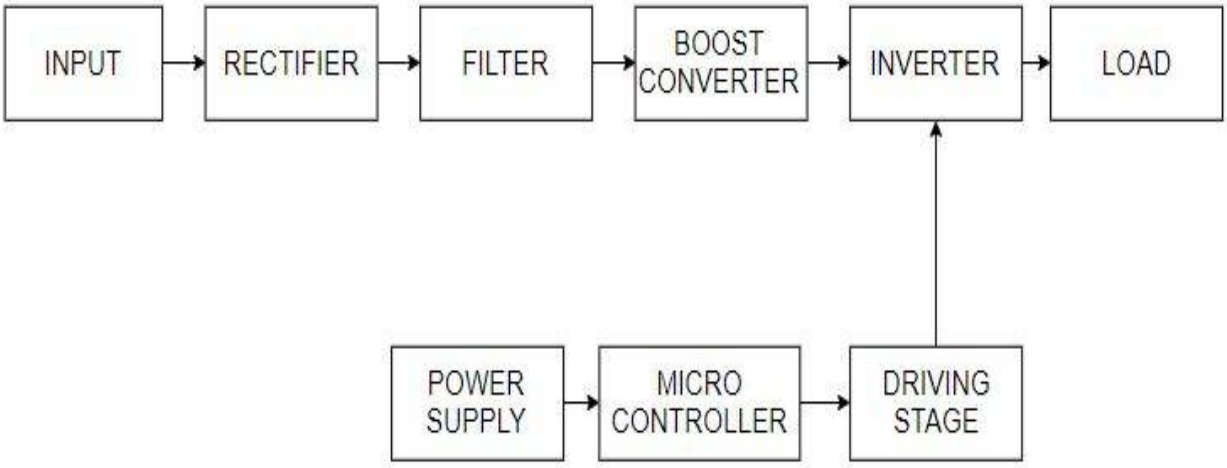
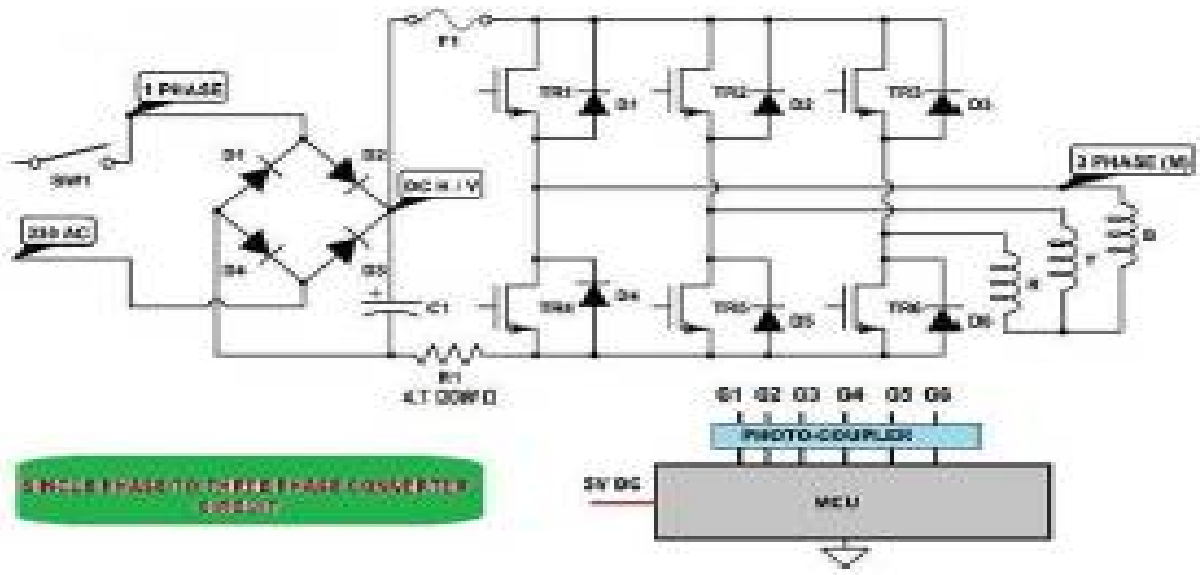
II.BLOCK DIAGRAM



The block diagram consists of mainly two parts, a converter stage and driving stage. The AC supply is given as the input to the rectifier block. The rectifier rectifies the AC signal to corresponding DC which may not be pure DC and contain some AC, the pulsating DC is then filtered using a capacitor or inductor filter then the output will be of pure DC. This output is given to the inverter block which is controlled by the driving stage. The gate of the IGBTs is controlled from a controller, in which the output of the controller is a sin PWM. The appropriate sin PWM program is loaded into the controller. The controller is energized from the 5V battery. The output of the inverter is given to the load.

