International Journal of Research in Engineering, Science and Management
Volume-3, Issue-6, June-2020
www.ijresm.com | ISSN (Online): 2581-5792

A Grid Tied PV System with Adaptive DC Link Voltage for CPI Voltage Variations

K. Manasa[1*], J. Uday Bhaskar[2], K. Rajini[3]
[1]*Student, Department of Electrical and Electronics Engineering, D. M. S. S. V. H. College of Engineering, Machilipatnam, India*
[2,3]*Associate Professor, Department of Electrical and Electronics Engineering, D. M. S. S. V. H. College of Engineering, Machilipatnam, India*
*Corresponding author: manasa.manasu.143@gmail.com

***Abstract*: This proposed model manages a three- stage two-organize grid tied SPV framework. The main stage is a help converter, which fills the need of MPPT and sustaining the removed sunlight based vitality to the DC connection of the PV inverter, while the second stage is a two-level VSC serving as PV inverter which bolsters control from a support converter into the matrix. The point of this controller is to accomplish an ideal MPP operation without the need of barometrical conditions estimations and to improve the productivity of the PV control framework. This model likewise utilizes a versatile DC connect voltage which is made versatile by modifying reference DC interface voltage as per CPI voltage. The versatile DC connects voltage control helps in the decrease of exchanging force misfortunes. A sustain forward term for sun oriented commitment is utilized to enhance the dynamic reaction. A photovoltaic framework can create wide scopes of voltage and current at terminal yield. Be that as it may, a PV cell is required to practically keep up a consistent direct present (DC) voltage at a craved level amid constant varieties. To get this objective, a DC/DC converter together with control plot topology is utilized. A versatile PI control plan is proposed to settle the yield voltage of the DC/DC converter, with a specific end goal to keep up and balance out the Adaptive DC-connect voltage in like manner to the progressions of voltage at the Common Point of Interconnection before the framework. The proposed system is simulated in SIMULINK/ MATLAB and results are validated.**

***Keywords*: Adaptive dc link, MPPT, Over voltage, Solar pv, Two-stage, Three phase, Under voltage.**

1. Introduction

The electrical energy has a vital role in development of human life. The renewable energy sources such as solar, wind, tidal etc. are few of such options which solve the problem of energy scarcity. The SPV (Solar Photovoltaic) systems have been proposed long back but the costs of solar panels have hindered the technology for long time, however the SPV systems are reaching grid parity, the solar energy based systems can be classified into standalone and grid interfaced systems. The energy storage (conventionally batteries) management is the key component of standalone system. SPV systems is high because of high cost of solar panels. Therefore, considering the initial investments for any installed plant, the aim is to extract maximum energy output from the given capacity.

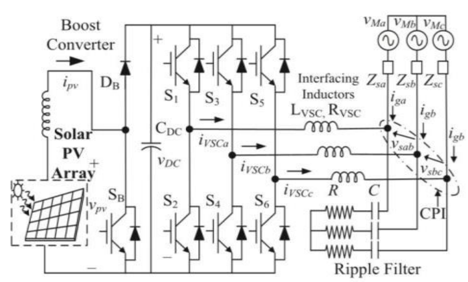
2. MPPT

MPPTs can be designed to drive an electric motor without a storage battery. They provide significant advantages, especially when starting a motor under load. This can require a starting current that is well above the short-circuit rating of the PV panel. A MPPT can step the panel's relatively high voltage and low current down to the low voltage and high current needed to start the motor.

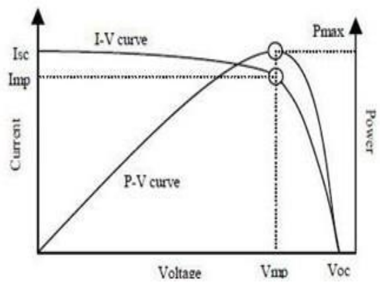
Once the motor is running and its current requirements have dropped, the MPPT will automatically increase the voltage to normal. In this application, the MPPT can be seen as an electrical analogue to the transmission in a car; the low gears provide extra torque to the wheels until the car is up to speed.

3. System Model

The system configuration for the proposed system is shown in Fig. 1. A two stage system is proposed for grid tied SPV system. The first stage is a DC-DC boost converter serving for MPPT and the second stage is a two-level three phase VSC. The PV array is connected at the input of the boost converter and its input voltage is controlled such that PV array delivers the maximum power at its output terminals. The output of boost converter is connected to DC link of VSC. The DC link voltage of VSC is dynamically adjusted by grid tied VSC on the basis of CPI voltage. The three phase VSC consists of three IGBT legs. The output terminals of VSC are connected to interfacing inductors and the other end of interfacing inductors are connected to CPI. A ripple filter is also connected at CPI to absorb high frequency switching ripples generated by the VSC.

