Design and analysis of luo converter based DMPPT and CPG for solar PV system

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***Abstract*— There is increasing urgent energy issues day by day, that's why the world attaches great importance to begin the development of new energy and related technology. At present, large scale photo-voltaic power generation and scale of renewable energy has become parts of development strategy, meanwhile it is the way to guide the development of photo-voltaic industry. However, because of its own characteristics different from conventional powergeneration grid connected PV power station and its security, stability, reliable operation become new challenges which power grid and PV power plant need to face. This review paper proposes a new power control concept for grid-connected photovoltaic (PV) inverters. The new control strategy is based on combination of a constant power generation (CPG) control with a distributed maximum power point tracking control (DMPPT) depending on the instantaneous available power from the PV panels. The essence of this concept lies in the selection of an appropriate power limit for the CPG control to achieve an improved thermal performance and an increased utilization factor of PV inverters. Ultimate objective is to cater for a higher penetration level of PV systems with intermittent nature.**

***Keywords*— PV-photo voltaic,CPG-constant power generation,DMPPT-Distributed maximum power point tracking.**

1.INTRODUCTION ABOUT DMPPT AND CPG

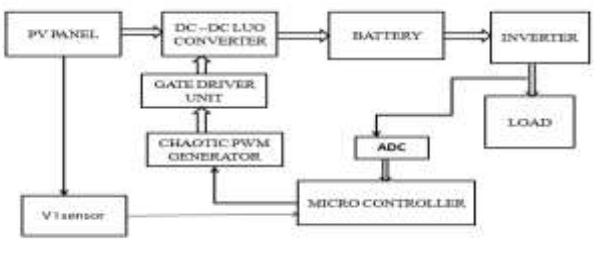
Maximum power point tracking (DMPPT) is effective for Photovoltaic (PV) inverters to maximize the energy harvested From PV panels. However, with increasing installations Of PV systems into the grid, the following issues appear If the inverters keep operation at DMPPT mode even within the Rated power range: 1) overloading of the grid at peak power Generation which may induce system level over-voltage and Line frequency instability 2) limited utilization of the PV Inverters, since they operate at relatively low power level with Respect to the designed power rating during most of long-term Field operations; 3) high temperature peaks and variations on Switching devices due to the intermittency, which accelerates. The degradation of the switching devices. To tackle the overloading issue, expanding the grid infrastructure (e.g., transformers, conductors) and integrating energy Storage elements are two of the solutions. However, as reported in, the expenses increased by grid expansion may severely exceed the initial project outlay. The energy storage Elements are mostly installed at the substation side instead of the individual inverters also considering cost and maintenance. Since the aforementioned solutions introduce considerable investments, two kinds of hybrid control concepts have been proposed in prior-art research. In an DMPPT control with a reduced power mode control has been introduced to avoid dynamic Overloading in a stand-alone wind-PV generation system. The selection of the power limit for the reduced power mode Control is dynamically in accordance to the power oscillations during wind turbine soft stalling.In armpit control with power curtailment Control is proposed to prevent over-voltage of low voltage feeders By limiting the excessive power injection to the grid from PV inverters. The selection of the power limit for the power curtailment Control depends on the upper voltage limit of the low Voltage feeders. These control concepts can effectively avoid the over-loading issue with an acceptable reduction of the overall Energy generation.

However, the issue on the utilization Of PV inverter remains and the thermal performance of the PV Inverters is still unknown. This letter therefore proposes a hybrid power control conceptwith the objective to improve the thermal performance and increasethe utilization factor of PV inverters. It has the following Features: 1) a constant power generation (CPG) control mode is activated by using a direct power control when the dc powerFrom PV panels reaches to a specific limit, the value of which Depends on the trade-offs of thermal loading (therefore lifetime Of switching devices, PV inverter utilization factor, and annualEnergy yield under yearly mission profiles (i.e., solar irradiance And ambient temperature). It should be noted that the selection of this power limit is different from those in [3] and [8] as discussed Above. 2) The DMPPT mode is active when the dc power is below the specific power level. The proposed DMPPT-CPG control Concept allows a reduction of required power ratings of PV Inverters and also a reduction of junction temperature peaks and Variations on the power devices (i.e., an extended lifetime) Meanwhile, it could contribute to the system level Power management to some extent, due to its role in smoothing And limiting the power fed into the grid.

