Modified Bridgeless SEPIC Converter

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Abstract : **There are many types of dc-dc converters. Buck converters can only reduce voltage, boost converters can only increase voltage and buck-boost, Cuk and SEPIC converters can increase or decrease the voltage. Buck-boost converters can be cheaper because they only require a single inductor and a capacitor. This often makes the buck-boost inefficient. Cuk converters solve both of these problems by using an extra capacitor an inductor. Both Cuk and buck-boost converter operation cause large amounts of electrical stress on the components, this can result in device failure or overheating. SEPIC converters solve both of these problems. The SEPIC converter allows a range of dc voltage to be adjusted to maintain a constant voltage output. SEPIC converter is used to overcome the limitation of conventional buck boost converter like inverted output, pulsating input current, high voltage stress make it unreliable for wide range of operation. The single-ended primary inductor converter (SEPIC) is a type of DC/DC converter allowing the electrical potential at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle. In this project we design and implement a SEPIC converter with full duty cycle control which is supported by its simulation. Withthe advantages of superior longevity, fast response, small size and color rendering, light-emitting diodes (LEDs) have been widely used for various lighting applications, such as signage lights, traffic lights, liquid crystal display television (LCD TV) back lights and so on. Since the package and costing technology are getting more and more mature, the cost of LEDs decreases greatly, with a great potential to replace existing lighting sources such as fluorescent lamps.**

Index Terms **– SEPIC, Buck, Boost,, Cuk convertors, LED, LCD.**

I. INTRODUCTION

The single-ended primary-induct or converter (SEPIC is capable of operating from an input voltage that is greater or less than the regulated output voltage. A side from being able to function as both a buck and boost converter, the SEPIC also has minimal active components, a simple controller, and clamped switching waveforms that provide low noise operation.
SEPIC is a DC to DC converter and is capable of operating in either step up or step down mode and widely used in battery operated equipment by varying duty cycle of gate signal of MOSFET . We can step up or step down voltage .For duty cycle above 50 % it will step up and below 50 % it will step down the voltage to required value. Various conversion topologies like buck, boot, buck- boost are used to step up or step down voltage. Some limitation like pulsating input and output current, inverted output voltage, in case of buck converter floating switch make it unreliable for different application. So it is not easy for conventional power converter design to maintain high efficiency especially when it step or step down voltage. All these characteristics are obtained in SEPIC DC to DC power conversion. Different designs are used using active and passive components. Non-inverted output ,low equivalent series resistance(ESR) of coupling capacitor minimize ripple and prevent heat built up which make it reliable for wide range of operation.
Presently a days the utilization of high brilliance light transmitting diode increasingly in open air lightning application, for example, road light. Light transmitting diodes have been demonstrated most suitable answer for road lightning applications. There are such a large number of necessities to take preferences and configuration of LED, for example, high power element, long life time, precise current control, high effectiveness. As per the yield power rating force stage to control a LED can be grouped to one stage and two stage structure. The LED technology continues to change and evolve. The energy

efficiency (lumens/watt) of today's LEDs allows them to replace the classical tungsten filament and gas vapor lighting systems with solid-state technology. The most efficient LEDs are able to perform as well as Compact Fluorescent Lamps (CFL). The most important advantage of LEDs over tungsten and gas vapor bulbs is the cycle life. LED lifetimes currently show a 30 % improvement over their counter parts. LEDs are being used in the automotive and commercial lighting industries with good results. LEDs must be carefully integrated into lighting systems because of their sensitivity to thermal and electrical stress. The LED current must be optimized for both thermal and electrical characteristics. Excessive driving current will deteriorate LED performance, shorten the life time, and cause permanent reduction in the luminous intensity. LEDs may be driven using constant current sources in order to maintain a consistent color output. One low cost but inefficient solution for driving LEDs is using series resistors. The series resist or method is very sensitive to power supply variation. Constant LED current depends on a constant supply voltage. Any variation of the voltage supplying the resist or and LED combination will result in a change in current and thus a change in output color .There are more efficient solutions for driving LEDs that save energy and provide good current control. Two methods of driving an LED are Constant Current and Pulse Width Modulation (PWM) current control. The design topology used for this application note will be the Single Ended Primary Inductive Controller or SEPIC topology. The SEPIC topology allows both buck and boost operation. This allows for a constant current drive output with variations in input voltage. The SEPIC uses a current sense feedback loop for efficient control.

