International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

A Buck and Boost Based Grid Connected PV Inverter Maximizing Power Yield From Two PV Arrays in Mismatched Environmental Conditions

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Abstract:

To extract the maximum power from two serially connected subarrays, it is proposed in this paper that a single phase grid connected transformerless photovoltaic (PV) inverter, which can operate in either buck or boost mode and can extract the maximum power simultaneously from two serially connected subarrays while each subarray is subjected to a different environmental condition, be used. It is much less restrictive to employ a minimal number of serially connected solar PV modules to form a subarray when using an inverter that can operate in either buck or boost mode depending on the application since the inverter can operate in either mode depending on the application. It is as a result of this that the power yield from each subarray increases when each subarray is exposed to a different set of environmental variables. According to the design specifications, the topological configuration of the inverter and its control approach should be such that high-frequency components are not present in the common mode voltage, allowing the amplitude of the leakage current associated with the PV arrays to remain within a specified range of values. Additionally, a high degree of operating efficiency is achieved across the whole working range. Having completed a thorough analysis of the system, which eventually results in the development of a mathematical model of the system, it is assessed whether or not the project is practical by conducting extensive simulation studies. Extensive experimental experiments are required in order to demonstrate the accuracy of the design, and a 1.5 kW laboratory prototype is required.

Index Terms—Buck and Boost based photovoltaic (PV) inverter, grid connection, maximum power point (MPP), mismatched environmental condition, series connected module, single phase, transformer less.

INTRODUCTION

If you are designing a photovoltaic (PV) system, one of the most important considerations to make is making sure that individual PV modules in a solar-electric (PV) array perform to their maximum potential even when the modules are subjected to different environmental conditions as a result of differences in insulation level and/or differences in operating temperature. An incompatibility between the operating parameters of the modules results in a significant reduction in the power produced by a solar-electric array. When there are a large number of PV modules connected in series in a solar PV array, dealing with the problem of mismatched environmental conditions

(MECs) becomes increasingly complex. Because the input dc-link voltage of an inverter in a grid connected transformer less (GCT) PV system must be of a certain size in order to reach the desired magnitude, a large number of series linked modules are required. Figure 1 shows the number of series linked modules required in a GCT PV system. A GCT PV system, such as a single phase GCT (SPGCT) inverter based system created from H-bridges or a neutral point clamp (NPC) inverter based system, has its power output severely decreased as a consequence of the MEC. To cope with the problem that emerges as a consequence of MEC in a PV system, a number of techniques have been offered in the literature. Such techniques are described in full in this study, which includes an in-depth examination of each one.

Maximum power point tracking (MPPT) is a complicated algorithm that can be used to track the global maximum power point (MPP) of a PV array, which can be used to maximise the amount of power extracted during MEC. By selecting the appropriate connectivity between PV modules or by monitoring the global maximum power point (MPP) of the PV array, it is possible to maximise the amount of power extracted during MEC. When it comes to SPGCT PV systems with a low power output, however, these tactics are unsuccessful. Additionally, modifying the electrical connections of solar panels to reconfigure them in an array is ineffective for SPGCT solar systems due to the considerable rise in number of components and escalation in complexity of operation. Each PV module in a PV array has been individually controlled, either via the use of a power electronic equalisation system or the connection of a direct current to direct current converter, in order to harvest the most power possible from each PV module during MEC. For systems that make use of a power electronic equaliser, a substantial number of components are necessary, which increases the cost and complexity of the system's operation. Using the technique outlined in, each PV module is operated at its unique maximum power point (MPP), with the difference in power between each module being managed only by the generation control circuit (GCC) of the system. According to the system described in, the power yield of a PV array may be enhanced by using shunt current compensation for each module as well as series voltage compensation for each PV string in the array. Integration solutions for PV systems make use of specialised direct current to direct current converters that are built into each PV module. Because of the large number of converter stages involved in the aforementioned schemes, as well as the large number of components involved in these schemes, the efficiency of these schemes is poor, and as a result, they suffer from the same limitations as the power electronic equalizer-based system described above. It is possible to create a string of modules by joining a number of modules together in sequence to form a string, and the strings so produced may then be made to work under MPP in the same manner that each individual module would have functioned. Even in this instance, there is only a little reduction in the overall number of components and the complexity of the control system. More than one system described in the literature divides up the PV modules into two subarrays, with each subarray being designed to operate at its own maximum power point (MPP).

