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A Nowel DC Microgrid Using Hybrid Renewable System for Smart Energy Delivery

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***Abstract*: Electric energy is one of the important requirements of any country because it has a vital influence on their social and economic development .A significant portion of energy demand has been heavily dependent on fossil fuels like natural gas, coal and etc. The mentioned conventional energy sources have a number of drawbacks such as the great volatility in costs, limited and inadequately distribution on the earth's crust, harmful emissions and etc. On the other hand, rapid increase in energy demand has led to a gap between production and demand of energy. To solve the problems raise, renewable energy resources such as wind, photovoltaic (PV), micro hydro and etc. It can be a suitable solution. Due to intermittent nature of many renewable energy sources and their dependence on environmental conditions, hybrid combinations of two or more of renewable energy sources can improve system's performance. Hybrid renewable energy systems can work in stand-alone or grid connected (GC) mode. Hybrid renewable energy systems have main advantages in comparison to single source system. Some of these benefits have been. In this paper, paradigms and common methods available for control and energy management of Hybrid renewable energy systems are reviewed and compared with each other.**

***Keywords*: Photovoltaic array, Maximum power point tracking, Simulink, Boost converter.**

1. INTRODUCTION

An integrated energy system intelligently managing interconnected loads and distributed energy resources and capable of operating in parallel with, or independently, from the existing utility's grid.

The direct current (DC) micro grid presented in this paper offers significant energy efficiency, cost, reliability, and safety benefits compared to conventional alternating current (AC) systems. In the Bosch DC micro grid (DCMG) architecture, onsite DC distributed generation such as solar PV is directly connected to energy-efficient DC lighting, DC ventilation, and other DC loads via a 380 V nominal DC bus. A central AC/DC gateway converter provides supplemental grid power whenever local generation cannot fully supply the load. Thus, the DCMG eliminates the use of AC/DC rectifiers at the loads and reduces the need for DC/AC inverters that are currently required to interconnect solar photovoltaic's (PV) to the electric utility.

The reduction in conversion equipment makes the overall system more efficient and reliable and reduces maintenance costs. The use of a separate DC bus provides a built-in mechanism for operating critical DC loads during grid outages (to the extent that energy is available from local DC generation or storage) without requiring a mechanical transfer switch. From the utility perspective, the DC architecture reduces the size of inverters required to export excess PV energy, thereby mitigating the potential impact of PV variability on the grid. Furthermore, DC-based battery storage can be much more efficiently connected to a DCMG, enabling a more cost-effective way to smooth solar power intermittency.

In modern society, an increasing number of electrical loads in buildings, such as computers, consumer electronics, light emitting diodes (LEDs), or variable speed motors, are supplied by dc power. At the same time, distributed renewable sources such as photovoltaic (PV), as well as batteries for electric vehicles and on-site storage, are based on dc. To integrate these technologies into existing ac power systems, complicated dc/ac inverters and controllers are required to synchronize with ac systems and to provide high-quality ac currents without harmonics. A dc distribution in buildings in conjunction with PV generation and battery storage would eliminate ac/dc and dc/ac conversion stages, resulting in a significant reduction of power conversion losses, lower cost of components, as well as higher system reliability. Hybrid ac/dc micro grids have been proposed for improved interconnection of distributed energy systems, including multiple renewable sources (ac and dc), loads, electrical storages, and the power grid. Hybrid ac/dc micro grids exploit the advantages of both ac and dc systems and may facilitate the integration process of dc power technologies into existing ac systems. Dc building micro grids promise significant efficiency improvements and cost reductions, in particular if implemented together with on-site PV generation and battery

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storage [2]. Despite these advantages, there are several challenges, which hinder the adoption of dc micro grids in buildings. These challenges are related to lack of standardized equipment (dc network components are missing, end use appliances are lacking dc connectivity) and little industrial experience.

