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Design of DC-DC converter circuit for solar photo-voltaic cell

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Abstract
In the present scenario, the utilization of the power resources are diminishing down generations and the need for alternating resources like renewable sources are being checked for. Solar Energy is one such renewable source that can contain the power demand of generations. But, the constraints involved makes it complicated for usage and on the backdrop of these constraints several models have been proposed. Constraints such as low solar radiation and night time need storage to meet the energy demand. But, failures in the PV system due to storage batteries lead to increment in capital cost including high installation and replacement cost. So, the output of a PV generator is matched with a variable load using switch mode DC to DC converter. The input fed to a buck converter is stepped down to our required value. The output voltage is maintained constant under normal stable condition. If any disturbance is subjected to the proposed model, altering the output voltage is corrected using PI controller. Hence, this model with low power usage and auto controller solves us many challenges obeying the constraints.

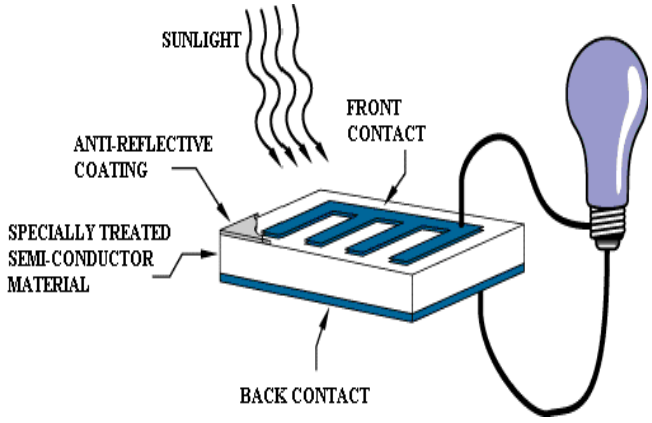
Keywords: Buck Converter, Conventional PI Controller, Photo-Voltaic Cell and Solar Cell

Introduction
For conventional power supply we use renewable sources like solar power which uses photo - voltaic cell for storing solar energy with utilization of buck converter which gives improved power factor along with faster response. The control of the input voltage of DC-DC converters is frequently required in photovoltaic (PV) applications. This paper analyzes the step-down buck converter fed by a PV array. In this special situation, unlike conventional converters, the output voltage is constant and the input voltage is variable. Conventional converter models generally found in the literature are not applicable to this situation. Converters with input voltage control are seldom studied and this paper aims to clarify this subject. The output voltage of a DC-DC converter is controlled by operating it in the closed loop, and altering its MOSFET (switch) gate signal accordingly. It is basically governed by a switching logic, thus constituting a set of subsystems depending upon the status (on-off) of the switch. PI controllers are the most widely-used type of controller for industrial applications.
They are structurally simple and exhibit robust performance over a wide range of operating conditions. In the absence of the complete knowledge of the process, these types of controllers are the most efficient process.

Renewable Energy Resources
Renewable sources are energy supplies that are refilled by natural processes at least as fast as we use them. All renewable energy comes, ultimately, from the sun. We can use the solar power directly (as in solar heating systems) or indirectly (as in hydroelectric power, wind power, and power from biomass fuels). Usage of renewable sources energy sources can save us money, assure that our grandchildren and great grandchildren will have enough energy, and free us from the uncertainties of depending on energy supplies.

Types of Renewable Resources
Solar Energy, Wind Power, Biomass, Hydro Power, Geothermal Energy

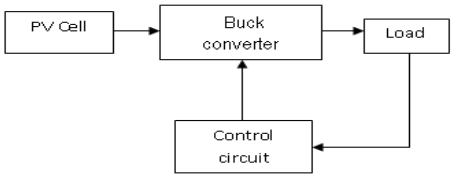
Solar cell
A solar cell, or photovoltaic cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels.
Solar cells are described as being photovoltaic irrespective of whether the source is sunlight or an artificial light. They are used as a photo detector detecting light or other electromagnetic radiation near the visible range, or measuring light intensity.