This streamlines the control setup and minimises the amount of components required to operate the system. Both tactics, on the other hand, have been shown to be inadequate in terms of overall efficiency. A buck and boost stage in the SPGCT PV inverter optimises power extraction during the MEC phase of the solar PV system's MEC cycle. With the development of the intermediate boost stage, the number of series-connected PV modules that must be utilised in a PV array has been reduced, as has the number of solar panels needed in a PV array. In either the dc to dc converter stage or the inverter stage of the schemes described here, the switches are operated at a high frequency, resulting in a large reduction in the size of the passive element count and, as a result, an increase in the operational efficiency of the systems. Furthermore, the stated efficiency of is one to two percentage points higher than the observed efficiency of To ensure that the maximum amount of power evacuation from each subarray is achieved during the MEC process, a concerted effort has been put forth in this paper to divide the PV modules into two serially connected subarrays, with each subarray being controlled with the help of buck and boost based inverters. This approach of separating an input PV array into two subarrays, as compared to the methods provided in, reduces the number of series-connected modules in a subarray by nearly half, as seen in Figure 1. With topological structures and control mechanisms comparable to those proposed here, solar array leakage current may be kept below acceptable limits by inverters.

The voltage stress across the active devices is also reduced by about half when compared to the techniques described in, allowing for exceptionally high-frequency operation without increasing the switching loss. Using high-frequency operation reduces the size of the passive components that are employed, which is beneficial. As a result, the strategy that has been proposed has a high degree of operational efficacy. When the recommended approach was used, it was revealed that the measured peak efficiency and the European efficiency (in euros) were both 97.65 percent and 97.02 percent, respectively, when the technique was applied. This page contains a description of the specific operation of the recommended inverter, as well as a mathematical validation of the device's operation. Following that, in Section III, the mathematical model of the proposed inverter is built, which is followed by the philosophy of control strategy in Section IV, which brings the article to a close. After discussing the selection criteria for the values of the output filter components, which also covers the values of the input filter components, Section V turns to the topic of filter component values. Detailed simulation studies have been conducted to validate the proposed method, and the findings of these studies are presented in Section VI of this paper. A laboratory prototype of the proposed inverter with a power output of 1.5 kW has been constructed in order to undertake thorough experimental testing on the device under consideration. Section VII displays the results of the scheme's measurements, which establish its feasibility and effectiveness while also demonstrating its feasibility and efficacy, respectively.

PROPOSED INVERTER

A dc to dc converter step is followed by an inverting stage, as seen in the schematic, to form the dual-buck and boost-based inverter (DBBI) suggested in this paper (see Fig. 1). A total of two dc to dc converter segments, CONV1 and CONV2, are used to service the two subarrays of the solar PV array, PV1 and PV2, respectively. The dc to dc converter stage is separated into two separate dc to dc converter segments, CONV1 and CONV2. Among the components of the CONV1 section are the following:

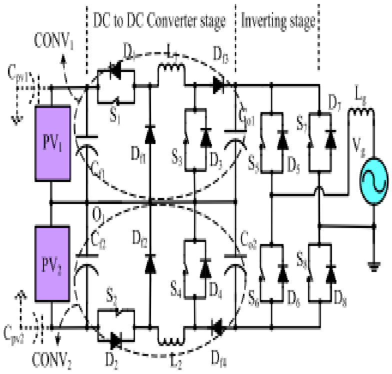

Fig. 4.1. Dual buck and boost based Inverter.

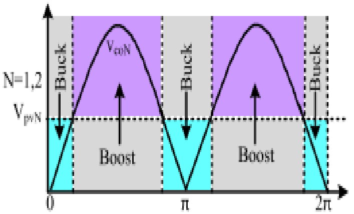

Fig 4. 2. Buck stage and boost stage of the proposed inverter.

In addition to the free-wheeling diodes Df 1 and Df 3, the circuit includes self-commutating filters, inductors, and capacitors L1, Cf 1, and Co1, as well as self-commutating diodes Df 1 and Df 3. Furthermore, self-commutated switches S1 and its antiparallel body diode D1 are self-commutated switches, as is S3 and its antiparallel body diode D3, in addition to being self-commutated switches. The self-commutated switches S2 and S4 as well as their antiparallel body diodes D2 and D4, the free wheeling diodes Df 2 and Df 4, as well as the filter inductors and capacitors L2, Cf 2, and Co2 are all included in the CONV2 sector of the schematic diagram. The self-commutated switches S2 and S4 as well as their antiparallel body diodes D2 and D4, as well as the free wheeling di The self-commutated switches (S5, S6, S7, and S8), as well as their corresponding body diodes (D5, S6, S7, and S8), that comprise the inverting stage are shown in Figure 1. The inversion step is shown in Figure 1. When the grid is linked to the inverter stage, Lg serves as an interface between the two, and this is referred to as a filter inductor in the industry (Lg). In this case, the capacitors are paired, and they represent the parasitic capacitance that occurs between the solar photovoltaic (PV) array and the ground potential. Take, for example, the image in Fig. 2. The buck mode is active when Vpv1 is less than or equal to vco1, and the buck mode is triggered when Vpv2 is less than or equal to vco2. The buck mode is activated when Vpv2 is less than or equal to vco2.

