

Single Phase to Three Phase Converter

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Abstract - This paper presents a converter topology for driving a three-phase motor load from a single-phase supply. It consists of a rectifier and an inverter circuit. The front-end rectifier is to provide a DC link voltage through a split capacitor. The two-leg inverter converts this DC link voltage into 3 phase supply. This converter can run a three-phase Induction motor which is much more efficient compared to a single-phase motor. In this paper, two closed-loop controllers are employed to achieve balanced output voltage. Among those two closed-loop controllers, one is for maintaining the DC link voltage constant and, the other is for inverter output. Therefore, the single-phase to three-phase converter brings the controllable output voltage as in a six-switch standard three-phase inverter. The front-end rectifier has the capability of active input current shaping. The designed converter model is simulated by using MATLAB Simulink software.

I Introduction

In the past, single-phase to three-phase conversion systems were made possible by the connection of passive elements capacitors and reactors with autotransformer converters. Such kind of system presents well know disadvantages and limitations. Both have the advantages of simple structure and reasonably low cost. Since the beginning of the solid state power electronics, the semiconductor devices were the major technology used to drive the power processors. Looking at the semiconductor devices used in the former controlled rectifiers and comparing them with the new technologies it makes possible to figure out the astonishing Development. Beyond the

improvement related to power switches, it was also identified a great activity in terms of the circuit topology innovations in the field of three phase to three-phase, single phase to single phase and three-phase to single phase conversion systems. The single-phase induction motor drives by the three-phase induction motor drives in some low-power industrial applications. When the three phase induction motor is driven by a single phase induction motor by rotary phase converters and autotransformer capacitor phase converters, this causes more loss as compared to the new this method. Motor drives constitute a predominant load for the agricultural sector. As most rural communities in the India are supplied with single-phase ac power, these drives have to be realized with single-phase motors, or with three phase motors (Induction Motors) driven by phase converters. Autotransformer capacitor phase converters, however, cannot easily obtain balanced output voltage with reasonable cost, and rotary converters are heavy and have significant no-load losses, also both topologies have high inrush current during motor start up. The three-phase induction motors have some advantages in the machine efficiency, power factor, and torque ripples compared to their single-phase counterparts. Though the precise control of single phase induction motor is less complex in comparison to the three phase induction motor, but when the torque requirement is considered then three phase induction motor is the best choice. The applications for these motors cover almost every stage of manufacturing and processing. It is not surprising to find that among all type of electric

motors, Induction motor is so popular, when one considers its simplicity, reliability, and low cost. Therefore, it is desirable to replace the single-phase induction motor drives by the three-phase induction motor drives in some low-power industrial applications in some rural areas where only a single-phase utility is available, we should convert a single-phase to a three phase supply. This paper proposes an alternative solution for phase conversion with very low overall cost, moderate motor performance during start up and high steady-state performance at line frequency.

II Literature review

1. Naung Cho Wynn et al. (2008) A new single phase to three phase converter topology for small industries is presented in this paper: Phase converter, include this paper, is a new technology that supplies three phase power from a single phase source to power inductive, resistive and capacitive loads with distinct advantages over any existing converter technology. The converter consists of DC power supply, a MOSFET Hex-bridge, integrated gate drive IC, and a DSP to generate the switching signals. The switching signals generated are a unique version of selective harmonic elimination, which produces a consistent starting point for the switching functions, independent of the number of harmonics eliminated This converter covers the basis of induction motors and different types of other motors. They are ideal for farms, workshops, garages and large building etc.

2. EuzeliCipriano dos Santos et al. (2012) Single-phase to three-phase conversion using power electronics converters is a well-known technology, especially when the configurations and control strategies already established in the technical literature are considered. Regarding the configurations conceived over the years, it can be observed two main tendencies: 1) configurations with a reduced number of components; and 2) configurations with an increased number of components. The search for topologies with a reduced number of components was the trend over a long period of time. This can be, in

part, explained by the high cost of the power switch when compared to the capacitor used in the dclink bus. Then, the converter leg was sometimes substituted for the midpoint capacitor. However, as far as the price of the semiconductor was going down, such tendency has been changed, and now the configurations with an increased number of components do appear as an interesting option, especially in terms of reliability, efficiency, and distortions improvement. A comprehensive review of the two possibilities (reduced and increased number of components) has been considered in this paper. Also, the single-phase to three-phase ac-ac direct conversion configurations and those which aim to reduce the dc-link voltage fluctuation have been included. The goal of this paper is to provide a complete range on the status of single-phase to three-phase power conversion technologies to professionals and researchers interested in this topic.