III.CIRCUIT DIAGRAM



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From the circuit diagram shown above the single phase supply is converted to DC and again inverted to AC [2] .The gate drive circuit needs an interface between the controlling signals coming from the microcontroller and the IGBT in the circuit. The microcontroller gives 5V signal, while the waveform generators allow for a specified voltage level. The gate to source voltage needed for desired operation of the IGBT is on a 110 DC level, but in order to get line to line voltage of 415V AC as output the DC level of IGBT is to be more than 110V. In addition, the high side IGBT in this circuit do not have the source connected to ground, so the actual voltage needed to drive the gate depends on the varying voltage at the source. One drawback to the high switching frequencies is the decrease in efficiency that occurs from switching loss and also generates little acoustic noise since the switching frequency lies in the audible acoustic range (20 Hz – 4 k – 20 kHz). These control schemes also provide good dynamic performances. However, this application does not need good dynamic performance since there are no dynamic load and speed requirements. The rating of power element such as power IGBTs DC bus is of 1200V.

IV.WORKING

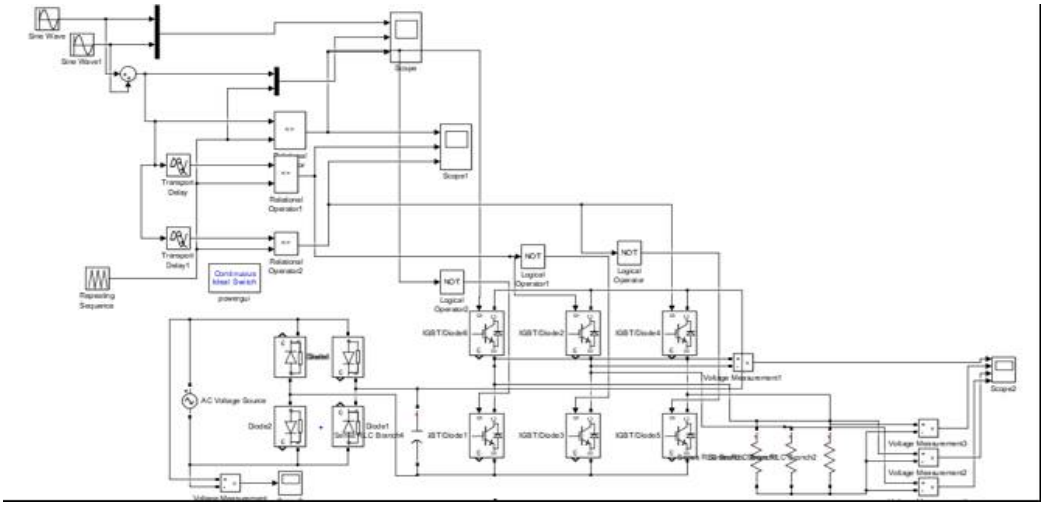
As shown in above circuit diagram that the single phase 230V supply is given to the input of the rectifier with the help of a autotransformer which is used to adjust the AC input voltage and the rectifier circuit will convert the single phase AC to DC. The filter is connected to reduce the harmonics present in the AC and gives the pure DC, the fuse is connected to protect the circuit and the resistor is connected to limit the current.

The output of rectifier will not be sufficient for the inverter to give the output of line to line voltage 415V AC. So a boost converter is designed and kept in between rectifier and inverter circuit which will boost the DC value from 300V to 600V, as then boost converter circuit is connected to six leg inverter which consists of IGBTs to convert to three phase AC. Each gate of IGBT is connected to of microcontroller. In microcontroller the embedded program of sine PWM is loaded and which drives the IGBT [3].

