

DC MICRO GRID USING BOOST CONVERTER WITH MAXIMUM POWER POINT TRACKING(MPPT) OF PERTURB AND OBSERVE METHOD

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Abstract -- A smart wireless DC micro-grid suitable for efficient utilization of energy available from Distributed Renewable Energy Generators (DREGs) is described. This concept is experimentally demonstrated using a solar photovoltaic (PV) array delivering power to fluorescent lighting; other DC loads such as Light-Emitting Diodes (LEDs) and DC ceiling fans can be easily integrated into the proposed hybrid micro-grid. Here we use the perturb and observe method of Maximum power point tracker to obtain the maximum power and the DC-DC boost converter is used to boost the voltage from the solar array. They are simulated in MATLAB/Simulink.

INTRODUCTION

The established US electrical utility infrastructure was conceived more than 100 years ago. The decision for an AC grid was made on two principles; AC voltage had higher transmission efficiency and AC

motors and generators were more cost-effective compared to their DC counterparts. The grid today is vulnerable and relatively inefficient when compared to distributed generation [1]. Distributed generation avoids both the vulnerability of transmission and distribution links, and the 6.5% transmission/distribution power losses. The advent of semiconductor electronics, which require a DC input, and the recent rapid growth of renewable energy technologies are dramatically changing the nature of transmission, distribution, and utilization of electrical energy. Most of today's electrical loads—lighting, adjustable-speed motors, brushless DC motors, and computing and communication equipment—are more compatible with DC power [2]. Most Distributed Renewable Energy Generators (DREGs)—including solar

SOLAR CELL

In this paper the solar cell is designed to produce 18 V and 1.7 A



The Solar Cell block represents a solar cell current source.

The solar cell model includes the following components:

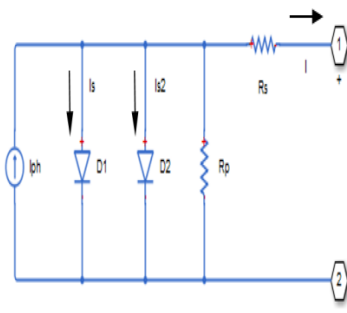
- Solar-Induced Current
- Temperature Dependence
- Thermal Port

Solar-Induced Current

The block represents a single solar cell as a resistance R_s that is connected in series with a parallel combination of the following elements:

- Current source
- Two exponential diodes
- Parallel resistor R_p

The following illustration shows the equivalent circuit diagram:



The output current I is:

where:

- I_{ph} is the solar-induced current:
- where:
 - I_r is the irradiance (light intensity) in W/m^2 falling on the cell.
 - I_{ph0} is the measured solar-generated current for the irradiance I_{r0} .
- I_s is the saturation current of the first diode.
- I_{s2} is the saturation current of the second diode.
- V_t is the thermal voltage, kT/q , where:
 - k is the Boltzmann constant.
 - T is the **Device simulation temperature** parameter value.
 - q is the elementary charge on an electron.
- N is the quality factor (diode emission coefficient) of the first diode.
- N_2 is the quality factor (diode emission coefficient) of the second diode.
- V is the voltage across the solar cell electrical ports.
- The quality factor varies for amorphous cells, and is typically 2 for polycrystalline cells.
- The block lets you choose between two models:

- An 8-parameter model where the preceding equation describes the output current
- A 5-parameter model that applies the following simplifying assumptions to the preceding equation:
 - The saturation current of the second diode is zero.
 - The impedance of the parallel resistor is infinite.

If you choose the 5-parameter model, you can parameterize this block in terms of the preceding equivalent circuit model parameters or in terms of the short-circuit current and open-circuit voltage the block uses to derive these parameters.

All models adjust the block resistance and current parameters as a function of temperature.

You can model any number of solar cells connected in series using a single Solar Cell block by setting the parameter **Number of series cells** to a value larger than 1. Internally the block still simulates only the equations for a single solar cell, but scales up the output voltage according to the number of cells. This results in a more efficient simulation than if equations for each cell were simulated individually.