II. LITERATURE SURVEY

[1] J. Leema Rose and B.Sankaragomathi,"Design, Modeling, Analysis and Simulation of a SEPIC Converter"
This paper gives the basic working principle of a SEPIC and its design calculations. Using the given formulas we have designed the SEPIC converter for a street lightning. It also explains the topology and comparison between converters.

[2] " Modeling and Analysis of DC- DC SEPIC Converter with Coupled Inductors" .
This paper gives the working and effect of duty cycle on the converter. It mentions the advantages of using a coupling inductor. For our project, we use the given duty cycle calculations and gate control methods. And mentions the simulated efficiency as 91% .

[3] Subramani Saravanan, Neelakandan Ramesh Babu, " A modified high step-up non-isolat ed DC-DC converter for PV application" .
The principle of operation of modified SEPIC is given in this paper. The design and its performance is simulated. It has a simulated efficiency of 92.5%.
Here iT is modified by adding a second capacitor which improves the over all static gain. This results in the conv erter having better steady state stability and lower settling time. We have changed the gate drive to an Arduino Nano for the switching frequency of 24kHz.We are using this as a high efficiency drive for DC motor

[4] "Analysis of SEPIC converter" IJEDR 2018 Volume 6, Issue 2. ISSN:2321-9939. This paper gives the information regarding the ability of the SEPIC converter to operate from an input voltage that is greater or less than the regulated output voltage. Explains the simulation of closed loop control show that we can control the dc output voltage as per our requirement.

[5] Naresh. C, Karthiyegan. R "Simulation and performance of modified coupled inductor based SEPIC converter with high gain" IJITEE
This paper proves that the coupled inductor based SEPIC coverter is better than without coupled inductor.

III. EXISTING SYSTEM:

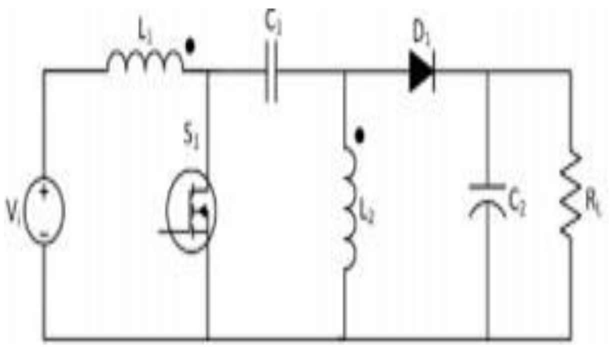

Fig. 1 . SEPIC Converter Circuit

The single-ended primary-inductor converter (SEPIC) is a type of DC/DC converter that allows the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor .[Ref fig.1].A SEPIC is essentially a boost converter followed by a buck-boost converter, therefor it is similar to a traditional buck- boost converter, but has advantages of having non-inverted output (the output has the same voltage polarity as the input),using a series capacitor to couple energy from the input to the output (and thus can respond more gracefully to a short-circuit output),and being capable of true shutdown: when the switch is turned off ,its output drops to 0V, following a fairly hefty transient dump of charge. All dc-dc converter operate by rapidly turning on and off MOSFET, generally with a high frequency pulse. What the converter does as a result of this is what makes the SEPI converter superior. For the SEPIC, when the pulse is high/the MOSFET is on, inductor1 is charged by the input voltage and inductor2 is charged by capacitor1 .The diode is off and the output is maintained by capacitor2 . When the pulse is low/ the MOSFET is off ,the inductors output through the diode to the load and the capacitors are charged. The greater the percentage of time(duty cycle) the pulse is low, the greater the output will be. This is because the longer the inductors charge, the greater their voltage will be. However, if the pulse lasts too long, the capacitors will not be able to charge and the converter will fail.

IV. PROPOSED SYSTEM:

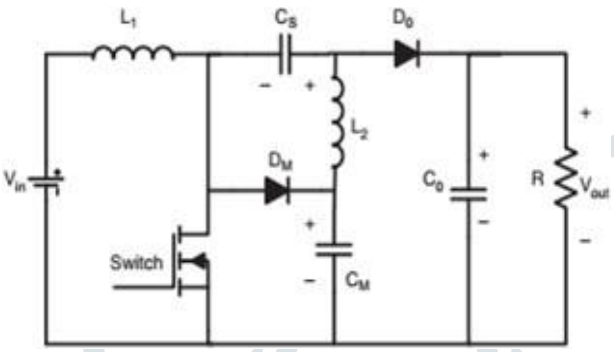

Fig. 2 . Modified SEPIC Converter Circuit

Fig. 2 is the modified SEPIC convertor. In this modified circuit, the static gain is improved and theoretically doubled. The static gain is doubled and the switching voltage is reduced to half of the value than that of the boost converter. In this, high in rush current flows through the inductor L1 , and to reduce that , a large input inductor is required. It consists of soft switching operation for turn ON and turn OFF condition for all low input voltages.