A. ABOUT LUO CONVERTER AND ALGORITHM

This chapter deals with the proposed method.The Single-phase two-stage configuration is preferable for residential pv applications.The Control structure of a two-stage single-phase pv system with the proposed control concept is which indicates that the hybrid control strategy is implemented in the control of the boost stage depending on the instantaneous available power of the pv panels, the actual output power of the pv panels can be expressed as where *po* (*t*) is the output power of the pv panels (i.e., input power of the power conversion stage), *p*pv(*t*) is the available maximum power of the pv panels and *l*imit is selected by taking into account the tradeoffs among the thermal performance (lifetime) of power devices, the pv inverter utilization factor, and the annual energy yield.As The available pv power is weather-dependent, the operation modes will alter accordingly with the solar irradiance and ambient temperature. Exemplifies different operation regions for a single-phase pv system during a day with the proposed control strategy the operation principle of the proposed hybrid dmppt-cpg control can be described as follows. When ppt (*t*) _ p limit , the system enters into cpg operation mode and the dmppt control is deactivated. The pv output power is regulated by a proportional controller to maintain the output power constant (i.e., *Po* (*t*) = p limit). When *pp v* (*t*) <limits, the system maximizes the output power with an dmppt control, and thus the cpg control is disabled.

The cpg control can be achieved by diverting the operating point from the maximum power point, if the available power of the pv panel exceeds the power limit when the solar irradiance is increased from0.8 kw/m2 to 1 kw/m2, the operating point of the pv panels either moves to “l” or “h” rather than “m”the operating point of the pv inverter is changed. There are three alternatives of the control variables for cpg control: vpv, ipv, and or ppv. The first two control options can be achieved on a basis of the existing power point tracking algorithms, e.g. Perturb and observe (p&o) and incremental conductance methods the third one is applied in this study by using *l*imit as a power reference since it is relatively simple. It is worthwhile investigating the dynamic performance of different implementation methods, which is beyond the scope of this system and is considered as a further in-depth study.Additionally, the selection of *l*imit should be compromised with the energy loss defined the dependency of energy reduction on *l*imit for a 3-kw pv system operating under a specific yearly mission profile. The energy loss is increased with the reduced value of plimit.



Fig,1. Block diagram

2.LUO CONVERTER DESIGN

LUO converters are simplest form of DC-DC converter which operates on voltage lift technique. This LUO converter operates on PUSH-PULL state. The switched type LUO converter is developed. Switched capacitor DC-DC converters are made only of switched capacitors. Because switched capacitors can be integrated into power semiconductor integrated circuit (IC) chips, they have limited size and work at high switching frequency. They have been successfully employed in the inductor less DC-DC converters and have opened the way to constructing converters with high power density. LUO converter can be incorporating Impedance network. It helps to Buck or Boost the output voltage of PV, depending on the value of Duty cycle and also acts as a second order filter.The DC-DC converters are used to convert a DC power at one voltage level to another one. In recent years, the modern power electronic systems require power supply with high reliability, high efficiency, and low input ripple. In all DC-DC converter voltage and efficiency is limited by parasitic elements. LUO Converters are newly developed DC-DC converter to overcome the above limiter effects. LUO converter with Voltage Lift (VL) Technique is a popular method widely used in electronic circuit design. It can be a good way of improving DC-DC converters characteristics and has been successfully applied for DCDC converters. However, the output voltage increases in stage by stage just along the arithmetic progression.

3.CIRCUIT OPEERATION OF LUO CONVERTER

The circuit diagram of the Buck - output Luo converter In the circuit, S is the power switch and D is the freewheeling diode. The energy storage passive elements are inductors L1, L2 and capacitors C1, C2, R is the load resistance. To analyze the operation of the Luo converter, the circuit can be divided into two modes. When the switch is ON, the inductor L1 is charged by the supply voltage E. At the same time, the inductor L2 absorbs the energy from source and the capacitor C1. The load is supplied by the capacitor C2. The equivalent circuit of Luo converter in mode 1 operation is shown in (a). During switch is in OFF state, and hence, the current is drawn from the source becomes zero, as shown in (b). Current iL1 flows through the freewheeling diode to charge the capacitor C1. Current iL2 flows through C2 –R circuit and the freewheeling diode D to keep itself continuous