2. LITERATURE REVIEW

The benefits of hybrid micro grids may be even larger for commercial and office buildings with integrated PV, due to a higher share of dc internal loads and increased self-consumption of PV electricity. This paper presented research on hybrid ac/dc micro grids for improved integration of PV and battery storage in buildings. They are the layout for minimum loop inductance and heat dissipation, gate drive power supply for high side Gallium-Nitride (GaN) device and high resolution digital PWM control methodology. The special package of the available GaN devices requires a PCB layout method that takes into account the thermal design as well as the switching loop inductance. Besides, the high dv/dt will introduce a circulating current in the high-side gate drivers and power supplies. This current should be minimized. Furthermore, conventional digital PWM modules is not precise enough for high frequency (usually >50kHz) converter modulation and will cause limited cycle oscillation. A high resolution digital phase-shift modulation scheme is utilized to improve the resolution of the phase-shift control for the 150 kHz converter. In the end, an optimized engineering design method is proposed. The experimental results are analyzed on a 1kW bidirectional dc-dc converter to verify the concepts.

A coordinated adaptive droop control is addressed for DC microgrid to optimize its power distribution. The optimal solution for economical dispatch problem (EDP) of the microgrid is found through a fully distributed hierarchical control. The strive for efficient and cost-effective photovoltaic (PV) systems motivated the power electronic design developed here. The work resulted in a dc–dc converter for module integration and distributed maximum power point tracking (MPPT) with a novel adaptive control scheme. The latter is essential for the combined features of high energy efficiency and high power quality over a wide range of operating conditions. The switching frequency is optimally modulated as a function of solar irradiance for power conversion efficiency maximization. With the rise of irradiance, the frequency is reduced to reach the conversion efficiency target. A search algorithm is developed to determine the optimal switching frequency step. Reducing the switching frequency may, however, compromise MPPT efficiency. Furthermore, it leads to increased ripple content. Therefore, to achieve a uniform high power quality under all conditions, interleaved converter cells are adaptively activated. The overall cost is kept low by selecting components that allow for implementing the functions at low cost. Simulation results show the high value of the module integrated converter for dc standalone and microgrid applications. A 400-W prototype was implemented at 0.14 Euro/W. Testing showed efficiencies above 95 %, taking into account all losses from power conversion, MPPT, and measurement and control circuitry.

a novel method to keep the current ripple to be constant despite of the load current condition for DC/DC converter. The presented method doesn't require any extra circuit component. Experimental DC/DC converter is implemented which is with input voltage of 12 V, output voltage of 1.5 V, output current of 10 A, and switching frequency of 200-250 kHz. Experimental results are presented to fully support the claims .The simulation of incremental conductance (IncCond) maximum power point tracking (MPPT) used in solar array power systems with direct control method. The main difference of the proposed system to existing MPPT systems includes elimination of the proportional–integral control loop and investigation of the effect of simplifying the control circuit. The resultant system is capable of tracking MPPs accurately and rapidly without steady-state oscillation, and also, its dynamic performance is satisfactory. The IncCond algorithm is used to track MPPs because it performs precise control under rapidly changing atmospheric conditions. MATLAB and SIMULINK were employed for simulation studies. Simulation results indicate the feasibility and improved functionality of the system. Index Terms: incremental conductance (IncCond), maximum power point tracking (MPPT), photovoltaic (PV) system.

In the dc-dc power conversion, the high step-up converter is introduced to improve the conversion efficiency in conventional boost converters to allow the parallel operation of low-voltage PV arrays, and to decouple and simplify the control design of the PWM inverter. Moreover, an adaptive total sliding-mode control system is designed for the voltage control of the PWM inverter to maintain a sinusoidal output voltage with lower total harmonic distortion and less variation under various output loads. In addition, an active sun tracking scheme without any light sensors is investigated to make the PV modules face the sun directly for capturing the maximum irradiation and promoting system efficiency. Experimental results are given to verify the validity and reliability of the high step-up converter, the PWM inverter control, and the active sun tracker for the high-performance stand-alone PV generation system.

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3. RESEARCH METHODOLOGY

A simple and effective prototype of a solar tracking system was implemented, several improvements can be done on it in future works to make it even better.

1. Incorporating boost converter and sensors of the panel mounting so as to detect sunlight during sunrise and sunset. At the few modifications to the control algorithm, the solar tracking system can be made to turn off at sunset and turn on at sunrise. Thus its more effective in solar system for a sustainable whole system of work.