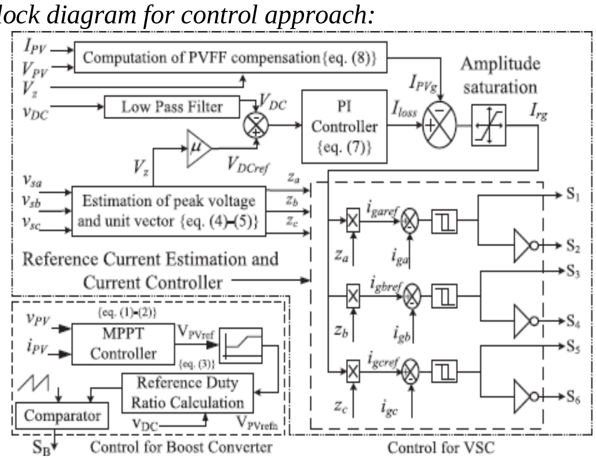


Current-voltage and power-voltage characteristics of a solar cell:



In solar power system the power delivered to the load is highly dependent on solar radiation and PV array temperature. I-V and P-V curves of a solar cell with constant module temperature and solar radiation.

Block diagram for control approach:



Equations:

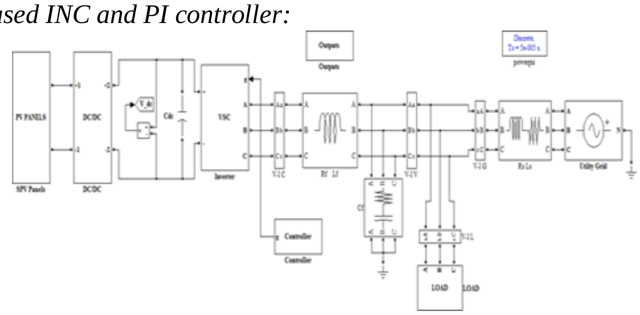
$$I_{PV} = I_{SC} - I_o \left[\exp\left(\frac{V_{PV} + R_S I_{PV}}{V_t}\right) - 1\right]$$

$$D_{ref}(k) = 1 - \frac{V_{PVrefn}(k)}{V_{DC}(k)}$$

$$I_{loss}(k) = I_{loss}(k-1) + K_p\{v_e(k) - v_e(k-1)\} + K_i v_e(k)$$

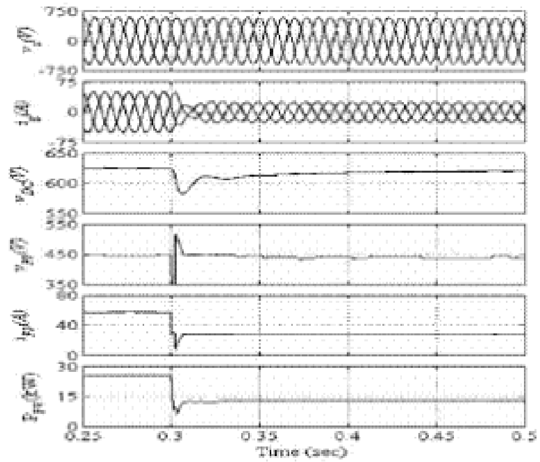
$$I_{rg} = I_{loss} - I_{PVg}$$

Simulink model of two stage grid tied SPV system using MPPT based INC and PI controller:



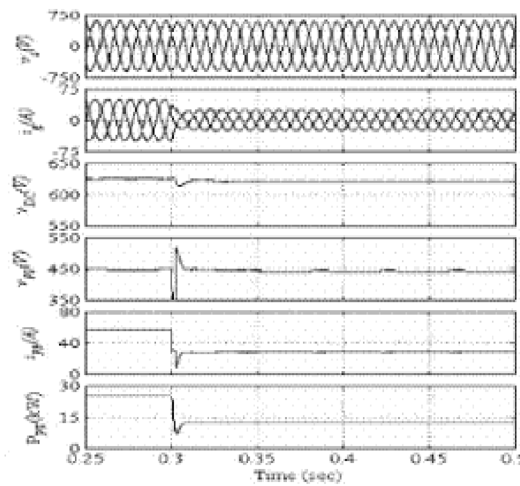
Expected simulation results:

Change in solar insulation without feed forward for pv contribution:



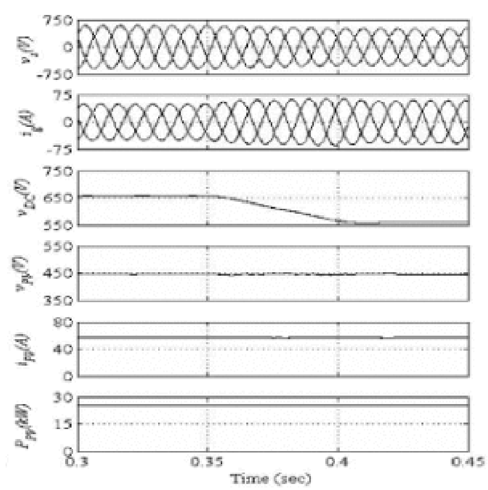
(a)

Change in solar insulation with feed forward for PV contribution:



