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Power Factor Corrector for Lighting Applications Using LUO Converter

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Abstract:
The power factor achieved by the incandescent lamp is not same as the power factor achieved by the compact fluorescent lamp. The existing system used electronic-ballast for power factor correction, it has the disadvantage of using large dc-link capacitor which introduces high distorted input current and results in high harmonics and low power factor. The proposed system consists of LUO converter with pulse width modulation. LUO converter produce low power density and high efficiency, similarly pulse width modulation is used to improve the lamp current crest factor and reduce the power loss.

Keywords: *Rectifier, PFC, PWM, controller, VI measurements, inverter, LCD display*

1. Introduction

The fluorescent lamps are the most common type of light source in use, which have a good color-rendering index. At the forefront of the most efficient incandescent alternatives are LED and Fluorescent technologies. LED and fluorescent have advantages and challenges that can provide significantly improved efficacy (lumens/watt) over incandescent lighting. Both technologies have the capability of providing opportunities to add intelligence beyond simple incandescent light bulb replacement.

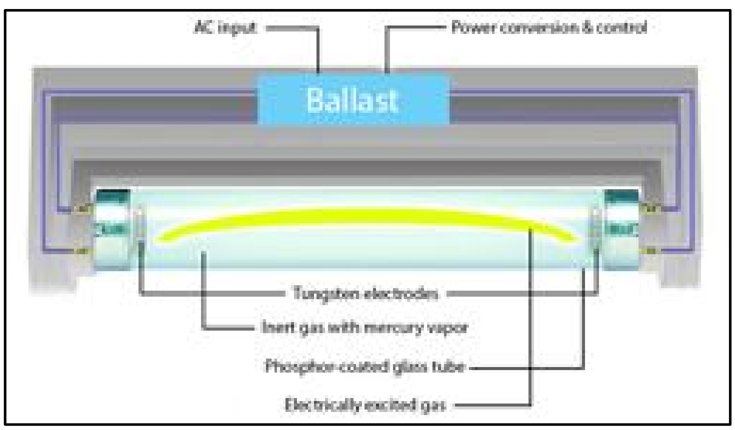
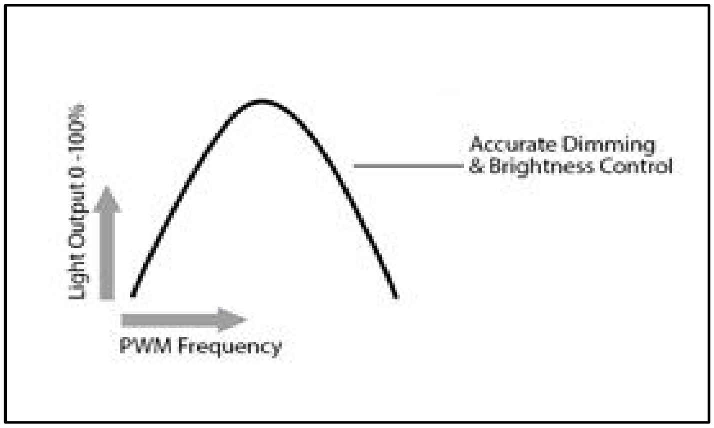


Figure 1: Fluorescent lamp

By using single compact fluorescent lamp consumer can save large amount of money and energy. To provide smooth dimming control and to control this reaction a high resolution PWM frequency control is required.



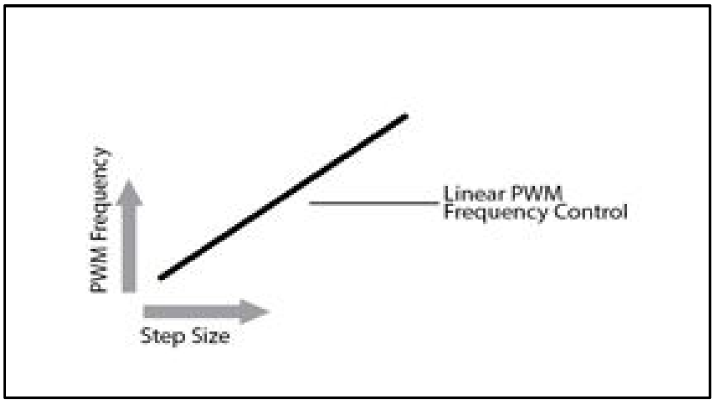


Figure 2: Characteristics of CFL

2. Literature Survey

The Super lift technique is introduced in the work of [1] instead of voltage lift technique which has been used in the Luo convertors. In Luo convertor the output voltage value improve according to arithmetic progression which is not much effective in increasing the power factor. In Super lift technique, the voltage transfer gain increases due to variation of output voltage according to geometric progression.