DC-DC Converter
A DC-DC converter step downs high voltage to low voltage. A DC-DC switching regulator is known to be superior over a linear regulator mainly because of its better efficiency and

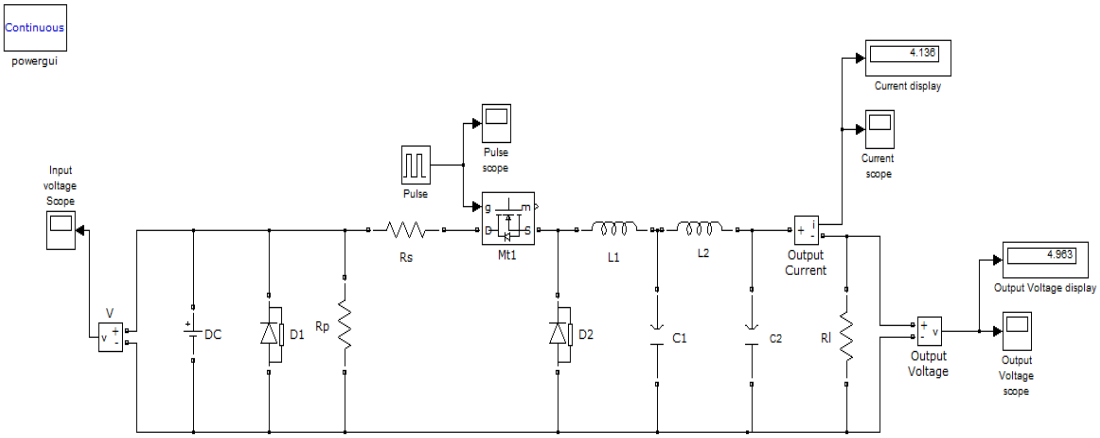
higher current-driving capability. There are various topologies in the context of DC-DC converters the buck-boost converter are widely used. The control of the input voltage of DC-DC converters is frequently required in photovoltaic (PV) applications.

Block Diagram of PV Installation System



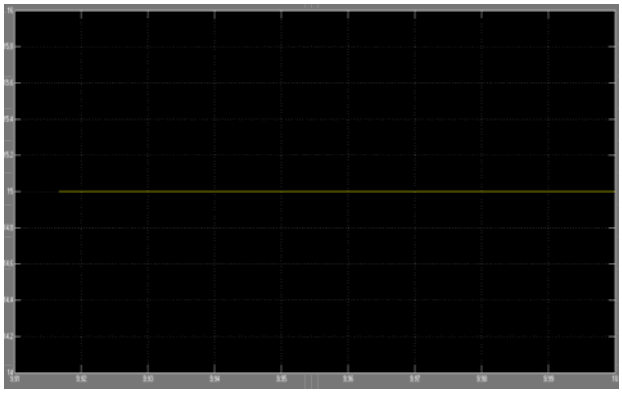
Simulation results

Simulink circuit of solar installation system:



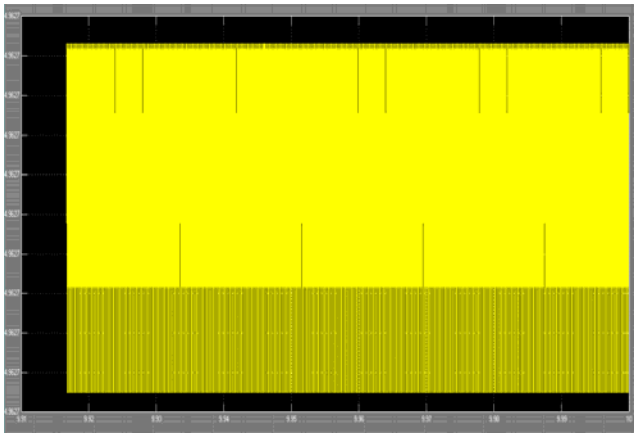
This is the basic circuit of solar installation system with null disturbances with input voltage as 15v which gives output voltage approx. 5v