2. Methodology for PV panel constant output

The efficiency of solar cells depends on many factors such as temperature, insulation, spectral characteristics of sunlight, dirt, shadow, and so on. Changes in insulation on panels due to fast climatic changes such as cloudy weather and increase in ambient temperature can reduce the photovoltaic (PV) array output power. In other words, each PV cell produces energy pertaining to its operational and environmental conditions. In addressing the poor efficiency of PV systems, some methods are proposed, among which is a new concept called ―maximum power point tracking‖ (MPPT).All MPPT methods follow the same Goal which is maximizing the PV array output power by tracking the maximum power on every operating condition.

There is a large number of algorithms that are able to track MPPs. Some of them are simple, such as those based on voltage and current feedback, and some are more complicated, such as perturbation and observation (P&O) or the incremental conductance (IncCond) method. They also vary in complexity, sensor requirement, speed of convergence, cost, range of operation, popularity, ability to detect multiple local maxima, and their applications. Having a curious look at the recommended methods, hill climbing and P&O are the algorithms that were in the center of consideration because of their simplicity and ease of implementation. Hill climbing is perturbation in the duty ratio of the power converter, and the P&O method is perturbation in the operating voltage of the PV array. However, the P&O algorithm cannot compare the array terminal voltage with the actual MPP voltage, since the change in power is only considered to be a result of the array terminal voltage perturbation. As a result, they are not accurate enough because they perform steady-state oscillations, which consequently waste the energy. By minimizing the perturbation step size, oscillation can be reduced, but a smaller perturbation size slows down the speed of tracking MPPs.

The Block diagram of proposed system is shown in fig.1When a direct connection carried out between the source and load, the output of PV module extract maximum energy and offers a high DC voltage for the inverter which converts the DC voltage to a sinusoidal AC and connects with the grid. Proposed system comprise of two DC sources first one is PV and second one is taking from single phase AC source by converting into DC to meet isolated DC load demand of their different power density to supply transient and steady load respectively. All sources are connected to DC bus by different DC-DC converters. A power flow control strategy adapts their variable DC voltage to Bus voltage by means of these converters.

The PV side Boost Converter is controlled by Perturbation & Observation (P&O) MPPT algorithm to extract the maximum power from the variable solar. In this we uses an "Opposed current half bridge" type inverter with hysteresis current controller, adopted to ensure desired power quality, and can also supply sinusoidal current at unity power factor.

Our system consists of two DC sources first one is PV and second one is taking from single phase AC source by converting into DC to meet isolated DC load demand of their different power density to supply transient and steady load respectively. All sources are connected to DC bus by different DC-DC converters. A power flow control strategy adapts their variable DC voltage to Bus voltage by means of these converters.

Due to the development of high performance and high density microprocessors, it is required to reduce the supplied voltage while increasing the current rating. The point-of-Load (POL) converter is usually designed and implemented to provide well regulated voltage to microelectronic load. The allowed output voltage ripple becomes smaller for such applications.. However, the current slew rate is increased. For such applications, the effect of parameter variation caused by temperature and load variation etc. becomes very essential to converter design and implementation.

It is well known that the inductor, L, shown in Fig. 1 affects the current ripple and thereby causing the variation of output voltage ripple and efficiency. The lower its inductance, the larger the current ripple will be. However, the inductance reduces as the load current increases since the increases of load current forces the inductor to go toward saturation.

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Under all kinds of load conditions, the inductor current ripple is constant in ideal case. Actually, the ripple increases under heavy load condition. Although the issue has been discussed, to our best knowledge, no cost-effective method has been presented to deal with it. Digital power provides some particular advantages over analog approach. These advantages include: no aging issue for control loop, low power consumption, easy to change topology and control algorithm, fast time to market and easy to design the associated ASIC. In this paper a novel method to reduce the current ripple is presented for digital-controlled point-of-Load buck converter**.**

The MATLAB simulink model of the utility grid connected with parallel combination of PV system. In this simulink model, the grid voltage is preset as Vg = 110 V. The value of DC power supply generated by the combination of PV model and battery is Vdc = 110 V.

The description of various control blocks are given below, some major block ore DC to DC converter, filter, control system bock, various loads ,AC to DC converter etc.