Luo convertors which use the voltage lift technique is discussed in [2] and [3]. Luo convertors convert positive to positive DC-DC voltage with high efficiency, high power density and simple structured topology. This convertor is capable of offering high step-up DC conversion. Zero output voltage and current ripples are some of its features which make the convertor to be used in wide variety of industrial applications.

In the work [4], the harmonic distortion produced by compact fluorescent lamp and rectified incandescent lamps in the input power is explained. Even electronically and mechanically ballasted CFLs also produces low power factor. Though the active circuits are effective in increasing the power factor, it is costlier and used only for CFLs above 30W. Hence various passive circuits are discussed to increase the power factor at reasonable cost.

An appropriate SPWM operation of switching element to improve the power factor is discussed in the work [5]. Here passive filters are used in AC-DC convertor. This passive filter reduces the harmonics produced in the Ac side of the convertor and hence this setup increases the power factor.

3. Proposed System

The main objective of our proposed system is to improve the power factor and to reduce the harmonics using LUOconverter.This converter will act as the buck as well as boost converter depending upon the pulse width given .It act as the buck converter when the duty cycle is greater than 50ms and acts as the boost converter when the duty cycle is less than the 50ms. When we use this converter we can obtain the power factor of about 99% and most of the harmonics are reduced. As it is independence of voltage variations with wide variation of frequency and voltage of greater control is obtained.

THD increases exponentially and inversely proportional to power factor. When we compare the performance of 13-W CFL and 40-W incandescent lamp with the input of 120V we can observe that the reactive power produced by the CFL is higher than fluorescent lamp.If the switching frequency is constant and the duty cycle is 50% then the switching voltage V_{sw}enters the resonant circuit making the lamp current has greater ripple with double line frequency. When the crest factor is lower than the expected value of 1.7 then we can say that the fluorescent lamp achieve its lifetime.

This paper explains the power factor controller of the CFL using LUO converter.The low converter is simple with the inverter circuit and it does not need to integrateinorder to minimize the size of the circuit and the overall cost of the ballast circuit. PWM is implemented inorder to adjust the duty cycle of the ballast circuit to improve the lamp current CF. It has the ability to achieve the Zero Current Switching at both of switching on and switching off to maximize the lamp efficiency.

3.1. Description of the Proposed System

Our proposed system consists of LUO converter as the power factor controller.The block diagram is as shown below. The ac supply is rectified by the rectifier circuit and dc supply is fed to PFC circuit (LUO converter). The resonant inverter converts the dc to ac with respect to the power factor obtained from the PFC and this is used to drive the load.

The power to the load is measured and compared with the reference power and the controller will send the controlled output signal to the LCD display. If there is power difference then the PWM will modulate the width of the pulse (i.e the duty cycle)of the inverter circuit and the PFC, since the power factor of the load is compensated by the capacitor and inductor in the resonant inverter.

3.1.1. Current Measurement

According to current continuity law, the current can be measured in any portion of the single loop circuit.

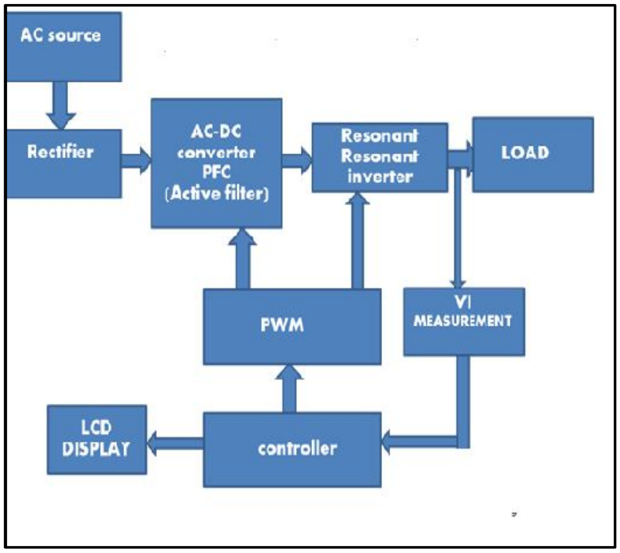


Figure 3: Block diagram

3.1.2. Voltage Measurement

To measure the voltage, we need to probe the voltage between two nodes in the circuit. Various types of analog and digital electronics instruments are capable of amplifying or attenuating the input signals. Smart voltmeter circuit is as shown in the figure.4.

