A Novel Single-Stage LED Driver with Power Factor and using current path control switches

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Abstract:

The main aim of the project is to switch on the load by using buck boost converter and current path switches. The proposed system integrates a control circuit, a bridge diode, and buck boost converter with multiple switches connected to the LED segments in parallel.

Keywords:

PIC Microcontroller, Buck boost converter, DC-DC converter, h-bridge inverter with MOSFET,

1. Introduction:

Compared with fluorescent lamps and high-intensity discharge (HID) lamps, LEDs have the advantage of being small size, long-life, easy dimming, have high luminous efficiency, better color rendering and fast response. In addition, unlike fluorescent lamps that need to use mercury metal that is harmful to the environment, LEDs do not contain any mercury and are environmentally friendly. Therefore, LED has gradually replaced fluorescent lamps and HID lamps, and has become the mainstream light source of modern lighting. LED is a point light source with a small size, so it is difficult to dissipate heat, therefore, the power of a single LED is usually not large. For high-power LED lighting systems, multiple LEDs must be used to meet the power requirements. When many LEDs are used, the connection method is to connect multiple LEDs in series to form a LED string, and then connect the LED strings in parallel

For parallel-connected LED strings, due to the inevitable subtle differences between each LED, when the number of LEDs in series increases, the conduction voltage difference of each string will increase, resulting in inconsistent LED currents in each string. Moreover, LEDs have negative temperature coefficient characteristics, which will strengthen the current imbalance between each string, and even result in LED thermal runaway and burn. Therefore, the research on current-balance technology of parallel LEDs is an important topic of LED lighting systems.

2. EXISITING SYSTEMS:

The combination of capacitors and switches pair is termed an H-bridge and requires separate input DC voltage for every H-bridge. One among the benefits of this sort of multi-level inverter is that it needs less number of components compared with diode clamped and flying capacitor inverters making it more desirable. The value and weight of the inverter are but those of the 2 inverters discussed before. Soft-switching is feasible by a number of the new switching methods which is able to reduce the losses. Advanced H-bridge type Inverter another configuration developed to complete the disadvantages is advanced H-Bridge configuration.
Therefore at higher levels the general cost and complexity of system reduces. This topology separates the circuit into two parts, one part is named level generation part and is employed for generating output voltage levels in positive polarity. Level generation part requires high frequency switches to come up with the specified levels at the proper time. The second part is called polarity generation part and is employed for generating the negative polarity of the output voltage. This part is that the low-frequency part and operating at line frequency or supply frequency. The most disadvantage is it uses isolated DC sources even as in cascaded topology. It should be noted that isolated power supplies avoid voltage balancing problems created by capacitors in previous two configurations. Advantages are that they need lesser number of switches compared to previous configurations and better harmonics elimination. Other disadvantages

is that the system is bulky and wish extra space and is expensive.

Disadvantages.

- It requires more number of clamping diodes.
- Control and price of system also becomes difficult with increase of voltage levels.
- The system is bulky and wish more room and is dear

3. Implementation:

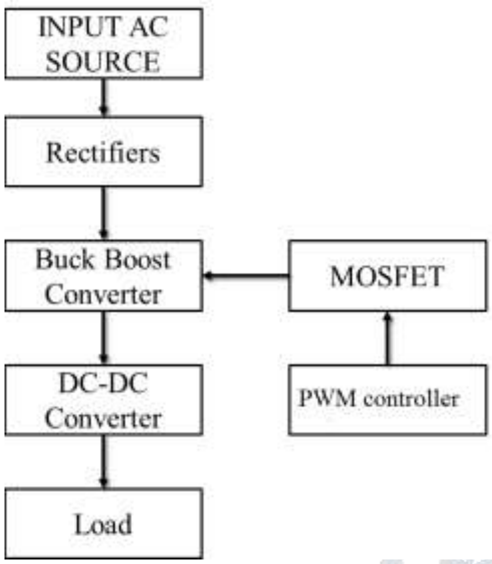


Fig : Flow Diagram

From the help of above flow diagram, the PWM controller is used to generate PWM signals to turn on the MOSFET which in turn triggers the Buck-Boost converter. The Buck-Boost converter get the supply from the main supply and the rectifier section. Signal from the buck boost converter goes to the DC-DC converter section which then switches on the LOAD.