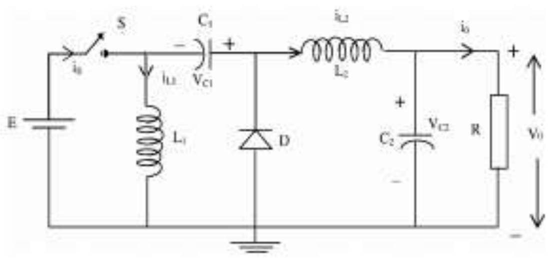


Fig.2. Luo converter circuit

L1, L2 and capacitors C1, C2, R is the load resistance. To analyze the operation of the Luo converter, the circuit can be divided into two modes. When the switch is ON, the inductor L1 is charged by the supply voltage E. At the same time, the inductor L2 absorbs the energy from source and the capacitor C1. The load is supplied by the capacitor C2. The equivalent circuit of Luo converter in mode 1 operation is shown in (a). During switch is in OFF state, and hence, the current is drawn from the source becomes zero, as shown in (b). Current iL1 flows through the freewheeling diode to charge the capacitor C1. Current iL2 flows through C2 –R circuit and the freewheeling diode D to keep itself continuous. If adding additional filter components like inductor and capacitor to reduce the harmonic levels of the output voltage

A.Mode 1

when the switch is ON, the inductor L1 is charged by the supply voltage E. At the same time, the inductor L2 absorbs the energy from source and the capacitor C1. The load is supplied by the capacitor C2.

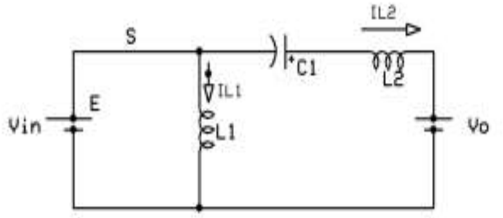


Fig.3 Mode1 operation

B.Mode 2

switch is in OFF state, and hence, the current is drawn from the source becomes zero, as shown in (b). Current iL1 flows through the freewheeling diode to charge the capacitor C1. Current iL2 flows through C2 –R circuit and the freewheeling diode D to keep itself continuous.

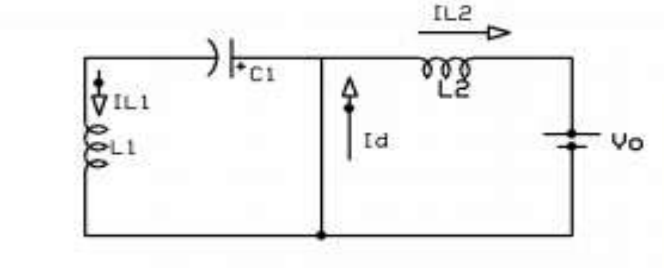


Fig.4 Mode2 operation

In discontinuous conduction mode, output should be in the form of discontinuous. In this mode diode is not present and inductor discharge through V0 and L2. The output stage of the Luo buck converter is comprised of an inductor and capacitor. The output stages stores and delivers energy to the load, and smooth out the switch node voltage to produce a constant output voltage. Inductor selection directly influences the amount of current ripple seen on the inductor current, as well as the current capability of the buck converter itself. Inductors vary from manufacturer to manufacturer in both material and value,and typically have a tolerance of 20%. Inductors have an inherent DC resistance (known as the DCR) that impacts the performance of the output stage. Minimizing the DCR improves the overall performance of the converter. For that application it requires a high load current, it is recommended to select an inductor with a low DCR. The DCR is smaller for lower inductor values, but there is a trade−off between inductance and ripple current; the lower the inductance, the higher the ripple current through the inductor.