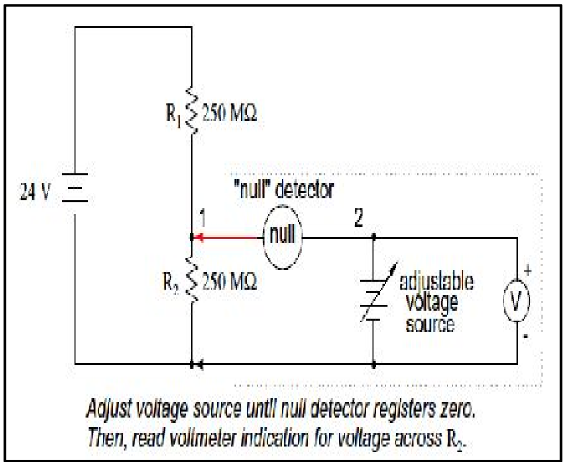


Figure 4: Adjust voltage source detector

4. Simulation

Proteus software is used to simulate the circuit. It is an easy simulating software to simulate microcontrollers, function generator, oscilloscope and also all other electronics components. The proteus is the software in which the simulation coding is written to display the result of the circuit. The simulation circuit is shown in the figure.5

A transformer is an electro-magnetic static device, which transfer electrical energy from one circuit to another, either at the same voltage or at different voltage but at same frequency. Here the voltage is step-down to the required voltage level. The step-down voltage is fed to the bridge rectifier circuit to convert ac to dc. The filtering circuit is used to remove pulsating ac; the filtering circuit may be inductor and capacitor. The capacitor blocks DC and allows AC, whereas inductor blocks AC and allows AC.Voltage regulator maintains the voltage constant.