1) Low-frequency switches SW;

2) Floating H-bridge; and

3) Example of the feedback control loop

Advantages:

- ✓ Lower harmonics,
- ✓ Low switching losses,
- ✓ Low stress on switches
- ✓ To reduce the amount of switches
- ✓ High efficiency.

4. Related Work:

The brief introduction of different modules used in this project is discussed below:

4.1. Input Source:

In this project 230v AC 50hz frequency is used to give the input soure to the project.

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid-state diodes, vacuum tube diodes, mercury arc valves, and other components.

A device that it can perform the opposite function (converting DC to AC) is known as an inverter.

When only one diode is used to rectify AC (by blocking the negative or positive portion of the waveform), the difference between the term diode and the term rectifier is merely one of usage, i.e., the term rectifier describes a diode that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with only one diode. Before the development of silicon semiconductor rectifiers, vacuum tube diodes and copper (I) oxide or selenium rectifier stacks were used.

Bridge full wave rectifier:

The Bridge rectifier circuit is shown in fig: 3.3.7, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through R_L.

For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave. This DC supply is give input the buck boost converter.

4.2. Full-Bridge topology:

A full bridge single phase inverter is a switching device that generates a square wave AC output voltage on the application of DC input by adjusting the switch turning ON and OFF based on the appropriate switching sequence, where the output voltage generated is of the form +Vdc, -Vdc, Or 0.

The following are the advantages:

- Absence of voltage fluctuation in the circuit
- Suitable for high input voltage
- Energy efficient
- The current rating of the power devices is equal to the load current.

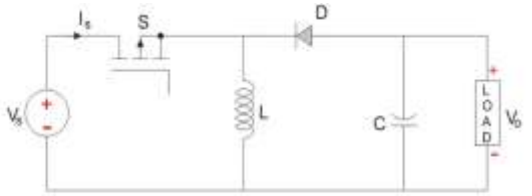
The following are the applications

- Applicable in applications like low and medium power example square wave / quasi square wave voltage
- A sinusoidal wave which is distorted is used as input in high power applications
- Using high-speed power semiconductor devices, the harmonic contents at the output can be reduced by PWM techniques
- other applications like AC variable motor, heating induction device, standby power supply
- Solar Inverters
- compressors, etc

4.3. Converter:

Buck Boost:

Buck-boost converters offer a more efficient solution with fewer, smaller external components. They are able to both step-up and step-down voltages using this minimal number of components while also offering a lower operating duty cycle and higher efficiency across a wide range of input and output voltages.



The input voltage source is connected to a solid state device. The second switch used is a diode. The diode is connected, in reverse to the direction of power flow from source, to a capacitor and the load and the two are connected in parallel as shown in the figure above.

The controlled switch is turned on and off by using Pulse Width Modulation(PWM). PWM can be time based or frequency based. Frequency based modulation has disadvantages like a wide range of frequencies to achieve the desired control of the switch which in turn will give the desired output voltage. Time based Modulation is mostly used for DC-DC converters. It is simple to construct and use. The frequency remains constant in this type of PWM modulation.

DC-DC boost converter:

A boost converter (step-up converter) is a DC-to-DC power converter with an output voltage greater than its input voltage. It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

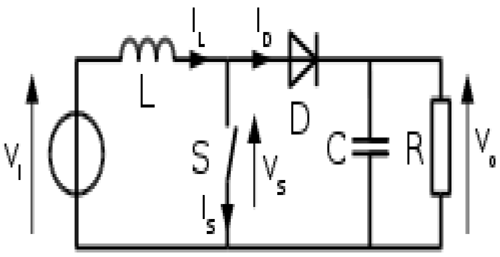


Fig: DC-DC Boost converter

4.4 Analysis:

The input signal to the circuit is an AC signal that is shown in the fig 7.1.Using the MATLAB software we get the LED output voltage, current and diode rectifier voltage wave forms as shown in the fig 7.2.In the fig 7.3 the wave forms of boost converter voltage and current are shown.

