Innovative Ćuk Converter Designs for Solar-based Applications

POWER CONVERTER (19EEE336)
PROJECT REPORT

Submitted by,

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Problem Statement:

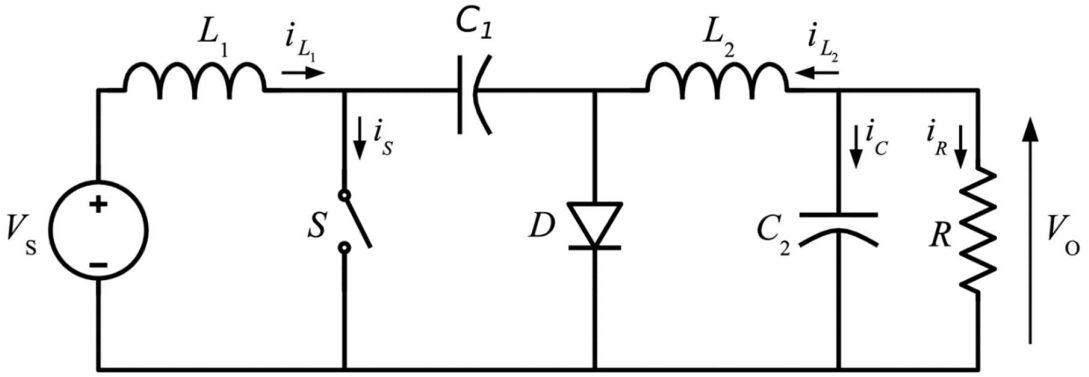
The DC voltage produced by the solar cell will vary according to the irradiation on the solar cell. However, any load requires a constant DC to operate efficiently. So, to convert the variable DC voltage to a constant voltage a DC-DC converter is used, it can also increase the longevity of the system loads. But there are many disadvantages in using a DC-DC converter like high output current ripple, leading to a high THD. The load is constantly varying requiring a change in the voltage given to the load available, this can be addressed by including a closed-loop control method with the converter, varying the output of the converter according to the voltage required.

Aim:

To design a cuk converter for providing a constant voltage to the loads according to their need and increase its flexibility in stepping up the voltage by increasing the input given to the cuk converter using a boosting circuit.

Theory:

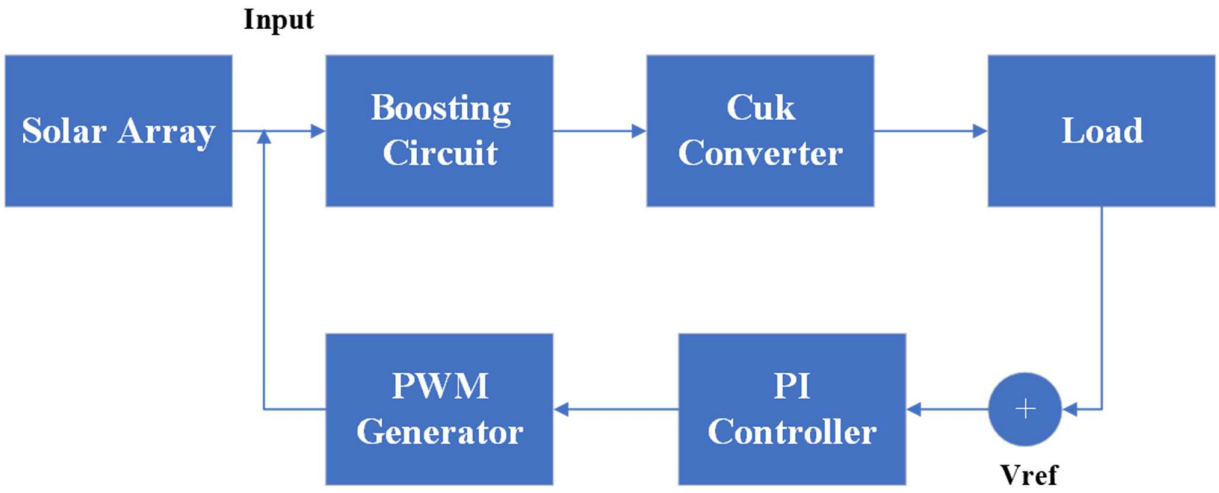
The Cuk converter is a DC-DC converter that provides a constant DC-DC output voltage magnitude either greater than or lesser than the magnitude of the input voltage. It is a combination of both the buck and the boost converter. The output of the cuk converter is inverted. In the CUK converter, the capacitor is used as the main energy storage device compared to most of the converters in which the inductors are the main source of energy storage.