Working of modified SEPIC Converter:

First Stage [t 0 - t 1] :

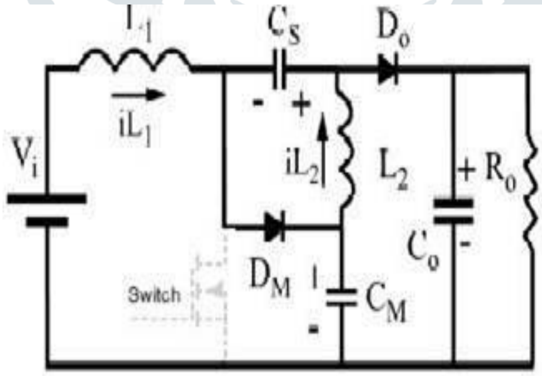

Fig. 3 . First stage of modified SEPIC Converter

At the instant t0 , switch S is turned-off and the energy stored in the input inductor L1 is transferred to the output through the CS capacitor and output diode Do and also is transferred to the CM capacitor through the diode DM. Therefore, the switch voltage is equal to the CM capacitor voltage. The energy stored in the inductor L2 is transferred to the output through the diode Do. [ref fig.3] .

Second Stage[t1 —t2] :

At the instant t1 ,switch S is turned-on and the diodes DM and Do are blocked and the inductors L1 and L2 store energy. The input voltage is applied to the input inductor L1 and the voltage VCS-VCM is applied to the inductor L 2 . T he VCM voltage is higher than the VCS voltage. [ref fig. 4 .] .

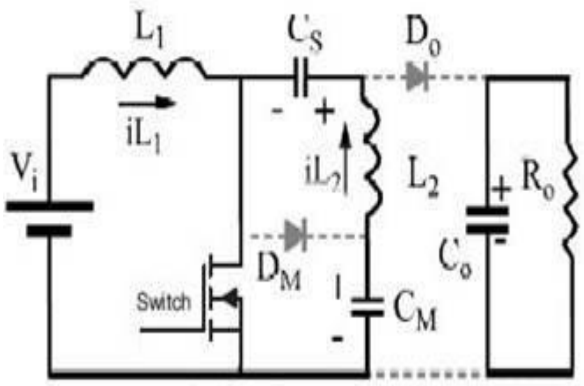

Fig. 4.. second stage of modified SEPIC converter

V. BLOCK DIAGRAM:

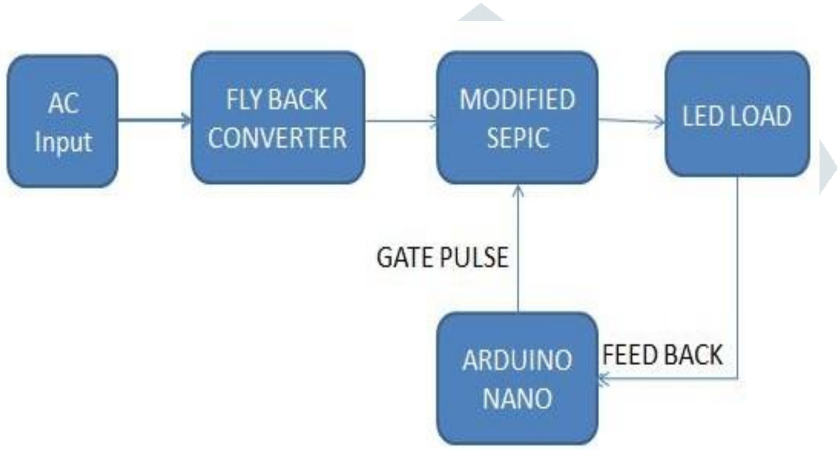

Fig. 5 System Block Diagram

The overall setup is shown in fig. 5. AC input is given to the Flyback converter, this converts AC to constant DC of 12V 5Amps. Arduino Nano is used to manage the frequency of the input SEPIC Converter, Gate pulse switches the MOSFET. The SEPIC Topology is used to drive the DC Load. The feedback maintains the output constant regardless of load fluctuations. In case the feedback is not present, every time the load is varied the input voltage has to be manually changed.

