A GENERAL REVIEW OF PHOTOVOLTAIC INVERTER AND MPPT

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ABSTRACT
Energy from the sun is the best option for electricity generation as it is available everywhere and is free to harness. This energy is essential for all life on Earth. It is a renewable resource that is clean, economical, and less pollution compared to other resources and energy. Therefore, solar energy is rapidly gaining an important means of expanding renewable energy resources. Maximizing power output from a solar system is desirable to increase efficiency. A great increase of photovoltaic (PV) power generators installations has taken place in recent years, due to the increasing efficiency of solar cells as well as the improvements of manufacturing technology of solar panels. This paper concentrates on study of solar cell, photovoltaics, a module integrated isolated solar micro inverter, maximum power point tracking system.

Key words- A module integrated isolated solar micro inverter, maximum power point tracking (MPPT), Photovoltaic (PV)

I. INTRODUCTION
The output of the single solar cell is very less, therefore the solar cells are connected in series to form PV module. The PV modules are connected in series and parallel to form Photovoltaic (PV) Array [1]. While fossil fuel exhaustion and greenhouse effects are widely concerned around the world, one of the most important issues toward these problems is to find alternative energy for long-term solutions. Green energy offering the promise of clean and abundant energy gathered from self renewing sources such as solar energy, geothermal energy, and wind source is broadly developed. Solar cells are unique in that they directly convert the incident solar irradiation into electricity. Photovoltaic (PV) power management concepts are essential to extract as much power as possible from the solar energy. PV energy systems are being extensively studied because of their benefits of environmental friendly and renewable characteristics. Typically, several PV panels are connected in series to provide a high-voltage output. However, the PV panels often work in mismatching conditions due to different panel orientations and shadowing effects. This mismatching problem thus reduces the power production of the whole PV string. To overcome the drawback, several literature works have proposed a module-integrated converter concept. Individual maximum power point tracking (MPPT) converters are attached to each PV panel for extracting its maximum power. Such a PV module composed of a PV panel with an individual dc-ac inverter is called a solar micro inverter [2][11][6]. The work is well supported by both a comparative study in terms of accuracy of different PV modeling techniques and a set of simulation and experimental results validating the proposed approach. As pointed out in [9], the necessity of measuring the array current can be eliminated by applying the sliding-mode observer for its estimation. The estimated current has some chattering ripples, but its average value coincides exactly with the real current average value. A new MPPT algorithm for a small-scale dual-module integrated PV grid-connected system that consists of two PV modules is proposed in [9]. It enables a simple hardware implementation using conventional proportional–integral (PI) controllers instead of digital platforms required in other MPPT methods. Experimental results are presented.
A photovoltaic system is an arrangement of components designed to supply usable electric power for a variety of purposes, using the Sun as the power source. A solar array consists of multiple photovoltaic modules, casually referred to as solar panels, to convert solar radiation into usable direct current (DC) electricity. DC to DC converter converts it into step up form and then fed it to the inverter and last destination is load [1].
II. SYSTEM DESCRIPTION

The grid-tied isolated solar inverter consists of an inverse-buck current-fed isolated dual boost converter with a secondary voltage doubler, a polarity selector, and an output LC filter. The high-voltage E-Caps are not needed in the solar inverter circuit [2].

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**Fig. 2:** Circuit topology of the studied isolated solar micro inverter. [2]

**Fig. 3:** Equivalent circuits under (a) Mode 1 and (b) Mode 2. [2]
When the ac grid voltage is higher than a given boundary voltage $V_b$ expressed as (1), the solar micro inverter is operated under this mode

$$V_b = \frac{2n}{1 - \delta_{boost,\text{min}}} V_{pv}$$  \hspace{1cm} (1)

Where $n$ is the turn ratio of the isolation transformer $T_1$, $\delta_{boost,\text{min}}$ is the minimum duty cycle of $Q_1$ and $Q_2$, and $V_{pv}$ denotes the PV panel voltage. Under this operation mode, the buck switch $Q_b$ is always on. The PV panel voltage $V_{pv}$ is fed directly to the input of the interleaved dual boost circuit. The duty cycle $\delta_{boost}$ of $Q_1$ and $Q_2$ is modulated as (2) to provide a rectified sinusoidal waveform $|V_g|$ on capacitors $C_1$ and $C_2$ that is connected with the ac grid system via the polarity selector and the $LC$ output filter. Because the polarity selector is operated at the line frequency and switches at zero crossing of the ac grid voltage, the switching loss can be neglected. Assuming that the conduction losses on power devices of the inverse buck circuit and the polarity selector can be ignored, the only loss of the studied isolated solar micro inverter is due to the single-stage power conversion of the isolated dual-boost circuit. High conversion efficiency can be thus achieved [2], i.e.

$$\delta_{boost} = 1 - \frac{2nV_{pp}}{|V_g|}$$  \hspace{1cm} (2)

- **State 1(t0–t1):**
  During this time interval, power MOSFETs $Q_1$ and $Q_2$ are both on and diodes $D_1$ and $D_2$ are off. The solar energy is stored into input inductors $L_1$ and $L_2$. The load energy is provided by voltage-doubler capacitors $C_1$ and $C_2$

- **State 2(t1–t2):**
  At $t_1$, power MOSFET $Q_1$ is turned off. The solar energy stored in input inductor $L_1$ is released via transformer $T_1$ and diode $D_1$.