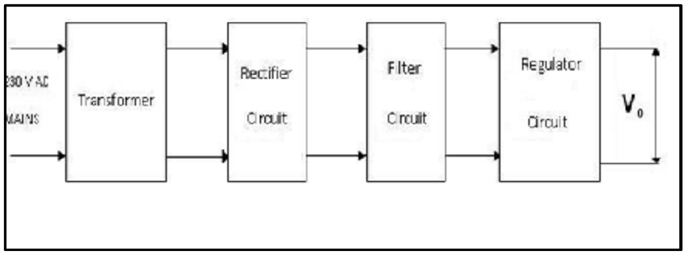


Figure 5: Power supply block diagram

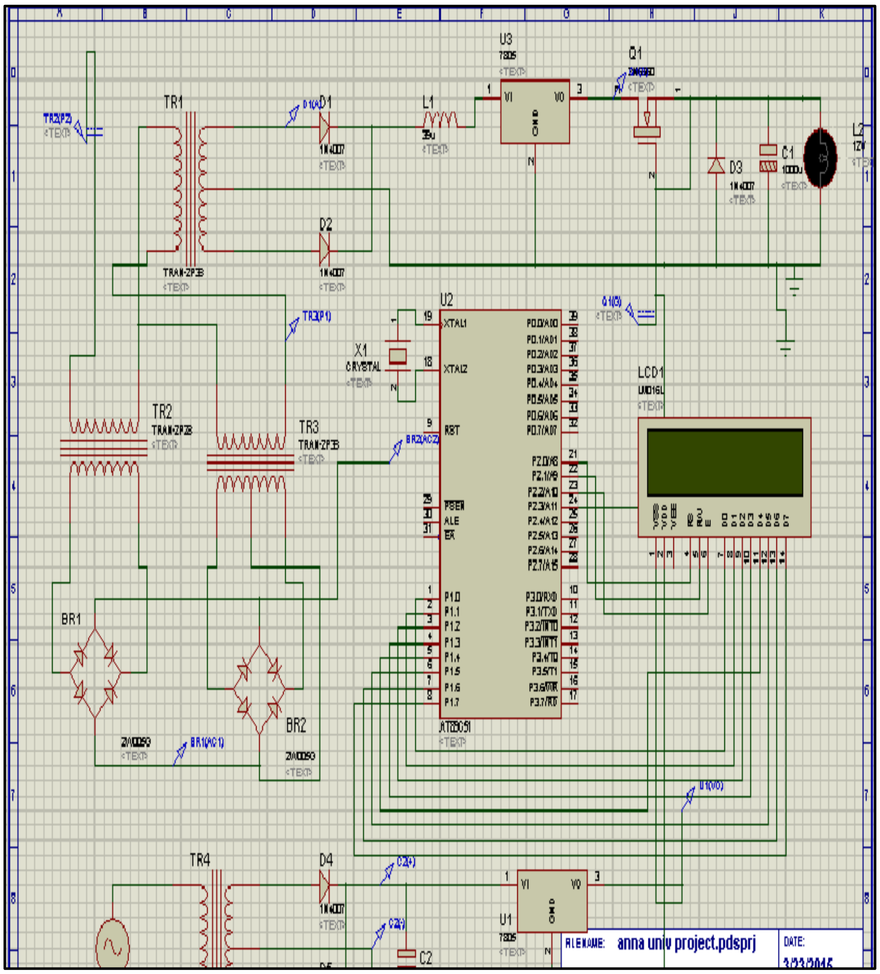


Figure 6: Circuit Diagram of CFL

The bridge rectifier is connected to current and potential transformer as shown in fig. to measure the voltage and current fed to the load through inverter circuit. The output from the bridge rectifier and the voltage regulator is given to the microcontroller (ATMEGA 8) in which the reference power factor and the actual output power factor is compared and send the control signal to the PWM if there is any error else it sends the output power factor to the LCD Display. This balanced power factor is send to the load which is the fluorescent lamp. The capacitor is connected across the load in order to compensate the lagging power factor of the load we used.

4.1. Simulation Output

In the figure 7 describes CFL dimming based on a converter output and PWM technique it trigger the MOSFET by adjusting the gate pulse we can make the lamp to improves its power factor near to unity .similarly the figure 8 describes LCD displays the output voltage of load and also it displays the power factor achieved by the lamp.

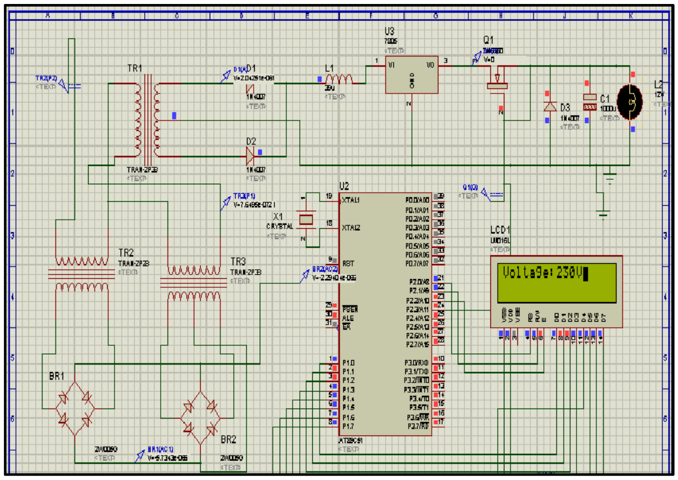


Figure 7: Voltage Measurement

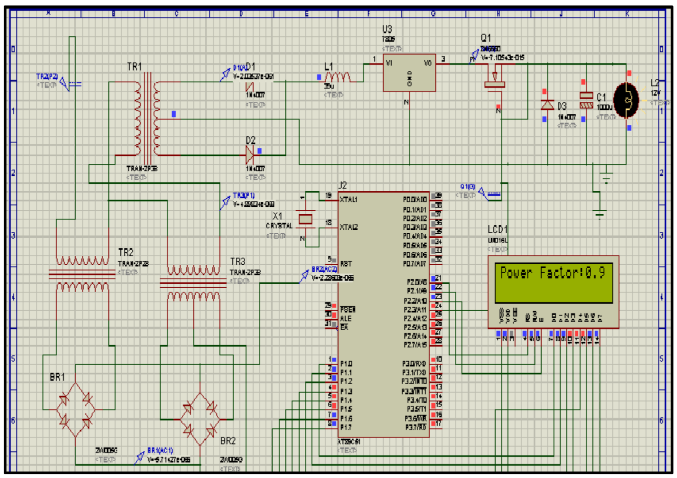


Figure 8: Measurement of power factor

5. Conclusion

The simulated and the experimental result shows that the angle ’a’ is varied with respect to the power factor of the load which is maximum. The value of this angle depends upon the load we used, output power, filtering circuit, and the switching frequency. A sinusoidal signal obtained from the microprocessor and leading upon the sinusoidal grid voltage determines the PWM converters operation and so the appropriate value of the angle ’a’ can be determined. Th etarget is to shift the grid current waveform relatively.A microcontroller is used for power factor controller is capable of adding capacitor banks across the load automatically when the power factor is lagging and is capable of removing capacitor banks from load when there is leading power factor. This work also facilitates to monitor the power factor changes on LCD in real time basis This is suitable for applications where manual switching of capacitors is to be replaced by automatic switching.

6. Acknowledgement

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7. References

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