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# Power Quality Improvement in Conventional Electronic Load Controller for an Isolated Power Generation

1 B Saritha, 2 S Sravanthi

1 Assistant Professor, Lords Institute of Engineering and Technology, Hyderabad, India.

2 Assistant Professor, Lords Institute of Engineering and Technology, Hyderabad, India

## Abstract

Use of an induction machine as a generator is becoming more and more popular for the renewable sources. Brushless construction with squirrel cage rotor, reduced size, absence of DC supply for excitation to reduce maintenance and better transient performance are the main advantages of the asynchronous generator over the synchronous generator. Although having number of advantages, reactive power consumption and poor voltage regulation under varying loads is the major hurdle in its effective operation. In this paper we have proposed a voltage and frequency controller for an isolated asynchronous generator.

**Keywords:** e-load, IAG, ELC

## Introduction:

The autotransformer-based configurations provide the reduction in magnetics rating, as the transformer magnetic coupling transfers only a small portion of the total kilo volt ampere of the induction generator drive.

This paper presents an autotransformer-based 24-pulse ac–dc converter with reduced magnetics rating and suitable for retrofit applications (where presently 6-pulse converter is being used. This arrangement results in elimination up to 21st harmonic in the input line current.

A comparison of existing topologies has been made to demonstrate the effectiveness and the advantages of the proposed configuration. The proposed converter is able to achieve almost unity power factor in wide operating range of the drive.

## Electronic Load Controller:

In Nepal, almost all of the micro hydro systems are based on run-off-river type. Storage system has not been put into practice because of its high cost. This result in the generation of constant power by the generator but the consumer load may vary from time to time. In the case of peak load almost all the generated power is consumed but when the required load is less than the generated power the voltage and the speed of the generator increases which causes serious problems in the appliances used by the consumer and

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other system components such as transformer and motor loads. Over voltage may cause overheating, reduction in life of different devices whereas under voltage reduces the heat output in case of heating devices and intensity of lighting devices.

An electronic load (or e-load) is a device or assembly that simulates loading on an electronic-circuit.

**CIRCUIT CONFIGURATION AND DESIGN OF PROPOSED 24-PULSE AC-DC CONVERTER:**

For harmonic elimination, the required minimum phase shift is given by below formulae.

Phaseshift=$60^{o}$/numberofconverters.

For achieving a 12-pulse rectification, the phase shift between the two sets of voltages may be either $0^{o}$ and $30^{o}$ or $\pm 15^{0}$ with respect to the supply voltages. In this work, an autotransformer based on the $0^{o}$ and $30^{o}$ phase shift has been studied to reduce the size of the magnetics.

The two rectifier output voltages $V_{d1}$ and $V_{d2}$ are identical except for a phase shift of 30◦ (required for achieving 12-pulse operation) and these voltages contain ripple of six times the source frequency. The rectifier output voltage $V_d$ is given by

$V_d=0.5(V_{d1}+V_{d2})$……………………………*(1)*

Similarly, the voltage across interphase transformer or reactor is given by

$V_{d1}=V_{d1}-V_{d2}$……………………………………..(2)

$V_m$ is an ac voltage ripple of six times source frequency appearing.

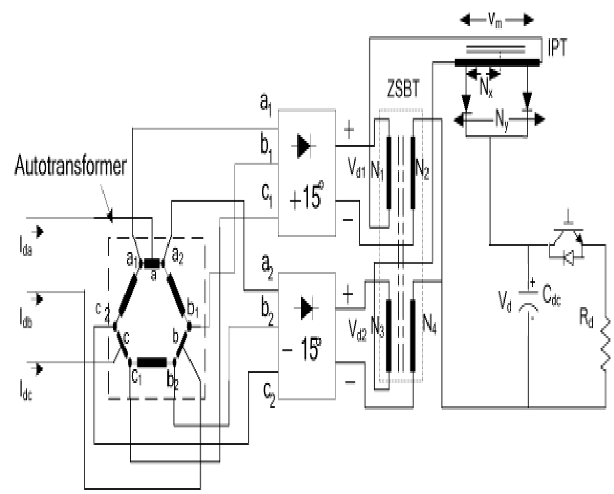


Fig 1: Proposed 24 Pulse ELC

**Polygon connected autotransformer**

To achieve 12-pulse rectification, the necessary requirement is the generation of two sets of line voltages of equal magnitude that are 30º out of phase with respect to each other (either +15º and -15º or 0º and 30º).

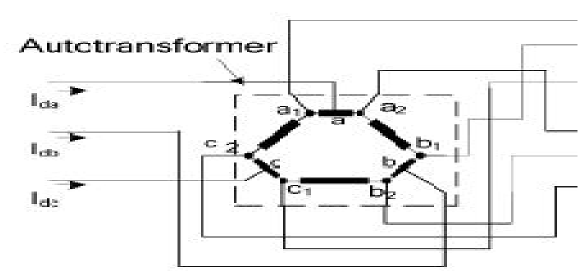


Fig 2: Auto transformer

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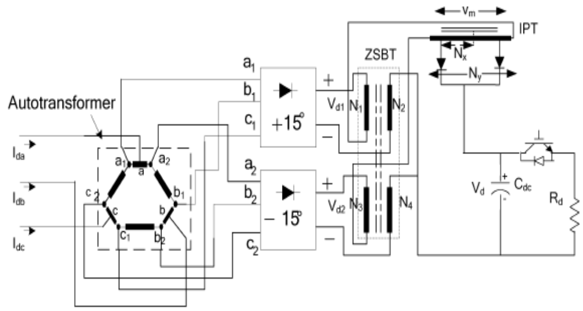


- ✓ Integral controller
- ✓ Differential controller
- ✓ Proportional-Integral (PI)controller
- ✓ Proportional-Differential (PD)controller
- ✓ Proportional-Integral-Differential(PID) controller

Among above, only PI-controller is used in our system configuration (i.e., conventional and proposed).