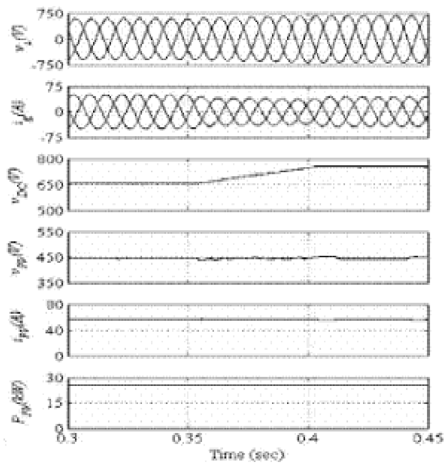
(b)

Normal to under voltage (415v to 350v):



(c)

Voltage variations from normal to over voltage (415v 480v):



(d)

4. Conclusion

A two-stage system has been proposed for three-phase grid connected solar PV generation. Earlier, works have been done in this area using Incremental based MPP Technique to control the boost converter and adaptive DC link voltage control approach for control of grid tied VSC.A PV array feed forward term is used which helps in fast dynamic response. The concept of adaptive DC link voltage has been proposed for grid tied VSC for PV application however, the same concept can be extended for all shunt connected grid interfaced devices such as, STATCOM, DSTATCOM etc. The proposed model yields increased energy output using the same hardware resources just by virtue of difference in DC link voltage control structure. The THD of the grid current which has improved quite a lot from the earlier works. In this model it is not only increased the speed of the system but also improved its accuracy. We can further improve the system by using other artificial intelligence techniques. The same can be implemented for more variations at CPI. The simulation results are validated the validity of proposed system.

References

[1] M. Pavan and V. Lughi, "Grid parity in the Italian commercial and industrial electricity market," in *Proc. Int. Conf. Clean Elect. Power(ICCEP'13)*, 2013, pp. 332–335.
[2] M. Delfanti, V. Olivieri, B. Erkut, and G. A. Turturro, "Reaching PV grid parity: LCOE analysis for the Italian framework," in *Proc. 22nd Int. Conf. Exhib. Elect. Distrib. (CIRED'13)*, 2013, pp. 1–4.
[3] H.Wang and D. Zhang, "The stand-alone PV generation system with parallel battery charger," in *Proc. Int. Conf. Elect. Control Eng. (ICECE'10)*,2010, pp. 4450–4453
[4] M. Kolhe, "Techno-economic optimum sizing of a stand-alone solar photovoltaic system," *IEEE Trans. Energy Convers.*, vol. 24, no. 2, pp. 511–519, Jun. 2009.
[5] D. Debnath and K. Chatterjee, "A two stage solar photovoltaic based standalone scheme having battery as energy storage element for rural deployment," *IEEE Trans. Ind. Electron.*, vol. 62, no. 7, pp. 4148–4157, Jul. 2015.
[6] S. Krithiga and N. G. Ammasai Gounden, "Power electronic configuration for the operation of PV system in combined grid-connected and stand-alone modes," *IET Power Electron.*, vol.
[7] I. J. Balaguer-Álvarez and E. I. Ortiz-Rivera, "Survey of distributed generation islanding detection methods," *IEEE Latin Amer. Trans.*, vol. 8, no. 5, pp. 565–570, Sep. 2010.
[8] C. A. Hill, M. C. Such, D. Chen, J. Gonzalez, and W. M. Grady, "Battery energy storage for enabling integration of distributed solar power generation," *IEEE Trans. Smart Grid*, vol. 3, no. 2, pp. 850–857, Jun.2012.
[9] W. Xiao, F. F. Edwin, G. Spagnuolo, and J. Jatskevich, "Efficient approaches for modeling and simulating photovoltaic power systems," *IEEE J. Photovoltaics*, vol. 3, no. 1, pp. 500–508, Jan. 2013.
[10] P. Chiradeja, "Benefit of distributed generation: A line loss reduction analysis," in *Proc. IEEE/PES Transmiss. Distrib. Conf. Exhib.: Asia Pac.*,2005, pp. 1–5.
[11] A. Yadav and L. Srivastava, "Optimal placement of distributed generation: An overview and key issues," in *Proc. Int. Conf. Power Signals Control Comput. (EPSCICON'14)*, 2014, pp. 1–6.
[12] K. A. Joshi and N. M. Pindoriya, "Impact investigation of rooftop Solar PV system: A case study in India," in *Proc. 3rd IEEE PES Int. Conf. Exhib. Innovative Smart Grid Technol. (ISGT Europe)*, 2012, pp. 1–8.
[13] E. Drury, T. Jenkin, D. Jordan, and R. Margolis, "Photovoltaic investment risk and uncertainty for residential customers," *IEEE J. Photo voltaics*, vol. 4, no. 1, pp. 278–284, Jan. 2014.
[14] B. Subudhi and R. Pradhan, "A comparative study on maximum powerpoint tracking techniques for photovoltaic power systems," *IEEE Trans. Sustain. Energy*, vol. 4, no. 1, pp. 89–98, Jan. 2013.
[15] F. Liu, S. Duan, F. Liu, B. Liu, and Y. Kang, "A variable step size INCMPPT method for PV systems," *IEEE Trans. Ind. Electron.*, vol. 55, no. 7, pp. 2622–2628, Jul. 2008.