# Study on Solar System Distribution System and Converter Topologies with Controlling Techniques

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***Abstract:*** **Power generation faces a major challenge in meeting peak load requirements. Energy suppliers are highly dependent on fossil fuels due to the limited resources of non-renewable energy production. Therefore, researchers and scientists are looking for distributed generators (DGs) to provide additional power during peak periods of the energy curve. Solar energy gives them an extra twist to meet the load demand during this time. This paper describes the PV generator power system, inverter, inverter controller, transformer and mounting system offered.**

**Keywords: DG, MPPT, DSP, PV.**

## I. Introduction

The use of renewable energy sources such as solar and wind energy can be extended to include residential and transportation applications due to environmental benefits. For high voltage applications, the type of solar cell must be considered, which is divided into three main groups: mono crystalline (mono crystalline construction), polycrystalline (partially crystalline) and amorphous silicon thin film [1]. Solar power systems can be divided into two types: off-grid and off-grid. In the case of off-grid solar energy systems, the main power is supplied only by photovoltaic modules and batteries. These systems are suitable for remote areas normally isolated from the local network. In order to maximize the power absorbed by the photovoltaic modules, the MPPT (Maximum Power Point Tracking) charge controller is used by converting the variable DC voltage to the maximum voltage of the power point. The important device in off-grid solar systems is the grid inverter, which converts direct current from photovoltaic modules and batteries into alternating current to power the building directly. Inverters are divided into two types: mains inverters and normal inverters. The first converts solar electricity directly into the main electricity. While the latter convert's direct current from photovoltaic modules and batteries into a local network. The latter is also used to recharge batteries [2]. In the case of solar energy systems connected to the grid, the building is powered both by the local grid and by a photovoltaic system in order to meet the electrical needs of the consumer and reduce electricity costs [3]. The photovoltaic modules are connected to a grid inverter which directly converts direct current into alternating current (220 V, 50 Hz). For solar systems connected to the grid with storage system, MPPT charge controller, i. H. A DC-DC converter, used to charge the battery bank, which is connected to a separate inverter. The construction of these systems can be powered in the event of a power failure. The disadvantages of these systems are the large losses in the electronic power converters and the high maintenance costs[4].

## II. Literature review

M. Madsen, A. Knott et al [5] In this article, the design of a resonance converter with a switching frequency in the very high frequency range (30-300 MHz), a large reduction ratio (ten times) and low output power (1W) is presented. Different inverters and rectifiers are analyzed and compared. Class E inverters and rectifiers are selected based on complexity and efficiency estimates. Three different levels of performance are implemented; one with a large input choke, one with a low capacitance switch and one with a low resistance switch. Power levels are designed with the same specifications and efficiencies of 60.7-82.9% are obtained.

A.J. Mahdi et al. [6] This article presents an improved MPPT (Maximum Power Point Tracking) algorithm of a photovoltaic system in real climatic conditions. The proposed MPPT is based on the P&O strategy (perturbation and observation) and on the variable pitch method with which the load voltage is controlled in order to guarantee optimal operating points of a photovoltaic system. The proposed MPPT algorithm was implemented by a dSPACE DSP controller. Experimental results show that the photovoltaic energy system, using the proposed MPPT algorithm, is able to closely follow the maximum power points (with minimal

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stationary power oscillations) with rapid fluctuations in irradiation.

M. S. Benghanem et al. [7] The production of electricity from fossil fuels for general use is associated with problems such as greenhouse gas emissions, environmental threats and energy crises. Simulations were performed to vary the irradiation from 400 Wm-2 to 1000 Wm-2. We process the simulation data in Matlab and the result is that the radiation that falls on the module directly affects the current supplied by the module, which in turn affects its filling and efficiency factor. There is also a relationship between the series resistance of the photovoltaic module and the maximum output power, and we obtain a mathematical expression that combines the series resistance and the intensity of the incident radiation.