If you want to model N cells in parallel, you can do so for single cells by scaling the parameter values accordingly. That is, multiply short-circuit current, diode saturation

current, and solar-generated currents by N , and divide series resistance by N . To connect solar cell blocks in parallel, where each block contains multiple cells in series, make multiple copies of the block and connect accordingly.

DC-DC BOOST CONVERTER

Here 18 V is converted to 255 V, inductance $L=100$ micro henry and capacitance $C=100$ micro farad. Switched mode supplies can be used for many purposes including DC to DC converters. Often, although a DC supply, such as a battery may be available, its available voltage is not suitable for the system being supplied. For example, the motors used in driving electric automobiles require much higher voltages, in the region of 500V, than could be supplied by a battery alone. Even if banks of batteries were used, the extra weight and space taken up would be too great to be practical. The answer to this problem is to use fewer batteries and to boost the available DC voltage to the required level by using a boost converter. Another problem with batteries, large or small, is that their output voltage varies as the available charge is used up, and at some point the battery voltage becomes too low to power the circuit being supplied. However, if this low output level can be boosted

back up to a useful level again, by using a boost converter, the life of the battery can be extended.

The DC input to a boost converter can be from many sources as well as batteries, such as rectified AC from the mains supply, or DC from solar panels, fuel cells, dynamos and DC generators. The boost converter is different to the Buck Converter in that its output voltage is equal to, or greater than its input voltage. However it is important to remember that, as power (P) = voltage (V) x current (I), if the output voltage is increased, the available output current must decrease.

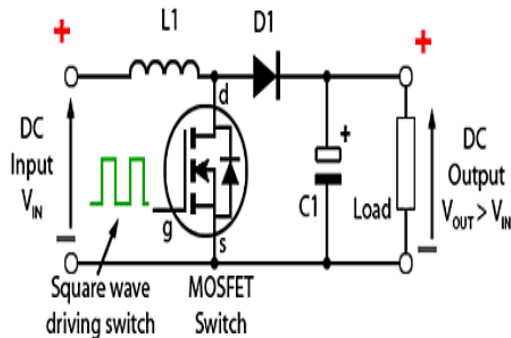


Fig. A Basic Boost Converter Circuit

Fig. A illustrates the basic circuit of a Boost converter. However, in this example the switching transistor is a power MOSFET, both Bipolar power transistors and MOSFETs are used in power switching, the choice being determined by the current, voltage, switching speed and cost

considerations. The rest of the components are the same as those used in the buck converter illustrated in Fig. A, except that their positions have been rearranged.

Boost converter Operation

Fig B illustrates the circuit action during the initial high period of the high frequency square wave applied to the MOSFET gate at start up.

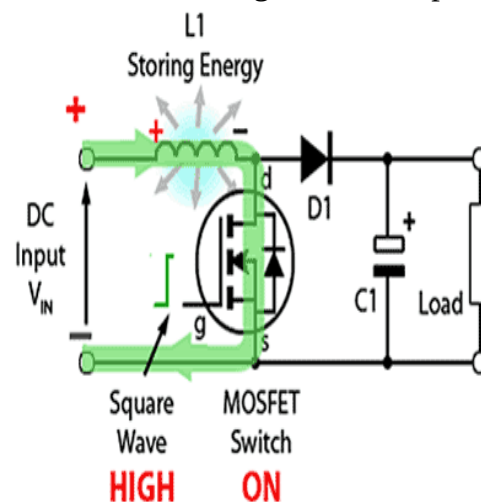


Fig. B Boost Converter Operation at Switch On

During this time MOSFET conducts, placing a short circuit from the right hand side of L1 to the negative input supply terminal. Therefore a current flows between the positive and negative supply terminals through L1, which stores energy in its magnetic field. There is virtually no current flowing in the remainder of the circuit as the combination of D1, C1 and the load

represent a much higher impedance than the path directly through the heavily conducting MOSFET.