3. Presented a simple converter topology for driving a load with a single-phase ac supply. Using only six active switch IGBT's. The converter supplies balanced output voltages at rated frequency, the proposed topology permits to reduce the rectifier switch currents, the harmonic distortion at the input converter side, and presents improvements on the fault and control approaches are supported by test results. The convertor takes single phase supply and converts it into three phase supply with the help of thyristors. The single phase supply is first converted into dc supply by using rectifier again dc supply of rectifier is given to inverter where IGBT's are used and converts the dc supply again into three phase ac supply. The experimental result showed that sinusoidal waveform produced remained approximately constant with increase in load and the developed hardware has satisfactory converted the single phase power to three phase power supply.

III Design Aspects

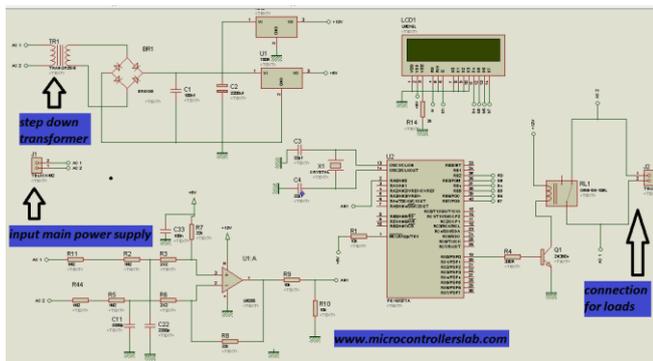


Fig.1 Circuit Diagram

In Agriculture area Three phase is only 8hours. Remaining hours there is only Single phase supply is available. So, hence we convert single phase supply to three phase to overcome farmers problem. In this, when supply comes at incoming unit, It gives supply to sensing unit. It sense where the supply is single phase or three phase, If supply is single phase then it gives supply to converter. It is a super capacitor based fully microcontroller converter, in this single phase to three phase conversion takes place. Then this three phase converted supply gives to voltage frequency converter. Which controls voltage and frequency & gives the controlled supply to the motor. If supply is 3 phase then, the supply is go through the relay unit to controller & the motor. In this condition rest of the system is in pause mode.

In this circuit four terminals of incoming supply R, Y, B, N, are conneted to 3 pole contacor and supply go to three banana pins. Then the supply go to the2 transformer , it steps down the suuply voltage to 24 volt & 1.5 amp. Then the supply go to the 3 phase pure sine wave transistor and thyristor based inverter. The inverter circuit activates by 8052 microcontroller based 6 stage transistor based gate firing circuit. Then the supply is passed through 2 pole 16A relay contactor and then the supply go to the output terminals. In this circuit 1 capacitor is connected for power factor improvement and for phase split purpose.

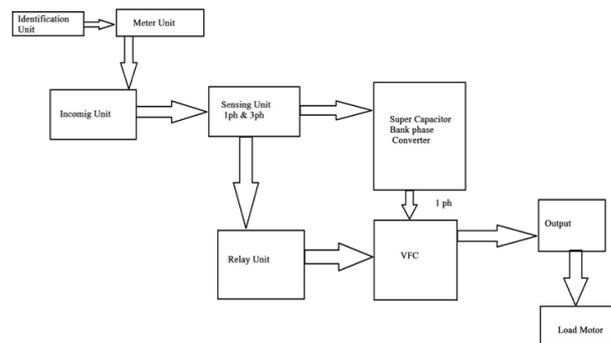


Fig. 2 Block Diagram

IV Experimental Results

A. Hardware result



Fig. 2 Experimental result

The incoming supply R Y B N is connected to four terminals on kit. The incoming supply on kit is connected to 3 pole contactor. In this, when supply comes at incoming unit, It gives supply to sensing unit. It sense where the supply is single phase or three phase, If supply is single phase then it gives supply to converter. It is a super capacitor based fully microcontroller converter, in this single phase to three phase conversion takes place. Then this three phase converted supply gives to voltage frequency converter. Which controls voltage and frequency & gives the controlled supply to the motor. If supply is 3 phase then, the supply is go through the relay unit to controller & the motor. In this condition rest of the system is in pause mode. In this circuit four terminals

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B Simulation Results

A three-phase 5hp Induction motor with the specifications listed in the appendix section has been used in this simulation. The MATLAB model of the single-phase to three-phase converter is simulated and the results is shown in the below figures for the given three-phase induction motor. The output line voltages, three-phase output currents, speed (ω_m), Electromagnetic torque (Nm) and THD for the input current.