We are giving 230v supply to rectifier, during positive half of input two diode are triggered and for negative half of input another two diode are trigger and AC supply is converted to DC. In inverting stage we using six IGBT as inverter. Upper side three IGBT are called as positive group IGBT and lower side three IGBT are called as negative group IGBT. IGBT work in 120 degree mode of operation in which one IGBT from positive group and another two from negative group and after that one from negative group another from positive group. Same procedure is followed by whole inverter circuit. Diodes are connect across each IGBT to limit the reverse current flowing through the inverter. In this way we getting the three phase from middle of two IGBTs.

V. SIMULATION AND RESULTS

SIMULATION MODEL



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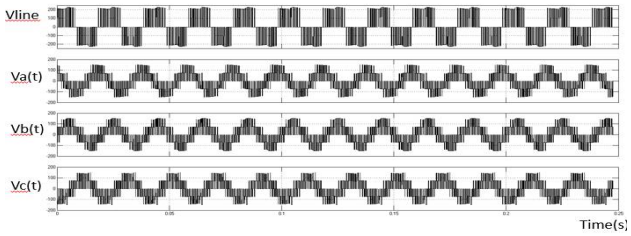
The simulation was done using MATLAB 2013 software and the results is shown below.

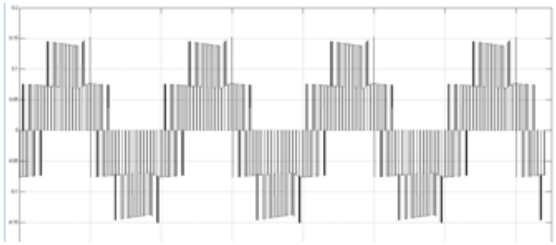
RESULTS:

LINE AND PHASE VOLTAGES



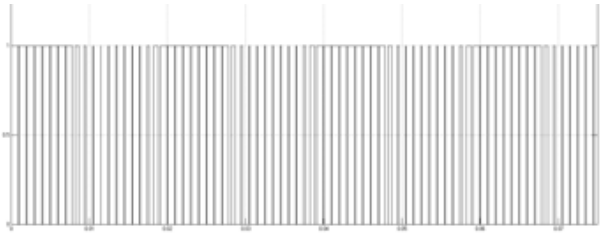
The line to line voltage and phase voltage of three phases are shown

CURRENT PER PHASE



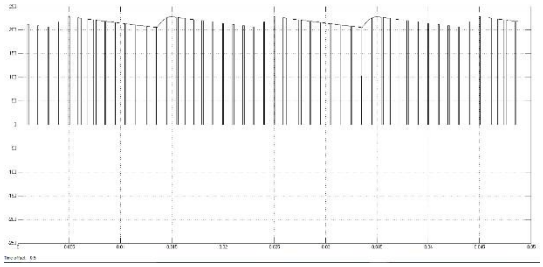
The load current per phase is shown .

GATE PULSE OF IGBTs



The gate pulses from the driver which is given to the gate of the six IGBTs

VOLTAGE ACROSS IGBTs



The voltage across each IGBTs shown.