- **State 3(t2–t3):**
  During this time interval, power MOSFETs $Q_1$ and $Q_2$ are both on once again and diodes $D_1$ and $D_2$ are off. The current conduction path is the same with that of State 1.

- **State 4(t3–t4):**
  At $t_3$, power MOSFET $Q_2$ is turned off. The solar energy stored in input inductor $L_2$ is released via transformer $T_1$ and diode $D_2$. After completing one switching cycle, the circuit operation is back to State 1.
Fig. 7 shows the theoretical switching waveforms of the buck switch \( Q_b \). As shown in Fig. 8, the circuit operation during Mode 2 for the isolated solar inverter can be divided into two switching states.[2]

- **State 1\((t_0–t_1)\):**
  During this time interval, power MOSFET \( Q_b \) is on and diode \( D_b \) is off. The solar energy is stored into buck inductor \( L_b \). The voltage across \( L_b \) can be expressed as follows:
  \[
  V_{L_b} = V_{pp} - \frac{|V_g|}{K_b}
  \]  
  \( (3) \)

- **State 2\((t_1–t_2)\):**
  At \( t_1 \), power MOSFET \( Q_b \) is turned off. The solar energy stored in buck inductor \( L_b \) is released via diode \( D_b \). The voltage across \( L_b \) can be expressed as follows:[2]
  \[
  V_{L_b} = -\frac{|V_g|}{K_b}
  \]  
  \( (4) \)

### III. MPPT

Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the large possible power from one or more photovoltaic plates, typically solar panels, though optical power transmission systems can improve efficiency from similar technology. Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency which can be analyzed based on the current and voltage (I-V) characteristics. It is the purpose of the MPPT system to sample the output of the solar cells and apply the proper load to gain maximum power for any given environmental conditions.[6][12] MPPT devices are typically integrated into an electric power converter system that provides current or voltage conversion, filtering, and regulation for driving various loads, including power grids, dc sources, or motors.[1][11][12] In a full day, sunlight is only available for a limited time and depends heavily on surrounding conditions. In many photovoltaic systems, a particular control algorithm, namely maximum power point tracking (MPPT), is utilized to take full advantage of the available sun energy. Thus, the direction of this paper is to develop topologies for MPPT systems in order to more efficiently use harvested solar energy.[12]

The operation of MPPT is to adjust photovoltaic interfaces so that the operating characteristics of the load and the photovoltaic array match at the maximum power point (MPP) no matter what the stand-alone or grid-connected photovoltaic application, which are numerous. This paper first investigates how partial shading affects the performance of MPPT and solar power generation. Second, it discusses topologies used for the optimization of MPPT of photovoltaic power systems. This paper presents two system structures suitable for photovoltaic features and MPPT. Finally, it gives a comparative study to select the best converter topology for photovoltaic interfaces [11]-[13].

![Fig.8 MPPT block system](image)

![Fig.9: Photovoltaic modules installed on one frame at the same angle and direction](image)

![Fig.10 Measured I–V curves of one-cell-shaded and non-shaded modules](image)
Modules were partially shaded. The different output characteristics of the one-solar cell-shaded module and the nonshaded module are shown in Fig.10 with their current and voltage curves. As illustrated, the peak power point degrades to 15.44W from 21.48W when one of the 72 cells is shaded [12]. The block diagram shown in Fig.8 ignores a charge and discharge interface for the storage devices [8]. This is necessary to keep the normal charge or discharge cycle between the storage unit and dc voltage bus. To limit the scope of the analysis, only the interface of the dc/dc MPPT module is designed and investigated in the following studies.

IV. CONCLUSION
This paper performs a systematic study of photovoltaic’s, a module integrated isolated solar micro inverter with maximum power point tracking. It shows that when we use the MPPT in the system the MPPT accuracy of the development solar micro inverter is around 0.98 and efficiency 98% to 99%. The commercial success of a PV highly depends on its reliability and efficiency. Improved reliability is expected due to the single-stage approach and due to the elimination of harmonics. A fairly high conversion efficiency of up to 98% has been achieved after testing different combinations of semiconductors. A high efficiency not only is a selling point but also contributes to improved reliability as the internal thermal stress is reduced.

REFERENCES