A minimum inductance must be met in order to meet the ripple current requirements of the specific application circuit. The output capacitance directly affects the output voltage of the converter and the response time of the output feedback loop, also the amount of output voltage overshoot that occurs during changes in load current. A ripple voltage exists on the DC output as the current through the inductor and capacitor increases and decreases. Increasing the value of output capacitance value reduces the amount of voltage ripple present in the circuit. However, there is a trade-off between capacitance and the output response. Increasing the capacitance reduces the output voltage ripple and output voltage overshoot, but increases the response time it takes output voltage feedback loop to respond to changes in load. Therefore, a minimum capacitance must be considered, in order to reduce the ripple voltage and voltage overshoot requirements of the converter, while maintaining a feedback loop that can respond quickly enough to load changes. Capacitors also have a parasitic series resistance, known as the equivalent series resistance (ESR). The steady state capacitor value is 0A The ESR impacts the output voltage ripple and the overall efficiency of the converter. Because of this, designers are moving to low ESR designs. Surface mount ceramic capacitors are becoming prevalent in systems that require high performance in a small form factor. The choice of multiple capacitors connected in parallel allows designers to achieve the necessary capacitance for the system while greatly reducing the equivalent ESR.

Fig.5 Graph for module power and voltage:

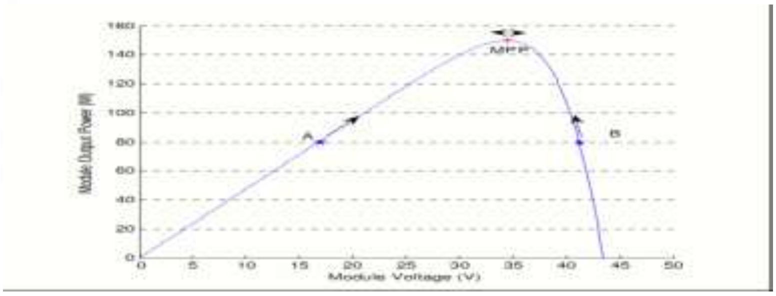
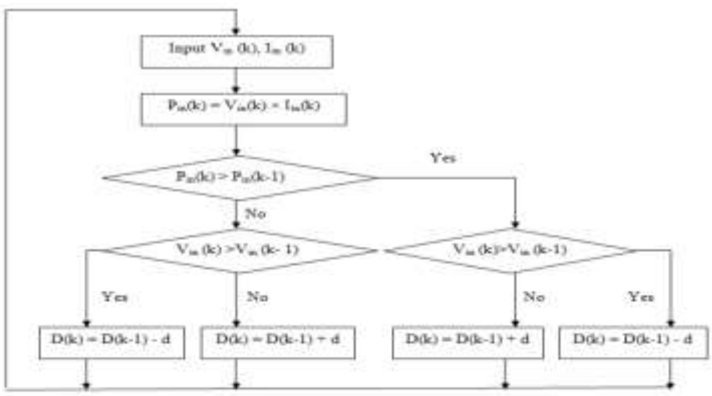
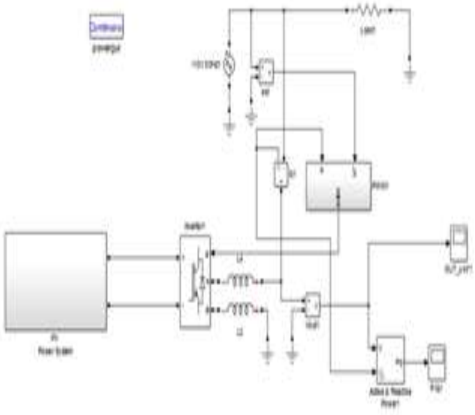