4. SIMULATION WITH MATLAB

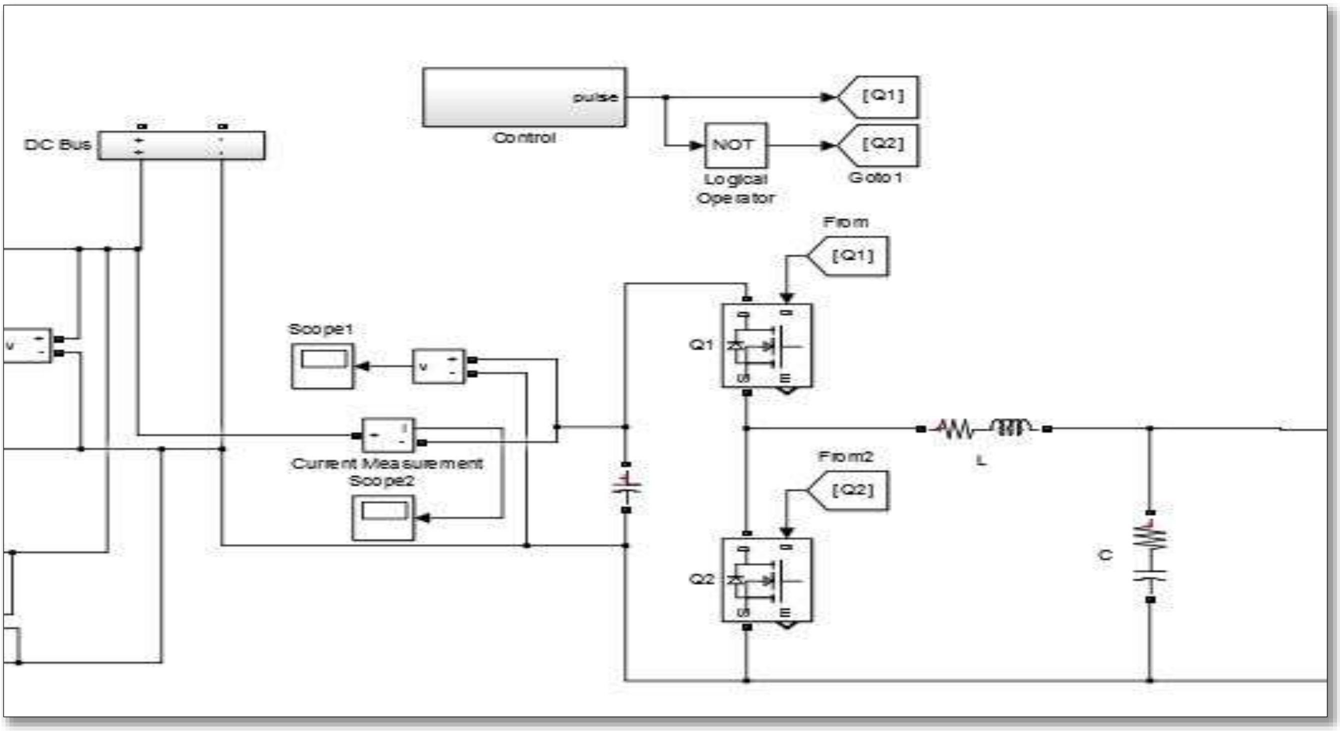

Fig. shows simulation diagram for improving sustainability and efficiency of solar photovoltaic based operated system.

The given MATLAB model shows us proposed system for improving efficiency of the system.