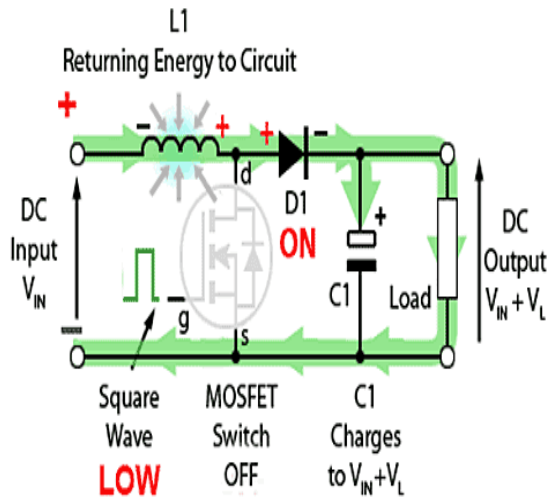


Fig. C Current Path with MOSFET Off

Fig. C shows the current path during the low period of the switching square wave cycle. As the MOSFET is rapidly turned off the sudden drop in current causes L1 to produce a back e.m.f. in the opposite polarity to the voltage across L1 during the on period, to keep current flowing. This results in two voltages, the supply voltage V_{IN} and the back e.m.f. (V_L) across L1 in series with each other.

This higher voltage ($V_{IN} + V_L$), now that there is no current path through the MOSFET, forward biases D1. The resulting current through D1 charges up C1 to $V_{IN} + V_L$ minus the small forward voltage drop

across D1, and also supplies the load.

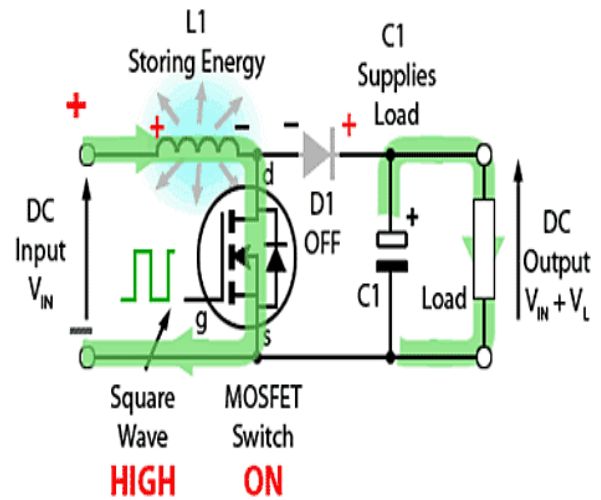


Fig. D Current Path with MOSFET On

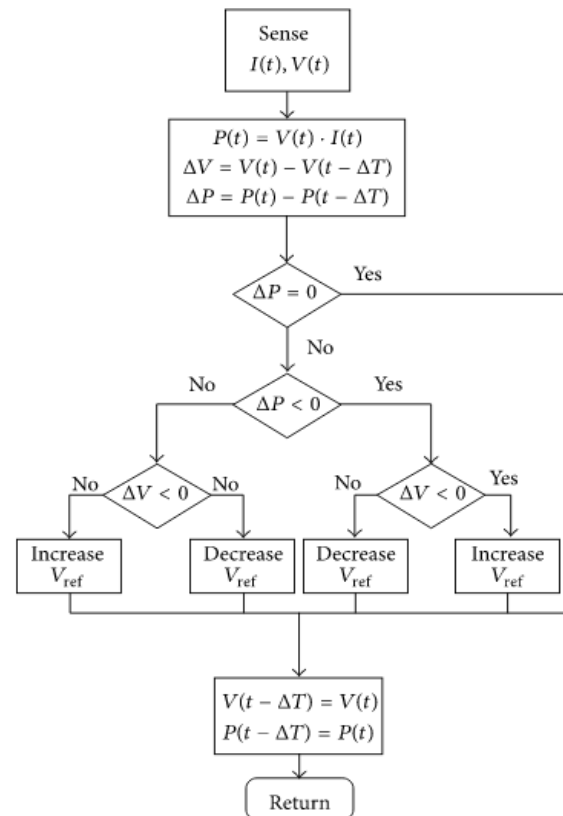
Fig.D shows the circuit action during MOSFET on periods after the initial start up. Each time the MOSFET conducts, the cathode of D1 is more positive than its anode, due to the charge on C1. D1 is therefore turned off so the output of the circuit is isolated from the input, however the load continues to be supplied with $V_{IN} + V_L$ from the charge on C1. Although the charge C1 drains away through the load during this period, C1 is recharged each time the MOSFET switches off, so maintaining an almost steady output voltage across the load.