**Results Analysis:**

Following figures shows the different transient waveforms of IAG with conventional ELC using six-pulse diode bridge rectifier. Here the value of the capacitor is selected for generating the rated rms voltage (415V) at rated load (7.5 kW). Initially, the consumer load is OFF and ELC is consuming full power to an auxiliary load. At 1s, a consumer load of around 4kW is switched ON and it is observed that to control the constant power at the generator terminal, the current drawn by the ELC is reduced. While on removal of consumer load at 2.3s, it is again increased. Because of using six-pulse bridge rectifier based ELC, the distortion in the generated voltage and current is observed, and the magnitude and frequency of the generated voltage are controlled (Here it is clearly demonstrated that when the consumer load is applied, the controller responds and current flowing through ELC is reduced to control total generated power at he generated terminal constant). Availability of the sufficient excitation capacitor keeps the constant voltage at the generator terminal. Here an observation is made that because of non-linear behavior of ELC due to six-pulse diode rectifier, the generator voltage and current are badly distorted, and when there is zero consumer load, situation becomes more severe.

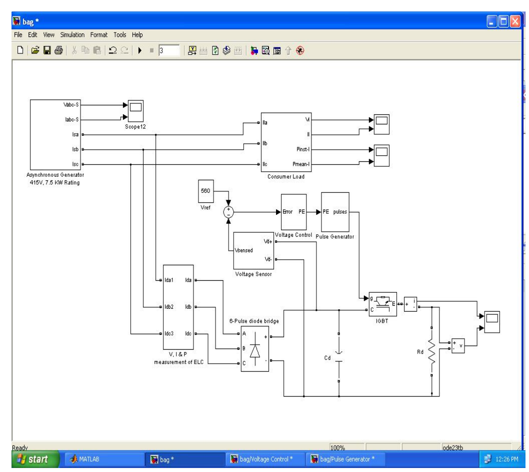

Fig 3: six pulse ELC for an IAG

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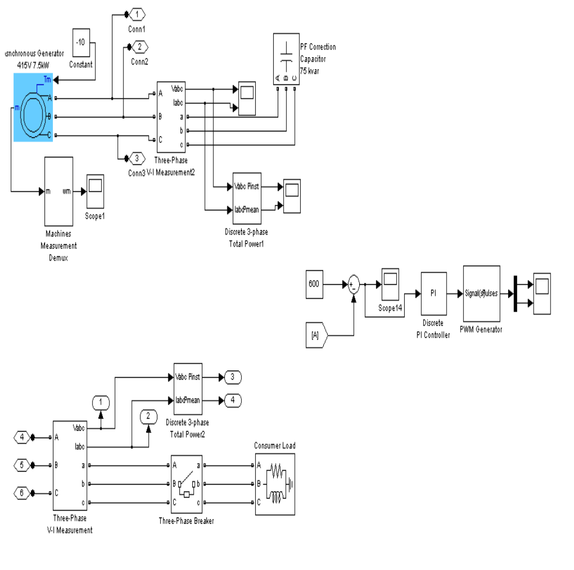

Fig 4: Sub system for six pulse ELC

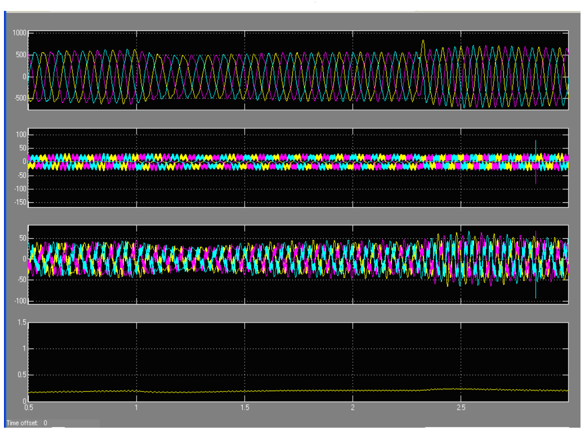

Fig 5 Simulated transient waveforms of IAG using six pulse ELC.

## Conclusion

The proposed ELC has been realized using 24-pulse converter and chopper. With proposed 24-pulse ELC, it is clearly demonstrated that the distortion of the generated voltage and current is improved and there is negligible distortion in the generated voltage and current (on the application of the consumer load and the no load, the distortion in the generated voltage and current are same). The proposed 24-pulse ELC has given improved performance of voltage and frequency regulation of IAG with negligible harmonic distortion in the generated voltage and current at varying consumer loads.

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