VI. DESIGN AND CALCULATION:

Assumptions

- Input Voltage: Vi = 15V.
- Output Volt age: Vo=15 0 V.
- Switching Frequency: f=24kHz.
- Switch duty-cycle:

$$D = \frac{Vo-Vi}{Vo+Vi} = \frac{150-15}{150+15} = 0.8182.$$

- Switch and diodes voltages:

$$V_S = V_{Do} = V_{DM} = \frac{Vi}{1-D} = \frac{15}{1-0.8182} = 82.5V.$$

- L_1 & L_2: For current ripple for 5A.

$$L_1 = L_2 = \frac{Vi*D}{\Delta iL*f} = \frac{15*0.8182}{5*24*1000} = 102\mu H.$$

- C_S and C_M :

$$C_S = C_M = \frac{Io}{\Delta Vc*f} = \frac{0.667}{8.25*24*1000} = \mathbf{3.37\ F\mu}$$

Where

$$\Delta V_C = \left(\frac{Vi}{1-D}\right)\left(\frac{10}{100}\right) = \left(\frac{15}{1-0.8182}\right)*0.1 = 8.25V.$$

VII. APPLICATIONS OF MODIFIED SEPIC CONVERTER:

1. Battery-operated equipment"s and handheld devices.
2. NiMH (Nickel-metal hydride battery) chargers.
3. LED lighting applications.
4. DC power supplies with a wide range of input voltages.
5. It can also be used in photovoltaic cells.

VIII. CONCLUSION:

The majority of battery operated circuits require dc-dc conversion to maintain full operation. In most circumstances that require stepping up and down the input voltage, modified SEPIC converters are worth the price of the extra inductor and capacitor for the efficiency and stable operation they provide. While this project does go into detail about simulation results for the modified SEPIC converter.

This model gives the basic information about modified SEPIC Converter. In this we are using modified SEPIC Converter for DC motor. The main objectives are to reduce the electrical stress on the components, to provide better steady state stability, lower settling time and increased static gain. It has stimulated efficiency of about 90%. We can use this converter for both buck and boost operations and in this we have boosted operation of the converter from 15V to 150V and buck operation can give upto 6V output. Comparative analysis is made on all type DC - DC Converters and modified SEPIC converter has better efficiency. It reduces the harmonics and electrical stress on the components, Increased steady state stability and reduced settling time. Low switch voltage operation and controlled output voltage variation is in between 6V and 150V with input voltage 15V, duty ratio 80% with 24kHz switching frequency.

IX. FUTURE WORK:

In future we can use this modified SEPIC Converter for many DC-DC applications like street lighting. This modified SEPIC Converter can be implemented in industries also.

Modified SEPIC Converters can also be used in LED lamp drivers. We can also use it in lab equipments which need precise input voltage. This can be used in maximum power tracking of photovoltaic cells. This can be implemented in Batteries. In future instead of MOSFET other switches like IGBT can be implemented in the circuit. MOSFET is controlled by Arduino Nano instead of that other controllers can be used.

The proposed topology can find application in systems with low input and high output voltage. This topology can also be applied in the applications which require reduced losses, high power density, low weight, and volume. Since the system uses renewable energy source it can be effectively used in wide range of applications.

X. ACKNOWLEDGEMENT:

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XI. REFERENCES:

[1] J. Leema rose and B. shankaragomathi, "Design, Modelling, Analysis and simulation of a SEPIC Converter".

[2] Subramani Saravanan, Neelakandan Ramesh Babu, " a modified high step up non isolated DC-DC converter for PV applications".

[3] Siddharth Sabyasachi, PratyushaMohanty,"STABILITY ANALYSIS OF SEPIC CONVERTER USING MATLAB/ SIMULINK".

[4] Naresh. C, Karthiyegan. R "Simulation and performance of modified coupled inductor based SEPIC converter with high gain" IJITEE.

[5] Trivedi Bhavin , Bhavesh Patel, Kamlesh Sonwane, "Analysis of SEPIC convertor". IJEDR 2018 volume 6, Issue 2.

[6] Sagar B Pawar, Nikhil Kumbhar, Seema P Diwan "SEPIC based control of BLDC motor drive".

[7] N. Madhumitha, Dr C. Christober Asir Rajan, "An improved bridgeless SEPIC PFC converter". IJSER, Volume 5, Issue 3.

[8] P. Ponuthai, S. Saravanan, Dr. P. Usharani. "A SEPIC Based Dual Output DC-DC Converter for solar applications".IJIRSET.

[9] Abana Malhothra, Prerna Gaur, "Implementation of SEPI converter" IJEEE. ISSN 0974-2174, volume 7. Number 4(2014).

[10] M. Senbaga, S. Sathyamoorthi, "Implementation in High power factor Application system using SEPIC converter".

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