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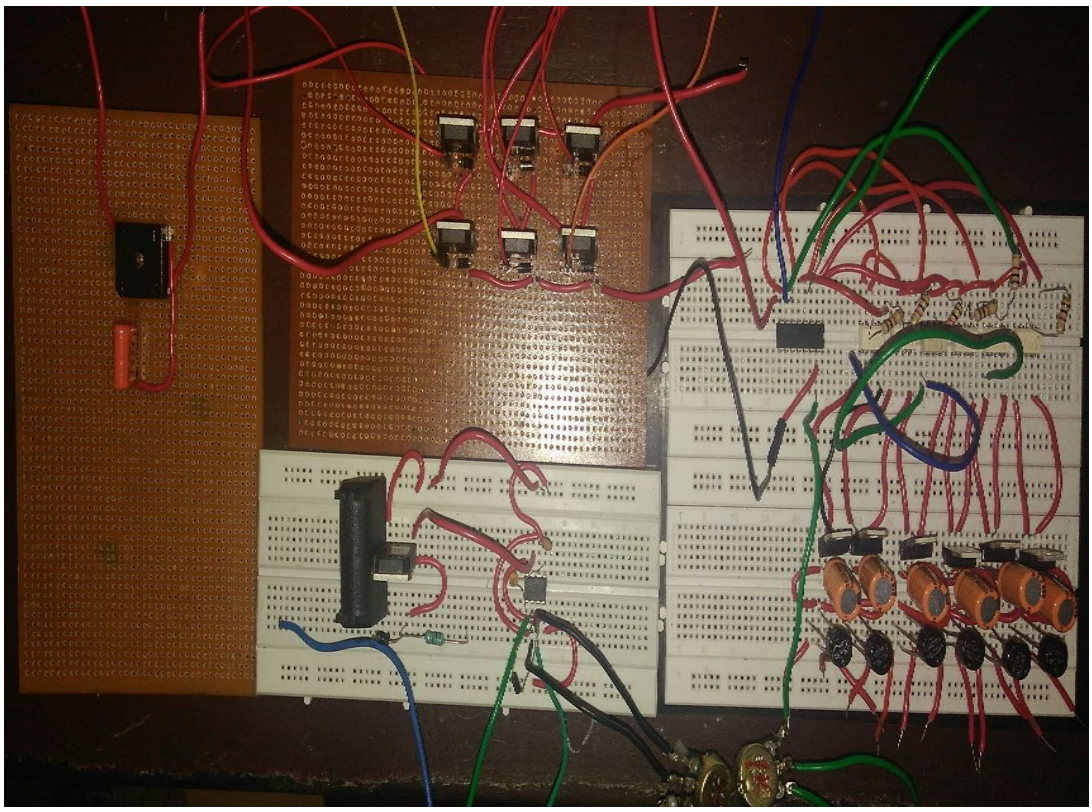
VI.EXPERIMENTAL SETUP

HARDWARE :



The experimental setup consists of Rectifier, Boost converter and an Inverter circuit. Rectifier part comprises of 1000V,10A Bridge rectifier and 1000 microfarad capacitor which is used as filter. Boost converter comprises of an inductor of 1mH,Capacitor of 33 microfarad,500 volts and an IGBT of 1200V,25A which is used as the switching device. Inverter section is a six leg inverter, in which 6 IGBT of 1200V,25A is used.TLP250 IGBT driver is provided for the proper gating pulses of inverter circuits.12V supply for driver circuit is given from 230/12 volt,1A transformer and is rectified using 1A bridge rectifier. Rectified dc is filtered using 100 microfarad capacitor and constant DC voltage of 12 volt is taken out using LM7812 voltage regulator.