4.1 RESULT

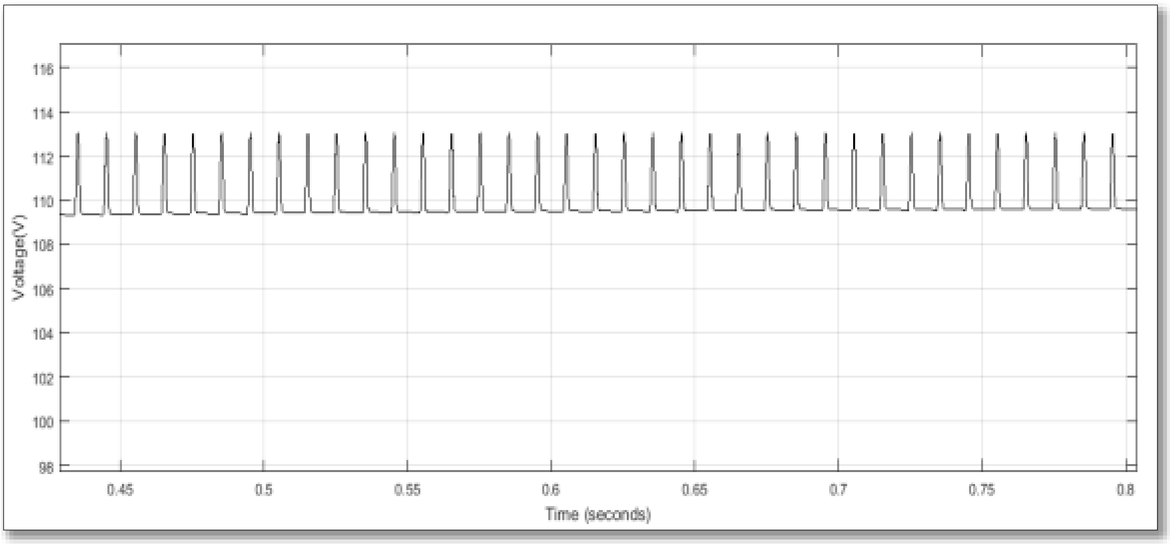

Fig.3 voltage ripple output before implementation of proposed work

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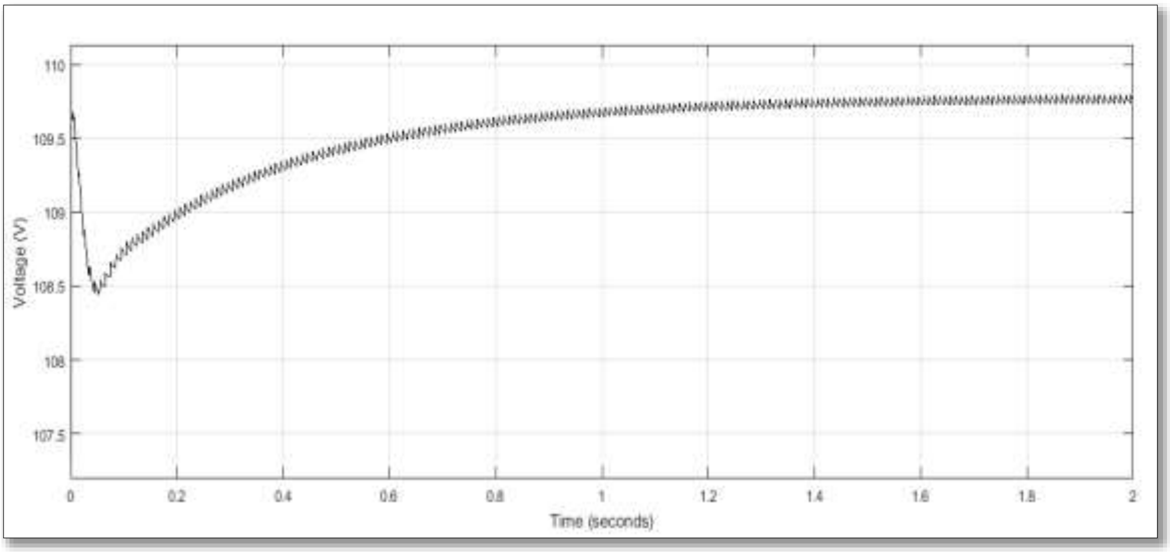