P and O - MPPT

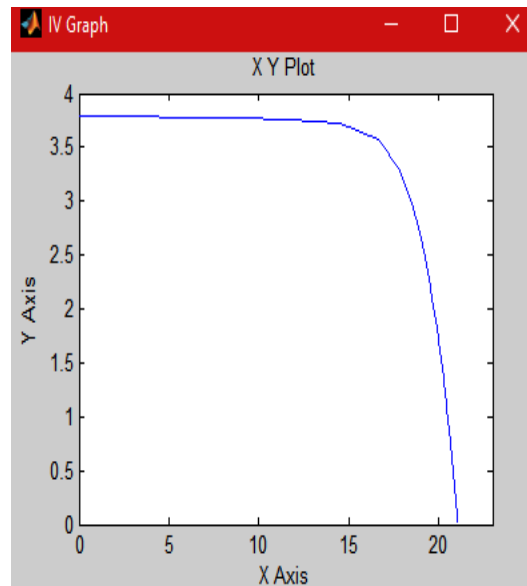
P&O is one the simplest MPPT methods with excellent performance and can be easily implemented in low cost systems. Some more sophisticated methods are based on the same principle employed in P&O method.

The principle lies in disturbing the voltage or the current of the PV module and observing its effect on the resulting power. The algorithm compares the power of the previous step with that for the next step so that it can increase or decrease the voltage or current. This method changes the reference value, which can be a constant current or voltage. The operating point is then periodically moved towards the MPP by either increasing or decreasing the array voltage or current. The current is then modified at a constant rate, which represents a parameter that must be adjusted to obtain tradeoffs between fast dynamic response and reduced steady-state ripple.

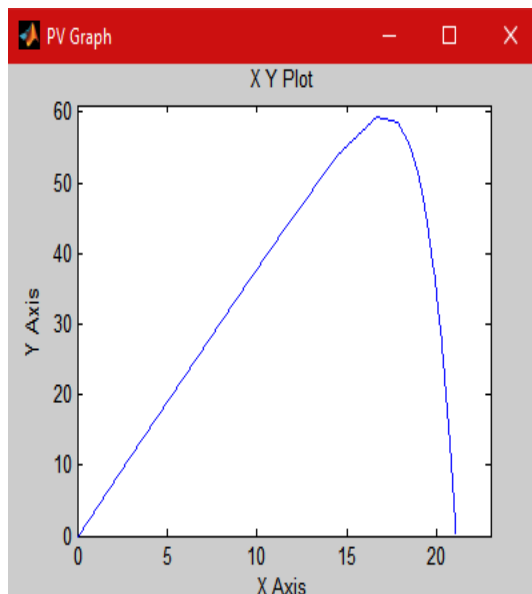
The flowchart representation of P&O is given in Figure , which requires both voltage and current sensors. It is worth to mention that the performance can be improved by changing the step for the converter's duty cycle, so that tracking can be adjusted to better achieve MPP. When such step is variable, the method is called modified P&O.



RESULT



IV GRAPH

**PV GRAPH****TABLE COLUMN :**

OUTPUT CURREN T	OUTPUT VOLTAG E	LOA D
15	110	25
15	120	50
15	132	75
15	140	100

CONCLUSION

Thus the MATLAB/Simulink is simulated for different conditions of the energy produced from the solar cell. Perturb and observe method is used to track the maximum power point. The DC-DC boost converter is operated by the pulse produced from the MPPT (Maximum power point tracking). By using the perturb and observe method maximum efficiency is produced and verified in MATLAB/Simulink.

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