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Grid Synchronous Inverter

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Abstract

Grid Synchronous inverter is the fast and accurate controlling method for tracking the voltage reference source. In this inverter the Hysteresis Band Voltage PWM control can detect reference voltage in an effective and accurate manner which is crucial in order to implement stable control strategy. Incremental conductance algorithm tracks the maximum power point and triggers the switching operation of boost converter. The Push Pull Inverter converts the dc to ac with boosted track. This paper aims at analysing the simulation of the proposed method and the performance of the synchronised output waveform from the solar input with reference to the local grid supply.

Keywords: Hysteresis Voltage Control Pulse Width Modulation (PWM), Push Pull Inverter, Maximum Power Point Tracking (MPPT), and Boost Converter.

Introduction

Most of the industries in India still depend on State Electricity Board power distribution as the means of their primary supply. Due to energy shortage owing to natural factors industries are forced to depend on renewable energy sources like solar energy. However in order to achieve that conversion, large number of solar panels should be installed to reach the sufficient power. This requires heavy investment which proves to be a financial hurdle for many of the companies.

An alternative to this scenario is to converter a particular section into solar energy dependence as per industrial needs. By adopting the proposed method in this paper the industries requirement can be met with best results. In Grid Synchronous Inverter [1][5], the supply from the solar panel is synchronised with reference supply which is used to drive the machine. So the voltage and frequency of solar supply input is synchronised with existing primary input supply. Using this method convert a particular system to solar dependence incorporates with other automated systems without effecting the synchronisation. Here incase any variations in voltage or frequency [2] occur in the primary supply, it will be automatically tracked to the corresponding values to maintain synchronised condition.

Proposed Block Diagram

In this method energy from solar panel is boosted and used to charged the battery. Push pull inverter [9] converts dc to ac and boosts the required output according to the winding ratio of the transformer.The controller controls the output voltage with fast and accurate response. Also voltage Hysteresis PWM control is incorporated for the smooth tracking [3][4].

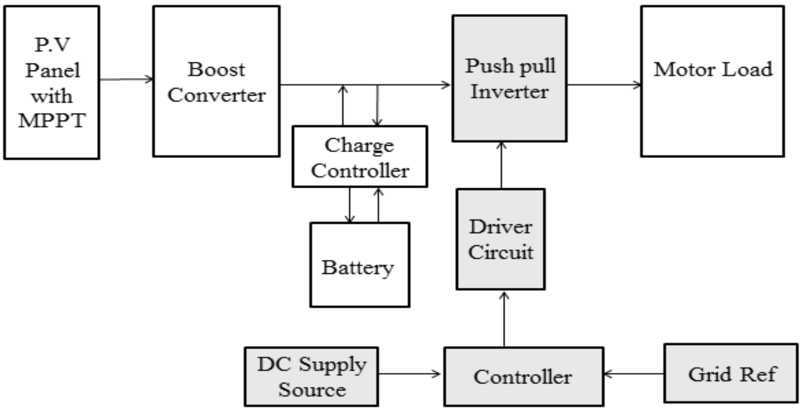

Figure 1: Proposed Block Diagram

Hysteresis band PWM is basically an instantaneous feedback voltage control method of PWM [6] where the actual voltage continually tracks the command voltage within a hysteresis band. The control circuit generates the sine reference voltage wave of desired magnitude and frequency and it is compared with the actual phase voltage wave. As the voltage exceeds a prescribed hysteresis band [7], the upper switch in the inverter is turned off and the lower switch is turned on. As a result the output voltage transitions from +0.1 V_d to -0.1 V_d and the voltage starts to decay.

As the voltage crosses the lower band limit, the lower switch is turned off and the upper switch is turned on. A lock-out time (t_d) is provided at each transition to prevent a shoot through fault. The actual voltage wave is thus forced to track the sine reference wave within the hysteresis band by back-and forth (or bang-bang) switching of the upper and lower switches. Hysteresis band control will allow the parameter to stay in the selected band. The band should be initialized to the band limit according to the application. The figure (2) shows the Hysteresis voltage band control PWM wave form and the figure (3) shows the circuit diagram of proposed system

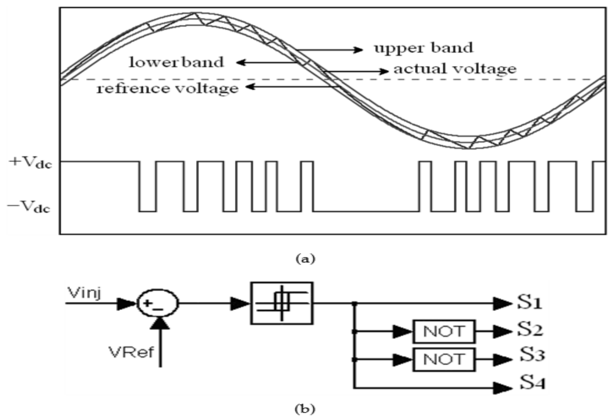

Figure 2: Hysteresis Voltage Band Control Wave Form

In Boost converter [8] step up the input dc voltage from the solar panel which is designed by the expressions in duty cycle δ, Inductance L, capatance C