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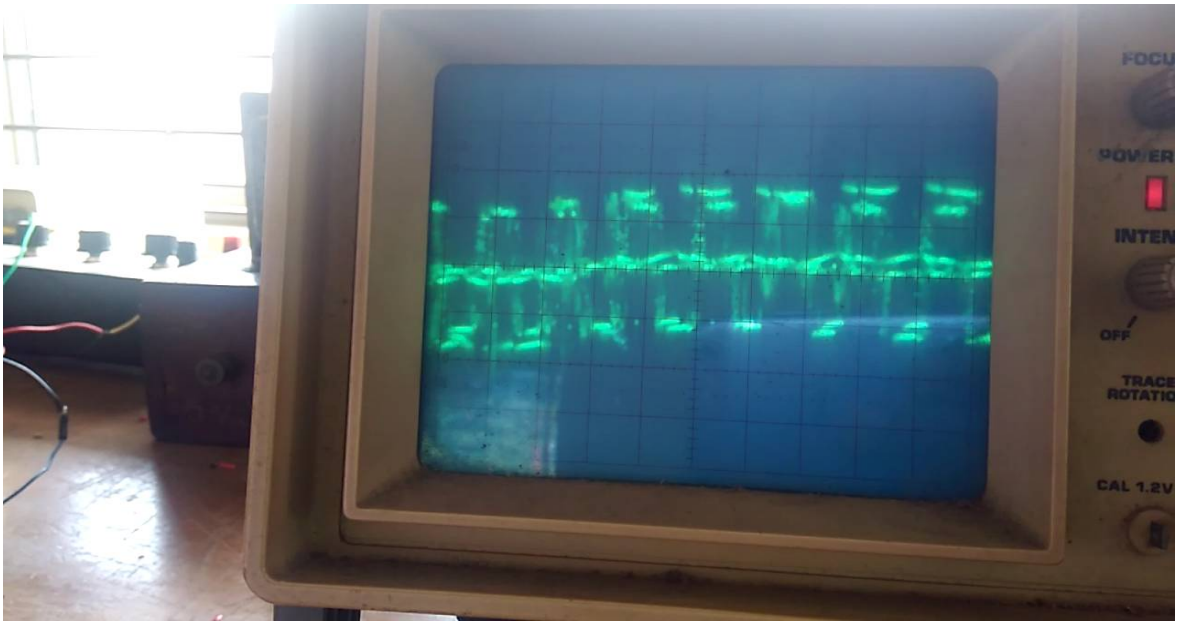
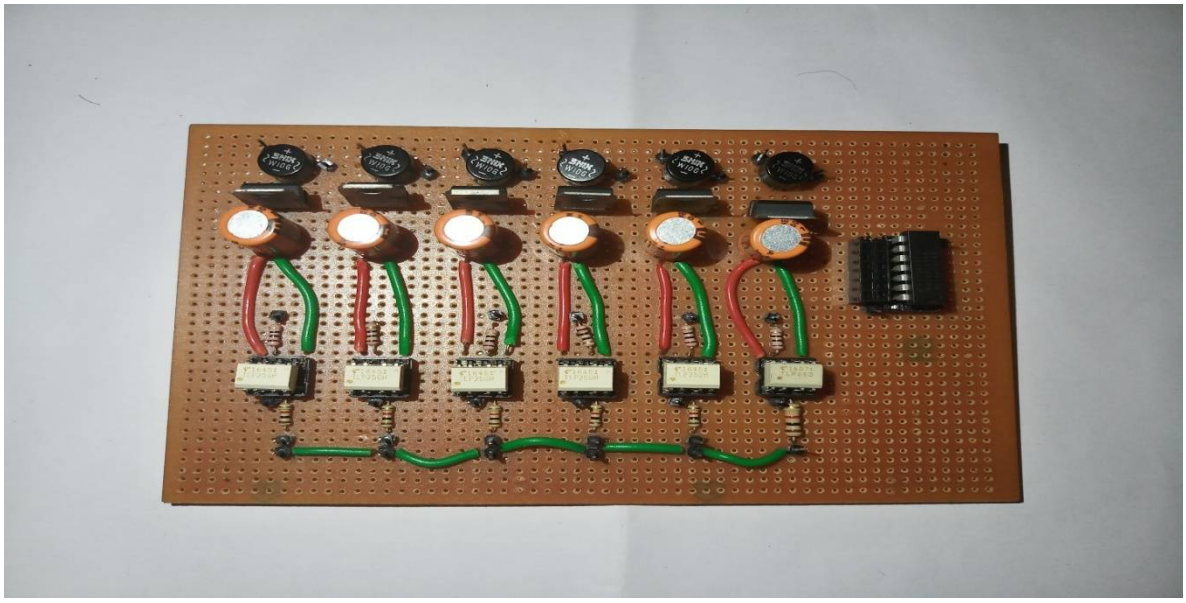
CRO OUTPUT OF LINE TO LINE VOLTAGE



The output is shown in the CRO is line to line voltage and the input is given from a voltage source

GATE DRIVER CIRCUIT



In order to avoid the conduction of same leg in the inverter circuit TLP250 driver ICs is used.

The given figure shows the driver circuit for IGBTs.

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VI.CONCLUSION

The idea of this paper utilize to give a three phase supply from a single phase source to drive the load.A boost converter is used improve the DC voltage level in order to get the output AC voltage of appropriate value. After boost converter circuit the power factor will be reduced since converters are used, so power factor has to be improved, which can be done using the power factor correction circuit. An alternative solutionfor phase conversion with very low overall cost, high steady-state performance at line frequency.This system fits the requirements in rural areaswhere only a single-phase supply is available.

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