Fig.4 voltage ripple output after implementation of proposed work

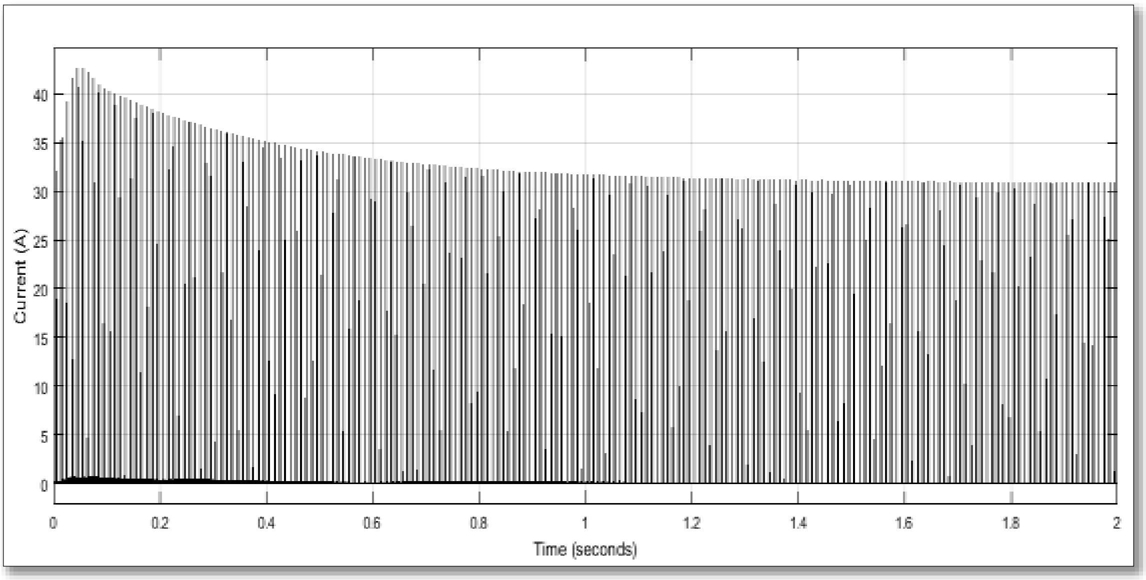

Fig.5 current ripple output before implementation of proposed work

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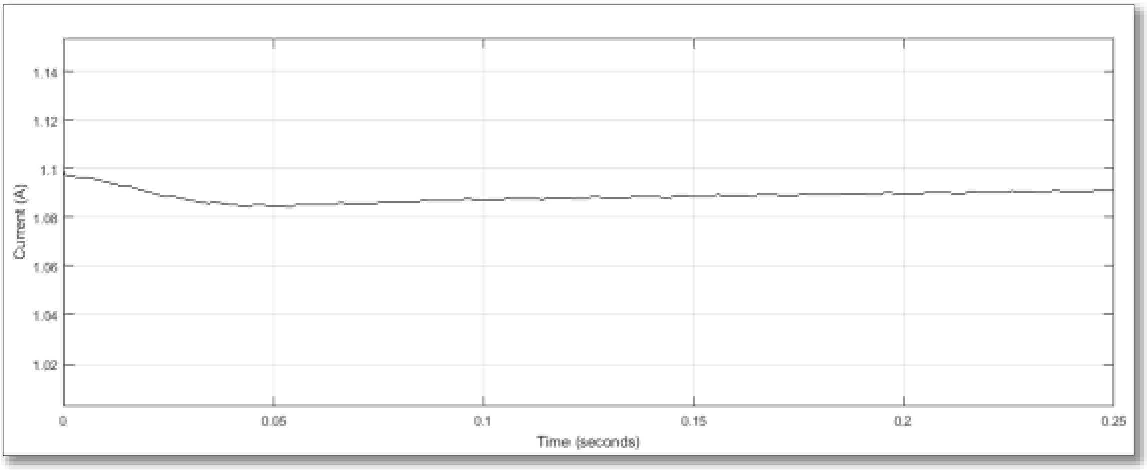

Fig.6 current ripple output after implementation of proposed work

Ripple analysis report:

Parameter	Before proposed methodology	After proposed methodology
Current (Amp)	0 to 32	1.097 to 1.098
Voltage (V)	109.5 to 113	109.7 to 119.8

After comparing both the outputs it is clear that the efficiency of the output is relatively constant for a longer period of time after implementation of proposed system.It also increases its efficiency by more than 50% and reducing current ripples which shows that the system is successful in achieving its target accordingly.

5. CONCLUSIONS

The intensive use of energy from the solar cell is essential for providing solutions to environmental problems like pollution and global warming. As the position of sun keeps changing in the day the angle of incidence changes hence we proposed a model to rotate the panel to improve the angle of incidence for considering the optimal MPP point even under shaded and un-shaded conditionsThis paper presents a novel method to keep the current ripple to be constant despite of the load current condition for DC micro grid.Above Figure shows the measured results of inductance of output inductor under load conditions. The current ripple can be reduced by increasing the switching frequency as illustrated using switching frequency 250 kHz as an example. However, the current ripple is improved at the cost of more switching losses. Moreover, the current ripple cannot be kept constant even the switching frequency is increased.

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