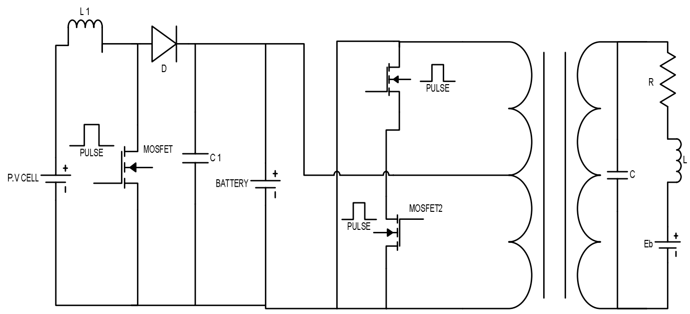

Figure 3: Circuit Diagram of Proposed Method

$$\delta = \frac{V_{in}}{V_o} \quad \text{………………..} \qquad (1)$$

$$L= \frac{V_{in}\times\delta}{f\times\Delta v} \quad \text{………………..} \qquad (2)$$

$$C=\frac{\delta}{R\times\Delta v\times f} \quad \text{………………} \qquad (3)$$

Push pull inverter is a DC to AC inverter with low frequency step up transformer and are based on low frequency switching of the low voltage DC side, applying the resulting DC pulses to a step-up transformer.The advantages of the push-pull method are its simple trigger circuits and the reduction in the number of switches for low and medium power applications in comparison with the full bridge method.

The main advantage is the isolation between the source and output provided by the magnetics in the transformer. Another deciding factor is the simplicity of the switching over a full bridge design. By having to turn on only one switch at a time, timing issues become less critical.This makes the push pull inverter more reliable and achievable.In Push Pull Inverter there is a transformer winding for the step-up operation with respect to the winding turns ratio. The transformer is centrally tapped to get the desired output and the input of inverter is fed from the dc source. The rating of inverter is determined by the winding of transformer.

Incremental conductance algorithm tracks the maximum power point and triggers the switching operation of boost converter. The principle is based on the fact that the slope of the curve power vs. voltage (current) of the PV module is zero at the Maximum Power Point MPP, positive (negative) on the left of it and negative (positive) on the right.

By comparing the increment of the power (ΔP) vs. the increment of the voltage (ΔV) or current (ΔI) between two consecutive samples, the change in theMaximum Power Point MPP voltage can be calculated. The figure (4) shows the Incremental Conductance Algorithm.

- $\Delta V/\Delta P = 0$ $(\Delta I/\Delta P)$ at the MPP
- $\Delta V/\Delta P < 0(\Delta I/\Delta P)$ on the left
- $\Delta V/\Delta P > 0(\Delta I/\Delta P)$ on the right