5. CONCLUSION:

A Novel Single-Stage LED Driver with Power Factor and using current path control switches is proposed. The circuit configuration is mainly integrated with DC-DC converter, a buck–boost converter and a current balancing circuit. The BUCK BOOST converter is used as a PFC converter, and the winding current was designed effectively and improve the power factor; while the current balancing circuit applied the principle of capacitor ampere-second balance to achieve the same current for each LED string. Only one active switch was used and controlled by the method of PWM.

6. ACKNOWLEDGEMENT

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7. RESULTS:

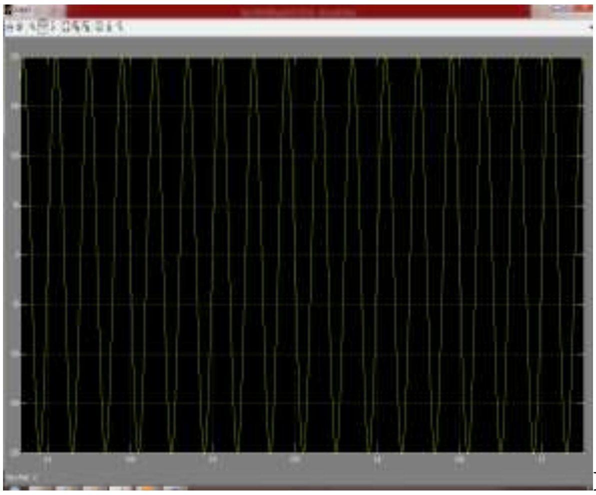

Fig: 7.1 Input AC Source:

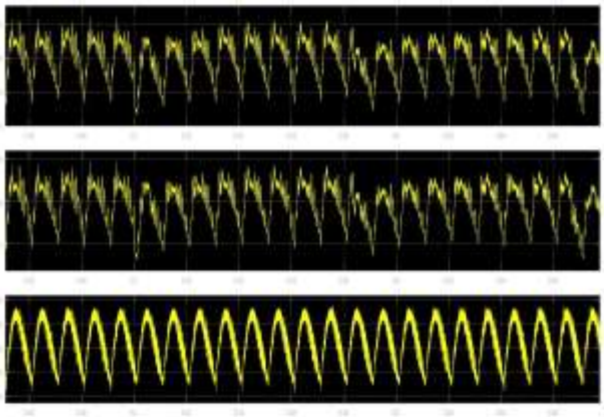

Fig: 7.2 LED Output voltage and Current and Diode Rectifier Voltage

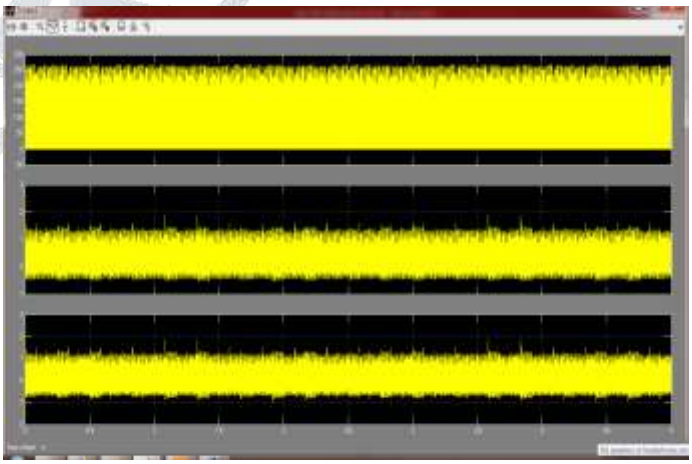

Fig: 7.3 Boost Converter Voltage & Current:

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