M. Ghazali et al. [8] The main objective of this study was to measure and determine the efficiency of polycrystalline, monocrystalline and amorphous silicon solar modules using a uniaxial date / time solar tracker for the installation of photovoltaic modules (dynamic system) as a strategy to increase module performance in the hot-humid climate in Malaysia. Solar movement studies were conducted in equatorial countries to determine the position of the sun in place (azimuth and elevation angle) using the stereographic diagram and daily tabular solar data. Polycrystalline solar modules have been found to have a better performance ratio and better average module efficiency than other photovoltaic modules tested in the Malaysian climate.

## III. DIAGRAM OF THE PROPOSED PV ARRAY POWER SYSTEM

The scheme of the photovoltaic solar system proposed with a photovoltaic generator that feeds a grid through a boost. Two control signals (i.e. PWM1 to regulate the mains current at the maximum power points and PWM2 to control the AC output voltage) are essential for producing reliable output power at true fluctuating irradiation levels. An LC filter is connected between an inverter and the local network in order to obtain sinusoidal alternating voltage.

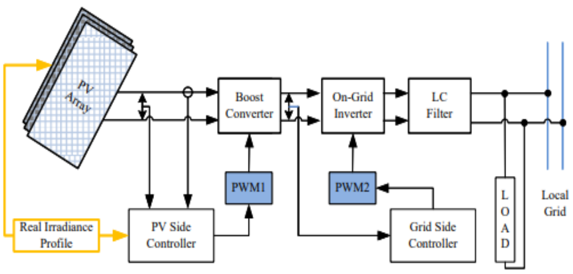


Figure 1 Block diagram of the PV array power system

## IV. INVERTER

An inverter is a critical interface component that uses the power function and converts direct current (DC) from the PV generator to alternating current (AC) so that the system output is compatible with a local network in terms of values voltage and frequency (mainly 50 Hz and 60 Hz in the USA). In addition, the inverters act as control and optimization devices, e.g. It can disconnect power from the network if the network itself fails. Inverters, like any other component of a photovoltaic system, must be selected based on the conditions of the system and site. The following types of inverters are most commonly used in various photovoltaic systems [3].

1. String inverters: multiple strings are connected to one inverter. A string inverter is considered to be very reliable, very sensitive to shading problems, relatively inexpensive and compatible with performance optimizers.

2. Central inverter: several strings are connected in a combined box that supplies direct current to the central inverter. Central inverters can support multiple module sequences and require fewer component connections. They are more suitable for large installations with constant production across the bay.

3. Micro-inverter: an inverter is connected to each module individually, eg. H. Module-level electronics that provide DC / AC conversion on the panel and monitor its performance. If one of the panels is shaded, the performance of the other panels is not affected. Micro inverters are more efficient but still more expensive and suitable for installations with large shading problems or systems with different viewing directions. A micro inverter can be integrated into a module (AC module), which allows for a cheaper and simpler installation.

4. Battery inverter: bidirectional, consisting of a charger and an inverter. These inverters manage the energy between the generator and the grid while the batteries remain charged, monitor the state of charge of the battery and provide energy for the continuous operation of critical loads regardless of the grid.

## V. INVERTER CONTROL

The control structure that has been implemented for the single-phase inverter is shown in Fig. 2. The photovoltaic system consists in photovoltaic generator (PVG), a maximum power point tracking (MPPT) and the inverter.

The control structure proposed for the single-phase inverter corresponds to 2 control loops as shown in Fig. 3