Input voltage

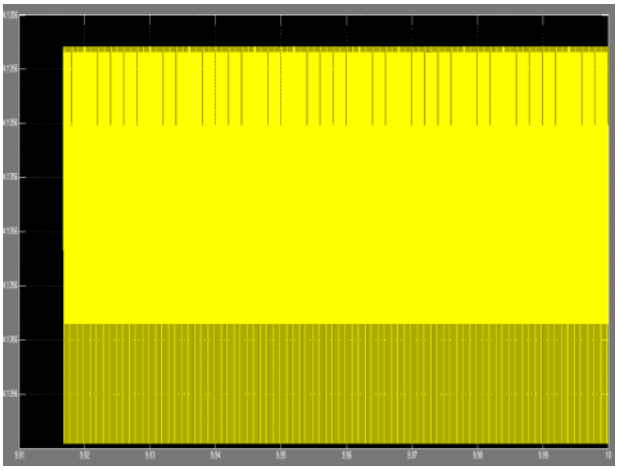


Driving pulses

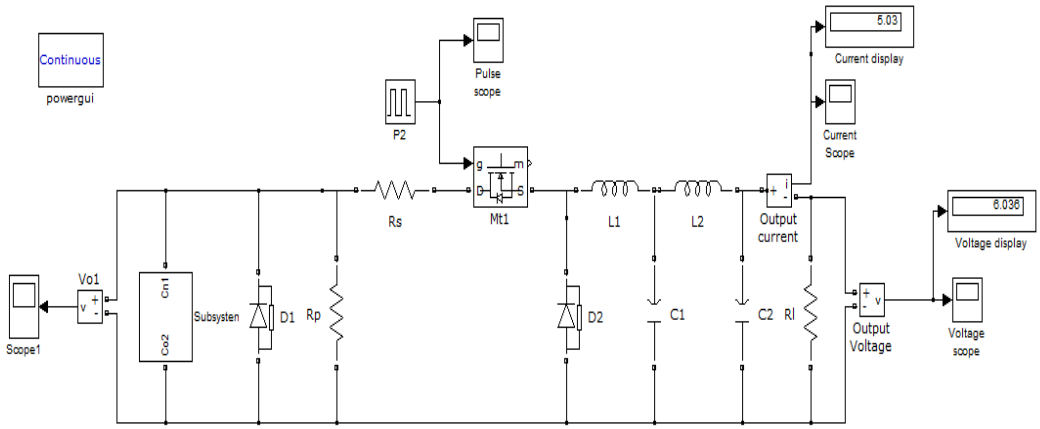
DC Output voltage



DC Output current



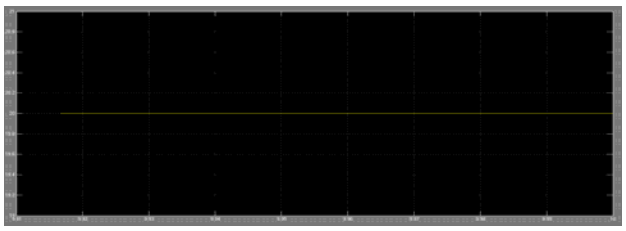
Open loop system with external disturbance at the input



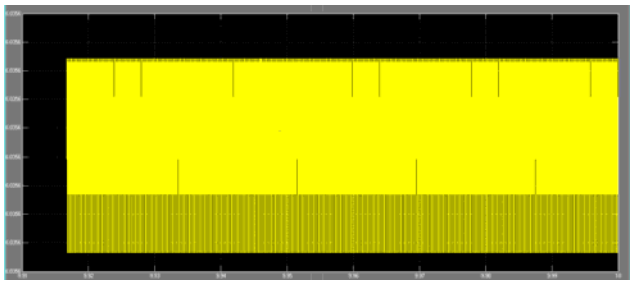
Since solar energy is not continuously emitted due to which disturbances occur which are characterized as drop in voltage level.