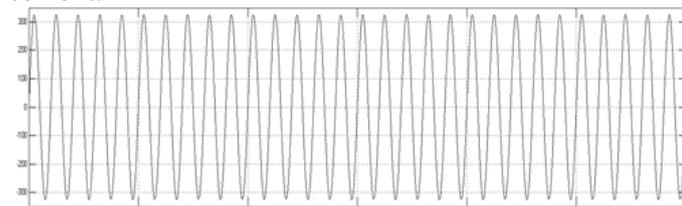


Fig. 3 Input source voltage

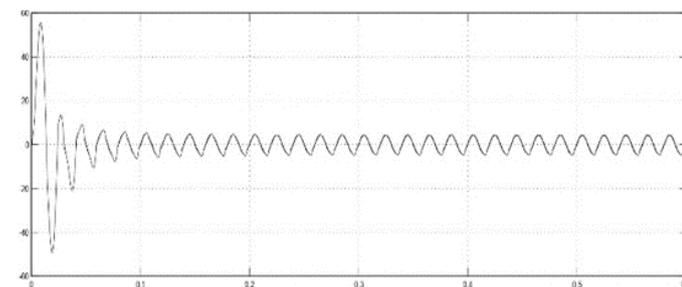


Fig.4 Source current

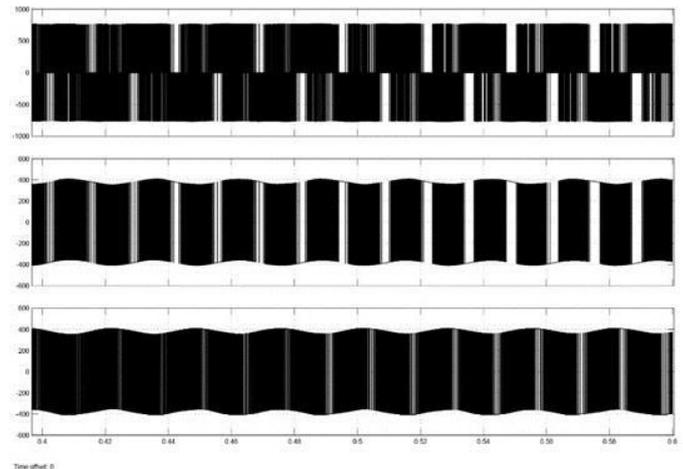


Fig.5 Three phase inverter output voltage

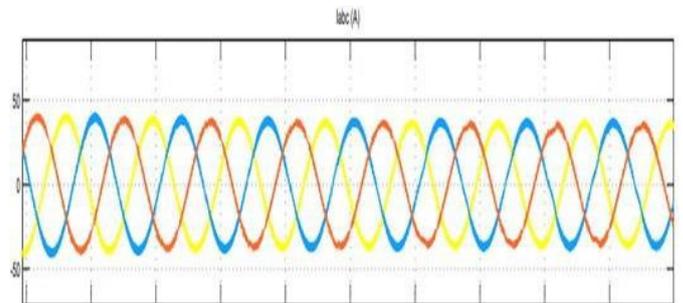


Fig. 6 Induction motor input currents

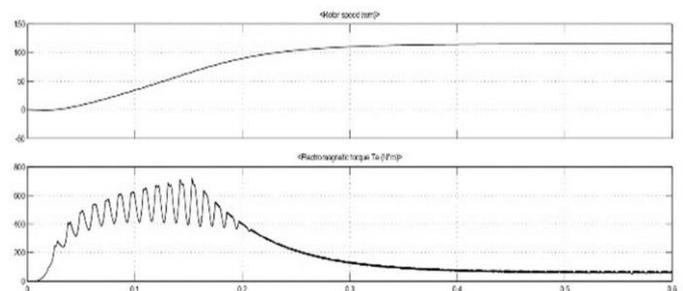


Fig.7 Motor speed and Electromagnetic torque

V Conclusion

Three phase asynchronous induction motors are widely used in industrial applications due to their features of low cost, high reliability and less maintenance. Due to the need for three-phase electricity in today's remote areas for agriculture work where three phase power is not available easily, in those areas these single phase to three phase converters are use full. Operating a three phase induction motor using single

phase supply has been presented. The developed system is useful in remote areas where three phase supply is not available easily. Applications of single phase to three phase converter are:

- Electric Vehicle.
- In Irrigation Pumps for Agriculture purpose.
- Rural Area Water Supply.

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