Fig.6 Flowchart for pertube and observe algorithm





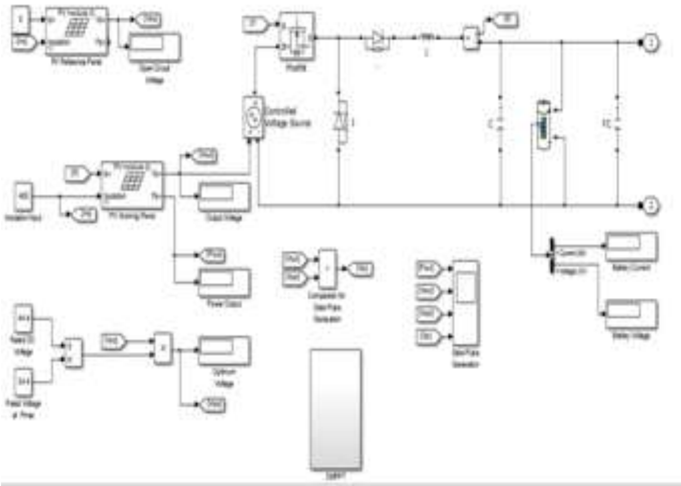


FIG. 7 .SIMULINK MODEL OF SYSTEM

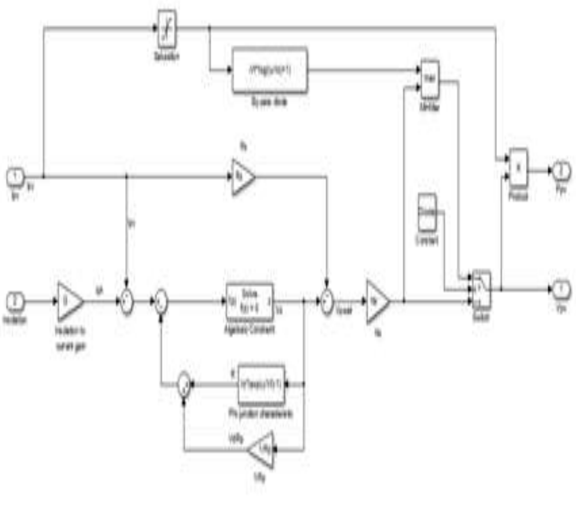


Fig.8 Pv model

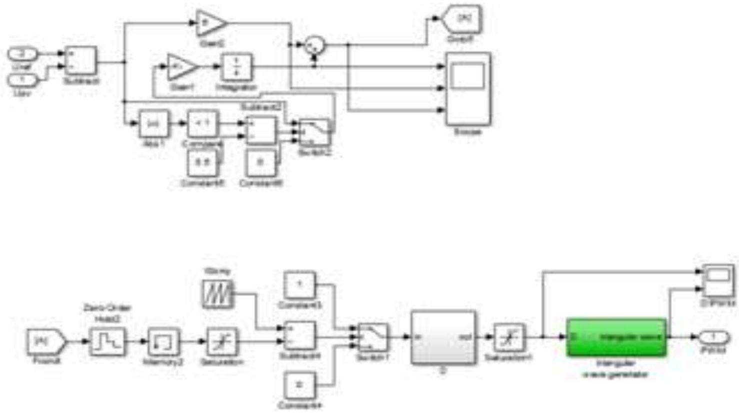


FIG.9 P&O DESIGN

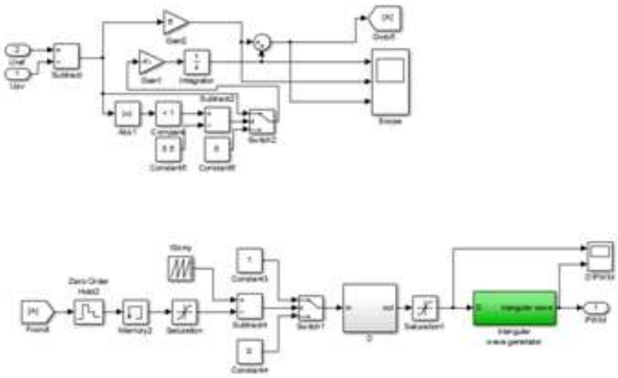


Fig.10 DMPPT and CPG

c.Simulation Results

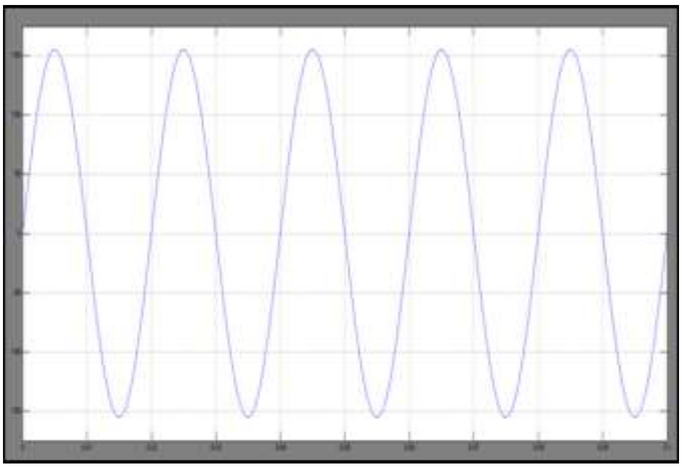


Fig.11 Output voltage across the inverter(vo)