There are variations on the basic Ćuk converter. For example, the coils may share a single magnetic core, which drops the output ripple, and adds efficiency. Because the power transfer flows continuously via the capacitor, this type of switcher has minimized EMI radiation. The Ćuk converter allows energy to flow bidirectionally by using a diode and a switch.

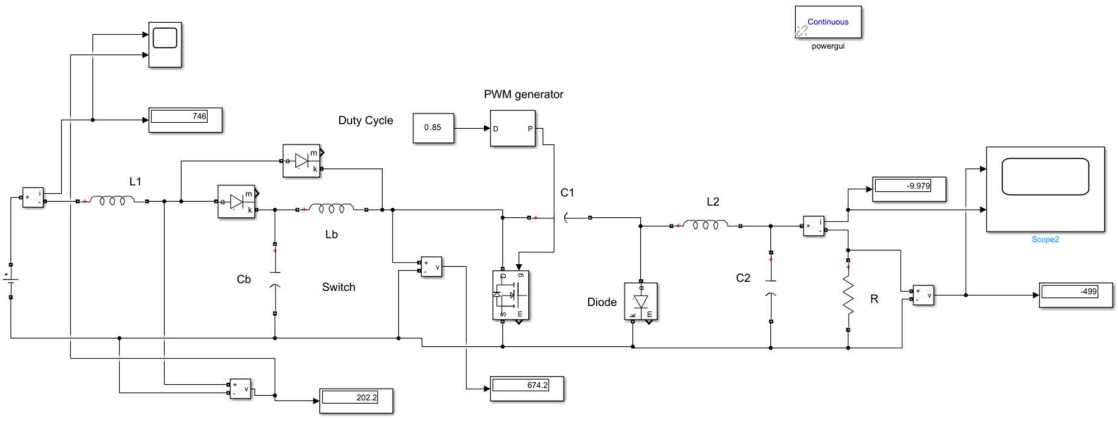
Cuk converters are ideal for use in the battery management systems of electric vehicles, renewable energy integration that includes systems with solar panels on the input side and hybrid solar-wind energy systems, and photovoltaic applications to facilitate regulation and operation at the maximum power point (MPP), high voltage, negative polarity output voltage, and low standby continuous current applications.

Block Diagram:

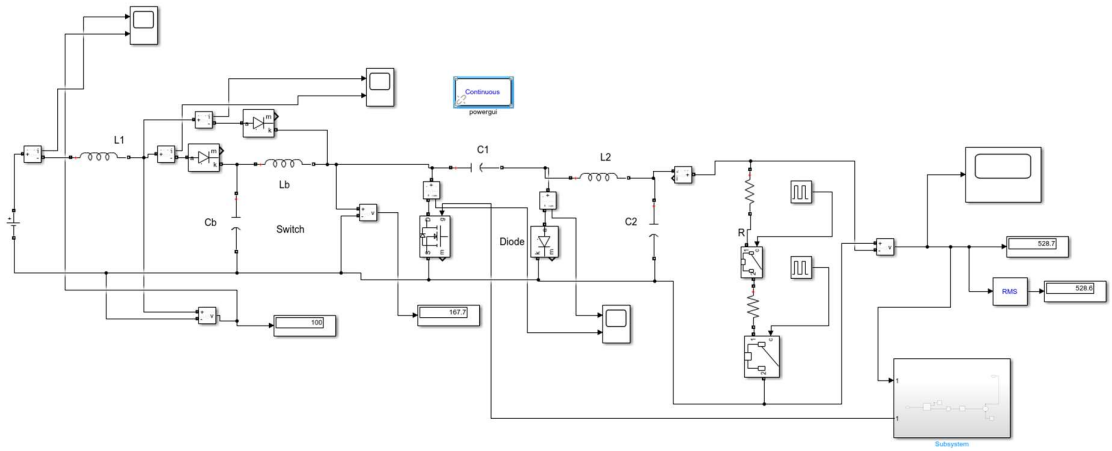


parameter	value
Inductor L1 & Lb	2.17e-5
Capacitor C1 & Cb	3.32e-5
Inductor L2	1.0625e-4
Capacitor C2	8e-6
Input voltage	100V
Output voltage	500V
Duty cycle	0.83
Output power	5000W (5kW)
Switching frequency	50kHZ

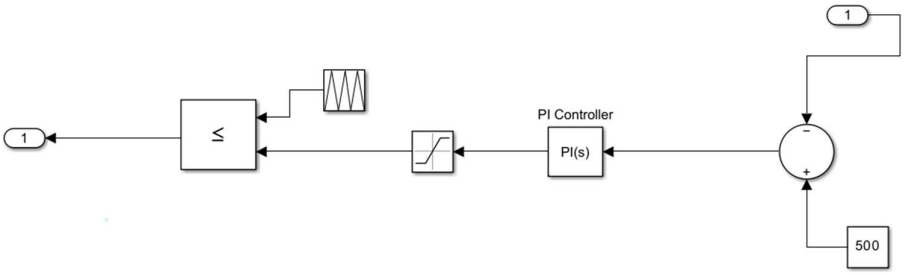
Simulation with open loop:



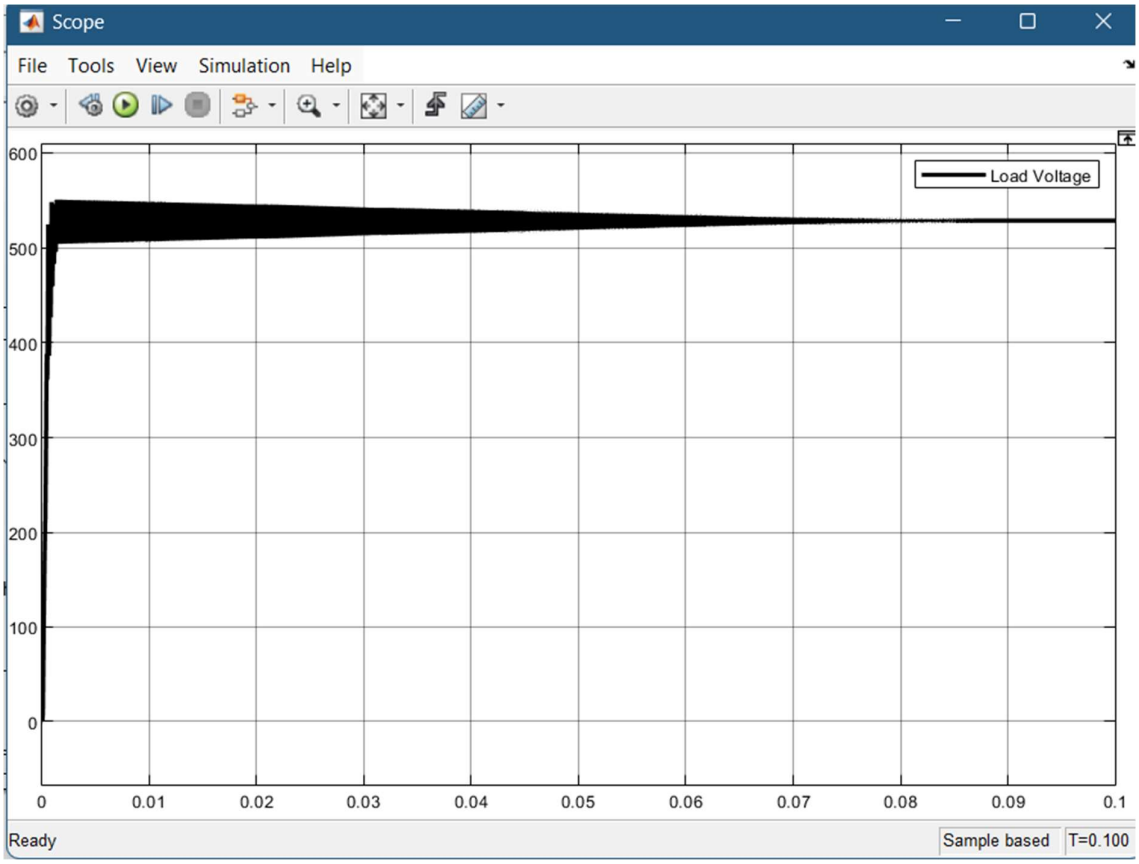
Simulation with closed loop:



Subsystem:



Output Voltage Waveform:



Inference:

After performing both the open loop and closed loop control of the modified CUK converter which has the advantage of producing a high voltage conversion ratio. This advantage is observed when we compare both conventional and modified boost network Cuk converters. Again, closed-loop control or feedback control is more beneficiaries than an open-loop control mechanism. It has more accuracy it continuously monitors its output and makes the required adjustments to get its desired output. Simply speaking in open-loop control we have to give or change the duty cycle according to output. However, in feedback control, no duty cycle adjustment is needed. It adjusts the output parameters by using a PI controller with a repeating sequence block with a switching time by comparing it with a reference value.

Conclusion:

It can be concluded that this modified boost network cuk converter ensures efficiency and minimizes energy losses in the system. This type of converter is compatible with the battery system which has safe energy storage. It is also low-cost efficient and promotes renewable usage by reducing energy emissions. It also makes solar installations more accessible because of its benefits. Its main advantage is operating in safe mode i.e. if there are any power fluctuations and harmonics this type of arrangement of the circuit makes the grid to be stable which crucial in handling solar systems at residential places.