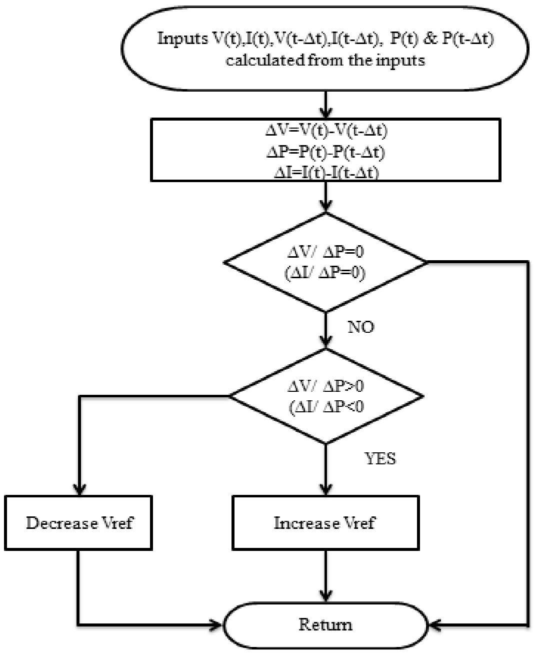

Figure 4:MPPT Algorithm

Simulation of Proposed Method

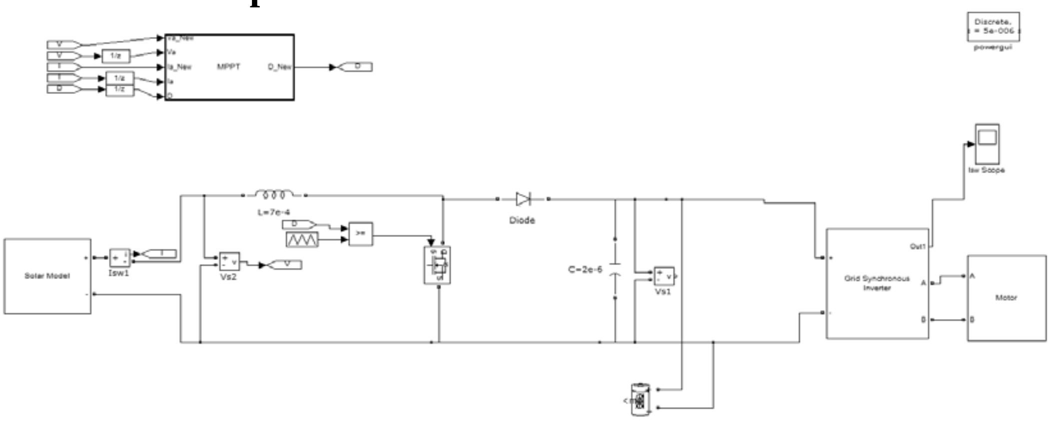

Figure 5: Simulation Diagram of Proposed Method

The figure (5) and (6) shows the simulation circuit of Grid Synchronous Inverter and synchronised output wave form respectively. Here the output wave form is tracks accurately with the reference wave form are shown in figure (6). The figure (7) shows the output speed of load, induction Motor is connected as the load here.

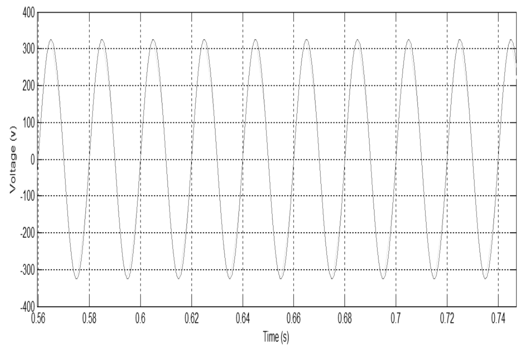

Figure 6: Synchronized Output

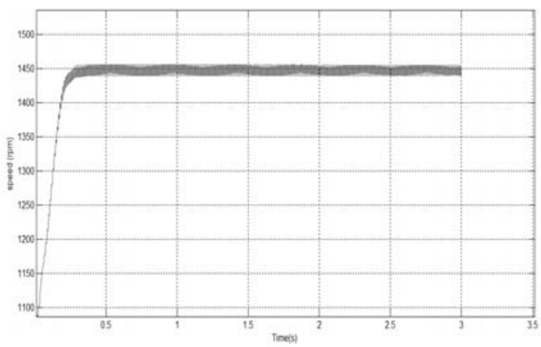

Figure 7: Speed of Induction Motor

Conclusions

Grid Synchronous Inverter was simulated and performance of synchronisation waveform was analysed successfully. It is applicable in various industrial areas and this method can be customised for different levels of applications with respect to client requirements. It can even be incorporated with automated systems and can easily maintain synchronisation with other devices and machines. The proposed control strategy can be potentially extended to automated three phase grid synchronous inverter, grid synchronous inverters with DTC for three phase motor, three phase smart grid synchronous inverters.

References

[1] Mohammad A.Abusara and Suleiman M. Sharkh "Design and Control of a Grid- Connected Interleaved Inverter," IEEE Trans. Power Electron., vol. 28, no.2, pp.748 -764, Feb 2013.

[2] E.Twining and D.G Holmes "Grid Current Regulation Of a Three Phase VoltageSource Inverter With An LCL Filter," in Proc.20th Annu.IEEE Power Electron.Spec.conf.,Jun.23-27,2002,vol.13 pp.1189-1194.

[3] S. Chung, "A Phase Tracking System For Three Phase Utility Interface Inverters," IEEE Trans. Power Electron., vol. 15, no. 3, pp. 431–438, May 2000.

[4] S. Shinnaka, "A Robust Single-Phase PLL System With Stable and Fast Tracking," IEEE Trans. Ind. Appl., vol. 44, no. 2, pp. 624–633, Mar./Apr.2008.

[5] M. Ciobotaru, V. G. Agelidis, R. Teodorescu, and F. Blaabjerg, "Accurate and Less-Disturbing Active Antiislanding Method Based on PLL for Grid Connected Converters," IEEE Trans. Power Electron., vol. 25, no. 6,pp. 1576–1584, Jun. 2010.

[6] D. N. Zmood and D. G. Holmes, "Stationary Frame Current Regulation of PWM Inverters With Zero Steady-State Error," IEEE Trans. Power Electron.,vol. 18,no. 3, pp. 814–822, May 2003.

[7] G. F. Franklin, J. D. Powell, and A. Emami-Naeini, "Feedback Control of Dynamic Systems", 6th ed. Englewood Cliffs, NJ: Prentice- Hall, 2009.

[8] M. Karimi-Ghartemani and M. R. Iravani, "A Method For Synchronization Of Power Electronic Converters In Polluted and Variable-Frequency Environments," IEEE Trans. Power Syst., vol. 19, no. 3, pp. 1263–1270, Aug.2004.

[9] Jiann-Fuh Chen , Ren-Yi Chen, Tsorng-Juu Liang and Wei-Jin Tzeng (2007), "Buck-type current-fed push-pull converter with ZCS for high voltage applications," in Proc. IEEE Region 10 Conference, pp.1-4.