Activation of the buck mode is also possible when Vpv2 is less than or equal to vco2. MPP voltages are represented by the variables Vpv1 and Vpv2, respectively, if PV1 and PV2 are utilised. When the output voltages of CONV1 and CONV2 are used, the MPP voltages are represented by the variables vco1 and vco2, respectively. To achieve sinusoidal grid current (ag) in buck mode operation, the duty ratios of S1 and S2 are changed sinusoidally, while those of S3 and S4 are maintained at zero during the operation. In the instance where Vpv1 is more than or equal to Vco1, the CONV1 operates in boost mode; nevertheless, in the scenario where Vpv2 is greater than or equal to Vco2, the CONV2 operates in boost mode as well. The duty ratios of the switches are increased in boost mode, and the duty ratios of the switches are changed in a sinusoidal manner to guarantee sinusoidal ig is maintained. It is necessary to keep S1 and S2 turned on throughout the mode in order to achieve sinusoidal irradiation. It is critical to maintain synchronisation between the sinusoidal switching pulses produced by the switches of CONV1 and CONV2 and the grid voltage vg in order to guarantee that the unity power factor is maintained while operating. For the positive half-cycle (PHC), the switches S5 and S8 must be kept turned on, while for the negative half-cycle (NHC), they must be kept turned off (NHC). In order to ensure that the negative half-cycle (NHC) is completed successfully, the switches S6 and S7 must remain on for the whole negative half-cycle (NHC), while the switches S5 and S8 must be switched off (NHC). As seen in Figure 3 (including standby mode), the proposed inverter is visible in all of its operating modes.

Results:

For the purpose of demonstrating the effectiveness of the proposed inverter, a PV array consisting of two PV subarrays is explored, with each subarray consisting of four series connected Canadian solar polycrystalline modules "CS6P-165PE" [25] is investigated [26]. Following are the MPP parameters for each subarray under standard test circumstances (STC), as shown in Table I. Simulation and testing were carried out with the help of parameters and elements.

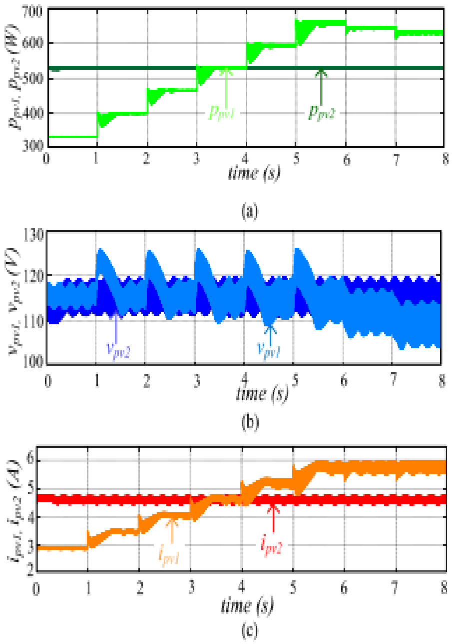

Fig5. 1. Simulated waveform. Variation in (a) ppv1 and ppv2 , (b) vpv1 and vpv2 , and (c) ipv1 and ipv2 during entire range of operation.

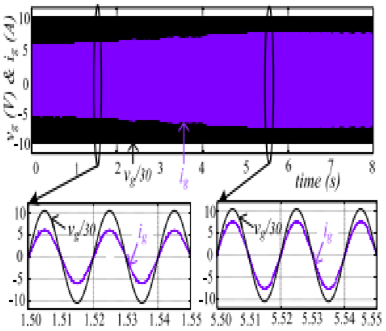

Fig5.2. Simulated waveform.vg and ig and their magnified views.

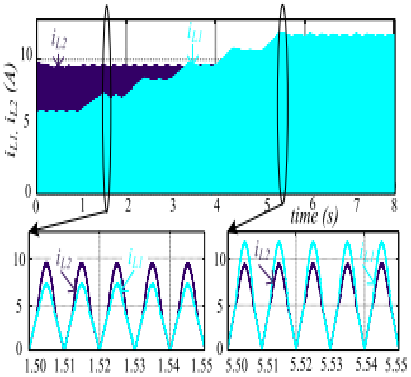

Fig5.3. Simulated waveform.iL1 and iL2 and their magnified views.

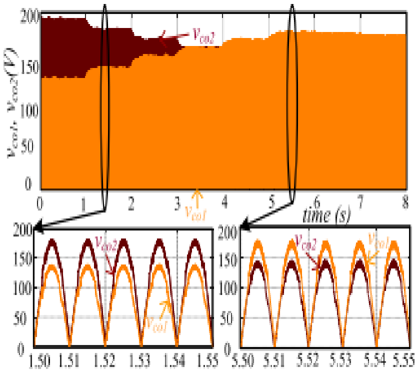

Fig5.4. Simulated waveform.vco1 and vco2 and their magnified views.