Input voltage with disturbance

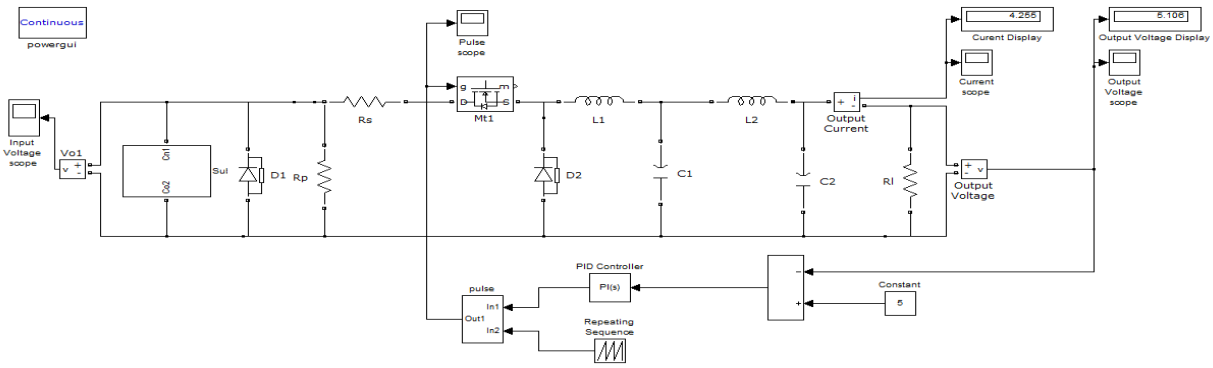
By the occurrence of disturbances the input voltage varies from 15v to 20v with rise in current level.



Output voltage with disturbance of open loop system

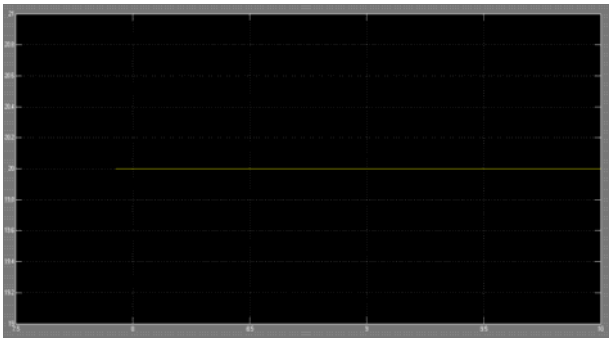


Simulink model of Closed loop system with external disturbance at the input

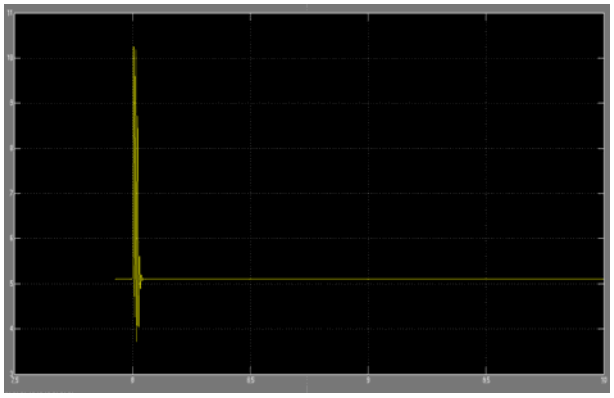


Input voltage with disturbance

By using pi controller which forms as a closed loop system we can achieve constant voltage



Output voltage with disturbance of closed loop system



Conclusion

This paper analyses the various problems accounted during utilization of solar power by PV cells. The closed loop system is able to maintain constant voltage. This converter hasadvantages like reduced hardware and good output voltage regulation. The simulation results are in line with the theoretical predictions.

References

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