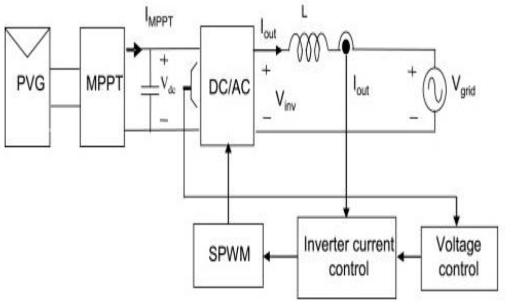


Fig.2. Control structure diagram

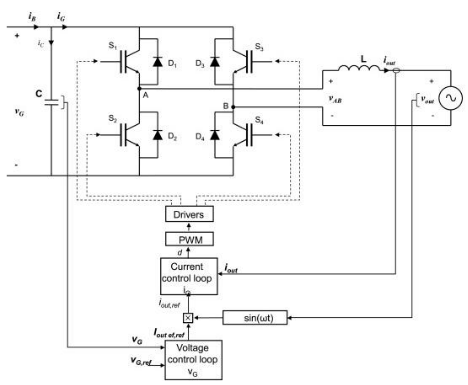


Fig.3. Control of the inverter connected to the grid.

- An external DC voltage control circuit is required to keep the intermediate circuit voltage constant and to ensure proper operation of the MPPT.
- An internal current control circuit is used to control the power injected into the grid. This allows you to control the output current in instantaneous values. To apply a sinusoidal current in phase with the mains voltage, the reference current is generated by a sinusoidal reference, the amplitude is controlled by the output of the external voltage loop.

One of the advantages of this control strategy is its simplicity in terms of the control circuit calculation requirements.

## VI. TRANSFORMER

A transformer or a substation is a critical component in power distribution in a grid-connected system as it adjusts the voltage of alternating current from the inverter to the grid voltage. Transformers can either step the voltage up to the grid or step down the utility voltage to individual loads. Working principle of a transformer is based on electromagnetic induction. An electrical current runs through primary windings (input) and produces magnetic field with certain magnetic flux. The magnetic flux goes through the transformer core till secondary windings (output) and electromagnetic force (EMF) which in turn produces voltage. The number of turns in the output relative to the input defines if the voltages gets stepped up or down. By the configuration substations might be pad-mounted with underground electrical connections, installed indoors or enclosed in fence with overhead wiring. Transformers are either dry-type, which are cooled by air ventilation or filled with dielectric liquid, mineral or vegetable oil that insulates the components and transfers extra (waste) heat generated in the core and windings. Pad-mounted liquid substations are typically used in ground grid-tied systems.

## VII. MOUNTING SYSTEM

The type of mounting system for a photovoltaic system depends on the location and is available for installation. In order to maximize the use of the project area based on site conditions, various mounting system configurations can be installed such as floor mounting, pole mounting, and roof mounting with and without roof penetration. Since the case study is a terrain-based system, its pros and cons are interesting and should be discussed. Floor mounting prevents overheating of photovoltaic modules by natural air convection. Floor systems are installed safely and easily accessible for maintenance. The floor-mounting structure can be optimized for any angle of inclination. However, the system does have its drawbacks, including space requirements and shading problems between lines [3]. In addition, floor mounting can be improved by the location system, which ensures that the modules are always facing the sun and receive the maximum amount of radiation. One- and two-axis tracking is the most commonly used. As can be seen, uniaxial trackers allow panels to follow the sun from east to west, while biaxial trackers can follow the east-west movement of the sun with its angular height.

Floating photovoltaic systems or floating photovoltaic panels, which can also be considered a ground support, are increasingly popular around the world. Float Voltaic are generally installed in a limited project area, but they can be extremely useful for the water body by reducing evaporation and algae growth.

All the components of a photovoltaic system with the exception of the modules can be called Balance of System (BOS). BOS includes inverters, wiring, MPPT, mounting system, fuses, batteries and loads, switches and more. In other words, the balancing components of the system transfer the energy generated by the modules (DC) through the conversion system to the grid (AC load). The optimization and modernization of a photovoltaic system is carried out through the BOS, which represents most of the costs and maintenance.

## VIII. CONCLUSION

Photovoltaic power generation as an important form of new energy has a good development experience. However, a large number of PV arrays will impact the safe and reliable operation of the traditional distribution network. Considering the energy quality, reliability and safety of the photovoltaic power generation system, the best possible use of solar resources for generation is important. This paper also describes the proposed inverter, transformer, mounting system and power system of the PV generator.

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