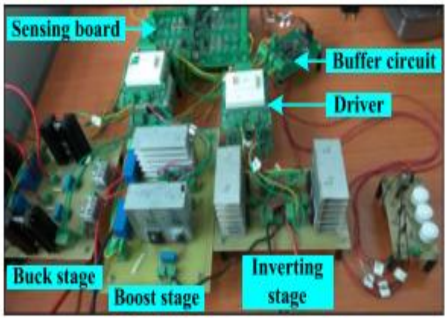

Fig5.5. Experimental prototype of the proposed inverter.

The magnified versions of ig and vg when (a) insolation of PV1 is 40% and insolation of PV2 is 80%, (b) insolation of PV1 is 100% and insolation of PV2 is 80%, the magnified versions of the PV1 and PV2 when (c) insolation of PV1 is 40% and insolation of PV2 is 80%, the magnified versions of the vpv1 and Vpv2 when (d) insol

CONCLUSION

It is proposed in this paper that a single phase GCT buck and boost based PV inverter be developed that is capable of running two subarrays at their respective maximum power points (MPPs). These were some of the enticing aspects of this inverter, to name just a few:
A realistic method of mitigating the impact of MECs on the PV array has been proposed in a previous section.
Two, the level of operational efficiency achieved (euro = 97.02 percent) was very high; and three, the amount of money saved was significant.

3) It had the ability to operate component converters in a decoupled way, which was advantageous.

4) A basic MPPT algorithm was developed in order to ensure that the component converters' MPP functionality was not compromised.

In addition, the leakage current linked to the PV arrays stayed below the limitations defined in VDE 0126-11-1, which is the German standard. The proposed inverter was submitted to a mathematical analysis, which resulted in the development of a miniature signal model for the device. In this work, we present the criteria for calculating the values of the output filter components, as well as the methods for finding these values.

Comprehensive modelling studies were carried out to verify the system, and comprehensive practical tests on a 1.5 kW prototype of the inverter that had been particularly constructed for this purpose were carried out to establish the viability of the scheme. At the end of the day, the strategy was determined to be workable.

REFERENCES

[1] T. Shimizu, O. Hashimoto, and G. Kimura, "A novel high-performance utility-interactive photovoltaic inverter system," IEEE Trans. Power Electron., vol. 18, no. 2, pp. 704–711, Mar. 2003.

[2] S. V. Araujo, P. Zacharias, and R. Mallwitz, "Highly efficient single-phase transformerless inverters for grid-connected photovoltaic systems," IEEE Trans. Ind. Electron., vol. 57, no. 9, pp. 3118–3128, Sep. 2010.

[3] B. Ji, J. Wang, and J. Zhao, "High-efficiency single-phase transformerless PV H6 inverter with hybrid modulation method," IEEE Trans. Ind. Electron., vol. 60, no. 5, pp. 2104–2115, May 2013.

[4] R. Gonzalez, E. Gubia, J. Lopez, and L. Marroyo, "Transformerless single phase multilevel-based photovoltaic inverter," IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2694–2702, Jul. 2008.

[5] H. Xiao and S. Xie, "Transformerless split-inductor neutral point clamped three-level PV grid-connected inverter," IEEE Trans. Power Electron., vol. 27, no. 4, pp. 1799–1808, Apr. 2012.

[6] A. Bidram, A. Davoudi, and R. S. Balog, "Control and circuit techniques to mitigate partial shading effects in photo voltaic arrays," IEEE J. Photovolt., vol. 2, no. 4, pp. 532–546, Oct. 2012.

[7] N. D. Kaushika and N. K. Gautam, "Energy yield simulations of interconnected solar PV arrays," IEEE Trans. Energy Convers., vol. 18, no. 1, pp. 127–134, Mar. 2003.

[8] H. Patel and V. Agarwal, "Maximum power point tracking scheme for PV systems operating under partially shaded conditions," IEEE Trans. Ind. Electron., vol. 55, no. 4, pp. 1689–1698, Apr. 2008.

[9] D. Nguyen and B. Lehman, "An adaptive solar photovoltaic array using model-based reconfiguration algorithm," IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2644–2654, Jul. 2008.

[10] G. Velasco-Quesada, F. Guinjoan-Gispert, R. Pique-Lopez, M. RomanLumbreras, and A. Conesa-Roca, "Electrical PV array reconfiguration

strategy for energy extraction improvement in grid-connected PV systems," IEEE Trans. Ind. Electron., vol. 56, no. 11, pp. 4319–4331, Nov. 2009.