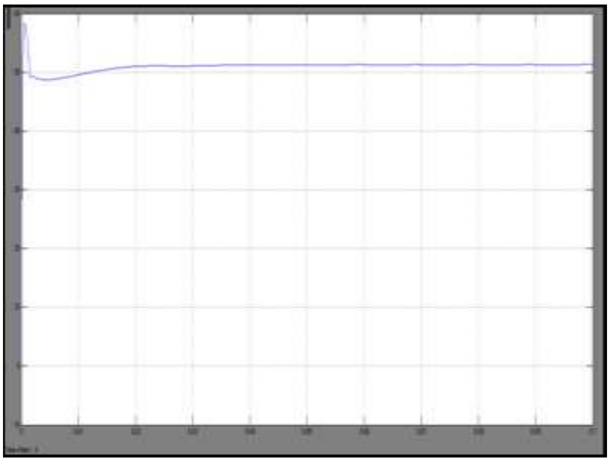


Fig.12 Generated DC

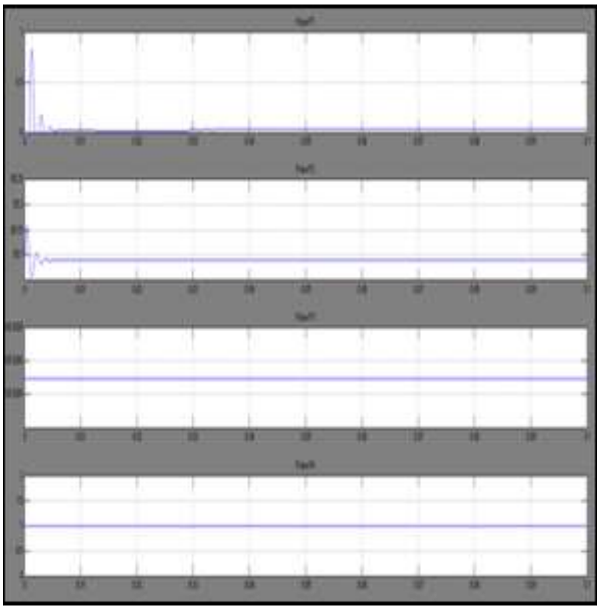


Fig.13 DMPPT channel gate pulse

IV. CONCLUSIONS

A hybrid DMPPT–CPG control concept is proposed for grid connected PV inverters by considering the long-term mission profiles and the system level power management requirements. Aforementioned advantages are compromised with the energy loss due to the proposed control, allowing the optimal selection of the power control limit depending on specific mission profiles. In the study case of a single-phase PV inverter, the power limit is selected as 80% of the maximum feed-in power of the PV panels, which is corresponding to a 6.23% energy yield reduction under a specific yearly mission profile. The PV inverter utilization is increased by 17% and the lifetime of the power devices is extended to 5.62 times of that in DMPPT control mode. The proposed control strategy enables to increase the utilization factor of PV inverters and to reduce the temperature variations on power devices. Moreover, it is beneficial to system level power management by smoothing and limiting the PV inverter output power to some extent. This benefit is especially important to increase the PV installations with the existing grid infrastructure under a high PV penetration degree in the future. The power devices is extended to 5.62 times of that in DMPPT control mode The effectiveness of the proposed topology and control algorithm was tested using simulations and results are presented. The results demonstrate that the proposed system is able to control ac-side current, and battery charging and discharging currents at different levels of solar irradiation.

ACKNOWLEDGMENT

I would like to thank our chairman Mr . R. Thirunavu karasu, Managing Director Mr.T.Senthilkumar,advisor Mr. S. Kodhandapani , principal Dr. B.GOBI,M.E.,Ph.D., and my co-ordinatorDr.C.VENKATESAN,ME.,Ph.D.,for encouraging and providing necessary facilities towards the growth carrying this work. The authors knowledge with the help of Mr.A.BALASUBRAMANIAN.SM.E., Arasu Engineering College Tamilnadu in assisting me towards implemented the project work.

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